CHAPTER

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STRUCTURES - GENERAL

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51-00-06 GENERAL	
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51-10-01 GENERAL	
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46	BLANK
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A = Added, R = Revised, O = Overflow, D = Deleted

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11	Nov 01/2003	50	Nov 01/2003	20	BLANK
12	Nov 01/2003	51	Nov 01/2003	51-20-10 GENERAL	
13	Nov 01/2003	52	Nov 01/2003	1	Nov 01/2003
14	Nov 01/2003	53	Nov 01/2003	2	Nov 01/2003
15	Nov 01/2003	54	Nov 01/2003	3	Jul 10/2004
16	Nov 01/2003	55	Nov 01/2003	4	Jul 10/2004
17	Nov 01/2003	56	Nov 01/2003	5	Nov 01/2003
18	Nov 01/2003	57	Nov 01/2003	6	Nov 01/2003
19	Nov 01/2003	58	Nov 01/2003	7	Nov 01/2003
20	Nov 01/2003	59	Nov 01/2003	8	Nov 01/2003
21	Nov 01/2003	60	Nov 01/2003	9	Nov 01/2003
22	Nov 01/2003	61	Nov 01/2003	10	Nov 01/2003
23	Nov 01/2003	62	Nov 10/2004	11	Nov 01/2003
24	Nov 01/2003	63	Nov 01/2003	12	BLANK
25	Nov 01/2003	64	Nov 01/2003	51-20-13 GENERAL	
26	Nov 01/2003	65	Nov 01/2003	1	Nov 10/2004
27	Nov 01/2003	66	Nov 01/2003	2	Nov 10/2004
28	Nov 01/2003	67	Nov 01/2003	3	Nov 10/2004
29	Nov 01/2003	68	BLANK	4	Nov 10/2004
30	Nov 01/2003	51-20-08 GENERAL		51-30-01 GENERAL	
31	Nov 01/2003	1	Nov 01/2003	1	Mar 10/2009
32	Nov 01/2003	2	Jul 10/2005	2	Mar 10/2009
33	Nov 01/2003	3	Nov 01/2003	3	Nov 01/2003
34	Nov 01/2003	4	Nov 10/2006	4	Nov 10/2005
35	Nov 01/2003	5	Nov 10/2006	5	Nov 01/2003
36	Nov 01/2003	6	Nov 10/2006	6	Nov 01/2003
37	Nov 01/2003	7	Nov 01/2003	7	Nov 01/2003
38	Nov 01/2003	8	Nov 01/2003	8	Nov 01/2003
39	Nov 01/2003	9	Nov 01/2003	9	Nov 01/2003
40	Nov 01/2003	10	Nov 01/2003	10	Nov 10/2004
41	Nov 01/2003	11	Nov 01/2003	11	Nov 10/2004
42	Nov 01/2003	12	Nov 01/2003	12	Nov 10/2004
43	Nov 01/2003	13	Nov 01/2003	13	Nov 10/2004
44	Nov 01/2003	14	Nov 01/2003	14	Mar 10/2004
45	Nov 01/2003	15	Nov 10/2004	15	Mar 10/2004
46	Nov 01/2003	16	Nov 01/2003	16	Nov 01/2003
47	Nov 01/2003	17	Nov 01/2003	17	Nov 01/2003
48	Nov 01/2003	18	Nov 01/2003	18	Nov 01/2003
49	Nov 01/2003	19	Nov 01/2003	19	Nov 01/2003

A = Added, R = Revised, O = Overflow, D = Deleted

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Subject/Page	Date	Subject/Page	Date	Subject/Page	Date
51-30-01 GENERAL (cont)		51-30-04 GENERAL (cont)		51-40-02 GENERAL (cont)	
20	Nov 01/2003	2	Nov 01/2003	6	Mar 10/2006
21	Nov 01/2003	51-30-05 GENERAL		7	Mar 10/2006
22	Nov 10/2004	1	Nov 01/2003	8	Mar 10/2006
23	Nov 10/2004	2	Nov 01/2003	9	Mar 10/2006
24	Nov 01/2003	3	Nov 01/2003	10	Mar 10/2006
25	Nov 01/2003	4	Nov 01/2003	11	Mar 10/2006
26	Nov 01/2003	5	Nov 01/2003	12	Nov 10/2005
27	Nov 01/2003	6	Nov 01/2003	13	Nov 01/2003
28	Nov 01/2003	7	Nov 01/2003	14	Nov 01/2003
29	Nov 01/2003	8	Nov 01/2003	15	Nov 01/2003
30	Nov 01/2003	9	Nov 01/2003	16	Nov 01/2003
51-30-02 GENERAL		10	Nov 01/2003	17	Nov 01/2003
1	Nov 10/2004	11	Nov 01/2003	18	Nov 01/2003
2	Nov 10/2004	12	Nov 01/2003	19	Nov 01/2003
51-30-03 GENERAL		13	Nov 01/2003	20	Nov 01/2003
1	Nov 10/2004	14	Nov 01/2003	21	Nov 01/2003
2	Nov 10/2004	15	Nov 01/2003	22	Nov 01/2003
3	Nov 10/2004	16	Nov 01/2003	23	Nov 01/2003
4	Nov 10/2004	51-30-06 GENERAL		24	Nov 01/2003
5	Nov 10/2004	1	Nov 01/2003	25	Nov 01/2003
6	Nov 10/2004	2	Nov 10/2004	26	Nov 01/2003
7	Nov 10/2004	3	Nov 10/2004	27	Nov 01/2003
8	Nov 10/2004	4	Nov 01/2003	28	Nov 01/2003
9	Nov 10/2004	51-40-00 GENERAL		29	Nov 01/2003
10	Nov 10/2004	1	Nov 01/2003	30	Nov 01/2003
11	Nov 10/2004	2	BLANK	31	Nov 01/2003
12	Nov 10/2004	51-40-01 GENERAL		32	Nov 01/2003
13	Nov 10/2004	1	Nov 01/2003	33	Nov 01/2003
14	Nov 10/2004	2	Nov 01/2003	34	Nov 01/2003
15	Nov 10/2004	3	Jul 10/2008	35	Nov 01/2003
16	Nov 10/2004	4	Nov 01/2003	36	Nov 01/2003
17	Nov 10/2004	5	Nov 01/2003	37	Nov 01/2003
18	Nov 10/2004	6	Nov 01/2003	38	Nov 01/2003
19	Nov 10/2004	51-40-02 GENERAL		39	Nov 01/2003
20	Nov 10/2004	1	Mar 10/2006	40	Nov 01/2003
21	Nov 10/2004	2	Mar 10/2006	41	Nov 01/2003
22	BLANK	3	Mar 10/2006	42	Nov 01/2003
51-30-04 GENERAL		4	Mar 10/2006	43	Nov 01/2003
1	Nov 01/2003	5	Mar 10/2006	44	Nov 01/2003

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45	Nov 01/2003	1	Nov 01/2003	40	Mar 10/2004
46	Nov 01/2003	2	Mar 10/2005	41	Jul 10/2004
47	Nov 01/2003	3	Mar 10/2004	42	Jul 10/2004
48	Nov 01/2003	4	Nov 01/2003	43	Nov 01/2003
49	Nov 01/2003	5	Mar 10/2004	44	Jul 10/2004
50	Nov 01/2003	6	Nov 01/2003	45	Jul 10/2004
51	Nov 01/2003	7	Nov 10/2006	46	Jul 10/2004
52	Nov 01/2003	8	Jul 10/2004	47	Jul 10/2004
53	Nov 01/2003	9	Mar 10/2004	48	Mar 10/2004
54	Nov 01/2003	10	Jul 10/2004	49	Jul 10/2004
55	Nov 01/2003	11	Nov 01/2003	50	Jul 10/2004
56	Nov 01/2003	12	Jul 10/2004	51	Jul 10/2004
57	Nov 01/2003	13	Nov 01/2003	52	Jul 10/2004
58	Nov 01/2003	14	Nov 01/2003	53	Jul 10/2004
59	Nov 01/2003	15	Jul 10/2004	54	Jul 10/2004
60	Nov 01/2003	16	Nov 01/2003	55	Jul 10/2004
61	Nov 01/2003	17	Nov 01/2003	56	Jul 10/2004
62	Nov 01/2003	18	Jul 10/2004	57	Jul 10/2004
63	Nov 01/2003	19	Nov 10/2005	58	Jul 10/2004
64	Nov 01/2003	20	Nov 01/2003	59	Jul 10/2004
65	Nov 01/2003	21	Nov 01/2003	60	Mar 10/2004
66	Nov 01/2003	22	Nov 01/2003	61	Jul 10/2004
67	Nov 01/2003	23	Nov 01/2003	62	Jul 10/2004
68	Nov 01/2003	24	Jul 10/2004	63	Jul 10/2004
69	Nov 01/2003	25	Jul 10/2004	64	Jul 10/2004
70	Nov 01/2003	26	Jul 10/2004	65	Jul 10/2004
71	Nov 01/2003	27	Nov 01/2003	66	Jul 10/2004
72	Nov 01/2003	28	Jul 10/2004	67	Mar 10/2004
73	Nov 01/2003	29	Mar 10/2004	68	Jul 10/2004
74	Nov 01/2003	30	Jul 10/2004	69	Jul 10/2004
75	Nov 01/2003	31	Nov 01/2003	70	Mar 10/2004
76	Nov 01/2003	32	Nov 01/2003	71	Mar 10/2004
77	Nov 01/2003	33	Jul 10/2004	72	Mar 10/2004
78	Nov 01/2003	34	Jul 10/2004	73	Jul 10/2004
79	Nov 01/2003	35	Jul 10/2004	74	Jul 10/2004
80	Nov 01/2003	36	Nov 01/2003	75	Mar 10/2004
81	Nov 01/2003	37	Jul 10/2004	76	Jul 10/2004
82	Nov 01/2003	38	Nov 01/2003	77	Jul 10/2004
		39	Jul 10/2004	78	Jul 10/2004

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79	Jul 10/2004	11	Nov 01/2003	33	Nov 01/2003
80	Jul 10/2004	12	Nov 01/2003	34	Nov 01/2003
81	Jul 10/2004	13	Nov 01/2003	35	Nov 01/2003
82	Jul 10/2004	14	Nov 01/2003	36	Nov 01/2003
83	Jul 10/2004	15	Nov 01/2003	37	Nov 01/2003
84	Jul 10/2004	16	Nov 01/2003	38	Nov 01/2003
85	Jul 10/2004	51-40-05 GENERAL		39	Nov 01/2003
86	Nov 10/2005	1	Nov 01/2003	40	BLANK
87	Nov 01/2003	2	Nov 01/2003	51-40-06 GENERAL	
88	Jul 10/2004	3	Nov 01/2003	1	Nov 01/2003
89	Jul 10/2004	4	Nov 01/2003	2	Jul 10/2004
90	Jul 10/2004	5	Nov 01/2003	3	Nov 01/2003
91	Jul 10/2004	6	Nov 01/2003	4	Mar 10/2005
92	Jul 10/2004	7	Nov 01/2003	5	Nov 01/2003
93	Jul 10/2004	8	Nov 01/2003	6	Nov 01/2003
94	Jul 10/2004	9	Nov 01/2003	7	Nov 01/2003
95	Jul 10/2004	10	Nov 01/2003	8	Nov 01/2003
96	Jul 10/2004	11	Nov 01/2003	9	Nov 01/2003
97	Jul 10/2004	12	Nov 01/2003	10	Nov 01/2003
98	Jul 10/2004	13	Nov 01/2003	51-40-07 GENERAL	
98.1	Jul 10/2004	14	Nov 01/2003	1	Nov 01/2003
98.2	Jul 10/2004	15	Nov 01/2003	2	Nov 01/2003
98.3	Jul 10/2004	16	Nov 01/2003	3	Nov 01/2003
98.4	Jul 10/2004	17	Nov 01/2003	4	Nov 01/2003
98.5	Jul 10/2004	18	Nov 01/2003	5	Nov 01/2003
98.6	Jul 10/2004	19	Nov 01/2003	6	Nov 01/2003
98.7	Jul 10/2004	20	Nov 01/2003	7	Nov 01/2003
98.8	Jul 10/2004	21	Nov 01/2003	8	Nov 01/2003
51-40-04 GENERAL		22	Nov 01/2003	9	Nov 01/2003
1	Nov 01/2003	23	Nov 01/2003	10	Nov 01/2003
2	Nov 01/2003	24	Nov 01/2003	11	Nov 01/2003
3	Nov 01/2003	25	Nov 01/2003	12	Nov 01/2003
4	Nov 01/2003	26	Nov 01/2003	13	Nov 01/2003
5	Nov 01/2003	27	Nov 01/2003	14	Nov 01/2003
6	Nov 01/2003	28	Nov 01/2003	15	Nov 01/2003
7	Nov 01/2003	29	Nov 01/2003	16	Nov 01/2003
8	Nov 01/2003	30	Nov 01/2003	17	Nov 01/2003
9	Nov 01/2003	31	Nov 01/2003	18	Nov 01/2003
10	Nov 01/2003	32	Nov 01/2003	19	Nov 01/2003

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24	Nov 01/2003
25	Nov 01/2003
26	Nov 01/2003
27	Nov 01/2003
28	Nov 01/2003
29	Nov 01/2003
30	Nov 01/2003
31	Nov 01/2003
32	Nov 01/2003
33	Nov 01/2003
34	Nov 01/2003
35	Nov 01/2003
36	Nov 01/2003
37	Nov 01/2003
38	Nov 01/2003
39	Nov 01/2003
40	Nov 01/2003
41	Nov 01/2003
42	Nov 01/2003
43	Nov 01/2003
44	Nov 01/2003
45	Nov 01/2003
46	Nov 01/2003
47	Nov 01/2003
48	Nov 01/2003
49	Nov 01/2003
50	Nov 01/2003
51	Nov 01/2003
52	Nov 01/2003
53	Nov 01/2003
54	Nov 01/2003
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51-40-07 GENERAL (cont)	
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62	Nov 01/2003
63	Nov 01/2003
64	Nov 01/2003
65	Nov 01/2003
66	Nov 01/2003
67	Nov 01/2003
68	Nov 01/2003
69	Nov 01/2003
70	Nov 01/2003
71	Nov 01/2003
72	Nov 01/2003
73	Nov 01/2003
74	Nov 01/2003
75	Nov 01/2003
76	Nov 01/2003
77	Nov 01/2003
78	Nov 01/2003
79	Nov 01/2003
80	Nov 01/2003
81	Nov 01/2003
82	Nov 01/2003
83	Nov 01/2003
84	Nov 01/2003
85	Nov 01/2003
86	Nov 01/2003
87	Nov 01/2003
88	Nov 01/2003
89	Nov 01/2003
90	Mar 10/2004
91	Mar 10/2004
92	Mar 10/2004
51-40-08 GENERAL	
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51-40-08 GENERAL (cont)	
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6	Nov 01/2003
7	Nov 01/2003
8	Nov 01/2003
9	Nov 01/2003
10	Nov 01/2003
11	Nov 01/2003
12	Nov 01/2003
13	Nov 01/2003
14	Nov 01/2003
15	Nov 01/2003
16	Nov 01/2003
17	Nov 01/2003
18	Nov 01/2003
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21	Nov 01/2003
22	Nov 01/2003
23	Nov 01/2003
24	Nov 01/2003
51-40-09 REPAIR GENERAL	
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202	Mar 10/2005
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205	Jul 10/2004
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207	Jul 10/2004
208	Jul 10/2004
209	Jul 10/2004
210	Jul 10/2004
211	Jul 10/2004
212	Jul 10/2004
213	Nov 01/2003
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215	Nov 01/2003
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217	Nov 01/2003
218	Nov 01/2003

A = Added, R = Revised, O = Overflow, D = Deleted

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219	Mar 10/2005	21	Nov 10/2006	35	Nov 01/2003
220	Mar 10/2005	22	Nov 01/2003	36	Nov 01/2003
221	Nov 01/2003	23	Nov 01/2003	37	Nov 01/2003
222	Nov 01/2003	24	BLANK	38	Nov 01/2003
223	Nov 01/2003	51-50-02 GENERAL		39	Nov 01/2003
224	Nov 01/2003	1	Nov 01/2003	40	Nov 01/2003
225	Nov 01/2003	2	Nov 10/2006	41	Nov 01/2003
226	Mar 10/2005	3	Nov 01/2003	42	Nov 01/2003
227	Mar 10/2005	4	Nov 01/2003	43	Nov 01/2003
228	Mar 10/2005	5	Nov 10/2006	44	Nov 01/2003
229	Nov 01/2003	6	Nov 01/2003	45	Nov 01/2003
230	Nov 01/2003	7	Nov 01/2003	46	Nov 01/2003
231	Nov 01/2003	8	Nov 01/2003	47	Nov 01/2003
232	Nov 01/2003	9	Nov 01/2003	48	Nov 01/2003
233	Nov 01/2003	10	Nov 01/2003	49	Nov 01/2003
234	Nov 01/2003	11	Nov 01/2003	50	Nov 01/2003
235	Nov 01/2003	12	Nov 01/2003	51	Nov 01/2003
236	BLANK	13	Nov 01/2003	52	Nov 01/2003
51-50-01 GENERAL		14	Nov 01/2003	53	Nov 01/2003
1	Nov 01/2003	15	Nov 01/2003	54	Nov 01/2003
2	Nov 10/2006	16	Nov 01/2003	55	Nov 01/2003
3	Nov 10/2006	17	Nov 01/2003	56	Nov 01/2003
4	Mar 10/2006	18	Nov 01/2003	57	Nov 01/2003
5	Mar 10/2006	19	Nov 01/2003	58	BLANK
6	Mar 10/2006	20	Nov 01/2003	51-60-00 GENERAL	
7	Nov 01/2003	21	Nov 01/2003	1	Nov 01/2003
8	Nov 01/2003	22	Nov 01/2003	2	Nov 01/2003
9	Nov 01/2003	23	Nov 01/2003	3	Nov 01/2003
10	Nov 01/2003	24	Nov 01/2003	4	Nov 01/2003
11	Nov 01/2003	25	Nov 01/2003	5	Nov 01/2003
12	Nov 01/2003	26	Nov 01/2003	6	Nov 01/2003
13	Nov 01/2003	27	Nov 01/2003	7	Nov 01/2003
14	Nov 01/2003	28	Nov 01/2003	8	Nov 01/2003
15	Nov 01/2003	29	Nov 01/2003	9	Mar 10/2007
16	Nov 01/2003	30	Nov 01/2003	10	Nov 01/2003
17	Nov 01/2003	31	Nov 01/2003	11	Nov 01/2003
18	Nov 01/2003	32	Nov 01/2003	12	Nov 01/2003
19	Nov 01/2003	33	Nov 01/2003	13	Mar 10/2007
20	Nov 01/2003	34	Nov 01/2003	14	Nov 01/2003

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51-60-01 GENERAL		51-60-02 GENERAL (cont)		51-60-04 GENERAL (cont)	
1	Nov 01/2003	3	Nov 01/2003	26	Nov 10/2004
2	Nov 10/2007	4	Nov 01/2003	27	Nov 10/2004
3	Nov 01/2003	5	Jul 10/2004	28	Nov 10/2004
4	Nov 01/2003	6	BLANK	29	Nov 10/2004
5	Nov 01/2003	51-60-03 GENERAL		30	Nov 10/2004
6	Nov 01/2003	1	Nov 01/2003	31	Nov 10/2004
7	Nov 10/2007	2	Nov 01/2003	32	Nov 10/2004
8	Nov 01/2003	3	Nov 01/2003	33	Nov 10/2004
9	Nov 01/2003	4	Nov 01/2003	34	Nov 10/2004
10	Nov 10/2007	5	Nov 10/2008	35	Nov 10/2004
11	Nov 01/2003	6	Nov 10/2007	36	Nov 10/2004
12	Nov 01/2003	7	Nov 01/2003	37	Nov 10/2004
13	Nov 10/2007	8	Nov 01/2003	38	Nov 10/2004
14	Nov 10/2007	51-60-04 GENERAL		39	Nov 10/2004
15	Nov 01/2003	1	Nov 01/2003	40	Nov 10/2004
16	Nov 01/2003	2	Nov 10/2007	41	Nov 10/2004
17	Nov 01/2003	3	Nov 01/2003	42	Nov 10/2004
18	Nov 01/2003	4	Nov 01/2003	43	Nov 10/2004
19	Nov 01/2003	5	Nov 01/2003	44	Nov 10/2004
20	Nov 01/2003	6	Nov 01/2003	45	Nov 10/2004
21	Nov 01/2003	7	Nov 01/2003	46	Nov 10/2004
22	Nov 01/2003	8	Nov 10/2008	47	Nov 10/2004
23	Nov 01/2003	9	Nov 01/2003	48	Nov 10/2004
24	Nov 01/2003	10	Nov 01/2003	49	Nov 10/2004
25	Nov 01/2003	11	Nov 10/2004	50	Nov 10/2004
26	Nov 01/2003	12	Nov 10/2004	51-60-05 GENERAL	
27	Nov 01/2003	13	Nov 10/2007	1	Mar 10/2007
28	Nov 01/2003	14	Nov 10/2004	2	Mar 10/2007
29	Mar 10/2007	15	Nov 10/2004	3	Mar 10/2007
30	Nov 01/2003	16	Nov 10/2004	4	Nov 01/2003
31	Nov 10/2006	17	Nov 10/2007	5	Mar 10/2007
32	Nov 01/2003	18	Nov 10/2004	6	BLANK
33	Nov 01/2003	19	Nov 10/2004	51-60-06 GENERAL	
34	Nov 01/2003	20	Nov 10/2004	1	Nov 01/2003
35	Nov 01/2003	21	Nov 10/2004	2	Nov 01/2003
36	BLANK	22	Nov 10/2004	3	Nov 01/2003
51-60-02 GENERAL		23	Nov 10/2007	4	Nov 01/2003
1	Nov 01/2003	24	Nov 10/2007	5	Nov 01/2003
2	Nov 01/2003	25	Nov 10/2004	6	Nov 01/2003

A = Added, R = Revised, O = Overflow, D = Deleted

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A = Added, R = Revised, O = Overflow, D = Deleted

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202	Nov 10/2007	212	Jul 10/2004	203	Mar 10/2005
203	Jul 10/2005	213	Jul 10/2004	204	Mar 10/2005
204	Nov 10/2007	214	Nov 01/2003	51-70-04 REPAIR 3	
205	Nov 10/2007	215	Nov 01/2003	201	Mar 10/2005
206	Nov 10/2007	216	Nov 01/2003	202	Mar 10/2005
207	Nov 01/2003	217	Nov 01/2003	203	Mar 10/2005
208	BLANK	218	Jul 10/2004	204	BLANK
51-70-02 GENERAL		219	Nov 01/2003	51-70-04 REPAIR 4	
1	Mar 10/2006	220	Nov 01/2003	201	Nov 01/2003
2	Jul 10/2004	221	Nov 01/2003	202	Mar 10/2005
3	Nov 10/2006	222	Nov 10/2006	203	Mar 10/2005
4	Nov 01/2003	223	Nov 01/2003	204	BLANK
5	Nov 01/2003	224	Nov 01/2003	51-70-04 REPAIR 5	
6	Mar 10/2006	225	Nov 01/2003	201	Nov 01/2003
7	Mar 10/2006	226	Nov 01/2003	202	Nov 01/2003
8	Mar 10/2006	227	Nov 01/2003	203	Mar 10/2005
51-70-03 GENERAL		228	Nov 01/2003	204	Mar 10/2005
1	Nov 01/2003	229	Nov 01/2003	205	Mar 10/2005
2	Nov 01/2003	230	Nov 01/2003	206	Mar 10/2005
3	Nov 01/2003	231	Nov 01/2003	51-70-04 REPAIR 6	
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5	Nov 01/2003	233	Nov 01/2003	202	Mar 10/2005
6	Nov 01/2003	234	Nov 01/2003	203	Mar 10/2005
7	Nov 01/2003	235	Nov 01/2003	204	BLANK
8	Nov 01/2003	236	Nov 01/2003	51-70-04 REPAIR 7	
9	Nov 01/2003	237	Nov 01/2003	201	Nov 01/2003
10	Nov 01/2003	238	Nov 01/2003	202	Mar 10/2005
51-70-04 REPAIR GENERAL		239	Nov 01/2003	203	Mar 10/2005
201	Nov 01/2003	240	Nov 01/2003	204	BLANK
202	Nov 10/2004	241	Nov 01/2003	51-70-04 REPAIR 8	
203	Mar 10/2006	242	Nov 01/2003	201	Nov 01/2003
204	Nov 10/2004	51-70-04 REPAIR 1		202	BLANK
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207	Nov 01/2003	203	Mar 10/2005	202	Mar 10/2005
208	Nov 10/2008	204	BLANK	203	Mar 10/2005
209	Jul 10/2004	51-70-04 REPAIR 2		204	BLANK
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211	Jul 10/2004	202	Mar 10/2005	201	Mar 10/2005

A = Added, R = Revised, O = Overflow, D = Deleted

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STRUCTURES - GENERAL

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Subject/Page	Date	Subject/Page	Date	Subject/Page	Date
51-70-06 REPAIR 15 (cont)		51-70-10 REPAIR GENERAL (cont)		51-70-10 REPAIR GENERAL (cont)	
204	BLANK	216	Jul 10/2007	255	Jul 10/2007
51-70-08 GENERAL		217	Jul 10/2007	256	Jul 10/2007
1	Nov 10/2007	218	Jul 10/2007	257	Jul 10/2007
2	Nov 10/2004	219	Jul 10/2007	258	Jul 10/2007
51-70-09 GENERAL		220	Jul 10/2007	259	Jul 10/2007
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2	BLANK	222	Jul 10/2007	261	Jul 10/2007
51-70-09 REPAIR GENERAL		223	Jul 10/2007	262	Jul 10/2007
201	Nov 10/2008	224	Jul 10/2007	263	Jul 10/2007
202	Mar 10/2006	225	Jul 10/2007	264	Jul 10/2007
203	Nov 10/2006	226	Jul 10/2007	265	Jul 10/2007
204	Nov 10/2006	227	Jul 10/2007	266	Jul 10/2007
205	Nov 10/2006	228	Jul 10/2007	267	Jul 10/2007
206	Nov 10/2006	229	Jul 10/2007	268	Jul 10/2007
207	Nov 10/2006	230	Jul 10/2007	269	Jul 10/2007
208	Nov 10/2006	231	Jul 10/2007	270	Jul 10/2007
51-70-10 GENERAL		232	Jul 10/2007	271	Jul 10/2007
1	Jul 10/2007	233	Jul 10/2007	272	Jul 10/2007
2	Jul 10/2007	234	Jul 10/2007	273	Jul 10/2007
3	Jul 10/2007	235	Jul 10/2007	274	Jul 10/2007
4	Jul 10/2007	236	Jul 10/2007	275	Jul 10/2007
5	Jul 10/2007	237	Jul 10/2007	276	Jul 10/2007
6	BLANK	238	Nov 10/2007	277	Jul 10/2007
51-70-10 REPAIR GENERAL		239	Nov 10/2007	278	Jul 10/2007
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206	Jul 10/2007	245	Jul 10/2007	284	Jul 10/2007
207	Jul 10/2007	246	Jul 10/2007	285	Jul 10/2007
208	Jul 10/2007	247	Jul 10/2007	286	Jul 10/2007
209	Jul 10/2007	248	Jul 10/2007	287	Jul 10/2007
210	Jul 10/2007	249	Jul 10/2007	288	Jul 10/2007
211	Jul 10/2007	250	Jul 10/2007	289	Jul 10/2007
212	Jul 10/2007	251	Jul 10/2007	290	Jul 10/2007
213	Jul 10/2007	252	Jul 10/2007	291	Jul 10/2007
214	Jul 10/2007	253	Jul 10/2007	292	Jul 10/2007
215	Jul 10/2007	254	Jul 10/2007	293	Jul 10/2007

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STRUCTURES - GENERAL

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Subject/Page	Date
51-70-11 REPAIR GENERAL (cont)	
208	Nov 01/2003
209	Nov 01/2003
210	Nov 01/2003
211	Nov 01/2003
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213	Nov 01/2003
214	Nov 01/2003
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218	Nov 01/2003
219	Nov 01/2003
220	Nov 10/2004
51-70-12 REPAIR GENERAL	
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51-70-12 REPAIR 1	
201	Nov 10/2007
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204	Nov 10/2004
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207	Nov 10/2004
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210	Nov 10/2004
211	Nov 10/2004
212	Nov 10/2004
51-70-12 REPAIR 2	
201	Nov 10/2007
202	Nov 10/2004
203	Nov 10/2004
204	Nov 10/2004
205	Nov 10/2007
206	Nov 01/2003
207	Nov 01/2003
208	Nov 01/2003
209	Nov 01/2003
51-70-12 REPAIR 2 (cont)	
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212	Nov 01/2003
213	Nov 10/2004
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201	Mar 10/2005
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215	Nov 10/2004
216	Nov 10/2004
51-70-13 REPAIR 2	
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204	Nov 10/2004
205	Nov 10/2004
206	Nov 10/2004
51-70-13 REPAIR 3	
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51-70-13 REPAIR 4	
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11	Mar 10/2007
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13	Mar 10/2007
14	Mar 10/2007
51-70-14 ALLOWABLE DAMAGE GENERAL	
101	Nov 01/2003
102	Nov 01/2003
103	Nov 01/2003
104	Nov 10/2007
105	Nov 01/2003
106	Nov 01/2003
107	Nov 01/2003
108	Nov 01/2003
109	Nov 10/2007
110	Jul 10/2004
51-70-14 REPAIR GENERAL	
201	Nov 10/2006
202	Nov 01/2003
203	Nov 10/2008

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Subject/Page	Date	Subject/Page	Date	Subject/Page	Date
51-70-14 REPAIR GENERAL (cont)		51-70-14 REPAIR 2 (cont)		51-70-14 REPAIR 4 (cont)	
204	Nov 01/2003	209	Nov 01/2003	216	Nov 01/2003
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206	Nov 01/2003	211	Nov 01/2003	218	Nov 01/2003
51-70-14 REPAIR 1		212	Nov 01/2003	219	Nov 01/2003
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203	Nov 01/2003	51-70-14 REPAIR 3		222	Nov 01/2003
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209	Nov 01/2003	206	Nov 01/2003	203	Nov 01/2003
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211	Nov 10/2004	208	Nov 01/2003	205	Nov 01/2003
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213	Nov 01/2003	210	Nov 01/2003	207	Nov 01/2003
214	Nov 01/2003	211	Nov 01/2003	208	Nov 01/2003
215	Nov 10/2004	212	Nov 01/2003	209	Nov 01/2003
216	Nov 01/2003	213	Nov 01/2003	210	BLANK
217	Nov 01/2003	214	Jul 10/2008		
218	Nov 10/2004	215	Nov 01/2003		
219	Nov 01/2003	216	BLANK		
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222	Nov 01/2003	202	Nov 10/2007		
223	Nov 01/2003	203	Nov 01/2003		
224	Nov 10/2007	204	Nov 01/2003		
225	Nov 01/2003	205	Nov 01/2003		
226	Nov 01/2003	206	Nov 01/2003		
51-70-14 REPAIR 2		207	Nov 01/2003		
201	Nov 10/2007	208	Nov 01/2003		
202	Nov 10/2007	209	Nov 01/2003		
203	Nov 01/2003	210	Nov 10/2007		
204	Nov 10/2007	211	Nov 01/2003		
205	Nov 01/2003	212	Nov 01/2003		
206	Nov 10/2007	213	Nov 01/2003		
207	Nov 10/2007	214	Nov 01/2003		
208	Nov 01/2003	215	Nov 10/2007		

A = Added, R = Revised, O = Overflow, D = Deleted

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GENERAL - STRUCTURES

1. **Applicability**

   A. This chapter gives the general repair data that is applicable to the subsequent chapters in this manual.

2. **General**

   A. The data found in this chapter includes:

      (1) General repair practices to be used for the different areas of the airplane

      (2) Typical repair materials

      (3) Typical repair procedures

      (4) Aerodynamic smoothness requirements

      (5) Control surface balance data.

   B. This chapter also gives the necessary data and procedures to support the airplane in the jigged position for repair work and symmetry check data.

GENERAL - DEFINITIONS OF REFERENCE PLANES, REFERENCE LINES, AND GENERAL ABBREVIATIONS

1. General

A. This general section gives the definitions of reference planes, reference lines and general abbreviations as they are used in the chapters that follow in this Structural Repair Manual.

B. Refer to Table 1/GENERAL through Table 6/GENERAL for the lists of general abbreviations and references and their definitions.

Table 1:

GENERAL ABBREVIATIONS	
ABBREVIATION	**DEFINITION**
AL or al	Aluminum
APPROX or approx	Approximately
ASSY or assy	Assembly
AISI	American Iron and Steel Institute
BMS	Boeing Material Specification
BHD or bhd	Bulkhead
CAD	Cadmium
CG	Center of Gravity
CL	Centerline
CRES	Corrosion Resistant Steel
CSK or csk	Countersink
°C	Degrees Celsius (Centigrade)
D	Diameter of a fastener
DIA or dia	Diameter
°F	Degrees Fahrenheit
FS	Front Spar
FT or ft	Feet or foot
FTG of ftg	Fitting
FWD or fwd	Forward
HORIZ or horiz	Horizontal
HT TR or ht tr	Heat-Treat
INBD or inbd	Inboard
KSI or ksi	Kilopounds per square inch
LB or lb	Pound(s)
LE	Leading Edge
LE STA	Leading Edge Station
OUTBD or outbd	Outboard
PH	Precipitation Hardening
PSI or psi	Pounds per Square Inch
QTY or qty	Quantity

GENERAL ABBREVIATIONS	
ABBREVIATION	**DEFINITION**
R or r	Radius
REF or ref	Reference
RS	Rear Spar
STA	Station
SYM or sym	Symmetrical

C. Refer to Table 2/GENERAL for the list of general airplane reference abbreviations and their definitions for the fuselage.

Table 2:

GENERAL AIRPLANE REFERENCES - FUSELAGE	
ABBREVIATION	**DEFINITION**
BBL or BL	Body (Fuselage) Buttock Line
RBL or RBBL	Right Buttock Line
LBL or LBBL	Left Buttock Line
BSTA or BS	Body (Fuselage) Station
BRP	Body (Fuselage) Reference Plane
BWL or WL	Body (Fuselage) Waterline
DOOR STA	Door Station
DOOR BL	Door Buttock Line

D. Refer to Table 3/GENERAL for the list of general airplane reference abbreviations and their definitions for the wing.

Table 3:

GENERAL AIRPLANE REFERENCES - WING	
ABBREVIATION	**DEFINITION**
FSS	Front Spar Station
IFSS	Inboard Front Spar Station
ISS	Inboard Slat Station
LES	Leading Edge Station
OFSS	Outboard Front Spar Station
OSS	Outboard Slat Station
TE	Trailing Edge
WBL	Wing Buttock Line
WRP	Wing Reference Plane
W STA or WS	Wing Station

E. Refer to Table 4/GENERAL for the list of general airplane reference abbreviations and their definitions for the vertical stabilizer.

Table 4:

GENERAL AIRPLANE REFERENCES - VERTICAL STABILIZER	
ABBREVIATION	**DEFINITION**
FIN STA	Vertical Stabilizer (Fin) Station
RUD STA	Rudder Station
FSS	Front Spar Station

F. Refer to Table 5/GENERAL for the list of general airplane reference abbreviations and their definitions for the horizontal stabilizer.

Table 5:

GENERAL AIRPLANE REFERENCES - HORIZONTAL STABILIZER	
ABBREVIATION	**DEFINITION**
AUX SPAR STA	Auxiliary Spar Station
ELEV STA	Elevator Station
FS STA	Front Spar Station
HS BL	Horizontal Stabilizer Buttock Line
HSRP	Horizontal Stabilizer Reference Plane
RS STA	Rear Spar Station

G. Refer to Table 6/GENERAL for the list of general airplane reference abbreviations and their definitions for the engine nacelles.

Table 6:

GENERAL AIRPLANE REFERENCES - ENGINE NACELLES	
ABBREVIATION	**DEFINITION**
NAC BL	Nacelle Buttock Line
NAC STA	Nacelle Station
NAC WL	Nacelle Waterline

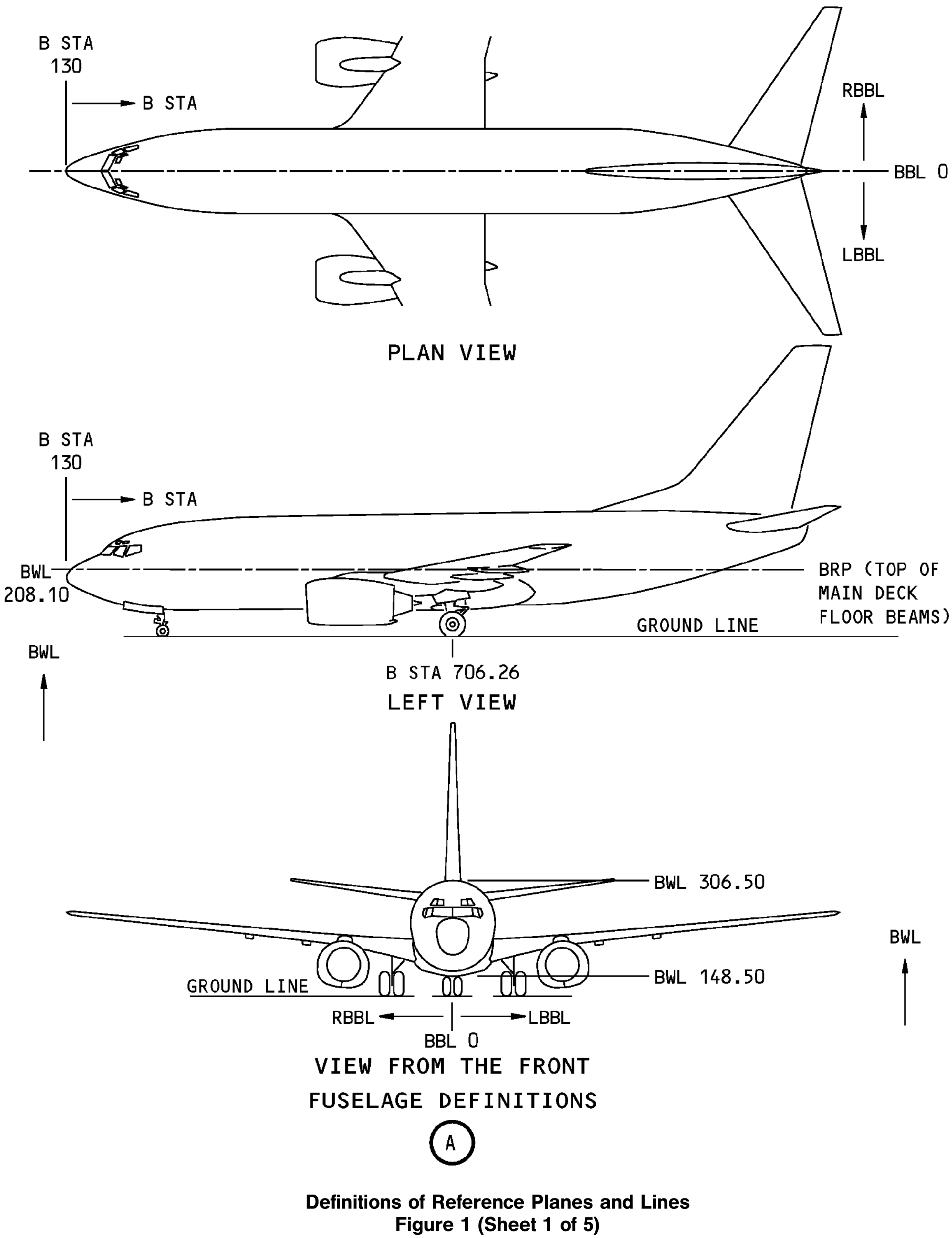
2. Definitions of Abbreviations That Are Applicable to the Fuselage (Refer to Figure 1, Detail A)

A. BRP: Body (Fuselage) Reference Plane - A horizontal plane found at the top surface of the main deck floor beams (BWL 208.10).

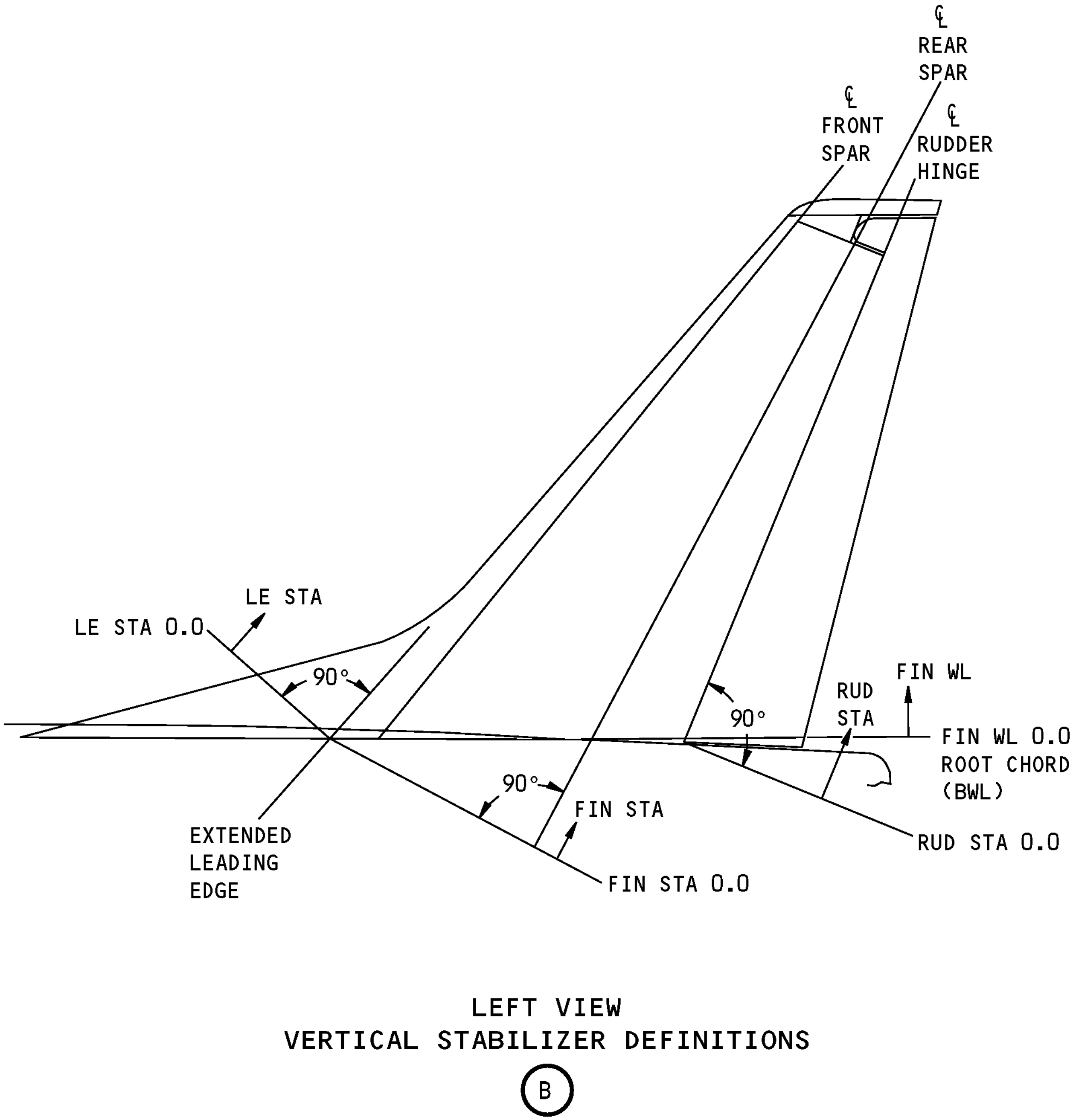
B. B STA: Body (Fuselage) Station - A vertical plane that is perpendicular to the fuselage centerline, measured by its distance from Body Station 0.00. Body Station 0.00 is found 130.0 inches forward of the nose.

C. BBL: Body (Fuselage) Buttock Line - A vertical plane that is parallel to the fuselage vertical centerline plane, measured by its distance from Body Buttock Line 0.00. Body Buttock Line 0.00 is the fuselage longitudinal centerline.

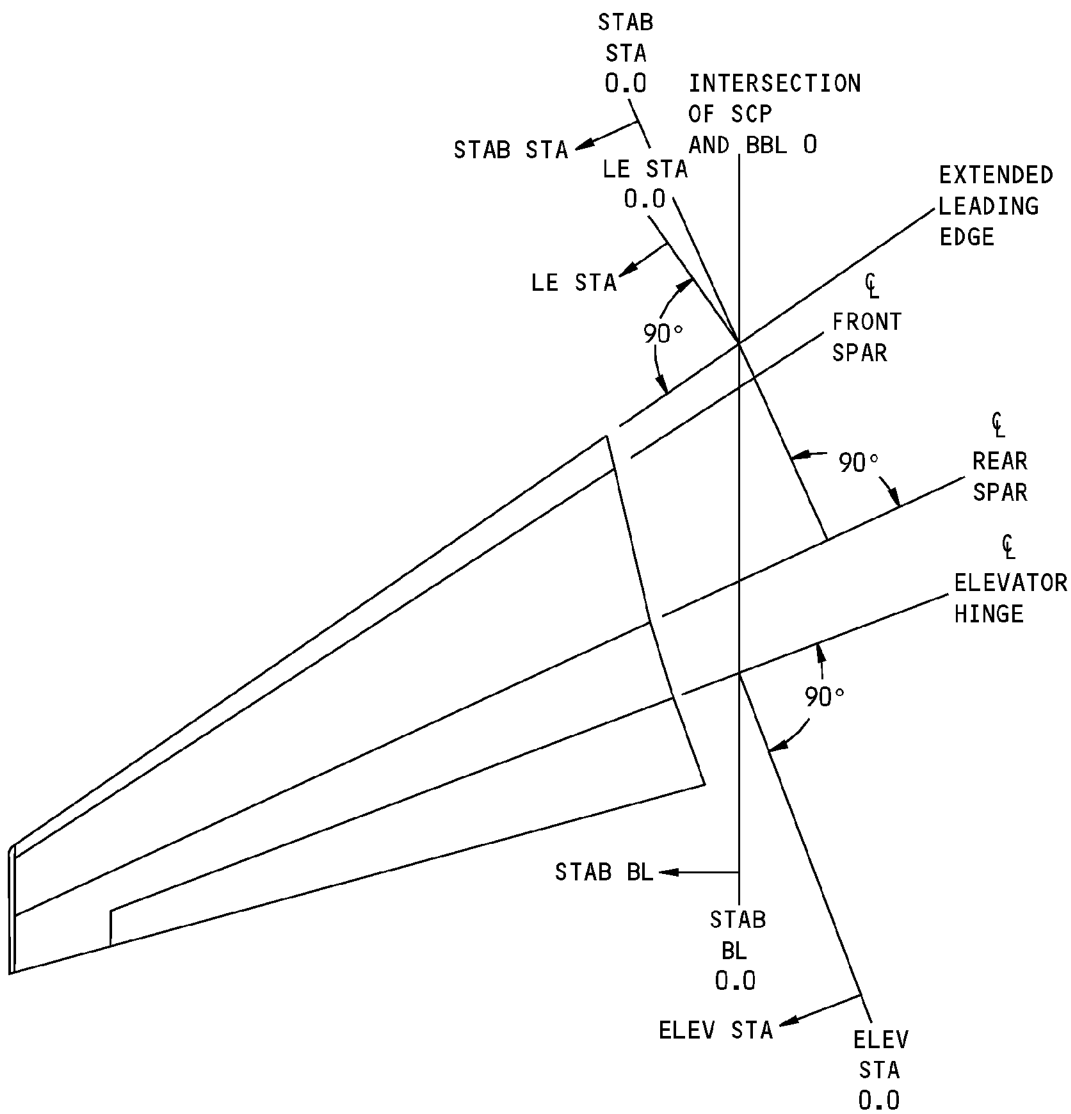
D. BWL: Body (Fuselage) Waterline - A horizontal plane found by its perpendicular distance from a parallel plane, measured by its distance from Body Waterline 0.00. Body Waterline 0.00 is an imaginary horizontal plane found 148.50 inches below the lowest fuselage suface.



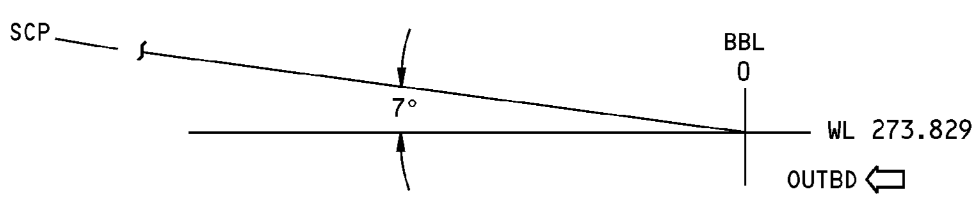
Definitions of Reference Planes and Lines
Figure 1 (Sheet 1 of 5)



Definitions of Reference Planes and Lines
Figure 1 (Sheet 2 of 5)



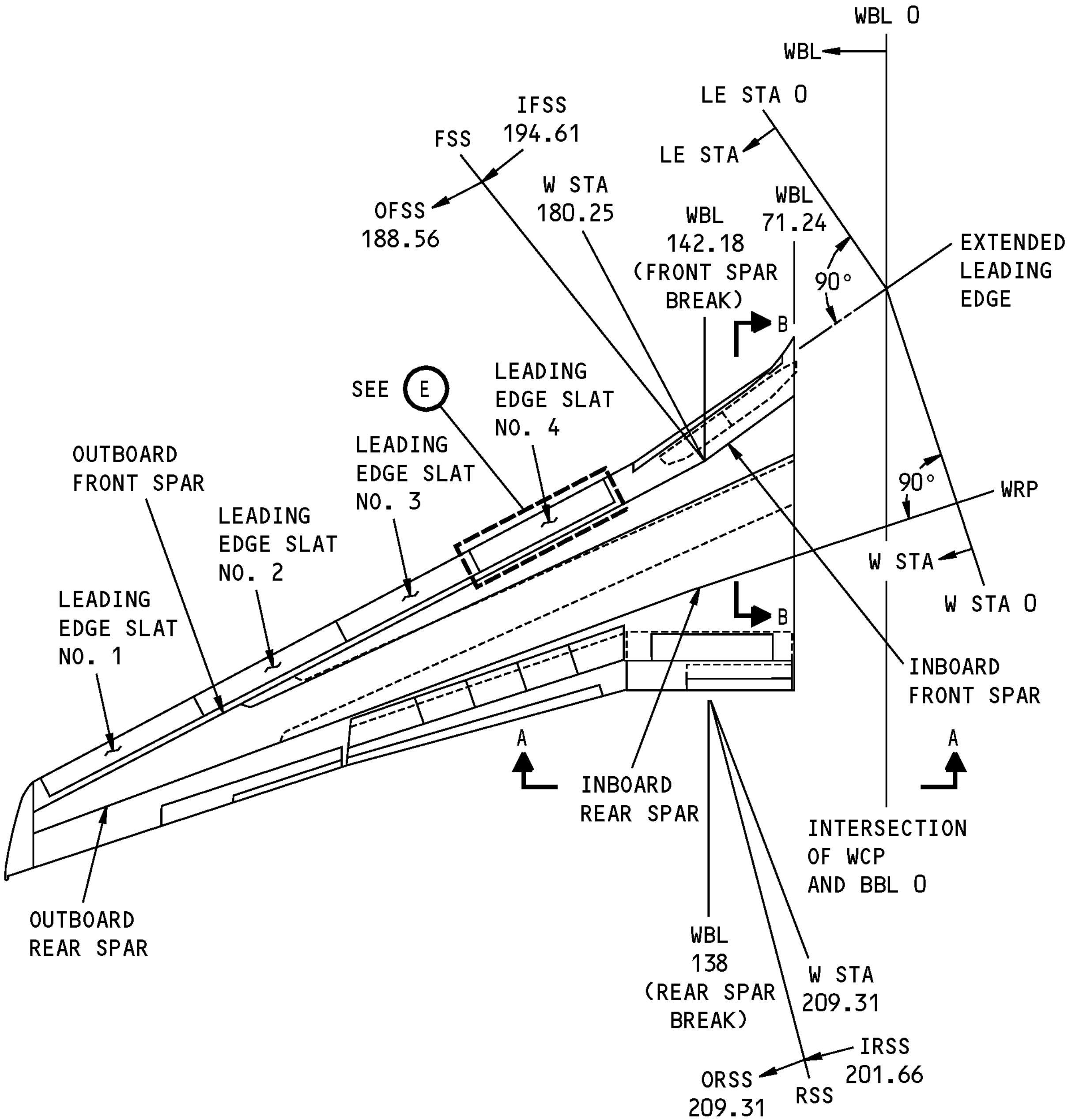
VIEW IS NORMAL TO STABILIZER CHORD PLANE
HORIZONTAL STABILIZER DEFINITIONS



VIEW FROM THE REAR

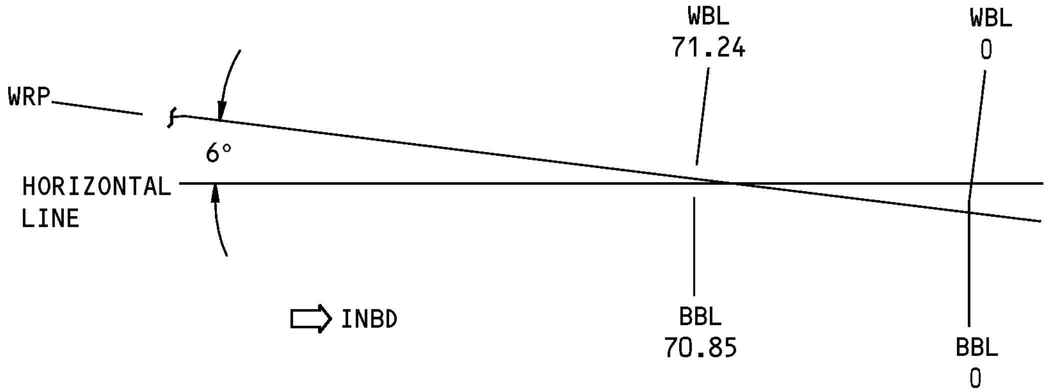
C

Definitions of Reference Planes and Lines
Figure 1 (Sheet 3 of 5)

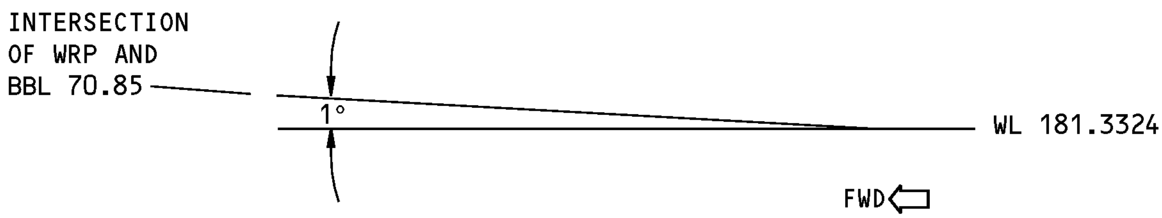


VIEW NORMAL TO WING CHORD PLANE
WING DEFINITIONS
D

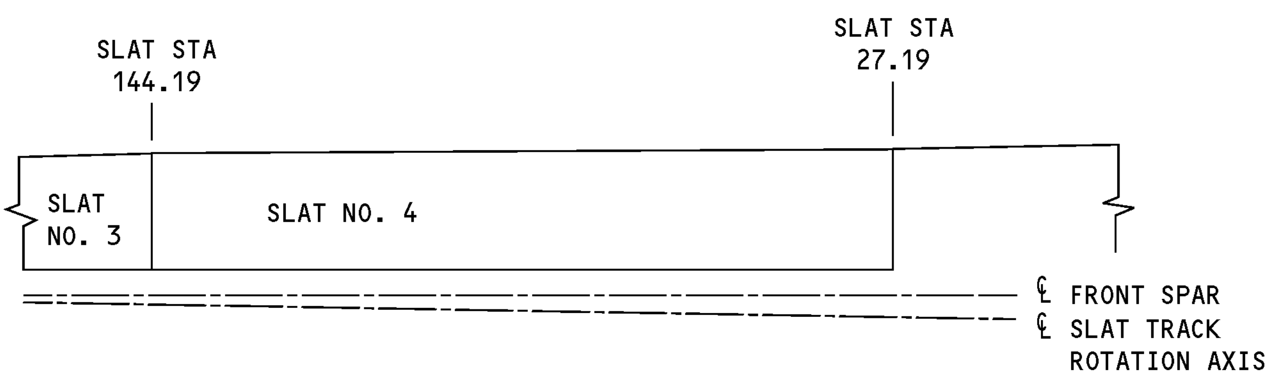
Definitions of Reference Planes and Lines
Figure 1 (Sheet 4 of 5)



WING DIHEDRAL
A-A



ANGLE OF INCIDENCE
B-B



E

Definitions of Reference Planes and Lines
Figure 1 (Sheet 5 of 5)

3. **Definitions of Abbreviations That Are Applicable to the Vertical Stabilizer (Refer to Figure 1, Detail B)**

   A. FIN STA: Fin Station - A plane perpendicular to the centerline of the vertical stabilizer rear spar, measured by its distance from Fin Station 0.00. Fin Sta 0.00 is found at the intersection of the Body Waterline 300.50 (Root Chord) and the extension of vertical stabilizer leading edge line.

   B. LE STA: Leading Edge Station - A plane perpendicular to the vertical stabilizer leading edge, measured by its distance from Leading Edge Station 0.00. Leading Edge Station 0.00 is found at the intersection of the Body Waterline 300.50 (Root Chord) and the extension of vertical stabilizer leading edge line.

   C. RUD STA: Rudder Station - A plane perpendicular to the rudder hinge centerline, measured by its distance from Rudder Station 0.00. Rudder Station 0.00 is found at the intersection of the Body Waterline 300.50 (Root Chord) and the rudder hinge centerline.

   D. FIN WL: Fin Waterline - A horizontal plane, parallel to and measured by its distance from Fin Waterline 0.00.Fin Waterline 0.00 is found at Body Waterline 300.50 (Root Chord).

4. **Definitions of Abbreviations That Are Applicable to the Horizontal Stabilizer (Refer to Figure 1, Detail C)**

   A. SCP: Stabilizer Chord Plane - A plane that is inclined 7 degrees up in the outboard direction from Body Waterline 272.029 at Stabilizer Buttock Line 0.00 with the horizontal stabilizer at 0 degrees incidence.

   B. STAB BL: Stabilizer Buttock Line - A plane perpendicular to the horizontal stabilizer chord plane and parallel to the trace of the fuselage centerline. It is measured by its distance from Stabilizer Buttock Line 0.00. Stabilizer Buttock Line 0.00 is found at the intersection of the stabilizer chord plane and Body Buttock Line 0.00.

   C. ELEV STA: Elevator Station - A plane perpendicular to the elevator hinge centerline, measured by its distance from Elevator Station 0.00. Elevator Station 0.00 is found at the intersection of the elevator hinge centerline and Stabilizer Buttock Line 0.00.

   D. LE STA: Leading Edge Station - A plane perpendicular to the horizontal stabilizer leading edge and the stabilizer chord plane. It is measured by its distance from Leading Edge Station 0.00. Leading Edge Station 0.00 is found at the intersection of Stabilizer Buttock Line 0.00 and the extension of the horizontal stabilizer leading edge line.

   E. STAB STA: Stabilizer Station - A plane perpendicular to the horizontal stabilizer rear spar centerline and the stabilizer chord plane. It is measured by its distance from Stabilizer Station 0.00. Stabilizer Station 0.00 is found at the intersection of Stabilizer Buttock Line 0.00 and the extension of the horizontal stabilizer leading edge line.

5. **Definitions of Abbreviations That Are Applicable to the Wing (Refer to Figure 1, Detail D)**

   A. MAC: Mean Aerodynamic Chord - The chord of an imaginary airfoil section of the wing that has vectors that are the same as the actual wing through all of the flight range of the wing.

   B. WCP: Wing Chord Plane - A plane that is inclined 6 degrees up in the outboard direction from Body Waterline 183.50 at the intersection of Body Buttock Line 70.85, and the rear spar inclined 1 degree up in the forward direction from Body Waterline 181.3324 at the intersection Body Buttock Line 70.85 and the rear spar.

   C. WRP: Wing Reference Plane - The plane of the wing outboard rear spar that extends inboard.

   D. W STA: Wing Station - A plane perpendicular to the Wing Chord Plane and the Wing Reference Plane (the outboard rear spar) measured by its distance from Wing Station 0.00. Wing Station 0.00 is found at the intersection of the Wing Buttock Line 0.00 and the extension of the wing leading edge line.

E. WBL: Wing Buttock Line - A plane perpendicular to the Wing Chord Plane and parallel to the trace of the fuselage centerline. It is measured by its distance from Wing Buttock Line 0.00. Wing Buttock Line 0.00 is found at the intersection of the Wing Chord Plane and Body buttock Line 0.00.

F. FSS: Front Spar Station - A plane perpendicular to the wing chord plane and the wing front spar. Front Spar Station 188.56 is found at the intersection of Wing Station 180.25 and the wing front spar. Front spar stations on the inboard front spar are not parallel to the Front Spar Stations on the outboard front spar.

G. RSS: Rear Spar Station - A plane perpendicular to the wing chord plane and the wing rear spar. Rear Spar Station 201.66 is found at the intersection of Wing Station 209.31 and the rear spar. Rear spar stations on the inboard rear spar are not parallel to the Rear Spar Stations on the outboard rear spar.

H. LE STA: Leading Edge Station - A plane perpendicular to the wing leading edge and the wing chord plane, measured by its distance from Leading Edge Station 0.00. Leading Edge Station 0.00 is found at the intersection of Wing Buttock Line 0.00 the extension of the wing leading edge line.

I. SLAT STA: Slat Station - A plane perpendicular to the slat track axis of rotation measured from Slat Station 0.00. Slat Station 0.00 is found at the intersection of Wing Buttock Line 195.5388 and the slat track axis of rotation.

6. Definitions of Abbreviations that are Applicable to the CFM56-7 Engine Nacelle

A. NAC BL: Nacelle Buttock Line - A line that is to the left or right and parallel to the centerline of the engine. Nacelle Buttock Line 0.00 for the engine is 1 degree inboard from Wing Buttock Line 191 at the wing leading edge.

B. NAC WL: Nacelle Waterline - A plane that declines down 1.5 degrees from the local wing chord line at NAC STA 247.8. NAC WL 100.00 is the centerline of the engine.

C. NAC STA: Nacelle Station - A vertical plane perpendicular to the nacelle centerline. It is the distance to the rear from an imaginary point inches forward of the inlet cowl mounting flange found on the engine fan case.

GENERAL - MAJOR INSTALLATION AND INTEGRATION DRAWINGS

1. General

A. This general section gives the major installation and integration drawing numbers for the Boeing 737-800 airplanes. Refer to Table 1/GENERAL.

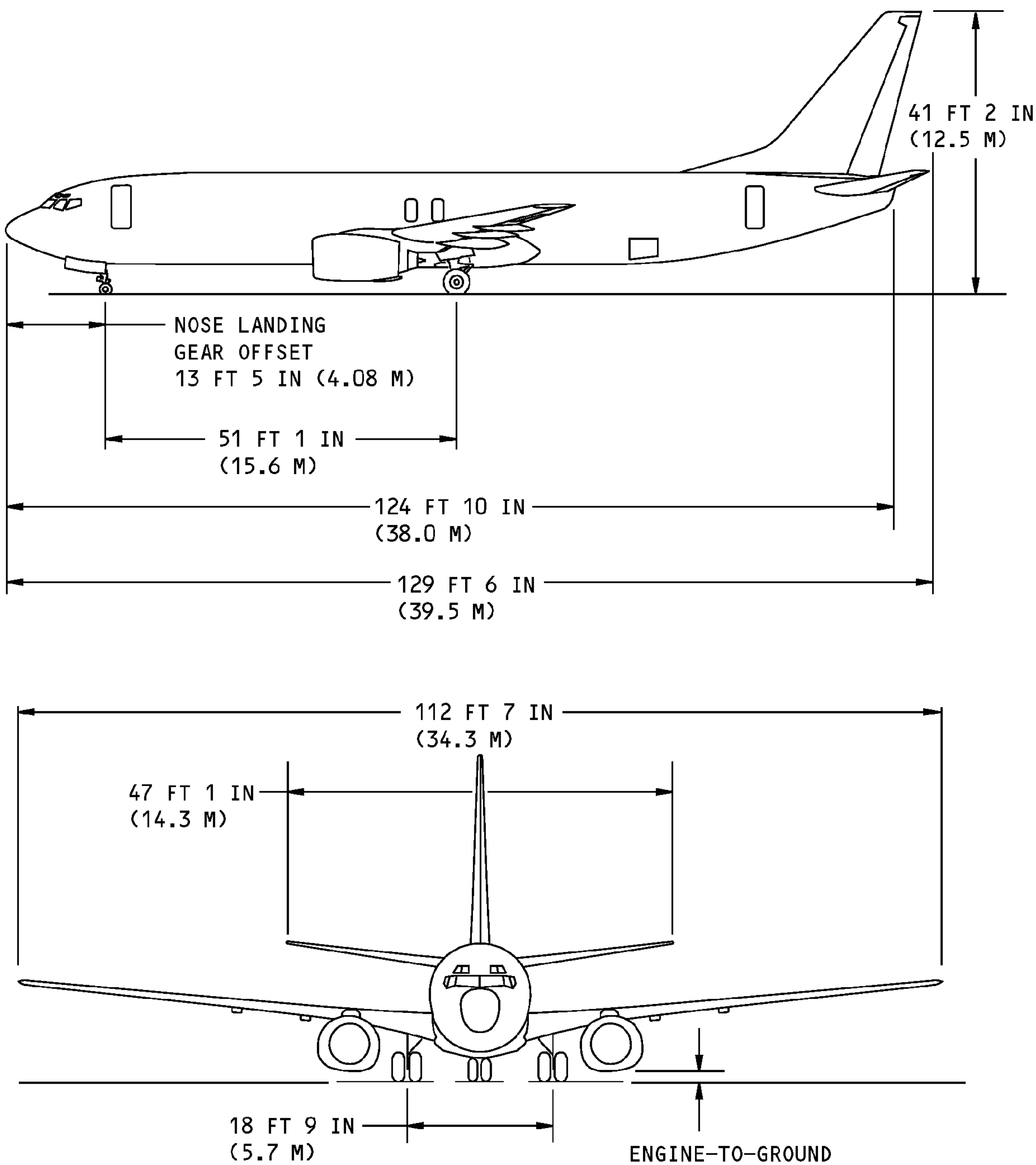
B.

Table 1:

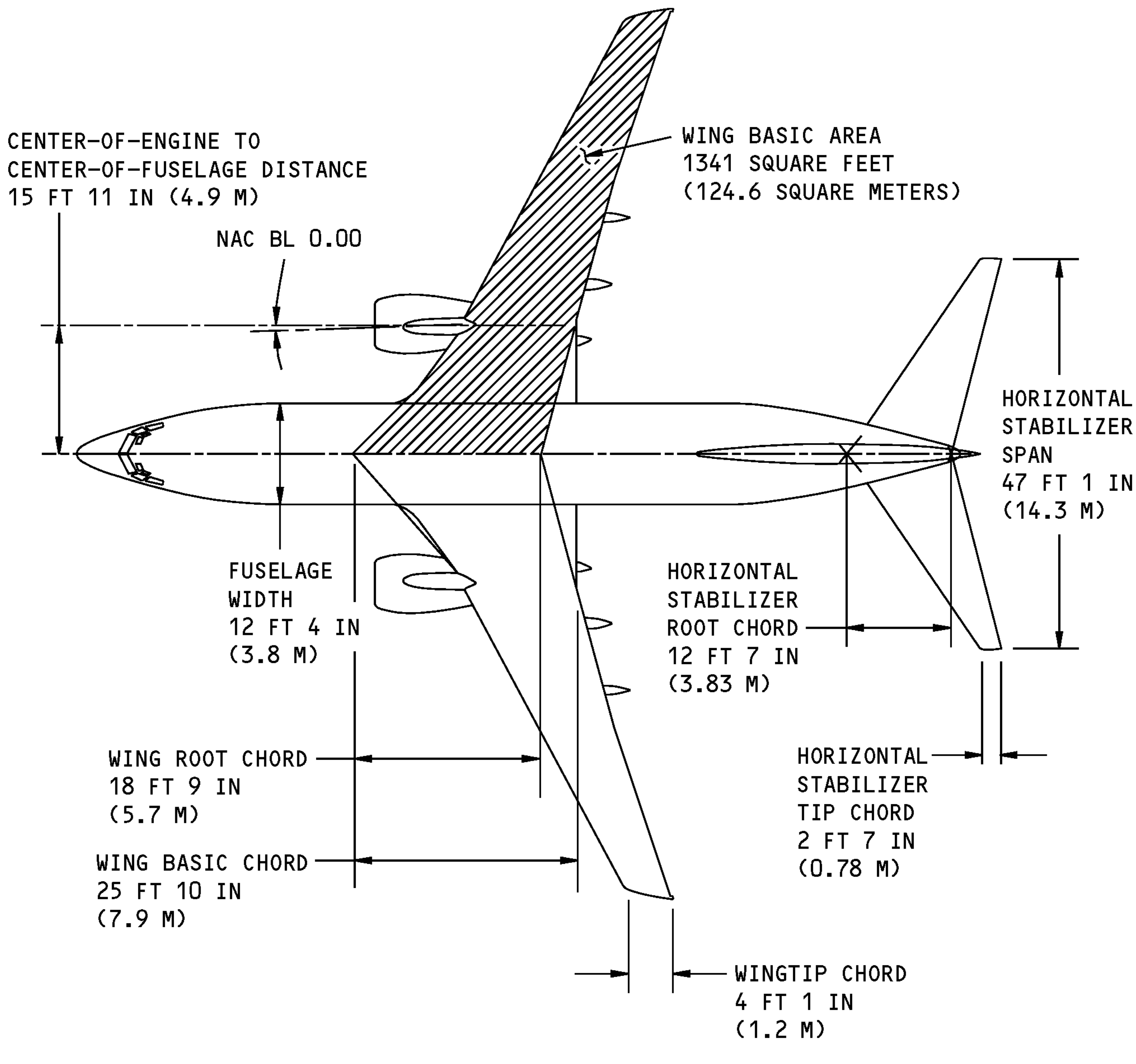
737 MAJOR INSTALLATION AND INTEGRATION DRAWINGS		
SECTION	DESCRIPTION	DRAWING NUMBER
	737 Final Assembly - Product Collector	001A0101
10	Wing Product Collector, Left Wing Product Collector, Right	001A1001 001A1002
30	Management Pre-module Collector - 737 CFM56-7 Nacelle, Propulsion System Basic	301A2094
40	Fuselage	001A4001
70	Vertical Fin	170A1601
80	Horizontal Stabilizer	180A1601

GENERAL - PRINCIPAL DIMENSIONS

1. **General**
   A. This section contains the principal dimensions for the fuselage, horizontal stabilizer, vertical stabilizer, and wing. Refer to Principal Dimensions and Areas, Figure 1/GENERAL.
   B. Some dimensions change with the center of gravity location and airplane loads. For these dimensions a minimum and a maximum is given.



Principal Dimensions and Areas
Figure 1 (Sheet 1 of 2)



Principal Dimensions and Areas
Figure 1 (Sheet 2 of 2)

2. Principal Dimensions

A. Airplane:

(1) Height:
- Minimum - not applicable
- Maximum - 41 feet and 2 inches (12.54 M)

(2) Length - 129 feet and 6 inches (39.47M)

B. Engines:

(1) Engine-to-Ground Distance
- Minimum - 19 inches (0.48 M)
- Maximum - 25 inches (0.63 M)

(2) Fuselage-to-Engine Distance (from the centerline of the fuselage to the centerline of the engine) - 15 feet and 11 inches (4.85 M)

C. Fuselage:

(1) Height of Body Reference Plane (WL) Above Ground at Main Landing Gear
- Minimum - 7 feet and 1 inch (2.15 M)
- Maximum - 8 feet and 2 inches (2.48 M)

(2) Height (constant cross section)
- Above Body Reference Plane - 8 feet and 2 inches (2.48 M)
- Below Body Reference Plane - 5 feet 0 inch (1.52 M)

(3) Height to Centerline of Windows Above Body Reference Plane - 20 feet and 6 inches (6.24 M)

(4) Width - 12 feet and 4 inches (3.75 M)

D. Horizontal Stabilizer:

(1) Aspect Ratio = 6.161

(2) Dihedral (Stabilizer Reference Plane in relation to the Body Reference Plane) - 7 degrees

(3) Span (from the left tip to the right tip) 47 feet and 1 inch (14.35 M)

(4) Sweepback (at the 25 percent chord line) - 30 degrees

(5) Taper Ratio - 0.203

(6) Tip Chord - 2 feet and 7 inches (0.78 M)

E. Landing Gear:

(1) Track - 18 feet and 9 inches (5.71 M)

(2) Nose Landing Gear Offset - 13 feet 5 inches (4.08 M)

(3) Wheelbase - 51 feet and 2 inches (15.60 M)

F. Vertical Stabilizer:

(1) Aspect Ratio = 1.941

(2) Height (from the Root Chord to the top of the stabilizer) - 23 feet and 6 inches (7.16 M)

(3) Root Chord - 19 feet and 1 inch (5.81 M)

(4) Sweepback (at the 25 percent chord line) - 35 degrees

(5) Taper Ratio - 0.271

G. Wings:

(1) Aspect Ratio = 9.45

(2) Basic Chord (theoretical) - 25 feet and 10 inches (7.87 M)

(3) Dihedral (Wing Reference Plane in relation to the Body Reference Plane) - 6 degrees

(4) Mean Aerodynamic Chord (basic wing only) 13 feet and 0 inch (3.96 M)

(5) Planform Taper Ratio
- Tip Chord (Root Chord) - 0.219

(6) Root Chord (theoretical, at Body Centerline) - 18 feet and 9 inches (5.71 M)

(7) Sweepback (at the 25 percent chord line) - 25.03 degrees

(8) Taper Ratio - 0.219

(9) Tip Chord (theoretical) - 4 feet and 1.25 inches (1.25 M)

H. Areas:

(1) Horizontal Stabilizer - 352.8 square feet (32.77 M^2)

(2) Vertical Stabilizer - 284.6 square feet (26.44 M^2)

(3) Wing Basic Area - 1341 square feet (124.6 M^2)

GENERAL - STRUCTURAL CLASSIFICATION

1. **Applicability**

   A. This subject is applicable to the primary and secondary structure of the airplane.

2. **General**

   A. This section gives the Principal Structural Elements (PSEs) and Secondary Structure of the airplane. This can be used to find the classification of major and minor repairs.

   B. Refer to Structural Classification Diagram, Figure 1/GENERAL for the classification of structures.

   C. Refer to Primary and Secondary Structures of the Airplane, Figure 2/GENERAL for the identification of the primary and secondary structures of the airplane.

   (1) Refer to the and tables that follow for the specified primary structures PSE and non-PSE components, and secondary structures:

   (a) Paragraph 5./GENERAL and Table 1/GENERAL - Doors

   (b) Paragraph 6./GENERAL and Table 2/GENERAL - Fuselage

   (c) Paragraph 7./GENERAL and Table 3/GENERAL - Nacelles and Pylons

   (d) Paragraph 8./GENERAL and Table 4/GENERAL - Stabilizers

   (e) Paragraph 9./GENERAL and Table 5/GENERAL - Wings

   D. The Principal Structural Elements (PSEs) given in this subject agree with the 737-600/700/800/900 Maintenance Review Board Report (MRBR), DOCUMENT D626A001-MRBR.

   NOTE: If the data between this SRM and the MRBR is different, refer to the MRBR over the SRM.

   E. Repairs to PSEs in the wing, nacelle and pylon structures as given in Table 3/GENERAL and Table 5/GENERAL are required to be evaluated for damage tolerance capability.

3. **References**

Reference	Title
DOCUMENT D626A001-MRBR	737-600/700/800/900 MAINTENENCE REVIEW BOARD REPORT DOCUMENT

4. **Definitions**

   A. The definitions of primary and secondary structures are as follows:

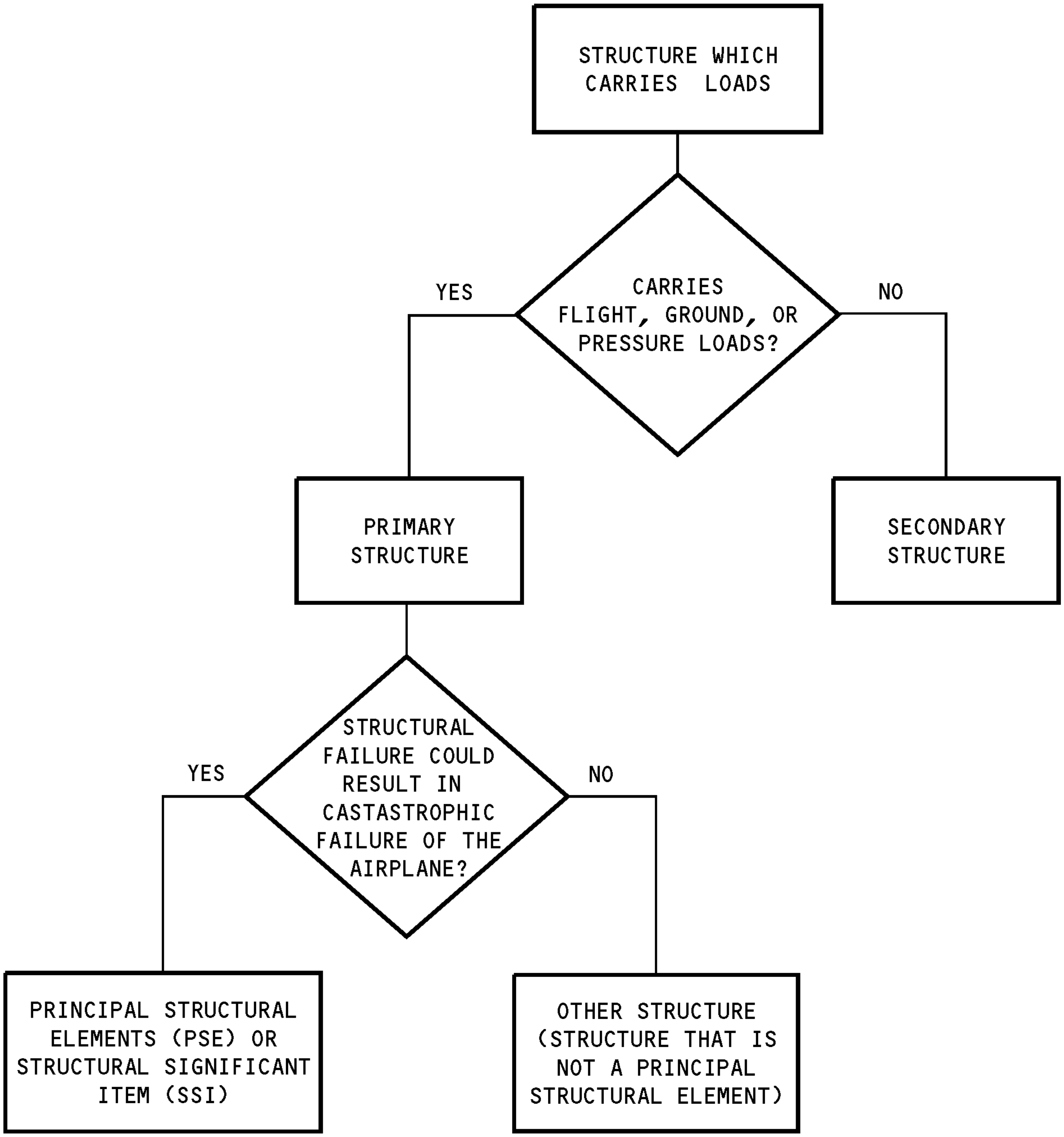
   WARNING: THE FAILURE OF PSE'S COULD RESULT IN THE CATASTROPHIC FAILURE OF THE AIRPLANE.

   (1) Primary Structure: Structure which carries flight, ground, or pressure loads. Primary structure is classified into two categories: Principal Structural Elements (PSE) and Other Structure. Most of the primary structures on the airplane are Principal Structural Elements (PSE). PSEs are also known as Structural Significant Items (SSI).

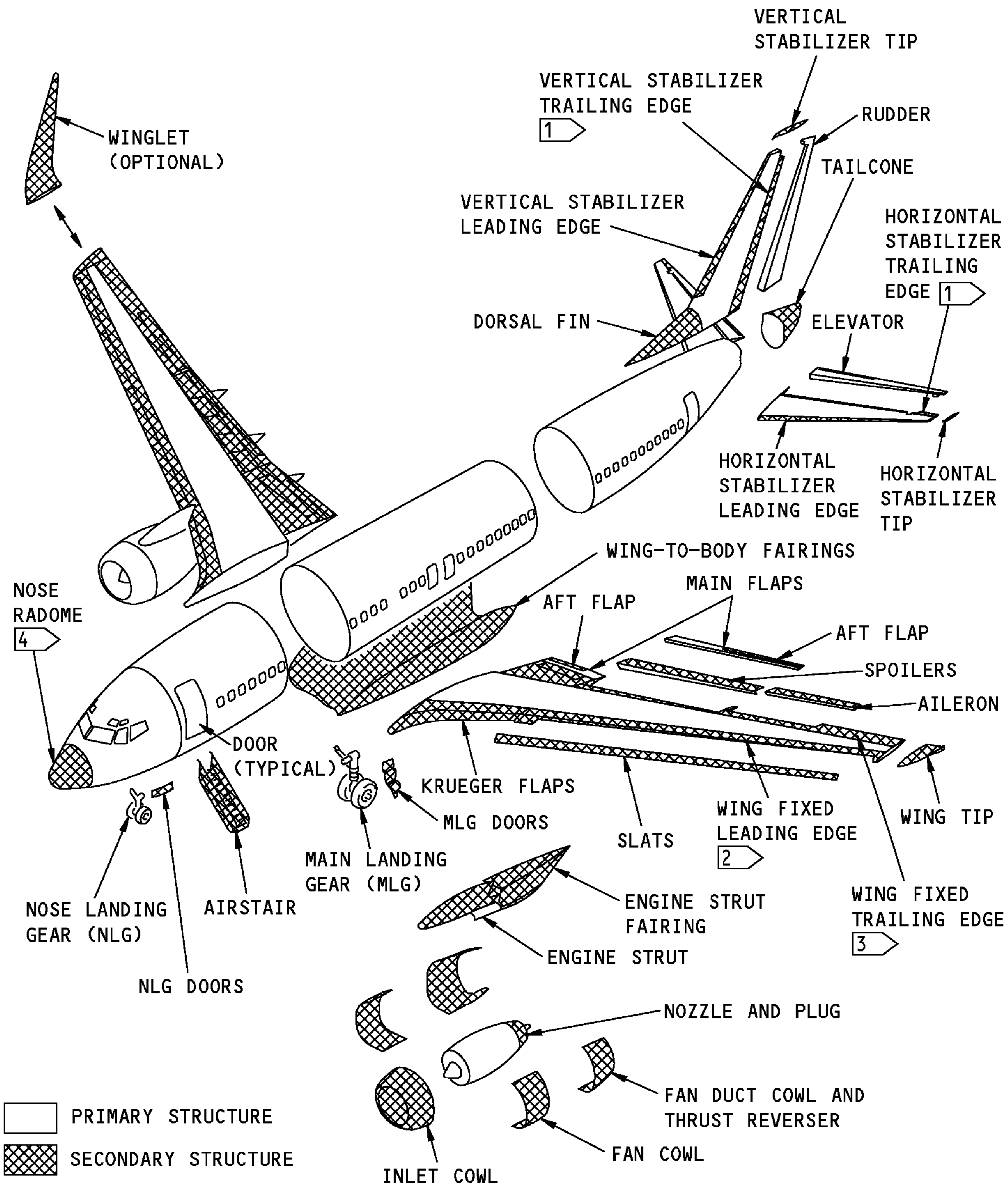
   (a) Principal Structural Elements (PSE): Primary structure which contribute significantly to carrying flight, ground, and pressurization loads, and whose failure could result in the catastrophic failure of the airplane.

   (b) Other Structure: Primary structure that is not a Principal Structural Element (PSE).

   (2) Secondary Structure: Structure which carries only air or inertial loads generated on or within the secondary structure. Most secondary structures are important to the aerodynamic performance of the airplane.



Structural Classification Diagram
Figure 1



Primary and Secondary Structures of the Airplane
Figure 2 (Sheet 1 of 2)

NOTES

1. THE PRIMARY STRUCTURE OF THE FIXED TRAILING EDGE PANELS OF THE VERTICAL AND HORIZONTAL STABILIZERS ARE THE RUDDER AND ELEVATOR SUPPORT STRUCTURE.

2. THE PRIMARY STRUCTURE OF THE WING LEADING EDGE ARE THE LEADING EDGE FLAP AND SLAT SUPPORT STRUCTURES.

3. THE PRIMARY STRUCTURE OF THE WING TRAILING EDGE ARE THE STRUCTURE THAT GIVES SUPPORT TO THE FLAPS, AILERONS, AND SPOILERS, AND THE LANDING BEAMS AND THEIR SUPPORTS.

4. THE NOSE RADOME HAS SPECIAL TRANSMISSIVITY REQUIREMENTS THAT CAN LIMIT THE SIZE AND TYPES OF REPAIRS.

Primary and Secondary Structures of the Airplane
Figure 2 (Sheet 2 of 2)

5. **The primary and secondary structures for the doors are given in Table 1.**

A. Primary structure include the skin, structure, stop fittings and pins of these doors:

(1) Entry, Galley, Cargo, Emergency Exit, Automatic Overwing Exit Door, Airstair, Equipment Access, and Forward Access.

B. Secondary structure includes the skin and structure of doors that are not primary structure.

Table 1:

DOOR STRUCTURE				
ATA NUMBER	DESCRIPTION	PRIMARY		SECONDARY
		PSE	OTHER	
52-10-01	Forward Galley Door Skin	X		
52-10-01	Aft Entry Door Skin	X		
52-10-01	Aft Galley Door Skin	X		
52-10-01	Forward Entry Door Skin	X		
52-10-02	Forward Galley Door Structure	X		
52-10-02	Aft Entry Door Structure	X		
52-10-02	Aft Galley Door Structure	X		
52-10-02	Forward Entry Door Structure	X		
52-20-01	Emergency Exit Door Skin (Automatic Overwing Exit Door Skin)	X		
52-20-02	Emergency Exit Door Structure (Automatic Overwing Exit Door Structure)	X		
52-30-01	Cargo Door Skin	X		
52-30-01	Forward Cargo Door Skin	X		
52-30-02	Cargo Door Structure	X		
52-30-02	Forward Cargo Door Structure	X		
52-40-01	Access and Blowout Door Skin			X
52-40-01	APU Access Door Skin			X
52-40-01	External Power Receptacle Access Door Skin			X
52-40-01	Lavatory Service Door Skin			X
52-40-01	Water Service Door Skin			X
52-40-01	Tailcone Access Door Skin			X
52-40-01	Tailcone System Door Skin			X
52-40-02	APU Access Door Structure			X
52-40-02	Access and Blowout Door Structure			X
52-40-90	Service Door Fittings			X
52-41-01	Equipment Access Door Skin	X		
52-41-01	Forward Access Door Skin	X		
52-41-02	Forward Access Door Structure	X		
52-41-02	Equipment Access Door Structure	X		
52-60-01	Forward Airstair Door Skin	X		
52-60-02	Forward Airstair Door Structure	X		

DOOR STRUCTURE				
ATA NUMBER	DESCRIPTION	PRIMARY		SECONDARY
		PSE	OTHER	
52-80-01	Nose and Main Landing Gear Door Skins			X
52-80-02	Nose and Main Landing Gear Door Structures			X
52-80-90	Nose Landing Gear Door Fittings			X
52-80-90	Main Landing Gear Door Fittings			X

6. **The primary and secondary structures for the fuselage are given in Table 2.**

A. Fuselage primary PSE structure include:

(1) Fuselage skin panels, skin splices, door surround cutouts, and window belts

(2) Frames, stringers, stiffeners, and intercostals

(3) Bulkhead structures

(4) Beam and keel beam structures

(5) Landing gear support structure

(6) Wing-to-body drag angles.

B. Fuselage primary other structure include:

(1) Floor panels and beam assemblies

(2) Cargo compartment structure and floor panels

(3) Seat tracks.

C. Fuselage secondary structure include:

(1) Nose radome

(2) Wing-to-body fairings (except the drag angles)

(3) Fuselage section 48 fairings and seals

(4) Tailcone and tailskid.

Table 2:

FUSELAGE STRUCTURE				
ATA NUMBER	DESCRIPTION	PRIMARY		SECONDARY
		PSE	OTHER	
53-10-01	Fuselage Skin - Section 41 (BS 178 to BS 259.5)	X		
53-10-01	Fuselage Skin - Section 41 (BS 259.5 to BS 360)	X		
53-10-03	Stringers - Section 41	X		
53-10-04	Intercostals - 41	X		
53-10-07	Frames - Section 41	X		
53-10-08	Bulkhead (BS 294.5)	X		
53-10-08	Bulkhead (BS 178)	X		
53-10-08	Canted Bulkhead (BS 224.8 to 227.8)	X		
53-10-08	Bulkhead (BS 259.5)	X		
53-10-08	Bulkhead (BS 294.5)	X		

FUSELAGE STRUCTURE				
ATA NUMBER	DESCRIPTION	PRIMARY		SECONDARY
		PSE	OTHER	
53-10-14	Nose Landing Gear Structure	X		
53-10-15	Door Surround Structure	X		
53-10-50	Main Deck Floor Panels - Section 41		X	
53-10-51	Crew Area Floor Structure		X	
53-10-51	Floor Structure - Section 41		X	
53-10-52	Seat Tracks - Section 41		X	
53-10-54	Forward Equipment Bay Floor Structure		X	
53-10-54	Forward Equipment Bay Floor Support		X	
53-10-72	Nose Radome			X
53-10-90	Nose Landing Gear Support Fittings	X		
53-30-01	Fuselage Skin - Section 43 (BS 360 to BS 540)	X		
53-30-03	Fuselage Stringers - Section 43	X		
53-30-04	Intercostals - Section 43	X		
53-30-07	Frames Section 43	X		
53-30-12	Keel Beam Extrusion - Section 43	X		
53-30-13	Beams - Section 43	X		
53-30-15	Door Surround Structure - Section 43	X		
53-30-30	Auxiliary Structure			X
53-30-50	Main Deck Floor Panels - Section 43		X	
53-30-51	Floor Structure - Section 43		X	
53-30-52	Seat Tracks - Section 43		X	
53-30-53	Forward Cargo Compartment Floor Panels		X	
53-30-53	Forw-ard Cargo Compartment Floor Structure		X	
53-30-70	Wing-to-Body Fairing Skins - Section 43			X
53-30-70	Wing-to-Body Fairing Structure (Except Drag Angles)			X
53-30-71	Wing-to-Body Fairing Structure (Drag Angles Only)	X		
53-40-01	Fuselage Skin - Section 44 (BS 540 to BS 727)	X		
53-40-03	Fuselage Stringers - Section 44	X		
53-40-04	Fuselage Intercostals - Section 44	X		
53-40-07	Frames - Section 44	X		
53-40-08	Bulkhead (BS 727)	X		
53-40-08	Bulkhead (BS 540)	X		
53-40-08	Bulkhead (BS 663)	X		
53-40-12	Keel Beam - Section 44	X		
53-40-13	Crease Beam - Section 44	X		
53-40-14	Main Landing Gear Structure	X		

FUSELAGE STRUCTURE				
ATA NUMBER	DESCRIPTION	PRIMARY		SECONDARY
		PSE	OTHER	
53-40-15	Door Surround Structure - Section 44	X		
53-40-50	Main Deck Floor Panels - Section 44	X		
53-40-51	Floor Structure - Section 44	X		
53-40-52	Seat Tracks - Section 44		X	
53-40-70	Wing-to Body Fairing Skins - Section 44			X
53-40-71	Wing-to Body Fairing Structure - Section 44			X
53-60-01	Fuselage Skin - Section 46 (BS 727 to BS 888)	X		
53-60-03	Fuselage Stringers - Section 46	X		
53-60-04	Fuselage Intercostals - Section 46	X		
53-60-07	Frames - Section 46	X		
53-60-12	Keel Beam Extension - Section 46	X		
53-60-13	Beams - Section 46	X		
53-60-15	Door Surround Structure - Section 46	X		
53-60-50	Main Deck Floor Panels - Section 46		X	
53-60-51	Floor Structure - Section 46		X	
53-60-52	Seat Tracks - Section 46		X	
53-60-53	Aft Cargo Compartment Floor Panels		X	
53-60-53	Aft Cargo Compartment Floor Structure		X	
53-60-70	Wing-to-Body Fairing Skin - Section 46			X
53-60-71	Wing-to-Body Fairing Structure - Section 46			X
53-70-01	Fuselage Skin - Section 47 (BS 888 to BS 1016)	X		
53-70-03	Fuselage Stringers - Section 47	X		
53-70-04	Fuselage Intercostals - Section 47	X		
53-70-07	Frames - Section 47	X		
53-70-15	Door Surround Structure - Section 47	X		
53-70-50	Passenger Compartment Floor Panels - Section 47		X	
53-70-51	Floor Structure		X	
53-70-52	Seat Tracks - Section 47		X	
53-70-53	Aft Cargo Compartment Floor Structure - Section 47		X	
53-70-53	Aft Cargo Compartment Floor Panels - Section 47		X	
53-80-01	Fuselage Skin - Section 48 (BS 1016 to BS 1156)	X		
53-80-03	Fuselage Stringers - Section 48	X		
53-80-04	Fuselage Intercostals - Section 48	X		
53-80-07	Frames - Section 48	X		
53-80-08	Bulkhead (BS 1016)	X		
53-80-08	Bulkhead (BS 1042)	X		

FUSELAGE STRUCTURE				
ATA NUMBER	DESCRIPTION	PRIMARY		SECONDARY
		PSE	OTHER	
53-80-08	Bulkhead (BS 1088)	X		
53-80-08	Bulkhead (BS 1156)	X		
53-80-13	Horizontal Beams - Section 48	X		
53-80-13	Torque Box Beams	X		
53-80-15	Door Surround Structure - Section 48	X		
53-80-30	APU Air Inlet Liner Assembly		X	
53-80-70	Tailcone			X
53-80-70	Stabilizer-to-Body Fairing Seal			X
53-80-70	Tailskid Fairing Skin			X
53-80-70	Body-to-Rudder Seal Retainer - Section 48		X	
53-80-71	Fairing Structure - Section 48			X
53-80-71	Stabilizer-to-Body Fairing Sliding Seal Structure		X	
53-80-71	Body-to-Rudder Seal Retainer		X	
53-80-90	Attachment Fittings - Section 48	X		
56-10-02	Flight Compartment Window Structure	X		
56-20-02	Cabin Window Structure	X		
56-30-02	Emergency Exit Door Window Structure (Automatic Overwing Exit Door)	X		
56-30-02	Forward Entry/Galley Door Window Structure	X		
56-30-02	Aft Entry/Galley Door Window Structure	X		

7. **The primary and secondary structures for the nacelles and pylons are given in Table 3.**

   A. Engine primary structure include:

      (1) Strut skins, bulkheads, spars, fittings, and pins

      (2) Strut-to-wing attachments, links, brace, and pins.

Table 3:

NACELLES AND PYLONS STRUCTURE				
ATA NUMBER	DESCRIPTION	PRIMARY		SECONDARY
		PSE	OTHER	
54-10-01	Inlet Cowl Skin			X
54-10-02	Inlet Cowl Structure			X
54-10-90	Inlet Cowl Fittings			X
54-20-01	Fan Cowl Skin			X
54-20-02	Fan Cowl Structure			X
54-20-90	Fan Cowl Fittings			X
54-30-01	Fan Duct/Thrust Reverser Aft Cowl			X

NACELLES AND PYLONS STRUCTURE				
ATA NUMBER	DESCRIPTION	PRIMARY		SECONDARY
		PSE	OTHER	
54-30-01	Fan Duct/Thrust Reverser Cowl			X
54-30-02	Thrust Reverser Inner Duct Wall			X
54-30-02	Thrust Reverser Torque Box Structure			X
54-30-70	Fan Duct/Thrust Reverser Fairing Skin			X
54-30-90	Fan Duct/Thrust Reverser Cowl Fittings			X
54-40-20	Turbine Exhaust Structure			X
54-50-01	Strut Side Skins	X		
54-50-02	Strut Upper Spar	X		
54-50-02	Strut Lower Spar	X		
54-50-70	Strut Forward Fairing Skin			X
54-50-70	Strut-to-Wing Junction Fairing			X
54-50-70	Strut Aft Fairing Skin			X
54-50-71	Strut Forward Fairing Structure			X
54-50-71	Strut Aft Fairing Structure			X
54-50-71	Thrust Reverser/Strut Fairing Structure			X
54-50-90	Strut/Torque Box Frame		X	
54-50-90	Strut/Torque Box Bulkhead	X		
54-50-90	Strut Fittings	X		
54-50-90	Strut-to-Wing Fittings	X		

8. **The primary and secondary structures for the stabilizers are given in Table 4.**

A. Stabilizer primary structure include:

(1) Inspar skins

(2) Elevator skin, spars, ribs, and fittings

(3) Vertical Stabilizer lower close rib

(4) Front and rear spar chords, webs, and lugs

(5) Terminal, pivot, and jackscrew fittings

(6) Horizontal Stabilizer center section primary and thrust beams.

(7) Rudder skin and structure.

Table 4:

STABILIZER STRUCTURE				
ATA NUMBER	DESCRIPTION	PRIMARY		SECONDARY
		PSE	OTHER	
55-10-01	Horizontal Stabilizer Skin	X		
55-10-01	Horizontal Stabilizer Leading Edge Skins			X
55-10-01	Horizontal Stabilizer Trailing Edge Skins			X

STABILIZER STRUCTURE				
ATA NUMBER	DESCRIPTION	PRIMARY		SECONDARY
		PSE	OTHER	
55-01-04	Horizontal Stabilizer Upper Lower Intercostals		X	
55-10-04	Horizontal Stabilizer Upper Inspar Intercostals		X	
55-10-09	Horizontal Stabilizer Forward Box Ribs		X	
55-10-09	Horizontal Stabilizer Torque Box Ribs		X	
55-10-09	Horizontal Stabilizer Trailing Edge Ribs		X	
55-10-10	Horizontal Stabilizer Front Spar	X		
55-10-10	Horizontal Stabilizer Rear Spar	X		
55-10-10	Horizontal Stabilizer Center Section Spar	X		
55-10-13	Horizontal Stabilizer Beams	X		
55-10-30	Horizontal Stabilizer Tip			X
55-10-30	Horizontal Stabilizer Cove			X
55-10-90	Horizontal Stabilizer Fittings - Pivot, Jackscrew, and Terminal	X		
55-10-90	Horizontal Stabilizer Fittings	X		
55-20-01	Elevator Skins	X		
55-20-01	Elevator Tab Skins	X		
55-20-02	Elevator Leading Edge Structure	X		
55-20-02	Elevator Ribs	X		
55-20-02	Elevator Rear Spar	X		
55-20-02	Elevator Tab Structure	X		
55-20-90	Elevator Fittings	X		
55-20-90	Elevator Tab Fittings	X		
55-30-01	Vertical Stabilizer Inspar Skins	X		
55-30-01	Vertical Stabilizer Leading Edge Skins			X
55-30-01	Vertical Stabilizer Dorsal Fin Skin			X
55-30-04	Vertical Stabilizer Intercostals		X	
55-30-05	Vertical Stabilizer Beams		X	
55-30-09	Vertical Stabilizer Leading Edge Ribs			X
55-30-09	Vertical Stabilizer Inspar Ribs		X	
55-30-09	Vertical Stabilizer Trailing Edge Ribs			X
55-30-09	Vertical Stabilizer Dorsal Fin Ribs			X
55-30-10	Vertical Stabilizer Front Spar (Chords and Webs)	X		
55-30-10	Vertical Stabilizer Rear Spar (Chords and Webs)	X		
55-30-13	Vertical Stabilizer Beams	X		
55-30-30	Vertical Stabilizer Tip			X
55-30-30	Vertical Stabilizer Cove			X
55-30-90	Vertical Stabilizer Front Spar Terminal Fittings	X		

STABILIZER STRUCTURE				
ATA NUMBER	DESCRIPTION	PRIMARY		SECONDARY
		PSE	OTHER	
55-30-90	Vertical Stabilizer Rear Spar Terminal Fittings	X		
55-30-90	Vertical Stabilizer Fittings (Except the Terminal Fittings)		X	
55-40-01	Rudder Skin	X		
55-40-02	Rudder Ribs	X		
55-40-02	Rudder Spar Ribs	X		
55-40-02	Balance Arm Structure	X		
55-40-03	Rudder Tip			X
55-40-90	Rudder Fittings	X		

9. **The primary and secondary structures for the wings are given in Table 5.**

A. Wing box skins are primary structure and include segments and attachments to other structures as follows:

(1) Stringers

(2) Spar chords

(3) Keel beam

(4) Floor beam

(5) Fuselage drag angle

(6) Lower beam at BL 41.0

(7) Fittings

(8) Rib shear ties

(9) Flap tracks.

B. Other wing box primary structures include:

(1) Front and rear spar chords, stiffeners, rib posts, webs, and terminal fittings

(2) Keel beam stiffeners at the rear spars.

C. Wing center section primary structures include:

(1) Skins, including segments and attachments to stringers, spar chords, keel beam, fuselage drag angle, and lower beam at BL 41.0

(2) Spanwise beams

(3) Floor beams

(4) Lower beam at BL 41.0

(5) Side of body splices, rib webs, and stiffeners

(6) Spars.

D. Wing trailing edges primary structure include:

(1) Main landing gear beams

(2) Trunnion housings, fittings and pins

(3) Gear beam support fittings, pins, and fuse pins

(4) Stabilizer links, fuse pins, and fittings

(5) Inboard and outboard main flaps which include:

(a) Support track assemblies

(b) Support fitting assemblies

(c) Support links and pins

(d) Main flap inspar skins, spars, ribs, fittings, links, torque tube, and carriage assemblies.

(e) Aft flap track support assemblies

E. Spoiler primary structure include inboard actuator fittings.

Table 5:

WING STRUCTURE				
ATA NUMBER	DESCRIPTION	PRIMARY		SECONDARY
		PSE	OTHER	
57-10-01	Wing Center Section Upper Skin	X		
57-10-01	Wing Center Section Lower Skin	X		
57-10-03	Wing Center Section Stiffeners	X		
57-10-10	Wing Center Section Rear Spar - Not Including the Lower Left Web And Lower Right Web (GFRP)	X		
57-10-10	Wing Center Section Rear Spar - Lower Left And Right Web (GFRP)		X	
57-10-10	Wing Center Section Front Spar	X		
57-10-13	Wing Center Section Support Beams	X		
57-10-13	Wing Center Section Span Wise Beams	X		
57-20-01	Outer Wing Lower Skin	X		
57-20-01	Outer Wiing Lower Skin Access Panels		X	
57-20-01	Outer Wing Upper Skin	X		
57-20-03	Outer Wing Lower Stringers	X		
57-20-03	Outer Wing Upper Stringers	X		
57-20-09	Outer Wing Ribs	X		
57-20-10	Outer Wing Front Spar	X		
57-20-10	Outer Wing Front Spar Slat Cans		X	
57-20-10	Outer Wing Rear Spar	X		
57-20-90	Outer Wing Front Fittings	X		
57-30-01	Wing Tip Skin			X
57-30-01	Winglet Skin			X
57-30-02	Wing Tip Structure			X
57-30-02	Winglet Structure			X
57-41-01	Wing Inboard Fixed Leading Edge Skin			X
57-41-01	Wing Outboard Fixed Leading Edge Skin			X
57-41-02	Wing Inboard Fixed Leading Edge Structure			X
57-41-02	Wing Outboard Fixed Leading Edge Structure			X

WING STRUCTURE				
ATA NUMBER	DESCRIPTION	PRIMARY		SECONDARY
		PSE	OTHER	
57-42-01	Wing Slat Leading Edge Skin			X
57-42-02	Wing Slat Leading Edge Structure			X
57-43-02	Wing Leading Edge Flap Structure			X
57-43-90	Wing Leading Edge Flap Fittings			X
57-51-01	Wing Fixed Trailing Edge Skin			X
57-51-02	Wing Fixed Trailing Edge Structure			X
57-51-14	Main Landing Gear Beam	X		
57-53-01	Inboard/Outboard Trailing Edge Flap Skin (Structures Adjacent to and Between Supports on the Main Flap)			X
57-53-02	Inboard/Outboard Trailing Edge Flap Structure (Structures Adjacent to and Between Supports on the Main Flap)	X		
57-53-02	Inboard/Outboard Trailing Edge Flap Structure (Aft Flaps and Cantilevered Part of the Main Flaps)			X
57-53-70	Wing Trailing Edge Flap Track Fairing Skin			X
57-53-71	Wing Trailing Edge Flap Track Fairing Structure			X
57-60-01	Aileron Skin			X
57-60-01	Aileron Tab Skin			X
57-60-02	Aileron Structure			X
57-60-02	Aileron Tab Structure			X
57-60-90	Aileron Tab Fittings			X
57-60-90	Aileron Fittings			X
57-70-01	Spoiler Tab Skin			X
57-70-01	Spoiler Inboard Skin			X
57-70-02	Spoiler Outboard Skin			X
57-70-02	Spoiler Inboard Structure			X
57-70-02	Spoiler Outboard Structure			X
57-70-90	Spoiler Actuator Fittings	X		

GENERAL - CROSS REFERENCES FOR BOEING SOURCE DOCUMENTS

1. **General**

   A. Some of the data that you find in Chapter 51 comes from the Boeing Process Specifications Document (D-18888-1) and other Boeing source documents.

   B. Refer to Table 1/GENERAL for a list of source documents that are used to make the information contained in Chapter 51. They are listed in order by ATA Chapter-Section-Subject in the Structural Repair Manual (SRM). If the source document is used only as a reference, it is not included in Table 1/GENERAL.

Table 1:

SRM CHAPTER 51 - BOEING DOCUMENTS CROSS REFERENCES		
ATA NUMBER	**SOURCE DOCUMENT**	**SUBJECT**
51-20-02	BAC 5946	Temper Inspection of Aluminum
51-20-05	BAC 5000	Mating Surface and Fillet Seals
	BACD2027	Countersink Symbols and Dimensions
51-20-06	BAC 5730	Shot Peening
51-20-01	D6-5000	Protective Finish Application
51-30-01	BAC 5300	Forming, Straightening, and Fitting of Metal Parts
51-40-02 51-40-04	BAC 5004	Installation of Permanent Fasteners
51-40-05 51-40-06	BAC 5004-1	Installation of Solid Rivets
51-40-08	BAC 5004-2	Installation of Permanent Straight Shank Fasteners
	BAC 5004-3	Installation of Blind Fasteners
	BAC 5009	Bolt and Nut Installation
	BAC 5054	Installation of Taper Shank Fasteners
	BAC 5060	Installation of Interference Fit, Radius Lead-in Fasteners
	BAC 5047 BAC 5047-1 BAC 5047-2	Installation of Fluid-Tight Fasteners
	BAC 5049	Dimpling and Countersinking
	BAC 5063	Fastener Installation in Composite Structure
	BACD2027	Countersink Symbols and Dimensions
51-40-09	BAC 5768	Mandrel Cold Working of Holes in Aluminum
	BAC 5973	Sleeve Cold Working of Holes in Aluminum
51-70-14	BAC 5598	Bonding Aluminum Foil to Composite Parts

GENERAL - STRUCTURAL REPAIR DEFINITIONS

1. Applicability

A. This subject gives the definitions related to repair classification and inspection for damage-tolerant and non-damage tolerant primary and secondary structures as applicable.

2. References

Reference	Title
51-10-02	INSPECTION AND REMOVAL OF DAMAGE
SOPM 20-20-01	Magnetic Particle Inspection
SOPM 20-20-02	Penetrant Methods of Inspection

3. General Information

A. There are two classifications of repairs in this SRM:

(1) Repairs that have been evaluated and analyzed for damage tolerance capability and are classified as Category A, B, or C repairs.

NOTE: Repairs to Principle Structural Elements (PSE's) in the wing, nacelle and pylon structures (identified in 51-00-04) are required to be evaluated for damage tolerance capability.

(2) Repairs that have not been evaluated and analyzed for damage tolerance capability and are classified as Permanent, Interim or Time-Limited Repairs. These classifications apply to all fuselage and empennage repairs

B. The definitions of the different categories of damage tolerant repairs are as follows:

(1) Category A Repair: A permanent repair for which the inspections given in the Maintenance Planning Data (MPD) document, are sufficient and no other actions are necessary.

(2) Category B Repair: A permanent repair for which supplemental inspections are necessary at the specified threshold and repeat intervals.

(3) Category C Repair: A time-limited repair which must be replaced and reworked within a specified time limit. Also supplemental inspections can be necessary at a specified threshold and repeat interval.

C. The definitions of the different types of repairs that have not been evaluated and analyzed for damage tolerance are as follows:

(1) Permanent Repair: A repair where no action is necessary except the operator's normal maintenance.

(2) Interim Repair: A repair that has the necessary structural strength and could stay on the aircraft indefinitely. The repair must be inspected at specified intervals and replaced if deterioration is detected or damage is found.

(3) Time-Limited Repair: A repair that has the necessary structural strength but does not have sufficient durability. This repair must be replaced after a specified time, usually given as a number of flight cycles, flight hours or a calendar time.

D. The definitions of the terms as they apply to the repairs are as follows:

(1) Damage Tolerance: The ability of structure to sustain anticipated loads in the presence of damage, such as fatigue cracks until it is detected through inspection or malfunction and repaired.

(2) Damage Tolerant Repair: A repair that meets the necessary damage tolerance conditions.

(3) Repeat Intervals: The period in flight cycles, flight hours or calendar time that occurs between the necessary inspections.

(4) Supplemental Inspections: Special inspections of the repaired structure which are done in addition to an operator's normal maintenance inspections.

(5) Threshold: The period in flight cycles, flight hours or calendar time from the time an airplane is delivered or a repair is made until the first supplemental inspection is necessary. For Category B repairs, the threshold starts from the time the repair was installed if the repair fasteners in the critical rows have been installed in new fastener holes or existing fastener holes that have been zero-timed. If the repair fasteners are installed in existing fastener holes that have not been zero-timed, the inspection threshold will start from the time the airplane was delivered.

(6) Time Limit: The maximum period in flight cycles, flight hours or calendar time that is permitted until it is necessary to replace or rework a time-limited repair.

(7) Zero-Timing: The process used to improve the repair durability in order to make the inspection threshold start from the time the repair is installed. This involves the removal of small cracks and fatigue damaged material by oversizing the existing fastener holes before the repair is installed as given in 51-10-02. Zero-timing must only be used where specifically permitted in an SRM chapter-section-repair. Also zero-timing must not cause short edge-margin and fastener spacing, and knife-edging on the repair fasteners.

(8) Critical Fastener Row: Fastener row to be inspected to meet damage tolerance requirements.

(9) Zonal Inspection: A General Visual Inspection of each aircraft zone, defined by access and area as given in the Maintenance Planning Data (MPD) document, to check system and powerplant installation and structure for security and general condition.

(10) Types of Inspections:

(a) General Visual (Surveillance) Inspection (GVI): A visual examination of an interior or exterior area, installation or assembly to detect obvious damage, failure or irregularity. This level of inspection is made from within touching distance unless otherwise specified. A mirror may be necessary to enhance visual access to all exposed surfaces in the inspection area. This level of inspection is made under normally available lighting conditions such as daylight, hangar lighting, flashlight or drop-light and may require removal or opening of access panels or doors. Stands, ladders or platforms may be required to gain proximity to the area being checked.

(b) Detailed Inspection (DET): An intensive examination of a specific item, installation or assembly to detect damage, failure or irregularity. Available lighting is normally supplemented with a direct source of good lighting at an intensity deemed appropriate by the inspector. Inspection aids such as mirrors, magnifying lenses, etc. may be used. Surface cleaning and elaborate access procedures may be required.

(c) Special Detailed (Non-Destructive Testing) Inspection (SDI): An intensive examination of a specific item(s), installation, or an assembly to detect damage, failure or irregularity. The examination is likely to make extensive use of specialized inspection techniques and/or equipment. Intricate cleaning and substantial access or disassembly procedure may be required. Non-Destructive Testing (NDT) inspections are used to examine all subsurface damage and most small surface cracks. NDT is also used in areas where a visual inspection is not sufficient to find the dimensions of damage. NDT procedures recommended for use in the SRM are as follows:

1) Eddy Current: An NDT procedure which uses eddy current to find damage in metals that have good conductivity properties. The Eddy Current inspection is the preferred NDT procedure used to find most damage on metal parts. The three types of Eddy Current inspections used in the SRM are as follows:

   High Frequency Eddy Current (HFEC) Inspection: Used to find surface cracks, porosity and corrosion.

   Medium Frequency Eddy Current (MFEC) Inspection: Used to find subsurface cracks in the first layer that start and grow along the faying surface. It also will detect the surface cracks.

   Low Frequency Eddy Current (LFEC) Inspection: Used to find subsurface cracks, and corrosion.

   Refer to Part 6 of the NDT Manual for Eddy Current inspection procedures.

2) Ultrasonic: An NDT procedure which uses sound waves to find surface or subsurface damage (cracks, porosity, delamination, or disbonds, for example) on metal and composite materials that have good permeability properties. Refer to Part 4 of the NDT Manual for Ultrasonic inspection procedures.

3) Resonance Frequency: A tap test NDT procedure that can be used to find delaminations and interply disbonds in composite, honeycomb or bonded structures that have thin skins. Refer to Part 1 of the NDT Manual for the Resonance Frequency inspection procedures.

4) X-Ray: An NDT procedure that uses radiography to find cracks and damage (disbonds, for example) in metallic and composite structures which cannot be accessed for visual inspection. X-Rays can identify if fluids are inside honeycomb parts and can be used to identify the dimensions of the damage. Refer to Part 2 of the NDT Manual for the X-Ray inspection procedures.

5) Magnetic Particle: An NDT procedure that applies a magnetic field to a ferro-magnetic part which has fine magnetic particles on the surface. The magnetic field causes the magnetic particles to group together in areas that have cracks on or near the surface. Refer to SOPM 20-20-01 for the Magnetic Particle inspection procedures.

6) Penetrant: Penetrant examination uses the property of a liquid to go into a defect that is open at the surface of the part. The liquid is applied to the surface and permitted to soak in. A developer is applied to pull the liquid out of the defect so it can be seen. Visible penetrants are examined under white light. Fluorescent penetrants are examined under ultraviolet light. Refer to SOPM 20-20-02 for the Penetrant inspection procedures.

GENERAL - DEFINITIONS OF TERMS USED IN THE STRUCTURAL REPAIR MANUAL (SRM)

1. Applicability

A. This subject gives the definitions for terms that are used in the SRM.

2. References

Reference	Title
51-00-04	STRUCTURAL CLASSIFICATION

3. General Information

A. The definitions that follow are applicable to terms that are used in the allowable damage and repair subjects throughout this manual.

(1) Adhesive-Supported: An adhesive that has a woven or non-woven carrier cloth.

(2) Adhesive System: A primer and an adhesive used for the metal-to-metal bond.

(3) Adhesive-Unsupported: An adhesive that has no carrier cloth.

(4) Back Pressure: Positive pressure in the vacuum bag during an autoclave cure cycle.

(5) Bagside: The side of a part or assembly that was cured against the vacuum bag during the manufacture of the part.

(6) Bake: An oven heat cycle that does not fully cure the primer (Type I) material.

(7) Bleeder: A porous material that gives a continuous path over and around the part. The bleeder removes the unwanted resin and volatile gasses from the repair.

(8) Bleed:

(a) To give up color when a surface or component touches water or solvents, or

(b) An unwanted movement of certain materials in adhesives to the surface of a bonded component or into adjacent materials, or

(c) To remove unwanted resin from an assembly during the cure cycle.

(9) Bleedout:

(a) The excess resin that moves to the surface. This normally occurs during filament winding, or

(b) The spread of adhesive away from the bond area.

(10) Bond Line: The adhesive that is between two parts after the cure.

(11) Breather: A porous material that gives a continuous air path above and around a repair.

(12) Bubble: A spherical internal void of air or gas that is trapped in a composite material.

(13) Buckling:

(a) Crimped or bent fibers in a composite material. This often occurs when the resin shrinks during the cure, or

(b) A mode of failure generally characterized by an unstable lateral material deflection that is a result of compressive action on the structural part.

(14) Buckle Line: A line of collapsed honeycomb cells (normally 2-3 cells wide) with un-distorted cells on either side. These lines generally occur on the inner radius of the formed core.

(15) Build-up: An area inside a laminate that is made thicker with added plies or layers of material.

(16) Butt Splice: Two pieces of material that are adjacent to each other without an overlap to make a continuous surface.

(17) Cold Bond: A fiberglass reinforced wet layup that is applied to a composite part and is cured at 20°F (minimum) below the initial cure temperature of the component. This is also referred to as a cold wrap.

(18) Cold Wrap: A fiberglass reinforced wet layup that is applied to a composite part and is cured at 20°F (minimum) below the initial cure temperature of the component. This is also referred to as a cold bond.

(19) Compaction, or Ply Compaction: To install a temporary vacuum bag to compress the plies in a layup. This will remove trapped air and compact the layup.

(20) Core: Metallic or non-metallic honeycomb structure that is bonded between two facesheets in a sandwich construction.

(21) Core Distortion: A condition that causes the shape of the core cells to change from a normal shape to a skewed shape.

(22) Core Ribbon Direction: The direction parallel to the bondline of the adjacent cells of a honeycomb core.

(23) Core Splice Adhesive: An adhesive that is used to connect the pieces of core to make a bond.

(24) Cure Cycle: The pressure and heat that is applied to a part during the cure for a specified time.

(25) Cure Period: The specified time that a part stays at the cure temperature.

(26) Cure Temperature:

(a) The temperature that is applied to the assembly during the cure cycle, or

(b) The minimum temperature or temperature range necessary in a cure cycle to fully cure a composite component.

(27) Cure Time: The length of time that a part is at the cure temperature and pressure or vacuum. The cure time does not include the time necessary to get the component to the cure temperature.

(28) Delamination: A separation of the plies from each other.

(29) Edge Delamination: A separation of the skins or plies from each other at the edge of a part.

(30) Edge Void: An area where there is no adhesive along an edge after the cure.

(31) Facesheet: The skin that is bonded to the core in a sandwich construction.

(32) Fiber breakout: A fiber separation or broken fibers on the surface plies at drilled holes or machined edges.

(33) Filler Ply: A ply that is used to fill a recess in the repair area.

(34) Handling Life: The total time that a material can be out of cold storage and still have its tack and drape for forming to the final contour.

(35) Inclusions: Unwanted material like particles, chips and films in a cured part.

(36) Instrumented NDT: An inspection that uses approved instrumentation to find internal defects or flaws in a material.

(37) Lagging Thermocouple: The thermocouple that shows the slowest heating and cooling rates.

(38) Lap Splice: Two pieces of material in the same ply layer that make an overlap joint.

(39) Layup: The application of repair plies impregnated with a laminating resin to a damaged part.

(40) Leading Thermocouple: The thermocouple that shows the fastest heating and cooling rates.

(41) Mechanical Life: The total time that an adhesive can stay out of cold storage before the start of the cure.

(42) Mechanical Pressure: A pressure that is applied by non-fluid means, such as weight bags, jacks, or other devices.

(43) Metal-to-Metal Construction: An assembly that has no honeycomb structure.

(44) Non-Destructive Test (NDT): An inspection procedure that uses methods that do not cause damage to the part.

(45) Part Temperature: The actual temperature of the repair part, measured by a pyrometer (thermocouples or other probes) during the cure cycle.

(46) Ply (Non-structural): A ply or layer in a composite structure that is not needed to transmit loads, but is used:

  (a) As isolation from other materials, or

  (b) As a barrier from moisture and other contamination, or

  (c) As a filler to get a needed contour, or

  (d) To get the needed smoothness (can be sanded to get the necessary result).

(47) Ply (Structural): A ply or layer in a composite structure that is used to transmit loads.

(48) Ply Wrinkle: An out-of-plane distortion of fibers in a cured part.

(49) Porosity: Very small bubbles of air that are trapped during the cure, or a cluster of small trapped pockets of air, gas or vacuum, inside a solid composite material. Porosity does not refer to the surface conditions.

(50) Post Cure: An added elevated-temperature cure, usually without pressure to improve the final properties or fully cure a repair.

(51) Pot Life: The time that a resin system or potting compound can be applied. Sometimes it is referred to as working life.

(52) Pourcoat: A liquid honeycomb sealant material used to make the honeycomb core stable after crushing or as a seal from moisture that may enter the cell walls.

(53) Prepreg, or Preimpregnated Material: Fabric or tape that is impregnated with resin by the manufacturer.

(54) Primary Structure: Structural components or assemblies that are necessary to sustain design ultimate flight and ground loads. Refer to 51-00-04 for the locations of primary and secondary structure.

(55) Secondary Structure: Structural components that unload into primary structure, such as fairings and most control surfaces.

(56) Repair: The rebuild or rework of a damaged assembly to return it to all or part of its initial strength.

(57) Ribbon Direction: The direction that is parallel to the bond line of the adjacent cells in a honeycomb core.

(58) Room Temperature: Ambient temperature conditions. For engineering functions, this temperature is 65°F (18°C) to 90°F (32°C).

(59) Selvage: The woven edge of a reinforcement fabric.

(60) Storage Life: The maximum collected time that a material can be in cold storage before it becomes non-serviceable.

(61) Taper Ratio: The ratio of the length of a taper sand to its depth.

(62) Toolside: The side of the part or assembly that is cured against the tool, mold or mandrel during the manufacture of the part.

(63) Vacuum Bag: A film material that is used to cover and seal against the tool surface where a vacuum or pressure is applied.

(64) Void:

(a) An area where the adhesive is missing, or

(b) A delamination, or an area where there the mating surfaces do not touch, or

(c) An empty space in a cured resin-fiber system.

(65) Warp: The lengthwise yarns of the fabric reinforcements that are parallel to the selvage.

(66) Water-Break-Free Surface: A metallic surface that keeps a continuous water film for a minimum of 30 seconds with clean water that is less than 100°F (38°C).

(67) Wet Layup: Repairs made with dry fabric soaked with a laminating resin system.

GENERAL - AERODYNAMIC SMOOTHNESS REQUIREMENTS

1. General

A. The 737 airplane must have an aerodynamically clean shape and a smooth external surface to give high performance. It is important to keep the initial contour and smoothness of the external surfaces of the airplane. The conditions that follow decrease the performance of the airplane:

(1) Damage that is not repaired

(2) Dents that are not filled

(3) Repairs that change the shape of the external surface.

B. The aerodynamic surfaces of the airplane are divided into three areas of aerodynamic smoothness as shown in Aerodynamic Smoothness Areas, Figure 1/GENERAL.

(1) Extra critical aerodynamic surfaces are those surfaces where the airflow has a direct effect on flight critical instruments, loss of local lift force, or high drag or thrust loss caused by high-speed flow. The shape of structural components that have an effect on local lift forces must be carefully controlled to prevent premature stalling. The extra critical areas are:

(a) Surfaces near the pitot probes, angle-of-attack sensors, and static ports.

(b) Upper and lower surfaces forward of the wing leading edge splice straps that are common to the fixed leading edge, slats, or other leading edge devices, and wingtips.

(c) Horizontal and vertical tail leading edge surfaces forward of the front spar.

(d) Leading edge areas of high-lift devices and flight control surfaces such as the wing trailing edge flaps, ailerons, and elevators.

(e) Surfaces on the nacelle or pylon as follows:

1) Bottom of the aft strut fairing, aft of the fan nozzle trailing edge in the area washed by the fan exhaust plume.

2) Internal and external sides of the inlet cowl skin including both sides of the lip skin/ inner barrel joint.

(2) Critical aerodynamic surfaces are those surfaces that must have a high level of aerodynamic smoothness. The critical areas are:

(a) Fuselage nose to fuselage station 664, but not including the areas specified as extra critical.

(b) Wing upper surface from the leading edge to the rear spar centerline but not including the areas specified as extra critical.

(c) The upper surface of the ailerons and the upper surface of the wings forward of the ailerons to the wing rear spar centerline.

(d) Both sides of the horizontal (upper and lower) and vertical tail (left and right) external surfaces between the centerlines of the front and rear spars.

(e) The upper and lower surfaces of the elevators.

(f) Nacelle and pylon areas shown in Aerodynamic Smoothness Areas, Figure 1/GENERAL and Aerodynamic Smoothness - Nacelle and Strut (CFM56-7 Engine), Figure 6/GENERAL, Detail A.

(3) All other surfaces are non-critical aerodynamic surfaces.

C. Refer to Table 1/GENERAL for a list of the aerodynamic smoothness drawings for the fuselage, wing, empennage, and nacelle and strut.

Table 1: AERODYNAMIC SMOOTHNESS DRAWINGS

AERODYNAMIC SMOOTHNESS DRAWINGS	
DRAWING NUMBER	TITLE
041A5100	Aerodynamic Smoothness Requirements - Fuselage, 737
041A5110	Aerodynamic Smoothness Requirements - Empennage, 737
110A4151	Aerodynamic Smoothness Requirements - Wing, 737
69-16254*[1]	Tolerances for Flush Skin Fasteners, Wing
302A2000	Aerodynamic Smoothness Requirements - Strut and Nacelle - CFM56-7 Engine

*[1] Note: This drawing is applicable to all 737 airplanes.

CAUTION: WEAR SHOES WITH SOFT SOLES OR OVERSHOES OF SOFT RUBBER WHEN YOU WORK OR WALK IN AND AROUND EXTRA CRITICAL AND CRITICAL AERODYNAMIC AREAS. THIS WILL HELP TO PREVENT DAMAGE TO THE SURFACES. IF YOU DO NOT OBEY, THE PERFORMANCE OF THE AIRPLANE WILL DECREASE.

D. For the best airplane performance, use a flush repair instead of an external repair in extra critical and critical aerodynamic areas. If you can not use a flush repair instead of an external repair, do as follows:

(1) Make sure there is a chamfer on the external repair patch. Refer to Aerodynamic Smoothness Requirements, Figure 2/GENERAL, Detail A for the typical dimensions of the chamfer.

(2) Make sure the external repair is put in position and agrees with the conditions of the sensitive areas as shown in Aerodynamic Smoothness - Fuselage, Figure 3/GENERAL through Aerodynamic Smoothness - Nacelle and Strut (CFM56-7 Engine), Figure 6/GENERAL.

(3) Refer to 51-10-03 if the airplane is approved for Reduced Vertical Separation Minimum (RVSM) operation and has damage near the primary static ports.

E. For joints and fasteners in extra critical and critical areas, the following requirements are applicable:

(1) All joints, except the longitudinal lap splices of the fuselage skin, must be sufficiently smooth to agree with the extra critical and critical aerodynamic smoothness requirements.

(2) The heads of fasteners that are not flush must agree with the limits given in Aerodynamic Smoothness Requirements, Figure 2/GENERAL through Aerodynamic Smoothness - Nacelle and Strut (CFM56-7 Engine), Figure 6/GENERAL.

(3) BMS 5-95 or BMS 5-142 aerodynamic smoother must be used in the areas that follow (Refer to AMM 51-31-00/201):

(a) All spaces between skins. Refer to Aerodynamic Smoothness Requirements, Figure 2/GENERAL, Detail B.

(b) All permanently installed bolts and screws that are below the initial contour.

F. For joints and fasteners in non-critical areas:

(1) Refer to Aerodynamic Smoothness Requirements, Figure 2/GENERAL, Detail C for definitions of positive steps and negative steps that can occur at skin butt joints.

(2) Apply BMS 5-95 or BMS 5-142 aerodynamic smoother at all joints except the access panels which are used frequently. Refer to Aerodynamic Smoothness Requirements, Figure 2/GENERAL, Detail B.

(3) Chordwise lap joints are permitted on the fuselage aft of the wing rear spar.

(4) It is not necessary to apply aerodynamic smoother to the heads of bolts and screws.

G. Refer to Table 2/GENERAL and Figure 2, Details D through G, for more aerodynamic smoothness data that are common to the external surfaces of the fuselage, empennage, wing, and nacelle and strut structure.

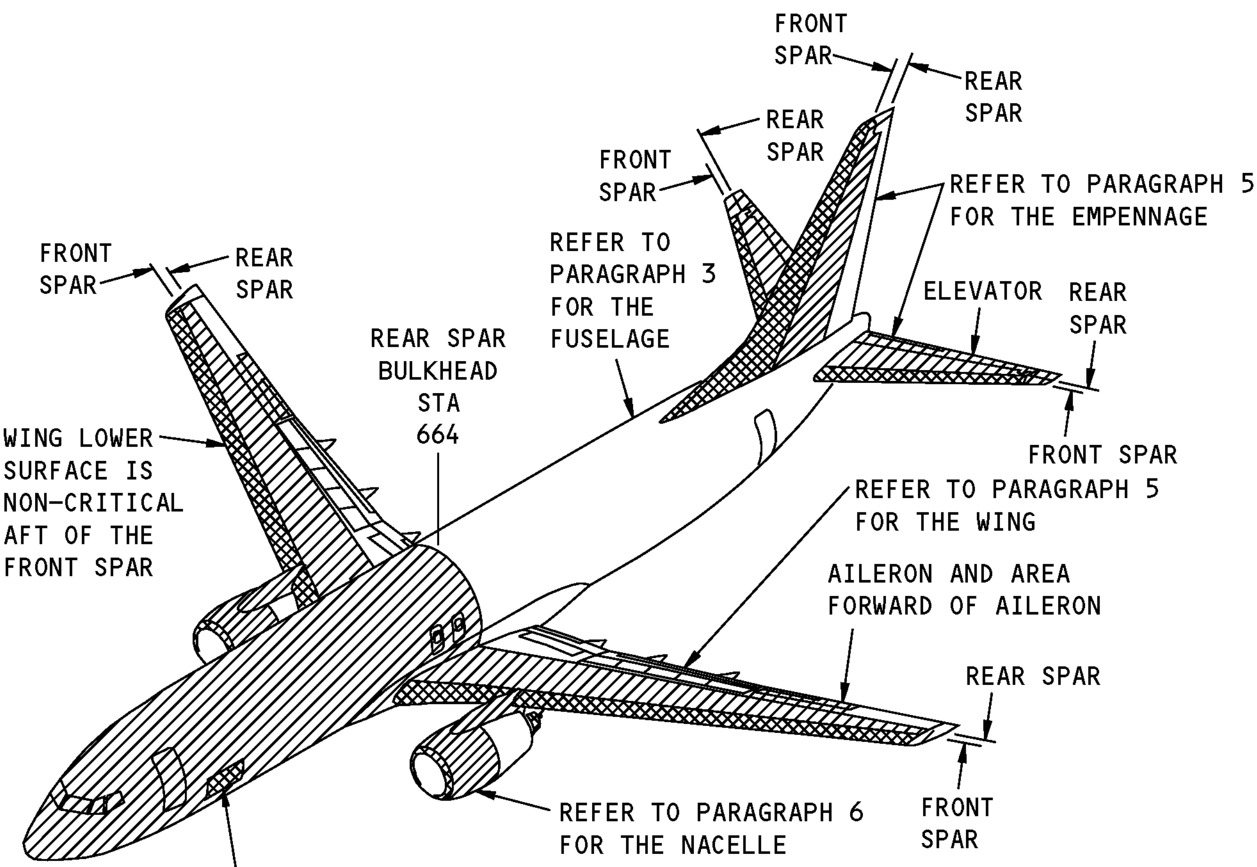
Table 2: AERODYNAMIC SMOOTHNESS DATA FOR THE EXTERNAL SURFACES OF THE AIRPLANE

AERODYNAMIC SMOOTHNESS DATA FOR THE EXTERNAL SURFACES OF THE AIRPLANE	
DESCRIPTION	**FIGURE 2 DETAIL**
Typical Chamfered External Repair Patch	A
Aerodynamic Smoother for Gaps	B
Aerodynamic Step	C
Skin Waviness Measurement	D
Permitted Gap Width and Depth	E
Fastener Flushness Measurement	F
Fastener Flushness Measurement on Contoured Surfaces	G
Surface Roughness Limits	NOTES

H. Refer to Table 3/GENERAL for the Paragraph, Figure, and SRM Section references for the aerodynamic smoothness of the airplane.

Table 3: PARAGRAPH, FIGURE, AND SRM SECTION REFERENCES FOR THE AERODYNAMIC SMOOTHNESS OF THE AIRPLANE

PARAGRAPH, FIGURE, AND SRM SECTION REFERENCES FOR THE AERODYNAMIC SMOOTHNESS OF THE AIRPLANE			
AIRPLANE STRUCTURE	**PARAGRAPH**	**FIGURE**	**SRM SECTION**
Fuselage	3	3	———————
Fuselage - Areas near the Air Data Sensors	4	4	SRM 51-10-03 (if the airplane is approved for Reduced Vertical Separation Minimum (RVSM) operation)
Empennage and Wing	5	5	———————
Nacelles and Struts	6	6	———————
Fasteners (Microshaving)	7, 8	7	———————



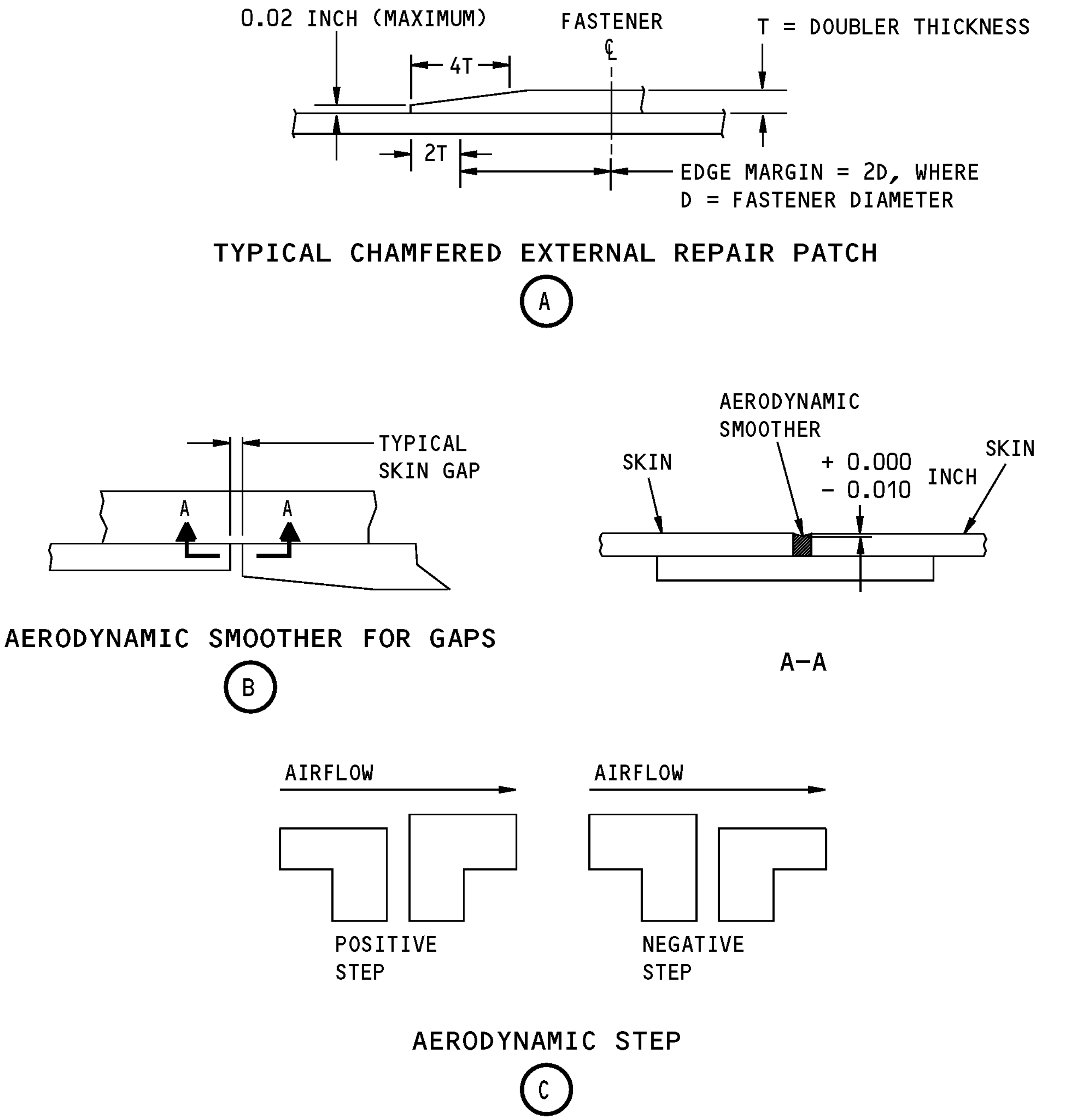
EXTRA CRITICAL AREA. EXTRA HIGH LEVEL OF AERODYNAMIC SMOOTHNESS IS NECESSARY.

CRITICAL AREA INCLUDES INTERNAL NACELLE AIRFLOW SURFACES AND THE LEADING EDGE (FIRST 20 PERCENT OF THE CHORD) OF ALL HIGH LIFT DEVICES AND CONTROL SURFACES. HIGH LEVEL OF AERODYNAMIC SMOOTHNESS IS NECESSARY.

NON-CRITICAL AREA

A

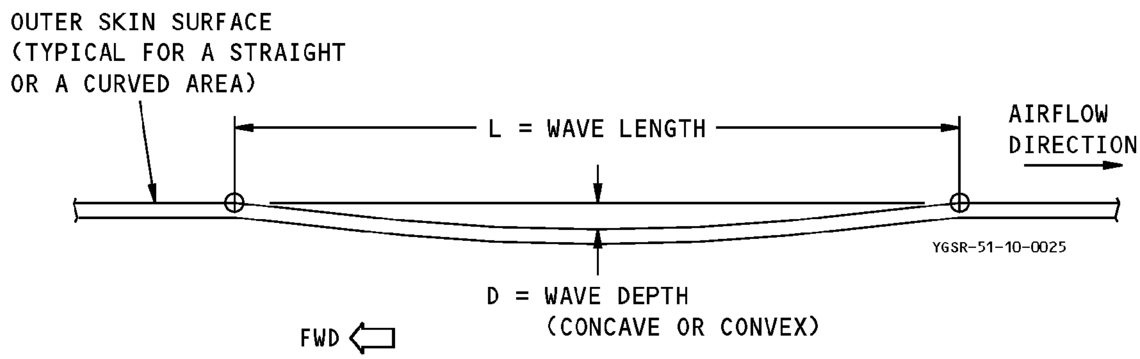
Aerodynamic Smoothness Areas
Figure 1



NOTES

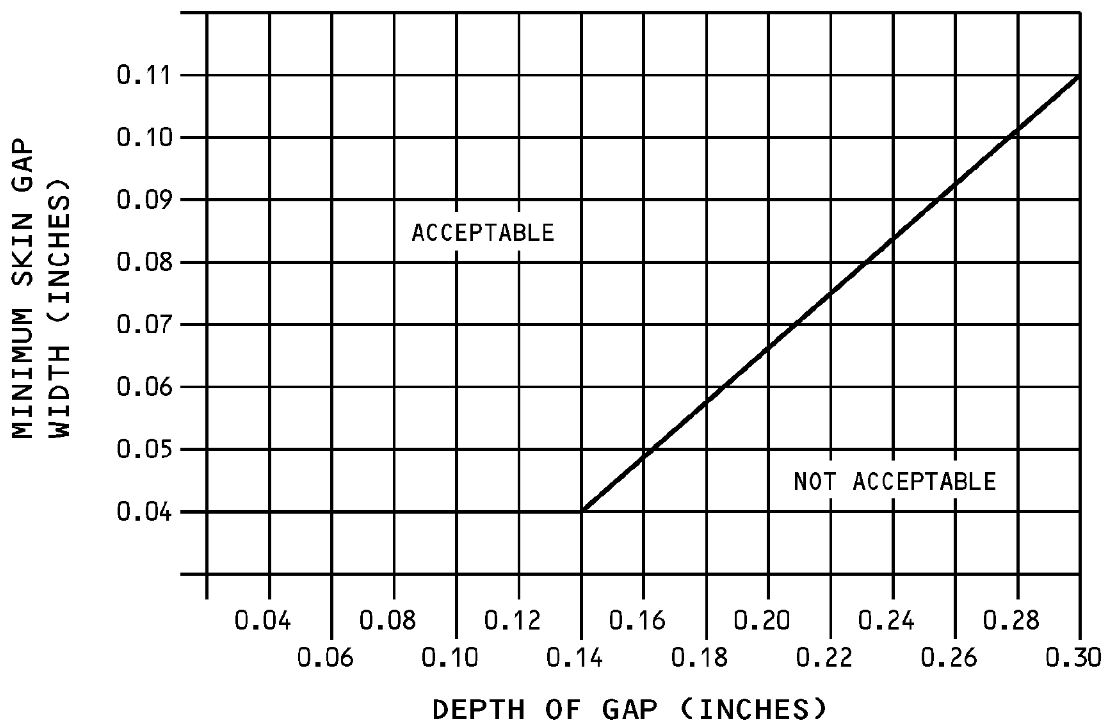
- SURFACE FINISH IN EXTRA CRITICAL AND CRITICAL AREAS MUST BE 130 MICROINCHES OR BETTER WITH A 0.03 INCH CUTOFF.
- SURFACE FINISH IN NON-CRITICAL AREAS MUST BE 180 MICROINCHES OR BETTER WITH A 0.03 INCH CUTOFF.

Aerodynamic Smoothness Requirements
Figure 2 (Sheet 1 of 4)



SKIN WAVINESS MEASUREMENT

D

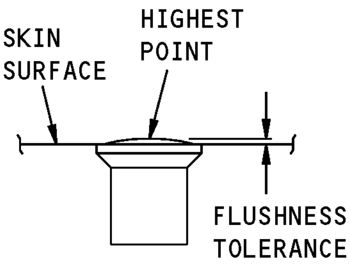


NOTE: THE CORRECT RATIO OF THE WIDTH OF THE GAP TO THE DEPTH OF THE GAP IS NECESSARY TO MAKE SURE THAT THE AERODYNAMIC SMOOTHER HAS A SUFFICIENT BOND.

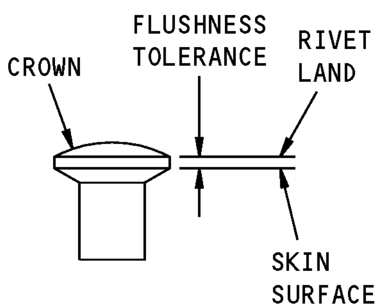
PERMITTED GAP WIDTH AND DEPTH

E

Aerodynamic Smoothness Requirements
Figure 2 (Sheet 2 of 4)

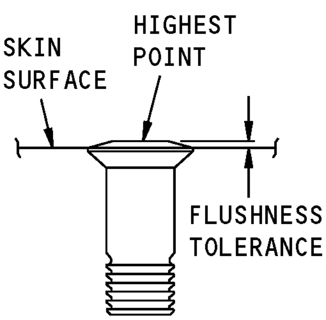


BACR15GF



FASTENER FLUSHNESS FOR BACR15CE RIVETS IS MEASURED BY THE HEIGHT OF THE RIVET LAND (NOT THE CROWN) ABOVE THE SKIN SURFACE.

BACR15CE



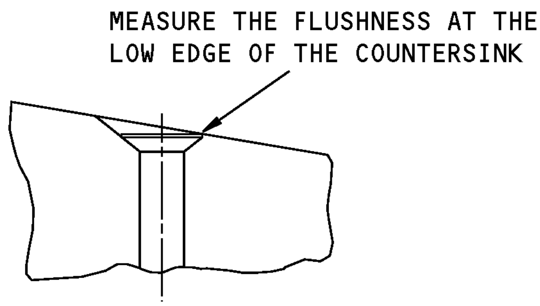
BACB30XT, BAC30XU, BACB30YP

NOTE: FASTENER FLUSHNESS IS MEASURED FROM THE HIGHEST POINT OF THE INSTALLED FASTENER TO THE SKIN SURFACE.

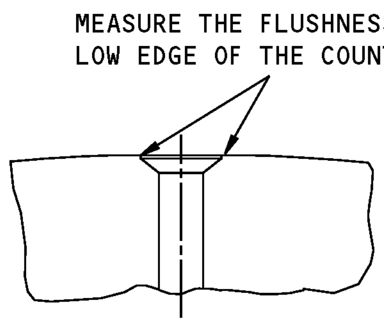
FASTENER FLUSHNESS MEASUREMENT

F

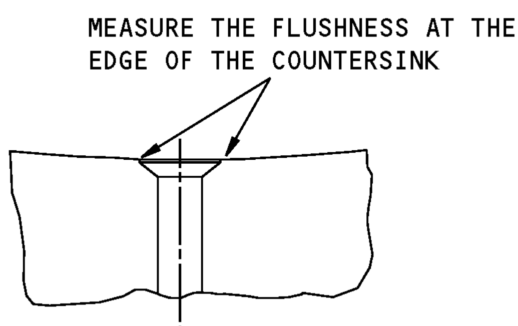
Aerodynamic Smoothness Requirements
Figure 2 (Sheet 3 of 4)



FLUSH FASTENER INSTALLATION ON A SLANTED SURFACE



FLUSH FASTENER INSTALLATION ON A CONVEX SURFACE



FLUSH FASTENER INSTALLATION ON A CONCAVE SURFACE

FASTENER FLUSHNESS MEASUREMENT ON CONTOURED SURFACES

G

Aerodynamic Smoothness Requirements
Figure 2 (Sheet 4 of 4)

2. References

Reference	Title
51-10-03	SKIN WAVINESS INSPECTION FOR RVSM OPERATION
51-20-01	PROTECTIVE TREATMENT OF METALLIC AND COMPOSITE MATERIALS
51-30-05	EQUIPMENT AND TOOLS FOR REPAIRS
53-00-01	FUSELAGE SKIN
AMM 51-31-00	SEALS AND SEALING
AMM 51-31-00/201	Seals And Sealing - Maintenance Practices

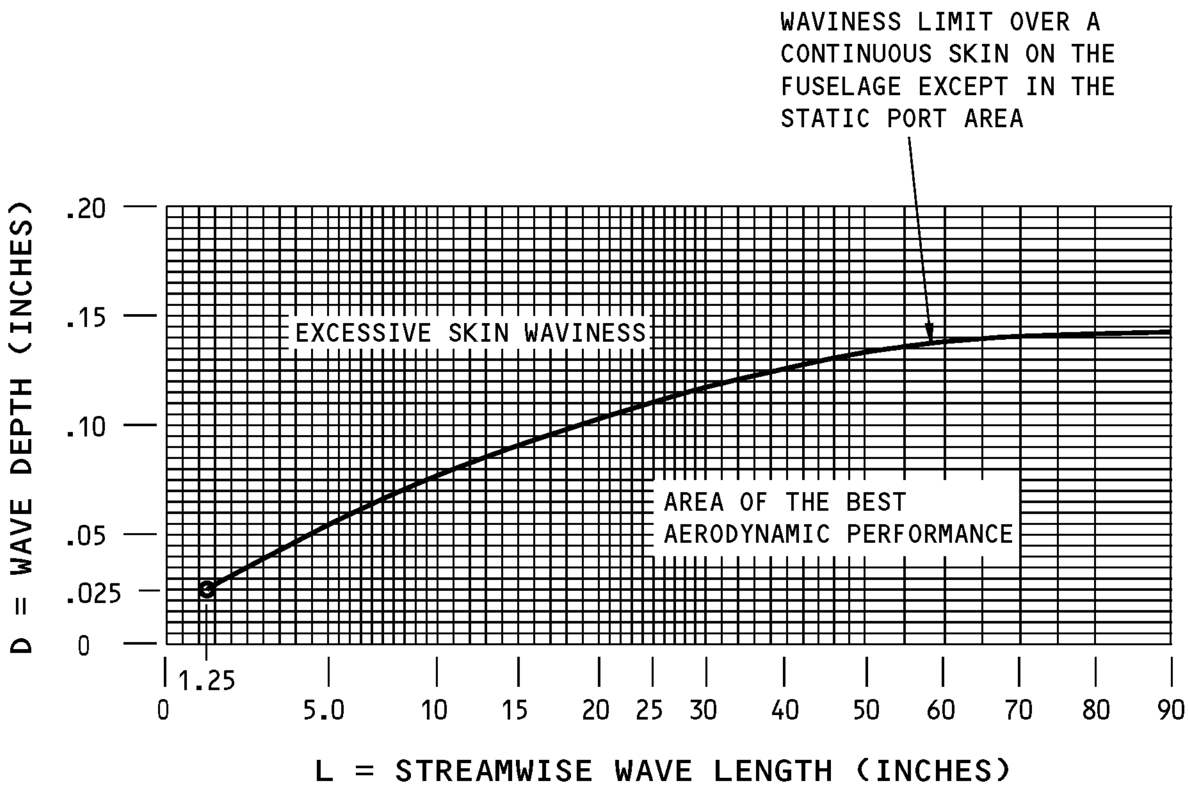
3. Aerodynamic Smoothness of the Fuselage

A. Refer to Aerodynamic Smoothness - Fuselage, Figure 3/GENERAL, Detail A and Figure 2, Detail D for the limits of skin waviness.

B. Refer to Aerodynamic Smoothness - Fuselage, Figure 3/GENERAL, Details B and C, and Figure 2, Detail E, for the gaps and mismatches that are permitted at fuselage skin joints.

C. Refer to Aerodynamic Smoothness Requirements, Figure 2/GENERAL, Details F and G for measuring fastener flushness.

D. Refer to Aerodynamic Smoothness - Fuselage, Figure 3/GENERAL, Table A for the fastener flushness data in the extra critical, critical, and non-critical areas of the fuselage. Refer to Aerodynamic Smoothness Areas, Figure 1/GENERAL.



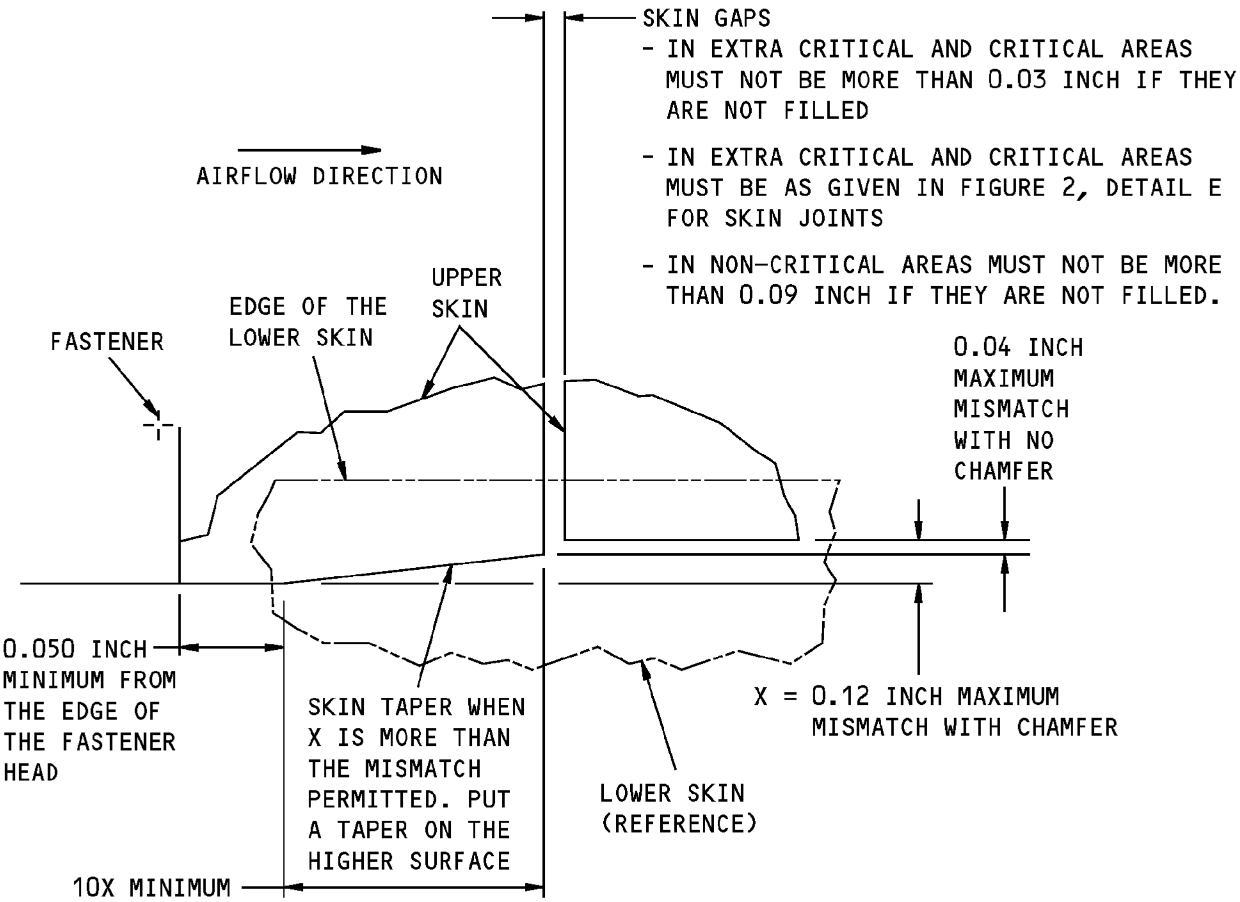
NOTE: THE AIRPLANE CAN FLY IN THE AREA OF EXCESSIVE SKIN WAVINESS BUT WITH A DECREASE IN AERODYNAMIC PERFORMANCE IF:

- THE SKIN SMOOTHNESS IS LESS THAN THE LIMITS OF SRM 53-00-01, FIGURE 102, DETAIL G BUT MORE THAN THE SKIN WAVINESS LIMIT SHOWN.

FUEL CONSUMPTION WILL BE MORE WHEN THE SKIN WAVINESS IS MORE THAN THE LIMITS.

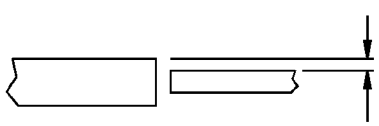
A

Aerodynamic Smoothness - Fuselage
Figure 3 (Sheet 1 of 2)



PERMITTED GAP AND MISMATCH AT FUSELAGE SKIN JOINTS

B



MAXIMUM PERMITTED MISMATCH
- 0.02 INCH FORWARD OF BS 664
- 0.03 INCH BETWEEN BS 664 AND BS 1012
- 0.04 INCH AFT OF BS 1012, BUT NOT AT BS 1016.
- 0.08 TO 0.12 INCH AT BS 1016 WHERE A MAXIMUM OF 36 INCHES OF THE TOTAL CIRCUMFERENCE OF THE FUSELAGE CAN HAVE MISMATCH. OF THE 36 INCHES WITH MISMATCH, CONTINUOUS LENGTHS MUST BE LESS THAN 12 INCHES

PERMITTED MISMATCH AT SKIN BUTT JOINTS

C

Aerodynamic Smoothness - Fuselage
Figure 3 (Sheet 2 of 2)

4. **Fastener Flushness Tolerances**

NOTE: In all areas, height measurements for all fasteners are made from the structural aerodynamic surface to the highest point on the fastener head.

NOTE: There is no differentiation between hand-installed and machine-installed rivets.

A. Fastener flushness tolerances for Flush - Shear Head Rivets

(1) In CRITICAL Areas of the Wing, Empennage, and Nacelle / Strut, the Tolerances will be:

- 90% = +.001 to +.004
- 10% = +.0005 to +.006
- All others will be shaved flush +.001 to +.003

(2) In NON-CRITICAL Areas of the Wing, Empennage, and Nacelle / Strut, the Tolerances will be:

- 90% = +.001 to +.005
- 10% = +.001 to +.007
- All others will be driven flush within -.002 to +.007 and may be shaved flush +.001 to +.003

NOTE: Micro Shaving is not permitted for reduced shear head rivets such as BACR15CE, BACR15GF or BACR15FV (as given in BAC5004-1).

B. Fastener Tolerances for Hex-Drive Bolts and Lockbolts

(1) Fastener flushness for BACB30WQ bolts = +.0055 ±.003.

(2) In EXTRA-CRITICAL Areas of the Wing, Empennage, and Nacelle / Strut, the Tolerances will be:

- 90% flat-head Hex-Drive Bolts and Lockbolts flush within ±.003
- 10% flat-head Hex-Drive Bolts and Lockbolts = -.005 to +.003
- Dome-head Hex-Drive Bolts and Lockbolts flush within +.0025 -.002/+.003

(3) In CRITICAL Areas of the Wing, Empennage, and Nacelle / Strut, the Tolerances will be:

- 90% flat-head Hex-Drive Bolts and Lockbolts flush within = ±.003
- 10% flat-head Hex-Drive Bolts and Lockbolts = -.005 to +.003
- Dome-head 5/32 (-5) and 3/16 (-6) Hex-Drive Bolts and Lockbolts flush within +.0045 ±.003.
- Dome-head 1/4 (-8) , 5/16 (-10) Hex Drive Bolts and Lockbolts flush within +.0055 ±.003

(4) In NON-CRITICAL Areas of the Wing, Empennage, and Nacelle / Strut, the Tolerances will be:

- All flat-head Hex-Drive and Lockbolts flush within +.0045 ±.003
- Dome-head 5/32 (-5) and 3/16 (-6) Hex-Drive Bolts and Lockbolts flush within +.0045 ±.003
- Dome-head 1/4 (-8) , 5/16 (-10) Hex Drive Bolts and Lockbolts flush within the +.0055 ±.003

C. Fastener flushness tolerances for CRITICAL and NON-CRITICAL areas of the fuselage for CE, GF and FV type rivets are as follows:

- A minimum of 90% flush within +.001 to +.006
- A maxinum of 10% may be flush within +.0061 to +.008.

NOTE: There is no differentiation between hand-installed and machine-installed rivets.

5. **Aerodynamic Smoothness in the Areas of the Fuselage Near the Air Data Sensors**

A. Refer to Figure 4/GENERAL, for the aerodynamic smoothness necessary for the skin adjacent to the components that follow:

NOTE: These limits given are applicable only to the aerodynamic effects on the angle-of-attack sensors, the pitot probes, and the static ports. You must also keep the structural limits applicable to repairs. While each repair can be satisfactory apart from other repairs in these locations, the sum of all the repairs can decrease airplane performance. You must try to prevent this. For Reduced Vertical Separation Minimum (RVSM) operation, the maximum number of repairs on the airplane in the extra critical area around the primary static ports is two. Refer to 51-10-03 for the data for RVSM operation.

(1) The angle-of-attack sensors

(2) The pitot probes

(3) The static ports.

B. The conditions that follow are applicable to repairs in the extra critical area adjacent to the angle-of-attack sensors. Refer to Figure 4/GENERAL, Details A and B for the locations of these sensors.

(1) Flush repairs are permitted in the area of the angle-of-attack sensor if:

(a) They do not change the initial contour of the airplane in the 200T by 200T zone, where T is the maximum thickness of the tapered shim. Refer to 53-00-01 for repairs.

(b) There are no tapered shims in the 200T by 200T zone.

(c) Only countersink fasteners are permitted.

(2) External repairs are permitted in the area of the angle-of-attack sensor if:

(a) The edges of the repair doubler are not in the 200T by 200T zone, where T is the maximum thickness of the external repair plate.

(b) The repair doubler extends across the entire 200T by 200T zone.

(c) You put a chamfer with a taper ratio of 4:1 with a maximum edge thickness of 0.02 inch (0.51 mm) on the edges of the repair doubler.

(d) The alignment of the vane of the sensor agrees with the limits given in the production drawings.

(3) Surface waviness must not be more than the limits given in Figure 4/GENERAL, Detail I.

C. Refer to Figure 4/GENERAL, Detail C for the conditions that are applicable to repairs in the extra critical area adjacent to the primary static ports.

NOTE: The extra critical area adjacent to the primary static ports is divided into Zone A, Zone B, and Zone C. These zones give the types of repairs that are permitted.

(1) For repairs in Zones A, B, and C, the definitions of repair length and width are as follows:

(a) The length is the direction of the repair that is parallel to the airplane centerline.

(b) The width is the direction of the repair that is perpendicular to the airplane centerline.

(2) The conditions that follow are applicable to repairs in Zone A.

(a) You can install external repairs if you satisfy the conditions given in 51-10-03:

1) You put a chamfer with a taper ratio of 4:1 on the edges of external repairs with a maximum thickness of 0.02 in. (0.51 mm). Refer to Figure 2/GENERAL, Detail A.

2) You use only countersink fasteners.

3) You do not use tapered shims in Zone A.

4) You do not put the edge of an external repair in Zone A.

5) You make sure that an external repair that is put into Zone A is positioned across all of the zone and agrees with the condition that follows:

a) The length of the repair must be more than 2.2 times the width (L > 2.2W).

(b) Flush repairs are not permitted in Zone A.

(c) In all cases, the surface waviness of the airplane skin in the area of a static port must be acceptable.

1) To find the surface waviness, do the steps that follow:

a) Find the primary static ports on each side of the fuselage.

b) Measure the skin waviness at a distance of 0.2 inch (5.1 mm) above and below each primary static port. Refer to Figure 4/GENERAL, Detail D.

- Align the center of a metal 6-inch scale with the center of the static port.
- Measure along a body waterline in the forward and aft direction.

c) Examine the area for a "dip" or "bulge" condition. Refer to Figure 4/GENERAL, Detail D.

- Dip: The skin touches the two ends of the scale but not the middle part of the scale.
- Bulge: The skin touches the middle part of the scale but not at the ends of the scale. There are two types of bulges.

  Bulge with Movement: The 6-inch scale can easily move up or down on the bulge.

  Bulge with Plateau: The 6-inch scale is on a level area of the bulge and is resistant to up and down movement.

d) Measure and record the waviness. Refer to Figure 4/GENERAL, Detail D. Record the data on the form in Figure 4/GENERAL, Detail E.

- Dip: Use a feeler gage to measure the maximum clearance between the middle part of the scale and the skin. Record this data as a negative (-) value.
- Bulge with Movement: Move the scale up or down to make the end touch the skin. When one end touches the skin, use a feeler gage to measure the clearance between the high end of the scale and the skin. Move the other end of the scale against the skin. Measure the clearance. Use the larger of the two values and record the data as a positive (+) value.
- Bulge with Plateau: Put the scale on the level area. Use a feeler gage to measure the clearance between the two ends of the scale and the fuselage skin. Use the larger of the two values and record the data as a positive (+) value.

e) Calculate the waviness for each of the four static ports. Refer to Figure 4/GENERAL, Detail D for an example of the calculations.

- If the measurements above and below the static ports are Dips: Waviness = (DIP above + DIP below)/2 = a negative (-) value
- If the measurements above and below the static ports are Bulges with Movement: Waviness = (BULGE above + BULGE below)/4 = a positive (+) value
- If the measurements above and below the static ports are Bulges with Plateau: Waviness = (BULGE above + BULGE below)/2 = a positive (+) value

- If one measurement is a Dip and the other measurement is a Bulge with Movement: Waviness = (DIP + 1/2 BULGE)/2 = a positive (+) or a negative (-) value
- If one measurement is a Dip and the other measurement is a Bulge with Plateau: Waviness = (DIP + BULGE)/2 = a positive (+) or a negative (-) value

f) The waviness must not be more than ±0.02 inch (±0.51 mm).

2) Rivets that are in a 3-inch radius from the center of a static pressure port are flush with the skin surface to a tolerance of +0.003 to -0.000 inch (+0.076 to -0.000 mm).

a) Make sure the fastener spacing is 2.0 inches (50.8 mm) to 3.0 inches (76.2 mm) in the circumferential and longitudinal directions.

3) The relation between waviness and streamwise length must agree with the values given in Figure 4/GENERAL, Detail H.

4) The surface contour changes must not be more than the limits given in Figure 4/GENERAL, Detail I.

(3) The conditions that follow are applicable to repairs in Zone B:

(a) You use only countersink fasteners.

(b) You make sure that an external repair that is in Zone B:

1) Is positioned across all of Zone B

2) Has a length that is more than the width (L > W)

3) Has a chamfer with a taper ratio of 4:1 on the edges of external repairs with a maximum thickness of 0.02 in. (0.51 mm). Refer to Figure 2/GENERAL, Detail A.

(c) You can install flush repairs if:

1) Tapered shims that are used have a minimum taper of 50:1 and are not less than 2.0 inches (50.8 mm) from Zone A.

(4) The conditions that follow are applicable to repairs in Zone C.

(a) You use only countersink fasteners.

(b) You put a chamfer with a taper ratio of 4:1 on the edges of external repairs with a maximum thickness of 0.02 in. (0.51 mm). Refer to Figure 2/GENERAL, Detail A.

(c) You can install flush repairs if:

1) Tapered shims that are used have a minimum taper of 50:1 and are not less than 2.0 inches (50.8 mm) from Zone A.

D. Refer to Figure 4/GENERAL, Details F and G for the conditions that are applicable to repairs in the extra critical area adjacent to the secondary static ports.

NOTE: The extra critical area adjacent to the secondary static ports is divided into Zone A, Zone B, and Zone C. These zones give the types of repairs that are permitted.

(1) For repairs in Zones A, B, and C, the definitions of repair length and width are as follows:

(a) The length is the direction of the repair that is parallel to the airplane centerline.

(b) The width is the direction of the repair that is perpendicular to the airplane centerline.

(2) The conditions that follow are applicable to repairs adjacent to the secondary static ports in Zone A.

(a) You can install external repairs if:

1) You put a chamfer with a taper ratio of 4:1 on the edges of external repairs with a maximum thickness of 0.20 inch (0.51 mm). Refer to Aerodynamic Smoothness Requirements, Figure 2/GENERAL, Detail A.
2) You use only countersink fasteners.
3) You do not use tapered shims in Zone A.
4) You do not put the edge of an external repair in Zone A.
5) You make sure that an external repair that is put into Zone A is positioned across all of the zone and agrees with these conditions:
   a) If the thickness of the repair doubler is more than 0.08 inch (2.03 mm) then the length of the repair must be more than 2 times the width (L > 2W).
   b) If the thickness of the repair is less than 0.08 inch (2.03 mm) then the length of the repair must be more than 1.5 times the width (L > 1.5W).

(b) You can install flush repairs if:
1) They do not change the initial contour of the airplane.
2) You use only countersink fasteners.
3) The surface contour of a repair in a 3-inch radius from the centerline of a static port does not have a wave depth of more than 0.007 inch (0.177 mm). To find the wave depth, do the steps that follow:
   a) Put the edge of a 6-inch scale across the center of the static pressure port in the forward and aft direction.
   b) Find the space between the skin and the scale. This space is the skin wave.
   c) Measure the space between the skin and the scale.
4) Rivets that are in a 3-inch radius from the center of a static pressure port are flush with the skin surface to a tolerance of +0.003 to -0.000 inch (+0.076 to -0.000 mm).
   a) Make sure the fastener spacing is 2.0 inches (50.8 mm) to 3.0 inches (76.2 mm) in the circumferential and longitudinal directions.
5) The relation between wave depth and wave length agree with the values given in Figure 4/GENERAL, Detail H.
6) The surface contour changes are not more than the limits given in Figure 4/GENERAL, Detail I.

(3) The conditions that follow are applicable to repairs in Zone B.

(a) You put a chamfer with a taper ratio of 4:1 on the edges of external repairs with a maximum thickness of 0.02 inch (0.51 mm). Refer to Aerodynamic Smoothness Requirements, Figure 2/GENERAL, Detail A.

(b) You make sure that an external repair that is in Zone B:
1) Is positioned across all of Zone B
2) Has a length that is more than the width (L > W).

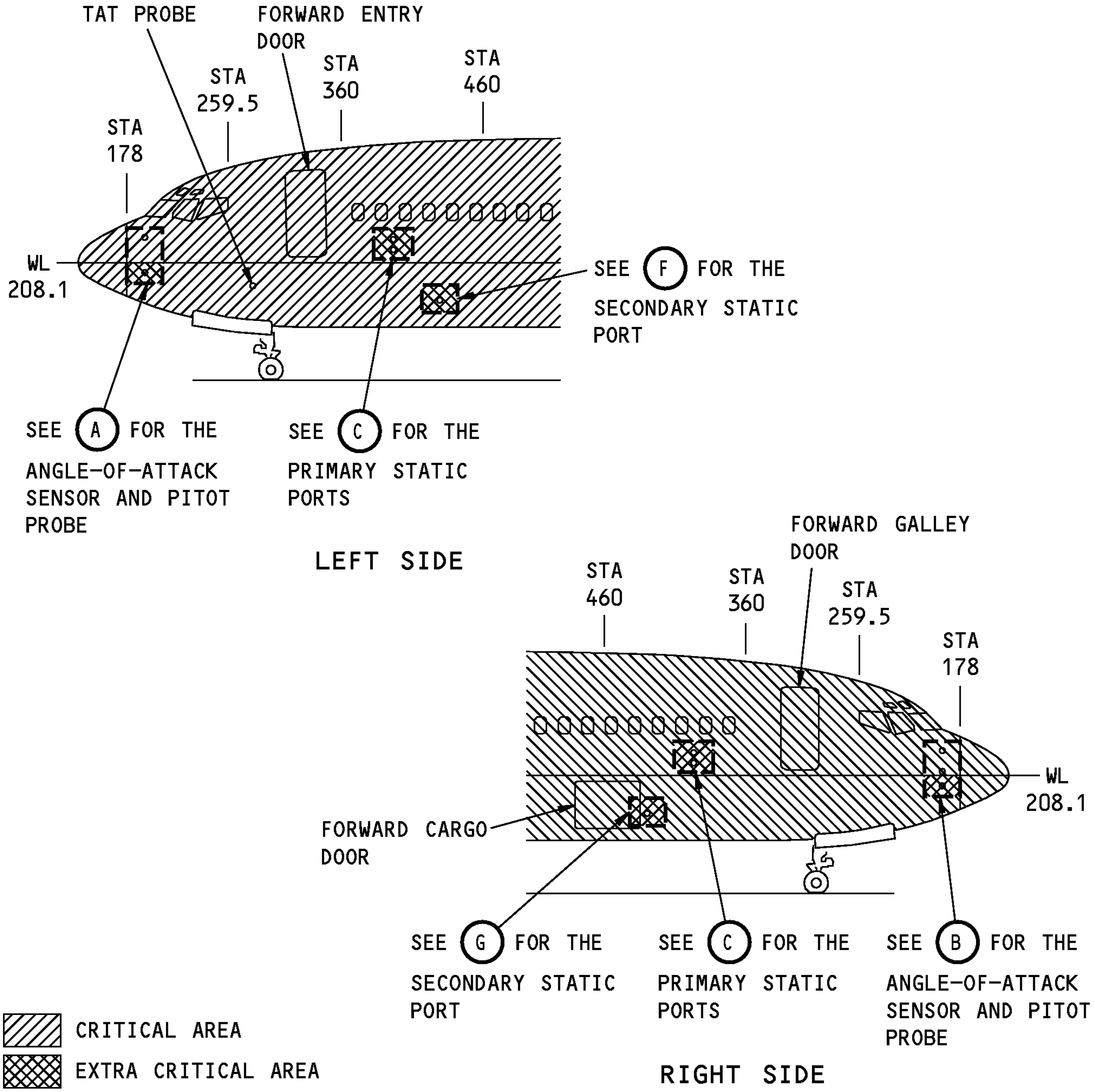
(c) You can install flush repairs if:
1) Tapered shims that are used have a minimum taper ratio of 50:1 and are not less than 2.00 inches (50.8 mm) from Zone A.

(4) The conditions that follow are applicable to repairs in Zone C.

(a) You put a chamfer with a taper ratio of 4:1 on the edges of external repairs with a maximum thickness of 0.02 inch (0.51 mm). Refer to Aerodynamic Smoothness Requirements, Figure 2/GENERAL, Detail A.

(b) You can install flush repairs if:

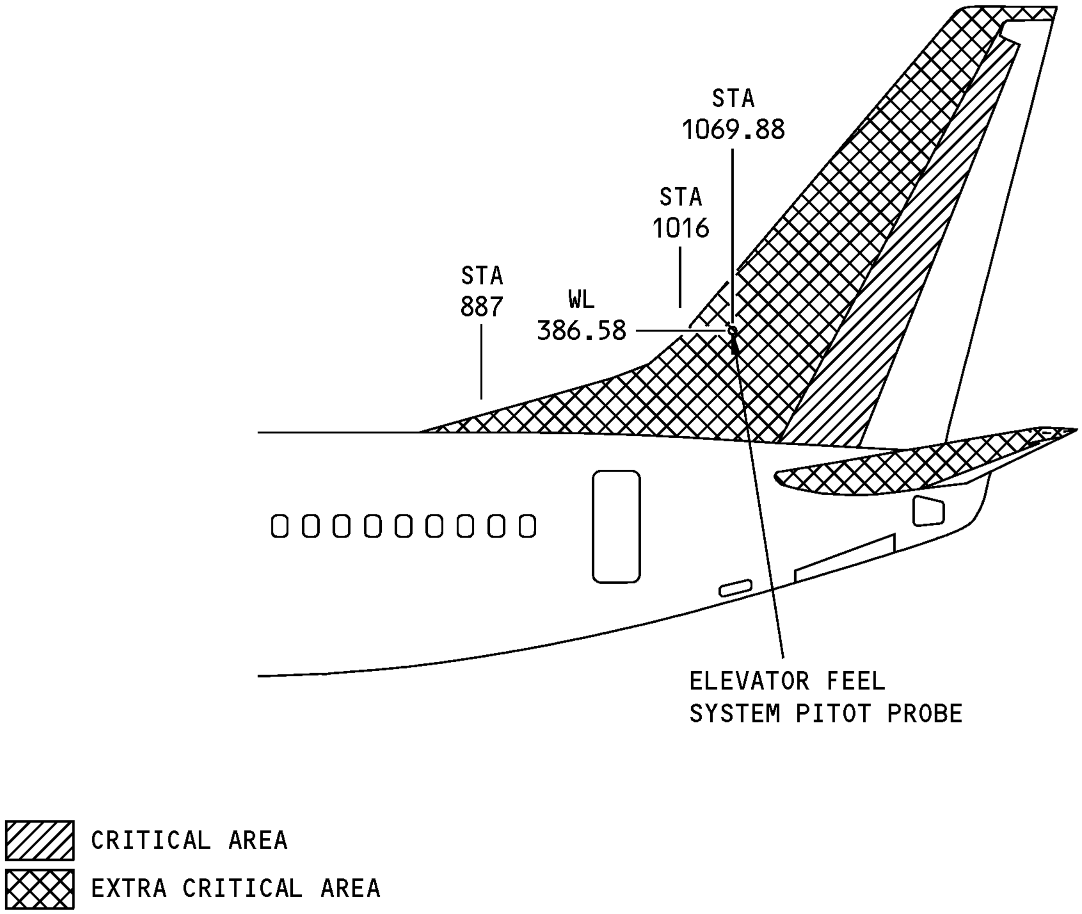
1) Tapered shims that are used have a minimum taper ratio of 50:1 and are not less than 2.00 inches (50.8 mm) from Zone A.



NOTES

- SEE TABLE A FOR THE AERODYNAMIC REQUIREMENTS FOR THE AIR DATA SENSORS. REFER TO SRM 51-10-03 IF THE AIRPLANE IS APPROVED FOR REDUCED VERTICAL SEPARATION MINIMUM (RVSM) OPERATION AND HAS DAMAGE NEAR THE PRIMARY STATIC PORTS.

Aerodynamic Smoothness - Angle-of-Attack Sensors, Pitot Probes, and Static Ports
Figure 4 (Sheet 1 of 13)



LEFT SIDE IS SHOWN, RIGHT SIDE IS OPPOSITE

NOTES

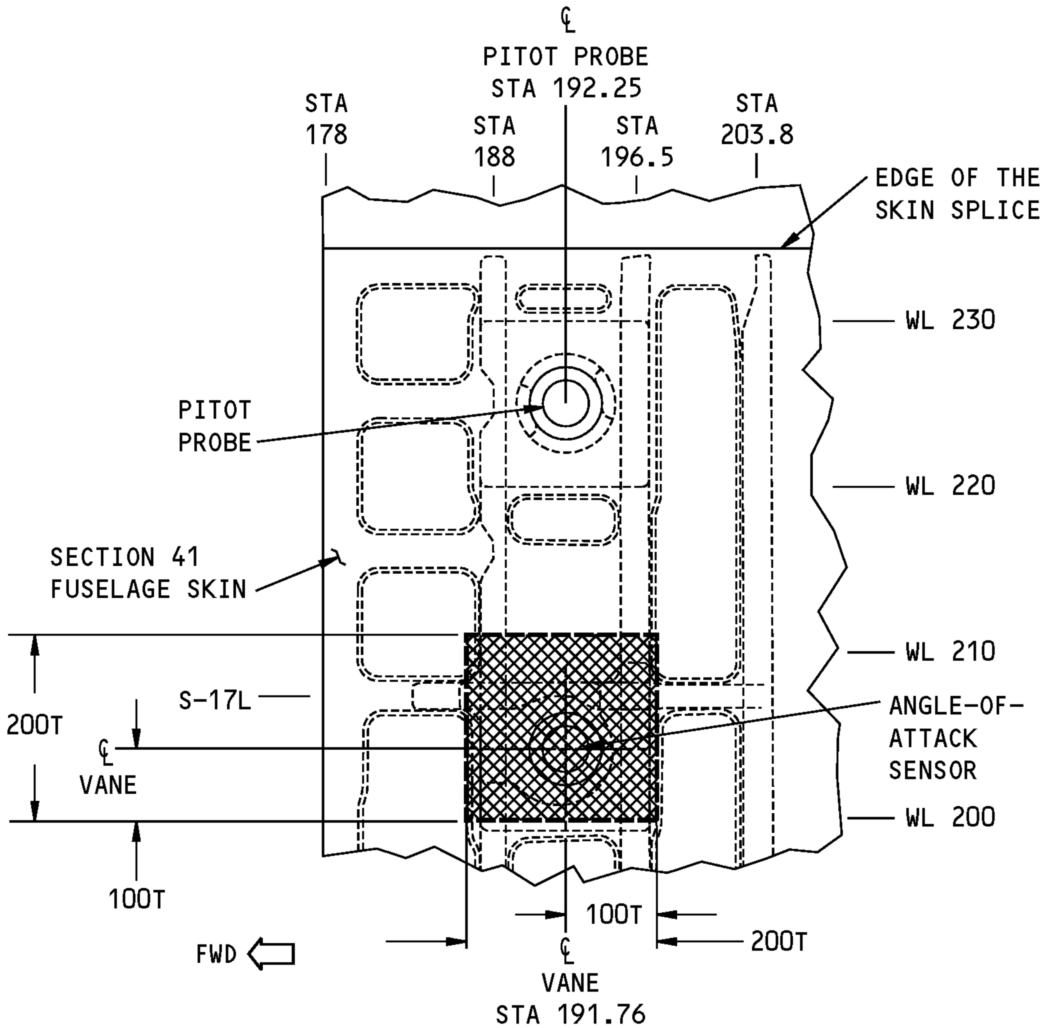
- SEE TABLE A FOR THE AERODYNAMIC REQUIREMENTS FOR THE AIR DATA SENSORS. REFER TO SRM 51-10-03 IF THE AIRPLANE IS APPROVED FOR REDUCED VERTICAL SEPARATION MINIMUM (RVSM) OPERATION AND HAS DAMAGE NEAR THE PRIMARY STATIC PORTS.

Aerodynamic Smoothness - Angle-of-Attack Sensors, Pitot Probes, and Static Ports
Figure 4 (Sheet 2 of 13)

AERODYNAMIC REQUIREMENTS FOR REPAIRS NEAR AIR DATA SENSORS			
AIR DATA SENSOR	LOCATION	AERODYNAMIC REQUIREMENTS	COMMENTS
ANGLE-OF-ATTACK SENSORS (ALPHA VANES)	BODY: STA 191.75 WL 204.21 LEFT AND RIGHT SIDE	EDGES OF REPAIR MUST BE AT LEAST 100T AWAY FROM THE VANE IN ALL DIRECTIONS. SEE DETAILS A, B, AND I	SRM 53-00-01 REPAIRS ARE PERMITTED IF THE CRITERIA IN DETAILS A AND B ARE MET
PITOT PROBES	BODY: STA 192.25 WL RIGHT SIDE 225 AND 213 WL LEFT SIDE 225	USE GENERAL REPAIR CRITERIA APPLICABLE TO THE FORWARD FUSELAGE. SEE DETAIL I	
TAT PROBE	BODY: STA 267.83 WL 191.76 LEFT SIDE ONLY	USE GENERAL REPAIR CRITERIA APPLICABLE TO THE FORWARD FUSELAGE. SEE DETAIL I	
STATIC PRESSURE PORTS -PRIMARY AIR DATA SYSTEM	BODY: STA 410 WL 218 AND 220 LEFT AND RIGHT SIDE	SEE DETAILS C, D, H, AND I	REFER TO SRM 53-00-01 FOR REPAIR DATA. REFER TO SRM 51-10-03 FOR RVSM DATA
STATIC PRESSURE PORTS -SECONDARY AIR DATA SYSTEM	BODY: STA 430 WL 166.60 LEFT AND RIGHT SIDE	SEE DETAILS F, G, H, AND I	
PITOT PROBE - ELEVATOR FEEL SYSTEM	VERTICAL FIN: STA 1069.88 WL 386.58 LEFT AND RIGHT SIDE	USE GENERAL REPAIR CRITERIA APPLICABLE TO THE VERTICAL STABILIZER	

TABLE A

Aerodynamic Smoothness - Angle-of-Attack Sensors, Pitot Probes, and Static Ports
Figure 4 (Sheet 3 of 13)



EXTRA CRITICAL AREA - REPAIR DOUBLER EDGES AND TAPERED SHIMS ARE NOT PERMITTED IN THIS AREA. A REPAIR MUST COVER THE ENTIRE CRITICAL AREA.

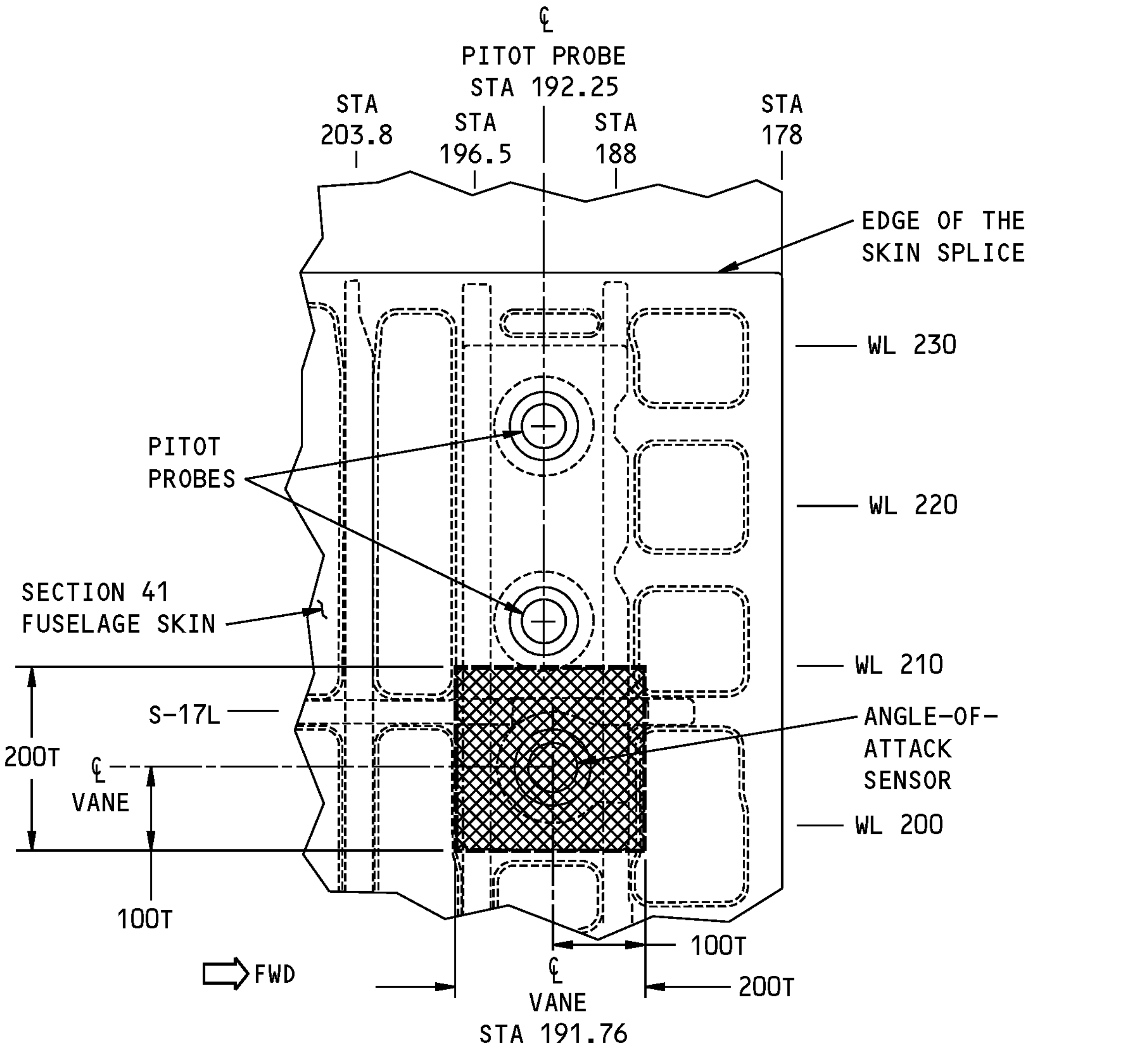
LEFT SIDE IS SHOWN
EXTRA CRITICAL AREA NEAR THE ANGLE-OF-ATTACK SENSOR

A

NOTES

- T = THICKNESS OF THE EXTERNAL REPAIR DOUBLER, OR THE THICKNESS OF THE TAPERED SHIM BETWEEN THE INITIAL SKIN AND ADJACENT STRUCTURE (FOR A FLUSH REPAIR)
- KEEP THE ALIGNMENT OF THE VANE TO THE TOLERANCES GIVEN ON THE BOEING PRODUCTION DRAWING
- CHAMFER EXTERNAL REPAIR EDGES TO A 4:1 TAPER RATIO WITH A MAXIMUM EDGE THICKNESS OF 0.02 INCH (0.51 mm)

Aerodynamic Smoothness - Angle-of-Attack Sensors, Pitot Probes, and Static Ports
Figure 4 (Sheet 4 of 13)



EXTRA CRITICAL AREA - REPAIR DOUBLER EDGES AND TAPERED SHIMS ARE NOT PERMITTED IN THIS AREA. A REPAIR MUST COVER THE ENTIRE CRITICAL AREA.

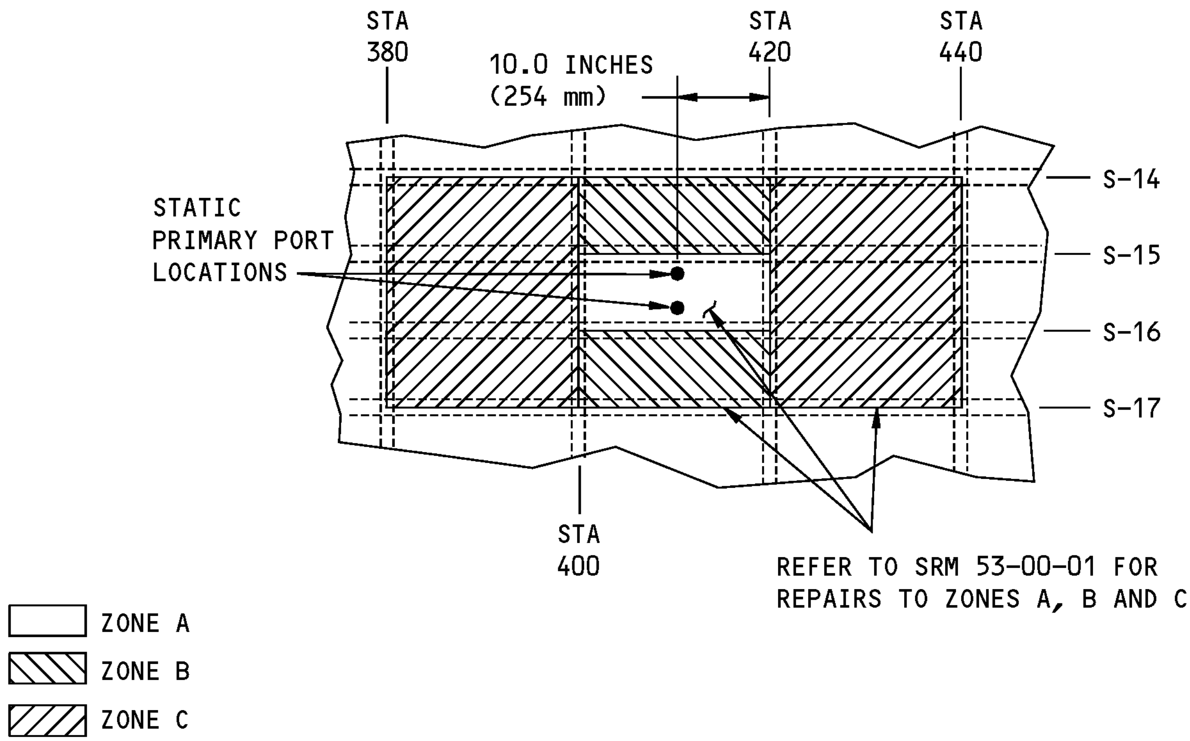
RIGHT SIDE IS SHOWN
EXTRA CRITICAL AREA NEAR THE ANGLE-OF-ATTACK SENSOR

B

NOTES

- T = THICKNESS OF THE EXTERNAL REPAIR DOUBLER, OR THE THICKNESS OF THE TAPERED SHIM BETWEEN THE INITIAL SKIN AND ADJACENT STRUCTURE (FOR A FLUSH REPAIR)
- KEEP THE ALIGNMENT OF THE VANE TO THE TOLERANCES GIVEN ON THE BOEING PRODUCTION DRAWING
- CHAMFER EXTERNAL REPAIR EDGES TO A 4:1 TAPER RATIO WITH A MAXIMUM EDGE THICKNESS OF 0.02 INCH (0.51 mm)

Aerodynamic Smoothness - Angle-of-Attack Sensors, Pitot Probes, and Static Ports
Figure 4 (Sheet 5 of 13)

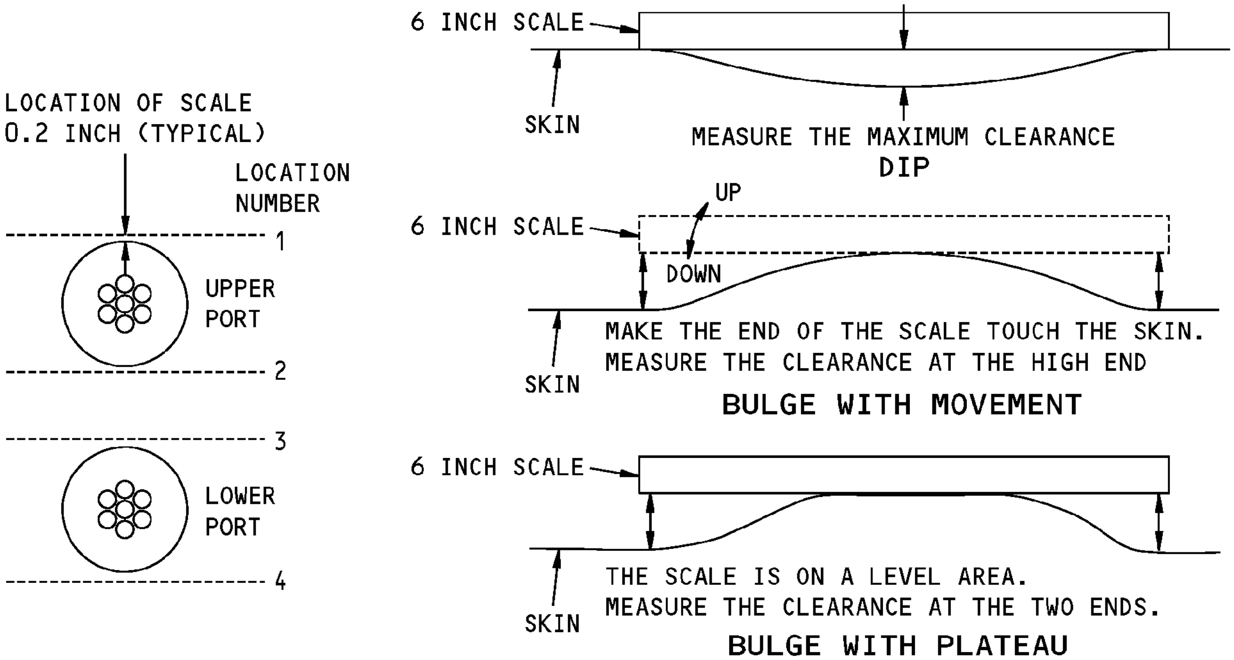


NOTE: REFER TO DETAIL H FOR THE MAXIMUM PERMITTED WAVINESS. REFER TO DETAIL I FOR THE LIMITS ON SURFACE CONTOUR CHANGE NEAR STATIC PORTS.

EXTRA CRITICAL AREA ADJACENT TO THE PRIMARY STATIC PORTS
LEFT SIDE IS SHOWN, RIGHT SIDE IS OPPOSITE

C

Aerodynamic Smoothness - Angle-of-Attack Sensors, Pitot Probes, and Static Ports
Figure 4 (Sheet 6 of 13)

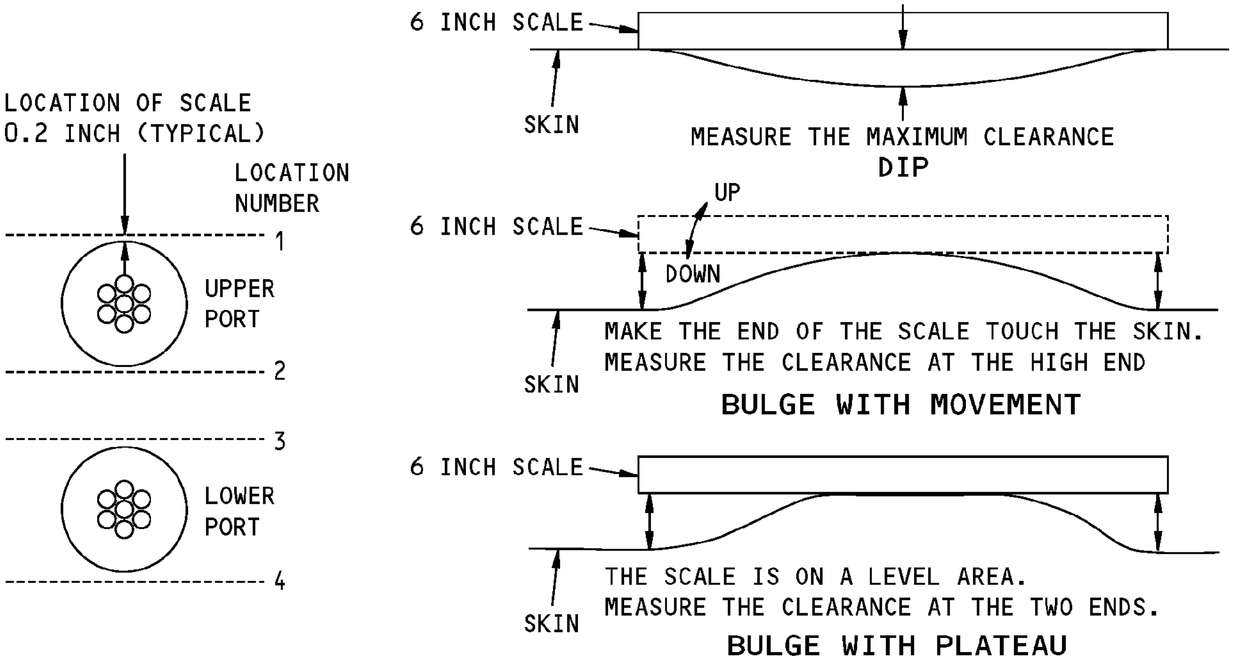


LEFT SIDE								
	LOCATION	DIP	BULGE WITH MOVEMENT			BULGE WITH PLATEAU		
		MAXIMUM	FORWARD	AFT	MAXIMUM	FORWARD	AFT	MAXIMUM
UPPER PORT	1	-0.010						
	2	-0.004						
	WAVINESS	-0.007						
LOWER PORT	3		0.008	0.000	0.008			
	4		0.020	0.010	0.020			
	WAVINESS				0.007			
RIGHT SIDE								
	LOCATION	DIP	BULGE WITH MOVEMENT			BULGE WITH PLATEAU		
		MAXIMUM	FORWARD	AFT	MAXIMUM	FORWARD	AFT	MAXIMUM
UPPER PORT	1	-0.010						
	2	-0.000						
	WAVINESS	-0.005						
LOWER PORT	3					0.008	0.000	0.008
	4					0.020	0.010	0.020
	WAVINESS							0.014

EXAMPLE CALCULATIONS OF SKIN WAVINESS MEASUREMENT NEAR PRIMARY STATIC PORTS - REFER TO SRM 51-10-01, PARAGRAPH 4.C(2)(b)3)

D

Aerodynamic Smoothness - Angle-of-Attack Sensors, Pitot Probes, and Static Ports
Figure 4 (Sheet 7 of 13)



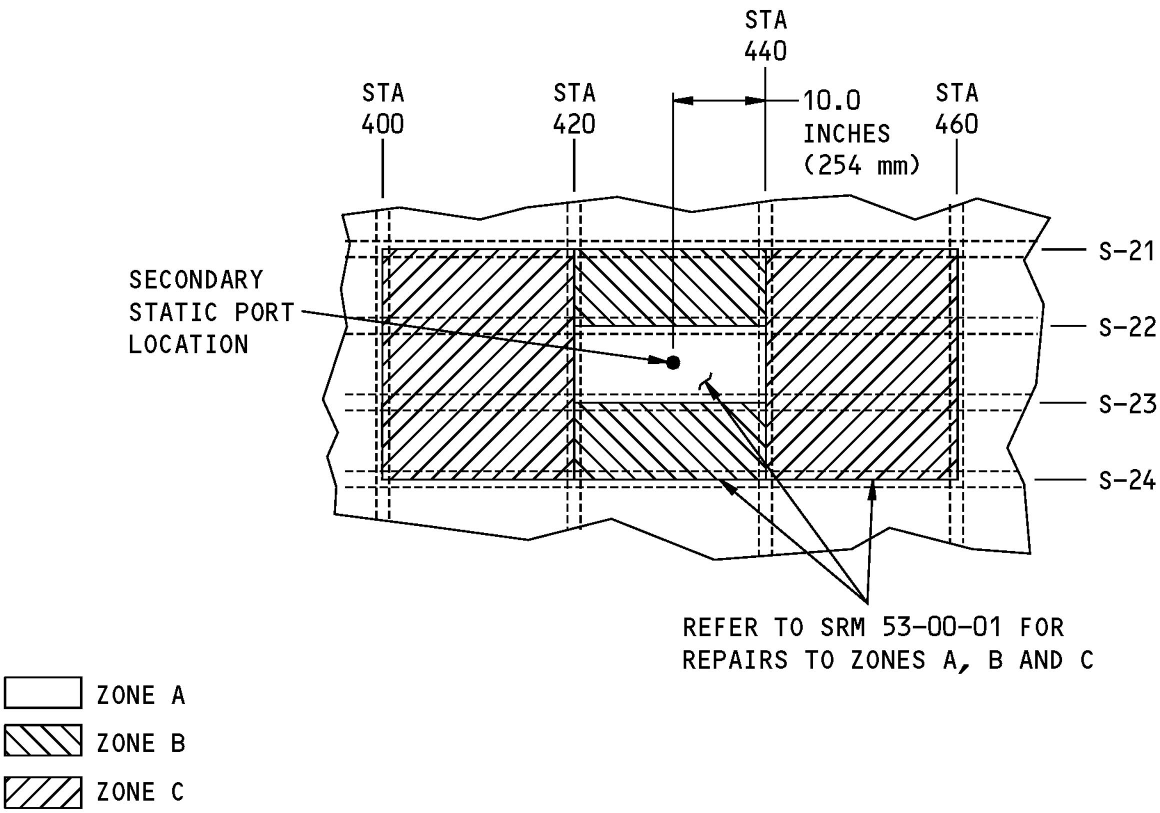
LEFT SIDE								
	LOCATION	DIP	BULGE WITH MOVEMENT			BULGE WITH PLATEAU		
		MAXIMUM	FORWARD	AFT	MAXIMUM	FORWARD	AFT	MAXIMUM
UPPER PORT	1							
	2							
	WAVINESS							
LOWER PORT	3							
	4							
	WAVINESS							

RIGHT SIDE								
	LOCATION	DIP	BULGE WITH MOVEMENT			BULGE WITH PLATEAU		
		MAXIMUM	FORWARD	AFT	MAXIMUM	FORWARD	AFT	MAXIMUM
UPPER PORT	1							
	2							
	WAVINESS							
LOWER PORT	3							
	4							
	WAVINESS							

FORM FOR SKIN WAVINESS MEASUREMENT NEAR PRIMARY STATIC PORTS –
REFER TO SRM 51-10-01, PARAGRAPH 4.C(2)(b)3)

E

Aerodynamic Smoothness - Angle-of-Attack Sensors, Pitot Probes, and Static Ports
Figure 4 (Sheet 8 of 13)

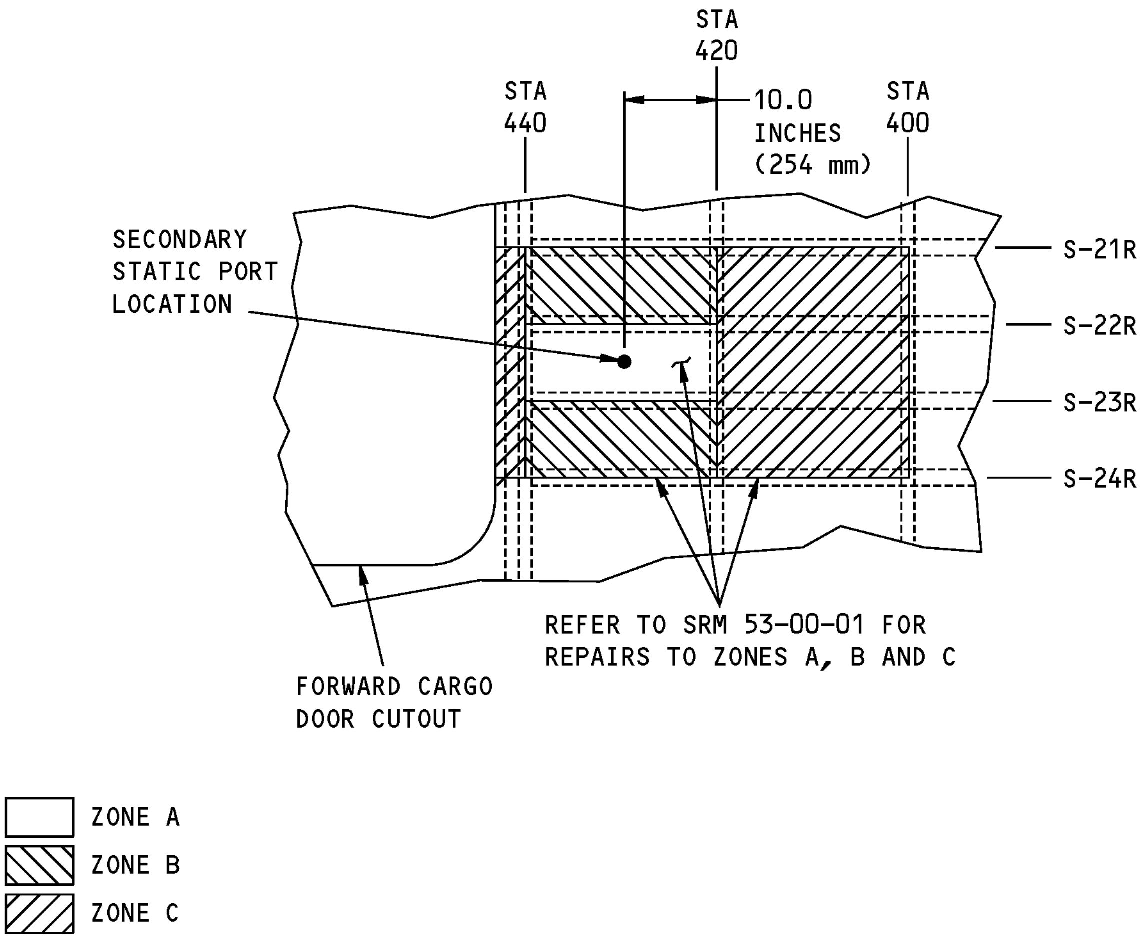


NOTE: REFER TO DETAIL H FOR THE MAXIMUM PERMITTED WAVINESS. REFER TO DETAIL I FOR THE LIMITS ON SURFACE CONTOUR CHANGE NEAR STATIC PORTS.

EXTRA CRITICAL AREA ADJACENT TO THE SECONDARY
STATIC PORT ON THE LEFT SIDE

F

Aerodynamic Smoothness - Angle-of-Attack Sensors, Pitot Probes, and Static Ports
Figure 4 (Sheet 9 of 13)

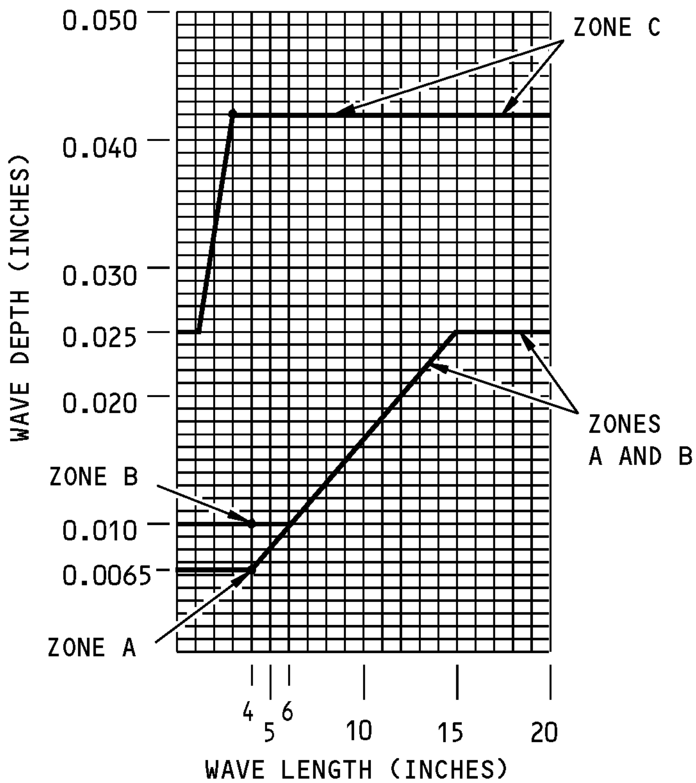


NOTE: REFER TO DETAIL H FOR THE MAXIMUM PERMITTED WAVINESS. REFER TO DETAIL I FOR THE LIMITS ON SURFACE CONTOUR CHANGE NEAR STATIC PORTS.

EXTRA CRITICAL AREA ADJACENT TO THE SECONDARY STATIC PORT NEAR THE FORWARD CARGO DOOR ON THE RIGHT SIDE

G

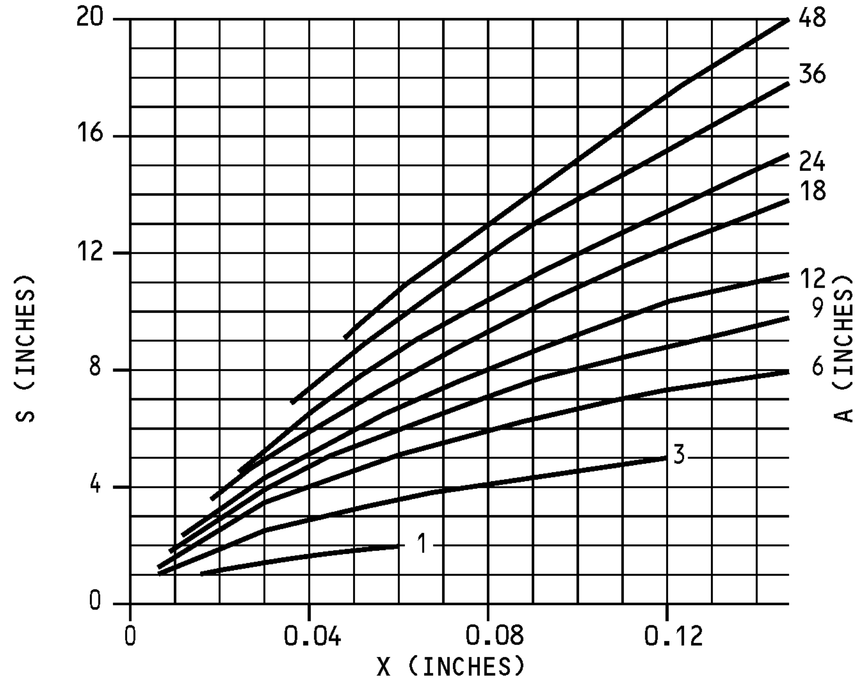
Aerodynamic Smoothness - Angle-of-Attack Sensors, Pitot Probes, and Static Ports
Figure 4 (Sheet 10 of 13)



WAVINESS PERMITTED AROUND PRIMARY AND SECONDARY STATIC PORTS

H

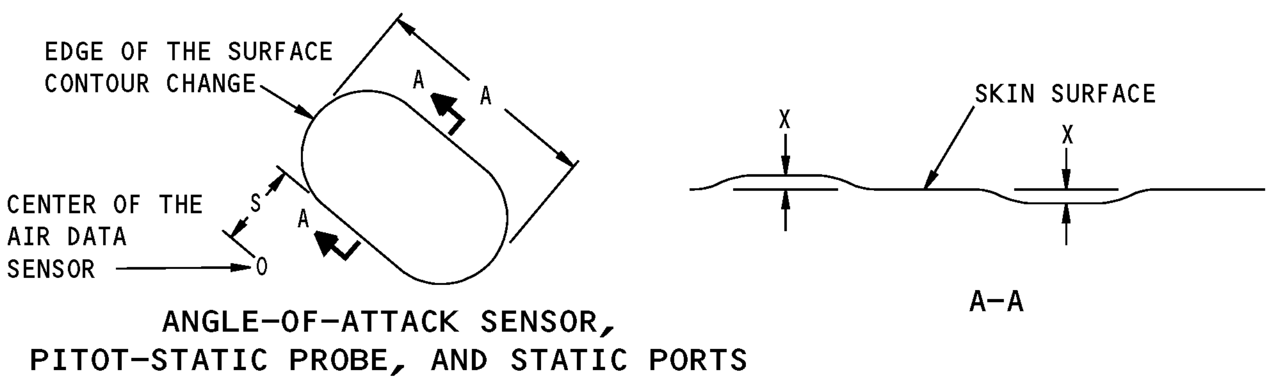
Aerodynamic Smoothness - Angle-of-Attack Sensors, Pitot Probes, and Static Ports
Figure 4 (Sheet 11 of 13)



A = THE LARGEST DIMENSION OF CONTOUR CHANGE

X = THE MAXIMUM DEPTH OR HEIGHT OF THE CONTOUR CHANGE

S = THE MINIMUM DISTANCE FROM THE AIR DATA SENSOR TO THE NEAREST EDGE OF THE CONTOUR CHANGE (I.E, TO THE LOCATION WHERE THE CHANGE FROM CONTOUR STARTS)



LIMITS ON SURFACE CONTOUR CHANGE NEAR ANGLE-OF-ATTACK SENSORS, PITOT PROBES, AND STATIC PORTS 1 2 3

I

Aerodynamic Smoothness - Angle-of-Attack Sensors, Pitot Probes, and Static Ports
Figure 4 (Sheet 12 of 13)

NOTES

- ALL DIMENSIONS ARE INCHES UNLESS SPECIFIED DIFFERENTLY.

1 FOR RSVM OPERATION, AN AIRPLANE CAN HAVE A MAXIMUM OF TWO SURFACE CONTOUR CHANGES IN THE EXTRA CRITICAL AREA OF THE PRIMARY STATIC PORTS. THE TWO CONTOUR CHANGES CAN BE ON ONE SIDE OF THE AIRPLANE, OR ONE CAN BE ON EACH SIDE. EACH SURFACE CONTOUR CHANGE MUST AGREE WITH PERMITTED LIMITS AS SHOWN IN DETAIL I. THESE LIMITS ARE GIVEN TO MAKE SURE THAT THE NECESSARY PERFORMANCE OF THE ALTIMETRY SYSTEM IS POSSIBLE. REFER ALSO TO SRM 51-10-03.

2 THE LIMITS ARE GIVEN TO MAKE SURE THAT THE NECESSARY PERFORMANCE OF THE AIRSPEED SYSTEM IS POSSIBLE. LARGER SURFACE CONTOUR CHANGES CAN BE POSSIBLE. CONTACT THE BOEING COMPANY FOR MORE ANALYSIS.

3 IN ADDITION TO THE SKIN WAVINESS LIMITS, MAKE SURE THE 3-INCH RADIUS AREA AROUND THE PRIMARY STATIC PORTS HAS NO PAINT, STENCILS, OR SEALANT.

Aerodynamic Smoothness - Angle-of-Attack Sensors, Pitot Probes, and Static Ports
Figure 4 (Sheet 13 of 13)

6. Aerodynamic Smoothness of the Empennage and Wing

A. Refer to Aerodynamic Smoothness - Empennage and Wing, Figure 5/GENERAL, Detail A, and Figure 2, Detail D for limits of skin waviness.

B. Refer to Aerodynamic Smoothness - Empennage and Wing, Figure 5/GENERAL, Detail B and Figure 2, Detail E for the gaps and mismatches permitted at empennage and wing skin joints.

(1) It is not necessary to put a chamfer on the skin forward of the front spar if the mismatch is 0.007 inch (0.177 mm) or less.

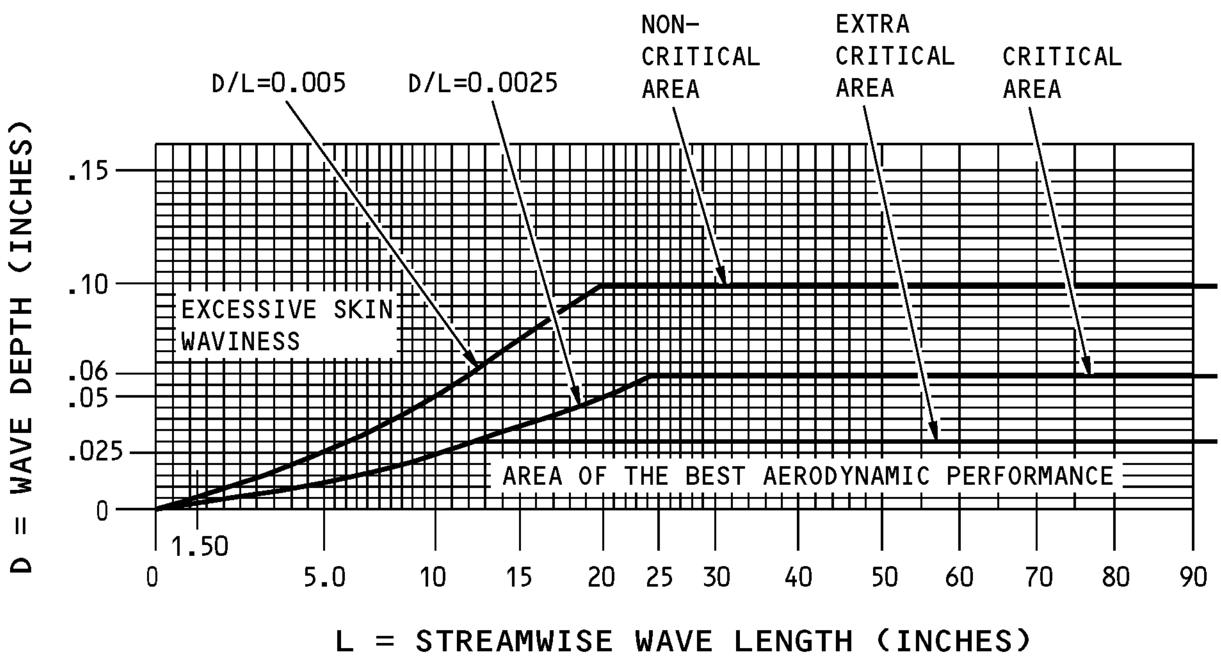
(2) It is not necessary to put a chamfer on the skin aft of the front spar if the mismatch is 0.015 inch (0.381 mm) or less.

C. Refer to Aerodynamic Smoothness - Empennage and Wing, Figure 5/GENERAL, Detail C for the data on the maximum permitted change from contour for the rudder and elevators.

D. Refer to Aerodynamic Smoothness Requirements, Figure 2/GENERAL, Details F and G for measuring fastener flushness.

E. Refer to Aerodynamic Smoothness - Empennage and Wing, Figure 5/GENERAL, Table A for the fastener flushness data in the extra critical, critical, and non-critical areas of the empennage. Refer to Aerodynamic Smoothness Areas, Figure 1/GENERAL.

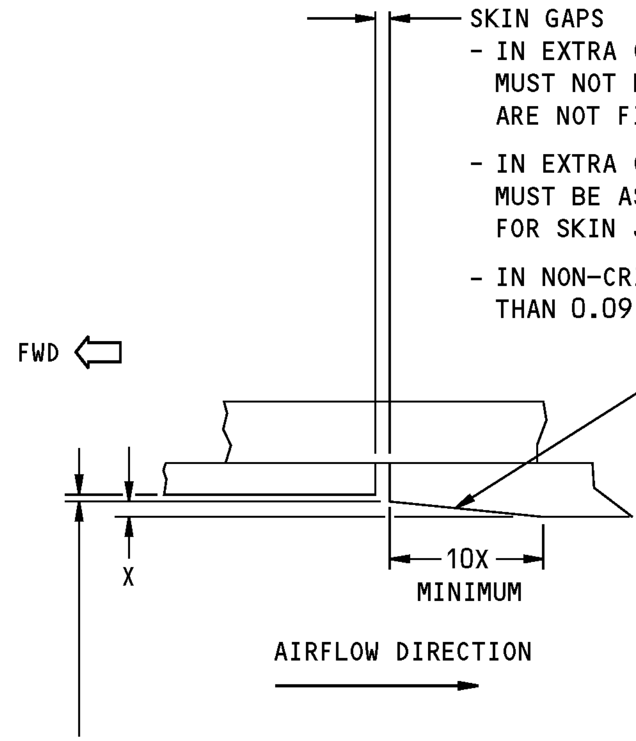
F. Refer to Aerodynamic Smoothness - Empennage and Wing, Figure 5/GENERAL, Table B for the fastener flushness data in the extra critical, critical, and non-critical areas of the wing. Refer to Aerodynamic Smoothness Areas, Figure 1/GENERAL.



NOTE: SKIN SMOOTHNESS OVER CONTINUOUS SKIN MUST BE IN THE LIMITS SHOWN ON CURVE (TYPICAL FOR STRAIGHT OR CURVED AREAS).

A

Aerodynamic Smoothness - Empennage and Wing
Figure 5 (Sheet 1 of 3)



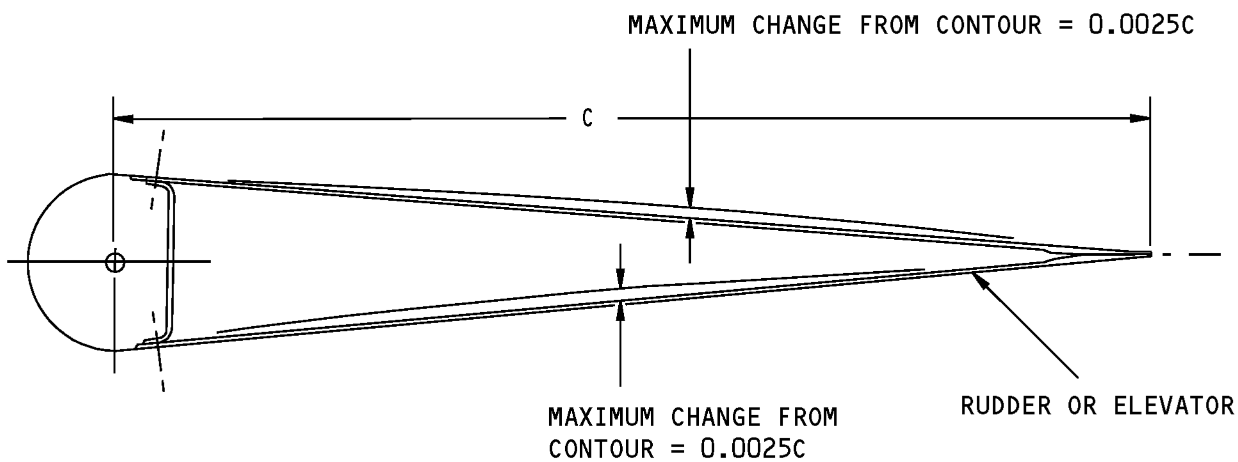
PERMITTED MISMATCH:
- IN EXTRA CRITICAL AND CRITICAL AREAS MUST NOT BE MORE THAN 0.010 INCH AT THE FRONT SPAR JOINTS, 0.010 INCH AT JOINTS AHEAD OF FRONT SPAR AND 0.015 INCH FOR JOINTS BETWEEN SPARS

  ALSO FOR THE EMPENNAGE:
  - 0.010 INCH FOR JOINTS FOR THE FORWARD 50% OF ELEVATOR AND RUDDER CHORDS
  - SPANWISE MISMATCH ALONG LEADING EDGE OF HORIZONTAL STABILIZER AND VERTICAL FIN MUST NOT BE MORE THAN ±0.03 INCH AT SKIN SPLICES
  - DORSAL FIN TO VERTICAL FIN MISMATCH MUST NOT BE MORE THAN ±0.030 INCH.
- IN NON-CRITICAL AREAS MUST NOT BE MORE THAN 0.030 INCH.

PERMITTED GAP AND MISMATCH AT EMPENNAGE AND WING SKIN JOINTS

B

Aerodynamic Smoothness - Empennage and Wing
Figure 5 (Sheet 2 of 3)



CONTOUR CHANGE DATA
C

Aerodynamic Smoothness - Empennage and Wing
Figure 5 (Sheet 3 of 3)

7. Aerodynamic Smoothness of the Strut and Nacelle - CFM56-7 Engine

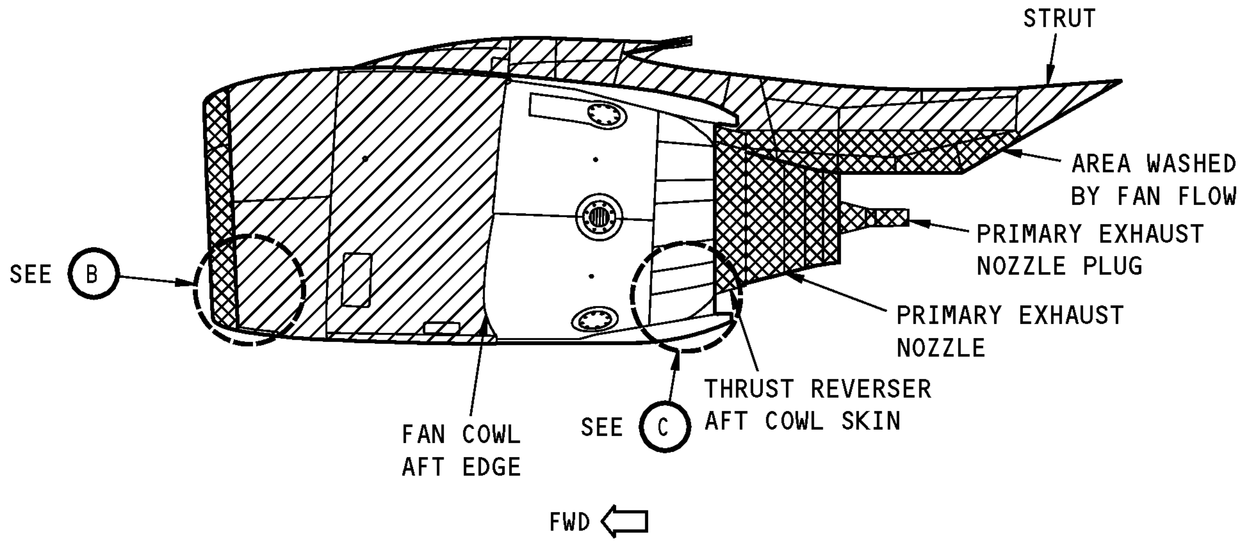
A. Refer to Aerodynamic Smoothness - Nacelle and Strut (CFM56-7 Engine), Figure 6/GENERAL, Details A, B, and C for the extra critical, critical, and non-critical aerodynamic areas of the strut and nacelle.

B. Refer to Aerodynamic Smoothness - Nacelle and Strut (CFM56-7 Engine), Figure 6/GENERAL, Detail D and Table A and Aerodynamic Smoothness Requirements, Figure 2/GENERAL, Detail D for the limits of skin waviness.

C. Refer to Aerodynamic Smoothness - Nacelle and Strut (CFM56-7 Engine), Figure 6/GENERAL, Detail E and Table B, and Aerodynamic Smoothness Requirements, Figure 2/GENERAL, Detail E for the gaps and mismatches that are permitted at strut and nacelle skin joints.

D. Refer to Aerodynamic Smoothness Requirements, Figure 2/GENERAL, Details F and G for measuring fastener flushness on the strut and nacelle.

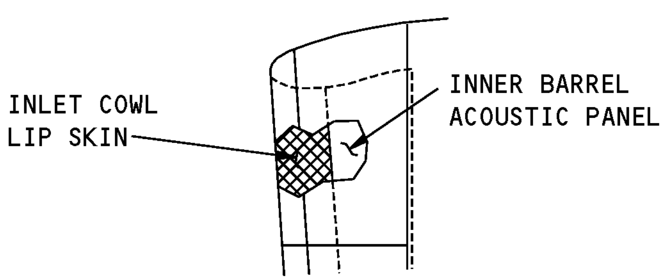
E. Refer to Aerodynamic Smoothness - Nacelle and Strut (CFM56-7 Engine), Figure 6/GENERAL, Table C for the fastener flushness data in the extra critical, critical, and non-critical areas of the strut and nacelle. Refer to Microshaving of Aluminum Alloy Rivets, Figure 7/GENERAL, Details A, B, and C.



LEFT SIDE IS SHOWN, RIGHT SIDE IS OPPOSITE

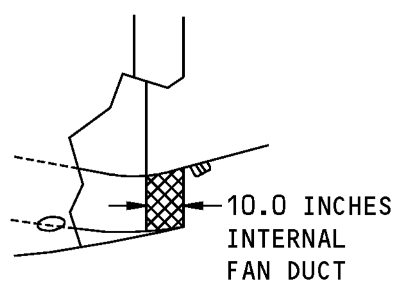
EXTRA CRITICAL, CRITICAL AND NON-CRITICAL AREAS
FOR THE NACELLE AND STRUT

A



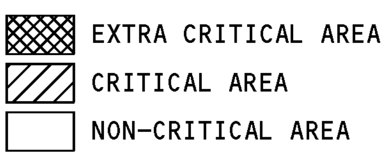
INLET COWL LIP SKIN

B

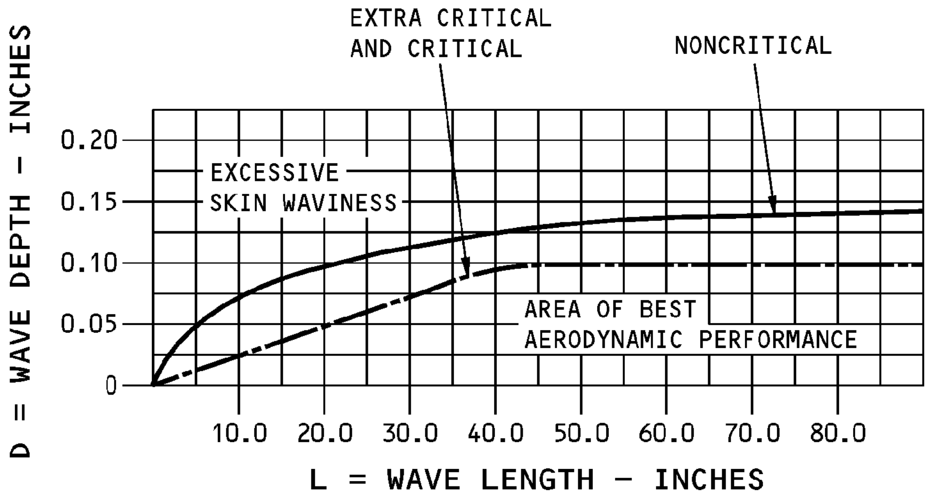


THRUST REVERSER SLEEVE
TRAILING EDGE

C



Aerodynamic Smoothness - Nacelle and Strut (CFM56-7 Engine)
Figure 6 (Sheet 1 of 5)



CFM56-7 PYLON

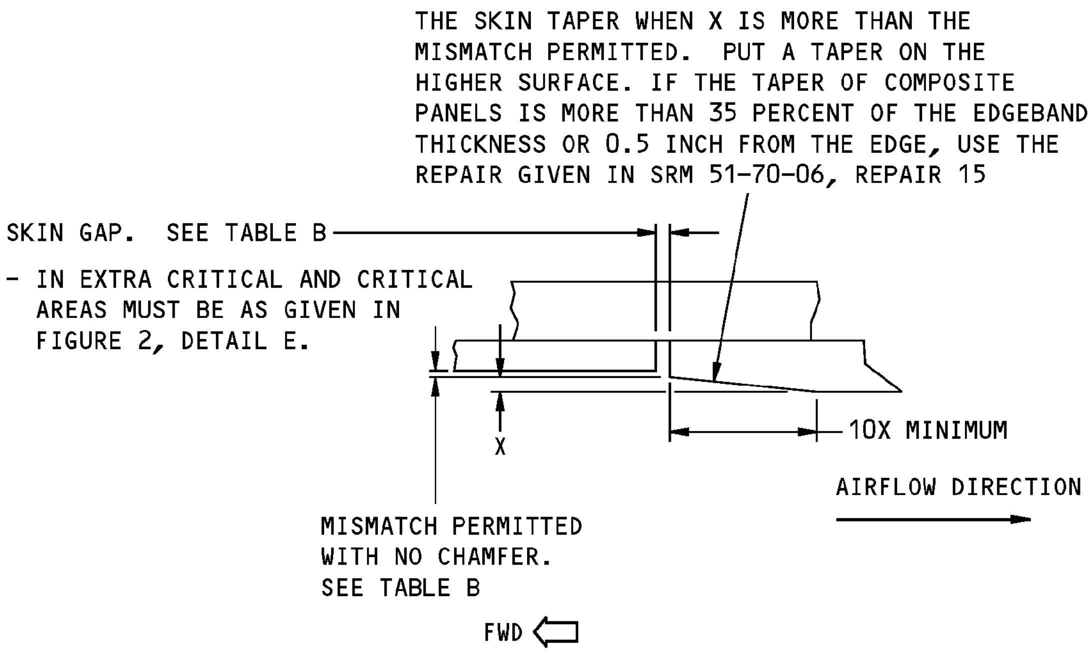
NOTE: SKIN SMOOTHNESS OVER CONTINUOUS SKIN MUST BE IN THE LIMITS SHOWN ON CURVE (TYPICAL FOR STRAIGHT OR CURVED AREAS).

D

AERODYNAMIC SMOOTHNESS REQUIREMENTS FOR CFM56-7 STRUTS				
CONDITION		LOCATION	EXTRA CRITICAL AND CRITICAL	NONCRITICAL
1	WAVE DEPTH TO LENGTH RATIO	ALL SKINS	0.0025	SEE GRAPH
2	1.0 INCH MAXIMUM DIAMETER DISH AT FASTENERS (MAY BE ADDITIVE TO ABOVE) - USE A 6.0 INCH STRAIGHTEDGE AND FEELER GAGE TO FIND THE VALUE	AT FASTENERS	0.0050	0.0100

TABLE A

Aerodynamic Smoothness - Nacelle and Strut (CFM56-7 Engine)
Figure 6 (Sheet 2 of 5)



GAP AND MISMATCH PERMITTED AT NACELLE AND STRUT SKIN JOINTS

E

AERODYNAMIC SMOOTHNESS GAPS AND MISMATCHES OF LONGITUDINAL AND TRANSVERSE JOINTS FOR FIXED SKINS, HINGED PANELS, AND REMOVABLE PANELS - NACELLE AND STRUT

CONDITION	MEASUREMENT	EXTRA CRITICAL AREAS	CRITICAL AREAS	NON-CRITICAL AREAS
FLUSH REPAIRS	GAP	FILLED IF POSSIBLE	FILLED IF POSSIBLE	FILLED IF POSSIBLE
	MISMATCH	+/-0.020 INCH OR AS GIVEN IN THE REPAIR PROCEDURE	+/-0.020 INCH OR AS GIVEN IN THE REPAIR PROCEDURE	+/-0.030 INCH OR AS GIVEN IN THE REPAIR PROCEDURE
EXTERNAL REPAIRS	GAP	REFER TO THE APPLICABLE REPAIR FOR THE STRUCTURE IN THE SRM.		
	MISMATCH			

TABLE B

Aerodynamic Smoothness - Nacelle and Strut (CFM56-7 Engine)
Figure 6 (Sheet 3 of 5)

AERODYNAMIC SMOOTHNESS FASTENER FLUSHNESS - NACELLE AND STRUT			
FASTENER TYPE COUNTERSUNK HEAD	EXTRA CRITICAL AREAS	CRITICAL AREAS	NON-CRITICAL AREAS
HEX DRIVE BOLTS, LOCKBOLTS, AND HIGH-STRENGTH FASTENERS (NOT INCLUDING BACB30XT, BACB30XU, BACB30YP)	A MINIMUM OF 90 PERCENT MUST BE FLUSH TO A TOLERANCE OF +0.003 TO -0.003 INCH. 10 PERCENT CAN BE FLUSH TO +0.003 TO -0.005 INCH.	SAME AS EXTRA CRITICAL AREAS	MUST BE FLUSH TO A TOLERANCE OF +0.005 TO -0.003 INCH.
BACB30XT, BACB30XU, BACB30YP DOMED, REDUCED SHEAR HEAD HEX DRIVE BOLTS AND LOCKBOLTS	MUST BE FLUSH TO A TOLERANCE OF +0.0055 TO +0.0005 INCH.	-5 AND -6 (3/16) SIZES: - MUST BE FLUSH TO A TOLERANCE OF +0.0075 TO +0.0015 INCH. -8 (1/4), -10 (5/16) AND -12 (3/8) SIZES: - MUST BE FLUSH TO A TOLERANCE OF +0.0085 TO -0.0025 INCH	SAME AS CRITICAL AREAS
SCREWS AND BOLTS	SAME AS CRITICAL AREAS	MUST BE FLUSH TO A TOLERANCE OF +0.003 TO -0.003 INCH.	MUST BE FLUSH TO A TOLERANCE OF +0.005 TO -0.001 INCH.
SHEAR HEAD RIVETS (NOT INCLUDING BACR15CE, BACR15GF)	SAME AS CRITICAL AREAS	MUST BE FLUSH TO A TOLERANCE OF +0.003 TO +0.001 INCH. (SHAVING PERMITTED)	MUST BE FLUSH TO A TOLERANCE OF +0.007 TO -0.002 INCH. SHAVING PERMITTED TO A TOLERANCE OF +0.003 TO +0.001 INCH

TABLE C

Aerodynamic Smoothness - Nacelle and Strut (CFM56-7 Engine)
Figure 6 (Sheet 4 of 5)

AERODYNAMIC SMOOTHNESS FASTENER FLUSHNESS - NACELLE AND STRUT			
FASTENER TYPE COUNTERSUNK HEAD	EXTRA CRITICAL AREAS	CRITICAL AREAS	NON-CRITICAL AREAS
BACR15CE, BACR15GF ALUMINUM REDUCED SHEAR HEAD RIVETS NOTE: DO NOT SHAVE RIVETS HEADS	SAME AS CRITICAL AREAS	A MINIMUM OF 90 PERCENT MUST BE FLUSH TO A TOLERANCE OF +0.004 TO +0.001 INCH. 10 PERCENT CAN BE FLUSH TO +0.006 TO +0.0005 INCH.	A MINIMUM OF 90 PERCENT MUST BE FLUSH TO A TOLERANCE OF +0.005 TO +0.001 INCH. 10 PERCENT CAN BE FLUSH TO +0.007 TO +0.001 INCH.
RIVETS IN COMPOSITE PANELS	SAME AS CRITICAL AREAS	MUST BE FLUSH TO A TOLERANCE OF +0.010 TO 0.000 INCH.	MUST BE FLUSH TO A TOLERANCE OF +0.010 TO 0.000 INCH.
FASTENERS OTHER THAN RIVETS IN COMPOSITE PANELS	SAME AS CRITICAL AREAS	MUST BE FLUSH TO A TOLERANCE OF +0.008 TO -0.008 INCH.	MUST BE FLUSH TO A TOLERANCE OF +0.008 TO -0.008 INCH.

TABLE C

Aerodynamic Smoothness - Nacelle and Strut (CFM56-7 Engine)
Figure 6 (Sheet 5 of 5)

8. Procedures to Microshave Aluminum Alloy Rivets

NOTE: Do not use 7050 aluminum rivets unless they are specified in a repair or an engineering drawing. This fastener will not usually fill the hole and the fastener can crack when you microshave it. We recommend that you use an MS20426DD rivet.

A. Use a microshave tool to cut aluminum alloy rivet heads to agree with the surface smoothness requirements. The microshave tool:

(1) Is a pistol-grip air motor with an adjustable microstop.

(2) Cuts the rivet head to 0.002 inch (0.050 mm) above the surface.

(3) Has spring-loaded rubber feet mounted in a stabilizer so that the cutter does not slip. Refer to Microshaving of Aluminum Alloy Rivets, Figure 7/GENERAL for the microshave data.

B. When you microshave aluminum rivets, do the steps that follow to keep the strength of the rivet:

(1) Use a cutter that is larger in diameter than the rivet head. Refer to Microshaving of Aluminum Alloy Rivets, Figure 7/GENERAL, Table A, for the cutter diameters that are recommended.

(2) Refer to Microshaving of Aluminum Alloy Rivets, Figure 7/GENERAL, Table B, for the sources of microshave tools.

(3) The height (H) of the installed fastener head above the surface of the structure must agree with the limits given in Microshaving of Aluminum Alloy Rivets, Figure 7/GENERAL, Table C.

NOTE: This condition is applicable after you drive the fastener but before you microshave it.

(4) The diameter of the fastener head must not be less than the dimension D after you microshave it. Refer to Microshaving of Aluminum Alloy Rivets, Figure 7/GENERAL, Table C.

(5) To get a constant depth of cut when you microshave a large number of the fasteners, do as follows:

WARNING: DISCONNECT THE MICROSHAVE TOOL FROM THE SOURCE OF AIR OR ELECTRICAL POWER BEFORE YOU ADJUST OR TOUCH THE CUTTER. IF YOU DO NOT OBEY, INJURY TO PERSONS CAN OCCUR.

(a) Adjust the stop of the microshave tool so it is between 0.001 inch and 0.002 inch (0.025 mm and 0.050 mm) past the cutter.

(b) Do a test of the adjustment on a piece of scrap material.

(c) Adjust the stop again, if necessary, until you get the correct depth of cut.

(6) Use constant pressure on the microshave tool so you get a steady speed.

(7) Move the microshave tool lightly on the surface around the fastener head to cut all the edges of the rivet.

(8) Apply the finish to the rivet heads. Refer to 51-20-01.

C. When you microshave rivets installed in metal structure, the limits that follow are applicable:

(1) You can not microshave all steel or titanium fasteners.

(2) You can not microshave BACR15CE, BACR15DS, BACR15GF, or NAS1097 100-degree shear head rivets.

D. When you microshave rivets installed in composite panels, the limits that follow are applicable:

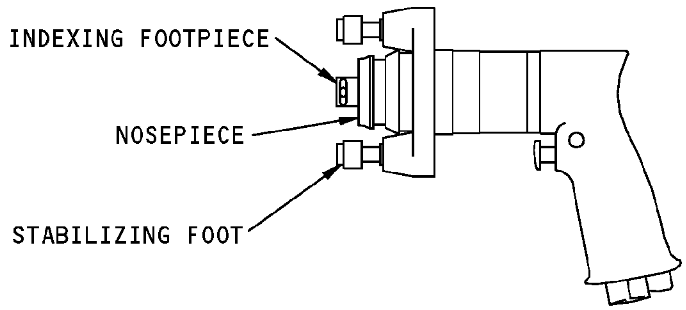
(1) You can microshave all solid countersink rivets but those specified in Aerodynamic Smoothness - Empennage and Wing, Figure 5/GENERAL, Tables A and B.

(2) You can microshave solid countersink rivets when you install them in fiberglass panels.

(3) You can not microshave solid countersink rivets when you install them in Carbon Fiber Reinforced Plastic (CFRP) panels.

MICROSHAVE CUTTER DIMENSIONS (INCHES)	
RIVET DIAMETER	CUTTER DIAMETER
1/8	0.375
5/32	0.500
3/16	0.500
1/4	0.625
5/16	0.750
3/8	1.00

TABLE A



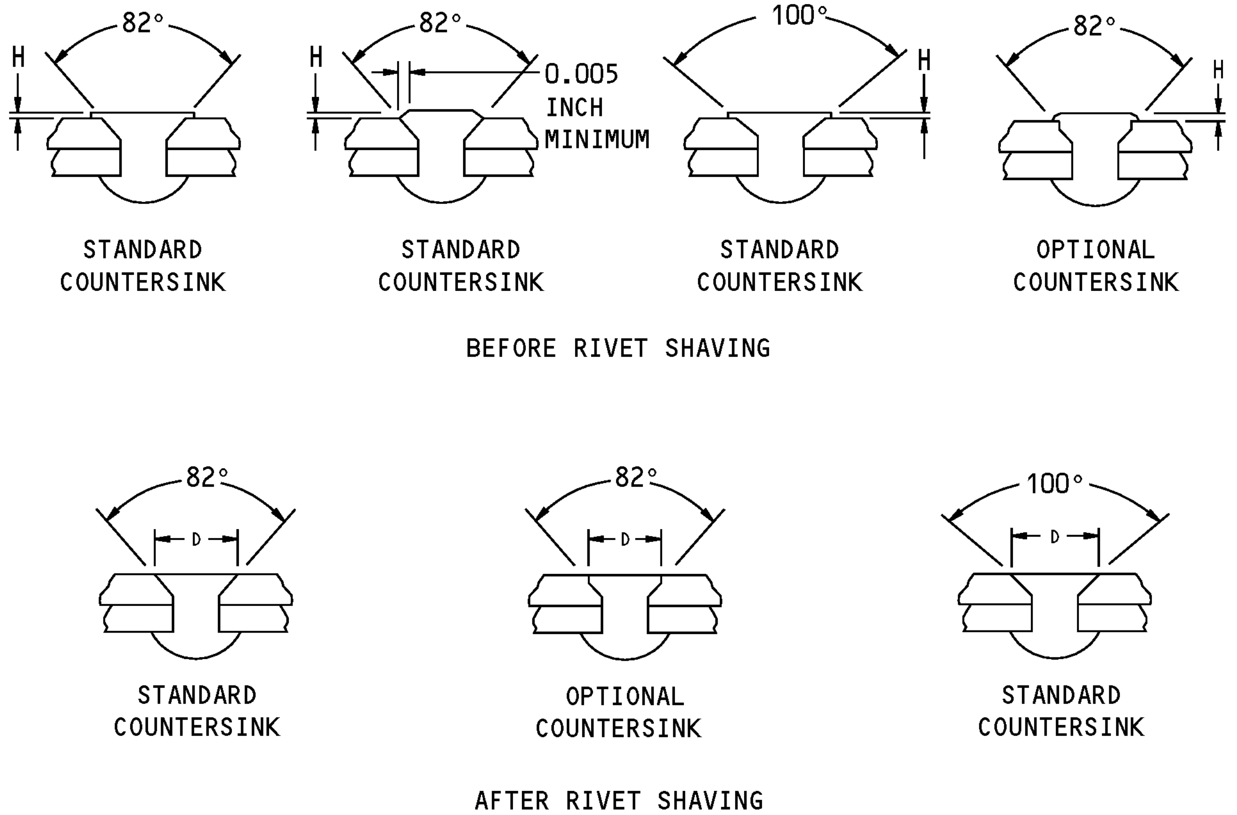
MICROSHAVE TOOL
A

SOURCES FOR THE MICROSHAVE TOOL	
MICROSHAVE TOOL	MANUFACTURER
AT429SXB (ATI MODEL)	American Tool Inc. 2425 West Vineyard Ave. Escondido, Ca. 92829-1222 Phone: (619) 746-8301
15CNS60-95 (DOTCO MODEL)	Cooper Power Tools P.O. Box 1410 Lexington, SC. 29071-1410 Phone: (803) 951-7571
ZT306 ZT405 ZT208 (ELECTRIC)	Zephyr Manufacturing Co. Inc. 201 Hindry Ave. P.O. Box 759 Inglewood, California 90307
TD-300-0AD TD-300A-0AID TD-300-0AID	Ingersoll-Rand Co. Compressor Division Hamilton St. Painted Post, New York 14870

TABLE B

Microshaving of Aluminum Alloy Rivets
Figure 7 (Sheet 1 of 2)

RIVET HEAD SHAVING DIMENSIONS (INCHES)



RIVET DIAMETER	BEFORE SHAVING H MAXIMUM (REFERENCE) 82°	BEFORE SHAVING H MAXIMUM (REFERENCE) 100°	AFTER SHAVING MINIMUM DIAMETER D STANDARD COUNTERSINK 82°	AFTER SHAVING MINIMUM DIAMETER D OPTIONAL COUNTERSINK 82°	AFTER SHAVING MINIMUM DIAMETER D STANDARD COUNTERSINK 100°
1/8	0.009	0.007	0.210	0.192	0.204
5/32	0.011	0.009	0.247	0.235	0.262
3/16	0.013	0.010	0.331	0.285	0.326
1/4	0.015	0.012	0.438	0.375	0.443
5/16	0.018	0.014	0.546	0.465	0.526
3/8	0.021	0.016	0.654	0.570	0.650

TABLE C

Microshaving of Aluminum Alloy Rivets
Figure 7 (Sheet 2 of 2)

9. Procedures to Microshave BACR15GA Titanium Hollow-End Rivets

A. Do not microshave titanium rivets in the extra-critical and critical aerodynamic areas.

B. You can not microshave more than 25 percent of the BACR15GA rivets on a single part to get the necessary smoothness.

C. Do not microshave the manufactured head of a rivet.

D. You can microshave the flared end of the rivet to a minimum height of +0.010 inch (0.254 mm) above the surface contour.

(1) The flared end of the rivet must not be more than 0.04 inch (1.016 mm) off center.

GENERAL - INSPECTION AND REMOVAL OF DAMAGE

1. **Applicability**
   A. Use this chapter-section-subject for the investigation, inspection and removal of any type of damage to the airplane skin and structure.
   B. This chapter-section-subject also gives the general definitions for the types of damage that are given in the different chapters of this structural repair manual.
2. **References**

Reference	Title
51-00-00, GENERAL	Structures
51-00-07, GENERAL	Definitions of Terms Used in the Structural Repair Manual (SRM)
51-10-01, GENERAL	Aerodynamic Smoothness Requirements
51-10-05, GENERAL	Instructions to Permit Airplane Operation With Missing Fasteners in Secondary Structure
51-20-01, GENERAL	Protective Treatment of Metallic and Composite Materials
51-20-02, GENERAL	Heat Treat Verification - Hardness and Conductivity Testing
51-20-08, GENERAL	Erosion Protection
51-20-10, GENERAL	Freeze Plug Installation
51-40-02	FASTENER INSTALLATION AND REMOVAL
51-40-05, GENERAL	Fastener Hole Sizes
51-60-00, GENERAL	Control Surface Balance Procedures
AMM 51-21	INTERIOR AND EXTERIOR FINISHES
AMM 51-21-99 P/B 701	DECORATIVE EXTERIOR PAINT SYSTEM - CLEANING/PAINTING
AMM 28-11-00	Integral Fuel Tanks
CPM 20-40-00, Part I	General
CPM Volume 1, 20-40-00	Corrosion Removal
SOPM 20-20-02	Penetrant Methods of Inspection
SOPM 20-30-03	Standard Overhaul Practices Manual
SOPM 20-30-80	Solvents For General Cleaning of Metal (Series 80)
SOPM 20-41-02	Application of Chemical and Solvent Resistant Finishes
SOPM 20-43-02	Anodizing of Magnesium Alloys
SOPM 20-60-04	Miscellaneous Materials
737 NDT Part 6, 51-00-00	Structures - General

3. **Damage Classification**
   A. Make sure that you refer to the applicable chapter-section-subject for "Allowable Damage" in chapters 52 through 57 of this structural repair manual for the correct rework limits and the specified shot peening data.
   B. Use your good judgment to find the type of damage and an estimate of the cross-sectional area changes by a visual inspection of a specified area.

   NOTE: Measure the damage or the combination of damage for both the correct depth and the correct length.

C. In this structural repair manual, the term "damage" is defined as a cross-sectional area change or a permanent distortion of a structural member. Use the terms that follow:

(1) "Allowable Damage" is defined as damage that is permitted with no other flight restrictions.

(2) "Repairable Damage" is defined as damage that can be reworked or repaired.

(3) "Replacement of Damaged Parts" is defined as damage where the part must be replaced.

D. You must decide what type of damage has occurred to a structural member or to a structural material. The definitions of the different types of damage that can occur to the external skin of the airplane panels are given in the paragraphs that follow:

(1) Abrasion: A damaged area that is the result of scuffing, rubbing, or other surface erosion. This type of damage is usually rough and has an irregular shape.

(2) Corrosion: Damage that is the result of a complex electro-chemical action, and gives a cross-sectional area change. The depth of this damage must be determined by a cleanup or a removal operation. This type of damage occurs on the surfaces, hole bores, or edges of structural elements.

(3) Crack: A partial fracture or a full brake in the material that causes a significant cross-sectional area change. This damage usually has an irregular line and is often the result of fatigue in the material.

(4) Crease: A damaged area that is depressed or folded back so that its boundaries are sharp or with well defined lines or ridges. Consider a crease to be equal to a crack.

(5) Delamination: A type of disbond that occurs between adjacent plies of material. If an allowable damage section or repair section does not give limits for disbonds, then use the limits specified for delaminations.

(6) Dent: A damaged area that is pushed in from its normal contour with no change in the cross-sectional area of the material. The edges of the damaged area are smooth. This damage is usually caused by a hit from a smoothly contoured object. The length of the dent is the longest distance from one end to the other end. The width of the dent is the second longest distance across the dent, measured at 90 degrees to the direction of the length.

NOTE: A dent-like form of damage to a panel area with a thick skin can be the possible result of the peening action of a smoothly contoured object. If the inner surface of skin shows no contour change, then the damage can be thought of as a local cross-sectional area change.

(7) Disbond: A disbond occurs when there is a separation between two or more plies of bonded material. Also a disbond occurs when there is a separation between a bonded skin and core. A disbond does not have to occur across the full surface. If an allowable damage section or repair section does not give limits for disbonds, then use the limits specified for delaminations.

(8) Gouge: A damaged area where the result is a cross-sectional change caused by a sharp object and gives a continuous, sharp or smooth groove in the material.

(9) Hole: A puncture or cut-out that is fully surrounded by undamaged material. Other types of damage can be removed by making an oversized hole or a hole that has an irregular shape, if this hole stays in the allowable damage limits or can be repaired with an approved procedure.

(10) Nick: A local gouge with sharp edges. You can consider a series of nicks in a line pattern to be equal to a gouge.

(11) Puncture: A puncture is damage that goes fully through a part thickness and has no regular shape. For example, a puncture can occur when a part is hit by a sharp object. A repair of the damage must be less than the allowable damage limits. Refer to the applicable chapters in the Structural Repair Manual for the allowable damage limits and the approved repair procedures.

(12) Scratch: A line of damage in the material where the result is a cross-sectional area change. This damage is usually caused by contact with a very sharp object.

4. Allowable Damage

A. Make sure that you refer to the applicable allowable damage chapter-section-subject in Chapter 52 thru 57 of this structural repair manual for the rework limits and the necessary shot peening data.

B. Some types of damage or distortion are permitted, with no flight restrictions if the damage condition can be corrected by a simple procedure. For example, damage that can be corrected when you smooth out nicks or gouges is called "Allowable Damage".

(1) The allowable damage limits for the major assemblies and component parts are defined in the applicable chapter-section-subject of the structural repair manual.

(2) The Boeing Company recommends that you use an optical micrometer with a tripod base to find the depth of the damage in the material.

(a) The data for the optical micrometer is as follows: Optical Micrometer - Model Number 966A1 Manufactured by Monocle Industries P.O. Box 2426 618 Hawk Lane Coppell, Texas USA 75019 Telephone Number - (972) 393-9920

(b) As an alternative measurement system, you can use the tool that follows: Scratch Measurement System Measurement Systems, Inc. 2262 Northwest Parkway, Suite B Marietta, Georgia USA 30067 Telephone Number - (770) 951-0878

C. Hidden cracks can be included with other types of damage, such as dents, nicks, gouges, scratches, cracks, and punctures. Refer to the Non-Destructive Test (NDT) for the applicable inspection method to find hidden cracks.

NOTE: Once the damage inspection is done and the damage is found to be in the allowable rework limits, no additional inspections are necessary before the airplane returns to service. However, during the rework process, other inspection steps may be necessary to make sure that all of the damage was identified and all the necessary rework actions were done.

5. Procedures to Remove Nicks, Scratches and Gouges

A. Aluminum Metal Alloys

NOTE: It is possible to burnish damage that does not go all the way through the clad aluminum. Refer to Paragraph 16.H./GENERAL for the clad penetration test. Refer to Paragraph 6./GENERAL for burnishing requirements and procedures.

CAUTION: DO NOT USE A CARBON STEEL BRUSH OR STEEL WOOL ON ALUMINUM METAL SURFACES. IF YOU DO NOT OBEY, THEN TINY DISSIMILAR METAL PARTICLES WILL BECOME EMBEDDED IN THE SURFACE OF THE METAL. THIS CAN CAUSE CORROSION AND MORE DAMAGE TO THE PART.

(1) Abrade or use chemicals to remove all of the paint in the damaged area.

CAUTION: COMPLETE DAMAGE REMOVAL IS NECESSARY TO ESTABLISH APPROPRIATE REPAIR ACTIONS AND TO AVOID DEVELOPMENT OF FATIGUE CRACKING. DAMAGE THAT IS NOT COMPLETELY REMOVED CAN REDUCE THE FATIGUE STRENGTH OF THE PART, WHICH CAN RESULT IN CRACKING. IN EXTREME CASES, UNDETECTED CRACKING COULD COMPROMISE STRUCTURAL INTEGRITY.

(2) Use the abrasives given in Abrasives for Sanding or Scouring, Figure 5/GENERAL to blend out the damaged area.

(3) After you complete the surface rework, then you must use an applicable nondestructive test procedure to make sure that the area does not have cracks.

WARNING: DO NOT GET SOLVENTS IN YOUR MOUTH, YOUR EYES, OR ON YOUR SKIN. DO NOT BREATHE THE FUMES FROM SOLVENTS. SOLVENTS ARE DANGEROUS MATERIALS. SOLVENTS CAN BE FLAMMABLE OR CAUSE DAMAGE TO THE ENVIRONMENT. REFER TO THE MATERIAL SAFETY DATA SHEETS (MSDS) AND THE LOCAL SAFETY PRECAUTIONS.

(4) Clean the damaged area with a soft cloth moist with cleaning solvent. Refer to SOPM 20-30-03 for the applicable cleaning solvent and general cleaning procedures.

(5) Apply a protective treatment and primer to the base metal surface as given in 51-20-01, GENERAL.

(6) If necessary, apply a decorative finish to the area. Refer to AMM PAGEBLOCK 51-21-99/701.

B. Titanium

WARNING: USE CARE WHEN YOU REWORK TITANIUM. SMALL PARTICLES AND FINE SHAVINGS OF TITANIUM ARE HIGHLY FLAMMABLE. TITANIUM DUST IS HIGHLY FLAMMABLE AND CAN CAUSE AN EXPLOSION. WATER WITH HOT TITANIUM CAN CAUSE A STEAM EXPLOSION. EXTINGUISH ALL FIRES OF TITANIUM WITH FULLY DRY TALC, CALCIUM CARBONATE, SAND, OR GRAPHITE. APPLY THE POWDER TO A DEPTH OF 1/2 INCH OR MORE OVER THE BURNING METAL. DO NOT USE FOAM, WATER, CARBON TETRACHLORIDE, OR CARBON DIOXIDE. IF YOU DO NOT OBEY, YOU CAN CAUSE INJURY TO PERSONS.

(1) Clean up the damage by sanding manually or with power tools. Do not use a mechanical grinder. Use cloth, or paper backed silicon carbide or aluminum oxide abrasive that is 80-grit or finer. Wet sanding is the recommended procedure. As an alternative, use stainless steel wool or pumice (350 mesh or finer). Make an abraded finish as follows:

(a) Select the abrasive as given in Abrasives for Sanding or Scouring, Figure 5/GENERAL.

(b) Use supporting disks for disk sanders that are made from rubber or other flexible material.

(c) If applicable, use support drums for drum sanders that have an outer layer of rubber or other flexible material that is 0.10 inch (2.54 mm) in thickness.

(d) Do not use too much pressure, dwell time, or speed (2000 surface feet per minute, maximum).

(e) Parts that show discoloration that can not be removed with Series 80 solvent, must be rejected. Refer to SOPM 20-30-80 for the applicable solvents.

(f) Make the surface finish to 32 microinches Ra or smoother.

(g) When you remove damage on an edge, make the direction of the marks made by the tools to be parallel to the edge.

C. Magnesium

WARNING: USE CARE WHEN YOU REWORK MAGNESIUM. SMALL PARTICLES AND FINE SHAVINGS OF MAGNESIUM ARE HIGHLY FLAMMABLE. MAGNESIUM DUST IS HIGHLY FLAMMABLE AND CAN CAUSE AN EXPLOSION. WATER WITH HOT MAGNESIUM CAN CAUSE A STEAM EXPLOSION. EXTINGUISH ALL FIRES OF MAGNESIUM WITH FULLY DRY TALC, CALCIUM CARBONATE, SAND, OR GRAPHITE. APPLY THE POWDER TO A DEPTH OF 1/2 INCH OR MORE OVER THE BURNING METAL. DO NOT USE FOAM, WATER, CARBON TETRACHLORIDE, OR CARBON DIOXIDE. IF YOU DO NOT OBEY, YOU CAN CAUSE INJURY TO PERSONNEL.

CAUTION: DO NOT USE CARBON STEEL BRUSH OR STEEL WOOL ON MAGNESIUM SURFACES. TINY DISSIMILAR METAL PARTICLES WILL BECOME EMBEDDED IN THE MAGNESIUM CAUSING FURTHER CORROSION AND SUBSEQUENT DAMAGE TO PART. DO NOT USE SILICON CARBIDE ABRASIVES ON MAGNESIUM SURFACES.

(1) Identify the material as magnesium.

(2) Fully clean the damaged area.

(3) Sand all of the paint film in the damaged area to make a smooth surface.

NOTE: Sand down through the metal surface, as necessary, to remove all of the damage.

(4) Do an inspection to measure the damage.

(a) Do a visual inspection with a 10-power magnifying glass to make sure all of the damage was removed.

(b) If, after the above visual inspection, you think there could be more damage, then do an eddy current inspection or a penetrant inspection on the repair area. Refer to 737 NDT Part 6, 51-00-00, and Use of the Squeegee, Figure 4/GENERAL of the NDT Manual for eddy current inspections. Refer to SOPM 20-20-02 for the penetrant inspections.

(c) All of the damage must be removed. Repeat this inspection procedure until no more damage can be found by these inspection procedures.

(5) After all of the damage is removed, apply a protective treatment to the bare metal surface as given in SOPM 20-43-02.

D. Metallic and Non-Metallic Composite Materials

(1) For the cleanup of damage for Aramid Fiber, Carbon Fiber, Glass Fiber and Hybrid Fiber composite structures, refer to the allowable damage section in the component section of the specified chapter-section- subject.

(2) Refer to 51-20-08, GENERAL for specific machining methods of non-metallic composite materials.

(3) Refer to Band Sawing of Metallic and Non-Metallic Honeycomb Core Materials , Figure 6/GENERAL for the recommended methods when a band saw is used on metallic and non-metallic honeycomb core materials.

6. Burnishing

A. Unless the allowable damage section specifies differently, burnishing is a procedure that you can use to remove small nicks, scratches, and gouges in an unpainted, clad aluminum surface.

(1) Refer to Paragraph 16.H./GENERAL for the clad penetration test.

(2) You can burnish clad aluminum surfaces of secondary structure if the damage does not go through the clad. It is not necessary to do supplemental inspections or to record the location of the damage. If the damage goes through the clad aluminum, refer to the applicable allowable damage section for the instructions to remove the damage.

(3) You can burnish clad aluminum surfaces of primary structure if the damage agrees with the conditions in Figure 7/GENERAL.

NOTE: If Figure 7/GENERAL does not let you burnish the damage, you can do one of the alternatives that follow:
- Get an inspection plan from Boeing, or
- Refer to the SRM allowable damage and repair sections, or
- Replace the part.

(a) Burnished areas that agree with the conditions in Figure 7/GENERAL can be inspected at intervals specified in the airline maintenance planning data. It is not necessary to do supplemental inspections or to record the location of the damage.

(b) Remove damage that goes through the clad aluminum as given in the applicable allowable damage or repair sections. Refer to Figure 7/GENERAL.

B. To burnish an area with a small defect:

WARNING: DO NOT GET SOLVENTS IN YOUR MOUTH, YOUR EYES, OR ON YOUR SKIN. DO NOT BREATHE THE FUMES FROM SOLVENTS. SOLVENTS ARE DANGEROUS MATERIALS. SOLVENTS CAN BE FLAMMABLE OR CAUSE DAMAGE TO THE ENVIRONMENT. REFER TO THE MATERIAL SAFETY DATA SHEETS (MSDS) AND THE LOCAL SAFETY PRECAUTIONS.

(1) Clean the damaged area with a soft cloth moist with cleaning solvent. Refer to SOPM 20-30-03 for the applicable cleaning solvent and general cleaning procedures.

(2) Use an ST990, ST994 or equivalent burnishing tool.

(3) Put a petroleum jelly lubricant (or equivalent) on the area to be burnished.

(4) Rub along the sides of the defect while you push the clad aluminum to the center of the damaged area.

(5) Stay at less than 0.25 inch (6 mm) from the edge of the damage while you push on the clad aluminum.

(6) Gradually decrease the pressure until the burnished area is smooth.

(7) Remove the lubricant from the aluminum.

(8) Clean and then apply a chemical conversion coating to the bare metal of the skin. Refer to 51-20-01, GENERAL.

7. Damage That Can Be Repaired

A. Unless the repair procedure is specified as a temporary repair, all of the repair procedures in this structural repair manual are permanent repairs. It is not necessary for permanent repairs to have more aircraft inspections other than the specified maintenance inspections given by the FAA regulations.

CAUTION: DURING A REPAIR PROCEDURE, YOU MUST USE EXTREME CARE TO MAKE SURE THAT THE DRAIN HOLES HAVE NOT BEEN COVERED BY REPAIR PARTS. ALSO, THE DRAIN HOLE LOCATIONS MUST NOT BE REMOVED DURING THE REMOVAL OF DAMAGED AREA. WHEN YOU DO A REPAIR, THE DRAIN HOLES MUST BE KEPT IN THEIR INITIAL POSITIONS, IF POSSIBLE. ALL REPAIR FASTENERS MUST BE SPACED CORRECTLY, SO THAT YOU CAN INSTALL DRAIN HOLES INTO THE REPAIR PARTS.

B. Make repairs to:

(1) Repairable external surface damage by an external or a flush type repair as given in Paragraphs C and D below.

(2) Repairable region damage is applicable in 51-00-00, GENERAL, or by other repairs that are called out in repair procedures throughout this manual.

C. An external repair is a repair that can be applied quickly. It is used to keep airplane down-time to a minimum. It is usually a field oriented type repair, as opposed to a repair that is done in a shop. This type of repair protrudes in relationship to a damaged aerodynamic surface. You can replace this type of repair if necessary for appearance or aerodynamic reasons. Refer to Paragraph D below.

D. A flush repair is a repair that can be used to replace an external repair as described in Paragraph B above. It is normally a shop type procedure, opposite a field oriented type repair. This type of repair is flush in relationship to a damaged aerodynamic surface.

E. The repair types given in Paragraphs C and D above are structural equivalents of each other for static strength. The operator has the option to use either type for a structurally airworthy, FAA approved repair. Some repairs are designed so that fastener holes that are made during a field type repair can be used for a subsequent shop type repair.

NOTE: The performance of the airplane can be affected by external type repairs made in aerodynamic critical areas. Refer to 51-10-01, GENERAL.

F. All of the other repairs that are given in this manual that cover internal metal structural components:

(1) Are structurally airworthy.

(2) Are FAA approved for the service life of the airplane.

(3) Can be flush or external type of repairs.

G. Category B (Interim) and Category C (Time-Limited) Repairs

(1) Refer to 51-00-07, GENERAL for the correct definitions of these types of repairs.

(2) Category B or Interim repairs can stay on the airplane indefinitely if you find that there are no signs of deterioration of the repair area during regular supplemental maintenance inspections.

(a) Interim repairs must be inspected at specified intervals and replaced if any deterioration is evident. These intervals are usually specified as flight hours, flight cycles, or letter checks. The letter checks are different from model to model for Boeing airplanes. The letter checks are specified in the Maintenance Planning Data document.

(b) The repairs are FAA approved contingent on the accomplishment of inspections at the intervals specified in this document.

(3) Category C or Time-Limited types of repairs given in this manual are temporary repairs. These types of repair designations can provide a practical solution to a specific repair problem.

(a) Time-limited repairs must be replaced after a specified time with a permanent repair. This time is usually specified as flight hours, flight cycles, or letter checks. The letter checks are different for different models of Boeing airplanes. The letter checks are specified in the Maintenance Planning Data document. Periodic inspection requirements may be imposed to ensure the integrity of the repair.

(b) These repairs are FAA approved contingent on the accomplishment of inspections at the intervals specified and the installation of a permanent repair by a specified time.

(4) The SRM contains some allowable damage and repairs that use letter checks to define when a subsequent inspection and repair must be done. Examples are "A" check or "C" check. If an operator does not use letter checks or divides letter checks into segments, an equivalent time interval to the letter checks must be used. Refer to the Airline Maintenance Inspection Intervals document, D6-26100. Example: An operator divides a "C" check into four segments (Segments 1 through 4). During segment 2, damage that is found must be repaired by the next "C" check as given in the SRM. Thus, the damage must be repaired by segment 2 of the next "C" check interval.

8. Replacement of the Part

A. The option to replace a part is given when the repair of the component is not a recommended solution.

(1) Sometimes, the amount of damage to the part will make it necessary to replace it.

(2) These situations are specified in the different allowable damage and repair chapter-section-subjects given in this manual.

B. The repair procedures specified in Chapters 52 through 57 give the approved repairs for the repairable structural items.

C. The structural items that do not have entries are called repairable by replacement.

9. Repair of Damage that is more than the Allowable Damage Limits

NOTE: Refer to the repair sections in Chapters 52 through 57 to see if more applicable repair instructions are available.

A. Remove the initial finish as necessary to apply a sealant or to apply a protective treatment to the surface.

B. Remove the damaged components to be replaced and the damaged areas to be repaired.

NOTE: Use a router and template or a hole saw to cut circular holes in aluminum honeycomb or fiberglass structure. Refer to Router and Template, Figure 2/GENERAL and Use of the Hole Saw, Figure 3/GENERAL.

C. Remove all the nicks, scratches, burrs, and sharp edges from repair parts and the surfaces of the initial parts as given in this chapter-section-subject.

D. Apply a chemical conversion coating to the surfaces or edges of the initial aluminum parts and the aluminum repair parts as given in 51-20-01, GENERAL.

E. Apply the protective finish as necessary to the initial and repair parts.

F. Determine the sealing level and the type of sealing procedures necessary. Refer to 51-10-05, GENERAL for sealant materials and substitute sealant materials.

(1) For external surfaces when access is limited, seal the mating surfaces with the sealant materials that follow:

(a) For pressure requirements, use BMS 5-95.

(b) For high temperature requirements, use BMS 5-63.

(c) For moisture protection requirements, use BMS 5-95.

NOTE: You can use the squeegee shown in Use of the Squeegee, Figure 4/GENERAL to apply the sealant.

(2) For flush repairs on external surfaces when access is available to the pressurized side, use the fillet seal and fastener seal procedures. Use mating surface sealants for flush repairs when access is limited or not available. Apply fillet and fastener sealants with the sealant materials that follow:

(a) For integral tank requirements, use BMS 5-26 or BMS 5-45 (Refer to 51-10-05, GENERAL).

(b) For pressure requirements, use BMS 5-70 or 5-95.

(c) For high temperature requirements, use BMS 5-63 (Refer to SOPM 20-60-04).

(d) For moisture requirements, use BMS 5-95.

G. Make the Repair Parts

(1) Refer to the specified chapter-section-subject to make the repair parts.

(2) Refer to Abrasives for Sanding or Scouring, Figure 5/GENERAL to machine the metallic or non-metallic honeycomb core parts.

H. Prepare the mating surfaces for the installation of the repair parts.

(1) For external repairs:

(a) Clean the mating surfaces.

(b) Apply the correct sealant material as given in Paragraph F above.

(c) Install the repair parts.

(d) Install the necessary fasteners. Refer to 51-40-02.

(e) Apply the protective finish if necessary as given in AMM SECTION 51-21.

(2) For flush repairs:

(a) Clean the mating surfaces.

(b) Apply the adhesive to the mating surfaces. You can use the squeegee shown in Use of the Squeegee, Figure 4/GENERAL.

(c) Install the repair parts.

(d) Apply the necessary fillet seal and the sealant to the fasteners.

(e) Apply the BMS 5-95 aerodynamic smoother to the gaps as necessary in the aerodynamically critical areas.

(f) Apply the protective finish as necessary. Refer to AMM SECTION 51-21.

I. Do the other necessary post repair checks.

(1) Balance the control surfaces again as necessary. Refer to 51-60-00, GENERAL.

10. Hole Preparation for Repairs

CAUTION: USE SUFFICIENT PRECAUTIONS TO MAKE SURE THAT SYSTEM COMPONENTS, AIRPLANE ELECTRICAL WIRES AND STRUCTURES, ARE NOT DAMAGED BY DRILLS, METAL SHAVINGS AND OTHER CONTAMINATION WHILE YOU DO WORK. METAL SHAVINGS OR CONTAMINATION LEFT IN THE AIRPLANE CAN TOUCH WIRE BUNDLES AND CAUSE CHAFING DAMAGE TO ELECTRICAL WIRES. CHAFFED WIRES CAN CAUSE ARCING DAMAGE.

A. Drilling a Fastener Hole in Metal Structure

(1) Refer to 51-40-05, GENERAL for the correct hole sizes.

(2) All of the repair procedures given in the manual strongly recommend that you use properly sized and properly maintained drills and drill bits.

(3) When necessary to prepare a hole, use a bushing tool as a guide to obtain a hole that is not larger than the drill size. Also use the bushing tool to hold the drill perpendicular to the repair surface.

(4) Use the correct drill speed, in feet per minute, which will give a smooth, bright finish throughout the hole surface.

(5) If the hole has a rough or galled surface, then manually hand-ream the hole until the inside surface is smooth.

(6) You must follow the recommendations given in the repair procedures, so that the repairs and preventative modifications will stay on the airplane during its service life.

B. Removal of Small Cracks and Fatigue Damaged Material from an Existing Hole (Zero-Timing)

(1) This procedure is recommended for the initial fastener holes before a repair part is installed. Zero-timing makes the repair durability better. If this procedure is done for all existing fastener holes in the critical rows of the repair (which are usually the perimeter fasteners of the repair doubler in a skin repair) then the inspection threshold will start from the time of repair installation. If not, then the threshold starts from the time the airplane was delivered.

(2) Visually inspect all of the existing holes for irregular surface conditions such as burrs, galling, corrosion and out-of-round or elongated holes. These irregular surface conditions can interfere with the High Frequency Eddy Current (HFEC) inspection, for this reason you can use a Borescope, an Endoscope or other types of optical aids to help the visual inspection.

NOTE: If a "clean-up" is necessary to remove one or more of these conditions, ream the hole to 1/64 inch oversize from its existing size. A surface finish of 125 microinches Ra or better is necessary.

(3) Inspect the fastener hole with the HFEC method. Refer to 737 NDT Part 6, 51-00-00, and Corrosion Removal Tools, Figure 1/GENERAL or Figure 6 for the inspection of the open hole.

(a) If no cracks are found, make the hole diameter 1/16 inch oversize to remove any fatigue damaged material.

(b) If cracks are found, make the hole diameter larger by 1/64 inch increments until HFEC inspection shows no more cracks. Then, make the hole another 1/16 inch larger to remove any fatigued damaged materials.

NOTE: The limit to make the hole larger is different for each situation and depends on the load pattern and the stress levels in the rework area. Sometimes, it may be necessary to install a plug through which a fastener that is the same size as the initial fastener can be installed. Refer to 51-20-10, GENERAL for freeze plug installation.

(4) Ream the hole as necessary to the finished size for installation of the fastener or the plug.

(5) If coldworking is necessary, ream the hole to the correct size and do the coldworking procedure.

11. Procedure for Stop-Drilling of Cracks

NOTE: Stop-drilling a crack prevents its growth. You can use this procedure for stop-drilling of crack, only if it is referred to in the applicable allowable damage or repair chapter-section-subject or other approved repairs. If this procedure for stop-drilling of cracks is not referred to in the applicable allowable damage or repair procedure or other approved repairs then all of the cracks must be cut out and a repair for the cutout must be done.

A. The correct procedure for stop-drilling a crack is as follows:

(1) Drill or counterbore a 0.25 inch stop hole through the structure at each end of the crack. Drill the hole in a position so that the center of the hole is 0.10 inch past the visible end of the crack.

(2) Do a High Frequency Eddy Current (HFEC) inspection of each drilled stop hole. Refer to 737 NDT Part 6, 51-00-00, and Corrosion Removal Tools, Figure 1/GENERAL or Figure 6 for the inspection of the open hole. Make sure that there are no more cracks on the side opposite from the initial crack.

(a) If a crack is not found, make the hole 1/16 inch in diameter larger to remove any fatigue damaged material.

(b) If a crack is found, make the hole larger by 1/64 inch increments until no crack remains. Then, make the hole another 1/16 inch larger to remove any fatigue damaged material.

NOTE: The limit to make the hole larger is different for each situation and depends on the load pattern and the stress levels in the rework area.

(c) In aluminum structures, install a 2017-T3 or 2017-T4 aluminum plug rivet into the stop-holes, if necessary.

(d) In titanium, corrosion-resistant steel (CRES), and inconel structures, install a monel plug rivet into the stop-holes, if necessary.

12. Missing or Loose Fasteners in Secondary Structure

A. Refer to 51-10-05, GENERAL to find if it is possible to operate the airplane with missing or loose fasteners in secondary structure.

13. Corrosion Damage and Rework Limits

NOTE: Make sure that you refer to the applicable allowable damage chapter-section-subject for the rework limits and the necessary shot peening.

A. Corrosion evaluation will be necessary after you do an initial inspection and cleaning procedure to determine the nature and the extent of repair or rework.

B. Examine the corrosion to make an analysis of the damage. It is difficult to give a distinct and specific dividing line between the various conditions. Thus, the first requirement for evaluation of corrosion damage is good and sound maintenance judgment. Evaluate corrosion as follows:

(1) Light corrosion: A discoloration or pitting to a depth of approximately 0.001 inch maximum. This type of damage is normally removed with light sanding by hand or a mild chemical treatment.

(2) Moderate corrosion: Almost the same as Light corrosion, but there can be evidence of flaking, scaling, or blistering. Pitting can be to the depth of 0.010 inch. This type of damage is normally removed by vigorous manual sanding or by using mechanical sanding equipment.

(3) Severe corrosion: More severe than moderate corrosion. There is evidence of severe blistering, exfoliation, and scaling or flaking. Pitting is deeper than 0.010 inch. This type of damage is removed by hard mechanical sanding or grinding.

NOTE: Do not use a grinder on titanium. This will help prevent damage from heat.

C. For corrosion damage, it is necessary to do rework to the damaged area, to find the penetration depth of the damage into a structural member, before you can establish its classification as allowable damage or damage requiring repair.

D. All corrosion products must be removed completely when corroded structures are reworked as the corroding process will continue even though the affected surface is refinished. In extreme cases, continued propogation will impact structural integrity.

14. **Corrosion Damage Removal Procedure and Inspection**

A. Aluminum, Steel, and Tungsten

NOTE: Make sure that you refer to the applicable allowable damage chapter-section-subject for the rework limits and the necessary shot peening.

(1) Remove all the sludge or powdery material you find in the integral fuel tank area as given in AMM 28-11-00.

CAUTION: WHEN YOU MAKE THE SURFACE ROUGH ON STEEL, MAKE SURE THAT YOU CHANGE THE SPEED AND THE FEEDS TO PREVENT HEAT OR SPARKS. DO NOT PERMIT THE SURFACE TEMPERATURE TO BE MORE THAN WHAT YOU CAN TOUCH WITH YOUR BARE SKIN. IF YOU DO NOT OBEY, YOU CAN CAUSE DAMAGE TO THE PART. WHEN YOU DO ABRASIVE BLAST PROCEDURES IN AREAS WHERE LUBRICATION FLUIDS OR GREASE ARE APPLIED, USE CARE TO PREVENT CONTAMINATION OF THE LUBRICANT WITH THE BLAST RESIDUE. THIS CONTAMINATION CAN AFFECT THE LUBRICATION PROPERTIES AND THE RESULT CAN BE INCREASED WEAR OF THE LUBRICATED PARTS.

(2) To remove the corrosion, use a rotary file, a rubber-backed disc sander, a carbide-tipped scraper, or aluminum oxide abrasive as necessary. Refer to Abrasives for Sanding or Scouring, Figure 5/GENERAL to find the permitted abrasives. Use air motors for all of the power tools. Refer to Corrosion Removal Tools, Figure 1/GENERAL for the tools that are permitted for use.

NOTE: As an alternative, you can use the glass bead blasting procedure to remove filiform corrosion from aluminum clad skins. Do not use glass bead blasting to remove other corrosion on aluminum. Refer to CPM Volume 1, 20-40-00.

(3) Make a group of several corrosion spots in a local area so that you have an elliptical-shaped rework surface.

(4) Carefully blend the edges into the adjacent areas. Make the rework surface equal to 125 microinches Ra or smoother, unless a different surface smoothness is specified in the component repair section.

(5) Do an inspection for damage caused by corrosion.

CAUTION: REMOVE ALL THE DAMAGE. THIS WILL PREVENT MORE CORROSION DAMAGE AND WILL HELP TO DEFINE THE CORRECT REPAIR ACTION. CORROSION THAT IS NOT FULLY REMOVED WILL CONTINUE TO GROW EVEN IF THE PART IS REFINISHED. IN EXTREME CASES, CONTINUED CORROSION GROWTH COULD AFFECT THE STRUCTURAL INTEGRITY OF THE PART.

(a) Do a visual inspection with a 10-power magnifying glass to make sure all of the corrosion was removed and to find possible cracks. You can remove an additional 0.002 inch of materrial as given in CPM 20-40-00, Part I to make sure that the corrosion has been fully removed. Alternatively, for aluminum structure where the corrosion has attacked the grain boundary of the material, the use of a dye penetrant inspection as given in SOPM 20-20-02 will assist in detecting intergranular corrosion that could have been hidden by the blending process.

(b) If, after the above visual inspection, you think there could be cracks, do an eddy current inspection or a penetrant inspection on the repair area. Refer to the applicable Corrosion Preventive Manual for additional data.

NOTE: If the allowable damage or repair subject that refers to this chapter-section-subject for corrosion removal, and the subject has a requirement for the inspection for cracks, then do the eddy current inspection or penetrant inspection.

(c) Refer to 737 NDT Part 6, 51-00-00, and Use of the Squeegee, Figure 4/GENERAL for eddy current inspections. Refer to SOPM 20-20-02 for the penetrant inspections.

(d) All of the corrosion and all of the cracks must be removed. Repeat the applicable corrosion damage removal procedure and inspection, until no more corrosion or cracks can be found by these inspection procedures.

WARNING: USE CARE WHEN YOU REWORK MAGNESIUM. SMALL PARTICLES AND FINE SHAVINGS OF MAGNESIUM ARE HIGHLY FLAMMABLE. MAGNESIUM DUST IS HIGHLY FLAMMABLE AND CAN CAUSE AN EXPLOSIVE. WATER WITH HOT MAGNESIUM CAN CAUSE A STEAM EXPLOSION. EXTINGUISH ALL FIRES OF MAGNESIUM WITH FULLY DRY TALC, CALCIUM CARBONATE, SAND, OR GRAPHITE. APPLY THE POWDER TO A DEPTH OF 1/2 INCH OR MORE OVER THE BURNING METAL. DO NOT USE FOAM, WATER, CARBON TETRACHLORIDE, OR CARBON DIOXIDE. IF YOU DO NOT OBEY, YOU CAN CAUSE INJURY TO PERSONS.

CAUTION: MAGNESIUM IS THE MOST CHEMICALLY ACTIVE METAL THAT IS USED TO BUILD AIRPLANES, AND IT IS THE MOST DIFFICULT TO PROTECT FROM CORROSION. IF A LOSS IN THE PROTECTIVE COATING OCCURS, YOU MUST ACT IMMEDIATELY TO PREVENT FURTHER CORROSION. IF YOU DO NOT OBEY, THE RESULT CAN BE SERIOUS STRUCTURAL DAMAGE. DO NOT USE SILICON CARBIDE ABRASIVES ON MAGNESIUM SURFACES. DO NOT USE A CARBON STEEL BRUSH OR STEEL WOOL ON MAGNESIUM SURFACES. TINY DISSIMILAR PARTICLES WILL BECOME EMBEDDED IN THE MAGNESIUM CAUSING FURTHER CORROSION AND SUBSEQUENT DAMAGE TO THE PART. DO NOT USE SILICON CARBIDE ABRASIVES ON MAGNESIUM SURFACES.

B. Magnesium:

(1) Identify the material as magnesium.

NOTE: You can find corrosion in magnesium easily. When the corrosion begins, its products can be several times larger than the initial volume of the magnesium metal. The corrosion starts with a separation of the paint film, and as white spots on the surface of the metal which can quickly grow into mound that look like snow. You must fully remove the corrosion and apply a chemical treatment and restore the protective coating.

(2) Fully clean the damaged area.

(3) If necessary, remove the paint.

(4) Find the type of corrosion damage and remove it. Refer to Paragraph 5./GENERAL

(a) Refer to Paragraph 14.B.(5)/GENERAL to remove light corrosion damage.

(b) Refer to Paragraph 14.B.(6)/GENERAL to remove moderate to severe corrosion damage.

CAUTION: DO NOT USE THE PROCEDURE THAT FOLLOWS FOR:
- ADHESIVE BONDED PARTS OR ASSEMBLIES
- AREAS WHERE THE BRUSH-ON SOLUTION CAN BECOME TRAPPED
- AREAS THAT WERE MADE BARE BY GRINDING FOR ELECTRICAL BONDING IF YOU DO NOT OBEY, DAMAGE TO THE ADHESIVE SYSTEMS CAN OCCUR.

(5) Remove the "light corrosion damage" as follows"

(a) Remove the loose corrosion with aluminum wool.

(b) Do an inspection for damage caused by corrosion.

1) Do a visual inspection with a 10-power magnifying glass to make sure all of the corrosion was removed and to find possible cracks.

2) If, after the above visual inspection, you think there could be cracks, do an eddy current inspection or a penetrant inspection on the repair area. Refer to the applicable Corrosion Prevention Manual for additional data.

NOTE: If the allowable damage or repair subject that refer to this chapter-section-subject for corrosion removal, and the subject has a requirement for the inspection for cracks, then do the eddy current inspection or penetrant inspection.

3) Refer to 737 NDT Part 6, 51-00-00, and Use of the Squeegee, Figure 4/GENERAL for eddy current inspections. Refer to SOPM 20-20-02 for the penetrant inspections.

4) All of the corrosion and all of the cracks must be removed. Repeat the applicable corrosion damage removal procedure and inspection, until no more corrosion or cracks can be found by these inspection procedures.

(c) Isolate other parts such as rubber parts, bearings, and cast or pressed inserts from the treating solution and its fumes.

(d) Apply DOW 19 chromate conversion treatment to the reworked surface with as given in SOPM 20-43-02.

(e) Apply two layers of BMS 10-11, Type 1 primer. Refer to SOPM 20-41-02.

(f) Apply two layers of BMS 10-60, Type 1 or Type II enamel.

(6) Remove "moderate to severe corrosion damage" as follows:

WARNING: WEAR PROTECTIVE GOGGLES OR A FACE SHIELD WHEN YOU REMOVE THE CORROSION. IF YOU DO NOT OBEY, THE RESULT CAN BE INJURY TO PERSONNEL.

CAUTION: DO NOT USE CARBON STEEL WIRE BRUSHES OR SILICON CARBIDE ABRASIVES ON MAGNESIUM. USE CARE NOT TO CAUSE OTHER DAMAGE FROM THE CORROSION PRODUCTS TO THE AREAS ADJACENT TO THE DAMAGE. IF YOU DO NOT OBEY, YOU CAN CAUSE MORE DAMAGE TO THE PARTS.

(a) Remove the heavy corrosion products with a stainless steel wire brush.

(b) Remove the remaining corrosion by sanding. Use the applicable abrasive as given in Abrasives for Sanding or Scouring, Figure 5/GENERAL.

(c) Do an inspection for damage caused by corrosion.

1) Do a visual inspection with a 10-power magnifying glass to make sure all of the corrosion was removed and to find possible cracks.

2) If, after the above visual inspection, you think there could be cracks, do an eddy current inspection or a penetrant inspection on the repair area. Refer to the applicable Corrosion Prevention Manual for additional data.

NOTE: If the allowable damage or repair subject that refers to this chapter-section-subject for corrosion removal, and the subject has a requirement for the inspection for cracks, then do the eddy current inspection or penetrant inspection.

3) Refer to 737 NDT Part 6, 51-00-00, and Use of the Squeegee, Figure 4/GENERAL for eddy current inspections. Refer to SOPM 20-20-02 for the penetrant inspections.

4) All of the corrosion and all of the cracks must be removed. Repeat the applicable corrosion damage removal procedure and inspection, until no more corrosion or cracks can be found by these inspection procedures.

CAUTION: APPLY PROTECTION TO THE BARE MAGNESIUM SURFACE. CORROSION BEGINS WITH THE SEPARATION OF THE PAINT FILM FROM THE METAL.

(d) Immediately after all damage is removed, apply DOW 17 (preferred), or DOW 19 (alternative) as given in SOPM 20-43-02.

(e) Apply two layers of BMS 10-11, Type 1 to the reworked area. Refer to SOPM 20-41-02.

(f) Apply two layers of BMS 10-60, Type 1 or Type II enamel.

15. Safety Procedures for Working With Chemicals

NOTE: Paragraph A contains the general safety precautions, which contain specific rules for handling chemicals with hazardous physical properties. Paragraph B contains emergency procedures for the immediate treatment of personnel who have inadvertently come into contact with one of the harmful chemicals. Chemicals that have hazardous physical properties are given in the manufacturer’s safety precautions and emergency safety procedures. All personnel that use or handle hazardous chemicals must fully know the safety data contained in the that follow.

A. General Safety Precautions

(1) When it is necessary to use or handle any of the solvents, special cleaners, paint strippers (strong alkalies and acids), etchants (corrosion removers containing acids), or surface activation material (chemical conversion coatings), you must obey the safety precautions that follow:

(a) Avoid long term breathing of solvents or acid vapors. Do not use solvents and acids in confined spaces without sufficient ventilation or approved respiratory protection.

(b) Never add water to acid. Always add acid to water.

(c) Do not mix chemicals except as given in a specified mixing procedure.

(d) Clean water that you can use for emergencies must be available in the immediate work area before you work with chemicals.

(e) Avoid long term or repeated contact of solvents, cleaners, etchants (acid), or chemical conversion coating material with your skin.

1) Rubber or plastic gloves must be worn when you use solvents, cleaners, paint strippers, etchants, or conversion coating materials.

2) Goggles or plastic face shields and suitable protective clothing must be worn when cleaning, stripping, etching, or applying a conversion coating to overhead surfaces.

(f) When you mix alkalies with water or other substance, use containers which are made to withstand heat generated by this process.

(g) Wash any paint stripper, etchant, or conversion coating material immediately from body skin or clothing.

(h) Materials splashed in the eyes must be immediately flushed out with water. Get immediate medical aid for the injured personnel.

(i) Do not eat or keep food in areas where it can absorb toxic poisons. Always wash your hands before eating or smoking.

(j) All equipment must be cleaned after work has been completed.

(k) Implement all company specified safety precautions in your work area.

B. Emergency Safety Procedures

WARNING: PERSONNEL MUST BE THOROUGHLY FAMILIAR WITH THE FOLLOWING EMERGENCY SAFETY PROCEDURES BEFORE THEY CAN USE ANY MATERIALS WHICH ARE REFERENCED IN ANY EMERGENCY SAFETY PROCEDURE PARAGRAPHS.

(1) If one or more persons are exposed to physical contact with any of the materials that follow:

(a) Methyl alcohol

(b) Methyl Ethyl Ketone

(c) Methyl Isobutyl Ketone

(d) Toluene

(e) Trichloroethylene

(f) Epoxy resin

(g) Methylene chloride

(h) Chemical conversion coatings

(i) Xylene

(j) Petroleum Naphthas

(k) Chromates

(l) Dichromates

(m) Acetates

(n) Cyclohexanone

(o) Cellosolve

(p) Carbon tetrachloride

(2) Then use the safety procedures that follow:

(a) If a chemical is splashed into the eyes, do not rub them.

(b) Flush the eyes immediately with water for at least 15 minutes. Lift upper and lower eyelids frequently to ensure complete washing.

(c) If a chemical is splashed on clothing or large areas of your body, immediately remove contaminated clothing and wash your body with plenty of soap and water. Also wash the clothing before they are worn again.

(d) If a chemical is splashed onto an easily accessible part of the body, immediately wash with soap and water.

(e) If a person is suffering headache or other obvious symptoms resulting from overexposure to chemicals, move the person to fresh air immediately.

(f) If a person inhales chemical vapors and the persons breathing has slowed down or stopped, then remove the person from the area and start artificial respiration immediately. Call for medical aid and continue this procedure until medical aid arrives.

(3) If one or more persons are exposed to physical contact with any of the materials that follow:

(a) Hydrofluoric acid

(b) Nitric acid

(c) Phosphoric acid

(d) Phenol

(e) Cresols

(f) Tricresyl phosphate

(4) Treat as follows:

WARNING: IT CANNOT BE OVEREMPHASIZED THAT IMMEDIATE TREATMENT IS MOST IMPORTANT WITH SKIN, EYE AND INHALATION EXPOSURE TO THESE MATERIALS.

(a) Eyes: If splashed into the eyes, do not rub them, flush them immediately with water for at least 15 minutes. Lift upper and lower eyelids frequently to ensure complete washing. Call for medical aid immediately.

(b) Exposed Skin: If splashed on skin, wash affected area with large amounts of water for at least 15 minutes. Get medical aid as soon as possible.

(c) Clothing: If splashed on clothing or large area of body, remove contaminated clothing and wash body under a shower for at least 15 minutes. Wash clothing before reuse. Get medical aid as soon as possible.

(d) Inhalation: If vapors are inhaled, remove worker to fresh air and apply artificial respiration if necessary. Call for medical aid immediately.

NOTE: Tricresyl phosphate is not considered an inhalation hazard.

(e) Internally: Use one of the procedures that follow:

1) Worker is unconscious:

a) Do not give any liquid.

b) Begin artificial respiration and have someone call for medical aid immediately.

2) Worker is conscious:

a) Phenols and Cresols: Do not attempt to induce vomiting. Encourage him to wash out his mouth with large amounts of water. Call for medical aid immediately.

b) Phosphoric Acid: Do not induce vomiting. Call for medical aid immediately.

c) Hydrofluoric Acid: Drink water to dilute acid, then cause vomiting by placing finger in the back of throat. Repeat. Wash out mouth repeatedly. Call for medical aid immediately.

d) Nitric Acid: Do not induce vomiting. Drink copious amounts of water, if possible. Call for medical aid immediately.

e) Tricresyl Phosphate: Cause vomiting by placing finger in the back of the worker's throat. If necessary, have him drink water, then use finger to induce vomiting. Call for medical acid immediately.

16. Identification of Metals

A. Make sure that you refer to the applicable subjects in Chapters 52 through 57 in this manual to identify the metal material. If positive identification cannot be made, then chemical spot testing can be done.

WARNING: PERSONNEL MUST BECOME THOROUGHLY FAMILIAR WITH THE SAFETY PRECAUTIONS AND EMERGENCY SAFETY PROCEDURES IN PARAGRAPH 13, BEFORE ANY CHEMICAL TESTING IS DONE.

CAUTION: CHEMICAL SPOT TESTING SHOULD BE USED ONLY WHEN ALL OTHER MEANS OF IDENTIFICATION HAVE BEEN EXHAUSTED. FASTENERS MUST NOT BE IDENTIFIED BY CHEMICAL SPOT TESTS.

B. A serious problem encountered in corrosion control is the identification of the metal on which corrosion occurs. The importance of this identification arises from the fact that all metals possess certain chemical characteristics that are common only to themselves and which vary greatly from metal to metal, and from alloy to alloy of the same metal.

C. Since these characteristics are common to all metals and their alloys, chemical cleaning solutions and chemical protective films will react differently with various metals; and in some cases, produce adverse reactions which can severely weaken or destroy the structural capabilities of the metal. Aluminum, steel, and magnesium sheet and plate are stenciled on the back for identification.

D. When these markings are not distinguishable or the metal is not identified in the applicable chapter-section-subject, or when a plating material must be identified, positive identification can be made by chemical spot testing, hardness testing, or a combination of the two methods.

E. Chemical testing

(1) The chemical identification of the various types of metals used in airplane construction should be accomplished. Before any tests are conducted, the preliminary surface preparation and primary classification of the metal should be accomplished by the following procedure:

CAUTION: MASK ANY ADJACENT STRUCTURE MADE OF ADVANCED COMPOSITES. PAINT REMOVER CAN DAMAGE THE RESIN SYSTEM IN FIBERGLASS, ARAMID AND CARBON FIBER STRUCTURE.

(a) On the surface to be tested, choose an area where there is no corrosion and remove paint (if present) from a 1-inch square. Paint may be stripped with a cloth soaked in methyl ethyl ketone or paint remover or any equivalent material.

(b) Clean area of surface to be tested.

(c) Try to identify the exposed metal surface by visually comparing it with samples of previously identified materials.

(d) Identify the metal as ferrous or nonferrous by placing a magnet on the exposed surface.

1) Magnetic attraction classifies the base metal as a ferrous magnetic material (iron or steel).

2) The absence of magnetic attraction classifies the base metal as either an austenitic steel or a nonferrous metal (aluminum, magnesium, etc.).

(e) If the metal is magnetic, refer to Paragraph F for chemical spot testing. If the metal is nonmagnetic, refer to Paragraph G. Refer to Paragraph H for the clad aluminum penetration test.

F. Chemical Spot Analysis of Magnetic Metals

(1) The magnetic metals usually employed in aircraft construction are ferrous alloys (low alloy steel and chromium-nickel-iron alloys sometimes called stainless steels). These magnetic alloys, when plated, are generally plated with either chromium, nickel, zinc, cadmium, silver, or with a combination of these platings. If a magnetic alloy has been plated with cadmium, zinc, or chromium, it will exert magnetic attraction. Nickel plating will show slight magnetic attraction even if the substrate or base metal is not magnetic.

(2) If positive identification of the metal plating is necessary, identification by chemical spot analysis should be made after accomplishing a hardness test as detailed in 51-20-02, GENERAL.

CAUTION: DO NOT PERFORM CHEMICAL SPOT TEST ON STEELS HEAT TREATED TO 220,000 PSI AND ABOVE.

(a) Place a drop of 10% hydrochloric acid (HCl) on the prepared metal surface. Make sure that the surface is dry before applying acid.

1) A rapid reaction producing a dark deposit indicates that the metal is zinc.

WARNING: THE ADDITION OF SODIUM SULFIDE (NA2S) TO ACID PRODUCES A POISONOUS GAS. ADEQUATE VENTILATION MUST BE PROVIDED WHEN THESE TESTS ARE BEING PERFORMED. DO NOT ALLOW LARGE QUANTITIES OF SODIUM SULFIDE (NA2S AND ACID TO BE MIXED.

2) A slow or no reaction indicates that the metal may be cadmium, chromium, nickel, or steel.

(b) After 1 minute, add a drop of sodium sulfide (Na^2S) to the drop of hydrochloric acid (HCl).

1) A white precipitate identifies the metal as zinc.

2) A yellow ring formed around a white precipitate identifies the metal as cadmium.

3) A black ring formed around a white precipitate identifies the metal as iron or steel.

4) A black precipitate indicates that the metal is chromium or nickel.

(c) Confirm the cadmium, zinc, iron, or steel test by placing a drop of 20% nitric acid (HNO3) on a fresh spot. After 1 minute, add a drop of sodium sulfide (Na2S) to the drop of nitric acid (HNO3).

1) A white precipitate identifies the metal as zinc.

2) A yellow precipitate identifies the metal as cadmium.

3) A black spot identifies the metal as iron or steel.

(d) Confirm the chromium test by placing a drop of 10% hydrochloric acid on a fresh spot. Add a drop of concentrated sulfuric acid (H2SO4) to the drop of hydrochloric acid.

1) A color change to green after 1 or 2 minutes identifies the metal as chromium.

(e) Confirm the nickel test by placing a drop of ammonium hydroxide (NH40H) to the drop of dimethylgloxime solution.

1) A pink to red precipitate identifies the metal as nickel.

(f) Clean and refinish as given in Paragraph I.

G. Chemical Spot Analysis of Nonmagnetic Metals

(1) The most common nonmagnetic metals used in aircraft construction are aluminum, magnesium, and austenitic steels (generally used as 18-8 stainless steel). The positive identification of these nonmagnetic metals is accomplished by the following procedure:

(a) Place a drop of 10% hydrochloric acid (HCl) on the prepared metal surface and allow to stand for 1 minute. Ensure that surface is dry before applying acid.

NOTE: Zinc deposits on nonmagnetic metals will react with 10% hydrochloric acid but will not produce a black spot.

1) A rapid or violent reaction that produces a black spot indicates that the metal is magnesium.

2) A slow reaction indicates that the metal is aluminum.

3) No reaction indicates that the metal is an austenitic steel or a nonmagnetic plating material.

(b) If a reaction that did not produce a black spot is noted in step (a), determine if zinc is present as detailed in Paragraph G.

(c) If the results of step (b) above are negative, confirm the magnesium and aluminum tests by placing a drop of 10% sodium hydroxide (Na0H) on a fresh spot. Check for the following:

1) No reaction which will identify the metal as magnesium.

2) A reaction that produces a colorless spot to identify the metal as a clad aluminum alloy.

3) A reaction that produces a black spot to identify the metal as a bare aluminum alloy.

(d) If an aluminum alloy is identified in step (a), then do a test to distinguish the different alloys by placing a drop of 10% cadmium chloride on a fresh spot.

1) A dark gray deposit forming within a few seconds will identify the metal as Series 7000 bare aluminum alloy.

2) A dark gray deposit forming within 2 minutes will identify the metal as Series 7000 clad aluminum alloy.

3) No deposit formation in the time specified for Series 7000 clad will identify the metal as Series 2000 aluminum alloy (a faint deposit will form after 15 to 20 minutes).

(e) Confirm the austenitic steel test by dissolving 10 grams of cupric chloride.

1) Place (CuC12, 2H20) in 100 milliliters (cubic centimeters) of hydrochloric acid and place a drop of the solution on a fresh spot.

2) After 2 minutes, add 3 or 4 drops of distilled water to the drop of hydrochloric acid solution and dry the surface.

3) The appearance of a brown spot identifies the metal as an austenitic steel.

(f) If no reaction was noted in step (a) or (e) above, test for a plating material as given in steps (a) through (c) of Paragraph G.

(g) If step (f) shows the presence of plating on the nonmagnetic metals, the plating must be removed by mechanical abrasion and the base metal identified by the visual and/or chemical methods.

(h) Clean and refinish as given in Paragraph I.

H. Clad Penetration Test

(1) Clean the area to be tested by swabbing with a soft wiper moistened with BMS 3-2 solvent.

(2) Wipe the surface dry.

(3) Mask off damage to prevent staining of adjacent areas by the test solution. Permit no more than 1/32 inch bare metal around periphery of damage.

WARNING: DO NOT PERMIT THE TEST SOLUTION TO CONTACT YOUR SKIN OR EYES. WEAR PROTECTIVE CLOTHING AND EYE PROTECTION. THE TEST SOLUTION IS CAUSTIC AND WILL CAUSE INJURY TO PERSONNEL.

(4) Mix the test solution. Use the following portions:

(a) Potassium Nitrate 200 grams

(b) Sodium Hydroxide 100 grams

(c) Water to make one liter of solution

CAUTION: DO NOT PERMIT THE TEST SOLUTION TO CONTACT ANY OTHER AREA THAN WHAT YOU WILL TEST. THE TEST SOLUTION IS CAUSTIC AND WILL DAMAGE STRUCTURE.

(5) Apply one drop of test solution to the deepest point of the damage. Use the sharp point of a toothpick. Use the minimum amount of test solution necessary to penetrate to the bottom of the damage.

(6) If the bottom of the damage reveals a distinct black indication, the damage has penetrated the cladding to the base material.

(7) Do not allow test solution to stand over 3 minutes. Rinse thoroughly with water.

I. Post Identification Cleaning

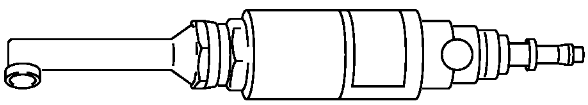
WARNING: THE REAGENTS USED IN THE CHEMICAL SPOT TEST ARE EXTREMELY CORROSIVE. OBSERVE THE SAFETY PRECAUTIONS OF PARAGRAPH 13. IF YOU DO NOT OBEY, INJURY TO PERSONNEL CAN OCCUR.

(1) After identification of the metal is completed, clean the area as follows:

(a) Blot any remaining chemicals with a dry cloth.

(b) Swab the area several times with a cloth made moist with water.

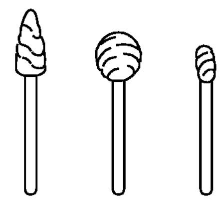
(c) Test the surface for acidity by placing a piece of litmus paper on the moistened surface. Make sure the pH of the metal is neutral.



90° AIR MOTOR, 1800 TO 6000 RPM RANGE
MANUFACTURED BY COOPER POWER TOOLS
P.O. BOX 1410
670 INDUSTRIAL DRIVE
LEXINGTON, SOUTH CAROLINA 29071
TELEPHONE NUMBER 1-800-845-5629

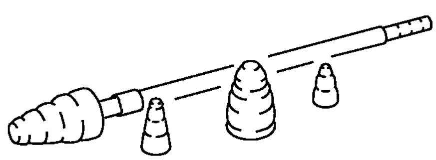
AS AN ALTERNATIVE, YOU CAN USE A
90° AIR MOTOR MANUFACTURED BY
DESOUTTER INCORPORATED
24415 HALSTEAD ROAD
FARMINGTON HILLS, MISSOURI 48335
TELEPHONE NUMBER 1-248-476-5358
OR AN EQUIVALENT SUPPLIER

A



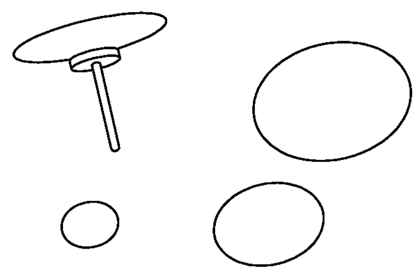
ROTARY FILES. BALL AND CONICAL
SHAPES. MANUFACTURED BY AN INDUSTRIAL
SUPPLIER OR AN EQUIVALENT TYPE OF
SUPPLIER

B



SPIRAPOINT CONES WITH 1/2 INCH
DIAMETER ADAPTER CONE. SIZES 3/4 BY
1-1/2 INCHES, 1/2 BY 3/4 INCH AND 5/8
BY 1-1/2 INCHES. MANUFACTURED BY
AN INDUSTRIAL SUPPLIER OR AN
EQUIVALENT TYPE OF SUPPLIER

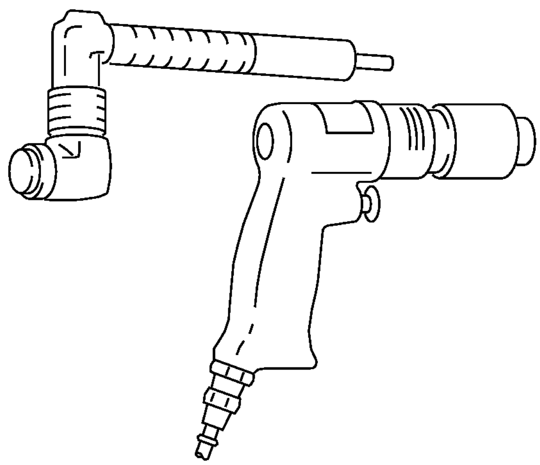
C



MUSHROOM SANDING PAD WITH 1, 2, AND
3 INCH DIAMETER ALUMINUM OXIDE
ABRASIVE DISCS. 1/4 INCH DIAMETER
SHANK FOR AIR MOTOR. 1/4-28 SIZE
THREADED SHANK FOR 90° AIR MOTOR
MANUFACTURED BY AN INDUSTRIAL SUPPLIER
OR AN EQUIVALENT TYPE OF SUPPLIER

D

Corrosion Removal Tools
Figure 1 (Sheet 1 of 2)

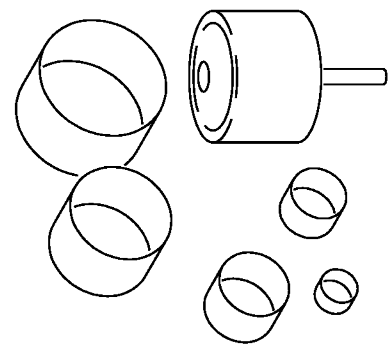


90° AIR MOTOR, 1800 TO 6000 RPM RANGE
MANUFACTURED BY COOPER POWER TOOLS
P.O. BOX 1410
670 INDUSTRIAL DRIVE
LEXINGTON, SOUTH CAROLINA 29071

AS AN ALTERNATIVE, YOU CAN USE A 90° AIR
MOTOR MANUFACTURED BY DESOUTTER INCORPORATED
24415 HALSTEAD ROAD
FARMINGTON HILLS, MISSOURI 48335
TELEPHONE NUMBER 1-248-476-5358
OR AN EQUIVALENT SUPPLIER

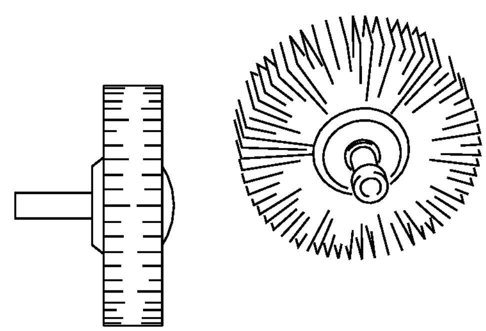
ALSO SHOWN IS A 360° ADAPTER MANUFACTURED
BY AN INDUSTRIAL SUPPLIER OR AN EQUIVALENT
SUPPLIER

E



DRUM SANDER. 1/4 INCH DIAMETER DRIVE
DRUM. 3/4 INCH AND 1 BY 1 INCH SLEEVE.
ALUMINUM OXIDE ABRASIVE. MANUFACTURED
BY AN INDUSTRIAL SUPPLIER OR AN
EQUIVALENT TYPE OF SUPPLIER

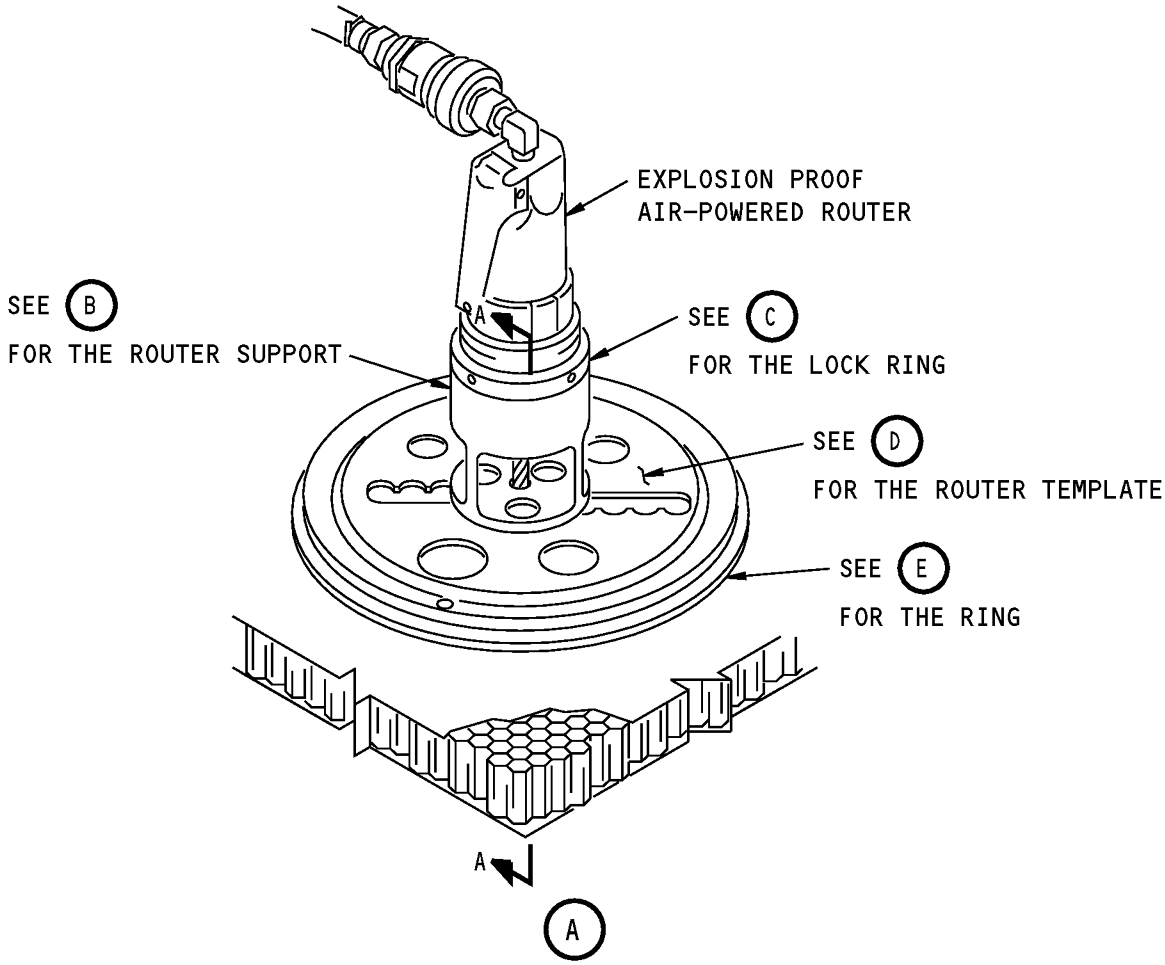
F

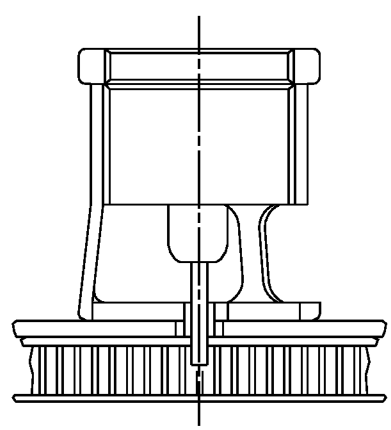


FLEXIBLE SANDING WHEEL. "GRIND-O-FLEX,"
1/2 BY 2 INCHES AND 1 BY 3 INCHES. 80 GRIT,
ALUMINUM OXIDE ABRASIVE. MANUFACTURED BY
BY AN INDUSTRIAL SUPPLIER OR AN
EQUIVALENT TYPE OF SUPPLIER

G

Corrosion Removal Tools
Figure 1 (Sheet 2 of 2)





Router and Template
Figure 2 (Sheet 1 of 7)

WARNING: WEAR A FACE SHIELD OR PROTECTIVE EYE GOGGLES WHEN YOU USE THIS ROUTER. DISCONNECT THE AIR SUPPLY WHEN YOU MOUNT OR ADJUST THE ROUTER HEIGHT. IF YOU DO NOT OBEY, INJURY TO PERSONNEL CAN OCCUR.

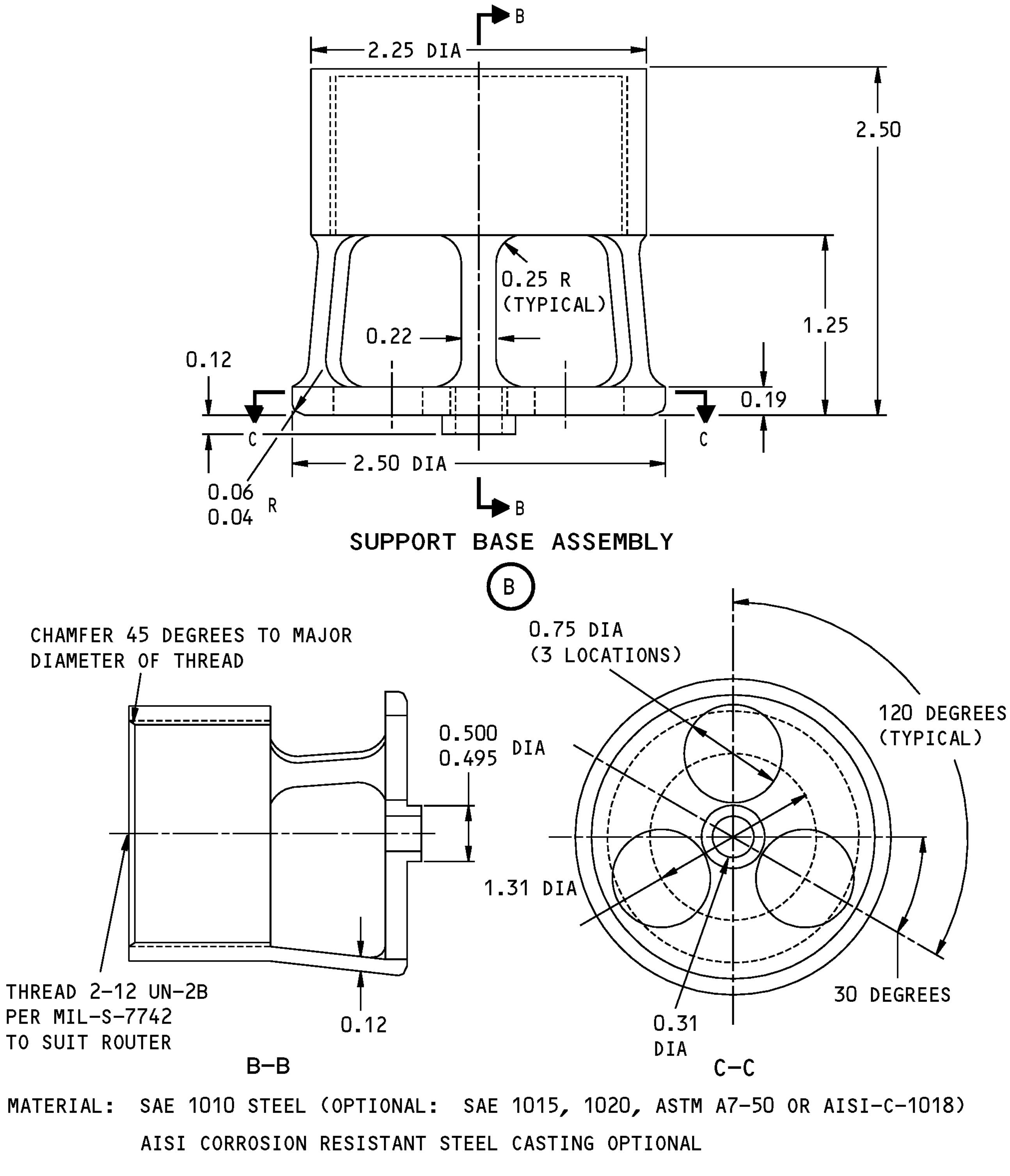
NOTES

- ALL DIMENSIONS ARE IN INCHES, UNLESS IT IS GIVEN DIFFERENTLY.
- AN EXPLOSION-PROOF AIR-POWERED ROUTER ASSEMBLY IS RECOMMENDED FOR THE REMOVAL OF THE SKIN AND DAMAGED CORE IN A FLAT PANEL.
- YOU CAN USE THE ROUTER ASSEMBLY SETUP, SHOWN IN DETAIL I, TO CUT HOLES IN FLAT METAL PANELS OR NON-METAL COMPOSITE PANELS, INCLUDING THOSE WITH A HONEYCOMB CORE.
- HOLD THE ROUTER ASSEMBLY PERPENDICULAR TO THE REPAIR SURFACE AS SHOWN IN DETAIL A.
  - THE ROUTER SUPPORT AND THE LOCK RING ARE DESIGNED TO KEEP THE ROUTER PERPENDICULAR TO THE REPAIR SURFACE.
  - USE THE ROUTER SUPPORT TO ADJUST THE DEPTH OF THE CUT.
- USE THE ROUTER TEMPLATE ASSEMBLY, AS SHOWN IN DETAIL IV, TO CUT THE DAMAGE FROM THE REPAIR AREA. THIS TEMPLATE IS DESIGNED FOR USE WITH A 0.25 INCH (6mm) ROUTER BIT.
  - THE ROUTER TEMPLATE AND RING ARE DESIGNED TO PERMIT YOU TO CUT CIRCULAR HOLES OF DIFFERENT SIZES.
  - AS AN ALTERNATIVE, YOU CAN USE A PLYWOOD TEMPLATE THAT IS DESIGNED TO PERMIT CUTS TO BE MADE IN OTHER SHAPES AND SIZES.

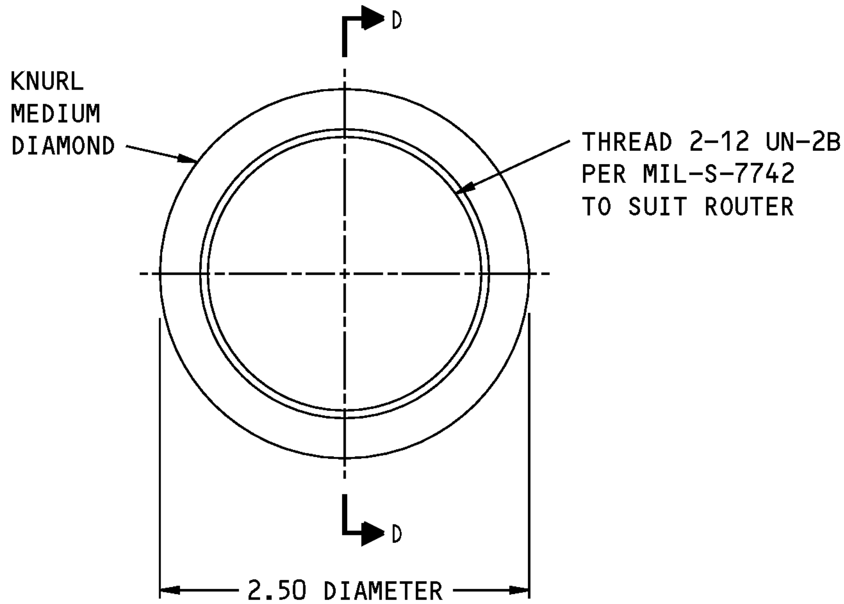
  THE ROUTER RECOMMENDED FOR USE BY THE BOEING COMPANY IS THE "ACORNAD-1, MODEL 31R-510" AIR POWERED ROUTER.
  - THIS ROUTER IS MANUFACTURED BY COOPER POWER TOOL (1-800-845-5629), AND IS SUPPLIED BY:

    F AND M MASCO INCORPORATED
    9149 DRYFORK ROAD
    HARRISON, OHIO 45030
    (1-800-333-2151)

Router and Template
Figure 2 (Sheet 2 of 7)



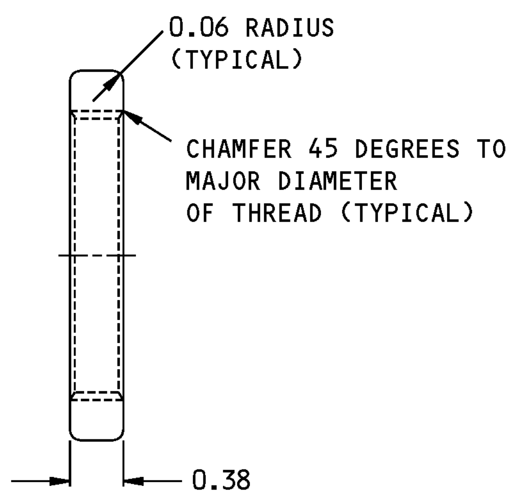
Router and Template
Figure 2 (Sheet 3 of 7)



MATERIAL: SAE 1010 STEEL (OPTIONAL: SAE 1015, 1020, ASTM A7-50 OR AISI-C-1018)

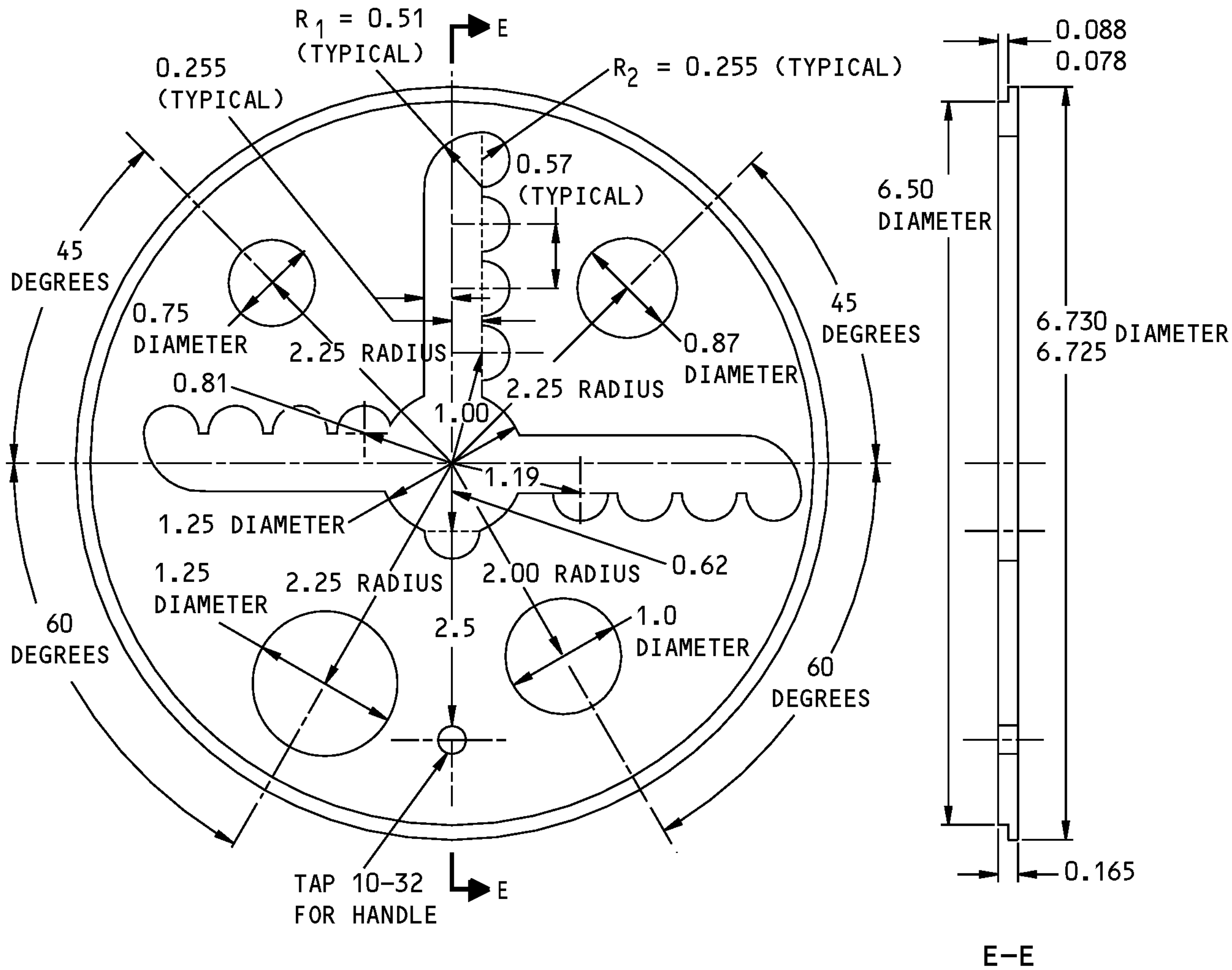
LOCK RING

C



D-D

Router and Template
Figure 2 (Sheet 4 of 7)



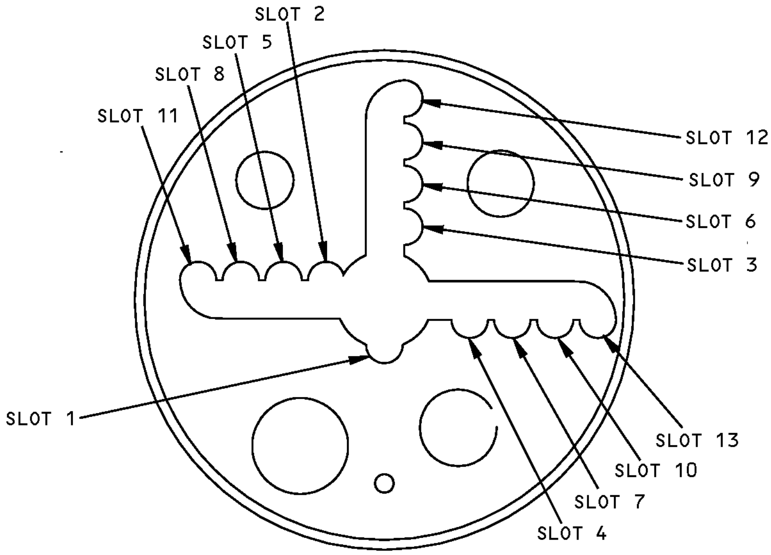
NOTE: SEE DETAIL E FOR THE SLOT POSITION DIAGRAM

MATERIAL: SAE 1010 STEEL (OPTIONAL: SAE 1015, 1020, ASTM A7-50 OR AISI-C-1018)

ROUTER TEMPLATE

D

Router and Template
Figure 2 (Sheet 5 of 7)



SLOT POSITION DIAGRAM

E

INSTRUCTIONS TO USE THE ROUTER TEMPLATE:

NOTE: THE TEMPLATE IS DESIGNED TO GUIDE THE AIR-POWERED ROUTER ASSEMBLY WHILE IT CUTS OUT DAMAGE IN A CIRCULAR OUTLINE WITH A 0.25 INCH ROUTER BIT. SEE DETAIL D.

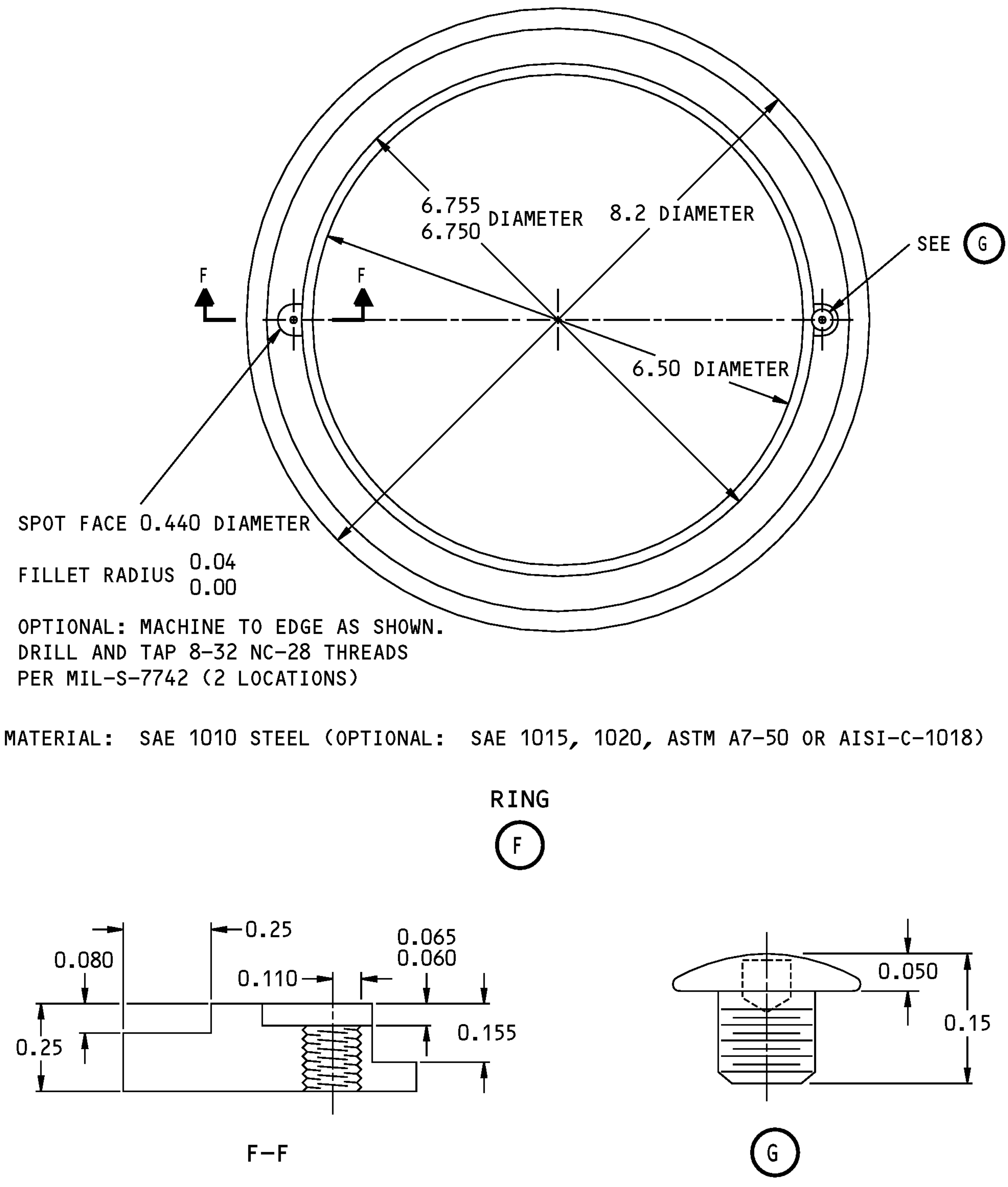
1. TO CUT OUT LARGER DIAMETERS FROM THE REPAIR AREA, PUT THE TEMPLATE RING OVER THE CENTER OF THE DAMAGE.
2. PUT MASKING TAPE DOWN OVER THE TEMPLATE TO HOLD IT IN POSITION FOR CUTTING.

   NOTE: THE TEMPLATE TURNS FREELY INSIDE THE RING. THE HEADS OF THE TWO SCREWS PREVENT THE TEMPLATE FROM MOVING OUT OF ITS SEATED POSITION.
3. START ROUTING THE AREA FROM THE CENTER OF THE DAMAGE. PUT THE ROUTER INTO THE SEMICIRCULAR SLOT LABELED "SLOT 1" AS SHOWN IN DETAIL E.
4. START THE AIR-ROUTER AND TURN THE TEMPLATE IN A CLOCKWISE DIRECTION TO REMOVE THE DAMAGE.

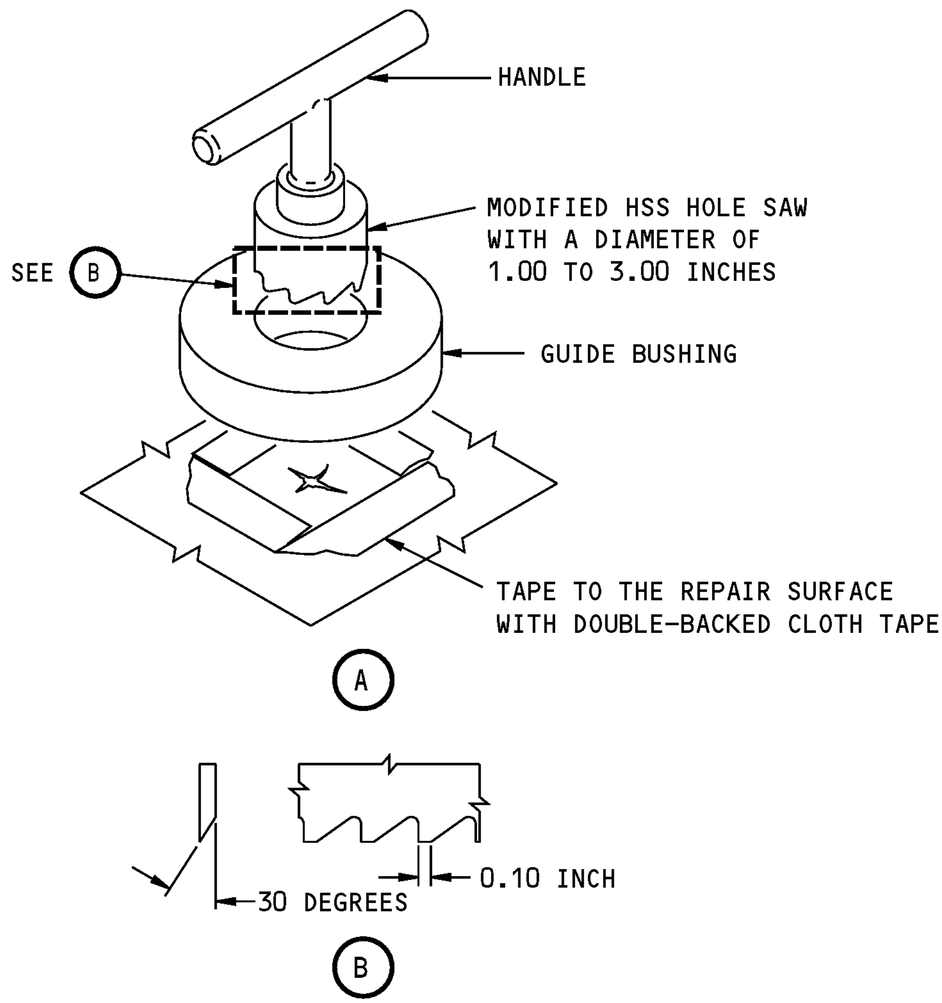
   NOTE: YOU CAN PUT A HANDLE INTO THE TAPPED HOLE TO HELP TURN THE TEMPLATE IN THE CORRECT DIRECTION.
5. AFTER YOU COMPLETE THE CIRCLE WITH THE ROUTER IN SLOT 1, THEN PUT THE ROUTER INTO THE NEXT NUMBERED SLOT, SHOWN IN DETAIL E AS "SLOT 2, SLOT 3, SLOT 4, SLOT 5, AND SO ON, UNTIL THE DAMAGE IS REMOVED.

   NOTE: USE THE ROUTER SEQUENCE GIVEN IN DETAIL E FOR EACH NEXT LARGER SLOT DIAMETER TO CUT OUT THE DAMAGE.

Router and Template
Figure 2 (Sheet 6 of 7)



Router and Template
Figure 2 (Sheet 7 of 7)



INSTRUCTIONS TO USE THE HOLE SAW:

1. THE HOLE SAW AND GUIDE SHOWN IN DETAIL A IS USED TO CUT HOLES IN DAMAGED ALUMINUM SKIN OR ALUMINUM PANELS. YOU CAN CUT 1.0, 2.0 AND, 3.0 INCH DIAMETER HOLES.

   NOTE: AS AN ALTERNATIVE, YOU CAN USE THE POWER ROUTER SHOWN IN FIGURE 2.

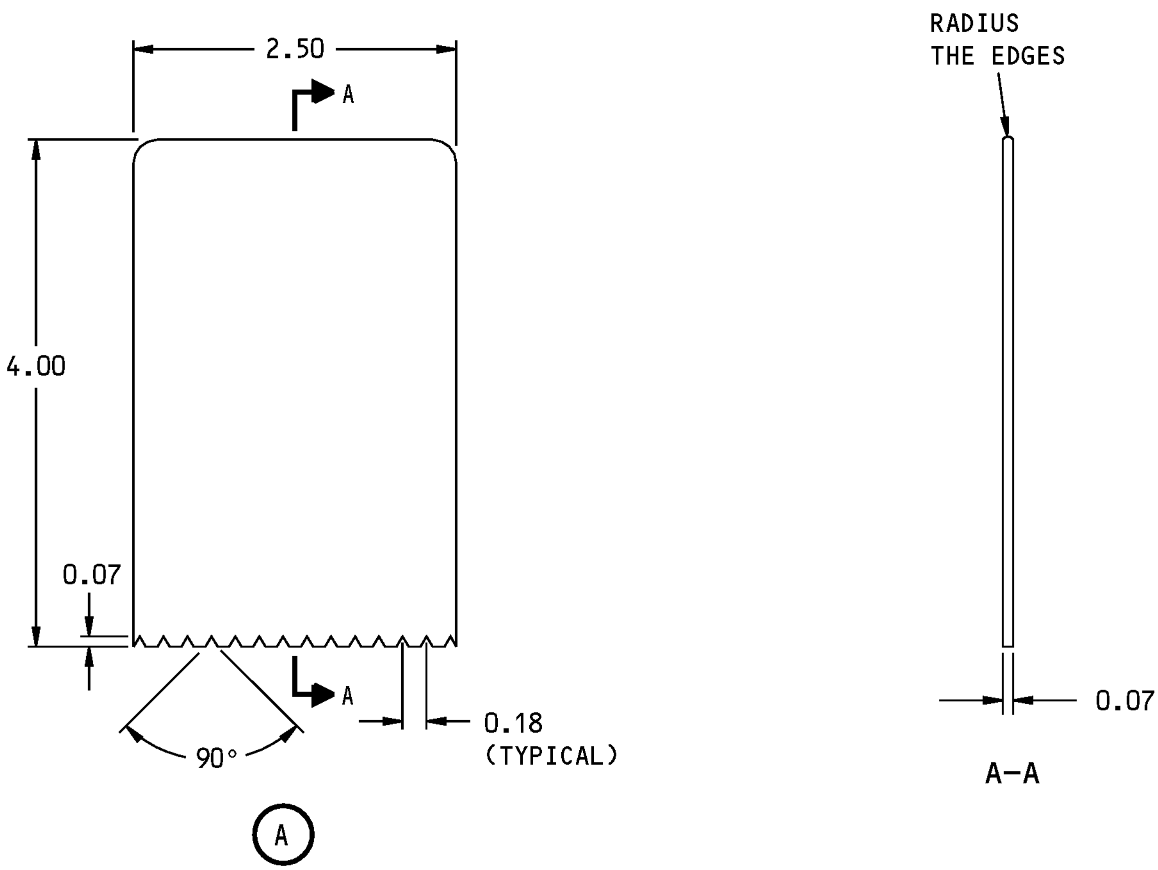
2. MAKE THE GUIDE BUSHING FROM 0.75 INCH THICK ALUMINUM PLATE. CUT THE CENTER HOLE IN THE BUSHING TO A SIZE THAT WILL PERMIT YOU TO TURN THE HOLE SAW FREELY.

3. PUT THE GUIDE BUSHING ON THE SURFACE OF THE REPAIR AREA. USE DOUBLE-BACKED TAPE TO HOLD THE GUIDE IN POSITION.

4. PUT THE HOLE SAW IN THE GUIDE BUSHING. HOLD THE SAW PERPENDICULAR TO THE TO THE SURFACE WHILE YOU CUT.

   NOTE: USE A LIGHT PRESSURE AS YOU SLOWLY TURN THE SAW TO CUT THE SURFACE.

Use of the Hole Saw
Figure 3



NOTE: ALL DIMENSIONS ARE IN INCHES.

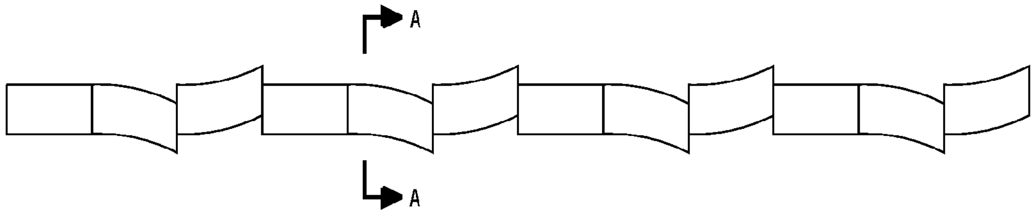
INSTRUCTIONS:

1. MAKE THE SQUEEGEE FROM 0.07 INCH THICK PLEXIGLASS OR EQUIVALENT MATERIAL.
2. USE THE EDGE WITH THE NOTCHES TO IMPREGNATE FIBERGLASS CLOTH WITH ADHESIVE RESIN, OR YOU CAN REMOVE TRAPPED AIR BUBBLES FROM A WET LAYUP.

Use of the Squeegee
Figure 4

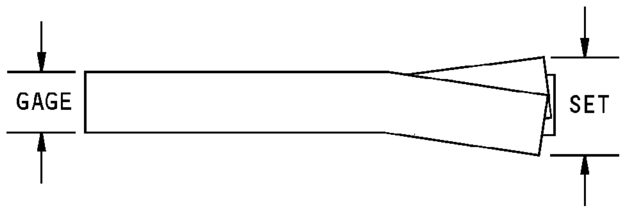
METALS OR MATERIALS TO BE PROCESSED	RESTRICTIONS	OPERATION	ABRASIVE PAPER OR CLOTH			ABRASIVE FABRIC OR PAD	WOOL		PUMICE 350 MESH OR FINER	SCOTCH-BRITE TYCRO WHEELS
			ALUMINUM OXIDE	SILICON CARBIDE	GARNET		ALUMINUM	STAINLESS STEEL		
FERROUS ALLOYS HEAT TREATED TO 220,000 PSI AND ABOVE	DO NOT USE ACID BASE RUST REMOVERS. DO NOT USE HAND-HELD POWER TOOLS. GRINDING IS NOT PERMITTED	CORROSION REMOVAL OR FAIRING	150-GRIT OR FINER	150-GRIT OR FINER		FINE TO ULTRAFINE	X	X	X	
		FINISHING	400-GRIT				X	X	X	
FERROUS NICKEL AND COBALT ALLOYS	DOES NOT APPLY TO STEEL HEAT TREATED TO 220,000 PSI AND ABOVE	CORROSION REMOVAL OR FAIRING	150-GRIT OR FINER	180-GRIT OR FINER		FINE TO ULTRAFINE	X	X	X	5A OR 7S MEDIUM
		FINISHING	400-GRIT				X	X	X	7S FINE
ALUMINUM ALLOYS EXCEPT CLAD ALUMINUM	DO NOT USE SILICON CARBIDE ABRASIVE.	CORROSION REMOVAL OR FAIRING	60-GRIT OR FINER		7/0-GRIT OR FINER	VERY FINE AND ULTRAFINE	X		X	5A MEDIUM
		FINISHING	400-GRIT				X		X	
CLAD ALUMINUM	SANDING LIMITED TO THE REMOVAL OF MINOR SCRATCHES.	CORROSION REMOVAL OR FAIRING	240-GRIT OR FINER		7/0-GRIT OR FINER	VERY FINE AND ULTRAFINE			X	
		FINISHING	400-GRIT						X	
MAGNESIUM ALLOYS	DO NOT USE CARBON STEEL BRUSHES SILICON CARBIDE ABRASIVES.	CORROSION REMOVAL OR FAIRING	240-GRIT OR FINER			VERY FINE AND ULTRAFINE	X		X	
		FINISHING	400-GRIT				X		X	
TITANIUM		CORROSION REMOVAL OR FAIRING	80-GRIT OR FINER	80-GRIT OR FINER				X	X	5A OR 7S MEDIUM
		CLEANING AND FINISHING	150-GRIT OR FINER	180-GRIT OR FINER				X	X	7S FINE

Abrasives for Sanding or Scouring
Figure 5



RAKER TOOTH FORM OF BAND SAW BLADE

A

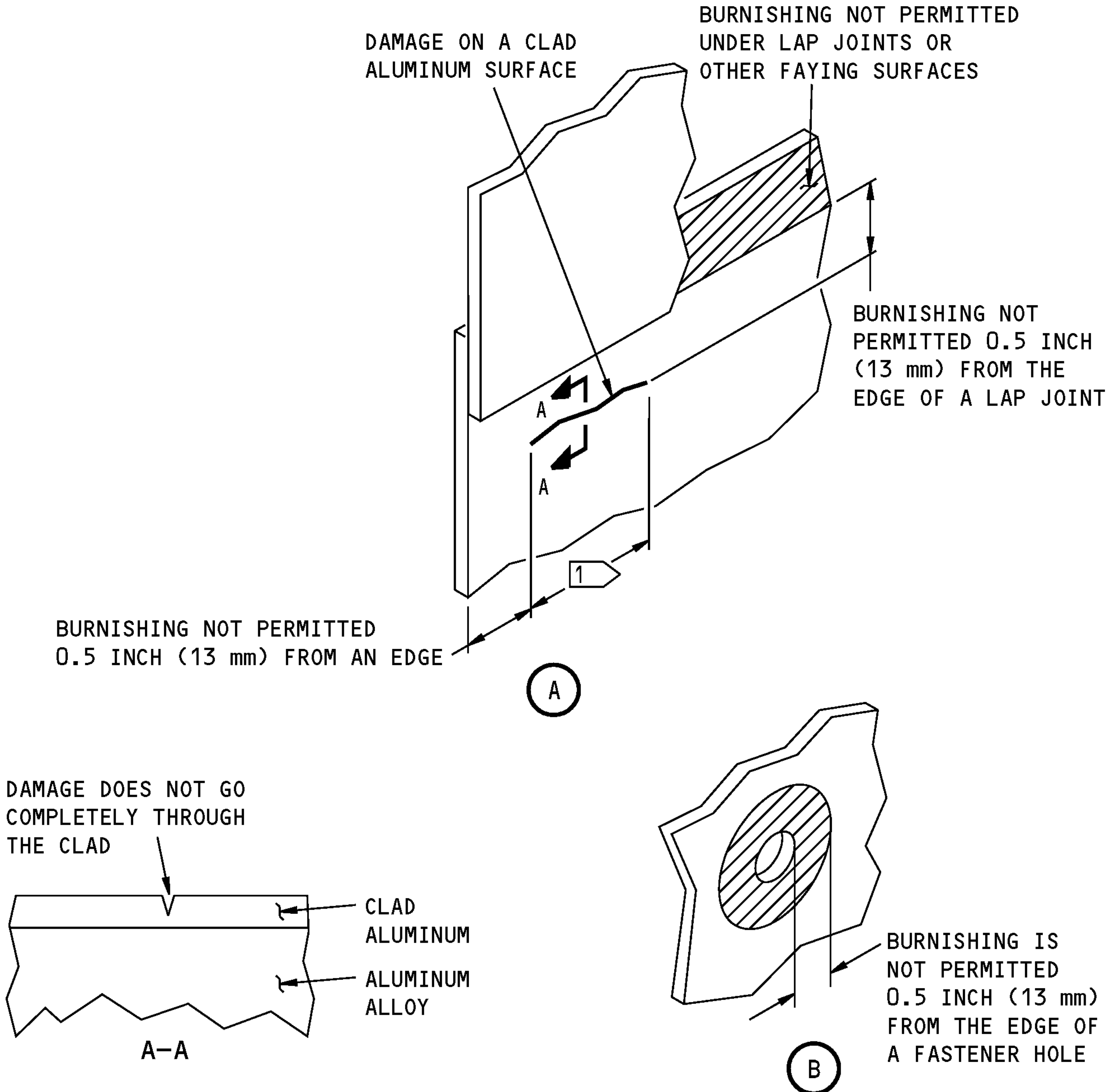


SECTION A-A

WORKPIECE MATERIAL	WORKPIECE THICKNESS	BAND TYPE	TOOTH FORM	PITCH	BAND SPEED (FOOT/ MINIMUM)	CUTTING RATE (SQUARE INCH/ MINIMUM)	CUTTING FLUID
ALUMINUM METAL HONEYCOMB CORE (CUT PARALLEL TO CELL WALLS)	LESS THAN 6.0 INCHES (15.24 cm)	WELD EDGE	RAKER	14	4000	100	NONE
NON-METAL NOMEX HONEYCOMB CORE (CUT PARALLEL TO CELL WALLS)	LESS THAN 12.0 INCHES (30.5 mm)	CONTINUOUS DIAMOND EDGE	60 TO 80-GRIT		6000	100	NONE (VACUUM REMOVAL OF DUST)
		CONTINUOUS REMINGTON TUNGSTEN CARBIDE	70 TO 100-GRIT		6000	100	

RECOMMENDED CONDITIONS FOR BAND SAWING HONEYCOMB CORE MATERIALS

Band Sawing of Metallic and Non-Metallic Honeycomb Core Materials
Figure 6



NOTES

1 DAMAGE MUST BE LESS THAN OR EQUAL TO THE MAXIMUM LENGTH GIVEN IN THE ALLOWABLE DAMAGE LIMITS OF THE APPLICABLE CHAPTER-SECTION-SUBJECT GIVEN IN THIS MANUAL, OR 2.0 INCHES (50 mm) IF NO LIMIT IS GIVEN IN THE ALLOWABLE DAMAGE SECTION.

Burnishing Restrictions on Primary Structure
Figure 7

GENERAL - REDUCED VERTICAL SEPARATION MINIMUM (RVSM) REQUIREMENTS

1. Applicability

A. This subject gives the general procedures for airplanes that are approved to operate in airspace, or on routes, where Reduced Vertical Separation Minimum (RVSM) is applied.

NOTE: RVSM airspace is an airspace or route between Flight Level 290 and 410 where airplanes have vertical separation of 1,000 feet (300 M).

B. The procedures in this subject are not applicable to get the initial approval for the airplane for flight in RVSM airspace.

2. General

A. These procedures are for airplanes that are approved for flight in RVSM airspace. You can not use these procedures to get the initial approval for the airplane for flight in RVSM airspace.

B. When you have damage in the extra critical area of the primary static ports, you must measure the skin waviness. These procedures tell you how to return a RVSM-certified airplane to service after repair of damage in the area of the primary static ports.

C. The extra critical areas of the left system and right system primary static ports are on both sides of the airplane, as shown in Primary Static Ports Inspection for RVSM Operation, Figure 1/GENERAL.

D. Surface contour changes are damages that are not repaired or surface changes caused by the effects of damage. They can be dents, bulges, or wrinkles extending into the extra critical area that are caused by damage located outside of the extra critical area.

E. Changes from the initial contour (contour changes) in the extra critical area of the primary static ports are permitted if:

(1) They are less than the allowable damage and operating limits as given in 53-00-01, ALLOWABLE DAMAGE 1

(2) They are less than the limits shown in 51-10-01, GENERAL, Figure 3 and Figure 4.

F. For RVSM operation, use the data that follows for surface contour changes in the extra critical area of the primary static ports.

(1) An airplane can have a maximum of two surface contour changes in the extra critical area of the primary static ports.

(a) Two contour changes are permitted on one side of the airplane, or one contour change is permitted on each side of the airplane.

(b) Small surface scratches that do not go through the clad part of the skin are not thought of as contour changes.

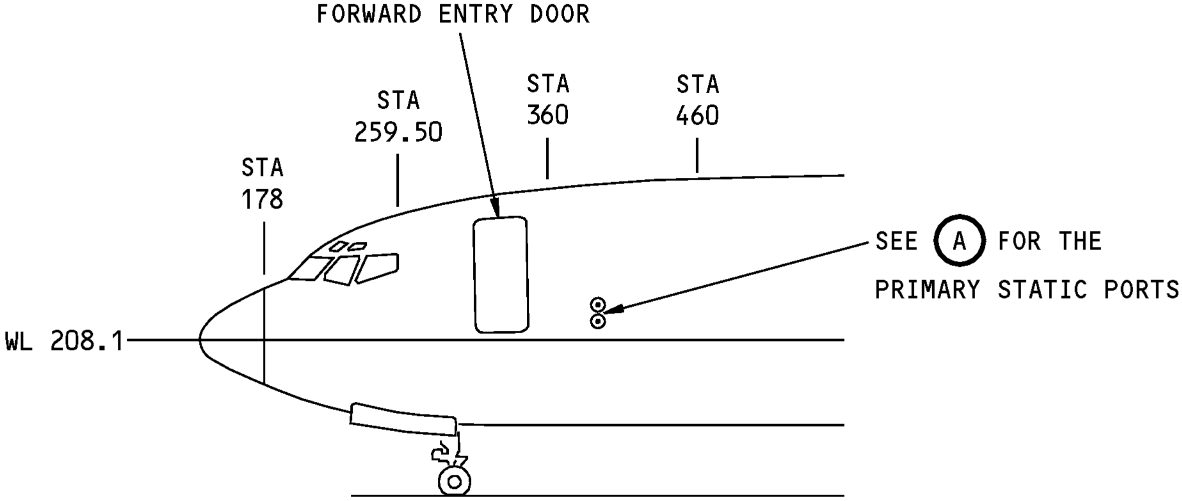
(c) Small surface imperfections that are smooth and are not more than +/- 0.003 inch (+/- 0.080 mm) in depth are not thought of as contour changes.

G. External skin repairs are permitted in the extra critical area of the primary static ports only if you apply the limits as given in 51-10-01, GENERAL, Figure 4.

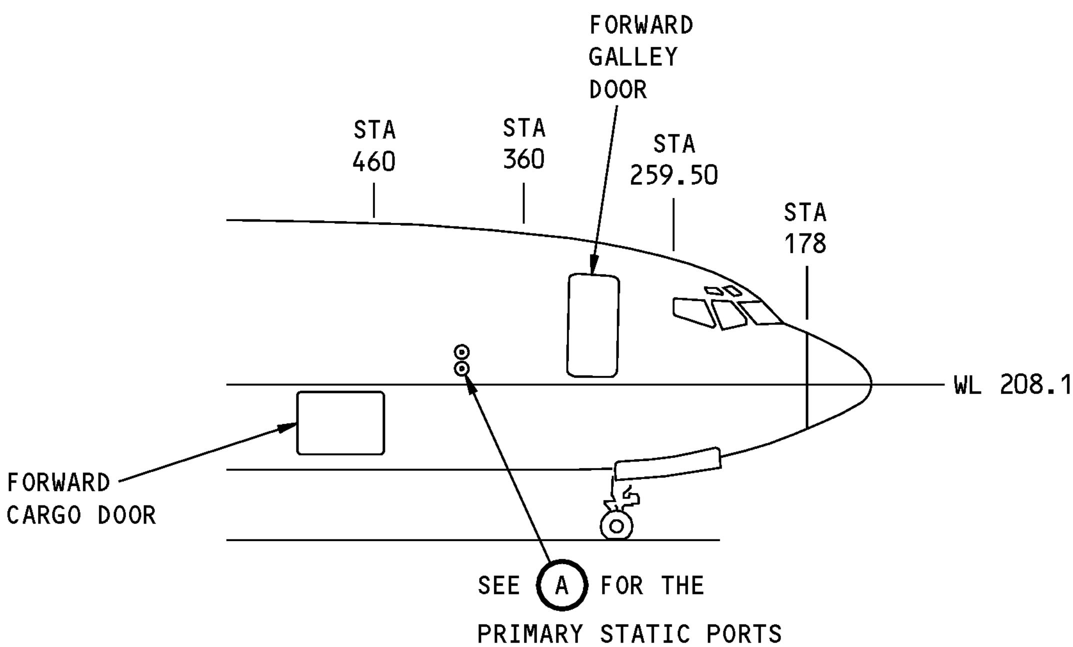
H. For RVSM operation, use the data that follows for repairs in the extra critical area of the primary static ports.

(1) An airplane can have a maximum of two repairs in the extra critical area of the primary static ports.

(a) Two repairs are permitted on one side of the airplane, or one repair is permitted on each side of the airplane.

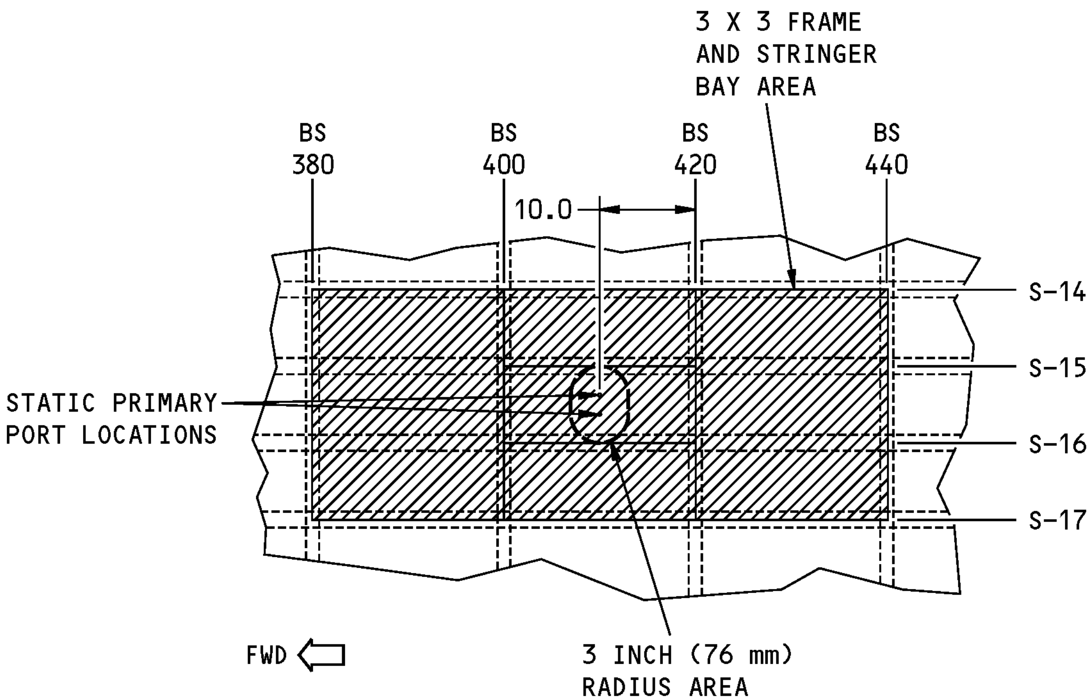


LEFT SIDE



RIGHT SIDE

Primary Static Ports Inspection for RVSM Operation
Figure 1 (Sheet 1 of 2)



LEFT SIDE IS SHOWN, RIGHT SIDE IS OPPOSITE

EXTRA CRITICAL AREA ADJACENT TO THE PRIMARY STATIC PORTS

A

Primary Static Ports Inspection for RVSM Operation
Figure 1 (Sheet 2 of 2)

3. References

Reference	Title
51-10-01	AERODYNAMIC SMOOTHNESS
51-10-01, GENERAL	Aerodynamic Smoothness Requirements
53-00-01, ALLOWABLE DAMAGE 1	Fuselage Skin
53-00-01, REPAIR P/B REPAIR	FUSELAGE SKIN
AMM 34-11-02/401	Static Port - Inspection/Check
AMM 34-11-02/601	Static Port - Inspection/Check

4. Procedures for Surface Contour Changes and General Repairs

A. Extra Critical Area Around the Primary Static Port

(1) When you have damage in the area of the primary static ports you must measure the skin waviness.

NOTE: Surface contour changes in the area of the primary static ports are permitted if they are less than the limits that are shown in 51-10-01, GENERAL, Figure 4. A maximum of two surface contour changes as given in 51-10-01, GENERAL, Figure 4, are permitted in the area of the primary static ports. The two contour changes can be on one side of the airplane, or one contour change can be on each side. A maximum of two external skin repairs or two internal skin repairs which extend across a frame or a stringer, are permitted in the area of the primary static ports only if you apply the limits that are shown in 51-10-01, Paragraph 4./GENERAL. The two repairs can be on one side of the airplane, or one repair can be on each side.

(a) Refer to 51-10-01, GENERAL, Figure 4 and Paragraph 4.C./GENERAL for the limits that are permitted for surface contour changes in the extra critical area of the primary static ports.

(b) Refer to 53-00-01, ALLOWABLE DAMAGE 1 for the allowable damage and operating limits for the fuselage skin.

(c) Do an inspection of the extra critical area around the primary static ports.

(d) Refer also to 51-10-01, GENERAL and Paragraph 4.C./GENERAL for procedures on how to measure for skin waviness.

B. 3-inch (76 mm) Radius Area

(1) Visually examine the area with a radius of 3 inches (76 mm) around the static pressure ports. Refer to Typical Primary Static Port Inspections for RVSM Operation, Figure 2/GENERAL.

(a) Remove paint, stencils or excess sealant from the area.

(2) Measure the skin waviness in the area with a radius of 3 inches (76 mm) around the static pressure ports.

(a) Use the inspection procedure as given in AMM 34-11-02/601. The skin waviness must be less than the limit given in AMM 34-11-02/601.

C. Primary Static Ports

(1) Visually examine the primary static ports to make sure they are clean, there is no blockage or corrosion, and they are smooth.

(2) Measure the step height of the primary static ports. Refer to Typical Primary Static Port Inspections for RVSM Operation, Figure 2/GENERAL.

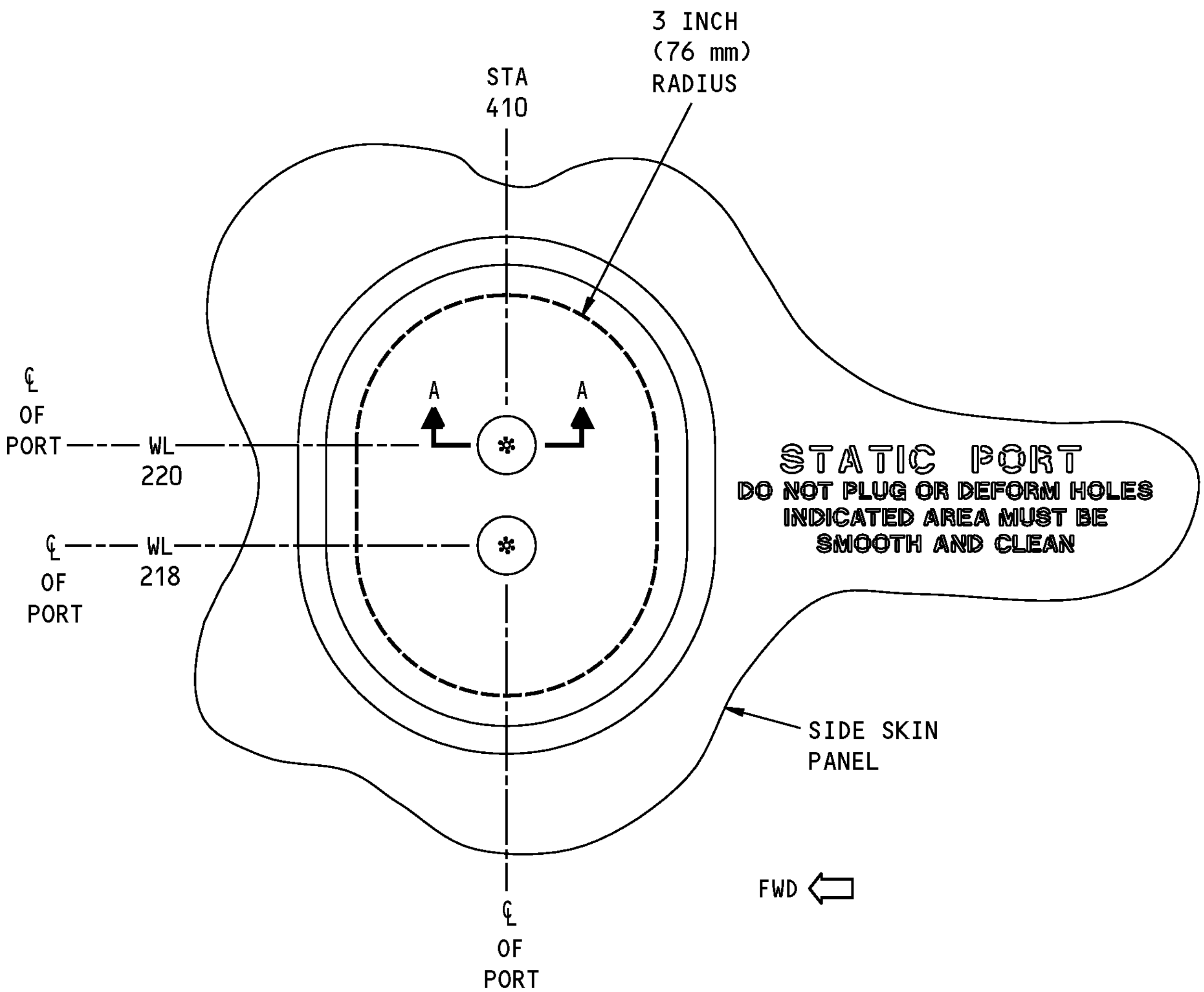
NOTE: The step height is the amount of offset between the surfaces of the skin and the primary static ports.

(a) If the primary static ports have a negative step height of more than 0.002 inch (0.051 mm), then replace the ports.

NOTE: This tolerance is for the installed primary static ports. When new primary static ports are to be installed, the tolerance is -0.000 to +0.003 inch (-0.000 to +0.076 mm).

(b) If the primary static ports have a positive step height of more than 0.006 inch (0.152 mm), then microshave the ports.

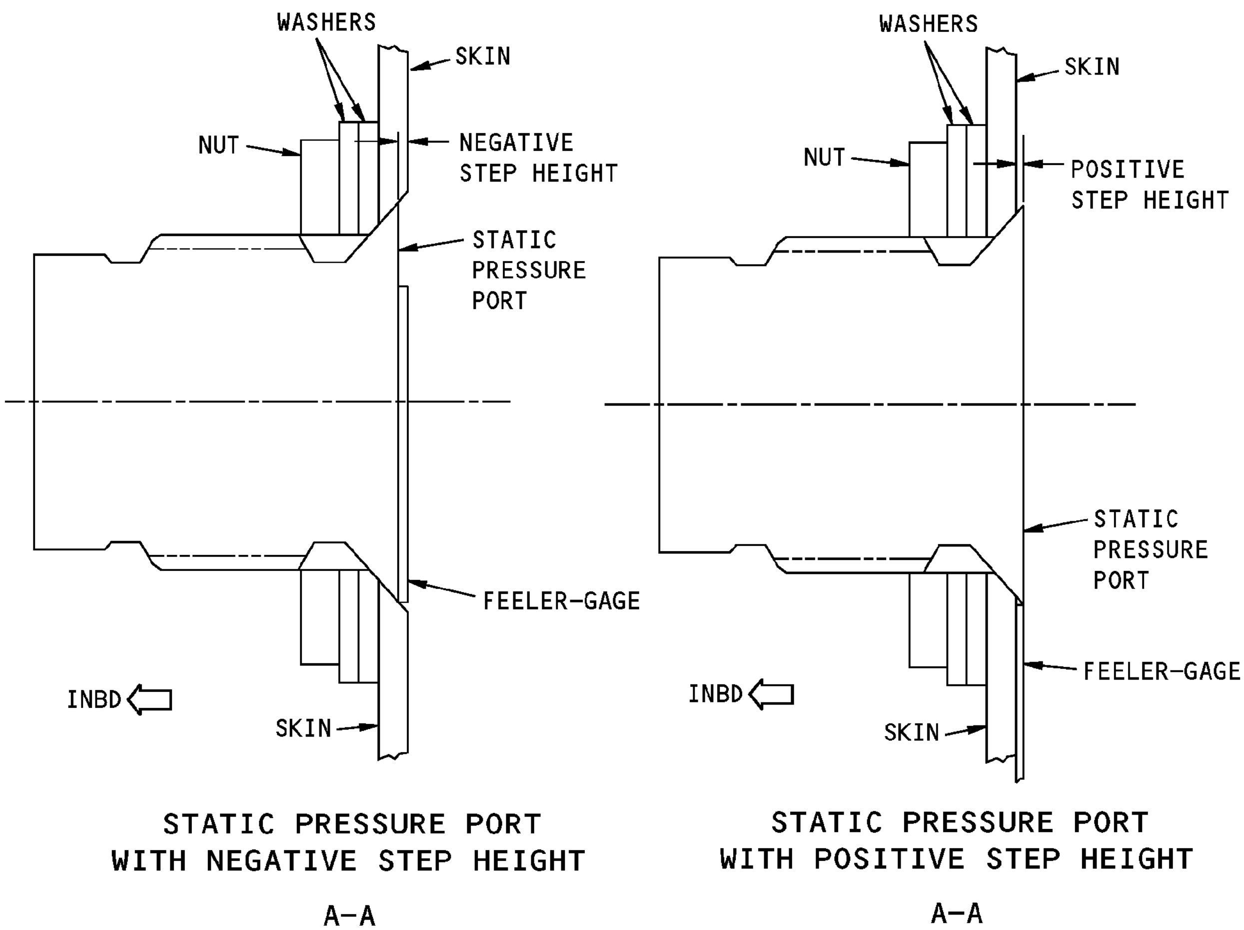
(3) Make sure the surfaces of the primary static ports are smooth, have no burrs, and have a chemical conversion coating. Refer to AMM 34-11-02/401 for more information on the removal and installation of the primary static ports.



TYPICAL 3 INCH (76 mm) RADIUS AREA

A

Typical Primary Static Port Inspections for RVSM Operation
Figure 2 (Sheet 1 of 2)



Typical Primary Static Port Inspections for RVSM Operation
Figure 2 (Sheet 2 of 2)

GENERAL - INSTRUCTIONS TO PERMIT AIRPLANE OPERATION WITH MISSING FASTENERS IN SECONDARY STRUCTURE

1. Applicability

A. This subject gives the procedures to find if it is possible to operate an airplane with missing fasteners in secondary structure.

(1) The structures that follow are examples of secondary structure that are permitted to have missing fasteners (Refer to 51-00-04):

(a) Fairings

(b) Trailing Edge Panels

(c) Access Panels

(2) Missing fasteners must be of the types that are easy to remove, such as bolts and screws.

B. This subject is not applicable to:

(1) Fasteners that attach primary structure to the airplane

(2) Fasteners in control surfaces. These include ailerons, trailing edge flaps, elevators, rudder, leading edge devices, and spoilers

(3) Fasteners in leading edge panels of the wing, horizontal stabilizer and vertical stabilizer

(4) Fasteners in panels adjacent to side load ribs and/or balance bays (Refer to Panels Where Missing Fasteners are not Permitted, Figure 1/GENERAL, Details B through E)

(5) Fasteners in engine cowls and engine pylon fairings

(6) Permanent type fasteners such as rivets and lockbolts

(7) Hex drive bolts installed with permanent type BACC30 collars or their equivalents.

2. General

A. Refer to Paragraph 4./GENERAL for help to make a decision if an airplane is in a permitted dispatch condition. If the airplane is not in a permitted dispatch condition, then you must do one or more of the steps that follow:

(1) Install the correct fastener in each missing fastener location until the airplane is in the permitted dispatch condition.

NOTE: You are permitted to remove a fastener from a different location and install it in a location that has a missing fastener.

- Make sure that the fastener that is removed is the correct type, diameter, and length for the location where it will be installed.
- Refer to Paragraph 4./GENERAL to make sure that a missing fastener is permitted at the location from which the fastener was removed.
- Make a record of the location of the initial missing fastener. Make an inspection of the location as given in Paragraph 4./GENERAL At each inspection interval, make sure that the fastener is not missing again.

(2) Tell an engineer who has the authority to do an analysis, and then make a decision.

(3) Call The Boeing Company and ask for an analysis.

B. Do one of the steps that follows if a countersunk hole is damaged or has unsatisfactory wear:

(1) Do a temporary repair. Install a flanged CRES washer under the bolt head (BACW10D* or BACW10CC, or equivalent). Refer to Paragraph 4.B./GENERAL for the inspection intervals and for when a permanent repair must be done.

(2) Count the fastener location as a missing fastener. Make sure that a missing fastener is permitted at that location. Refer to Paragraph 4.A./GENERAL

3. References

Reference	Title
51-00-04	STRUCTURAL CLASSIFICATION
51-20-05	REPAIR SEALING

4. Permitted Dispatch Conditions

CAUTION: THE INSTRUCTIONS IN PARAGRAPH 3 CONTAIN INSPECTIONS AND FLIGHT LIMITATIONS. MISSING FASTENERS ARE PERMITTED ONLY IF THESE INSPECTIONS AND FLIGHT LIMITATIONS ARE OBEYED.

A. An airplane is in a permitted dispatch condition if it agrees with all of the conditions that follow:

NOTE: If a part does not agree with one or more of the conditions that follow, refer to the Master Minimum Equipment List (MMEL) to find if the airplane is permitted to operate without the part (for example: small access doors and panels). Do not operate an airplane with one of these parts installed unless it agrees with all of the conditions that follow.

(1) All fasteners as given in Paragraph 1.B./GENERAL must be installed in the structure.

(2) Fasteners in the panels as given in Paragraph 1.A./GENERAL can be missing if the panels agree with the conditions that follow:

(a) All electrical grounding and bonding fasteners are installed and operate correctly.

(b) All fasteners are installed in the leading edge which is open to the airflow. Refer to Missing Fastener Locations That are Permitted in Secondary Structure, Figure 2/GENERAL, Detail A .

(c) All corner fasteners are installed. Refer to Missing Fastener Locations That are Permitted in Secondary Structure, Figure 2/GENERAL,.

(d) All fasteners are installed on sides with eight or less fasteners. Refer to Missing Fastener Locations That are Permitted in Secondary Structure, Figure 2/GENERAL, Detail A.

(e) One missing fastener in ten is permitted on a side. This does not include a side which is a leading edge open to the airflow.

NOTE: A side that has only nine fasteners can have a missing fastener if it is in the middle location. Refer to Missing Fastener Locations That are Permitted in Secondary Structure, Figure 2/GENERAL, Detail A.

(f) A maximum of two adjacent missing fasteners is permitted. This does not include a leading edge open to the airflow. Refer to Missing Fastener Locations That are Permitted in Secondary Structure, Figure 2/GENERAL, Detail A.

(g) A minimum of three fasteners adjacent to a corner fastener is installed. Refer to Missing Fastener Locations That are Permitted in Secondary Structure, Figure 2/GENERAL, Detail A.

(h) A minimum of five fasteners are installed adjacent to an attached fitting or a primary load point. Refer to Missing Fastener Locations That are Permitted in Secondary Structure, Figure 2/GENERAL, Detail B.

B. If the airplane has missing fasteners and is in the permitted dispatch condition as given in Paragraph 4.A./GENERAL, then do the steps that follow:

(1) Make sure that all of the fasteners that are installed have the correct torque as given in one of the references that follows:

(a) The engineering drawing that shows the panel installation

(b) The Structural Repair Manual

(c) The Airplane Maintenance Manual.

(2) Make a record of the locations of missing fasteners and fasteners that are loose, or will not keep the minimum torque value.

NOTE: you are permitted to put an approved sealant on the fastener threads to increase the torque value of the fastener. Refer to 51-20-05 for the approved sealants and sealing procedures.

(3) Make a record of the locations of fastener holes and countersinks that show unsatisfactory damage or wear.

(4) Put aluminum foil speed tape over all open fastener holes.

(5) Do an inspection of the panels that have missing or loose fasteners at the intervals that follow:

(a) After you find the missing or loose fasteners, you must do an inspection of the panels before a maximum time period of 30 calendar days occurs.

(b) You must then do an inspection of the panels at each interval of 10 calendar days until you replace the missing or loose fasteners.

(6) Do the steps that follow to make an inspection of the panels for missing and loose fasteners:

(a) Make sure that there are no additional missing or loose fasteners.

(b) If there are additional missing or loose fasteners, refer to Paragraph 4./GENERAL to find if the airplane is in the permitted dispatch condition. Then do the steps in Paragraph 2 again.

(c) Make sure that aluminum foil speed tape is applied over all open fastener holes. Replace the aluminum foil speed tape if it shows deterioration.

(7) Do the steps that follow before 60 days or 500 flight hours occur:

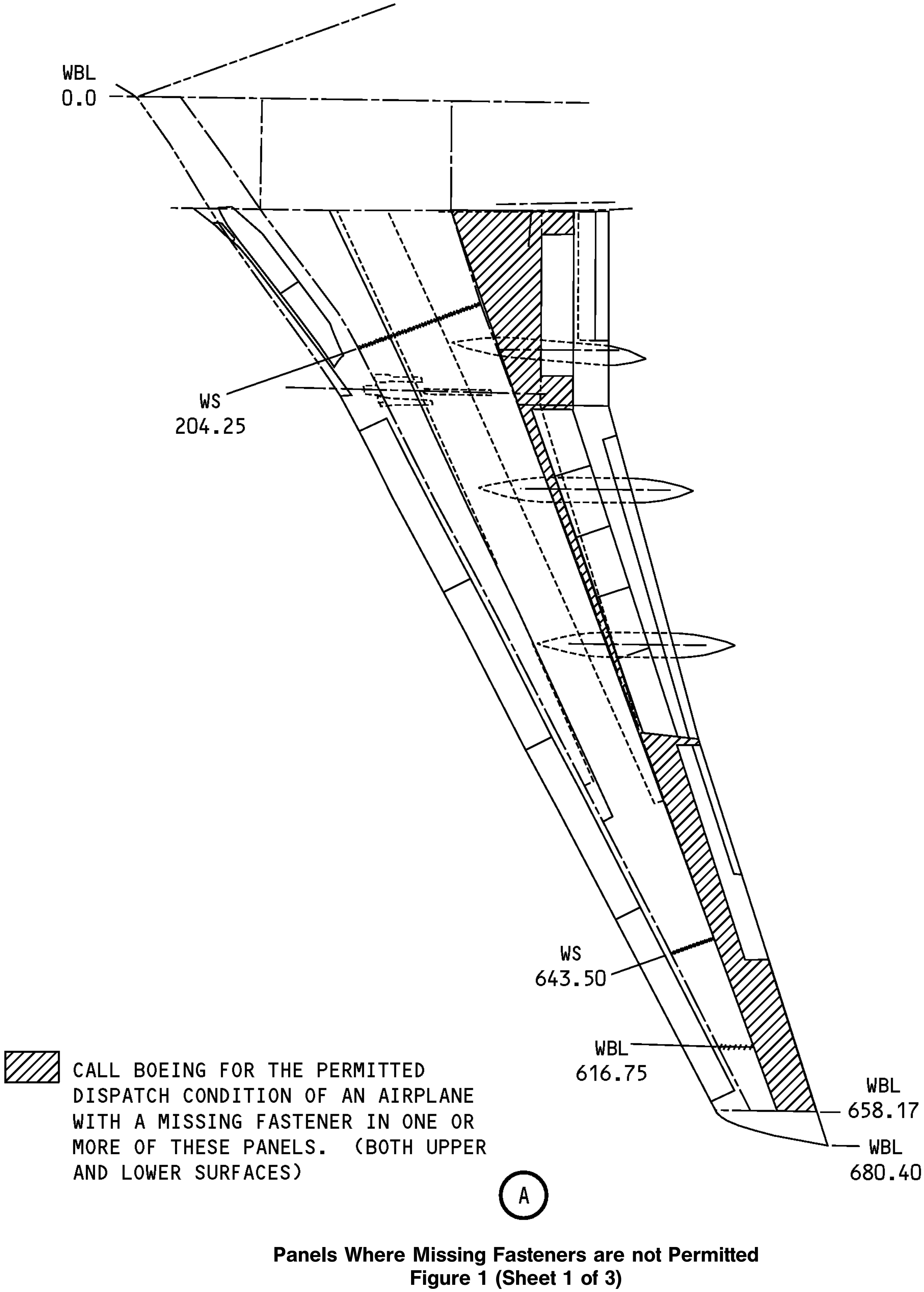
NOTE: Time measurement of the days or flight hours starts when missing or loose fasteners are first found.

(a) Do a permanent repair for holes and countersinks that are damaged or show unsatisfactory wear.

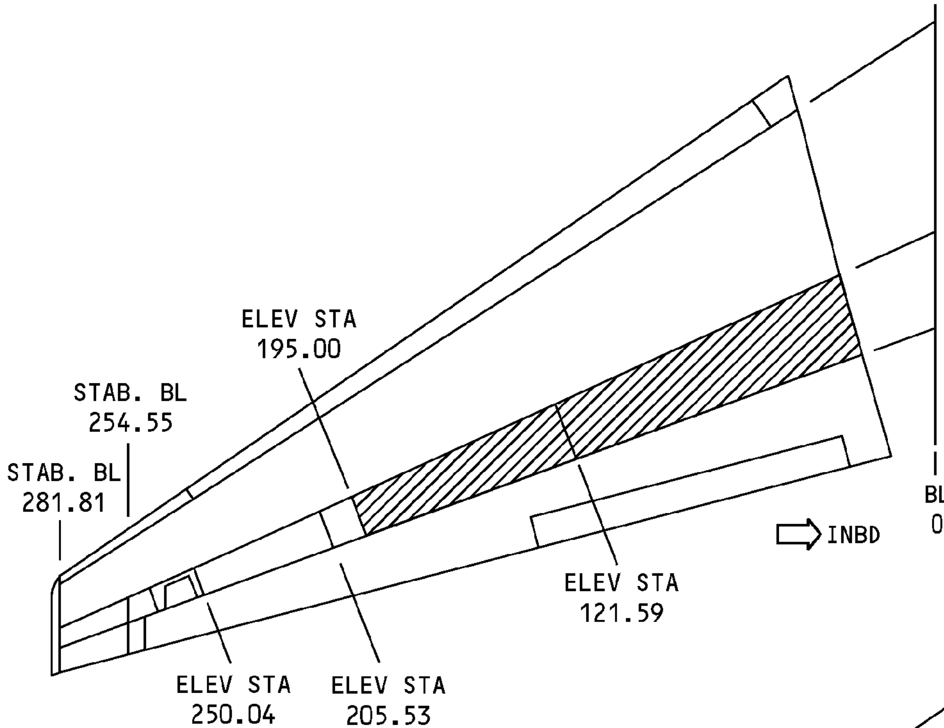
(b) Replace nutplates at all missing or loose fastener locations.

NOTE: Also replace nutplates at initial fastener locations that were filled with a replacement fastener as given in Paragraph 2.A.(1)/GENERAL, or sealed as given in Paragraph 4.B.(2)/GENERAL

(c) Replace all missing or loose fasteners.

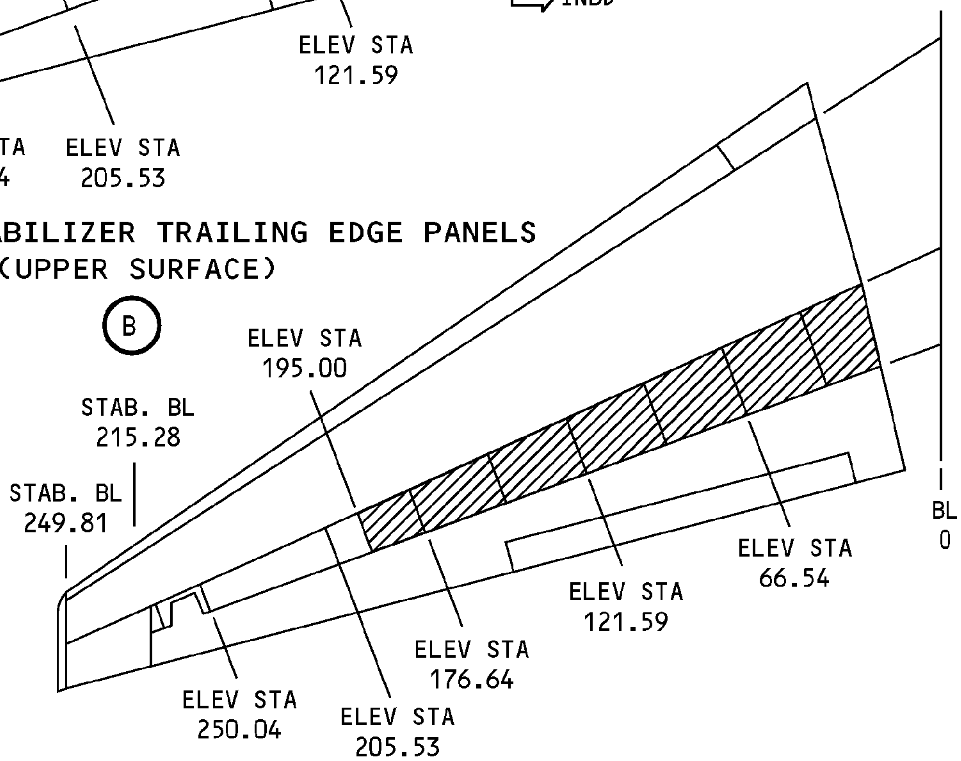


Panels Where Missing Fasteners are not Permitted
Figure 1 (Sheet 1 of 3)



HORIZONTAL STABILIZER TRAILING EDGE PANELS
(UPPER SURFACE)

B

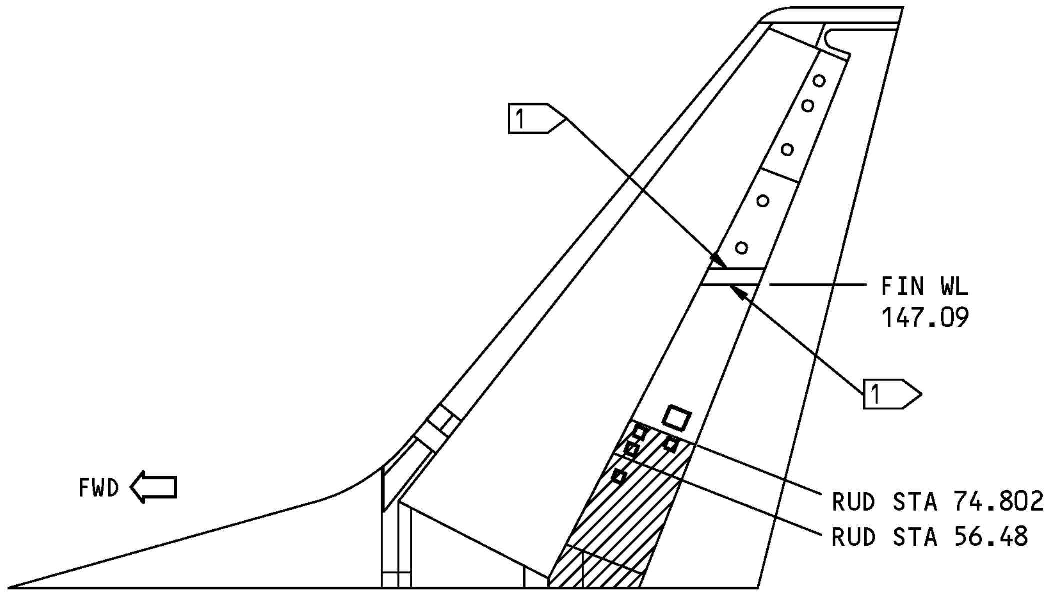


HORIZONTAL STABILIZER TRAILING EDGE PANELS
(LOWER SURFACE)

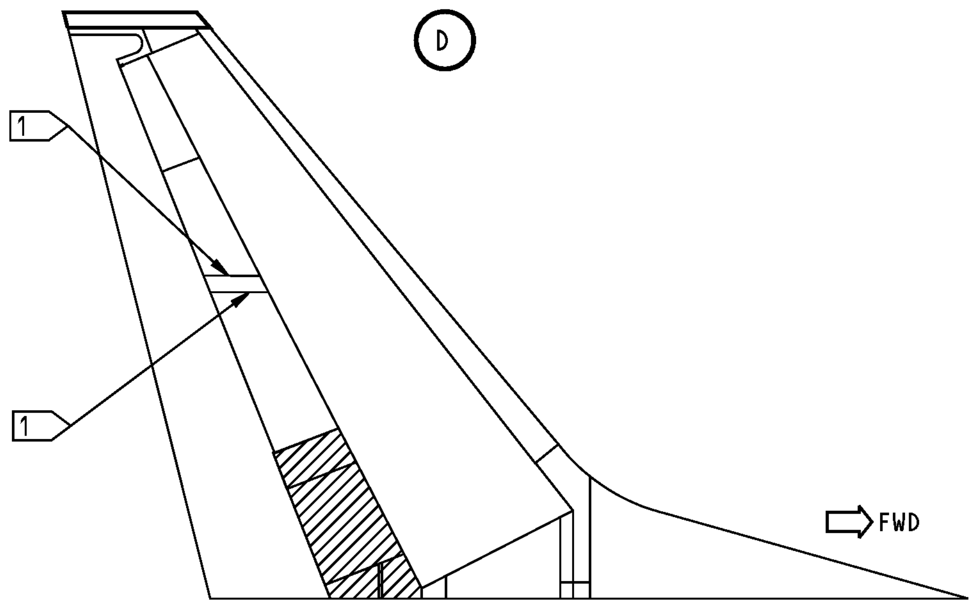
MISSING FASTENERS ARE NOT PERMITTED IN THESE PANELS

C

Panels Where Missing Fasteners are not Permitted
Figure 1 (Sheet 2 of 3)



VERTICAL FIN
(LEFT SIDE)
D



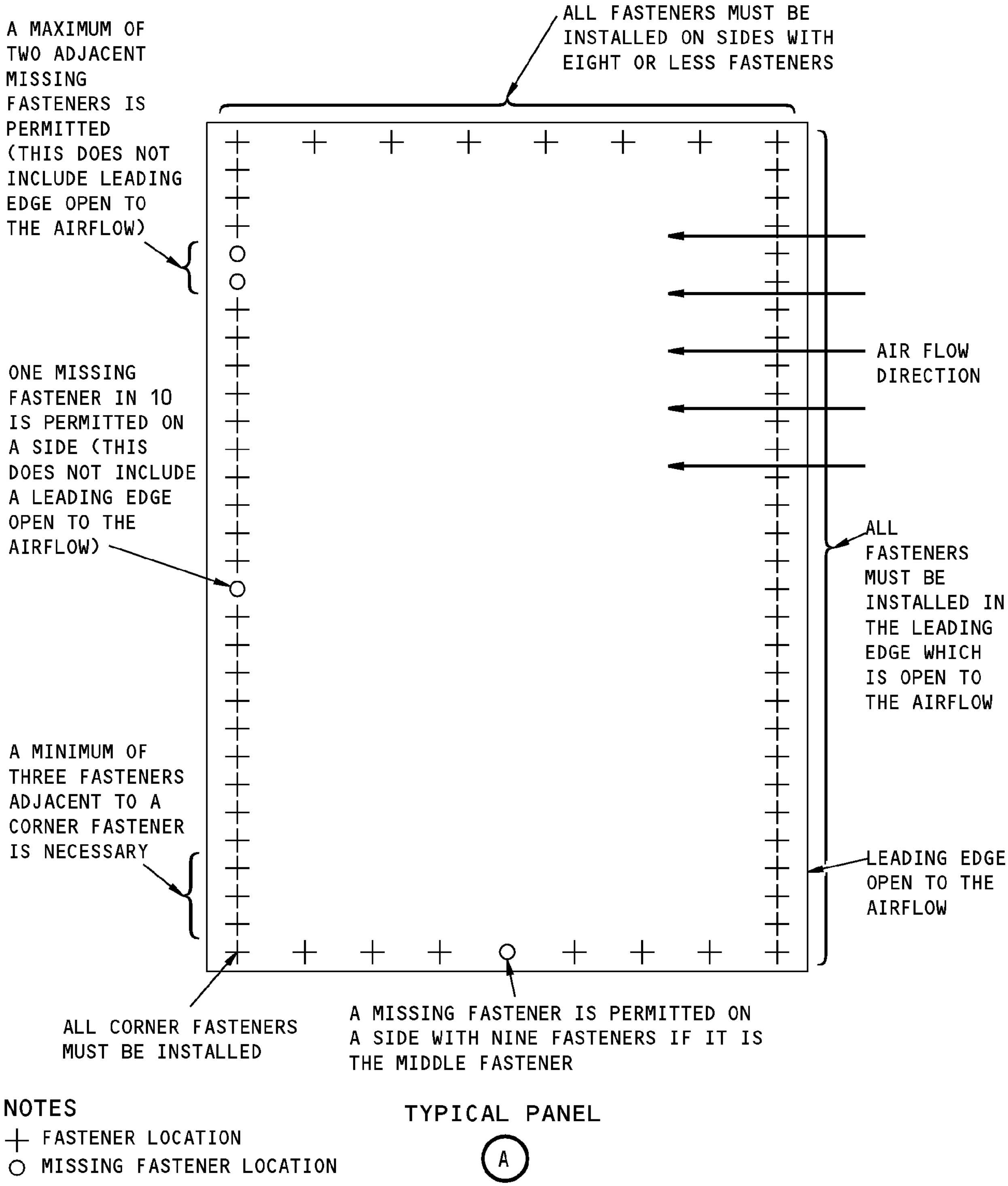
VERTICAL FIN
(RIGHT SIDE)
E

NOTES

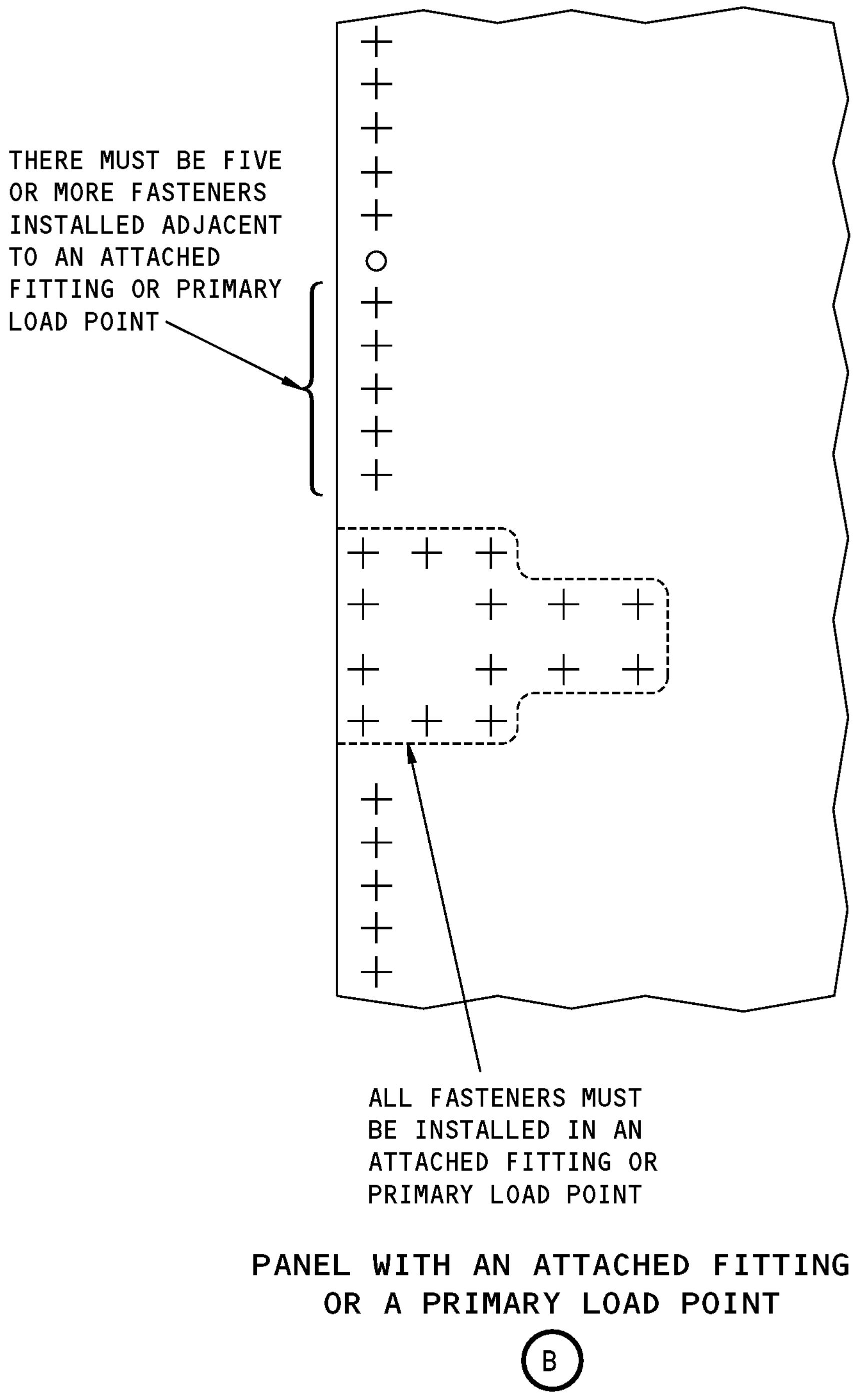
1 NO MISSING OR LOOSE FASTENERS ARE PERMITTED ON THIS EDGE OF THE PANEL.

MISSING FASTENERS ARE NOT PERMITTED IN THESE PANELS

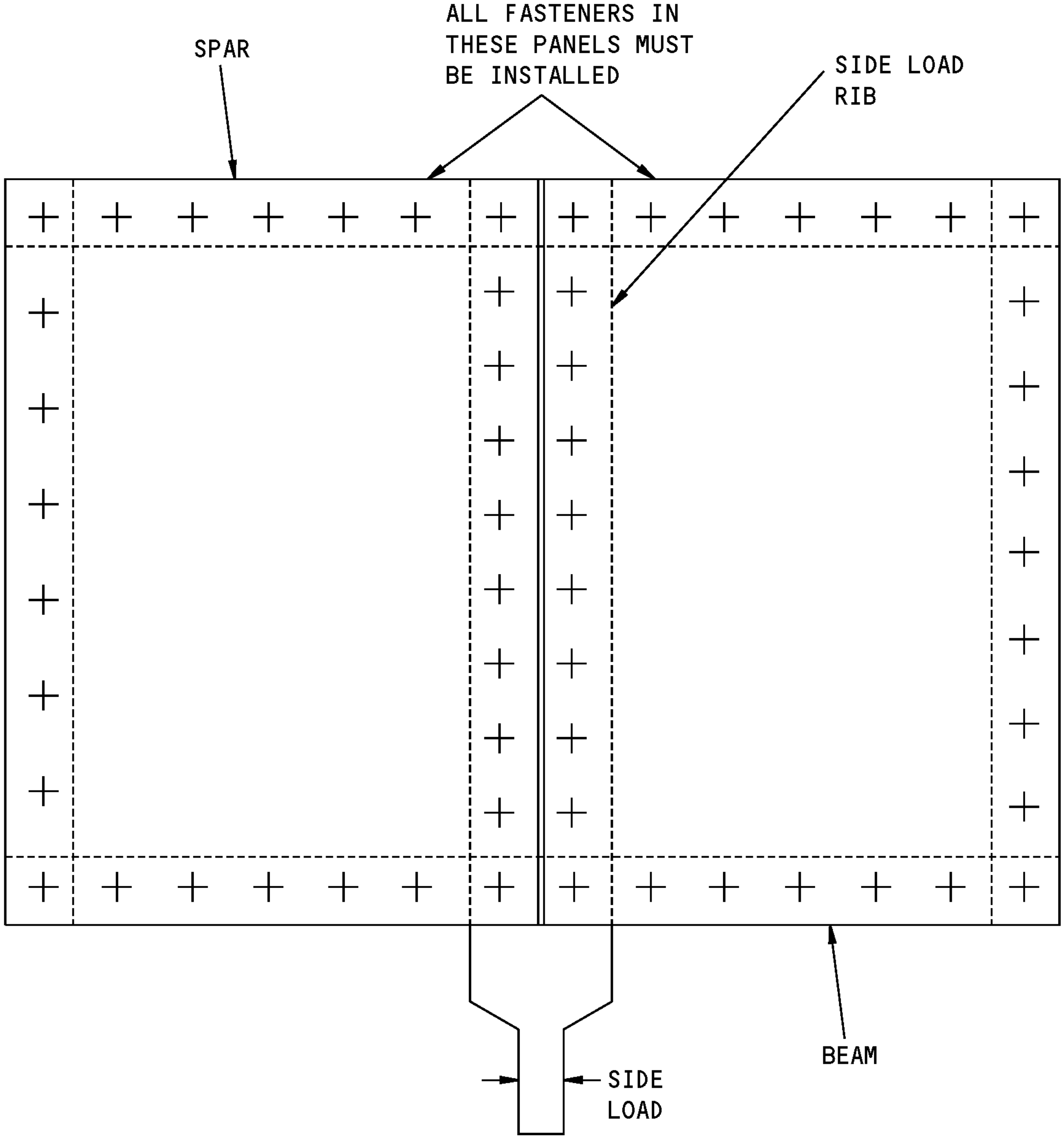
Panels Where Missing Fasteners are not Permitted
Figure 1 (Sheet 3 of 3)



Missing Fastener Locations That are Permitted in Secondary Structure
Figure 2 (Sheet 1 of 3)



Missing Fastener Locations That are Permitted in Secondary Structure
Figure 2 (Sheet 2 of 3)



PANEL NEXT TO A SIDE LOAD RIB
C

Missing Fastener Locations That are Permitted in Secondary Structure
Figure 2 (Sheet 3 of 3)

GENERAL - PROTECTIVE TREATMENT OF METALLIC AND COMPOSITE MATERIALS

1. Applicability

A. This subject is applicable to metal and composite structures and materials.

2. General

A. When you do a repair or rework procedure that breaks the surface of an initial structure, you must apply a protective treatment. The treatment makes a base for the paint and inhibits corrosion when you apply it before the installation of the repair parts.

B. Aluminum alloys in initial structure need a subsequent chemical conversion coating when the repair procedures remove the initial coatings.

C. Aluminum alloy repair parts need a protective treatment before you apply a primer.

(1) Chromic acid anodize is recommended as a protective coating for bare aluminum.

D. Steel alloy parts need a cadmium or a zinc-nickel alloy plating.

E. Use Alodine 600 on aluminum parts when you use BMS 10-20 primer.

F. Clad aluminum surfaces that are not painted need a protective treatment with Alodine 1000. Refer to SOPM 20-43-03.

G. If corrosion occurs on a structural component surface, the surface must be re-finished. This is true even when the damage is not more than the applicable allowable damage limits. Apply the decorative finish if applicable, as given in the Airplane Maintenance Manual (AMM).

H. Refer to 51-10-02 for the mechanical cleanup procedures used to remove burrs or sharp edges.

I. The product that follows is approved for use to make a chemical film on aluminum alloys:

NOTE: These film layers are softer than the anodic treatment. However, they give a satisfactory protective layer and paint base.

(1) Alodine is a registered trade name for a proprietary procedure owned by Parker-Amchem, Henkel Corp.

J. Examine the areas where fire or high temperature has occurred to see if the structure is weak or damaged. Refer to 51-20-03.

3. References

Reference	Title
51-10-02	INSPECTION AND REMOVAL OF DAMAGE
51-20-02	HEAT TREAT VERIFICATION - HARDNESS AND CONDUCTIVITY TESTING
51-20-03	HEAT DAMAGE EVALUATION
51-20-05	REPAIR SEALING
51-30-03	NON-METALLIC MATERIALS
51-60-00	CONTROL SURFACE BALANCING
51-70-03	COMPOSITE MATERIALS ALTERNATIVES
51-70-04, REPAIR GENERAL	Repair Procedures for Wet Layup Materials
51-70-09	BONDED METAL STRUCTURE REPAIR PROCEDURES
AMM 20-30-88	AIRPLANE STRUCTURE CLEANING SOLVENTS (Series 88)
AMM 20-40-11 P/B 201	AIRPLANE GROUNDING - MAINTENANCE PRACTICES
AMM 51-21	INTERIOR AND EXTERIOR FINISHES
AMM 28-11-00/201	Fuel Tanks - Maintenance Practices

(Continued)

Reference	Title
AMM 51-21-00/701	Interior And Exterior Finishes - Cleaning/Painting
CPM Volume 1, 20-40-00	Corrosion Removal
SOPM 20-30-03	Standard Overhaul Practices Manual
SOPM 20-30-80	Solvents For General Cleaning of Metal (Series 80)
SOPM 20-41-05	Application of Corrosion Inhibiting Compound
SOPM 20-42-01	Low Hydrogen Embrittlement Cadmium Plating
SOPM 20-42-05	Bright Cadmium Plating
SOPM 20-43-03	Chemical Conversion Coatings for Aluminum
SOPM 20-50-19	General Sealing
737 NDT Part 4, 51-00-02	Full Depth Honeycomb and Laminate Structure Inspection

4. Maximum Permitted Temperatures for Coatings, Sealants, Adhesives, Primers, and Paints (Refer to Table 1.)

A.

Table 1:

MAXIMUM PERMITTED TEMPERATURES FOR COATINGS, SEALANTS, ADHESIVES, PRIMERS, AND PAINTS	
COATING, SEALANTS, ADHESIVES, PRIMERS, AND PAINTS	**MAXIMUM PERMITTED TEMPERATURE °F (°C)**
BAC 5710, Type 47 PTFE Coating	700 (371) Peak 425 (218) Continuous
BAC 5755, Aluminized Primer	450 (232)
BMS 3-27, Coating	160 (71)
BMS 5-26, Sealant	200 (93)
BMS 5-28 Potting Compound Type 3,4,15,17,19,24,28 Type 11 Type 6,7,12 Class 1,13,14 Class 2,27	 160 (71) 250 (121) 350 (177)
BMS 5-63, Sealant	450 (232)
BMS 5-89, Primer	300 (149)
BMS 5-92, Adhesive	160 (71)
BMS 5-95, Sealant	200 (93)
BMS 5-126, Type II, III Potting Compound	160 (71)
BMS 10-11, Type I and II Primer	300 (149)
BMS 10-20, Type II Primer	300 (149)
BMS 10-21, Type III Anti-static Coating	300 (149)
BMS 10-60, Type I and II Paint	300 (149)
BMS 10-79, Type I and II Sealant	300 (149)
BMS 10-86, (BAC 5710, Type 27) Teflon Coating	300 (149)
BMS 10-100, BAC 5797 Coating	200 (93)
BMS 10-103, Primer	300 (149)

MAXIMUM PERMITTED TEMPERATURES FOR COATINGS, SEALANTS, ADHESIVES, PRIMERS, AND PAINTS	
COATING, SEALANTS, ADHESIVES, PRIMERS, AND PAINTS	**MAXIMUM PERMITTED TEMPERATURE °F (°C)**
BMS 14-4, Type IV Coating	550 (288)
DC93-006	450 (232)
Chemical Conversion Coating on Aluminum (Un-painted)	140 (60)
Chemical Conversion Coating on Aluminum (Painted)	300 (149)
Chemical Conversion Coating on Steel	200 (93)
Anodized or Hardcoat on Aluminum (Un-painted)	300 (149)
Anodized or Hardcoat on Aluminum (Painted)	400 (204)

5. Aluminum Alloys - Brush Chemical Conversion Coating Process

WARNING: USE EXTREME CARE WHEN YOU WORK WITH CORROSIVE CHEMICALS. USE A RESPIRATOR, GOGGLES, RUBBER OR NEOPRENE GLOVES, BOOTS, AND APRONS MADE OF ACID-RESISTANT MATERIALS WHEN YOU WORK WITH THE POWDER OR APPLY THE SOLUTION. CORROSIVE CHEMICALS CAN CAUSE INJURY TO PERSONS. DO NOT PERMIT THE CHEMICAL TO TOUCH YOUR SKIN. WASH IT OFF IMMEDIATELY WITH WATER. IF THE CHEMICAL GETS IN YOUR EYES, WASH WITH WATER FOLLOWED BY AN EYE WASH OR BORIC ACID AND GET MEDICAL AID IMMEDIATELY. RINSE THE SWABS OR PAPER (USED TO APPLY OR REMOVE THE CHEMICALS) THOROUGHLY WITH WATER BEFORE THEY DRY AND BEFORE YOU DISCARD THEM. IF YOU DO NOT, THEY CAN BECOME A FIRE HAZARD.

A. Materials and equipment needed:

(1) Use one of the following:

(a) Alodine 1200 powder, or

(b) Alodine 600 powder.

(2) Tycro wheels - Type 3A, very fine aluminum oxide wheels; Scotch-Brite pad, Type A; very fine aluminum oxide pads; or 400-grit aluminum oxide paper

(3) Cheesecloth or new rags that contain less than 0.75 percent oil

(4) Methyl Ethyl Ketone (MEK) or the equivalent.

B. Prepare the brush chemical conversion coating solution.

NOTE: A dirty solution is unsatisfactory. Prepare the solution in small quantities. Discard the solution if it is dirty.

(1) Put the contents of each container of chemical conversion coating powder on a clean paper and remove the amount to be used.

WARNING: DO NOT BREATHE THE VAPORS WHEN YOU WORK WITH NITRIC ACID. USE RESPIRATORY PROTECTION. DO NOT LET THE ACID TOUCH YOUR SKIN, EYES, OR CLOTHING. IF CONTACT WITH THE EYES OCCURS, DO NOT RUB. FLUSH WITH WATER FOR 15 MINUTES AND GET MEDICAL AID IMMEDIATELY. WEAR ACID-PROOF GLOVES, PROTECTIVE CLOTHING, GOGGLES, AND A FACE SHIELD. FAILURE TO OBEY CAN CAUSE INJURY. KEEP THE ACID AWAY FROM HEAT, FIRE, OR SPARKS. AVOID EXPOSURE TO OTHER MATERIALS.

(a) Add 3 ounces of chemical conversion coating powder for each gallon of de-ionized or distilled water. Make the mixture in a steel or acid-resistant container (Do not use lead or glass).

NOTE: If you use water that is not distilled, add nitric acid to control the pH. Use pHydrion papers to find the pH level.

- For the Alodine products, the pH must be 1.50 to 2.00.

(2) Mix until the powder is fully dissolved. Let the solution stand for one hour before use.

C. Prepare the surface for the chemical conversion coating.

(1) Isolate the areas that need protection from running, splashing or dripping of the solution.

(a) Seal or plug all possible entry points to assemblies with honeycomb or foam plastic with an applicable sealing or caulking material or rubber plugs.

(b) Painted, anodized or previously conversion coated surfaces do not need to be isolated.

(2) Clean the area to be chemical conversion coated with a solvent or degreaser and a clean brush or rags. Dry with warm air or wipe dry.

(3) Remove all the finish from the repair area. Remove the anodized, chemical conversion coatings mechanically with:

(a) Tycro, Type 3A, very fine aluminum oxide wheels attached to a drill motor, or

(b) Scotch-Brite pad, Type A, or

(c) 400-grit aluminum oxide paper.

(4) Clean until all signs of organic or inorganic coatings are gone and only a bright shiny aluminum surface shows. Wipe dry with a clean cheesecloth to remove loose particles and residue.

(5) Wipe with a clean cheesecloth moist (not soaked). Do this step again and again until no visible residue shows on the cheesecloth after wiping.

(6) Remove all corrosion that has occurred as given in steps (1) through (5) above.

(7) Allow 15 minutes to dry.

(8) Refer to AMM 28-11-00/201 for instructions to clean the structure and the repair parts before the installation of sealant in the integral fuel tanks.

D. Apply the chemical conversion coating solution.

CAUTION: DO NOT PERMIT THE CHEMICAL CONVERSION COATING SOLUTION TO DRY ON THE BRUSHES OR CHEESECLOTHS. WASH ALL OF THE CHEMICAL CONVERSION COATING SOLUTION FROM THESE MATERIALS FULLY BEFORE THEY DRY. PUT THE DRY BRUSHES AND CHEESECLOTHS IN A FIREPROOF CONTAINER. FAILURE TO OBEY CAN CAUSE A FIRE BY SPONTANEOUS COMBUSTION.

(1) Apply the coating fully and equally with a fiber or nylon brush or clean cheesecloth.

(2) Let the solution stay for 3 to 4 minutes to form a coating. Keep the area moist during this period by gently blotting with a cheesecloth moist with the chemical conversion solution.

CAUTION: USE CARE WHEN YOU RINSE AND DRY THE COATED SURFACE. THE NEW COATING IS SOFT AND CAN BE EASILY DAMAGED. FAILURE TO OBEY CAN CAUSE AN UNSATISFACTORY CHEMICAL CONVERSION COATING.

(3) Rinse with water by gently blotting with a moist (not soaked) cheesecloth. Blot gently for 1 to 2 minutes then use a clean cheesecloth.

(4) Let the surface fully dry in the air. The use of filtered hot air (130°F (54°C) maximum) for 15 minutes is recommended.

(5) Apply the final finish or start the adhesive procedures as given in 51-70-09 as soon as possible after drying. Wear clean gloves to keep the part clean and dry and to prevent surface contamination.

6. **Steel-Cadmium Plating Procedures**

A. Dissimilar materials are classified into four groups (Refer to Table 2/GENERAL). The classification is based on the surface material (base metal of a non-plated part) or the plating or coating on the part. All the members of each group are similar materials. The materials from the other groups are dissimilar to them.

Table 2:

CLASSIFICATION OF DISSIMILAR MATERIALS	
GROUP NUMBER	**MATERIALS**
GROUP I	Magnesium and its alloys
GROUP II	Cadmium-titanium, cadmium, zinc, aluminum, and their alloys
GROUP III	Iron, steels (but not CRES), lead, tin, and their alloys
GROUP IV	Copper, brass, bronze (aluminum-bronze or aluminum-nickel-bronze), copper-nickel, copper-beryllium, chromium, and molybdenum Nickel and nickel alloys, cobalt alloys, titanium and titanium alloys, CRES, tungsten, carbon, CFRP, silver, and gold

B. Oxidation is not a problem with corrosion-resistant steel parts. But these parts are cathodic when they touch dissimilar metals and should be cadmium plated or coated with primer. Also, you should apply a layer of sealant to the mating surfaces. Refer to Paragraph 6.A./GENERAL for the definition of dissimilar metals.

C. Steel parts that are not corrosion-resistant and which are used for repairs, must be cadmium plated or zinc-nickel alloy plated for protection from corrosion. Refer to SOPM 20-42-01 and SOPM 20-42-05 for cadmium plating.

D. Until the reworked surfaces of steel parts can be plated, apply a temporary protective coating to the surfaces that are heat-treated to less than 220 ksi. Do the steps that follow:

NOTE: For steels that are heat-treated to more than 220 ksi, tell The Boeing Company.

(1) Abrasive clean the steel parts. Refer to 51-10-02.

(2) Apply 2 layers of BMS 10-11, Type 1 primer as given in AMM 51-21-00/701.

7. **Magnesium Alloys - Conversion Coating Procedures**

A. Magnesium alloys are very susceptible to corrosion when the metal is open to the air without a protective finish. An oxide-carbonate film will normally form on an open magnesium alloy surface but this film gives very little protection against corrosion. A correct protective finish is necessary.

B. The materials that follow are necessary for the Dow 19 chemical conversion coating procedures.

(1) Chromic Acid

(2) Calcium Sulfate

(3) Cheesecloth

(4) Methyl Ethyl Ketone (MEK), Methyl Isobutyl Ketone (MIBK), or acetone

(5) Sodium Hydroxide

(6) Sulfuric Acid

C. Prepare the chemical conversion coating solution for a brush-on application.

NOTE: Make the solution and keep it in a polyethylene or glass container.

(1) Fill a clean polyethylene or glass container 9/10 full with distilled water.

(2) Slowly add 1-1/3 ounces of chromium trioxide for each gallon of solution wanted.

(3) Add 1 ounce of calcium sulfate for each gallon of solution wanted.

(4) Add distilled water to fill to the quantity of the wanted solution.

(5) Use pHydrion papers to find the pH level.

(a) The pH must be 1.2 to 1.6.

(b) Add sodium hydroxide or sulfuric acid to control the pH.

D. Prepare the surface of the repair for the conversion coating.

(1) Mask off the area around the surface of the repair with tape.

(2) Protect structures that contain honeycomb core or foam plastic, and put a cover on all holes, gaps, and inlets to prevent the entrance of the solution.

(3) Use clean dry cheesecloth to remove loose material and residue.

(4) Clean the repair area with cheesecloth made moist (not saturated) with. Refer to SOPM 20-30-03 for the cleaning procedures. Do this step again until you cannot see residue on the cheesecloth.

(5) Permit the surface to dry for 15 minutes.

E. Apply the chemical conversion coating.

CAUTION: DO NOT RUB THE WET SURFACE WITH FORCE. FAILURE TO OBEY CAN CAUSE DAMAGE TO THE CHEMICAL CONVERSION COATING.

(1) Apply the solution with a brush, swab, swatches, cellulose sponge, or white blotting paper. Keep a continuous wet film until the metal surface becomes a dull golden or dark brown color. Discard the remaining solution.

(2) Rinse the repair area with clean cold water.

CAUTION: DO NOT USE HIGH PRESSURE AIR TO DRY THE SURFACE BECAUSE THE CHEMICAL CONVERSION COATING IS STILL SOFT.

(3) Permit the chemical conversion coating to dry at ambient temperature.

(4) Apply a finish to the surface as soon as possible after the chemical conversion coating dries. Refer to AMM SECTION 51-21. Use clean gloves and keep the parts clean and dry to prevent surface contamination.

8. Protective Treatment of Mating Surfaces

A. Each metal and metal alloy has an inherent electrical potential. When these materials touch other materials of a different potential and an electrolyte is present, galvanic corrosion can be the result. Refer to Protective Treatment of Mating Surfaces, Figure 1/GENERAL for protective treatments that can be used for mating surfaces.

B. CFRP, although classified as a non-metal, is an electrically conductive material. It has an electrolytic reaction with metals from the other groups with which it has a mating surface, or with fasteners made from dissimilar materials (Table 2/GENERAL, Groups I through III). Do the steps that follow to prevent corrosion of the structure to which CFRP panels are attached.

(1) Apply one ply of fiberglass to the surfaces of the CFRP panel that will be attached to aluminum structure. The fiberglass ply must extend a minimum of 4 inches from the aluminum. The fiberglass ply is usually co-cured with the CFRP.

(2) For other surfaces of the CFRP that do not touch the aluminum but are less than 4 inches from a moisture path of an aluminum part, apply one of the protective treatments that follows:

(a) One co-cured ply of fiberglass, or

(b) One co-cured ply of Tedlar, or

(c) Two layers of BMS 10-103 primer, or

(d) One layer of BMS 10-103 primer and one layer of BMS 10-60, Type II enamel.

(3) Apply BMS 5-92, Type I adhesive to all cut edges of the CFRP laminate that is less than 4 inches from a moisture path of an aluminum part. Refer to SOPM 20-50-19.

(4) Apply one layer of BMS 10-103 primer.

(a) BMS 10-103 primer is necessary on all external aerodynamic surfaces.

C. The protective treatments given in Protective Treatment of Mating Surfaces, Figure 1/GENERAL are satisfactory for field type repairs where you need the procedure to be fast and simple. Refer to AMM 51-21-00/701 to apply the internal or external finish.

PROTECTIVE TREATMENT OF MATING SURFACES				
MATERIAL	TREATMENT OF MATING SURFACES OTHER THAN SURFACES TO BE BONDED OR LOCATED IN INTEGRAL FUEL TANKS TO INCLUDE THOSE THAT TOUCH HYDRAULIC FLUID [2] [3]		SURFACES TO BE STRUCTURALLY BONDED	SURFACES IN INTEGRAL FUEL TANKS
	SIMILAR MATERIALS [1]	DISSIMILAR MATERIALS [1] [4]		
ALUMINUM ALLOYS [5]	Chemical Conversion Coating (Refer to Paragraph 2) and apply: - One layer of BMS 10-11, Type 1 primer to each surface in the fuselage upper lobe - Two layers of BMS 10-11, Type 1 primer to each surface in the fuselage lower lobe.	Chemical Conversion Coating (Refer to Paragraph 2) and apply: - One layer of BMS 10-11, Type 1 primer to each surface in the fuselage upper lobe - Two layers of BMS 10-11, Type 1 primer to each surface in the fuselage lower lobe. [6]	Refer to SRM 51-70-09.	Refer to SRM 51-20-05.

TABLE A

Protective Treatment of Mating Surfaces
Figure 1 (Sheet 1 of 4)

PROTECTIVE TREATMENT OF MATING SURFACES				
MATERIAL	TREATMENT OF MATING SURFACES OTHER THAN SURFACES TO BE BONDED OR LOCATED IN INTEGRAL FUEL TANKS TO INCLUDE THOSE THAT TOUCH HYDRAULIC FLUID [2] [3]		SURFACES TO BE STRUCTURALLY BONDED	SURFACES IN INTEGRAL FUEL TANKS
	SIMILAR MATERIALS [1]	DISSIMILAR MATERIALS [1] [4]		
NON-CORROSION RESISTANT STEEL	For a heat-treat that is not more than 220 ksi, cadmium plate or zinc-nickel plate (Refer to SOPM 20-42-05) and apply one layer of BMS 10-11, Type 1 Primer to each surface. For a heat-treat that is more than 220 ksi, cadmium-titanium plate (Refer to SOPM 20-42-02) and apply one layer of BMS 10-11, Type 1 primer to each surface.	For a heat-treat that is not more than 220 ksi, cadmium plate or zinc-nickel plate (Refer to SOPM 20-42-05) and apply one layer of BMS 10-11, Type 1 Primer to each surface. For a heat-treat that is more than 220 ksi, cadmium-titanium plate (Refer to SOPM 20-42-02) and apply one layer of BMS 10-11, Type 1 primer to each surface. [7]	Refer to SRM 51-70-09.	Refer to SRM 51-20-05.

TABLE A

Protective Treatment of Mating Surfaces
Figure 1 (Sheet 2 of 4)

PROTECTIVE TREATMENT OF MATING SURFACES				
MATERIAL	TREATMENT OF MATING SURFACES OTHER THAN SURFACES TO BE BONDED OR LOCATED IN INTEGRAL FUEL TANKS TO INCLUDE THOSE THAT TOUCH HYDRAULIC FLUID [2] [3]		SURFACES TO BE STRUCTURALLY BONDED	SURFACES IN INTEGRAL FUEL TANKS
	SIMILAR MATERIALS [1]	DISSIMILAR MATERIALS [1] [4]		
CORROSION RESISTANT STEEL (CRES)	There is no requirement.	Cadmium plate (Refer to SOPM 20-42-05) and apply one layer of BMS 10-11, Type 1 Primer to each surface. [7]		
MATERIALS GIVEN IN TABLE 2, GROUP IV (CRES AND CFRP EXCLUDED)	There is no requirement.	Apply one layer of BMS 10-11, Type 1 Primer to each surface. Cadmium plate (Refer to SOPM 20-42-05) and apply one layer of BMS 10-11, Type 1 primer to nickel and nickel alloys and to copper and copper alloys.		
CFRP	There is no requirement.	Refer to Paragraph 7.B.	Refer to SRM 51-70-04 or SRM 51-70-05.	Not applicable.

TABLE A (CONTINUED)

Protective Treatment of Mating Surfaces
Figure 1 (Sheet 3 of 4)

NOTES

1 REFER TO TABLE 1 FOR THE GROUPS OF SIMILAR AND DISSIMILAR MATERIALS.

2 ALL NON-BONDED FUSELAGE, WING AND ENGINE PYLON SKIN MATING SURFACES NEED A MATING SURFACE SEAL AS GIVEN IN SRM 51-20-05 AND PRIMER.

3 HYDRAULIC FLUID, FIRE RESISTANT, BMS 3-11

4 ALL NON-BONDED MATING SURFACES OF DISSIMILAR METALS NEED A MATING SURFACE SEAL APPLIED AS GIVEN IN SRM 51-20-05 AND PRIMER. MATING SURFACES NEED ONLY ONE LAYER OF PRIMER ON EACH SURFACE.

5 IT IS RECOMMENDED THAT BARE ALUMINUM SURFACES BE CHROMIC ACID ANODIZED WHEN POSSIBLE. REFER TO SOPM 20-43-01.

6 ALUMINUM ALLOYS THAT TOUCH CFRP NEED:

- A CHEMICAL CONVERSION COATING
- ONE LAYER OF BMS 10-79, TYPE III PRIMER
- ONE LAYER OF BMS 10-60, TYPE I ENAMEL.

DO NOT USE CLAD 7075 TO TOUCH CFRP.

7 CADMIUM PLATE IS NOT PERMITTED TO TOUCH CFRP OR TITANIUM.

Protective Treatment of Mating Surfaces
Figure 1 (Sheet 4 of 4)

9. Protective Treatment Necessary for Fastener Installation

A. Refer to Protective Treatment for Fastener Installation, Figure 2/GENERAL to find the need for protection of the structure from galvanic corrosion that occurs because of the fastener installation.

B. Install the fasteners that are not permanent with MIL-C-11796, Class 3 or BMS 3-27 corrosion preventive compounds with the exceptions that follow:

(1) In integral fuel tanks. Refer to AMM 28-11-00/201.

(2) In areas where dry fastener installation is necessary, or where BMS 5-26 and BMS 5-63 fastener sealant installation is necessary. Refer to 51-20-05 and the specific component repair sections.

C. Install permanent fasteners that are not made from aluminum alloy (hex-drive bolts, lockbolts, CRES bolts and titanium bolts) in dissimilar metal structures with one of the applicable sealants that follows:

NOTE: Apply the sealant in the fastener hole and around the fastener head. Install the fasteners before the end of the squeeze-out life of the sealant. Refer to 51-20-05.

(1) With BMS 5-95 sealant, or

(2) With BMS 5-26 sealant for use in fuel resistant installations, or

(3) With BMS 5-63 sealant for use in firewall installations and fittings attached to CFRP panels of the thrust reverser, or

(4) With GE RTV174 or Dow Corning 93-006 for use in high temperature installations.

D. Aluminum rivets with shaved heads in un-painted anodized aluminum alloy surfaces must have a clear layer of Alodine 1000 applied.

FASTENER MATERIAL IN CONTACT WITH STRUCTURE	MATERIAL IN CONTACT WITH FASTENER			
	MAGNESIUM AND MAGNESIUM ALLOYS	ALUMINUM ALLOYS, CADMIUM AND ZINC PLATE	LEAD, TIN, BARE IRON AND CARBON OR LOW ALLOY STEELS	CORROSION RESISTANT STEELS, NICKEL AND COBALT BASE ALLOYS, TITANIUM, COPPER, BRASS, CHROME PLATE AND CARBON FIBER
ALUMINUM	1	2	1	5 6
CADMIUM OR ZINC PLATE	1	3	1	4 6
CHROME PLATE	5	5	5	2
UNPLATED CORROSION RESISTANT STEEL	5	5	5	2
NICKEL OR COBALT BASE ALLOYS	5	5	5	2
UNCOATED TITANIUM	5	5	5	2
BMS 10-85 COATED TITANIUM	1	3	2	2

NOTE: REFER TO PARAGRAPH 7 FOR THE NECESSARY PROTECTIVE TREATMENT.

1 PROTECTIVE TREATMENT IS NECESSARY.

2 PROTECTIVE TREATMENT IS NOT NECESSARY.

3 PROTECTIVE TREATMENT IS NOT NECESSARY EXCEPT FOR EXTERNAL AREAS.

4 PROTECTIVE TREATMENT IS NECESSARY EXCEPT FOR CORROSION RESISTANT STEEL FASTENERS IN MATERIALS GIVEN IN TABLE 1, GROUP IV. DO NOT INSTALL CADMIUM PLATED FASTENERS IN TITANIUM STRUCTURE.

5 DO NOT USE THESE FASTENERS IN THESE METAL GROUPS.

6 NOT ALLOWED IN CARBON FIBER MATERIAL.

Protective Treatment for Fastener Installation
Figure 2

10. Use of Water-Displacing Corrosion Inhibiting Compound (WDCIC) For Corrosion Protection

A. Use Water Displacing Corrosion Inhibiting Compound (WDCIC) with finish systems to prevent corrosion when the finish is damaged. The compound can get into small cavities and push water out. It can get between mating surfaces or between fasteners and their holes where the finish is broken.

NOTE: Do an analysis of the airplane's environment, the corrosion inhibitor being used and the application schedule to make sure that the corrosion protection is sufficient. We recommend that you use BMS 3-23 and BMS 3-29. Other corrosion inhibiting compounds can be satisfactory.

B. BMS 3-23 and BMS 3-29 are organic compounds. They are non-volatile base materials in solvents to make a fluid and can be applied with an airless paint spray pump, aerosol can or with a brush. They do not contain silicone.

(1) BMS 3-23:

(a) There are two types of BMS 3-23.

1) Type I is a transparent colorless film which can be detected only with the use of ultraviolet light.

2) Type II is a colored film which provides easy visual detection.

(b) When BMS 3-23 dries it leaves a thin layer of wax-like material on the surface.

(c) Surfaces with BMS 3-23 applied stay tacky and will collect unwanted material (excluded is Dinitrol AV-8 which is not tacky when it dries). Therefore, these surfaces must be cleaned often and have BMS 3-23 applied again.

(d) Refer to 51-30-03 for the sources of BMS 3-23 and BMS 3-29.

(2) BMS 3-29:

(a) There is one type of BMS 3-29. Surfaces with BMS 3-29 applied become dry after 24 hours.

(b) The dry layer of BMS 3-29 is not easily worn. However, it must be applied again if the surface is cleaned.

C. WDCIC can be applied to areas of the airplane's structure where corrosion has started or where corrosion can occur later.

(1) If corrosion has occurred, apply the WDCIC temporarily until the corrosion is removed.

CAUTION: DO NOT APPLY WDCIC TO AREAS SUCH SOLENOIDS AS STATED IN SOPM 20-41-05. SOME SOLENOIDS CAN BECOME INOPERATIVE AND CAUSE THE FAILURE OF DOORS TO LOCK WHICH RESULTS IN A REJECTED TAKEOFF.

D. WDCIC will not decrease the initial torque on fasteners. However, the application should be limited to the approved areas of aluminum structure such as:

(1) Areas in Table 3/GENERAL

(2) All mating surface edges where paint, primer or sealant has deterioration

(3) Areas where the decorative paint film is broken around the fasteners (inhibits filiform corrosion)

(4) All other locations where corrosion has been detected.

Table 3:

LOCATIONS FOR WATER DISPLACING CORROSION INHIBITING COMPOUND APPLICATION	
MAJOR STRUCTURE	**LOCATION**
FUSELAGE	- All internal surfaces of the body structure from the forward pressure bulkhead to the aft pressure bulkhead - The two sides of all pressure bulkheads - The nose wheelwell space - The main wheelwell spaces - The internal and external surfaces of the keel beam - All the structure below the scuff plates of the thresholds - The internal structure of all doors - All the structure in Section 48 forward of the firewall of the APU - Body skin, wing skin, and the structure below the wing-to- body fairing panels - The skin and structure below the tail skid fairing - In the Wing Center Section, the external surfaces of the rear spar and the external side of the lower surface
WING	- Leading edge spaces - Trailing edge spaces - Interspar structure outboard of the surge tank - Internal structure of the flaps - Support structure of the flaps - Support structure of the nacelle
EMPENNAGE	- The interspar structure of the horizontal and vertical stabilizers - The forward surfaces of the front spars of the horizontal and vertical stabilizers - The rear spar spaces of the horizontal and vertical stabilizers - The inboard surfaces of the closure rib of the horizontal stabilizer - The lower surfaces of the closure rib of the vertical stabilizer - The truss structure of the center section - The body skin below and between the closure angles of the vertical stabilizer

E. WDCIC has been applied to most areas of the airplane during manufacture for added corrosion protection. If you do rework or repair in these areas, you should apply the WDCIC again. Table 3/GENERAL gives the locations of these areas.

F. Refer to the 737 Corrosion Prevention Manual (CPM) for more information on the use of WDCIC.

G. Some precautions are necessary when you use WDCIC.

WARNING: USE CARE WHEN YOU USE WDCIC. IT IS AS TOXIC AS KEROSENE AND THE PRECAUTIONS ARE THE SAME. WHEN YOU SPRAY IN A CONFINED AREA, THE MAXIMUM HUMAN EXPOSURE LEVEL IS 500 PARTS PER MILLION (PPM) FOR 8 HOURS. DO NOT LET WDCIC TOUCH YOUR SKIN. FAILURE TO OBEY CAN CAUSE INJURY. ALIPHATIC NAPHTHA IS THE PREFERRED SOLVENT FOR WDCIC AND IT IS ALSO TOXIC. USE MECHANICAL VENTILATION WHEN YOU USE NAPHTHA IN A CONFINED SPACE. SKIN PROTECTION CAN ALSO BE NECESSARY. FAILURE TO OBEY CAN CAUSE INJURY.

(1) Make sure that oxygen systems are shielded to prevent direct or indirect contamination.

(2) Protect electrical connectors and contacts from possible contamination.

(3) Remove all unwanted WDCIC from moving parts with a clean and dry rag. The thin film that remains is sufficient for corrosion protection. A build-up of WDCIC can become hard at low temperatures and can reduce the operating efficiency of the moving parts.

(4) Protect control cables, pulleys, Teflon bearings, and lubricated surfaces from direct application. These materials act as solvents for lubricants. The lubrication can be destroyed and the result can be higher than normal wear of the parts.

(5) Use care when you use WDCIC near door or emergency hatch seals, grease seals or rubber lined clamps for tubing or wiring. These materials can cause rubber to swell and cause the seals to fail. Skydrol seals can also be affected. Therefore, WDCIC must not be used on actuator rods.

(6) Do not apply WDCIC near engines, cowling or other areas of high temperature or where firewall sealant is used. Do not apply WDCIC on the thermal anti-ice duct in the leading edge cavity. High temperature causes deterioration in these compounds.

(7) Protect insulation blankets from WDCIC. These compounds can reduce the ability of these blankets to repel water.

H. Materials and equipment used when you work with WDCIC:

- Masking tape
- Perchloroethylene, Technical - 0-T-236 or the equivalent. Refer to SOPM 20-30-03.
- Solvent - P-D-680 or the equivalent. Refer to SOPM 20-30-03.
- Wipers (cheesecloth, gauze, new or clean rags, tissue, paper or other absorbent materials
- Protective closures to keep the WDCIC out of other equipment such as oxygen system tubing.

I. Prepare the surface for the application of WDCIC.

(1) Let new paint or primer dry for 8 hours minimum before you apply WDCIC.

CAUTION: DISCONNECT ALL SOURCES OF POWER WHEN YOU USE WDCIC NEAR BATTERY-OPERATED OR OTHER ELECTRICAL EQUIPMENT. A LARGE QUANTITY OF WATER IS NECESSARY TO COMPLETE SOME PROCEDURES AND THERE IS THE POSSIBILITY OF ELECTRICAL SHOCK.

(2) Remove all external power sources.

(3) Put an electrical ground on the airplane to prevent static electricity. Refer to AMM PAGEBLOCK 20-40-11/201 for the procedures to electrically ground the airplane.

(4) Clean the area with a vacuum as necessary to remove unwanted materials.

WARNING: USE MECHANICAL VENTILATION WHEN YOU USE NAPHTHA IN A CONFINED SPACE. SKIN PROTECTION CAN ALSO BE NECESSARY. FAILURE TO OBEY CAN CAUSE INJURY.

(5) Clean the surface with or solvent.

(6) Isolate the area where WDCIC is unwanted. Use masking tape, and paper or plastic film.

(7) Isolate electrical connectors to prevent contamination of the electrical contacts.

(8) Isolate the oxygen system components.

(9) Build protective barriers around control cables, pulleys, bearings and lubricated surfaces.

J. The procedures used to apply the WDCIC.

(1) WDCIC has a solvent carrier with a low surface tension that helps displace water from a metal surface. As the solvent evaporates, a thin film remains to form a barrier to prevent the chemical reaction that causes corrosion. WDCIC has the ability to penetrate cracks and crevices. Therefore pressure spraying is not necessary.

(2) WDCIC can by applied with an airless paint spray pump, aerosol can or with a brush.

(3) Subsequent layers of WDCIC can be added if the surface is still clean. If the surface is dirty, it must be cleaned before another layer is applied.

(4) WDCIC is only applied to areas specified by released engineering data.

(5) Apply the WDCIC after you apply other finishes such as paint, primer or sealant. This prevents the possible bleed-out from the mating surfaces because of the penetrating qualities of the WDCIC.

(6) Apply a continuous wet layer to permit penetration in cracks and crevices.

(a) Dry layer thickness

1) BMS 3-23 has no minimum film thickness because a sufficiently large quantity is necessary to make sure the compound goes into the crevices, joints, and laps.

2) Apply a film thickness of 0.001 inch to 0.003 inch for BMS 3-29.

(b) Let the compounds stay for 60 minutes before the excess is removed.

(c) Remove the excess with clean cloths or gauze.

(d) Remove the protective barriers put in position before the application began.

(e) Give the area a good flow of air until the volatile solvents are gone. The cure time is:

1) 1 hour for BMS 3-23

2) 3 hours for BMS 3-29.

(f) WDCIC contains wax and should not be used on surfaces that get hotter than 140°F (60°C).

K. Application procedures for BMS 3-23 and BMS 3-29.

(1) Spray application

(a) Aerosol cans can be used but are not the preferred procedure.

(b) The preferred spray application procedure is the use of approved pressure pot equipment with an airless spray gun operated at 45 psi. The suppliers of this equipment are:

1) Nordson Corporation, 28601 Clemens Rd., Westlake, OH, 44195

2) Binks Manufacturing Company, 9201 West Belmont Avenue, Franklin Park, IL 60131-2807

(c) Brush Application

1) Apply the compound with a brush or a clean cloth. This procedure works best in small areas where access is limited and gives the best protection to adjacent equipment.

L. Removal procedures for WDCIC

(1) The removal of WDCIC is necessary before you re-paint, apply sealant or do a penetrant inspection. The solvents that follow are used to remove WDCIC:

NOTE: Methyl Ethyl Ketone (MEK) is not recommended.

(a) Naphtha

(b) Biogenic SE377C

(c) Citra-safe

(2) Give a good flow of air until the solvent is gone.

M. Exterior discoloration by corrosion inhibiting compounds

(1) When you use a large amount of WDCIC on the internal surfaces, some discoloration on the external surfaces can occur. This is called bleed-through. It is normal at fasteners that are not fluid tight and it is not an indication that fastener replacement is needed.

(2) WDCIC bleed-through can cause stains on the external surface or the decorative finish of the airplane. A difference in the oxidation on the exterior surface can occur. It is recommended that you clean the surfaces in these areas frequently to prevent permanent discoloration.

11. **Solvent Dispersed Corrosion Inhibiting Compound (SDCIC) (BMS 3-26, Type II)**

A. WDCIC is the primary corrosion inhibitor used in the manufacture of the airplane. When a more durable surface protection is needed, use BMS 3-26, Type II, Solvent Dispersed Corrosion Inhibiting Compound (SDCIC).

(1) These materials are volatile liquids that can be applied by spray or brush. The liquid carrier evaporates and a foggy residue remains that is dry in 24 hours.

(2) BMS 3-26, Type II gives a hard film, but it does not have the penetrating ability of BMS 3-23 or BMS 3-29 water displacing corrosion inhibiting compound.

(3) The application of SDCIC should be limited to those situations where it is specifically called out for use.

NOTE: Do an analysis of the airplane's operating environment, the corrosion inhibitor used and the application schedule to make sure that sufficient corrosion protection occurs.

(4) For SDCIC, we recommend the use of BMS 3-26, Type II. However, other compounds can be a satisfactory substitute.

B. Some precautions are necessary when you use SDCIC.

(1) The same precautions applicable for water displacing corrosion inhibiting compounds are applicable for SDCIC (Refer to Paragraph 10.G./GENERAL).

(2) BMS 3-26, Type II is applied to surfaces at an ambient temperature that is between 50°F and 100°F (10°C and 38°C).

C. For compatibility, the materials in the SDCIC are usually hydrocarbons. Subsequent layers of a different compound can be applied with no bad result.

D. Clean the area before you apply the SDCIC. A clean surface is best when you apply SDCIC. A good continuous film of corrosion inhibitor will be the result.

(1) Remove loose dirt and other unwanted materials with a vacuum or by wiping. Then, clean the area with the regular airplane cleaning agents or solvents.

E. The procedures to apply the SDCIC.

(1) Put an electrical ground on the airplane to prevent static electricity. Refer to AMM PAGEBLOCK 20-40-11/201 for the procedures to ground the airplane. Make sure that all primers and enamels have been cured for 8 hours minimum.

NOTE: Make sure that you follow other precautions that are given in Paragraph 11.B./GENERAL above.

(2) Apply a wet layer of the SDCIC to get a continuous film.

NOTE: Spray application is recommended as the best way to get an even film thickness. However, a brush application procedure is satisfactory.

(3) Permit a continuous flow of clean air in the area until the volatile solvents have fully evaporated.

F. The procedures used to apply BMS 3-26, Type II.

NOTE: Apply the BMS 3-26, Type II at an ambient temperature that is between 50°F and 100°F (10°C and 38°C). If thinning is necessary, add Aliphatic Naphtha as necessary to permit spraying.

(1) The same procedures applicable for BMS 3-23 and BMS 3-29 are applicable for BMS 3-26, Type II (Refer to Paragraph 10.J./GENERAL) with the following difference:

(a) Let it dry. The cure time for BMS 3-26, Type II is 6 hours.

G. The procedures used to remove SDCIC.

(1) You must fully remove SDCIC before you re-paint or apply sealant. Also, you must do the solvent clean procedure before you do a penetrant inspection.

WARNING: USE MECHANICAL VENTILATION WHEN YOU USE NAPHTHA IN A CONFINED SPACE. SKIN PROTECTION CAN ALSO BE NECESSARY. FAILURE TO OBEY CAN CAUSE INJURY.

(2) Use naphtha as a solvent to remove SDCIC.

NOTE: The use of Methyl Ethyl Ketone (MEK) is not recommended.

12. Repair For Cracks in the Finish on Carbon Fiber Reinforced Plastic (CFRP) Parts

A. General

(1) When cracks in the finish occur, moisture can go into the cracks and cause a loss of the finish. Sunlight can cause damage to the bare composite surface where the finish is lost.

(2) The repair in Paragraph 12.B./GENERAL is applicable to cracks in the surface paint with no damage to the composite fibers or the resin matrix.

(3) The repair in Paragraph 12.C./GENERAL is applicable to cracks in the surface paint with damage to the composite resin matrix.

(4) If there is damage to the resin matrix and the composite fibers, repair the surface as given in the specific component repair section in the Structural Repair Manual in Chapters 52 through 57.

B. Interim Repair Procedures

NOTE: The procedures that follow can be permanent repair procedures if there is no damage to the resin matrix.

NOTE: The control surfaces (aileron, elevator, rudder and rudder tab) have static balance limits. Measure the static balance moment after each interim repair. The static balance moment must not be larger than the operational balance limit. Refer to 51-60-00 to find the moment, repair limits, and control surface balance procedures.

(1) Find the level of crack damage in the surface finish.

CAUTION: DO NOT USE PAINT STRIPPERS TO REMOVE THE FINISH. THESE MATERIALS CAUSE DAMAGE TO THE RESIN SYSTEM. WHEN YOU MAKE THE SURFACE ROUGH, DO NOT DAMAGE THE FIBERS. FAILURE TO OBEY CAN CAUSE DAMAGED FIBERS AND A DECREASE IN THE STRUCTURAL STRENGTH OF THE COMPONENT. REPAIR FIBERS THAT HAVE NO PROTECTION OR ARE DAMAGED.

(2) Remove the cracks in the surface finish. Use Number 240 or smaller Scotch-Brite (recommended) or abrasive paper.

WARNING: WEAR PROTECTIVE CLOTHING AND EYE PROTECTION WHEN YOU WORK WITH SOLVENTS AND COMPOSITE MATERIALS. FAILURE TO OBEY CAN CAUSE INJURY. KEEP THE SOLVENTS AWAY FROM FIRE, HEAT, OR SPARKS. FAILURE TO OBEY CAN CAUSE AN EXPLOSION.

(3) Clean the area. Use a clean cheesecloth moist with a mixture of 50 percent MEK and 50 percent (by volume) toluene or equivalent solvents. Dry the area with a clean cheesecloth before the solvent dries.

(4) Apply a finish to the repair area.

C. Permanent Repair Procedures

(1) General

(a) There are two permanent repair alternatives. Repair Number 1 uses BMS 5-95, BMS 5-26, or BMS 5-63 sealants, as applicable, to seal cracks and prevent the entrance of water into the composite structure. Repair Number 2 is a wet layup repair that uses BMS 9-3 fiberglass fabric. Refer to 51-30-03 for the sources of the repair materials.

(2) Repair Number 1

(a) Find the level of the damage.

WARNING: WHEN YOU WORK WITH SOLVENTS AND COMPOSITE MATERIALS, USE APPROVED GLOVES, PROTECTIVE CLOTHES, AND MECHANICAL VENTILATION OR RESPIRATORY PROTECTION. USE EYE PROTECTION. FAILURE TO OBEY CAN CAUSE INJURY. KEEP THE SOLVENTS AWAY FROM SOURCES OF HEAT, FIRE, OR SPARKS. FAILURE TO OBEY CAN CAUSE AN EXPLOSION.

CAUTION: DO NOT USE PAINT STRIPPERS TO REMOVE THE FINISH. PAINT STRIPPERS CAN CAUSE DAMAGE TO THE RESIN SYSTEM. WHEN YOU MAKE THE SURFACE ROUGH, DO NOT DAMAGE THE FIBERS. FAILURE TO OBEY CAN CAUSE DAMAGED FIBERS AND A DECREASE IN THE STRUCTURAL STRENGTH OF THE COMPONENT. REPAIR DAMAGED FIBERS. AFTER YOU USE ALTERNATIVE MEDIA ABRASIVE PROCEDURES TO REMOVE THE FINISH:

- THERE CAN BE NO FIBER DAMAGE WHEN YOU MAKE AN INSPECTION OF THE REPAIR AREA WITH A 10X MAGNIFYING GLASS.
- DO AN ULTRASONIC THROUGH TRANSMISSION TEST. REFER TO NDT PART 4, 51-00-02.

(b) Remove all of the finishes from the surface of the graphite composite. Use No. 240 or smaller Scotch-Brite or abrasive paper to remove the finishes. Do not damage the fibers.

NOTE: The recommended abrasive is No. 240 Scotch-Brite. It is structurally satisfactory to use alternative media abrasive procedures. The procedure must agree with document D6-55564, "Requirements for Alternative Paint Stripping Processes.

(c) Use a clean cheesecloth made moist with a 50/50 mixture of methyl ethyl ketone (MEK) and toluene. Dry the area with a clean cheesecloth before the solvent dries.

(d) Mix BMS 5-95 Class F spray sealant base and accelerator in a ratio of 15 to 1 by weight (a ratio of 100 to 6.9 by volume). Add 20% of the 50/50 mixture of MEK and toluene to make the mixture thinner. The pot life of the mixture is 1.5 hours at 75°F (24°C).

(e) Use an air spray at a minimum of 50 psi to apply two layers of BMS 5-95 to the repair surface. Apply each layer in a continuous wet film thickness of 0.005-0.008 inch. Let the surface dry in air for 15 minutes after you apply the first layer. The dry film thickness of the two layers must be 0.006-0.010 inch.

(f) Let the surface dry a minimum of 2 hours at 60-130°F (16-54°C) after you apply the second layer.

(g) Apply a finish to the repair area. Refer to 51-70-04, REPAIR GENERAL. It is not necessary to use a primer.

(3) Repair Number 2 - BMS 8-301/BMS 9-3 Fiberglass Wet Layup Permanent Repair (Method 1)

(a) Find the level of the damage.

WARNING: WHEN YOU WORK WITH SOLVENTS AND COMPOSITE MATERIALS, USE APPROVED GLOVES, PROTECTIVE CLOTHES, AND MECHANICAL VENTILATION OR RESPIRATORY PROTECTION. USE EYE PROTECTION. FAILURE TO OBEY CAN CAUSE INJURY. KEEP THE SOLVENTS AWAY FROM SOURCES OF HEAT, FIRE, OR SPARKS. FAILURE TO OBEY CAN CAUSE AN EXPLOSION.

CAUTION: DO NOT USE PAINT STRIPPERS TO REMOVE THE FINISH. PAINT STRIPPERS CAN CAUSE DAMAGE TO THE RESIN SYSTEM. WHEN YOU MAKE THE SURFACE ROUGH, DO NOT DAMAGE THE FIBERS. FAILURE TO OBEY CAN CAUSE DAMAGE TO THE FIBERS AND A DECREASE IN THE STRUCTURAL STRENGTH OF THE COMPONENT. REPAIR DAMAGED FIBERS. AFTER YOU USE ALTERNATIVE MEDIA ABRASIVE PROCEDURES TO REMOVE THE FINISH:

- THERE CAN BE NO FIBER DAMAGE WHEN YOU MAKE AN INSPECTION OF THE REPAIR AREA WITH A 10X MAGNIFYING GLASS.
- DO AN ULTRASONIC THROUGH TRANSMISSION TEST. REFER TO NDT PART 4, 51-00-02.

(b) Remove all of the finishes from the surface of the graphite composite. Use No. 240 or smaller Scotch-Brite or abrasive paper to remove the finishes. Do not damage the fibers.

NOTE: The recommended abrasive is No. 240 Scotch-Brite. It is structurally satisfactory to use alternative media abrasive procedures. The procedure must agree with document D6-55564, "Requirements for Alternative Paint Stripping Processes".

(c) Use a clean cheesecloth made moist with a 50/50 mixture of methyl ethyl ketone (MEK) and toluene. Dry the area with a clean cheesecloth before the solvent dries.

(d) Cut a piece of BMS 9-3 Style 120 fiberglass sufficiently large to cover the repair area. Weigh the fiberglass. This is the weight of the resin necessary to impregnate the fiberglass fabric.

(e) Mix BMS 8-301 Class 1 (Hysol EA9390A) or BMS 8-301 Class 2 (FR7020) resin (part A) and hardener (part B) as given in the manufacturer’s instructions. Mix parts A and B by hand for 2 to 3 minutes to make a constant mixture.

(f) Measure the quantity of resin found in Paragraph 12.C.(3)(d)/GENERAL Use the resin in less than 2 hours after you mix it.

(g) Apply an initial thin layer of resin with a brush to fill cracks and areas that have been put out of contour.

(h) Put the BMS 9-3 Style 120 fiberglass in position on the repair area. Put the remaining resin on the fiberglass. Use a tool with a flat, rigid edge to apply the resin equally on the fiberglass. Put one layer of FEP parting film on the fiberglass. Use the tool on the parting film to push the resin into the fiberglass equally and to remove air that is caught in the resin mix. Work from the center of the repair area to the edges.

(i) Put a vacuum bag on the repair. Refer to 51-70-04, REPAIR GENERAL for Class 1 resin. Refer to 51-70-04, REPAIR GENERAL for Class 2 resin.

(j) Let the repair cure. Refer to 51-70-04, REPAIR GENERAL or Class 1 resin. Refer to 51-70-04, REPAIR GENERALfor Class 2 resin.

(k) Apply a finish to the repair area. Refer to 51-70-04, REPAIR GENERAL for Class 1 resin. Refer to 51-70-04, REPAIR GENERAL for Class 2 resin.

(l) Make an inspection of the repair. Refer to 51-70-04, REPAIR GENERAL for Class 1 resin. Refer to 51-70-04, REPAIR GENERALf or Class 2 resin.

(4) Repair Number 2 - BMS 8-301/BMS 9-3 Fiberglass Wet Layup Permanent Repair (Method 2)

(a) Find the level of the damage.

WARNING: WHEN YOU WORK WITH SOLVENTS AND COMPOSITE MATERIALS, USE APPROVED GLOVES, PROTECTIVE CLOTHES, AND MECHANICAL VENTILATION OR RESPIRATORY PROTECTION. USE EYE PROTECTION. FAILURE TO OBEY CAN CAUSE INJURY. KEEP THE SOLVENTS AWAY FROM SOURCES OF HEAT, FIRE, OR SPARKS. FAILURE TO OBEY CAN CAUSE AN EXPLOSION.

CAUTION: DO NOT USE PAINT STRIPPERS TO REMOVE THE FINISH. PAINT STRIPPERS CAN CAUSE DAMAGE TO THE RESIN SYSTEM. WHEN YOU MAKE THE SURFACE ROUGH, DO NOT DAMAGE THE FIBERS. FAILURE TO OBEY CAN CAUSE DAMAGE TO THE FIBERS AND A DECREASE IN THE STRUCTURAL STRENGTH OF THE COMPONENT. REPAIR DAMAGED FIBERS. AFTER YOU USE ALTERNATIVE MEDIA ABRASIVE PROCEDURES TO REMOVE THE FINISH:

- THERE CAN BE NO FIBER DAMAGE WHEN YOU MAKE AN INSPECTION OF THE REPAIR AREA WITH A 10X MAGNIFYING GLASS.
- DO AN ULTRASONIC THROUGH TRANSMISSION TEST. REFER TO NDT PART 4, 51-00-02.

(b) Remove all of the finishes from the surface of the graphite composite. Use No. 240 or smaller Scotch-Brite or abrasive paper to remove the finishes. Do not damage the fibers.

NOTE: The recommended abrasive is No. 240 Scotch-Brite. It is structurally satisfactory to use alternative media abrasive procedures. The procedure must agree with document D6-55564, "Requirements for Alternative Paint Stripping Processes.

(c) Use a clean cheesecloth made moist with a 50/50 mixture of methyl ethyl ketone (MEK) and toluene. Dry the area with a clean cheesecloth before the solvent dries.

(d) Cut a piece of BMS 9-3 Style 120 fiberglass to the same shape as the repair area.

(e) Cut two pieces of FEP solid parting film 3 inches larger all around than the repair area. Use a clean cheesecloth made moist with a 50/50 mixture of methyl ethyl ketone (MEK) and toluene. Dry the area with a clean cheesecloth before the solvent dries.

(f) Put one piece of parting film on a smooth surface. Hold the parting film in position on the surface with tape.

(g) Weigh the fiberglass fabric. Multiply the weight of the fabric by 1.3 times. This calculation is the weight of the resin necessary to impregnate the fiberglass fabric.

NOTE: The ratio of the resin to fiberglass content is approximately 1 to 1 by weight after you remove the parting film.

(h) Mix BMS 8-301 Class 1 (Hysol EA9390A) or BMS 8-301 Class 2 (FR7020) resin (part A) and hardener (part B) as given in the manufacturer's instructions. Mix parts A and B by hand for 2 to 3 minutes to make a constant mixture.

(i) Put half of the resin mixture in the center of the parting film positioned on the smooth surface.

(j) Put the fiberglass fabric on the resin and parting film.

(k) Put the remaining resin in the center of the fiberglass fabric.

(l) Put the other piece of parting film on the fiberglass and resin.

(m) Use a tool with a flat, rigid edge on the parting film to push the resin into the fiberglass. Work from the center of the fiberglass fabric to the edges. Keep all of the resin in the fiberglass fabric.

(n) Put the resin impregnated fiberglass on the repair area.

(o) Put a vacuum bag on the repair. Refer to 51-70-04, REPAIR GENERAL for Class 1 resin. Refer to 51-70-04, REPAIR GENERAL for Class 2 resin.

(p) Let the repair cure. Refer to 51-70-04, REPAIR GENERAL for Class 1 resin. Refer to 51-70-04, REPAIR GENERAL for Class 2 resin.

(q) Apply a finish to the repair area. Refer to 51-70-04, REPAIR GENERAL for Class 1 resin. Refer to 51-70-04, REPAIR GENERAL for Class 2 resin.

(r) Make an inspection of the repair. Refer to 51-70-04, REPAIR GENERAL for Class 1 resin. Refer to 51-70-04, REPAIR GENERALfor Class 2 resin.

GENERAL - HEAT TREAT VERIFICATION - HARDNESS AND CONDUCTIVITY TESTING

1. **General**

A. To identify the heat treat condition of materials, you can do tests and compare the results with those on samples with known conditions. To do these tests you can:

- Use portable hardness testers which indent the part or material to test the hardness
- Do eddy current conductivity tests.

For these two types of tests, access to only one side of the part in necessary. Generally, for aluminum, hardness tests alone do not give the satisfactory results. You should use these tests along with conductivity tests, especially when you do tests on fire-damaged structure.

NOTE: Do not create a stress riser when you indent a highly loaded area like a lug or an area near a hole.

B. The portable hardness testers that follow are approved for use, and can be used when there is access to only one side of the part (Refer to Portable Hardness Testers, Figure 1/GENERAL for a list of these testers in the order of the recommended preference.

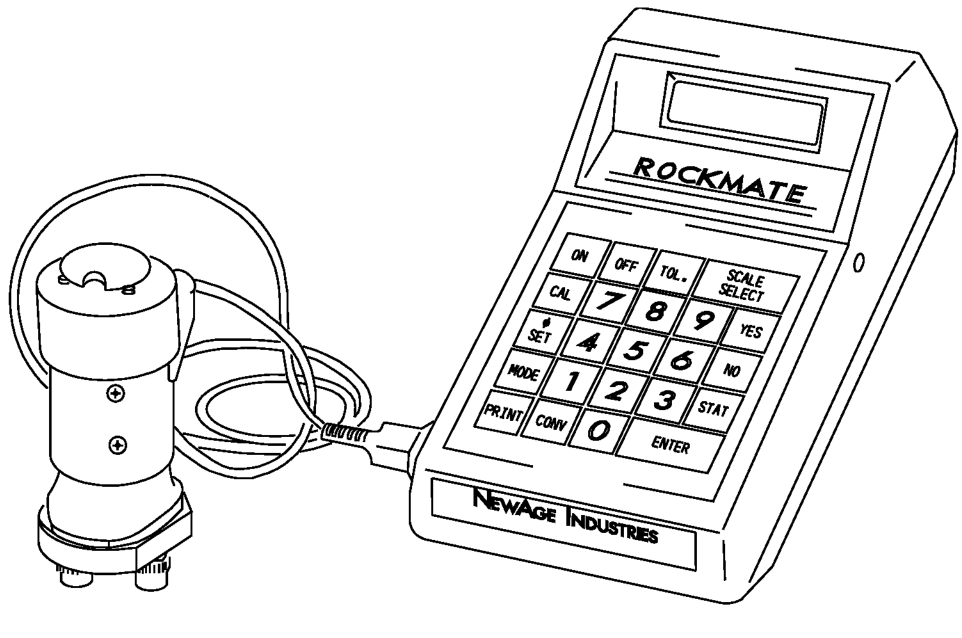
NOTE: Portable hardness testers give the best results when you do the test on a sample (of the same alloy and heat treat) immediately before you test the material on the airplane.

(1) New Age Rockmate, from New Age Industries, Willow Grove, PA (Refer to Detail A). The Rockmate can measure in different hardness scales on aluminum and steel. The Rockmate gives the most accurate results of these listed here.

(2) The Microdur, from Krautkramer Branson, Lewiston, PA (Refer to Detail B). The Microdur can measure in the Rockwell B (aluminum), and C (steel) scales.

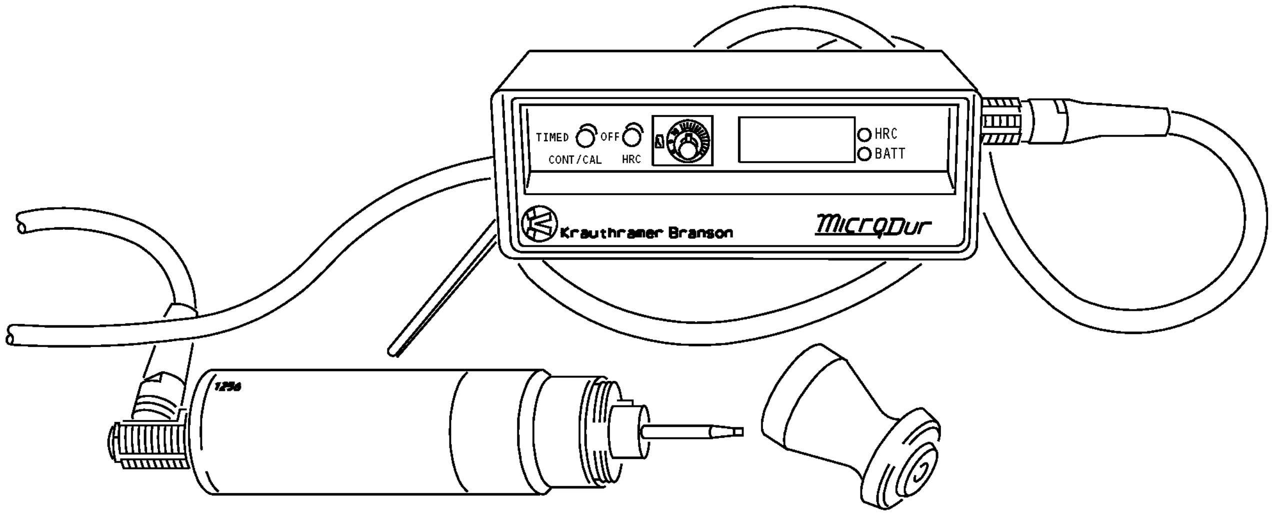
(3) New Age MRD1, from New Age Industries, Willow Grove, PA (Refer to Detail C). The New Age MRD1 can measure in the Rockwell A (steel), and B (aluminum) scales. This tester must be calibrated by using samples of known hardness.

(4) Barcol Tester, from Barber-Coleman Co., Rockford, IL (Refer to Portable Hardness Testers, Figure 1/GENERAL, Detail D). The Barcol Tester does not give a direct hardness number. The Barcol Tester gives a dial indication that you must compare with a dial indication measured from a sample that has a known hardness condition. The Barcol Tester is not recommended for use on steel.



NEW AGE ROCKMATE

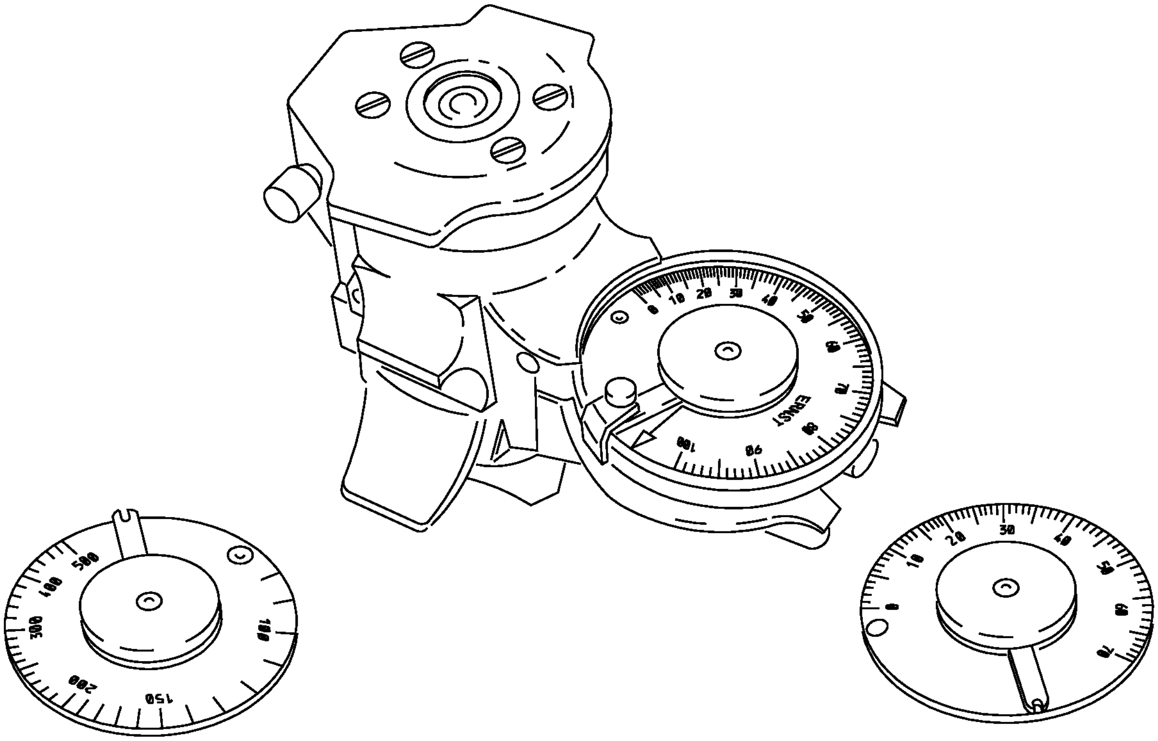
A



MICRODUR

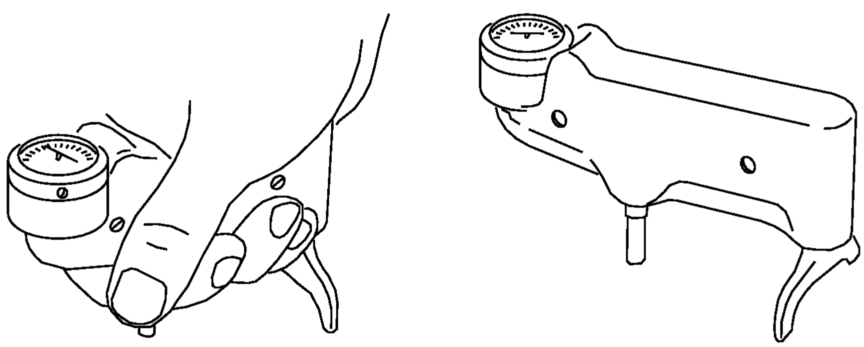
B

Portable Hardness Testers
Figure 1 (Sheet 1 of 2)



NEW AGE MRD1

C



BARCOL PORTABLE HARDNESS TESTER

D

Portable Hardness Testers
Figure 1 (Sheet 2 of 2)

2. **References**

Reference	Title
51-10-02	INSPECTION AND REMOVAL OF DAMAGE
737 NDT Part 6, 51-00-01	Aluminum Part Surface Inspection

3. **Procedures To Do The Hardness Testing**

CAUTION: DO NOT USE THE PORTABLE HARDNESS TESTERS ON MATERIAL THAT IS SO THIN THAT DISTORTION CAN OCCUR FROM THE IMPACT OF THE INDENTER. DO THE TESTS ON COMPARATIVE SAMPLES. DO NOT APPLY THE INDENTER SO NEAR TO THE EDGE OF THE MATERIAL THAT WOULD PERMIT BUCKLING TO OCCUR. WHEN YOU TEST CLAD ALUMINUM ALLOYS, REMOVE THE CLADDING BEFORE YOU DO THE TESTS. IF YOU DO NOT OBEY, THE RESULT CAN BE UNSATISFACTORY MEASUREMENTS AND MORE DAMAGE TO THE PARTS.

A. To do the hardness testing procedures with portable hardness testers, do the steps that follow.

CAUTION: DO NOT USE A GRINDER TO REMOVE THE PLATING FROM THE PART. CHROMIUM OR NICKEL PLATING MAY HAVE BEEN USED. IF NECESSARY, IDENTIFY THE TYPE OF PLATING AS GIVEN IN SRM 51-10-01, AND REMOVE IT WITH THE NORMAL PROCEDURES. DO NOT DO A CHEMICAL SPOT TEST ON AREAS WHERE THE PLATING HAS BEEN REMOVED. IF YOU DO NOT OBEY, YOU CAN CAUSE DAMAGE TO THE PART.

(1) Remove the protective finishes down to bare metal from an area approximately 0.50 inch in diameter.

(2) Do a calibration check of the instrument as given in the manufacturer’s instructions.

(a) For the direct read-out instruments, compare the measurements with those of similar materials with a known hardness condition.

(b) For Barcol instruments, find the scale of acceptance limits on materials of known hardness.

CAUTION: DO NOT PERMIT SIDE THRUST ON THE POINT OF THE INDENTER WHEN YOU APPLY THE PRESSURE. IF YOU DO NOT OBEY, THE RESULT WILL BE AN UNSATISFACTORY MEASUREMENT.

(3) Hold the indenter perpendicular to the surface and apply pressure.

(4) Do several measurements over the surface of the structure.

(5) Refer to Conductivity and Hardness Acceptance - (Aluminum), Figure 2/GENERAL to see if the material has the necessary heat treat for the metal.

4. **Procedures to do the Eddy Current Testing (aluminum only)**

A. You can use the results from the electrical conductivity (eddy current) tests and variable frequency electrical conductivity tests with the results from hardness tests to find the heat treat of the aluminum part.

NOTE: Electrical conductivity tests alone can give incorrect heat treat results, especially when heat damage may have occurred. Also, some alloys have heat treat ranges that overlap.

(1) Refer to NDT Part 6, 51-00-01 for the procedures to do conductivity testing of aluminum.

(2) Refer to Conductivity and Hardness Acceptance - (Aluminum), Figure 2/GENERAL, Conductivity Limits for Aluminum Determined with an Eddy Current Instrument at a Frequency of 60 KHz, Figure 3/GENERAL, and Conductivity Limits for Aluminum Determined with the Verimet M4900B and M4900C Variable Frequency Conductivity Meters, Figure 4/GENERAL to find the conductivity values for the material (alloy, temper, bare or clad).

NOTES

- THE SOURCE OF DATA FOR THIS FIGURE CAN BE FOUND IN BOEING PROCESS SPECIFICATION BAC 5946.
- MECHANICAL HARDNESS TESTING PROCEDURES MUST BE DONE ON A NON-CLAD SURFACE. IF ALL THE SURFACES OF A PART HAVE AN ALUMINUM CLAD COATING, THEN CLAD MUST BE REMOVED FROM THE TEST AREA.

[1] THE VALUES THAT ARE SHOWN ARE FOR FLAT, BARE ALUMINUM ONLY. IF THE PART HAS ONE OR MORE SURFACES WITH AN ALUMINUM CLAD COATING, THEN A CLAD CORRECTION FACTOR IS REQUIRED. REFER TO BSS 7351 FOR A SOURCE OF BOEING APPROVED CORRECTION FACTORS. ALTERNATIVE METHODS AND CORRECTION FACTORS ARE ACCEPTABLE FOR CLAD AND CURVED SURFACES IF APPROVED BY BOEING OR YOUR LOCAL REGULATORY AGENCY. REFER TO NDT PART 6, 51-00-00, FIGURE 20, FOR THE DETAILED PROCEDURE ON ELECTRICAL CONDUCTIVITY MEASUREMENTS FOR ALUMINUM. FOR ADDITIONAL INFORMATION ON EDDY CURRENT TESTING OF ALUMINUM ALLOYS, REFER TO BOEING PROCESS SPECIFICATION BAC 5946 AND BSS 7351, OR ASK THE BOEING COMPANY.

[2] APPLICABLE ONLY TO PARTS WHICH HAVE BEEN SUPERPLASTIC FORMED (SPF) AND HEAT TREATED.

[3] CONDUCTIVITY MAXIMUM FOR 2024 RIVETS IS 33.5 PERCENT IACS.

[4] CONDUCTIVITY VALUES ARE FOR DATA ONLY AND MUST NOT BE USED FOR REJECTION OF AL-LI ALLOYS.

[5] USE THE BRINELL (500KG) SCALE FOR HARDNESS TESTING. REFER TO BAC 5650

[6] UNLESS OTHERWISE SPECIFIED, DO NOT TEST WELDED PARTS IN THE WELD BEAD OR ADJACENT HEAT-AFFECTED AREAS WHEN WELDED IN THE -T4 OR -W CONDITION AND SUBSEQUENTLY AGED TO THE -T6 CONDITION.

[7] IT IS POSSIBLE THAT ADDITIONAL RESTRICTIONS OR QUALIFICATIONS ARE IN BAC 5602 OR THE MATERIAL SPECIFICATIONS FOR THE OVERAGED TEMPERS (T73, T73XX, T74XX, T76XX) OF THESE ALLOYS. TENSILE YIELD STRENGTH CAN LIMIT THE ACCEPTANCE OF MATERIALS THAT HAVE CONDUCTIVITY AND HARDNESS WITHIN THE ABOVE RANGES. REFER TO THE APPLICABLE SPECIFICATION.

[8] TEMPER -T74XX (WAS DESIGNATED 767T736XXX)

[9] ELECTRICAL CONDUCTIVITY FOR 7050-T74XXX IN THE RANGE OF 38.0 TO 44.0 IS PERMITTED UNLESS:

- YOU VERIFY A MATERIAL RESPONSE TO A SOLUTION HEAT TREATMENT AND AGING AS SPECIFIED IN BAC 5602.
- WHEN THIS OCCURS, ELECTRICAL CONDUCTIVITY IN THE RANGE OF 38.0 TO 44.0 IS PERMITTED ONLY IF THE CONDITIONS THAT FOLLOW ARE APPLICABLE:
  1. YS (xx.x ksi) - EC (xx.x(IACS)) < 32.0 WHERE E.C. IS ELECTRICAL CONDUCTIVITY YS IS YIELD STRENGTH (LONGITUDINAL FOR EXTRUDED AND FORGED PRODUCTS; LONG TRAVERSE FOR PLATE PRODUCTS).

Conductivity and Hardness Acceptance - (Aluminum)
Figure 2 (Sheet 1 of 2)

NOTES (CONTINUED)

2. THE YIELD STRENGTH CANNOT EXCEED 72 KSI.

3. MECHANICAL PROPERTIES FROM CERTIFICATION RECORDS OF THE LOT CAN BE USED IN THESE EQUATIONS IF NO ADDITIONAL HEAT TREATMENT HAS BEEN DONE SINCE PURCHASE.

NOTE: FOR 7050-T74XX, THE PROCUREMENT SPECIFICATIONS ARE AMS 4050 AND BMS 7-323 FOR PLATE, AMS 4342 FOR EXTRUDED BAR, ROD, AND SHAPES, AND BMS 7-214 FOR FORGINGS.

10 ELECTRICAL CONDUCTIVITY FOR 7050-T735XX IN THE RANGE OF 40.0 TO 44.0 PERCENT IACS IS PERMITTED FOR THE CONDITIONS THAT FOLLOW:

A. FOR THE 40.0 TO 40.9 RANGE, ELECTRICAL CONDUCTIVITY IS PERMITTED IF THE LONGITUDINAL YIELD STRENGTH IS LESS THAN 69 KSI.

B. FOR THE 41.0 TO 44.0 RANGE, ELECTRICAL CONDUCTIVITY IS PERMITTED IF THE LONGITUDINAL YIELD STRENGTH MEETS THE REQUIREMENTS OF AMS 4341.

11 ELECTRICAL CONDUCTIVITY FOR 7050-T76XXX IN THE RANGE OF 37.0 TO 44.0 IS PERMITTED UNLESS:

- YOU VERIFY A MATERIAL RESPONSE TO A SOLUTION HEAT TREATMENT AND AGING AS SPECIFIED IN BAC 5602.
- WHEN THIS OCCURS, ELECTRICAL CONDUCTIVITY IN THE RANGE OF 38.0 TO 40.0 IS ACCEPTABLE ONLY IF THE CONDITIONS THAT FOLLOW ARE APPLICABLE:

1. AMS 4340: LONGITUDINAL YS (xx.x KSI) - EC (xx.x IACS) < 39.0
2. AMS 4201: LONG TRAVERSE YS (xx.x KSI) - EC (xx.x IACS) < 36.0
3. BAC 5602: LONGITUDINAL YS (xx.x KSI) - EC (xx.x IACS) < 36.0
4. MECHANICAL PROPERTIES FROM CERTIFICATION RECORDS OF THE LOT CAN BE USED IN THESE EQUATIONS IF NO ADDITIONAL HEAT TREATMENT HAS BEEN DONE SINCE PURCHASE.

12 THE MINIMUM PERMITTED CONDUCTIVITY READING ON MACHINED SURFACES OF 7075-T7751 MUST BE 34.5 PERCENT IACS.

13 HARDNESS MUST BE MEASURED ON SURFACES WHICH ARE BETWEEN 1T/4 AND 3T/4 OF THE SOLUTION HEAT TREATED THICKNESS.

14 TABLE VALUES ARE UNCORRECTED FOR VARIATIONS DUE TO GEOMETRY CONDITIONS WHICH INFLUENCE HARDNESS MEASUREMENTS (FOR EXAMPLE, CURVATURE). CORRECTION FACTORS FOR THESE VARIATIONS ARE APPLIED TO THE ACCEPTANCE LIMITS AND/OR MEASURED VALUES VALUES AS APPLICABLE PRIOR TO ACCEPTANCE OR REJECTION.

15 SUB-TEMPERS OF THE ALLOYS AND TEMPERS THAT FOLLOW DO NOT SHOW IMPORTANT DIFFERENCES TO PERMIT SEPARATION BY HARDNESS ALONE. FOR EXAMPLE, 2024-T3511 TO 7075-T73511 ARE INSPECTED TO THE VALUES SHOWN FOR 2024-T3 AND 7075-T73, RESPECTIVELY.

Conductivity and Hardness Acceptance - (Aluminum)
Figure 2 (Sheet 2 of 2)

BARE ALUMINUM ALLOY AND TEMPER		SINGLE SHEET THICKNESS (GAGE), INCHES [1]						
		0.016	0.020	0.025	0.032	0.040	0.050	0.060 AND ABOVE
		ELECTRICAL CONDUCTIVITY (PERCENT IACS)						
2024-0	MAXIMUM MINIMUM	44.0 35.4	51.5 45.3	54.1 49.3	51.5 47.7	49.0 45.5	49.0 45.5	49.0 45.5
2024-T3	MAXIMUM MINIMUM	21.6 14.0	28.0 19.7	33.3 26.2	35.6 30.6	34.1 30.1	32.7 28.9	32.0 28.5
2024-T4	MAXIMUM MINIMUM	21.6 14.0	28.0 19.7	33.3 26.2	35.6 30.6	34.1 30.1	32.7 28.9	32.0 28.5
2024-T6X	MAXIMUM MINIMUM	30.0 25.2	37.6 32.5	42.5 38.3	42.3 38.9	40.7 37.4	40.0 36.3	40.0 36.0
2024-T8XXX	MAXIMUM MINIMUM	32.1 27.0	40.6 34.6	45.0 40.1	44.2 40.1	42.3 38.9	42.0 38.0	42.0 38.0
2219-T6X	MAXIMUM MINIMUM	24.0 21.6	31.5 28.0	37.2 33.3	38.2 35.6	36.5 34.1	35.3 32.7	35.0 32.0
2219-T8XXX	MAXIMUM MINIMUM	24.0 20.0	31.5 25.5	37.2 31.3	38.2 34.2	36.5 33.0	35.3 31.5	35.0 31.0
6061-0	MAXIMUM MINIMUM	51.5 41.7	59.2 49.0	61.7 51.7	58.6 50.1	56.0 47.2	56.0 47.0	56.0 47.0
6061-T4	MAXIMUM MINIMUM	35.4 25.2	45.3 32.5	49.3 38.3	47.7 38.9	45.5 37.4	45.5 36.3	45.5 36.0
6061-T6	MAXIMUM MINIMUM	46.0 32.0	53.7 37.6	56.4 42.5	53.4 42.5	51.0 40.7	51.0 40.0	51.0 40.0
7075-0	MAXIMUM MINIMUM	42.7 34.1	50.0 43.8	52.5 47.7	51.0 46.1	47.7 44.2	47.5 44.0	47.5 44.0
7075-T6	MAXIMUM MINIMUM	24.0 17.5	31.5 23.3	37.2 29.5	38.2 33.1	36.5 32.0	35.3 30.5	35.0 30.0
7075-T73XXX	MAXIMUM MINIMUM	32.9 27.0	41.5 34.6	45.7 40.1	44.8 40.1	42.9 38.9	42.5 38.0	42.5 38.0
7075-T76XXX	MAXIMUM MINIMUM	32.1 25.8	40.6 33.5	45.0 39.3	44.2 39.4	42.3 38.1	42.0 37.2	42.0 38.0

[1] FOR THICKNESS OF MATERIAL BETWEEN 0.032 AND 0.060 THAT ARE NOT SHOWN IN THIS TABLE, THE MAXIMUM AND MINIMUM CONDUCTIVITY VALUES CAN BE INTERPOLATED FROM THE VALUES SHOWN IN THIS TABLE.

Conductivity Limits for Aluminum Determined with an Eddy Current Instrument at a Frequency of 60 KHz
Figure 3 (Sheet 1 of 3)

CLAD ALUMINUM ALLOY AND TEMPER		SINGLE SHEET THICKNESS (GAGE), INCHES 1							
		0.016	0.020	0.025	0.032	0.040	0.050	0.063	ABOVE 0.063
		ELECTRICAL CONDUCTIVITY (APPARENT) (PERCENT IACS)							
2024-0	MAXIMUM MINIMUM	44.0 35.4	51.5 45.3	54.1 49.3	51.5 47.7	49.0 45.5	49.0 45.5	49.0 45.5	REFER TO SHEET 3
2024-T3	MAXIMUM MINIMUM	21.6 15.2	28.0 20.8	33.3 27.7	35.6 31.2	33.8 30.7	33.6 29.5	33.8 29.2	
2024-T4	MAXIMUM MINIMUM	21.6 15.2	28.0 20.8	33.3 27.7	35.6 31.2	33.8 30.7	33.6 29.5	33.8 29.2	
2024-T81	MAXIMUM MINIMUM	32.5 27.5	42.0 34.5	45.5 40.0	44.5 41.3	44.0 40.0	43.0 38.5	43.0 38.5	
7075-0	MAXIMUM MINIMUM	42.7 34.1	50.0 43.8	52.5 47.7	50.0 46.1	47.7 44.2	47.5 44.0	47.8 44.2	
7075-T6	MAXIMUM MINIMUM	25.4 14.2	33.6 21.6	37.6 28.6	39.3 32.3	37.5 31.5	35.8 30.6	35.8 30.7	
7075-T73	MAXIMUM MINIMUM	33.0 28.0	42.5 37.0	45.5 40.0	45.0 43.5	43.5 41.0	43.0 38.0	43.5 38.5	
8090-T3	MAXIMUM MINIMUM	-- --	-- --	-- --	-- --	-- --	-- --	16.5 14.5	16.5 14.5

Conductivity Limits for Aluminum Determined with an Eddy Current Instrument at a Frequency of 60 KHz
Figure 3 (Sheet 2 of 3)

CLAD ALUMINUM ALLOY AND TEMPER		SINGLE SHEET THICKNESS (GAGE), INCHES							
		BELOW 0.080	0.080	0.090	0.100	0.110	0.125	0.140	0.160
		ELECTRICAL CONDUCTIVITY (APPARENT) (PERCENT IACS)							
2024-O	MAXIMUM MINIMUM	SEE SHEET 2	49.2 45.5	49.3 45.6	49.5 45.8	49.6 45.9	49.9 46.0	50.0 46.1	50.2 46.3
2024-T3	MAXIMUM MINIMUM		34.1 29.2	34.3 29.2	34.7 29.5	35.0 29.7	35.6 30.1	36.2 30.4	37.0 31.1
2024-T4	MAXIMUM MINIMUM		34.1 29.2	34.3 29.2	34.7 29.5	35.0 29.7	35.6 30.1	36.2 30.4	37.0 31.1
2024-T81	MAXIMUM MINIMUM		43.0 39.0	43.0 39.0	43.5 39.5	43.5 39.5	44.0 40.0	44.0 40.0	44.5 41.5
7075-O	MAXIMUM MINIMUM		47.9 44.3	48.0 44.4	48.1 44.5	48.2 44.6	48.4 44.7	48.6 44.8	48.9 45.0
7075-T6	MAXIMUM MINIMUM		36.2 30.8	36.5 31.0	36.8 31.2	37.0 31.5	37.6 31.8	38.2 32.2	38.9 32.7
7075-T73	MAXIMUM MINIMUM		43.5 38.5	43.5 39.0	43.5 39.0	43.5 39.5	44.0 39.5	44.0 40.0	44.0 41.0

Conductivity Limits for Aluminum Determined with an Eddy Current Instrument at a Frequency of 60 KHz
Figure 3 (Sheet 3 of 3)

BARE ALUMINUM ALLOY AND TEMPER		SINGLE SHEET THICKNESS (GAGE), INCHES 1						
		0.016	0.020	0.025	0.032	0.040	0.050	0.060 AND ABOVE
		ELECTRICAL CONDUCTIVITY (PERCENT IACS)						
2024-0	MAXIMUM MINIMUM	42.7 37.0	47.8 43.5	51.7 47.8	53.0 49.2	50.5 46.9	48.6 45.1	48.2 44.8
2024-T3	MAXIMUM MINIMUM	27.7 22.5	31.7 26.0	35.2 29.3	37.0 32.0	35.5 31.5	32.6 28.8	31.6 28.2
2024-T4	MAXIMUM MINIMUM	27.7 22.5	31.7 26.0	35.0 29.3	37.0 32.0	35.5 31.5	32.6 28.8	31.6 28.2
2024-T6X	MAXIMUM MINIMUM	33.6 30.1	38.3 34.8	42.4 39.0	43.7 40.3	42.1 38.8	39.7 36.1	39.4 35.5
2024-T8XXX	MAXIMUM MINIMUM	34.7 30.3	40.3 36.2	44.4 40.4	45.6 41.5	43.7 40.3	41.7 37.8	41.4 37.5
2219-T8XXX	MAXIMUM MINIMUM	29.3 26.2	34.1 29.9	38.1 33.4	39.6 35.6	37.9 34.4	35.1 31.4	34.5 30.6
2219-T6X	MAXIMUM MINIMUM	29.3 27.7	34.1 31.7	38.1 35.0	39.6 37.0	37.9 35.5	35.1 32.6	34.5 31.6
6061-0	MAXIMUM MINIMUM	47.8 41.2	53.1 46.1	57.8 49.8	60.1 51.6	57.5 48.7	55.4 46.6	55.1 46.3
6061-T4	MAXIMUM MINIMUM	37.0 30.1	43.5 34.8	47.8 39.0	49.2 40.3	46.9 28.8	45.1 36.1	44.8 35.5
6061-T6	MAXIMUM MINIMUM	44.1 33.6	49.3 38.3	53.5 42.4	54.9 43.7	52.5 42.1	50.5 39.7	50.2 39.4
7075-0	MAXIMUM MINIMUM	41.9 36.1	46.8 42.5	50.4 46.6	52.5 47.5	49.2 45.6	47.1 43.6	46.8 43.3
7075-T6XXX	MAXIMUM MINIMUM	29.3 24.9	34.1 28.4	48.1 31.9	39.6 34.5	37.9 33.4	35.1 30.4	34.5 29.6
7075-T73XXX	MAXIMUM MINIMUM	32.3 30.3	40.9 36.2	44.9 40.4	46.2 41.5	44.3 40.3	42.2 37.8	41.9 37.5
7075-T76XXX	MAXIMUM MINIMUM	34.7 30.5	40.3 35.4	44.4 39.8	45.6 40.8	43.7 39.5	41.7 37.0	41.4 36.5
8090-T3	MAXIMUM MINIMUM	---- ----	---- ----	---- ----	---- ----	---- ----	---- ----	16.5 14.5

Conductivity Limits for Aluminum Determined with the Verimet M4900B and M4900C Variable Frequency Conductivity Meters
Figure 4 (Sheet 1 of 3)

CLAD ALUMINUM ALLOY AND TEMPER		SINGLE SHEET THICKNESS (GAGE), INCHES [1]							
		0.016	0.020	0.025	0.032	0.040	0.050	0.063	ABOVE 0.063
		ELECTRICAL CONDUCTIVITY (APPARENT) (PERCENT IACS)							
2024-0	MAXIMUM MINIMUM	41.6 36.9	47.7 43.8	52.2 48.2	53.0 49.4	50.0 46.9	47.8 44.9	47.7 45.1	SEE SHEET 3
2024-T3	MAXIMUM MINIMUM	27.5 22.4	31.7 28.3	35.4 31.2	36.9 31.8	34.1 30.1	33.8 29.5	34.5 29.4	
2024-T4	MAXIMUM MINIMUM	27.5 22.4	31.7 26.3	35.4 31.2	36.9 31.8	34.1 30.1	33.8 29.5	34.5 29.4	
2024-T81	MAXIMUM MINIMUM	35.0 31.0	41.0 37.5	45.5 41.5	46.5 42.5	44.0 40.0	42.5 38.5	43.0 38.5	
7075-0	MAXIMUM MINIMUM	40.9 36.1	46.8 42.8	50.8 46.9	51.5 47.9	48.9 45.7	47.6 43.6	46.8 44.1	
7075-T6	MAXIMUM MINIMUM	30.3 21.6	35.8 26.9	38.8 31.8	41.0 33.1	38.6 31.2	36.0 30.6	36.5 31.1	
7075-T73	MAXIMUM MINIMUM	35.0 32.0	41.5 38.0	45.5 41.0	46.5 43.5	44.5 41.0	42.5 39.5	42.5 38.5	

[1] FOR THICKNESS OF MATERIAL BETWEEN 0.032 AND 0.060 THAT ARE NOT SHOWN IN THIS TABLE, THE MAXIMUM AND MINIMUM CONDUCTIVITY VALUES CAN BE INTERPOLATED FROM THE VALUES SHOWN IN THIS TABLE.

Conductivity Limits for Aluminum Determined with the Verimet M4900B and M4900C Variable Frequency Conductivity Meters
Figure 4 (Sheet 2 of 3)

CLAD ALUMINUM ALLOY AND TEMPER		SINGLE SHEET THICKNESS (GAGE), INCHES							
		BELOW 0.080	0.080	0.090	0.100	0.110	0.125	0.140	0.160
		ELECTRICAL CONDUCTIVITY (APPARENT) (PERCENT IACS)							
2024-O	MAXIMUM MINIMUM	SEE SHEET 2	48.5 45.0	48.4 45.3	48.6 45.5	46.3 43.5	49.2 45.3	49.4 45.7	49.4 45.7
2024-T3	MAXIMUM MINIMUM		34.3 29.8	34.8 29.6	35.2 29.9	35.0 30.9	35.9 31.5	36.3 30.8	37.2 32.0
2024-T4	MAXIMUM MINIMUM		34.3 29.8	34.8 29.6	35.2 29.9	35.0 30.9	35.9 31.5	36.3 30.8	37.2 32.0
2024-T81	MAXIMUM MINIMUM		43.0 39.0	43.0 38.5	43.0 38.5	42.0 38.0	43.0 39.5	43.0 40.0	44.0 41.0
7075-O	MAXIMUM MINIMUM		47.3 43.8	47.3 44.2	47.4 44.3	47.5 44.2	47.7 44.1	48.1 44.5	48.1 44.1
7075-T6	MAXIMUM MINIMUM		36.2 31.3	36.9 31.5	37.2 31.7	36.5 32.3	37.6 32.9	38.2 32.5	39.9 33.4
7075-T73	MAXIMUM MINIMUM		42.5 38.5	42.5 38.5	42.5 38.5	41.5 38.0	43.0 40.0	43.5 40.5	43.5 40.5

Conductivity Limits for Aluminum Determined with the Verimet M4900B and M4900C Variable Frequency Conductivity Meters
Figure 4 (Sheet 3 of 3)

TENSILE STRENGTH 1,000 POUNDS PER SQUARE INCH	ROCKWELL		SUPERFICIAL ROCKWELL			VICKERS	KNOOP	BRINELL	
	C 150 kg	A 60 kg	45N 45 kg	30N 30 kg	15N 15 kg	136 DEGREE DIAMOND PYRAMID 10 kg	KNOOP DIAMOND 600 GRAMS	10mm BALL 3000 kg TUNGSTEN CARBIDE BALL	10mm BALL 3000 kg STEEL BALL
301	55	78.5	61	73	88	611	630	588	---
292	54	78	59.5	72	87.5	592	612	571	---
283	53	77.5	58.5	71	87	573	594	554	---
273	52	77	57.5	70.5	86.5	556	576	538	---
264	51	76.5	56	69.5	86	539	558	523	500
256	50	76	55	68.5	85.5	523	542	508	488
246	49	75	54	67.5	85	508	526	494	476
237	48	74.5	52.5	66.5	84.5	493	510	479	464
231	47	74	51.5	66	84	479	495	465	453
221	46	73.5	50	65	83.5	465	480	452	442
215	45	73	49	64	83	452	466	440	430
208	44	72.5	48	63	82.5	440	452	427	419
201	43	72	46.5	62	82	428	438	415	408
194	42	71.5	45.5	61.5	81.5	417	426	405	398
188	41	71	44.5	60.5	81	406	414	394	387
181	40	70.5	43	59.5	80.5	396	402	385	377
176	39	70	42	58.5	80	386	391	375	367
170	38	69.5	41	57.5	79.5	376	380	365	357
165	37	69	39.5	56.5	79	367	370	356	347
160	36	68.5	38.5	56	78.5	357	360	346	337
155	35	68	37	55	78	348	351	337	327
150	34	67.5	36	54	77	339	342	329	318
147	33	67	35	53	76.5	330	334	319	309
142	32	66.5	33.5	52	76	321	326	310	301
139	31	66	32.5	51.5	75.5	312	318	302	294
136	30	65.5	31.5	50.5	75	304	311	293	286
132	29	65	30	49.5	74.5	296	304	286	279
129	28	64.5	29	48.5	74	288	297	278	272
126	27	64	28	47.5	73.5	281	290	271	265
123	26	63.5	26.5	47	72.5	274	284	264	259
120	25	63	25.5	46	72	267	278	258	253
118	24	62.5	24	45	71.5	261	272	252	247
115	23	62	23	44	71	255	266	246	241
112	22	61.5	22	43	70.5	250	261	241	235
110	21	61	20.5	42.5	70	245	256	236	230
107	20	60.5	19.5	41.5	69.5	240	251	231	225
104	19	60	18.5	40.5	69	235	241	226	220
102	17	59.5	17	39.5	68.5	227	236	218	210

Conversion of Alloy Steel Hardness to Tensile Strength
Figure 5

GENERAL - HEAT DAMAGE ANALYSIS

1. Applicability

A. This section is applicable to metal and composite structure that has been open to fire or high temperature.

2. General

A. High temperature can decrease the strength of metal and composite structures.

B. A change in paint color can be an indication that fire or high temperature in an airplane structure has occurred.

C. In composite structures, an indication of fire or high temperature can be blisters, scorches, wrinkles, ablation, paint discoloration, visible fibers, warping, cracks, and delamination.

D. Fire suppression materials can cause corrosion in metal parts, and damage to composite parts. Remove all fire suppression materials as given in CPM Volume 1, 20-42-00.

E. Carbon soot and other combustion products accelerate corrosion. Fully remove all of these unwanted materials.

3. References

Reference	Title
51-20-02	HEAT TREAT VERIFICATION - HARDNESS AND CONDUCTIVITY TESTING
CPM Volume 1, 20-42-00	Corrosion Removal Techniques - Procedures After Fire Damage
737 NDT Part 1, 51-01-03	NDT Assessment of Lightning Strike Damage to Graphite/Epoxy Composite Structure
737 NDT Part 6, 51-00-00, Figure 3	Investigation of Fire Damage on Aircraft Structure

4. Damage Analysis

A. Examine the areas where fire or high temperature has occurred to see if the structure is weak or damaged.

(1) To find weak structure in metal parts, use one of the steps that follows:

(a) Use a conductivity test procedure as given in 737 NDT Part 6, 51-00-00, Figure 3.

(b) Do a hardness test procedure as given in 51-20-02.

(2) If there is visual damage in composite parts, use instrumented NDT procedures to find other unseen damage. Examine all of the adjacent areas up to 6 inches away from the area of visual damage. Refer to 737 NDT Part 1, 51-01-03for Lightning Strike Damage procedure.

B. Repair or replace all the weak or damaged structure immediately.

GENERAL - CORRECTION PROCEDURE FOR THE LEAKAGE OF MERCURY

1. **Applicability**

   A. This section is applicable to structure where mercury contamination has occurred.

2. **General**

   A. Mercury and mercury compounds will go through small cracks in paint and other protective finishes. Mercury can quickly mix (amalgamate) with aluminum alloys and other metals that it touches.

      (1) Mercury that touches aluminum will have a gray powder or fuzz-like appearance.

      (2) This corrosion has a tree-like appearance under the surface of the part.

3. **References**

Reference	Title
51-10-02	INSPECTION AND REMOVAL OF DAMAGE
AMM 05-51-14 P/B 201	MERCURY SPILLAGE CONDITION - MAINTENANCE PRACTICES (CONDITIONAL INSPECTION)
CPM Volume 1, 20-41-00	Corrosion Removal Techniques - Procedures After Mercury Spillage
737 NDT Part 1, 51-02-00	X-Ray, General Radiographic Practices

4. **Correction Procedures**

WARNING: DO NOT GET MERCURY IN YOUR MOUTH, EYES, OR ON YOUR SKIN. DO NOT BREATHE THE FUMES FROM THE MERCURY. WEAR PROTECTIVE SPLASH GOGGLES AND GLOVES WHEN YOU CLEAN A MERCURY SPILL. MERCURY IS POISONOUS AND CAN CAUSE INJURY TO PERSONS.

CAUTION: CONTAIN AND REMOVE THE LEAKAGE OF MERCURY AND MERCURY COMPOUNDS IMMEDIATELY. MERCURY AND MERCURY COMPOUNDS THAT TOUCH ALUMINUM WILL CAUSE CORROSION DAMAGE. IF YOU DO NOT ACT QUICKLY, THE CORROSION CAN GO ALL THE WAY THROUGH THE AIRPLANE STRUCTURE.

   A. Remove the mercury immediately.

      (1) For the procedures you must do when mercury leakage occurs, refer to one of the procedures that follow:

         (a) AMM PAGEBLOCK 05-51-14/201

         (b) CPM Volume 1, 20-41-00

   B. Use the X-ray procedure to find the limits of the damage to the airplane structure caused by mercury contamination. Refer to 737 NDT Part 1, 51-02-00.

   C. Remove all of the metal structure that the mercury touches. Damage that is found with the X-ray procedures given in Paragraph B. is not permitted. Refer to 51-10-02 for the definition of allowable damage.

GENERAL - REPAIR SEALING

1. **Applicability**

   A. This subject contains the data and procedures necessary to seal repairs on the airplane.

2. **General**

   A. Some areas of the fuselage and wing are sealed to make a pressurized zone of the fuselage and integral fuel tanks. Other areas of the airplane are sealed to prevent the entry of fluids and moisture (Example: Below the toilets and galleys). Areas that are sealed at the initial manufacture of the airplane must be sealed again when you do repairs in these areas.

      (1) Refer to AMM TASK 51-31-00-160-801 for seals and sealing.

      (2) Refer to AMM TASK 28-11-00-300-803 for fuel tank repairs.

      (3) Refer to SOPM 20-50-19 for the sealing of repairs.

   B. Refer to Figure 1 for substitute sealants. Sealants specified in repairs have been selected for their special qualities. Substitute sealants shown in Figure 1 have can be used when the specified sealant is not available.

CAUTION: DO NOT SEAL AIRFRAME DRAIN HOLES. KEEP THE DRAIN PATHS CLEAR. IF YOU DO NOT OBEY, MOISTURE CAN STAY IN SOME AREAS. THE RESULT CAN BE CORROSION DAMAGE TO THE AIRPLANE.

   C. The airplane has external drain holes and internal drain paths so that water and other moisture will not stay in areas around the airframe. Do not fill or block these holes or drain paths when you seal repairs. Refer to AMM TASK 51-41-11-200-801 for the locations of these drain holes and drainage paths.

CAUTION: DO NOT USE TOOLS THAT CAN CAUSE DAMAGE WHEN YOU REMOVE SEALANT FROM STRUCTURAL PARTS. BE CAREFUL IF YOU REMOVE SEALANT FROM AREAS ADJACENT TO (OR ON) AN ALUMINUM CLAD SURFACE THAT IS PRIMARY STRUCTURE. (FOR EXAMPLE: CLAD ALUMINUM FUSELAGE SKIN ADJACENT TO A LAP JOINT, WING-TO-BODY FAIRING, OR A SPLICE PLATE BEHIND A BUTT JOINT. BE CAREFUL ALSO, WHEN YOU REMOVE SEALANT FROM AROUND EXTERNAL PATCH REPAIRS AND JOINTS AROUND FLUSH PATCH REPAIRS).

   D. To remove sealant from a structural part, refer to AMM TASK 51-31-00-160-801 for sealant removalinin non-fuel tank areas, and AMM TASK 28-11-00-300-803 for sealant removal in fuel tank areas. Be careful not to cause damage to the part surface.

      (1) Do a visual inspection of the structure after you remove the sealant to see if there are any nicks, scratches, scribe marks or other damage. Tel an engineer or the Boeing Company if you find damage in primary structure that is adjacent to a lap joint, wing-to-body fairing, or a splice plate that is behind a butt joint. Refer to 51-00-04, GENERAL for the structural classification. For all other damage, refer to the instructions given in the applicable allowable damage section of the SRM before you continue.

3. **References**

Reference	Title
51-00-04, GENERAL	Structural Classification
AMM 28-11-00-300-803	Repair of Sealant Leaks in the Fuel Tank Structure (P/B 801)
AMM 51-31-00-160-801	Prepare For Sealing (P/B 201)
AMM 51-41-11-200-801	External Drainage Inspection/Check (P/B 601)

(Continued)

Reference	Title
SOPM 20-50-19	General Sealing

4. Alternative Sealants Data

A. Refer to Figure 1/GENERALfor the alternative sealants data..

PERMITTED SUBSTITUTES FOR INITIAL SPECIFIED SEALANT							
INITIAL SPECIFIED SEALANTS	PERMITTED ALTERNATIVE SEALANTS						
	BMS 5-45	BMS 5-63	BMS 5-95	BMS [1] 5-142	PR-1826 [2]	PR-1828	BMS 5-150
BMS 5-19	YES	NO	NO	NO	YES	NO	NO
BMS 5-26	SEE TABLE C	NO	NO	NO	YES	YES	NO
BMS 5-32	YES	NO	YES	YES	YES	YES	NO
BMS 5-45	---	NO	NO	NO	YES	NO	NO
BMS 5-63	NO	---	NO	NO	NO	NO	NO
BMS 5-79	YES	NO	SEE TABLE B	YES	YES	YES	NO
BMS 5-95	YES	NO	---	YES	YES	YES	YES (CLASS B-2 ONLY)
BMS 5-142	YES	NO	YES	---	YES	YES	YES

TABLE A

BMS 5-79 SEALANT ALTERNATIVES	
INITIAL MATERIAL	ALTERNATIVE MATERIAL
BMS 5-79	BMS 5-95
CLASS B-1/2	CLASS B-1/2
CLASS B-2	CLASS B-2
CLASS B-4	CLASS B-4
CLASS B-8	NONE
CLASS C-24	CLASS C-20
CLASS C-48	CLASS C-80
CLASS D-2	BMS 5-16

TABLE B

NOTES

[1] THIS ALTERNATIVE IS NOT PERMITTED FOR MATING SURFACE SEAL, PRE-PACK SEALING, AND WET FASTENER INSTALLATION PROCEDURES.

[2] THIS SEALANT HAS A PRIMER THAT MUST ALSO BE USED.

Alternative Sealants Data
Figure 1 (Sheet 1 of 2)

BMS5-26, TYPES, CLASSES, GRADE	SUPERSEDED BY BMS5-45, CLASSES, GRADE
TYPE I, CLASS A-1/2, GRADE 1	CLASS A-2, GRADE 1 OR GRADE 2
TYPE I, CLASS A-2, GRADE 1	CLASS A-2, GRADE 1 OR GRADE 2
TYPE I, CLASS B-1/2	CLASS B-1/2
TYPE I, CLASS B-2	CLASS B-2
TYPE II, CLASS A-2, GRADE 1	CLASS A-2, GRADE 1
TYPE II, CLASS A-2, GRADE 2	CLASS A-2, GRADE 2
TYPE II, CLASS B-2	CLASS B-2
TYPE II, CLASS C-24	CLASS C-24
TYPE II, CLASS C-48	CLASS C-48
TYPE II, CLASS C-168	CLASS C-168

TABLE C

Alternative Sealants Data
Figure 1 (Sheet 2 of 2)

GENERAL - SHOT PEENING

1. References

Reference	Title
SOPM 20-10-03	General - Shot Peening Procedures

2. Applicability

A. This section gives the data about shot peening for aluminum, steel and titanium parts that you rework. Table 1/GENERAL gives this data in a chart. It includes minimum part thicknesses, intensities, and shot numbers.

3. General

A. As you decrease the thickness of the part by the removal of damage, you can use a lower shot peening intensity. It is important to find the thickness of the part after the damage is removed. Then you can use the correct intensity as given in Table 1/GENERAL for a given thickness of reworked material.

B. Do not shot peen parts that are thinner than the minimum thicknesses shown in Table 1/GENERAL. When you shot peen an area that has a taper, the remaining material must not be thinner than the minimum thickness in Table 1/GENERAL.

C. Refer to SOPM 20-10-03 for more shot peening data.

Table 1:

SHOT PEEN DATA			
MATERIAL/ HEAT TREAT	MINIMUM THICKNESS (INCHES)	INTENSITY	SHOT NUMBER
STEEL HEAT TREATED LESS THAN 150 KSI	0.04	0.002A-0.004A	230-780
	0.05	0.002A-0.005A	230-780
	0.07	0.003A-0.006A	230-780
	0.08	0.004A-0.007A	230-780
	0.10	0.005A-0.010A	230-780
	0.12	0.006A-0.011A	230-780
	0.15	0.008A-0.013A	230-780
	0.17	0.010A-0.015A	230-780
	0.20	0.012A-0.017A	230-780
	0.24 and thicker	0.014A-0.019A	230-780
STEEL HEAT TREATED BETWEEN 150 AND 240 KSI	0.01	0.002A-0.004A	170-460
	0.05	0.003A-0.005A	170-460
	0.07	0.003A-0.006A	170-460
	0.08	0.005A-0.010A	170-460
	0.10	0.006A-0.011A	170-460
	0.12	0.008A-0.013A	170-460
	0.14	0.010A-0.015A	170-460
	0.16	0.012A-0.017A	170-460
	0.20 and thicker	0.014A-0.019A	170-460

SHOT PEEN DATA			
MATERIAL/ HEAT TREAT	**MINIMUM THICKNESS (INCHES)**	**INTENSITY**	**SHOT NUMBER**
STEEL HEAT TREATED BETWEEN 270 AND 300 KSI	0.03	0.002A-0.004A	170-460
	0.04	0.003A-0.005A	170-460
	0.05	0.005A-0.010A	170-460
	0.06	0.006A-0.011A	170-460
	0.08	0.008A-0.013A	170-460
	0.10	0.010A-0.015A	170-460
	0.12	0.012A-0.017A	170-460
	0.15 and thicker	0.014A-0.019A	170-460
ALUMINUM ALLOYS	0.05	0.002A-0.004A	230-550
	0.06	0.003A-0.005A	230-550
	0.08	0.004A-0.007A	230-550
	0.10	0.005A-0.010A	230-550
	0.13	0.006A-0.011A	230-550
	0.16	0.008A-0.013A	230-550
	0.19	0.010A-0.015A	230-550
	0.23 and thicker	0.012A-0.017A	230-550
TITANIUM ALLOYS	0.04	0.002A-0.004A	230-460
	0.05	0.003A-0.005A	230-460
	0.07	0.003A-0.006A	230-460
	0.08	0.004A-0.007A	230-460
	0.10	0.005A-0.010A	230-460
	0.12	0.006A-0.011A	230-460
	0.15	0.008A-0.013A	230-460
	0.17	0.010A-0.015A	230-460
	0.20	0.012A-0.017A	230-460
	0.24	0.014A-0.019A	230-460

GENERAL - THE MACHINING AND DRILLING OF COMPOSITE STRUCTURES AND COMPOSITE-TO-METAL ASSEMBLIES

1. **Applicability**

   A. This subject gives the general procedures to cut, drill, ream, and countersink holes composite structures and composite-to-metal assemblies.

   B. These procedures are applicable to primary and secondary aircraft structure. If necessary, refer to 51-00-04 for the classification of the structures.

   C. The procedures to drill holes given in this section are not applicable if a special procedure is given in this manual for a repair.

   D. These procedures are not applicable to:

      (1) Lightening holes

      (2) Clearance holes

      (3) System holes.

2. **General**

   A. Composite structures are different from metallic structures as follows:

      (1) Composite material has more stiffness than metal materials. This makes the it more difficult to pull a drill up from a composite structure than a metal structure.

      (2) Surface fibers of the composite material can be pulled out when the material is cut. This makes it difficult to deburr or countersink holes.

      (3) Composite materials are abrasive, which causes high drill and cutter wear. Carbide or diamond cutters are recommended to machine and drill composite materials.

      NOTE: Composite materials can easily delaminate if they are not cut or drilled correctly. The use of a backup drill plate will prevent delamination. Lubricants are not necessary when you drill or cut some of the composite materials. But, if Boelube is used as a lubricant, clean the Boelube lubricant that remains with BMS 3-2, Type 1 or BMS 11-7 solvent.

   B. Refer to 51-30-05 for the tools and equipment you can use to drill or cut the composite materials.

   C. Refer to Table 1/GENERAL for the paragraph references of the different machining and drilling procedures given in this subject.

Table 1:

PARAGRAPH REFERENCES TO DRILL AND MACHINE COMPOSITE STRUCTURES OR COMPOSITE-TO-METAL ASSEMBLIES	
PARAGRAPH REFERENCE	SUBJECT
4	Drill Holes in Composite Structures and Composite-to-Metal Assemblies
5	Ream Holes in Composite Structures and Composite-to-Metal Assemblies
6	Countersink Holes in Composite Structures and Composite-to- Metal Assemblies
7	Deburr Holes in Composite Structures and Composite-to-Metal Assemblies
8	Make an Inspection of Deburred Holes in Composite Structures and Composite-to-Metal Assemblies
9	Do a Rough Cut on Composite Structures
10	Do a Final Cut on Composite Structures
11	Remove Frayed or Delaminated Fibers from Cut Composite Structures

PARAGRAPH REFERENCES TO DRILL AND MACHINE COMPOSITE STRUCTURES OR COMPOSITE-TO-METAL ASSEMBLIES	
PARAGRAPH REFERENCE	SUBJECT
12	Apply Protective Treatment to Machined or Drilled Composite Structures

3. References

Reference	Title
51-00-04	STRUCTURAL CLASSIFICATION
51-10-01	AERODYNAMIC SMOOTHNESS
51-20-01	PROTECTIVE TREATMENT OF METALLIC AND COMPOSITE MATERIALS
51-30-05	EQUIPMENT AND TOOLS FOR REPAIRS
51-40-05	FASTENER HOLE SIZES
51-40-06	FASTENER EDGE MARGINS
51-40-08	COUNTERSINKING
51-70-04	REPAIR PROCEDURES FOR WET LAYUP MATERIALS

4. Drill Holes in Composite Structures and Composite-to-Metal Assemblies

A. General Instructions

(1) Before you drill a hole in primary structure, it is recommended that you drill a test hole in a piece of scrap material. This piece of scrap material must be of the same type and thickness as the initial part or assembly.

(2) Drill the hole and examine it for the properties that follow:

(a) Hole shape and diameter

(b) Breakout on the surface opposite of the drill surface

(c) Cracks around the hole

(d) Burrs that could be excessive

(e) Delamination

(f) Nicks or gouges

(g) Hole alignment

(h) Hole perpendicularity.

(3) Clamp the assembly to be drilled tightly with a clamp or temporary fasteners.

(a) Make sure that the mating surfaces of the parts in the assembly touch in the area of the hole.

1) If the mating surfaces do not touch, the drill pressure will cause the parts to be separated and to become incorrectly aligned. Refer to Use of a Clamp or Temporary Fasteners, Figure 1/GENERAL for the results if you drill a hole the correct or the incorrect way.

(4) Make a mark on the part for the hole location. If the mark will cause penetration of the part surface, make sure you put the mark inside the hole diameter.

(5) Put a backup drill plate on the surface opposite the drill surface when you drill a composite part. This will prevent damage to the part.

(a) The backup drill plate:

1) Must not be harder than the composite material that is to be drilled.

2) Must have a sufficient thickness so that it will not deflect when the you drill through it.

NOTE: Examples of the backup drill plate materials you can use are urethane (Shore 90A durometer), GFRP, phenolic material, or wood (clear fir or oak).

(b) Clamp or tightly hold the backup plate in position against the exit surface of the composite structure.

1) Make sure that there is no gap between the backup plate and the structure when you drill the hole.

(6) If you use a drill jig or template, make sure you permit a clearance equal to the chip clearance and the thickness of the part to be drilled. Refer to Power Feed Drill Setup, Figure 2/GENERAL for the clearance.

(7) The fastener edge margins in composite materials must be equal to or larger than 3 times the fastener diameter (±0.05 inch). Refer to 51-40-06 for the data for fastener edge margins.

(8) Use only clean, sharp tools and correctly ground drills. Dull tools or incorrectly ground drills will cause inaccurate cuts, unsatisfactory holes, and damage or burns to the structure.

(a) Refer to Drills Used to Drill Holes in Composite Structures and Composite-to-Metal Assemblies, Figure 3/GENERAL for the different drills you can use.

(b) Refer to Reamers Used to Ream Holes in Composite Structures and Composite-to-Metal Assemblies, Figure 4/GENERAL for different reamers you can use.

(c) Refer to Cutters Used to Countersink Holes in Composite Structures and Composite-to-Metal Assemblies, Figure 5/GENERAL and Cutters Used to End Mill GRFP and GRFP Structures, Figure 6/GENERAL for the different cutter types you can use.

(9) It is recommended that you drill a pilot hole before you drill the undersize hole.

NOTE: It is recommended you use a No. 30 size ST10-907-H and ST1241BAD general purpose carbide insert drills or ST1257B solid carbide drill when you drill a pilot hole for CFRP structure.

(a) To help you to align the parts correctly, drill the pilot hole in only one of the two mating parts. Keep the other part blank when the two parts make an interface.

(10) You can use a power feed drill motor or a hand feed drill motor to drill a hole. Refer to Figure 7/GENERAL for different drill motor and other equipment types. Refer to 51-30-05 for the suppliers of these tools and equipment you can use.

NOTE: Power feed drills give more accurate results than hand feed drills. But hand feed drills are usually preferred for the repairs because they are easy to use.

(a) If you choose to use a hand feed drill motor, use a drill guide. Refer to Drill Guides, Figure 8/GENERAL for the different drill guides you can use.

NOTE: To drill a straight hole, you must hold the drill guide tightly.

(11) Make sure the perpendicularity of the hole is within 2 degrees to the surface of the structure. Refer to Drill Perpendicularity, Figure 9/GENERAL for the correct and incorrect perpendicularities.

(12) It is recommended you use more than one step when you drill a hole in composite structure.

(a) You are permitted to drill a hole in one step only if you can keep the hole tolerances and surface finish conditions.

(b) For a close tolerance hole, drill a 1/32 inch undersize hole, then ream it to full size.

(c) For a close tolerance hole in composite-to-metal assemblies, drill a 1/16 inch undersize hole, then ream it to full size.

B. Drill Holes in GFRP, CFRP, and CFRP-to-GFRP Assemblies

(1) Make a selection of the drill types that you will use to drill pilot and undersize holes.

(a) Refer to Drills Used to Drill Holes in Composite Structures and Composite-to-Metal Assemblies, Figure 3/GENERAL for the different drill types that you can use to drill composite structures.

(b) Refer to Drill Data for GFRP, CFRP, and GFRP-to-CFRP Assembly, Figure 10/GENERAL, Table A or B to select the correct drill speed and feed rate (if applicable).

WARNING: WEAR AN APPROVED DUST MASK AND SAFETY GLASSES WHEN YOU DRILL, REAM, OR COUNTERSINK COMPOSITE STRUCTURE. USE A VACUUM TO REMOVE THE DUST AND DEBRIS. IF YOU NOT OBEY, INJURY TO PERSONS CAN OCCUR.

WARNING: ELECTRICALLY GROUND CFRP PARTS TO PREVENT AN ELECTRICAL DISCHARGE. IF YOU DO NOT OBEY, INJURY TO PERSON AND DAMAGE TO THE PARTS CAN OCCUR. SELECT AN UNPAINTED AREA OF THE PART TO ATTACH A GROUNDING WIRE. AN ELECTRICAL GROUND IS NOT POSSIBLE THROUGH MOST PAINT AND PRIMERS.

WARNING: DO NOT USE A SPINDLE SPEED OF OVER 6,000 RPM FOR DRILLS LONGER THAN THREE INCHES . IF YOU DO NOT OBEY AND USE A LONGER DRILL, THE DRILL CAN BREAK AND CAUSE INJURY TO PERSONS.

CAUTION: DO NOT PERMIT CARBON DUST TO COME IN CONTACT WITH ELECTRIC MOTORS, SWITCHES, RELAYS, CONTACTS, OR ELECTRONIC CIRCUITS. USE VACUUM EQUIPMENT ON POWER TOOLS. CARBON DUST IS AN ELECTRICAL CONDUCTOR AND CAN CAUSE SHORT CIRCUITS IN ELECTRICAL EQUIPMENT. IF YOU DO NOT OBEY, PERMANENT DAMAGE TO EQUIPMENT CAN OCCUR.

CAUTION: DO NOT USE HIGH SPEED STEEL (HSS) OR COBALT DRILL BITS ON CFRP OR GFRP STRUCTURE. IF YOU DO NOT OBEY AND DO THIS THE DRILL BITS WILL IMMEDIATELY BECOME DULL AND DAMAGE TO THE HOLE AREA CAN OCCUR.

(2) Drill the pilot or undersize holes at the fastener hole locations.

(a) Drill No. 30 diameter pilot holes as necessary.

(b) Drill the holes to an undersize diameter of 1/32 inch as necessary for close tolerances. Refer to Drills Used to Drill Holes in Composite Structures and Composite-to-Metal Assemblies, Figure 3/GENERAL for the drill diameter tolerances. Apply a stable, medium force to the drill.

NOTE: You can use Boelube or cetyl alcohol as a lubricant to prevent heat buildup. If you apply Boelube, make sure you do not fill the flutes of the drill with solid lubricant.

(3) Ream the hole to the full diameter of the fastener hole. Refer to Paragraph 5./GENERAL for the procedure.

(4) Clean the Boelube from the parts with the solvents that follow:

(a) Use BMS 3-2, Type I solvent if you install the fasteners without sealant.

(b) Use BMS 11-7 solvent if you will install the fasteners wet with sealant.

C. Drill Holes in GFRP-to-Aluminum or CFRP-to-Aluminum Assemblies

(1) Make a selection of the drills that you will use for pilot and undersize holes.

(a) Refer to Drills Used to Drill Holes in Composite Structures and Composite-to-Metal Assemblies, Figure 3/GENERAL for different drill types you can use to drill holes in composite-to-metal assemblies.

(b) Refer to Drill Data for GFRP-To-Aluminum, and CFRP-To-Aluminum Assemblies, Figure 11/GENERAL, Table A to select the correct drill, speed, and feed rate (if applicable).

WARNING: WEAR AN APPROVED DUST MASK AND SAFETY GLASSES WHEN YOU DRILL, REAM OR COUNTERSINK IN COMPOSITE STRUCTURE. USE A VACUUM TO REMOVE THE DUST AND DEBRIS. IF YOU DO NOT OBEY, INJURY TO PERSONS CAN OCCUR.

CAUTION: DO NOT USE A SPINDLE SPEED OVER 6,000 RPM FOR DRILLS LONGER THAN THREE INCHES. IF YOU DO NOT OBEY AND USE A DRILL LONGER THE DRILL CAN BREAK AND CAUSE INJURY TO PERSONS.

(2) Drill the No. 30 diameter pilot holes at the fastener locations.

NOTE: It is recommended you apply Boelube or cetyl alcohol when you drill a composite-to-aluminum assembly. If you do not use a lubricant, the aluminum chips will attach to the drill and damage the composite part. If you apply Boelube, make sure you do not fill the flutes of the drill solid lubricant.

(3) Drill the holes to an undersize diameter of 1/16-inch as necessary for close tolerances. Refer to Drills Used to Drill Holes in Composite Structures and Composite-to-Metal Assemblies, Figure 3/GENERAL for the drill diameter tolerances. Apply a stable, medium force to the drill.

(4) Ream the hole to the full diameter of the fastener hole. Refer to Paragraph 5./GENERAL for the procedure.

(5) Clean the Boelube from the parts with the solvents that follow:

(a) Use BMS 3-2, Type I solvent if you install the fasteners without sealant.

(b) Use BMS 11-7 solvent if you will install the fasteners wet with sealant.

D. Drill Holes in CFRP-to-Titanium and GFRP-to-Titanium Assemblies

(1) Make a selection of the drill types that you will use to drill pilot and undersize holes.

(a) Refer to Drills Used to Drill Holes in Composite Structures and Composite-to-Metal Assemblies, Figure 3/GENERAL for the different drill types you can use to drill holes in composite-to-metal assemblies.

(b) Refer to Drill Data for CFRP-to-Titanium and GFRP-to-Titanium Assemblies, Figure 12/GENERAL, Table A to select the correct drill speed and feed rate, if applicable.

(2) Apply Boelube or cetyl alcohol as a lubricant to the drill.

NOTE: Boelube can be applied manually to the drill when you drill a material with a thickness up to one drill diameter. For a material thicker than one drill diameter, use a drill with an oil-hole connected to a pump that supplies Boelube mist or a coolant.

WARNING: USE CARE WHEN YOU DRILL TITANIUM. SMALL PARTICLES AND FINE SHAVINGS OF TITANIUM ARE HIGHLY FLAMMABLE. WATER THAT TOUCHES HOT TITANIUM CAN CAUSE A STEAM EXPLOSION. EXTINGUISH ALL FIRES OF TITANIUM WITH FULLY DRY TALC, CALCIUM CARBONATE, SAND OR GRAPHITE. APPLY THE POWDER TO A DEPTH OF 1/2 INCH OR MORE ON THE BURNING METAL. DO NOT USE FOAM, WATER, HALON, CARBON TETRACHLORIDE, OR CARBON DIOXIDE. IF YOU DO NOT OBEY, YOU CAN CAUSE INJURY TO PERSONS.

WARNING: WEAR AN APPROVED DUST MASK AND SAFETY GLASSES WHEN YOU DRILL, REAM OR COUNTERSINK IN COMPOSITE STRUCTURE. USE A VACUUM TO REMOVE THE DUST AND DEBRIS. IF YOU DO NOT OBEY, INJURY TO PERSONS CAN OCCUR.

WARNING: ELECTRICALLY GROUND CFRP PARTS TO PREVENT ELECTRICAL DISCHARGE. IF YOU DO NOT OBEY, INJURY TO PERSON AND DAMAGE TO THE PARTS CAN OCCUR. SELECT AN UNPAINTED AREA OF THE PART TO ATTACH A GROUNDING WIRE. AN ELECTRICAL GROUND IS NOT POSSIBLE THROUGH MOST PAINT AND PRIMERS.

CAUTION: DO NOT PERMIT CARBON DUST TO COME IN CONTACT WITH ELECTRIC MOTORS, SWITCHES, RELAYS, CONTACTS, OR ELECTRONIC CIRCUITS. USE VACUUM EQUIPMENT ON POWER TOOLS. CARBON DUST IS AN ELECTRICAL CONDUCTOR AND CAN CAUSE SHORT CIRCUITS IN ELECTRICAL EQUIPMENT. IF YOU DO NOT OBEY, PERMANENT DAMAGE TO EQUIPMENT CAN OCCUR.

CAUTION: DO NOT USE HIGH SPEED STEEL (HSS) OR COBALT DRILL BITS ON CFRP OR GFRP STRUCTURE. IF YOU DO NOT OBEY AND DO THIS THE DRILL BITS WILL IMMEDIATELY BECOME DULL AND DAMAGE TO THE HOLE AREA CAN OCCUR.

(3) Drill No. 30 diameter pilot holes at the fastener hole locations.

(a) It is recommended you drill the pilot holes through the titanium and then drill the composite parts.

1) Use an ST10-907-J2 or NAS 907 Type D short fluted, No. 30 diameter cobalt twist drill. The ST10-907-J2 drill is preferred if you need to make quick adjustments. Refer to Table 2/GENERAL for hand feed drill speeds for titanium parts.

NOTE: It is not recommended that you drill the pilot holes dry through the titanium structure. You can use a lubricant or coolant to get a better hole quality.

Table 2:

HAND FEED DRILL SPEEDS FOR TITANIUM STRUCTURE		
DRILL DIAMETER (INCH)	**MAXIMUM RPM (DRY)**	**MAXIMUM RPM (WET)**
UP TO 1/16 (NO. 40 SIZE)	850	1275
UP TO 5/32 (NO. 30 SIZE)	500	750
UP TO 7/32 (NO. 10 SIZE)	375	550
UP TO 1/4	300	450
UP TO 3/8	200	300

NOTE: RPM = Revolutions Per Minute

2) Put the titanium part in position over the composite panel.

CAUTION: DO NOT USE A DRILL SPEED THAT IS FASTER THAN WHAT IS GIVEN IN FIGURE 10, TABLE A. DO NOT USE A DULL DRILL BIT. HIGH DRILL SPEEDS OR DULL DRILL BITS WILL CAUSE HOLE AREAS IN THE COMPOSITE STRUCTURE TO BECOME OVERHEATED. IF YOU DO NOT OBEY, YOU CAN CAUSE DAMAGE THE COMPOSITE STRUCTURE.

3) Drill the pilot holes through the titanium part into the composite structure.

4) Install temporary fasteners.

(b) If you pilot drill the Titanium and composite assembly in one step instead of separate steps, then use a drill types given in Drill Data for CFRP-to-Titanium and GFRP-to-Titanium Assemblies, Figure 12/GENERAL.

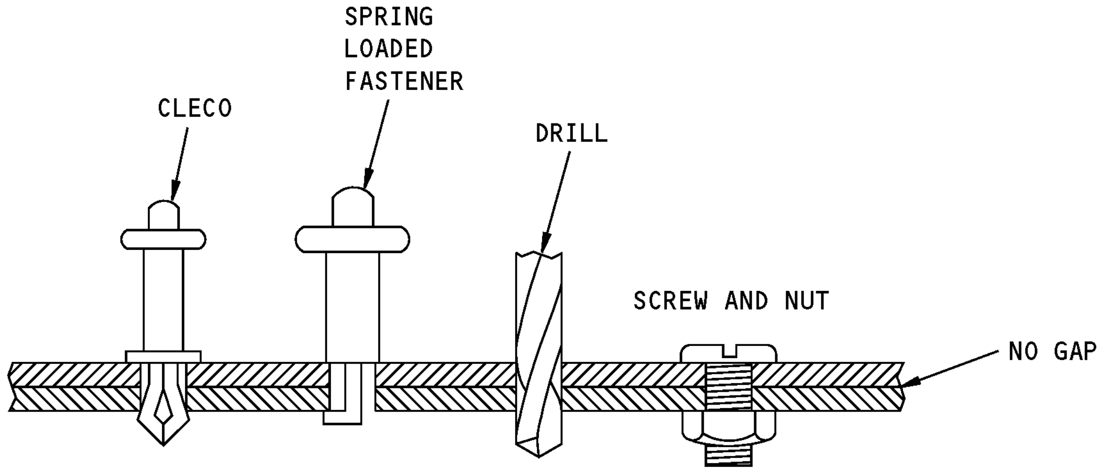
CAUTION: APPLY THE SELECTED FEED FORCE AS GIVEN IN FIGURE 12 TO POWER A FEED DRILL. APPLY CONSTANT AND HEAVY PRESSURE TO A HAND FEED DRILL WHEN YOU DRILL TITANIUM. IF YOU DO NOT OBEY AND THERE IS A LOSS IN PRESSURE, THE TITANIUM PART CAN HARDEN.

(c) Drill the holes to an undersize diameter of 1/16 inch. Refer to Drills Used to Drill Holes in Composite Structures and Composite-to-Metal Assemblies, Figure 3/GENERAL for the applicable drill diameter tolerances.

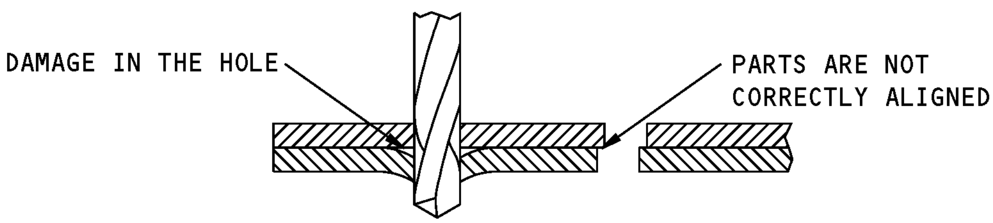
(d) Ream the hole to the full size. Refer to Paragraph 5./GENERAL for the procedure to ream the titanium-to-CFRP assemblies.

NOTE: More than one drill and ream procedure can be necessary when you drill larger diameter holes to titanium structure.

(4) Clean the parts of the Boelube lubricant that remain with BMS 3-2, Type I or BMS 11-7 solvent.

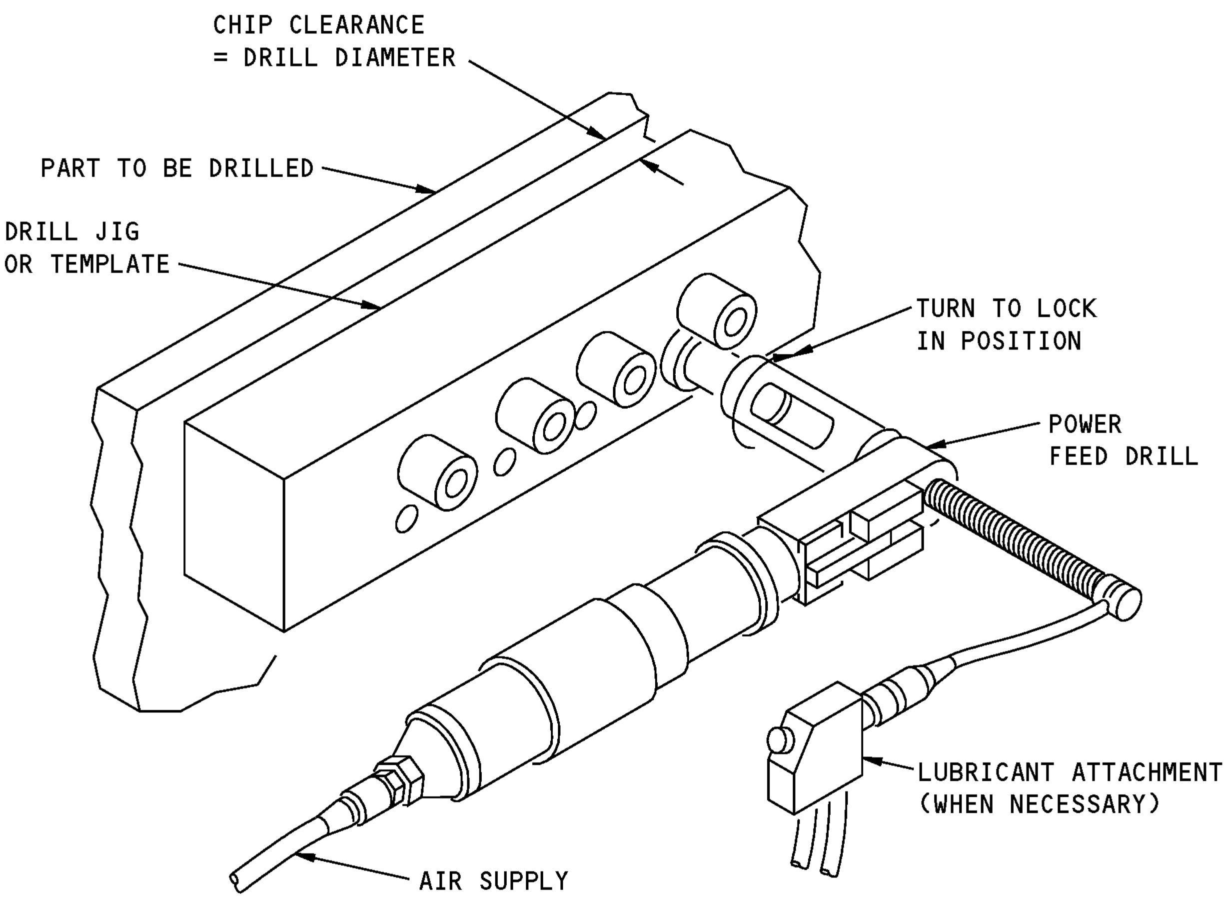


PARTS CORRECTLY ALIGNED

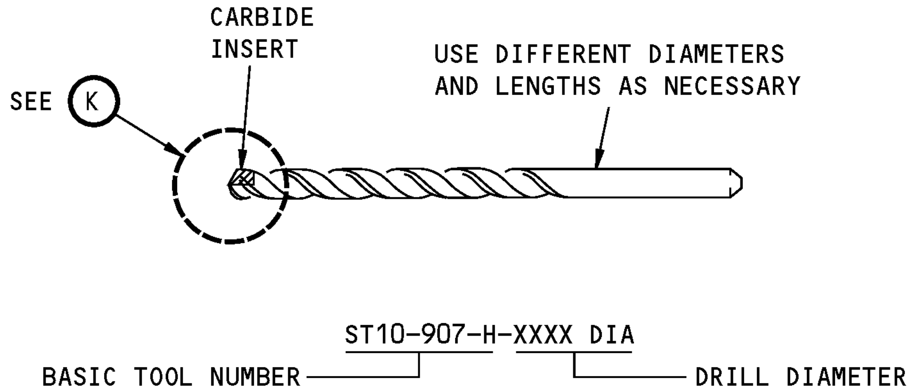


PARTS NOT CORRECTLY ALIGNED

Use of a Clamp or Temporary Fasteners
Figure 1



Power Feed Drill Setup
Figure 2



NOTES: THE DRILL SHOWN IS USED ONLY TO DRILL UNDERSIZE OR PILOT HOLES IN COMPOSITE STRUCTURES.

TO PREVENT FIBER BREAKOUT IN CFRP STRUCTURE, USE A BACKUP DRILL PLATE.

THE DRILL SHOWN IS NOT APPLICABLE FOR THE DRILLING OF HOLES WITH A DIAMETER TOLERANCE OF MORE THAN 0.004 INCH.

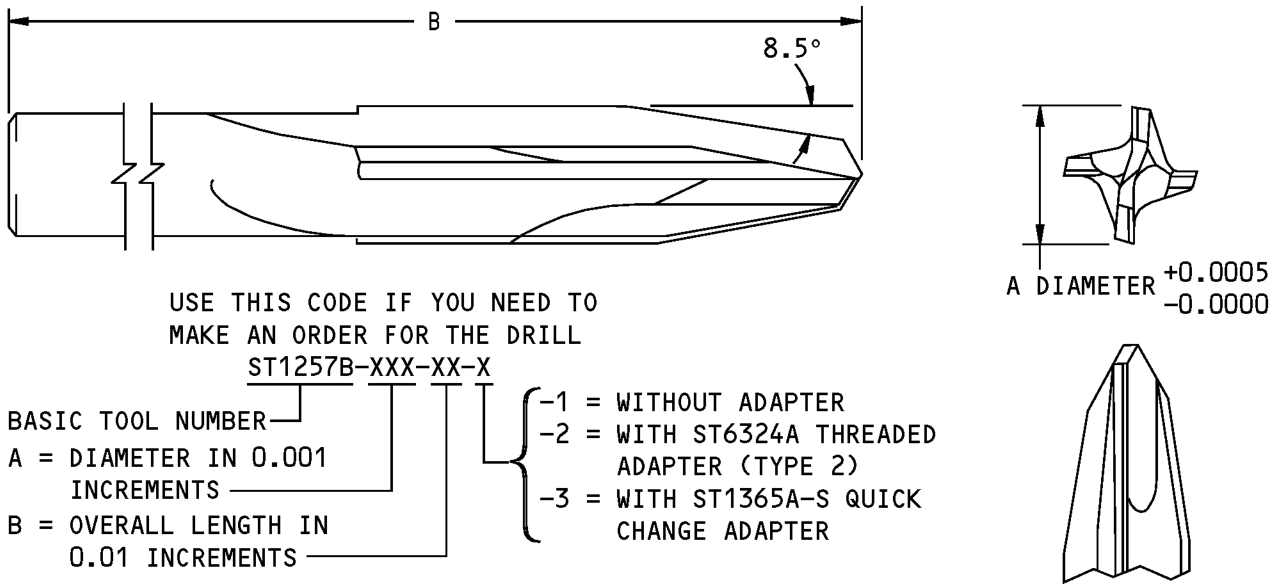
THE DRILL DIAMETER TOLERANCES ARE AS FOLLOWS FOR THESE HOLE DIAMETERS (IN INCHES):
- FOR DRILL DIAMETERS 1/16 INCH TO 1/8 INCH IS +0.0000 TO -0.0005 INCH
- FOR DRILL DIAMETERS OVER 1/8 INCH TO 1/4 INCH IS +0.0000 TO -0.0007 INCH
- FOR DRILL DIAMETERS OVER 1/4 INCH IS +0.0000 TO -0.0010 INCH.

THE RECOMMENDED DRILL DIAMETERS ARE AS FOLLOWS FOR THESE HOLE CLASSES:
- FOR CLASS I HOLES, DO NOT DRILL FULL SIZE HOLES
- FOR CLASS II AND III HOLES, USE 0.0040 INCH ABOVE THE MINIMUM OF THE HOLE DIAMETER TOLERANCE.

ST10-907-H 1 GENERAL PURPOSE DRILL JOBBERS - CARBIDE INSERT, TYPE 1

A

Drills Used to Drill Holes in Composite Structures and Composite-to-Metal Assemblies
Figure 3 (Sheet 1 of 11)



NOTES: THE DRILL SHOWN IS USED TO PREVENT FIBER BREAKOUT IN COMPOSITE STRUCTURE.

THE DRILL SHOWN CAN BE USED AS A REAMER IN COMPOSITE-TO-METAL ASSEMBLIES.

USE THIS DRILL TO REWORK THE HOLES THAT ARE INCORRECTLY DRILLED. IT IS NOT NECESSARY TO MAKE THE HOLE OVERSIZED.

WITH THIS DRILL, IT IS DIFFICULT TO KEEP 0.0003 INCH HOLE DIAMETER TOLERANCE.

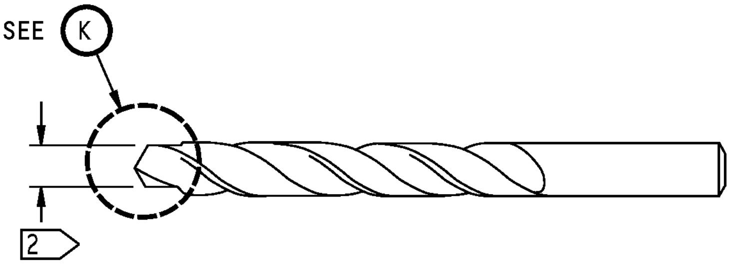
THIS DRILL IS DIFFICULT TO RESHARPEN CONSISTENTLY AND IT DOES NOT HAVE SUFFICIENT DUST COLLECTION CAPACITY.

THE RECOMMENDED DRILL DIAMETERS ARE AS FOLLOWS FOR THESE HOLE CLASSES:
- FOR CLASS I HOLES, USE A DRILL DIAMETER THAT IS 0.0005 INCH ABOVE THE MINIMUM HOLE DIAMETER.
- FOR CLASS II AND III HOLES, USE A DRILL DIAMETER THAT IS 0.0060 INCH ABOVE THE MINIMUM HOLE DIAMETER.

ST1257B 1 4-FLUTE, SOLID CARBIDE,
STRAIGHT SHANK, RIGHT HAND DRILL

B

Drills Used to Drill Holes in Composite Structures and Composite-to-Metal Assemblies
Figure 3 (Sheet 2 of 11)



NOTES: THE DRILL SHOWN IS USED TO DRILL HIGH QUALITY CLOSE TOLERANCE HOLES IN COMPOSITE STRUCTURES.

THE DRILL DIAMETER TOLERANCE (IN INCHES) FOR ALL DRILL DIAMETERS IS +0.0000 TO -0.0005 INCH

USE THIS DRILL WITH ANDREWS POWER FEED DRILLS IN COMPOSITE-TO-METAL ASSEMBLIES.

IF YOU USE THIS DRILL IN CFRP STRUCTURE, USE A BACKUP DRILL PLATE WITH THIS DRILL OR YOU WILL HAVE FIBER BREAKOUT.

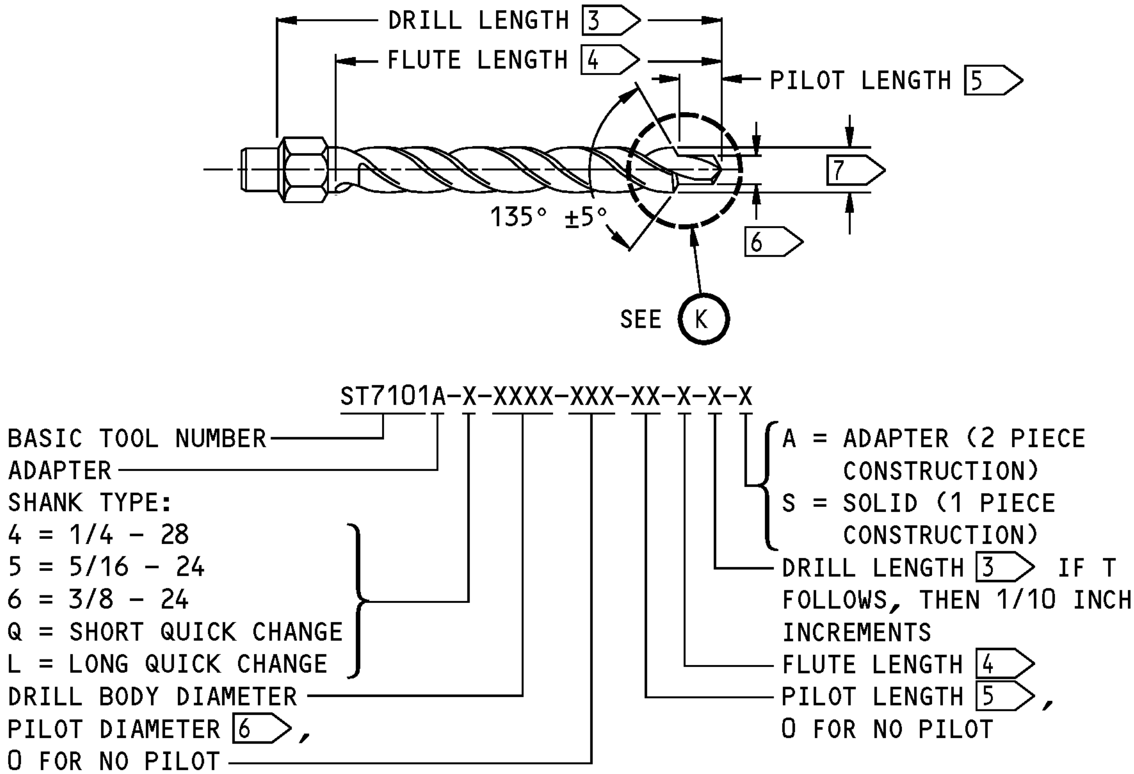
THE PILOT SECTION OF THIS DRILL SOMETIMES BREAKS IF IT IS USED ON A COMPOSITE-TO-TITANIUM ASSEMBLY.

THE RECOMMENDED DRILL DIAMETERS ARE AS FOLLOWS FOT THESE HOLE CLASSES:
- FOR CLASS I HOLES, USE A HOLE DIAMETER THAT IS 0.0005 INCH ABOVE THE MINIMUM HOLE DIAMETER.
- FOR CLASS II AND III HOLES; USE A HOLE DIAMETER THAT IS 0.0060 INCH ABOVE THE MINIMUM HOLE DIAMETER.

ST10-937-C 1 SOLID CARBIDE (PRECISION)
STEPPED DOUBLE MARGIN DRILL, TYPE 1

C

Drills Used to Drill Holes in Composite Structures and Composite-to-Metal Assemblies
Figure 3 (Sheet 3 of 11)



NOTES: THE DRILL SHOWN USED TO DRILL HIGH QUALITY, CLOSE TOLERANCE HOLES IN STRUCTURES WITH A THICKNESS OF 0.062 TO 1.12 INCH. THE DRILL DIAMETER TOLERANCE IS +0.0000 TO -0.0005 INCH.

TO PREVENT FIBER BREAKOUT IN CFRP STRUCTURE A BACKUP DRILL PLATE.

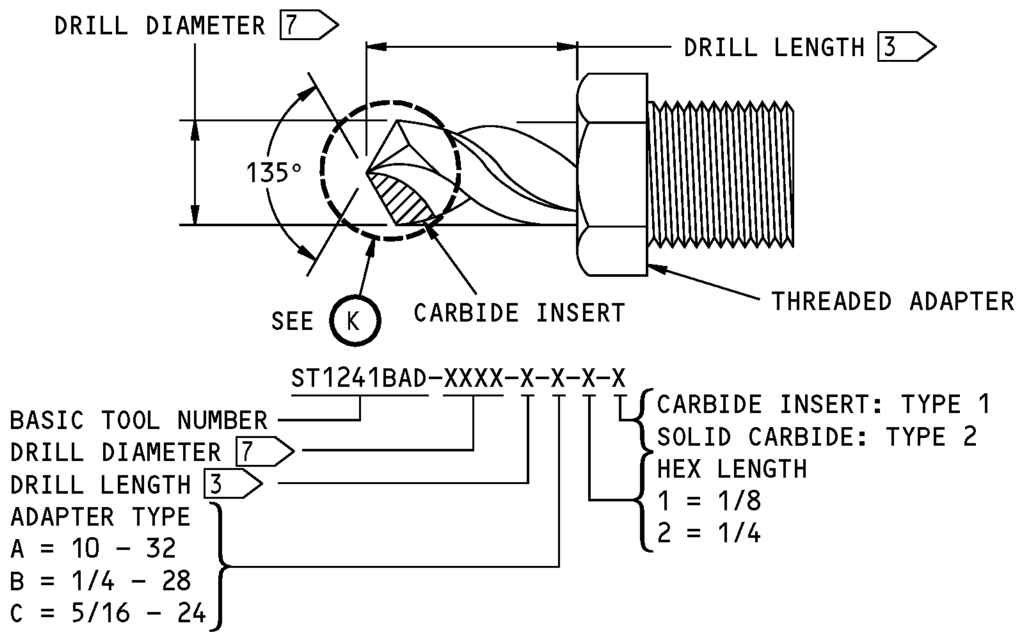
THE PILOT SECTION OF THE DRILL SOMETIMES BREAKS IF IT IS USED IN A COMPOSITE-TO-TITANIUM ASSEMBLY.

THE RECOMMENDED DRILL DIAMETERS ARE AS FOLLOWS FOR THESE HOLE CLASSES:
- FOR CLASS I HOLES USE A DRILL DIAMETER THAT IS 0.0010 INCH ABOVE THE MINIMUM HOLE DIAMETER.
- FOR CLASS II AND III HOLES USE A DRILL DIAMETER THAT IS 0.0060 INCH ABOVE THE MINIMUM HOLE DIAMETER.

ST7101A 1 SOLID CARBIDE (PRECISION) STEPPED DOUBLE MARGIN DRILL, TWO PIECE CONSTRUCTION, AND THREADED SHANK

D

Drills Used to Drill Holes in Composite Structures and Composite-to-Metal Assemblies
Figure 3 (Sheet 4 of 11)



NOTES: THE DRILL SHOWN IS USED WITH ANGLE DRILL MOTORS.

THE DRILL SHOWN IS USED ONLY TO DRILL UNDERSIZED OR PILOT HOLES ON COMPOSITE STRUCTURES.

USE THIS DRILL ONLY IF THE BACKUP MATERIAL PREVENTS FIBER BREAKOUT ON COMPOSITE-TO-METAL STRUCTURES.

TO PREVENT FIBER BREAKOUT, IN CFRP STRUCTURES USE A BACKUP PLATE.

THE DRILL SHOWN IS NOT APPLICABLE FOR THE DRILL HOLE WITH A DIAMETER TOLERANCE OF MORE THAN 0.0040 INCH.

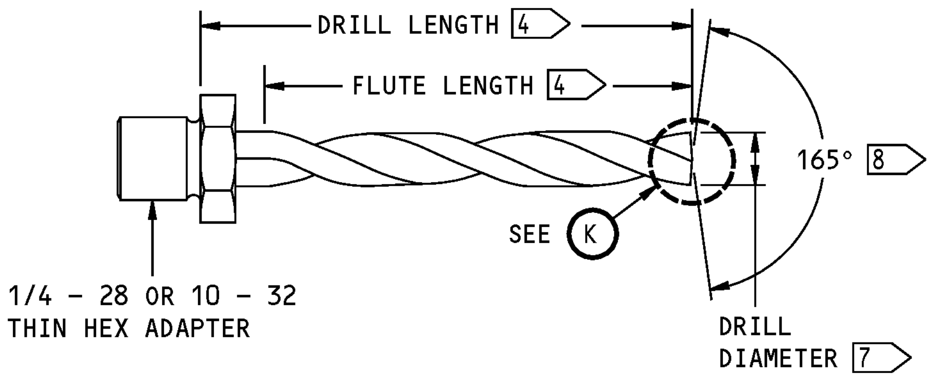
THE DRILL DIAMETER TOLERANCES ARE AS FOLLOWS FOR THESE DIAMETER HOLES:
- FOR DRILL DIAMETER 1/16 INCH TO 1/8 INCHTHE TOLERANCE IS +0.0000 TO -0.0005
- FOR DRILL DIAMETER OVER 1/8 INCH THE TOLERANCE IS +0.0000 TO -0.0007

THIS DRILL IS NOT RECOMMENDED FOR FULL SIZE CLASS I HOLES.

ST1241BAD 1 GENERAL PURPOSE CARBIDE INSERT DRILL WITH THREADED ADAPTER

E

Drills Used to Drill Holes in Composite Structures and Composite-to-Metal Assemblies
Figure 3 (Sheet 5 of 11)



ST1241FA-X-X-XXXX-XX-XX-X-C

BASIC TOOL NUMBER
SERIES
SHANK TYPE
A = THD ADAPTER
B = THD SHANK
C = STRAIGHT SHANK
D = THD ADAPTER
THIN SHANK
Q = QUICK CHANGE

C = CARBIDE
DRILL POINT (TYPE I OR II)
DRILL LENGTH 4
FLUTE LENGTH 4
DRILL DIAMETER 7
SHANK THD SIZE
0 = STRAIGHT AND QUICK
CHANGE SHANK
1 = 1/4 - 28
2 = 5/16 - 24
3 = 3/8 - 24
4 = 10 - 32

NOTES: THE DRILL SHOWN IS USED TO DRILL A FULL SIZE HOLE ON A REPAIR PART THROUGH A FULL SIZE HOLE ON THE INITIAL PART. THE DRILL SHOWN IS NOT APPLICABLE FOR THE DRILL HOLES WITH A DIAMETER TOLERANCE OF +0.0000 TO TO -0.0005 INCH.

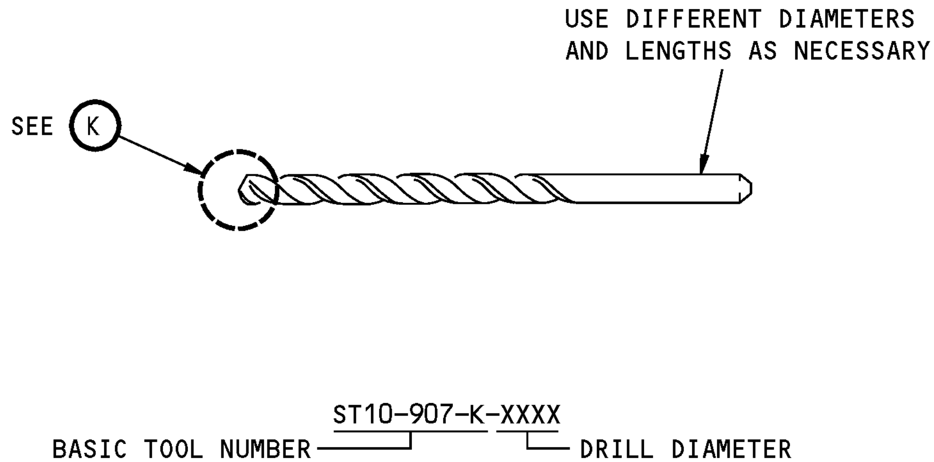
USE A TYPE II DRILL POINT WHEN THE GUIDE PART THICKNESS IS MORE THAN 1/3 OF THE DRILL DIAMETER. USE A TYPE I DRILL POINT WHEN THE GUIDE PART THICKNESS IS LESS THAN 1/3 OF THE GUIDE PART THICKNESS.

TO PREVENT FIBER BREAKOUT IN CFRP STRUCTURE USE A BACKUP PLATE.

THE RECOMMENDED DRILL DIAMETER IS 0.0005 INCH SMALLER THAN THE DIAMETER OF THE FULL SIZE HOLE.

ST1241FA 1, UNCLEARED TWIST DRILL -
HIGH SPEED STEEL (HSS) OR CARBIDE
F

Drills Used to Drill Holes in Composite Structures and Composite-to-Metal Assemblies
Figure 3 (Sheet 6 of 11)



NOTES: THE DRILL SHOWN IS USED TO DRILL FASTENER HEADS.

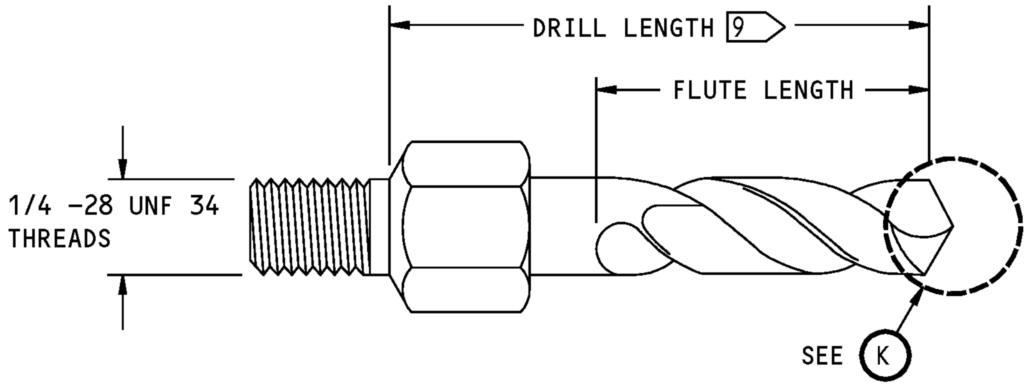
THE DRILL SHOWN IS NOT APPLICABLE FOR THE DRILL HOLES WITH A DIAMETER TOLERANCE OF MORE THAN 0.0040 INCH.

THE DRILL DIAMETER TOLERANCES ARE AS FOLLOWS FOR THESE HOLE DIAMETERS:
- FOR DRILL DIAMETERS 1/16 INCH TO 1/8 INCH, +0.0000 TO -0.0005
- FOR DRILL DIAMETERS OVER 1/8 TO 1/4 INCH, +0.0000 TO -0.0007
- FOR DRILL DIAMETERS OVER 1/4 INCH TO 1/2 INCH, +0.0000 TO -0.0010

ST10-907-K 1 GENERAL PURPOSE HSS DRILL JOBBERS - TYPE 1

G

Drills Used to Drill Holes in Composite Structures and Composite-to-Metal Assemblies
Figure 3 (Sheet 7 of 11)



NOTES: THE DRILL SHOWN IS USED TO DRILL FASTENER HEADS THAT ARE IN LIMITED ACCESS AREAS.

THE DRILL SHOWN IS NOT APPLICABLE FOR DRILL HOLES WITH A HOLE DIAMETER TOLERANCE OF MORE THAN 0.0040 INCH.

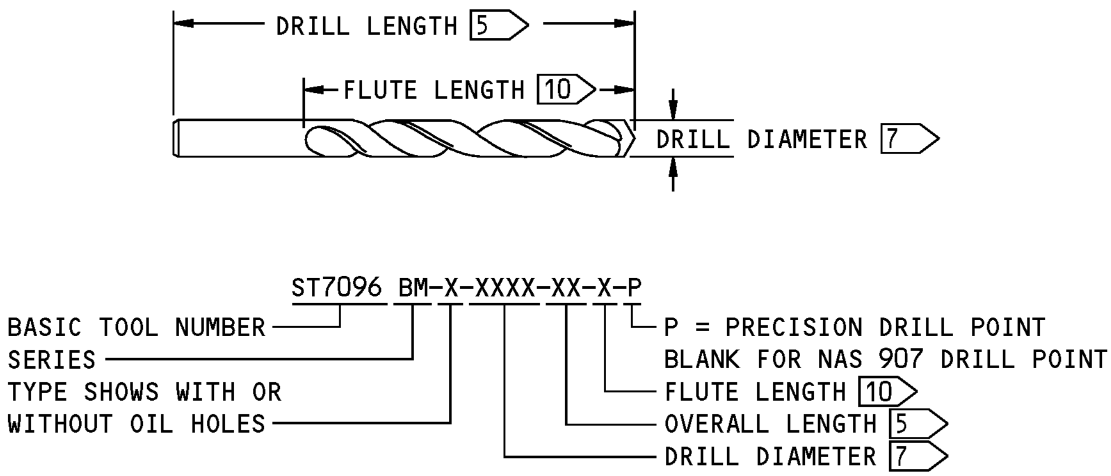
THE DRILL DIAMETER TOLERANCES ARE AS FOLLOWS FOR THESE HOLE DIAMETERS:
- FOR DRILL DIAMETERS 1/16 INCH TO 1/8 INCH, +0.0000 TO -0.0005
- FOR DRILL DIAMETERS OVER 1/8 TO 1/4 INCH, +0.0000 TO -0.0007
- FOR DRILL DIAMETERS OVER 1/4 INCH TO 1/2 INCH, +0.0000 TO -0.0010

USE A DRILL DIAMETER THAT IS 0.003 INCH SMALLER THAN THE HOLE DIAMETER WHEN YOU DRILL FASTENER HEADS.

ST10-0001-E 1, GENERAL PURPOSE THREADED
HIGH SPEED STEEL (HSS) DRILL

H

Drills Used to Drill Holes in Composite Structures and Composite-to-Metal Assemblies
Figure 3 (Sheet 8 of 11)

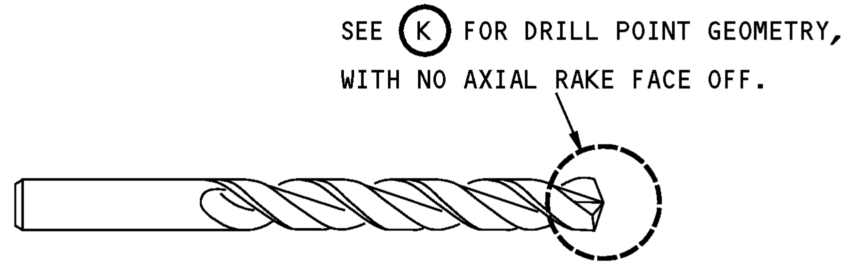


NOTE: THE DRILL SHOWN IS USED TO DRILL DEEP HOLES IN GFRP-TO-TITANIUM ASSEMBLIES.

ST7096 BM 1, CARBIDE TIPPED OIL FEED -
HIGH SPEED STEEL (HSS) DRILL

I

Drills Used to Drill Holes in Composite Structures and Composite-to-Metal Assemblies
Figure 3 (Sheet 9 of 11)



ST1255F-XXXX-1

BASIC TOOL NUMBER (ST1255F)

DRILL DIAMETER (XXXX)

6 INCH LENGTH (-1)

NOTES: THE DRILL SHOWN USED TO DRILL COMPOSITE-TO-ALUMINUM ASSEMBLIES.

THE DRILL DIAMETER TOLERANCE FOR ALL DRILL DIAMETERS IS +0.0000 TO -0.0005 INCH.

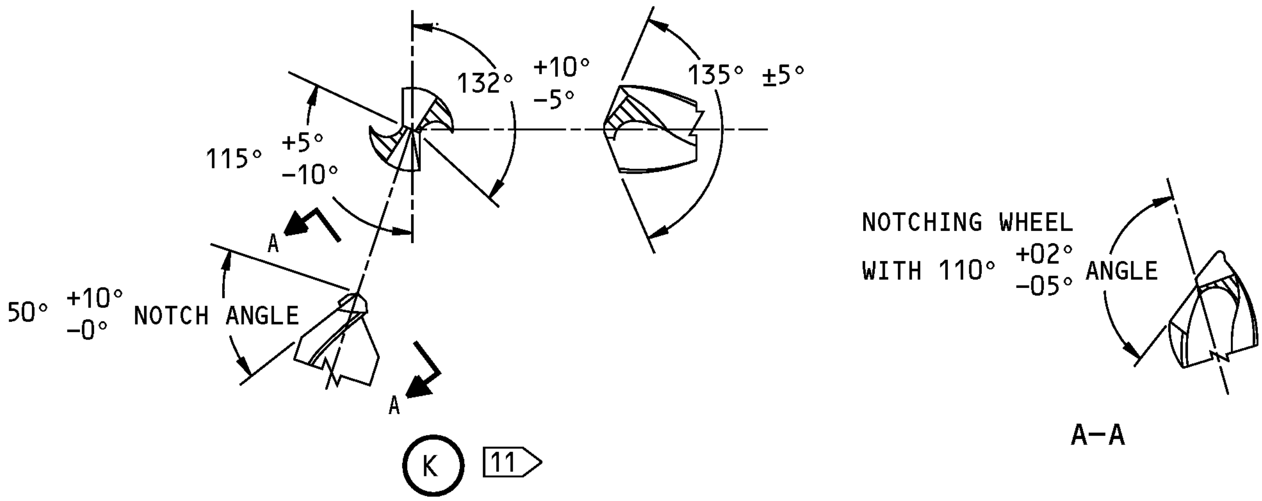
TO PREVENT FIBER BREAKOUT IN CFRP STRUCTURES, USE A BACKUP PLATE.

THE RECOMMENDED DRILL DIAMETERS ARE AS FOLLOWS FOR THESE HOLE CLASSES:
- FOR CLASS I HOLES, USE A DRILL DIAMETER THAT IS 0.0005 INCH ABOVE THE MINIMUM HOLE DIAMETER.
- FOR CLASS II AND III HOLES, USE A DRILL DIAMETER THAT IS 0.0050 INCH ABOVE THE MINIMUM HOLE DIAMETER.

ST1255F [1] SOLID CARBIDE,
PARABOLIC FLUTE DRILL - DOUBLE ANGLE POINT

J

Drills Used to Drill Holes in Composite Structures and Composite-to-Metal Assemblies
Figure 3 (Sheet 10 of 11)



NOTES

- ALL DIMENSIONS ARE IN INCHES, UNLESS OTHERWISE SPECIFIED.

1 BOEING STANDARD TOOL NUMBER

2 THE PILOT DIAMETER MUST BE 80 PERCENT OF THE DRILL DIAMETER WITH -0.002 TOLERANCE.

3 IN 1/8 INCH INCREMENTS

4 IN 1/4 INCH INCREMENTS

5 IN 1/100 INCH INCREMENTS

6 IN 1/1,000 INCH INCREMENTS

7 IN 1/10,000 INCH INCREMENTS

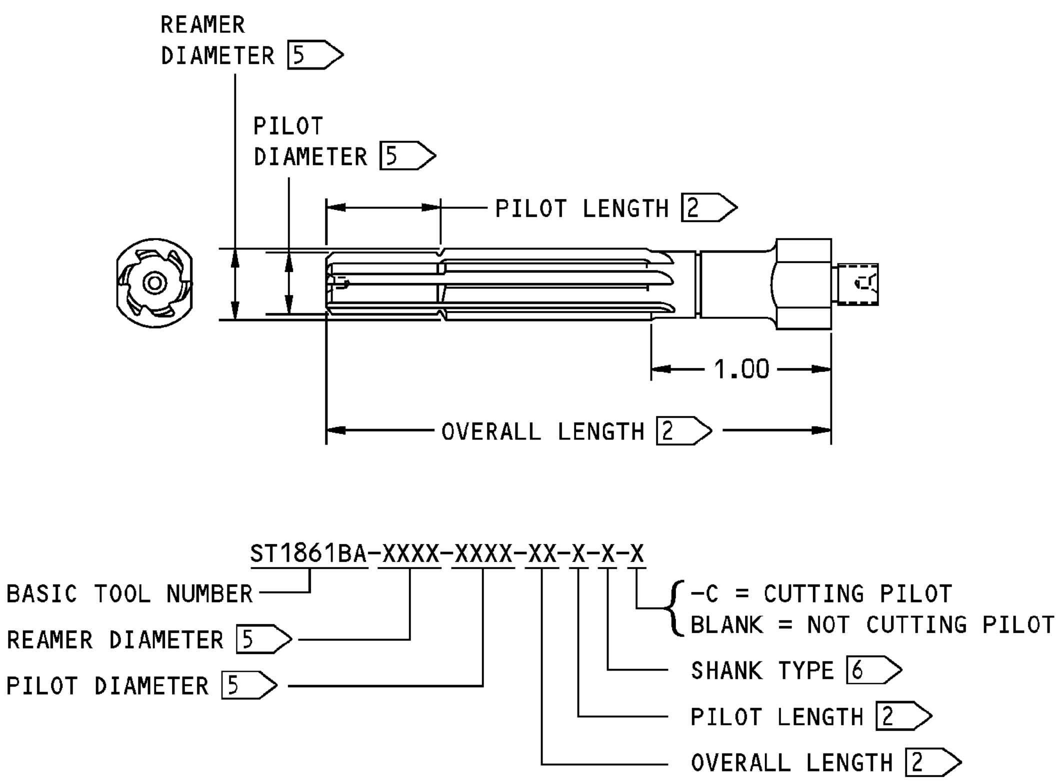
8 TYPE II DRILL POINT GEOMETRY IS SHOWN

9 AVAILABLE DRILL LENGTHS ARE 1.0, 2.12, 3.0, OR 4.0

10 IN 1/16 INCH INCREMENTS

11 THIS DRILL POINT GEOMETRY IS FOR REFERENCE ONLY. TELL BOEING IF YOU NEED A TOOL DRAWING FOR A SPECIFIC DRILL.

Drills Used to Drill Holes in Composite Structures and Composite-to-Metal Assemblies
Figure 3 (Sheet 11 of 11)



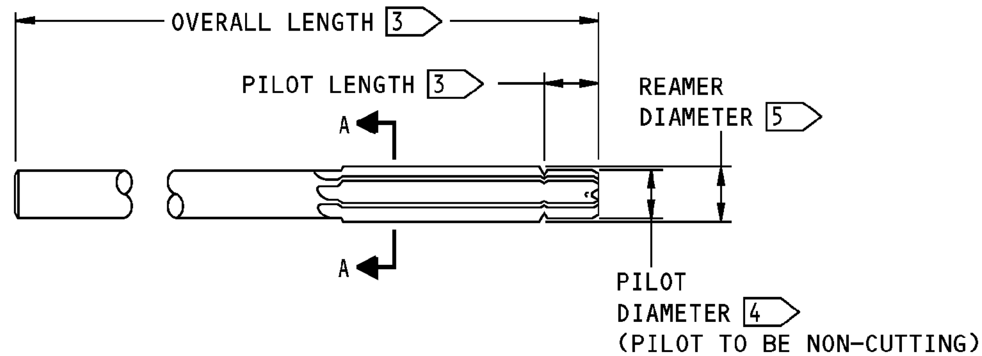
<u>NOTES</u>: THE REAMER SHOWN IS USED TO REAM HOLES IN COMPOSITE STRUCTURES, COMPOSITE-TO-METAL ASSEMBLIES, COMPOSITE-TO ALUMINUM, AND COMPOSITE-TO-TITANIUM ASSEMBLIES.

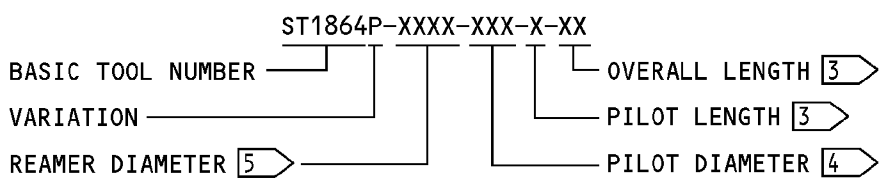
THE REAMER IS USED WHERE A HIGH QUALITY, CLOSE TOLERANCE HOLE IS NECESSARY

ST1861BA 1, PILOTED AND THREADED REAMER - SOLID CARBIDE

A

Reamers Used to Ream Holes in Composite Structures and Composite-to-Metal Assemblies
Figure 4 (Sheet 1 of 4)



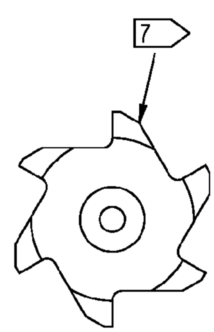


NOTES: THE REAMER SHOWN IS USED TO REAM HOLES IN COMPOSITE STRUCTURES, COMPOSITE-TO-METAL ASSEMBLIES, AND CFRP STACKUPS.

THE REAMER IS USED WHERE A HIGH QUALITY, CLOSE TOLERANCE HOLE IS NECESSARY.

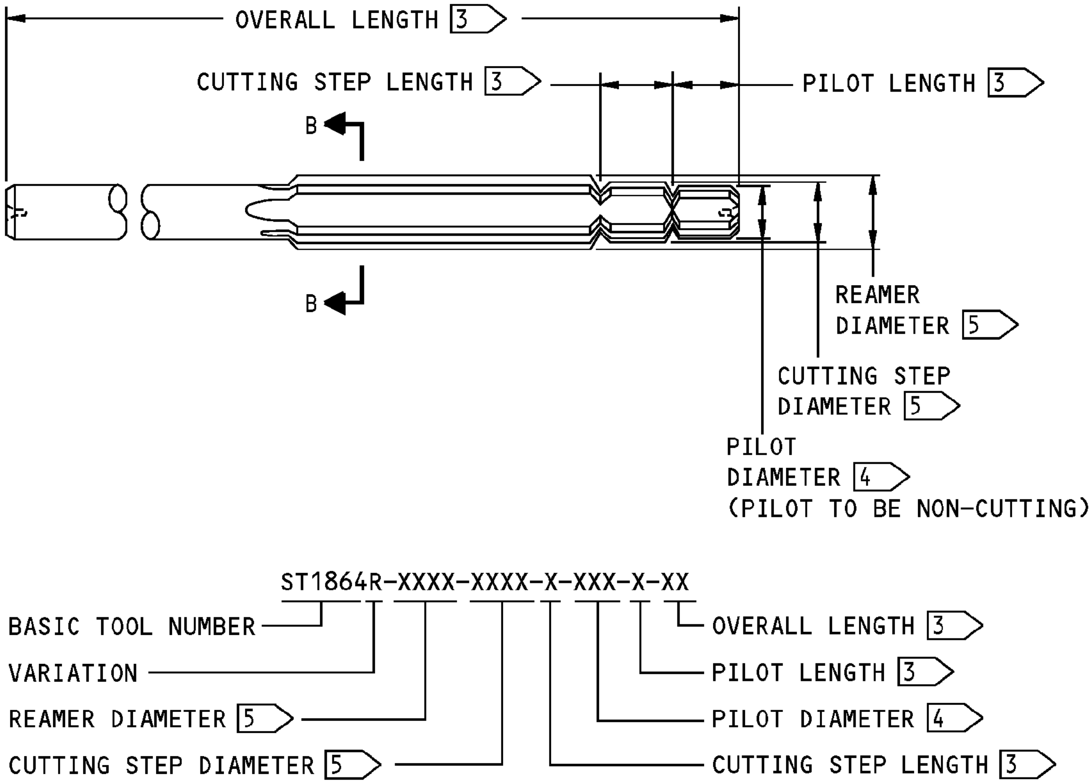
ST1864P 1, PILOTED STRAIGHT SHANK REAMER - SOLID CARBIDE

B



A-A

Reamers Used to Ream Holes in Composite Structures and Composite-to-Metal Assemblies
Figure 4 (Sheet 2 of 4)



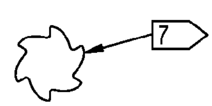
CAUTION: MAKE SURE THAT THERE IS SUFFICIENT CLEARANCE ON THE EXIT SIDE OF THE PART FOR THE PILOT AND CUTTING STEP SECTIONS OF THE REAMER TO EXIT FREELY. IF YOU DO NOT OBEY, YOU CAN CAUSE DAMAGE TO THE ADJACENT PART ON THE EXIT SIDE.

NOTES: THE REAMER SHOWN IS USED TO REAM HOLES IN COMPOSITE STRUCTURES, COMPOSITE-TO-METAL ASSEMBLIES, AND CFRP STACKUPS.

THE REAMER SHOWN IS USED WHERE A HIGH QUALITY, CLOSE TOLERANCE HOLE IS NECESSARY. THE REAMER SHOWN WILL MAKE THE FULL REAM IN ONE STEP.

ST1864R 1, PILOTED AND STRAIGHT SHANK DOUBLE STEP REAMER - SOLID CARBIDE

C



B-B

Reamers Used to Ream Holes in Composite Structures and Composite-to-Metal Assemblies
Figure 4 (Sheet 3 of 4)

NOTES

- ALL DIMENSIONS ARE IN INCHES, UNLESS OTHERWISE SPECIFIED.
- THE REAMER DIAMETER TOLERANCE IN INCHES ARE AS FOLLOWS:
  -FOR HOLE DIAMETERS 0.0469 THROUGH 0.5000 INCH IS -0.0000 TO +0.0002
  -FOR HOLE DIAMETERS OVER 0.5000 INCH THROUGH 0.7500 INCH IS -0.0000 TO +0.0003
- TELL THE BOEING COMPANY IF YOU NEED A TOOL DRAWING FOR A SPECIFIC REAMER.

1 BOEING STANDARD TOOL NUMBER

2 IN 1/8 INCH INCREMENTS

3 IN 1/16 INCH INCREMENTS

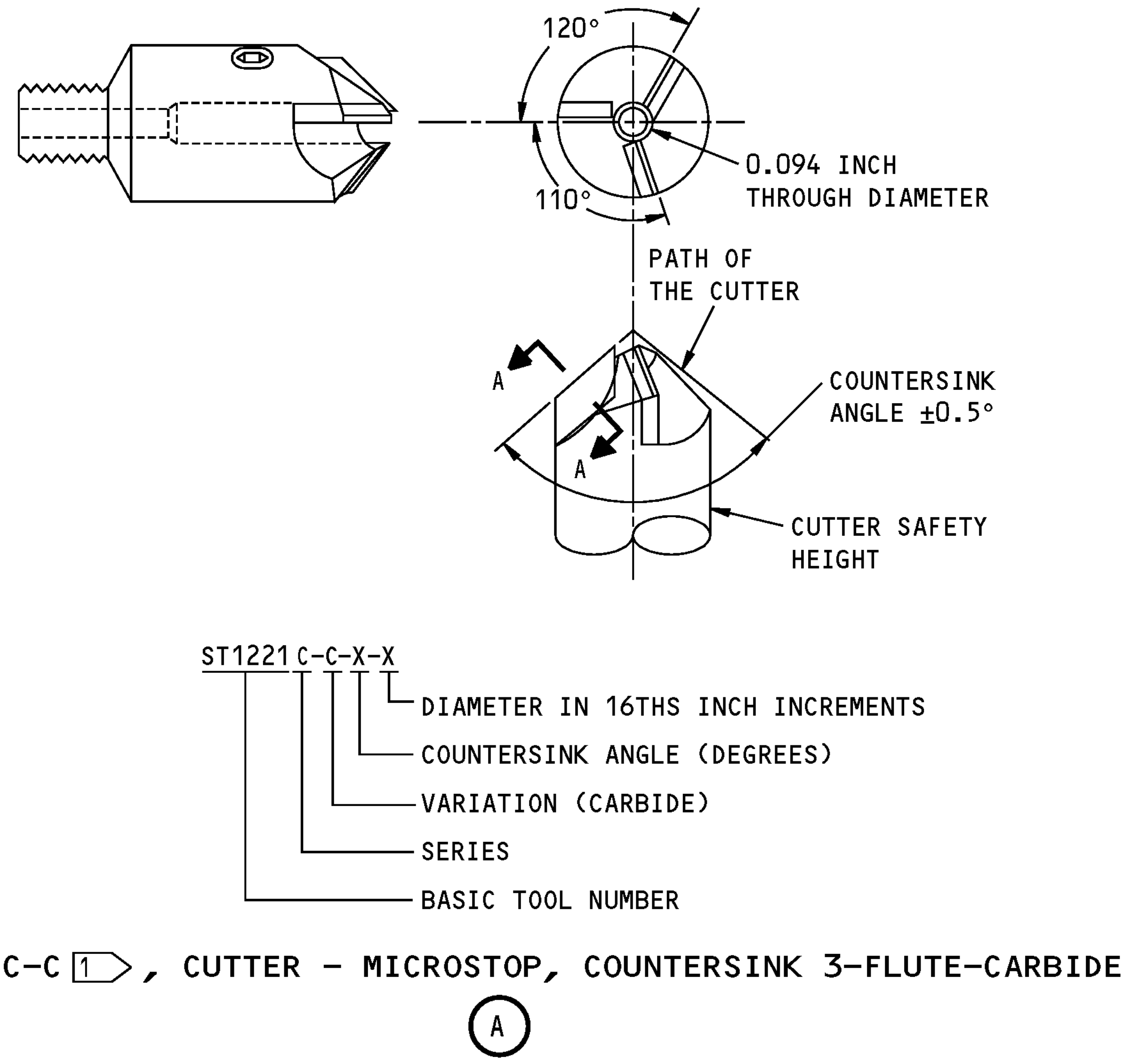
4 IN 1/1,000 INCH INCREMENTS

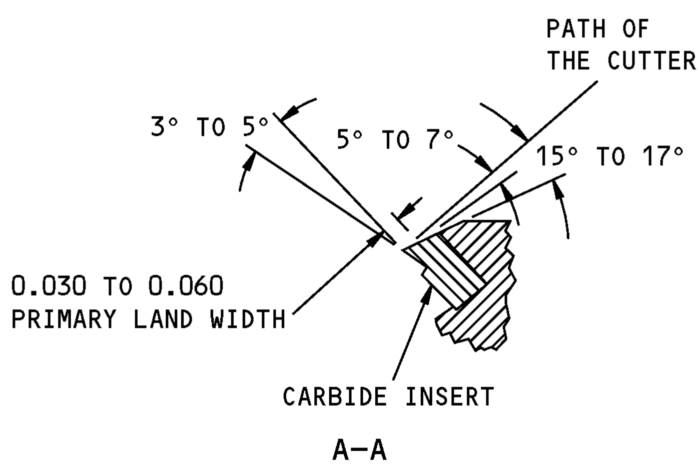
5 IN 1/10,000 INCH INCREMENTS

6 SHANK TYPE:
-1 = THREADED ONE PIECE
-2 = THREADED TWO PIECE
-3 = QUICK CHANGE - LONG
-4 = QUICK CHANGE - SHORT

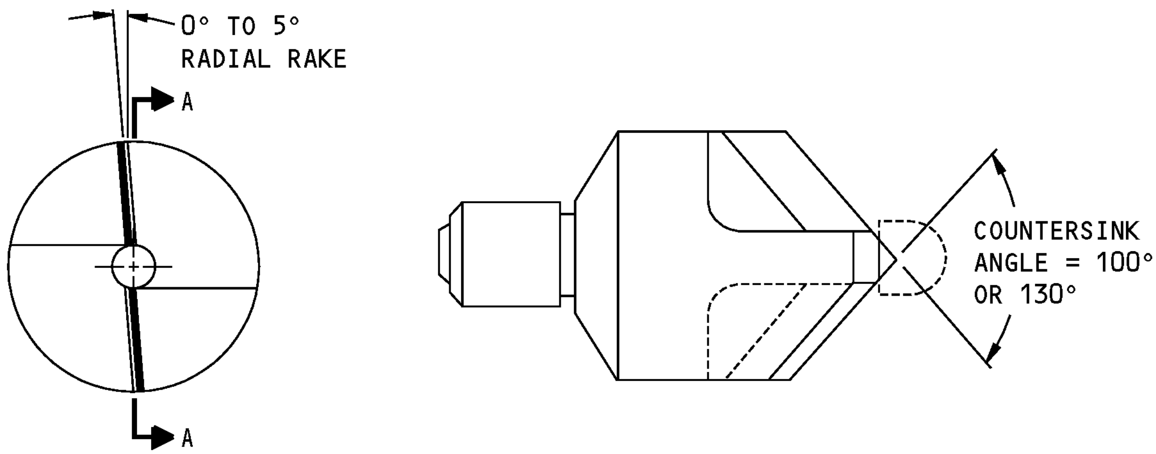
7 REAMERS WITH UP TO 0.249 INCH DIAMETER HAVE 4 FLUTES. REAMERS WITH 0.250 INCH OR LARGER DIAMETER HAVE 6 FLUTES

Reamers Used to Ream Holes in Composite Structures and Composite-to-Metal Assemblies
Figure 4 (Sheet 4 of 4)





Cutters Used to Countersink Holes in Composite Structures and Composite-to-Metal Assemblies
Figure 5 (Sheet 1 of 3)



ST1223C-D [1], CUTTER - 2-FLUTE, POLYCRYSTALLINE DIAMOND

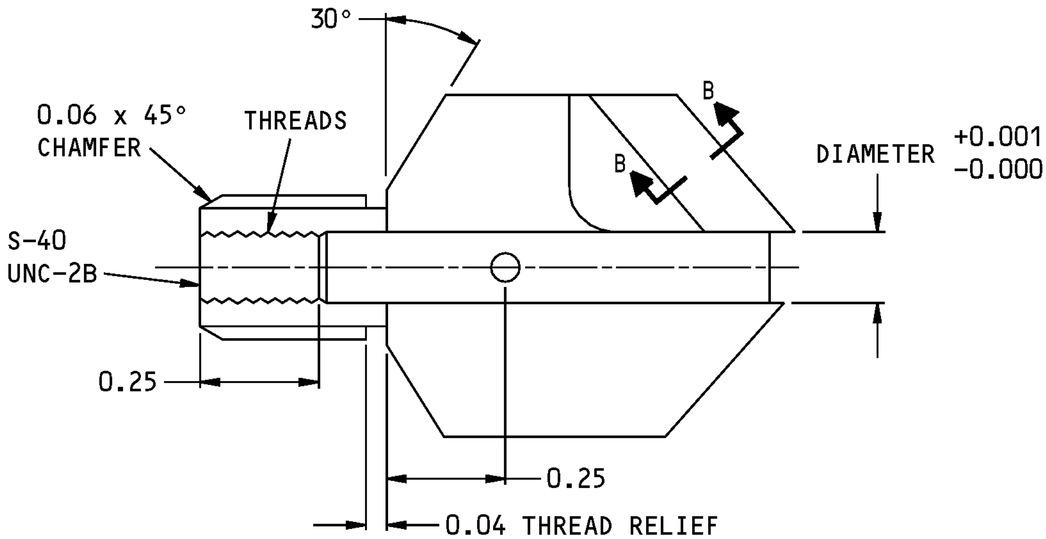
B

NOTES

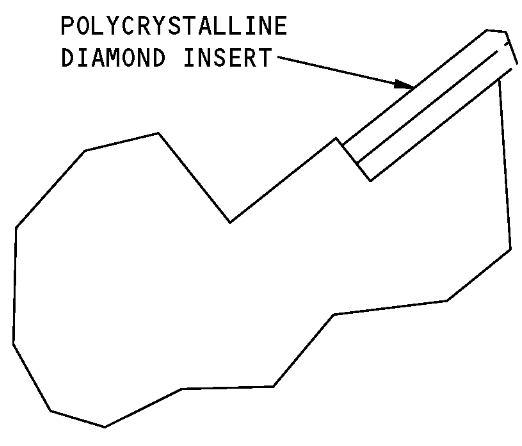
- ALL DIMENSIONS ARE IN INCHES, UNLESS OTHERWISE SPECIFIED.
- TELL THE BOEING COMPANY IF YOU NEED A TOOL DRAWING FOR A SPECIFIC CUTTER.

[1] BOEING STANDARD TOOL NUMBER

Cutters Used to Countersink Holes in Composite Structures and Composite-to-Metal Assemblies
Figure 5 (Sheet 2 of 3)

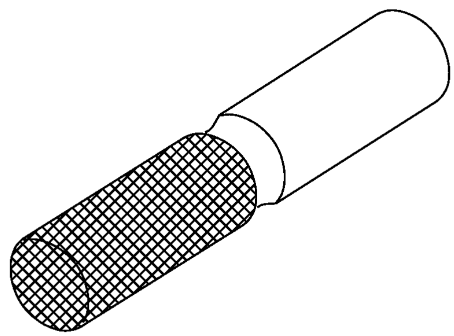


A-A



B-B

Cutters Used to Countersink Holes in Composite Structures and Composite-to-Metal Assemblies
Figure 5 (Sheet 3 of 3)



Cutters Used to End Mill GRFP and GRFP Structures
Figure 6

DRILL MOTORS USED FOR HOLE PREPARATION IN COMPOSITES AND COMPOSITE-TO-METAL ASSEMBLIES		
DESCRIPTION	SUPPLIER	NOTES
HAND FEED DRILL MOTORS (PISTOL GRIP)	3 7 9 11 14	16 19 20 22
HAND FEED DRILL MOTORS (90 DEGREE ANGLE HEAD)	3 11 14	16 19 20 22
POWER FEED DRILL MOTORS (NUTPLATE AIR FEED)	3 11 14	16 19 21 22
POWER FEED DRILL MOTORS (PECK FEED AIR FEED)	3 7	16 19 22 23 24 28
POWER FEED DRILL MOTORS (POSITIVE FEED - RIGHT ANGLE)	3 11	16 19 22 25 26 29
POWER FEED DRILL MOTORS (POSITIVE FEED, PIGGY-BACK)	3 11	16 19 22 25 26 30
POWER FEED DRILL MOTORS (POSITIVE FEED, IN-LINE)	3 11	16 19 22 25 26 30

TABLE A

Cutting Tools for Composite Structures and Composite-to-Metal Assemblies
Figure 7 (Sheet 1 of 6)

DRILL MOTORS USED FOR HOLE PREPARATION IN COMPOSITES AND COMPOSITE-TO-METAL ASSEMBLIES		
DESCRIPTION	SUPPLIER	NOTES
POWER FEED DRILL MOTORS (SELF-COLLECTING AIR FEED, TEMPLATE FOOT)	3 11 14	16 19 20 26
POWER FEED DRILL MOTORS (SELF-COLLECTING AIR FEED, CONCENTRIC COLLET)	3 11 14	16 19 22 26 27

TABLE A (CONTINUED)

Cutting Tools for Composite Structures and Composite-to-Metal Assemblies
Figure 7 (Sheet 2 of 6)

HOLE PREPARATION EQUIPMENT FOR COMPOSITES AND COMPOSITE-TO-METAL ASSEMBLIES		
DESCRIPTION	TYPE	SUPPLIER [16] [19]
MISCELLANEOUS	Microstops/Countersink Holders • Adapter • Jacobs Chuck • Quick Change Chuck • Drill Guide • Extension • Drill Bushing • Drill Stop • Nutplate Jigs	[1] [4] [6]
CUTTERS	Drills • ST1257B, ST10-937-C, ST7101A (solid carbide) • ST10-907-H, ST1241BAD, ST1255FA (carbide tipped HSS) • ST7096 BM oil-hole, carbide tipped HSS drill • ST1241FA (HSS or carbide) • ST10-907-K, ST10-0001-E (HSS)	[2] [5] [8] [10] [12] [13] [15] [17] [18]
	Countersinks • ST1221C-C • ST10-1223 • ST1223C-D	
	Reamers (with undersize pilot) • ST1861BA (carbide) • ST1864P (carbide) • ST1864R (carbide double step)	
	Hole Saws • Diamond Grit Hole Saws	

TABLE B

Cutting Tools for Composite Structures and Composite-to-Metal Assemblies
Figure 7 (Sheet 3 of 6)

EQUIPMENT USED TO TRIM COMPOSITES AND COMPOSITE-TO-METAL ASSEMBLIES		
DESCRIPTION	TYPE	SUPPLIER 16 19
AIR MOTORS FOR TRIMMING	18,000 - 23,000 RPM (0.9 HP)	
	18,000 - 23,000 RPM, High Speed Router Assembly with an integral vacuum pick-up.	
SAWS FOR TRIMMING	Band Saw - 1000-3000 SFM	
	Circular Saw - 3000-5000 RPM	
	Portable Circular Saw - 15,000-18,000 RPM	
CUTTERS FOR TRIMMING	Band Saw Blade - Carbide abrasive, medium grit Circular Saw Blade - Diamond abrasive blade, 40 grit, 8-10 inch diameter - Carbide abrasive, medium grit Portable Circular Saw Blade - Diamond abrasive, 40 grit, 2-4 inch diameter - Carbide abrasive, medium grit Spindle Shaping - Diamond abrasive, 40 mesh Routing - Diamond abrasive, 40 mesh Trimming to Fit - Diamond abrasive, 40 mesh	32
ABRASIVES (DEBURR)	60 grit, sanding block 80 grit, silicone carbide block 150 grit, water resistant sandpaper 180 grit, belt 180 grit, 2-inch disc sander 280/320 grit, sanding block	32
MISCELLANEOUS	6 inch Belt Sander for deburring, 80 grit belt	32

TABLE C

Cutting Tools for Composite Structures and Composite-to-Metal Assemblies
Figure 7 (Sheet 4 of 6)

NOTES

- RPM = REVOLUTIONS PER MINUTE
- HSS = HIGH SPEED STEEL
- SFM = SURFACE FEET PER MINUTE
- ALL DIMENSIONS ARE IN INCHES, UNLESS OTHERWISE SPECIFIED.
- MAKE SURE THAT YOU HAVE THE LAST REVISION OF THE TOOL DRAWING OR THE SUPPLIER CATALOG BEFORE YOU ORDER THE TOOL OR EQUIPMENT. TELL THE BOEING COMPANY IF YOU NEED A TOOL DRAWING FOR A SPECIFIC TOOL OR EQUIPMENT.
- REFER TO SRM 51-30-05 FOR THE SUPPLIER INFORMATION.

1 A.T.I. TOOLS INC.

2 ADVANCED CUTTING TOOLS INC.

3 COOPER POWER TOOLS DIVISION

4 MAGNAVON INDUSTRIES, INC.

5 CARBRO CO.

6 ZEPHYR MFG. CO., INC.

7 INGERSOLL-RAND CO.
(SUPPLIER FOR INGERSOLL-RAND AND ARO PRODUCTS)

8 QUALITY CARBIDE TOOL

9 ATLAS COPCO TOOLS INC.
(SUPPLIER FOR ATLAS COPCO AND CHICAGO PNEUMATIC PRODUCTS)

10 GUHRING INC.

11 INDRESCO, INDUSTRIAL TOOL DIVISION
(SUPPLIER FOR CLECO, FRESSER, QUACKENBUSH PRODUCTS)

12 PRECISION TWIST DRILL CO., CARBIDE DIVISION

13 UNION BUTTERFIELD

14 DEUTSCH-AMERICAN PNEUMATIC TOOL CO.

15 KONZCO

16 MOST SUPPLIER ADDRESSES/PHONE NUMBERS CAN BE FOUND IN THE THOMAS REGISTER OF AMERICAN MANUFACTURERS.

17 CJT KOOL CARB

18 GREENFIELD-CLEVELAND TWIST

19 TELL THE BOEING COMPANY IF YOU NEED THE CURRENT APPROVED LIST OF TOOL AND EQUIPMENT SUPPLIERS.

Cutting Tools for Composite Structures and Composite-to-Metal Assemblies
Figure 7 (Sheet 5 of 6)

NOTES (CONTINUED)

20 THESE DRILL MOTORS ARE USED TO DRILL HOLES IN METAL, COMPOSITE, AND COMPOSITE-TO-METAL ASSEMBLIES TO AN UNDERSIZE CONDITION.

21 THESE DRILL MOTORS ARE USED TO DRILL HOLES IN METAL AND COMPOSITE-TO-METAL ASSEMBLIES THAT NEED MANY NUTPLATES. IF A SMALL NUMBER OF NUTPLATES ARE TO BE INSTALLED, USE SMALL HAND HELD NUTPLATE JIGS.

22 REFER TO THE SUPPLIER CATALOG FOR ALL DRILL MOTOR DATA.

23 PECK FEED DRILL MOTORS ARE RECOMMENDED ONLY TO DRILL FULL SIZE HOLES IN CFRP/GFRP-TO-TITANIUM AND CFRP-TO-TITANIUM ASSEMBLIES.

24 REFER TO THE SUPPLIER CATALOG FOR THE SPINDLE SPEEDS.

25 THESE DRILL MOTORS ARE RECOMMENDED TO DRILL HOLES IN METAL AND METAL-TO-COMPOSITE ASSEMBLIES TO AN UNDERSIZE CONDITION.

26 REFER TO THE SUPPLIER CATALOG FOR THE SPEEDS AND FEED RATES.

27 THESE DRILL MOTORS ARE USED TO DRILL HOLES IN COMPOSITES OR COMPOSITES-TO-METAL ASSEMBLIES TO AN UNDERSIZE CONDITION. ALSO, A DRILL PLATE IS USED WITH THESE DRILL MOTORS.

28 USE OF COOLANT IS NECESSARY WHEN ONE-SHOT PECK DRILL IS USED TO DRILL HOLES.

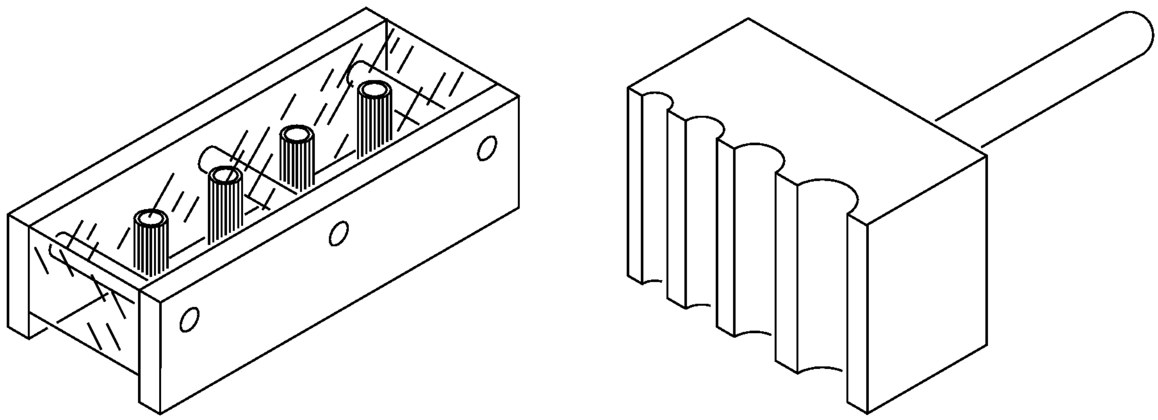
29 FEMALE THREADS FOR THE NOSEPIECE CONNECTION IS RECOMMENDED WHENEVER POSSIBLE. REFER TO THE SUPPLIER OR ST CATALOG TO DETERMINE THE PROPER NOSEPIECE STYLE DESIGNATION.

30 REFER TO THE SUPPLIER OR ST CATALOG TO DETERMINE THE PROPER NOSEPIECE STYLE DESIGNATION.

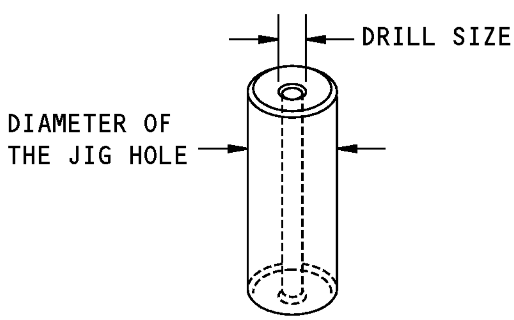
31 REFER TO THE SUPPLIER CATALOG FOR FOOT CONFIGURATIONS AND ACCESSORIES.

32 ABRASIVE TECHNOLOGY

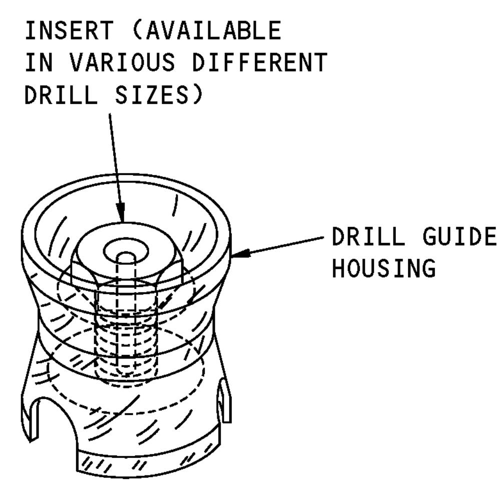
Cutting Tools for Composite Structures and Composite-to-Metal Assemblies
Figure 7 (Sheet 6 of 6)



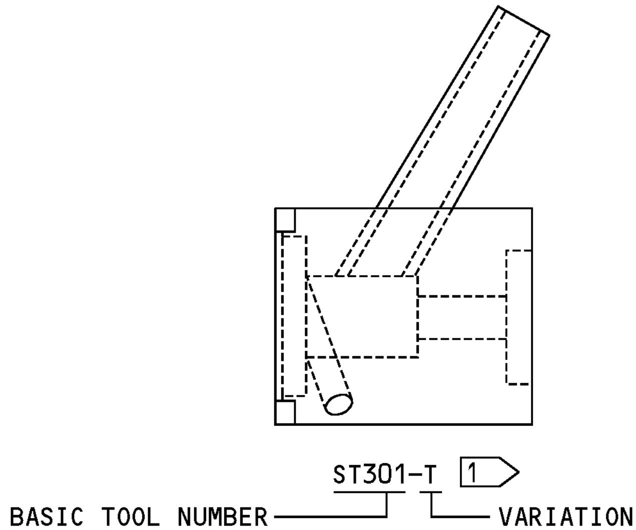
DRILL GUIDE BLOCKS



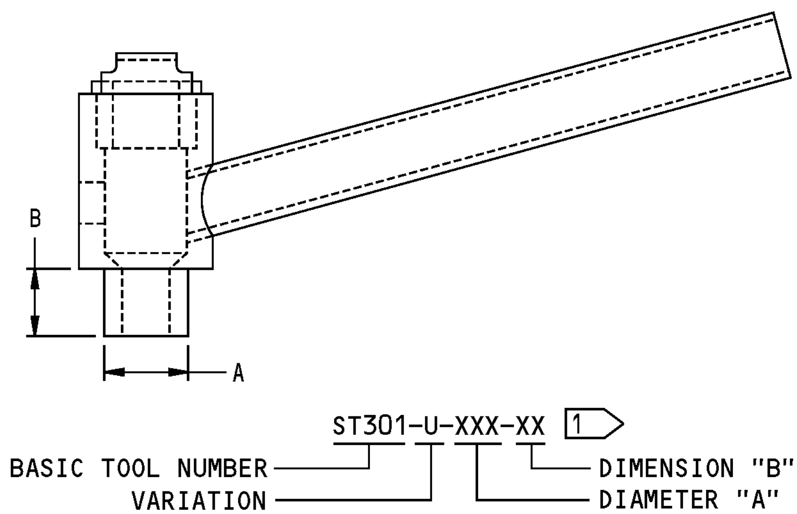
HAND MADE DRILL
GUIDE FOR A DRILL JIG



Drill Guides
Figure 8 (Sheet 1 of 2)



VACUUM ATTACHMENT FOR A DRILL GUIDE
USED TO COLLECT DUST

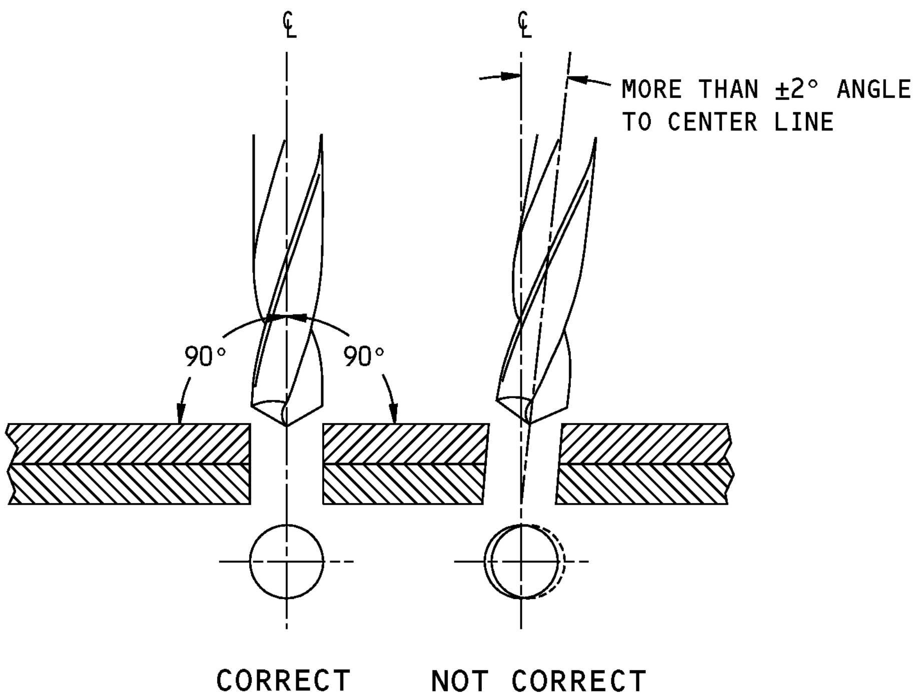


THE VACUUM ATTACHMENT FOR A HAND HELD DRILL MOTOR
USED TO COLLECT COMPOSITE DUST

NOTES

1 BOEING STANDARD TOOL NUMBER

Drill Guides
Figure 8 (Sheet 2 of 2)



Drill Perpendicularity
Figure 9

MATERIAL-RPM DATA TO HAND DRILL GFRP, CFRP AND GFRP-TO-CFRP ASSEMBLY			
MATERIAL	GFRP		CFRP AND GFRP/CFRP [1]
DRILL TYPE	[2]		[2]
DRILL LIFE (HOLES)	50-100		50-100
DRILL DIAMETER (INCH)	MAXIMUM RPM (DRY)	MAXIMUM RPM (WET)	MAXIMUM RPM (DRY)
UP TO 1/16 (NO. 40 SIZE)	5000	5000	5000
UP TO 5/32 (NO. 30 SIZE)	5000	5000	5000
UP TO 7/32 (NO. 10 SIZE)	4500	4500	4500
UP TO 1/4	3000	3000	3000
UP TO 3/8	3000	3000	3000

TABLE A

WARNING: DO NOT USE DRILLS LONGER THAT 3 INCHES IN LENGTH AT DRILL SPEEDS HIGHER THAN 6,000 REVOLUTIONS PER MINUTE (RPM). IF YOU DO NOT OBEY, YOU CAN GET A BROKEN DRILL AND SERIOUS INJURY TO PERSONS CAN OCCUR.

NOTES

- RPM = REVOLUTIONS PER MINUTE
- IPR = INCHES PER REVOLUTION

[1] MAKE SURE THAT YOU COLLECT THE DUST WITH A VACUUM.

[2] REFER TO FIGURE 3 FOR DIFFERENT TYPES OF THE DRILLS THAT YOU CAN USE TO DRILL HOLES IN COMPOSITE STRUCTURES.

[3] THE FEED RATE GIVEN IS FOR POWER FEED DRILLS IN UNIDIRECTIONAL TAPE MATERIAL. THE FEED RATE CAN BE INCREASED TO 0.004-0.005 IPR IF:

- A STRONG BACKUP PLATE IS USED
- THE CFRP OR GFRP-TO-CFRP ASSEMBLY HAS FABRIC THAT IS CO-CURED ON THE DRILL EXIT SIDE.

Drill Data for GFRP, CFRP, and GFRP-to-CFRP Assembly
Figure 10 (Sheet 1 of 2)

MATERIAL-RPM DATA TO POWER FEED DRILL GFRP, CFRP AND GFRP-TO-CFRP ASSEMBLY						
MATERIAL	GFRP 1			CFRP AND GFRP/CFRP 1		
DRILL TYPE	2			2		
DRILL LIFE (HOLES)	50-100			50-100		
DRILL DIAMETER (INCH)	MAXIMUM RPM (DRY)	MAXIMUM RPM (WET)	FEED (IPR)	MAXIMUM RPM (DRY)	MAXIMUM RPM (WET)	FEED (IPR) 3
UP TO 1/16 (NO. 40 SIZE)	6000	6000	0.005	6000	6000	0.002
UP TO 5/32 (NO. 30 SIZE)	6000	6000	0.005	6000	6000	0.002
UP TO 7/32 (NO. 10 SIZE)	6000	6000	0.005	6000	6000	0.002
UP TO 1/4	6000	6000	0.005	6000	6000	0.002
UP TO 3/8	5000	6000	0.005	6000	5000	0.002
UP TO 1/2	3000	5000	0.005	5000	3000	0.002
UP TO 5/8	3000	3000	0.005	3000	3000	0.002
UP TO 3/4	2000	3000	0.005	2000	2000	0.002
UP TO 1	1000	3000	0.005	1000	1000	0.002

TABLE B

Drill Data for GFRP, CFRP, and GFRP-to-CFRP Assembly
Figure 10 (Sheet 2 of 2)

MATERIAL-RPM DATA TO HAND OR POWER FEED DRILL GFRP-TO-ALUMINUM AND CFRP-TO-ALUMINUM ASSEMBLIES		
MATERIAL	GFRP-TO-ALUMINUM AND CFRP-TO-ALUMINUM ASSEMBLIES [5]	
DRILL TYPE	[2]	
DRILL LIFE (HOLES)	50-100	
DRILL DIAMETER (INCH)	MAXIMUM RPM (WET) [3]	FEED (IPR) [4] [1]
UP TO 1/16 (NO. 40 SIZE)	5000	0.002
UP TO 5/32 (NO. 30 SIZE)	5000	0.002
UP TO 7/32 (NO. 10 SIZE)	4500	0.003
UP TO 1/4	3000	0.004
UP TO 3/8	3000	0.004
UP TO 1/2	1500	0.006
UP TO 5/8	1250	0.006
UP TO 3/4	1000	0.008
UP TO 1	750	0.008

TABLE A

WARNING: DO NOT USE DRILLS LONGER THAT 3 INCHES IN LENGTH AND DRILL SPEEDS HIGHER THAN 6,000 REVOLUTIONS PER MINUTE (RPM). IF YOU DO NOT OBEY, YOU CAN GET A BROKEN DRILL AND SERIOUS INJURY TO PERSONS CAN OCCUR.

NOTES

- RPM = REVOLUTIONS PER MINUTE
- IPR = INCHES PER REVOLUTION

[1] THIS IS APPLICABLE TO POWER-FEED EQUIPMENT ONLY.

[2] REFER TO FIGURE 3 FOR THE DIFFERENT TYPES OF THE DRILLS THAT CAN BE USED TO DRILL HOLES IN COMPOSITE-TO-ALUMINUM ASSEMBLIES

[3] IT IS RECOMMENDED TO DRILL THE PART WET WITH A LUBRICANT. USE OF A LUBRICANT WILL MAKE THE HOLE QUALITY BETTER.

[4] THIS FEED RATE IS APPLICABLE TO DRILL CFRP WITH CO-CURED FABRIC AND ALUMINUM ON DRILL EXIT SIDE.

[5] MAKE SURE THAT YOU COLLECT THE DUST WITH A VACUUM.

Drill Data for GFRP-To-Aluminum, and CFRP-To-Aluminum Assemblies
Figure 11

MATERIAL - RPM DATA TO HAND OR POWER FEED DRILL CFRP-TO-TITANIUM AND GFRP-TO-TITANIUM ASSEMBLIES			
MATERIAL	CFRP-TO-TITANIUM AND CFRP-TO-TITANIUM ASSEMBLIES [1]		
DRILL TYPE	ST10-907-H [2] ST7096-BM [3] [4] [8]		
DRILL DIAMETER (INCH)	MAXIMUM RPM (DRY) [7]	MAXIMUM RPM (WET)	FEED (IPR) [5] [6]
UP TO 1/16 (NO. 40 SIZE)	850	1275	0.001
UP TO 5/32 (NO. 30 SIZE)	500	750	0.001
UP TO 7/32 (NO. 10 SIZE)	375	550	0.002
UP TO 1/4	300	450	0.002
UP TO 3/8	200	300	0.004
UP TO 1/2	150	225	0.004
UP TO 5/8	125	190	0.004
UP TO 3/4	100	150	0.006
UP TO 1	75	110	0.006

TABLE A

NOTES

- RPM = REVOLUTIONS PER MINUTE
- IPR = INCHES PER REVOLUTION

[1] MAKE SURE THAT YOU COLLECT THE DUST WITH A VACUUM.

[2] USE THIS DRILL FOR AN ASSEMBLY THAT IS 0.18 INCH MAXIMUM IN THICKNESS, OF WHICH A MAXIMUM OF 0.10 INCH OF THE DEPTH MAXIMUM IS PERMITTED FOR TITANIUM. THE ST10-907-H GENERAL PURPOSE CARBIDE INSERT DRILL MUST HAVE A BACKUP ON THEF EXIT SIDE OF THE HOLE TO PREVENT FIBER BREAKOUT. THE ST10-907-H DRILL CAN ONLY BE USED TO DRILL PILOT AND UNDERSIZE HOLES THAT ARE REAMED TO FULL SIZE. REFER TO FIGURE 3 FOR DRILL POINT GEOMETRY.

[3] FOR DEEP HOLES, USE A CARBIDE-TIPPED, OIL-HOLE DRILL WITH A THREADED SHANK. REFER TO FIGURE 3 FOR DRILL POINT GEOMETRY.

[4] REFER TO FIGURE 7 FOR THE SUPPLIER AND SRM 51-30-05 FOR THE SUPPLIER INFORMATION.

[5] THE FEED RATE GIVEN IS TO POWER FEED DRILL CFRP WITH CO-CURED FABRIC OR OR TITANIUM ON THE DRILL EXIT SIDE.

[6] THIS IS APPLICABLE TO POWER-FEED EQUIPMENT ONLY.

[7] IT IS RECOMMENDED TO DRILL THE PART WET USING A LUBRICANT. USE OF A LUBRICANT WILL MAKE THE HOLE QUALITY BETTER.

[8] THIS DRILL IS USED WITH POWER FEED (PECK DRILLING) PROCEDURE.

Drill Data for CFRP-to-Titanium and GFRP-to-Titanium Assemblies
Figure 12

5. **Ream Holes in Composite Structures and Composite-to-Metal Assemblies**

WARNING: WEAR AN APPROVED DUST MASK AND SAFETY GLASSES WHEN YOU REAM HOLES IN COMPOSITE STRUCTURE. USE A VACUUM TO REMOVE DUST AND DEBRIS. IF YOU DO NOT OBEY, INJURY TO PERSONS CAN OCCUR.

WARNING: ELECTRICALLY GROUND CFRP PARTS TO PREVENT ELECTRICAL DISCHARGE. IF YOU DO NOT OBEY, INJURY TO PERSON AND DAMAGE TO THE PARTS CAN BE THE RESULT. SELECT AN UNPAINTED AREA OF THE PART TO ATTACH A GROUNDING WIRE. AN ELECTRICAL GROUND IS NOT POSSIBLE THROUGH MOST PAINT AND PRIMERS.

CAUTION: DO NOT PERMIT CARBON DUST TO COME IN CONTACT WITH ELECTRIC MOTORS, SWITCHES, RELAYS, CONTACTS, OR ELECTRONIC CIRCUITS. USE VACUUM EQUIPMENT ON POWER TOOLS. CARBON DUST IS AN ELECTRICAL CONDUCTOR AND CAN CAUSE SHORT CIRCUITS IN ELECTRICAL EQUIPMENT. IF YOU DO NOT OBEY, PERMANENT DAMAGE TO EQUIPMENT CAN OCCUR.

CAUTION: DO NOT USE HIGH SPEED STEEL (HSS) OR COBALT DRILL BITS ON CFRP OR GFRP STRUCTURE. IF YOU DO NOT OBEY AND DO THIS THE DRILL BITS WILL IMMEDIATELY BECOME DULL AND DAMAGE TO THE HOLE AREA CAN OCCUR.

A. Ream Holes in CFRP, GFRP Structures and CFRP/GFRP-to-Aluminum Assemblies

(1) Make a selection of the reamer.

(a) If you use the ST1864P reamer, you will need to ream the hole in two separate steps.

(b) If you use the ST1864R reamer, you can ream the hole in one step.

(c) Refer to Reamers Used to Ream Holes in Composite Structures and Composite-to-Metal Assemblies, Figure 4/GENERAL for different types of the reamers.

(d) Refer to Ream Data for GFRP, CFRP Structures, and GFRP-to-CFRP, GFRP-to-Aluminum,and CFRP-to-Aluminum Assemblies, Figure 13/GENERAL, Table A and Table B for the reamer speeds and feed speeds (if applicable).

(e) Hand feed reamers are recommended.

(2) Ream the hole dry.

B. Ream Holes in CFRP-to-Titanium or GFRP-to-Titanium Assemblies

(1) Make a selection of the reamer.

(a) If you use the ST1864P reamer, you will need to ream the hole in two separate steps.

(b) If you use the ST1864R reamer, you can ream the hole in one step.

(c) Refer to Ream Data for CFRP-to-Titanium and GFRP-to-Titanium Assemblies, Figure 14/GENERAL, Table A for the reamer speeds.

NOTE: Hand feed reamers are recommended for holes up to 3/8 inch in diameter.

(2) Apply Boelube or cetyl alcohol to the reamer.

(3) Ream the hole as follows:

(a) Put the reamer on the entry side of the hole.

(b) To ream holes up to 5/16 inch diameter, make a minimum cut of 1/64 inch.

(c) To ream holes larger than 5/16 inch in diameter make a minimum cut of 1/32 inch.

(4) Stop the rotation of the reamer when the larger diameter of the reamer goes through the material.

(5) Remove the reamer from the hole.

NOTE: When you do this turn the reamer manually in the direction of the cut.

(6) Clean the parts of the Boelube lubricant that remains with BMS 3-2, type I or BMS 11-7 solvent.

REAM DATA FOR GFRP, CPRP STRUCTURES, AND GFRP-TO-CFRP ASSEMBLIES [1]			
REAMER DIAMETER (INCH) [2]	SPEED (RPM)	FEED (IPT) [3] [6]	REAMER TYPE
1/8	2000	0.004 TO 0.006	[4] [5]
3/16	2000	0.004 TO 0.006	
1/4	1500	0.004 TO 0.006	
3/8	1500	0.004 TO 0.006	
1/2	1000	0.004 TO 0.006	
5/8	1000	0.004 TO 0.006	

TABLE A

NOTES

- RPM = REVOLUTIONS PER MINUTE
- IPT = INCHES PER TOOTH

[1] COLLECT THE DUST WITH A VACUUM, WHEN YOU REAM THE GFRP STRUCTURES OR GFRP-TO-ALUMINUM ASSEMBLIES.

[2] A CUT OF 1/64 INCH MINIMUM ON THE DIAMETER IS NECESSARY WHEN YOU REAM HOLES UP TO 5/16 INCH IN DIAMETER. FOR LARGER HOLES, A CUT OF 1/32 INCH MINIMUM ON THE DIAMETER IS NECESSARY.

[3] THIS IS APPLICABLE TO POWER-FEED EQUIPMENT ONLY.

[4] FOR SELECTION OF THE REAMER TYPE, REFER TO FIGURE 4.

[5] THE ST1864P REAMER WILL HAVE A 2-STEP REAM OPERATION. WITH THE ST1864R, THE TASK CAN BE COMPLETED IN ONE STEP.

[6] INCH PER REVOLUTION (IPR) = INCH PER TOOTH (IPT) TIMES NUMBER OF TEETH.
FOR EXAMPLE: 0.006 IPT X 6 TEETH = 0.036 IPR.

Ream Data for GFRP, CFRP Structures, and GFRP-to-CFRP, GFRP-to-Aluminum,and CFRP-to-Aluminum Assemblies
Figure 13 (Sheet 1 of 2)

REAM DATA FOR GFRP-TO-ALUMINUM AND CFRP-TO-ALUMINUM ASSEMBLIES [1]			
REAMER DIAMETER (INCH) [2]	SPEED (RPM)	FEED (IPT) [3] [6]	REAMER TYPE
1/8	800	0.004 TO 0.006	[4] [5]
3/16	800	0.004 TO 0.006	
1/4	700	0.004 TO 0.006	
3/8	700	0.005 TO 0.007	
1/2	600	0.006 TO 0.008	
5/8	600	0.006 TO 0.008	

TABLE B

Ream Data for GFRP, CFRP Structures, and GFRP-to-CFRP, GFRP-to-Aluminum,and CFRP-to-Aluminum Assemblies
Figure 13 (Sheet 2 of 2)

REAM DATA FOR CFRP-TO-TITANIUM AND GFRP-TO-TITANIUM ASSEMBLIES			
REAMER DIAMETER (INCH) 3	SPEED (RPM)	FEED (IPT) 1 5	REAMER TYPE
up to 1/8	500	0.003 TO 0.005	2 4
up to 3/16	400	0.004 TO 0.006	
up to 1/4	300	0.004 TO 0.006	
up to 3/8	200	0.005 TO 0.007	
up to 1/2	130	0.006 TO 0.008	
up to 5/8	100	0.008 TO 0.010	

TABLE A

NOTES

- RPM = REVOLUTIONS PER MINUTE
- IPT = INCHES PER TOOTH

1 THIS IS APPLICABLE TO POWER-FEED EQUIPMENT ONLY.

2 USE A ST1864P SOLID CARBIDE SINGLE STEP REAMER OR A ST1864R SOLID CARBIDE DOUBLE STEP REAMER. THE ST1864P REAMER WILL HAVE A 2 STEP REAM OPERATION. WITH THE ST1864R, THE TASK WILL BE COMPLETED IN ONE STEP.

3 A MINIMUM CUT OF 1/64 INCH IN THE DIAMETER IS NECESSARY WHEN YOU REAM HOLES UP TO 5/16 INCH IN DIAMETER. FOR LARGER HOLES, A 1/32 INCH CUT ON THE DIAMETER IS NECESSARY.

4 HAND FEED REAMERS ARE RECOMMENDED FOR THE HOLES UP TO 3/8 INCH IN DIAMETER.

5 INCH PER REVOLUTION (IPR) = INCH PER TOOTH (IPT) TIMES NUMBER OF TEETH. EXAMPLE: 0.006 IPT X 6 TEETH = 0.036 IPR.

Ream Data for CFRP-to-Titanium and GFRP-to-Titanium Assemblies
Figure 14

6. Countersink Holes in Composite Structures and Composite-to-Metal Assemblies

A. Countersink the holes with the microstop countersink tool.

WARNING: USE CARE WHEN YOU COUNTERSINK TITANIUM. SMALL PARTICLES AND FINE SHAVINGS OF TITANIUM ARE HIGHLY FLAMMABLE. WATER THAT TOUCHES HOT TITANIUM CAN CAUSE A STEAM EXPLOSION. EXTINGUISH ALL FIRES OF TITANIUM WITH FULLY DRY TALC, CALCIUM CARBONATE, SAND OR GRAPHITE. APPLY THE POWDER TO A DEPTH OF 1/2 INCH OR MORE ON THE BURNING METAL. DO NOT USE FOAM, WATER, HALON, CARBON TETRACHLORIDE, OR CARBON DIOXIDE. IF YOU DO NOT OBEY, YOU CAN CAUSE INJURY TO PERSONS.

WARNING: WEAR AN APPROVED DUST MASK AND SAFETY GLASSES WHEN YOU COUNTERSINK IN COMPOSITE STRUCTURE. USE A VACUUM TO REMOVE DUST AND DEBRIS. IF YOU DO NOT OBEY, INJURY TO PERSONS CAN OCCUR.

WARNING: ELECTRICALLY GROUND CFRP PARTS TO PREVENT ELECTRICAL DISCHARGE. IF YOU DO NOT OBEY, INJURY TO PERSON AND DAMAGE TO THE PARTS CAN BE THE RESULT. SELECT AN UNPAINTED AREA OF THE PART TO ATTACH A GROUNDING WIRE. AN ELECTRICAL GROUND IS NOT POSSIBLE THROUGH MOST PAINT AND PRIMERS.

CAUTION: DO NOT PERMIT CARBON DUST TO COME IN CONTACT WITH ELECTRIC MOTORS, SWITCHES, RELAYS, CONTACTS, OR ELECTRONIC CIRCUITS. USE VACUUM EQUIPMENT ON POWER TOOLS. CARBON DUST IS AN ELECTRICAL CONDUCTOR AND CAN CAUSE SHORT CIRCUITS IN ELECTRICAL EQUIPMENT. IF YOU DO NOT OBEY, PERMANENT DAMAGE TO EQUIPMENT CAN OCCUR.

CAUTION: DO NOT USE HIGH SPEED STEEL (HSS) OR COBALT DRILL BITS ON CFRP OR GFRP STRUCTURE. IF YOU DO NOT OBEY AND DO THIS THE DRILL BITS WILL IMMEDIATELY BECOME DULL AND DAMAGE TO THE HOLE AREA CAN OCCUR.

(1) Use a microstop tool to countersink the holes. Refer to Microstop-Vacuum Foot Setup to Countersink in Composite Structures and Composite-to-Metal Assemblies, Figure 15/GENERAL for the setup of the microstop tool.

(a) Make a selection of the cutter type. Refer to Table 3/GENERAL for the cutter types and tool speeds. Refer to Cutters Used to Countersink Holes in Composite Structures and Composite-to-Metal Assemblies, Figure 5/GENERAL for the sharp cutter geometries.

NOTE: It is recommended you use a Polycrystaline Diamond (PCD) cutter to countersink GFRP material.

Table 3:

COUNTERSINK DATA FOR COMPOSITE-TO-COMPOSITE AND COMPOSITE-TO-METAL ASSEMBLIES		
MATERIAL	CUTTER TYPE	DRILL MOTOR SPEED (RPM)
GFRP	ST1221C-C ST1223C-D	500 - 1500
CFRP	ST1221C-C ST1223C-D	500 - 1500
ALUMINUM	ST1221C-C	2000 - 3000
TITANIUM	ST1221C-C	150 - 300

NOTE: RPM = Revolutions Per Minute

(b) Adjust the depth of the microstop countersink tool. Make sure that the cutter is tight and secure.

1) Pull the upper and lower sections of the tool in opposite directions, and rotate them left or right.

2) Check the index marks for the necessary depth. Each index mark shows a depth of 0.001 inch or 0.005 inch and are different for alternative types or brands of microstop tools. Refer to Adjustment of Microstop Tool, Figure 16/GENERAL for an illustration of the microstop tool.

NOTE: Each fastener size will need a different microstop cutter and adjustment.

(c) For tapered surfaces, attach a mask the phenolic pad (Boeing Standard Tool No. ST1223DA) onto the microstop tool. Refer to Microstop-Countersink Phenolic-Foot, Figure 17/GENERAL to adjust the size of pad.

(d) Countersink the hole to the necessary depth with the procedures that follow:

1) Countersink the hole to the depth on a piece of test material with a sharp cutter.

a) Set the countersink depth on a piece of test material that is the same shape and type as the structure that will be countersunk.

b) Make a countersink with a fully torqued fastener that is equivalent to the one you will use.

c) If the hole is satisfactory, countersink the holes into all of the parts.

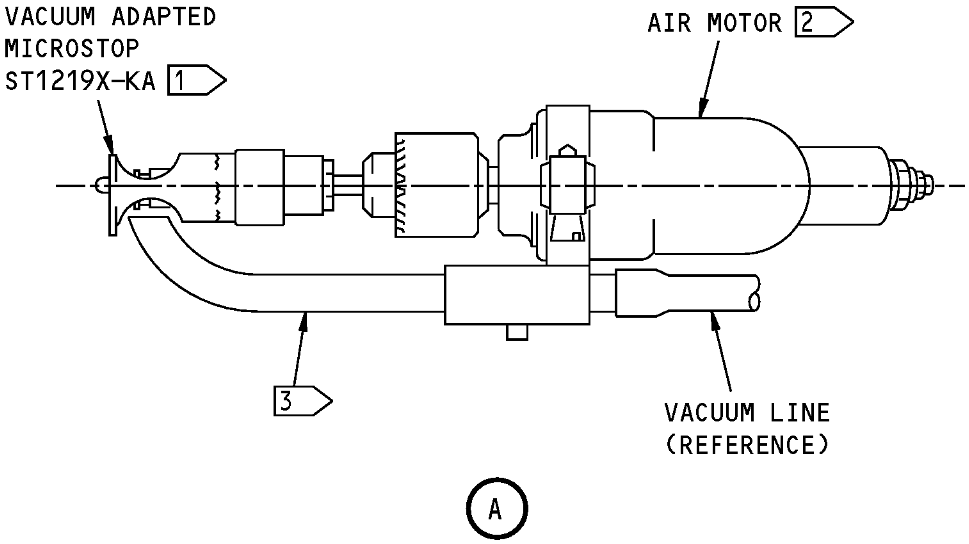
2) If you must countersink a large number of flush fasteners, you must have 2 cutters ready for use.

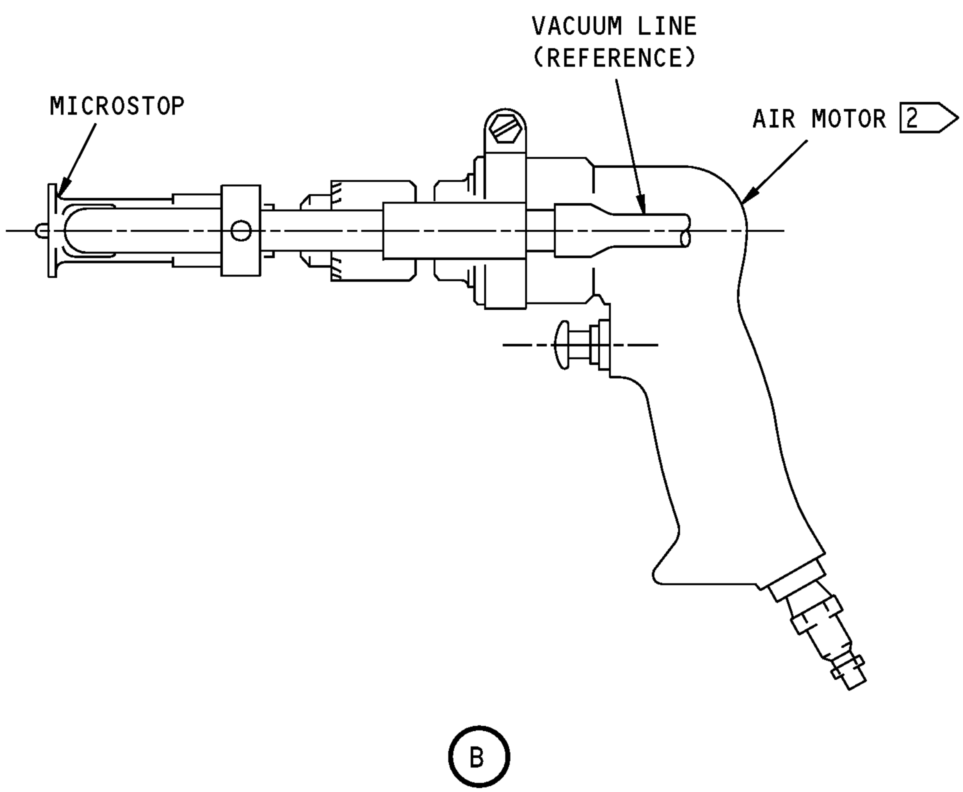
a) Set the countersink depth for the two cutters:

- Make all of the countersinks with the first cutter
- Set the countersink depth for the second cutter on the test material that was used for the first cutter setup.
- Make a more accurate countersink with the second cutter.

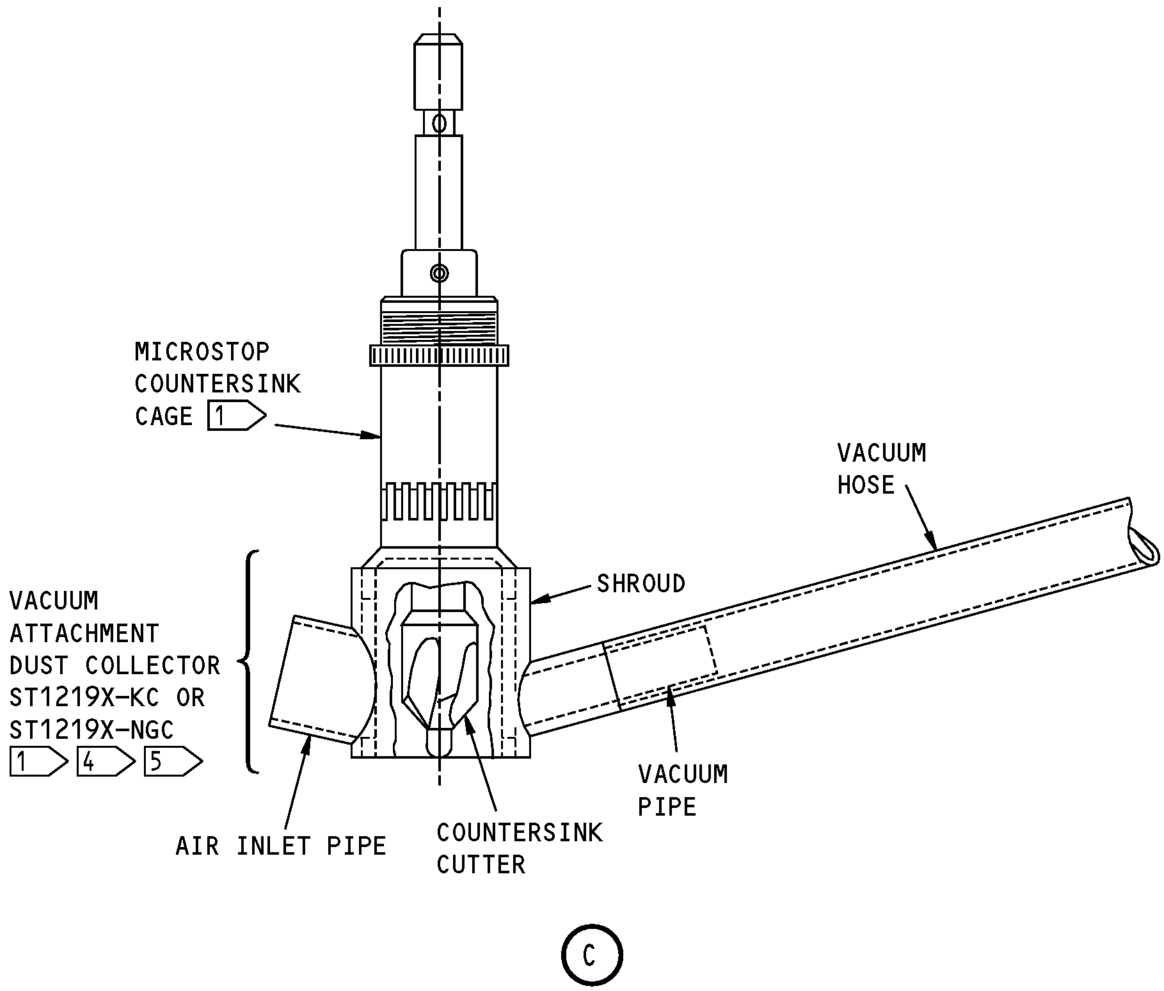
b) Measure the countersink depth from time to time. Make sure that the countersink depth is correct before you make all the holes.

(e) Install a temporary fastener to check if the countersink depth is acceptable. If necessary, refer to 51-10-01 for the aerodynamic smoothness.





Microstop-Vacuum Foot Setup to Countersink in Composite Structures and Composite-to-Metal Assemblies
Figure 15 (Sheet 1 of 2)



NOTES

1 BOEING STANDARD TOOL NUMBER

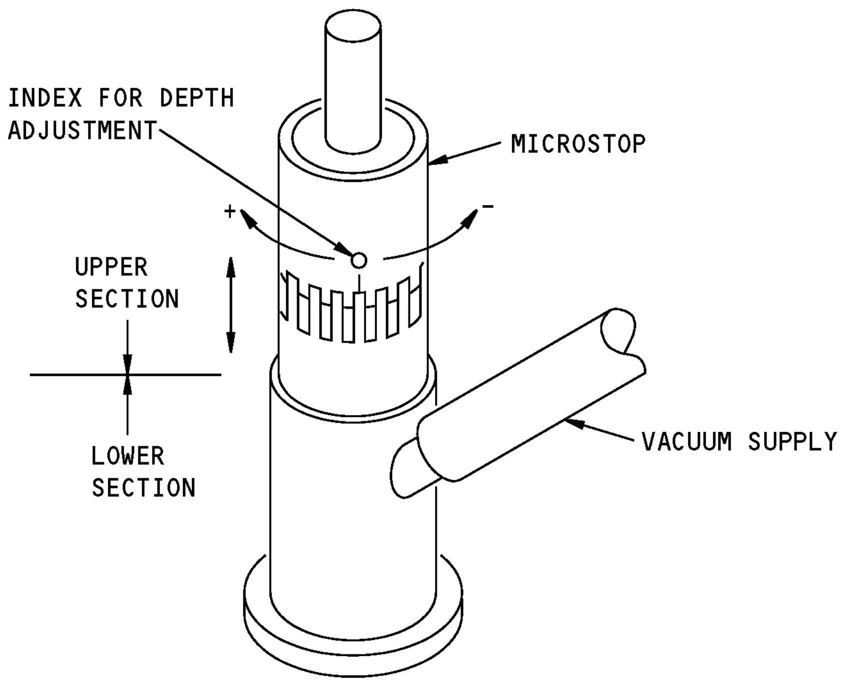
2 5000 RPM AIR MOTOR.

3 STAINLESS STEEL TUBING, 1/2 O.D. X 0.035 WALL X 7 1/2

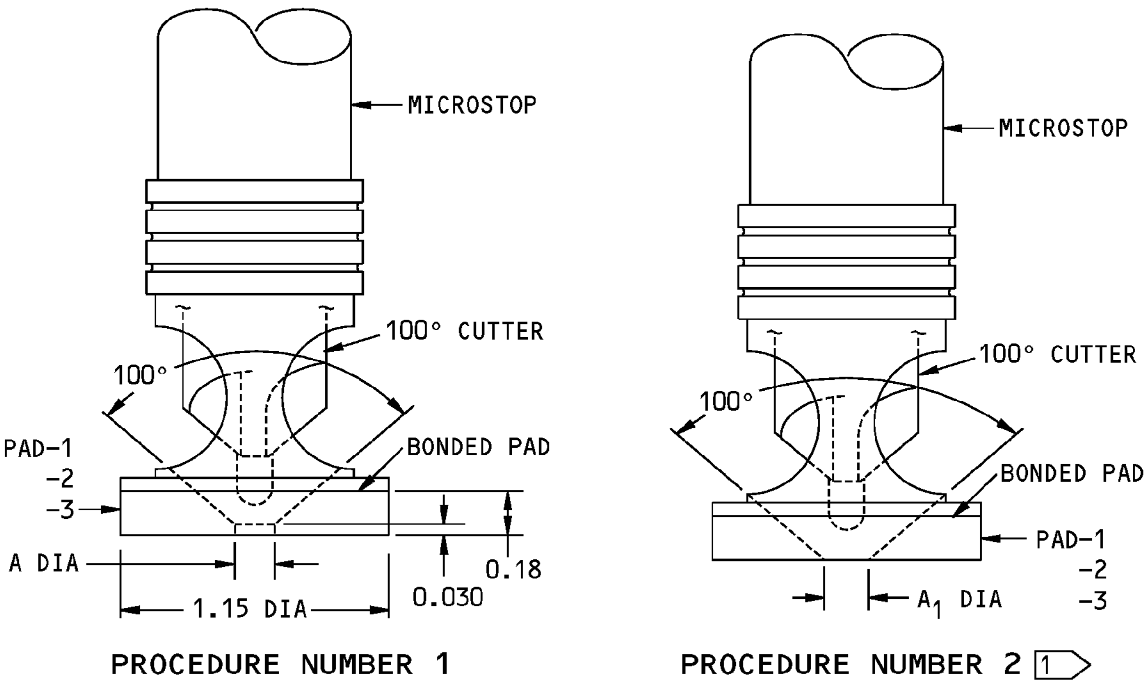
4 USE A ST1219X-KC-10 DUST COLLECTOR (THE MAGNAVON NUMBER 33-1636-0100 MICROSTOP COUNTERSINK CAGE) AND A ST1219X-KC-12 DUST COLLECTOR (THE MAGNAVON NUMBER 33-1636-0150 MICROSTOP COUNTERSINK CAGE OR EQUIVALENT).

5 USE A ST1219X-NGC DUST COLLECTOR WITH ZEPHYR MICROSTOP COUNTERSINK CAGE.

Microstop-Vacuum Foot Setup to Countersink in Composite Structures and Composite-to-Metal Assemblies
Figure 15 (Sheet 2 of 2)



Adjustment of Microstop Tool
Figure 16



BOEING STANDARD TOOL NUMBER ST1223DA
MICROSTOP-COUNTERSINK PHENOLIC-FOOT

A

DIAMETERS FOR ST1223DA MICROSTOP-COUNTERSINK PHENOLIC-FOOT			
BOEING STANDARD TOOL NUMBER	PAD ITEM NUMBER	A $^{+0.005}_{-0.000}$ DIA PROCEDURE NUMBER 1	A_1 $^{+0.010}_{-0.000}$ DIA ESTABLISHED SURFACE FLUSHNESS PROCEDURE NUMBER 2
ST1223DA-156	-1	0.156	0.156
ST1223DA-187	-2	0.187	0.187
ST1223DA-250	-3	0.250	0.250

NOTES

- ALL DIMENSIONS ARE IN INCHES, UNLESS OTHERWISE SPECIFIED.

1 AFTER THE PHENOLIC PAD IS ATTACHED, ADJUST THE CUTTER TO GET THE A_1 DIAMETER AS SHOWN.

Microstop-Countersink Phenolic-Foot
Figure 17

7. Deburr Holes in Composite Structures and Composite-to-Metal Assemblies

CAUTION: DO NOT USE POWER FEED TOOLS TO DEBURR HOLED IN COMPOSITE STRUCTURE OR APPLY TOO MUCH PRESSURE ON THE SANDPAPER. IF YOU DO NOT OBEY, YOU CAN CAUSE DAMAGE TO THE PLIES THAT CARRY LOAD.

A. Deburr the hole with sandpaper that is 180 grit or finer, or use a countersink.

(1) Apply light force in different directions until the surface becomes smooth. Refer to Use of Sandpaper to Deburr a Hole Area, Figure 18/GENERAL.

(2) Remove the burr chips frequently when you deburr the hole.

Use of Sandpaper to Deburr a Hole Area
Figure 18

8. Make an Inspection of Deburred Holes in Composite Structures and Composite-to-Metal Assemblies

A. Definitions

(1) Delamination A separation between the plies of composite structure. This can occur because of internal stresses that are caused when the composite structure is cut or machined. Refer to Hole Drilling Defects, Figure 19/GENERAL, Detail A for an example of delamination in a drilled hole.

(2) Fiber Breakout Breaks in the structure of the exit side or cut edge of a hole in composite structure. This can occur when the composite structure is drilled or cut. Fiber breakout can be one or more plies thick. Refer to Hole Drilling Defects, Figure 19/GENERAL, Detail B for an example of fiber breakout in a drilled hole.

(3) Microcracks Cracks that can be difficult to find visually. Microcracks usually occur parallel to the drill direction of the material or along the ply direction. Refer to Hole Drilling Defects, Figure 19/GENERAL, Detail C . for an example of microcracks in a drilled hole.

(4) Fiber or Resin Pullout The removal of small pieces of resin or composite fibers from the fiber matrix of a composite part. This can occur when a part is cut or drilled. Refer to Hole Drilling Defects, Figure 19/GENERAL, Detail D for an example of fiber or resin pullouts in a drilled hole.

B. Properties of a Good Quality Hole

(1) For the properties of a good quality hole area, refer to the figure, paragraph, or SRM subject that follows:

(a) Refer to Hole Properties for GFRP, CFRP, and GFRP-to-CFRP Assemblies, Figure 20/GENERAL, Detail A for the hole properties.

(b) Refer to Hole Properties for GFRP, CFRP, and GFRP-to-CFRP Assemblies, Figure 20/GENERAL, Detail B for the permitted defect limits in a drilled hole.

(c) Refer to Paragraph 8.C./GENERAL for rework criteria of the defects that are more than the allowable limits.

(d) Refer to 51-40-05 for the fastener hole dimensions.

(2) For the properties of a good quality hole area in composite-to-metal assemblies, refer to the criteria and SRM subjects that follow:

(a) The perpendicularity of a hole with a tolerance of 0.004 inch or less in diameter must be within 2 degrees of the surface.

(b) Burrs, lubricants, and faying surface sealant that will prevent the proper installation of the fastener must be removed.

(c) Refer to 51-40-05 for the permitted defect limits and fastener hole dimensions in the metal structure.

(d) Refer to 51-40-08 for the countersink data and procedures for holes in metal structures.

C. Rework Criteria for the Defective Holes in Composite Structures

(1) If a defect occurs when you drill or machine the composite structure, you must rework the defect. Refer to Table 4/GENERAL for the data on how to rework the defects.

Table 4:

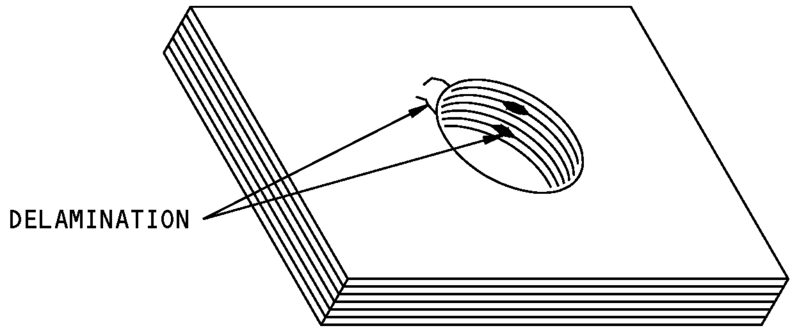
REWORK CRITERIA FOR THE DEFECTS IN COMPOSITE STRUCTURE			
DEFECT TYPE	**ALLOWABLE LIMITS**	**REWORK LIMITS**	**REWORK PROCEDURES**
CFRP plies: Frayed, burred, scorched, or delaminated areas near machined edges	0.030 inch long, normal to the edge. Refer to Figure 22 For the external ply of unidirectional ply tape or Style 3K-135-8H, a breakout that is not more than 0.150 inch normal to the edge is permitted. Refer to Figure 20	Rework is not permitted For the exter- nal ply of 3K-135-8H or unidirectional tape, a break- out that is not more than 0.250 inch normal to the edge is permitted	Not applicable Coat and cure with resin. Make the surface smooth smooth. Do not sand into the fibers
GFRP Surface Ply and Cuts and Scratches	Cuts or scratches are permitted. Damage to carbon fibers is not permitted	Rework is not permitted	Not applicable

D. Repair Countersinks or Holes in GFRP, CFRP, and CFRP-to-GFRP Assemblies That Are Drilled Incorrectly

(1) Install a pin to keep the location of the hole before you repair the countersink or the hole.

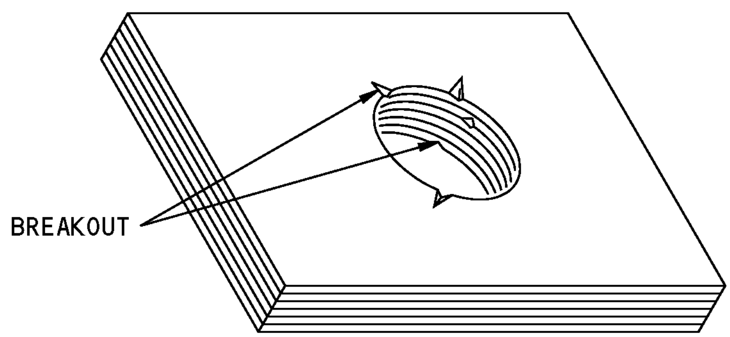
(a) Refer to 51-70-04, Repair 9 for repair of countersinks or holes that are drilled incorrectly.

(2) Apply a release agent to the pin to make the removal of the pin easier after the repair.



DELAMINATION

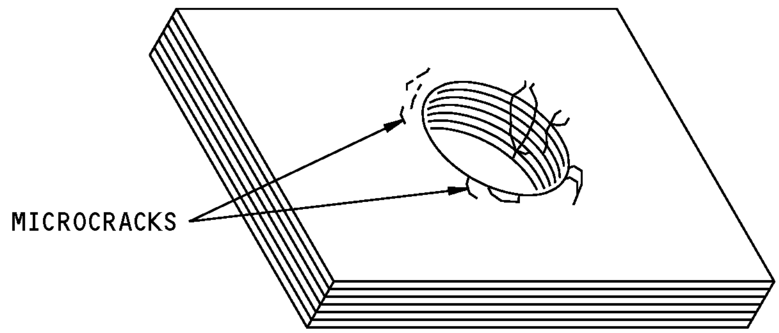
A



BREAKOUT

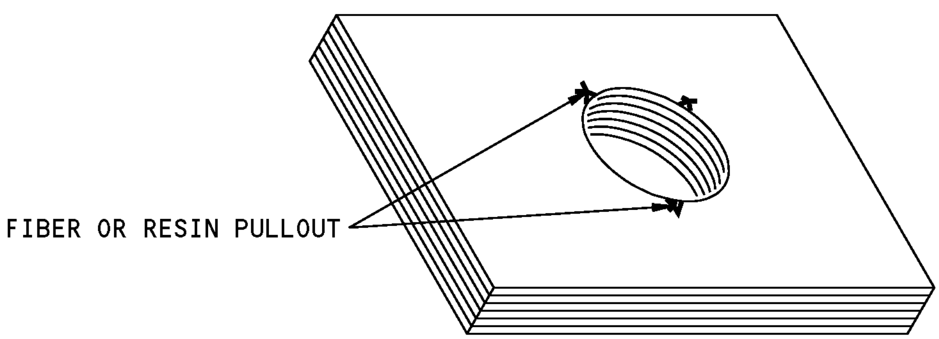
B

Hole Drilling Defects
Figure 19 (Sheet 1 of 2)



MICROCRACKS

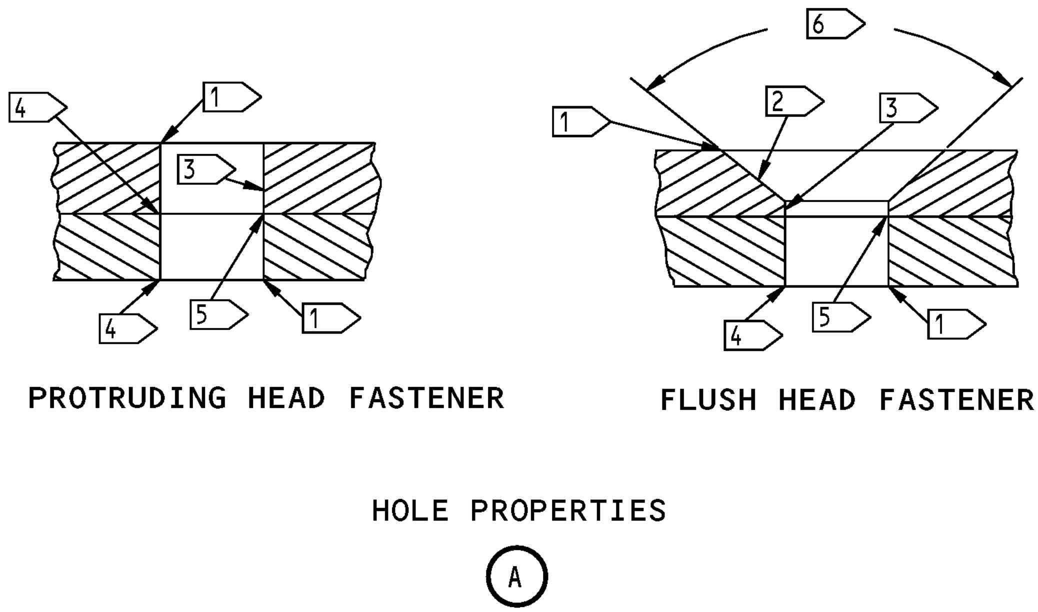
C



FIBER OR RESIN PULLOUT

E

Hole Drilling Defects
Figure 19 (Sheet 2 of 2)



NOTES

- IF GFRP PLIES ARE USED AS EXTERNAL PLIES TO ISOLATE CFRP STRUCTURE, OR TO MINIMIZE FIBER BREAKOUT, USE BREAKOUT LIMITS FOR CFRP.
- USE THE BREAKOUT LIMITS FOR CFRP WHEN GFRP PLIES (USED AS ISOLATION PLIES OR TO MINIMIZE FIBER BREAKOUT) ARE ADDED TO THE TOOL OR BAG SIDE OR BOTH OF A CFRP STRUCTURE.

1 FIBER BREAKOUT AND DELAMINATION OF THE EXTERNAL PLY GREATER THAN THE LIMITS GIVEN IN TABLE A IS NOT PERMITTED.

2 COUNTERSINKS MUST BE CONCENTRIC TO THE HOLE WITHIN 0.003 INCH. THE COUNTERSINK AXIS MUST BE PARALLEL TO THE HOLE WITHIN 1°.

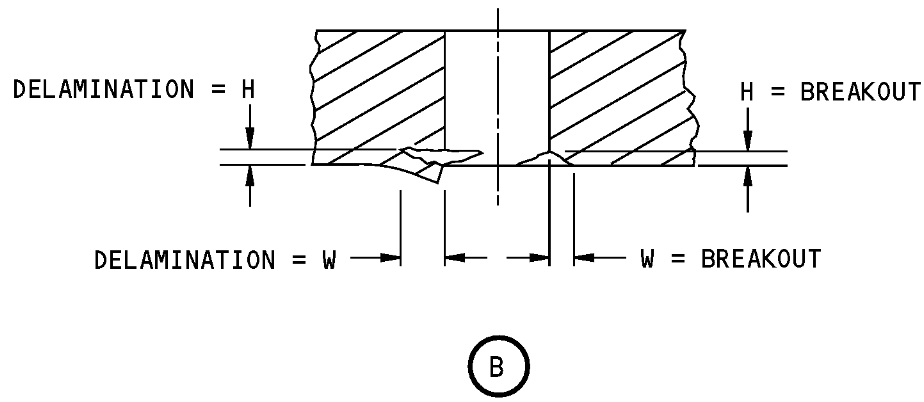
3 DELAMINATION, SCRATCHES OR TOOL MARKS ON THE SURFACE OF THE HOLE OR THE COUNTERSINK IS NOT PERMITTED IF THEY ARE VISIBLE.

4 REMOVE BURRS, DUST, OR FIBER PARTICLES WHICH PREVENT INSTALLATION OF THE FASTENER OR TOUCHING OF THE PARTS.

5 BREAKOUT DAMAGE AT THE EDGES OF THE HOLE MUST NOT EXCEED LIMITS GIVEN IN TABLE A. BREAKOUT DAMAGE IS CHIPPING, SPLINTERING, OR BROKEN FIBERS.

6 100° OR 130° COUNTERSINK ANGLE WITH A TOLERANCE OF ±2°.

Hole Properties for GFRP, CFRP, and GFRP-to-CFRP Assemblies
Figure 20 (Sheet 1 of 2)



ALLOWABLE LIMITS FOR DEFECTS TO FASTENER HOLES						
SIZE (INCHES)	CFRP FABRIC BMS 8-168,BMS 8-212, BMS 8-256,BMS 8-297, BMS 8-302,BMS 8-303, AND BMS 8-304		CFRP TAPE BMS 8-168,BMS 8-212, BMS 8-256,BMS 8-297, AND BMS 8-276		GFRP FABRIC BMS 8-327	
	H MAX (INCHES)	W MAX (INCHES)	H MAX (INCHES)	W MAX (INCHES)	H MAX (INCHES)	W MAX (INCHES)
3/32	0.007	0.015	0.014	0.050	0.030	0.100
1/8	↓	0.020	↓	0.050	↓	↓
9/64	↓	0.025	↓	0.075	↓	↓
5/32	↓	0.030	↓	0.100	↓	↓
3/16	↓	0.030	↓	0.100	↓	↓
1/4	↓	0.040	↓	0.100	↓	↓
5/16	↓	0.040	↓	0.120	↓	↓
3/8	↓	0.040	↓	0.120	↓	↓
7/16	↓	0.040	↓	0.150	↓	↓
1/2	↓	0.040	↓	0.150	↓	↓

TABLE A

Hole Properties for GFRP, CFRP, and GFRP-to-CFRP Assemblies
Figure 20 (Sheet 2 of 2)

9. Do a Rough Cut on Composite Structures

WARNING: WEAR AN APPROVED DUST MASK AND SAFETY GLASSES WHEN YOU MACHINE AND CUT COMPOSITE STRUCTURES. USE A VACUUM TO PICKUP THE DUST AND DEBRIS. IF YOU DO NOT OBEY, INJURY TO PERSONS CAN OCCUR.

CAUTION: DO NOT PERMIT COMPOSITE DUST TO COME IN CONTACT WITH ELECTRIC MOTORS, SWITCHES, RELAYS, CONTACTS, OR ELECTRONIC CIRCUITS. USE VACUUM EQUIPMENT ON POWER TOOLS. COMPOSITE DUST IS AN ELECTRICAL CONDUCTOR AND CAN CAUSE SHORT CIRCUITS IN ELECTRICAL EQUIPMENT. IF YOU DO NOT OBEY, PERMANENT DAMAGE TO EQUIPMENT CAN OCCUR.

A. Mark the contour lines on the material to be cut. Make sure there will be sufficient material left over for a final cut.

B. Do a rough cut with one of the tools that follow:

NOTE: It is recommended you use a medium to low feed rates when you cut the composite parts. You must decrease the pressure near the end of the cut to prevent chips. High feed speeds can result in excessive blade heat and wear, and a poor cut quality can be the result.

(1) Band Saw:

(a) Make sure the unidirectional tape side of the CFRP and CFRP-to-GFRP assembly faces upward.

(b) Use a band saw for irregular, curved contours and straight cuts. Refer to Table 5/GENERAL for the selection of the saw blade type and speeds.

(c) Use a backup part on the exit side to prevent delamination.

Table 5:

BAND SAW DATA					
MATERIAL		CUTTER		SPEED (SURFACE FEET/MIN)	FEED RATE (FEET/MIN)
GFRP	UP TO 0.25 INCH	Carbide Abrasive	Medium Grit	1000-4000	3-6
	0.25 TO 0.5 INCH			1000-4000	2-4
	OVER 0.5 INCH			1000-4000	1-2
CFRP	UP TP 0.12 INCH	Carbide Abrasive	60 - 80 Grit	1000-3000	2-6
	0.12 TO 0.3 INCH			1000-3000	2-4
	OVER 0.3 INCH			1000-3000	1-2

(2) Circular Saw:

(a) Use a circular saw to make straight cuts in large composite sheets.

1) Use an 8.0 to 10.0 inch diameter diamond abrasive (40-60-grit) cutter or a carbide abrasive (medium grit) cutter at 3000-5000 revolutions per minute (RPM).

(b) Use a blade height that is 0.25 inch above the work piece to prevent delamination in the material plies.

(3) Portable Circular Saw:

(a) Use a portable circular saw to make straight cuts in a small composite sheets.

1) Use a 2.0 inch diameter diamond abrasive (40-60-grit) cutter or a carbide abrasive (medium grit) cutter at 15,000-18,000 revolutions per minute (RPM).

NOTE: The use of vacuum equipment is recommended. Refer to Vacuum Equipment for Cleanup Operations, Figure 21/GENERAL for the vacuum equipment installation.

NOTE: To convert this tool speed (RPM) to surface feet per minute (SFM) multiply the tool RPM by 0.2617 and the cutter diameter as follows:

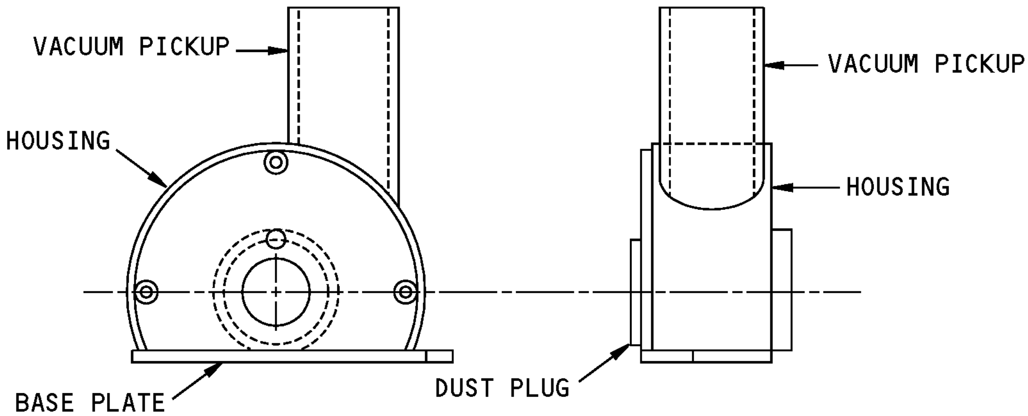
- Tool RPM X 0.2617 X Cutter Diameter = SFM
- An example calculation to find SFM speeds for a portable circular saw is as follows:

15,000 RPM X 0.2617 X 2 inches = 7851 SFM

18,000 RPM X 0.2617 X 2 inches = 9421 SFM

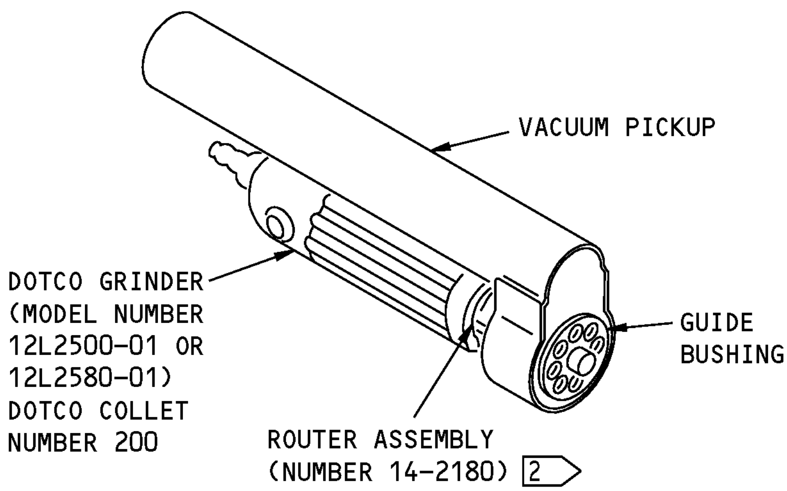
(4) Valve Stem Cutter:

(a) Use a valve stem cutter to cut honeycomb core structure, refer to Use of the Valve Stem Cutter, Figure 22/GENERAL for the procedures.



ST1265H [1] VACUUM GUARD FOR DOTCO PORTABLE CIRCULAR SAW MODEL 10L1281-32

A



ST301-J-15 [1] VACUUM PICKUP FOR DOTCO GRINDER

B

NOTES

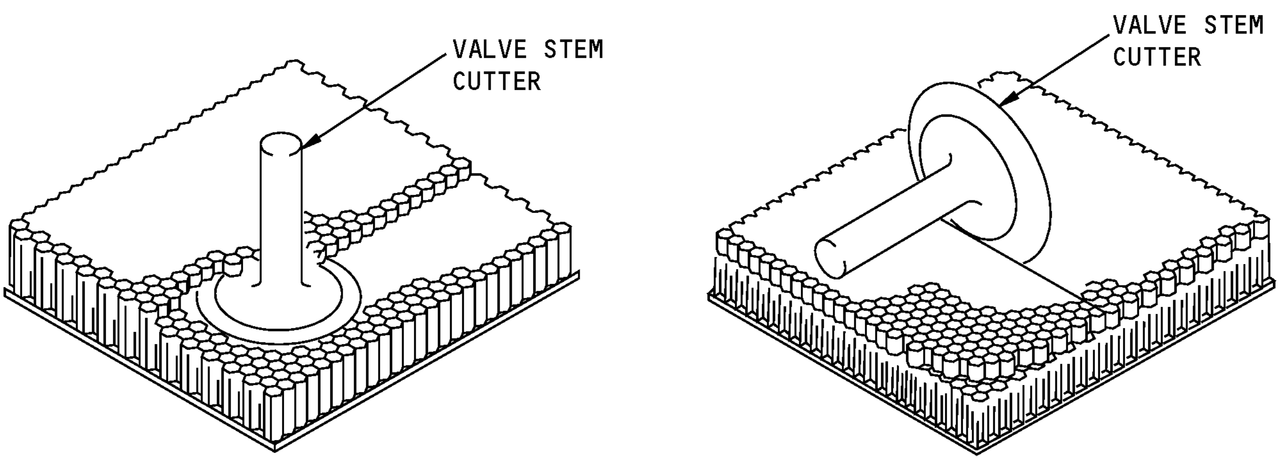
[1] BOEING STANDARD TOOL NUMBER

[2] PACIFIC DISTRIBUTING INC. REFER TO SRM 51-30-05 FOR THE SUPPLIER DATA.

Vacuum Equipment for Cleanup Operations
Figure 21

VALVE STEM CUTTERS

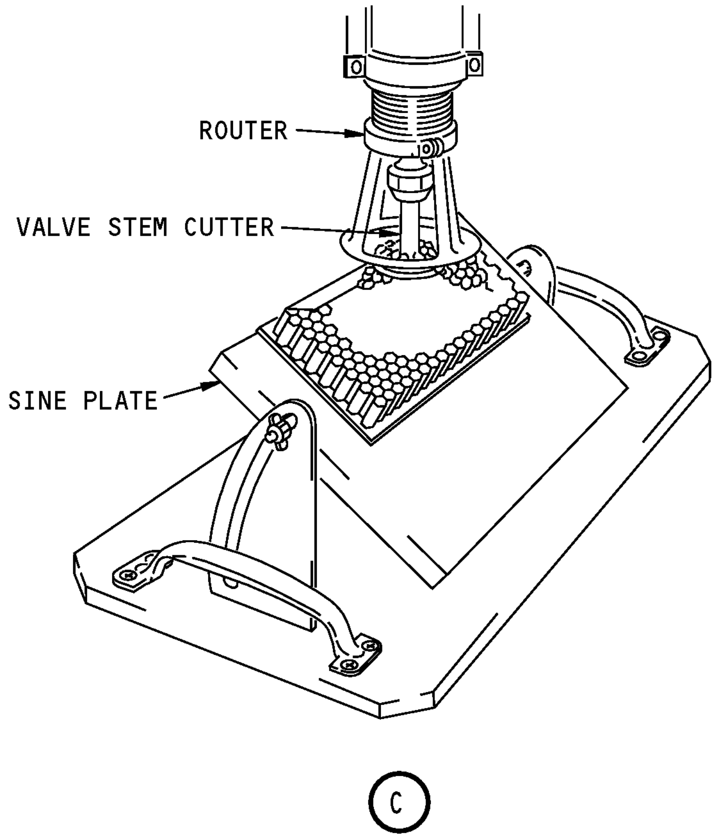
A



FLAT CUT FOR DOUBLER RECESSES, EDGE STEPS,
OR THICKNESS REDUCTION

B

Use of the Valve Stem Cutter
Figure 22 (Sheet 1 of 2)



NOTES

- REFER TO SRM 51-30-05 FOR THE CUTTER SIZES AND THE MANUFACTURER.
- ATTACH THE CUTTERS TO THE POWER ROUTER.
- TO MAKE TAPERED CUTS OR WEDGE SHAPED DETAILS, MACHINE WITH A SINE PLATE.
- TO HOLD NONMETALLIC HONEYCOMB IN POSITION, YOU CAN:
  1. USE DOUBLE-BACKED TAPE
  2. BOND A LAYER OF ADHESIVE FILM TO THE SURFACE OF THE HONEYCOMB
  3. BOND A LAYER OF ADHESIVE FILM AND A LAYER OF PREPREGNATED FIBERGLASS CLOTH.
- TO HOLD HONEYCOMB DETAILS IN POSITION FOR REWORK, YOU CAN USE:
  1. VACUUM
  2. LARGE AREA PADS WITH CLAMPS
  3. SHOT BAGS.

Use of the Valve Stem Cutter
Figure 22 (Sheet 2 of 2)

10. **Do a Final Cut on Composite Structures**

WARNING: WEAR AN APPROVED DUST MASK AND SAFETY GLASSES WHEN YOU MACHINE AND TRIM THE COMPOSITE STRUCTURE. USE A VACUUM TO REMOVE THE DUST AND DEBRIS. IF YOU DO NOT OBEY, INJURY TO PERSONS CAN BE THE OCCUR.

CAUTION: DO NOT PERMIT COMPOSITE DUST TO COME IN CONTACT WITH ELECTRIC MOTORS, SWITCHES, RELAYS, CONTACTS, OR ELECTRONIC CIRCUITS. USE VACUUM EQUIPMENT ON POWER TOOLS. COMPOSITE DUST IS AN ELECTRICAL CONDUCTOR AND CAN CAUSE SHORT CIRCUITS IN ELECTRICAL EQUIPMENT. IF YOU DO NOT OBEY, PERMANENT DAMAGE TO EQUIPMENT OCCUR.

A. Do the final cut with one of the procedures that follow:

NOTE: The radial depth should be a maximum of 25 percent of the cutter diameter or 0.06 inch, that which is less. This will prevent delamination in the heavier trims.

(1) Spindle-Shape or Router:

(a) Use a high-speed (approximately 23,000 RPM) portable router or fixed shaper to give shape to the curved sections or to cut the formed parts to the correct dimension. Refer to Table 6/GENERAL for selection of the cutter type and speed you can use.

Table 6:

ROUTER AND SPINDLE SHAPING DATA				
MATERIAL	**CUTTER**		**SPEED (SURFACE FEET/MIN)**	**FEED RATE (INCH/MIN)**
GFRP	Carbide (C-2)	Standard (Aluminum)	500-2000	3-10
	Diamond abrasive	60 to 80-grit	1200-5000	5-15
	Carbide abrasive	Medium grit	1200-5000	5-15
CFRP	Diamond abrasive	60 to 80-grit	1200-5000	5-15

(2) End Mill:

(a) Do an end mill to give shape to the edges and the make slots in the composite structure.

1) Refer to Cutters Used to End Mill GRFP and GRFP Structures, Figure 6/GENERAL for the cutter geometries.

2) Refer to Table 7/GENERAL for selection of cutters and other end milling data.

3) Use climb cut to prevent delamination in GFRP structure.

4) Use a dust collector.

Table 7:

END MILLING DATA					
MATERIAL	**CUTTER**		**SPEED (SURFACE FEET/MIN)**	**FEED RATE**	**CUT DEPTH (INCH)**
GFRP	Diamond Abrasive	60 to 80 grit	600 to 1000	4 to 8 inch/min	0.015 to 0.050
	Carbide	Aluminum	50 to 80	0.003 to 0.005 inch/tooth	0.003 to 0.005
CFRP	Diamond Abrasive	60 to 80 grit	600 to 1000	4 to 8 inch/min	0.060 maximum
	Carbide	Aluminum	50 to 80	0.003 to 0.005 inch/tooth	0.003 to 0.005

11. Remove Frayed or Delaminated Fibers From Cut Composite Structures

WARNING: WEAR AN APPROVED DUST MASK AND SAFETY GLASSES WHEN YOU CUT, MACHINE, DRILL, REAM, OR COUNTERSINK IN COMPOSITE STRUCTURE. USE A VACUUM TO REMOVE DUST AND DEBRIS. IF YOU DO NOT OBEY, INJURY TO PERSONS CAN OCCUR.

CAUTION: DO NOT PERMIT COMPOSITE DUST TO COME IN CONTACT WITH ELECTRIC MOTORS, SWITCHES, RELAYS, CONTACTS, OR ELECTRONIC CIRCUITS. USE VACUUM EQUIPMENT ON POWER TOOLS. COMPOSITE DUST IS AN ELECTRICAL CONDUCTOR AND CAN CAUSE SHORT CIRCUITS IN ELECTRICAL EQUIPMENT. IF YOU DO NOT OBEY, PERMANENT DAMAGE TO EQUIPMENT CAN OCCUR.

A. Do as follows to deburr the cut CFRP, GFRP, and CFRP-to-GFRP assemblies:

(1) Use a 280/320 (wet or dry) medium grit abrasive cloth.

NOTE: Some fine finishes need a secondary stroke with a 200 grit garnet cloth.

(2) Use a 2-inch, 180-grit abrasive, disc sander that is powered with an air motor.

(3) Use a belt sander with an 80-grit band.

(a) Sand in the direction of the fiber towards the centerline of the material.

(b) Use a Dotco 10L1280-32 with a Number 14-1301 sanding attachment, or the equivalent.

12. Apply Protective Treatment to Machined or Drilled Composite Structures

A. Apply the finish to the repair part.

(1) Use the same finish that is on the initial component.

(2) Refer to 51-20-01 for the protective treatment of composite materials.

GENERAL - EROSION PROTECTION

1. **Applicability**

   A. The subject gives the data applicable to the skin surfaces of the components that follow:

      (1) Nose radome

      (2) Wing leading edge slats

      (3) Horizontal stabilizer leading edge

      (4) High frequency (HF) antenna and vertical stabilizer leading edge

      (5) Engine inlet cowls and vortex control devices.

2. **General**

   WARNING: THE APPLICATION OF EROSION PROTECTION MATERIALS THAT IS NOT SYMMETRICAL WILL CHANGE THE FLIGHT PROPERTIES OF THE AIRPLANE. MAKE SURE THAT YOU KEEP THE SYMMETRY BETWEEN THE LEFT AND RIGHT WINGS AND LEFT AND RIGHT HORIZONTAL STABILIZERS. IF YOU DO NOT OBEY, THE RESULT CAN BE A FLUTTER CONDITION THAT CAN CAUSE A HAZARD TO FLIGHT SAFETY. THE MATERIALS USED TO CLEAN THE AIRPLANE AND THE EROSION PROTECTION MATERIALS ARE POISONOUS AND FLAMMABLE. USE SUFFICIENT VENTILATION AND FIRE PRECAUTIONS. IF YOU DO NOT OBEY, A FIRE HAZARD AND INJURY TO PERSONS CAN OCCUR.

   A. Wind and rain erosion can damage the skin surfaces of the leading edges of some of the components on the airplane. Erosion protection materials give protection from wind and rain erosion.

   B. You can apply erosion protection materials to the areas shown in Erosion Protection Locations, Figure 1/GENERAL, unless the allowable damage subject for a specified component does not permit their use.

   C. Refer to Table 1/GENERAL for the erosion protection materials that are used in this subject.

   D. Refer to 51-30-03 for the sources of the erosion protection materials.

   E. If an erosion protection material shows deterioration, you must remove it and apply the erosion protection material again.

Table 1:

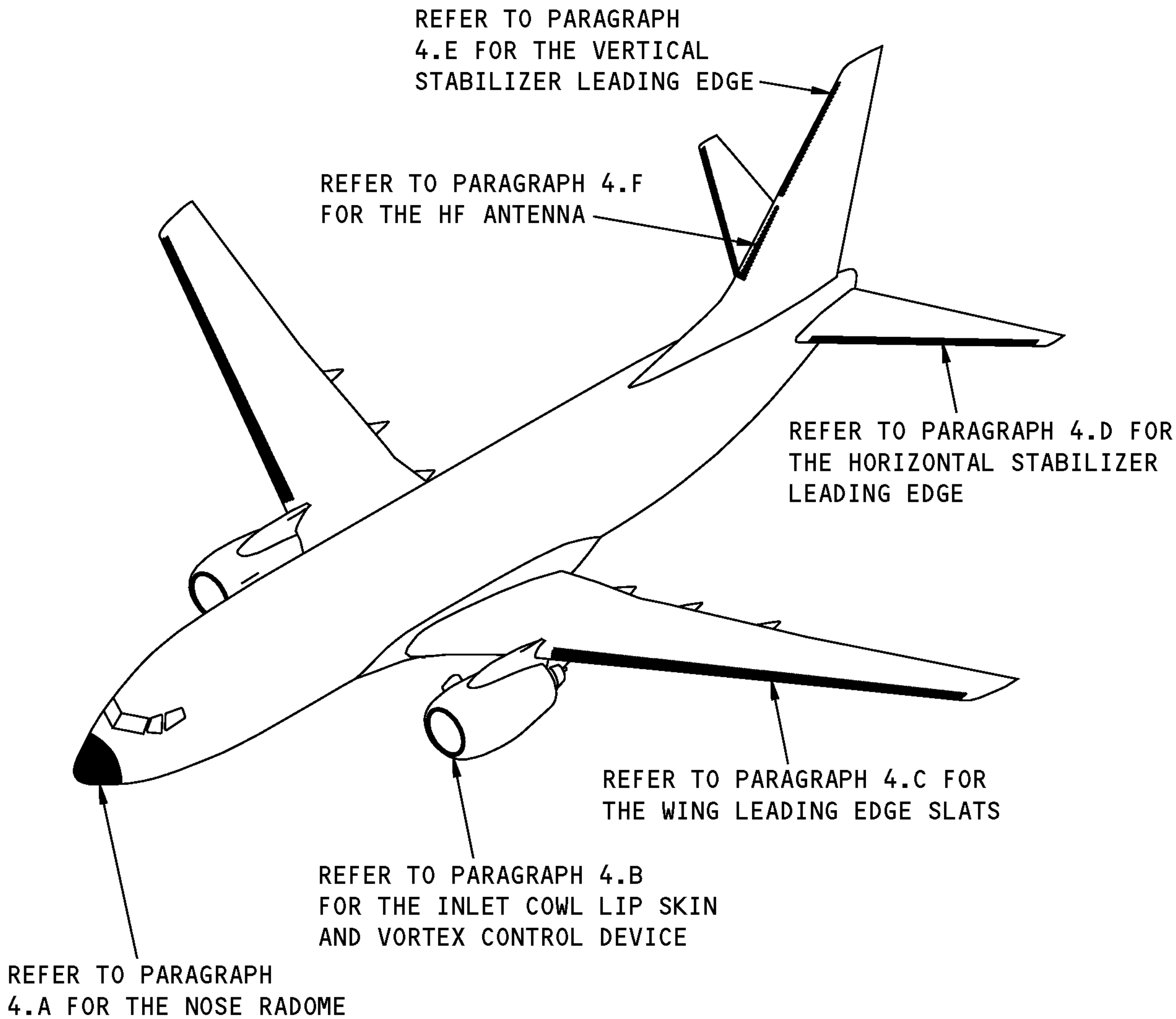
EROSION PROTECTION MATERIALS		
MATERIAL TYPE	**MATERIAL**	**PARAGRAPH**
PRIMER	Chemglaze 9924 wash primer base (part A) and catalyst (part B)	7
	Astrocoat primer base 8200 (part A) and accelerator 8201 (part B)	7
	BMS 10-79, Type II, Grade A urethane compatible, corrosion resistant primer	7
	BMS 10-103 Nonchromated primer	6
EROSION PROTECTION COATING	Black Caapcoat B-274 vehicle, curing agent and accelerator	8
	Black Astrocoat Base 8000 and catalyst 8100	8
	Non-yellowing White Caapcoat C-W4 vehicle curing agent, and accelerator	8
	Non-yellowing white Astrocoat base 8004 8101	8
	White Astrocoat base 8001 and catalyst 8100	8
	Gray Caapcoat FP-200 vehicle, curing agent, and accelerator	8
	BMS 10-60, Type II protective enamel	6

EROSION PROTECTION MATERIALS		
MATERIAL TYPE	**MATERIAL**	**PARAGRAPH**
EROSION PROTECTION TAPE	Polyurethane tape 8673	9
EDGE SEALER	Clear Skydrol Resistant Topcoating 683-3-2, 683-3-9, or 683-3-20 base and catalyst X-310A	10

F. There are two types of erosion protection materials.
(1) Erosion protection coatings:
(a) These materials are usually a mixture of a base and a catalyst.
(b) You apply erosion protection primer and coatings with spray equipment.
1) You can apply erosion protection coatings to small areas with a brush.
(2) Erosion protection tape:
(a) This material is a pressure sensitive tape.
(b) After the tape is applied, you must apply a two-part edge sealer to the edges of the tape.
(c) Erosion protection tape is not permitted on:
1) The nose radome
2) The High Frequency (HF) antenna
3) The engine inlet cowl
4) The vortex control device.

G. Refer to the allowable damage subject for the specified component for:
(1) Permitted erosion damage
(2) Cleanup of erosion damage
(3) Removal of erosion protection coatings
(4) Removal of erosion protection tape.

H. Refer to Paragraph 4./GENERAL to find:
(1) The location where the erosion protection materials can be applied
(2) The different erosion protection materials that can be applied at a location.



NOTE: THE SHADED AREAS SHOW THE LOCATIONS WHERE YOU CAN APPLY THE EROSION PROTECTION MATERIALS.

Erosion Protection Locations
Figure 1

3. References

Reference	Title
51-10-01	AERODYNAMIC SMOOTHNESS
51-20-01	PROTECTIVE TREATMENT OF METALLIC AND COMPOSITE MATERIALS
51-30-03	NON-METALLIC MATERIALS
AMM 20-30-84-910-801	Final Cleaning of Metal Prior to Painting (Series 84) (P/B 201)
AMM 20-30-87	AIRPLANE STRUCTURE CLEANING SOLVENTS (Series 87)
AMM 51-21-11	PAINT STRIPPING
AMM 51-21-11/701	Paint Stipping - Cleaning/Painting
SOPM 20-30-84	Final Cleaning of Metal Prior to Painting (Series 84)
SOPM 20-30-87	Final Cleaning of Composites Prior to Painting (Series 87)

4. Application of Erosion Protection Materials

CAUTION: DO NOT APPLY EROSION PROTECTION TAPE TO THE NOSE RADOME. IF YOU DO NOT OBEY, A DECREASE IN PERFORMANCE OF THE RADAR SYSTEM CAN OCCUR.

A. Nose radome:

(1) Refer to Erosion Protection Location for the Nose Radome, Figure 2/GENERAL for the locations on the nose radome where the erosion protection coating can be applied.

(2) Apply the erosion protection coating with the steps that follow:

(a) Prepare the surface as given in Paragraph 5./GENERAL

(b) Apply one layer of BMS 10-103 primer and one layer of BMS 10-60, Type II protective enamel as given in Paragraph 6./GENERAL

CAUTION: DO NOT APPLY EROSION PROTECTION TAPE TO THE INLET COWL LIP SKIN OR THE VORTEX CONTROL DEVICE. IF YOU DO NOT OBEY, THE TAPE CAN GET INTO THE ENGINE AND CAUSE DAMAGE.

B. Engine inlet lip skin and vortex control device:

(1) Refer to Erosion Protection Locations for the Inlet Cowl Lip Skin, Figure 3/GENERAL for the locations on the engine inlet cowl lip skin where erosion protection coatings can be applied.

(2) Refer to Erosion Protection Locations for the Vortex Control Device, Figure 4/GENERAL for the locations on the vortex control device where erosion protection coatings can be applied.

(3) Apply the erosion protection coating with the steps that follow:

(a) Prepare the surface as given in Paragraph 5./GENERAL

(b) Apply the primer as given in Paragraph 7./GENERAL Refer to Table 1/GENERAL for the types of primers you can use.

(c) Apply the erosion protection coating as given in Paragraph 8./GENERAL Refer to Table 1/GENERAL for the types of erosion protection coatings you can use.

C. Wing leading edge slats:

(1) You can apply erosion protection coatings or erosion protection tape to the wing leading edge slats, but the erosion protection tape is usually applied.

(2) Refer to Erosion Protection Locations for the Wing Leading Edge Slat Skins, Figure 5/GENERAL for the locations on the wing leading edge slats where erosion protection materials can be applied.

(3) Apply the erosion protection tape with the steps that follow:

(a) Prepare the surface as given in Paragraph 5./GENERAL

(b) Apply the tape as given in Paragraph 9./GENERAL Refer to Table 1/GENERAL for the type of tape you can use.

(c) Apply the edge sealer as given in Paragraph 10./GENERAL Refer to Table 1/GENERAL for the type of edge sealer you can use.

(4) Apply erosion protection coatings with the steps that follow:

(a) Prepare the surface as given in Paragraph 5./GENERAL

(b) Apply the primer as given in Paragraph 7./GENERAL Refer to Table 1/GENERAL for the types of primers you can use.

(c) Apply the erosion protection coating as given in Paragraph 8./GENERAL Refer to Table 1/GENERAL for the types of erosion protection coatings you can use.

D. Horizontal stabilizer leading edge:

(1) You can apply erosion protection coatings or erosion protection tape to the horizontal stabilizer leading edge, but the erosion protection tape is usually applied.

(2) Refer to Erosion Protection Locations for the Horizontal Stabilizer Leading Edge Skins, Figure 6/GENERAL for the locations on the horizontal stabilizer leading edge where erosion protection materials can be applied.

(3) Apply the erosion protection tape with the steps that follow:

(a) Prepare the surface as given in Paragraph 5./GENERAL

(b) Apply the tape as given in Paragraph 9./GENERAL Refer to Table 1/GENERAL for the type of tape you can use.

(c) Apply the edge sealer as given in Paragraph 10./GENERAL Refer to Table 1/GENERAL for the type of edge sealer you can use.

(4) Apply erosion protection coatings with the steps that follow:

(a) Prepare the surface as given in Paragraph 5./GENERAL

(b) Apply the primer as given in Paragraph 7./GENERAL Refer to Table 1/GENERAL for the types of primers you can use.

(c) Apply the erosion protection coating as given in Paragraph 8./GENERAL Refer to Table 1/GENERAL for the types of erosion protection coatings you can use.

E. Vertical stabilizer leading edge from LE STA 232.07 to LE STA 333.70:

(1) You can apply erosion protection coatings or erosion protection tape to the vertical stabilizer leading edge, but the erosion protection tape is usually applied.

(2) Refer to Erosion Protection Locations for the Vertical Stabilizer Leading Edge Skins, Figure 7/GENERAL for the locations on the vertical stabilizer leading edge where the erosion protection materials can be applied.

(3) Apply the erosion protection tape with the steps that follow:

(a) Prepare the surface as given in Paragraph 5./GENERAL

(b) Apply the tape as given in Paragraph 9./GENERAL Refer to Table 1/GENERAL for the types of tape you can use.

(c) Apply the edge sealer as given in Paragraph 10./GENERAL Refer to Table 1/GENERAL for the type of edge sealer you can use.

(4) Apply the erosion protection coating with the steps that follow:

(a) Prepare the surface as given in Paragraph 5./GENERAL

(b) Apply the primer as given in Paragraph 7./GENERAL Refer to Table 1/GENERAL for the types of primers you can use.

(c) Apply the erosion protection coating as given in Paragraph 8./GENERAL Refer to Table 1/GENERAL for the types of erosion protection coatings you can use.

CAUTION: DO NOT APPLY EROSION PROTECTION COATINGS OR TAPE TO THE METAL LEADING EDGE SKIN BETWEEN LE STA 98.03 TO LE STA 232.07. THE HIGH FREQUENCY (HF) ANTENNA IS INSTALLED IN THIS PART OF THE LEADING EDGE SKIN OF THE VERTICAL STABILIZER. IF YOU DO NOT OBEY, A DECREASE IN PERFORMANCE OF THE HF SYSTEM CAN OCCUR.

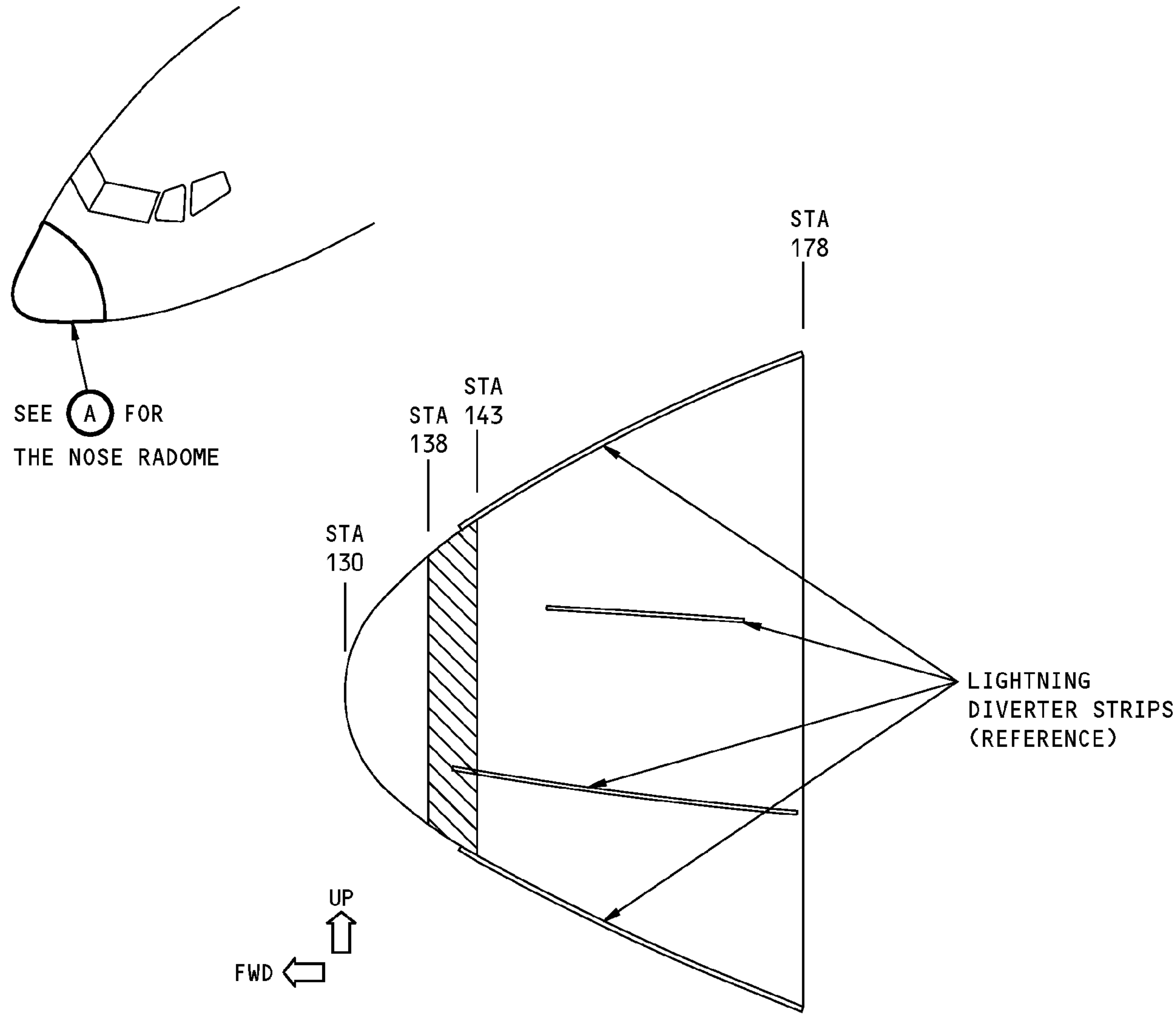
F. High Frequency (HF) antenna:

(1) Refer to Erosion Protection Locations for the Vertical Stabilizer Leading Edge Skins, Figure 7/GENERAL for the locations on the HF antenna where the erosion protection coating can be applied.

(2) Apply the erosion protection coating with the steps that follow:

(a) Prepare the surface as given in Paragraph 5./GENERAL

(b) Apply one layer of BMS 10-103 primer and one layer of BMS 10-60, Type II protective enamel as given in Paragraph 6./GENERAL



PERMITTED LOCATION FOR EROSION PROTECTION COATINGS

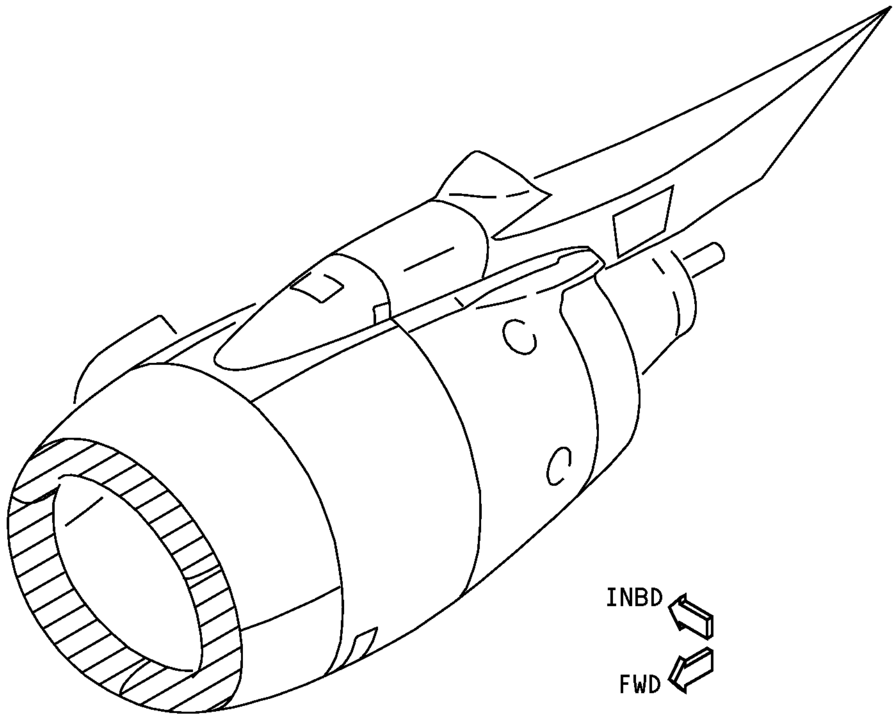
EROSION PROTECTION COATINGS ARE NOT PERMITTED BETWEEN STA 138 AND STA 143

NOTE: EROSION PROTECTION TAPE IS NOT PERMITTED ON THE NOSE RADOME.

LEFT SIDE VIEW

A

Erosion Protection Location for the Nose Radome
Figure 2

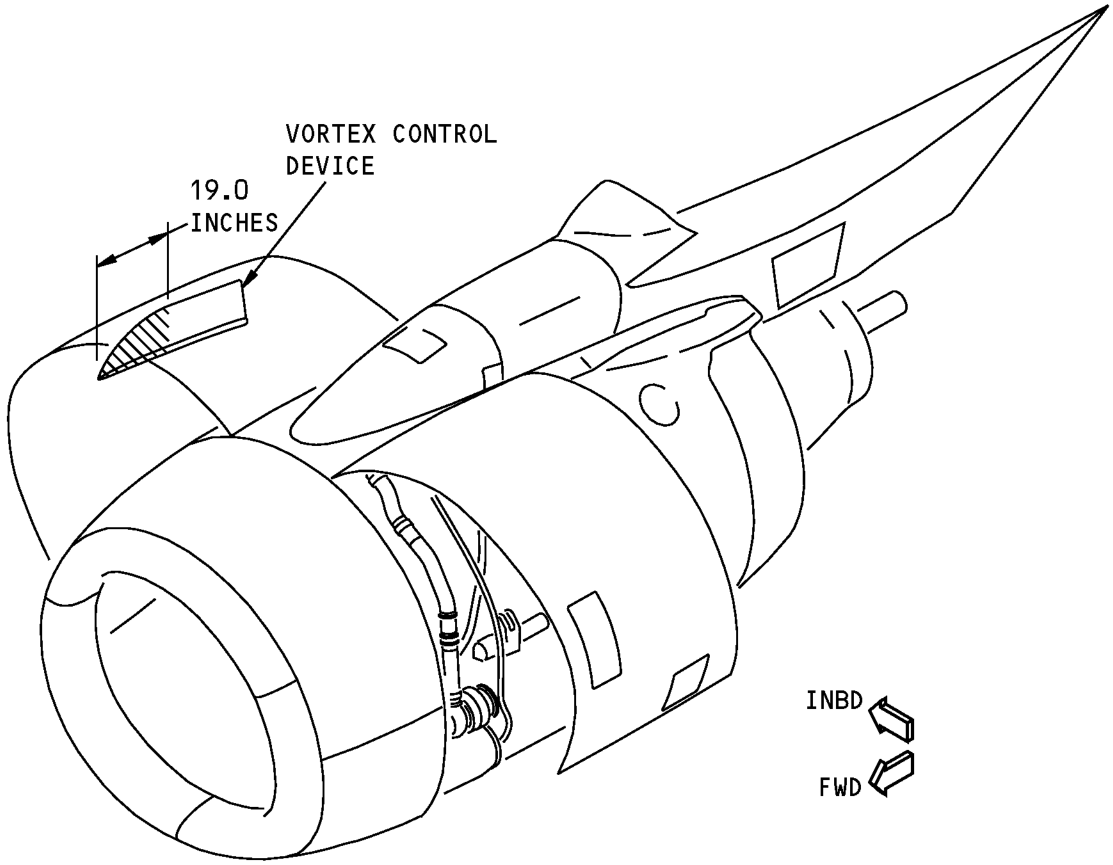


PERMITTED LOCATION FOR EROSION PROTECTION COATINGS

NOTE: EROSION PROTECTION TAPE IS NOT PERMITTED ON THE INLET COWL LIP SKIN.

LEFT ENGINE IS SHOWN, RIGHT ENGINE IS OPPOSITE

Erosion Protection Locations for the Inlet Cowl Lip Skin
Figure 3

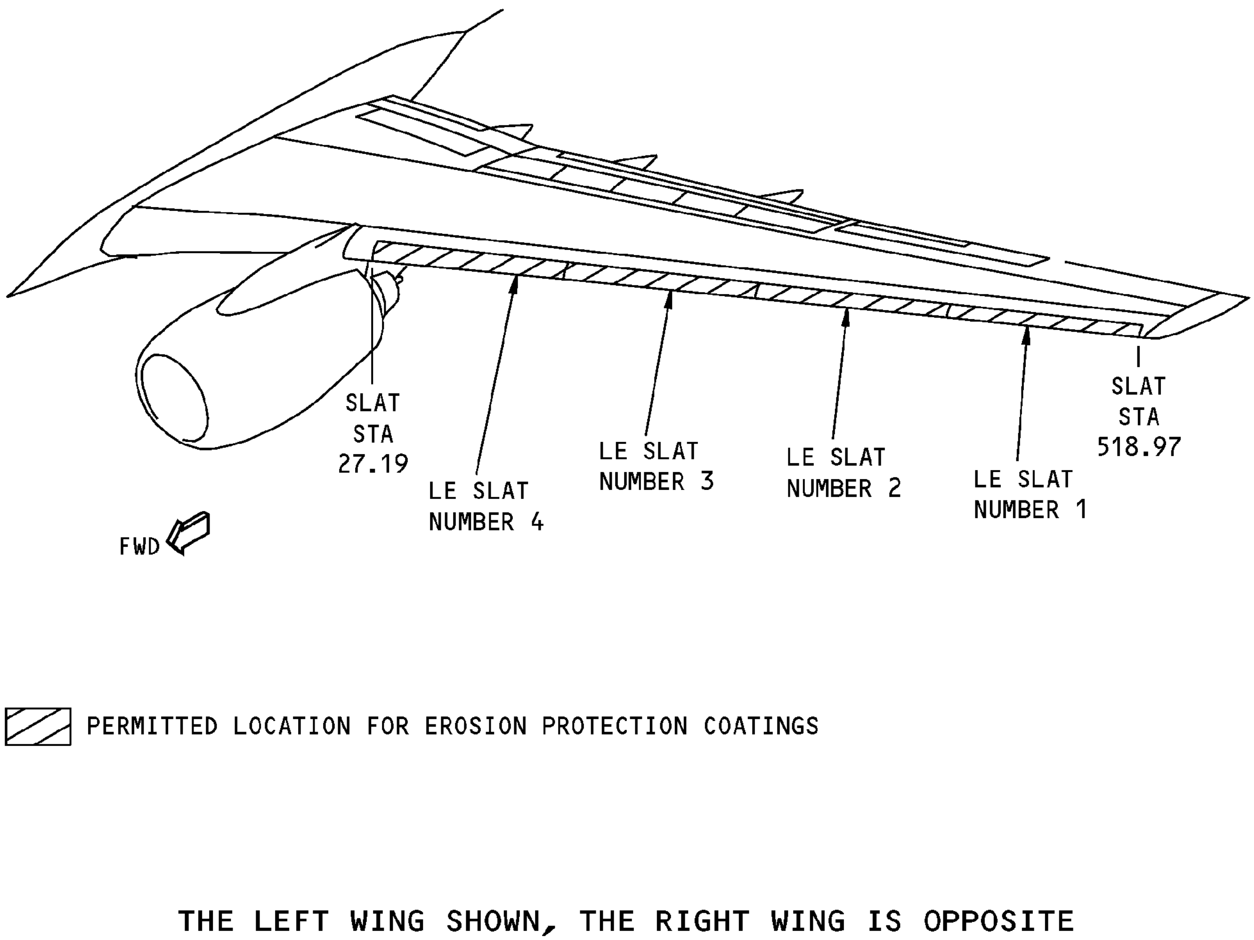


PERMITTED LOCATION FOR EROSION PROTECTION COATINGS

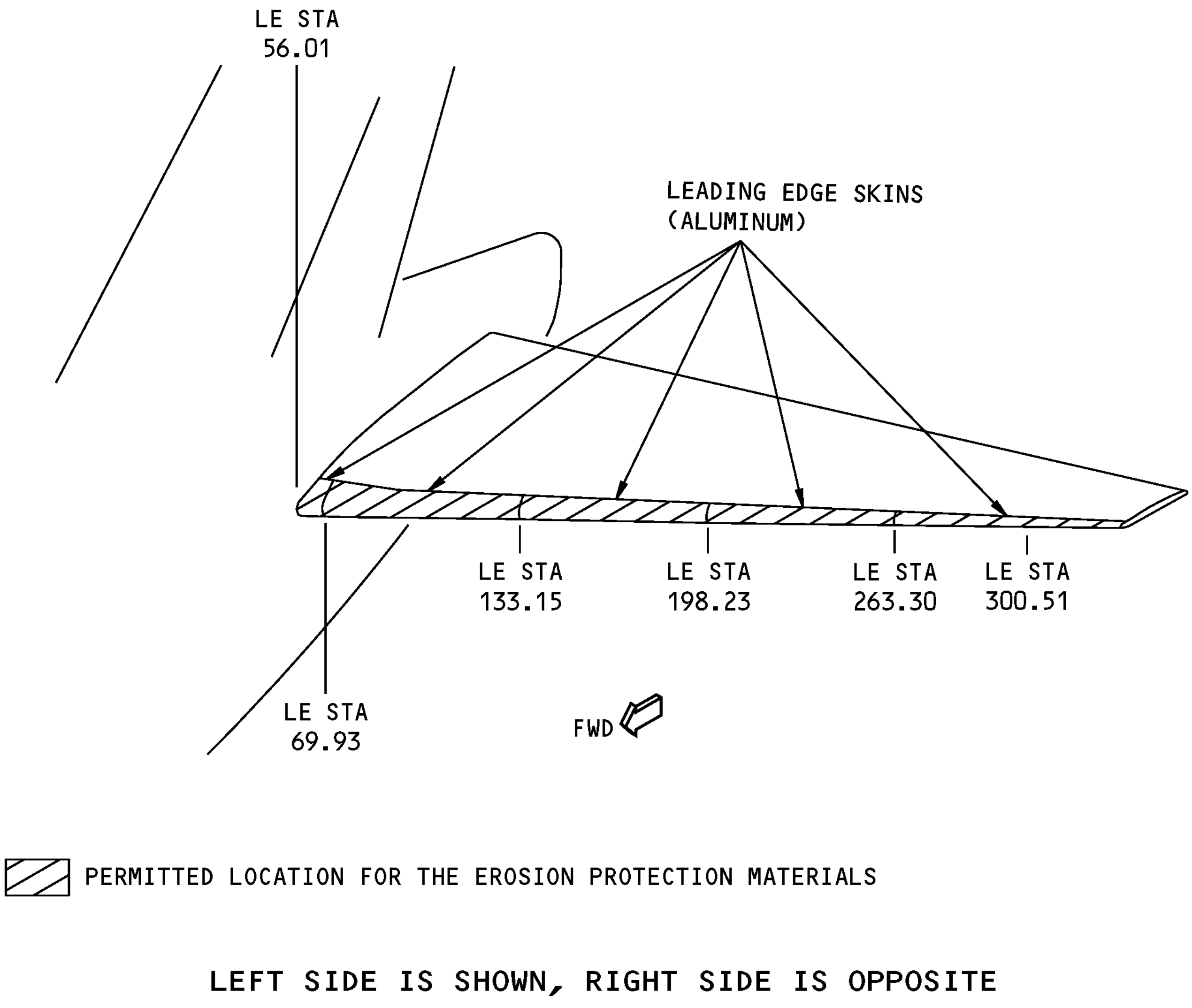
NOTE: EROSION PROTECTION TAPE IS NOT PERMITTED ON THE VORTEX CONTROL DEVICE.

LEFT ENGINE IS SHOWN, RIGHT ENGINE IS OPPOSITE

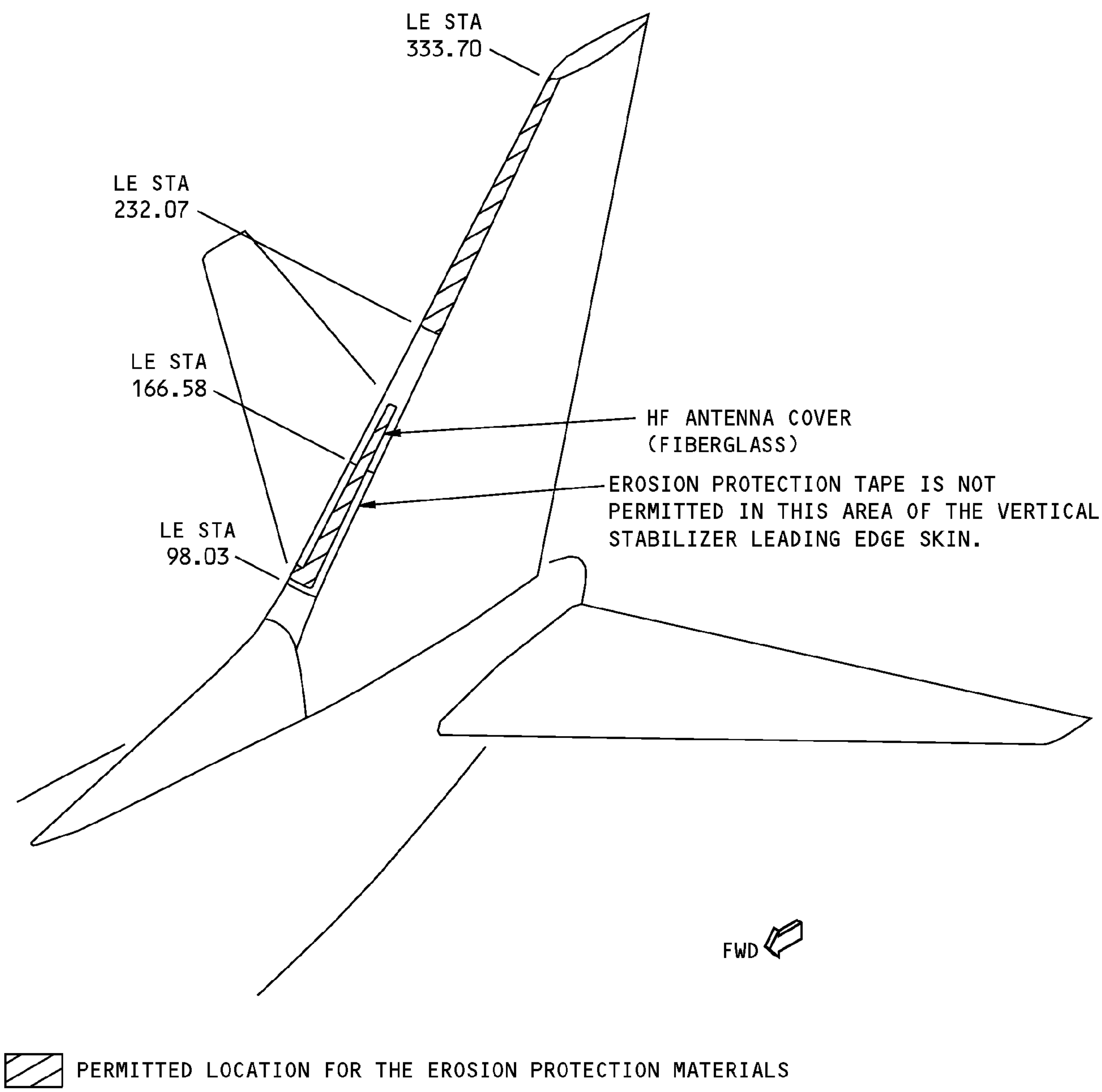
Erosion Protection Locations for the Vortex Control Device
Figure 4



Erosion Protection Locations for the Wing Leading Edge Slat Skins
Figure 5



Erosion Protection Locations for the Horizontal Stabilizer Leading Edge Skins
Figure 6



Erosion Protection Locations for the Vertical Stabilizer Leading Edge Skins
Figure 7

5. Preparation of the Surfaces

CAUTION: DO NOT USE CHEESECLOTH OR ANY OTHER FABRIC TO DRY A SURFACE THAT YOU CLEAN WITH ABRASIVE BLAST. THE SMALL PIECES OF CHEESECLOTH OR FABRIC THAT REMAIN ON THE ROUGH SURFACE WILL DECREASE THE LIFE OF THE EROSION PROTECTION MATERIAL.

A. Prepare aluminum surfaces for erosion protection materials.

(1) If you apply an erosion protection coating, prepare an area that is 0.5 inch larger on each side of the erosion damage area. Refer to Necessary Overlap for Erosion Protection Coatings and Tape Applied to a Leading Edge, Figure 8/GENERAL.

(2) If you apply erosion protection tape, prepare an area that is a minimum of 0.5 inch larger on each side of the erosion damage area. Make an equal overlap on each side of the erosion damage area. Refer to Necessary Overlap for Erosion Protection Coatings and Tape Applied to a Leading Edge, Figure 8/GENERAL.

(3) Remove the unwanted exterior finish, as applicable. Refer to AMM 51-21-11/701.

(4) Make sure a chemical conversion coating has been applied to the aluminum surfaces that have damage cleanup. Refer to the applicable allowable damage subject.

(5) Make the surfaces clean with cheesecloth that is moist with.

(6) Dry the surfaces with clean, dry cheesecloth.

(7) Make sure the surfaces are fully dry before you apply the erosion protection materials.

(8) If you apply erosion protecting coatings, apply masking tape around the erosion damaged area plus 0.5 inch all around.

B. Prepare the surfaces of the nose radome and HF antenna for the erosion protection coatings.

(1) Clean the surfaces with cheesecloth made moist with. Dry the surfaces with clean cheesecloth.

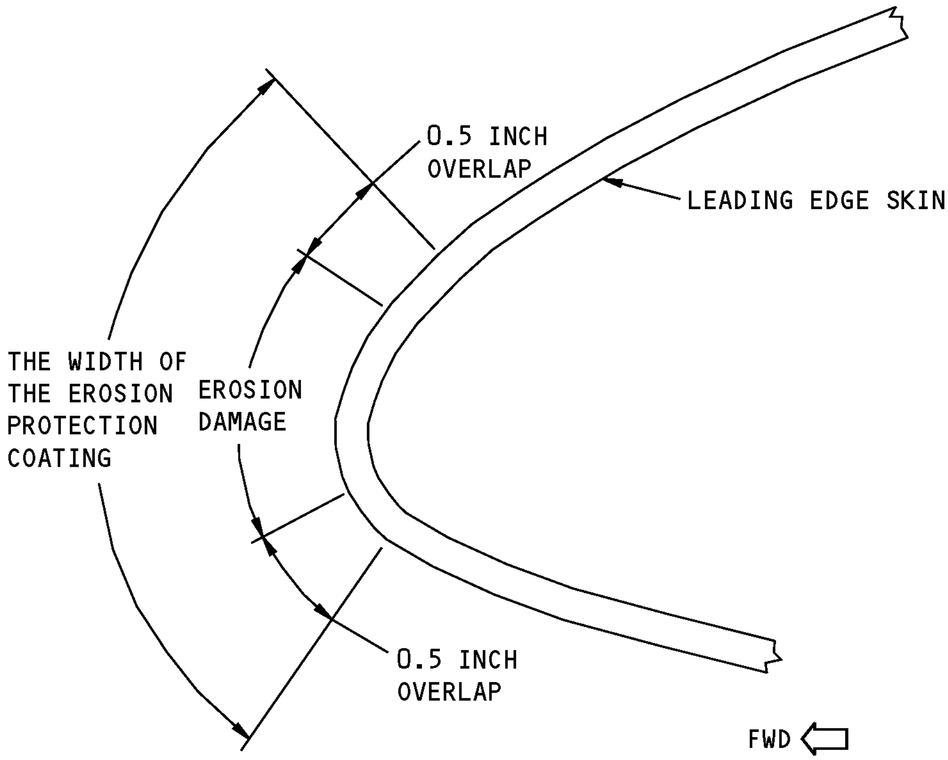
CAUTION: DO NOT DAMAGE THE FIBERS WHEN YOU MAKE THE SURFACES ROUGH WITH ABRASIVE PAPER. IF YOU DO NOT OBEY, YOU WILL CAUSE A DECREASE IN THE STRENGTH OF THE PART.

(2) Make the composite surfaces lightly rough with 240-grit or smaller abrasive paper. Be careful not to damage the fibers.

(3) Remove the abrasive dust with clean cheesecloth made moist with.

(4) Dry the surfaces with clean cheesecloth.

(5) Make sure the surfaces are fully dry before you apply the erosion protection materials.



SECTION THROUGH A TYPICAL LEADING EDGE

Necessary Overlap for Erosion Protection Coatings and Tape Applied to a Leading Edge
Figure 8

6. **Application of the Primer and Erosion Protection Coating to the Nose Radome or HF Antenna**

NOTE: The steps that follow are applicable only to the Nose Radome and HF Antenna.

A. Apply the BMS 10-103 nonchromated primer or BMS 10-79, Type II or Type III urethane compatible corrosion resistant primer.

(1) Apply the primer with a spray gun to give a dry film thickness of 0.0003 inch to 0.0008 inch.

(2) Let the primer cure at a temperature between 70°F and 90°F (21°C and 32°C) for a minimum of two hours and not more than 48 hours.

B. Apply the BMS 10-60, Type II protective enamel.

(1) Apply the enamel to give a dry film thickness of 0.008 inch to 0.010 inch.

(2) Let the enamel cure as given in the manufacturer's instructions.

7. **Application of the Primer to the Aluminum Surfaces**

A. You must apply a primer before you apply the erosion protection coating.

B. Refer to Table 1/GENERAL for the types of primers you can apply.

C. Apply the Chemglaze 9924 wash primer base and catalyst.

(1) Mix the Chemglaze primer base and catalyst as given in the manufacturer's instructions.

(2) Apply the primer with a spray gun to give a dry film thickness of 0.00025 to 0.0005 inch.

(3) Let the primer cure at a temperature between 70°F and 90°F (21°C and 32°C) for a minimum of 1 hour and not more than 24 hours before you apply the next layer.

D. Apply the Astrocoat 8200 primer base and 8201 primer accelerator.

(1) Mix the primer base and primer accelerator as given in the manufacturer's instructions.

(2) Apply the primer with a spray gun to give a dry film thickness of 0.0005 inch to 0.0015 inch.

(3) Let the primer cure at a temperature between 70°F and 80°F (21°C and 28°) for a minimum of 1 hour but not more than 20 hours.

E. Apply the BMS 10-79, Type II urethane compatible corrosion resistant primer.

(1) Apply the primer with a spray gun to give a dry film thickness of 0.0003 inch to 0.0008 inch.

(2) Let the primer cure at a temperature between 70°F and 90°F (21°C and 32°C) for a minimum of two hours and not more than 24 hours.

8. **Application of the Erosion Protection Coating**

A. Make sure a primer was applied before you apply an erosion protection coating. Refer to Paragraph 7./GENERAL

B. Refer to Table 1/GENERAL for the types and colors of erosion protection coatings you can apply.

C. Apply the Astrocoat erosion protection coating.

NOTE: Apply the Astrocoat erosion protection coating over Astrocoat primer only. Refer to Paragraph 7.D./GENERAL for the application of Astrocoat primer.

NOTE: The instructions that follow are applicable to:

- Black Astrocoat Base 8000 and catalyst 8100
- Non-yellowing White Astrocoat Base 8004 and catalyst 8101
- White Astrocoat Base 8001 and catalyst 8100

(1) Mix the base and the catalyst as given in the manufacturer's instructions.

(2) Apply the mixture with a spray gun to get a total dry film thickness of 0.010 inch to 0.014 inch.

NOTE: If you correctly apply the coating, the surface will be smooth. This is because the low points are filled as you apply subsequent layers.

(a) Apply each layer of the mixture to a dry film thickness of not more than 0.001 inch.

(b) Let each layer cure approximately one hour at a temperature between 70°F and 75°F (21°C and 24°C) with a relative humidity of 40 to 50 percent.

NOTE: Each layer must not be tacky to the touch of your finger before you apply the next layer.

(c) The time between applications of subsequent layers must not be more than 4 hours.

(3) Immediately after you apply the last layer, remove the masking tape.

NOTE: This will prevent the removal of the coating with the masking tape.

(4) Let the last layer cure as shown in Cure Time for Astrocoat Erosion Protection Coatings, Figure 9/GENERAL.

D. Apply the Caapcoat Polyurethane Coating.

NOTE: The instructions that follow are applicable to:

- Black Caapcoat B-274
- Non-yellowing White Caapcoat C-W4
- Gray Caapcoat FP-200

(1) Mix the Caapcoat polyurethane coating as given in the manufacturer's instructions.

(2) Apply the coating in subsequent layers to get a dry film thickness of 0.008 inch to 0.012 inch.

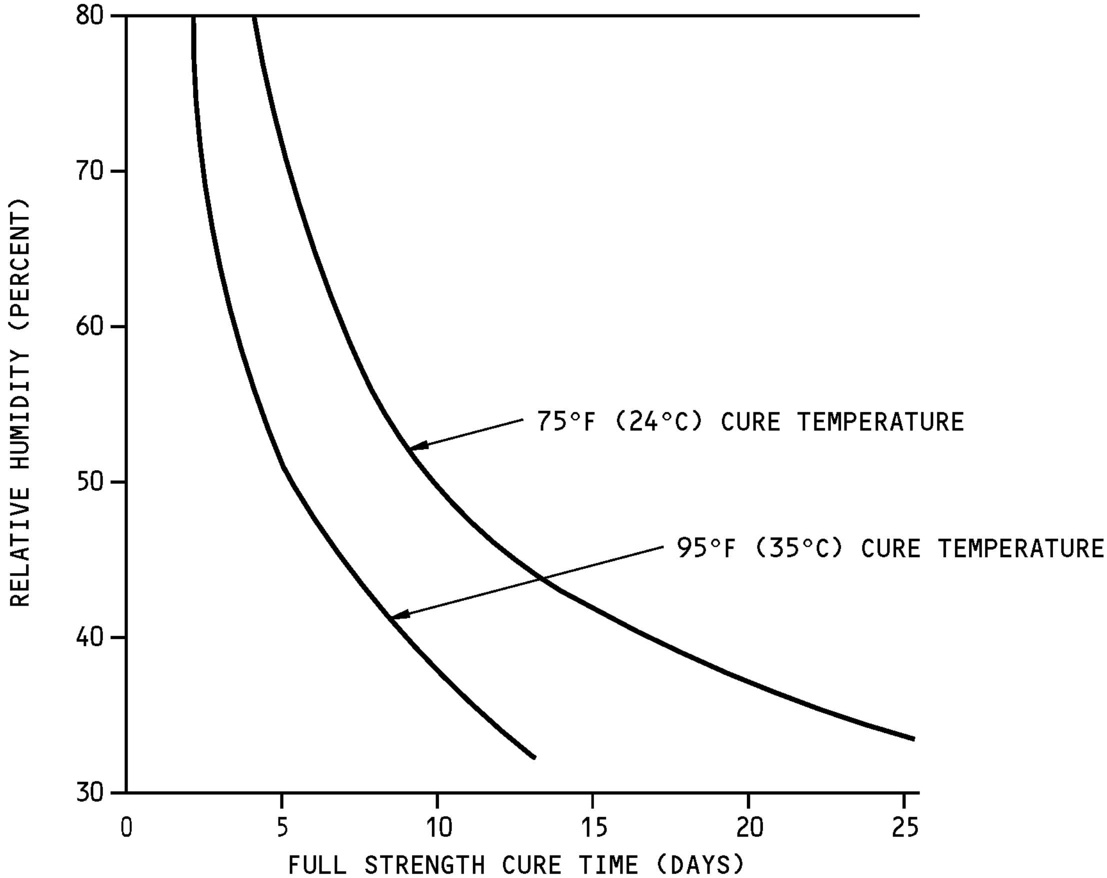
(3) Let the coating cure a minimum of 10-20 minutes and a maximum of 2 hours between each subsequent layer.

(4) The cure time for the coating is between 2 and 3 days in ambient conditions.

(a) After an initial cure time of 24-hours in ambient conditions, you can decrease the cure time with heat to a maximum temperature of 150°F (66°C) for 3 hours.

(5) Remove the masking tape immediately after you apply the last layer.

NOTE: This will prevent the removal of the coating with the masking tape.



NOTE: THE GRAPH SHOWS THE CURE TIME NECCESSARY FOR FULL STRENGTH AND RESISTANCE TO RAIN EROSION.

AFTER YOU APPLY THE LAST LAYER OF ASTROCOAT EROSION PROTECTION COATING AND BEFORE YOU PUT THE AIRPLANE IN SERVICE, DO THESE STEPS:

- FOR AIRPLANES PUT IN SERVICE THAT WILL NOT BE IN RAIN, LET THE EROSION PROTECTION CURE A MINUMUM OF 24 HOURS AT 70-75°F (21-24°C) WITH A RELATIVE HUMIDITY OF 40-50 PERCENT.
- FOR AIRPLANES PUT IN SERVICE THAT WILL BE IN RAIN, LET THE EROSION PROTECTION CURE A MINIMUM OF 72 HOURS AT 70-75°F (21-24°C) WITH A RELATIVE HUMIDITY OF 40-50 PERCENT.

Cure Time for Astrocoat Erosion Protection Coatings
Figure 9

9. Application of the Erosion Protection Tape

CAUTION: APPLY THE EROSION PROTECTION TAPE CORRECTLY. IF YOU DO NOT APPLY THE TAPE CORRECTLY, YOU CAN CAUSE A DECREASE IN THE AERODYNAMIC PERFORMANCE OF THE AIRPLANE AND A DECREASE IN THE LIFE OF THE EROSION PROTECTION TAPE.

A. Refer to Table 1/GENERAL for the type of tape you can apply.

B. Apply the tape with the steps that follow.

(1) Put a mark on each leading edge skin panel 1/2 inch from each end of the panel. Use a felt-tip marking pen.

(a) For surfaces that have erosion damage cleanup that agrees with the allowable damage limits, put the mark a minimum of 1/2 inch more all around the damaged area. This is not applicable to cleanup nearer than 1/2 inch to the lengthwise end of the panel.

(2) Cut the tape to the correct dimensions.

(a) We recommend you use a width of six inches.

(b) Measure the length of each leading edge skin panel and cut the tape 1.0 inch less than the length of the component.

NOTE: The adhesive on the tape is sensitive to pressure. If you cut the length too long, you can have a problem with wrinkles and creases when you apply it.

(3) Use one of the two procedures that follow to apply the tape.

NOTE: We recommend that you begin the application of the tape at:

- The outboard ends of the leading edge skin panels of the wing leading edge slats and the horizontal stabilizer
- The upper ends of the leading edge skin panels of the vertical stabilizer.

(a) Procedure A:

1) Remove the backing paper approximately one inch along the lengthwise edge.

2) Apply this edge to the mark you made in step 9.B.(1).

3) Remove the backing paper as you press the tape in position.

(b) Procedure B:

1) Apply a solution of one part detergent to 50 parts water to the leading edge. The wet surface permits small adjustments of the tape.

2) Remove the paper backing from the tape.

3) Put the edge of the tape in position at the mark you made in step 9.B.(1) and press it against the leading edge surface.

4) Use a rubber squeegee or a roller to smooth the tape out from the centerline of the leading edge.

5) Remove all the air bubbles and the detergent solution.

6) Rub the tape down satisfactorily with clean cheesecloth or a small rubber roller.

7) If small air bubbles are under the tape, use a pin to make a hole in the tape to release the air and rub the tape down again.

10. Application of the Edge Sealer

NOTE: The external surface where you apply the edge sealer must be fully dry before you apply the edge sealer.

A. Apply the Edge Sealer - Skydrol Resistant Topcoating.

NOTE: The instructions that follow are applicable to Skydrol Resistant Topcoating

- Base: 683-3-2, 683-3-9, or 683-3-20
- Catalyst: X-310A.

(1) Mix the Skydrol Resistant Topcoating base and catalyst as given in the manufacturer's instructions.

B. Apply the edge sealer with a brush.

NOTE: Let the sealant dry tack free before overcoating.

(1) Make a 3/8 inch to 1/2 inch overlap on all edges of the tape and the skin panel.

(2) Apply the mixture to a total dry film thickness of 0.001 inch to 0.002 inch.

GENERAL - FREEZE PLUG INSTALLATION

1. **Applicability**

   A. This subject gives the procedures for a repair with an aluminum freeze plug. A structural engineering review is necessary before freeze plugs are installed. If necessary, Boeing can help with the structural engineering review.

   B. The freeze plug installation repair procedure is applicable to aluminum alloy material that has a minimum thickness of 0.063 inch (1.60 mm).

2. **General**

   A. A freeze plug installation is a structural repair procedure that you can use in aluminum structure. The freeze plug is installed in a hole with an interference fit. This repair will transmit compressive stress loads. Because of its durability, this repair is preferred to a plug that does not have an interference fit or to an open hole.

   B. This section gives two procedures to install freeze plugs.

      (1) The installation of straight shank freeze plugs. Refer to Paragraph 4.A./GENERAL

      (2) The installation of countersink freeze plugs. Refer to Paragraph 4.B./GENERAL

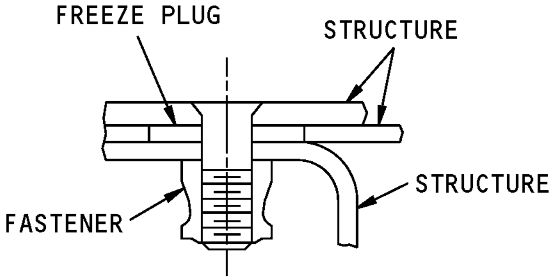
   C. It is best to have parts on each side of the freeze plug to hold it in position. Refer to Examples of Freeze Plug Installation, Figure 1/GENERAL, Detail A . If you can not hold the freeze plug in this way, use straps, washers, or countersinks. Refer to Examples of Freeze Plug Installation, Figure 1/GENERAL, Detail B . Install the washers and straps wet with BMS 5-95 sealant between the mating surfaces. Refer to 51-20-05.

   D. To find the edge margin and the diameter of the freeze plug installation, use the diameter of the hole for the freeze plug. Do not use the diameter of a fastener hole through a freeze plug.

   E. You can put shims between the structural members temporarily, to help you install the freeze plug flush. Make sure that you remove the shims after you install the freeze plug.

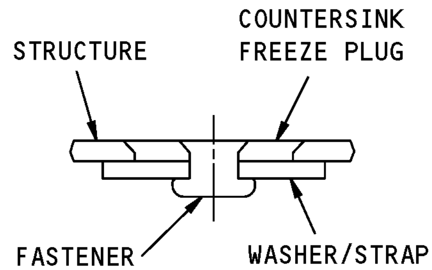
   F. Apply BMS 5-95 sealant to the mating surfaces of the structure before you install the freeze plugs.

   G. If more than one structural member is damaged, you must install a separate freeze plug for each part. Refer to Examples of Freeze Plug Installation, Figure 1/GENERAL, Detail C . You can install a single freeze plug in skin and hot bonded doublers if there is no delamination. Refer to Examples of Freeze Plug Installation, Figure 1/GENERAL, Detail D.



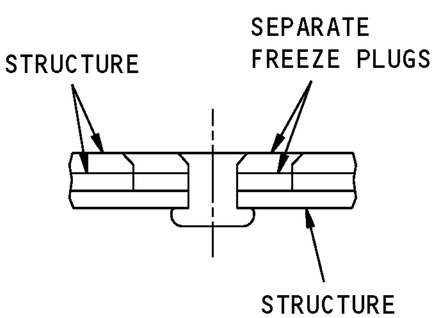
FREEZE PLUG THAT IS CONTAINED BETWEEN TWO OTHER PARTS

A



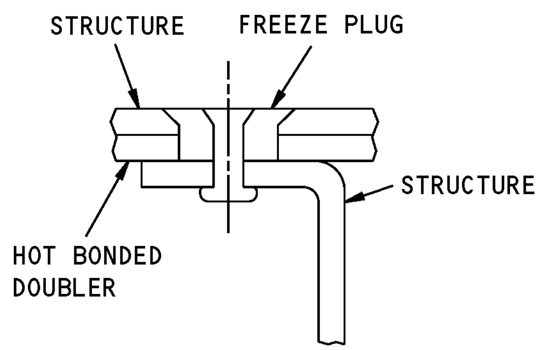
FREEZE PLUG WITH WASHER/STRAP

B



FREEZE PLUGS IN MORE THAN ONE STRUCTURAL MEMBER

C



SINGLE FREEZE PLUG IN STRUCTURE WITH HOT BONDED DOUBLER

D

Examples of Freeze Plug Installation
Figure 1

3. References

Reference	Title
51-10-01	AERODYNAMIC SMOOTHNESS
51-10-02	INSPECTION AND REMOVAL OF DAMAGE
51-20-01	PROTECTIVE TREATMENT OF METALLIC AND COMPOSITE MATERIALS
51-20-05	REPAIR SEALING
51-40-08	COUNTERSINKING

4. Freeze Plug Installation Procedures

A. Install a straight shank freeze plug.

(1) Remove the damage. Refer to 51-10-02.

(a) Use the smallest diameter drill and reamer possible to remove the damage.

NOTE: Make sure that the freeze plug will have a minimum wall thickness of 0.05 inch (1.27 mm) if a fastener hole will be drilled through it. Refer to Straight Shank Freeze Plug Installation, Figure 2/GENERAL.

(b) Remove all the nicks, scratches, gouges, and sharp edges from the freeze plug hole.

(c) Machine the freeze plug hole to a surface finish of 63 microinches Ra or smoother.

(d) Make sure the cylindricity tolerance for the freeze plug hole is 0.0003 inch (0.007 mm). Refer to Cylindricity, Figure 3/GENERAL.

(2) Measure the diameter of the freeze plug hole to 4 decimal positions (X.XXXX).

(3) Measure the thickness of the damaged aluminum structure to the nearest 3 decimal positions (X.XXX). Refer to Straight Shank Freeze Plug Installation, Figure 2/GENERAL, Section A-A .

(4) Make the straight shank freeze plug.

NOTE: If more than one structural member is damaged, you must install a separate freeze plug for each part. Refer to Examples of Freeze Plug Installation, Figure 1/GENERAL, Detail C.

(a) Make the freeze plug from 7075-T6 aluminum alloy.

(b) Make the freeze plug the same thickness or thicker than the thickness of the structure it will be installed in. The thickness tolerance of the freeze plugs must be +0.003 inch to -0.000 inch (+0.076 mm to -0.000 mm) of the material thickness.

NOTE: The diameter-to-thickness ratio of the plug must be 10 to 1 or less.

(c) Make the diameter of the freeze plug 1.0035 to 1.0040 times larger than diameter of the hole. For an example, if the diameter of the hole is 0.4500 inch (11.43 mm), the diameter of the freeze plug must be 0.4516 inch to 0.4518 inch (11.471 mm to 11.476 mm).

(d) Make sure that the freeze plug will have a minimum wall thickness of 0.05 inch (1.27 mm) if a fastener hole will be drilled through it. Refer to Straight Shank Freeze Plug Installation, Figure 2/GENERAL.

(e) Make sure the cylindricity tolerance for the freeze plug is 0.0002 inch (0.005 mm). Refer to Cylindricity, Figure 3/GENERAL.

(f) Machine the outer diameter of the freeze plug to a surface finish of 63 microinches Ra or smoother.

(g) Measure the outer diameter of the freeze plug to four decimal positions (X.XXXX).

(h) For freeze plugs in more than one structural member, put a chamfer on the mating edges of each freeze plug 45 degrees x 0.003 to 0.006 inch (0.762 mm to 0.152 mm). Refer to Freeze Plugs in More Than One Structural Member, Figure 4/GENERAL.

(5) Apply a chemical conversion coating to the freeze plug. Refer to 51-20-01).

(6) Drill a pilot hole through the center of the freeze plug if a fastener will be installed. As an alternative, use a hole from an initially installed fastener and back drill through the freeze plug.

CAUTION: WEAR PROTECTIVE CLOTHING WHEN YOU WORK WITH LIQUID NITROGEN. MAKE SURE THAT THE WORK AREA HAS A GOOD FLOW OF CLEAN AIR. LIQUID NITROGEN IS APPROXIMATELY MINUS 320°F (MINUS 196°C). IF YOU DO NOT OBEY, INJURY TO PERSONS CAN BE THE RESULT.

(7) Put the freeze plug in liquid nitrogen for a minimum of 10 minutes immediately before installation.

(8) Apply BMS 5-95 sealant to the edges of the hole. This will help in the installation of the freeze plug.

(9) Install the freeze plug.

(a) Install the freeze plug flush to a tolerance of +0.003 inch to -0.000 inch (+0.076 mm to -0.000 mm).

NOTE: If the freeze plug buckles when it is installed, you must replace it.

(b) Microshave the freeze plug, if necessary. Refer to 51-10-01.

1) Make sure that excess sealant is removed before you microshave.

2) Do not microshave through the clad surfaces.

3) Apply a chemical conversion coating to the bare external surfaces of the freeze plug after you microshave it.

(c) The mating surfaces of the freeze plug must be 0.003 inch (0.076 mm) or less above or below the structure mating surfaces. Refer to Freeze Plugs in More Than One Structural Member, Figure 4/GENERAL.

(10) Drill the fastener hole through the freeze plug pilot hole, or an initially drilled fastener hole in the structure.

NOTE: Make sure that the freeze plug has a minimum wall thickness of 0.050 inch (1.27 mm). Refer to Straight Shank Freeze Plug Installation, Figure 2/GENERAL.

(11) Install the fastener specified in the repair or engineering drawing through the freeze plug and the attached structure.

(12) Apply a finish to the surfaces of the freeze plug that have a chemical conversion coating. Apply the same finish that is on the adjacent structure. Refer to 51-20-01.

CAUTION: GET APPROVAL FROM THE BOEING COMPANY BEFORE YOU INSTALL COUNTERSINK FREEZE PLUGS. THE USE OF COUNTERSINK FREEZE PLUGS MAY NOT BE A SATISFACTORY REPAIR SOLUTION FOR ALL SITUATIONS. IF YOU DO NOT OBEY, THE REPAIR WILL NOT BE FAA APPROVED.

B. To install countersink freeze plugs, do the steps that follow:

(1) Remove the damage. Refer to 51-10-02.

(a) Use the smallest diameter drill and reamer possible to remove the damage.

NOTE: Make sure that the freeze plug will have a minimum wall thickness of 0.05 inch (1.27 mm) if a fastener hole will be drilled through it. Refer to Countersunk Freeze Plug Installation, Figure 5/GENERAL.

(b) Remove all the nicks, scratches, gouges, and sharp edges from the freeze plug hole.

(c) Machine the freeze plug hole to a surface finish of 63 microinches Ra or smoother.

(d) Make sure the cylindricity tolerance for the freeze plug hole is 0.0003 inch (0.0076 mm). Refer to Cylindricity, Figure 3/GENERAL.

(2) Measure the diameter of the freeze plug hole to 4 decimal positions (X.XXXX).

(3) Measure the thickness of the damaged aluminum structure to 3 decimal positions (X.XXX). Refer to Countersunk Freeze Plug Installation, Figure 5/GENERAL, Section A-A .

(4) Make the countersink freeze plug.

NOTE: If more than one structural member is damaged, you must install a different freeze plug for each part. Refer to Examples of Freeze Plug Installation, Figure 1/GENERAL, Detail C .

(a) Make the freeze plug from 7075-T6 aluminum alloy.

(b) Make the freeze plug the same thickness or thicker than the thickness of the structure it will be installed in. The thickness tolerance of the freeze plugs must be +0.003 inch to -0.000 inch (+0.076 mm to -0.000 mm) of the material thickness.

NOTE: The diameter-to-thickness ratio of the plug must be 10 to 1 or less.

(c) Make the diameter of the freeze plug 1.0035 to 1.0040 times larger than diameter of the hole. For an example, if the diameter of the hole is 0.4500 inch (11.43 mm), the diameter of the freeze plug must be 0.4516 to 0.4518 inch (11.471 mm to 11.476 mm).

(d) Make sure that the freeze plug will have a minimum wall thickness of 0.05 inch (1.27 mm) if a fastener hole will be drilled through it. Refer to Countersunk Freeze Plug Installation, Figure 5/GENERAL.

(e) Machine the freeze plug so that it has a 100 degree countersink with countersink diameter C and depth B. Refer to Countersink Diameter Versus Countersink Depth, Figure 6/GENERAL.

NOTE: The countersink depth B of the freeze plug must not be larger than 50 percent of the thickness of the damaged aluminum structure.

(f) Make sure the cylindricity tolerance for the freeze plug is 0.0002 inch (0.0051 mm). Refer to Cylindricity, Figure 3/GENERAL.

(g) Machine the outer diameter of the freeze plug to a surface finish of 63 microinches Ra or smoother.

(h) For freeze plugs in more than one structural member, put a chamfer on the mating edges of each freeze plug 45 degrees x 0.003 inch to 0.006 inch (0.076 mm to (0.152 mm). Refer to Freeze Plugs in More Than One Structural Member, Figure 4/GENERAL.

(i) Measure the shank diameter D of the freeze plug to four decimal positions (X.XXXX). Refer to Countersink Diameter Versus Countersink Depth, Figure 6/GENERAL.

(5) Apply a chemical conversion coating to the freeze plug. Refer to 51-20-01.

(6) Drill a pilot hole through the center of the freeze plug if a fastener will be installed. As an alternative, use a hole from an initially installed fastener and back drill through the freeze plug.

(7) Make a 100 degree countersink in the structure that is the same diameter as the freeze plug.

NOTE: If you are not sure of the correct adjustment of the micro-stop countersink tool, make a countersink in a piece of scrap material first. Make adjustments to the micro-stop until you find the correct depth of cut. Refer to 51-40-08.

(8) Measure the countersink diameter in the structure. Make sure that it is the same as the countersink diameter C of the freeze plug. Refer to Countersink Diameter Versus Countersink Depth, Figure 6/GENERAL.

CAUTION: WEAR PROTECTIVE CLOTHING WHEN YOU WORK WITH LIQUID NITROGEN. MAKE SURE THAT THE WORK AREA HAS A GOOD FLOW OF CLEAN AIR. LIQUID NITROGEN IS APPROXIMATELY MINUS 320°F (MINUS 196°C). IF YOU DO NOT OBEY, INJURY TO PERSONS CAN BE THE RESULT.

(9) Put the freeze plug in liquid nitrogen for a minimum of 10 minutes immediately before installation.

(10) Apply BMS 5-95 sealant to the edges of the hole. This will help in the installation of the freeze plug.

(11) Install the freeze plug.

(a) Install the freeze plug flush to a tolerance of +0.003 to -0.000 inch (+0.076 mm to -0.000 mm).

NOTE: If the freeze plug buckles when it is installed, you must replace it.

(b) Microshave the freeze plug if necessary. Refer to 51-10-01.

1) Make sure that excess sealant is removed before you microshave.

2) Do not microshave through the clad surfaces.

3) Apply a chemical conversion coating on the bare external surfaces of the plug after you microshave it.

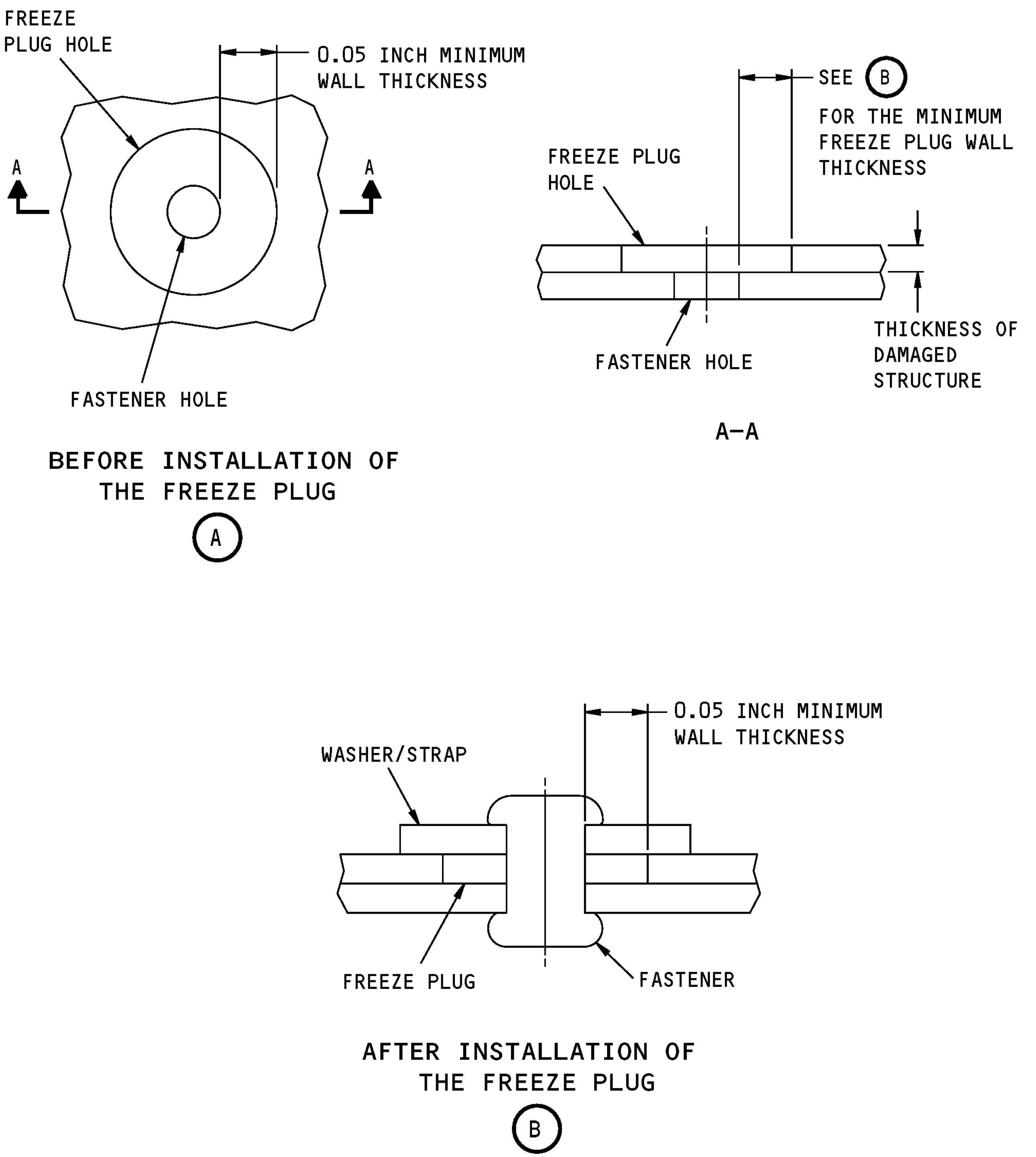
(c) The freeze plug mating surfaces must be 0.003 inch (0.076 mm) or less above or below the structure mating surfaces. Refer to Freeze Plugs in More Than One Structural Member, Figure 4/GENERAL.

(12) Drill the fastener hole through the freeze plug pilot hole, or an initially drilled fastener hole in the structure.

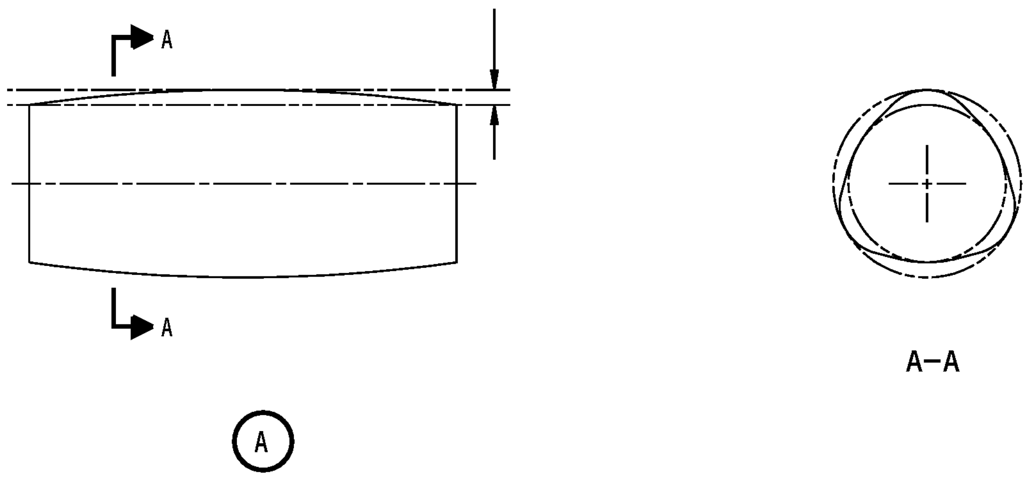
NOTE: Make sure that the freeze plug has a minimum wall thickness of 0.050 inch (1.27 mm). Refer to Countersunk Freeze Plug Installation, Figure 5/GENERAL.

(13) Install the fastener specified in the repair or engineering drawing through the freeze plug and the attached structure.

(14) Apply a finish to the surfaces of the freeze plug that have chemical conversion coating. Apply the same finish that is on the adjacent structure. Refer to 51-20-01.



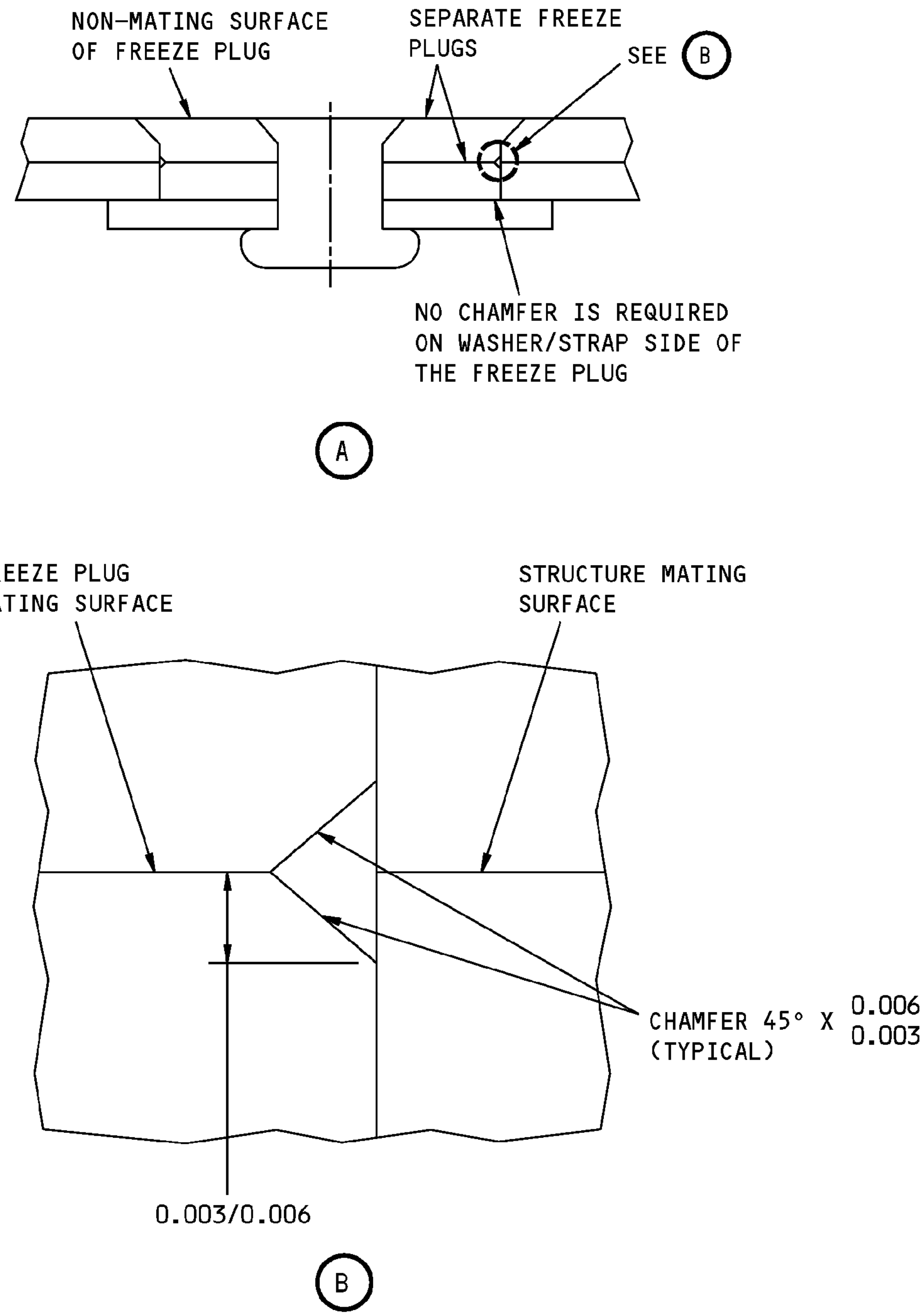
Straight Shank Freeze Plug Installation
Figure 2



NOTES

- CYLINDRICITY IS A CONDITION WHERE ALL POINTS ON A SURFACE ARE AN EQUAL DISTANCE FROM THE SAME AXIS. A CYLINDRICITY TOLERANCE SPECIFIES AN AREA WITH TWO CYLINDERS AS LIMITS, THAT THE SURFACE MUST BE BETWEEN.
- FOR THE FREEZE PLUG INSTALLATION, THOSE AXES ARE:
  - THE CENTER OF THE HOLE THAT WILL BE REPAIRED.
  - THE CENTER OF THE FREEZE PLUG USED TO REPAIR THE HOLE.
- THE SURFACES THAT THE TOLERANCES APPLY TO ARE:
  - THE HOLE THAT WILL BE REPAIRED.
  - THE FREEZE PLUG USED TO REPAIR THE HOLE.

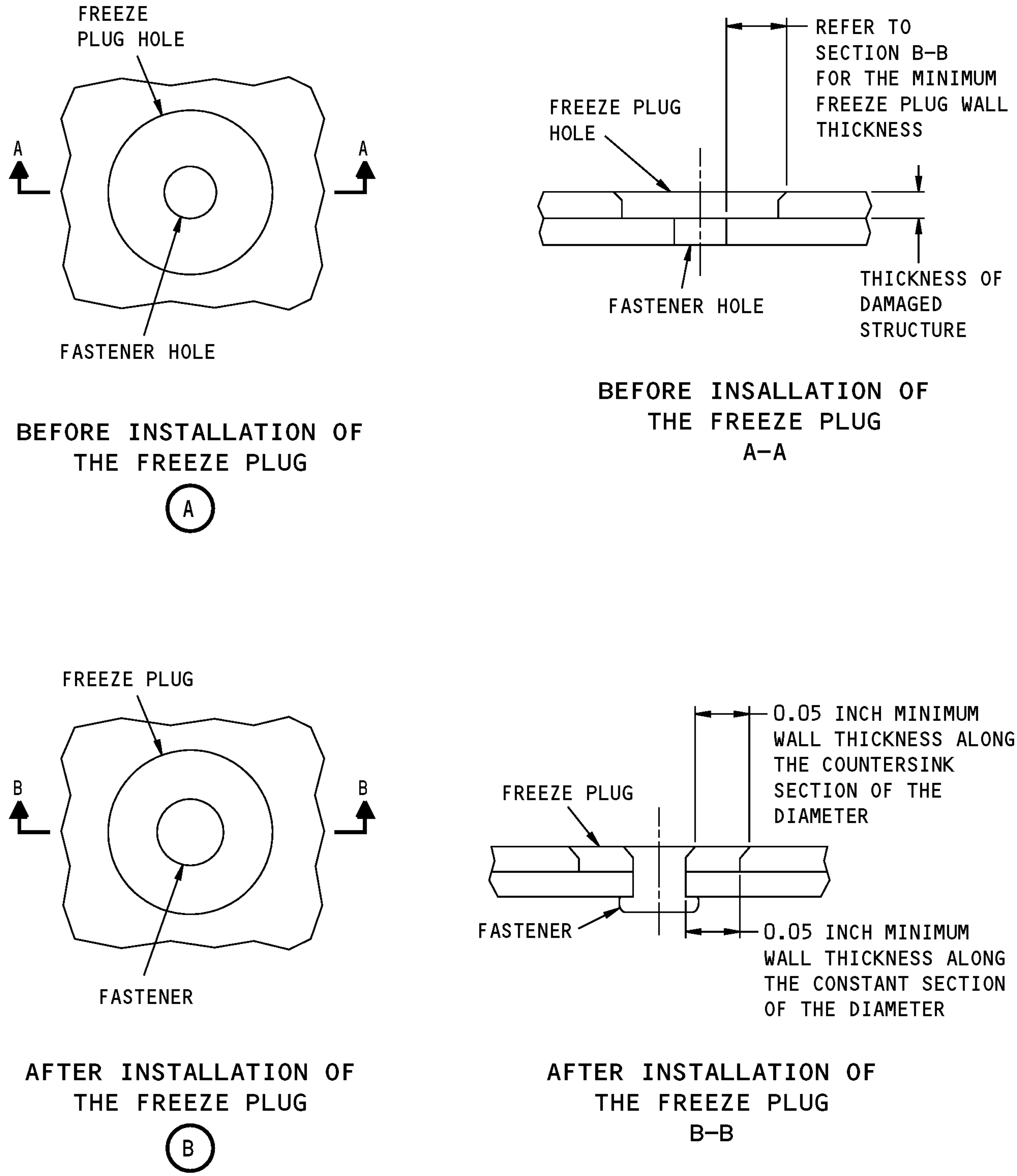
Cylindricity
Figure 3



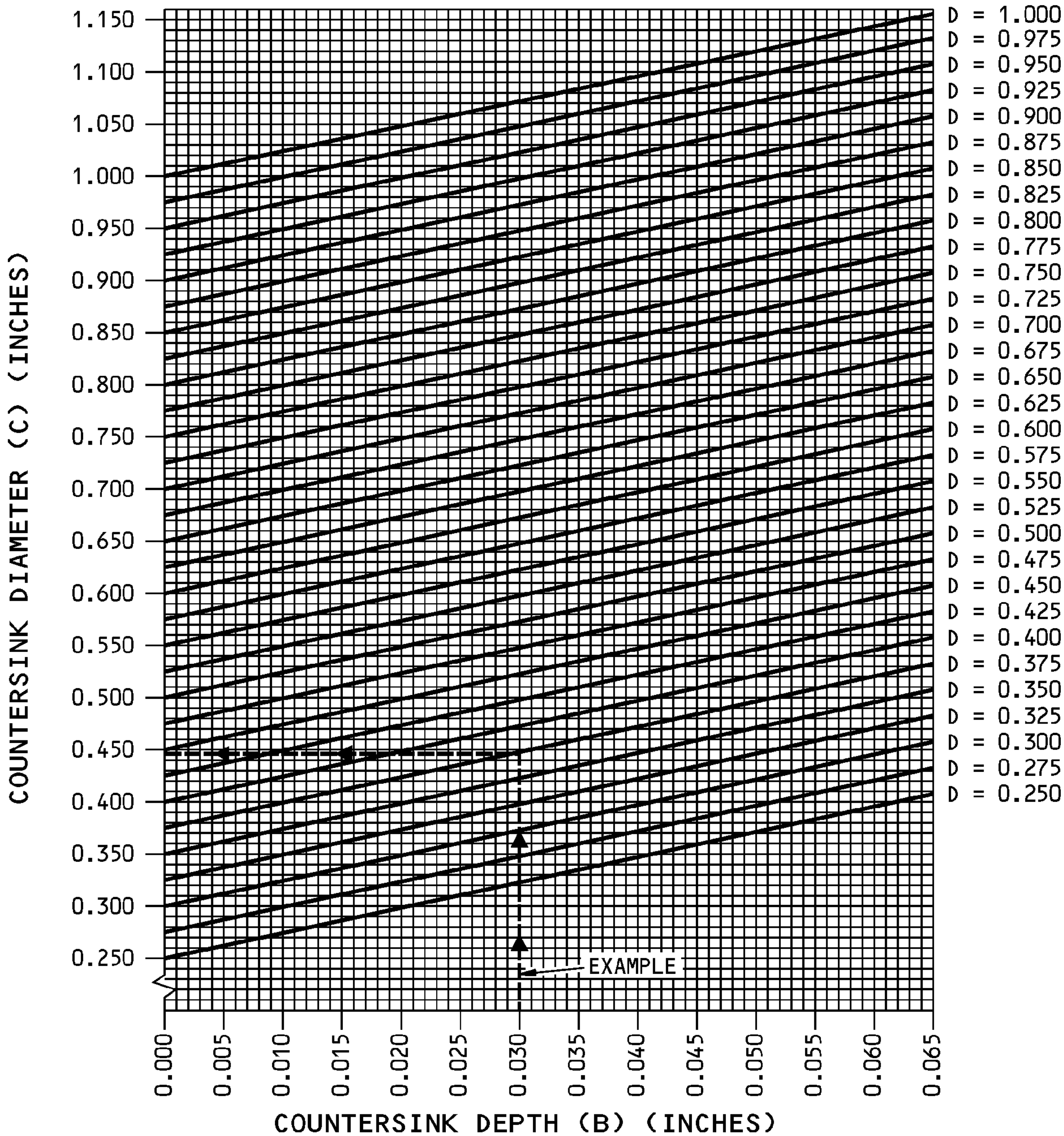
NOTE: ALL DIMENSIONS SHOWN ARE IN INCHES.

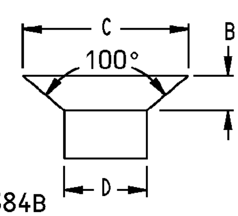
THE FREEZE PLUG MATING SURFACE MUST BE 0.003 INCH OR LESS ABOVE OR BELOW THE STRUCTURE MATING SURFACE.

Freeze Plugs in More Than One Structural Member
Figure 4



Countersunk Freeze Plug Installation
Figure 5





EXAMPLE:

D = 0.375
B = 0.030
C = 0.447

C = D+2.384B

Countersink Diameter Versus Countersink Depth
Figure 6

GENERAL - SURFACE ROUGHNESS FINISH REQUIREMENTS

1. **Applicability**

   A. This subject gives the data on how to measure the surface roughness on a metal surface.

2. **General**

   A. Surface roughness has an affect on the fatigue life. Smoother (finer) surface finishes improve the fatigue life. Most machining or abrasive grinding operations create notch patterns on the surface which result in stress fatigue cracks.

   B. Surface roughness and finish requirements on reworked parts are shown as arithmetic values.

   C. These arithmetic values are numbers in micro-inches. The lower the number, the smoother the surface finish. Refer to Figure 1 (Sheet 1)for the Arithmetic Average Deviation.

3. **General Machining**

   A. Roubhness Values:

   NOTE: The following are the maximum acceptable roughness values for machine finishes. There are no limits to the smoothness unless it is specified by a lower limit.

   (1) 500 micro-inch rough machine finish:

   (a) Rough, low grade surfaces that result in heavy cuts and course feeds in milling, turning, shaping, boring and from very rough filling, rough disc grinding and snagging. Examples of this surface are sand castings, rough forgings, or the ripple finish on parts made by Keller end milling.

   (b) Not permitted on critically loaded parts, where a failure would result in a dangerous condition for ground personnel or the flight of the airplane.

   (2) 250 micro-inch normal machine finish on steel that is heat treated up to 200,000 psi:

   (a) Coarse production surfaces that results from very coarse surface grind, rough file, disc grind, and from rapid feeds in turning, milling, shaping, drilling, poring, grinding, etc., where definite tool marks are permitted. This roughness can also be produced on the neutral surfaces of forgings, permanent mold castings, extrusions and rolled surfaces.

   (b) Not permitted on:

   1) Steel that is heat treated higher that 200,000 psi, or in areas the high fatigue stresses

   2) Aluminum alloys

   3) Steel surfaces that are mated with aluminum alloys.

   (3) 125 micro-inch machined finish on steel or aluminum surfaces

   (a) The roughness surface recommended for parts with fatigue stress or vibration. This surface roughness is also permitted for bearing surfaces when the motion is slow and loads are light or infrequent. This surface finish can also be on permanemt mold castings, die castings, cold rolled surfaces, aluminum extrusions and some titanium 6AL-4V extrusions.

   (b) Not permitted on:

   1) Surfaces with high fatigue stresses

   2) Fast rotating shafts and axles, or parts that have severe vibration

   3) The mating surfaces of steel and 7075 aluminum alloy parts when these parts are in areas with fatigue stresses.

   (4) 63 micro-inch machined finish:

(a) A good machined finish, produced under controlled production procedures that use high speeds, fine feeds and that take light cuts with well sharpened cutters. This surface value may be specified where close fits are required and may be used for all stressed parts.

(b) This surface roughness is satisfactory for bearing surfaces when the motion is slow and loads are light or infrequent. This surface roughness can also be on aluminum extrusions, cold rolled surfaces, die castings, and permanent mold castings when tightly controlled. Can be used where close fits are required for stressed parts. It is adequate for bores in highly stressed parts that are exposed to vibration but little or no relative motion.

(c) Also permitted on:

1) Thin, highly loaded sections or areas of high stress concentration under fatigue loading

2) Surfaces mated with highly stressed areas.

4. Measurement

A. Surface roughness may be measured by one of the methods that follow.

NOTE: For sources for surface finish comparators, refer to Table 1/GENERAL.

(1) Physical comparator such as surface roughness scratch plates or finish blocks used in machine shops. Do the steps that follow:

(a) Select a comparator with a value that is specified in the repair drawing.

(b) Select the roughest area on the part surface fo be measured.

(c) Feel the comparator and the part with a fingernail.

(d) Select the direction on the comparator and the part surface which shows the highest roughness.

(e) Look to see if the surface is as smooth as the comparator.

(2) Stylus-Type Inspection Instrument:

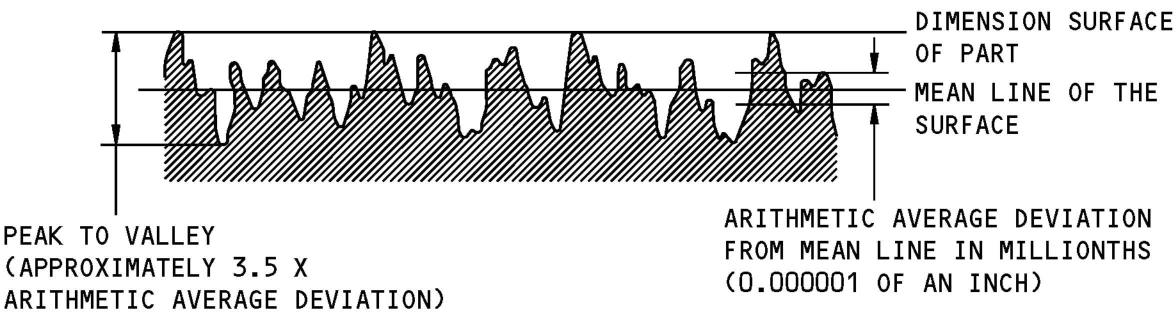
(a) This instrument must meet the American National Standards Institute (ANSI) Standard B246.1 or the equivalent standard for precision and accuracy.

(b) Operate the stylus-type inspection instrument as given in the manufacturer's instructions.

Table 1:

SOURCES FOR TOOLS	
TOOL	**SOURCE**
Surface Finish Comparators and Inspection Instruments	FLEXBAR MACHINE CORPORATION 250 Gibbs Road Islandia, NY 11749 Phone: (800) 879-7575 Fax: (631) 582-8487 E-Mail: sales@flexbar.com Internet: http://www.flexbar.com/sufruf
PORTABLE BATTERY POWERED LASERCHECK SURFACE ROUGHNESS GAGE	OPTICAL DIMENSIONS 25422 Trabuco Rd. #105-435 Lake Forrest, CA 92630-2797 Phone: (949) 768-0405 Fax: (949) 768-0419 Internet: http://www.opticaldimensions.com
ELECTRONIC SURFACE ROUGHNESS TESTER	GAGING.COM 5016 Tropical Cliff Ave. Las Vegas, NV 89130 Phone: (702) 456-2264 Fax: (702) 456-2275 Internet: http://www.gaging.com

SOURCES FOR TOOLS	
TOOL	SOURCE
SURFACE ROUGHNESS GAGE	HOUSTON PRECISION, INC. 8729 Gulf Freeway Houston, TX 77017-6504 Phone: (800) 943-3812, or (713) 943-1155 E-mail: sales@houstonprecision.com Internet: http://www.houstonprecision.com



Arithmetic Average Deviation
Figure 1

GENERAL - SHEET METAL MATERIALS

1. **Applicability**

   A. This section contains the data that is applicable to structural repairs which use sheet metal materials.

2. **General**

   A. Most of the sheet metal used in the structure of the airplane is aluminum alloy. Some sheet metal made from corrosion resistant alloy, titanium alloy, and steel alloy is also used. Figure 1 (Sheet 1) shows different materials with approximately equivalent strengths.

   B. Apply a finish that gives protection to all bare aluminum alloy parts and the surfaces that you cut and drill. Finishes can also be necessary on other metals like titanium, CRES, and nickel alloys. Refer to 51-20-02, GENERAL and SOPM 20-41-02.

   C. If it is necessary to apply heat-treat to an aluminum part, you can refer to BAC 5602 or the equivalent procedure.

   D. Definitions of Tools;

      (1) Hand tool: A tool that you can hold and operate with your hands.

      (2) Hand drill: A drill that you can hold in your hands, has adjustable speed, and does not have automatic feed control.

      (3) RPM: Revolutions per minute.

3. **References**

Reference	Title
51-10-02	INSPECTION AND REMOVAL OF DAMAGE
51-20-01	PROTECTIVE TREATMENT OF METALLIC AND COMPOSITE MATERIALS
51-20-02	HEAT TREAT VERIFICATION - HARDNESS AND CONDUCTIVITY TESTING
51-20-02, GENERAL	Heat Treat Verification - Hardness and Conductivity Testing
51-20-05	REPAIR SEALING
BAC 5602	Heat Treat of Aluminum Alloys
SOPM 20-10-07	Machining of Titanium
SOPM 20-20-01	Magnetic Particle Inspection
SOPM 20-20-02	Penetrant Methods of Inspection
SOPM 20-30-03	Standard Overhaul Practices Manual
SOPM 20-41-02	Application of Chemical and Solvent Resistant Finishes
SOPM 20-50-12	Application of Adhesives

4. **Aluminum Alloys**

   A. You can identify aluminum alloys with the four-digit index system of the Aluminum Association. Two examples of an alloy identification are 2024 and 7075.

   B. The "-TXXX" code that follows an alloy identification shows the temper of the material after it is heat-treated. If an "O" follows the alloy identification, it shows that the material is in the annealed condition. You can form aluminum easily in the annealed condition, but it must be heat-treated before you install it on the airplane.

C. The word "clad" in the material description shows that the alloy has a thin layer of pure aluminum on it to give more corrosion resistance. The layer of aluminum was applied to the alloy before the last rolling procedure.

D. Material Replacement, Figure 2/GENERAL shows alternative replacement materials. If the initial material is not available, then use one of the alternative materials shown. Material Replacement, Figure 2/GENERAL also gives material replacement factors and an example of how to use them.

E. The aluminum alloys most frequently used in sheet metal are 7075-T6 and 2024-T3. 7075-T6 is stronger than 2024-T3. The two materials have different minimum bend radii and different forming properties. The minimum bend radius of 7075-T6 is larger than 2024-T3, so it is formed in the annealed condition (7075-O). After the 7075-O sheet is formed, it is then heat-treated to 7075-T62. 2024-T3 is usually formed in the heat-treated condition. The minimum inner bend radii of different aluminum alloys are given in Minimum Inner Bend Radii for Aluminum Alloy Sheet, Figure 3/GENERAL.

F. You must be careful with metal parts. Small damage, such as scratches, burrs, and nicks can decrease the fatigue strength of the material.

G. If the alloy identification has been removed from a sheet of aluminum, use the hardness and conductivity tests given in 51-20-02 to identify the material.

MATERIAL		DOMESTIC SPECIFICATION (USA) (Acceptable Alternatives)		UNITED KINGDOM DESIGNATION
		MATERIAL	SPECIFICATION	SPECIFICATION
ALUMINUM	SHEET	CLAD 2024-T3	QQ-A-250/5	L109 [1]
ALUMINUM	SHEET	CLAD 2024-T42	QQ-A-250/5	L110
ALUMINUM	SHEET	BARE 2024-T3	QQ-A-250/4 or AMS-QQ-A-250/4	L70 [1]
ALUMINUM	SHEET	CLAD 2014-T6	QQ-A-250/3	L165 (Replaced L73)
ALUMINUM	SHEET	2219-T81	QQ-A-250/30	DTD5070
ALUMINUM	SHEET	5052	AMS 4017	2L55
ALUMINUM	SHEET	6061	AMS 4117	BS 1474
ALUMINUM	SHEET	CLAD 7075	QQ-A-250/13	L88
ALUMINUM	PLATE	2024-T351	QQ-A-250/4	L97
ALUMINUM	BAR AND ROD	2024-T4	QQ-A-225/6	L64 [2]
ALUMINUM	BAR AND ROD	2024-T6	QQ-A-225/6	L65
ALUMINUM	CASTING	A357.0	MIL-A-21180 CLASS II	L92
ALUMINUM	CASTING	A356.0	MIL-A-21180	BS 1490
ALUMINUM	DIE FORGING	2014-T6	QQ-A-367	L77
TITANIUM	SHEET	COMPURE-70	MIL-T-9046,TYPE 1, COMP B	TA6
TITANIUM	SHEET	COMPURE-60	MIL-T-9046,TYPE 1, COMP C	DTD5323
TITANIUM	SHEET	Ti-6Al-4V	MIL-T-9046	BS 2TA.10
TITANIUM	BAR FORGING	COMPURE-60	MIL-T-9047, COMP 1	TA9
TITANIUM	FORGING	Ti-6Al-4V	MIL-F-83142, COMP 6	DTD5323
TITANIUM	CASTING	Ti-6Al-4V	MIL-T-81915, TYPE III, COMP A	DTD5363
TITANIUM	BAR	Ti-6Al-2Sn-4Zr-2Mo	MIL-T-9047	BS TA.45
TITANIUM	FORGING	Ti-6Al-2Sn-4Zr-2Mo	AMS 4976	BS TA.44

Approximately Equivalent Strength Materials
Figure 1 (Sheet 1 of 3)

MATERIAL		DOMESTIC SPECIFICATION (USA) (Acceptable Alternatives)		UNITED KINGDOM DESIGNATION
		MATERIAL	SPECIFICATION	SPECIFICATION
CARBON STEEL	SHEET/ PLATE/ BAR	1020	AMS 5032	040A20
	BAR/ROD	1040	060A40	MIL-S-11310
	SHEET/ BAR	1080	AMS 5110	80CS
ALLOY STEEL	SHEET/ PLATE	4340	AMS 6359	817M40
		4130	AMS 6348	708A30
		4140	AMS 6395	708M40
	BAR	52100	AMS 6440	534A99
		300M	AMS6417	S155A
	FORGING	4340 (QUENCH AND TEMPER-HT 125-145 KSI)	MIL-S-5000B, COMP F	BSS154
CORROSION RESISTANT STAINLESS STELL	SHEET/ PLATE	301	MIL-S-5059	301S21
		302	MIL-S-5059	302S25
	BAR/ROD	303	AMS 5640, TYPE 1	303S22
	SHEET/ PLATE	304	AMS 5501	304S15
		304L	MIL-S-4043	304S11
		316	AMS 5524	316S31
		321	QQ-S-766	321S20
		347	AMS 5512	347S31
		410	410S21	AMS 5504
		15-5PH	AMS 5862	15Cr5Ni
		17-4PH	AMS 5604	17Cr4Ni
		17-7PH	AMS 5528	301S81
		A286	AMS 5726	BS 1503
	BAR	420	AMS 5506	420S29
		431	AMS 5628	431S29

Approximately Equivalent Strength Materials
Figure 1 (Sheet 2 of 3)

MATERIAL		DOMESTIC SPECIFICATION (USA) (Acceptable Alternatives)		UNITED KINGDOM DESIGNATION
		MATERIAL	SPECIFICATION	SPECIFICATION
NICKEL	SHEET/ PLATE/	NICKEL ALLOY 625	AMS 5599	BS 3076
		NICKEL ALLOY X-750	AMS 5542	H505
COPPER	SHEET	Al-Ni-Bronze (C630000)	AMS 4640	BS 2870
	BAR/ROD/ PLATE/ TUBE/ FORGING	Cu-Be (C17200)	AMS 4650	CB101

NOTES

1 ADD 10 PERCENT THICKNESS FOR EQUIVALENT STRENGTH.

2 t = THICKNESS. FOR t LESS THAN 4.0 INCHES, ADD 10 PERCENT MORE THICKNESS. FOR t OF 4.0 INCHES OR MORE, ADD 20 PERCENT MORE THICKNESS.

Approximately Equivalent Strength Materials
Figure 1 (Sheet 3 of 3)

MATERIAL REPLACEMENT INDEX		
TYPE	INITIAL MATERIAL	ALTERNATIVE MATERIAL
SHEET 0.016 TO 0.125	Clad 2024-T42	Clad 2024-T3
		2024-T3
		Clad 7075-T6 [1] [8]
		7075-T6 [1] [8]
	Clad 2024-T3	2024-T3
		Clad 7075-T6 [1] [8]
		7075-T6 [1] [8]
	Clad 7075-T6	7075-T6
FORMED OR EXTRUDED SECTION	2024-T42	2024-T3 [1] [2] [8]

TABLE A

MOST AVAILABLE STANDARD ALUMINUM SHEET METAL GAGES
0.012, 0.016, 0.020, 0.025, 0.032, 0.036, 0.040, 0.045, 0.050, 0.056, 0.063, 0.071, 0.080, 0.090, 0.100, 0.125, 0.160, 0.190, 0.200

TABLE B

Material Replacement
Figure 2 (Sheet 1 of 3)

REPLACEMENT OF SHEET MATERIALS										
SHEET MATERIAL TO BE REPLACED	MATERIAL REPLACEMENT FACTOR									
	7075-T6	CLAD 7075-T6	2024-T3		CLAD 2024-T3		2024-T4 2024-T42		CLAD 2024-T4 CLAD 2024-T42	
	[3]	[3] [7]	[4]	[5]	[4]	[5]	[4]	[5]	[4]	[5]
7075-T6	1.00	1.10	1.25	[6]	1.33	[6]	[6]	[6]	[6]	[6]
CLAD 7075-T6	1.00	1.00	1.16	[6]	1.23	[6]	[6]	[6]	[6]	[6]
2024-T3	1.00 [1]	1.00 [1]	1.00	1.00	1.09	1.10	1.14	1.21	1.24	1.31
CLAD 2024-T3	1.00 [1]	1.00 [1]	1.00	1.00	1.00	1.00	1.00	1.00	1.16	1.29
2024-T42	1.00 [1]	1.00 [1]	1.00	1.00	1.00	1.00	1.00	1.00	1.09	1.14
CLAD 2024-T42	1.00 [1]	1.00 [1]	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

TABLE C

Material Replacement
Figure 2 (Sheet 2 of 3)

NOTES

- ALL DIMENSIONS ARE IN INCHES UNLESS GIVEN DIFFERENTLY.
- IT IS POSSIBLE THAT MORE CORROSION PROTECTION WILL BE NECESSARY WHEN BARE MATERIAL IS USED TO REPLACE CLAD MATERIAL. REFER TO SRM 51-20-01.
- IT IS POSSIBLE FOR THE MATERIAL REPLACEMENT FACTORS THAT ARE LARGER THAN 1.00 TO BE A LOWER VALUE FOR A SPECIFIC LOCATION ON THE AIRPLANE. TELL BOEING IF YOU NEED THIS VALUE.
- REFER TO FIGURE 3 FOR MINIMUM BEND RADII.

  EXAMPLE:
  TO REPLACE 0.040 THICK 7075-T6 MATERIAL WITH CLAD 7075-T6, MULTIPLY THE THICKNESS BY THE MATERIAL REPLACEMENT FACTOR TO GET THE REPLACEMENT THICKNESS (0.040 X 1.10 = 0.044, SO USE 0.045).

[1] THESE MATERIALS CANNOT BE USED AS REPLACEMENTS FOR THE INITIAL MATERIAL IN:

- THE AREAS THAT ARE PRESSURIZED
- THE WING INTERSPAR STRUCTURE
- THE WING CENTER SECTION STRUCTURE
- THE UNPRESSURIZED FUSELAGE STRUCTURE IN FUSELAGE SECTION 48
- THE STRUT OR NACELLE STRUCTURE
- IN DAMAGE TOLERANT REPAIRS.

[2] USE THE SEBSEQUENT HIGHER STANDARD THICKNESS WHEN YOU USE A FORMED SECTION AS AN ALTERNATIVE FOR AN EXTRUSION.

[3] FOR ALL THICKNESSES OF FLAT SHEET AND FORMED SECTIONS.

[4] FOR FLAT SHEET LESS THAN 0.071 THICK.

[5] FOR FLAT SHEET 0.071 THICK AND THICKER, AND FOR FORMED SECTIONS.

[6] THIS MATERIAL IS NOT A PERMITTED ALTERNATIVE FOR THE SHEET MATERIAL TO BE REPLACED.

[7] FOR STRUCTURAL BONDS, CLAD 7075-T6 CANNOT BE USED AS AN ALTERNATIVE.

[8] TO PREVENT CRACKS WHEN YOU FORM THE MATERIAL, YOU MUST FORM IT IN THE O TEMPER THEN HEAT TREAT IT TO T62 TEMPER.

Material Replacement
Figure 2 (Sheet 3 of 3)

MINIMUM INNER BEND RADII								
	ALUMINUM							
MAXIMUM THICKNESS IN INCHES (INCLUSIVE)	1100-0 2219-0 3003-0 5052-0 5052-H32 6061-0	2219-T42 2024-0 3003-H14 5052-H34 6061-T4 6013-T4 [2]	2219-T31 2219-T37 2024-W 7075-W	7075-0 7178-0	2219-T62 2219-T81 2024-T3 2024-T4 6061-T6	7075-T6 7075-T73 7075-T76 7178-T6 2024-T36	2219-T87 2024-T86	2024-T3 LAMINATE (BMS 5-69)
0.016 [1]	0.03	0.03	0.03	0.03	0.06	0.09	0.25	
0.020	0.03	0.03	0.03	0.03	0.06	0.09	0.25	
0.025	0.03	0.06	0.06	0.06	0.09	0.12	0.31	
0.032	0.03	0.06	0.06	0.06	0.12	0.16	0.44	0.12
0.036	0.06	0.06	0.09	0.06	0.16	0.19	0.50	
0.040	0.06	0.06	0.09	0.06	0.16	0.19	0.56	0.16
0.045	0.06	0.09	0.09	0.09	0.19	0.25	0.56	
0.050	0.06	0.09	0.12	0.09	0.19	0.25	0.62	0.19
0.056	0.06	0.12	0.12	0.12	0.22	0.28	0.62	
0.063	0.06	0.12	0.16	0.12	0.22	0.31	0.62	
0.071	0.09	0.12	0.16	0.12	0.28	0.38	0.75	0.25
0.080	0.09	0.16	0.19	0.19	0.34	0.44	0.88	
0.090	0.09	0.19	0.22	0.19	0.38	0.50	1.12	
0.100	0.12	0.22	0.25	0.22	0.44	0.62	1.25	
0.112	0.12	0.25	0.34	0.28	0.50	0.75	1.75	
0.125	0.12	0.25	0.50	0.28	0.56	0.88		
0.140	0.12	0.34	0.56	0.38	0.62	1.00		
0.160	0.16	0.38	0.62	0.44	0.75	1.12		
0.180	0.19	0.44	0.69	0.50	0.88	1.25		
0.190	0.19	0.50	0.75	0.56	0.88	1.25		

TABLE A

NOTES

- ALL DIMENSIONS ARE IN INCHES UNLESS GIVEN DIFFERENTLY.

[1] FOR MATERIAL LESS THAN 0.016 INCH THICK, THE MINIMUM BEND RADIUS IS THE SAME AS FOR 0.016 INCH THICK MATERIAL.

[2] AGE TO T6 CONDITION AFTER YOU FORM IT.

Minimum Inner Bend Radii for Aluminum Alloy Sheet
Figure 3

5. Titanium Alloys

WARNING: SMALL PARTICLES AND THIN CUTS OF TITANIUM ARE FLAMMABLE. IN A SUFFICIENT CONCENTRATION, AN EXPLOSION CAN OCCUR. EXTINGUISH FIRES OF TITANIUM WITH FULLY DRY TALC, CALCIUM CARBONATE, SAND, OR GRAPHITE. APPLY THE POWDER TO A DEPTH OF 1/2 INCH (12.7 MM) OR MORE ON THE AREA THAT IS ON FIRE. DO NOT USE FOAM, WATER, CARBON TETRACHLORIDE, HALON, OR CARBON DIOXIDE. WATER IN CONTACT WITH MOLTEN TITANIUM CAN CAUSE A STEAM EXPLOSION. IF YOU DO NOT OBEY, AN INJURY CAN OCCUR.

A. Titanium alloy looks almost the same as corrosion resistant steel (CRES) and is almost as strong. For equal volumes of titanium and CRES, the weight of titanium alloy is approximately 56 percent the weight of steel.

B. Titanium is very resistant to atmospheric corrosion and it is usually not necessary to apply a finish to it. But you must isolate titanium from magnesium, aluminum, and alloy steel (including cadmium plate). If titanium touches magnesium, aluminum or alloy steel, galvanic corrosion will occur. Refer to 51-10-02, 51-20-05, and SOPM 20-41-02 for finishes, treatments, and seals that give protection.

C. Some repairs in this manual use parts made from Ti-6Al-4V annealed titanium sheet that must be bent to a specified shape. Use the Hot Forming or Cold Forming procedures that follow to bend the repair parts made from Ti-6Al-4V annealed titanium sheet.

(1) To use the Hot Forming procedure to bend Ti-6Al-4V annealed titanium sheet, do the steps that follow:

(a) Apply a scale inhibitor to the part before you heat it.

(b) Increase the temperature of the part to more than 1200°F (649°C), but less than 1500°F (816°C).

(c) Bend the part to a radius that is not less than the minimum radius given in Minimum Radii for Straight Bend Lines in Titanium Sheet, Figure 4/GENERAL. If the radius is smaller than what is given in Minimum Radii for Straight Bend Lines in Titanium Sheet, Figure 4/GENERAL, do a penetrant inspection of the bend. Refer to SOPM 20-20-02.

(d) Keep the part at this temperature for more than 10 minutes but less than 10 hours.

(e) After the part is cool, remove the scale from the surface. To remove the scale, etch all the surfaces to the depths shown in Minimum Radii for Straight Bend Lines in Titanium Sheet, Figure 4/GENERAL. Refer to SOPM 20-30-03 to etch titanium.

(2) To use the Cold Forming procedure to bend Ti-6Al-4V annealed titanium sheet at room temperature, do the steps that follow:

(a) Bend the part to a radius that is not less than the minimum radius given in Minimum Radii for Straight Bend Lines in Titanium Sheet, Figure 4/GENERAL. If the radius is smaller than what is given in Minimum Radii for Straight Bend Lines in Titanium Sheet, Figure 4/GENERAL, do a penetrant inspection of the bend. Refer to SOPM 20-20-02.

(b) Do the steps that follow to decrease the stress in the part:

1) Increase the temperature of the part to more than 1250°F (677°C), but less than 1450°F (788°C).

2) Keep the part at this temperature for more than 30 minutes but less than 10 hours.

D. Use a positive power feed drill when you drill titanium. Use a hand drill only when a positive power feed drill is not available. Refer to SOPM 20-10-07 for information to drill titanium with positive power feed drills. Equipment Used to Hand Drill and Cut Titanium, Figure 5/GENERAL shows the equipment to use when you drill titanium.

Do the steps that follow when you drill titanium:

(1) The largest diameter hole you can drill in one step with a hand drill is 0.1563 inch (3.97 mm). This is because you must push on the drill with a large force. When you push on the drill, the larger diameter drill bits will not cut satisfactorily and cause damage to the hole.

(2) Use a ’pistol grip’ type hand drill, if available, because you can push with more force on the drill.

(3) You can drill holes of 0.1875 inch (4.76 mm) diameter and larger if you start with a bit diameter of 0.1563 inch (3.97 mm). Increase the diameter of the hole in increments of 0.0313 or 0.0625 inch (0.79 mm or 1.59 mm). If you use a hand drill with a 90 degree angle head, then you must use 0.0313 inch (0.79 mm) increments. If you use the usual ’pistol grip’ type hand drill, then you can use an increment of 0.0625 inch (1.59 mm). You can use the larger increment because you can push harder with the ’pistol grip’ type hand drill. Holes with diameters as large as 0.75 inch (19.05 mm) have been made using this procedure.

(4) Use high-speed steel drill bits when you hand drill. Refer to Table 1/GENERAL for the recommended drill speeds when you drill titanium.

Table 1:

RECOMMENDED DRILL SPEEDS	
DRILL DIAMETER IN INCHES (MILLIMETERS)	**RPM**
0.0625 (1.59) 0.125 (3.18) 0.1875 (4.76)	920 to 1830 460 to 920 230 to 460

(5) The life of a drill bit is shorter when you drill titanium than when you drill steel. Do not use a blunt bit or let the bit rub the surface of the metal and not cut it. If one of these conditions occurs, the titanium surface will become work-hardened and it will not be easy to start the drill again.

(6) When you hand drill two or more titanium parts at the same time, you must attach them together with clamps. To attach them together with clamps, use temporary bolts, Cleco clamps, or tool clamps. Put the clamps around the area that you will drill, and as near to the area as possible.

(7) When you hand drill thin or flexible parts, put a support (such as a block of wood) behind the part. The results will be good, clean holes, smaller exit burrs, and less broken drill bits.

(8) Titanium has a low thermal conductivity. When it becomes hot, other metals will easily weld to it. Particles of titanium will frequently become welded to the sharp edges of the drill bit if the drill speed is too high. When you drill large plates or extrusions, use sulphurized oil or a water soluble coolant.

(9) Cutting Fluids

(a) When you drill, use cutting fluid. The holes will have a better tolerance and the drill bit will wear more slowly.

(b) Use cutting fluid if the hole has a depth larger than the diameter of the drill bit. If the hole has a depth less than the diameter of the drill bit, cutting fluid is not necessary.

(c) The different types of cutting fluid are shown below. When you use cutting fluid, clean the repaired area before you apply paint or sealant. Refer to SOPM 20-41-02 and SOPM 20-50-12.

(d) If it is possible to clean the repair area after you drill, then use one of these two cutting fluids:

1) Daracool 706 (4% cutting fluid, 96% water mix)

2) BOELUBE

(e) If it is not possible to clean the repair area after you drill, then use BOELUBE.

(f) The cutting fluids are available from these sources:

1) Daracool 706:
W.R. Grace and Co.
Davison Chemical Division
10 East Baltimore Street
Baltimore MA 21202-1630

2) BOELUBE:
The Orelube Corp.
201 East Bethpage Road
Plainview, NY 11803-4202

E. When you ream titanium alloy with a hand tool, do the steps that follow.

(1) Use high-speed steel reamers. You can use reamers with straight flutes or reamers with minimum edges of 0.010 inch (0.25 mm) or less.

(2) The drill must have a maximum speed of less than 600 RPM.

(3) When you ream a hole, use a higher feed rate than when you drill a hole. Ream the hole with a feed rate that will make a satisfactory finish. When you ream, the reamer must constantly cut the metal.

(4) If the hole has a depth larger than the diameter of the reamer bit, use cutting fluid when you ream. If the hole has a depth less than the diameter of the reamer bit, then cutting fluid is not necessary.

(5) When you ream a hole to the correct fastener dimension, remove as much material as possible. Remove a minimum of 0.0156 inch (0.40 mm) from the hole when the diameter of the hole is less than 0.3125 inch (7.94 mm). Remove a minimum of 0.0313 inch (0.79 mm) from the hole when the diameter of the hole is 0.3125 inch (7.94 mm) and larger.

(6) Remove the reamer from the hole before you stop its rotation.

(7) When a reamer is made from a larger diameter reamer, it is usually circle ground. When a reamer is circle ground, the width of the edge of the reamer increases. If the width of the edge of the reamer increases, then it will make a hole that is too large. To prevent holes that are too large, decrease the edge width to between 0.010 and 0.015 inch (0.25 and 0.38 mm).

F. When you countersink titanium, do the steps that follow:

(1) Use the same speeds and feed rate as when you drill.

(2) Do not use hand tools to countersink a hole in titanium when the hole diameter is larger than 0.1875 inch (4.76 mm).

(3) Use high-speed steel cutters to countersink holes in titanium.

(4) When you use a cutting fluid, the speed of the cutter must be 25 to 30 SFM (Surface Feet per Minute) (7.62 M to 9.14 M per minute). When you do not use a cutting fluid, the speed of the cutter must be 20 to 25 SFM (7.62 M to 9.14 M per minute).

(5) Use a microstop countersink tool for a hole with a diameter of 0.1875 inch (4.76 mm) or less.

G. When you cut the titanium with a hand tool, use the steps that follow:

(1) Most tools are made for materials that are easy to cut, such as aluminum or mild steel. To satisfactorily cut the titanium:

(a) Use a tool that is made to cut material that is two times as thick as the titanium.

(b) Use a tool with a slow speed.

(c) Use the type of equipment that is equivalent to what is shown in Equipment Used to Hand Drill and Cut Titanium, Figure 5/GENERAL.

(2) Use tools such as roller shears or nibblers to cut titanium sheet if the sheet thickness is 0.100 inch (0.25 mm) or less.

NOTE: For thicknesses larger than 0.100 inch (0.25 mm), roller shears cause edge cracks.

(a) If you use a nibbler with a low speed (approximately 450 strokes per minute), it is not necessary to use cutting fluid.

(b) If you use a nibbler with a high speed (above 600 strokes per minute) you must use a cutting fluid. For example, you can use an oil that becomes liquid in water, such as TJ-73 spray.

(c) After the titanium is cut, the edge must be square, scalloped, and lightly burred. Remove approximately 0.010 inch (0.25 mm) of the material to make the edge clean. Maintain 125 microinches surface roughness or better. Put a finish on the cut edges by hand.

NOTE: If there are many burrs, it is possible that the punch is damaged.

(3) Do not use routers to cut titanium. Routers do not cut titanium satisfactorily and it is not easy to hold the tool stable and keep the feed rate constant.

(4) Use saber saws only when you cannot use other tools because they cut more slowly and the blades become blunt quickly.

H. Refer to SOPM 20-10-07 to machine titanium with equipment that is not movable.

I. When you machine titanium, you must remove all of the sharp edges. Unless given differently in a repair, remove all of the machined edges to a minimum radius of 0.008 inch (0.20 mm), 125 microinches surface roughness or better.

NOTE: If the temperature increases too much when you machine the titanium, a change in color will occur. Remove all of the titanium with a color that is darker than the color of light straw.

MINIMUM BEND RADII		
THICKNESS	TI-6AL-4V ANNEALED COLD FORMED	TI-6AL-4V ANNEALED HOT FORMED [1]
0.016	0.12	0.06
0.020	0.16	0.09
0.025	0.19	0.09
0.032	0.22	0.09
0.036	0.25	0.12
0.040	0.25	0.12
0.050	0.31	0.12
0.056	0.34	0.16
0.063	0.38	0.16
0.071	0.44	0.19
0.080	0.50	0.19
0.090	0.56	0.22
0.100	0.62	0.25
0.112	0.69	0.25
0.125	0.75	0.28
0.140	0.88	0.34
0.160	1.00	0.34
0.180	1.13	0.41
0.190	1.63	0.41
0.200	2.00	0.44

TABLE A

Minimum Radii for Straight Bend Lines in Titanium Sheet
Figure 4 (Sheet 1 of 2)

MINIMUM DEPTH TO BE REMOVED (INCH)				
FORMING TEMPERATURE °F (°C)	LENGTH OF TIME AT FORMING TEMPERATURE			
	30-60 MINUTES	1-2 HOURS	2-6 HOURS	6-10 HOURS
1201-1300 (649-704)	0.001	0.001	0.002	0.003
1301-1400 (705-760)	0.001	0.002	0.003	0.003
1401-1500 (761-816)	0.002	0.003	0.004	0.006

TABLE B

NOTES

ALL DIMENSIONS ARE IN INCHES UNLESS GIVEN DIFFERENTLY.

1 THE MINIMUM BEND RADII FOR HOT FORMING TI-6AL-4V IS APPLICABLE WHEN YOU USE A HEATED DIE AND THE PART TEMPERATURE IS KEPT ABOVE 1200° F (649° C)

Minimum Radii for Straight Bend Lines in Titanium Sheet
Figure 4 (Sheet 2 of 2)

DRILL MOTORS				
MANUFACTURER	MODEL	SPEED (RPM)	DRILL CAPACITY (INCH)	HANDLE TYPE
COOPER BUCKEYE 1	31D-101-38	5200	1/4	Offset
	21D-501	4750	1/4	Straight
	21A-621	4750	1/4	90°
	46A-508	540	1/2	90°
DEUTSCH-APT 2	9824-4249	4950	1/4	Offset
	9328-4251	450	1/2	Offset
	9359	450/2000	1/2	Offset
	3951-5003	1000	3/8	Straight
	8191-8198-8201	4500	1/4	45°
COOPER DOTCO 1	15CSL94-51	1600	3/8	Offset
	55CSS92-54	2150	1/4	Offset

TABLE A

CUTTING TOOLS		
TOOL TYPE	MANUFACTURER	MODEL
ROLLER SHEARS	Cooper Buckeye	31U-113
PORTABLE NIBBLER	Cooper Buckeye	31NR-502
SABER SAW	Cooper Buckeye	31ZK-548

TABLE B

Equipment Used to Hand Drill and Cut Titanium
Figure 5 (Sheet 1 of 2)

SABER SAW BLADE DATA			
TITANIUM THICKNESS (INCH)	BLADE PITCH (TEETH/INCH)	CUTTING RATE (INCH/MINUTE)	BLADE LIFE (INCH)
0.049	32	10	24
0.070	24	5	100
0.125	18	1	7

TABLE C

NOTE: THIS DATA IS FOR HIGH SPEED STEEL BLADES THAT CUT AT A RATE OF 90 SURFACE FEET PER MINUTE. USE A WATER SOLUBLE OIL SPRAY MIST LIKE DARACOOL 760 WHEN YOU CUT TITANIUM WITH A SABER SAW. A LARGE FORCE IS NECESSARY TO MANUALLY CUT WITH A SABER SAW. THIS FORCE INCREASES AS THE SHEET THICKNESS INCREASES. THE LARGEST THICKNESS OF TITANIUM SHEET THAT CAN BE CUT EASILY IS 0.070 INCH.

NOTES

1 A SOURCE FOR THIS TOOL IS:
COOPER IND., COOPER POWER TOOLS DIV.
P.O. BOX 1410
LEXINGTON, SC 29071-1410

2 A SOURCE FOR THIS TOOL IS:
DEUTSCH AMERICAN PNEUMATIC TOOL CO.
14710 MAPLE AVE.
GARDENA, CA 90248-1934

Equipment Used to Hand Drill and Cut Titanium
Figure 5 (Sheet 2 of 2)

6. <u>Corrosion Resistant Steel (CRES)</u>

A. When high strength is necessary, some sheet metal parts are made of CRES.

B. CRES must not touch magnesium, aluminum or alloy steel. If it does, galvanic corrosion will occur. To isolate CRES from magnesium and aluminum, apply a finish that gives protection between the mating surfaces. Refer to 51-20-01 for the finishes that give protection.

C. The minimum bend radii of CRES sheet material are shown in Minimum Radii for Straight Bend Lines in Steel Sheet, Figure 6/GENERAL.

MINIMUM INNER BEND RADII [2]					
MATERIAL THICK-NESS (INCHES) [1]	STEEL				
	ALLOY [3]				
	4130 ANNEALED	ALL OTHER ALLOY STEELS (ANNEALED)	15-5 PH, 17-4 PH (ANNEALED, SOLUTION TREATED)	17-7 PH, PH 15-7 MO	
				ANNEALED	AGED TH 1050
0.016	0.06	0.06	0.03	0.03	0.16
0.020	0.06	0.06	0.06	0.03	0.16
0.025	0.06	0.06	0.06	0.03	0.16
0.028	0.06	0.09	0.09	0.03	0.19
0.032	0.06	0.09	0.09	0.03	0.25
0.036	0.09	0.12	0.09	0.03	0.31
0.040	0.09	0.12	0.12	0.06	0.31
0.045	0.09	0.16	0.12	0.06	0.38
0.050	0.09	0.16	0.12	0.06	0.38
0.056	0.09	0.19	0.16	0.06	0.44
0.063	0.09	0.19	0.16	0.09	0.50
0.071	0.09	0.22	0.22	0.09	0.62
0.080	0.12	0.25	0.22	0.09	0.62
0.090	0.12	0.28	0.25	0.09	0.75
0.100	0.16	0.31	0.28	0.12	0.88
0.112	0.16	0.34	0.28	0.12	
0.125	0.16	0.38	0.31	0.12	
0.140	0.19	0.38	0.34	0.16	
0.160	0.22	0.44	0.38	0.16	
0.180	0.28	0.50	0.44	0.19	
0.190	0.34	0.50	0.50	0.19	
0.200	0.44	0.62	0.50	0.25	

TABLE A

Minimum Radii for Straight Bend Lines in Steel Sheet
Figure 6 (Sheet 1 of 3)

MINIMUM INNER BEND RADII 4					
MATERIAL THICKNESS (INCHES) 1	STEEL				
	ALLOY				
	ALL 300 SERIES CRES				
	ANNEALED	1/4 HARD	1/2 HARD	3/4 HARD	FULLY HARD
0.016	0.06	0.06	0.06	0.09	0.09
0.020	0.06	0.06	0.06	0.09	0.12
0.025	0.06	0.06	0.06	0.09	0.16
0.028	0.06	0.06	0.09	0.12	0.19
0.032	0.06	0.06	0.09	0.12	0.19
0.036	0.06	0.09	0.12	0.16	0.22
0.040	0.06	0.09	0.12	0.16	0.25
0.045	0.06	0.09	0.12	0.19	0.31
0.050	0.09	0.09	0.12	0.22	0.31
0.056	0.09	0.12	0.16	0.22	0.34
0.063	0.09	0.12	0.19	0.25	0.38
0.071	0.09	0.16	0.22	0.31	0.44
0.080	0.09	0.16	0.22	0.34	0.50
0.090	0.09	0.19	0.25	0.38	0.62
0.100	0.12	0.22	0.28	0.44	0.62
0.112	0.12	0.22	0.31	0.50	0.75
0.125	0.12	0.25	0.34	0.50	0.75
0.140	0.16	0.31	0.38	0.62	0.88
0.160	0.16	0.34	0.44	0.62	1.00
0.180	0.19	0.38	0.50	0.75	1.12
0.190	0.19	0.38	0.50	0.88	1.25
0.200	0.22	0.44	0.50	0.88	1.25

TABLE A

Minimum Radii for Straight Bend Lines in Steel Sheet
Figure 6 (Sheet 2 of 3)

NOTES

- ALL DIMENSIONS ARE IN INCHES UNLESS GIVEN DIFFERENTLY.
- ANLD = ANNEALED
- QTR = QUARTER
- COND = CONDITION
- NORM = NORMALIZED

1 FOR MATERIAL LESS THAN 0.016 INCH THICK, THE MINIMUM BEND RADIUS IS THE SAME AS FOR 0.016 INCH THICK MATERIAL.

2 DO A MAGNETIC PARTICLE INSPECTION IF ANGLE "A" IS LARGER THAN 90 DEGREES. REFER TO SOPM 20-20-01.

3 15-5PH CORROSION RESISTANT STEEL IS RECOMMENDED FOR A SHEET THICKNESS OF 0.050 INCH OR THICKER, BUT 17-7PH IS PERMITTED UP TO A THICKNESS 0.091 INCH IN CONDITION H1050.

4 DO A DYE PENETRANT INSPECTION OF THE RADIUS AFTER YOU FORM IT IF ANGLE "A" IS LARGER THAN 90 DEGREES. REFER TO SOPM 20-20-02.

Minimum Radii for Straight Bend Lines in Steel Sheet
Figure 6 (Sheet 3 of 3)

7. **Nickel Alloy Steels**

A. Nickel Alloy 625 and Nickel Alloy 718 are nickel-chromium alloys. These alloys are corrosion resistant and stay strong at high temperatures. Because of these properties, nickel alloy steel is frequently used in the powerplant structure.

B. Do not drill Nickel Alloy 625 or 718 with the same procedures you use to drill other metals. There will be faster wear of the bits or they will break. Also, damage to the edge of the hole can occur when the bit goes through the metal. Do the steps that follow when you drill Nickel Alloy 625 and Nickel Alloy 618:

(1) Use power feed equipment to drill pilot holes in the parts before you assemble them.

(2) Put the repair parts temporarily into position and drill the pilot holes in the mating structure.

(3) Increase the diameter of each pilot hole to the diameter given for the fastener in the repair.

C. You can use a hand drill for nickel alloys in all heat-treat conditions. Use the procedures that follow to drill material thicknesses of 0.09 inch and less.

(1) Drill bit type

(a) A 118-degree "stove burner" drill bit is stronger than a 135-degree cobalt drill bit. Also, the 118-degree bit point causes no damage to the edge of the hole. The usual 135-degree cobalt bit point will cause damage to the edge of the hole. But you can drill No. 30 or No. 40 pilot holes with cobalt "rivet knock-out" drill bits.

(b) You can use one of the 135-degree steel drill bits that follow:
- NAS907, Types C, P3, or P5 for Nickel Alloy 718
- NAS907, Type P9 for Nickel Alloy 625

(2) Drill Force

(a) Feed rates are not applicable when you hand drill. When you hand drill, you must push hard on the drill but stay at a constant cut rate. Example: for a No. 30 hole, push on the drill with an approximate force of 50 pounds (222.4 N).

(b) Drill holes with diameters between 3/16 inch (4.76 mm) and 3/8 inch (9.52 mm) in two steps. One step is sufficient for holes with diameters less than 3/16 inch (4.76 mm). You can use a 1 inch per foot (25.4 mm per 0.30 M) tapered reamer to increase the diameter of the pilot hole to 0.1563 inch (3.97 mm).

(3) Refer to Table 2/GENERAL for the maximum drill speeds to use when you drill nickel alloys.

Table 2:

DRILL SIZES AND SPEEDS	
DRILL SIZE	**MAXIMUM RPM**
80-30 29-U 3/8 inch	500 300 150

(4) Cutting fluid

(a) A cutting fluid is not necessary when you hand drill nickel alloys.

8. Flat Patterns

A. To make a repair part from a flat pattern (the shape of a flat piece of sheet metal necessary to make a bent part), do the steps that follow.

(1) Bend a piece of wire around the damaged part or make a sketch of the cross-section. Refer to Flat Pattern Layout, Figure 7/GENERAL for an example.

(2) Find the flange width, web width, bend radius, bend angle, and material thickness dimensions. For the example in Flat Pattern Layout, Figure 7/GENERAL, the dimensions are as follows:

A = Flange Width = 1.00 inch (25.4 mm)

B = Web Width = 3.00 inches (76.2 mm)

C = Flange Width = 1.20 inches (30.48 mm)

T = Material Thickness = 0.063 inch (1.60 mm)

R1 = Bend Radius = 0.12 inch (3.04 mm)

R2 = Bend Radius = 0.12 inch (3.04 mm)

D1 = Bend Angle = 45°

D2 = Bend Angle = 135°

NOTE: Refer to Minimum Inner Bend Radii for Aluminum Alloy Sheet, Figure 3/GENERAL for the minimum bend radii permitted on the different types and thicknesses of aluminum sheet.

Refer to Minimum Radii for Straight Bend Lines in Titanium Sheet, Figure 4/GENERAL for the minimum bend radii permitted on the different types and thicknesses of titanium sheet.

Refer to Minimum Radii for Straight Bend Lines in Steel Sheet, Figure 6/GENERAL for the minimum bend radii permitted on the different types and thicknesses of steel sheet.

(3) Find the SB (set back) dimension(s) as shown in Flat Pattern Set Back Graph, Figure 8/GENERAL or use the equation:

$SB = [\tan(0.5 \times D)] \times (R + T)$

where:

D = the bend angle in degrees

R = the bend radius in inches

T = the material thickness in inches

For the example in Flat Pattern Layout, Figure 7/GENERAL, the two set back dimensions are:

$SB1 = [\tan(0.5 \times D1)] \times (R1 + T) = [\tan(0.5 \times 45)] \times (0.12 + 0.063) = 0.076$ inch

$SB2 = [\tan(0.5 \times D2)] \times (R2 + T) = [\tan(0.5 \times 135)] \times (0.12 + 0.063) = 0.442$ inch

(4) Find the X dimension(s) as shown in Flat Pattern X Dimension Graph, Figure 9/GENERAL or use the equation:

$X = (2 \times SB) - \{[(0.01745 \times R) + (0.0078 \times T)] \times D\}$

where:

SB = the set back in inches

R = the bend radius in inches

T = the material thickness in inches

D = the bend angle in degrees

For the example in Flat Pattern Layout, Figure 7/GENERAL, the two X dimensions are:

$X1 = (2 \times SB1) - \{[(0.01745 \times R1) + (0.0078 \times T)] \times D1\}$

$= (2 \times 0.076) - \{[(0.01745 \times 0.12) + (0.0078 \times 0.063)] \times 45\}$

$= 0.036$ inch

$X2 = (2 \times SB2) - \{[(0.01745 \times R2) + (0.0078 \times T)] \times D2\}$

$= (2 \times 0.442) - \{[(0.01745 \times 0.12) + (0.0078 \times 0.063)] \times 135\}$

$= 0.535$ inch

(5) Find the Developed Width. Subtract the X dimension(s) from the sum of all of the flange and web width dimensions.

For the example in Flat Pattern Layout, Figure 7/GENERAL:

Developed Width = A - X1 + B - X2 + C = 1.00 inch - 0.036 inch + 3.00 inches - 0.535 inch + 1.20 inches = 4.63 inches

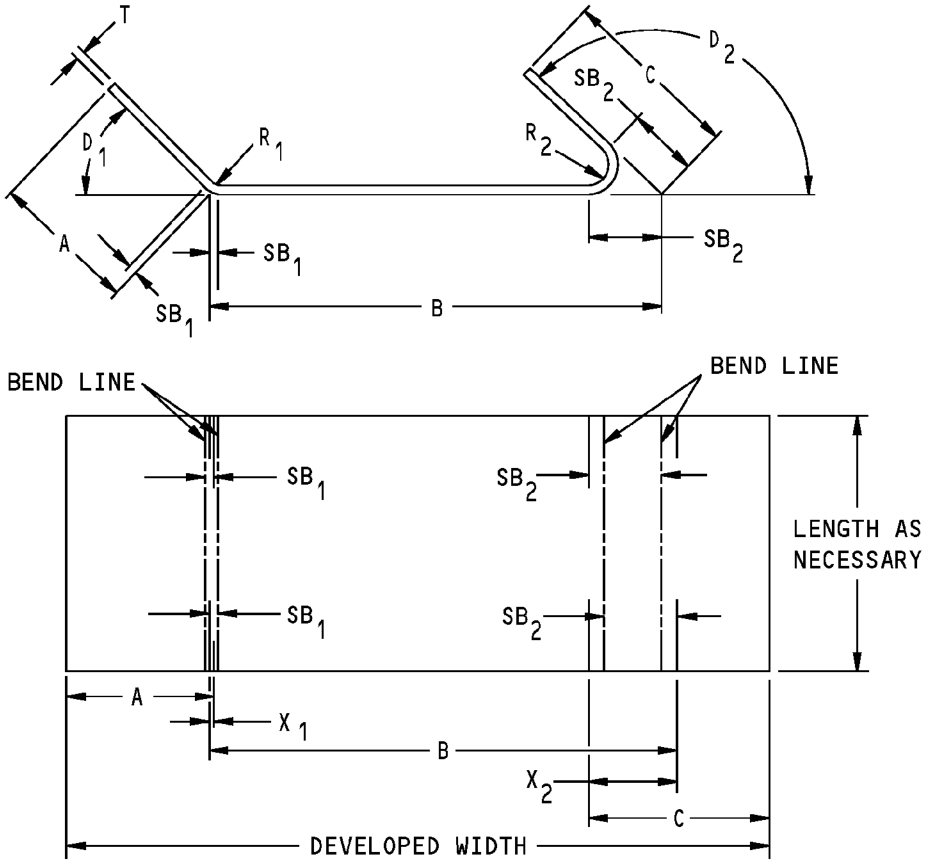
CAUTION: DO NOT USE A METAL SCRIBER. THE SCRATCHES ON THE METAL CAN CAUSE CRACKS.

(6) Put the necessary information for the flat pattern on a flat sheet of repair material that has no pilot holes.

(7) Make a line with a sharp crayon on the sheet of repair material fully around the flat pattern.

(8) Cut out the repair part.

(9) Bend the repair part to the shape of the damaged part.



FLAT PATTERN

EXAMPLE:

FOR: $A = 1.00$ $C = 1.20$ $R_1 = 0.12$ $D_1 = 45°$

$B = 3.00$ $T = 0.063$ $R_2 = 0.12$ $D_2 = 135°$

THEN: $SB_1 = 0.076$ (REFER TO PARAGRAPH 8.A.(3))

$SB_2 = 0.442$ (REFER TO PARAGRAPH 8.A.(3))

$X_1 = 0.036$ (REFER TO PARAGRAPH 8.A.(4))

$X_2 = 0.535$ (REFER TO PARAGRAPH 8.A.(4))

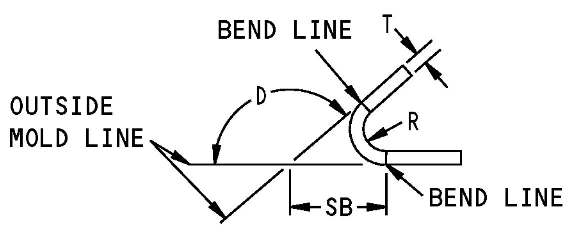
DEVELOPED WIDTH = $A - X_1 + B - X_2 + C$ (REFER TO PARAGRAPH 8.A.(5))

$= 1.00 - 0.036 + 3.00 - 0.535 + 1.20$

$= 4.63$

NOTE: ALL DIMENSIONS ARE IN INCHES UNLESS GIVEN DIFFERENTLY.

Flat Pattern Layout
Figure 7



D = BEND ANGLE

R = BEND RADIUS

T = THICKNESS

SB = SET BACK (THE DISTANCE FROM THE MOLD LINE TO THE BEND LINE)

SET BACK GRAPH INSTRUCTIONS:

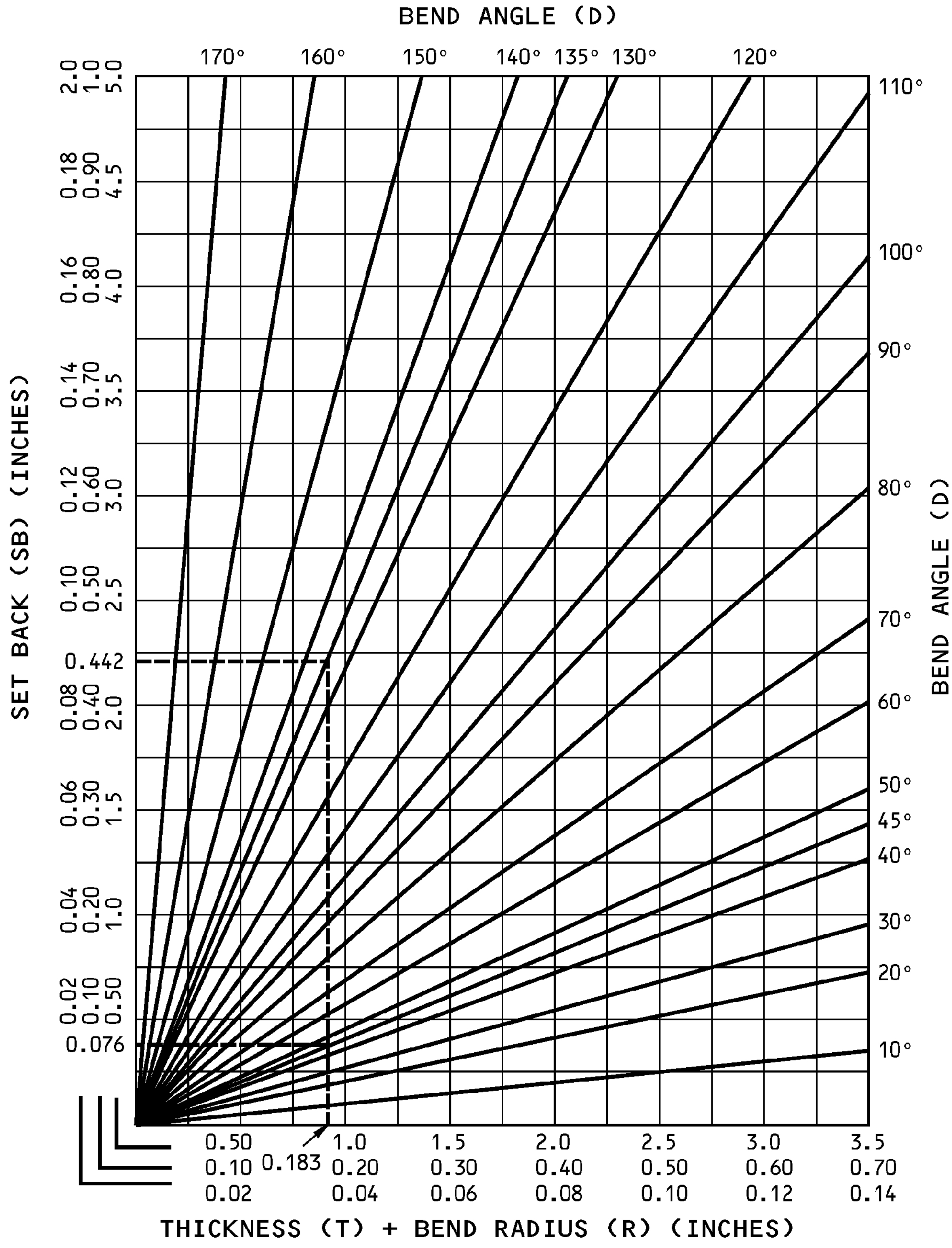
1. GO INTO THE GRAPH AT THE BOTTOM ON THE APPLICABLE SCALE USING THE SUM OF T + R.
2. READ UP TO THE BEND ANGLE (D).
3. FIND THE SET BACK (SB) FROM THE SCALE ON THE LEFT OF THE GRAPH.

   EXAMPLE:

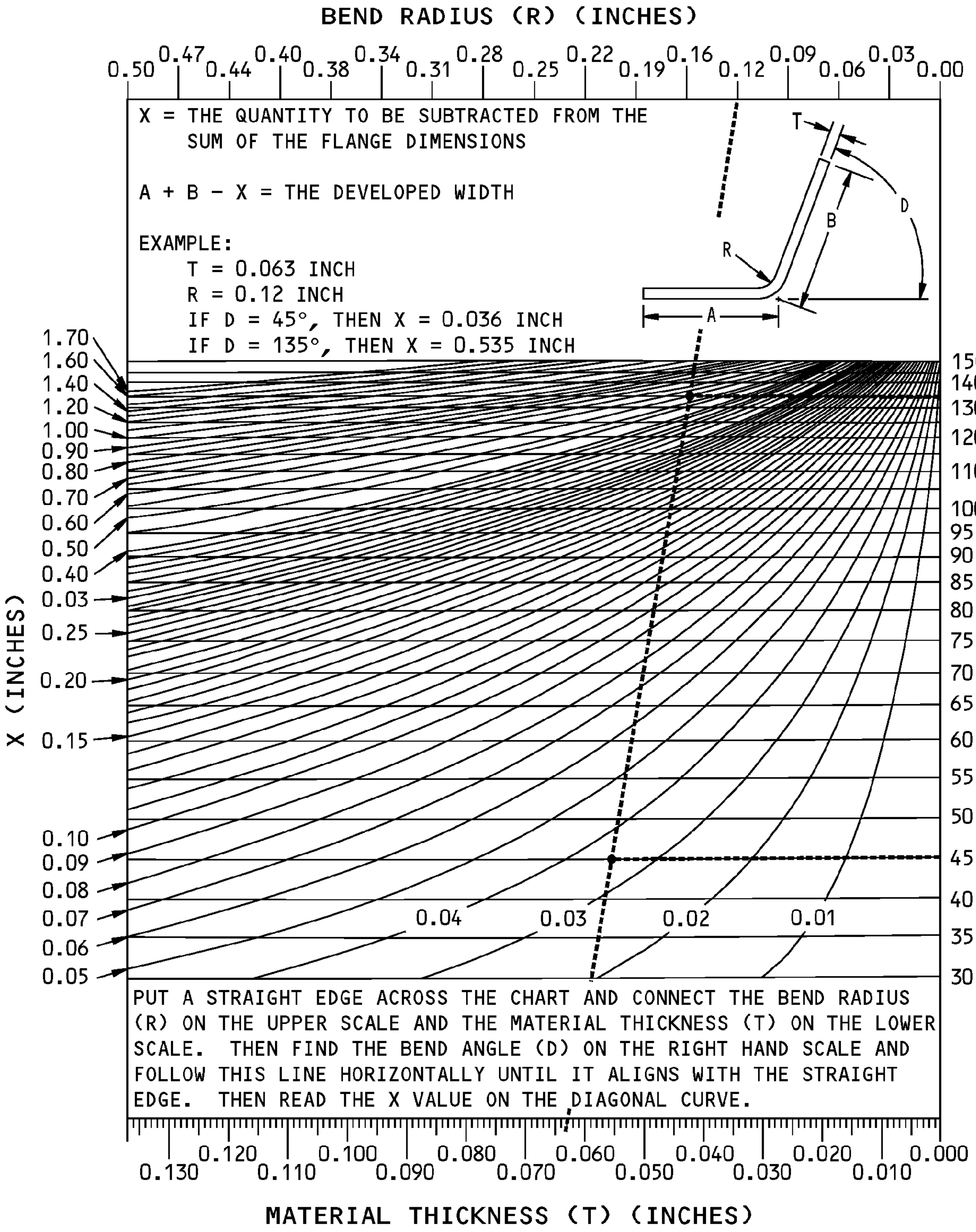
   FOR T = 0.063 INCH, R = 0.12 INCH, T + R = 0.183 INCH.

   IF D = 45°, SB = 0.076 INCH. IF D = 135°, SB = 0.442 INCH.

Flat Pattern Set Back Graph
Figure 8 (Sheet 1 of 2)



Flat Pattern Set Back Graph
Figure 8 (Sheet 2 of 2)



Flat Pattern X Dimension Graph
Figure 9

9. Instructions for the Use of Shims

A. Refer to Instructions for the Use of Shims, Figure 10/GENERAL for the instructions to use shims in repairs.

SHIM USAGE			
SHIM THICKNESS AS A PERCENTAGE OF THE FASTENER DIAMETER	FASTENER TYPE AND MATERIAL	NON-STRUCTURAL SHIM [2]	STRUCTURAL SHIM [1]
LESS THAN 20%	Rivets (aluminum)	X	
20% AND MORE [3]			X
LESS THAN 25%	Shear lockbolts or hi-loks (steel or titanium)	X	
25% AND MORE [4]			X
LESS THAN 25%	Tension lockbolts, bolts, or hi-loks (steel or titanium)	X	
25% AND MORE [5]			X

EXAMPLE:

FOR A 0.040 INCH THICK SHIM AND A 5/32 (0.1562) INCH DIAMETER ALUMINUM ALLOY RIVET, THE SHIM THICKNESS AS A PERCENTAGE OF THE FASTENER DIAMETER

$$= \frac{\text{SHIM THICKNESS}}{\text{FASTENER DIAMETER}} \times 100\%$$

$$= \frac{0.040 \text{ INCH}}{0.1562 \text{ INCH}} \times 100\%$$

$$= 25.6\%$$

A STRUCTURAL SHIM IS NECESSARY BECAUSE THE MAXIMUM NON-STRUCTURAL SHIM THICKNESS, AS A PERCENTAGE OF THE FASTENER DIAMETER OF AN ALUMINUM ALLOY RIVET, IS LESS THAN 21%.

Instructions for the Use of Shims
Figure 10 (Sheet 1 of 2)

NOTES

1 THE SHIM MUST BE ATTACHED TO THE REPAIR PART OR THE INITIAL PART. THE STRUCTURAL SHIM IS USED TO PREVENT MOVEMENT WHICH COULD POSSIBLY BEND THE FASTENER.

2 TO MAKE THE INSTALLATION EASIER, THE SHIM CAN BE BONDED TO THE REPAIR PART WITH BMS 5-95 OR, UNLESS THERE IS A FAY SURFACE SEAL AT THE LOCATION, BAC5010, TYPE 70 ADHESIVE.

3 IF THE TOTAL THICKNESS OF THE ASSEMBLED PARTS IS MORE THAN 2 TIMES THE RIVET DIAMETER, BOEING RECOMMENDS THAT YOU USE A BACB30VT()K HEX DRIVE BOLT WITH A BACC30BL COLLAR OR A BACB30VU()K HEX DRIVE BOLT WITH A BACC30BL COLLAR. REFER TO SRM 51-40-08 FOR THE MINIMUM MATERIAL THICKNESS NECESSARY WHEN YOU INSTALL COUNTERSINK FASTENERS.

4 IF THE TOTAL THICKNESS OF THE ASSEMBLED PARTS IS MORE THAN 2.8 TIMES THE FASTENER DIAMETER, BOEING RECOMMENDS THAT YOU USE A BACB30NX()K HEX DRIVE BOLT WITH A BACC30BH COLLAR OR A BACB30NY()K HEX DRIVE BOLT WITH A BACC30BH COLLAR. REFER TO SRM 51-40-08 FOR THE MINIMUM MATERIAL THICKNESS NECESSARY WHEN YOU INSTALL COUNTERSINK FASTENERS.

5 THE TOTAL THICKNESS OF THE ASSEMBLED PARTS MUST NOT BE MORE THAN 3.5 TIMES THE FASTENER DIAMETER.

Instructions for the Use of Shims
Figure 10 (Sheet 2 of 2)

GENERAL - SOURCES FOR METALLIC REPAIR MATERIALS

1. Applicability

A. This section gives the data for the sources of metallic materials that are used in repairs contained in the Structural Repair Manual (SRM). The data for non-metallic repair materials is found in 51-30-03.

2. General

A. The names, addresses, and products of the vendors are provided in Paragraph 4./GENERAL The Commercial and Government Entity (CAGE) code numbers or vendor codes of some of the vendors are also provided. The CAGE code numbers are given in the Federal Cataloging Handbook H4/H8.

3. References

Reference	Title
51-30-03	NON-METALLIC MATERIALS

4. Vendor Data

A.

Table 1:

INDEX FOR THE METALLIC REPAIR MATERIALS DATA	
MATERIAL	**LOCATION**
Vendor Codes	Table 2
Metallic Honeycomb Materials	Table 3

B.

Table 2:

VENDOR DATA	
VENDOR CODE	**VENDOR NAME AND ADDRESS**
V0858B	Hexcel SA Rue Des Bourdons 50 Parc Industriel 4840 Wel Kenraedt, Belgium
V51344	Hexcel Corporation Valley Industrial Park Gila Bend Highway, PO Box 66 Casa Grande, Arizona 85222

C.

Table 3:

METALLIC HONEYCOMB CORE MATERIALS	
MATERIAL	**SOURCE (VENDOR/VENDOR CODE)**
BMS 4-4 Aluminum Honeycomb Core All Types, Grade I, Classes N and P: Dura-Core II	Alcore, Inc. 1324 Brass Hill Road Belcamp, MD 21017
Hexcel CR111 5052	V51344 and the vendors that follow:

METALLIC HONEYCOMB CORE MATERIALS	
MATERIAL	SOURCE (VENDOR/VENDOR CODE)
	Hexcel Corporation St. Clair Industrial Park Pottsville, PA 17901
	Hexcel Corporation Bayview Industrial Park 1310 Steele Road Burlington, WA 98233
All Types, Grade I, Class ND: Hexcel CR111 5042	V0858B, V51344 and the vendors that follow:
	Hexcel Corporation St. Clair Industrial Park Pottsville, PA 17901
	Hexcel Corporation Bayview Industrial Park 1310 Steele Road Burlington, WA 98233
BMS 4-6 Flexible Aluminum Honeycomb Core Classes 1 and 2: CR111 Flex-Core	V15344

GENERAL - SOURCES FOR NON-METALLIC REPAIR MATERIALS

1. **Applicability**

   A. This section gives the data for the sources of non-metallic materials that are used to make repairs contained in the Structural Repair Manual (SRM). The data for metallic repair materials is found in 51-30-01, GENERAL.

   B. The materials are called out in the applicable repair data in Chapters 52 thru 57 of this manual. The purpose is to give the sources for these materials.

2. **General**

   A. The names and addresses of the vendors and the Commercial and Government Entity (CAGE) code numbers or vendor codes are provided. The CAGE code numbers are found in the Federal Cataloging Handbook H4/H8.

   B. When no source is specified in Table 3/GENERAL through Table 18/GENERAL, it means that all sources are acceptable.

   C. Many of these materials such as resins and prepreg materials used for composite repairs have a shelf life that is limited. Thus, they have special storage needs. The applicable storage data is available from the material suppliers.

   D. The data for the sealant classifications and their alternatives is found in 51-20-05, GENERAL

3. **References**

Reference	Title
51-20-05, GENERAL	Repair Sealing
51-30-01, GENERAL	Sheet Metal Materials

4. **Vendor Data**

   A. Table 2/GENERAL gives a list of the material suppliers with their vendor codes.

   B. Table 1/GENERAL gives an index of the subjects and the tables that contain the applicable data.

   C. Table 3/GENERAL thru Table 14/GENERAL contain the vendor data for the sources of the non-metallic materials.

Table 1:

INDEX FOR THE NON-METALLIC MATERIALS DATA	
MATERIAL	**LOCATION FOR THE VENDOR DATA**
Vendor Data	Table 2
Protective Treatment Materials	Table 3
Sealants	Table 4
Corrosion Inhibitors	Table 5
Adhesives	Table 6
Adhesive Films	Table 7
Resins and Potting Compounds	Table 8
Tapes	Table 9
Solvents	Table 10
Glass Fabrics	Table 11
Decorative Laminates	Table 12

INDEX FOR THE NON-METALLIC MATERIALS DATA	
MATERIAL	**LOCATION FOR THE VENDOR DATA**
Carbon Fiber Tape	Table 13
Carbon Fiber Fabric	Table 14
Aluminized Glass Fabric	Table 15
Non-Metallic Honeycomb Core	Table 16
Abrasives	Table 17
Miscellaneous Materials	Table 18

Table 2:

VENDOR DATA	
VENDOR CODE	**VENDOR - NAME AND ADDRESS**
VF5123	Brochier 33rd Ave, Franklin Roosevelt 69125 Decines Charpieu, France
VK1007	Ciba-Geigy Composites Duxford Cambridge CB2 4QA, England
VK2096	Fothergill and Harvey, Ltd. Industrial Textiles Division Summit Littleborough 0L15 9QT England
VK5066	Ciba-Geigy, Ltd. Bonded Structures Division Duxford, Cambridge CB2 4QD England
VZ0033	Gibson Chemicals, Ltd. 350 Reserve Road Cheltenham Victoria, 3192 Australia
V0L040	Dinol International, Inc. 20600 Eureka Road, Suite 414 Taylor, MI 48180-5306
V02684	Ciba-Geigy Corporation 4917 Dawn Avenue East Lansing, MI 48823
V03481	B.F. Goodrich, Aerospace Division 150 Division Drive Wilmington, NC 28401
V04374	The Dexter Corporation 211 Franklin Olean, New York 14760-1297
V04621	Hexcel Corporation 11555 Dublin Blvd. Dublin, CA 94568
V04622	Narmco Materials 1440 North Kraemer Blvd. Anaheim, CA 92806
V04963	Minnesota Mining and Manufacturing Co. 3M Center St. Paul, MN 55144-1000

VENDOR DATA	
VENDOR CODE	**VENDOR - NAME AND ADDRESS**
V0587B	Yokohama Rubber Company Industrial Products Division CPO Box 180 Tokyo, 100-91 Japan
V07542	American Cyanamid Company, Inc. Chemicals and Plastics Division Bloomingdale Dept 1300 Revolution Street Havre de Grace, MD 21078
V0858B	Hexcel Corporation Rue Des Bourdons 50 Parc Industriel 4840 Wel Kenraedt, Belgium
V0864B	Textile Products, Inc. 2521 West Woodland Drive Anaheim, CA 92801
V0865B	Saki Composites Corporation 1349-1 Hosojima, Shimada City Shizuoka-Pref., 427 Japan
V10396	Hercules, Inc. Aerospace Division, Bacchus Works P.O. Box 98 Magna, UT 84044
V18873	E. I. Dupont de Nemours and Co, Inc. 1007 Market Street, P.O. Box 1535 Wilmington, DE 19899
V22121	Magnolia Plastics, Inc. 5547 Peachtree Industrial Blvd. Chamblee, GA 30341
V26348	Fiber-Resin Corporation 170 W. Providencia Avenue Burbank, CA 91502
V3P211	Fiberite West Coast Corporation 645 North Cypress Orange, CA 92661-6603
V30137	Ciba-Geigy Corporation 5115 East La Palma Avenue Anaheim, CA 92807-2018
V33564	Dexter Hysol Aerospace, Inc. 2850 Willow Pass Road P.O. Box 312 Pittsburg, CA 94565
V33740	Hitco - Auburn Facility 3016 Auburn Avenue Auburn, WA 98002-1809
V45255	Owens-Corning Fiberglass Corporation Fiberglass Tower Toledo, OH 43604-1540
V51344	Hexcel Corporation Valley Industrial Park Gila Bend Hwy Casa Grande, AZ 85222

VENDOR DATA	
VENDOR CODE	**VENDOR - NAME AND ADDRESS**
V54527	Shell Oil Company 1 Shell Plaza P.O. Box 2463 Houston, TX 77001
V6E915	Westcoast Paper Company 2203 First Avenue South Seattle, WA 98134
V6M825	Clark-Schwebel Fiberglass Corporation 5 Corporate Park White Plains, New York 10604-3805 Anderson, SC 29622
V61102	Turco Products, Inc. 7300 Bolsa Avenue Westminster, CA 92684-3600
V61426	ATACS Products, Inc. 1120 SW 16th Renton, WA 98055
V66724	Holt Lloyd Corporation 4647 Hugh Howell Road Tucker, Georgia 30084
V7F755	Fisher Bag Company 1560 First Avenue South Seattle, WA 98134
V71191	Koppers Company, Inc. 5431 District Blvd. Vernon, CA 90040
V80463	Parker Amchem 32100 Stephens Hwy Madison Heights, MI 48071
V80524	Union Carbide Corporation Chemicals and Plastics Division Bound Brook Plant - River Road Bound Brook, NJ 08805
V80798	Cabot Corporation 125 High Street Boston, MA 02110-2721
V81205	The Boeing Company 7755 E. Marginal Way P.O. Box 3707 Seattle, WA 98124
V85570	Courtaulds Aerospace 1608 4th Street Berkely, CA 94710
V89138	Witco Chemical Corporation 1250 North Main Street Los Angeles, CA 90012-1834
V90897	American Cyanamid Company South Cherry Street Wallington, CT 06492

VENDOR DATA	
VENDOR CODE	VENDOR - NAME AND ADDRESS
V91610	Hexcel Corporation West Coast Manufacturing Division 10 Trevarno Livermore, CA 94550-2232
V92216	Pratt and Lampbert, Inc. 945 Burlington, P.O. Box 206 Kansas City, MO 64141
V98502	AKZO Coatings, Inc. 434 West Meats Blvd. Orange, CA 92661
V99384	Ciba-Geigy Furnace Products Division 5121 San Fernando Road West Los Angeles, CA 90039-1011
V99742	Johnson and Johnson, Permacel Division U.S. Highway 1 MO P.O. Box 671 New Brunswick, New Jersey 08903

Table 3:

PROTECTIVE TREATMENT MATERIALS	
MATERIAL	SOURCE (VENDOR/VENDOR CODE)
Alcohol - Phosphoric Solution	
TURCO Prepaint	V61102
Kelite Polylote	V84063
Water Solution (Refer to SRM 51-20-01) Butyl Cellulose	No source is specified
Phosphoric Acid (85%)	No source is specified
Triton X-100	Triton Manufacturing Company Division of Triton Industries Inc. P.O. Box 361 East Haddam, CT 06423
BAC5710, Type 51, High Temperature Polyurethane Primer	
Base 825-009, Catalyst 910-175, Thinner 020-044	V85570
BMS 10-11 Corrosion Inhibiting Primer	
Type I: There are many qualified vendor products available. Refer to the BMS Qualified Products List (QPL) or call The Boeing Company for more information.	V88570, V98502, and the vendors that follow:
	Deft Chemical Coatings 17451 Von Karman Avenue Irvine, CA 92714
	Tempo Paint and Varnish Company 205 Fenmar Drive Weston, Ontario, Canada M9L 2X4
	Hiratsuka Kanagawa, Japan 254

PROTECTIVE TREATMENT MATERIALS	
MATERIAL	SOURCE (VENDOR/VENDOR CODE)
	Crown Metro Aerospace Dexter Aerospace Materials Division P.O. Box 5695 315 Echelon Road Donaldson Center Greenville, SC 29606 Dexter, S.p.A. Crown Metro Aerospace Via delle Industrie 22 31020 San Zenone Degli Ezzelini Treviso, Italy Dexter Aerospace Materials Division 1 East Water Street Waukegan, IL 60085
BMS 10-21 Anti-Static Coating Type I is superseded by Type III Type III:	
Base 528X310, Activator 910X464	V88570
Base 463-6-84, Activator X-566	V98502
Base 10-P2-3, Activator EC-110	Crown Metro Aerospace Dexter Aerospace Material Division P.O. Box 5695 315 Echelon Road Donaldson Center Greenville, SC 29606
BMS 10-60 Enamel	
Type II: There are many qualified vendor products available. Refer to the BMS Qualified Products List (QPL) or call The Boeing Company for more information.	V85570, V98502 and the vendors that follow:
	Courtaulds Aerospace 11601 United Street Mojave, CA 93501 Crown Metro Aerospace Dexter Aerospace Materials Division P.O. Box 5695 315 Echelon Road Donaldson Center Greenville, SC 29606 Dexter, S.p.A. Crown Metro Aerospace Via delle Industrie 22 31020 San Zenone Degli Ezzelini Treviso, Italy Dexter Aerospace Materials Division 1 East Water Street Waukegan, IL 60085
BMS 10-79 Corrosion Resistant Primer	

PROTECTIVE TREATMENT MATERIALS	
MATERIAL	SOURCE (VENDOR/VENDOR CODE)
Type II and Type III: There are many qualified vendor products available. Refer to the BMS Qualified Products List (QPL) or call The Boeing Company for more information.	V85570 and the vendor that follows: Courtaulds Aerospace 11601 United Street Mojave, CA 93501
Cab-o-Sil (10 to 20 percent), Grade M-5, Grade PTG	V80798
Chemical Conversion Coating Alodine 600; Alodine 1000; Alodine 1200 Iridite 14-2 Turcoat Alumigold	 V84063 V89138 V61102
Hydroflouric Acid	No source is specified
MIL-C-11796, Class 3, Corrosion Preventive Compound	No source is specified
Mylar Tape	No source is specified
Nitric Acid Phydrion Papers, No. 60781	No source is specified

Table 4:

SEALANTS	
MATERIAL	SOURCE (VENDOR/VENDOR CODE)
Silicone Sealing Compound	No source is specified
Non-Silicone (Polyurethane or Polysulphide)	No source is specified
BMS 3-24 Grease	V54527
BMS 5-26, Type III Fuel Tank Sealant Classes A-2 and B-2: Pro-Seal 890 and PR1440 Class C-24: Pro-Seal 890	 V85570 V85570
BME 5-32 Sealant Superseded by BMS 5-26 and BMS 5-95	
BMS 5-63 Firewall Sealant Class B-4: Compound Dapco 18-4, Primer Dapco 1-100	 D Aircraft Products Co. 1191 Hawk Circle Anaheim, CA 52708
BMS 5-79 Sealant Class B-1/2 is superseded by BMS 5-95, Class B-1/2 Class B-2 is superseded by BMS 5-95, Class B-2 Class B-4 is superseded by BMS 5-95, Class B-4 Class B-8 is not superseded Class C-24 is superseded by BMS 5-95, Class C-20 Class C-48 is superseded by BMS 5-95, Class C-80	

SEALANTS	
MATERIAL	SOURCE (VENDOR/VENDOR CODE)
Class D-2 is superseded by BMS 5-16	
BMS 5-95 Chromate-Loaded Sealant	
Classes B-1/2 and B-2:	
Pro-seal 870	V85570
Class C-20, Type I:	
Pro-Seal 870 and PR1436	V85570

Table 5:

CORROSION INHIBITORS	
MATERIAL	SOURCE (VENDOR/VENDOR CODE)
MIL-C-16173, Grade 3	No source is specified
BMS 3-23 Corrosion Inhibiting Compound	
Type I:	
Boeshield T-9	VZ0033
Type II:	
Boeshield T-9	VZ0033
Dinitrol AV8	V0L040
LPS Hardcoat	V66724
ZC 023	ZIP-CHEM Products 1860 Dobbin Drive San Jose, CA 95133
BMS 3-26 Corrosion Inhibiting Compound	
Type II:	
Dinitrol AV 100 D	V0L040
Ardrox 3322	Ardrox, Inc. 16961 Knott Ave. La Mirada, CA 90638
BMS 3-29 Corrosion Inhibiting Compound	
Dinitrol AV30	V0L040
Procyon	V66724
ZC 029	ZIP-CHEM Products 1860 Dobbin Drive San Jose, CA 95133
BMS 10-20 Corrosion Resistant Finish	
Type II, Class A:	
Base 454-4-1, Activator CA-109, Thinner TL-52	V98502 or
	Dexter Aerospace Materials Division 1 East Water Street Waukegan, IL 60085
	or

CORROSION INHIBITORS	
MATERIAL	SOURCE (VENDOR/VENDOR CODE)
	Crown Metro Aerospace Dexter Aerospace Materials Division P.O. Box 5695 315 Echelon Road Donaldson Center Greenville, SC 29606
Base 10-P1-4, Activator EC-108, Thinner TL-19	Crown Metro Aerospace Dexter Aerospace Materials Division P.O. Box 5695 315 Echelon Road Donaldson Center Greenville, SC 29606
Type II, Class B:	
Base 454-4-5, Activator X-395, Thinner TL-132	V98502 or
	Crown Metro Aerospace Dexter Aerospace Materials Division P.O. Box 5695 315 Echelon Road Donaldson Center Greenville, SC 29606
	or
	Dexter Aerospace Materials Division 1 East Water Street Waukegan, IL 60085
BMS 5-89 Corrosion Inhibiting Adhesive Primer (CIAP)	
Type I:	
BR-127-THF	V07542
BR-127EE	V07542
BR-127 Two Component	V07542
EC 3960	V04963 or
	3M Sumitomo, AC&S Division 8-8 Minamihashimoto 3-Chome Sagamihara-Shi Kanagawa, 229 Japan
	or
	3M France B.P. 183 Tilloy Lez Cambrai 59404 Cambrai, Cedex, France
Courtaulds Aerospace 513-707 CIAP	V85570

Table 6:

ADHESIVES	
MATERIAL	SOURCE (VENDOR/VENDOR CODE)
BMS 5-14 Adhesive	

ADHESIVES	
MATERIAL	SOURCE (VENDOR/VENDOR CODE)
M6249	Uniroyal, Inc. Adhesives and Coatings 312 N. Hill Street Mishawaka, IN 46544
BMS 5-25 Adhesive	
Type II, Grade 1:	
EPIBOND 1539A/B-10	V99384
EA901NA	V33564
BMS 5-92 Adhesive	
Type I or Type II:	
EC-2216 A/B	3M Company 3211 East Chestnut Expressway Springfield, MO 65802
BMS 5-107 Adhesive	
Class 1:	
Epibond 420 A/B	V99384
Redux 420 A/B	VK5066
BMS 5-109 Adhesive	
Type II, Class 2, Grade A:	
EA 934 NA	V33564
EA 9394	V33564
EA 9394S	V33564
BMS 5-123 Adhesive	
Type I, Class 1:	
ATACS 4103	V61426
Type I, Class 2:	
ATACS 5103	V61426
Epoxy-Patch 608	V04347
Epoxy-Patch 615	V04347
Type I, Class 3:	
Epibond 8543	V99384

Table 7:

ADHESIVES FILMS	
MATERIAL	SOURCE (VENDOR/VENDOR CODE)
BMS 5-51 Adhesive	
Type II is superseded by BMS 5-129 for composites and BMS 5-101, Type II for metal bond	See BMS 5-129
Type III is superseded by BMS 5-101, Type III	See BMS 5-101
BMS 5-90 Foaming Adhesive	

ADHESIVES FILMS	
MATERIAL	SOURCE (VENDOR/VENDOR CODE)
Type III, Class 250/350-10-10:	
FM 490A	V07542
MA562; PL685	Sovereign Specialty Chemicals L.P. Adhesive Systems Division 123 West Bartges Street Akron, OH 44311-1081
Type IV, Class 250/350-10-10:	
PL460	Sovereign Specialty Chemicals L.P. Adhesive Systems Division 123 West Bartges Street Akron, OH 44311-1081
BMS 5-101 Structural Adhesive (For 180°F Service Applications)	
Type II, Grade 5:	
AF-163-2 OST; AF-163-3M	3M Company 3211 East Chestnut Expressway Springfield, MO 65802
EA9628; EA9628NW; EA9628 OST	V33564
FM-73M; FM-73M-OST	V07542
Type II, Grade 10:	
AF-163-2K; AF-163-2 OST	3M Company 3211 East Chestnut Expressway Springfield, MO 65802
EA9628; EA9628NW; EA9628 OST	V33564
FM-73; FM-73M; FM-73M-OST	V07542
Type II, Grade 15:	
AF-163-2K; AF-163-2M	3M Company 3211 East Chestnut Expressway Springfield, MO 65802
FM-73; FM-73M; FM-73M-OST	V07542
EA9628	V33564
BMS 5-129 Structural Adhesive (For 250°F Service Applications)	
Type II, Class IIA, Grade 10:	
AF-126-2	V33564
Type II, Class IIB, Grade 10:	
AF-123-5	V04963
BMS 5-141 Structural Adhesive (For -67°F to 300°F Service Applications)	
Hysol 9394, Parts A and B; Hysol 9394S, Parts A and B	V33564
BMS 5-154 Adhesive	
Type II, Class 1, Grade 05:	

ADHESIVES FILMS	
MATERIAL	**SOURCE (VENDOR/VENDOR CODE)**
1515-3M 05 PSF; 1515-3M-HT 05 PSF	CYTEC Industries CYTEC Engineered Materials 1440 N. Kraemer Boulevard Anaheim, CA 92806
Type II, Class 1, Grade 05:	
PL 795 05 PSF	Sovereign Specialty Chemicals L.P. Adhesive Systems Division 123 West Bartges Street Akron, OH 44311
BMS 8-145 Adhesive Film	
Type I:	
AF-131-2	3M Company 3211 East Chestnut Expressway Springfield, Missouri 65802
Type I:	
FM-355	V07452

Table 8:

RESINS AND POTTING COMPOUNDS	
MATERIAL	**SOURCE (VENDOR/VENDOR CODE)**
BMS 5-28 Potting Compound	
Type 3: Epocast 1511A Resin, Epocast 1511B Hardener	V30137
Type 7, Class 1: CG-1305 Resin, CG-1305 Hardener	V02684
FR 7162A Resin, FR 7162B Hardener	V26348
Type 7, Class 2: Epocast 89537A Resin, Epocast 89537B Hardener	V02684
Type 13: Epocast 938	V30137
Type 15: Epocast 1615A Resin, Epocast 1615B Hardener	V30137
Type 17: Epocast 1617A Resin, Epocast 1617B Hardener	V30137
Magnobond 91A Resin, Magnobond 91B Hardener	V22121
FR 7176A Resin, FR 7176B Hardener	V26348
Magnobond 92-1A Resin, Magnobond 92-1B Hardener	V22121
Magnobond 99A Resin, Magnobond 99B Hardener	V22121
Type 19: Epocast 1619A Resin, Epocast 1619B Hardener	V30137
FR 7174A Resin, FR 7174B Hardener	V26348
Potting Compound	
EC-3587B-1	V04963
EC-3587B-1/4	V04963
BMS 8-207 Resin	
Type I, Class 1: EC1838A Resin, EC1838B Hardener	3M Company 3211 E. Chestnut Expressway Springfield, MO 65802
Type I, Class 1: MXR7774A Resin, MXR7774B Hardener	V6P211

RESINS AND POTTING COMPOUNDS	
MATERIAL	SOURCE (VENDOR/VENDOR CODE)
Type I, Class 2: FR-40 Resin, 5413C Hardener Type II, Class 2: FR 8840A Resin, FR 8840B Hardener Epocast 1613A Resin, Epocast 1613B Hardener	V26348 V26348 V30137
BMS 8-301 Resin Class 1: EA 9390A Resin, EA 9390B Hardener Class 2: EY 3804A Resin, EY 3840B Hardener	 V33564 V26348
Milled Glass Fibers	V45255
Phenolic Microbaloons	V80524

Table 9:

TAPES	
MATERIAL	SOURCE (VENDOR/VENDOR CODE)
3M-Y436 Aluminum Foil Tape	V04963
Permacel P280 Polyester Tape	V99742
Scotchbrand No. 853	V04963
Black Plastic Tape No. 472	V04963

Table 10:

SOLVENTS	
MATERIAL	SOURCE (VENDOR/VENDOR CODE)
Acetone	No source is specified
Aliphatic Naphtha TT-N-95, Types I and II	V04963
BMS 3-2 Cleaning Solvent Type I superseded by TT-N-95, Type I Type II superseded by TT-N-95, Type II	See Aliphatic Naphtha
BMS 11-7 Cleaning Solvent Type I:	
Sikkens 96.130	AZKO/Dexter Aerospace Finishes Department R.I.B. 2170 BA Sassenheim The Netherlands
Turco 4460	V61102
T-2279A	Pratt and Lambert Industrial Coating Division 16116 East 13th Street Wichita, KS 67230
T-825, Pre-Sealing Cleaning Solvent	V71191
A-2688	Barton Solvents, Inc. 204 36th Street P.O. Box 900 Bettendorf, IA 52722

SOLVENTS	
MATERIAL	SOURCE (VENDOR/VENDOR CODE)
Methyl Ethyl Ketone (MEK)	No source is specified
Methyl Isobutyl Ketone (MIBK)	No source is specified
Perchloroethylene, O-T-236	No source is specified
Trichloroethylene	No source is specified

Table 11:

GLASS FABRICS	
MATERIAL	SOURCE (VENDOR/VENDOR CODE)
BMS 8-79, Type 120, Class III, Grade 1, and Type 1581, Class III, Grade I, and Type 7781, Class III, Grade I:	
120-F155-S-F69	V91610
120-F255-S-F69	V91610
NARMCO-3203-120, Z6040	V04622
NARMCO-3203F-120, Volan A	V04622
MXB 7701-120-Z6040	V3P211
120-F055F5FCS272	V04622
G120/F6986S03-S920NM	V0587B
BMS 8-139,	
Type 120, Class I:	
120-F161-108-F50	V91610
NARMCO-588-120, Volan A	V04622
Type 1581, Class I:	
181-F161-108-F50	V91610
NARMCO-588-120, Volan A	V04622
BMS 8-151,	
Type I, Class 1, Grade A:	
MXB 7251/120	V3P211
G120/F21003	V0578B
Type III, Class 1, Grade A:	
MXB 7251/181	V3P211
G1581/F21003-S 920 NM	V0587B
Type IV, Class 1, Grade A:	
MXB 7251/8800	V3P211
G8800/F21003-S 920 NM	V0578B
Type V, Class 2, Grade A:	
MXB 7271/108/1-642	V0587B
BMS 8-169,	
Type 120: Cycom 919-120	V07542

GLASS FABRICS	
MATERIAL	**SOURCE (VENDOR/VENDOR CODE)**
BMS 9-3,	
Type D, All Classes (Classes 1 and 15 are excluded)	V6M825
Type H, All Classes (Classes 1 and 15 are excluded)	V6M825
Type H2, All Classes (Classes 1 and 15 are excluded)	V6M825
Pre-cured Fiberglass Sheet	
Permaglass XERT7/9	ATACS Products Inc. 14040 Interurban Ave. S. Tukwila, WA 98168-4723

Table 12:

DECORATIVE LAMINATES	
MATERIAL	**SOURCE**
BAC5596, Type I: BMS 8-143, Type 100 (Nomex) Type II: BMS 8-143, Type 181 (Fiberglass) Type III: BMS 8-176, (Non-reinforced)	The Boeing Co. (V81205)

Table 13:

CARBON FIBER TAPE	
MATERIAL	**SOURCE (VENDOR/VENDOR CODE)**
BMS 8-168 Epoxy Impregnated Graphite Tapes - 250°F (121°C) Cure	
Type II, Class I, Grade 95:	
T3T-95-F155-76	V91610
T6C-95-12-F155-76	V91610
T2C-95-12-F155-76	V91610
CYCOM 919GT-3095	V07542
Class 1, Type II, Grade 145:	
T3T-95-F155-76	V91610
T6C-145-12-F155-76	V91670
T2C-145-12-F155-76	V91670
HYE-10714AC(145)	V3P211
Class 1, Type III, Grade 190:	
T3T-190-12-F155-76	V91610
T6C-190-12-F155-76	V91670
T2C-190-12-F155-76	V91670
HYE-10714AC(190)	V3P211
HYE-16714AD(190)	V3P211

CARBON FIBER TAPE	
MATERIAL	SOURCE (VENDOR/VENDOR CODE)
CYCOM 919GT-3190	V07542
BMS 8-212 Epoxy Impregnated Graphite Tapes - 350°F (177°C) Cure	
Type II, Class I, Grade 190:	
RIGIDITE 5208-300-190-35 Percent	V04622
RIGIDITE 5208-C3000-190-35 Percent	V04622
RIGIDITE 5208FT-300-190-35 Percent	V04622
HYE-1034C(190)-II	V3P211
T3T190-12-F263-2	V91610
T5T190-12-F263-2	V91610
T6C190-12-F263-2	V91610
T2C190-12-F263-2	V91610
Type III, Class I, Grade 95:	
RIGIDITE 5208-C3000-95-35 Percent	V04622
RIGIDITE 5208-C600-95-35 Percent	V04622
HyE-30341C(95)-III	V3P211
T6C95-12-F263-7	V91610
T2C95-12-F263-7	V91610
T3T95-12-F263-7	V91610
T3G95-12-F263-7	V91610
CYCOM 985GT3095	V10396
Fibredux 922C-TS-3.6-37 Percent	VK5066
Type III, Class 1, Grade 145:	
RIGIDITE 5208-C3000-145-37 Percent	V04622
RIGIDITE 5208-C6000-145-37 Percent	V04622
HYE-1034C(145)-III	V3P211
HYE-3034C(145)-III	V3P211
HYE-3034E(145)-III	V3P211
T6C145-12-F263-7	V91610
T2C145-12-F263-7	V91610
T3T145-12-F263-7	V91610
T3G145-12-F263-7	V91610
AS4/3501-5A	V10396
CYCOM 985GT3145	V10396
Fibredux 922C-TS-5.5-37 Percent	VK5066

Table 14:

CARBON FIBER FABRIC	
MATERIAL	VENDOR CODE
BMS 8-168 Epoxy Impregnated Graphite Woven Fabric - 250°F (121°C) Cure	

CARBON FIBER FABRIC	
MATERIAL	**VENDOR CODE**
Type II, Class 2, Syle 3K-70-PW:	
HMF 5-322/97714AC	V3P211
HMF 6-322/97714AC	V3P211
HMF 5-322D/97714AC	V3P211
HMF 6-322D/97714AC	V3P211
CYCOM 919GF-3070PW	V07542
BMS 8-212 Epoxy Impregnated Graphite Woven Fabric - 350°F (177°C) Cure	
Type III, Class 2, Style 3K-135-8H:	
RIGIDITE 5208 Woven C3000 Style 3K-135-8H-37 Percent	V04622
RIGIDITE 5208F Woven C300 Style 3K-135-8H-37 Percent	V04622
HMF-5-133/34-III	V3P211
HMF-5-133D/34-III	V3P211
HMF-5-1133D/34-III	V3P211
F3B-584-42-F263-7	V3P211
F3T-584-42-F263-7	V3P211
F3C-584-42-F263-7	V3P211
F3G-584-42-F263-7	V3P211
F3L-584-42-F263-7	V3P211
AW-370-8H/3501-5AD	V10396
CYCOM 985-GF3135-H8	V10396
Fibredux 922C-815-37 Percent	VK5066
Type IV, Class 2, Style 3K-70-PW:	
HMF-5-322/34C-IV	V3P211
HMF-5-322D/34C-IV	V3P211
HMF-6-322/34C-IV	V3P211
HMF-6-322D/34C-IV	V3P211
HMF-5-1322/34C-IV	V3P211
HMF-6-1322/34C-IV	V3P211
HMF-5-2461/34C-IV	V3P211
HMF-6-2461/34C-IV	V3P211
W3B-282-42-F263-8	V0858B
W3C-282-42-F263-8	V91610
W3G-282-42-F263-8	V91610
W3T-282-42-F263-8	V0858B
CYCOM 985F32358H	V10396
CYCOM 985GF3135H8	V10396
Fibredux 922C-814NT-40 Percent	VK5066
BMS 8-258 Epoxy Impregnated Graphite Woven Fabric - 275°F (135°C) Cure Vacuum Bag Process	
Class 2, Style 3K-70-PW:	

CARBON FIBER FABRIC	
MATERIAL	**VENDOR CODE**
CYCOM 919GF30700PW-42	V07542
CYCOM 919FE30700PW-42	V07542
CYCOM 919FK30700PW-42	V07542
BMS 9-8 Yarn and Fabric Graphite Reinforcements	
Type I, Class 2, Style 3K-70-P:	
W-5-134, W-5-322, W42-5-2, W-5-1134, and W-5-1322	V3P211
ES-1954 and ES-1956	V33740
F3T-282 and F3C-282	V04621
4163 and 4133	V0864B
7373	V0865B
G814NT	VF5123
43193/1	V0858B
9610 and 9820	VK2096
CGG-100	V30137
Type I, Class 2, Style 3K-135-8H:	
W-5-133, W-5-401 and W-5-1133	V3P211
ES-1955 and ES-1957	V33740
F3T584 and F3C-584	V04621
4243 and 4245	V04621
G815	V0864B
43364/1	V0858B
9650 and 9860	V0864B
A0053/000	VK2096
CGG-104	V30137

Table 15:

ALUMINUM COATED GLASS FABRIC	
MATERIAL	**VENDOR CODE**
BMS 8-278 Aluminum Coated, Epoxy Resin Impregnated, Glass Fabric Cloth	
Type I, Class 250: TEF7-F155-84	V91610
Type I, Class 350: TEF7-F161-199	V91610
Type II, Class 250: TEF5-F155-84	V91610
Type II, Class 350: TEF5-F161-199	V91610

Table 16:

NON-METALLIC HONEYCOMB CORE	
MATERIAL	**SOURCE (VENDOR/VENDOR CODE)**
BMS 8-124 Non-Metallic Honeycomb Core	
Class I, Type 1, Grade 4.0:	

NON-METALLIC HONEYCOMB CORE	
MATERIAL	SOURCE (VENDOR/VENDOR CODE)
HRP-3/16-4.5	V51344
HTP-3/16-4.0	V51344
Class 1, Type 1, Grade 5.5:	
HRP-3/16-5.5	V51344
HTP-3/16-5.0	V51344
Class 1, Type 1, Grade 8:	
HRP-3/16-8.0	V51344
HTP-3/16-8.0	V30137
Class 1, Type 1, Grade 12.0:	
HRP-3/16-12.0	V51344
HTP-3/16-12.0	V30137
Class 1, Type 1, Grade 4.0:	
HRP-3/16-4.0	V51344
Class 4, Type V, Grade 3.0:	
HRH-10-1/8-3.0	V30137
HMX-1/8-3.0	V30137
HFT-1/8-3.0	V0858B
A-1-48-3	VK1007
HRH10-1/8-3.0	VK1007
SAH-1/8-3.0	Showa Aircraft Industry Co., Ltd. No. 600, Tanaka-Machi Akishima-Shi Tokyo, 196 Japan
Class 4, Type V, Grade 4.0:	
HMX-1/8-4.0	V30137
A-1-64-3	VK1007
Class 4, Type V, Grade 5.0:	
HRH-10-1/8-5	DIC-Hexcel Ltd. 2-5, Kogyou Danachi, Kamatsu-Shi, Isikawa-Ken, 923 Japan
SAH-1/8-5.0	Showa Aircraft Industry Co., Ltd. No. 600, Tanaka-Machi Akishima-Shi Tokyo, 196 Japan
Class 4, Type V, Grade 8.0:	
HRH-10-1/8-8	V51344
HMX-1/8-8	V31037
SAH-1/8-8.0	Showa Aircraft Industry Co., Ltd. No. 600, Tanaka-Machi Akishima-Shi Tokyo, 196 Japan
Class 4, Type V, Grade 9.0:	
HRH-10-1/8-9	V51344
HMX-1/8-9	V30137

NON-METALLIC HONEYCOMB CORE	
MATERIAL	**SOURCE (VENDOR/VENDOR CODE)**
SAH-1/8-9.0	Showa Aircraft Industry Co., Ltd. No. 600, Tanaka-Machi Akishima-Shi Tokyo, 196 Japan
Class 4, Type IV, Grade 3.0:	
HRH-10-1/4-OX-3.0	V51344
HMX-1/4-OX-3.0	V30137
HRH-10/OX-4/4-3.0	V51344

Table 17:

ABRASIVES	
MATERIAL	**SOURCE (VENDOR/VENDOR CODE)**
Aluminum Oxide Abrasive Paper No. 80-Grit; No. 150-Grit; No. 180-Grit; No. 320-Grit; No. 400-Grit	No source is specified
Scotchbrite Pad - Type A No. 150; No. 240	V04963
Silica Sand, No. 1	No source is specified
Silicone Carbide Paper No. 80-Grit; No. 150-Grit; No. 180-Grit; No. 240-Grit	No source is specified
Garnet Abrasive Paper 7/0	No source is specified
Soda Lime Glass Beads, No. 60-Grit	No source is specified
Steel Shot, No. 30 (VACUBLAST)	No source is specified
Tycro Aluminum Oxide Wheels Type 3A; 5A (Medium, Fine); Type 7S (Medium, Fine)	V04963
Wool, Aluminum and Stainless Steel	No source is specified
Pumice - 350 Mesh	No source is specified

Table 18:

MISCELLANEOUS MATERIALS	
MATERIAL	**SOURCE (VENDOR/VENDOR CODE)**
Bleeder Cloth Osnaburg Cloth (un-bleached) CCC-C-429	V6E915, V7F755
Gauze	No source is specified
Cetyl Alcohol	No source is specified
Lauric Acid	No source is specified
Boelube 100A	The Orelube Corporation 201 East Bethpage Road Plainview, NY 11803
Freon TB-1	V18873
Solid FEP Parting Film	No source is specified

MISCELLANEOUS MATERIALS	
MATERIAL	**SOURCE (VENDOR/VENDOR CODE)**
Perforated FEP Parting Film	No source is specified
Vacuum Bag Material	No source is specified
Teflon Parting Film	No source is specified
Airweave SS	Airtech International, Inc. 2542 E. Del Amo Blvd. P.O. Box 6207 Carson, CA 90749
Sealing Compound (Extruded)	No source is specified
BMS 8-64 Flow Resistant Acoustic Fabric Type I: Dacron Batiste, Lot 3070, Color: White Dacron Batiste, 9027 White	 Collins and Aikman 313 Bethany Road Albemarle, NC 28001 Elite Textiles 701 Concord Road Albemarle, NC 28001
BMS 8-289 Aluminum Foil Adhesive Laminate Material Type 0/350/2/1100/002, Form I, Grade B: C-CLAD H-250/350-002 Type 0/350/2/1235/002, Form I, Grade B: C-CLAD J-250/350-002 Type 0/250/4/1235/002, Form I, Grade B: C-CLAD N-250/350-002 Type 0/250/8/1145/002, Form I, Grade B: C-CLAD T-250/350-002	 Hill Industries, Inc. 10851 Point Vashon Drive SW Vashon, WA 98070 Hill Industries, Inc. 10851 Point Vashon Drive SW Vashon, WA 98070 Hill Industries, Inc. 10851 Point Vashon Drive SW Vashon, WA 98070 Hill Industries, Inc. 10851 Point Vashon Drive SW Vashon, WA 98070
BMS 8-336 Expanded Metal Foil Type 1, Class 1, Grade 016, Form A: 4AL-8-080	 EXMET Corporation 7 Great Hill Road P.O. Box 1266 Naugatuck, CT 06770

GENERAL - DANGEROUS MATERIALS

1. **Applicability**

   A. This section gives data that is necessary when you do work with dangerous materials.

2. **References**

Reference	Title
51-10-02	INSPECTION AND REMOVAL OF DAMAGE
51-30-01	SHEET METAL MATERIALS
SOPM 20-10-09	Machining of Copper Beryllium Alloys

3. **Dangerous Materials**

WARNING: DO NOT BREATHE THE DUST THAT IS THE RESULT OF GRINDING, SANDING, HONING, ABRASIVE SAWING, ABRASIVE BLASTING, OR ELECTRICAL DISCHARGE MACHINING (EDM) OF COPPER BERYLLIUM ALLOYS. THE DUST AND FUMES ARE DANGEROUS AND CAN CAUSE INJURY TO PERSONS.

   A. Copper Beryllium Alloys

      (1) Copper beryllium is a copper alloy that contains 2 percent beryllium. The solid form of this material does not give a risk to health or the environment. Copper beryllium scrap is not dangerous waste. The scrap has value and is usually recycled.

      (2) Some of the machining processes used for copper beryllium alloys where dust is the result can be dangerous. These processes include grinding, sanding, honing, abrasive sawing, abrasive blasting, and electrical discharge machining (EDM). The machining of these materials can be done in a way that is not dangerous when you use the correct equipment and wet machining procedures.

      (3) The most often used machining procedures for copper beryllium do not cause dust and thus are not dangerous. Typically, copper beryllium is machined wet like other metals. These processes give no dust and include boring, reaming, sawing, drilling, milling, turning, and deburring with cutting tools. Refer to SOPM 20-10-09 for the recommended machining procedures for copper beryllium alloys.

      (4) There is no increased health risk if copper beryllium in solid form touches your skin. Isolated machining equipment is not a requirement.

      (5) Copper beryllium is insoluble in most cutting oils and water-based machining fluids. There is no danger from fire.

   B. Magnesium Alloys

WARNING: PREVENT SOURCES OF IGNITION. SMALL PARTICLES OF MAGNESIUM ARE VERY FLAMMABLE. IN THE CORRECT CONCENTRATION IT CAN CAUSE AN EXPLOSION. IF WATER TOUCHES HOT MAGNESIUM A STEAM EXPLOSION CAN OCCUR. EXTINGUISH FIRES OF MAGNESIUM WITH FULLY DRY TALC, CALCIUM CARBONATE, SAND, OR GRAPHITE. APPLY THE POWDER TO A DEPTH OF 1/2 INCH OR MORE ON TOP OF THE METAL THAT IS ON FIRE. DO NOT USE FOAM, WATER, CARBON TETRACHLORIDE, OR CARBON DIOXIDE.

      (1) Small particles of magnesium are a source of fire. Refer to 51-10-02 for procedures and precautions to use when you work with magnesium.

   C. Titanium Alloys

WARNING: PREVENT SOURCES OF IGNITION. SMALL PARTICLES OF TITANIUM ARE VERY FLAMMABLE. IN THE CORRECT CONCENTRATION IT CAN CAUSE AN EXPLOSION. IF WATER THAT TOUCHES HOT TITANIUM A STEAM EXPLOSION CAN OCCUR. EXTINGUISH FIRES OF TITANIUM WITH FULLY DRY TALC, CALCIUM CARBONATE, SAND OR GRAPHITE. APPLY THE POWDER TO A DEPTH OF 1/2 INCH OR MORE ON TOP OF THE METAL THAT IS ON FIRE. DO NOT USE FOAM, WATER, CARBON TETRACHLORIDE, OR CARBON DIOXIDE.

(1) Small particles of titanium are a source of fire. Refer to 51-10-02 and 51-30-01 for procedures and precautions to use when you work with titanium.

GENERAL - EQUIPMENT AND TOOLS FOR REPAIRS

1. **General**

   A. This subject gives a list of the equipment and hand tools that are used to make repairs. This subject also gives the necessary vendor data. The purpose of the list is to give data about the equipment and tools and their uses.

   B. The Boeing Company makes no recommendation as to what brand to use, only what brand or its equivalent can be used. The Boeing Company also makes no representation as to the quality of the different brands.

   C. The use of electrical equipment near fuel or other volatile materials can be dangerous. Speak with the local fire authority before you use electrical equipment near these materials.

   D. Refer to:

      (1) Miscellaneous Equipment, Figure 1/GENERAL for a list of repair equipment

      (2) Hand Tools, Figure 2/GENERAL for a list of hand tools.

TOOL	MANUFACTURER'S DESIGNATION	MANUFACTURER	REMARKS
AIR-BLAST GUN	VACU-BLAST JR., #41303 OR EQUIVALENT	VACU-BLAST WOODSON HOUSE AJAX AVENUE SLOUGH BERKSHIRE, SL1 4DS ENGLAND -OR- P.O. BOX 286 HERINGTON, KS 67449	CLEAN METAL SURFACES
ASPIRATOR, VACUUM	VACUUM MODEL TD-260 OR EQUIVALENT	AIR-VAC ENGINEERING P.O. BOX 215 30 PROGRESS AVE SEYMOUR CT 06483 AIRTRONICS 1940 124TH AVE NE BLDG. A-107 BELLEVUE, WA 98005	CONVERTS AIR PRESSURE TO VACUUM
BAGS, PRESSURE	10-LB SAND OR SHOT BAGS	COMMERCIAL-ANY SOURCE	USE AS A SUBSTITUTE PRESSURE MEDIUM
BLANKET, HEATING	5 WATTS/IN^2 MINIMUM	ATACS PRODUCTS, INC. 14040 INTERURBAN AVE S. TUKWILA, WA 98168 HEATCON COMPOSITE SYSTEMS 600 ANDOVER PARK E SEATTLE, WA 98188-OR- UNIT 8, EDISON RD, ST. IVES, HUNTINGDON, CAMBRIDGE PE17 4LZ ENGLAND GMI 9 RUE BUFFAULT 75009 PARIS, FRANCE OR GMI/EMPTECH 5957 GLENDALE DRIVE CHILLIWACK, B.C., CANADA V2R 3A5 JR TECHNOLOGY LTD. 81 NORTH END, MELDRETH ROYSTON, HERTS, ENGLAND SG86NU	TO PROVIDE HEAT FOR CURING ADHESIVE

Miscellaneous Equipment
Figure 1 (Sheet 1 of 8)

TOOL	MANUFACTURER'S DESIGNATION	MANUFACTURER	REMARKS
		PYROMETRIC SERVICE CORP. 1312 S. 96TH ST SEATTLE, WA 98108-5010	
		TAYCO ENGINEERING, INC. 10874 HOPE ST P.O. BOX 6034 CYPRESS, CA 90630	
		WICHITECH INDUSTRIES, INC. OAKLAND CENTER, 8990 RT. 108 COLUMBIA, MD 21045	
CLEANER, VACUUM [2]	INDUSTRIAL-TYPE MODEL #APN4423 (TORNADO); USE A 556AL BARREL AS A DUST RECEIVER	BREUER/TORNADO CORP. 7401 W. LAWRENCE AVE. CHICAGO, IL 60656	CLEAN UP SANDING AND DEBRIS
CONTAINERS, 1 LITER BEAKER-TYPE, POLYETHYLENE	#13915-679 SHERWOOD OR EQUIVALENT	V.W.R. SCIENTIFIC 355 TRECK DRIVE SEATTLE, WA 98188	MIXING RESINS AND POTTING COMPOUNDS
CONTAINERS, SAFETY, FOOT-LEVER-TYPE	METAL, EAGLE 906-FL OR EQUIVALENT	V.W.R. SCIENTIFIC 355 TRECK DRIVE SEATTLE, WA 98188	HOLDING USED CLOTHES WITH TOXIC MATERIALS
CORK SHEET	0.125-IN.	COMMERCIAL - ANY SOURCE	
CAUL PLATE	FABRICATE LOCALLY USING 0.016 ALUMINUM SHEET		USE TO DISTRIBUTE PRESSURE OVER AREAS OF A REPAIR
COUNTERSINK, MICRO-STOP, 100° ADJUSTABLE DRIVE	#6300-LARGE, #6400-SMALL, OR EQUIVALENT	MC MASTER-CARR P.O. BOX 740100 ATLANTA, GA 30374-0100 WWW.MCMASTER.COM	COUNTERSINKING HOLES FOR RIVETS, SCREWS, OR BOLTS

Miscellaneous Equipment
Figure 1 (Sheet 2 of 8)

TOOL	MANUFACTURER'S IDENTIFICATION	MANUFACTURER	REMARKS
CUTTER, HONEYCOMB, VALVE STEM TYPE, TWO-PIECE	30-030-1 HOLDER [4] 30-030-2 CUTTER	ONSRUD CUTTER MFG CO. 800 LIBERTY DRIVE P.O. BOX 550 LIBERTYVILLE, IL 60048	ALUMINUM HONEYCOMB CUTTER
CUTTER, HONEYCOMB, VALVE STEM TYPE, ONE-PIECE	31-010 0.50 DIA [3] 31-015 0.75 DIA [3] 31-020 1.0 DIA [3] 31-025 1.5 DIA [4] 31-030 2.0 DIA [4]	OR ANY OTHER COMMERCIAL SOURCE	ALUMINUM HONEYCOMB CUTTER
DRILL MOTOR [2]	ELECTRIC 600 RPM, MODEL 15C 1489 OR EQUIVALENT	AERO INDUSTRIAL TOOL 482 E. MEADOW AVE E. MEADOW, NY 11554	CONVENTIONAL DRILLING, SANDING, OR CIRCULAR SAWING
	PNEUMATIC, 1/4-IN. CHUCK, MODEL #3008-0 OR EQUIVALENT	CHICAGO PNEUMATIC 1800 OVERVIEW DR. ROCKHILL, SC 29730	
DRILL MOTOR, 90° ANGLE	PNEUMATIC, VARIABLE SPEED, MODEL #10L-1201B OR EQUIVALENT	AERO INDUSTRIAL TOOL 482 E. MEADOW AVE E. MEADOW, NY 11554	CONVENTIONAL DRILLING, SANDING, OR CIRCULAR SAWING
GAUGE, AIR PRESSURE	0 TO 100 PSI, MODEL J4654 OR EQUIVALENT	MARSH INSTRUMENT CO. P.O. BOX 361 ANTIOCH, IL 60076	TO INDICATE AIR LINE PRESSURE
GAUGE, VACUUM	0 TO 32 IN. HG	MARSH INSTRUMENT CO. P.O. BOX 361 ANTIOCH, IL 60076	TO INDICATE VACUUM LINE PRESSURE
GLOVES, COTTON	WHITE, UNTREATED, LINTLESS	MC MASTER-CARR P.O. BOX 740100 ATLANTA, GA 30374-0100 WWW.MCMASTER. COM	USE FOR HANDLING CLEANED PARTS OR ADHESIVES
GLOVES, INSULATING	HEAT INSULATING	ANY SOURCE	USE FOR HANDLING HOT PARTS

Miscellaneous Equipment
Figure 1 (Sheet 3 of 8)

TOOL	MANUFACTURER'S IDENTIFICATION	MANUFACTURER	REMARKS
HEATER ASSEMBLY 2	HOT AIR, BF-400-10, OR EQUIVALENT	ENGINEERED AIR SYSTEMS 1270 N. PRICE RD. ST. LOUIS, MO 63132	HOT AIR BLOWER TO DUCT AIR TO AREA BEING CURED
HEATER, AIR 2	1000 TO 2000 WATTS, MODEL HGS 50110J	MASTER APPLIANCE CORP. 2420 18TH ST. RACINE, WI 53403	FOR HEAT-TACKING ADHESIVES, HEAT-DRYING HONEYCOMB CORE OR ASSEMBLIES, WARMING COMPOUNDS AND/OR RESINS
	ALTERNATE	IDEAL INDUSTRIES, INC. 1006 PARK AVENUE SYCAMORE, IL 60178	
LAMP, HEATING	250 TO 300 WATTS, EXPLOSION PROOF, TUNGSTEN OR QUARTZ TUBE	MC MASTER-CARR P.O. BOX 740100 ATLANTA, GA. 30374-0100 WWW.MCMASTER.COM	LOW-TEMPERATURE CURING OF ADHESIVES, POTTING COMPOUNDS, OR RESINS
LAMP, HEATING ASSEMBLY	25 OR 40/4 #375G30 OR EQUIVALENT	DELTROL CONTROLS CORP. 2740 SO. 20TH ST. MILWAUKEE, WI 53215	LOW-TEMPERATURE CURING OF ADHESIVES, POTTING COMPOUNDS, OR RESINS
MAT, FIBERGLASS	2 OZ FIBERGLASS OR 7500 TOOLING MAT	REN PLASTICS 5656 S. CEDAR ST. LANSING, MI 48909 DEXTER CORP. (HYSOL PRODUCTS) ONE DEXTER DRIVE SEABROOK, NH 03874	CAN BE USED FOR LAMINATED TOOLING, FIBERGLASS BLEEDER CLOTH, INSULATION MATERIAL, OR A SUBSTITUTE FOR OSNABURG BREEDER CLOTH
MOTOR ASSEMBLY, PNEUMATIC	ARBOR SAW/MOTOR	AERO INDUSTRIAL TOOL 482 E. MEADOW AVE E. MEADOW, NY 11554	TO CUT AWAY DAMAGED MATERIAL
MULTITESTER	LOW CURRENT, LOW OHM, KELVIN-BRIDGE-TYPE	COMMERCIAL - ANY SOURCE	TAKING ELECTRONIC MEASUREMENTS

Miscellaneous Equipment
Figure 1 (Sheet 4 of 8)

TOOL	MANUFACTURER'S IDENTIFICATION	MANUFACTURER	REMARKS
PEENING TOOL, POWER [2]	1/4-IN. STEM (DRILL ROD), SLOT END FOR FLAPPER STRIP MIL-B-1170, TYPE II, CLASS E, STYLE 1		USE FOR SHOT PEENING REQUIREMENTS
POWER SUPPLY, DC	REGAL LINE MODEL R2518 UNFILTERED BENCH MODEL R SERIES DC OR EQUIVALENT		USE AS A POWER SOURCE FOR PHOSPHORIC ACID ANODIZING.
RECORDER, TEMPERATURE, 24-POINT, AUTOMATIC CHART-TYPE	MODEL #15306836-24	HONEYWELL	MEASURING TEMPERATURE AT THE ADHESIVE CURE LINE BY THERMOCOUPLES; 1 THROUGH 24 POINTS AVAILABLE
RECORDER, TEMPERATURE, 1-POINT, INDIVIDUAL PRINTOUT, ROLLER CHART	MODEL #122 115-VOLT, 60-CYCLE	GULTON GRAPHIC INSTRUMENT 1900 S. COUNTRY TR. E. GREENWICH, RI 02818	MEASURING ONE THERMOCOUPLE ON A LINE CHART
REGULATOR, AIR PRESSURE	0 TO 125 PSI, MODEL 11-002-025 OR EQUIVALENT	C.A. NORGREN CO. 5400 S. DELEWARE ST LITTLETON, CO 80120	MEASURE AND CONTROL AIR PRESSURE
REGULATOR, VACUUM	0- TO 30-INCH HG, OR EQUIVALENT	MC MASTER-CARR P.O. BOX 740100 ATLANTA, GA 30374-0100 WWW.MCMASTER.COM	MEASURE VACUUM AT THE ASSEMBLY
SAFETY FACE SHIELD	TRU-SAFE #119-1 OR SAFELINE #6799 (10 BY 18-1/4) OR EQUIVALENT	COMMERCIAL-ANY SOURCE	FOR FACE AND EYE PROTECTION
SAFETY FACE SHIELD HOLDER	RICE HEAD SHIELD #707 OR EQUIVALENT		HOLDS REPLACEABLE FACE SHIELD

Miscellaneous Equipment
Figure 1 (Sheet 5 of 8)

TOOL	MANUFACTURER'S IDENTIFICATION	MANUFACTURER	REMARKS
SAFETY GLASSES	5944D SMOKE CLEAR LENSES OR EQUIVALENT	H.L. BOUTON CO., INC. BUZZARD BAY, MA 02532 MC MASTER-CARR P.O. BOX 740100 ATLANTA, GA 30374-0100 WWW.MCMASTER.COM	FOR EYE PROTECTION
SCALE, BALANCE	1.0 GRAM ACCURACY, MULTIPLE MODELS	METTLER, 1900 POLARIS PKWY. COLUMBUS, OH 43240 OR OHAUS CORPORATION 29 HANOVER RD. FLORHAM PARK, NJ 07932	WEIGHING COMPOUNDS AND RESIN MIXTURES
SEALANT GUN	AIR-OPERATED, OR EQUIVALENT GLUE GUN	MC MASTER-CARR P.O. BOX 740100 ATLANTA, GA 30374-0100 WWW.MCMASTER.COM	DISPENSING OF FILLERS AND SEALANTS
SHAVER, MICRO-RIVET-HEAD	MODEL 2T-405, ADJUSTABLE, OR EQUIVALENT	ADVANCED AIR TOOL CO., INC. 131 ALLEN BLVD. FARMINGDALE, NY 11735-5616	SHAVE PROTRUDING RIVET HEADS
SINE PLATE	0° TO 45° INCLINATION FROM HORIZONTAL POSITION	BROWN & SHARPE PRECISION PARK 200 FRENCHTOWN RD. N. KINGSTOWN, RI 02852	USE WITH CORE-SLICING EQUIPMENT
SPRAY UNIT	POWER UNIT, ATOMIZED W/GLASS 6 OZ CONTAINER	PRECISION VALVE CORP. P.O. BOX 309 YONKERS, NY 10702	USED TO APPLY SMALL AMOUNTS OF LIQUID PRIMER, ADHESIVE, OR RESINS
SURFACE BLEEDER, SURFACE BREATHER, AND INSULATION	BMS 9-3, TYPE D	SEE 51-20-03, FIG. 2	

Miscellaneous Equipment
Figure 1 (Sheet 6 of 8)

TOOL	MANUFACTURER'S IDENTIFICATION	MANUFACTURER	REMARKS
TEMPERATURE CONTROLLER, CONSOLE, PORTABLE SELF-CONTAINED [1] [2]		ATACS PRODUCTS, INC. 14040 INTERURBAN AVE S. TUKWILA, WA 98168 HEATCON COMPOSITE SYSTEMS 600 ANDOVER PARK E. SEATTLE, WA 98188 JR TECHNOLOGY LTD. 81 NORTH END, MELDRETH ROYSTON, HERTS, ENGLAND SG86NU PYROMETRIC SERVICE CORP. 1312 S 96TH ST. SEATTLE, WA 98108-5010 TAYCO ENGINEERING, INC. 10874 HOPE ST. P.O. BOX 6034 CYPRESS, CA 90603 WICHITECH INDUSTRIES, INC. OAKLAND CENTER 8990 RT. 108 COLUMBIA, MD 21045	USE WITH HEAT BLANKETS, THERMOCOUPLES, AND VACUUM UNIT FOR APPLICATION AND RECORDING OF HEAT AND PRESSURE
TRANSFORMER, PORTABLE [2]	VARIABLE CONTROL 115-VOLT, 60-CYCLE		USE WITH HEATING BLANKETS AS A POWER SUPPLY
VACUUM UNIT [2]	ANY UNIT COMPATIBLE WITH TEMPERATURE CONTROL CONSOLE		INCLUDES VACUUM PUMP AND TRANSDUCER
VACUUM PROBE, QUICK DISCONNECT	VACU-VALVE, #401 ROUND BASE, #401A RECTANGULAR BASE	AIRTECH INTERNATIONAL, INC. 5700 SKYLAB RD. HUNTINGTON BEACH, CA 92647	USE FOR EVACUATION OF AIR INSIDE BAG FILM

Miscellaneous Equipment
Figure 1 (Sheet 7 of 8)

NOTES

1 HOT BOND CONSOLES MUST HAVE THE FOLLOWING FEATURES:

(1) CONTROL OF POWER INPUT TO HEAT BLANKETS

(2) PROVIDE FOR EVACUATION OF LAY-UP

(3) CONTROL VACUUM

(4) CONTINUOUSLY RECORD TEMPERATURE INPUT FROM AT LEAST 1 THERMOCOUPLE

(5) PROVIDE MANUAL MONITORING OF AT LEAST 3 THERMOCOUPLES

(6) SETTING OF CURE TIME

(7) AUTOMATIC SHUT-OFF AT THE END OF CURE TIME

2 THE USE OF ELECTRICAL EQUIPMENT IS HAZARDOUS WHEN USED IN PROXIMITY OF FUEL AND OTHER VOLATILE MATERIALS. OBSERVE ALL SAFETY PRECAUTIONS

3 0.25 SHANK

4 0.50 SHANK

Miscellaneous Equipment
Figure 1 (Sheet 8 of 8)

TOOL	MANUFACTURER'S IDENTIFICATION	MANUFACTURER	REMARKS
ANGLES, 90° ALUMINUM	ASSORTED SIZES, SHOP STOCK	COMMERCIAL-ANY SOURCE	USE WITH CLAMP WEDGE BLOCKS OR REPAIRS AT EDGE OF ASSEMBLIES
BLADE, SAW	RAZOR 3/4 IN., #34-C	X-ACTO ONE COMMERCE SQUARE 2005 MARKET ST. PHILADELPHIA, PA 17103	FINAL SAWING OF EXTRUSIONS AND SKINS
BLADE HANDLE, SAW	X-ACTO #5	X-ACTO ONE COMMERCE SQUARE 2005 MARKET ST. PHILADEPHIA, PA 17103	HANDLE FOR THE #34-C RAZOR SAW BLADE
BLOCK, SANDING	METAL OR WOOD	COMMERCIAL-ANY SOURCE OR IN-HOUSE FABRICATION	USE WITH SANDING PAPER TO ACHIEVE A FLAT FINISH SURFACE
BOTTLES, LIQUID DISPENSING, POLYETHYLENE	SQUEEZE-TYPE, 16OZ., #16057-120 OR EQUIVALENT USE SPOUT CAP, 28 MM, #H-16657 OR EQUIVALENT	V.W.R. SCIENTIFIC 355 TRECK DRIVE SEATTLE, WA 98188	DISPENSING CLEANING SOLVENTS AND LIQUIDS
BRUSH, ACID		COMMERCIAL-ANY SOURCE	
BRUSH, PAINT	1.0 INCH WIDE, SHORT BRISTLE	COMMERCIAL-ANY SOURCE	FOR APPLICATION OF SOLVENTS, PASTE, OR ADHESIVES
BURNISHING TOOL	METAL, ASSORTED SIZES SPOON TYPE	COMMERCIAL-ANY SOURCE	USE FOR BURNISHING SCRATCHES
BURNISHING TOOL	0.187 POLYETHYLENE	COMMERCIAL-ANY SOURCE	USE FOR BURNISHING SCRATCHES
CLAMPS, C-TYPE	ASSORTED SIZES	COMMERCIAL-ANY SOURCE	USE FOR MECHANICAL CLAMPING TO APPLY PRESSURE TO A REPAIR, OR TO WEDGE BLOCKS (IF USED)
DIVIDERS, METAL-MARKING	CAPACITY, 8 INCHES	COMMERCIAL-ANY SOURCE	USE TO MARKING CUTOUTS ON ALUMINUM OR TITANIUM SURFACES AND DETAIL FABRICATION

Hand Tools
Figure 2 (Sheet 1 of 7)

TOOL	MANUFACTURER'S IDENTIFICATION	MANUFACTURER	REMARKS
DRILLS, HI-SPEED STEEL	NUMBER OR LETTER DRILL SET, 90°/108° POINT ANGLE	COMMERCIAL-ANY SOURCE	FOR DRILLING ALUMINUM
DRILLS, COBALT	NUMBER OR LETTER DRILL SET, 135° POINT ANGLE	COMMERCIAL-ANY SOURCE	FOR DRILLING TITANIUM
DRILL STOP, SPRING-LOADED	WEDGELOCK DS-10 WEDGELOCK DS-20 WEDGELOCK DS-30 WEDGELOCK DS-40	MONOGRAM AEROSPACE FASTENERS 2343 S GARFIELD AVE LOS ANGELES, CA 90040	FOR SETTING DRILL DEPTH
FILE, HAND, FLAT MILL	6-, 8-, 10-, OR 12-INCH	COMMERCIAL-ANY SOURCE	USE FOR DEBURRING AND SIZING DETAILS
FILE, HAND, ROUND (RAT-TAIL)	1/8-, 1/4-, 3/8-, OR 1/2-INCH	COMMERCIAL-ANY SOURCE	USE FOR DEBURRING AND FILING HOLES
FILE, HAND, ROTARY	1/2-, 3/4-, OR 1-IN. DIAMETER ROUND END	COMMERCIAL-ANY SOURCE	USE FOR REMOVING METAL AND HONEYCOMB CORE
FILE, HAND, FLAT VIXON	12- OR 14-INCH	COMMERCIAL-ANY SOURCE	USE FOR HEAVY ROUGH CUT IN METAL REMOVAL
FUNNELS, POLYETHYLENE, 28 MM OPENING, SHORT STEM	3-INCH DIAMETER #3-2050-040 6-INCH DIAMETER #3-2050-084 6-IN. DIAMETER #3-0255-088	V.W.R. SCIENTIFIC 355 TRECK DRIVE SEATTLE, WA 98188 OR LOCAL SUPPLIER OF LABORATORY SUPPLIES	USE FOR DISPENSING CHEMICALS, SOLVENTS, OR ACIDS.
HAMMER, MACHINISTS BALL PEEN	FED. GGG-H-86, TYPE II, CLASS 1, STYLE A, 8 OZ.	COMMERCIAL-ANY SOURCE	HAND WORK
HAMMER, TAPPING, INSPECTION		IN-HOUSE FABRICATION	INSPECTION TOOL
KNIFE, RETRACTABLE BLADE	MECHANICAL, RAZOR BLADE	COMMERCIAL-ANY SOURCE	THIN CORE SLICING, ADHESIVE CUTTING, FILM CUTTING, TAPE CUTTING, MISCELLANEOUS CUTTING OR TRIMMING
MICROMETERS, GAP-TYPE, CERTIFIED	0.0 TO 1.0 INCH, ADJUSTABLE STEM	COMMERCIAL-ANY SOURCE	USE FOR THICKNESS MEASUREMENTS OF SHEET METAL AND FOR INSPECTION OPERATIONS

Hand Tools
Figure 2 (Sheet 2 of 7)

TOOL	MANUFACTURER'S IDENTIFICATION	MANUFACTURER	REMARKS
MICROMETERS, DEPTH, CERTIFIED	0.0 TO 2.0 INCHES	COMMERCIAL-ANY SOURCE	USE FOR MEASURING DEPTH OF HONEYCOMB CORE OR ASSEMBLY THICKNESS
NEEDLE, HYPODERMIC	18 GAGE, 2 INCHES LONG, #BD-1098 BECTON/DICKSON	V.W.R. SCIENTIFIC 355 TRECK DRIVE SEATTLE, WA 98188	CUT STEM TO LENGTH DESIRED. USE FOR RESIN INJECTIONS TO FILL VOIDS
PRESSURE PLATES	0.125 AND 0.250 ALUMINUM PLATE, VARIOUS SIZES 6061-T4 ALUMINUM ALLOY PLATE OR EQUIVALENT	COMMERCIAL-ANY SOURCE	USE FOR PRESSURE APPLICATION DURING THE CURE CYCLY
PHENOLIC SHEET	0.125 TEMPLATE STOCK MIL-P-15035 OR EQUIVALENT	COMMERCIAL-ANY SOURCE	USE FOR ROUTER TEMPLATES
PIPET, STRAIGHT TIP MEDICINE DROPPER	#52950-002 OR EQUIVALENT	V.W.R. SCIENTIFIC 355 TRECK DRIVE SEATTLE, WA 98188	USE FOR INJECTION OF LIQUID ADHESIVE
PLASTIC SHEET, ACRYLIC	0.187 DRILL TEMPLATE STOCK OR EQUIVALENT MIL-P-5425A	COMMERCIAL-ANY SOURCE	USE FOR DRILL TEMPLATES
PLASTIC SHEET, MYLAR	0.0075 INCH WIDE, 650-FT ROLL	DUPONT	USE FOR MAKING OUTLINE TEMPLATES FOR HONEYCOMB CORE DETAILS
PLASTIC APPLICATOR	P.A-1 PLASTIC	3M	USE FOR SPREADING, SCREEDING, AND SMOOTHING OF ADHESIVES, RESINS, OR COMPOUNDS
PLATE, MIXING	0.125 OR 0.250 ALUMINUM PLATE	COMMERCIAL-ANY SOURCE, IN-HOUSE SHOP STOCK	MYLAR SHEET CAN BE USED AS A SUBSTITUTE FOR MIXING COMPOUNDS, RESINS, OR ADHESIVE PASTES
PLIERS, ANGLE NOSE, MULTIPLE HOLE	FED. GGG-P-00471, TYPE II, STYLE B, CLASS 1	COMMERCIAL-ANY SOURCE	MANUAL USE
PLIERS, DUCKBILL, 6-INCH	FED. GGG-P-471	COMMERCIAL-ANY SOURCE	MANUAL USE

Hand Tools
Figure 2 (Sheet 3 of 7)

TOOL	MANUFACTURER'S IDENTIFICATION	MANUFACTURER	REMARKS
PLIERS, NEEDLE NOSE STRAIGHT	FED. GGG-P-471	COMMERCIAL-ANY SOURCE	MANUAL USE
PLIERS, STRAIGHT NOSE SLIP-JOINT W/CUTTER	FED. GGG-P-471	COMMERCIAL-ANY SOURCE	MANUAL USE
PLYWOOD, INDOOR	0.250 TEMPLATE STOCK OR EQUIVALENT	COMMERCIAL-ANY SOURCE	USE FOR ROUTER TEMPLATES
ROD, STIRRING	0.125 THRU 0.375-INCH DIAMETER STEEL, GLASS, OR POLYETHYLENE	COMMERCIAL-ANY SOURCE	USE FOR MIXING OR STIRRING LIQUIDS AND COMPOUNDS
ROLLER	WOOD OR HARD RUBBER, 6 INCHES LONG, 2-INCH DIAMETER	COMMERCIAL-ANY SOURCE	ROLL OUT COMPOUNDS, LIQUID ADHESIVES, OR TRAPPED AIR UNDER FILMS OR CLOTH
ROUTER ATTACHMENT	MODEL QRC-3C OR QRC-3D COLLET, 9003 NOSE, 9013, 9022 BEARING, 9015 RET. RING, 9016; #881390 COMPLETE, USE WITH MODEL 11GLF-230/250 ROUTER MOTORS OR EQUIVALENT	MC MASTER-CARR P.O. BOX 740100 ATLANTA, GA 30374-0100 WWW.MCMASTER.COM COOPER POWER TOOLS 2000 S. STATION CRUZ ST. ANAHEIM, CA 92805	HAND-ROUTING DAMAGED MATERIAL WITH ROUTER BIT GUIDE THAT INCLUDES SET-BACK DIMENSIONAL
ROUTER BUSHING	#SP-310-31J OR EQUIVALENT	MC MASTER-CARR P.O. BOX 740100 ATLANTA, GA 30374-0100 WWW.MCASTER.COM	USE WITH QRC-3C AND -3D ROUTER MOTORS
ROUTER, MOTOR	PNEUMATIC, HI-SPEED, 20,000 RPM, QRC-3C OR 3D OR EQUIVALENT	MC MASTER-CARR P.O. BOX 740100 ATLANTA, GA 30374-0100 WWW.MCMASTER.COM COOPER POWER TOOLS 2000 SO. STATION CRUZ ST. ANAHEIM, CA 92805	USE FOR DAMAGE REMOVAL; SEE "ROUTER ATTACHMENT" FOR QRC ROUTERS

Hand Tools
Figure 2 (Sheet 4 of 7)

TOOL	MANUFACTURER'S IDENTIFICATION	MANUFACTURER	REMARKS
	PNEUMATIC, HI-SPEED, MODEL 11GLF-230 RPM 25,000, WITH ACCESSORIES OR EQUIVALENT	MC MASTER-CARR P.O. BOX 740100 ATLANTA, GA 30374-0100 WWW.MCMASTER.COM COOPER POWER TOOLS 2000 SO. STATION CRUZ ST. ANAHEM, CA 92805	USE #881390 ROUTER ATTACHMENT INCLUDES SETBACK BUSHING
ROUTER, BITS	1/4-INCH DIAMETER, 2-FLUTE LH SPIRAL, HI-SPEED STEEL FOR ALUMINUM; 1/4-INCH DIAMETER, 3-FLUTE LH SPIRAL, CARBIDE FOR TITANIUM OR EQUIVALENT	COMMERCIAL-ANY SOURCE	USE WITH ANY ROUTER MOTOR.
SAFETY FACE SHIELD	TRU-SAFE #119-1 OR SAFELINE #6799 (10 BY 18-1/4) OR EQUIVALENT	COMMERCIAL-ANY SOURCE	FOR FACE AND EYE PROTECTION
SAFETY FACE SHIELD HOLDER	RICE HEAD SHIELD #707 OR EQUIVALENT	COMMERCIAL-ANY SOURCE	HOLDS REPLACEABLE FACE SHIELD
SAFETY GLASSES	5944D SMOKE CLEAR LENSES	H.L. BOUTON CO., INC. BUZZARD BAY, MA 02532	FOR EYE PROTECTION
SANDER, POWER [1]	BELT, FLEXIBLE DISC, ORBITAL, OR ROTATING PAD TYPES	COMMERCIAL-ANY SOURCE	USE FOR TAPER SANDING REPAIR AREA, PAINT REMOVAL, SMOOTHING CURED REPAIRS
SAW, ARBOR	1/4-IN. DIAMETER EXPANDABLE END, ALLEN SCREW LOCK	IN-HOUSE FABRICATION (SEE FIG. 8-12)	HOLDING ARBOR FOR SLOTTING SAW BLADES
SAW, BLADE	HACKSAW, 12-INCH, ASSORTED TEETH, 18, 24, 28 AND 32 PER INCH	COMMERICAL - ANY SOURCE	USE FOR REMOVAL OR DAMAGED MATERIAL

Hand Tools
Figure 2 (Sheet 5 of 7)

TOOL	MANUFACTURER'S IDENTIFICATION	MANUFACTURER	REMARKS
SAW BLADE HOLDER		COMMERICAL - ANY SOURCE	HOLDER FOR HACKSAW BLADES
SAW, CIRCULAR WITH ADAPTER AND BLADE	CP-3017-0KS-1000-3 OR EQUIVALENT	CHICAGO PNEUMATIC 1800 OVERVIEW DR. ROCKHILL, SC 29730	USE TO SAW SLOTS IN PANEL
SAW, CUTTER	5/8 INCH	COMMERCIAL-ANY	CUTTER FOR ARBOR SAW
SAW, HOLE	1/2-, 1-, 2-, 3-, AND 4-INCH	COMMERICAL - ANY SOURCE	USE FOR REMOVAL OF DAMAGED MATERIAL
SAW, RECIPROCATING WITH BLADES	FOR ALUMINUM OR TI SKINS, CO-3017-FO OR EQUIVALENT	CHICAGO PNEUMATIC 1800 OVERVIEW DR. ROCKHILL, SC 29730	USE TO REMOVE DAMAGED MATERIAL FROM BONDED PANELS
SAW, SLOTTING	1/4-INCH DIAMETER ARBOR HOLE, 2-INCH BLADE	COMMERICAL - ANY SOURCE	USE FOR REMOVAL OF DAMAGED MATERIAL
SCALE, FLEXIBLE	12-INCH #338R TEMPERED OR EQUIVALENT	COMMERCIAL - ANY SOURCE	DETERMINING SIZES
SCREEN WIRE	#16 MESH 0.018 DIAMETER WIRE CRS TYPE 304	PACIFIC NORTHWEST WIRE 18623 89TH PL. S. KENT, WA 98032	USE FOR PHOSPHORIC ACID ANODIZING
SCRIBE	REVERSIBLE POINT	COMMERCIAL-ANY SOURCE	MAKING DETAIL LAYOUT OUTLINES ON MYLAR OR TEMPLATE STOCK
SHEARS, METAL CUTTING	10-INCH FED. GGG-5-291 TYPE II, CLASS 1, STYLE B	COMMERCIAL-ANY SOURCE	CUTTING METAL DETAILS, PREFIT TRIMMING OF DETAILS
SPATULA, MIXING	WOOD OR METAL	COMMERCIAL-ANY SOURCE	MIXING COMPOUNDS, SLICING LIGHT DENSITY CORE, SPREADING COMPOUNDS AND ADHESIVES
SQUARE, COMBINATION	12-INCH GROOVED BLADE, STYLE "BP"	COMMERCIAL-ANY SOURCE	MARKING DETAILS

Hand Tools
Figure 2 (Sheet 6 of 7)

TOOL	MANUFACTURER'S IDENTIFICATION	MANUFACTURER	REMARKS
SQUEEGE, FLAT	SYNTHETIC RUBBER, PHENOLIC, LAMINATE, OR PLEXIGLASS	COMMERCIAL-ANY SOURCE	USE FOR SMOOTHING RESINS OR COMPOUNDS.
TONGUE DEPRESSORS	WOOD	COMMERCIAL-ANY SOURCE	MIXING AND SPREADING COMPOUNDS AND ADHESIVES

1 THE USE OF ELECTRICAL EQUIPMENT IS HAZARDOUS WHEN USED IN PROXIMITY OF FUEL AND OTHER VOLATILE MATERIALS. OBSERVE ALL SAFETY PRECAUTIONS.

Hand Tools
Figure 2 (Sheet 7 of 7)

GENERAL - ORDER DATA FOR COMPOSITE REPAIR MATERIALS

1. **Applicability**

   A. This general section contains the necessary data to order composite repair materials from The Boeing Company.

2. **General**

   A. All the materials given in this section can be ordered from Boeing Spares. If the materials are needed as soon as possible, call the Boeing Airplane-On-Ground (AOG) Spares office at 1-206-544-9000. For other orders, call the Boeing Regional Spares Manager who works with your airline or repair facility.

   B. The materials called out in this section are used to make the composite repairs given in the 737-800 Structural Repair Manual (SRM).

   C. The information in this section includes order numbers and units of measure to order from Boeing Spares only. Refer to Paragraph 4./GENERAL for the order information. Refer to 51-30-03 for information on sources for other nonmetallic materials.

   D. The shelf life of some materials may be limited. Special procedures for storage and shipment of some materials may be necessary. You can get this information from the supply source.

3. **References**

Reference	Title
51-30-03	NON-METALLIC MATERIALS

4. **Order Information**

   A. Table 1/GENERAL gives the necessary order information for the composite repair materials.

   B. Order the repair materials by their order number as given in Table 1/GENERAL.

   C. Include the data that follows in the order noteline:
      - 737-800 SRM, 51-30-06.

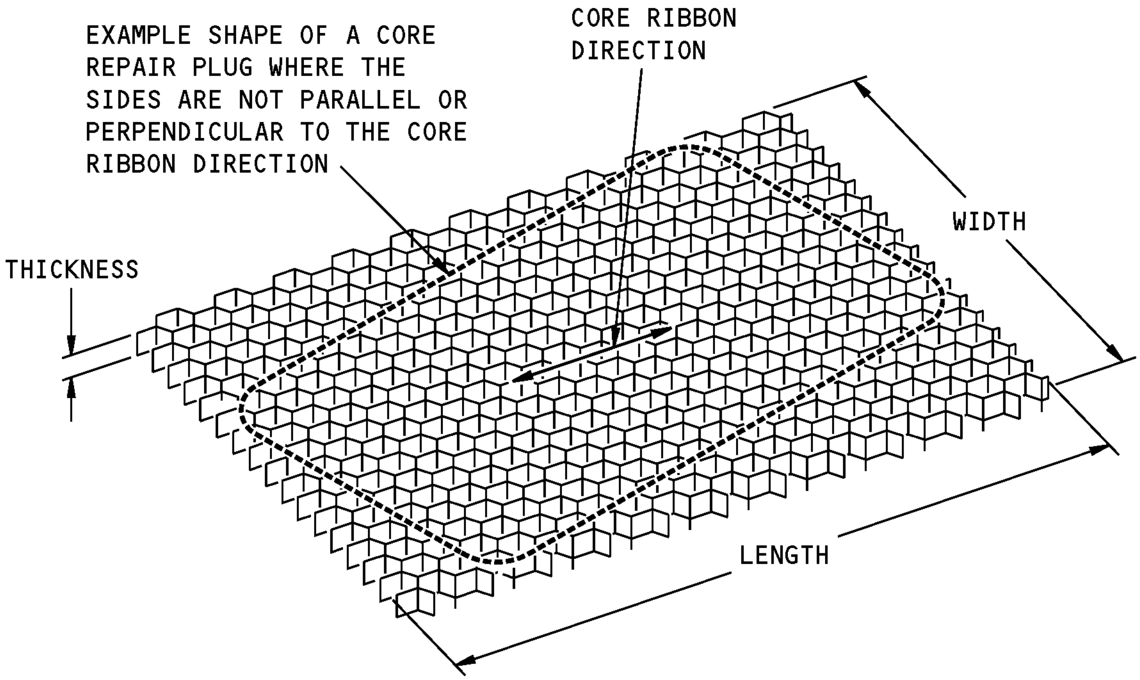
   D. Order all of the preimpregnated materials as AOG critical.

Table 1:

COMPOSITE REPAIR MATERIALS			
MATERIAL	ORDER NUMBER	UNIT OF MEASURE	REMARKS
BMS 5-28, Type 6 (Potting compound)	BMS5-28TY6	1 quart kit	
	BMS5-28TYPE6	1 pint kit	
	5522360051	1 gallon each	
BMS 5-28, Type 7 (Potting compound)	BMS5-28TY7CL2	1 quart kit	
	5522360053	1 gallon each	
BMS 5-28, Type 17 (Potting compound)	BMS5-28TY17	1 quart kit	
	BMS5-28TYPE17	1 pint kit	
	5522360050	6 pound kit	
BMS 5-90, Grade 50 (Foaming adhesive)	BMS5-90TY3CL250GR50	2 square foot sheet	Ship and store frozen
BMS 5-92, Type I - EC2216 A/B (Adhesive)	BMS5-92TY1	1 quart kit	
	BMS5-92TYPE1	6 ounces each	

COMPOSITE REPAIR MATERIALS			
MATERIAL	**ORDER NUMBER**	**UNIT OF MEASURE**	**REMARKS**
BMS 5-129, Type 2, Class IA, Grade 10 (Adhesive)	BMS5-129TY2CL1AGR10	Length by the yard (36 inches wide)	Ship and store frozen
BMS 5-154, Grade 05 (Adhesive)	BMS5-154TY2CL2GR5	Length and width by the foot (maximum width of 3 feet)	Ship and store frozen
BMS 8-79, Class III, Type 120 (Glass Fiber Reinforced Plastic (GFRP) fabric)	BMS8-79CL3GRATY220	Length by the yard (38 inches wide)	Ship and store frozen
BMS 8-79, Class III, Type 7781 (GFRP fabric)	BMS8-79CL3GRATY7781	Length by the yard (38 inches wide)	Ship and store frozen
BMS 8-139, Class I, Style 120 (GFRP fabric)	BMS8-139, TY120CL1	Length by the yard (38 inches wide)	Ship and store frozen
BMS 8-139, Class I, Style 7781 (GFRP fabric)	BMS8-139CL1TY7781	Length by the yard (38 inches wide)	Ship and store frozen
BMS 8-145, Type I (Adhesive film)	BMS8-145TY1	Length by the yard (40 inches wide)	Ship and store frozen
BMS 8-168, Class 2, Type II, Style 3K-70-PW (Carbon Fiber Reinforced Plastic (CFRP) fabric)	BMS8-168T2C2ST3k70PW	Length by the yard (42 inches wide)	Ship and store frozen
BMS 8-212, Class 2, Type II, Style 3K-135-8H (CFRP fabric)	BMS8-212T2C23K1358H	Length by the yard (42 inches wide	Ship and store frozen
BMS 8-212, Class 2 Type IV, Style 3K-70-PW (CFRP fabric)	BMS8-212T4C2ST3K70PW	Length by the yard (42 inches wide)	Ship and store frozen
BMS 8-256, Class 2, Type IV, Style 3K-70-PW (CFRP fabric)	BMS8-256T4C2ST3K70PW	Length by the yard (42 inches wide)	Ship and store frozen
BMS 8-276, Class 1, Type 35, Form 1 (Toughened-epoxy CFRP tape)	BMS8-276C1FR1T35X12	Length by the foot (12 inches wide)	Ship and store frozen
BMS 8-297, Type 4, Class 2, Style 3K-70-PW (CFRP fabric)	BMS8-297T4C2S3K70PW	Length by the yard (42 inches wide)	Ship and store frozen
BMS 8-301, Class 1 (Adhesive)	BMS8-301CL1	1 quart each	Ship and store frozen
BMS 8-301, Class 2 (Adhesive)	BMS8-301CL2	1 quart each	Ship and store frozen
BMS 8-339, Class 1 (Pitch based CFRP honeycomb core)	BMS8-339CL1 (Refer to Figure 1 for the types of dimensions that are needed when you order the core)	Length and width by the foot. Many thicknesses are available.	
BMS 8-342, Class 2, Type 3, Grade 15 (Polyacrylonitrile (PAN) based CFRP honeycomb core)	BMS8-342CL2TY3GR15 (Refer to Figure 1 for the types of dimensions that are needed when you order the core)	Length and width by the foot. Many thicknesses are available.	
BMS 9-3, Type D, Class 7, Style 120 (Glass fiber fabric)	BMS9-3TYDCL7	125 yards minimum (38 inches wide)	
BMS 9-3, Type H-2, Class 7, Style 181 (Glass fiber fabric)	BMS9-3TYHCL7STY181	125 yards minimum (5.5 inches wide)	
BMS 9-8, Type I, Class 2, Style 3K-70-P (Carbon fiber fabric)	BMS9-8T1C2S3K70PW	Length by the yard (42 inches wide)	
CAB-O-SIL (Filler)	CABOSILGRM5	10 pounds minimum	

COMPOSITE REPAIR MATERIALS			
MATERIAL	**ORDER NUMBER**	**UNIT OF MEASURE**	**REMARKS**
EPIBOND 156 A/B (Surfacer)	EPIBOND156AB	1 quart kit	
Milled Glass Fibers (Filler)	MILLEDGLASSFIBER	By the pound (1/16 inch long milled fibers)	
Phenolic Microballoons (Filler)	BJO-0930	1 bag each (17 pound bag)	



NOTE: WHEN YOU ORDER THE CORE, GIVE:

- THE LENGTH THAT IS NEEDED IN THE CORE RIBBON DIRECTION
- THE WIDTH THAT IS NEEDED PERPENDICULAR TO THE CORE RIBBON DIRECTION
- THE THICKNESS THAT IS NEEDED.

Necessary Dimensions for Ordering the Core
Figure 1

NOTE: The General Fastener data has been moved to SRM 51-40-01.

GENERAL - FASTENERS

1. Applicability

A. This section gives general data about Boeing approved fasteners used on this airplane. It also gives data about the inspection procedures for loose fasteners.

2. General

A. Fastener Codes and Symbols

(1) The Boeing Company Drawing System for the airplane model in this Structural Repair Manual uses a fastener symbol system as given in NAS 523 and Boeing Design Detail Standard BACD2074. Refer to Fastener Symbols, Figure 1/GENERAL for examples of fastener symbols used in Boeing engineering drawings.

(2) Boeing approved fasteners and fastener/mating part combinations have specified fastener codes. Fastener codes are not used in this manual, but are used on the Boeing engineering drawings. Fastener codes are cross referenced to the fastener part numbers on the drawings and in Boeing Design Detail Standard BACD2074.

B. Suppliers of Boeing approved fasteners

(1) Suppliers of Boeing approved fasteners can be found in the Procurement Section of each Boeing Fastener Specification.

C. Loose Fasteners

NOTE: Brown streaks on the external fuselage surface can be caused by corrosion inhibiting compound that moves along the fastener shank. These streaks are not usually caused by loose fasteners.

(1) Refer to 51-10-05 if you find loose or missing fasteners. Loose fasteners can be identified by the conditions that follow:

(a) The fastener moves in relation to the material that it holds.

(b) Tipped fastener head can show looseness or slippage of the material. The edges of a rivet head that are rolled upward also show looseness.

(c) A black or dark gray colored stain adjacent to or around the fastener head can show a loose rivet. A streak of dirt or oil aft of a loose rivet is usually apparent.

(d) Fasteners can be loose if the paint around the fastener head is cracked.

(2) You can also examine the structure for loose fasteners as shown in Loose Fastener Check, Figure 2/GENERAL.

3. References

Reference	Title
51-10-05	AIRPLANE OPERATION WITH MISSING FASTENERS IN SECONDARY STRUCTURE
51-40-02	FASTENER INSTALLATION AND REMOVAL
51-40-03	FASTENER SUBSTITUTION
51-40-04	TORQUE VALUES
51-40-05	FASTENER HOLE SIZES
51-40-06	FASTENER EDGE MARGINS
51-40-07	STRENGTHS OF FASTENERS
51-40-08	COUNTERSINKING
51-40-09	COLD WORKING OF HOLES FOR FATIGUE IMPROVEMENT

4. Fastener Types

A. This section gives general data about the usual types of mechanical fasteners found on this airplane. Refer to Identification Marks on Boeing Standard Rivets, Figure 3/GENERAL for examples of identification marks found on Boeing standard rivets.

B. Fasteners can be grouped as either permanent or removable as follows:

(1) Permanent fasteners are used in the assembly of the structure that is not disassembled during usual service. Most permanent fasteners become unserviceable after they are removed and must be discarded. Some hex-drive bolts continue to be serviceable after they are removed. Inspect hex-drive bolts to see if they continue to be serviceable as given in 51-40-02. These types of fasteners are permanent:

- solid rivets
- lockbolts
- hex-drive bolts
- radius lead-in bolts
- blind rivets
- blind bolts
- honeycomb sandwich panel inserts

(2) Removable fasteners are used in the assembly of structure that can or must be disassembled during usual service. These types of fasteners are removable fasteners:

- bolts
- screws
- set-screws
- nuts
- nutplates
- threaded inserts
- washers
- pins

C. Solid Rivets

(1) Most of the fasteners used on this airplane are solid-shank rivets made from specified aluminum alloys. Solid rivets are permanent fasteners that are used where rivets must have sufficient shear strength and where complete hole-filling is important.

(2) You can use softer alloy rivets as alternative fasteners for the usual rivets in some locations. Although softer alloy rivets are permitted in some locations, a larger number of fasteners or a larger diameter of fastener can be necessary to get the same structural strength. Make sure the material edge margin and fastener spacing are correct when you use softer alloy rivets as alternative fasteners. Refer to 51-40-03 for the data about approved fastener substitutions and to see if there are limitations on their use.

D. Lockbolts and Hex-Drive Bolts

(1) Lockbolts are permanent fasteners that have a collar that is swaged onto the serrated end of the bolt. Lockbolts have a higher shear strength and a higher clamp-up force than solid rivets.

(2) Hex-drive bolts are almost the same as lockbolts but use a threaded shank together with a threaded collar or nut. Some special hex-drive bolts use a fluted threaded shank together with a swage-locking collar. You can use hex-drive bolts as alternative fasteners to lockbolts if you do not have access to the lockbolt installation tools. Refer to 51-40-03 for the approved alternatives.

E. Radius Lead-In Bolts

(1) You can use radius lead-in bolts in highly stressed aluminum alloy structure where durability (resistance to fatigue) is necessary. Radius lead-in bolts are different from the usual fasteners as follows:

(a) The shank has a radius lead-in area under the head

(b) The shank is 0.006 inch diameter oversize

(c) Radius lead-in bolts are driven into high interference-fit holes during installation.

F. Blind Rivets and Blind Bolts

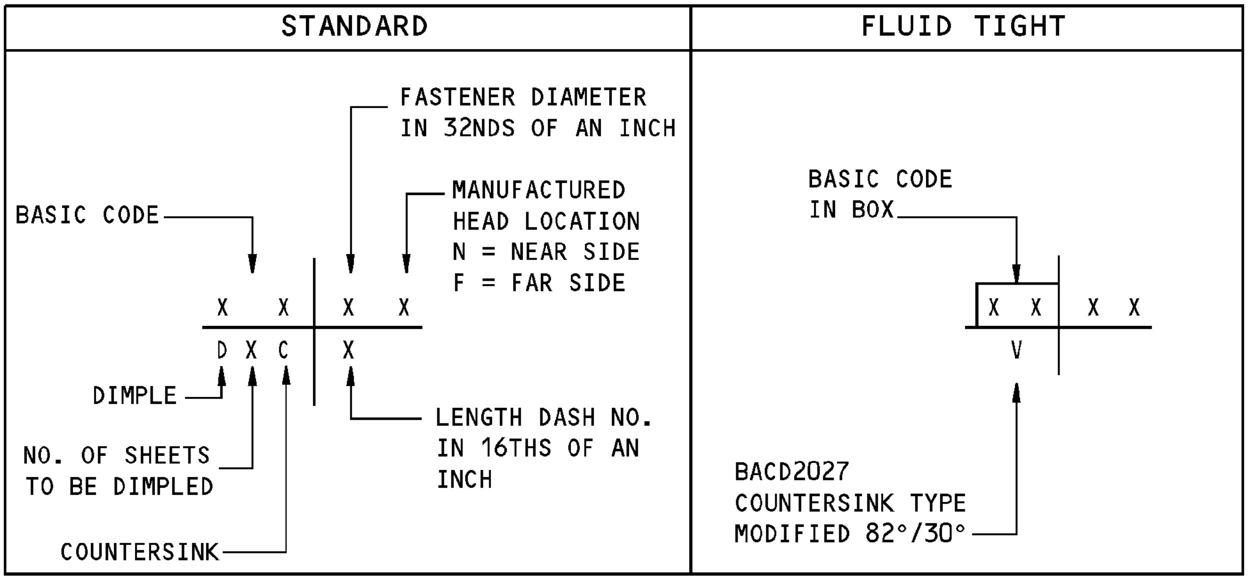
CAUTION: DO NOT USE BLIND FASTENERS AT THE LOCATIONS THAT FOLLOW:

- WHERE THE HEADS CAN BE PRIED
- AT FLUID-TIGHT JOINTS
- WING ATTACHMENT FITTINGS
- PYLON ATTACHMENT FITTINGS
- LANDING GEAR FITTINGS
- CONTROL SURFACE HINGE BRACKETS
- CONTROL SURFACE ATTACHMENT FITTINGS
- FIXED TAIL SURFACE ATTACHMENT FITTINGS
- OTHER TENSION OR HIGHLY STRESSED LOCATIONS.

BLIND FASTENERS CAN FAIL IF YOU USE THEM IN THESE LOCATIONS.

(1) You can use blind fasteners when there is access to only one side of the structure. In some locations, you can use blind fasteners where access is not available to make the upset head of a head solid rivet. Blind bolts have larger manufactured heads and higher tension and shear strengths than the usual blind rivets.

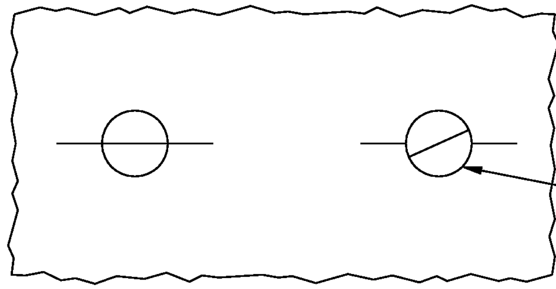
NOTE: Blind fasteners are permanent only when they replace the initial blind fasteners specified in the drawing for the component, or if specified as permanent in a FAA approved repair. Although blind rivets are permitted under some conditions as alternatives to solid fasteners, a larger number of blind fasteners or a larger diameter of blind fastener can be necessary to get the same structural strength. Make sure that the material edge margin and fastener spacing are sufficient when you use blind fasteners as alternative fasteners. Refer to 51-40-03 for the approved alternatives. In some repairs there will be specified time-limits for replacement of blind fasteners with permanent fasteners, or inspections, or both.



YNE | 6N / C	BACR15FV6KE RIVET 120° MODIFIED SHEAR HEAD 3/16 DIAMETER 7050-T73 COUNTERSINK, NEAR SIDE
RL | 5	NAS1398D BLIND RIVET 5/32 DIAMETER 2017-T4
XFV | 8 / DC	BACB30GY LOCKBOLT 100° SHEAR HEAD 1/4 DIAMETER STEEL, WITH BACC30K COLLAR DIMPLED SKIN COUNTERSINK STRUCTURE
XCZ | 8	BACB30FM HEX-DRIVE BOLT 1/4 DIAMETER STEEL, WITH BACC30M COLLAR
YKJ | 4N / C | 12	BACB30PT4K12L BOLT 70° RADIUS LEAD-IN HEAD EXTENDED THREAD LENGTH 1/8 DIAMETER 3/4 GRIP LENGTH 6AL-4V TITANIUM WITH BACN10WM ALUMINUM COATED NUT COUNTERSINK, NEAR SIDE

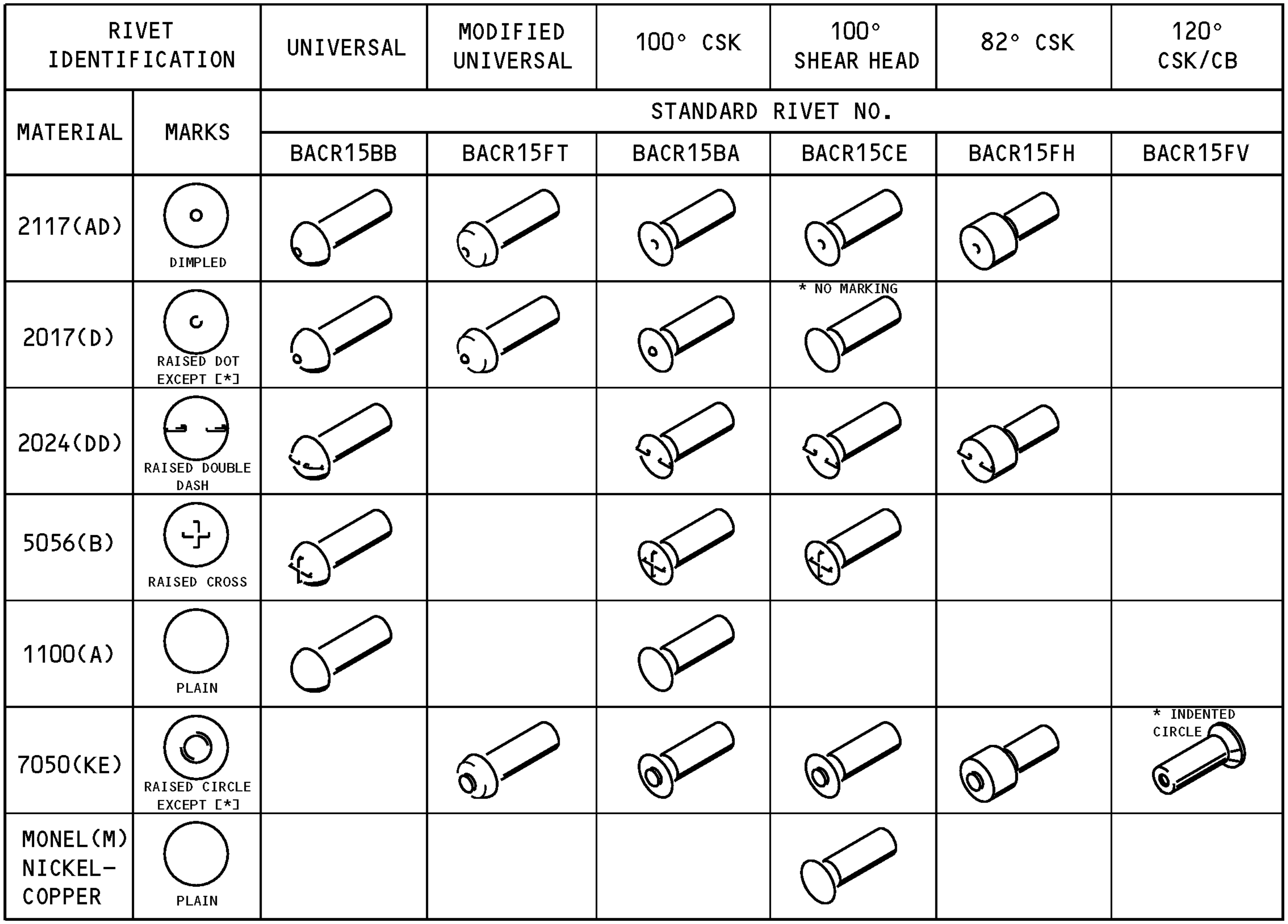
EXAMPLES

Fastener Symbols
Figure 1



NOTE: MAKE A RED LINE MARK ACROSS THE FASTENER HEAD AND THE ADJACENT MATERIAL. DO A CHECK OF THE LINE MARK AT THE NEXT INSPECTION. A LOOSE FASTENER IS SHOWN BY A BREAK IN THE LINE MARK.

Loose Fastener Check
Figure 2



RIVET IDENTIFICATION		UNIVERSAL	MODIFIED UNIVERSAL	100° CSK	100° SHEAR HEAD	82° CSK	120° CSK/CB
MATERIAL	MARKS	STANDARD RIVET NO.					
		BACR15BB	BACR15FT	BACR15BA	BACR15CE	BACR15FH	BACR15FV
2117(AD)	DIMPLED						
2017(D)	RAISED DOT EXCEPT [*]				* NO MARKING		
2024(DD)	RAISED DOUBLE DASH						
5056(B)	RAISED CROSS						
1100(A)	PLAIN						
7050(KE)	RAISED CIRCLE EXCEPT [*]						* INDENTED CIRCLE
MONEL(M) NICKEL-COPPER	PLAIN						

Identification Marks on Boeing Standard Rivets
Figure 3

GENERAL - FASTENER INSTALLATION AND REMOVAL

1. **Applicability**

A. This subject gives procedures for the removal and installation of structural fasteners in metallic and non-metallic structure.

2. **General**

A. Some of the data in this subject can be found in Boeing Process Specifications BAC 5004-1, BAC 5004-2, BAC 5004-3, BAC 5009, BAC 5047, and BAC 5060.

B. Hole Finder

(1) You can use a hole finder to find the positions of the initial fastener holes. Use a hole finder if the position of the hole is blocked by the repair parts, or if access is a problem.

(2) Refer to Hole Finder, Figure 1/GENERAL for an example of this tool. Use a tool with a rivet peg that has the same diameter as the applicable hole.

CAUTION: USE SUFFICIENT PRECAUTIONS TO MAKE SURE THAT SYSTEM COMPONENTS, AIRPLANE ELECTRICAL WIRES AND STRUCTURES, ARE NOT DAMAGED BY DRILLS, METAL SHAVINGS AND OTHER CONTAMINATION WHILE YOU DO WORK. METAL SHAVINGS OR CONTAMINATION LEFT IN THE AIRPLANE CAN TOUCH WIRE BUNDLES AND CAUSE CHAFING DAMAGE TO ELECTRICAL WIRES. CHAFFED WIRES CAN CAUSE ARCING DAMAGE.

C. Refer to 51-30-01 for the procedure to drill in metal structures. Refer to 51-20-08 for the procedure to drill in advanced composite structures.

D. Refer to 51-40-05 for hole size dimensions and hole quality specifications.

E. When you install flush head fasteners, refer to Fastener Flushness Specifications, Figure 2/GENERAL for the fastener flushness specifications. Refer to 51-40-08 for countersinking and counterbore procedures.

F. Refer to 51-40-09 if it is necessary to cold work fastener holes.

3. **References**

Reference	Title
51-10-01	AERODYNAMIC SMOOTHNESS
51-20-01	PROTECTIVE TREATMENT OF METALLIC AND COMPOSITE MATERIALS
51-20-05	REPAIR SEALING
51-20-07	MACHINING AND DRILLING OF COMPOSITE STRUCTURES
51-20-08	EROSION PROTECTION
51-30-01	SHEET METAL MATERIALS
51-40-01	FASTENERS
51-40-04	TORQUE VALUES
51-40-05	FASTENER HOLE SIZES
51-40-06	FASTENER EDGE MARGINS
51-40-08	COUNTERSINKING
51-40-09	COLD WORKING OF HOLES FOR FATIGUE IMPROVEMENT
AMM 20-30-92	AIRPLANE STRUCTURE CLEANING SOLVENTS (Series 92)
SOPM 20-30-92	Final Cleaning Prior to Generl Sealing (Series 92)
SOPM 20-50-19	General Sealing

4. **Solid Shank Rivets**

A. General

(1) The solid shank rivets installed on this airplane are usually made from 2017, 2117, or 7050 aluminum alloy. In some locations, rivets made from 5056 or 2024 aluminum alloys, or nickel-copper alloy (monel) are used.

(a) Rivets made from 2017, 2117, 5056, and 7050 aluminum alloy and nickel-copper rivets can be stored at room temperature.

(b) Rivets made from 2024 aluminum alloy must be heat treated and then stored as a temperature of -10°F (-23°C) or lower. After removal from cold storage the rivets must be completely driven in 15 minutes. These rivets must not be returned to cold storage once they have been removed.

(2) Machine-driven rivets are frequently used during the initial airplane assembly. Some machine-driven rivets have a formed head on each end of the rivet (slug rivet). Slug rivets can be installed with hand tools but manufactured head rivets are usually installed as an alternative to slug rivets.

(3) Refer to 51-20-05 for replacement of rivets that are installed in an integral fuel tank.

B. Installation of Solid Rivets

(1) Rivet guns and bucking bars must be large enough to drive rivets quickly. Three to four seconds duration is best. Seven seconds is the maximum.

(2) Do not overdrive rivets because this can cause diagonal cracks. It is recommended that bucking bars be very smooth when you install all types of rivets. Smooth bucking bars are very important when you drive 7050 or 2017 aluminum alloy rivets.

(3) Use heavy, slow speed rivet guns and heavier bucking bars for nickel-copper alloy rivets.

(4) Install 5056 rivets wet with sealant if the rivets are installed in aluminum structure. Install 5056 rivets dry if installed in magnesium structure. Install all other rivets dry, unless specified differently in a repair procedure.

(5) Installation Dimensions for Non-Fluid-Tight Solid Shank Rivets, Figure 3/GENERAL shows the grip ranges, shank projection before driving, and the driven head sizes for solid shank rivets used in non-fluid-tight applications.

(6) Installation Dimensions for Fluid-Tight Solid Shank Rivets, Figure 4/GENERAL shows the grip ranges and the driven head sizes for solid shank rivets used in fluid-tight applications.

NOTE: The driven head for fluid-tight universal head rivets is always formed on the seal plane of the integral fuel tank.

C. Do the inspections that follow after you install the rivets:

(1) Measure the button dimensions as shown in Installation Dimensions for Non-Fluid-Tight Solid Shank Rivets, Figure 3/GENERAL or Installation Dimensions for Fluid-Tight Solid Shank Rivets, Figure 4/GENERAL, as applicable.

(2) Do an inspection of the heads and buttons for cracks as shown in Gap Analysis for Rivet Heads and Buttons, Figure 7/GENERAL.

(3) Do an inspection for gaps under the heads of installed rivets as shown in Gap Analysis for Rivet Heads and Buttons, Figure 7/GENERAL.

D. Rework of Rivet Holes

(1) Rework is necessary when a rivet will be installed in a hole that was filled before by a rivet. Rework can also be necessary if a new hole does not comply with the quality specifications shown in 51-20-07, 51-40-05, or 51-40-08. Reworked holes must comply with the same quality specifications as the initial holes.

(2) It is permitted to rework holes to 1/32 inch oversize.

E. For procedures to remove solid shank rivets, refer to Solid Shank Rivet Removal, Figure 8/GENERAL.

5. Blind Rivets

A. General

(1) Blind rivets are intended for use where access is limited to one side of the work.

(2) Refer to 51-40-01 for limitations on the use of blind rivets.

B. Installation

(1) Blind rivets are installed with special tools, usually supplied by the fastener manufacturer.

NOTE: Blind rivets are supplied with different spindle configurations, full serrations, and partial serrations. Rivets having different spindle configurations usually cannot be installed with the same pulling head on the tool.

(2) Check for correct installation as follows:

(a) The heads of protruding type blind rivets must be seated so that a 0.002 inch thick shim cannot touch the rivet shank.

(b) The heads of flush type blind rivets must be seated so that a 0.002 inch thick shim cannot be inserted between the head of the rivet and the countersink for more than 40% of the circumference of the head and does not touch the rivet shank.

(c) Check that stem and collar protrusions agree with the limits shown in Installation of Blind Bolts and Blind Rivets, Figure 9/GENERAL, Table A .

C. Removal

(1) Remove the blind rivets as shown in Removal of Blind Rivets, Figure 10/GENERAL.

6. Blind Bolts

A. General

(1) MS21140 flush head and MS21141 protruding head blind bolts are approved for use on this airplane.

(2) Refer to 51-40-01 for limits on the use of blind bolts.

B. Installation

(1) Blind bolts are installed with special tools, usually supplied by the fastener manufacturer.

(2) Check for correct installation as follows:

(a) Check for correct seating of bolt heads as shown in Installation of Blind Bolts and Blind Rivets, Figure 9/GENERAL.

(b) Check that the stem and collar protrusions agree with the limits shown in Installation of Blind Bolts and Blind Rivets, Figure 9/GENERAL.

C. Removal

(1) Remove blind bolts using the steps given in Blind Bolt Removal, Figure 11/GENERAL.

NOTE: Special removal kits are available from the fastener manufacturers.

7. **Lockbolts and Hex-Drive Bolts**

A. General

(1) The recommended fasteners in aluminum structure are aluminum coated titanium, aluminum coated A-286, or cadmium-plated A-286. Cadmium-plated alloy-steel fasteners are a structurally acceptable alternative. However, the cadmium plating is a sacrificial coating and in a corrosive environment can come off the fastener. This can cause the alloy steel fastener to corrode. This can then cause streaks of rust and/or the start of corrosion on adjacent aluminum structure.

(2) Collars for lockbolts and hex-drive bolts come from the manufacturer with a layer of lubrication. Do not remove the lubrication and do not add more lubrication.

(3) Hex–drive bolts must be replaced with new hex–drive bolts when removed collars or nuts are Alloy Steel, CRES or Titanium.

(4) Make sure that the joint is tightly clamped while you install the bolt.

(5) Install the fasteners wet with sealant.

NOTE: Refer to 51-20-05 and SOPM 20-50-19 to install fasteners in the integral fuel tank and for other procedures to apply sealant.

(6) All lockbolts and hex-drive bolts must have the manufactured head fully seated in the structure before you install the collar.

NOTE: Push on the manufactured head to seat the fastener. Do not pull on the pin to seat the head.

B. Use of Washers

NOTE: The total number of washers that can be used for fillet relief, grip length adjustment, or corrosion protection is two plus the permitted number of counterbore substitution washers (used with hex-drive bolts). Too many washers can cause unwanted eccentricity and can cause fasteners to become loose. If you cannot get a good grip length adjustment, have an engineer do an analysis. An engineer can make a decision to add another washer. Washer material must be similar to the fastener and structure materials. Refer to 51-20-01 for the classification of dissimilar materials. The correct washer material and part numbers to use are given in Washers with Lockbolts and Hex-Drive Bolts, Figure 13/GENERAL.

(1) Fillet Relief Washers Under Protruding Head Fasteners

(a) A head-to-shank relief is necessary for all types of lockbolts and hex-drive bolts. As an alternative to making a fillet relief in the structure, you can put a fillet relief washer under a protruding head fastener.

(b) A maximum of one washer can be used for fillet relief.

(c) Use only washers that have a side with a fillet relief or countersink.

(d) Put the fillet relief (or countersink) side of the washer under the fastener head.

(2) Corrosion Protection and Grip Length Adjustment Washers

NOTE: The maximum number of this type of washer that can be used is two, with a maximum thickness of 1/16 inch (1.6 mm).

(a) Use only standard washers (no countersink washers) unless the grip adjustment washer is put directly under the fastener head when a fillet relief washer is necessary.

(b) Install the washer(s) as follows:

1) You can put one or two washers between a standard collar (or nut) and the structure.

2) You can put one or two washers between a standard collar (or nut) and a self-aligning washer (BACW10CA).

3) You can put one grip adjustment washer under a fastener head when:
- both a self-aligning nut and a self-aligning washer (BACNW10MT with a BACW10AU) are used, or
- a self-sealing collar (BACC30BP) is used, or
- a self-sealing nut (BACN10WM) is used, or
- a self-aligning collar-washer assembly (BACC30BQ or BACC30AG) is used.
- the structure is not magnesium.

NOTE: If a grip adjustment washer is necessary, put the washer between the fillet relief washer and the structure.

(3) Counterbore Substitution Washers

NOTE: When non-counterbored, self-locking nuts (BACN10GW, BACN10JC, BACN10YR, MS21042, MS21043, NAS679, NAS1291, NAS1804, and NAS1805) are used as an alternative to mating collars on hex-drive bolts, use counterbore substitution washers. When non-counterbored nuts are used with self-aligning washers (BACW10CA), use counterbore substitution washers. Refer to Washers with Lockbolts and Hex-Drive Bolts, Figure 13/GENERAL for washer selection. Counterbore substitution washers can be used as corrosion protection washers. You are permitted to use counterbore washers plus the permitted number of fillet relief, grip adjustment, and corrosion protection washers. Counterbore substitution washers are not required for counterbored nuts (BACN10MT, BACN10TN, BACN10WM, BACN10XJ, BACN10YT, BACN10YZ, BACN10ZV, BACN10ZZ, BACN11E, KFN305, KFN511, KFN609, and H600).

(a) Make sure that all the threads on the nut touch the threads on the bolt.

(b) Use a 1/16 inch (1.6 mm) thick washer and a 1/32 inch (0.8 mm) thick washer with lightweight hex-drive bolts (BACB30VT, BACB30VU, and BACB30YP). Put the 1/16 inch (1.6 mm) thick washer against the structure.

NOTE: If the chamfer on the end of the bolt is not fully above the end of the nut, use only a 1/16 inch (1.6 mm) thick washer.

(c) With standard hex-drive bolts (BACB30FM, BACB30FN, BACB30JC, BACB30MB, BACB30MY, BACB30ND, BACB30NW, BACB30NX, BACB30NY, BACB30YK, BACB10YL, BACB30YM, BACB30YN, HLT420, HLT421, HLT422, and HLT423), do the applicable steps that follow:

1) For bolt sizes that are 1/4 inch or less in diameter, use two 1/16 inch (1.6 mm) thick washers. This is also applicable to first, second, and third oversize fasteners for these bolt diameters.

NOTE: If the chamfer on the end of the bolt is not fully above the end of the nut, use only a 1/16 inch (1.6 mm) thick washer.

2) For bolt sizes that are 5/16 inch through 5/8 inch diameter and for these size bolts that are first and second oversize, use two 1/16 inch (1.6 mm) thick washers. For these size bolts that are third oversize, use three 1/16 inch (1.6 mm) washers.

NOTE: If the chamfer on the end of the bolt is not fully above the end of the nut, use only a 1/16 inch (1.6 mm) thick washer.

3) For bolt sizes that are 3/4 inch or larger in diameter, use three 1/16 inch (1.6 mm) thick washers. This is also applicable to first, second, and third oversize bolts.

NOTE: If the chamfer on the end of the bolt is not fully above the end of the nut, use only a 1/16 inch (1.6 mm) thick washer.

C. Lockbolt Installation and Removal

(1) The "pull type" lockbolt is installed with a special type of pneumatic pulling gun. The gun pulls on the end of the shank, known as the pintail, and at the same time, swages a collar onto the shank. The pintail breaks off at the correct load.

(2) Before you install the lockbolt collar, remove sealant and/or contamination from the grooves of the lockbolt pintail. Very small quantities of sealant can stay on the pintail after it is cleaned.

NOTE: Sealant on the surface of the structure that has flowed from under a swaged collar is not usually permitted. Sealant is only permitted to flow from under a swaged collar if the lockbolt has a sealant escape groove.

(3) Grip length adjustment can be made as given in Paragraph 7.B./GENERAL

(4) Lockbolts can be driven out after collar removal. Collars can be removed by splitting them from one side with a chisel. Put a bucking bar on the opposite side of the collar during this procedure to prevent elongation of the fastener hole. As an alternative, the collar can be milled off.

D. Hex-Drive Bolt Installation and Removal

(1) Hex-drive bolts are threaded fasteners usually installed with a type of nut that has a one-piece collar with a hexagonal torquing device. The hexagonal torquing device breaks off at the correct load. This eliminates the need to measure torque.

(2) The bolts can be installed with power or hand tools. Hand tools can be used as follows:

(a) Insert the bolt into the hole until the head is seated.

(b) Install the collar and turn it until it is finger-tight.

(c) Put a hexagonal key in the recess of the shank end and make sure the bolt does not turn. Turn the collar with a modified ratchet and socket or a box wrench until the wrenching device is torqued off. Refer to Lockbolt and Hex-Drive Bolt Installation, Figure 12/GENERAL.

(3) Where access is not available for the installation of the special collar, it is permitted to use locknuts. This special collar is manufactured with a counterbore which permits the bolt to fit into a recess in the collar. Counterbore substitution washers are necessary with non-counterbored locknuts. Refer to Paragraph 7.B./GENERAL and Washers with Lockbolts and Hex-Drive Bolts, Figure 13/GENERAL for locknut selection and washer requirements. Refer to Paragraph 7.D.(5)/GENERAL for the torque procedure.

(4) After the collar is installed, do an inspection of the bolt as follows:

(a) Examine the pin protrusion as shown in Pin and Collar Limits for Installed Lockbolts and Hex-Drive Bolts, Figure 14/GENERAL.

(b) Examine the gaps under the bolt head as shown in Lockbolt and Hex-Drive Bolt Installation, Figure 12/GENERAL.

(c) Examine head dishing in flush head fasteners as shown in Lockbolt and Hex-Drive Bolt Installation, Figure 12/GENERAL.

(5) Torque Procedure

(a) When the engineering drawing specifies an installation of multiple hex-drive bolts with locknuts and the sequence to tighten the bolts is not specified, do not tighten adjacent bolts in sequence.

1) If the bolts are in a circle, hand tighten first one bolt, then its opposite. Do this for all bolts in a sequence. Then torque all bolts in an alternating pattern around the circle, first one bolt then its opposite.

2) If five or more bolts are in a row, hand tighten the end bolts first, then the bolts that remain. Then torque all bolts in an alternating pattern along the row.

(b) Torque the nuts to the values given in 51-40-04.

(6) Hex-drive bolts are removed by inserting a hexagonal key in the pin recess and gripping and turning the collar with locking pliers.

8. Radius Lead-In Bolts (Refer to Figure 15.)

A. General

(1) Radius lead-in bolts are used in this airplane for their good fatigue properties. These fasteners have a shank diameter larger than hex-drive bolts and lockbolts are installed to give an interference fit. There are two oversizes available for each nominal size that you can use in repair work.

B. Hole Preparation

(1) New Holes

(a) New holes can be made with either of the two methods that follows:

1) A hole can be made in one operation with the specified size ST7044 precision drill. Drill the hole at 2000 rpm with a feed rate of 2.0 inches for each 8 to 12 seconds.

2) A hole can be made from a pilot hole.

a) Drill the pilot hole 1/64 inch under the size of the ST1219Y-1RCA reamer pilot. Keep the drill perpendicular to the part surface to ± 1/2 degree.

b) Ream the pilot hole to the size of the ST1219Y-1RCA reamer pilot.

c) With the required size of ST1219T-1RCA reamer/countersink installed in the ST1219X-Y tripod, adjust the depth of the countersink.

d) Attach a hand feed drill motor to the tripod unit and ream the hole using a constant hand feed at 500 rpm.

NOTE: Apply sufficient pressure to fully countersink the hole in one operation. The pressure must be constant from hole to hole to keep the countersink depth control.

(b) Use a cutting and drilling lubricant when you drill and ream holes. A recommended cutting and lubricating medium is Cetyl Alcohol or BOELUBE, which comes in liquid, solid, paste, or spray form.

(c) Before you drill holes in the airplane structure drill and ream a minimum of five holes in scrap material as given in Paragraph (d) below.

(d) Before you install the fastener inspect the hole to make sure that it agrees with the specifications given in 51-40-05.

NOTE: Inspect the hole diameter before you inspect for straightness.

(2) Oversize holes

NOTE: When an initial fastener is removed, the hole must be oversized unless the hole is inspected and the hole condition is permitted as specified in 51-40-05.

(a) With the next oversize ST1219Y-1RCA reamer/countersink tool installed in the ST1219X-Y tripod, oversize the hole as specified in 51-40-05.

C. Installation

(1) Choose a bolt with the necessary grip length and thread protrusion as given in Installation of Radius Lead-In Bolts, Figure 15/GENERAL.

(2) If the thread protrusion is not as specified in Installation of Radius Lead-In Bolts, Figure 15/GENERAL, a grip adjustment washer can be used. Refer to Installation of Radius Lead-In Bolts, Figure 15/GENERAL.

(3) Apply an applicable sealant to the underside of the bolt head. If the bolt has a flush head, you apply the sealant to the countersunk hole as an alternative. Refer to 51-20-05 for seals and sealing.

(4) Drive or press the bolt into the hole. The parts must be clamped together and the structure supported with a suitable bucking bar during this operation.

NOTE: A maximum interface separation of 0.004 inch is permitted at the bolt shank in fay seal areas. In non faying seal areas a separation of less than 0.002 inch is permitted. Holes can be lubricated with cetyl alcohol to reduce installation force.

(5) Install nuts and washers as given in Paragraph 8.D./GENERAL and Installation of Radius Lead-In Bolts, Figure 15/GENERAL.

(6) Torque Procedure

(a) When the engineering drawing specifies an installation of multiple hex-drive bolts with locknuts and the sequence to tighten the bolts is not specified, do not tighten adjacent bolts in sequence.

1) If the bolts are in a circle, hand tighten first one bolt, then its opposite. Do this for all bolts in sequence. Then torque all bolts in an alternating pattern around the circle, first one bolt then its opposite.

2) If five or more bolts are in a row, hand tighten the end bolts first, then the bolts that remain. Then torque all bolts in an alternating pattern along the row.

(b) Torque the nuts to the values given in 51-40-04.

(7) Clean the threads of sealant or any other residue and install the nut to the torque wrench values specified in 51-40-04. The installation of all bolts through parts assembled with faying surface seals should be completed with a minimum of 60 minutes of the sealant application life left. After a minimum of 20 minutes from the initial torque application, retorque the nuts to the maximum torque value +00 to -20 pound-inches (+0.00 to -2.26 Newton-Meters). Complete the retorquing before the sealant application life expires. Refer to SOPM 20-50-19 for the application life of the sealant materials.

(8) Make sure that the dish on the head of the installed fastener is smooth and does not have a raised ring.

(9) Make sure that the bolt head is flush as given in 51-10-01 unless given differently in an engineering drawing.

NOTE: Additional driving of the bolt to get the correct flushness is permitted. Make sure that the nut is retightened as given in 51-40-04.

(10) Make sure that the shank protrusion is in the specified limits given in Installation of Radius Lead-In Bolts, Figure 15/GENERAL.

(11) Examine the gaps under the bolt head and nut as shown in Installation of Radius Lead-In Bolts, Figure 15/GENERAL.

D. Use of Washers

NOTE: Refer to Installation of Radius Lead-In Bolts, Figure 15/GENERAL for washer types and sizes.

(1) Seal the nuts.

NOTE: Do not use a washer between a seal nut and the structure.

(2) Fillet Relief Washers Under Protruding Head Fasteners

(a) A head-to-shank relief is necessary for radius lead-in bolts. As an alternative to making a fillet relief in the structure you can put a fillet relief washer under protruding head fasteners.

(b) A maximum of one washer is permitted for fillet relief.

(c) Use only washers that have a side with a fillet relief or a countersink.

(d) Put the fillet relief (or countersink) side of the washer under the fastener head.

(3) Grip Adjustment Washers

(a) A maximum of one washer is permitted for grip adjustment. Use only standard washers (not countersink washers) unless the grip adjustment washer is put directly under the head of a BACB30WR fastener when a fillet relief washer or a countersink washer is necessary.

(b) You can use a grip adjustment washer with a counterbore substitution washer and/or a fillet relief washer. If a grip adjustment washer will be installed with a counterbore substitution washer, then put a standard grip adjustment washer between the counterbore substitution washer and the structure.

(4) Counterbore Substitution Washers

(a) One 1/16 inch (1.6 mm) thick washer can be used under a nominal size BACN10HY or BACN10SZ non-sealing nut for counterbore substitution.

(b) One 1/6 inch (1.6 mm) thick washer can be used when the BACN10MT self-aligning nut and BACW10AU self-aligning washer are used. Put the counterbore substitution washer under the BACN10AU self-aligning washer.

E. Removal

(1) Remove the fastener by removing the nut and driving out the bolt. Due to the interference fit of the bolt this may require some sharp blows initially; therefore, the structure must be supported by a bucking bar that is recessed to accept the bolt during removal. A washer must be placed over the protruding threaded end of the bolt to protect the structure.

NOTE: As an alternative, a hole may be drilled through the bolt.

9. Bolts

A. General

(1) The recommended fasteners in aluminum structure are aluminum coated titanium, aluminum coated A-286, or cadmium plated A-286. Cadmium plated alloy steel fasteners are a structurally acceptable alternative. The cadmium plating is a sacrificial coating and in a corrosive environment can come off the fastener. This can cause the alloy steel fastener to corrode. This, then, can cause streaks of rust and/or the start of corrosion on adjacent aluminum structure.

(2) Fasteners are installed wet with sealant.

NOTE: Refer to 51-20-05 to install fasteners in the integral fuel tank and other procedures to apply sealant.

B. Installation

(1) All threads of the nut must be completely engaged and the complete chamfered portion of the end of the bolt must protrude beyond the outer surface of the nut. Flat ended bolts must protrude at least 1/32 inch beyond the outer surface of the nut.

(2) Nuts must not engage any incomplete threads next to the shank of the bolt.

(3) No lubricants other than which is on the nuts or bolts, as purchased are to be used unless otherwise specified.

(4) After inserting a bolt into the structure through a wet sealed area, it is not required to remove the sealant from the bolt threads. Make sure that the nut is tightened within the sealant squeeze out time specified in SOPM 20-50-19.

(5) No threads in bearing are permitted in fittings or sheets 0.093 inch or less in thickness. In thickness greater then 0.093 inch, a maximum of two threads are permitted in bearing (but not more than 25 percent of the minimum thickness of the hole wall will have threads in bearing). Refer to Figure 16/GENERAL for the values of minimum bolt protrusion above the structure surface (that avoid exceeding limits for threads in bearing). This requirement does not apply to fully threaded fasteners, and does not apply to plate nut applications or through inserts.

(6) Bolt heads must be installed with heads up or forward, wherever practicable, unless otherwise specified.

C. Use of Washers

NOTE: The total number of washers that can be used for fillet relief, grip length adjustment, or corrosion protection is three. Too many washers can cause unwanted eccentricity and can cause fasteners to become loose. If you cannot get a good grip length adjustment, have an engineer do an analysis. An engineer can make a decision to add another washer. Washer material must be similar to the fastener and structure materials. Refer to 51-20-01 for the classification of dissimilar materials. The correct washer material and part numbers to use are given in Installation of Bolts, Figure 16/GENERAL.

(1) Fillet Relief Washers Under Protruding Head Fasteners

(a) A head-to-shank relief is necessary for all types of protruding head bolts. As an alternative to making a fillet relief in the structure, you can put a fillet relief washer under protruding head bolts.

(b) A maximum of one washer can be used for fillet relief.

(c) Use only washers that have a side with a fillet relief or countersink.

(d) Put the fillet relief or countersink side of the washer under the fastener head.

(2) Corrosion Protection and Grip Length Adjustment Washers

NOTE: The maximum number of this type of washer that can be used is two.

(a) Use only standard washers (not countersink washers) unless the grip adjustment washer is put directly under the fastener head when a fillet relief or a countersink washer is necessary.

(b) Install the washer(s) as follows:

1) You can put one or two washers between a standard nut and the structure.

2) You can put one or two washers between a standard nut and a self-aligning washer (BACW10CA).

3) You can put one grip adjustment washer under a fastener head when both a self-aligning nut and a self-aligning washer (BACB10MT with a BACW10AU) are used.

NOTE: If a grip adjustment washer is necessary, put the washer between the fillet relief washer and the structure.

D. Torque Procedure

(1) When the engineering drawing specifies an installation of multiple hex-drive bolts with locknuts, and the sequence to tighten the bolts is not specified, do not tighten adjacent bolts in sequence.

(a) If the bolts are in a circle, hand tighten first one bolt, then its opposite. Do this for all bolts in sequence. Then torque all bolts in an alternating pattern around the circle, first one bolt then its opposite.

(b) If five or more bolts are in a row, hand tighten the end bolts first, then the bolts that remain. Then torque all bolts in an alternating pattern along the row.

(2) Torque the nuts to the values given in 51-40-04.

(3) Clean the threads of sealant or any other residue and install the nut to the torque wrench values specified in 51-40-04. The installation of all bolts through parts assembled with faying surface seals should be completed with a minimum of 60 minutes of the sealant application life left. After a minimum of 20 minutes from the initial torque application, retorque the nuts to the maximum torque value +00 to -20 pound-inches (+0.00 to -2.26 Newton-Meters). Complete the retorquing before the sealant application life expires. Refer to SOPM 20-50-19 for the application life of the sealant materials.

10. Installation of Fasteners in Composites

A. Refer to 51-20-07 for drilling, countersinking, and machining of composites, treatment of fastener holes, and fastener hole quality.

B. Refer to Paragraph 11./GENERAL for the installation of BACR15GA rivets in composites.

C. Install Carbon Fiber Reinforced Plastic (CFRP) panels on CFRP panels or CFRP structure.

(1) Remove all loose fasteners.

(2) Drill holes, if necessary, as given in the specified repair instructions for the component.

(3) Install CRES or titanium fasteners dry. Use of aluminum fastener in CFRP or hybrid/CFRP structures is not recommended because corrosion can be the result.

D. Install Aramid or Glass Fiber Reinforced Plastic (AFRP or GFRP) panels.

(1) Remove all loose fasteners.

(2) Drill holes, if necessary, as given in the specified repair instructions for the component.

(3) Install the fasteners wet with BMS 5-95 sealant.

11. Hollow-Ended Rivets (BACR15GA)

A. General

(1) BACR15GA hollow-ended rivets are used in composite structural applications.

(2) Refer to Paragraph 10./GENERAL for the installation of fasteners in composites.

B. Hole Preparation

(1) Clamp components together before drilling so that no gap exists between components at the hole location during hole preparation.

CAUTION: THE USE OF LUBRICANTS OTHER THAN THOSE SPECIFIED CAN CAUSE DAMAGE TO RESIN SYSTEMS.

(2) Filtered air, CO2, non-oil containing freon, BOELUBE, or cetyl alcohol can be used as drilling lubricants.

(3) A good backup is required on the exit side of panel to prevent breakout damage. Refer to 51-20-07 for breakout limits.

(4) Countersink holes per 51-20-07. Refer to 51-40-08 for BACR15GA rivet countersink dimensions.

C. Installation (Refer to Installation Requirements for Hollow-Ended (BACR15GA) Rivets, Figure 5/GENERAL.)

(1) Installation of BACR15GA rivets can be done with either of the following rivet squeeze tools:

(a) CP-0214 rivet squeezer or equivalent (preferred tool).

(b) ST-1010-399-3 rivet squeezer coupled to a CP505A hydraulic rivet gun and a EQE 1555 hydraulic power unit (alternate tool). Refer to Installation Requirements for Hollow-Ended (BACR15GA) Rivets, Figure 5/GENERAL for squeeze force settings.

(c) The forming dies that follow shall be used for flaring the hollow end of the rivet into the countersink:

1) Use a ST1157G flaring tool for single-stage installations (preferred method).

2) For double-stage installations, use a ST1157A flaring tool for 140 degree initial angle and 160 degree final angle, or 120 degree initial angle and 140 degree final angle (alternate method).

(2) Inspect rivets after installation.

(a) Visible cracks in the flared end of the rivet are not permitted.

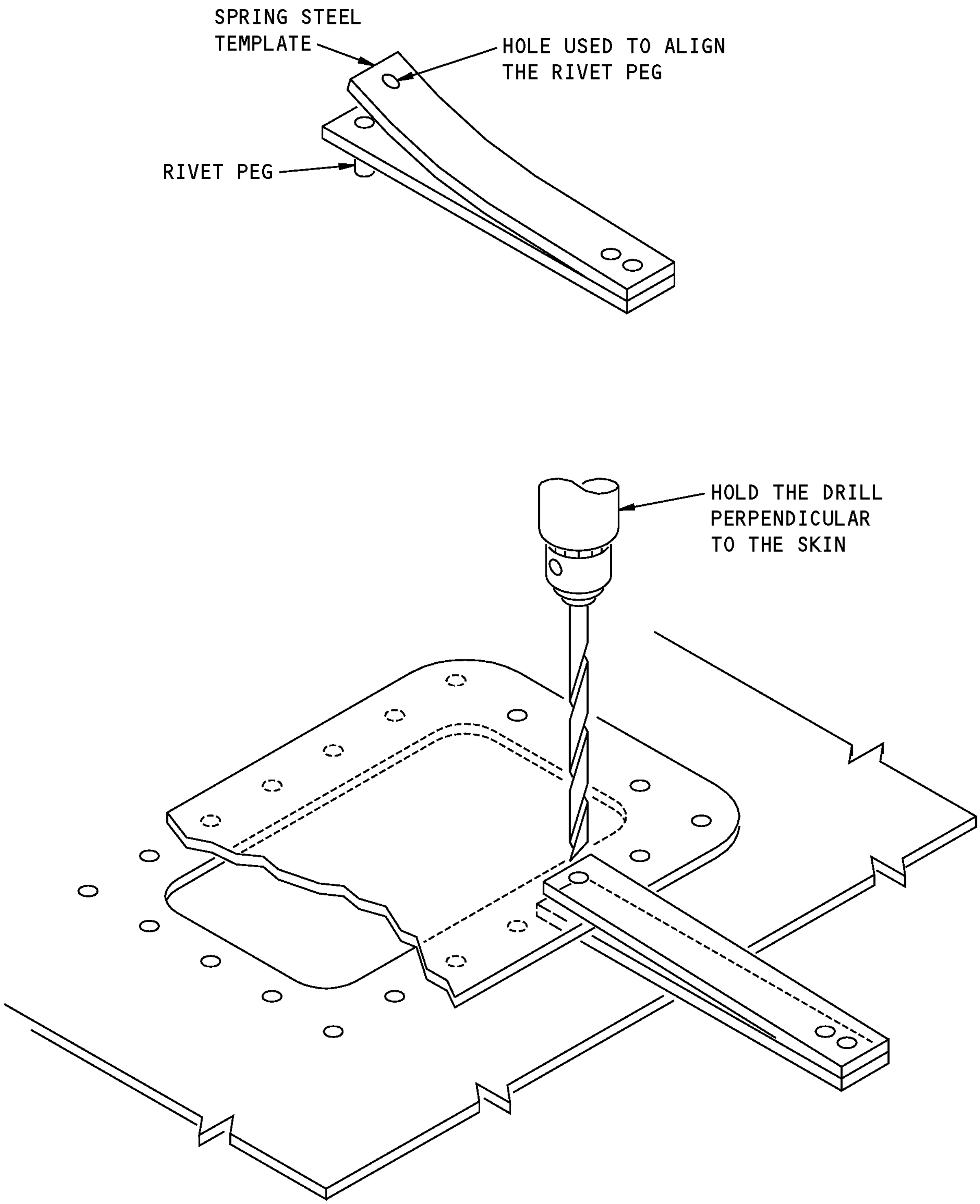
(b) Rivets must be flush within 0.000 to +0.015 inch for both ends of rivet.

1) The manufactured head of a countersink rivet can be microshaved to not less than +0.010 inch protrusion.

2) Microshaving of more than 25% of the rivets in a single component is not permitted.

(c) The manufactured head of a countersink rivet must not be off center by more than 0.04 inch.

D. Removal of BACR15GA rivets can be accomplished by the procedures used for solid shank rivets. Refer to Solid Shank Rivet Removal, Figure 8/GENERAL.



Hole Finder
Figure 1

NOTES

- SEE DETAIL A FOR INSPECTION OF FLUSHNESS.

FASTENER	HEAD HEIGHT SPECIFICATIONS FOR FLUSH HEAD FASTENERS
RIVETS	• UNLESS SEPCIFIED DIFFERENTLY ON THE ENGINEER DRAWING, FLUSH HEAD RIVETS ON NONAERODYNAMIC SURFACES MUST BE FLUSH TO THE SPECIFICATIONS THAT FOLLOW: (1) BACR15GF, BACR15CE AND NAS1097 RIVETS MUST BE FLUSH -0.000 TO +0.005 INCH. (2) ALL OTHER COUNTERSINK RIVETS MUST BE FLUSH -0.000 TO +0.010 INCH. • UNLESS SPECIFIED DIFFERENTLY IN SRM 51-10-01 OR ON THE ENGINEERING DRAWING, FLUSH RIVET HEADS ON AERODYNAMIC SURFACES MUST BE FLUSH TO THE SPECIFICATIONS THAT FOLLOW: (1) BACR15GF RIVETS MUST BE FLUSH TO +0.001 TO +0.007 INCH. (2) ALL OTHER FLUSH HEAD RIVETS MUST BE FLUSH -0.001 TO +0.002 INCH. • BACR15GF, NAS1097, AND BACR15CE RIVET HEADS MUST NOT BE SHAVED OR MODIFIED TO AGREE WITH FLUSHNESS SPECIFICATIONS. • RIVETS OTHER THAN NAS1097, BACR15GF, AND BACR15CE RIVETS CAN BE SHAVED AS SPECIFIED IN SRM 51-10-01 TO AGREE WITH FLUSHNESS SPECIFICATIONS.

TABLE A

Fastener Flushness Specifications
Figure 2 (Sheet 1 of 5)

FASTENER	HEAD HEIGHT SPECIFICATIONS FOR FLUSH HEAD FASTENERS
LOCKBOLTS AND HEX-DRIVE BOLTS	• FLUSH HEAD FASTENERS MUST BE FLUSH -0.005 TO +0.010 INCH UNLESS SPECIFIED DIFFERENTLY IN SRM 51-10-01 OR ON THE ENGINEER DRAWING. • DOMED HEAD FASTENERS (BACB30XT, BACB30XU AND BACB30YP) MUST BE FLUSH +0.0025 TO +0.0085 INCH UNLESS SPECIFIED DIFFERENTLY IN SRM 51-10-01 OR ON THE ENGINEER DRAWING. • FLUSH HEAD FASTENERS THAT ARE TO BE COATED WITH BMS 5-62, BMS 8-70, BMS 8-78, OR BMS 8-103, MUST BE FLUSH -0.005 TO +0.015 INCH. • IT IS NOT PERMITTED TO SHAVE THE HEADS OF LOCKBOLTS AND HEX-DRIVE BOLTS TO AGREE WITH THE FLUSHNESS SPECIFICATION. IF THE FASTENER HEAD IS NOT FLUSH TO SPECIFICATION: (1) MORE DRIVING OF THE PIN IS PERMITTED FOR HEX-DRIVE BOLTS IF THE COLLAR IS REPLACED OR THE NUT IS RE-TIGHTENED AS SPECIFIED IN SRM 51-40-04. (a) HEX-DRIVE BOLTS MUST BE REPLACED WITH NEW FASTENERS WHEN THE REMOVED COLLARS OR NUTS ARE ALLOY STEEL, CRES OR TITATNIUM. (b) WHEN ALUMINUM COLLARS OR NUTS ARE REMOVED FROM COMPLETED ASSEMBLIES OR INSTALLATION: EXAMINE THE HEX-DRIVE BOLT FOR THREAD DAMAGE BEFORE YOU INSTALL A NEW COLLAR OR NUT. IF THE THREAD IS DAMAGED, THE HEX-DRIVE BOLT MUST BE REPLACED WITH A NEW HEX-DRIVE BOLT. (2) FOR LOCKBOLTS, MORE DRIVING IS NOT PERMITTED. THE FASTENER MUST BE REPLACED.

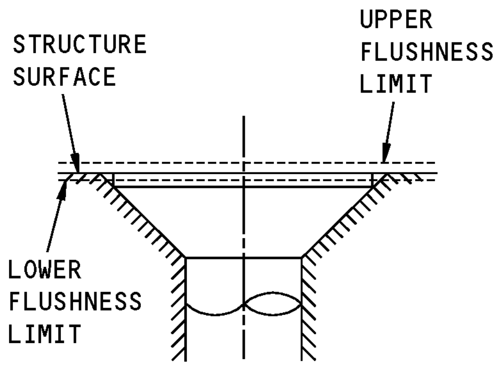
TABLE A

Fastener Flushness Specifications
Figure 2 (Sheet 2 of 5)

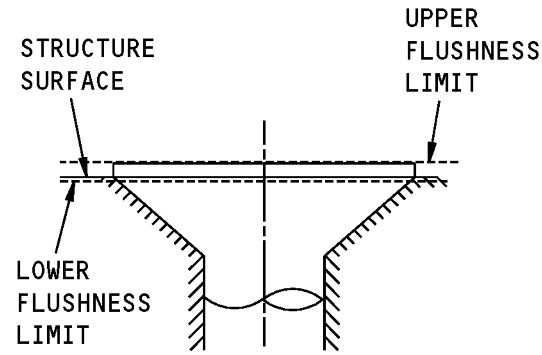
FASTENER	HEAD HEIGHT SPECIFICATIONS FOR FLUSH HEAD FASTENERS
BLIND FASTENERS	• FLUSHNESS SPECIFICATION FOR FLUSH HEAD FASTENERS SHALL BE −0.005 TO +0.010 INCH UNLESS SPECIFIED DIFFERENTLY ON THE ENGINEERING DRAWING. (1) MAKE SURE THAT THE LOCKING RING AND STEM ARE IN THE POSITIONS SPECIFIED IN FIGURE 9 BEFORE YOU SHAVE A BLIND RIVET. THE LOCKING RINGS AND/OR STEMS OF NAS1398, NAS1399, NAS1738, NAS1739, AND BACR15FR RIVETS CAN BE SHAVED A MAXIMUM OF 0.010 INCH TO AGREE WITH THE FLUSHNESS SPECIFICATION. SHAVING OF THE RIVET HEAD IS NOT PERMITTED. (2) THE STEMS OF BACB30AY, BACB30CC, BACB30JG BOLTS CAN BE SHAVED TO AGREE WITH THE FLUSHNESS SPECIFICATION. QUALITY CONTROL INSPECTION AND APPROVAL OF STEM POSITION PRIOR TO SHAVING IS REQUIRED. SHAVING OF THE BOLT HEAD IS NOT ALLOWED. • THE LOCKING RINGS AND/OR STEMS OF MS90353, MS90354, MS21140 AND MS21141 BOLTS MAY BE SHAVED TO MEET FLUSHNESS REQUIREMENTS. QUALITY CONTROL INSPECTION AND APPROVAL OF LOCKING RING AND STEM POSITION PRIOR TO SHAVING IS REQUIRED. SHAVING OF THE BOLT HEAD IS NOT ALLOWED.
BOLTS	• FLUSH HEAD FASTENERS MUST BE FLUSH −0.005 TO +0.010 INCH UNLESS SPECIFIED DIFFERENTLY IN SRM 51-10-01 OR ON THE ENGINEER DRAWING. • FLUSH HEAD FASTENERS THAT ARE TO BE COATED WITH BMS 5-62, BMS 8-70, BMS 8-78, OR BMS 8-103, MUST BE FLUSH −0.005 TO +0.015 INCH. • IT IS NOT PERMITTED TO SHAVE THE HEADS OF BOLTS TO AGREE WITH THE FLUSHNESS SPECIFICATION.
RADIUS LEAD-IN BOLTS	• BACB30PT BOLTS MUST BE FLUSH ±0.000 TO +0.006, UNLESS SPECIFIED DIFFERENTLY IN SRM 51-10-01 OR ON THE ENGINEER DRAWING. • BACB30WQ BOLTS MUST BE FLUSH AS SPECIFIED IN SRM 51-10-01 OR ON THE ENGINEER DRAWING. • IT IS NOT PERMITTED TO SHAVE THE HEADS OF BOLTS TO AGREE WITH THE FLUSHNESS SPECIFICATION.

TABLE A

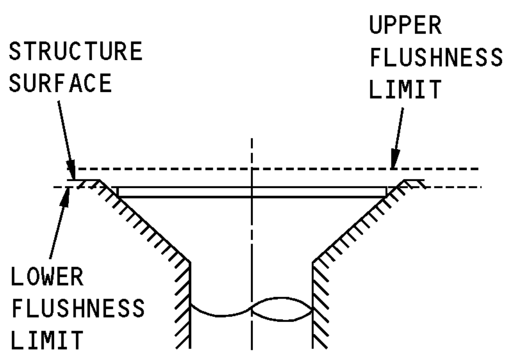
Fastener Flushness Specifications
Figure 2 (Sheet 3 of 5)



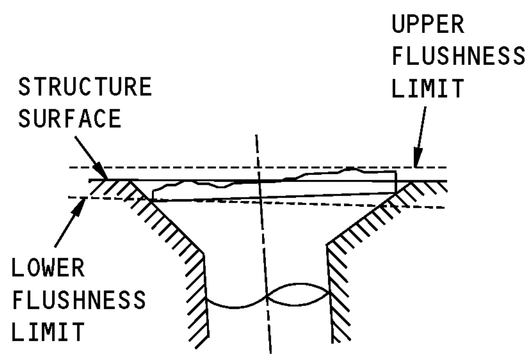
FASTENER HEAD HAS A CONTINUOUS SURFACE WITH THE STRUCTURE (ZERO VALUE)



FASTENER HEAD IS AT UPPER FLUSHNESS LIMIT (POSITIVE VALUE)



FASTENER EXACTLY AT LOWER FLUSHNESS LIMIT (NEGATIVE VALUE)

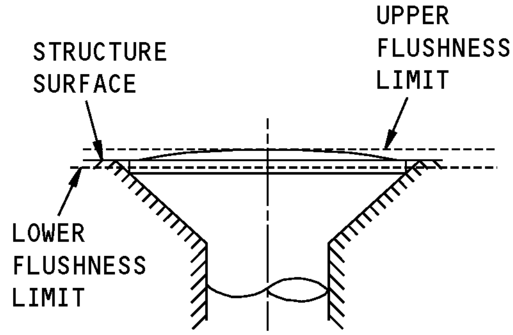


FASTENER HOLE NOT PERPENDICULAR TO STRUCTURE SURFACE. TOP OF FASTENER HEAD NOT PERPENDICULAR TO SHANK. TOP OF FASTENER HEAD NOT FLAT. ALL EDGES ARE AT OR IN BETWEEN THE UPPER AND LOWER FLUSHNESS LIMITS

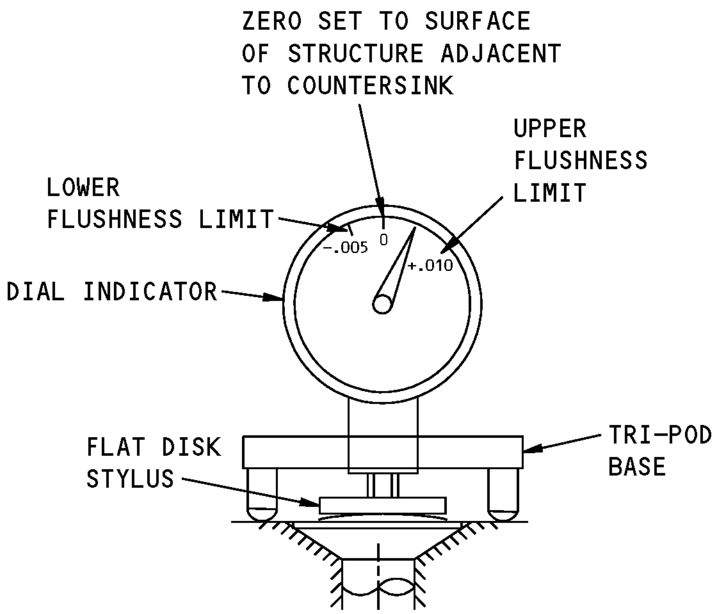
HOW TO MEASURE FLUSHNESS

A

Fastener Flushness Specifications
Figure 2 (Sheet 4 of 5)



FASTENER WITH CROWN (OR DOME) ON TOP OF HEAD. FASTENER FLUSHNESS JUST MEETS FLUSHNESS LIMITS

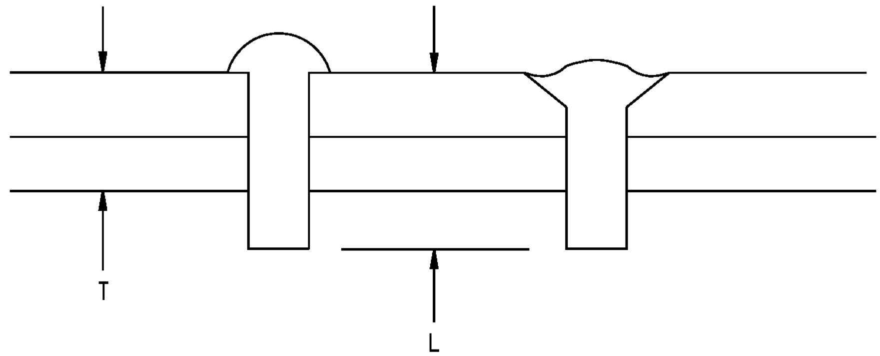


DIAL INDICATOR AND FLAT DISK STYLUS FOR FINDING PERMITTED FLUSHNESS VALUES (THIS METHOD ALSO APPLIES TO FLUSH HEAD FASTENERS WITHOUT A CROWN OR DOME)

HOW TO MEASURE FLUSHNESS (CONTINUED)

A

Fastener Flushness Specifications
Figure 2 (Sheet 5 of 5)



RIVET LENGTH (L) AND GRIP (T) DIMENSIONS
FOR STANDARD ALUMINUM SOLID RIVETS

A

NOTES

- THE SOURCE OF INFORMATION FOR THIS FIGURE CAN BE FOUND IN BOEING PROCESS SPECIFICATION BAC 5004-1.
- SEE TABLE A FOR GRIP RANGES AND RIVET LENGTHS.
- SEE TABLES B AND C FOR BUTTON DIMENSIONS.
- REFER TO FIGURES 6 AND 7 FOR ANALYSIS OF THE RIVET HEAD AND BUTTON AFTER INSTALLATION.

1 THESE RIVET LENGTHS ARE FOR NEW HOLES AND OVERSIZED HOLES ONLY. IF A HOLE THAT WAS FILLED BEFORE IS NOT OVERSIZED, USE A RIVET LENGTH ONE SIZE HIGHER.

2 FOR RIVETS WITH A SPECIFIED 1.4X DIAMETER DRIVEN HEAD THE NEXT HALF-SIZED (R5 SUFFIX TO PART NUMBER) LENGTH MAY BE REQUIRED. FOR RIVETS WITH A SPECIFIED 1.5X DIAMETER DRIVEN HEAD, THE NEXT WHOLE DASH NUMBER MAY BE REQUIRED.

IN THICK STACKUPS, FOR RIVETS INSTALLED IN HOLES THAT ARE THE MAXIMUM ALLOWED DIAMETER, THE NEXT HALF-SIZED (R5) LENGTH CAN BE NECESSARY.

IN MINIMUM STACKUPS, A HALF-SIZE (R5 SUFFIX TO PART NUMBER) SHORTER LENGTH CAN BE USED FOR WEIGHT SAVINGS.

3 OVERSIZE REPLACEMENTS

4 WHEN NORMAL DRIVING STANDARDS ARE SPECIFIED

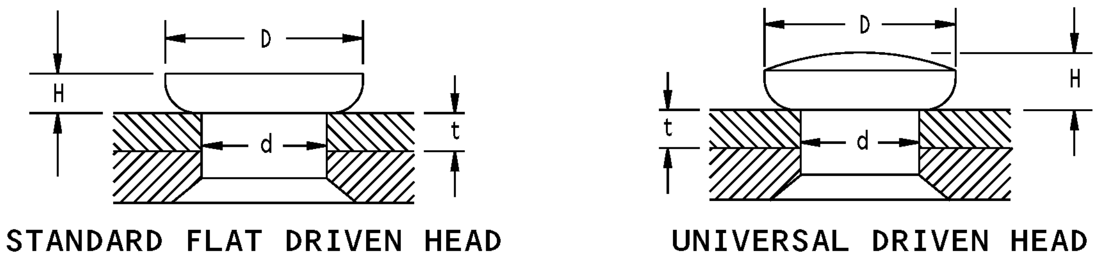
5 WHEN OVER-DRIVING IS SPECIFIED

Installation Dimensions for Non-Fluid-Tight Solid Shank Rivets
Figure 3 (Sheet 1 of 4)

RIVET LENGTH L [1]		GRIP (T) RANGES FOR RIVET LENGTHS AND DIAMETERS [2]								
SIZE	DASH NO.	3/32 OR 3 DIA	1/8 OR 4 DIA	5/32 OR 5 DIA	3/16 OR 6 DIA	7/32 OR 7 DIA	1/4 OR 8 DIA	9/32 OR 9 DIA	5/16 OR 10 DIA	3/8 OR 12 DIA
3/16	-3	0.084	0.058	0.035						
1/4	-4	0.085 0.142	0.059 0.117	0.036 0.093	0.068					
5/16	-5	0.143 0.201	0.118 0.176	0.094 0.152	0.069 0.127	0.107	0.078	0.058		
3/8	-6	0.202 0.260	0.177 0.234	0.153 0.211	0.128 0.185	0.108 0.166	0.079 0.136	0.059 0.117	0.087	0.038
7/16	-7	0.261 0.319	0.235 0.293	0.212 0.270	0.186 0.244	0.167 0.225	0.137 0.195	0.118 0.176	0.088 0.146	0.039 0.097
1/2	-8	0.294 0.352	0.320 0.377	0.271 0.327	0.245 0.303	0.226 0.283	0.196 0.254	0.177 0.234	0.146 0.205	0.098 0.156
9/16	-9	0.378 0.436	0.353 0.411	0.328 0.387	0.304 0.362	0.284 0.342	0.255 0.313	0.235 0.293	0.206 0.264	0.157 0.215
5/8	-10	0.437 0.495	0.412 0.469	0.388 0.446	0.363 0.420	0.343 0.401	0.314 0.371	0.294 0.352	0.265 0.322	0.216 0.273
11/16	-11	----	0.470 0.528	0.447 0.505	0.421 0.479	0.402 0.460	0.372 0.430	0.353 0.411	0.323 0.381	0.274 0.332
3/4	-12	----	0.529 0.587	0.506 0.563	0.480 0.538	0.461 0.518	0.431 0.489	0.412 0.469	0.382 0.440	0.333 0.391
13/16	-13	----	0.588 0.646	0.564 0.622	0.539 0.597	0.519 0.577	0.490 0.548	0.470 0.528	0.441 0.499	0.392 0.450
7/8	-14	----	----	0.623 0.681	0.598 0.655	0.578 0.636	0.549 0.606	0.529 0.587	0.500 0.557	0.451 0.508
15/16	-15	----	----	0.682 0.740	0.656 0.714	0.634 0.695	0.607 0.665	0.588 0.646	0.558 0.616	0.509 0.567
1	-16	----	----	0.741 0.798	0.715 0.773	0.696 0.753	0.666 0.724	0.647 0.704	0.617 0.675	0.568 0.626
17/16	-17	----	----	----	0.774 0.832	0.754 0.812	0.725 0.783	0.705 0.763	0.676 0.734	0.627 0.685
9/8	-18	----	----	----	0.833 0.890	0.813 0.871	0.784 0.841	0.764 0.822	0.735 0.792	0.686 0.743
19/16	-19	----	----	----	0.891 0.949	0.872 0.930	0.842 0.900	0.823 0.881	0.793 0.851	0.744 0.802
5/4	-20	----	----	----	0.950 1.008	0.931 0.988	0.901 0.959	0.882 0.939	0.852 0.910	0.803 0.861
21/16	-21	----	----	----	----	0.989 1.047	0.960 1.018	0.940 0.998	0.911 0.969	0.862 0.920
11/8	-22	----	----	----	----	----	1.019 1.076	0.999 1.057	0.970 1.027	0.921 0.978

GRIP RANGES AND RECOMMENDED RIVET LENGTHS
FOR STANDARD ALUMINUM SOLID RIVETS
TABLE A

Installation Dimensions for Non-Fluid-Tight Solid Shank Rivets
Figure 3 (Sheet 2 of 4)



NOMINAL RIVET DIAMETER	D MINIMUM DRIVEN RIVET BUTTON DIAMETER				H DRIVEN RIVET BUTTON THICKNESS OR HEIGHT		
	ALL RIVETS EXCEPT AS NOTED		BACR15GF AND 7050 ALUMINUM ALLOY RIVETS		BACR15GF BACR15CE BACR15DS BACR15FV MS14218 NAS1097	ALL OTHER RIVETS	ALL RIVETS
	1.3d [4]	1.4d [5]	1.4d [4]	1.5d [5]	MINIMUM	MINIMUM	MAXIMUM RECOMMENDED
1/16	0.081	0.088	0.088	0.094	0.025	0.025	0.040
3/32	0.122	0.131	0.131	0.141	0.038	0.038	0.060
1/8	0.165	0.175	0.175	0.188	0.050	0.050	0.080
5/32	0.203	0.219	0.219	0.234	0.050	0.062	0.100
3/16	0.245	0.264	0.264	0.282	0.060	0.075	0.120
7/32 [3]	0.285	0.311	0.311	0.333	0.070	0.085	0.140
1/4	0.325	0.350	0.350	0.375	0.080	0.100	0.160
9/32 [3]	0.365	0.397	0.397	0.425	0.090	0.110	0.180
5/16	0.406	0.438	0.438	0.465	0.125	0.125	0.200
11/32 [3]	0.450	0.481	0.481	0.515	0.135	0.135	0.210
3/8	0.488	0.525	0.525	0.562	0.150	0.150	0.210
13/32 [3]	0.530	0.569	0.569	0.609	0.165	0.165	0.215

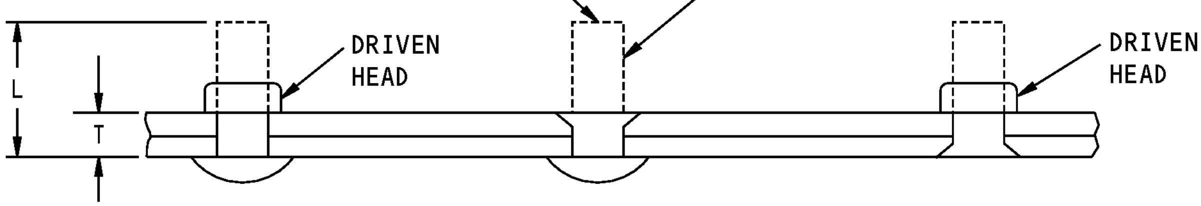
TABLE B

Installation Dimensions for Non-Fluid-Tight Solid Shank Rivets
Figure 3 (Sheet 3 of 4)

NOMINAL RIVET DIAMETER	THICKNESS (t) OF SHEET ADJACENT TO RIVET BUTTON	BUTTON THICKNESS MINIMUM	BUTTON DIAMETER MINIMUM
3/32	0.016-0.050	0.023	0.113
	0.051 AND ABOVE	0.038	0.122
1/8	0.016-0.050	0.030	0.150
	0.051 AND ABOVE	0.050	0.163
5/32	0.016-0.050	0.035	0.180
	0.051 AND ABOVE	0.062	0.203
3/16	0.016-0.050	0.040	0.222
	0.051 AND ABOVE	0.075	0.244
1/4	0.016-0.050	0.050	0.275
	0.051 AND ABOVE	0.087	0.325

CRES AND NICKEL-COPPER RIVETS
TABLE C

Installation Dimensions for Non-Fluid-Tight Solid Shank Rivets
Figure 3 (Sheet 4 of 4)



RIVET LENGTH (L) AND GRIP (T) DIMENSIONS

A

NOTES

- THE SOURCE OF INFORMATION FOR THIS FIGURE CAN BE FOUND IN BOEING PROCESS SPECIFICATION BAC 5047.
- REFER TO FIGURES 6 AND 7 FOR ANALYSIS OF THE RIVET HEAD AND BUTTON AFTER INSTALLATION.

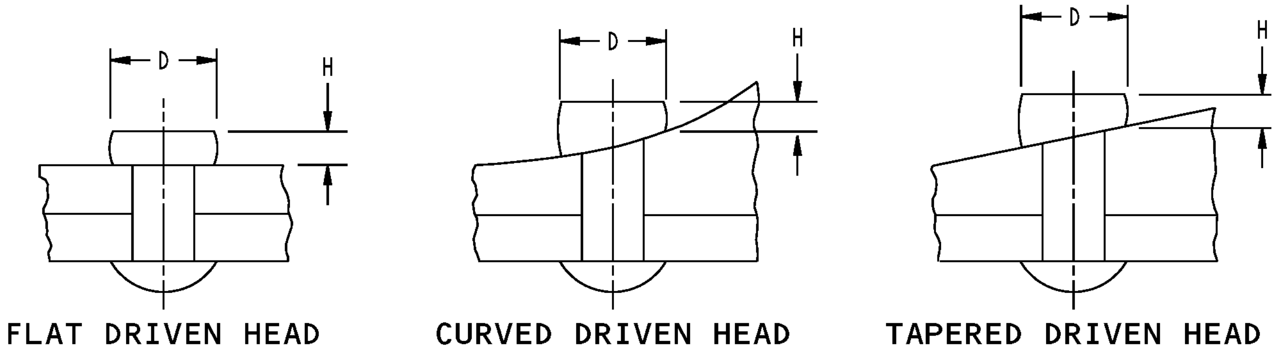
1 OVERSIZE REPLACEMENT

Installation Dimensions for Fluid-Tight Solid Shank Rivets
Figure 4 (Sheet 1 of 3)

NOMINAL RIVET LENGTH L			APPROXIMATE GRIP (T) INCHES						
DECIMAL	FRACTION	DASH NO.	3/32 DIA	1/8 DIA	5/32 DIA	3/16 DIA	1/4 DIA	5/16 DIA	3/8 DIA
0.1875	3/16	-3	0.086						
0.2500	1/4	-4	0.142	0.117	0.087				
0.3125	5/16	-5	0.199	0.174	0.146	0.119			
0.3750	3/8	-6	0.235	0.232	0.205	0.178			
0.4375	7/16	-7	0.312	0.290	0.263	0.237	0.180	0.120	
0.5000	1/2	-8	0.368	0.348	0.322	0.295	0.240	0.181	
0.5625	9/16	-9	0.424	0.406	0.381	0.356	0.300	0.242	0.183
0.6250	5/8	-10	0.480	0.464	0.439	0.416	0.360	0.302	0.244
0.6875	11/16	-11		0.522	0.498	0.475	0.420	0.362	0.307
0.7500	3/4	-12		0.579	0.557	0.534	0.480	0.423	0.366
0.8125	13/16	-13		0.637	0.617	0.594	0.540	0.484	0.427
0.8750	7/8	-14			0.675	0.654	0.600	0.544	0.488
0.9375	15/16	-15			0.732	0.712	0.660	0.605	0.549
1.0000	1	-16			0.782	0.773	0.720	0.665	0.610
1.0625	1 1/16	-17				0.832	0.780	0.726	0.671
1.1250	1 1/8	-18				0.890	0.840	0.787	0.732
1.1875	1 3/16	-19					0.901	0.847	0.793
1.2500	1 1/4	-20					0.961	0.908	0.854
1.3125	1 5/16	-21					1.021	0.968	0.915
1.3750	1 3/8	-22						1.029	0.976
1.4375	1 7/16	-23						1.090	1.037
1.5000	1 1/2	-24						1.150	1.098

NOMINAL RIVET LENGTH L AND APPROXIMATE GRIP (T) INCHES
TABLE A

Installation Dimensions for Fluid-Tight Solid Shank Rivets
Figure 4 (Sheet 2 of 3)



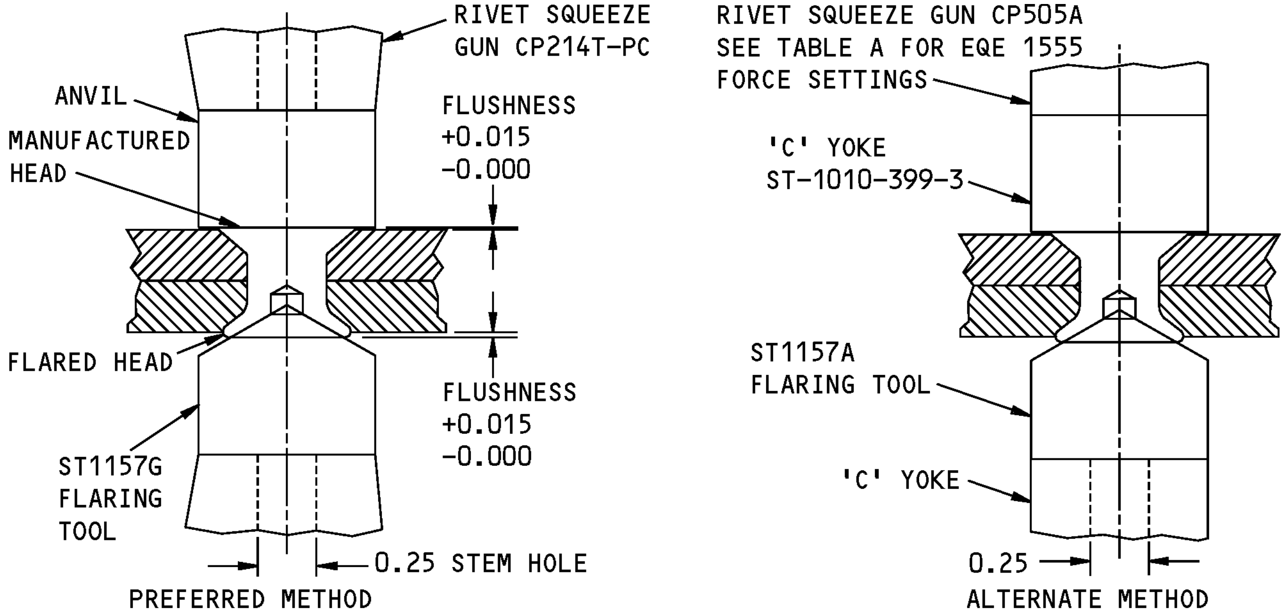
DRIVEN RIVET BUTTON DIMENSIONS

B

NOMINAL RIVET DIA		D MINIMUM BUTTON DIAMETER		H BUTTON THICKNESS	
		ALL RIVETS EXCEPT AS NOTED	7050 ALUMINUM ALLOY RIVETS	MINIMUM	MAXIMUM (RECOMMENDED)
0.1250	1/8	0.165	-----	0.050	0.080
0.1560	5/32	0.203	0.219	0.062	0.100
0.1875	3/16	0.245	0.264	0.075	0.120
0.2190	7/32 [1]	0.285	0.311	0.085	0.140
0.2500	1/4	0.325	0.350	0.100	0.160
0.2810	9/32 [1]	0.365	0.397	0.110	0.180
0.3125	5/16	0.406	0.438	0.125	0.200
0.3440	11/32 [1]	0.450	0.482	0.135	0.210
0.3750	3/8	0.488	0.525	0.150	0.210
0.4060	13/32 [1]	0.530	-----	0.165	0.215
0.4370	7/16	0.570	-----	0.175	0.220
0.4690	15/32 [1]	0.610	-----	0.190	0.230

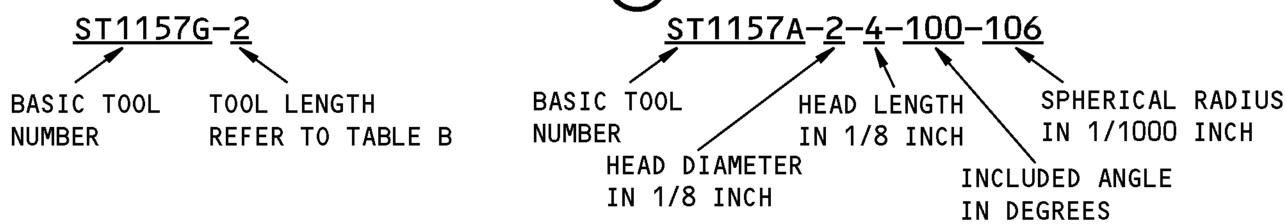
HAND OR MACHINE DRIVEN RIVET BUTTON DIMENSIONS
TABLE B

Installation Dimensions for Fluid-Tight Solid Shank Rivets
Figure 4 (Sheet 3 of 3)



TOOL AND FLUSHNESS REQUIREMENTS
FOR HOLLOW-ENDED (BACR15GA) RIVETS

A



FLARING TOOL DESCRIPTION

NOMINAL RIVET DIAMETER	SQUEEZE FORCE (LB) ±200 LB
5/32	3000
3/16	3500
7/32	4000

FORCE SETTINGS FOR POWER SUPPLY
UNIT EQE 1555 [1]
TABLE A

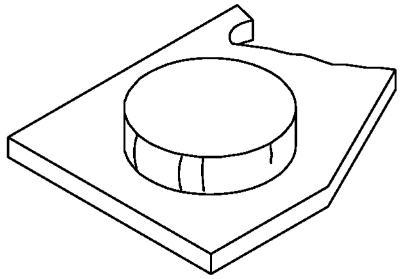
TOOL LENGTH NUMBER	TOOL LENGTH 'L' (INCHES)
-1	0.150
-2	0.300
-3	0.500
-4	0.750

TOOL LENGTH NUMBERS
TABLE B

NOTES

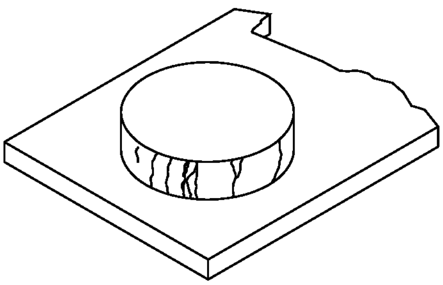
[1] POWER SUPPLY UNIT IS AVAILABLE FROM:
E. F. BAILEY CO.
5610 4TH AVE. S
SEATTLE, WA 98108
SPECIFY BOEING STANDARD PUMP SPL 1555-7-1

Installation Requirements for Hollow-Ended (BACR15GA) Rivets
Figure 5



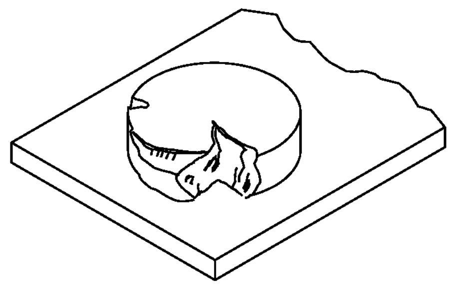
VERTICAL CRACKS DUE TO LAPS
IN THE MATERIAL IS SATISFACTORY

A



VERTICAL CRACKS IN CRES
ALLOY, NICKEL-COPPER ALLOY,
AND TITANIUM RIVETS

B



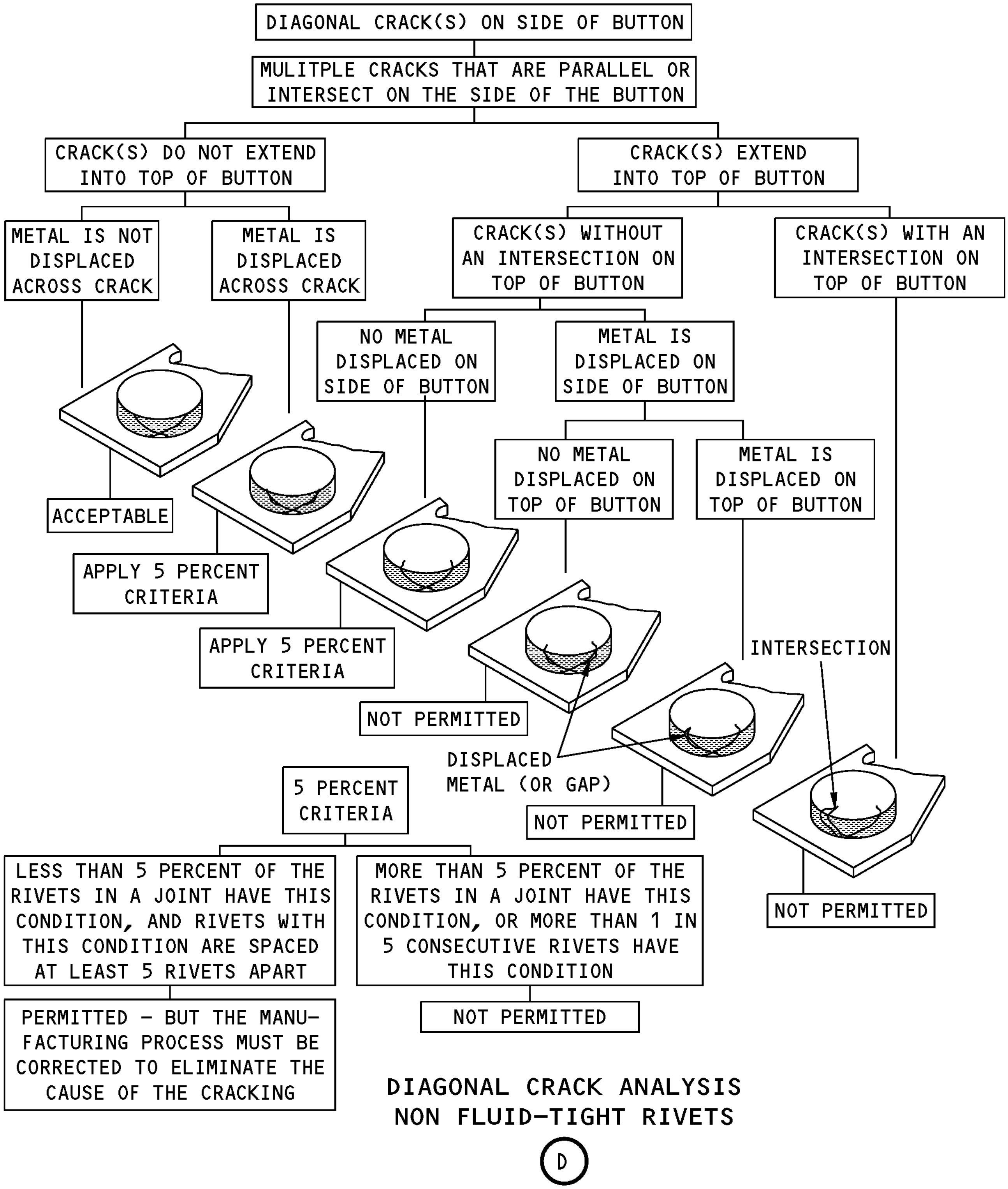
VERTICAL CRACKS DUE TO
OVERHEATING DURING HEAT
TREATMENT IS UNSATISFACTORY

C

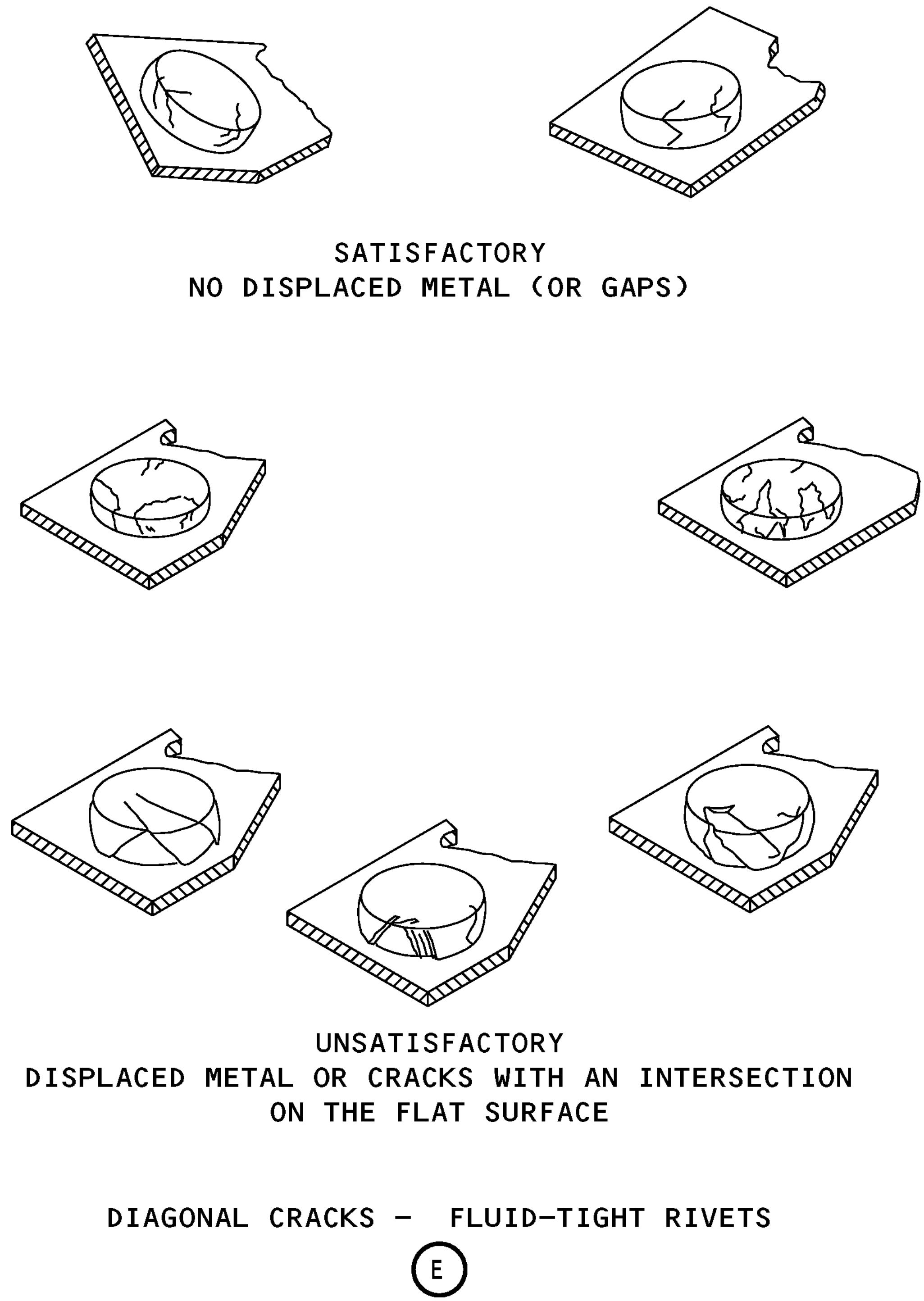
NOTES

- THE SOURCE OF INFORMATION FOR THIS FIGURE CAN BE FOUND IN BOEING PROCESS SPECIFICATIONS BAC 5004-1 AND BAC 5047.
- SEE DETAILS A THRU C FOR VERTICAL CRACKS IN FLUID-TIGHT AND NON FLUID-TIGHT RIVETS.
- SEE DETAIL D FOR DIAGONAL CRACKS IN NON FLUID-TIGHT RIVETS.
- SEE DETAIL E FOR DIAGONAL CRACKS IN FLUID-TIGHT RIVETS.

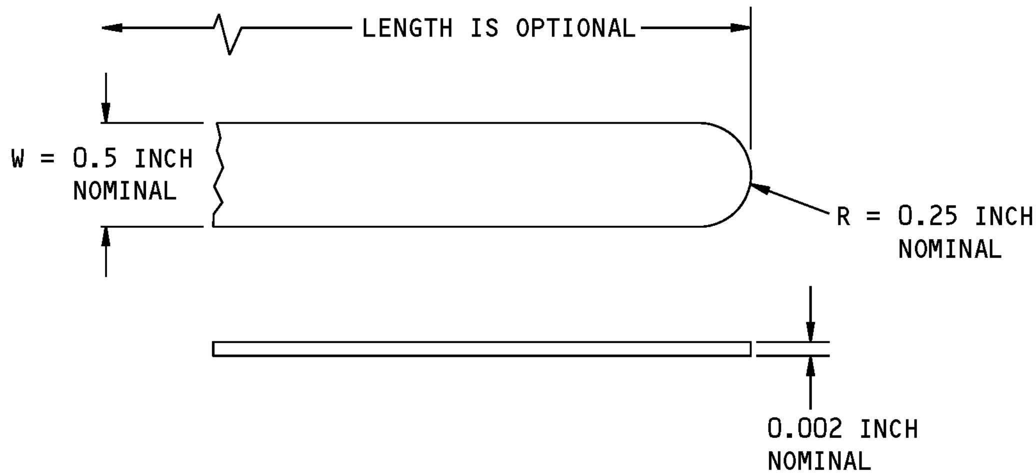
Analysis of Cracks in the Buttons of Solid Shank Rivets
Figure 6 (Sheet 1 of 3)



Analysis of Cracks in the Buttons of Solid Shank Rivets
Figure 6 (Sheet 2 of 3)



Analysis of Cracks in the Buttons of Solid Shank Rivets
Figure 6 (Sheet 3 of 3)



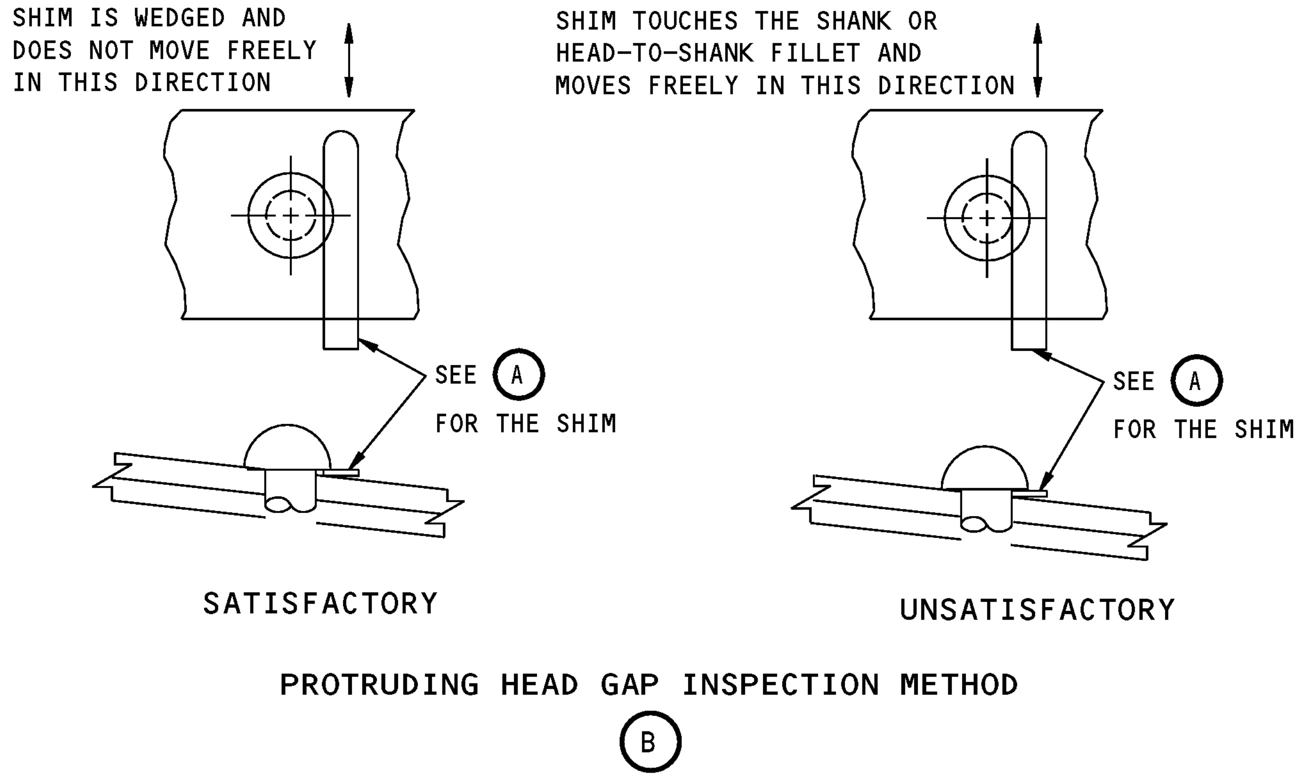
GAP INSPECTION SHIM

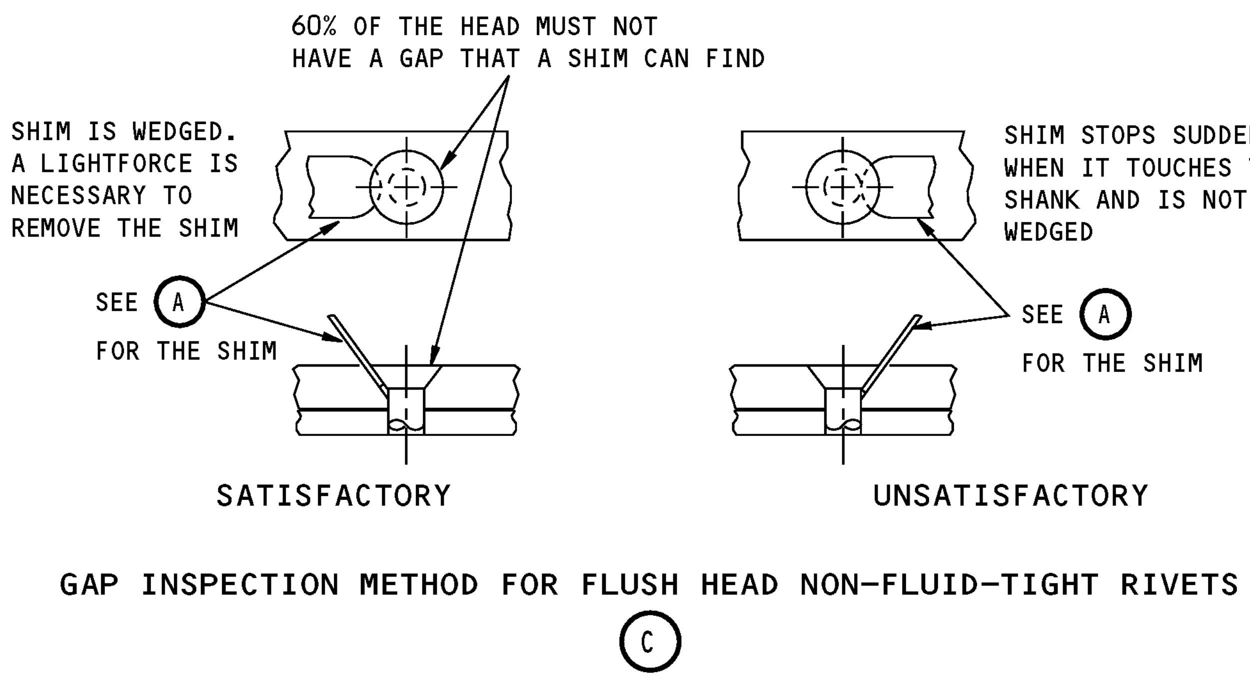
A

INSPECTION	GAP ANALYSIS (REFERENCE BAC5004-1 AND BAC5047)
PROTRUDING HEADS	• SEE DETAIL B
FLUSH HEADS	• SEE DETAIL C FOR NON-FLUID-TIGHT RIVETS • SEE DETAIL D FOR FLUID-TIGHT RIVETS
NON-FLUSH DRIVEN BUTTONS (ALL RIVETS)	• SEE DETAIL F
FLUSH DRIVEN BUTTONS (ALL RIVETS)	• SEE DETAIL G

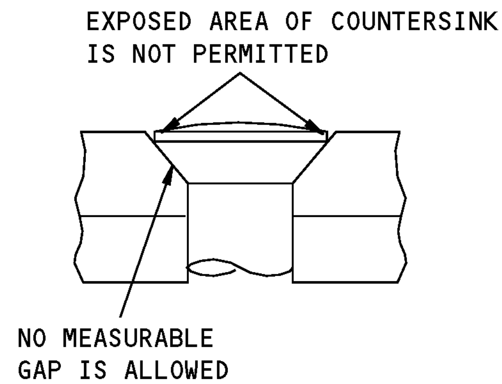
TABLE A

Gap Analysis for Rivet Heads and Buttons
Figure 7 (Sheet 1 of 3)



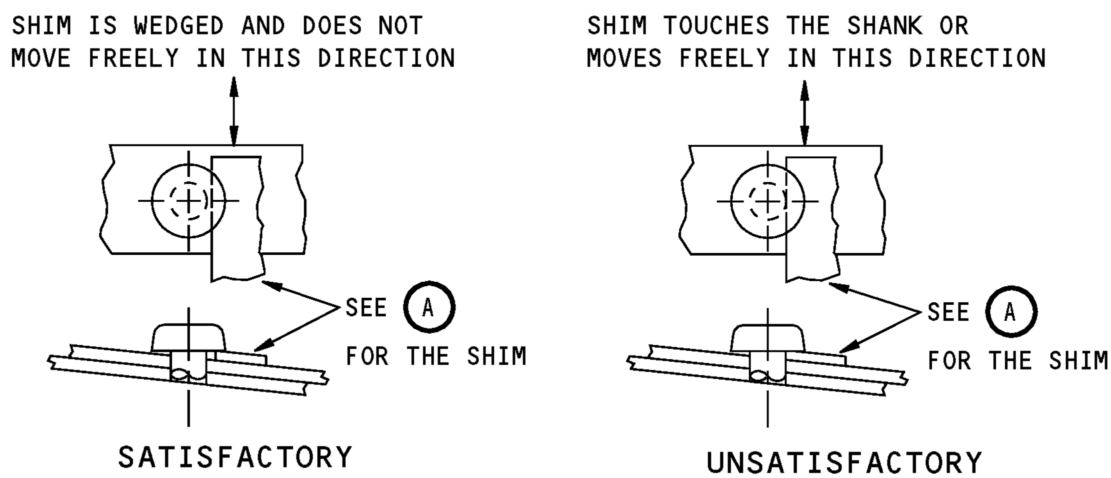


Gap Analysis for Rivet Heads and Buttons
Figure 7 (Sheet 2 of 3)



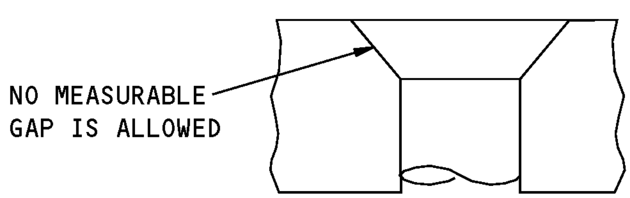
GAP INSPECTION METHOD FOR
FLUSH HEAD FLUID-TIGHT RIVETS

D



GAP INSPECTION METHOD FOR NON-FLUSH DRIVEN BUTTONS (ALL RIVETS)

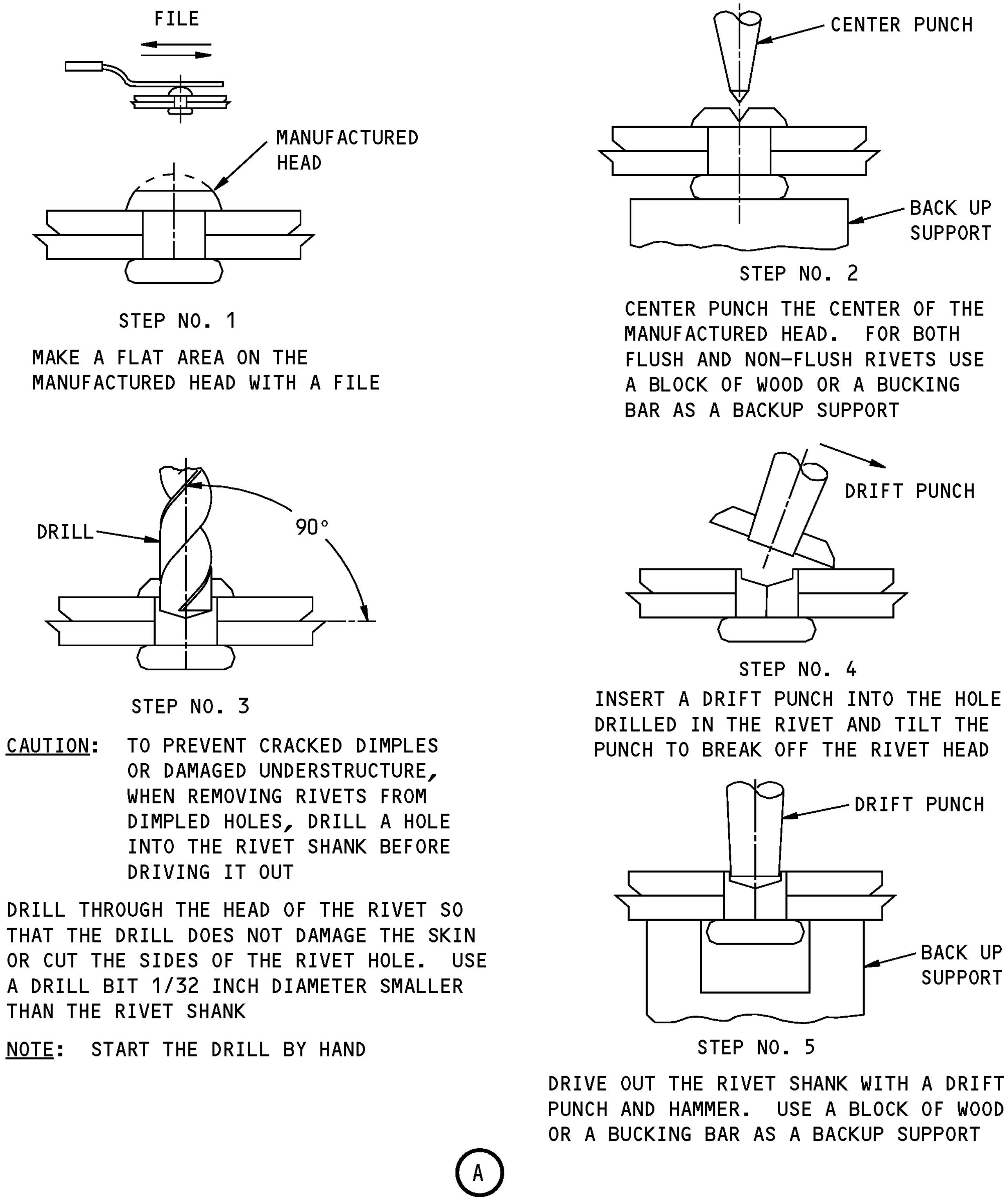
E



GAP INSPECTION METHOD FOR
FLUSH DRIVEN BUTTONS (ALL RIVETS)

F

Gap Analysis for Rivet Heads and Buttons
Figure 7 (Sheet 3 of 3)



Solid Shank Rivet Removal
Figure 8

NOTES

- THE SOURCE OF INFORMATION FOR THIS FIGURE CAN BE FOUND IN BOEING PROCESS SPECIFICATION BAC 5004-3.
- SEE TABLES A THROUGH C FOR STEM AND COLLAR PROTRUSION LIMITS.
- SEE DETAILS D AND E FOR GAP ANALYSIS.

[1] SEE DETAILS A AND B FOR VALUES THAT FOLLOW:

- A = MAXIMUM ALLOWABLE DISTANCE OF LOCKING COLLAR ABOVE (+) OR BELOW (-) FASTENER HEAD
- B = MAXIMUM ALLOWABLE DISTANCE OF LOCKING COLLAR ABOVE TOP OF LAND ON STEM
- C = MAXIMUM ALLOWABLE DISTANCE OF TOP OF LAND ON STEM ABOVE (+) OR BELOW (-) FASTENER HEAD.

[2] SEE DETAIL C FOR THE LOCKRING FLASH POSITION.

[3] EVALUATE GAPS AS FOLLOWS:

A. THE HEADS OF ALL PROTRUDING-HEAD FASTENERS MUST SEAT SO THAT A 0.003-INCH THICK SHIM DOES NOT CONTACT THE FASTENER SHANK WHEN INSPECTED AS SHOWN IN DETAIL E. CONTACT WITH THE SHANK IS INDICATED WHEN THE SHIM DOES NOT WEDGE AND WILL SLIDE FREELY UNDER THE HEAD AS SHOWN IN DETAIL E. THE HEADS OF PROTRUDING-HEAD BLIND BOLTS MUST SEAT IN AT LEAST ONE LOCATION ON THE PERIPHERY OF THE HEAD AND THE REMAINING GAP SHALL BE IN ACCORDANCE WITH DETAIL E USING THE SHIM THICKNESS SHOWN IN TABLE D.

B. THE HEADS OF ALL FLUSH-HEAD FASTENERS MUST SEAT SO THAT:

(1) A 0.003-INCH THICK SHIM CANNOT BE INSERTED BETWEEN THE FASTENER HEAD AND THE COUNTERSINK FOR MORE THAN 40 PERCENT OF THE CIRCUMFERENCE OF THE HEAD.

(2) A 0.003-INCH THICK SHIM DOES NOT CONTACT THE FASTENER SHANK WHEN INSPECTED AS SHOWN IN DETAIL F.

Installation of Blind Bolts and Blind Rivets
Figure 9 (Sheet 1 of 5)

NOMINAL RIVET DIA	A	B	C	
1/8	±0.020	+0.015	+0.020	-0.010
5/32	±0.020	+0.020	+0.020	-0.010
3/16	±0.020	+0.025	+0.020	-0.010
1/4	±0.020	+0.030	+0.020	-0.010

STEM AND COLLAR PROTRUSION LIMITS FOR NAS1398, NAS1399, NAS1738, AND NAS1739 BLIND RIVETS
TABLE A [1]

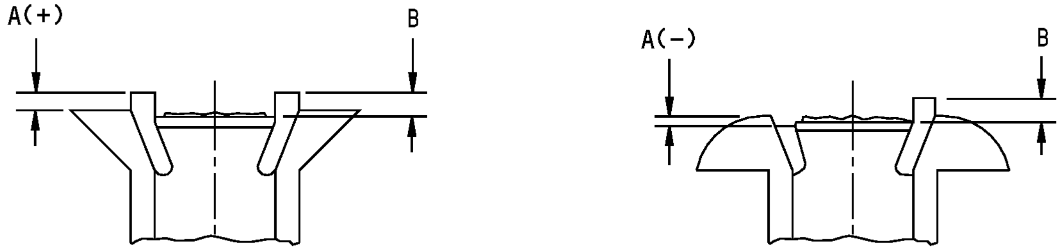
NOMINAL BOLT DIA	A	B	C
5/32	±0.017	-	±0.010
3/16	±0.022	-	±0.012
1/4	±0.029	-	±0.015
5/16	±0.037	-	±0.019
3/8	±0.045	-	±0.023
7/16	±0.050	-	±0.027
1/2	±0.056	-	±0.031

STEM AND COLLAR PROTRUSION LIMITS FOR MS21140, MS21141, MS90353, AND MS90354 BLIND BOLTS
TABLE B [1]

NOMINAL RIVET DIAMETER INCH	A	B	C	
1/8	+0.005	---	+0.010	-0.015
5/32	+0.005	---	+0.010	-0.020
3/16	+0.005	---	+0.010	-0.020

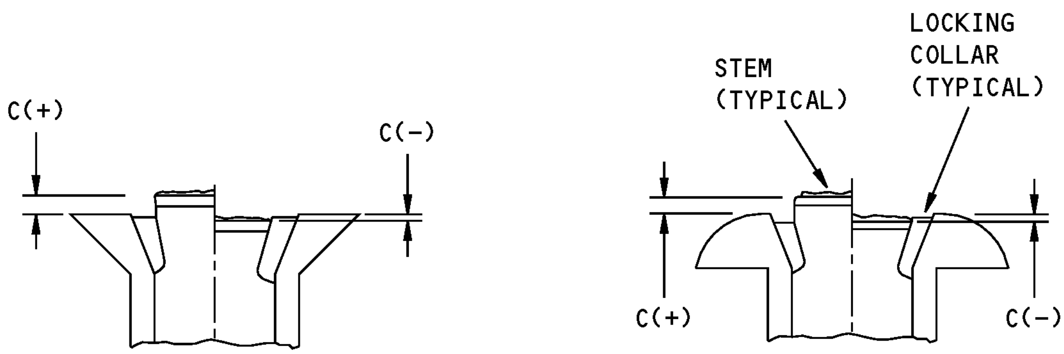
STEM AND COLLAR PROTRUSION LIMITS FOR BACR15FP AND BACR15FR BLIND RIVETS
TABLE C [1] [2]

Installation of Blind Bolts and Blind Rivets
Figure 9 (Sheet 2 of 5)



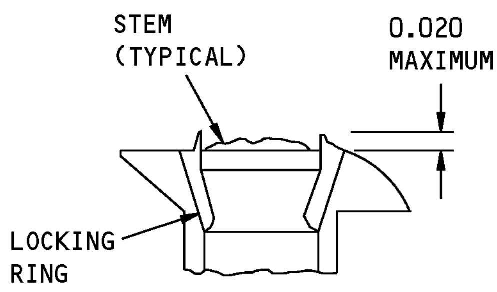
LOCKING COLLAR PROTRUSION LIMITS

A



STEM PROTRUSION LIMITS

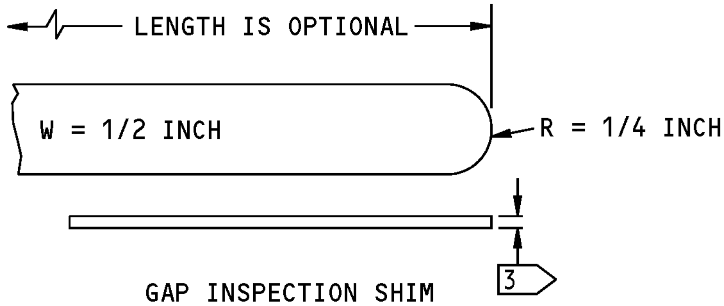
B



LOCKING RING FLASH POSITION (BACR15FP AND BACR15FR)

C

Installation of Blind Bolts and Blind Rivets
Figure 9 (Sheet 3 of 5)

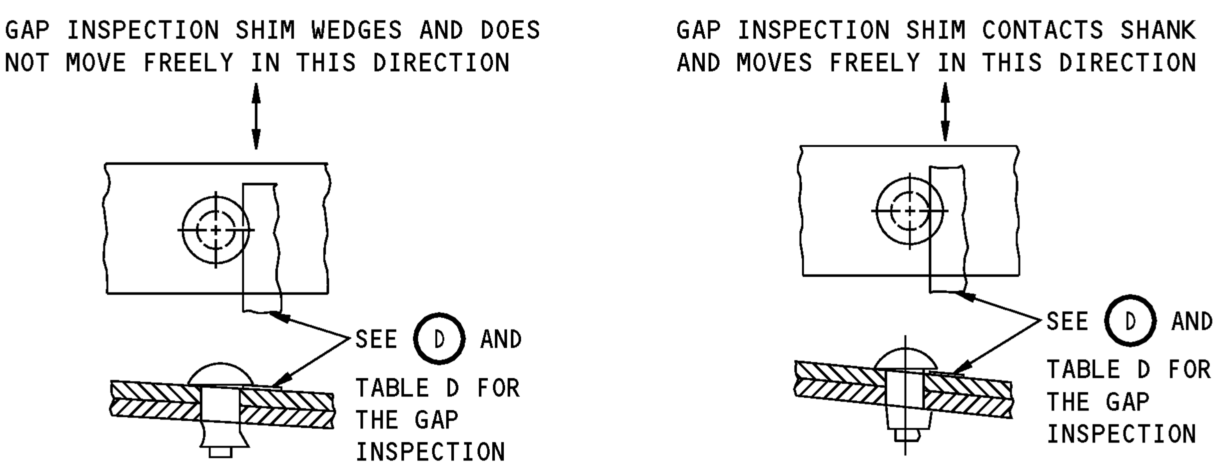


GAP INSPECTION SHIM

D

NOMINAL FASTENER DIAMETER (INCH)	SHIM THICKNESS T + 0.0005 - 0.0000
5/32	0.004
3/16	0.005
1/4	0.006
5/16	0.007
3/8	0.008
7/16	0.009
1/2	0.010

SHIM THICKNESS FOR BLIND BOLTS
TABLE D

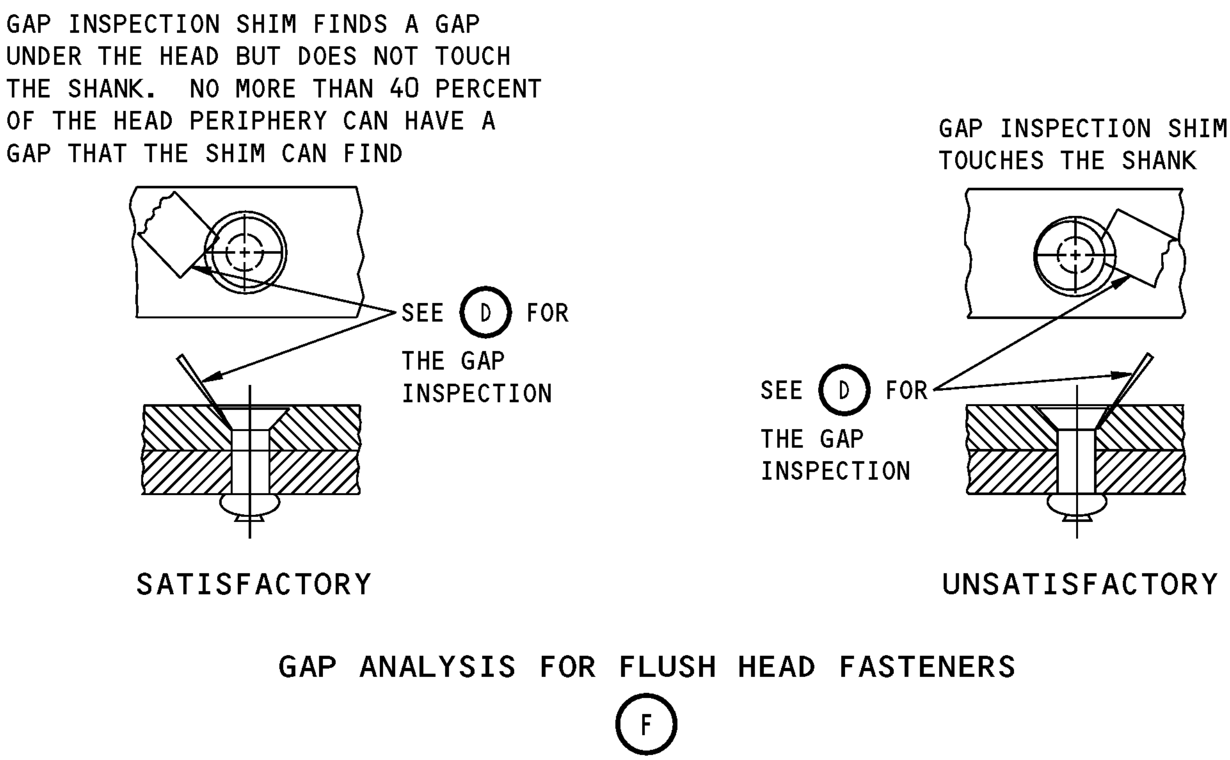


SATISFACTORY UNSATISFACTORY

GAP ANALYSIS FOR PROTRUDING HEAD FASTENERS

E

Installation of Blind Bolts and Blind Rivets
Figure 9 (Sheet 4 of 5)



Installation of Blind Bolts and Blind Rivets
Figure 9 (Sheet 5 of 5)

BLIND RIVET REMOVAL INSTRUCTIONS

1. For fasteners installed in thick material, remove the lock by driving out the rivet stem with a tapered steel drift pin. See Detail A.

   NOTE: If the rivets were installed in thin sheets, driving out the locked stem may cause damage to the sheets. The recommended procedure is to use a small drill as a guide for a larger drill on top of the rivet stem, and the tapered portion of the stem to drill and destroy the lock.

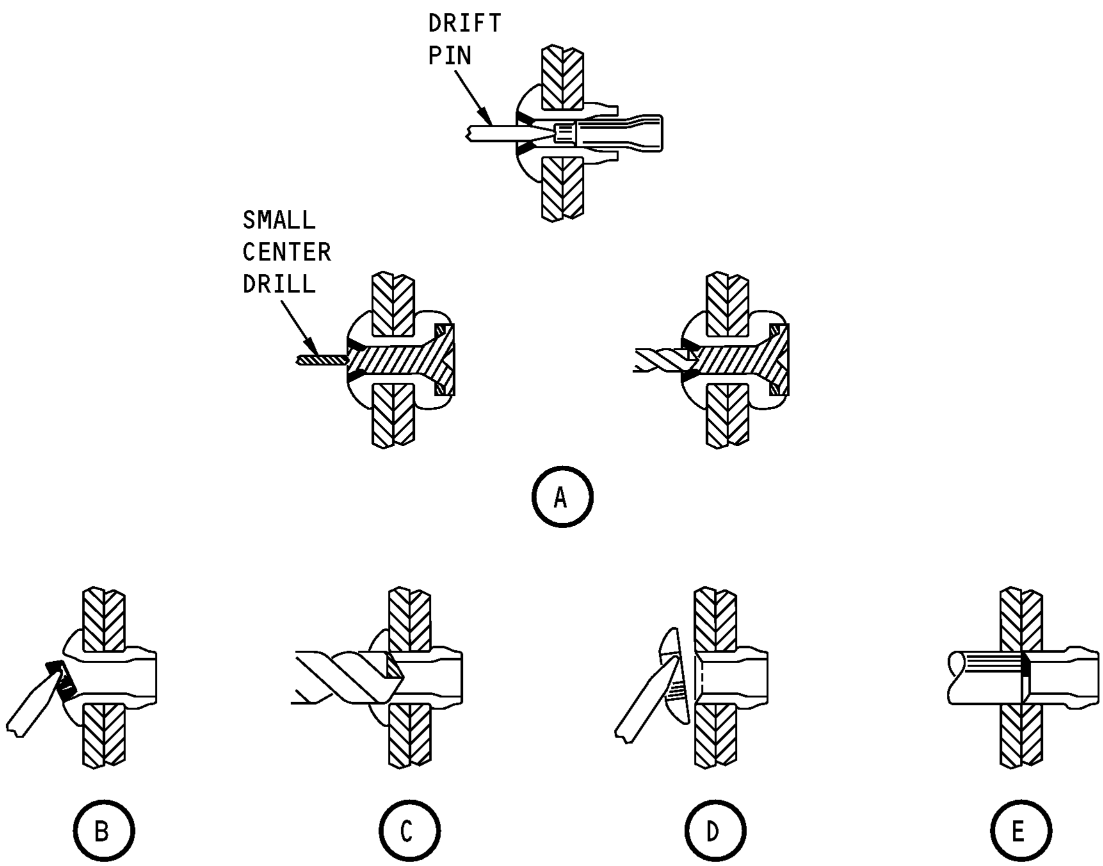
2. Pry the rest of the locking collar out of the rivet head with the drift pin. See Detail B.

   CAUTION: DO NOT DRILL COMPLETELY THROUGH THE RIVET SLEEVE TO REMOVE THE RIVET. IF YOU DO, DAMAGE WILL OCCUR FROM AN ENLARGED HOLE.

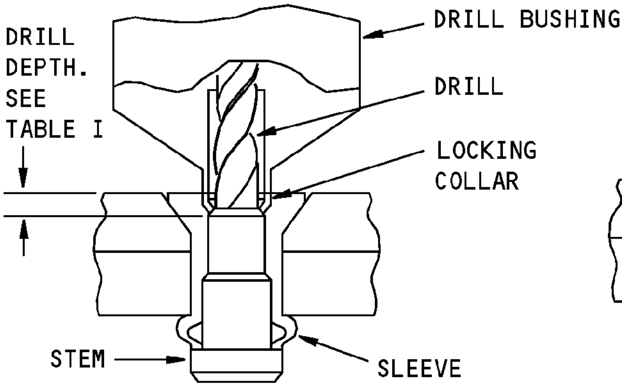
3. Drill (nearly completely) through the head of the rivet with a drill that is the same size as the rivet shank. See Detail C.

4. Break off the rivet head. Use the drift pin as a pry tool. See Detail D.

5. Drive out the rivet shank that remains with a pin that has the same diameter as the rivet shank. See Detail E.

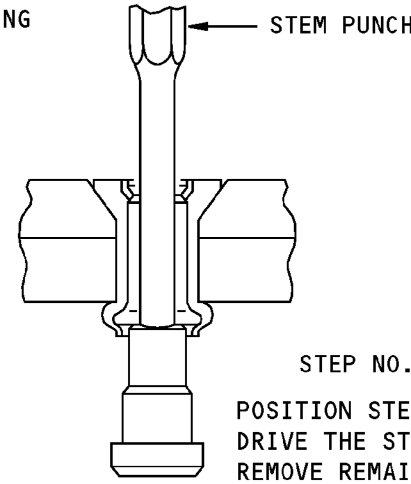


Removal of Blind Rivets
Figure 10



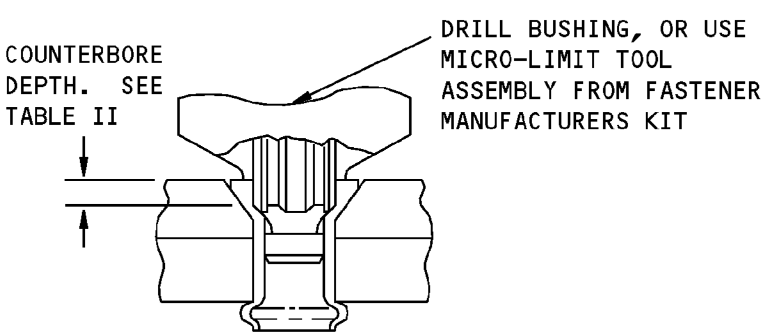
STEP NO. 1

PLACE DRILL BUSHING SQUARELY ON THE LOCKING COLLAR AND DRILL THE STEM TO THE DEPTH SHOWN IN TABLE A



STEP NO. 2

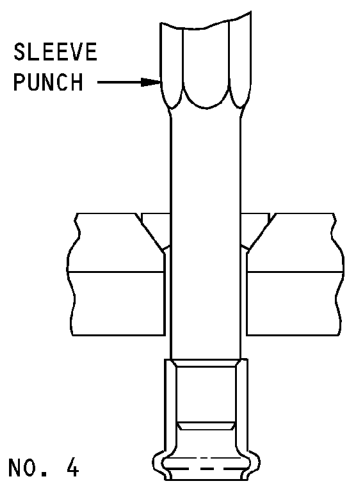
POSITION STEM PUNCH AND DRIVE THE STEM OUT. REMOVE REMAINING PORTION OF LOCKING COLLAR



STEP NO. 3

COUNTERBORE SLEEVE TO THE DEPTH SHOWN IN TABLE B

NOTE: WHEN USING DRILL BUSHING, ENSURE THAT CONCENTRICITY IS MAINTAINED WITH DIAMETER OF BOLT



STEP NO. 4

CAREFULLY POSITION SLEEVE PUNCH AND DRIVE OUT THE SLEEVE. TILT THE PUNCH SLIGHTLY AND REMOVE FASTENER HEAD

NOMINAL BOLT DIA	DRILL DEPTH
5/32	0.070/0.050
3/16	0.090/0.070
1/4	0.110/0.090
5/16	0.130/0.110
3/8	0.150/0.130

TABLE A

NOMINAL BOLT DIA	COUNTERBORE DEPTH	
	PROTRUDING HEAD	FLUSH HEAD
5/32	0.065/0.055	0.067/0.057
3/16	0.130/0.120	0.075/0.065
1/4	0.135/0.125	0.100/0.090
5/16	0.136/0.126	0.132/0.122
3/8	0.200/0.190	0.160/0.150

TABLE B

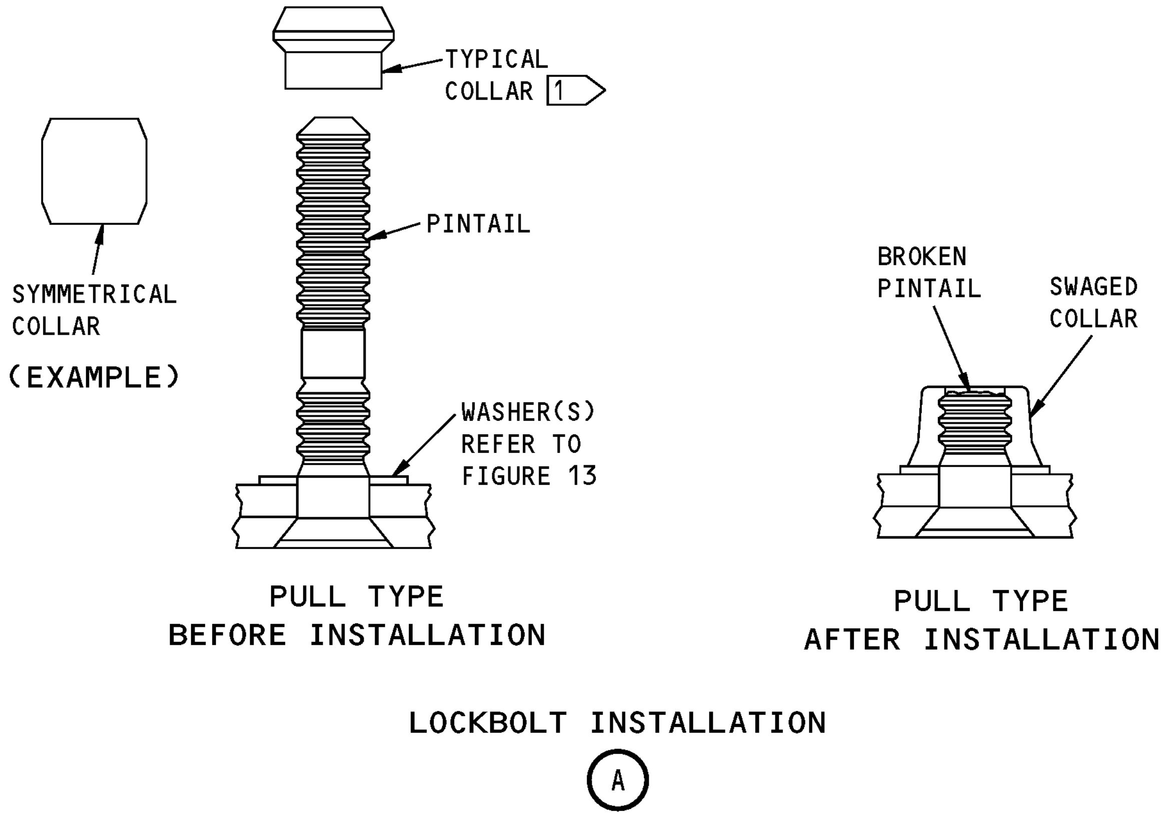
Blind Bolt Removal
Figure 11

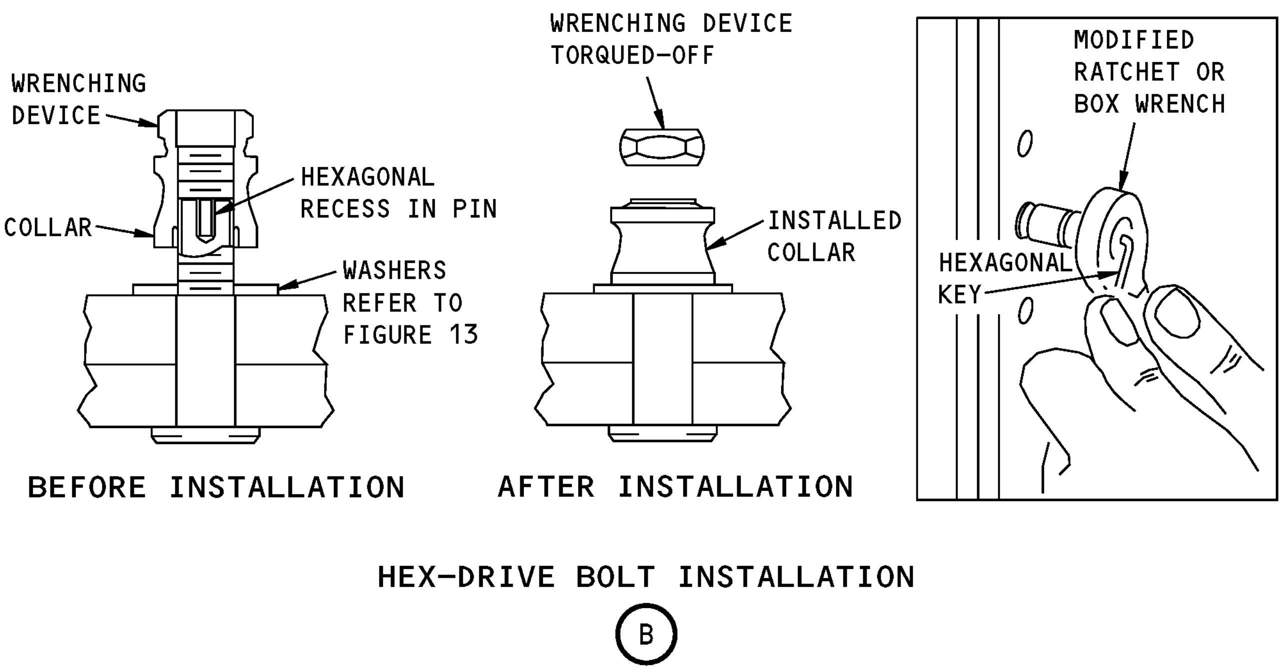
NOTES

- THE SOURCE OF INFORMATION FOR THIS FIGURE CAN BE FOUND IN BOEING PROCESS SPECIFICATION BAC 5004-2.
- SEE DETAIL A FOR LOCKBOLT INSTALLATION.
- SEE DETAILS B AND C FOR HEX-DRIVE BOLT INSTALLATION.
- PULL-TYPE, SHEAR, LIGHTWEIGHT TITANIUM LOCKBOLTS MUST BE INSTALLED WITH TOOLS THAT ARE FITTED WITH SWAGE DIES AS SHOWN IN TABLE A AND DETAIL D (OR EQUIVALENT TOOLS).
- SEE TABLE B AND DETAIL E FOR HEAD DISHING SPECIFICATIONS.
- SEE TABLE C AND DETAILS F AND G FOR GAP ANALYSIS.
- REFER TO FIGURE 13 FOR WASHER INSTALLATION.
- REFER TO FIGURE 14 FOR PIN PROTRUSION AND COLLAR LIMITS.
- COLLARS WITH SELF RETAINING FEATURES (FOR EXAMPLE: BACC30BK()R AND BACC30BF()R MUST BE POINTED SO THAT THE RETAINING FEATURE POINTS AWAY FROM THE STRUCTURE. DO NOT USE THESE COLLARS INSIDE OF FUEL TANKS.
- PULL-TYPE SHEAR AND TENSION STANDARD LOCKBOLTS MUST BE INSTALLED WITH PULL TOOLS FITTED WITH SWAGE DIES HAVING ST10-1027G, (OR EQUIVALENT), CAVITY CONFIGURATION.

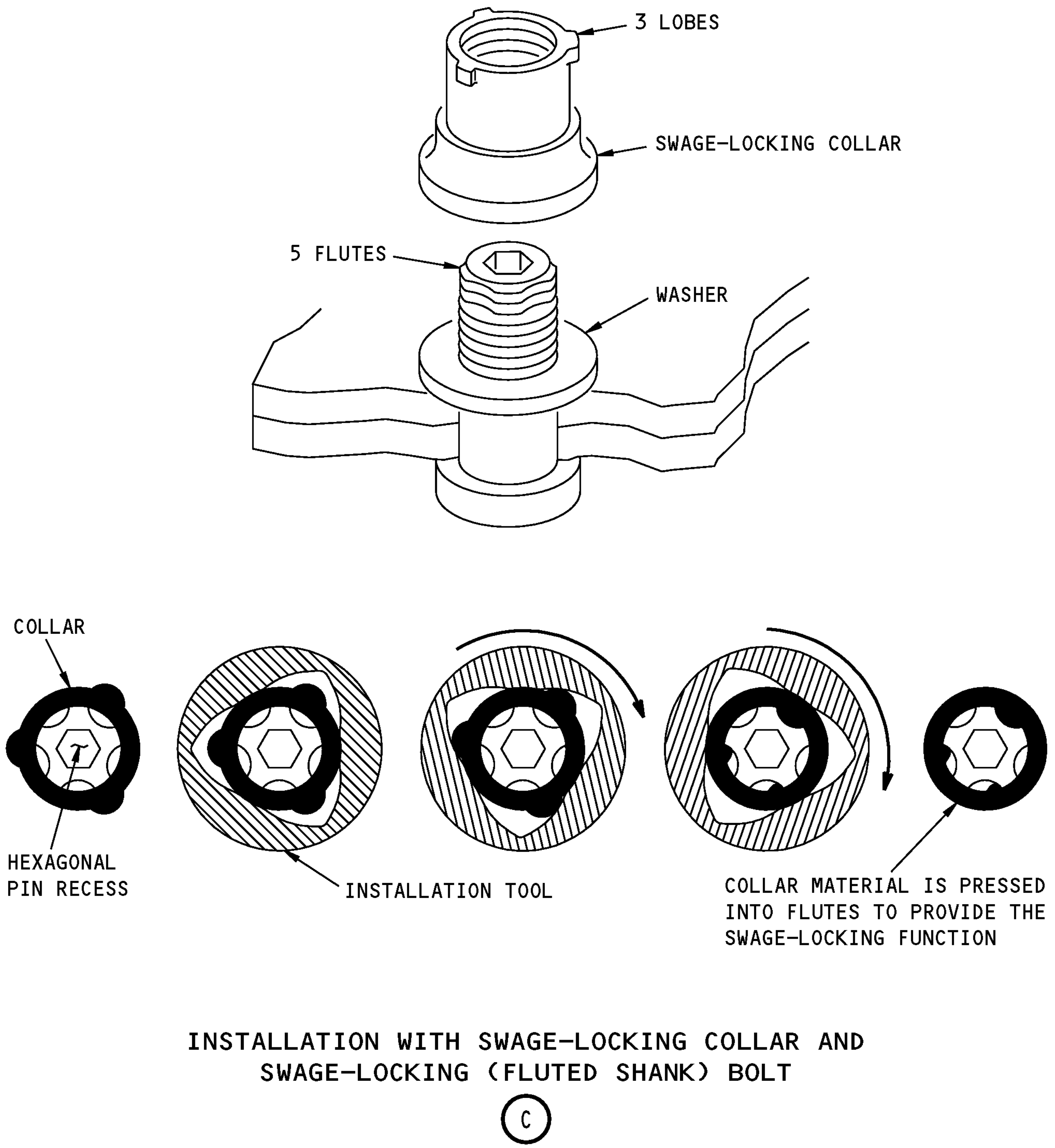
1 TYPICAL COLLARS ARE NOT SYMMETRICAL AND MUST BE INSTALLED AS SHOWN IN DETAIL A. IF THE COLLAR IS SYMMETRICAL IN SHAPE, IT WILL NOT BE IMPORTANT WHICH END IS AGAINST THE STRUCTURE. EXAMPLES OF SYMMETRICAL COLLARS ARE: BACC30BE, BACC30BF, BACC30L, BACC30K, BACC30BK, NAS1080C04, NAS1080C05, NAS1080E04, NAS1080E05, NAS1080MG04, NAS1080MG05, AND NAS1080K.

Lockbolt and Hex-Drive Bolt Installation
Figure 12 (Sheet 1 of 7)

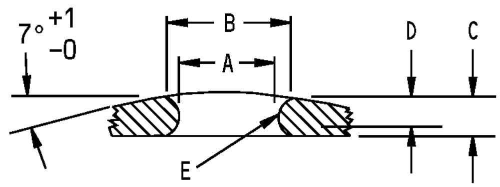




Lockbolt and Hex-Drive Bolt Installation
Figure 12 (Sheet 2 of 7)



Lockbolt and Hex-Drive Bolt Installation
Figure 12 (Sheet 3 of 7)



LIGHTWEIGHT LOCKBOLT SWAGE DIE DIMENSIONS

D

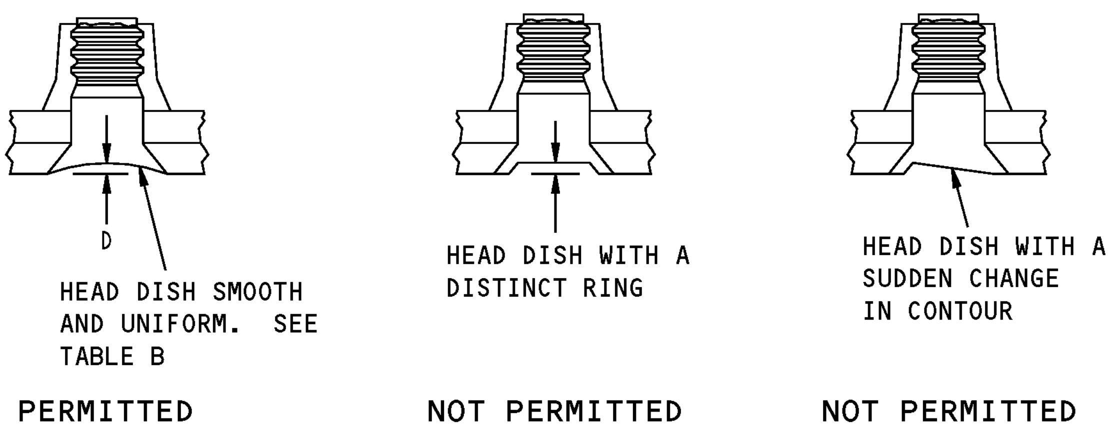
NOMINAL DIAMETER	A +0.0010 -0.0000	B +0.0030 -0.0000	C +0.0015 -0.0005	D REFERENCE	E +0.0010 -0.0000 RADIUS
5/32	0.2219	0.2580	0.103	0.0661	0.121
3/16	0.2450	0.2813	0.120	0.0670	0.130
1/4	0.3241	0.3722	0.157	0.0928	0.188
5/16	0.4062	0.4667	0.195	0.1201	0.250
3/8	0.4797	0.5525	0.233	0.1469	0.311

LIGHTWEIGHT LOCKBOLT SWAGE DIE DIMENSIONS (INCH)
TABLE A

Lockbolt and Hex-Drive Bolt Installation
Figure 12 (Sheet 4 of 7)

FASTENER TYPE	FASTENER MATERIAL	NOMINAL DIAMETER	D (MAX)
PULL TYPE SHEAR HEAD LOCKBOLTS	ALUMINUM AND ALLOY STEEL	3/16	0.012
		1/4	0.012
		5/16	0.010
		3/8 AND LARGER	0.007
	A286 CRES	ALL	0.008
PULL-TYPE TENSION HEAD LOCKBOLTS	TITANIUM	ALL	0.004
ALL OTHERS	ALL	ALL	0.004

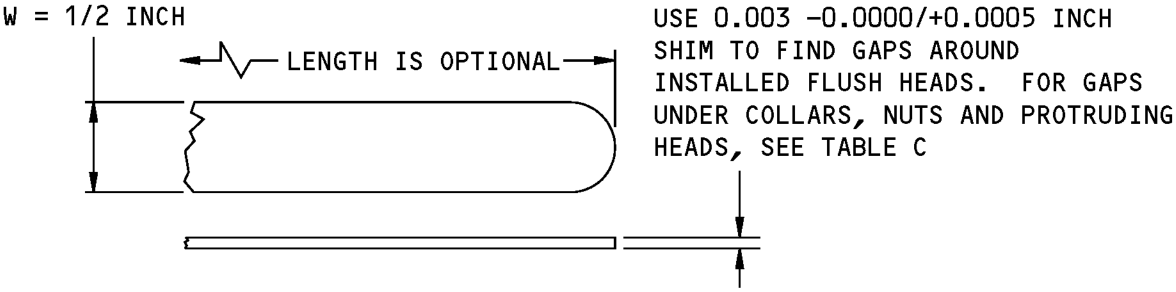
FASTENER HEAD DISH LIMITS
TABLE B



HEAD DISHING LIMITATIONS FOR FLUSH
HEAD LOCKBOLTS AND HEX-DRIVE BOLTS

E

Lockbolt and Hex-Drive Bolt Installation
Figure 12 (Sheet 5 of 7)

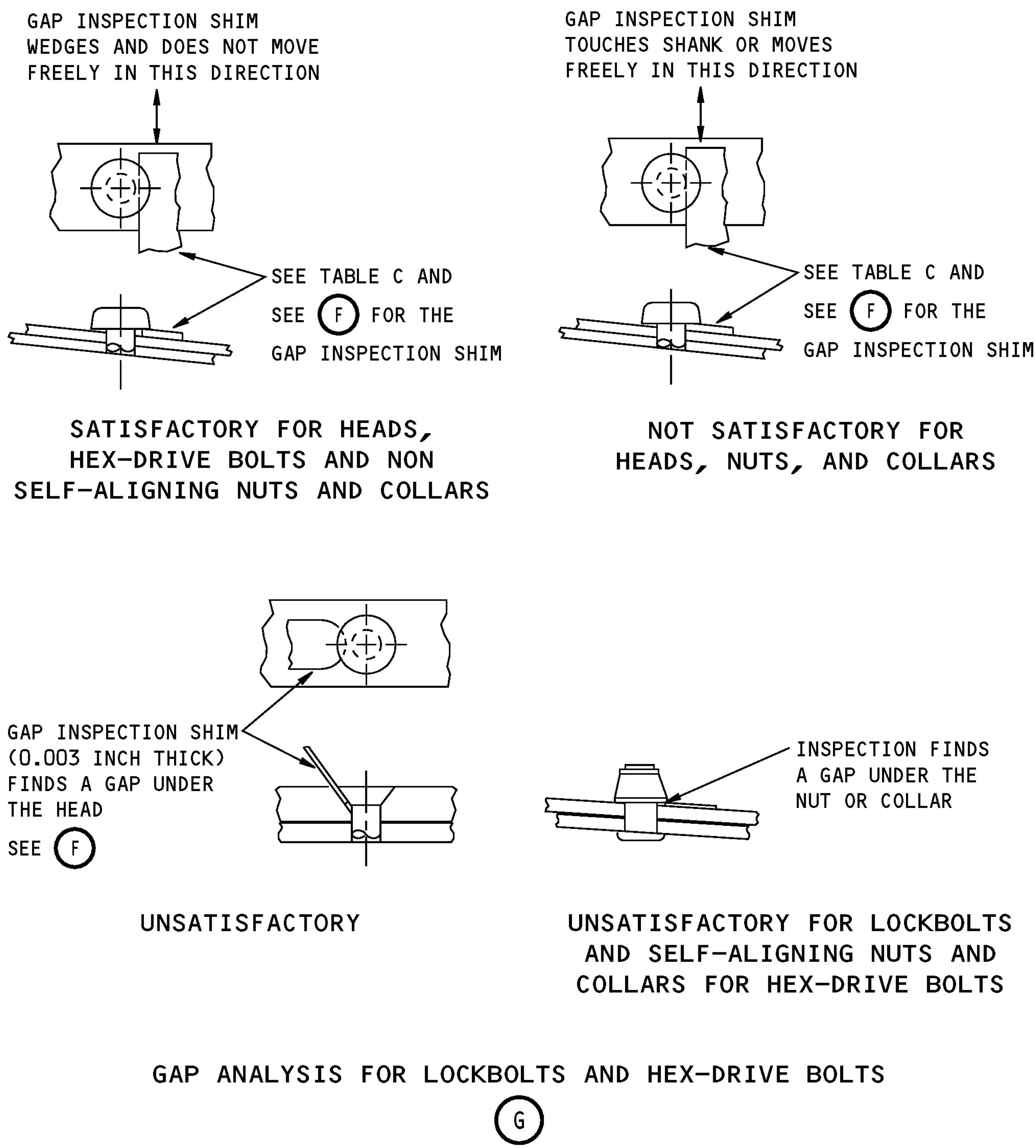


GAP INSPECTION SHIM
F

NOMINAL FASTENER DIAMETER		SHIM THICKNESS +0.0005 -0.0000
5/32	0.164	0.004
3/16	0.190	0.005
1/4	0.250	0.006
5/16	0.313	0.007
3/8	0.375	0.008
7/16	0.438	0.009
1/2	0.500	0.010
9/16	0.563	0.011
5/8	0.625	0.013
3/4	0.750	0.015
7/8	0.875	0.017
1	1.000	0.019

SHIM STOCK SIZE FOR COLLARS, NUTS AND PROTRUDING HEADS OF LOCKBOLTS AND HEX-DRIVE FASTENERS
TABLE C

Lockbolt and Hex-Drive Bolt Installation
Figure 12 (Sheet 6 of 7)



Lockbolt and Hex-Drive Bolt Installation
Figure 12 (Sheet 7 of 7)

NOTES

- THE SOURCE OF INFORMATION FOR THIS FIGURE CAN BE FOUND IN BOEING PROCESS SPECIFICATION BAC 5004-2.
- SEE DETAILS A AND B FOR WASHER LIMITATIONS.

1 SEE TABLE A FOR THE CORRECT WASHER MATERIAL. SEE TABLE B FOR WASHER PART NUMBERS.

2 DO NOT USE MORE THAN TWO WASHERS UNDER A LOCKBOLT COLLAR. (THIS INCLUDES THE CORROSION PROTECTION WASHER). SEE DETAILS C AND D FOR ADDITIONAL INFORMATION ON WASHERS USED WITH LOCKNUTS AND HEX-DRIVE BOLTS.

3 ALUMINUM WASHERS MUST BE ALODINE COATED AS GIVEN IN SRM 51-20-01.

4 LOCATE CORROSION PROTECTION WASHER NEXT TO STRUCTURE WHEN A SECOND WASHER IS USED FOR GRIP ADJUSTMENT (EXCEPT AS NOTED).

5 LOCATE GRIP ADJUSTMENT WASHER NEXT TO COLLAR WHEN USED WITH A CORROSION PROTECTION WASHER.

6 USE AN UNPLATED CRES WASHER NEXT TO STRUCTURE AND A CADMIUM PLATED CRES WASHER NEXT TO COLLAR.

7 A MAXIMUM OF TWO WASHERS IS ALLOWED UNDER COLLAR.

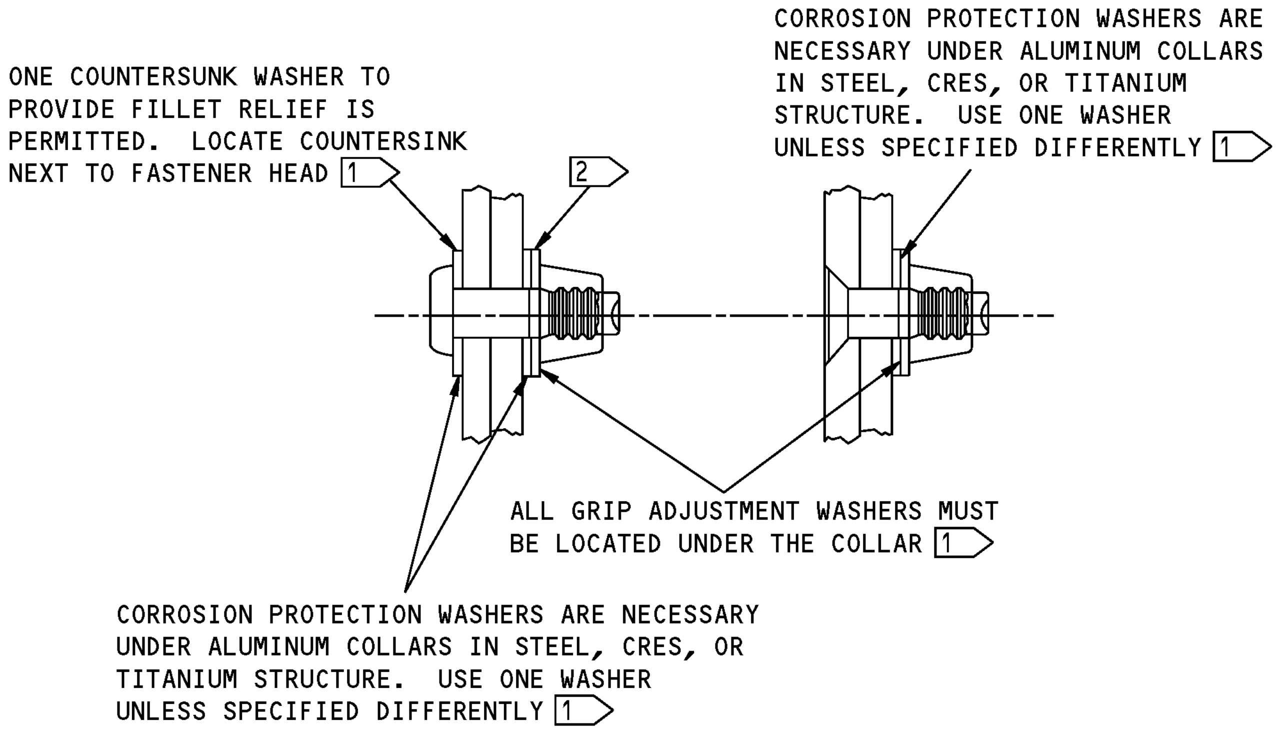
8 FOR MAXIMUM HEAD DISHING (D) ALLOWED SEE TABLE B.

9 5052 ALUMINUM WASHER IS MANDATORY UNDER PROTRUDING FASTENER HEAD IF HEAD END BEARS ON MAGNESIUM.

10 CADMIUM PLATED WASHER MUST NOT COME IN CONTACT WITH THE TITANIUM STRUCTURE. IT IS TO BE USED BETWEEN THE CRES UNPLATED WASHER AND THE ALUMINUM COLLAR OR NUT.

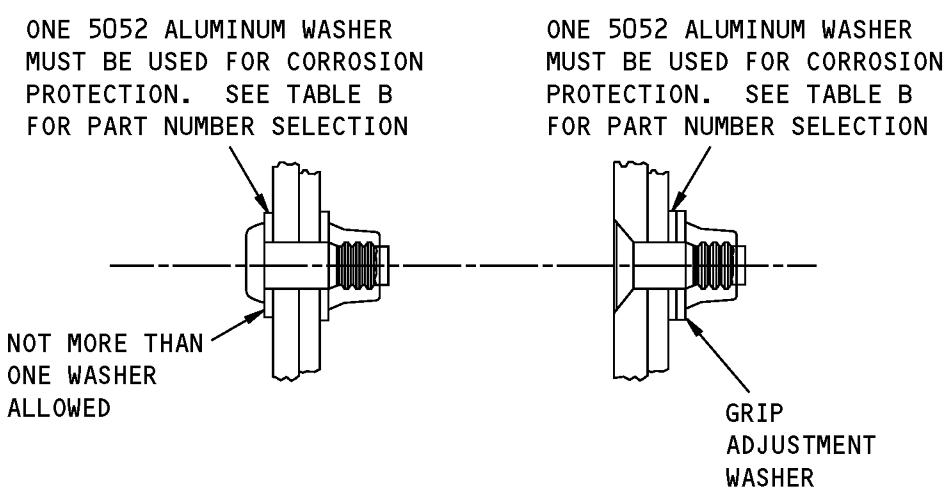
11 DO NOT USE ALUMINUM WASHERS WITH NON-ALUMINUM TENSION FASTENERS. (EXAMPLE: BACB30NX/NY BOLTS WITH BACC30BH OR BACC30X COLLARS)

Washers with Lockbolts and Hex-Drive Bolts
Figure 13 (Sheet 1 of 5)



WASHER LIMITATIONS FOR STEEL, ALUMINUM, AND TITANIUM STRUCTURES

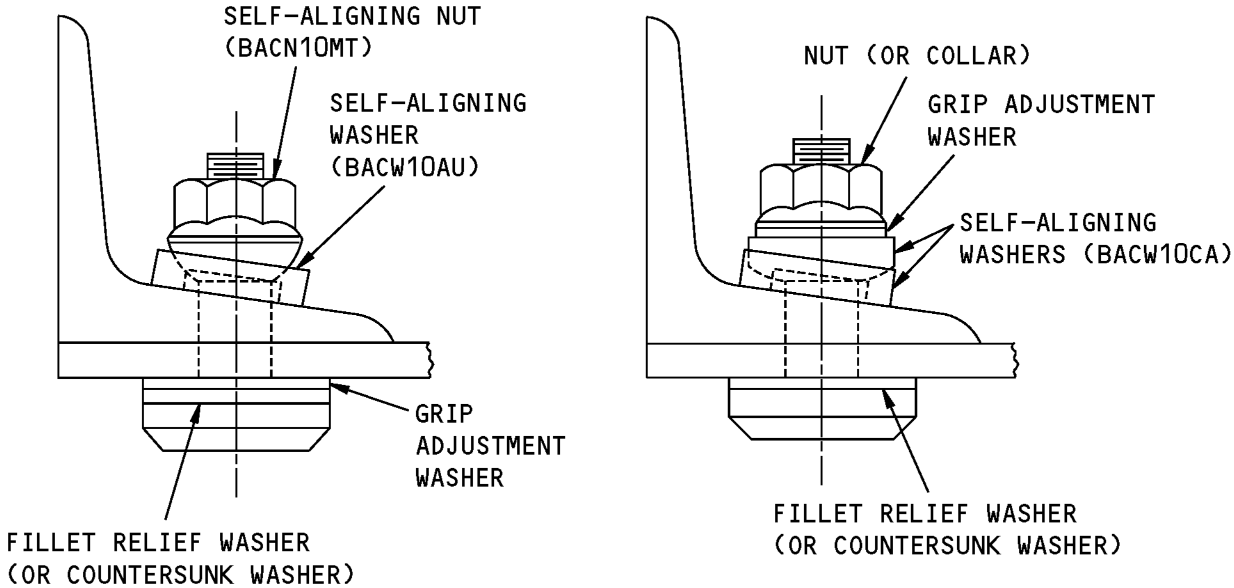
A



WASHER LIMITATIONS FOR MAGNESIUM STRUCTURES

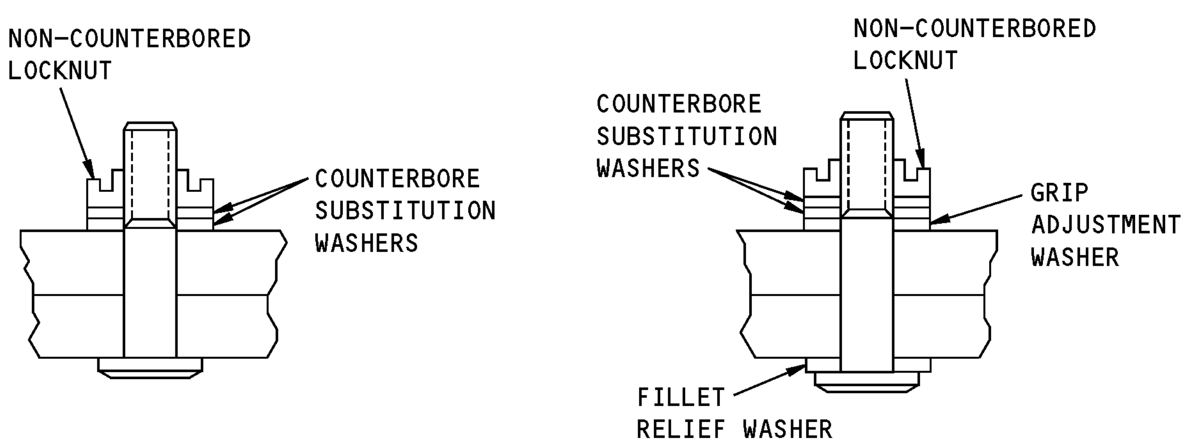
B

Washers with Lockbolts and Hex-Drive Bolts
Figure 13 (Sheet 2 of 5)



USE OF WASHERS WITH SELF-ALIGNING
NUTS AND SELF-ALIGNING WASHERS

C



USE OF COUNTERBORE SUBSTITUTION WASHERS

D

Washers with Lockbolts and Hex-Drive Bolts
Figure 13 (Sheet 3 of 5)

COLLAR OR NUT MATERIAL	STRUCTURE MATERIAL	CORROSION PROTECTION WASHER MATERIAL [4] [7] (MANDATORY)	COUNTERBORE SUBSTITUTION OR GRIP ADJUSTMENT WASHER MATERIAL [5] [7]	FILLET RELIEF WASHER (LOCATE NEXT TO STRUCTURE)	SELF-ALIGNING WASHER (LOCATE NEXT TO STRUCTURE)
ALUMINUM	ALUMINUM	NONE	2024 AL [3] OR CAD PLATED CRES	2024 OR 7075	CAD PLATED CRES
	STEEL	CAD PLATED CRES	2024 AL [3] OR CAD PLATED CRES	CAD PLATED CRES	CAD PLATED CRES
	CRES	CAD PLATED CRES	2024 AL [3] OR CAD PLATED CRES	UNPLATED CRES	CAD PLATED CRES [10]
	TITANIUM	[6] [10]	2024 AL [3] OR CAD PLATED CRES	UNPLATED CRES	CAD PLATED CRES [10]
	MAGNESIUM	5052 AL [9]	2024 AL [3]	5052 AL [9]	---
CAD PLATED STEEL, CAD PLATED CRES, OR CAD PLATED NICKEL-COPPER ALLOY	ALUMINUM	NONE	2024 AL [3] OR CAD PLATED CRES	2024 OR 7075 AL OR CAD PLATED CRES	CAD PLATED CRES
	STEEL	NONE	UNPLATED CRES	UNPLATED CRES	CAD PLATED CRES
	CRES	NONE	UNPLATED CRES	UNPLATED CRES	CAD PLATED CRES
	TITANIUM	UNPLATED CRES	UNPLATED CRES	UNPLATED CRES	---
	MAGNESIUM	5052 AL [9]	2024 AL [3] OR CAD PLATED CRES	5052 AL [9]	---
UNPLATED CRES OR UNPLATED NICKEL-COPPER ALLOY	ALUMINUM	CAD PLATED CRES	CAD PLATED CRES	2024 OR 7075 AL OR CAD PLATED CRES	CAD PLATED CRES
	STEEL	CAD PLATED CRES	CAD PLATED CRES	CAD PLATED CRES	CAD PLATED CRES
	CRES	NONE	UNPLATED CRES	UNPLATED CRES	UNPLATED CRES
	TITANIUM	NONE	UNPLATED CRES	UNPLATED CRES	UNPLATED CRES
	MAGNESIUM	5052 AL [9]	CAD PLATED CRES	5052 AL [9]	---

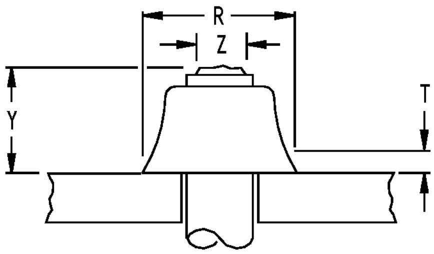
WASHER MATERIAL [11]
TABLE A

Washers with Lockbolts and Hex-Drive Bolts
Figure 13 (Sheet 4 of 5)

PLAIN WASHER MATERIAL	WASHER PART NUMBERS (REF)			
	NOMINAL	0.0156 O.S.	0.0312 O.S.	0.0468 O.S.
STEEL OR CRES CAD PLATED	NAS1149E()P BACW10BN()SP	BACW10BP()1DP BACW10BP()1DPN	BACW10BP()2DP BACW10BP()2DPU	USE NEXT LARGER STANDARD SIZE
2024 ALUMINUM	BACW10BN()AP NAS1149D()J	BACW10AW()AS BACW10AW()AST BACW10BN()1AP	BACW10AW()AS BACW10AW()AST BACW10BN()2AP	BACW10AW30()AS BACW10AW30()AST
5052 ALUMINUM	BACW10BN()ANP NAS620A() NAS1197-()	BACW10AW()AN BACW10AW()ANT BACW10BN()1ANP	BACW10AW10()AN BACW10AW10()ANT BACW10BN()2ANP	BACW10AW30()AN BACW10AW30()ANT
CRES UNPLATED	BACW10BN()UP BACW10BP()APU BACW10BP()PTU NAS620C() NAS1149E()R	BACW10BP()1APU BACW10BP()1PTU	BACW10BP()2APU BACW10BP()2PTU	USE NEXT LARGER STANDARD SIZE
COUNTERSUNK WASHER MATERIAL	WASHER PART NUMBERS (REF)			
	NOMINAL	0.0156 O.S.	0.0312 O.S.	0.0466 O.S.
STEEL OR CRES CAD PLATED	BACW10CT()C	BACW10CT()1C	BACW10CT()2C	USE NEXT LARGER STANDARD SIZE.
2024 OR 7075 ALUMINUM	BACW10CT()D BACW10CT()J	BACW10AW-C()AS BACW10CT()1J	BACW10AW-C10()AS BACW10CT()2D BACW10CT()2J	BACW10AW-C30()AS
5052 ALUMINUM	BACW10BN()ANC	BACW10AW-C()AN	BACW10AW-C10()AN	BACW10AW-C30()AN
CRES UNPLATED	BACW10CT()CU	BACW10()1CU	BACW10CT()2CU	USE NEXT LARGER STANDARD SIZE

WASHER PART NUMBER REFERENCE 11
TABLE B

Washers with Lockbolts and Hex-Drive Bolts
Figure 13 (Sheet 5 of 5)



R = SWAGED COLLAR REFERENCE DIAMETER

T = MAXIMUM HEIGHT OF R DIAMETER ABOVE SHEET OR WASHER.

Y = PIN PROTRUSION-HEIGHT OF Z DIAMETER ABOVE SHEET OR WASHER.

Z = REFERENCE DIAMETER LOCATES MEASURING POINT FOR Y.

TENSION, PULL TYPE
LOCKBOLTS AND COLLARS
A 1

NOTES

- THE SOURCE OF INFORMATION FOR THIS FIGURE IS FOUND IN BOEING PROCESS SPECIFICATION BAC5004-2.
- SEE DETAIL A FOR LOCKBOLTS.
- SEE DETAILS F AND G FOR HEX-DRIVE BOLTS.

1 SEE TABLE A FOR LIGHTWEIGHT LOCKBOLTS AND TABLE B FOR TENSION, PULL TYPE LOCKBOLTS.

2 SEE DETAIL C FOR HG85-10, HG99-(), AND HG100-().

3 BOTH ENDS OF THE GAGE MUST ACCEPT.

4 PIN PROTRUSION IS MEASURED FROM THE STRUCTURE SURFACE WHEN COUNTERBORE SUBSTITUTION WASHERS ARE USED OR WHEN NO GRIP ADJUSTMENT WASHER IS PRESENT, AND FROM THE COLLAR/NUT SIDE SURFACE OF GRIP ADJUSTMENT WASHER(S) WHERE THESE WASHERS ARE USED. SEE TABLE D.

5 IF SELF-ALIGNING NUTS (EXAMPLE: BACN10MT) ARE USED ON SLOPED SURFACES, MEASURE PROTRUSION AS SHOWN. PIN PROTRUSION IS MEASURED FROM THE TOP OF SELF-ALIGNING WASHERS (EXAMPLE: BACW10CA) IF USED UNDER COLLAR OR NUT. SEE TABLE D.

6 PIN PROTRUSION IS MEASURED FROM THE PIN END ABOVE THE SHEET OR WASHER. SEE TABLE E.

7 THESE GAGES CAN BE PURCHASED FROM:

FAIRCHILD AEROSPACE FASTENER DIVISION
CHATSWORTH OPERATIONS
9631 DESOTO AVE.
CHATSWORTH, CA 91311-5013

Pin and Collar Limits for Installed Lockbolts and Hex-Drive Bolts
Figure 14 (Sheet 1 of 16)

LOCKBOLT PART NO.	COLLAR PART NO.	Y		Z	R	T		GAGE NO.
		TOUCH GO	TOUCH NO GO			TOUCH GO	TOUCH NO GO	
BACB30VM5 BADB30VN5	BACC30BK5 (2024-T4)	0.131	0.237	0.124	0.234	0.039	0.112	HG110-05
BACB30VM6 BACB30VN6 BACB30XT6	BACC30BK6 (2024-T4)	0.134	0.250	0.152	0.262	0.031	0.113	HG110-06
BACB30VM8 BACB30VN8 BACB30XT8	BACC30BK8 (2024-T4)	0.193	0.301	0.209	0.344	0.058	0.139	HG110-08
BACB30VM10 BACB30VN10 BACB30XT10	BACC30BK10 (2024-T4)	0.252	0.367	0.259	0.436	0.072	0.145	HG110-10
BACB30VM12 BACB30VN12 BACB30XT12	BACC30BK12 (2024-T4)	0.304	0.419	0.322	0.512	0.103	0.172	HG110-12

LIGHTWEIGHT LOCKBOLT INSPECTION DIMENSION
TABLE A

Pin and Collar Limits for Installed Lockbolts and Hex-Drive Bolts
Figure 14 (Sheet 2 of 16)

LOCKBOLT PART NO.	COLLAR PART NO.	Y	Z	R	T	GAGE NO.
BACB30GP5 BACB30GQ5 NAS1525 NAS1535 (7075-T6)	NAS1080D05 (6061-T7)	0.230 0.167	0.136	0.253	0.030	HG85-7 ST8711D-5
BACB30DX5 BACB30DY5 NAS1465 NAS1475 (STEEL)	NAS1080R05 (STEEL) NAS1080-05 (2024-T4) NAS1080MG05 (NICKEL-COPPER ALLOY)	0.234 0.161	0.136	0.253	0.037	HG85-12 ST8711S-5
BACB30UA6 BACB30UB6 (TITANIUM)	BACC30BF6 (2024-T42)	0.406 0.271	0.160	0.285	0.095	HG100-06 ST8707A-06
BACB30GP6 BACB30GQ6 NAS1526 NAS1536 (7075-T6)	NAS1080D06 (6061-T7	0.280 0.208	0.164	0.303	0.039	HG85-10 ST8711H-6
BACB30DX6 BACB30DY6 BACB30GX6 NAS1466 (STEEL)	NAS1080R06 (STEEL) BACC30Q6 NAS1080-06 (2024-T4)	0.280 0.208	0.164	0.303	0.039	HG85-10 ST8711H-6

STANDARD TENSION, PULL TYPE LOCKBOLT INSPECTION DIMENSION
TABLE B

Pin and Collar Limits for Installed Lockbolts and Hex-Drive Bolts
Figure 14 (Sheet 3 of 16)

LOCKBOLT PART NO.	COLLAR PART NO.	Y	Z	R	T	GAGE NO.
BACB30TY6 BACB30TZ6	BACC30BE6 (2024-T73)	0.343 0.228	0.160	0.285	0.094	HG99-06 ST8728B-06
BACB30AU8 (BLIND)	NONE	0.280 0.208	0.164	0.303	0.039	HG85-10 ST8711H-6
BACB30UA8 BACB30UB8 (TITANIUM)	BACC30BF8 (2024-T42)	0.487 0.349	0.214	0.380	0.120	HG100-08 ST8707A-08
BACB30GP-8 BACB30GQ-8 NAS1528 NAS1538 (7075-T6)	NAS1080D08 (6061-T7)	0.374 0.295	0.224	0.400	0.038	HG85-2 ST8711DS-8
BACB30DX8 BACB30DY8 BACB30GX8 NAS1468 NAS1478 (STEEL)	NAS1080R08 (STEEL) BACC30Q8 NAS1080-08 (2024-T4)	0.374 0.295	0.224	0.400	0.038	HG85-2 ST8711DS-8
BACB30TY-8 BACB30TZ-8 (TITANIUM)	BACC30BE8 (2024-T73)	0.411 0.289	0.214	0.380	0.121	HG99-08 ST8728-B-08
BACB30AU10 (BLIND)	NONE	0.374 0.295	0.224	0.400	0.038	HG85-2 ST8711DS-8
BACB30UA10 BACB30UB10 (TITANIUM)	BACC30BF10 (2024-T42)	0.591 0.452	0.279	0.462	0.184	HG100-10 ST8707A-10

STANDARD TENSION, PULL TYPE LOCKBOLT INSPECTION DIMENSION
TABLE B (CONTINUED)

Pin and Collar Limits for Installed Lockbolts and Hex-Drive Bolts
Figure 14 (Sheet 4 of 16)

LOCKBOLT PART NO.	COLLAR PART NO.	Y	Z	R	T	GAGE NO.
BACB30GP10 BACB30GQ10 NAS1530 NAS1540 (7075-T6)	NAS1080D10 (6061-T7)	0.459 0.339	0.268	0.486	0.083	HG85-3 ST8711D-10
BACB30DX10 BACB30DY10	NAS1080P10 (2024-T4)	0.492 0.404	0.268	0.473	0.110	HG85-8 ST8711F-10
BACB30GX10 NAS1470 NAS1480 (STEEL)	NAS1080R10 (STEEL)	0.492 0.404	0.268	0.473	0.110	HG85-8 ST8711F-10
BACB30TY10 BACB30TZ10 (TITANIUM)	BACC30BE10 (2024-T73)	0.496 0.385	0.278	0.462	0.150	HG99-10 ST8728B-10
BACB30UA12 BACB308B12 (TITANIUM)	BACC30BF12 (2024-T42)	0.642 0.503	0.341	0.572	0.156	HG100-12 ST8707A-12
BACB30GP12 BACB30GQ12 NAS1532 NAS1542 (7075-T6)	NAS1080D12 (6061-T7)	0.549 0.411	0.339	0.602	0.062	HG85-4 ST8711D-12

STANDARD TENSION, PULL TYPE LOCKBOLT INSPECTION DIMENSION
TABLE B (CONTINUED)

Pin and Collar Limits for Installed Lockbolts and Hex-Drive Bolts
Figure 14 (Sheet 5 of 16)

LOCKBOLT PART NO.	COLLAR PART NO.	Y	Z	R	T	GAGE NO.
BACB30DX12 BACB30DY12 BACB30GX12 NAS1472 NAS1482 (STEEL)	NAS1080P12 (2024-T4) NAS1080R12 (STEEL)	0.604 0.507	0.339	0.576	0.120	HG85-9 ST8711F-12
BACB30TY12 BACB30TZ12 (TITANIUM)	BACC30BE12 (2024-T73)	0.531 0.420	0.339	0.572	0.146	HG99-12 ST8728-B-12

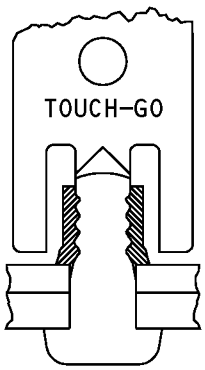
STANDARD TENSION, PULL TYPE LOCKBOLT INSPECTION DIMENSION
TABLE B (CONTINUED)

Pin and Collar Limits for Installed Lockbolts and Hex-Drive Bolts
Figure 14 (Sheet 6 of 16)

LOCKBOLT PART NO.	COLLAR PART NO.	Y	Z	R	T	GAGE NO.
BACB30GW6 BACB30GY6 BACB30LD6	BACC30K6 (2024-T4) NAS1080E06 (STEEL)	0.264 0.191	0.164	N/A	N/A	HG77-14A
BACB30GW8 BACB30GY8 BACB30LD8	BACC30K8 (2024-T4) NAS1080E08 (STEEL)	0.243 0.316	0.224	N/A	N/A	HG77-13A
BACB30GW10 BACB30GY10 BACB30LD10	BACC30K10 (2024-T4) NAS1080E10 (STEEL)	0.341 0.268	0.268	N/A	N/A	HG76-3
BACB30GW12 BACB30GY12 BACB30LD12	BACC30K12 (2024-T4) NAS1080E12 (STEEL)	0.390 0.319	0.339	N/A	N/A	HG77-17A

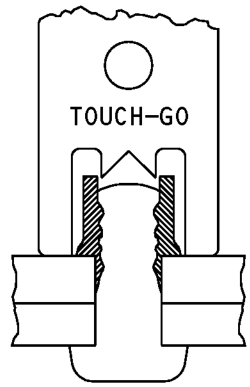
STANDARD SHEAR, PULL TYPE LOCKBOLT INSPECTION DIMENSION
TABLE C

Pin and Collar Limits for Installed Lockbolts and Hex-Drive Bolts
Figure 14 (Sheet 7 of 16)



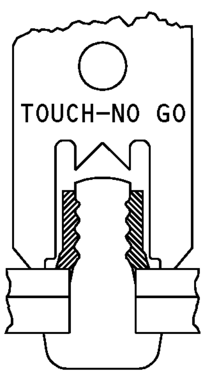
POINTS TOUCH PIN.
LEGS OF GAGE CLEAR
SHEET LINE. PIN
IS ACCEPTABLE

ACCEPT



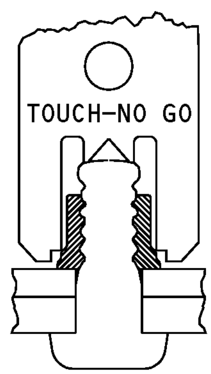
POINTS DO NOT TOUCH
END OF PIN. LEGS
OF GAGE TOUCH SHEET
LINE. PIN GRIP
LENGTH IS TOO SHORT

REJECT



POINTS A DO NOT
TOUCH PIN. LEGS
OF GAGE TOUCH SHEET
LINE. POINTS B DO
NOT TOUCH COLLAR.
PIN GRIP AND COLLAR
SWAGE IS ACCEPTABLE

ACCEPT



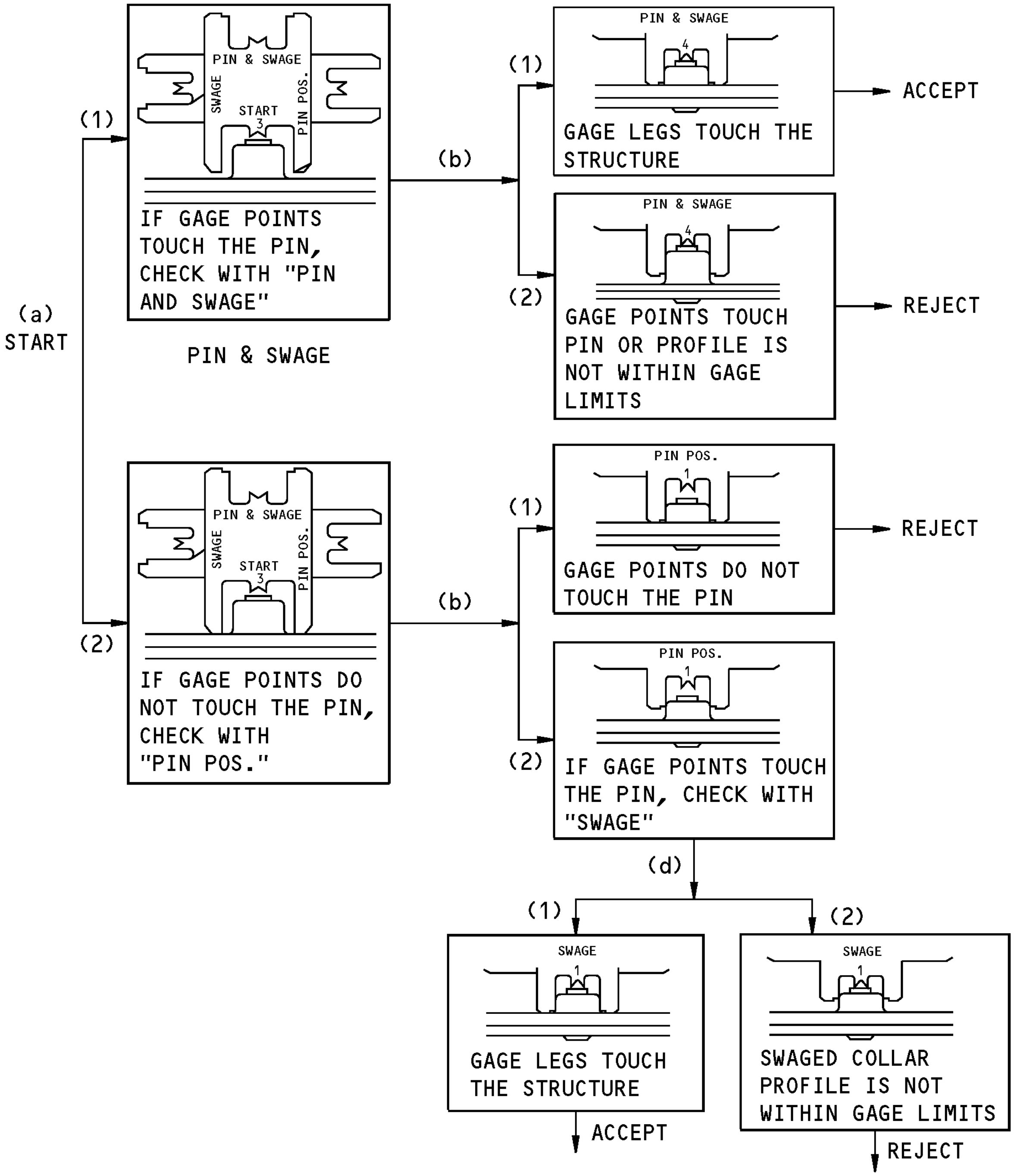
POINTS A TOUCH PIN.
LEGS OF GAGE CLEAR
SHEET LINE OR
POINTS B TOUCH
COLLAR. PIN GRIP
IS TOO LONG, COLLAR
NOT SWAGED ENOUGH

REJECT

USE OF GAGE HG85-() 2 3

B

Pin and Collar Limits for Installed Lockbolts and Hex-Drive Bolts
Figure 14 (Sheet 8 of 16)



USE OF HG85-10, HG99-(), AND HG100-()

C

Pin and Collar Limits for Installed Lockbolts and Hex-Drive Bolts
Figure 14 (Sheet 9 of 16)

STEP (a) START (USED TO CHECK LOCKBOLT PROTRUSION HEIGHT):

1. If gage points touch the pin, the protrusion height is between nominal (0.225) and maximum (0.280). Check for acceptance with PIN AND SWAGE (Step (b)).
2. If gage points do not touch the pin, the protrusion height is between nominal (0.225) and minimum (0.208). Check for minimum height with PIN POS. (Step (c)).

STEP (b) PIN AND SWAGE, (USED TO CHECK MINIMUM PROTRUSION HEIGHT AND SWAGED COLLAR PROFILE FOR NOMINAL TO MAXIMUM PROTRUSION HEIGHT INSTALLATION):

1. Accept the installation if gage legs touch the structure.
2. Reject if gage points touch the pin (protrusion too high) or if profile is not within limits.

STEP (c) PIN POSITION, (USED TO CHECK MINIMUM PROTRUSION HEIGHT):

1. Reject if gage points do not touch the pin (protrusion height shorter than minimum).
2. If gage points touch the pin, check swage profile with Swage (Step (d)).

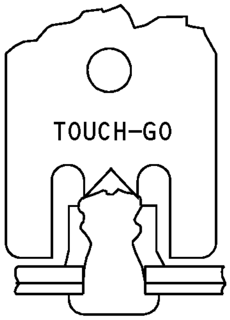
STEP (d) SWAGE, (USED TO CHECK SWAGED COLLAR PROFILE FOR PROTRUSION HEIGHT, NOMINAL TO MINIMUM INSTALLATION):

1. Accept the installation if gage legs touch the structure.
2. Reject if swaged collar profile is not within gage limits.

USE OF HG85-10, HG99-(), AND HG100-()

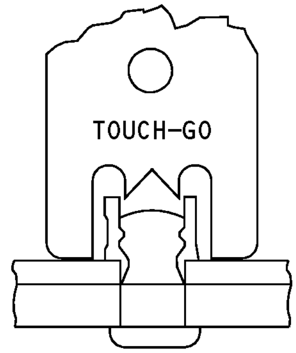
C (CONTINUED)

Pin and Collar Limits for Installed Lockbolts and Hex-Drive Bolts
Figure 14 (Sheet 10 of 16)



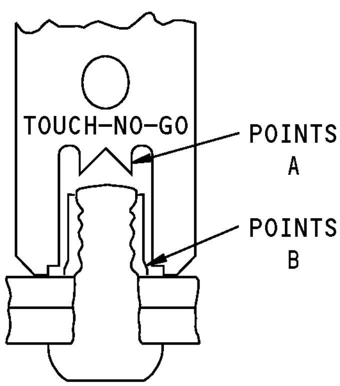
POINTS TOUCH PIN.
LEGS OF GAGE CLEAR
SHEET LINE. PIN IS
ACCEPTABLE. GAGE
PIN WITH TOUCH-GO END

ACCEPT



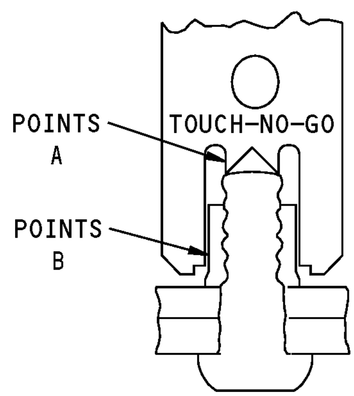
POINTS DO NOT TOUCH
PIN. LEGS OF GAGE
CLEAR SHEET LINE.
PIN GRIP IS TOO SHORT

REJECT



POINTS A DOES NOT TOUCH
PIN. LEGS OF GAGE CLEAR
SHEET LINE. POINTS B DO
NOT TOUCH COLLAR. PIN
GRIP AND COLLAR SWAGE
IS ACCEPTABLE. GAGE
PIN WITH TOUCH-GO END

ACCEPT



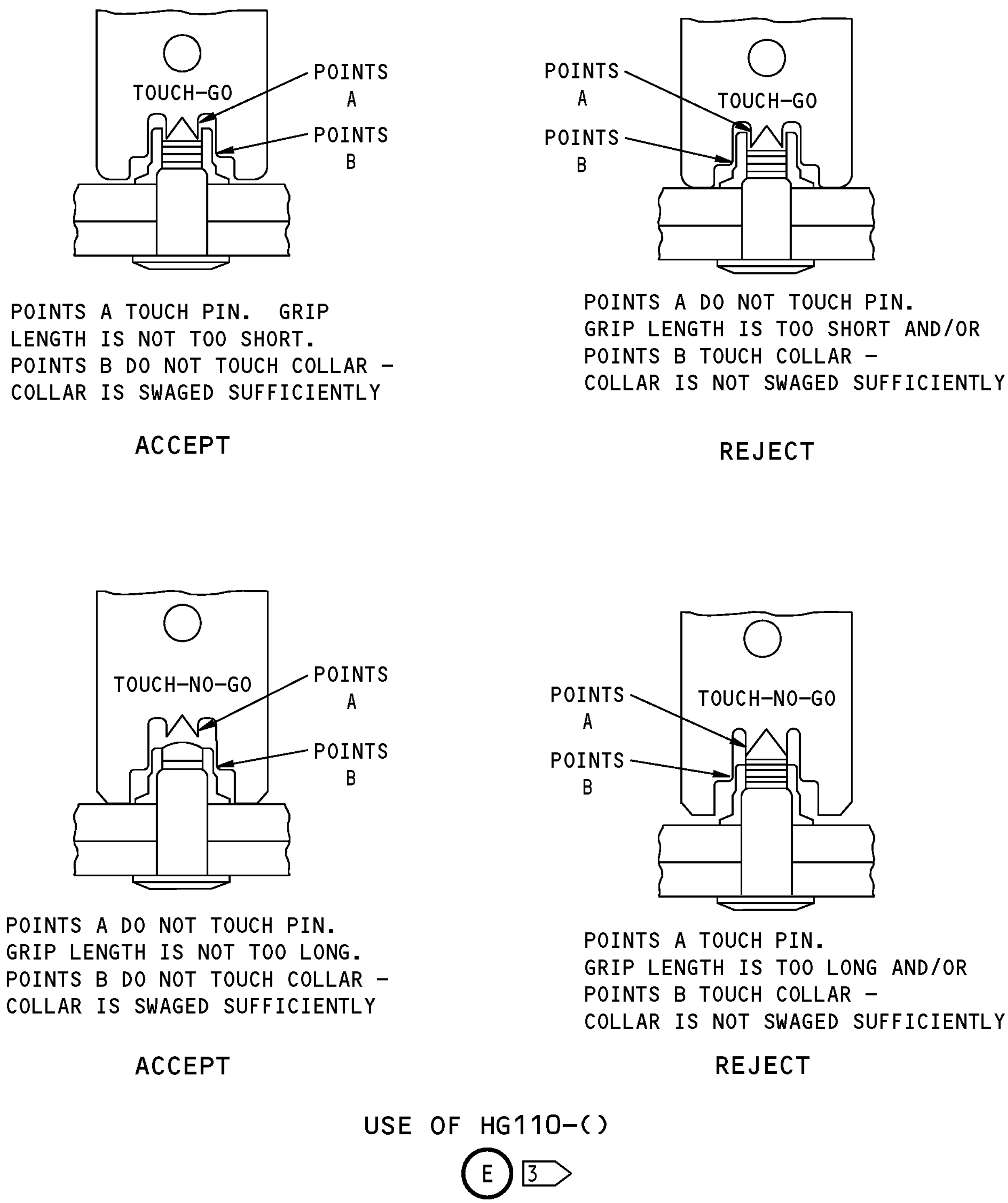
POINTS A TOUCH PIN.
LEGS OF GAGE CLEAR
SHEET LINE. POINTS B
TOUCH COLLAR. PIN
GRIP IS TOO LONG,
COLLAR IS NOT SWAGED
ENOUGH

REJECT

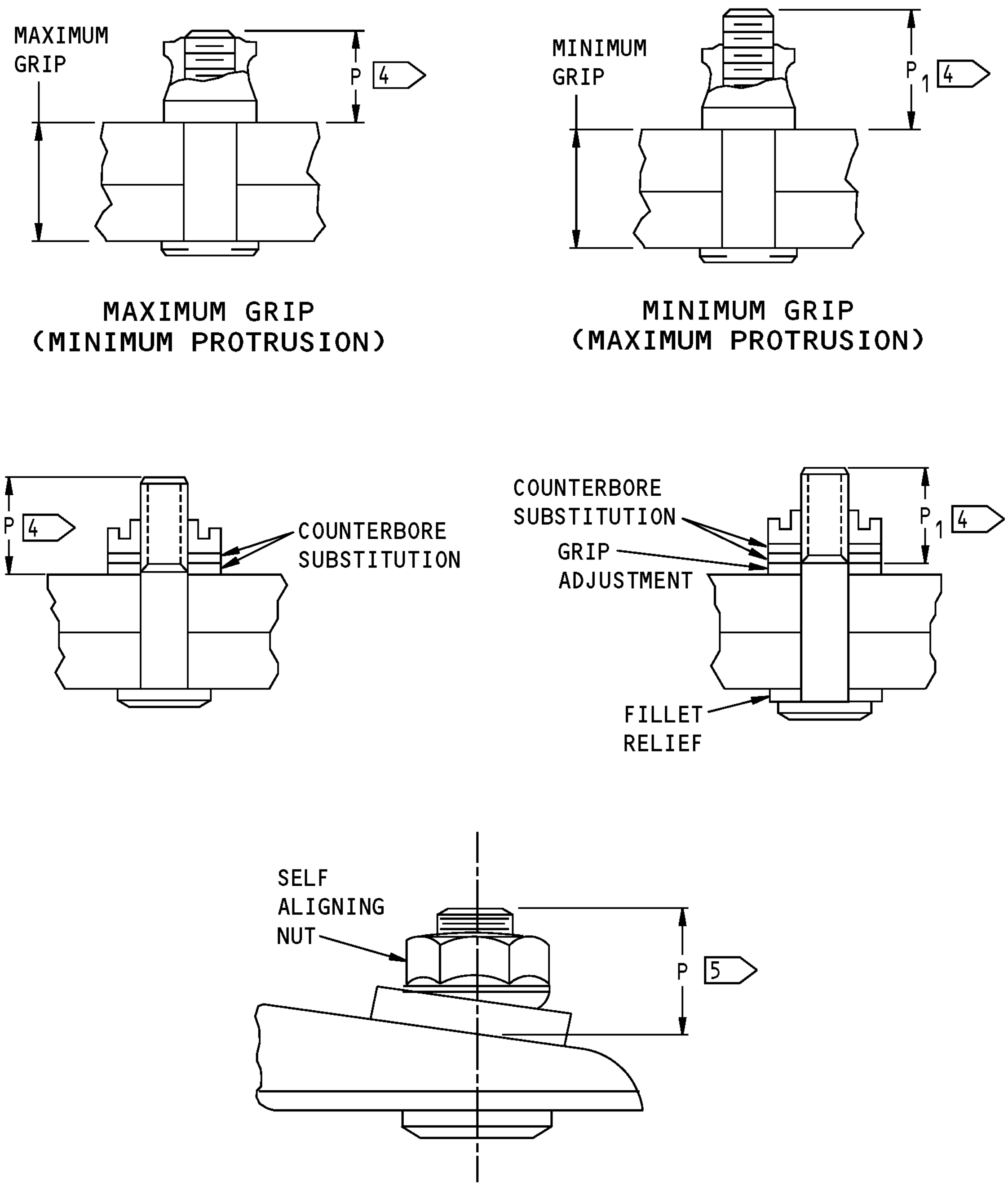
USE OF HG77-()A

D 3

Pin and Collar Limits for Installed Lockbolts and Hex-Drive Bolts
Figure 14 (Sheet 11 of 16)



Pin and Collar Limits for Installed Lockbolts and Hex-Drive Bolts
Figure 14 (Sheet 12 of 16)



PIN PROTRUSION LIMITS FOR INSTALLED HEX-DRIVE BOLTS

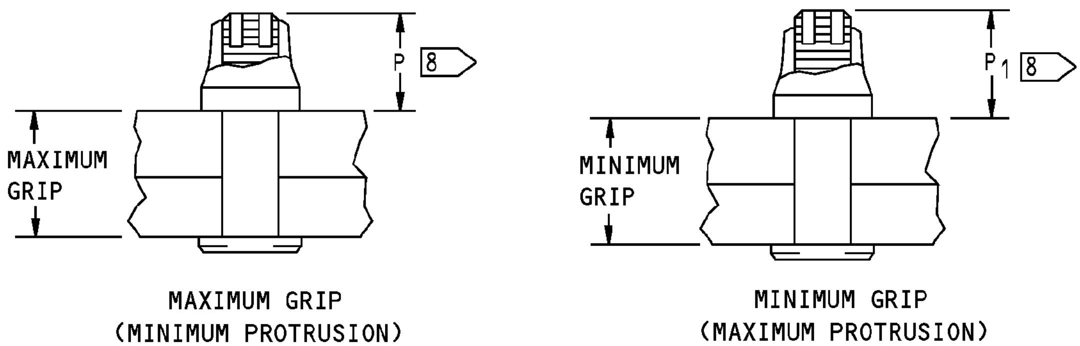
F

Pin and Collar Limits for Installed Lockbolts and Hex-Drive Bolts
Figure 14 (Sheet 13 of 16)

FASTENER		STANDARD							LIGHTWEIGHT		
		NOMINAL, 0.0156 AND 0.0312 OVERSIZE, INCH			0.0468 OVERSIZE, INCH				NOMINAL, INCH		
		SHEAR AND TENSION		ST8712 PROT GAGE DASH NO. (2-1522) PROT GAGE SIZE NO.	SHEAR		TENSION		SHEAR		ST8712 PROT GAGE DASH NO. (2-1522) PROT GAGE SIZE NO.
					P		P		P		
DASH NO.	NOMINAL THREAD	P MIN (MIN PROTRUSION)	P MIN (MAX PROTRUSION)		MIN	MAX	MIN	MAX	MIN	MAX	
-5	0.1640-32	0.302	0.384	-5 (5/32)	0.333	0.414	0.315	0.397	0.270	0.352	5/32
-6	0.1900-32	0.315	0.397	-6 (3/16)	0.346	0.427	0.350	0.432	0.280	0.362	3/16
-8	0.2500-28	0.385	0.467	-8 (1/4)	0.416	0.497	0.420	0.502	0.310	0.392	1/4
-10	0.3125-24	0.490	0.572	-10 (5/6)	0.521	0.602	0.520	0.602	0.370	0.452	5/16
-12	0.3750-24	0.535	0.617	-12 (3/8)	0.566	0.647	0.565	0.647	0.410	0.492	3/8
-14	0.4375-20	0.625	0.707	-14--	0.656	0.737	0.650	0.732	0.475	0.557	--
-16	0.5000-20	0.675	0.757	-16--	0.706	0.787	0.700	0.782	0.515	0.597	--
-18	0.5625-18	0.760	0.842	-18--	0.791	0.872	0.790	0.872	0.590	0.672	--
-20	0.6250-18	0.815	0.897	-20--	0.846	0.927	0.865	0.947	0.630	0.712	--
-24	0.7500-16	1.040	1.122	-24--	1.071	1.152	1.090	1.172	--	--	--
-28	0.8750-14	1.200	1.282	-28--	1.231	1.312	--	--	--	--	--
-32	1.0000-12	1.380	1.462	-32--	1.411	1.492	--	--	--	--	--

PIN PROTRUSION FOR HEX-DRIVE BOLTS
TABLE D

Pin and Collar Limits for Installed Lockbolts and Hex-Drive Bolts
Figure 14 (Sheet 14 of 16)



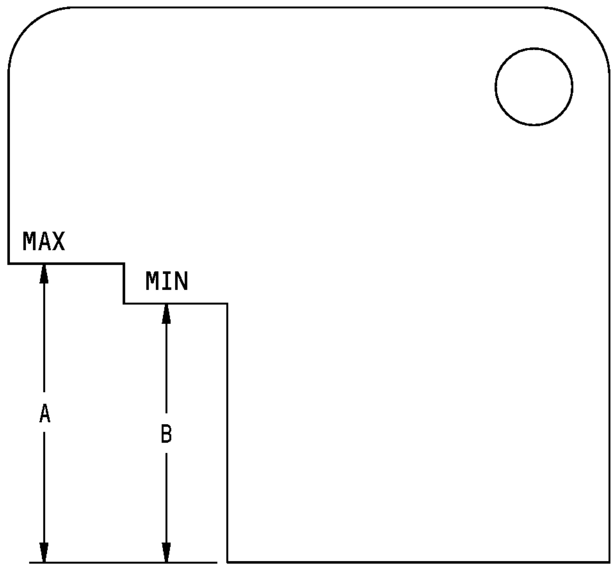
PIN PROTRUSION LIMITS FOR INSTALLED
SWAGE-LOCKING HEX DRIVE BOLTS

G

PIN PROTRUSION LIMITS FOR SWAGE-LOCKING HEX DRIVE BOLTS					
NOMINAL BOLT DIAMETER	STANDARD AND 0.0156 OVERSIZE BOLTS		INSPECTION GAGE SEE H	0.0312 OVERSIZE BOLTS	
	MINIMUM PROTRUSION P (INCH)	MAXIMUM PROTRUSION P_1 (INCH)		MINIMUM PROTRUSION P (INCH)	MAXIMUM PROTRUSION P_1 (INCH)
5/32	0.275	0.358	EB2G1309-5	-	-
3/16	0.295	0.378	EB2G1309-6	0.315	0.398
1/4	0.340	0.423	EB2G1309-8	0.375	0.458
5/16	0.435	0.518	EB2G1309-10	0.480	0.563
3/8	0.475	0.558	EB2G1309-12	0.520	0.603

TABLE E

Pin and Collar Limits for Installed Lockbolts and Hex-Drive Bolts
Figure 14 (Sheet 15 of 16)



PROTRUSION GAGE (SEE TABLE F)

H

GAGE NUMBER [7]	A (INCH) ±0.002	B (INCH) ±0.002
EB2G1309-5	0.358	0.275
EB2G1309-6	0.378	0.295
EB2G1309-8	0.423	0.340
EB2G1309-10	0.518	0.435
EB2G1309-12	0.558	0.475

PROTRUSION GAGE TOLERANCES

TABLE F

Pin and Collar Limits for Installed Lockbolts and Hex-Drive Bolts
Figure 14 (Sheet 16 of 16)

NOTES

- THE SOURCE OF INFORMATION FOR THIS FIGURE CAN BE FOUND IN BOEING PROCESS SPECIFICATION BAC 5060.
- SEE DETAIL A FOR BOLT ALIGNMENT AND DETAIL B FOR THREAD PROTRUSION.
- SEE TABLE A FOR NUT PART NUMBERS, TABLES B AND C FOR WASHERS, AND TABLES D AND E FOR THREAD PROTRUSION LIMITS.
- SEE DETAILS B AND C FOR WASHER USE.

1 DO NOT INSTALL BACN10TN, BACN10WN, BACN10HY, OR BACN10SZ NUTS ON SLOPE ANGLES GREATER THAN 2 DEGREES. USE BACN10MT SEALNUT AND BACW10AU SELF-ALIGNING WASHER ON SLOPES BETWEEN 2 AND 6 DEGREES.

2 DO NOT USE BACN10WM OR BACN10TN SEALNUTS WITH OVERSIZE BOLTS. DO NOT USE WASHERS WITH BACN10WM AND BACN10TN SEALNUTS.

3 FOR BACN10TN AND BACN10WM SEALNUTS, THE TEFLON SEAL MUST NOT EXTRUDE BEYOND THE PERIPHERY OF THE NUT BASE.

4 FILLET RELIEF WASHER MUST BE A COUNTERSINK WASHER AND MUST BE INSTALLED UNDER THE HEAD OF THE BACB30WR RADIUS LEAD-IN BOLT WITH COUNTERSINK DIRECTLY UNDER THE HEAD OF THE BOLT. SEE TABLE C.

5 COUNTERBORE SUBSTITUTION WASHERS FOR OVERSIZE FASTENERS CAN ADD ONE ADDITIONAL 0.032 THICK WASHER TO THIS INSTALLATION. SEE TABLE A.

6 COUNTERBORE SUBSTITUTION WASHERS ARE NECESSARY AS FOLLOWS: ONE 0.063 INCH NOMINAL THICKNESS PLAIN WASHER, EXCEPT FOR SIZE 7 NUTS WHERE ONE 0.063 INCH NOMINAL THICKNESS PLAIN WASHER PLUS ONE 0.032 INCH NOMINAL THICKNESS PLAIN WASHER IS NECESSARY. A MAXIMUM THICKNESS CORRESPONDING TO ONE ADDITIONAL 0.063 INCH NOMINAL THICKNESS PLAIN WASHER MAY BE USED FOR GRIP ADJUSTMENT. IN FUEL TANK AREAS, SEAL AS SHOWN IN SRM 51-20-05.

7 COUNTERBORE SUBSTITUTION WASHERS ARE NECESSARY AS FOLLOWS: ONE 0.063 INCH NOMINAL THICKNESS PLAIN WASHER PLUS ONE 0.032 INCH THICKNESS PLAIN WASHER. A MAXIMUM THICKNESS CORRESPONDING TO ONE ADDITIONAL 0.063 INCH NOMINAL THICKNESS PLAIN WASHER CAN BE USED FOR GRIP ADJUSTMENT. IN FUEL TANK AREAS, SEAL AS SHOWN IN SRM 51-20-05.

8 ONE 0.063 INCH NOMINAL THICKNESS PLAIN COUNTERBORE SUBSTITUTION WASHER IS NECESSARY.

9 BACN10MT()X NUT USES THE NEXT FULL SIZE OVER BACW10AU SELF-ALIGNING WASHER (AS AN EXAMPLE, BACN10MT4X USES THE BACW10AU5 WASHER) AND USES ONE 0.063 INCH NOMINAL THICKNESS PLAIN WASHER PLUS ONE 0.032 INCH NOMINAL THICKNESS PLAIN WASHER. BACN10MT()X AND BACW10AU() SELF-ALIGNING NUT COMBINATIONS ARE NOT PERMITTED WITH NOMINAL OR OVERSIZE BACB30PT BOLTS.

10 SEE TABLE C FOR CORRECT WASHER.

Installation of Radius Lead-In Bolts
Figure 15 (Sheet 1 of 7)

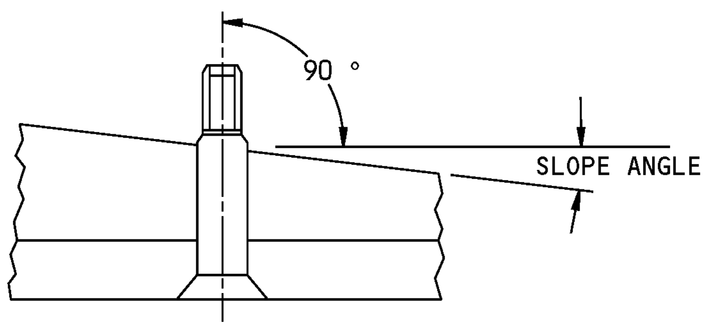
NOTES (CONTINUED)

[11] IT IS NECESSARY THAT BACN10MT()X BE USED WITH THE NEXT FULL SIZE OF BACW10AU() WASHER, (FOR EXAMPLE, THE BACN10MX4X NUT USES THE BACW10AU5 WASHER).

DO NOT USE BACN10MT()X WITH BACB30PT NOMINAL OR OVERSIZES.

[12] WHEN OVERSIZE NUTS ARE USED WITH OVERSIZE BOLTS, PROTRUSION VALUES ARE NOT AFFECTED. SEE TABLE B FOR WASHER THICKNESS SELECTION. SEE TABLE C FOR GRIP ADJUSTMENT.

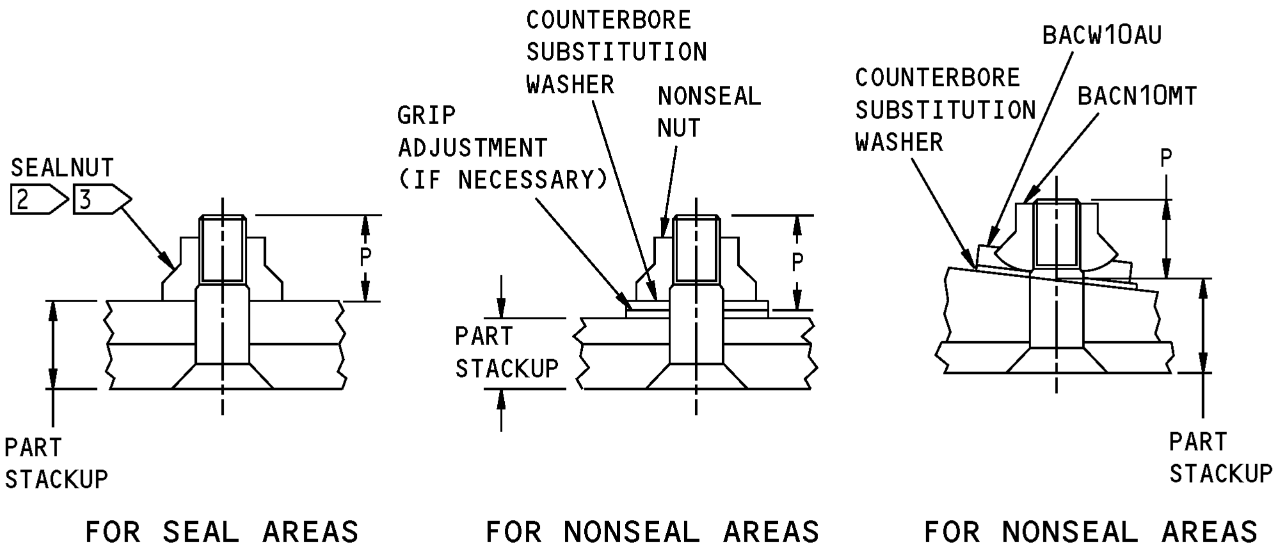
[13] BACW10P416AN THROUGH BACW10421AN ALUMINUM WASHERS MAY BE USED WHERE THE USE OF THE LARGE WASHER WILL INTERFERE WITH ADJACENT STRUCTURE AND REWORK OF THE WASHERS BY RADIUSING OR TRIMMING IS REQUIRED TO ELIMINATE THE INTERFERENCE. THE TRIMMED WASHER MAY NOT PROVIDE LESS BEARING SURFACE THAN THE BACW10AU WASHER (SEE DETAIL C). SURFACE FINISH MUST BE 125 RHR OR BETTER. THE TRIMMED SURFACES MUST BE FINISHED WITH A MANUAL APPLICATION OF A CONVERSION COATING AS SPECIFIED IN SRM 51-20-01, BEFORE YOU INSTALL THE FASTENER.



ANGULAR MEASUREMENT BETWEEN BOLT AND STRUCTURE
MATERIAL FOR PROPER NUT SELECTION

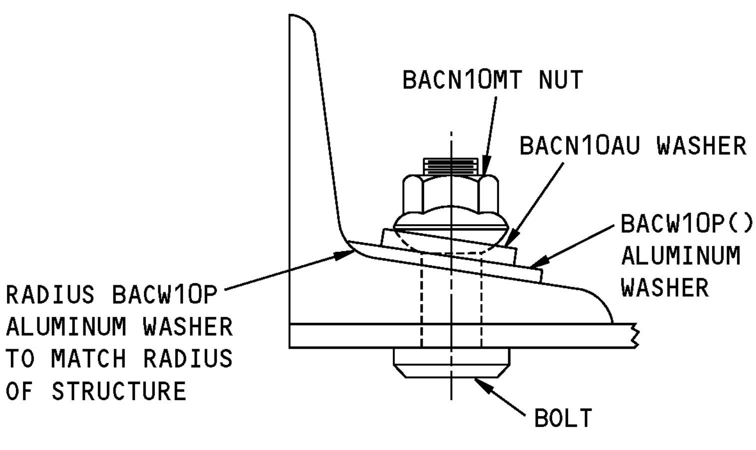
A [1]

Installation of Radius Lead-In Bolts
Figure 15 (Sheet 2 of 7)



THREAD PROTRUSION AND WASHER USE

B



RADIUSED WASHER WITH THE SELF-ALIGNING NUT

C

Installation of Radius Lead-In Bolts
Figure 15 (Sheet 3 of 7)

NUT ON STANDARD SIZE BOLT	NUT ON FIRST OVERSIZE BOLT	NUT ON SECOND OVERSIZE BOLT
BACN10HY()M	BACN10HY()M [6]	BACN10HY()MX [7]
BACN10HY()AC	BACN10HY()AC [6]	BACN10HY()ACX [7]
BACN10MY() AND BACW10AU()	BACN10MT() AND BACW10AU() [6]	BACN10MY()X AND BACW10AU() [9]
BACN10TN()K [2]	BACN10SZ() [6] BACN10HY()M [6] BACN10HY()AC [6]	BACN10HY()MX [7] BACN10HY()ACX [7]
BACN10WM() [2]	BACN10HY()AC [6]	BACN10HY()MX [7] BACN10HY()ACX [7]

NOMINAL AND OVERSIZE NUT PART NUMBERS [10]
TABLE A

NOMINAL DIA NUT AND BOLT COMBINATIONS	WASHER TYPE			TOTAL QUANTITY OF WASHERS [5]
	FILLET RELIEF	COUNTERBORE SUBSTITUTION [5]	GRIP ADJUSTMENT	
BACB30PT()K()L WITH BACN10WM()	DO NOT USE	NOT NECESSARY	DO NOT USE	NONE
BACB3WQ()K()L WITH BACN10TN()K	DO NOT USE	NOT NECESSARY	DO NOT USE	NONE
BACB30PT()K()L, OR BACB30WQ()K()L WITH ALL NON-SEAL NUTS	DO NOT USE	ONE 0.063 THICK WASHER IS NECESSARY (SEE TABLE C)	ONE 0.032 OR 0.063 THICK WASHER IS PERMITTED (SEE TABLE C)	2 MAXIMUM
BACB30WR()K()L WITH BACN10TN()K	ONE 0.063 THICK WASHER IS PERMITTED [4]	NOT PERMITTED	ONE 0.032 OR 0.063 THICK WASHER IS PERMITTED (SEE TABLE C)	2 MAXIMUM
BACB30WR()K()L WITH ALL NON-SEAL NUTS	ONE 0.063 THICK WASHER IS PERMITTED [4]	ONE 0.063 THICK WASHER IS NECESSARY (SEE TABLE C)	ONE 0.032 OR 0.063 THICK WASHER IS PERMITTED (SEE TABLE C)	3 MAXIMUM

THE QUANTITY OF NECESSARY AND PERMITTED WASHERS ON A NOMINAL DIAMETER FASTENER
TABLE B

Installation of Radius Lead-In Bolts
Figure 15 (Sheet 4 of 7)

NOMINAL WASHER THICKNESS	COUNTERSUNK WASHER FOR FILLET RELIEF OR GRIP ADJUSTMENT FOR USE WITH NOMINAL AND OVERSIZE BACB30WR BOLTS	COUNTERBORE SUBSTITUTION AND GRIP ADJUSTMENT WASHERS FOR USE UNDER NUTS USED WITH NOMINAL AND OVERSIZE BACB30WR, BACB30WQ AND BACB30PT BOLTS — NUT PART NUMBER: BACN10HY() BACN10SZ() BACN10HY()X	BACN10MT() +BACW10AU() BACN10MT()X +BACW10AU() [11]
NOMINAL I.D. WASHERS			
0.032	-----------	BACW10AT2()AS BACW10AW()AS	BACW10P410CG THRU BACW10P415CG
0.063	BACW10EG()J BACW10EG()C	BACW10AW()AST BACW10AT3()AS	BACW10P416CG THRU BACW10P421CG BACW10P416AN [13] THRU BACW10P421AN
0.0156 OVERSIZE I.D. WASHERS			
0.032	-----------	BACW10AW()AS BACW10AT2()AS	BACW10P422CG THRU BACW10P427CG
0.063	BACW10EG()1J BACW10EG()1C	BACW10AW()AST BACW10AT3()AS	BACW10P428CG THRU BACW10P433CG
0.0312 OVERSIZE I.D. WASHERS			
0.032		BACW10P446CG THRU BACW10P451CG	BACW10P434CG THRU BACW10P439CG
0.063	BACW10EG()2J BACW10EG()2C	BACW10P452CG THRU BACW10P457CG	BACW10P440CG THRU BACW10P445CG

WASHER SELECTION
TABLE C

Installation of Radius Lead-In Bolts
Figure 15 (Sheet 5 of 7)

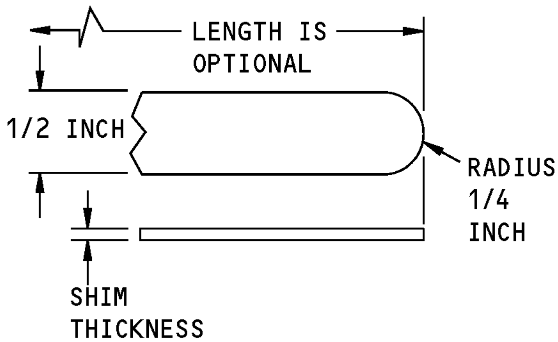
BOLT PART NUMBERS	1ST DASH NUMBER	NOMINAL THREAD SIZE	NUT PART NUMBERS	MINIMUM PROTRUSION (P MIN)	MAXIMUM PROTRUSION (P MIN)
BACB30PT()K()L	4	0.2500-28	BACN10TN	0.428	0.510
	5	0.3125-24	BACN10WM	0.503	0.585
	6	0.3750-24		0.528	0.610
	4	0.2500-28		0.381	0.454
BACB30WQ()K()L	5	0.3125-24	BACN10TN	0.435	0.508
BACB30WR()K()L	6	0.3750-24		0.493	0.566
	7	0.4375-20		0.590	0.663
	3	0.1900-32	BACN10HY	0.326	0.399
BACB30WQ()K()L	4	0.2500-28	BACN10SZ	0.381	0.454
BACB30WR()K()L	5	0.3125-24	BACN10MT	0.435	0.508
	6	0.3750-24	+BACW10AU	0.493	0.566
	7	0.4375-20		0.590	0.663

FASTENER THREAD PROTRUSION LIMITS
TABLE D

BOLT PART NUMBERS	1ST DASH NUMBER	NOMINAL THREAD SIZE	NUT PART NUMBERS 12	MINIMUM PROTRUSION (P MIN)	MAXIMUM PROTRUSION (P MIN)
BACB30PT()K()LX	4	0.2500-28	--	0.428	0.510
BACB30PT()K()LY	5	0.3125-24	BACN10HY()()	0.503	0.585
	6	0.3750-24	BACN10HY()()X	0.528	0.610
BACB30WQ()K()LX	3	0.1900-32	BACN10HY()()	0.374	0.447
BACB30WQ()K()LY	4	0.2500-28	BACN10MT()	0.426	0.499
	5	0.3125-24	+BACW10AU()	0.460	0.533
BACB30WR()K()LX	6	0.3750-24	BACN10MT()()X	0.535	0.608
BACB30WR()K()LY	7	0.4375-20	+BACW10AU() BACN10HY()()X	0.625	0.698

OVERSIZE FASTENER THREAD PROTRUSION LIMITS
TABLE E

Installation of Radius Lead-In Bolts
Figure 15 (Sheet 6 of 7)

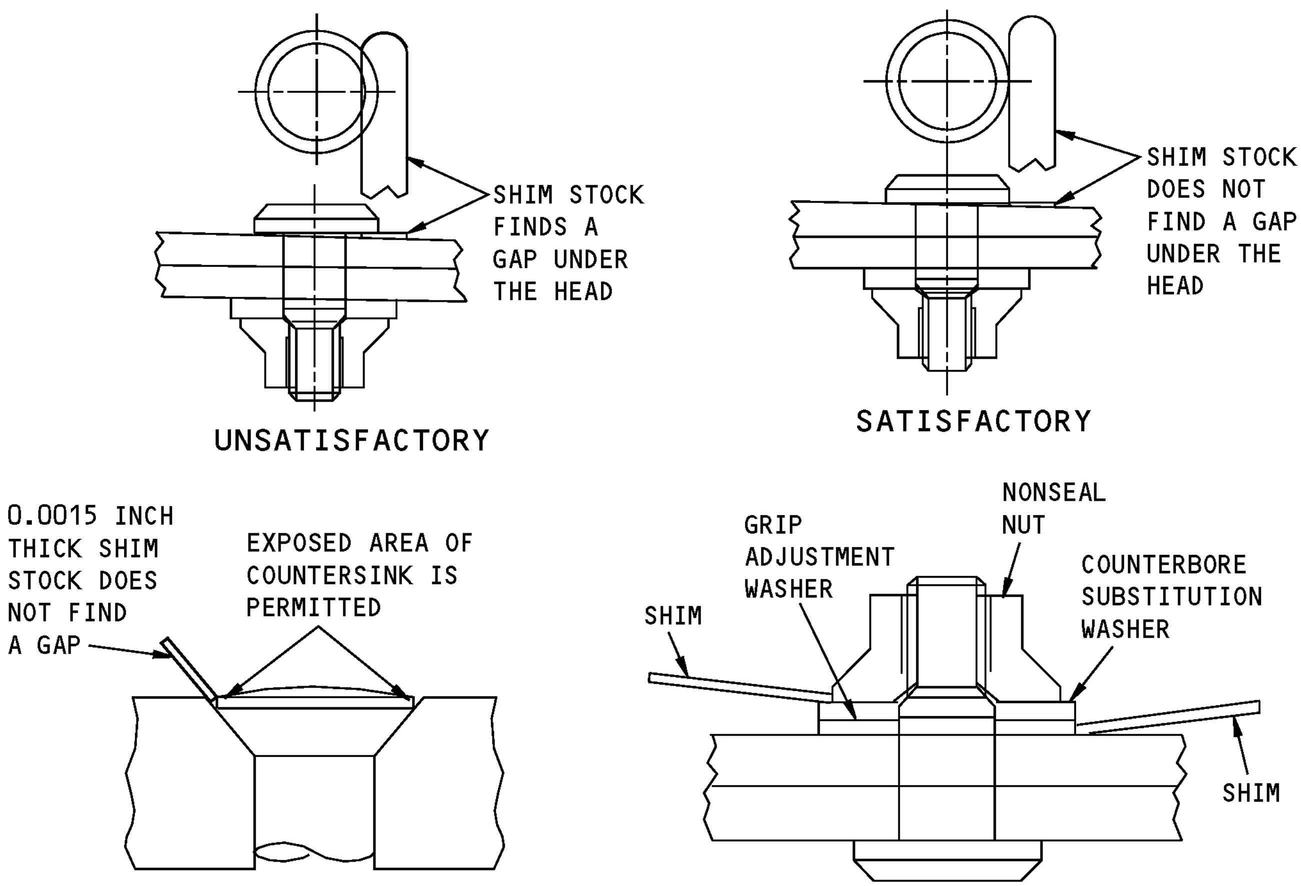


SHIM CONFIGURATION

D

NOMINAL THREAD SIZE	MAXIMUM SHIM THICKNESS
0.1900-32	0.005
0.2500-28	0.006
0.3125-24	0.007
0.3750-24	0.008
0.4375-20	0.008

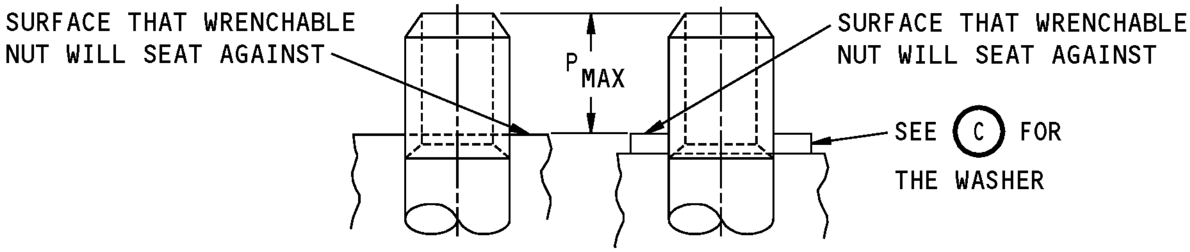
SHIM THICKNESS UNDER INSTALLED NUTS AND PROTRUDING HEADS OF RADIUS LEAD-BOLTS
TABLE F



SHIM THICKNESS UNDER INSTALLED NUTS AND HEADS OF RADIUS LEAD-IN BOLTS

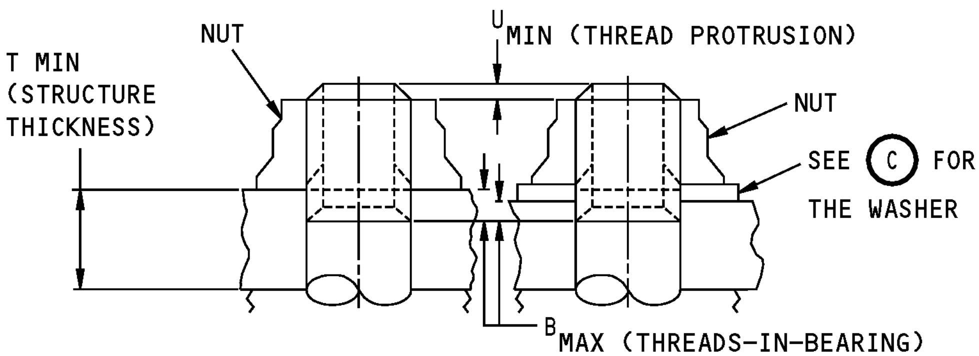
E

Installation of Radius Lead-In Bolts
Figure 15 (Sheet 7 of 7)



BOLT THREAD PROTRUSION ABOVE BASE OF HEX AND 12-POINT, NONCOUNTERBORED, NONCASTELLATED NUTS (SEE TABLE A)

A



MINIMUM BOLT THREAD PROTRUSION THROUGH THE NUT AND FOR THREADS-IN-BEARING (SEE TABLE B)

B

NOTES

- THE SOURCE OF INFORMATION FOR THIS FIGURE CAN BE FOUND IN BOEING PROCESS SPECIFICATION BAC 5009.
- SEE DETAILS A AND B FOR THREAD PROTRUSION.
- SEE DETAIL C AND TABLE C FOR WASHER USEAGE.
- SEE DETAILS D AND E AND TABLE D FOR GAP ANALYSIS.

1 PREFIX FOR 2 LETTER BOLT PART NUMBER CODES SHOWN IS BACB30. EXAMPLE: PN INDICATES BACB30PN SERIES. PREFIX FOR 4 DIGIT BOLT PART NUMBER CODES SHOWN IS NAS. EXAMPLE: 6603 INDICATES NAS6603 SERIES (NAS6603 THRU NAS 6620).

2 NOT APPLICABLE TO BOLTS WITH CASTELLATED NUTS. NOT APPLICABLE TO PLATE NUTS. NOT APPLICABLE TO BARREL NUTS. NOT APPLICABLE TO FULLY THREADED SCREWS.

3 TO CALCULATE ACTUAL B MAX, MEASURE TOTAL STRUCTURE THICKNESS (STACKUP) AT HOLE, (ADD THICKNESS FOR ANY WASHERS), SUBTRACT NOMINAL GRIP LENGTH (GRIP LENGTH DASH NUMBER TIMES 0.0625) OF FASTENER AND SUBTRACT 0.010 INCH FOR FASTENER GRIP LENGTH TOLERANCE.

Installation of Bolts
Figure 16 (Sheet 1 of 7)

NOMINAL THREAD SIZE	THREAD PROTRUSION "P MAX" NOMINAL SIZE BOLTS [1]					THREAD PROTRUSION "P MAX" 0.0156 O.S. BOLTS [1]				
	PN, LE,US	LM, LP,LR, LU,MR, PC,MS XJ,NM, XK,XM, LN,NN, 6603, XL,WP, 6703, NE, 6803,NS	LH,LJ, LK,LL, LT,NF, NR,NT, NU,NJ, UU,NK, UW,XN, NL,RF	VF, 6203, 6303, 8702	PU,PF, PW	PN,LE, US	LM,LP, LR,LU, MR,PC, MS,XJ, NM,XK, NN,XL, XM,LN, 6603, WP, 6703, NE, 6803,NS	LH,LJ, LK,LL, LT,NF, NJ,NR, NK,NT, NL, NU,RF, UU, UW, XN	VF, 6203, 6303, 8703	PU, PF, PW
0.0860-56	--	--	--	--	--	--	--	--	--	--
0.1120-40	--	0.213	0.213	--	--	--	0.196	0.196	--	--
0.1380-32	--	0.252	0.252	--	0.262	--	0.235	0.235	--	0.245
0.1640-32	--	0.289	0.289	0.266	--	--	0.272	0.272	0.249	--
0.1900-32	0.334	0.289	0.289	0.277	0.299	0.317	0.272	0.272	0.260	0.282
0.2500-28	0.439	0.364	0.328	0.319	0.374	0.423	0.348	0.312	0.303	0.358
0.3125-24	0.526	0.402	0.387	0.381	0.412	0.510	0.386	0.371	0.365	0.396
0.3750-24	0.576	0.511	0.403	0.397	0.521	0.560	0.495	0.387	0.381	0.505
0.4375-20	0.658	0.619	0.466	0.463	0.629	0.641	0.602	0.449	0.446	0.612
0.5000-20	0.738	0.660	0.466	0.463	0.670	0.721	0.643	0.449	0.446	0.653
0.5625-18	0.829	0.759	0.524	0.523	--	0.813	0.743	0.508	0.507	--
0.6250-18	0.889	0.821	0.556	0.555	0.831	0.873	0.805	0.540	0.539	0.815
0.7500-16	1.064	0.954	0.586	0.588	--	1.047	0.937	0.569	0.572	--
0.8750-14	1.241	1.088	0.666	0.673	--	1.224	1.071	0.649	0.656	--
1.0000-12	1.415	1.201	0.783	0.797	--	1.398	1.184	0.766	0.780	--
1.1250-12	1.575	1.350	0.877	0.891	--	1.558	1.333	0.860	0.874	--
1.2500-12	1.715	1.538	0.971	0.985	--	1.698	1.521	0.954	0.968	--
1.3750-12	2.173	--	--	--	--	2.156	--	--	--	--
1.5000-12	2.360	--	--	--	--	2.343	--	--	--	--

BOLT THREAD PROTRUSION ABOVE BASE OF HEX AND 12-POINT, NONCOUNTERBORED, NONCASTELLATED NUTS [2]

TABLE A

Installation of Bolts
Figure 16 (Sheet 2 of 7)

NOMINAL THREAD SIZE	THREAD PROTRUSION "P MAX" 0.0312 O.S. BOLTS 1				
	PN,LE,US	LM,LP,LR,LU MR,PC,MS,XJ, NM,XK,NN,XM, LN,6603,WP, 6703,NE,6803, NS,XL	LH,LJ,LK,LL, LT,NF,NR,NT, NU,NJ,UU,NK, UW,XN,NL,RF	VF,6203,6303, 8703	PU,PF,PW
0.0860-56	--	--	--	--	--
0.1120-40	--	0.180	0.180	--	--
0.1380-32	--	0.213	0.218	--	0.228
0.1640-32	--	0.255	0.255	0.232	--
0.1900-32	0.300	0.255	0.255	0.243	0.265
0.2500-28	0.406	0.331	0.295	0.286	0.341
0.3125-24	0.493	0.369	0.354	0.348	0.379
0.3750-24	0.543	0.478	0.370	0.364	0.488
0.4375-20	0.625	0.586	0.433	0.430	0.596
0.5000-20	0.705	0.627	0.433	0.430	0.637
0.5625-18	0.796	0.726	0.491	0.490	--
0.6250-18	0.856	0.788	0.523	0.522	0.798
0.7500-16	1.030	0.920	0.552	0.555	--
0.8750-14	1.207	1.054	0.632	0.639	--
1.0000-12	1.381	1.167	0.749	0.763	--
1.1250-12	1.541	1.316	0.843	0.857	--
1.2500-12	1.681	1.504	0.937	0.951	--
1.3750-12	2.139	--	--	--	--
1.5000-12	2.326	--	--	--	--

BOLT THREAD PROTRUSION ABOVE BASE OF HEX AND 12-POINT, NONCOUNTERBORED, NONCASTELLATED NUTS 2

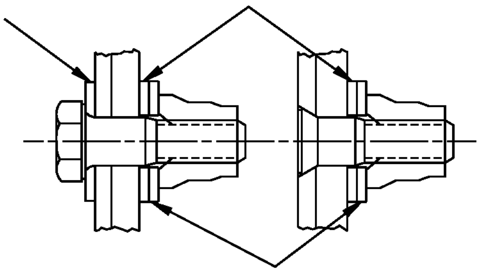
TABLE A (CONTINUED)

Installation of Bolts
Figure 16 (Sheet 3 of 7)

NOMINAL THREAD SIZE	MINIMUM THREAD PROTRUSION THROUGH THE NUT: U MIN			THREADS IN BEARING FOR STRUCTURE THICKNESS UNDER THE NUT: STRUCTURE THICKNESS T MIN								THREADS-IN-BEARING [3]
				EQUAL TO OR LESS THAN 0.093	0.100	0.200	0.300	0.400	0.500	0.600	EQUAL TO OR GREATER THAN	
	ALL BOLTS EXCEPT AS NOTED	[1] VF (ONLY)	[1] LK (ONLY)	THREADS-IN-BEARING B MAX								B MAX
0.0860-56	--	--	--	0.000	0.025	0.036	0.036	0.036	0.036	0.036	0.143	0.036
0.1120-40	0.031	--	0.031	0.000	0.025	0.050	0.050	0.050	0.050	0.050	0.200	0.050
0.1380-32	0.039	--	0.039	0.000	0.025	0.050	0.063	0.063	0.063	0.063	0.250	0.063
0.1640-32	0.039	0.031	0.039	0.000	0.025	0.050	0.063	0.063	0.063	0.063	0.250	0.063
0.1900-32	0.039	0.031	0.045	0.000	0.025	0.050	0.063	0.063	0.063	0.063	0.250	0.063
0.2500-28	0.045	0.036	0.045	0.000	0.025	0.050	0.071	0.071	0.071	0.071	0.286	0.071
0.3125-24	0.052	0.042	0.052	0.000	0.025	0.050	0.075	0.083	0.083	0.083	0.333	0.083
0.3750-24	0.052	0.042	0.052	0.000	0.025	0.050	0.075	0.083	0.083	0.083	0.333	0.083
0.4375-20	0.062	0.050	--	0.000	0.025	0.050	0.075	0.100	0.100	0.100	0.400	0.100
0.5000-20	0.062	0.050	--	0.000	0.025	0.050	0.075	0.100	0.100	0.100	0.400	0.100
0.5625-18	0.068	--	--	0.000	0.025	0.050	0.075	0.100	0.111	0.111	0.444	0.111
0.6250-18	0.068	--	--	0.000	0.025	0.050	0.075	0.100	0.111	0.111	0.444	0.111
0.7500-16	0.078	--	--	0.000	0.025	0.050	0.075	0.100	0.125	0.125	0.500	0.125
0.8750-14	0.089	--	--	0.000	0.025	0.050	0.075	0.100	0.125	0.125	0.571	0.143
1.0000-12	0.104	--	--	0.000	0.025	0.050	0.075	0.100	0.125	0.150	0.667	0.167
1.1250-12	0.104	--	--	0.000	0.025	0.050	0.075	0.100	0.125	0.150	0.667	0.167
1.2500-12	0.104	--	--	0.000	0.025	0.050	0.075	0.100	0.125	0.150	0.667	0.167
1.3750-12	0.104	--	--	0.000	0.025	0.050	0.075	0.100	0.125	0.150	0.667	0.167
1.5000-12	0.104	--	--	0.000	0.025	0.050	0.075	0.100	0.125	0.150	0.667	0.167

BOLT THREAD PROTRUSION THROUGH THE NUT
AND FOR THREADS-IN-BEARING
TABLE B

Installation of Bolts
Figure 16 (Sheet 4 of 7)



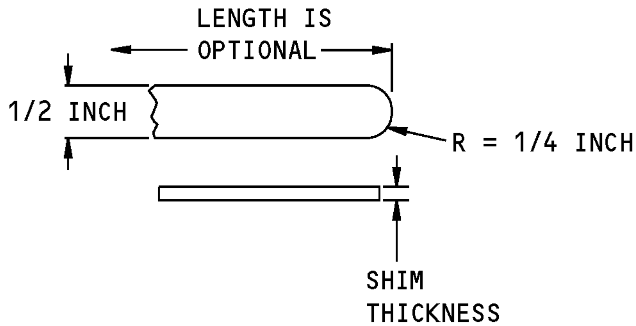
USE OF WASHERS

C

EXAMPLE BOLT PART NUMBERS	STRUCTURE MATERIAL	PLAIN WASHER UNDER NUT	COUNTERSUNK WASHER UNDER BOLT HEAD
BACB30, TYPE EM, FD LE, LM, LN, LP, LR, LU, MR, MS, NE, NM, NN, PN, SW, UG, US, VC, WP, XA, XJ, XK, XL, XM, MS21250, NAS6603 THRU 6620, NAS6703 THRU 6720, NAS6803 THRU 6820	ALUMINUM	BACW10BP()DP, OR NAS1149E()P	BACW10BP()CD
	STEEL	BACW10BP()DP, OR NAS1149E()P	BACW10BP()CD
	CRES	BACW10BP()APU, OR NAS1149E()R	BACW10BP()ACU
	TITANIUM	BACW10BP()APU, OR NAS1149E()R	BACW10BP()ACU
ALL OTHER BOLTS AND SCREWS	ALUMINUM	BACW10BN()AP, OR NAS1149E()P	BACW10BN()AC
	STEEL	BACW10BP()DP, OR NAS1149D()P	BACW10BP()CD
	CRES	BACW10BP()APU, OR NAS1149C()R, OR NAS1149E()R	BACW10BP()ACU
	TITANIUM	BACW10BP()APU, OR NAS1149C()R, OR NAS1149E()R	BACW10BP()ACU

WASHER USAGE
TABLE C

Installation of Bolts
Figure 16 (Sheet 5 of 7)



GAP INSPECTION SHIM

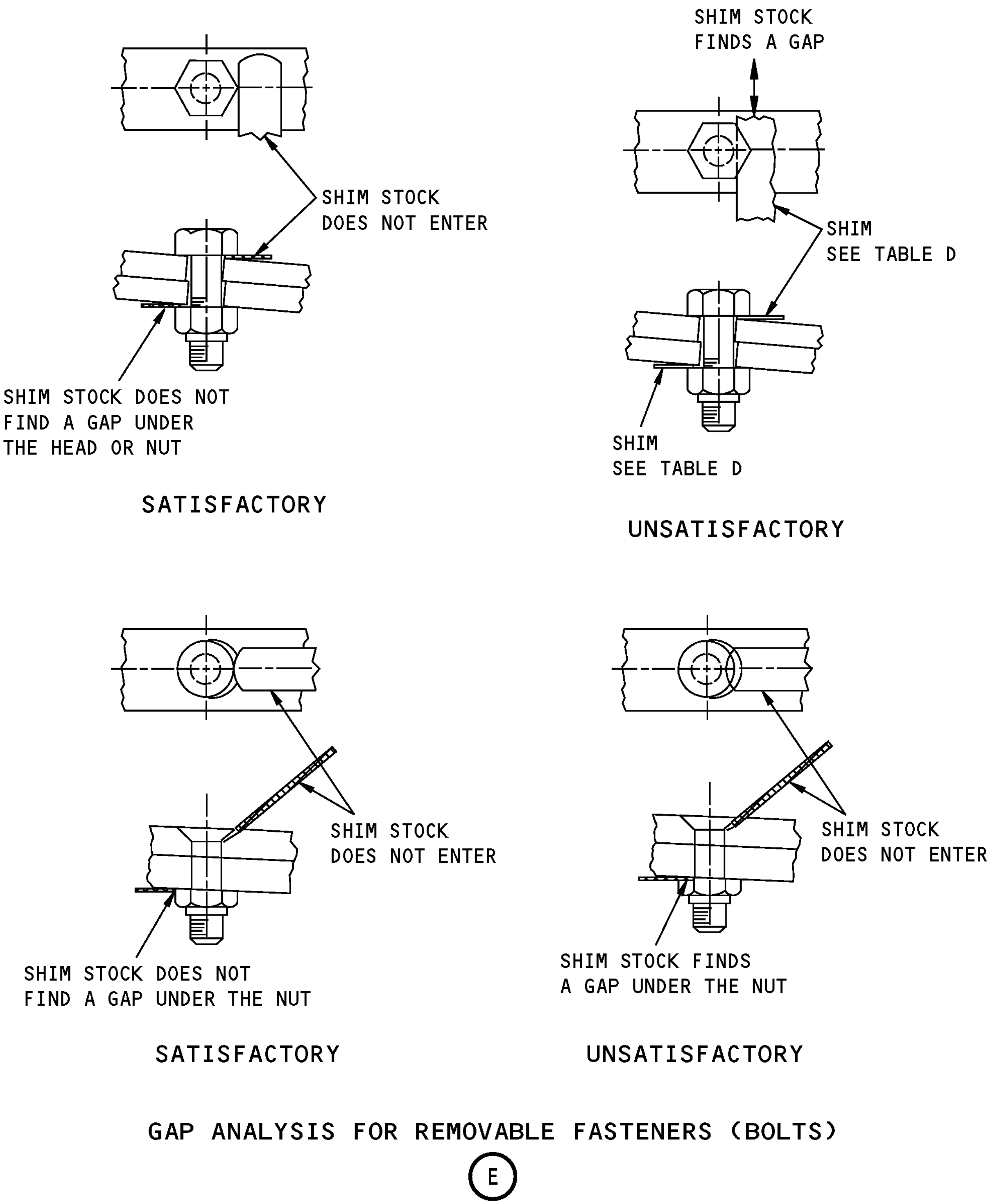
D

NOMINAL THREAD SIZE	SHIM THICKNESS +0.0000/ -0.0005
0.1640-32	0.004
0.1900-32	0.005
0.2500-28	0.006
0.3125-24	0.007
0.3750-24	0.008
0.4375-20	0.009
0.5000-20	0.010
0.5625-20	0.011
0.6250-18	0.012
0.7500-16	0.014
0.8750-14	0.016
1.0000-12	0.018
1.1250-12	0.020
1.2500-12	0.022
1.3750-12	0.024
1.5000-12	0.026
1.6250-12	0.028
1.7500-12	0.030
2.0000-12	0.034

NUT GAP SHIM THICKNESS

TABLE D

Installation of Bolts
Figure 16 (Sheet 6 of 7)



Installation of Bolts
Figure 16 (Sheet 7 of 7)

GENERAL - FASTENER SUBSTITUTION

1. **Applicability**

   A. Use this chapter-section-subject to find an equivalent fastener or an alternative fastener to replace the fastener that was initially installed in the airplane structure. You can also use this chapter-section-subject to find replacement fasteners for subsequent repair on the airplane.

2. **General**

   A. When the repairs given in this manual are adapted for in-service repairs, it is possible for the operator to use a different type of fastener as an alternative to the fastener specified in the repair procedure.

   B. The fastener selection for repairs specified in the Structural Repair Manual or by the engineering drawings is based on the data that follows:
   - Strength
   - Corrosion protection
   - Weight
   - Temperature
   - Fatigue properties
   - Method of installation.

   C. It can be necessary to install alternative fasteners because:
   - The specified fastener is not available
   - It is not easy to get access to a necessary location
   - The special repair is different from the general repair.

   D. Paragraph 4./GENERAL gives definitions and other fastener data that are related to the Fastener Substitution Tables given in Fastener Substitution - Rivets, Figure 1/GENERAL, Fastener Substitution - Bolts, Figure 2/GENERAL and Fastener Substitution - Lockbolts, Figure 3/GENERAL.

3. **References**

Reference	Title
51-40-06	FASTENER EDGE MARGINS

4. **Fastener Substitution Tables**

   A. Table 1/GENERAL gives an index for the Fastener Substitution Tables. Equivalent and alternative fasteners are shown by part numbers in different columns in the Fastener Substitution Tables. The flagnotes given near the fastener part numbers tell about the permitted use of the equivalent or alternative fasteners.

   B. An EQUIVALENT fastener is a fastener which is directly interchangeable with the initial fastener. Usually the equivalent fasteners are given under a vendor part number and are not always the same as those supplied to the Boeing Company.

CAUTION: DO NOT USE THE FASTENER SUBSTITUTION TABLES TO FIND ALTERNATIVES FOR THE FASTENERS LISTED IN THE ALTERNATIVE COLUMN. IF YOU DO NOT OBEY, THE REPAIR WILL NOT BE APPROVED.

   C. An ALTERNATIVE fastener is a fastener with equal or greater strength properties than the initial fastener. However, an alternative fastener cannot be used when:

   (1) They do not give the necessary pressure or fuel seal

(2) Non-magnetic fasteners are necessary and the fastener is magnetic

(3) Fastener thread length, grip length or diameter is not available

(4) Access does not permit fastener installation

(5) Fastener installation tools are not available.

D. When the equivalent or alternative fastener is used, use the same fastener spacing shown in the applicable repair procedure.

E. Do not use an equivalent or alternative flush-head fastener if the necessary countersink is deeper than the initial flush-head fastener.

F. If an alternative bolt is used, it must have the same locking feature as the initial bolt. Usual locking features include a drilled head, drilled shank, or a self-locking nut. For bolts used as alternatives for hex-drive bolts or lockbolts that are installed in non-interference holes, an applicable self-locking nut must be installed.

G. Do not use aluminum or alloy steel fasteners as alternatives for titanium or corrosion resistant steel fasteners in graphite structures.

H. The equivalent and alternative fasteners given in the substitution tables can have different electrical conductivity than the initial fasteners. If the electrical bonding across the fastener is necessary, make sure that the equivalent or alternative fasteners have the necessary electrical conductivity.

5. Fasteners Inactive for Boeing Design (Supersessions)

A. It is possible to continue to use fasteners that are inactive for design in Boeing Airplanes. If you have a fastener in stock that a Boeing Fastener Specification shows as superseded, you are permitted to use it if the alternative fastener (or fasteners) is a Class I, Class II, IIA, III or IV Supersession.

B. If a fastener has been superseded by a Class V Supersession, Boeing recommends that you use an alternative fastener.

Table 1:

FASTENER TYPE	REFER TO
Fastener Substitution - Rivets	Figure 1
Fastener Substitution - Bolts	Figure 2
Fastener Substitution - Lockbolts	Figure 3

NOTES

- REFER TO TABLE I FOR THE FASTENER SUBSTITUTION INDEX.
- REFER TO SRM 51-40-02 FOR THE REMOVAL AND THE INSTALLATION OF FASTENERS.
- REFER TO SRM 51-20-01 FOR THE NECESSARY PROTECTIVE TREATMENT TO INSTALL FASTENERS.

[A] YOU MUST KEEP THE COUNTERSINK DEPTH CONSTANT FOR ALL BACR15CE AND BACR15GF RIVETS.

- IF SUBSTITUTE RIVETS ARE INSTALLED, YOU MUST MICRO-SHAVE THE ALTERNATIVE RIVET TO MAKE SURE THAT THE REPAIR SURFACE IS SMOOTH.

[B] THE NOMINAL DIAMETER OF THE BACR15FP, BACR15FR, NAS1738, AND THE NAS1739 BLIND RIVETS ARE APPROXIMATELY 1/64 INCH GREATER THAN THE NOMINAL DIAMETER OF NAS1398 AND NAS1399 BLIND RIVETS. REFER TO SRM 51-40-05.

[C] NAS1398 AND NAS1399 BLIND RIVETS ARE SUPPLIED WITH SPINDLES THAT HAVE A FULL SERRATION, OR A PARTIAL SERRATION.

- NAS1398-()-() AND NAS1399-()-() HAVE A PARTIAL SERRATION
- NAS1398-()A() AND NAS1399-()A() HAVE A FULL SERRATION.

NOTE: USE ONLY THE SPECIFIED TOOL FOR A GIVEN TYPE OF SPINDLE SERRATION.

[D] THESE FASTENERS ARE ONLY PERMITTED FOR THE ATTACHMENT OF NUTPLATES.

[E] THIS FASTENER IS NOT PERMITTED FOR USE IN MAGNESIUM STRUCTURES.

[F] ASK THE BOEING COMPANY FOR FASTENER ALTERNATIVES.

[G] THIS FASTENER IS PERMITTED WHEN THE DIAMETER IS $\leq$5/16 INCH.

[H] THE INITIAL FASTENER IS USED IN FUEL AREAS OF THE WING. IT IS POSSIBLE THAT THE REPLACEMENT FASTENER WILL HAVE SPECIAL INTERFERENCE REQUIREMENTS. ASK THE BOEING COMPANY FOR ALTERNATIVE FASTENER AND INSTALLATION INSTRUCTIONS.

[I] THE BLIND RIVET IS ONLY APPLICABLE TO THE ATTACHMENT OF NUTPLATES THAT HAVE A PRIMARY FASTENER HOLE DIAMETER UP TO A MAXIMUM OF 1/4 INCH.

- THIS IS NOT APPLICABLE TO THE ATTACHMENT OF DOME SEAL NUTS, RIGHT ANGLE NUTPLATES, OR STANDOFFS.
- THIS IS APPLICABLE TO NUTPLATE ATTACHMENT WHERE THE PRIMARY FASTENER IS INSTALLED IN A NON-COLD WORKED CLASS 2 OR CLASS 3 HOLE.

THE BLIND RIVET IS NOT PERMITTED IN AREAS NEAR THE ENGINE INLETS, FUSELAGE SKINS, FUSELAGE FRAMES, FLOOR BEAMS, WING LEADING OR TRAILING EDGE STRUCTURE.

THE BLIND RIVET CAN ONLY BE USED WHEN YOU DO NOT HAVE SUFFICIENT ACCESS TO INSTALL SOLID RIVETS.

- INSTALL THE BLIND RIVETS WET WITH THE APPLICABLE SEALANT.

[J] DO NOT USE THESE FASTENERS IN FUEL TANK AREAS.

[K] THIS FASTENER IS ALLOY STEEL AND IS ONLY PERMITTED FOR USE INSIDE THE PRESSURIZED FUSELAGE ABOVE THE FLOOR.

[L] REDUCED HEAD FASTENERS ARE NOT PERMITTED AS SUBSTITUTES FOR UNIVERSAL HEAD RIVETS IN FUSELAGE SKIN AND PRESSURE BULKHEAD STRUCTURES.

[M] THIS FASTENER IS NOT PERMITTED IN ALUMINUM STRUCTURE OR WHERE ELECTRICAL CONDUCTIVITY IS REQUIRED.

[N] SUBSTITUTION IS NOT PERMITTED IN AREAS WHERE THE ALTERNATIVE PART RIVET HEAD WOULD TOUCH A PART RADIUS ON THE STRUCTURE.

[O] SUBSTITUTION FOR REDUCED HEAD RIVET NOT PERMITTED IN ALUMINUM STRUCTURE. DO NOT MICROSHAVE MONEL RIVETS IN ALUMINUM STRUCTURE.

[P] INSTALL TO THE SAME BUTTON DIMENSIONS AS THE BACR15GF RIVET.

Fastener Substitution - Rivets
Figure 1 (Sheet 1 of 16)

TYPE OF RIVET FASTENER	LOCATION OF FASTENER	
	TABLE NUMBER	SHEET NUMBER
RIVET - SOLID SHANK - PROTRUDING HEAD	II	3 THROUGH 5
RIVET - SOLID SHANK - FLUSH HEAD	III	6 THROUGH 9
RIVET - BLIND - PROTRUDING HEAD	IV	10 THROUGH 12
RIVET - BLIND - FLUSH HEAD	V	13 THROUGH 15
RIVET - SLUG	VI	16

RIVET FASTENER SUBSTITUTION INDEX
TABLE I

Fastener Substitution - Rivets
Figure 1 (Sheet 2 of 16)

INITIAL FASTENER OR SPECIFIED REPAIR FASTENER		FASTENER SUBSTITUTION	
PART NUMBER	DESCRIPTION	EQUIVALENT	ALTERNATIVE
BACR15AY()-()	ALLOY STEEL HI SHEAR FLAT HEAD INTERFERENCE F17 160 KSI		[F]
BACR15BB()A()	1100F AL, ANODIZED, CLOSE TOLERANCE SHANK	MS20470A	BACR15DR()P() [E] [I] [J] [K] BACR15DR()PAC() [E] [I] [J]
BACR15BB()A()C	1100-F AL, CONVERSION COATED, CLOSE TOLERANCE SHANK		BACR15DR()P() [E] [I] [J] [K] BACR15DR()PAC() [E] [I] [J]
BACR15BB()AD()	2117-T4 AL, ANODIZED OR CONVERSION COATED, CLOSE TOLERANCE SHANK	MS20470AD	BACR15BB()AD()C BACR15DR()P() [E] [I] [J] [K] BACR15DR()PAC() [E] [I] [J] BACR15FT()AD [L]
BACR15BB()AD()C	2117-T4 AL, CONVERSION COATED, CLOSE TOLERANCE SHANK		BACR15DR()P() [E] [I] [J] [K] BACR15DR()PAC() [E] [I] [J]
BACR15BB()B()	5056-H32 AL, ANODIZED OR CONVERION COATED, CLOSE TOLERANCE SHANK		BACR15BB()B()C BACR15DR()P() [E] [I] [J] [K] BACR15DR()PAC() [E] [I] [J]
BACR15BB()B()C	5056-H32 AL, CONVERSION COATED, CLOSE TOLERANCE SHANK		BACR15DR()P() [E] [I] [J] [K] BACR15DR()PAC() [E] [I] [J]
BACR15BB()D()	2017-T4 AL, ANODIZED OR CONVERSION COATED, CLOSE TOLERANCE SHANK	MS20470D	BACR15BB()D()C BACR15BB()DD() BACR15DR()P() [E] [I] [J] [K] BACR15DR()PAC() [E] [I] [J] BACR15FT()D() [G] [L] BACR15FT()KE()C [G] [L] MS20470DD
BACR15BB()D()C	2017-T4 AL, CONVERSION COATED, CLOSE TOLERANCE SHANK		BACR15DR()P() [E] [I] [J] [K] BACR15DR()PAC() [E] [I] [J] BACR15FT()KE()C [G] [L]

RIVET - SOLID SHANK - PROTRUDING HEAD
TABLE II

Fastener Substitution - Rivets
Figure 1 (Sheet 3 of 16)

INITIAL FASTENER OR SPECIFIED REPAIR FASTENER		FASTENER SUBSTITUTION	
PART NUMBER	DESCRIPTION	EQUIVALENT	ALTERNATIVE
BACR15BB()DD()	2024-T4 AL, ANODIZED, CLOSE TOLERANCE SHANK	MS20470DD	BACR15DR()P() E I J K
			BACR15DR()PAC() E I J
			BACR15FT()DD() L
			BACR15FT()KE()C G J L
BACR15DX()M()	MONEL, CLOSE TOLERANCE SHANK		NASM20615-()M()
BACR15DX()-()	A286 CRES UNIVERSAL HEAD CLOSE TOLERANCE SHANK		NAS1198()-()
BACR15ET()AD()	2117-T4 AL, ANODIZED, UNIVERSAL HEAD, CLOSE TOLERANCE SHANK, 0.031 OVERSIZE		NAS1242AD
BACR15ET()B()	5056-H32 AL, ANODIZED, UNIVERSAL HEAD, CLOSE TOLERANCE SHANK, 0.031 OVERSIZE		NAS1242B
BACR15ET()D()	2017-T4 AL, ANODIZED, UNIVERSAL HEAD, CLOSE TOLERANCE SHANK, 0.031 OVERSIZE		NAS1242D
			NAS1242DD
BACR15ET()DD()	2024-T4 AL, ANODIZED, UNIVERSAL HEAD, CLOSE TOLERANCE SHANK, 0.031 OVERSIZE		NAS1242DD
BACR15FT()AD()	2117-T4 AL, ANODIZED, MODIFIED UNIVERSAL HEAD, CLOSE TOLERANCE SHANK		BACR15BB()AD() N
			BACR15BB()AD()C N
			MS20470AD N
BACR15FT()D()	2017-T4 AL, ANODIZED, MODIFIED UNIVERSAL HEAD, CLOSE TOLERANCE SHANK		BACR15BB()D() N
			BACR15BB()DD() N
			BACR15FT()KE()C
			MS20470D N
			MS20470DD N

RIVET - SOLID SHANK - PROTRUDING HEAD
TABLE II

Fastener Substitution - Rivets
Figure 1 (Sheet 4 of 16)

INITIAL FASTENER OR SPECIFIED REPAIR FASTENER		FASTENER SUBSTITUTION	
PART NUMBER	DESCRIPTION	EQUIVALENT	ALTERNATIVE
BACR15FT()DD()	2024-T4 AL, ANODIZED, MODIFIED UNIVERSAL HEAD, CLOSE TOLERANCE SHANK	NO EQUIVALENT	BACR15BB()DD() N
			BACR15DR()P() E I J K
			BACR15DR()PAC() E I J
			BACR15FT()KE()C G J L
			MS20470DD N
BACR15FT()KE()C	7050-T73 AL, CONVERSION COATED, MODIFIED UNIVERSAL HEAD, CLOSE TOLERANCE SHANK	NO EQUIVALENT	BACR15BB()DD() N
			BACR15FT()DD()
			MS20470DD N
MS20470A	1100-F AL, UNIVERSAL HEAD	BACR15BB()A()	BACR15FT()A()C
MS20470AD()-()	2117-T4 AL, ANODIZED, UNIVERSAL HEAD	BACR15BB()AD()	BACR15BB()AD()C
			BACR15FT()AD() L
MS20470B()-()	5056-H32 AL, ANODIZED, UNIVERSAL HEAD	BACR15BB()B()	BACR15FT()B()C
MS20470D()-()	2017-T4 AL, ANODIZED, UNIVERSAL HEAD	BACR15BB()D()	BACR15BB()D()C
			BACR15BB()DD()
			BACR15FT()D() G L
			BACR15FT()DD() L
			BACR15FT()KE()C G L
			MS20470DD
MS20470DD	2024-T4 AL, ANODIZED, UNIVERSAL HEAD	BACR15BB()DD()	BACR15FT()DD() L
MS20470E	7050-T73 AL, UNIVERSAL HEAD	NO EQUIVALENT	BACR15BB()DD()
			BACR15FT()KE()C L
			MS20470DD
MS20615()M	MONEL	BACR15DX()M()	NO ALTERNATIVE
NAS1198	A286 CRES	BACR15DX()-()	NO ALTERNATIVE

RIVET - SOLID SHANK - PROTRUDING HEAD
TABLE II

Fastener Substitution - Rivets
Figure 1 (Sheet 5 of 16)

INITIAL FASTENER OR SPECIFIED REPAIR FASTENER		FASTENER SUBSTITUTION	
PART NUMBER	DESCRIPTION	EQUIVALENT	ALTERNATIVE
BACR15AD()AD()	2117-T4 AL, ANODIZED, 100° HEAD, 0.031 OVERSIZE	NO EQUIVALENT	NAS1241AD
BACR15AD()DD()	2024-T4 AL, ANODIZED, 100° HEAD, 0.031 OVERSIZE	NO EQUIVALENT	NAS1241DD
BACR15AD()D()	2017-T4 AL, ANODIZED, 100° HEAD, 0.031 OVERSIZE	NO EQUIVALENT	NAS1241DD NAS1241D
BACR15AD()B()	5056-H32 AL, ANODIZED, 100° HEAD, 0.031 OVERSIZE	NO EQUIVALENT	NAS1241B
BACR15AZ()-()	ALLOY STEEL HI SHEAR 100° HEAD INTERFERENCE FIT 160 KSI	NO EQUIVALENT	[F]
BACR15BA()A()	1100F AL, ANODIZED, 100° HEAD, CLOSE TOLERANCE SHANK	MS20426A	BACR15DR()-() [E] [I] [J] [K] BACR15DR()AC() [E] [I] [J]
BACR15BA()A()C	1100-F AL, CONVERSION COATED, 100° PRECISION HEAD, CLOSE TOLERANCE SHANK	NO EQUIVALENT	BACR15DR()-() [E] [I] [J] [K] BACR15DR()AC() [E] [I] [J]
BACR15BA()AD()	2117-T4 AL, ANODIZED OR CONVERSION COATED, 100° PRECISION HEAD, CLOSE TOLERANCE SHANK	MS20426AD	BACR15BA()AD()C BACR15DR()AC() [E] [I] [J] BACR15DR()-() [E] [I] [J] [K] BACR15GE()CW() [E] [I] [J]
BACR15BA()AD()C	2117-T4 AL, CONVERSION COATED, 100° PRECISION HEAD, CLOSE TOLERANCE SHANK	NO EQUIVALENT	BACR15DR()-() [E] [I] [J] [K] BACR15DR()AC() [E] [I] [J] BACR15GE()CW() [E] [I] [J]

RIVET - SOLID SHANK - FLUSH HEAD
TABLE III

Fastener Substitution - Rivets
Figure 1 (Sheet 6 of 16)

INITIAL FASTENER OR SPECIFIED REPAIR FASTENER		FASTENER SUBSTITUTION	
PART NUMBER	DESCRIPTION	EQUIVALENT	ALTERNATIVE
BACR15BA()B()	5056F AL, ANODIZED, 100° HEAD, CLOSE TOLERANCE SHANK		BACR15BA()AD() [E] BACR15BA()D() [E] MS20426AD [E] MS20426B [E] MS20426D [E]
BACR15BA()B()C	5056-H32 AL, CONVERSION COATED, 100° PRECISION HEAD, CLOSE TOLERANCE SHANK		BACR15DR()-() [E] [I] [J] [K] BACR15DR()AC() [E] [I] [J]
BACR15BA()D()	2017-T3 AL, CONVERSION COATED, 100° PRECISION HEAD, CLOSE TOLERANCE SHANK	MS20426D	BACR15BA()D()C BACR15BA()DD() BACR15DR()-() [E] [I] [J] [K] BACR15DR()AC() [E] [I] [J] MS20426DD
BACR15BA()DD()	2024-T4 AL, ANODIZED, 100° PRECISION HEAD, CLOSE TOLERANCE SHANK	MS20426DD	BACR15DR()-() [E] [I] [J] [K] BACR15DR()AC() [E] [I] [J]
BACR15CE()AD()	2117-T4 AL, ANODIZED, 100° SHEAR HEAD		BACR15BA()AD [A] MS20426AD [A] NAS1097AD
BACR15CE()B()	5056-H32 AL, ANODIZED, 100° SHEAR HEAD		BACR15BA()B [A] MS20426B [A] NAS1097B
BACR15CE()D()	2017-T4 AL, CONVERSION COATED, 100° SHEAR HEAD		BACR15BA()D() [A] BACR15BA()DD() [A] BACR15GF()D() MS20426D [A] MS20426DD [A] NAS1097D
BACR15CE()M()	MONEL, 100° SHEAR HEAD		NAS1200M MS20427M [A] [O]

RIVET - SOLID SHANK - FLUSH HEAD
TABLE III

Fastener Substitution - Rivets
Figure 1 (Sheet 7 of 16)

INITIAL FASTENER OR SPECIFIED REPAIR FASTENER		FASTENER SUBSTITUTION	
PART NUMBER	DESCRIPTION	EQUIVALENT	ALTERNATIVE
BACR15DY()-()	A286 CRES 100° SHEAR HEAD CLOSE TOLERANCE SHANK	NO EQUIVALENT	NAS1200()-()
BACR15DY()M()	MONEL 100° SHEAR HEAD CLOSE TOLERANCE SHANK	NO EQUIVALENT	NAS1200M()-()
BACR15FH()AD()	2117-T4 AL, ANODIZED, MODIFIED, 82° HEAD (INDEX HEAD)	NO EQUIVALENT	H
BACR15FH()DD()	2024-T4 AL, ANODIZED, MODIFIED, 82° HEAD (INDEX HEAD)	NO EQUIVALENT	H
BACR15FH()KE()	7050-T73 AL, ANODIZED, MODIFIED 82° HEAD (INDEX HEAD)	NO EQUIVALENT	H
BACR15GF()D()	2017-T4 AL, CONVERSION COATED, 100° PRECISION SHEAR HEAD	NO EQUIVALENT	BACR15CE()D() P
BACR15GH()KE()	7050-T73 AL, ANODIZED, INDEX HEAD	NO EQUIVALENT	H
MS20427M()	MONEL, 100° HEAD	NO EQUIVALENT	BACR15GE()C() E I J
MS20427M()C()	MONEL, CADMIUM PLATED, 100° HEAD	NO EQUIVALENT	BACR15GE()CW() E I J
MS20426AD	2117-T4 AL, ANODIZED, 100° HEAD	BACR15BA()AD()	BACR15BA()AD()C MS20426AD
MS20426DD	2024-T4 AL, ANODIZED, 100° HEAD	BACR15BA()DD()	BACR15DR()-() E I J K BACR15DR()AC() E I J
MS20426D()-()	2017-T4 AL, ANODIZED, 100° HEAD	BACR15BA()D()	BACR15BA()D()C BACR15BA()DD MS20426DD

RIVET - SOLID SHANK - FLUSH HEAD
TABLE III

Fastener Substitution - Rivets
Figure 1 (Sheet 8 of 16)

INITIAL FASTENER OR SPECIFIED REPAIR FASTENER		FASTENER SUBSTITUTION	
PART NUMBER	DESCRIPTION	EQUIVALENT	ALTERNATIVE
MS20426A	1100-F, 100° HEAD	BACR15BA()A()	BACR15DR()-() E I J K
MS20426B	5056-H32 AL, ANODIZED, 100° HEAD	BACR15BA()B()	BACR15DR()AC() E I J
BACR15FV()KE()	7050-T73 AL, ANODIZED OR CONVERSION COATED, 120° MODIFIED SHEAR HEAD	MS14218E()-()	NO ALTERNATIVE
MS14218E()-()	7050-T73 AL, ANODIZED OR CONVERSION COATED, 120° FLUSH INTERFERENCE SHEAR HEAD	BACR15FV()KE()	NO ALTERNATIVE

RIVET - SOLID SHANK - FLUSH HEAD
TABLE III

Fastener Substitution - Rivets
Figure 1 (Sheet 9 of 16)

INITIAL FASTENER OR SPECIFIED REPAIR FASTENER		FASTENER SUBSTITUTION	
PART NUMBER	DESCRIPTION	EQUIVALENT	ALTERNATIVE
BACR15DA()-()	5056-F AL BLIND SELF PLUGGING	NO EQUIVALENT	BACR15FR()E()R NAS1398B()-() NAS1738B()-() NAS1738E()-()
BACR15DA()H()	5056-F AL BLIND-PULL THRU	NO EQUIVALENT	BACR15FR()E()R MS20604B()T() MS20604B()W() NAS1398B()-() NAS1738B()-() NAS1738E()-()
BACR15DR()P()	NONSTRUCTURAL (PULL THRU TYPE), C1018 STEEL SLEEVE, CAD PLATED, MAX TEMP 450°F (232°C), UNIVERSAL HEAD	NO EQUIVALENT	BACR15BB()D [D] BACR15DR()PAC() BACR15FT()D() [D] MS20470D [D]
BACR15EB-P()-()	BULBED CHERRYLOCK, SELF-PLUGGING, 5056 AL SLEEVE. MAX TEMP 250°F (121°C)	NO EQUIVALENT	BACR15FR()E()R NAS1738E NAS1738MW
BACR15FR()E()R	CHERRY-MAX SYSTEM, CRES STEM, 5056 AL SLEEVE, LOCKED SPINDLE-BULBED, MAX TEMP 250°F	ALLFAST AF3253-()-()B CHERRY CR3253-()-() HUCK HR3253-()-()	NO ALTERNATIVE
CHERRY CR6253-()-()	CHERRY SST, 5056 AL SLEEVE, A-286 CRES STEM, A-286 CRES LOCK COLLAR, UNIVERSAL HEAD, OVERSIZED DIAMETER, MAX TEMP 250°F	NO EQUIVALENT	NO ALTERNATIVE
NAS1398B()-() [C]	5056 AL SLEEVE, LOCKED SPINDLE, PARTIAL SERRATED STEM, MAX TEMP 250°F, UNIVERSAL HEAD	CHERRY CR2263-()-() ALLFAST AF2050-()-()	NAS1398D()-() [C] [E] NAS398D()A() [C] [E] NAS1738E [B] BACR15FR()E() [B] BACR15FR()E()R [B] NAS1738B [B]

RIVET - BLIND - PROTRUDING HEAD
TABLE IV

Fastener Substitution - Rivets
Figure 1 (Sheet 10 of 16)

INITIAL FASTENER OR SPECIFIED REPAIR FASTENER		FASTENER SUBSTITUTION	
PART NUMBER	DESCRIPTION	EQUIVALENT	ALTERNATIVE
NAS1398B()A() [C]	5056 AL SLEEVE, LOCKED SPINDLE, FULL SERRATED STEM, MAX TEMP 250°F	CHERRY CR2273-()-() ALLFAST RV1250-()-()	BACR15FR()E() [B] BACR15FR()E()R [B] NAS1398B()-() [C] NAS1398D()-() [C] [E] NAS1398D()A() [C] [E] NAS1738B [B] NAS1738E [B]
NAS1398C()-() [C]	A-286 CRES SLEEVE, LOCKED SPINDLE, PARTIAL SERRATED STEM, MAX TEMP 1200°F	CHERRY CR2663-()-() ALLFAST AF2040-()-()	NAS1398C()A() [C]
NAS1398C()A() [C]	A-286 CRES SLEEVE, LOCKED SPINDLE, FULL SERRATED STEM, MAX TEMP 1200°F (649°C)	CHERRY CR2673-()-() ALLFAST RV1240-()-()	NAS1398C()-() [C]
NAS1398CW()-() [C]	A-286 CRES SLEEVE, CADMIUM PLATED, LOCKED SPINDLE, PARTIAL SERRATED STEM, MAX TEMP 450°F (232°C)	ALLFAST AF2040W-()-() CHERRY CR2663CW-()-()	NAS1398CW()A() [C]
NAS1398CW()A() [C]	A-286 CRES SLEEVE, CADMIUM PLATED, LOCKED SPINDLE, FULL SERRATED STEM, MAX TEMP 450°F (232°C)	CHERRY CR2673CW-()-() ALLFAST RV1240W-()-()	NAS1398CW()-() [C]
NAS1398D()-() [C]	2017 AL SLEEVE, LOCKED SPINDLE, PARTIAL SERRATED STEM, MAX TEMP 250°F (121°C)	ALLFAST AF2000-()-() CHERRY CR2163-()-()	BACR15FR()E() [B] BACR15FR()E()R [B] NAS1398D()A() [C] NAS1738B [B] NAS1738E [B]
NAS1398D()A() [C]	2017 AL SLEEVE, LOCKED SPINDLE, FULL SERRATED STEM, MAX TEMP 250°F (121°C)	ALLFAST RV1200-()-() CHERRY CR2173-()-()	BACR15FR()E() [B] BACR15FR()E()R [B] NAS1398D()-() [C] NAS1738B [B] NAS1738E [B]

RIVET - BLIND - PROTRUDING HEAD
TABLE IV

Fastener Substitution - Rivets
Figure 1 (Sheet 11 of 16)

INITIAL FASTENER OR SPECIFIED REPAIR FASTENER		FASTENER SUBSTITUTION	
PART NUMBER	DESCRIPTION	EQUIVALENT	ALTERNATIVE
NAS1398M()-() $\boxed{C}$	MONEL SLEEVE, LOCKED SPINDLE, PARTIAL SERRATED STEM, MAX TEMP 900°F (482°C)	ALLFAST AF2090M-()-() CHERRY CR2563M-()-()	BACR15FR()M() $\boxed{B}$ BACR15FR()M()R $\boxed{B}$ NAS1398M()A() $\boxed{C}$ NAS1738M $\boxed{B}$
NAS1398M()A() $\boxed{C}$	MONEL SLEEVE, LOCKED SPINDLE, FULL SERRATED STEM, MAX TEMP 900°F (482°C)	ALLFAST RV1290M-()-() CHERRY CR2573-()-()	BACR15FR()M() $\boxed{B}$ BACR15FR()M()R $\boxed{B}$ NAS1398M()-() $\boxed{C}$ NAS1738M $\boxed{B}$
NAS1398MW()-() $\boxed{C}$	MONEL SLEEVE, CADMIUM PLATED, LOCKED SPINDLE, PARTIAL SERRATED STEM, MAX TEMP 450°F (232°C)	ALLFAST AF2090W-()-() CHERRY CR2563-()-()	NAS1398MW()A() $\boxed{C}$ NAS1738MW $\boxed{B}$
NAS1398MW()A() $\boxed{C}$	MONEL SLEEVE, CADMIUM PLATED, LOCKED SPINDLE, FULL SERRATED STEM, MAX TEMP 450°F (232°C)	ALLFAST RV1290-()-() CHERRY CR2573P-()-()	NAS1398MW()-() $\boxed{C}$ NAS1738MW $\boxed{B}$
NAS1738B()-()	5056 AL SLEEVE, MECHANICALLY LOCKED SPINDLE, BULBED, MAX TEMP 250°F, UNIVERSAL HEAD	CHERRY CR2249-()-()	NAS1738E BACR15FR()E BACR15FR()E()R
NAS1738C	INCONEL 600 SLEEVE, MECHANICALLY LOCKED SPINDLE, BULBED, MAX TEMP 250°F (121°C), UNIVERSAL HEAD	CHERRY CR2839-()-()	NO ALTERNATIVE
NAS1738E()-()	5056 AL SLEEVE, MECHANICALLY LOCKED SPINDLE, BULBED, MAX TEMP 250°F (121°C)	CHERRY CR2239-()-() ALLFAST AF2550-()-()	BACR15FR()E() BACR15FR()E()R
NAS1738M()-()	MONEL SLEEVE, MECHANICALLY LOCKED SPINDLE, BULBED, MAX TEMP 900°F (482°C)	CHERRY CR2539-()-() ALLFAST AF2290-()-()	BACR15FR()M() BACR15FR()M()R
NAS1738MW()-()	MONEL SLEEVE, MECHANICALLY LOCKED SPINDLE, BULBED, MAX TEMP 450°F (232°C)	CHERRY CR2539P-()-() ALLFAST AF2290W-()-()	BACR15FR()MP() $\boxed{M}$

RIVET - BLIND - PROTRUDING HEAD
TABLE IV

Fastener Substitution - Rivets
Figure 1 (Sheet 12 of 16)

INITIAL FASTENER OR SPECIFIED REPAIR FASTENER		FASTENER SUBSTITUTION	
PART NUMBER	DESCRIPTION	EQUIVALENT	ALTERNATIVE
BACR15DA()C()	5056-F BLIND 100° HEAD SELF PLUGGING	NO EQUIVALENT	BACR15FP()E()R NAS1399B()-() NAS1739B()-() NAS1739E()-()
BACR15DA()CH()	5056-F BLIND 100° HEAD PULL THRU	NO EQUIVALENT	BACR15FP()E()R NAS1399B()-() NAS1739B()-() NAS1739E()-() MS20605B()T() MS20605B()W()
BACR15DR()-()	NON-STRUCTURAL (PULL THRU TYPE), C1018 STEEL SLEEVE, CADMIUM PLATED, 100° HEAD, MAX TEMP 450°F (232°C)	CHERRY CCR264SS-()-() ALLFAST AF5171-()-()	BACR15BA()AD()C D BACR15BA()D()C D BACR15DR()AC() BACR15GE()CW()
BACR15EB()-()	BULBED CHERRYLOCK, SELF-PLUGGING, 5056 AL SLEEVE. MAX TEMP 250°F (121°C)	NO EQUIVALENT	BACR15FP()E()R NAS1739E NAS1739MW NAS1739B
BACR15FP()E()R	CHERRY-MAX SYSTEM, 5056 AL SLEEVE, CADMIUM PLATED, 100° HEAD, MAX TEMP 250°F (121°C)	ALLFAST AF3252-()-()B CHERRY CR3252-()-() HUCK HR3252-()-()	NO ALTERNATIVE
NAS1399B()A() C	5056 AL SLEEVE, LOCKED SPINDLE, 100° HEAD, FULL SERRATED STEM, MAX TEMP 250°F (121°C)	CHERRY CR2272-()-() ALLFAST RV1251-()-() CHERRY CR2262-()-()	BACR15FP()E() B BACR15FP()E()R B NAS1399B()-() C NAS1399D()-() C E NAS1399D()A() C E NAS1739B B NAS1739E B
NAS1399B()-() C	5056 AL SLEEVE, LOCKED SPINDLE, 100° HEAD, PARTIAL SERRATED STEM, MAX TEMP 250°F (121°C)	CHERRY CR2262-()-() ALLFAST AF2051-()-() VOI-SHAN CR9262-()A()	BACR15FP()E() B BACR15FP()E()R B NAS1399B()A() C NAS1399D()-() C E NAS1399D()A() C E NAS1739B B NAS1739E B

RIVET - BLIND - FLUSH HEAD
TABLE V

Fastener Substitution - Rivets
Figure 1 (Sheet 13 of 16)

INITIAL FASTENER OR SPECIFIED REPAIR FASTENER		FASTENER SUBSTITUTION	
PART NUMBER	DESCRIPTION	EQUIVALENT	ALTERNATIVE
NAS1399C()-()	A-286 CRES SLEEVE, LOCKED SPINDLE, 100° HEAD, PARTIAL SERRATED STEM, MAX TEMP 250°F	CHERRY CR2662-()-() ALLFAST AF2041-()-()	NAS1399C()A()
NAS1399C()A() [C]	A-286 CRES SLEEVE, LOCKED SPINDLE, 100° HEAD, FULL SERRATED STEM, MAX TEMP 1200°F	CHERRY CR2672-()-() ALLFAST RV1241-()-() CHERRY CR2662-()-()	NAS1399C()-() [C]
NAS1399CW()-() [C]	A-286 CRES SLEEVE, CAD PLATED, LOCKED SPINDLE, 100° HEAD, PARTIAL SERRATED STEM, MAX TEMP 450°F	ALLFAST AF2041W-()-() CHERRY CR2662CW-()-()	NAS1399CW()A() [C]
NAS1399CW()A() [C]	A-286 CRES SLEEVE, CADMIUM PLATED, LOCKED SPINDLE, 100° HEAD, FULL SERRATED STEM, MAX TEMP 450°F	CHERRY CR2672CW-()-() ALLFAST RV1241W-()-() CHERRY CR2662W-()-()	NAS1399CW()-() [C]
NAS1399D()-() [C]	2017 AL SLEEVE, LOCKED SPINDLE, 100° HEAD, PARTIAL SERRATED STEM, MAX TEMP 250°F	CHERRY CR2162-()-() ALLFAST AF2001W-()-() VOI-SHAN CR9162-()A()	BACR15FP()E() [B] BACR15FP()E()R [B] NAS1399D()A() [C] NAS1739B [B] NAS1739E [B]
NAS1399D()A() [C]	2017 AL SLEEVE, LOCKED SPINDLE, 100° HEAD, FULL SERRATED STEM, MAX TEMP 250°F	CHERRY CR2172-()-() ALLFAST RV1201-()-() CHERRY CR2162-()-() VOI-SHAN CR9162-()A()	BACR15FP()E() [B] BACR15FP()E()R [B] NAS1739B()-() [B] NAS1399D()-() [C] NAS1739E()-() [B]
NAS1399M()-() [C]	MONEL SLEEVE, LOCKED SPINDLE, 100° HEAD, PARTIAL SERRATED STEM, MAX TEMP 900°F	CHERRY CR2562M-()() ALLFAST AF2091-()-()	BACR15FP()M() [B] BACR15FP()M()R [B] NAS1399M()A() [C] NAS1739M [B]

RIVET - BLIND - FLUSH HEAD
TABLE V

Fastener Substitution - Rivets
Figure 1 (Sheet 14 of 16)

INITIAL FASTENER OR SPECIFIED REPAIR FASTENER		FASTENER SUBSTITUTION	
PART NUMBER	DESCRIPTION	EQUIVALENT	ALTERNATIVE
NAS1399M()A() [C]	MONEL SLEEVE, LOCKED SPINDLE, 100° HEAD, FULL SERRATED STEM, MAX TEMP 900°F	CHERRY CR2572-()-() ALLFAST RV1291M-()-() CHERRY CR2562M-()-()	BACR15FP()M() [B] BACR15FP()M()R [B] NAS1399M()-() [C] NAS1739M [B]
NAS1399MW()-() [C]	MONEL SLEEVE, CADMIUM PLATED, LOCKED SPINDLE, 100° HEAD, PARTIAL SERRATED STEM, MAX TEMP 450°F	CHERRY CR2562-()-() ALLFAST AF2091W-()-()	NAS1739MW [B] NAS1399MW()A() [C]
NAS1399MW()A() [C]	MONEL SLEEVE, CADMIUM PLATED, LOCKED SPINDLE, 100° HEAD, FULL SERRATED STEM, MAX TEMP 450°F	ALLFAST RV1291-()-() CHERRY CR2572P-()-() CHERRY CR2562-()-()	NAS1399MW()-() [C] NAS1739MW [B]
NAS1739B	5056 AL SLEEVE, 100° HEAD, MECHANICALLY LOCKED SPINDLE, BULBED, MAX TEMP 250°F	CHERRY CR2248-()-()	BACR15FP()E() BACR15FP()E()R NAS1739E
NAS1739C	INCONEL 600 SLEEVE, 100° HEAD, MECHANICALLY LOCKED SPINDLE, BULBED	CHERRY CR2838-()-()	NO ALTERNATIVE
NAS1739E()-()	5056 AL SLEEVE, 100° HEAD, MECHANICALLY LOCKED SPINDLE, BULBED, MAX TEMP 250°F	ALLFAST AF2551()-() CHERRY CR2238()-() CHERRY CR3252-()-() BACR15FP()E()	BACR15FP()E() BACR15FP()E()R
NAS1739M	MONEL SLEEVE, 100° HEAD, MECHANICALLY LOCKED SPINDLE, BULBED, MAX TEMP 900°F	ALLFAST AF2291-()-() CHERRY CR2538-()-()	BACR15FP()M() BACR15FP()M()R
NAS1739MW	MONEL SLEEVE, CADMIUM PLATED, 100° HEAD, MECHANICALLY LOCKED SPINDLE, BULBED, MAX TEMP 450°F	ALLFAST AF2291W-()-() CHERRY CR2538P-()-()	BACR15FP()MP() [M]

RIVET - BLIND - FLUSH HEAD
TABLE V

Fastener Substitution - Rivets
Figure 1 (Sheet 15 of 16)

INITIAL FASTENER OR SPECIFIED REPAIR FASTENER		FASTENER SUBSTITUTION	
PART NUMBER	DESCRIPTION	EQUIVALENT	ALTERNATIVE
BACR15BD()AD()	2117-T4 AL, ANODIZED	NO EQUIVALENT	H
BACR15BD()DD()	2024-T4 AL, ANODIZED	NO EQUIVALENT	H
BACR15GG()KE()	7050-T73 AL, ANODIZED	NO EQUIVALENT	H

RIVETS - SLUG
TABLE VI

Fastener Substitution - Rivets
Figure 1 (Sheet 16 of 16)

NOTES

- REFER TO TABLE I FOR THE FASTENER SUBSTITUTION INDEX.
- REFER TO SRM 51-40-02 FOR THE REMOVAL AND THE INSTALLATION OF FASTENERS.
- THE SHEAR AND TENSION TYPE FASTENERS USE DIFFERENT TORQUE VALUES AND INSTALLATION TOOLS. REFER TO SRM 51-40-04.
- REFER TO SRM 51-20-01 FOR THE NECESSARY PROTECTIVE TREATMENT FOR FASTENER INSTALLATION.
- DO NOT USE CADMIUM PLATED FASTENERS IN TITANIUM OR GRAPHITE (CARBON FIBER) STRUCTURE.

[A] DO NOT USE ALLOY STEEL FASTENERS AS AN ALTERNATIVE FOR THE CORROSION RESISTANT STEEL (CRES) OR TITANIUM FASTENERS IN:

- AREAS WHERE ANTI-MAGNETIC FASTENERS ARE NECESSARY
- GRAPHITE (CARBON FIBER) STRUCTURE
- CRES STRUCTURE

[B] THESE BOLTS MUST HAVE A HOLE WITH A LARGER FILLET RELIEF UNDER THE BOLT HEAD. REFER TO SRM 51-40-05.

USE THESE FASTENERS ONLY IF THERE IS NOT A HEIGHT LIMIT ON THE FASTENER HEAD.

[C] ASK THE BOEING COMPANY FOR FASTENER ALTERNATIVES.

[D] A WASHER WITH A COUNTERBORE THAT IS EQUIVALENT TO THE COUNTERBORE OF THE COLLAR MUST BE USED ON THE NUT SIDE IF NUTS ARE USED. NUTS CAN BE USED AS AN ALTERNATIVE FOR THE HEX-DRIVE BOLT COLLARS.

[E] WHEN A H-11 STEEL BOLT IS REMOVED FOR ANY REASON, ALWAYS REPLACE THE BOLT WITH AN ALTERNATIVE FASTENER.

[F] THESE FASTENERS ARE PERMITTED ONLY IN CLOSE REAM OR LARGER HOLES (NON-INTERFERENCE HOLES).

[G] WHEN A PH13-8Mo CRES BOLT IS REMOVED FOR ANY REASON, ALWAYS REPLACE THE BOLT WITH AN ALTERNATIVE FASTENER.

[H] WHEN A CADMIUM PLATED TITANIUM BOLT IS REMOVED FOR ANY REASON, ALWAYS REPLACE THE BOLT WITH AN ALTERNATIVE FASTENER.

[I] THIS FASTENER IS NOT PERMITTED IN AREAS WHERE THE TEMPERATURE IS MORE THAN 350°F (177°C).

THIS FASTENER IS NOT PERMITTED IN AREAS WHERE ELECTRICAL CONDUCTIVITY IS REQUIRED AS GIVEN IN BAC5117.

[J] THIS FASTENER IS ONLY PERMITTED IN METAL-TO-METAL ASSEMBLIES. DO NOT USE THESE FASTENERS IN COMPOSITE-TO-COMPOSITE OR COMPOSITE-TO-METAL ASSEMBLIES.

[K] THIS FASTENER IS NOT PERMITTED IN AREAS WHERE THE TEMPERATURE IS MORE THAN 450°F (232°C).

[L] THE RECOMMEND FASTENERS IN ALUMINUM STRUCTURE ARE ALUMINUM PIGMENT (BMS 10-85) COATED TITANIUM, ALUMINUM PIGMENT (BMS 10-85) COATED A286, OR CADMIUM PLATED A286.

<u>NOTE</u>: THE CADMIUM-PLATED ALLOY STEEL FASTENERS ARE PERMITTED AS A STRUCTURAL ALTERNATIVE.

HOWEVER, AN ALLOY-STEEL FASTENER, AND THE ADJACENT ALUMINUM STRUCTURE TOGETHER CAN CAUSE CORROSION.

THEREFORE, THESE FASTENERS, THE EQUIVALENT, AND THE ALTERNATIVE MUST BE INSTALLED WET WITH THE CORRECT SEALANT.

BOEING RECOMMENDS THAT YOU APPLY TWO COATS OF BMS 10-79 TYPE III PRIMER ON THE FASTENER HEAD.

[M] DO NOT USE CADMIUM PLATED FASTENERS AS AN ALTERNATIVE FOR BARE OR ALUMINUM COATED FASTENERS WHEN YOU INSTALL FASTENERS THROUGH THE MATERIALS THAT FOLLOW:

- TITANIUM STRUCTURE
- GRAPHITE (CARBON FIBER) STRUCTURE.

[N] THIS FASTENER IS PERMITTED FOR FASTENERS THAT ARE 0.625 INCH OR LESS IN DIAMETER.

[O] THESE COLLARS CAN BE USED ON SURFACES THAT HAVE A SLOPE OF 7 DEGREES (OR LESS) ANGLE.

[P] THE PART WITH D-CODE (DRIVE NUT) IS RECOMMENDED.

[Q] ALLOY STEEL FASTENERS MUST BE REPLACED WITH ALLOY STEEL FASTENERS WHEN YOU ATTACH A SENSOR TARGET TO THE TARGET MOUNTING BRACKET AT CYLINDRICAL PROXIMITY SENSOR INSTALLATIONS.

[R] A WASHER IS NECESSARY FOR THIS TYPE OF INSTALLATION. REFER TO SRM 51-40-02.

[S] SUBSTITUTION IS PERMITTED FOR 0.3125 AND 0.375 DIAMETER FASTENERS ONLY.

[T] THE FASTENER MUST BE INSTALLED WITH TORQUE CONTROLLED TOOLING. REFER TO SRM 51-40-04.

[U] THIS FASTENER IS NOT PERMITTED IN AREAS WHERE THE TEMPERATURE IS MORE THAN 600°F (316°C).

Fastener Substitution - Bolts
Figure 2 (Sheet 1 of 67)

NOTES (CONTINUED)

[V] THIS SUBSTITUTION IS PERMITTED ONLY IF THE DIAMETER OF THE FASTENER IS 4 THRU 10.

[W] SUBSTITUTION IS NOT PERMITTED WHERE RE-TORQUING OF THE FASTENER IS NECESSARY.

[X] USE THE SAME NUT OR COLLAR THAT WAS USED ON THE INITIAL OR SPECIFIED REPAIR FASTENER.

[Y] APPLICABLE ONLY FOR DIAMETERS THAT ARE 0.250 INCH AND LARGER.

[Z] WHEN YOU REMOVE ALLOY STEEL BOLTS THAT HAVE A LAYER OF BMS 10-85 (NOT CAD PLATED) APPLIED, ALWAYS REPLACE THEM WITH AN ALTERNATIVE FASTENER.

[AA] THE MAXIMUM TEMPERATURE GIVEN IN THE DESCRIPTION IS FOR THE BOLT ONLY. THE MAXIMUM TEMPERATURE APPLICATION FOR THE BOLT/COLLAR COMBINATION MAY BE LESS, IF THERE ARE LIMITS PUT ON THE COLLAR.

THE FOLLOWING GUIDELINES ARE APPLICABLE TO THE COLLARS:

- ALUMINUM COLLARS HAVE A MAXIMUM TEMPERATURE OF 250°F (171°C)
- CADMIUM PLATED CRES COLLARS HAVE A MAXIMUM TEMPERATURE OF 450°F (232°C)
- UNPLATED CRES COLLARS HAVE A MAXIMUM TEMPERATURE OF 900°F (482°C)
- MONEL COLLARS HAVE A MAXIMUM TEMPERATURE OF 900°F (482°C).

Fastener Substitution - Bolts
Figure 2 (Sheet 2 of 67)

TYPE OF FASTENER	LOCATION OF FASTENER	
	TABLE NUMBER	SHEET NUMBERS
BOLT - HEX DRIVE - PROTRUDING HEAD (SHEAR)	TABLE II	4 THRU 12
BOLT - HEX DRIVE - FLUSH HEAD (SHEAR)	TABLE III	13 THRU 24
BOLT - HEX DRIVE - PROTRUDING HEAD (TENSION)	TABLE IV	25 THRU 29
BOLT - HEX DRIVE - FLUSH HEAD (TENSION)	TABLE V	30 THRU 34
BOLT - EXTERNAL WRENCHING - PROTRUDING HEAD	TABLE VI	35 THRU 48
BOLT - RECESS DRIVE - FLUSH HEAD	TABLE VII	49 THRU 56
BOLT - RECESS DRIVE - PROTRUDING HEAD	TABLE VIII	57 THRU 59
BOLT - BLIND - PROTRUDING HEAD	TABLE IX	60 THRU 61
BOLT - BLIND - FLUSH HEAD	TABLE X	62 THRU 64
BOLT - TAPER SHANK - PROTRUDING HEAD	TABLE XI	65 THRU 67

BOLT FASTENER SUBSTITUTION INDEX
TABLE I

Fastener Substitution - Bolts
Figure 2 (Sheet 3 of 67)

INITIAL FASTENER OR SPECIFIED REPAIR FASTENER			FASTENER SUBSTITUTION		
PART NUMBER	DESCRIPTION	MATING PART	EQUIVALENT	ALTERNATIVE	MATING PART
BACB30FM()-() [Q] [AA]	ALLOY STEEL, CADMIUM PLATED, 95 KSI SHEAR, CETYL ALCOHOL LUBRICATED, MAX TEMP 450°F (232°C)	BACC30AG()	HI-SHEAR HL18PB	BACB30FM()A()	BACC30AG()
			SPS HL18PB	BACB30MY()K() [I]	BACC30AG()
			HUCK HL18PB	BACB30VN()K() [I]	BACC30BK()
			FAIRCHILD HL18PB	BACB30VT()K() [I]	BACC30BQ()
		BACC30M()	DEUTSCH HL18PB	BACB30FM()A() [I]	BACC30M()
			AIC HL18PB	BACB30MY()K() [I]	BACC30M()
			WEST COAST HL18PB	BACB30VT()K() [I]	BACC30BL()
					BACN10YZ() [T]
					BACN10ZV() [T]
BACB30FM()A() [AA]	A-286 CRES, CADMIUM PLATED, 95 KSI SHEAR, CETYL ALCOHOL LUBRICATED, MAX TEMP 450°F (232°C)	BACC30AB()C	HI-SHEAR HL440UC	BACB30MY()K() [I]	BACC30AB()C
			SPS HL440UC	BACB30VT()K() [I]	BACC30BS()
		BACC30AB()S	HUCK HL440UC	BACB30MY()K() [I]	BACC30AB()S
			FAIRCHILD HL440UC	BACB30VT()K() [I]	BACC30BS()S
		BACC30AG()	DEUTSCH HL440UC	BACB30MY()K() [I]	BACC30AG()
			AIC HL440UC	BACB30VT()K() [I]	BACC30BQ()
		BACC30M()	WEST COAST HL440UC	BACB30MY()K() [I]	BACC30M()
				BACB30VT()K() [I]	BACC30BL()
BACB30FM()A()SU [AA]	A286 CRES, PASSIVATED, 95 KSI SHEAR, DRY FILM LUBRICATED, MAX TEMP 450°F (232°C)	BACC30AB()S	HI-SHEAR HL40DU	BACB30FM()A()U	BACC30AB()S
			SPS HL40DU	BACB30MB()A()SU	BACC30AB()S
			HUCK HL40DU	BACB30MB()A()U	BACC30AB()S
			DEUTSCH HL40DU		
			FAIRCHILD HL40DU		
			AIC HL40DU		
			WEST COAST HL40DU		

BOLT - HEX DRIVE - PROTRUDING HEAD (SHEAR)
TABLE II

Fastener Substitution - Bolts
Figure 2 (Sheet 4 of 67)

INITIAL FASTENER OR SPECIFIED REPAIR FASTENER			FASTENER SUBSTITUTION		
PART NUMBER	DESCRIPTION	MATING PART	EQUIVALENT	ALTERNATIVE	MATING PART
BACB30FM()A()U [AA]	A286 CRES, PASSIVATED, 95 KSI SHEAR, CETYL ALCOHOL LUBRICATED, MAX TEMP 900°F (482°C)	BACC30AB()P	HI-SHEAR HL40 SPS HL40 HUCK HL40 FAIRCHILD HL40 DEUTSCH HL40 AIC HL40 WEST COAST HL40	BACB30MB()A()U	BACC30AB()P
		BACC30AB()S		BACC30MB()A()U	BACC30AB()S
BACB30FM()AK() [AA]	A-286 CRES, ALUMINUM PIGMENTED COATING, 95 KSI SHEAR, CETYL ALCOHOL LUBRICATED, MAX TEMP 350°F (177°C)	BACC30AB()S	HI-SHEAR HL440AZ SPS HL440AZ HUCK HL440AZ FAIRCHILD HL440AZ DEUTSCH HL440AZ AIC HL440AZ WEST COAST HL440AZ	BACB30MY()K()	BACC30AB()S
		BACC30M()		BACB30MY()K()	BACC30M() BACN10XJ() [T]
BACB30FM()K() [Q] [Z] [AA]	ALLOY STEEL, ALUMINUM PIGMENTED COATING, 95 KSI SHEAR, CETYL ALCOHOL LUBRICATED, MAX TEMP 350°F (177°C)	BACC30M()		BACB30FM()-() [L] [M]	BACC30M() BACN10XJ() [T]
				BACB30MY()K()	BACC30M() BACN10XJ() [T]
				BACB30VT()K()	BACC30BL() BACN10YZ() [T]
				BACB30FM()AK()	BACC30M() BACN10XJ() [T]
		BACC30AG()		BACB30FM()-() [L] [M]	BACC30AG() BACN10ZZ()D [T]
				BACB30MY()K()	BACC30AG() BACN10ZZ()D [T]
				BACB30VT()K()	BACC30BQ()
				BACB30FM()AK()	BACC30AG() BACN10ZZ()D [T]

BOLT - HEX DRIVE - PROTRUDING HEAD (SHEAR)
TABLE II

Fastener Substitution - Bolts
Figure 2 (Sheet 5 of 67)

INITIAL FASTENER OR SPECIFIED REPAIR FASTENER			FASTENER SUBSTITUTION		
PART NUMBER	DESCRIPTION	MATING PART	EQUIVALENT	ALTERNATIVE	MATING PART
BACB30GZ()-() [AA]	7075-T6 AL, ANODIZED, 44.5 KSI SHEAR, CETYL ALCOHOL LUBRICATED, MAX TEMP 250°F (121°C)	BACC30P	HI-SHEAR HL22 FAIRCHILD HL22 WEST COAST HL22	NO ALTERNATIVE	
BACB30MY()C() [H] [AA]	6AL-4V TITANIUM CADMIUM PLATED, 95 KSI SHEAR, CETYL ALCOHOL LUBRICATED, MAX TEMP 450°F (232°C)	BACC30AB()C	NO EQUIVALENT	BACB30FM()AK() [I]	BACB30AB()C
					BACN10YT()CD [T]
				BACB30MB()AK() [I]	BACC30X()
					BACN10BH()
					BACN10YT()CD [T]
				BACB30MY()K() [I]	BACC30AB()C
					BACN10YT()CD [T]
				BACB30NX()K() [I]	BACC30BH()
					BACC30X()
					BACN10YT()CD [T]
				BACB30VT()K() [I]	BACC30BS()
		BACC30AG()		BACB30FM()-() [A] [L]	BACC30AG()
					BACN10ZZ()D [T]
				BACB30FM()A()	BACC30AG()
					BACN10ZZ()D [T]
				BACB30FM()AK() [I]	BACC30AG()
					BACN10ZZ()D [T]
				BACB30MY()K() [I]	BACC30AG()
					BACN10ZZ()D [T]
				BACB30VN()K() [I] [J]	BACC30BK()
				BACB30VT()K() [I]	BACC30BQ()

BOLT - HEX DRIVE - PROTRUDING HEAD (SHEAR)
TABLE II

Fastener Substitution - Bolts
Figure 2 (Sheet 6 of 67)

INITIAL FASTENER OR SPECIFIED REPAIR FASTENER			FASTENER SUBSTITUTION		
PART NUMBER	DESCRIPTION	MATING PART	EQUIVALENT	ALTERNATIVE	MATING PART
BACB30MY()C() [H] [AA]	6AL-4V TITANIUM, CADMIUM PLATED, 95 KSI SHEAR, CETYL ALCOHOL LUBRICATED, MAX TEMP 450°F (232°C)	BACC30M()	NO EQUIVALENT	BACB30FM()-() [A] [L]	BACC30AB()C
					BACC30AG()
					BACC30M()
					BACN10XJ() [T]
					BACN10YT()CD [T]
					BACN10ZZ()D [T]
				BACB30FM()A()	BACC30AB()C
					BACC30AG()
					BACC30M()
					BACN10XJ() [T]
					BACN10ZZ()D [T]
				BACB30FM()AK() [I]	BACC30AB()C
					BACC30AG()
					BACC30M()
					BACN10XJ() [T]
					BACN10YT()CD [T]
					BACN10ZZ()D [T]
				BACB30GW()A()	BACC30K()
					NAS1080E
				BACB30MB()-()	BACC30BH()
					BACC30X()
					BACN10YT()CD
				BACB30MB()A()	BACC30BH()
					BACC30X()
					BACN10YT()CD

BOLT - HEX DRIVE - PROTRUDING HEAD (SHEAR)
TABLE II

Fastener Substitution - Bolts
Figure 2 (Sheet 7 of 67)

INITIAL FASTENER OR SPECIFIED REPAIR FASTENER			FASTENER SUBSTITUTION		
PART NUMBER	DESCRIPTION	MATING PART	EQUIVALENT	ALTERNATIVE	MATING PART
BACB30MY()C() [H] [AA]	6AL-4V TITANIUM, CADMIUM PLATED, CETYL ALCOHOL LUBRICATED, MAX TEMP 450°F (232°C)	BACC30M()	NO EQUIVALENT	BACB30MY()K() [I]	BACC30AB()C
					BACC30AG()
					BACC30M()
					BACN10XJ() [T]
					BACN10YT()CD [T]
					BACN10ZZ()D [T]
				BACB30NX()K() [I]	BACC30BH() BACC30X() BACN10YT()CD [T]
				BACB30VN()K() [I] [J]	BACC30BK()
				BACB30VT()K() [I]	BACC30BL() BACC30BQ() BACN10YZ()
BACB30MY()K() [AA]	6AL-4V TITANIUM, ALUMINUM PIGMENTED COATING, 95 KSI SHEAR, CETYL ALCOHOL LUBRICATED, MAX TEMP 350°F (177°C)	BACC30AB()C	HI-SHEAR HL10VAZ	BACB30VT()K()	BACC30BS()
		BACC30AB()S	SPS HL10VAZ	BACB30FM()AK()	BACC30AB()S
			HUCK HL10VAZ		BACN10YT()CS [T]
			FAIRCHILD HL10VAZ		BACN10YT()CSA [T]
			DEUTSCH HL10VAZ	BACB30MB()AK()	BACC30X()S
			AIC HL10VAZ		BACN10BH()S
			WEST COAST HL10VAZ	BACB30NM()K() [F]	BACN10GW()AS
					NAS1805-() [R]
				BACB30NX()K()	BACC30BH()S [R]
					BACC30X()S
		BACC30AG()		BACB30FM()-() [A] [L] [M]	BACC30AG()
					BACN10ZZ()D [T]
				BACB30FM()A() [M]	BACC30AG()
					BACN10ZZ()D [T]
				BACB30FM()AK()	BACC30AG()
					BACN10ZZ()D [T]
				BACB30VN()K() [J]	BACC30BK()
				BACB30VT()K()	BACC30BQ()

BOLT - HEX DRIVE - PROTRUDING HEAD (SHEAR)
TABLE II

Fastener Substitution - Bolts
Figure 2 (Sheet 8 of 67)

INITIAL FASTENER OR SPECIFIED REPAIR FASTENER			FASTENER SUBSTITUTION		
PART NUMBER	DESCRIPTION	MATING PART	EQUIVALENT	ALTERNATIVE	MATING PART
BACB30MY()K() [AA]	6AL-4V TITANIUM, ALUMINUM PIGMENTED COATING, 95 KSI SHEAR, CETYL ALCOHOL LUBRICATED, MAX TEMP 350°F (177°C)	BACC30M()	HI-SHEAR HL10VAZ	BACB30FM()-() [A] [L] [M]	BACC30AB()C
			SPS HL10VAZ		BACC30AG()
			HUCK HL10VAZ		BACC30M()
			FAIRCHILD HL10VAZ		BACN10XJ() [T]
			DEUTSCH HL10VAZ		BACN10YT()CD [T]
			AIC HL10VAZ		BACN10ZZ()D [T]
			WEST COAST HL10VAZ	BACB30FM()A() [M]	BACC30AB()C
					BACC30AG()
					BACC30M()
					BACCN10XJ() [T]
					BACN10YT()CD [T]
					BACN10ZZ()D [T]
				BACB30FM()AK()	BACC30AB()C
					BACC30AG()
					BACC30M()
					BACN10XJ() [T]
					BACN10YT()CD [T]
					BACN10ZZ()D [T]
				BACB30GW()A() [J] [M]	BACC30K()
					NAS1080E
				BACB30MB()-() [A] [L] [M]	BACC30BH()
					BACC30X()
					BACN10YT()CD [T]
				BACB30MB()A() [M]	BACC30BH()
					BACC30X()
					BACN10YT()CD [T]
				BACB30NX()K()	BACC30BH()
					BACC30X()
					BACN10YT()CD [T]
				BACB30VN()K() [J]	BACC30BK()
				BACB30VT()K()	BACC30BL()
					BACN10YZ() [T]

BOLT - HEX DRIVE - PROTRUDING HEAD (SHEAR)
TABLE II

Fastener Substitution - Bolts
Figure 2 (Sheet 9 of 67)

INITIAL FASTENER OR SPECIFIED REPAIR FASTENER			FASTENER SUBSTITUTION		
PART NUMBER	DESCRIPTION	MATING PART	EQUIVALENT	ALTERNATIVE	MATING PART
BACB30MY()R() [AA]	6AL-4V TITANIUM, PHOSPHATE FLUORIDE COATED, 95 KSI SHEAR, CETYL ALCOHOL LUBRICATED, MAX TEMP 600°F (316°C)	BACC30AG()	HI-SHEAR HL10VRA	BACB30MY()K() [I]	BACC30AG()
		BACC30M()	SPS HL10VRA	BACB30MY()K() [I]	BACC30M()
			HUCK HL10VRA		BACN10XJ() [T]
			FAIRCHILD HL10VRA		
			DEUTSCH HL10VRA		
			AIC HL10VRA		
			WEST COAST HL10VRA		
BACB30VT5HK() [AA]	6AL-4V TITANIUM, ALUMINUM PIGMENTED COATING, 95 KSI SHEAR, LIGHTWEIGHT, CETYL ALCOHOL LUBRICATED, MAX TEMP 350°F (177°C) (ENLARGED V HEX)		HI-SHEAR HST108AG	BACB30VT5K()	
			SPS HST108AG		
			AIC HST108AG		
			FAIRCHILD VL310AG		
			HUCK VL310AG		
BACB30VT()K() [AA]	6AL-4V TITANIUM, ALUMINUM PIGMENTED COATING, 95 KSI SHEAR, LIGHTWEIGHT, CETYL ALCOHOL LUBRICATED, MAX TEMP 350°F (177°C)	BACC30BL()	HI-SHEAR HST10AG	BACB30MY()K()	BACC30AB()C
			SPS HST10AG		BACC30AG()
			AIC HST10AG		BACC30M()
			FAIRCHILD VL10AG	BACB30VN()K() [J]	BACC30BK() [O]
		BACC30BP()	HUCK VL10AG	BACB30VN()K() [J]	BACC30BK() [O]
		BACC30BQ()		BACB30MY()K()	BACC30AG()
				BACB30VN()K() [J]	BACC30BK() [O]
		BACC30BS()S		BACB30MY()K()	BACC30AB()S
		BACN10YZ()		BACB30MY()K()	BACN10XJ() [T]
		BACN10ZV()		BACB30MY()K()	BACN10XJ() [T]
BACB30XE()K()	6AL-4V TITANIUM AL COATED, 95 KSI SHEAR, LIGHTWEIGHT, CETYL ALCOHOL LUBRICATED, SWAGE LOCKING	BACC30CG()	NO EQUIVALENT	BACB30VT()K()	BACC30BS()S
		BACC30CH()		BACB30VT()K()	BACC30BS()S WITH BACW10CA()CCU AND BACW10CA()PVU
		BACC30CK()		BACB30VT()K()	BACC30BL()

BOLT - HEX DRIVE - PROTRUDING HEAD (SHEAR)
TABLE II

Fastener Substitution - Bolts
Figure 2 (Sheet 10 of 67)

INITIAL FASTENER OR SPECIFIED REPAIR FASTENER			FASTENER SUBSTITUTION		
PART NUMBER	DESCRIPTION	MATING PART	EQUIVALENT	ALTERNATIVE	MATING PART
BACB30YL()K()	NICKEL ALLOY 718, 125 KSI SHEAR, ALUMINUM PIGMENTED COATING, CETYL ALCOHOL LUBRICATED, MAX TEMP 350°F (177°C)	BACC30CQ()C	HI-SHEAR HLT420AP AIC HLT420AP SPS HLT420AP	HLT420AP	HL791RD
		BACC30CQ()S		HLT420AP	HL791BF
HLT420-()-()	NICKEL ALLOY 718, 125 KSI SHEAR, PASSIVATED, CETYL ALCOHOL LUBRICATED		BACB30YL()U()		
HLT420AP-()-()	NICKEL ALLOY 718, 125 KSI SHEAR, ALUMINUM PIGMENTED COATING, CETYL ALCOHOL LUBRICATED		BACB30YL()K()		
HLT420PB-()-()	NICKEL ALLOY 718, 125 KSI SHEAR, CADMIUM PLATED, CETYL ALCOHOL LUBRICATED			BACB30YL()K() [I]	
HLT620-()-()	NICKEL ALLOY 718, 1/64 OVERSIZE, 125 KSI SHEAR, PASSIVATED, CETYL ALCOHOL LUBRICATED		BACB30YL()U()X		
HLT620AP-()-()	NICKEL ALLOY 718, 1/64 OVERSIZE, 125 KSI SHEAR, ALUMINUM PIGMENTED COATING, CETYL ALCOHOL LUBRICATED		BACB30YL()K()X		

BOLT - HEX DRIVE - PROTRUDING HEAD (SHEAR)
TABLE II

Fastener Substitution - Bolts
Figure 2 (Sheet 11 of 67)

INITIAL FASTENER OR SPECIFIED REPAIR FASTENER			FASTENER SUBSTITUTION		
PART NUMBER	DESCRIPTION	MATING PART	EQUIVALENT	ALTERNATIVE	MATING PART
HLT620PB-()-()	NICKEL ALLOY 718, 1/64 OVERSIZE, 125 KSI SHEAR, CADMIUM PLATED, CETYL ALCOHOL LUBRICATED		NO EQUIVALENT	BACB30YL()K()X [I]	
HLT714-()-()	NICKEL ALLOY 718, 1/32 OVERSIZE, 125 KSI SHEAR, PASSIVATED CETYL ALCOHOL LUBRICATED		BACB30YL()U()Y		
HLT714AP-()-()	NICKEL ALLOY 718, 1/32 OVERSIZE, 125 KSI SHEAR, ALUMINUM PIGMENTED COATING, CETYL ALCOHOL LUBRICATED		BACB30YL()K()Y		
HLT714PB-()-()	NICKEL ALLOY 718, 1/32 OVERSIZE, 125 KSI SHEAR, CADMIUM PLATED, CETYL ALCOHOL LUBRICATED		NO EQUIVALENT	BACB30YL()K()Y [I]	
HL644AP-()-() [G]	PH13-8 Mo STAINLESS STEEL, ALUMINUM PIGMENTED COATING, CETYL ALCOHOL LUBRICATED		NO EQUIVALENT	HLT420AP-()-()	
HL860AP-()-()	6AL-4V TITANIUM, TITANIUM COMPOSITE APPLICATIONS, ALUMINUM PIGMENTED COATING, CETYL ETHYL LUBRICATED		BACB30VG()K()		

BOLT - HEX DRIVE - PROTRUDING HEAD (SHEAR)
TABLE II

Fastener Substitution - Bolts
Figure 2 (Sheet 12 of 67)

INITIAL FASTENER OR SPECIFIED REPAIR FASTENER			FASTENER SUBSTITUTION		
PART NUMBER	DESCRIPTION	MATING PART	EQUIVALENT	ALTERNATIVE	MATING PART
BACB30FN()-() Q AA	ALLOY STEEL, 100° HEAD, CADMIUM PLATED, 95 KSI SHEAR, CETYL ALCOHOL LUBRICATED MAX TEMP 450°F (232°C)	BACC30AG()	HI-SHEAR HL19PB	BACB30FN()A()	BACC30AG()
			SPS HL19PB	BACB30NW()K() I	BACC30AG()
			HUCK HL19PB	BACB30VU()K() I	BACC30BQ()
			DEUTSCH HL19PB	BACB30YP()K() I	BACC30BQ()
		BACC30M()	FAIRCHILD HL19PB	BACB30FN()A()	BACC30M()
			AIC HL19PB	BACB30NW()K() I	BACC30M()
			WEST COAST HL19PB	BACB30VU()K() I	BACC30BL()
					BACN10YZ() T
					BACN10ZV() T
				BACB30YP()K() I	BACC30BL()
					BACN10YZ() T
					BACN10ZV() T
BACB30FN()A() AA	A286 CRES, 100° HEAD, CADMIUM PLATED, 95 KSI SHEAR, CETYL ALCOHOL LUBRICATED MAX TEMP 450°F (232°C)	BACC30AB()C	HI-SHEAR HL441UC	BACB30NW()K() I	BACC30AB()C
			SPS HL441UC	BACB30VU()K() I	BACC30BS()
			HUCK HL441UC	BACB30YP()K() I	BACC30BS()
		BACC30AB()S	DEUTSCH HL441UC	BACB30NW()K() I	BACC30AB()S
			FAIRCHILD HL441UC	BACB30YP()K() I	BACC30BS()S
			AIC HL441UC	BACB30VU()K() I	BACC30BS()S
		BACC30AG()	WEST COAST HL441UC	BACB30NW()K() I	BACC30AG()
				BACB30YP()K() I	BACC30BQ()
				BACB30VU()K() I	BACC30BQ()
		BACC30M()		BACB30NW()K() I	BACC30M()
				BACB30VU()K() I	BACC30BL()
					BACN10YZ() T
				BACB30YP()K() I	BACC30BL()
					BACN10YZ() T

BOLT - HEX DRIVE - FLUSH HEAD (SHEAR)
TABLE III

Fastener Substitution - Bolts
Figure 2 (Sheet 13 of 67)

INITIAL FASTENER OR SPECIFIED REPAIR FASTENER			FASTENER SUBSTITUTION		
PART NUMBER	DESCRIPTION	MATING PART	EQUIVALENT	ALTERNATIVE	MATING PART
BACB30FN()AK() AA	A286 CRES, 100° HEAD, ALUMINUM PIGMENTED COATING, 95 KSI SHEAR, CETYL ALCOHOL LUBRICATED MAX TEMP 350°F (177°C)	BACC30AB()C	HI-SHEAR HL441AZ	BACB30NW()K()	BACC30AB()C
			SPS HL441AZ	BACB30VU()K()	BACC30BS()
			HUCK HL441AZ	BACB30YP()K()	BACC30BS()
		BACC30AB()S	DEUTSCH HL441AZ	BACB30NW()K()	BACC30AB()S
			FAIRCHILD HL441AZ	BACB30VU()K()	BACC30BS()S
			AIC HL441AZ	BACB30YP()K()	BACC30BS()S
			WEST COAST HL441AZ		
			WEST COAST WC131		
			AIC L-839C		
BACB30FN()A()SU	A286 CRES, PASSIVATED, 95 KSI SHEAR, DRY FILM LUBRICATED, 100° HEAD MAX TEMP 450°F (232°C)	BACC30AB()S	HI-SHEAR HL41DU	BACB30FN()A()U	BACC30AB()S
			SPS HL41DU		
			HUCK HL41DU		
			DEUTSCH HL41DU		
			FAIRCHILD HL41DU		
			AIC HL41DU		
			WEST COAST HL41DU		
BACB30FN()A()U AA	A286 CRES, PASSIVATED, 95 KSI SHEAR, CETYL ALCOHOL LUBRICATED, 100° HEAD MAX TEMP 900°F (482°C)	BACC30AB()P	HI-SHEAR HL41	NO ALTERNATIVE	
		BACC30AB()S	SPS HL41		
			HUCK HL41		
			DEUTSCH HL41		
			FAIRCHILD HL41		
			AIC HL41		
			WEST COAST HL41		

BOLT - HEX DRIVE - FLUSH HEAD (SHEAR)
TABLE III

Fastener Substitution - Bolts
Figure 2 (Sheet 14 of 67)

INITIAL FASTENER OR SPECIFIED REPAIR FASTENER			FASTENER SUBSTITUTION		
PART NUMBER	DESCRIPTION	MATING PART	EQUIVALENT	ALTERNATIVE	MATING PART
BACB30FN()K() [Q] [Z]	ALLOY STEEL, AL COATED, 95 KSI SHEAR, CETYL ALCOHOL LUBRICATED, MAX TEMP 350°F (177°C)	BACC30AG()	NO EQUIVALENT	BACB30FN()A() [M]	BACC30AG()
				BACB30NW()K()	BACC30AG()
				BACB30VU()K()	BACC30BQ()
				BACB30YP()K()	BACC30BQ()
		BACC30M()		BACB30FN()A() [M]	BACC30M()
				BACB30NW()K()	BACC30M()
				BACB30VU()K()	BACC30BL()
					BACN10YZ() [T]
					BACN10ZV() [T]
				BACB30YP()K()	BACC30BL()
					BACN10YZ() [T]
					BACN10ZV() [T]
BACB30HA()-() [AA]	7075-T6 AL, ANODIZED, 44.5 KSI SHEAR, CETYL ALCOHOL LUBRICATED, 100° HEAD, MAX TEMP 250°F (121°C)	BACC30P()	HI-SHEAR HL23 FAIRCHILD HL23 WESTCOAST HL23	NO ALTERNATIVE	
BACB30HA()R() [AA]	7075-T6 AL, ANODIZED, 44.5 KSI SHEAR, CETYL ALCOHOL LUBRICATED, 100° REDUCED SHEAR HEAD, MAX TEMP 250°F (121°C)	BACC30P()R	HI-SHEAR HL505 FAIRCHILD HL505 WESTCOAST HL505	NO ALTERNATIVE	
BACB30ND()-() [Q] [AA]	ALLOY STEEL, CADMIUM PLATED 95 KSI SHEAR, CETYL ALCOHOL LUBRICATED, 100° (MS20426) HEAD, MAX TEMP 450°F (232°C)	BACC30AG()	HI-SHEAR HL525 SPS HL525 HUCK HL525 DEUTSCH HL525 FAIRCHILD HL525 WEST COAST HL525	BACB30ND()A()	BACC30AG()
					BACN10ZZ()D [T]
				BACB30NZ()K() [I]	BACC30AG()
					BACN10ZZ()D [T]
		BACC30M()		BACB30ND()A()	BACC30M()
				BACB30NZ()K() [I]	BACC30M()

BOLT - HEX DRIVE - FLUSH HEAD (SHEAR)
TABLE III

Fastener Substitution - Bolts
Figure 2 (Sheet 15 of 67)

INITIAL FASTENER OR SPECIFIED REPAIR FASTENER			FASTENER SUBSTITUTION		
PART NUMBER	DESCRIPTION	MATING PART	EQUIVALENT	ALTERNATIVE	MATING PART
BACB30ND()A() [AA]	A286 CRES, CADMIUM PLATED, 95 KSI SHEAR, CETYL ALCOHOL LUBRICATED, 100° (MS20426) HEAD, MAX TEMP 450°F (232°C)	BACC30AG()	HI-SHEAR HL445PB	BACB30ND()-() [A] [L]	BACC30AG()
			SPS HL445PB		BACN10ZZ()D [T]
			HUCK HL445PB	BACB30NZ()K() [I]	BACC30AG()
			DEUTSCH HL445PB		BACN10ZZ()D [T]
		BACC30M()	FAIRCHILD HL445PB	BACB30ND()-() [A] [L]	BACC30M()
			WEST COAST HL445PB	BACB30NZ()K() [I]	BACC30M()
BACB30ND()A()U [AA]	A286 CRES, PASSIVATED, 95 KSI SHEAR, CETYL ALCOHOL LUBRICATED, 100° (MS20426) HEAD, MAX TEMP 900°F (482°C)	BACC30AB()P	HI-SHEAR HL445	NO ALTERNATIVE	
			SPS HL445		
			HUCK HL445		
			DEUTSCH HL445		
			FAIRCHILD HL445		
			WEST COAST HL445		
BACB30NW()C() [H] [AA]	6AL-4V TITANIUM, 100° REDUCED HEAD, CADMIUM PLATED, 95 KSI SHEAR, CETYL ALCOHOL LUBRICATED, MAX TEMP 450°F (232°C)	BACC30AB()C	NO EQUIVALENT	BACB30FN()-() [A] [L]	BACC30AB()C
					BACN10YT()CD [T]
				BACB30FN()A()	BACC30AB()C
					BACN10YT()CD [T]
				BACB30FN()AK() [I]	BACC30AB()C
					BACN10YT()CD [T]
				BACB30VU()K() [I]	BACC30BS()
				BACB30YP()K() [I]	BACC30BS()
		BACC30AG()		BACB30FN()-() [A] [L]	BACC30AG()
					BACN10ZZ()D [T]
				BACB30FN()A()	BACC30AG()
					BACN10ZZ()D [T]
				BACB30FN()AK() [I]	BACC30AG()
					BACN10ZZ()D [T]
				BACB30NW()K() [I]	BACC30AG()
					BACN10ZZ()D [T]
				BACB30TY()K() [I] [J]	BACC30BE()
				BACB30VM()K() [I] [J]	BACC30BK()
				BACB30VU()K() [I]	BACC30BQ()
				BACB30YP()K() [I]	BACC30BQ()

BOLT - HEX DRIVE - FLUSH HEAD (SHEAR)
TABLE III

Fastener Substitution - Bolts
Figure 2 (Sheet 16 of 67)

INITIAL FASTENER OR SPECIFIED REPAIR FASTENER			FASTENER SUBSTITUTION		
PART NUMBER	DESCRIPTION	MATING PART	EQUIVALENT	ALTERNATIVE	MATING PART
BACB30NW()C() [H] [AA]	6AL-4V TITANIUM, 100° REDUCED HEAD, CADMIUM PLATED, 95 KSI SHEAR, CETYL ALCOHOL LUBRICATED, MAX TEMP 450°F (232°C)	BACC30M()	NO EQUIVALENT	BACB30FN()-() [A] [L]	BACC30AG()
					BACC30M()
				BACB30FN()A()	BACC30AB()C
					BACC30AG()
					BACC30M()
					BACN10XJ() [T]
					BACN10YT()CD [T]
					BACN10ZZ()D [T]
				BACB30FN()AK() [I]	BACC30AB()C
					BACC30AG()
					BACC30M()
					BACN10XJ() [T]
					BACN10YT()CD [T]
					BACN10ZZ()D [T]
				BACB30NW()K() [I]	BACC30AG()
					BACN10ZZ()D [T]
				BACB30TY()K() [I] [J]	BACC30BE()
				BACB30VM()K() [I] [J]	BACC30BK()
				BACB30VU()K() [I]	BACC30BL()
					BACN10YZ() [T]
				BACB30YP()K() [I]	BACC30BL()
					BACN10YZ() [T]

BOLT - HEX DRIVE - FLUSH HEAD (SHEAR)
TABLE III

Fastener Substitution - Bolts
Figure 2 (Sheet 17 of 67)

INITIAL FASTENER OR SPECIFIED REPAIR FASTENER			FASTENER SUBSTITUTION		
PART NUMBER	DESCRIPTION	MATING PART	EQUIVALENT	ALTERNATIVE	MATING PART
BACB30NW()K() [AA]	6AL-4V TITANIUM, 100° REDUCED HEAD, ALUMINUM PIGMENTED COATING, 95 KSI SHEAR, CETYL ALCOHOL LUBRICATED	BACC30AB()C	HI-SHEAR HL11VAZ	BACB30FN()-() [A] [L] [M]	BACC30AB()C
			SPS HL11VAZ		BACN10YT()CD [T]
			HUCK HL11VAZ	BACB30FN()A() [M]	BACC30AB()C
			DEUTSCH HL11VAZ		BACN10YT()CD [T]
			FAIRCHILD HL11VAZ	BACB30FN()AK()	BACC30AB()C
			AIC HL11VAZ		BACN10YT()CD [T]
			WEST COAST HL11VAZ	BACB30VU()K()	BACC30BS()
				BACB30YP()K()	BACC30BS()
		BACC30AB()S		BACB30VU()K()	BACC30BS()S
				BACB30YP()K()	BACC30BS()S
		BACC30AG()		BACB30FN()-() [A] [L] [M]	BACC30AG()
					BACN10ZZ()D [T]
				BACB30FN()A() [M]	BACC30AG()
					BACN10ZZ()D [T]
				BACB30FN()AK()	BACC30AG()
					BACN10ZZ()D [T]
				BACB30TY()K() [J]	BACC30BE()
				BACB30VM()K() [J]	BACC30BK()
				BACB30VU()K()	BACC30BQ()
				BACB30YP()K()	BACC30BQ()
		BACC30M()		BACB30FN()-() [A] [L] [M]	BACC30AG()
					BACC30M()
				BACB30FN()A() [M]	BACC30AB()C
					BACC30AG()
					BACC30M()
					BACN10XJ() [T]
					BACN10YT()CD [T]
					BACN10ZZ()D [T]
				BACB30FN()AK()	BACC30AB()C
					BACC30AG()
					BACC30M()
					BACN10XJ() [T]
					BACN10YT()CD [T]
					BACN10ZZ()D [T]

BOLT - HEX DRIVE - FLUSH HEAD (SHEAR)
TABLE III

Fastener Substitution - Bolts
Figure 2 (Sheet 18 of 67)

INITIAL FASTENER OR SPECIFIED REPAIR FASTENER			FASTENER SUBSTITUTION		
PART NUMBER	DESCRIPTION	MATING PART	EQUIVALENT	ALTERNATIVE	MATING PART
BACB30NW()K() [AA]	6AL-4V TITANIUM, 100° REDUCED HEAD, ALUMINUM PIGMENTED COATING, 95 KSI SHEAR, CETYL ALCOHOL LUBRICATED	BACC30M()	HI-SHEAR HL11VAZ SPS HL11VAZ HUCK HL11VAZ DEUTSCH HL11VAZ FAIRCHILD HL11VAZ AIC HL11VAZ WEST COAST HL11VAZ	BACB30TY()K() [J]	BACC30BE()
				BACB30VM()K() [J]	BACC30BK()
				BACB30VU()K()	BACC30BL()
					BACN10YZ() [T]
		BACN10YT()CS		BACB30VU()K()	BACC30BS()S [W]
				BACB30YP()K()	BACC30BS()S [W]
		BACN10YT()CD		BACB30VU()K()	BACC30BS() [W]
				BACB30YP()K()	BACC30BS() [W]
BACB30NW()R() [AA]	6AL-4V TITANIUM, 100° REDUCED HEAD, PHOSPHATE FLUORIDE COATED, 95 KSI SHEAR, CETYL ALCOHOL LUBRICATED	BACC30AG()	HI-SHEAR HL11VRA SPS HL11VRA HUCK HL11VRA DEUTSCH HL11VRA FAIRCHILD HL11VRA AIC HL11VRA WEST COAST HL11VRA	BACB30VU()K() [I]	BACC30BQ()
				BACB30YP()K() [I]	BACC30BQ()
		BACC30M()		BACB30VU()K() [I]	BACC30BL()
					BACN10YZ() [T]
				BACB30YP()K() [I]	BACC30BL()
					BACN10YZ() [T]
BACB30NW()S() [AA]	6AL-4V TITANIUM, 100° REDUCED HEAD, PHOSPHATE FLUORIDE COATED, 95 KSI SHEAR, SOLID FILM LUBRICATED	BACC30AB()S	HI-SHEAR HL11VSY SPS HL11VSY HUCK HL11VSY DEUTSCH HL11VSY FAIRCHILD HL11VSY AIC HL11VSY WEST COAST HL11VSY	BACB30VU()S()	BACC30BS()S
BACB30NZ()C() [H] [AA]	6AL-4V TITANIUM, CAD PLATED 95 KSI SHEAR, CETYL ALCOHOL LUBRICATED, 100° (MS20426) HEAD, MAX TEMP 450°F (232°C)	BACC30M()	NO EQUIVALENT	BACB30ND()-() [A] [L]	BACC30M()
				BACB30ND()A()	BACC30M()
				BACB30NZ()K() [I]	BACC30M()
		BACC30AG()		BACB30ND()-() [A] [L]	BACC30AG()
					BACN10ZZ()D [T]
				BACB30ND()A()	BACC30AG()
					BACN10ZZ()D [T]
				BACB30NZ()K() [I]	BACC30AG()
					BACN10ZZ()D [T]
		BACC30AB()C		BACB30ND()A()	BACC30AB()C
				BACB30NZ()K() [I]	BACC30AB()C

BOLT - HEX DRIVE - FLUSH HEAD (SHEAR)
TABLE III

Fastener Substitution - Bolts
Figure 2 (Sheet 19 of 67)

INITIAL FASTENER OR SPECIFIED REPAIR FASTENER			FASTENER SUBSTITUTION		
PART NUMBER	DESCRIPTION	MATING PART	EQUIVALENT	ALTERNATIVE	MATING PART
BACB30NZ()K() [AA]	6AL-4V TITANIUM, ALUMINUM PIGMENTED COATING 95 KSI SHEAR, CETYL ALCOHOL LUBRICATED, 100° (MS20426) HEAD, MAX TEMP 350°F (177°C)	BACC30M()	HI-SHEAR HL523AZ SPS HL523AZ HUCK HL523AZ DEUTSCH HL523AZ FAIRCHILD HL523AZ WEST COAST HL523AZ AIC HL523AZ	BACB30ND()A() [M]	BACC30M()
				BACB30ND()-() [A] [L] [M]	BACC30M()
		BACC30AG()		BACB30ND()A() [M]	BACC30AG()
					BACN10ZZ()D [T]
				BACB30ND()-() [A] [L] [M]	BACC30AG()
					BACN10ZZ()D [T]
		BACC30AB()C		BACB30ND()A() [M]	BACC30AB()C
BACB30VU5HK() [AA]	6AL-4V TITANIUM, 100° REDUCED HEAD, ALUMINUM PIGMENTED COATING, 95 KSI SHEAR, LIGHTWEIGHT, CETYL ALCOHOL LUBRICATED, (ENLARGED INTERNAL HEX)		HI-SHEAR HST109AG SPS HST109AG AIC HST109AG	BACB30VU5K()	
BACB30VU()K() [AA]	6AL-4V TITANIUM, 100° REDUCED HEAD, ALUMINUM PIGMENTED COATING, 95 KSI SHEAR, LIGHTWEIGHT, CETYL ALCOHOL LUBRICATED	BACC30BL()	HI-SHEAR HST11AG SPS HST11AG AIC HST11AG FAIRCHILD VL11AG HUCK VL11AG	BACB30NW()K()	BACC30M()
				BACB30VM()K() [J]	BACC30BK() [O]
				BACB30XT()K() [J]	BACC30BK() [O]
				BACB30YP()K()	BACC30BL()
		BACC30BP()		BACB30VM()K() [J]	BACC30BK() [O]
				BACB30XT()K() [J]	BACC30BK() [O]
				BACB30YP()K()	BACC30BP()
		BACC30BQ()		BACB30NW()K()	BACN10ZZ()D [T]
					BACC30AG()
				BACB30VM()K()	BACC30BK()
				BACB30XT()K()	BACC30BK()
				BACB30YP()K()	BACC30BQ()
		BACC30BS()		BACB30YP()K()	BACC30BS()
		BACC30BS()S		BACB30YP()K()	BACC30BS()S
		BACN10YZ()		BACC30NW()K()	BACN10YT()CD [T]
		BACN10ZV()		BACB30NW()K()	BACN10YT()CD [T]

BOLT - HEX DRIVE - FLUSH HEAD (SHEAR)
TABLE III

Fastener Substitution - Bolts
Figure 2 (Sheet 20 of 67)

INITIAL FASTENER OR SPECIFIED REPAIR FASTENER			FASTENER SUBSTITUTION		
PART NUMBER	DESCRIPTION	MATING PART	EQUIVALENT	ALTERNATIVE	MATING PART
BACB30XG()K()	6AL-4V TITANIUM, 100 DEGREES (MS20426) HEAD, AL COATED 95 KSI SHEAR LIGHTWEIGHT, CETYL ALCOHOL LUBRICATED, SWAGE LOCKING	BACC30CG()	NO EQUIVALENT	BACB30NZ()K()	BACC30AB()S
					BACN10YR()CM $\boxed{D}$ $\boxed{S}$
		BACC30CH()		BACB30NZ()K()	BACC30AB()S WITH BACW10CA()CCU AND BACW10CA()PVU
		BACC30CK()		BACB30NZ()K()	BACC30M()
					BACN10YR()CD $\boxed{D}$
BACB30XR()K()	6AL-4V TITANIUM, 130 DEGREES SHEAR HEAD, AL COATED LIGHTWEIGHT, CETYL ALCOHOL LUBRICATED, SWAGE LOCKING	BACC30CG()	NO EQUIVALENT	BACB30WM()K()	BACC30BS()S
					BACN10YR()CM $\boxed{D}$
		BACC30CH()		BACB30WM()K()	BACC30BU()PW
					BACN10YR()CM WITH BACW10CA()CCU AND BACW10CA()PVU
BACB30YN()K()	NICKEL ALLOY 718, 125 KSI SHEAR, 100° REDUCED SHEAR HEAD	BACC30CQ()C	HI-SHEAR HLT421AP	HLT421AP	HL791RD
		BACC30CQ()S	AIC HLT421AP	HLT421AP	HL791BF
BACB30YP()K() $\boxed{AA}$	6AL-4V TITANIUM, 100° REDUCED SHEAR DOME HEAD, ALUMINUM PIGMENTED COATING, 95 KSI SHEAR, LIGHTWEIGHT, CETYL ALCOHOL LUBRICATED	BACC30BL()	AIR INDUSTRIES HST331 FAIRCHILD VL331 HI-SHEAR HST331 HUCK VL18	BACB30NW()K()	BACC30M()
					BACN10XJ() $\boxed{T}$
				BACB30VM()K() $\boxed{J}$	BACC30BK() $\boxed{O}$
				BACB30XT()K() $\boxed{J}$	BACC30BK() $\boxed{O}$
				BACB30VU()K()	BACC30BL()
					BACN10YZ() $\boxed{T}$
		BACC30BP()		BACB30VM()K() $\boxed{J}$	BACC30BK() $\boxed{O}$
				BACB30XT()K() $\boxed{J}$	BACC30BK() $\boxed{O}$
				BACB30VU()K()	BACC30BP()

BOLT - HEX DRIVE - FLUSH HEAD (SHEAR)
TABLE III

Fastener Substitution - Bolts
Figure 2 (Sheet 21 of 67)

INITIAL FASTENER OR SPECIFIED REPAIR FASTENER			FASTENER SUBSTITUTION		
PART NUMBER	DESCRIPTION	MATING PART	EQUIVALENT	ALTERNATIVE	MATING PART
BACB30YP()K() [AA]	6AL-4V TITANIUM, 100° REDUCED SHEAR DOME HEAD, ALUMINUM PIGMENTED COATING, 95 KSI SHEAR, LIGHTWEIGHT, CETYL ALCOHOL LUBRICATED	BACC30BQ()		BACB30NW()K()	BACC30AG()
					BACN10ZZ()D [T]
				BACB30VM()K() [J]	BACC30BK()
				BACB30XT()K() [J]	BACC30BK()
				BACB30VU()K()	BACC30BQ()
		BACC30BS()		BACB30VU()K()	BACC30BS()
		BACC30BS()S		BACB30VU()K()	BACC30BS()S
		BACN10YZ()		BACC30NW()K()	BACN10YT()CD
		BACN10ZV()		BACB30NW()K()	BACN10YT()CD [T]
HLT421-()-() [AA]	NICKEL ALLOY 718, 125 KSI SHEAR, 100° HEAD, GRIT BLAST TOP OF HEAD, PASSIVATED, CETYL ALCOHOL LUBRICATED		BACB30YN()U()	NO ALTERNATIVE	
HLT421AP-()-() [AA]	NICKEL ALLOY 718, 125 KSI SHEAR, 100° HEAD, ALUMINUM PIGMENTED COATING, CETYL ALCOHOL LUBRICATED		BACB30YN()K()	NO ALTERNATIVE	
HLT421PB-()-() [AA]	NICKEL ALLOY 718, 125 KSI SHEAR, 100° HEAD, CADMIUM PLATED, CETYL ALCOHOL LUBRICATED			BACB30YN()K() [I]	

BOLT - HEX DRIVE - FLUSH HEAD (SHEAR)
TABLE III

Fastener Substitution - Bolts
Figure 2 (Sheet 22 of 67)

INITIAL FASTENER OR SPECIFIED REPAIR FASTENER			FASTENER SUBSTITUTION		
PART NUMBER	DESCRIPTION	MATING PART	EQUIVALENT	ALTERNATIVE	MATING PART
HLT621-()-()	NICKEL ALLOY 718, 125 KSI SHEAR, 1/64 OVERSIZE, 100° HEAD, PASSIVATED CETYL ALCOHOL LUBRICATED		BACB30YN()U()X	NO ALTERNATIVE	
HLT621AP-()-()	NICKEL ALLOY 718, 125 KSI SHEAR, 1/64 OVERSIZE, 100° HEAD, ALUMINUM PIGMENTED COATING, CETYL ALCOHOL LUBRICATED		BACB30YN()K()X	NO ALTERNATIVE	
HLT621PB-()-()	NICKEL ALLOY 718, 125 KSI SHEAR, 1/64 OVERSIZE, 100° HEAD, CADMIUM PLATED, CETYL ALCOHOL LUBRICATED		NO EQUIVALENT	BACB30YN()K()X [I]	
HLT715-()-()	NICKEL ALLOY 718, 125 KSI SHEAR, 1/32 OVERSIZE, 100° HEAD, PASSIVATED, CETYL ALCOHOL LUBRICATED		BACB30YN()U()Y		
HLT715AP-()-()	NICKEL ALLOY 718, 125 KSI SHEAR, 1/32 OVERSIZE, 100° HEAD, ALUMINUM PIGMENTED COATING, CETYL ALCOHOL LUBRICATED		BACB30YN()K()Y		

BOLT - HEX DRIVE - FLUSH HEAD (SHEAR)
TABLE III

Fastener Substitution - Bolts
Figure 2 (Sheet 23 of 67)

INITIAL FASTENER OR SPECIFIED REPAIR FASTENER			FASTENER SUBSTITUTION		
PART NUMBER	DESCRIPTION	MATING PART	EQUIVALENT	ALTERNATIVE	MATING PART
HLT715PB-()-()	NICKEL ALLOY 718, 125 KSI SHEAR, 1/32 OVERSIZE, 100° HEAD, CADMIUM PLATED, CETYL ALCOHOL LUBRICATED		NO EQUIVALENT	BACB30YN()K()Y [I]	
HL645AP-()-() [G]	PH13-8 Mo STAINLESS STEEL, 100° FLUSH HEAD, ALUMINUM PIGMENTED COATING, CETYL ALCOHOL LUBRICATED		NO EQUIVALENT	BACB30YN()K() HLT421AP-()-()	
HL645PB-()-() [G]	PH13-8 Mo STAINLESS STEEL, 100° FLUSH HEAD, CADMIUM PLATED, CETYL ALCOHOL LUBRICATED		NO EQUIVALENT	BACB30YN()K() [I] HLT421AP-()-() [I]	
HL645TB-()-() [G]	PH13-8 Mo STAINLESS STEEL, 100° FLUSH HEAD, SOLID FILM, CETYL ALCOHOL LUBRICATED		NO EQUIVALENT	BACB30YN()K() [I] HLT421AP-()-() [I]	
HL859AP-()-()	6AL-4V TITANIUM, 156° FLUSH 3.5D HEAD, TITANIUM COMPOSITE APPLICATIONS, ALUMINUM PIGMENTED COATING, CETYL ALCOHOL LUBRICATED	HL97	NO EQUIVALENT	HL859AZ-()-()	HL97

BOLT - HEX DRIVE - FLUSH HEAD (SHEAR)
TABLE III

Fastener Substitution - Bolts
Figure 2 (Sheet 24 of 67)

INITIAL FASTENER OR SPECIFIED REPAIR FASTENER			FASTENER SUBSTITUTION		
PART NUMBER	DESCRIPTION	MATING PART	EQUIVALENT	ALTERNATIVE	MATING PART
BACB30MB()-() [Q] [AA]	ALLOY STEEL, 160 KSI TENSION, 95 KSI SHEAR, CADMIUM PLATED, CETYL ALCOHOL LUBRICATED, MAX TEMP 450°F (232°C)	BACC30M()	HI-SHEAR HL1050PB SPS HL1050PB HUCK HL1050PB FAIRCHILD HL1050PB AIC HL1050PB WEST COAST HL1050PB	BACB30MB()A()	BACC30M() BACN10XJ() [T]
				BACB30NX()K() [I]	BACC30M() BACN10XJ() [T]
		BACC30BH() OR BACC30X()		BACB30MB()A()	BACC30BH() BACC30X() BACN10YT()CD [T]
				BACB30NX()K() [I]	BACC30BH() BACC30X() BACN10YT()CD [T]
BACB30MB()A() [AA]	A286 CRES, 160 KSI TENSION, 95 KSI SHEAR, CADMIUM PLATED, CETYL ALCOHOL LUBRICATED, MAX TEMP 450°F (232°C)	BACC30BH() OR BACC30X()	HI-SHEAR HL448UC SPS HL448UC HUCK HL448UC FAIRCHILD HL448UC AIC HL448UC WEST COAST HL448UC	BACB30NX()K() [I]	BACC30BH() BACC30X() BACN10YT()CD [T]
BACB30MB()A()U [AA]	A286 CRES, 160 KSI TENSION, 95 KSI SHEAR, PASSIVATED CETYL ALCOHOL LUBRICATED, MAX TEMP 900°F (482°C)	BACC30BH()P OR BACC30X()P	HI-SHEAR HL448 SPS HL448 HUCK HL448 FAIRCHILD HL448 AIC HL448 WEST COAST HL448	BACB30NX()-()	BACC30BH()P BACC30X()P BACN10YT()CSA [T]
		BACC30BH()S OR BACC30X()S		BACB30NX()-()	BACC30BH()S BACC30X()S BACN10YT()CSA [T]

BOLT - HEX DRIVE - PROTRUDING HEAD (TENSION)
TABLE IV

Fastener Substitution - Bolts
Figure 2 (Sheet 25 of 67)

INITIAL FASTENER OR SPECIFIED REPAIR FASTENER			FASTENER SUBSTITUTION		
PART NUMBER	DESCRIPTION	MATING PART	EQUIVALENT	ALTERNATIVE	MATING PART
BACB30MB()AK() [AA]	A286 CRES, 160 KSI TENSION, 95 KSI SHEAR, ALUMINUM PIGMENTED COATING, CETYL ALCOHOL LUBRICATED, MAX TEMP 350°F (177°C)	BACC30BH() OR BACC30X()	HI-SHEAR HL448AZ SPS HL448AZ HUCK HL448AZ FAIRCHILD HL448AZ AIC HL448AZ WEST COAST HL448AZ WEST COAST WC133	BACB30NX()K()	BACC30BH()
					BACC30X()
		BACC30BH()S OR BACC30X()S		BACB30NX()K()	BACC30BH()S
					BACC30X()S
BACB30MB()K() [Q] [Z] [AA]	ALLOY STEEL, AL COATED, 95 KSI SHEAR, CETYL ALCOHOL LUBRICATED, MAX TEMP 350°F (177°C)	BACC30BH() OR BACC30X()	NO EQUIVALENT	BACB30NX()K()	BACC30BH()
					BACC30X()
		BACC30BH()S OR BACC30X()S		BACB30NX()K()	BACC30BH()S
					BACC30X()S
BACB30NX()K()	6AL-4V TITANIUM, 95 KSI SHEAR, ALUMINUM PIGMENTED COATING, CETYL ALCOHOL LUBRICATED, MAX TEMP 350°F (177°C)	BACC30BH() OR BACC30X()	HI-SHEAR HL1012AZ SPS HL1012AZ HUCK HL1012AZ FAIRCHILD HL1012AZ AIC HL1012AZ WEST COAST HL1012AZ	BACB30MB()-() [A] [L] [M]	BACC30BH()
					BACC30X()
					BACN10YT()CD [T]
				BACB30MB()A() [M]	BACC30BH()
					BACC30X()
					BACN10YT()CD [T]
				BACB30MB()AK()	BACC30BH()
					BACC30X()
					BACN10YT()CD [T]
				BACB30NX()K()	BACN10YT()CD [T]
		BACC30BH()S OR BACC30X()S		BACB30LE()K() [B] [F]	BACN10HR()CS [R] [T]
				BACB30MB()AK()	BACC30BH()S
					BACC30X()S
		BACC30BH()SW OR BACC30X()SW		BACB30LE()K() [B] [F]	BACN10HR()CS [R] [T]
				BACB30MB()AK()	BACC30BH()S
					BACC30X()S

BOLT - HEX DRIVE - PROTRUDING HEAD (TENSION)
TABLE IV

Fastener Substitution - Bolts
Figure 2 (Sheet 26 of 67)

INITIAL FASTENER OR SPECIFIED REPAIR FASTENER			FASTENER SUBSTITUTION		
PART NUMBER	DESCRIPTION	MATING PART	EQUIVALENT	ALTERNATIVE	MATING PART
BACB30NX()C()	6AL-4V TITANIUM, 95 KSI SHEAR, CADMIUM PLATED, CETYL ALCOHOL LUBRICATED MAX TEMP 450°F (232°C)	BACC30X() OR BACC30BH()	NO EQUIVALENT	BACB30MB()-() [A] [L]	BACC30BH()
					BACC30X()
					BACN10YT()CD [T]
				BACB30MB()A()	BACC30BH()
					BACC30X()
					BACN30YT()CD [T]
				BACB30MB()AK() [I]	BACC30BH()
					BACC30X()
					BACN30YT()CD [T]
				BACB30NX()K() [I]	BACC30BH()
					BACC30X()
					BACN30YT()CD [T]
BACB30XH()K()	6AL-4V TITANIUM, LIGHTWEIGHT, AL COATED, CETYL ALCOHOL LUBRICATED, SWAGE LOCKING	BACC30CG()	NO EQUIVALENT	BACB30NX()K()	BACC30AB()S
					BACN10YR()CM [D] [S]
				BACB30VT()K() [J]	BACC30BS()S
		BACC30CH()		BACB30NX()K()	BACC30AB()S WITH BACW10CA()CCU AND BACW10CA()PVU
		BACC30CJ()		BACB30NX()K()	BACC30BH()S
		BACC30CK()		BACB30NX()K()	BACC30M()
					BACN10YR()CD [D]
				BACB30VT()K() [J]	BACC30BL()
					BACC30BZ()
BACB30XZ()K()	NICKEL ALLOY 718, LIGHTWEIGHT, PASSIVATED, AL COATED, CETYL ALCOHOL LUBRICATED, SWAGE LOCKING	BACC30CG()	NO EQUIVALENT	BACB30YK()K()	BACC30AB()S
					BAC10YR()CM [D] [S]
		BACC30CJ()		BACB30YK()K()	BACC30CP()S

BOLT - HEX DRIVE - PROTRUDING HEAD (TENSION)
TABLE IV

Fastener Substitution - Bolts
Figure 2 (Sheet 27 of 67)

INITIAL FASTENER OR SPECIFIED REPAIR FASTENER			FASTENER SUBSTITUTION		
PART NUMBER	DESCRIPTION	MATING PART	EQUIVALENT	ALTERNATIVE	MATING PART
BACB30YK()K()	NICKEL ALLOY 718, 125 KSI SHEAR, ALUMINUM PIGMENTED COATING, CETYL ALCOHOL LUBRICATED	BACC30CP()C	HI-SHEAR HLT422AP AIC HLT422AP	HLT422AP	HLT792KK
		BACC30CP()S		HLT422AP	HL792BT
HLT422-()-()	NICKEL ALLOY 718, GRIT BLAST TOP HEAD, PASSIVATED, CETYL ALCOHOL LUBRICATED		BACB30YK()U()		
HLT422AP-()-()	NICKEL ALLOY 718, ALLUMINUM PIGMENTED COATING, CETYL ALCOHOL LUBRICATED		BACB30YK()K()		
HLT422PB-()-()	NICKEL ALLOY 718, CADMIUM PLATED, CETYL ALCOHOL LUBRICATED			BACB30YK()K() $\boxed{I}$	
HLT622-()-()	NICKEL ALLOY 718, 1/64 OVERSIZE, PASSIVATED, CETYL ALCOHOL LUBRICATED		BACB30YK()U()X		
HLT622AP-()-()	NICKEL ALLOY 718, ALUMINUM PIGMENTED COATING, 1/64 OVERSIZE, CETYL ALCOHOL LUBRICATED		BACB30YK()K()X		

BOLT - HEX DRIVE - PROTRUDING HEAD (TENSION)
TABLE IV

Fastener Substitution - Bolts
Figure 2 (Sheet 28 of 67)

INITIAL FASTENER OR SPECIFIED REPAIR FASTENER			FASTENER SUBSTITUTION		
PART NUMBER	DESCRIPTION	MATING PART	EQUIVALENT	ALTERNATIVE	MATING PART
HLT622PB-()-()	NICKEL ALLOY 718, CADMIUM PLATED, 1/64 OVERSIZE, CETYL ALCOHOL LUBRICATED		NO EQUIVALENT	BACB30YK()K()X [I]	
HL646PB-()-() [G]	PH13-8Mo STAINLESS STEEL, CADMIUM PLATED, CETYL ALCOHOL LUBRICATED		NO EQUIVALENT	HLT422AP()-() [I] BACB30YK()K() [I]	
HL646TB-()-() [G]	PH13-8Mo STAINLESS STEEL, SOLID FILM, CETYL ALCOHOL LUBRICATED		NO EQUIVALENT	HLT422AP()-() [I] BACB30YK()K() [I]	
HLT716-()-()	NICKEL ALLOY 718, PASSIVATED, 1/32 OVERSIZE, CETYL ALCOHOL LUBRICATED		BACB30YK()U()Y		
HLT716AP-()-()	NICKEL ALLOY 718, ALUMINUM PIGMENTED COATING, 1/32 OVERSIZE, CETYL ALCOHOL LUBRICATED		BACB30YK()K()Y		
HLT716PB-()-()	NICKEL ALLOY 718, CADMIUM PLATED, 1/32 OVERSIZE, CETYL ALCOHOL LUBRICATED		NO EQUIVALENT TABLE IV	BACB30YK()K()Y [I]	

BOLT - HEX DRIVE - PROTRUDING HEAD (TENSION)

Fastener Substitution - Bolts
Figure 2 (Sheet 29 of 67)

INITIAL FASTENER OR SPECIFIED REPAIR FASTENER			FASTENER SUBSTITUTION		
PART NUMBER	DESCRIPTION	MATING PART	EQUIVALENT	ALTERNATIVE	MATING PART
BACB30JC()-() [Q] [AA]	ALLOY STEEL, 100° (AN509) HEAD,160 KSI TENSION, CADMIUM PLATED, CETYL ALCOHOL LUBRICATED 450°F (232°C)	BACC30X() OR BACC30BH()	HI-SHEAR HL21PB SPS HL21PB HUCK HL21PB FAIRCHILD HL21PB AIC HL21PB WEST COAST HL21PB	BACB30NY()K() [I]	BACC30BH() BACC30X() BACNYT()CD [T]
		BACC30Z()		BACB30NY()K() [I]	BACC30BH()P BACC30X()P
BACB30JC()A() [AA]	A286 CRES, 100° (AN509) HEAD, 160 KSI TENSION, CADMIUM PLATED, CETYL ALCOHOL LUBRICATED, MAX TEMP 450°F (232°C)	BACC30X() OR BACC30BH()	HI-SHEAR HL449UC SPS HL449UC HUCK HL449UC FAIRCHILD HL449UC AIC HL449UC WEST COAST HL449UC	BACB30NY()K() [I]	BACC30BH() BACC30X() BACN10YT()CD [T]
BACB30JC()AK() [AA]	A286 CRES, 100° (AN509) HEAD, 160 KSI TENSION, ALUMINUM COATED, CETYL ALCOHOL LUBRICATED, MAX TEMP 350°F (177°C)	BACC30X() OR BACC30BH()	HI-SHEAR HL449AZ DEUTSCH HL449AZ SPS HL449AZ FAIRCHILD HL449AZ WEST COAST HL449AZ	BACB30JC()-() [A] [L] [M]	BACC30BH() BACC30X() BACN10YT()CD [T]
				BACB30JC()A() [M]	BACC30BH() BACC30X() BACN10YT()CD [T]
				BACB30JC()AK()	BACN10YT()CD [T]
				BACB30NY()K()	BACC30BH() BACC30X() BACN10YT()CD [T]
BACB30JC()A()U	A286 CRES, PASSIVATED, 160 KSI TENSION, CETYL ALCOHOL LUBRICATED, 100° (AN509) HEAD, MAX TEMP 900°F (482°C)	BACC30X()P	AIC HL49 HI-SHEAR HL49 SPS HL49 FAIRCHILD HL49 DEUTSCH HL49 WEST COAST HL49	BACB30LP()U() [F]	NAS1805-()P [R] [T]
				BACB30LR()U() [F]	NAS1805-()P [R] [T]

BOLT - HEX DRIVE - FLUSH HEAD (TENSION)
TABLE V

Fastener Substitution - Bolts
Figure 2 (Sheet 30 of 67)

INITIAL FASTENER OR SPECIFIED REPAIR FASTENER			FASTENER SUBSTITUTION		
PART NUMBER	DESCRIPTION	MATING PART	EQUIVALENT	ALTERNATIVE	MATING PART
BACB30NY()C() [H] [AA]	6AL-4V TITANIUM, 160 KSI TENSION, CADMIUM PLATED, CETYL ALCOHOL, LUBRICATED MAX TEMP 450°F (232°C)	BACC30X() OR BACC30BH()	NO EQUIVALENT	BACB30JC()-() [A] [L]	BACC30BH()
					BACC30X()
					BACN10YT()CD [T]
				BACB30JC()A()	BACC30BH()
					BACC30X()
					BACN10YT()CD [T]
				BACB30JC()AK() [I]	BACC30BH()
					BACC30X()
					BACN10YT()CD [T]
				BACB30NY()K() [I]	BACC30BH()
					BACC30X()
					BACN10YT()CD [T]
BACB30NY()K() [AA]	6AL-4V TITANIUM, 160 KSI TENSION, ALUMINUM PIGMENTED COATING, CETYL ALCOHOL LUBRICATED, MAX TEMP 350°F (177°C)	BACC30X() OR BACC30BH()	HI-SHEAR HL1013VAZ SPS HL1013VAZ HUCK HL1013VAZ FAIRCHILD HL1013VAZ AIC HL1013VAZ WEST COAST HL1013VAZ	BACB30JC()-() [A] [L] [M]	BACC30BH()
					BACC30X()
					BACN10YT()CD [T]
				BACB30JC()A() [M]	BACC30BH()
					BACC30X()
					BACN10YT()CD [T]
				BACB30JC()AK()	BACC30BH()
					BACC30X()
					BACN10YT()CD [T]
				BACB30NY()K()	BACN10YT()CD [T]
BACB30XF()K()	6AL-4V TITANIUM, 100° HEAD, LIGHTWEIGHT, 95 KSI SHEAR, AL COATED, CETYL ALCOHOL LUBRICATED, SWAGE LOCKING	BACC30CG()	NO EQUIVALENT	BACB30NY()K()	BACC30AB()S
		BACC30CH()		BACB30NY()K()	NAS1805-() WITH BACW10CA()CCU AND BACW10CA()PVU
		BACC30CJ()		BACB30NY()K()	BACC30BH()S
		BACC30CK()		BACB30NY()K()	BACC30M()

BOLT - HEX DRIVE - FLUSH HEAD (TENSION)
TABLE V

Fastener Substitution - Bolts
Figure 2 (Sheet 31 of 67)

INITIAL FASTENER OR SPECIFIED REPAIR FASTENER			FASTENER SUBSTITUTION		
PART NUMBER	DESCRIPTION	MATING PART	EQUIVALENT	ALTERNATIVE	MATING PART
BACB30XY()K()	NICKEL ALLOY 718, 100° HEAD, LIGHTWEIGHT, PASSIVATED, AL COATED, CETYL ALCOHOL LUBRICATED, SWAGE LOCKING	BACC30CJ()	NO EQUIVALENT	BACB30YM()K()	BACC30CP()S
BACB30YM()K()	NICKEL ALLOY 718, 125 KSI SHEAR, 100° HEAD, ALUMINUM PIGMENTED COATING, CETYL ALCOHOL LUBRICATED	BACC30CP()C	HI-SHEAR HLT423AP	HLT423AP	HL792KK
		BACC30CP()S	AIC HLT423AP	HLT423AP	HL792BT
HLT423-()-()	NICKEL ALLOY 718, 100° FLUSH (MS24694) HEAD, GRIT BLAST TOP OF HEAD, PASSIVATED, CETYL ALCOHOL LUBRICATED		BACB30YM()U()		
HLT423AP-()-()	NICKEL ALLOY 718, 100° FLUSH (MS24694) HEAD, ALUMINUM PIGMENTED COATING, CETYL ALCOHOL LUBRICATED		BACB30YM()K()		
HLT423PB-()-()	NICKEL ALLOY 718, 100° FLUSH (MS24694) HEAD, CADMIUM PLATED, CETYL ALCOHOL LUBRICATED		NO EQUIVALENT	BACB30YM()K() I	

BOLT - HEX DRIVE - FLUSH HEAD (TENSION)
TABLE V

Fastener Substitution - Bolts
Figure 2 (Sheet 32 of 67)

INITIAL FASTENER OR SPECIFIED REPAIR FASTENER			FASTENER SUBSTITUTION		
PART NUMBER	DESCRIPTION	MATING PART	EQUIVALENT	ALTERNATIVE	MATING PART
HLT623-()-()	NICKEL ALLOY 718, 100° FLUSH (MS24694) HEAD, 1/64 OVERSIZE, PASSIVATED, CETYL ALCOHOL LUBRICATED		BACB30YM()U()X		
HLT623AP-()-()	NICKEL ALLOY 718, 100° FLUSH (MS24694) HEAD, 1/64 OVERSIZE, ALUMINUM PIGMENTED COATING, CETYL ALCOHOL LUBRICATED		BACB30YM()K()X		
HLT623PB-()-()	NICKEL ALLOY 718, 100° FLUSH (MS24694) HEAD, 1/64 OVERSIZE, CADMIUM PLATED, CETYL ALCOHOL LUBRICATED		NO EQUIVALENT	BACB30YM()K()X $\boxed{I}$	

BOLT - HEX DRIVE - FLUSH HEAD (TENSION)
TABLE V

Fastener Substitution - Bolts
Figure 2 (Sheet 33 of 67)

INITIAL FASTENER OR SPECIFIED REPAIR FASTENER			FASTENER SUBSTITUTION		
PART NUMBER	DESCRIPTION	MATING PART	EQUIVALENT	ALTERNATIVE	MATING PART
HLT717-()-()	NICKEL ALLOY 718, 100° FLUSH (MS24649) HEAD, 1/32 OVERSIZE, PASSIVATED, CETYL ALCOHOL LUBRICATED		BACB30YM()U()Y		
HLT717AP-()-()	NICKEL ALLOY 718, 100° FLUSH (MS24694) HEAD, 1/32 OVERSIZE, ALUMINUM PIGMENTED CETYL ALCOHOL LUBRICATED		BACB30YM()K()Y		
HLT717PB-()-()	NICKEL ALLOY 718, 100° FLUSH (MS24649) HEAD, 1/32 OVER-SIZE, CADMIUM PLATED, CETYL ALCOHOL LUBRICATED		NO EQUIVALENT	BACB30YM()K()Y [I]	

BOLT - HEX DRIVE - FLUSH HEAD (TENSION)
TABLE V

Fastener Substitution - Bolts
Figure 2 (Sheet 34 of 67)

INITIAL FASTENER OR SPECIFIED REPAIR FASTENER			FASTENER SUBSTITUTION		
PART NUMBER	DESCRIPTION	MATING PART	EQUIVALENT	ALTERNATIVE	MATING PART
BACB30FD()-()	ALLOY STEEL, CADMIUM FLUOBORATE PLATED, 12 POINT HEAD, 180 KSI TENSION, MAX TEMP 450°F (232°C)		NO EQUIVALENT	BACB30LE()-() BACB30LE()K() [I] BACB30US()P() BACB30US()K() [I]	
BACB30GE()-()	HEX CLOSE TOL 160,000 PSI SHORT THREAD		NO EQUIVALENT	BACB30LE()-() [B] BACB30LE()K() [B] [I] BACB30LJ()-() BACB30LM()-() BACB30LT()-() BACB30MR()K() [B] [I] BACB30NE()-() [A] [L] BACB30NF()-() BACB30NM()K() [I] BACB30NR()K() [I] [V] BACB30US()K() [B] [I] BACB30US()P() [B] NAS6703 THRU NAS6720	
BACB30LE()-()	A286 CRES, CADMIUM PLATED, 12 POINT HEAD, LONG THREAD, 200 KSI TENSION, MAX TEMP 450°F (232°C)		NO EQUIVALENT	BACB30LE()K() [I] BACB30US()K() [I] BACB30US()P()	

BOLT - EXTERNAL WRENCHING - PROTRUDING HEAD
TABLE VI

Fastener Substitution - Bolts
Figure 2 (Sheet 35 of 67)

INITIAL FASTENER OR SPECIFIED REPAIR FASTENER			FASTENER SUBSTITUTION		
PART NUMBER	DESCRIPTION	MATING PART	EQUIVALENT	ALTERNATIVE	MATING PART
BACB30LE()DK()	A286 CRES, 12 POINT HEAD, 200 KSI TENSILE 110 KSI SHEAR, LONG THREAD ALUMINUM PIGMENTED COATING, MAX TEMP 350°F (177°C)	BACN10JD() OR BACN11N() OR MS14144	NO EQUIVALENT	BACB30US()K()D	X
BACB30LE()K()		BACN10HR()CD		BACB30LE()-() M	BACN10HR()CD R
				BACB30US()K()	BACN10HR()CD R
				BACB30US()P() M	BACN10HR()CD R
BACB30LE()U()	A286 CRES, PASSIVATED, 12 POINT HEAD, LONG THREAD, 200 KSI TENSION, MAX TEMP 900°F (482°C)		NO EQUIVALENT	BACB30US()-() U	
BACB30LJ()-()	A286 CRES, HEX HEAD, 95 KSI SHEAR, SHORT THREAD, CADMIUM PLATED, MAX TEMP 450°F (232°C)		NO EQUIVALENT	BACB30LE()-() B	
				BACB30LE()K() B I	
				BACB30LM()-()	
				BACB30LT()-()	
				BACB30MR()K() B I	
				BACB30NM()K() I	
				BACB30NR()K() I	
				BACB30US()K() B I	
				BACB30US()P() B	
				NAS6703 THRU NAS6720	
BACB30LJ()D()	A286 CRES, HEX HEAD, 95 KSI SHEAR, SHORT THREAD, CADMIUM PLATED, DRILLED SHANK, MAX TEMP 450°F (232°C)	BACN10JD() OR BACN11N() OR MS14145	NO EQUIVALENT	BACB30LE()DK() B I	X
				BACB30LM()D()	X
				BACB30LT()D()	X
				BACB30NE()D() A	X
				BACB30US()K()D B I	X
				NAS6703D THRU NAS6720D	X

BOLT - EXTERNAL WRENCHING - PROTRUDING HEAD
TABLE VI

Fastener Substitution - Bolts
Figure 2 (Sheet 36 of 67)

INITIAL FASTENER OR SPECIFIED REPAIR FASTENER			FASTENER SUBSTITUTION		
PART NUMBER	DESCRIPTION	MATING PART	EQUIVALENT	ALTERNATIVE	MATING PART
BACB30LJ()U()	A286 CRES, PASSIVATED, HEX HEAD, SHORT THREAD, 95 KSI SHEAR, MAX TEMP 900°F (482°C)		NO EQUIVALENT	BACB30LM()U() BACB30LT()U() BACB30LE()U() [B] BACB30PN()-() [B] BACB30US()-() [B] [U] NAS6703U THRU NAS6720U	
BACB30LJ()SU()	A286 CRES, PASSIVATED, HEX HEAD, SHORT THREAD, 95 KSI SHEAR, DRY FILM LUBRICATED, MAX TEMP 450°F (232°C)		NO EQUIVALENT	BACB30LJ()U() BACB30LM()U() BACB30LM()SU() BACB30LT()U() BACB30LE()U() [B] BACB30PN()-() [B] BACB30US()-() [B] NAS6703U THRU NAS6720U	
BACB30LM()-()	A286 CRES, CADMIUM PLATED, HEX HEAD, LONG THREAD, 160 KSI TENSION, MAX TEMP 450°F (232°C)		NAS6703 THRU NAS6720	BACB30LE()-() [B] BACB30LE()K() [B] [I] BACB30MR()K() [B] [I] BACB30NM()K() [I] BACB30US()K() [B] [I]	
BACB30LM()SU()	A286 CRES, PASSIVATED, HEX HEAD, LONG THREAD, 160 KSI TENSION, DRY FILM LUBRICATED, MAX TEMP 450°F (232°C)		NO EQUIVALENT	BACB30LE()U() [B] BACB30LM()U() BACB30PN()-() [B] BACB30US()-() [B] NAS6703U THRU NAS6720U	
BACB30LM()U()	A286 CRES, PASSIVATED, HEX HEAD, LONG THREAD, 160 KSI TENSION, MAX TEMP 900°F (482°C)		NAS6703U THRU NAS6720U	BACB30LE()U() [B] BACB30PN()-() [B] BACB30US()-() [B] [U]	
BACB30LT()-()	A286 CRES, CADMIUM PLATED, 12 POINT HEAD, SHORT THREAD, 110 KSI SHEAR, MAX TEMP 450°F (232°C)		NO EQUIVALENT	BACB30LE()-() [B] BACB30LE()K() [B] [I] BACB30US()K() [B] [I] BACB30US()P() [B] BACB30LT()K() [I]	

BOLT - EXTERNAL WRENCHING - PROTRUDING HEAD
TABLE VI

Fastener Substitution - Bolts
Figure 2 (Sheet 37 of 67)

INITIAL FASTENER OR SPECIFIED REPAIR FASTENER			FASTENER SUBSTITUTION		
PART NUMBER	DESCRIPTION	MATING PART	EQUIVALENT	ALTERNATIVE	MATING PART
BACB30LT()DK()	A286 CRES, 12 POINT HEAD, 110 KSI SHEAR, SHORT THREAD, CLOSE TOLERANCE, DRILLED SHANK, ALUMINUM PIGMENTED COATING, MAX TEMP 350°F (177°C)	BACN10JD OR BACN11N() OR MS14145	NO EQUIVALENT	BACB30LT()D() [M]	[X]
				BACB30US()K()D [B]	[X]
BACB30LT()K()	A286 CRES, 12 POINT HEAD, 110 KSI SHEAR, SHORT THREAD, CLOSE TOLERANCE, ALUMINUM PIGMENTED COATING, MAX TEMP 350°F (177°C)		NO EQUIVALENT	BACB30LT()-() [M]	
				BACB30US()K() [B]	
				BACB30US()P() [B] [M]	
BACB30LT()U()	A286 CRES, 12 POINT HEAD, 110 KSI SHEAR, SHORT THREAD, CLOSE TOLERANCE, PASSIVATED, MAX TEMP 1200°F (649°C)	BACN10JC()CM OR BACN10YR()CM	NO EQUIVALENT	NO ALTERNATIVE	
BACB30LT()DU()		BACN10JD() OR BACN11N()			
BACB30MR()C() [H]	6AL-4V TITANIUM, CAD PLATED, 12 POINT, HEAD LONG THREADED. 95 KSI MAX TEMP 450°F (232°C)		NO EQUIVALENT	BACB30LE()K() [I]	
				BACB30MR()K() [I]	
				BACB30US()K() [I]	
				BACB30US()P()	
BACB30MR()K()	6AL-4V TITANIUM, 12 POINT HEAD, 95 KSI SHEAR, LONG THREAD, ALUMINUM PIGMENTED COATING, MAX TEMP 350°F (177°C)		NO EQUIVALENT	BACB30LE()-() [M]	
				BACB30LE()K()	
				BACB30US()K()	
				BACB30US()P() [M]	

BOLT - EXTERNAL WRENCHING - PROTRUDING HEAD
TABLE VI

Fastener Substitution - Bolts
Figure 2 (Sheet 38 of 67)

INITIAL FASTENER OR SPECIFIED REPAIR FASTENER			FASTENER SUBSTITUTION		
PART NUMBER	DESCRIPTION	MATING PART	EQUIVALENT	ALTERNATIVE	MATING PART
BACB30MR()DK()	6AL-4V TITANIUM, 12 POINT HEAD, 95 KSI SHEAR, LONG THREAD, ALUMINUM PIGMENTED COATING, DRILLED SHANK, MAX TEMP 350°F (177°C)	BACN10JD() OR BACN11N() OR MS14144	NO EQUIVALENT	BACB30LE()DK()	X
				BACB30US()K()D	X
BACB30MT()-() E	H-11 STEEL BOLT, 12 POINT HEAD, 220 KSI TENSION, 125 KSI SHEAR		NO EQUIVALENT	BACB30US()K()	
BACB30MT()H() E BACB30MT()HK() E BACB30MT()HL() E BACB30MT()HT() E	H-11 STEEL BOLT, 12 POINT HEAD, 220 KSI TENSION, 125 KSI SHEAR DRILLED HEAD		NO EQUIVALENT	BACB30US()K()H	
BACB30MT()K() E	H-11 STEEL, ALUMINUM PIGMENTED COATING, 12 POINT HEAD, LONG THREAD, 220 KSI TENSION, MAX TEMP 350°F (177°C)		NO EQUIVALENT	BACB30US()K()	
				BACB30US()P() M	
BACB30MT()L() E	H-11 STEEL, ALUMINUM PIGMENTED COATING, 12 POINT HEAD, LONG THREAD, 220 KSI TENSION, MAX TEMP 600°F (316°C)		NO EQUIVALENT	BACB30US()K() I K	
				BACB30US()P()	
BACB30MT()T() E	H-11 STEEL, DIFFUSED NICKEL-CADMIUM PLATED, 12 POINT HEAD, LONG THREAD, 220 KSI TENSION, MAX TEMP 600°F (316°C)		NO EQUIVALENT	BACB30US()K() I K	
				BACB30US()P()	

BOLT - EXTERNAL WRENCHING - PROTRUDING HEAD
TABLE VI

Fastener Substitution - Bolts
Figure 2 (Sheet 39 of 67)

INITIAL FASTENER OR SPECIFIED REPAIR FASTENER			FASTENER SUBSTITUTION		
PART NUMBER	DESCRIPTION	MATING PART	EQUIVALENT	ALTERNATIVE	MATING PART
BACB30NE()-()	ALLOY STEEL, CADMIUM PLATED, HEX HEAD, LONG THREAD, 160 KSI TENSION, MAX TEMP 450°F (232°C)		NAS6603 THRU NAS6620	BACB30LE()-() [B] BACB30LE()K() [B] [I] BACB30LM()-() BACB30MR()K() [B] [I] BACB30NM()K() [I] BACB30US()K() [B] [I] BACB30US()P() [B] NAS6703 THRU NAS6720	
BACB30NF()-()	ALLOY STEEL, HEX HEAD, SHORT THREAD, 95 KSI SHEAR, CADMIUM PLATED, MAX TEMP 450°F (232°C)		NO EQUIVALENT	BACB30LE()-() [B] BACB30LE()K() [B] [I] BACB30LJ()-() BACB30LM()-() BACB30LT()-() BACB30MR()K() [B] [I] BACB30NE()-() [A] [L] BACB30NM()K() [I] BACB30NR()K() [I] [V] BACB30US()K() [B] [I] BACB30US()P() [B] NAS6603 THRU NAS6620 NAS6703 THRU NAS6720	
BACB30NH()-() [G]	PH13-8Mo CRES, CADMIUM PLATE, 12 POINT HEAD, LONG THREAD, 220 KSI TENSION, MAX TEMP 450°F (232°C)		NO EQUIVALENT	BACB30US()K() [I]	
BACB30NH()U() [G]	PH13-8Mo CRES, PASSIVATED, 12 POINT HEAD, LONG THREAD, 220 KSI TENSION, MAX TEMP 600°F (316°C)		NO EQUIVALENT	BACB30US()-() BACB30US()K() [I]	

BOLT - EXTERNAL WRENCHING - PROTRUDING HEAD
TABLE VI

Fastener Substitution - Bolts
Figure 2 (Sheet 40 of 67)

INITIAL FASTENER OR SPECIFIED REPAIR FASTENER			FASTENER SUBSTITUTION		
PART NUMBER	DESCRIPTION	MATING PART	EQUIVALENT	ALTERNATIVE	MATING PART
BACB30NH()SU() [G]	PH13-8Mo CRES, PASSIVATED, 12 POINT HEAD, LONG THREAD, 220 KSI TENSION, DRY FILM LUBRICATED, MAX TEMP 450°F (232°C)		NO EQUIVALENT	BACB30US()-() BACB30US()K() [I]	
BACB30NJ()-() [E]	H-11 STEEL, DIFFUSED NICKEL-CADMIUM PLATED, 12 POINT HEAD, SHORT THREAD, 125 KSI SHEAR, MAX TEMP 600°F (316°C)		NO EQUIVALENT	BACB30US()K() [B] [I] BACB30US()P() [B] [K]	
BACB30NJ()K() [E]	H-11 STEEL, ALUMINUM PIGMENTED COATING, 12 POINT HEAD, SHORT THREAD, 125 KSI SHEAR, MAX TEMP 350°F (177°C)		NO EQUIVALENT	BACB30US()K() [B] BACB30US()P() [B] [M]	
BACB30NJ()L() [E]	H-11 STEEL, ALUMINUM PIGMENTED COATING, 12 POINT HEAD, SHORT THREAD, 125 KSI SHEAR MAX TEMP 600°F (316°C)		NO EQUIVALENT	BACB30US()K() [B] [I] BACB30US()P() [B] [K]	
BACB30NL()-() [G]	PH13-8Mo CRES, CADMIUM PLATED, 12 POINT HEAD, SHORT THREAD, 125 KSI SHEAR, MAX TEMP 450°F (232°C)		NO EQUIVALENT	BACB30US()K() [B] [I] BACB30US()P() [B]	

BOLT - EXTERNAL WRENCHING - PROTRUDING HEAD
TABLE VI

Fastener Substitution - Bolts
Figure 2 (Sheet 41 of 67)

INITIAL FASTENER OR SPECIFIED REPAIR FASTENER			FASTENER SUBSTITUTION		
PART NUMBER	DESCRIPTION	MATING PART	EQUIVALENT	ALTERNATIVE	MATING PART
BACB30NL()SU() [G]	PH13-8Mo CRES, PASSIVATED, 12 POINT HEAD, SHORT THREAD, 125 KSI SHEAR, DRY FILM LUBRICATED, MAX TEMP 450°F (232°C)			BACB30US()-() [B]	
BACB30NL()U() [G]	PH13-8Mo CRES, PASSIVATED, 12 POINT HEAD, SHORT THREAD, 125 KSI SHEAR, MAX TEMP 600°F (316°C)			BACB30US()-() [B]	
BACB30NM()C() [H]	6AL-4V TITANIUM, CADMIUM PLATED, HEX HEAD, LONG THREAD, 160 KSI TENSION, MAX TEMP 450°F (232°C)			BACB30LE()K() [B] [I]	
				BACB30MR()K() [B] [I]	
				BACB30NM()K() [I]	
				BACB30US()K() [B] [I]	
				BACB30US()P() [B]	
BACB30NM()K()	6AL-4V TITANIUM, ALUMINUM PIGMENTED COATING, HEX HEAD, LONG THREAD, 160 KSI TENSION, MAX TEMP 350°F (177°C)			BACB30LE()-() [B] [M]	
				BACB30LE()K() [B]	
				BACB30MR()K() [B]	
				BACB30US()K() [B]	
				BACB30US()P() [B] [M]	
BACB30NR()C() [H]	6AL-4V TITANIUM, CADMIUM PLATED, HEX HEAD, SHORT THREAD, 95 KSI SHEAR, MAX TEMP 450°F (232°C)			BACB30LE()K() [B] [I]	
				BACB30MR()K() [B] [I]	
				BACB30NM()K() [I]	
				BACB30NR()K() [I]	
				BACB30US()K() [B] [I]	
				BACB30US()P() [B]	

BOLT - EXTERNAL WRENCHING - PROTRUDING HEAD
TABLE VI

Fastener Substitution - Bolts
Figure 2 (Sheet 42 of 67)

INITIAL FASTENER OR SPECIFIED REPAIR FASTENER			FASTENER SUBSTITUTION		
PART NUMBER	DESCRIPTION	MATING PART	EQUIVALENT	ALTERNATIVE	MATING PART
BACB30NR()K()	6AL-4V TITANIUM, ALUMINUM PIGMENTED COATING, HEX HEAD, SHORT THREAD, 95 KSI SHEAR, MAX TEMP 350°F (177°C)		NO EQUIVALENT	BACB30LE()-() [B] [M] BACB30LE()K() [B] BACB30LT()-() [M] BACB30MR()K() [B] BACB30NM()K() BACB30US()K() [B] BACB30US()P() [B] [M]	
BACB30PN()-()	INCONEL 718, 12 POINT HEAD, LONG THREAD, MAX TEMP 1200°F (649°C)		NO EQUIVALENT	BACB30LE()U() BACB30US()K() [I] BACB30US()-() [U]	
BACB30TR()HT() [E]	H-11STEEL, DIFFUSED NICKEL-CADMIUM PLATED, 220 KSI MIN TENSILE 125 KSI MIN SHEAR 12 POINT LOW PROFILE, DRILLED HEAD 600°F (316°C)		NO EQUIVALENT	BACB30US()K()H [I] BACB30US()P()H [K]	
BACB30TR()K() [E]	H-11 STEEL, ALUMINUM PIGMENTED COATING, 12 POINT LOW PROFILE HEAD, 220 KSI TENSION, 125 KSI SHEAR, MAX TEMP 350°F (177°C)		NO EQUIVALENT	BACB30US()K()	

BOLT - EXTERNAL WRENCHING - PROTRUDING HEAD
TABLE VI

Fastener Substitution - Bolts
Figure 2 (Sheet 43 of 67)

INITIAL FASTENER OR SPECIFIED REPAIR FASTENER			FASTENER SUBSTITUTION		
PART NUMBER	DESCRIPTION	MATING PART	EQUIVALENT	ALTERNATIVE	MATING PART
BACB30TR()L() [E]	H-11 STEEL, ALUMINUM PIGMENTED COATING, 12 POINT LOW PROFILE HEAD, 220 KSI TENSION, 125 KSI SHEAR, MAX TEMP 600°F (316°C)		NO EQUIVALENT	BACB30US()K() [I]	
BACB30TR()T() [E]	H-11 STEEL, DIFFUSED NICKEL CADMIUM PLATED, 12 POINT LOW PROFILE HEAD, 220 KSI TENSION, 125 KSI SHEAR, MAX TEMP 600°F (316°C)		NO EQUIVALENT	BACB30US()K() [I]	
BACB30US()K()	INCONEL 718, 12 POINT HEAD, LONG THREAD, 125 KSI SHEAR, BMS 10-85 COATED, MAX TEMP 350°F (177°C)		NO EQUIVALENT	BACB30US()P() [M]	
BACB30US()P()	NICKEL ALLOY 718, 12 POINT HEAD, 220 KSI TENSILE, 125 KSI SHEAR, LONG THREAD, CADMIUM PLATED, MAX TEMP 450°F (232°C)	BACN10HR OR BACN10HR()CD	NO EQUIVALENT	BACB30US()K() [I]	BACN10HR()CD [R]

BOLT - EXTERNAL WRENCHING - PROTRUDING HEAD
TABLE VI

Fastener Substitution - Bolts
Figure 2 (Sheet 44 of 67)

INITIAL FASTENER OR SPECIFIED REPAIR FASTENER			FASTENER SUBSTITUTION		
PART NUMBER	DESCRIPTION	MATING PART	EQUIVALENT	ALTERNATIVE	MATING PART
BACB30UU()-()	INCONEL 718, PASSIVATED, 12 POINT HEAD, SHORT THREAD, 125 KSI SHEAR, MAX TEMP 1200°F (649°C)		NO EQUIVALENT	BACB30US()-() [B]	
BACB30UU()K()	INCONEL 718, ALUMINUM PIGMENTD COATING, 12 POINT HEAD, SHORT THREAD, 125 KSI SHEAR, MAX TEMP 350°F (177°C)		NO EQUIVALENT	BACB30US()K() [B] BACB30US()P() [B] [M] BACB30UU()P() [M]	
BACB30UU()P()	NICKEL ALLOY 718, 12 POINT HEAD, 125 KSI SHEAR, SHORT THREAD, CLOSE TOLERANCE, CADMIUM PLATED, MAX TEMP 450°F (232°C)		NO EQUIVALENT	BACB30US()P() [B] BACB30US()K() [B] [I] BACB30UU()K() [I]	
BACB30XJ()K()	6AL-4V TITANIUM, HEX HEAD, 150 KSI TENSILE, LONG THREAD, ALUMINUM PIGMENTED COATING	NAS1805-()L		BACB30XL()K() [B]	NAS1805-()L [R]

BOLT - EXTERNAL WRENCHING - PROTRUDING HEAD
TABLE VI

Fastener Substitution - Bolts
Figure 2 (Sheet 45 of 67)

INITIAL FASTENER OR SPECIFIED REPAIR FASTENER			FASTENER SUBSTITUTION		
PART NUMBER	DESCRIPTION	MATING PART	EQUIVALENT	ALTERNATIVE	MATING PART
BACB30XL()K()	6AL-4V TITANIUM, 12 POINT HEAD, 150 KSI TENSILE, 90 KSI SHEAR, ALUMINUM PIGMENTED COATING, MAX TEMP 350°F (177°C)	NAS1805-()L	NO EQUIVALENT	NO ALTERNATIVE	
BACB30XN()K()	6AL-4V TITANIUM, HEX HEAD, 90 KSI SHEAR, SHORT THREAD, ALUMINUM PIGMENTED COATING		NO EQUIVALENT	BACB30XJ()K()	
				BACB30XL()K() [B]	
BACB30ZB()-()	ALLOY STEEL, HEX HEAD, SHORT THREAD, CLOSE TOLERANCE CADMIUM PLATED, MAX TEMP 450°F (232°C)		NO EQUIVALENT	BACB30LE()-() [B]	
				BACB30LE()K() [B] [I]	
				BACB30LJ()-()	
				BACB30LM()-()	
				BACB30LT()-()	
				BACB30NE()-() [A] [L]	
				BACB30NF()-()	
				BACB30NR()K() [I] [V]	
				BACB30US()K() [B] [I]	
				BACB30US()P() [B]	
				NAS6603 THRU NAS6620	
				NAS6703 THRU NAS6720	

BOLT - EXTERNAL WRENCHING - PROTRUDING HEAD
TABLE VI

Fastener Substitution - Bolts
Figure 2 (Sheet 46 of 67)

INITIAL FASTENER OR SPECIFIED REPAIR FASTENER			FASTENER SUBSTITUTION		
PART NUMBER	DESCRIPTION	MATING PART	EQUIVALENT	ALTERNATIVE	MATING PART
NAS1103 THRU NAS1120	ALLOY STEEL, HEX HEAD, SHORT THREAD, CADMIUM PLATED, MAX TEMP 450°F (232°C)		NO EQUIVALENT	BACB30LE()-() B	
				BACB30LE()K() B I	
				BACB30LJ()-()	
				BACB30LM()-()	
				BACB30LT()-()	
				BACB30NE()-() A L	
				BACB30NF()-()	
				BACB30NR()K() I V	
				BACB30US()K() B I	
				BACB30US()P() B	
				BACB30ZB()-()	
				NAS6603 THRU NAS6620	
				NAS6703 THRU NAS6720	
NAS6603 THRU NAS6620	ALLOY STEEL, CADMIUM PLATED, HEX HEAD, LONG THREAD, 160 KSI TENSION MAX TEMP 450°F (232°C)		BACB30NE()-()	BACB30LE()-() B	
				BACB30LE()K() B I	
				BACB30LM()-()	
				BACB30MR()K() B I	
				BACB30NF()-()	
				BACB30NM()K() I	
				BACB30US()K() B I	
				BACB30US()P() B	
				NAS6703 THRU NAS6720	
NAS6703 THRU NAS6720	A286 CRES, CADMIUM PLATED, HEX HEAD, LONG THREAD, 160 KSI TENSION, MAX TEMP 450°F (232°C)		BACB30LM()-()	BACB30US()P() B	

BOLT - EXTERNAL WRENCHING - PROTRUDING HEAD
TABLE VI

Fastener Substitution - Bolts
Figure 2 (Sheet 47 of 67)

INITIAL FASTENER OR SPECIFIED REPAIR FASTENER			FASTENER SUBSTITUTION		
PART NUMBER	DESCRIPTION	MATING PART	EQUIVALENT	ALTERNATIVE	MATING PART
NAS6703A() THRU NAS6720A()	A-286 CRES, HEX HEAD, CLOSE TOLERANCE, 160 KSI TENSILE, 95 KSI SHEAR, LONG THREAD, UNDRILLED, ALUMINUM PIGMENTED COATING, NON-LOCKING		NO EQUIVALENT	BACB30LE()-() [B] [M] BACB30LE()K() [B] BACB30LM()-() [M] BACB30MR()K() [B] BACB30NM()K() BACB30US()K() [B] BACB30US()P() [B] [M] NAS6703-() THRU NAS6720-() [M]	
NAS6703AD() THRU NAS6720AD()	A-286 CRES, HEX HEAD, CLOSE TOLERANCE, 160 KSI TENSILE, 95 KSI SHEAR, LONG THREAD, DRILLED, ALUMINUM PIGMENTED COATING, NON-LOCKING	BACN10JD() OR BACN11N() OR MS14144	NO EQUIVALENT	BACB30NM()DK() NAS6703D() THRU NAS6720D() [M] [N]	[X]
NAS6703U THRU NAS6720U	A286 CRES, PASSIVATED, HEX HEAD, LONG THREAD, 160 KSI TENSION, MAX TEMP 900°F (482°C)		BACB30LM()U()	BACB30LE()U() [B] BACB30PN()-() [B] BACB30US()-() [B] [U]	

BOLT - EXTERNAL WRENCHING - PROTRUDING HEAD
TABLE VI

Fastener Substitution - Bolts
Figure 2 (Sheet 48 of 67)

INITIAL FASTENER OR SPECIFIED REPAIR FASTENER			FASTENER SUBSTITUTION		
PART NUMBER	DESCRIPTION	MATING PART	EQUIVALENT	ALTERNATIVE	MATING PART
BACB30AB-P()-()	ALLOY STEEL 100° CLOSE TOLERANCE 160 KSI PHILLIPS RECESS, SHORT THREAD, DRILLED, CADMIUM PLATED, MAX TEMP 450°F (232°C)			BACB30LH()D() BACB30LR()D() BACB30LU()D()	[X]
BACB30AB-P()-()A	ALLOY STEEL 100° CLOSE TOLERANCE 160 KSI PHILLIPS RECESS, SHORT THREAD, UNDRILLED, CADMIUM PLATED, MAX TEMP 450°F (232°C)			BACB30LH()-() BACB30LP()-() BACB30LR()-() BACB30LU()-() BACB30MS()K() [I] BACB30NN()K() [I]	
BACB30EL()-()	ALLOY STEEL, CADMIUM PLATED, HI-TORQUE RECESS, 100° REDUCED HEAD, SHORT THREAD, 95 KSI SHEAR, MAX TEMP 450°F (232°C)			BACB30EL()C() BACB30EL()CN() BACB30NU()K() [I] BACB30VF()K() [I] NAS8703 THRU NAS8712	
BACB30EL()CN()	ALLOY STEEL, DIFFUSED-NICKEL CADMIUM PLATED, HI-TORQUE, SHORT THREAD, REDUCED HEAD, 95 KSI SHEAR, MAX TEMP 600°F (316°C)			BACB30NU()K() [I] BACB30VF()K() [I] NAS8703 THRU NAS8712 [K]	
BACB30FA()-()P	ALLOY STEEL, CADMIUM PLATED, HI-TORQUE RECESS, SELF-LOCKING, 100° HEAD, MAX TEMP 450°F (232°C)			BACB30FA()R()P	

BOLT - RECESS DRIVE - FLUSH HEAD
TABLE VII

Fastener Substitution - Bolts
Figure 2 (Sheet 49 of 67)

INITIAL FASTENER OR SPECIFIED REPAIR FASTENER			FASTENER SUBSTITUTION		
PART NUMBER	DESCRIPTION	MATING PART	EQUIVALENT	ALTERNATIVE	MATING PART
BACB30FB()-()	ALLOY STEEL CADMIUM PLATED, HI-TORQUE RECESS, 100° REDUCED HEAD LONG THREAD, 160 KSI TENSION MAX TEMP 450°F (232°C)		NO EQUIVALENT	NO ALTERNATIVE	
BACS12GP3K()	SCREW, 6AL-4V TITANIUM, ALUMINUM PIGMENTED COATING, CROSS RECESS, 100° HEAD, POINTED, FULL THREADED, MAX TEMP 350°F (177°C)		NO EQUIVALENT	BACS12GM3-() A L M BACS12GP3L() BACS12GR3L()	
BACB30LH()-()	A286 CRES, CADMIUM PLATED, CROSS RECESS, 100° HEAD, SHORT THREAD, 95 KSI SHEAR, MAX TEMP 450°F (232°C)		NO EQUIVALENT	BACB30LP()-() BACB30LR()-() BACB30LU()-() A L BACB30MS()K() I BACB30NN()K() I	
BACB30LH()U()	A286 CRES, PASSIVATED, CROSS RECESS, 100° HEAD, SHORT THREAD, 95 KSI SHEAR, MAX TEMP 900°F (482°C)		NO EQUIVALENT	BACB30LP()U() BACB30LR()U()	

BOLT - RECESS DRIVE - FLUSH HEAD
TABLE VII

Fastener Substitution - Bolts
Figure 2 (Sheet 50 of 67)

INITIAL FASTENER OR SPECIFIED REPAIR FASTENER			FASTENER SUBSTITUTION		
PART NUMBER	DESCRIPTION	MATING PART	EQUIVALENT	ALTERNATIVE	MATING PART
BACB30LL()-()	A286 CRES, CADMIUM PLATED, DOVETAIL RECESS, 100° REDUCED HEAD, SHORT THREAD, 95 KSI SHEAR, MAX TEMP 450°F (232°C)		NO EQUIVALENT	BACB30EL()-() [A] [L] BACB30EL()CN() [A] [L] BACB30NU()K() [I] BACB30UW()K() [I] BACB30UW()P() BACB30VF()K() [I]	
BACB30LL()U()	A286 CRES, PASSIVATED, DOVETAIL RECESS, 100° REDUCED HEAD, SHORT THREAD, 95 KSI SHEAR, MAX TEMP 900°F (482°C)		NO EQUIVALENT	BACB30UW()-()	
BACB30LP()-()	A286 CRES, CAD CADMIUM PLATED, HI-TORQUE RECESS, 100° HEAD, LONG THREAD, 160 KSI TENSION, MAX TEMP 450°F (232°C)		NO EQUIVALENT	BACB30LR()-() [N] BACB30LU()-() [A] [L] [N] BACB30NN()K() [I] [N]	
BACB30LP()U()	A286 CRES, PASSIVATED, HI-TORQUE RECESS, 100° HEAD, LONG THREAD, 160 KSI TENSION, MAX TEMP 900°F (482°C)		NO EQUIVALENT	BACB30LR()U() [N]	

BOLT - RECESS DRIVE - FLUSH HEAD
TABLE VII

Fastener Substitution - Bolts
Figure 2 (Sheet 51 of 67)

INITIAL FASTENER OR SPECIFIED REPAIR FASTENER			FASTENER SUBSTITUTION		
PART NUMBER	DESCRIPTION	MATING PART	EQUIVALENT	ALTERNATIVE	MATING PART
BACB30LR()-()	A286 CRES, 100° HEAD, CROSS RECESS, LONG THREAD, CLOSE TOLERANCE, CADMIUM PLATED, 160 KSI TENSION, MAX TEMP 450°F (232°C)			BACB30LP()-() BACB30LU()-() $\boxed{A}$ $\boxed{L}$ BACB30NN()K() $\boxed{I}$	
BACB30LR()K()	A286 CRES, 100° HEAD, CROSS RECESS, LONG THREAD, CLOSE TOLERANCE, ALUMINUM PIGMENTED COATING, 160 KSI TENSION, MAX TEMP 350°F (177°C)			BACB30LP()-() $\boxed{M}$ BACB30LR()-() $\boxed{M}$ BACB30LU()-() $\boxed{A}$ $\boxed{L}$ $\boxed{M}$ BACB30MS()K() $\boxed{V}$ BACB30NN()K()	
BACB30LR()DK()		BACN10JD() OR BACN11N() OR MS14144		BACB30LR()D() $\boxed{M}$	$\boxed{X}$
BACB30LR()U()	A286 CRES, 100° HEAD, CROSS RECESS, LONG THREAD, CLOSE TOLERANCE, PASSIVATED, 160 KSI TENSION, MAX TEMP 900°F (482°C)			BACB30LP()U()	
BACB30LU()-()	ALLOY STEEL, 100° HEAD, CROSS RECESS, LONG THREAD, 95 KSI SHEAR, CLOSE TOLERANCE, ALUMINUM PIGMENTED COATING, MAX TEMP 450°F (232°C)			BACB30LP()-() BACB30LR()-() BACB30NN()K() $\boxed{I}$	

BOLT - RECESS DRIVE - FLUSH HEAD
TABLE VII

Fastener Substitution - Bolts
Figure 2 (Sheet 52 of 67)

INITIAL FASTENER OR SPECIFIED REPAIR FASTENER			FASTENER SUBSTITUTION		
PART NUMBER	DESCRIPTION	MATING PART	EQUIVALENT	ALTERNATIVE	MATING PART
BACB30MS()C() [H]	6AL-4V TITANIUM, 100° HEAD, DOVETAIL RECESS, LONG THREAD, CADMIUM PLATED, 160 KSI TENSION, MAX TEMP 350°F (177°C)			BACB30MS()K() [I] BACB30NN()K() [I] BACB30WP()K()R [I]	
BACB30MS()K()	6AL-4V TITANIUM, 100° HEAD, DOVETAIL RECESS, LONG THREAD, ALUMINUM PIGMENTED COATING, 160 KSI TENSION, MAX TEMP 350°F (177°C)			BACB30NN()K() BACB30WP()K()R	
BACB30NN()C() [H]	6AL-4V TITANIUM, 100° HEAD, CROSS RECESS, LONG THREAD, CADMIUM PLATED, 160 KSI TENSION, MAX TEMP 450°F (232°C)			BACB30MS()K() [I] [Y] BACB30NN()K() [I] BACB30WP()K()R [I]	
BACB30NN()K()	6AL-4V TITANIUM, 100° HEAD, CROSS RECESS, LONG THREAD, ALUMINUM PIGMENTED COATING, 160 KSI TENSION, MAX TEMP 350°F (177°C)			BACB30MS()K() [Y] BACB30WP()K()R	

BOLT - RECESS DRIVE - FLUSH HEAD
TABLE VII

Fastener Substitution - Bolts
Figure 2 (Sheet 53 of 67)

INITIAL FASTENER OR SPECIFIED REPAIR FASTENER			FASTENER SUBSTITUTION		
PART NUMBER	DESCRIPTION	MATING PART	EQUIVALENT	ALTERNATIVE	MATING PART
BACB30NU()C() [H]	6AL-4V TITANIUM, 100° REDUCED HEAD, DOVETAIL RECESS, SHORT THREAD, 95 KSI SHEAR, CADMIUM PLATED, MAX TEMP 450°F (232°C)			BACB30NU()K() [I] BACB30VF()K() [I]	
BACB30NU()K()	6AL-4V TITANIUM, 100° REDUCED HEAD, DOVETAIL RECESS, SHORT THREAD, 95 KSI SHEAR, ALUMINUM PIGMENTED COATING, MAX TEMP 350°F (177°C)			BACB30VF()K()	
BACB30NU()R()	6AL-4V TITANIUM, 100° REDUCED HEAD, DOVETAIL RECESS, SHORT THREAD, 95 KSI SHEAR, PHOSPHATE FLUORIDE COATED, CETYL ALCOHOL LUBRICATED			BACB30NU()K() [I] BACB30VF()K() [I] BACB30VF()R()	
BACB30SW()-() [E]	H-11 STEEL, DIFFUSED NICKEL CADMIUM PLATED, 100 DEGREE HEAD, HI-TORQUE, 125 KSI SHEAR, LONG THREAD			[C]	
BACB30SW()K() [E]	H-11 STEEL, ALUMINUM PIGMENTED COATING, 100° HEAD, HI-TORQUE, 125 KSI SHEAR, LONG THREAD			[C]	

BOLT - RECESS DRIVE - FLUSH HEAD
TABLE VII

Fastener Substitution - Bolts
Figure 2 (Sheet 54 of 67)

INITIAL FASTENER OR SPECIFIED REPAIR FASTENER			FASTENER SUBSTITUTION		
PART NUMBER	DESCRIPTION	MATING PART	EQUIVALENT	ALTERNATIVE	MATING PART
BACB30TP3-()	ALLOY STEEL, CADMIUM PLATED, CROSS RECESS, 100° HEAD, POINTED, MAX TEMP 450°F (232°C)		NO EQUIVALENT	BACB30LH3-() BACB30LP3-() BACB30LU3-() [A] [L] BACB30NN3K() [I]	
BACB30UR()K()	6AL-4V TITANIUM, ALUMINUM PIGMENTED COATING, 100° REDUCED HEAD, SHORT THREAD, OFFSET CRUCIFORM 95 KSI SHEAR		NO EQUIVALENT	BACB30VF()K()	
BACB30UR()R()	6AL-4V TITANIUM, PHOSPHATE FLOURIDE COATED, CETYL ALCOHOL LUBRICATED, 100° REDUCED HEAD, SHORT THREAD, OFFSET CRUCIFORM 95 KSI SHEAR		NO EQUIVALENT	BACB30VF()K() [I] BACB30VF()R()	
BACB30UW()P()	NICKEL ALLOY 718, 100° REDUCED HEAD, DOVETAIL RECESS, 125 KSI SHEAR, SHORT THREAD, CADMIUM PLATED, MAX TEMP 450°F (232°C)		NO EQUIVALENT	BACB30UW()K() [I]	

BOLT - RECESS DRIVE - FLUSH HEAD
TABLE VII

Fastener Substitution - Bolts
Figure 2 (Sheet 55 of 67)

INITIAL FASTENER OR SPECIFIED REPAIR FASTENER			FASTENER SUBSTITUTION		
PART NUMBER	DESCRIPTION	MATING PART	EQUIVALENT	ALTERNATIVE	MATING PART
BACB30VF()K()	6AL-4V TITANIUM, ALUMINUM PIGMENTED COATING, CROSS RECESS, 100° REDUCED HEAD, SHORT THREAD, 95 KSI SHEAR, MAX TEMP 350°F (177°C)		NO EQUIVALENT	NO ALTERNATIVE	
BACB30VF()R()	6AL-4V TITANIUM, 100° REDUCED HEAD, CROSS RECESS, 95 KSI SHEAR, SHORT THREAD, PHOSPHATE FLUORIDE COATED, CETYL, ALCOHOL LUBRICATED		NO EQUIVALENT	BACB30VF()K() [I]	
BACB30WP()P()R	NICKEL ALLOY 718, 100° HEAD, DOVETAIL RECESS, 125 KSI SHEAR, LONG THREAD, CADMIUM PLATED, MAX TEMP 450°F (232°C)		NO EQUIVALENT	BACB30WP()K()R [I]	
BACB30XM()K()	6AL-4V TITANIUM, 100° HEAD, CROSS RECESS, 150 KSI TENSILE, LONG THREAD, ALUMINUM PIGMENTED COATING, MAX TEMP 350°F (177°C)	NAS1805-()L	NO EQUIVALENT	NO ALTERNATIVE	

BOLT - RECESS DRIVE - FLUSH HEAD
TABLE VII

Fastener Substitution - Bolts
Figure 2 (Sheet 56 of 67)

INITIAL FASTENER OR SPECIFIED REPAIR FASTENER			FASTENER SUBSTITUTION		
PART NUMBER	DESCRIPTION	MATING PART	EQUIVALENT	ALTERNATIVE	MATING PART
BACB30EM-P()-()	ALLOY STEEL, DIFFUSED NICKEL-CADMIUM PLATED, DOVETAIL RECESS, CLOSE TOLERANCE, PAN HEAD, SHORT THREAD, 160 KSI TENSION, MAX TEMP 600°F (316°C)			BACB30EM-P()L() [A] [L] BACB30LK()-() BACB30NT()K() [I] NAS623-()-() [A] [L]	
BACB30EM-P()L()	ALLOY STEEL, DIFFUSED NICKEL-CADMIUM PLATED, DOVETAIL RECESS, CLOSE TOLERANCE, PAN HEAD, LONG THREAD, 160 KSI TENSION, MAX TEMP 600°F (316°C)			BACB30LE()K() [B] [I] BACB30LM()-() BACB30MR()K() [B] [I] BACB30NM()K() [I] BACB30US()K() [B] [I] NAS6603 THRU NAS6620 [L] NAS6703 THRU NAS6720	
BACB30LK()-()	A286 CRES, CADMIUM PLATED, CROSS RECESS, PAN HEAD, SHORT THREAD, 95 KSI SHEAR, MAX TEMP 450°F (232°C)			BACB30LE()-() [B] BACB30LE()K() [B] [I] BACB30LJ()-() BACB30LM()-() BACB30LT()-() BACB30MR()K() [B] [I] BACB30NE()-() [A] [L] BACB30NM()K() [I] BACB30US()K() [B] [I] BACB30US()P() [B] NAS6603 THRU NAS6620 [A] [L] NAS6703 THRU NAS6720	

BOLT - RECESS DRIVE - PROTRUDING HEAD
TABLE VIII

Fastener Substitution - Bolts
Figure 2 (Sheet 57 of 67)

INITIAL FASTENER OR SPECIFIED REPAIR FASTENER			FASTENER SUBSTITUTION		
PART NUMBER	DESCRIPTION	MATING PART	EQUIVALENT	ALTERNATIVE	MATING PART
BACB30LK()U()	A286 CRES, PASSIVATED, CROSS RECESS, PAN HEAD, SHORT THREAD, 95 KSI SHEAR, MAX TEMP 900°F (482°C)		NO EQUIVALENT	BACB30LE()U() [B]	
				BACB30LJ()U()	
				BACB30LM()U()	
				BACB30LT()U()	
				BACB30US()-() [B]	
				NAS6703U THRU NAS6720U	
BACB30NT()C() [H]	6AL-4V TITANIUM, CAD PLATED, PHILLIPS RECESS SHORT THREADED. 95 KSI MAX TEMP 450°F (232°C)		NO EQUIVALENT	BACB30LE()K() [B] [I]	
				BACB30LK()-()	
				BACB30MR()K() [B] [I]	
				BACB30NJ()K() [I]	
				BACB30NM()K() [I]	
				BACB30NR()K() [I]	
				BACB30NT()K() [I]	
BACB30NT()K()	6AL-4V TITANIUM, ALUMINUM PIGMENTED COATING, CROSS RECESS, PAN HEAD, SHORT THREAD 95 KSI SHEAR, MAX TEMP 350°F (177°C)		NO EQUIVALENT	BACB30LE()-() [B] [M]	
				BACB30LE()K() [B]	
				BACB30LJ()-() [M]	
				BACB30LK()-() [M]	
				BACB30LM()-() [M]	
				BACB30LT()-() [M]	
				BACB30MR()K() [B]	
				BACB30NE()-() [A] [L] [M]	
				BACB30NF()-() [A] [L] [M]	
				BACB30NM()K()	
				BACB30NR()K()	
				BACB30US()K() [B]	
				BACB30US()P() [B] [M]	
				NAS6603 THRU NAS6620 [A] [L] [M]	
				NAS6703 THRU NAS6720 [M]	

BOLT - RECESS DRIVE - PROTRUDING HEAD
TABLE VIII

Fastener Substitution - Bolts
Figure 2 (Sheet 58 of 67)

INITIAL FASTENER OR SPECIFIED REPAIR FASTENER			FASTENER SUBSTITUTION		
PART NUMBER	DESCRIPTION	MATING PART	EQUIVALENT	ALTERNATIVE	MATING PART
NAS623-()-()	SCREW, ALLOY STEEL, CADMIUM PLATED, PHILLIPS RECESS, PAN HEAD, SHORT THREAD, 95 KSI SHEAR, MAX TEMP 450°F (232°C)		NO EQUIVALENT	BACB30LE()-() [B]	
				BACB30LE()K() [B] [I]	
				BACB30LJ()-()	
				BACB30LK()-()	
				BACB30LM()-()	
				BACB30LT()-()	
				BACB30MR()K() [B] [I]	
				BACB30NM()K() [I]	
				BACB30NR()K() [I]	
				BACB30NT()K() [I]	
NAS623-()-()W	SCREW, ALLOY STEEL, CADMIUM PLATED, PHILLIPS RECESS, PAN HEAD, SHORT THREAD, 95 KSI SHEAR, MAX TEMP 450°F (232°C)		NO EQUIVALENT	BACB30LE()-() [B]	
				BACB30LE()K() [B] [I]	
				BACB30LJ()-()	
				BACB30LK()-()	
				BACB30LM()-()	
				BACB30LT()-()	
				BACB30MR()K() [B] [I]	
				BACB30NM()K() [I]	
				BACB30NR()K() [I]	
				BACB30NT()T() [I]	
				NAS623-()-() [L]	

BOLT - RECESS DRIVE - PROTRUDING HEAD
TABLE VIII

Fastener Substitution - Bolts
Figure 2 (Sheet 59 of 67)

INITIAL FASTENER OR SPECIFIED REPAIR FASTENER			FASTENER SUBSTITUTION		
PART NUMBER	DESCRIPTION	MATING PART	EQUIVALENT	ALTERNATIVE	MATING PART
BACB30LB()C()	A286 CRES SLEEVE, PASSIVATED, POSITIVE MECHANICAL LOCK, PULL TYPE, MAX TEMP 450°F (232°C)		NO EQUIVALENT	MS21141-()()	
BACB30LB()C()CD	A286 CRES SLEEVE, CADMIUM PLATED, POSITIVE MECHANICAL LOCK, PULL TYPE, MAX TEMP 450°F (232°C)		NO EQUIVALENT	MS21141-()()P	
BACB30LB()-()	ALLOY STEEL SLEEVE, CADMIUM PLATED, POSITIVE MECHANICAL LOCK, PULL TYPE, MAX TEMP 450°F (232°C)		NO EQUIVALENT	MS90354-()()	
BACB30UY()-()	6AL-4V TITANIUM, PHOSPHATE FLUORIDE COATED		NO EQUIVALENT	BACB30VL()-() [P]	
				BACB30VL()-()D	
				BACB30VL()C()D	

BOLT - BLIND - PROTRUDING HEAD
TABLE IX

Fastener Substitution - Bolts
Figure 2 (Sheet 60 of 67)

INITIAL FASTENER OR SPECIFIED REPAIR FASTENER			FASTENER SUBSTITUTION		
PART NUMBER	DESCRIPTION	MATING PART	EQUIVALENT	ALTERNATIVE	MATING PART
BAC30VL()-()	LOW PROFILE HEAD, SHEAR, LIGHTWEIGHT, 304 CRES SLEEVE, TITANIUM ALLOY NUT		NO EQUIVALENT	BACB30VL()-()D BACB30VL()C()D	
BACB30VL()-()D	LOW PROFILE HEAD, SHEAR, LIGHTWEIGHT, 304 CRES SLEEVE, TITANIUM ALLOY NUT, DISPOSABLE DRIVE NUT		NO EQUIVALENT	BACB30VL()-() P BACB30VL()C()D	
BACB30VL()C()D	LOW PROFILE HEAD, SHEAR, LIGHTWEIGHT, 304 CRES SLEEVE, A-286 SS NUT, DISPOSABLE DRIVE NUT		NO EQUIVALENT	BACB30VL()-() P BACB30VL()-()D	
MS21141-()()	A286 CRES SLEEVE, PASSIVATED, POSITIVE MECHANICAL LOCK, PULL TYPE, MAX MAX TEMP 1200°F (649°C)		NO EQUIVALENT	BACB30LB()C()	
MS21141-()()P	A286 CRES SLEEVE, CADMIUM PLATED, POSITIVE MECHANICAL LOCK, PULL TYPE, MAX TEMP 450°F (232°C)		NO EQUIVALENT	BACB30LB()C()CD	
MS90354-()()	ALLOY STEEL SLEEVE, CADMIUM PLATED, POSITIVE MECHANICAL LOCK, PULL TYPE, MAX TEMP 450°F (232°C)		NO EQUIVALENT	BACB30LB()-()	

BOLT - BLIND - PROTRUDING HEAD
TABLE IX

Fastener Substitution - Bolts
Figure 2 (Sheet 61 of 67)

INITIAL FASTENER OR SPECIFIED REPAIR FASTENER			FASTENER SUBSTITUTION		
PART NUMBER	DESCRIPTION	MATING PART	EQUIVALENT	ALTERNATIVE	MATING PART
BACB30LA()C()	A286 CRES SLEEVE, PASSIVATED, 100° HEAD, POSITIVE MECHANICAL LOCK, PULL TYPE, MAX TEMP 1200°F (649°C)		NO EQUIVALENT	MS21140-()()	
BACB30LA()C()CD	A286 CRES SLEEVE, CADMIUM PLATED, 100° HEAD, POSITIVE MECHANICAL LOCK, PULL TYPE, MAX TEMP 450°F (232°C)		NO EQUIVALENT	MS21140-()()P	
BACB30LA()-()	ALLOY STEEL SLEEVE, CADMIUM PLATED, 100° HEAD, POSITIVE MECHANICAL LOCK, PULL TYPE, MAX TEMP 450°F (232°C)		NO EQUIVALENT	MS90353-()()	
BACB30UZ()-()	6AL-4V TITANIUM, PHOSPHATE FLUORIDE COATED, 130° HEAD		NO EQUIVALENT	BACB30VK()-() P	
				BACB30VK()-()D	
				BACB30VK()C()D	
BACB30VK()-()	CRES SLEEVE, 6AL-4V TITANIUM NUT, 130° HEAD, REDUCED SHEAR, LIGHTWEIGHT, PHOSPHATE FLUORIDE TREATED, PASSIVATED SLEEVE, MAX TEMP 350°F (177°C)		NO EQUIVALENT	BACB30VK()-()D	
				BACB30VK()C()D	

BOLT - BLIND - FLUSH HEAD
TABLE X

Fastener Substitution - Bolts
Figure 2 (Sheet 62 of 67)

INITIAL FASTENER OR SPECIFIED REPAIR FASTENER			FASTENER SUBSTITUTION		
PART NUMBER	DESCRIPTION	MATING PART	EQUIVALENT	ALTERNATIVE	MATING PART
BACB30VK()-()D	CRES SLEEVE, 130° HEAD, REDUCED SHEAR, LIGHTWEIGHT, PHOSPHATE FLUORIDE TREATED, PASSIVATED SLEEVE, DISPOSABLE DRIVE NUT, MAX TEMP 350°F (177°C)		NO EQUIVALENT	BACB30VK()-() P BACB30VK()C()D	
BACB30VK()C()D	CRES SLEEVE, A-286 CRES NUT, 130° HEAD, REDUCED SHEAR, LIGHTWEIGHT, PASSIVATED NUT AND SLEEVE, DISPOSABLE DRIVE NUT, MAX TEMP 350°F (177°C)		NO EQUIVALENT	BACB30VK()-() P BACB30VK()-()D	
MS21140-()()	A286 CRES SLEEVE, PASSIVATED, 100° HEAD, POSITIVE MECHANICAL LOCK, PULL TYPE, MAX TEMP 1200°F (649°C)		NO EQUIVALENT	BACB30LA()C()	
MS21140-()()P	A286 CRES SLEEVE, CADMIUM PLATED, 100° HEAD, POSITIVE MECHANICAL LOCK, PULL TYPE, MAX TEMP 450°F (232°C)		NO EQUIVALENT	BACB30LA()C()CD	

BOLT - BLIND - FLUSH HEAD
TABLE X

Fastener Substitution - Bolts
Figure 2 (Sheet 63 of 67)

INITIAL FASTENER OR SPECIFIED REPAIR FASTENER			FASTENER SUBSTITUTION		
PART NUMBER	DESCRIPTION	MATING PART	EQUIVALENT	ALTERNATIVE	MATING PART
MS90353-()()	ALLOY STEEL SLEEVE, CADMIUM PLATED, 100° HEAD, POSITIVE MECHANICAL LOCK, PULL TYPE, MAX TEMP 450°F (232°C)		NO EQUIVALENT	BACB30LA()-()	

BOLT - BLIND - FLUSH HEAD
TABLE X

Fastener Substitution - Bolts
Figure 2 (Sheet 64 of 67)

INITIAL FASTENER OR SPECIFIED REPAIR FASTENER			FASTENER SUBSTITUTION		
PART NUMBER	DESCRIPTION	MATING PART	EQUIVALENT	ALTERNATIVE	MATING PART
BACB30MW()C() [H]	6AL-4V TITANIUM, CADMIUM PLATED, CETYL ALCOHOL LUBRICATED, SHEAR HEAD, 95 KSI SHEAR, MAX TEMP 450°F (232°C)		NO EQUIVALENT	BACB30MW()K() [I]	
				BACB30PB()-() [A] [L]	
				BACB30PB()A()	
				BACB30PB()AK() [I]	
				BACB30PE()-() [A] [L]	
				BACB30PE()A()	
				BACB30PE()AK() [I]	
BACB30MW()K()	6AL-4V TITANIUM, BMS 10-85 COATED, CETYL ALCOHOL LUBRICATED, SHEAR HEAD, 95 KSI SHEAR, MAX TEMP 350°F (177°C)		NO EQUIVALENT	BACB30PB()-() [A] [L] [M]	
				BACB30PB()A() [M]	
				BACB30PB()AK()	
				BACB30PE()-() [A] [L] [M]	
				BACB30PE()A() [M]	
				BACB30PE()AK()	
BACB30PB()-()	ALLOY STEEL, CADMIUM PLATED, CETYL ALCOHOL LUBRICATED, SHEAR HEAD, 108 KSI SHEAR, MAX TEMP 450°F (232°C)		NO EQUIVALENT	BACB30BP()A()	
				BACB30PE()-() [L]	
				BACB30PE()A()	
				BACB30PE()AK() [I]	
				BACB30PB()AK() [I]	
BACB30PB()A()	A286 CRES, CADMIUM PLATED, CETYL ALCOHOL LUBRICATED, SHEAR HEAD, 110 KSI SHEAR, MAX TEMP 450°F (232°C)		NO EQUIVALENT	BACB30PE()A()	
				BACB30PE()AK() [I]	
				BACB30PB()AK() [I]	
BACB30PB()AK()	A286 CRES, BMS 10-85 COATED, CETYL ALCOHOL LUBRICATED, SHEAR HEAD, 110 KSI SHEAR, MAX TEMP 350°F (177°C)		NO EQUIVALENT	BACB30PB()A() [M]	
				BACB30PE()A() [M]	
				BACB30PE()AK()	

BOLT - TAPER SHANK - PROTRUDING HEAD
TABLE XI

Fastener Substitution - Bolts
Figure 2 (Sheet 65 of 67)

INITIAL FASTENER OR SPECIFIED REPAIR FASTENER			FASTENER SUBSTITUTION		
PART NUMBER	DESCRIPTION	MATING PART	EQUIVALENT	ALTERNATIVE	MATING PART
BACB30PB()K() [Z]	ALLOY STEEL, BMS 10-85 COATED, CETYL ALCOHOL LUBRICATED, SHEAR HEAD, 108 KSI SHEAR MAX TEMP 600° (316°)		NO EQUIVALENT	BACB30PB()-() [K] [M] BACB30PB()A() [K] [M] BACB30PB()AK() [I] BACB30PE()-() [K] [M] BACB30PE()A() [K] [M] BACB30PE()AK() [I]	
BACB30PE()-()	ALLOY STEEL, CADMIUM PLATED, CETYL ALCOHOL LUBRICATED, TENSION HEAD, 180 KSI TENSION, MAX TEMP 450°F (232°C)		NO EQUIVALENT	BACB30PE()A() BACB30PE()AK() [I]	
BACB30PE()A()	A286 CRES, CAD PLATED, CETYL ALCOHOL LUBRICATED, TENSION HEAD, 200 KSI TENSION, MAX TEMP 450°F (232°C)		NO EQUIVALENT	BACB30PE()AK() [I]	
BACB30PE()AK()	A286 CRES, BMS 10-85 COATED, CETYL ALCOHOL LUBRICATED, TENSION HEAD, 200 KSI TENSION, MAX TEMP 350°F (177°C)		NO EQUIVALENT	BACB30PE()A() [M]	
BACB30PE()K() [Z]	ALLOY STEEL, BMS 10-85 COATED, CETYL ALCOHOL LUBRICATED, TENSION HEAD, 180 KSI TENSION, MAX TEMP 600°F (316°C)		NO EQUIVALENT	BACB30PE()-() [K] [M] BACB30PE()A() [K] [M] BACB30PE()AK() [I]	

BOLT - TAPER SHANK - PROTRUDING HEAD

TABLE XI

Fastener Substitution - Bolts
Figure 2 (Sheet 66 of 67)

INITIAL FASTENER OR SPECIFIED REPAIR FASTENER			FASTENER SUBSTITUTION		
PART NUMBER	DESCRIPTION	MATING PART	EQUIVALENT	ALTERNATIVE	MATING PART
BACB30KD()-()	ALLOY STEEL, CAD PLATED, CETYL ALCOHOL LUBRICATED, SHEAR HEAD, 108 KSI SHEAR, MAX TEMP 450°F (232°C)		NO EQUIVALENT	BACB30KD()A()	
BACB30KD()A()	A286 CRES, CAD PLATED,CETYL ALCOHOL LUBRICATED, SHEAR HEAD, 110 KSI SHEAR, MAX TEMP 450°F (232°C)		NO EQUIVALENT	NO ALTERNATIVE	
BACB30MU()C() [H]	6AL-4V TITANIUM, CAD PLATED, CETYL ALCOHOL LUBRICATED, SHEAR HEAD, 95 KSI SHEAR, MAX TEMP 450° (232°C)		NO EQUIVALENT	BACB30KD()-() [A] [L] BACB30KD()A() BACB30MU()K() [I]	
BACB30MU()K()	6AL-4V TITANIUM, BMS, 10-85 COATED, CETYL ALCOHOL LUBRICATED, SHEAR HEAD, 95 KSI SHEAR, MAX TEMP 350° (177°C)		NO EQUIVALENT	BACB30KD()A() [M] BACB30KD()-() [A] [L] [M]	
BACB30PD()A()	A286 CRES, CAD PLATED,CETYL ALCOHOL LUBRICATED, TENSION HEAD, 200 KSI TENSION, MAX TEMP 450°F (232°C)		NO EQUIVALENT	NO ALTERNATIVE	
BACB30PD()-()	ALLOY STEEL, CAD PLATED, CETYL ALCOHOL LUBRICATED, TENSION HEAD, 180 KSI TENSION, MAX TEMP 450°F (232°C)		NO EQUIVALENT	BACB30PD()A()	

BOLT - TAPER SHANK - FLUSH HEAD
TABLE XI

Fastener Substitution - Bolts
Figure 2 (Sheet 67 of 67)

NOTES

- REFER TO TABLE I FOR THE FASTENER SUBSTITUTION INDEX.
- REFER TO SRM 51-40-02 FOR THE REMOVAL AND THE INSTALLATION OF FASTENERS.
- THE SHEAR AND TENSION TYPE FASTENERS USE DIFFERENT TORQUE VALUES AND INSTALLATION TOOLS. REFER TO SRM 51-40-04.
- REFER TO SRM 51-20-01 FOR THE NECESSARY PROTECTIVE TREATMENT FOR FASTENER INSTALLATION.
- DO NOT USE CADMIUM PLATED FASTENERS IN TITANIUM OR GRAPHITE (CARBON FIBER) STRUCTURE.

[A] APPLY A FILLET SEAL TO THE WET SIDE OF THE FASTENER INSIDE THE FUEL TANK. REFER TO SRM 51-20-05.

[B] DO NOT INSTALL THIS COLLAR OR NUT ON A SLOPED SURFACE.

[C] THIS FASTENER IS NOT PERMITTED IN AREAS WHERE THE TEMPERATURE IS MORE THAN 350°F (177°C)

THIS FASTENER IS NOT PERMITTED IN AREAS WHERE ELECTRICAL CONDUCTIVITY IS REQUIRED. REFER TO BAC5117.

[D] USE A SELF-ALIGNING COLLAR BACC30CH() WHEN THE COLLAR SIDE SLOPE IS MORE THAN 0.5 DEGREES.

[E] THIS FASTENER IS PERMITTED ONLY IN CLOSE REAM OR LARGER HOLES (NON-INTERFERENCE).

[F] DO NOT USE CADMIUM PLATED FASTENERS AS AN ALTERNATIVE FOR BARE OR ALUMINUM COATED FASTENERS WHEN YOU INSTALL FASTENERS THROUGH THE MATERIALS THAT FOLLOW:

- TITANIUM STRUCTURE
- GRAPHITE (CARBON FIBER) STRUCTURE

[G] THESE FASTENERS MUST BE INSTALLED WITH TORQUE-CONTROLLED TOOLING. REFER TO SRM 51-40-04.

[H] THE RECOMMENDED FASTENERS IN ALUMINUM STRUCTURE ARE TITANIUM WITH BMS 10-85 APPLIED, A-286 WITH BMS 10-85 APPLIED, OR CADMIUM-PLATED A-286.

- CADMIUM-PLATED ALLOY-STEEL FASTENERS ARE A STRUCTURALLY ACCEPTABLE ALTERNATIVE.
- HOWEVER, IN A CORROSIVE ENVIRONMENT THE CADMIUM PLATING, WHICH IS A SACRIFICIAL COATING, MAY DISAPPEAR ALLOWING THE ALLOY-STEEL FASTENER TO CORRODE.
- THIS MAY RESULT IN THE RUST-STREAKING OF THE SURROUNDING STRUCTURE AND THE INITIATION OF CORROSION OF ANY ADJACENT ALUMINUM STRUCTURE.

NOTE: ALL THESE FASTENERS, BOTH THE RECOMMENDED AND THE ALTERNATIVES, SHOULD BE INSTALLED WET WITH THE NECESSARY SEALANT MATERIAL.

[I] DO NOT USE ALLOY STEEL FASTENERS AS AN ALTERNATIVE FOR THE CORROSION RESISTANT STEEL (CRES) OR TITANIUM FASTENERS IN:

- AREAS WHERE ANTI-MAGNETIC FASTENERS ARE NECESSARY
- GRAPHITE (CARBON FIBER) STRUCTURE
- CRES STRUCTURE

[J] SPEAK TO THE BOEING COMPANY FOR FASTENER ALTERNATIVES

Fastener Substitution - Lockbolts
Figure 3 (Sheet 1 of 21)

TYPE OF LOCKBOLT FASTENER	LOCATION OF FASTENER	
	TABLE NUMBER	SHEET NUMBER
LOCKBOLT - PROTRUDING HEAD (SHEAR)	II	3 THROUGH 8
LOCKBOLT - FLUSH HEAD (SHEAR)	III	9 THROUGH 15
LOCKBOLT - PROTRUDING HEAD (TENSION)	IV	16 THROUGH 18
LOCKBOLT - FLUSH HEAD (TENSION)	V	19 THROUGH 21

LOCKBOLT FASTENER SUBSTITUTION INDEX
TABLE I

Fastener Substitution - Lockbolts
Figure 3 (Sheet 2 of 21)

INITIAL FASTENER OR SPECIFIED REPAIR FASTENER			FASTENER SUBSTITUTION		
PART NUMBER	DESCRIPTION	MATING PART	EQUIVALENT	ALTERNATIVE	MATING PART
BACB30AR()-()	ALLOY STEEL, CADMIUM PLATED, 95 KSI SHEAR, LUBRICATED FLAT HEAD, STUMP TYPE, MAX TEMP 250°F (121°C)	BACC30K() OR NAS1080C()	NO EQUIVALENT	BACB30FM()-() [H]	BACC30AG() [A]
					BACC30M() [A] [B]
					BACN10XJ() [A] [B] [G]
				BACB30FM()A()	BACC30AG() [A]
					BACC30M() [A] [B]
					BACN10XJ() [A] [B] [G]
				BACB30GW()-()	BACC30K()
					NAS1080C()
				BACB30GW()A() [H]	BACC30K()
					NAS1080C()
				BACB30VN()K() [C]	BACC30BK()
				BACB30VT()K() [C]	BACC30BL() [A] [B]
					BACC30BQ() [A]
					BACN10YZ() [A] [B] [G]
BACB30CU()-()	ALLOY STEEL CAD PLATED 0.0156 OVERSIZE PULL TYPE GUN DRIVEN	BACC30K() OR NAS1080C()	NO EQUIVALENT	BACB30FP()-()	BACC30AG() [A]
					BACC30M() [A] [B]
					BACN10XJ() [A] [B] [G]
				BACB30MY()K()X [C]	BACC30AG() [A]
					BACC30M() [A] [B]
					BACN10XJ() [A] [B] [G]
				BACB30NX()K()X [C]	BACC30AG() [A]
					BACC30M() [A] [B]
					BACN10XJ() [A] [B] [G]

LOCKBOLT - PROTRUDING HEAD (SHEAR)
TABLE II

Fastener Substitution - Lockbolts
Figure 3 (Sheet 3 of 21)

INITIAL FASTENER OR SPECIFIED REPAIR FASTENER			FASTENER SUBSTITUTION		
PART NUMBER	DESCRIPTION	MATING PART	EQUIVALENT	ALTERNATIVE	MATING PART
BACB30GW()-()	ALLOY STEEL, C.T. SHANK, 1.0 PINTAIL, (PULL TYPE, GUN DRIVEN), CADMIUM PLATED	BACC30K() OR NAS1080C()	NO EQUIVALENT	BACB30FM()-() $\boxed{H}$	BACC30AG() $\boxed{A}$
					BACC30M() $\boxed{A}$ $\boxed{B}$
				BACB30FM()A()	BACC30AG() $\boxed{A}$
					BACC30M() $\boxed{A}$ $\boxed{B}$
				BACB30MY()K() $\boxed{C}$	BACC30AG() $\boxed{A}$
					BACC30M() $\boxed{A}$ $\boxed{B}$
				BACB30VN()K() $\boxed{C}$	BACC30BK()
				BACB30VT()K() $\boxed{C}$	BACC30BL() $\boxed{A}$ $\boxed{B}$
					BACC30BQ() $\boxed{A}$
					BACN10YZ() $\boxed{A}$ $\boxed{B}$ $\boxed{G}$
					BACC30BP() $\boxed{B}$
BACB30GW()A()	A-286 CRES, C.T. SHANK, 1.0 PINTAIL, (PULL TYPE, GUN DRIVEN), CADMIUM PLATED	BACC30K()	NO EQUIVALENT	BACB30VN()K() $\boxed{C}$	BACC30BK()
				BACB30VT()K() $\boxed{C}$	BACC30BL() $\boxed{A}$ $\boxed{B}$
					BACC30BP() $\boxed{B}$
					BACN10YZ() $\boxed{A}$ $\boxed{B}$ $\boxed{G}$
					BACC30BQ() $\boxed{A}$
		NAS1080E()		BACB30FM()A()	BACC30AB()C $\boxed{A}$ $\boxed{B}$
					BACC30AG() $\boxed{A}$ $\boxed{E}$
				BACB30VN()K() $\boxed{C}$	BACC30BK() $\boxed{E}$
				BACB30VT()K() $\boxed{C}$	BACC30BL() $\boxed{A}$ $\boxed{B}$ $\boxed{E}$
					BACC30BP() $\boxed{B}$ $\boxed{E}$
					BACC30BQ() $\boxed{A}$ $\boxed{E}$
					BACC30BS() $\boxed{A}$ $\boxed{B}$
					BACN10YZ() $\boxed{A}$ $\boxed{B}$ $\boxed{G}$ $\boxed{E}$

LOCKBOLT - PROTRUDING HEAD (SHEAR)
TABLE II

Fastener Substitution - Lockbolts
Figure 3 (Sheet 4 of 21)

INITIAL FASTENER OR SPECIFIED REPAIR FASTENER			FASTENER SUBSTITUTION		
PART NUMBER	DESCRIPTION	MATING PART	EQUIVALENT	ALTERNATIVE	MATING PART
BACB30GW()A()U	A286 CRES, PASSIVATED, 95 KSI SHEAR, LUBRICATED, PULLTYPE, MAX TEMP 900°F (482°C)	BACC30L()	NO EQUIVALENT	BACB30FM()A()U	BACC30AB()S [A] [B]
				BACB30MB()A()U	BACC30AB()S [A] [B]
BACB30GW()D()	ALLOY STEEL CAD PLATED LUBRICATED 95 KSI SHEAR MAX TEMP 450°F (232°C)	BACC30K() OR NAS1080C()	NO EQUIVALENT	BACB30FM()-() [H] [I]	BACC30AG() [A]
					BACC30M() [A] [B]
				BACB30FM()A()	BACC30AG() [A]
					BACC30M() [A] [B]
				BACB30MY()K() [C]	BACC30AG() [A]
					BACC30M() [A] [B]
				BACB30VN()K() [C]	BACC30BK()
				BACB30VT()K() [C]	BACC30BL() [A] [B]
					BACC30BQ() [A]
					BACN10YZ() [A] [B] [G]
					BACC30BP() [B]
BACB30GW()D()N	ALLOY STEEL, DIFFUSED NICKEL-CADMIUM PLATED, 95 KSI SHEAR, LUBRICATED, PULL TYPE, MAX TEMP 600°F (316°C)	NAS1080E	NO EQUIVALENT	[J]	

LOCKBOLT - PROTRUDING HEAD (SHEAR)
TABLE II

Fastener Substitution - Lockbolts
Figure 3 (Sheet 5 of 21)

INITIAL FASTENER OR SPECIFIED REPAIR FASTENER			FASTENER SUBSTITUTION		
PART NUMBER	DESCRIPTION	MATING PART	EQUIVALENT	ALTERNATIVE	MATING PART
BACB30TZ()K()	6AL-4V TITANIUM, ALUMINUM PIGMENTED COATING, 95 KSI SHEAR, CETYL ALCOHOL LUBRICATED, PULL TYPE, MAX TEMP 250°F (121°C)	BACC30BE	NO EQUIVALENT	BACB30FM()-() [F] [H] [I]	BACC30AG() [A] [B]
					BACC30M() [A] [B]
					BACN10XJ() [A] [B] [G]
				BACB30FM()A() [F]	BACC30AG() [A]
					BACC30M() [A] [B]
					BACN10XJ() [A] [B] [G]
				BACB30MY()K()	BACC30AG() [A]
					BACC30M() [A]
					BACN10XJ() [A] [B] [G]
				BACB30VN()K()	BACC30BK()
				BACB30VT()K()	BACC30BL() [A] [B]
					BACC30BP() [B]
					BACC30BQ() [A]
					BACN10YZ() [A] [B] [G]
BACB30UD()K()	6AL-4V TITANIUM, ALUMINUM PIGMENTED COATING, 95 KSI SHEAR, CETYL ALCOHOL LUBRICATED, STUMP TYPE, MAX TEMP 250°F (121°C)	BACC30K() OR BACC30BE()	NO EQUIVALENT	BACB30FM()-() [F] [H] [I]	BACC30AG() [A]
					BACC30M() [A] [B]
					BACN10XJ() [A] [B] [G]
				BACB30FM()A() [F]	BACC30AG() [A]
					BACC30M() [A] [B]
					BACN10XJ() [A] [B] [G]
				BACB30MY()K()	BACC30AG() [A]
					BACC30M() [A] [B]
					BACN10XJ() [A] [B] [G]
				BACB30VN()K()	BACC30BK()
				BACB30VT()K()	BACC30BP() [B]
					BACC30BQ() [A]
					BACC30BL() [A] [B]
					BACN10YZ() [A] [B] [G]

LOCKBOLT - PROTRUDING HEAD (SHEAR)
TABLE II

Fastener Substitution - Lockbolts
Figure 3 (Sheet 6 of 21)

INITIAL FASTENER OR SPECIFIED REPAIR FASTENER			FASTENER SUBSTITUTION		
PART NUMBER	DESCRIPTION	MATING PART	EQUIVALENT	ALTERNATIVE	MATING PART
BACB30VN()K()	6AL-4V TITANIUM, 95 KSI SHEAR, LIGHTWEIGHT, ALUMINUM PIGMENTED COATING, CETYL ALCOHOL LUBRICATED, MAX TEMP 250°F (121°C)	BACC30BK()	NO EQUIVALENT	BACB30FM()-() [F] [H] [I]	BACC30AG() [A]
					BACC30M() [A] [B]
					BACN10XJ() [A] [B] [G]
				BACB30FM()A() [F]	BACC30AG() [A]
					BACC30M() [A] [B]
					BACN10XJ() [A] [B] [G]
				BACB30MY()K()	BACC30AG() [A]
					BACC30M() [A] [B]
					BACN10XJ() [A] [B] [G]
				BACB30VT()K()	BACC30BL() [A] [B]
					BACC30BP() [B]
					BACC30BQ() [A]
					BACN10YZ() [A] [B] [G]

LOCKBOLT - PROTRUDING HEAD (SHEAR)
TABLE II

Fastener Substitution - Lockbolts
Figure 3 (Sheet 7 of 21)

INITIAL FASTENER OR SPECIFIED REPAIR FASTENER			FASTENER SUBSTITUTION		
PART NUMBER	DESCRIPTION	MATING PART	EQUIVALENT	ALTERNATIVE	MATING PART
BACB30VR()K()	6AL-4V TITANIUM, 95 KSI SHEAR, STUMP TYPE, LIGHTWEIGHT, ALUMINUM PIGMENTED COATING, CETYL ALCOHOL LUBRICATED MAX TEMP 250°F (121°C)	BACC30BK()	NO EQUIVALENT	BACB30FM()-() [F] [H] [I]	BACC30AG() [A]
					BACC30M() [A] [B]
					BACN10XJ() [A] [B] [G]
				BACB30FM()A() [F]	BACC30AG() [A]
					BACC30M() [A] [B]
					BACN10XJ() [A] [B] [G]
				BACB30MY()K()	BACC30AG() [A]
					BACC30M() [A] [B]
					BACN10XJ() [A] [B] [G]
				BACB30VN()K()	BACC30BK()
				BACB30VT()K()	BACC30BL() [A] [B]
					BACC30BP() [B]
					BACC30BQ() [A]
					BACN10YZ() [A] [B] [G]
BACB30XC()HK()	6AL-4V TITANIUM, 95 KSI SHEAR, AL COATED, CETYL ALCOHOL LUBRICATED, WITH SEALANT ESCAPE GROOVE, FOR USE IN COMPOSITES, MAX TEMP 250°F	BACC30BN()L	NO EQUIVALENT	BACB30XH()K()	BACC30CG() [D]
				BACB30NX()K()	BACC30AB()S [B]
BACB30XC()K()	6AL-4V TITANIUM, 95 KSI SHEAR, AL COATED, CETYL ALCOHOL LUBRICATED, FOR USE IN COMPOSITES, MAX TEMP 250°F	BACC30BN()L	NO EQUIVALENT	BACB30XH()K()	BACC30CG() [D]
				BACB30NX()K()	BACC30AB()S [B]

LOCKBOLT - PROTRUDING HEAD (SHEAR)
TABLE II

Fastener Substitution - Lockbolts
Figure 3 (Sheet 8 of 21)

INITIAL FASTENER OR SPECIFIED REPAIR FASTENER			FASTENER SUBSTITUTION		
PART NUMBER	DESCRIPTION	MATING PART	EQUIVALENT	ALTERNATIVE	MATING PART
BACB30CT()-()	ALLOY STEEL, CAD PLATED, 0.0156 OVERSIZE PULL TYPE GUN DRIVEN	NAS1080D()	NO EQUIVALENT	BACB30FQ()-()	BACC30M() [A] [B]
				BACB30FQ()A()	BACC30M() [A] [B]
				BACB30NW()K()X [C]	BACC30M() [A] [B]
BACB30GQ()-()	7075-T6 AL PULL TYPE 100° HEAD GUN DRIVEN	NAS1080D()	NO EQUIVALENT	NAS1535 THRU 1542	NAS1080K()
BACB30GS()-()	7075-T6 AL STUMP TYPE 100° HEAD HAMMER DRIVEN	NAS1080D()	NO EQUIVALENT	NAS1535 THRU 1542	NAS1080K()
BACB30GY()-()	ALLOY STEEL, 100° HEAD, STEEL C.T. SHANK, 1.0 PINTAIL, (PULL TYPE, GUN DRIVEN), CADMIUM PLATED, CETYL ALCOHOL LUBRICATED	BACC30K() OR NAS1080C()	NO EQUIVALENT	BACB30VU()K() [C] [D]	BACC30BL() [A] [B]
					BACC30BP() [B]
					BACC30BQ() [A]
					BACN10YZ() [A] [B] [G]
				BACB30XT()K() [C] [D]	BACC30BK()
		NAS1080E		BACB30VU()K() [C] [D]	BACC30BL() [A] [B] [E]
					BACC30BP() [B] [E]
					BACC30BQ() [A] [E]
					BACC30BS() [A] [B]
					BACN10YZ() [A] [B] [E] [G]
				BACB30XT()K() [C] [D]	BACC30BK() [E]

LOCKBOLT - FLUSH HEAD (SHEAR)
TABLE III

Fastener Substitution - Lockbolts
Figure 3 (Sheet 9 of 21)

INITIAL FASTENER OR SPECIFIED REPAIR FASTENER			FASTENER SUBSTITUTION		
PART NUMBER	DESCRIPTION	MATING PART	EQUIVALENT	ALTERNATIVE	MATING PART
BACB30GY()A()	A-286 CRES, 100° HEAD, STEEL C.T. SHANK, 1.0 PINTAIL, (PULL TYPE, GUN DRIVEN), CADMIUM PLATED, CETYL ALCOHOL LUBRICATED	BACC30K() OR NAS1080C()	NO EQUIVALENT	BACB30VU()K() C D	BACC30BL() A B
					BACC30BP() B
					BACC30BQ() A
					BACN10YZ() A B G
				BACB30XT()K() C D	BACC30BK()
		NAS1080E		BACB30VU()K() C D	BACC30BL() A B E
					BACC30BP() B E
					BACC30BQ() A E
					BACC30BS() A B
					BACN10YZ() A B E G
				BACB30XT()K() C D	BACC30BK() E
BACB30GY()A()U	A286 CRES, PASSIVATED, 95 KSI SHEAR, CETYL ALCOHOL LUBRICATED, 100° HEAD, PULL TYPE, MAX TEMP 900°F (482°C)	BACC30L()	NO EQUIVALENT	BACB30FN()A()U	BACC30AB()S A B
BACB30GY()D()N	ALLOY STEEL, NICKEL-CADMIUM PLATED, 95 KSI SHEAR, LUBRICATED, PULL TYPE, MAX TEMP 600°F (316°C)	NAS1080E	NO EQUIVALENT	J	

LOCKBOLT - FLUSH HEAD (SHEAR)
TABLE III

Fastener Substitution - Lockbolts
Figure 3 (Sheet 10 of 21)

INITIAL FASTENER OR SPECIFIED REPAIR FASTENER			FASTENER SUBSTITUTION		
PART NUMBER	DESCRIPTION	MATING PART	EQUIVALENT	ALTERNATIVE	MATING PART
BACB30TY()K()	6AL-4V TITANIUM, ALUMINUM PIGMENTED COATING, 95 KSI SHEAR, CETYL ALCOHOL LUBRICATED, 100° HEAD, PULL TYPE, MAX TEMP 250°F (121°C)	BACC30BE()	NO EQUIVALENT	BACB30NW()K()	BACC30AG()
					BACC30M() [A] [B]
					BACN10XJ() [A] [B] [G]
				BACB30VU()K()	BACC30BL() [A] [B]
					BACC30BP() [B]
					BACC30BQ() [A]
					BACN10YZ() [A] [B] [G]
				BACB30XT()K()	BACC30BK()
BACB30UC()K()	6AL-4V TITANIUM, 100° REDUCED HEAD, STUMP TYPE, 95 KSI SHEAR, ALUMINUM PIGMENTED COATING, CETYL ALCOHOL LUBRICATED	NAS1080K()	NO EQUIVALENT	BACB30NW()K()	BACC30M() [A] [B]
				BACB30VU()K()	BACC30BP() [B]
					BACC30BL() [A] [B]
					BACC30BQ() [A]
					BACB10YZ() [A] [B] [G]
BACB30UC()K()A	6AL-4V TITANIUM, 100° REDUCED HEAD, STUMP TYPE, CHAMFERED STUMP END, 95 KSI SHEAR, ALUMINUM PIGMENTED COATING, CETYL ALCOHOL LUBRICATED	BACC30BE()	NO EQUIVALENT	BACB30NW()K()	BACC30M() [A] [B]
				BACB30VU()K()	BACC30BL() [A] [B]
					BACC30BP() [B]
					BACC30BQ() [A]
					BACN10YZ() [A] [B] [G]

LOCKBOLT - FLUSH HEAD (SHEAR)
TABLE III

Fastener Substitution - Lockbolts
Figure 3 (Sheet 11 of 21)

INITIAL FASTENER OR SPECIFIED REPAIR FASTENER			FASTENER SUBSTITUTION		
PART NUMBER	DESCRIPTION	MATING PART	EQUIVALENT	ALTERNATIVE	MATING PART
BACB30VM()K()	6AL-4V TITANIUM, 100° HEAD, LIGHTWEIGHT, 95 KSI SHEAR, ALUMINUM PIGMENTED COATING, CETYL ALCOHOL LUBRICATED, MAX TEMP 250°F (121°C)	BACC30BK()	NO EQUIVALENT	BACB30NW()K()	BACC30M() [A] [B]
				BACB30VM()K()	BACC30BK()
				BACB30VU()K()	BACC30BL() [A] [B]
					BACC30BP() [B]
					BACC30BQ() [A]
					BACN10YZ() [A] [B] [G]
				BACB30XT()K()	BACC30BK()
BACB30VP()K()	6AL-4V TITANIUM, 100° HEAD, STUMP TYPE, LIGHTWEIGHT, 95 KSI SHEAR, ALUMINUM PIGMENTED COATING, CETYL ALCOHOL LUBRICATED, MAX TEMP 250°F (121°C)	BACC30BK()	NO EQUIVALENT	BACB30NW()K()	BACC30M() [A] [B]
				BACB30VM()K()	BACC30BK()
				BACB30VU()K()	BACC30BL() [A] [B]
					BACC30BP() [B]
					BACC30BQ() [A]
					BACN10YZ() [A] [B] [G]
				BACB30XT()K()	BACC30BK()
BACB30WB()HK()	6AL-4V TITANIUM, 130° HEAD, LIGHTWEIGHT, 95 KSI SHEAR, ALUMINUM PIGMENTED COATING, CETYL ALCOHOL LUBRICATED, MAX TEMP 250°F (121°C), WITH SEALANT ESCAPE GROOVE, FOR USE IN COMPOSITES	BACC30BN()L	NO EQUIVALENT	NO ALTERNATIVE	

LOCKBOLT - FLUSH HEAD (SHEAR)
TABLE III

Fastener Substitution - Lockbolts
Figure 3 (Sheet 12 of 21)

INITIAL FASTENER OR SPECIFIED REPAIR FASTENER			FASTENER SUBSTITUTION		
PART NUMBER	DESCRIPTION	MATING PART	EQUIVALENT	ALTERNATIVE	MATING PART
BACB30WB()K()	6AL-4V TITANIUM, 130° HEAD, LIGHTWEIGHT, 95 KSI SHEAR, ALUMINUM PIGMENTED COATING, CETYL ALCOHOL LUBRICATED, MAX TEMP 250°F (121°C), FOR USE IN COMPOSITES	BACC30BN()L	NO EQUIVALENT	BACB30XR()K()	BACC30CG() [D]
BACB30WD()HK()	6AL-4V TITANIUM, 100° (MS24694) HEAD, LIGHTWEIGHT, 95 KSI SHEAR, ALUMINUM PIGMENTED COATING, CETYL ALCOHOL LUBRICATED, MAX TEMP 250°F (121°C), WITH SEALANT ESCAPE GROOVE, FOR USE IN COMPOSITES	BACC30BN()L	NO EQUIVALENT	BACB30NY()K()	BACC30AB()S [B]
BACB30WD()K()	6AL-4V TITANIUM, 100° (MS24694) HEAD, LIGHTWEIGHT, 95 KSI SHEAR, AL COATED, CETYL ALCOHOL LUBRICATED, MAX TEMP 250°F, FOR USE IN COMPOSITES	BACC30BN()L	NO EQUIVALENT	BACB30XF()K()	BACC30CG() [D]
				BACB30NY()K()	BACC30AB()S [B]

LOCKBOLT - FLUSH HEAD (SHEAR)
TABLE III

Fastener Substitution - Lockbolts
Figure 3 (Sheet 13 of 21)

INITIAL FASTENER OR SPECIFIED REPAIR FASTENER			FASTENER SUBSTITUTION		
PART NUMBER	DESCRIPTION	MATING PART	EQUIVALENT	ALTERNATIVE	MATING PART
BACB30WE()HK()	6AL-4V TITANIUM, 100° (MS24694) HEAD, LIGHTWEIGHT, 95 KSI SHEAR, STUMP TYPE, ALUMINUM PIGMENTED COATING, CETYL ALCOHOL LUBRICATED, MAX TEMP 250°F (121°C), WITH SEALANT ESCAPE GROOVE, FOR USE IN COMPOSITES	BACC30BN()L	NO EQUIVALENT	BACB30WD()HK()	BACC30BN()L
BACB30XB()HK()	6AL-4V TITANIUM, 100° HEAD, LIGHTWEIGHT, 95 KSI SHEAR, ALUMINUM PIGMENTED COATING, CETYL ALCOHOL LUBRICATED, MAX TEMP 250°F (121°C), WITH SEALANT ESCAPE GROOVE, FOR USE IN COMPOSITES	BACC30BN()L	NO EQUIVALENT	BACB30NZ()K()	BACC30AB()S [B]

LOCKBOLT - FLUSH HEAD (SHEAR)
TABLE III

Fastener Substitution - Lockbolts
Figure 3 (Sheet 14 of 21)

INITIAL FASTENER OR SPECIFIED REPAIR FASTENER			FASTENER SUBSTITUTION		
PART NUMBER	DESCRIPTION	MATING PART	EQUIVALENT	ALTERNATIVE	MATING PART
BACB30XB()K()	6AL-4V TITANIUM, 100° HEAD, LIGHTWEIGHT, 95 KSI SHEAR, AL COATED, CETYL ALCOHOL LUBRICATED, MAX TEMP 250°F (121°C), FOR USE IN COMPOSITES	BACC30BN()	NO EQUIVALENT	BACB30XG()K()	BACC30CG() [D]
				BACB30NZ()K()	BACC30AB()S [B]
BACB30XT()K()	6AL-4V TITANIUM, 100° HEAD, LIGHTWEIGHT, 95 KSI SHEAR, ALUMINUM PIGMENTED COATING, CETYL ALCOHOL LUBRICATED, MAX TEMP 250° (121°C)	BACC30BK()	NO EQUIVALENT	BACB30YP()K()	BACC30BL() [A] [B] BACC30BP() [B] BACC30BQ [A] BACN10YZ() [A] [B] [G]
BACB30YC()HK()	6AL-4V TITANIUM, 100° HEAD, LIGHTWEIGHT, STUMP TYPE, 95 KSI SHEAR, ALUMINUM PIGMENTED COATING, CETYL ALCOHOL LUBRICATED, MAX TEMP 250°F (121°C), WITH SEALANT ESCAPE GROOVE, FOR USE IN COMPOSITES	BACC30BN()L	NO EQUIVALENT	BACB30XB()HK()	BACC30BN()L

LOCKBOLT - FLUSH HEAD (SHEAR)
TABLE III

Fastener Substitution - Lockbolts
Figure 3 (Sheet 15 of 21)

INITIAL FASTENER OR SPECIFIED REPAIR FASTENER			FASTENER SUBSTITUTION		
PART NUMBER	DESCRIPTION	MATING PART	EQUIVALENT	ALTERNATIVE	MATING PART
BACB30DX()-()	8740 ALLOY STEEL, C.T. SHANK, 1.0 PINTAIL, (PULL TYPE, GUN DRIVEN), CADMIUM PLATED	NAS1080-() OR NAS1080P()	NO EQUIVALENT	BACB30NX()K() $\boxed{C}$	BACC30X() $\boxed{A}$ $\boxed{B}$
				BACB30UB()K() $\boxed{C}$	BACC30BF()
		NAS1080R()		BACB30NX()K() $\boxed{C}$	BACC30X() $\boxed{A}$ $\boxed{B}$
				BACB30UB()K() $\boxed{C}$ $\boxed{E}$	BACC30BF()
BACB30DX()A()	A-286 CRES C.T. SHANK, 1.0 PINTAIL, (PULL TYPE, GUN DRIVEN), CADMIUM PLATED	NAS1080-() OR NAS1080P()	NO EQUIVALENT	BACB30NX()K() $\boxed{C}$	BACC30X() $\boxed{A}$ $\boxed{B}$
				BACB30UB()K() $\boxed{C}$	BACC30BF()
		NAS1080R()		BACB30NX()K() $\boxed{C}$	BACC30X() $\boxed{A}$ $\boxed{B}$
				BACB30UB()K() $\boxed{C}$ $\boxed{E}$	BACC30BF()
BACB30DX()A()U	A-286 CRES C.T. SHANK, 1.0 PINTAIL, (PULL TYPE, GUN DRIVEN), PASSIVATED	BACC30Q()	NO EQUIVALENT	BACC30MB()A()U	BACC30X()S $\boxed{A}$ $\boxed{B}$
BACB30DX()D()N	ALLOY STEEL, NICKEL-CADMIUM PLATED, 160 KSI TENSION, LUBRICATED, PULL TYPE, MAX TEMP 900°F (482°C)		NO EQUIVALENT	$\boxed{J}$	
BACB30GP()-()	7075-T6 AL, ANODIZED, 77 KSI TENSION, LUBRICATED, PULL TYPE, MAX TEMP 250°F (121°C)	NAS1080D	NO EQUIVALENT	NAS1515 THRU NAS1532	NAS1080D
BACB30GR()-()	7075-T6 AL, CLOSE TOLERANCE SHANK, STUMP TYPE, MAX TEMP 250°F (121°C)	NAS1080D	NO EQUIVALENT	BACB30GP()-()	NAS1080D
				NAS1525 THRU NAS1532	NAS1080D

LOCKBOLT - PROTRUDING HEAD (TENSION)
TABLE IV

Fastener Substitution - Lockbolts
Figure 3 (Sheet 16 of 21)

INITIAL FASTENER OR SPECIFIED REPAIR FASTENER			FASTENER SUBSTITUTION		
PART NUMBER	DESCRIPTION	MATING PART	EQUIVALENT	ALTERNATIVE	MATING PART
BACB30HC()-()	8740 ALLOY STEEL, CLOSE TOLERANCE SHANK, (STUMP TYPE, HAMMER DRIVEN), CADMIUM PLATED	NAS1080	NO EQUIVALENT	BACB30NX()K() [C]	BACC30X() [A] [B]
				BACB30UB()K() [C]	BACC30BF()
		NAS1080R		BACB30NX()K() [C]	BACC30X() [A] [B]
				BACB30UB()K() [C] [E]	BACC30BF()
BACB30HC()A()	A286 CRES, CADMIUM PLATED, 160 KSI TENSION, LUBRICATED, CLOSE TOLERANCE SHANK, (STUMP TYPE, HAMMER DRIVEN), MAX TEMP 250°F (121°C)	NAS1080	NO EQUIVALENT	BACB30MB()A()	BACC30X() [A] [B]
				BACB30NX()K() [C]	BACC30X() [A] [B]
				BACB30UB()K() [C]	BACC30BF()
		NAS1080R		BACB30MB()A()	BACC30X() [A] [B]
				BACB30NX()K() [C]	BACC30X() [A] [B]
				BACB30UB()K() [C] [E]	BACC30BF()
BACB30HC()A()U	A286 CRES, CADMIUM PASSIVATED, 160 KSI TENSION, LUBRICATED, CLOSE TOLERANCE SHANK, (STUMP TYPE, HAMMER DRIVEN), MAX TEMP 900°F (482°C)	BACC30Q()	NO EQUIVALENT	BACB30MB()A()U	BACC30X()P [A] [B]

LOCKBOLT - PROTRUDING HEAD (TENSION)
TABLE IV

Fastener Substitution - Lockbolts
Figure 3 (Sheet 17 of 21)

INITIAL FASTENER OR SPECIFIED REPAIR FASTENER			FASTENER SUBSTITUTION		
PART NUMBER	DESCRIPTION	MATING PART	EQUIVALENT	ALTERNATIVE	MATING PART
BACB30HC()D()N	ALLOY STEEL, NICKEL-CADIMUM PLATED, 160 KSI TENSION, LUBRICATED, CLOSE TOLERANCE SHANK, (STUMP TYPE, HAMMER DRIVEN), MAX TEMP 600°F (316°C)		NO EQUIVALENT	J	
BACB30UB()K()	6AL-4V TITANIUM, 160 KSI TENSION, 95 KSI SHEAR, ALUMINUM PIGMENTED COATING, CETYL ALCOHOL LUBRICATED, MAX TEMP 250°F (121°C)	BACC30BF()	NO EQUIVALENT	BACB30NX()K()	BACC30BH() A B BACC30X() A B BACN10YT()CD A B G
BACB30YD()HK()	6AL-4V TITANIUM, 95 KSI SHEAR, STUMP TYPE, LIGHTWEIGHT, ALUMINUM PIGMENTED COATING, CETYL ALCOHOL LUBRICATED, MAX TEMP 250°F (121°C), WITH SEALANT ESCAPE GROOVE, FOR USE IN COMPOSITES	BACC30BN()L	NO EQUIVALENT	BACB30XC()HK()	BACC30BN()L

LOCKBOLT - PROTRUDING HEAD (TENSION)
TABLE IV

Fastener Substitution - Lockbolts
Figure 3 (Sheet 18 of 21)

INITIAL FASTENER OR SPECIFIED REPAIR FASTENER			FASTENER SUBSTITUTION		
PART NUMBER	DESCRIPTION	MATING PART	EQUIVALENT	ALTERNATIVE	MATING PART
BACB30DY()-()	ALLOY STEEL, CADMIUM PLATED, 160 KSI TENSION, LUBRICATED, 100° (MS20426) HEAD, PULL TYPE, MAX TEMP 250°F (121°C)	NAS1080	NO EQUIVALENT	BACB30DY()A()	NAS1080
		NAS1080P		BACB30DY()A()	NAS1080P
		NAS1080R		BACB30DY()A()	NAS1080R
BACB30DY()A()	A286 CRES, CADMIUM PLATED, 160 KSI TENSION, LUBRICATED, 100° (MS20426) HEAD, PULL TYPE, MAX TEMP 250°F (121°C)		NO EQUIVALENT	NO ALTERNATIVE	
BACB30GQ()-()	7075-T6 AL, ANODIZED, 77 KSI TENSION, LUBRICATED, 100° (MS20426) HEAD, PULL TYPE, MAX TEMP 250°F (121°C)	NAS1080D	NO EQUIVALENT	NAS1535 THRU NAS1542	NAS1080D
BACB30GS()-()	7075-T6 AL, CLOSE TOLERANCE SHANK, STUMP TYPE, MAX TEMP 250°F (121°C)	NAS1080D	NO EQUIVALENT	BACB30GQ()-()	NAS1080D
				NAS1535 THRU NAS1542	NAS1080D

LOCKBOLT - FLUSH HEAD (TENSION)
TABLE V

Fastener Substitution - Lockbolts
Figure 3 (Sheet 19 of 21)

<table>
<tr><th colspan="3">INITIAL FASTENER OR SPECIFIED REPAIR FASTENER</th><th colspan="3">FASTENER SUBSTITUTION</th></tr>
<tr><th>PART NUMBER</th><th>DESCRIPTION</th><th>MATING PART</th><th>EQUIVALENT</th><th>ALTERNATIVE</th><th>MATING PART</th></tr>
<tr><td rowspan="6">BACB30GX()-()</td><td rowspan="6">ALLOY STEEL, CADMIUM PLATED, 160 KSI TENSION, LUBRICATED, 100° (AN509) HEAD, PULL TYPE, MAX TEMP 250°F (121°C)</td><td rowspan="6">NAS1080 OR NAS1080P OR NAS1080R</td><td rowspan="6">NO EQUIVALENT</td><td rowspan="3">BACB30JC()-() [H]</td><td>BACC30BH() [A] [B]</td></tr>
<tr><td>BACC30X() [A] [B]</td></tr>
<tr><td>BACN10YT()CD [A] [B] [G]</td></tr>
<tr><td rowspan="3">BACB30JC()A()</td><td>BACC30BH() [A] [B]</td></tr>
<tr><td>BACC30X() [A] [B]</td></tr>
<tr><td>BACN10YT()CD [A] [B] [G]</td></tr>
<tr><td>BACB30GX()-()X</td><td>ALLOY STEEL, CAD PLATED, UNLUBRICATED 95 KSI SHEAR MAX TEMP 450°F (232°C)</td><td>NAS1080 OR NAS1080P OR NAS1080R</td><td>NO EQUIVALENT</td><td>[J]</td><td></td></tr>
<tr><td>BACB30GX()D()N</td><td>ALLOY STEEL, DIFFUSED NICKEL-CADIUM PLATED, 160 KSI TENSION, LUBRICATED, 100° (AN509) HEAD, PULL TYPE, MAX TEMP 600°F (316°C)</td><td></td><td>NO EQUIVALENT</td><td>[J]</td><td></td></tr>
<tr><td rowspan="4">BACB30HD()-()</td><td rowspan="4">ALLOY STEEL, CADMIUM PLATED, 160 KSI TENSION, LUBRICATED, 100° (MS20426) HEAD, STUMP TYPE, MAX TEMP 250°F (121°C)</td><td rowspan="2">NAS1080</td><td rowspan="4">NO EQUIVALENT</td><td>BACB30DY()-()</td><td>NAS1080</td></tr>
<tr><td>BACB30DY()A()</td><td>NAS1080</td></tr>
<tr><td rowspan="2">NAS1080R</td><td>BACB30DY()-()</td><td>NAS1080R</td></tr>
<tr><td>BACB30DY()A()</td><td>NAS1080R</td></tr>
<tr><td rowspan="3">BACB30HD()A()</td><td rowspan="3">A286 CRES, CADMIUM PLATED, 160 KSI TENSION, LUBRICATED, 100° (AN509) HEAD, STUMP TYPE, MAX TEMP 250°F (121°C)</td><td>NAS1080</td><td rowspan="3">NO EQUIVALENT</td><td>BACB30DY()A()</td><td>NAS1080</td></tr>
<tr><td>NAS1080R</td><td>BACB30DY()A()</td><td>NAS1080R</td></tr>
<tr><td>BACC30Q()</td><td>BACB30DY()A()</td><td>BACC30Q()</td></tr>
</table>

LOCKBOLT - FLUSH HEAD (TENSION)
TABLE V

Fastener Substitution - Lockbolts
Figure 3 (Sheet 20 of 21)

INITIAL FASTENER OR SPECIFIED REPAIR FASTENER			FASTENER SUBSTITUTION		
PART NUMBER	DESCRIPTION	MATING PART	EQUIVALENT	ALTERNATIVE	MATING PART
BACB30HG()-()	ALLOY STEEL, CADMIUM PLATED, 160 KSI TENSION, LUBRICATED, 100° (AN509) HEAD, STUMP TYPE, MAX TEMP 250°F (121°C)	NAS1080	NO EQUIVALENT	BACB30JC()-() [H]	BACC30X() [A] [B]
				BACB30NY()K() [C]	BACC30X() [A] [B]
				BACB30UA()K() [C]	BACC30BF()
		NAS1080R		BACB30JC()-() [H]	BACC30X() [A] [B]
				BACB30NY()K() [C]	BACC30X() [A] [B]
BACB30UA()K()	6AL-4V TITANIUM, 100° HEAD, 160 KSI TENSION, ALUMINUM PIGMENTED COATING, CETYL ALCOHOL LUBRICATED	BACC30BF()	NO EQUIVALENT	BACB30NY()K()	BACC30BH() [A] [B]
					BACC30X() [A] [B]
					BACN10YT()CD [A] [B] [G]

LOCKBOLT - FLUSH HEAD (TENSION)
TABLE V

Fastener Substitution - Lockbolts
Figure 3 (Sheet 21 of 21)

GENERAL - TORQUE VALUES

1. **Applicability**

   A. The torque values given in this subject can be used for fasteners in structural repairs, unless a Service Bulletin or an engineering drawing specifies a different torque value for the same fasteners in the same structure.

   B. Refer to the Airplane Maintenance Manual for torque values on other fasteners.

2. **General**

   A. The torque values for external wrenching bolts in metallic materials are given in Torque Values for External Wrenching Bolts in Metallic Materials, Figure 1/GENERAL.

   B. The torque values for hex-drive bolts in metallic materials are given in Torque Values for Hex-Drive Bolts in Metallic Materials, Figure 2/GENERAL.

   C. The torque values for radius lead-in bolts in metallic materials are given in Torque Values for Radius Lead-In Bolts in Metallic Materials, Figure 3/GENERAL.

   D. The torque values for fasteners in composite materials are given in Torque Values for Fasteners in Composite Materials, Figure 4/GENERAL.

   E. Refer to 51-40-02 for the procedures to install bolts, washers, nuts, and locknuts.

3. **References**

Reference	Title
51-40-02	FASTENER INSTALLATION AND REMOVAL

4. **Torque Wrench Adaptors and Extensions**

   A. Torque wrench adaptors and/or extensions are used when it is difficult to apply the torque directly.

   B. When you use adaptors and/or extensions, a corrected torque wrench reading is necessary. Follow the examples shown in Indicated Torque Calculations for the Torque Wrench with Adapters and Extensions, Figure 5/GENERAL to find the corrected torque wrench reading.

   C. Use adaptors only on rigid frame torque wrenches.

   D. Apply force to the torque wrench handle or extension perpendicular to the handle and in the plane of its rotation.

NOTES

- THE SOURCE OF INFORMATION FOR THIS FIGURE CAN BE FOUND IN BOEING PROCESS SPECIFICATION BAC 5009.
- SEE TABLES A THRU D FOR TENSION HEAD BOLTS.
- SEE TABLE E FOR REDUCED SHEAR HEAD BOLTS.

1 WHEN ANY BOLT IS TO BE INSTALLED BY WRENCHING THE HEAD, (FOR EXAMPLE: AS WHEN INSTALLING BOLT INTO PLATENUTS, CLIP-NUTS, BARREL-NUTS, INSERTS OR TAPPED HOLES), THE INSTALLATION TORQUE MUST BE WITHIN ±10% OF THE MAXIMUM OF THE SPECIFIED RANGE.

2 WHEN AN UNLUBRICATED BOLT IS USED, USE THE DRY BOLT COLUMN FOR TORQUE VALUES. (THIS INCLUDES IF WET SEALANT IS ON THE BOLT THREADS).

3 LUBRICATED BOLTS INCLUDE DRYFILM LUBRICATED (MIL-L-8937 OR MIL-L-46010) BOLTS AND BOLTS WITH ANTI-FRICTION COMPOUNDS SUCH AS EASE-OFF 990 OR BOSTIK NEVER-SEEZ ANTISEIZE COMPOUNDS, MIL-C-11796 OR ZIP-CHEM ZC-027L CORROSION PREVENTION COMPOUNDS, OR MIL-G-2382 GREASE APPLIED TO THE THREADS.

4 WHEN THE BOLT PART NUMBER AND THE NUT PART NUMBER SPECIFIED IN THE DRAWING OR REPAIR ARE IN DIFFERENT COLUMNS, USE THE INSTALLATION TORQUE FROM THE COLUMN WITH THE LESSER TORQUE VALUE.

5 INSTALLATION TORQUE FOR 3/4-16 BACB30MR, BACB30XL, BACB30NM, BACB30XJ, BACB30MS, BACB30NN, BACB30XK, AND BACB30XM IS 1000 TO 2200 IN-LB FOR DRY BOLTS AND 1000 TO 2150 IN-LB FOR LUBED BOLTS. THE INSTALLATION TORQUE FOR ALL OTHER 3/4-16 BOLTS LISTED IN THE COLUMN IS 2400 TO 3500 IN-LB FOR DRY BOLTS AND 1700 TO 2150 IN-LB FOR LUBED BOLTS.

Torque Values for External Wrenching Bolts in Metallic Materials
Figure 1 (Sheet 1 of 7)

NUT PART NUMBER AND STYLE	BACN10HR (12 POINT), BACN10JG (12 POINT), BACN10HC (12 POINT), BACN10YN (12 POINT VESPEL)	
BOLT HEAD STYLE	12 POINT	
BOLT PART NUMBER	BACB30NH BACB30US BACB30MT BACB30TR	
THREAD SIZE AND BASIC MAJOR DIAMETER	TORQUE RANGE IN-LBS [1]	
	DRY BOLT [2]	LUBED BOLT [3]
0.1900 10-32	70 TO 100	50 TO 60
0.2500 1/4-28	90 TO 125	70 TO 80
0.3125 5/16-24	180 TO 250	145 TO 180
0.3750 3/8-24	300 TO 500	275 TO 330
0.4375 7/16-20	510 TO 840	370 TO 440
0.5000 1/2-20	870 TO 1300	500 TO 650
0.5625 9/16-18	1300 TO 1800	800 TO 1000
0.6250 5/8-18	1900 TO 2300	1350 TO 1650
0.7500 3/4-16	3300 TO 4300	2800 TO 3300
0.8750 7/8-14	5100 TO 6700	3900 TO 4500
1.0000 1-12 OR 1-14	7000 TO 10900	6200 TO 7000
1.1250 1-1/8-12	9500 TO 13000	8300 TO 9400
1.2500 1-1/4-12	15800 TO 19200	11000 TO 12000
1.3750 1-3/8-12	20000 TO 24000	16000 TO 17000

NUT INSTALLATION TORQUE RANGE - TENSION BOLTS [4]
TABLE A

Torque Values for External Wrenching Bolts in Metallic Materials
Figure 1 (Sheet 2 of 7)

<table>
<tr><td>NUT PART NUMBER AND STYLE</td><td colspan="4">NAS1804 (12 POINT), NAS1805 (12 POINT),
BACN10B (12 POINT), BACN10GW (12 POINT),
BACN10JA (PLATE NUT), BACN10JB (PLATE NUT),
BACN10RM (PLATE NUT), NAS577 (BARREL NUT),
BACN11N AND MS14144 CASTELLATED-THICK STYLE)
BACN10JD (CASTELLATED-THICK STYLE)</td></tr>
<tr><td>BOLT HEAD STYLE</td><td>12 POINT</td><td>HEX</td><td>PAN</td><td>100 DEG</td></tr>
<tr><td>BOLT PART NUMBER</td><td>BACB30FD
BACB30LE
BACB30MR
BACB30XL
BACB30PN
MS21250</td><td>BACB30NM
BACB30XJ
BACB30NE
BACB30LM
NAS6603
THRU
NAS6620
NAS6703
THRU
NAS6720
NAS6803
THRU
NAS6820</td><td>BACB20LN
BACB30NS
BACB30EM
NAS1216</td><td>BACB30LP
BACB30EM
BACB30LU
BACB30LR
BACB30MS
BACB30NN
BACB30XK
BACB30XM
BACB30SW
BACB30XA</td></tr>
<tr><td rowspan="2">THREAD SIZE AND BASIC MAJOR DIAMETER</td><td colspan="4">TORQUE RANGE IN-LBS [1]</td></tr>
<tr><td colspan="2">DRY BOLT [2]</td><td colspan="2">LUBED BOLT [3]</td></tr>
<tr><td>0.1900 10-32
0.2500 1/4-28
0.3125 5/16-24
0.3750 3/8-24</td><td colspan="2">30 TO 35
60 TO 100
130 TO 200
220 TO 410</td><td colspan="2">20 TO 25
50 TO 75
90 TO 125
150 TO 250</td></tr>
<tr><td>0.4375 7/16-20
0.5000 1/2-20
0.5625 9/16-18
0.6250 5/8-18</td><td colspan="2">370 TO 690
630 TO 1070
1000 TO 1470
1400 TO 1900</td><td colspan="2">260 TO 425
440 TO 650
700 TO 920
1000 TO 1200</td></tr>
<tr><td>0.7500 3/4-16
0.8750 7/8-14
1.0000 1-12 OR 1-14
1.1250 1-1/8-12</td><td colspan="2">[5]
3700 TO 5500
5100 TO 8900
6900 TO 10700</td><td colspan="2">[5]
2600 TO 3400
3600 TO 5500
4900 TO 6700</td></tr>
<tr><td>1.2500 1-1/4-12</td><td colspan="2">11500 TO 15700</td><td colspan="2">7500 TO 9700</td></tr>
</table>

NUT INSTALLATION TORQUE RANGE - TENSION BOLTS [4]
TABLE B

Torque Values for External Wrenching Bolts in Metallic Materials
Figure 1 (Sheet 3 of 7)

NUT PART NUMBER AND STYLE	ALL PLATE-NUTS EXCEPT BACN10JA, BACN10JB, AND BACN10RM, ALL CLIP-NUTS, INSERTS, AND TAPPED HOLES, BACN10YR, NAS679, MS21042, MS21043 (HEX SELF LOCKING), BACN10JC. (THREAD SIZES NO. 4 THRU 7/16 ONLY), BACN10JD, (CASTELLATED-THICK STYLE SIZES 3/16 THRU 3/8 INCH) BACN11N AND MS14144 (CASTELLATED-THICK STYLE SIZES 3/16 THRU 3/8 INCH)	
BOLT HEAD STYLE	12 POINT	HEX
BOLT PART NUMBER	BACB30LT, BACB30NL, BACB30NJ, BACB30UU	BACB30LJ, BACB30NF, BACB30NR, BACB30PU, BACB30PW, BACB30XN, BACS12BG, BACS12CB, BACB30GU, NAS428, NAS563, NAS572, NAS1801, NAS1802, NAS6203 THRU NAS6220
THREAD SIZE AND BASIC MAJOR DIAMETER	TORQUE RANGE IN-LBS 1 DRY BOLT 2	
0.0860 2-56 OR 2-64 0.1120 4-40 OR 4-48 0.1380 6-32 OR 6-40 0.1640 8-32 OR 8-36 0.1900 10-32	3.4 TO 4.5 6 TO 8 12 TO 15 15 TO 20 25 TO 35	
0.2500 1/4-28 0.3125 5/16-24 0.3750 3/8-24 0.4375 7/16-20 0.5000 1/2-20	50 TO 80 100 TO 150 160 TO 240 250 TO 350 480 TO 790	
0.5625 9/16-18 0.6250 5/8-18 0.7500 3/4-16 0.8750 7/8-14 1.0000 1-12 OR 1-14	800 TO 1150 1100 TO 1500 2300 TO 3000 2500 TO 4500 3700 TO 7500	
1.1250 1-1/8-12 1.2500 1-1/4-12	5000 TO 9000 9000 TO 13000	

NUT INSTALLATION TORQUE RANGE - TENSION BOLTS 4
TABLE C

Torque Values for External Wrenching Bolts in Metallic Materials
Figure 1 (Sheet 4 of 7)

NUT PART NUMBER AND STYLE	ALL PLATE-NUTS EXCEPT BACN10JA, BACN10JB, AND BACN10RM, ALL CLIP-NUTS, INSERTS, AND TAPPED HOLES, BACN10YR, NAS679, MS21042, MS21043 (HEX SELF LOCKING), BACN10JC. (THREAD SIZES NO. 4 THRU 7/16 ONLY), BACN10JD, (CASTELLATED-THICK STYLE SIZES 3/16 THRU 3/8 INCH) BACN11N AND MS14144 (CASTELLATED-THICK STYLE SIZES 3/16 THRU 3/8 INCH)		
BOLT HEAD STYLE	PAN	100 DEG	SOCKET
BOLT PART NUMBER	BACB30BE, BACB30LK, BACB30NT, BACB30PU, BACB30PW, BACB30XN, BACS12BG, BAC12FA, NAS600 THRU NAS623, NAS1217, NAS1218, NAS6203 THRU NAS6220	BACB30LH, BACB30PC, BACB30RF, BACB30SW, BACB30TP, BACB30WP, BACS12BF, BACS12BP, BACS12ER, BACS12GM, BACS12GP, BACS12GR, BACS12GX, NAS514, NAS517	MS21262 MS24678 NAS1351 NAS1352
THREAD SIZE AND BASIC MAJOR DIAMETER	TORQUE RANGE IN-LBS [1]		
	LUBED BOLT [3]		
0.0860 2-56 OR 2-64 0.1120 4-40 OR 4-48 0.1380 6-32 OR 6-40 0.1640 8-32 OR 8-36 0.1900 10-32	3.4 TO 4.5 6 TO 8 12 TO 15 15 TO 17 20 TO 25		
0.2500 1/4-28 0.3125 5/16-24 0.3750 3/8-24 0.4375 7/16-20 0.5000 1/2-20	50 TO 75 90 TO 125 150 TO 200 240 TO 300 440 TO 650		
0.5625 9/16-18 0.6250 5/8-18 0.7500 3/4-16 0.8750 7/8-14 1.0000 1-12 OR 1-14	700 TO 920 1000 TO 1200 1700 TO 2150 2600 TO 3400 3600 TO 5500		
1.1250 1-1/8-12 1.2500 1-1/4-12	4900 TO 6700 7500 TO 9700		

NUT INSTALLATION TORQUE RANGE - TENSION BOLTS [4]
TABLE C

Torque Values for External Wrenching Bolts in Metallic Materials
Figure 1 (Sheet 5 of 7)

NUT PART NUMBER AND STYLE	BACN10JC (THREAD SIZES 1/2 THRU THRU 1-12), BACN10JD, BACN11N AND MS14145 (CASTELLATED-THIN STYLE, ALL SIZES) MS21245 (HEX, SELF-LOCKING, THIN)	BACN10YJ (NYLON NUT)
BOLT HEAD STYLE	ALL	ALL
BOLT PART NUMBER	ALL	METAL BOLTS ONLY
THREAD SIZE AND BASIC MAJOR DIAMETER	TORQUE RANGE IN-LBS [1]	TORQUE RANGE IN-LBS [1]
	DRY OR LUBRICATED BOLT	DRY OR LUBRICATED BOLT
0.0860 2-56 OR 2-64	2.5 TO 4.5	--
0.1120 4-40 OR 4-48	6 TO 8	--
0.1380 6-32 OR 6-40	12 TO 15	--
0.1640 8-32 OR 8-36	15 TO 17	5 TO 6
0.1900 10-32	18 TO 25	6 TO 8
0.2500 1/4-28	30 TO 50	--
0.3125 5/16-24	60 TO 95	--
0.3750 3/8-24	95 TO 160	--
0.4375 7/16-20	220 TO 280	--
0.5000 1/2-20	290 TO 510	--
0.5625 9/16-18	480 TO 850	--
0.6250 5/8-18	660 TO 980	--
0.7500 3/4-16	1300 TO 2000	--
0.8750 7/8-14	1500 TO 3300	--
1.0000 1-12 OR 1-14	2200 TO 5300	--
1.1250 1-1/8-12	3000 TO 6200	--
1.1250 1-1/8-12	3000 TO 6200	--
1.2500 1-1/4-12	5400 TO 8600	--
1.3750 1-3/8-12	7000 TO 9000	--
1.5000 1-1/2-12	10,000 TO 12,000	--

NUT INSTALLATION TORQUE RANGE - TENSION BOLTS [4]
TABLE D

Torque Values for External Wrenching Bolts in Metallic Materials
Figure 1 (Sheet 6 of 7)

NUT PART NUMBER AND STYLE		ALL
BOLT STYLE		100 DEGREE REDUCED SHEAR HEAD
PART NUMBER-BOLT		BACB30DP, BACB30EL, BACB30FB, BACB30LL, BACB30NU, BACB30RF, BACB30UR, BACB30UW, BACB30VF, BACB30XD, NAS1581, NAS1992 THRU NAS2000, NAS8703 THRU NAS8716
THREAD SIZE AND BASIC MAJOR DIA.		TORQUE-RANGE IN-LBS [1]
		DRY BOLT [2]
0.0860	2-56 OR 2-64	--
0.1120	4-40 OR 4-48	--
0.1380	6-32 OR 6-40	--
0.1640	8-32 OR 8-36	10 TO 18
0.1900	10-32	18 TO 25
0.2500	1/4-28	30 TO 40
0.3125	5/16-24	90 TO 100
0.3750	3/8-24	95 TO 105
0.4375	7/16-20	150 TO 170
0.5000	1/2-20	220 TO 245
0.5625	9/16-18	290 TO 325
0.6250	5/8-18	395 TO 435
0.7500	3/4-16	645 TO 720
0.8750	7/8-14	1040 TO 1150
1.0000	1-12 OR 1-14	1560 TO 1730

NUT INSTALLATION TORQUE RANGE -
REDUCED SHEAR HEAD BOLTS
TABLE E

Torque Values for External Wrenching Bolts in Metallic Materials
Figure 1 (Sheet 7 of 7)

FASTENER DIAMETER AND THREAD SIZE (INCH)	TORQUE RANGE (POUND-INCH)					
	SHEAR-TYPE HEX DRIVE BOLTS:					
	BOLT	BACB30YP BACB30VT BACB30VU		BACB30FM, BACB30FN, BACB30MY, BACB30ND, BACB30NW, BACB30NZ, BACB30YL, BACB30YN, HL360, HL420, HL421, HL834		
	NUT	BACN10YZ BACN10ZV	MS21043 BACN10JC MS21042 NAS1291 NAS679 BACN10YR	MS21043 BACN10JC BACN10XJ MS21042 NAS1291 KFN305 KFN600 H600 NAS679 KFN511 BACN10YR BACN10YT BACN10TN BACN11E	BACN10WM	KFN609 BACN10ZZ
	TORQUE INCH-POUNDS					
5/32-32		15-25	15-25			15-25
3/16-32		25-35	25-35			23-28
1/4-28		60-80	60-80		60-80	60-75
5/16-24		110-140	130-160		125-145	120-150
3/8-24		160-200	200-240		200-210	180-210
7/16-20			270-330			270-330
1/2-20			370-430			370-430
9/16-18			500-575			
5/8-18			625-700			
3/4-16			900-1000			

TORQUE VALUES FOR LOCKNUTS ON HEX DRIVE BOLTS
TABLE A

Torque Values for Hex-Drive Bolts in Metallic Materials
Figure 2 (Sheet 1 of 2)

FASTENER DIAMETER AND THREAD SIZE (INCH)	TORQUE RANGE (POUND-INCH)	
		TENSION-TYPE HEX DRIVE BOLTS:
	BOLT	BACB30JC BACB30MB BACB30NX BACB30NY BACB30YK BACB30YM HLT422 HLT423
	NUT	NAS1804 NAS1805 BACN10GW KFN305 BACN10MT KFN511 MS21042 BACN10YT BACN11E
	TORQUE INCH-POUNDS	
5/32-32		25-35
3/16-32		30-40
1/4-28		80-95
5/16-24		150-200
3/8-24		260-360
7/16-20		390-480
1/2-20		640-800
9/16-18		740-900
5/8-18		800-1000
3/4-16		1300-1650

TORQUE VALUES FOR LOCKNUTS ON HEX DRIVE BOLTS
TABLE A

Torque Values for Hex-Drive Bolts in Metallic Materials
Figure 2 (Sheet 2 of 2)

NOMINAL THREAD SIZE	INSTALLATION TORQUE (INCH-POUNDS)				NUTS ON BACB30WQ AND BACB30WR BOLTS	
	NUTS ON BACB30PT BOLTS					
	EXCEPT BACN10WM		BACN10WM			
	NOMINAL	RANGE	NOMINAL	RANGE	NOMINAL	RANGE
0.1900-32	N/A	N/A	N/A	N/A	30	25-35
0.2500-28	70	60-80	80	60-100	90	75-105
0.3125-24	135	125-145	145	125-165	155	135-175
0.3750-24	218	200-235	230	200-260	245	220-270
0.4375-20	N/A	N/A	N/A	N/A	340	310-370

TABLE A

NOTES

- THE SOURCE OF INFORMATION FOR THIS FIGURE CAN BE FOUND IN BOEING PROCESS SPECIFICATION BAC 5060.
- TORQUE VALUES IN THIS FIGURE CAN BE USED UNLESS AN APPLICABLE ENGINEER DRAWING SHOWS DIFFERENTLY.

Torque Values for Radius Lead-In Bolts in Metallic Materials
Figure 3

NOTES:

- THE SOURCE OF INFORMATION FOR THIS FIGURE CAN BE FOUND IN BOEING PROCESS SPECIFICATION BAC 5063.

1 WHEN PIN OR BOLT PART NUMBER AND NUT PART NUMBER SPECIFIED ON THE DRAWING APPEAR IN DIFFERENT COLUMNS, USE THE INSTALLATION TORQUE FROM THE COLUMN WITH THE LOWER TORQUE VALUE.

2 INSTALLATION TORQUE FOR 3/4-16 BACB30MR, BACB30XL, BACB30NM, BACB30XJ, BACB30MS, BACB30NN, BACB30XK AND BACB30XM IS 1000-2200 IN-LB. THE INSTALLATION TORQUE FOR ALL OTHER 3/4-16 BOLTS LISTED IN THIS COLUMN IS 2400 TO 3500 IN-LB.

3 THIS TABLE DOES NOT APPLY TO INSTALLATIONS WHERE A NUT, BOLT HEAD, OR WASHER BEARS DIRECTLY ON UNREINFORCED THERMOPLASTIC MATERIALS (EXAMPLE: NYLON).

Torque Values for Fasteners in Composite Materials
Figure 4 (Sheet 1 of 3)

NOMINAL FASTENER DIAMETER (INCH)		TORQUE, INCH-POUNDS				
		SHEAR-TYPE HEX DRIVE PINS:				TENSION-TYPE HEX DRIVE PINS:
	PIN	BACB30VT BACB30VU BACB30YP	BACB30FM BACB30FN BACB30MY BACB30NW BACB30NZ BACB30ND BACB30YL BACB30YN			BACB30JC BACB30MB BACB30NX BACB30NY BACB30YK BACB30YM
	NUT	MS21043 BACN10JC MS21042 NAS1291 KFN305 NAS679 BACN10YR BACN10YZ BACN10ZV	MS21043 BACN10JC BACN10XJ MS21042 NAS1291 KFN305 KFN600 H600 NAS679 KFN511 BACN10YR BACN11E	BACN10WM	KFN609 BACN10ZZ	NAS1804 NAS1805 BACN10GW KFN305 BACN10MT KFN511 MS21042 BACN10YT
5/32		15 TO 25		---	---	25 TO 35
3/16		25 TO 36		---	---	30 TO 40
1/4		60 TO 80		60 TO 80	60 TO 75	80 TO 95
5/16		130 TO 160		125 TO 145	120 TO 150	150 TO 200
3/8		200 TO 240		200 TO 300	180 TO 210	260 TO 360
7/16		270 TO 330		---	---	390 TO 480
1/2		370 TO 430		---	---	640 TO 800
9/16		500 TO 575		---	---	740 TO 900
5/8		625 TO 700		---	---	800 TO 1000
3/4		900 TO 1000			---	1300 TO 1650

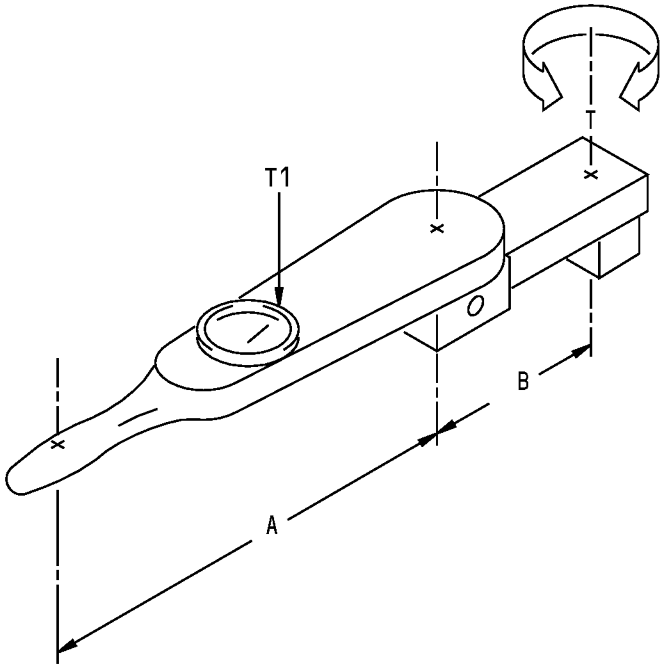
LOCKNUT TORQUE VALUES [1]
TABLE A

Torque Values for Fasteners in Composite Materials
Figure 4 (Sheet 2 of 3)

NUT NUMBER AND STYLE		BACN10HR (12 POINT) BACN10HC (BARREL NUT)	NAS1804 (12 POINT) NAS1805 (12 POINT) BACN10JA (PLATE NUT) BACN10JB (PLATE NUT) NAS577 (BARREL NUT) BACN10JD (CASTELLATED-THICK STYLE 0.4375 THRU 1.250)			
BOLT HEAD STYLE		12 POINT	12 POINT	HEX	PAN	100 DEG
BOLT PART NUMBER		BACB30US	BACB30LE BACB30MR BACB30PN BACB30XL MS21250	BACB30LM BACB30NM BACB30XJ NAS6603 THRU NAS6620 NAS6703 THRU NAS6720 NAS6803 THRU NAS6820	NAS1216	BACB30LP BACB30LR BACB30LU BACB30MS BACB30NN BACB30XK BACB30XM
THREAD SIZE AND BASIC MAJOR DIAMETER		IN-LBS	IN-LBS			
0.1900	10-32	50 TO 70	30 TO 35			
0.2500	1/4-28	90 TO 125	65 TO 100			
0.3125	5/16-24	180 TO 250	130 TO 200			
0.3750	3/8-24	300 TO 500	220 TO 410			
0.4375	7/16-20	510 TO 840	370 TO 690			
0.5000	1/2-20	870 TO 1300	630 TO 1070			
0.5625	9/16-18	1300 TO 1800	1000 TO 1470			
0.6250	5/8-18	1900 TO 2300	1400 TO 1900			
0.7500	3/4-16	3300 TO 4300	[2]			
0.8750	7/8-14	5100 TO 6700	3700 TO 5500			
1.0000	1-12 OR 1-14	7000 TO 10900	5100 TO 8900			
1.1250	1-1/8-12	9500 TO 13000	6900 TO 10700			
1.2500	1-1/4-12	15800 TO 19200	11500 TO 15700			
1.3750	1-3/8-12	20000 TO 24000	---			

INSTALLATION TORQUE RANGE - TENSION BOLTS [1] [3]
TABLE B

Torque Values for Fasteners in Composite Materials
Figure 4 (Sheet 3 of 3)



A = THE LENGTH OF THE TORQUE WRENCH

B = THE EFFECTIVE LENGTH OF THE ADAPTER AND THE EXTENSION BETWEEN THE ADAPTER AND THE TORQUE WRENCH, IF USED

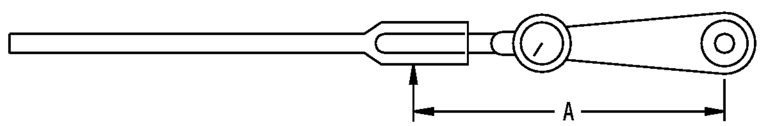
T = THE TORQUE SPECIFIED FOR THE NUT

T1 = THE INDICATED TORQUE (THE CORRECTED TORQUE WRENCH INDICATION)

FOR THE FOLLOWING EXAMPLES ASSUME THAT:
A = 10 IN.
B = 10 IN.
C = 10 IN.
T = 150 POUND-INCHES

WITH THE HANDLE EXTENSION ONLY, NO CORRECTION IS NECESSARY

T1 = T

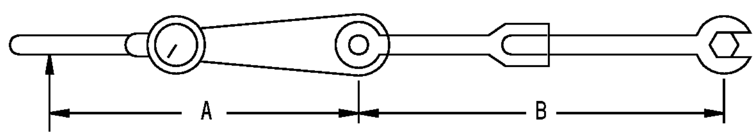


METHOD I

WITH THE ADAPTER, AN EXTENSION, AND THE WRENCH IN LINE, A CORRECTION IS NECESSARY

$$T1 = \frac{T \times A}{A + B} \qquad T1 = \frac{150 \times 10}{10 + 10}$$

T1 = 75 POUND-INCHES



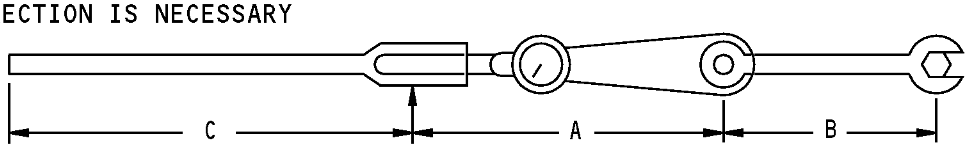
METHOD II

WITH THE HANDLE EXTENSION AND THE ADAPTER, A CORRECTION IS NECESSARY

$$T1 = \frac{T \times (A + C)}{A + B + C}$$

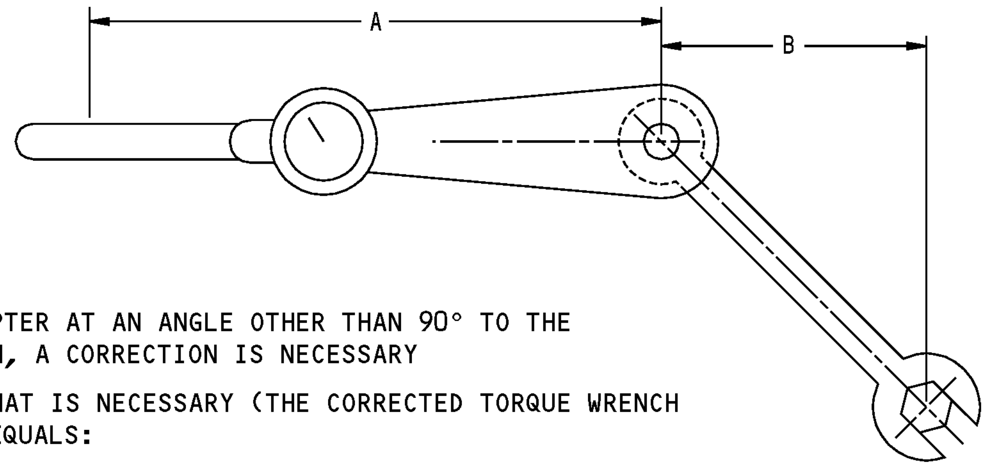
$$T1 = \frac{150 \times (10 + 10)}{10 + 10 + 10}$$

T1 = 100 POUND-INCHES



METHOD III

Indicated Torque Calculations for the Torque Wrench with Adapters and Extensions
Figure 5 (Sheet 1 of 2)



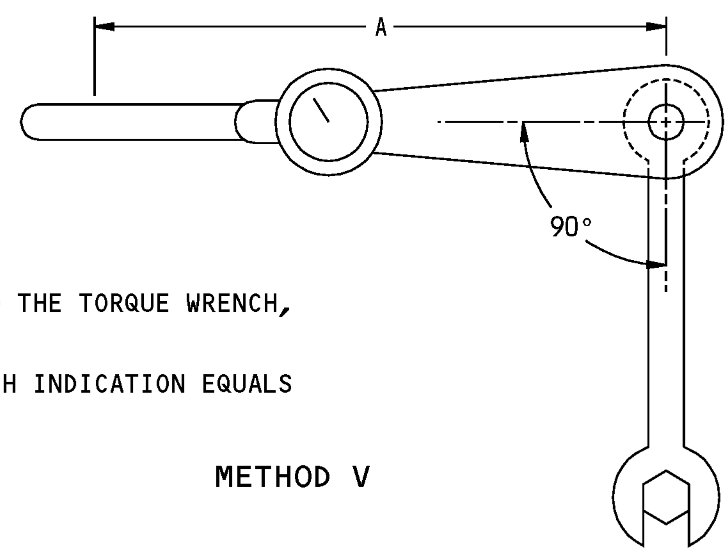
WITH THE ADAPTER AT AN ANGLE OTHER THAN 90° TO THE TORQUE WRENCH, A CORRECTION IS NECESSARY

THE TORQUE THAT IS NECESSARY (THE CORRECTED TORQUE WRENCH INDICATION) EQUALS:

$$T1 = \frac{T \times A}{A + B} \qquad T1 = \frac{150 \times 10}{10 + 10}$$

T1 = 75 POUND-INCHES

METHOD IV



WITH THE ADAPTER AT 90° TO THE TORQUE WRENCH, NO CORRECTION IS NECESSARY

THE NECESSARY TORQUE WRENCH INDICATION EQUALS THE NECESSARY TORQUE

T1 = T

METHOD V

Indicated Torque Calculations for the Torque Wrench with Adapters and Extensions
Figure 5 (Sheet 2 of 2)

GENERAL - FASTENER HOLE SIZES

1. **Applicability**

   A. This subject gives the hole size data for repair fasteners used in metallic and composite structures.

2. **General**

   A. Refer to Boeing Process Specification References, Figure 1/GENERAL for an index of fastener hole data and cross references to Boeing Process Specifications.

   B. Bolts, lockbolts, hex-drive bolts, and radius lead-in bolts can be installed in different types of holes. Some of the tables in this subject give hole sizes for the different types of holes. Refer to Paragraph 4./GENERAL for hole definitions.

3. **References**

Reference	Title
51-20-07, GENERAL	The Machining and Drilling of Composite Structures and Composite-to-Metal Assemblies
51-40-02, GENERAL	Fastener Installation and Removal
51-40-08, GENERAL	Countersink Data and Procedures for Metal Structures
51-40-09, REPAIR GENERAL	Cold Working Procedures to Increase the Fatigue Properties of Fastener Holes

4. **Hole Definitions**

   A. Clearance Fit - A hole with size limits larger than the shank diameter of the fastener to be installed. The installed fastener will always have a clearance between the shank and the mating structure. These types of holes are used with removable fasteners.

      (1) Close Ream - A hole that permits a minimum clearance between the fastener shank and the mating structure. This type of hole has the tightest tolerance of all the holes used for removable fasteners.

      (2) Class I - A hole that has sufficient clearance to permit easy removal of the fastener, but will also permit sufficient shear load transfer in the joint. This is the most used type of hole for removable fastener installations.

      (3) Class II - A hole that is larger than a Class I hole. This is the most used type of hole for nutplate installations.

      (4) Class III - A hole that is larger than a Class II hole. This type of hole is not frequently used in structural repairs.

   B. Interference Fit - A hole with size limits that are smaller than the shank diameter of the fastener to be installed. The installed fastener will always have an interference between the shank and the mating structure. An interference fit hole will always have a permanent fastener installed in it.

   C. Transition Fit - A hole with size limits that are very close to the shank diameter of the fastener to be installed. The installed fastener can have an interference, or it can have a clearance between the shank and the mating structure. A transition fit hole will always have a permanent fastener installed in it.

TYPE OF FASTENER HOLE	FIGURE	PROCESS SPECIFICATION
GENERAL INFORMATION	2	BAC 5004
SOLID RIVETS	3	BAC 5004-1
PERMANENT STRAIGHT SHANK FASTENERS	4	BAC 5004-2
BLIND RIVETS AND BOLTS	5	BAC 5004-3
BOLTS	6	BAC 5009
FLUID-TIGHT FASTENERS	7	BAC 5047
RADIUS LEAD-IN BOLTS	8	BAC 5060
HOLES IN COMPOSITES	9	BAC 5063

INDEX FOR 51-40-05 AND CROSS REFERENCE
TO BOEING PROCESS SPECIFICATIONS

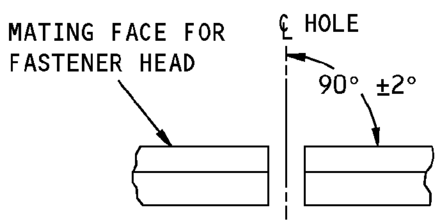
NOTES

- REFER TO SRM 51-40-09 FOR REAMED AND FINISHED HOLE SIZES IN COLD WORKED HOLES.

Boeing Process Specification References
Figure 1

ACCEPTABLE	NOT ACCEPTABLE
1. Circumferential scratches which are a minimum of 1/16 inch or 10% of the part thickness from the surface of the part, whichever is smaller. 2. Spiral scratches which are a minimum of 1/16 inch or 25% of the part thickness from the surface of the part, whichever is smaller. 3. Longitudinal scratches not more than 50% of length of hole in any one part and which neither starts nor ends within 1/16 inch or 25% of the part thickness from the surface of the part, whichever is smaller. 4. Surface roughness which does not exceed 125 microinches Ra.	1. Scratches, nicks or cuts intersecting a part surface or exceeding limits specified as acceptable.

SURFACE DEFECT CRITERIA FOR FASTENER HOLES



HOLES FOR ALL PROTRUDING AND FLUSH HEAD FASTENERS MUST BE WITHIN 2° OF PERPENDICULAR TO THE FACE ON WHICH THE FASTENER HEAD BEARS

HOLE ALIGN CHECK

NOTES

- THE SOURCE OF INFORMATION FOR THIS FIGURE CAN BE FOUND IN BOEING PROCESS SPECIFICATIONS BAC 5004, BAC 5009, BAC 5047, AND BAC 5060.
- THE DATA IN THIS FIGURE APPLIES TO FIGURES 3 THRU 8. REFER TO SRM 51-20-08 FOR SIMILAR INFORMATION FOR HOLES IN COMPOSITE STRUCTURE.

General Information for Fastener Holes in Metal Structure
Figure 2

NOMINAL RIVET DIAMETER	RECOMMENDED PILOT DRILL SIZE	STANDARD RIVETS				BACR15GF, NAS1097, BACR15CE RIVETS			
		RECOMMENDED DRILL		HOLE DIAMETER LIMITS		RECOMMENDED DRILL		HOLE DIAMETER LIMITS	
		NO.	SIZE	MIN	MAX	NO.	SIZE	MIN	MAX
1/16	--	51	(0.067)	0.066	0.072	--	--	--	--
3/32	--	40	(0.098)	0.098	0.103	40	(0.098)	0.098	0.103
1/8	3/32	30	(0.128)	0.128	0.135	30	(0.128)	0.128	0.134
5/32	1/8	20	(0.161)	0.159	0.171	21	(0.159)	0.159	0.165
3/16	1/8	10	(0.194)	0.191	0.202	11	(0.191)	0.190	0.196
1/4	1/8	F	(0.257)	0.254	0.265	F	(0.257)	0.255	0.261
5/16	1/8	O	(0.316)	0.316	0.327	O	(0.316)	0.316	0.323
3/8	1/8	V	(0.377)	0.377	0.390	V	(0.377)	0.377	0.385

STANDARD HOLE SIZES FOR SOLID RIVETS
TABLE A

ORIGINAL RIVET DIAMETER	(-6) 3/16		(-8) 1/4		(-10) 5/16		(-12) 3/8	
OVERSIZE RIVET DIAMETER	(-7) 7/32		(-9) 9/32		(-11) 11/32		(-13) 13/32	
	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX
MS20426 BACR15FT MS20470 NAS1242 BACR15BA BACR15BB	0.221	0.233	0.284	0.296	0.346	0.358	0.407	0.421
NAS1097 BACR15GF BACR15CE	0.223	0.229	0.286	0.293	--	--	--	--

OVERSIZE HOLE DIMENSIONS FOR SOLID RIVETS
TABLE B

NOTES

- THE SOURCE OF INFORMATION FOR THIS FIGURE CAN BE FOUND IN BOEING PROCESS SPECIFICATION BAC 5004-1.
- THIS DATA APPLIES TO NON FLUID-TIGHT RIVETS.
- HOLE DIAMETERS IN THIS FIGURE CAN BE USED UNLESS AN APPLICABLE ENGINEER DRAWING SHOWS DIFFERENTLY.

Solid Rivet Fastener Holes
Figure 3

NOTES

- THE SOURCE OF INFORMATION FOR THIS FIGURE CAN BE FOUND IN BOEING PROCESS SPECIFICATION BAC 5004-2.
- THIS DATA APPLIES TO PERMANENT TYPE, NON FLUID TIGHT, STRAIGHT SHANK FASTENERS (LOCKBOLTS AND HEX-DRIVE BOLTS).
- HOLE DIAMETERS IN THIS FIGURE CAN BE USED UNLESS AN APPLICABLE ENGINEER DRAWING SHOWS DIFFERENTLY.
- THE WING AND EMPENNAGE STRUCTURES HAVE FATIGUE-CRITICAL AREAS. IN THESE AREAS THERE ARE HEX DRIVE BOLTS AND LOCKBOLTS INSTALLED IN HIGH INTERFERENCE HOLES, COLD WORKED HOLES, OR COLD WORKED HIGH INTERFERENCE HOLES. TO FIND THE NECESSARY CONDITION FOR THE HOLES, SEE THE ENGINEERING PART DRAWINGS, SPECIFIC SRM REPAIR SECTIONS, OR CALL BOEING.
- SEE TABLE A FOR INITIAL HOLE SIZES. SEE TABLES B AND C FOR OVERSIZE FASTENERS.
- CLOSE REAM HOLE DIAMETERS ARE APPLICABLE TO THE FOLLOWING STRUCTURES:
  - TITANIUM
  - STEEL
  - ALUMINUM AND TITANIUM
  - ALUMINUM AND STEEL.
- SEE DETAIL A AND TABLE D FOR FINISHED HOLE SPECIFICATIONS FOR PROTRUDING HEAD FASTENERS. REFER TO SRM 51-40-08 FOR EQUIVALENT COUNTERSINK FASTENER SPECIFICATIONS.

1 FOR 5/32 (0.164) INCH DIAMETER BACB30DX, BACB30DY, BACB30GP, AND BACB30GQ FASTENERS, THE HOLE DIAMETER LIMITS ARE 0.162 TO 0.165 INCH.

2 IF THE EDGE MARGIN IS LESS THAN TWO DIAMETERS, TELL AN ENGINEER WHO HAS THE AUTHORITY TO DO AN ANALYSIS AND MAKE A DECISION.

3 OVERSIZE FASTENER IS NOT AVAILABLE.

4 USE A 3/16 FASTENER IN A STANDARD SIZE HOLE.

5 FOR PROPER INSTALLATION HOLE DIAMETER, REFER TO THE ENGINEERING DRAWING OR SERVICE BULLETIN TO FIND THE INITIAL HOLE SIZE.

6 IF THE EDGE MARGIN IS LESS THAN 2.5 DIAMETERS, TELL AN ENGINEER WHO HAS THE AUTHORITY TO DO AN ANALYSIS AND MAKE A DECISION.

7 TELL AN ENGINEER WHO HAS THE AUTHORITY TO DO AN ANALYSIS AND MAKE A DECISION.

8 MAKE THE RADIUS BLEND SMOOTHLY WITH THE SHANK DIAMETER.

9 FOR 1/64 OVERSIZE, ADD 0.016 INCH TO EACH OF THE MINIMUM AND MAXIMUM DIAMETERS.

FOR 1/32 OVERSIZE, ADD 0.031 INCH TO EACH OF THE MINIMUM AND MAXIMUM DIAMETERS.

10 THE CHAMFER IS NOT NECESSARY FOR 5/32 THRU 3/8 INCH DIAMETER FASTENERS IF THEY ARE INSTALLED IN HOLES THAT ARE NOT COLDWORKED.

Permanent Straight Shank Fastener Holes
Figure 4 (Sheet 1 of 6)

NOMINAL FASTENER DIAMETER	HOLE DIAMETER LIMITS FOR ALUMINUM STRUCTURES (INCH) (TRANSITION FIT)	HOLE DIAMETER LIMITS FOR TITANIUM AND STEEL STRUCTURES, AND COMBINATIONS WITH ALUMINUM (INCH) (CLOSE REAM)
5/32 (0.164) -5	0.161 TO 0.164 [1]	0.1635 TO 0.1645
3/16 (0.190) -6	0.187 TO 0.190	0.1895 TO 0.1905
1/4 (0.250) -8	0.247 TO 0.250	0.2495 TO 0.2505
5/16 (0.313) -10	0.309 TO 0.313	0.3120 TO 0.3130
3/8 (0.375) -12	0.371 TO 0.375	0.3745 TO 0.3755
7/16 (0.438) -14	0.434 TO 0.438	0.4370 TO 0.4380
1/2 (0.500) -16	0.496 TO 0.500	0.4995 TO 0.5005
9/16 (0.563) -18	0.559 TO 0.563	0.5620 TO 0.5630
5/8 (0.625) -20	0.621 TO 0.625	0.6245 TO 0.6255
3/4 (0.750) -24	0.746 TO 0.750	0.7495 TO 0.7505
7/8 (0.875) -28	0.871 TO 0.875	0.8745 TO 0.8755
1 (1.000) -32	0.996 TO 1.000	0.9995 TO 1.0005

INITIAL FASTENER HOLE DIAMETER LIMITS
TABLE A

Permanent Straight Shank Fastener Holes
Figure 4 (Sheet 2 of 6)

NOMINAL OVERSIZE		INITIAL FASTENER NOMINAL DIAMETER								
		(-5) 0.164	(-6) 0.190	(-8) 0.250	(-10) 0.313	(-12) 0.375	(-14) 0.438	(-16) 0.500	(-18) 0.563	(-20) 0.625
		INITIAL HOLE SIZE								
	TRANSITION FIT	0.164 0.161	0.190 0.187	0.250 0.247	0.313 0.309	0.375 0.371	0.438 0.434	0.500 0.496	0.563 0.559	0.625 0.621
	CLOSE REAM	0.1645 0.1635	0.1905 0.1895	0.2505 0.2495	0.3130 0.3120	0.3755 0.3745	0.4380 0.4370	0.5005 0.4995	0.5630 0.5620	0.6255 0.6245
NOMINAL OVERSIZE	HOLE SIZES FOR OVERSIZE REPLACEMENT FASTENERS									
1/64	TRANSITION FIT	[3]	0.203 0.200	0.266 0.263	0.328 0.325	0.391 0.388	0.453 0.450	0.516 0.513	0.579 0.575	0.641 0.637
	CLOSE REAM	[3]	0.2036 0.2026	0.2661 0.2651	0.3286 0.3276	0.3911 0.3901	0.4536 0.4526	0.5161 0.5151	0.5786 0.5776	0.6411 0.6401
1/32 [2]	TRANSITION FIT	[4]	0.219 0.216	0.281 0.278	0.344 0.341	0.406 0.403	0.469 0.466	0.531 0.528	0.595 0.591	0.657 0.653
	CLOSE REAM	[4]	0.2192 0.2182	0.2817 0.2807	0.3442 0.3432	0.4067 0.4057	0.4692 0.4682	0.5317 0.5307	0.5942 0.5932	0.6567 0.6557
3/64 [2]	TRANSITION FIT	[3]	0.235 0.232	0.297 0.294	0.360 0.357	0.422 0.419	0.486 0.482	0.547 0.544	0.609 0.606	0.672 0.669
	CLOSE REAM	[3]	0.2349 0.2339	0.2973 0.2963	0.3599 0.3589	0.4224 0.4214	0.4848 0.4838	0.5474 0.5464	0.6099 0.6089	0.6724 0.6714

OVERSIZE FASTENER HOLE DIAMETER LIMITS
(TRANSITION FIT AND CLOSE REAM)
TABLE B

Permanent Straight Shank Fastener Holes
Figure 4 (Sheet 3 of 6)

NOMINAL AND OVERSIZE FASTENER	HOLE SIZE-INITIAL AND OVERSIZE INTERFERENCE FIT [5]				NOMINAL AND OVERSIZE	HOLE SIZE-INITIAL AND OVERSIZE INTERFERENCE FIT [5]			
	0.0000 TO 0.0030	0.0005 TO 0.0035	0.0005 TO 0.0045	0.0010 TO 0.0040		0.0000 TO 0.0030	0.0005 TO 0.0035	0.0005 TO 0.0045	0.0010 TO 0.0040
5/32 (-5)	0.1605	0.1600	0.1590	0.1595	7/16 (-14)	0.4340	0.4335	0.4325	0.4330
	0.1625	0.1620	0.1620	0.1615		0.4360	0.4355	0.4355	0.4350
1/64	[3]	[3]	[3]	[3]	1/64 [6]	0.4496	0.4491	0.4481	0.4486
						0.4516	0.4511	0.4511	0.4506
1/32 [7]	[4]	[4]	[4]	[4]	1/32 [7]	0.4652	0.4647	0.4637	0.4642
						0.4672	0.4667	0.4667	0.4662
3/16 (-6)	0.1865	0.1860	0.1850	0.1855	1/2 (-16)	0.4965	0.4960	0.4950	0.4955
	0.1885	0.1880	0.1880	0.1875		0.4985	0.4980	0.4980	0.4975
1/64 [6]	0.1996	0.1991	0.1981	0.1986	1/64 [6]	0.5121	0.5116	0.5106	0.5111
	0.2016	0.2011	0.2011	0.2006		0.5141	0.5136	0.5136	0.5131
1/32 [7]	0.2152	0.2147	0.2137	0.2142	1/32 [7]	0.5277	0.5272	0.5262	0.5267
	0.2172	0.2167	0.2167	0.2162		0.5297	0.5292	0.5292	0.5287
1/4 (-8)	0.2465	0.2460	0.2450	0.2455	9/16 (-18)	0.5585	0.5580	0.5570	0.5575
	0.2485	0.2480	0.2480	0.2475		0.5605	0.5600	0.5600	0.5595
1/64 [6]	0.2621	0.2616	0.2606	0.2611	1/64 [6]	0.5741	0.5736	0.5726	0.5731
	0.2641	0.2636	0.2636	0.2631		0.5761	0.5766	0.5756	0.5751
1/32 [7]	0.2777	0.2772	0.2762	0.2767	1/32 [7]	0.5897	0.5892	0.5882	0.5887
	0.2797	0.2792	0.2792	0.2787		0.5917	0.5912	0.5912	0.5907
5/16 (-10)	0.3090	0.3085	0.3075	0.3080	5/8 (-20)	0.6210	0.6205	0.6195	0.6200
	0.3110	0.3105	0.3105	0.3100		0.6230	0.6225	0.6225	0.6220
1/64 [6]	0.3246	0.3241	0.3231	0.3236	1/64 [6]	0.6366	0.6361	0.6351	0.6356
	0.3266	0.3261	0.3261	0.3256		0.6386	0.6381	0.6381	0.6376
1/32 [7]	0.3402	0.3397	0.3387	0.3392	1/32 [7]	0.6522	0.6517	0.6507	0.6512
	0.3422	0.3417	0.3417	0.3412		0.6542	0.6537	0.6537	0.6532

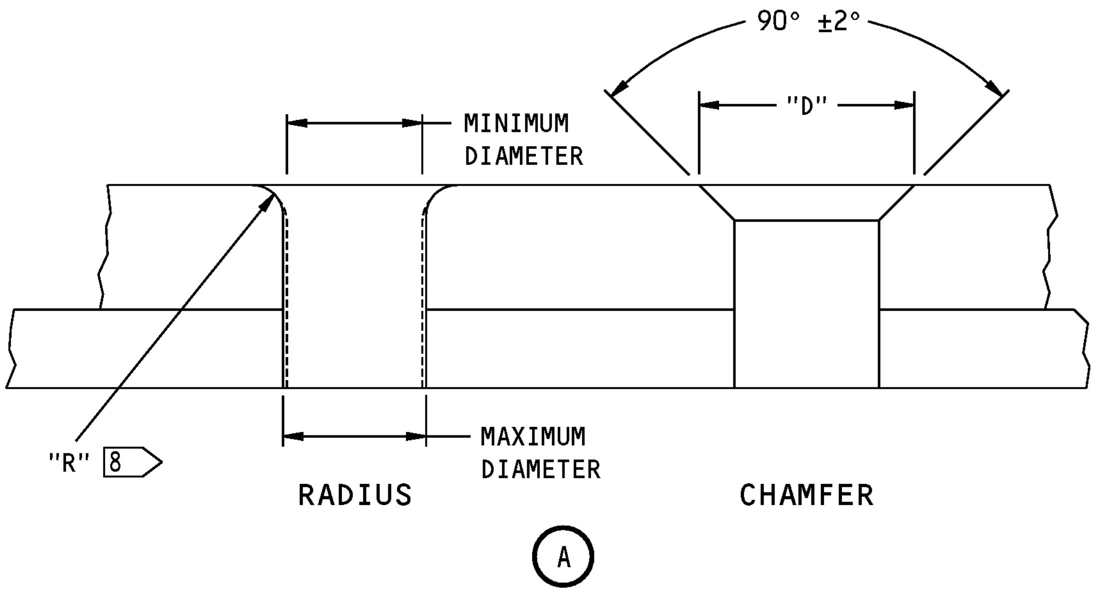
OVERSIZE FASTENER HOLE DIAMETER LIMITS (INTERFERENCE FIT)
TABLE C

Permanent Straight Shank Fastener Holes
Figure 4 (Sheet 4 of 6)

NOMINAL AND OVERSIZE FASTENER	HOLE SIZE-INITIAL AND OVERSIZE INTERFERENCE FIT [5]				NOMINAL AND OVERSIZE	HOLE SIZE-INITIAL AND OVERSIZE INTERFERENCE FIT [5]			
	0.0000 TO 0.0030	0.0005 TO 0.0035	0.0005 TO 0.0045	0.0010 TO 0.0040		0.0000 TO 0.0030	0.0005 TO 0.0035	0.0005 TO 0.0045	0.0010 TO 0.0040
3/8 (-12)	0.3715	0.3710	0.3700	0.3705	3/4 (-24)	0.7460	0.7455	0.7445	0.7450
	0.3735	0.3730	0.3730	0.3725		0.7480	0.7475	0.7475	0.7470
1/64	0.3871	0.3866	0.3856	0.3861	1/64 [6]	0.7616	0.7611	0.7601	0.7606
	0.3891	0.3886	0.3886	0.3881		0.7636	0.7631	0.7631	0.7626
1/32 [7]	0.4027	0.4012	0.4012	0.4017	1/32 [7]	0.7772	0.7767	0.7757	0.7762
	0.4047	0.4042	0.4042	0.4037		0.7792	0.7787	0.7787	0.7782

OVERSIZE FASTENER HOLE DIAMETER LIMITS (INTERFERENCE FIT)
TABLE C (CONTINUED)

Permanent Straight Shank Fastener Holes
Figure 4 (Sheet 5 of 6)



NOMINAL FASTENER DIAMETER	IN ALL METAL STRUCTURE "R" RADIUS		IN ALUMINUM AND MAGNESIUM STRUCTURE "D" 9 10 CHAMFER DIA		IN ALUMINUM AND MAGNESIUM STRUCTURE MIN SHEET THICKNESS TO BE CHAMFERED OR RADIUSED	IN ALL OTHER METAL STRUCTURE "D" 9 CHAMFER DIA		IN ALL OTHER METAL STRUCTURE MIN SHEET THICKNESS TO BE CHAMFERED OR RADIUSED
	MIN	MAX	MIN	MAX		MIN	MAX	
5/32	0.025	0.035	0.188	0.208	0.060	0.218	0.233	0.107
3/16			0.214	0.234	0.060	0.242	0.257	0.127
1/4			0.274	0.294	0.060	0.300	0.320	0.150
5/16	0.030	0.040	0.343	0.363	0.060	0.372	0.392	0.183
3/8			0.406	0.426	0.060	0.435	0.455	0.209
7/16			0.468	0.488	0.060	0.497	0.517	0.236
1/2			0.531	0.551	0.060	0.560	0.580	0.253
9/16	0.040	0.050	0.606	0.626	0.075	0.657	0.677	0.320
5/8			0.668	0.688	0.075	0.719	0.739	0.320
3/4	0.045	0.055	0.800	0.820	0.085	0.856	0.876	0.353
7/8	0.050	0.060	0.931	0.951	0.090	0.993	1.013	0.387
1	0.060	0.070	1.069	1.089	0.105	1.142	1.162	0.453

FILLET RELIEF LIMITS FOR PROTRUDING HEAD
HEX-DRIVE BOLT AND LOCKBOLT HOLES

TABLE D

Permanent Straight Shank Fastener Holes
Figure 4 (Sheet 6 of 6)

HOLE DIAMETERS FOR NAS1738, NAS1739, BACR15FP AND BACR15FR		
NOMINAL FASTENER DIAMETER	MINIMUM HOLE SIZE (INCH)	MAXIMUM HOLE SIZE (INCH)
1/8	0.143	0.146
5/32	0.176	0.180
3/16	0.205	0.209
ALL OTHER BLIND RIVETS		
NOMINAL FASTENER DIAMETER	MINIMUM HOLE SIZE (INCH)	MAXIMUM HOLE SIZE (INCH)
3/32	0.097	0.101
1/8	0.129	0.132
5/32	0.160	0.164
3/16	0.192	0.196
1/4	0.256	0.261

HOLE SIZES FOR BLIND RIVETS
TABLE A

NOMINAL FASTENER DIAMETER	HOLE SIZE (INCH)	
	MINIMUM	MAXIMUM
5/32	0.165	0.168
3/16	0.199	0.202
1/4	0.260	0.263
5/16	0.312	0.315
3/8	0.375	0.378
7/16	0.437	0.441

HOLE SIZES FOR BLIND BOLTS BACB30AY, BACB30CC, AND BACB30JG
TABLE B

NOTES

- THE SOURCE OF INFORMATION FOR THIS FIGURE CAN BE FOUND IN BOEING SPECIFICATION BAC 5004-3.
- SEE TABLE A FOR BLIND RIVETS AND TABLES B THRU D FOR BLIND BOLTS.

Holes for Blind Rivets and Bolts
Figure 5 (Sheet 1 of 2)

NOMINAL FASTENER DIAMETER	HOLE SIZE (INCH)	
	MINIMUM	MAXIMUM
5/32	0.164	0.167
3/16	0.199	0.202
1/4	0.260	0.263
5/16	0.312	0.315
3/8	0.374	0.377
7/16	0.437	0.441
1/2	0.500	0.504

HOLE SIZES FOR BLIND BOLTS MS90353,
MS90354, MS21140, AND MS21141
TABLE C

INITIAL FASTENER	1/64 OVERSIZE FASTENER		LIMITS	NOMINAL FASTENER DIAMETER				
				5/32	3/16	1/4	5/16	3/8
			LIMITS	INITIAL HOLE SIZE				
			MIN	0.164	0.199	0.260	0.312	0.374
			MAX	0.167	0.202	0.263	0.315	0.377
MS21140-()() MS21140-()()P	BACB30VJ()C() BACB30VJ()CD()	OB100-EU()() OB100-EU()()CD	LIMITS	1/64 OVERSIZE				
MS21141-()() MS21141-()()P	BACB30VH()C() BACB30VH()CD()	OBP-EU()() OBP-EU()()CD	MIN	0.180	0.215	0.276	0.328	0.390
MS90353-()() MS90354-()()	BACB30VJ()-() BACB30VH()-()	OB100-T()() OBP-T()()	MAX	0.183	0.218	0.279	0.331	0.393

OVERSIZE FASTENERS AND HOLE SIZES FOR OVERSIZE BLIND BOLTS
TABLE D

Holes for Blind Rivets and Bolts
Figure 5 (Sheet 2 of 2)

TYPE OF FASTENER HOLE	TABLE
CLOSE REAM HOLES	A
CLASS I HOLES	B
CLASS II HOLES	C
CLASS III HOLES	D

INDEX FOR FIGURE 6

NOTES

- THE SOURCE OF INFORMATION FOR THIS FIGURE CAN BE FOUND IN BOEING PROCESS SPECIFICATION BAC 5009.
- REFER TO THE ENGINEER DRAWING OR SERVICE BULLETIN. USE THE SAME HOLE TYPE (CLOSE REAM, CLASS I, CLASS II, OR CLASS III) AS SPECIFIED IN THE ENGINEER DRAWING, SERVICE BULLETIN, OR SRM REPAIR. REFER TO TABLES A THRU D FOR OVERSIZE HOLE DIMENSIONS.
- SEE DETAIL A AND TABLE E FOR FILLET RELIEF SPECIFICATIONS FOR PROTRUDING HEAD FASTENERS. REFER TO SRM 51-40-08 FOR EQUIVALENT COUNTERSINK FASTENER SPECIFICATIONS.

1 IF THE EDGE MARGIN IS LESS THAN TWO DIAMETERS, TELL AN ENGINEER WHO HAS THE AUTHORITY TO DO AN ANALYSIS AND MAKE A DECISION.

2 MAKE THE RADIUS BLEND SMOOTHLY WITH THE SHANK DIAMETER.

3 FOR OVERSIZE BOLTS, ADD 0.010 INCH TO EACH VALUE.

EXAMPLE: IF INITIAL "R" IS 0.041 TO 0.051 INCH, THEN THE "R" VALUES FOR OVERSIZE FASTENERS ARE 0.051 TO 0.061 INCH.

4 FOR OVERSIZE BOLTS, MULTIPLY THE MAXIMUM RADIUS FROM THE INITIAL BOLT TIMES TWO AND ADD THE MAXIMUM SHANK DIAMETER OF THE OVERSIZE BOLT. THE SPECIFIED TOLERANCE IS -0.000/+0.020 INCH.

EXAMPLE: IF THE INITIAL "R" IS 0.041 TO 0.051 INCH AND THE OVERSIZE SHANK DIAMETER IS 0.2804 TO 0.2814 INCH, THEN THE CALCULATION IS (0.051 X 2) + 0.2814 - 0.000/+0.020 = 0.3834 TO 0.3854 INCH.

Holes for Bolts
Figure 6 (Sheet 1 of 12)

OVERSIZE FASTENER	NOMINAL OVERSIZE	LIMIT	3/16 (0.1900)	1/4 (0.2500)	5/16 (0.3125)	3/8 (0.3750)	7/16 (0.4375)
CLOSE REAM HOLE							
--	INITIAL HOLE SIZE	MAX	0.1905	0.2505	0.3130	0.3755	0.4380
		MIN	0.1895	0.2495	0.3120	0.3745	0.4370
BACB30G	1/64 (0.0156)	MAX	--	--	--	--	--
		MIN	--	--	--	--	--
BACB30AC	1/64 (0.0156)	MAX	--	--	--	--	--
		MIN	--	--	--	--	--
BACB30J	1/32 (0.0312)	MAX	--	--	--	--	--
		MIN	--	--	--	--	--
BACB30AJ	1/32 (0.0312)	MAX	--	0.2814	0.3439	0.4064	0.4689
		MIN	--	0.2804	0.3429	0.4054	0.4679
BACB30DK	1/32 (0.0312)	MAX	--	--	--	--	--
		MIN	--	--	--	--	--
BACB30EG NAS2903 THRU 2920 NAS1243 THRU 1250 NAS1703 THRU 1710	1/64 (0.0156)	MAX	0.2036	0.2661	0.3286	0.3911	0.4536
		MIN	0.2026	0.2651	0.3276	0.3901	0.4526
BACB30EH NAS3003 THRU 3020 NAS1253 THRU 1260 NAS1603 THRU 1620	1/32 (0.0312)	MAX	0.2192	0.2817	0.3442	0.4067	0.4692
		MIN	0.2182	0.2807	0.3432	0.4057	0.4682
X CODE	1/64 (0.0156)	MAX	0.2036	0.2661	0.3286	0.3911	0.4536
		MIN	0.2026	0.2651	0.3276	0.3901	0.4526
Y CODE	1/32 (0.0312)	MAX	0.2192	0.2817	0.3442	0.4067	0.4692
		MIN	0.2182	0.2807	0.3432	0.4057	0.4682
BACB30TL	4/64 (0.0625)	MAX	--	--	--	--	--
		MIN	--	--	--	--	--
	5/64 (0.0781)	MAX	--	--	--	--	--
		MIN	--	--	--	--	--

HOLE SIZES FOR OVERSIZE REPLACEMENT
BOLTS - CLOSE REAM HOLE (INCHES)
TABLE A [1]

Holes for Bolts
Figure 6 (Sheet 2 of 12)

OVERSIZE FASTENER	NOMINAL OVERSIZE	LIMIT	1/2 (0.5000)	9/16 (0.5625)	5/8 (0.6250)	3/4 (0.7500)	7/8 (0.8750)
CLOSE REAM HOLE							
--	INITIAL HOLE SIZE	MAX	0.5005	0.5630	0.6255	0.7505	0.8755
		MIN	0.4995	0.5620	0.6245	0.7495	0.8745
BACB30G	1/64 (0.0156)	MAX	--	--	--	--	--
		MIN	--	--	--	--	--
BACB30AC	1/64 (0.0156)	MAX	--	--	--	0.7673	--
		MIN	--	--	--	0.7663	--
BACB30J	1/32 (0.0312)	MAX	--	--	--	--	--
		MIN	--	--	--	--	--
BACB30AJ	1/32 (0.0312)	MAX	0.5313	0.5943	0.6567	0.7815	0.9063
		MIN	0.5303	0.5933	0.6557	0.7805	0.9053
BACB30DK	1/32 (0.0312)	MAX	--	--	--	--	--
		MIN	--	--	--	--	--
BACB30EG NAS2903 THRU 2920 NAS1243 THRU 1250 NAS1703 THRU 1710	1/64 (0.0156)	MAX	0.5161	0.5786	0.6411	0.7661	0.8911
		MIN	0.5151	0.5776	0.6401	0.7651	0.8901
BACB30EH NAS3003 THRU 3020 NAS1253 THRU 1260 NAS1603 THRU 1620	1/32 (0.0312)	MAX	0.5317	0.5942	0.6567	0.7817	0.9067
		MIN	0.5307	0.5932	0.6557	0.7807	0.9057
X CODE	1/64 (0.0156)	MAX	0.5161	0.5786	0.6411	0.7661	0.8911
		MIN	0.5151	0.5776	0.6401	0.7561	0.8901
Y CODE	1/32 (0.0312)	MAX	0.5317	0.5942	0.6567	0.7817	0.9067
		MIN	0.5307	0.5932	0.6557	0.7807	0.9057
BACB30TL	4/64 (0.0625)	MAX	--	--	0.6880	--	0.9380
		MIN	--	--	0.6870	--	0.9370
	5/64 (0.0781)	MAX	--	--	0.7036	--	0.9536
		MIN	--	--	0.7026	--	0.9526

HOLE SIZES FOR OVERSIZE REPLACEMENT
BOLTS - CLOSE REAM HOLE (INCHES)
TABLE A (CONTINUED) 1

Holes for Bolts
Figure 6 (Sheet 3 of 12)

OVERSIZE FASTENER	NOMINAL OVERSIZE	LIMIT	1 (1.0000)	1-1/8 (1.1250)	1-1/4 (1.2500)	1-3/8 (1.3750)	1-1/2 (1.5000)
CLOSE REAM HOLE							
--	INITIAL HOLE SIZE	MAX	1.0005	1.1260	1.2510	1.3760	1.5010
		MIN	0.9995	1.1245	1.2495	1.3745	1.4995
BACB30G	1/64 (0.0156)	MAX	--	--	--	1.3924	1.5174
		MIN	--	--	--	1.3909	1.5159
BACB30AC	1/64 (0.0156)	MAX	--	--	--	--	--
		MIN	--	--	--	--	--
BACB30J	1/32 (0.0312)	MAX	--	--	--	1.4079	1.5330
		MIN	--	--	--	1.4064	1.5315
BACB30AJ	1/32 (0.0312)	MAX	1.0315	1.1570	1.2820	1.4070	1.5320
		MIN	1.0305	1.1555	1.2805	1.4055	1.5305
BACB30DK	1/32 (0.0312)	MAX	1.0317	1.1572	1.2822	1.4072	1.5322
		MIN	1.0307	1.1557	1.2807	1.4057	1.5307
BACB30EG NAS2903 THRU 2920 NAS1243 THRU 1250 NAS1703 THRU 1710	1/64 (0.0156)	MAX	1.0161	1.1416	1.2666	--	--
		MIN	1.0151	1.1401	1.2651	--	--
BACB30EH NAS3003 THRU 3020 NAS1253 THRU 1260 NAS1603 THRU 1620	1/32 (0.0312)	MAX	1.0317	1.1572	1.2822	--	--
		MIN	1.0307	1.1557	1.2807	--	--
X CODE	1/64 (0.0156)	MAX	1.0161	1.1416	1.2666	1.3916	1.5166
		MIN	1.0151	1.1401	1.2651	1.3901	1.5151
Y CODE	1/32 (0.0312)	MAX	1.0317	1.1572	1.2822	1.4072	1.5322
		MIN	1.0307	1.1557	1.2807	1.4057	1.5307
BACB30TL	4/64 (0.0625)	MAX	1.0630	--	--	1.4385	--
		MIN	1.0620	--	--	1.4370	--
	5/64 (0.0781)	MAX	1.0786	--	--	1.4541	--
		MIN	1.0776	--	--	1.4526	--

HOLE SIZES FOR OVERSIZE REPLACEMENT
BOLTS - CLOSE REAM HOLE (INCHES)
TABLE A (CONTINUED) 1

Holes for Bolts
Figure 6 (Sheet 4 of 12)

OVERSIZE FASTENER	NOMINAL OVERSIZE	LIMIT	3/16 (0.1900)	1/4 (0.2500)	5/16 (0.3125)	3/8 (0.3750)	7/16 (0.4375)	
CLASS I HOLE								
--	INITIAL HOLE SIZE	MAX	0.194	0.254	0.316	0.379	0.442	
		MIN	0.190	0.250	0.312	0.375	0.437	
BACB30G	1/64 (0.0156)	MAX	--	--	--	--	--	
		MIN	--	--	--	--	--	
BACB30AC	1/64 (0.0156)	MAX	--	--	--	--	--	
		MIN	--	--	--	--	--	
BACB30J	1/32 (0.0312)	MAX	--	--	--	--	--	
		MIN	--	--	--	--	--	
BACB30AJ	1/32 (0.0312)	MAX	--	0.285	0.347	0.409	0.473	
		MIN	--	0.281	0.343	0.405	0.468	
BACB30DK	1/32 (0.0312)	MAX	--	--	--	--	--	
		MIN	--	--	--	--	--	
BACB30EG NAS2903 THRU 2920 NAS1243 THRU 1250 NAS1703 THRU 1710	1/64 (0.0156)	MAX	0.207	0.270	0.332	0.395	0.458	
		MIN	0.203	0.266	0.328	0.391	0.453	
BACB30EH NAS3003 THRU 3020 NAS1253 THRU 1260 NAS1603 THRU 1620	1/32 (0.0312)	MAX	0.223	0.285	0.348	0.410	0.474	
		MIN	0.219	0.281	0.344	0.406	0.469	
X CODE	1/64 (0.0156)	MAX	0.207	0.270	0.332	0.395	0.458	
		MIN	0.203	0.266	0.328	0.391	0.453	
Y CODE	1/32 (0.0312)	MAX	0.223	0.285	0.348	0.410	0.473	
		MIN	0.219	0.281	0.344	0.406	0.468	
BACB30TL	4/64 (0.0625)	MAX	--	--	--	--	--	
		MIN	--	--	--	--	--	
	5/64 (0.0781)	MAX	--	--	--	--	--	
		MIN	--	--	--	--	--	

HOLE SIZES FOR OVERSIZE REPLACEMENT
BOLTS - CLASS I HOLE (INCHES)
TABLE B [1]

Holes for Bolts
Figure 6 (Sheet 5 of 12)

OVERSIZE FASTENER	NOMINAL OVERSIZE	LIMIT	1/2 (0.5000)	9/16 (0.5625)	5/8 (0.6250)	3/4 (0.7500)	7/8 (0.8750)
CLASS I HOLE							
--	INITIAL HOLE SIZE	MAX	0.505	0.567	0.630	0.757	0.882
		MIN	0.500	0.562	0.625	0.750	0.875
BACB30G	1/64 (0.0156)	MAX	--	--	--	--	--
		MIN	--	--	--	--	--
BACB30AC	1/64 (0.0156)	MAX	--	--	--	0.774	--
		MIN	--	--	--	0.767	--
BACB30J	1/32 (0.0312)	MAX	--	--	--	--	--
		MIN	--	--	--	--	--
BACB30AJ	1/32 (0.0312)	MAX	0.536	0.598	0.661	0.785	0.913
		MIN	0.531	0.593	0.656	0.781	0.906
BACB30DK	1/32 (0.0312)	MAX	--	--	--	--	--
		MIN	--	--	--	--	--
BACB30EG NAS2903 THRU 2920 NAS1243 THRU 1250 NAS1703 THRU 1710	1/64 (0.0156)	MAX	0.521	0.583	0.646	0.773	0.898
		MIN	0.516	0.578	0.641	0.766	0.891
BACB30EH NAS3003 THRU 3020 NAS1253 THRU 1260 NAS1603 THRU 1620	1/32 (0.0312)	MAX	0.536	0.598	0.661	0.788	0.913
		MIN	0.531	0.593	0.656	0.781	0.906
X CODE	1/64 (0.0156)	MAX	0.521	0.583	0.646	0.773	0.898
		MIN	0.516	0.578	0.641	0.766	0.891
Y CODE	1/32 (0.0312)	MAX	0.536	0.598	0.661	0.788	0.913
		MIN	0.531	0.593	0.656	0.781	0.906
BACB30TL	4/64 (0.0625)	MAX	--	--	0.6925	--	0.9445
		MIN	--	--	0.6875	--	0.9375
	5/64 (0.0781)	MAX	--	--	0.7081	--	0.9601
		MIN	--	--	0.7031	--	0.9531

HOLE SIZES FOR OVERSIZE REPLACEMENT
BOLTS - CLASS I HOLE (INCHES)
TABLE B (CONTINUED) 1

Holes for Bolts
Figure 6 (Sheet 6 of 12)

OVERSIZE FASTENER	NOMINAL OVERSIZE	LIMIT	1 (1.0000)	1-1/8 (1.1250)	1-1/4 (1.2500)	1-3/8 (1.3750)	1-1/2 (1.5000)
CLASS I HOLE							
--	INITIAL HOLE SIZE	MAX	1.010	1.135	1.260	1.385	1.510
		MIN	1.000	1.125	1.250	1.375	1.500
BACB30G	1/64 (0.0156)	MAX	--	--	--	1.421	1.546
		MIN	--	--	--	1.391	1.516
BACB30AC	1/64 (0.0156)	MAX	--	--	--	--	--
		MIN	--	--	--	--	--
BACB30J	1/32 (0.0312)	MAX	--	--	--	1.417	1.542
		MIN	--	--	--	1.407	1.532
BACB30AJ	1/32 (0.0312)	MAX	1.041	1.166	1.291	1.416	1.541
		MIN	1.031	1.156	1.281	1.406	1.531
BACB30DK	1/32 (0.0312)	MAX	1.041	1.166	1.291	1.416	1.541
		MIN	1.031	1.156	1.281	1.406	1.531
BACB30EG NAS2903 THRU 2920 NAS1243 THRU 1250 NAS1703 THRU 1710	1/64 (0.0156)	MAX	1.025	1.150	1.275	--	--
		MIN	1.016	1.141	1.266	--	--
BACB30EH NAS3003 THRU 3020 NAS1253 THRU 1260 NAS1603 THRU 1620	1/32 (0.0312)	MAX	1.041	1.166	1.291	--	--
		MIN	1.031	1.156	1.281	--	--
X CODE	1/64 (0.0156)	MAX	1.025	1.150	1.275	1.400	1.525
		MIN	1.016	1.141	1.266	1.391	1.516
Y CODE	1/32 (0.0312)	MAX	1.041	1.166	1.291	1.416	1.541
		MIN	1.031	1.156	1.281	1.406	1.531
BACB30TL	4/64 (0.0625)	MAX	1.0725	--	--	1.4475	--
		MIN	1.0625	--	--	1.4375	--
	5/64 (0.0781)	MAX	1.0881	--	--	1.4631	--
		MIN	1.0787	--	--	1.4531	--

HOLE SIZES FOR OVERSIZE REPLACEMENT
BOLTS - CLASS I HOLE (INCHES)
TABLE B (CONTINUED) 1

Holes for Bolts
Figure 6 (Sheet 7 of 12)

OVERSIZE FASTENER	NOMINAL OVERSIZE	LIMIT	3/16 (0.1900)	1/4 (0.2500)	5/16 (0.3125)	3/8 (0.3750)	7/16 (0.4375)
CLASS II HOLE							
--	INITIAL HOLE SIZE	MAX	0.199	0.261	0.327	0.391	0.457
		MIN	0.190	0.250	0.313	0.375	0.438
BACB30G	1/64 (0.0156)	MAX	--	--	--	--	--
		MIN	--	--	--	--	--
BACB30AC	1/64 (0.0156)	MAX	--	--	--	--	--
		MIN	--	--	--	--	--
BACB30J	1/32 (0.0312)	MAX	--	--	--	--	--
		MIN	--	--	--	--	--
BACB30AJ	1/32 (0.0312)	MAX	--	0.292	0.357	0.422	0.488
		MIN	--	0.281	0.343	0.406	0.469
BACB30DK	1/32 (0.0312)	MAX	--	--	--	--	--
		MIN	--	--	--	--	--
X CODE	1/64 (0.0156)	MAX	0.213	0.277	0.343	0.407	0.471
		MIN	0.203	0.266	0.329	0.391	0.454
Y CODE	1/32 (0.0312)	MAX	0.228	0.292	0.358	0.420	0.486
		MIN	0.219	0.281	0.344	0.406	0.469
BACB30TL	4/64 (0.0625)	MAX	--	--	--	--	--
		MIN	--	--	--	--	--
	5/64 (0.0781)	MAX	--	--	--	--	--
		MIN	--	--	--	--	--

HOLE SIZES FOR OVERSIZE REPLACEMENT
BOLTS - CLASS II HOLE (INCHES)
TABLE C 1

Holes for Bolts
Figure 6 (Sheet 8 of 12)

OVERSIZE FASTENER	NOMINAL OVERSIZE	LIMIT	1/2 (0.5000)	9/16 (0.5625)	5/8 (0.6250)	3/4 (0.7500)	7/8 (0.8750)
CLASS II HOLE							
--	INITIAL HOLE SIZE	MAX	0.521	0.583	0.645	0.773	0.898
		MIN	0.500	0.563	0.625	0.750	0.875
BACB30G	1/64 (0.0156)	MAX	--	--	--	--	--
		MIN	--	--	--	--	--
BACB30AC	1/64 (0.0156)	MAX	--	--	--	0.790	--
		MIN	--	--	--	0.767	--
BACB30J	1/32 (0.0312)	MAX	--	--	--	--	--
		MIN	--	--	--	--	--
BACB30AJ	1/32 (0.0312)	MAX	0.552	0.614	0.676	0.804	0.926
		MIN	0.531	0.594	0.656	0.781	0.906
BACB30DK	1/32 (0.0312)	MAX	--	--	--	--	--
		MIN	--	--	--	--	--
X CODE	1/64 (0.0156)	MAX	0.537	0.599	0.661	0.789	0.914
		MIN	0.516	0.579	0.641	0.766	0.891
Y CODE	1/32 (0.0312)	MAX	0.552	0.614	0.676	0.804	0.929
		MIN	0.531	0.594	0.656	0.781	0.906
BACB30TL	4/64 (0.0625)	MAX	--	--	0.7075	--	0.9605
		MIN	--	--	0.6875	--	0.9375
	5/64 (0.0781)	MAX	--	--	0.7231	--	0.9761
		MIN	--	--	0.7031	--	0.9531

HOLE SIZES FOR OVERSIZE REPLACEMENT
BOLTS - CLASS II HOLE (INCHES)
TABLE C (CONTINUED) 1

Holes for Bolts
Figure 6 (Sheet 9 of 12)

OVERSIZE FASTENER	NOMINAL OVERSIZE	LIMIT	1 (1.0000)	1-1/8 (1.1250)	1-1/4 (1.2500)	1-3/8 (1.3750)	1-1/2 (1.5000)
CLASS II HOLE							
--	INITIAL HOLE SIZE	MAX	1.026	1.155	1.280	1.405	1.530
		MIN	1.000	1.125	1.250	1.375	1.500
BACB30G	1/64 (0.0156)	MAX	--	--	--	1.421	1.546
		MIN	--	--	--	1.391	1.516
BACB30AC	1/64 (0.0156)	MAX	--	--	--	--	--
		MIN	--	--	--	--	--
BACB30J	1/32 (0.0312)	MAX	--	--	--	1.437	1.562
		MIN	--	--	--	1.407	1.532
BACB30AJ	1/32 (0.0312)	MAX	1.057	1.186	1.311	1.437	1.561
		MIN	1.031	1.156	1.281	1.406	1.531
BACB30DK	1/32 (0.0312)	MAX	1.057	1.186	1.311	1.436	1.561
		MIN	1.031	1.156	1.281	1.406	1.531
X CODE	1/64 (0.0156)	MAX	1.042	1.173	1.296	1.421	1.546
		MIN	1.016	1.141	1.266	1.391	1.516
Y CODE	1/32 (0.0312)	MAX	1.057	1.186	1.311	1.436	1.561
		MIN	1.031	1.156	1.281	1.406	1.531
BACB30TL	4/64 (0.0625)	MAX	1.0885	--	1.4675	--	--
		MIN	1.0625	--	1.4375	--	--
	5/64 (0.0781)	MAX	1.1041	--	1.4831	--	--
		MIN	1.0781	--	1.4531	--	--

HOLE SIZES FOR OVERSIZE REPLACEMENT
BOLTS - CLASS II HOLE (INCHES)
TABLE C (CONTINUED) 1

Holes for Bolts
Figure 6 (Sheet 10 of 12)

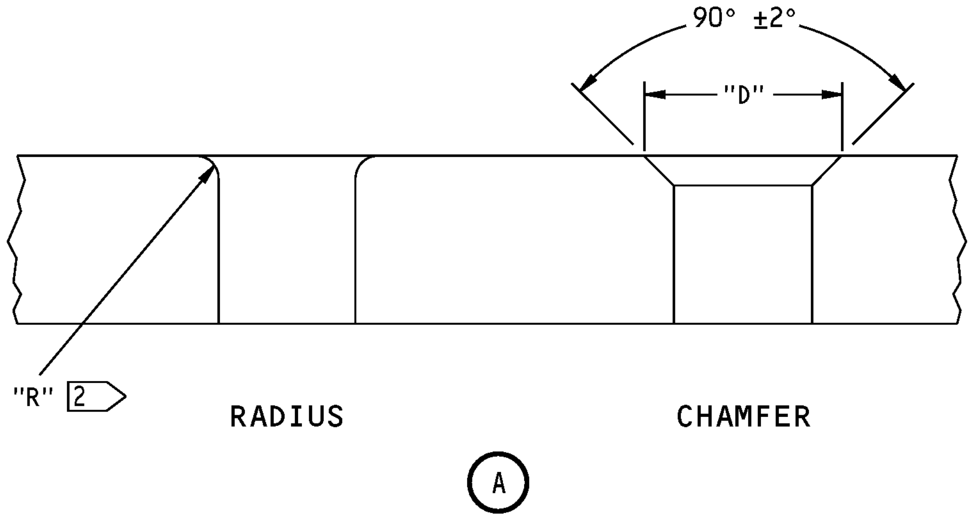
OVERSIZE FASTENER	NOMINAL OVERSIZE	LIMIT	3/4 (0.7500)	7/8 (0.8750)	1 (1.0000)	1-1/8 (1.1250)
CLASS III HOLE						
--	INITIAL HOLE SIZE	MAX	0.797	0.922	1.047	1.172
		MIN	0.778	0.903	1.028	1.153
BACB30G	1/64 (0.0156)	MAX	--	--	--	--
		MIN	--	--	--	--
BACB30AC	1/64 (0.0156)	MAX	0.814	--	--	--
		MIN	0.795	--	--	--
BACB30J	1/32 (0.0312)	MAX	--	--	--	--
		MIN	--	--	--	--

HOLE SIZES FOR OVERSIZE REPLACEMENT
BOLTS - CLASS III HOLE (INCHES)
TABLE D 1

OVERSIZE FASTENER	NOMINAL OVERSIZE	LIMIT	1-1/4 (1.2500)	1-3/8 (1.3750)	1-1/2 (1.5000)
CLASS III HOLE					
--	INITIAL HOLE SIZE	MAX	1.297	1.422	1.547
		MIN	1.278	1.403	1.528
BACB30G	1/64 (0.0156)	MAX	--	1.438	1.563
		MIN	--	1.419	1.544
BACB30AC	1/64 (0.0156)	MAX	--	--	--
		MIN	--	--	--
BACB30J	1/32 (0.0312)	MAX	--	1.454	1.560
		MIN	--	1.435	1.479

HOLE SIZES FOR OVERSIZE REPLACEMENT
BOLTS - CLASS III HOLE (INCHES)
TABLE D (CONTINUED) 1

Holes for Bolts
Figure 6 (Sheet 11 of 12)



NOMINAL FASTENER DIAMETER	BACB30FD, BACB30LE, BACB30MR, BACB30MT, BACB30NH, BACB30PN, BACB30TR, BACB30UG, BACB30US, BACB30XL MS21250		ALL OTHER PROTRUDING HEAD BOLTS	
	"R" 3 RADIUS	"D" 4 CHAMFER DIA	"R" 3 RADIUS	"D" 4 CHAMFER DIA
3/16	0.041-0.051	0.272-0.292	0.020-0.030	0.230-0.250
1/4	0.041-0.051	0.332-0.352	0.020-0.030	0.290-0.310
5/16	0.041-0.051	0.394-0.414	0.020-0.030	0.352-0.372
3/8	0.057-0.067	0.489-0.509	0.025-0.035	0.425-0.445
7/16	0.057-0.067	0.551-0.571	0.025-0.035	0.487-0.507
1/2	0.057-0.067	0.614-0.634	0.030-0.040	0.560-0.580
9/16	0.057-0.067	0.676-0.696	0.035-0.045	0.632-0.652
5/8	0.073-0.083	0.771-0.791	0.040-0.050	0.705-0.725
3/4	0.073-0.083	0.896-0.916	0.045-0.055	0.840-0.860
7/8	0.073-0.083	1.021-1.041	0.050-0.060	0.975-0.995
1	0.073-0.083	1.146-1.166	0.060-0.070	1.120-1.140
1 1/8	0.073-0.083	1.271-1.291	0.070-0.080	1.265-1.285
1 1/4	0.089-0.099	1.428-1.448	0.075-0.085	1.400-1.420
1 3/8	0.089-0.099	1.553-1.573	--	--
1 1/2	0.089-0.099	1.678-1.698	--	--
1 3/4	0.089-0.099	1.928-1.948	--	--

FILLET RELIEF LIMITS FOR PROTRUDING HEAD STRAIGHT SHANK BOLT HOLES WHEN A COUNTERSINK WASHER IS NOT USED UNDER THE BOLT HEAD
TABLE E

Holes for Bolts
Figure 6 (Sheet 12 of 12)

NOMINAL RIVET DIAMETER	FINISHED HOLE DIAMETER
0.125 (1/8)	0.127 +0.003 −0.000
0.156 (5/32)	0.159 +0.003 −0.000
0.1875 (3/16)	0.190 +0.003 −0.000
0.219 (7/32)	0.222 +0.003 −0.000
0.250 (1/4)	0.253 +0.003 −0.000
0.281 (9/32)	0.285 +0.003 −0.000
0.3125 (5/16)	0.315 +0.003 −0.000
0.344 (11/32)	0.348 +0.003 −0.000
0.3750 (3/8)	0.378 +0.003 −0.000
0.406 (13/32)	0.411 +0.003 −0.000
0.4375 (7/16)	0.441 +0.003 −0.000

HOLE SIZES FOR FLUID-TIGHT RIVETS
TABLE A

NOTES

- THE SOURCE OF INFORMATION FOR THIS FIGURE CAN BE FOUND IN BOEING PROCESS SPECIFICATION BAC 5047.
- HOLE DIAMETERS IN THIS FIGURE CAN BE USED UNLESS AN APPLICABLE ENGINEER DRAWING SHOWS DIFFERENTLY.
- HOLES AND COUNTERSINKS MUST BE 90 DEGREES TO THE PART SURFACE, ±2 DEGREES.

Fluid Tight Fastener Holes
Figure 7

NOTES

- THE SOURCE OF INFORMATION FOR THIS FIGURE CAN BE FOUND IN BOEING PROCESS SPECIFICATION BAC 5060.
- HOLE DIAMETERS IN THIS FIGURE CAN BE USED UNLESS AN APPLICABLE ENGINEER DRAWING SHOWS DIFFERENTLY.
- SEE DETAIL A AND TABLE F FOR FINISHED HOLE SPECIFICATIONS FOR PROTRUDING HEAD FASTENERS. REFER TO 51-40-08 FOR EQUIVALENT COUNTERSINK FASTENER SPECIFICATIONS.
- SEE TABLES A AND B FOR BACB30PT BOLTS. SEE TABLES C THRU E FOR BACB30WQ AND BACB30WR BOLTS.

1 IT IS NOT NECESSARY TO COLD WORK A HOLE FOR A FIRST OVERSIZE BOLT IF THE INITIAL HOLE WAS A CLASS I, HIGH INTERFERENCE, (SLEEVE OR SLEEVELESS) COLD WORKED HOLE. BUT IF THE INITIAL HOLE WAS A 1/64 INCH UNDERSIZE, CLASS I, SLEEVE, HIGH INTERFERENCE, COLD WORKED HOLE, THEN A HOLE FOR A FIRST OVERSIZE BOLT MUST BE COLD WORKED AGAIN. REFER TO SRM 51-40-09 FOR SLEEVE AND SLEEVELESS COLD WORKING PROCEDURES.

2 COLD WORK THE HOLE AS A CLASS I, HIGH INTERFERENCE HOLE, AS SPECIFIED IN SRM 51-40-09.

3 HOLES FOR FIRST AND SECOND OVERSIZE FASTENERS MUST HAVE THE SAME BOLT INTERFERENCE AS SPECIFIED FOR THE INITIAL HOLE.

4 ADD 0.0096 TO BOTH THE MINIMUM AND MAXIMUM CHAMFER DIAMETERS FOR FIRST OVERSIZE BOLTS. ADD 0.0252 INCH TO BOTH THE MINIMUM AND MAXIMUM CHAMFER DIAMETERS FOR SECOND OVERSIZE BOLTS.

5 IF COLD WORKING IS NECESSARY FOR AN OVERSIZE HOLE, THEN USE THE MANDREL-TO-HOLE INTERFERENCE AS SPECIFIED IN THE ENGINEER DRAWING.

Holes for Radius Lead-In Bolts
Figure 8 (Sheet 1 of 6)

NOMINAL THREAD SIZE	BOLT PART NUMBER	HOLE DIAMETER	
		MINIMUM	MAXIMUM
WING UPPER SURFACE			
0.2500-28	BACB30PT	0.2520	0.2540
0.3125-24		0.3145	0.3165
0.3750-24		0.3770	0.3790
WING LOWER SURFACE			
0.2500-28	BACB30PT	0.2510	0.2530
0.3125-24		0.3135	0.3155
0.3750-24		0.3760	0.3780

STANDARD HOLE SIZES FOR BACB30PT
70 DEGREE RADIUS LEAD-IN BOLTS
TABLE A

NOMINAL THREAD SIZE	FIRST OVERSIZE HOLE DIAMETER		SECOND OVERSIZE HOLE DIAMETER	
	MINIMUM	MAXIMUM	MINIMUM	MAXIMUM
WING UPPER SURFACE				
0.2500-28	0.2616	0.2636	0.2772	0.2792
0.3125-24	0.3241	0.3261	0.3397	0.3417
0.3750-24	0.3866	0.3886	0.4022	0.4042
WING LOWER SURFACE				
0.2500-28	0.2591	0.2616	0.2747	0.2772
0.3125-24	0.3216	0.3241	0.3372	0.3397
0.3750-24	0.3841	0.3866	0.3997	0.4022

OVERSIZE HOLE DIMENSIONS FOR BACB30PT
70 DEGREE RADIUS LEAD-IN BOLTS
TABLE B

Holes for Radius Lead-In Bolts
Figure 8 (Sheet 2 of 6)

NOMINAL THREAD SIZE	BOLT PART NUMBER	HOLE DIAMETER		COLD WORKED HOLE DIAMETER	
		MINIMUM	MAXIMUM	MINIMUM	MAXIMUM
WING UPPER SURFACE AND UPPER CHORD TO WEB					
0.1900-32	BACB30WQ AND BACB30WR	0.1928	0.1948	0.1933	0.1953
0.2500-28		0.2526	0.2546	0.2531	0.2551
0.3125-24		0.3151	0.3171	0.3156	0.3176
0.3750-24		0.3776	0.3796	0.3781	0.3801
0.4375-20		0.4401	0.4421	0.4406	0.4426
WING LOWER SURFACE AND LOWER CHORD TO WEB					
0.1900-32	BACB30WQ AND BACB30WR	0.1913	0.1933	0.1933	0.1953
0.2500-28		0.2511	0.2531	0.2531	0.2551
0.3125-24		0.3136	0.3156	0.3156	0.3176
0.3750-24		0.3761	0.3781	0.3781	0.3801
0.4375-20		0.4386	0.4406	0.4406	0.4426

STANDARD HOLE SIZES FOR BACB30WQ AND BACB30WR 100 DEGREE RADIUS LEAD-IN BOLTS
TABLE C

NOMINAL THREAD SIZE	FIRST OVERSIZE HOLE DIAMETER [1]		SECOND OVERSIZE HOLE DIAMETER [2]	
	MINIMUM	MAXIMUM	MINIMUM	MAXIMUM
WING UPPER SURFACE AND UPPER CHORD TO WEB				
0.1900-32	0.2029	0.2049	0.2185	0.2205
0.2500-28	0.2627	0.2647	0.2783	0.2803
0.3125-24	0.3252	0.3272	0.3408	0.3428
0.3750-24	0.3877	0.3897	0.4033	0.4053
0.4375-20	0.4502	0.4522	0.4658	0.4678
WING LOWER SURFACE AND LOWER CHORD TO WEB				
0.1900-32	0.2029	0.2049	0.2185	0.2205
0.2500-28	0.2627	0.2647	0.2783	0.2803
0.3125-24	0.3252	0.3272	0.3408	0.3428
0.3750-24	0.3877	0.3897	0.4033	0.4053
0.4375-20	0.4502	0.4522	0.4658	0.4678

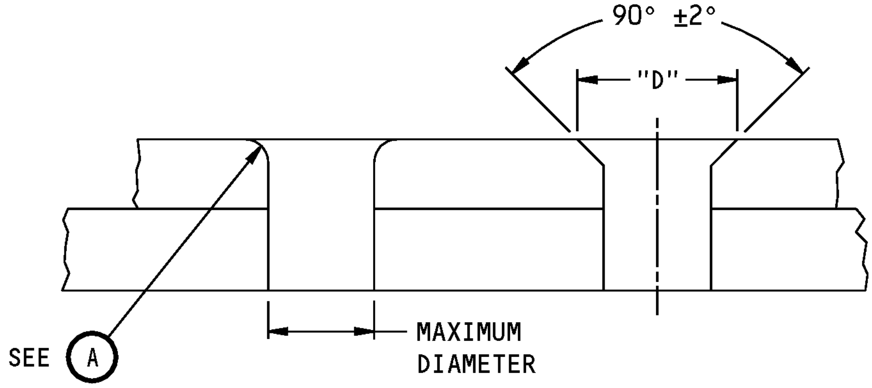
OVERSIZE HOLE DIMENSIONS FOR BACB30WQ AND BACB30WR 100 DEGREE RADIUS LEAD-IN BOLTS IN COLD WORKED HOLES
TABLE D [5]

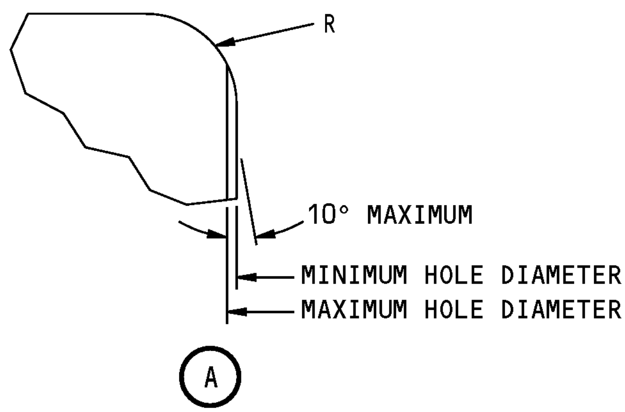
Holes for Radius Lead-In Bolts
Figure 8 (Sheet 3 of 6)

BOEING STANDARD NUMBER	BOLT INTERFACE	INITIAL OVERSIZE HOLE DIAMETER		FIRST OVERSIZE HOLE DIAMETER [3]		SECOND OVERSIZE HOLE DIAMETER [3]	
		MINIMUM	MAXIMUM	MINIMUM	MAXIMUM	MINIMUM	MAXIMUM
3	0.0005 TO 0.0035	0.1925	0.1948	0.2021	0.2044	0.2177	0.2200
	0.0010 TO 0.0035	0.1925	0.1943	0.2021	0.2039	0.2177	0.2195
	0.0010 TO 0.0040	0.1920	0.1943	0.2016	0.2039	0.2172	0.2195
	0.0020 TO 0.0050	0.1910	0.1933	0.2006	0.2029	0.2162	0.2185
4	0.0005 TO 0.0035	0.2525	0.2546	0.2621	0.2642	0.2777	0.2798
	0.0010 TO 0.0035	0.2525	0.2541	0.2621	0.2637	0.2777	0.2793
	0.0010 TO 0.0040	0.2520	0.2541	0.2616	0.2637	0.2772	0.2793
	0.0020 TO 0.0050	0.2510	0.2531	0.2606	0.2627	0.2762	0.2783
5	0.0005 TO 0.0035	0.3150	0.3171	0.3246	0.3267	0.3402	0.3423
	0.0010 TO 0.0035	0.3150	0.3166	0.3246	0.3262	0.3402	0.3418
	0.0010 TO 0.0040	0.3145	0.3166	0.3241	0.3262	0.3397	0.3418
	0.0020 TO 0.0050	0.3135	0.3156	0.3231	0.3252	0.3387	0.3408
6	0.0005 TO 0.0035	0.3775	0.3796	0.3871	0.3892	0.4027	0.4048
	0.0010 TO 0.0035	0.3775	0.3791	0.3871	0.3887	0.4027	0.4043
	0.0010 TO 0.0040	0.3770	0.3791	0.3866	0.3887	0.4022	0.4043
	0.0020 TO 0.0050	0.3760	0.3781	0.3856	0.3877	0.4012	0.4033
7	0.0005 TO 0.0035	0.4400	0.4421	0.4487	0.4517	0.4652	0.4673
	0.0010 TO 0.0035	0.4400	0.4416	0.4487	0.4512	0.4652	0.4668
	0.0010 TO 0.0040	0.4395	0.4416	0.4482	0.4512	0.4647	0.4668
	0.0020 TO 0.0050	0.4385	0.4406	0.4472	0.4502	0.4637	0.4658
8	0.0005 TO 0.0035	0.5020	0.5041	0.5107	0.5137	0.5272	0.5293
	0.0010 TO 0.0035	0.5020	0.5036	0.5107	0.5132	0.5272	0.5288
	0.0010 TO 0.0040	0.5015	0.5036	0.5102	0.5132	0.5267	0.5288
	0.0020 TO 0.0050	0.5005	0.5026	0.5092	0.5122	0.5257	0.5278

OVERSIZE HOLE DIMENSIONS FOR BACB30WQ AND BACB30WR 100 DEGREE RADIUS LEAD-IN BOLTS IN NON COLD WORKED HOLES
TABLE E

Holes for Radius Lead-In Bolts
Figure 8 (Sheet 4 of 6)

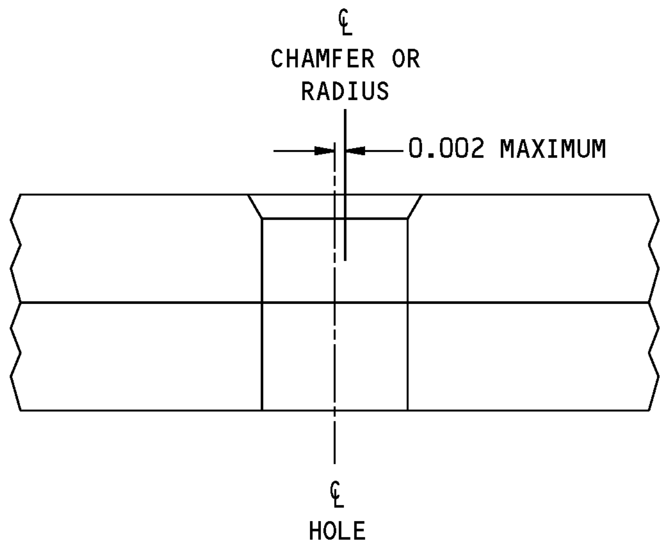




NOMINAL THREAD SIZE	PROTRUDING HEAD				
	"R" RADIUS		"D" CHAMFER DIA [4]		MINIMUM SHEET THICKNESS TO BE CHAMFERED OR RADIUSED
	MINIMUM	MAXIMUM	MINIMUM	MAXIMUM	
0.1900-32	0.015	0.025	0.226	0.236	0.060
0.2500-28	0.015	0.025	0.286	0.296	0.060
0.3125-24	0.020	0.030	0.358	0.368	0.060
0.3750-24	0.020	0.030	0.421	0.431	0.060
0.4375-20	0.020	0.030	0.483	0.493	0.080

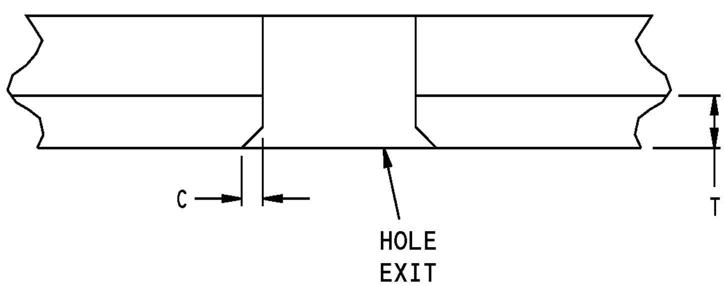
FILLET RELIEF LIMITS FOR PROTRUDING
HEAD RADIUS LEAD-IN BOLT HOLES
TABLE F

Holes for Radius Lead-In Bolts
Figure 8 (Sheet 5 of 6)



CONCENTRICITY SPECIFICATION

B



THICKNESS T	RADIUS OR CHAMFER C AT HOLE EXIT
UP TO 0.091 OVER 0.091	0.005 0.010

DEBURR SPECIFICATION

C

Holes for Radius Lead-In Bolts
Figure 8 (Sheet 6 of 6)

SUBJECT	TABLE
SOLID ALUMINUM RIVETS	A
NON-ALUMINUM RIVETS	B
BLIND RIVETS	C
SEMI-TUBULAR AND HOLLOW ENDED RIVETS	D
BOLTS	E AND F
LOCKBOLTS AND HEX-DRIVE FASTENERS	G AND H
BLIND BOLTS	I, J, AND K

INDEX FOR FIGURE 9

NOTES

- THE SOURCE OF INFORMATION FOR THIS FIGURE CAN BE FOUND IN BOEING PROCESS SPECIFICATION BAC 5063.
- HOLE DIAMETERS IN THIS FIGURE CAN BE USED UNLESS AN APPLICABLE ENGINEER DRAWING SHOWS DIFFERENTLY.
- REFER TO SRM 51-20-07 FOR MORE INFORMATION ON HOLE SPECIFICATIONS.
- HOLES AND COUNTERSINKS MUST BE 90° TO THE PART SURFACE, ±2°.

[1] DO NOT USE ALUMINUM FASTENERS IN COMPOSITE STRUCTURE THAT HAS CARBON FIBER (GRAPHITE) MATERIAL UNLESS PERMITTED BY THE ENGINEER DRAWING. CARBON MATERIAL CAN CAUSE ALUMINUM FASTENERS TO CORRODE.

[2] THIS TABLE DOES NOT APPLY TO NICKEL ALLOY MS16535 RIVETS. SEE TABLE B FOR NICKEL ALLOY MS16535 RIVETS.

[3] INFORMATION IN THIS TABLE APPLIES TO THE BOLTS THAT FOLLOW:

- BACB30VK, BACB30VL, BACB30XS, PLT1055, PLT1058, PLT1064, PLT1069, PLT1070, PLT220, PLT221, PLT270, PLT271, MS21140, MS21141

Fastener Hole Sizes in Composites
Figure 9 (Sheet 1 of 8)

RIVET TYPE [1]	NOMINAL RIVET DIA (INCH)	HOLE SIZE (INCH)					
		ARAMID/EPOXY TAPE OR FABRIC		ARAMID/EPOXY WITH ALUMINUM OR FIBERGLASS WITH AND WITHOUT ALUMINUM		THERMOPLASTIC	
		MINIMUM	MAXIMUM	MINIMUM	MAXIMUM	MINIMUM	MAXIMUM
BACR15CE,	3/32	0.098	0.103	0.098	0.103	0.098	0.103
BACR15GF	1/8	0.130	0.137	0.130	0.135	0.128	0.134
	5/32	0.161	0.169	0.159	0.167	0.159	0.165
	3/16	0.192	0.200	0.192	0.198	0.190	0.196
	1/4	0.255	0.261	0.255	0.261	0.255	0.261
BACR15BA,	3/32	0.098	0.103	0.098	0.103	0.098	0.103
BACR15BB,	1/8	0.130	0.137	0.128	0.135	0.128	0.135
BACR15FT	5/32	0.161	0.173	0.159	0.171	0.159	0.165
	3/16	0.193	0.204	0.191	0.202	0.191	0.202
	1/4	0.254	0.265	0.254	0.265	0.254	0.265

HOLE SIZES FOR SOLID ALUMINUM RIVETS
TABLE A

Fastener Hole Sizes in Composites
Figure 9 (Sheet 2 of 8)

RIVET TYPE [1]	NOMINAL RIVET DIA (INCH)	HOLE SIZE (INCH)					
		CARBON FIBER/ EPOXY (CFRP) TAPE OR FABRIC		ARAMID/EPOXY FABRIC		ARAMID/EPOXY WITH ALUMINUM OR FIBERGLASS WITH AND WITHOUT ALUMINUM	
		MINIMUM	MAXIMUM	MINIMUM	MAXIMUM	MINIMUM	MAXIMUM
MS16535 (NICKEL ALLOY, SEMI-TUBULAR)	3/32	0.091	0.095	0.093	0.098	0.910	0.950
	1/8	0.125	0.125	0.127	0.132	0.125	0.129
	5/32	0.148	0.152	0.150	0.155	0.148	0.152
	3/16	0.191	0.195	0.192	0.197	0.190	0.195
CSR903B	3/32	0.098	0.102	--	--	--	--
	1/8	0.129	0.133				
	5/32	0.159	0.163				
	3/16	0.191	0.195				

HOLE SIZES FOR NON-ALUMINUM RIVETS
TABLE B

RIVET TYPE	NOMINAL FASTENER DIAMETER	HOLE SIZE (INCH)	
		MINIMUM	MAXIMUM
BACR15DA, BACR15DR, BACR15GE, NAS1398, NAS1399	3/32	0.098	0.101
	1/8	0.129	0.132
	5/32	0.160	0.164
	3/16	0.192	0.196
BACR15FR, BACR15FP,	1/8	0.143	0.146
	5/32	0.176	0.180
	3/16	0.205	0.209

HOLE SIZES FOR BLIND RIVETS
TABLE C

Fastener Hole Sizes in Composites
Figure 9 (Sheet 3 of 8)

NOMINAL FASTENER DIAMETER	HOLE SIZE (INCH)	
	MINIMUM	MAXIMUM
5/32	0.159	0.162
3/16	0.190	0.193
7/32	0.224	0.227

HOLE SIZES FOR SEMI-TUBULAR MS16535 [2]
AND HOLLOW-ENDED BACR15GA RIVETS
TABLE D

NOMINAL FASTENER DIAMETER	HOLE SIZE (INCH)	
	MINIMUM	MAXIMUM
3/32	0.114	0.117
1/8	0.140	0.143
5/32	0.164	0.167
3/16	0.190	0.193
1/4	0.250	0.253
5/16	0.312	0.315
3/8	0.375	0.378
7/16	0.437	0.440
1/2	0.500	0.503
9/16	0.562	0.565
5/8	0.625	0.628
3/4	0.750	0.753
7/8	0.875	0.878
1	1.000	1.003

HOLE SIZES FOR BOLTS (REMOVABLE FASTENERS)
TABLE E

Fastener Hole Sizes in Composites
Figure 9 (Sheet 4 of 8)

NOMINAL FASTENER DIAMETER	FIRST OVERSIZE		SECOND OVERSIZE	
	MINIMUM	MAXIMUM	MINIMUM	MAXIMUM
3/32	--	--	0.140	0.143
1/8	--	--	0.164	0.167
5/32	--	--	0.190	0.193
3/16	0.203	0.206	0.219	0.222
1/4	0.266	0.269	0.281	0.284
5/16	0.328	0.331	0.344	0.347
3/8	0.390	0.394	0.406	0.409
7/16	0.453	0.456	0.468	0.471
1/2	0.516	0.519	0.531	0.534
9/16	0.578	0.581	0.593	0.596
5/8	0.641	0.644	0.656	0.659
3/4	0.766	0.769	0.781	0.784
7/8	0.891	0.894	0.906	0.909
1	1.016	1.019	1.031	1.034

HOLE SIZES (INCH) FOR OVERSIZE
(REMOVABLE FASTENERS) BOLTS

TABLE F

Fastener Hole Sizes in Composites
Figure 9 (Sheet 5 of 8)

NOMINAL FASTENER DIAMETER	HOLE SIZE (INCH)	
	MINIMUM	MAXIMUM
5/32	0.164	0.167
3/16	0.190	0.193
1/4	0.250	0.253
5/16	0.312	0.315
3/8	0.375	0.378
7/16	0.437	0.440
1/2	0.500	0.503
9/16	0.562	0.565
5/8	0.625	0.628
3/4	0.750	0.753

HOLE SIZES FOR LOCKBOLTS
AND HEX-DRIVE FASTENERS

TABLE G

Fastener Hole Sizes in Composites
Figure 9 (Sheet 6 of 8)

NOMINAL FASTENER DIAMETER	FIRST OVERSIZE		SECOND OVERSIZE	
	MINIMUM	MAXIMUM	MINIMUM	MAXIMUM
5/32	--	--	0.190	0.193
3/16	0.203	0.206	0.218	0.221
1/4	0.265	0.268	0.281	0.284
5/16	0.328	0.331	0.343	0.346
3/8	0.390	0.393	0.406	0.409
7/16	0.453	0.456	0.468	0.471
1/2	0.515	0.518	0.531	0.534
9/16	0.577	0.580	0.593	0.596
5/8	0.640	0.643	0.655	0.658
3/4	0.765	0.768	0.780	0.783
7/8	0.890	0.893	0.905	0.908
1	1.015	1.018	1.030	1.033

OVERSIZE HOLE SIZES FOR LOCKBOLTS
AND HEX-DRIVE FASTENERS

TABLE H

NOMINAL FASTENER DIAMETER	HOLE SIZE (INCH)	
	MINIMUM	MAXIMUM
5/32	0.1655	0.1680
3/16	0.1995	0.2020
1/4	0.2605	0.2630
5/16	0.3125	0.3150
3/8	0.3755	0.3780

HOLE SIZES FOR BLIND BOLTS

TABLE I

Fastener Hole Sizes in Composites
Figure 9 (Sheet 7 of 8)

OVERSIZE REPLACEMENT FASTENER		LIMITS	INITIAL NOMINAL FASTENER DIAMETER		
			-5 (5/32)	-6 (3/16)	-8 (1/4)
			INITIAL HOLE SIZE (INCH)		
		MIN	0.1655	0.1995	0.2605
		MAX	0.1680	0.2020	0.2630
		--	HOLE SIZES FOR OVERSIZE REPLACEMENT FASTENERS		
1/64	PLT221 PLT271 PLT1064	MIN	--	0.2160	0.2770
		MAX	--	0.2180	0.2790
1/32	PLT1069 PLT1055 PLT1070	MIN	--	0.2310	0.2920
		MAX	--	0.2330	0.2940
1/32	BACB30VL BACB30VK BACB30XS	MIN	0.1995	0.2285	0.2905
		MAX	0.2020	0.2310	0.2930

HOLE SIZES (INCH) FOR OVERSIZE BLIND BOLTS EXCEPT MS21140 AND MS21141

TABLE J

OVERSIZE REPLACEMENT FASTENER			LIMITS	INITIAL NOMINAL FASTENER DIAMETER				
				5/32	3/16	1/4	5/16	3/8
				INITIAL HOLE SIZE (INCH)				
			MIN	0.164	0.199	0.260	0.312	0.374
			MAX	0.167	0.202	0.263	0.315	0.377
			--	HOLE SIZES FOR OVERSIZE REPLACEMENT FASTENERS				
1/64	BACB30VJ()C() BACB30VJ()CD() BACB30VH()C() BACB30VH()CD()	0B100-EU()() 0B100-EU()()CD 0BP-EU()() 0BP-EU()()CD	MIN	0.180	0.215	0.276	0.328	0.390
			MAX	0.183	0.218	0.279	0.331	0.393

OVERSIZE FASTENERS AND HOLE SIZES FOR MS21140 AND MS21141 BLIND BOLTS

TABLE K

Fastener Hole Sizes in Composites
Figure 9 (Sheet 8 of 8)

GENERAL - FASTENER EDGE MARGINS

1. **Applicability**

   A. This subject gives the minimum edge margin data for metal and advanced composite structures. This subject does not include data for fastened joints critical in fatigue.

      (1) The edge margin data can be different for the different types of fasteners.

   B. This section does not contain the data for edge distances.

2. **General**

   A. An edge margin is the distance from the centerline of a fastener or fastener hole to the edge of the part. Refer to Fastener Edge Margin, Edge Distance, and End Margin, Figure 1/GENERAL.

   B. An edge distance is the distance from the edge of the fastener hole to the nearest edge of the part. Refer to Fastener Edge Margin, Edge Distance, and End Margin, Figure 1/GENERAL.

   C. Two or more parts that are fastened together are a joint. Refer to Joint Examples, Figure 2/GENERAL.

   D. To find the correct edge margin, you will need the data that follows:

      (1) The nominal diameter of the shank of the fastener (D)

      (2) The type of material (aluminum, corrosion resistant steel (CRES), and magnesium are examples)

      (3) The thickness of the material

      (4) The type of fastener head (protruding and countersunk are examples)

      (5) The stress load in the fastened joint (single shear, double shear, and tension are examples)

      (6) The type of hole (countersunk, dimpled, and straight through are examples).

   E. An edge margin that is less than the applicable value given in this section can be permitted if:

      (1) You know the stress loads in the fastened joint to make a decision

      (2) You do a structural engineering review.

   F. If the fastened joint is critical in fatigue refer to Paragraph 3.A./GENERAL

3. **Metal Structures**

   A. If a fastened joint is critical in fatigue and a load is applied (examples are longitudinal or spanwise wing splice or skin splice), further structural analysis is necessary.

   B. For the minimum fastener edge margin that is permitted, refer to the details that follow in Fastener Edge Margins in Metals, Figure 3/GENERAL, Tables A through F .

      (1) Table A - Edge Margins for:

         - 95 ksi Shear Strength Protruding Head (Bolts and Screws) in Aluminum Alloy Material - Single Shear
         - 95 ksi Shear Strength Tension Protruding Head (Lockbolts and Hex Drive Bolts) in Aluminum Alloy Material - Single Shear

      (2) Table B - Edge Margins for Protruding Head Aluminum Alloy Rivets in Aluminum Alloy Material - Single Shear

      (3) Table C - Edge Margins for Protruding Head Aluminum Alloy Rivets in Aluminum Alloy Material - Double Shear

      (4) Table D - Edge Margins for Protruding Head Copper-Nickel Rivets in Corrosion Resistant Steel (CRES) Material - Single Shear

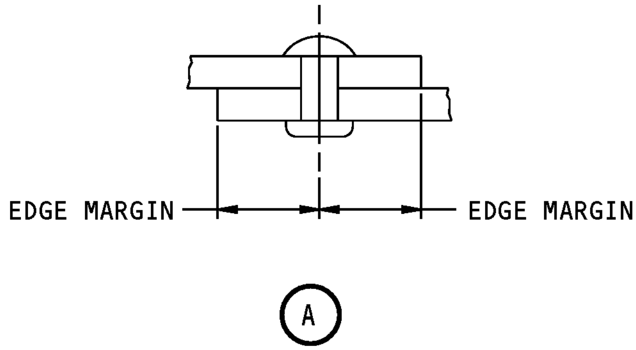
(5) Table E - Edge Margins for:
- 100 Degrees Head Copper-Nickel Rivets in Corrosion Resistant Steel (CRES) Material - Single Shear
- 100 Degrees Head Aluminum Alloy Rivets in Aluminum Alloy Material - Single Shear
- 120 Degrees Modified Head Aluminum Alloy Rivets In Aluminum Alloy Material - Single Shear

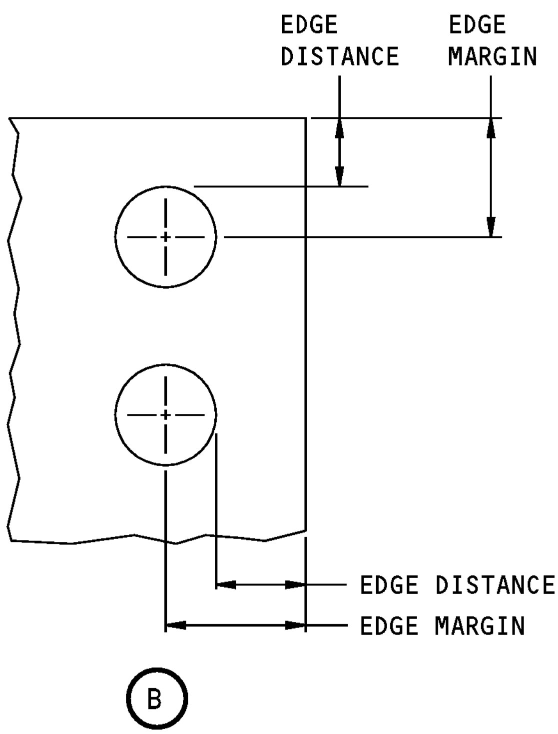
(6) Table F - Edge Margins for:
- 95 ksi Shear Strength 100 Degree Head (Bolts and Screws, Lockbolts, and Hex Drive Bolts) in Aluminum Alloy Material - Single Shear
- 95 ksi Shear Strength Shear Protruding Head (Lockbolts and Hex Drive Bolts) in Aluminum Alloy Material - Single Shear
- 100 Degree Flush Head Blind Fasteners

C. If holes have been coldworked with the Class I Sleeve Coldworking procedure, a structural engineering review is necessary to make sure that a minimum edge margin of 2.00D is sufficient. Refer to Fastener Edge Margins in Metals, Figure 3/GENERAL, Tables E and F for minimum fastener edge margins that are more than 2.00D (D = the nominal diameter of the shank of the fastener).

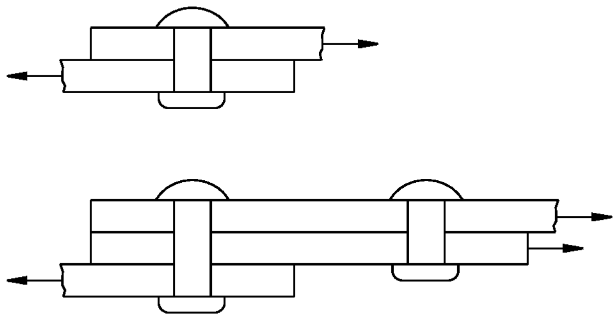
4. <u>Composite Structures</u>

A. You can find the correct fastener edge margin with the formula: 3.00D plus or minus 0.05 inch (D = the nominal diameter of the shank of the fastener).

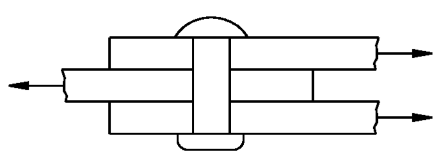




Fastener Edge Margin, Edge Distance, and End Margin
Figure 1



PLATES REQUIRING
SINGLE SHEAR EDGE MARGIN
A



PLATES REQUIRING
DOUBLE SHEAR EDGE MARGIN
B

Joint Examples
Figure 2

EDGE MARGINS FOR:
- 95 KSI SHEAR STRENGTH PROTRUDING HEAD (BOLTS, AND SCREWS) IN ALUMINUM ALLOY MATERIAL - SINGLE SHEAR
- 95 KSI SHEAR STRENGTH TENSION PROTRUDING HEAD (LOCKBOLTS AND HEX DRIVE BOLTS) IN ALUMINUM ALLOY MATERIAL - SINGLE SHEAR

THICKNESS (INCHES)	FASTENER DIAMETER (INCHES)							
	3/16	1/4	5/16	3/8	7/16	1/2	9/16	5/8
0.032	0.37	0.49						
0.036	0.37	0.49						
0.040	0.37	0.49						
0.045	0.37	0.49						
0.050	0.37	0.49	0.59					
0.056	0.37	0.49	0.59					
0.063	0.37	0.49	0.59	0.69				
0.071	0.37	0.49	0.59	0.69				
0.080	0.37	0.49	0.59	0.69	0.79			
0.090	0.37	0.49	0.59	0.69	0.79	0.90		
0.100	0.37	0.49	0.59	0.69	0.79	0.90	1.01	
0.112	0.37	0.49	0.59	0.69	0.79	0.90	1.01	
0.125	0.37	0.49	0.59	0.69	0.79	0.90	1.01	1.11
0.140	0.37	0.49	0.59	0.69	0.79	0.90	1.01	1.11
0.160	0.37	0.49	0.59	0.69	0.79	0.90	1.01	1.11
0.180	0.35	0.49	0.59	0.69	0.79	0.90	1.01	1.11
0.190	0.34	0.49	0.59	0.69	0.79	0.90	1.01	1.11
0.200	0.33	0.49	0.59	0.69	0.79	0.90	1.01	1.11
0.224	0.31	0.46	0.59	0.69	0.79	0.90	1.01	1.11
0.250	0.29	0.43	0.59	0.69	0.79	0.90	1.01	1.11
0.313	0.29	0.38	0.53	0.69	0.79	0.90	1.01	1.11
0.375	0.29	0.37	0.48	0.63	0.79	0.90	1.01	1.11
0.500	0.29	0.37	0.46	0.54	0.67	0.82	0.99	1.11
0.625	0.29	0.37	0.46	0.54	0.62	0.72	0.86	1.01
0.750	0.29	0.37	0.46	0.54	0.62	0.70	0.78	0.90

TABLE A

NOTE: THE EDGE MARGINS ARE GIVEN IN INCHES.
THE EDGE MARGIN TOLERANCE IS ±0.05 INCH.

Fastener Edge Margins in Metals
Figure 3 (Sheet 1 of 6)

EDGE MARGINS FOR PROTRUDING HEAD ALUMINUM ALLOY RIVETS IN ALUMINUM ALLOY MATERIAL - SINGLE SHEAR							
THICKNESS (INCHES)	FASTENER DIAMETER (INCHES)						
	[1] 3/32	[1] 1/8	[1] 5/32	[2] 3/16	[2] 1/4	[2] 5/16	[3] 3/8
0.012	0.21						
0.016	0.21	0.27					
0.018	0.21	0.27					
0.020	0.21	0.27	0.32				
0.022	0.21	0.27	0.32				
0.025	0.21	0.27	0.32				
0.028	0.21	0.27	0.32				
0.032	0.20	0.27	0.32	0.37			
0.036	0.19	0.26	0.32	0.37			
0.040	0.18	0.26	0.32	0.37	0.48		
0.045	0.17	0.24	0.32	0.37	0.48		
0.050	0.17	0.23	0.32	0.37	0.48	0.58	
0.056	0.17	0.22	0.29	0.37	0.48	0.58	
0.063	0.17	0.21	0.28	0.36	0.48	0.58	0.69
0.071		0.21	0.26	0.33	0.48	0.58	0.69
0.080		0.21	0.25	0.31	0.47	0.58	0.69
0.090		0.21	0.25	0.29	0.44	0.58	0.69
0.100		0.21	0.25	0.29	0.41	0.58	0.69
0.112			0.25	0.29	0.39	0.54	0.69
0.125			0.25	0.29	0.37	0.50	0.67
0.140			0.25	0.29	0.37	0.47	0.62
0.160			0.25	0.29	0.37	0.46	0.57
0.180				0.29	0.37	0.46	0.54
0.190				0.29	0.37	0.46	0.54
0.200				0.29	0.37	0.46	0.54
0.224				0.29	0.37	0.46	0.54
0.250				0.29	0.37	0.46	0.54

TABLE B

NOTE: THE EDGE MARGINS ARE GIVEN IN INCHES.
THE EDGE MARGIN TOLERANCE IS ±0.05 INCH.

[1] ADD 0.10 INCH TO THE EDGE MARGIN FOR CASTINGS.

[2] ADD 0.20 INCH TO THE EDGE MARGIN FOR CASTINGS.

[3] ADD 0.30 INCH TO THE EDGE MARGIN FOR CASTINGS.

Fastener Edge Margins in Metals
Figure 3 (Sheet 2 of 6)

EDGE MARGINS FOR PROTRUDING HEAD ALUMINUM ALLOY RIVETS IN ALUMINUM ALLOY MATERIAL - DOUBLE SHEAR							
THICKNESS (INCHES)	FASTENER DIAMETER (INCHES)						
	[1] 3/32	[1] 1/8	[1] 5/32	[2] 3/16	[2] 1/4	[2] 5/16	[3] 3/8
0.012	0.21	0.27	0.32				
0.016	0.21	0.27	0.32				
0.018	0.21	0.27	0.32				
0.020	0.21	0.27	0.32				
0.022	0.21	0.27	0.32				
0.025	0.21	0.27	0.32				
0.028	0.21	0.27	0.32				
0.032	0.21	0.27	0.32				
0.036	0.21	0.27	0.32				
0.040	0.21	0.27	0.32	0.37	0.48		
0.045	0.21	0.27	0.32	0.37	0.48		
0.050	0.21	0.27	0.32	0.37	0.48		
0.056	0.21	0.27	0.32	0.37	0.48	0.58	
0.063	0.20	0.27	0.32	0.37	0.48	0.58	0.69
0.071		0.27	0.32	0.37	0.48	0.58	0.69
0.080		0.26	0.32	0.37	0.48	0.58	0.69
0.090		0.25	0.32	0.37	0.48	0.58	0.69
0.100		0.23	0.31	0.37	0.48	0.58	0.69
0.112			0.29	0.37	0.48	0.58	0.69
0.125			0.28	0.36	0.48	0.58	0.69
0.140			0.26	0.33	0.48	0.58	0.69
0.160			0.24	0.31	0.47	0.58	0.69
0.180				0.29	0.44	0.58	0.69
0.190				0.29	0.43	0.58	0.69
0.200				0.29	0.41	0.58	0.69
0.224				0.29	0.39	0.54	0.68
0.250				0.29	0.37	0.50	0.67

TABLE C

NOTE: THE EDGE MARGINS ARE GIVEN IN INCHES.
THE EDGE MARGIN TOLERANCE IS ±0.05 INCH.

[1] ADD 0.10 INCH TO THE EDGE MARGIN FOR CASTINGS.

[2] ADD 0.20 INCH TO THE EDGE MARGIN FOR CASTINGS.

[3] ADD 0.30 INCH TO THE EDGE MARGIN FOR CASTINGS.

Fastener Edge Margins in Metals
Figure 3 (Sheet 3 of 6)

EDGE MARGINS FOR PROTRUDING HEAD COPPER-NICKEL RIVETS IN CORROSION RESISTANT STEEL (CRES) MATERIAL - SINGLE SHEAR						
ALLOY	THICKNESS (INCHES)	RIVET DIAMETER (INCHES)				
		3/32	1/8	5/32	3/16	1/4
CRES SHEET, AISI 301 AND 302 ALLOY STEEL (HEAT TREATED TO 100 KSI OR GREATER)	0.010	0.20	0.25	0.30	0.35	0.45
	0.012	0.20	0.25	0.30	0.35	0.45
	0.016	0.20	0.25	0.30	0.35	0.45
	0.018	0.20	0.25	0.30	0.35	0.45
	0.020	0.20	0.25	0.30	0.35	0.45
	0.022	0.18	0.25	0.30	0.35	0.45
	0.025	0.18	0.25	0.30	0.35	0.45
	0.028	0.18	0.24	0.30	0.35	0.45
	0.032	0.18	0.23	0.30	0.35	0.45
	0.036	0.18	0.23	0.29	0.35	0.45
	0.040	0.18	0.23	0.28	0.35	0.45
	0.045	0.18	0.23	0.27	0.35	0.45
	0.050	0.17	0.23	0.27	0.32	0.45
	0.056	0.17	0.22	0.27	0.32	0.41
	0.063	0.17	0.21	0.27	0.32	0.41
	0.071	0.17	0.21	0.27	0.32	0.41
	0.080	0.17	0.21	0.25	0.32	0.40
	0.090		0.21	0.25	0.29	0.40
	0.100			0.25	0.29	0.40
	0.112			0.25	0.29	0.39
	0.125				0.29	0.37

TABLE D

NOTE: THE EDGE MARGINS ARE GIVEN IN INCHES.
THE EDGE MARGIN TOLERANCE IS ±0.05 INCH.

Fastener Edge Margins in Metals
Figure 3 (Sheet 4 of 6)

EDGE MARGINS FOR:

- 100 DEGREES HEAD COPPER-NICKEL RIVETS IN CORROSION RESISTANT STEEL (CRES) MATERIAL - SINGLE SHEAR
- 100 DEGREES HEAD ALUMINUM ALLOY RIVETS IN ALUMINUM ALLOY MATERIAL - SINGLE SHEAR
- 120 DEGREES MODIFIED HEAD ALUMINUM ALLOY RIVETS IN ALUMINUM ALLOY MATERIAL - SINGLE SHEAR

THICKNESS (INCHES)	RIVET DIAMETER (INCHES)				
	1/8 [1]	5/32 [1]	3/16 [2]	1/4 [2] [4]	5/16 [2] [4]
0.020	0.31				
0.022	0.31				
0.025	0.31				
0.028	0.31				
0.032	0.31	0.37			
0.036	0.31	0.37			
0.040	0.31	0.37	0.43		
0.045	0.31	0.37	0.43		
0.050	0.31	0.37	0.43		
0.056	0.31	0.37	0.43		
0.063	0.31	0.37	0.43	0.55	0.67
0.071	0.31	0.37	0.43	0.55	0.67
0.080	0.31	0.37	0.43	0.55	0.67
0.090	0.31	0.37	0.43	0.55	0.67
0.100	0.31	0.37	0.43	0.55	0.67
0.112	0.31	0.37	0.43	0.55	0.67
0.125	0.31	0.37	0.43	0.55	0.67
0.140	0.31	0.37	0.43	0.55	0.67
0.160	0.31	0.37	0.43	0.55	0.67
0.180	0.31	0.37	0.43	0.55	0.67
0.190	0.31	0.37	0.43	0.55	0.67
0.200	0.31	0.37	0.43	0.55	0.67
0.224	0.31	0.37	0.43	0.55	0.67
0.250	0.31	0.37	0.43	0.55	0.67

TABLE E

NOTE: THE EDGE MARGINS ARE GIVEN IN INCHES.
THE EDGE MARGIN TOLERANCE IS ±0.05 INCH.

[1] ADD 0.10 INCH TO THE EDGE MARGIN FOR CASTINGS.

[2] ADD 0.20 INCH TO THE EDGE MARGIN FOR CASTINGS.

[4] DOES NOT APPLY TO COPPER-NICKEL RIVETS IN CORROSION RESISTANT STEEL (CRES) SHEET.

Fastener Edge Margins in Metals
Figure 3 (Sheet 5 of 6)

EDGE MARGINS FOR:

- 95 KSI SHEAR STRENGTH 100 DEGREE HEAD (BOLTS AND SCREWS, LOCKBOLTS AND HEX DRIVE BOLTS) IN ALUMINUM ALLOY MATERIAL - SINGLE SHEAR
- 95 KSI SHEAR STRENGTH SHEAR PROTRUDING HEAD (LOCKBOLTS AND HEX DRIVE BOLTS) IN ALUMINUM ALLOY MATERIAL - SINGLE SHEAR
- 100 DEGREE FLUSH HEAD BLIND FASTENERS

THICKNESS (INCHES)	FASTENER DIAMETER (INCHES)									
	1/8 [5]	5/32 [5]	3/16	1/4	5/16	3/8	7/16	1/2	9/16	5/8
0.032	0.30	0.36								
0.036	0.30	0.36								
0.040	0.30	0.36								
0.045	0.30	0.36								
0.050	0.30	0.36	0.43	0.57						
0.056	0.30	0.36	0.43	0.57						
0.063	0.30	0.36	0.43	0.57	0.70	0.84	0.97	1.12		
0.071	0.30	0.36	0.43	0.56	0.70	0.84	0.97	1.11	1.25	1.39
0.080	0.30	0.36	0.43	0.56	0.69	0.83	0.96	1.11	1.25	1.39
0.090	0.30	0.36	0.43	0.55	0.68	0.83	0.96	1.10	1.24	1.38
0.100	0.30	0.36	0.43	0.55	0.68	0.82	0.95	1.09	1.24	1.38
0.112	0.30	0.36	0.43	0.55	0.68	0.82	0.95	1.09	1.23	1.37
0.125	0.30	0.36	0.43	0.55	0.68	0.81	0.94	1.08	1.22	1.36
0.140	0.30	0.36	0.43	0.55	0.68	0.80	0.93	1.06	1.20	1.36
0.160	0.30	0.36	0.43	0.55	0.68	0.80	0.92	1.06	1.20	1.35
0.180	0.30	0.36	0.43	0.55	0.68	0.80	0.92	1.05	1.19	1.33
0.190	0.30	0.36	0.43	0.55	0.68	0.80	0.92	1.05	1.18	1.32
0.200	0.30	0.36	0.43	0.55	0.68	0.80	0.92	1.05	1.18	1.31
0.224	0.30	0.36	0.43	0.55	0.68	0.80	0.92	1.05	1.17	1.30
0.250	0.30	0.36	0.43	0.55	0.68	0.80	0.92	1.05	1.17	1.30
0.313	0.30	0.36	0.43	0.55	0.68	0.80	0.92	1.05	1.17	1.30
0.375	0.30	0.36	0.43	0.55	0.68	0.80	0.92	1.05	1.17	1.30
0.500	0.30	0.36	0.43	0.55	0.68	0.80	0.92	1.05	1.17	1.30
0.625	0.30	0.36	0.43	0.55	0.68	0.80	0.92	1.05	1.17	1.30
0.750	0.30	0.36	0.43	0.55	0.68	0.80	0.92	1.05	1.17	1.30

TABLE F

NOTE: THE EDGE MARGINS ARE GIVEN IN INCHES.
THE EDGE MARGIN TOLERANCE IS ±0.05 INCH.

[5] APPLIES ONLY TO BLIND FASTENERS.

Fastener Edge Margins in Metals
Figure 3 (Sheet 6 of 6)

GENERAL - STRENGTH OF FASTENERS

1. References

Reference	Title
51-40-05	FASTENER HOLE SIZES
51-40-06	FASTENER EDGE MARGINS

2. General Information

A. The information in this subject gives the strength of fasteners as they are used in different materials. The values given are the lesser of the bearing strength of the specified material or the shear strength of the fastener.

B. When you use these strength values, the necessary edge margins as given in 51-40-05 and 51-40-06 must be maintained.

C. Refer to Joint Shear Strength of Fasteners, Figure 1/GENERAL for a list of the locations of the fastener strength values that are applicable for the different fastened materials. Refer to Joint Shear Strength of Solid Aluminum Alloy Rivets, Figure 2/GENERAL through Joint Shear Strength of Shear Flush Head, 95 KSI Shear Strength, Bolts, Figure 10/GENERAL for the strength values.

UNIVERSAL AND MODIFIED HEAD, ALUMINUM RIVET				
FASTENER	MATERIAL	JOINT SHEAR STRENGTH	LOCATION	
			FIGURE	TABLE
BACR15BB()AD BACR15BB()D BACR15BB()DD BACR15FT()KE MS20470AD() MS20470D() MS20470DD()	CLAD OR BARE 2024-T3 SHEET	SINGLE	2	A,B,C
	CLAD OR BARE 2024-T3 SHEET AND CLAD OR BARE 2024-T351 PLATE	DOUBLE	2	D,E,F
	CLAD OR BARE 2024-T42 SHEET, CLAD 2024-T4 COILED SHEET, AND 2024-T42 TUBE	SINGLE	2	G,H,I
	CLAD OR BARE 2024-T42 SHEET, CLAD 2024-T4 COILED SHEET, AND 2024-T42 TUBE	DOUBLE	2	J,K,L
	CLAD OR BARE 7075-T6 SHEET AND 7075-T6,-T6510,-T6511 EXTRUSIONS LESS THAN 0.188 INCH THICK	SINGLE	2	M,N,O
	CLAD OR BARE 7075-T6 SHEET AND 7075-T6,-T6510,-T6511 EXTRUSIONS LESS THAN 0.188 INCH THICK	DOUBLE	2	P,Q,R
BACR15FT()AD BACR15FT()D	CLAD OR BARE 2024-T3 SHEET AND CLAD OR BARE 2024-T351 PLATE	DOUBLE	2	D,E
	CLAD OR BARE 2024-T42 SHEET, CLAD 2024-T4 COILED SHEET, AND 2024-T42 TUBE	DOUBLE	2	J,K
	CLAD OR BARE 7075-T6 SHEET AND 7075-T6,-T6510,-T6511 EXTRUSIONS LESS THAN 0.188 INCH THICK	DOUBLE	2	P,Q

TABLE A

Joint Shear Strength of Fasteners
Figure 1 (Sheet 1 of 10)

FLUSH HEAD ALUMINUM RIVET				
FASTENER	MATERIAL	JOINT SHEAR STRENGTH	LOCATION	
			FIGURE	TABLE
BACR15BA()AD BACR15BA()D BACR15BA()DD MS20426AD() MS20426D() MS20426DD()	CLAD OR BARE 2024-T3 SHEET	SINGLE	2	S,T,U
	CLAD OR BARE 2024-T3 SHEET AND CLAD OR BARE 2024-T351 PLATE	DOUBLE	2	X,Y,Z
	CLAD OR BARE 2024-T42 SHEET	SINGLE	2	AA,AB,AC
	CLAD OR BARE 2024-T42 SHEET, CLAD 2024-T4 COILED SHEET, AND 2024-T42 TUBE	DOUBLE	2	AD,AE,AF
	CLAD OR BARE 7075-T6	SINGLE	2	AG,AH,AI
	CLAD OR BARE 7075-T6 SHEET AND 7075-T6,-T6510,-T6511 EXTRUSIONS LESS THAN 0.188 INCH THICK	DOUBLE	2	AL,AM,AN
BACR15CE()D BACR15FV()KE BACR15GF()D	CLAD OR BARE 2024-T3 SHEET	SINGLE	2	V,W
	CLAD OR BARE 2024-T3 SHEET AND CLAD OR BARE 2024-T351 PLATE	DOUBLE		Y,Z
	CLAD OR BARE 2024-T42 SHEET, CLAD 2024-T4 COILED SHEET, AND 2024-T42 TUBE	DOUBLE	2	AE,AF
	CLAD OR BARE 7075-T6	SINGLE	2	AJ,AK
	CLAD OR BARE 7075-T6 SHEET AND 7075-T6,-T6510,-T6511 EXTRUSIONS LESS THAN 0.188 INCH THICK	DOUBLE	2	AM,AN
BACR15CE()AD BACR15FH()AD BACR15FH()DD BACR15FH()KE BACR15GH()KE	CLAD OR BARE 2024-T3 SHEET AND CLAD OR BARE 2024-T351 PLATE	DOUBLE	2	X,Z
	CLAD OR BARE 2024-T42 SHEET, CLAD 2024-T4 COILED SHEET, AND 2024-T42 TUBE	DOUBLE	2	AD,AF
	CLAD OR BARE 7075-T6 SHEET AND 7075-T6,-T6510,-T6511 EXTRUSIONS LESS THAN 0.188 INCH THICK	DOUBLE	2	AL,AN

TABLE B

Joint Shear Strength of Fasteners
Figure 1 (Sheet 2 of 10)

100° FLUSH HEAD MONEL RIVET				
FASTENER	MATERIAL	JOINT SHEAR STRENGTH	LOCATION	
			FIGURE	TABLE
MS20427M()	302 - ANNEALED CRES 301 - 1/4 HARD CRES 301 - 1/2 HARD CRES 301 - FULL HARD CRES	SINGLE	3	A,B,C

TABLE C

PROTRUDING HEAD BLIND RIVET WITH A 5056 ALUMINUM SLEEVE AND A 7075 ALUMINUM STEM				
FASTENER	MATERIAL	JOINT SHEAR STRENGTH	LOCATION	
			FIGURE	TABLE
NAS1398B()	CLAD OR BARE 2024-T3 SHEET	SINGLE	4	A,B

TABLE D

PROTRUDING HEAD BLIND RIVET WITH A 2017 ALUMINUM SLEEVE AND A 7075 ALUMINUM STEM				
FASTENER	MATERIAL	JOINT SHEAR STRENGTH	LOCATION	
			FIGURE	TABLE
NAS1398D()	CLAD OR BARE 2024-T3 SHEET	SINGLE	4	A,B

TABLE E

Joint Shear Strength of Fasteners
Figure 1 (Sheet 3 of 10)

100° FLUSH HEAD BLIND RIVET WITH A 5056 ALUMINUM SLEEVE AND A 7075 ALUMINUM STEM				
FASTENER	MATERIAL	JOINT SHEAR STRENGTH	LOCATION	
			FIGURE	TABLE
NAS1399B()	CLAD OR BARE 2024-T3 SHEET	SINGLE	4	C

TABLE F

100° FLUSH HEAD BLIND RIVET WITH A 2017 ALUMINUM SLEEVE AND A 7075 ALUMINUM STEM				
FASTENER	MATERIAL	JOINT SHEAR STRENGTH	LOCATION	
			FIGURE	TABLE
NAS1399D()	CLAD OR BARE 2024-T3 SHEET	SINGLE	4	C

TABLE G

PROTRUDING HEAD BLIND RIVET WITH A 5056 ALUMINUM SLEEVE				
FASTENER	MATERIAL	JOINT SHEAR STRENGTH	LOCATION	
			FIGURE	TABLE
NAS1738B() NAS1738E()	CLAD OR BARE 2024-T3 SHEET	SINGLE	4	D,E
BACR15FR()B BACR15FR()E NAS1738B() NAS1738E()	CLAD OR BARE 7075-T6 SHEET	SINGLE	4	F,G

TABLE H

Joint Shear Strength of Fasteners
Figure 1 (Sheet 4 of 10)

100° FLUSH HEAD BLIND RIVET WITH A 5056 ALUMINUM SLEEVE				
FASTENER	MATERIAL	JOINT SHEAR STRENGTH	LOCATION	
			FIGURE	TABLE
NAS1739B() NAS1739E()	CLAD OR BARE 2024-T3 SHEET	SINGLE	4	D,E
BACR15FP()B()R BACR15FP()E()R BACR15GJ() NAS1739B() NAS1739E()	CLAD OR BARE 7075-T6 SHEET	SINGLE	4	F,G

TABLE I

TENSION PROTRUDING HEAD, ALLOY STEEL A286 AND 6AL-4V TITANIUM, LOCKBOLTS AND HEX DRIVE BOLTS				
FASTENER	MATERIAL	JOINT SHEAR STRENGTH	LOCATION	
			FIGURE	TABLE
BACB30DX() BACB30HC() BACB30MB() BACB30NX() BACB30UB() NAS1465 THRU NAS1472 NAS6965 THRU NAS6972	CLAD OR BARE 2024-T3 SHEET AND CLAD OR BARE 2024-T351 PLATE	SINGLE	5	A,B
	CLAD OR BARE 2024-T42 SHEET AND PLATE, CLAD 2024-T4 SHEET AND PLATE, AND 2024-T42 TUBE	SINGLE	5	C,D
	CLAD OR BARE 7075-T6 SHEET CLAD OR BARE 7075-T651 PLATE, AND 7075-T6,-T6510, -T6511 EXTRUSIONS LESS THAN 0.188 INCH THICK	SINGLE	5	E,F

TABLE J

Joint Shear Strength of Fasteners
Figure 1 (Sheet 5 of 10)

TENSION PROTRUDING HEAD, ALLOY STEEL A286 AND 6AL-4V TITANIUM, BOLTS				
FASTENER	MATERIAL	JOINT SHEAR STRENGTH	LOCATION	
			FIGURE	TABLE
BACB30LJ() BACB30LK() BACB30LM() BACB30LN() BACB30MR() BACB30NE() BACB30NF() BACB30NM() BACB30PF() BACB30PU() BACB30PW() BACB30UG() MS20004 THRU MS20024 NAS623-2 THRU NAS623-6 NAS673 THRU NAS678 NAS1218-04 THRU NAS1218-08 NAS1223 THRU NAS1235 NAS1303 THRU NAS1320 NAS6603 THRU NAS6620 NAS6703 THRU NAS6720 NAS6803 THRU NAS6820	CLAD OR BARE 2024-T3 SHEET AND CLAD OR BARE 2024-T351 PLATE	SINGLE	6	A,B,C
	CLAD OR BARE 2024-T42 SHEET AND PLATE, CLAD 2024-T4 SHEET AND PLATE, AND 2024-T42 TUBE	SINGLE	6	D,E,F,G
	CLAD OR BARE 7075-T6 SHEET CLAD OR BARE 7075-T651 PLATE, AND 7075-T6,-T6510, -T6511 EXTRUSIONS LESS THAN 0.188 INCH THICK	SINGLE	6	H,I,J

TABLE K

Joint Shear Strength of Fasteners
Figure 1 (Sheet 6 of 10)

STANDARD FLUSH HEAD, ALLOY STEEL A286 AND 6AL-4V TITANIUM, LOCKBOLTS AND HEX DRIVE BOLTS				
FASTENER	MATERIAL	JOINT SHEAR STRENGTH	LOCATION	
			FIGURE	TABLE
BACB30GX() BACB30JC() BACB30NY() BACB30UA() NAS1456 THRU NAS1462	CLAD OR BARE 2024-T3 SHEET AND CLAD OR BARE 2024-T351 PLATE	SINGLE	7	A
	CLAD OR BARE 7075-T6 SHEET	SINGLE	7	B

TABLE L

Joint Shear Strength of Fasteners
Figure 1 (Sheet 7 of 10)

STANDARD FLUSH HEAD, ALLOY STEEL A286 AND 6AL-4V TITANIUM, BOLTS				
FASTENER	MATERIAL	JOINT SHEAR STRENGTH	LOCATION	
			FIGURE	TABLE
BACB30AB() BACB30EM() BACB30LH() BACB30LP() BACB30LR() BACB30LU() BACB30MS() BACB30PC() BACB30NN() NAS333 THRU NAS340 NAS517-2 THRU NAS517-8 NAS583 THRU NAS590 NAS663 THRU NAS668 NAS1221-04 THRU NAS1221-08 NAS1221-3 THRU NAS1221-6	CLAD OR BARE 2024-T3 SHEET AND CLAD OR BARE 2024-T351 PLATE	SINGLE	8	A
	CLAD OR BARE 7075-T6 SHEET AND CLAD OR BARE 7075-T651 PLATE	SINGLE	8	B
BACB30MN()	CLAD OR BARE 2024-T3 SHEET AND CLAD OR BARE 2024-T351 PLATE	SINGLE	8	A
BACB30FL() BACB30NN()	CLAD OR BARE 7075-T6 SHEET AND CLAD OR BARE 7075-T651 PLATE	SINGLE	8	B

TABLE M

Joint Shear Strength of Fasteners
Figure 1 (Sheet 8 of 10)

SHEAR, FLUSH AND PROTRUDING HEAD, ALLOY STEEL A286 AND 6AL-4V TITANIUM, LOCKBOLTS AND HEX DRIVE BOLTS				
FASTENER	MATERIAL	JOINT SHEAR STRENGTH	LOCATION	
			FIGURE	TABLE
BACB30FM() BACB30FN() BACB30GY() BACB30MY() BACB30NW() BACB30TY() BACB30TZ() BACB30UC() BACB30UD() BACB30VM() BACB30VN() BACB30VP() BACB30VR() BACB30VT() BACB30VU() BACB30XT() NAS1436 THRU NAS1442 NAS1446 THRU NAS1452	CLAD OR BARE 2024-T3 SHEET AND CLAD OR BARE 2024-T351 PLATE	SINGLE	9	A,B,C
	CLAD OR BARE 7075-T6 SHEET AND CLAD OR BARE 7075-T651 PLATE	SINGLE	9	D,E,F
BACB30GW()	CLAD OR BARE 7075-T6 SHEET AND CLAD OR BARE 7075-T651 PLATE	SINGLE	9	D,E,F

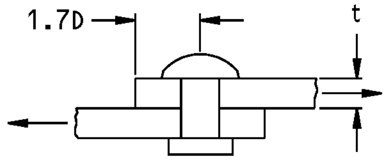
TABLE N

Joint Shear Strength of Fasteners
Figure 1 (Sheet 9 of 10)

SHEAR, FLUSH HEAD, ALLOY STEEL A286 AND 6AL-4V TITANIUM, BOLTS				
FASTENER	MATERIAL	JOINT SHEAR STRENGTH	LOCATION	
			FIGURE	TABLE
BACB30EL() BACB30FB() BACB30LL() BACB30NU() BACB30VF() BACB30XD()	CLAD OR BARE 2024-T3 SHEET AND CLAD OR BARE 2024-T351 PLATE	SINGLE	10	A
	CLAD OR BARE 7075-T6 SHEET AND CLAD OR BARE 7075-T651 PLATE	SINGLE	10	B

TABLE 0

Joint Shear Strength of Fasteners
Figure 1 (Sheet 10 of 10)



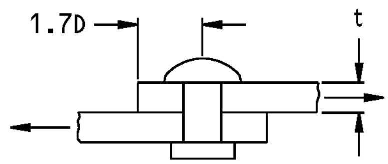
UNIVERSAL HEAD RIVET IN
A SINGLE SHEAR JOINT

UNIVERSAL HEAD RIVETS IN CLAD OR BARE 2024-T3 SHEET -
SINGLE SHEAR JOINT STRENGTH

FASTENERS								
PART NUMBERS	MS20470AD() BACR15BB()AD							
MATERIAL	2117-T3							
D (DIAMETER INCHES)	3/32	1/8	5/32	3/16	1/4	5/16	3/8
	0.0938	0.1250	0.1562	0.1875	0.2500	0.3125	0.3750
SINGLE SHEAR STRENGTH (POUNDS)	207	369	575	830	1470	2290	3300
t (THICKNESS INCHES)	SINGLE SHEAR JOINT STRENGTH (POUNDS)						
0.018	164	--	--	--	--	--	--
0.020	182	--	--	--	--	--	--
0.022	196	--	--	--	--	--	--
0.025	201	303	--	--	--	--	--
0.028	204	339	--	--	--	--	--
0.032	207	356	485	--	--	--	--
0.036	--	362	545	655	--	--	--
0.040	--	367	555	725	--	--	--
0.045	--	369	565	790	--	--	--
0.050	--	--	570	805	1210	--	--
0.056	--	--	575	820	1360	--	--
0.063	--	--	--	830	1410	1990	--
0.071	--	--	--	--	1440	2160	2690
0.080	--	--	--	--	1460	2210	3030
0.090	--	--	--	--	1470	2250	3140
0.100	--	--	--	--	--	2280	3210
0.112	--	--	--	--	--	2290	3250
0.125	--	--	--	--	--	--	3300

TABLE A

Joint Shear Strength of Solid Aluminum Alloy Rivets
Figure 2 (Sheet 1 of 40)

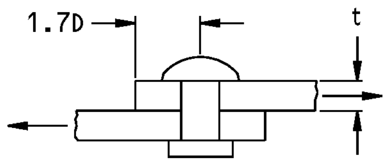


UNIVERSAL HEAD RIVET IN
A SINGLE SHEAR JOINT

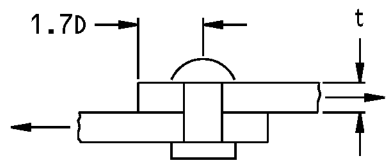
UNIVERSAL HEAD RIVETS IN CLAD OR BARE 2024-T3 SHEET - SINGLE SHEAR JOINT STRENGTH							
FASTENERS	PART NUMBERS	MS20470D() BACR15BB()D					
	MATERIAL	2017-T3					
	D (DIAMETER INCHES)	1/8	5/32	3/16	1/4	5/16	3/8
		0.1250	0.1562	0.1875	0.2500	0.3125	0.3750
	SINGLE SHEAR STRENGTH (POUNDS)	467	730	1050	1870	2910	4180
t (THICKNESS INCHES)		SINGLE SHEAR JOINT STRENGTH (POUNDS)					
0.025		303	--	--	--	--	--
0.028		339	--	--	--	--	--
0.032		388	485	--	--	--	--
0.036		436	545	655	--	--	--
0.040		465	605	725	--	--	--
0.045		467	680	820	--	--	--
0.050		--	710	910	1210	--	--
0.056		--	730	1020	1360	--	--
0.063		--	--	1050	1590	1990	--
0.071		--	--	--	1790	2240	2690
0.080		--	--	--	1860	2520	3030
0.090		--	--	--	1870	2840	3410
0.100		--	--	--	--	2900	3790
0.112		--	--	--	--	2910	4120
0.125		--	--	--	--	--	4180

TABLE B

Joint Shear Strength of Solid Aluminum Alloy Rivets
Figure 2 (Sheet 2 of 40)



UNIVERSAL HEAD RIVET IN A SINGLE SHEAR JOINT

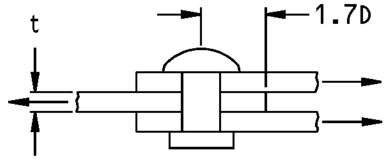


MODIFIED UNIVERSAL HEAD RIVET IN A SINGLE SHEAR JOINT

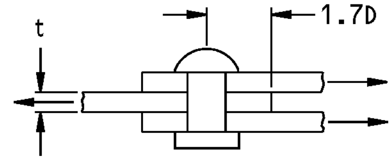
UNIVERSAL AND MODIFIED UNIVERSAL HEAD RIVETS IN CLAD OR BARE 2024-T3 SHEET - SINGLE SHEAR JOINT STRENGTH					
FASTENERS: PART NUMBERS	MS20470DD() BACR15BB()DD BACR15FT()KE				
FASTENERS: MATERIAL	2024-T3 AND 7050-T73				
FASTENERS: D (DIAMETER INCHES)	5/32	3/16	1/4	5/16	3/8
	0.1562	0.1875	0.2500	0.3125	0.3750
FASTENERS: SINGLE SHEAR STRENGTH (POUNDS)	785	1130	2010	3140	4530
t (THICKNESS INCHES)	SINGLE SHEAR JOINT STRENGTH (POUNDS)				
0.032	485	--	--	--	--
0.036	545	655	--	--	--
0.040	605	725	--	--	--
0.045	680	820	--	--	--
0.050	760	910	1210	--	--
0.056	785	1020	1360	--	--
0.063	--	1130	1590	1990	--
0.071	--	--	1790	2240	2690
0.080	--	--	2000	2520	3030
0.090	--	--	2010	2840	3410
0.100	--	--	--	3120	3790
0.112	--	--	--	3140	4240
0.125	--	--	--	--	4530

TABLE C

Joint Shear Strength of Solid Aluminum Alloy Rivets
Figure 2 (Sheet 3 of 40)



UNIVERSAL HEAD RIVET IN A DOUBLE SHEAR JOINT



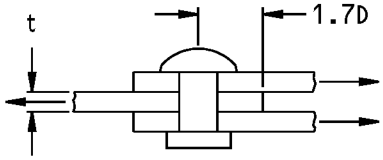
MODIFIED UNIVERSAL HEAD RIVET IN A DOUBLE SHEAR JOINT

UNIVERSAL AND MODIFIED UNIVERSAL HEAD RIVETS IN CLAD OR BARE 2024-T3 SHEET AND 2024-T351 PLATE - DOUBLE SHEAR JOINT STRENGTH

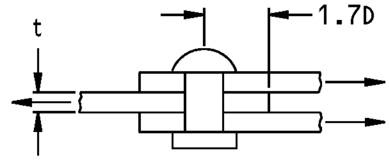
FASTENERS							
PART NUMBERS	MS20470AD() BACR15FT()AD BACR15BB()AD						
MATERIAL	2117-T3						
D (DIAMETER INCHES)	3/32	1/8	5/32	3/16	1/4	5/16	3/8
	0.0938	0.1250	0.1562	0.1875	0.2500	0.3125	0.3750
DOUBLE SHEAR STRENGTH (POUNDS)	414	750	1150	1660	2940	4580	6600
t (THICKNESS INCHES)	DOUBLE SHEAR JOINT STRENGTH (POUNDS)						
0.018	164	--	--	--	--	--	--
0.020	182	--	--	--	--	--	--
0.025	227	303	--	--	--	--	--
0.028	255	339	--	--	--	--	--
0.032	291	388	485	--	--	--	--
0.036	328	436	545	655	--	--	--
0.040	364	485	605	725	--	--	--
0.045	383	545	680	820	--	--	--
0.050	394	605	760	910	1210	--	--
0.056	404	670	850	1020	1360	--	--
0.063	414	690	995	1190	1590	1990	--
0.071	--	715	1050	1340	1790	2240	2690
0.080	--	730	1080	1480	2020	2520	3030
0.090	--	740	1110	1530	2270	2840	3410
0.100	--	--	1140	1580	2520	3160	3790
0.112	--	--	1150	1620	2660	3530	4240
0.125	--	--	--	1660	2750	3950	4730
0.160	--	--	--	--	2920	4310	5900
0.190	--	--	--	--	2940	4490	6200
0.250	--	--	--	--	--	4580	6600
0.312	--	--	--	--	--	--	--

TABLE D

Joint Shear Strength of Solid Aluminum Alloy Rivets
Figure 2 (Sheet 4 of 40)



UNIVERSAL HEAD RIVET IN
A DOUBLE SHEAR JOINT

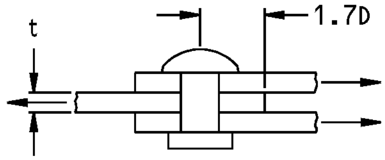


MODIFIED UNIVERSAL HEAD RIVET
IN A DOUBLE SHEAR JOINT

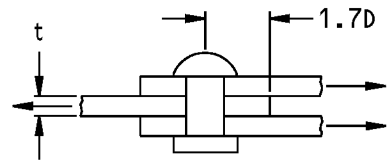
UNIVERSAL AND MODIFIED UNIVERSAL HEAD RIVETS IN CLAD OR BARE 2024-T3 SHEET AND 2024-T351 PLATE - DOUBLE SHEAR JOINT STRENGTH							
FASTENERS	PART NUMBERS	MS20470D()		BACR15FT()D		BACR15BB()D	
	MATERIAL	2017-T3					
	D (DIAMETER INCHES)	1/8	5/32	3/16	1/4	5/16	3/8
		0.1250	0.1562	0.1875	0.2500	0.3125	0.3750
	DOUBLE SHEAR STRENGTH (POUNDS)	935	1460	2100	3740	5800	8350
t (THICKNESS INCHES)		DOUBLE SHEAR JOINT STRENGTH (POUNDS)					
0.025		303	--	--	--	--	--
0.028		339	--	--	--	--	--
0.032		388	485	--	--	--	--
0.036		436	545	655	--	--	--
0.040		485	605	725	--	--	--
0.045		545	680	820	--	--	--
0.050		605	760	910	1210	--	--
0.056		680	850	1020	1360	--	--
0.063		795	995	1190	1590	1990	--
0.071		895	1120	1340	1790	2240	2690
0.080		925	1260	1510	2020	2520	3030
0.090		935	1410	1700	2270	2840	3410
0.100		--	1450	1890	2520	3160	3790
0.112		--	1460	2050	2830	3530	4240
0.125		--	--	2100	3160	3950	4730
0.160		--	--	--	3710	5100	6100
0.190		--	--	--	3740	5700	7250
0.250		--	--	--	--	5800	8350

TABLE E

Joint Shear Strength of Solid Aluminum Alloy Rivets
Figure 2 (Sheet 5 of 40)



UNIVERSAL HEAD RIVET IN A DOUBLE SHEAR JOINT



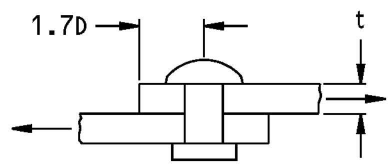
MODIFIED UNIVERSAL HEAD RIVET IN A DOUBLE SHEAR JOINT

UNIVERSAL AND MODIFIED UNIVERSAL HEAD RIVETS IN CLAD OR BARE 2024-T3 SHEET AND 2024-T351 PLATE - DOUBLE SHEAR JOINT STRENGTH

FASTENERS								
PART NUMBERS	MS20470DD() BACR15FT()KE BACR15BB()DD							
MATERIAL	2024-T3 AND 7050-T73							
D (DIAMETER INCHES)	1/8	5/32	3/16	7/32	1/4	9/32	5/16	3/8
	0.1250	0.1562	0.1875	0.2188	0.2500	0.2813	0.3125	0.3750
DOUBLE SHEAR STRENGTH (POUNDS)	1010	1570	2260	3080	4020	5100	6300	9050
t (THICKNESS INCHES)	DOUBLE SHEAR JOINT STRENGTH (POUNDS)							
0.025	303	--	--	--	--	--	--	--
0.028	339	--	--	--	--	--	--	--
0.032	388	485	--	--	--	--	--	--
0.036	436	545	655	--	--	--	--	--
0.040	485	605	725	850	--	--	--	--
0.045	545	680	820	955	--	--	--	--
0.050	605	760	910	1060	1210	--	--	--
0.056	680	850	1020	1190	1360	1530	--	--
0.063	795	995	1190	1390	1590	1790	1990	--
0.071	895	1120	1340	1570	1790	2020	2240	2690
0.080	1000	1260	1510	1770	2020	2270	2520	3030
0.090	1010	1420	1700	1990	2270	2560	2840	3410
0.100	--	1560	1890	2210	2520	2840	3160	3790
0.112	--	1570	2120	2480	2830	3180	3530	4240
0.125	--	--	2260	2760	3160	3550	3950	4730
0.160	--	--	--	3080	3990	4590	5100	6100
0.190	--	--	--	--	4020	5100	6050	7250
0.250	--	--	--	--	--	--	6300	8900
0.312	--	--	--	--	--	--	--	9050

TABLE F

Joint Shear Strength of Solid Aluminum Alloy Rivets
Figure 2 (Sheet 6 of 40)

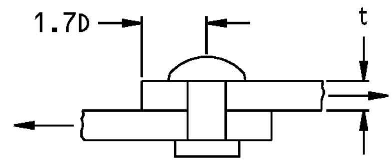


UNIVERSAL HEAD RIVET IN
A SINGLE SHEAR JOINT

UNIVERSAL HEAD RIVETS IN CLAD OR BARE 2024-T42 SHEET, CLAD 2024-T4 COILED SHEET, AND 2024-T42 TUBE - SINGLE SHEAR JOINT STRENGTH								
FASTENERS	PART NUMBERS	MS20470AD() BACR15BB()AD						
	MATERIAL	2117-T3						
	D (DIAMETER INCHES)	3/32	1/8	5/32	3/16	1/4	5/16	3/8
		0.0938	0.1250	0.1562	0.1875	0.2500	0.3125	0.3750
	SINGLE SHEAR STRENGTH (POUNDS)	207	369	575	830	1470	2290	3300
t (THICKNESS INCHES)		SINGLE SHEAR JOINT STRENGTH (POUNDS)						
0.018		132	--	--	--	--	--	--
0.020		145	--	--	--	--	--	--
0.025		201	243	--	--	--	--	--
0.028		204	273	--	--	--	--	--
0.032		207	312	390	--	--	--	--
0.036		--	351	438	526	--	--	--
0.040		--	367	487	585	--	--	--
0.045		--	369	549	658	--	--	--
0.050		--	--	570	730	975	--	--
0.056		--	--	575	817	1095	--	--
0.063		--	--	--	830	1320	1650	--
0.071		--	--	--	--	1440	1860	2235
0.080		--	--	--	--	1460	2100	2520
0.090		--	--	--	--	1470	2250	2835
0.100		--	--	--	--	--	2280	3150
0.112		--	--	--	--	--	2290	3250
0.125		--	--	--	--	--	--	3300

TABLE G

Joint Shear Strength of Solid Aluminum Alloy Rivets
Figure 2 (Sheet 7 of 40)

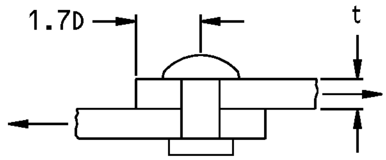


UNIVERSAL HEAD RIVET IN
A SINGLE SHEAR JOINT

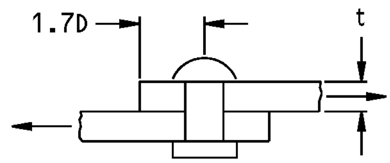
UNIVERSAL HEAD RIVETS IN CLAD OR BARE 2024-T42 SHEET, CLAD 2024-T4 COILED SHEET, AND 2024-T42 TUBE - SINGLE SHEAR JOINT STRENGTH							
FASTENERS	PART NUMBERS	MS20470D()			BACR15BB()D		
	MATERIAL	2017-T3					
	D (DIAMETER INCHES)	1/8	5/32	3/16	1/4	5/16	3/8
		0.1250	0.1562	0.1875	0.2500	0.3125	0.3750
	SINGLE SHEAR STRENGTH (POUNDS)	467	730	1050	1870	2910	4180
t (THICKNESS INCHES)		SINGLE SHEAR JOINT STRENGTH (POUNDS)					
0.025		243	--	--	--	--	--
0.028		273	--	--	--	--	--
0.032		312	390	--	--	--	--
0.036		351	438	526	--	--	--
0.040		438	487	585	--	--	--
0.045		467	549	658	--	--	--
0.050		--	609	730	975	--	--
0.056		--	682	817	1095	--	--
0.063		--	--	990	1320	1650	--
0.071		--	--	--	1485	1860	2235
0.080		--	--	--	1680	2100	2520
0.090		--	--	--	1870	2355	2835
0.100		--	--	--	--	2625	3150
0.112		--	--	--	--	2910	3525
0.125		--	--	--	--	--	3930

TABLE H

Joint Shear Strength of Solid Aluminum Alloy Rivets
Figure 2 (Sheet 8 of 40)



UNIVERSAL HEAD RIVET IN
A SINGLE SHEAR JOINT

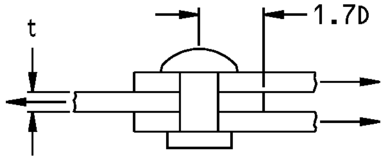


MODIFIED UNIVERSAL HEAD RIVET
IN A SINGLE SHEAR JOINT

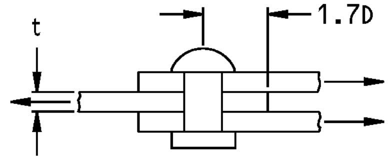
UNIVERSAL AND MODIFIED UNIVERSAL HEAD RIVETS IN CLAD OR BARE 2024-T42 SHEET, CLAD 2024-T4 COILED SHEET, AND 2024-T42 TUBE - SINGLE SHEAR JOINT STRENGTH					
FASTENERS: PART NUMBERS	MS20470DD() BACR15BB()DD BACR15FT()KE				
FASTENERS: MATERIAL	2024-T3 AND 7050-T73				
FASTENERS: D (DIAMETER INCHES)	5/32	3/16	1/4	5/16	3/8
	0.1562	0.1875	0.2500	0.3125	0.3750
FASTENERS: SINGLE SHEAR STRENGTH (POUNDS)	785	1130	2010	3140	4530
t (THICKNESS INCHES)	SINGLE SHEAR JOINT STRENGTH (POUNDS)				
0.025	--	--	--	--	--
0.028	--	--	--	--	--
0.032	390	--	--	--	--
0.036	438	526	--	--	--
0.040	487	585	--	--	--
0.045	549	658	--	--	--
0.050	609	730	975	--	--
0.056	785	1030	1095	--	--
0.063	--	1130	1320	1650	--
0.071	--	--	1485	1860	2235
0.080	--	--	1680	2100	2520
0.090	--	--	1890	2355	2835
0.100	--	--	--	2625	3150
0.112	--	--	--	2940	3525
0.125	--	--	--	--	4530

TABLE I

Joint Shear Strength of Solid Aluminum Alloy Rivets
Figure 2 (Sheet 9 of 40)



UNIVERSAL HEAD RIVET IN A DOUBLE SHEAR JOINT

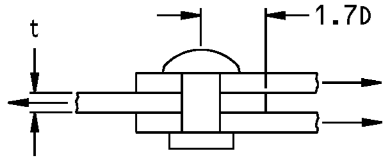


MODIFIED UNIVERSAL HEAD RIVET IN A DOUBLE SHEAR JOINT

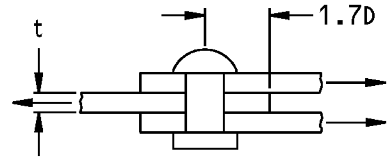
UNIVERSAL AND MODIFIED UNIVERSAL HEAD RIVETS IN CLAD OR BARE 2024-T42 SHEET, CLAD 2024-T4 COILED SHEET, AND 2024-T42 TUBE - DOUBLE SHEAR JOINT STRENGTH							
FASTENERS: PART NUMBERS	MS20470AD()		BACR15FT()AD			BACR15BB()AD	
FASTENERS: MATERIAL	2117-T3						
FASTENERS: D (DIAMETER INCHES)	3/32	1/8	5/32	3/16	1/4	5/16	3/8
	0.0938	0.1250	0.1562	0.1875	0.2500	0.3125	0.3750
FASTENERS: DOUBLE SHEAR STRENGTH (POUNDS)	414	740	1150	1660	2940	4580	6600
t (THICKNESS INCHES)	DOUBLE SHEAR JOINT STRENGTH (POUNDS)						
0.018	132	--	--	--	--	--	--
0.020	145	--	--	--	--	--	--
0.025	183	243	--	--	--	--	--
0.028	205	273	--	--	--	--	--
0.032	234	312	390	--	--	--	--
0.036	264	351	438	526	--	--	--
0.040	292	390	487	585	--	--	--
0.045	328	438	549	658	--	--	--
0.050	366	487	609	730	975	--	--
0.056	404	546	682	817	1095	--	--
0.063	414	661	825	990	1320	1650	--
0.071	--	715	930	1117	1492	1860	2235
0.080	--	730	1050	1260	1680	2100	2520
0.090	--	740	1110	1417	1890	2355	2835
0.100	--	--	1140	1575	2100	2625	3150
0.112	--	--	1150	1620	2355	2940	3525
0.125	--	--	--	1660	2625	3285	3930
0.160	--	--	--	--	2920	4200	5040
0.190	--	--	--	--	2940	4490	5985
0.250	--	--	--	--	--	4580	6600

TABLE J

Joint Shear Strength of Solid Aluminum Alloy Rivets
Figure 2 (Sheet 10 of 40)



UNIVERSAL HEAD RIVET IN A DOUBLE SHEAR JOINT

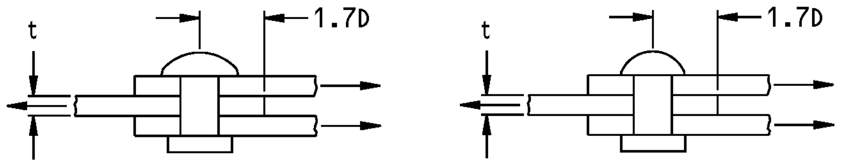


MODIFIED UNIVERSAL HEAD RIVET IN A DOUBLE SHEAR JOINT

UNIVERSAL AND MODIFIED UNIVERSAL HEAD RIVETS IN CLAD OR BARE 2024-T42 SHEET, CLAD 2024-T4 COILED SHEET, AND 2024-T42 TUBE - DOUBLE SHEAR JOINT STRENGTH							
FASTENERS	PART NUMBERS	MS20470D()		BACR15BB()D		BACR15FT()D	
FASTENERS	MATERIAL	2017-T3					
FASTENERS	D (DIAMETER INCHES)	1/8	5/32	3/16	1/4	5/16	3/8
FASTENERS	D (DIAMETER INCHES)	0.1250	0.1562	0.1875	0.2500	0.3125	0.3750
FASTENERS	DOUBLE SHEAR STRENGTH (POUNDS)	935	1460	2100	3740	5800	8350
t (THICKNESS INCHES)		DOUBLE SHEAR JOINT STRENGTH (POUNDS)					
0.025		243	--	--	--	--	--
0.028		273	--	--	--	--	--
0.032		312	390	--	--	--	--
0.036		351	438	526	--	--	--
0.040		390	487	585	--	--	--
0.045		438	549	658	--	--	--
0.050		487	609	730	975	--	--
0.056		546	682	817	1095	--	--
0.063		661	825	990	1320	1650	--
0.071		745	930	1117	1492	1860	2235
0.080		840	1050	1260	1680	2100	2520
0.090		945	1177	1417	1890	2355	2835
0.100		--	1312	1575	2100	2625	3150
0.112		--	1460	1770	2355	2940	3525
0.125		--	--	1965	2625	3285	3930
0.160		--	--	--	3360	4200	5040
0.190		--	--	--	3990	4980	5985
0.250		--	--	--	--	5800	7455

TABLE K

Joint Shear Strength of Solid Aluminum Alloy Rivets
Figure 2 (Sheet 11 of 40)



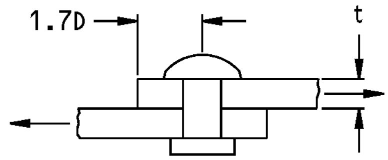
UNIVERSAL HEAD RIVET IN A DOUBLE SHEAR JOINT

MODIFIED UNIVERSAL HEAD RIVET IN A DOUBLE SHEAR JOINT

UNIVERSAL AND MODIFIED UNIVERSAL HEAD RIVETS IN CLAD OR BARE 2024-T42 SHEET, CLAD 2024-T4 COILED SHEET, AND 2024-T42 TUBE - DOUBLE SHEAR JOINT STRENGTH						
FASTENERS	PART NUMBERS	MS20470DD() BACR15FT()KE BACR15BB()DD				
	MATERIAL	2024-T3 AND 7050-T73				
	D (DIAMETER INCHES)	5/32	3/16	1/4	5/16	3/8
		0.1562	0.1875	0.2500	0.3125	0.3750
	DOUBLE SHEAR STRENGTH (POUNDS)	1570	2260	4020	6300	9050
t (THICKNESS INCHES)		DOUBLE SHEAR JOINT STRENGTH (POUNDS)				
0.025		--	--	--	--	--
0.028		--	--	--	--	--
0.032		390	--	--	--	--
0.036		438	526	--	--	--
0.040		487	585	--	--	--
0.045		549	658	--	--	--
0.050		609	730	975	--	--
0.056		682	817	1095	--	--
0.063		825	990	1320	1650	--
0.071		930	1117	1492	1860	2235
0.080		1050	1260	1680	2100	2520
0.090		1177	1417	1890	2355	2835
0.100		1312	1575	2100	2625	3150
0.112		1470	1770	2355	2940	3525
0.125		--	1965	2625	3285	3930
0.160		--	--	3360	4200	5040
0.190		--	--	3990	4980	5985
0.250		--	--	--	6210	7455

TABLE L

Joint Shear Strength of Solid Aluminum Alloy Rivets
Figure 2 (Sheet 12 of 40)

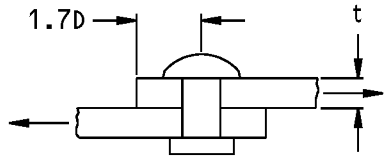


UNIVERSAL HEAD RIVET IN
A SINGLE SHEAR JOINT

UNIVERSAL HEAD RIVETS IN CLAD OR BARE 7075-T6 SHEET AND 7075-T6, -T6510,-T6511 EXTRUSIONS LESS THAN 0.188 INCH THICK - SINGLE SHEAR JOINT STRENGTH							
FASTENERS: PART NUMBERS	MS20470AD() BACR15BB()AD						
FASTENERS: MATERIAL	2117-T3						
FASTENERS: D (DIAMETER INCHES)	3/32	1/8	5/32	3/16	1/4	5/16	3/8
	0.0938	0.1250	0.1562	0.1875	0.2500	0.3125	0.3750
FASTENERS: SINGLE SHEAR STRENGTH (POUNDS)	207	369	575	830	1470	2290	3300
t (THICKNESS INCHES)	SINGLE SHEAR JOINT STRENGTH (POUNDS)						
0.018	189	--	--	--	--	--	--
0.020	193	--	--	--	--	--	--
0.025	201	339	--	--	--	--	--
0.028	204	347	--	--	--	--	--
0.032	207	356	530	--	--	--	--
0.036	--	362	545	755	--	--	--
0.040	--	367	555	775	--	--	--
0.045	--	369	565	790	--	--	--
0.050	--	--	570	805	1350	--	--
0.056	--	--	575	820	1380	--	--
0.063	--	--	--	830	1410	2110	--
0.071	--	--	--	--	1440	2160	3000
0.080	--	--	--	--	1460	2210	3080
0.090	--	--	--	--	1470	2250	3140
0.100	--	--	--	--	--	2280	3210
0.112	--	--	--	--	--	2290	3250
0.125	--	--	--	--	--	--	3300

TABLE M

Joint Shear Strength of Solid Aluminum Alloy Rivets
Figure 2 (Sheet 13 of 40)

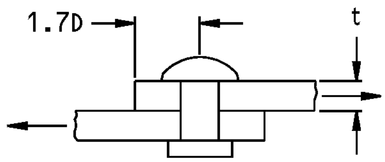


UNIVERSAL HEAD RIVET IN
A SINGLE SHEAR JOINT

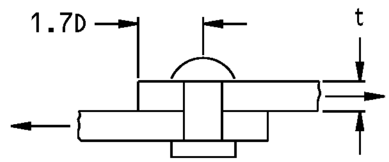
UNIVERSAL HEAD RIVETS IN CLAD OR BARE 7075-T6 SHEET AND 7075-T6,-T6510,-T6511 EXTRUSIONS LESS THAN 0.188 INCH THICK - SINGLE SHEAR JOINT STRENGTH							
FASTENERS	PART NUMBERS	MS20470D() BACR15BB()D					
	MATERIAL	2017-T3					
	D (DIAMETER INCHES)	1/8	5/32	3/16	1/4	5/16	3/8
		0.1250	0.1562	0.1875	0.2500	0.3125	0.3750
	SINGLE SHEAR STRENGTH (POUNDS)	467	730	1050	1870	2910	4180
t (THICKNESS INCHES)		SINGLE SHEAR JOINT STRENGTH (POUNDS)					
0.025		353	--	--	--	--	--
0.028		395	--	--	--	--	--
0.032		450	565	--	--	--	--
0.036		458	635	765	--	--	--
0.040		465	705	800	--	--	--
0.045		467	715	970	--	--	--
0.050		--	725	1020	1440	--	--
0.056		--	730	1040	1610	--	--
0.063		--	--	1050	1800	2280	--
0.071		--	--	--	1830	2570	3090
0.080		--	--	--	1860	2810	3480
0.090		--	--	--	1870	2850	3910
0.100		--	--	--	--	2900	4060
0.112		--	--	--	--	2910	4120
0.125		--	--	--	--	--	4180

TABLE N

Joint Shear Strength of Solid Aluminum Alloy Rivets
Figure 2 (Sheet 14 of 40)



UNIVERSAL HEAD RIVET IN A SINGLE SHEAR JOINT



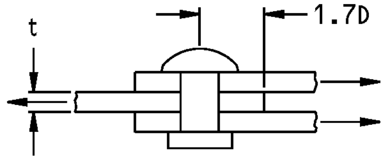
MODIFIED UNIVERSAL HEAD RIVET IN A SINGLE SHEAR JOINT

UNIVERSAL AND MODIFIED UNIVERSAL HEAD RIVETS IN CLAD OR BARE 7075-T6 SHEET AND 7075-T6,-T6510,-T6511 EXTRUSIONS LESS THAN 0.188 INCH THICK - SINGLE SHEAR JOINT STRENGTH

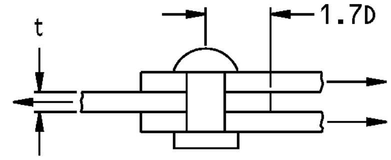
FASTENERS					
PART NUMBERS	MS20470DD() BACR15BB()DD BACR15FT()KE				
MATERIAL	2024-T3 AND 7050-T73				
D (DIAMETER INCHES)	5/32	3/16	1/4	5/16	3/8
	0.1562	0.1875	0.2500	0.3125	0.3750
SINGLE SHEAR STRENGTH (POUNDS)	785	1130	2010	3140	4530
t (THICKNESS INCHES)	SINGLE SHEAR JOINT STRENGTH (POUNDS)				
0.025	--	--	--	--	--
0.028	--	--	--	--	--
0.032	565	--	--	--	--
0.036	635	765	--	--	--
0.040	720	860	--	--	--
0.045	770	970	--	--	--
0.050	780	1080	1440	--	--
0.056	785	1110	1610	--	--
0.063	--	1130	1830	2280	--
0.071	--	--	1970	2570	3090
0.080	--	--	2000	2900	3480
0.090	--	--	2010	3080	3910
0.100	--	--	--	3120	4350
0.112	--	--	--	3140	4470
0.125	--	--	--	--	4530

TABLE O

Joint Shear Strength of Solid Aluminum Alloy Rivets
Figure 2 (Sheet 15 of 40)



UNIVERSAL HEAD RIVET IN
A DOUBLE SHEAR JOINT

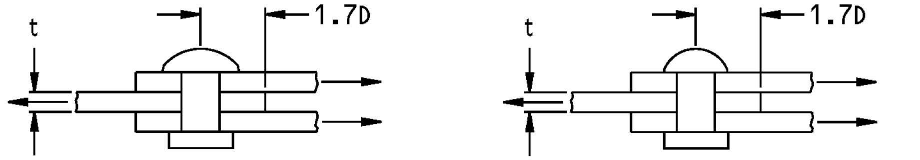


MODIFIED UNIVERSAL HEAD RIVET
IN A DOUBLE SHEAR JOINT

UNIVERSAL AND MODIFIED UNIVERSAL HEAD RIVETS IN CLAD OR BARE 7075-T6 SHEET AND 7075-T6,-T6510,-T6511 EXTRUSIONS LESS THAN 0.188 INCH THICK - DOUBLE SHEAR JOINT STRENGTH								
FASTENERS	PART NUMBERS	MS20470AD()			BACR15FT()AD		BACR15BB()AD	
	MATERIAL	2117-T3						
	D (DIAMETER INCHES)	3/32	1/8	5/32	3/16	1/4	5/16	3/8
		0.0938	0.1250	0.1562	0.1875	0.2500	0.3125	0.3750
	DOUBLE SHEAR STRENGTH (POUNDS)	414	740	1150	1660	2940	4580	6600
t (THICKNESS INCHES)		DOUBLE SHEAR JOINT STRENGTH (POUNDS)						
0.018		191	--	--	--	--	--	--
0.020		212	--	--	--	--	--	--
0.025		265	353	--	--	--	--	--
0.028		297	395	--	--	--	--	--
0.032		337	452	565	--	--	--	--
0.036		355	510	635	765	--	--	--
0.040		369	575	720	860	--	--	--
0.045		383	615	810	970	--	--	--
0.050		394	640	900	1080	1440	--	--
0.056		404	670	955	1210	1610	--	--
0.063		414	690	1000	1340	1830	2280	--
0.071		--	715	1050	1410	2060	2570	3090
0.080		--	730	1080	1480	2320	2900	3480
0.090		--	740	1110	1530	2450	3260	3910
0.100		--	--	1140	1580	2560	3610	4350
0.112		--	--	1150	1620	2660	3810	4870
0.125		--	--	--	1660	2750	3980	5300
0.160		--	--	--	--	2920	4310	5900
0.190		--	--	--	--	2940	4490	6200
0.250		--	--	--	--	--	4580	6600

TABLE P

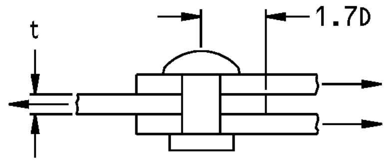
Joint Shear Strength of Solid Aluminum Alloy Rivets
Figure 2 (Sheet 16 of 40)



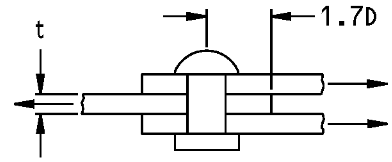
UNIVERSAL AND MODIFIED UNIVERSAL HEAD RIVETS IN CLAD OR BARE 7075-T6 SHEET AND 7075-T6,-T6510,-T6511 EXTRUSIONS LESS THAN 0.188 INCH THICK - DOUBLE SHEAR JOINT STRENGTH						
FASTENERS: PART NUMBERS	MS20470D()		BACR15FT()D		BACR15BB()D	
FASTENERS: MATERIAL	2017-T3					
FASTENERS: D (DIAMETER INCHES)	1/8	5/32	3/16	1/4	5/16	3/8
	0.1250	0.1562	0.1875	0.2500	0.3125	0.3750
FASTENERS: DOUBLE SHEAR STRENGTH (POUNDS)	935	1460	2100	3740	5800	8350
t (THICKNESS INCHES)	DOUBLE SHEAR JOINT STRENGTH (POUNDS)					
0.025	353	--	--	--	--	--
0.028	395	--	--	--	--	--
0.032	452	565	--	--	--	--
0.036	510	635	765	--	--	--
0.040	575	720	860	--	--	--
0.045	645	810	970	--	--	--
0.050	720	900	1080	1440	--	--
0.056	805	1010	1210	1610	--	--
0.063	875	1140	1370	1830	2280	--
0.071	900	1290	1540	2060	2570	3090
0.080	925	1370	1740	2320	2900	3480
0.090	935	1410	1940	2610	3260	3910
0.100	--	1450	2000	2900	3620	4350
0.112	--	1460	2050	3250	4060	4870
0.125	--	--	2100	3500	4530	5450
0.160	--	--	--	3710	5500	6950
0.190	--	--	--	3740	5700	7850
0.250	--	--	--	--	5800	8350

TABLE Q

Joint Shear Strength of Solid Aluminum Alloy Rivets
Figure 2 (Sheet 17 of 40)



UNIVERSAL HEAD RIVET IN A DOUBLE SHEAR JOINT

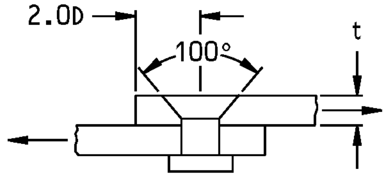


MODIFIED UNIVERSAL HEAD RIVET IN A DOUBLE SHEAR JOINT

UNIVERSAL AND MODIFIED UNIVERSAL HEAD RIVETS IN CLAD OR BARE 7075-T6 SHEET AND 7075-T6,-T6510,-T6511 EXTRUSIONS LESS THAN 0.188 INCH THICK - DOUBLE SHEAR JOINT STRENGTH								
FASTENERS: PART NUMBERS	MS20470DD() BACR15FT()KE BACR15BB()DD							
FASTENERS: MATERIAL	2024-T3 AND 7050-T73							
FASTENERS: D (DIAMETER INCHES)	1/8	5/32	3/16	7/32	1/4	9/32	5/16	3/8
	0.1250	0.1562	0.1875	0.2188	0.2500	0.2813	0.3125	0.3750
FASTENERS: DOUBLE SHEAR STRENGTH (POUNDS)	1010	1570	2260	3080	4020	5100	6300	9050
t (THICKNESS INCHES)	DOUBLE SHEAR JOINT STRENGTH (POUNDS)							
0.025	353	--	--	--	--	--	--	--
0.028	395	--	--	--	--	--	--	--
0.032	452	565	--	--	--	--	--	--
0.036	510	635	765	--	--	--	--	--
0.040	575	720	860	1010	--	--	--	--
0.045	645	810	970	1130	--	--	--	--
0.050	720	900	1080	1260	1440	--	--	--
0.056	805	1010	1210	1410	1610	1810	--	--
0.063	915	1140	1370	1600	1830	2060	2280	--
0.071	975	1290	1540	1800	2060	2320	2570	3090
0.080	1000	1450	1740	2030	2320	2610	2900	3480
0.090	1010	1520	1960	2280	2610	2940	3260	3910
0.100	--	1560	2150	2540	2900	3260	3620	4350
0.112	--	1570	2210	2840	3250	3650	4060	4870
0.125	--	--	2260	2980	3620	4080	4530	5450
0.160	--	--	--	3080	3990	4930	5800	6950
0.190	--	--	--	--	4020	5100	6150	8500
0.250	--	--	--	--	--	--	6300	9050

TABLE R

Joint Shear Strength of Solid Aluminum Alloy Rivets
Figure 2 (Sheet 18 of 40)

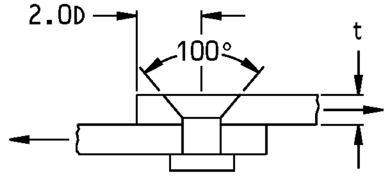


100° STANDARD FLUSH HEAD RIVET
IN A SINGLE SHEAR JOINT

100° STANDARD FLUSH HEAD RIVETS IN CLAD OR BARE 2024-T3 SHEET - SINGLE SHEAR JOINT STRENGTH				
FASTENERS: PART NUMBERS	MS20426AD()	BACR15BA()AD		
FASTENERS: MATERIAL	2117-T3			
FASTENERS: D (DIAMETER INCHES)	3/32	1/8	5/32	3/16
	0.0938	0.1250	0.1562	0.1875
FASTENERS: SINGLE SHEAR STRENGTH (POUNDS)	207	369	575	830
t (THICKNESS INCHES)	SINGLE SHEAR JOINT STRENGTH (POUNDS)			
0.040	193	--	--	--
0.045	201	--	--	--
0.050	206	340	--	--
0.056	207	350	--	--
0.063	--	363	525	--
0.071	--	369	540	--
0.080	--	--	560	770
0.090	--	--	575	795
0.100	--	--	--	820
0.112	--	--	--	830
0.125	--	--	--	--
0.140	--	--	--	--
0.160	--	--	--	--
0.180	--	--	--	--
0.190	--	--	--	--

TABLE S

Joint Shear Strength of Solid Aluminum Alloy Rivets
Figure 2 (Sheet 19 of 40)

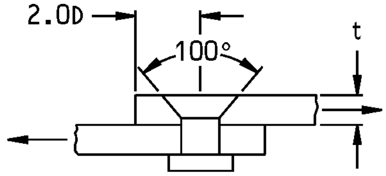


100° STANDARD FLUSH HEAD RIVET
IN A SINGLE SHEAR JOINT

100° STANDARD FLUSH HEAD RIVETS IN CLAD OR BARE 2024-T3 SHEET - SINGLE SHEAR JOINT STRENGTH					
FASTENERS	PART NUMBERS	MS20426D()		BACR15BA()D	
	MATERIAL	2017-T3			
	D (DIAMETER INCHES)	5/32	3/16	1/4	5/16
		0.1562	0.1875	0.2500	0.3125
	SINGLE SHEAR STRENGTH (POUNDS)	730	1050	1870	2910
t (THICKNESS INCHES)		SINGLE SHEAR JOINT STRENGTH (POUNDS)			
0.040		--	--	--	--
0.045		--	--	--	--
0.050		--	--	--	--
0.056		--	--	--	--
0.063		601	--	--	--
0.071		690	--	--	--
0.080		720	937	--	--
0.090		730	1010	--	--
0.100		--	1050	1515	2460
0.112		--	--	1710	2520
0.125		--	--	1770	2580
0.140		--	--	1820	2650
0.160		--	--	1870	2740
0.180		--	--	--	2830
0.190		--	--	--	2910

TABLE T

Joint Shear Strength of Solid Aluminum Alloy Rivets
Figure 2 (Sheet 20 of 40)

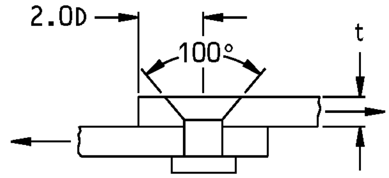


100° STANDARD FLUSH HEAD RIVET
IN A SINGLE SHEAR JOINT

100° STANDARD FLUSH HEAD RIVETS IN CLAD OR BARE 2024-T3 SHEET - SINGLE SHEAR JOINT STRENGTH			
FASTENERS	PARTS NUMBERS	MS20426DD()	BACR15BA()DD
	MATERIAL	2024-T3	
	D (DIAMETER INCHES)	3/16	1/4
		0.1875	0.2500
	SINGLE SHEAR STRENGTH (POUNDS)	1130	2010
t (THICKNESS INCHES)		SINGLE SHEAR JOINT STRENGTH (POUNDS)	
0.040		--	--
0.045		--	--
0.050		--	--
0.056		--	--
0.063		--	--
0.071		--	--
0.080		990	--
0.090		1030	--
0.100		1070	1665
0.112		1110	1820
0.125		1130	1880
0.140		--	1960
0.160		--	2000
0.180		--	2010
0.190		--	--

TABLE U

Joint Shear Strength of Solid Aluminum Alloy Rivets
Figure 2 (Sheet 21 of 40)

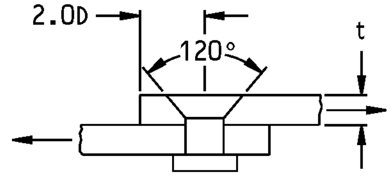


100° SHEAR FLUSH HEAD RIVET
IN A SINGLE SHEAR JOINT

100° SHEAR FLUSH HEAD RIVETS IN CLAD OR BARE 2024-T3 SHEET - SINGLE SHEAR JOINT STRENGTH					
FASTENERS	PART NUMBERS	BACR15CE()D BACR15GF()D			
	MATERIAL	2017-T3			
	D (DIAMETER INCHES)	1/8	5/32	3/16	1/4
		0.1250	0.1562	0.1875	0.2500
	SINGLE SHEAR STRENGTH (POUNDS)	467	730	1050	1870
t (THICKNESS INCHES)		SINGLE SHEAR JOINT JOINT STRENGTH (POUNDS)			
0.032		280	--	--	--
0.036		320	--	--	--
0.040		360	435	--	--
0.045		395	500	--	--
0.050		430	560	665	--
0.056		467	620	760	--
0.063		--	675	840	1090
0.071		--	730	925	1280
0.080		--	--	1010	1440
0.090		--	--	1050	1580
0.100		--	--	--	1720
0.112		--	--	--	1870

TABLE V

Joint Shear Strength of Solid Aluminum Alloy Rivets
Figure 2 (Sheet 22 of 40)

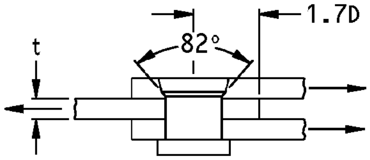


120° MODIFIED SHEAR FLUSH HEAD RIVET
IN A SINGLE SHEAR JOINT

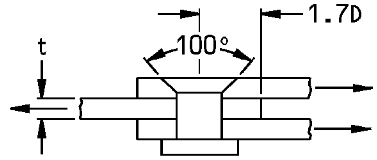
120° MODIFIED SHEAR FLUSH HEAD RIVETS IN CLAD OR BARE 2024-T3 SHEET - SINGLE SHEAR JOINT STRENGTH								
FASTENERS	PART NUMBERS	BACR15FV()KE						
	MATERIAL	7050-T73						
	D (DIAMETER INCHES)	1/8	5/32	3/16	7/32	1/4	9/32	5/16
		0.1250	0.1562	0.1875	0.2188	0.2500	0.2813	0.3125
	SINGLE SHEAR STRENGTH (POUNDS)	505	785	1130	1540	2010	2550	3140
t (THICKNESS INCHES)		SINGLE SHEAR JOINT STRENGTH (POUNDS)						
0.028		254	--	--	--	--	--	--
0.032		307	--	--	--	--	--	--
0.036		369	410	--	--	--	--	--
0.040		434	478	--	--	--	--	--
0.045		497	575	630	--	--	--	--
0.050		505	675	730	--	--	--	--
0.056		--	760	875	950	--	--	--
0.063		--	780	1040	1130	1200	--	--
0.071		--	785	1110	1360	1440	1530	--
0.080		--	--	1130	1540	1730	1830	1930
0.090		--	--	--	--	1990	2200	2320
0.100		--	--	--	--	2010	2520	2720
0.112		--	--	--	--	--	2550	3140

TABLE W

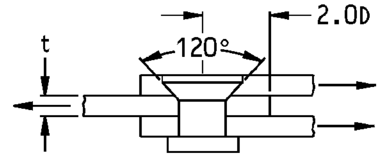
Joint Shear Strength of Solid Aluminum Alloy Rivets
Figure 2 (Sheet 23 of 40)



MODIFIED 82° INDEX FLUSH HEAD RIVET IN A DOUBLE SHEAR JOINT



100° STANDARD FLUSH HEAD RIVET IN A DOUBLE SHEAR JOINT



120° MODIFIED SHEAR FLUSH HEAD RIVET IN A DOUBLE SHEAR JOINT

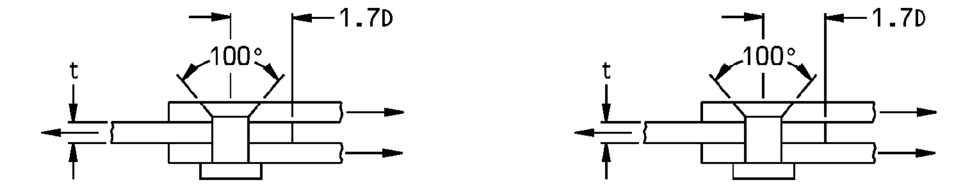
MODIFIED 82° INDEX, 100° STANDARD, AND 120° MODIFIED SHEAR FLUSH HEAD RIVETS IN CLAD OR BARE 2024-T3 SHEET AND 2024-T351 PLATE - DOUBLE SHEAR JOINT STRENGTH

FASTENERS								
FASTENERS	PART NUMBERS	MS20426AD() BACR15FH()AD BACR15BA()AD BACR15CE()AD						
FASTENERS	MATERIAL	2117-T3						
FASTENERS	D (DIAMETER INCHES)	3/32	1/8	5/32	3/16	1/4	5/16	3/8
FASTENERS	D (DIAMETER INCHES)	0.0938	0.1250	0.1562	0.1875	0.2500	0.3125	0.3750
FASTENERS	DOUBLE SHEAR STRENGTH (POUNDS)	414	750	1150	1680	2940	4580	6600
t (THICKNESS INCHES)		DOUBLE SHEAR JOINT STRENGTH (POUNDS)						
0.018		164*	--	--	--	--	--	--
0.020		182*	--	--	--	--	--	--
0.025		227*	303*	--	--	--	--	--
0.028		255*	339*	--	--	--	--	--
0.032		291*	388*	485*	--	--	--	--
0.036		328*	436*	545*	655*	--	--	--
0.040		364*	485*	605*	725*	--	--	--
0.045		383	545*	680*	820*	--	--	--
0.050		394	605*	760*	910*	1210*	--	--
0.056		404	670*	850*	1020*	1360*	--	--
0.063		414	690	995*	1190*	1590*	1990*	--
0.071		--	715	1050	1340*	1790*	2240*	2690*
0.080		--	730	1080	1480	2020*	2520*	3030*
0.090		--	740	1110	1530	2270*	2840*	3410*
0.100		--	--	1140	1580	2520*	3160*	3790*
0.112		--	--	1150	1620	2660	3530*	4240*
0.125		--	--	--	1660	2750	3950*	4730*
0.160		--	--	--	--	2920	4310	5900
0.190		--	--	--	--	2940	4490	6200
0.250		--	--	--	--	--	4580	6600

* THE VALUE IS FOR A KNIFE-EDGE CONDITION. THE USE OF THE FASTENER IN THE KNIFE-EDGE CONDITION IS NOT RECOMMENDED.

TABLE X

Joint Shear Strength of Solid Aluminum Alloy Rivets
Figure 2 (Sheet 24 of 40)

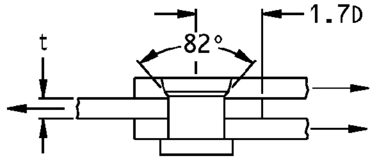


100° STANDARD AND 100° SHEAR FLUSH HEAD RIVETS IN CLAD OR BARE 2024-T3 SHEET AND 2024-T351 PLATE - DOUBLE SHEAR JOINT STRENGTH							
FASTENERS	PART NUMBERS	MS20426D() BACR15CE()D BACR15BA()D BACR15GF()D					
FASTENERS	MATERIAL	2017-T3					
FASTENERS	D (DIAMETER INCHES)	1/8	5/32	3/16	1/4	5/16	3/8
FASTENERS	D (DIAMETER INCHES)	0.1250	0.1562	0.1875	0.2500	0.3125	0.3750
FASTENERS	DOUBLE SHEAR STRENGTH (POUNDS)	935	1460	2100	3740	5800	8350
t (THICKNESS INCHES)		DOUBLE SHEAR JOINT STRENGTH (POUNDS)					
0.018		--	--	--	--	--	--
0.020		--	--	--	--	--	--
0.025		303*	--	--	--	--	--
0.028		339*	--	--	--	--	--
0.032		388*	485*	--	--	--	--
0.036		436*	545*	655*	--	--	--
0.040		485*	605*	725*	--	--	--
0.045		545*	680*	820*	--	--	--
0.050		605*	760*	910*	1210*	--	--
0.056		680*	850*	1020*	1360*	--	--
0.063		795*	995*	1190*	1590*	1990*	--
0.071		895*	1120*	1340*	1790*	2240*	2690*
0.080		925	1260*	1510*	2020*	2520*	3030*
0.090		935	1410	1700*	2270*	2840*	3410*
0.100		--	1450	1890*	2520*	3160*	3790*
0.112		--	1460	2050	2830*	3530*	4240*
0.125		--	--	2100	3160*	3950*	4730*
0.160		--	--	--	3710	5100*	6100*
0.190		--	--	--	3740	5700	7250*
0.250		--	--	--	--	5800	8350

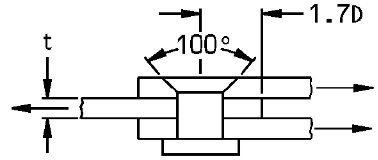
* THE VALUE IS FOR A KNIFE-EDGE CONDITION. THE USE OF THE FASTENER IN THE KNIFE-EDGE CONDITION IS NOT RECOMMENDED.

TABLE Y

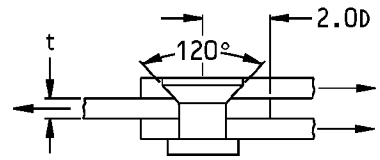
Joint Shear Strength of Solid Aluminum Alloy Rivets
Figure 2 (Sheet 25 of 40)



MODIFIED 82° INDEX FLUSH HEAD RIVET IN A DOUBLE SHEAR JOINT



100° STANDARD FLUSH HEAD RIVET IN A DOUBLE SHEAR JOINT



120° MODIFIED SHEAR FLUSH HEAD RIVET IN A DOUBLE SHEAR JOINT

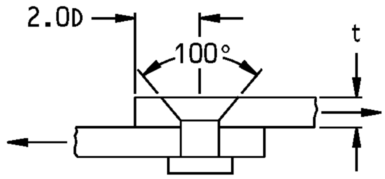
MODIFIED 82° INDEX, 100° STANDARD, AND 120° MODIFIED SHEAR FLUSH HEAD RIVETS IN CLAD OR BARE 2024-T3 SHEET AND 2024-T351 PLATE - DOUBLE SHEAR JOINT STRENGTH

FASTENERS								
PART NUMBERS	MS20426DD() BACR15FH()DD			BACR15FH()KE BACR15GH()KE			BACR15BA()DD BACR15FV()KE	
MATERIAL	2024-T3 AND 7050-T73							
D (DIAMETER INCHES)	1/8	5/32	3/16	7/32	1/4	9/32	5/16	3/8
	0.1250	0.1562	0.1875	0.2188	0.2500	0.2813	0.3125	0.3750
DOUBLE SHEAR STRENGTH (POUNDS)	1010	1570	2260	3080	4020	5100	6300	9050
t (THICKNESS INCHES)	DOUBLE SHEAR JOINT STRENGTH (POUNDS)							
0.025	303*	--	--	--	--	--	--	--
0.028	339*	--	--	--	--	--	--	--
0.032	388*	485*	--	--	--	--	--	--
0.036	436*	545*	655*	--	--	--	--	--
0.040	485*	605*	725*	850*	--	--	--	--
0.045	545*	680*	820*	955*	--	--	--	--
0.050	605*	760*	910*	1060*	1210*	--	--	--
0.056	680*	850*	1020*	1190*	1360*	1530*	--	--
0.063	795*	995*	1190*	1390*	1590*	1790*	1990*	--
0.071	895*	1120*	1340*	1570*	1790*	2020*	2240*	2690*
0.080	1000	1260*	1510*	1770*	2020*	2270*	2520*	3030*
0.090	1010	1420*	1700*	1990*	2270*	2560*	2840*	3410*
0.100	--	1560	1890*	2210*	2520*	2840*	3160*	3790*
0.112	--	1570	2120*	2480*	2830*	3180*	3530*	4240*
0.125	--	--	2260	2760*	3160*	3550*	3950*	4730*
0.160	--	--	--	3080	3990	4590*	5100*	6100*
0.190	--	--	--	--	4020	5100	6050*	7250*
0.250	--	--	--	--	--	--	6300	8900*
0.312	--	--	--	--	--	--	--	9050

* THE VALUE IS FOR A KNIFE-EDGE CONDITION. THE USE OF THE FASTENER IN THE KNIFE-EDGE CONDITION IS NOT RECOMMENDED.

TABLE Z

Joint Shear Strength of Solid Aluminum Alloy Rivets
Figure 2 (Sheet 26 of 40)

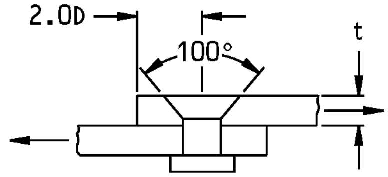


100° STANDARD FLUSH HEAD RIVET
IN A SINGLE SHEAR JOINT

100° STANDARD FLUSH HEAD RIVETS IN CLAD OR BARE 2024-T42 SHEET - SINGLE SHEAR JOINT STRENGTH					
FASTENERS	PART NUMBERS	MS20426AD() BACR15BA()AD			
	MATERIAL	2117-T3			
	D (DIAMETER INCHES)	3/32	1/8	5/32	3/16
		0.0938	0.1250	0.1562	0.1875
	SINGLE SHEAR STRENGTH (POUNDS)	207	369	575	830
t (THICKNESS INCHES)		SINGLE SHEAR JOINT STRENGTH (POUNDS)			
0.040		193	--	--	--
0.045		201	--	--	--
0.050		206	340	--	--
0.056		207	350	--	--
0.063		--	363	525	--
0.071		--	369	540	--
0.080		--	--	560	770
0.090		--	--	575	795
0.100		--	--	--	820
0.112		--	--	--	830
0.125		--	--	--	--
0.140		--	--	--	--
0.160		--	--	--	--
0.180		--	--	--	--
0.190		--	--	--	--

TABLE AA

Joint Shear Strength of Solid Aluminum Alloy Rivets
Figure 2 (Sheet 27 of 40)

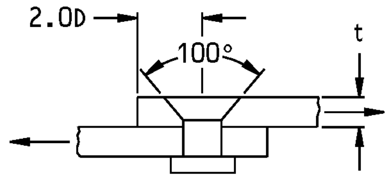


100° STANDARD FLUSH HEAD RIVET
IN A SINGLE SHEAR JOINT

100° STANDARD FLUSH HEAD RIVETS IN CLAD OR BARE OR BARE 2024-T42 SHEET - 2024-T42 SHEET - SINGLE SHEAR JOINT STRENGTH				
FASTENERS: PART NUMBERS	MS20426D()	BACR15BA()D		
FASTENERS: MATERIAL	2017-T3			
FASTENERS: D (DIAMETER INCHES)	5/32	3/16	1/4	5/16
	0.1562	0.1875	0.2500	0.3125
FASTENERS: SINGLE SHEAR STRENGTH (POUNDS)	730	1050	1870	2910
t (THICKNESS INCHES)	SINGLE SHEAR JOINT STRENGTH (POUNDS)			
0.040	--	--	--	--
0.045	--	--	--	--
0.050	--	--	--	--
0.056	--	--	--	--
0.063	601	--	--	--
0.071	690	--	--	--
0.080	720	937	--	--
0.090	730	1010	--	--
0.100	--	1050	1515	--
0.112	--	--	1710	2520
0.125	--	--	1770	2580
0.140	--	--	1820	2650
0.160	--	--	1870	2740
0.180	--	--	--	2830
0.190	--	--	--	2910

TABLE AB

Joint Shear Strength of Solid Aluminum Alloy Rivets
Figure 2 (Sheet 28 of 40)

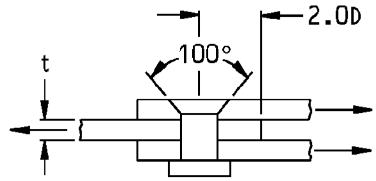


100° STANDARD FLUSH HEAD RIVET
IN A SINGLE SHEAR JOINT

100° STANDARD FLUSH HEAD RIVETS IN CLAD OR BARE 2024-T42 SHEET - SINGLE SHEAR JOINT STRENGTH			
FASTENERS	PARTS NUMBERS	MS20426DD() BACR15BA()DD	
	MATERIAL	2024-T3	
	D (DIAMETER INCHES)	3/16	1/4
		0.1875	0.2500
	SINGLE SHEAR STRENGTH (POUNDS)	1130	2010
t (THICKNESS INCHES)		SINGLE SHEAR JOINT STRENGTH (POUNDS)	
0.040		--	--
0.045		--	--
0.050		--	--
0.056		--	--
0.063		--	--
0.071		--	--
0.080		990	--
0.090		1030	--
0.100		1070	1615
0.112		1110	1820
0.125		1130	1880
0.140		--	1960
0.160		--	2000
0.180		--	2010
0.190		--	--

TABLE AC

Joint Shear Strength of Solid Aluminum Alloy Rivets
Figure 2 (Sheet 29 of 40)



100° STANDARD FLUSH HEAD RIVET
IN A DOUBLE SHEAR JOINT

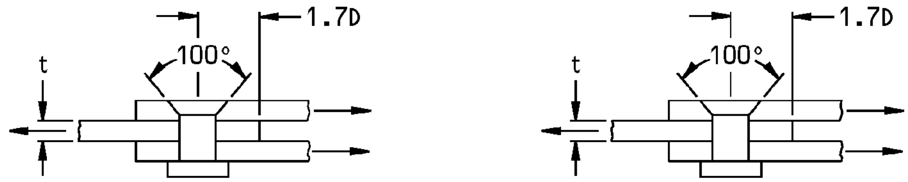
100° STANDARD FLUSH HEAD RIVETS IN CLAD OR BARE 2024-T42 SHEET, CLAD 2024-T4 COILED SHEET, AND 2024-T42 TUBE - DOUBLE SHEAR JOINT STRENGTH

FASTENERS							
PART NUMBERS	MS20426AD() BACR15FH()AD BACR15BA()AD BACR15CE()AD						
MATERIAL	2117-T3						
D (DIAMETER INCHES)	3/32	1/8	5/32	3/16	1/4	5/16	3/8
	0.0938	0.1250	0.1562	0.1875	0.2500	0.3125	0.3750
DOUBLE SHEAR STRENGTH (POUNDS)	414	750	1150	1660	2940	4580	6600
t (THICKNESS INCHES)	DOUBLE SHEAR JOINT STRENGTH (POUNDS)						
0.018	132*	--	--	--	--	--	--
0.020	145*	--	--	--	--	--	--
0.025	183*	243*	--	--	--	--	--
0.028	205*	273*	--	--	--	--	--
0.032	234*	312*	390*	--	--	--	--
0.036	264*	351*	438*	526*	--	--	--
0.040	292*	390*	487*	585*	--	--	--
0.045	328	438*	549*	658*	--	--	--
0.050	366	487*	609*	730*	975*	--	--
0.056	404	546	682*	817*	1095*	--	--
0.063	414	661	825	990*	1320*	1650*	--
0.071	--	715	930	1117*	1492*	1860*	2235*
0.080	--	730	1050	1260	1680*	2100*	2520*
0.090	--	740	1110	1417	1890*	2355*	2835*
0.100	--	--	1140	1575	2100	2625*	3150*
0.112	--	--	1150	1620	2355	2940*	3525*
0.125	--	--	--	1660	2625	3285	3930*
0.160	--	--	--	--	2920	4200	5040
0.190	--	--	--	--	2940	4490	5985
0.250	--	--	--	--	--	4580	6600

* THE VALUE IS FOR A KNIFE-EDGE CONDITION. THE USE OF THE FASTENER IN THE KNIFE-EDGE CONDITION IS NOT RECOMMENDED.

TABLE AD

Joint Shear Strength of Solid Aluminum Alloy Rivets
Figure 2 (Sheet 30 of 40)



100° STANDARD FLUSH HEAD RIVET IN A DOUBLE SHEAR JOINT

100° SHEAR FLUSH HEAD RIVET IN A DOUBLE SHEAR JOINT

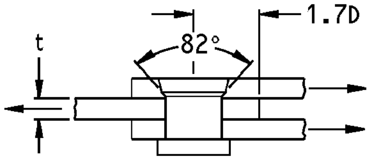
100° STANDARD AND 100° SHEAR FLUSH HEAD RIVETS IN CLAD OR BARE 2024-T42 SHEET, CLAD 2024-T4 COILED SHEET, AND 2024-T42 TUBE - DOUBLE SHEAR JOINT STRENGTH

FASTENERS	PART NUMBERS	MS20426D() BACR15BA()D BACR15CE()D BACR15GF()D					
	MATERIAL	2017-T3					
	D (DIAMETER INCHES)	1/8	5/32	3/16	1/4	5/16	3/8
		0.1250	0.1562	0.1875	0.2500	0.3125	0.3750
	DOUBLE SHEAR STRENGTH (POUNDS)	935	1460	2100	3740	5800	8350
t (THICKNESS INCHES)		DOUBLE SHEAR JOINT STRENGTH (POUNDS)					
0.025		243*	--	--	--	--	--
0.028		273*	--	--	--	--	--
0.032		312*	390*	--	--	--	--
0.036		351*	438*	526*	--	--	--
0.040		390*	487*	585*	--	--	--
0.045		438*	549*	658*	--	--	--
0.050		487*	609*	730*	975*	--	--
0.056		546*	682*	817*	1095*	--	--
0.063		661*	825*	990*	1320*	1650*	--
0.071		745	930*	1117*	1492*	1860*	2235*
0.080		840	1050*	1260*	1680*	2100*	2520*
0.090		935	1177	1417*	1890*	2355*	2835*
0.100		--	1312	1575*	2100*	2625*	3150*
0.112		--	1460	1770	2355*	2940*	3525*
0.125		--	--	1965	2625	3285*	3930*
0.160		--	--	--	3360	4200*	5040*
0.190		--	--	--	3740	4980	5985*
0.250		--	--	--	--	5800	7455

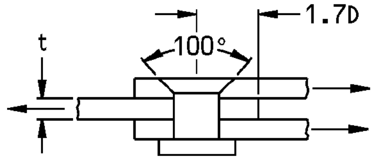
* THE VALUE IS FOR A KNIFE-EDGE CONDITION. THE USE OF THE FASTENER IN THE KNIFE-EDGE CONDITION IS NOT RECOMMENDED.

TABLE AE

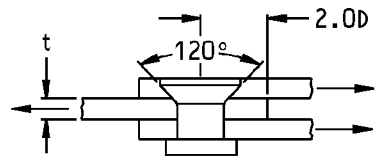
Joint Shear Strength of Solid Aluminum Alloy Rivets
Figure 2 (Sheet 31 of 40)



MODIFIED 82° INDEX FLUSH HEAD RIVET IN A DOUBLE SHEAR JOINT



100° STANDARD FLUSH HEAD RIVET IN A DOUBLE SHEAR JOINT



120° MODIFIED SHEAR FLUSH HEAD RIVET IN A DOUBLE SHEAR JOINT

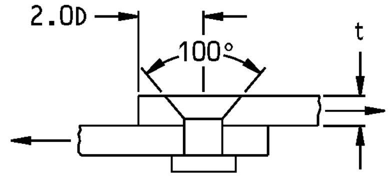
MODIFIED 82° INDEX, 100° STANDARD, AND 120° MODIFIED SHEAR FLUSH HEAD RIVETS IN CLAD OR BARE 2024-T42 SHEET, CLAD 2024-T4 COILED SHEET, AND 2024-T42 TUBE - DOUBLE SHEAR JOINT STRENGTH

FASTENERS	PART NUMBERS	MS20426DD() BACR15FV()KE BACR15FH()KE BACR15FH()DD BACR15BA()DD BACR15GH()KE				
	MATERIAL	2024-T3 AND 7050-T73				
	D (DIAMETER INCHES)	5/32	3/16	1/4	5/16	3/8
		0.1562	0.1875	0.2500	0.3125	0.3750
	DOUBLE SHEAR STRENGTH (POUNDS)	1570	2260	4020	6300	9050
t (THICKNESS INCHES)		DOUBLE SHEAR JOINT STRENGTH (POUNDS)				
0.032		390*	--	--	--	--
0.036		438*	526*	--	--	--
0.040		487*	585*	--	--	--
0.045		549*	658*	--	--	--
0.050		609*	730*	975*	--	--
0.056		682*	817*	1095*	--	--
0.063		825*	990*	1320*	1650*	--
0.071		930*	1117*	1492*	1860*	2235*
0.080		1050*	1260*	1680*	2100*	2520*
0.090		1177*	1417*	1890*	2355*	2835*
0.100		1312	1575*	2100*	2625*	3150*
0.112		1470	1770*	2355*	2940*	3525*
0.125		--	1965	2625*	3285*	3930*
0.160		--	--	3360	4200*	5040*
0.190		--	--	3990	4980	5985*
0.250		--	--	--	6210	7455

* THE VALUE IS FOR A KNIFE-EDGE CONDITION. THE USE OF THE FASTENER IN THE KNIFE-EDGE CONDITION IS NOT RECOMMENDED.

TABLE AF

Joint Shear Strength of Solid Aluminum Alloy Rivets
Figure 2 (Sheet 32 of 40)

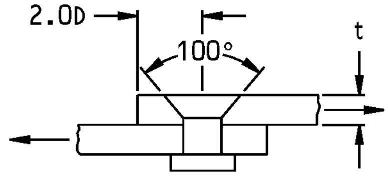


100° STANDARD FLUSH HEAD RIVET
IN A SINGLE SHEAR JOINT

100° STANDARD FLUSH HEAD RIVETS IN CLAD OR BARE 7075-T6 SHEET - SINGLE SHEAR JOINT STRENGTH					
FASTENERS	PART NUMBERS	MS20426AD() BACR15BA()AD			
	MATERIAL	2117-T3			
	D (DIAMETER INCHES)	3/32	1/8	5/32	3/16
		0.0938	0.1250	0.1562	0.1875
	SINGLE SHEAR STRENGTH (POUNDS)	207	369	575	830
t (THICKNESS INCHES)		SINGLE SHEAR JOINT STRENGTH (POUNDS)			
0.040		193	--	--	--
0.045		201	--	--	--
0.050		206	340	--	--
0.056		207	350	--	--
0.063		--	363	525	--
0.071		--	369	540	--
0.080		--	--	560	770
0.090		--	--	575	795
0.100		--	--	--	820
0.112		--	--	--	830
0.125		--	--	--	--
0.140		--	--	--	--
0.160		--	--	--	--
0.180		--	--	--	--
0.190		--	--	--	--

TABLE AG

Joint Shear Strength of Solid Aluminum Alloy Rivets
Figure 2 (Sheet 33 of 40)

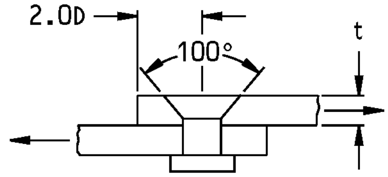


100° STANDARD FLUSH HEAD RIVET
IN A SINGLE SHEAR JOINT

100° STANDARD FLUSH HEAD RIVETS IN CLAD OR BARE 7075-T6 SHEET - SINGLE SHEAR JOINT STRENGTH					
FASTENERS	PART NUMBERS	MS20426D() BACR15BA()D			
	MATERIAL	2017-T3			
	D (DIAMETER INCHES)	5/32	3/16	1/4	5/16
		0.1562	0.1875	0.2500	0.3125
	SINGLE SHEAR STRENGTH (POUNDS)	730	1050	1870	2910
t (THICKNESS INCHES)		SINGLE SHEAR JOINT STRENGTH (POUNDS)			
0.040		--	--	--	--
0.045		--	--	--	--
0.050		--	--	--	--
0.056		--	--	--	--
0.063		601	--	--	--
0.071		690	--	--	--
0.080		720	937	--	--
0.090		730	1010	--	--
0.100		--	1050	1515	--
0.112		--	--	1710	2520
0.125		--	--	1770	2580
0.140		--	--	1820	2650
0.160		--	--	1870	2740
0.180		--	--	--	2830
0.190		--	--	--	2910

TABLE AH

Joint Shear Strength of Solid Aluminum Alloy Rivets
Figure 2 (Sheet 34 of 40)

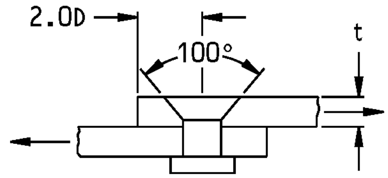


100° STANDARD FLUSH HEAD RIVET
IN A SINGLE SHEAR JOINT

100° STANDARD FLUSH HEAD RIVETS IN CLAD OR BARE 7075-T6 SHEET - SINGLE SHEAR JOINT STRENGTH			
FASTENERS	PARTS NUMBERS	MS20426DD()	BACR15BA()DD
	MATERIAL	2024-T3	
	D (DIAMETER INCHES)	3/16	1/4
		0.1875	0.2500
	SINGLE SHEAR STRENGTH (POUNDS)	1130	2010
t (THICKNESS INCHES)		SINGLE SHEAR JOINT STRENGTH (POUNDS)	
0.040		--	--
0.045		--	--
0.050		--	--
0.056		--	--
0.063		--	--
0.071		--	--
0.080		990	--
0.090		1030	--
0.100		1070	1665
0.112		1110	1820
0.125		1130	1880
0.140		--	1960
0.160		--	2000
0.180		--	2010
0.190		--	--

TABLE AI

Joint Shear Strength of Solid Aluminum Alloy Rivets
Figure 2 (Sheet 35 of 40)

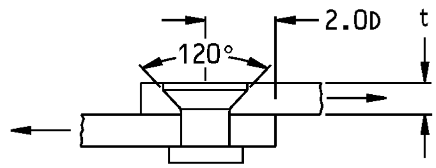


100° SHEAR FLUSH HEAD RIVET
IN A SINGLE SHEAR JOINT

100° SHEAR FLUSH HEAD RIVETS IN CLAD OR BARE 7075-T6 SHEET - SINGLE SHEAR JOINT STRENGTH					
FASTENERS	PART NUMBERS	BACR15CE()D BACR15GF()D			
	MATERIAL	2017-T3			
	D (DIAMETER INCHES)	1/8	5/32	3/16	1/4
		0.1250	0.1562	0.1875	0.2500
	SINGLE SHEAR STRENGTH (POUNDS)	467	730	1050	1870
t (THICKNESS INCHES)		SINGLE SHEAR JOINT STRENGTH (POUNDS)			
0.032		280	--	--	--
0.036		320	--	--	--
0.040		360	435	--	--
0.045		395	500	--	--
0.050		430	560	665	--
0.056		467	620	760	--
0.063		--	675	840	1090
0.071		--	730	925	1280
0.080		--	--	1010	1440
0.090		--	--	1050	1580
0.100		--	--	--	1720
0.112		--	--	--	1870

TABLE AJ

Joint Shear Strength of Solid Aluminum Alloy Rivets
Figure 2 (Sheet 36 of 40)

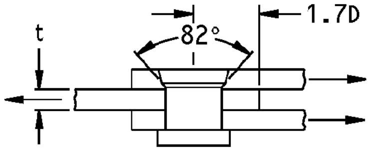


120° MODIFIED SHEAR FLUSH
HEAD RIVET IN A
SINGLE SHEAR JOINT

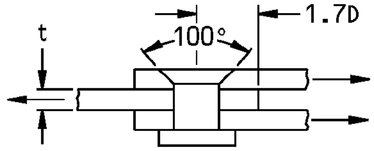
120° MODIFIED SHEAR FLUSH HEAD RIVETS IN CLAD OR BARE 7075-T6 SHEET - SINGLE SHEAR JOINT STRENGTH							
FASTENERS: PART NUMBERS	BACR15FV()KE						
FASTENERS: MATERIAL	7050-T73						
FASTENERS: D (DIAMETER INCHES)	1/8	5/32	3/16	7/32	1/4	9/32	5/16
	0.1250	0.1562	0.1875	0.2188	0.2500	0.2813	0.3125
FASTENERS: SINGLE SHEAR STRENGTH (POUNDS)	505	785	1130	1540	2010	2550	3140
t (THICKNESS INCHES)	SINGLE SHEAR JOINT STRENGTH (POUNDS)						
0.028	254	--	--	--	--	--	--
0.032	307	--	--	--	--	--	--
0.036	369	410	--	--	--	--	--
0.040	434	478	--	--	--	--	--
0.045	497	575	630	--	--	--	--
0.050	505	670	730	--	--	--	--
0.056	--	760	875	950	--	--	--
0.063	--	780	1040	1130	1200	--	--
0.071	--	785	1110	1360	1440	1530	--
0.080	--	--	1130	1540	1730	1830	1930
0.090	--	--	--	--	1990	2200	2320
0.100	--	--	--	--	2010	2520	2720
0.112	--	--	--	--	--	2550	3140

TABLE AK

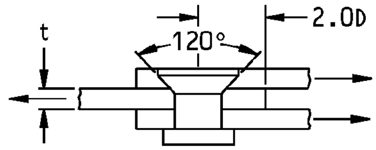
Joint Shear Strength of Solid Aluminum Alloy Rivets
Figure 2 (Sheet 37 of 40)



MODIFIED 82° INDEX FLUSH HEAD RIVET IN A DOUBLE SHEAR JOINT



100° STANDARD FLUSH HEAD RIVET IN A DOUBLE SHEAR JOINT



120° MODIFIED SHEAR FLUSH HEAD RIVET IN A DOUBLE SHEAR JOINT

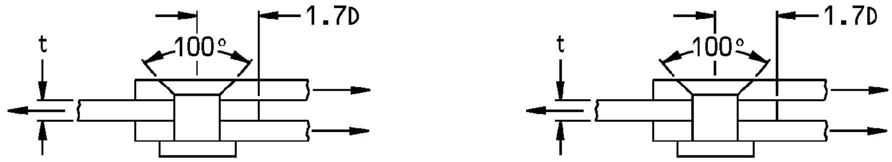
MODIFIED 82° INDEX, 100° STANDARD, AND 120° MODIFIED SHEAR FLUSH HEAD RIVETS IN CLAD OR BARE 7075-T6 SHEET AND 7075-T6,-T6510,-T6511 EXTRUSIONS LESS THAN 0.188 INCH THICK - DOUBLE SHEAR JOINT STRENGTH

FASTENERS	PART NUMBERS	MS20426AD() BACR15BA()AD BACR15FH()AD BACR15CE()AD						
	MATERIAL	2117-T3						
	D (DIAMETER INCHES)	3/32	1/8	5/32	3/16	1/4	5/16	3/8
		0.0938	0.1250	0.1562	0.1875	0.2500	0.3125	0.3750
	DOUBLE SHEAR STRENGTH (POUNDS)	414	740	1150	1660	2940	4580	6600
t (THICKNESS INCHES)		DOUBLE SHEAR JOINT STRENGTH (POUNDS)						
0.018		191*	--	--	--	--	--	--
0.020		212*	--	--	--	--	--	--
0.025		265*	353*	--	--	--	--	--
0.028		297*	395*	--	--	--	--	--
0.032		337	452*	565*	--	--	--	--
0.036		355	510*	635*	765*	--	--	--
0.040		369	575*	720*	860*	--	--	--
0.045		383	615	810*	970*	--	--	--
0.050		394	640	900	1080*	1440*	--	--
0.056		404	670	955	1210*	1610*	--	--
0.063		414	690	1000	1340	1830*	2280*	--
0.071		--	715	1050	1410	2060*	2570*	3090*
0.080		--	730	1080	1480	2320	2900*	3480*
0.090		--	740	1110	1530	2450	3260*	3910*
0.100		--	--	1140	1580	2560	3610	4350*
0.112		--	--	1150	1620	2660	3810	4870*
0.125		--	--	--	1660	2750	3980	5300
0.160		--	--	--	--	2920	4310	5900
0.190		--	--	--	--	2940	4490	6200
0.250		--	--	--	--	--	4580	6600

* THE VALUE IS FOR A KNIFE-EDGE CONDITION. THE USE OF THE FASTENER IN THE KNIFE-EDGE CONDITION IS NOT RECOMMENDED.

TABLE AL

Joint Shear Strength of Solid Aluminum Alloy Rivets
Figure 2 (Sheet 38 of 40)



100° STANDARD FLUSH HEAD RIVET IN A DOUBLE SHEAR JOINT

100° SHEAR FLUSH HEAD RIVET IN A DOUBLE SHEAR JOINT

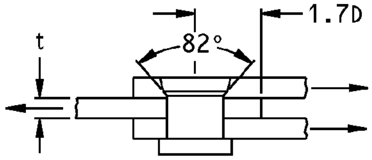
100° STANDARD AND 100° SHEAR FLUSH HEAD RIVETS IN CLAD OR BARE 7075-T6 SHEET AND 7075-T6, -T6510,-T6511 EXTRUSIONS LESS THAN 0.188 INCH THICK - DOUBLE SHEAR JOINT STRENGTH

FASTENERS							
	PART NUMBERS	MS20426D() BACR15BA()D BACR15CE()D BACR15GF()D					
	MATERIAL	2017-T3					
	D (DIAMETER INCHES)	1/8	5/32	3/16	1/4	5/16	3/8
		0.1250	0.1562	0.1875	0.2500	0.3125	0.3750
	DOUBLE SHEAR STRENGTH (POUNDS)	935	1460	2100	3740	5800	8350
t (THICKNESS INCHES)		DOUBLE SHEAR JOINT STRENGTH (POUNDS)					
0.025		353*	--	--	--	--	--
0.028		395*	--	--	--	--	--
0.032		452*	565*	--	--	--	--
0.036		510*	635*	765*	--	--	--
0.040		575*	720*	860*	--	--	--
0.045		645*	810*	970*	--	--	--
0.050		720*	900*	1080*	1440*	--	--
0.056		805*	1010*	1210*	1610*	--	--
0.063		875	1140*	1370*	1830*	2280*	--
0.071		900	1290*	1540*	2060*	2570*	3090*
0.080		925	1370	1740*	2320*	2900*	3480*
0.090		935	1410	1940	2610*	3260*	3910*
0.100		--	1450	2000	2900*	3620*	4350*
0.112		--	1460	2050	3250*	4060*	4870*
0.125		--	--	2100	3500	4530*	5450*
0.160		--	--	--	3710	5500	6950*
0.190		--	--	--	3740	5700	7850
0.250		--	--	--	--	5800	8350

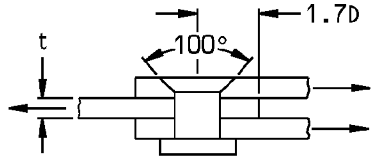
* THE VALUE IS FOR A KNIFE-EDGE CONDITION. THE USE OF THE FASTENER IN THE KNIFE-EDGE CONDITION IS NOT RECOMMENDED.

TABLE AM

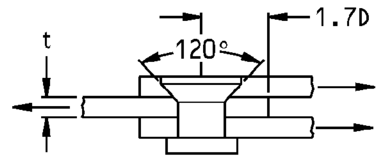
Joint Shear Strength of Solid Aluminum Alloy Rivets
Figure 2 (Sheet 39 of 40)



MODIFIED 82° INDEX FLUSH HEAD RIVET IN A DOUBLE SHEAR JOINT



100° STANDARD FLUSH HEAD RIVET IN A DOUBLE SHEAR JOINT



120° MODIFIED SHEAR FLUSH HEAD RIVET IN A DOUBLE SHEAR JOINT

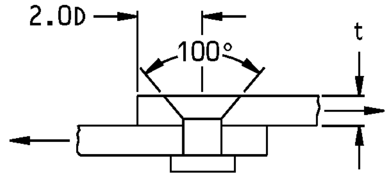
MODIFIED 82° INDEX, 100° STANDARD, AND 120° SHEAR FLUSH HEAD RIVETS IN CLAD OR BARE 7075-T6 SHEET AND 7075-T6,-T6510,-T6511 EXTRUSIONS LESS THAN 0.188 INCH THICK - DOUBLE SHEAR JOINT STRENGTH

FASTENERS								
PART NUMBERS	MS20426DD() BACR15FV()KE			BACR15FH()KE BACR15FH()DD			BACR15BA()DD BACR15GH()KE	
MATERIAL	2024-T3 AND 7050-T73							
D (DIAMETER INCHES)	1/8	5/32	3/16	7/32	1/4	9/32	5/16	3/8
	0.1250	0.1562	0.1875	0.2188	0.2500	0.2813	0.3125	0.3750
DOUBLE SHEAR STRENGTH (POUNDS)	1010	1570	2260	3080	4020	5100	6300	9050
t (THICKNESS INCHES)	DOUBLE SHEAR JOINT STRENGTH (POUNDS)							
0.025	353*	--	--	--	--	--	--	--
0.020	395*	--	--	--	--	--	--	--
0.032	452*	565*	--	--	--	--	--	--
0.036	510*	635*	765*	--	--	--	--	--
0.040	575*	720*	860*	1010*	--	--	--	--
0.045	645*	810*	970*	1130*	--	--	--	--
0.050	720*	900*	1080*	1260*	1440*	--	--	--
0.056	805*	1010*	1210*	1410*	1610*	1810*	--	--
0.063	915*	1140*	1370*	1600*	1830*	2060*	2280*	--
0.071	975	1290*	1540*	1800*	2060*	2320*	2570*	3090*
0.080	1000	1450*	1740*	2030*	2320*	2610*	2900*	3480*
0.090	1010	1520	1960*	2280*	2610*	2940*	3260*	3910*
0.100	--	1560	2150	2540*	2900*	3260*	3620*	4350*
0.112	--	1570	2210	2840*	3250*	3650*	4060*	4870*
0.125	--	--	2260	2980	3620*	4080*	4530*	5450*
0.160	--	--	--	3080	3990	4930	5800*	6950*
0.190	--	--	--	--	4020	5100	6150	8500
0.250	--	--	--	--	--	--	6300	9050

* THE VALUE IS FOR A KNIFE-EDGE CONDITION. THE USE OF THE FASTENER IN THE KNIFE-EDGE CONDITION IS NOT RECOMMENDED.

TABLE AN

Joint Shear Strength of Solid Aluminum Alloy Rivets
Figure 2 (Sheet 40 of 40)

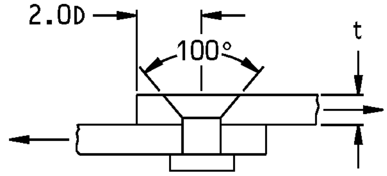


100° FLUSH HEAD RIVET
IN A SINGLE SHEAR JOINT

100° FLUSH HEAD RIVETS IN 302-ANNEALED CRES MACHINE COUNTERSUNK SHEET - SINGLE SHEAR JOINT STRENGTH				
FASTENERS	PART NUMBERS	MS20427M()		
	MATERIAL	MONEL		
	D (DIAMETER INCHES)	1/8	5/32	3/16
		0.1250	0.1562	0.1875
	SINGLE SHEAR STRENGTH (POUNDS)	605	940	1350
t (THICKNESS INCHES)		SINGLE SHEAR JOINT STRENGTH (POUNDS)		
0.020		--	--	--
0.025		--	--	--
0.032		--	--	--
0.040		--	--	--
0.050		466	--	--
0.063		605	759	--
0.071		--	855	--
0.080		--	940	1246
0.090		--	--	1350
0.100		--	--	--
0.125		--	--	--

TABLE A

Joint Shear Strength of Solid Cres Rivets
Figure 3 (Sheet 1 of 3)

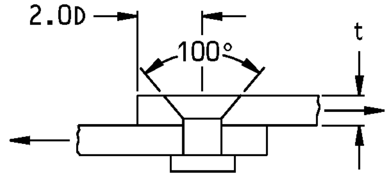


100° FLUSH HEAD RIVET
IN A SINGLE SHEAR JOINT

100° FLUSH HEAD RIVETS IN 301-1/4 HARD CRES MACHINE COUNTERSUNK SHEET - SINGLE SHEAR JOINT STRENGTH				
FASTENERS	PART NUMBERS	MS20427M()		
	MATERIAL	MONEL		
	D (DIAMETER INCHES)	1/8	5/32	3/16
		0.1250	0.1562	0.1875
	SINGLE SHEAR STRENGTH (POUNDS)	605	940	1350
t (THICKNESS INCHES)		SINGLE SHEAR JOINT STRENGTH (POUNDS)		
0.020		--	--	--
0.025		--	--	--
0.032		--	--	--
0.040		--	--	--
0.050		468	--	--
0.063		595	732	--
0.071		605	830	--
0.080		--	936	1118
0.090		--	940	1255
0.100		--	--	1350
0.125		--	--	--

TABLE B

Joint Shear Strength of Solid Cres Rivets
Figure 3 (Sheet 2 of 3)

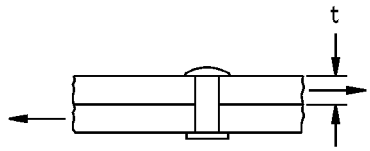


100° FLUSH HEAD RIVET
IN A SINGLE SHEAR JOINT

100° FLUSH HEAD RIVETS IN 301-1/2 HARD OR FULL CRES MACHINE COUNTERSUNK SHEET - SINGLE SHEAR JOINT STRENGTH					
FASTENERS	PART NUMBERS	MS20427M()			
	MATERIAL	MONEL			
	D (DIAMETER INCHES)	3/32	1/8	5/32	3/16
		0.0938	0.1250	0.1562	0.1875
	SINGLE SHEAR STRENGTH (POUNDS)	338	605	940	1350
t (THICKNESS INCHES)		SINGLE SHEAR JOINT STRENGTH (POUNDS)			
0.020		--	--	--	--
0.025		--	--	--	--
0.032		--	--	--	--
0.040		251	--	--	--
0.050		322	447	--	--
0.063		338	538	688	--
0.071		--	605	741	--
0.080		--	--	850	995
0.090		--	--	940	1132
0.100		--	--	--	1280
0.125		--	--	--	1350

TABLE C

Joint Shear Strength of Solid Cres Rivets
Figure 3 (Sheet 3 of 3)



PROTRUDING HEAD BLIND RIVET
IN A SINGLE SHEAR JOINT

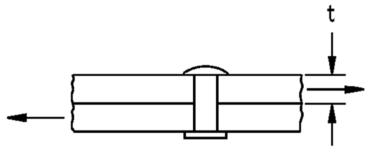
PROTRUDING HEAD BLIND NAS1398 RIVETS IN CLAD OR BARE 2024-T3 SHEET (FOR THICKNESSES 0.020 THRU 0.050) SINGLE SHEAR JOINT STRENGTH								
FASTENERS: PART NUMBERS	NAS1398B()				NAS1398D()			
FASTENERS: MATERIAL	5056 ALUMINUM SLEEVE 7075 ALUMINUM STEM				2017 ALUMINUM SLEEVE 7075 ALUMINUM STEM			
FASTENERS: D (DIAMETER INCHES)	1/8	5/32	3/16	1/4	1/8	5/32	3/16	1/4
	0.1250	0.1562	0.1875	0.2500	0.1250	0.1562	0.1875	0.2500
FASTENERS: SINGLE SHEAR STRENGTH (POUNDS)	388	595	860	1550	495	755	1090	1970
FASTENERS: TENSION (POUNDS)	230	375	540	1000	230	375	540	1000
FASTENERS: 67% TENSION (POUNDS) [1]	154	251	361	670	154	251	361	670
t (THICKNESS INCHES) [2]	SINGLE SHEAR JOINT STRENGTH (POUNDS)							
0.020	167	189	199	--	167	189	199	--
0.025	228	262	290	314	228	262	290	314
0.028	254	306	342	385	261	306	342	385
0.032	289	364	412	479	304	364	412	479
0.036	313	406	483	575	329	417	483	575
0.040	337	448	555	670	355	470	555	670
0.045	362	484	605	790	386	510	625	790
0.050	388	520	660	915	418	550	695	915

[1] USE THE 67% TENSION VALUES WHEN BLIND RIVETS ARE USED IN PRIMARY OR LOAD REVERSING STRUCTURE.

[2] THE MINIMUM SHEET THICKNESS PERMITTED ON THE BLIND SIDE IS EQUAL TO 0.25 TIMES THE DIAMETER OF THE NAS1398 RIVET. FOR THINNER MATERIAL, USE ONE OF THE RIVETS SHOWN IN TABLE C.

TABLE A

Joint Shear Strength of Blind Rivets
Figure 4 (Sheet 1 of 7)



PROTRUDING HEAD BLIND RIVET
IN A SINGLE SHEAR JOINT

PROTRUDING HEAD BLIND NAS1398 RIVETS IN CLAD OR BARE 2024-T3 SHEET (FOR THICKNESSES 0.056 THRU 0.125) SINGLE SHEAR JOINT STRENGTH

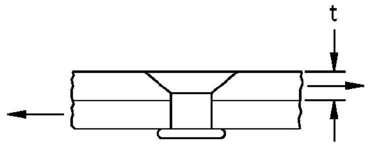
FASTENERS	PART NUMBERS	NAS1398B()				NAS1398D()			
FASTENERS	MATERIAL	5056 ALUMINUM SLEEVE 7075 ALUMINUM STEM				2017 ALUMINUM SLEEVE 7075 ALUMINUM STEM			
FASTENERS	D (DIAMETER INCHES)	1/8	5/32	3/16	1/4	1/8	5/32	3/16	1/4
FASTENERS		0.1250	0.1562	0.1875	0.2500	0.1250	0.1562	0.1875	0.2500
FASTENERS	SINGLE SHEAR STRENGTH (POUNDS)	388	595	860	1550	495	755	1090	1970
FASTENERS	TENSION (POUNDS)	230	375	540	1000	230	375	540	1000
FASTENERS	67% TENSION (POUNDS) [1]	154	251	361	670	154	251	361	670
t (THICKNESS INCHES) [2]		SINGLE SHEAR JOINT STRENGTH (POUNDS)							
0.056		--	555	715	1020	454	595	750	1050
0.063		--	595	780	1140	495	645	815	1200
0.071		--	--	855	1240	--	710	895	1300
0.080		--	--	860	1350	--	755	975	1420
0.090		--	--	--	1470	--	--	1070	1540
0.100		--	--	--	1550	--	--	1090	1670
0.112		--	--	--	--	--	--	--	1810
0.125		--	--	--	--	--	--	--	1970

[1] USE THE 67% TENSION VALUES WHEN BLIND RIVETS ARE USED IN PRIMARY OR LOAD REVERSING STRUCTURE.

[2] THE MINIMUM SHEET THICKNESS PERMITTED ON THE BLIND SIDE IS EQUAL TO 0.25 TIMES THE DIAMETER OF THE NAS1398 RIVET. FOR THINNER MATERIAL, USE ONE OF THE RIVETS SHOWN IN TABLE C.

TABLE B

Joint Shear Strength of Blind Rivets
Figure 4 (Sheet 2 of 7)



FLUSH HEAD BLIND RIVET IN
A SINGLE SHEAR JOINT

FLUSH HEAD BLIND NAS1399 RIVETS IN CLAD OR BARE 2024-T3 SHEET - SINGLE SHEAR JOINT STRENGTH

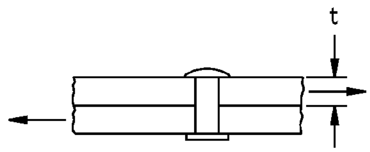
FASTENERS						
PART NUMBERS	NAS1399B()			NAS1399D()		
MATERIAL	5056 ALUMINUM SLEEVE 7075 ALUMINUM STEM			2017 ALUMINUM SLEEVE 7075 ALUMINUM STEM		
D (DIAMETER INCHES)	1/8	5/32	3/16	1/8	5/32	3/16
	0.1250	0.1562	0.1875	0.1250	0.1562	0.1875
SINGLE SHEAR STRENGTH (POUNDS)	388	595	860	495	755	1090
TENSION (POUNDS)	230	375	540	230	375	540
67% TENSION (POUNDS) [1]	154	251	361	154	251	361
t (THICKNESS INCHES) [2]	SINGLE SHEAR JOINT STRENGTH (POUNDS)					
0.045	139	--	--	139	--	--
0.050	171	--	--	171	--	--
0.056	228	217	--	223	217	--
0.063	295	273	--	295	273	--
0.071	366	367	330	370	367	330
0.080	388	474	456	423	474	456
0.090	--	580	598	459	594	598
0.100	--	595	739	495	650	739
0.112	--	--	800	--	700	865
0.125	--	--	860	--	755	970
0.140	--	--	--	--	--	1020
0.160	--	--	--	--	--	1090

[1] USE THE 67% TENSION VALUES WHEN BLIND RIVETS ARE USED IN PRIMARY OR LOAD REVERSING STRUCTURE.

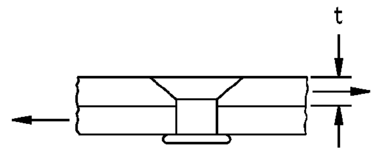
[2] THE MINIMUM SHEET THICKNESS PERMITTED ON THE BLIND SIDE IS EQUAL TO 0.25 TIMES THE DIAMETER OF THE NAS1399 RIVET.

TABLE C

Joint Shear Strength of Blind Rivets
Figure 4 (Sheet 3 of 7)



PROTRUDING HEAD BLIND RIVET
IN A SINGLE SHEAR JOINT



100° FLUSH HEAD BLIND RIVET
IN A SINGLE SHEAR JOINT

PROTRUDING AND FLUSH HEAD BLIND NAS1738 AND NAS1739 RIVETS IN CLAD OR BARE 2024-T3 SHEET (FOR THICKNESSES 0.020 THRU 0.050) SINGLE SHEAR JOINT STRENGTH

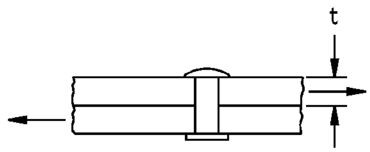
FASTENERS	HEAD STYLE	PROTRUDING HEAD			100° FLUSH HEAD		
FASTENERS	PART NUMBERS	NAS1738B() NAS1738E()			NAS1739B() NAS1739E()		
FASTENERS	MATERIAL	5056 ALUMINUM SLEEVE					
FASTENERS	D (DIAMETER INCHES) [1]	0.1250	0.1562	0.1875	0.1250	0.1562	0.1875
FASTENERS	SINGLE SHEAR STRENGTH (POUNDS)	620	935	1260	620	935	1260
FASTENERS	TENSION (POUNDS)	345	530	710	345	530	710
FASTENERS	67% TENSION (POUNDS) [2]	231	355	475	231	355	475
t (THICKNESS INCHES)		SINGLE SHEAR JOINT STRENGTH (POUNDS)					
0.020		199	216	228	--	--	--
0.025		267	305	330	--	--	--
0.028		310	358	391	--	--	--
0.032		368	428	473	--	--	--
0.036		397	496	555	239	--	--
0.040		427	565	635	266	--	--
0.045		453	605	725	305	--	--
0.050		480	650	815	344	410	--

[1] THE CORRECT DIAMETERS OF THE RIVETS ARE APPROXIMATELY 1/64 INCH LARGER THAN THE DIAMETERS GIVEN.

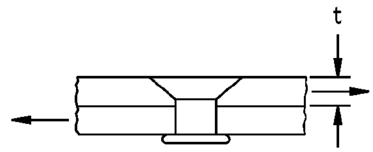
[2] USE THE 67% TENSION VALUES WHEN BLIND RIVETS ARE USED IN PRIMARY OR LOAD REVERSING STRUCTURE.

TABLE D

Joint Shear Strength of Blind Rivets
Figure 4 (Sheet 4 of 7)



PROTRUDING HEAD BLIND RIVET
IN A SINGLE SHEAR JOINT



100° FLUSH HEAD BLIND RIVET
IN A SINGLE SHEAR JOINT

PROTRUDING AND FLUSH HEAD BLIND NAS1738 AND NAS1739 RIVETS IN CLAD OR BARE 2024-T3 SHEET (FOR THICKNESSES 0.056 THRU 0.125) SINGLE SHEAR JOINT STRENGTH

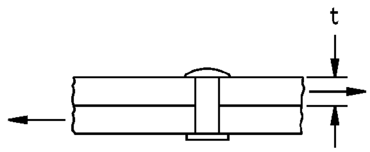
	PROTRUDING HEAD			100° FLUSH HEAD		
FASTENERS: HEAD STYLE	PROTRUDING HEAD			100° FLUSH HEAD		
FASTENERS: PART NUMBERS	NAS1738B() NAS1738E()			NAS1739B() NAS1739E()		
FASTENERS: MATERIAL	5056 ALUMINUM SLEEVE					
FASTENERS: D (DIAMETER INCHES) [1]	0.1250	0.1562	0.1875	0.1250	0.1562	0.1875
FASTENERS: SINGLE SHEAR STRENGTH (POUNDS)	620	935	1260	620	935	1260
FASTENERS: TENSION (POUNDS)	345	530	710	345	530	710
FASTENERS: 67% TENSION (POUNDS) [2]	231	355	475	231	355	475
t (THICKNESS INCHES)	SINGLE SHEAR JOINT STRENGTH (POUNDS)					
0.056	504	689	860	389	468	--
0.063	504	735	910	441	535	--
0.071	504	765	975	505	610	695
0.080	--	765	1027	555	695	795
0.090	--	--	1027	--	785	900
0.100	--	--	1027	--	835	1010
0.112	--	--	--	--	--	1070
0.125	--	--	--	--	--	1130

[1] THE CORRECT DIAMETERS OF THE RIVETS ARE APPROXIMATELY 1/64 INCH LARGER THAN THE DIAMETERS GIVEN.

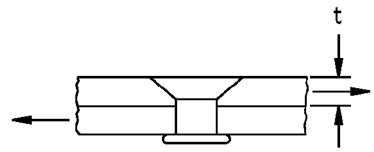
[2] USE THE 67% TENSION VALUES WHEN BLIND RIVETS ARE USED IN PRIMARY OR LOAD REVERSING STRUCTURE.

TABLE E

Joint Shear Strength of Blind Rivets
Figure 4 (Sheet 5 of 7)



PROTRUDING HEAD BLIND RIVET
IN A SINGLE SHEAR JOINT



100° FLUSH HEAD BLIND RIVET
IN A SINGLE SHEAR JOINT

PROTRUDING AND FLUSH HEAD BLIND NAS1738,NAS1739,BACR15FR,BACR15FP, BACR15GJ AND BACR15GK RIVETS IN CLAD OR BARE 7075-T6 SHEET (FOR THICKNESSES 0.020 THRU 0.056) SINGLE SHEAR JOINT STRENGTH

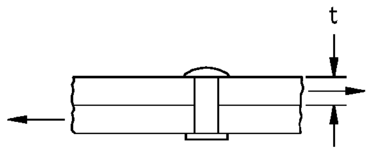
FASTENERS						
HEAD STYLE	PROTRUDING HEAD			100° FLUSH HEAD		
PART NUMBERS	NAS1738B() NAS1738E() BACR15FP()B()R BACB15FP()E()R BACR15FR()B BACB15FR()E BACR15FR()B()R			NAS1739B() NAS1739E() BACR15FP()B BACR15FP()E		
MATERIAL	SLEEVE - 5056-F					
D (DIAMETER INCHES) 1	1/8	5/32	3/16	1/8	5/32	3/16
	0.1250	0.1562	0.1875	0.1250	0.1562	0.1875
SINGLE SHEAR STRENGTH (POUNDS)	620	935	1260	620	935	1260
TENSION (POUNDS)	345	530	710	345	530	710
67% TENSION (POUNDS) 2	231	355	475	231	355	475
t (THICKNESS INCHES)	SINGLE SHEAR JOINT STRENGTH (POUNDS)					
0.020	268	--	--	--	--	--
0.025	292	409	--	--	--	--
0.032	328	454	570	--	--	--
0.036	355	477	600	228	--	--
0.040	372	500	630	256	--	--
0.045	396	535	675	286	--	--
0.050	426	565	710	324	394	--
0.056	459	615	755	360	445	--

1 THE CORRECT DIAMETERS OF THE RIVETS ARE APPROXIMATELY 1/64 INCH LARGER THAN THE DIAMETERS GIVEN.

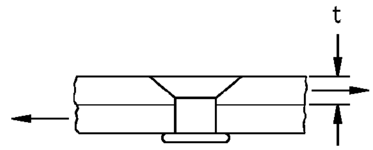
2 USE THE 67% TENSION VALUES WHEN BLIND RIVETS ARE USED IN PRIMARY OR LOAD REVERSING STRUCTURE.

TABLE F

Joint Shear Strength of Blind Rivets
Figure 4 (Sheet 6 of 7)



PROTRUDING HEAD BLIND RIVET
IN A SINGLE SHEAR JOINT



100° FLUSH HEAD BLIND RIVET
IN A SINGLE SHEAR JOINT

PROTRUDING AND FLUSH HEAD BLIND NAS1738,NAS1739,BACR15FR,BACR15FP,
BACR15GJ AND BACR15GK RIVETS IN CLAD OR BARE 7075-T6 SHEET
(FOR THICKNESSES 0.063 THRU 0.160) SINGLE SHEAR JOINT STRENGTH

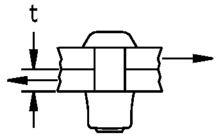
FASTENERS	PROTRUDING HEAD			100° FLUSH HEAD		
HEAD STYLE	PROTRUDING HEAD			100° FLUSH HEAD		
PART NUMBERS	NAS1738B() BACR15FP()B()R BACR15FR()B BACR15FR()B()R		NAS1738E() BACR15FP()E()R BACR15FR()E BACR15FR()E()R	NAS1739B() BACR15FP()B()R		NAS1739E() BACR15FP()E
MATERIAL	SLEEVE - 5056-F					
D (DIAMETER INCHES) 1	1/8	5/32	3/16	1/8	5/32	3/16
	0.1250	0.1562	0.1875	0.1250	0.1562	0.1875
SINGLE SHEAR STRENGTH (POUNDS)	620	935	1260	620	935	1260
TENSION (POUNDS)	345	530	710	345	530	710
67% TENSION (POUNDS) 2	231	355	475	231	355	475
t (THICKNESS INCHES)	SINGLE SHEAR JOINT STRENGTH (POUNDS)					
0.063	500	665	815	407	500	575
0.071	540	710	875	449	560	660
0.080	590	770	940	497	635	740
0.090	620	840	1020	545	695	835
0.100	--	900	1110	600	765	915
0.112	--	935	1200	620	840	1000
0.125	--	--	1260	--	920	1090
0.140	--	--	--	--	935	1210
0.160	--	--	--	--	--	1260

1 THE CORRECT DIAMETERS OF THE RIVETS ARE APPROXIMATELY 1/64 INCH LARGER THAN THE DIAMETERS GIVEN.

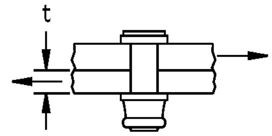
2 USE THE 67% TENSION VALUES WHEN BLIND RIVETS ARE USED IN PRIMARY OR LOAD REVERSING STRUCTURE.

TABLE G

Joint Shear Strength of Blind Rivets
Figure 4 (Sheet 7 of 7)



TENSION PROTRUDING HEAD
LOCKBOLT IN A
SINGLE SHEAR JOINT



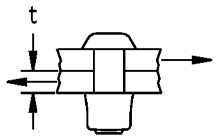
PROTRUDING HEAD
HEX DRIVE BOLT IN A
SINGLE SHEAR JOINT

TENSION PROTRUDING HEAD LOCKBOLTS AND HEX DRIVE BOLTS IN CLAD OR BARE 2024-T3 SHEET AND 2024-T351 PLATE (FOR THICKNESSES 0.032 THRU 0.100) SINGLE SHEAR JOINT STRENGTH

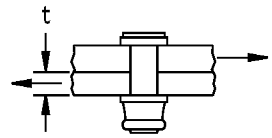
FASTENERS							
PART NUMBERS	NAS1465 THRU NAS1472, NAS6965 THRU NAS6972, BACB30DX(), BACB30MB(), BACB30HC(), BACB30NX()					BACB30MB() BACB30NX()	
		BACB30UB()					
MATERIAL	ALLOY STEEL, A286, OR 6AL-4V TITANIUM (95 KSI SHEAR STRENGTH)						
D (DIAMETER INCHES)	5/32	3/16	1/4	5/16	3/8	7/16	1/2
	0.1640	0.1900	0.2500	0.3125	0.3750	0.4375	0.5000
SINGLE SHEAR STRENGTH (POUNDS)	2000	2690	4650	7300	10500	14300	18600
t (THICKNESS INCHES)	SINGLE SHEAR JOINT STRENGTH (POUNDS)						
0.032	510	--	--	--	--	--	--
0.036	575	665	--	--	--	--	--
0.040	635	735	--	--	--	--	--
0.045	715	830	--	--	--	--	--
0.050	795	920	1210	--	--	--	--
0.056	890	1030	1360	--	--	--	--
0.063	1040	1210	1590	1990	--	--	--
0.071	1180	1360	1790	2240	2690	--	--
0.080	1330	1540	2020	2520	3030	3530	--
0.090	1490	1730	2270	2840	3410	3980	--
0.100	1660	1920	2520	3160	3790	4420	5050

TABLE A

Joint Shear Strength of Tension Protruding Head, 95 KSI Shear Strength, Lockbolts and Hex Drive Bolts
Figure 5 (Sheet 1 of 6)



TENSION PROTRUDING HEAD
LOCKBOLT IN A
SINGLE SHEAR JOINT

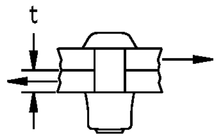


PROTRUDING HEAD
HEX DRIVE BOLT IN A
SINGLE SHEAR JOINT

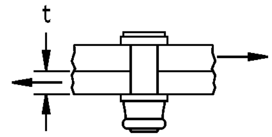
TENSION PROTRUDING HEAD LOCKBOLTS AND HEX DRIVE BOLTS IN CLAD OR BARE 2024-T3 SHEET AND 2024-T351 PLATE (FOR THICKNESSES 0.112 THRU 0.500) SINGLE SHEAR JOINT STRENGTH							
FASTENERS: PART NUMBERS	NAS1465 THRU NAS1472 NAS6965 THRU NAS6972 BACB30DX() BACB30MB() BACB30HC() BACB30NX()					BACB30MB() BACB30NX()	
		BACB30UB()					
FASTENERS: MATERIAL	ALLOY STEEL, A286, OR 6AL-4V TITANIUM (95 KSI SHEAR STRENGTH)						
FASTENERS: D (DIAMETER INCHES)	5/32	3/16	1/4	5/16	3/8	7/16	1/2
	0.1640	0.1900	0.2500	0.3125	0.3750	0.4375	0.5000
FASTENERS: SINGLE SHEAR STRENGTH (POUNDS)	2000	2690	4650	7300	10500	14300	18600
t (THICKNESS INCHES)	SINGLE SHEAR JOINT STRENGTH (POUNDS)						
0.112	1860	2150	2830	3530	4240	4950	5650
0.125	2000	2400	3160	3950	4730	5500	6300
0.140	--	2690	3570	4460	5350	6250	7150
0.160	--	--	4080	5100	6100	7150	8150
0.180	--	--	4590	5750	6900	8050	9200
0.200	--	--	4650	6350	7650	8900	10200
0.224	--	--	--	7150	8550	10000	11400
0.250	--	--	--	7300	8900	10400	11900
0.312	--	--	--	--	10500	13000	14800
0.375	--	--	--	--	--	14300	17800
0.500	--	--	--	--	--	--	18600

TABLE B

Joint Shear Strength of Tension Protruding Head, 95 KSI Shear Strength, Lockbolts and Hex Drive Bolts
Figure 5 (Sheet 2 of 6)



TENSION PROTRUDING HEAD
LOCKBOLT IN A
SINGLE SHEAR JOINT

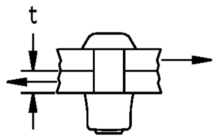


PROTRUDING HEAD
HEX DRIVE BOLT IN A
SINGLE SHEAR JOINT

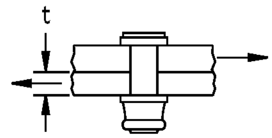
TENSION PROTRUDING HEAD LOCKBOLTS AND HEX DRIVE BOLTS IN CLAD OR BARE 2024-T42 SHEET AND PLATE, CLAD 2024-T4 SHEET AND PLATE, AND 2024-T42 TUBE (FOR THICKNESSES 0.032 THRU 0.100) SINGLE SHEAR JOINT STRENGTH							
FASTENERS: PART NUMBERS	NAS1465 THRU NAS1472 NAS6965 THRU NAS6972 BACB30DX() BACB30MB() BACB30HC() BACB30NX()					BACB30MB() BACB30NX()	
		BACB30UB()					
FASTENERS: MATERIAL	ALLOY STEEL, A286, OR 6AL-4V TITANIUM (95 KSI SHEAR STRENGTH)						
FASTENERS: D (DIAMETER INCHES)	5/32	3/16	1/4	5/16	3/8	7/16	1/2
	0.1640	0.1900	0.2500	0.3125	0.3750	0.4375	0.5000
FASTENERS: SINGLE SHEAR STRENGTH (POUNDS)	2000	2690	4650	7300	10500	14300	18600
t (THICKNESS INCHES)	SINGLE SHEAR JOINT STRENGTH (POUNDS)						
0.032	409	--	--	--	--	--	--
0.036	460	534	--	--	--	--	--
0.040	511	592	--	--	--	--	--
0.045	576	667	--	--	--	--	--
0.050	639	741	975	--	--	--	--
0.056	717	832	1095	--	--	--	--
0.063	870	1005	1320	1650	--	--	--
0.071	975	1132	1492	1860	2235	--	--
0.080	1102	1275	1680	2100	2520	--	--
0.090	1237	1440	1890	2355	2835	3300	3780
0.100	1380	1590	2100	2625	3150	3675	4200

TABLE C

Joint Shear Strength of Tension Protruding Head, 95 KSI Shear Strength, Lockbolts and Hex Drive Bolts
Figure 5 (Sheet 3 of 6)



TENSION PROTRUDING HEAD
LOCKBOLT IN A
SINGLE SHEAR JOINT



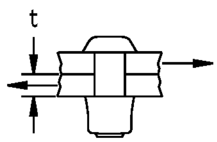
PROTRUDING HEAD
HEX DRIVE BOLT IN A
SINGLE SHEAR JOINT

TENSION PROTRUDING HEAD LOCKBOLTS AND HEX DRIVE BOLTS IN CLAD OR BARE 2024-T42 SHEET AND PLATE, CLAD 2024-T4 SHEET AND PLATE, AND 2024-T42 TUBE (FOR THICKNESSES 0.112 THRU 0.375) SINGLE SHEAR JOINT STRENGTH

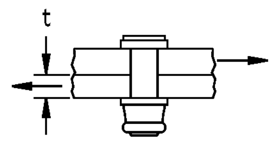
FASTENERS							
PART NUMBERS	NAS1465 THRU NAS1472 BACB30MB() NAS6965 THRU NAS6972 BACB30HC() BACB30DX() BACB30NX()					BACB30MB() BACB30NX()	
		BACB30UB()					
MATERIAL	ALLOY STEEL, A286, OR 6AL-4V TITANIUM (95 KSI SHEAR STRENGTH)						
D (DIAMETER INCHES)	5/32	3/16	1/4	5/16	3/8	7/16	1/2
	0.1640	0.1900	0.2500	0.3125	0.3750	0.4375	0.5000
SINGLE SHEAR STRENGTH (POUNDS)	2000	2690	4650	7300	10500	14300	18600
t (THICKNESS INCHES)	SINGLE SHEAR JOINT STRENGTH (POUNDS)						
0.112	1545	1785	2355	2940	3525	4110	4710
0.125	1725	1995	2625	3285	3930	4590	5250
0.140	--	2235	2940	3675	4410	5145	5880
0.160	--	--	3360	4200	5040	5880	6720
0.180	--	--	3780	4725	5670	6615	7575
0.200	--	--	4200	5250	6300	7350	8400
0.224	--	--	--	5880	7050	8250	9375
0.250	--	--	--	6210	7455	8700	9900
0.312	--	--	--	--	9300	10882	12375
0.375	--	--	--	--	--	13050	14925

TABLE D

Joint Shear Strength of Tension Protruding Head, 95 KSI Shear Strength, Lockbolts and Hex Drive Bolts
Figure 5 (Sheet 4 of 6)



TENSION PROTRUDING HEAD
LOCKBOLT IN A
SINGLE SHEAR JOINT



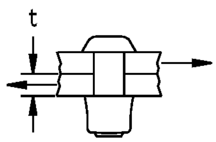
PROTRUDING HEAD
HEX DRIVE BOLT IN A
SINGLE SHEAR JOINT

TENSION PROTRUDING HEAD LOCKBOLTS AND HEX DRIVE BOLTS IN CLAD OR BARE 7075-T6 SHEET AND 7075-T651 PLATE; AND 7075-T6, 7075-T6510,7075-T6511, EXTRUSION LESS THAN 0.188 INCH THICK - (FOR THICKNESSES 0.032 THRU 0.100 INCH) SINGLE SHEAR JOINT STRENGTH

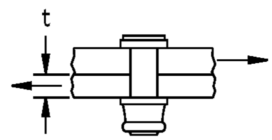
FASTENERS	5/32	3/16	1/4	5/16	3/8	7/16	1/2
PART NUMBERS	NAS1465 THRU NAS1472, NAS6965 THRU NAS6972, BACB30DX(), BACB30MB(), BACB30HC(), BACB30NX()					BACB30MB(), BACB30NX()	
		BACB30UB()					
MATERIAL	ALLOY STEEL, A286, OR 6AL-4V TITANIUM (95 KSI SHEAR STRENGTH)						
D (DIAMETER INCHES)	5/32	3/16	1/4	5/16	3/8	7/16	1/2
	0.1640	0.1900	0.2500	0.3125	0.3750	0.4375	0.5000
SINGLE SHEAR STRENGTH (POUNDS)	2000	2690	4650	7300	10500	14300	18600
t (THICKNESS INCHES)	SINGLE SHEAR JOINT STRENGTH (POUNDS)						
0.032	595	--	--	--	--	--	--
0.036	665	775	--	--	--	--	--
0.040	755	875	--	--	--	--	--
0.045	850	985	--	--	--	--	--
0.050	945	1090	1440	--	--	--	--
0.056	1060	1220	1610	--	--	--	--
0.063	1200	1390	1830	2280	--	--	--
0.071	1350	1560	2060	2570	3090	--	--
0.080	1520	1760	2320	2900	3480	4060	--
0.090	1710	1980	2610	3260	3910	4570	--
0.100	1900	2200	2900	3620	4350	5050	5800

TABLE E

Joint Shear Strength of Tension Protruding Head, 95 KSI Shear Strength, Lockbolts and Hex Drive Bolts
Figure 5 (Sheet 5 of 6)



TENSION PROTRUDING HEAD
LOCKBOLT IN A
SINGLE SHEAR JOINT

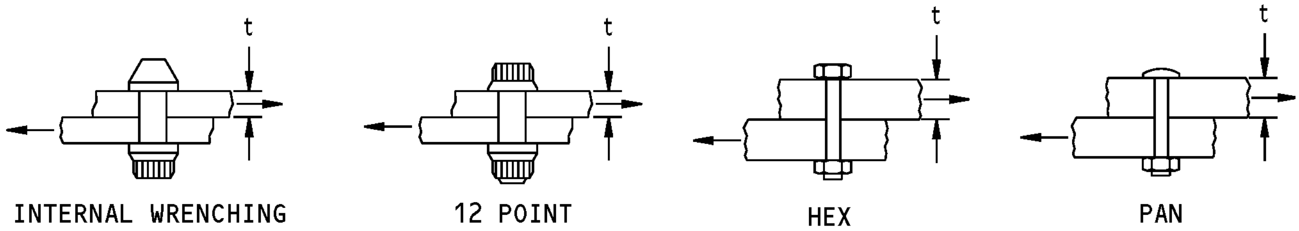


PROTRUDING HEAD
HEX DRIVE BOLT IN A
SINGLE SHEAR JOINT

TENSION PROTRUDING HEAD LOCKBOLTS AND HEX DRIVE BOLTS IN CLAD OR BARE 7075-T6 SHEET AND 7075-T651 PLATE; AND 7075-T6,7075-T6510,7075-T6511, EXTRUSION LESS THAN 0.188 INCH THICK - (FOR THICKNESS 0.112 THRU 0.375 INCH) SINGLE SHEAR JOINT STRENGTH							
FASTENERS: PART NUMBERS	NAS1465 THRU NAS1472 NAS6965 THRU NAS6972 BACB30DX() BACB30MB() BACB30HC() BACB30NX()					BACB30MB() BACB30NX()	
		BACB30UB()					
FASTENERS: MATERIAL	ALLOY STEEL, A286, OR 6AL-4V TITANIUM (95 KSI SHEAR STRENGTH)						
FASTENERS: D (DIAMETER INCHES)	5/32	3/16	1/4	5/16	3/8	7/16	1/2
	0.1640	0.1900	0.2500	0.3125	0.3750	0.4375	0.5000
FASTENERS: SINGLE SHEAR STRENGTH (POUNDS)	2000	2690	4650	7300	10500	14300	18600
t (THICKNESS INCHES)	SINGLE SHEAR JOINT STRENGTH (POUNDS)						
0.112	2000	2470	3250	4060	4870	5700	6500
0.125	--	2690	3620	4530	5450	6350	7250
0.140	--	--	4060	5050	6100	7100	8100
0.160	--	--	4640	5800	6950	8100	9300
0.180	--	--	4650	6500	7850	9150	10400
0.200	--	--	--	7300	8900	10400	11900
0.224	--	--	--	--	10000	11700	13300
0.250	--	--	--	--	10500	12400	14100
0.312	--	--	--	--	--	14300	17600
0.375	--	--	--	--	--	--	18600

TABLE F

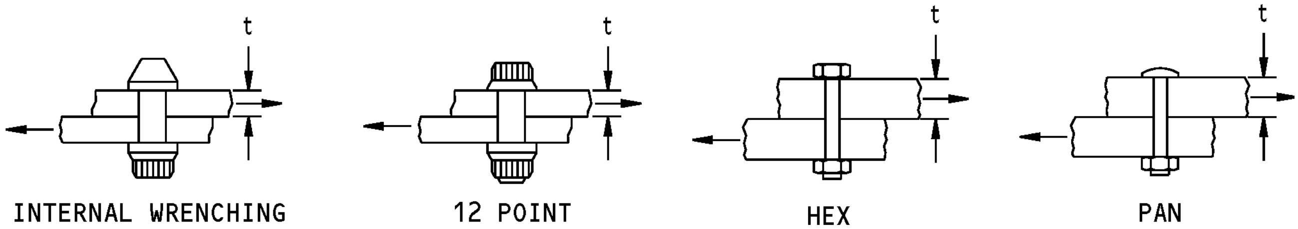
Joint Shear Strength of Tension Protruding Head, 95 KSI Shear Strength, Lockbolts and Hex Drive Bolts
Figure 5 (Sheet 6 of 6)



TENSION PROTRUDING HEAD BOLTS AND HEX DRIVE BOLTS IN CLAD OR BARE 2024-T3 SHEET AND 2024-T351 PLATE (FOR THICKNESSES 0.036 THRU 0.100 INCH) SINGLE SHEAR JOINT STRENGTH 3/16 TO 1/2 INCH DIAMETER FASTENERS							
FASTENERS	PART NUMBERS	MS20004 THRU MS20024 NAS623-2 THRU NAS623-6 NAS673 THRU NAS678 NAS1218-04 THRU NAS1218-08 NAS1223 THRU NAS1235 NAS1303 THRU NAS1320 NAS6603 THRU NAS6620 NAS6703 THRU NAS6720 NAS6803 THRU NAS6820	BACB30LJ() BACB30LK() BACB30LM() BACB30LN() BACB30MR() BACB30NE() BACB30NF() BACB30NM()	BACB30NR() BACB30NT() BACB30PF() BACB30PU() BACB30PW() BACB30UG()			
	MATERIAL	ALLOY STEEL, A286, OR 6AL-4V TITANIUM (95 KSI SHEAR STRENGTH)					
	D (DIAMETER INCHES)	3/16	1/4	5/16	3/8	7/16	1/2
		0.1900	0.2500	0.3125	0.3750	0.4375	0.5000
	SINGLE SHEAR STRENGTH (POUNDS)	2690	4650	7300	10500	14300	18600
t (THICKNESS INCHES)		SINGLE SHEAR JOINT STRENGTH (POUNDS)					
0.036		665	--	--	--	--	--
0.040		735	--	--	--	--	--
0.045		830	--	--	--	--	--
0.050		920	1210	--	--	--	--
0.056		1030	1360	--	--	--	--
0.063		1210	1590	1990	--	--	--
0.071		1360	1790	2240	2690	--	--
0.080		1540	2020	2520	3030	3530	--
0.090		1730	2270	2840	3410	3980	--
0.100		1920	2520	3160	3790	4420	5050

TABLE A

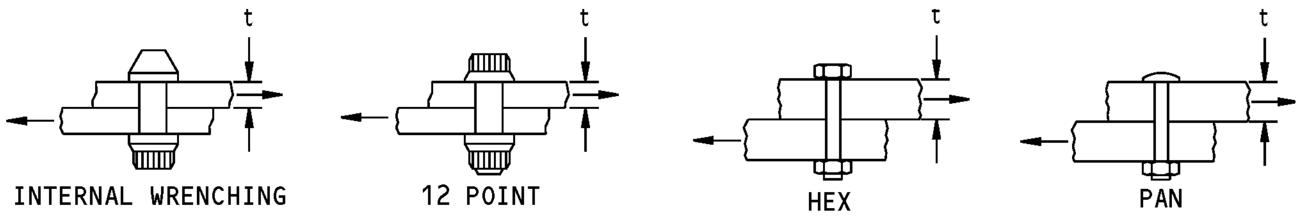
Joint Shear Strength of Tension Protruding Head, 95 KSI Shear Joint Strength, Bolts
Figure 6 (Sheet 1 of 10)



TENSION PROTRUDING HEAD BOLTS AND HEX DRIVE BOLTS IN CLAD OR BARE 2024-T3 SHEET AND 2024-T351 PLATE (FOR THICKNESSES 0.112 THRU 0.500 INCH) SINGLE SHEAR JOINT STRENGTH 3/16 TO 1/2 INCH DIAMETER FASTENERS						
FASTENERS: PART NUMBERS	MS20004 THRU MS20024 NAS623-2 THRU NAS623-6 NAS673 THRU NAS678 NAS1218-04 THRU NAS1218-08 NAS1223 THRU NAS1235 NAS1303 THRU NAS1320 NAS6603 THRU NAS6620 NAS6703 THRU NAS6720 NAS6803 THRU NAS6820	BACB30LJ() BACB30LK() BACB30LM() BACB30LN() BACB30MR() BACB30NE() BACB30NF() BACB30NM()	BACB30NR() BACB30NT() BACB30PF() BACB30PU() BACB30PW() BACB30UG()			
FASTENERS: MATERIAL	ALLOY STEEL, A286, OR 6AL-4V TITANIUM (95 KSI SHEAR STRENGTH)					
D (DIAMETER INCHES)	3/16	1/4	5/16	3/8	7/16	1/2
	0.1900	0.2500	0.3125	0.3750	0.4375	0.5000
SINGLE SHEAR STRENGTH (POUNDS)	2690	4650	7300	10500	14300	18600
t (THICKNESS INCHES)	SINGLE SHEAR JOINT STRENGTH (POUNDS)					
0.112	2150	2830	3530	4240	4950	5650
0.125	2400	3160	3950	4730	5500	6300
0.140	2690	3570	4460	5350	6250	7150
0.160	--	4080	5100	6100	7150	8150
0.180	--	4590	5750	6900	8050	9200
0.200	--	4650	6350	7650	8900	10200
0.224	--	--	7150	8550	10000	11400
0.250	--	--	7300	8900	10400	11900
0.312	--	--	--	10500	13000	14800
0.375	--	--	--	--	14300	17800
0.500	--	--	--	--	--	18600

TABLE B

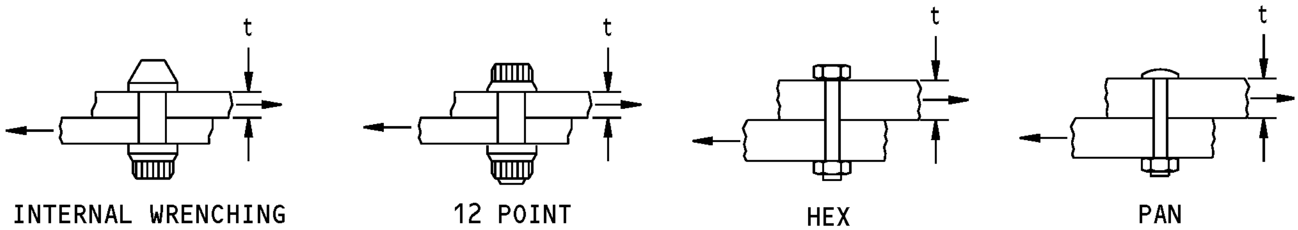
Joint Shear Strength of Tension Protruding Head, 95 KSI Shear Joint Strength, Bolts
Figure 6 (Sheet 2 of 10)



TENSION PROTRUDING HEAD BOLTS AND HEX DRIVE BOLTS IN CLAD OR BARE 2024-T3 SHEET AND 2024-T351 PLATE - SINGLE SHEAR JOINT STRENGTH 9/16 TO 1 INCH DIAMETER FASTENERS					
FASTENERS: PART NUMBERS	MS20004 THRU MS20024 NAS623-2 THRU NAS623-6 NAS673 THRU NAS678 NAS1218-04 THRU NAS1218-08 NAS1223 THRU NAS1235 NAS1303 THRU NAS1320 NAS6603 THRU NAS6620 NAS6703 THRU NAS6720 NAS6803 THRU NAS6820	BACB30LJ() BACB30LK() BACB30LM() BACB30LN() BACB30MR() BACB30NE() BACB30NF() BACB30NM()	BACB30NR() BACB30NT() BACB30PF() BACB30PU() BACB30PW() BACB30UG()		
FASTENERS: MATERIAL	ALLOY STEEL, A286, OR 6AL-4V TITANIUM (95 KSI SHEAR STRENGTH)				
FASTENERS: D (DIAMETER INCHES)	9/16	5/8	3/4	7/8	1
	0.5625	0.6250	0.7500	0.8750	1.0000
FASTENERS: SINGLE SHEAR STRENGTH (POUNDS)	23600	29100	41900	57000	74500
t (THICKNESS INCHES)	SINGLE SHEAR JOINT STRENGTH (POUNDS)				
0.112	6350	--	--	--	--
0.125	7100	7900	--	--	--
0.140	8050	8900	10700	--	--
0.160	9200	10200	12200	14300	--
0.180	10300	11500	13800	16100	--
0.200	11500	12700	15300	17800	20400
0.224	12900	14300	17100	20000	22800
0.250	13400	14800	17800	20800	23700
0.312	16700	18500	22200	25900	29600
0.375	20000	22300	26700	31200	35600
0.500	23600	29100	34900	40700	46500
0.562	--	--	39200	45700	52500
0.625	--	--	41900	51000	58000
0.750	--	--	--	57000	69500
0.812	--	--	--	--	74500

TABLE C

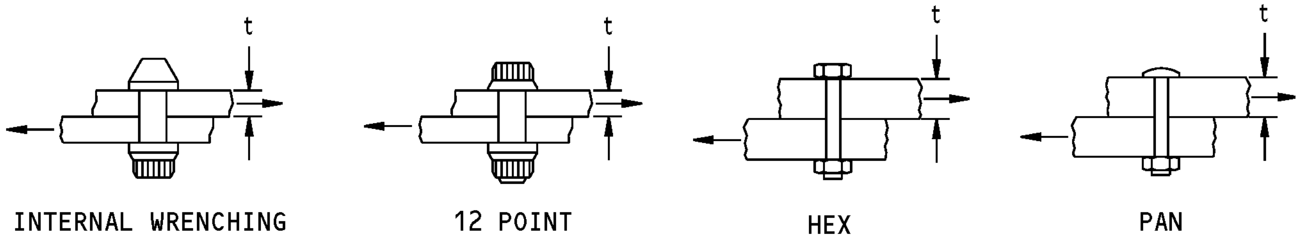
Joint Shear Strength of Tension Protruding Head, 95 KSI Shear Joint Strength, Bolts
Figure 6 (Sheet 3 of 10)



TENSION PROTRUDING HEAD BOLTS IN CLAD OR BARE 2024-T42 SHEET AND PLATE, CLAD 2024-T4 SHEET AND PLATE, AND 2024-T42 TUBE (FOR THICKNESSES 0.036 THRU 0.100 INCH) SINGLE SHEAR JOINT STRENGTH 3/16 TO 1/2 INCH DIAMETER FASTENERS						
FASTENERS: PART NUMBERS	MS20004 THRU MS20024 NAS623-2 THRU NAS623-6 NAS673 THRU NAS678 NAS1218-04 THRU NAS1218-08 NAS1223 THRU NAS1235 NAS1303 THRU NAS1320 NAS6603 THRU NAS6620 NAS6703 THRU NAS6720 NAS6803 THRU NAS6820	BACB30LJ() BACB30LK() BACB30LM() BACB30LN() BACB30MR() BACB30NE() BACB30NF() BACB30NM()	BACB30NR() BACB30NT() BACB30PF() BACB30PU() BACB30PW() BACB30UG()			
FASTENERS: MATERIAL	ALLOY STEEL, A286, OR 6AL-4V TITANIUM (95 KSI SHEAR STRENGTH)					
FASTENERS: D (DIAMETER INCHES)	3/16	1/4	5/16	3/8	7/16	1/2
	0.1900	0.2500	0.3125	0.3750	0.4375	0.5000
FASTENERS: SINGLE SHEAR STRENGTH (POUNDS)	2690	4650	7300	10500	14300	18600
t (THICKNESS INCHES)	SINGLE SHEAR JOINT STRENGTH (POUNDS)					
0.036	534	--	--	--	--	--
0.040	592	--	--	--	--	--
0.045	667	--	--	--	--	--
0.050	741	975	--	--	--	--
0.056	832	1095	--	--	--	--
0.063	1005	1320	1650	--	--	--
0.071	1132	1492	1860	2235	--	--
0.080	1275	1680	2100	2520	--	--
0.090	1440	1890	2355	2835	3300	3780
0.100	1590	2100	2625	3150	3675	4200

TABLE D

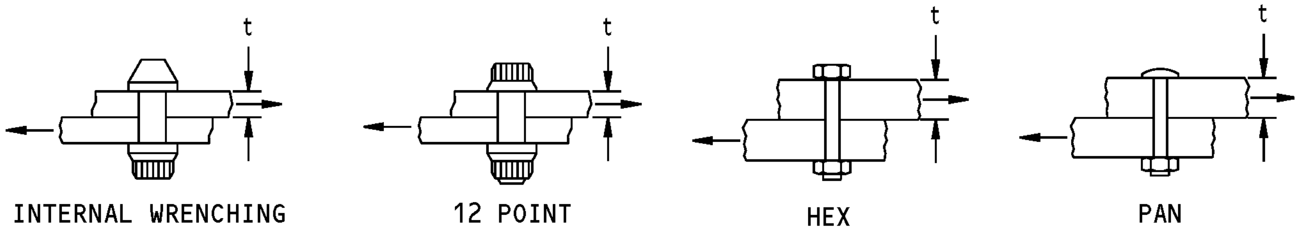
Joint Shear Strength of Tension Protruding Head, 95 KSI Shear Joint Strength, Bolts
Figure 6 (Sheet 4 of 10)



TENSION PROTRUDING HEAD BOLTS IN CLAD OR BARE 2024-T42 SHEET AND PLATE, CLAD 2024-T4 SHEET AND PLATE, AND 2024-T42 TUBE (FOR THICKNESSES 0.112 THRU 0.375 INCH) SINGLE SHEAR JOINT STRENGTH 3/16 TO 1/2 INCH DIAMETER FASTENERS						
FASTENERS: PART NUMBERS	MS20004 THRU MS20024 NAS623-2 THRU NAS623-6 NAS673 THRU NAS678 NAS1218-04 THRU NAS1218-08 NAS1223 THRU NAS1235 NAS1303 THRU NAS1320 NAS6603 THRU NAS6620 NAS6703 THRU NAS6720 NAS6803 THRU NAS6820	BACB30LJ() BACB30LK() BACB30LM() BACB30LN() BACB30MR() BACB30NE() BACB30NF() BACB30NM()	BACB30NR() BACB30NT() BACB30PF() BACB30PU() BACB30PW() BACB30UG()			
FASTENERS: MATERIAL	ALLOY STEEL, A286, OR 6AL-4V TITANIUM (95 KSI SHEAR STRENGTH)					
FASTENERS: D (DIAMETER INCHES)	3/16	1/4	5/16	3/8	7/16	1/2
	0.1900	0.2500	0.3125	0.3750	0.4375	0.5000
FASTENERS: SINGLE SHEAR STRENGTH (POUNDS)	2690	4650	7300	10500	14300	18600
t (THICKNESS INCHES)	SINGLE SHEAR JOINT STRENGTH (POUNDS)					
0.112	1785	2355	2940	3525	4110	4710
0.125	1995	2625	3285	3930	4590	5250
0.140	2235	2940	3675	4410	5145	5880
0.160	--	3360	4200	5040	5880	6720
0.180	--	3780	4725	5670	6615	7575
0.200	--	4200	5250	6300	7350	8400
0.224	--	--	5880	7050	8250	9375
0.250	--	--	6210	7455	8700	9900
0.312	--	--	--	9300	10875	12375
0.375	--	--	--	--	13050	14925

TABLE E

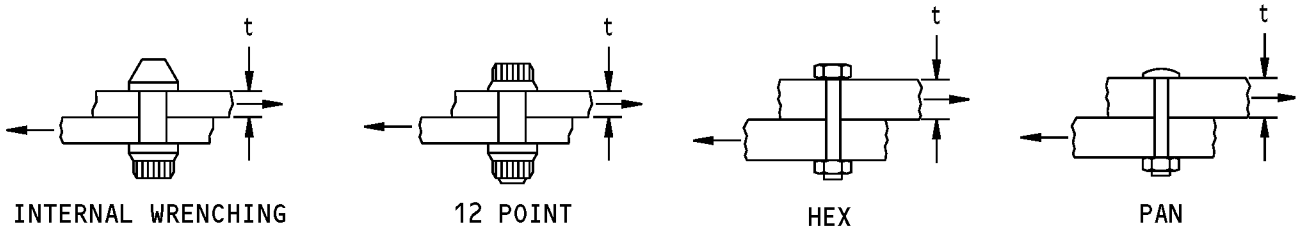
Joint Shear Strength of Tension Protruding Head, 95 KSI Shear Joint Strength, Bolts
Figure 6 (Sheet 5 of 10)



TENSION PROTRUDING HEAD BOLTS IN CLAD OR BARE 2024-T42 SHEET AND PLATE, CLAD 2024-T4 SHEET AND PLATE, AND 2024-T42 TUBE (FOR THICKNESSES 0.090 THRU 0.200 INCH) SINGLE SHEAR JOINT STRENGTH 9/16 TO 1 INCH DIAMETER FASTENERS						
FASTENERS	PART NUMBERS	MS20004 THRU MS20024 NAS623-2 THRU NAS623-6 NAS673 THRU NAS678 NAS1218-04 THRU NAS1218-08 NAS1223 THRU NAS1235 NAS1303 THRU NAS1320 NAS6603 THRU NAS6620 NAS6703 THRU NAS6720 NAS6803 THRU NAS6820	BACB30LJ() BACB30LK() BACB30LM() BACB30LN() BACB30MR() BACB30NE() BACB30NF() BACB30NM()	BACB30NR() BACB30NT() BACB30PF() BACB30PU() BACB30PW() BACB30UG()		
FASTENERS	MATERIAL	ALLOY STEEL, A286, OR 6AL-4V TITANIUM (95 KSI SHEAR STRENGTH)				
FASTENERS	D (DIAMETER INCHES)	9/16	5/8	3/4	7/8	1
FASTENERS	D (DIAMETER INCHES)	0.5625	0.6250	0.7500	0.8750	1.0000
FASTENERS	SINGLE SHEAR STRENGTH (POUNDS)	23600	29100	41900	57000	74500
t (THICKNESS INCHES)		SINGLE SHEAR JOINT STRENGTH (POUNDS)				
0.090		4245	--	--	--	--
0.100		4725	--	--	--	--
0.112		5295	--	--	--	--
0.125		5910	6555	--	--	--
0.140		6615	7350	8850	--	--
0.160		7575	8400	10050	11775	--
0.180		8475	9450	11325	13200	15150
0.200		9450	10500	12600	14700	16800

TABLE F

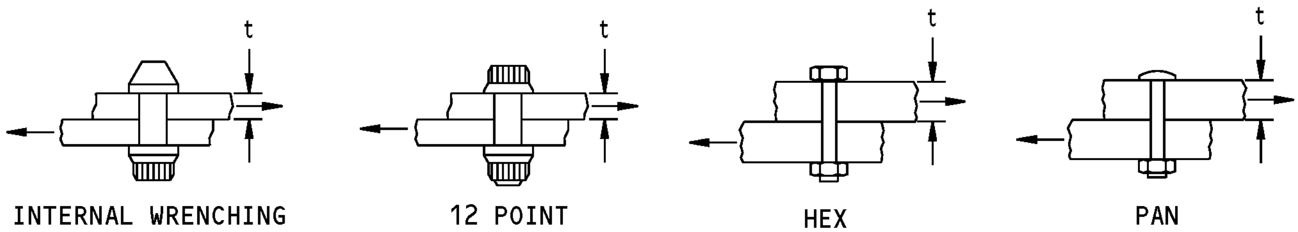
Joint Shear Strength of Tension Protruding Head, 95 KSI Shear Joint Strength, Bolts
Figure 6 (Sheet 6 of 10)



TENSION PROTRUDING HEAD BOLTS IN CLAD OR BARE 2024-T42 SHEET AND PLATE, CLAD 2024-T4 SHEET AND PLATE, AND 2024-T42 TUBE (FOR THICKNESSES 0.224 THRU 1.000 INCH) SINGLE SHEAR JOINT STRENGTH 9/16 TO 1 INCH DIAMETER FASTENERS						
FASTENERS	PART NUMBERS	MS20004 THRU MS20024 NAS623-2 THRU NAS623-6 NAS673 THRU NAS678 NAS1218-04 THRU NAS1218-08 NAS1223 THRU NAS1235 NAS1303 THRU NAS1320 NAS6603 THRU NAS6620 NAS6703 THRU NAS6720 NAS6803 THRU NAS6820	BACB30LJ() BACB30LK() BACB30LM() BACB30LN() BACB30MR() BACB30NE() BACB30NF() BACB30NM()	BACB30NR() BACB30NT() BACB30PF() BACB30PU() BACB30PW() BACB30UG()		
	MATERIAL	ALLOY STEEL, A286, OR 6AL-4V TITANIUM (95 KSI SHEAR STRENGTH)				
	D (DIAMETER INCHES)	9/16	5/8	3/4	7/8	1
		0.5625	0.6250	0.7500	0.8750	1.0000
	SINGLE SHEAR STRENGTH (POUNDS)	23600	29100	41900	57000	74500
t (THICKNESS INCHES)		SINGLE SHEAR JOINT STRENGTH (POUNDS)				
0.224		10575	11775	14100	16500	18750
0.250		11175	12450	14925	17400	21000
0.312		13950	15450	18600	21750	26250
0.375		16800	18600	22350	26100	31500
0.500		22350	24900	29850	34800	42000
0.562		--	--	33450	39150	47250
0.625		--	--	37200	43500	52500
0.750		--	--	--	52200	63000
1.000		--	--	--	--	74500

TABLE G

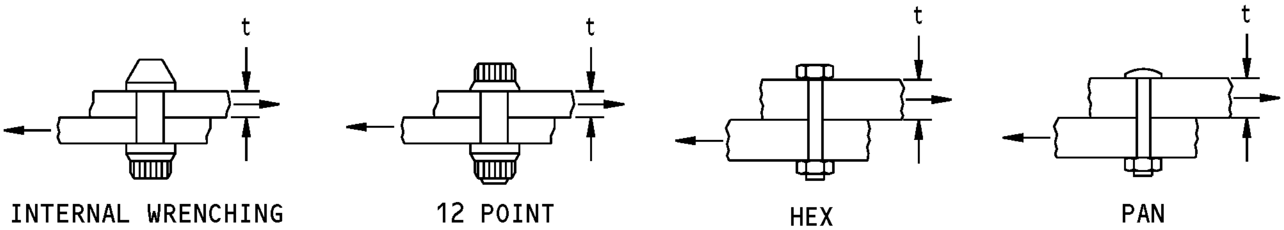
Joint Shear Strength of Tension Protruding Head, 95 KSI Shear Joint Strength, Bolts
Figure 6 (Sheet 7 of 10)



TENSION PROTRUDING HEAD BOLTS IN CLAD OR BARE 7075-T6 SHEET, 7075-T651 PLATE, AND 7075-T6, 7075-T6510, 7075-T6511 EXTRUSIONS LESS THAN 0.188 INCH THICK (FOR THICKNESSES 0.036 THRU 0.100 INCH) SINGLE SHEAR JOINT STRENGTH 3/16 TO 1/2 INCH DIAMETER FASTENERS						
FASTENERS: PART NUMBERS	MS20004 THRU MS20024 NAS623-2 THRU NAS623-6 NAS673 THRU NAS678 NAS1218-04 THRU NAS1218-08 NAS1223 THRU NAS1235 NAS1303 THRU NAS1320 NAS6603 THRU NAS6620 NAS6703 THRU NAS6720 NAS6803 THRU NAS6820			BACB30LJ() BACB30LK() BACB30LM() BACB30LN() BACB30MR() BACB30NE() BACB30NF() BACB30NM()		BACB30NR() BACB30NT() BACB30PF() BACB30PU() BACB30PW() BACB30UG()
FASTENERS: MATERIAL	ALLOY STEEL, A286, OR 6AL-4V TITANIUM (95 KSI SHEAR STRENGTH)					
FASTENERS: D (DIAMETER INCHES)	3/16	1/4	5/16	3/8	7/16	1/2
	0.1900	0.2500	0.3125	0.3750	0.4375	0.5000
FASTENERS: SINGLE SHEAR STRENGTH (POUNDS)	2690	4650	7300	10500	14300	18600
t (THICKNESS INCHES)	SINGLE SHEAR JOINT STRENGTH (POUNDS)					
0.036	775	--	--	--	--	--
0.040	875	--	--	--	--	--
0.045	985	--	--	--	--	--
0.050	1090	1440	--	--	--	--
0.056	1220	1610	--	--	--	--
0.063	1390	1830	2280	--	--	--
0.071	1560	2060	2570	3090	--	--
0.080	1760	2320	2900	3480	4060	--
0.090	1980	2610	3260	3910	4570	--
0.100	2200	2900	3620	4350	5050	5800

TABLE H

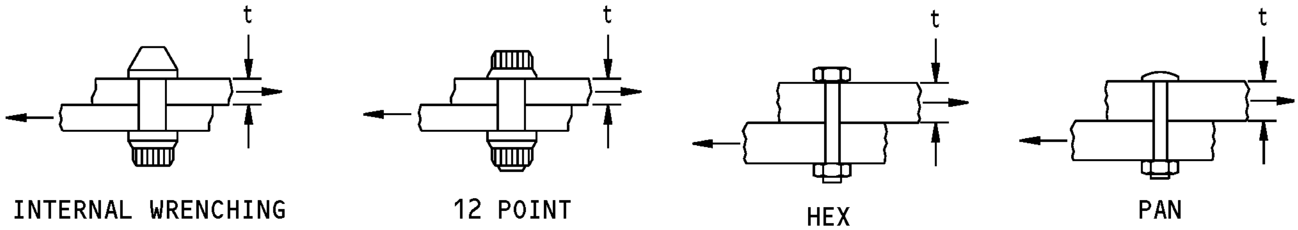
Joint Shear Strength of Tension Protruding Head, 95 KSI Shear Joint Strength, Bolts
Figure 6 (Sheet 8 of 10)



TENSION PROTRUDING HEAD BOLTS IN CLAD OR BARE 7075-T6 SHEET, 7075-T651 PLATE, AND 7075-T6, 7075-T6510, 7075-T6511 EXTRUSIONS LESS THAN 0.188 INCH THICK (FOR THICKNESSES 0.112 THRU 0.375 INCH) SINGLE SHEAR JOINT STRENGTH 3/16 TO 1/2 INCH DIAMETER FASTENERS						
FASTENERS — PART NUMBERS	MS20004 THRU MS20024 NAS623-2 THRU NAS623-6 NAS673 THRU NAS678 NAS1218-04 THRU NAS1218-08 NAS1223 THRU NAS1235 NAS1303 THRU NAS1320 NAS6603 THRU NAS6620 NAS6703 THRU NAS6720 NAS6803 THRU NAS6820			BACB30LJ() BACB30LK() BACB30LM() BACB30LN() BACB30MR() BACB30NE() BACB30NF() BACB30NM()		BACB30NR() BACB30NT() BACB30PF() BACB30PU() BACB30PW() BACB30UG()
FASTENERS — MATERIAL	ALLOY STEEL, A286, OR 6AL-4V TITANIUM (95 KSI SHEAR STRENGTH)					
FASTENERS — D (DIAMETER INCHES)	3/16	1/4	5/16	3/8	7/16	1/2
	0.1900	0.2500	0.3125	0.3750	0.4375	0.5000
FASTENERS — SINGLE SHEAR STRENGTH (POUNDS)	2690	4650	7300	10500	14300	18600
t (THICKNESS INCHES)	SINGLE SHEAR JOINT STRENGTH (POUNDS)					
0.112	2470	3250	4060	4870	5700	6500
0.125	2690	3620	4530	5450	6350	7250
0.140	--	4060	5050	6100	7100	8100
0.160	--	4640	5800	6950	8100	9300
0.180	--	4650	6500	7850	9150	10400
0.200	--	--	7300	8900	10400	11900
0.224	--	--	--	10000	11700	13300
0.250	--	--	--	10500	12400	14100
0.312	--	--	--	--	14300	17600
0.375	--	--	--	--	--	18600

TABLE I

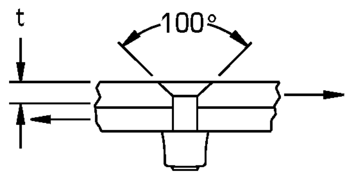
Joint Shear Strength of Tension Protruding Head, 95 KSI Shear Joint Strength, Bolts
Figure 6 (Sheet 9 of 10)



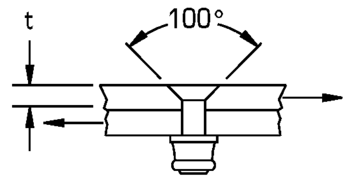
TENSION PROTRUDING HEAD BOLTS IN CLAD OR BARE 7075-T6 SHEET, 7075-T651 PLATE, AND 7075-T6,7075-T6510,7075-T6511 EXTRUSIONS LESS THAN 0.188 INCH THICK SINGLE SHEAR JOINT STRENGTH 9/16 TO 1 INCH DIAMETER FASTENERS					
FASTENERS: PART NUMBERS	MS20004 THRU MS20024 NAS623-2 THRU NAS623-6 NAS673 THRU NAS678 NAS1218-04 THRU NAS1218-08 NAS1223 THRU NAS1235 NAS1303 THRU NAS1320 NAS6603 THRU NAS6620 NAS6703 THRU NAS6720 NAS6803 THRU NAS6820	BACB30LJ() BACB30LK() BACB30LM() BACB30LN() BACB30MR() BACB30NE() BACB30NF() BACB30NM()	BACB30NR() BACB30NT() BACB30PF() BACB30PU() BACB30PW() BACB30UG()		
FASTENERS: MATERIAL	ALLOY STEEL, A286, OR 6AL-4V TITANIUM (95 KSI SHEAR STRENGTH)				
D (DIAMETER INCHES)	9/16	5/8	3/4	7/8	1
	0.5625	0.6250	0.7500	0.8750	1.0000
SINGLE SHEAR STRENGTH (POUNDS)	23600	29100	41900	57000	74500
t (THICKNESS INCHES)	SINGLE SHEAR JOINT STRENGTH (POUNDS)				
0.125	8150	9050	--	--	--
0.140	9150	10100	12200	--	--
0.160	10400	11600	13900	16200	--
0.180	11700	13000	15700	18300	--
0.200	13400	14900	17800	20800	23800
0.224	15000	16700	20000	23300	26700
0.250	15900	17700	21200	24700	28200
0.312	19800	22000	26400	30800	35300
0.375	23600	26500	31800	37100	42400
0.500	--	29100	41900	50300	57500
0.562	--	--	--	56600	64600
0.625	--	--	--	57000	71900
0.750	--	--	--	--	74500

TABLE J

Joint Shear Strength of Tension Protruding Head, 95 KSI Shear Joint Strength, Bolts
Figure 6 (Sheet 10 of 10)



STANDARD FLUSH HEAD LOCKBOLT
IN A SINGLE SHEAR JOINT



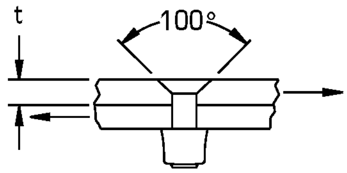
STANDARD FLUSH HEAD HEX DRIVE
BOLT IN A SINGLE SHEAR JOINT

STANDARD FLUSH HEAD LOCKBOLTS AND HEX DRIVE BOLTS IN CLAD OR BARE 2024-T3 SHEET AND 2024-T351 PLATE - SINGLE SHEAR JOINT STRENGTH

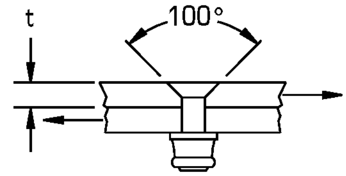
FASTENERS	PART NUMBERS	NAS1456 THRU NAS1462, BACB30GX(), BACB30JC(), BACB30NY(), BACB30UA()			
FASTENERS	MATERIAL	ALLOY STEEL, A286, OR 6AL-4V TITANIUM (95 KSI SHEAR STRENGTH)			
FASTENERS	D (DIAMETER INCHES)	3/16	1/4	5/16	3/8
FASTENERS		0.1900	0.2500	0.3125	0.3750
FASTENERS	SINGLE SHEAR STRENGTH (POUNDS)	2690	4650	7300	10500
t (THICKNESS INCHES)		SINGLE SHEAR JOINT STRENGTH (POUNDS)			
0.050		--	--	--	--
0.056		--	--	--	--
0.063		--	--	--	--
0.071		--	--	--	--
0.080		--	--	--	--
0.090		1550	--	--	--
0.100		1720	--	--	--
0.112		1930	--	--	--
0.125		2150	2870	--	--
0.140		2410	3220	4020	--
0.160		2690	3680	4600	--
0.180		--	4140	5150	6200
0.190		--	4320	5400	6550
0.200		--	4480	5750	6900
0.224		--	4650	6450	7700
0.250		--	--	6900	8600
0.312		--	--	7300	10500

TABLE A

Joint Shear Strength of Standard Flush Head, 95 KSI Shear Strength, Lockbolts and Hex Drive Bolts
Figure 7 (Sheet 1 of 2)



STANDARD FLUSH HEAD LOCKBOLT IN A SINGLE SHEAR JOINT

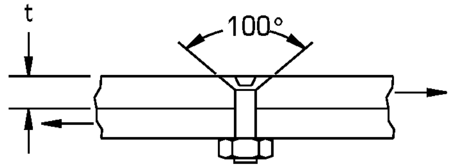


STANDARD FLUSH HEAD HEX DRIVE BOLT IN A SINGLE SHEAR JOINT

STANDARD FLUSH HEAD LOCKBOLTS AND HEX DRIVE BOLTS IN CLAD OR BARE 7075-T6 SHEET - SINGLE SHEAR JOINT STRENGTH					
FASTENERS	PART NUMBERS	NAS1456 THRU NAS1462, BACB30GX(), BACB30JC(), BACB30NY(), BACB30UA()			
	MATERIAL	ALLOY STEEL, A286, OR 6AL-4V TITANIUM (95 KSI SHEAR STRENGTH)			
	D (DIAMETER INCHES)	3/16	1/4	5/16	3/8
		0.1900	0.2500	0.3125	0.3750
	SINGLE SHEAR STRENGTH (POUNDS)	2690	4650	7300	10500
t (THICKNESS INCHES)		SINGLE SHEAR JOINT STRENGTH (POUNDS)			
0.050		--	--	--	--
0.056		--	--	--	--
0.063		--	--	--	--
0.071		--	--	--	--
0.080		--	--	--	--
0.090		1590	--	--	--
0.100		1800	--	--	--
0.112		2085	--	--	--
0.125		2460	2925	--	--
0.140		2690	3375	4140	--
0.160		--	4080	4770	--
0.180		--	4650	5460	6270
0.190		--	--	5940	6675
0.200		--	--	6375	7080
0.224		--	--	7250	8250
0.250		--	--	7300	9900
0.312		--	--	--	10500

TABLE B

Joint Shear Strength of Standard Flush Head, 95 KSI Shear Strength, Lockbolts and Hex Drive Bolts
Figure 7 (Sheet 2 of 2)

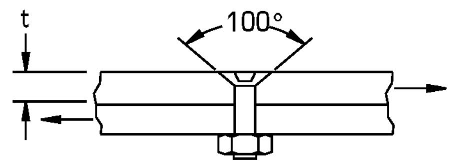


STANDARD FLUSH HEAD BOLT IN
A SINGLE SHEAR JOINT

STANDARD FLUSH HEAD BOLTS IN CLAD OR BARE 2024-T3 SHEET AND 2024-T351 PLATE - SINGLE SHEAR JOINT STRENGTH							
FASTENERS: PART NUMBERS	NAS333 THRU NAS340 NAS517-2 THRU NAS517-8 NAS583 THRU NAS590 NAS663 THRU NAS668 NAS1221-04 THRU NAS1221-08 NAS1221-3 THRU NAS1221-6 BACB30AB() BACB30LU() BACB30EM() BACB30MN() BACB30LH() BACB30MS() BACB30LP() BACB30NN() BACB30LR() BACB30PC()						
FASTENERS: MATERIAL	ALLOY STEEL, A286, OR 6AL-4V TITANIUM (95 KSI SHEAR STRENGTH)						
FASTENERS: D (DIAMETER INCHES)	3/16	1/4	5/16	3/8	7/16	1/2	9/16
	0.1900	0.2500	0.3125	0.3750	0.4375	0.5000	0.5625
FASTENERS: SINGLE SHEAR STRENGTH (POUNDS)	2690	4650	7300	10500	14300	18600	23600
t (THICKNESS INCHES)	SINGLE SHEAR JOINT STRENGTH (POUNDS)						
0.090	1550	--	--	--	--	--	--
0.100	1720	--	--	--	--	--	--
0.112	1930	--	--	--	--	--	--
0.125	2150	2870	--	--	--	--	--
0.140	2410	3220	--	--	--	--	--
0.160	2690	3680	4600	--	--	--	--
0.180	--	4140	5150	6200	--	--	--
0.190	--	4320	5400	6550	--	--	--
0.200	--	4480	5750	6900	8050	--	--
0.224	--	4650	6450	7700	9000	10300	--
0.250	--	--	6900	8600	10000	11500	--
0.312	--	--	7300	10500	12500	14300	16100
0.375	--	--	--	--	14300	17100	19400
0.438	--	--	--	--	--	18600	22200
0.500	--	--	--	--	--	--	23600

TABLE A

Joint Shear Strength of Standard Flush Head, 95 KSI Shear Strength, Bolts
Figure 8 (Sheet 1 of 2)

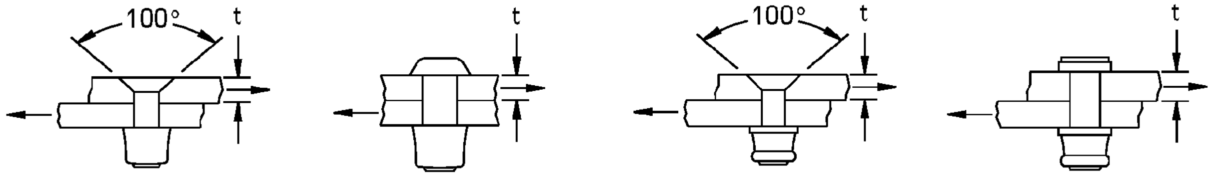


STANDARD FLUSH HEAD BOLT IN
A SINGLE SHEAR JOINT

STANDARD FLUSH HEAD BOLTS IN CLAD OR BARE 7075-T6 SHEET AND 7075-T651 PLATE - SINGLE SHEAR JOINT STRENGTH							
FASTENERS: PART NUMBERS	NAS333 THRU NAS340 NAS517-2 THRU NAS517-8 NAS583 THRU NAS590 NAS663 THRU NAS668 NAS1221-04 THRU NAS 1221-08 NAS1221-3 THRU NAS1221-6				BACB30AB() BACB30EM() BACB30FL() BACB30LH() BACB30LP() BACB30LR()		BACB30LU() BACB30NN() BACB30MS() BACB30PC()
FASTENERS: MATERIAL	ALLOY STEEL, A286, OR 6AL-4V TITANIUM (95 KSI SHEAR STRENGTH)						
FASTENERS: D (DIAMETER INCHES)	3/16	1/4	5/16	3/8	7/16	1/2	9/16
	0.1900	0.2500	0.3125	0.3750	0.4375	0.5000	0.5625
FASTENERS: SINGLE SHEAR STRENGTH (POUNDS)	2690	4650	7300	10500	14300	18600	23600
t (THICKNESS INCHES)	SINGLE SHEAR JOINT STRENGTH (POUNDS)						
0.090	1590	--	--	--	--	--	--
0.100	1800	--	--	--	--	--	--
0.112	2085	--	--	--	--	--	--
0.125	2460	2925	--	--	--	--	--
0.140	2690	3375	4140	--	--	--	--
0.160	--	4080	4770	--	--	--	--
0.180	--	4650	5460	6195	--	--	--
0.190	--	--	5940	6675	--	--	--
0.200	--	--	6375	7080	8100	--	--
0.224	--	--	7250	8250	9075	10425	--
0.250	--	--	7300	9900	10575	11850	--
0.312	--	--	--	10500	14300	15600	17100
0.375	--	--	--	--	--	18600	22050
0.500	--	--	--	--	--	--	23600

TABLE B

Joint Shear Strength of Standard Flush Head, 95 KSI Shear Strength, Bolts
Figure 8 (Sheet 2 of 2)



SHEAR FLUSH HEAD LOCKBOLT IN A SINGLE SHEAR JOINT | PROTRUDING HEAD LOCKBOLT IN A SINGLE SHEAR JOINT | SHEAR FLUSH HEAD HEX DRIVE BOLT IN A SINGLE SHEAR JOINT | PROTRUDING HEAD HEX DRIVE BOLT IN A SINGLE SHEAR JOINT

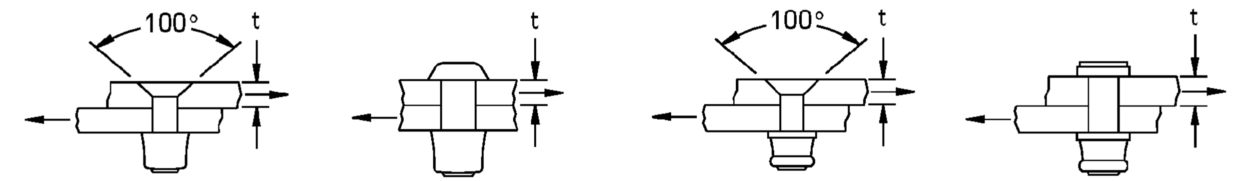
SHEAR FLUSH AND PROTRUDING HEAD LOCKBOLTS AND HEX DRIVE BOLTS IN CLAD OR BARE 2024-T3 SHEET AND 2024-T351 PLATE (FOR THICKNESSES 0.050 THRU 0.090 INCH) SINGLE SHEAR JOINT STRENGTH

FASTENERS								
FASTENERS	PART NUMBERS	NAS1436 THRU NAS1442 NAS1446 THRU NAS1452 BACB30FM() BACB30FN() BACB30GY() BACB30MY() BACB30NW() BACB30TY() BACB30TZ() BACB30UC() BACB30UD() BACB30VM() BACB30VN() BACB30VP() BACB30VR() BACB30VT() BACB30VU() BACB30XT()				BACB30FM() BACB30FN() BACB30MY() BACB30NW()		BACB30FM() BACB30MY() BACB30NW()
FASTENERS	MATERIAL	ALLOY STEEL, A286, OR 6AL-4V TITANIUM (95 KSI SHEAR STRENGTH)						
FASTENERS	D (DIAMETER INCHES)	3/16	1/4	5/16	3/8	7/16	1/2	9/16
FASTENERS	D (DIAMETER INCHES)	0.1900	0.2500	0.3125	0.3750	0.4375	0.5000	0.5625
FASTENERS	SINGLE SHEAR STRENGTH (POUNDS)	2690	4650	7300	10500	14300	18600	23600
t (THICKNESS INCHES)		SINGLE SHEAR JOINT STRENGTH (POUNDS)						
0.050		860	1150*	--	--	--	--	--
0.056		965	1280*	--	--	--	--	--
0.063		1080	1450*	1810*	--	--	--	--
0.071		1220	1630	2040*	2450*	--	--	--
0.080		1380	1840	2290	2760*	3220*	--	--
0.090		1550	2070	2580	3100	3620*	4140*	--

* THE VALUE IS FOR A KNIFE-EDGE CONDITION. THE USE OF FLUSH HEAD FASTENERS IN THE KNIFE-EDGE CONDITION IS NOT RECOMMENDED.

TABLE A

Joint Shear Strength of Shear Protruding Head, 95 KSI Shear Joint Strength, Bolts
Figure 9 (Sheet 1 of 6)



SHEAR FLUSH HEAD LOCKBOLT IN A SINGLE SHEAR JOINT

PROTRUDING HEAD LOCKBOLT IN A SINGLE SHEAR JOINT

SHEAR FLUSH HEAD HEX DRIVE BOLT IN A SINGLE SHEAR JOINT

PROTRUDING HEAD HEX DRIVE BOLT IN A SINGLE SHEAR JOINT

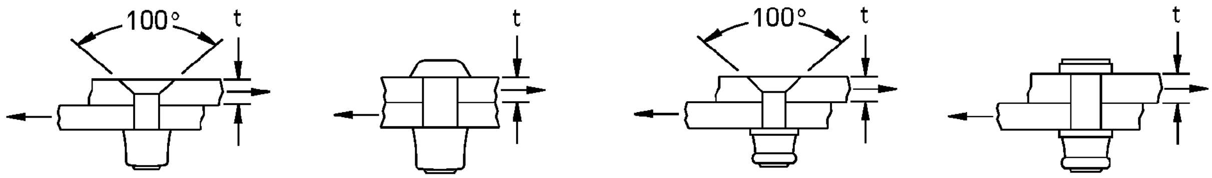
SHEAR FLUSH AND PROTRUDING HEAD LOCKBOLTS AND HEX DRIVE BOLTS IN CLAD OR BARE 2024-T3 SHEET AND 2024-T351 PLATE (FOR THICKNESSES 0.100 THRU 0.180 INCH)
SINGLE SHEAR JOINT STRENGTH

FASTENERS	PART NUMBERS	NAS1436 THRU NAS1442 NAS1446 THRU NAS1452 BACB30FM() BACB30FN() BACB30GY() BACB30MY() BACB30NW() BACB30TY()		BACB30TZ() BACB30UC() BACB30UD() BACB30VM() BACB30VN() BACB30VP() BACB30VR() BACB30VT() BACB30VU() BACB30XT()		BACB30FM() BACB30FN() BACB30MY() BACB30NW()		BACB30FM() BACB30MY() BACB30NW()
	MATERIAL	ALLOY STEEL, A286, OR 6AL-4V TITANIUM (95 KSI SHEAR STRENGTH)						
	D (DIAMETER INCHES)	3/16	1/4	5/16	3/8	7/16	1/2	9/16
		0.1900	0.2500	0.3125	0.3750	0.4375	0.5000	0.5625
	SINGLE SHEAR STRENGTH (POUNDS)	2690	4650	7300	10500	14300	18600	23600
t (THICKNESS INCHES)		SINGLE SHEAR JOINT STRENGTH (POUNDS)						
0.100		1720	2300	2870	3450	4030*	4600*	5150*
0.112		1920	2570	3210	3860	4510	5150	5800*
0.125		2020	2870	3590	4310	5050	5750	6450
0.140		2130	3220	4020	4830	5650	6450	7250
0.160		2170	3590	4590	5500	6450	7350	8250
0.180		2250	3670	5200	6200	7250	8300	9300

* THE VALUE IS FOR A KNIFE-EDGE CONDITION. THE USE OF FLUSH HEAD FASTENERS IN THE KNIFE-EDGE CONDITION IS NOT RECOMMENDED.

TABLE B

Joint Shear Strength of Shear Protruding Head, 95 KSI Shear Joint Strength, Bolts
Figure 9 (Sheet 2 of 6)



SHEAR FLUSH HEAD LOCKBOLT IN A SINGLE SHEAR JOINT

PROTRUDING HEAD LOCKBOLT IN A SINGLE SHEAR JOINT

SHEAR FLUSH HEAD HEX DRIVE BOLT IN A SINGLE SHEAR JOINT

PROTRUDING HEAD HEX DRIVE BOLT IN A SINGLE SHEAR JOINT

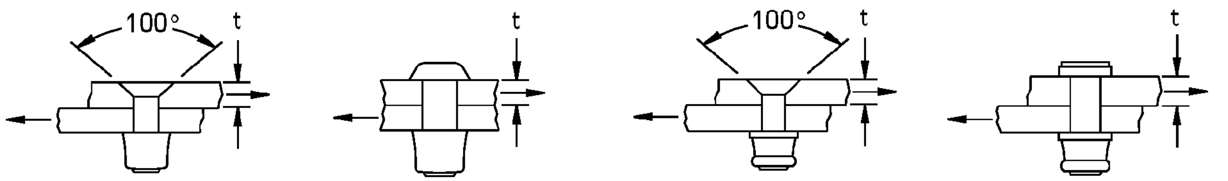
SHEAR FLUSH AND PROTRUDING HEAD LOCKBOLTS AND HEX DRIVE BOLTS IN CLAD OR BARE 2024-T3 SHEET AND 2024-T351 PLATE (FOR THICKNESSES 0.190 THRU 0.500 INCH)
SINGLE SHEAR JOINT STRENGTH

FASTENERS								
FASTENERS	PART NUMBERS	NAS1436 THRU NAS1442, NAS1446 THRU NAS1452, BACB30FM(), BACB30FN(), BACB30GY(), BACB30MY(), BACB30NW(), BACB30TY(), BACB30TZ(), BACB30UC(), BACB30UD(), BACB30VM(), BACB30VN(), BACB30VP(), BACB30VR(), BACB30VT(), BACB30VU(), BACB30XT()				BACB30FM(), BACB30FN(), BACB30MY(), BACB30NW()		BACB30FM(), BACB30MY(), BACB30NW()
	MATERIAL	ALLOY STEEL, A286, OR 6AL-4V TITANIUM (95 KSI SHEAR STRENGTH)						
	D (DIAMETER INCHES)	3/16	1/4	5/16	3/8	7/16	1/2	9/16
		0.1900	0.2500	0.3125	0.3750	0.4375	0.5000	0.5625
	SINGLE SHEAR STRENGTH (POUNDS)	2690	4650	7300	10500	14300	18600	23600
t (THICKNESS INCHES)		SINGLE SHEAR JOINT STRENGTH (POUNDS)						
0.190		2290	3730	5450	6550	7650	8750	9800
0.200		2330	3790	5600	6900	8050	9200	10300
0.224		2430	3920	5750	7700	9000	10300	11600
0.250		2540	4050	5950	8300	10100	11500	12900
0.312		2690	4650	6350	8650	11300	14200	16200
0.375		--	--	6500	8900	11800	14900	18300
0.500		--	--	--	--	12900	16200	19800

* THE VALUE IS FOR A KNIFE-EDGE CONDITION. THE USE OF FLUSH HEAD FASTENERS IN THE KNIFE-EDGE CONDITION IS NOT RECOMMENDED.

TABLE C

Joint Shear Strength of Shear Protruding Head, 95 KSI Shear Joint Strength, Bolts
Figure 9 (Sheet 3 of 6)



SHEAR FLUSH HEAD LOCKBOLT IN A SINGLE SHEAR JOINT

PROTRUDING HEAD LOCKBOLT IN A SINGLE SHEAR JOINT

SHEAR FLUSH HEAD HEX DRIVE BOLT IN A SINGLE SHEAR JOINT

PROTRUDING HEAD HEX DRIVE BOLT IN A SINGLE SHEAR JOINT

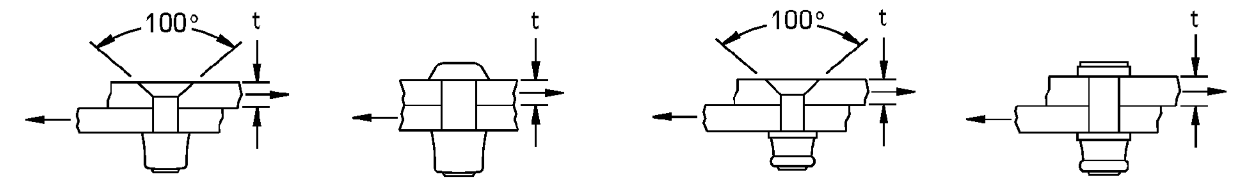
SHEAR FLUSH AND PROTRUDING HEAD LOCKBOLTS AND HEX DRIVE BOLTS IN CLAD OR BARE 7075-T6 SHEET AND 7075-T651 PLATE (FOR THICKNESSES 0.050 THRU 0.090 INCH)
SINGLE SHEAR JOINT STRENGTH

FASTENERS: PART NUMBERS	NAS1436 THRU NAS1442 NAS1446 THRU NAS1452 BACB30FM() BACB30FN() BACB30GW() BACB30GY() BACB30MY() BACB30NW() BACB30TY() BACB30TZ() BACB30UC() BACB30UD() BACB30VM() BACB30VN() BACB30VP() BACB30VR() BACB30VT() BACB30VU() BACB30XT()				BACB30FM() BACB30FN() BACB30MY() BACB30NW()		BACB30FM() BACB30MY() BACB30NW()
FASTENERS: MATERIAL	ALLOY STEEL, A286, OR 6AL-4V TITANIUM (95 KSI SHEAR STRENGTH)						
FASTENERS: D (DIAMETER INCHES)	3/16	1/4	5/16	3/8	7/16	1/2	9/16
	0.1900	0.2500	0.3125	0.3750	0.4375	0.5000	0.5625
FASTENERS: SINGLE SHEAR STRENGTH (POUNDS)	2690	4650	7300	10500	14300	18600	23600
t (THICKNESS INCHES)	SINGLE SHEAR JOINT STRENGTH (POUNDS)						
0.050	1010	1350*	--	--	--	--	--
0.056	1130	1500*	--	--	--	--	--
0.063	1270	1700*	2120*	--	--	--	--
0.071	1430	1910	2390*	2870*	--	--	--
0.080	1620	2150	2700	3240*	3780*	--	--
0.090	1820	2430	3030	3640	4250*	4850*	--

* THE VALUE IS FOR A KNIFE-EDGE CONDITION. THE USE OF FLUSH HEAD FASTENERS IN THE KNIFE-EDGE CONDITION IS NOT RECOMMENDED.

TABLE D

Joint Shear Strength of Shear Protruding Head, 95 KSI Shear Joint Strength, Bolts
Figure 9 (Sheet 4 of 6)



SHEAR FLUSH HEAD LOCKBOLT IN A SINGLE SHEAR JOINT

PROTRUDING HEAD LOCKBOLT IN A SINGLE SHEAR JOINT

SHEAR FLUSH HEAD HEX DRIVE BOLT IN A SINGLE SHEAR JOINT

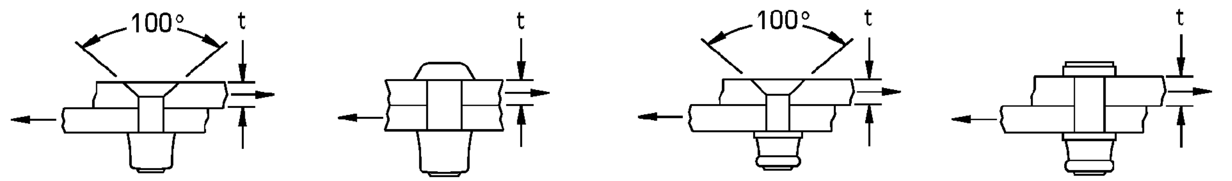
PROTRUDING HEAD HEX DRIVE BOLT IN A SINGLE SHEAR JOINT

SHEAR FLUSH AND PROTRUDING HEAD LOCKBOLTS AND HEX DRIVE BOLTS IN CLAD OR BARE 7075-T6 SHEET AND 7075-T651 PLATE (FOR THICKNESSES 0.100 THRU 0.180 INCH) SINGLE SHEAR JOINT STRENGTH							
FASTENERS: PART NUMBERS	NAS1436 THRU NAS1442 NAS1446 THRU NAS1452 BACB30FM() BACB30FN() BACB30GW() BACB30GY() BACB30MY() BACB30NW() BACB30TY() BACB30TZ() BACB30UC() BACB30UD() BACB30VM() BACB30VN() BACB30VP() BACB30VR() BACB30VT() BACB30VU() BACB30XT()				BACB30FM() BACB30FN() BACB30MY() BACB30NW()		BACB30FM() BACB30MY() BACB30NW()
FASTENERS: MATERIAL	ALLOY STEEL, A286, OR 6AL-4V TITANIUM (95 KSI SHEAR STRENGTH)						
FASTENERS: D (DIAMETER INCHES)	3/16	1/4	5/16	3/8	7/16	1/2	9/16
	0.1900	0.2500	0.3125	0.3750	0.4375	0.5000	0.5625
FASTENERS: SINGLE SHEAR STRENGTH (POUNDS)	2690	4650	7300	10500	14300	18600	23600
t (THICKNESS INCHES)	SINGLE SHEAR JOINT STRENGTH (POUNDS)						
0.100	2020	2700	3370	4050	4720*	5400*	6050*
0.112	2270	3020	3780	4530	5300	6050	6800*
0.125	2530	3370	4220	5050	5900	6750	7600
0.140	2690	3780	4720	5650	6600	7550	8500
0.160	--	4320	5400	6500	7550	8650	9700
0.180	--	4580	6050	7300	8500	9700	10900

* THE VALUE IS FOR A KNIFE-EDGE CONDITION. THE USE OF FLUSH HEAD FASTENERS IN THE KNIFE-EDGE CONDITION IS NOT RECOMMENDED.

TABLE E

Joint Shear Strength of Shear Protruding Head, 95 KSI Shear Joint Strength, Bolts
Figure 9 (Sheet 5 of 6)



SHEAR FLUSH HEAD LOCKBOLT IN A SINGLE SHEAR JOINT

PROTRUDING HEAD LOCKBOLT IN A SINGLE SHEAR JOINT

SHEAR FLUSH HEAD HEX DRIVE BOLT IN A SINGLE SHEAR JOINT

PROTRUDING HEAD HEX DRIVE BOLT IN A SINGLE SHEAR JOINT

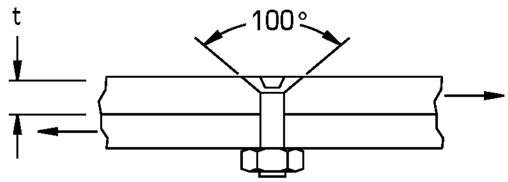
SHEAR FLUSH AND PROTRUDING HEAD LOCKBOLTS AND HEX DRIVE BOLTS IN CLAD OR BARE 7075-T6 SHEET AND 7075-T651 PLATE (FOR THICKNESSES 0.190 THRU 0.375 INCH)
SINGLE SHEAR JOINT STRENGTH

FASTENERS							
PART NUMBERS	NAS1436 THRU NAS1442, NAS1446 THRU NAS1452, BACB30FM(), BACB30FN(), BACB30GW(), BACB30GY(), BACB30MY(), BACB30NW(), BACB30TY(), BACB30TZ(), BACB30UC(), BACB30UD(), BACB30VM(), BACB30VN(), BACB30VP(), BACB30VR(), BACB30VT(), BACB30VU(), BACB30XT()				BACB30FM(), BACB30FN(), BACB30MY(), BACB30NW()		BACB30FM(), BACB30MY(), BACB30NW()
MATERIAL	ALLOY STEEL, A286, OR 6AL-4V TITANIUM (95 KSI SHEAR STRENGTH)						
D (DIAMETER INCHES)	3/16	1/4	5/16	3/8	7/16	1/2	9/16
	0.1900	0.2500	0.3125	0.3750	0.4375	0.5000	0.5625
SINGLE SHEAR STRENGTH (POUNDS)	2690	4650	7300	10500	14300	18600	23600
t (THICKNESS INCHES)	SINGLE SHEAR JOINT STRENGTH (POUNDS)						
0.190	--	4650	6350	7600	8900	10100	11400
0.200	--	--	6500	8100	9450	10800	12100
0.224	--	--	--	8900	10600	12100	13600
0.250	--	--	--	--	11800	13500	15200
0.312	--	--	--	--	12900	16400	19000
0.375	--	--	--	--	--	--	19900

* THE VALUE IS FOR A KNIFE-EDGE CONDITION. THE USE OF FLUSH HEAD FASTENERS IN THE KNIFE-EDGE CONDITION IS NOT RECOMMENDED.

TABLE F

Joint Shear Strength of Shear Protruding Head, 95 KSI Shear Joint Strength, Bolts
Figure 9 (Sheet 6 of 6)

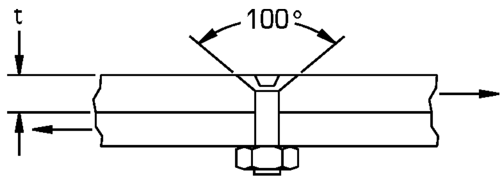


SHEAR FLUSH HEAD BOLT IN
A SINGLE SHEAR JOINT

SHEAR FLUSH HEAD BOLTS IN CLAD OR BARE 2024-T3 SHEET AND 2024-T351 PLATE - SINGLE SHEAR JOINT STRENGTH								
FASTENERS: PART NUMBERS	BACB30EL() BACB30FB() BACB30LL()				BACB30NU() BACB30VF() BACB30XD()			
FASTENERS: MATERIAL	ALLOY STEEL, A286, OR 6AL-4V TITANIUM (95 KSI SHEAR STRENGTH)							
FASTENERS: D (DIAMETER INCHES)	3/16	1/4	5/16	3/8	7/16	1/2	9/16	5/8
	0.1900	0.2500	0.3125	0.3750	0.4375	0.5000	0.5625	0.6250
FASTENERS: SINGLE SHEAR STRENGTH (POUNDS)	2690	4650	7300	10500	14300	18600	23600	29100
t (THICKNESS INCHES)	SINGLE SHEAR JOINT STRENGTH (POUNDS)							
0.050	860	--	--	--	--	--	--	--
0.056	965	--	--	--	--	--	--	--
0.063	1080	--	--	--	--	--	--	--
0.071	1220	1630	2040	--	--	--	--	--
0.080	1380	1840	2290	--	--	--	--	--
0.090	1550	2070	2580	3100	--	--	--	--
0.100	1720	2300	2870	3450	--	--	--	--
0.112	1920	2570	3210	3860	4510	5150	--	--
0.125	2020	2870	3590	4310	5050	5750	6450	--
0.140	2130	3220	4020	4830	5650	6450	7250	8050
0.160	2170	3590	4590	5500	6450	7350	8250	9200
0.180	2250	3670	5200	6200	7250	8300	9300	10300
0.190	2290	3730	5450	6550	7650	8750	9800	10900
0.200	2330	3790	5600	6900	8050	9200	10300	11500
0.224	2430	3920	5750	7700	9000	10300	11600	12900
0.250	2540	4050	5950	8300	10100	11500	12900	14400
0.312	2690	4650	6350	8650	11300	14200	16200	18000
0.375	--	--	6500	8900	11800	14900	18300	21500
0.500	--	--	--	--	12900	16200	19800	23700

TABLE A

Joint Shear Strength of Shear Flush Head, 95 KSI Shear Strength, Bolts
Figure 10 (Sheet 1 of 2)



SHEAR FLUSH HEAD BOLT IN
A SINGLE SHEAR JOINT

SHEAR FLUSH HEAD BOLTS IN CLAD OR BARE 7075-T6 SHEET AND SHEET AND 7075-T651 PLATE - SINGLE SHEAR JOINT STRENGTH								
FASTENERS: PART NUMBERS	BACB30EL() BACB30FB() BACB30LL() BACB30NU() BACB30VF() BACB30XD()							
FASTENERS: MATERIAL	ALLOY STEEL, A286, OR 6AL-4V TITANIUM (95 KSI SHEAR STRENGTH)							
FASTENERS: D (DIAMETER INCHES)	3/16	1/4	5/16	3/8	7/16	1/2	9/16	5/8
	0.1900	0.2500	0.3125	0.3750	0.4375	0.5000	0.5625	0.6250
FASTENERS: SINGLE SHEAR STRENGTH (POUNDS)	2690	4650	7300	10500	14300	18600	23600	29100
t (THICKNESS INCHES)	SINGLE SHEAR JOINT STRENGTH (POUNDS)							
0.050	1010	--	--	--	--	--	--	--
0.056	1130	--	--	--	--	--	--	--
0.063	1270	--	--	--	--	--	--	--
0.071	1430	1910	2390	--	--	--	--	--
0.080	1620	2150	2700	--	--	--	--	--
0.090	1820	2430	3030	3640	--	--	--	--
0.100	2020	2700	3370	4050	--	--	--	--
0.112	2270	3020	3780	4530	5300	6050	--	--
0.125	2530	3370	4220	5050	5900	6750	7600	--
0.140	2690	3780	4720	5650	6600	7550	8500	9450
0.160	--	4320	5400	6500	7550	8650	9700	10800
0.180	--	4580	6050	7300	8500	9700	10900	12100
0.190	--	4650	6350	7600	8900	10100	11400	12700
0.200	--	--	6500	8100	9450	10800	12100	13500
0.224	--	--	--	8900	10600	12100	13600	15100
0.250	--	--	--	--	11800	13500	15200	16900
0.312	--	--	--	--	12900	16400	19000	21100
0.375	--	--	--	--	--	--	19900	24000
0.500	--	--	--	--	--	--	--	--

TABLE B

Joint Shear Strength of Shear Flush Head, 95 KSI Shear Strength, Bolts
Figure 10 (Sheet 2 of 2)

SUBSTITUTE RIVET	RIVETED MATERIAL	RIVET DIAMETER: INITIAL MS20470D OR BACR15BB-D	RIVET DIAMETER: SUBSTITUTE RIVET	RIVETED MATERIAL GAGE .025	.028	.032	.036	.040	.045	.050	.056	.063	.071	.080	.090	.100	.112	.125
				QUANTITY FACTOR [C]														
NAS1398D BLIND PROTRUDING HEAD RIVET [A] [B] [D]	CLAD OR BARE 2024-T3 2024-T4 ALUMINUM ALLOY	1/8	1/8	1.5	1.5	1.5	1.5	1.5	1.4	1.3	1.2	1.1	1.1	1.0				
			5/32	1.3	1.3	1.2	1.2	1.2	1.1	1.0	0.9	0.9	0.8	0.8	0.7	0.7		
		5/32	5/32	1.6	1.6	1.5	1.5	1.5	1.5	1.5	1.4	1.3	1.2	1.2	1.1			
			3/16	1.5	1.5	1.4	1.4	1.3	1.2	1.2	1.1	1.0	1.0	0.9	0.8	0.8		
		3/16	3/16	1.8	1.8	1.6	1.6	1.5	1.5	1.5	1.6	1.5	1.4	1.3	1.2	1.1	1.1	1.0
			1/4			1.4	1.4	1.3	1.3	1.2	1.1	1.0	1.0	0.9	0.8	0.8	0.7	0.7
		1/4	1/4			1.8	1.8	1.7	1.7	1.5	1.6	1.6	1.6	1.5	1.4	1.3	1.3	1.2
	CLAD OR BARE 7075-T6 ALUMINUM ALLOY	1/8	1/8	1.8	1.8	1.7	1.5	1.5	1.4	1.3	1.2	1.1	1.1	1.0				
			5/32	1.6	1.6	1.4	1.4	1.2	1.1	1.0	0.9	0.9	0.8	0.8	0.7	0.7		
		5/32	5/32	2.0	2.0	1.8	1.8	1.7	1.5	1.5	1.4	1.3	1.2	1.2	1.1			
			3/16	1.9	1.9	1.7	1.6	1.4	1.4	1.2	1.1	1.0	1.0	0.9	0.8	0.8		
		3/16	3/16	2.2	2.2	2.0	2.0	1.8	1.8	1.7	1.6	1.5	1.4	1.3	1.2	1.1	1.1	1.0
			1/4			1.7	1.7	1.5	1.4	1.3	1.1	1.0	1.0	0.9	0.8	0.8	0.7	0.7
		1/4	1/4			2.2	2.2	2.0	2.0	1.8	1.8	1.7	1.6	1.5	1.4	1.3	1.3	1.2
BACR15BB()AD() OR MS20470AD PROTRUDING HEAD RIVETS	CLAD OR BARE 2024-T3 2024-T4 ALUMINUM ALLOY	1/8	1/8	1.0	1.0	1.2	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3				
			5/32	0.8	0.8	0.8	0.8	0.9	0.9	0.9	0.9	0.9	0.9	0.9				
		5/32	5/32	1.0	1.0	1.0	1.0	1.2	1.2	1.3	1.3	1.3	1.3	1.3				
			3/16	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9				
		3/16	3/16	1.0	1.0	1.0	1.0	1.0	1.0	1.2	1.3	1.3	1.3	1.3				
			1/4							0.8	0.8	0.8	0.8	0.8				
		1/4	1/4							1.0	1.1	1.2	1.3	1.3	1.3			
			5/16									0.8	0.9	0.9	0.9			
	CLAD OR BARE 7075-T6 ALUMINUM ALLOY	1/8	1/8	1.2	1.2	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3				
			5/32	0.8	0.8	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9				
		5/32	5/32	1.0	1.0	1.2	1.2	1.3	1.3	1.3	1.3	1.3	1.3	1.3				
			3/16	0.9	0.9	0.9	0.9	1.0	0.9	0.9	0.9	0.9	0.9	0.9				
		3/16	3/16	1.0	1.0	1.0	1.0	1.2	1.2	1.3	1.3	1.3	1.3	1.3	1.3	1.3		
			1/4							0.8	0.8	0.8	0.8	0.8	0.8	0.8		
		1/4	1/4							1.1	1.2	1.3	1.3	1.3	1.3	1.3		
			5/16									0.9	0.9	0.9	0.9	0.9		

Fastener Substitution for MS20470D and BACR15BB( )D Universal Head Rivets
Figure 11 (Sheet 1 of 2)

SUBSTITUTE RIVET	RIVETED MATERIAL	RIVET DIAMETER: INITIAL MS20470D OR BACR15BB-D	RIVET DIAMETER: SUBSTITUTE RIVET	RIVETED MATERIAL GAGE: .025	.028	.032	.036	.040	.045	.050	.056	.063	.071	.080	.090	.100	.112	.125
				QUANTITY FACTOR [C]														
NAS1738E BLIND PROTRUDING HEAD RIVET [A] [B] [D] [E]	CLAD OR BARE 2024-T3 2024-T4 ALUMINUM ALLOY	1/8	1/8			1.7	1.7	1.5	1.4	1.2	1.1	1.0	0.9	0.9	0.8			
			5/32			1.3	1.4	1.2	1.1	1.0	0.9	0.8	0.7	0.7	0.6	0.6	0.5	
		5/32	5/32			1.7	1.7	1.7	1.7	1.5	1.4	1.2	1.1	1.0	0.9	0.9	0.8	
			3/16			1.5	1.4	1.4	1.5	1.3	1.2	1.1	1.0	0.8	0.8	0.7	0.7	0.6
		3/16	3/16				1.7	1.7	1.7	1.7	1.7	1.5	1.3	1.2	1.1	1.0	0.9	0.9
	CLAD OR BARE 7075-T6 ALUMINUM ALLOY	1/8	1/8			1.4	1.3	1.3	1.2	1.1	1.1	1.0	0.9	0.8	0.8			
			5/32			1.0	1.0	1.0	0.9	0.9	0.8	0.8	0.7	0.7	0.6	0.6	0.5	
		5/32	5/32			1.2	1.3	1.4	1.4	1.3	1.2	1.1	1.1	1.0	0.9	0.9	0.8	
			3/16			1.0	1.0	1.1	1.1	1.1	1.0	0.9	0.9	0.8	0.8	0.7	0.7	0.6
		3/16	3/16				1.2	1.3	1.4	1.5	1.4	1.3	1.2	1.2	1.1	1.0	0.9	0.9

NOTES

- THIS FASTENER SUBSTITUTION TABLE IS NOT APPLICABLE TO THE STRUCTURAL AREAS ON THE AIRPLANE THAT ARE SPECIFIED IN PARAGRAPH 1.C.
- REFER TO SRM 51-30-5 FOR THE CORRECT FASTENER HOLE SIZES.

[A] MULTIPLY THE QUANTITY FACTORS BY 1.5 FOR BLIND RIVETS THAT ARE SUBSTITUTED ON ALL FASTENED JOINTS IN PRIMARY STRUCTURE, AND FASTENED JOINTS THAT ARE SUBJECT TO ALTERNATING LOADS.

[B] KEEP THE QUANTITY OF BLIND RIVETS TO A MINIMUM WHEN YOU USE THEM TO REPLACE SOME OF THE SOLID RIVETS IN A GIVEN JOINT. THIS WILL MAKE SURE THAT OVER-STRESSING OF THE REMAINING SOLID RIVETS WILL NOT OCCUR.

[C] ONLY USE THESE QUANTITY FACTORS FOR RIVETS THAT ARE IN SINGLE SHEAR LOADING APPLICATIONS.

[D] YOU CAN SUBSTITUTE NAS1738E RIVETS FOR NAS1398D RIVETS, BUT ONLY IF THE SHEET THICKNESS ON THE OPPOSITE SIDE IS LESS THAN 1/4 OF THE HOLE DIAMETER. MAKE SURE THAT THE ACCESSIBILITY OF THE RIVETING TOOL IS ADEQUATE ALSO.

[E] INSTALL NAS1738 RIVETS IN A LARGER SIZE HOLE THAN THE INITIAL FASTENER HOLE SIZE. USE THE TABLE THAT FOLLOWS FOR THE CORRECT HOLE SIZES TO INSTALL NAS1738 RIVETS.

RIVET NOMINAL DIAMETER	MINIMUM HOLE DIAMETER	MAXIMUM HOLE DIAMETER
1/8	0.143	0.146
5/32	0.176	0.180
3/16	0.205	0.209

Fastener Substitution for MS20470D and BACR15BB( )D Universal Head Rivets
Figure 11 (Sheet 2 of 2)

SUBSTITUTE RIVET	RIVETED MATERIAL	RIVET DIAMETER: INITIAL MS20426D OR BACR15BA-D	RIVET DIAMETER: SUBSTITUTE RIVET	.040	.045	.050	.056	.063	.071	.080	.090	.100	.112	.125	.140	.160	.180
				QUANTITY FACTOR [C]													
NAS1399D BLIND RIVET IN COUNTER-SUNK HOLES [A] [B] [D]	CLAD OR BARE 2024-T3 2024-T4 7075-T6 ALUMINUM ALLOY	5/32	5/32		3.5	3.3	2.8	2.6	2.4	2.0	1.6	1.4	1.2	1.0			
			3/16				2.4	2.0	1.8	1.5	1.3	1.1	0.9	0.8	0.7		
		3/16	3/16				2.9	2.5	2.2	2.0	1.8	1.6	1.3	1.1	1.0		
			1/4						2.1	1.9	1.7	1.4	1.2	1.0	0.8	0.7	
		1/4	1/4						2.7	2.4	2.1	2.1	1.9	1.7	1.4	1.2	1.2
BACR15BA( )AD OR MS20426AD RIVETS IN COUNTERSUNK HOLES	CLAD OR BARE 2024-T3 2024-T4 7075-T6 ALUMINUM ALLOY	5/32	5/32	1.1	1.1	1.1	1.2	1.2	1.3	1.3	1.3						
			3/16	1.0	0.9	0.9	0.9	0.9	1.0	1.0	1.0	0.9	0.9				
		3/16	3/16			1.1	1.1	1.1	1.2	1.3	1.3	1.3	1.3				
NAS1739E BLIND RIVETS IN COUNTER-SUNK HOLES [A] [B] [D] [E]	CLAD OR BARE 2024-T3 2024-T4 7075-T6 ALUMINUM ALLOY	5/32	5/32	1.4	1.3	1.4	1.3	1.2	1.3	1.2	1.1	1.0	0.9	0.8	0.8		
			3/16	1.2	1.2	1.2	1.1	1.1	1.1	1.0	0.9	0.8	0.8	0.7	0.7	0.6	
		3/16	3/16			1.4	1.4	1.4	1.3	1.3	1.3	1.2	1.1	1.0	0.9	0.9	

NOTES

- THIS FASTENER SUBSTITUTION TABLE IS NOT APPLICABLE TO THE STRUCTURAL AREAS ON THE AIRPLANE THAT ARE SPECIFIED IN PARAGRAPH 1.C.
- REFER TO SRM 51-30-5 FOR THE CORRECT FASTENER HOLE SIZES.

[A] MULTIPLY THE QUANTITY FACTORS BY 1.5 FOR BLIND RIVETS THAT ARE SUBSTITUTED ON ALL FASTENED JOINTS IN PRIMARY STRUCTURE, AND FASTENED JOINTS THAT ARE SUBJECT TO ALTERNATING LOADS.

[B] KEEP THE QUANTITY OF BLIND RIVETS TO A MINIMUM WHEN YOU USE THEM TO REPLACE SOME OF THE SOLID RIVETS IN A GIVEN JOINT. THIS WILL MAKE SURE THAT OVER-STRESSING OF THE REMAINING SOLID RIVETS WILL NOT OCCUR.

[C] ONLY USE THESE QUANTITY FACTORS FOR RIVETS THAT ARE IN SINGLE SHEAR LOADING APPLICATIONS.

[D] YOU CAN SUBSTITUTE NAS1738E RIVETS FOR NAS1398D RIVETS, BUT ONLY IF THE SHEET THICKNESS ON THE OPPOSITE SIDE IS LESS THAN 1/4 OF THE HOLE DIAMETER. MAKE SURE THAT THE ACCESSIBILITY OF THE RIVETING TOOL IS ADEQUATE ALSO.

[E] INSTALL NAS1738 RIVETS IN A LARGER SIZE HOLE THAN THE INITIAL FASTENER HOLE SIZE. USE THE TABLE THAT FOLLOWS FOR THE CORRECT HOLE SIZES TO INSTALL NAS1738 RIVETS.

RIVET NOMINAL DIAMETER	MINIMUM HOLE DIAMETER	MAXIMUM HOLE DIAMETER
1/8	0.143	0.146
5/32	0.176	0.180
3/16	0.205	0.209

Fastener Substitution for MS20426D and BACR15BA( )D Rivets in Counters
Figure 12

GENERAL - COUNTERSINK DATA AND PROCEDURES FOR METAL STRUCTURES

1. Applicability

A. The instructions given in this subject are applicable to countersink holes in metal structures.

B. Refer to 51-20-07 to find the instructions to countersink holes in composite structures.

2. General

A. Some of the data in this subject can be found in Boeing Process Specifications BAC 5004-1, BAC 5004-2, BAC 5004-3, BAC 5009, BAC 5047, and BAC 5060.

B. Refer to the Boeing Engineering Drawings and 51-10-01 for fastener head flushness data.

3. References

Reference	Title
51-10-01	AERODYNAMIC SMOOTHNESS
51-20-07	MACHINING AND DRILLING OF COMPOSITE STRUCTURES
51-40-02	FASTENER INSTALLATION AND REMOVAL
51-40-02, GENERAL	Fastener Installation and Removal
51-40-05, GENERAL	Fastener Hole Sizes
53-00-01	FUSELAGE SKIN
AMM 20-30-92-910-801	Final Cleaning Prior to General Sealing (Series 92) (P/B 201)
SOPM 20-30-03	Standard Overhaul Practices Manual
SOPM 20-30-92	Final Cleaning Prior to Generl Sealing (Series 92)

4. The Use of the Countersink-microstop Tool

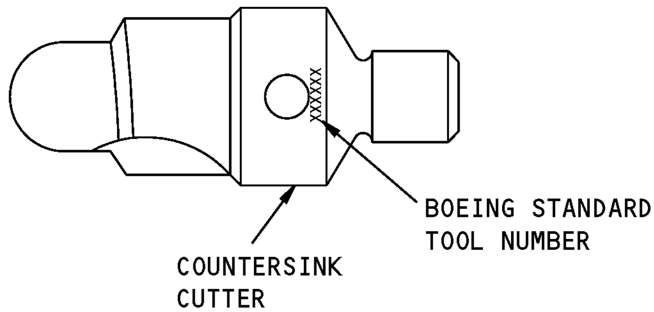
A. Use the countersink-microstop tool that is fitted with a removable cutter. Refer to The Microstop-Countersink Tool, Figure 1/GENERAL for the use of the microstop countersink.

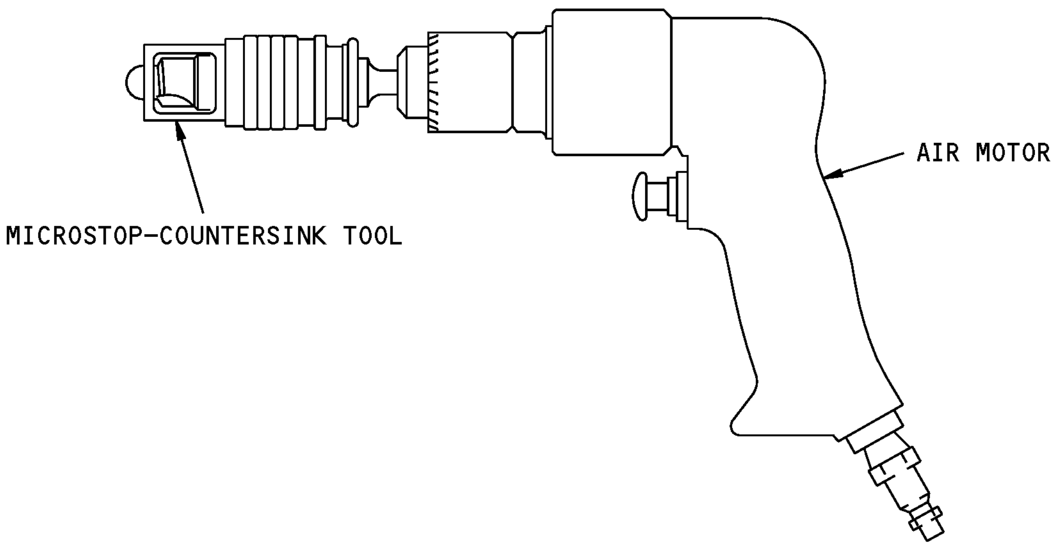
(1) The shaft of the countersink-microstop tool moves on a bearing inside an adjustable locking sleeve and foot piece assembly. The foot piece (or stop) fits onto the shaft bearing, and permits adjustments in countersink depth. You can make adjustments in increments of 0.001 inch.

CAUTION: MAKE SURE THAT THE PILOT PIN IS APPROXIMATELY 0.002 INCH LESS IN DIAMETER THAN THE FASTENER HOLE. THIS WILL PERMIT THE CUTTER TO SPIN WITHOUT BINDING INSIDE THE HOLE. IF YOU DO NOT OBEY, THE CUTTER WILL NOT OPERATE CORRECTLY AND THE RESULT CAN BE AN UNSATISFACTORY COUNTERSINK.

(2) A pilot pin guides the spinning cutter as it cuts into the material.

B. Countersink cutters are available with different cutting angles. The standard tool number code is stamped on each cutter as shown in The Microstop-Countersink Tool, Figure 1/GENERAL.





NOTES

- TO FIND THE CORRECT COUNTERSINK DEPTH:
  - USE THE MICROSTOP-COUNTERSINK TOOL TO MAKE 5 COUNTERSINK HOLES IN A SCRAP PIECE OF METAL. THE SCRAP PIECE OF METAL SHOULD BE MADE FROM THE SAME ALLOY AND THICKNESS AS THE PART THAT YOU COUNTERSINK.
  - INSTALL 5 FLUSH-HEAD REPAIR-FASTENERS IN THE SCRAP PIECE OF METAL.
  - INSPECT THE FASTENERS FOR CORRECT FASTENER-HEAD HEIGHT. REFER TO SRM 51-40-02.
  - ADJUST THE MICROSTOP-COUNTERSINK TOOL AND DO THE ABOVE STEPS AGAIN, UNTIL YOU GET THE CORRECT FASTENER-HEAD HEIGHT.
  - WHEN THE MICROSTOP-COUNTERSINK TOOL IS ADJUSTED FOR THE CORRECT FASTENER-HEAD HEIGHT, YOU CAN USE THE TOOL FOR THE REPAIR.
- TO SELECT THE MICROSTOP-COUNTERSINK TOOL, CUTTER, AND PILOT, SEE BOEING STANDARD TOOL DRAWINGS ST1221, ST1222 AND ST1223.
- IF COLDWORK IS NECESSARY, COLDWORK THE HOLE BEFORE YOU COUNTERSINK THE HOLE.

The Microstop-Countersink Tool
Figure 1 (Sheet 1 of 2)

NOTES (CONTINUED)

- SOME OF THE VENDORS FOR THE ST1221B,ST1222B AND ST1223B MICROSTOP-COUNTERSINK TOOLS ARE:

  AIRTECH INTERNATIONAL INC.
  2542 E. DEL AMO BLVD
  CARSON, CA 90749

  PACIFIC DISTRIBUTING, INC
  7118 BEACON AVE. S.
  SEATTLE, WA 98108

The Microstop-Countersink Tool
Figure 1 (Sheet 2 of 2)

5. Instructions to Use the Countersink-microstop Tool

A. To make the countersink depth adjustment on the countersink-microstop tool, do the steps that follow:

(1) Pull the sleeve back.

(2) Turn the stop to the correct countersink depth.

(3) Put the splines on the tool together so that the adjustment is securely locked.

B. Before you use the countersink-microstop tool, do as follows:

(1) Do a visual inspection of the countersink cutter. Do a check for:

(a) Pilot size

(b) Sharpness

(c) Degrees of the cutting angle

(d) True running.

(2) Make sure that the face on the countersink-microstop tool is clean and polished so that you do not cause damage to the repair material.

C. To use the countersink-microstop tool, do as follows:

NOTE: Do a check of the countersink depth on a piece of scrap material to verify the adjustment before you countersink the repair material.

(1) Set the cutter to a safe depth and slowly increase the depth to the correct setting.

NOTE: Make sure that you hold the countersink-microstop tool at a 90-degree angle to the material.

(2) Make a full depth of cut each time.

(3) Apply the pressure directly behind the countersink.

(4) Do not permit the foot piece to spin on the repair material.

(5) Install the repair fasteners as shown in 51-40-02.

(6) Make an inspection for the correct fastener head height as shown in 51-40-02.

(7) When you can install the fasteners to the correct depth in the scrap material, you can use the countersink-microstop tool to countersink the holes in the repair material.

6. Instructions for the Use of Countersink Repair Washers

A. Make the 100 degree countersink repair washer to match the initial countersunk hole. Refer to Countersink Repair Washer, Figure 2/GENERAL.

B. Clean the repair area.

WARNING: KEEP THE SOLVENTS THE AWAY FROM SOURCES OF HEAT, FIRE, OR SPARKS. HEAT, FIRE, OR SPARKS CAN CAUSE AN EXPLOSION. DO NOT LET THE SOLVENTS GET IN YOUR EYES, ON YOUR SKIN, OR ON YOUR CLOTHING. USE EYE PROTECTION AND MECHANICAL AIR OR RESPIRATORY EQUIPMENT WHEN YOU DO WORK IN A CLOSED LOCATION. IF YOU DO NOT OBEY, INJURY TO PERSONS CAN OCCUR.

(1) Clean the countersink hole and the repair washer with a solvent. Refer to SOPM 20-30-03 for the cleaning procedures

(2) Wipe the solvent from the parts with a clean dry cloth before the solvent evaporates.

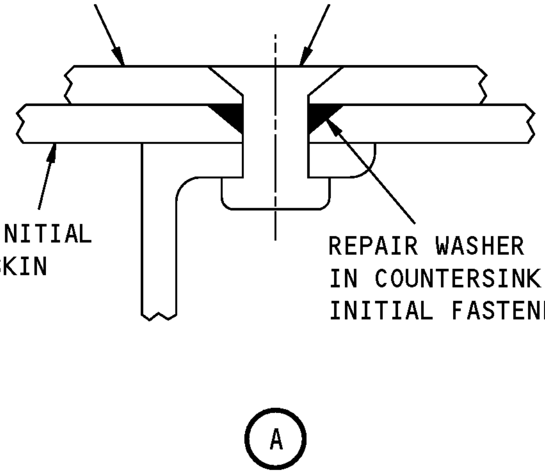
(3) Clean the parts with solvent again, if necessary, to remove all unwanted contamination.

C. Install the repair washer.

(1) Apply BMS 5-95 sealant between the mating surfaces of the countersunk hole and the repair washer.

(2) Put the repair washer in the countersunk hole. Use sufficient pressure to make sure the washer bonds correctly.

NOTE: The assembly can be moved immediately. The assembly will have maximum strength in 48 hours after the repair washer is installed.



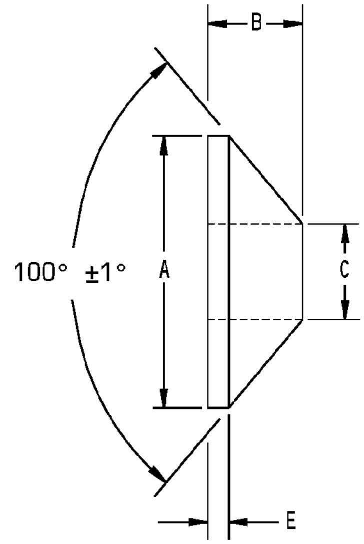
NOTES

- WHEN YOU USE THIS REPAIR REFER TO:
  - SRM 51-10-02 FOR INSPECTION AND REMOVAL OF DAMAGE
  - SRM 51-20-01 FOR PROTECTIVE TREATMENT OF METALLIC AND NONMETALLIC REPAIR PARTS
  - SRM 51-20-05 FOR REPAIR SEALING

1 APPLY A CHEMICAL CONVERSION COATING AS GIVEN IN SRM 51-20-01.

2 OTHER SIZES CAN BE FOUND IN BOEING DRAWING 66-2955.

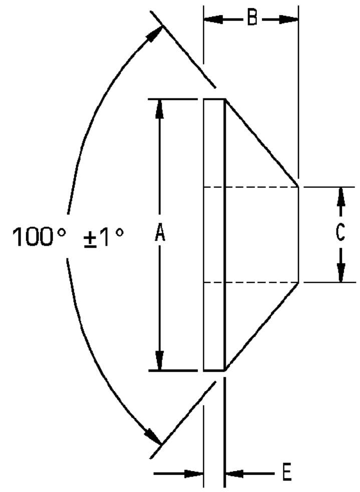
Countersink Repair Washer
Figure 2 (Sheet 1 of 5)



INITIAL FASTENER TYPE	DIAMETER	COUNTERSINK REPAIR WASHER [2] DIMENSIONS				MATERIAL [1]
		A ±0.005	B (REF)	C (DIAMETER)	E +0.005 −0.002	
BACR15CE BACR15GF NAS1097	1/8	0.181	0.030	0.128/0.135	0.006	2024-T4 BAR OR MAKE FROM BACR15CE RIVET
	5/32	0.234	0.037	0.159/0.171	0.006	
	3/16	0.284	0.045	0.191/0.202	0.006	
	7/32	0.284	0.032	0.221/0.233	0.006	
	1/4	0.382	0.060	0.254/0.265	0.006	
	9/32	0.382	0.047	0.284/0.296	0.006	

B

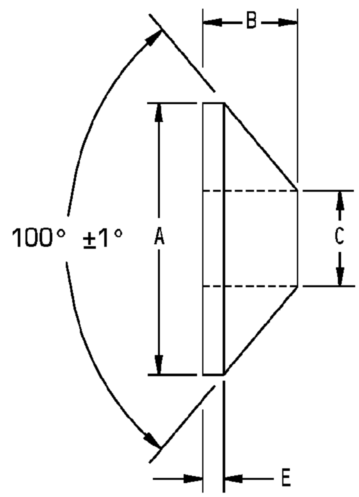
Countersink Repair Washer
Figure 2 (Sheet 2 of 5)



INITIAL FASTENER TYPE	DIAMETER	COUNTERSINK REPAIR WASHER [2] DIMENSIONS				MATERIAL [1]
		A ±0.005	B (REF)	C (DIAMETER)	E +0.005 −0.002	
BACR15BA BACB30DY BACB30HA BACB30HD BACB30ND BACB30NZ NAS1399	1/8	0.216	0.043	0.128/0.135	0.006	2024-T4 BAR OR MAKE FROM BACR15BA RIVET
	5/32	0.278	0.056	0.159/0.171	0.006	
	3/16	0.344	0.070	0.191/0.202	0.006	
	7/32	0.344	0.057	0.221/0.233	0.006	
	1/4	0.439	0.093	0.254/0.265	0.015	
	9/32	0.439	0.080	0.284/0.296	0.015	
	5/16	0.527	0.105	0.312/0.316	0.015	
	11/32	0.527	0.092	0.344/0.348	0.015	
	3/8	0.657	0.133	0.375/0.379	0.015	
	13/32	0.657	0.120	0.406/0.410	0.015	
	7/16	0.747	0.152	0.437/0.422	0.022	
	15/32	0.747	0.139	0.469/0.474	0.022	
	1/2	0.860	0.173	0.500/0.505	0.022	
	17/32	0.860	0.160	0.531/0.536	0.022	

C

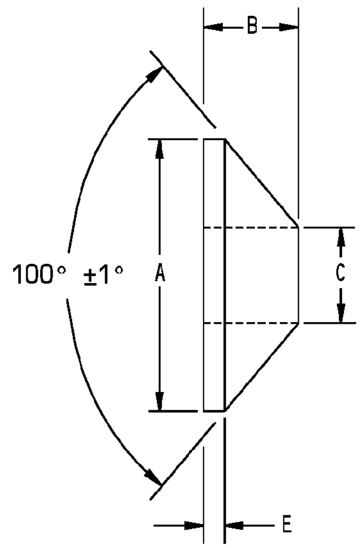
Countersink Repair Washer
Figure 2 (Sheet 3 of 5)



INITIAL FASTENER TYPE	DIAMETER	COUNTERSINK REPAIR WASHER 2 DIMENSIONS				MATERIAL 1
		A ±0.005	B (REF)	C (DIAMETER)	E +0.005 -0.002	
BACB30JC BACB30LU BACB30MS BACB30NY	3/16	0.344	0.079	0.191/0.194	0.015	2024-T4 BAR
	7/32	0.344	0.068	0.219/0.223	0.015	
	1/4	0.469	0.106	0.250/0.254	0.015	
	9/32	0.469	0.094	0.281/0.285	0.015	
	5/16	0.595	0.133	0.312/0.328	0.015	
	11/32	0.595	0.121	0.344/0.348	0.015	
	3/8	0.722	0.160	0.375/0.379	0.015	
	13/32	0.722	0.148	0.406/0.410	0.015	
	7/16	0.835	0.189	0.437/0.442	0.022	
	15/32	0.835	0.176	0.469/0.474	0.022	
	1/2	0.961	0.217	0.500/0.505	0.022	
	17/32	0.961	0.204	0.531/0.536	0.022	

D

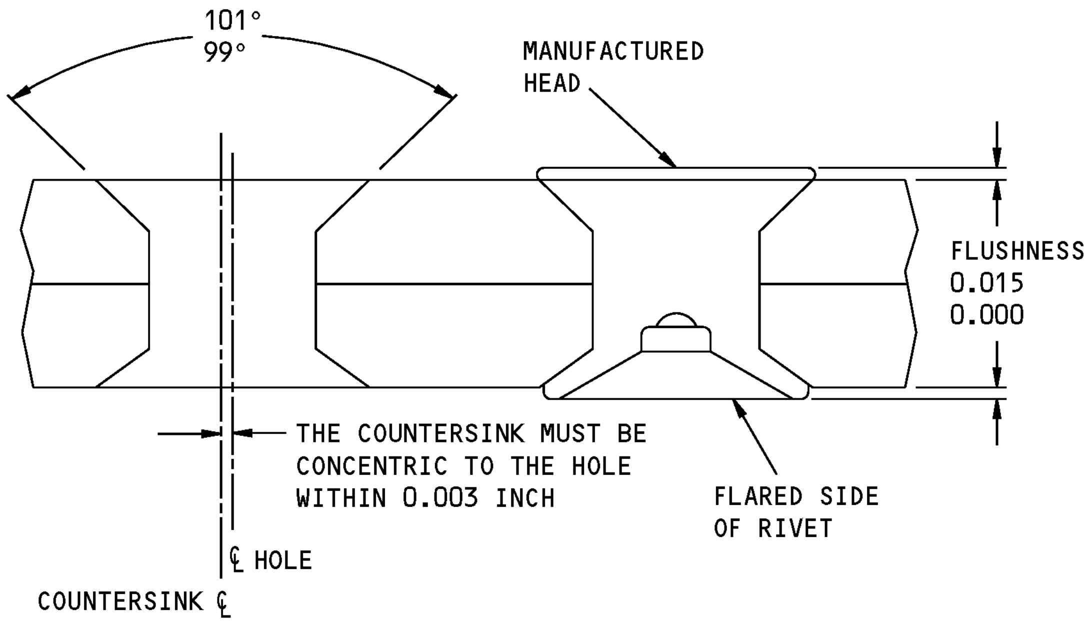
Countersink Repair Washer
Figure 2 (Sheet 4 of 5)



INITIAL FASTENER TYPE	DIAMETER	COUNTERSINK REPAIR WASHER 2 DIMENSIONS				MATERIAL 1
		A ±0.005	B (REF)	C (DIAMETER)	E +0.005 −0.002	
BACB30FN BACB30GY BACB30EL BACB30NU	3/16	0.277	0.046	0.191/0.194	0.010	2024-T4 BAR
	7/32	0.277	0.034	0.219/0.223	0.010	
	1/4	0.358	0.060	0.250/0.254	0.015	
	9/32	0.358	0.047	0.281/0.285	0.015	
	5/16	0.438	0.068	0.312/0.328	0.015	
	11/32	0.438	0.055	0.344/0.348	0.015	
	3/8	0.525	0.078	0.375/0.379	0.015	
	13/32	0.525	0.065	0.406/0.410	0.015	
	7/16	0.617	0.097	0.437/0.442	0.022	
	15/32	0.617	0.084	0.469/0.474	0.022	
	1/2	0.704	0.108	0.500/0.505	0.022	
	17/32	0.704	0.095	0.531/0.536	0.022	

E

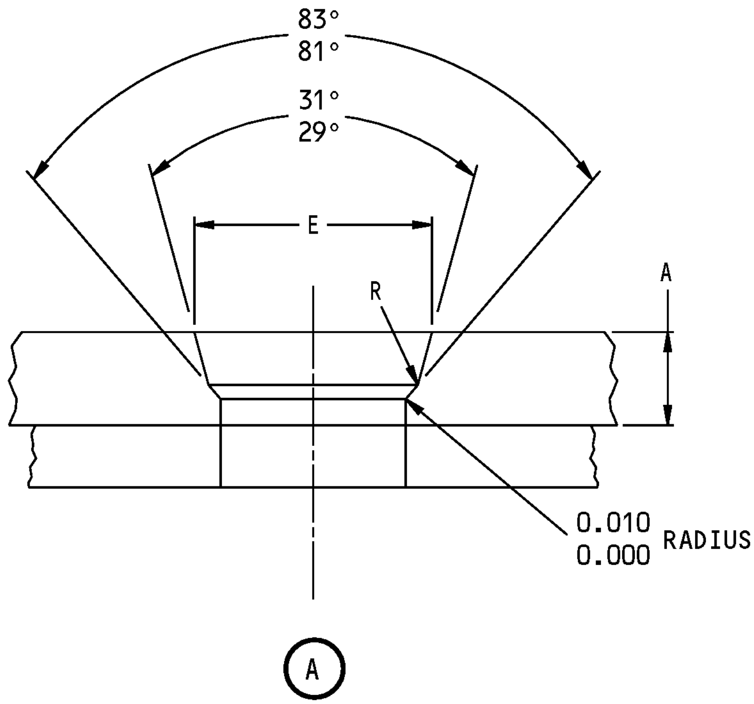
Countersink Repair Washer
Figure 2 (Sheet 5 of 5)



NOMINAL RIVET DIAMETER (INCH)	COUNTERSINK DIAMETER (INCH)
(-5) 5/32	0.242 0.227
(-6) 3/16	0.297 0.282
(-7) 7/32	0.325 0.318

COUNTERSINK DIMENSIONS FOR THE FLARED SIDE OF THE RIVET

Countersink Dimensions for BACR15GA Rivets
Figure 3



NOTES

- THE SOURCE OF INFORMATION FOR THIS FIGURE CAN BE FOUND IN BOEING SPECIFICATION BACD2027
- ALL DIMENSIONS ARE IN INCHES UNLESS IT IS SPECIFIED DIFFERENTLY.
- SEE TABLE A FOR BACR15FH AND BACR15GH RIVETS.
- SEE TABLE B FOR BACR15FH AND BACR15GH OVERSIZE RIVETS

Dimensions for Modified 82-Degree/30-Degree Countersink
Figure 4 (Sheet 1 of 2)

COUNTERSINK TYPE	RIVET DIAMETER	DIMENSION A		DIMENSION B		RADIUS R	
		MIN.	MAX.	MIN.	MAX.	MIN.	MAX.
IV	1/4	0.089	0.100	0.349	0.354	0.09	0.12
	5/16	0.099	0.110	0.419	0.424	0.09	0.12
	3/8	0.105	0.120	0.479	0.484	0.09	0.12
V	5/32	0.060	0.070	0.219	0.224	0.03	0.05
	3/16	0.075	0.085	0.270	0.275	0.09	0.12
	1/4	0.102	0.112	0.355	0.360	0.09	0.12
	5/16	0.128	0.138	0.434	0.439	0.09	0.12
	3/8	0.154	0.164	0.503	0.508	0.09	0.12
	7/16	0.183	0.193	0.588	0.593	0.09	0.12

COUNTERSINK DIMENSIONS FOR BACR15FH RIVETS

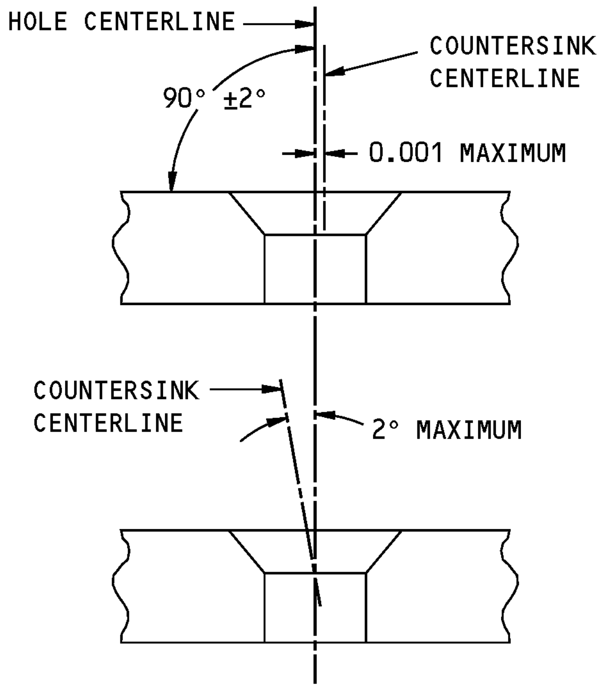
TABLE A

COUNTERSINK TYPE	RIVET DIAMETER	DIMENSION A		DIMENSION B		RADIUS R	
		MIN.	MAX.	MIN.	MAX.	MIN.	MAX.
IV	7/32	0.075	0.085	0.300	0.305	0.09	0.12
	9/32	0.090	0.100	0.379	0.384	0.09	0.12
	11/32	0.100	0.110	0.449	0.454	0.09	0.12
	7/16	0.115	0.125	0.549	0.554	0.09	0.12
V	7/32	0.080	0.085	0.300	0.305	0.09	0.12
	9/32	0.107	0.112	0.385	0.390	0.09	0.12
	7/16	0.154	0.164	0.575	0.580	0.09	0.12
	15/32	0.183	0.193	0.620	0.625	0.09	0.12

COUNTERSINK DIMENSIONS FOR BACR15FH OVERSIZE RIVETS

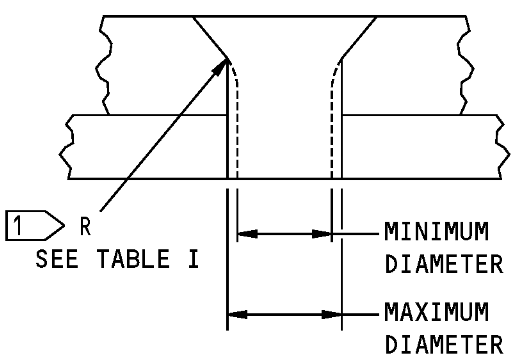
TABLE B

Dimensions for Modified 82-Degree/30-Degree Countersink
Figure 4 (Sheet 2 of 2)



PERMITTED COUNTERSINK MISALIGNMENT AND ECCENTRICITY

A



FILLET RELIEF

B

FASTENER SIZE	RADIUS R	
	MIN	MAX
5/32	0.030	0.040
3/16	0.030	0.040
1/4	0.030	0.040
5/16	0.040	0.050
3/8	0.040	0.050
7/16	0.050	0.060
1/2	0.050	0.060
9/16	0.050	0.060
5/8	0.050	0.060
3/4	0.050	0.060
7/8	0.050	0.060
1	0.050	0.060

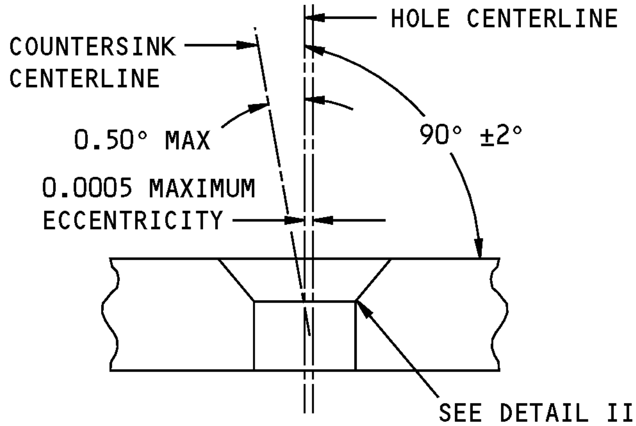
TABLE A

NOTES

- THE SOURCE OF INFORMATION FOR THIS FIGURE CAN BE FOUND IN BOEING SPECIFICATION BAC 5004-2.

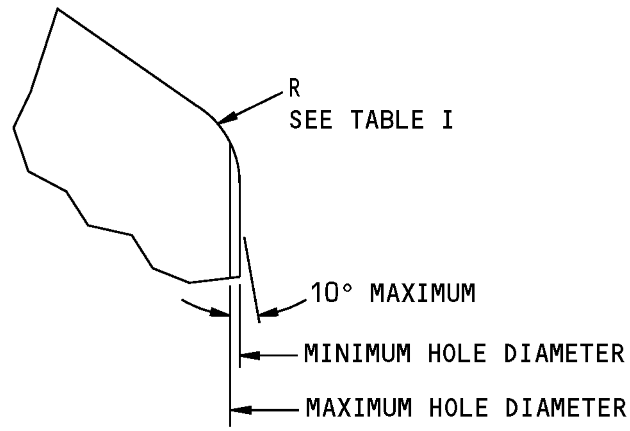
1 MAKE THE RADIUS BLEND SMOOTHLY WITH THE SHANK DIAMETER.

Countersink Detail for Flush Head Lockbolts and Hex-Drive Bolts
Figure 5



PERMITTED COUNTERSINK MISALIGNMENT
ECCENTRICITY AND FILLET RELIEF

A



B

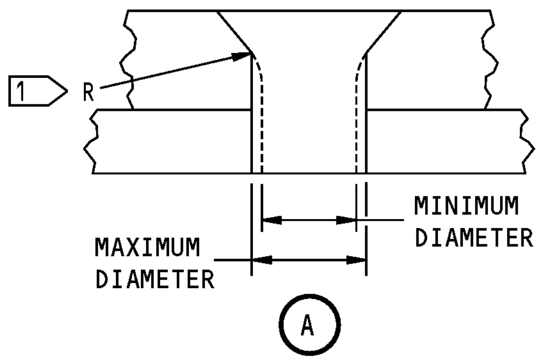
NOMINAL THREAD SIZE	FLUSH HEAD			
	BACB30WQ "R" RADIUS		BACB30PT "R" RADIUS	
	MIN	MAX	MIN	MAX
0.1900-32	0.020	0.030	-	-
0.2500-28	0.020	0.030	0.050	0.060
0.3125-24	0.030	0.040	0.050	0.060
0.3750-24	0.030	0.040	0.050	0.060
0.4375-20	0.030	0.040	-	-

FILLET RELIEF LIMITS FOR FLUSH
HEAD RADIUS LEAD-IN BOLT HOLES
TABLE A

NOTES

- THE SOURCE OF INFORMATION FOR THIS FIGURE CAN BE FOUND IN BOEING PROCESS SPECIFICATION BAC 5060.
- THE COUNTERSINK IS CUT AT THE SAME TIME THE HOLE IS DRILLED.

Countersink Detail for Flush Head Radius Lead-In Bolts
Figure 6



NOTES

- THE SOURCE OF INFORMATION FOR THIS FIGURE CAN BE FOUND IN BOEING PROCESS SPECIFICATION BAC 5009.

1 MAKE THE RADIUS BLEND SMOOTHLY WITH THE SHANK DIAMETER.

Fillet Relief for Bolts
Figure 7 (Sheet 1 of 2)

MAX SHANK DIA	100° FLUSH HEAD BOLT AND SCREW PART NUMBER SERIES									
	BACB30EM, BACB30FB, BACB30DL, BACB30DP, BACB30DY, BACB30FA, BACB30GD, BACB30MN, BACB30LH, BACB30LL, BACB30LP, BACB30LR, BACB30LU, BACB30NN, BACB30NU, BACB30MS, BACB30PC, BACB30RF, BACB30SW, BACB30TP, BACB30UW, BACB30VF, BACB30XK, BACB30XM, MS24693, MS27577, NAS1581, NAS1161, NAS8702		AN509, BACS12BF, BACS12BP, BACS12ER, BACS12GM, BACS12GP, BACS12GR, BACS12GX, MS24694, NAS514, NAS1219, NAS1221, NAS1299		BACB30AB, BACB30BF, BACB30WP, BACB30XD, NAS1790, NAS583 THRU 590, NAS1503, NAS1580, NAS1582, NAS1503 THRU 1510		NAS1972 THRU 1989, NAS1992 THRU 2000, NAS2803 THRU 2810, NAS333 THRU 340		NAS517, NAS1102, NAS1189, NAS1627, NAS1628	
	R FILLET RELIEF RADIUS									
	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX
0.1120	0.012	0.022	0.012	0.022	-- --	-- --	-- --	-- --	0.015	0.025
0.1380	0.012	0.022	0.012	0.022	-- --	-- --	-- --	-- --	0.020	0.030
0.1640	0.020	0.030	0.015	0.025	-- --	-- --	0.030	0.040	0.020	0.030
0.1900	0.020	0.030	0.015	0.025	0.035	0.045	0.030	0.040	0.020	0.030
0.2500	0.020	0.030	0.015	0.025	0.035	0.045	0.030	0.040	0.020	0.030
0.3125	0.025	0.035	0.020	0.030	0.045	0.055	0.030	0.040	0.025	0.035
0.3750	0.030	0.040	0.020	0.030	0.045	0.055	0.030	0.040	0.030	0.040
0.4375	0.030	0.040	0.020	0.030	0.055	0.065	0.030	0.040	0.035	0.045
0.5000	0.030	0.040	0.020	0.030	0.055	0.065	0.030	0.040	0.040	0.050
0.5625	0.030	0.040	0.020	0.030	0.065	0.075	0.030	0.040	-- --	-- --
0.6250	0.030	0.040	-- --	-- --	0.070	0.080	0.030	0.040	-- --	-- --
0.7500	0.030	0.040	-- --	-- --	0.080	0.090	-- --	-- --	-- --	-- --
0.8750	0.030	0.040	-- --	-- --	0.090	0.100	-- --	-- --	-- --	-- --
1.0000	0.030	0.040	-- --	-- --	0.100	0.110	-- --	-- --	-- --	-- --
1.1250	0.040	0.050	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --
1.2500	0.040	0.050	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --
1.3750	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --
1.5000	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --
1.7500	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --

FILLET RELIEF RADIUS LIMITS FOR FLUSH HEAD BOLTS AND SCREWS

TABLE A

Fillet Relief for Bolts
Figure 7 (Sheet 2 of 2)

NOTES

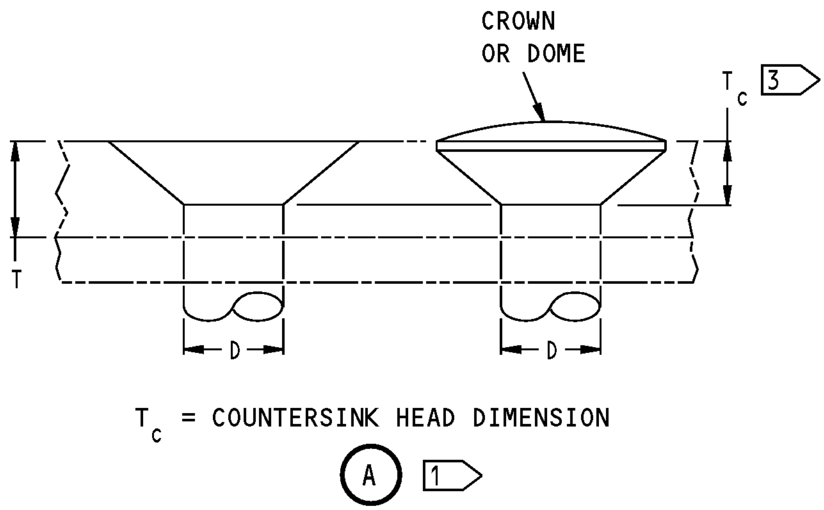
- T = MINIMUM SHEET THICKNESS = 1.5 X T_C
- ALL DIMENSIONS ARE GIVEN IN INCHES
- IN GENERAL, THE BOEING COMPANY RECOMMENDS THAT YOU USE THE LIMITS GIVEN IN THIS CHAPTER-SECTION-SUBJECT FOR MINIMUM SHEET THICKNESS. THE VALUES GIVEN WILL PREVENT KNIFE EDGE CONDITIONS IN COUNTERSINK HOLES, AND WILL REDUCE POSSIBLE FATIGUE CRACKING OF THE METAL.
- IF A REPAIR IN A DIFFERENT CHAPTER-SECTION-SUBJECT GIVES LIMITS THAT ARE NOT THE SAME AS SRM 51-40-08, THEN YOU CAN USE THE DATA GIVEN IN THAT SPECIFIC REPAIR PROCEDURE.
- THE VALUES GIVEN IN THIS FIGURE APPLY TO ANY COMBINATION OF A FASTENER AND THE METAL MATERIALS THAT ARE FASTENED TOGETHER. THE MINIMUM SHEET THICKNESS VALUES ARE FOR A ZERO TOLERANCE CONDITION BETWEEN THE FASTENER HEAD AND THE METAL SURFACE.
- WHERE THE FASTENER HEAD IS PERMITTED TO BE BELOW THE FLUSH SURFACE, YOU MUST INCREASE THE VALUE OF "T_C" BY THIS AMOUNT TO CALCULATE THE MINIMUM THICKNESS "T".
- UNLESS IT IS SPECIFIED IN THE CHAPTER-SECTION-SUBJECT THAT YOU ARE PERMITTED TO SHAVE A FASTENER HEAD, IN GENERAL, THE BOEING COMPANY RECOMMENDS THAT YOU DO NOT SHAVE THE FASTENER HEAD TO MAKE IT FLUSH WITH THE SURFACE OF THE REPAIR AREA.
- USE PROTRUDING HEAD FASTENERS WHEN THE THICKNESS "T" IS NOT SUFFICIENT TO CORRECTLY INSTALL A COUNTERSINK FASTENER.
- IF TWO SHEETS HAVE BEEN STRUCTURALLY BONDED TOGETHER AS GIVEN IN SRM 51-70-09, THEN THE MINIMUM SHEET THICKNESS CAN BE THE SUM OF BOTH SHEETS. (100° HEAD FASTENERS ONLY)
- DO NOT USE TABLE B AS A GUIDE FOR THE SUBSTITUTION OF LARGER DIAMETER FASTENERS IN A REPAIR AREA. USE ONLY THE OVERSIZED FASTENERS THAT ARE SPECIFIED IN THE REPAIR PROCEDURES GIVEN IN THIS STRUCTURAL REPAIR MANUAL.

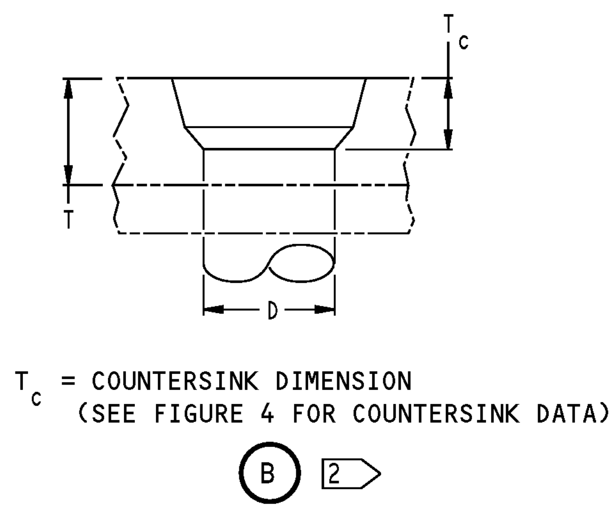
[1] TO INSTALL ALL FASTENER TYPES GIVEN IN TABLE A EXCEPT BACR15FH AND BACR15GH RIVETS.

[2] TO INSTALL BACR15FH AND BACR15GH TYPE IV AND V RIVETS GIVEN IN TABLE A.

[3] SOME FASTENERS HAVE A "CROWN" OR "DOME". THE HEIGHT OF THE CROWN OR DOME IS NOT USED TO CALCULATE MINIMUM SHEET THICKNESS.

Minimum Sheet Thickness for Countersinking of Fasteners
Figure 8 (Sheet 1 of 7)





Minimum Sheet Thickness for Countersinking of Fasteners
Figure 8 (Sheet 2 of 7)

EXAMPLE OF MINIMUM SHEET THICKNESS FOR COUNTERSUNK FASTENERS (T)												
FASTENER DESCRIPTION	NOMINAL FASTENER DIAMETER (D)											
	3/32	1/8	5/32	3/16	7/32	1/4	9/32	5/16	11/32	3/8	13/32	7/16
BOLT - HEX DRIVE												
BACB30XR				0.069		0.090						
BACB30JC			0.110	0.125		0.168		0.209		0.251		0.293
BACB30XW			0.060	0.069		0.090		0.101		0.116		
BACB30NW			0.062	0.072		0.092		0.102		0.117		0.146
BACB30VU			0.062	0.072		0.092		0.102		0.117		
BACB30FN			0.065	0.072		0.095		0.105		0.122		0.150
BACB30XG			0.081	0.102		0.140		0.158		0.200		
BACB30ND			0.084	0.117		0.147		0.164		0.206		0.231
BACB30NZ			0.081	0.104		0.141		0.158		0.200		0.231
BACB30XF			0.105	0.122		0.162		0.203		0.243		
BACB30NY			0.105	0.122		0.162		0.203		0.243		0.285
BACB30NY (1/64 OVERSIZE)				0.112		0.159		0.200		0.242		0.284
BACB30NY (1/32 OVERSIZE)				0.105		0.149		0.189		0.231		0.273
BACB30YM				0.122		0.162		0.203		0.243		0.285
BACB30YM (1/64 OVERSIZE)				0.116		0.159		0.200		0.242		0.284
BACB30YM (1/32 OVERSIZE)				0.105		0.149		0.189		0.231		0.273
BACB30YN				0.072		0.092		0.102		0.117		0.146
BACB30YN (1/64 OVERSIZE)				0.063		0.086		0.096		0.113		0.141
BACB30YN (1/32 OVERSIZE)				0.072		0.095		0.105		0.122		0.150
BACB30YP			0.062	0.071		0.092		0.102		0.120		

MINIMUM SHEET THICKNESS FOR
COUNTERSINKING OF 100° HEAD FASTENERS
TABLE A

Minimum Sheet Thickness for Countersinking of Fasteners
Figure 8 (Sheet 3 of 7)

EXAMPLE OF MINIMUM SHEET THICKNESS FOR COUNTERSUNK FASTENERS (T)												
FASTENER DESCRIPTION	NOMINAL FASTENER DIAMETER (D)											
	3/32	1/8	5/32	3/16	7/32	1/4	9/32	5/16	11/32	3/8	13/32	7/16
LOCKBOLT												
BACB30WB			0.060	0.068		0.089		0.099		0.114		
BACB30XT				0.069		0.090		0.101		0.125		
BACB30XU				0.069		0.090		0.101		0.125		
BACB30VM			0.065	0.074		0.095		0.107		0.122		
BACB30VP				0.074		0.095		0.107		0.122		
BACB30XB			0.081	0.104		0.141		0.158		0.200		
BACB30WD			0.110	0.126		0.165		0.206		0.248		
BACB30DY			0.083	0.107		0.147		0.164		0.206		
BACB30HD				0.107		0.147		0.164		0.206		
BACB30GY				0.074		0.095		0.107		0.122		
BACB30TY				0.074		0.095		0.107		0.122		
BACB30UC				0.074		0.095		0.107		0.122		

MINIMUM SHEET THICKNESS FOR
COUNTERSINKING OF 100° HEAD FASTENERS
TABLE A (CONT)

Minimum Sheet Thickness for Countersinking of Fasteners
Figure 8 (Sheet 4 of 7)

EXAMPLE OF MINIMUM SHEET THICKNESS FOR COUNTERSUNK FASTENERS (T)												
FASTENER DESCRIPTION	NOMINAL FASTENER DIAMETER (D)											
	3/32	1/8	5/32	3/16	7/32	1/4	9/32	5/16	11/32	3/8	13/32	7/16
BOLT - REMOVABLE												
BACB30UW				0.072		0.095		0.105		0.122		0.150
BACB30VF				0.072		0.095		0.105		0.120		0.150
NAS8702		0.059		0.074		0.095		0.105		0.122		0.152
BACB30XD				0.104		0.141		0.158		0.200		
BACB30LH				0.125		0.168		0.209		0.251		0.293
BACB30LH (1/64 OVERSIZE)				0.116		0.159		0.200		0.242		0.284
BACB30LH (1/32 OVERSIZE)				0.105		0.149		0.189		0.231		0.273
BACB30LR				0.072		0.095		0.105		0.122		0.150
BACB30LR (1/64 OVERSIZE)				0.063		0.159		0.200		0.242		0.284
BACB30LR (1/32 OVERSIZE)				0.072		0.149		0.189		0.231		0.273
BACB30NN				0.125		0.168		0.209		0.251		0.293
BACB30PC						0.168		0.209		0.251		0.293
BACB30LU		0.092	0.108	0.125		0.168		0.209		0.251		0.293
BACB30LU (1/64 OVERSIZE)				0.116		0.159		0.200		0.242		0.284
BACB30LU (1/32 OVERSIZE)				0.105		0.149		0.189		0.231		0.273
BACB30MS				0.125		0.168		0.209		0.251		0.293
BACB30EL				0.075		0.096		0.108		0.123		0.153
BACB30NU				0.065		0.087		0.098		0.114		0.143
BACB30NU (1/64 OVERSIZE)				0.065		0.087		0.098		0.114		0.143
BACB30NU (1/32 OVERSIZE)				0.072		0.095		0.105		0.122		0.150

MINIMUM SHEET THICKNESS FOR COUNTERSINKING OF
100° HEAD FASTENERS
TABLE A (CONT)

Minimum Sheet Thickness for Countersinking of Fasteners
Figure 8 (Sheet 5 of 7)

EXAMPLE OF MINIMUM SHEET THICKNESS FOR COUNTERSUNK FASTENERS (T)												
FASTENER DESCRIPTION	NOMINAL FASTENER DIAMETER (D)											
	3/32	1/8	5/32	3/16	7/32	1/4	9/32	5/16	11/32	3/8	13/32	7/16
BOLT - REMOVABLE												
BACB30LL				0.072		0.095		0.105		0.122		0.150
BACB30LL (1/64 OVERSIZE)				0.063		0.086		0.096		0.113		0.141
BACB30LL (1/32 OVERSIZE)				0.072		0.095		0.105		0.122		0.150
BACB30RF				0.072		0.095		0.105		0.122		0.150
BACB30RF (1/64 OVERSIZE)				0.063		0.086		0.096		0.111		0.141
BACB30RF (1/32 OVERSIZE)				0.072		0.095		0.105		0.122		0.150
BACB30LP				0.125		0.168		0.209		0.251		0.293
BACB30LP (1/64 OVERSIZE)				0.116		0.159		0.200		0.242		0.284
BACB30LP (1/32 OVERSIZE)				0.105		0.149		0.189		0.231		0.273
BACB30TP				0.125								
BOLT - RADIUS LEAD-IN												
BACB30PT						0.105		0.120		0.135		
BACB30WQ				0.074		0.095		0.107		0.123		0.150

MINIMUM SHEET THICKNESS FOR COUNTERSINKING OF
100° HEAD FASTENERS
TABLE A (CONT)

Minimum Sheet Thickness for Countersinking of Fasteners
Figure 8 (Sheet 6 of 7)

EXAMPLE OF MINIMUM SHEET THICKNESS FOR COUNTERSUNK FASTENERS (T)												
FASTENER DESCRIPTION	NOMINAL FASTENER DIAMETER (D)											
	3/32	1/8	5/32	3/16	7/32	1/4	9/32	5/16	11/32	3/8	13/32	7/16
BOLT - BLIND												
BACB30VK			0.059	0.065		0.086						
MS90353			0.108	0.120		0.158		0.206		0.248		0.290
MS21140			0.111	0.123		0.162		0.210		0.252		
RIVET - BLIND												
BACR15DR AND MS20605	0.054	0.063	0.083	0.105		0.143						
NAS1739		0.053	0.071	0.095								
BACR15FP		0.053	0.071	0.095								
NAS1399		0.063	0.083	0.105		0.143						
RIVET - SOLID SHANK												
NAS1200	0.032	0.044	0.056	0.069		0.090						
BACR15CE AND NAS1097	0.036	0.045	0.059	0.072		0.093						
BACR15DS					0.069		0.092					
BACR15GF	0.032	0.042	0.056	0.068	0.068	0.090	0.090	0.110				
BACR15BA	0.057	0.068	0.087	0.110		0.149		0.165		0.209		0.242
MS20426 AND MS20427	0.063	0.072	0.092	0.115		0.155		0.172		0.215		
BACR15AD					0.219		0.281		0.344		0.406	
BACR15FH BACR15GH TYPE IV			0.105	0.128		0.150		0.165		0.180		0.195
BACR15FH BACR15GH TYPE V			0.105	0.128		0.168		0.207		0.246		0.246
SCREW												
BACS12BP				0.120		0.159		0.200		0.239		
BACS12ER				0.120		0.159		0.200		0.239		
BACS12GP				0.120								
NAS514				0.120		0.159		0.200		0.239		
MS24693				0.125		0.165		0.207		0.248		

MINIMUM SHEET THICKNESS FOR COUNTERSINKING OF
100° HEAD FASTENERS
TABLE A (CONT)

Minimum Sheet Thickness for Countersinking of Fasteners
Figure 8 (Sheet 7 of 7)

REPAIR GENERAL - COLD WORKING PROCEDURES TO INCREASE THE FATIGUE PROPERTIES OF FASTENER HOLES

1. Applicability

CAUTION: COLD WORKING OF PARTS MACHINED FROM 7050-T74XX AND 7050-T76XX PLATE OR FORGED BLOCKS IS PERMITTED ONLY IF THE CENTERLINE OF THE HOLES ARE ORIENTED IN THE ST (SHORT TRANSVERSE) GRAIN DIRECTION. THE GRAIN DIRECTION IN 7050-T74XX AND 7050-T76XX PARTS MUST BE DETERMINED BEFORE COLD WORKING SO THAT COLD WORKING IN THE WRONG DIRECTION IS NOT DONE. CARE MUST BE TAKEN WITH 7050-T74XX AND 7050-T76XX FINISHED MACHINE PARTS THAT HAVE SIMILAR FLANGES, SUCH AS ANGLES, TO DETERMINE THE GRAIN DIRECTION RELATIVE TO EACH FLANGE BEFORE COLD WORKING. THESE PROCEDURES HAVE FAA APPROVAL ONLY IF IT IS SPECIFIED IN THE APPLICABLE REPAIR SUBJECT FOUND IN CHAPTERS 52 THROUGH 57 IN THIS MANUAL OR ON THE APPLICABLE ENGINEERING DRAWING.

A. This subject contains data for cold working fastener holes in aluminum alloy.

2. General

A. Cold working is a procedure used to increase the fatigue properties of fastener holes in the airplane structure. In this procedure, you push or pull a mandrel that is larger than the initial fastener hole through the fastener hole. The mandrel makes the diameter of the fastener hole permanently larger and causes a zone of compressive stress around the hole. This zone of compressive stress helps prevent the start and growth of fatigue cracks.

NOTE: Refer to Figure 201 for the cold working limits in 7050-T74XX and 7050-T76XX materials.

B. The tools that you will need for the cold working procedures are available from the vendors that follow:

(1) Fatigue Technology Inc.

100 Andover Park West

Seattle, Washington 98188-2868

(2) West Coast Industries Inc.

14900 Whitman Ave. North

Seattle Washington, 98133

C. There are two cold working procedures given in this subject:

(1) Cold Working With a Sleeve: In this procedure there is a sleeve in the fastener hole while it is cold worked. The sleeve contains the lubrication necessary for the cold working procedure. The sleeve is used once, then it is discarded.

(2) Cold Working Without a Sleeve: In this procedure the hole is cold worked without a sleeve. You must apply lubricant to the hole and the mandrel before you do the procedure.

D. There are two classes of cold working procedures. They are different in the level of interference they make in the fastener hole.

(1) Class 1: Class 1 cold working has a high interference. For cold working with a sleeve, the interference is 4 percent. For cold working without a sleeve, the interference is 5 percent. Class 1 cold worked holes are reamed to the finished hole diameter after the cold working procedure.

(2) Class 2: Class 2 cold working has a low interference. The interference is 3 percent for the two cold working procedures. Class 2 cold worked holes are usually not reamed after the cold working procedure.

E. Alternative cold working procedures are permitted as follows:

(1) Cold working with a sleeve is an alternative to cold working without a sleeve.

(2) Cold working without a sleeve is an alternative to cold working with a sleeve.

F. Alternative cold working procedures are not permitted as follows:

(1) Class 1 cold working cannot be used as an alternative for Class 2 cold working.

(2) Class 2 cold working cannot be used as an alternative for Class 1 cold working.

G. The instructions for the different types of cold working procedures are located in this subject as follows:

(1) Paragraph 4./REPAIR GENERAL gives the instructions for Class 1 and Class 2 cold working with a sleeve.

(2) Paragraph 4./REPAIR GENERAL gives the instructions for Class 1 cold working without a sleeve.

(3) Paragraph 5./REPAIR GENERAL gives the instructions for Class 2 cold working without a sleeve.

H. The definitions of terms applicable to the cold working of holes are as follows:

(1) Finished hole diameter: The diameter of the hole necessary to install the fastener to the correct class of fastener fit. Class 1 cold worked holes are reamed to the finished hole diameter after the cold working procedure. Class 2 cold worked holes are usually not reamed after the cold working procedure.

(2) Maximum permitted finished hole diameter: The largest diameter to which the cold worked hole can be made larger with a reamer. If it is necessary to make the hole larger than the maximum finished hole diameter, you must cold work the hole again.

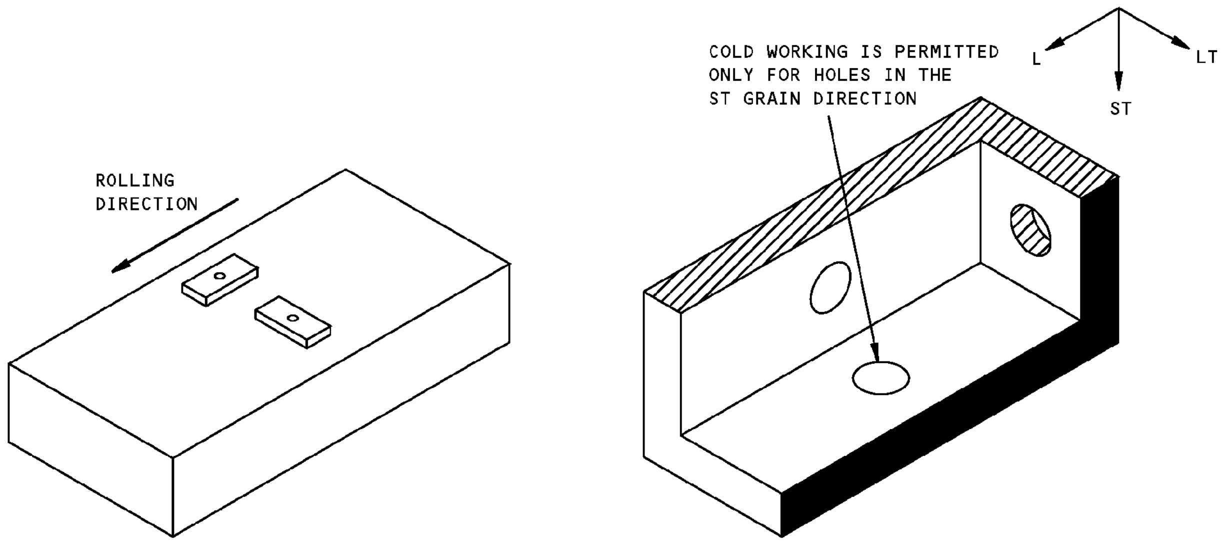
(3) Interference: The quantity that the hole is made larger by the cold working procedure. It is given as a percentage of the starting hole diameter.

(4) Power unit: Supplies the hydraulic power to the puller unit. For the cold working without a sleeve procedure, the power unit can also pump liquid Boelube to the puller unit.

(5) Puller unit: A hand held tool which supplies the force that pulls the mandrel through the fastener hole.

(6) Sleeve: A split metallic cylinder that is put on the mandrel before the mandrel is put into the fastener hole. A sleeve is used only for the cold working with a sleeve procedure. The sleeve contains all the lubricant necessary for the procedure. The sleeve is used once and then it is discarded.

(7) Starting hole diameter: The hole diameter before you cold work the hole.



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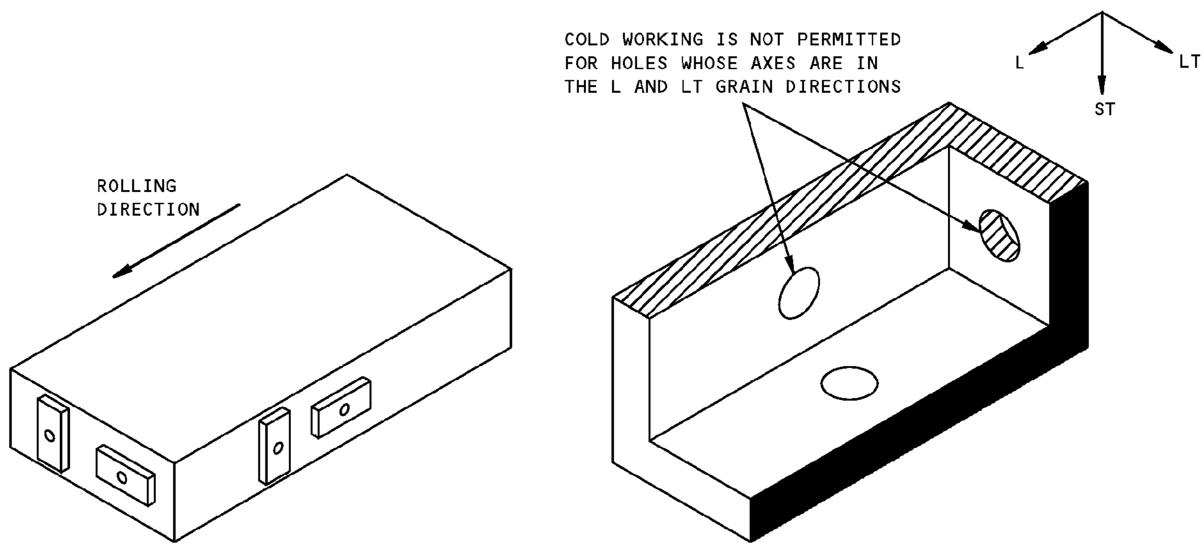


NOT APPROVED

L = LONGITUDINAL GRAIN DIRECTION

LT = LONG TRANSVERSE GRAIN DIRECTION

ST = SHORT TRANSVERSE GRAIN DIRECTION

Cold Working Limits in 7050-T74XX and 7050-T76XX Material
Figure 201

3. References

Reference	Title
51-40-05	FASTENER HOLE SIZES

4. Instructions for Class 1 and Class 2 Cold Working With a Sleeve

A. Refer to The Procedure for Cold Working With a Sleeve, Figure 202/REPAIR GENERAL for a general description of the steps you use to cold work a hole with a sleeve.

CAUTION: THE TOOLS YOU USE TO DO COLD WORKING ARE VERY IMPORTANT. IF YOU DO NOT USE THE CORRECT TOOLS, THE REPAIR WILL BE UNSATISFACTORY.

B. The tools that are used to correctly cold work a hole with a sleeve are as follows:

- Hole gage
- Mandrel
- Mandrel wear gage
- Nose cap
- Offset adapter for puller unit
- Power unit
- Puller unit
- Reamer for the starting hole diameter
- Reamer for the finished hole diameter
- Flared Sleeve
- Straight Sleeve

Examples of most of these tools are shown in Tools Used in the Class 1 and Class 2 Cold Working With a Sleeve Procedure, Figure 203/REPAIR GENERAL.

(1) Make sure the tools work correctly.

CAUTION: DO NOT USE A MANDREL THAT HAS BEEN WORN SMALLER THAN ITS MINIMUM PERMITTED DIAMETER. IF YOU USE A MANDREL THAT IS WORN TOO SMALL, THE REPAIR WILL BE UNSATISFACTORY.

(2) Do an inspection of the mandrel for wear with a mandrel wear gage.

C. Do an inspection of the hole before it is cold worked.

(1) Make sure the hole that you will cold work has the correct starting hole diameter.

(a) Use a hole gage to find the diameter of the hole.

(b) Refer to the applicable table for the starting hole diameter that is necessary.

1) Refer to Table 201/REPAIR GENERAL for holes that will be Class 1 cold worked with a sleeve.

2) Refer to Table 202/REPAIR GENERAL for holes that:

a) Will be Class 2 cold worked with a sleeve and have a bolt other than a hex-drive bolt or lockbolt installed, or

b) Will be Class 2 cold worked with a sleeve and left as an open hole.

3) Refer to Table 203/REPAIR GENERAL for holes that will be Class 2 cold worked with a sleeve and have a hex-drive bolt or a lockbolt installed.

4) Refer to Table 204/REPAIR GENERAL for holes that will be Class 2 cold worked with a sleeve and have a rivet installed.

(c) Use a reamer if you need to make the hole larger. Remove the cutting fluid that remains before you cold work the hole.

Table 201:

CLASS 1 COLD WORKING WITH A SLEEVE - HOLE DIAMETERS FOR All FASTENERS			
NOMINAL FASTENER DIAMETER (INCHES)	STARTING HOLE DIAMETER		MAXIMUM FINISHED HOLE DIAMETER (INCHES)
	MINIMUM (INCHES)	MAXIMUM (INCHES)	
5/32	0.143	0.146	0.1720
11/64	0.159	0.162	0.1880
3/16	0.177	0.180	0.2060
13/64	0.192	0.195	0.2220
7/32	0.209	0.212	0.2390
15/64	0.225	0.228	0.2550
1/4	0.235	0.238	0.2655
17/64	0.251	0.254	0.2815
9/32	0.266	0.269	0.2970
19/64	0.283	0.286	0.3140
5/16	0.297	0.300	0.3290
21/64	0.313	0.316	0.3450
11/32	0.328	0.331	0.3605
23/64	0.344	0.347	0.3765
3/8	0.359	0.362	0.3920
25/64	0.375	0.378	0.4080
13/32	0.391	0.394	0.4245
27/64	0.406	0.409	0.4400
7/16	0.421	0.424	0.4555
29/64	0.437	0.440	0.4715
15/32	0.450	0.453	0.4855
31/64	0.465	0.468	0.5005
1/2	0.474	0.477	0.5280
33/64	0.490	0.493	0.5440
17/32	0.505	0.508	0.5595
35/64	0.521	0.524	0.5755
9/16	0.537	0.540	0.5920
37/64	0.553	0.556	0.6080
19/32	0.568	0.571	0.6235
39/64	0.583	0.586	0.6390
5/8	0.597	0.600	0.6562
41/64	0.613	0.616	0.6719

CLASS 1 COLD WORKING WITH A SLEEVE - HOLE DIAMETERS FOR All FASTENERS			
NOMINAL FASTENER DIAMETER (INCHES)	STARTING HOLE DIAMETER		MAXIMUM FINISHED HOLE DIAMETER (INCHES)
	MINIMUM (INCHES)	MAXIMUM (INCHES)	
21/32	0.631	0.634	0.6875
43/64	0.646	0.649	0.7040
11/16	0.659	0.662	0.7188
45/64	0.675	0.678	0.7344
23/32	0.690	0.693	0.7500
47/64	0.706	0.709	0.7657
3/4	0.718	0.721	0.7812
49/64	0.734	0.737	0.7968
25/32	0.749	0.752	0.8125
51/64	0.765	0.768	0.8281
13/16	0.782	0.785	0.8437
53/64	0.798	0.801	0.8594
27/32	0.811	0.814	0.8750
55/64	0.826	0.829	0.8906
7/8	0.841	0.844	0.9062
57/64	0.857	0.860	0.9218
29/32	0.879	0.882	0.9420
59/64	0.894	0.897	0.9575
15/16	0.901	0.904	0.9910
61/64	0.917	0.920	1.0067
31/32	0.933	0.936	1.0230
63/64	0.949	0.952	1.0390
1	0.965	0.968	1.0468
1-1/64	0.981	0.984	1.0650
1-1/32	0.997	1.000	1.0780
1-3/64	1.013	1.016	1.1050
1-1/8	1.075	1.078	1.1700
1-9/64	1.091	1.094	1.1860
1-5/32	1.107	1.110	1.2020
1-11/64	1.123	1.126	1.2180
1-3/16	1.136	1.140	1.2320
1-13/64	1.152	1.156	1.2480
1-7/32	1.168	1.172	1.2640
1-15/64	1.184	1.188	1.2800
1-1/4	1.199	1.203	1.2970
1-17/64	1.215	1.219	1.3130

CLASS 1 COLD WORKING WITH A SLEEVE - HOLE DIAMETERS FOR All FASTENERS			
NOMINAL FASTENER DIAMETER (INCHES)	STARTING HOLE DIAMETER		MAXIMUM FINISHED HOLE DIAMETER (INCHES)
	MINIMUM (INCHES)	MAXIMUM (INCHES)	
1-9/32	1.231	1.235	1.3290
1-19/64	1.247	1.251	1.3450

Table 202:

CLASS 2 COLD WORKING WITH A SLEEVE - HOLE DIAMETERS FOR OPEN HOLES AND BOLTS OTHER THAN HEX-DRIVE BOLTS AND LOCKBOLTS				
NOMINAL FASTENER DIAMETER (INCHES)	STARTING HOLE DIAMETER		FINISHED HOLE DIAMETER	
	MINIMUM (INCHES)	MAXIMUM (INCHES)	MINIMUM (INCHES)	MAXIMUM (INCHES)
1/8	0.1225	0.1255	0.1267	0.1295
9/64	0.1381	0.1411	0.1423	0.1451
5/32	0.1537	0.1567	0.1580	0.1608
11/64	0.1694	0.1724	0.1737	0.1765
3/16	0.1850	0.1880	0.1894	0.1922
13/64	0.2006	0.2036	0.2050	0.2078
7/32	0.2162	0.2192	0.2206	0.2234
15/64	0.2319	0.2349	0.2364	0.2392
1/4	0.2475	0.2505	0.2520	0.2548
17/64	0.2631	0.2661	0.2676	0.2704
9/32	0.2787	0.2817	0.2833	0.2861
19/64	0.2944	0.2974	0.2990	0.3018
5/16	0.3100	0.3130	0.3145	0.3175
21/64	0.3256	0.3286	0.3301	0.3331
11/32	0.3412	0.3442	0.3458	0.3488
23/64	0.3569	0.3599	0.3615	0.3647
3/8	0.3725	0.3755	0.3771	0.3803
25/64	0.3881	0.3911	0.3928	0.3960
13/32	0.4037	0.4067	0.4083	0.4117
27/64	0.4194	0.4224	0.4241	0.4275
7/16	0.4350	0.4380	0.4396	0.4432
29/64	0.4506	0.4536	0.4551	0.4589
15/32	0.4662	0.4692	0.4708	0.4746
31/64	0.4819	0.4849	0.4865	0.4905
1/2	0.4975	0.5005	0.5020	0.5064
33/64	0.5131	0.5161	0.5176	0.5220
17/32	0.5287	0.5317	0.5332	0.5376
35/64	0.5444	0.5474	0.5489	0.5533
9/16	0.5600	0.5630	0.5647	0.5691

CLASS 2 COLD WORKING WITH A SLEEVE - HOLE DIAMETERS FOR OPEN HOLES AND BOLTS OTHER THAN HEX-DRIVE BOLTS AND LOCKBOLTS				
NOMINAL FASTENER DIAMETER (INCHES)	STARTING HOLE DIAMETER		FINISHED HOLE DIAMETER	
	MINIMUM (INCHES)	MAXIMUM (INCHES)	MINIMUM (INCHES)	MAXIMUM (INCHES)
37/64	0.5756	0.5786	0.5803	0.5847
19/32	0.5912	0.5942	0.5959	0.6003
39/64	0.6069	0.6099	0.6116	0.6160
5/8	0.6225	0.6255	0.6272	0.6316
41/64	0.6381	0.6411	0.6429	0.6473
21/32	0.6537	0.6567	0.6585	0.6629
43/64	0.6694	0.6724	0.6742	0.6786
11/16	0.6850	0.6880	0.6899	0.6943
45/64	0.7006	0.7036	0.7055	0.7099
23/32	0.7162	0.7192	0.7212	0.7256
47/64	0.7319	0.7349	0.7369	0.7413
3/4	0.7475	0.7505	0.7525	0.7571
49/64	0.7631	0.7661	0.7681	0.7727
25/32	0.7787	0.7817	0.7837	0.7883
51/64	0.7944	0.7974	0.7995	0.8041
13/16	0.8100	0.8130	0.8151	0.8197
53/64	0.8256	0.8286	0.8307	0.8353
27/32	0.8412	0.8442	0.8464	0.8510
55/64	0.8569	0.8599	0.8621	0.8667
7/8	0.8725	0.8755	0.8778	0.8824
57/64	0.8881	0.8911	0.8934	0.8980
29/32	0.9037	0.9067	0.9091	0.9137
59/64	0.9194	0.9224	0.9248	0.9294
15/16	0.9350	0.9380	0.9404	0.9452
61/64	0.9506	0.9536	0.9560	0.9608
31/32	0.9662	0.9692	0.9716	0.9764
63/64	0.9819	0.9849	0.9874	0.9922
1	0.9975	1.0005	1.0030	1.0078
1-1/64	1.0131	1.0161	1.0187	1.0235
1-1/32	1.0287	1.0317	1.0343	1.0391

Table 203:

CLASS 2 COLD WORKING WITH A SLEEVE - HOLE DIAMETERS FOR HEX-DRIVE BOLTS AND LOCKBOLTS				
NOMINAL FASTENER DIAMETER (INCHES)	STARTING HOLE DIAMETER		FINISHED HOLE DIAMETER	
	MINIMUM (INCHES)	MAXIMUM (INCHES)	MINIMUM (INCHES)	MAXIMUM (INCHES)
3/16	0.1830	0.1860	0.187	0.190

CLASS 2 COLD WORKING WITH A SLEEVE - HOLE DIAMETERS FOR HEX-DRIVE BOLTS AND LOCKBOLTS				
NOMINAL FASTENER DIAMETER (INCHES)	STARTING HOLE DIAMETER		FINISHED HOLE DIAMETER	
	MINIMUM (INCHES)	MAXIMUM (INCHES)	MINIMUM (INCHES)	MAXIMUM (INCHES)
13/64	0.1960	0.1990	0.200	0.203
7/32	0.2105	0.2135	0.216	0.219
1/4	0.2430	0.2460	0.247	0.250
17/64	0.2590	0.2620	0.263	0.266
9/32	0.2725	0.2755	0.278	0.281
5/16	0.3055	0.3085	0.309	0.313
21/64	0.3205	0.3235	0.325	0.328
11/32	0.3355	0.3385	0.341	0.344
3/8	0.3670	0.3700	0.371	0.375
25/64	0.3840	0.3870	0.388	0.391
13/32	0.3990	0.4020	0.403	0.406
7/16	0.4285	0.4315	0.434	0.438
29/64	0.4435	0.4465	0.450	0.453
15/32	0.4600	0.4630	0.466	0.469

Table 204:

CLASS 2 COLD WORKING WITH A SLEEVE - HOLE DIAMETERS FOR RIVETS				
NOMINAL FASTENER DIAMETER (INCHES)	STARTING HOLE DIAMETER		FINISHED HOLE DIAMETER	
	MINIMUM (INCHES)	MAXIMUM (INCHES)	MINIMUM (INCHES)	MAXIMUM (INCHES)
1/8	0.1245	0.1275	0.128	0.131
5/32	0.1555	0.1585	0.159	0.162
3/16	0.1865	0.1895	0.190	0.195
7/32	0.2160	0.2190	0.220	0.2245
1/4	0.2495	0.2525	0.253	0.257
9/32	0.2785	0.2815	0.283	0.286
5/16	0.3115	0.3145	0.317	0.3205
11/32	0.3410	0.3440	0.345	0.348
3/8	0.3725	0.3755	0.378	0.382
13/32	0.4035	0.4065	0.408	0.412
7/16	0.4340	0.4370	0.441	0.444

(2) Make sure the hole is not more than 2 degrees from perpendicular to the mating surface on which the fastener head will be installed. Refer to Condition of the Hole Before Cold Working, Figure 204/REPAIR GENERAL.

(3) Make sure the surface finish of the initial hole is 125 microinches Ra or smoother. The hole surface must not have longitudinal or helical scratches.

D. Hold the mated parts together with a clamp or with temporary fasteners while they are cold worked. Do not permit the mated parts to move in relation to each other.

E. Get the sleeve or sleeves needed for the cold working procedure.

(1) The part numbers for the sleeves are available from the vendors given in Paragraph 2.A./REPAIR GENERAL

CAUTION: DO NOT APPLY LUBRICANT TO THE SLEEVE. IF YOU DO, THE REPAIR WILL BE UNSATISFACTORY.

(2) The sleeve must have a gray colored dry film lubricant on the entire inside surface. Do not use a sleeve that does not have this lubricant.

(3) One or more sleeves can be used in a hole.

NOTE: We recommend that you use a single sleeve when it is possible.

(a) If you use one sleeve in a hole, make sure that:

1) The total length of the sleeve is a minimum of 1/32 inch longer than the thickness of the part or the total thickness of mated parts.

(b) If you use more than one sleeve in a hole, refer to Examples for the Use of More Than One Sleeve, Figure 205/REPAIR GENERAL and make sure that:

1) The splits in the sleeves are aligned with each other

2) The total length of the sleeves are a minimum of 1/32 inch longer than the thickness of the part or the total thickness of mated parts

3) The end of the sleeve is more than 1/32 inch from a mated surface

4) The end of a sleeve is more than one hole diameter away from the end of the hole.

F. Put the sleeve or sleeves on the mandrel. Push the sleeve or sleeves in the direction of the puller unit until they touch the nosecap.

WARNING: KEEP YOUR FINGERS AWAY FROM THE NOSE CAP OF THE PULLER UNIT DURING THE COLD WORKING PROCEDURE. IF YOU DO NOT OBEY, YOU CAN CAUSE AN INJURY. BROKEN HYDRAULIC FITTINGS AND HOSES ARE DANGEROUS. MAKE SURE THE HYDRAULIC FITTINGS AND HOSES ARE IN GOOD CONDITION BEFORE YOU USE THE PULLER UNIT. IF YOU DO NOT OBEY, YOU CAN CAUSE AN INJURY.

G. Put the mandrel into the hole.

(1) Make sure the nose cap of the puller unit fully touches the part that you will cold work.

(2) Hold the puller unit perpendicular to the parts that will be cold worked.

H. Pull the trigger of the puller unit to cold work the hole. Do not release the trigger until the mandrel fully retracts into the nosecap.

CAUTION: THE COLD WORKING PROCEDURE DAMAGES THE SLEEVE AND REMOVES THE LUBRICANT. IF YOU USE A SLEEVE MORE THAN ONCE, THE REPAIR WILL BE UNSATISFACTORY.

I. Remove the sleeve and discard it. Do not use a sleeve more than once.

J. For Class 1 cold worked holes only, do the steps that follow:

CAUTION: FOR CLASS 1 COLD WORKED HOLES, USE A HOLE GAGE TO MAKE SURE THE HOLE HAS BEEN CORRECTLY COLD WORKED BEFORE YOU REAM IT (TO THE FINISHED HOLE DIAMETER). IF YOU REAM A HOLE THAT HAS NOT BEEN CORRECTLY COLD WORKED, THE REPAIR WILL BE UNSATISFACTORY.

(1) Check the diameter of the hole with a hole gage to make sure that it was correctly cold worked.

(2) Refer to Table 201/REPAIR GENERAL for the finished hole diameters that are permitted.

(3) Ream the hole to a permitted finished hole diameter. Use a reamer that has a pilot diameter that will not permit the reamer to go into a hole that has not been cold worked.

NOTE: We recommend that you use a reamer that has a pilot that does not cut.

K. Remove the sharp edges from the hole.

L. Countersink the hole as necessary.

M. Do a visual inspection of the cold worked hole.

(1) Check the diameter of the hole to make sure that it has the correct finished hole diameter.

(2) Cracks at or near the hole that you can see visually are not permitted.

(a) You can ream the hole to remove the cracks. If you make the hole larger than the maximum finished hole diameter, you must:

1) Drill the hole to the next available starting diameter if it is permitted by the applicable repair subject, and

2) Cold work the hole again.

(3) For Class 1 cold worked holes only, it is possible that the cold worked hole will have an area that is not cut by the reamer (when you ream the hole to the finished hole diameter). This is permitted if:

(a) For a single part that is cold worked, the area that is not cut by the reamer is at the entrance or the exit of the hole.

(b) For two or more mated parts that are cold worked at the same time, the area that is not cut by the reamer is:

1) At the entrance or the exit of the hole, or

2) At the interface of the hole between each part.

(c) For each part that is cold worked, the length of the area that is not cut by the reamer is less than the smaller of:

1) 0.020 inch, or

2) 10 percent of the thickness of the part.

(4) The cold working procedure can lift an area of the surface around the hole. It is possible that the lifted area will cause the mated parts to move apart. If there is a lifted area around the hole, refer to Inspection of the Area that is Lifted, Figure 206/REPAIR GENERAL and do what follows:

(a) Put the fastener in the hole.

(b) Put a 0.005 inch thick shim between the mated parts.

1) If the shim does not touch the fastener, the condition of the hole is acceptable.

2) If the shim touches the fastener, you must:

a) Disassemble the mated parts

b) Remove the area of the surface that has been lifted

c) Assemble the parts again

d) Do Step (4)(b) again.

(5) If you find that a hole has not been cold worked correctly, or if you are not sure the hole has been cold worked, then:

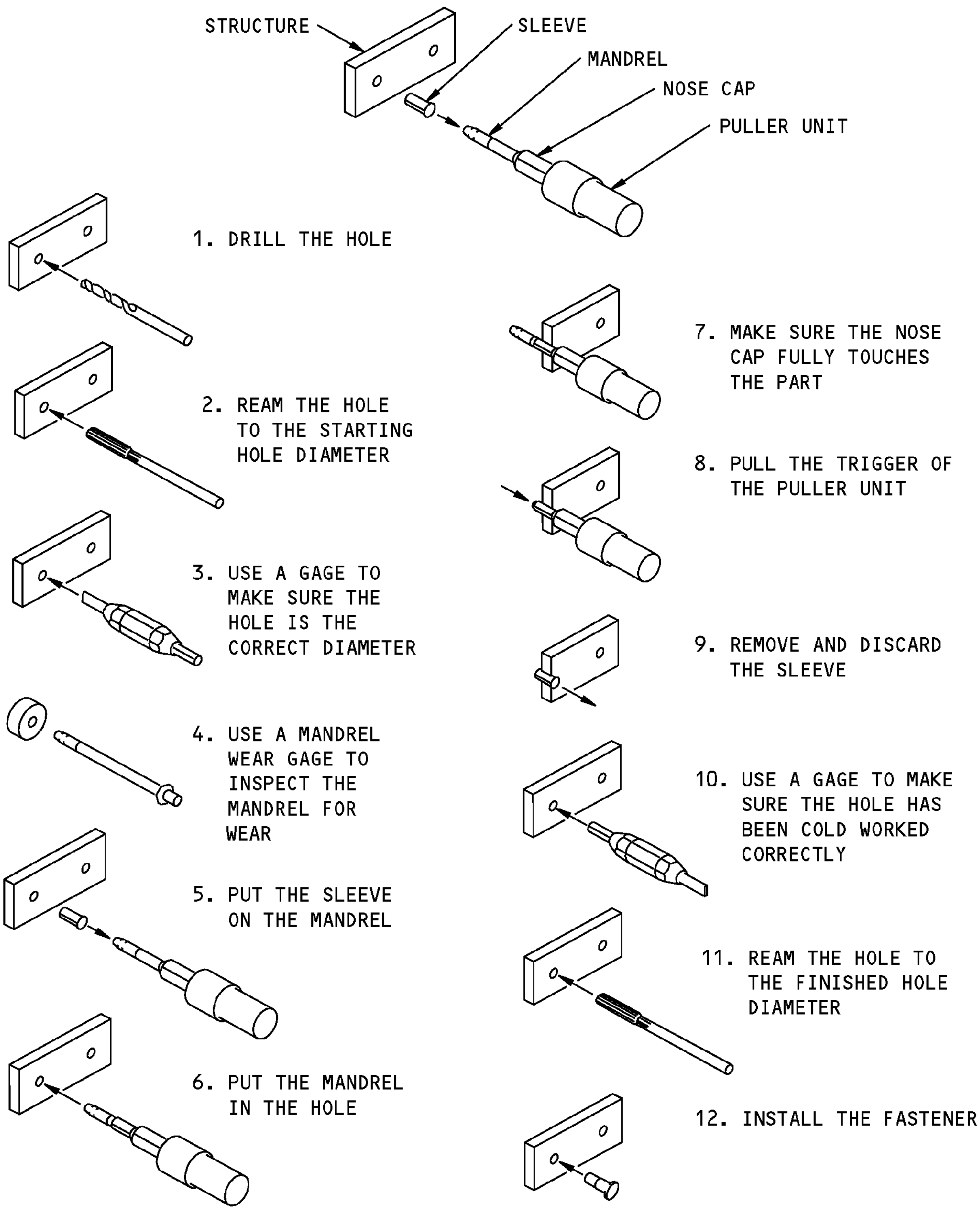
(a) If the diameter of the hole is less than the maximum starting hole diameter, you can cold work the hole again.

(b) If the diameter of the hole is larger than the maximum starting hole diameter:

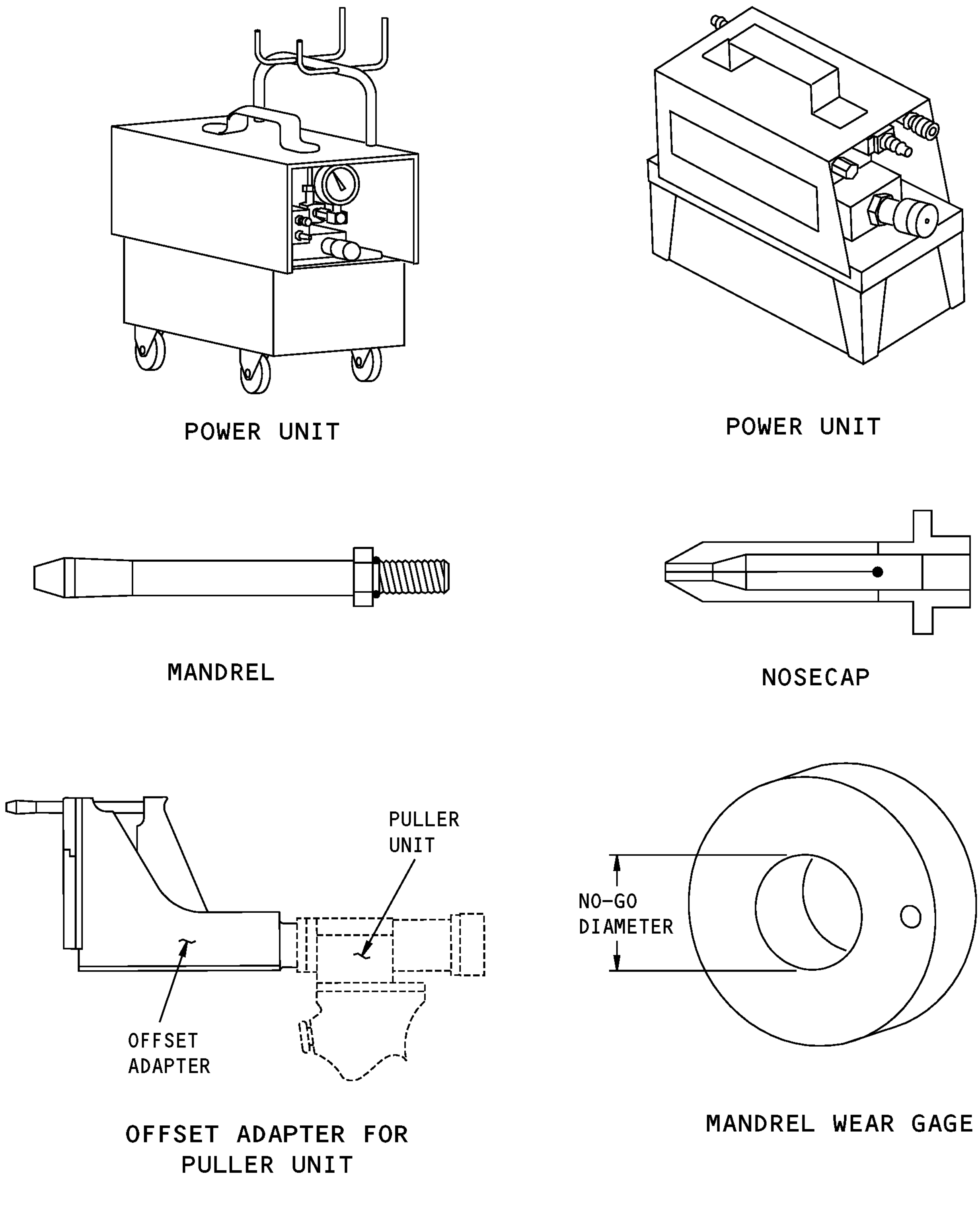
1) Drill the hole to the next available starting hole diameter if this is permitted by the applicable repair subject, and

2) Cold work the hole again.

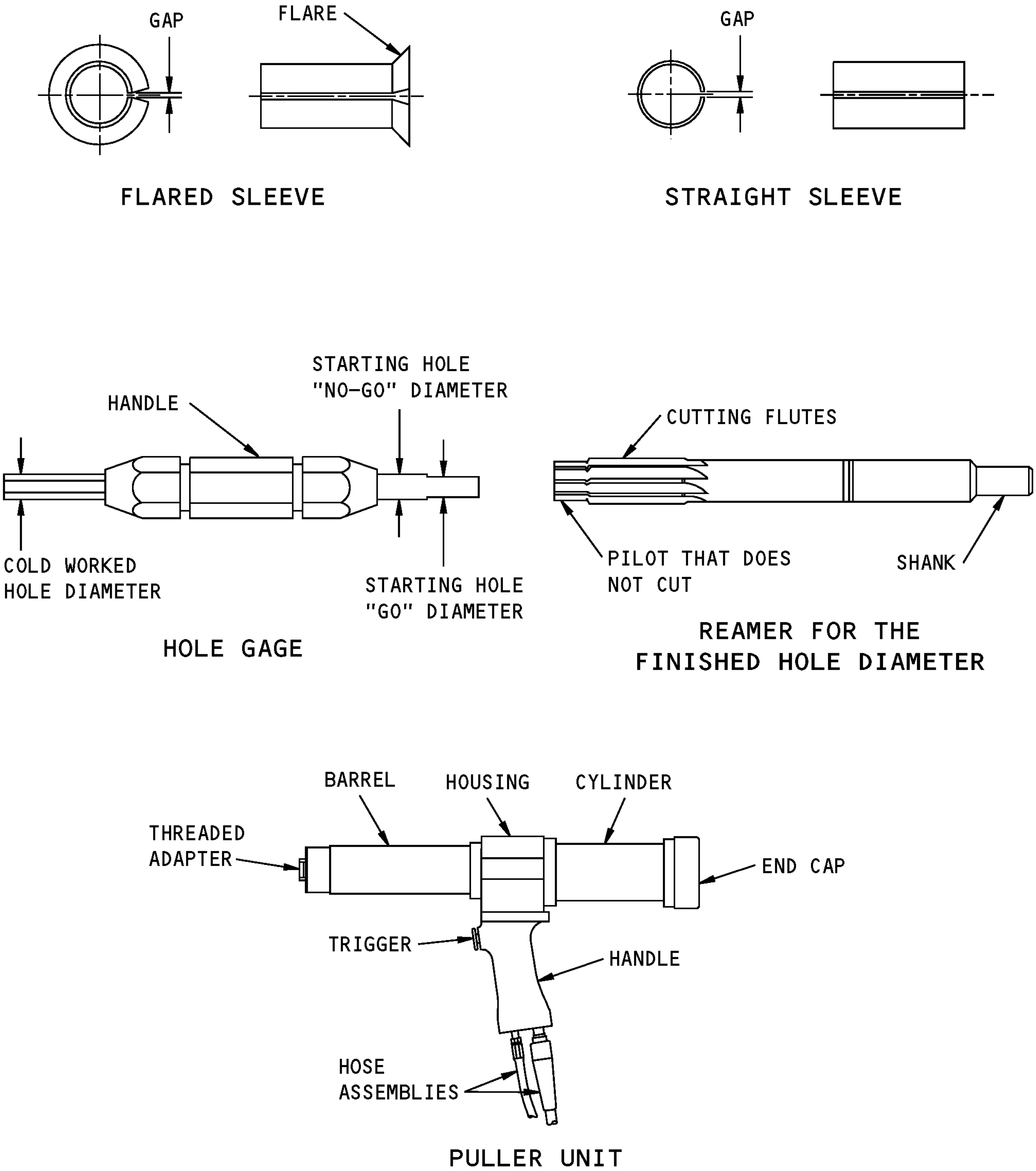
(6) Install the fastener.



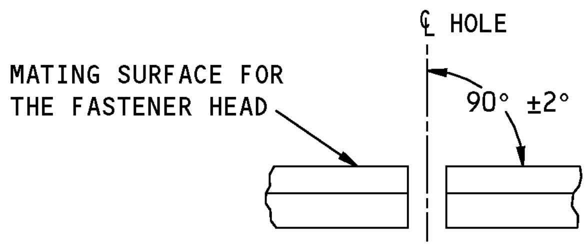
The Procedure for Cold Working With a Sleeve
Figure 202



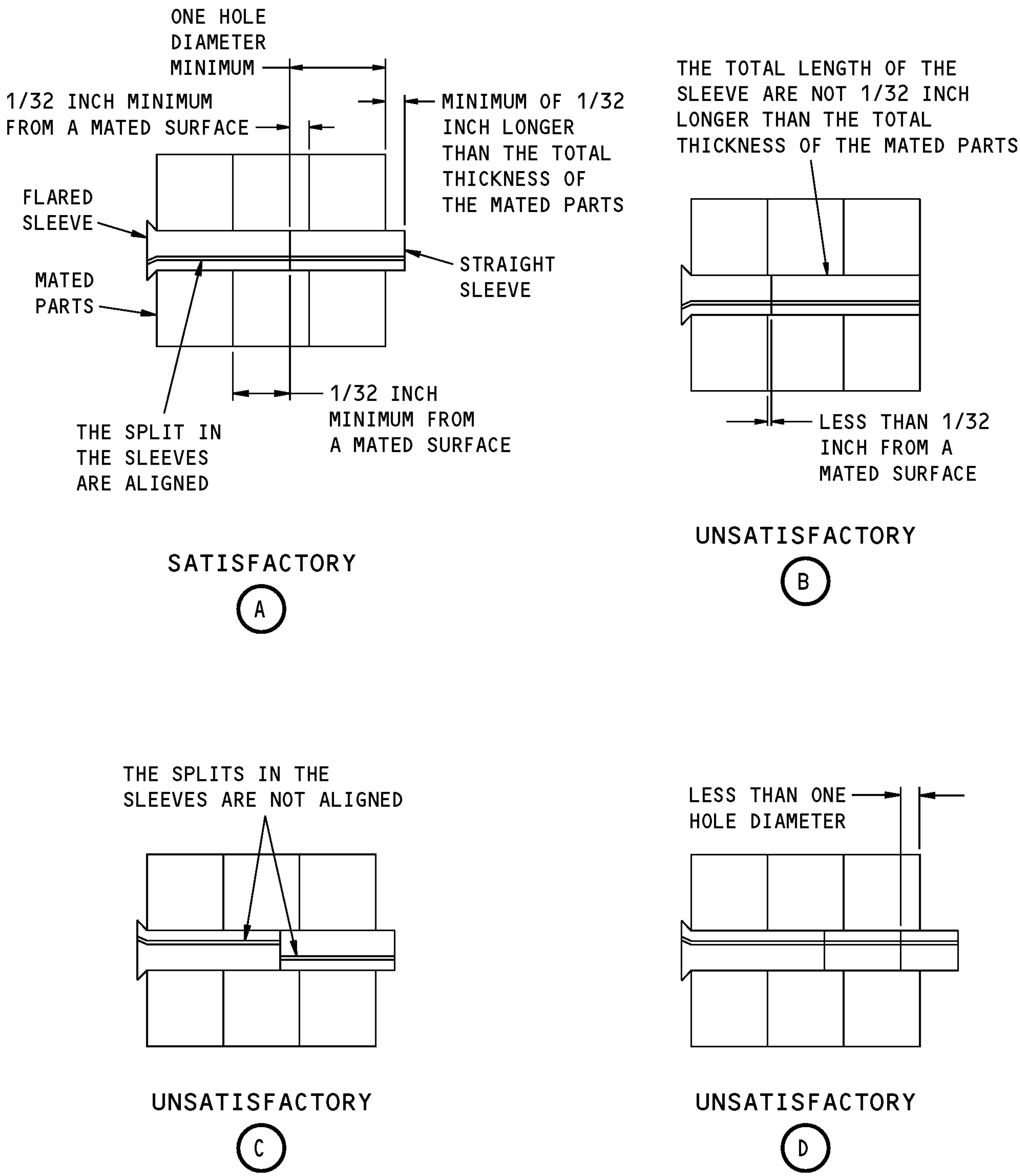
Tools Used in the Class 1 and Class 2 Cold Working With a Sleeve Procedure
Figure 203 (Sheet 1 of 2)



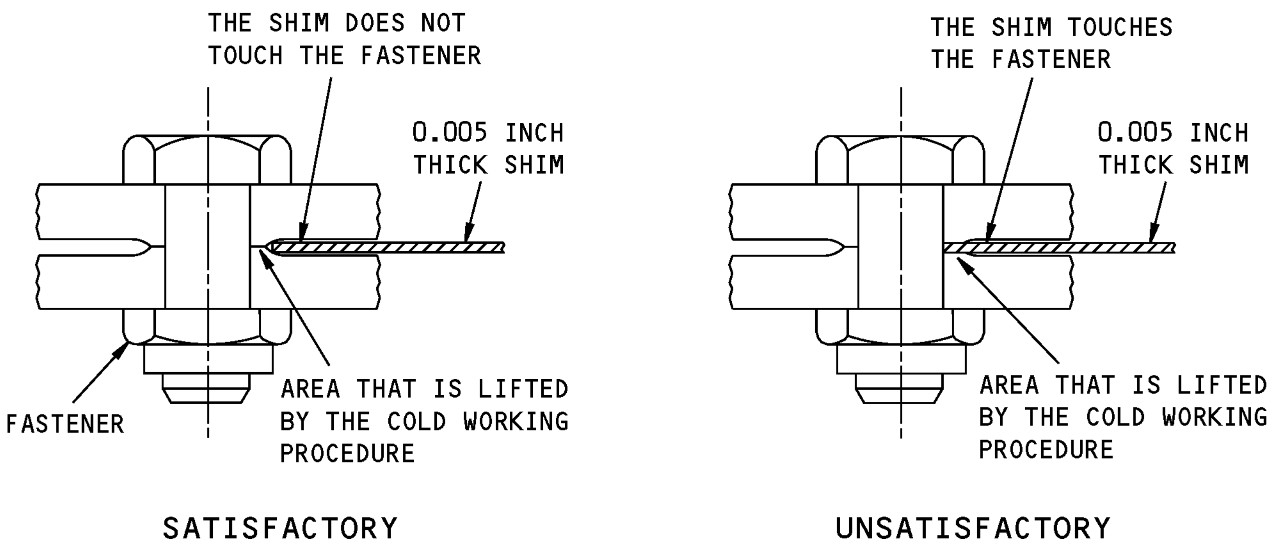
Tools Used in the Class 1 and Class 2 Cold Working With a Sleeve Procedure
Figure 203 (Sheet 2 of 2)



Condition of the Hole Before Cold Working
Figure 204



Examples for the Use of More Than One Sleeve
Figure 205



Inspection of the Area that is Lifted
Figure 206

5. **Instructions for Class 1 Cold Working Without a Sleeve**

A. Refer to The Procedure for Class 1 Cold Working Without a Sleeve, Figure 207/REPAIR GENERAL for a general description of the steps you use to Class 1 cold work a hole without a sleeve. The procedure uses a puller unit to pull the mandrel through the hole.

CAUTION: THE TOOLS YOU USE TO DO COLD WORKING ARE VERY IMPORTANT. IF YOU DO NOT USE THE CORRECT TOOLS, THE REPAIR WILL BE UNSATISFACTORY.

B. The tools that are used to correctly Class 1 cold work a hole without a sleeve are as follows:

- Hole gage
- Mandrel major diameter inspection pin
- Mandrel pilot
- Mandrel wear gage
- Pilot Wear Gage
- Power unit
- Puller unit
- Pump oil can that has a felt wick applicator
- Reamer for the starting hole diameter
- Reamer for the finished hole diameter
- Split mandrel

Examples of most of these tools are shown in Tools Used in the Class 1 Cold Working Without a Sleeve Procedure, Figure 208/REPAIR GENERAL.

(1) Make sure the tools work correctly.

CAUTION: DO NOT USE A MANDREL THAT HAS BEEN WORN SMALLER THAN ITS MINIMUM PERMITTED DIAMETER. IF YOU USE A MANDREL THAT IS WORN TOO SMALL, THE REPAIR WILL BE UNSATISFACTORY.

(2) Do an inspection of the mandrel for wear with a mandrel wear gage.

(3) Make sure that the mandrel has the correct major diameter. Use an inspection pin.

C. Do an inspection of the hole before it is cold worked.

(1) Make sure the hole that you will cold work has the correct starting hole diameter.

(a) Use a hole gage to find the diameter of the hole.

(b) Refer to the applicable table for the starting hole diameter that is necessary.

1) Refer to Table 205/REPAIR GENERAL for holes that will be Class 1 cold worked without a sleeve on the upper wing surface.

2) Refer to Table 206/REPAIR GENERAL for holes that will be Class 1 cold worked without a sleeve on the lower wing surface.

(c) Use a reamer if you need to make the hole larger. Remove the cutting fluid that remains before you cold work the hole.

Table 205:

CLASS 1 COLD WORKING WITHOUT A SLEEVE - HOLE DIAMETERS FOR THE UPPER WING SURFACE			
NOMINAL FASTENER DIAMETER (INCHES)	STARTING HOLE DIAMETER		MAXIMUM FINISHED HOLE DIAMETER (INCHES)
	MINIMUM (INCHES)	MAXIMUM (INCHES)	
1/4	0.2345	0.2365	0.2647
5/16	0.2970	0.2990	0.3272
3/8	0.3590	0.3610	0.3897

Table 206:

CLASS 1 COLD WORKING WITHOUT A SLEEVE - HOLE DIAMETERS FOR THE LOWER WING SURFACE			
NOMINAL FASTENER DIAMETER (INCHES)	STARTING HOLE DIAMETER		MAXIMUM FINISHED HOLE DIAMETER (INCHES)
	MINIMUM (INCHES)	MAXIMUM (INCHES)	
1/4	0.2320	0.2340	0.2647
5/16	0.2945	0.2965	0.3272
3/8	0.3575	0.3595	0.3897

(2) Make sure the hole is no more than 2 degrees from perpendicular to the mating surface on which the fastener head will be installed. Refer to Condition of the Hole Before Cold Working, Figure 209/REPAIR GENERAL.

(3) Make sure the surface finish of the initial hole is 63 microinches Ra or smoother. The hole surface must not have longitudinal or helical scratches.

D. Hold mated parts together with a clamp or with temporary fasteners while they are cold worked. Do not permit the mated parts to move in relation to each other.

E. Lubricate the hole.

(1) Make sure the hole is clean before you apply the lubricant.

(2) Apply lubricant to the inside surface of the hole. You can use Boelube 100A or 100F.

(3) There are two procedures that you can use to apply the Boelube:

(a) Automatically, with a Boelube pump that is part of the power unit

(b) Manually, with a pump oil can that has a felt wick applicator.

(4) After the liquid Boelube is applied, it is optional to rub solid Boelube across the entrance of the hole.

WARNING: KEEP YOUR FINGERS AWAY FROM THE NOSE CAP OF THE PULLER UNIT DURING THE COLD WORKING PROCEDURE. IF YOU DO NOT OBEY, YOU CAN CAUSE AN INJURY. MAKE SURE THE HYDRAULIC FITTINGS AND HOSES ARE IN GOOD CONDITION BEFORE YOU USE THE PULLER UNIT. BROKEN HYDRAULIC FITTINGS AND HOSES ARE DANGEROUS. IF YOU DO NOT OBEY, YOU CAN CAUSE AN INJURY.

F. Put the mandrel into the hole.

(1) Make sure the nose cap of the mandrel puller fully touches the part that you will cold work.

(2) Hold the puller unit perpendicular to the parts that will be cold worked.

G. Pull the trigger of the puller unit to cold work the hole. Do not release the trigger until the mandrel fully retracts into the nosecap.

H. Ream the hole to the finished hole diameter.

NOTE: Use a gage to make sure the hole has been correctly cold worked before you ream the hole to the finished hole diameter. If you ream a hole that has not been correctly cold worked, the repair will be unsatisfactory.

(1) Refer to 51-40-05 for the finished hole diameters.

(2) Refer to Table 205/REPAIR GENERAL and Table 206/REPAIR GENERAL for the maximum finished hole diameters.

(3) We recommend that you use a reamer that has a pilot that does not cut. The diameter of the pilot must be a size so that the reamer cannot go into a hole that has not been cold worked.

I. Remove the sharp edges from the hole.

J. Countersink the hole as necessary.

K. Do a visual inspection of the cold worked hole.

(1) Check the diameter of the hole to make sure it has the correct finished hole diameter.

(2) Cracks at or near the hole that you can see visually are not permitted.

(a) You can ream the hole to remove the cracks. If you make the hole larger than the maximum finished hole diameter, you must:

1) Drill the hole to the next available starting diameter if this is permitted by the applicable repair subject, and

2) Cold work the hole again.

(3) It is possible that the cold worked hole will have an area that is not cut by the reamer when you ream the hole to the finished hole diameter. This is permitted if that which follows is true:

(a) For a single part that is cold worked, the area that is not cut by the reamer is at the entrance or the exit of the hole.

(b) For two or more mated parts that are cold worked at the same time, the area that is not cut by the reamer is:

1) At the entrance or exit of the hole, or

2) At the interface of the hole between each of the parts.

(c) For each part that is cold worked, the length of the area that is not cut by the reamer is less than the smaller of:

1) 0.020 inch, or

2) 10 percent of the thickness of the part.

(4) The cold working procedure can lift an area of the surface around the hole. It is possible that the lifted area will cause the mated parts to move apart. If there is a lifted area around the hole, refer to Inspection of the Area that is Lifted, Figure 210/REPAIR GENERAL and do what follows:

(a) Put the fastener in the hole.

(b) Put a 0.005 inch thick shim between the mated parts.

1) If the shim does not touch the fastener, the condition of the hole is satisfactory.

2) If the shim touches the fastener, you must:

a) Disassemble the mated parts

b) Remove the area of the surface that has been lifted

c) Assemble the parts again

d) Do Step (4)(b) again.

(5) If you find that a hole has not been cold worked correctly, or if you are not sure the hole has been cold worked, then:

(a) If the diameter of the hole is less than the maximum starting hole diameter, you can cold work the hole again.

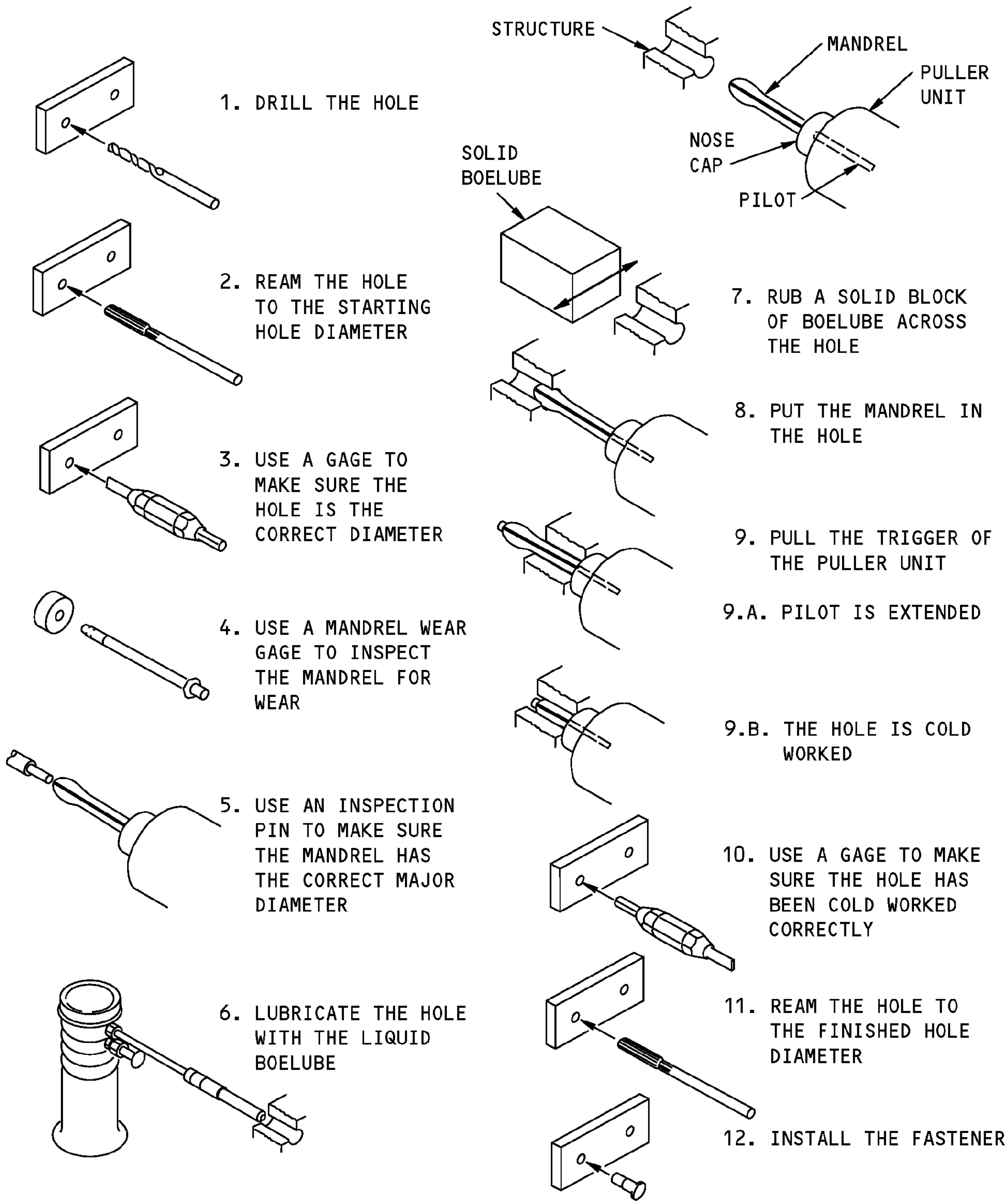
(b) If the diameter of the hole is larger than the maximum starting hole diameter:

1) Drill the hole to the next available starting hole diameter if this is permitted by the applicable repair subject, and

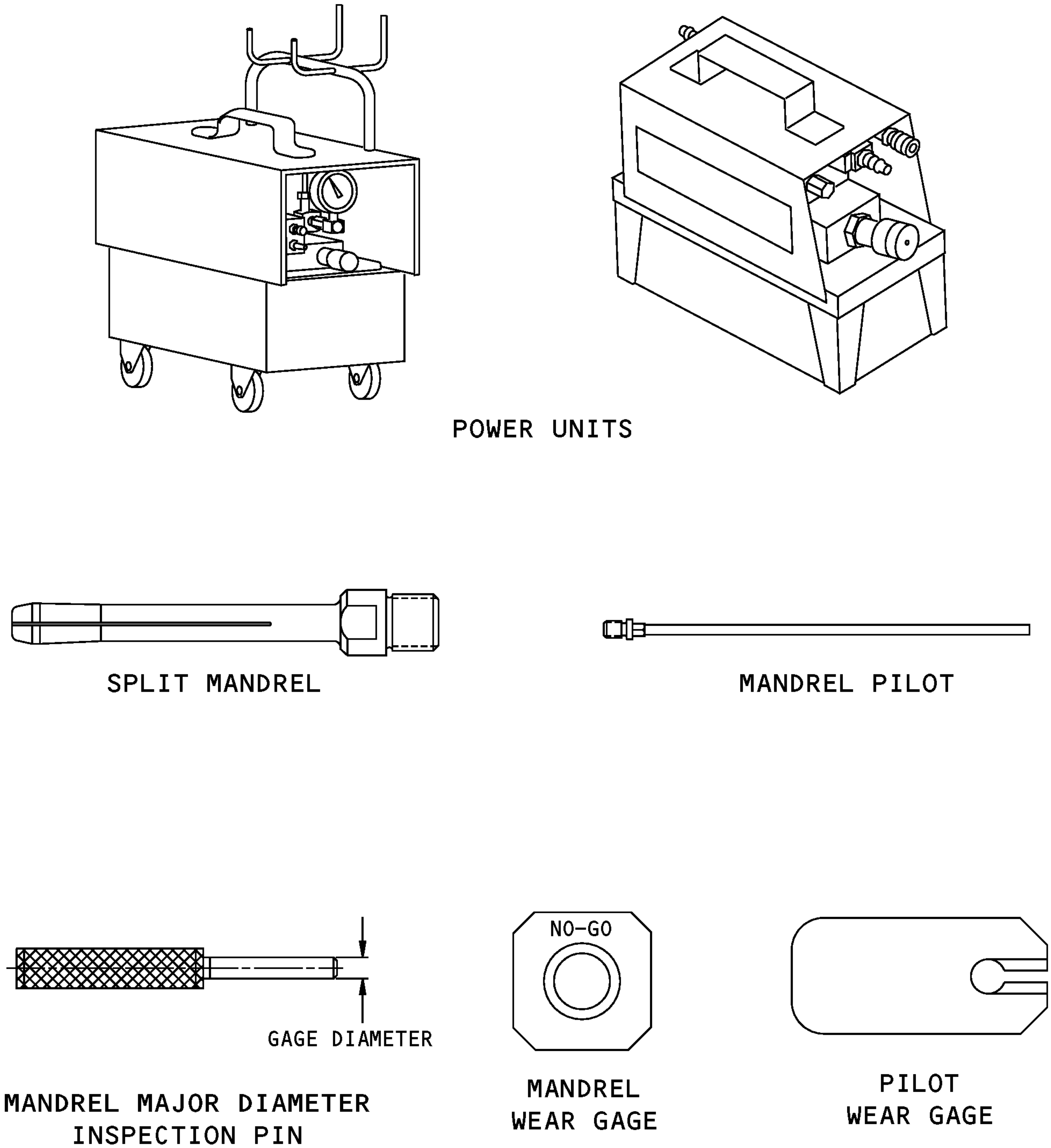
2) Cold work the hole again.

NOTE: You cannot cold work a hole that is oversize with the Class 1 cold working without a sleeve procedure. You must use the cold working with a sleeve procedure as given in Paragraph 5./REPAIR GENERAL to cold work an oversize hole.

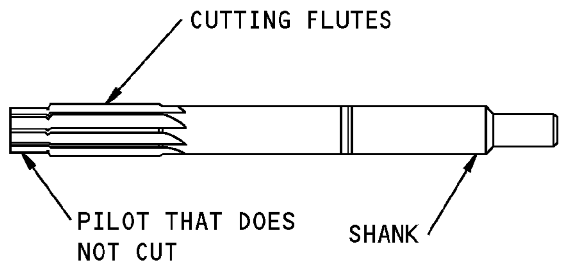
(6) Install the fastener.



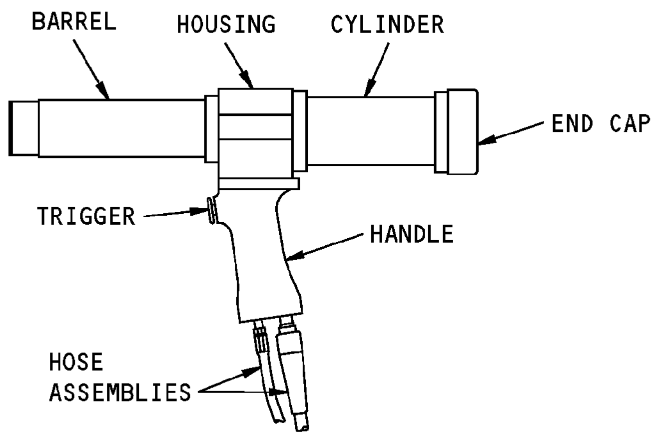
The Procedure for Class 1 Cold Working Without a Sleeve
Figure 207



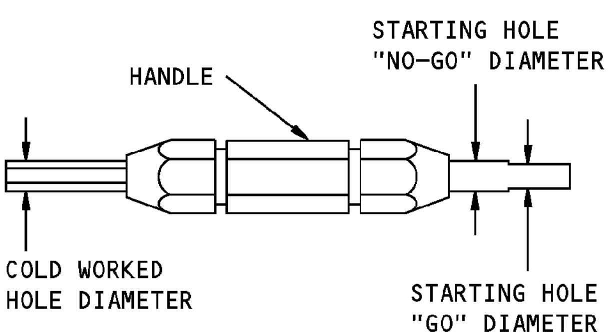
Tools Used in the Class 1 Cold Working Without a Sleeve Procedure
Figure 208 (Sheet 1 of 2)



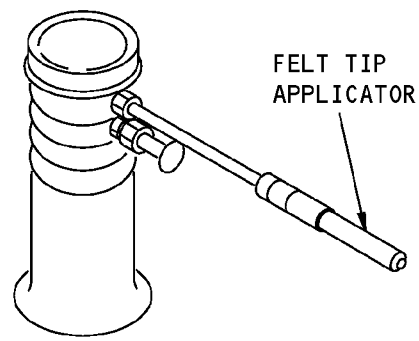
REAMER FOR FINISHED HOLE DIAMETER



PULLER UNIT

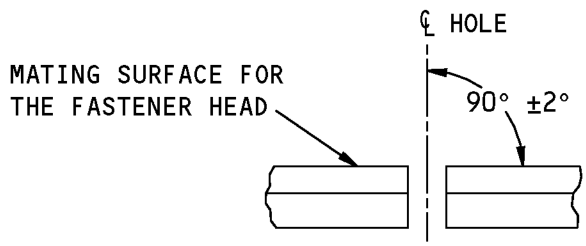


HOLE GAGE

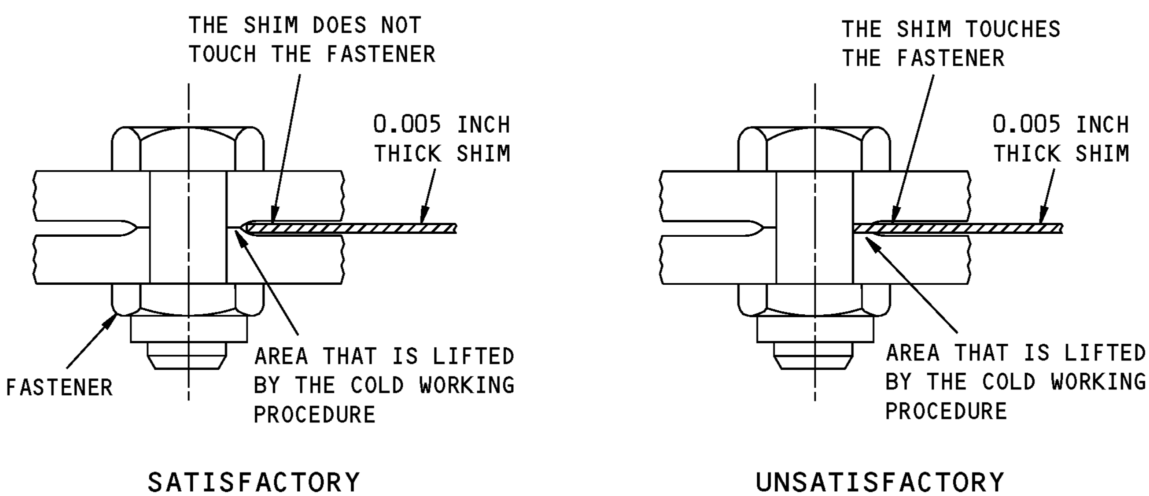


PUMP OIL CAN

Tools Used in the Class 1 Cold Working Without a Sleeve Procedure
Figure 208 (Sheet 2 of 2)



Condition of the Hole Before Cold Working
Figure 209



Inspection of the Area that is Lifted
Figure 210

6. **Instructions for Class 2 Cold Working Without a Sleeve**

   A. Refer to The Procedure for Class 2 Cold Working Without a Sleeve, Figure 211/REPAIR GENERAL for a general description of the steps you use to Class 2 cold work a hole without a sleeve. In the Class 2 procedure, a "D" type mandrel is pushed through the hole with a rivet gun or a "K" type mandrel is pulled through the hole with a puller unit.

CAUTION: THE TOOLS YOU USE TO DO COLD WORKING ARE VERY IMPORTANT. IF YOU DO NOT USE THE CORRECT TOOLS, THE REPAIR WILL BE UNSATISFACTORY.

   B. The tools that are used to correctly Class 2 cold work a hole without a sleeve are as follows:

"D" Mandrel:
- Hole gage
- Mandrel
- Rivet gun

"K" Mandrel:
- Hole gage
- Mandrel
- Power unit
- Puller unit

Examples of most of these tools are shown in Tools Used in the Class 2 Cold Working Without a Sleeve Procedure, Figure 212/REPAIR GENERAL.

(1) Make sure the tools work correctly.

CAUTION: DO NOT USE A MANDREL THAT HAS BEEN WORN SMALLER THAN ITS MINIMUM MAJOR DIAMETER. IF YOU USE A MANDREL THAT IS WORN TOO SMALL, THE REPAIR WILL BE UNSATISFACTORY.

(2) Do an inspection of the mandrel for wear. Refer to Table 207/REPAIR GENERAL and Table 208/REPAIR GENERAL for the minimum major diameter of the mandrel.

C. Do an inspection of the hole before it is cold worked.

(1) Make sure the hole that you will cold work has the correct starting diameter.

(a) Use a hole gage to find the diameter of the hole.

(b) Refer to the applicable table for the starting hole diameter that is necessary.

1) Refer to Table 207/REPAIR GENERAL for holes that:

a) Will be Class 2 cold worked without a sleeve and have a bolt other than a hex-drive bolt or lockbolt installed, or

b) Will be Class 2 cold worked without a sleeve and left as an open hole.

2) Refer to Table 208/REPAIR GENERAL for holes that will be Class 2 cold worked without a sleeve and have a hex-drive bolt or lockbolt installed.

3) Refer to the cold working with a sleeve procedure to cold work holes that will have a rivet installed.

(c) Use a reamer if you need to make the hole larger. Remove the cutting fluid that remains before you cold work the hole.

Table 207:

CLASS 2 COLD WORKING WITHOUT A SLEEVE - HOLE DIAMETERS FOR OPEN HOLES AND BOLTS OTHER THAN HEX-DRIVE BOLTS AND LOCKBOLTS						
NOMINAL FASTENER DIAMETER (INCHES)	STARTING HOLE DIAMETER		MANDREL MAJOR DIAMETER		FINISHED HOLE DIAMETER	
	MINIMUM (INCHES)	MAXIMUM (INCHES)	MINIMUM (INCHES)	MAXIMUM (INCHES)	MINIMUM (INCHES)	MAXIMUM (INCHES)
1/8	0.1245	0.1255	0.1308	0.1312	0.1267	0.1295
9/64	0.1401	0.1411	0.1464	0.1468	0.1423	0.1451
5/32	0.1557	0.1567	0.1621	0.1625	0.1580	0.1608

CLASS 2 COLD WORKING WITHOUT A SLEEVE - HOLE DIAMETERS FOR OPEN HOLES AND BOLTS OTHER THAN HEX-DRIVE BOLTS AND LOCKBOLTS						
NOMINAL FASTENER DIAMETER (INCHES)	STARTING HOLE DIAMETER		MANDREL MAJOR DIAMETER		FINISHED HOLE DIAMETER	
	MINIMUM (INCHES)	MAXIMUM (INCHES)	MINIMUM (INCHES)	MAXIMUM (INCHES)	MINIMUM (INCHES)	MAXIMUM (INCHES)
11/64	0.1714	0.1724	0.1778	0.1782	0.1737	0.1765
3/16	0.1870	0.1880	0.1935	0.1939	0.1894	0.1922
13/64	0.2026	0.2036	0.2090	0.2094	0.2050	0.2078
7/32	0.2182	0.2192	0.2246	0.2250	0.2206	0.2234
15/64	0.2339	0.2349	0.2402	0.2406	0.2364	0.2392
1/4	0.2495	0.2505	0.2558	0.2562	0.2520	0.2548
17/64	0.2651	0.2661	0.2717	0.2721	0.2676	0.2704
9/32	0.2807	0.2817	0.2876	0.2880	0.2833	0.2861
19/64	0.2964	0.2974	0.3035	0.3039	0.2990	0.3018
5/16	0.3120	0.3130	0.3195	0.3199	0.3145	0.3175
21/64	0.3276	0.3286	0.3352	0.3356	0.3301	0.3331
11/32	0.3432	0.3442	0.3509	0.3513	0.3458	0.3488
23/64	0.3589	0.3599	0.3667	0.3671	0.3615	0.3647
3/8	0.3745	0.3755	0.3824	0.3828	0.3771	0.3803
25/64	0.3901	0.3911	0.3981	0.3985	0.3928	0.3960
13/32	0.4057	0.4067	0.4138	0.4142	0.4083	0.4117
27/64	0.4214	0.4224	0.4296	0.4300	0.4241	0.4275
7/16	0.4370	0.4380	0.4453	0.4457	0.4396	0.4432
29/64	0.4526	0.4536	0.4608	0.4612	0.4551	0.4589
15/32	0.4682	0.4692	0.4767	0.4771	0.4708	0.4746
31/64	0.4839	0.4849	0.4925	0.4929	0.4865	0.4905
1/2	0.4995	0.5005	0.5082	0.5086	0.5020	0.5064
33/64	0.5151	0.5161	0.5239	0.5243	0.5176	0.5220
17/32	0.5307	0.5317	0.5396	0.5400	0.5332	0.5376
35/64	0.5464	0.5474	0.5554	0.5558	0.5489	0.5533
9/16	0.5620	0.5630	0.5711	0.5715	0.5647	0.5691
37/64	0.5776	0.5786	0.5868	0.5872	0.5803	0.5847
19/32	0.5932	0.5942	0.6025	0.6029	0.5959	0.6003
39/64	0.6089	0.6099	0.6183	0.6187	0.6116	0.6160
5/8	0.6245	0.6255	0.6340	0.6344	0.6272	0.6316
41/64	0.6401	0.6411	0.6497	0.6501	0.6429	0.6473
21/32	0.6557	0.6567	0.6654	0.6658	0.6585	0.6629
43/64	0.6714	0.6724	0.6813	0.6817	0.6742	0.6786

Table 208:

CLASS 2 COLD WORKING WITHOUT A SLEEVE - HOLE DIAMETERS FOR HEX-DRIVE BOLTS AND LOCKBOLTS						
NOMINAL FASTENER DIAMETER (INCHES)	STARTING HOLE DIAMETER		MANDREL MAJOR DIAMETER		FINISHED HOLE DIAMETER	
	MINIMUM (INCHES)	MAXIMUM (INCHES)	MINIMUM (INCHES)	MAXIMUM (INCHES)	MINIMUM (INCHES)	MAXIMUM (INCHES)
3/16	0.1850	0.1860	0.1913	0.1917	0.1870	0.1900
13/64	0.1980	0.1990	0.2043	0.2047	0.2000	0.2030
7/32	0.2140	0.2150	0.2203	0.2207	0.2160	0.2190
1/4	0.2450	0.2460	0.2513	0.2517	0.2470	0.2500
17/64	0.2610	0.2620	0.2673	0.2677	0.2630	0.2660
9/32	0.2760	0.2770	0.2823	0.2827	0.2780	0.2810
5/16	0.3075	0.3085	0.3148	0.3152	0.3090	0.3130
21/64	0.3225	0.3235	0.3305	0.3309	0.3250	0.3280
11/32	0.3390	0.3400	0.3463	0.3467	0.3410	0.3440
3/8	0.3695	0.3705	0.3768	0.3772	0.3710	0.3750
25/64	0.3860	0.3870	0.3941	0.3945	0.3880	0.3910
13/32	0.4010	0.4020	0.4083	0.4087	0.4030	0.4060

(2) Make sure the hole is no more than 2 degrees from perpendicular to the mating surface on which the fastener head will be installed. Refer to Condition of the Hole Before Cold Working, Figure 213/REPAIR GENERAL.

(3) Make sure the surface finish of the initial hole is 63 microinches Ra or smoother. The hole surface must not have longitudinal or helical scratches.

D. Hold the mated parts together with a clamp or with temporary fasteners while they are cold worked. Do not permit the mated parts to move in relation to each other.

E. Apply Boelube paste to the mandrel.

F. Apply Boelube paste to the hole.

G. Put the mandrel into the hole.

(1) If you cold work with a "D" type mandrel, then:

WARNING: KEEP YOUR FINGERS AWAY FROM THE END OF THE RIVET GUN DURING THE COLD WORKING PROCEDURE. IF YOU DO NOT OBEY, YOU CAN CAUSE AN INJURY. USE A METAL CONTAINER FILLED WITH CLOTH TO CATCH THE MANDREL WHEN IT GOES THROUGH THE HOLE. IF YOU DO NOT OBEY, YOU CAN CAUSE AN INJURY.

CAUTION: DO NOT PERMIT THE RIVET GUN TO HIT THE PART. IF THE RIVET GUN HITS THE PART, YOU CAN DAMAGE THE PART.

(a) Push the mandrel through the hole with a rivet gun.

1) Hold the rivet gun perpendicular to the hole that will be cold worked.

2) Use a metal container filled with cloth to catch the mandrel when it goes through the hole.

(2) If you cold work with a "K" type mandrel, then:

(a) Lightly hit the mandrel with a hammer to move the mandrel into the hole.

(b) Connect the mandrel to the puller unit.

WARNING: KEEP YOUR FINGERS AWAY FROM THE NOSE CAP OF THE PULLER UNIT DURING THE COLD WORKING PROCEDURE. IF YOU DO NOT OBEY, YOU CAN CAUSE AN INJURY. BROKEN HYDRAULIC FITTINGS AND HOSES ARE DANGEROUS. MAKE SURE THE HYDRAULIC FITTINGS AND HOSES ARE IN GOOD CONDITION BEFORE YOU USE THE PULLER UNIT. IF YOU DO NOT OBEY, YOU CAN CAUSE AN INJURY.

(c) Make sure the nose cap of the mandrel puller fully touches the part that you will cold work.

(d) Hold the puller unit perpendicular to the parts that will be cold worked.

(e) Pull the trigger of the puller unit to cold work the hole.

H. Remove the sharp edges from the hole.

I. Countersink the hole as necessary.

J. Do a visual inspection of the cold worked hole.

(1) Check the diameter of the hole to make sure it has the correct finished hole diameter.

(2) Cracks at or near the hole that you can see visually are not permitted.

(a) You can ream the hole to remove the cracks. If you make the hole larger than the maximum finished hole diameter, you must:

1) Drill the hole to the next available starting diameter if this is permitted by the applicable repair subject, and

2) Cold work the hole again.

(3) The cold working procedure can lift an area of the surface around the hole. It is possible that the lifted area will cause the mated parts to move apart. If there is a lifted area around the hole, refer to Inspection of the Area that is Lifted, Figure 214/REPAIR GENERAL and do what follows:

(a) Put the fastener in the hole.

(b) Put a 0.005 inch thick shim between the mated parts.

1) If the shim does not touch the fastener, then the condition of the hole is satisfactory.

2) If the shim touches the fastener, you must:

a) Disassemble the mating parts.

b) Remove the area of the surface that has been lifted.

c) Assemble the parts again.

d) Do Step (3)(b) again.

(4) If you find that a hole has not been cold worked correctly, or if you are not sure the hole has been cold worked, then do the steps that follow:

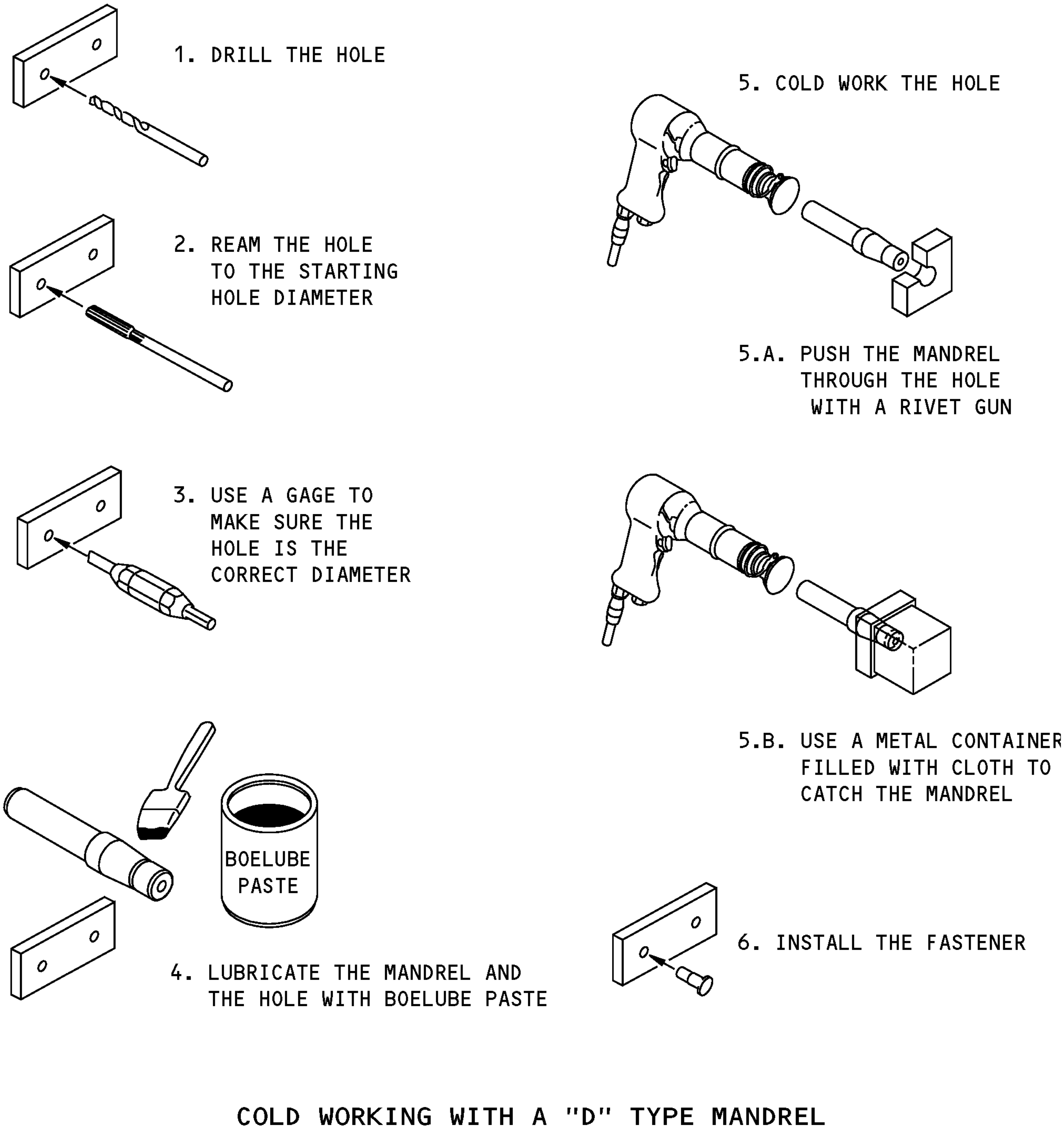
(a) If the diameter of the hole is less than the maximum initial hole diameter, you can cold work the hole again.

(b) If the diameter of the hole is larger than the maximum initial hole diameter, then do the steps that follow:

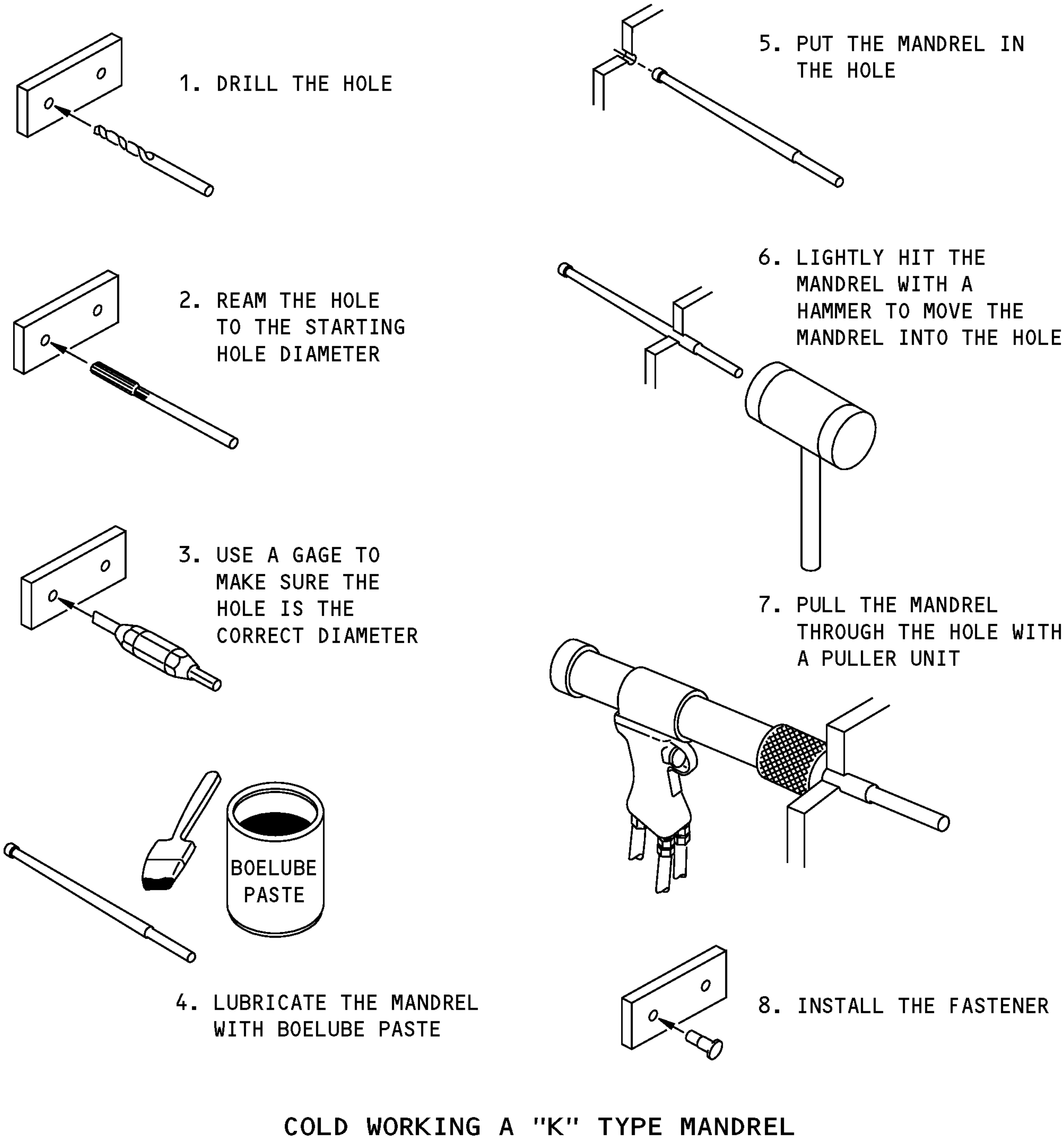
1) Drill the hole to the next available hole diameter if this is permitted by the applicable repair subject, and

2) Cold work the hole again.

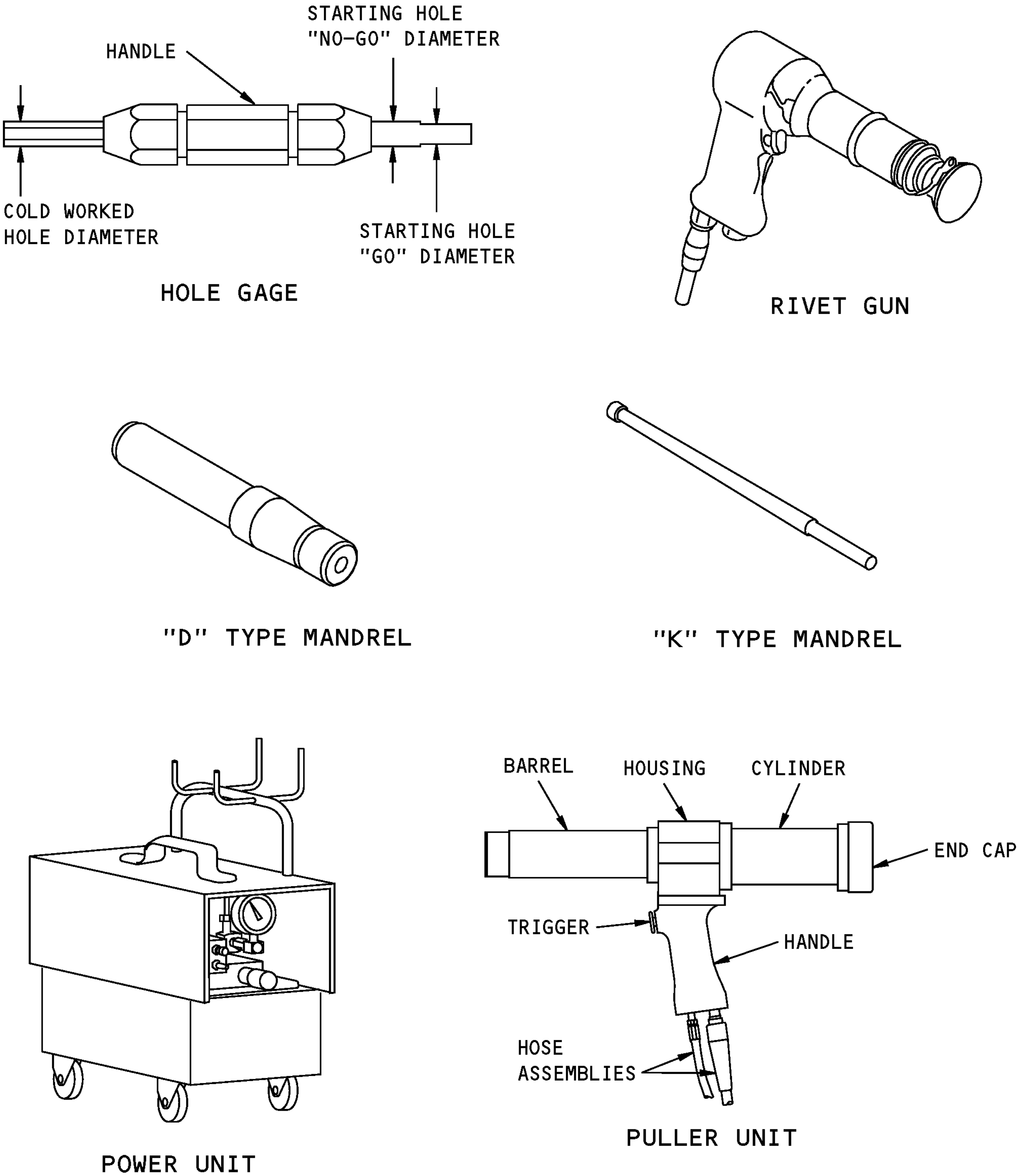
(5) Install the fastener.



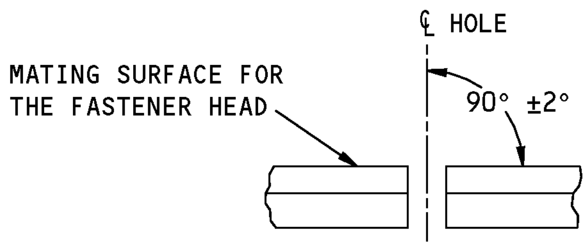
The Procedure for Class 2 Cold Working Without a Sleeve
Figure 211 (Sheet 1 of 2)



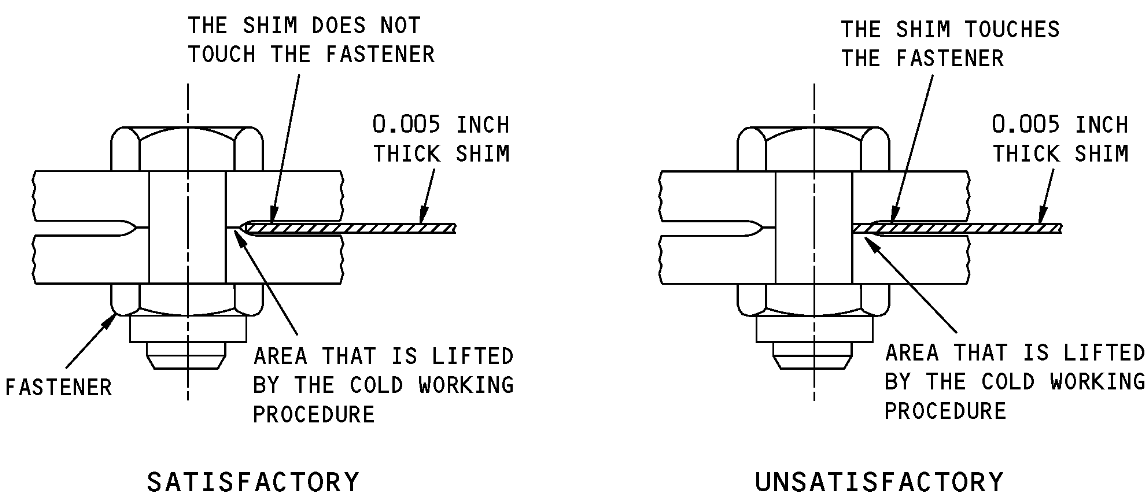
The Procedure for Class 2 Cold Working Without a Sleeve
Figure 211 (Sheet 2 of 2)



Tools Used in the Class 2 Cold Working Without a Sleeve Procedure
Figure 212



Condition of the Hole Before Cold Working
Figure 213



Inspection of the Area that is Lifted
Figure 214

GENERAL - SYMMETRY AND INCIDENCE CHECK PROCEDURES

1. Applicability

A. This subject gives the data for symmetry and incidence checks that will help you find structural damage that has occurred on the airplane.

B. Do symmetry and incidence checks if structural damage is thought to have occurred after:

(1) A hard landing

(2) A flight that is out of the normal range of operation

(3) A repair to a major structural component.

2. General

A. The equipment given in Table 1/GENERAL is necessary to do the symmetry and incidence checks.

B. Use a symmetry check:

(1) On the fuselage, wings, horizontal stabilizers, and engines. Refer to Symmetry Check - Distance A, Figure 4/GENERAL through Symmetry Check - Distance L, Figure 14/GENERAL.

(2) To find the differences between the distance dimensions on the left and right sides of the airplane.

C. Use an incidence check:

(1) On the wings and stabilizers. Refer to Figures Incidence Check Point Locations, Figure 15/GENERAL through 17 .

(2) To find the differences between the angle of incidence dimensions on the left and right sides of the airplane.

D. Large differences between the dimensions found and the dimensions specified in this subject will show possible structural damage.

E. For the airplane station diagrams, refer to:

(1) 53-00-00 for the fuselage.

(2) 55-10-00 for the horizontal stabilizer.

(3) 55-30-00 for the vertical stabilizer.

Table 1:

SYMMETRY AND INCIDENCE CHECK EQUIPMENT			
ITEM	**QUANTITY**	**CHECK**	**SOURCE**
Scaffolds or work stands (or the equivalent)	As needed	Symmetry	Many sources
Measuring tape: 150 feet (45720 mm) long, 0.010 inch (0.254 mm) increment marks or the equivalent	1	Symmetry	Many sources
Spring scale: 25 pounds (11.34 kg) tension or the equivalent	1	Symmetry	Many sources
Pointer assembly (optional)	1	Symmetry	Boeing-Part Number A51002-1 (which contains a set of these 4 items, as given in ITEM 51-50-01) or make the equivalent items from Boeing Drawing A51002
Tow ring target (optional)	1	Symmetry	
Inclinometer support assembly: 72 inches (1828.8 mm) long	1	Incidence	
Inclinometer support assembly: 36 inches (914.4 mm) long	1	Incidence	

SYMMETRY AND INCIDENCE CHECK EQUIPMENT			
ITEM	QUANTITY	CHECK	SOURCE
Inclinometer	1	Incidence	Many sources
Square	1	Incidence	Many sources

NOTE: Measurements given in inches (millimeters) and pounds (kilograms).

3. **References**

Reference	Title
53-00-00	FUSELAGE - GENERAL
55-10-00	HORIZONTAL STABILIZER
55-30-00	VERTICAL STABILIZER
AMM 12-15-31	Main Landing Gear Shock Strut - Servicing
AMM 20-40-11	Airplane Grounding
AMM 27-51-00/201	Trailing Edge Flap System - Maintenance Practices
AMM 27-81-00	Leading Edge Flap and Slat Control System - Maintenance Practices
AMM 32-00-01/201	Landing Gear Ground Locks and Door Locks
AMM 78-31-00/201	Thrust Reverser System - Maintenance Practices
ITEM 51-50-01	Alignment Equipment - Airplane Structural Repair

4. **Instructions to Prepare the Airplane**

A. Put the airplane on a hard and level surface in a building that is free of the wind, if possible.

NOTE: It is not necessary to jack or make the airplane level.

(1) Remove the power from all of the fans and air conditioning equipment in the building.

(2) Close the outside doors of the building during windy weather.

(3) If you have wind that is more than 35 knots, use tie downs to keep the airplane level.

B. If a building is not available, do what follows:

(1) Put the airplane on a hard and level surface.

(2) Keep the outer surface of the airplane as close to ambient temperature as possible.

NOTE: The optimum condition to prepare the airplane is at night, on cloudy days, or in the shade. Direct sunlight or an engine that has been in operation will cause heat that can possibly expand outer airplane surfaces. If this happens, wait a minimum of one hour before you do the checks.

(3) Put the nose of the airplane into the wind, if there is wind.

C. Install all the landing gear ground locks, door locks and safety pins. Refer to AMM 32-00-01/201 for the procedures.

D. Ground the airplane. Refer to AMM 20-40-11 for the grounding procedures.

E. Make sure there is an equal amount of fuel on each side of the airplane.

(1) Make sure the heat exchangers for the hydraulic systems are put fully into the fuel of each wing tank.

NOTE: If you cannot put a heat exchanger fully into the fuel, use ground hydraulic power instead of hydraulic power from the airplane systems.

(a) If you operate the left and right hydraulic systems, each wing tank must contain:

1) An equal amount of fuel that is a minimum of 250 gallons (946 liters) each.

(b) If you operate the center hydraulic system, each wing tank must contain:

1) An equal amount of fuel that is a minimum of 250 gallons (946 liters) each.

(c) It is not necessary to defuel the airplane.

F. Set the flight controls as follows:

WARNING: ALL PERSONNEL MUST BE CLEAR OF THE OPERATING ENVELOPE OF THE CONTROL SURFACES AND OTHER MOVABLE PARTS BEFORE THEY ARE OPERATED. IF YOU DO NOT OBEY, AN INJURY CAN OCCUR.

CAUTION: ALL TOOLS AND EQUIPMENT MUST BE CLEAR OF THE OPERATING ENVELOPE OF THE CONTROL SURFACES AND OTHER MOVABLE PARTS BEFORE THEY ARE OPERATED. IF YOU DO NOT OBEY, DAMAGE TO THE AIRPLANE STRUCTURE CAN OCCUR.

CAUTION: DO NOT OPERATE THE HYDRAULIC PUMPS IF THE PUMP TEMPERATURE IS MORE THAN 105 DEGREES C, OR THE PUMP FAULT LIGHT COMES ON. IF YOU DO NOT OBEY, THE HYDRAULIC FLUID CAN BECOME TOO HOT, AND DAMAGE TO THE PUMPS CAN OCCUR.

(1) Retract the leading edge slats. Refer to AMM 27-81-00 for the procedures.

(2) Retract the trailing edge flaps. Refer to AMM 27-51-00/201 for the procedures.

(3) Put the ailerons, spoilers, flaperons, rudder, and elevators into their neutral position.

G. Open the thrust reversers. Refer to AMM 78-31-00/201 to get access to symmetry point S11 on the power plants.

H. Close all of the passenger and crew doors, cargo doors, and service doors.

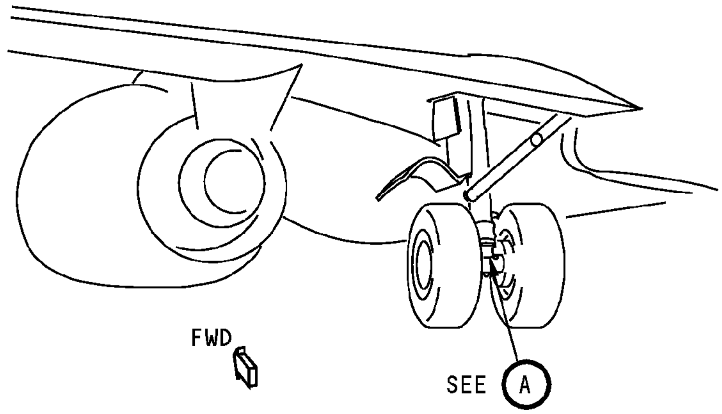
I. Set the left and right side Main Landing Gear (MLG) shock struts, as follows:

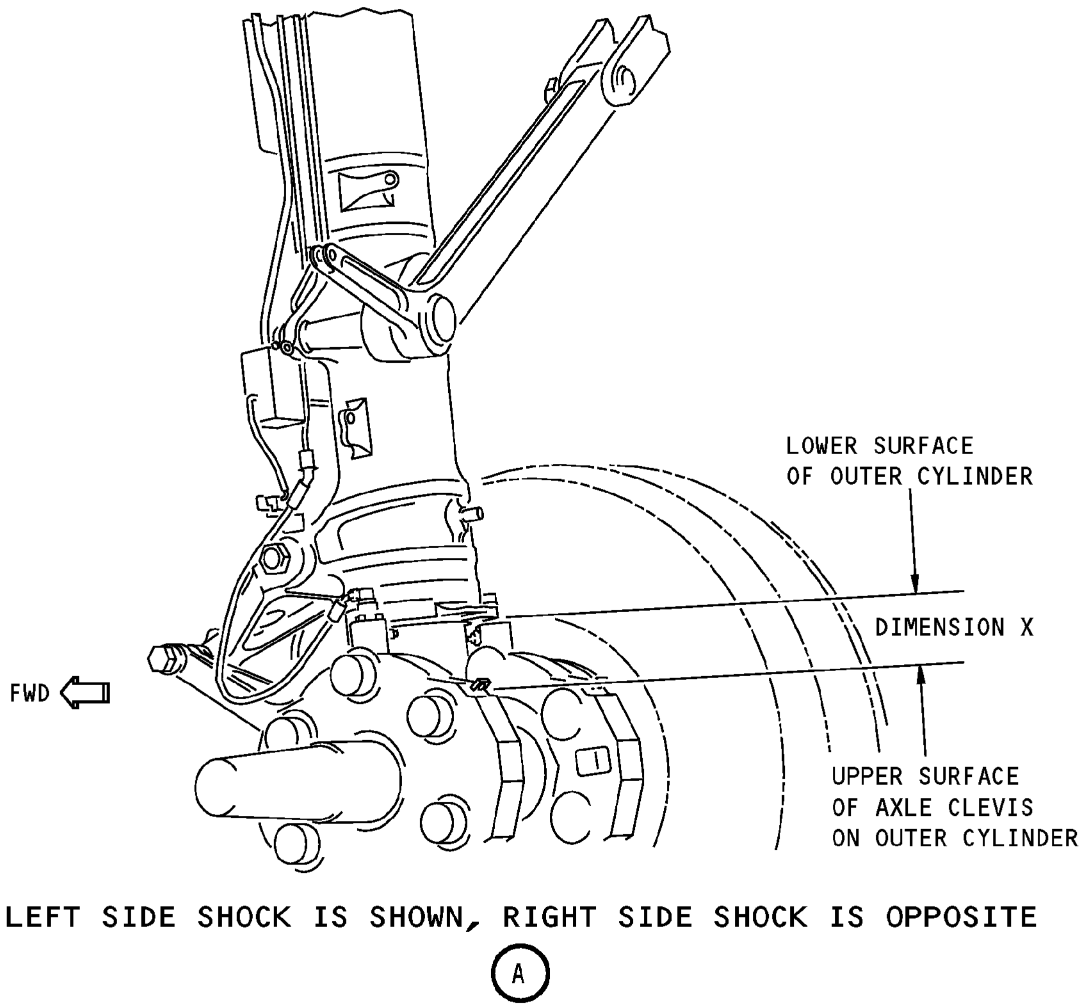
(1) Measure the dimension between the lower surface of the outer cylinder and the upper surface of the axle clevis on the outer cylinder. Refer to Dimension to be Measured on the Main Landing Gear Shock Strut, Figure 1/GENERAL.

(2) Calculate and compare the dimensions you found for each shock strut.

NOTE: The difference between the two dimensions you found must not be more than 1.0 inch (25.4 mm).

(3) If the difference between the two dimensions you found is more than 1.0 inch (25.4 mm), inflate or deflate the shock strut. Refer to AMM 12-15-31 for the procedures.





Dimension to be Measured on the Main Landing Gear Shock Strut
Figure 1

5. **Symmetry Check Instructions**

A. Get the necessary equipment as identified in Table 1/GENERAL to do the symmetry check.

B. Refer to Symmetry Check - Symmetry Point Locations, Figure 2/GENERAL for the locations of the symmetry points.

C. Refer to Table 2/GENERAL for the data that is applicable to the distance dimensions of the symmetry check.

NOTE: Some of the distance dimensions use a common point. The symmetry check can be done faster if you measure the distance dimensions in a sequence that uses the common points. For example, Distances G (S2, S12) and K (S2, S11) could be done in sequence.

Table 2:

SYMMETRY CHECK DATA (REFER TO DRAWING 016A1001 FOR THE SYMMETRY POINTS)			
LEFT AND RIGHT SIDE DISTANCE IDENTIFIER	SYMMETRY POINTS	FIGURE NUMBER	PERMITTED DIFFERENCE BETWEEN THE LEFT AND RIGHT SIDE DISTANCES INCHES (MILLIMETERS)
A	S5, S9	4	2.0 (50.80)
B	S7, S9	5	1.0 (25.40)
C	S1, S6	6	1.5 (38.10)
D	S3, S6	7	1.5 (38.10)
E	S6, S8	8	2.0 (50.80)
F	S4, S8	9	1.0 (25.40)
G	S2, S12	10	1.0 (25.40)
H	S3, S12	11	1.0 (25.40)
J	S10, S13	12	1.0 (25.40)
K	S2, S11	13	1.0 (25.40)
L	S6, S13	14	1.5 (38.10)

CAUTION: DO NOT STAND ON THE WINGS WHEN YOU MEASURE DISTANCES A, C, D, E, AND L. DO NOT STAND ON THE HORIZONTAL STABILIZERS WHEN YOU MEASURE DISTANCES B, E, AND F. USE ADJUSTABLE WORK STANDS OR SCAFFOLDS. IF YOU DO NOT OBEY, THE ADDED WEIGHT CAN CHANGE THE POSITIONS OF THESE STRUCTURES, AND MEASUREMENT ERRORS CAN OCCUR.

D. Measure the distance dimensions.

(1) Put the scaffolds, work stands, and other equipment necessary to get access to the symmetry points in position.

(2) Measure the distances.

(a) Measure the tension of the steel tape with the spring scale as shown in Procedures to Measure the Distance Dimensions, Figure 3/GENERAL.

1) When you measure Distances A, B, G, H, J, and L, do as follows:

a) Attach the pointer assembly to the tape.

b) Align the pointer assembly parallel with the tape.

2) When you measure distances C, D, E, F, and K, use of a pointer assembly is optional.

(b) Apply tension to the tape as necessary to keep errors in measurement to a minimum.

(c) Pull the tape from one symmetry point to the other symmetry point. Refer to Symmetry Check - Distance A, Figure 4/GENERAL through Symmetry Check - Distance L, Figure 14/GENERAL.

1) For Distances A, B, G, H, J, and L, pull the tip of the pointer up to the other symmetry point.

a) Use the tow ring target at symmetry point S13 to measure Distances J and L.

2) For Distances C, D, E, F, J, and K, pull the tape past and against the two symmetry points.

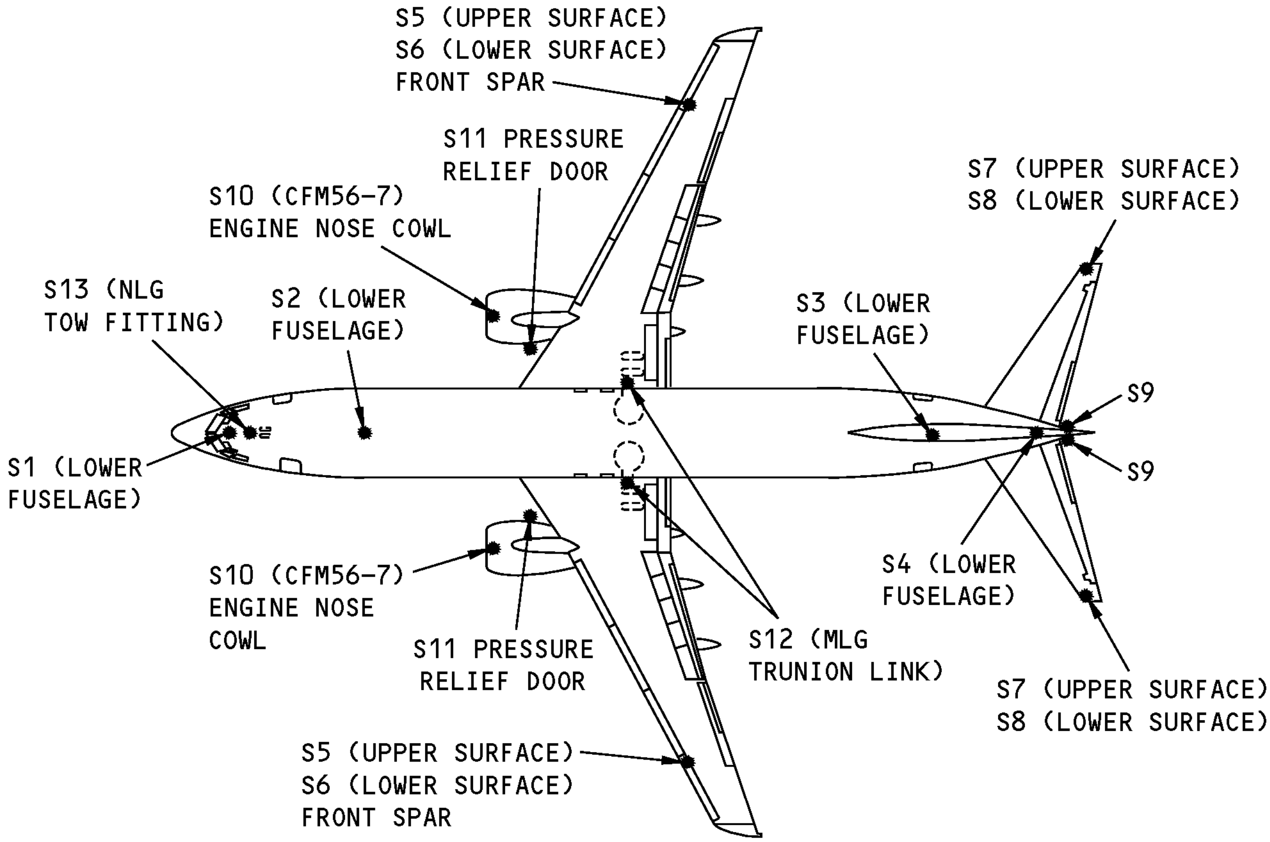
(d) Measure all of the distance dimensions for the left and right sides of the airplane. Refer to the applicable figure as given in Table 2/GENERAL for each of the distance dimensions.

(3) Make a record of the distance dimensions.

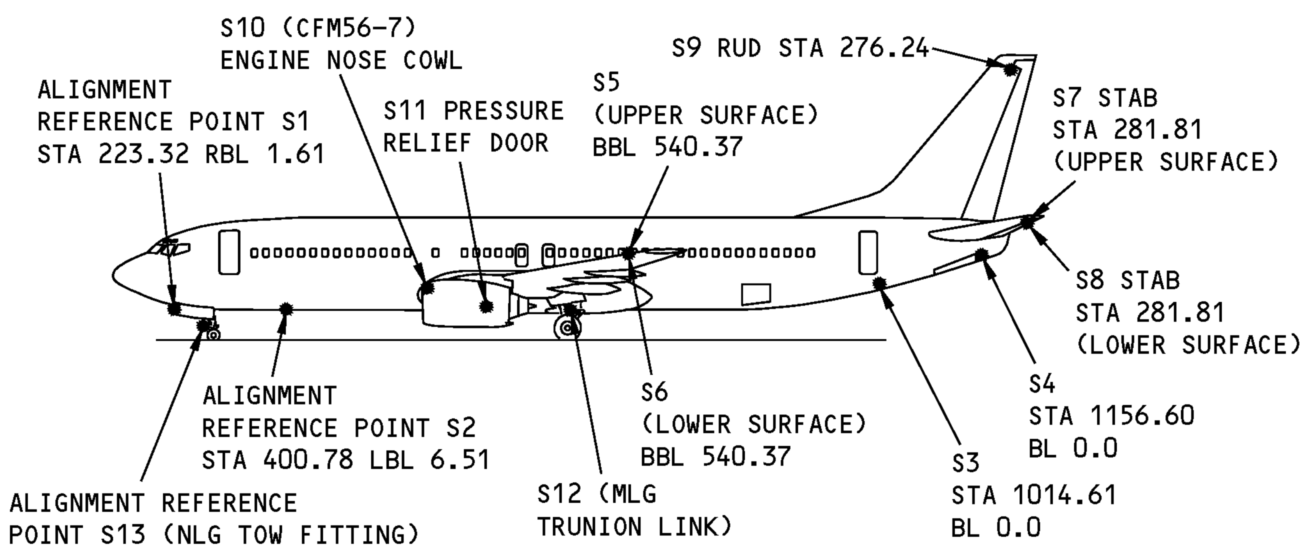
(4) Calculate the difference between the equivalent left and right sides distance dimensions.

(5) Do the check of the distance dimensions again if the difference is larger than the permitted values given in Table 2/GENERAL.

(6) Refer to Paragraph 7./GENERAL for the instructions that are related to the results you get.

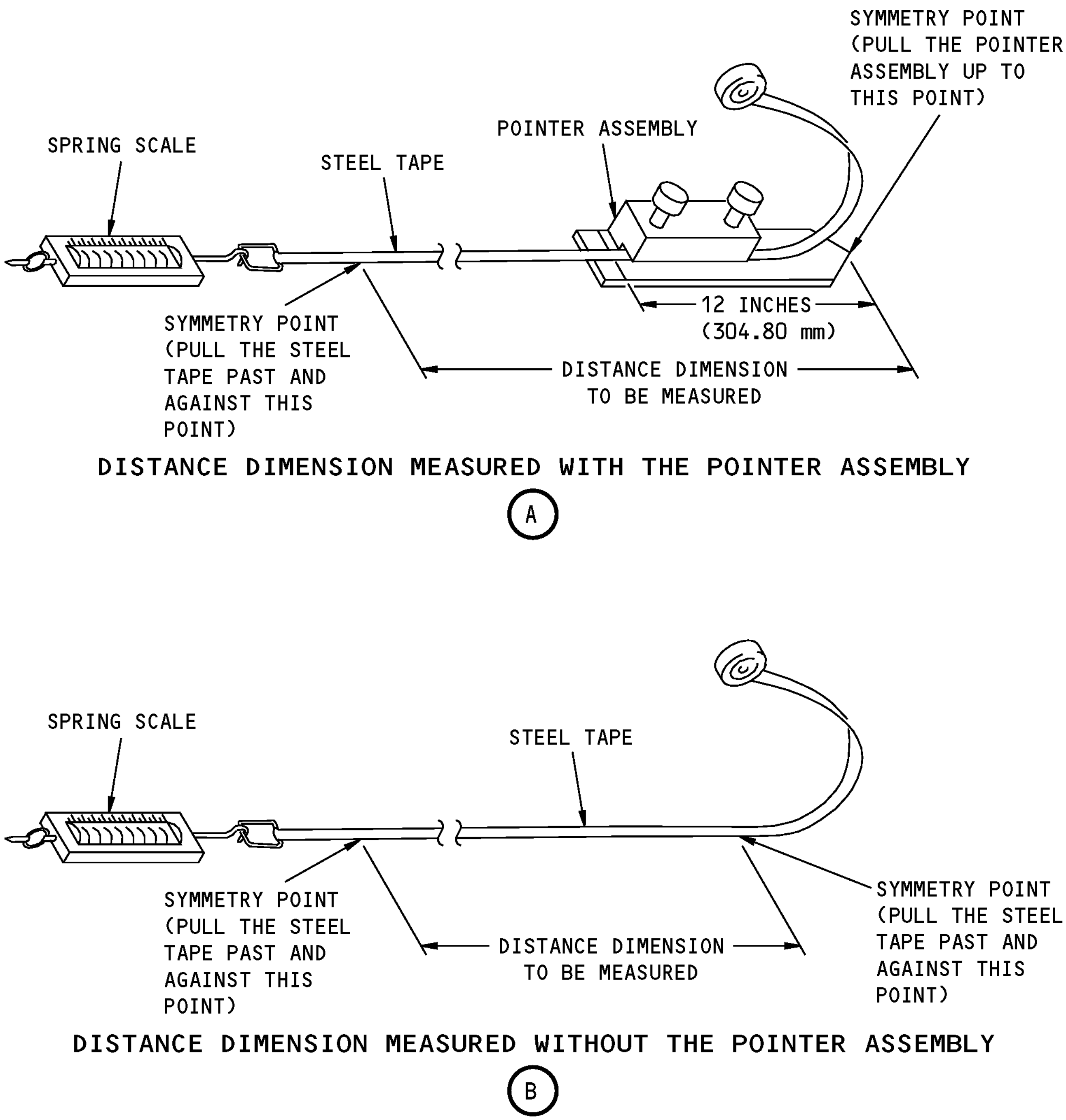


PLAN VIEW

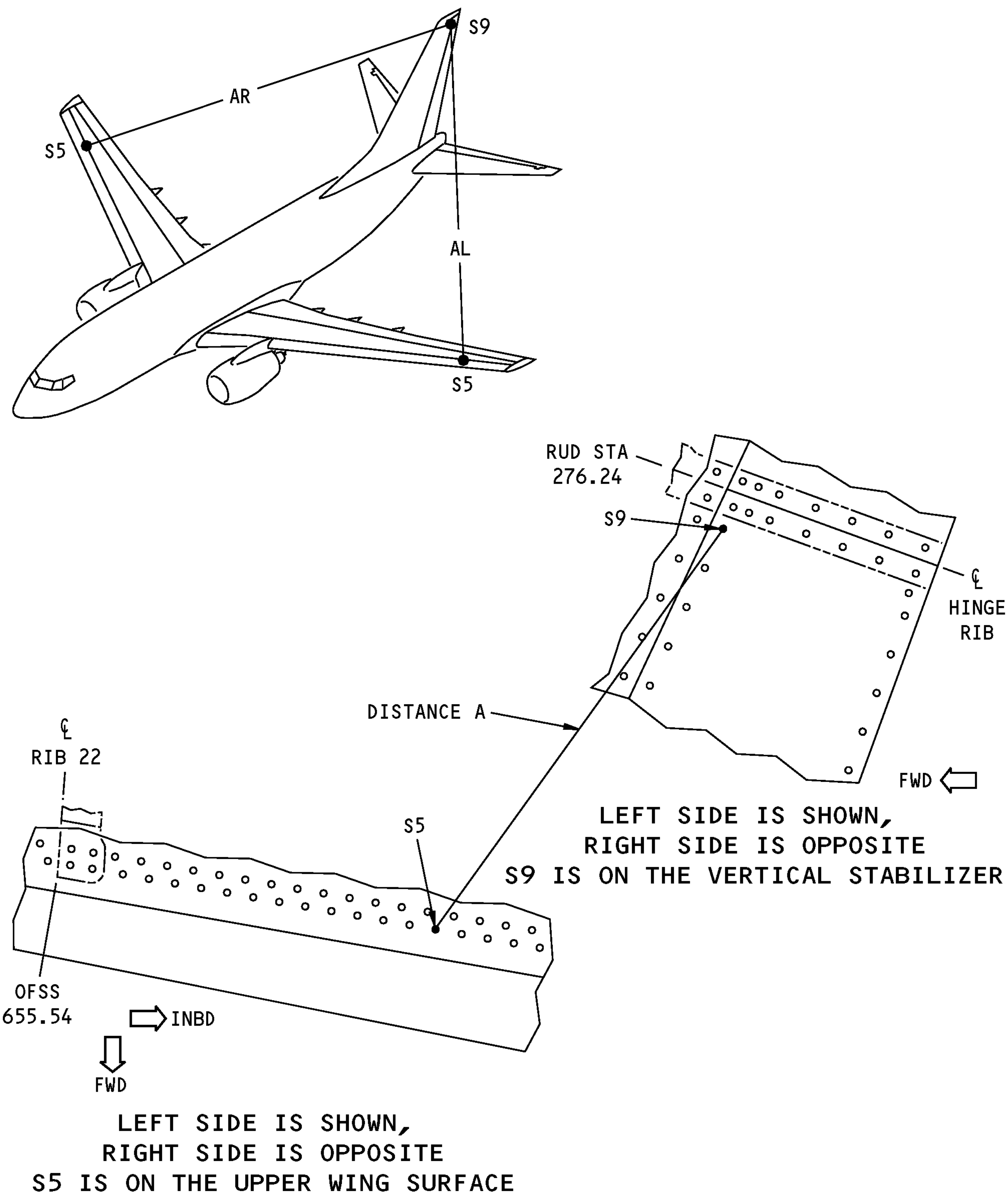


SIDE VIEW

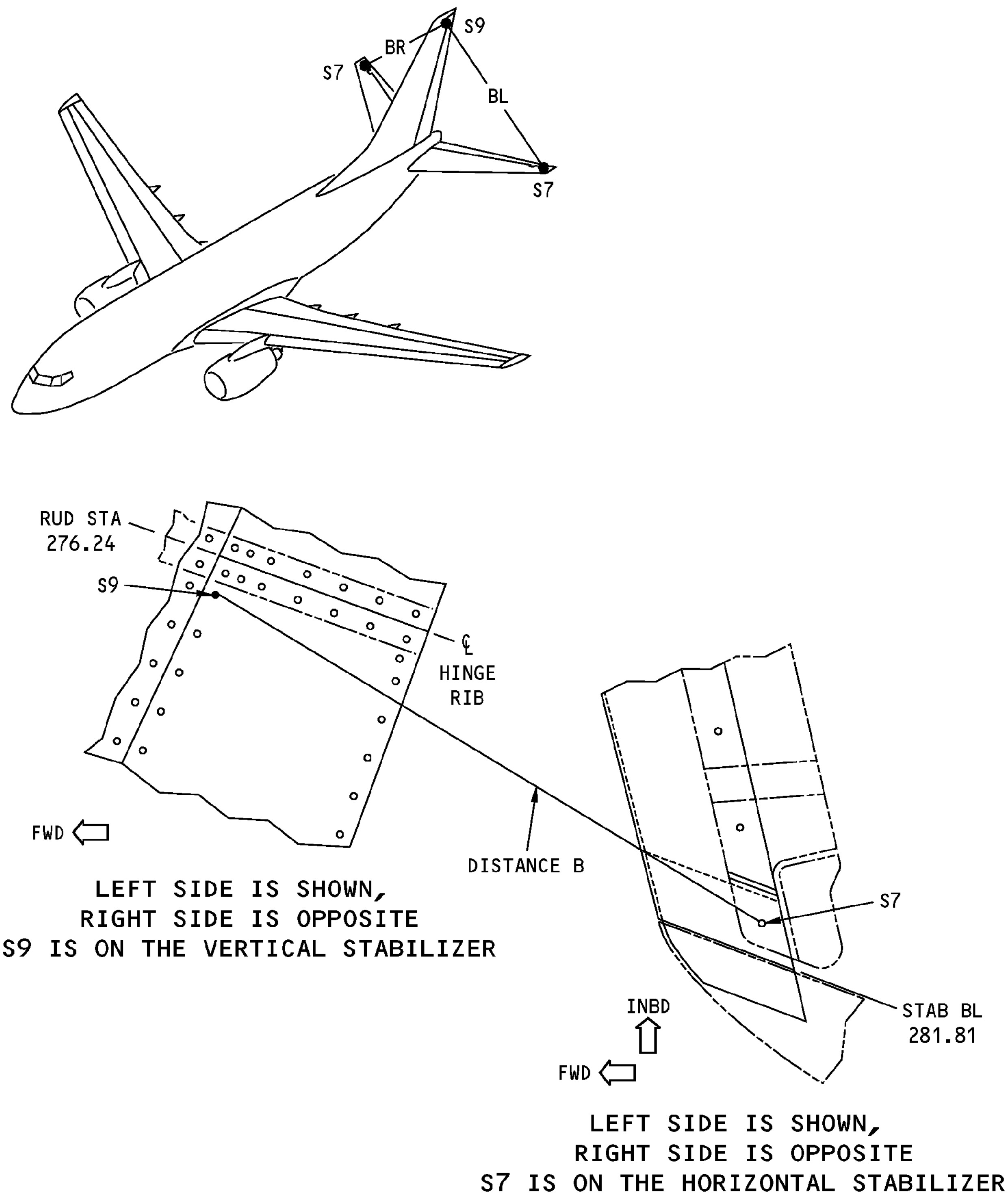
Symmetry Check - Symmetry Point Locations
Figure 2



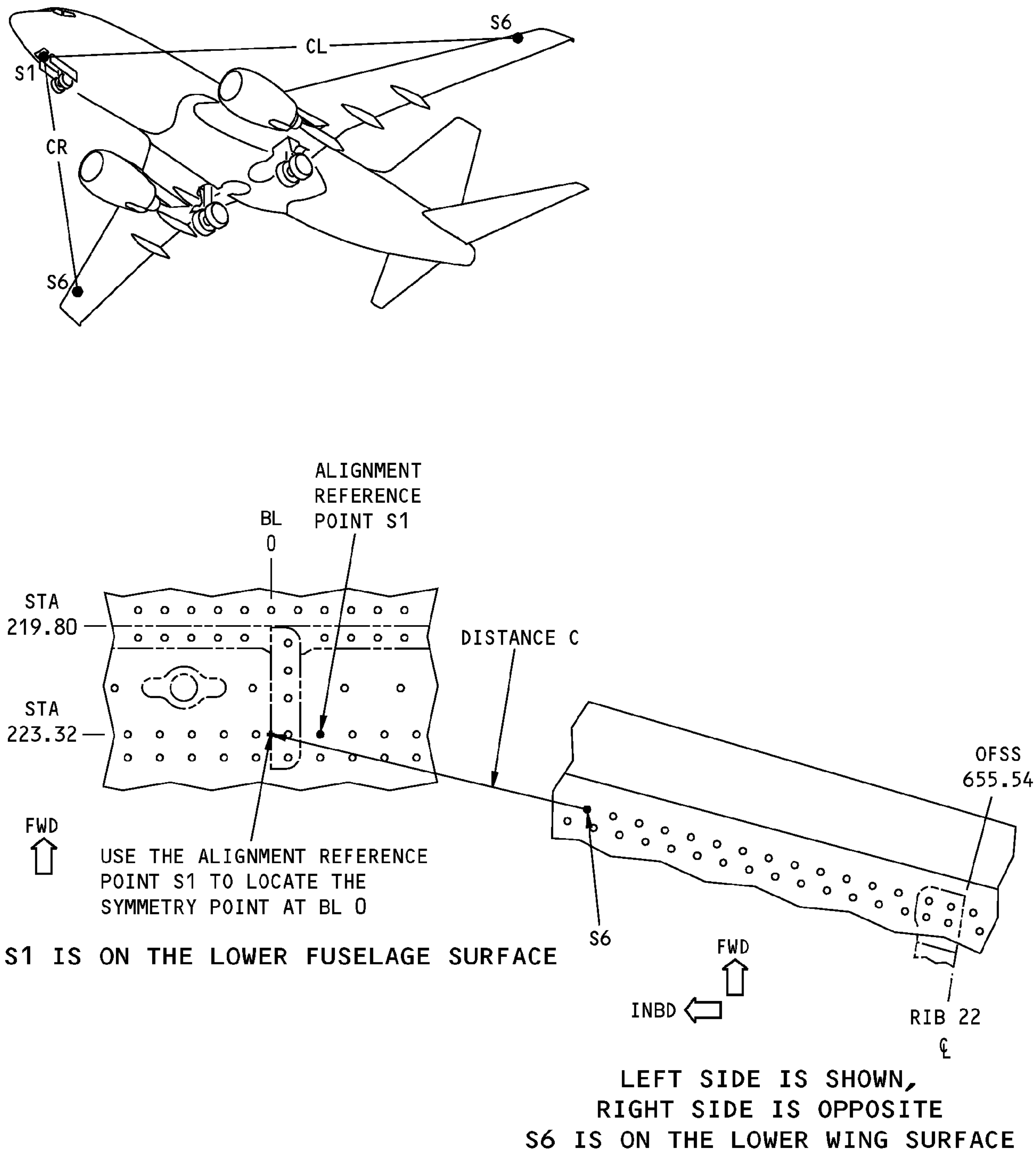
Procedures to Measure the Distance Dimensions
Figure 3



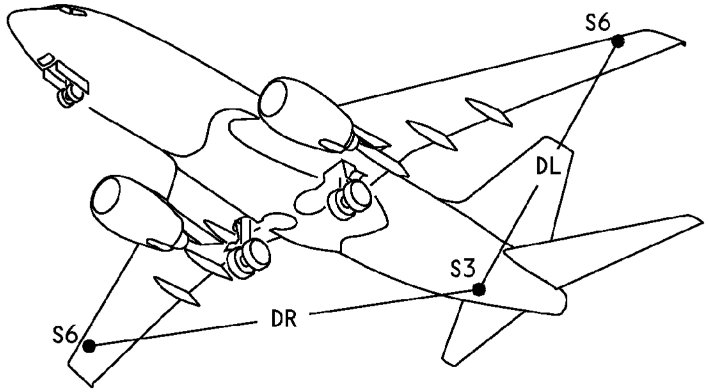
Symmetry Check - Distance A
Figure 4

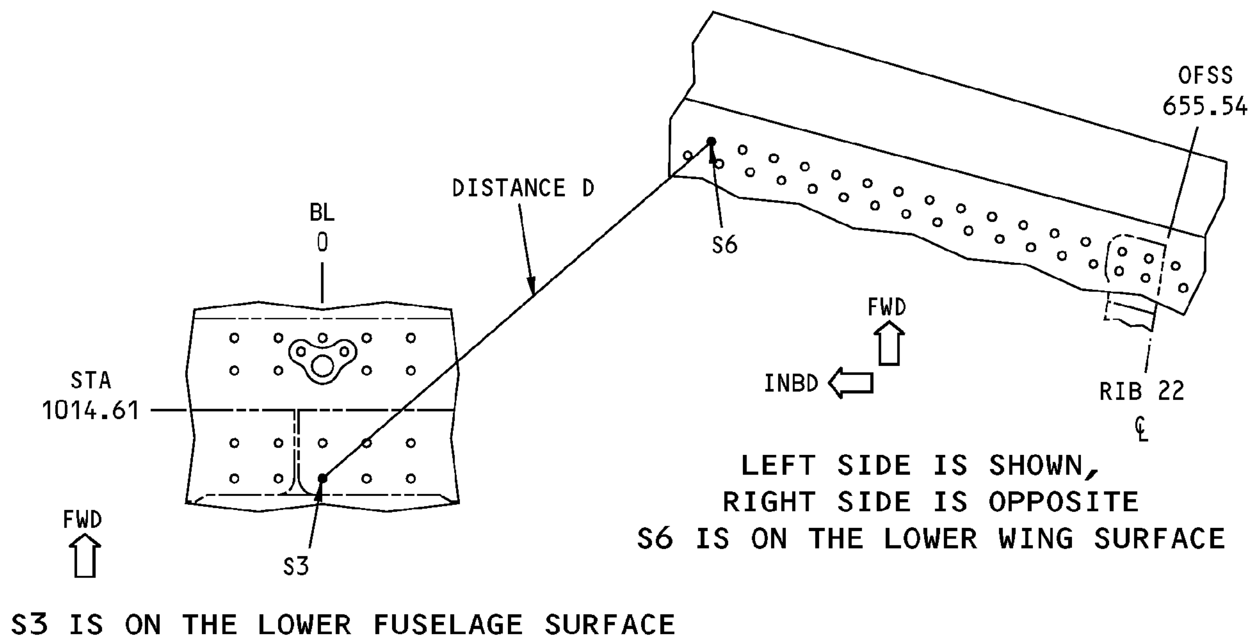


Symmetry Check - Distance B
Figure 5

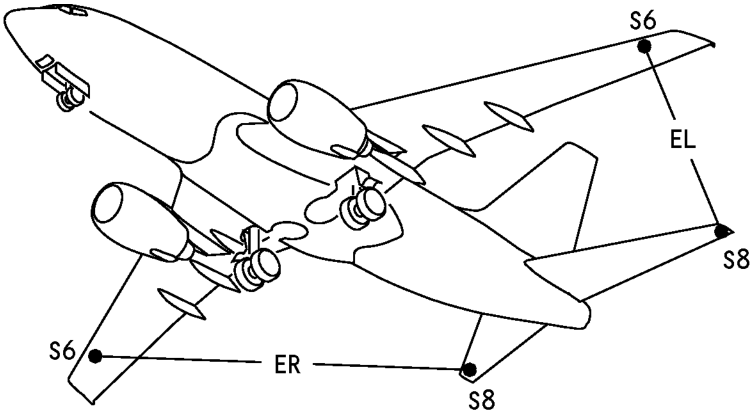


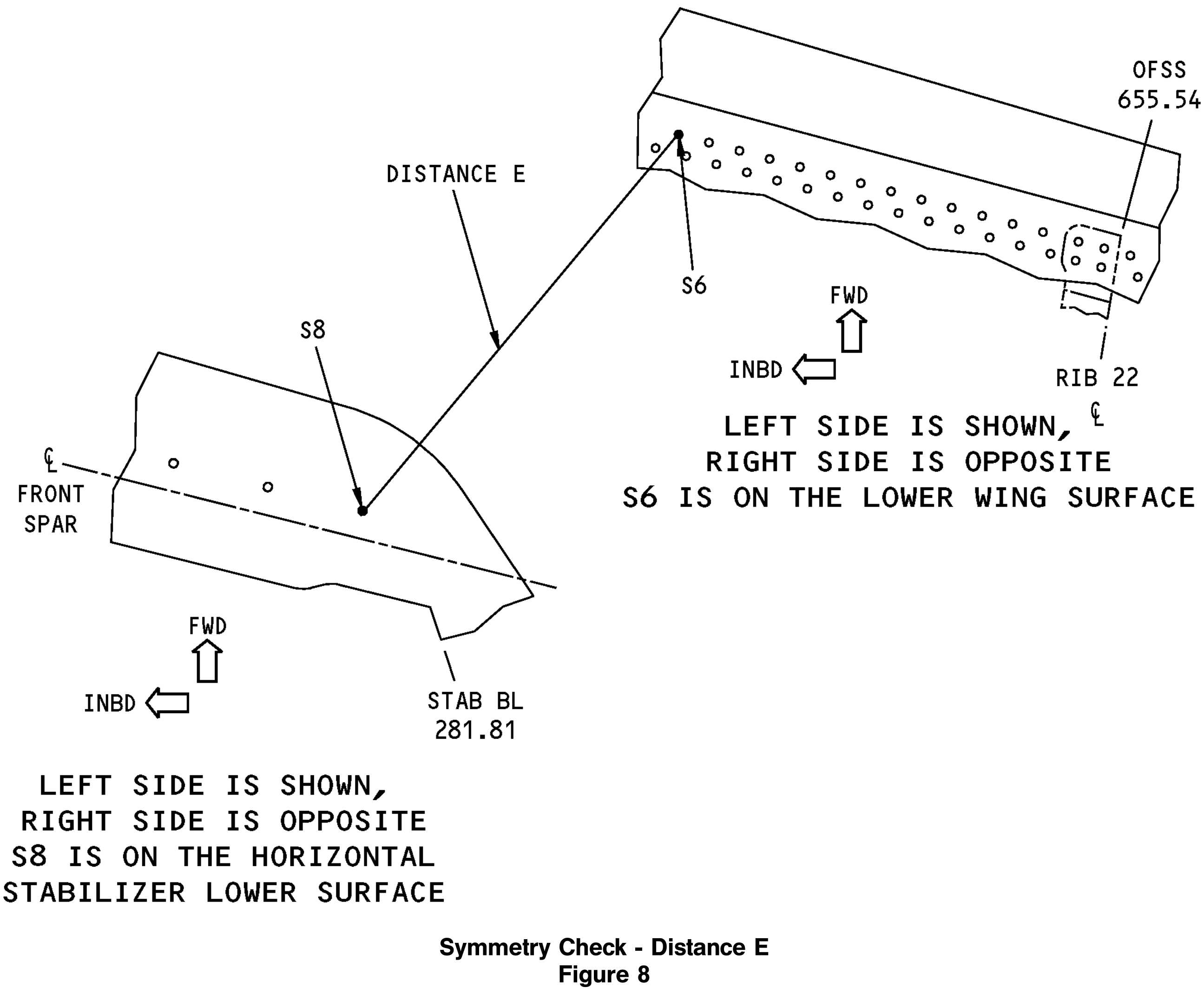
Symmetry Check - Distance C
Figure 6



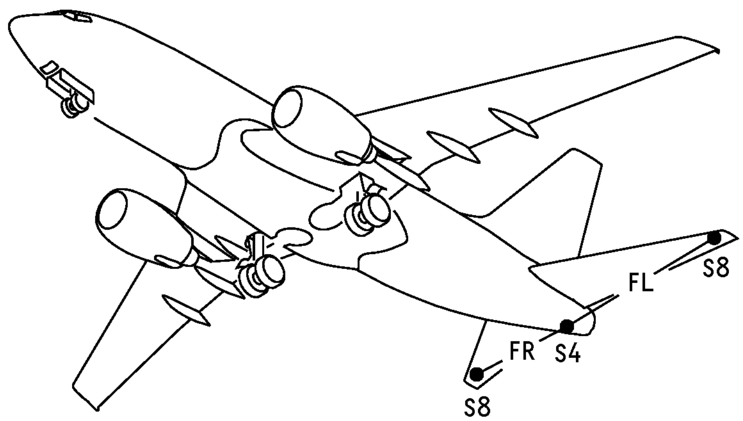


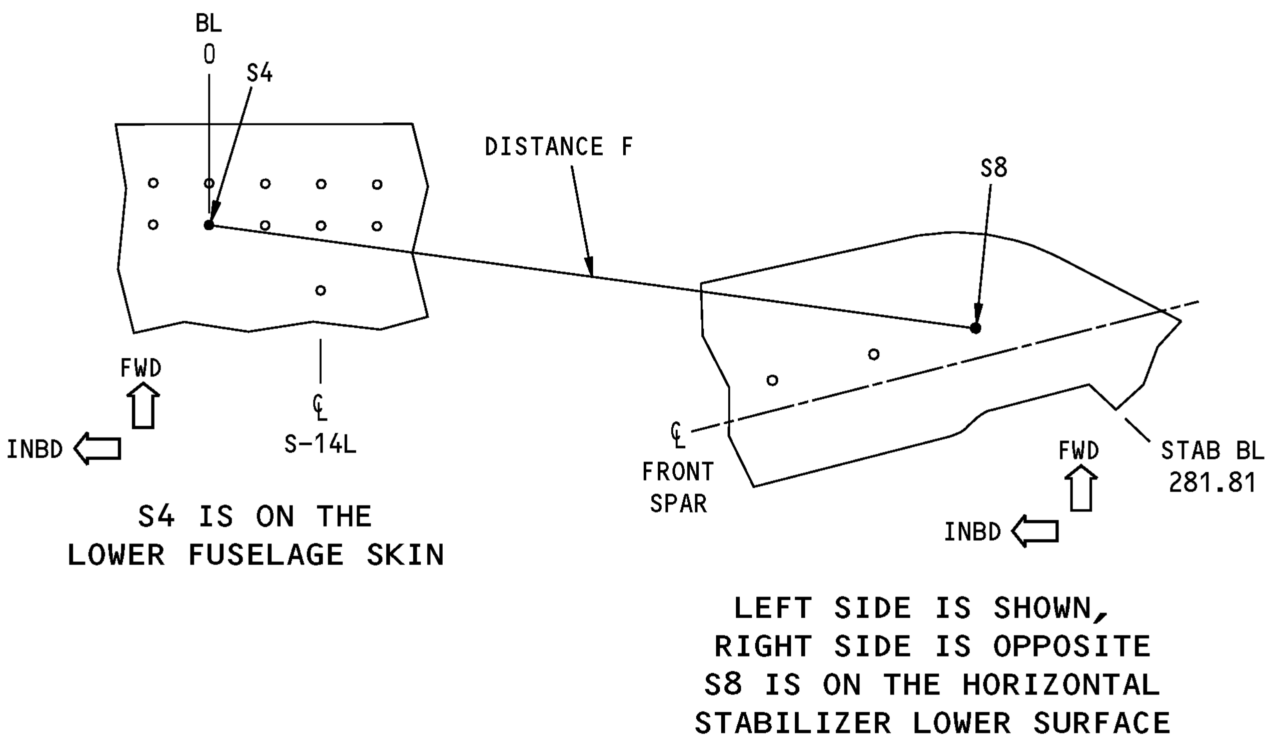
Symmetry Check - Distance D
Figure 7



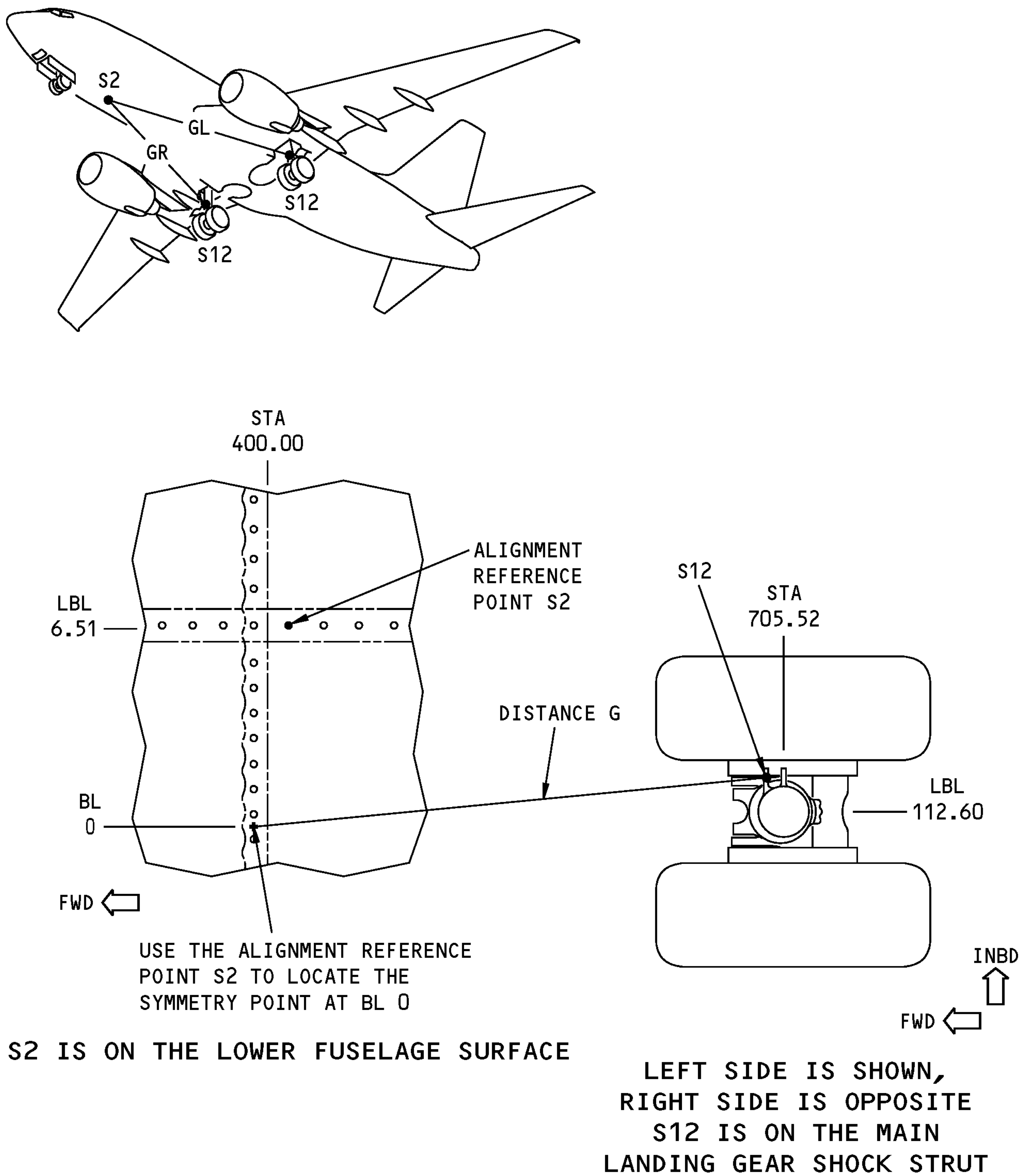


Symmetry Check - Distance E
Figure 8

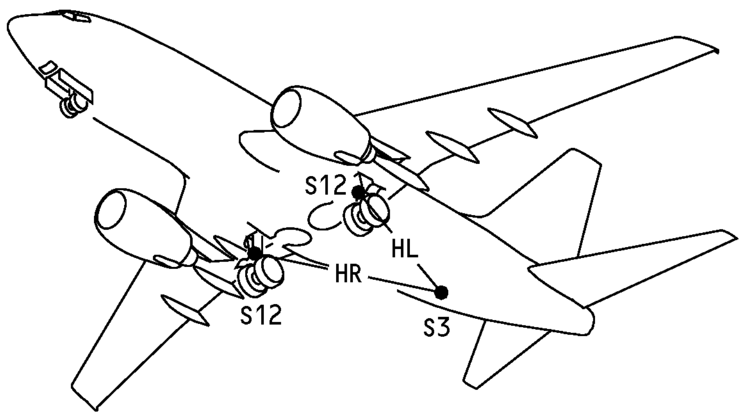


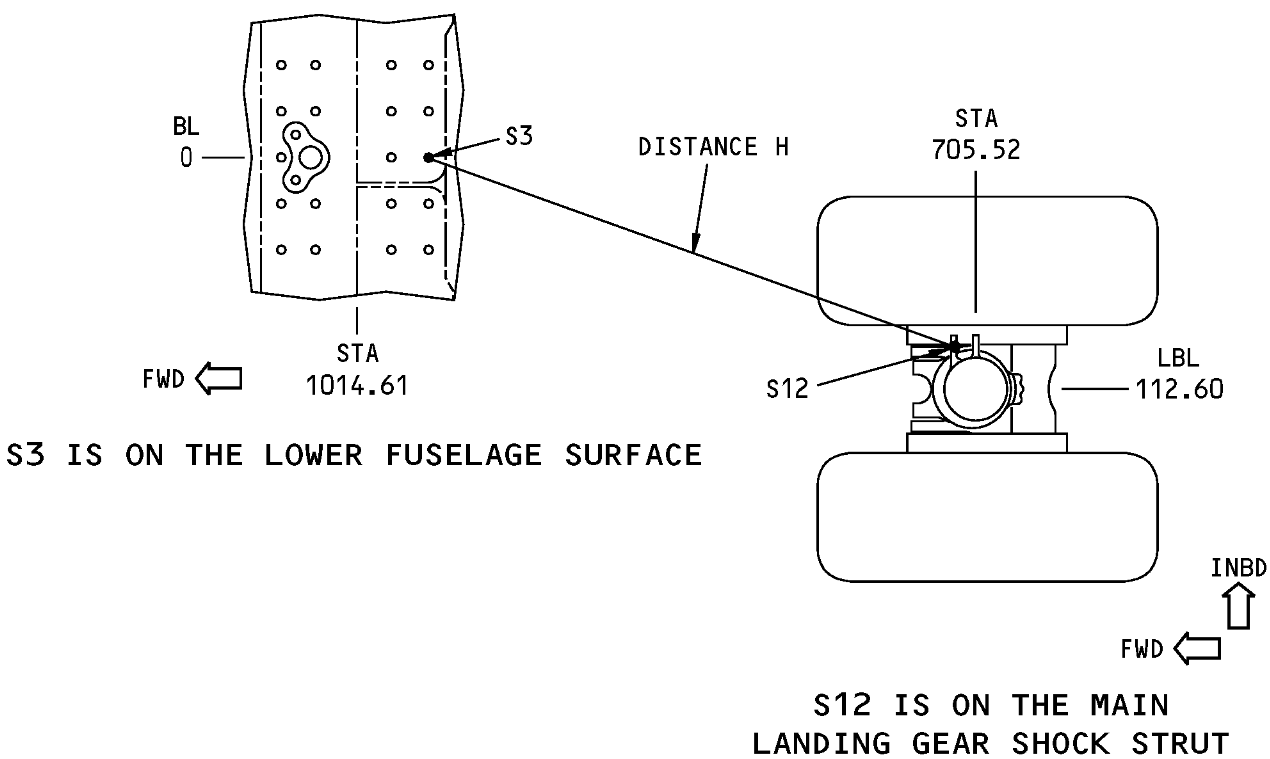


Symmetry Check - Distance F
Figure 9

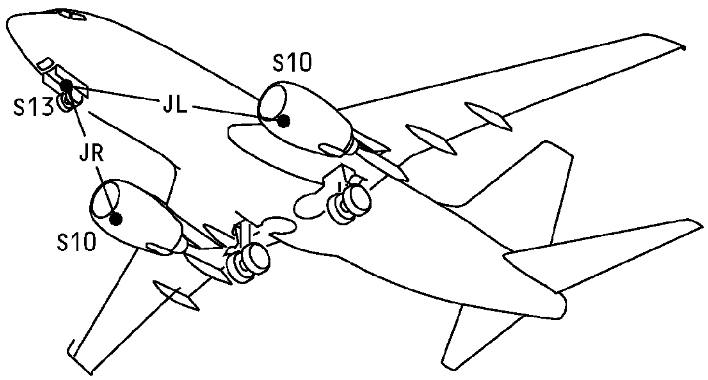


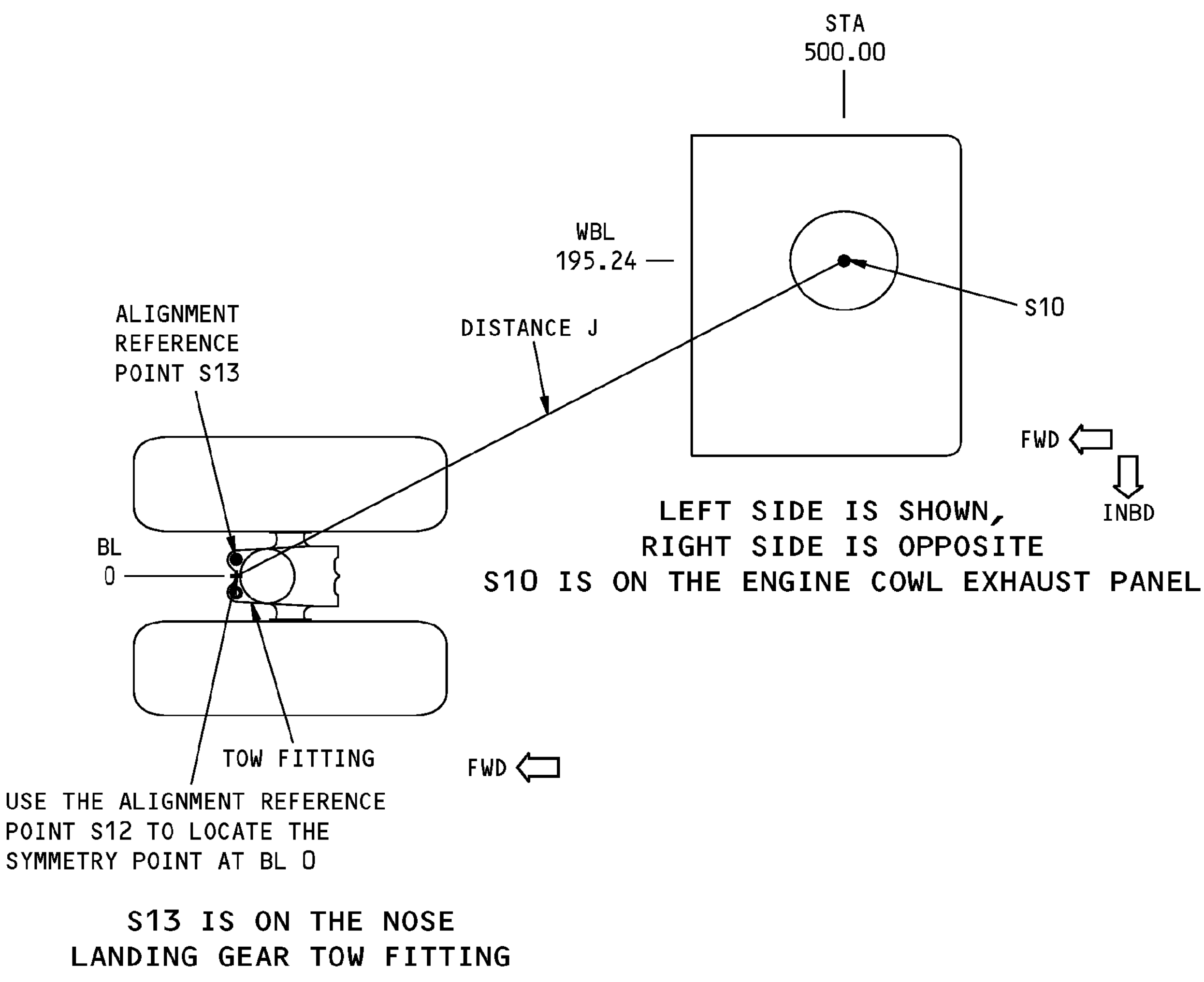
Symmetry Check - Distance G
Figure 10



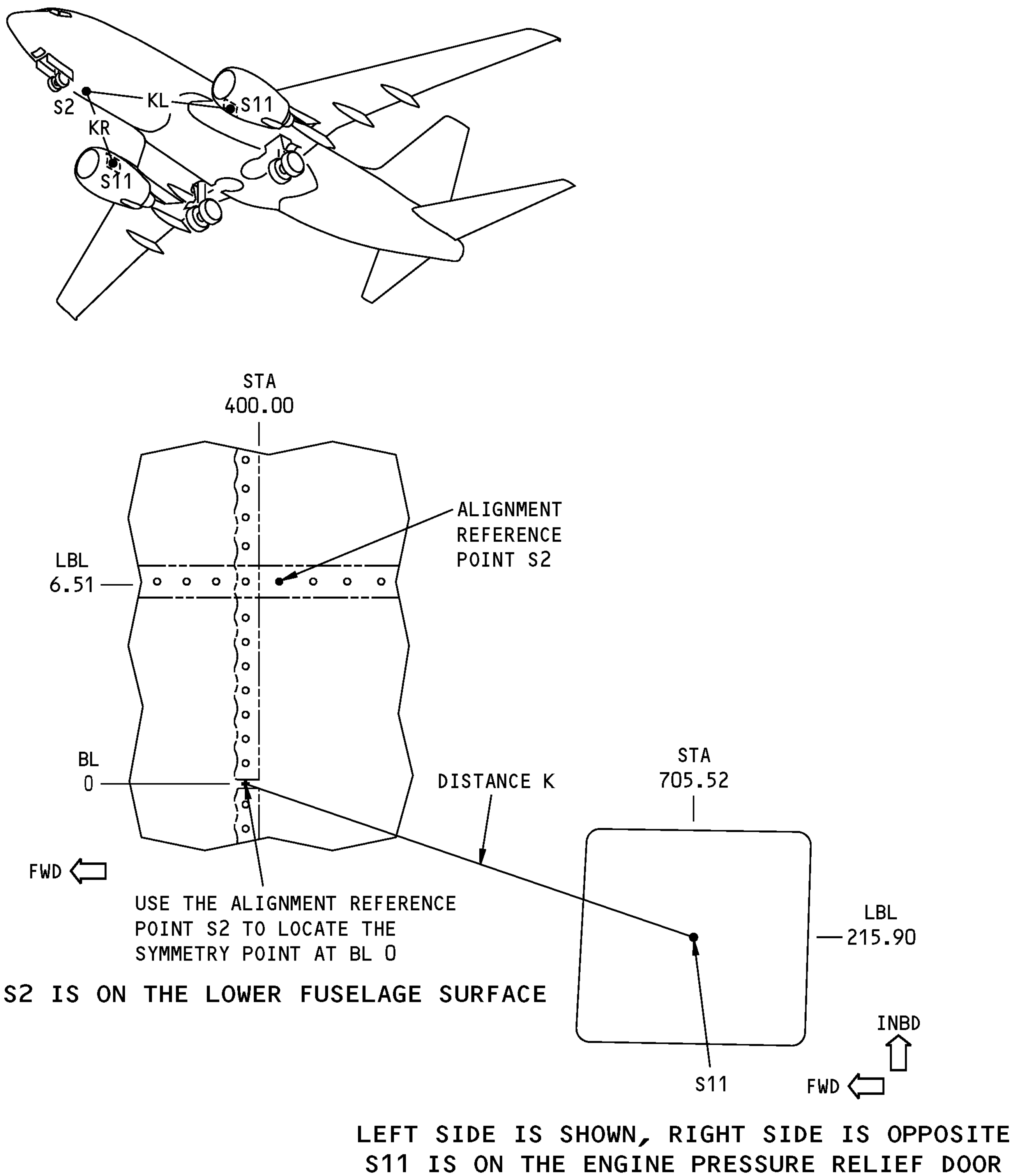


Symmetry Check - Distance H
Figure 11

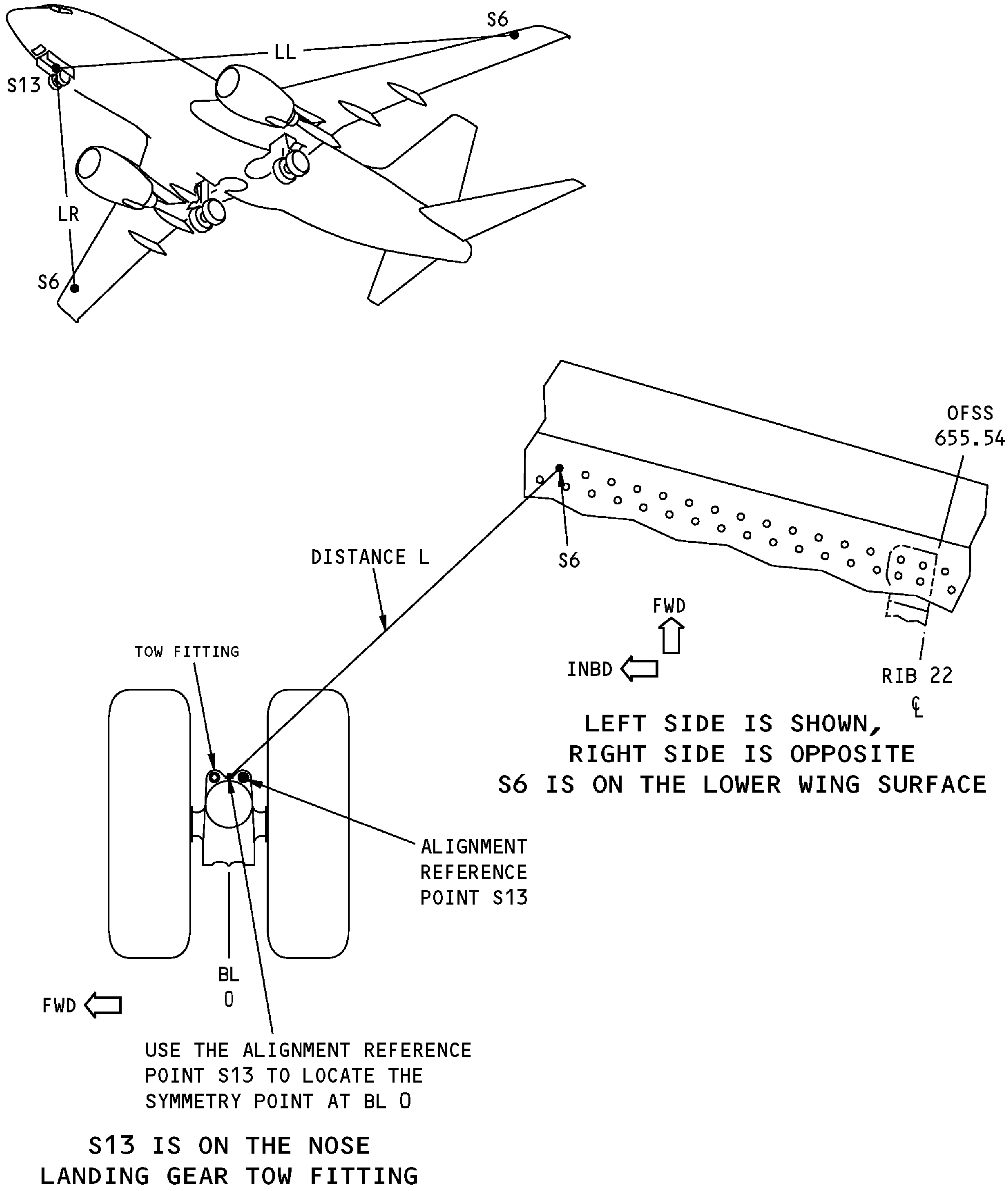




Symmetry Check - Distance J
Figure 12



Symmetry Check - Distance K
Figure 13



Symmetry Check - Distance L
Figure 14

6. **Incidence Check Instructions**

A. Get the necessary equipment as identified in Table 1/GENERAL to do the incidence check.

B. For the incident point locations and the allowable differences of incidences. Refer to Table 3/GENERAL.

C. Refer to Incidence Check Point Locations, Figure 15/GENERAL for the location of the incidence points.

CAUTION: DO NOT PERMIT MORE THAN TWO PEOPLE TO BE ON A WING OR A HORIZONTAL STABILIZER DURING THE INCIDENCE CHECK. IF YOU DO NOT OBEY, THE ADDED WEIGHT CAN CHANGE THE POSITIONS OF THESE STRUCTURES, AND MEASUREMENT ERRORS CAN OCCUR.

D. Measure the angles of incidence.

(1) Put the inclinometer support in the specified position.

(a) For the wings, use the 72-inch inclinometer support and do as follows:

1) Align the support parallel to BL 0.

2) Put the forward pointer at I1.

(b) For the horizontal stabilizers, use the 36-inch inclinometer support and do as follows:

1) Align the support parallel to BL 0.

2) Put the forward pointer at I2.

(2) Put the inclinometer on the inclinometer support.

(a) Put the square against the inclinometer support to make sure the support is perpendicular to the wing or horizontal stabilizer surface.

(3) Measure the angle of incidence dimension.

(4) Make a record of the angle of incidence dimension.

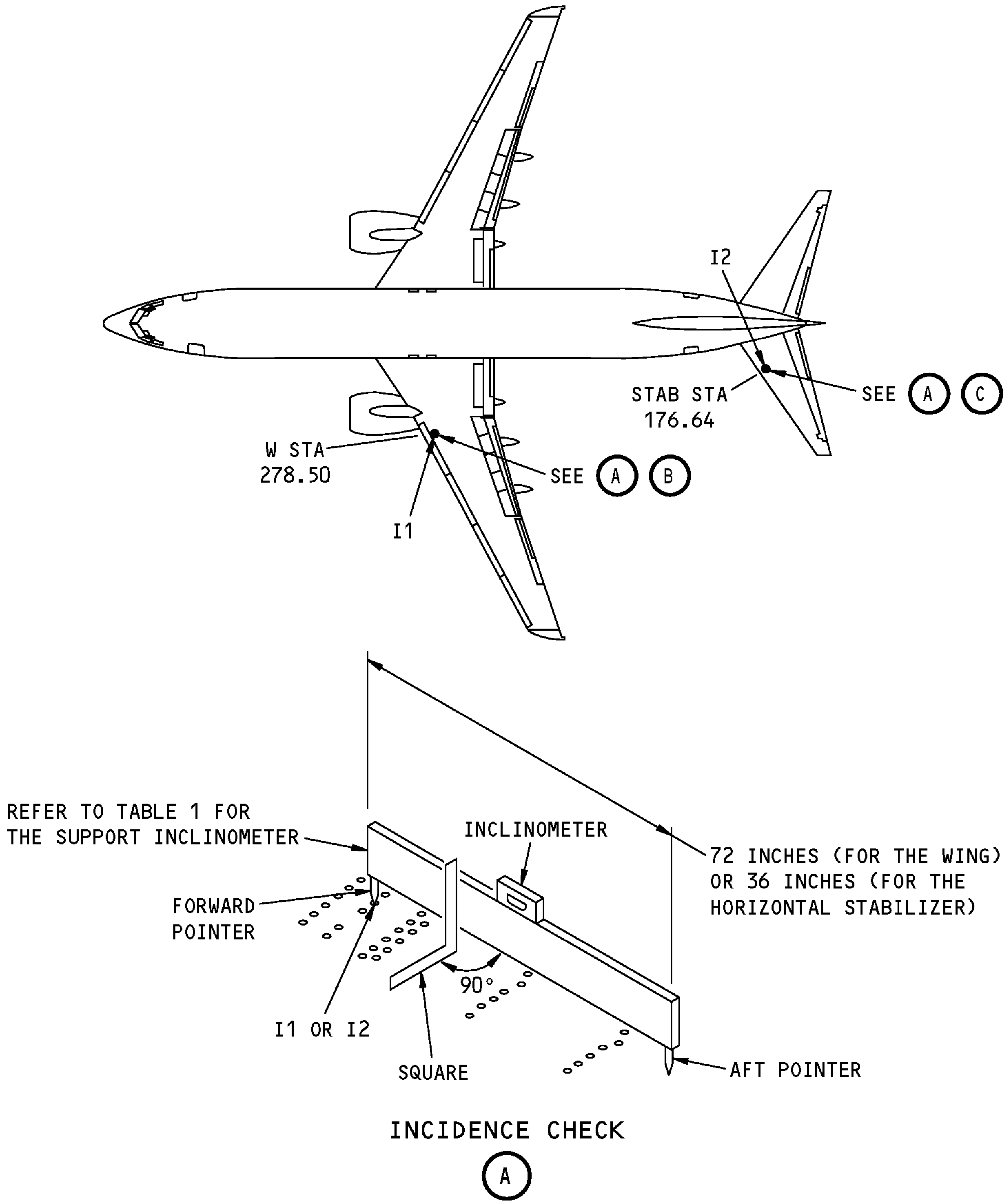
(5) Calculate the difference between the equivalent left and right side angle of incidence dimensions.

(6) Do the check of the angle of incidence dimensions again if the difference is larger than the permitted values given in Table 3/GENERAL.

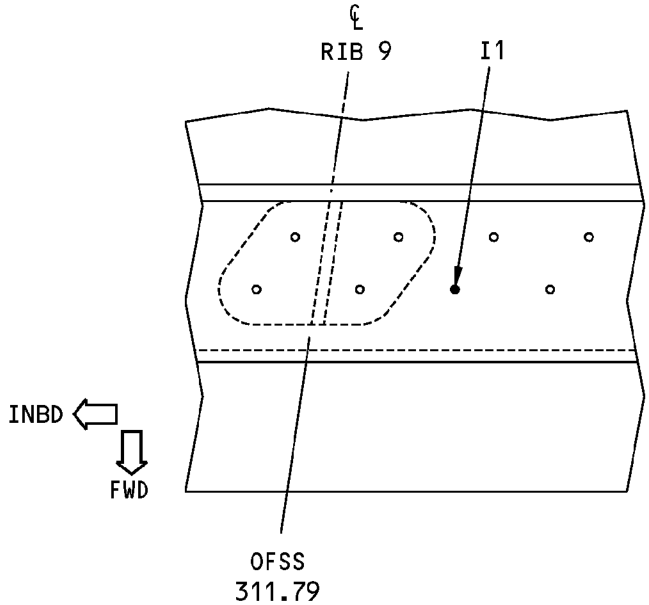
(7) Refer to Paragraph 7./GENERAL for the instructions that are related to the results that you get.

Table 3:

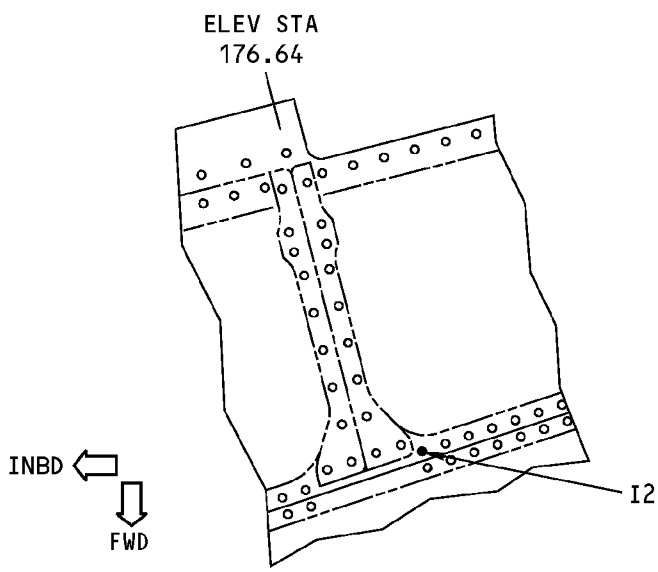
INCIDENCE CHECK DATA			
LEFT AND RIGHT RIGHT SIDE ANGLE OF INCIDENCE IDENTIFIER	SYMMETRY POINTS	FIGURE NUMBER	PERMITTED DIFFERENCE BETWEEN THE LEFT AND RIGHT ANGLE OF INCIDENCE DIMENSIONS DEGREES
M	I1	15	6 minutes (0.10 degree)
N	I2	15	6 minutes (0.10 degree)



Incidence Check Point Locations
Figure 15 (Sheet 1 of 2)



LEFT SIDE IS SHOWN, RIGHT SIDE IS OPPOSITE
WING CHECK
B



LEFT SIDE IS SHOWN, RIGHT SIDE IS OPPOSITE
HORIZONTAL STABILIZER CHECK
C

Incidence Check Point Locations
Figure 15 (Sheet 2 of 2)

7. Instructions for the Results of the Symmetry and Incidence Checks

A. Where the differences are equal to or less than values permitted in Table 2/GENERAL and Table 3/GENERAL and there are no signs of structural damage, the airplane can be returned to service.

B. If the differences are larger than values given in Table 2/GENERAL and Table 3/GENERAL, more investigations is necessary.

(1) Make an analysis of the dimensions to find the possible areas where structural damage has occurred. Usual indications of structural damage are:

(a) Buckled or cracked skins, spar webs or chords, stiffeners, castings, forgings, or machined parts.

(b) Loose or tilted fasteners.

(c) Fastener failure.

(d) Fuel leaks in the wing fuel tank areas.

(e) Cracked paint, which is an indication that the components have moved.

(f) Doors and access panels that do not close correctly because of changes in the shape of the adjacent structure.

(g) Incorrect fits between movable parts of a mechanism.

(h) Unusually large trim for a control surface.

(i) Control surfaces that overlap or do not align correctly.

(2) Get the approval of the Boeing Company or other approved authorities to return the airplane to service, when the inspections show:

(a) No indication of structural damage.

(b) No cause for the unsatisfactory differences that were measured by the symmetry or incidence check.

GENERAL - SUPPORT OF THE AIRPLANE FOR REPAIR

1. **Applicability**
   A. This subject gives the procedures necessary to support the airplane in a jig position before you make a major structural repair to:
      (1) The fuselage.
      (2) The horizontal or vertical stabilizers.
      (3) The wings.
   B. This subject is not applicable to the recovery of the airplane. Refer to the Airplane Recovery Document, D626A004, for the recovery of damaged airplanes that need special handling.
2. **General**
   A. Refer to Table 1/GENERAL for the references for the airplane support procedures.
   B. Refer to Table 2/GENERAL for the equipment necessary to support the airplane.
   C. For the airplane station diagrams, refer to:
      (1) 53-00-00 for the fuselage
      (2) 55-10-00 for the horizontal stabilizer
      (3) 55-30-00 for the vertical stabilizer
      (4) SRM 57-00-00 for the wings
   D. If the airplane cannot be supported for repair by the procedures that follow, contact The Boeing Company.

Table 1:

PARAGRAPH AND FIGURE REFERENCES FOR THE AIRPLANE SUPPORT PROCEDURES		
PROCEDURE	PARAGRAPH	FIGURE
Get the Equipment	4	—
Prepare the Airplane for Support	5	1
Jack and Level the Airplane	6	2
Support the Fuselage in a Jig Position	7	3,4,8
Support the Wing in a Jig Position	8	3,5,6
Support the Horizontal Stabilizer in a Jig Position	9	3,7
Do the Repairs	10	—
Remove the Airplane from a Jig Position	11	—
Make the Structures to Support the Airplane in a Jig Position	12	8,9,10, 11

Table 2:

EQUIPMENT TO SUPPORT THE AIRPLANE		
EQUIPMENT	QUANTITY	SOURCE
Plumb Bob and Cord	1	Many sources
Leveling Scale (or equivalent)	1	Many sources
Gage (with increments in tons, pounds, or kilograms, or the equivalent)	1	Many sources

EQUIPMENT TO SUPPORT THE AIRPLANE		
Support Structure (A-Frame Type for the fuselage)	5	Many sources (Refer to Paragraph 12 if you need to make the support structure.)
Supplementary Support Structure (A-Frame Type for the wing)	6	Many sources (Refer to Paragraph 12 if you need to make the support structure.)
Supplementary Support Structure (A-Frame Type for the horizontal stabilizer)	2	Many sources (Refer to Paragraph 12 if you need to make the support structure.)
Jack Equipment (Optional to support the engine)	1	Boeing Part Number C51001-1 (or the equivalent)
Load Cell	1	Many sources

3. **References**

Reference	Title
53-00-00	FUSELAGE - GENERAL
55-10-00	HORIZONTAL STABILIZER
55-30-00	VERTICAL STABILIZER
57-00-03	WING STRINGERS
AMM 08-21	AIRPLANE LEVELING
AMM 07-11-01	Jack Airplane
AMM 07-11-01/201	Airplane Jacking - Maintenance Practices
AMM 12-15-31	Main Landing Gear Shock Strut - Servicing
AMM 20-40-11/201	Airplane Grounding - Maintenance Practices
AMM 25-21-46/401	Sidewall Panel - Removal/Installation
AMM 27-51-00/201	Trailing Edge Flap System - Maintenance Practices
AMM 27-81-00/201	Leading Edge Slat System - Maintenance Practices
AMM 28-26-00	Airplane Defueling Procedures
AMM 32-00-01	Landing Gear Downlock Pins - Maintenance Practices
AMM 56-21-00/401	Passenger Cabin Windows - Removal/Installation
AMM 71-00-02	Engine Removal

4. **Get the Equipment**

A. Get the necessary equipment as identified in Table 2/GENERAL to support the airplane.

(1) If you do not have the support structures, you can make them. Refer to Paragraph 12./GENERAL for the specified support structure to use and the procedures for their use. Refer to Table 7/GENERAL for the materials to make the support structures.

5. **Prepare the Airplane for Support**

A. Put the airplane on a hard and level surface in a building that is free of the wind, if possible.

(1) Remove the power from all of the fans and air conditioning equipment in the building.

(2) Close the outside doors of the building during windy weather.

(3) If you have wind that is more than 35 knots, use tie-downs to keep the airplane level.

B. If a building is not available, do as follows:

(1) Put the airplane on a hard and level surface.

(2) Put the nose of the airplane into the wind, if there is wind.

C. Decrease the weight of the airplane to an Operating Empty Weight (OEW) for a safer lift condition.

(1) Defuel the airplane. Refer to AMM 28-26-00 for the defueling procedures.

D. Install all the landing gear ground locks and door locks. Refer to AMM 32-00-01 for the procedures.

E. Ground the airplane. Refer to AMM 20-40-11/201 for the grounding procedures.

F. Set the flight controls as follows:

WARNING: ALL PERSONNEL MUST BE CLEAR OF THE OPERATING ENVELOPE OF THE CONTROL SURFACES AND OTHER MOVABLE PARTS BEFORE THEY ARE OPERATED. IF YOU DO NOT OBEY, AN INJURY CAN OCCUR.

CAUTION: ALL TOOLS AND EQUIPMENT MUST BE CLEAR OF THE OPERATING ENVELOPE OF THE CONTROL SURFACES AND OTHER MOVABLE PARTS BEFORE THEY ARE OPERATED. IF YOU DO NOT OBEY, DAMAGE TO THE AIRPLANE STRUCTURE CAN OCCUR.

(1) Retract the leading edge slats. Refer to AMM 27-81-00/201 for the procedures.

(2) Retract the trailing edge flaps. Refer to AMM 27-51-00/201 for the procedures.

(3) Put the ailerons, spoilers, flaperons, rudder, stabilizers, and elevators into neutral position.

(4) Close all of the passenger and crew doors, cargo doors, and service doors.

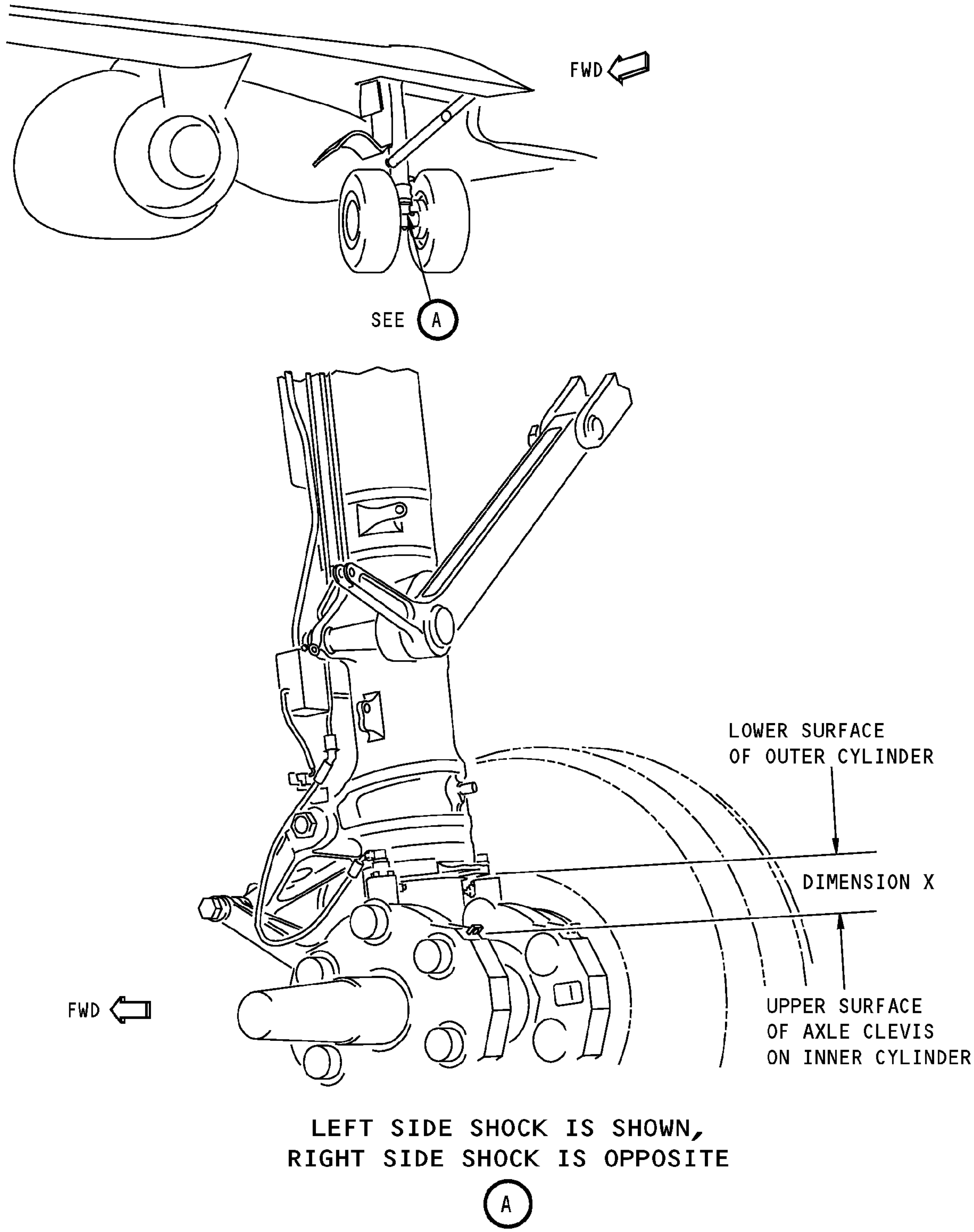
(5) Set the left and right side Main Landing Gear (MLG) shock struts as follows:

(a) Measure the dimension between the lower surface of the outer cylinder and the upper surface of the axle clevis on the inner cylinder. Refer to Dimension to be Measured on the Main Landing Gear Shock Strut, Figure 1/GENERAL.

(b) Calculate and compare the dimensions you found for each shock strut.

NOTE: The difference between the two dimensions you found must not be more that 1.0 inch (25.4 mm).

(c) If the difference between the two dimensions you found is more than 1.0 inch (25.4 mm), inflate or deflate the shock strut. Refer to AMM 12-15-31 for the procedures.



Dimension to be Measured on the Main Landing Gear Shock Strut
Figure 1

6. Jack and Level the Airplane

A. Refer to Location of Jack Supports, Figure 2/GENERAL for the locations of the jacks and other supports around the airplane.

(1) You will use three main jacks and four auxiliary jacks to support the airplane.

B. Jack the airplane.

(1) Refer to AMM 07-11-01 for:

(a) The jacking procedures

(b) The maximum jacking loads and support data.

C. Make the airplane level laterally and longitudinally. Refer to AMM SECTION 08-21 for the procedures.

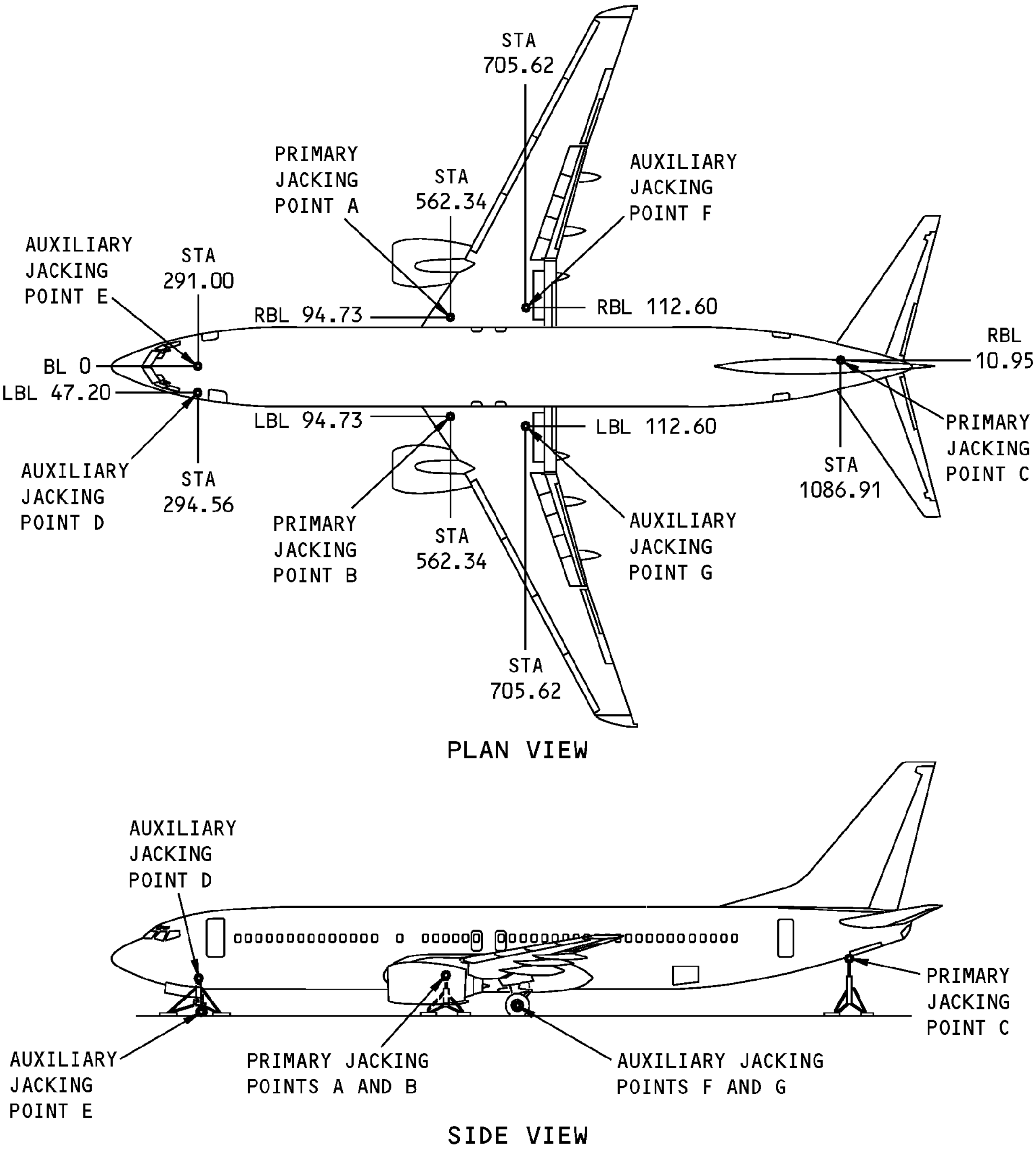
(1) Attach the plumb bob and cord to the applicable airplane structure.

(2) Put the plumb bob in position just above the ground target.

(3) Position the leveling scale.

(a) The plumb bob must be in the zero position on the leveling scale.

(4) If the plumb bob is not in the zero position, you must make the airplane level.



PRIMARY AND AUXILIARY JACK POINT LOCATIONS

Location of Jack Supports
Figure 2

7. Support the Fuselage in a Jig Position

A. Install the support structures.

NOTE: If there is a repair in the area of a fuselage cradle support, use the alternative fuselage support. Refer to Paragraph 7.A.(2)/GENERAL and Fuselage Support Structure, Figure 8/GENERAL, Detail I .

(1) Support of the Fuselage in the Jig Position

(a) Align the support structures under the fuselage at STA 360, STA 571, STA 662, STA 727, and STA 1016, as shown in Location of Support Structures, Figure 3/GENERAL.

1) Install a contoured fuselage saddle for the support structure at STA 360, STA 727, and STA 1016. Refer to Paragraph 12./GENERAL

2) Install a keel beam saddle for the support structure at STA 571 and STA 662. Refer to Paragraph 12./GENERAL

NOTE: Remove parts of the wing-to-body fairing and its support structure as necessary.

WARNING: DO NOT PUT A LOAD OF MORE THAN 5,000 POUNDS (2268 KG) ON THE SUPPORT STRUCTURE AT STA 360, STA 727, AND STA 1016. DO NOT PUT MORE THAN 5,000 POUNDS (2268 KG) ON THE SUPPORT STRUCTURE AT STA 571 AND STA 662. IF YOU DO NOT OBEY, DAMAGE TO THE AIRPLANE STRUCTURE AND EQUIPMENT, AND INJURY TO PERSONNEL CAN OCCUR.

CAUTION: DO NOT REMOVE THE LOAD FROM THE PRIMARY JACKS, EXCEPT AT POINT C WITH EXTREME CAUTION. IF YOU DO NOT OBEY, YOU WILL PUT MORE WEIGHT ON THE SUPPORT STRUCTURES THAN IS PERMITTED, AND DAMAGE TO THE AIRPLANE STRUCTURE CAN OCCUR. REFER TO AMM 07-11-01 FOR THE MAXIMUM LOADS PERMITTED.

(b) Move the support structures against the fuselage structure to transmit part of the load from the jacks.

(2) Alternative Support of the Fuselage in the Jig Position with a Window Support Assembly

NOTE: The steps that follow must be used when a cradle support cannot be located as specified because of a repair in that area. You can use more than one window support assembly if necessary. A maximum of two sets of window supports is permitted in sections 43 and 46.

(a) Remove the interior panel to get access to the window panels. Refer to AMM 25-21-46/401.

(b) Remove the windows as necessary. Refer to AMM 56-21-00/401.

(c) Place the window blocks and beams in the window frames as shown in Fuselage Support Structure, Figure 8/GENERAL, Details H and I .

(d) Install the fuselage support jigs as shown in Fuselage Support Structure, Figure 8/GENERAL, Details H and I until contact is made with the window beams.

1) Place the support beams as necessary to satisfy the fuselage leveling requirements.

2) Make sure that the hardwood fits against the window frame to distribute the loads evenly.

a) Make sure that there are no gaps greater than 0.01 inch (0.3 mm) between the window support assembly and the window frame.

WARNING: DO NOT PUT A LOAD OF MORE THAN 1,500 POUNDS (680 KG) ON THE WINDOW FRAME SUPPORT STRUCTURE IN SECTIONS 43 AND 46. IF YOU DO NOT OBEY, DAMAGE TO THE AIRPLANE STRUCTURE AND EQUIPMENT, AND INJURY TO PERSONNEL CAN OCCUR.

CAUTION: DO NOT REMOVE THE LOAD FROM THE PRIMARY JACKS, EXCEPT AT POINT C WITH EXTREME CAUTION. IF YOU DO NOT OBEY, YOU WILL PUT MORE WEIGHT ON THE SUPPORT STRUCTURES THAN IS PERMITTED, AND DAMAGE TO THE AIRPLANE STRUCTURE CAN OCCUR. REFER TO AMM 07-11-01 FOR THE MAXIMUM LOADS PERMITTED.

(e) Move the support structures against the fuselage structure to transmit part of the load from the jacks.

CAUTION: THE AFT FUSELAGE JACK POINT C IS OFFSET FROM BL 0 AND CAN POSSIBLY TWIST THE FUSELAGE WHEN THE AIRPLANE IS JACKED. IF THIS OCCURS, IT CAN BE NECESSARY TO REMOVE THIS JACK TO KEEP THE AIRPLANE STABLE. IF YOU DO NOT OBEY, THE REPAIR YOU MAKE CAN BE UNSATISFACTORY.

(3) You are permitted to remove the aft fuselage jack at jack point C only if:

(a) All the support structures are in position

(b) The load for each support structure is not more than is permitted

(c) You do so with extreme caution.

B. Align the fuselage.

(1) Refer to Fuselage Alignment Points, Figure 4/GENERAL for the alignment points on the fuselage.

(2) Find alignment point BF and use this as your datum point.

(3) Align a horizontal reference plane, with WL 148.70, a small distance below alignment point BF.

(a) Use a leveling scale, or equivalent.

(b) Make a record of the difference in height between the reference plane and alignment point BF.

NOTE: You will use this height difference to make sure that the positions you find for the other alignment points are as specified in Fuselage Alignment Points, Figure 4/GENERAL. If the height difference you found is the same after you adjust the fuselage for the other alignment points, then it is not necessary to adjust the points. If the height difference changes, then you must adjust the points again.

(4) Find alignment points BA and BC.

(a) Measure and compare the heights of points BA and BC to the heights specified for these points above WL 148.70 in Fuselage Alignment Points, Figure 4/GENERAL.

1) If you do not get the heights specified in Table A for BA and BC, adjust the support structures.

a) Adjust the support structure at STA 571 if the difference is small.

b) Adjust the support structures at STA 571, STA 662, STA 727, and the jacks at jack points A and C, if the difference is large.

- Make sure the jacks at jack points A, B, and C stay in position.

- Make sure the load at each jack point is not more than is permitted. Refer to AMM 07-11-01 for the maximum jack loads permitted.

(5) Find alignment point BK.

(a) Measure and compare the height of point BK to the height specified for point BK above WL 148.70 in Fuselage Alignment Points, Figure 4/GENERAL.

1) If you do not get the height specified in Table A for point BK, adjust the support structure at STA 1016.

a) Make sure the jacks at jack points A, B, and C stay in position.

b) Make sure the load at each jack point is not more than is permitted. Refer to AMM 07-11-01 for the maximum jack loads permitted.

(6) Find alignment point BM.

(a) Measure and compare the height of point BM to the height specified for point BM above WL 148.70 in Fuselage Alignment Points, Figure 4/GENERAL.

NOTE: If the jack is in position at jack point C, you will not see alignment point BM. To find point BM, you must project the airplane centerline BL 0 on the floor. Hang a plumb bob and cord from point BM and mark the floor where the plumb bob touches it. Another procedure is to install a cord at and between the two auxiliary supports, one at each wing, to find the center at BL 0. Refer to Paragraph 8./GENERAL to find the positions of the auxiliary supports at the wings.

1) If you do not get the height specified in Table A for point BM, add and adjust a support structure at the horizontal stabilizer.

a) Make sure point BK is in alignment.

b) Install the horizontal stabilizer supports at STAB STA 166.3. Refer to Paragraph 9./GENERAL for the procedures.

c) Make sure the jacks at jack points A, B, and C stay in position.

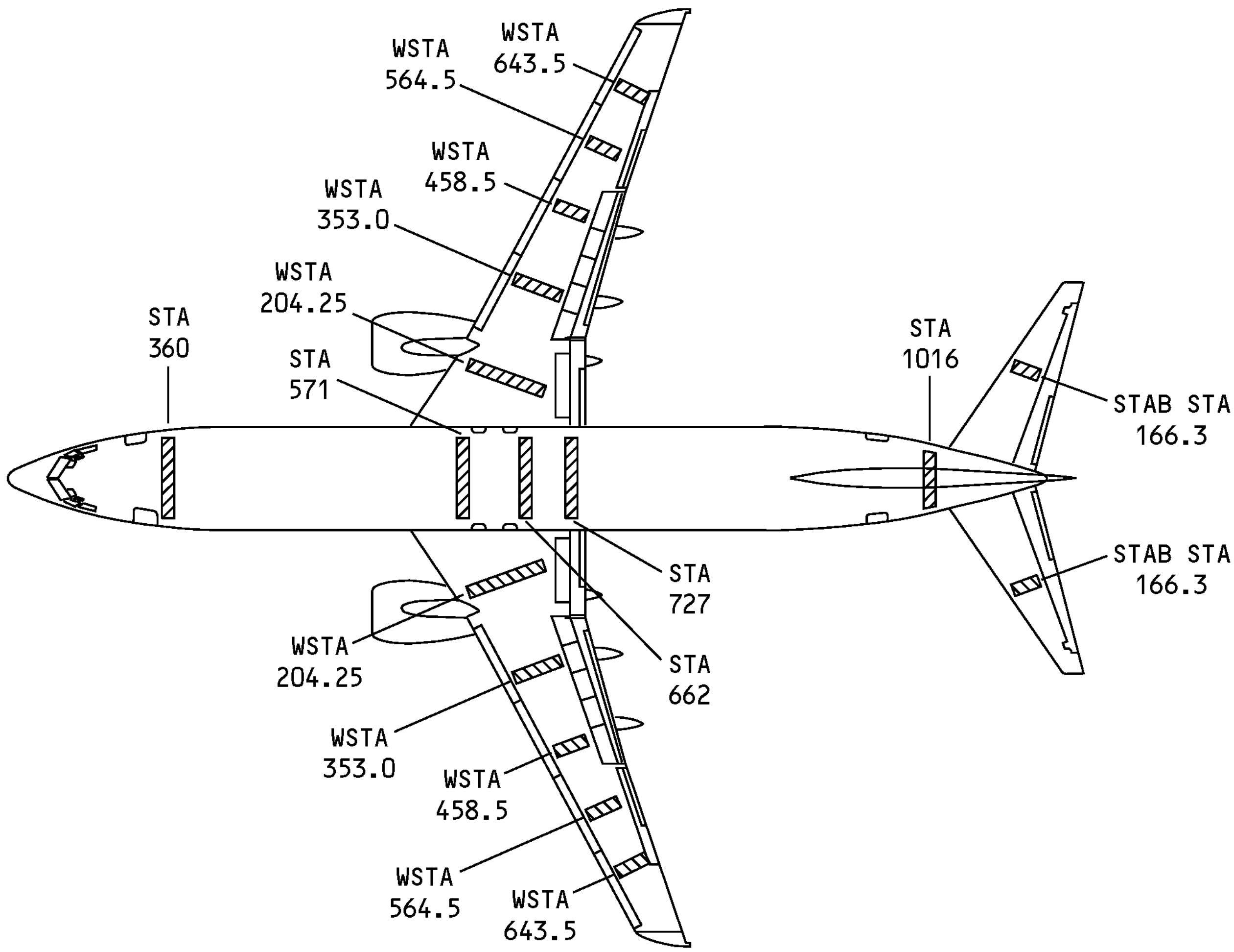
d) Make sure the load at each jack point, is not more than is permitted. Refer to AMM 07-11-01 for the maximum jack loads permitted.

(7) Measure the difference in height between alignment point BF and the reference plane you found in Paragraph 7.B.(3)/GENERAL and (4).

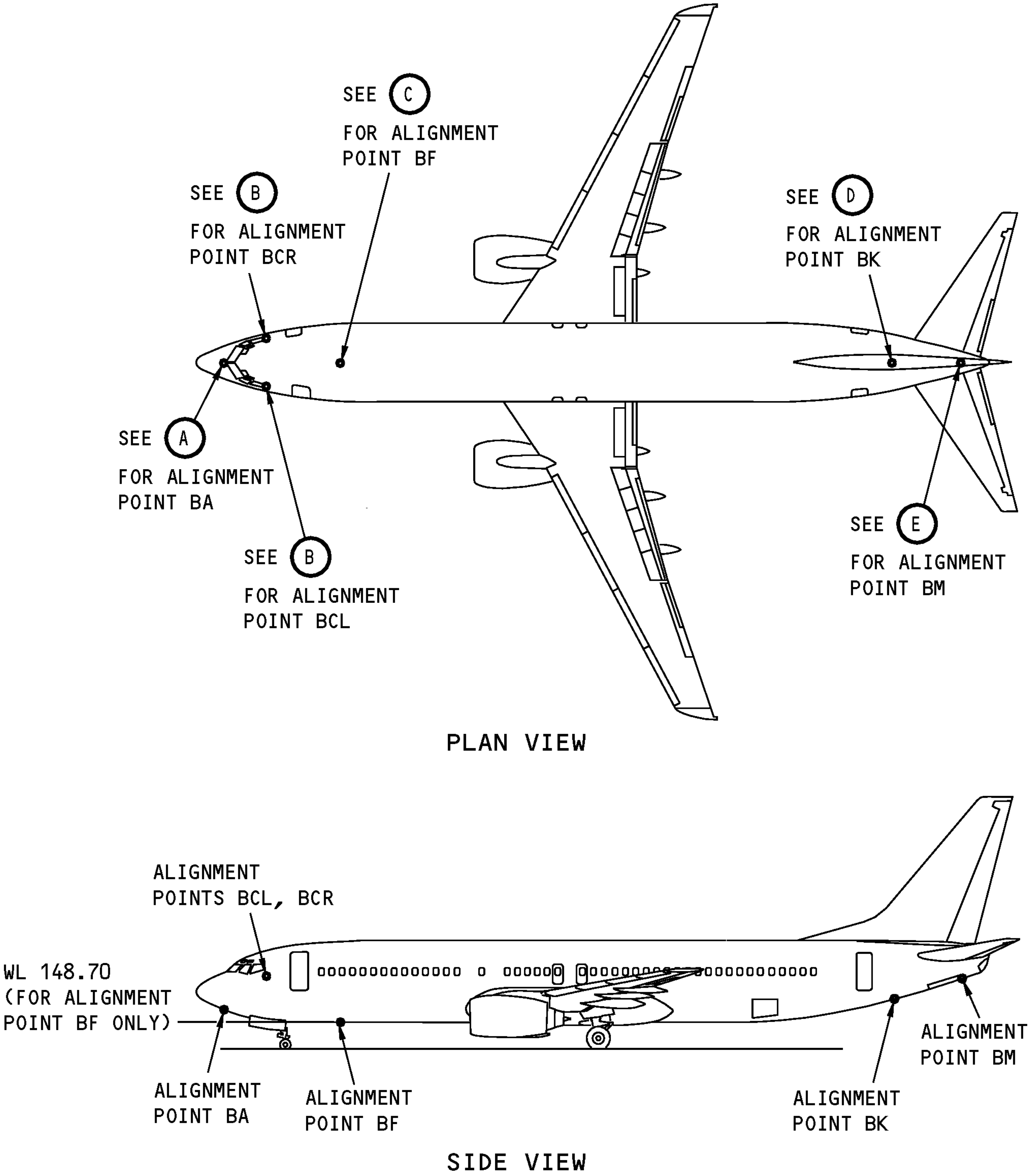
(a) If the dimension is different, then you must do the steps in Paragraph 7.B.(4)/GENERAL through Paragraph 7.B.(7)/GENERAL again.

(b) If the dimension is the same, then inspect alignment points BA, BK, and BM.

1) Make adjustments to the support structures, as necessary, to align the points to the positions specified in Fuselage Alignment Points, Figure 4/GENERAL. Refer to the steps in Paragraph 7.B.(4)/GENERAL through Paragraph 7.B.(7)/GENERAL



Location of Support Structures
Figure 3

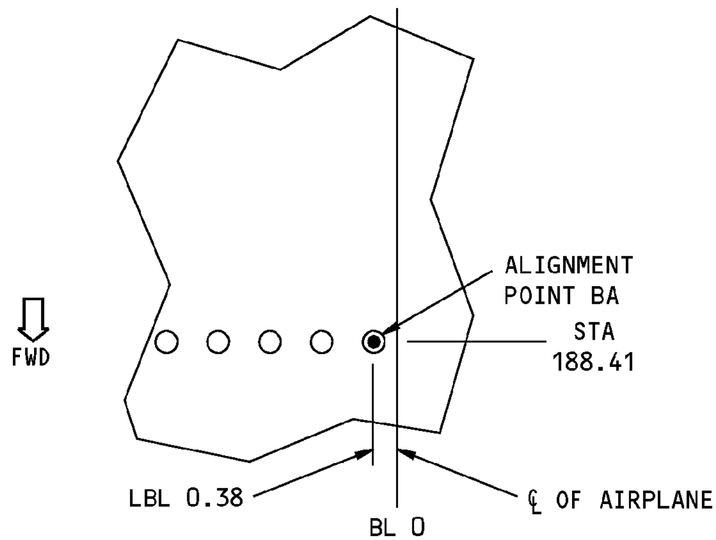


Fuselage Alignment Points
Figure 4 (Sheet 1 of 5)

FUSELAGE ALIGNMENT POINTS					
ALIGNMENT POINT	BODY STATION	BODY BUTTOCK LINE	BODY WATER LINE	HEIGHT ABOVE OR BELOW WATER LINE 148.70 (IN JIG POSITION) INCHES (mm)	
BA	188.41	0.38	170.76	22.06 (560.3)	
BCL/BCR	258.96	50.15	245.56	96.86 (2460.2)	
BF	400.78	6.51	148.70	0.00 (0.0)	DATUM
BK	1014.61	0.00	188.09	39.39 (1000.5)	
BM	1156.60	0.00	229.99	81.29 (2064.5)	

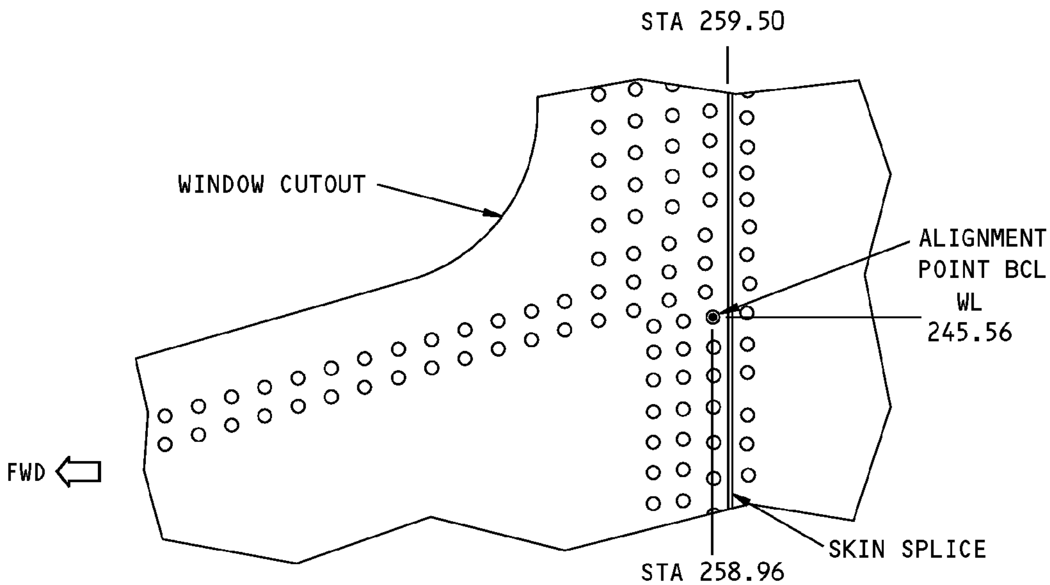
TABLE A

Fuselage Alignment Points
Figure 4 (Sheet 2 of 5)



BOTTOM VIEW OF THE FUSELAGE - ALIGNMENT POINT BA

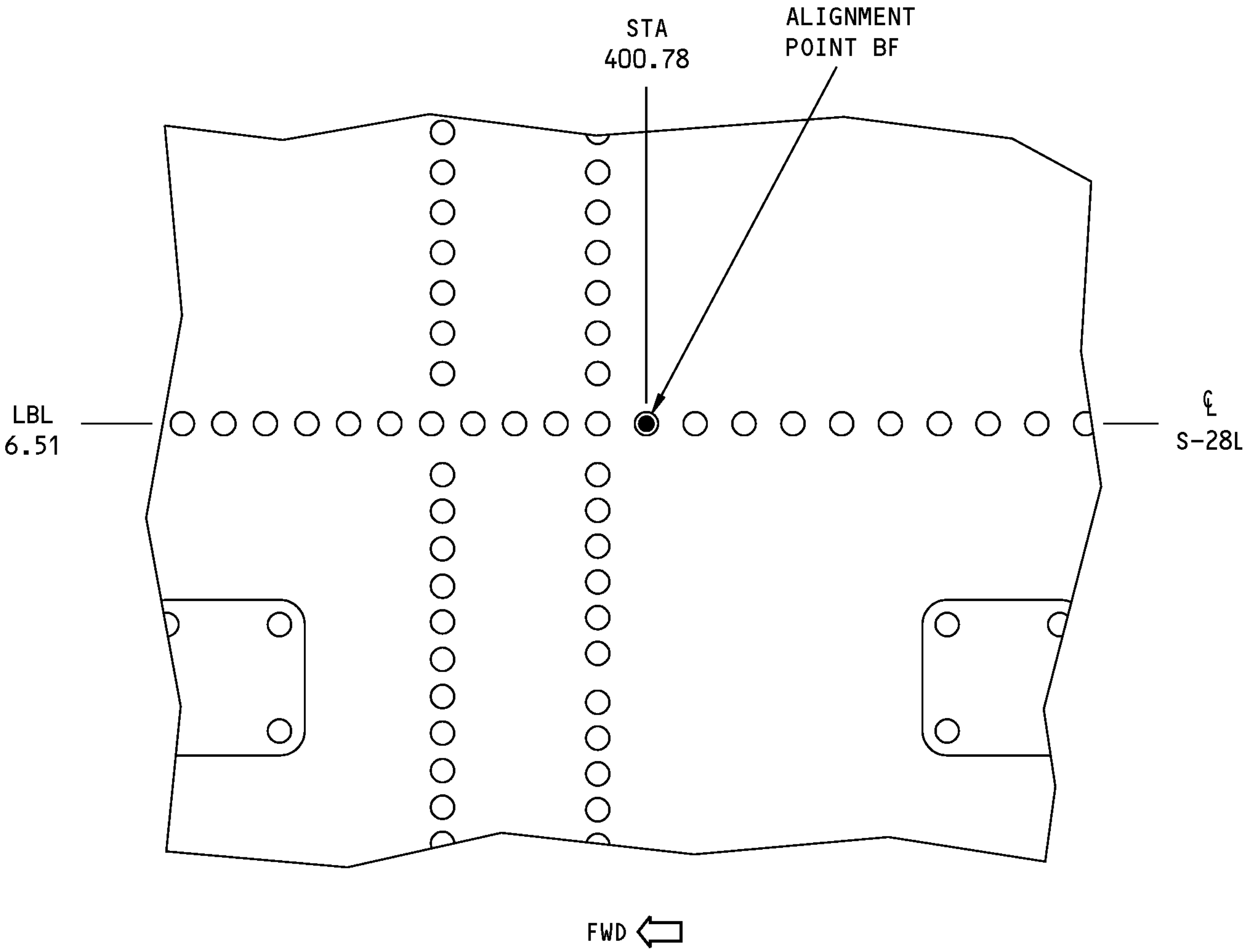
A



LEFT SIDE VIEW OF THE FUSELAGE BELOW THE PILOTS AFT WINDOW (ALIGNMENT POINT BCL IS SHOWN, ALIGNMENT POINT BCR IS ON THE RIGHT RIGHT SIDE OF THE AIRPLANE)

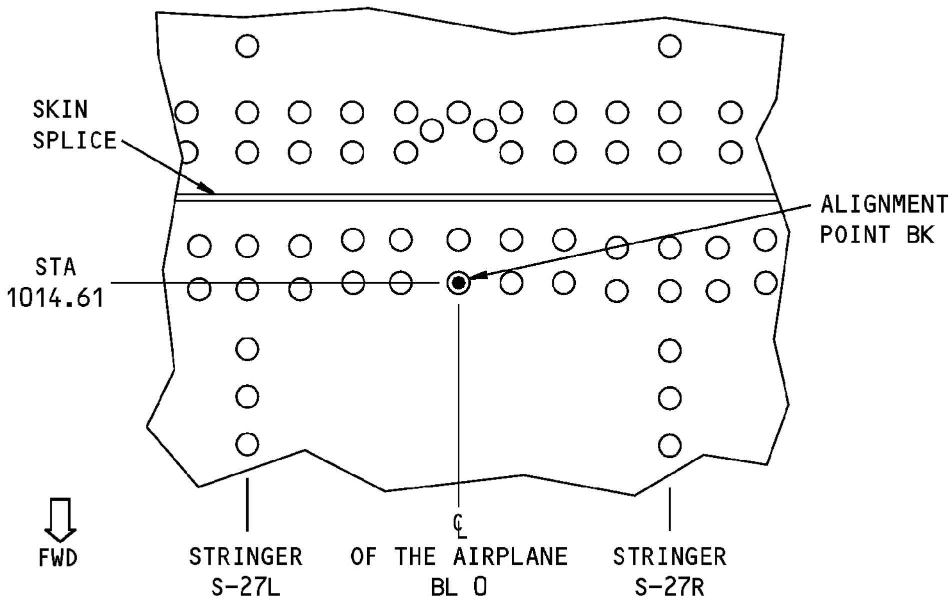
B

Fuselage Alignment Points
Figure 4 (Sheet 3 of 5)



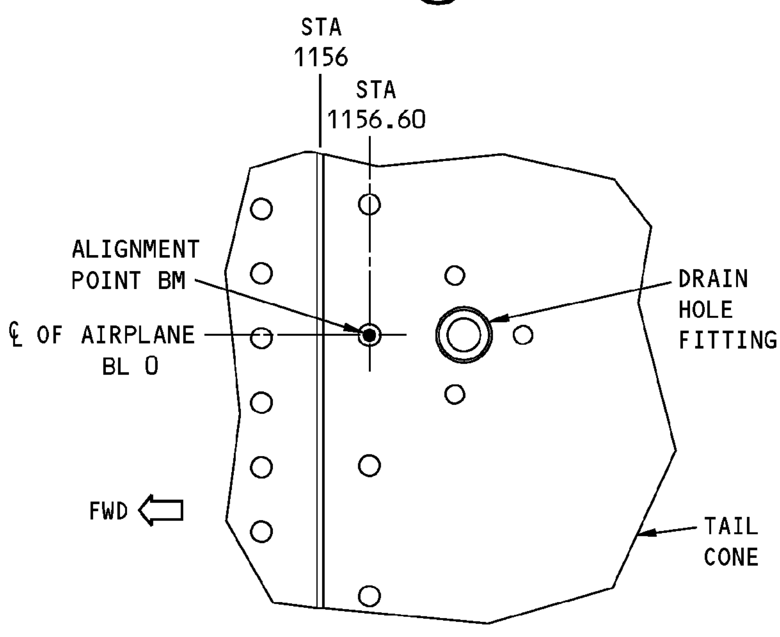
BOTTOM VIEW OF THE FUSELAGE - ALIGNMENT POINT BF
C

Fuselage Alignment Points
Figure 4 (Sheet 4 of 5)



BOTTOM VIEW OF THE FUSELAGE - ALIGNMENT POINT BK

D



BOTTOM VIEW OF THE FUSELAGE - ALIGNMENT POINT BM

E

Fuselage Alignment Points
Figure 4 (Sheet 5 of 5)

8. Support the Wing in a Jig Position

A. Install the cradle support structures for the wing.

(1) Make sure the fuselage of the airplane is in a jig position.

(2) Put the support structures necessary to support the wing into position.

(3) Adjust the support structures under the wings at WSTA 204.25, WSTA 353.0, WSTA 458.5, WSTA 564.5, and WSTA 643.5, as shown in Location of Support Structures, Figure 3/GENERAL.

WARNING: DO NOT PUT A LOAD OF MORE THAN 8,000 POUNDS (3629 KG) ON THE SUPPORT STRUCTURE AT WSTA 204.25. DO NOT PUT A LOAD THAT IS MORE THAN 5,000 POUNDS (2268 KG) ON THE CRADLE AT WSTA 353.0, WSTA 458.5, WSTA 564.5, OR WSTA 643.5. IF YOU DO NOT OBEY, DAMAGE TO THE WING AND THE EQUIPMENT, AND INJURY TO PERSONNEL CAN OCCUR.

CAUTION: DO NOT REMOVE THE LOAD FROM THE PRIMARY JACKS, EXCEPT AT POINT C WITH EXTREME CAUTION. IF YOU DO NOT OBEY, YOU WILL PUT MORE WEIGHT ON THE CRADLES THAN IS PERMITTED, AND DAMAGE TO THE AIRPLANE STRUCTURE CAN OCCUR. REFER TO AMM 07-11-01 FOR THE MAXIMUM LOADS PERMITTED.

(4) Move and align the support structures against the wings.

(5) If you make a repair around the engine strut attach structure, it can be necessary to remove the engine from the strut. Refer to AMM 71-00-02 for the engine removal procedure, or do as follows:

(a) Support the engine with a cradle support structure. Refer to AMM 71-00-02 for the procedures.

(b) Remove the base you used to move the airplane into the work area.

(c) Put the load cell and jack into position as shown in Jacking Equipment - Engine Support, Figure 5/GENERAL.

(d) Apply 8,700 pounds (4.3 tons) (3946 kg) of pressure to the jack.

(e) Remove the engine. Refer to AMM 71-00-02 for the procedures.

B. Adjust the support structures under the wing to transmit part of the load that is on the jacks.

(1) Make sure:

(a) All other support structures are in position.

(b) All loads are not more than is permitted for each support structure.

(c) You do so with extreme caution.

C. Align the wings.

(1) Find alignment points.

(a) Refer to Wing Alignment Points, Figure 6/GENERAL for the alignment point locations on the wings.

(2) Find alignment points WE and use it as your datum point.

(3) Align a horizontal reference plane with WL 180.17 a small distance below the wing skin surface at point WE.

(a) Use a leveling scale, or equivalent.

(b) Make a record of the difference in height between the reference plane and point WE.

NOTE: You will use this height difference to make sure that the positions you find for the other alignment points are as specified. Refer to Wing Alignment Points, Figure 6/GENERAL for the positions specified for the alignment points. If the height difference you found is the same after you adjust the wings for the other alignment points, then it is not necessary to adjust the points. If the height difference has changed, then you must adjust the alignment points again.

(4) Find alignment point WA.

(a) Measure and compare the height of points WA to the height specified for these points above WL 180.17 in Wing Alignment Points, Figure 6/GENERAL.

1) If you do not get the height specified in Table A for point WA, adjust the support structure at WBL 157.

a) Make sure the jacks at jack points A, B, and C stay in position.

b) Make sure the load at each jack point, is not more than is permitted. Refer to AMM 07-11-01 for the maximum loads permitted.

(5) Find alignment points WB and WF, and adjust as necessary.

(a) Measure and compare the heights of points WB and WF to the heights specified for these points above WL 180.17 in Wing Alignment Points, Figure 6/GENERAL.

1) If you do not get the heights specified in Table A for WB and WF, adjust the support structure at WSTA 353.0.

(6) Find alignment points WC, WG, WD, and WH.

(a) Measure and compare the heights of the points WC, WG, WD, and WH to the heights specified for these points above WL 180.17 in Wing Alignment Points, Figure 6/GENERAL.

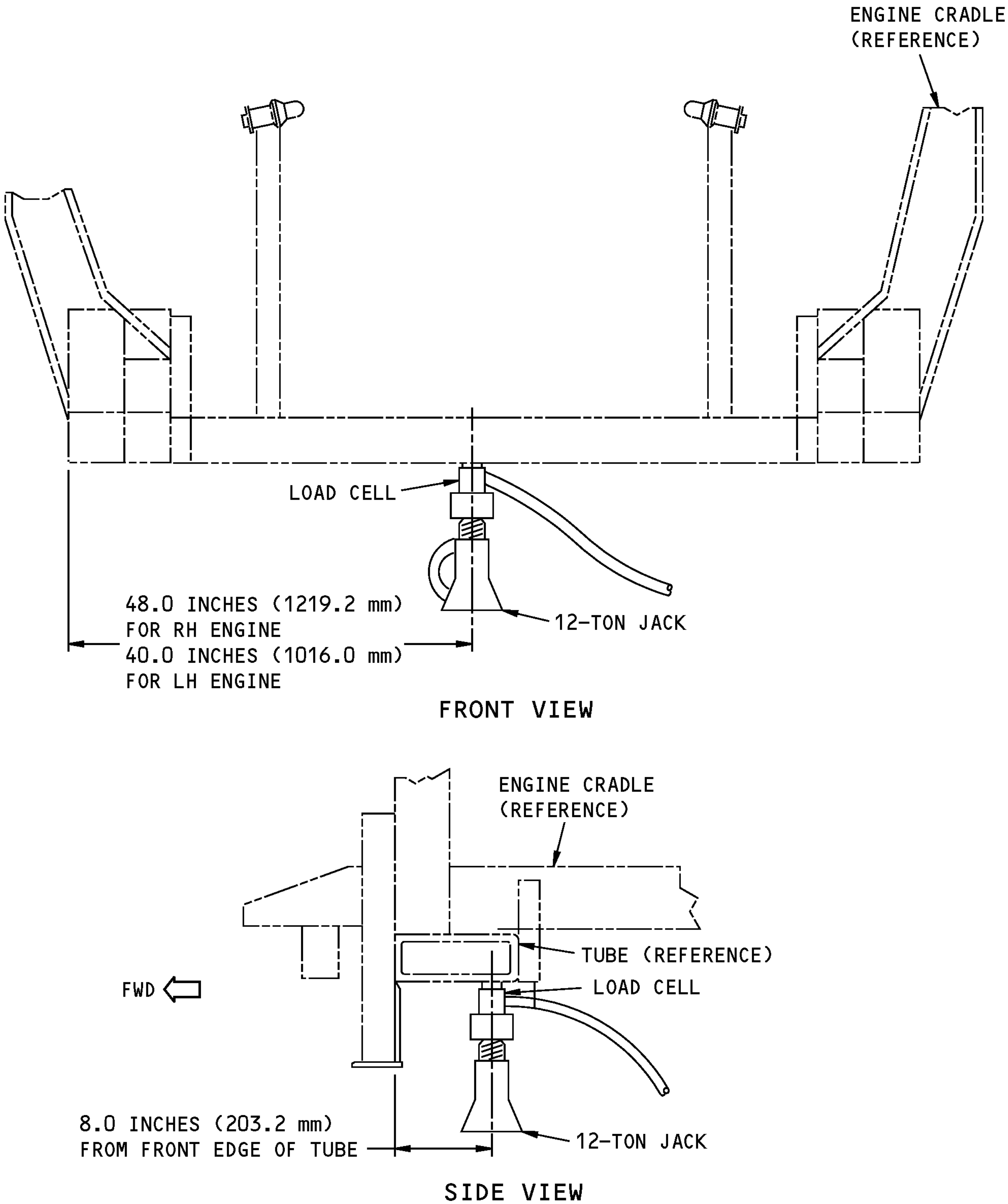
1) If you do not get the heights specified for WC, WG, WD, and WH, adjust the support structure at WSTA 458.5 and WSTA 643.5.

(7) Measure the difference in height between alignment point WE and the reference plane you found on Paragraph 8.C.(2)/GENERAL and (3).

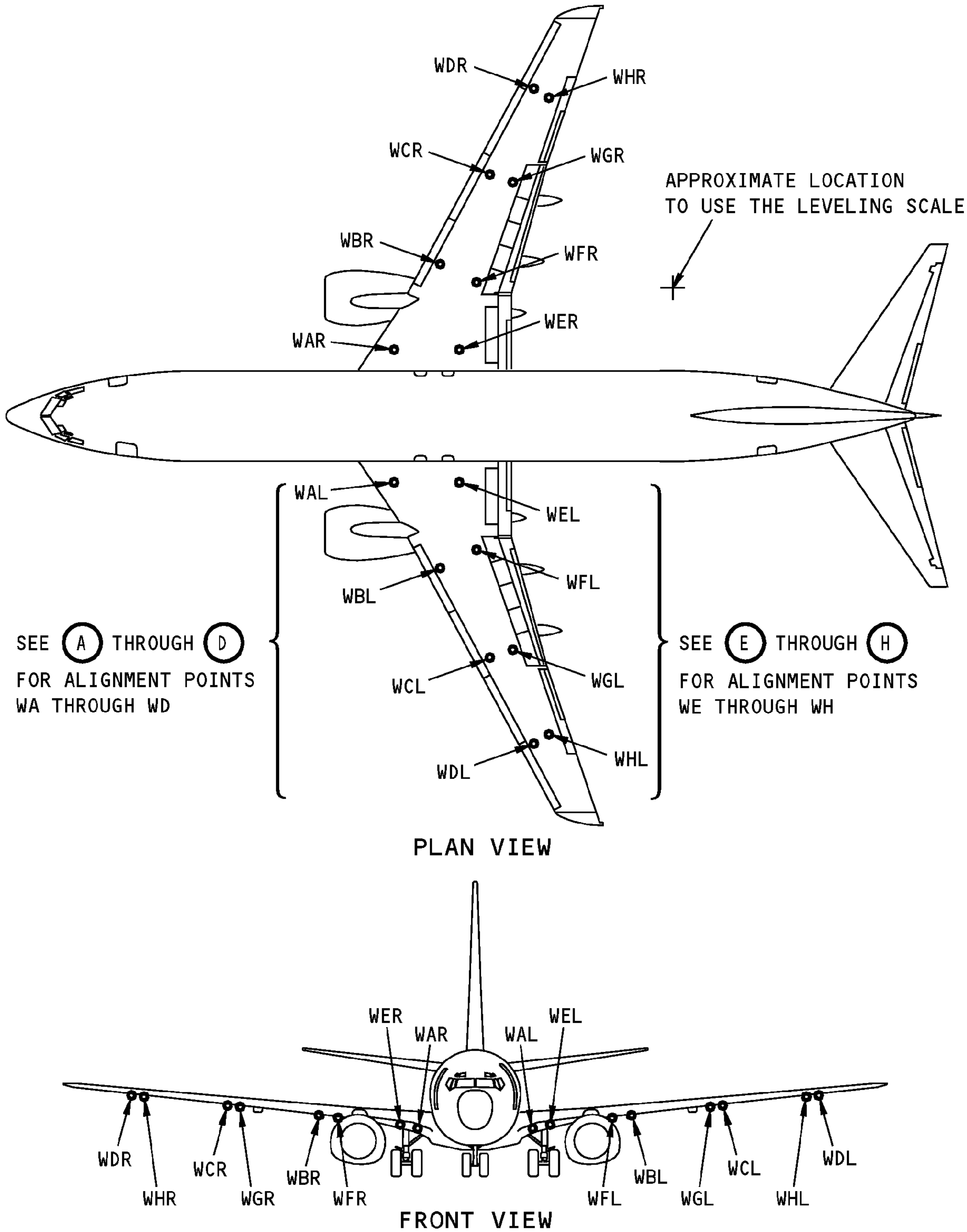
(a) If the dimension is different, then you must do the steps in Paragraph 8.C./GENERAL again.

(b) If the dimension is the same, then inspect all of the alignment points.

1) Make adjustments to the support structure, as necessary, to align the points to the positions specified in Wing Alignment Points, Figure 6/GENERAL. Refer to the steps in Paragraph 8.C.(3)/GENERAL through (7).



Jacking Equipment - Engine Support
Figure 5



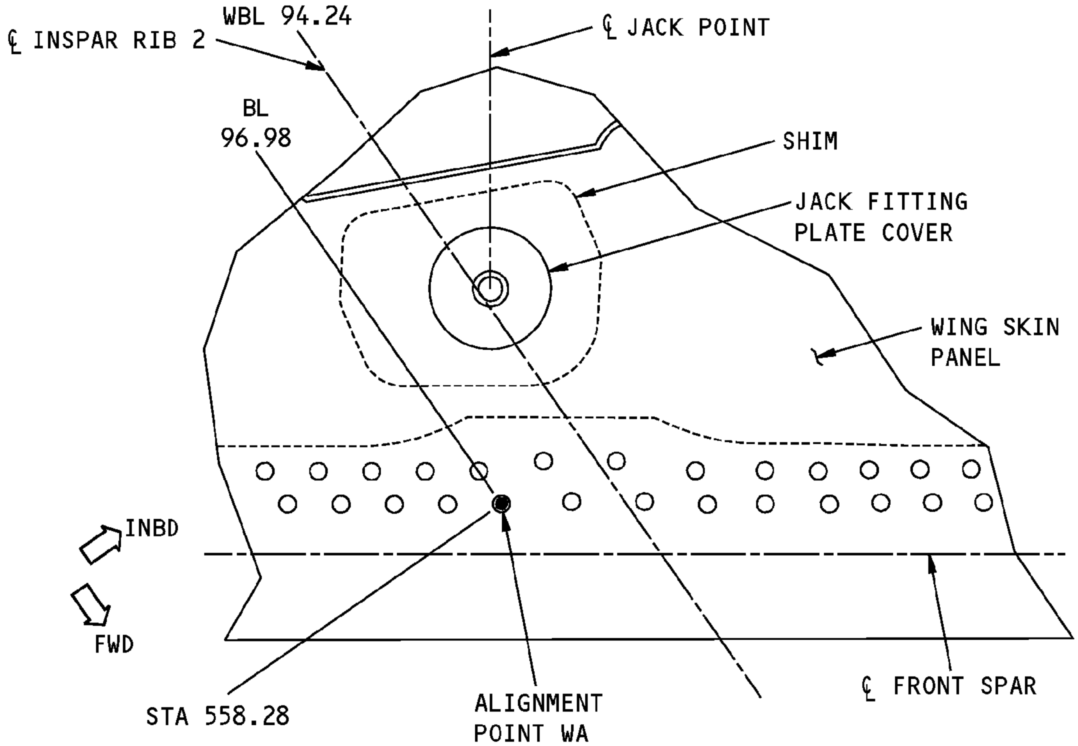
Wing Alignment Points
Figure 6 (Sheet 1 of 6)

WING ALIGNMENT POINTS					
ALIGNMENT POINT	BODY STATION	BODY BUTTOCK LINE	BODY WATER LINE	HEIGHT ABOVE OR BELOW WATER LINE 180.17 (IN JIG POSITION) INCHES (mm)	
WAL/WAR	558.28	±96.98	177.16	-3.01 (-76.5)	
WBL/WBR	650.15	±251.65	202.85	22.68 (576.1)	
WCL/WCR	727+0.78	±398.44	218.44	38.27 (972.1)	
WDL/WDR	727C+15.48	±540.37	233.06	52.89 (1343.4)	
WEL/WER	676.12	±117.45	180.17	0.00 (0.0)	DATUM
WFL/WFR	714.57	±221.19	198.49	18.32 (465.3)	
WGL/WGR	727B+7.46	±381.07	216.79	36.62 (930.1)	
WHL/WHR	730.29	±529.62	232.23	52.06 (1322.3)	

TABLE A

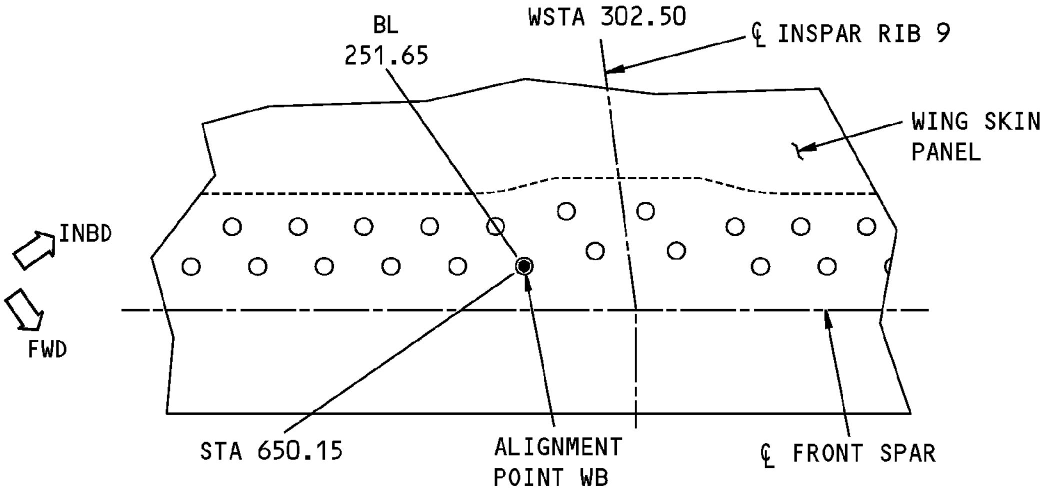
NOTE: THE WING ALIGNMENT POINTS ARE LOCATED ON THE LOWER SKIN SURFACES.

Wing Alignment Points
Figure 6 (Sheet 2 of 6)



BOTTOM VIEW OF WING - ALIGNMENT POINT WA

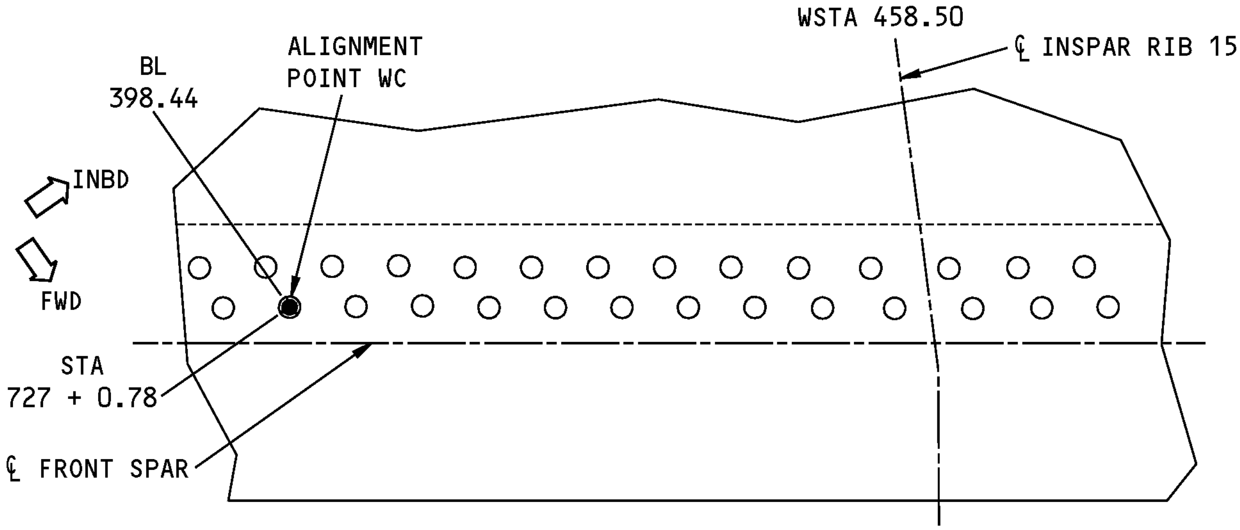
A



BOTTOM VIEW OF WING - ALIGNMENT POINT WB

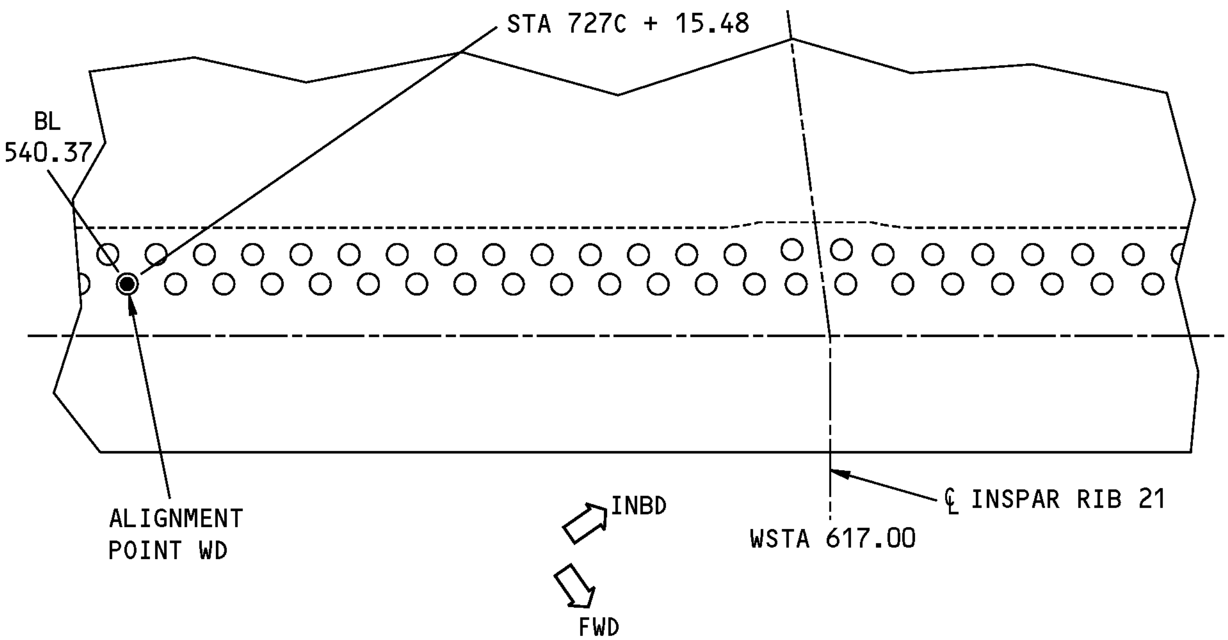
B

Wing Alignment Points
Figure 6 (Sheet 3 of 6)



BOTTOM VIEW OF WING - ALIGNMENT POINT WC

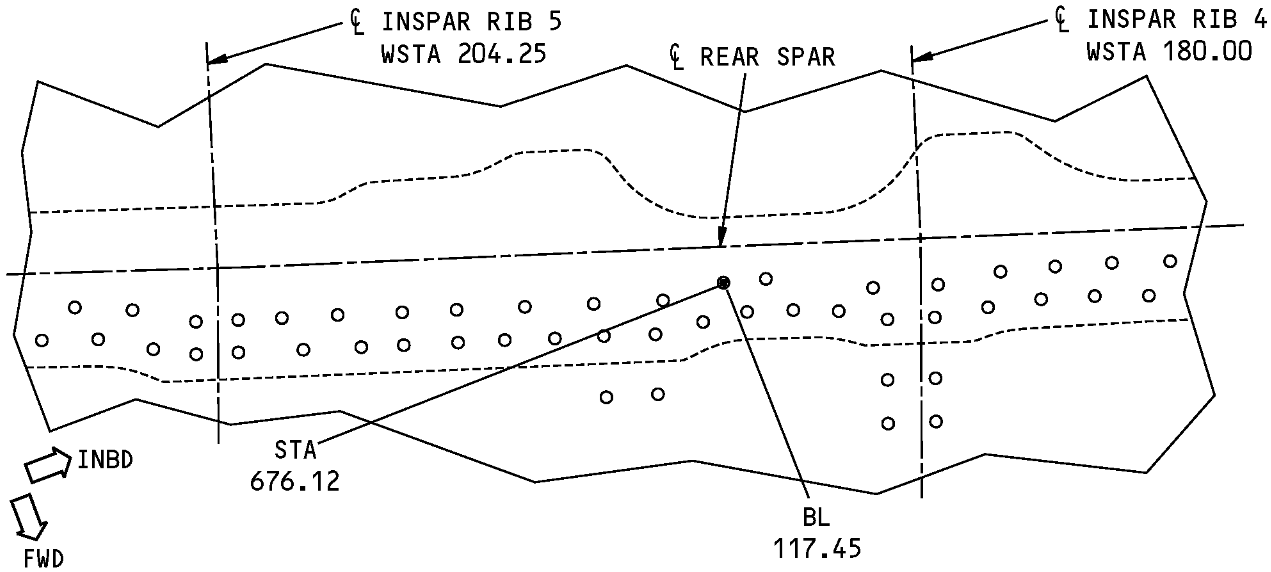
C



BOTTOM VIEW OF WING - ALIGNMENT POINT WD

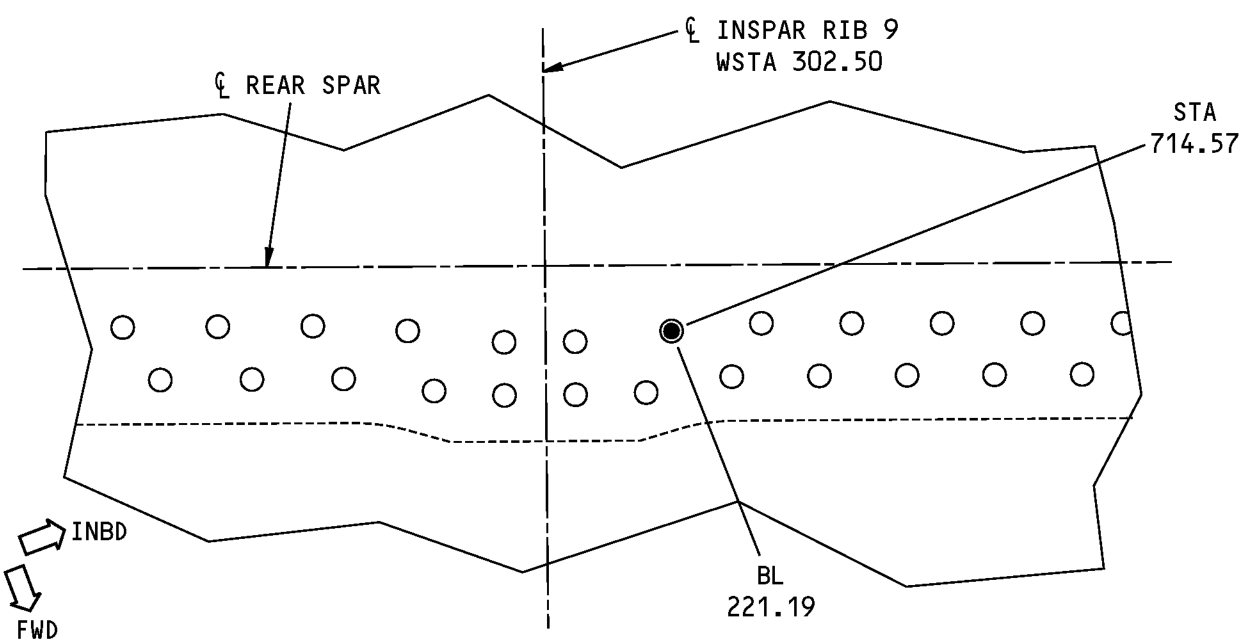
D

Wing Alignment Points
Figure 6 (Sheet 4 of 6)



BOTTOM VIEW OF WING - ALIGNMENT POINT WE

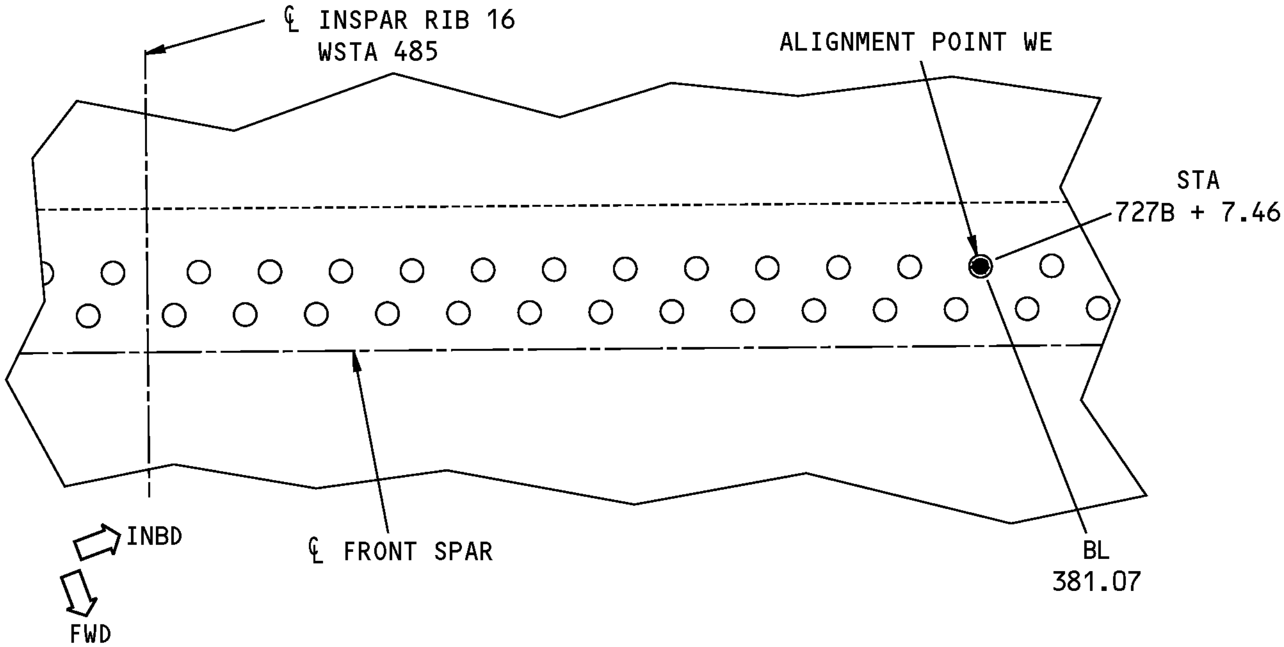
E



BOTTOM VIEW OF WING - ALIGNMENT POINT WF

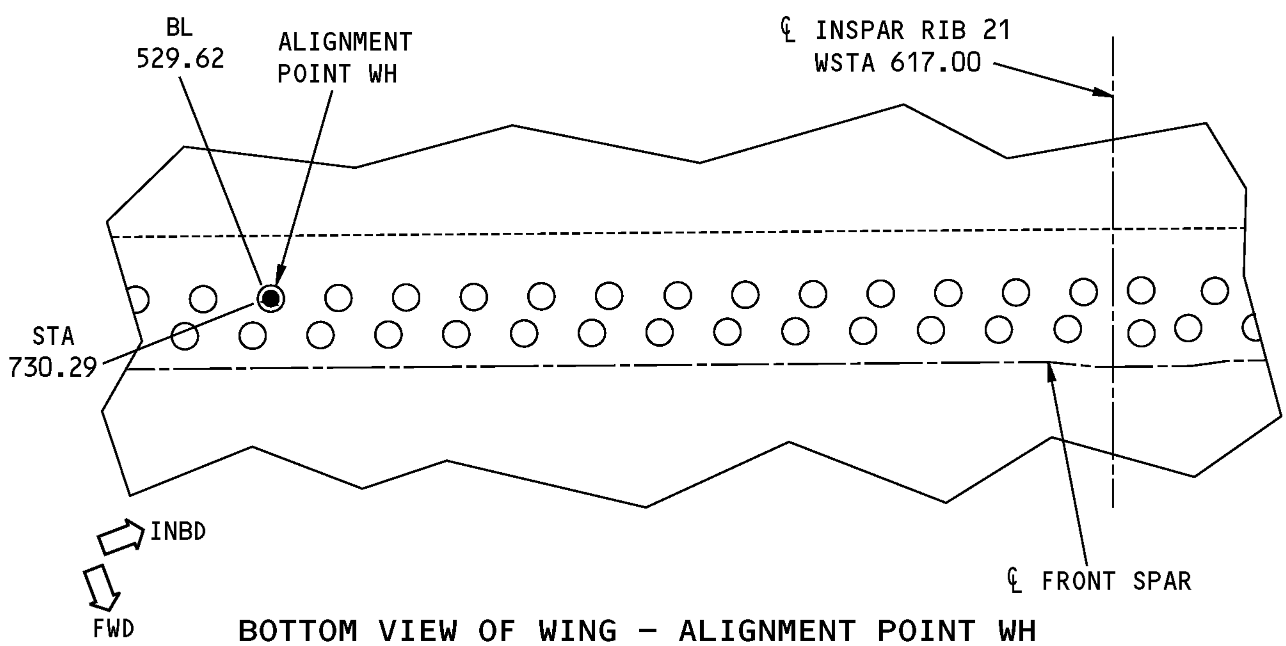
F

Wing Alignment Points
Figure 6 (Sheet 5 of 6)



BOTTOM VIEW OF WING - ALIGNMENT POINT WG

G



BOTTOM VIEW OF WING - ALIGNMENT POINT WH

H

Wing Alignment Points
Figure 6 (Sheet 6 of 6)

9. **Support the Horizontal Stabilizer in a Jig Position**

A. Install the cradle support structures for the horizontal stabilizer.

(1) Make sure the fuselage and wing are in jig positions.

(2) Put the support structures necessary to support the horizontal stabilizer into position.

(3) Adjust the support structures under the horizontal stabilizers at STAB STA 166.3 as shown in Location of Support Structures, Figure 3/GENERAL.

NOTE: You must adjust the support structure under the left and right stabilizers at the same time.

WARNING: DO NOT PUT A LOAD OF MORE THAN 500 POUNDS (227 KG) ONTO THE SUPPORT STRUCTURES. IF YOU DO NOT OBEY, DAMAGE TO THE HORIZONTAL STABILIZER AND THE EQUIPMENT, AND INJURY TO PERSONNEL CAN OCCUR.

CAUTION: DO NOT REMOVE THE LOAD FROM THE PRIMARY JACKS, EXCEPT AT POINT C WITH EXTREME CAUTION. IF YOU DO NOT OBEY, YOU WILL PUT MORE WEIGHT ON THE CRADLES THAN IS PERMITTED, AND DAMAGE TO THE AIRPLANE STRUCTURE CAN OCCUR. REFER TO AMM 07-11-01 FOR THE MAXIMUM LOADS PERMITTED.

(4) Move and align the support structures against the horizontal stabilizers.

B. Adjust the support structures under the horizontal stabilizers.

(1) Make sure:

(a) All other supports are in position.

(b) All loads are not more than is permitted for each support.

(c) You do so with extreme caution.

C. Align the horizontal stabilizers.

(1) Refer to Stabilizer Alignment Points, Figure 7/GENERAL for the alignment points on the horizontal stabilizer.

(2) Find alignment points HLB on each stabilizer and use as your datum point.

(3) Align a horizontal reference plane with WL 270.96 a small distance below the lower skin surface at alignment point HLB on each stabilizer.

(a) Use a leveling scale, or equivalent.

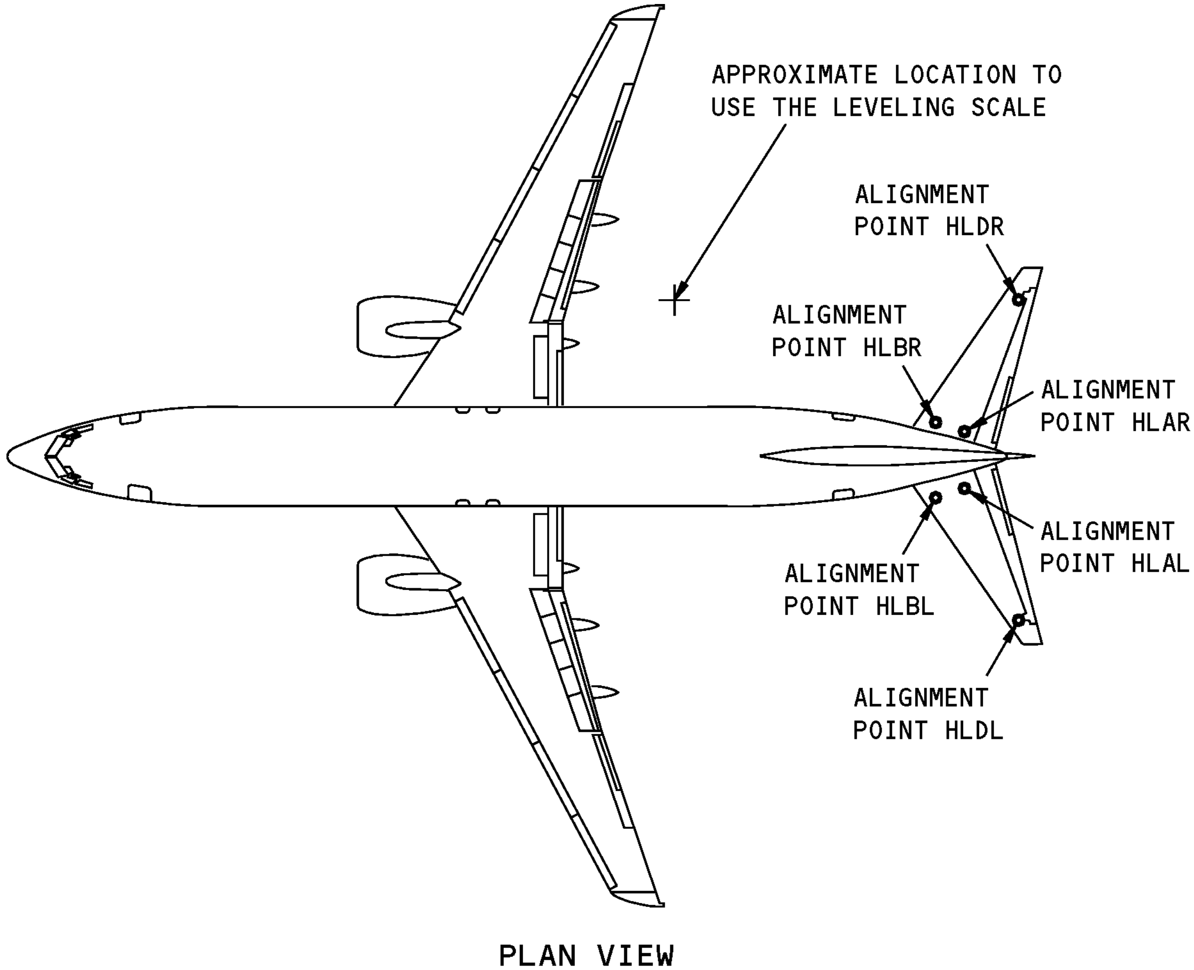
(b) Make a record of the difference in height between the reference plane and alignment point HLB.

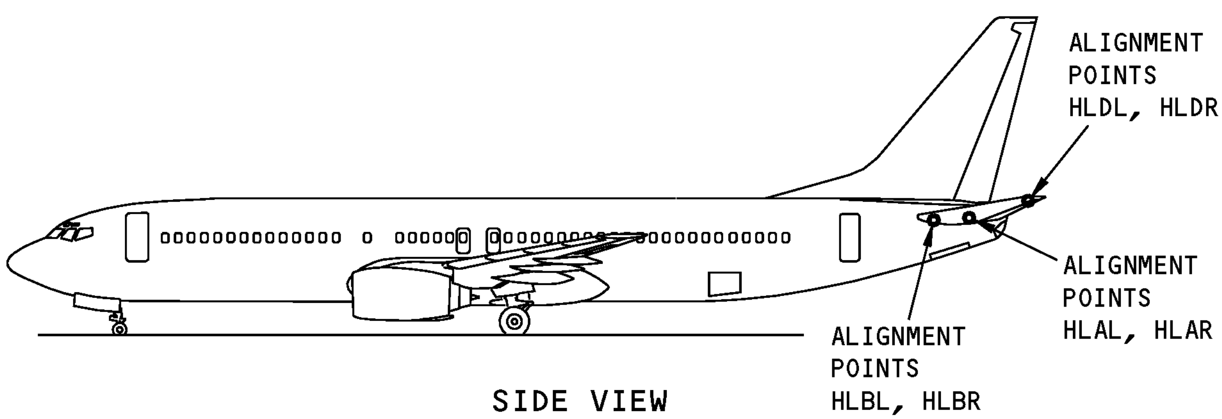
NOTE: You will use this height difference to make sure that the positions you find for the other alignment points are as specified. Refer to Stabilizer Alignment Points, Figure 7/GENERAL for the positions specified for the alignment points. If the height difference you found is the same after you set the other alignment points HLA and HLD, then you do not need to adjust the points. If the height difference changes after you set the other alignment points HLA and HLD, then you must adjust those points as specified. If you make a repair to only one stabilizer, it is not necessary for the other stabilizer to be in exact alignment.

(4) Find alignment points HLA and HLD.

(a) Measure and compare the heights of points HLA and HLD to the heights specified for these points above WL 270.96 in Stabilizer Alignment Points, Figure 7/GENERAL.

(b) If you do not get the heights specified in Table A for HLA and HLD, adjust the support structures at STAB STA 166.3.

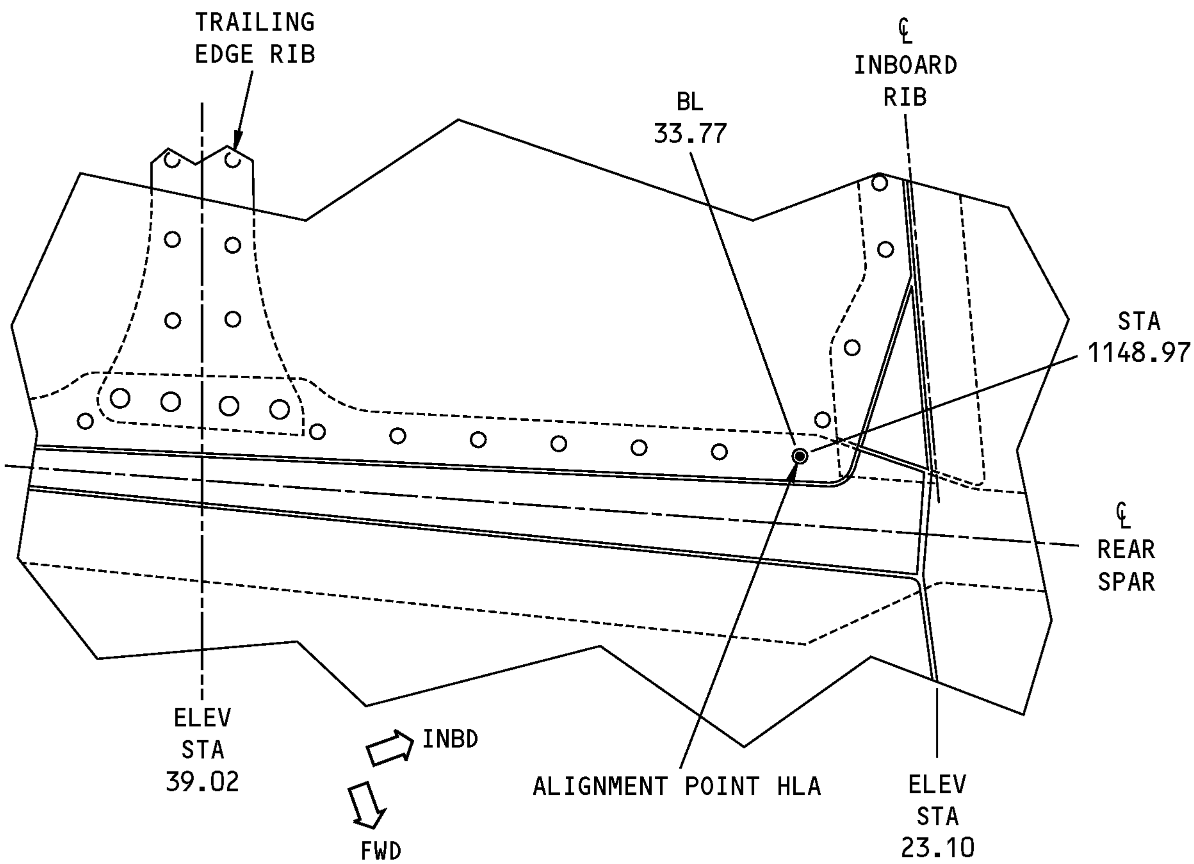




Stabilizer Alignment Points
Figure 7 (Sheet 1 of 3)

STABILIZER ALIGNMENT POINTS (REFER TO DRAWING 016A1001)					
ALIGNMENT POINT	BODY STATION	BODY BUTTOCK LINE	BODY WATER LINE	HEIGHT ABOVE OR BELOW WATER LINE 270.96 (IN JIG POSITION) INCHES (mm)	
HLAL/HLAR	1148.97	±33.77	265.91	-5.05 (-128.3)	
HLBL/HLBR	1100.07	±53.03	270.96	0.00 (0.0)	DATUM
HLDL/HLDR	1239.65	±235.47	297.51	26.55 (674.4)	

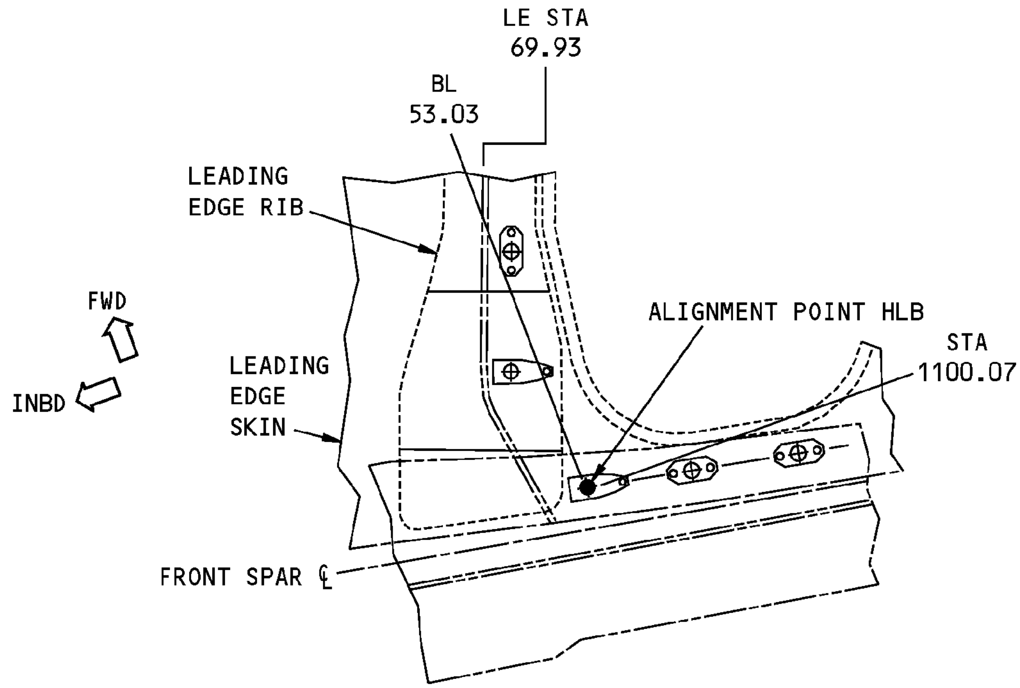
TABLE A



BOTTOM VIEW OF STABILIZER - ALIGNMENT POINT HLA

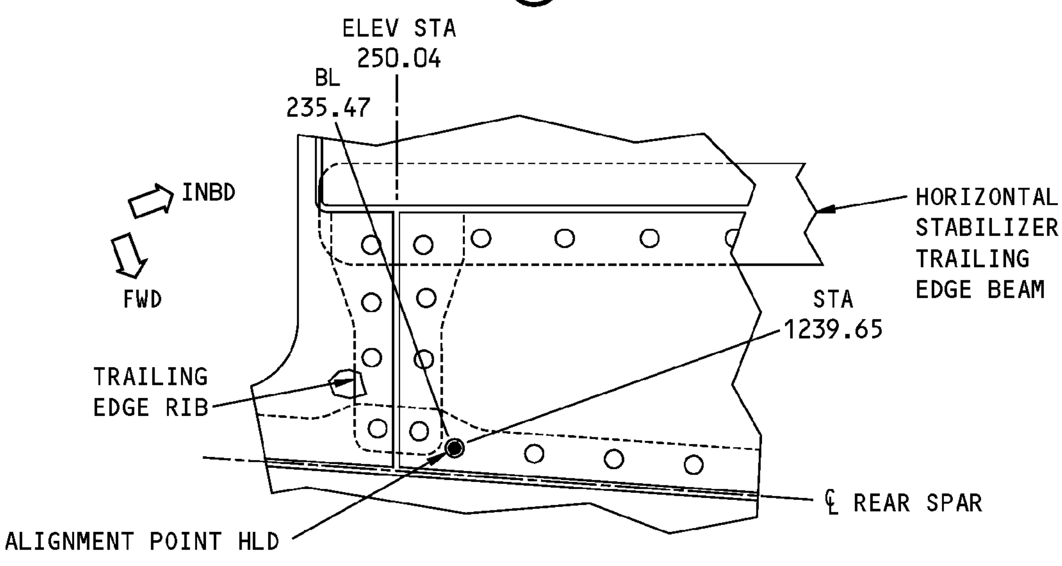
A

Stabilizer Alignment Points
Figure 7 (Sheet 2 of 3)



BOTTOM VIEW OF THE HORIZONTAL STABILIZER – ALIGNMENT POINT HLB

B



BOTTOM VIEW OF THE HORIZONTAL STABILIZER – ALIGNMENT POINT HLD

C

Stabilizer Alignment Points
Figure 7 (Sheet 3 of 3)

10. Do the Repairs

WARNING: YOU MUST PUT THE FUSELAGE, WINGS, AND HORIZONTAL STABILIZER IN THE JIG POSITIONS BEFORE YOU DO A MAJOR STRUCTURAL REPAIR. IF YOU DO NOT OBEY, THE AIRPLANE WILL NOT BE STABLE AND MOVEMENT OF THE STRUCTURES CAN OCCUR. IF THIS HAPPENS, DAMAGE TO THE AIRPLANE STRUCTURE AND EQUIPMENT, AND INJURY TO PERSONNEL CAN OCCUR.

A. Make sure the airplane structure does not change positions or move when you do a repair.

(1) Inspect the alignment of the applicable structure, jacks, and supports at intervals during a repair.

(2) Adjust the alignment points as necessary.

(a) For the fuselage, do the steps given in Paragraph 7.B.(5)/GENERAL through Paragraph 7.B.(7)/GENERAL

(b) For the wings, do the steps given in Paragraph 8.C.(4)/GENERAL through Paragraph 8.C.(7)/GENERAL

(c) For the horizontal stabilizer, do the steps given in Paragraph 9.C.(5).

11. Remove the Airplane from a Jig Position

A. Remove the tools and equipment from the work area.

B. Install the jack at jack point C, if it was removed.

C. Adjust the jacks at jack points A, B, and C until all of the weight is transmitted to the jacks.

D. Adjust the support structures so you can remove them from under the structures you supported.

E. If the engine was removed, do as follows:

(1) Adjust the load cell and jack away from the engine. Refer to AMM 71-00-02 for the procedures.

(2) Remove the load cell and jack.

(3) Remove the cradle support structure from the engine. Refer to AMM 71-00-02 for the procedures.

F. Remove the support structures from the work area.

G. Remove the airplane from the jacks. Refer to AMM 07-11-01/201 for the procedures.

12. Make the Structures to Support the Airplane in a Jig Position

NOTE: Typical support structures are shown in Fuselage Support Structure, Figure 8/GENERAL through Wing and Horizontal Stabilizer Cradle Support Saddle, Figure 11/GENERAL. Other configurations that are structurally equivalent and have the same load capabilities can be used.

A. Make the support structure.

(1) Refer to Fuselage Support Structure, Figure 8/GENERAL and Fuselage Support Saddle, Figure 9/GENERAL for the fuselage support structure.

(2) Refer to Wing and Horizontal Stabilizer Support Structure, Figure 10/GENERAL and Wing and Horizontal Stabilizer Cradle Support Saddle, Figure 11/GENERAL for the wing and horizontal stabilizer cradle support structure.

(a) Make the saddle.

1) Refer to:

a) Fuselage Support Saddle, Figure 9/GENERAL for the fuselage cradle support saddle.

b) Fuselage Support Saddle, Figure 9/GENERAL for the keel beam saddle.

c) Wing and Horizontal Stabilizer Cradle Support Saddle, Figure 11/GENERAL for the wing and horizontal stabilizer cradle support saddles.

2) Get the materials for the saddle as given in Table 7/GENERAL.

3) Make the cutout for the part [1] body.

a) Refer to Fuselage Support Saddle, Figure 9/GENERAL for the coordinates for the contour of the cutout for the fuselage cradle support saddle.

b) Refer to Fuselage Support Saddle, Figure 9/GENERAL for the dimensions of the keel beam saddle.

c) Refer to Wing and Horizontal Stabilizer Cradle Support Saddle, Figure 11/GENERAL for the coordinates for the contour of the cutout for the wing and horizontal stabilizer cradle support saddles.

4) Assemble the support saddle.

a) Clamp the lumber together, with the contoured edges and the straight edges aligned.

b) Bond the base with a strong adhesive to the straight edge, as necessary.

c) Install carriage bolts that are 3/8 inch in diameter with nuts and washers.

d) Attach the part [3] saddle and part [4] saddle cover over the surface of the [1] body assembly that will touch the airplane.

- Install carriage bolts, that are 1/4 inch in diameter with nuts and washers.

(b) Make the A-Frame type structure.

1) Use four-sided lumber that:

a) Is without knots, shakes, or checks.

b) Has the physical properties equivalent to structural grade douglas fir found in the West Coast part of the USA.

2) When you install the fasteners:

a) Use carriage bolts that are a minimum of 5/16 inch in diameter with nuts and washers.

3) Make the structural base.

NOTE: Make sure the support structure will be of a height that will sufficiently support the applicable structure. Refer to Location of Support Structures, Figure 3/GENERAL for the locations.

a) For the necessary lumber to build the A-Frame support jig, refer to:

- Fuselage Support Structure, Figure 8/GENERAL for the fuselage support structure.
- Wing and Horizontal Stabilizer Support Structure, Figure 10/GENERAL for the wing and horizontal stabilizer cradle support structure.

b) Put the jack screws on the A-Frame structure.

c) Assemble the cradle or keel beam saddle and the A-Frame structure.

d) Move the support structure underneath the airplane structure that will be supported.

e) Adjust the jack screws as necessary to put the cradle or keel beam saddle against the airplane structure.
   - If the cradle or keel beam saddle does not touch the airplane structure, it will be necessary to adjust the dimensions or replace the lumber for the base.

(3) As necessary, make the alternative or cribbing type structure as shown in Fuselage Support Structure, Figure 8/GENERAL thru Wing and Horizontal Stabilizer Cradle Support Saddle, Figure 11/GENERAL.

Table 3:

FUSELAGE SUPPORT SADDLE COORDINATES FOR THE CONTOUR OF THE CUTOUT IN INCHES (mm)			
STA 360.00 AND STA 727.00		STA 1016	
X (BBL)	Y (BWL)	X (BBL)	Y (BWL)
0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
2.50 (63.50)	0.04 (1.02)	2.50 (63.50)	0.06 (1.52)
5.00 (127.00)	0.17 (4.32)	5.00 (127.00)	0.22 (5.59)
7.50 (190.50)	0.37 (9.40)	7.50 (190.50)	0.49 (12.45)
10.00 (254.00)	0.66 (16.76)	10.00 (254.00)	0.88 (22.35)
12.50 (317.50)	1.04 (26.42)	12.50 (317.50)	1.37 (34.80)
15.00 (381.00)	1.50 (38.1)	15.00 (381.00)	1.99 (50.55)
17.50 (444.50)	2.05 (52.07)	17.50 (444.50)	2.72 (69.09)
20.00 (508.00)	2.70 (68.58)	20.00 (508.00)	3.58 (90.93)
22.50 (571.50)	3.44 (87.38)	22.50 (571.50)	4.57 (116.08)
25.00 (635.00)	4.28 (108.71)	25.00 (635.00)	5.70 (144.78)
27.50 (698.50)	5.22 (132.59)	27.50 (698.50)	6.98 (177.29)
30.00 (762.00)	6.27 (159.26)	30.00 (762.00)	8.41 (213.61)
32.50 (825.50)	7.44 (188.98)	32.50 (825.50)	10.02 (254.51)
35.00 (889.00)	8.72 (221.49)	35.00 (889.00)	11.83 (300.48)
37.50 (952.50)	10.14 (257.56)	37.50 (952.50)	13.85 (351.79)
40.00 (1016.00)	11.69 (296.93)	40.00 (1016.00)	16.11 (409.19)
42.50 (1079.50)	13.40 (340.36)	42.50 (1079.50)	18.67 (474.22)
45.00 (1143.00)	15.27 (387.86)	45.00 (1143.00)	21.58 (548.13)
47.50 (1206.50)	(Y AT STA 360) 17.33 (440.18) (Y AT STA 727) 18.00 (457.20)	47.50 (1206.50)	24.93 (633.22)
50.00 (1270.00)	19.60 (497.84)	50.00 (1270.00)	28.89 (733.81)

Table 4:

WING SADDLE COORDINATES FOR THE CONTOUR OF THE CUTOUT IN INCHES (mm)					
WING STA 204.25		WING STA 353.0		WING STA 458.5	
X	Y	X	Y	X	Y
0.00 (0.00)	5.67 (144.02)	0.00 (0.00)	3.62 (91.95)	0.00 (0.00)	2.37 (60.19)

WING SADDLE COORDINATES FOR THE CONTOUR OF THE CUTOUT IN INCHES (mm)					
WING STA 204.25		WING STA 353.0		WING STA 458.5	
X	Y	X	Y	X	Y
2.50 (63.50)	5.21 (132.33)	2.50 (63.50)	3.27 (83.06)	2.50 (63.50)	2.04 (51.82)
5.00 (127.00)	4.77 (121.16)	5.00 (127.00)	2.92 (74.17)	5.00 (127.00)	1.74 (44.20)
7.50 (190.50)	4.35 (110.49)	7.50 (190.50)	2.60 (66.04)	7.50 (190.50)	1.46 (37.08)
10.00 (254.00)	3.94 (100.08)	10.00 (254.00)	2.29 (58.17)	10.00 (254.00)	1.22 (30.99)
12.50 (317.50)	3.55 (90.17)	12.50 (317.50)	2.01 (51.05)	12.50 (317.50)	0.99 (25.15)
15.00 (381.00)	3.18 (80.77)	15.00 (381.00)	1.74 (44.20)	15.00 (381.00)	0.79 (20.07)
17.50 (444.50)	2.85 (72.39)	17.50 (444.50)	1.49 (37.85)	17.50 (444.50)	0.62 (15.75)
20.00 (508.00)	2.52 (64.01)	20.00 (508.00)	1.26 (32.00)	20.00 (508.00)	0.46 (11.68)
22.50 (571.50)	2.22 (56.39)	22.50 (571.50)	1.05 (26.67)	22.50 (571.50)	0.34 (8.64)
25.00 (635.00)	1.93 (49.02)	25.00 (635.00)	0.86 (21.84)	25.00 (635.00)	0.22 (5.59)
27.50 (698.50)	1.67 (42.42)	27.50 (698.50)	0.69 (17.53)	27.50 (698.50)	0.13 (3.30)
30.00 (762.00)	1.43 (36.32)	30.00 (762.00)	0.54 (13.72)	30.00 (762.00)	0.07 (1.78)
32.50 (825.50)	1.21 (30.73)	32.50 (825.50)	0.40 (10.16)	32.50 (825.50)	0.02 (0.51)
35.00 (889.00)	1.00 (25.4)	35.00 (889.00)	0.28 (7.11)	35.00 889.000)	0.00 (0.00)
37.50 (952.50)	0.82 (20.83)	37.50 (952.50)	0.19 (4.83)	37.50 (952.50)	0.00 (0.00)
40.00 (1016.00)	0.66 (16.76)	40.00 (1016.00)	0.12 (3.05)	40.00 (1016.00)	0.02 (0.51)
42.50 (1079.50)	0.51 (12.95)	42.50 (1079.50)	0.06 (1.52)	42.50 (1079.50)	0.06 (1.52)
45.00 (1143.00)	0.38 (9.65)	45.00 (1143.00)	0.02 (0.51)	45.00 (1143.00)	0.13 (3.30)
47.50 (1206.50)	0.27 (6.86)	47.50 (1206.50)	0.00 (0.00)	47.50 (1206.50)	0.21 (5.33)
50.00 (1270.00)	0.18 (4.57)	50.00 (1270.00)	0.00 (0.00)	50.00 (1270.00)	0.32 (8.13)
52.50 (1333.50)	0.11 (2.79)	52.50 (1333.50)	0.02 (0.51)	52.50 (1333.50)	0.46 (11.68)
55.00 (1397.00)	0.06 (1.52)	55.00 (1397.00)	0.06 (1.52)	53.49 (1358.65)	0.51 (12.95)
57.50 (1460.50)	0.03 (0.76)	57.50 (1460.50)	0.11 (2.79)	55.00 (1397.00)	0.62 (15.75)
60.00 (1524.00)	0.01 (0.25)	60.00 (1524.00)	0.19 (4.83)	—	—
62.50 (1587.50)	0.00 (0.00)	62.50 (1587.50)	0.29 (7.37)	—	—
65.00 (1651.00)	0.00 (0.00)	—	—	—	—
67.50 (1714.50)	0.02 (0.51)	—	—	—	—
70.00 (1778.00)	0.04 (1.02)	—	—	—	—
72.50 (1841.50)	0.08 (2.03)	—	—	—	—
75.00 (1905.00)	0.12 (3.05)	—	—	—	—
77.50 (1968.50)	0.17 (4.32)	—	—	—	—
80.00 (2032.00)	0.22 (5.59)	—	—	—	—
82.50 (2095.50)	0.28 (7.11)	—	—	—	—
85.00 (2159.00)	0.34 (8.64)	—	—	—	—
87.50 (2222.50)	0.41 (10.41)	—	—	—	—

Table 5:

WING SADDLE COORDINATES FOR THE CONTOUR OF THE CUTOUT IN INCHES (mm)			
WING STA 564.50		WING STA 643.50	
X	Y	X	Y
0.00 (0.00)	1.56 (39.62)	0.00 (0.00)	1.00 (25.40)
2.50 (63.50)	1.26 (32.00)	2.50 (63.50)	0.76 (19.30)
5.00 (127.00)	1.00 (25.40)	5.00 (127.00)	0.55 (13.97)
7.50 (190.50)	0.78 (19.81)	7.50 (190.50)	0.37 (9.40)
10.00 (254.00)	0.58 (14.73)	10.00 (254.00)	0.24 (6.10)
12.50 (317.50)	0.41 (10.41)	12.50 (317.50)	0.13 (3.30)
15.00 (381.00)	0.27 (6.86)	15.00 (381.00)	0.05 (1.27)
17.50 (444.50)	0.16 (4.06)	17.50 (444.50)	0.01 (0.25)
20.00 (508.00)	0.08 (2.03)	20.00 (508.00)	0.00 (0.00)
22.50 (571.50)	0.03 (0.76)	22.50 (571.50)	0.01 (0.25)
25.00 (635.00)	0.00 (0.00)	25.00 (635.00)	0.06 (1.52)
27.50 (698.50)	0.00 (0.00)	27.50 (698.50)	0.12 (3.05)
30.00 (762.00)	0.03 (0.76)	30.00 (762.00)	0.20 (5.08)
32.50 (825.50)	0.07 (1.78)	32.50 (825.50)	0.30 (7.62)
35.00 (889.00)	0.14 (3.56)	———	———
37.50 (952.50)	0.22 (5.59)	———	———
40.00 (1016.00)	0.33 (8.38)	———	———
42.50 (1079.50)	0.46 (11.68)	———	———

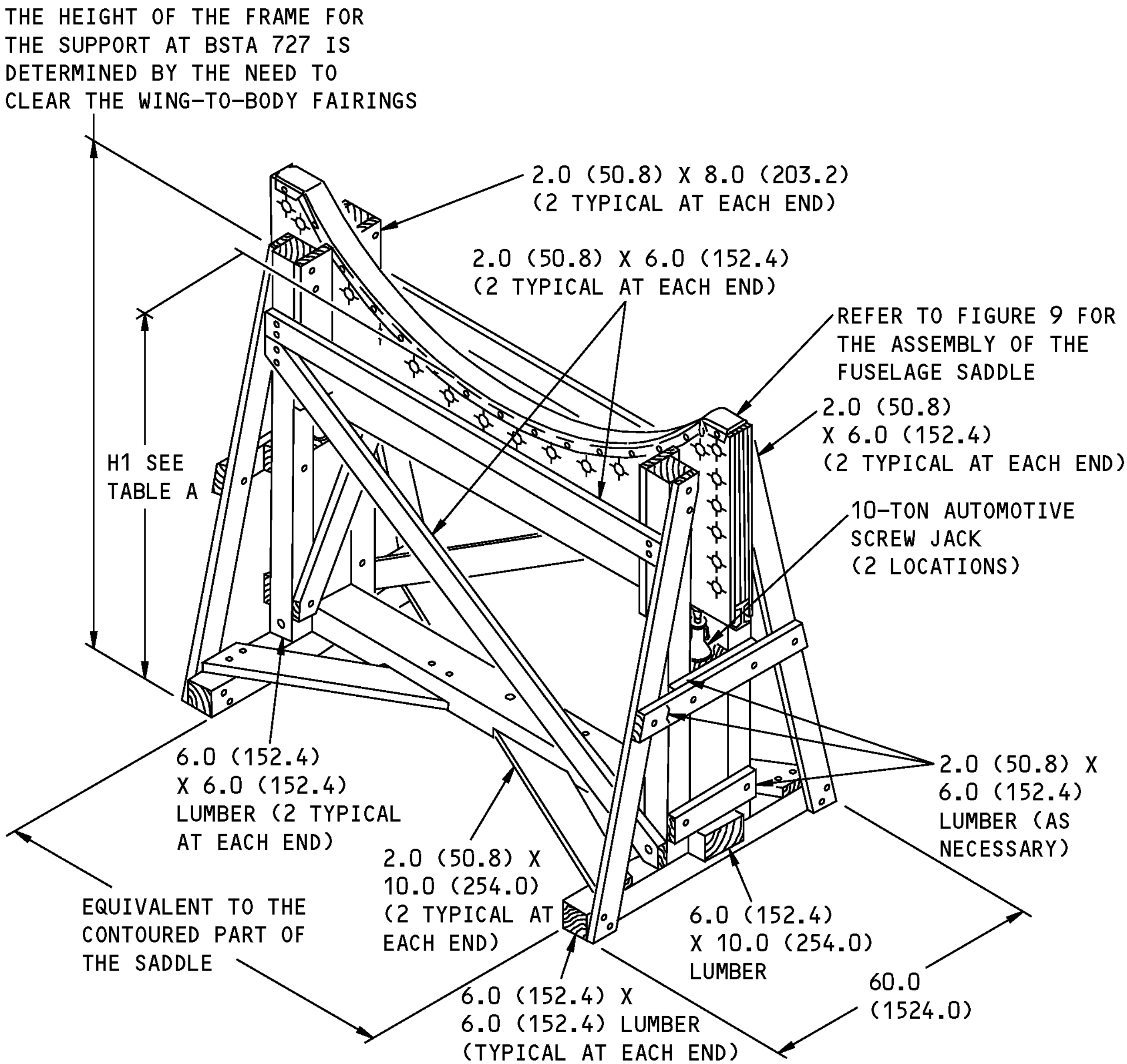
Table 6:

HORIZONTAL STABILIZER SADDLE COORDINATES FOR THE CONTOUR OF THE CUTOUT, INCHES, (mm)	
STAB STA 166.30	
X	Y
0.00 (0.00)	3.85 (97.79)
2.50 (63.50)	3.25 (82.55)
5.00 (127.00)	2.75 (69.85)
7.50 (190.50)	2.32 (58.93)
10.00 (254.00)	1.95 (49.53)
12.50 (317.50)	1.61 (40.89)
15.00 (381.00)	1.30 (33.02)
17.50 (444.50)	1.03 (26.16)
20.00 (508.00)	0.79 (20.06)
22.50 (571.50)	0.59 (14.98)
25.00 (635.00)	0.41 (10.41)

HORIZONTAL STABILIZER SADDLE COORDINATES FOR THE CONTOUR OF THE CUTOUT, INCHES, (mm)	
STAB STA 166.30	
X	Y
27.50 (698.50)	0.27 (6.86)
30.00 (762.00)	0.16 (4.06)
32.50 (825.50)	0.08 (2.03)
35.00 (889.00)	0.02 (0.51)
37.50 (952.50)	0.00 (00.00)
40.00 (1016.00)	0.02 (0.02)

Table 7:

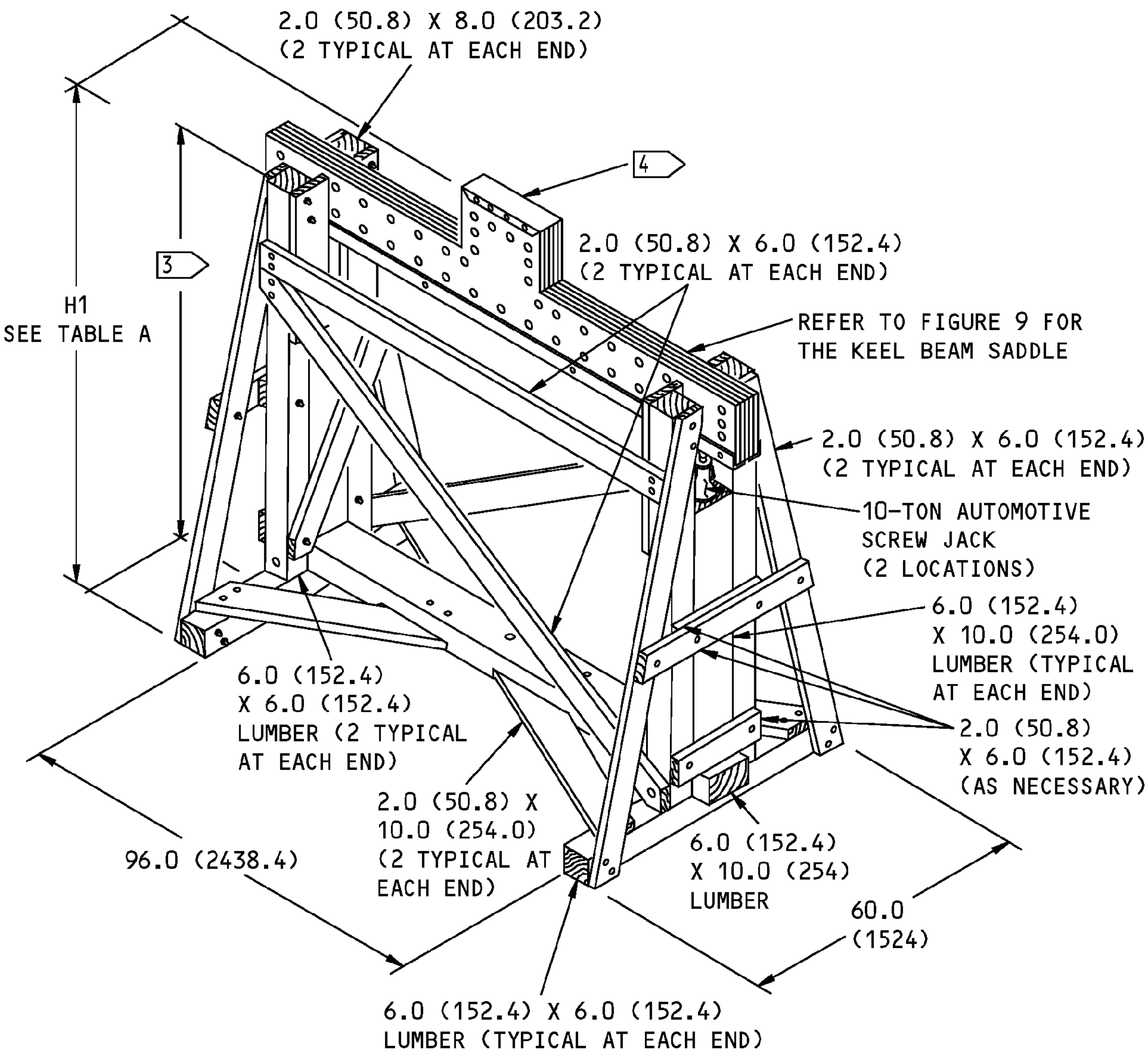
MATERIALS FOR THE SUPPORT SADDLE			
ITEM	DESCRIPTION	QUANTITY	MATERIAL
[1]	Body	5	Use 1.0 inch (25.4 mm) exterior plywood board that is grade AB or better
[2]	Base	1	Use a structural steel I-beam
[3]	Saddle Pad	1	Use a rubber mat that has a durometer rating of 50 to 60. It is optional to use a felt mat that is a minimum of 0.50 inch (12.70 mm) thick
[4]	Saddle Cover	1	Use canvas duck that has a weight of approximately 10 ounces (283.5 grams) to one square foot (929 square centimeters)
[5]	Base (Alternate Saddle)	1	Use a 6 X 16 lumber beam
[6]	Bearing Plate (Alternate Saddle)	1	Use a 0.250 inch X 5.50 inches X 7.5 inches) (6.350 mm X 139.70 mm X 190.50 mm) steel plate
[7]	Cribbing Saddle Base (As necessary)	2	Use a 6 X 6 lumber beam



A-FRAME TYPE FUSELAGE SUPPORT JIG - CONTOURED
FUSELAGE SADDLE FOR STA 360, STA 727, AND STA 1016

A

Fuselage Support Structure
Figure 8 (Sheet 1 of 12)



A-FRAME TYPE FUSELAGE SUPPORT JIG - KEEL BEAM SADDLE FOR
STA 571 AND STA 662

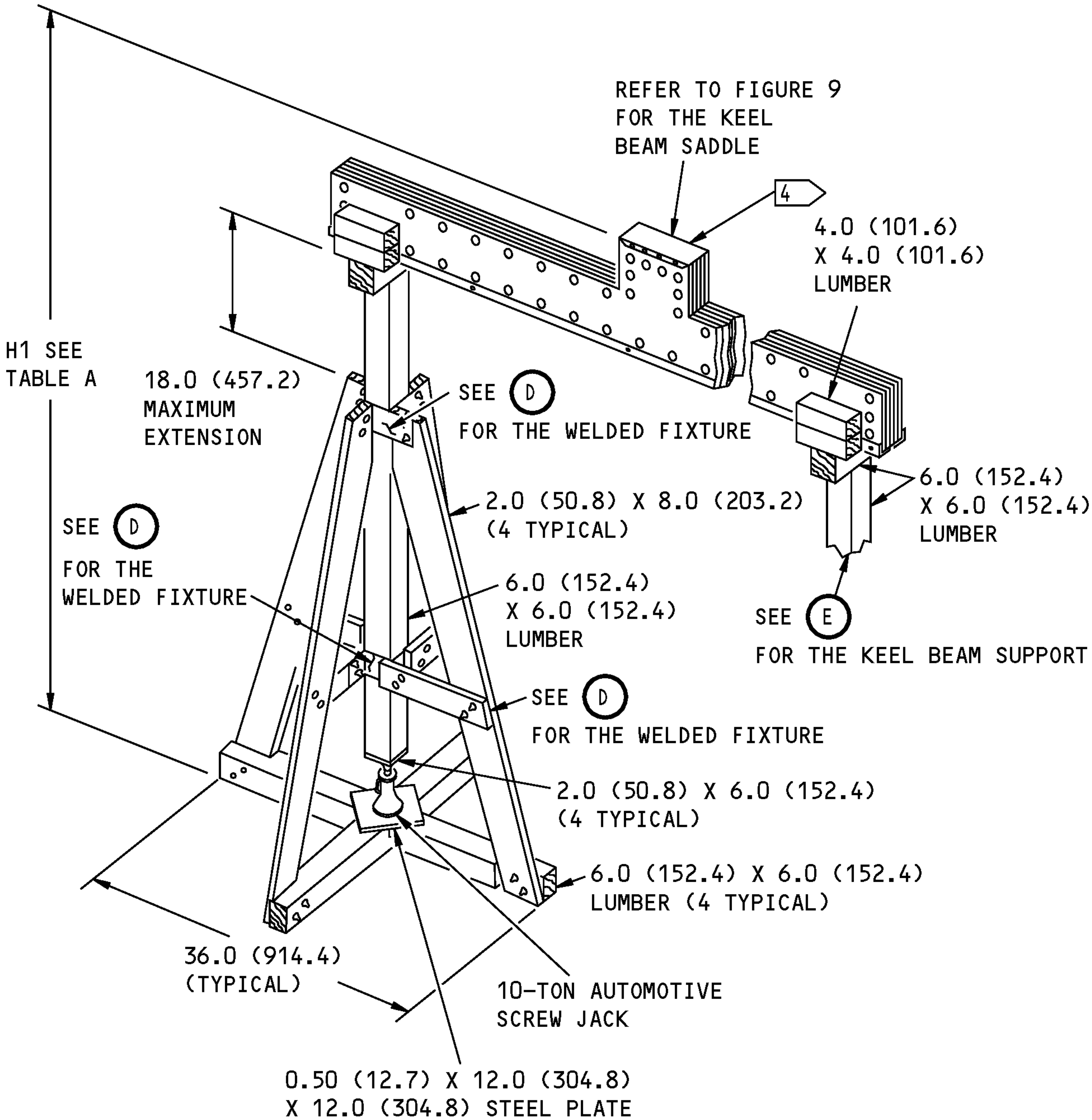
B

Fuselage Support Structure
Figure 8 (Sheet 2 of 12)

SUPPORT LOCATION	H1 DIMENSIONS 1	
	MLG SHOCK STRUTS DEFLATED, INCHES (mm)	MLG SHOCK STRUTS NOT DEFLATED, INCHES (mm)
STA 360 STA 571 STA 662 STA 727	40.0 (1016.0)	70.0 (1778.0)
STA 1016	80.0 (2032.0)	110.0 (2794.0)

TABLE A

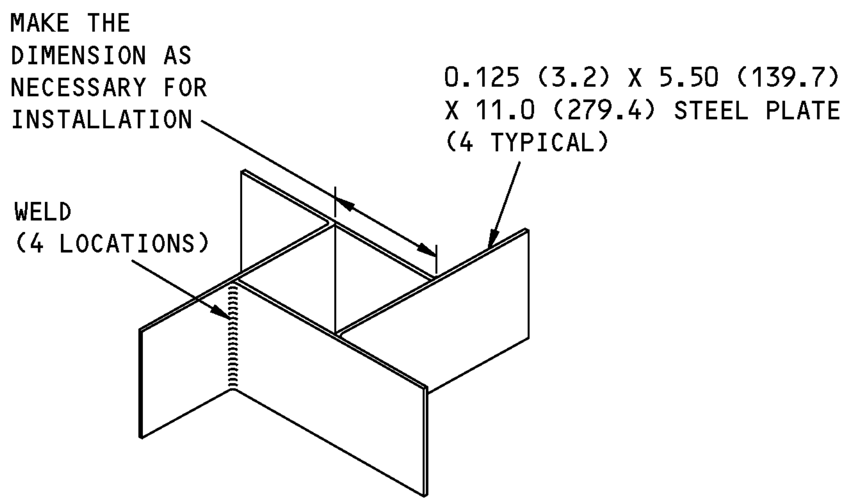
Fuselage Support Structure
Figure 8 (Sheet 3 of 12)



ALTERNATIVE A-FRAME TYPE SUPPORT JIG - KEEL BEAM
SADDLE FOR STA 571 AND STA 662

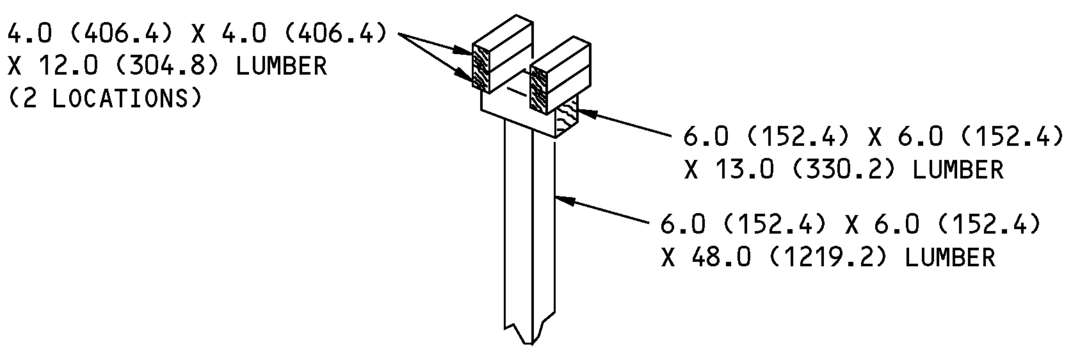
C

Fuselage Support Structure
Figure 8 (Sheet 4 of 12)



WELDED FIXTURE

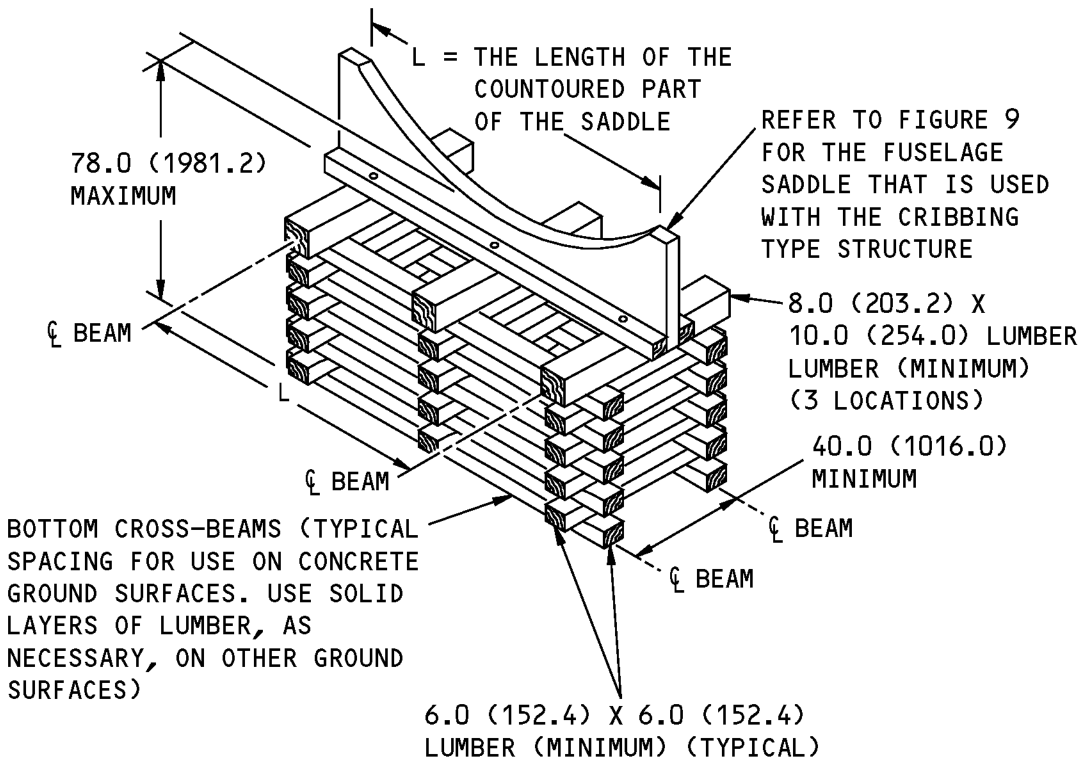
D



KEEL BEAM SUPPORT

E

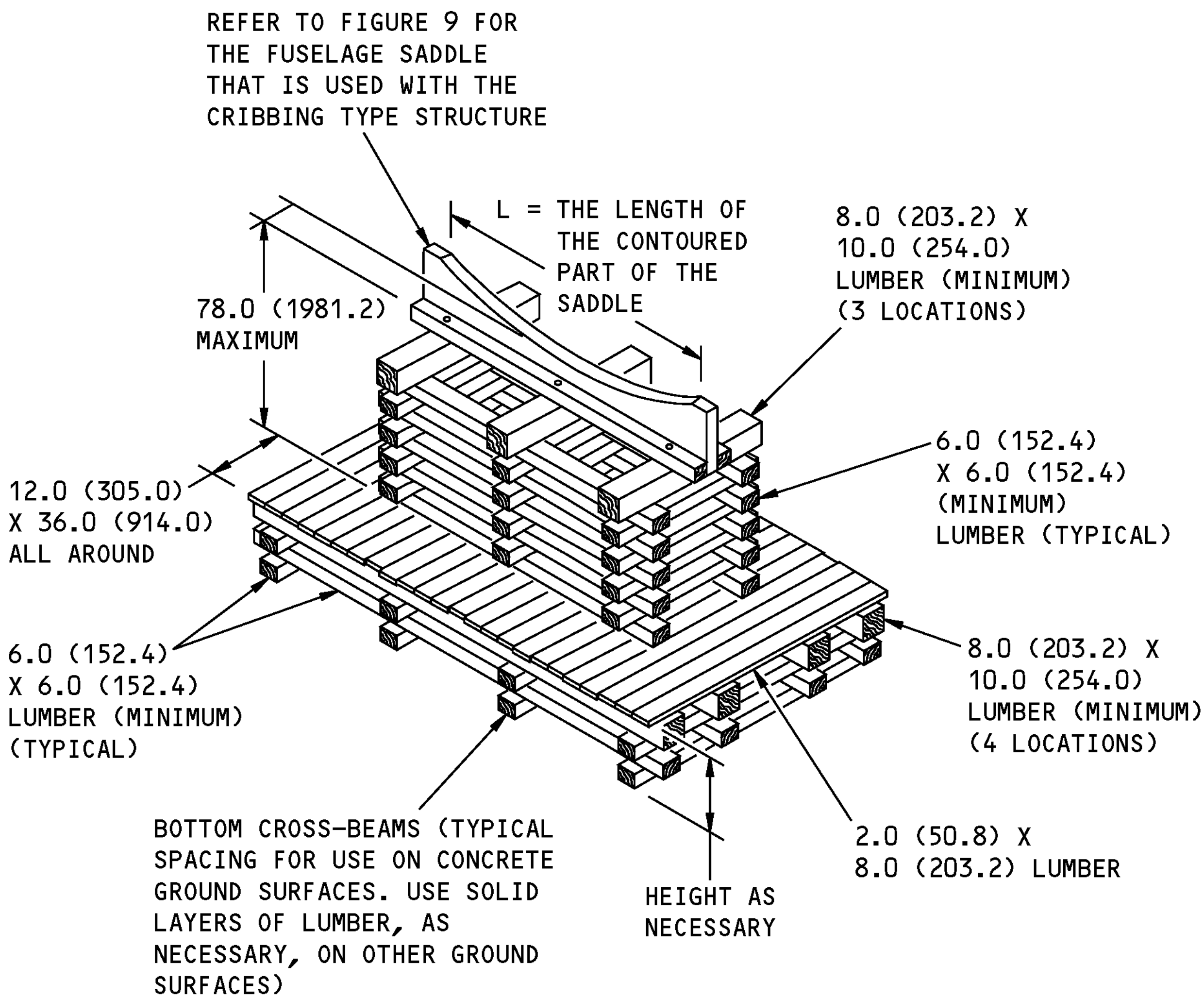
Fuselage Support Structure
Figure 8 (Sheet 5 of 12)



CRIBBING TYPE FUSELAGE SUPPORT JIG
FOR HEIGHTS OF 78.0 (1981.2) MAXIMUM
(ALTERNATIVE TO A-FRAME TYPE STRUCTURE)

F

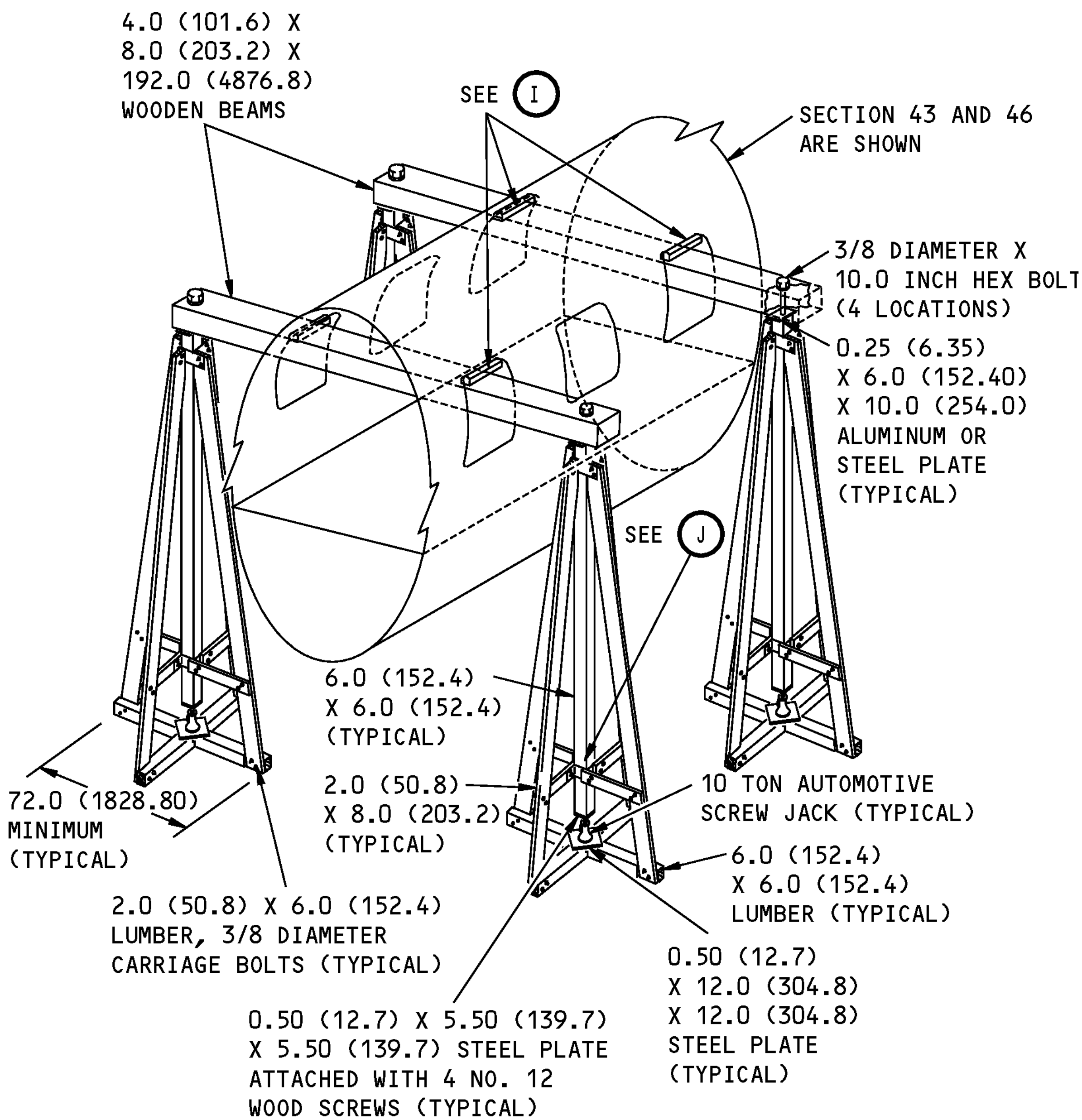
Fuselage Support Structure
Figure 8 (Sheet 6 of 12)



CRIBBING TYPE FUSELAGE SUPPORT JIG
FOR HEIGHTS GREATER THAN 78.0 (1981.2) MAXIMUM
(ALTERNATIVE TO A-FRAME TYPE STRUCTURE)

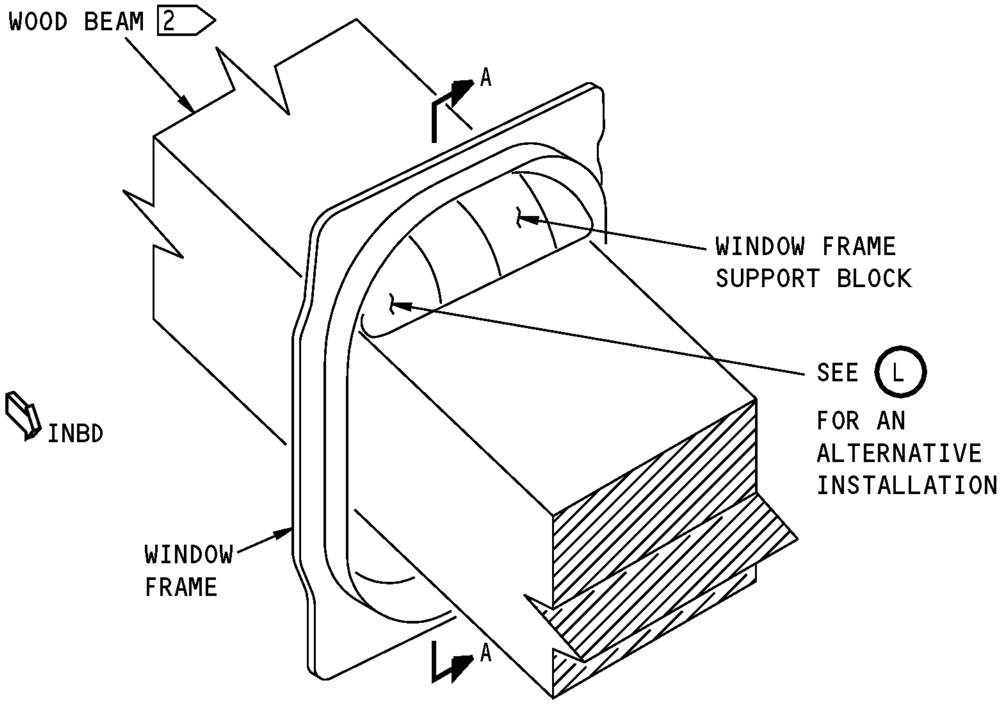
G

Fuselage Support Structure
Figure 8 (Sheet 7 of 12)

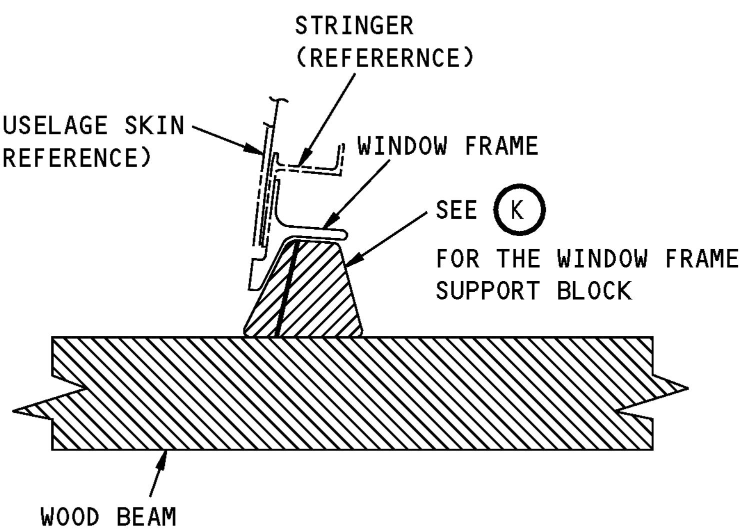


ALTERNATIVE FUSELAGE SUPPORT
WINDOW SUPPORT ASSEMBLY
H

Fuselage Support Structure
Figure 8 (Sheet 8 of 12)

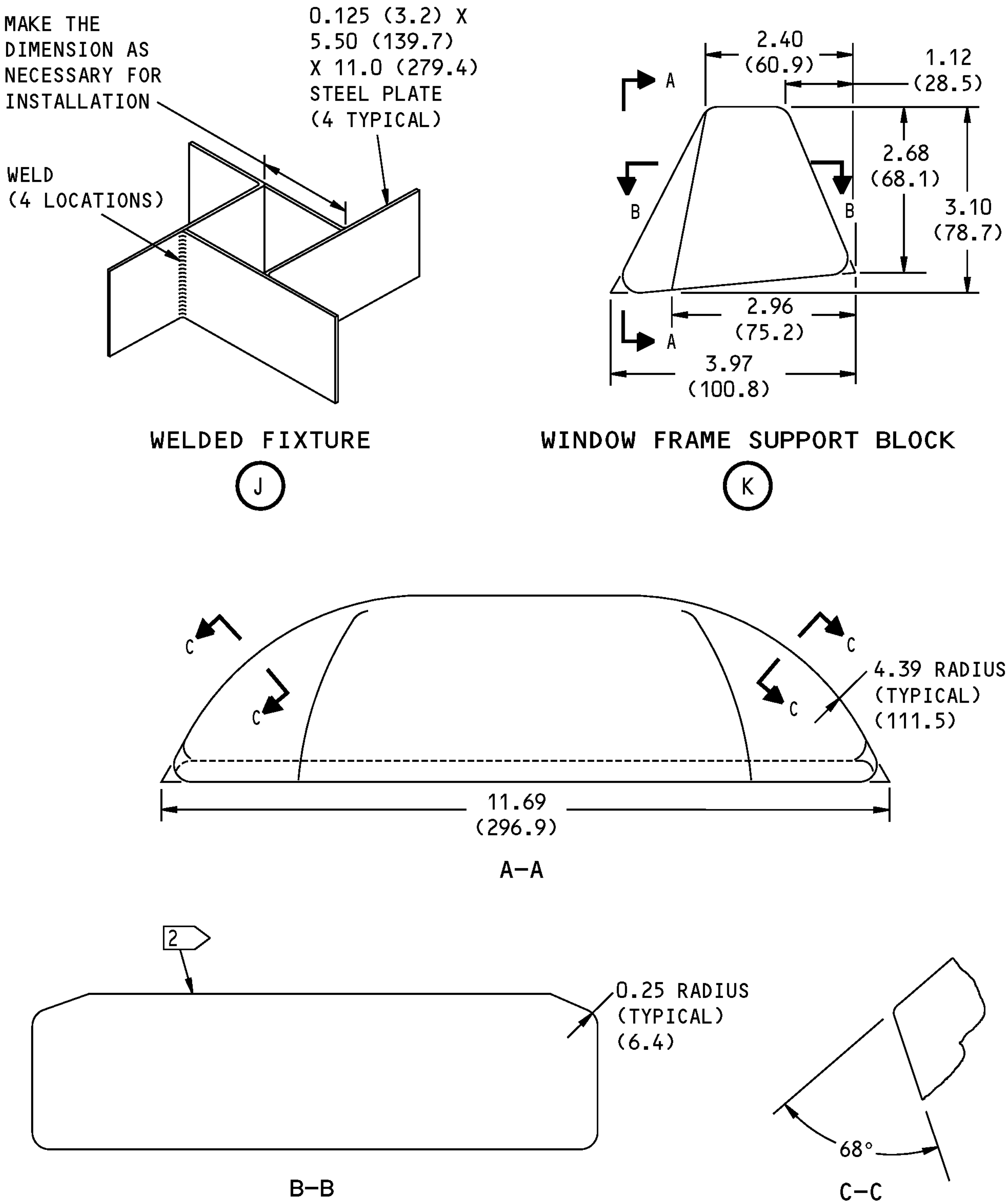


TYPICAL WINDOW FRAME AND
WINDOW FRAME SUPPORT BLOCK LAY-OUT
I

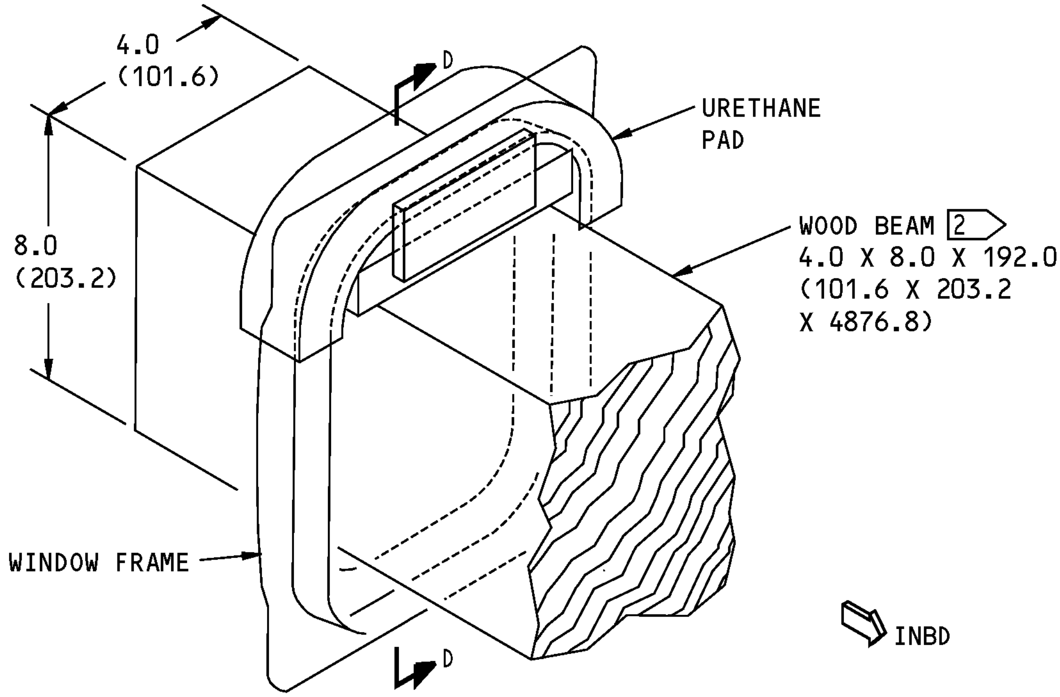


A-A

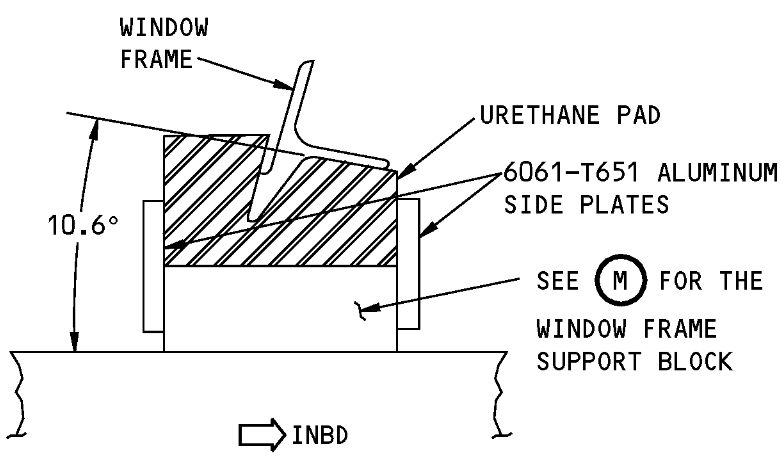
Fuselage Support Structure
Figure 8 (Sheet 9 of 12)



Fuselage Support Structure
Figure 8 (Sheet 10 of 12)

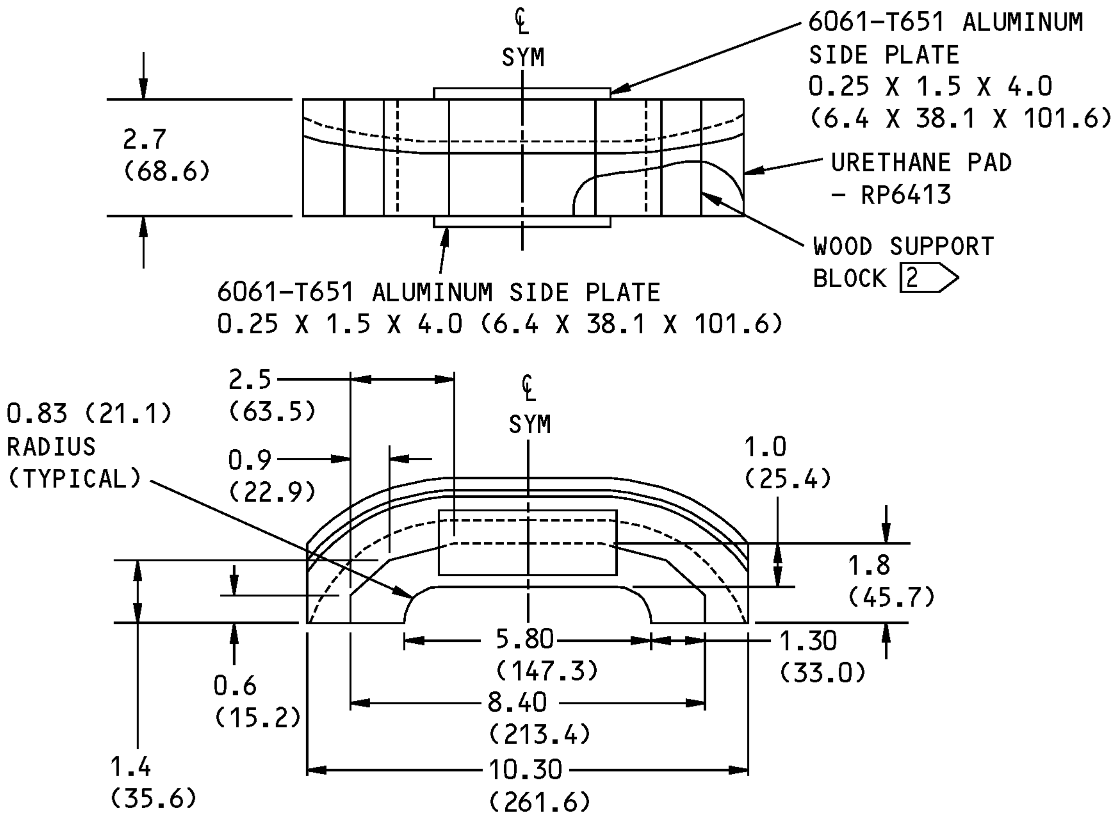


ALTERNATIVE WINDOW SUPPORT INSTALLATION
L



D-D

Fuselage Support Structure
Figure 8 (Sheet 11 of 12)



ALTERNATIVE WINDOW FRAME SUPPORT BLOCK

M

NOTES

- ALL LUMBER DIMENSIONS SHOWN (6 X 6 FOR EXAMPLE) ARE AMERICAN LUMBER STANDARDS.
- ALL DIMENSIONS ARE IN INCHES (mm).

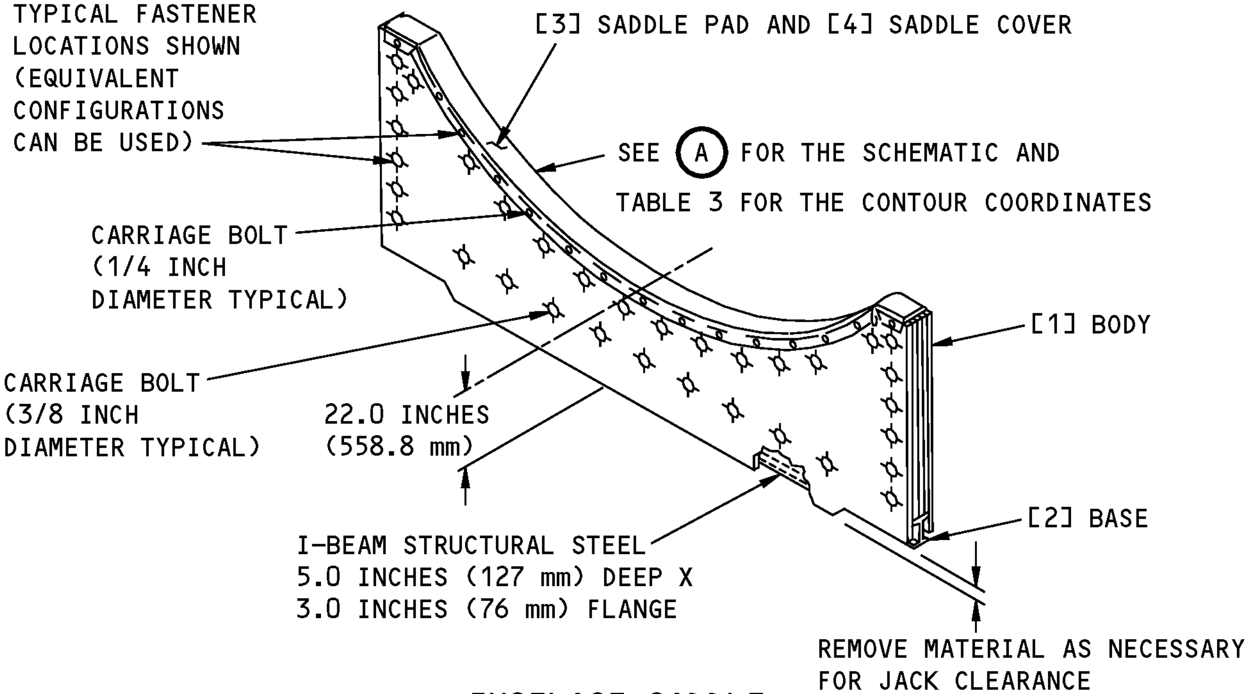
1 THE DIMENSIONS GIVEN ARE AN EXAMPLE. THE MAXIMUM DIMENSIONS FOR H1 ARE DETERMINED BY THE MAXIMUM HEIGHT TO WHICH THE AIRPLANE CAN BE JACKED AS GIVEN IN AMM 07-11-01.

2 MADE FROM ANY AVAILABLE HARDWOOD SUCH AS ASH, MAPLE, OAK, ETC.

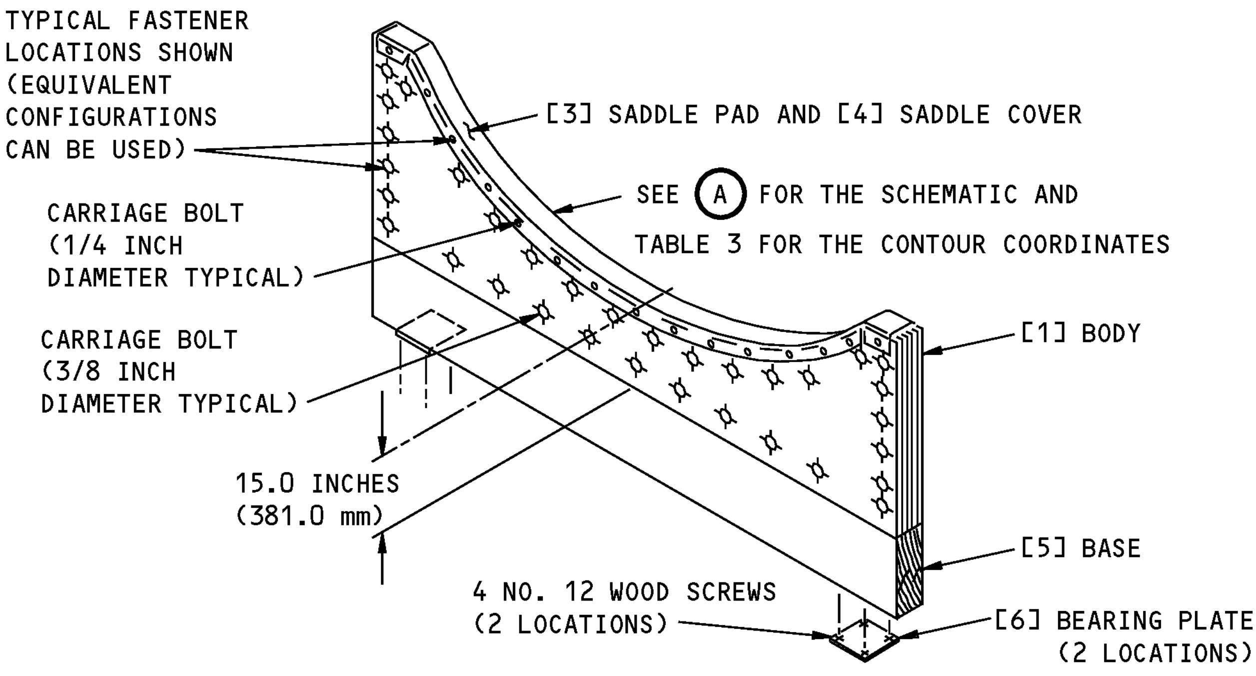
3 THE HEIGHT OF THE FRAME FOR THE SUPPORT IS DETERMINED BY THE NEED TO CLEAR THE WING-TO-BODY FAIRINGS.

4 MUST BE POSITIONED AND CENTERED TO APPLY LOAD DIRECTLY UNDER THE KEEL BEAM FORMERS, NOT ACROSS THE KEEL BEAM CORDS ALONE, AND NOT TO WING-TO-BODY FAIRING SUPPORT STRUCTURE. FAIRING SUPPORT STRUCTURE IS NOT CAPABLE OF CARRYING LOAD AND MUST BE REMOVED BEFORE SUPPORTING THE KEEL BEAM.

Fuselage Support Structure
Figure 8 (Sheet 12 of 12)



FUSELAGE SADDLE

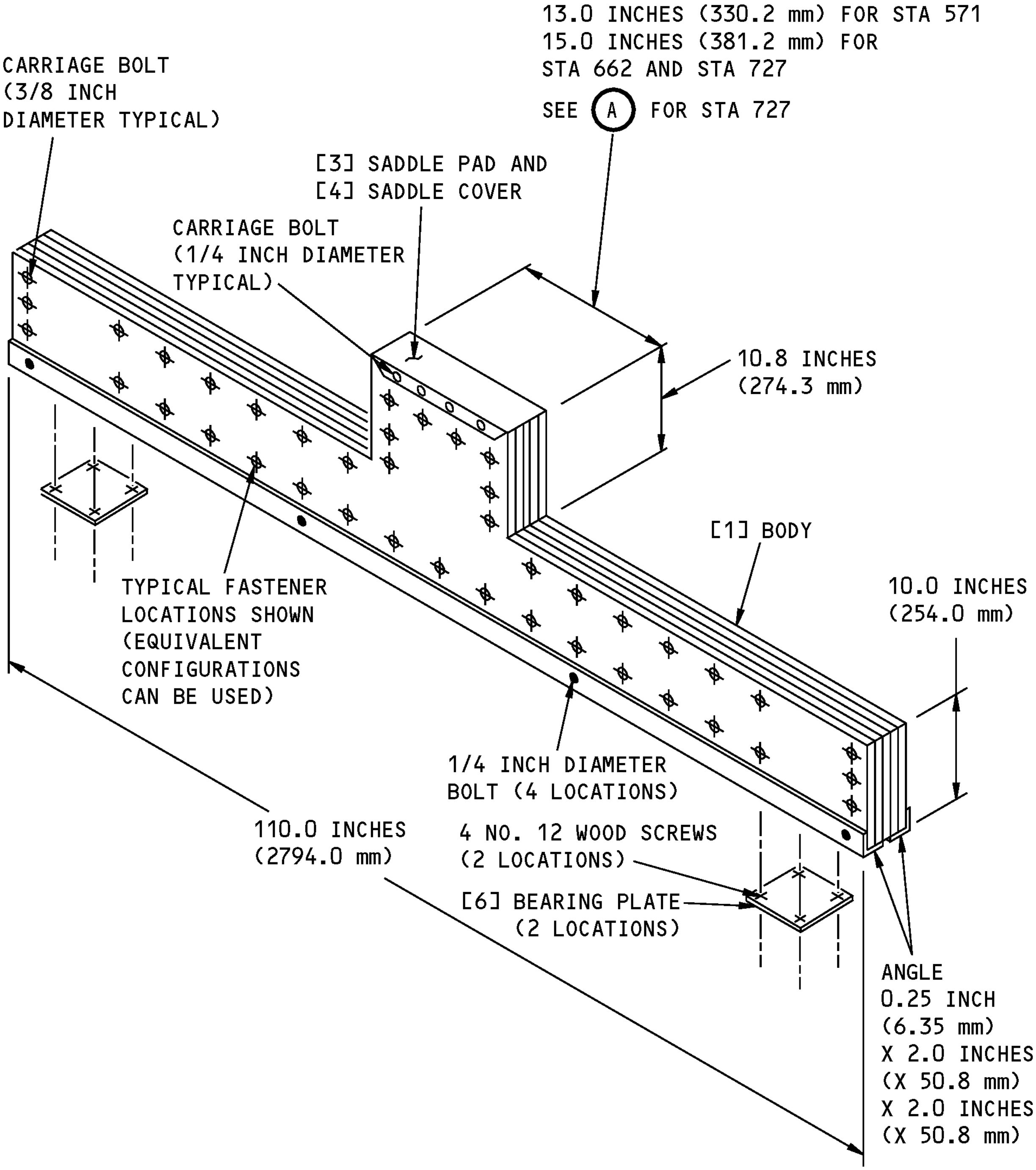


ALTERNATE FUSELAGE SADDLE FOR AN A-FRAME TYPE STRUCTURE

NOTES

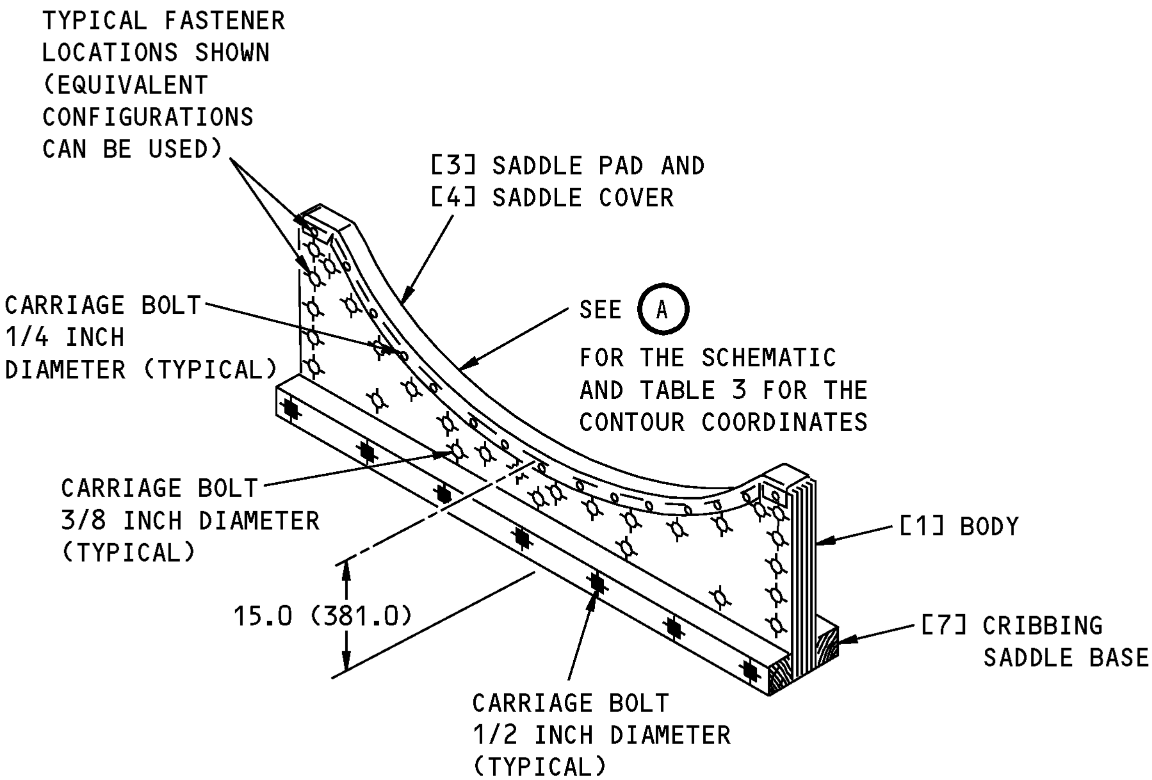
- REFER TO TABLE 7 FOR THE MATERIALS FOR THE SUPPORT SADDLE.

Fuselage Support Saddle
Figure 9 (Sheet 1 of 4)



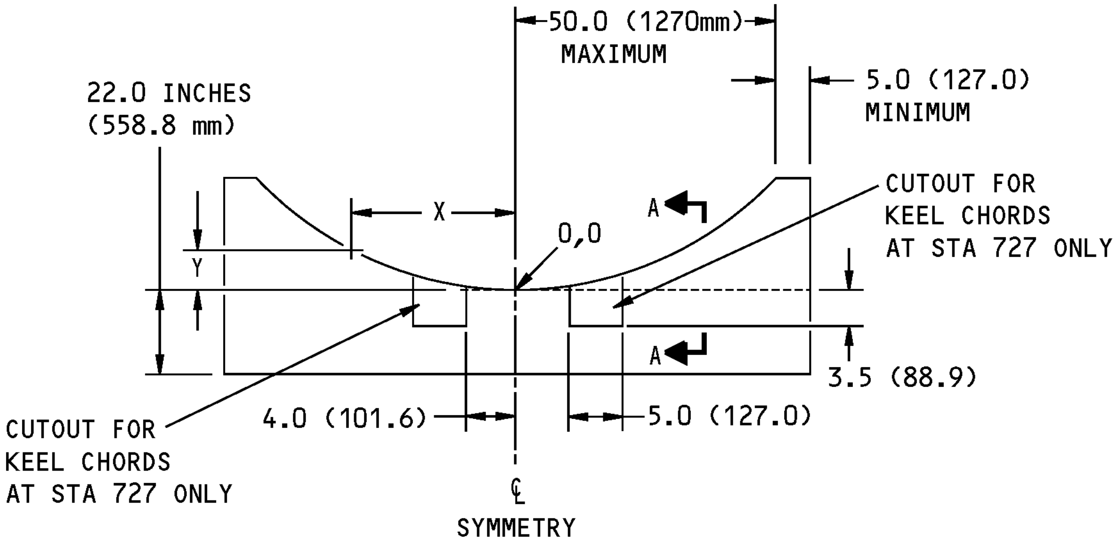
KEEL BEAM SADDLE

Fuselage Support Saddle
Figure 9 (Sheet 2 of 4)



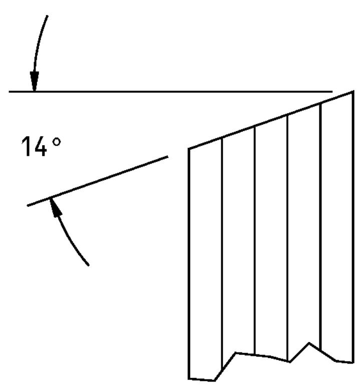
FUSELAGE SADDLE FOR A CRIBBING TYPE STRUCTURE

Fuselage Support Saddle
Figure 9 (Sheet 3 of 4)



FUSELAGE SADDLE SCHEMATIC

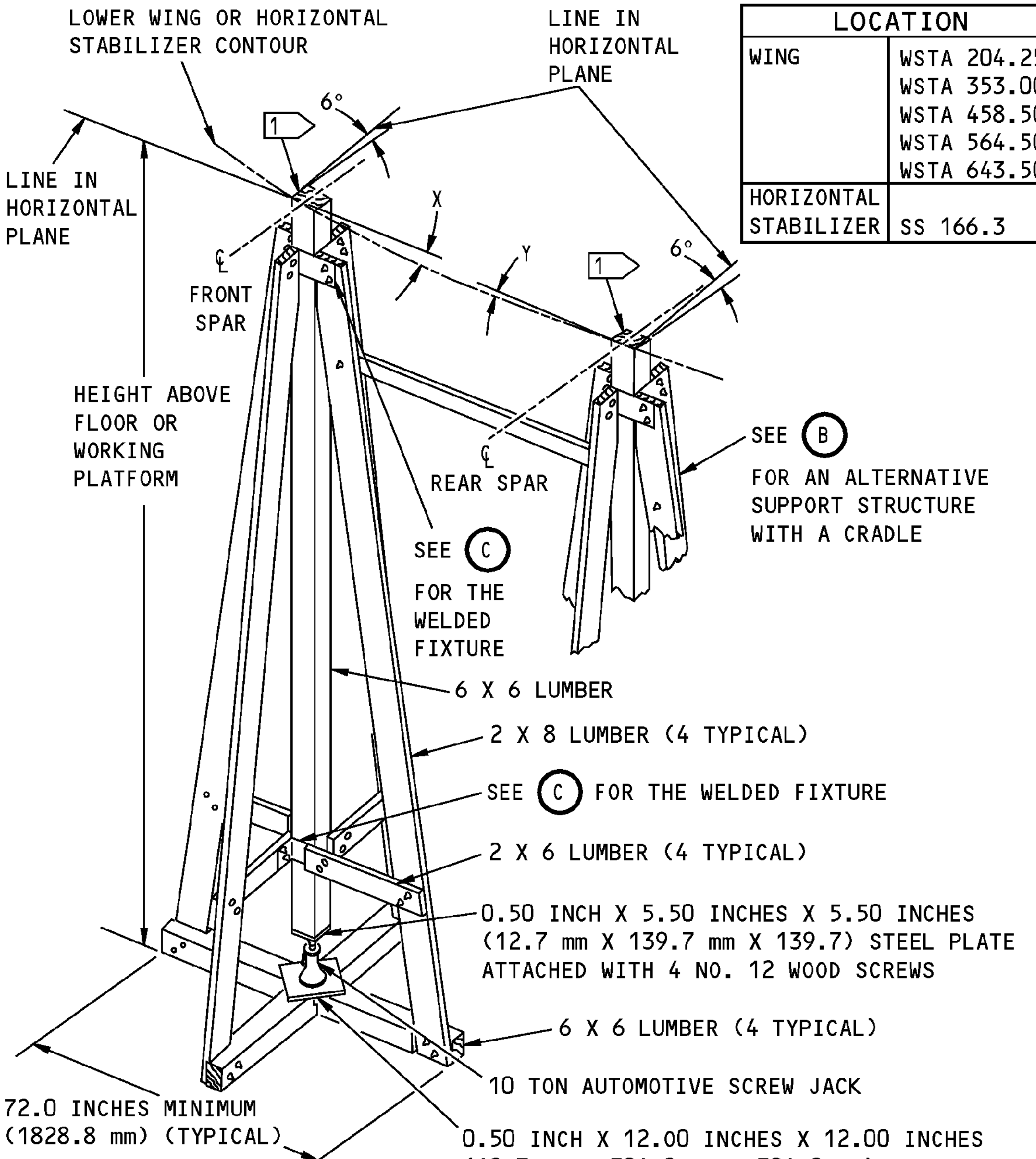
A



FOR STA 1016 ONLY
A-A

NOTE: REFER TO TABLE 3 FOR THE CONTOUR COORDINATES X AND Y.

Fuselage Support Saddle
Figure 9 (Sheet 4 of 4)



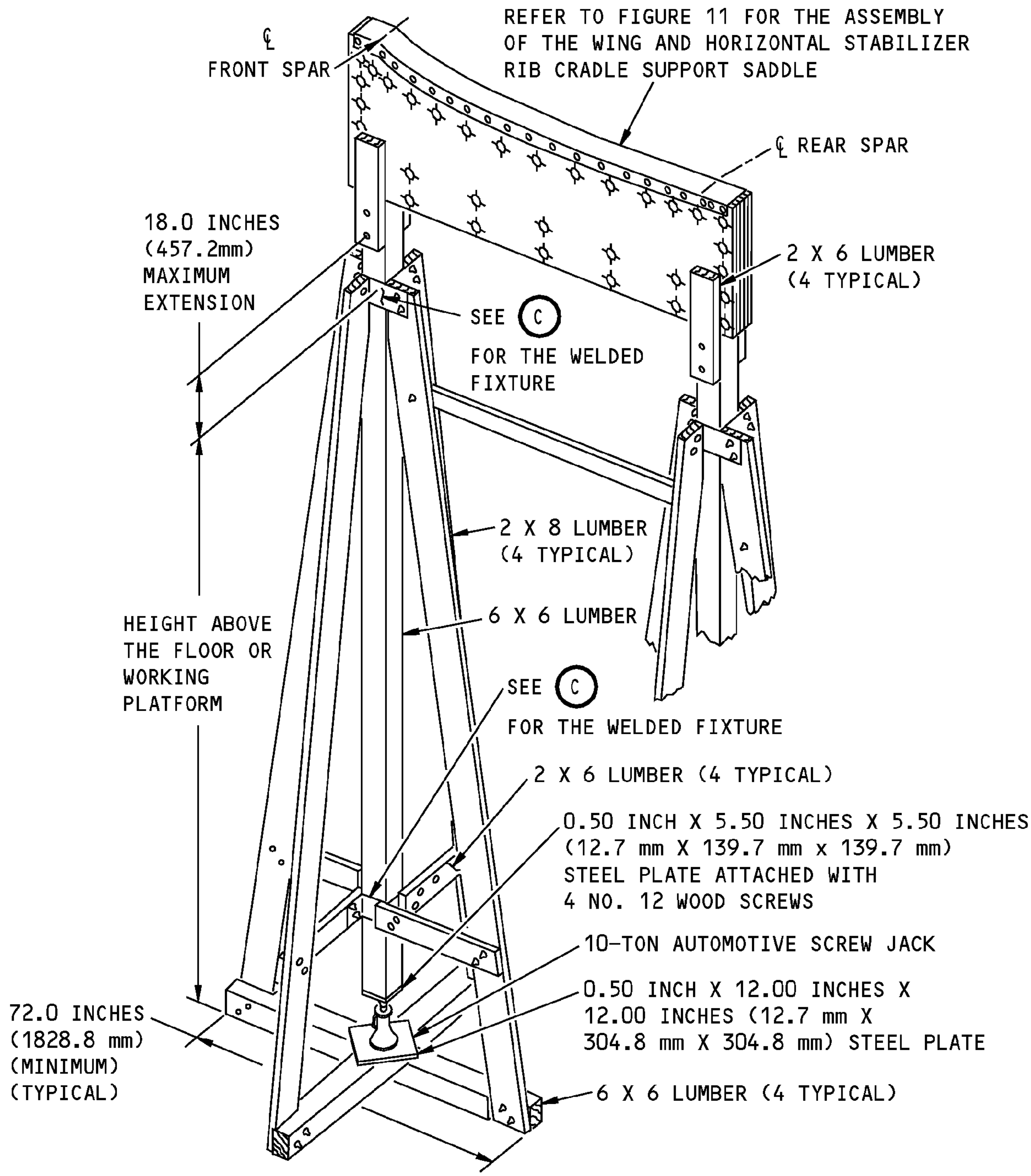
LOCATION		X	Y
WING	WSTA 204.25 WSTA 353.00 WSTA 458.50 WSTA 564.50 WSTA 643.50	6°	3°
HORIZONTAL STABILIZER	SS 166.3	6°	3°

SUPPLEMENTARY SUPPORT A-FRAME TYPE
WING AND HORIZONTAL STABILIZER SUPPORT JIG
A

NOTES

1 PAD WITH 1.0 TO 1.5 INCHES (25.4 TO 38.1 mm) THICK RUBBER, DUROMETER OF 50 TO 60 AND COVER WITH 10 OZ. CANVAS DUCK.

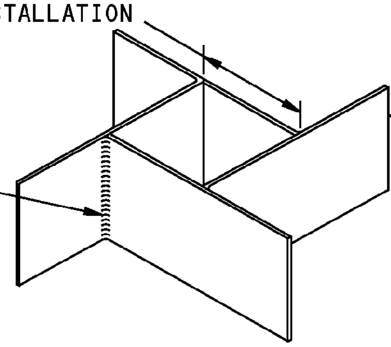
Wing and Horizontal Stabilizer Support Structure
Figure 10 (Sheet 1 of 4)



SUPPLEMENTARY SUPPORT A-FRAME TYPE
WING AND HORIZONTAL STABILIZER SUPPORT JIG WITH A CRADLE

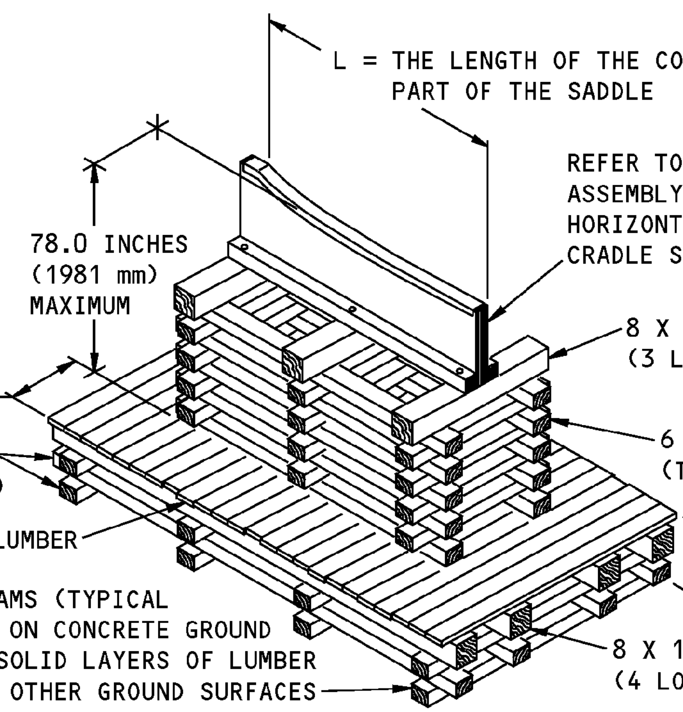
B

Wing and Horizontal Stabilizer Support Structure
Figure 10 (Sheet 2 of 4)



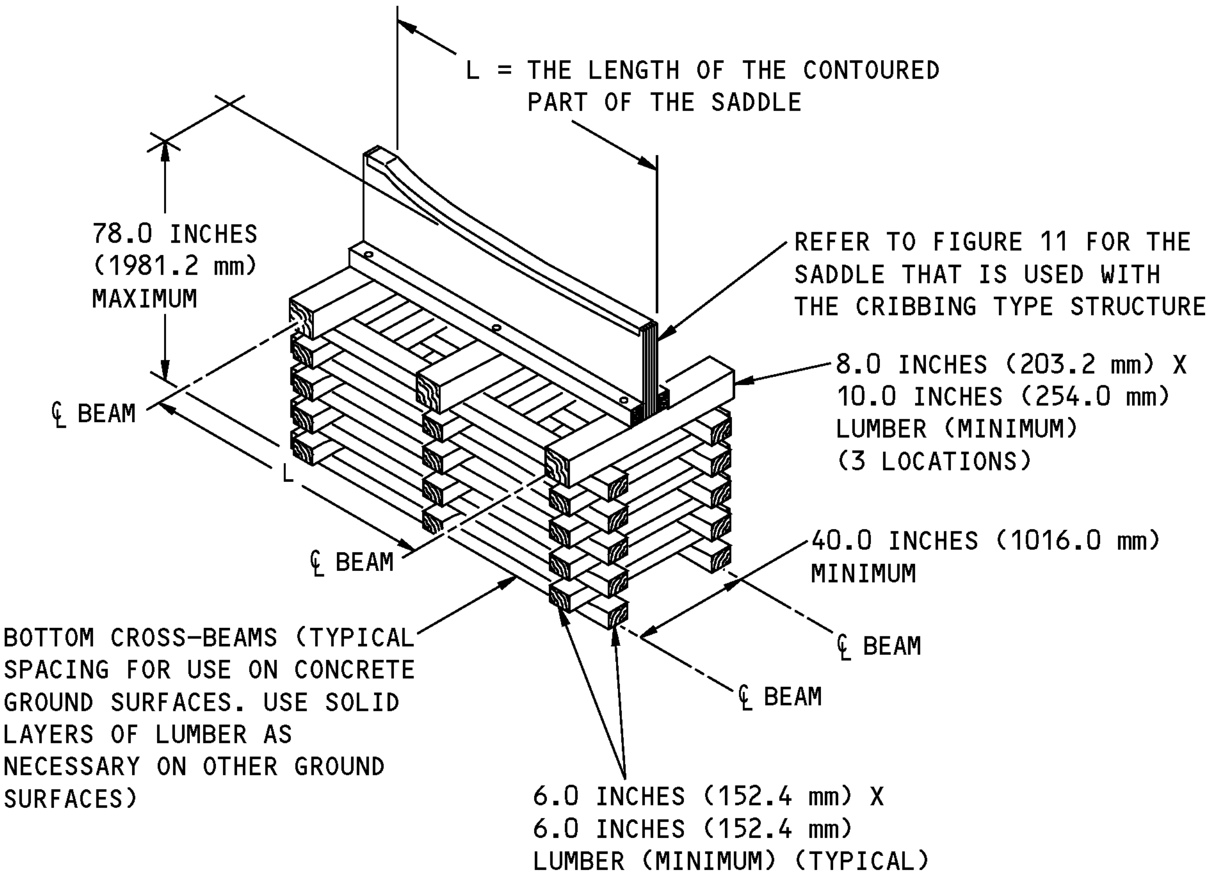
WELDED FIXTURE

C



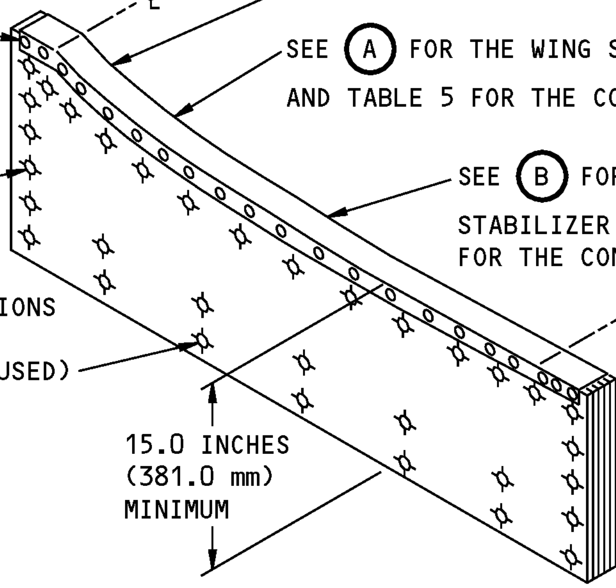
CRIBBING TYPE WING AND HORIZONTAL STABILIZER SUPPORT JIG
FOR HEIGHTS GREATER THAN 78.0 INCHES (1981.2 mm)
(ALTERNATIVE TO A-FRAME TYPE STRUCTURE)

Wing and Horizontal Stabilizer Support Structure
Figure 10 (Sheet 3 of 4)

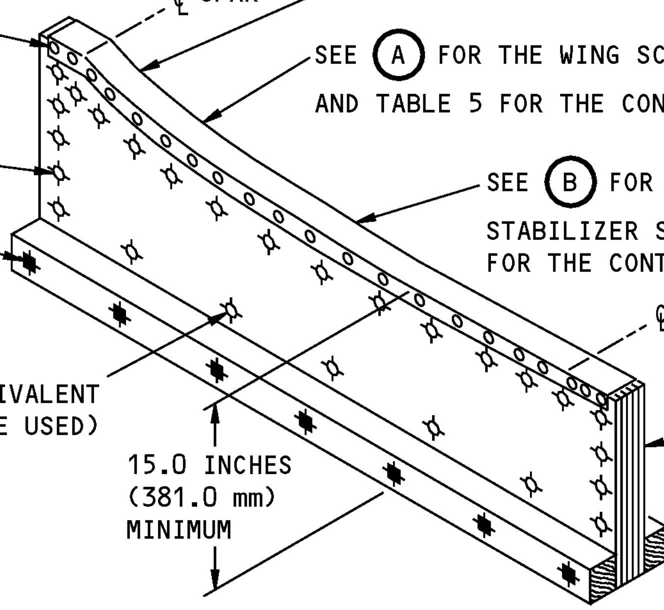


CRIBBING TYPE WING AND HORIZONTAL STABILIZER SUPPORT JIG
FOR HEIGHTS UP TO 78.0 INCHES (1981.2 mm)
(ALTERNATIVE TO A-FRAME TYPE STRUCTURE)

Wing and Horizontal Stabilizer Support Structure
Figure 10 (Sheet 4 of 4)



WING AND HORIZONTAL STABILIZER RIB SADDLE

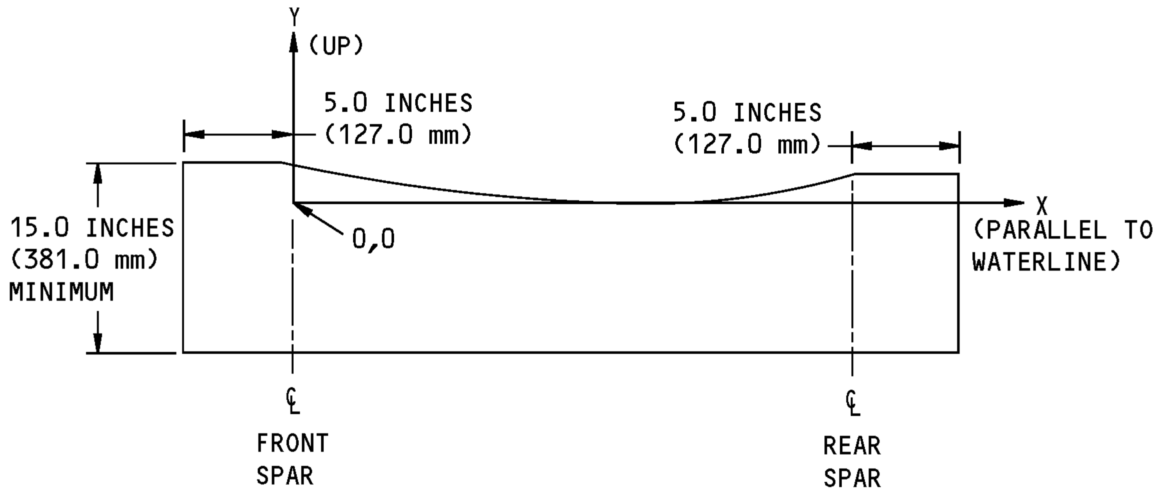


WING AND HORIZONTAL STABILIZER RIB SADDLE
FOR A CRIBBING TYPE STRUCTURE

NOTES

- REFER TO TABLE 7 FOR THE MATERIALS FOR THE SUPPORT SADDLE.

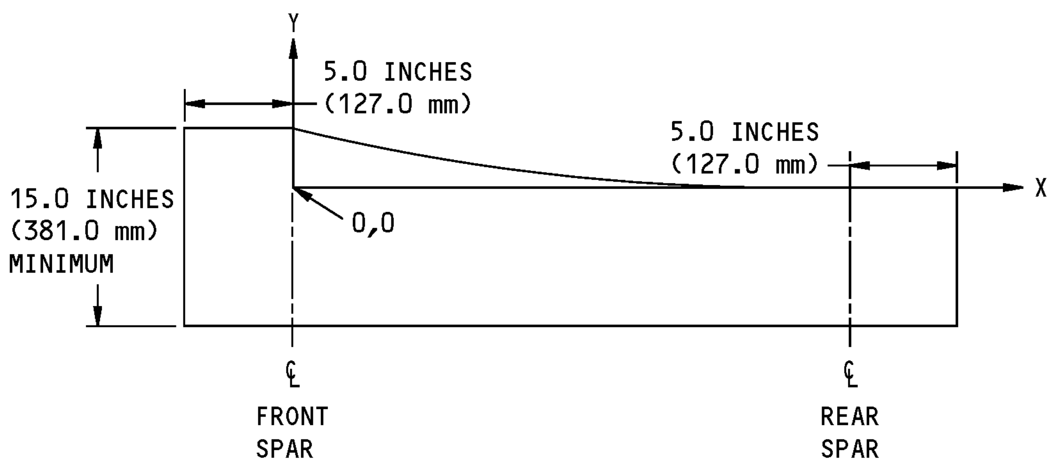
Wing and Horizontal Stabilizer Cradle Support Saddle
Figure 11 (Sheet 1 of 2)



NOTE: REFER TO TABLE 4 AND TABLE 5 FOR THE CONTOUR COORDINATES X AND Y.

CONTOUR OF THE WING SADDLE

A



NOTE: REFER TO TABLE 6 FOR THE CONTOUR COORDINATES X AND Y.

CONTOUR OF THE HORIZONTAL STABILIZER SADDLE

B

Wing and Horizontal Stabilizer Cradle Support Saddle
Figure 11 (Sheet 2 of 2)

GENERAL - CONTROL SURFACE BALANCE PROCEDURES

1. **Applicability**

   A. This subject gives the general balance data for the parts that follow:

      (1) Aileron

      (2) Aileron Balance Panel

      (3) Aileron Tab

      (4) Elevator

      (5) Elevator Balance Panel

      (6) Elevator Tab

      (7) Rudder.

2. **General**

   A. Refer to Table 1/GENERAL for the references for the data and procedures given in this subject.

   B. There are two categories of balance requirements for the Control Surfaces. Refer to Table 2/GENERAL or Table 3/GENERAL for the category, balance limits, and SRM subject location for each control surface.

   NOTE: Table 2/GENERAL is applicable to airplane cum line numbers 1 through 1174. Table 3/GENERAL is applicable to airplane cum line numbers 1175 and on.

      (1) Refer to Table 2/GENERAL or Table 3/GENERAL for the category, balance limits, and SRM subject location for each control surface.

      (2) Category I: Surfaces that can be adjusted to meet the necessary operational static balance limits.

      (3) Category II: Surfaces that have a weight limit range with no adjustment function.

Table 1:

BALANCE DATA INDEX	
SUBJECT	**PARAGRAPH**
References	3
Definitions of Terms	4
Accuracy of Measurement	5
Tools and Equipment	6
Sign Convention	7
Balance Procedures That Are Common to All Categories I and II Control Surfaces	8
Serviceability of Categories I and II Control Surfaces	8

   C. The measure of a Control Surface is the actual Balance Moment of the total Control Surface weight about its hinge centerline.

   D. Before the airplane is delivered, an initial balance is given to the Category I and II Control Surfaces.

      (1) The Static Balance Moment will not be more than the Manufacture Limit.

Table 2:

CONTROL SURFACE STATIC BALANCE REQUIREMENTS FOR AIRPLANE CUM LINE NUMBERS 1 THROUGH 1174				
CONTROL SURFACE (SRM SUBJECT)	**CATEGORY**	**STATIC BALANCE LIMITS REQUIREMENTS**		
		MANUFACTURE	**CALCULATED REWORK**	**OPERATIONAL**
AILERON (SRM 51-60-01)	I	-30.70 lb-in to -10.70 lb-in	-30.70 lb-in to -6.00 lb-in	-30.70 lb-in to -2.50 lb-in
AILERON BALANCE PANELS (SRM 51-60-02)	II		NOT APPLICABLE	
	Bay No. 1	+3.42 to 3.68 lbs		+3.42 to +3.68 lbs
	Bay No. 2	+3.74 to 4.00 lbs		+3.74 to +4.00 lbs
	Bay No. 3	+3.92 to 4.18 lbs		+3.92 to +4.18 lbs
	Bay No. 4	+4.16 to 4.42 lbs		+4.16 to +4.42 lbs
AILERON TAB (SRM 51-60-03)	I	+4.76 lbs MAXIMUM	NOT APPLICABLE	+4.76 lbs MAXIMUM
ELEVATOR (SRM 51-60-04)*[1]	I	-108.33 lb-in to -45.77 lb-in	-108.33 lb-in to -45.77 lb-in	-108.33 lb-in to -24.91 lb-in
ELEVATOR BALANCE PANELS (SRM 51-60-05)	II		NOT APPLICABLE	
	Bay No. 2	+2.31 to +2.61 lbs		+2.31 to +2.61 lbs
	Bay No. 3	+2.07 to +2.37 lbs		+2.07 to +2.37 lbs
	Bay No. 4	+1.98 to +2.28 lbs		+1.98 to +2.28 lbs
ELEVATOR TAB (SRM 51-60-06)*[1]	I	+6.50 lbs MAXIMUM	NOT APPLICABLE	+7.26 lbs MAXIMUM
RUDDER (SRM 51-60-07)	I	+418.2 lb-in to +540.0 lb-in	+418.2 lb-in to +540.0 lb-in	+418.2 lb-in to +636.8 lb-in

*[1] Note: Prior to completion of Service Bulletins 737-55-1080 and 737-55-1082.

Table 3:

CONTROL SURFACE STATIC BALANCE REQUIREMENTS FOR AIRPLANE CUM LINE NUMBERS 1175 AND ON				
CONTROL SURFACE (SRM SUBJECT)	**CATEGORY**	**STATIC BALANCE LIMITS REQUIREMENTS**		
		MANUFACTURE	**CALCULATED REWORK**	**OPERATIONAL**
AILERON (SRM 51-60-01)	I	-30.70 lb-in to -10.70 lb-in	-30.70 lb-in to -6.00 lb-in	-30.70 lb-in to -2.50 lb-in
AILERON BALANCE PANELS (SRM 51-60-02)	II		NOT APPLICABLE	
	Bay No. 1	+3.42 to +3.68 lbs		+3.42 to +3.68 lbs
	Bay No. 2	+3.74 to +4.00 lbs		+3.74 to +4.00 lbs
	Bay No. 3	+3.92 to +4.18 lbs		+3.92 to +4.18 lbs
	Bay No. 4	+4.16 to +4.42 lbs		+4.16 to +4.42 lbs
AILERON TAB (SRM 51-60-03)	I	+4.76 lbs MAXIMUM	NOT APPLICABLE	+4.76 lbs MAXIMUM
ELEVATOR (SRM 51-61-04)*[1]	I	-175.28 lb-in to -110.17 lb-in	-175.28 lb-in to -110.17 lb-in	-175.28 lb-in to -88.47 lb-in

CONTROL SURFACE STATIC BALANCE REQUIREMENTS FOR AIRPLANE CUM LINE NUMBERS 1175 AND ON				
CONTROL SURFACE (SRM SUBJECT)	CATEGORY	STATIC BALANCE LIMITS REQUIREMENTS		
		MANUFACTURE	CALCULATED REWORK	OPERATIONAL
ELEVATOR BALANCE PANELS (SRM 51-60-05)	II		NOT APPLICABLE	
	Bay No. 2	+2.31 to +2.61 lbs		+2.31 to +2.61 lbs
	Bay No. 3	+2.07 to +2.37 lbs		+2.07 to +2.37 lbs
	Bay No. 4	+1.98 to +2.28 lbs		+1.98 to +2.28 lbs
ELEVATOR TAB (SRM 51-61-06)*[1]	I	+8.60 lbs MAXIMUM WEIGHT +14.95 lb-in MAXIMUM MOMENT	NOT APPLICABLE	+9.00 lbs MAXIMUM WEIGHT +15.48 lbs MAXIMUM MOMENT
RUDDER (SRM 51-60-07)	I	+418.2 lb-in to +540.0 lb-in	+418.2 lb-in to +540.0 lb-in	+418.2 lb-in to +636.8 lb-in

*[1] Note: Airplane line numbers prior to 1175 must have completed Service Bulletins 737-55-1080 or 737-55-1081 and 737-55-1082.

CAUTION: YOU MUST MAKE SURE THAT THE CONTROL SURFACES IDENTIFIED IN THIS SUBJECT ARE BALANCED AT ALL TIMES. IF YOU DO A REWORK, REPAINT, OR REPAIR TO A CONTROL SURFACE, YOU MUST DO A BALANCE OF THAT SURFACE. IF YOU REWORK, REPAINT, OR REPAIR A CONTROL SURFACE TAB, YOU MUST WEIGH THAT TAB. IF YOU DO NOT OBEY, YOU CAN HAVE A CONDITION THAT IS DANGEROUS TO THE SAFETY OF FLIGHT.

E. When you do a balance of a Category I or II Control Surface, do as follows:

(1) There are two ways to balance a Control Surface:

(a) On the airplane where the Balance Moment is calculated with equations only.

1) Make sure the Balance Moment is not more than the calculated Rework Limit.

(b) Off the airplane where the Balance Moment is calculated from the actual weight that is found with a balance fixture.

1) Make sure the Balance Moment is not more than the Operational Limit.

(2) Refer to the applicable SRM Chapter-Section-Subject (51-60-01 through 51-61-06) for the instructions on how to balance a Category I or II Control Surface.

F. Refer to Table 1/GENERAL for a index of the procedures you will need to balance a Category I or II Control Surface.

3. References

Reference	Title
51-60-01	AILERON BALANCING PROCEDURES
51-60-01, GENERAL	Aileron Balance Procedure
51-60-02, GENERAL	Weight Control Procedure for the Aileron Balance Panels
51-60-03, GENERAL	Aileron Tab Balance Procedure
51-60-04, GENERAL	Elevator Balance Procedure For Airplane Line Numbers 1 Through 1174 Prior To Completion of Service Bulletins 737-55-1080, 737-55-1081, and 737-55-1082
51-60-05, GENERAL	Weight Control Procedure for the Elevator Balance Panels
51-60-06, GENERAL	Elevator Tab Balance Procedure For Airplane Line Numbers 1 Through 1174 Prior To Completion of Service Bulletins 737-55-1080, 737-55-1081, and 737-55-1082

(Continued)

Reference	Title
51-60-07, GENERAL	Rudder Balance Procedure
51-61-04, GENERAL	Elevator Balance Procedure For Airplane Line Numbers 1175 And On And Line Numbers 1 Through 1174 With Completion of Service Bulletins 737-55-1080, 737-55-1081, and 737-55-1082
51-61-06	ELEVATOR TAB BALANCE PROCEDURE
51-61-06, GENERAL	Elevator Tab Balance Procedure For Airplane Line Numbers 1175 And-On and Line Numbers 1 Through 1174 With Completion of Service Bulletins 737-55-1080, 737-55-1081, and 737-55-1082

4. **Definition of Terms**

A. The definition of terms that are applicable to Control Surface balance procedures are as follows:

(1) Balance Adjust Weights: Small weight increments which can be added or subtracted to a Category I Control Surface to put it into fine balance. During manufacture, these weights are used to adjust for small variations in the Category I Control Surfaces at the initial balance check. In service, Balance Adjust Weights are used as necessary to balance a reworked Category I Control Surface.

(2) Balance Panel: Panels attached to the forward portion of the Control Surface and fixed trailing edge structure. The Balance Panels have an effect on the balance of the Control Surface.

(3) Check Balance Moment: The final moment of a Control Surface that is found by measurement or by calculation. This moment must not be more than the specified balance limits. The Check Balance Moment is the value which is stamped on the Control Surface nameplate and identification markers, and is recorded in the Rework Record.

(4) Control Surface: The movable portion of a wing or tail surface which control movement about one of the airplane's axes.

(5) Fixed Balance Weights: Specially designed, permanent weights installed on a Control Surface forward of the hinge centerline at manufacture. Fixed Balance Weights make up a large part of the total weight necessary for balance.

(6) Manufacturing Balance Limit: The limit that the actual Check Balance Moment of the Control Surface must be less than or equal to (at the factory) before the Control Surface is delivered to the customer.

(7) Moment (M): The product of the weight or the Weight Reaction (WR) times the Moment Arm (d).

(8) Moment Arm (d): The horizontal, perpendicular distance from the hinge centerline to the point where the weight is put to the surface, or the point where the Weight Reaction is measured.

(9) Operational Limit: The limits to which the Control Surface is certified. This can also be called the Certified Balance Limit.

(10) Repaint: A procedure that adds exterior primer and paint to a Control Surface that has had initial paint applied at manufacture.

(11) Rework Capability: The difference between the Operational Balance Limit and the Check Balance Moment added with the moment increment of unused Balance Adjust Weights.

(12) Rework Moment: The change in a Control Surface balance moment because of a repair or repaint of the surface. The Rework Moment is the difference between the material removed and the material added, multiplied by the moment arm of the Rework Weight.

(13) Rework Record: A record of all the Rework done to a Control Surface. The record must contain:

(a) The Rework Capability (for Rework to be done later)

(b) The Rework Moment of the Control Surface

(c) All repair and Re-paint procedures done before with their Center of Gravity (CG) locations, Rework Weight, and date

(d) Data that tells the operator if rebalance was done by calculation (on the airplane) or by measurement (on the fixture).

(14) Rework: A procedure which changes the hinge line moment of the Control Surface. This includes repairs, repaints, and the addition or deletion of Balance Adjust Weights

(15) Rework Balance Limit: When a Control Surface is rebalanced by calculation, it must be balanced within the rework balance limits. The Rework Balance Limits are reduced from the Operational Limits to account for any error in calculating the Rework Weight and Moment.

(16) Rework Weight (RW): The incremental weight change that results from a Repair or Repaint of a Control Surface.

(17) Sign Convention: It is common for distances aft of the hinge centerline to be positive while distances forward of the hinge centerline are considered negative. Weight Reactions are considered positive if the surface creates a downward force on the scale support. Weight Reactions are considered negative if the surface creates an upward force on the scale support.

(18) Static Balance: A condition in which the center of gravity of a Control Surface is located within the specified limits.

(19) Trial Balance Moment: The initial measurement of moment on a balance jig. The Trial Balance Moment is done to find the number of adjust weights you need to put the Control Surface in balance. After the installation of the adjust weights, the balance moment is checked and becomes the Check Balance Moment when the specified limits are found.

(20) Weight Reaction (WR): The force (in pounds) of a Control Surface located on a support point at a given distance from its hinge centerline. You can find the Weight Reaction if you put a weight scale under the reaction points.

5. Accuracy of Measurement

A. It is important to use equipment that is calibrated to make measurements that can do as follows:

(1) Measure the Moment Arm (d) to an accuracy of ±0.1 inch (2.5 mm).

(2) Measure the angle that the Control Surface is leveled at to a precision of ±1 degree.

(3) Measure the weight to the tolerances given in Table 4/GENERAL.

Table 4:

WEIGHT MEASUREMENT PRECISION	
WEIGHT RANGE (POUNDS)	**PRECISION TOLERANCE**
Less Than 9.99	± 0.01 pound (4.5 g)
10.0 to 34.9	± 0.1 percent of the measured weight
35.0 to 299.9	± 0.2 percent of the measured weight
300.0 and More	± 0.25 percent of the measured weight

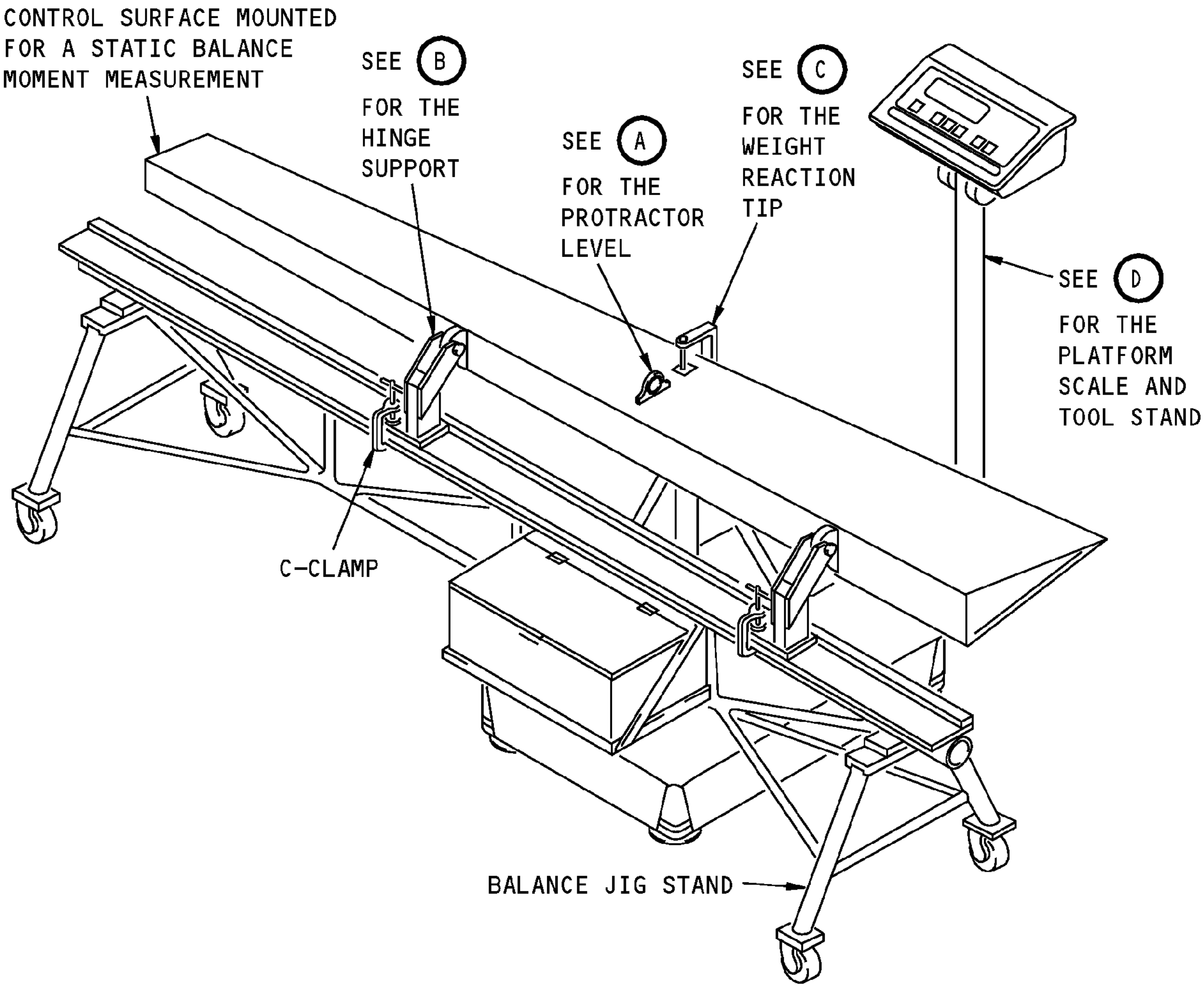
6. Tools and Equipment

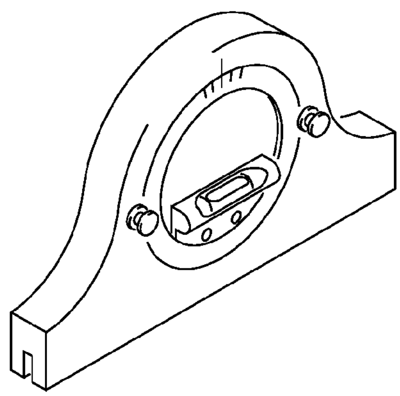
A. Refer to Table 5/GENERAL and Figure 1 for the tools and equipment that are necessary to balance the control surface.

NOTE: You can use alternative tools that are equivalent, unless the procedure tells you that the specified tool or equipment is mandatory. If you use the alternative tools or equipment, make sure they give the same results and are as safe to the parts and personnel as those tools or equipment specified in the procedure.

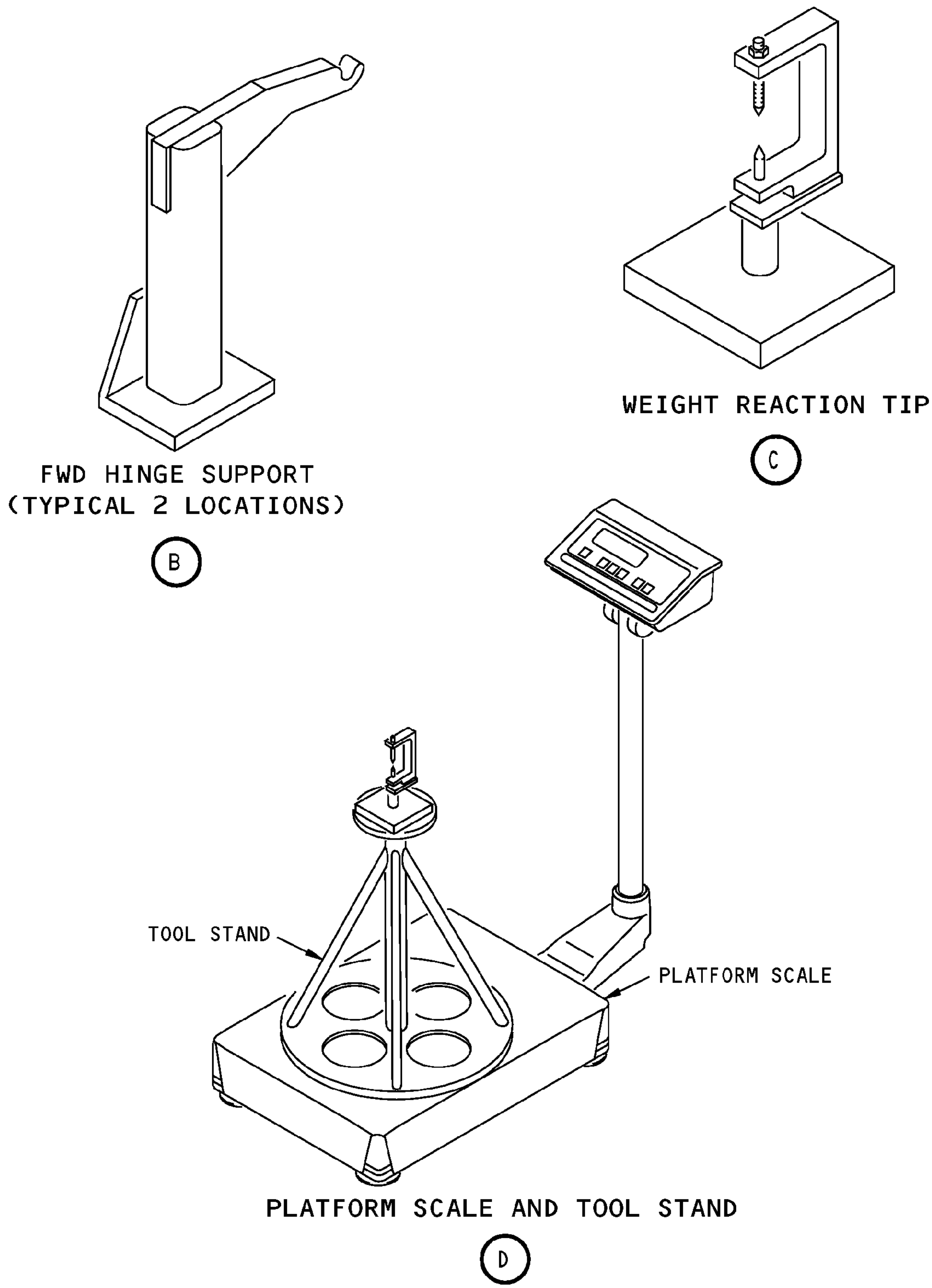
Table 5:

SPECIAL TOOLS AND EQUIPMENT			
ITEM	QUANTITY	PART NUMBER	SOURCE
Balance Jig Stand	1	Boeing FME5-71799	The Boeing Commercial Airplane Group (BCAG)
Tool Stand	1	Boeing F70330	BCAG
Weight Reaction Tip	1	Boeing F70330	BCAG
Hinge Support	2	Boeing F70330	BCAG
Platform Scale	1	—	Not specified. A certified scale that has 0.01 pound (4.5 g) gradations and a 500 pound (226.8 kg) capacity is the necessary minimum.
Protractor Level	1	—	Not specified. A level that has an accuracy of ±1 degree is the necessary minimum.
Elevator Tab Assembly Support Tool	1	Boeing MIT183A8100	BCAG
C-Clamps	2	—	Not specified.
Balance Scale	1	—	Not specified. A certified scale that has 0.005 pound (2.27 g) graduations and a 10 pound (4.5 kg) capacity is the necessary minimum.





Typical Static Balance Moment Measurement Tools and Equipment
Figure 1 (Sheet 1 of 2)



Typical Static Balance Moment Measurement Tools and Equipment
Figure 1 (Sheet 2 of 2)

7. **Sign Conventions:**

A. When you balance a Category I or II Control Surface, use the sign conventions that follow.

(1) Distances:

(a) Make the distances aft of the hinge centerline to be positive (+).

(b) Make the distances forward of the hinge centerline to be negative (-).

(2) Weight Reactions:

(a) Weight Reactions are considered to be positive (+) if the Control Surface makes a downward load on the support.

(b) Weight Reactions are considered to be negative (-) if the Control Surface makes an upward load on the support.

(3) Check Balance Moments:

(a) Positive (+) Balance Moments identify Control Surfaces that are under-balanced. This means:

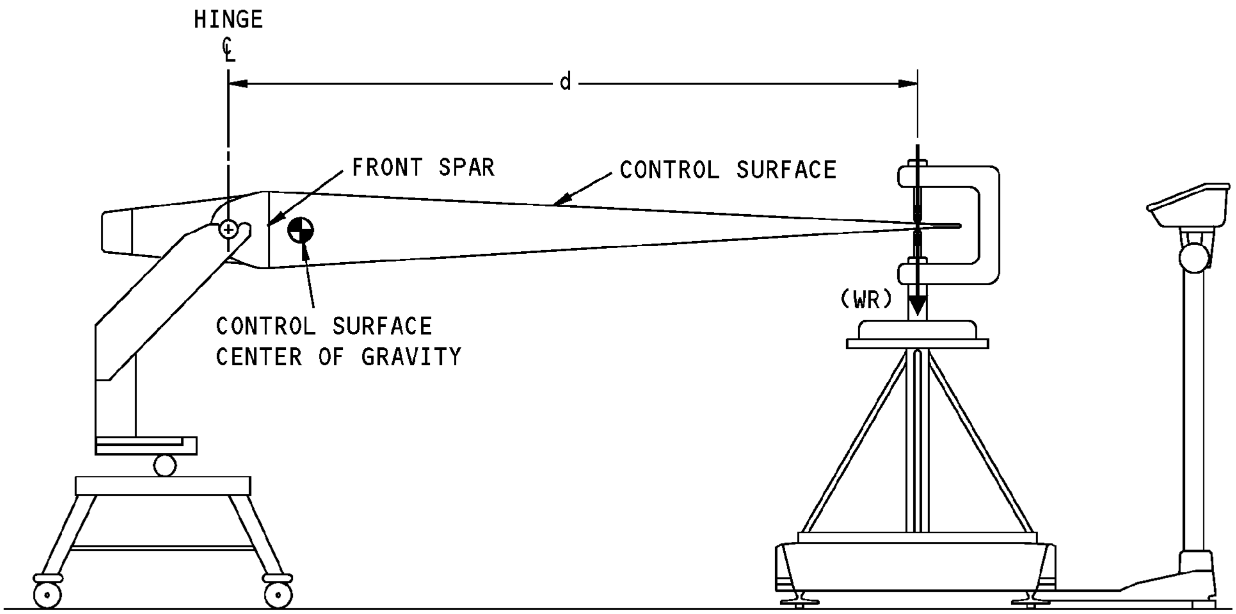
1) The center of gravity is aft of the hinge centerline. An example would be the rudder. Refer to Under-Balanced Control Surface Sample Calculation, Figure 2/GENERAL.

(b) Negative (-) balance moments identify control surfaces that are over-balanced.

1) The center of gravity is forward of the hinge centerline. An example would be the aileron or elevator. Refer to Over-Balanced Control Surface Sample Calculation, Figure 3/GENERAL.

Table 6:

REPAIR MATERIAL WEIGHTS		
DESCRIPTION	**SPECIFICATION**	**WEIGHT**
Preimpregnated Fiberglass	BMS 8-139, Class 3, Style 108	0.000118 $lbs/in^2/ply$
	BMS 8-139, Class 3, Style 120	0.000255 $lbs/in^2/ply$
Honeycomb Core	BMS 8-124, Class 4, Type 5, Grade 3	0.0017 lbs/in^3
Adhesive	BMS 8-245, Class 1, Type 2, Grade 3A	0.000226 lbs/in^2
	BMS 5-90, Type 2, Grade 50	0.0025 lbs/in^2
Carbon Fiber Reinforced Plastic (CFRP)	BMS 8-256, Type 4, Class 2, Style 3K-70-PW	0.000458 $lbs/in^2/ply$
Sealants	BMS 5-95	0.055 lbs/in^3
	BMS 5-142	0.035 lbs/in^3
Finishes	BMS 10-60, Type 2	0.0000486 $lbs/in^2/mil$
	BMS 10-86, Type 1 or 2	0.0000486 $lbs/in^2/mil$
	BMS 10-103, Type 1	0.000069 $lbs/in^2/mil$
Other Materials	1 Mil Tedlar	0.000055 lbs/in^2
	BMS 8-341, Type 2	0.000226 lbs/in^2



ARRANGEMENT OF EQUIPMENT TO MEASURE THE
STATIC BALANCE MOMENT OF A CONTROL SURFACE

SAMPLE CALCULATION (MOMENT): M = (WR) x d

SCALE READING	= _____	POUNDS
WEIGHT OF THE TOOL STAND	= _____	POUNDS
WEIGHT REACTION (WR)	= _____	POUNDS [1]
MOMENT ARM (d)	= _____	INCHES [2]
STATIC BALANCE MOMENT (M)	= _____	POUND INCHES

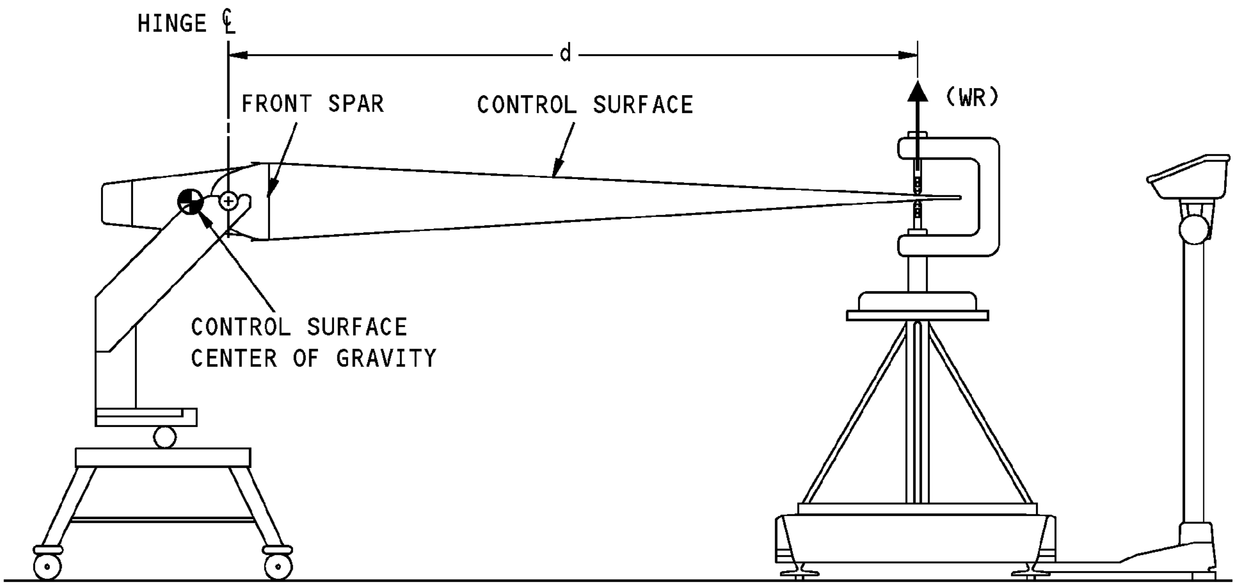
NOTES

- THE DIAGRAM IS TYPICAL FOR THE RUDDER. IT IS NOT TYPICAL FOR THE ELEVATOR AND AILERON.
- THE ACTUAL STATIC BALANCE MOMENT IS COMPARED WITH THE OPERATIONAL LIMIT FOR THE CONTROL SURFACE. IF NECESSARY, MAKE AN ADJUSTMENT TO THE MASS BALANCE TO MAKE THE STATIC BALANCE MOMENT (M) NOT BE MORE THAN THE OPERATIONAL LIMITS.

[1] (WR) = THE SCALE READING MINUS THE WEIGHT OF THE TOOL STAND. THE DOWNWARD FORCE IS POSITIVE.

[2] THE DISTANCES FORWARD OF THE HINGE CENTERLINE ARE NEGATIVE. THE DISTANCES AFT OF THE HINGE CENTERLINE ARE POSITIVE.

Under-Balanced Control Surface Sample Calculation
Figure 2



ARRANGEMENT OF EQUIPMENT TO MEASURE THE
STATIC BALANCE MOMENT OF A CONTROL SURFACE

SAMPLE CALCULATION (MOMENT): M = (WR) x d

SCALE READING	=	_____	POUNDS
WEIGHT OF THE TOOL STAND	=	_____	POUNDS
WEIGHT REACTION (WR)	=	_____	POUNDS [1]
MOMENT ARM (d)	=	_____	INCHES [2]
STATIC BALANCE MOMENT (M)	=	_____	POUND INCHES

NOTES

- THE DIAGRAM IS TYPICAL FOR THE ELEVATOR AND AILERON. IT IS NOT TYPICAL FOR THE RUDDER.
- THE ACTUAL STATIC BALANCE MOMENT IS COMPARED WITH THE OPERATIONAL LIMIT FOR THE CONTROL SURFACE. IF NECESSARY, MAKE AN ADJUSTMENT TO THE MASS BALANCE TO MAKE THE STATIC BALANCE MOMENT (M) NOT BE MORE THAN THE OPERATIONAL LIMITS.

[1] (WR) = THE SCALE READING MINUS THE WEIGHT OF THE TOOL STAND. THE UPWARD FORCE IS NEGATIVE.

[2] THE DISTANCES FORWARD OF THE HINGE CENTERLINE ARE NEGATIVE. THE DISTANCES AFT OF THE HINGE CENTERLINE ARE POSITIVE.

Over-Balanced Control Surface Sample Calculation
Figure 3

8. Balance Procedures That Are Common to All Categories I and II Control Surfaces

A. You can balance the Control Surface on the airplane or off the airplane.

(1) To balance the Control Surface on the airplane, do the general procedures that follow to find the Balance Moment.

(a) Find the Rework Weight (RW) and the Moment Arm (d).

(b) Find the distance from (RW) to the hinge centerline as given in the applicable SRM. Refer to Chapter-Section-Subject (51-60-01 through 51-61-06).

(c) Calculate the Rework Moment of the Control Surface with the formula M = (RW) X (d).

1) Make sure you use the correct sign convention for (RW) and d. Refer to Paragraph 7./GENERAL for the correct sign convention to use.

2) Refer to Under-Balanced Control Surface Sample Calculation, Figure 2/GENERAL and Over-Balanced Control Surface Sample Calculation, Figure 3/GENERAL for the example calculations.

(d) Check the Rework Record for reworks that have been done. If you have past reworks, do as follows:

1) Add all of the Rework Moments that have been done to the Check Balance Moment.

(e) If the available Balance Adjust Weights are not sufficient to obtain the Calculated Rework Limits, then:

1) The Control Surface is not serviceable

2) You must do the procedures given in Paragraph 9./GENERAL

(f) If the available Balance Adjust Weights are sufficient to obtain the calculated rework limits, continue with the instructions that remain in Paragraph 8.A.(1)/GENERAL

(g) Install or remove the Balance Adjust Weights as necessary to allow the moment of the Control Surface to be within the Calculated Rework Limits.

(h) Stamp the moment value on a metal nameplate and attach it to the Control Surface.

NOTE: Do not steel stamp the installed markers.

(i) Make an entry of the Rework Moment, location, and the date in the airplane's rework record.

(2) To balance the Control Surface off the airplane, do the general procedures that follow to find the Balance Moment.

(a) Put the Control Surface in a balanced fixture that will permit the surface to pivot freely about its hinge centerline.

(b) Make the Control Surface level as given in the applicable Chapter-Section-Subject (51-60-01 through 51-61-06).

(c) Find the Weight Reaction (WR) and the moment arm (d).

(d) Find the distance (d) from (WR) to the hinge centerline as given in the applicable SRM. Refer to Chapter-Section-Subject (51-60-01 through 51-61-06).

(e) Calculate the Balance Moment of the Control Surface with the formula M = (WR) X (d).

1) Make sure you use the correct sign convention for (WR) and d. Refer to Paragraph 7./GENERAL for the correct sign convention to use.

2) Refer to Under-Balanced Control Surface Sample Calculation, Figure 2/GENERAL and Over-Balanced Control Surface Sample Calculation, Figure 3/GENERAL for the example calculations.

(f) Install or remove the Balance Adjust Weights as necessary to adjust the Balance Moment of the Control Surface to be within the Operational Limits.

(g) If the available Balance Adjust Weights are not sufficient to obtain the Operational Limits, then:

1) The Control Surface is not serviceable

2) You must do the procedures given in Paragraph 9./GENERAL

(h) Do steps 8.A.(2)(b) through 8.A.(2)(e) again to check the new Balance Moment.

(i) Stamp the moment value on a metal nameplate and attach it to the Control Surface.

NOTE: Do not steel stamp the installed markers.

(j) Make an entry of the Check Balance Moment, rework location, and the date in the airplane's rework record.

9. Serviceability of Categories I and II Control Surfaces

A. Repair, rework, or repaint of the Control Surface is not permitted if the Control Surface cannot be put back into service.

(1) For a Control Surface to be serviceable, it must be balanced within the limits given in Table 2/GENERAL or Table 3/GENERAL.

B. A Category I Control Surface can be put into service after a repair, rework, or repaint, if:

(1) You can get the balance limits given in Table 2/GENERAL or Table 3/GENERAL when you add a sufficient number of adjust weights.

NOTE: For a Control Surface balanced on the airplane by calculation, the Calculated Rework Limits must be used. For a Control Surface balanced off the airplane with a balance fixture, the Operational Limits must be used.

C. A Category II Control Surface can be put into service after a repair, rework, or repaint only after it has been weighed.

NOTE: The weight is within the limits given in Table 2/GENERAL or Table 3/GENERAL.

D. It is possible to make a Category I Control Surface serviceable by removing the Control Surface from the airplane and finding the Balance Moment with a balance fixture. Use the Operational Limits given in Table 2/GENERAL or Table 3/GENERAL.

E. Category I Control Surfaces which are not removed from the airplane or are not within the Operational Limits in a balance fixture can be made serviceable if you do as follows.

(1) Remove all the paint applied to the Control Surface.

NOTE: Removal of part of the paint on the Control Surface is not permitted.

(2) Apply a new finish that is equivalent to the initial finish.

(3) Remove the necessary Balance Adjust Weights equivalent in moment to the addition of all previous Rework Moments caused by repainting.

NOTE: Do not remove the Balance Adjust Weights for the initial finish or the finish applied during manufacture.

(4) Make sure that Balance Adjust Weights installed for repairs that have been done (do not include repaints) remain equivalent in moment to:

(a) The addition of all Rework Moments that have been done.

(5) Install the necessary Balance Adjust Weights equivalent in moment for the new finish applied to get the balance limits given in Table 2/GENERAL or Table 3/GENERAL.

NOTE: For a Control Surface balanced on the airplane by calculation, the Calculated Rework Limits must be used. For a Control Surface balanced off the airplane with a balance fixture, the Operational Limits must be used.

(6) Stamp the moment value on a metal nameplate and attach it to the Control Surface.

NOTE: Do not steel stamp the installed markers.

(7) Make an entry of the Check Balance Moment, rework Location, and the date in the airplane's rework record.

(8) If a Control Surface cannot be made serviceable, then do one of the two:

(a) Remove and replace the Control Surface

(b) Ask The Boeing Company to make an analysis of the Rework Record so it can be decided if the Control Surface can be serviceable in the future.

GENERAL - AILERON BALANCE PROCEDURE

1. **Applicability**

WARNING: IF THE BALANCE MOMENT OF THE AILERON IS NOT WITHIN THE LIMITS OF THE SECONDARY STATIC BALANCE REQUIREMENTS, A CONDITION DANGEROUS TO FLIGHT SAFETY CAN OCCUR.

CAUTION: IF AN AILERON ASSEMBLY IS REMOVED FROM THE AIRPLANE, REWORKED, REPAIRED, OR REPAINTED, OR IF A NEW AILERON ASSEMBLY IS INSTALLED, IT MUST BE BALANCED AND STAMPED WITH THE NEW STATIC BALANCE HINGE MOMENT (SBHM). WHEN YOU DO ABRASIVE BLAST PROCEDURES IN AREAS WHERE LUBRICATION FLUIDS OR GREASE ARE APPLIED, USE CARE TO PREVENT CONTAMINATION OF THE LUBRICANT WITH THE BLAST RESIDUE. THIS CONTAMINATION CAN AFFECT THE LUBRICATION PROPERTIES AND THE RESULT CAN BE INCREASED WEAR OF THE LUBRICATED PARTS.

A. This subject gives the necessary data for the static balance requirements for the aileron assembly.

B. Refer to 51-60-02 for the weight control procedure for the aileron balance panels.

C. Refer to 51-60-03 for the aileron tab balance procedure.

2. **General**

A. Refer to 51-60-00 for the general data such as:
   (1) Categories of control surfaces
   (2) General balance instructions
   (3) Serviceability
   (4) Definitions of terms
   (5) Sign conventions
   (6) Measurement accuracy
   (7) Special tools and equipment
   (8) Repair material weights.

B. The aileron assembly is a Category I Control Surface.

C. Before you complete a repair or repaint on the aileron, you must make sure that it is possible to balance the aileron within the limits of the secondary static balance requirements as given in Paragraph 2.F./GENERAL after the repair or repaint has been completed.
   (1) To make sure that it is possible to balance the aileron within the limits of the secondary static balance requirements as given in Paragraph 2.F./GENERAL after the repair or repaint has been completed, you must:
      (a) Find the current Static Balance Hinge Moment (SBHM)
      (b) Find the ΔM as a result of the repair or repaint
      (c) Find the number of available aileron balance adjust weight positions and thus the rework capability.

D. If it is not possible to meet the secondary static balance requirements with the current Static Balance Hinge Moment (SBHM), the ΔM as a result of the repair or repaint, and the number of available aileron balance adjust weight positions, you can restore the rework capability as follows:
   (1) Remove all layers of paint from the aileron assembly.

(a) Remove the aileron assembly from the wing. Refer to AMM 27-11-11-000-801.

NOTE: Removal of the aileron assembly from the wing is necessary for removal of the balance adjust weights.

(b) Refer to AMM 51-21-11/701 for the paint removal procedures.

(c) Remove the balance adjust weights which are equal in moment to the layers of paint that were added to the initial paint application.

NOTE: These layers of paint are removed to restore the rework capability of the aileron assembly. This does not include the initial paint application. Do not remove the adjust weights necessary for the initial paint application.

(d) Restore the decorative exterior paint to the aileron assembly.

1) Use the same specifications as the initial paint application you removed.

2) Refer to AMM PAGEBLOCK 51-21-99/701 for the paint application procedures.

NOTE: The restored paint is a repaint. It will be necessary to add adjust weights that are equal in moment to this paint application.

NOTE: If there are other rework areas or repairs on the aileron assembly, it is still necessary to add adjust weights equal in moment to these areas.

E. The aileron can be balanced by one of two methods:

(1) The static balance jig procedure Refer to Paragraph 5.A./GENERAL for the balance procedure on the static balance jig.

(a) The aileron must be removed from the airplane to be balanced on the static balance jig. For the configuration of the aileron at the time of the balance procedure, refer to Paragraph 2.G./GENERAL

(2) The calculation procedure Refer to Paragraph 5.B./GENERAL for the balance procedure by calculation.

(a) This procedure does not require the use of a static balance jig. The calculation procedure can be used with the aileron on or off the airplane as long as the repair and balance requirements are met. You must make sure that the necessary data is recorded during the repair or rework so that the calculations can be made accurately.

(b) Be careful when you calculate the weight of the material removed (or lost as a result of damage) and the weight of the material added.

1) Measure or calculate the weight of the material removed and the weight of the material added as accurately as possible.

2) Keep the tolerance very small or else you can have weight that is not satisfactory. What follows will have an effect on the tolerance:

a) The tolerance of the weighing equipment

b) The precision in your estimation of the weight of the material that has been removed

c) The precision in your estimation of the weight of the repair materials or paint.

(c) Find the distance from the hinge line to the center of gravity of the repair to within ±0.1 inch (±2.5 mm). What follows will have an effect on the tolerance:

1) The possible error in the estimation of the position of the center of gravity of the repair

2) The possible error in the measurement of the distance from the center of gravity of the repair to the aileron hinge line.

F. The aileron installation must be balanced so that the total effective center of gravity is within the limits for the primary static balance requirement.

(1) The primary static balance requirement, or the location of the center of gravity for the aileron installation, is 0.05 to 0.30 inch (1.270 to 7.620 mm) forward of the aileron hinge line.

(2) To get this, you must make sure, by measurement or calculation, that the secondary static balance requirements for the aileron are met. Refer to Table 1/GENERAL for the secondary static balance requirements.

(3) The secondary static balance requirement for the aileron assembly when you balance the aileron by measurement on the balance jig requires a component moment between -30.70 and -2.50 lbf.in (-3.47 and -0.28 Nm).

(4) The secondary static balance requirement for the aileron assembly when you balance the aileron by calculation on or off the airplane requires a component moment between -30.70 and -6.00 lbf.in (-3.47 and -0.68 Nm).

(5) It is suggested that you balance the aileron assembly nearest to the most forward component moment of -30.70 lbf.in (-3.47 Nm) to account for future repairs, painting, or rework.

Table 1:

COMPONENT	ENGINEERING DRAWING	SECONDARY STATIC BALANCE REQUIREMENT		
		COMPONENT WEIGHT lbm (kg)	COMPONENT MOMENT lbf.in (Nm)	REFER TO SRM
Aileron Assembly	113A7100-( ) 113A7400-( )	Not Applicable	BALANCE PROCEDURE BY MEASUREMENT ON THE BALANCE JIG: -30.70 to -2.50 (-3.47 to -0.28)	51-60-01 Paragraph 5.A
			BALANCE PROCEDURE BY CALCULATION ON THE AIRPLANE: -30.70 to -6.00 (-3.47 to -0.68)	51-60-01 Paragraph 5.B
Balance Panel Bay Number 1	113A7315-1 (LH and RH)	3.55 ± 0.13 (1.61) ± (0.059)	Not Applicable	51-60-02
Balance Panel Bay Number 2	113A7315-2 (LH and RH)	3.87 ± 0.13 (1.76) ± (0.059)	Not Applicable	51-60-02
Balance Panel Bay Number 3	113A7315-3 (LH and RH)	4.05 ± 0.13 (1.84) ± (0.059)	Not Applicable	51-60-02
Balance Panel Bay Number 4	113A7315-4 (LH and RH)	4.29 ± 0.13 (1.95) ± (0.059)	Not Applicable	51-60-02
Aileron Tab Assembly	113A7200-( )	5.36 maximum (2.43 maximum)	Not Applicable	51-60-03
Fixed Balance Weights	113A7183-5 (LH and RH)	0.53 to 0.58 (0.24 to 0.26)	Not Applicable	Not Applicable
	113A7183-7 (LH) 113A7183-8 (RH)	1.76 to 1.94 (0.80 to 0.88)	Not Applicable	Not Applicable
	113A7183-9 (LH and RH)	2.79 to 3.05 (1.27 to 1.38)	Not Applicable	Not Applicable
	113A7223-1 (LH and RH)	1.10 to 1.20 (0.50 to 0.54)	Not Applicable	Not Applicable
	113A7223-3 (LH and RH)	0.54 to 0.60 (0.24 to 0.27)	Not Applicable	Not Applicable

G. Before you balance the aileron assembly on the static balance jig, you must make sure that it is a complete assembly as given on engineering drawing 113A7100-( ) and 113A7400-( )

NOTE: Refer to Configuration of the Aileron at the Time of the Balance Procedure on the Static Balance Jig, Figure 1/GENERAL for the as-balanced configuration of the aileron assembly. The as-balanced configuration includes all exterior finishes. Some parts need to be removed from the aileron assembly as given on engineering drawing 113A7100-( ) and 113A7400-( ). These parts are listed in Paragraph 2.G.(2).

(1) The as-balanced configuration of the aileron assembly for the static balance jig procedure does not include the parts that follow:

(a) Radial Seals - Part Numbers 113A7150-1 through 113A7150-12

(b) Radial Seal Retainers - Part Numbers 113A7151-1 through 113A7151-18

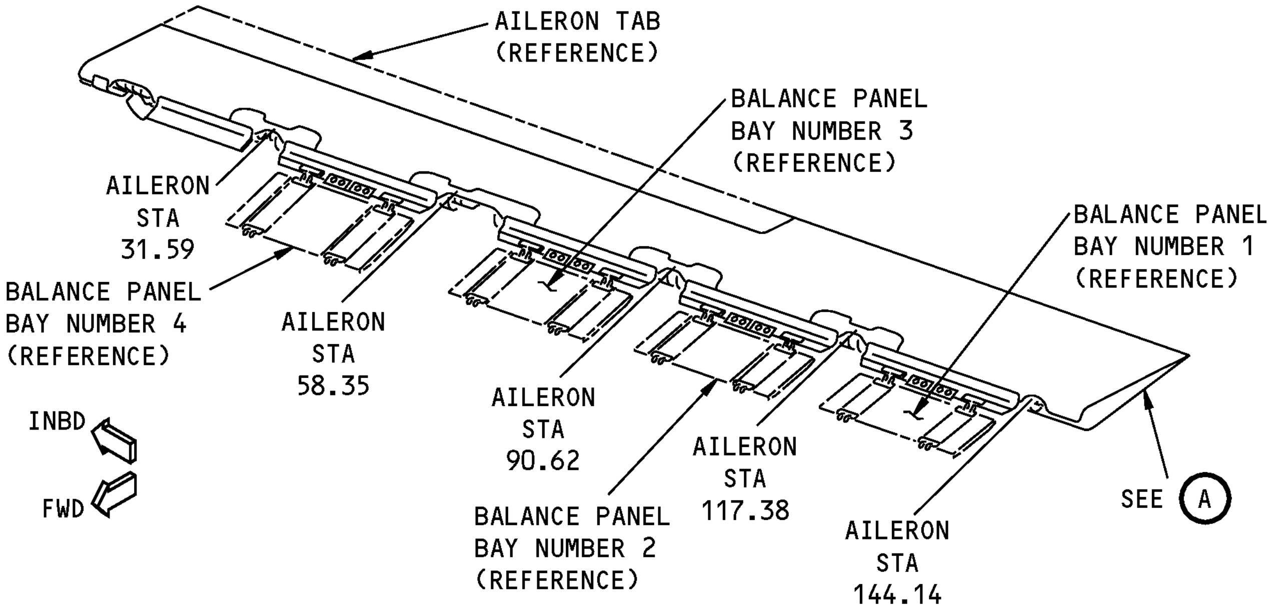
(c) Hinge Cover Assemblies - Part Numbers 113A7171-1/-2, -5/-6, -9/-10, -13/-14, -17/-18, -21/-22, and -25/-26

(d) Nose Clip - Part Numbers 113A7184-1/-2

(e) All attaching parts of the parts listed above.

H. Because of the configuration of the wing, it is not possible to add aileron balance adjust weights to the aileron without the removal of the aileron from the airplane.

I. Make sure that you keep to the sign conventions as given in 51-60-00, except where noted.

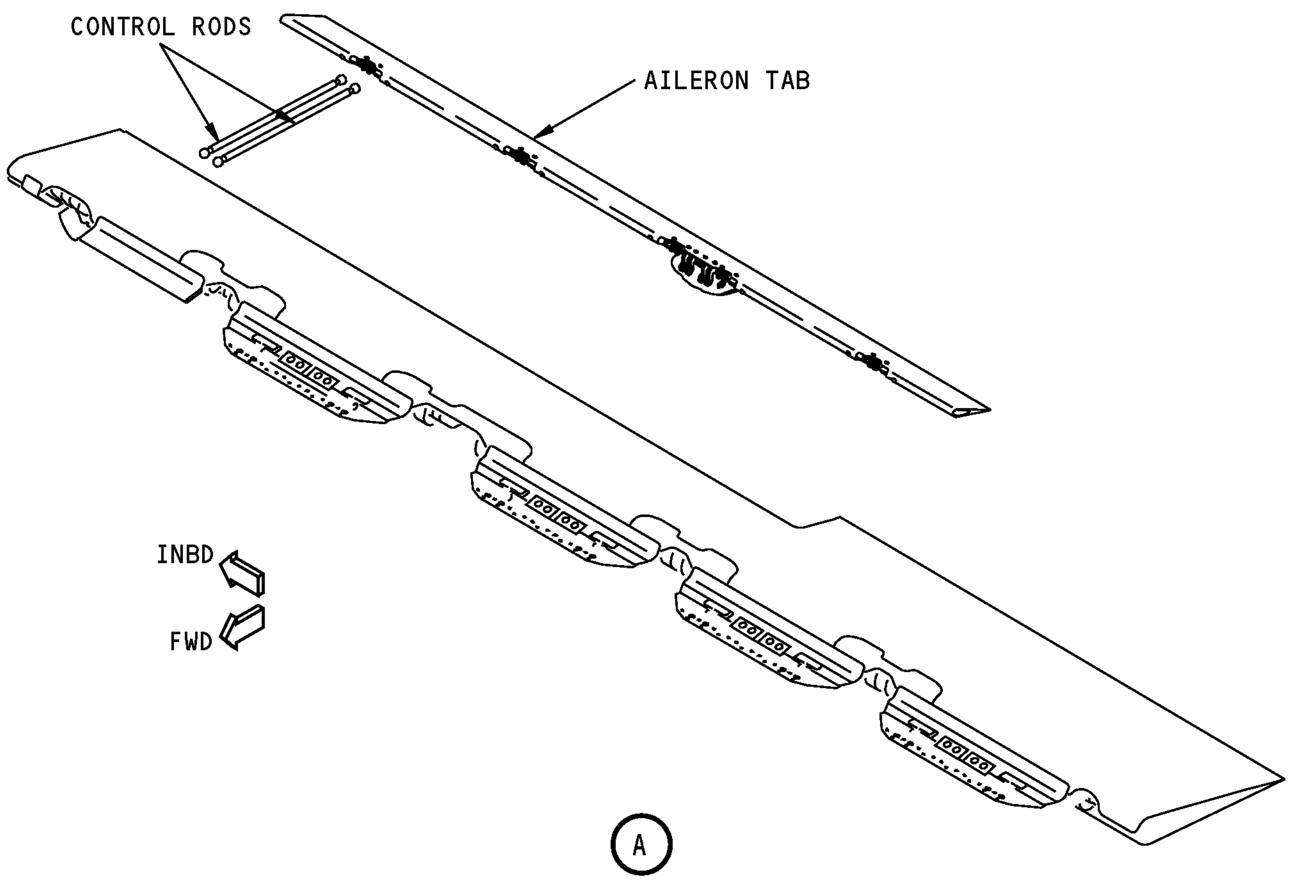


LEFT SIDE AILERON IS SHOWN, RIGHT SIDE AILERON IS OPPOSITE

NOTES

- THE AILERON MUST BE A COMPLETE ASSEMBLY AS GIVEN ON ENGINEERING DRAWING 113A7100-( ) OR 113A7400-( ). THIS INCLUDES ALL PROTECTIVE FINISHES AND DECORATIVE PAINT.
- DO NOT INCLUDE:
  - INSTALLATION BOLTS, NUTS, AND WASHERS THAT ATTACH THE AILERON TAB TO THE AILERON
  - CONTROL RODS AND THEIR INSTALLATION BOLTS, NUTS, AND WASHERS.
- REFER TO PARAGRAPH 2.G FOR A DETAILED BREAKDOWN OF THE AS-BALANCED CONFIGURATION OF THE AILERON WHEN BALANCED ON THE STATIC BALANCE JIG.

Configuration of the Aileron at the Time of the Balance Procedure on the Static Balance Jig
Figure 1 (Sheet 1 of 2)



Configuration of the Aileron at the Time of the Balance Procedure on the Static Balance Jig
Figure 1 (Sheet 2 of 2)

3. References

Reference	Title
51-60-00	CONTROL SURFACE BALANCING
51-60-02	WEIGHT CONTROL PROCEDURE FOR THE AILERON BALANCE PANELS
51-60-03	AILERON TAB BALANCE PROCEDURE
51-60-03, GENERAL	Aileron Tab Balance Procedure
51-70-05	REPAIR PROCEDURES FOR PREIMPREGNATED MATERIALS
AMM 51-21-99 P/B 701	DECORATIVE EXTERIOR PAINT SYSTEM - CLEANING/PAINTING
AMM 27-11-11-000-801	Aircraft Maintenance Manual
AMM 27-11-11/401	Aileron - Removal/Installation
AMM 27-11-21/401	Aileron Tab - Removal/Installation
AMM 27-11-31/401	Aileron Balance Panel Removal and Installation
AMM 51-21-11/701	Paint Stipping - Cleaning/Painting
SOPM 20-50-13	Application of Weather, Fuel, Oil, Solvent, and Heat Resistant Protective Coatings

4. Prepare for the Balance Procedure

A. For the balance procedure on the balance jig, do as follows:

(1) Remove the aileron from the airplane. Refer to AMM 27-11-11/401.

(2) Remove the aileron tab from the aileron. Refer to AMM 27-11-21/401.

(3) Remove the aileron balance panels from the aileron. Refer to AMM 27-11-31/401.

(4) Make sure that the fixed weights and balance bay hinge seals are installed.

(5) Make sure that the aileron assembly that you want to balance has the configuration as given in Paragraph 2.G./GENERAL

B. For the balance procedure by calculation there are no specific preparations for the balance procedure.

5. Balance Procedure

A. Aileron Assembly Static Balance Procedure by Measurement on the Static Balance Jig

NOTE: The secondary static balance requirement for the aileron assembly when you balance the aileron by measurement on the balance jig requires a component moment between -30.70 and -2.50 lbfin (-3.47 and -0.28 Nm).

(1) Install the aileron assembly, with the lower surface up, in the static balance jig. Refer to Aileron Support and Balance at time of the Balance Procedure on the Static Balance Jig, Figure 2/GENERAL.

(a) Use aileron hinge fittings number 2 (AILERON STA 117.38) and number 5 (AILERON STA 31.59) for the installation of the aileron assembly in the balance jig.

NOTE: Make sure that the aileron assembly can pivot freely about its hinge centerline.

(b) Level the horizontal chord plane ± 1 degree with a protractor level.

(2) Use the platform scale and toolstand to measure the Weight Reaction (WR) at a tab hinge fitting centerline. Refer to Aileron Support and Balance at time of the Balance Procedure on the Static Balance Jig, Figure 2/GENERAL.

WR = __________ lbf (N)

NOTE: Refer to 51-60-00 for the weight measurement precision for the Weight Reaction (WR).

(3) Calculate the trial Check Balance Moment (CBM) with the formula:

trial CBM = (WR) x (d), where:

- WR is the Weight Reaction measured at a tab hinge fitting in lbf (N)
- d is the moment arm distance between the aileron hinge centerline and the tab hinge fitting centerline (d = +10.48 in. (+266.19 mm = +0.266 m)).

trial CBM = __________ lbfin (Nm) The trial CBM is the new final moment (Static Balance Hinge Moment) if it is within the given limits.

(a) If -30.70 lbfin $\leq$ trial CBM $\leq$ -2.50 lbfin (-3.47 Nm $\leq$ trial CBM $\leq$ -0.28 Nm), the secondary static balance requirement for the aileron assembly is met. In this situation you can do one of the steps that follow:

1) Because the static balance requirement for the aileron assembly is met you do not need to install additional aileron balance adjust weights. The trial CBM is the new final moment (Static Balance Hinge Moment) if it is within the given limits. Continue with step 5.A.(7).

2) Balance the aileron assembly to a desired balance moment anywhere between -30.70 and -2.50 lbfin (-3.47 and -0.28 Nm) by adding sufficient aileron balance adjust weights. Refer to Paragraph 5.C./GENERAL for an Example.

3) Balance the aileron assembly nearest to the most forward component moment of -30.70 lbfin (-3.47 Nm) to account for future repairs, painting, or rework. Refer to Paragraph 5.C./GENERAL for an Example.

(b) If the trial CBM is less negative than -2.50 lbfin (-0.28 Nm) or positive, the secondary static balance requirement for the aileron assembly is not met and you must add aileron balance adjust weights. In this situation you can do one of the steps that follow:

1) Balance the aileron assembly to a desired balance moment anywhere between -30.70 and -2.50 lbfin (-3.47 and -0.28 Nm) by adding sufficient aileron balance adjust weights. Refer to Paragraph 5.C./GENERAL for an Example.

2) Balance the aileron assembly nearest to the most forward component moment of -30.70 lbfin (-3.47 Nm) to account for future repairs, painting, or rework. Refer to Paragraph 5.C./GENERAL for an Example.

(c) A trial CBM that is more negative than -30.70 lbfin (-3.47 Nm) is not likely to occur and therefore will not be described in this subject.

(4) Find the number of aileron balance adjust weights that you must install to meet the secondary static balance requirement for the aileron assembly.

(a) Aileron Assembly Balance Adjust Weight Table, Figure 3/GENERAL, Table I gives the total change in moment (ΔM) as a result of the addition of a number of aileron balance adjust weights to an existing number of adjust weights already installed. The values of ΔM given in the table account for the weight of the different adjust weights as well as for the sequence in which the adjust weights must be installed.

(b) For a given trial CBM as found in Paragraph 5.A.(3)/GENERAL and together with the formula:

-30.70 $\leq$ (ΔM + trial CBM) $\leq$ -2.50 (lbfin) (-3.47 $\leq$ (ΔM + trial CBM) $\leq$ -0.28 (Nm)) you can find the necessary number of aileron balance adjust weights from Aileron Assembly

Balance Adjust Weight Table, Figure 3/GENERAL, Table I that must be installed for a given number of adjust weights already installed and the desired Static Balance Hinge Moment (SBHM) desired SBHM = (ΔM) + (trial CBM)

(5) Install the necessary number of aileron balance adjust weights found in step 5.A.(4), part number 113A7183-3 and/or 113A7183-6.

(a) Refer to Aileron Balance Adjust Weight Location and Installation Sequence, Figure 4/GENERAL for:

1) The location where the aileron balance adjust weights must be installed

2) The sequence in which the aileron balance adjust weights must be installed.

(b) If the Boeing aileron balance adjust weights, part number 113A7183-3 or 113A7183-6, are not available, you can make aileron balance adjust weights as given in Aileron Balance Adjust Weights, Figure 5/GENERAL.

(c) Install the aileron balance adjust weights, part number 113A7183-3 with:

NOTE: Before you install the aileron balance adjust weights you must remove the NAS6703-6 bolts that attach the fixed weight to the nose fitting and replace them with NAS6703-8 bolts.

1) NAS6703-8 bolts

2) BACW10BP3DP washers (under the nuts)

3) BACN10YR3CD nuts.

(d) Install the aileron balance adjust weights, part number 113A7183-6 with:

NOTE: Before you install the aileron balance adjust weights you must remove the NAS6703-8 bolts that attach the fixed weight to the nose fitting and replace them with NAS6703-12 bolts.

1) NAS6703-12 bolts

2) BACW10BP3DP washers (under the nuts)

3) BACN10YR3CD nuts.

(6) Calculate a second trial Check Balance Moment (CBM):

(a) Level the horizontal chord plane ±1 degree with a protractor level.

(b) Use the platform scale and toolstand to measure the Weight Reaction (WR) at a tab hinge fitting centerline. Refer to Aileron Support and Balance at time of the Balance Procedure on the Static Balance Jig, Figure 2/GENERAL.

WR = __________ lbf (N)

NOTE: Refer to 51-60-00 for the weight measurement precision for the Weight Reaction (WR).

(c) second trial Check Balance Moment (CBM) = (WR) x (d), where:

- WR is the (new) Weight Reaction measured in lbf (N)
- d is the moment arm distance between the aileron hinge centerline and the tab hinge fitting centerline (d = +10.48 in. (+266.19 mm = +0.266 m)).

second trial CBM = __________ lbfin (Nm)

(d) If the second trial CBM is within the limits as given in Paragraph 2.F./GENERAL, the second trial Check Balance Moment (CBM) becomes the new Static Balance Hinge Moment (SBHM).

second trial CBM = new (SBHM) = __________ lbfin (Nm) Continue with step 5.A.(7).

(e) If the second trial CBM is not within the limits as given in Paragraph 2.F./GENERAL, do one of the steps that follow:

1) If there are enough weight positions to bring the moment within the limits, repeat steps 5.A.(1) through 5.A.(6).

2) If there are not enough weight positions to bring the moment within the limits, do as follows:

a) Remove all layers of paint from the aileron assembly. Refer to AMM 51-21-11/701 for the paint removal procedures.

b) Restore the aileron assembly decorative exterior paint system. Refer to AMM PAGEBLOCK 51-21-99/701.

c) Repeat steps 5.A.(1) through 5.A.(6).

d) If it is not possible to get the aileron balanced within the specified limits after the removal of multiple layers of paint, you must replace the aileron assembly.

(7) Vibro-engrave or rubber-stamp the value of the new Static Balance Hinge Moment (SBHM) on the metal part identification plate (MS27253-1) that is attached to the aileron assembly.

(a) Apply a Skydrol resistant finish to the rubber-stamped data as given in SOPM 20-50-13.

(b) Do not stamp the installed metal nameplate with steel stamps.

(8) Make a record in the repair log of:

(a) The new Static Balance Hinge Moment (SBHM)

(b) The fact that the aileron has been balanced on the static balance jig

(c) The type of repair

(d) The location of the repair

(e) The date when the aileron was repaired and balanced

(f) The number of aileron balance adjust weights that are installed and the number of available spaces for the addition of weight.

B. Aileron Assembly Static Balance Procedure by Calculation

NOTE: The secondary static balance requirement for the aileron assembly when you balance the aileron by calculation requires a component moment between -30.70 and -6.00 lbfin (-3.47 to -0.68 Nm).

(1) Review the repair log and find the available Rework Moment (RM).

(2) Measure the distance D (within 0.1 inch (2.5 mm)). D is the distance from the rework center of gravity (CG) along the skin surface to the intersection of the centerline of the aileron hinge and the upper skin. Refer to Aileron Balance, Figure 6/GENERAL.

D = __________ inches (m)

(3) Measure or calculate the distance Y. Y is the distance from the aileron hinge centerline to the line through the CG of the rework, perpendicular to the aileron hinge line and parallel to the aileron chord line. Refer to Aileron Balance, Figure 6/GENERAL. To calculate the distance Y, use the formula that follows:

Y = (D) x (cos 6.7°) = __________ inches (m)

(4) Weigh or calculate the Weight removed (Wr). Wr is the Weight removed as a result of rework, repair, or re-painting. Refer to Paragraph 5.D./GENERAL for an Example Calculation of the Weight removed (Wr).

Wr = +_________ lbm (kg) (KEEP POSITIVE)

(5) Weigh or calculate the Weight added (Wa). Wa is the Weight added as a result of rework, repair, or re-painting. Refer to Paragraph 5.D./GENERAL for an Example Calculation of the Weight added (Wa).

Wa = __________ lbm (kg)

(6) Calculate the Rework Weight (RW). RW is the net change in weight as a result of rework, repair, or re-painting. Refer to Paragraph 5.D./GENERAL for an Example Calculation of the Rework Weight (RW).

RW = Wa - Wr = __________ lbm (kg)

(7) Calculate the Rework Moment (RM). RM is the net change in balance moment as a result of rework, repair, or re-painting. Refer to Paragraph 5.D./GENERAL for an Example Calculation of the Rework Moment (RM).

RM = (RW) x (Y) = __________ lbfin (Nm)

(8) Calculate the trial Check Balance Moment (CBM). The trial CBM is the new final moment (Static Balance Hinge Moment) if it is within the given limits.

trial CBM = (SBHM) + (RM) = __________ lbfin (Nm) where SBHM is the Static Balance Hinge Moment that is the previous final moment stamped on the nameplate of the aileron.

(a) If -30.70 lbfin $\leq$ trial CBM $\leq$ -6.00 lbfin (-3.47 Nm $\leq$ trial CBM $\leq$ -0.68 Nm), the secondary static balance requirement for the aileron assembly is met. In this situation you can do one of the steps that follow:

1) Because the static balance requirement for the aileron assembly is met you do not need to install adjust weights. Continue with step 5.B.(13).

2) Balance the aileron assembly to a desired balance moment anywhere between -30.70 and -6.00 lbfin (-3.47 and -0.68 Nm) by adding sufficient aileron balance adjust weights. Refer to Paragraph 5.D./GENERAL for an Example.

3) Balance the aileron assembly nearest to the most forward component moment of -30.70 lbfin (-3.47 Nm) to account for future repairs, painting, or rework. Refer to Paragraph 5.D./GENERAL for an Example.

(b) If the trial CBM is less negative than -6.00 lbfin (-0.68 Nm) or positive, the secondary static balance requirement for the aileron assembly is not met and you must add aileron balance adjust weights. In this situation you can do one of the steps that follow:

1) Balance the aileron assembly to a desired balance moment anywhere between -30.70 and -6.00 lbfin (-3.47 and -0.68 Nm) by adding sufficient aileron balance adjust weights. Refer to Paragraph 5.D./GENERAL for an Example.

2) Balance the aileron assembly nearest to the most forward component moment of -30.70 lbfin (-3.47 Nm) to account for future repairs, painting, or rework. Refer to Paragraph 5.D./GENERAL for an Example.

(c) A trial CBM that is more negative than -30.70 lbfin (-3.47 Nm) is not likely to occur and therefore will not be described in this subject.

(9) Find the number of aileron balance adjust weights that you must install to meet the secondary static balance requirement for the aileron assembly.

(a) Aileron Assembly Balance Adjust Weight Table, Figure 3/GENERAL, Table I gives the total change in moment (ΔM) as a result of the addition of a number of aileron balance adjust weights to an existing number of adjust weights already installed. The values of ΔM given in the table account for the weight of the different adjust weights as well as for the sequence in which the adjust weights must be installed.

(b) For a given trial CBM as found in Paragraph 5.B.(8)/GENERAL and together with the formula:

$-30.70 \leq (\Delta M + \text{trial CBM}) \leq -6.00$ (lbfin) ($-3.47 \leq (\Delta M + \text{trial CBM}) \leq -0.68$ (Nm)) you can find the necessary number of aileron balance adjust weights from Aileron Assembly Balance Adjust Weight Table, Figure 3/GENERAL, Table I that must be installed for a given number of adjust weights already installed and the desired Static Balance Hinge Moment (SBHM) desired SBHM = (ΔM) + (trial CBM)

(10) Remove the aileron from the airplane. Refer to AMM 27-11-11-000-801.

NOTE: Because of the configuration of the wing, it is not possible to add aileron balance adjust weights to the aileron without the removal of the aileron from the airplane.

(11) Install the necessary number of aileron balance adjust weights found in step 5.B.(9), part number 113A7183-3 and/or 113A7183-6.

(a) Refer to Aileron Balance Adjust Weight Location and Installation Sequence, Figure 4/GENERAL for:

1) The location where the aileron balance adjust weights must be installed

2) The sequence in which the aileron balance adjust weights must be installed.

(b) If the Boeing aileron balance adjust weights, part number 113A7183-3 or 113A7183-6, are not available, you can make aileron balance adjust weights as given in Aileron Balance Adjust Weights, Figure 5/GENERAL.

(c) Install the aileron balance adjust weights, part number 113A7183-3 with:

NOTE: Before you install the aileron balance adjust weights you must remove the NAS6703-6 bolts that attach the fixed weight to the nose fitting and replace them with NAS6703-8 bolts.

1) NAS6703-8 bolts

2) BACW10BP3DP washers (under the nuts)

3) BACN10YR3CD nuts.

(d) Install the aileron balance adjust weights, part number 113A7183-6 with:

NOTE: Before you install the aileron balance adjust weights you must remove the NAS6703-8 bolts that attach the fixed weight to the nose fitting and replace them with NAS6703-12 bolts.

1) NAS6703-12 bolts

2) BACW10BP3DP washers (under the nuts)

3) BACN10YR3CD nuts.

(12) Calculate a second trial Check Balance Moment (CBM) with the formula:

second trial CBM = previous (SBHM) + (RM) + ΔM

second trial CBM = first trial CBM + ΔM second trial CBM = __________ lbfin (Nm) where: previous SBHM is the Static Balance Hinge Moment that is the previous final moment stamped on the nameplate of the aileron. RM is the Rework Moment as found in Paragraph 5.B.(7)/GENERAL

ΔM is the change in moment selected from Aileron Assembly Balance Adjust Weight Table, Figure 3/GENERAL, Table I for a given number of aileron balance adjust weights added (n).

(a) If the second trial CBM is within the limits as given in Paragraph 2.F./GENERAL, the second trial Check Balance Moment (CBM) becomes the new Static Balance Hinge Moment (SBHM).

second trial CBM = new (SBHM) = __________ lbfin (Nm) Continue with step 5.B.(13).

(b) If the second trial CBM is not within the limits as given in Paragraph 2.F./GENERAL, do one of the steps that follow:

1) If there are enough weight positions to bring the moment within the limits, repeat steps 5.B.(1) through 5.B.(12).

2) If there are not enough weight positions to bring the moment within the limits, you can restore rework capability as follows:

a) Remove the aileron assembly from the wing. Refer to AMM 27-11-11-000-801.

NOTE: Removal of the aileron assembly from the wing is necessary for removal of the balance adjust weights.

b) Remove all layers of paint from the aileron assembly.

- Remove the balance adjust weights which are equal in moment to the layers of paint that were added to the initial paint application.
- Refer to AMM 51-21-11/701 for the paint removal procedures.

NOTE: These layers of paint are removed to restore the rework capability of the aileron assembly. This does not include the initial paint application. Do not remove the adjust weights necessary for the initial paint application.

c) Restore the decorative exterior paint to the aileron assembly.

- Use the same specifications as the initial paint application you removed.
- Refer to Table 2/GENERAL for the data for 0.001 inch thickness of paint and its effect on the moment and moment arm.
- Refer to AMM PAGEBLOCK 51-21-99/701 for the paint application procedures.

NOTE: The restored paint is a repaint. It will be necessary to add adjust weights that are equal in moment to this paint application.

NOTE: If there are other rework areas or repairs on the aileron assembly, it is still necessary to add adjust weights equal in moment to these areas.

Table 2:

VARIABLES FOR THE CALCULATION OF THE EFFECT OF ONE PAINT LAYER (BMS 10-60), 0.001 INCH (0.0254 mm) THICK ON THE COMPONENT MOMENT OF THE AILERON		
PAINTED SURFACE AREA PER AILERON	MOMENT AS A RESULT OF PAINT	MOMENT ARM OF ADDED PAINT (Distance aft of the aileron hinge center-line)

VARIABLES FOR THE CALCULATION OF THE EFFECT OF ONE PAINT LAYER (BMS 10-60), 0.001 INCH (0.0254 mm) THICK ON THE COMPONENT MOMENT OF THE AILERON		
PAINTED SURFACE AREA PER AILERON	**MOMENT AS A RESULT OF PAINT**	**MOMENT ARM OF ADDED PAINT**
ft^2 (m^2)	lbfin (Nm)	inches (mm)
25.3 (2.35)	+ 0.8855 (+ 0.1000)	+ 5.0 (+ 127.0)

d) Repeat steps 5.B.(1) through 5.B.(12).

e) If it is not possible to get the aileron balanced within the specified limits after the removal of multiple layers of paint, you can balance the aileron on the static balance jig because the limits for balancing on the balance jig are less strict. If this will not bring the aileron balance within the limits you must replace the aileron assembly.

(13) Vibro-engrave or rubber-stamp the value of the new Static Balance Hinge Moment (SBHM) on the metal part identification plate (MS27253-1) that is attached to the aileron assembly.

(a) Apply a Skydrol resistant finish to the rubber-stamped data as given in SOPM 20-50-13.

(b) Do not stamp the installed metal nameplate with steel stamps.

(14) Make a record in the repair log of:

(a) The new Static Balance Hinge Moment (SBHM)

(b) The fact that the aileron has been balanced by calculation

(c) The type of repair

(d) The location of the repair

(e) The date when the aileron was repaired and balanced

(f) The number of aileron balance adjust weights that are installed and the number of available spaces for the addition of weight.

C. Example 1 - Aileron Assembly Static Balance Procedure by Measurement on the Balance Jig
Assume that a new aileron is damaged and the decision is made to remove the aileron from the airplane for repair and balancing.

(1) Make sure that the aileron assembly that you want to balance has the configuration as given in Paragraph 2.G./GENERAL

(2) Install the aileron assembly, with the lower surface up, in the static balance jig. (Refer to Aileron Support and Balance at time of the Balance Procedure on the Static Balance Jig, Figure 2/GENERAL.)

(a) Use aileron hinge fittings number 2 (AILERON STA 117.38) and number 5 (AILERON STA 31.59) for the installation of the aileron assembly in the balance jig.

NOTE: Make sure that the aileron assembly can pivot freely about its hinge centerline.

(b) Level the horizontal chord plane ±1 degree with a protractor level.

(3) Use the platform scale and toolstand to measure the Weight Reaction (WR) at a tab hinge fitting centerline. (Refer to Aileron Support and Balance at time of the Balance Procedure on the Static Balance Jig, Figure 2/GENERAL.)

WR = -0.37 lbf (-1.65 N)

(4) Find the moment arm distance d from Aileron Support and Balance at time of the Balance Procedure on the Static Balance Jig, Figure 2/GENERAL. The moment arm distance d is the distance between the aileron hinge centerline and the tab hinge fitting centerline. This distance is aft of the aileron hinge centerline and is therefore positive.

d = +10.48 in. (+266.19 mm = +0.226 m)

(5) Calculate the trial Check Balance Moment (CBM) with the formula:

trial CBM = (WR) x (d), where:

trial CBM = (-0.37) x (+10.48) = -3.88 lbfin (-0.44 Nm)

(6) With this trial CBM you can do one of the steps that follow:

(a) The trial CBM meets the secondary static balance requirement as given in Paragraph 2.F./GENERAL, so it is not necessary to install additional aileron balance adjust weights. In this case, the trial CBM is the new final moment Static Balance Hinge Moment. Continue with step 5.C.(7).

(b) If you want to balance the aileron assembly to a desired balance moment anywhere between -30.70 and -2.50 lbfin (-3.47 and -0.28 Nm) by adding sufficient aileron balance adjust weights, do as follows:

1) First, you must decide what the desired balance moment will be. In this example the desired balance moment is chosen to be -15.00 lbfin (-1.69 Nm) maximum. This means that we will aim for a final Static Balance Hinge Moment (SBHM) of -15.00 lbfin (-1.69 Nm).

2) Then, you must find the number of aileron balance adjust weights that are already installed. For example: 3. This means that there are 9 positions left for additional weights.

3) Find the ΔM that must be added to the trial CBM to get the desired balance moment:

ΔM = desired balance moment - trial CBM

ΔM = (-15.00) - (-3.88) = -11.12 lbfin (-1.26 Nm) maximum

4) In Aileron Assembly Balance Adjust Weight Table - Example 1, Figure 7/GENERAL, Table I move horizontally from left to right starting in the row of 3 existing adjust weights (point A). From this point, move to the right horizontally until you find the ΔM (point B) that you must add to your trial CBM to get the desired balance moment: with a maximum ΔM of -11.12 lbfin (-1.26 Nm) you must add 5 aileron balance adjust weights to get as close as possible to your desired balance moment (point C).

5) Install the 5 aileron balance adjust weights as given in Paragraph 5.A.(5)/GENERAL

6) Calculate a second trial Check Balance Moment (CBM):

a) Level the horizontal chord plane $\pm$1 degree with a protractor level.

b) Use the platform scale and toolstand to measure the Weight Reaction (WR) at a tab hinge fitting centerline. Refer to Aileron Support and Balance at time of the Balance Procedure on the Static Balance Jig, Figure 2/GENERAL.

WR = -1.35 lbf (-6.01 N)

c) second trial Check Balance Moment (CBM) = (WR) x (d)

second trial CBM = (-1.35) x (+10.48)

second trial CBM = -14.15 lbfin (-1.60 Nm)

d) The second trial CBM is within the limits as given in Paragraph 2.F./GENERAL The second trial Check Balance Moment (CBM) becomes the new Static Balance Hinge Moment (SBHM).

second CBM = new (SBHM) = -14.15 lbfin (-1.60 Nm) Continue with step 5.C.(7).

(c) If you want to balance the aileron assembly nearest to the most forward component moment of -30.70 lbfin (-3.47 Nm) to account for future repairs, painting, or rework, do as follows:

1) First, you must find the number of aileron balance adjust weights that are already installed. For example: 3. This means that there are 9 positions left for additional weights.

2) In Aileron Assembly Balance Adjust Weight Table - Example 1, Figure 7/GENERAL, Table I move horizontally from left to right starting in the row of 3 existing adjust weights (point A). From this point, move to the right horizontally until you find the maximum ΔM that you can add to your trial CBM with the number of positions left for the addition of weights (point D):

$-30.70 \leq (\Delta M + (-3.88)) \leq -2.50$ (lbfin) ($-3.47 \leq (\Delta M + (-0.44)) \leq -0.28$ (Nm)) This gives a maximum ΔM that you can add with 9 additional aileron balance adjust weights of: maximum $\Delta M = (-30.7) - (-3.88)$ lbfin maximum $\Delta M = -26.82$ lbfin (-3.03 Nm) From Aileron Assembly Balance Adjust Weight Table - Example 1, Figure 7/GENERAL, Table I you find that the maximum ΔM is -18.78 lbfin (-2.12 Nm) (point D) when you add the maximum available number of adjust weights of 9 (point E).

3) Install the 9 aileron balance adjust weights as given in Paragraph 5.A.(5)/GENERAL

4) Calculate a second trial Check Balance Moment (CBM):

a) Level the horizontal chord plane ±1 degree with a protractor level.

b) Use the platform scale and toolstand to measure the Weight Reaction (WR) at a tab hinge fitting centerline. Refer to Aileron Support and Balance at time of the Balance Procedure on the Static Balance Jig, Figure 2/GENERAL.

WR = -2.16 lbf (-9.61 N)

c) second trial Check Balance Moment (CBM) = (WR) x (d), second trial CBM = -22.66 lbfin (-2.56 Nm)

d) The second trial CBM is within the limits as given in Paragraph 2.F./GENERAL The second trial Check Balance Moment (CBM) becomes the new Static Balance Hinge Moment (SBHM).

second trial CBM = new (SBHM) = -22.66 lbfin (-2.56 Nm) Continue with step 5.C.(7).

(7) Vibro-engrave or rubber-stamp the value of the new Static Balance Hinge Moment (SBHM) on the metal part identification plate (MS27253-1) that is attached to the aileron assembly.

(a) Apply a Skydrol resistant finish to the rubber-stamped data as given in SOPM 20-50-13.

(b) Do not stamp the installed metal nameplate with steel stamps.

(8) Make a record in the repair log of:

(a) The new Static Balance Hinge Moment (SBHM)

(b) The fact that the aileron has been balanced on the static balance jig

(c) The type of repair

(d) The location of the repair

(e) The date when the aileron was repaired and balanced

(f) The number of aileron balance adjust weights that are installed and the number of available spaces for the addition of weight.

D. Example 2 - Aileron Assembly Static Balance Procedure by Calculation

(1) For this example we will assume what follows:

(a) A 250°F (121°C) cure repair as given in 51-70-05 has been done to the aileron with the aileron on the airplane.

(b) The current recorded Static Balance Hinge Moment (SBHM) is -12.34 lbfin (-1.39 Nm).

(c) Five of the twelve aileron balance adjust weights have been installed during previous balance procedures.

(d) It is estimated that the Rework Moment (RM) as a result of the repair will not bring the aileron balance outside of the limits. Addition of aileron balance adjust weights will therefore not be necessary, unless you want to balance the aileron to a desired moment or nearest to the most forward component moment to account for future repairs, painting, and rework.

(2) Measure the distance D (within 0.1 inch (2.5 mm)). D is the distance from the rework center of gravity (CG) along the skin surface to the intersection of the centerline of the aileron hinge and the upper skin. Refer to Aileron Balance, Figure 6/GENERAL. For this example we will assume that

D = 8.5 in. (216.7 mm = 0.217 m)

(3) Measure or calculate the distance Y. Y is the distance from the aileron hinge centerline to the line through the CG of the rework, perpendicular to the aileron hinge line and parallel to the aileron chord line. Refer to Aileron Balance, Figure 6/GENERAL. To calculate the distance Y, use the formula that follows:

$Y = (D) \times (\cos 6.7^\circ) = (8.5) \times (\cos 6.7^\circ) = 8.4$ in. (0.213 m)

(4) Find which repair operations will add weight and which repair operations will remove weight. The weight of the repair ply material is not the same as the original material weight. Therefore, a Weight removed (Wr) and a Weight added (Wa) calculation must be made. The difference between the added and removed paint is negligible unless paint was added beyond the boundaries of the paint removed. The materials which will add weight to the 250°F (121°C) repair are shown in Typical Repair of Damage to one Skin of Honeycomb Panel, Figure 8/GENERAL.

NOTE: For the Weight removed (Wr) calculation the areas of the plies removed are thought to be the same as those plies that replace them. Therefore, the weight change results from the weight per unit difference. Typically for a 250°F (121°C) repair the replacement plies are slightly heavier than the original plies and a net weight increase results from the addition of repair ply material.

(a) Weigh or calculate the Weight removed (Wr). Wr is the Weight removed as a result of rework, repair, or re-painting.

1) If you weigh the Weight removed (Wr) make sure that you weigh all the removed material at the same time.

2) Be careful when you calculate the weight of the material removed (or lost as a result of damage) and the weight of the material added.

a) Measure or calculate the weight of the material removed and the weight of the material added as accurately as possible.

b) Keep the tolerance very small or else you can have weight that is not satisfactory. What follows will have an effect on the tolerance:
- The tolerance of the weighing equipment
- The precision in your estimation of the weight of the material that has been removed
- The precision in your estimation of the weight of the repair materials or paint.

3) If you calculate the Weight removed (Wr) do as follows:

NOTE: Refer to 51-60-00 for the weights of the materials.

Wr = (Area of Material) x (Weight per unit Area)

a) For innermost original ply - CFRP, BMS 8-256, Type IV, Class 2, Style 3K-70-PW (6.0 in. (152.4 mm) in diameter):

$Wr1 = (\pi/4)(6.0)^2(0.00046)$

Wr1 = +0.0130 lbm (+0.0059 kg)

b) For middle original ply - CFRP, BMS 8-256, Type IV, Class 2, Style 3K-70-PW (7.0 in. (177.8 mm) in diameter):

$Wr2 = (\pi/4)(7.0)^2(0.00046)$

Wr2 = +0.0177 lbm (+0.0080 kg)

c) For outermost original ply - CFRP, BMS 8-256, Type IV, Class 2, Style 3K-70-PW (8.0 in. (203.2 mm) in diameter):

$Wr3 = (\pi/4)(8.0)^2(0.00046)$

Wr3 = +0.0260 lbm (+0.0118 kg)

d) The total Weight removed (Wr):

Wr = Wr1 + Wr2 + Wr3

Wr = 0.0130 + 0.0177 + 0.0260

Wr = +0.0567 lbm (+0.0257 kg)

(5) Weigh or calculate the Weight added (Wa). Wa is the Weight added as a result of rework, repair, or re-painting. Refer to Typical Repair of Damage to one Skin of Honeycomb Panel, Figure 8/GENERAL for the layout of the added repair materials.

(a) If you weigh the Weight added (Wa) make sure that you weigh all the added material at the same time to prevent the accumulation of error in the measurement.

(b) Be careful when you calculate the weight of the material removed (or lost as a result of damage) and the weight of the material added.

1) Measure or calculate the weight of the material removed and the weight of the material added as accurately as possible.

2) Keep the tolerance very small or else you can have weight that is not satisfactory. What follows will have an effect on the tolerance:
- The tolerance of the weighing equipment
- The precision in your estimation of the weight of the material that has been removed
- The precision in your estimation of the weight of the repair materials or paint.

(c) If you calculate the Weight added (Wa) do as follows:

NOTE: Refer to 51-60-00 for the weights of the materials.

$$Wa = (\text{Area of Material}) \times (\text{Weight per unit Area})$$

1) Repair Item 1 - Adhesive Film - BMS 8-245, Type II, Class 1, Grade 3A (10.0 in. (254.0 mm) in diameter):

   $Wa1 = (\pi/4)(10.0)^2(0.00020)$

   $Wa1 = 0.0160$ lbm (0.0073 kg)

2) Repair Item 2 - Filler Ply - CFRP, BMS 8-256, Type IV, Class 2, Style 3K-70-PW (5.0 in. (127.0 mm) in diameter):

   $Wa2 = (\pi/4)(5.0)^2(0.00046)$

   $Wa2 = 0.0090$ lbm (0.0041 kg)

3) Repair Item 3 - Replacement Ply - CFRP, BMS 8-256, Type IV, Class 2, Style 3K-70-PW (6.0 in. (152.4 mm) in diameter):

   $Wa3 = (\pi/4)(6.0)^2(0.00046)$

   $Wa3 = 0.0130$ lbm (0.0059 kg)

4) Repair Item 4 - Replacement Ply - CFRP, BMS 8-256, Type IV, Class 2, Style 3K-70-PW (7.0 in. (177.8 mm) in diameter):

   $Wa4 = (\pi/4)(7.0)^2(0.00046)$

   $Wa4 = 0.0177$ lbm (0.0080 kg)

5) Repair Item 5 - Replacement Ply - CFRP, BMS 8-256, Type IV, Class 2, Style 3K-70-PW (8.0 in. (203.2 mm) in diameter):

   $Wa5 = (\pi/4)(8.0)^2(0.00046)$

   $Wa5 = 0.0260$ lbm (0.0118 kg)

6) Repair Item 6 - Extra Repair Ply - CFRP, BMS 8-256, Type IV, Class 2, Style 3K-70-PW (9.0 in. (228.6 mm) in diameter):

   $Wa6 = (\pi/4)(9.0)^2(0.00046)$

   $Wa6 = 0.0293$ lbm (0.0133 kg)

7) Repair Item 7 - Extra Repair Ply - CFRP, BMS 8-256, Type IV, Class 2, Style 3K-70-PW (10.0 in. (254.0 mm) in diameter):

   $Wa7 = (\pi/4)(10.0)^2(0.00046)$

   $Wa7 = 0.0361$ lbm (0.0164 kg)

8) Repair Item 8 - Adhesive Film - BMS 8-245, Type II, Class 1, Grade 3A (11.0 in. (279.4 mm) in diameter):

   $Wa8 = (\pi/4)(11.0)^2(0.00020)$

   $Wa8 = 0.0190$ lbm (0.0086 kg)

9) The total Weight added (Wa):

   $Wa = Wa1 + Wa2 + Wa3 + Wa4 + Wa5 + Wa6 + Wa7 + Wa8$

   $Wa = 0.0160 + 0.0090 + 0.0130 + 0.0177 + 0.0260 + 0.0293 + 0.0361 + 0.0190$

   $Wa = 0.1661$ lbm (0.0753 kg)

(6) Calculate the Rework Weight (RW). RW is the net change in weight as a result of rework, repair, or re-painting.

RW = Wa - Wr = 0.1661 - 0.0567

RW = 0.1094 lbm (0.0496 kg)

(7) Calculate the Rework Moment (RM). RM is the net change in balance moment as a result of rework, repair, or re-painting.

RM = (RW) x (Y)

RM = (0.1094) x (8.4) = +0.9 lbfin (+0.1 Nm)

(8) Calculate the trial Check Balance Moment (CBM). The trial CBM is the new final moment (Static Balance Hinge Moment) if it is within the given limits.

trial CBM = (SBHM) + (RM)

trial CBM = (-12.34) + (0.9) = -11.1 lbfin (-1.3 Nm) where SBHM is the Static Balance Hinge Moment that is the previous final moment stamped on the nameplate of the aileron.

(9) With this trial CBM you can do one of the steps that follow:

(a) The trial CBM meets the secondary static balance requirement as given in Paragraph 2.F./GENERAL, so it is not necessary to install additional aileron balance adjust weights. In this case, the trial CBM is the new final moment Static Balance Hinge Moment. Continue with step 5.D.(10).

(b) If you want to balance the aileron assembly to a desired balance moment anywhere between -30.70 and -6.00 lbfin (-3.47 and -0.68 Nm) by adding sufficient aileron balance adjust weights, do as follows:

1) First, you must decide what the desired balance moment will be. In this example the desired balance moment is chosen to be -15.0 lbfin (-1.7 Nm) maximum. This means that we will aim for a final Static Balance Hinge Moment (SBHM) of -15.0 lbfin (-1.7 Nm).

2) Then, you must find the number of aileron balance adjust weights that are already installed. In this example: 5. This means that there are 7 positions left for additional weights.

3) Find the ΔM that must be added to the trial CBM to get the desired balance moment:

ΔM = desired balance moment - trial CBM

ΔM = (-15.0) - (-11.1) = -3.9 lbfin (-0.4 Nm) maximum

4) In Aileron Assembly Balance Adjust Weight Table - Example 2, Figure 9/GENERAL, Table I move horizontally from left to right starting in the row of 5 existing adjust weights (point V). From this point, move to the right horizontally until you find the ΔM (point W) that you must add to your trial CBM to get the desired balance moment:

- With a maximum ΔM of -3.9 lbfin (-0.4 Nm) you must add 1 aileron balance adjust weight to get as close as possible to your desired balance moment (point X).

5) Remove the aileron from the airplane. Refer to AMM 27-11-11-000-801.

NOTE: Because of the configuration of the wing, it is not possible to add aileron balance adjust weights to the aileron without the removal of the aileron from the airplane.

6) Install the 1 aileron balance adjust weight as given in Paragraph 5.B.(11)/GENERAL

7) Calculate the new Static Balance Hinge Moment (SBHM):

new SBHM = trial CBM + ΔM

new SBHM = (-11.1) + (-2.28)

new SBHM = -13.4 lbfin (-1.5 Nm) Continue with step 5.D.(10).

(c) If you want to balance the aileron assembly nearest to the most forward component moment of -30.70 lbfin (-3.47 Nm) to account for future repairs, painting, or rework, do as follows:

1) First, you must find the number of aileron balance adjust weights that are already installed. In this example: 5. This means that there are 7 positions left for additional weights.

2) In Aileron Assembly Balance Adjust Weight Table - Example 2, Figure 9/GENERAL, Table I move horizontally from left to right starting in the row of 5 existing adjust weights (point V). From this point, move to the right horizontally until you find the maximum ΔM that you can add to your trial CBM with the number of positions left for the addition of weights (point Y):

-30.70 $\leq$ (ΔM + (-11.1)) $\leq$ -6.00 (lbfin) (-3.47 $\leq$ (ΔM + (-1.3)) $\leq$ -0.68 (Nm)) This gives a maximum ΔM that you can add with 7 additional aileron balance adjust weights of: maximum ΔM = (-30.70) - (-11.1) lbfin maximum ΔM = -19.6 lbfin (-2.2 Nm) From Aileron Assembly Balance Adjust Weight Table - Example 2, Figure 9/GENERAL, Table I you find that the maximum ΔM is -14.80 lbfin (-1.67 Nm) (point Y) when you add the maximum available number of adjust weights of 7 (point Z).

3) Remove the aileron from the airplane. Refer to AMM 27-11-11-000-801.

NOTE: Because of the configuration of the wing, it is not possible to add aileron balance adjust weights to the aileron without the removal of the aileron from the airplane.

4) Install the 7 aileron balance adjust weights as given in Paragraph 5.B.(11)/GENERAL

5) Calculate the new Static Balance Hinge Moment (SBHM):

new SBHM = first trial CBM + ΔM

new SBHM = (-11.1) + (-14.80)

new SBHM = -25.9 lbfin (-2.9 Nm) Continue with step 5.D.(10).

(10) Vibro-engrave or rubber-stamp the value of the new Static Balance Hinge Moment (SBHM) on the metal part identification plate (MS27253-1) that is attached to the aileron assembly.

(a) Apply a Skydrol resistant finish to the rubber-stamped data as given in SOPM 20-50-13.

(b) Do not stamp the installed metal nameplate with steel stamps.

(11) Make a record in the repair log of:

(a) The new Static Balance Hinge Moment (SBHM)

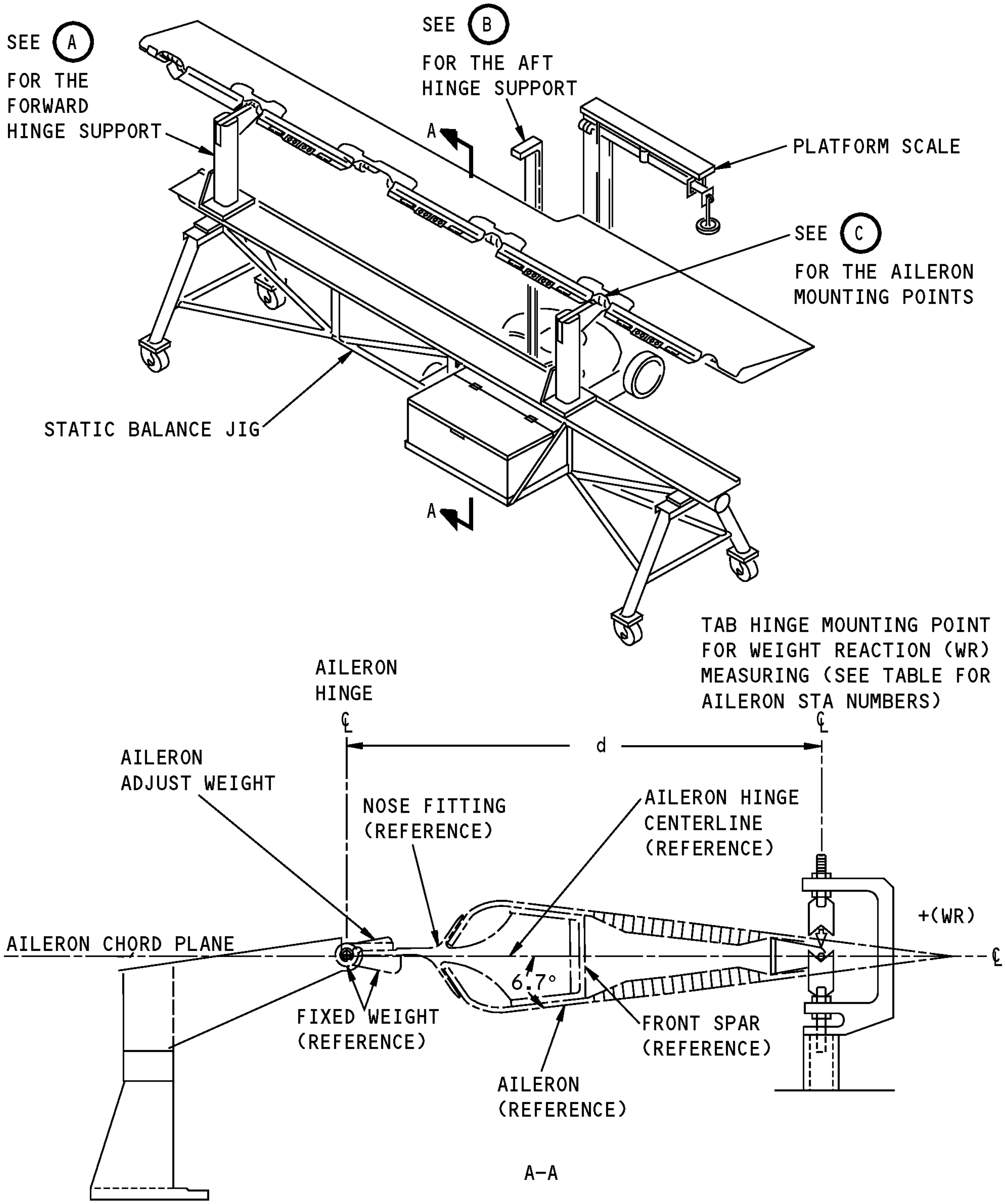
(b) The fact that the aileron has been balanced by calculation

(c) The type of repair

(d) The location of the repair

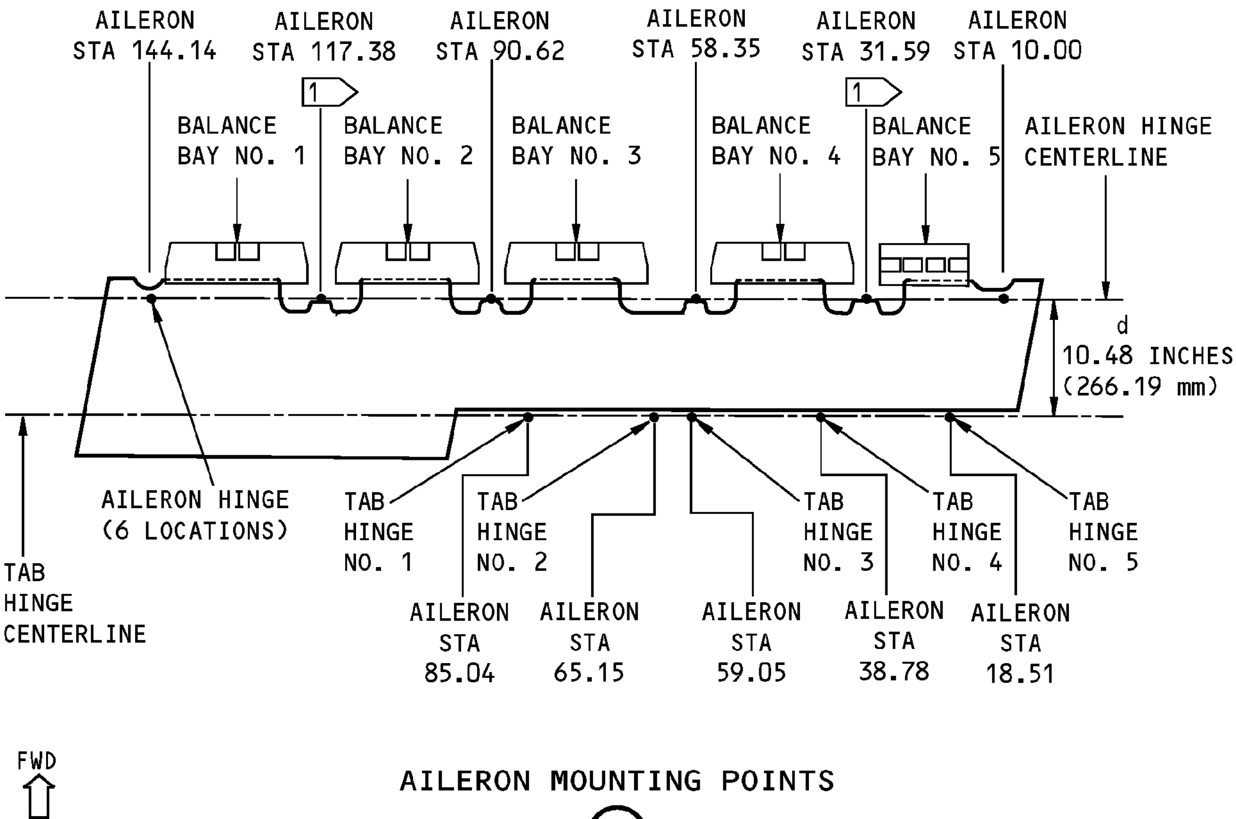
(e) The date when the aileron was repaired and balanced

(f) The number of aileron balance adjust weights that are installed and the number of available spaces for the addition of weight.



Aileron Support and Balance at time of the Balance Procedure on the Static Balance Jig
Figure 2 (Sheet 1 of 3)

TAB HINGE NUMBER	AILERON STA
1	85.04
2	65.15
3	59.05
4	38.78
5	18.51



AILERON MOUNTING POINTS

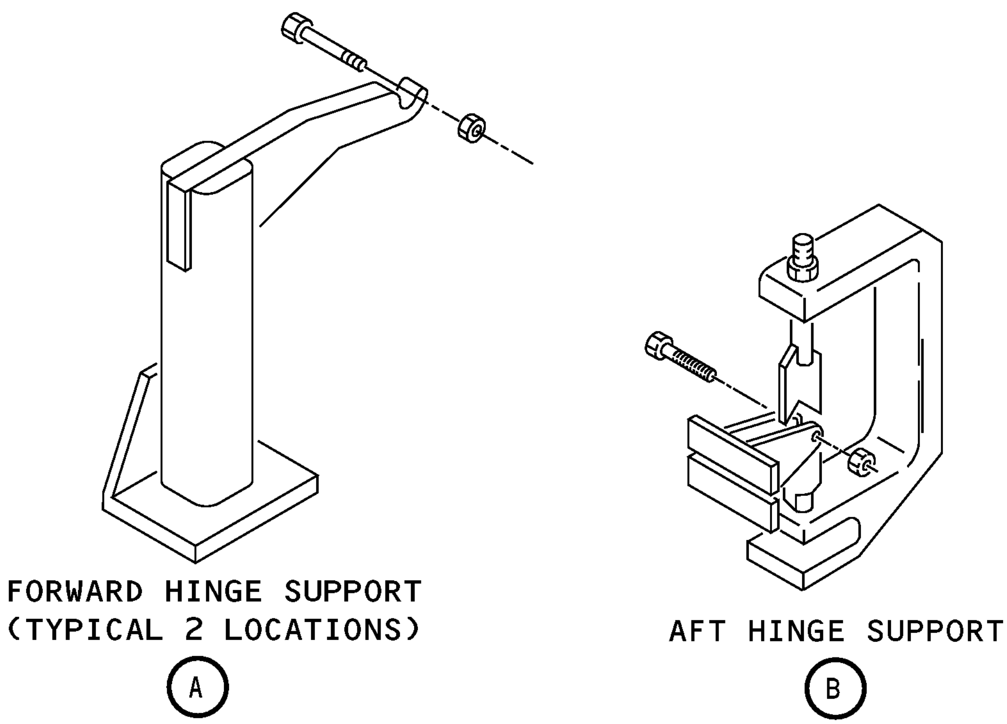
C

NOTES

- MOUNTING POINT FOR WEIGHT REACTION (WR) MEAUREMENTS IS LOCATED AT ANY OF THE TAB HINGES NO. 1 THROUGH NO. 5.

1 STATIC BALANCE JIG MOUNTING POSITIONS ARE LOCATED AT AILERON HINGES NO. 2 (AILERON STA 117.38) AND NO. 5 (AILERON STA NO. 31.59).

Aileron Support and Balance at time of the Balance Procedure on the Static Balance Jig
Figure 2 (Sheet 2 of 3)



Aileron Support and Balance at time of the Balance Procedure on the Static Balance Jig
Figure 2 (Sheet 3 of 3)

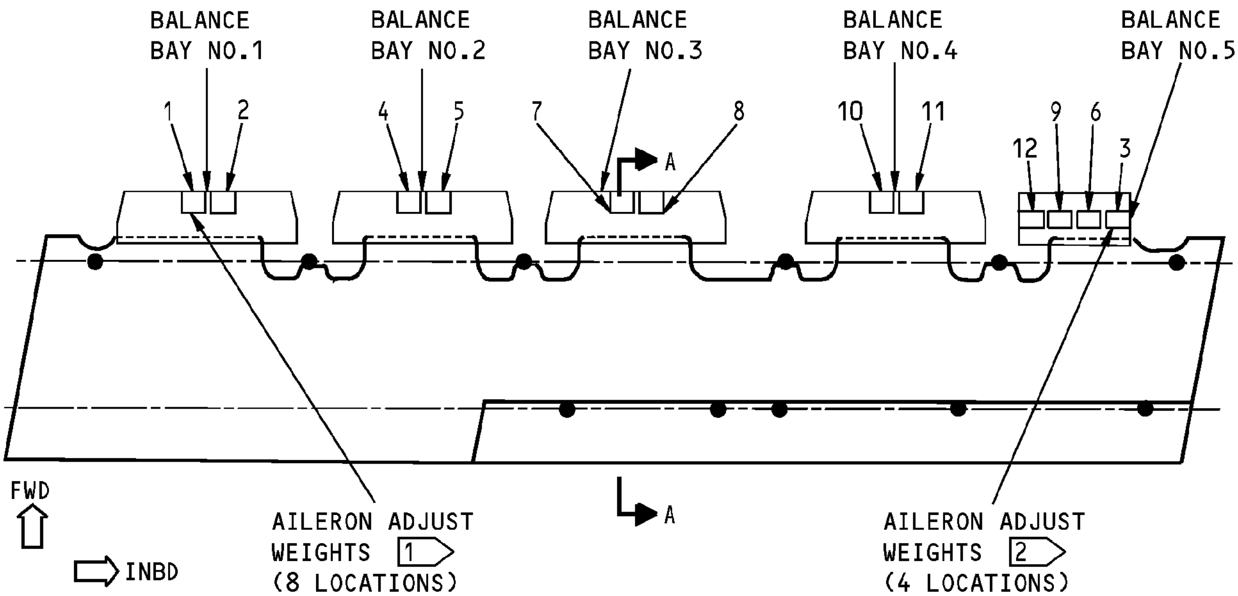
NUMBER OF EXISTING WEIGHTS	AILERON BALANCE TABLE FOR AILERON ASSEMBLY 113A7100-( ) AND 113A7400-( ) — TOTAL CHANGE IN MOMENT ΔM (lbf.in) DUE TO ADDING (n) ADJUST WEIGHTS TO EXISTING WEIGHTS — NUMBER OF ADJUST WEIGHTS (n) TO BE ADDED TO EXISTING WEIGHTS											
	1	2	3	4	5	6	7	8	9	10	11	12
0	-1.99	-3.98	-6.27	-8.26	-10.25	-12.53	-14.52	-16.51	-18.79	-20.78	-22.77	-25.05
1	-1.99	-4.28	-6.27	-8.26	-10.54	-12.53	-14.52	-16.80	-18.79	-20.78	-23.06	
2	-2.28	-4.27	-6.26	-8.54	-10.53	-12.52	-14.80	-16.79	-18.78	-21.06		
3	-1.99	-3.98	-6.26	-8.25	-10.24	-12.52	-14.51	-16.50	-18.78			
4	-1.99	-4.27	-6.26	-8.25	-10.53	-12.52	-14.51	-16.79				
5	-2.28	-4.27	-6.26	-8.54	-10.53	-12.52	-14.80					
6	-1.99	-3.98	-6.26	-8.25	-10.24	-12.52						
7	-1.99	-4.27	-6.26	-8.25	-10.53							
8	-2.28	-4.27	-6.26	-8.54								
9	-1.99	-3.98	-6.26									
10	-1.99	-3.98										
11	-2.28											

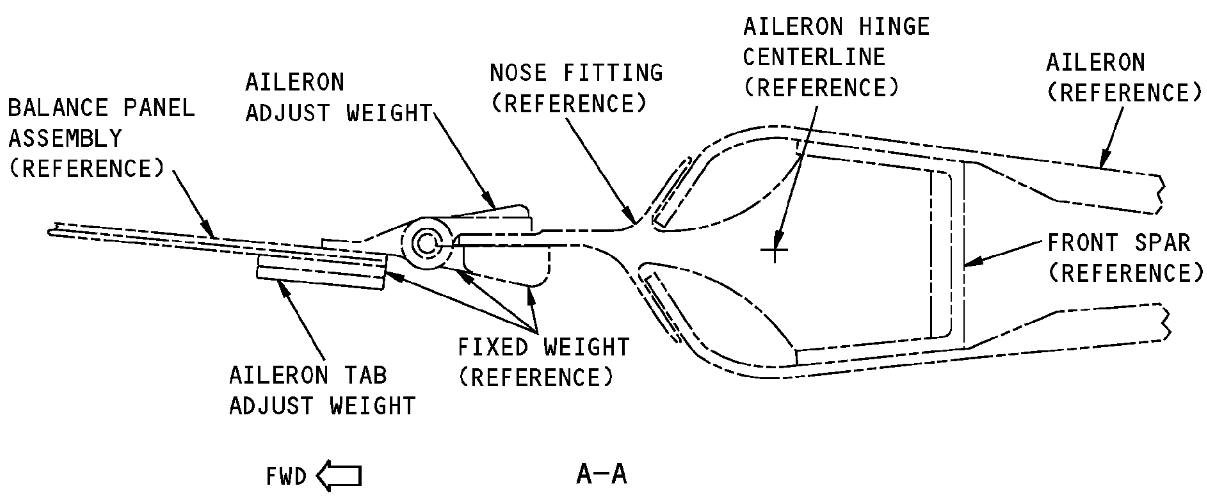
TABLE I

NOTE: THE SEQUENCE OF INSTALLATION OF THE BALANCE ADJUST WEIGHTS AND THE WEIGHT OF THE DIFFERENT BALANCE ADJUST WEIGHTS ARE INCLUDED IN TABLE I. REFER TO FIGURE 4 FOR THE INSTALLATION SEQUENCE OF THE BALANCE ADJUST WEIGHTS.

TO CONVERT FROM lbf.in to Nm MULTIPLY BY 0.1129248.

Aileron Assembly Balance Adjust Weight Table
Figure 3





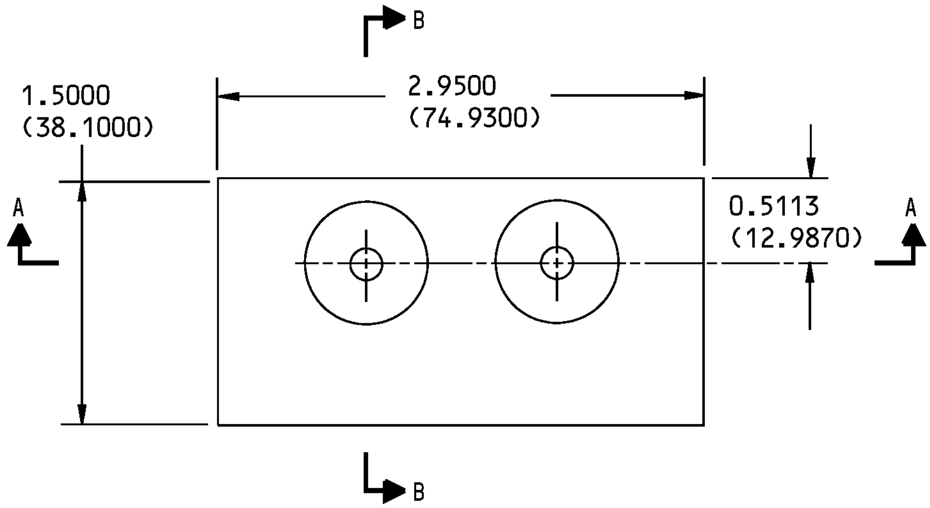
NOTES

- THE NUMBERS AT THE AILERON WEIGHTS SHOW THE SEQUENCE IN WHICH THE WEIGHTS MUST BE INSTALLED.

1 AILERON BALANCE ADJUST WEIGHT 113A7183-3 (BALANCE BAYS NO. 1,2,3, AND 4).

2 AILERON BALANCE ADJUST WEIGHT 113A7183-6 (BALANCE BAYS NO. 5 ONLY).

Aileron Balance Adjust Weight Location and Installation Sequence
Figure 4



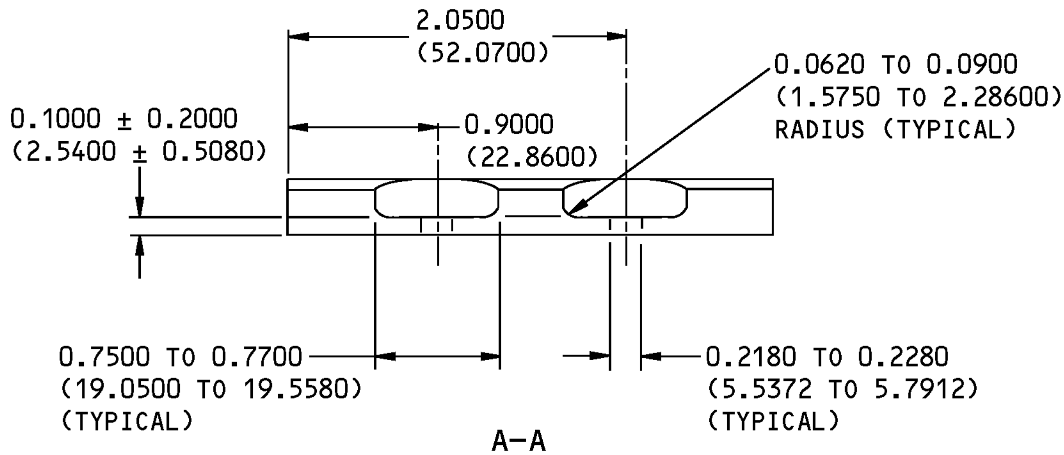
AILERON BALANCE ADJUST WEIGHT 113A7183-3

A

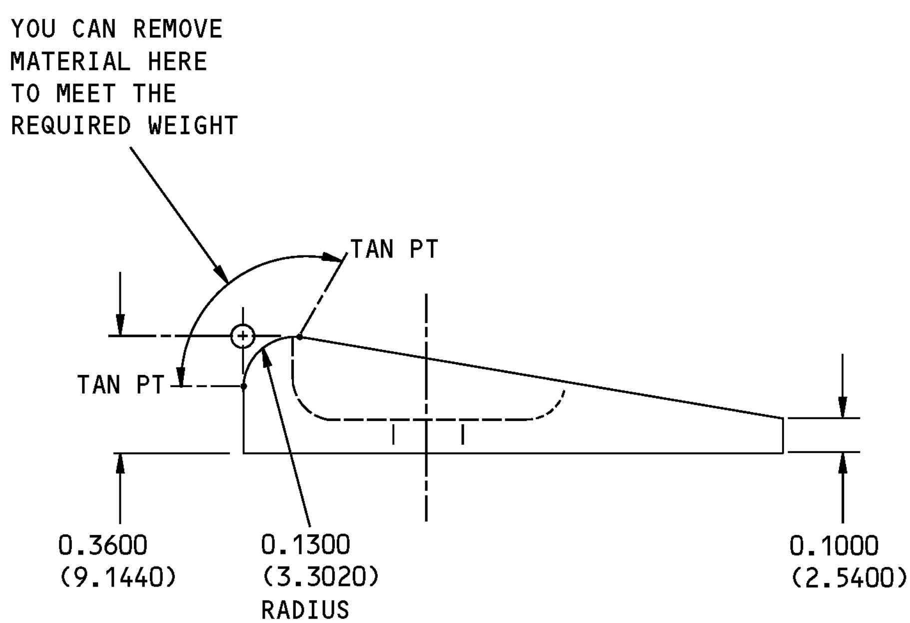
NOTES

- ALL DIMENSIONS ARE IN INCHES (mm)
- THE FINISHED PART MUST HAVE A WEIGHT OF 0.74 TO 0.80 POUNDS (0.3357 TO 0.3629 KILOGRAM).
- MATERIAL: TUNGSTEN ALLOY AS GIVEN IN MIL-T-21014, SINTERED CLASS 1 (OPTIONAL: CLASS 2).
- ALL SINTERED SURFACES MUST BE 250 R_a OR SMOOTHER.
- ALL MACHINED SURFACES MUST BE 125 R_a OR SMOOTHER.
- DRY ABRASIVE BLAST (REFER TO SOPM 20-30-03) AND APPLY TWO COATS OF BMS 10-79, TYPE III PRIMER AS GIVEN IN SOPM 20-44-04.
- THE FINISHED PART MUST HAVE A WEIGHT OF 0.49 TO 0.54 POUND (0.2223 TO 0.2449 KILOGRAM).

Aileron Balance Adjust Weights
Figure 5 (Sheet 1 of 4)

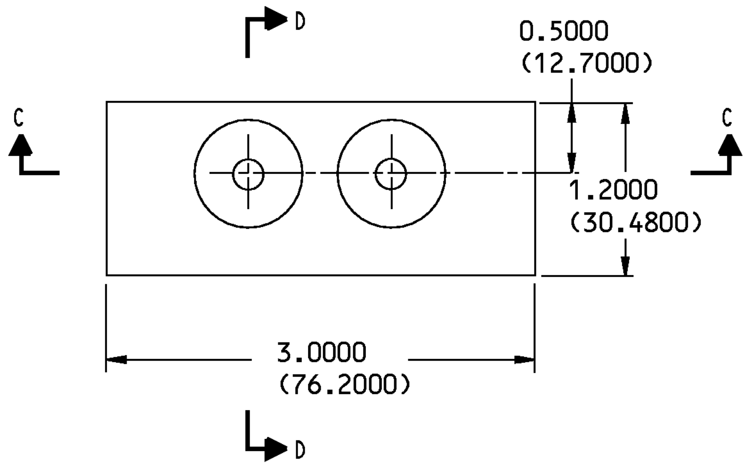


A-A



B-B

Aileron Balance Adjust Weights
Figure 5 (Sheet 2 of 4)



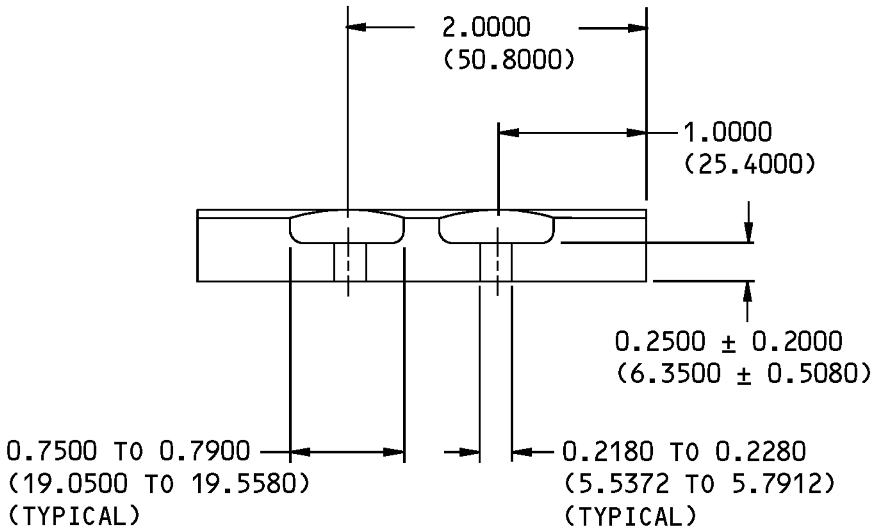
AILERON BALANCE ADJUST WEIGHT 113A7183-6

B

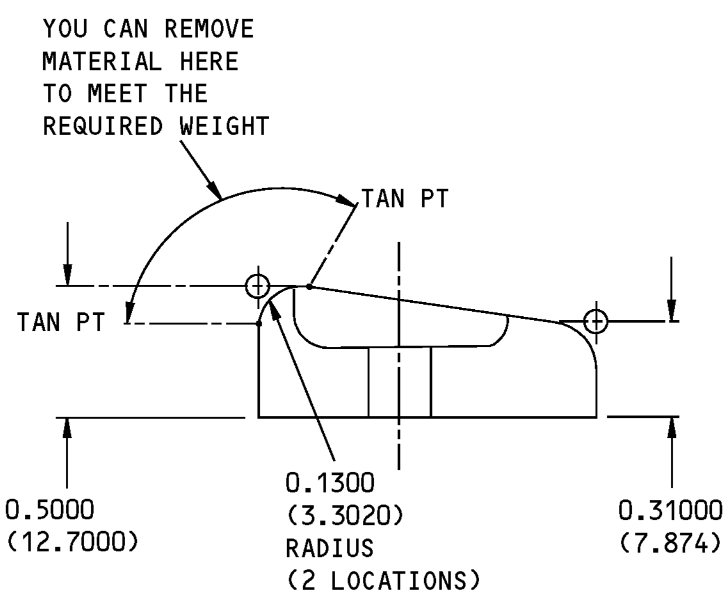
NOTES

- ALL DIMENSIONS ARE IN INCHES (mm)
- MATERIAL: TUNGSTEN ALLOY AS GIVEN IN MIL-T-21014, SINTERED CLASS 1 (OPTIONAL: CLASS 2).
- ALL SINTERED SURFACES MUST BE 250 R_a OR SMOOTHER.
- ALL MACHINED SURFACES MUST BE 125 R_a OR SMOOTHER.
- DRY ABRASIVE BLAST (REFER TO SOPM 20-30-03) AND APPLY TWO COATS OF BMS 10-79, TYPE III PRIMER AS GIVEN IN SOPM 20-44-04.
- THE FINISHED PART MUST HAVE A WEIGHT OF 0.74 TO 0.80 POUND (0.3356 TO 0.3628 KILOGRAM).

Aileron Balance Adjust Weights
Figure 5 (Sheet 3 of 4)

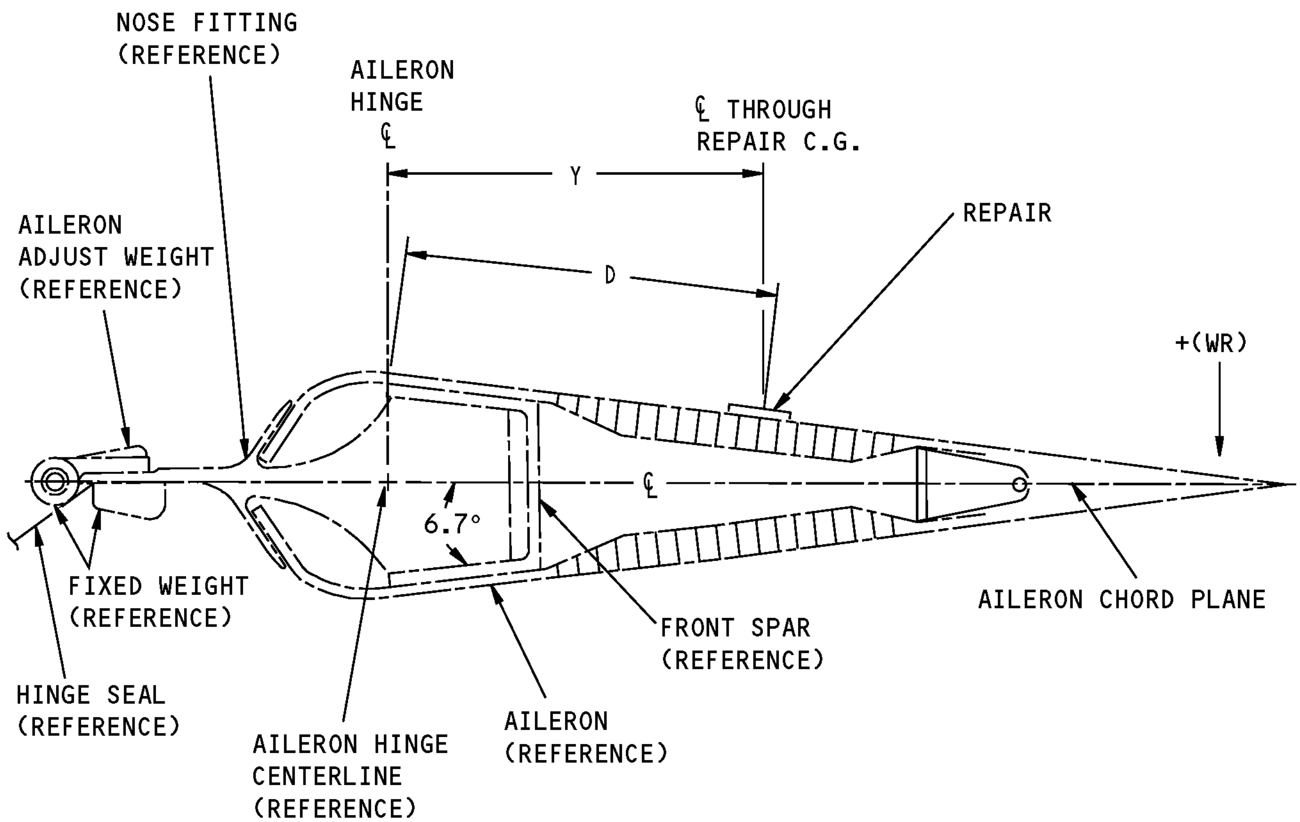


C-C



D-D

Aileron Balance Adjust Weights
Figure 5 (Sheet 4 of 4)



Aileron Balance
Figure 6

NUMBER OF INITIAL WEIGHTS	AILERON ASSEMBLY 113A7100-( ) AND 113A7400-( )											
	TOTAL CHANGE IN MOMENT ΔM (lbf.in) CAUSED WHEN ADJUST WEIGHTS ARE ADDED TO THE INITIAL WEIGHTS											
	NUMBER OF ADJUST WEIGHTS (n) TO BE ADDED TO INITIAL WEIGHTS											
	1	2	3	4	C 5	6	7	8	E 9	10	11	12
0	-1.99	-3.98	-6.27	-8.26		-12.53	-14.52	-16.51		-20.78	-22.77	-25.05
1	-1.99	-4.28	-6.27	-8.26		-12.53	-14.52	-16.80		-20.78	-23.06	
2	-2.28	-4.27	-6.26	-8.54		-12.52	-14.80	-16.79		-21.06		
3					-10.24	-12.52	-14.51	-16.50	-18.78			
		-4.27	-6.26	-8.25		-12.52	-14.51					
	-2.28											
	-1.99	-3.98	-6.26	-8.25	-10.24	-12.52						
7	-1.99	-4.27	-6.26	-8.25	-10.53							
8	-2.28	-4.27	-6.26	-8.54								
9	-1.99	-3.98	-6.26									
10	-1.99	-3.98										
11	-2.28											

TABLE I

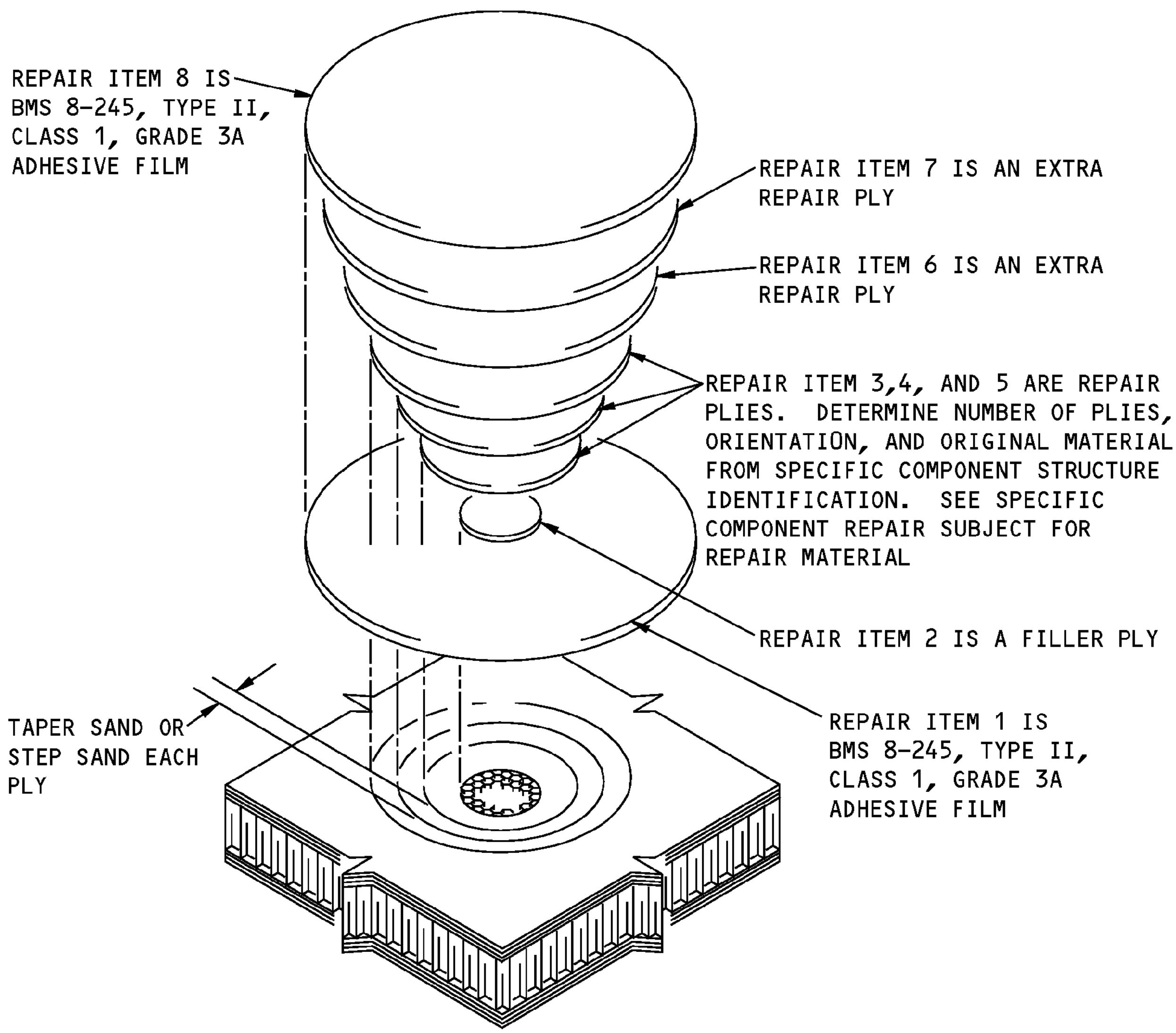
NOTES

- TO ADJUST THE BALANCE OF THE AILERON ASSEMBLY, DO AS FOLLOWS WITH THE DATA GIVEN IN TABLE I:

  STEP A - FIND THE NUMBER OF INITIAL WEIGHTS THAT ARE ON THE AILERON ASSEMBLY
  STEP B - FIND THE CHANGE IN MOMENT THAT YOU WILL NEED TO BALANCE THE AILERON ASSEMBLY
  STEP C - FIND THE NUMBER OF ADJUST WEIGHTS NECESSARY FOR THE CHANGE IN MOMENTUM. THIS IS THE NUMBER OF ADJUST WEIGHTS YOU WILL ADD TO THE ASSEMBLY. REFER TO FIGURE 4 FOR THE SEQUENCE ON WHICH TO INSTALL THE ADDED ADJUST WEIGHTS.

- TO CONVERT FROM lbf.in TO Nm MULTIPLY BY 0.1129848

Aileron Assembly Balance Adjust Weight Table - Example 1
Figure 7



NOTES

- REPAIR ITEMS 1, 2, 6, 7, AND 8 ARE EXTRA MATERIALS AND ADD WEIGHT TO THE REPAIR AREA ABOVE THAT WHICH WAS REMOVED AND IS BEING REPLACED.
- REPAIR ITEMS 3, 4, AND 5 ARE REPLACING ORIGINAL PLIES OF APPROXIMATELY THE SAME AREA BUT OF DIFFERENT WEIGHT PER UNIT AREA.

Typical Repair of Damage to one Skin of Honeycomb Panel
Figure 8

NUMBER OF INITIAL WEIGHTS	AILERON ASSEMBLY 113A7100-( ) AND 113A7400-( )											
	TOTAL CHANGE IN MOMENT ΔM (lbf.in) CAUSED WHEN ADJUST WEIGHTS ARE ADDED TO THE INITIAL WEIGHTS											
	NUMBER OF ADJUST WEIGHTS (n) TO BE ADDED TO INITIAL WEIGHTS											
	X 1	2	3	4	5	6	Z 7	8	9	10	11	12
0	-1.99	-3.98	-6.27	-8.26	-10.25	-12.53		-16.51	-18.79	-20.78	-22.77	-25.05
1	-1.99	-4.28	-6.27	-8.26	-10.54	-12.53	-14.52	-16.80	-18.79	-20.78	-23.06	
2	-2.28	-4.27	-6.26	-8.54	-10.53	-12.52	-14.80	-16.79	-18.78	-21.06		
V					-10.24	-12.52	-14.51	-16.50	-18.78			
			-6.26	-8.25			-14.51	-16.79				
5	-2.28	-4.27	-6.26	-8.54	-10.53	-12.52	-14.80	Y				
6		-3.98	-6.26	-8.25	-10.24	-12.52						
7		-4.27	-6.26	-8.25	-10.53							
8	W	-4.27	-6.26	-8.54								
9	-1.99	-3.98	-6.26									
10	-1.99	-3.98										
11	-2.28											

TABLE I

NOTES

- TO ADJUST THE BALANCE OF THE AILERON ASSEMBLY, DO AS FOLLOWS WITH THE DATA GIVEN IN TABLE I:

  STEP V - FIND THE NUMBER OF INITIAL WEIGHTS THAT ARE ON THE AILERON ASSEMBLY
  STEP W - FIND THE CHANGE IN MOMENT THAT YOU WILL NEED TO BALANCE THE AILERON ASSEMBLY
  STEP X - FIND THE NUMBER OF ADJUST WEIGHTS NECESSARY FOR THE CHANGE IN MOMENTUM. THIS IS THE NUMBER OF ADJUST WEIGHTS YOU WILL ADD TO THE ASSEMBLY. REFER TO FIGURE 4 FOR THE SEQUENCE ON WHICH TO INSTALL THE ADDED ADJUST WEIGHTS.

Aileron Assembly Balance Adjust Weight Table - Example 2
Figure 9

6. **Put the Airplane Back to Its Usual Condition**

A. As applicable, install all the parts that you removed in Paragraph 2.G.(2).

B. As applicable, install the aileron balance panels on the aileron. Refer to AMM 27-11-31/401.

C. As applicable, install the aileron tab on the aileron. Refer to AMM 27-11-21/401.

D. As applicable, install the aileron on the airplane. Refer to AMM 27-11-11/401.

GENERAL - WEIGHT CONTROL PROCEDURE FOR THE AILERON BALANCE PANELS

1. **Applicability**

A. This subject gives the necessary data for the static balance requirements for the aileron balance panels:

NOTE: Refer to Aileron Balance Panels - As-Weighed Configuration, Figure 1/GENERAL for the aileron balance panels.

(1) Balance Panel Assembly - Bay Number 1

(2) Balance Panel Assembly - Bay Number 2

(3) Balance Panel Assembly - Bay Number 3

(4) Balance Panel Assembly - Bay Number 4.

B. Refer to 51-60-01 for the aileron balance procedure.

C. Refer to 51-60-03 for the aileron tab balance procedure.

2. **General**

A. Refer to 51-60-00 for the general data such as:

(1) Categories of control surfaces

(2) General balance instructions

(3) Serviceability

(4) Definitions of terms

(5) Sign conventions

(6) Measurement accuracy

(7) Special tools and equipment

(8) Repair material weights.

B. The aileron balance panels are Category II Control Surfaces.

C. The aileron balance panels are not balanced, but their weight has an effect on the balance of the aileron.

(1) The weight of each aileron balance panel is limited as given in Table 1/GENERAL.

Table 1:

STATIC BALANCE REQUIREMENTS FOR THE AILERON BALANCE PANELS - WEIGHT LIMITATIONS		
AILERON BALANCE PANEL	**ENGINEERING DRAWING**	**COMPONENT WEIGHT** POUNDS (KILOGRAMS)
Bay Number 1	113A7315-1	3.55 ± 0.13 (1.610 ± 0.589)
Bay Number 2	113A7315-2	3.87 ± 0.13 (1.755 ± 0.589)
Bay Number 3	113A7315-3	4.05 ± 0.13 (1.837 ± 0.589)
Bay Number 4	113A7315-4	4.29 ± 0.13 (1.946 ± 0.589)

D. Each time a balance panel is repaired or reworked it must be weighed as given in Paragraph 5./GENERAL

E. Before you weigh the balance panel, you must make sure that the balance panel has the correct as-weighed configuration.

(1) Refer to Aileron Balance Panels - As-Weighed Configuration, Figure 1/GENERAL for the as-weighed configuration of the aileron balance panels.

(2) Refer to Table 2/GENERAL for the references for the as-weighed configuration of the aileron balance panels.

Table 2:

PARAGRAPH REFERENCES FOR THE AS-WEIGHED CONFIGURATION OF THE AILERON BALANCE PANELS	
AILERON BALANCE PANEL	**PARAGRAPH**
Bay Number 1	2.F
Bay Number 2	2.G
Bay Number 3	2.H
Bay Number 4	2.I

F. Balance Panel Assembly - Bay Number 1 must be a complete assembly as given on engineering drawing 113A7315-1.

(1) This includes all the parts that follow:

(a) Fixed Weight - Part Number 113A7223-1 (total of 1 per assembly)

(b) Panel - Part Number 113A7310-1 (total of 1 per assembly)

(c) Hinge Half - Part Number 113A7311-1 (total of 2 per assembly)

(d) Hinge Half - Part Number 113A7311-2 (total of 2 per assembly)

(e) Stiffener - Part Number 113A7312-1 (total of 2 per assembly)

(f) Seal Retainer - Part Number 113A7322-1 (total of 2 per assembly)

(g) Seal Retainer - Part Number 113A7322-5 (total of 1 per assembly)

(h) Nutplates (total of 38 per assembly)

(i) All the attaching parts of the parts listed above.

(2) This does not include the parts that follow:

(a) Fixed Weights - Part Number 113A7223-3

(b) The fasteners that attach the fixed weights to the balance panel.

G. Balance Panel Assembly - Bay Number 2 must be a complete assembly as given on engineering drawing 113A7315-2.

(1) This includes all the parts that follow:

(a) Fixed Weight - Part Number 113A7223-1 (total of 1 per assembly)

(b) Panel - Part Number 113A7310-2 (total of 1 per assembly)

(c) Hinge Half - Part Number 113A7311-1 (total of 2 per assembly)

(d) Hinge Half - Part Number 113A7311-2 (total of 2 per assembly)

(e) Stiffener - Part Number 113A7312-2 (total of 2 per assembly)

(f) Seal Retainer - Part Number 113A7322-2 (total of 2 per assembly)

(g) Seal Retainer - Part Number 113A7322-5 (total of 1 per assembly)

(h) Nutplates (total of 38 per assembly)

(i) All the attaching parts of the parts listed above.

(2) This does not include the parts that follow:

(a) Fixed Weights - Part Number 113A7223-3

(b) The fasteners that attach the fixed weights to the balance panel.

H. Balance Panel Assembly - Bay Number 3 must be a complete assembly as given on engineering drawing 113A7315-3.

(1) This includes all the parts that follow:

(a) Fixed Weight - Part Number 113A7223-1 (total of 1 per assembly)

(b) Panel - Part Number 113A7310-3 (total of 1 per assembly)

(c) Hinge Half - Part Number 113A7311-1 (total of 2 per assembly)

(d) Hinge Half - Part Number 113A7311-2 (total of 2 per assembly)

(e) Stiffener - Part Number 113A7312-3 (total of 2 per assembly)

(f) Seal Retainer - Part Number 113A7322-3 (total of 2 per assembly)

(g) Seal Retainer - Part Number 113A7322-5 (total of 1 per assembly)

(h) Nutplates (total of 38 per assembly)

(i) All the attaching parts of the parts listed above.

(2) This does not include the parts that follow:

(a) Tab Adjust Weights - Part Number 113A7223-2

(b) The fasteners that attach the tab adjust weights to the balance panel.

I. Balance Panel Assembly - Bay Number 4 must be a complete assembly as given on engineering drawing 113A7315-4.

(1) This includes all the parts that follow:

(a) Fixed Weight - Part Number 113A7223-1 (total of 1 per assembly)

(b) Panel - Part Number 113A7310-4 (total of 1 per assembly)

(c) Hinge Half - Part Number 113A7311-1 (total of 2 per assembly)

(d) Hinge Half - Part Number 113A7311-2 (total of 2 per assembly)

(e) Stiffener - Part Number 113A7312-4 (total of 2 per assembly)

(f) Seal Retainer - Part Number 113A7322-4 (total of 2 per assembly)

(g) Seal Retainer - Part Number 113A7322-5 (total of 1 per assembly)

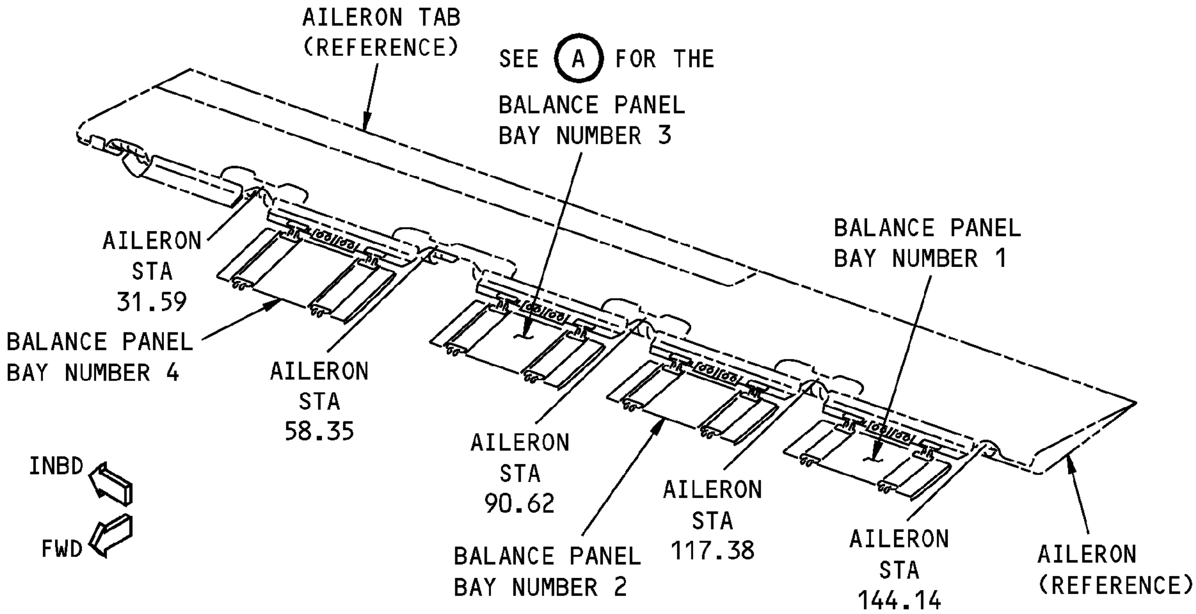
(h) Nutplates (total of 40 per assembly)

(i) All the attaching parts of the parts listed above.

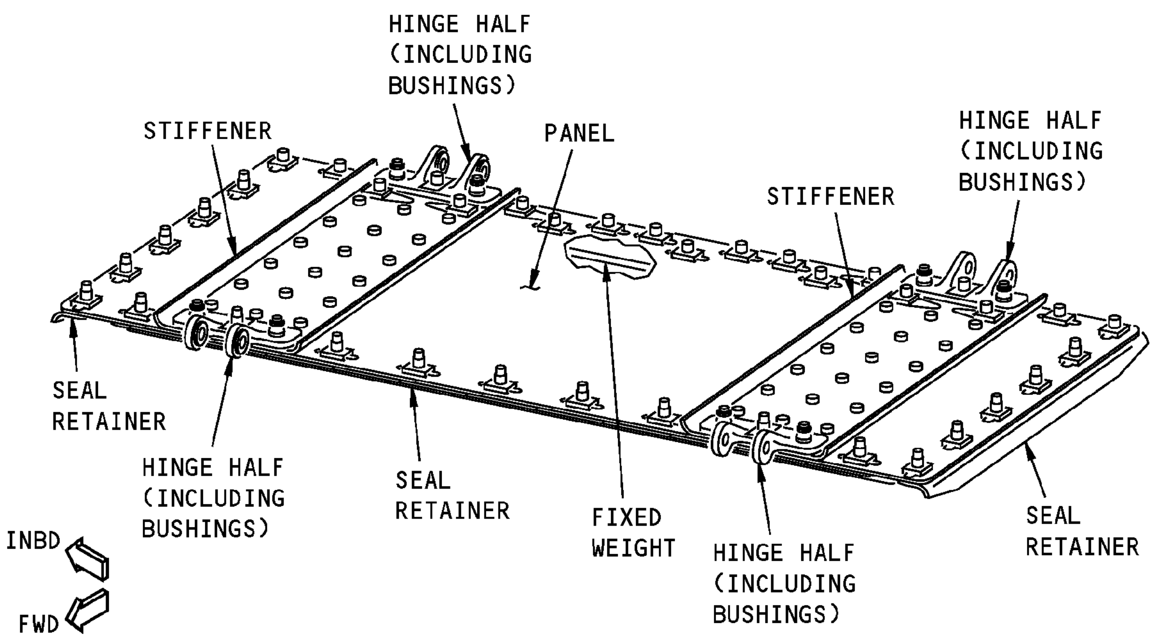
(2) This does not include the parts that follow:

(a) Tab Adjust Weights - Part Number 113A7223-2

(b) The fasteners that attach the tab adjust weights to the balance panel.



LEFT SIDE AILERON IS SHOWN, RIGHT SIDE AILERON IS OPPOSITE



BALANCE PANEL BAY NUMBER 3 IS SHOWN,
OTHER BALANCE PANELS ARE SIMILAR

A

Aileron Balance Panels - As-Weighed Configuration
Figure 1

3. References

Reference	Title
51-60-00	CONTROL SURFACE BALANCING
51-60-01	AILERON BALANCING PROCEDURES
51-60-03	AILERON TAB BALANCE PROCEDURE
AMM 27-11-31/401	Aileron Balance Panel Removal and Installation

4. Prepare for the Weigh Procedure

A. Remove the aileron balance panel. Refer to AMM 27-11-31/401.

(1) Make sure that the aileron balance panel that you want to weigh has the configuration as given in Paragraph 2.F./GENERAL through Paragraph 2.I./GENERAL

(a) If fixed weights (bay number 1 and 2) or tab adjust weights (bay number 3 and 4) are installed, do what follows:

1) Remove the fixed weights or tab adjust weights, as applicable.

2) Make a note of:

a) The type, number, and location of each weight that you removed per balance panel

b) The type and number of fasteners that you removed.

NOTE: You must also remove the fasteners in fixed weight or tab adjust weight locations where no weights are installed.

5. Weigh Procedure

A. Weigh the aileron balance panel and make sure that the weight is within the limits as given in Paragraph 2.C./GENERAL, Table 1/GENERAL.

NOTE: The weight measurement precision for the aileron balance panels is ± 0.01 pound (4.5 grams).

(1) If the weight of the aileron balance panel is larger than the limits given in Paragraph 2.C./GENERAL, Table 1/GENERAL, you must replace the balance panel with one that has the correct weight.

6. Put the Airplane Back to Its Usual Condition

A. Install all the parts that you have removed in step 4.A.(1)(a) on the aileron balance panel.

B. Install the aileron balance panel. Refer to AMM 27-11-31/401.

GENERAL - AILERON TAB BALANCE PROCEDURE

1. **Applicability**

CAUTION: IF AN AILERON TAB ASSEMBLY IS REMOVED FROM THE AIRPLANE, REWORKED, REPAIRED, OR REPAINTED, OR IF A NEW AILERON TAB ASSEMBLY IS INSTALLED, IT MUST BE WEIGHED AND STAMPED WITH THE ACTUAL WEIGHT AND QUANTITY OF BALANCE ADJUST WEIGHTS. WHEN YOU DO ABRASIVE BLAST PROCEDURES IN AREAS WHERE LUBRICATION FLUIDS OR GREASE ARE APPLIED, USE CARE TO PREVENT CONTAMINATION OF THE LUBRICANT WITH THE BLAST RESIDUE. THIS CONTAMINATION CAN AFFECT THE LUBRICATION PROPERTIES AND THE RESULT CAN BE INCREASED WEAR OF THE LUBRICATED PARTS.

A. This subject gives the necessary data for the static balance requirements for the aileron tab assembly.

B. Refer to 51-60-01 for the aileron balance procedure.

C. Refer to 51-60-02 for the weight control procedure for the aileron balance panels.

2. **General**

A. Refer to 51-60-00 for the general data such as:

(1) Categories of control surfaces

(2) General balance instructions

(3) Serviceability

(4) Definitions of terms

(5) Sign conventions

(6) Measurement accuracy

(7) Special tools and equipment

(8) Repair material weights.

B. The aileron tab assembly is a Category I Control Surface.

C. The aileron tab assembly is not balanced, but the weight has an effect on the balance of the aileron.

(1) The weight of the aileron tab assembly is limited to a maximum of 5.36 pounds (2.431 kilograms).

(2) To balance out variations in the weight of the aileron tab assembly, tab adjust weights are installed in the lower balance weight locations of bay numbers 3 and 4. Refer to Aileron Tab Adjust Weight Location, Figure 1/GENERAL.

(a) The aileron tab adjust weights do not balance out the full weight of the tab assembly, but only the increment of weight over nominal.

(b) For a given increment of tab assembly weight, a specified number of tab adjust weights is necessary. Refer to Table 1/GENERAL for the number of tab adjust weights that must be installed for a given increment of tab assembly weight.

NOTE: The part number of the tab adjust weight is 113A7223-2. The weight of each tab adjust weight is 0.4 ±0.02 pound (0.181 ±0.0091 kilogram).

Table 1:

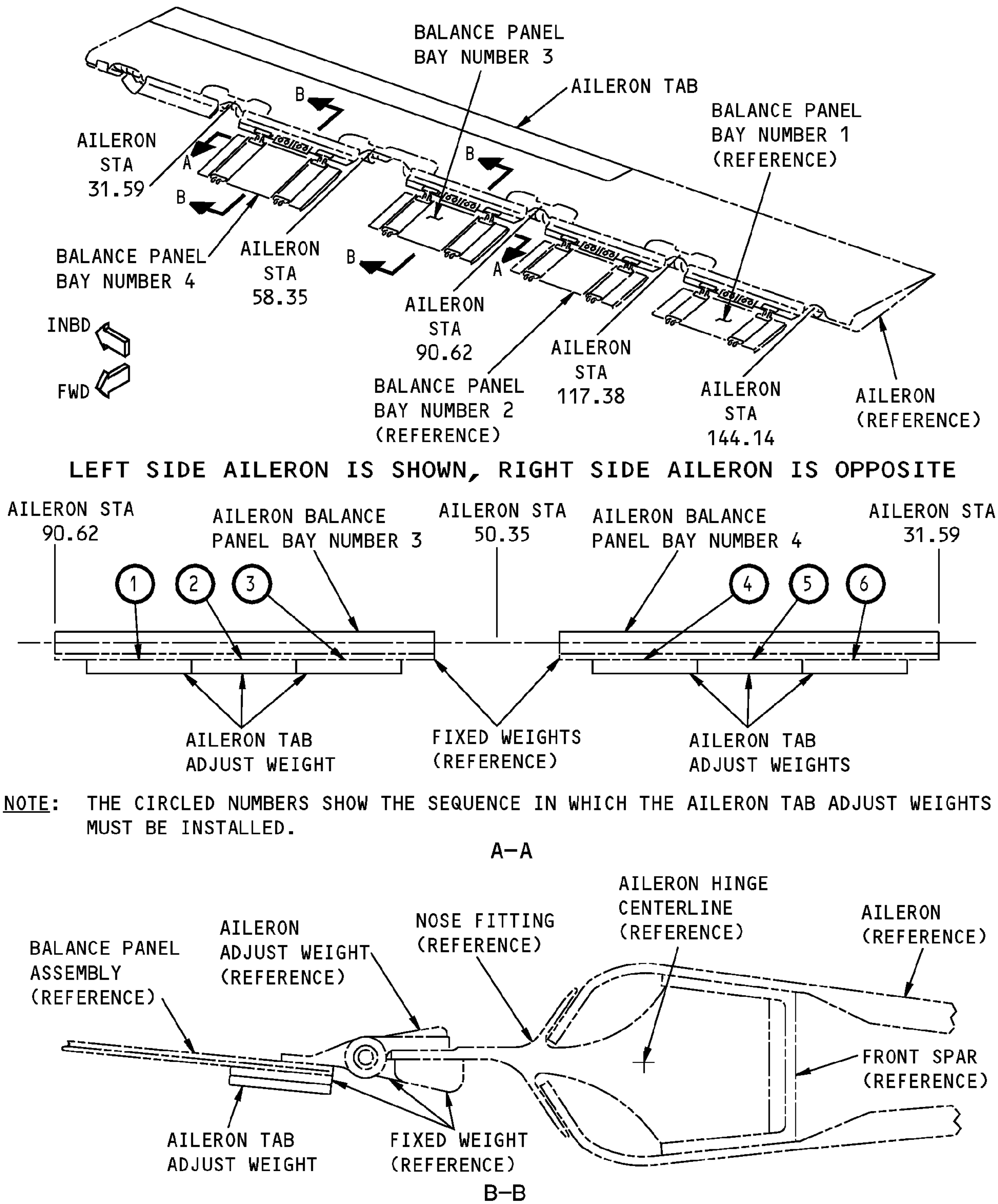
AILERON TAB ASSEMBLY 113A7200-( )	
TAB ASSEMBLY WEIGHT POUNDS (KILOGRAMS)	NUMBER OF ADJUST WEIGHTS NECESSARY

AILERON TAB ASSEMBLY 113A7200-( )	
TAB ASSEMBLY WEIGHT	NUMBER OF ADJUST WEIGHTS NECESSARY
Less than 4.46 (2.023)	0
4.47 to 4.61 (2.028) to (2.091)	1
4.62 to 4.76 (2.096) to (2.159)	2
4.77 to 4.91 (2.164) to (2.227)	3
4.92 to 5.06 (2.232) to (2.295)	4
5.07 to 5.21 (2.299) to (2.363)	5
5.22 to 5.36 (2.368) to (2.431)	6

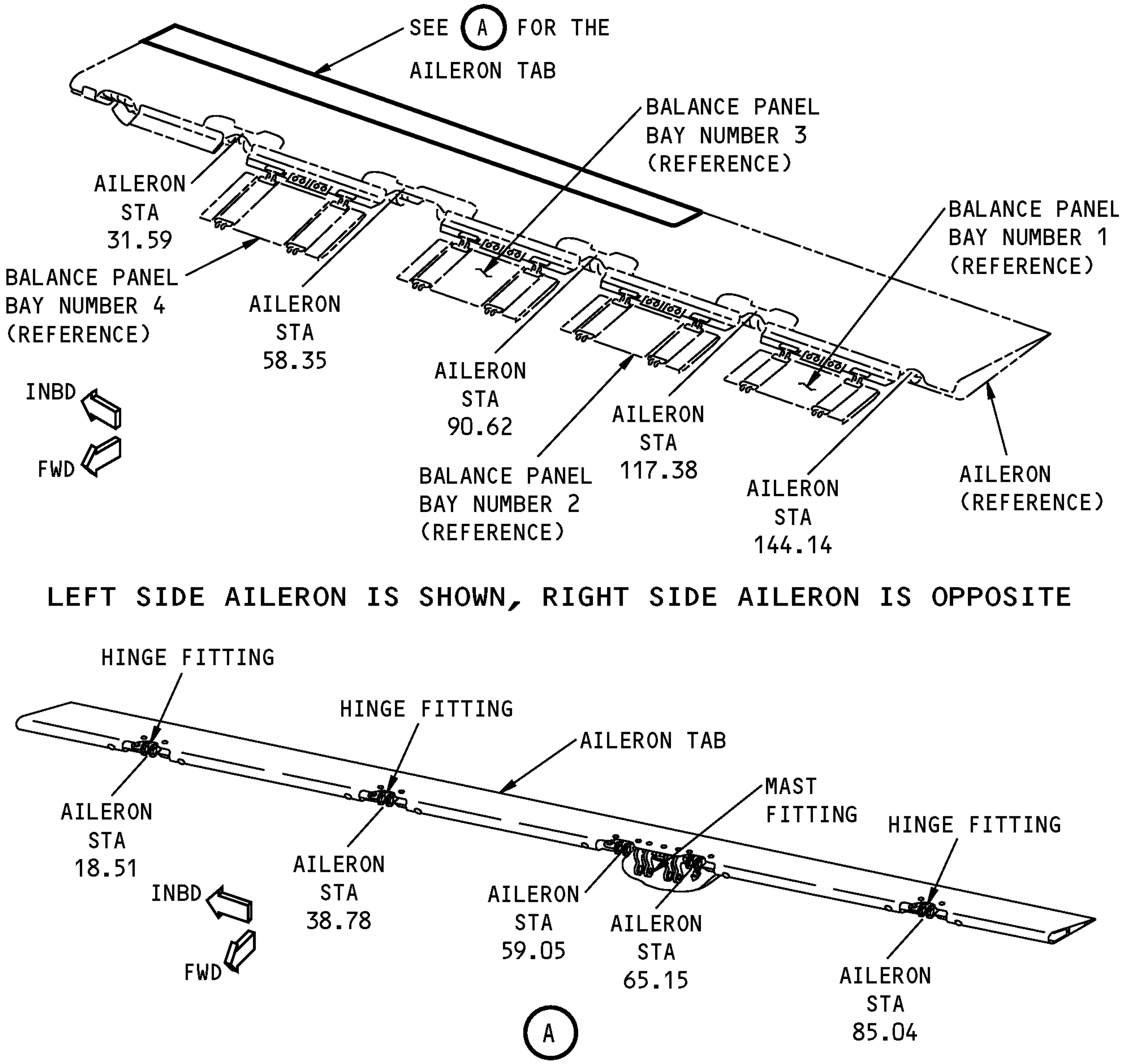
D. Before you weigh the aileron tab assembly, you must make sure that it is a complete assembly as given on engineering drawing 113A7200-( ).

NOTE: Refer to Aileron Tab As-Weighed Configuration, Figure 2/GENERAL for the as-weighed configuration of the aileron tab assembly.

(1) This includes all the parts that follow:



Aileron Tab Adjust Weight Location
Figure 1



NOTES

- THE AILERON TAB MUST BE A COMPLETE ASSEMBLY AS GIVEN ON ENGINEERING DRAWING 113A7200-( ). THIS INCLUDES ALL PROTECTIVE FINISHES AND DECORATIVE PAINT.
- DO NOT INCLUDE:
  - BONDING JUMPERS AND THEIR FASTENERS
  - INSTALLATION BOLTS, NUTS, AND WASHERS THAT ATTACH THE TAB TO THE AILERON
  - CONTROL RODS AND THEIR INSTALLATION BOLTS, NUTS, AND WASHERS

Aileron Tab As-Weighed Configuration
Figure 2

3. References

Reference	Title
51-60-00	CONTROL SURFACE BALANCING
51-60-01	AILERON BALANCING PROCEDURES
51-60-02	WEIGHT CONTROL PROCEDURE FOR THE AILERON BALANCE PANELS
AMM 51-21-99 P/B 701	DECORATIVE EXTERIOR PAINT SYSTEM - CLEANING/PAINTING
AMM 06-44-00	Aircraft Maintenance Manual
AMM 27-11-21/401	Aileron Tab - Removal/Installation
AMM 51-21-11/701	Paint Stipping - Cleaning/Painting
SOPM 20-30-03	Standard Overhaul Practices Manual
SOPM 20-44-04	Application of Urethane Compatible Primers

4. Prepare for the Balance Procedure

A. Remove the aileron tab from the aileron. Refer to AMM 27-11-21/401.

(1) Make sure that the aileron tab that you want to balance has the configuration as given in Paragraph 2.D./GENERAL

5. Balance Procedure

A. Do as follows for the aileron tab assembly static balance procedure:

(1) Weigh the aileron tab assembly and make a note of the weight that you measured.

NOTE: The weight measurement precision for the aileron tab assembly is ±0.01 pound (4.5 grams).

(a) If the weight of the aileron tab assembly is 5.36 pounds (2.431 kilograms) or less, do as follows:

NOTE: If the weight of the aileron tab assembly is more than 5.36 pounds (2.431 kilograms), then continue with step 5.A.(1)(b).

1) Refer to Table 1/GENERAL to find the total number of tab adjust weights that must be installed.

2) Find the number of tab adjust weights that are already installed in the lower balance weight locations of bay number 3 and 4.

NOTE: Refer to Aileron Tab Adjust Weight Location, Figure 1/GENERAL for the location of bay number 3 and 4.

3) Subtract the number of tab adjust weights that you found in step 5.A.(1)(a)2) from the number of tab adjust weights that you found in step 5.A.(1)(a)1).

a) If the result is positive, continue with step 5.A.(1)(a)4).

b) If the result is negative, continue with step 5.A.(1)(a)5).

4) Install the necessary number of tab adjust weights found in step 5.A.(1)(a)3), part number 113A7223-2.

NOTE: If the aileron and aileron balance panels are still installed on the airplane, you can get access to the lower balance weight locations of bay numbers 3 and 4 through access panels 571BB (LH), 571CB (LH), 571DB (LH), 671BB (RH), 671CB (RH), and 671DB (RH). Refer to AMM 06-44-00.

a) Refer to Aileron Tab Adjust Weight Location, Figure 1/GENERAL for:
- The location where the tab adjust weights must be installed
- The sequence in which the tab adjust weights must be installed.

b) If the Boeing tab adjust weights, part number 113A7223-2, are not available, you can make tab adjust weights as given in Aileron Tab Adjust Weight Part Number 113A7223-2, Figure 3/GENERAL.

c) Install the tab adjust weights with BACB30NM3K6 bolts.
- Install the bolts with MIL-C-11796, Class 3 corrosion preventive compound.

NOTE: Before you install the tab adjust weights you must remove the BACB30NM3K5 bolts that attach the fixed weight to the balance panel and replace them with BACB30NM3K6 bolts.

d) Continue with step 5.A.(2).

5) Remove the necessary number of tab adjust weights.

NOTE: If the aileron and aileron balance panels are still installed on the airplane, you can get access to the lower balance weight locations of bay numbers 3 and 4 through access panels 571BB (LH), 571CB (LH), 571DB (LH), 671BB (RH), 671CB (RH), and 671DB (RH). Refer to AMM 06-44-00.

a) Refer to Aileron Tab Adjust Weight Location, Figure 1/GENERAL for:
- The location where the tab adjust weights are installed
- The sequence in which the tab adjust weights must be removed.

b) Remove the necessary number of tab adjust weights found in step 5.A.(1)(a)3), part number 113A7223-2.

c) Install BACB30NM3K5 bolts to attach the fixed weight to the balance panel at the location where a tab adjust weight has been removed.
- Install the bolts with MIL-C-11796, Class 3 corrosion preventive compound.

d) Continue with step 5.A.(2).

(b) If the weight of the aileron tab assembly is more than 5.36 pounds (2.431 kilograms), do as follows:

1) Remove multiple layers of paint from the aileron tab assembly to reduce the weight of the tab assembly, as applicable. Refer to AMM 51-21-11/701 for removal of paint.

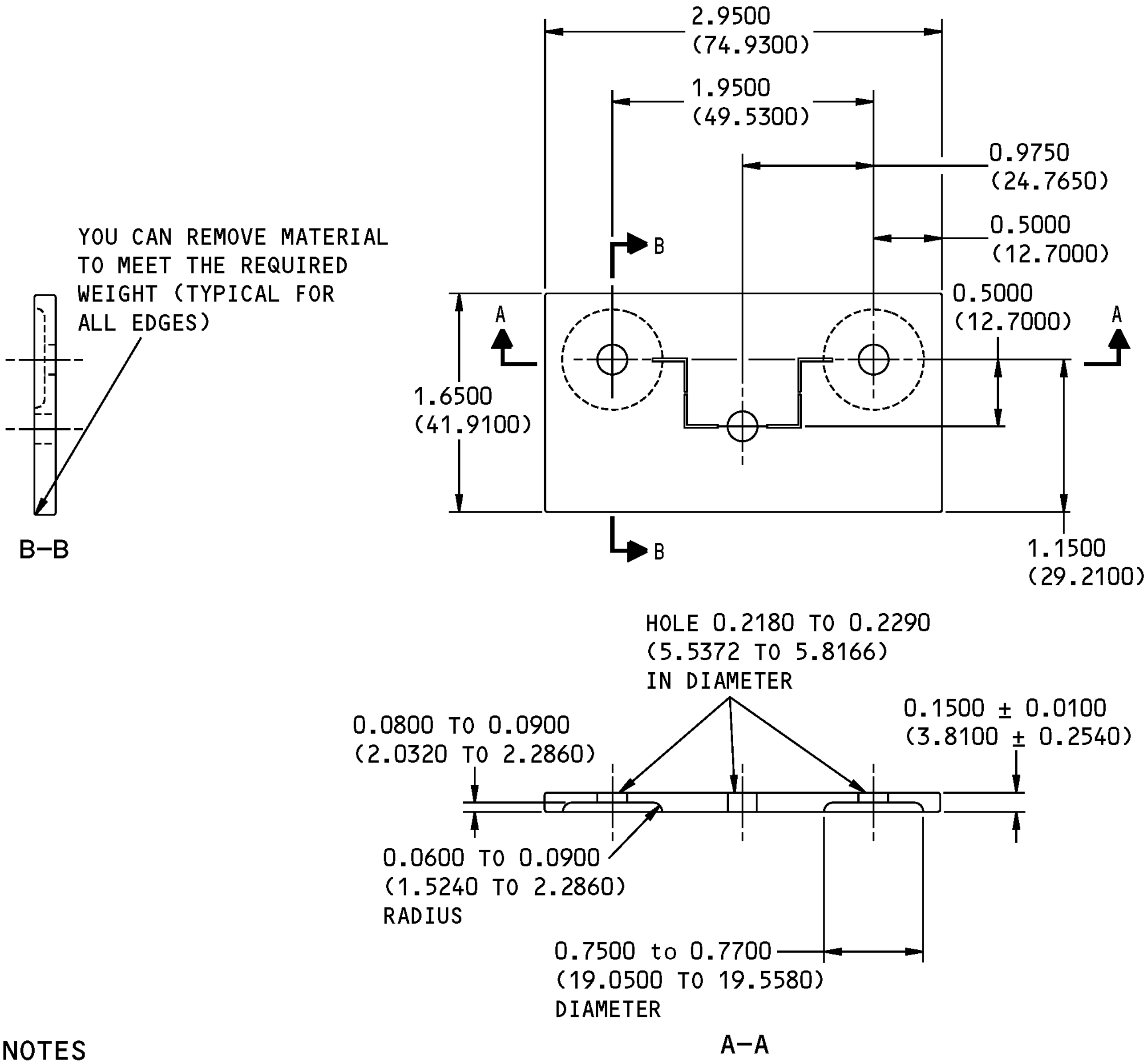
NOTE: Refer to 51-60-00 for the repair material weights.

2) Restore the aileron tab assembly decorative exterior paint system. Refer to AMM PAGEBLOCK 51-21-99/701.

3) Repeat step 5.A.

(c) If it is not possible to reduce the weight of the aileron tab assembly as given in Paragraph 5.A.(1)(b)/GENERAL, you must replace the aileron tab assembly with one that has the correct weight.

(2) Stamp the value of the aileron tab weight and the number of tab adjust weights that are installed on the metal nameplate (BACM10L1CVR) that is attached to the aileron tab assembly.



NOTES

- ALL DIMENSIONS ARE IN INCHES (mm)
- MATERIAL: TUNGSTEN ALLOY AS GIVEN IN MIL-T-21014.
  SINTERED CLASS 1 (OPTIONAL: CLASS 2)
- ALL SINTERED SURFACES MUST BE 250 R_a OR SMOOTHER
- DRY ABRASIVE BLAST (REFER TO SOPM 20-30-03) AND APPLY TWO COATS OF BMS 10-79, TYPE III PRIMER AS GIVEN IN SOPM 20-44-04.
- THE FINISHED PART MUST HAVE A WEIGHT OF 0.38 TO 0.42 POUND (0.1724 TO 0.1905 KILOGRAM)

Aileron Tab Adjust Weight Part Number 113A7223-2
Figure 3

6. Put the Airplane Back to Its Usual Condition

A. Install the aileron tab. Refer to AMM 27-11-21/401.

GENERAL - ELEVATOR BALANCE PROCEDURE FOR AIRPLANE LINE NUMBERS 1 THROUGH 1174 PRIOR TO COMPLETION OF SERVICE BULLETINS 737-55-1080, 737-55-1081, AND 737-55-1082

1. Applicability

WARNING: IF THE BALANCE MOMENT OF THE ELEVATOR IS NOT WITHIN THE LIMITS OF THE SECONDARY STATIC BALANCE REQUIREMENTS, A CONDITION DANGEROUS TO FLIGHT SAFETY CAN OCCUR.

CAUTION: IF AN ELEVATOR ASSEMBLY IS REMOVED FROM THE AIRPLANE, REWORKED, REPAIRED, OR REPAINTED, OR IF A NEW ELEVATOR ASSEMBLY IS INSTALLED, IT MUST BE BALANCED AND STAMPED WITH THE NEW STATIC BALANCE HINGE MOMENT (SBHM). WHEN YOU DO ABRASIVE BLAST PROCEDURES IN AREAS WHERE LUBRICATION FLUIDS OR GREASE ARE APPLIED, USE CARE TO PREVENT CONTAMINATION OF THE LUBRICANT WITH THE BLAST RESIDUE. THIS CONTAMINATION CAN AFFECT THE LUBRICATION PROPERTIES AND THE RESULT CAN BE INCREASED WEAR OF THE LUBRICATED PARTS.

A. This subject gives the necessary data for the static balance requirements for the elevator assembly.

NOTE: This procedure is applicable to airplanes with line numbers 1 through 1174 that have not been modified as given in Service Bulletins 737-55-1080, 737-55-1081 and 737-55-1082. Refer to 51-61-04 for airplanes with line nunbers equal to or greater than 1175 and for all the other airplanes that have been modified as given in Service Bulletins 737-55-1080, 737-55-1081 and 737-55-1082.

B. Refer to 51-60-05 for the weight control procedure for the elevator balance panels.

C. Refer to 51-60-06 or 51-61-06 for the elevator tab balance procedure.

2. General

A. Refer to 51-60-00 for the general data such as:

(1) Categories of control surfaces

(2) General balance instructions

(3) Serviceability

(4) Definitions of terms

(5) Sign conventions

(6) Measurement accuracy

(7) Special tools and equipment

(8) Repair material weights.

B. The elevator assembly is a Category I Control Surface.

C. Before you complete a repair or repaint on the elevator, you must make sure that it is possible to balance the elevator within the limits of the secondary static balance requirements as given in Paragraph 2.F after the repair or repaint has been completed.

(1) To make sure that it is possible to balance the elevator within the limits of the secondary static balance requirements as given in Paragraph 2.F after the repair or repaint has been completed, you must:

(a) Find the current Static Balance Hinge Moment (SBHM)

(b) Find the ΔM as a result of the repair or repaint

(c) Find the number of available elevator balance adjust weight positions and thus the rework capability.

D. If it is not possible to meet the secondary static balance requirements with the current Static Balance Hinge Moment (SBHM), the ΔM as a result of the repair or repaint and the number of available elevator balance adjust weight positions, you can restore the rework capability as follows:

(1) Remove all layers of paint from the elevator assembly. Refer to AMM 51-21-11/701 for the paint removal procedures.

(a) Remove the balance adjust weights which are equal in moment to the layers of paint that were added to the initial paint application.

NOTE: These layers of paint are removed to restore the rework capability of the elevator assembly. This does not include the initial paint application. Do not remove the adjust weights necessary for the initial paint application.

(b) Restore the decorative exterior paint to the elevator assembly.

1) Use the same specification as the initial paint application you removed.

2) Refer to AMM PAGEBLOCK 51-21-99/701 for the paint application procedures.

NOTE: The restored paint is a repaint. It will be necessary to add adjust weights that are equal in moment to this paint application. If there are other rework areas or repairs on the elevator assembly, it is still necessary to add adjust weights equal in moment to these areas.

E. The elevator can be balanced by one of two methods:

(1) The static balance jig procedure. Refer to Paragraph 5.A for the balance procedure on the static balance jig.

(a) The elevator must be removed from the airplane to be balanced on the static balance jig. For the configuration of the elevator at the time of the balance procedure, refer to Paragraph 2.G.

(2) The calculation procedure. Refer to Paragraph 5.B for the balance procedure by calculation.

(a) This procedure does not require the use of a static balance jig. The calculation procedure can be used with the elevator on or off the airplane as long as the repair and balance requirements are met. You must make sure that the necessary data is recorded during the repair or rework so that the calculations can be made accurately.

(b) Be careful when you calculate the weight of the material removed (or lost as a result of damage) and the weight of the material added.

1) Measure or calculate the weight of the material removed and the weight of the material added as accurately as possible.

2) Keep the tolerance very small. If you do not, you can have a weight that is not satisfactory. The conditions that follow will have an effect on the tolerance:

a) The tolerance of the weighing equipment

b) The precision in your estimation of the weight of the material that has been removed

c) The precision in your estimation of the weight of the repair materials or paint.

(c) Find the distance from the hinge line to the center of gravity of the repair to within $\pm$0.1 inch ($\pm$2.5 mm). The conditions that follow will have an affect on the tolerance:

1) The possible error in the estimation of the position of the center of gravity of the repair

2) The possible error in the measurement of the distance from the center of gravity of the repair to the elevator hinge line.

F. The elevator installation must be balanced so that the total effective center of gravity is within the limits for the primary static balance requirement.

(1) The primary static balance requirement, or the location of the center of gravity for the elevator installation, is 0.4 to 0.0 inch (10.16 to 0.0 mm) forward of the elevator hinge line.

(a) To get the primary static balance requirement, you must make sure, by measurement or calculation, that the secondary static balance requirements for the elevator are met. Refer to Table 1/GENERAL for the secondary static balance requirements.

1) The secondary static balance requirement for the elevator assembly, when you balance the elevator by measurement on the balance jig, requires a component moment between -108.33 and -24.91 lbfin (-12.24 and -2.81 Nm).

2) The secondary static balance requirement for the elevator assembly when you balance the elevator by calculation on or off the airplane requires a component moment between -108.33 and -45.77 lbfin (-12.24 and -5.17 Nm).

(2) It is suggested that you balance the elevator assembly nearest to the most forward component moment to account for future repairs, painting, or rework.

NOTE: The most forward component moment is -108.33 lbfin (-12.24 Nm).

Table 1:

COMPONENT	ENGINEERING DRAWING	SECONDARY STATIC BALANCE REQUIREMENT		
		COMPONENT WEIGHT lbm (kg)	COMPONENT MOMENT lbfin (Nm)	REFER TO SRM
Elevator Assembly	183A0101-( ) 183A0102-( ) 183A0103-1 thru 183A0103-5 183A0104-()	Not Applicable	BALANCE PROCEDURE BY MEASUREMENT ON THE BALANCE JIG: -108.33 to -24.91 (-12.24 to -2.81)	51-60-04 Paragraph 5.A
			BALANCE PROCEDURE BY CALCULATION ON THE AIRPLANE: -108.33 to -45.77 (-12.24 to -5.17)	51-60-04 Paragraph 5.B
Balance Panel Bay Number 2	183A9102-3 (LH) 183A9102-4 (RH)	2.46 ± 0.15 (1.12) ± (0.068)	Not Applicable	51-60-05
Balance Panel Bay Number 3	183A9103-3 (LH) 183A9103-4 (RH)	2.22 ± 0.15 (1.01) ± (0.068)	Not Applicable	51-60-05
Balance Panel Bay Number 4	183A9104-3 (LH) 183A9104-4 (RH)	2.13 ± 0.15 (0.97) ± (0.068)	Not Applicable	51-60-05
Elevator Tab Assembly	183A8100-1 thru 183A8100-4	7.26 maximum (3.29 maximum)	Not Applicable	51-60-06
Elevator Horn Tip Weight	183A7300-3 (LH and RH)	15.00 +0.15 -0.25 (6.80 +0.068) (-0.11)	Not Applicable	Not Applicable

G. Before you balance the elevator assembly on the static balance jig, you must:

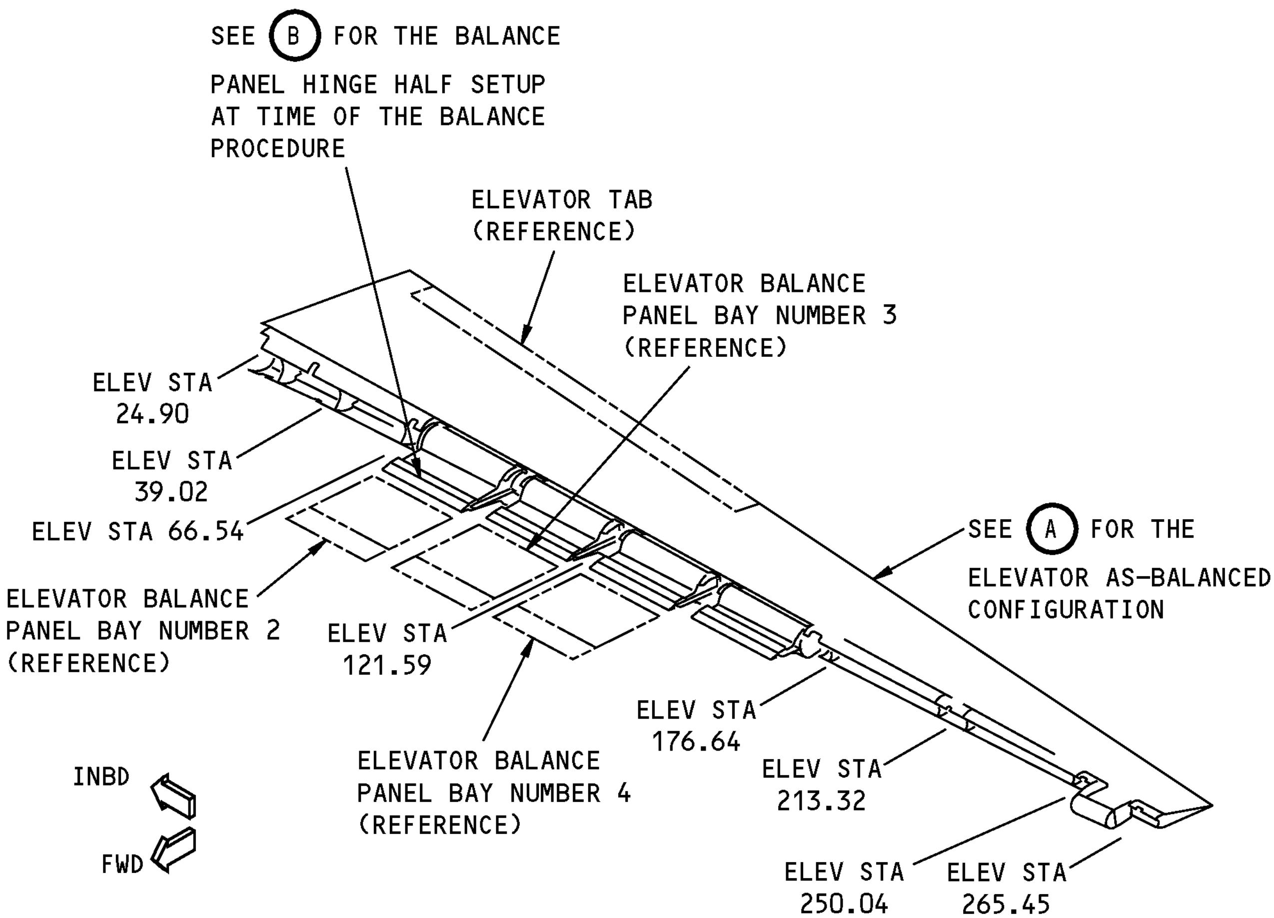
(1) Make sure that it is a complete assembly as given on engineering drawing 183A0101( ), 183A0102-( ), 183A0103-1 thru -5, or 183A0104-( )

NOTE: Refer to Configuration of the Elevator at the Time of the Balance Reduced on the Static Balance Jig, Figure 1/GENERAL for the as-balanced configuration of the elevator assembly. The as-balanced configuration includes all exterior finishes. Elevator tab adjust weights must not be on the elevator assembly when you do the balance.

(2) The as-balanced configuration of the elevator assembly for static balance does not include the balance panel seals, part number 183A0300.

H. Because of the configuration of the horizontal stabilizer, it is not possible to add elevator balance adjust weights to the upper locations of the balance bays of the elevator without the removal of the elevator from the airplane. The lower locations of the balance bays of the elevator are accessible when the lower trailing edge access panels are removed.

I. Make sure that you keep to the sign conventions as given in 51-60-00, except where noted.

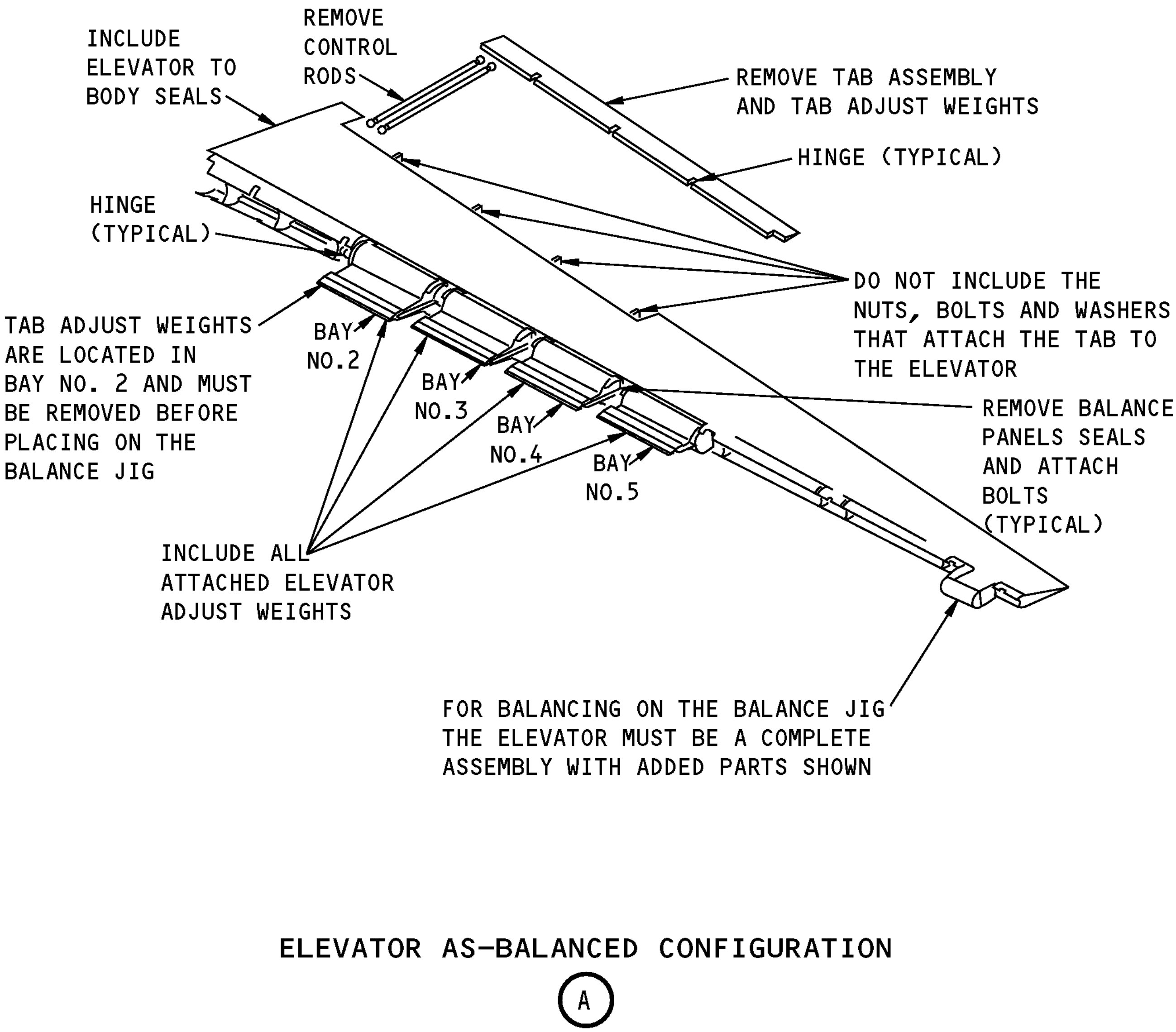


NOTES

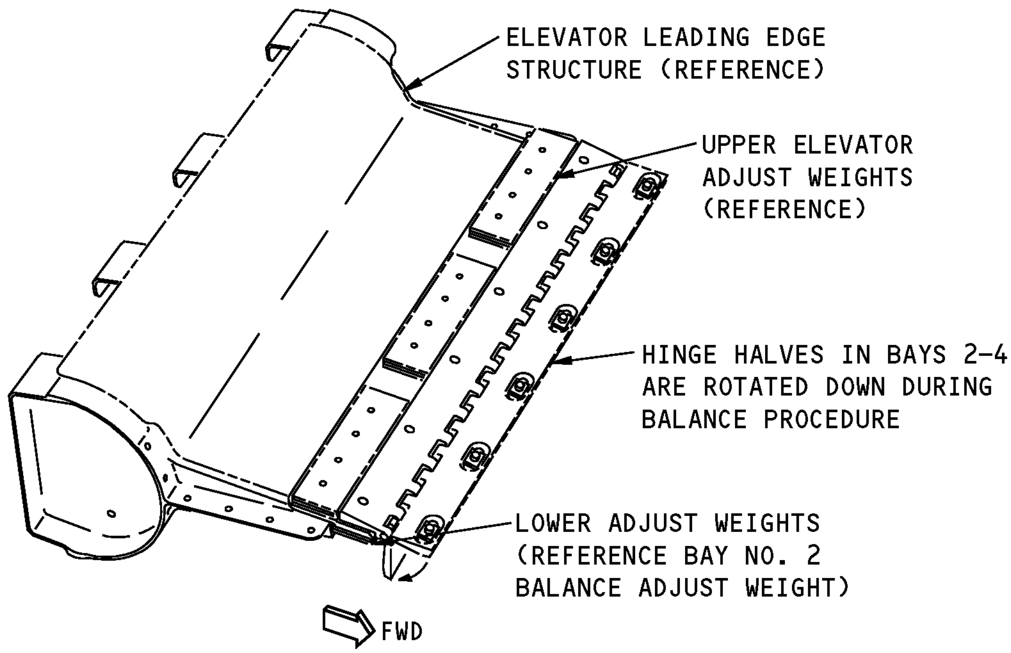
- THE ELEVATOR MUST BE A COMPLETE ASSEMBLY AS GIVEN ON ENGINEERING DRAWING 183A0101-(), 183A0102-(), 183A0103-1 THRU -5, OR 183A0104-(). THIS INCLUDES ALL PROTECTIVE FINISHES AND DECORATIVE PAINT.

- DO NOT INCLUDE:
  - BALANCE PANEL SEALS (REFER TO ENGINEERING DRAWING 183A0300)
  - INSTALLATION BOLTS, NUTS, AND WASHERS THAT ATTACH THE ELEVATOR TAB TO THE ELEVATOR
  - CONTROL RODS AND THEIR INSTALLATION BOLTS, NUTS, AND WASHERS.
  - TAB BALANCE ADJUST WEIGHTS (BAY NO. 2, LOWER)

Configuration of the Elevator at the Time of the Balance Reduced on the Static Balance Jig
Figure 1 (Sheet 1 of 3)



Configuration of the Elevator at the Time of the Balance Reduced on the Static Balance Jig
Figure 1 (Sheet 2 of 3)



BALANCE PANEL HINGE HALF SETUP AT THE TIME OF THE BALANCE PROCEDURE

B

Configuration of the Elevator at the Time of the Balance Reduced on the Static Balance Jig
Figure 1 (Sheet 3 of 3)

3. References

Reference	Title
51-60-00	CONTROL SURFACE BALANCING
51-60-05	WEIGHT CONTROL PROCEDURE FOR THE ELEVATOR BALANCE PANELS
51-60-06	ELEVATOR TAB BALANCE PROCEDURE
51-61-04	ELEVATOR BALANCE PROCEDURE
51-61-06	ELEVATOR TAB BALANCE PROCEDURE
51-70-05	REPAIR PROCEDURES FOR PREIMPREGNATED MATERIALS
AMM 51-21-99 P/B 701	DECORATIVE EXTERIOR PAINT SYSTEM - CLEANING/PAINTING
AMM 06-42-00	Aircraft Maintenance Manual
AMM 27-31-11/401	Elevator - Removal/Installation
AMM 27-31-31/401	Elevator Tab - Removal/Installation
AMM 27-31-41/401	Elevator Balance Panel Removal and Installation
AMM 51-21-11/701	Paint Stipping - Cleaning/Painting
SOPM 20-30-03	Standard Overhaul Practices Manual
SOPM 20-41-02	Application of Chemical and Solvent Resistant Finishes
SOPM 20-44-04	Application of Urethane Compatible Primers
SOPM 20-50-13	Application of Weather, Fuel, Oil, Solvent, and Heat Resistant Protective Coatings

4. Prepare for the Balance Procedure

A. For the balance procedure on the balance jig, do as follows:

(1) Remove the elevator from the airplane. Refer to AMM 27-31-11/401.

(2) Remove the elevator tab from the elevator. Refer to AMM 27-31-31/401.

(3) Remove the elevator balance panels from the elevator. Refer to AMM 27-31-41/401.

(4) Remove the tab adjust weights and the balance panel seals.

(5) Make sure that the elevator assembly that you want to balance has the configuration as given in Paragraph 2.G.

B. For the balance procedure by calculation there are no specific preparations necessary.

5. Balance Procedure

A. Elevator Assembly Static Balance Procedure by Measurement on the Static Balance Jig

NOTE: The secondary static balance requirement for the elevator assembly, when you balance the elevator by measurement on the balance jig, requires a component moment between -108.33 and -24.91 lbfin (-12.24 and -2.81 Nm).

(1) Install the elevator assembly, with the upper surface up, in the static balance jig. Refer to Elevator Support and Balance at the Time of the Balance Procedure on the Static Balance Jig, Figure 2/GENERAL.

(a) Use elevator hinge fitting number 2 (ELEVATOR STA 39.02), hinge fitting number 4 (ELEVATOR STA 121.59) (optional), and hinge fitting number 5 (ELEVATOR STA 176.64) for the installation of the elevator assembly in the balance jig.

NOTE: Make sure that the elevator assembly can pivot freely about its hinge centerline.

(b) Rotate all balance panel hinge halves (3 places) to their lowest position as shown in Configuration of the Elevator at the Time of the Balance Reduced on the Static Balance Jig, Figure 1/GENERAL.

(c) Level the horizontal chord plane ±1 degree with a protractor level.

(2) Use the platform scale and toolstand to measure the Weight Reaction (WR) at tab hinge fitting number 3 centerline. Refer to Elevator Support and Balance at the Time of the Balance Procedure on the Static Balance Jig, Figure 2/GENERAL.

WR = __________ lbf (N)

NOTE: Refer to 51-60-00 for the weight measurement precision for the Weight Reaction (WR).

(3) Calculate the trial Check Balance Moment (CBM) with the formula:

trial CBM = (WR) x (d), where:

- WR is the Weight Reaction measured at tab hinge fitting number 3 in lbf (N)
- d is the moment arm distance between the elevator hinge centerline and the tab hinge fitting centerline at tab hinge fitting number 3 (d = +22.01 in. (+559.05 mm = +0.559 m)).

trial CBM = __________ lbfin (Nm) The trial CBM is the new final moment (Static Balance Hinge Moment) if it is within the given limits.

(a) If -108.33 lbfin ≤ trial CBM ≤ -24.91 lbfin (-12.24 Nm ≤ trial CBM ≤ -2.81 Nm), the secondary static balance requirement for the elevator assembly is met. In this situation you can do one of the steps that follow:

1) Because the static balance requirement for the elevator assembly is met, it is not necessary to install additional elevator balance adjust weights. The trial CBM is the new final moment (Static Balance Hinge Moment) if it is within the given limits. Continue with step 5.A.(7).

2) Balance the elevator assembly to a desired balance moment between -108.33 and -24.91 lbfin (-12.24 and -2.81 Nm) by the addition of a sufficient number of elevator balance adjust weights. Refer to Paragraph 5.D for an Example.

3) Balance the elevator assembly nearest to the most forward component moment of -108.33 lbfin (-12.24 Nm) to account for future repairs, painting, or rework. Refer to Paragraph 5.D for an Example.

(b) If the trial CBM is less negative than -24.91 lbfin (-2.81 Nm) or positive, the secondary static balance requirement for the elevator assembly is not met and you must add elevator balance adjust weights. In this situation you can do one of the steps that follow:

1) Balance the elevator assembly to a desired balance moment between -108.33 and -24.91 lbfin (-12.24 and -2.81 Nm) by the addition of a sufficient number of elevator balance adjust weights. Refer to Paragraph 5.D for an Example.

2) Balance the elevator assembly nearest to the most forward component moment of -108.33 lbfin (-12.24 Nm) to account for future repairs, painting, or rework. Refer to Paragraph 5.D for an Example.

(c) A trial CBM that is more negative than -108.33 lbfin (-12.24 Nm) is not likely to occur and therefore will not be described in this subject.

(4) Find the number of elevator balance adjust weights that you must install to meet the secondary static balance requirement for the elevator assembly.

NOTE: When the elevator assembly is balanced on a static balance jig it is recommended that you use the upper elevator balance adjust weights first. Only the lower elevator balance adjust weights are accessible when the elevator assembly is installed on the airplane. If possible, the lower elevator balance adjust weight locations should be reserved for balancing the elevator on the airplane.

(a) Elevator Assembly Balance Adjust Weight Table, Figure 3/GENERAL, Table I gives the total change in moment (ΔM) as a result of the addition of a number of upper elevator balance adjust weights to an existing number of adjust weights previously installed. The values of ΔM given in the table account for the weight of the different adjust weights, the moment arms of the balance adjust weights, and for the sequence in which the adjust weights must be installed.

(b) Elevator Assembly Balance Adjust Weight Table, Figure 3/GENERAL, Table I I gives the total change in moment (ΔM) as a result of the addition of a number of lower elevator balance adjust weights to an existing number of adjust weights previously installed. The values of ΔM given in the table account for the weight of the different adjust weights, the moment arms of the balance adjust weights, and for the sequence in which the adjust weights must be installed.

(c) For a given trial CBM as found in Paragraph 5.A.(3), together with the formula:

$-108.33 \leq (\Delta M + \text{trial CBM}) \leq -24.91$ (lbfin) ($-12.14 \leq (\Delta M + \text{trial CBM}) \leq -2.81$ (Nm)) you can find the necessary number of elevator balance adjust weights from Elevator Assembly Balance Adjust Weight Table, Figure 3/GENERAL, Tables I and II that must be installed for a given number of adjust weights previously installed and the desired Static Balance Hinge Moment (SBHM) desired SBHM = (ΔM) + (trial CBM)

(5) Install the necessary number of elevator balance adjust weights found in step 5.A.(4):

- upper elevator balance adjust weight: part number 69-53211-2 (Balance bay numbers 2, 3, and 4 only)
- lower elevator balance adjust weight: part number 183A0210-1 (Balance bay numbers 3, 4, and 5 only).

(a) Refer to Elevator Balance Adjust Weight Location and Installation Sequence, Figure 4/GENERAL for:

1) The location where the elevator balance adjust weights must be installed

2) The sequence in which the elevator balance adjust weights must be installed.

(b) If the Boeing elevator balance adjust weights, part numbers 69-53211-2 or 183A0210-1, are not available, you can make elevator balance adjust weights as given in Elevator Balance Adjust Weights, Figure 5/GENERAL.

(c) Install the elevator balance adjust weights, part number 69-53211-2. Refer to Table 2/GENERAL for the maximum permitted number of elevator balance adjust weights per bay and station.

1) As necessary, apply one layer of BMS 5-95 between the elevator balance adjust weight and the hinge plate.

2) Install the elevator balance adjust weights with:

a) BACW10BP3ACU washers (under the bolt heads)

b) BACB30LM3D() or NAS6703D() bolts. Install the bolts with MIL-C-11796, Class 3 corrosion preventive compound. Refer to Table 3/GENERAL for the grip length of the attachment bolt for a given number of elevator balance adjust weights.

c) BACW10BP3NAPU and/or BACW10BP3APU washers (under the nuts)

NOTE: Use any combination of washers to allow the cotter pin to properly engage the nut castellations. Total quantity: minimum of 1 washers maximum of 2 washers

d) BACN10JD103CD nuts

e) BACP18BC02A06P cotter pins.

(d) Install the elevator balance adjust weights, part number 183A0210-1. Refer to Table 2/GENERAL for the maximum permitted number of elevator balance adjust weights per bay and station.

1) As necessary, apply one layer of BMS 5-95 between the elevator balance adjust weight and the hinge plate.

2) Install the elevator balance weights as follows:

a) Bay 3 and 4 lower adjust weights

<1> Install weights with BACB30LM4H() or NAS6704() bolts with MIL-C-11796 class 3. Torque the bolts between 68 and 83 lb-in.

<2> Make sure you use a BACW10BP4ACU washer under the bolt head.

NOTE: Use any combination of BACW10BP4NAPU and BACW10BP4APU washers adjacent to BACW10BP4ACU washer to engage completely. No threads may go past the opposite side of the hinge half. Make sure you use a minimum (0) additional washers adjacent to the necessary washer. Make sure you use a maximum (2) additional washers to permit thread engagement.

<3> Refer to Table 3 for the grip length of the attachment bolts for the given number of adjust weights.

<4> Lock adjacent bolt heads with MS20995N32 lockwire as given in BAC 5018.

b) Bay 5 lower adujst weights

<1> Install weights with BACB30LJ4D() bolts and BACN11N104CS nuts with MIL-C-11796 class 3.

<2> Make sure you use a BACW10BPNAPU washer under the nut.

NOTE: Use any combination of BACW10BP4ACU and BACW10BP4NAPU washers under the bolt head to permit the cotter pin to properly engage castellations. Use a minimum (0) additional washers under the bolt head and a maximum (2) additional washers under the bolt head to properly engage the cotter pin.

<3> Refer to Table 3 for the grip length of the attachment bolts for the given number of adjust weights.

<4> Install cotter pin BACP18BC02A10P as given in BAC 5018.

Table 2:

BALANCE BAY	STATION	MAXIMUM ALLOWABLE QUANTITY OF WEIGHTS	
2	INBOARD	3 UPPER	-
	CENTER	3 UPPER	-
	OUTBOARD	3 UPPER	-
3	INBOARD	3 UPPER	3 LOWER
	CENTER	3 UPPER	2 LOWER
	OUTBOARD	3 UPPER	1 LOWER
4	INBOARD	3 UPPER	3 LOWER
	CENTER	3 UPPER	2 LOWER
	OUTBOARD	3 UPPER	1 LOWER
5	INBOARD	-	3 LOWER
	CENTER	-	2 LOWER
	OUTBOARD	-	1 LOWER

Table 3:

ELEVATOR ASSEMBLY BALANCE ADJUST WEIGHTS ATTACHMENT BOLT GRIP LENGTH DASH NUMBERS			
NUMBER OF ADJUST WEIGHTS IN STACK-UP	ATTACHMENT BOLT BACB30LM3D() OR NAS6703D() UPPER WEIGHT INSTALLATION BAY 2,3,4 ONLY	ATTACHMENT BOLT BACB30LM4H() OR NAS6704H() LOWER WEIGHT INSTALLATION BAY 3,4 ONLY	ATTACHMENT BOLT BACB30LJ4D() LOWER WEIGHT INSTALLATION BAY 5 ONLY
3	12	11	11
2	10	9	8
1	7	7	6
0	5	4	—

(6) Calculate a second trial Check Balance Moment (CBM):

(a) Rotate all balance panel hinge halves (3 places) to their lowest position as shown in Configuration of the Elevator at the Time of the Balance Reduced on the Static Balance Jig, Figure 1/GENERAL.

(b) Level the horizontal chord plane ±1 degree with a protractor level.

(c) Use the platform scale and toolstand to measure the Weight Reaction (WR) at tab hinge fitting number 3 centerline. Refer to Elevator Support and Balance at the Time of the Balance Procedure on the Static Balance Jig, Figure 2/GENERAL.

WR = __________ lbf (N)

NOTE: Refer to 51-60-00 for the weight measurement precision for the Weight Reaction (WR).

(d) second trial Check Balance Moment (CBM) = (WR) x (d), where:

- WR is the (new) Weight Reaction measured in lbf (N)
- d is the moment arm distance between the elevator hinge centerline and the tab hinge fitting centerline at tab hinge fitting number 3 (d = +22.01 in. (+559.05 mm = +0.559 m))

second trial CBM = __________ lbfin (Nm)

(e) If the second trial CBM is within the limits as given in Paragraph 2.F, the second trial Check Balance Moment (CBM) becomes the new Static Balance Hinge Moment (SBHM).

second trial CBM = new (SBHM) = __________ lbfin (Nm) Continue with step 5.A.(7).

(f) If the second trial CBM is not within the limits as given in Paragraph 2.F, do one of the steps that follow:

1) If there are enough weight positions to bring the moment within the limits, repeat steps 5.A.(1) through 5.A.(6).

2) If there are not enough weight positions to bring the moment within the limits, do as follows:

a) Remove all layers of paint from the elevator assembly. Refer to AMM 51-21-11/701 for the paint removal procedures.

b) Restore the elevator assembly decorative exterior paint system. Refer to AMM PAGEBLOCK 51-21-99/701.

c) Repeat steps 5.A.(1) through 5.A.(6).

d) If it is not possible to get the elevator balanced within the specified limits after the removal of multiple layers of paint, you must replace the elevator assembly.

(7) Vibro-engrave or rubber-stamp the value of the new Static Balance Hinge Moment (SBHM) on the metal part identification plate (MS27253C2) that is attached to the elevator assembly.

(a) Apply a Skydrol resistant finish to the rubber-stamped data as given in SOPM 20-50-13.

(b) Do not stamp the installed metal nameplate with steel stamps.

(8) Make a record in the repair log of:

(a) The new Static Balance Hinge Moment (SBHM)

(b) The fact that the elevator has been balanced on the static balance jig

(c) The type of repair

(d) The location of the repair

(e) The date when the elevator was repaired and balanced

(f) The number of elevator balance adjust weights that are installed and the number of available spaces for the addition of weight.

B. Elevator Assembly Static Balance Procedure by Calculation

NOTE: The secondary static balance requirement for the elevator assembly when you balance the elevator by calculation requires a component moment between -108.33 and -45.77 lbfin (-12.24 and -5.17 Nm).

(1) Review the repair log and find the available Rework Moment (RM).

(2) Measure the distance D (within 0.1 inch (2.5 mm)). D is the distance from the rework center of gravity (CG) along the skin surface to the intersection of the centerline of the elevator hinge and the upper skin. Refer to Elevator Balance at Time of Balance Procedure by Calculation, Figure 6/GENERAL.

D = __________ inches (m)

(3) Measure or calculate the distance Y. Y is the distance from the elevator hinge centerline to the line through the CG of the rework, perpendicular to the elevator hinge line and parallel to the elevator chord line. Refer to Elevator Balance at Time of Balance Procedure by Calculation, Figure 6/GENERAL. To calculate the distance Y, use the formula that follows:

$Y = (D) \times (\cos 7.7^\circ) =$ __________ inches (m)

(4) Weigh or calculate the Weight removed (Wr). Wr is the Weight removed as a result of rework, repair, or re-painting. Refer to Paragraph 5.E for an Example Calculation of the Weight removed (Wr).

Wr = +_________ lbm (kg) (KEEP POSITIVE)

(5) Weigh or calculate the Weight added (Wa). Wa is the Weight added as a result of rework, repair, or re-painting. Refer to Paragraph 5.E for an Example Calculation of the Weight added (Wa).

Wa = __________ lbm (kg)

(6) Calculate the Rework Weight (RW). RW is the net change in weight as a result of rework, repair, or re-painting. Refer to Paragraph 5.E for an Example Calculation of the Rework Weight (RW).

RW = Wa - Wr = __________ lbm (kg)

(7) Calculate the Rework Moment (RM). RM is the net change in balance moment as a result of rework, repair, or re-painting. Refer to Paragraph 5.E for an Example Calculation of the Rework Moment (RM).

RM = (RW) x (Y) = __________ lbfin (Nm)

(8) Calculate the trial Check Balance Moment (CBM). The trial CBM is the new final moment (Static Balance Hinge Moment) if it is within the given limits.

trial CBM = (SBHM) + (RM) = __________ lbfin (Nm) where SBHM is the Static Balance Hinge Moment that is the previous final moment stamped on the nameplate of the elevator.

(a) If -108.33 lbfin $\leq$ trial CBM $\leq$ -45.77 lbfin (-12.24 Nm $\leq$ trial CBM $\leq$ -5.17 Nm), the secondary static balance requirement for the elevator assembly is met. In this situation you can do one of the steps that follow:

1) Because the static balance requirement for the elevator assembly is met it is not necessary to install adjust weights. Continue with step 5.C.

2) Balance the elevator assembly to a desired balance moment between -108.33 and -45.77 lbfin (-12.24 and -5.17 Nm) by the addition of a sufficient number of elevator balance adjust weights. Refer to Paragraph 5.D for an Example.

3) Balance the elevator assembly nearest to the most forward component moment of -108.33 lbfin (-12.24 Nm) to account for future repairs, painting, or rework. Refer to Paragraph 5.D for an Example.

(b) If the trial CBM is less negative than -45.77 lbfin (-5.17 Nm) or positive, the secondary static balance requirement for the elevator assembly is not met and you must add elevator balance adjust weights. In this situation you can do one of the steps that follow:

1) Balance the elevator assembly to a desired balance moment between -108.33 and -45.77 lbfin (-12.24 and -5.17 Nm) by the addition of a sufficient number of elevator balance adjust weights. Refer to Paragraph 5.D for an Example.

2) Balance the elevator assembly nearest to the most forward component moment of -108.33 lbfin (-12.24 Nm) to account for future repairs, painting, or rework. Refer to Paragraph 5.D for an Example.

(c) A trial CBM that is more negative than -108.33 lbfin (-12.24 Nm) is not likely to occur and therefore will not be described in this subject.

(9) Find the number of elevator balance adjust weights that you must install to meet the secondary static balance requirement for the elevator assembly.

NOTE: When the elevator assembly is balanced on a static balance jig it is recommended that you use the upper elevator balance adjust weights first. Only the lower elevator balance adjust weights are accessible when the elevator assembly is installed on the airplane. If possible, the lower elevator balance adjust weight locations should be reserved for balancing the elevator on the airplane.

(a) Elevator Assembly Balance Adjust Weight Table, Figure 3/GENERAL, Table I gives the total change in moment (ΔM) as a result of the addition of a number of upper elevator balance adjust weights to an existing number of adjust weights previously installed. The values of ΔM given in the table account for the weight of the different adjust weights, the moment arms of the balance adjust weights, and for the sequence in which the adjust weights must be installed.

(b) Elevator Assembly Balance Adjust Weight Table, Figure 3/GENERAL, Table II gives the total change in moment (ΔM) as a result of the addition of a number of lower elevator balance adjust weights to an existing number of adjust weights previously installed. The values of ΔM given in the table account for the weight of the different adjust weights, the moment arms of the balance adjust weights, and for the sequence in which the adjust weights must be installed.

(c) For a given trial CBM as found in Paragraph 5.B.(8), together with the formula:

$-108.33 \leq (\Delta M + \text{trial CBM}) \leq -45.77$ lbfin ($-12.24 \leq (\Delta M + \text{trial CBM}) \leq -5.17$ Nm) you can find the necessary number of elevator balance adjust weights from Elevator Assembly Balance Adjust Weight Table, Figure 3/GENERAL, Tables I and II that must be installed for a given number of adjust weights already installed and the desired Static Balance Hinge Moment (SBHM) desired SBHM = (ΔM) + (trial CBM)

(10) If you want to add upper elevator balance adjust weights, you must remove the elevator from the airplane. Refer to AMM 27-31-11/401.

(11) Install the necessary number of elevator balance adjust weights found in step 5.B.(9)

upper elevator balance adjust weight: part number 69-53211-2 (Balance bay numbers 2, 3, and 4 only)

lower elevator balance adjust weight: part number 183A0210-1 (Balance bay numbers 3, 4, and 5 only)

(a) Refer to Elevator Balance Adjust Weight Location and Installation Sequence, Figure 4/GENERAL for:

1) The location where the elevator balance adjust weights must be installed

2) The sequence in which the elevator balance adjust weights must be installed.

(b) If the Boeing elevator balance adjust weights, part numbers 69-53211-2 or 183A0210-1, are not available, you can make elevator balance adjust weights as given in Elevator Balance Adjust Weights, Figure 5/GENERAL.

(c) Install the elevator balance adjust weights, part number 69-53211-2. Refer to Table 2 for the maximum permitted number of elevator balance adjust weights per bay and station.

1) As necessary, apply one layer of BMS 5-95 between the elevator balance adjust weight and the hinge plate.

2) Install the elevator balance adjust weights with:

a) BACW10BP3ACU washers (under the bolt heads)

b) BACB30LM3D() or NAS6703D() bolts. Install the bolts with MIL-C-11796, Class 3 corrosion preventive compound. Refer to Table 3 for the grip length of the attachment bolt for a given number of elevator balance adjust weights.

c) BACW10BP3NAPU and/or BACW10BP3APU washers (under the nuts)

NOTE: Use any combination of washers to allow the cotter pin to properly engage nut castellations. Total quantity: minimum of 1 washers maximum of 2 washers

d) BACN10JD103CD nuts

e) BACP18BC02A06P cotter pins.

(d) Install the elevator balance adjust weights, part number 183A0210-1. Refer to Table 2 for the maximum permitted number of elevator balance adjust weights per bay and station.

1) As necessary, apply one layer of BMS 5-95 between the elevator balance adjust weight and the hinge plate.

2) Install the elevator balance weights as follows:

a) Bay 3 and 4 lower adjust weights

<1> Install weights with BACB30LM4H() or NAS6704() bolts with MIL-C-11796 class 3. Torque the bolts between 68 and 83 lb-in.

<2> Make sure you use a BACW10BP4ACU washer under the bolt head.

NOTE: Use any combination of BACW10BP4NAPU and BACW10BP4APU washers adjacent to BACW10BP4ACU washer to engage completely. No threads may go past the opposite side of the hinge half. Make sure you use a minimum (0) additional washers adjacent to the necessary washer. Make sure you use a maximum (2) additional washers to permit thread engagement.

<3> Refer to Table 3 for the grip length of the attachment bolts for the given number of adjust weights.

<4> Lock adjacent bolt heads with MS20995N32 lockwire as given in BAC 5018.

b) Bay 5 lower adjust weights

<1> Install weights with BACB30LJ4D() bolts and BACN11N104CS nuts with MIL-C-11796 class 3.

<2> Make sure you use a BACW10BPNAPU washer under the nut.

NOTE: Use any combination of BACW10BP4ACU and BACW10BP4NAPU washers under the bolt head to permit the cotter pin to properly engage castellations. Use a minimum (0) additional washers under the bolt head and a maximum (2) additional washers under the bolt head to properly engage the cotter pin.

<3> Refer to Table 3 for the grip length of the attachment bolts for the given number of adjust weights.

<4> Install cotter pin BACP18BC02A10P as given in BAC 5018.

(12) Calculate a second trial Check Balance Moment (CBM) with the formula:

second trial CBM = previous (SBHM) + (RM) + ΔM

second trial CBM = first trial CBM + ΔM

second trial CBM = __________ lbfin (Nm) where: previous SBHM is the Static Balance Hinge Moment that is the previous final moment stamped on the nameplate of the elevator. RM is the Rework Moment as found in Paragraph 5.B.(7).

ΔM is the change in moment selected from Elevator Assembly Balance Adjust Weight Table, Figure 3/GENERAL, Tables I and/or II for a given number of elevator balance adjust weights added (n).

(a) If the second trial CBM is within the limits as given in Paragraph 2.F, the second trial Check Balance Moment (CBM) becomes the new Static Balance Hinge Moment (SBHM).

second trial CBM = new (SBHM) = __________ lbfin (Nm) Continue with step 5.C.

(b) If the second trial CBM is not within the limits as given in Paragraph 2.F, do one of the steps that follows:

1) If there are not enough weight positions to bring the moment within the limits, do steps 5.B.(1) through 5.B.(12).

2) If there are not enough weight positions to bring the moment within the limits, you can restore rework capability as follows:

a) Remove all layers of paint from the elevator assembly.

- Refer to AMM 51-21-11/701 for the paint removal procedures.
- Remove the balance adjust weights which are equal in moment to the layers of paint that were added to the initial paint application.

NOTE: These layers of paint are removed to restore the rework capability of the elevator assembly. This does not include the initial paint application. Do not remove the adjust weights necessary for the initial paint application.

b) Restore the decorative exterior paint to the elevator assembly.

- Use the same specification as the initial paint application you removed.
- Refer to Table 4/GENERAL for the data for 0.001 inch thickness of paint and its effect on the moment and moment arm.
- Refer to AMM PAGEBLOCK 51-21-99/701 for the paint application procedures. (The restored paint is a repaint. It will be will be necessary to add adjust weights that are equal in moment to this paint application. If there are other rework areas or repairs on the elevator assembly, it is still necessary to add adjust weights equal in moment to these areas.)
- Repeat steps 5.B.(1) through 5.B.(12).
- If it is not possible to get the elevator balanced within the specified limits after the removal of multiple layers of paint, you can balance the elevator on the static balance jig because the limits for balancing on the balance jig are less strict. If this will not bring the elevator balance within the limits you must replace the elevator assembly.

Table 4:

VARIABLES FOR THE CALCULATION OF THE EFFECT OF ONE PAINT LAYER (BMS 10-60), 0.001 in. (0.0254 mm) THICK ON THE COMPONENT MOMENT OF THE ELEVATOR		
PAINTED SURFACE AREA PER ELEVATOR	**MOMENT AS A RESULT OF PAINT**	**MOMENT ARM OF ADDED PAINT** (Distance aft of the elevator hinge centerline)
ft^2 (m^2)	lbfin (Nm)	inches (mm)
70.8 (6.58)	+ 5.0056 (+ 0.5656)	+ 10.1 (+ 256.5)

C. Vibro-engrave or rubber-stamp the value of the new Static Balance Hinge Moment (SBHM) on the metal part identification plate (MS27253C2) that is attached to the elevator assembly.

(1) Apply a Skydrol resistant finish to the rubber-stamped data as given in SOPM 20-50-13.

(2) Do not stamp the installed metal nameplate with steel stamps.

(3) Make a record in the repair log of:

(a) The new Static Balance Hinge Moment (SBHM)

(b) The fact that the elevator has been balanced by calculation

(c) The type of repair

(d) The location of the repair

(e) The date when the elevator was repaired and balanced

(f) The number of elevator balance adjust weights that are installed and the number of available spaces for the addition of weight.

D. Example 1 - Elevator Assembly Static Balance Procedure by Measurement on the Balance Jig

Assume that a new elevator is damaged and the decision is made to remove the elevator from the airplane for repair and balancing.

(1) Make sure that the elevator assembly that you want to balance has the configuration as given in Paragraph 2.G.

(2) Install the elevator assembly, with the upper surface up, in the static balance jig. (Refer to Elevator Support and Balance at the Time of the Balance Procedure on the Static Balance Jig, Figure 2/GENERAL)

(a) Use elevator hinge fitting number 2 (ELEVATOR STA 39.02), hinge fitting number 4 (ELEVATOR STA 121.59) (optional), and hinge fitting number 5 (ELEVATOR STA 176.64) for the installation of the elevator assembly in the balance jig.

NOTE: Make sure that the elevator assembly can pivot freely about its hinge centerline.

(b) Rotate all balance panel hinge halves (3 places) to their lowest position as shown in Configuration of the Elevator at the Time of the Balance Reduced on the Static Balance Jig, Figure 1/GENERAL.

(c) Level the horizontal chord plane ±1 degree with a protractor level.

(3) Use the platform scale and toolstand to measure the Weight Reaction (WR) at tab hinge fitting number 3 centerline. (Refer to Elevator Support and Balance at the Time of the Balance Procedure on the Static Balance Jig, Figure 2/GENERAL)

WR = +7.19 lbf (+31.98 N)

(4) Find the moment arm distance d from Elevator Support and Balance at the Time of the Balance Procedure on the Static Balance Jig, Figure 2/GENERAL. The moment arm distance d is the distance between the elevator hinge centerline and the tab hinge fitting centerline at tab hinge fitting number 3. This distance is aft of the elevator hinge centerline and is therefore positive.

d = +22.01 in. (+559.05 mm = +0.559 m)

(5) Calculate the trial Check Balance Moment (CBM) with the formula:

trial CBM = (WR) x (d), where:

trial CBM = (+31.98) x (+22.01) = +158.25 lbfin (+17.91 Nm)

(6) With this trial CBM you can do one of the steps that follow:

(a) The trial CBM does not meet the secondary static balance requirement as given in Paragraph 2.F, so it is necessary to install additional elevator balance adjust weights.

(b) To balance the elevator assembly to a desired balance moment between -108.33 and -24.91 lbfin (-12.24 and -2.81 Nm) by the addition of a sufficient number of elevator balance adjust weights, do as follows:

1) Decide what the desired balance moment will be. In this example the desired balance moment is chosen to be -66.00 lbfin (-7.46 Nm) maximum. This means that we will aim for a final Static Balance Hinge Moment (SBHM) of -66.00 lbfin (-7.46 Nm).

2) Find the number of elevator balance adjust weights that are already installed. In this example we assume that 4 upper elevator balance adjust weights are installed. This means that there are 23 positions left for additional upper weights. No lower elevator balance adjust weights are installed. This means that all 18 positions for lower weights are available.

NOTE: When the elevator assembly is balanced on a static balance jig it is recommended that you use the upper elevator balance adjust weights first. Only the lower elevator balance adjust weights are accessible when the elevator assembly is installed on the airplane. If possible, the lower elevator balance adjust weight locations should be reserved for balancing the elevator on the airplane.

3) Find the number of upper elevator balance adjust weights that must be installed first. In Elevator Assembly Balance Adjust Weight Table - Example 1, Figure 7/GENERAL, Table I move horizontally from left to right starting in the row of 4 existing adjust weights (point A). From this point, move to the right horizontally until you find the ΔM (upper) (point B) that you must add to your trial CBM to get the desired balance moment:

a) Find the ΔM that must be added to the trial CBM to get the desired balance moment:

ΔM = desired balance moment - trial CBM

ΔM = (-66.00) - (+158.25) = -224.87 lbfin (-25.41 Nm) maximum

b) With a maximum ΔM (desired) of -224.87 lbfin (-25.41 Nm) you must add 23 upper elevator balance adjust weights to get as near as possible to your desired balance moment (point C).

c) The addition of all remaining 23 upper adjust weights results in a ΔM (upper) of -194.80 lbfin (-22.01 Nm). To get nearer to the desired balance moment you will also have to add lower adjust weights.

4) Find the number of lower elevator balance adjust weights as follows:

a) The ΔM for the lower adjust weights needed to get the desired balance moment is:

ΔM (lower) = ΔM (desired) - ΔM (upper)

ΔM (lower) = (-224.87) - (-194.80)

ΔM (lower) = -30.07 lbfin (-3.40 Nm)

b) In Elevator Assembly Balance Adjust Weight Table - Example 1, Figure 7/GENERAL, Table II, move horizontally from left to right starting in the row of 0 existing lower adjust weights (point D). From this point, move to the right horizontally until you find the ΔM (point E) that you must add to your trial CBM to get the desired balance moment:

- With a desired ΔM (lower) of -30.07 lbfin (-3.40 Nm) you must add 4 lower elevator balance adjust weights to get as near as possible to your desired balance moment (point F).

5) Install the 23 upper and 4 lower elevator balance adjust weights as given in Paragraph 5.A.(5).

6) Calculate a second trial Check Balance Moment (CBM):

a) Rotate all balance panel hinge halves (3 places) to their lowest position as shown in Configuration of the Elevator at the Time of the Balance Reduced on the Static Balance Jig, Figure 1/GENERAL.

b) Level the horizontal chord plane ±1 degree with a protractor level.

c) Use the platform scale and toolstand to measure the Weight Reaction (WR) at tab hinge fitting number 3 centerline. (Refer to Elevator Support and Balance at the Time of the Balance Procedure on the Static Balance Jig, Figure 2/GENERAL)

WR = -2.81 lbf (-12.50 N)

d) second trial Check Balance Moment (CBM) = (WR) x (d)

second trial CBM = (-2.81) x (+22.01)

second trial CBM = -61.81 lbfin (-6.98 Nm)

e) The second trial CBM is within the limits as given i Paragraph 2.F. The second trial Check Balance Moment (CBM) becomes the new Static Balance Hinge Moment (SBHM).

second CBM = new (SBHM) = -61.81 lbfin (-6.98 Nm) Continue with step 5.D.(7).

(c) To balance the elevator assembly nearest the most forward component moment of -108.33 lbfin (-12.24 Nm) to account for future repairs, painting, or rework, do as follows:

1) Find the number of elevator balance adjust weights that are already installed. In this example we assume that 4 upper elevator balance adjust weights are installed. This means that there are 23 positions left for additional upper weights. No lower elevator balance adjust weights are installed. This means that all 18 positions for lower weights are available.

NOTE: When the elevator assembly is balanced on a static balance jig it is recommended that you use the upper elevator balance adjust weights first. Only the lower elevator balance adjust weights are accessible when the elevator assembly is installed on the airplane. If possible, the lower elevator balance adjust weight locations should be reserved for balancing the elevator on the airplane.

2) Find the ΔM that must be added to the trial CBM to get the moment nearest to the most forward component moment:

   ΔM = most forward component moment - trial CBM

   ΔM = (-108.33) - (+158.25) = -266.58 lbfin (-30.12 Nm) maximum

3) Find the number of upper elevator balance adjust weights that must be installed first. In Elevator Assembly Balance Adjust Weight Table - Example 1, Figure 7/GENERAL, Table I move horizontally from left to right starting in the row of 4 existing adjust weights (point A). From this point, move to the right horizontally until you find the ΔM (upper) (point B) that you must add to your trial CBM to get the most forward component moment:

   a) With a ΔM of -266.58 lbfin (-30.12 Nm) you must add 23 upper elevator balance adjust weights to get as close as possible to your most forward component moment (point C).

   b) The addition of all remaining 23 upper adjust weights results in a ΔM (upper) of -194.80 lbfin (-22.01 Nm). To get closer to the most forward component moment you will have to add lower adjust weights too.

4) The number of lower elevator balance adjust weights can be found as follows:

   a) The ΔM for the lower adjust weights needed to get the desired balance moment is:

      ΔM (lower) = ΔM (most forward component moment) - ΔM (upper)

      ΔM (lower) = (-266.58) - (-194.80)

      ΔM (lower) = -71.78 lbfin (-8.11 Nm)

   b) In Elevator Assembly Balance Adjust Weight Table - Example 1, Figure 7/GENERAL, Table II move horizontally from left to right starting in the row of 0 existing lower adjust weights (point D). From this point, move to the right horizontally until you find the ΔM (point G) that you must add to your trial CBM to get the most forward component moment:

      - With a desired ΔM (lower) of -71.78 lbfin (-8.11 Nm) you must add 10 lower elevator balance adjust weights to get as close as possible to your most forward component moment (point H).

5) Install the 23 upper and 10 lower elevator balance adjust weights as given in Paragraph 5.A.(5).

6) Calculate a second trial Check Balance Moment (CBM):

   a) Rotate all balance panel hinge halves (3 places) to their lowest position as shown in Configuration of the Elevator at the Time of the Balance Reduced on the Static Balance Jig, Figure 1/GENERAL.

   b) Level the horizontal chord plane $\pm$1 degree with a protractor level.

   c) Use the platform scale and toolstand to measure the Weight Reaction (WR) at tab hinge fitting number 3 centerline. (Refer to Elevator Support and Balance at the Time of the Balance Procedure on the Static Balance Jig, Figure 2/GENERAL)

      WR = -4.86 lbf (-21.62 N)

   d) second trial Check Balance Moment (CBM) = (WR) x (d) second trial CBM = (-4.86) X (+22.01)

      second trial CBM = -106.88 lbfin (-12.08 Nm)

e) The second trial CBM is within the limits as given i Paragraph 2.F. The second trial Check Balance Moment (CBM) becomes the new Static Balance Hinge Moment (SBHM).

second CBM = new (SBHM) = -106.88 lbfin (-12.08 Nm) Continue with step 5.D.(7).

(7) Vibro-engrave or rubber-stamp the value of the new Static Balance Hinge Moment (SBHM) on the metal part identification plate (MS27253C2) that is attached to the elevator assembly.

(a) Apply a Skydrol resistant finish to the rubber-stamped data as given in SOPM 20-50-13.

(b) Do not stamp the installed metal nameplate with steel stamps.

(8) Make a record in the repair log of:

(a) The new Static Balance Hinge Moment (SBHM)

(b) The fact that the elevator has been balanced on the static balance jig

(c) The type of repair

(d) The location of the repair

(e) The date when the elevator was repaired and balanced

(f) The number of elevator balance adjust weights that are installed and the number of available spaces for the addition of weight.

E. Example 2 - Elevator Assembly Static Balance Procedure by Calculation

(1) For this example we will assume what follows:

(a) A 250°F (121°C) cure repair as given in 51-70-05 has been done to the elevator with the elevator on the airplane.

(b) The current recorded Static Balance Hinge Moment (SBHM) is

-67.89 lbfin (-7.67 Nm).

(c) Fourteen of the twenty-seven upper elevator balance adjust weights have been installed during previous balance procedures. There are no lower elevator balance adjust weights installed.

(d) It is estimated that the Rework Moment (RM) as a result of the repair will not bring the elevator balance outside of the limits. Addition of elevator balance adjust weights will therefore not be necessary, unless you want to balance the elevator to a desired moment or nearest to the most forward component moment to account for future repairs, painting, and rework.

(2) Measure the distance D (within 0.1 inch (2.5 mm)). D is the distance from the rework center of gravity (CG) along the skin surface to the intersection of the centerline of the elevator hinge and the upper skin. Refer to Elevator Balance at Time of Balance Procedure by Calculation, Figure 6/GENERAL. For this example we will assume that

D = 8.1 in. (205.7 mm = 0.206 m)

(3) Measure or calculate the distance Y. Y is the distance from the elevator hinge centerline to the line through the CG of the rework, perpendicular to the elevator hinge line and parallel to the elevator chord line. Refer to Elevator Balance at Time of Balance Procedure by Calculation, Figure 6/GENERAL. To calculate the distance Y, use the formula that follows:

$Y = (D) \times (\cos 7.7^\circ) = (8.1) \times (\cos 7.7^\circ) = 8.0$ in. (0.203 m)

(4) Find which repair operations will add weight and which repair operations will remove weight. The weight of the repair ply material is not the same as the original material weight. Therefore, a Weight removed (Wr) and a Weight added (Wa) calculation must be made. The difference between the added and removed paint is negligible unless paint was added beyond the boundaries of the paint removed. The materials which will add weight to the 250°F (121°C) repair are shown in Repair (Typical) - Repair of Damage to One Skin and Honeycomb Core , Figure 8/GENERAL.

NOTE: For the Weight removed (Wr) calculation the areas of the plies removed are thought to be the same as those plies that replace them. Therefore, the weight change results from the weight per unit difference. Typically for a 250°F (121°C) repair the replacement plies are slightly heavier than the original plies and a net weight increase results from the addition of repair ply material.

(a) Weigh or calculate the Weight removed (Wr). Wr is the Weight removed as a result of rework, repair, or re-painting.

1) Be careful when you calculate the weight of the material removed (or lost as a result of damage) and the weight of the material added.

a) Measure or calculate the weight of the material removed and the weight of the material added as accurately as possible.

b) Keep the tolerance very small or else you can have weight that is not satisfactory. What follows will have an effect on the tolerance:

- The tolerance of the weighing equipment
- The precision in your estimation of the weight of the material that has been removed
- The precision in your estimation of the weight of the repair materials or paint.

2) If you calculate the Weight removed (Wr) do as follows:

NOTE: Refer to 51-60-00 for the weights of the materials.

Wr = (Area of Material) x (Weight per unit Area) for ply material

Wr = (Volume of Material) x (Weight per unit Volume) for honeycomb material

a) For non-metallic honeycomb core, BMS 8-124, Class IV, Type V, Grade 3.0 (5.0 in. (127.0 mm) in diameter, 0.40 inch (10.2 mm) in depth):

$Wr1 = (\pi/4)(5.0)^2(0.40)(0.0017\ lb/in^3)$

$Wr1 = +0.0134$ lbm ($+0.0061$ kg)

b) For first (innermost) original ply - CFRP, BMS 8-256, Type IV, Class 2, Style 3K-70-PW (6.0 in. (152.4 mm) in diameter):

$Wr2 = (\pi/4)(6.0)^2(0.00046\ lb/in^2/ply)$

$Wr2 = +0.0130$ lbm ($+0.0059$ kg)

c) For second (middle) original ply - CFRP, BMS 8-256, Type IV, Class 2, Style 3K-70-PW (7.0 in. (177.8 mm) in diameter):

$Wr3 = (\pi/4)(7.0)^2(0.00046\ lb/in^2/ply)$

$Wr3 = +0.0177$ lbm ($+0.0080$ kg)

d) For third (middle) original ply - CFRP, BMS 8-256, Type IV, Class 2, Style 3K-70-PW (8.0 in. (203.2 mm) in diameter):

$Wr4 = (\pi/4)(8.0)^2(0.00046\ lb/in^2/ply)$

$Wr4 = +0.0231$ lbm ($+0.0105$ kg)

e) For fourth (outermost) original ply - CFRP, BMS 8-256, Type IV, Class 2, Style 3K-70-PW (9.0 in. (228.6 mm) in diameter):

$Wr5 = (\pi/4)(9.0)^2(0.00046\ lb/in^2/ply)$

$Wr5 = +0.0293$ lbm ($+0.0133$ kg)

f) The total Weight removed (Wr):

$Wr = Wr1 + Wr2 + Wr3 + Wr4 + Wr5$

$Wr = 0.0134 + 0.0130 + 0.0177 + 0.0231 + 0.0293$

$Wr = +0.0965$ lbm ($+0.0438$ kg)

(5) Weigh or calculate the Weight Added (Wa). Wa is the Weight added as a result of rework, repair, or re-painting. Refer to Repair (Typical) - Repair of Damage to One Skin and Honeycomb Core , Figure 8/GENERAL for the layout of the added repair materials.

(a) Be careful when you calculate the weight of the material removed (or lost as a result of damage) and the weight of the material added.

1) Measure or calculate the weight of the material removed and the weight of the material added as accurately as possible.

2) Keep the tolerance very small or else you can have weight that is not satisfactory. What follows will have an effect on the tolerance:

a) The tolerance of the weighing equipment

b) The precision in your estimation of the weight of the material that has been removed

c) The precision in your estimation of the weight of the repair materials or paint.

3) If you calculate the Weight Added (Wa) do as follows:

NOTE: Refer to 51-60-00 for the weights of the materials.

Wa = (Area of Material) x (Weight per unit Area) for ply material

Wa = (Volume of Material) x (Weight per unit Volume) for honeycomb material

a) Repair Item 1 - Adhesive Film - BMS 8-245, Type II, Class 1, Grade 3A (5.0 in. (127.0 mm) in diameter):

$Wa1 = (\pi/4)(5.0)^2(0.00020\ lb/in^2)$

$Wa1 = 0.0039$ lbm (0.0018 kg)

b) Repair Item 2 - Foaming Adhesive - BMS 5-90, Type II, Grade 50 (0.40 in. (10.2 mm) in width, 5π in. (127π mm) in length):

$Wa2 = (5\pi)(0.40)(0.0025\ lb/in^2)$

$Wa2 = 0.0157$ lbm (0.0071 kg)

c) Repair Item 3 - Replacement Core Plug - Non-metallic honeycomb core, BMS 8-124, Class IV, Type V, Grade 3.0 (5.0 in. (152.4 mm) in diameter, 0.40 in. (10.2 mm) in depth):

$Wa3 = (\pi/4)(5.0)^2(0.40)(0.0017\ lb/in^3)$

$Wa3 = 0.0134$ lbm (0.0061 kg)

d) Repair Item 4 - Adhesive Film - BMS 8-245, Type II, Class 1, Grade 3A (12.0 in. (304.8 mm) in diameter):

$Wa4 = (\pi/4)(12.0)^2(0.00020\ lb/in^2)$

$Wa4 = 0.0226$ lbm (0.0103 kg)

e) Repair Item 5 - Filler Ply - CFRP, BMS 8-256, Type IV, Class 2, Style 3K-70-PW (5.0 in. (127.0 mm) in diameter):

$Wa5 = (\pi/4)(5.0)^2(0.00046\ lb/in^2/ply)$

$Wa5 = 0.0090$ lbm (0.0041 kg)

f) Repair Item 6 - Replacement Ply - CFRP, BMS 8-256, Type IV, Class 2, Style 3K-70-PW (6.0 in. (152.4 mm) in diameter):

$Wa6 = (\pi/4)(6.0)^2(0.00046\ lb/in^2/ply)$

$Wa6 = 0.0130$ lbm (0.0059 kg)

g) Repair Item 7 - Replacement Ply - CFRP, BMS 8-256, Type IV, Class 2, Style 3K-70-PW (7.0 in. (177.8 mm) in diameter):

$Wa7 = (\pi/4)(7.0)^2(0.00046\ lb/in^2/ply)$

$Wa7 = 0.0177$ lbm (0.0080 kg)

h) Repair Item 8 - Replacement Ply - CFRP, BMS 8-256, Type IV, Class 2, Style 3K-70-PW (8.0 in. (203.2 mm) in diameter):

$Wa8 = (\pi/4)(8.0)^2(0.00046\ lb/in^2/ply)$

$Wa8 = 0.0231$ lbm (0.0105 kg)

i) Repair Item 9 - Replacement Ply - CFRP, BMS 8-256, Type IV, Class 2, Style 3K-70-PW (9.0 in. (228.6 mm) in diameter):

$Wa9 = (\pi/4)(9.0)^2(0.00046\ lb/in^2/ply)$

$Wa9 = 0.0293$ lbm (0.0133 kg)

j) Repair Item 10 - Extra Repair Ply - CFRP, BMS 8-256, Type IV, Class 2, Style 3K-70-PW (10.0 in. (254.0 mm) in diameter):

$Wa10 = (\pi/4)(10.0)^2(0.00046\ lb/in^2/ply)$

$Wa10 = 0.0361$ lbm (0.0164 kg)

k) Repair Item 11 - Extra Repair Ply - CFRP, BMS 8-256, Type IV, Class 2, Style 3K-70-PW (11.0 in. (279.4 mm) in diameter):

$Wa11 = (\pi/4)(11.0)^2(0.00046\ lb/in^2/ply)$

$Wa11 = 0.0437$ lbm (0.0198 kg)

l) Repair Item 12 - Adhesive Film - BMS 8-245, Type II, Class 1, Grade 3A (12.0 in.) (304.8 mm) in diameter:

$Wa12 = (\pi/4)(12.0)^2(0.00020\ lb/in^2)$

$Wa12 = 0.0226$ lbm (0.0103 kg)

m) The total Weight Added (Wa):

$Wa = Wa1 + Wa2 + Wa3 + Wa4 + Wa5 + Wa6 + Wa7 + Wa8 + Wa9 + Wa10 + Wa11 + Wa12$

$Wa = 0.0039 + 0.0157 + 0.0134 + 0.0226 + 0.0090 + 0.0130 + 0.0177 + 0.0231 + 0.0293 + 0.0361 + 0.0437 + 0.0226$

Wa = 0.2501 lbm (0.1134 kg)

(6) Calculate the Rework Weight (RW). RW is the net change in weight as a result of rework, repair, or re-painting.

RW = Wa - Wr = 0.2501 - 0.0965

RW = 0.1536 lbm (0.0697 kg)

(7) Calculate the Rework Moment (RM). RM is the net change in balance moment as a result of rework, repair, or re-painting.

RM = (RW) x (Y)

RM = (0.1536) x (8.0) = +1.2 lbfin (+0.1 Nm)

(8) Calculate the trial Check Balance Moment (CBM). The trial CBM is the new final moment (Static Balance Hinge Moment) if it is within the given limits.

trial CBM = (SBHM) + (RM)

trial CBM = (-67.89) + (1.2) = -66.7 lbfin (-7.5 Nm) where SBHM is the Static Balance Hinge Moment that is the previous final moment stamped on the nameplate of the elevator.

(9) With this trial CBM you can do one of the steps that follow:

(a) The trial CBM meets the secondary static balance requirement as given in Paragraph 2.F, so it is not necessary to install additional elevator balance adjust weights. In this case, the trial CBM is the new final moment Static Balance Hinge Moment. Continue with step 5.E.(10).

(b) If you want to balance the elevator assembly to a desired balance moment anywhere between -108.33 and -45.77 lbfin (-12.24 and -5.17 Nm) by adding sufficient elevator balance adjust weights, do as follows:

1) First, you must decide what the desired balance moment will be. In this example the desired balance moment is chosen to be -93.0 lbfin (-10.5 Nm) maximum. This means that we will aim for a final Static Balance Hinge Moment (SBHM) of -93.0 lbfin (-10.5 Nm).

2) Then, you must find the number of elevator balance adjust weights that are already installed. In this example we assume that 10 upper elevator balance adjust weights are installed. This means that there are 17 positions left for additional upper weights. No lower elevator balance adjust weights are installed. This means that all 18 positions for lower weights are available.

3) Find the ΔM that must be added to the trial CBM to get the desired balance moment:

ΔM = desired balance moment - trial CBM

ΔM = (-93.0) - (-66.5) = -26.5 lbfin (-3.0 Nm) maximum

NOTE: Because all the lower elevator balance adjust weight positions are available, the ΔM required can be reached with the addition of lower adjust weights only. In this situation the elevator does not have to be removed from the airplane.

4) The number of lower elevator balance adjust weights that must be installed can be found as follows: In Elevator Assembly Balance Adjust Weight Table - Example 2, Figure 9/GENERAL, Table I move horizontally from left to right starting in the row of 0 existing adjust weights (point V). From this point, move to the right horizontally until you find the ΔM (lower) (point W) that you must add to your trial CBM to get the desired balance moment: With a maximum desired ΔM of -26.5 lbfin (-3.0 Nm) you must add 4 lower elevator balance adjust weights to get as close as possible to your desired balance moment (point X).

5) Get access to the lower balance weight locations of balance bays number 3, 4, and 5.

   a) Remove access panels 333CB (LH) and 343CB, 333DB (LH) and 343DB (RH), and 333EB (LH) and 343EB (RH), as applicable. Refer to AMM 06-42-00.

6) Install the 4 lower elevator balance adjust weights as given in Paragraph 5.B.(11).

7) Calculate the new Static Balance Hinge Moment (SBHM):

   new SBHM = trial CBM + ΔM

   new SBHM = (-66.5) + (-25.26)

   new SBHM = -91.8 lbfin (-10.4 Nm)

   Continue with step 5.E.(10).

(c) To balance the elevator assembly nearest to the most forward component moment of -108.33 lbfin (-12.24 Nm) to account for future repairs, painting, or rework, do as follows:

1) Find the number of elevator balance adjust weights that are already installed. In this example we assume that 10 upper elevator balance adjust weights are installed. This means that there are 17 positions left for additional upper weights. No lower elevator balance adjust weights are installed. This means that all 18 positions for lower weights are available.

2) Find the ΔM that must be added to the trial CBM to get closest to the most forward component moment:

   ΔM = most forward component moment - trial CBM

   ΔM = (-108.33) - (-66.5) = -41.8 lbfin (-4.7 Nm) maximum

   NOTE: Because all the lower elevator balance adjust weight positions are available, the ΔM required can be reached with the addition of lower adjust weights only. In this situation the elevator does not have to be removed from the airplane.

3) The number of lower elevator balance adjust weights that must be installed can be found as follows: In Elevator Assembly Balance Adjust Weight Table - Example 2, Figure 9/GENERAL, Table I move horizontally from left to right starting in the row of 0 existing adjust weights (point V). From this point, move to the right horizontally until you find the ΔM (lower) (point Y) that you must add to your trial CBM to get the most forward component moment: With a desired ΔM of -41.8 lbfin (-4.7 Nm) you must add 6 lower elevator balance adjust weights to get as close as possible to your most forward component moment (point Z).

4) Install the 6 lower elevator balance adjust weights as given in Paragraph 5.B.(11).

5) Calculate the new Static Balance Hinge Moment (SBHM):

   new SBHM = first trial CBM + ΔM

   new SBHM = (-66.5) + (-39.54)

new SBHM = -106.0 lbfin (-12.0 Nm)

Continue with step 5.E.(10).

(10) Vibro-engrave or rubber-stamp the value of the new Static Balance Hinge Moment (SBHM) on the metal part identification plate (MS27253C2) that is attached to the elevator assembly.

(a) Apply a Skydrol resistant finish to the rubber-stamped data as given in SOPM 20-50-13.

(b) Do not stamp the installed metal nameplate with steel stamps.

(11) Make a record in the repair log of:

(a) The new Static Balance Hinge Moment (SBHM)

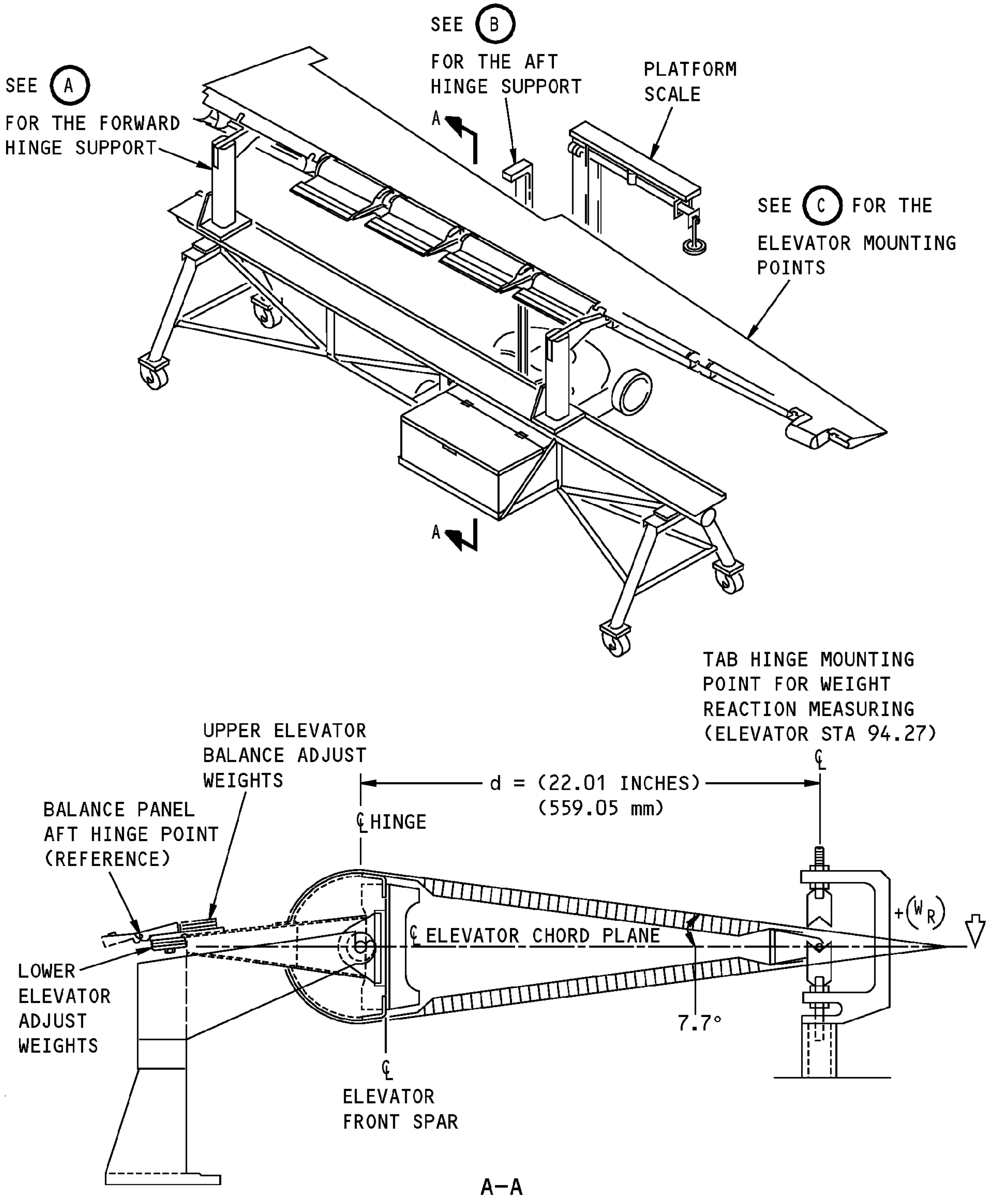
(b) The fact that the elevator has been balanced by calculation

(c) The type of repair

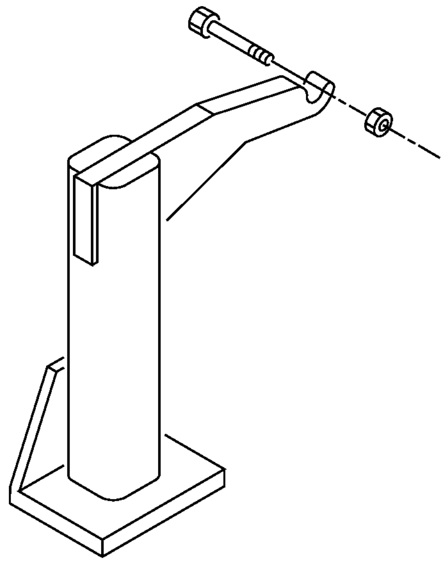
(d) The location of the repair

(e) The date when the elevator was repaired and balanced

(f) The number of elevator balance adjust weights that are installed and the number of available spaces for the addition of weight.

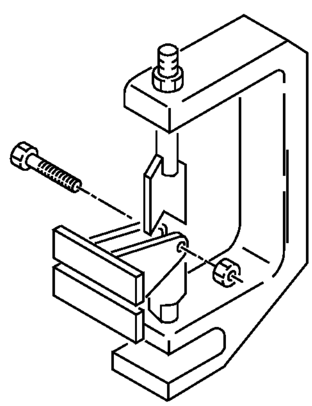


Elevator Support and Balance at the Time of the Balance Procedure on the Static Balance Jig
Figure 2 (Sheet 1 of 3)



FORWARD HINGE SUPPORT
(TYPICAL 2 LOCATIONS)

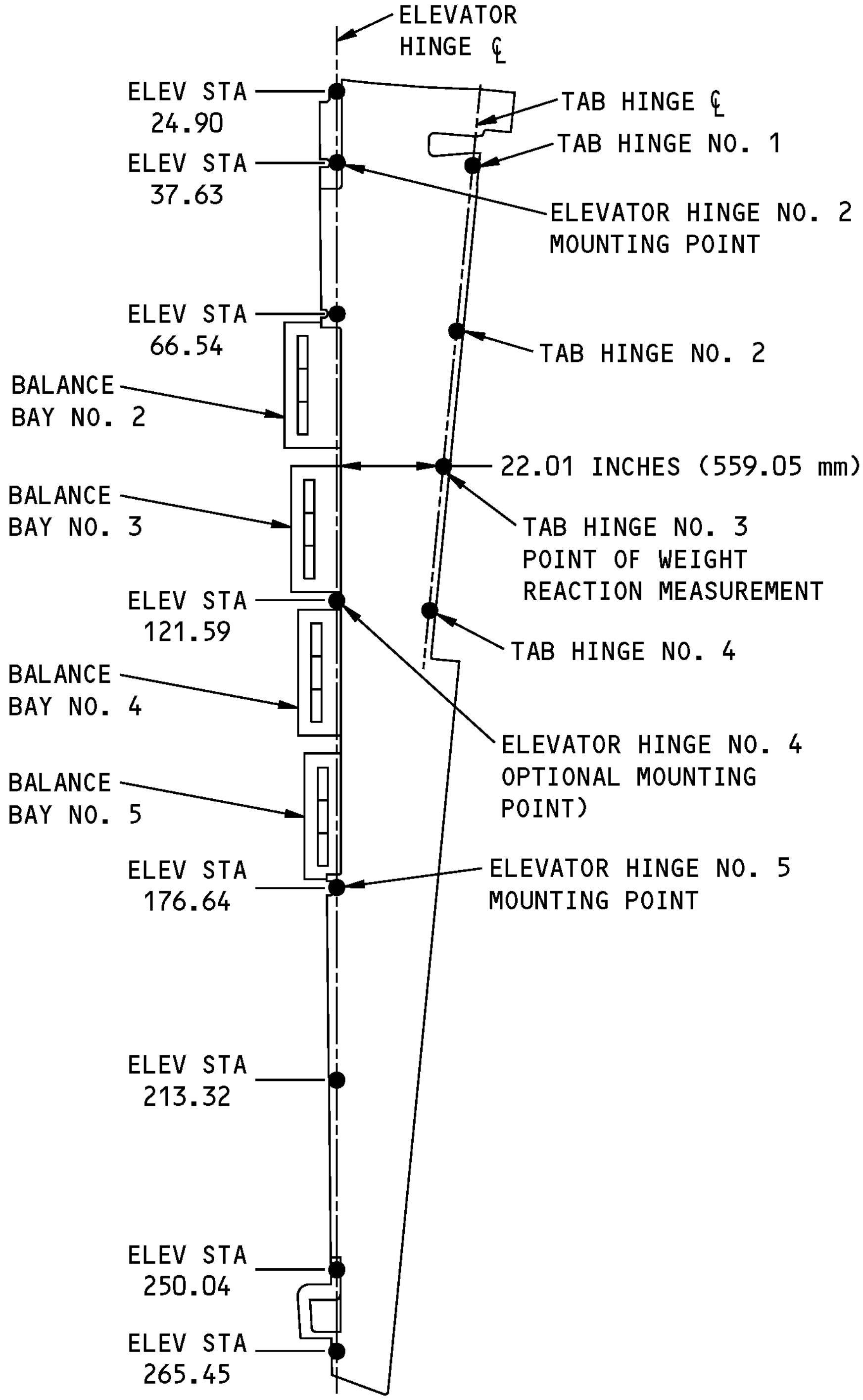
A



AFT HINGE SUPPORT

B

Elevator Support and Balance at the Time of the Balance Procedure on the Static Balance Jig
Figure 2 (Sheet 2 of 3)



ELEVATOR MOUNTING POINTS

C

Elevator Support and Balance at the Time of the Balance Procedure on the Static Balance Jig
Figure 2 (Sheet 3 of 3)

NUMBER OF EXISTING UPPER WEIGHTS	ELEVATOR ASSEMBLY 183A0101-(), 183A0102-(), 183A0103-(), 183A0104-()										
	TOTAL CHANGE IN MOMENT ΔM (UPPER) DUE TO ADDING (n) UPPER ADJUST WEIGHTS (lbf.in) [1]										
	NUMBER OF 69-53211-2 UPPER ADJUST WEIGHTS (n) TO BE ADDED TO EXISTING UPPER WEIGHTS										
	1	2	3	4	5	6	7	8	9	10	11
0	7.00	14.00	21.00	29.30	37.60	45.90	55.50	65.10	74.70	81.70	88.70
1	7.00	14.00	22.30	30.60	38.90	48.50	58.10	67.70	74.70	81.70	88.70
2	7.00	15.30	23.60	31.90	41.50	51.10	60.70	67.70	74.70	81.70	90.00
3	8.30	16.60	24.90	34.50	44.10	53.70	60.70	67.70	74.70	83.00	91.30
4	8.30	16.60	26.20	35.80	45.40	52.40	59.40	66.40	74.70	83.00	91.30
5	8.30	17.90	27.50	37.10	44.10	51.10	58.10	66.40	74.70	83.00	92.60
6	9.60	19.20	28.80	35.80	42.80	49.80	58.10	66.40	74.70	84.30	93.90
7	9.60	19.20	26.20	33.20	40.20	48.50	56.80	65.10	74.70	84.30	93.90
8	9.60	16.60	23.60	30.60	38.90	47.20	55.50	65.10	74.70	84.30	91.30
9	7.00	14.00	21.00	29.30	37.60	45.90	55.50	65.10	74.70	81.70	88.70
10	7.00	14.00	22.30	30.60	38.90	48.50	58.10	67.70	74.70	81.70	88.70
11	7.00	15.30	23.60	31.90	41.50	51.10	60.70	67.70	74.70	81.70	90.00
12	8.30	16.60	24.90	34.50	44.10	53.70	60.70	67.70	74.70	83.00	91.30
13	8.30	16.60	26.20	35.80	45.40	52.40	59.40	66.40	74.70	83.00	91.30
14	8.30	17.90	27.50	37.10	44.10	51.10	58.10	66.40	74.70	83.00	92.60
15	9.60	19.20	28.80	35.80	42.80	49.80	58.10	66.40	74.70	84.30	93.90
16	9.60	19.20	26.20	33.20	40.20	48.50	56.80	65.10	74.70	84.30	93.90
17	9.60	16.60	23.60	30.60	38.90	47.20	55.50	65.10	74.70	84.30	
18	7.00	14.00	21.00	29.30	37.60	45.90	55.50	65.10	74.70		
19	7.00	14.00	22.30	30.60	38.90	48.50	58.10	67.70			
20	7.00	15.30	23.60	31.90	41.50	51.10	60.70				
21	8.30	16.60	24.90	34.50	44.10	53.70					
22	8.30	16.60	26.20	35.80	45.40						
23	8.30	17.90	27.50	37.10							
24	9.60	19.20	28.80								
25	9.60	19.20									
26	9.60										

GO TO SHEET 2

UPPER BALANCE ADJUST WEIGHTS
TABLE I

Elevator Assembly Balance Adjust Weight Table
Figure 3 (Sheet 1 of 5)

NUMBER OF EXISTING UPPER WEIGHTS	ELEVATOR ASSEMBLY 183A0101-(), 183A0102-(), 183A0103-(), 183A0104-()										
	TOTAL CHANGE IN MOMENT ΔM (UPPER) DUE TO ADDING (n) UPPER ADJUST WEIGHTS (lbf.in) [1]										
	NUMBER OF 69-53211-2 UPPER ADJUST WEIGHTS (n) TO BE ADDED TO EXISTING UPPER WEIGHTS										
	12	13	14	15	16	17	18	19	20	21	22
0	95.70	104.00	112.30	120.60	130.20	139.80	149.40	156.40	163.40	170.40	178.70
1	97.00	105.30	113.60	123.20	132.80	142.40	149.40	156.40	163.40	171.70	180.00
2	98.30	106.60	116.20	125.80	135.40	142.40	149.40	156.40	164.70	173.00	181.30
3	99.60	109.20	118.80	128.40	135.40	142.40	149.40	157.70	166.00	174.30	183.90
4	100.90	110.50	120.10	127.10	134.10	141.10	149.40	157.70	166.00	175.60	185.20
5	102.20	111.80	118.80	125.80	132.80	141.10	149.40	157.70	167.30	176.90	186.50
6	103.50	110.50	117.50	124.50	132.80	141.10	149.40	159.00	168.60	178.20	
7	100.90	107.90	114.90	123.20	131.50	139.80	149.40	159.00	168.60		
8	98.30	105.30	113.60	121.90	130.20	139.80	149.40	159.00			
9	95.70	104.00	112.30	120.60	130.20	139.80	149.40				
10	97.00	105.30	113.60	123.20	132.80	142.40					
11	98.30	106.60	116.20	125.80	135.40						
12	99.60	109.20	118.80	128.40							
13	100.90	110.50	120.10								
14	102.20	111.80									
15	103.50										

GO TO SHEET 3

UPPER BALANCE ADJUST WEIGHTS
TABLE I

Elevator Assembly Balance Adjust Weight Table
Figure 3 (Sheet 2 of 5)

NUMBER OF EXISTING UPPER WEIGHTS	ELEVATOR ASSEMBLY 183A0101-(), 183A0102-(), 183A0103-(), 183A0104-()				
	TOTAL CHANGE IN MOMENT ΔM (UPPER) DUE TO ADDING (n) UPPER ADJUST WEIGHTS (lbf.in) [1]				
	NUMBER OF 69-53211-2 UPPER ADJUST WEIGHTS (n) TO BE ADDED TO EXISTING UPPER WEIGHTS				
	23	24	25	26	27
0	187.00	195.30	204.90	214.50	224.10
1	188.30	197.90	207.50	217.10	
2	190.90	200.50	210.10		
3	193.50	203.10			
4	194.80				

UPPER BALANCE ADJUST WEIGHTS
TABLE I

Elevator Assembly Balance Adjust Weight Table
Figure 3 (Sheet 3 of 5)

NUMBER OF EXISTING LOWER WEIGHTS	ELEVATOR ASSEMBLY 183A0101-(), 183A0102-(), 183A0103-(), 183A0104-() TOTAL CHANGE IN MOMENT ΔM (LOWER) DUE TO ADDING (n) LOWER ADJUST WEIGHTS (lbf.in) 2 NUMBER OF 183A0210-1 LOWER ADJUST WEIGHTS (n) TO BE ADDED TO EXISTING LOWER WEIGHTS										
	1	2	3	4	5	6	7	8	9	10	11
0	6.04	12.08	18.12	25.26	32.40	39.54	47.79	56.04	64.29	70.33	76.37
1	6.04	12.08	19.22	26.36	33.50	41.75	50.00	58.25	64.29	70.33	77.47
2	6.04	13.18	20.32	27.46	35.71	43.96	52.21	58.25	64.29	71.43	78.57
3	7.14	14.28	21.42	29.67	37.92	46.17	52.21	58.25	65.39	72.53	80.78
4	7.14	14.28	22.53	30.78	39.03	45.07	51.11	58.25	65.39	73.64	81.89
5	7.14	15.39	23.64	31.89	37.93	43.97	51.11	58.25	66.50	74.75	80.79
6	8.25	16.50	24.75	30.79	36.83	43.97	51.11	59.36	67.61	73.65	80.79
7	8.25	16.50	22.54	28.58	35.72	42.86	51.11	59.36	65.40	72.54	80.79
8	8.25	14.29	20.33	27.47	34.61	42.86	51.11	57.15	64.29	72.54	
9	6.04	12.08	19.22	26.36	34.61	42.86	48.90	56.04	64.29		
10	6.04	13.18	20.32	28.57	36.82	42.86	50.00	58.25			
11	7.14	14.28	22.53	30.78	36.82	43.96	52.21				
12	7.14	15.39	23.64	29.68	36.82	45.07					
13	8.25	16.50	22.54	29.68	37.93						
14	8.25	14.29	21.43	29.68							
15	6.04	13.18	21.43								
16	7.14	15.39									
17	8.25										

GO TO SHEET 5

LOWER BALANCE ADJUST WEIGHTS
TABLE II

Elevator Assembly Balance Adjust Weight Table
Figure 3 (Sheet 4 of 5)

NUMBER OF EXISTING LOWER WEIGHTS	ELEVATOR ASSEMBLY 183A0101-(), 183A0102-(), 183A0103-(), OR 183A0104-()						
	TOTAL CHANGE IN MOMENT ΔM (LOWER) DUE TO ADDING (n) LOWER ADJUST WEIGHTS (lbf.in) [2]						
	NUMBER OF 183A0210-1 LOWER ADJUST WEIGHTS (n) TO BE ADDED TO EXISTING LOWER WEIGHTS						
	12	13	14	15	16	17	18
0	83.51	90.65	98.90	107.15	113.19	120.33	128.58
1	84.61	92.86	101.11	107.15	114.29	122.54	
2	86.82	95.07	101.11	108.25	116.50		
3	89.03	95.07	102.21	110.46			
4	87.93	95.07	103.32				
5	87.93	96.18					
6	89.04						

LOWER BALANCE ADJUST WEIGHTS
TABLE II

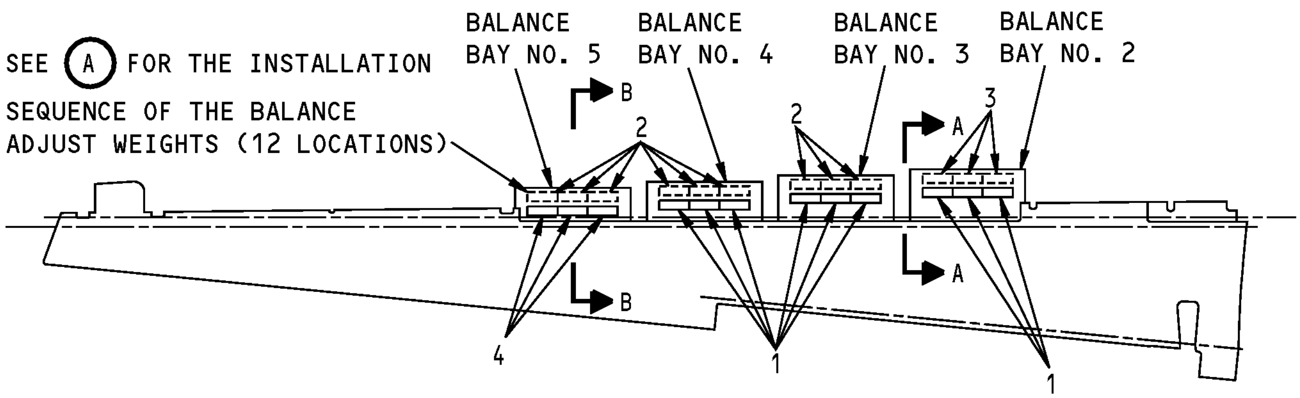
NOTES

- THE SEQUENCE OF INSTALLATION OF THE BALANCE ADJUST WEIGHTS, THE WEIGHT OF THE BALANCE ADJUST WEIGHTS, AND THE MOMENT ARM PER BALANCE BAY AND ADJUST WEIGHT ARE INCLUDED IN TABLE I.
- REFER TO FIGURE 4 FOR THE INSTALLATION SEQUENCE OF THE BALANCE ADJUST WEIGHTS.
- TO CONVERT FROM lbf.in TO Nm, MULTIPLY BY 0.1129848

[1] ALL MOMENT INCREMENTS (ΔM [UPPER]) ARE NEGATIVE

[2] ALL MOMENT INCREMENTS (ΔM [LOWER]) ARE NEGATIVE

Elevator Assembly Balance Adjust Weight Table
Figure 3 (Sheet 5 of 5)



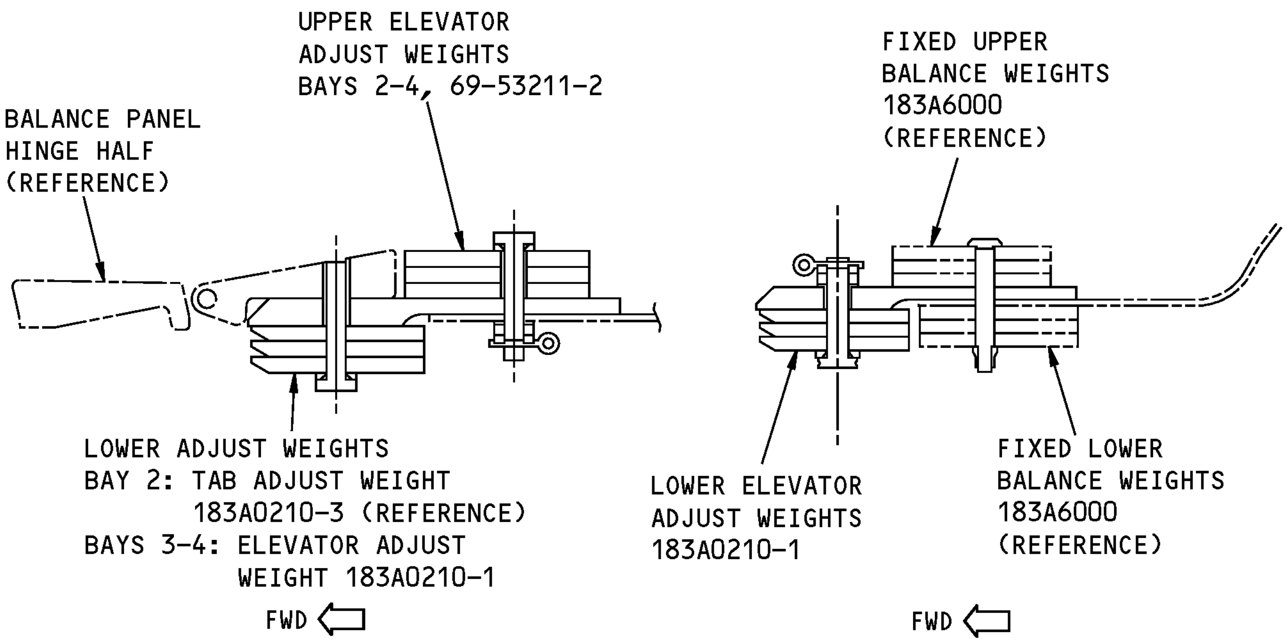
FWD
INBD

1 - UPPER ELEVATOR ADJUST WEIGHT 69-53211-2

2 - LOWER ELEVATOR ADJUST WEIGHT 183A0210-1

3 - LOWER TAB ADJUST WEIGHT 183A0210-3 (REFERENCE)

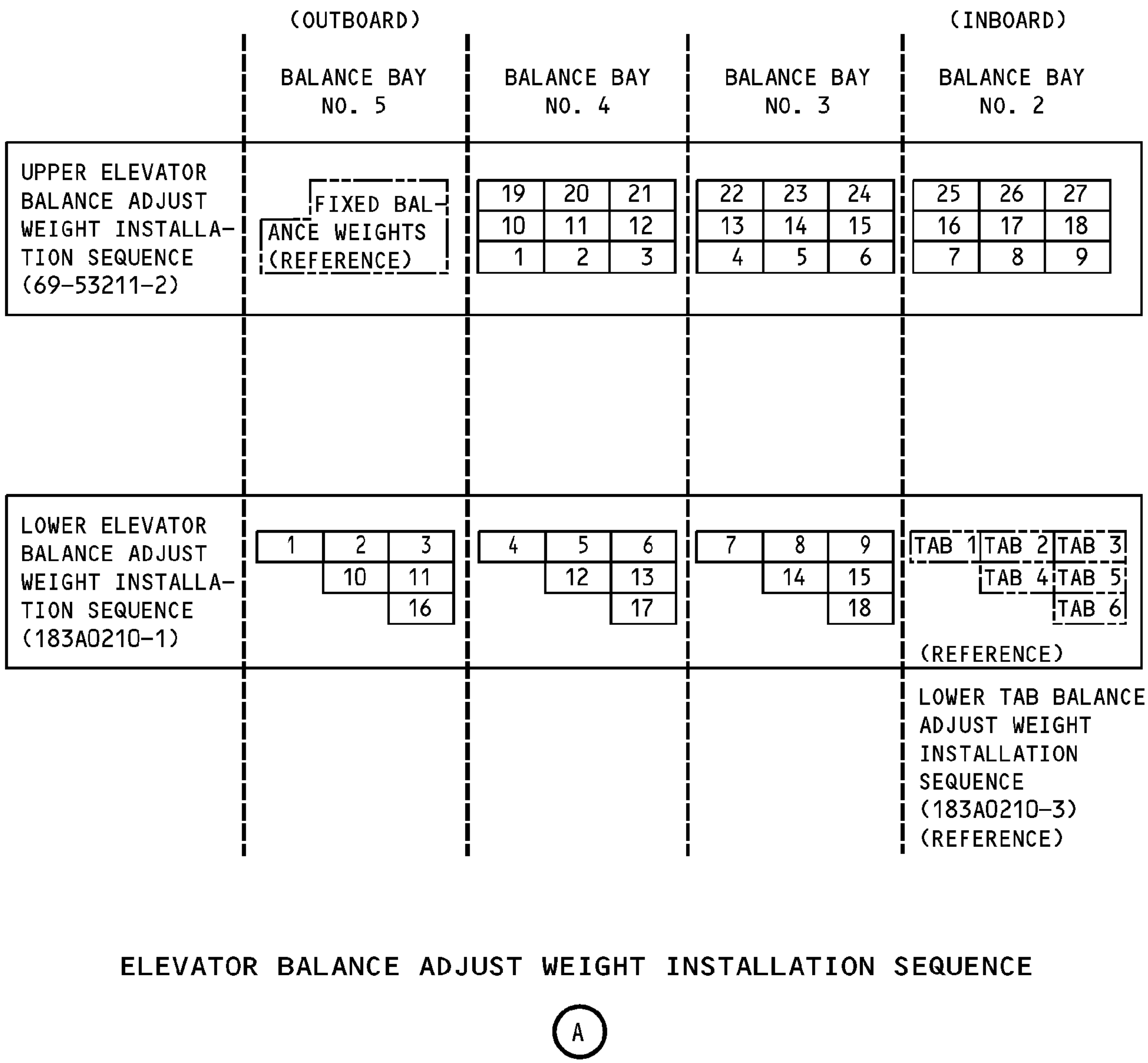
4 - FIXED LOWER BALANCE WEIGHT AND FIXED UPPER BALANCE WEIGHT 183A6000 (REFERENCE FOR INSTALLATION OF WEIGHTS)



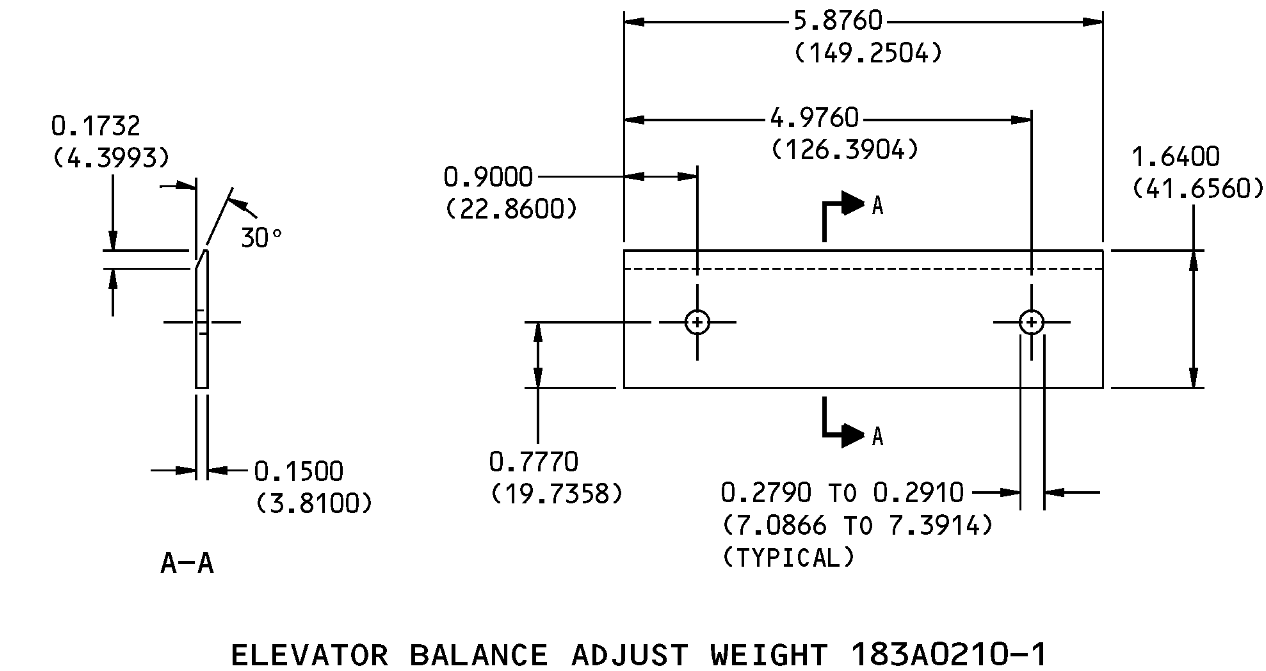
VIEW WHEN YOU LOOK INBOARD
BALANCE BAYS 2-4 (TYPICAL)
A-A

VIEW WHEN YOU LOOK INBOARD
BALANCE BAY 5
B-B

Elevator Balance Adjust Weight Location and Installation Sequence
Figure 4 (Sheet 1 of 2)



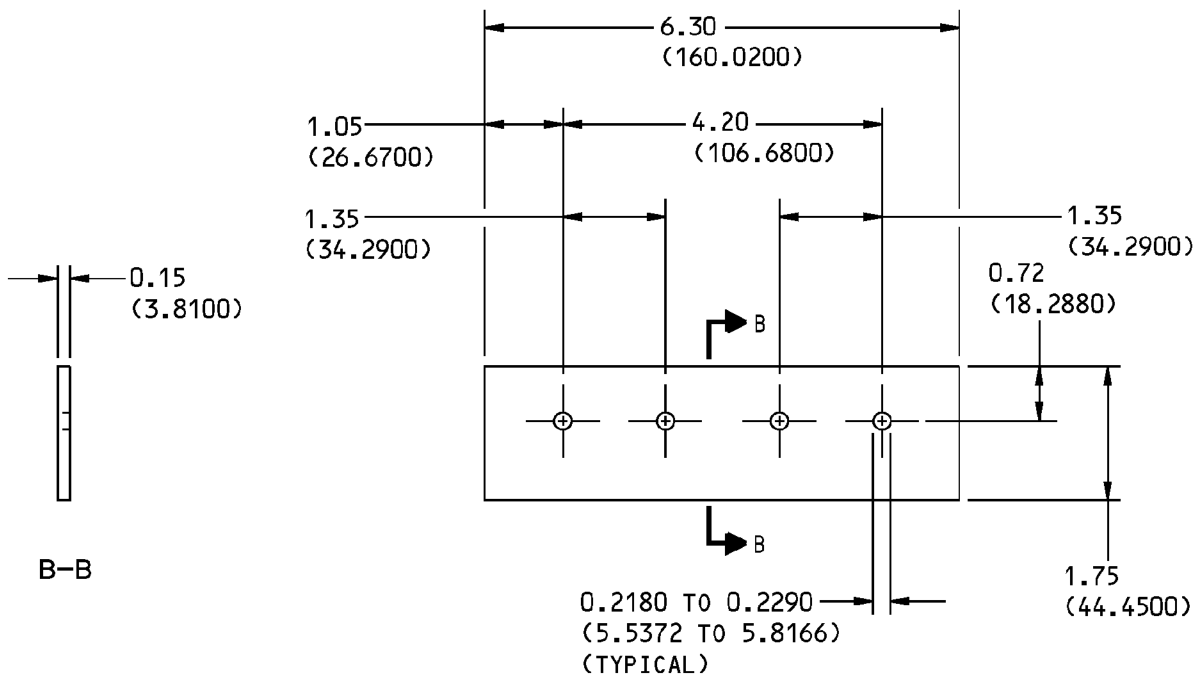
Elevator Balance Adjust Weight Location and Installation Sequence
Figure 4 (Sheet 2 of 2)



NOTES

- ALL DIMENSIONS ARE IN INCHES (mm).
- MATERIAL: TUNGSTEN ALLOY AS GIVEN IN MIL-T-21014, SINTERED CLASS 1.
- ALL SINTERED SURFACES MUST BE 250 R_a OR SMOOTHER.
- ALL MACHINED SURFACES MUST BE 125 R_a OR SMOOTHER.
- DRY ABRASIVE BLAST (REFER TO SOPM 20-30-03) AND APPLY TWO COATS OF BMS 10-79, TYPE III PRIMER AS GIVEN IN SOPM 20-44-04.
- THE FINISHED PART MUST HAVE A WEIGHT OF 0.78 TO 0.92 POUND (0.3538 TO 0.4173 KILOGRAM).

Elevator Balance Adjust Weights
Figure 5 (Sheet 1 of 2)

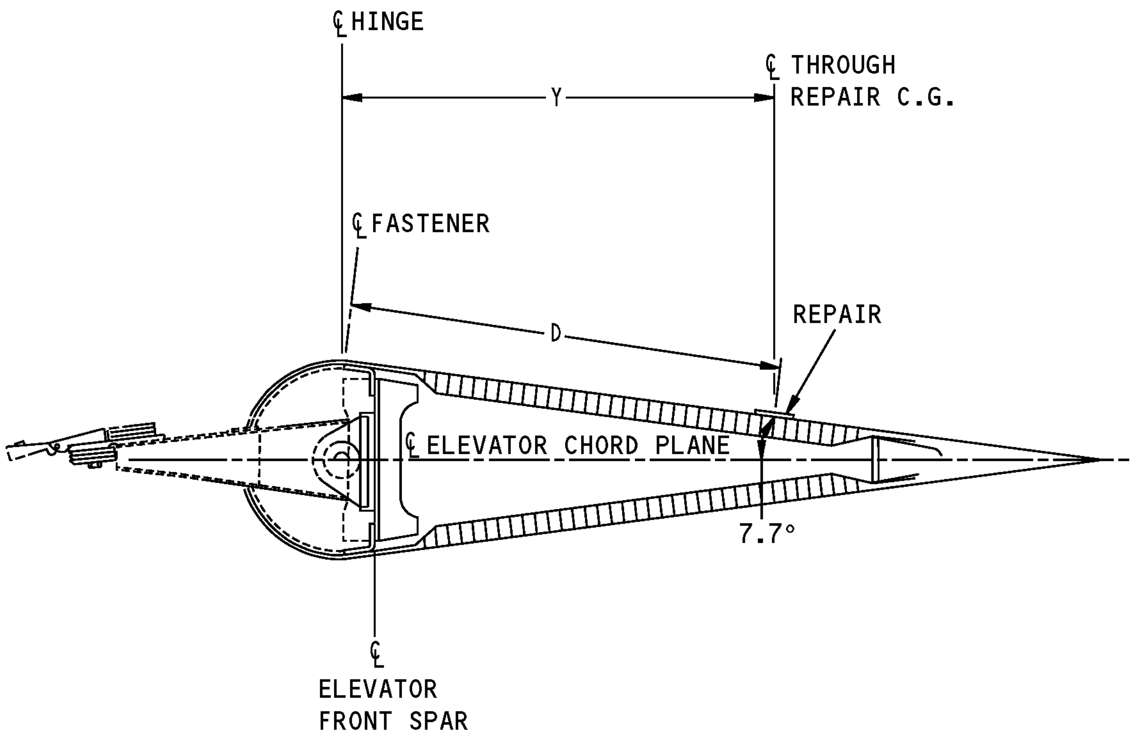


ELEVATOR BALANCE ADJUST WEIGHT 69-53211-2

NOTES

- ALL DIMENSIONS ARE IN INCHES (mm)
- MATERIAL: TUNGSTEN ALLOY AS GIVEN IN MIL-T-21014, SINTERED CLASS 1
- ALL SINTERED SURFACES MUST BE 250 R_a OR SMOOTHER
- ALL MACHINED SURFACES MUST BE 125 R_a OR SMOOTHER
- APPLY TWO COATS OF BMS 10-11, TYPE 1 PRIMER AS GIVEN IN SOPM 20-41-02
- THE FINISHED PART MUST HAVE A WEIGHT OF 0.93 TO 1.07 POUNDS (0.4218 TO 0.4853 KILOGRAM)

Elevator Balance Adjust Weights
Figure 5 (Sheet 2 of 2)



Elevator Balance at Time of Balance Procedure by Calculation
Figure 6

ELEVATOR ASSEMBLY
183A0101-(), 183A0102-(), 183A0103-(), 183A0104-()

TOTAL CHANGE IN MOMENT ΔM (UPPER) DUE TO ADDING (n) UPPER ADJUST WEIGHTS (lbf.in) 1

NUMBER OF 69-53211-2 UPPER ADJUST WEIGHTS (n) TO BE ADDED TO EXISTING UPPER WEIGHTS

NUMBER OF EXISTING UPPER WEIGHTS	1	2	3	4	5	6	7	8	9	10	11
0	7.00	14.00	21.00	29.30	37.60	45.90	55.50	65.10	74.70	81.70	88.70
1	7.00	14.00	22.30	30.60	38.90	48.50	58.10	67.70	74.70	81.70	88.70
2	7.00	15.30	23.60	31.90	41.50	51.10	60.70	67.70	74.70	81.70	90.00
3	8.30	16.60	24.90	34.50	44.10	53.70	60.70	67.70	74.70	83.00	91.30
4	~~8.30~~	~~16.60~~	~~26.20~~	~~35.80~~	~~45.40~~	~~52.40~~	~~59.40~~	~~66.40~~	~~74.70~~	~~83.00~~	~~91.30~~
	8.30	17.90	27.50	37.10	44.10	51.10	58.10	66.40	74.70	83.00	92.60
A	9.60	19.20	28.80	35.80	42.80	49.80	58.10	66.40	74.70	84.30	93.90
	9.60	19.20	26.20	33.20	40.20	48.50	56.80	65.10	74.70	84.30	93.90
8	9.60	16.60	23.60	30.60	38.90	47.20	55.50	65.10	74.70	84.30	91.30
9	7.00	14.00	21.00	29.30	37.60	45.90	55.50	65.10	74.70	81.70	88.70
10	7.00	14.00	22.30	30.60	38.90	48.50	58.10	67.70	74.70	81.70	88.70
11	7.00	15.30	23.60	31.90	41.50	51.10	60.70	67.70	74.70	81.70	90.00
12	8.30	16.60	24.90	34.50	44.10	53.70	60.70	67.70	74.70	83.00	91.30
13	8.30	16.60	26.20	35.80	45.40	52.40	59.40	66.40	74.70	83.00	91.30
14	8.30	17.90	27.50	37.10	44.10	51.10	58.10	66.40	74.70	83.00	92.60
15	9.60	19.20	28.80	35.80	42.80	49.80	58.10	66.40	74.70	84.30	93.90
16	9.60	19.20	26.20	33.20	40.20	48.50	56.80	65.10	74.70	84.30	93.90
17	9.60	16.60	23.60	30.60	38.90	47.20	55.50	65.10	74.70	84.30	
18	7.00	14.00	21.00	29.30	37.60	45.90	55.50	65.10	74.70		
19	7.00	14.00	22.30	30.60	38.90	48.50	58.10	67.70			
20	7.00	15.30	23.60	31.90	41.50	51.10	60.70				
21	8.30	16.60	24.90	34.50	44.10	53.70					
22	8.30	16.60	26.20	35.80	45.40						
23	8.30	17.90	27.50	37.10							
24	9.60	19.20	28.80								
25	9.60	19.20									
26	9.60										

GO TO SHEET 2

UPPER BALANCE ADJUST WEIGHTS
TABLE I

Elevator Assembly Balance Adjust Weight Table - Example 1
Figure 7 (Sheet 1 of 5)

NUMBER OF EXISTING UPPER WEIGHTS	ELEVATOR ASSEMBLY 183A0101-(), 183A0102-(), 183A0103-(), 183A0104-()										
	TOTAL CHANGE IN MOMENT ΔM (UPPER) DUE TO ADDING (n) UPPER ADJUST WEIGHTS (lbf.in) 1										
	NUMBER OF 69-53211-2 UPPER ADJUST WEIGHTS (n) TO BE ADDED TO EXISTING UPPER WEIGHTS										
	12	13	14	15	16	17	18	19	20	21	22
0	95.70	104.00	112.30	120.60	130.20	139.80	149.40	156.40	163.40	170.40	178.70
1	97.00	105.30	113.60	123.20	132.80	142.40	149.40	156.40	163.40	171.70	180.00
2	98.30	106.60	116.20	125.80	135.40	142.40	149.40	156.40	164.70	173.00	181.30
3	99.60	109.20	118.80	128.40	135.40	142.40	149.40	157.70	166.00	174.30	183.90
4	~~100.90~~	~~110.50~~	~~120.10~~	~~127.10~~	~~134.10~~	~~141.10~~	~~149.40~~	~~157.70~~	~~166.00~~	~~175.60~~	~~185.20~~
	102.20	111.80	118.80	125.80	132.80	141.10	149.40	157.70	167.30	176.90	186.50
A	103.50	110.50	117.50	124.50	132.80	141.10	149.40	159.00	168.60	178.20	
	100.90	107.90	114.90	123.20	131.50	139.80	149.40	159.00	168.60		
8	98.30	105.30	113.60	121.90	130.20	139.80	149.40	159.00			
9	95.70	104.00	112.30	120.60	130.20	139.80	149.40				
10	97.00	105.30	113.60	123.20	132.80	142.40					
11	98.30	106.60	116.20	125.80	135.40						
12	99.60	109.20	118.80	128.40							
13	100.90	110.50	120.10								
14	102.20	111.80									
15	103.50										

GO TO SHEET 3

UPPER BALANCE ADJUST WEIGHTS
TABLE I

Elevator Assembly Balance Adjust Weight Table - Example 1
Figure 7 (Sheet 2 of 5)

C

NUMBER OF EXISTING UPPER WEIGHTS	ELEVATOR ASSEMBLY 183A0101-(), 183A0102-(), 183A0103-(), 183A0104-()				
	TOTAL CHANGE IN MOMENT ΔM (UPPER) DUE TO ADDING (n) UPPER ADJUST WEIGHTS (lbf.in) [1]				
	NUMBER OF 69-53211-2 UPPER ADJUST WEIGHTS (n) TO BE ADDED TO EXISTING UPPER WEIGHTS				
	23	24	25	26	27
0		195.30	204.90	214.50	224.10
1		197.90	207.50	217.10	
2		200.50	210.10		
3		203.10			
4	194.80				

A B

UPPER BALANCE ADJUST WEIGHTS
TABLE I

NOTES

- TO ADJUST THE BALANCE OF THE ELEVATOR ASSEMBLY, DO AS FOLLOWS WITH THE DATA GIVEN IN TABLE I:

  STEP A - FIND THE NUMBER OF INITIAL WEIGHTS THAT ARE ON THE ELEVATOR ASSEMBLY.

  STEP B - FIND THE CHANGE IN MOMENT THAT YOU WILL NEED TO BALANCE THE ELEVATOR ASSEMBLY.

  STEP C - FIND THE NUMBER OF ADJUST WEIGHTS NECESSARY FOR THE CHANGE IN MOMENT. THIS IS THE NUMBER OF ADJUST WEIGHTS YOU WILL ADD TO THE ASSEMBLY. REFER TO FIGURE 4 FOR THE SEQUENCE ON WHICH TO INSTALL THE ADDED WEIGHTS.

- TO CONVERT lbf.in TO Nm, MULTIPLY BY 0.1129848.

[1] ALL MOMENT INCREMENTS ΔM [UPPER] ARE NEGATIVE.

Elevator Assembly Balance Adjust Weight Table - Example 1
Figure 7 (Sheet 3 of 5)

NUMBER OF EXISTING LOWER WEIGHTS	ELEVATOR ASSEMBLY 183A0101-(), 183A0102-(), 183A0103-(), 183A0104-()										
	TOTAL CHANGE IN MOMENT ΔM (LOWER) DUE TO ADDING (n) LOWER ADJUST WEIGHTS (lbf.in) 2										
	NUMBER OF 183A0210-1 LOWER ADJUST WEIGHTS (n) TO BE ADDED TO EXISTING LOWER WEIGHTS									H	
	1	2	3	4		6	7	8	9	10	11
0				25.26		39.54	47.79	56.04	64.29	70.33	76.37
		12.08	19.22			41.75	50.00	58.25			77.47
D	6.04		20.32	E	F	43.96	52.21		64.29	G	78.57
	7.14	14.28	21.42					58.25	65.39	72.53	80.78
4	7.14	14.28	22.53	30.78	39.03	45.07	51.11	58.25	65.39	73.64	81.89
5	7.14	15.39	23.64	31.89	37.93	43.97	51.11	58.25	66.50	74.75	80.79
6	8.25	16.50	24.75	30.79	36.83	43.97	51.11	59.36	67.61	73.65	80.79
7	8.25	16.50	22.54	28.58	35.72	42.86	51.11	59.36	65.40	72.54	80.79
8	8.25	14.29	20.33	27.47	34.61	42.86	51.11	57.15	64.29	72.54	
9	6.04	12.08	19.22	26.36	34.61	42.86	48.90	56.04	64.29		
10	6.04	13.18	20.32	28.57	36.82	42.86	50.00	58.25			
11	7.14	14.28	22.53	30.78	36.82	43.96	52.21				
12	7.14	15.39	23.64	29.68	36.82	45.07					
13	8.25	16.50	22.54	29.68	37.93						
14	8.25	14.29	21.43	29.68							
15	6.04	13.18	21.43								
16	7.14	15.39									
17	8.25										

GO TO SHEET 5

LOWER BALANCE ADJUST WEIGHTS
TABLE II

Elevator Assembly Balance Adjust Weight Table - Example 1
Figure 7 (Sheet 4 of 5)

NUMBER OF EXISTING LOWER WEIGHTS	ELEVATOR ASSEMBLY 183A0101-(), 183A0102-(), 183A0103-(), 183A0104-()						
	TOTAL CHANGE IN MOMENT ΔM (LOWER) DUE TO ADDING (n) LOWER ADJUST WEIGHTS (lbf.in) [2]						
	NUMBER OF 183A0210-1 LOWER ADJUST WEIGHTS (n) TO BE ADDED TO EXISTING LOWER WEIGHTS						
	12	13	14	15	16	17	18
0	83.51	90.65	98.90	107.15	113.19	120.33	128.58
1	84.61	92.86	101.11	107.15	114.29	122.54	
2	86.82	95.07	101.11	108.25	116.50		
3	89.03	95.07	102.21	110.46			
4	87.93	95.07	103.32				
5	87.93	96.18					
6	89.04						

LOWER BALANCE ADJUST WEIGHTS
TABLE II

NOTES

- TO ADJUST THE BALANCE OF THE ELEVATOR ASSEMBLY, DO AS FOLLOWS WITH THE DATA GIVEN IN TABLE II:

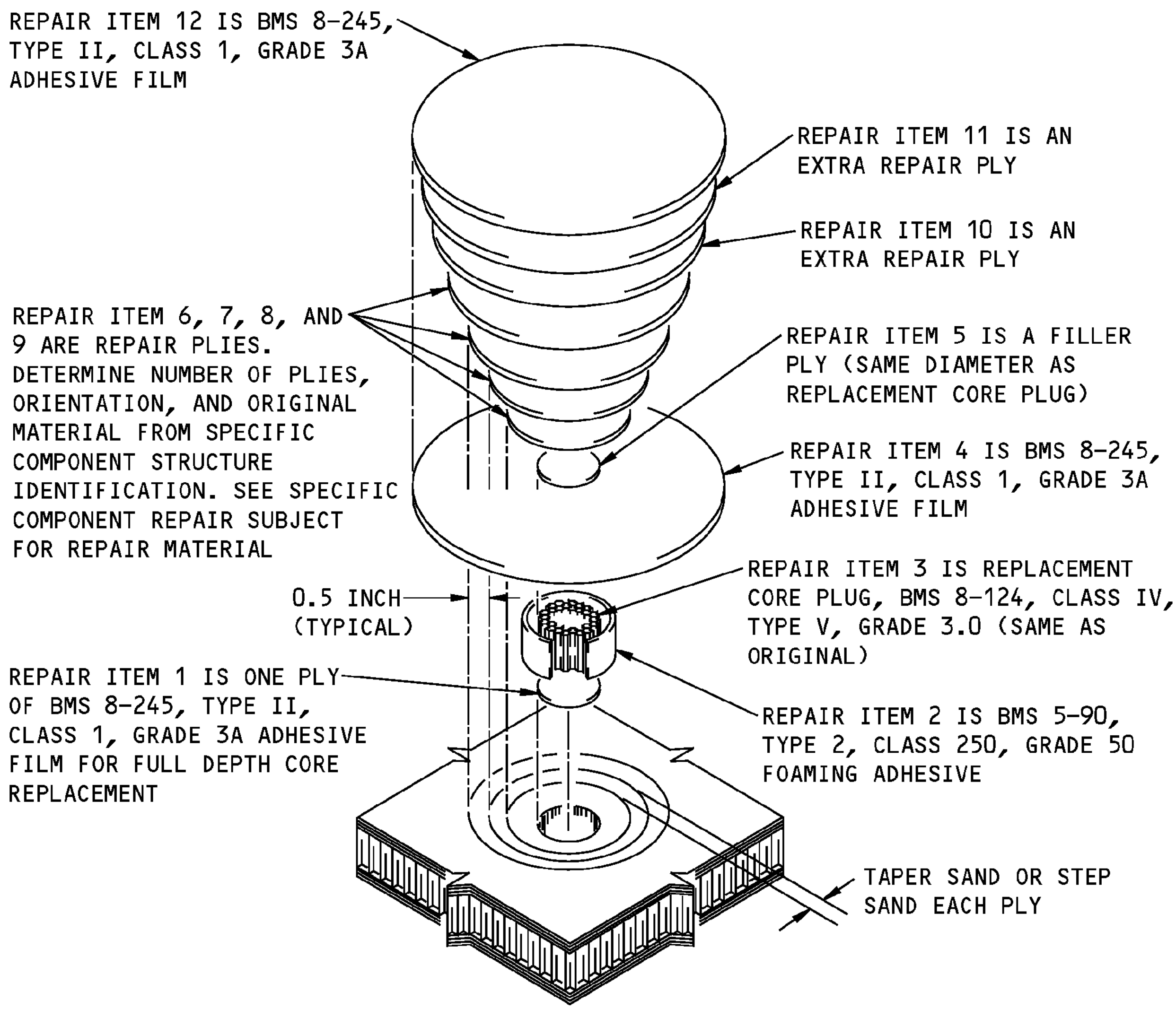
  STEP D – FIND THE NUMBER OF INITIAL WEIGHTS THAT ARE ON THE ELEVATOR ASSEMBLY.

  STEP E – FIND THE CHANGE IN MOMENT THAT YOU WILL NEED TO BALANCE THE ELEVATOR ASSEMBLY.

  STEP F – FIND THE NUMBER OF ADJUST WEIGHTS NECESSARY FOR THE CHANGE IN MOMENT. THAT IS THE NUMBER OF ADJUST WEIGHTS YOU WILL ADD TO THE ASSEMBLY. REFER TO FIGURE 4 FOR THE SEQUENCE ON WHICH TO INSTALL THE ADDED WEIGHTS.

[2] ALL MOMENT INCREMENTS (ΔM [LOWER]) ARE NEGATIVE.

Elevator Assembly Balance Adjust Weight Table - Example 1
Figure 7 (Sheet 5 of 5)



NOTES

- REPAIR ITEMS 1, 2, 3, 4, 5, 10, 11, AND 12 ARE EXTRA MATERIALS AND ADD WEIGHT TO THE REPAIR AREA ABOVE THAT WHICH WAS REMOVED AND IS BEING REPLACED
- REPAIR ITEMS 6, 7, 8, AND 9 ARE REPLACING ORIGINAL PLIES OF APPROXIMATELY THE SAME AREA BUT OF DIFFERENT WEIGHT PER UNIT AREA

Repair (Typical) - Repair of Damage to One Skin and Honeycomb Core
Figure 8

X

NUMBER OF EXISTING LOWER WEIGHTS	ELEVATOR ASSEMBLY 183A0101-(), 183A0102-(), 183A0103-(), 183A0104-()										
	TOTAL CHANGE IN MOMENT ΔM (LOWER) DUE TO ADDING (n) LOWER ADJUST WEIGHTS (lbf.in) 1										
	NUMBER OF 183A0210-1 LOWER ADJUST WEIGHTS (n) TO BE ADDED TO EXISTING LOWER WEIGHTS										
	1	2	3	4	5	6		8	9	10	11
0				25.26	32.40	39.54		56.04	64.29	70.33	76.37
	6.04	12.08	19.22		33.50			58.25	64.29	70.33	77.47
V	6.04	13.18	20.32	W	35.71	Y	Z	58.25	64.29	71.43	78.57
	7.14	14.28	21.42	29.67	37.92	46.17	52.21	58.25	65.39	72.53	80.78
4	7.14	14.28	22.53	30.78	39.03	45.07	51.11	58.25	65.39	73.64	81.89
5	7.14	15.39	23.64	31.89	37.93	43.97	51.11	58.25	66.50	74.75	80.79
6	8.25	16.50	24.75	30.79	36.83	43.97	51.11	59.36	67.61	73.65	80.79
7	8.25	16.50	22.54	28.58	35.72	42.86	51.11	59.36	65.40	72.54	80.79
8	8.25	14.29	20.33	27.47	34.61	42.86	51.11	57.15	64.29	72.54	
9	6.04	12.08	19.22	26.36	34.61	42.86	48.90	56.04	64.29		
10	6.04	13.18	20.32	28.57	36.82	42.86	50.00	58.25			
11	7.14	14.28	22.53	30.78	36.82	43.96	52.21				
12	7.14	15.39	23.64	29.68	36.82	45.07					
13	8.25	16.50	22.54	29.68	37.93						
14	8.25	14.29	21.43	29.68							
15	6.04	13.18	21.43								
16	7.14	15.39									
17	8.25										

GO TO SHEET 2

LOWER BALANCE ADJUST WEIGHTS
TABLE I

Elevator Assembly Balance Adjust Weight Table - Example 2
Figure 9 (Sheet 1 of 2)

NUMBER OF EXISTING LOWER WEIGHTS	ELEVATOR ASSEMBLY 183A0101-(), 183A0102-(), 183A0103-(), 183A0104-()						
	TOTAL CHANGE IN MOMENT ΔM (LOWER) DUE TO ADDING (n) LOWER ADJUST WEIGHTS (lbf.in) [1]						
	NUMBER OF 183A0210-1 LOWER ADJUST WEIGHTS (n) TO BE ADDED TO EXISTING LOWER WEIGHTS						
	12	13	14	15	16	17	18
0	83.51	90.65	98.90	107.15	113.19	120.33	128.58
1	84.61	92.86	101.11	107.15	114.29	122.54	
2	86.82	95.07	101.11	108.25	116.50		
3	89.03	95.07	102.21	110.46			
4	87.93	95.07	103.32				
5	87.93	96.18					
6	89.04						

LOWER BALANCE ADJUST WEIGHTS
TABLE I

NOTES

- TO ADJUST THE BALANCE OF THE ELEVATOR ASSEMBLY, DO AS FOLLOWS WITH THE DATA GIVEN IN TABLE II:

  STEP V - FIND THE NUMBER OF INITIAL WEIGHTS THAT ARE ON THE ELEVATOR ASSEMBLY.

  STEP W - FIND THE CHANGE IN MOMENT THAT YOU WILL NEED TO BALANCE THE ELEVATOR ASSEMBLY.

  STEP X - FIND THE NUMBER OF ADJUST WEIGHTS NECESSARY FOR THE CHANGE IN MOMENT. THAT IS THE NUMBER OF ADJUST WEIGHTS YOU WILL ADD TO THE ASSEMBLY. REFER TO FIGURE 4 FOR THE SEQUENCE ON WHICH TO INSTALL THE ADDED WEIGHTS.

- TO CONVERT FROM lbf.in TO Nm, MULTIPLY BY 0.1129848.

[1] ALL MOMENT INCREMENTS (ΔM [LOWER]) ARE NEGATIVE.

Elevator Assembly Balance Adjust Weight Table - Example 2
Figure 9 (Sheet 2 of 2)

6. Put the Airplane Back to Its Usual Condition

A. As applicable, install the elevator balance panels on the elevator. Refer to AMM 27-31-41/401.

B. As applicable, install the elevator tab on the elevator. Refer to AMM 27-31-31/401.

C. As applicable, install the elevator on the airplane. Refer to AMM 27-31-11/401.

GENERAL - WEIGHT CONTROL PROCEDURE FOR THE ELEVATOR BALANCE PANELS

1. **Applicability**

   A. This subject gives the necessary data for the static balance requirements for the elevator balance panels:

   NOTE: Refer to Elevator Balance Panels - As-Weighed Configuration, Figure 1/GENERAL for the elevator balance panels.

   (1) Balance Panel Assembly - Bay Number 2

   (2) Balance Panel Assembly - Bay Number 3

   (3) Balance Panel Assembly - Bay Number 4.

   B. Refer to 51-60-04 or ELEVATOR BALANCE PROCEDURE, 51-61-04 for the elevator balance procedure.

   C. Refer to 51-60-06 or ELEVATOR TAB BALANCE PROCEDURE, 51-61-06 for the elevator tab balance procedure.

2. **General**

   A. Refer to 51-60-00 for the general data such as:

   (1) Categories of control surfaces

   (2) General balance instructions

   (3) Serviceability

   (4) Definitions of terms

   (5) Sign conventions

   (6) Measurement accuracy

   (7) Special tools and equipment

   (8) Repair material weights.

   B. The elevator balance panels are Category II Control Surfaces.

   C. The elevator balance panels are not balanced, but their weight has an effect on the balance of the elevator.

   (1) The weight of each elevator balance panel is limited as given in Table 1/GENERAL.

Table 1:

STATIC BALANCE REQUIREMENTS FOR THE ELEVATOR BALANCE PANELS - WEIGHT LIMITATIONS		
ELEVATOR BALANCE PANEL	ENGINEERING DRAWING	COMPONENT WEIGHT IN POUNDS (KILOGRAMS)
BAY NUMBER 2	183A9102-() 183A9102-()	2.46 ± 0.15 (1.116 ± 0.068)
BAY NUMBER 3	183A9103-() 183A9103-()	2.22 ± 0.15 (1.007 ± 0.068)
BAY NUMBER 4	183A9104-() 183A9104-()	2.13 ± 0.15 (0.966 ± 0.068)

   D. Each time a balance panel is repaired or reworked it must be weighed as given in Paragraph 5./GENERAL

   E. Before you weigh the balance panel, you must make sure that the balance panel has the correct as-weighed configuration.

(1) Refer to Elevator Balance Panels - As-Weighed Configuration, Figure 1/GENERAL for the as-weighed configuration of the elevator balance panels.

(2) Refer to Table 2/GENERAL for the references for the as-weighed configuration of the elevator balance panels.

Table 2:

PARAGRAPH REFERENCES FOR THE AS-WEIGHED CONFIGURATION OF THE ELEVATOR BALANCE PANELS	
ELEVATOR BALANCE PANEL	**PARAGRAPH**
Bay Number 2	2.F
Bay Number 3	2.G
Bay Number 4	2.H

F. Balance Panel Assembly - Bay Number 2 must be a complete assembly as given on engineering drawing 183A9102-() (LH) and 183A9102-() (RH).

(1) This includes all the parts that follow:

(a) Panel Doubler Assembly - Part Number 183A9112-() (LH) and 183A9112-() (RH) (total of 1 for each assembly)

(b) Idler Hinge Half - Part Number 183A9130-() (LH) and 183A9130-() (RH) (total of 2 for each assembly)

(c) Idler Hinge - Part Number 183A9130-() (LH) and 183A9130-() (RH) (total of 1 for each assembly)

(d) Hinge Pin - Part Number MS20253P2-2518L (LH and RH) (total of 2 per assembly)

(e) Seal - Part Number 183A9140-() (LH and RH) (total of 4 for each assembly)

(f) Seal Assembly - Part Number 183A9140-() (LH and RH) (total of 1 for each assembly)

(g) Stop Angle - Part Number 183A9150-() (LH and RH) (total of 1 for each assembly)

(h) Nutplates (total of 19 for each assembly)

(i) All the attaching parts of the parts listed above.

G. Balance Panel Assembly - Bay Number 3 must be a complete assembly as given on engineering drawing 183A9103-() (LH) and 183A9103-() (RH).

(1) This includes all the parts that follow:

(a) Panel Doubler Assembly - Part Number 183A9113-() (LH) and 183A9113-() (RH) (total of 1 for each assembly)

(b) Idler Hinge Half - Part Number 183A9130-() (LH) and 183A9130-() (RH) (total of 2 for each assembly)

(c) Idler Hinge - Part Number 183A9130-() (LH) and 183A9130-() (RH) (total of 1 for each assembly)

(d) Hinge Pin - Part Number MS20253P2-2518L (LH and RH) (total of 2 per assembly)

(e) Seal - Part Number 183A9140-() (LH and RH) (total of 4 for each assembly)

(f) Seal Assembly - Part Number 183A9140-() (LH and RH) (total of 1 for each assembly)

(g) Stop Angle - Part Number 183A9150-() (LH and RH) (total of 1 for each assembly)

(h) Nutplates (total of 19 for each assembly)

(i) All the attaching parts of the parts listed above.

H. Balance Panel Assembly - Bay Number 4 must be a complete assembly as given on engineering drawing 183A9104-() (LH) and 183A9104-() (RH).

(1) This includes all the parts that follow:

(a) Panel Doubler Assembly - Part Number 183A9114-() (LH) and 183A9114-() (RH) (total of 1 for each assembly)

(b) Idler Hinge Half - Part Number 183A9130-() (LH) and 183A9130-() (RH) (total of 2 for each assembly)

(c) Idler Hinge - Part Number 183A9130-() (LH) and 183A9130-() (RH) (total of 1 for each assembly)

(d) Hinge Pin - Part Number MS20253P2-2518L (LH and RH) (total of 2 for each assembly)

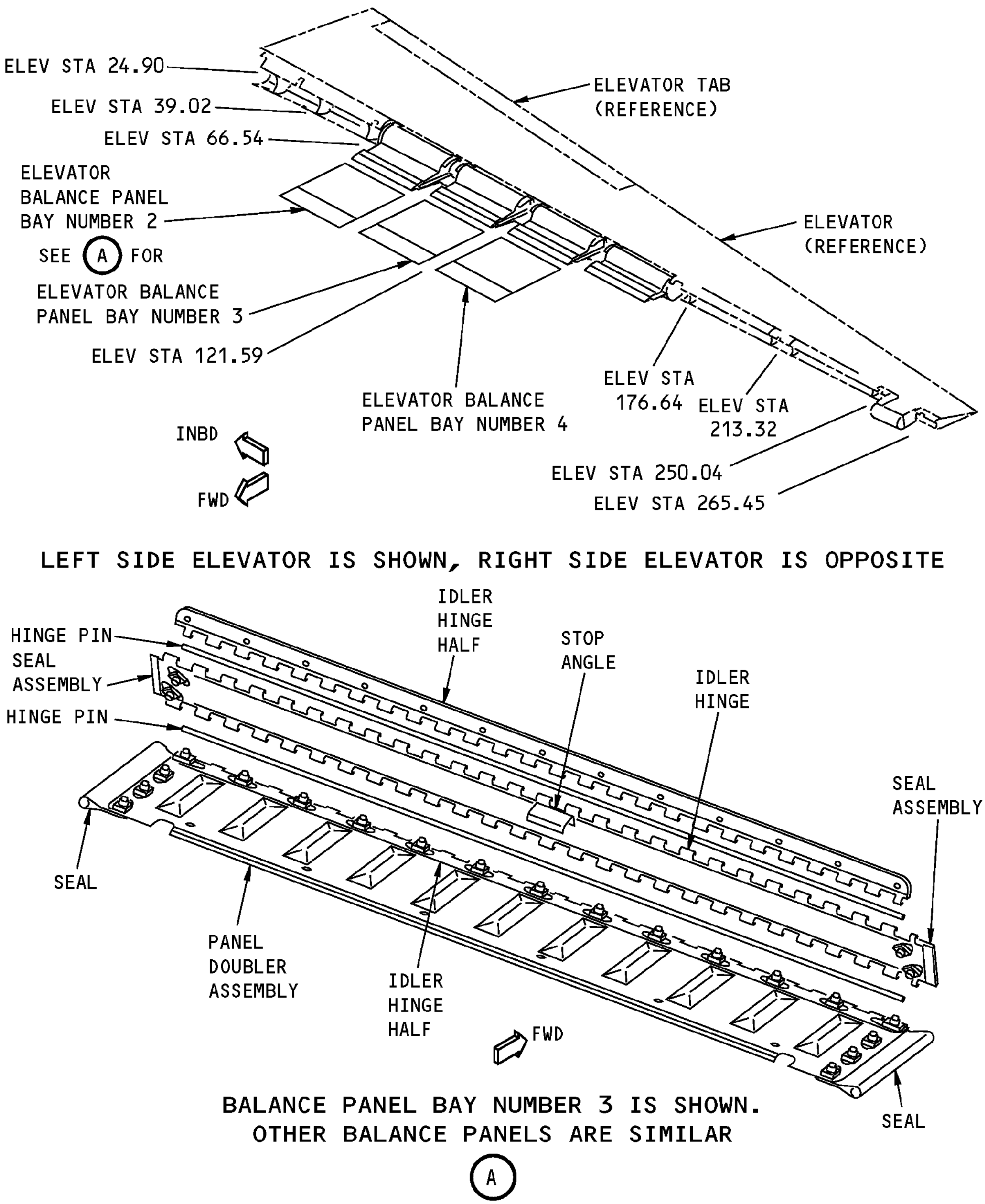
(e) Seal - Part Number 183A9140-() (LH and RH) (total of 4 for each assembly)

(f) Seal Assembly - Part Number 183A9140-() (LH and RH) (total of 1 for each assembly)

(g) Stop Angle - Part Number 183A9150-() (LH and RH) (total of 1 for each assembly)

(h) Nutplates (total of 19 for each assembly)

(i) All the attaching parts of the parts listed above.



Elevator Balance Panels - As-Weighed Configuration
Figure 1

3. References

Reference	Title
51-60-00	CONTROL SURFACE BALANCING
51-60-04	ELEVATOR BALANCE PROCEDURE
51-60-06	ELEVATOR TAB BALANCE PROCEDURE
51-61-04	ELEVATOR BALANCE PROCEDURE
51-61-06	ELEVATOR TAB BALANCE PROCEDURE
AMM 27-31-41/401	Elevator Balance Panel Removal and Installation

4. Prepare for the Weigh Procedure

A. Remove the elevator balance panel. Refer to AMM 27-31-41/401.

(1) Make sure that the elevator balance panel that you want to weigh has the configuration as given in Paragraph 2.F./GENERAL through Paragraph 2.H./GENERAL

5. Weigh Procedure

A. Weigh the elevator balance panel and make sure that the weight is within the limits as given in Paragraph 2.C./GENERAL, Table 1/GENERAL.

NOTE: The weight measurement precision for the elevator balance panels is ± 0.01 pound (4.5 grams).

(1) If the weight of the elevator balance panel is larger than the limits given in Paragraph 2.C./GENERAL, Table 1/GENERAL, you must replace the balance panel with one that has the correct weight.

6. Put the Airplane Back to Its Usual Condition

A. Install all the parts that you have removed in step 4.A.(1) on the elevator balance panel.

B. Install the elevator balance panel. Refer to AMM 27-31-41/401.

GENERAL - ELEVATOR TAB BALANCE PROCEDURE FOR AIRPLANE LINE NUMBERS 1 THROUGH 1174 PRIOR TO COMPLETION OF SERVICE BULLETINS 737-55-1080, 737-55-1081, AND 737-55-1082

1. **Applicability**

CAUTION: IF AN ELEVATOR TAB ASSEMBLY IS REMOVED FROM THE AIRPLANE, REWORKED, REPAIRED, OR REPAINTED, OR IF A NEW ELEVATOR TAB ASSEMBLY IS INSTALLED, IT MUST BE WEIGHED AND STAMPED WITH THE ACTUAL WEIGHT AND QUANTITY OF BALANCE ADJUST WEIGHTS.

A. This subject gives the necessary data for the static balance requirements for the elevator tab assembly.

NOTE: This procedure is applicable to airplanes with line numbers 1 through 1174 that have not been modified as given in Service Bulletins 737-55-1080, 737-55-1081, and 737-55-1082. Refer to 51-61-06 for airplanes with line numbers that are equal to or greater than 1175, and for all other airplanes that have been modified as given in Service Bulletins 737-55-1080, 737-55-1081, and 737-55-1082.

B. Refer to 51-60-04 for the elevator balance procedure.

C. Refer to 51-60-05 for the weight control procedure for elevator balance panels.

2. **General**

A. Refer to 51-60-00 for the general data such as:

(1) Categories of control surfaces

(2) General balance instructions

(3) Serviceability

(4) Definitions of terms

(5) Sign conventions

(6) Measurement accuracy

(7) Special tools and equipment

(8) Repair material weights.

B. The elevator tab assembly is a Category I Control Surface.

C. The elevator tab assembly is not balanced, but the weight has an effect on the balance of the elevator.

(1) The weight of the elevator tab assembly is limited to a maximum of 7.26 pounds (3.293 kilograms).

(2) To balance out variations in the weight of the elevator tab assembly, tab adjust weights are installed in the lower balance weight locations of bay number 2. Refer to Elevator Tab Adjust Weights Location, Figure 1/GENERAL.

(a) The elevator tab adjust weights do not balance out the full weight of the tab assembly, but only the increment of weight over nominal.

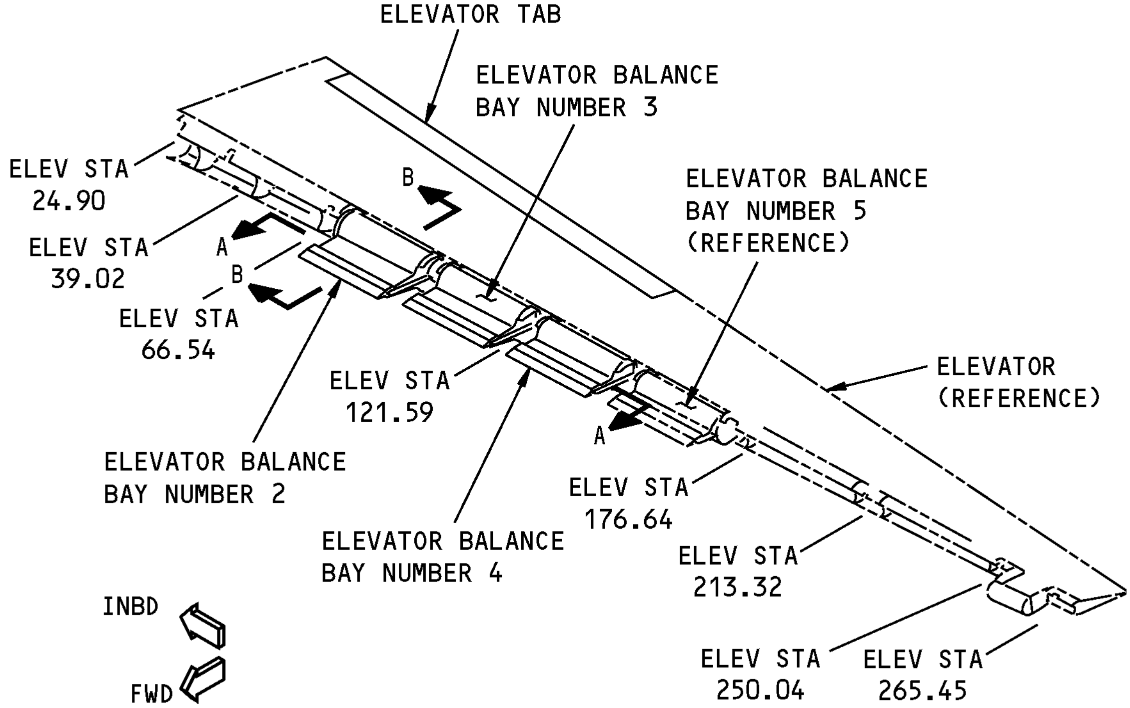
(b) For a given increment of tab assembly weight, a specified number of tab adjust weights is necessary. Refer to Table 1/GENERAL for the number of tab adjust weights that must be installed for a given increment of tab assembly weight.

NOTE: The part number of the tab adjust weight is 183A0210-3. The weight of each tab adjust weight is 0.5 ± 0.05 pound (0.227 ± 0.0227 kilogram).

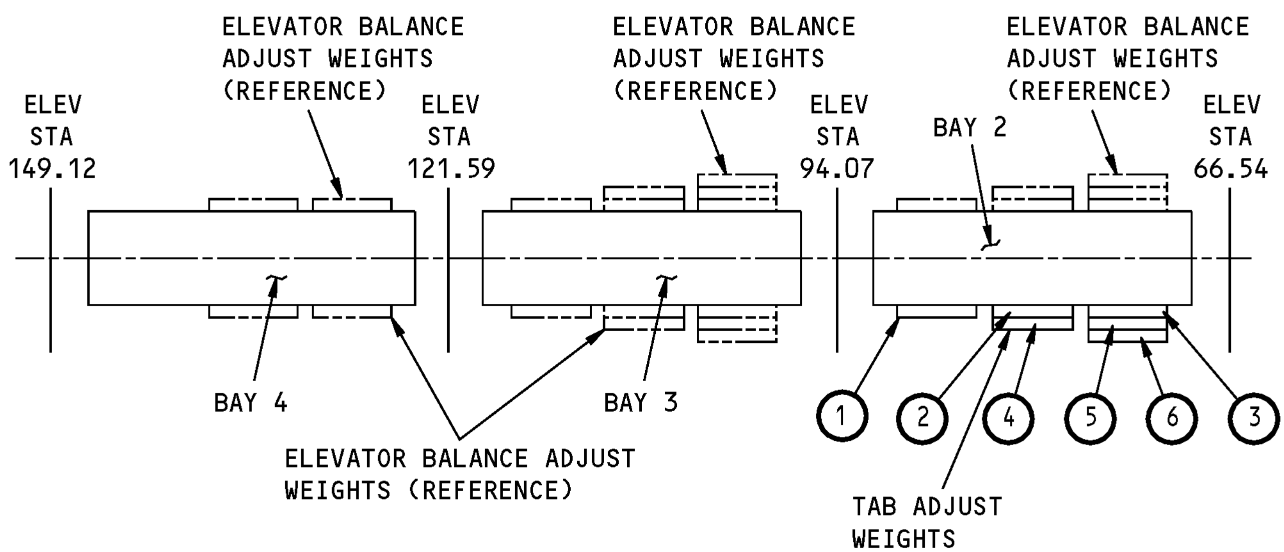
Table 1:

ELEVATOR TAB ASSEMBLY TAB ADJUST WEIGHTS 183A8100-1 THROUGH 183A8100-4	
TAB ASSEMBLY WEIGHT IN POUNDS (KILOGRAMS)	**NUMBER OF ADJUST WEIGHTS NECESSARY**
Less than 5.88 (2.667)	0
5.89 to 6.11 (2.671) to (2.771)	1
6.12 to 6.34 (2.776) to (2.876)	2
6.35 to 6.57 (2.880) to (2.980)	3
6.58 to 6.80 (2.985) to (3.084)	4
6.81 to 7.03 (3.089) to (3.188)	5
7.04 to 7.26 (3.193) to (3.293)	6

D. Before you weigh the elevator tab assembly, you must make sure that it is in the as-weighed configuration given in Elevator Tab As-Weighed Configuration, Figure 2/GENERAL.



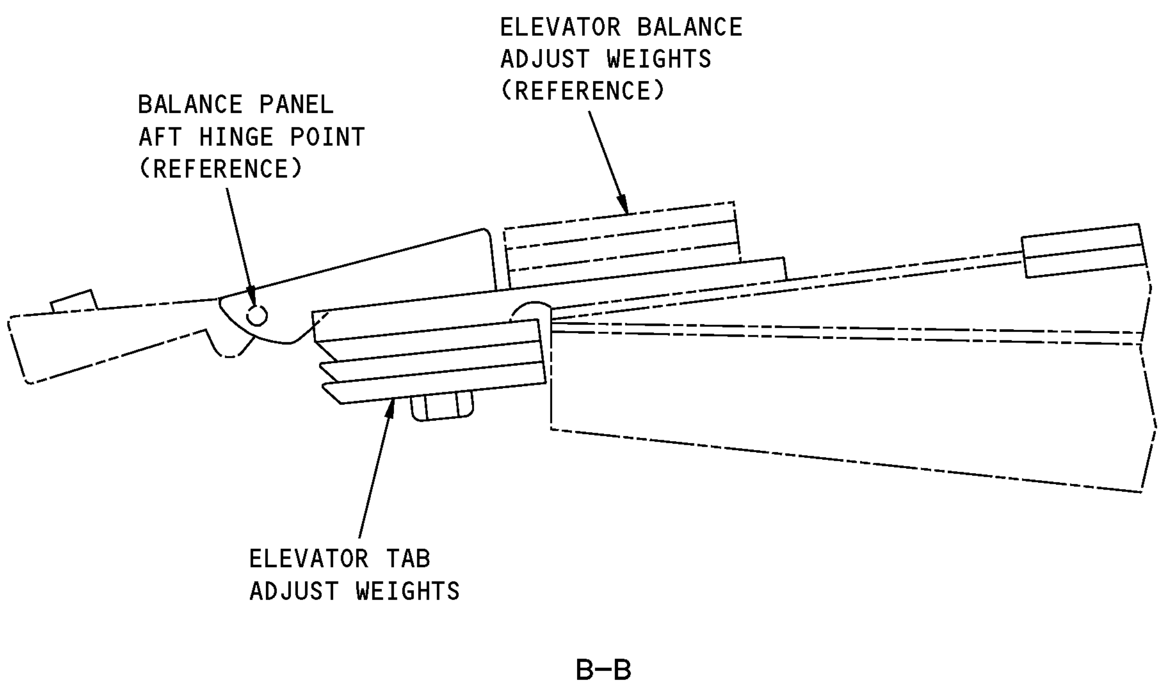
LEFT SIDE ELEVATOR IS SHOWN, RIGHT SIDE ELEVATOR IS OPPOSITE



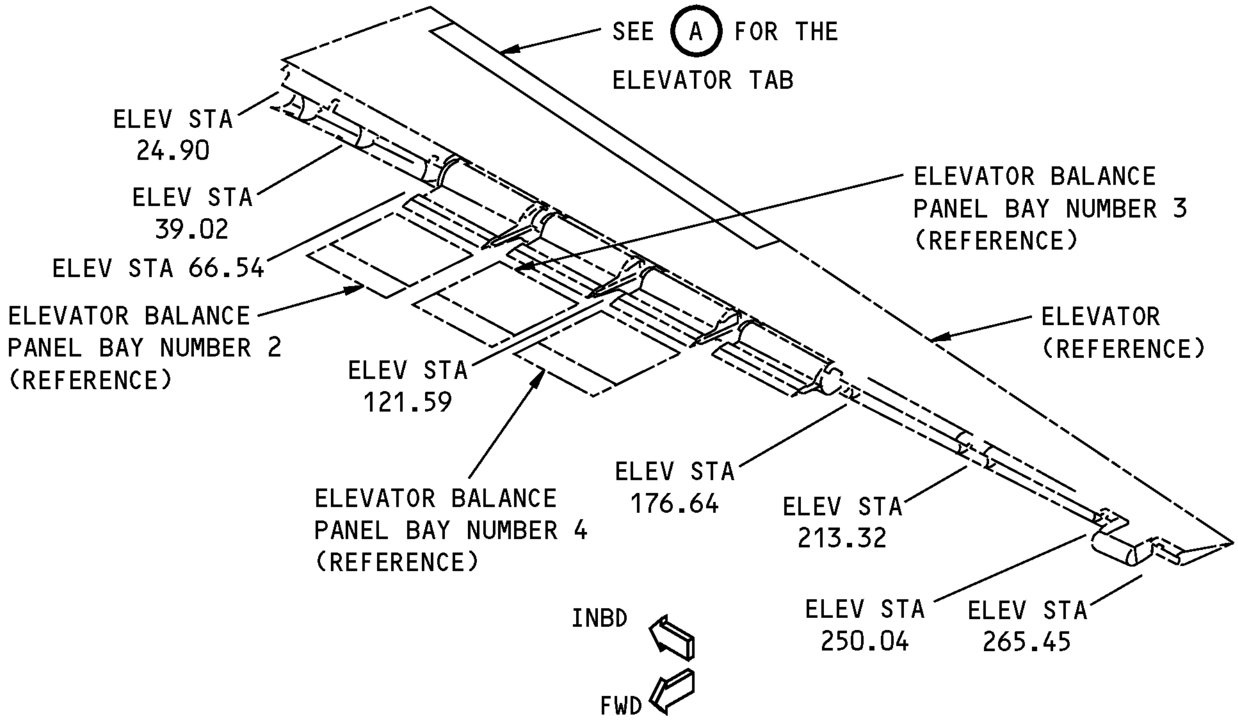
NOTE: THE CIRCLED NUMBERS SHOW THE SEQUENCE IN WHICH THE ELEVATOR TAB ADJUST WEIGHTS MUST BE INSTALLED.

A-A

Elevator Tab Adjust Weights Location
Figure 1 (Sheet 1 of 2)



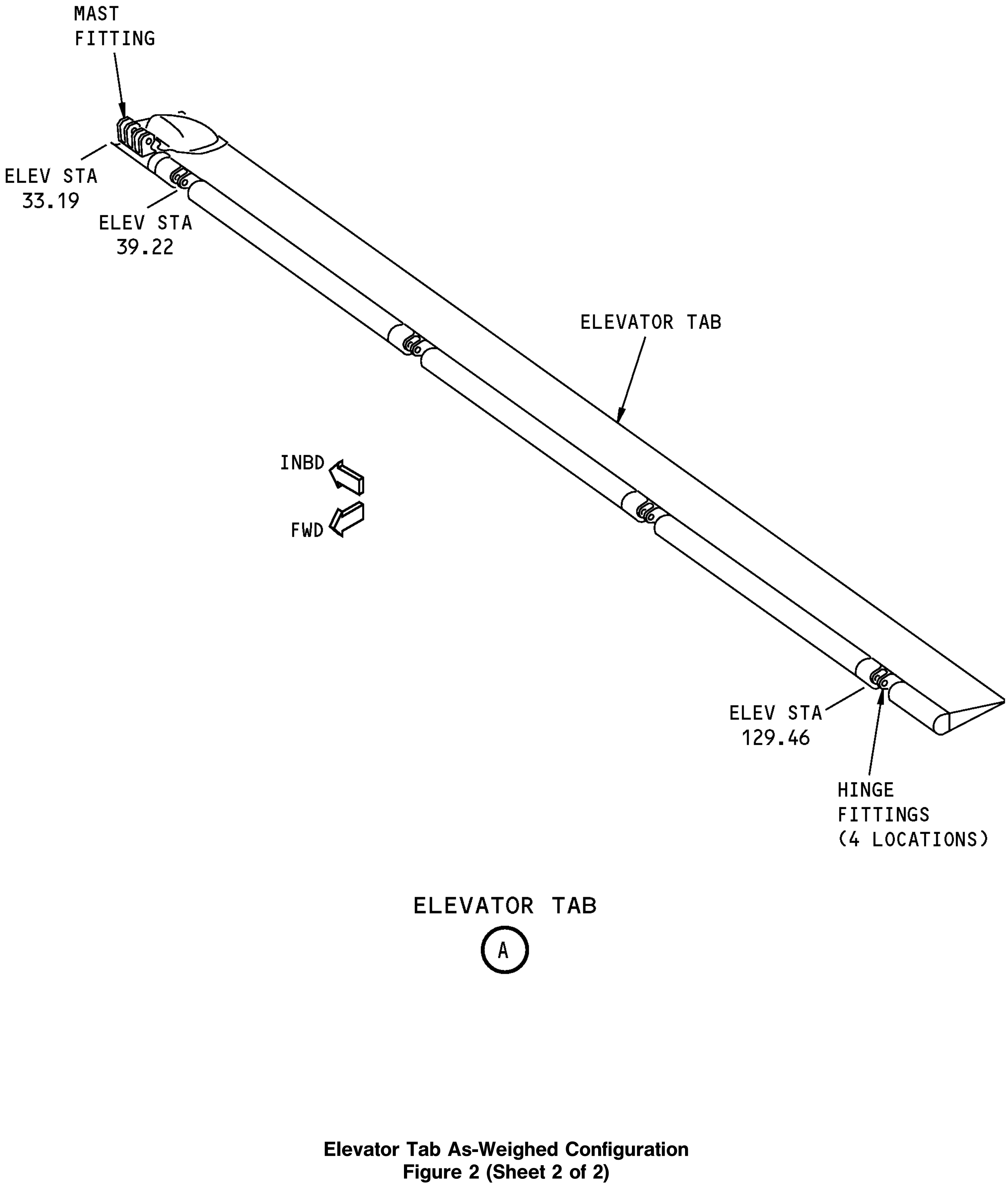
Elevator Tab Adjust Weights Location
Figure 1 (Sheet 2 of 2)



NOTES

- THE ELEVATOR TAB MUST BE A COMPLETE ASSEMBLY AS GIVEN ON ENGINEERING DRAWING 183A8100-1 THRU 183A8100-4. THIS INCLUDES ALL PROTECTIVE FINISHES AND DECORATIVE PAINT, BONDING JUMPERS AND THEIR FASTENERS.
- DO NOT INCLUDE:
  - INSTALLATION BOLTS, NUTS, AND WASHERS THAT ATTACH THE TAB TO THE ELEVATOR
  - CONTROL RODS AND THEIR INSTALLATION BOLTS, NUTS, AND WASHERS.
- INCLUDE ALL OF THE PARTS THAT FOLLOW:
  - TAB BONDED ASSEMBLY - PART NUMBER 183A8200-1 (LH) AND 183A8200-2 (RH) (TOTAL OF 1 FOR EACH ASSEMBLY)
  - HINGE FITTING - PART NUMBER 183A8300-1 (LH AND RH) (TOTAL OF 1 FOR EACH ASSEMBLY)
  - HINGE FITTING - PART NUMBER 183A8300-2 (LH AND RH) (TOTAL OF 3 FOR EACH ASSEMBLY)
  - MAST ARM FITTING - PART NUMBER 183A8400-1 (LH) AND 183A8400-2 (RH) (TOTAL OF 1 FOR EACH ASSEMBLY)
  - MAST ARM FITTING - PART NUMBER 183A8500-1 (LH) AND 183A8500-2 (RH) (TOTAL OF 1 FOR EACH ASSEMBLY)
  - HINGE COVER - PART NUMBER 183A8600-1 (LH AND RH) (TOTAL OF 2 FOR EACH ASSEMBLY)
  - HINGE COVER - PART NUMBER 183A8600-2 (LH AND RH) (TOTAL OF 6 FOR EACH ASSEMBLY)
  - ALL ATTACHING PARTS OF THE PARTS LISTED ABOVE

Elevator Tab As-Weighed Configuration
Figure 2 (Sheet 1 of 2)



Elevator Tab As-Weighed Configuration
Figure 2 (Sheet 2 of 2)

3. References

Reference	Title
51-60-00	CONTROL SURFACE BALANCING
51-60-04	ELEVATOR BALANCE PROCEDURE
51-60-05	WEIGHT CONTROL PROCEDURE FOR THE ELEVATOR BALANCE PANELS
51-61-06	ELEVATOR TAB BALANCE PROCEDURE
AMM 06-42-00	EMPENNAGE (MAJOR ZONE 300) ACCESS DOORS AND PANELS
AMM 27-31-31	ELEVATOR TAB
AMM 51-21-11	PAINT STRIPPING
AMM 51-21-99 P/B 701	DECORATIVE EXTERIOR PAINT SYSTEM - CLEANING/PAINTING
AMM 06-42-00	Aircraft Maintenance Manual
AMM 27-31-31/401	Elevator Tab - Removal/Installation
AMM 51-21-11/701	Paint Stipping - Cleaning/Painting
BAC 5018	Installation of Safetying Devices
SOPM 20-41-02	Application of Chemical and Solvent Resistant Finishes
SOPM 20-42-05	Bright Cadmium Plating

4. Prepare for the Balance Procedure

A. Remove the elevator tab from the airplane. Refer to AMM 27-31-31/401.

(1) Make sure that the elevator tab that you want to balance has the configuration as given in Paragraph 2.D.

5. Balance Procedure

A. Do as follows for the elevator tab assembly static balance procedure:

(1) Weigh the elevator tab assembly and make a note of the weight that you measured.

NOTE: The weight measurement precision for the elevator tab assembly is ±0.01 pound (4.5 grams).

(a) If the weight of the elevator tab assembly is 7.26 pounds (3.293 kilograms) or less, do as follows:

NOTE: If the weight of the elevator tab assembly is more than 7.26 pounds (3.293 kilograms), then continue with step 5.A.(1)(b).

1) Refer to Table 1/GENERAL to find the total number of tab adjust weights that must be installed.

2) Find the number of tab adjust weights that are already installed in the lower balance weight locations of bay number 2.

NOTE: Refer to Elevator Tab Adjust Weights Location, Figure 1/GENERAL for the location of bay number 2.

3) Subtract the number of tab adjust weights that you found in step 5.A.(1)(a)2) from the number of tab adjust weights that you found in step 5.A.(1)(a)1).

a) If the result is positive, continue with step 5.A.(1)(a)4).

b) If the result is negative, continue with step 5.A.(1)(a)5).

4) Install the necessary number of tab adjust weights found in step 5.A.(1)(a)3), part number 183A0210-3.

NOTE: If the elevator and elevator balance panels are still installed on the airplane, you can get access to the lower balance weight locations of bay number 2 through access panels 333CB (LH) and 343CB (RH). Refer to AMM 06-42-00.

a) Refer to Elevator Tab Adjust Weights Location, Figure 1/GENERAL for:
- The location where the tab adjust weights must be installed
- The sequence in which the tab adjust weights must be installed.

b) If the Boeing tab adjust weights, part number 183A0210-3, are not available, you can make tab adjust weights as given in Elevator Tab Adjust Weight, Part Number 183A0210-3, Figure 3/GENERAL.

c) Install the tab adjust weights with BACB30LM4H() or NAS6704H() bolts and BACW10BP4ACU washers. Refer to Table 2/GENERAL for the grip length of the attachment bolt for a given number of tab adjust weights. The fasteners must not protrude beyond the opposite face of the hinge half.
- Install BACW10BP4NAPU and/ or BACW10BP4APU (under the BACW10BP4ACU washers).

NOTE: Use any combination of washers to allow the bolt threads to properly engage the hinge half. Total Quantity: minimum of 0 washers, maximum of 2 washers.

- As necessary, apply one layer of BMS 5-95 between the tab adjust weight and the hinge plate.
- Install the bolts with MIL-C-11796, Class 3 corrosion preventive compound and torque the bolts between 68 and 83 lb-in.
- Lock the bolts with lockwire (MS20995NC32).
- Continue with step 5.A.(2).

5) Remove the necessary number of tab adjust weights.

NOTE: If the elevator and elevator balance panels are still installed on the airplane, you can get access to the lower balance weight locations of bay number 2 through access panel 333CB (LH) and 343CB (RH). Refer to AMM 06-42-00.

a) Refer to Elevator Tab Adjust Weights Location, Figure 1/GENERAL for:
- The location where the tab adjust weights are installed
- The sequence in which the tab adjust weights must be removed.

b) Remove the necessary number of tab adjust weights found in step 5.A.(1)(a)3), part number 183A0210-3.

c) Install the remaining tab adjust weights with BACB30LM4H() or NAS6704H() bolts and BACW10BP4ACU washers. Refer to Table 2/GENERAL for the grip length of the attachment bolt for a given number of tab adjust weights. The fasteners must not protrude beyond the opposite face of the hinge half.

- Install BACW10BP4NAPU and/ or BACW10BP4APU (under the BACW10BP4ACU washers).

NOTE: Use any combination of washers to allow the bolt threads to properly engage the hinge half. Total Quantity: minimum of 0 washers, maximum of 2 washers.

- As necessary, apply one layer of BMS 5-95 between the tab adjust weight and the hinge plate.
- Install the bolts with MIL-C-11796, Class 3 corrosion preventive compound and torque the bolts between 68 and 83 lb-in.
- Lock the bolts with lockwire (MS20995NC32).
- Continue with step 5.A.(2).

Table 2:

ELEVATOR TAB ASSEMBLY TAB ADJUST WEIGHTS ATTACHMENT BOLT GRIP LENGTH	
NUMBER OF TAB ADJUST WEIGHTS IN STACK-UP	ATTACHMENT BOLT BACB30LM4H() or NAS6704H( ) GRIP LENGTH
3	13
2	11
1	7
0	4 (REF)

(b) If the weight of the elevator tab assembly is more than 7.26 pounds (3.293 kilograms), do as follows:

1) Remove multiple layers of paint from the elevator tab assembly to reduce the weight of the tab assembly, as applicable. Refer to AMM 51-21-11/701 for removal of paint.

NOTE: Refer to 51-60-00 for the repair material weights.

2) Restore the elevator tab assembly decorative exterior paint system. Refer to AMM PAGEBLOCK 51-21-99/701.

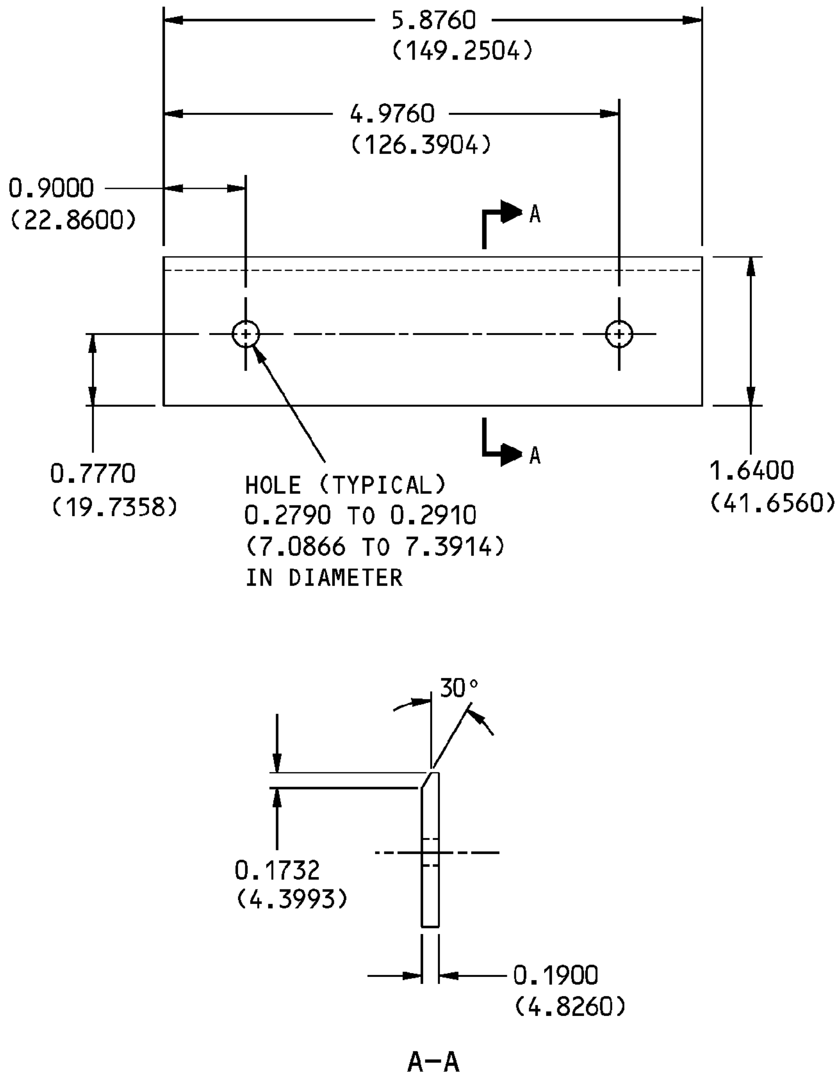
3) Do step Paragraph 5.A./GENERAL again.

(c) If it is not possible to reduce the weight of the elevator tab assembly as given in Paragraph 5.A.(1)(b), you must replace the elevator tab assembly with one that has the correct weight.

(2) Stamp the value of the elevator tab weight and the number of tab adjust weights that are installed on the metal nameplate (BAC27DWG26) that is attached to the elevator tab assembly.

6. Put the Airplane Back to Its Usual Condition

A. Install the elevator tab. Refer to AMM 27-31-31/401.



NOTES

- ALL DIMENSIONS ARE IN INCHES (mm).
- MATERIAL: 15-5 PH CRES AS GIVEN IN BMS 7-240, TYPE I AND HEAT TREAT TO 150 TO 170 KSI AS GIVEN IN BAC 5619
- 125 MICROINCHES R_a FINISH ON ALL EDGES
- CADMIUM PLATE AS GIVEN IN QQ-P-416, TYPE 2, CLASS 2 (REFER TO SOPM 20-42-05)
- APPLY ONE LAYER OF BMS 10-11, TYPE I PRIMER (REFER TO SOPM 20-41-02)
- THE FINISHED PART MUST HAVE A WEIGHT OF 0.50 ± 0.05 POUND (0.227 ± 0.0227 KILOGRAM)

Elevator Tab Adjust Weight, Part Number 183A0210-3
Figure 3

GENERAL - RUDDER BALANCE PROCEDURE

1. **Applicability**

WARNING: IF THE BALANCE MOMENT OF THE RUDDER IS NOT WITHIN THE LIMITS OF THE SECONDARY STATIC BALANCE REQUIREMENTS, A CONDITION DANGEROUS TO FLIGHT SAFETY CAN OCCUR.

CAUTION: IF A RUDDER ASSEMBLY IS REMOVED FROM THE AIRPLANE, REWORKED, REPAIRED, OR REPAINTED, OR IF A NEW RUDDER ASSEMBLY IS INSTALLED, IT MUST BE BALANCED AND STAMPED WITH THE NEW STATIC BALANCE HINGE MOMENT (SBHM). WHEN YOU DO ABRASIVE BLAST PROCEDURES IN AREAS WHERE LUBRICATION FLUIDS OR GREASE ARE APPLIED, USE CARE TO PREVENT CONTAMINATION OF THE LUBRICANT WITH THE BLAST RESIDUE. THIS CONTAMINATION CAN AFFECT THE LUBRICATION PROPERTIES AND THE RESULT CAN BE INCREASED WEAR OF THE LUBRICATED PARTS.

A. This subject gives the necessary data for the static balance requirements for the rudder assembly.

2. **General**

A. Refer to 51-60-00 for the general data such as:

(1) Categories of control surfaces

(2) General balance instructions

(3) Serviceability

(4) Definitions of terms

(5) Sign conventions

(6) Measurement accuracy

(7) Special tools and equipment

(8) Repair material weights.

B. The rudder assembly is a Category I Control Surface.

C. Before you complete a repair or repaint on the rudder, you must make sure that it is possible to balance the rudder within the limits of the secondary static balance requirements as given in Paragraph 2.F./GENERAL after the repair or repaint has been completed.

(1) To make sure that it is possible to balance the rudder within the limits of the secondary static balance requirements as given in Paragraph 2.F./GENERAL after the repair or repaint has been completed, you must:

(a) Find the current Static Balance Hinge Moment (SBHM)

(b) Find the ΔM as a result of the repair or repaint

(c) Find the number of available rudder balance adjust weight positions and thus the rework capability.

D. If it is not possible to meet the secondary static balance requirements with the current Static Balance Hinge Moment (SBHM), the ΔM as a result of the repair or repaint, and the number of available rudder balance adjust weight positions, you can restore the rework capability as follows:

(1) Remove all layers of paint from the rudder assembly.

(a) Refer to AMM 51-21-11/701 for the paint removal procedures.

(b) Remove the balance adjust weights which are equal in moment to the layers of paint that where added to the initial paint application.

NOTE: These layers of paint are removed to restore the rework capability of the rudder assembly. This does not include the initial paint application. Do not remove the adjust weights necessary for the initial paint application.

(c) Restore the decorative exterior paint to the rudder assembly.

1) Use the same specification as the initial paint application you removed.

2) Refer to AMM PAGEBLOCK 51-21-99/701 for the paint application procedures.

NOTE: The restored paint is repaint. It will be necessary to add adjust weights that are equal in moment to this paint application. If there are other rework areas or repairs on the rudder assembly, it is still necessary to add adjust weights equal in moment to these areas.

E. The rudder can be balanced by one of two methods:

(1) The static balance jig procedure Refer to Paragraph 5.A./GENERAL for the balance procedure on the static balance jig.

(a) The rudder must be removed from the airplane to be balanced on the static balance jig. For the configuration of the rudder at the time of the balance procedure, refer to Paragraph 2.G./GENERAL

(2) The calculation procedure Refer to Paragraph 5.B./GENERAL for the balance procedure by calculation.

(a) This procedure does not require the use of a static balance jig. The calculation procedure can be used with the rudder on or off the airplane as long as the repair and balance requirements are met. You must make sure that the necessary data is recorded during the repair or rework so that the calculations can be made accurately.

(b) Be careful when you calculate the weight of the material removed (or lost as a result of damage) and the weight of material added.

1) Measure or calculate the weight of the material removed and the weight of material added as accurately as possible.

2) Keep the tolerance very small. If you do not, you can have a weight that is not satisfactory. What follows will have an effect on the tolerance:

a) The tolerance of the weighing equipment

b) The precision in your estimation of the weight of the material that has been removed

c) The precision in your estimation of the weight of the repair materials or paint.

(c) Find the distance from the hinge line to the center of gravity of the repair to within ±0.1 in. (±2.5 mm). What follows will have an effect on the tolerance:

1) The possible error in the estimation of the position of the center of gravity of the repair

2) The possible error in the measurement of the distance from the center of gravity of the repair to the rudder hinge line.

F. The rudder installation must be balanced so that the total effective center of gravity is within the limits for the primary static balance requirement.

(1) The primary static balance requirement, or the location of the center of gravity for the rudder installation, is 1.8 to 2.7 inches (45.72 to 68.58 mm) aft of the rudder hinge line.

(2) To get the primary static balance requirement, you must make sure, by measurement or calculation, that the secondary static balance requirements for the rudder are met. Refer to Table 1/GENERAL for the secondary static balance requirements.

(3) The secondary static balance requirement for the rudder assembly when you balance the rudder by measurement on the balance jig requires a component moment between +418.2 and +636.8 lbfin (+47.25 and +71.95 Nm).

(4) The secondary static balance requirement for the rudder assembly when you balance the rudder by calculation on or off the airplane requires a component moment between +418.2 and +540.0 lbfin (+47.25 and +61.01 Nm).

(5) It is suggested that you balance the rudder assembly nearest to the most forward component moment of +418.2 lbfin (+47.25 Nm) to account for future repairs, painting, or rework.

Table 1:

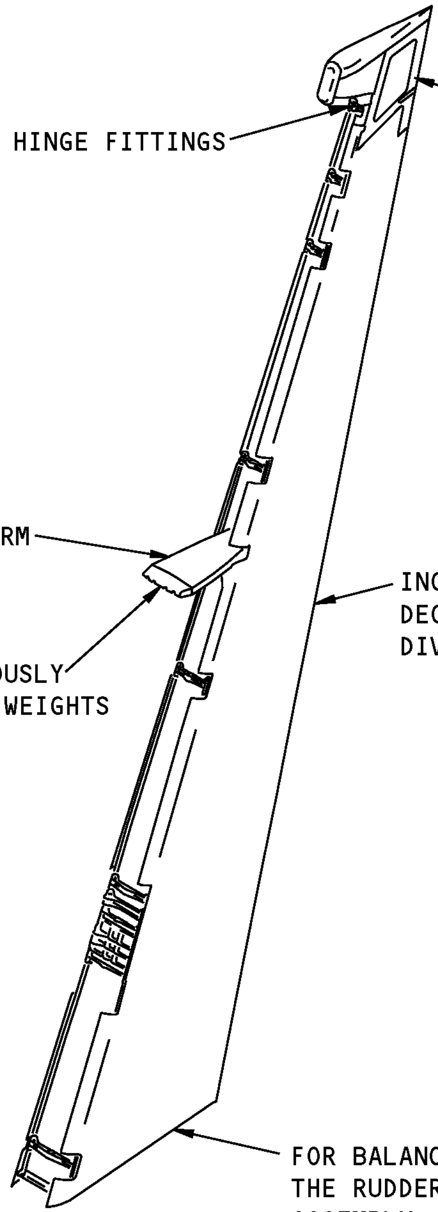
COMPONENT	ENGINEERING DRAWING	SECONDARY STATIC BALANCE REQUIREMENT		
		COMPONENT WEIGHT lbm (kg)	COMPONENT MOMENT lbfin (Nm)	REFER TO SRM
Rudder Assembly	173A0100-( ) 173A0103-( )	Not Applicable	BALANCE PROCEDURE BY MEASUREMENT ON THE BALANCE JIG: +418.2 to +636.8 (+47.25 to +71.95)	51-60-07 Paragraph 5.A
			BALANCE PROCEDURE BY CALCULATION ON THE AIRPLANE: +418.2 to +540.0 (+47.25 to +61.01)	51-60-07 Paragraph 5.B
Rudder Balance Arm Weight	173A5103-3	40.00 ±0.15 (18.14 ±0.068)	Not Applicable	Not Applicable
Rudder Horn Tip Weight	173A6101-1	12.50 ±0.15 (5.67 ±0.68)	Not Applicable	Not Applicable

G. Before you balance the rudder assembly on the static balance jig, you must make sure that it is a complete assembly as given on engineering drawing 173A0100-678.

NOTE: Refer to Configuration of Rudder at Time of Balancing On the Balance Jig, Figure 1/GENERAL for the as-balanced configuration of the rudder assembly. The as-balanced configuration includes all exterior finishes.

H. When the rudder is installed on the airplane, the rudder balance adjust weights are accessible when the rudder is rotated to the side and the adjust weight access covers are removed from the rudder balance arm.

I. Make sure that you keep to the sign conventions as given in 51-60-00, except where noted.



NOTES

- REMOVE NUTS, BOLTS, AND WASHERS THAT ATTACH RUDDER TO VERTICAL STABILIZER.

Configuration of Rudder at Time of Balancing On the Balance Jig
Figure 1

3. References

Reference	Title
51-60-00	CONTROL SURFACE BALANCING
51-70-05	REPAIR PROCEDURES FOR PREIMPREGNATED MATERIALS
AMM 51-21-99 P/B 701	DECORATIVE EXTERIOR PAINT SYSTEM - CLEANING/PAINTING
AMM 27-21-11/401	Rudder - Removal/Installation
AMM 51-21-11/701	Paint Stipping - Cleaning/Painting
SOPM 20-30-03	Standard Overhaul Practices Manual
SOPM 20-44-04	Application of Urethane Compatible Primers
SOPM 20-50-13	Application of Weather, Fuel, Oil, Solvent, and Heat Resistant Protective Coatings

4. Prepare for the Balance Procedure

A. For the balance procedure on the balance jig, do as follows:

(1) Remove the rudder from the airplane. Refer to AMM 27-21-11/401.

(2) Make sure that the rudder assembly that you want to balance has the configuration as given in Paragraph 2.G./GENERAL

B. For the balance procedure by calculation there are no specific preparations for the balance procedure.

5. Balance Procedure

A. Rudder Assembly Static Balance Procedure by Measurement on the Static Balance Jig

NOTE: The secondary static balance requirement for the rudder assembly when you balance the rudder by measurement on the balance jig requires a component moment between +418.2 and +636.8 lbfin (+47.25 and +71.95 Nm).

(1) Install the rudder assembly in the static balance jig. Refer to Rudder Support and Balance at Time of the Balance Procedure on the Static Balance Jig, Figure 2/GENERAL.

(a) Use rudder hinge fitting number 4 (RUDDER STA 74.80), hinge fitting number 5 (RUDDER STA 129.74) (optional), and hinge fitting number 6 (RUDDER STA 184.67) for the installation of the rudder assembly in the balance jig.

NOTE: Make sure that the rudder assembly can pivot freely about its hinge centerline.

(b) Level the horizontal chord plane ±1 degree with a protractor level.

(2) Use the platform scale and toolstand to measure the Weight Reaction (WR) at a forward balance arm drain hole. Refer to Rudder Support and Balance at Time of the Balance Procedure on the Static Balance Jig, Figure 2/GENERAL.

WR = __________ lbf (N)

NOTE: Refer to 51-60-00 for the weight measurement precision for the Weight Reaction (WR).

(3) Calculate the trial Check Balance Moment (CBM) with the formula:

trial CBM = (WR) x (d), where:

- WR is the Weight Reaction measured at a forward balance arm drain hole in lbf (N) (Refer to Rudder Support and Balance at Time of the Balance Procedure on the Static Balance Jig, Figure 2/GENERAL)

- d is the moment arm distance between the rudder hinge centerline and a forward balance arm drain hole (d = -17.05 in. (-433.07 mm = -0.433 m)).

trial CBM = __________ lbfin (Nm) The trial CBM is the new final moment (Static Balance Hinge Moment) if it is within the given limits.

(a) If +418.2 lbfin ≤ trial CBM ≤ +636.8 lbfin (+47.25 Nm ≤ trial CBM ≤ +71.95 Nm), the secondary static balance requirement for the rudder assembly is met. In this situation you can do one of the steps that follow:

1) Because the static balance requirement for the rudder assembly is met, it is not necessary to install additional rudder balance adjust weights. The trial CBM is the new final moment (Static Balance Hinge Moment) if it is within the given limits. Continue with step 5.A.(8).

2) Balance the rudder assembly to a desired balance moment between +418.2 and +636.8 lbfin (+47.25 and +71.95 Nm) by the addition of a sufficient number of rudder balance adjust weights. Refer to Paragraph 5.C./GENERAL for an Example.

3) Balance the rudder assembly nearest the most forward component moment of +418.2 lbfin (+47.25 Nm) to account for future repairs, painting, or rework. Refer to Paragraph 5.C./GENERAL for an Example.

(b) If the trial CBM is more than +636.8 lbfin (+71.95 Nm), the secondary static balance requirement for the rudder assembly is not met and you must add rudder balance adjust weights. In this situation you can do one of the steps that follow:

1) Balance the rudder assembly to a desired balance moment between +418.2 and +636.8 lbfin (+47.25 and +71.95 Nm) by the addition of a sufficient number of rudder balance adjust weights. Refer to Paragraph 5.C./GENERAL for an Example.

2) Balance the rudder assembly nearest the most forward component moment of +418.2 lbfin (+47.25 Nm) to account for future repairs, painting, or rework. Refer to Paragraph 5.C./GENERAL for an Example.

(c) A trial CBM that is less than +418.2 lbfin (+47.25 Nm) is not likely to occur and therefore will not be described in this subject.

(4) Find the number of rudder balance adjust weights that you must install to meet the secondary static balance requirement for the rudder assembly.

(a) Rudder Assembly Balance Adjust Weight Table, Figure 3/GENERAL, Table I gives the total change in moment (ΔM) as a result of the addition of a number of rudder balance adjust weights to an existing number of adjust weights already installed. The values of ΔM given in the table account for the weight of the different adjust weights, and the moment arms of the balance adjust weights.

(b) For a given trial CBM as found in Paragraph 5.A.(3)/GENERAL and together with the formula: +418.2 ≤ (ΔM + trial CBM) ≤ +636.8 (lbfin) (+47.25 ≤ (ΔM + trial CBM) ≤ +71.95 (Nm)) you can find the necessary number of rudder balance adjust weights from Rudder Assembly Balance Adjust Weight Table, Figure 3/GENERAL, Table I that must be installed for a given number of adjust weights already installed and the desired Static Balance Hinge Moment (SBHM) desired SBHM = (ΔM) + (trial CBM)

(5) Remove the rudder adjust weights access covers.

(a) Remove the eight nuts that attach the access cover to the rudder balance arm assembly.

(b) Remove the access covers.

(6) Install the necessary number of rudder balance adjust weights found in step 5.A.(4), part number 173A5300-1.

NOTE: The maximum number of rudder balance adjust weights in a stack is 24. The maximum total number of rudder balance adjust weights is thus 48. The adjust weights must be distributed evenly between the two adjust weight locations. A difference of 1 adjust weight between the two adjust weight locations is permitted.

(a) Refer to Rudder Assembly Balance Adjust Weight Location, Figure 4/GENERAL for the location where the rudder balance adjust weights must be installed.

(b) If the Boeing rudder balance adjust weights, part number 173A5300-1 are not available, you can make rudder balance adjust weights as given in Rudder Balance Adjust Weight, Figure 5/GENERAL.

(c) Install the rudder balance adjust weights, part number 173A5300-1.

1) As necessary, apply one layer of BMS 5-95 between the rudder balance adjust weight and the rudder balance arm casting.

2) Install the rudder balance adjust weights with:

a) BACW10BP5CD washers (under the bolt heads)

b) BACB30LE5K() bolts. Install the bolts with BMS 3-27 corrosion preventive compound. Refer to Table 2/GENERAL for the grip length of the attachment bolt for a given number of rudder balance adjust weights.

c) NAS1149E0563P washers (under the nuts)

d) BACN10HR5CS nuts (130-200 lb-in.)

Table 2:

RUDDER ASSEMBLY BALANCE ADJUST WEIGHTS ATTACHMENT BOLT GRIP LENGTH DASH NUMBERS			
NUMBER OF RUDDER BALANCE ADJUST WEIGHTS IN STACK-UP	ATTACHMENT BOLT BACB30LE5K ( ) GRIP LENGTH DASH NUMBER	NUMBER OF RUDDER BALANCE ADJUST WEIGHTS IN STACK-UP	ATTACHMENT BOLT BACB30LE5K ( ) GRIP LENGTH DASH NUMBER
0	55	13	76
1	57	14	78
2	59	15	79
3	60	16	81
4	62	17	83
5	63	18	84
6	65	19	86
7	67	20	87
8	68	21	89
9	70	22	91
10	71	23	92
11	73	24	94
12	75		

(7) Calculate a second trial Check Balance Moment (CBM):

(a) Level the horizontal chord plane ±1 degree with a protractor level.

(b) Use the platform scale and toolstand to measure the Weight Reaction (WR) at a forward balance arm drain hole. Refer to Rudder Support and Balance at Time of the Balance Procedure on the Static Balance Jig, Figure 2/GENERAL.

WR = __________ lbf (N)

NOTE: Refer to 51-60-00 for the weight measurement precision for the Weight Reaction (WR).

(c) second trial Check Balance Moment (CBM) = (WR) x (d), where:

- WR is the (new) Weight Reaction measured in lbf (N)
- d is the moment arm distance between the rudder hinge centerline and a forward balance arm drain hole (d = -17.05 in. (-433.07 mm = -0.433 m)).

second trial CBM = __________ lbfin (Nm)

(d) If the second trial CBM is within the limits as given in Paragraph 2.F./GENERAL, the second trial Check Balance Moment (CBM) becomes the new Static Balance Hinge Moment (SBHM).

second trial CBM = new (SBHM) = __________ lbfin (Nm) Continue with step 5.A.(8).

(e) If the second trial CBM is not within the limits as given in Paragraph 2.F./GENERAL, do one of the steps that follow:

1) If there are enough weight positions to bring the moment within the limits, repeat steps 5.A.(1) through 5.A.(7).

2) If there are not enough weight positions to bring the moment within the limits, do as follows:

a) Remove all layers of paint from the rudder assembly. Refer to AMM PAGEBLOCK 51-21-99/701 for the paint removal procedures.

b) Restore the rudder assembly decorative exterior paint system. Refer to AMM PAGEBLOCK 51-21-99/701.

c) Repeat steps 5.A.(1) through 5.A.(7).

d) If it is not possible to get the rudder balanced within the specified limits after the removal of multiple layers of paint, you must replace the rudder assembly.

(8) Vibro-engrave or rubber-stamp the value of the new Static Balance Hinge Moment (SBHM) on the metal part identification plate (MS27253C2) that is attached to the rudder assembly.

(a) Apply a Skydrol resistant finish to the rubber-stamped data as given in SOPM 20-50-13.

(b) Do not stamp the installed metal nameplate with steel stamps.

(9) Make a record in the repair log of:

(a) The new Static Balance Hinge Moment (SBHM)

(b) The fact that the rudder has been balanced on the static balance jig

(c) The type of repair

(d) The location of the repair

(e) The date when the rudder was repaired and balanced

(f) The number of rudder balance adjust weights that are installed and the number of available spaces for the addition of weight.

B. Rudder Assembly Static Balance Procedure by Calculation

NOTE: The secondary static balance requirement for the rudder assembly when you balance the rudder by calculation requires a component moment between +418.2 and +540.0 lbfin (+47.25 and +61.01 Nm).

(1) Review the repair log and find the available Rework Moment (RM).

(2) Measure the distance D (within 0.1 inch (2.5 mm)). D is the distance from the rework center of gravity (CG) along the skin surface to the intersection of the centerline of the rudder hinge and the "upper" skin. Refer to Rudder Balance at Time of the Balance Procedure by Calculation, Figure 6/GENERAL.

D = __________ inches (m)

(3) Measure or calculate the distance Y. Y is the distance from the rudder hinge centerline to the line through the CG of the rework, perpendicular to the rudder hinge line and parallel to the rudder chord line. Refer to Rudder Balance at Time of the Balance Procedure by Calculation, Figure 6/GENERAL. To calculate the distance Y, use the formula that follows:

$Y = (D) \times (\cos 7.7^\circ) =$ __________ inches (m)

(4) Weigh or calculate the Weight removed (Wr). Wr is the Weight removed as a result of rework, repair, or re-painting. Refer to Paragraph 5.D./GENERAL for an Example Calculation of the Weight removed (Wr).

Wr = +__________ lbm (kg) (KEEP POSITIVE)

(5) Weigh or calculate the Weight added (Wa). Wa is the Weight added as a result of rework, repair, or re-painting. Refer to Paragraph 5.D./GENERAL for an Example Calculation of the Weight added (Wa).

Wa = __________ lbm (kg)

(6) Calculate the Rework Weight (RW). RW is the net change in weight as a result of rework, repair, or re-painting. Refer to Paragraph 5.D./GENERAL for an Example Calculation of the Rework Weight (RW).

RW = Wa - Wr = __________ lbm (kg)

(7) Calculate the Rework Moment (RM). RM is the net change in balance moment as a result of rework, repair, or re-painting. Refer to Paragraph 5.D./GENERAL for an Example Calculation of the Rework Moment (RM).

RM = (RW) x (Y) = __________ lbfin (Nm)

(8) Calculate the trial Check Balance Moment (CBM). The trial CBM is the new final moment (Static Balance Hinge Moment) if it is within the given limits.

trial CBM = (SBHM) + (RM) = __________ lbfin (Nm) where SBHM is the Static Balance Hinge Moment that is the previous final moment stamped on the nameplate of the rudder.

(a) If +418.2 lbfin ≤ trial CBM ≤ +540.0 lbfin (+47.25 Nm ≤ trial CBM ≤ +61.01 Nm), the secondary static balance requirement for the rudder assembly is met. In this situation you can do one of the steps that follow:

1) Because the static balance requirement for the rudder assembly is met, it is not necessary to install additional adjust weights. Continue with step 5.B.(13).

2) Balance the rudder assembly to a desired balance moment between +418.2 and +540.0 lbfin (+47.25 and +61.01 Nm) by the addition of a sufficient number of rudder balance adjust weights. Refer to Paragraph 5.D./GENERAL for an Example.

3) Balance the rudder assembly nearest the most forward component moment of +418.2 lbfin (+47.25 Nm) to account for future repairs, painting, or rework. Refer to Paragraph 5.D./GENERAL for an Example.

(b) If the trial CBM is more than +540.0 lbfin (+61.01 Nm), the secondary static balance requirement for the rudder assembly is not met and you must add rudder balance adjust weights. In this situation you can do one of the steps that follow:

1) Balance the rudder assembly to a desired balance moment between +418.2 and +540.0 lbfin (+47.25 and +61.01 Nm) by the addition of a sufficient number of rudder balance adjust weights. Refer to Paragraph 5.D./GENERAL for an Example.

2) Balance the rudder assembly nearest the most forward component moment of +418.2 lbfin (+47.25 Nm) to account for future repairs, painting, or rework. Refer to Paragraph 5.D./GENERAL for an Example.

(c) A trial CBM that is less than +418.2 lbfin (+47.25 Nm) is not likely to occur and therefore will not be described in this subject.

(9) Find the number of rudder balance adjust weights that you must install to meet the secondary static balance requirement for the rudder assembly.

(a) Rudder Assembly Balance Adjust Weight Table, Figure 3/GENERAL, Table I gives the total change in moment (ΔM) as a result of the addition of a number of rudder balance adjust weights to an existing number of adjust weights already installed. The values of ΔM given in the table account for the weight of the different adjust weights, and the moment arms of the balance adjust weights.

(b) For a given trial CBM as found in Paragraph 5.B.(8)/GENERAL and together with the formula: $+418.2 \leq (\Delta M + \text{trial CBM}) \leq +540.0$ (lbfin) ($+47.25 \leq (\Delta M + \text{trial CBM}) \leq +61.01$ (Nm)) you can find the necessary number of rudder balance adjust weights from Rudder Assembly Balance Adjust Weight Table, Figure 3/GENERAL, Table I that must be installed for a given number of adjust weights already installed and the desired Static Balance Hinge Moment (SBHM) desired SBHM = (ΔM) + (trial CBM)

(10) Remove the rudder adjust weights access covers.

(a) Remove the eight nuts that attach the access cover to the rudder balance arm assembly.

(b) Remove the access covers.

(11) Install the necessary number of rudder balance adjust weights found in step 5.B.(9), part number 173A5300-1.

NOTE: The maximum number of rudder balance adjust weights in a stack is 24. The maximum total number of rudder balance adjust weights is thus 48. The adjust weights must be distributed evenly between the two adjust weight locations. A difference of 1 adjust weight between the two adjust weight locations is permitted.

(a) Refer to Rudder Assembly Balance Adjust Weight Location, Figure 4/GENERAL for the location where the rudder balance adjust weights must be installed.

(b) If the Boeing rudder balance adjust weights, part number 173A5300-1 are not available, you can make rudder balance adjust weights as given in Rudder Balance Adjust Weight, Figure 5/GENERAL.

(c) Install the rudder balance adjust weights, part number 173A5300-1.

1) As necessary, apply one layer of BMS 5-95 between the rudder balance adjust weight and the rudder balance arm casting.

2) Install the rudder balance adjust weights with:

a) BACW10BP5CD washers (under the bolt heads)

b) BACB30LE5K() bolts. Install the bolts with BMS 3-27 corrosion preventive compound. Refer to Table 2/GENERAL for the grip length of the attachment bolt for a given number of rudder balance adjust weights.

c) NAS1149E0563P washers (under the nuts)

d) BACN10HR5CS nuts (130-200 lb-in.)

(12) Calculate a second trial Check Balance Moment (CBM) with the formula:

second trial CBM = previous (SBHM) + (RM) + ΔM

second trial CBM = first trial CBM + ΔM

second trial CBM = __________ lbfin (Nm) where: previous SBHM is the Static Balance Hinge Moment that is the previous final moment stamped on the nameplate of the rudder. RM is the Rework Moment as found in Paragraph 5.B.(7)/GENERAL

ΔM is the change in moment selected from Rudder Assembly Balance Adjust Weight Table, Figure 3/GENERAL, Tables I for a given number of rudder balance adjust weights added (n).

(a) If the second trial CBM is within the limits as given in Paragraph 2.F./GENERAL, the second trial Check Balance Moment (CBM) becomes the new Static Balance Hinge Moment (SBHM).

second trial CBM = new (SBHM) = __________ lbfin (Nm) Continue with step 5.B.(13).

(b) If the second trial CBM is not within the limits as given in Paragraph 2.F./GENERAL, do one of the steps that follow:

1) If there are enough weight positions to bring the moment within the limits, repeat steps 5.B.(1) through 5.B.(12).

2) If there are not enough weight positions to bring the moment within the limits, do as follows:

a) Remove all layers of paint from the rudder assembly.

- Refer to AMM 51-21-11/701 for the paint removal procedures
- Remove the balance adjust weights which are equal in moment to the layers of paint that were added to the initial paint application.

NOTE: These layers of paint are removed to restore the rework capability of the rudder assembly. This does not include the initial paint application. Do not remove the adjust weights necessary for the initial paint application.

b) Restore the decorative exterior paint to the rudder assembly.

- Use the same specification as the initial paint application you removed.
- Refer to Table 3/GENERAL for the data of one application of paint and its effect on the moment and moment arm.
- Refer to AMM PAGEBLOCK 51-21-99/701 for the paint application procedures. (The restored paint is a repaint. It will be necessary to add adjust weights that are equal in moment to this paint application. If there are other rework areas or repairs on the rudder assembly, it is still necessary to add adjust weights equal in moment to these areas.)
- Repeat steps 5.B.(1) through 5.B.(12).
- If it is not possible to get the rudder balanced within the specified limits after the removal of multiple layers of paint, you can balance the rudder on the static

balance jig because the limits for balancing on the balance jig are less strict. If this will not bring the rudder balance within the limits you must replace the rudder assembly.

Table 3:

VARIABLES FOR THE CALCULATION OF THE EFFECT OF ONE PAINT LAYER (BMS 10-60), 0.001 in. (0.0254 mm) THICK ON THE COMPONENT MOMENT OF THE RUDDER		
PAINTED SURFACE AREA PER RUDDER	**MOMENT AS A RESULT OF PAINT**	**MOMENT ARM OF ADDED PAINT** (Distance aft of the rudder hinge center-line)
ft^2 (m^2)	lbfin (Nm)	in. (mm)
158.8 (14.75)	+19.3418 (+2.1853)	+17.4 (+441.96)

(13) Vibro-engrave or rubber-stamp the value of the new Static Balance Hinge Moment (SBHM) on the metal part identification plate (MS27253C2) that is attached to the rudder assembly.

(a) Apply a Skydrol resistant finish to the rubber-stamped data as given in SOPM 20-50-13.

(b) Do not stamp the installed metal nameplate with steel stamps.

(14) Make a record in the repair log of:

(a) The new Static Balance Hinge Moment (SBHM)

(b) The fact that the rudder has been balanced by calculation

(c) The type of repair

(d) The location of the repair

(e) The date when the rudder was repaired and balanced

(f) The number of rudder balance adjust weights that are installed and the number of available spaces for the addition of weight.

C. Example 1 - Rudder Assembly Static Balance Procedure by Measurement on the Balance Jig Assume that a new rudder is damaged and the decision is made to remove the rudder from the airplane for repair and balancing.

(1) Make sure that the rudder assembly that you want to balance has the configuration as given in Paragraph 2.G./GENERAL

(2) Install the rudder assembly in the static balance jig. (Refer to Rudder Support and Balance at Time of the Balance Procedure on the Static Balance Jig, Figure 2/GENERAL.)

(a) Use rudder hinge fitting number 4 (RUDDER STA 74.80), hinge fitting number 5 (RUDDER STA 129.74) (optional), and hinge fitting number 6 (RUDDER STA 184.67) for the installation of the rudder assembly in the balance jig.

NOTE: Make sure that the rudder assembly can pivot freely about its hinge centerline.

(b) Level the horizontal chord plane ±1 degree with a protractor level.

(3) Use the platform scale and toolstand to measure the Weight Reaction (WR) at a forward balance arm drain hole. (Refer to Rudder Support and Balance at Time of the Balance Procedure on the Static Balance Jig, Figure 2/GENERAL.)

WR = -32.75 lbf (-145.68 N)

(4) Find the moment arm distance d from Rudder Support and Balance at Time of the Balance Procedure on the Static Balance Jig, Figure 2/GENERAL. The moment arm distance d is the distance between the rudder hinge centerline and the forward balance arm drain hole. This distance is forward of the rudder hinge centerline and is therefore negative.

d = -17.05 in. (-433.07 mm = -0.433 m)

(5) Calculate the trial Check Balance Moment (CBM) with the formula:

trial CBM = (WR) x (d), where:

trial CBM = (-32.75) x (-17.05) = +558.39 lbfin (+63.09 Nm)

(6) With this trial CBM you can do one of the steps that follow:

(a) The trial CBM meets the secondary static balance requirement as given in Paragraph 2.F./GENERAL, so it is not necessary to install additional rudder balance adjust weights. Continue with step 5.C.(7).

(b) To balance the rudder assembly to a desired balance moment between +418.2 and +636.8 lbfin (+47.25 and +71.95 Nm) by the addition of a sufficient number of rudder balance adjust weights, do as follows:

1) First, decide what the desired balance moment will be. In this example the desired balance moment is chosen to be +527.5 lbfin (+59.60 Nm) maximum. This means that we will aim for a final Static Balance Hinge Moment (SBHM) of +527.50 lbfin (+59.60 Nm).

2) Then, find the number of rudder balance adjust weights that are already installed. In this example we assume that 18 rudder balance adjust weights are installed. This means that there are 30 positions left for additional weights.

3) Find the ΔM that must be added to the trial CBM to get the desired balance moment:

ΔM = desired balance moment - trial CBM

ΔM = (+527.50) - (+558.39) = -30.89 lbfin (-3.49 Nm) maximum

4) In Rudder Assembly Balance Adjust Weight Table - Example 1, Figure 7/GENERAL, Table I move horizontally from left to right starting in the row of 18 existing adjust weights (point A). From this point, move to the right horizontally until you find the ΔM (point B) that you must add to your trial CBM to get the desired balance moment: with a maximum ΔM (desired) of -30.89 lbfin (-3.49 Nm) you must add 7 rudder balance adjust weights to get as near as possible to the desired balance moment (point C).

a) The addition of 7 adjust weights results in a ΔM of -30.00 lbfin (-3.39 Nm).

5) Remove the rudder adjust weights access covers.

a) Remove the eight nuts that attach the access cover to the rudder balance arm assembly.

b) Remove the access covers.

6) Install the 7 rudder balance adjust weights as given in Paragraph 5.A.(6)/GENERAL

7) Calculate a second trial Check Balance Moment (CBM):

a) Level the horizontal chord plane ±1 degree with a protractor level.

b) Use the platform scale and toolstand to measure the Weight Reaction (WR) at a forward balance arm drain hole. (Refer to Rudder Support and Balance at Time of the Balance Procedure on the Static Balance Jig, Figure 2/GENERAL.)

WR = -30.99 lbf (-137.85 N)

c) second trial Check Balance Moment (CBM) = (WR) x (d), second trial CBM = (-30.99) x (-17.05)

second trial CBM = +528.39 lbfin (+59.70 Nm)

d) The second trial CBM is within the limits as given in Paragraph 2.F./GENERAL The second trial Check Balance Moment (CBM) becomes the new Static Balance Hinge Moment (SBHM).

second CBM = new (SBHM) = +528.39 lbfin (+59.70 Nm) Continue with step 5.C.(7).

(c) To balance the rudder assembly nearest the most forward component moment of +418.2 lbfin (+47.25 Nm) to account for future repairs, painting, or rework, do as follows:

1) First, find the number of rudder balance adjust weights that are already installed. In this example we assume that 18 rudder balance adjust weights are installed. This means that there are 30 positions left for additional weights.

2) Find the ΔM that must be added to the trial CBM to get the moment nearest to the most forward component moment:

ΔM = most forward component moment - trial CBM

ΔM = (+418.2) - (+558.39) = -140.19 lbfin (-15.84 Nm) maximum

3) In Rudder Assembly Balance Adjust Weight Table - Example 1, Figure 7/GENERAL, Table I move horizontally from left to right starting in the row of 18 existing adjust weights (point A). From this point, move to the right horizontally until you find the ΔM (point D) that you must add to your trial CBM to get the most forward component moment:

a) With a desired ΔM of -140.19 lbfin (-15.84 Nm) you must add 30 rudder balance adjust weights to get as close as possible to the most forward component moment (point E).

b) The addition of all remaining 30 adjust weights results in a ΔM of -124.52 lbfin (-14.07 Nm).

4) Remove the rudder adjust weights access covers.

a) Remove the eight nuts that attach the access cover to the rudder balance arm assembly.

b) Remove the access covers.

5) Install the 30 rudder balance adjust weights as given in Paragraph 5.A.(5)/GENERAL

6) Calculate a second trial Check Balance Moment (CBM):

a) Level the horizontal chord plane ±1 degree with a protractor level.

b) Use the platform scale and toolstand to measure the Weight Reaction (WR) at a forward balance arm drain hole. (Refer to Rudder Support and Balance at Time of the Balance Procedure on the Static Balance Jig, Figure 2/GENERAL.)

WR = -25.45 lbf (-113.21 N)

c) second trial Check Balance Moment (CBM) = (WR) x (d)

second trial CBM = (-25.45) X (-17.05)

second trial CBM = +433.87 lbfin (+49.02 Nm)

d) The second trial CBM is within the limits as given in Paragraph 2.F./GENERAL The second trial Check Balance Moment (CBM) becomes the new Static Balance Hinge Moment (SBHM).

second CBM = new (SBHM) = +433.87 lbfin (+49.02 Nm) Continue with step 5.C.(7).

(7) Vibro-engrave or rubber-stamp the value of the new Static Balance Hinge Moment (SBHM) on the metal part identification plate (MS27253C2) that is attached to the rudder assembly.

(a) Apply a Skydrol resistant finish to the rubber-stamped data as given in SOPM 20-50-13.

(b) Do not stamp the installed metal nameplate with steel stamps.

(8) Make a record in the repair log of:

(a) The new Static Balance Hinge Moment (SBHM)

(b) The fact that the rudder has been balanced on the static balance jig

(c) The type of repair

(d) The location of the repair

(e) The date when the rudder was repaired and balanced

(f) The number of rudder balance adjust weights that are installed and the number of available spaces for the addition of weight.

D. Example 2 - Rudder Assembly Static Balance Procedure by Calculation

(1) For this example we will assume what follows:

(a) A 250°F (121°C) cure repair as given in 51-70-05 has been done to the rudder with the rudder on the airplane.

(b) The current recorded Static Balance Hinge Moment (SBHM) is +480.00 lbfin (+54.23 Nm).

(c) Fourteen of the forty-eight rudder balance adjust weights have been installed during previous balance procedures.

(d) It is estimated that the Rework Moment (RM) as a result of the repair will not bring the rudder balance outside of the limits. The addition of rudder balance adjust weights will therefore not be necessary, unless you want to balance the rudder to a desired moment or nearest the most forward component moment to account for future repairs, painting, and rework.

(2) Measure the distance D within 0.1 inch (2.5 mm). D is the distance from the rework center of gravity (CG) along the skin surface to the intersection of the centerline of the rudder hinge and the upper skin. Refer to Rudder Balance at Time of the Balance Procedure by Calculation, Figure 6/GENERAL. For this example we will assume that

D = 21.6 in. (548.6 mm = 0.549 m)

(3) Measure or calculate the distance Y. Y is the distance from the rudder hinge centerline to the line through the CG of the rework, perpendicular to the rudder hinge line and parallel to the rudder chord line. Refer to Rudder Balance at Time of the Balance Procedure by Calculation, Figure 6/GENERAL. To calculate the distance Y, use the formula that follows:

Y = (D) x (cos 7.7°) = (21.6) x (cos 7.7°) = 21.4 in. (0.544 m)

(4) Find which repair operations will add weight and which repair operations will remove weight. The weight of the repair ply material is not the same as the original material weight. Therefore, a Weight removed (Wr) and a Weight added (Wa) calculation must be made. The difference between the added and removed paint is negligible unless paint was added beyond the boundaries of the paint removed. The materials which will add weight to the 250°F (121°C) repair are shown in Repair (TYP) - Repair of Damage to One Skin of Honeycomb Panel-Example 2, Figure 8/GENERAL.

NOTE: For the Weight removed (Wr) calculation the areas of the plies removed are thought to be the same as those plies that replace them. Therefore, the weight change results from the weight per unit difference. Typically for a 250°F (121°C) repair the replacement plies are slightly heavier than the original plies and a net weight increase results from the addition of repair ply material.

(a) Weigh or calculate the Weight removed (Wr). Wr is the Weight removed as a result of rework, repair, or re-painting.

1) Be careful when you calculate the weight of the material removed (or lost as a result of damage) and the weight of the material added.

a) Measure or calculate the weight of the material removed and the weight of the material added as accurately as possible.

b) Keep the tolerance very small. If you do not, you can have a weight that is not satisfactory. What follows will have an effect on the tolerance:

- The tolerance of the weighing equipment
- The precision in your estimation of the weight of the material that has been removed
- The precision in your estimation of the weight of the repair materials or paint.

2) If you calculate the Weight removed (Wr) do as follows:

NOTE: Refer to 51-60-00 for the weights of the materials.

Wr = (Area of Material) x (Weight per unit Area)

a) For the innermost initial ply - CFRP, BMS 8-256, Type IV, Class 2, Style 3K-70-PW (6.0 in. (152.4 mm) in diameter):

$Wr1 = (1/4\pi)(6.0)^2(0.00046)$

Wr1 = +0.0130 lbm (+0.0059 kg)

b) For middle initial ply - CFRP, BMS 8-256, Type IV, Class 2, Style 3K-70-PW (7.0 in. (177.8 mm) in diameter):

$Wr2 = (1/4\pi)(7.0)^2(0.00046)$

Wr2 = +0.0177 lbm (+0.0080 kg)

c) For outermost initial ply - CFRP, BMS 8-256, Type IV, Class 2, Style 3K-70-PW (8.0 in. (203.2 mm) in diameter):

$Wr3 = (1/4\pi)(8.0)^2(0.00046)$

Wr3 = +0.0260 lbm (+0.0118 kg)

d) The total Weight removed (Wr):

Wr = Wr1 + Wr2 + Wr3

Wr = 0.0130 + 0.0177 + 0.0260

$Wr = +0.0567$ lbm ($+0.0257$ kg)

(5) Weigh or calculate the Weight Added (Wa). Wa is the Weight added as a result of rework, repair, or re-painting. Refer to Repair (TYP) - Repair of Damage to One Skin of Honeycomb Panel-Example 2, Figure 8/GENERAL for the layout of the added repair materials.

(a) Be careful when you calculate the weight of the material removed (or lost as a result of damage) and the weight of the material added.

1) Measure or calculate the weight of the material removed and the weight of the material added as accurately as possible.

2) Keep the tolerance very small. If you do not, you can have a weight that is not satisfactory. What follows will have an effect on the tolerance:

a) The tolerance of the weighing equipment

b) The precision in your estimation of the weight of the material that has been removed

c) The precision in your estimation of the weight of the repair materials or paint.

3) If you calculate the Weight Added (Wa) do as follows:

NOTE: Refer to 51-60-00 for the weights of the materials.

Wa = (Area of Material) x (Weight per unit Area)

a) Repair Item 1 - Adhesive Film - BMS 8-245, Type II, Class 1, Grade 3A (10.0 in. (254.0 mm) in diameter):

$Wa1 = (1/4\pi)(10.0)^2(0.00020)$

$Wa1 = 0.0160$ lbm (0.0073 kg)

b) Repair Item 2 - Filler Ply - CFRP, BMS 8-256, Type IV, Class 2, Style 3K-70-PW (5.0 in. (127.0 mm) in diameter):

$Wa2 = (1/4\pi)(5.0)^2(0.00046)$

$Wa2 = 0.0090$ lbm (0.0041 kg)

c) Repair Item 3 - Replacement Ply - CFRP, BMS 8-256, Type IV, Class 2, Style 3K-70-PW (6.0 in. (152.4 mm) in diameter):

$Wa3 = (1/4\pi)(6.0)^2(0.00046)$

$Wa3 = 0.0130$ lbm (0.0059 kg)

d) Repair Item 4 - Replacement Ply - CFRP, BMS 8-256, Type IV, Class 2, Style 3K-70-PW (7.0 in. (177.8 mm) in diameter):

$Wa4 = (1/4\pi)(7.0)^2(0.00046)$

$Wa4 = 0.0177$ lbm (0.0080 kg)

e) Repair Item 5 - Replacement Ply - CFRP, BMS 8-256, Type IV, Class 2, Style 3K-70-PW (8.0 in. (203.2 mm) in diameter):

$Wa5 = (1/4\pi)(8.0)^2(0.00046)$

$Wa5 = 0.0260$ lbm (0.0118 kg)

f) Repair Item 6 - Extra Repair Ply - CFRP, BMS 8-256, Type IV, Class 2, Style 3K-70-PW (9.0 in. (228.6 mm) in diameter):

$Wa6 = (1/4\pi)(9.0)^2(0.00046)$

$Wa6 = 0.0293$ lbm (0.0133 kg)

g) Repair Item 7 - Extra Repair Ply - CFRP, BMS 8-256, Type IV, Class 2, Style 3K-70-PW (10.0 in. (254.0 mm) in diameter):

$Wa7 = (1/4\pi)(10.0)^2(0.00046)$

Wa7 = 0.0361 lbm (0.0164 kg)

h) Repair Item 8 - Adhesive Film - BMS 8-245, Type II, Class 1, Grade 3A (11.0 in. (279.4 mm) in diameter):

$Wa8 = (1/4\pi)(11.0)^2(0.00020)$

Wa8 = 0.0190 lbm (0.0086 kg)

i) The total Weight Added (Wa):

Wa = Wa1 + Wa2 + Wa3 + Wa4 + Wa5 + Wa6 + Wa7 + Wa8

Wa = 0.0160 + 0.0090 + 0.0130 + 0.0177 + 0.0260 + 0.0293 + 0.0361 + 0.0190

Wa = 0.1661 lbm (0.0753 kg)

(6) Calculate the Rework Weight (RW). RW is the net change in weight as a result of rework, repair, or re-painting.

RW = Wa - Wr = 0.1661 - 0.0567

RW = 0.1094 lbm (0.0496 kg)

(7) Calculate the Rework Moment (RM). RM is the net change in balance moment as a result of rework, repair, or re-painting.

RM = (RW) x (Y)

RM = (0.1094) x (21.4) = +2.3 lbfin (+0.3 Nm)

(8) Calculate the trial Check Balance Moment (CBM). The trial CBM is the new final moment (Static Balance Hinge Moment) if it is within the given limits.

trial CBM = (SBHM) + (RM)

trial CBM = (+480.00) + (+2.3) = +482.3 lbfin (+54.5 Nm) where SBHM is the Static Balance Hinge Moment that is the previous final moment stamped on the nameplate of the rudder.

(9) With this trial CBM you can do one of the steps that follow:

(a) The trial CBM meets the secondary static balance requirement as given in Paragraph 2.F./GENERAL, so it is not necessary to install additional rudder balance adjust weights. In this case, the trial CBM is the new final moment Static Balance Hinge Moment. Continue with step 5.D.(10).

(b) To balance the rudder assembly to a desired balance moment between +418.2 and +540.0 lbfin (+47.25 and +61.01 Nm) by the addition of a sufficient number of rudder balance adjust weights, do as follows:

1) First, decide what the desired balance moment will be. In this example the desired balance moment is chosen to be +456.8 lbfin (+51.6 Nm) maximum. This means that we will aim for a final Static Balance Hinge Moment (SBHM) of +456.8 lbfin (+51.6 Nm).

2) Then, find the number of rudder balance adjust weights that are already installed. In this example the number is 14. This means that there are 34 positions left for additional weights.

3) Find the ΔM that must be added to the trial CBM to get the desired balance moment:

ΔM = desired balance moment - trial CBM

$\Delta M = (+456.8) - (+482.3) = -25.5$ lbfin (-2.9 Nm) maximum

4) In Rudder Assembly Balance Adjust Weight Table - Example 2, Figure 9/GENERAL, Table I move horizontally from left to right starting in the row of 14 existing adjust weights (point V). From this point, move to the right horizontally until you find the ΔM (point W) that you must add to your trial CBM to get the desired balance moment: with a maximum desired ΔM of -25.5 lbfin (-2.9 Nm) you must add 5 rudder balance adjust weight to get as close as possible to the desired balance moment (point X).

5) Remove the rudder adjust weights access covers.

   a) Remove the eight nuts that attach the access cover to the rudder balance arm assembly.

   b) Remove the access covers.

6) Install the 5 rudder balance adjust weights as given in Paragraph 5.B.(11)/GENERAL

7) Calculate the new Static Balance Hinge Moment (SBHM):

   new SBHM = trial CBM + ΔM

   new SBHM = (+482.3) + (-21.72)

   new SBHM = +460.6 lbfin (+52.0 Nm) Continue with step 5.D.(10).

(c) To balance the rudder assembly nearest the most forward component moment of +418.2 lbfin (+47.25 Nm) to account for future repairs, painting, or rework, do as follows:

1) Find the ΔM that must be added to the trial CBM to get the moment nearest the most forward component moment:

   ΔM = most forward component moment - trial CBM

   $\Delta M = (+418.2) - (+482.3) = -64.1$ lbfin (-7.2 Nm) maximum

2) In Rudder Assembly Balance Adjust Weight Table - Example 2, Figure 9/GENERAL, Table I move horizontally from left to right starting in the row of 14 existing adjust weights (point V). From this point, move to the right horizontally until you find the ΔM (point Y) that you must add to your trial CBM to get the most forward component moment: with a desired ΔM of -64.14 lbfin (-7.25 Nm) you must add 14 rudder balance adjust weights to get as close as possible to the most forward component moment (point Z).

   a) The addition of 14 adjust weights results in a ΔM of -60.08 lbfin (-6.79 Nm).

3) Remove the rudder adjust weights access covers.

   a) Remove the eight nuts that attach the access cover to the rudder balance arm assembly.

   b) Remove the access covers.

4) Install the 14 rudder balance adjust weights as given in Paragraph 5.B.(11)/GENERAL

5) Calculate the new Static Balance Hinge Moment (SBHM):

   new SBHM = first trial CBM + ΔM

   new SBHM = (+482.3) + (-60.08)

   new SBHM = +422.2 lbfin (+47.7 Nm) Continue with step 5.D.(10).

(10) Vibro-engrave or rubber-stamp the value of the new Static Balance Hinge Moment (SBHM) on the metal part identification plate (MS27253C2) that is attached to the rudder assembly.

(a) Apply a Skydrol resistant finish to the rubber-stamped data as given in SOPM 20-50-13.

(b) Do not stamp the installed metal nameplate with steel stamps.

(11) Make a record in the repair log of:

(a) The new Static Balance Hinge Moment (SBHM)

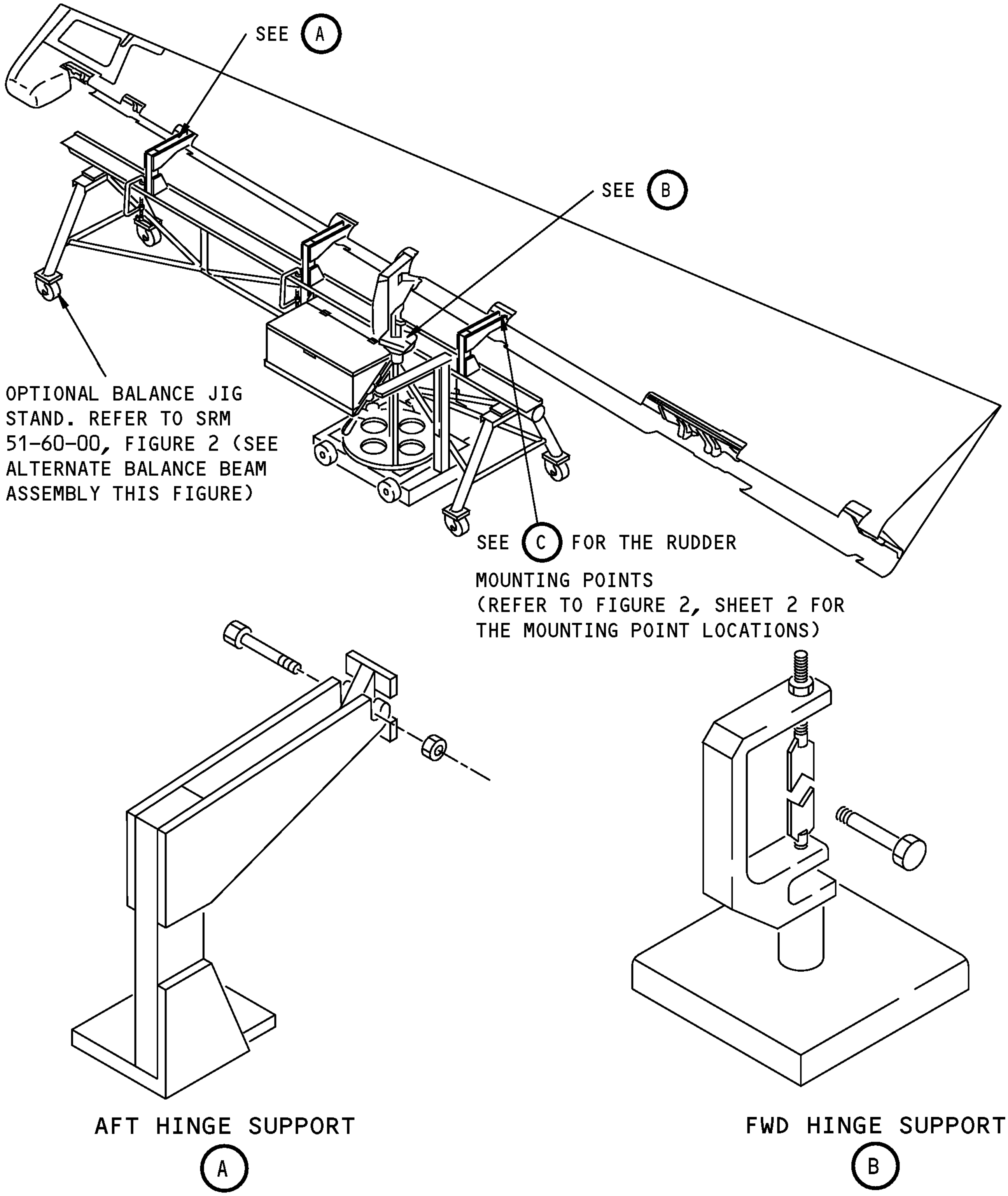
(b) The fact that the rudder has been balanced by calculation

(c) The type of repair

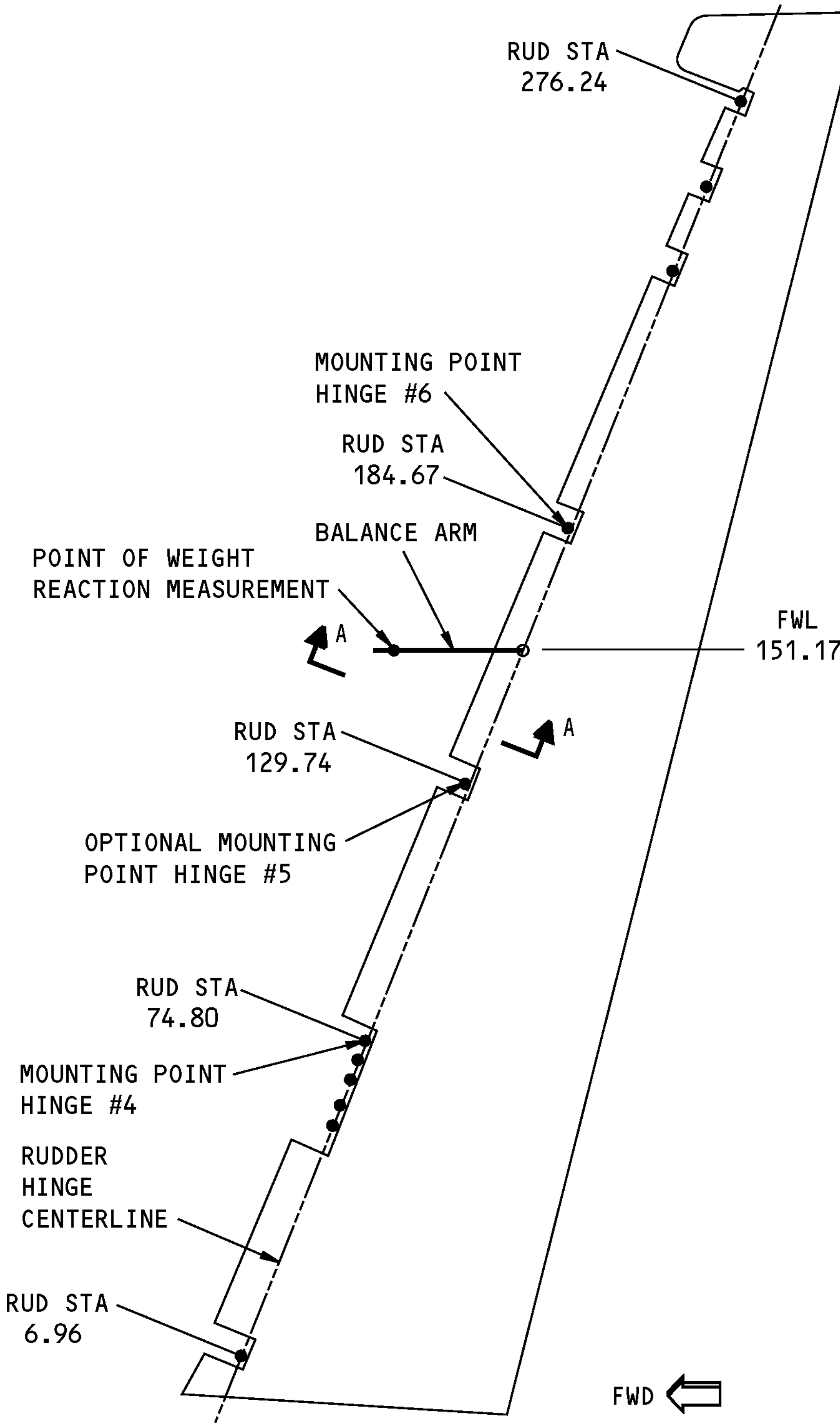
(d) The location of the repair

(e) The date when the rudder was repaired and balanced

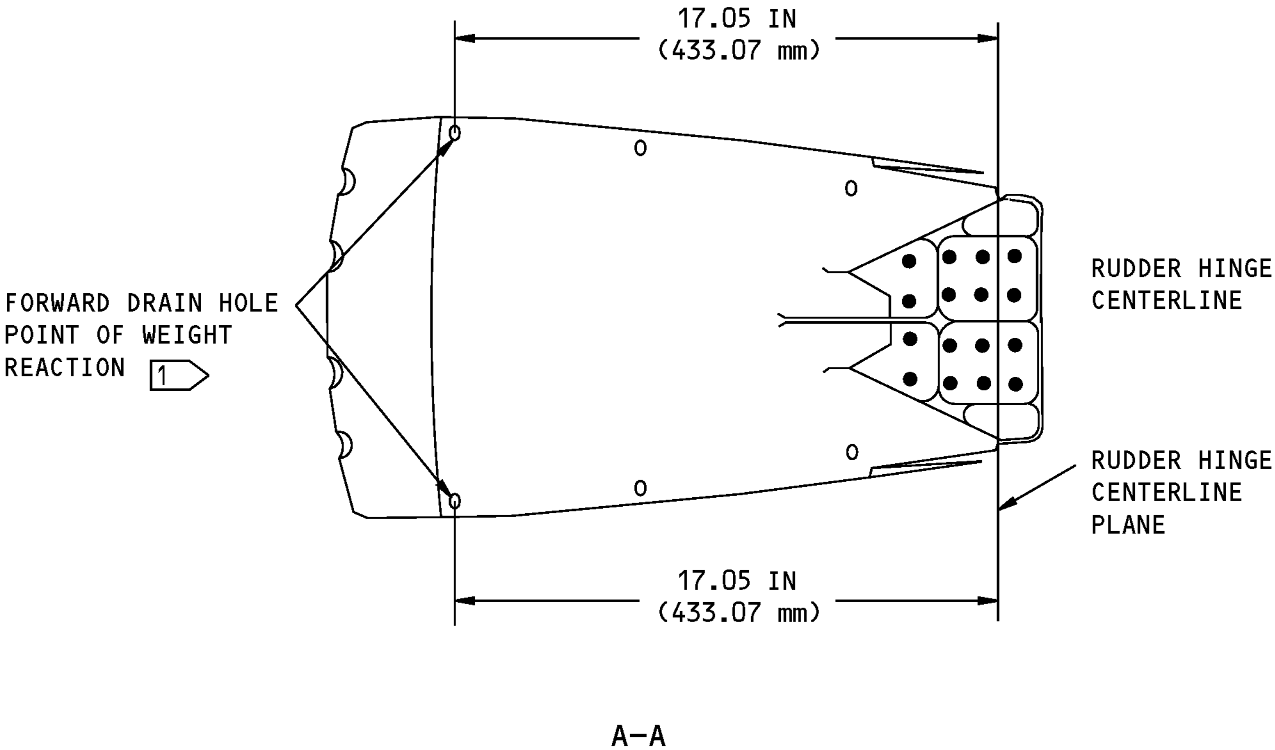
(f) The number of rudder balance adjust weights that are installed and the number of available spaces for the addition of weight.



Rudder Support and Balance at Time of the Balance Procedure on the Static Balance Jig
Figure 2 (Sheet 1 of 4)



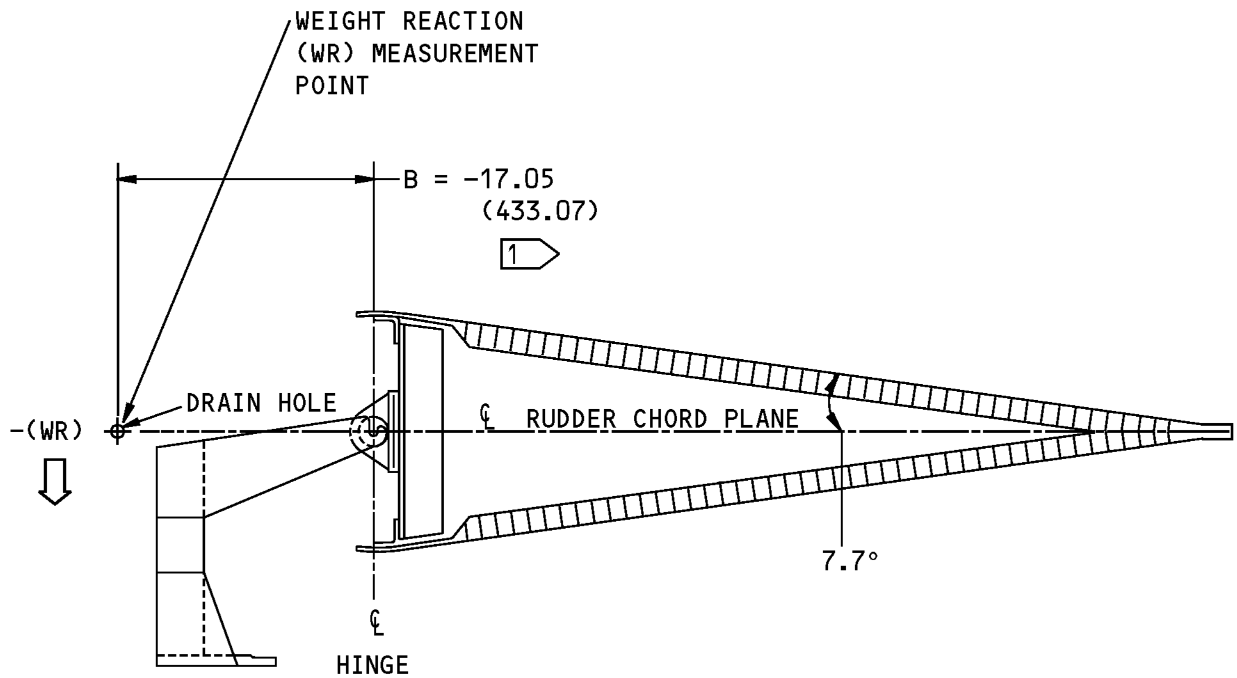
Rudder Support and Balance at Time of the Balance Procedure on the Static Balance Jig
Figure 2 (Sheet 2 of 4)



NOTES

1 WEIGHT REACTION MAY BE MEASURED AT EITHER OF THE FORWARD DRAIN HOLES.

Rudder Support and Balance at Time of the Balance Procedure on the Static Balance Jig
Figure 2 (Sheet 3 of 4)



NOTES

1 DIMENSION B IS MEASURED PERPENDICULAR TO THE HINGE CENTERLINE.

Rudder Support and Balance at Time of the Balance Procedure on the Static Balance Jig
Figure 2 (Sheet 4 of 4)

RUDDER ASSEMBLY 173A0100-(), 173A0103-()

TOTAL CHANGE IN MOMENT ΔM DUE TO ADDING (n) ADJUST WEIGHTS (lbf.in)

NUMBER OF 173A5300-1 ADJUST WEIGHTS (n) TO BE ADDED TO EXISTING WEIGHTS

NUMBER OF EXISTING WEIGHTS	1	2	3	4	5	6	7	8	9	10	11
0	4.53	9.06	13.56	18.06	22.54	27.02	31.48	35.94	40.37	44.80	49.21
1	4.53	9.03	13.53	18.01	22.49	26.95	31.41	35.84	40.27	44.68	49.09
2	4.50	9.00	13.48	17.96	22.42	26.88	31.31	35.74	40.15	44.56	48.95
3	4.50	8.98	13.46	17.92	22.38	26.81	31.24	35.65	40.06	44.45	48.84
4	4.48	8.96	13.42	17.88	22.31	26.74	31.15	35.56	39.95	44.34	48.70
5	4.48	8.94	13.40	17.83	22.26	26.67	31.08	35.47	39.86	44.22	48.58
6	4.46	8.92	13.35	17.78	22.19	26.60	30.99	35.38	39.74	44.10	48.44
7	4.46	8.89	13.32	17.73	22.14	26.53	30.92	35.28	39.64	43.98	48.32
8	4.43	8.86	13.27	17.68	22.07	26.46	30.82	35.18	39.52	43.86	48.18
9	4.43	8.84	13.25	17.64	22.03	26.39	30.75	35.09	39.43	43.75	48.07
10	4.41	8.82	13.21	17.60	21.96	26.32	30.66	35.00	39.32	43.64	47.93
11	4.41	8.80	13.19	17.55	21.91	26.25	30.59	34.91	39.23	43.52	47.81
12	4.39	8.78	13.14	17.50	21.84	26.18	30.50	34.82	39.11	43.40	47.67
13	4.39	8.75	13.11	17.45	21.79	26.11	30.43	34.72	39.01	43.28	47.55
14	4.36	8.72	13.06	17.40	21.72	26.04	30.33	34.62	38.89	43.16	47.40
15	4.36	8.70	13.04	17.36	21.68	25.97	30.26	34.53	38.80	43.04	47.28
16	4.34	8.68	13.00	17.32	21.61	25.90	30.17	34.44	38.68	42.92	47.14
17	4.34	8.66	12.98	17.27	21.56	25.83	30.10	34.34	38.58	42.80	47.02
18	4.32	8.64	12.93	17.22	21.49	25.76	30.00	34.24	38.46	42.68	46.88
19	4.32	8.61	12.90	17.17	21.44	25.68	29.92	34.14	38.36	42.56	46.76
20	4.29	8.58	12.85	17.12	21.36	25.60	29.82	34.04	38.24	42.44	46.61
21	4.29	8.56	12.83	17.07	21.31	25.53	29.75	33.95	38.15	42.32	46.49

FOR CONTINUATION SEE SHEETS 2 AND 6

TABLE I

Rudder Assembly Balance Adjust Weight Table
Figure 3 (Sheet 1 of 9)

RUDDER ASSEMBLY 173A0100-(), 173A0103-()

TOTAL CHANGE IN MOMENT ΔM DUE TO ADDING (n) ADJUST WEIGHTS (lbf.in)

NUMBER OF EXISTING WEIGHTS	NUMBER OF 173A5300-1 ADJUST WEIGHTS (n) TO BE ADDED TO EXISTING WEIGHTS										
	12	13	14	15	16	17	18	19	20	21	22
0	53.62	58.01	62.40	66.76	71.12	75.46	79.80	84.12	88.44	92.73	97.02
1	53.48	57.87	62.23	66.59	70.93	75.27	79.59	83.91	88.20	92.49	96.76
2	53.34	57.70	62.06	66.40	70.74	75.06	79.38	83.67	87.96	92.23	96.50
3	53.20	57.56	61.90	66.24	70.56	74.88	79.17	83.46	87.73	92.00	96.24
4	53.06	57.40	61.74	66.06	70.38	74.67	78.96	83.23	87.50	91.74	95.98
5	52.92	57.26	61.58	65.90	70.19	74.48	78.75	83.02	87.26	91.50	95.72
6	52.78	57.10	61.42	65.71	70.00	74.27	78.54	82.78	87.02	91.24	95.46
7	52.64	56.96	61.25	65.54	69.81	74.08	78.32	82.56	86.78	91.00	95.20
8	52.50	56.79	61.08	65.35	69.62	73.86	78.10	82.32	86.54	90.74	94.94
9	52.36	56.65	60.92	65.19	69.43	73.67	77.89	82.11	86.31	90.51	94.68
10	52.22	56.49	60.76	65.00	69.24	73.46	77.68	81.88	86.08	90.25	94.42
11	52.08	56.35	60.59	64.83	69.05	73.27	77.47	81.67	85.84	90.01	94.16
12	51.94	56.18	60.42	64.64	68.86	73.06	77.26	81.43	85.60	89.75	93.90
13	51.79	56.03	60.25	64.47	68.67	72.87	77.04	81.21	85.36	89.51	93.64
14	51.64	55.86	60.08	64.28	68.48	72.65	76.82	80.97	85.12	89.25	93.38
15	51.50	55.72	59.92	64.12	68.29	72.46	76.61	80.76	84.89	89.02	93.12
16	51.36	55.56	59.76	63.93	68.10	72.25	76.40	80.53	84.66	88.76	92.86
17	51.22	55.42	59.59	63.76	67.91	72.06	76.19	80.32	84.42	88.52	92.60
18	51.08	55.25	59.42	63.57	67.72	71.85	75.98	80.08	84.18	88.26	92.34
19	50.93	55.10	59.25	63.40	67.53	71.66	75.76	79.86	83.94	88.02	92.08
20	50.78	54.93	59.08	63.21	67.34	71.44	75.54	79.62	83.70	87.76	91.82
21	50.64	54.79	58.92	63.05	67.15	71.25	75.33	79.41	83.47	87.53	91.56

FOR CONTINUATION
SEE SHEETS 3 AND 7

TABLE I

Rudder Assembly Balance Adjust Weight Table
Figure 3 (Sheet 2 of 9)

NUMBER OF EXISTING WEIGHTS	RUDDER ASSEMBLY 173A0100-(), 173A0103-() — TOTAL CHANGE IN MOMENT ΔM DUE TO ADDING (n) ADJUST WEIGHTS (lbf.in) — NUMBER OF 173A5300-1 ADJUST WEIGHTS (n) TO BE ADDED TO EXISTING WEIGHTS										
	23	24	25	26	27	28	29	30	31	32	33
0	101.29	105.56	109.80	114.04	118.26	122.48	126.68	130.88	135.05	139.22	143.37
1	101.03	105.27	109.51	113.73	117.95	122.15	126.35	130.52	134.69	138.84	142.99
2	100.74	104.98	109.20	113.42	117.62	121.82	125.99	130.16	134.31	138.46	142.59
3	100.48	104.70	108.92	113.12	117.32	121.49	125.66	129.81	133.96	138.09	142.22
4	100.20	104.42	108.62	112.82	116.99	121.16	125.31	129.46	133.59	137.72	141.82
5	99.94	104.14	108.34	112.51	116.68	120.83	124.98	129.11	133.24	137.34	141.44
6	99.66	103.86	108.03	112.20	116.35	120.50	124.63	128.76	132.86	136.96	141.04
7	99.40	103.57	107.74	111.89	116.04	120.17	124.30	128.40	132.50	136.58	140.66
8	99.11	103.28	107.43	111.58	115.71	119.84	123.94	128.04	132.12	136.20	140.26
9	98.85	103.00	107.15	111.28	115.41	119.51	123.61	127.69	131.77	135.83	139.89
10	98.57	102.72	106.85	110.98	115.08	119.18	123.26	127.34	131.40	135.46	139.49
11	98.31	102.44	106.57	110.67	114.77	118.85	122.93	126.99	131.05	135.08	139.11
12	98.03	102.16	106.26	110.36	114.44	118.52	122.58	126.64	130.67	134.70	138.71
13	97.77	101.87	105.97	110.05	114.13	118.19	122.25	126.28	130.31	134.32	138.33
14	97.48	101.58	105.66	109.74	113.80	117.86	121.89	125.92	129.93	133.94	137.93
15	97.22	101.30	105.38	109.44	113.50	117.53	121.56	125.57	129.58	133.57	137.56
16	96.94	101.02	105.08	109.14	113.17	117.20	121.21	125.22	129.21	133.20	
17	96.68	100.74	104.80	108.83	112.86	116.87	120.88	124.87	128.86		
18	96.40	100.46	104.49	108.52	112.53	116.54	120.53	124.52			
19	96.14	100.17	104.20	108.21	112.22	116.21	120.20				
20	95.85	99.88	103.89	107.90	111.89	115.88					
21	95.59	99.60	103.61	107.60	111.59						

FOR CONTINUATION SEE SHEETS 4 AND 8

TABLE I

Rudder Assembly Balance Adjust Weight Table
Figure 3 (Sheet 3 of 9)

RUDDER ASSEMBLY 173A0100-(), 173A0103-()

TOTAL CHANGE IN MOMENT ΔM DUE TO ADDING (n) ADJUST WEIGHTS (lbf.in)

NUMBER OF 173A5300-1 ADJUST WEIGHTS (n) TO BE ADDED TO EXISTING WEIGHTS

NUMBER OF EXISTING WEIGHTS	34	35	36	37	38	39	40	41	42	43	44
0	147.52	151.65	155.78	159.88	163.98	168.06	172.14	176.20	180.26	184.29	188.32
1	147.12	151.25	155.35	159.45	163.53	167.61	171.67	175.73	179.76	183.79	187.80
2	146.72	150.82	154.92	159.00	163.08	167.14	171.20	175.23	179.26	183.27	187.28
3	146.32	150.42	154.50	158.58	162.64	166.70	170.73	174.76	178.77	182.78	186.77
4	145.92	150.00	154.08	158.14	162.20	166.23	170.26	174.27	178.28	182.27	186.26
5	145.52	149.60	153.66	157.72	161.75	165.78	169.79	173.80	177.79	181.78	
6	145.12	149.18	153.24	157.27	161.30	165.31	169.32	173.31	177.30		
7	144.72	148.78	152.81	156.84	160.85	164.86	168.85	172.84			
8	144.32	148.35	152.38	156.39	160.40	164.39	168.38				
9	143.92	147.95	151.96	155.97	159.96	163.95					
10	143.52	147.53	151.54	155.53	159.52						
11	143.12	147.13	151.12	155.11							
12	142.72	146.71	150.70								
13	142.32	146.31									
14	141.92										

FOR CONTINUATION SEE SHEET 5

TABLE I

Rudder Assembly Balance Adjust Weight Table
Figure 3 (Sheet 4 of 9)

RUDDER ASSEMBLY 173A0100-(), 173A0103-()

TOTAL CHANGE IN MOMENT ΔM DUE TO ADDING (n) ADJUST WEIGHTS (lbf.in)

NUMBER OF EXISTING WEIGHTS	NUMBER OF 173A5300-1 ADJUST WEIGHTS (n) TO BE ADDED TO EXISTING WEIGHTS										
	45	46	47	48							
0	192.33	196.34	200.33	204.32							
1	191.81	195.80	199.79								
2	191.27	195.26									
3	190.76										

TABLE I

NOTES

- ALL MOMENT INCREMENTS (ΔM) ARE NEGATIVE.
- REFER TO FIGURE 4 FOR THE LOCATION WHERE THE RUDDER BALANCE ADJUST WEIGHTS MUST BE INSTALLED.
- TO CONVERT FROM lbf.in TO Nm MULTIPLY BY 0.1129848.

Rudder Assembly Balance Adjust Weight Table
Figure 3 (Sheet 5 of 9)

NUMBER OF EXISTING WEIGHTS	RUDDER ASSEMBLY 173A0100-(), 173A0103-() TOTAL CHANGE IN MOMENT ΔM DUE TO ADDING (n) ADJUST WEIGHTS (lbf.in) NUMBER OF 173A5300-1 ADJUST WEIGHTS (n) TO BE ADDED TO EXISTING WEIGHTS										
	1	2	3	4	5	6	7	8	9	10	11
22	4.27	8.54	12.78	17.02	21.24	25.46	29.66	33.86	38.03	42.20	46.35
23	4.27	8.51	12.75	16.97	21.19	25.39	29.59	33.76	37.93	42.08	46.23
24	4.24	8.48	12.70	16.92	21.12	25.32	29.49	33.66	37.81	41.96	46.09
25	4.24	8.46	12.68	16.88	21.08	25.25	29.42	33.57	37.72	41.85	45.98
26	4.22	8.44	12.64	16.84	21.01	25.18	29.33	33.48	37.61	41.74	45.84
27	4.22	8.42	12.62	16.79	20.96	25.11	29.26	33.39	37.52	41.62	45.72
28	4.20	8.40	12.57	16.74	20.89	25.04	29.17	33.30	37.40	41.50	45.58
29	4.20	8.37	12.54	16.69	20.84	24.97	29.10	33.20	37.30	41.38	45.46
30	4.17	8.34	12.49	16.64	20.77	24.90	29.00	33.10	37.18	41.26	45.32
31	4.17	8.32	12.47	16.60	20.73	24.83	28.93	33.01	37.09	41.15	45.21
32	4.15	8.30	12.43	16.56	20.66	24.76	28.84	32.92	36.98	41.04	45.07
33	4.15	8.28	12.41	16.51	20.61	24.69	28.77	32.83	36.89	40.92	44.95
34	4.13	8.26	12.36	16.46	20.54	24.62	28.68	32.74	36.77	40.80	44.81
35	4.13	8.23	12.33	16.41	20.49	24.55	28.61	32.64	36.67	40.68	44.69
36	4.10	8.20	12.28	16.36	20.42	24.48	28.51	32.54	36.55	40.56	44.55
37	4.10	8.18	12.26	16.32	20.38	24.41	28.44	32.45	36.46	40.45	44.44
38	4.08	8.16	12.22	16.28	20.31	24.34	28.35	32.36	36.35	40.34	
39	4.08	8.14	12.20	16.23	20.26	24.27	28.28	32.27	36.26		
40	4.06	8.12	12.15	16.18	20.19	24.20	28.19	32.18			
41	4.06	8.09	12.12	16.13	20.14	24.13	28.12				
42	4.03	8.06	12.07	16.08	20.07	24.06					
43	4.03	8.04	12.05	16.04	20.03						

FOR CONTINUATION SEE SHEETS 7 AND 9

TABLE I

Rudder Assembly Balance Adjust Weight Table
Figure 3 (Sheet 6 of 9)

RUDDER ASSEMBLY 173A0100-(), 173A0103-()

TOTAL CHANGE IN MOMENT ΔM DUE TO ADDING (n) ADJUST WEIGHTS (lbf.in)

NUMBER OF EXISTING WEIGHTS	NUMBER OF 173A5300-1 ADJUST WEIGHTS (n) TO BE ADDED TO EXISTING WEIGHTS										
	12	13	14	15	16	17	18	19	20	21	22
22	50.50	54.63	58.76	62.86	66.96	71.04	75.12	79.18	83.24	87.27	91.30
23	50.36	54.49	58.59	62.69	66.77	70.85	74.91	78.97	83.00	87.03	91.04
24	50.22	54.32	58.42	62.50	66.58	70.64	74.70	78.73	82.76	86.77	90.78
25	50.08	54.18	58.26	62.34	66.40	70.46	74.49	78.52	82.53	86.54	90.53
26	49.94	54.02	58.10	62.16	66.22	70.25	74.28	78.29	82.30	86.29	90.28
27	49.80	53.88	57.94	62.00	66.03	70.06	74.07	78.08	82.07	86.06	
28	49.66	53.72	57.78	61.81	65.84	69.85	73.86	77.85	81.84		
29	49.52	53.58	57.61	61.64	65.65	69.66	73.65	77.64			
30	49.38	53.41	57.44	61.45	65.46	69.45	73.44				
31	49.24	53.27	57.28	61.29	65.28	69.27					
32	49.10	53.11	57.12	61.11	65.10						
33	48.96	52.97	56.96	60.95							
34	48.82	52.81	56.80								
35	48.68	52.67									
36	48.54										

FOR CONTINUATION SEE SHEET 8

TABLE I

Rudder Assembly Balance Adjust Weight Table
Figure 3 (Sheet 7 of 9)

NUMBER OF EXISTING WEIGHTS	RUDDER ASSEMBLY 173A0100-(), 173A0103-()										
	TOTAL CHANGE IN MOMENT ΔM DUE TO ADDING (n) ADJUST WEIGHTS (lbf.in)										
	NUMBER OF 173A5300-1 ADJUST WEIGHTS (n) TO BE ADDED TO EXISTING WEIGHTS										
	23	24	25	26	27	28	29	30	31	32	33
22	95.31	99.32	103.31	107.30							
23	95.05	99.04	103.03								
24	94.77	98.76									
25	94.52										

TABLE I

Rudder Assembly Balance Adjust Weight Table
Figure 3 (Sheet 8 of 9)

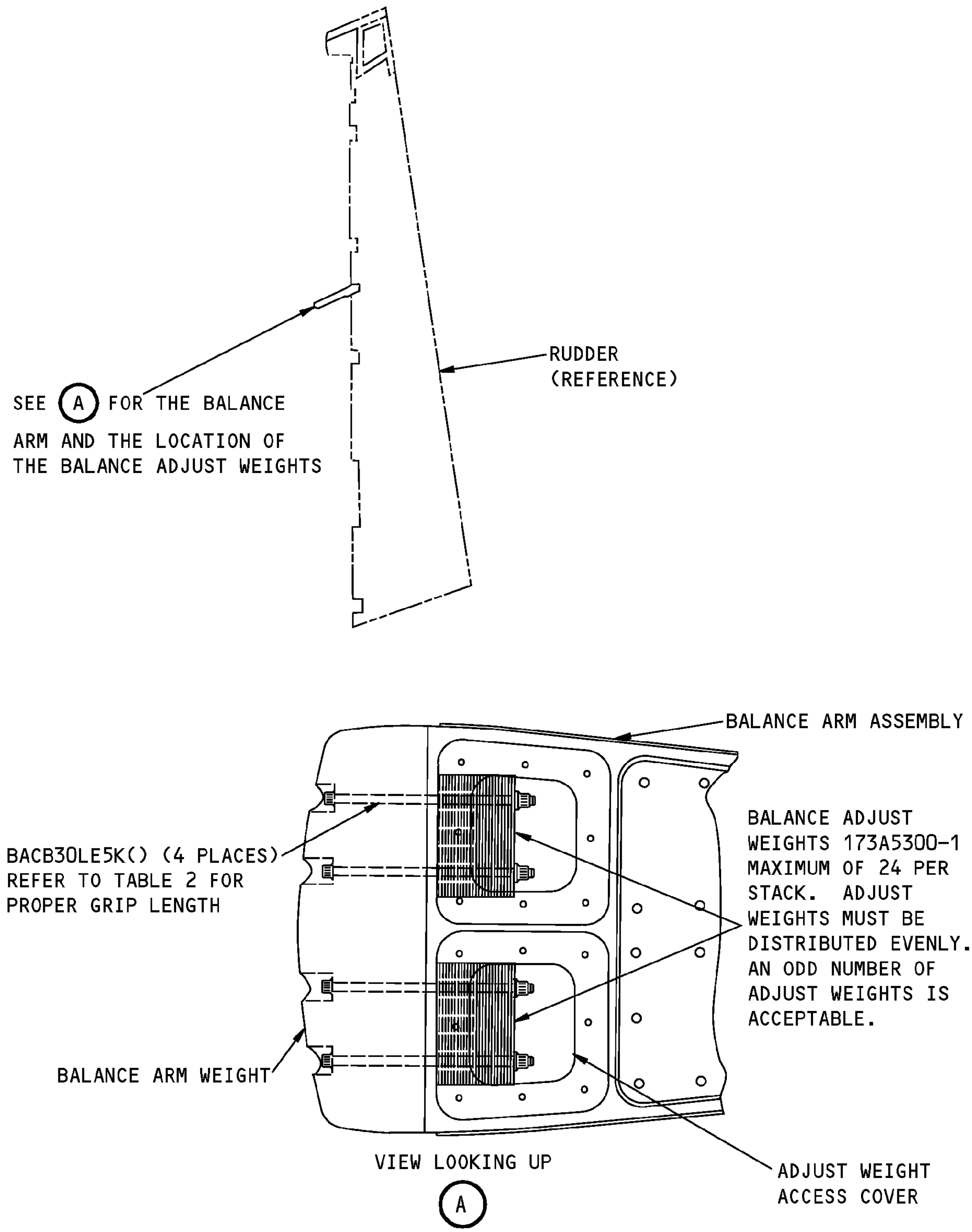
RUDDER ASSEMBLY 173A0100-(), 173A0103-()

TOTAL CHANGE IN MOMENT ΔM DUE TO ADDING (n) ADJUST WEIGHTS (lbf.in)

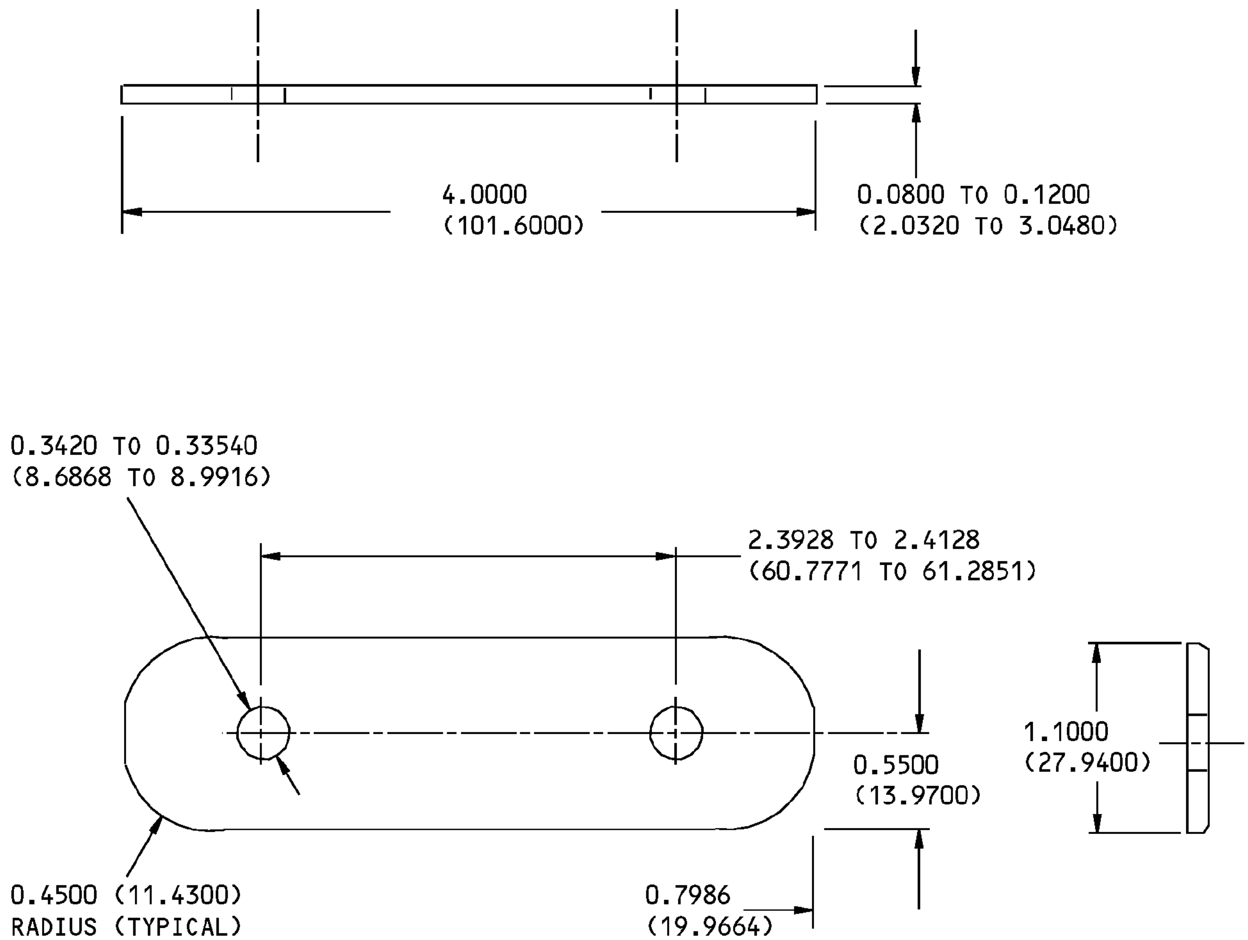
NUMBER OF EXISTING WEIGHTS	NUMBER OF 173A5300-1 ADJUST WEIGHTS (n) TO BE ADDED TO EXISTING WEIGHTS										
	1	2	3	4	5	6	7	8	9	10	11
44	4.01	8.02	12.01	16.00							
45	4.01	8.00	11.99								
46	3.99	7.98									
47	3.99										

TABLE I

Rudder Assembly Balance Adjust Weight Table
Figure 3 (Sheet 9 of 9)



Rudder Assembly Balance Adjust Weight Location
Figure 4



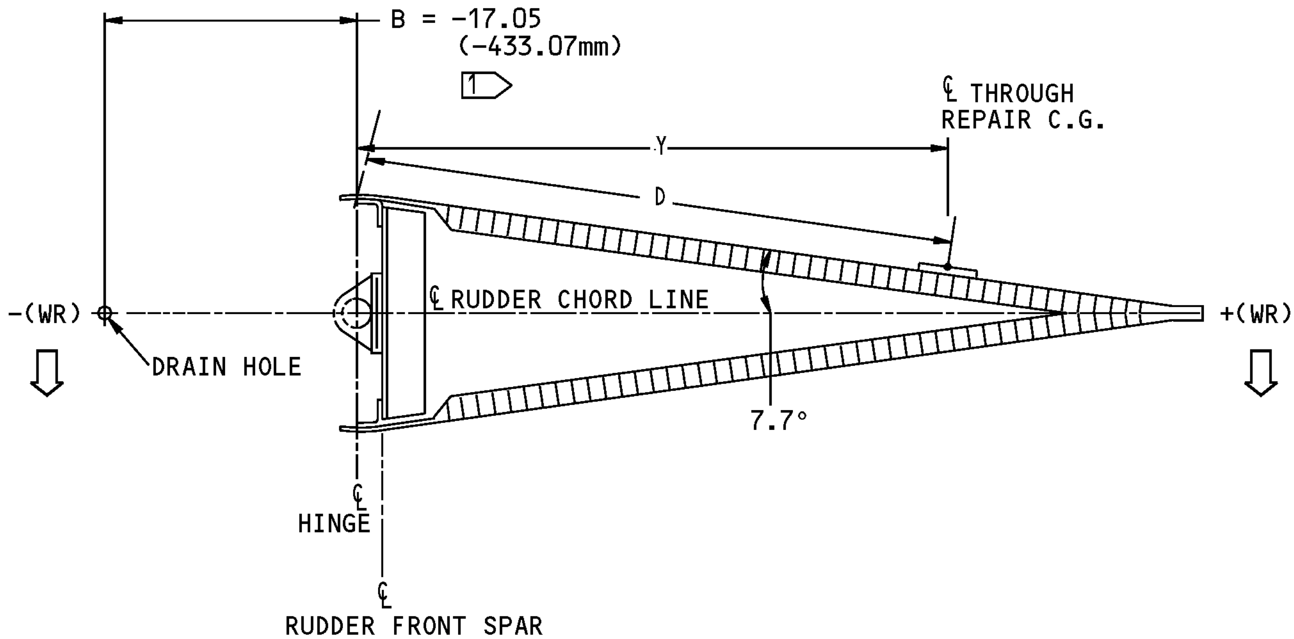
RUDDER BALANCE ADJUST WEIGHT - PART NUMBER 173A5300-1

A

NOTES

- ALL DIMENSIONS ARE IN INCHES (mm).
- MATERIAL: TUNGSTEN ALLOY AS GIVEN IN MIL-T-21014, SINTERED CLASS 1.
- ALL SINTERED SURFACES MUST BE 250 R_a OR SMOOTHER.
- ALL MACHINED SURFACES MUST BE 125 R_a OR SMOOTHER.
- DRY ABRASIVE BLAST (REFER TO SOPM 20-30-03) AND APPLY TWO COATS OF BMS 10-79, TYPE III PRIMER AS GIVEN IN SOPM 20-44-04.
- THE FINISHED PART MUST HAVE A WEIGHT OF 0.22 TO 0.28 POUND (0.0998 TO 0.1270 kilogram).

Rudder Balance Adjust Weight
Figure 5



NOTES

[1] DIMENSION B IS MEASURED PERPENDICULAR TO THE HINGE CENTERLINE.

Rudder Balance at Time of the Balance Procedure by Calculation
Figure 6

NUMBER OF EXISTING WEIGHTS	RUDDER ASSEMBLY 173A0100-(), 173A0103-()										
	TOTAL CHANGE IN MOMENT ΔM (UPPER) DUE TO ADDING (n) ADJUST WEIGHTS (lbf.in)										
	NUMBER OF 173A5300-1 ADJUST WEIGHTS (n) TO BE ADDED TO EXISTING WEIGHTS										
	1	2	3	4	5	6	7	8	9	10	11
0	4.53	9.06	13.56	18.06	22.54	27.02		35.94	40.37	44.80	49.21
1	4.53	9.03	13.53	18.01	22.49	26.95		C	40.27	44.68	49.09
2	4.50	9.00	13.48	17.96	22.42	26.88			40.15	44.56	48.95
3	4.50	8.98	13.46	17.92	22.38	26.81		35.65	40.06	44.45	48.84
4	4.48	8.96	13.42	17.88	22.31	26.74		35.56	39.95	44.34	48.70
5	4.48	8.94	13.40	17.83	22.26	26.67		35.47	39.86	44.22	48.58
6	4.46	8.92	13.35	17.78	22.19	26.60		35.38	39.74	44.10	48.44
7	4.46	8.89	13.32	17.73	22.14	26.53		35.28	39.64	43.98	48.32
8	4.43	8.86	13.27	17.68	22.07	26.46		35.18	39.52	43.86	48.18
9	4.43	8.84	13.25	17.64	22.03	26.39		35.09	39.43	43.75	48.07
10	4.41	8.82	13.21	17.60	21.96	26.32		35.00	39.32	43.64	47.93
11	4.41	8.80	13.19	17.55	21.91	26.25		34.91	39.23	43.52	47.81
12	4.39	8.78	13.14	17.50	21.84	26.18		34.82	39.11	43.40	47.67
13	4.39	8.75	13.11	17.45	21.79	26.11		34.72	39.01	43.28	47.55
14	4.36	8.72	13.06	17.40	21.72	26.04		34.62	38.89	43.16	47.40
15	4.36	8.70	13.04	17.36	21.68	25.97		34.53	38.80	43.04	47.28
16	4.34	8.68	13.00	17.32	21.61	25.90		34.44	38.68	49.92	47.14
17	4.34	8.66	12.98	17.27	21.56	25.83		34.34	38.58	42.80	47.02
18	4.32	8.64	12.93	17.22	21.49	25.76	30.00	34.24	38.46	42.68	46.88
A		8.61	12.90	17.17	21.44		B	34.14	38.36	42.56	46.76
	4.29		12.85	17.12	21.36			34.04	38.24	42.44	46.61
	4.29	8.56				25.53	29.75	33.95	38.15	42.32	46.49

FOR CONTINUATION SEE SHEET 2

TABLE I

Rudder Assembly Balance Adjust Weight Table - Example 1
Figure 7 (Sheet 1 of 3)

NUMBER OF EXISTING WEIGHTS	RUDDER ASSEMBLY 173A0100-(), 173A0103-() TOTAL CHANGE IN MOMENT ΔM (UPPER) DUE TO ADDING (n) ADJUST WEIGHTS (lbf.in) NUMBER OF 173A5300-1 ADJUST WEIGHTS (n) TO BE ADDED TO EXISTING WEIGHTS										
	12	13	14	15	16	17	18	19	20	21	22
0	53.62	58.01	62.40	66.76	71.12	75.46	79.80	84.12	88.44	92.73	97.02
1	53.48	57.87	62.23	66.59	70.93	75.27	79.59	83.91	88.20	92.49	96.76
2	53.34	57.70	62.06	66.40	70.74	75.06	79.38	83.67	87.96	92.23	96.50
3	53.20	57.56	61.90	66.24	70.56	74.88	79.17	83.46	87.73	92.00	96.24
4	53.06	57.40	61.74	66.06	70.38	74.67	78.96	83.23	87.50	91.74	95.98
5	52.92	57.26	61.58	65.90	70.19	74.48	78.75	83.02	87.26	91.50	95.72
6	52.78	57.10	61.42	65.71	70.00	74.27	78.54	82.78	87.02	91.24	95.46
7	52.64	56.96	61.25	65.54	69.81	74.08	78.32	82.56	86.78	91.00	95.20
8	52.50	56.79	61.08	65.35	69.62	73.86	78.10	82.32	86.54	90.74	94.94
9	52.36	56.65	60.92	65.19	69.43	73.67	77.89	82.11	86.31	90.51	94.68
10	52.22	56.49	60.76	65.00	69.24	73.46	77.68	81.88	86.08	90.25	94.42
11	52.08	56.35	60.59	64.83	69.05	73.27	77.47	81.67	85.84	90.01	94.16
12	51.94	56.18	60.42	64.64	68.86	73.06	77.26	81.43	85.60	89.75	93.90
13	51.79	56.03	60.25	64.47	68.67	72.87	77.04	81.21	85.36	89.51	93.64
14	51.64	55.86	61.08	64.28	68.48	72.65	76.82	80.97	85.12	89.25	93.38
15	51.50	55.72	59.92	64.12	68.29	72.46	76.61	80.76	84.89	89.02	93.12
16	51.36	55.56	59.76	63.93	68.10	72.25	76.40	80.53	84.66	88.76	92.86
17	51.22	55.42	59.59	63.76	67.91	72.06	76.19	80.32	84.42	88.52	92.60
18											
19	50.93	55.10	59.25	63.40	67.53	71.66	75.76	79.86	83.94	88.02	92.08
20	50.78	54.93	59.08	63.21	67.34	71.44	75.54	79.62	83.70	87.76	91.82
21	50.64	54.79	58.92	63.05	67.15	71.25	75.33	79.41	83.47	87.53	91.56

FOR CONTINUATION SEE SHEET 3

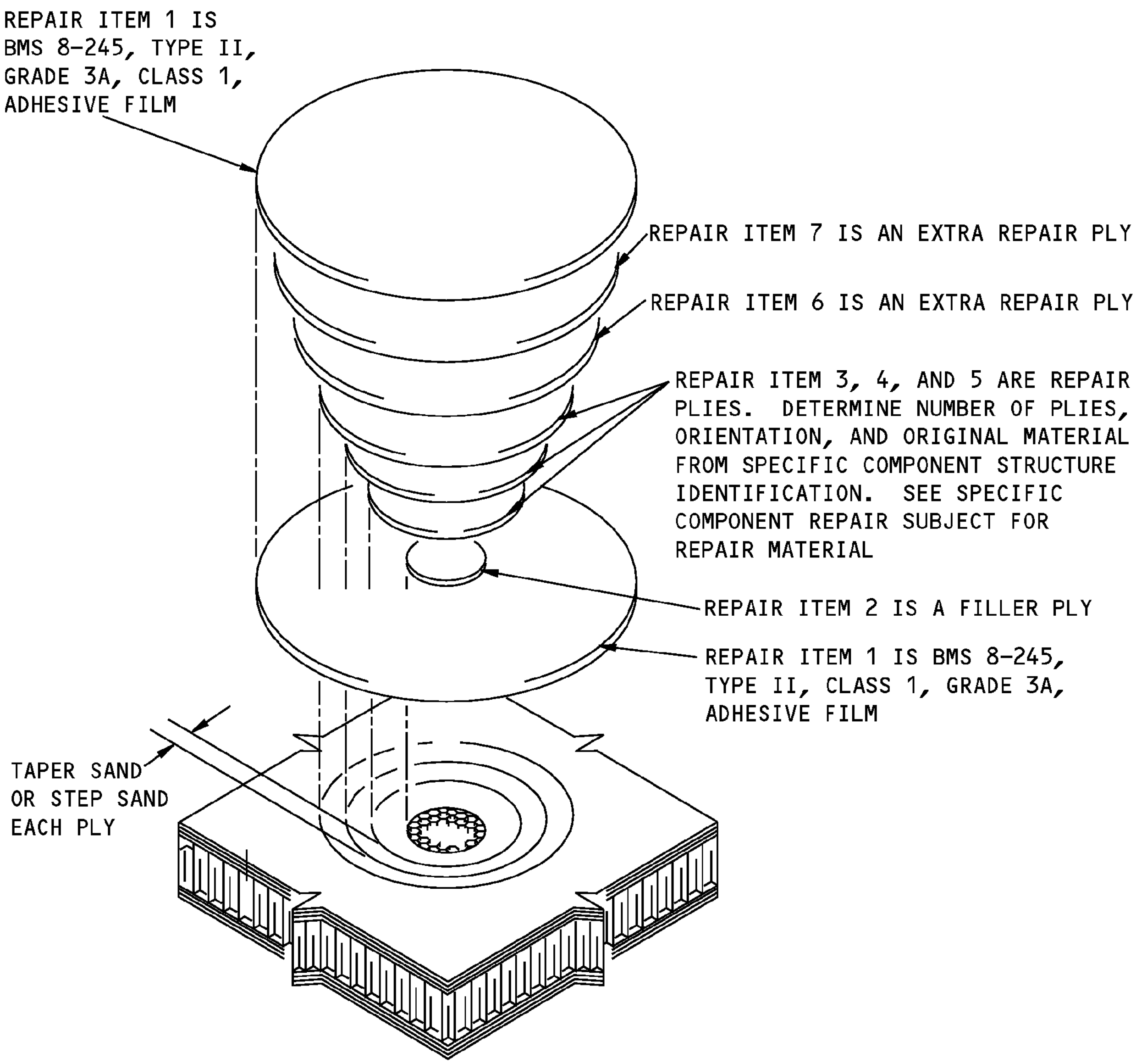
TABLE I

Rudder Assembly Balance Adjust Weight Table - Example 1
Figure 7 (Sheet 2 of 3)

NUMBER OF EXISTING WEIGHTS	RUDDER ASSEMBLY 173A0100-(), 173A0103-() TOTAL CHANGE IN MOMENT ΔM (UPPER) DUE TO ADDING (n) ADJUST WEIGHTS (lbf.in) NUMBER OF 173A5300-1 ADJUST WEIGHTS (n) TO BE ADDED TO EXISTING WEIGHTS						E				
	23	24	25	26	27	28	29	30	31	32	33
0	101.29	105.56	109.80	114.04	118.26	122.48			135.05	139.22	143.37
1	101.03	105.27	109.51	113.73	117.95	122.15		130.52	134.69	138.84	142.99
2	100.74	104.98	109.20	113.42	117.62	121.82		130.16	134.31	138.46	142.59
3	100.48	104.70	108.92	113.12	117.32	121.49		129.81	133.96	138.09	142.22
4	100.20	104.42	108.62	112.82	116.99	121.16		129.46	133.59	137.72	141.82
5	99.94	104.14	108.34	112.51	116.68	120.83		129.11	133.24	137.34	141.44
6	99.66	103.86	108.03	112.20	116.35	120.50		128.76	132.86	136.96	141.04
7	99.40	103.57	107.74	111.89	116.04	120.17		128.40	132.50	136.58	140.66
8	99.11	103.28	107.43	111.58	115.71	119.84		128.04	132.12	136.20	140.26
9	98.85	103.00	107.15	111.28	115.41	119.51		127.69	131.77	135.83	139.89
10	98.57	102.72	106.85	110.98	115.08	119.18		127.34	131.40	135.46	139.49
11	98.31	102.44	106.57	110.67	114.77	118.85		126.99	131.05	135.08	139.11
12	98.03	102.16	106.26	110.36	114.44	118.52		126.64	130.67	134.70	138.71
13	97.77	101.87	105.97	110.05	114.13	118.19		126.28	130.31	134.32	138.33
14	97.48	101.58	105.66	109.74	113.80	117.86		125.92	129.93	133.94	137.93
A	97.22	101.30	105.38	109.44	113.50	117.53		125.57	129.58	133.57	137.56
	96.94	101.02	105.08	109.14	113.17	117.20		125.22	129.21	133.20	
	96.98	100.74	104.80	108.83	112.86	116.87	121.21		128.86		
18								124.52			
19	96.14	100.17	104.20	108.21	112.22	116.21	120.53				
20	95.85	99.88	103.89	107.90	111.89	115.88	120.20				
21	95.59	99.60	103.61	107.60	111.59			D			

TABLE I

Rudder Assembly Balance Adjust Weight Table - Example 1
Figure 7 (Sheet 3 of 3)



NOTES

- REPAIR ITEMS 1, 2, 6, 7, AND 8 ARE EXTRA MATERIALS AND ADD WEIGHT TO THE REPAIR AREA ABOVE THAT WHICH WAS REMOVED AND IS BEING REPLACED.
- REPAIR ITEMS 3, 4, AND 5 ARE REPLACING ORIGINAL PLIES OF APPROXIMATELY THE SAME AREA BUT OF DIFFERENT WEIGHT PER UNIT AREA.

Repair (TYP) - Repair of Damage to One Skin of Honeycomb Panel-Example 2
Figure 8

X

NUMBER OF EXISTING WEIGHTS	RUDDER ASSEMBLY 173A0100-(), 173A0103-() TOTAL CHANGE IN MOMENT ΔM DUE TO ADDING (n) ADJUST WEIGHTS (lbf.in) NUMBER OF 173A5300-1 ADJUST WEIGHTS (n) TO BE ADDED TO EXISTING WEIGHTS									
	1	2	3	4	5	6	7	8	9	10	11
0	4.53	9.06	13.56	18.06		27.02	31.48	35.94	40.37	44.80	49.21
1	4.53	9.03	13.53	18.01		26.95	31.41	35.84	40.27	44.68	49.09
2	4.50	9.00	13.48	17.96		26.88	31.31	35.74	40.15	44.56	48.95
3	4.50	8.98	13.46	17.92		26.81	31.24	35.65	40.06	44.45	48.84
4	4.48	8.96	13.42	17.88		26.74	31.15	35.56	39.95	44.34	48.70
5	4.48	8.94	13.40	17.83		26.67	31.08	35.47	39.86	44.22	48.58
6	4.46	8.92	13.35	17.78		26.60	30.99	35.38	39.74	44.10	48.44
7	4.46	8.89	13.32	17.73		26.53	30.92	35.28	39.64	43.98	48.32
8	4.43	8.86	13.27	17.68		26.46	30.82	35.18	39.52	43.86	48.18
9	4.43	8.84	13.25	17.64		26.39	30.75	35.09	39.43	43.75	48.07
10	4.41	8.82	13.21	17.60		26.32	30.66	35.00	39.32	43.64	47.93
11	4.41	8.80	13.19	17.55		26.25	30.59	34.91	39.23	43.52	47.81
12	4.39	8.78	13.14	17.50		26.18	30.50	34.82	39.11	43.40	47.67
13	4.39	8.75	13.11	17.45		26.11	30.43	34.72	39.01	43.28	47.55
14					21.72	26.04	30.33	34.62	38.89	43.16	47.40
	4.36	8.70	13.04	17.36		25.97	30.26	34.53	38.80	43.04	47.28
V	4.34	8.68	13.00	17.32	W	25.90	30.17	34.44	38.68	42.92	47.14
	4.34	8.66	12.98	17.27		25.83	30.10	34.34	38.58	42.80	47.02
18	4.32	8.64	12.93	17.22	21.49	25.76	30.00	34.24	38.46	42.68	46.88
19	4.32	8.61	12.90	17.17	21.44	25.68	29.92	34.14	38.36	42.56	46.76
20	4.29	8.58	12.85	17.12	21.36	25.60	29.82	34.04	38.24	42.44	46.61
21	4.29	8.56	12.83	17.07	21.31	25.53	29.75	33.95	38.15	42.32	46.49

FOR CONTINUATION SEE SHEET 2

TABLE I

Rudder Assembly Balance Adjust Weight Table - Example 2
Figure 9 (Sheet 1 of 2)

NUMBER OF EXISTING WEIGHTS	RUDDER ASSEMBLY 173A0100-(), 173A0103-()										
	TOTAL CHANGE IN MOMENT ΔM DUE TO ADDING (n) ADJUST WEIGHTS (lbf.in)										
	NUMBER OF 173A5300-1 ADJUST WEIGHTS (n) TO BE ADDED TO EXISTING WEIGHTS										
			Z								
	12	13	14	15	16						
0	53.62	58.01		66.76	71.12						
1	53.48	57.87		66.59	70.93						
2	53.34	57.70		66.40	70.74						
3	53.20	57.56		66.24	70.56						
4	53.06	57.40		66.06	70.38						
5	52.92	57.26		65.90	70.19						
6	52.78	57.10		65.71	70.00						
7	52.64	56.96		65.54	69.81						
8	52.50	56.79		65.35	69.62						
9	52.36	56.65		65.19	69.43						
10	52.22	56.49		65.00	69.24						
11	52.08	56.35		64.83	69.05						
12	51.94	56.18		64.64	68.86						
13	51.79	56.03		64.47	68.67						
14	51.64	55.86	60.08	64.28	68.48						
				64.12	68.29						
				63.93	68.10						
V	51.22	55.42	Y	63.76	67.91						
18	51.08	55.25	59.42	63.57	67.72						
19	50.93	55.10	59.25	63.40	67.53						
20	50.78	54.93	59.08	63.21	67.34						
21	50.64	54.79	58.92	63.05	67.15						

TABLE I

Rudder Assembly Balance Adjust Weight Table - Example 2
Figure 9 (Sheet 2 of 2)

6. **Put the Airplane Back to Its Usual Condition**

A. As applicable, install the rudder on the airplane. Refer to AMM 27-21-11/401.

GENERAL - ELEVATOR BALANCE PROCEDURE FOR AIRPLANE LINE NUMBERS 1175 AND ON AND LINE NUMBERS 1 THROUGH 1174 WITH COMPLETION OF SERVICE BULLETINS 737-55-1080, 737-55-1081, AND 737-55-1082

1. Applicability

WARNING: MAKE SURE THAT THE BALANCE MOMENT OF THE ELEVATOR IS IN THE LIMITS OF THE SECONDARY STATIC BALANCE REQUIREMENTS. IF YOU DO NOT, A CONDITION THAT IS DANGEROUS TO FLIGHT SAFETY CAN OCCUR.

CAUTION: DO THE BALANCE PROCEDURE TO THE ELEVATOR ASSEMBLY AFTER YOU REMOVE IT FROM THE AIRPLANE TO DO THE REPAIR OR REPAINT. DO THE BALANCE PROCEDURE TO A NEW ELEVATOR ASSEMBLY BEFORE IT IS INSTALLED. MARK THE ELEVATOR WITH THE NEW STATIC BALANCE HINGE MOMENT (SBHM).

CAUTION: WHEN YOU DO ABRASIVE BLAST PROCEDURES IN AREAS WHERE LUBRICATION FLUIDS OR GREASE ARE APPLIED, USE CARE TO PREVENT CONTAMINATION OF THE LUBRICANT WITH THE BLAST RESIDUE. THIS CONTAMINATION CAN AFFECT THE LUBRICATION PROPERTIES AND THE RESULT CAN BE INCREASED WEAR OF THE LUBRICATED PARTS.

A. This subject gives the necessary data for the static balance requirements for the elevator assembly.

NOTE: This procedure is applicable to airplanes with line numbers equal to or greater than 1175. Refer to 51-60-04 for airplanes with line numbers 1 through 1174 that have not been modified as given in Service Bulletins 737-55-1080, 737-55-1081, and737-55-1082.

B. Refer to 51-60-05 for the weight control procedure for the elevator balance panels.

C. Refer to 51-60-06 or 51-61-06 for the elevator tab balance procedure.

2. General

A. Refer to 51-60-00 for the general data such as:
   (1) Categories of control surfaces
   (2) General balance instructions
   (3) Serviceability
   (4) Definitions of terms
   (5) Sign conventions
   (6) Measurement accuracy
   (7) Special tools and equipment
   (8) Repair material weights.

B. The elevator assembly is a Category I Control Surface.

C. Before you complete a repair or repaint on the elevator, you must make sure that it is possible to balance the elevator within the limits of the secondary static balance requirements as given in Paragraph 2.F./GENERAL after the repair or repaint has been completed.
   (1) To make sure that it is possible to balance the elevator within the limits of the secondary static balance requirements as given in Paragraph 2.F./GENERAL after the repair or repaint has been completed, you must:
      (a) Find the current Static Balance Hinge Moment (SBHM)

(b) Find the ΔM as a result of the repair or repaint

(c) Find the number of available elevator balance adjust weight positions and thus the rework capability.

D. If it is not possible to meet the secondary static balance requirements with the current Static Balance Hinge Moment (SBHM), the ΔM as a result of the repair or repaint and the number of available elevator balance adjust weight positions, you can restore the rework capability as follows:

(1) Remove all layers of paint from the elevator assembly. Refer to AMM PAGEBLOCK 51-21-11/701 for the paint removal procedures.

(a) Remove the balance adjust weights which are equal in moment to the layers of paint that were added to the initial paint application.

NOTE: These layers of paint are removed to restore the rework capability of the elevator assembly. This does not include the initial paint application. Do not remove the adjust weights necessary for the initial paint application.

(b) Restore the decorative exterior paint to the elevator assembly.

1) Use the same specification as the initial paint application you removed.

2) Refer to AMM PAGEBLOCK 51-21-99/701 for the paint application procedures.

NOTE: The restored paint is a repaint. It will be necessary to add adjust weights that are equal in moment to this paint application. If there are other rework areas or repairs on the elevator assembly, it is still necessary to add adjust weights equal in moment to these areas.

E. The elevator can be balanced by one of two methods:

(1) The static balance jig procedure Refer to Paragraph 5.A./GENERAL for the balance procedure on the static balance jig.

(a) The elevator must be removed from the airplane to be balanced on the static balance jig. For the configuration of the elevator at the time of the balance procedure, refer to Paragraph 2.G./GENERAL

(2) The calculation procedure Refer to Paragraph 5.B./GENERAL for the balance procedure by calculation.

(a) This procedure does not require the use of a static balance jig. The calculation procedure can be used with the elevator on or off the airplane as long as the repair and balance requirements are met. You must make sure that the necessary data is recorded during the repair or rework so that the calculations can be made accurately.

(b) Be careful when you calculate the weight of the material removed (or lost as a result of damage) and the weight of the material added.

1) Measure or calculate the weight of the material removed and the weight of the material added as accurately as possible.

2) Keep the tolerance very small. If you do not, you can have a weight that is not satisfactory. The conditions that follow will have an effect on the tolerance:

a) The tolerance of the weighing equipment

b) The precision in your estimation of the weight of the material that has been removed

c) The precision in your estimation of the weight of the repair materials or paint.

(c) Find the distance from the hinge line to the center of gravity of the repair to within ±0.1 inch (±2.5 mm). The conditions that follow will have an affect on the tolerance:

1) The possible error in the estimation of the position of the center of gravity of the repair

2) The possible error in the measurement of the distance from the center of gravity of the repair to the elevator hinge line.

F. The elevator installation must be balanced so that the total effective center of gravity is within the limits for the primary static balance requirement.

(1) The primary static balance requirement, or the location of the center of gravity for the elevator installation, is 0.4 to 0.0 inch (10.16 to 0.0 mm) forward of the elevator hinge line.

(a) To get the primary static balance requirement, you must make sure, by measurement or calculation, that the secondary static balance requirements for the elevator are met. Refer to Table 1/GENERAL for the secondary static balance requirements.

1) The secondary static balance requirement for the elevator assembly, when you balance the elevator by measurement on the balance jig, requires a component moment between -175.28 and -88.47 lbfin (-19.80 and -10.00 Nm).

2) The secondary static balance requirement for the elevator assembly when you balance the elevator by calculation on or off the airplane requires a component moment between -175.28 and -110.17 lbfin (-19.80 and -12.45 Nm).

(2) It is suggested that you balance the elevator assembly nearest to the most forward component moment of -175.28 lbfin (-19.80 Nm) to account for future repairs, painting, or rework.

Table 1:

COMPONENT	ENGINEERING DRAWING	SECONDARY STATIC BALANCE REQUIREMENT		
		COMPONENT WEIGHT lbm (kg)	COMPONENT MOMENT lbfin (Nm)	REFER TO SRM
Elevator Assembly*[1]	183A0103-7 183A0103-8	Not Applicable	BALANCE PROCEDURE BY MEASUREMENT ON THE BALANCE JIG: -175.28 to -88.47 (-19.80 to -10.00)	51-61-04 Paragraph 5.A
			BALANCE PROCEDURE BY CALCULATION ON THE AIRPLANE: -175.28 to -110.17 (-19.80 to -12.45)	51-61-04 Paragraph 5.B
Balance Panel Bay Number 2	183A9102-()(LH) 183A9102-()(RH)	2.46 ± 0.15 (1.12) ± (0.068)	Not Applicable	51-60-05
Balance Panel Bay Number 3	183A9103-()(LH) 183A9103-()(RH)	2.22 ± 0.15 (1.01) ± (0.068)	Not Applicable	51-60-05
Balance Panel Bay Number 4	183A9104-()(LH) 183A9104-()(RH)	2.13 ± 0.15 (0.97) ± (0.068)	Not Applicable	51-60-05
Elevator Tab Assembly (See Note 1)	183A8100-5 183A8100-6	9.00 maximum (4.08 maximum)	15.48 maximum (1.75 maximum)	51-61-06
Elevator Horn Tip Weight	183A7300-3 (LH and RH)	15.00 +0.15 -0.25 (6.80 +0.068) (-0.11)	Not Applicable	Not Applicable

*[1] Airplane line numbers prior to 1175 must have completed Service Bulletins 737-55-1080, 737-55-1081, and 737-55-1082.

G. Before you balance the elevator assembly on the static balance jig, you must:

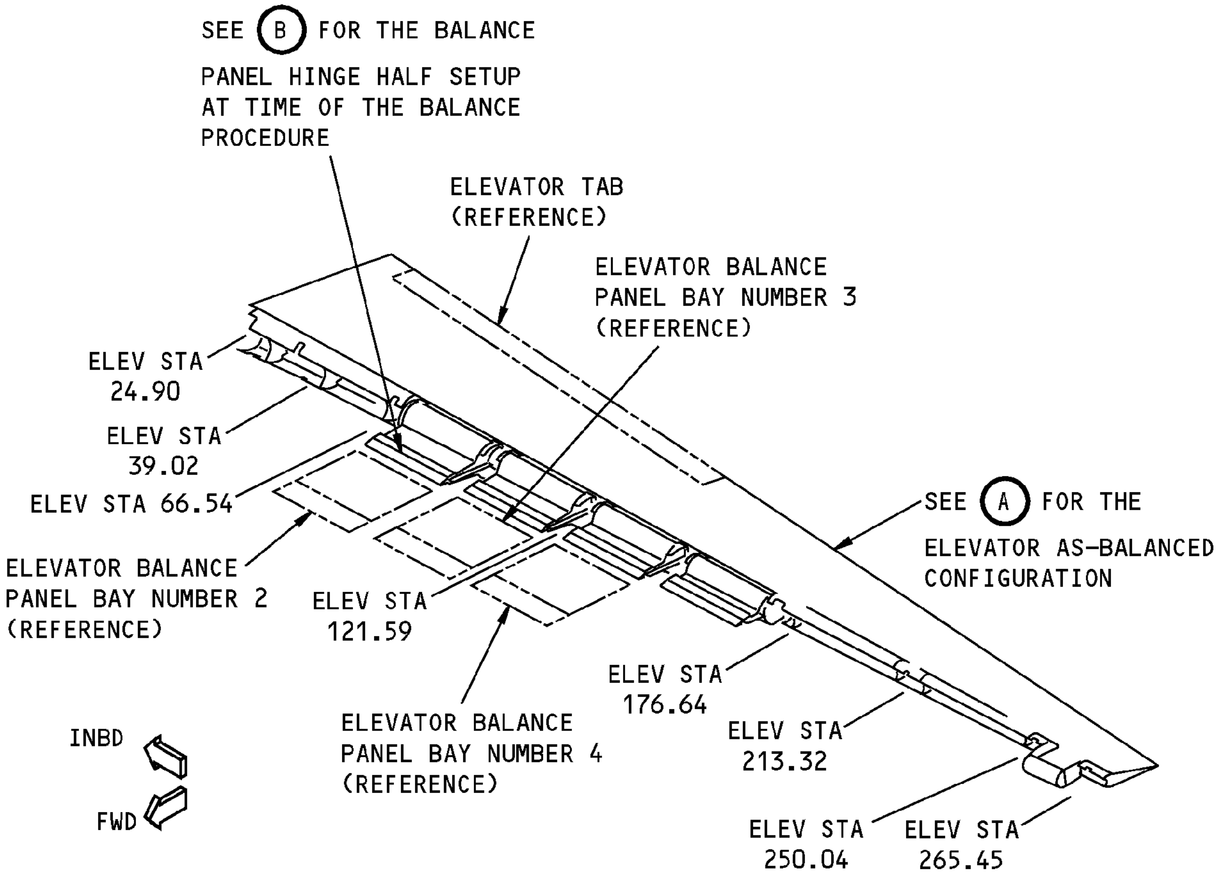
(1) Make sure that it is a complete assembly as given on engineering drawing 183A0103-7, 183A0103-8.

NOTE: Refer to Configuration of the Elevator at the Time of the Balance Reduced on the Static Balance Jig, Figure 1/GENERAL for the as-balanced configuration of the elevator assembly. The as-balanced configuration includes all exterior finishes. Elevator tab adjust weights must not be on the elevator assembly when you do the balance.

(2) The as-balanced configuration of the elevator assembly for static balance does not include the balance panel seals, part number 183A0300.

H. Because of the configuration of the horizontal stabilizer, it is not possible to add elevator balance adjust weights to the upper locations of the balance bays of the elevator without the removal of the elevator from the airplane. The lower locations of the balance bays of the elevator are accessible when the lower trailing edge access panels are removed.

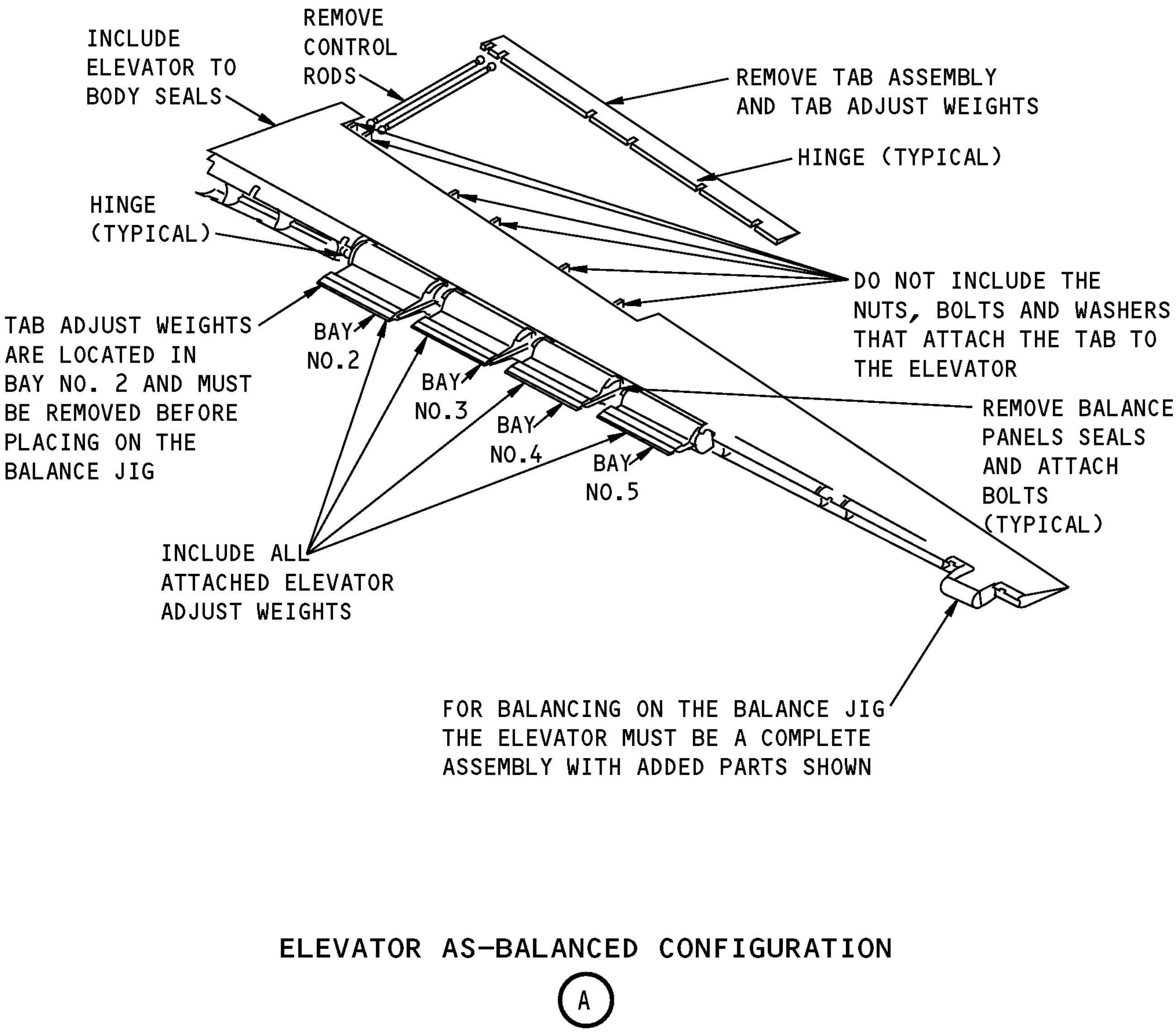
I. Make sure that you keep to the sign conventions as given in 51-60-00, except where noted.



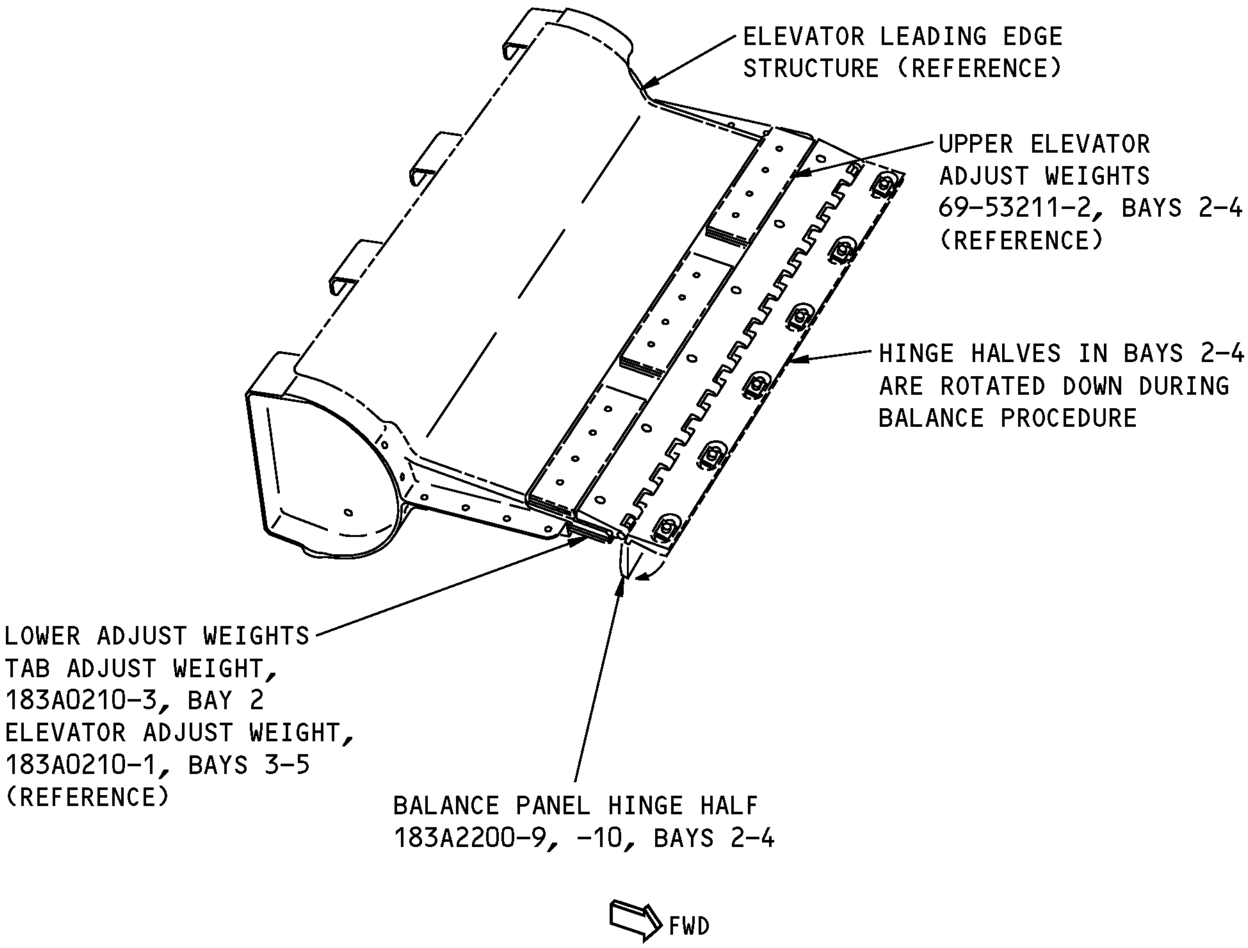
NOTES

- THE ELEVATOR MUST BE A COMPLETE ASSEMBLY AS GIVEN ON ENGINEERING DRAWING 183A0103-7, 183A0103-8, 002A0016-31, 002A0016-32. THIS INCLUDES ALL PROTECTIVE FINISHES AND DECORATIVE PAINT.
- DO NOT INCLUDE:
  - BALANCE PANEL SEALS (REFER TO ENGINEERING DRAWING 183A0300)
  - INSTALLATION BOLTS, NUTS, AND WASHERS THAT ATTACH THE ELEVATOR TAB TO THE ELEVATOR
  - CONTROL RODS AND THEIR INSTALLATION BOLTS, NUTS, AND WASHERS.
  - TAB BALANCE ADJUST WEIGHTS (BAY NO. 2, LOWER)

Configuration of the Elevator at the Time of the Balance Reduced on the Static Balance Jig
Figure 1 (Sheet 1 of 3)



Configuration of the Elevator at the Time of the Balance Reduced on the Static Balance Jig
Figure 1 (Sheet 2 of 3)



BALANCE PANEL HINGE HALF SETUP AT THE TIME OF THE BALANCE PROCEDURE

B

Configuration of the Elevator at the Time of the Balance Reduced on the Static Balance Jig
Figure 1 (Sheet 3 of 3)

3. References

Reference	Title
51-60-00	CONTROL SURFACE BALANCING
51-60-04	ELEVATOR BALANCE PROCEDURE
51-60-05	WEIGHT CONTROL PROCEDURE FOR THE ELEVATOR BALANCE PANELS
51-60-06	ELEVATOR TAB BALANCE PROCEDURE
51-61-06	ELEVATOR TAB BALANCE PROCEDURE
51-70-05	REPAIR PROCEDURES FOR PREIMPREGNATED MATERIALS
AMM 06-42-00	EMPENNAGE (MAJOR ZONE 300) ACCESS DOORS AND PANELS
AMM 27-31-11 P/B 401	ELEVATOR - REMOVAL/INSTALLATION
AMM 27-31-31 P/B 401	ELEVATOR TAB - REMOVAL/INSTALLATION
AMM 27-31-41 P/B 401	ELEVATOR BALANCE PANEL - REMOVAL/INSTALLATION
AMM 51-21-11 P/B 701	PAINT STRIPPING - CLEANING/PAINTING
AMM 51-21-99 P/B 701	DECORATIVE EXTERIOR PAINT SYSTEM - CLEANING/PAINTING
BAC 5018	Installation of Safetying Devices
SOPM 20-30-03	Standard Overhaul Practices Manual
SOPM 20-41-02	Application of Chemical and Solvent Resistant Finishes
SOPM 20-44-04	Application of Urethane Compatible Primers
SOPM 20-50-13	Application of Weather, Fuel, Oil, Solvent, and Heat Resistant Protective Coatings

4. Prepare for the Balance Procedure

A. For the balance procedure on the balance jig, do as follows:

(1) Remove the elevator from the airplane. Refer to AMM PAGEBLOCK 27-31-11/401.

(2) Remove the elevator tab from the elevator. Refer to AMM PAGEBLOCK 27-31-31/401.

(3) Remove the elevator balance panels from the elevator. Refer to AMM PAGEBLOCK 27-31-41/401.

(4) Remove the tab adjust weights and the balance panel seals.

(5) Make sure that the elevator assembly that you want to balance has the configuration as given in Paragraph 2.G./GENERAL

B. For the balance procedure by calculation there are no specific preparations necessary.

5. Balance Procedure

A. Elevator Assembly Static Balance Procedure by Measurement on the Static Balance Jig

NOTE: The secondary static balance requirement for the elevator assembly, when you balance the elevator by measurement on the balance jig, requires a component moment between -175.28 and -88.47 lbfin (-19.80 and -10.00 Nm).

(1) Install the elevator assembly, with the upper surface up, in the static balance jig. Refer to Elevator Support and Balance at the Time of the Balance Procedure on the Static Balance Jig, Figure 2/GENERAL.

(a) Use elevator hinge fitting number 2 (ELEVATOR STA 39.02), hinge fitting number 4 (ELEVATOR STA 121.59) (optional), and hinge fitting number 5 (ELEVATOR STA 176.64) for the installation of the elevator assembly in the balance jig.

NOTE: Make sure that the elevator assembly can pivot freely about its hinge centerline.

(b) Rotate all balance panel hinge halves (3 places) to their lowest position as shown in Configuration of the Elevator at the Time of the Balance Reduced on the Static Balance Jig, Figure 1/GENERAL.

(c) Level the horizontal chord plane ±1 degree with a protractor level.

(2) Use the platform scale and toolstand to measure the Weight Reaction (WR) at tab hinge fitting number 4 centerline. Refer to Elevator Support and Balance at the Time of the Balance Procedure on the Static Balance Jig, Figure 2/GENERAL.

WR = __________ lbf (N)

NOTE: Refer to 51-60-00 for the weight measurement precision for the Weight Reaction (WR).

(3) Calculate the trial Check Balance Moment (CBM) with the formula:

trial CBM = (WR) x (d), where:

- WR is the Weight Reaction measured at tab hinge fitting number 4 in lbf (N)
- d is the moment arm distance between the elevator hinge centerline and the tab hinge fitting centerline at tab hinge fitting number 4 (d = +23.40 in. (+594.36 mm = +0.594 m)).

trial CBM = __________ lbfin (Nm) The trial CBM is the new final moment (Static Balance Hinge Moment) if it is within the given limits.

(a) If -175.28 lbfin ≤ trial CBM ≤ -88.47 lbfin (-19.80 Nm ≤ trial CBM ≤ -10.00 Nm), the secondary static balance requirement for the elevator assembly is met. In this situation you can do one of the steps that follow:

1) Because the static balance requirement for the elevator assembly is met, it is not necessary to install additional elevator balance adjust weights. The trial CBM is the new final moment (Static Balance Hinge Moment) if it is within the given limits. Continue with step 5.A.(7).

2) Balance the elevator assembly to a desired balance moment between -175.28 and -88.47 lbfin (-19.80 and -10.00 Nm) by the addition of a sufficient number of elevator balance adjust weights. Refer to Paragraph 5.D./GENERAL for an Example.

3) Balance the elevator assembly nearest to the most forward component moment of -175.28 lbfin (-19.80 Nm) to account for future repairs, painting, or rework. Refer to Paragraph 5.D./GENERAL for an Example.

(b) If the trial CBM is less negative than -88.47 lbfin (-10.00 Nm) or positive, the secondary static balance requirement for the elevator assembly is not met and you must add elevator balance adjust weights. In this situation you can do one of the steps that follow:

1) Balance the elevator assembly to a desired balance moment between -175.28 and -88.47 lbfin (-19.80 and -10.00 Nm) by the addition of a sufficient number of elevator balance adjust weights. Refer to Paragraph 5.D./GENERAL for an Example.

2) Balance the elevator assembly nearest to the most forward component moment of -175.28 lbfin (-19.80 Nm) to account for future repairs, painting, or rework. Refer to Paragraph 5.D./GENERAL for an Example.

(c) A trial CBM that is more negative than -175.28 lbfin (-19.80 Nm) is not likely to occur and therefore will not be described in this subject.

(4) Find the number of elevator balance adjust weights that you must install to meet the secondary static balance requirement for the elevator assembly.

NOTE: When the elevator assembly is balanced on a static balance jig it is recommended that you use the upper elevator balance adjust weights first. Only the lower elevator balance adjust weights are accessible when the elevator assembly is installed on the airplane. If possible, the lower elevator balance adjust weight locations should be reserved for balancing the elevator on the airplane.

(a) Elevator Assembly Balance Adjust Weight Table, Figure 3/GENERAL, Table I gives the total change in moment (ΔM) as a result of the addition of a number of upper elevator balance adjust weights to an existing number of adjust weights previously installed. The values of ΔM given in the table account for the weight of the different adjust weights, the moment arms of the balance adjust weights, and for the sequence in which the adjust weights must be installed.

(b) Elevator Assembly Balance Adjust Weight Table, Figure 3/GENERAL, Table II gives the total change in moment (ΔM) as a result of the addition of a number of lower elevator balance adjust weights to an existing number of adjust weights previously installed. The values of ΔM given in the table account for the weight of the different adjust weights, the moment arms of the balance adjust weights, and for the sequence in which the adjust weights must be installed.

(c) For a given trial CBM as found in Paragraph 5.A.(3)/GENERAL, together with the formula:

$-175.28 \leq (\Delta M + \text{trial CBM}) \leq -88.47$ (lbfin) ($-19.80 \leq (\Delta M + \text{trial CBM}) \leq -10.00$ (Nm)) you can find the necessary number of elevator balance adjust weights from Elevator Assembly Balance Adjust Weight Table, Figure 3/GENERAL, Tables I and II that must be installed for a given number of adjust weights previously installed and the desired Static Balance Hinge Moment (SBHM) desired SBHM = (ΔM) + (trial CBM)

(5) Install the necessary number of elevator balance adjust weights found in step 5.A.(4):

upper elevator balance adjust weight: part number 69-53211-2 (Balance bay numbers 2, 3, and 4 only)

lower elevator balance adjust weight: part number 183A0210-1 (Balance bay numbers 3, 4, and 5 only)

(a) Refer to Elevator Balance Adjust Weight Location and Installation Sequence, Figure 4/GENERAL for:

1) The location where the elevator balance adjust weights must be installed

2) The sequence in which the elevator balance adjust weights must be installed.

(b) If the Boeing elevator balance adjust weights, part numbers 69-53211-2 or 183A0210-1, are not available, you can make elevator balance adjust weights as given in Elevator Balance Adjust Weights, Figure 5/GENERAL.

(c) Install the elevator balance adjust weights, part number 69-53211-2. Refer to Table 2/GENERAL for the maximum permitted number of elevator balance adjust weights per bay and station.

1) As necessary, apply one layer of BMS 5-95 between the elevator balance adjust weight and the hinge plate.

2) Install the elevator balance adjust weights with:

a) BACW10BP3ACU washers (under the bolt heads)

b) BACB30LM3D() or NAS6703D() bolts. Install the bolts with MIL-C-11976, Class 3 corrosion preventive compound. Refer to Table 3/GENERAL for the grip length of the attachment bolt for a given number of elevator balance adjust weights.

c) BACW10BP3NAPU and/or BACW10BP3APU washers (under the nuts)

NOTE: Use any combination of washers to allow the cotter pin to properly engage the nut castellations. Total quantity: minimum of 1 washers maximum of 2 washers

d) BACN10JD103CD nuts

e) BACP18BC02A06P cotter pins.

(d) Install the elevator balance adjust weights, part number 183A0210-1. Refer to Table 2/GENERAL for the maximum permitted number of elevator balance adjust weights per bay and station.

1) As necessary, apply one layer of BMS 5-95 between the elevator balance adjust weight and the hinge plate.

2) Install the elevator balance weights as follows:

a) Bay 3 and 4 lower adjust weights

<1> Install weights with BACB30LM4H() or NAS6704() bolts with MIL-C-11796 class 3. Torque the bolts between 68 and 83 lb-in.

<2> Make sure you use a BACW10BP4ACU washer under the bolt head.

NOTE: Use any combination of BACW10BP4NAPU and BACW10BP4APU washers adjacent to BACW10BP4ACU washer to engage completely. No threads may go past the opposite side of the hinge half. Make sure you use a minimum (0) additional washers adjacent to the necessary washer. Make sure you use a maximum (2) additional washers to permit thread engagement.

<3> Refer to Table 3/GENERAL for the grip length of the attachment bolts for the given number of adjust weights.

<4> Lock adjacent bolt heads with MS20995N32 lockwire as given in BAC 5018.

b) Bay 5 lower adujst weights

<1> Install weights with BACB30LJ4D() bolts and BACN11N104CS nuts with MIL-C-11796 class 3.

<2> Make sure you use a BACW10BPNAPU washer under the nut.

NOTE: Use any combination of BACW10BP4ACU and BACW10BP4NAPU washers under the bolt head to permit the cotter pin to properly engage castellations. Use a minimum (0) additional washers under the bolt head and a maximum (2) additional washers under the bolt head to properly engage the cotter pin.

<3> Refer to Table 3/GENERAL for the grip length of the attachment bolts for the given number of adjust weights.

<4> Install cotter pin BACP18BC02A10P as given in BAC 5018.

Table 2:

BALANCE BAY	STATION	MAXIMUM ALLOWABLE QUANTITY OF WEIGHTS	
2	INBOARD	3 UPPER	-
	CENTER	3 UPPER	-
	OUTBOARD	3 UPPER	-
3	INBOARD	3 UPPER	3 LOWER
	CENTER	3 UPPER	2 LOWER
	OUTBOARD	3 UPPER	1 LOWER
4	INBOARD	3 UPPER	3 LOWER
	CENTER	3 UPPER	2 LOWER
	OUTBOARD	3 UPPER	1 LOWER
5	INBOARD	-	3 LOWER
	CENTER	-	2 LOWER
	OUTBOARD	-	1 LOWER

Table 3:

ELEVATOR ASSEMBLY BALANCE ADJUST WEIGHTS ATTACHMENT BOLT GRIP LENGTH DASH NUMBERS			
NUMBER OF ADJUST WEIGHTS IN STACK-UP	ATTACHMENT BOLT BACB30LM3D() OR NAS6703D() UPPER WEIGHT INSTALLATION BAY 2,3,4 ONLY	ATTACHMENT BOLT BACB30LM4H() OR NAS6704H() LOWER WEIGHT INSTALLATION BAY 3,4 ONLY	ATTACHMENT BOLT BACB30LJ4D() LOWER WEIGHT INSTALLATION BAY 5 ONLY
3	12	11	11
2	10	9	8
1	7	7	6
0	5	4	—

(6) Calculate a second trial Check Balance Moment (CBM):

(a) Rotate all balance panel hinge halves (3 places) to their lowest position as shown in Configuration of the Elevator at the Time of the Balance Reduced on the Static Balance Jig, Figure 1/GENERAL.

(b) Level the horizontal chord plane ±1 degree with a protractor level.

(c) Use the platform scale and toolstand to measure the Weight Reaction (WR) at tab hinge fitting number 4 centerline. Refer to Elevator Support and Balance at the Time of the Balance Procedure on the Static Balance Jig, Figure 2/GENERAL.

WR = __________ lbf (N)

NOTE: Refer to 51-60-00 for the weight measurement precision for the Weight Reaction (WR).

(d) second trial Check Balance Moment (CBM) = (WR) x (d), where:

- WR is the (new) Weight Reaction measured in lbf (N)

- d is the moment arm distance between the elevator hinge centerline and the tab hinge fitting centerline at tab hinge fitting number 4 (d = +23.40 in. (+594.36 mm = +0.594 m))

second trial CBM = __________ lbfin (Nm)

(e) If the second trial CBM is within the limits as given in Paragraph 2.F./GENERAL, the second trial Check Balance Moment (CBM) becomes the new Static Balance Hinge Moment (SBHM).

second trial CBM = new (SBHM) = __________ lbfin (Nm) Continue with step 5.A.(7).

(f) If the second trial CBM is not within the limits as given in Paragraph 2.F./GENERAL, do one of the steps that follow:

1) If there are enough weight positions to bring the moment within the limits, repeat steps 5.A.(1) through 5.A.(6).

2) If there are not enough weight positions to bring the moment within the limits, do as follows:

a) Remove all layers of paint from the elevator assembly. Refer to AMM PAGEBLOCK 51-21-11/701 for the paint removal procedures.

b) Restore the elevator assembly decorative exterior paint system. Refer to AMM PAGEBLOCK 51-21-99/701.

c) Repeat steps 5.A.(1) through 5.A.(6).

d) If it is not possible to get the elevator balanced within the specified limits after the removal of multiple layers of paint, you must replace the elevator assembly.

(7) Vibro-engrave or rubber-stamp the value of the new Static Balance Hinge Moment (SBHM) on the metal part identification plate (MS27253C2) that is attached to the elevator assembly.

(a) Apply a Skydrol resistant finish to the rubber-stamped data as given in SOPM 20-50-13.

(b) Do not stamp the installed metal nameplate with steel stamps.

(8) Make a record in the repair log of:

(a) The new Static Balance Hinge Moment (SBHM)

(b) The fact that the elevator has been balanced on the static balance jig

(c) The type of repair

(d) The location of the repair

(e) The date when the elevator was repaired and balanced

(f) The number of elevator balance adjust weights that are installed and the number of available spaces for the addition of weight.

B. Elevator Assembly Static Balance Procedure by Calculation

NOTE: The secondary static balance requirement for the elevator assembly when you balance the elevator by calculation requires a component moment between -175.28 and -110.17 lbfin (-19.80 and -12.45 Nm).

(1) Review the repair log and find the available Rework Moment (RM).

(2) Measure the distance D (within 0.1 inch (2.5 mm)). D is the distance from the rework center of gravity (CG) along the skin surface to the intersection of the centerline of the elevator hinge and the upper skin. Refer to Elevator Balance at Time of Balance Procedure by Calculation, Figure 6/GENERAL.

D = __________ inches (m)

(3) Measure or calculate the distance Y. Y is the distance from the elevator hinge centerline to the line through the CG of the rework, perpendicular to the elevator hinge line and parallel to the elevator chord line. Refer to Elevator Balance at Time of Balance Procedure by Calculation, Figure 6/GENERAL. To calculate the distance Y, use the formula that follows:

Y = (D) x (cos 7.7°) = __________ inches (m)

(4) Weigh or calculate the Weight removed (Wr). Wr is the Weight removed as a result of rework, repair, or re-painting. Refer to Paragraph 5.E./GENERAL for an Example Calculation of the Weight removed (Wr).

Wr = +_________ lbm (kg) (KEEP POSITIVE)

(5) Weigh or calculate the Weight added (Wa). Wa is the Weight added as a result of rework, repair, or re-painting. Refer to Paragraph 5.E./GENERAL for an Example Calculation of the Weight added (Wa).

Wa = __________ lbm (kg)

(6) Calculate the Rework Weight (RW). RW is the net change in weight as a result of rework, repair, or re-painting. Refer to Paragraph 5.E./GENERAL for an Example Calculation of the Rework Weight (RW).

RW = Wa - Wr = __________ lbm (kg)

(7) Calculate the Rework Moment (RM). RM is the net change in balance moment as a result of rework, repair, or re-painting. Refer to Paragraph 5.E./GENERAL for an Example Calculation of the Rework Moment (RM).

RM = (RW) x (Y) = __________ lbfin (Nm)

(8) Calculate the trial Check Balance Moment (CBM). The trial CBM is the new final moment (Static Balance Hinge Moment) if it is within the given limits.

trial CBM = (SBHM) + (RM) = __________ lbfin (Nm) where SBHM is the Static Balance Hinge Moment that is the previous final moment stamped on the nameplate of the elevator.

(a) If -175.28 lbfin ≤ trial CBM ≤ -110.17 lbfin (-19.80 Nm ≤ trial CBM ≤ -12.45 Nm), the secondary static balance requirement for the elevator assembly is met. In this situation you can do one of the steps that follow:

1) Because the static balance requirement for the elevator assembly is met it is not necessary to install adjust weights. Continue with step 5.C.

2) Balance the elevator assembly to a desired balance moment between -175.28 and -110.17 lbfin (-19.80 and -12.45 Nm) by the addition of a sufficient number of elevator balance adjust weights. Refer to Paragraph 5.D./GENERAL for an Example.

3) Balance the elevator assembly nearest to the most forward component moment of -175.28 lbfin (-19.80 Nm) to account for future repairs, painting, or rework. Refer to Paragraph 5.D./GENERAL for an Example.

(b) If the trial CBM is less negative than -110.17 lbfin (-12.45 Nm) or positive, the secondary static balance requirement for the elevator assembly is not met and you must add elevator balance adjust weights. In this situation you can do one of the steps that follow:

1) Balance the elevator assembly to a desired balance moment between -175.28 and -110.17 lbfin (-19.80 and -12.45 Nm) by the addition of a sufficient number of elevator balance adjust weights. Refer to Paragraph 5.D./GENERAL for an Example.

2) Balance the elevator assembly nearest to the most forward component moment of -175.28 lbfin (-19.80 Nm) to account for future repairs, painting, or rework. Refer to Paragraph 5.D./GENERAL for an Example.

(c) A trial CBM that is more negative than -175.28 lbfin (-19.80 Nm) is not likely to occur and therefore will not be described in this subject.

(9) Find the number of elevator balance adjust weights that you must install to meet the secondary static balance requirement for the elevator assembly.

NOTE: When the elevator assembly is balanced on a static balance jig it is recommended that you use the upper elevator balance adjust weights first. Only the lower elevator balance adjust weights are accessible when the elevator assembly is installed on the airplane. If possible, the lower elevator balance adjust weight locations should be reserved for balancing the elevator on the airplane.

(a) Elevator Assembly Balance Adjust Weight Table, Figure 3/GENERAL, Table I gives the total change in moment (ΔM) as a result of the addition of a number of upper elevator balance adjust weights to an existing number of adjust weights previously installed. The values of ΔM given in the table account for the weight of the different adjust weights, the moment arms of the balance adjust weights, and for the sequence in which the adjust weights must be installed.

(b) Elevator Assembly Balance Adjust Weight Table, Figure 3/GENERAL, Table II gives the total change in moment (ΔM) as a result of the addition of a number of lower elevator balance adjust weights to an existing number of adjust weights previously installed. The values of ΔM given in the table account for the weight of the different adjust weights, the moment arms of the balance adjust weights, and for the sequence in which the adjust weights must be installed.

(c) For a given trial CBM as found in Paragraph 5.B.(8)/GENERAL, together with the formula:

$-175.28 \leq (\Delta M + \text{trial CBM}) \leq -110.17$ lbfin ($-19.80 \leq (\Delta M + \text{trial CBM}) \leq -12.45$ Nm) you can find the necessary number of elevator balance adjust weights from Elevator Assembly Balance Adjust Weight Table, Figure 3/GENERAL, Tables I and II that must be installed for a given number of adjust weights already installed and the desired Static Balance Hinge Moment (SBHM) desired SBHM = (ΔM) + (trial CBM)

(10) If you want to add upper elevator balance adjust weights, you must remove the elevator from the airplane. Refer to AMM PAGEBLOCK 27-31-11/401.

(11) Install the necessary number of elevator balance adjust weights found in step 5.B.(9)

upper elevator balance adjust weight: part number 69-53211-2 (Balance bay numbers 2, 3, and 4 only)

lower elevator balance adjust weight: part number 183A0210-1 (Balance bay numbers 3, 4, and 5 only)

(a) Refer to Elevator Balance Adjust Weight Location and Installation Sequence, Figure 4/GENERAL for:

1) The location where the elevator balance adjust weights must be installed

2) The sequence in which the elevator balance adjust weights must be installed.

(b) If the Boeing elevator balance adjust weights, part numbers 69-53211-2 or 183A0210-1, are not available, you can make elevator balance adjust weights as given in Elevator Balance Adjust Weights, Figure 5/GENERAL.

(c) Install the elevator balance adjust weights, part number 69-53211-2. Refer to Table 2/GENERAL for the maximum permitted number of elevator balance adjust weights per bay and station.

1) As necessary, apply one layer of BMS 5-95 between the elevator balance adjust weight and the hinge plate.

2) Install the elevator balance adjust weights with:

a) BACW10BP3ACU washers (under the bolt heads)

b) BACB30LM3D() or NAS6703D() bolts. Install the bolts with MIL-C-11796, Class 3 corrosion preventive compound. Refer to Table 3/GENERAL for the grip length of the attachment bolt for a given number of elevator balance adjust weights.

c) BACW10BP3NAPU and/or BACW10BP3APU washers (under the nuts)

NOTE: Use any combination of washers to allow the cotter pin to properly engage nut castellations. Total quantity: minimum of 1 washers maximum of 2 washers

d) BACN10JD103CD nuts

e) BACP18BC02A06P cotter pins.

(d) Install the elevator balance adjust weights, part number 183A0210-1. Refer to Table 2/GENERAL for the maximum permitted number of elevator balance adjust weights per bay and station.

1) As necessary, apply one layer of BMS 5-95 between the elevator balance adjust weight and the hinge plate.

2) Install the elevator balance weights as follows:

a) Bay 3 and 4 lower adjust weights

<1> Install weights with BACB30LM4H() or NAS6704() bolts with MIL-C-11796 class 3. Torque the bolts between 68 and 83 lb-in.

<2> Make sure you use a BACW10BP4ACU washer under the bolt head.

NOTE: Use any combination of BACW10BP4NAPU and BACW10BP4APU washers adjacent to BACW10BP4ACU washer to engage completely. No threads may go past the opposite side of the hinge half. Make sure you use a minimum (0) additional washers adjacent to the necessary washer. Make sure you use a maximum (2) additional washers to permit thread engagement.

<3> Refer to Table 3/GENERAL for the grip length of the attachment bolts for the given number of adjust weights.

<4> Lock adjacent bolt heads with MS20995N32 lockwire as given in BAC 5018.

b) Bay 5 lower adujst weights

<1> Install weights with BACB30LJ4D() bolts and BACN11N104CS nuts with MIL-C-11796 class 3.

<2> Make sure you use a BACW10BPNAPU washer under the nut.

NOTE: Use any combination of BACW10BP4ACU and BACW10BP4NAPU washers under the bolt head to permit the cotter pin to properly engage castellations. Use a minimum (0) additional washers under the bolt head and a maximum (2) additional washers under the bolt head to properly engage the cotter pin.

<3> Refer to Table 3/GENERAL for the grip length of the attachment bolts for the given number of adjust weights.

<4> Install cotter pin BACP18BC02A10P as given in BAC 5018.

(12) Calculate a second trial Check Balance Moment (CBM) with the formula:

second trial CBM = previous (SBHM) + (RM) + ΔM

second trial CBM = first trial CBM + ΔM

second trial CBM = __________ lbfin (Nm) where: previous SBHM is the Static Balance Hinge Moment that is the previous final moment stamped on the nameplate of the elevator. RM is the Rework Moment as found in Paragraph 5.B.(7)/GENERAL

ΔM is the change in moment selected from Elevator Assembly Balance Adjust Weight Table, Figure 3/GENERAL, Tables I and/or II for a given number of elevator balance adjust weights added (n).

(a) If the second trial CBM is within the limits as given in Paragraph 2.F./GENERAL, the second trial Check Balance Moment (CBM) becomes the new Static Balance Hinge Moment (SBHM).

second trial CBM = new (SBHM) = __________ lbfin (Nm) Continue with step 5.C.

(b) If the second trial CBM is not within the limits as given in Paragraph 2.F./GENERAL, do one of the steps that follows:

1) If there are not enough weight positions to bring the moment within the limits, do steps 5.B.(1) through 5.B.(12).

2) If there are not enough weight positions to bring the moment within the limits, you can restore rework capability as follows:

a) Remove all layers of paint from the elevator assembly.
- Refer to AMM PAGEBLOCK 51-21-11/701 for the paint removal procedures.
- Remove the balance adjust weights which are equal in moment to the layers of paint that were added to the initial paint application.

NOTE: These layers of paint are removed to restore the rework capability of the elevator assembly. This does not include the initial paint application. Do not remove the adjust weights necessary for the initial paint application.

b) Restore the decorative exterior paint to the elevator assembly.
- Use the same specification as the initial paint application you removed.
- Refer to Table 4/GENERAL for the data for 0.001 inch thickness of paint and its effect on the moment and moment arm.
- Refer to AMM PAGEBLOCK 51-21-99/701 for the paint application procedures. (The restored paint is a repaint. It will be will be necessary to

add adjust weights that are equal in moment to this paint application. If there are other rework areas or repairs on the elevator assembly, it is still necessary to add adjust weights equal in moment to these areas.)

- Repeat steps 5.B.(1) through 5.B.(12).
- If it is not possible to get the elevator balanced within the specified limits after the removal of multiple layers of paint, you can balance the elevator on the static balance jig because the limits for balancing on the balance jig are less strict. If this will not bring the elevator balance within the limits you must replace the elevator assembly.

Table 4:

VARIABLES FOR THE CALCULATION OF THE EFFECT OF ONE PAINT LAYER (BMS 10-60), 0.001 in. (0.0254 mm) THICK ON THE COMPONENT MOMENT OF THE ELEVATOR		
PAINTED SURFACE AREA PER ELEVATOR	**MOMENT AS A RESULT OF PAINT**	**MOMENT ARM OF ADDED PAINT** (Distance aft of the elevator hinge center-line)
ft^2 (m^2)	lbfin (Nm)	inches (mm)
70.8 (6.58)	+ 5.0056 (+ 0.5656)	+ 10.1 (+ 256.5)

C. Vibro-engrave or rubber-stamp the value of the new Static Balance Hinge Moment (SBHM) on the metal part identification plate (MS27253C2) that is attached to the elevator assembly.

(1) Apply a Skydrol resistant finish to the rubber-stamped data as given in SOPM 20-50-13.

(2) Do not stamp the installed metal nameplate with steel stamps.

(3) Make a record in the repair log of:

(a) The new Static Balance Hinge Moment (SBHM)

(b) The fact that the elevator has been balanced by calculation

(c) The type of repair

(d) The location of the repair

(e) The date when the elevator was repaired and balanced

(f) The number of elevator balance adjust weights that are installed and the number of available spaces for the addition of weight.

D. Example 1 - Elevator Assembly Static Balance Procedure by Measurement on the Balance Jig
Assume that a new elevator is damaged and the decision is made to remove the elevator from the airplane for repair and balancing.

(1) Make sure that the elevator assembly that you want to balance has the configuration as given in Paragraph 2.G./GENERAL

(2) Install the elevator assembly, with the upper surface up, in the static balance jig. (Refer to Elevator Support and Balance at the Time of the Balance Procedure on the Static Balance Jig, Figure 2/GENERAL)

(a) Use elevator hinge fitting number 2 (ELEVATOR STA 39.02), hinge fitting number 4 (ELEVATOR STA 121.59) (optional), and hinge fitting number 5 (ELEVATOR STA 176.64) for the installation of the elevator assembly in the balance jig.

NOTE: Make sure that the elevator assembly can pivot freely about its hinge centerline.

(b) Rotate all balance panel hinge halves (3 places) to their lowest position as shown in Configuration of the Elevator at the Time of the Balance Reduced on the Static Balance Jig, Figure 1/GENERAL.

(c) Level the horizontal chord plane ±1 degree with a protractor level.

(3) Use the platform scale and toolstand to measure the Weight Reaction (WR) at tab hinge fitting number 4 centerline. (Refer to Elevator Support and Balance at the Time of the Balance Procedure on the Static Balance Jig, Figure 2/GENERAL)

WR = +1.81 lbf (+8.05 N)

(4) Find the moment arm distance d from Elevator Support and Balance at the Time of the Balance Procedure on the Static Balance Jig, Figure 2/GENERAL. The moment arm distance d is the distance between the elevator hinge centerline and the tab hinge fitting centerline at tab hinge fitting number 4. This distance is aft of the elevator hinge centerline and is therefore positive.

d = +23.40 in. (+594.36 mm = +0.594 m)

(5) Calculate the trial Check Balance Moment (CBM) with the formula:

trial CBM = (WR) x (d), where:

trial CBM = (+1.81) x (+23.40) = +42.35 lbfin (+4.78 Nm)

(6) With this trial CBM you can do one of the steps that follow:

(a) The trial CBM does not meet the secondary static balance requirement as given in Paragraph 2.F./GENERAL, so it is necessary to install additional elevator balance adjust weights.

(b) To balance the elevator assembly to a desired balance moment between -175.28 and -88.47 lbfin (-19.80 and -10.00 Nm) by the addition of a sufficient number of elevator balance adjust weights, do as follows:

1) Decide what the desired balance moment will be. In this example the desired balance moment is chosen to be -124.00 lbfin (-14.01 Nm) maximum. This means that we will aim for a final Static Balance Hinge Moment (SBHM) of -124.00 lbfin (-14.01 Nm).

2) Find the number of elevator balance adjust weights that are already installed. In this example we assume that 11 upper elevator balance adjust weights are installed. This means that there are 16 positions left for additional upper weights. No lower elevator balance adjust weights are installed. This means that all 18 positions for lower weights are available.

NOTE: When the elevator assembly is balanced on a static balance jig it is recommended that you use the upper elevator balance adjust weights first. Only the lower elevator balance adjust weights are accessible when the elevator assembly is installed on the airplane. If possible, the lower elevator balance adjust weight locations should be reserved for balancing the elevator on the airplane.

3) Find the number of upper elevator balance adjust weights that must be installed first. In Elevator Assembly Balance Adjust Weight Table - Example 1, Figure 7/GENERAL, Table I move horizontally from left to right starting in the row of 11 existing adjust weights (point A). From this point, move to the right horizontally until you find the ΔM (upper) (point B) that you must add to your trial CBM to get the desired balance moment:

a) Find the ΔM that must be added to the trial CBM to get the desired balance moment:

ΔM = desired balance moment - trial CBM

ΔM = (-124.00) - (+42.35) = -166.35 lbfin (-18.80 Nm) maximum

b) With a maximum ΔM (desired) of -166.35 lbfin (-18.80 Nm) you must add 16 upper elevator balance adjust weights to get as near as possible to your desired balance moment (point C).

c) The addition of all remaining 16 upper adjust weights results in a ΔM (upper) of -135.40 lbfin (-15.30 Nm). To get nearer to the desired balance moment you will also have to add lower adjust weights.

4) Find the number of lower elevator balance adjust weights as follows:

a) The ΔM for the lower adjust weights needed to get the desired balance moment is:

ΔM (lower) = ΔM (desired) - ΔM (upper)

ΔM (lower) = (-166.35) - (-135.40)

ΔM (lower) = -30.95 lbfin (-3.50 Nm)

b) In Elevator Assembly Balance Adjust Weight Table - Example 1, Figure 7/GENERAL, Table II, move horizontally from left to right starting in the row of 0 existing lower adjust weights (point D). From this point, move to the right horizontally until you find the ΔM (point E) that you must add to your trial CBM to get the desired balance moment:

- With a desired ΔM (lower) of -30.95 lbfin (-3.50 Nm) you must add 4 lower elevator balance adjust weights to get as near as possible to your desired balance moment (point F).

5) Install the 16 upper and 4 lower elevator balance adjust weights as given in Paragraph 5.A.(5)/GENERAL

6) Calculate a second trial Check Balance Moment (CBM):

a) Rotate all balance panel hinge halves (3 places) to their lowest position as shown in Configuration of the Elevator at the Time of the Balance Reduced on the Static Balance Jig, Figure 1/GENERAL.

b) Level the horizontal chord plane ±1 degree with a protractor level.

c) Use the platform scale and toolstand to measure the Weight Reaction (WR) at tab hinge fitting number 4 centerline. (Refer to Elevator Support and Balance at the Time of the Balance Procedure on the Static Balance Jig, Figure 2/GENERAL)

WR = -5.06 lbf (-22.51 N)

d) second trial Check Balance Moment (CBM) = (WR) x (d)

second trial CBM = (-5.06) x (+23.40)

second trial CBM = -118.40 lbfin (-13.38 Nm)

e) The second trial CBM is within the limits as given in Paragraph 2.F./GENERAL The second trial Check Balance Moment (CBM) becomes the new Static Balance Hinge Moment (SBHM).

second CBM = new (SBHM) = -118.40 lbfin (-13.38 Nm) Continue with step 5.D.(7).

(c) To balance the elevator assembly nearest the most forward component moment of -175.28 lbfin (-19.80 Nm) to account for future repairs, painting, or rework, do as follows:

1) Find the number of elevator balance adjust weights that are already installed. In this example we assume that 11 upper elevator balance adjust weights are installed. This means that there are 16 positions left for additional upper weights. No lower elevator balance adjust weights are installed. This means that all 18 positions for lower weights are available.

   NOTE: When the elevator assembly is balanced on a static balance jig it is recommended that you use the upper elevator balance adjust weights first. Only the lower elevator balance adjust weights are accessible when the elevator assembly is installed on the airplane. If possible, the lower elevator balance adjust weight locations should be reserved for balancing the elevator on the airplane.

2) Find the ΔM that must be added to the trial CBM to get the moment nearest to the most forward component moment:

   ΔM = most forward component moment - trial CBM

   ΔM = (-175.28) - (+42.35) = -217.63 lbfin (-24.59 Nm) maximum

3) Find the number of upper elevator balance adjust weights that must be installed first. In Elevator Assembly Balance Adjust Weight Table - Example 1, Figure 7/GENERAL, Table, move horizontally from left to right starting in the row of 11 existing adjust weights (point A). From this point, move to the right horizontally until you find the ΔM (upper) (point B) that you must add to your trial CBM to get the most forward component moment:

   a) With a ΔM of -217.63 lbfin (-24.59 Nm) you must add 16 upper elevator balance adjust weights to get as close as possible to your most forward component moment (point C).

   b) The addition of all remaining 16 upper adjust weights results in a ΔM (upper) of -135.40 lbfin (-15.30 Nm). To get closer to the most forward component moment you will have to add lower adjust weights too.

4) The number of lower elevator balance adjust weights can be found as follows:

   a) The ΔM for the lower adjust weights needed to get the desired balance moment is:

      ΔM (lower) = ΔM (most forward component moment) - ΔM (upper)

      ΔM (lower) = (-217.63) - (-135.40)

      ΔM (lower) = -82.23 lbfin (-9.29 Nm)

   b) In Elevator Assembly Balance Adjust Weight Table - Example 1, Figure 7/GENERAL, Table II move horizontally from left to right starting in the row of 0 existing lower adjust weights (point D). From this point, move to the right horizontally until you find the ΔM (point G) that you must add to your trial CBM to get the most forward component moment:

      - With a desired ΔM (lower) of -82.23 lbfin (-9.29 Nm) you must add 11 lower elevator balance adjust weights to get as close as possible to your most forward component moment (point H).

5) Install the 16 upper and 11 lower elevator balance adjust weights as given in Paragraph 5.A.(5)/GENERAL

6) Calculate a second trial Check Balance Moment (CBM):

a) Rotate all balance panel hinge halves (3 places) to their lowest position as shown in Configuration of the Elevator at the Time of the Balance Reduced on the Static Balance Jig, Figure 1/GENERAL.

b) Level the horizontal chord plane ±1 degree with a protractor level.

c) Use the platform scale and toolstand to measure the Weight Reaction (WR) at tab hinge fitting number 3 centerline. (Refer to Elevator Support and Balance at the Time of the Balance Procedure on the Static Balance Jig, Figure 2/GENERAL)

WR = -7.24 lbf (-32.20 N)

d) second trial Check Balance Moment (CBM) = (WR) x (d) second trial CBM = (-7.24) X (+23.40)

second trial CBM = -169.42 lbfin (-19.14 Nm)

e) The second trial CBM is within the limits as given in Paragraph 2.F./GENERAL The second trial Check Balance Moment (CBM) becomes the new Static Balance Hinge Moment (SBHM).

second CBM = new (SBHM) = -169.42 lbfin (-19.24 Nm) Continue with step 5.D.(7).

(7) Vibro-engrave or rubber-stamp the value of the new Static Balance Hinge Moment (SBHM) on the metal part identification plate (MS27253C2) that is attached to the elevator assembly.

(a) Apply a Skydrol resistant finish to the rubber-stamped data as given in SOPM 20-50-13.

(b) Do not stamp the installed metal nameplate with steel stamps.

(8) Make a record in the repair log of:

(a) The new Static Balance Hinge Moment (SBHM)

(b) The fact that the elevator has been balanced on the static balance jig

(c) The type of repair

(d) The location of the repair

(e) The date when the elevator was repaired and balanced

(f) The number of elevator balance adjust weights that are installed and the number of available spaces for the addition of weight.

E. Example 2 - Elevator Assembly Static Balance Procedure by Calculation

(1) For this example we will assume what follows:

(a) A 250°F (121°C) cure repair as given in 51-70-05 has been done to the elevator with the elevator on the airplane.

(b) The current recorded Static Balance Hinge Moment (SBHM) is

-125.53 lbfin (-14.18 Nm).

(c) Fourteen of the twenty-seven upper elevator balance adjust weights have been installed during previous balance procedures. There are no lower elevator balance adjust weights installed.

(d) It is estimated that the Rework Moment (RM) as a result of the repair will not bring the elevator balance outside of the limits. Addition of elevator balance adjust weights will therefore not be necessary, unless you want to balance the elevator to a desired moment or nearest to the most forward component moment to account for future repairs, painting, and rework.

(2) Measure the distance D (within 0.1 inch (2.5 mm)). D is the distance from the rework center of gravity (CG) along the skin surface to the intersection of the centerline of the elevator hinge and the upper skin. Refer to Elevator Balance at Time of Balance Procedure by Calculation, Figure 6/GENERAL. For this example we will assume that

D = 8.6 in. (218.4 mm = 0.218 m)

(3) Measure or calculate the distance Y. Y is the distance from the elevator hinge centerline to the line through the CG of the rework, perpendicular to the elevator hinge line and parallel to the elevator chord line. Refer to Elevator Balance at Time of Balance Procedure by Calculation, Figure 6/GENERAL. To calculate the distance Y, use the formula that follows:

$Y = (D) \times (\cos 7.7^\circ) = (8.6) \times (\cos 7.7^\circ) = 8.5$ in. (0.216 m)

(4) Find which repair operations will add weight and which repair operations will remove weight. The weight of the repair ply material is not the same as the original material weight. Therefore, a Weight removed (Wr) and a Weight added (Wa) calculation must be made. The difference between the added and removed paint is negligible unless paint was added beyond the boundaries of the paint removed. The materials which will add weight to the 250°F (121°C) repair are shown in Repair (Typical) - Repair of Damage to One Skin and Honeycomb Core , Figure 8/GENERAL.

NOTE: For the Weight removed (Wr) calculation the areas of the plies removed are thought to be the same as those plies that replace them. Therefore, the weight change results from the weight for each unit difference. Typically for a 250°F (121°C) repair the replacement plies are slightly heavier than the initial plies and a net weight increase results from the addition of repair ply material.

(a) Weigh or calculate the Weight removed (Wr). Wr is the Weight removed as a result of rework, repair, or re-painting.

1) Be careful when you calculate the weight of the material removed (or lost as a result of damage) and the weight of the material added.

a) Measure or calculate the weight of the material removed and the weight of the material added as accurately as possible.

b) Keep the tolerance very small or else you can have weight that is not satisfactory. What follows will have an effect on the tolerance:

- The tolerance of the weighing equipment
- The precision in your estimation of the weight of the material that has been removed
- The precision in your estimation of the weight of the repair materials or paint.

2) If you calculate the Weight removed (Wr) do as follows:

NOTE: Refer to 51-60-00 for the weights of the materials.

Wr = (Area of Material) x (Weight for each unit Area) for ply material

Wr = (Volume of Material) x (Weight for each unit Area) for honeycomb material

a) For non-metallic honeycomb core, BMS 8-124, Class IV, Type V, Grade 3.0 (5.0 in. (127.0 mm) in diameter, 0.40 inch (10.2 mm) in depth):

$Wr1 = (\pi/4)(5.0)^2(0.40)(0.0017 \text{ lb/in}^3)$

$Wr1 = +0.0134$ lbm ($+0.0061$ kg)

b) For first (innermost) original ply - CFRP, BMS 8-256, Type IV, Class 2, Style 3K-70-PW (6.0 in. (152.4 mm) in diameter):

$Wr2 = (\pi/4)(6.0)^2(0.00046\ lb/in^2/ply)$

$Wr2 = +0.0130$ lbm ($+0.0059$ kg)

c) For second (middle) original ply - CFRP, BMS 8-256, Type IV, Class 2, Style 3K-70-PW (7.0 in. (177.8 mm) in diameter):

$Wr3 = (\pi/4)(7.0)^2(0.00046\ lb/in^2/ply)$

$Wr3 = +0.0177$ lbm ($+0.0080$ kg)

d) For third (middle) original ply - CFRP, BMS 8-256, Type IV, Class 2, Style 3K-70-PW (8.0 in. (203.2 mm) in diameter):

$Wr4 = (\pi/4)(8.0)^2(0.00046\ lb/in^2/ply)$

$Wr4 = +0.0231$ lbm ($+0.0105$ kg)

e) For fourth (outermost) original ply - CFRP, BMS 8-256, Type IV, Class 2, Style 3K-70-PW (9.0 in. (228.6 mm) in diameter):

$Wr5 = (\pi/4)(9.0)^2(0.00046\ lb/in^2/ply)$

$Wr5 = +0.0293$ lbm ($+0.0133$ kg)

f) The total Weight removed (Wr):

$Wr = Wr1 + Wr2 + Wr3 + Wr4 + Wr5$

$Wr = 0.0134 + 0.0130 + 0.0177 + 0.0231 + 0.0293$

$Wr = +0.0965$ lbm ($+0.0438$ kg)

(5) Weigh or calculate the Weight Added (Wa). Wa is the Weight added as a result of rework, repair, or re-painting. Refer to Repair (Typical) - Repair of Damage to One Skin and Honeycomb Core , Figure 8/GENERAL for the layout of the added repair materials.

(a) Be careful when you calculate the weight of the material removed (or lost as a result of damage) and the weight of the material added.

1) Measure or calculate the weight of the material removed and the weight of the material added as accurately as possible.

2) Keep the tolerance very small or else you can have weight that is not satisfactory. What follows will have an effect on the tolerance:

a) The tolerance of the weighing equipment

b) The precision in your estimation of the weight of the material that has been removed

c) The precision in your estimation of the weight of the repair materials or paint.

3) If you calculate the Weight Added (Wa) do as follows:

NOTE: Refer to 51-60-00 for the weights of the materials.

Wa = (Area of Material) x (Weight per unit Area) for ply material

Wa = (Volume of Material) x (Weight per unit) Area for honeycomb material

a) Repair Item 1 - Adhesive Film - BMS 8-245, Type II, Class 1, Grade 3A (5.0 in. (127.0 mm) in diameter):

$Wa1 = (\pi/4)(5.0)^2(0.00020\ lb/in^2)$

$Wa1 = 0.0039$ lbm (0.0018 kg)

b) Repair Item 2 - Foaming Adhesive - BMS 5-90, Type II, Grade 50 (0.40 in. (10.2 mm) in width, 5π in. (127π mm) in length):

$Wa2 = (5\pi)(0.40)(0.0025\ lb/in^2)$

$Wa2 = 0.0157$ lbm (0.0071 kg)

c) Repair Item 3 - Replacement Core Plug - Non-metallic honeycomb core, BMS 8-124, Class IV, Type V, Grade 3.0 (5.0 in. (152.4 mm) in diameter, 0.40 in. (10.2 mm) in depth):

$Wa3 = (\pi/4)(5.0)^2(0.40)(0.0017\ lb/in^3)$

$Wa3 = 0.0134$ lbm (0.0061 kg)

d) Repair Item 4 - Adhesive Film - BMS 8-245, Type II, Class 1, Grade 3A (12.0 in. (304.8 mm) in diameter):

$Wa4 = (\pi/4)(12.0)^2(0.00020\ lb/in^2)$

$Wa4 = 0.0226$ lbm (0.0103 kg)

e) Repair Item 5 - Filler Ply - CFRP, BMS 8-256, Type IV, Class 2, Style 3K-70-PW (5.0 in. (127.0 mm) in diameter):

$Wa5 = (\pi/4)(5.0)^2(0.00046\ lb/in^2/ply)$

$Wa5 = 0.0090$ lbm (0.0041 kg)

f) Repair Item 6 - Replacement Ply - CFRP, BMS 8-256, Type IV, Class 2, Style 3K-70-PW (6.0 in. (152.4 mm) in diameter):

$Wa6 = (\pi/4)(6.0)^2(0.00046\ lb/in^2/ply)$

$Wa6 = 0.0130$ lbm (0.0059 kg)

g) Repair Item 7 - Replacement Ply - CFRP, BMS 8-256, Type IV, Class 2, Style 3K-70-PW (7.0 in. (177.8 mm) in diameter):

$Wa7 = (\pi/4)(7.0)^2(0.00046\ lb/in^2/ply)$

$Wa7 = 0.0177$ lbm (0.0080 kg)

h) Repair Item 8 - Replacement Ply - CFRP, BMS 8-256, Type IV, Class 2, Style 3K-70-PW (8.0 in. (203.2 mm) in diameter):

$Wa8 = (\pi/4)(8.0)^2(0.00046\ lb/in^2/ply)$

$Wa8 = 0.0231$ lbm (0.0105 kg)

i) Repair Item 9 - Replacement Ply - CFRP, BMS 8-256, Type IV, Class 2, Style 3K-70-PW (9.0 in. (228.6 mm) in diameter):

$Wa9 = (\pi/4)(9.0)^2(0.00046\ lb/in^2/ply)$

$Wa9 = 0.0293$ lbm (0.0133 kg)

j) Repair Item 10 - Extra Repair Ply - CFRP, BMS 8-256, Type IV, Class 2, Style 3K-70-PW (10.0 in. (254.0 mm) in diameter):

$Wa10 = (\pi/4)(10.0)^2(0.00046\ lb/in^2/ply)$

$Wa10 = 0.0361$ lbm (0.0164 kg)

k) Repair Item 11 - Extra Repair Ply - CFRP, BMS 8-256, Type IV, Class 2, Style 3K-70-PW (11.0 in. (279.4 mm) in diameter):

$Wa11 = (\pi/4)(11.0)^2(0.00046\ lb/in^2/ply)$

Wa11 = 0.0437 lbm (0.0198 kg)

l) Repair Item 12 - Adhesive Film - BMS 8-245, Type II, Class 1, Grade 3A (12.0 in.) (304.8 mm) in diameter:

$Wa12 = (\pi/4)(12.0)^2(0.00020\ lb/in^2)$

Wa12 = 0.0226 lbm (0.0103 kg)

m) The total Weight Added (Wa):

Wa = Wa1 + Wa2 + Wa3 + Wa4 + Wa5 + Wa6 + Wa7 + Wa8 + Wa9 + Wa10 + Wa11 + Wa12

Wa = 0.0039 + 0.0157 + 0.0134 + 0.0226 + 0.0090 + 0.0130 + 0.0177 + 0.0231 + 0.0293 + 0.0361 + 0.0437 + 0.0226

Wa = 0.2501 lbm (0.1134 kg)

(6) Calculate the Rework Weight (RW). RW is the net change in weight as a result of rework, repair, or re-painting.

RW = Wa - Wr = 0.2501 - 0.0965

RW = 0.1536 lbm (0.0697 kg)

(7) Calculate the Rework Moment (RM). RM is the net change in balance moment as a result of rework, repair, or re-painting.

RM = (RW) x (Y)

RM = (0.1536) x (8.5) = +1.3 lbfin (+0.2 Nm)

(8) Calculate the trial Check Balance Moment (CBM). The trial CBM is the new final moment (Static Balance Hinge Moment) if it is within the given limits.

trial CBM = (SBHM) + (RM)

trial CBM = (-125.53) + (1.3) = -124.23 lbfin (-14.0 Nm) where SBHM is the Static Balance Hinge Moment that is the previous final moment stamped on the nameplate of the elevator.

(9) With this trial CBM you can do one of the steps that follow:

(a) The trial CBM meets the secondary static balance requirement as given in Paragraph 2.F./GENERAL, so it is not necessary to install additional elevator balance adjust weights. In this case, the trial CBM is the new final moment Static Balance Hinge Moment. Continue with step 5.E.(10).

(b) If you want to balance the elevator assembly to a desired balance moment anywhere between -175.28 and -110.17 lbfin (-19.80 and -12.45 Nm) by adding sufficient elevator balance adjust weights, do as follows:

1) First, you must decide what the desired balance moment will be. In this example the desired balance moment is chosen to be -152.0 lbfin (-17.2 Nm) maximum. This means that we will aim for a final Static Balance Hinge Moment (SBHM) of -152.0 lbfin (-17.2 Nm).

2) Then, you must find the number of elevator balance adjust weights that are already installed. In this example we assume that 10 upper elevator balance adjust weights are installed. This means that there are 17 positions left for additional upper weights. No lower elevator balance adjust weights are installed. This means that all 18 positions for lower weights are available.

3) Find the ΔM that must be added to the trial CBM to get the desired balance moment:

ΔM = desired balance moment - trial CBM

ΔM = (-152.0) - (-124.23) = -27.77 lbfin (-3.14 Nm) maximum

NOTE: Because all the lower elevator balance adjust weight positions are available, the ΔM required can be reached with the addition of lower adjust weights only. In this situation the elevator does not have to be removed from the airplane.

4) The number of lower elevator balance adjust weights that must be installed can be found as follows: In Elevator Assembly Balance Adjust Weight Table - Example 2, Figure 9/GENERAL, Table I move horizontally from left to right starting in the row of 0 existing adjust weights (point V). From this point, move to the right horizontally until you find the ΔM (lower) (point W) that you must add to your trial CBM to get the desired balance moment: With a maximum desired ΔM of -27.77 lbfin (-3.14 Nm) you must add 4 lower elevator balance adjust weights to get as close as possible to your desired balance moment (point X).
   a) The addition of 4 lower adjust weights results in a ΔM (lower) of -25.26 lbfin (-2.85 Nm).
5) Get access to the lower balance weight locations of balance bays number 3, 4, and 5.
   a) Remove access panels 333CB (LH) and 343CB, 333DB (LH) and 343DB (RH), and 333EB (LH) and 343EB (RH), as applicable. Refer to AMM SUBJECT 06-42-00.
6) Install the 4 lower elevator balance adjust weights as given in Paragraph 5.B.(11)/GENERAL
7) Calculate the new Static Balance Hinge Moment (SBHM):

   new SBHM = trial CBM + ΔM

   new SBHM = (-124.23) + (-25.26)

   new SBHM = -149.49 lbfin (-16.89 Nm) Continue with step 5.E.(10).

(c) To balance the elevator assembly nearest to the most forward component moment of -175.28 lbfin (-19.80 Nm) to account for future repairs, painting, or rework, do as follows:
1) Find the number of elevator balance adjust weights that are already installed. In this example we assume that 10 upper elevator balance adjust weights are installed. This means that there are 17 positions left for additional upper weights. No lower elevator balance adjust weights are installed. This means that all 18 positions for lower weights are available.
2) Find the ΔM that must be added to the trial CBM to get closest to the most forward component moment:

   ΔM = most forward component moment - trial CBM

   ΔM = (-175.28) - (-124.23) = -51.05 lbfin (-5.77 Nm) maximum

   NOTE: Because all the lower elevator balance adjust weight positions are available, the ΔM required can be reached with the addition of lower adjust weights only. In this situation the elevator does not have to be removed from the airplane.

3) The number of lower elevator balance adjust weights that must be installed can be found as follows: In Elevator Assembly Balance Adjust Weight Table - Example 2, Figure 9/GENERAL, Table I move horizontally from left to right starting in the row of 0 existing adjust weights (point V). From this point, move to the right horizontally until you find the ∆M (lower) (point Y) that you must add to your trial CBM to get the most forward component moment: With a desired ∆M of -51.05 lbfin (-5.77 Nm) you must add 7 lower elevator balance adjust weights to get as close as possible to your most forward component moment (point Z).
   a) The addition of 7 lower adjust weights results in a ∆M (lower) of -47.79 lbfin (-5.40 Nm).
4) Install the 7 lower elevator balance adjust weights as given in Paragraph 5.B.(11)/GENERAL
5) Calculate the new Static Balance Hinge Moment (SBHM):

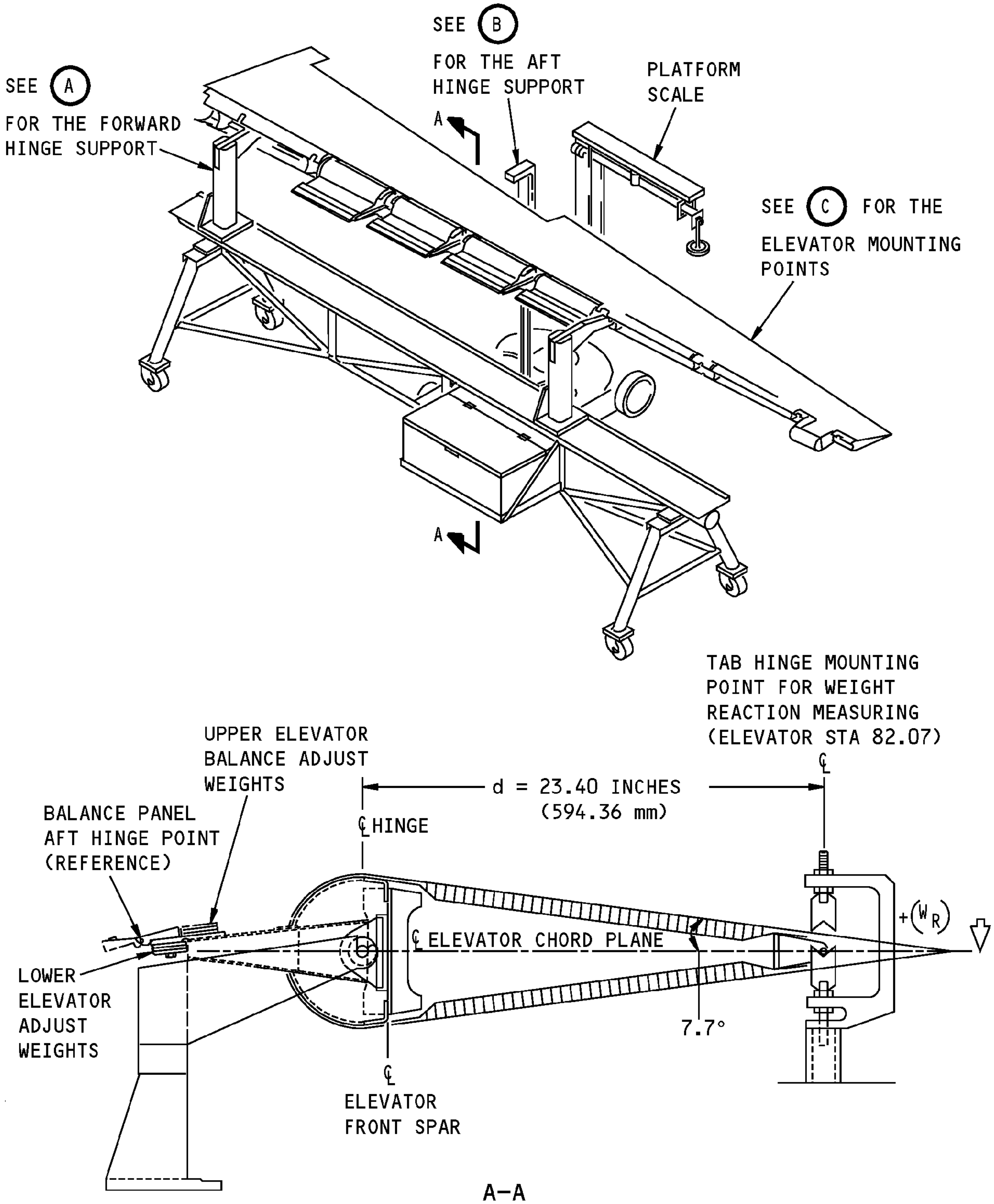
   new SBHM = first trial CBM + ∆M

   new SBHM = (-124.23) + (-47.79)

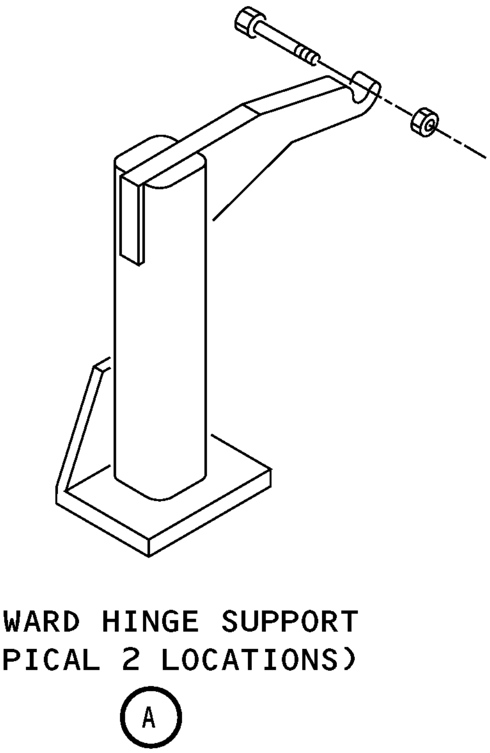
   new SBHM = -172.02 lbfin (-19.44 Nm) Continue with step 5.E.(10).

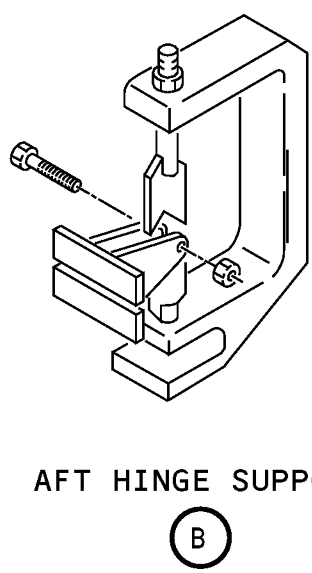
(10) Vibro-engrave or rubber-stamp the value of the new Static Balance Hinge Moment (SBHM) on the metal part identification plate (MS27253C2) that is attached to the elevator assembly.
   (a) Apply a Skydrol resistant finish to the rubber-stamped data as given in SOPM 20-50-13.
   (b) Do not stamp the installed metal nameplate with steel stamps.

(11) Make a record in the repair log of:
   (a) The new Static Balance Hinge Moment (SBHM)
   (b) The fact that the elevator has been balanced by calculation
   (c) The type of repair
   (d) The location of the repair
   (e) The date when the elevator was repaired and balanced
   (f) The number of elevator balance adjust weights that are installed and the number of available spaces for the addition of weight.

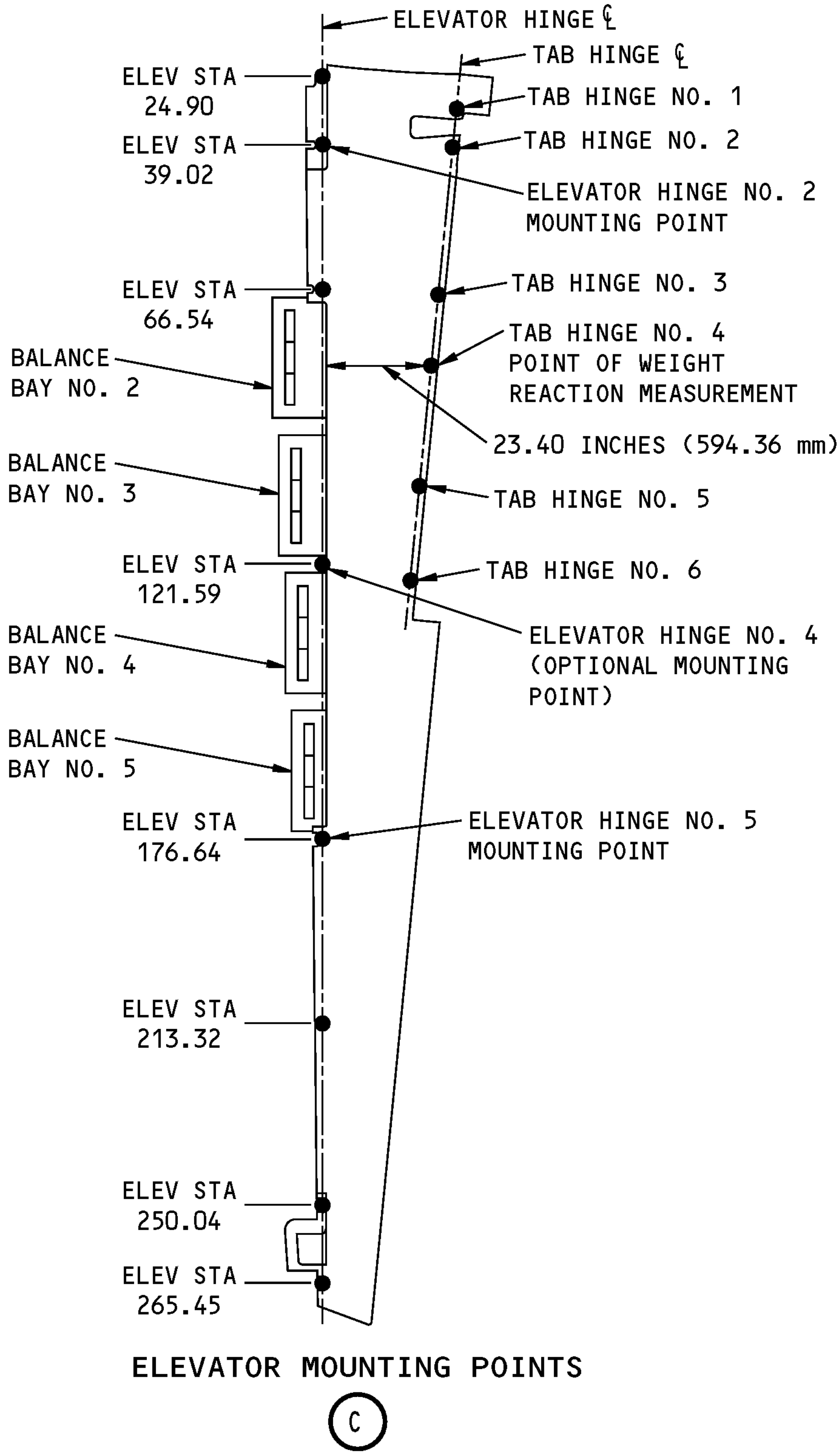


Elevator Support and Balance at the Time of the Balance Procedure on the Static Balance Jig
Figure 2 (Sheet 1 of 3)





Elevator Support and Balance at the Time of the Balance Procedure on the Static Balance Jig
Figure 2 (Sheet 2 of 3)



Elevator Support and Balance at the Time of the Balance Procedure on the Static Balance Jig
Figure 2 (Sheet 3 of 3)

NUMBER OF EXISTING UPPER WEIGHTS	ELEVATOR ASSEMBLY 183A0103-(), 002A0016-31, 002A0016-32										
	TOTAL CHANGE IN MOMENT ΔM (UPPER) DUE TO ADDING (n) UPPER ADJUST WEIGHTS (lbf.in) [1]										
	NUMBER OF 69-53211-2 UPPER ADJUST WEIGHTS (n) TO BE ADDED TO EXISTING UPPER WEIGHTS										
	1	2	3	4	5	6	7	8	9	10	11
0	7.00	14.00	21.00	29.30	37.60	45.90	55.50	65.10	74.70	81.70	88.70
1	7.00	14.00	22.30	30.60	38.90	48.50	58.10	67.70	74.70	81.70	88.70
2	7.00	15.30	23.60	31.90	41.50	51.10	60.70	67.70	74.70	81.70	90.00
3	8.30	16.60	24.90	34.50	44.10	53.70	60.70	67.70	74.70	83.00	91.30
4	8.30	16.60	26.20	35.80	45.40	52.40	59.40	66.40	74.70	83.00	91.30
5	8.30	17.90	27.50	37.10	44.10	51.10	58.10	66.40	74.70	83.00	92.60
6	9.60	19.20	28.80	35.80	42.80	49.80	58.10	66.40	74.70	84.30	93.90
7	9.60	19.20	26.20	33.20	40.20	48.50	56.80	65.10	74.70	84.30	93.90
8	9.60	16.60	23.60	30.60	38.90	47.20	55.50	65.10	74.70	84.30	91.30
9	7.00	14.00	21.00	29.30	37.60	45.90	55.50	65.10	74.70	81.70	88.70
10	7.00	14.00	22.30	30.60	38.90	48.50	58.10	67.70	74.70	81.70	88.70
11	7.00	15.30	23.60	31.90	41.50	51.10	60.70	67.70	74.70	81.70	90.00
12	8.30	16.60	24.90	34.50	44.10	53.70	60.70	67.70	74.70	83.00	91.30
13	8.30	16.60	26.20	35.80	45.40	52.40	59.40	66.40	74.70	83.00	91.30
14	8.30	17.90	27.50	37.10	44.10	51.10	58.10	66.40	74.70	83.00	92.60
15	9.60	19.20	28.80	35.80	42.80	49.80	58.10	66.40	74.70	84.30	93.90
16	9.60	19.20	26.20	33.20	40.20	48.50	56.80	65.10	74.70	84.30	93.90
17	9.60	16.60	23.60	30.60	38.90	47.20	55.50	65.10	74.70	84.30	
18	7.00	14.00	21.00	29.30	37.60	45.90	55.50	65.10	74.70		
19	7.00	14.00	22.30	30.60	38.90	48.50	58.10	67.70			
20	7.00	15.30	23.60	31.90	41.50	51.10	60.70				
21	8.30	16.60	24.90	34.50	44.10	53.70					
22	8.30	16.60	26.20	35.80	45.40						
23	8.30	17.90	27.50	37.10							
24	9.60	19.20	28.80								
25	9.60	19.20									
26	9.60										

GO TO SHEET 2

UPPER BALANCE ADJUST WEIGHTS
TABLE I

Elevator Assembly Balance Adjust Weight Table
Figure 3 (Sheet 1 of 5)

NUMBER OF EXISTING UPPER WEIGHTS	ELEVATOR ASSEMBLY 183A0103-(), 002A0016-31, 002A0016-32										
	TOTAL CHANGE IN MOMENT ΔM (UPPER) DUE TO ADDING (n) UPPER ADJUST WEIGHTS (lbf.in) [1]										
	NUMBER OF 69-53211-2 UPPER ADJUST WEIGHTS (n) TO BE ADDED TO EXISTING UPPER WEIGHTS										
	12	13	14	15	16	17	18	19	20	21	22
0	95.70	104.00	112.30	120.60	130.20	139.80	149.40	156.40	163.40	170.40	178.70
1	97.00	105.30	113.60	123.20	132.80	142.40	149.40	156.40	163.40	171.70	180.00
2	98.30	106.60	116.20	125.80	135.40	142.40	149.40	156.40	164.70	173.00	181.30
3	99.60	109.20	118.80	128.40	135.40	142.40	149.40	157.70	166.00	174.30	183.90
4	100.90	110.50	120.10	127.10	134.10	141.10	149.40	157.70	166.00	175.60	185.20
5	102.20	111.80	118.80	125.80	132.80	141.10	149.40	157.70	167.30	176.90	186.50
6	103.50	110.50	117.50	124.50	132.80	141.10	149.40	159.00	168.60	178.20	
7	100.90	107.90	114.90	123.20	131.50	139.80	149.40	159.00	168.60		
8	98.30	105.30	113.60	121.90	130.20	139.80	149.40	159.00			
9	95.70	104.00	112.30	120.60	130.20	139.80	149.40				
10	97.00	105.30	113.60	123.20	132.80	142.40					
11	98.30	106.60	116.20	125.80	135.40						
12	99.60	109.20	118.80	128.40							
13	100.90	110.50	120.10								
14	102.20	111.80									
15	103.50										

GO TO SHEET 3

UPPER BALANCE ADJUST WEIGHTS
TABLE I

Elevator Assembly Balance Adjust Weight Table
Figure 3 (Sheet 2 of 5)

NUMBER OF EXISTING UPPER WEIGHTS	ELEVATOR ASSEMBLY 183A0103-(), 002A0016-31, 002A0016-32				
	TOTAL CHANGE IN MOMENT ΔM (UPPER) DUE TO ADDING (n) UPPER ADJUST WEIGHTS (lbf.in) [1]				
	NUMBER OF 69-53211-2 UPPER ADJUST WEIGHTS (n) TO BE ADDED TO EXISTING UPPER WEIGHTS				
	23	24	25	26	27
0	187.00	195.30	204.90	214.50	224.10
1	188.30	197.90	207.50	217.10	
2	190.90	200.50	210.10		
3	193.50	203.10			
4	194.80				

UPPER BALANCE ADJUST WEIGHTS
TABLE I

Elevator Assembly Balance Adjust Weight Table
Figure 3 (Sheet 3 of 5)

NUMBER OF EXISTING LOWER WEIGHTS	ELEVATOR ASSEMBLY 183A0103-(), 002A0016-31, 002A0016-32										
	TOTAL CHANGE IN MOMENT ΔM (LOWER) DUE TO ADDING (n) LOWER ADJUST WEIGHTS (lbf.in) [2]										
	NUMBER OF 183A0210-1 LOWER ADJUST WEIGHTS (n) TO BE ADDED TO EXISTING LOWER WEIGHTS										
	1	2	3	4	5	6	7	8	9	10	11
0	6.04	12.08	18.12	25.26	32.40	39.54	47.79	56.04	64.29	70.33	76.37
1	6.04	12.08	19.22	26.36	33.50	41.75	50.00	58.25	64.29	70.33	77.47
2	6.04	13.18	20.32	27.46	35.71	43.96	52.21	58.25	64.29	71.43	78.57
3	7.14	14.28	21.42	29.67	37.92	46.17	52.21	58.25	65.39	72.53	80.78
4	7.14	14.28	22.53	30.78	39.03	45.07	51.11	58.25	65.39	73.64	81.89
5	7.14	15.39	23.64	31.89	37.93	43.97	51.11	58.25	66.50	74.75	80.79
6	8.25	16.50	24.75	30.79	36.83	43.97	51.11	59.36	67.61	73.65	80.79
7	8.25	16.50	22.54	28.58	35.72	42.86	51.11	59.36	65.40	72.54	80.79
8	8.25	14.29	20.33	27.47	34.61	42.86	51.11	57.15	64.29	72.54	
9	6.04	12.08	19.22	26.36	34.61	42.86	48.90	56.04	64.29		
10	6.04	13.18	20.32	28.57	36.82	42.86	50.00	58.25			
11	7.14	14.28	22.53	30.78	36.82	43.96	52.21				
12	7.14	15.39	23.64	29.68	36.82	45.07					
13	8.25	16.50	22.54	29.68	37.93						
14	8.25	14.29	21.43	29.68							
15	6.04	13.18	21.43								
16	7.14	15.39									
17	8.25										

GO TO SHEET 5

LOWER BALANCE ADJUST WEIGHTS
TABLE II

Elevator Assembly Balance Adjust Weight Table
Figure 3 (Sheet 4 of 5)

NUMBER OF EXISTING LOWER WEIGHTS	ELEVATOR ASSEMBLY 183A0103-(), 002A0016-31, 002A0016-32						
	TOTAL CHANGE IN MOMENT ΔM (LOWER) DUE TO ADDING (n) LOWER ADJUST WEIGHTS (lbf.in) [2]						
	NUMBER OF 183A0210-1 LOWER ADJUST WEIGHTS (n) TO BE ADDED TO EXISTING LOWER WEIGHTS						
	12	13	14	15	16	17	18
0	83.51	90.65	98.90	107.15	113.19	120.33	128.58
1	84.61	92.86	101.11	107.15	114.29	122.54	
2	86.82	95.07	101.11	108.25	116.50		
3	89.03	95.07	102.21	110.46			
4	87.93	95.07	103.32				
5	87.93	96.18					
6	89.04						

LOWER BALANCE ADJUST WEIGHTS
TABLE II

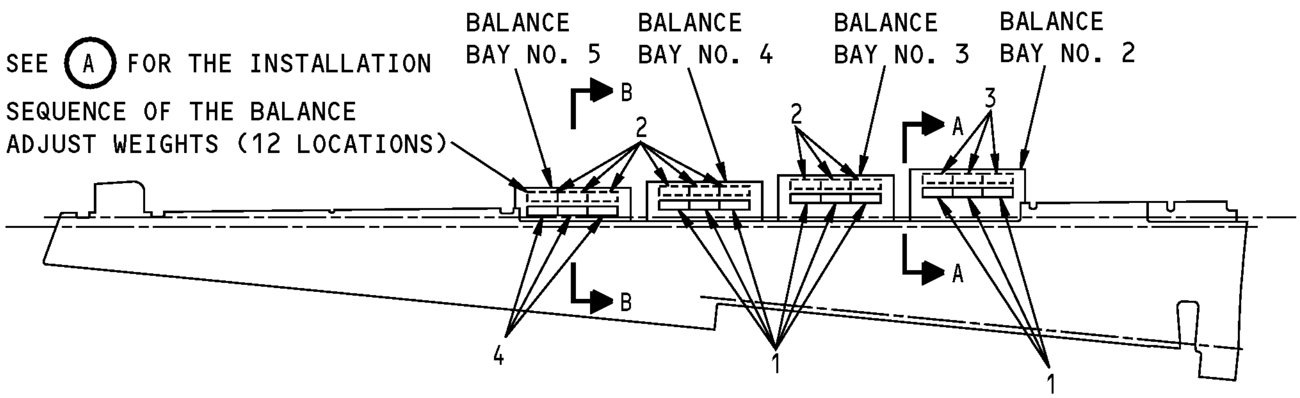
NOTES

- THE SEQUENCE OF INSTALLATION OF THE BALANCE ADJUST WEIGHTS, THE WEIGHT OF THE BALANCE ADJUST WEIGHTS, AND THE MOMENT ARM PER BALANCE BAY AND ADJUST WEIGHT ARE INCLUDED IN TABLE I.
- REFER TO FIGURE 4 FOR THE INSTALLATION SEQUENCE OF THE BALANCE ADJUST WEIGHTS.
- TO CONVERT FROM lbf.in TO Nm, MULTIPLY BY 0.1129848

[1] ALL MOMENT INCREMENTS (ΔM [UPPER]) ARE NEGATIVE

[2] ALL MOMENT INCREMENTS (ΔM [LOWER]) ARE NEGATIVE

Elevator Assembly Balance Adjust Weight Table
Figure 3 (Sheet 5 of 5)



FWD

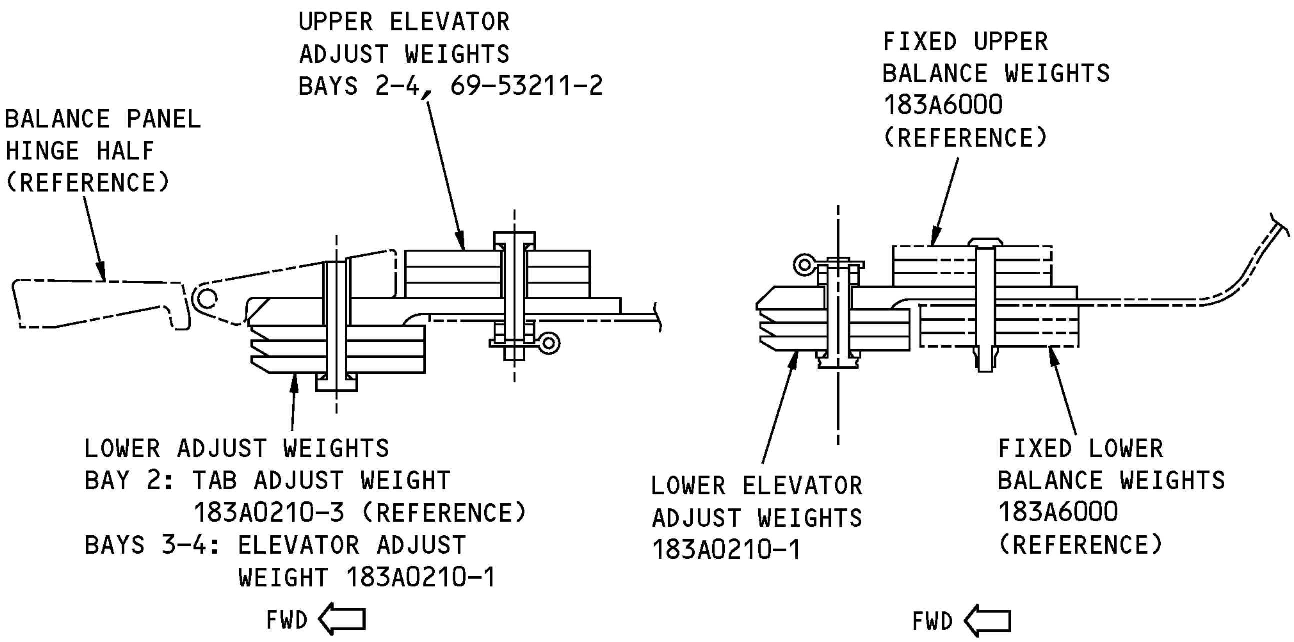
INBD

1 - UPPER ELEVATOR ADJUST WEIGHT 69-53211-2

2 - LOWER ELEVATOR ADJUST WEIGHT 183A0210-1

3 - LOWER TAB ADJUST WEIGHT 183A0210-3 (REFERENCE)

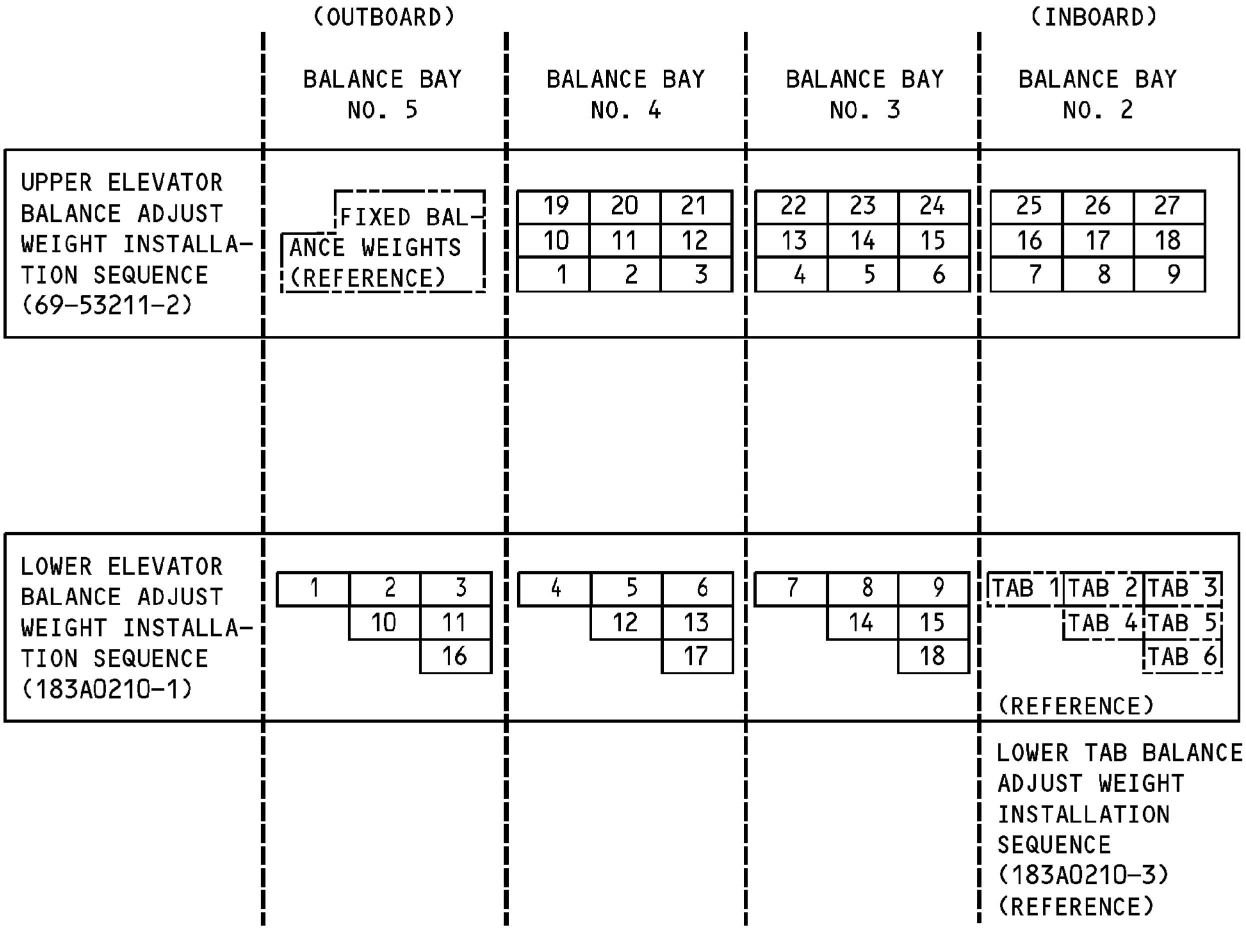
4 - FIXED LOWER BALANCE WEIGHT AND FIXED UPPER BALANCE WEIGHT 183A6000 (REFERENCE FOR INSTALLATION OF WEIGHTS)



VIEW WHEN YOU LOOK INBOARD
BALANCE BAYS 2-4 (TYPICAL)
A-A

VIEW WHEN YOU LOOK INBOARD
BALANCE BAY 5
B-B

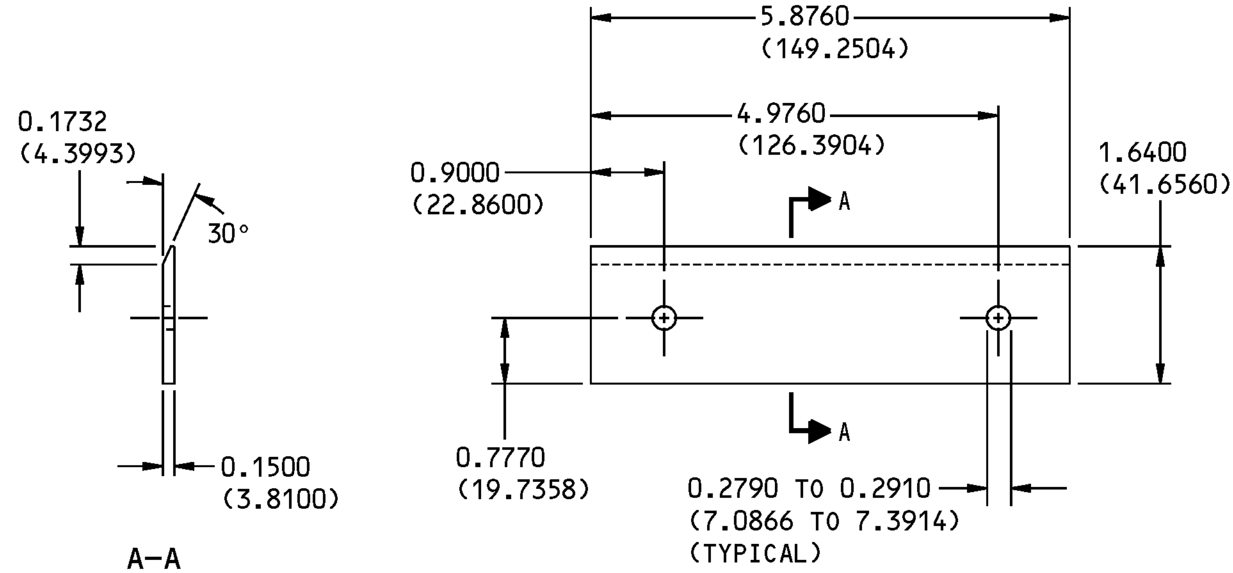
Elevator Balance Adjust Weight Location and Installation Sequence
Figure 4 (Sheet 1 of 2)



ELEVATOR BALANCE ADJUST WEIGHT INSTALLATION SEQUENCE

A

Elevator Balance Adjust Weight Location and Installation Sequence
Figure 4 (Sheet 2 of 2)

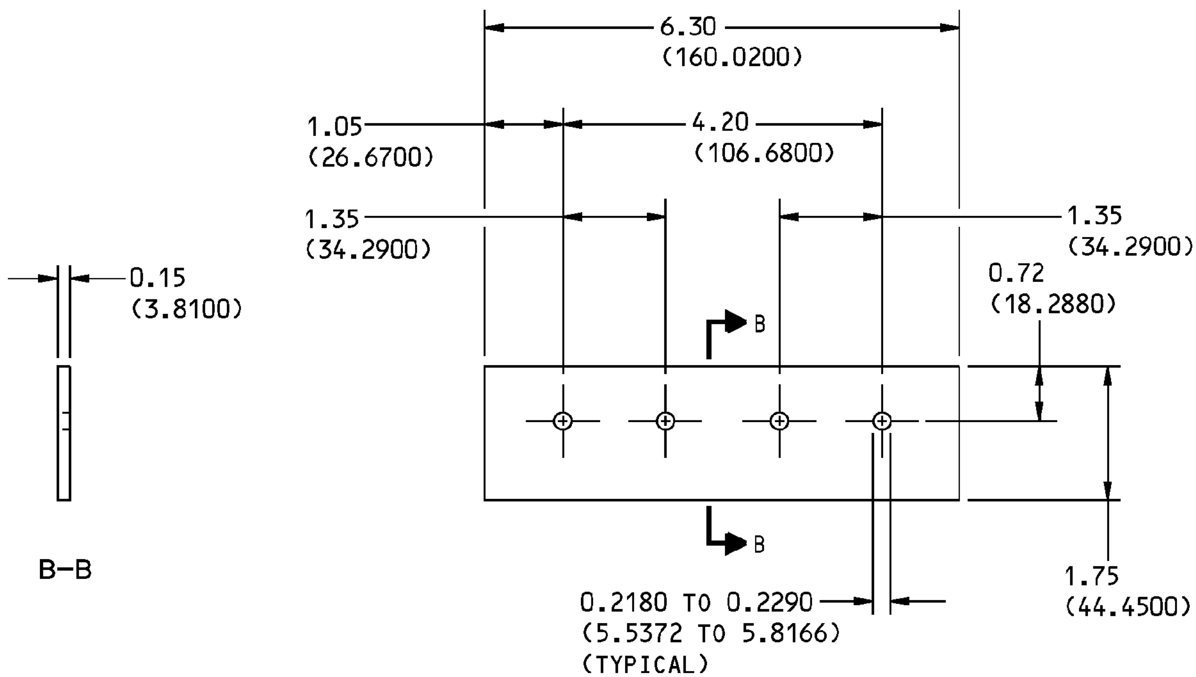


ELEVATOR BALANCE ADJUST WEIGHT 183A0210-1

NOTES

- ALL DIMENSIONS ARE IN INCHES (mm).
- MATERIAL: TUNGSTEN ALLOY AS GIVEN IN MIL-T-21014, SINTERED CLASS 1.
- ALL SINTERED SURFACES MUST BE 250 R_a OR SMOOTHER.
- ALL MACHINED SURFACES MUST BE 125 R_a OR SMOOTHER.
- DRY ABRASIVE BLAST (REFER TO SOPM 20-30-03) AND APPLY TWO COATS OF BMS 10-79, TYPE III PRIMER AS GIVEN IN SOPM 20-44-04.
- THE FINISHED PART MUST HAVE A WEIGHT OF 0.78 TO 0.92 POUND (0.3538 TO 0.4173 KILOGRAM).

Elevator Balance Adjust Weights
Figure 5 (Sheet 1 of 2)

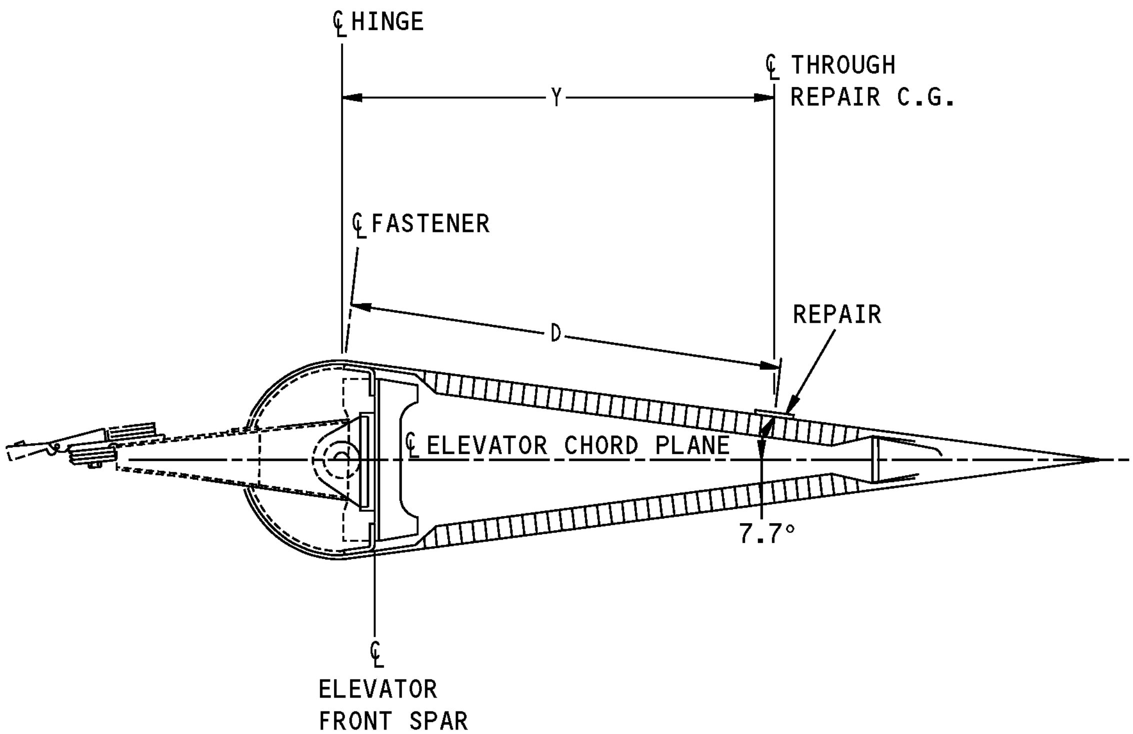


ELEVATOR BALANCE ADJUST WEIGHT 69-53211-2

NOTES

- ALL DIMENSIONS ARE IN INCHES (mm)
- MATERIAL: TUNGSTEN ALLOY AS GIVEN IN MIL-T-21014, SINTERED CLASS 1
- ALL SINTERED SURFACES MUST BE 250 R_a OR SMOOTHER
- ALL MACHINED SURFACES MUST BE 125 R_a OR SMOOTHER
- APPLY TWO COATS OF BMS 10-11, TYPE 1 PRIMER AS GIVEN IN SOPM 20-41-02
- THE FINISHED PART MUST HAVE A WEIGHT OF 0.93 TO 1.07 POUNDS (0.4218 TO 0.4853 KILOGRAM)

Elevator Balance Adjust Weights
Figure 5 (Sheet 2 of 2)



Elevator Balance at Time of Balance Procedure by Calculation
Figure 6

NUMBER OF EXISTING UPPER WEIGHTS	ELEVATOR ASSEMBLY 183A0103-(), 002A0016-31, 002A0016-32 — TOTAL CHANGE IN MOMENT ΔM (UPPER) DUE TO ADDING (n) UPPER ADJUST WEIGHTS (lbf.in) 1 — NUMBER OF 69-53211-2 UPPER ADJUST WEIGHTS (n) TO BE ADDED TO EXISTING UPPER WEIGHTS										
	1	2	3	4	5	6	7	8	9	10	11
0	7.00	14.00	21.00	29.30	37.60	45.90	55.50	65.10	74.70	81.70	88.70
1	7.00	14.00	22.30	30.60	38.90	48.50	58.10	67.70	74.70	81.70	88.70
2	7.00	15.30	23.60	31.90	41.50	51.10	60.70	67.70	74.70	81.70	90.00
3	8.30	16.60	24.90	34.50	44.10	53.70	60.70	67.70	74.70	83.00	91.30
4	8.30	16.60	26.20	35.80	45.40	52.40	59.40	66.40	74.70	83.00	91.30
5	8.30	17.90	27.50	37.10	44.10	51.10	58.10	66.40	74.70	83.00	92.60
6	9.60	19.20	28.80	35.80	42.80	49.80	58.10	66.40	74.70	84.30	93.90
7	9.60	19.20	26.20	33.20	40.20	48.50	56.80	65.10	74.70	84.30	93.90
8	9.60	16.60	23.60	30.60	38.90	47.20	55.50	65.10	74.70	84.30	91.30
9	7.00	14.00	21.00	29.30	37.60	45.90	55.50	65.10	74.70	81.70	88.70
10	7.00	14.00	22.30	30.60	38.90	48.50	58.10	67.70	74.70	81.70	88.70
11	~~7.00~~	~~15.30~~	~~23.60~~	~~31.90~~	~~41.50~~	~~51.10~~	~~60.70~~	~~67.70~~	~~74.70~~	~~81.70~~	~~90.00~~
	8.30	16.60	24.90	34.50	44.10	53.70	60.70	67.70	74.70	83.00	91.30
A	8.30	16.60	26.20	35.80	45.40	52.40	59.40	66.40	74.70	83.00	91.30
	8.30	17.90	27.50	37.10	44.10	51.10	58.10	66.40	74.70	83.00	92.60
15	9.60	19.20	28.80	35.80	42.80	49.80	58.10	66.40	74.70	84.30	93.90
16	9.60	19.20	26.20	33.20	40.20	48.50	56.80	65.10	74.70	84.30	93.90
17	9.60	16.60	23.60	30.60	38.90	47.20	55.50	65.10	74.70	84.30	
18	7.00	14.00	21.00	29.30	37.60	45.90	55.50	65.10	74.70		
19	7.00	14.00	22.30	30.60	38.90	48.50	58.10	67.70			
20	7.00	15.30	23.60	31.90	41.50	51.10	60.70				
21	8.30	16.60	24.90	34.50	44.10	53.70					
22	8.30	16.60	26.20	35.80	45.40						
23	8.30	17.90	27.50	37.10							
24	9.60	19.20	28.80								
25	9.60	19.20									
26	9.60										

GO TO SHEET 2

UPPER BALANCE ADJUST WEIGHTS
TABLE I

Elevator Assembly Balance Adjust Weight Table - Example 1
Figure 7 (Sheet 1 of 5)

C

NUMBER OF EXISTING UPPER WEIGHTS	ELEVATOR ASSEMBLY 183A0103-(), 002A0016-31, 002A0016-32										
	TOTAL CHANGE IN MOMENT ΔM (UPPER) DUE TO ADDING (n) UPPER ADJUST WEIGHTS (lbf.in) [1]										
	NUMBER OF 69-53211-2 UPPER ADJUST WEIGHTS (n) TO BE ADDED TO EXISTING UPPER WEIGHTS										
	12	13	14	15	16	17	18	19	20	21	22
0	95.70	104.00	112.30	120.60	130.20	139.80	149.40	156.40	163.40	170.40	178.70
1	97.00	105.30	113.60	123.20	132.80	142.40	149.40	156.40	163.40	171.70	180.00
2	98.30	106.60	116.20	125.80	135.40	142.40	149.40	156.40	164.70	173.00	181.30
3	99.60	109.20	118.80	128.40	135.40	142.40	149.40	157.70	166.00	174.30	183.90
4	100.90	110.50	120.10	127.10	134.10	141.10	149.40	157.70	166.00	175.60	185.20
5	102.20	111.80	118.80	125.80	132.80	141.10	149.40	157.70	167.30	176.90	186.50
6	103.50	110.50	117.50	124.50	132.80	141.10	149.40	159.00	168.60	178.20	
7	100.90	107.90	114.90	123.20	131.50	139.80	149.40	159.00	168.60		
8	98.30	105.30	113.60	121.90	130.20	139.80	149.40	159.00			
9	95.70	104.00	112.30	120.60	130.20	139.80	149.40				
10	97.00	105.30	113.60	123.20	132.80	142.40					
11	~~98.30~~	~~106.60~~	~~116.20~~	~~125.80~~	135.40						
	99.60	109.20	118.80	128.40							
A	100.90	110.50	120.10								
	102.20	111.80									
15	103.50										

B

UPPER BALANCE ADJUST WEIGHTS
TABLE I

Elevator Assembly Balance Adjust Weight Table - Example 1
Figure 7 (Sheet 2 of 5)

NUMBER OF EXISTING UPPER WEIGHTS	ELEVATOR ASSEMBLY 183A0103-(), 002A0016-31, 002A0016-32				
	TOTAL CHANGE IN MOMENT ΔM (UPPER) DUE TO ADDING (n) UPPER ADJUST WEIGHTS (lbf.in) [1]				
	NUMBER OF 69-53211-2 UPPER ADJUST WEIGHTS (n) TO BE ADDED TO EXISTING UPPER WEIGHTS				
	23	24	25	26	27
0	187.00	195.30	204.90	214.50	224.10
1	188.30	197.90	207.50	217.10	
2	190.90	200.50	210.10		
3	193.50	203.10			
4	194.80				

UPPER BALANCE ADJUST WEIGHTS
TABLE I

NOTES

- TO ADJUST THE BALANCE OF THE ELEVATOR ASSEMBLY, DO AS FOLLOWS WITH THE DATA GIVEN IN TABLE I:

  STEP A - FIND THE NUMBER OF INITIAL WEIGHTS THAT ARE ON THE ELEVATOR ASSEMBLY.

  STEP B - FIND THE CHANGE IN MOMENT THAT YOU WILL NEED TO BALANCE THE ELEVATOR ASSEMBLY.

  STEP C - FIND THE NUMBER OF ADJUST WEIGHTS NECESSARY FOR THE CHANGE IN MOMENT. THIS IS THE NUMBER OF ADJUST WEIGHTS YOU WILL ADD TO THE ASSEMBLY. REFER TO FIGURE 4 FOR THE SEQUENCE ON WHICH TO INSTALL THE ADDED WEIGHTS.

- TO CONVERT lbf.in TO Nm, MULTIPLY BY 0.1129848.

[1] ALL MOMENT INCREMENTS ΔM [UPPER] ARE NEGATIVE.

Elevator Assembly Balance Adjust Weight Table - Example 1
Figure 7 (Sheet 3 of 5)

NUMBER OF EXISTING LOWER WEIGHTS	ELEVATOR ASSEMBLY 183A0103-(), 002A0016-31, 002A0016-32										
	TOTAL CHANGE IN MOMENT ΔM (LOWER) DUE TO ADDING (n) LOWER ADJUST WEIGHTS (lbf.in) [2]										
	NUMBER OF 183A0210-1 LOWER ADJUST WEIGHTS (n) TO BE ADDED TO EXISTING LOWER WEIGHTS										
	1	2	3	4		6	7	8	9	10	11
0				25.26		39.54	47.79	56.04	64.29	70.33	76.37
		12.08	19.22			41.75	50.00	58.25	64.29		
	6.04		20.32			43.96	52.21			71.43	
	7.14	14.28	21.42					58.25	65.39	72.53	80.78
4	7.14	14.28	22.53	30.78	39.03	45.07	51.11	58.25	65.39	73.64	81.89
5	7.14	15.39	23.64	31.89	37.93	43.97	51.11	58.25	66.50	74.75	80.79
6	8.25	16.50	24.75	30.79	36.83	43.97	51.11	59.36	67.61	73.65	80.79
7	8.25	16.50	22.54	28.58	35.72	42.86	51.11	59.36	65.40	72.54	80.79
8	8.25	14.29	20.33	27.47	34.61	42.86	51.11	57.15	64.29	72.54	
9	6.04	12.08	19.22	26.36	34.61	42.86	48.90	56.04	64.29		
10	6.04	13.18	20.32	28.57	36.82	42.86	50.00	58.25			
11	7.14	14.28	22.53	30.78	36.82	43.96	52.21				
12	7.14	15.39	23.64	29.68	36.82	45.07					
13	8.25	16.50	22.54	29.68	37.93						
14	8.25	14.29	21.43	29.68							
15	6.04	13.18	21.43								
16	7.14	15.39									
17	8.25										

GO TO SHEET 5

LOWER BALANCE ADJUST WEIGHTS
TABLE II

Elevator Assembly Balance Adjust Weight Table - Example 1
Figure 7 (Sheet 4 of 5)

NUMBER OF EXISTING LOWER WEIGHTS	ELEVATOR ASSEMBLY 183A0103-(), 002A0016-31, 002A0016-32						
	TOTAL CHANGE IN MOMENT ΔM (LOWER) DUE TO ADDING (n) LOWER ADJUST WEIGHTS (lbf.in) [2]						
	NUMBER OF 183A0210-1 LOWER ADJUST WEIGHTS (n) TO BE ADDED TO EXISTING LOWER WEIGHTS						
	12	13	14	15	16	17	18
0	83.51	90.65	98.90	107.15	113.19	120.33	128.58
1	84.61	92.86	101.11	107.15	114.29	122.54	
2	86.82	95.07	101.11	108.25	116.50		
3	89.03	95.07	102.21	110.46			
4	87.93	95.07	103.32				
5	87.93	96.18					
6	89.04						

LOWER BALANCE ADJUST WEIGHTS
TABLE II

NOTES

- TO ADJUST THE BALANCE OF THE ELEVATOR ASSEMBLY, DO AS FOLLOWS WITH THE DATA GIVEN IN TABLE II:

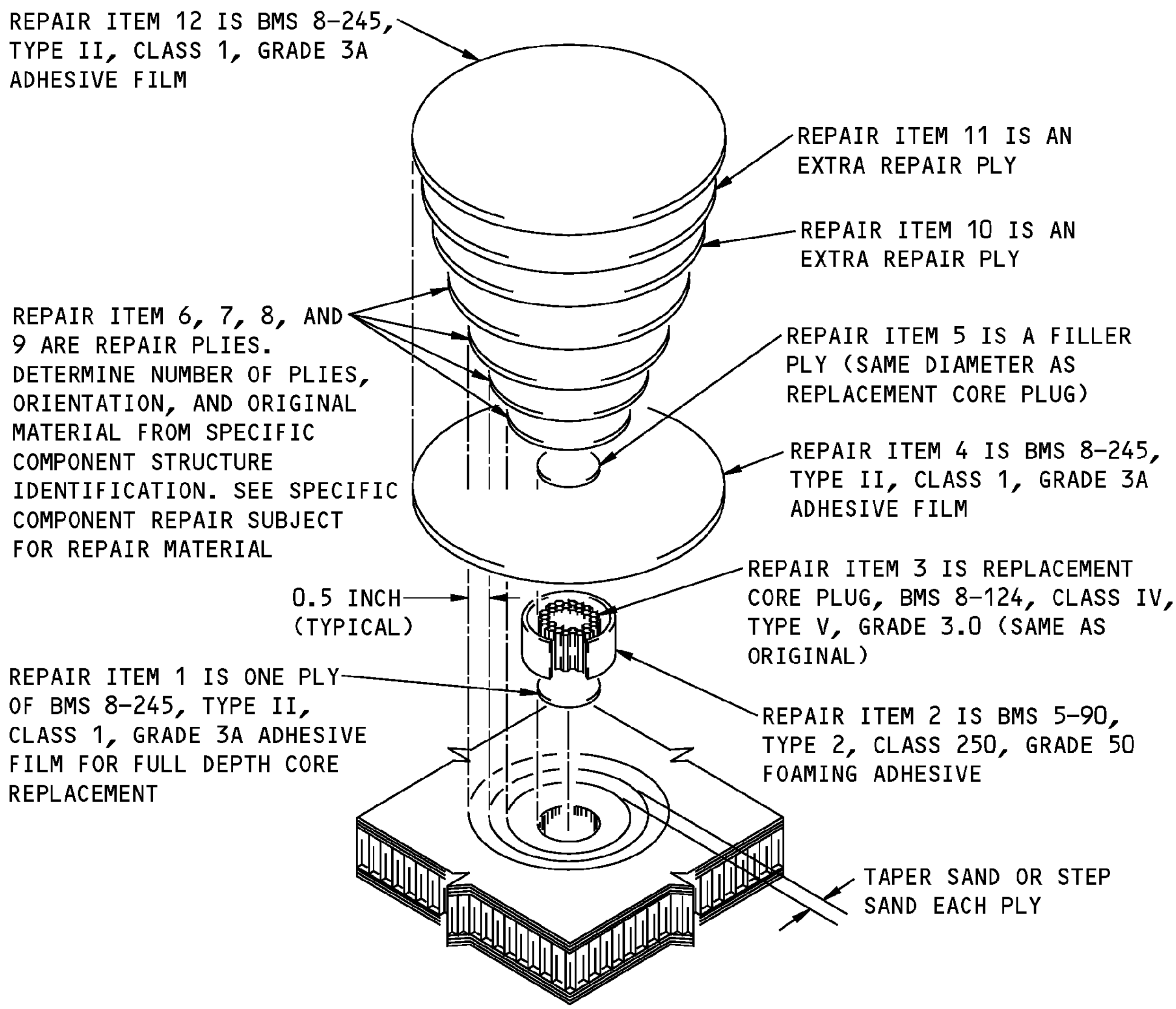
  STEP D – FIND THE NUMBER OF INITIAL WEIGHTS THAT ARE ON THE ELEVATOR ASSEMBLY.

  STEP E – FIND THE CHANGE IN MOMENT THAT YOU WILL NEED TO BALANCE THE ELEVATOR ASSEMBLY.

  STEP F – FIND THE NUMBER OF ADJUST WEIGHTS NECESSARY FOR THE CHANGE IN MOMENT. THAT IS THE NUMBER OF ADJUST WEIGHTS YOU WILL ADD TO THE ASSEMBLY. REFER TO FIGURE 4 FOR THE SEQUENCE ON WHICH TO INSTALL THE ADDED WEIGHTS.

[2] ALL MOMENT INCREMENTS (ΔM [LOWER]) ARE NEGATIVE.

Elevator Assembly Balance Adjust Weight Table - Example 1
Figure 7 (Sheet 5 of 5)



NOTES

- REPAIR ITEMS 1, 2, 3, 4, 5, 10, 11, AND 12 ARE EXTRA MATERIALS AND ADD WEIGHT TO THE REPAIR AREA ABOVE THAT WHICH WAS REMOVED AND IS BEING REPLACED
- REPAIR ITEMS 6, 7, 8, AND 9 ARE REPLACING ORIGINAL PLIES OF APPROXIMATELY THE SAME AREA BUT OF DIFFERENT WEIGHT PER UNIT AREA

Repair (Typical) - Repair of Damage to One Skin and Honeycomb Core
Figure 8

X

NUMBER OF EXISTING LOWER WEIGHTS	ELEVATOR ASSEMBLY 183A0103-(), 002A0016-31, 002A0016-32										
	TOTAL CHANGE IN MOMENT ΔM (LOWER) DUE TO ADDING (n) LOWER ADJUST WEIGHTS (lbf.in) [1]										
	NUMBER OF 183A0210-1 LOWER ADJUST WEIGHTS (n) TO BE ADDED TO EXISTING LOWER WEIGHTS										
	1	2	3	4	5	6	7		9	10	11
0				25.26	32.40	39.54	47.79		64.29	70.33	76.37
	6.04	12.08	19.22		33.50	41.75			64.29	70.33	77.47
V	6.04	13.18	20.32	W	35.71	43.96	Y	Z	64.29	71.43	78.57
	7.14	14.28	21.42	29.67	37.92	46.17	52.21	58.25	65.39	72.53	80.78
4	7.14	14.28	22.53	30.78	39.03	45.07	51.11	58.25	65.39	73.64	81.89
5	7.14	15.39	23.64	31.89	37.93	43.97	51.11	58.25	66.50	74.75	80.79
6	8.25	16.50	24.75	30.79	36.83	43.97	51.11	59.36	67.61	73.65	80.79
7	8.25	16.50	22.54	28.58	35.72	42.86	51.11	59.36	65.40	72.54	80.79
8	8.25	14.29	20.33	27.47	34.61	42.86	51.11	57.15	64.29	72.54	
9	6.04	12.08	19.22	26.36	34.61	42.86	48.90	56.04	64.29		
10	6.04	13.18	20.32	28.57	36.82	42.86	50.00	58.25			
11	7.14	14.28	22.53	30.78	36.82	43.96	52.21				
12	7.14	15.39	23.64	29.68	36.82	45.07					
13	8.25	16.50	22.54	29.68	37.93						
14	8.25	14.29	21.43	29.68							
15	6.04	13.18	21.43								
16	7.14	15.39									
17	8.25										

GO TO SHEET 2

LOWER BALANCE ADJUST WEIGHTS
TABLE I

Elevator Assembly Balance Adjust Weight Table - Example 2
Figure 9 (Sheet 1 of 2)

NUMBER OF EXISTING LOWER WEIGHTS	ELEVATOR ASSEMBLY 183A0103-(), 002A0016-31, 002A0016-32						
	TOTAL CHANGE IN MOMENT ΔM (LOWER) DUE TO ADDING (n) LOWER ADJUST WEIGHTS (lbf.in) 1						
	NUMBER OF 183A0210-1 LOWER ADJUST WEIGHTS (n) TO BE ADDED TO EXISTING LOWER WEIGHTS						
	12	13	14	15	16	17	18
0	83.51	90.65	98.90	107.15	113.19	120.33	128.58
1	84.61	92.86	101.11	107.15	114.29	122.54	
2	86.82	95.07	101.11	108.25	116.50		
3	89.03	95.07	102.21	110.46			
4	87.93	95.07	103.32				
5	87.93	96.18					
6	89.04						

LOWER BALANCE ADJUST WEIGHTS
TABLE I

NOTES

- TO ADJUST THE BALANCE OF THE ELEVATOR ASSEMBLY, DO AS FOLLOWS WITH THE DATA GIVEN IN TABLE II:

  STEP V - FIND THE NUMBER OF INITIAL WEIGHTS THAT ARE ON THE ELEVATOR ASSEMBLY.

  STEP W - FIND THE CHANGE IN MOMENT THAT YOU WILL NEED TO BALANCE THE ELEVATOR ASSEMBLY.

  STEP X - FIND THE NUMBER OF ADJUST WEIGHTS NECESSARY FOR THE CHANGE IN MOMENT. THAT IS THE NUMBER OF ADJUST WEIGHTS YOU WILL ADD TO THE ASSEMBLY. REFER TO FIGURE 4 FOR THE SEQUENCE ON WHICH TO INSTALL THE ADDED WEIGHTS.

- TO CONVERT FROM lbf.in TO Nm, MULTIPLY BY 0.1129848.

1 ALL MOMENT INCREMENTS (ΔM [LOWER]) ARE NEGATIVE.

Elevator Assembly Balance Adjust Weight Table - Example 2
Figure 9 (Sheet 2 of 2)

6. Put the Airplane Back to Its Usual Condition

A. As applicable, install the elevator balance panels on the elevator. Refer to AMM PAGEBLOCK 27-31-41/401.

B. As applicable, install the elevator tab on the elevator. Refer to AMM PAGEBLOCK 27-31-31/401.

C. As applicable, install the elevator on the airplane. Refer to AMM PAGEBLOCK 27-31-11/401.

GENERAL - ELEVATOR TAB BALANCE PROCEDURE FOR AIRPLANE LINE NUMBERS 1175 AND-ON AND LINE NUMBERS 1 THROUGH 1174 WITH COMPLETION OF SERVICE BULLETINS 737-55-1080, 737-55-1081, AND 737-55-1082

1. Applicability

CAUTION: IF AN ELEVATOR TAB ASSEMBLY IS REMOVED FROM THE AIRPLANE, REWORKED, REPAIRED, OR REPAINTED, OR IF A NEW ELEVATOR TAB ASSEMBLY IS INSTALLED, IT MUST BE WEIGHED AND STAMPED WITH THE ACTUAL WEIGHT AND QUANTITY OF BALANCE ADJUST WEIGHTS. ALSO, THE TAB ASSEMBLY MOMENT MUST BE WITHIN THE LIMITS OF THE STATIC BALANCE REQUIREMENTS.

A. This subject gives the necessary data for the static balance requirements for the elevator tab assembly.

NOTE: This procedure is applicable to airplanes with line numbers equal to or greater than 1175. Refer to 51-60-06 for airplanes with line numbers 1 through 1175 that have not been modified as given in Service Bulletins 737-55-1080, 737-55-1081, and 737-55-1082.

B. Refer to 51-60-04 and 51-61-04 for the elevator balance procedure.

C. Refer to 51-60-05 for the weight control procedure for elevator balance panels.

2. General

A. Refer to 51-60-00 for the general data such as:

(1) Categories of control surfaces

(2) General balance instructions

(3) Serviceability

(4) Definitions of terms

(5) Sign conventions

(6) Measurement accuracy

(7) Special tools and equipment

(8) Repair material weights.

B. The elevator tab assembly is a Category I Control Surface.

C. The elevator tab assembly is not balanced, but the weight has an effect on the balance of the elevator. The elevator tab assembly moment must also be within the required limit.

(1) The weight of the elevator tab assembly is limited to a maximum of 9.00 pounds (4.08 kilograms).

(a) To balance out variations in the weight of the elevator tab assembly, tab adjust weights are installed in the lower balance weight locations of bay number 2. Refer to Elevator Tab Adjust Weights Location, Figure 1/GENERAL.

1) The elevator tab adjust weights do not balance out the full weight of the tab assembly, but only the increment of weight over nominal.

2) For a given increment of tab assembly weight, a specified number of tab adjust weights is necessary. Refer to Table 1/GENERAL for the number of tab adjust weights that must be installed for a given increment of tab assembly weight.

NOTE: The part number of the tab adjust weight is 183A0210-3. The weight of each tab adjust weight is 0.5 ± 0.05 pound (0.227 ± 0.0227 kilogram).

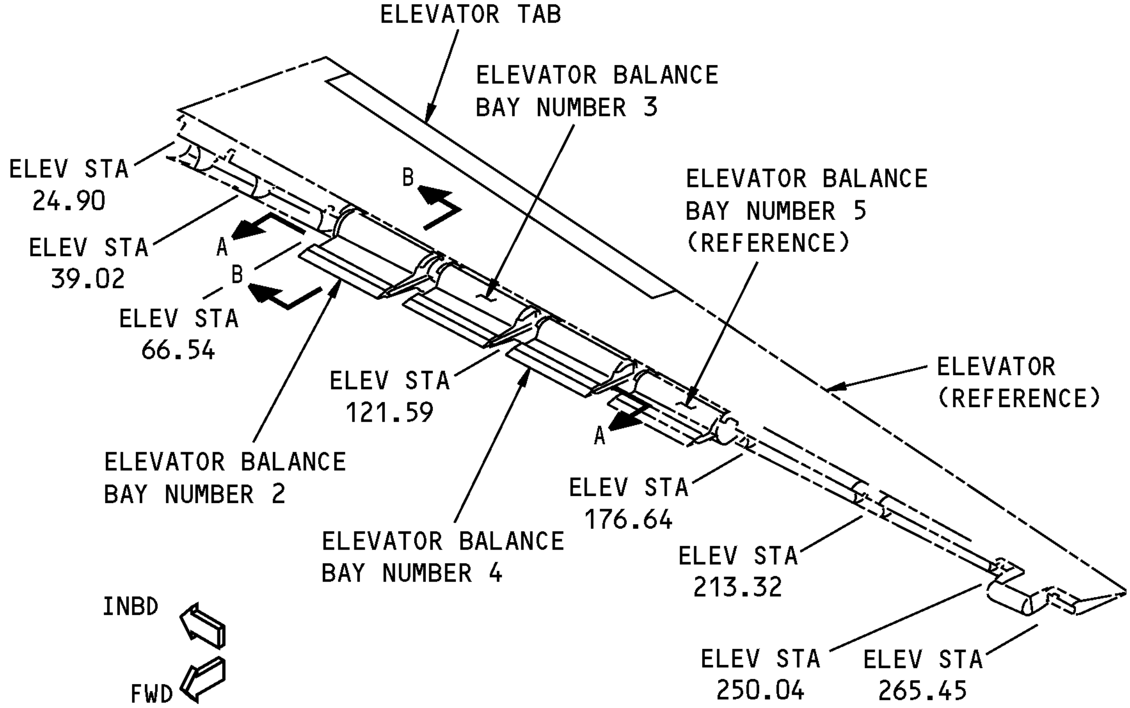
Table 1:

ELEVATOR TAB ASSEMBLY TAB ADJUST WEIGHTS 183A8100-5, 183A8100-6	
TAB ASSEMBLY WEIGHT IN POUNDS (KILOGRAMS)	**NUMBER OF ADJUST WEIGHTS NECESSARY**
Less than 8.08 (3.665)	2
8.09 to 8.31 (3.669) to (3.769)	3
8.32 to 8.54 (3.773) to (3.874)	4
8.55 to 8.77 (3.878) to (3.978)	5
8.78 to 9.00 (3.983) to (4.082)	6

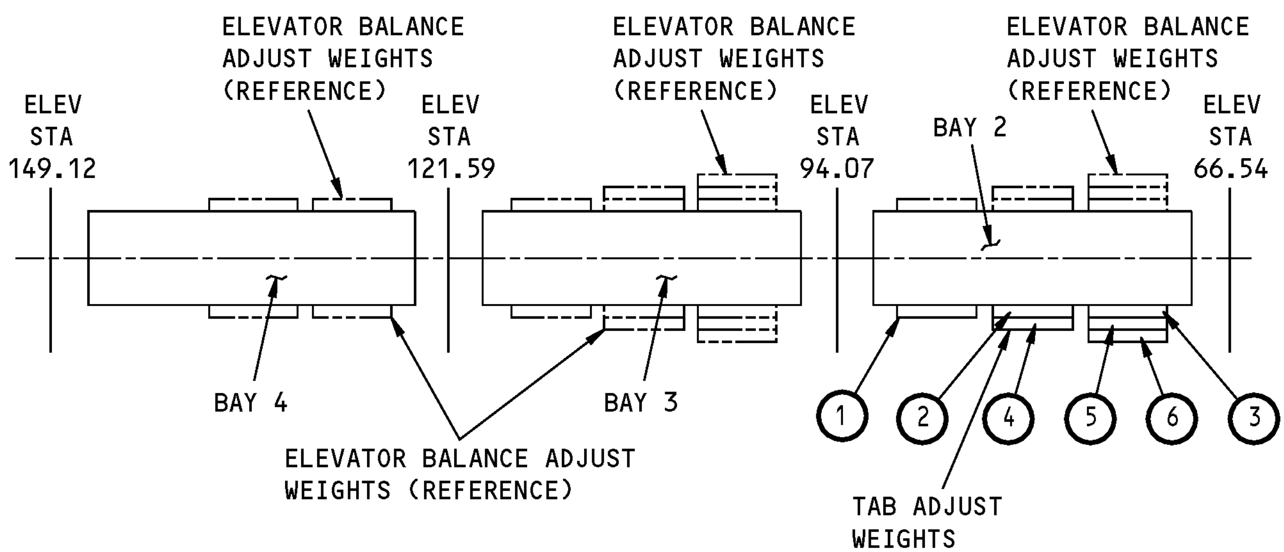
(2) The Tab Assembly Moment is limited to a maximum of 15.48 lbfin (1.74 Nm).

(a) No adjustment of the elevator tab assembly moment is possible.

D. Before you weigh the elevator tab assembly, you must make sure that it is in the as-weighed configuration given in Elevator Tab As-Weighed Configuration, Figure 2/GENERAL.



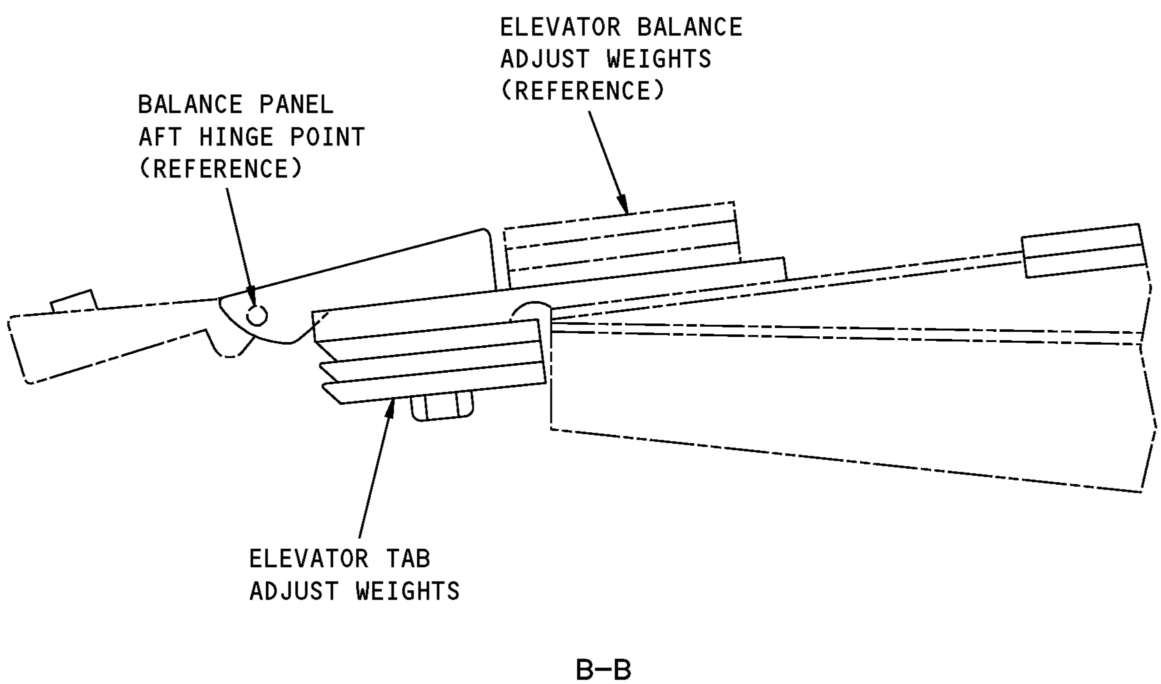
LEFT SIDE ELEVATOR IS SHOWN, RIGHT SIDE ELEVATOR IS OPPOSITE



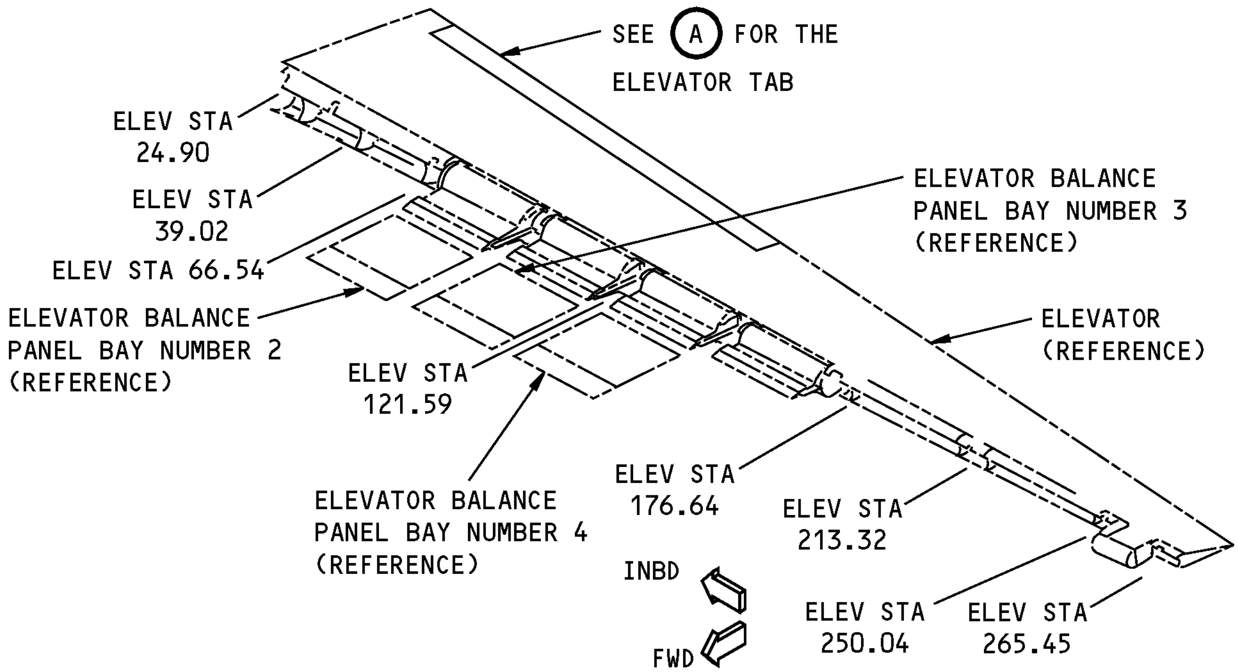
NOTE: THE CIRCLED NUMBERS SHOW THE SEQUENCE IN WHICH THE ELEVATOR TAB ADJUST WEIGHTS MUST BE INSTALLED.

A-A

Elevator Tab Adjust Weights Location
Figure 1 (Sheet 1 of 2)



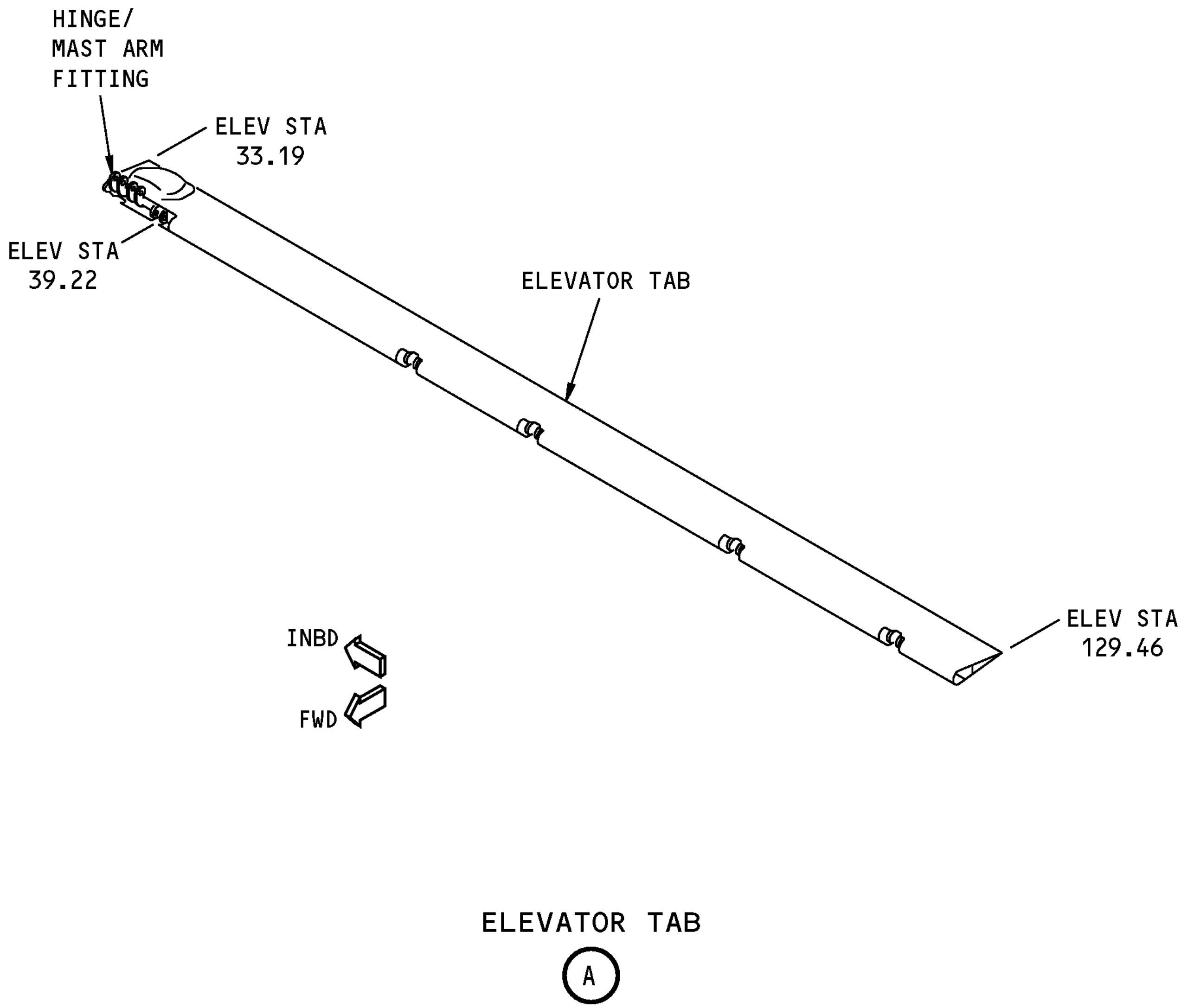
Elevator Tab Adjust Weights Location
Figure 1 (Sheet 2 of 2)



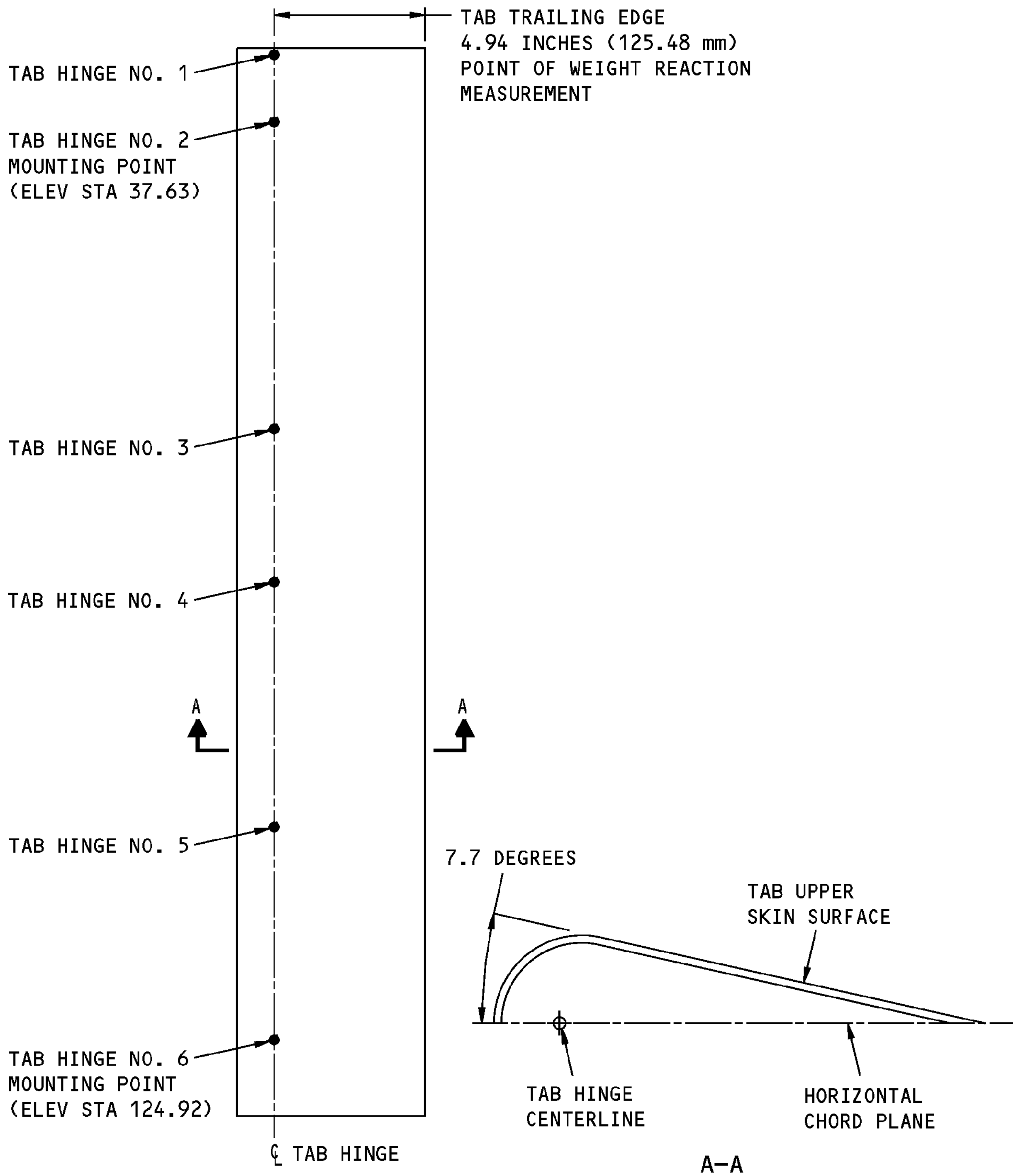
NOTES

- THE ELEVATOR TAB MUST BE A COMPLETE ASSEMBLY AS GIVEN ON ENGINEERING DRAWING 183A8100-5, 183A8100-6. THIS INCLUDES ALL PROTECTIVE FINISHES AND DECORATIVE PAINT, BONDING JUMPERS AND THEIR FASTENERS.
- DO NOT INCLUDE:
  - INSTALLATION BOLTS, NUTS, AND WASHERS THAT ATTACH THE TAB TO THE ELEVATOR
  - CONTROL RODS AND THEIR INSTALLATION BOLTS, NUTS, AND WASHERS.

Elevator Tab As-Weighed Configuration
Figure 2 (Sheet 1 of 3)



Elevator Tab As-Weighed Configuration
Figure 2 (Sheet 2 of 3)



Elevator Tab As-Weighed Configuration
Figure 2 (Sheet 3 of 3)

3. References

Reference	Title
51-60-00	CONTROL SURFACE BALANCING
51-60-04	ELEVATOR BALANCE PROCEDURE
51-60-05	WEIGHT CONTROL PROCEDURE FOR THE ELEVATOR BALANCE PANELS
51-60-06	ELEVATOR TAB BALANCE PROCEDURE
51-61-04	ELEVATOR BALANCE PROCEDURE
AMM 51-21-99 P/B 701	DECORATIVE EXTERIOR PAINT SYSTEM - CLEANING/PAINTING
AMM 06-42-00	Aircraft Maintenance Manual
AMM 27-31-31/401	Elevator Tab - Removal/Installation
AMM 51-21-11/701	Paint Stipping - Cleaning/Painting
BAC 5018	Installation of Safetying Devices
SOPM 20-41-02	Application of Chemical and Solvent Resistant Finishes
SOPM 20-42-05	Bright Cadmium Plating

4. Prepare for the Balance Procedure

A. Remove the elevator tab from the airplane. Refer to AMM 27-31-31/401.

(1) Make sure that the elevator tab that you want to balance has the configuration as given in Paragraph 2.D./GENERAL

5. Balance Procedure

A. Do as follows for the elevator tab assembly static balance procedure:

(1) Weigh the elevator tab assembly and make a note of the weight that you measured.

NOTE: The weight measurement precision for the elevator tab assembly is ±0.01 pound (4.5 grams).

(2) If the weight of the elevator tab assembly is 9.00 pounds (4.082 kilograms) or less, do as follows:

NOTE: If the weight of the elevator tab assembly is more than 9.00 pounds (4.082 kilograms), then continue with step 5.C.

(a) Install the elevator tab assembly, with the upper surface up, in the static balance jig. Refer to 51-60-00.

1) Use elevator tab hinge fitting number 2 (ELEVATOR STA 37.63) and hinge fitting number 6 (ELEVATOR STA 124.92) for the installation of the elevator tab assembly in the balance jig. Refer to Elevator Tab As-Weighed Configuration, Figure 2/GENERAL.

NOTE: Make sure that the elevator assembly can pivot freely about it’s hinge centerline.

2) Level the horizontal chord plane ±1 degree with a protractor level.

(b) Use a platform scale and toolstand to measure the Weight Reaction (WR) at the trailing edge of the elevator tab. Refer to Elevator Tab As-Weighed Configuration, Figure 2/GENERAL.

WR = __________ lbf (N)

NOTE: Refer to 51-60-00 for the weight measurement precision for the Weight Reaction (WR). Make sure that you keep to the sign convention as given in 51-60-00.

(c) Calculate the Tab Assembly Moment (M) with the formula:

Tab Assembly Moment M = (WR) x (d), where:

- WR is the Weight Reaction measured at the trailing edge of the elevator tab in lbf (N)
- d is the moment arm distance between the tab hinge centerline and the trailing edge of the elevator tab (d = +4.94 in. (+125.48 mm = +0.125 m)).

Tab Assembly Moment M = __________ lbfin (Nm)

1) If the Tab Assembly Moment (M) is more than 15.48 lbfin (1.74 Nm), the static balance requirement for the elevator tab assembly is not met. In this situation you can do one of the steps that follow:

a) Rework the existing repairs to make sure they are as light as possible or remove multiple layers of paint to reduce the weight of the tab assembly, as applicable. Refer to AMM 51-21-11/701 for removal of paint.

- Restore the elevator tab assembly decorative exterior paint system. Refer to AMM PAGEBLOCK 51-21-99/701.
- If it is not possible to reduce the Tab Assembly Moment, you must replace the elevator tab assembly with one that will give you the correct moment.
- Repeat step 5.A.

2) If the Tab Assembly Moment (M) is less than 15.48 lbfin (1.74 Nm), the static balance requirement for the elevator tab assembly is met.

B. Balance the weight of the tab by using the tab adjust weights.

(1) Refer to Table 1/GENERAL to find the total number of tab adjust weights that must be installed.

(2) Find the number of tab adjust weights that are already installed in the lower balance weight locations of bay number 2.

NOTE: Refer to Elevator Tab Adjust Weights Location, Figure 1/GENERAL for the location of bay number 2.

(3) Subtract the number of tab adjust weights that you found installed from the number of tab adjust weights given in Table 1/GENERAL.

(a) If the result is positive, continue with the next step.

(b) If the result is negative, continue with step 5.B.(5).

(4) Install the necessary number of tab adjust weights, part number 183A0210-3, to satisfy the Table 1/GENERAL requirement.

NOTE: If the elevator and elevator balance panels are still installed on the airplane, you can get access to the lower balance weight locations of bay number 2 through access panels 333CB (LH) and 343CB (RH). Refer to AMM 06-42-00.

(a) Refer to Elevator Tab Adjust Weights Location, Figure 1/GENERAL for:

1) The location where the tab adjust weights must be installed

2) The sequence in which the tab adjust weights must be installed.

(b) If the Boeing tab adjust weights, part number 183A0210-3, are not available, you can make tab adjust weights as given in Elevator Tab Adjust Weight, Part Number 183A0210-3, Figure 3/GENERAL.

(c) Install the tab adjust weights with BACB30LM4H() or NAS6704H() bolts and BACW10BP4ACU washers. Refer to Table 2/GENERAL for the grip length of the attachment bolt for a given number of tab adjust weights. The fasteners must not protrude beyond the opposite face of the hinge half.

1) Install BACW10BP4NAPU and/ or BACW10BP4APU (under the BACW10BP4ACU washers).

NOTE: Use any combination of washers to allow the bolt threads to properly engage the hinge half. Total Quantity: minimum of 0 washers, maximum of 2 washers.

2) As necessary, apply one layer of BMS 5-95 between the tab adjust weight and the hinge plate.

3) Install the bolts with MIL-C-11796, Class 3 corrosion preventive compound and torque the bolts between 68 and 83 lb-in.

4) Lock the bolts with lockwire (MS20995NC32) as given in BAC5018.

5) Continue with step 5.D.

(5) Remove the necessary number of tab adjust weights.

NOTE: If the elevator and elevator balance panels are still installed on the airplane, you can get access to the lower balance weight locations of bay number 2 through access panel 333CB (LH) and 343CB (RH). Refer to AMM 06-42-00.

(a) Refer to Elevator Tab Adjust Weights Location, Figure 1/GENERAL for:

1) The location where the tab adjust weights are installed

2) The sequence in which the tab adjust weights must be removed is the reverse order shown.

(b) Remove the necessary number of tab adjust weights, part number 183A0210-3.

(c) Install the correct grip length BACB30LM4H() or NAS6704H() bolts and BACW10BP4ACU washers. Refer to Table 2/GENERAL for the grip length of the attachment bolt for a given number of tab adjust weights. The fasteners must not protrude beyond the opposite face of the hinge half.

1) Install BACW10BP4NAPU and/ or BACW10BP4APU (under the BACW10BP4ACU washers).

NOTE: Use any combination of washers to allow the bolt threads to properly engage the hinge half. Total Quantity: minimum of 0 washers, maximum of 2 washers.

2) As necessary, apply one layer of BMS 5-95 between the tab adjust weight and the hinge plate.

3) Install the bolts with MIL-C-11796, Class 3 corrosion preventive compound and torque the bolts between 68 and 83 lb-in.

4) Lock the bolts with lockwire (MS20995NC32) as given in BAC5018.

5) Continue with step 5.D.

Table 2:

ELEVATOR TAB ASSEMBLY TAB ADJUST WEIGHTS ATTACHMENT BOLT GRIP LENGTH	
NUMBER OF TAB ADJUST WEIGHTS IN STACK-UP	ATTACHMENT BOLT BACB30LM4H() or NAS6704H( ) GRIP LENGTH
3	13
2	11
1	7
0	4 (REF)

C. If the weight of the elevator tab assembly is more than 9.00 pounds (4.082 kilograms), do as follows:

(1) Remove multiple layers of paint from the elevator tab assembly to reduce the weight of the tab assembly, as applicable. Refer to AMM 51-21-11/701 for removal of paint.

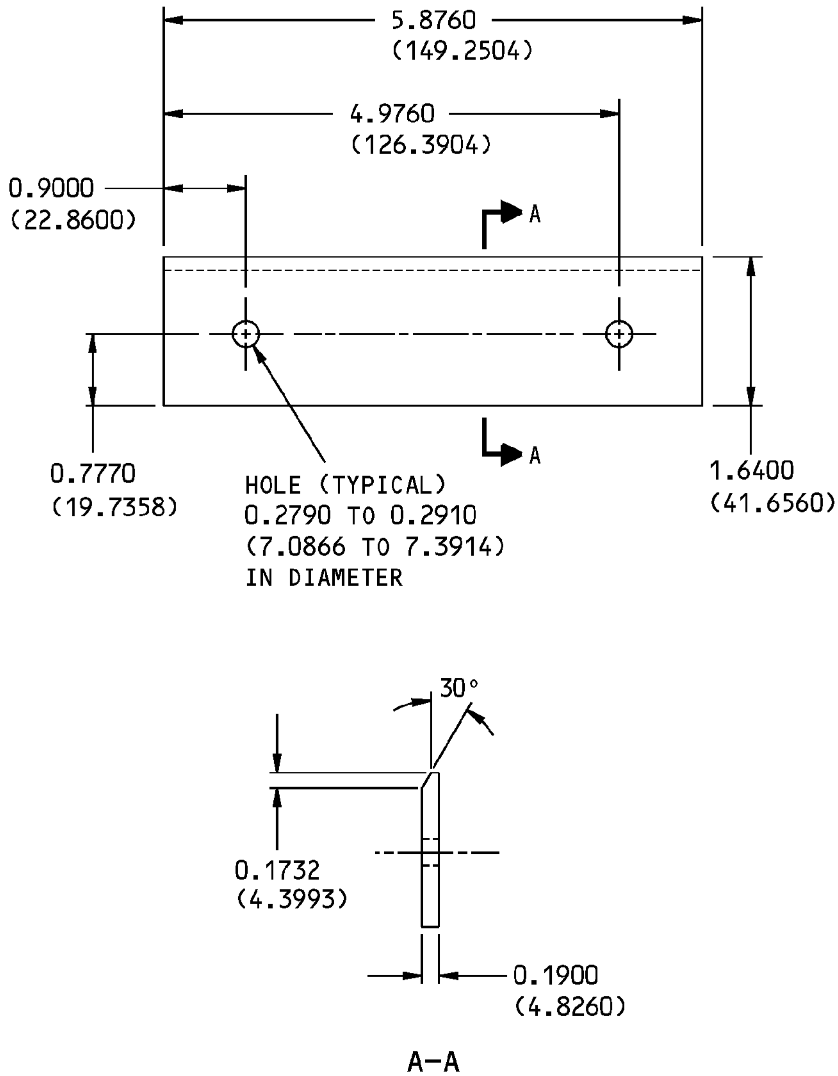
NOTE: Refer to 51-60-00 for the repair material weights.

(2) Restore the elevator tab assembly decorative exterior paint system. Refer to AMM PAGEBLOCK 51-21-99/701.

(3) If it is not possible to reduce the weight, you must replace the elevator tab assembly with one that has the correct weight.

(4) Repeat step 5.A.

D. Stamp the value of the elevator tab weight, the tab assembly moment, and the number of tab adjust weights that are installed on the metal nameplate (BAC27DWG33) that is attached to the elevator tab assembly.



NOTES

- ALL DIMENSIONS ARE IN INCHES (mm).
- MATERIAL: 15-5 PH CRES AS GIVEN IN BMS 7-240, TYPE I AND HEAT TREAT TO 150 TO 170 KSI AS GIVEN IN BAC 5619
- 125 MICROINCHES R_a FINISH ON ALL EDGES
- CADMIUM PLATE AS GIVEN IN QQ-P-416, TYPE 2, CLASS 2 (REFER TO SOPM 20-42-05)
- APPLY ONE LAYER OF BMS 10-11, TYPE I PRIMER (REFER TO SOPM 20-41-02)
- THE FINISHED PART MUST HAVE A WEIGHT OF 0.50 ± 0.05 POUND (0.227 ± 0.0227 KILOGRAM)

Elevator Tab Adjust Weight, Part Number 183A0210-3
Figure 3

6. **Put the Airplane Back to Its Usual Condition**

   A. Install the elevator tab. Refer to AMM 27-31-31/401.

REPAIR GENERAL - PROCEDURES TO REWORK OR FILL ALLOWABLE DENTS ON THE EXTERNAL AERODYNAMIC SURFACES OF METALLIC PARTS

1. Applicability

A. This subject gives the procedures to:

(1) Rework a dent that:

(a) Is on the external aerodynamic surface of the airplane

(b) Is in a 2000 series (which includes C188) or 7000 series aluminum sheet or aluminum facesheet/aluminum honeycomb sandwich panel

(c) Is in an area that is a maximum of 0.063 inch thick

(d) Does not have other damage (such as creases, nicks, gouges, scratches, or punctures) that is more than what is permitted by the allowable damage limits given in the Chapter-Section-Subject for the specified part

(e) Is permitted by the applicable allowable damage limits given in the Chapter-Section-Subject for the specified part.

(2) Fill a dent that:

(a) Is on the external aerodynamic surface of the airplane

(b) Is in a metallic part

(c) Is permitted by the applicable allowable damage limits given in the Chapter-Section-Subject for the specified part. The allowable damage data will also tell you if you are not permitted to fill the dent.

B. The instructions in this subject are not applicable to:

NOTE: Refer to the Chapter-Section-Subject of these parts for the applicable dent information.

(1) Non-metallic parts

(2) Parts that have an aluminum sheet bonded to a non-metallic honeycomb core

(3) Parts that have non-metallic plies bonded to an aluminum honeycomb core.

C. Do not put dents back to their initial contour in the areas that follow:

NOTE: Refer to the applicable repair section in this manual to repair the damage in these areas.

(1) Damaged bonded structures that have delaminations

(2) Damaged areas where the skin is attached to a frame, a stringer, an intercostal, or a doubler

(3) Damaged area across a fastener hole.

D. A dented skin area that is in a stringer and frame bay can be put back to its initial contour. For repairs across a stringer, a frame, or more than one frame bay, tell the Boeing Company.

E. This subject does not give approval for the condition of the dent, before or after you rework or fill the dent. Refer to the applicable allowable damage data in the Chapter-Section-Subject of the specified part to find the limits that are permitted for the dent.

2. General

A. Dents can cause:

(1) A decrease in the flight performance

(2) An effect on the flight qualities of the airplane that is not satisfactory,

(3) An increase in stall speed of the airplane

(4) Buffeting.

B. For the data that is not given in this subject but is necessary before you fill a dent, refer to:

(1) The allowable damage data in the Chapter-Section-Subject for the specified part to find if there are locations where you are not permitted to fill a dent,

(2) The allowable damage data in the Chapter-Section-Subject for the specified part to find the limits on the types of structural adhesives or fairing compounds that can be used

C. Make sure the aerodynamic smoothness is satisfactory as given in 51-10-01 or the performance of the airplane will decrease.

NOTE: Dents are permitted to the dimensions given in the applicable Chapter-Section-Subject for the specified part. It is possible that these dimensions can be larger than the smoothness limits given in 51-10-01.

3. References

Reference	Title
51-10-01	AERODYNAMIC SMOOTHNESS
51-10-02	INSPECTION AND REMOVAL OF DAMAGE
51-20-01	PROTECTIVE TREATMENT OF METALLIC AND COMPOSITE MATERIALS
51-70-10, REPAIR GENERAL	Aluminum Skin/Aluminum Honeycomb Panel Repairs
AMM 51-21-00-100-801	Airplane Surface Preparation for Application of Finish (P/B 701)
AMM 51-21-99 P/B 701	DECORATIVE EXTERIOR PAINT SYSTEM - CLEANING/PAINTING
AMM 51-21-11/701	Paint Stipping - Cleaning/Painting
SOPM 20-20-02	Penetrant Methods of Inspection
SOPM 20-44-04	Application of Urethane Compatible Primers
737 NDT Part 1, 51-05-01	Tap Test Inspection of Honeycomb Sandwich Structure
737 NDT Part 4, 51-00-05	Bondline Delamination Inspection in Honeycomb Structure
737 NDT Part 6, 51-00-00, Figure 4	Surface Inspection of Aluminum Parts

4. Procedures to Rework and Fill Dents

A. Do an inspection of the dent damage.

(1) Before and after you rework an aluminum sheet, or before you fill a dent, do the step that follows:

(a) Do a High Frequency Eddy Current (HFEC) inspection of the damaged area as given in 737 NDT Part 6, 51-00-00, Figure 4. Make sure there are no cracks in the dent or in the adjacent area. If there are cracks, they must be repaired.

NOTE: The penetrant inspection is permitted as an alternative to the HFEC inspection. Refer to SOPM 20-20-02 for the penetrant inspection procedure.

(2) Before and after you rework an aluminum facesheet/aluminum honeycomb sandwich panel, or before you fill a dent, do the steps that follow:

(a) Do a HFEC inspection of the damaged area as given in 737 NDT Part 6, 51-00-00, Figure 4. Make sure there are no cracks in the dent or in the adjacent area. If there are cracks, they must be repaired.

(b) Do an inspection of the damaged area to find if there is delamination between the facesheets and the core caused by the dent. It is recommended that you use an instrumented Non-Destructive Test (NDT) procedure as given in 737 NDT Part 4, 51-00-05. The tap test procedure as given in 737 NDT Part 1, 51-05-01 is optional. If there is delamination, make sure it is not more than the allowable limits specified in the applicable Chapter-Section-Subject.

WARNING: MAKE SURE THE OPERATOR OF THE ELECTROMAGNETIC DENT PULLER FOLLOWS THE MANUFACTURER'S INSTRUCTIONS. IF THE INSTRUCTIONS ARE NOT OBEYED, THE OPERATOR CAN GET AN ELECTRIC SHOCK OR DAMAGE TO THE PARTS CAN OCCUR.

(3) Rework the dent as follows:

NOTE: The Boeing Company uses an electromagnetic dent remover that is sold by:

Electroimpact, Inc.

4606 107th Street Southwest

Mukilteo, WA, 98275, USA

Phone: 425-348-8090

Internet: http://www.electroimpact.com

If you use this dent remover, ask The Boeing Company for the instructions as given in document D6-38394, Electromagnetic Dent Remover.

(a) For an aluminum facesheet/aluminum honeycomb sandwich panel that has dent conditions that agree with the limits given in Paragraph 1.A.(1)/REPAIR GENERAL, only use an electromagnetic dent remover to rework the dent.

CAUTION: DO NOT USE METAL FORMING PROCEDURES OTHER THAN THE PROCEDURE WHICH USES THE ELECTROMAGNETIC DENT PULLER TO REWORK DENTS IN ALUMINUM FACESHEET/ALUMINUM HONEYCOMB SANDWICH PANELS. IF YOU DO, DAMAGE TO THE STRUCTURAL BOND BETWEEN THE FACESHEET AND THE CORE (THAT IS MORE THAN THE ALLOWABLE DAMAGE LIMITS) CAN OCCUR.

(b) For an aluminum sheet that has dent conditions that agree with the limits given in Paragraph 1.A.(1)/REPAIR GENERAL, use the applicable metal forming procedures (which includes the procedure that uses the electromagnetic dent remover) to rework the dent.

(c) Remove all of the allowable damage (nicks, gouges, scratches, corrosion, and sharp creases) from the area of the dent. Refer to 51-10-02.

(4) Make sure the reworked dent is satisfactory.

(a) Do an inspection of the dent as given in Paragraph 4.A.(1)/REPAIR GENERAL. If honeycomb sandwich was reworked, then inspect as given in Paragraph 4.A.(2)/REPAIR GENERAL

(b) Make sure the reworked condition of the dent agrees with the allowable damage limits given in the Chapter-Section-Subject of the damaged part.

(5) Apply a chemical conversion coating to all the bare surfaces of the rework area. Refer to 51-20-01.

(6) If applicable, apply one layer of BMS 10-79, Type II or III primer to the rework area. Refer to SOPM 20-44-04.

(7) If applicable, apply a decorative external finish to the reworked area. Refer to AMM PAGEBLOCK 51-21-99/701.

B. Dent fill procedures

(1) Do an inspection of the dent as given in Paragraph 4.A./REPAIR GENERAL.

(2) Remove the external finish in the area of the dent plus a minimum of 0.50 inch of the external finish around the dent. Refer to AMM 51-21-11/701.

(3) Put masking tape around the rework area.

(4) Remove all the allowable damage (nicks, gouges, scratches, corrosion, and sharp creases) from the area of the dent. Refer to 51-10-02.

(5) Apply a chemical conversion coating to all the bare surfaces of the rework area. Refer to 51-20-01.

(6) Apply one layer of BMS 10-79, Type II or III primer or the applicable decorative external finish to the rework area. Refer to SOPM 20-44-04 for the procedures to apply BMS 10-79, Type II or III primer.

(a) Refer to the applicable AMM subject for other decorative finishes.

(7) Fill the dent with one of the two types of materials that follow:

(a) BMS 5-92, Type I or Type V structural adhesive as given in Paragraph 4.C./REPAIR GENERAL, or

(b) EC-3587-1/4 or EC-3587-1 fairing compound as given in Paragraph 4.D./REPAIR GENERAL.

C. Fill the dent with BMS 5-92, Type I or Type V structural adhesive.

WARNING: MAKE SURE THAT YOU WEAR GLOVES, PROTECTIVE CLOTHING AND EYE PROTECTION WHEN YOU WORK WITH THE UNCURED RESINS OF BMS 5-92, TYPE I AND TYPE V STRUCTURAL ADHESIVES. MAKE SURE THAT THERE IS A GOOD FLOW OF CLEAN AIR. UNCURED RESINS ARE DANGEROUS. IF THE UNCURED RESINS TOUCH YOUR SKIN, WASH YOUR SKIN WITH WARM WATER AND SOAP. IF YOU DO NOT OBEY, YOU CAN CAUSE INJURY.

(1) Apply BMS 5-92, Type I or Type V structural adhesive.

(a) Mix the Part A, and the Part B, components together as given in Table 201/REPAIR GENERAL. If you mix a lesser or larger quantity of Part A or B together, or the temperature does not agree with those in Table 201/REPAIR GENERAL, the pot life will be different. Refer to the manufacturer's recommendations when you use different quantities of Part A and Part B than those given in Table 201/REPAIR GENERAL.

NOTE: The pot life is the length of time in which you can apply the structural adhesive.

(b) Apply the structural adhesive to the dent until it is slightly higher than the necessary contour.

NOTE: If necessary, you can put a plastic sheet (polyethylene or equivalent) on the filled area to help hold the necessary contour. Hold the plastic sheet down with masking tape.

(c) Smooth the structural adhesive out on the area around the dent that has a chemical conversion coating.

Table 201:

BMS 5-92 STRUCTURAL ADHESIVE			
TYPE	**PART A QUANTITY**	**PART B QUANTITY**	**POT LIFE**
I	58 grams	42 grams	120 minutes at 65°F (18°C) to 80°F (27°C) from the time Parts A and B are mixed together
V Class 1	Refer to the manufacturer's instructions	Refer to the manufacturer's instructions	20 minutes at 60°F (16°C) to 80°F (27°C) from the time Parts A and B are mixed together
V Class 2	Refer to the manufacturer's instructions	Refer to the manufacturer's instructions	60 minutes at 60°F (16°C) to 80°F (27°C) from the time Parts A and B are mixed together

(2) Cure the BMS 5-92, Type I or Type V structural adhesive.

(a) Refer to BMS 5-92, Type I Structural Adhesive Cure Cycle, Figure 201/REPAIR GENERAL for the cure time and cure temperature of BMS 5-92, Type I structural adhesive.

(b) Cure BMS 5-92, Type V, Class 1 structural adhesive at:

1) 70°F (21°C) to 100°F (38°C) for a minimum of 3 hours, or

2) 120°F (49°C) to 130°F (54°C) for a minimum of 2 hours.

(3) Cure the BMS 5-92, Type IV, Class 2 structural adhesive at

(a) 70°F (21°C) to 100°F (38°C) for a minimum of 7 hours.

WARNING: MAKE SURE THAT YOU WEAR GLOVES, PROTECTIVE CLOTHING, EYE PROTECTION AND AN APPROVED MASK WHEN YOU SAND THE STRUCTURAL ADHESIVE. MAKE SURE THAT THERE IS A GOOD FLOW OF CLEAN AIR. IF YOU DO NOT OBEY, THE FINE DUST THAT IS THE RESULT CAN CAUSE DAMAGE TO YOUR RESPIRATORY SYSTEM.

(4) Sand the cured structural adhesive to the necessary contour of the aerodynamic surface. Use care so that you do not cause damage to the surfaces external to the rework area.

(5) Apply one layer of BMS 10-79, Type II or III primer to the structural adhesive. Refer to SOPM 20-44-04.

(6) Apply BMS 10-60, type II enamel or other decorative external finish to the reworked area. Refer to AMM TASK 51-21-00-100-801 or AMM PAGEBLOCK 51-21-99/701 as applicable.

D. Fill the dent with EC-3587-1/4 or EC-3587-1 fairing compound.

WARNING: MAKE SURE THAT YOU WEAR GLOVES, PROTECTIVE CLOTHING AND EYE PROTECTION WHEN YOU WORK WITH THE UNCURED RESINS OF EC-3587-1/4 OR EC-3587-1 FAIRING COMPOUND. MAKE SURE THAT THERE IS A GOOD FLOW OF CLEAN AIR. UNCURED RESINS ARE DANGEROUS. IF THE UNCURED RESINS TOUCH YOUR SKIN, WASH YOUR SKIN WITH WARM WATER AND SOAP. IF YOU DO NOT OBEY, INJURY TO PERSONS CAN OCCUR.

(1) Apply EC-3587-1/4 or EC-3587-1 fairing compound.

(a) Refer to Table 202/REPAIR GENERAL for the application times and the cure temperatures of the fairing compound.

Table 202:

CURE TIME, CURE TEMPERATURE, AND APPLICATION TIME FOR EC-3587-1/4 AND EC-3587-1 FAIRING COMPOUNDS			
MATERIAL	CURE TIME	CURE TEMPERATURE	APPLICATION TIME
EC-3587-1/4	48 hours	70°F (21°C) to 80°F (27°C)	15 minutes at 70°F (21°C) to 80°F (27°C)
EC-3587-1/4	20 hours	115°F (46°C) to 125°F (52°C)	15 minutes at 70°F (21°C) to 80°F (27°C)
EC-3587-1	96 hours	70°F (21°C) to 80°F (27°C)	60 minutes at 70°F (21°C) to 80°F (27°C)
EC-3587-1	30 hours	115°F (46°C) to 125°F (52°C)	60 minutes at 70°F (21°C) to 80°F (27°C)

(b) Apply the fairing compound to the dent until it is slightly higher than the necessary contour.

NOTE: If necessary, you can put a plastic sheet (polyethylene or equivalent) on the filled area to help hold the necessary contour. Hold the plastic sheet down with masking tape.

(c) Smooth the fairing compound out on the area around the dent that has a chemical conversion coating.

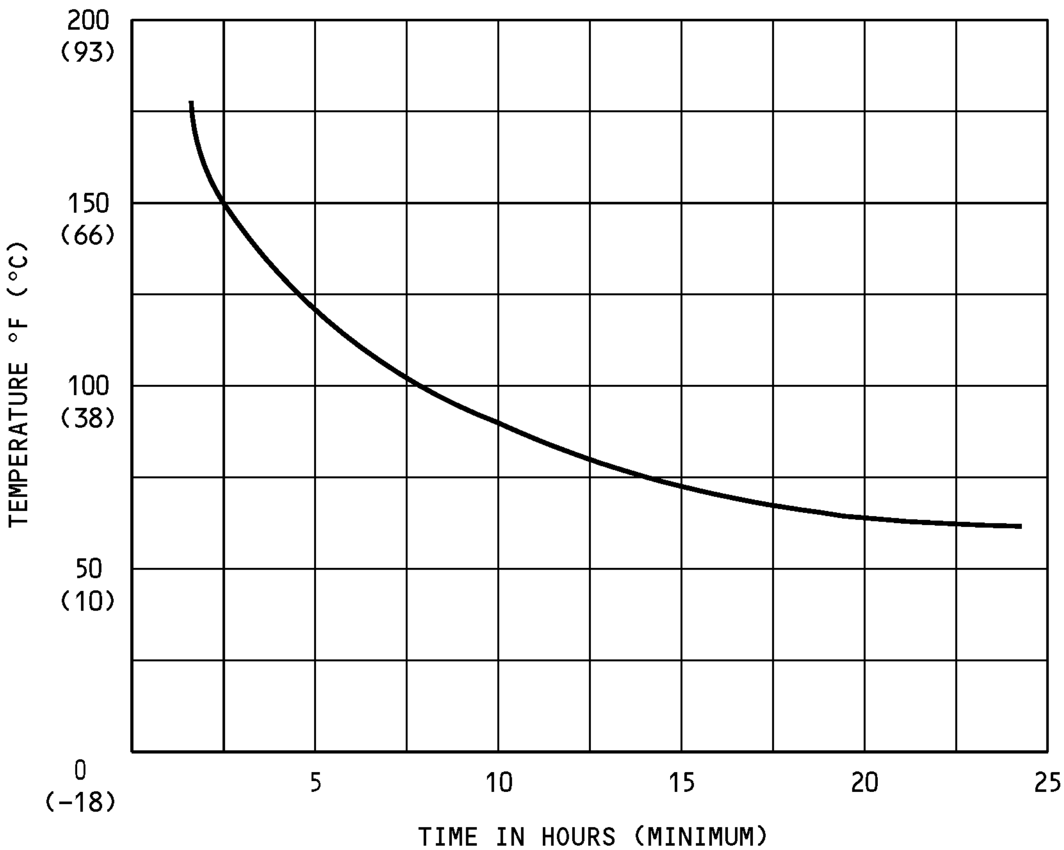
(2) Cure the fairing compound. Refer to Table 202/REPAIR GENERAL for the cure time and cure temperature of the fairing compound.

WARNING: MAKE SURE THAT YOU WEAR GLOVES, PROTECTIVE CLOTHING, EYE PROTECTION AND AN APPROVED MASK WHEN YOU SAND THE FAIRING COMPOUND. MAKE SURE THAT THERE IS A GOOD FLOW OF CLEAN AIR. IF YOU DO NOT OBEY, THE FINE DUST THAT IS THE RESULT CAN CAUSE DAMAGE TO YOUR RESPIRATORY SYSTEM.

(3) Sand the cured fairing compound to the necessary contour of the aerodynamic surface. Use care not to cause damage to the surfaces external to the rework area.

(4) Apply one layer of BMS 10-79, Type II or III primer to the fairing compound. Refer to SOPM 20-44-04.

(5) Apply a decorative external finish to the reworked area. Refer to AMM PAGEBLOCK 51-21-99/701.



BMS 5-92, Type I Structural Adhesive Cure Cycle
Figure 201

GENERAL - LOCATIONS OF THE PRINCIPAL COMPOSITE COMPONENTS

1. **Applicability**

   A. The subject is applicable as a reference aid to find the locations of advanced composite structures.

2. **General**

   A. For the locations of advanced composite structures:

      (1) Refer to Locations of the Principal Composite Components Made of Carbon Fiber Reinforced Plastic (CFRP), Figure 1/GENERAL for the locations of Carbon Fiber Reinforced Plastic (CFRP) bonded parts

      (2) Refer to Locations of the Principal Composite Components Made of Glass Fiber Reinforced Plastic (GFRP), Figure 2/GENERAL for the locations of Glass Fiber Reinforced Plastic (GFRP) bonded parts

      (3) Refer to Figure 3/GENERAL for the locations of Hybrid CFRP-GFRP bonded parts.

Table 1:

LOCATION OF THE PRINCIPAL CARBON FIBER REINFORCED PLASTIC (GFRP) MANUFACTURED AT 350°F (177°C)		
COMPONENT DESCRIPTION	**REFERENCE DRAWINGS**	**SRM CHAPTER, SECTION, SUBJECT**
Rudder Skin Panel Assembly	173A4001	55-40-01
Rudder Spar	173A2100	55-40-02
Rudder Structure - Ribs	173A1101 173A1102 173A1105 173A1106 173A1107 173A1108	55-40-02
Elevator Upper Skin Panel	183A3100	55-20-01
Elevator Lower Skin Panel	183A3200	55-20-01
Elevator Front Spar	183A1100	55-20-02
Elevator Rear Spar	183A4100	55-20-02
Elevator Structure - Ribs	183A5100 183A5120 183A5130 183A5140 183A5150	55-20-02
Elevator Tab	183A8200	55-20-01
Elevator Tab Leading Edge	183A8220	55-20-01
Aileron Upper Skin Panel	113A7131	57-60-01
Aileron Lower Skin Panel	113A7132	57-60-01
Aileron Front Spar	113A7110	57-60-02
Aileron Rear Spar	113A7130	57-60-02
Aileron Ribs	113A7140 113A7141 113A9242 113A9343 113A9144 113A9145 113A9246	57-60-02
Nacelle Strut Fairing Skin Panels	313A2111 313A2211 313A2221 313A2231	54-50-70
Thrust Reverser Assembly	315A2101 315A2502 315A2561	54-30-01

Table 2:

LOCATION OF THE PRINCIPAL GLASS FIBER REINFORCED PLASTIC (GFRP) MANUFACTURED AT 350°F (177°C)		
COMPONENT DESCRIPTION	**REFERENCE DRAWINGS**	**SRM CHAPTER, SECTION, SUBJECT**
Forward Inboard Wheel Well Skin Panel	149A7652	53-40-70
Nacelle Strut Fairing Skin Panels	313A2121 313A2531 313A2610 313A2620	54-50-70

Table 3:

LOCATION OF THE PRINCIPAL CARBON FIBER REINFORCED PLASTIC (CFRP) MANUFACTURED AT 250°F (121°C)		
COMPONENT DESCRIPTION	**REFERENCE DRAWINGS**	**SRM CHAPTER, SECTION, SUBJECT**
Nose Landing Gear Doors	141A6902	52-80-01
Wing-To-Body Fairing Skin Panels	149A7232 149A7259	53-40-70

Table 4:

LOCATION OF THE PRINCIPAL GLASS FIBER REINFORCED PLASTIC (GFRP) MANUFACTURED AT 250°F (121°C)		
COMPONENT DESCRIPTION	**REFERENCE DRAWINGS**	**SRM CHAPTER, SECTION, SUBJECT**
Nose Radome	65-73294 1001102 (Vendor Part)	53-10-72
Cargo Compartment Floor Panels - Section 43	453A1610 453A1611	53-30-53
Cargo Compartment Floor Panels - Section 46	453A2610 453A2611	53-60-53
Tail Cone Assembly	148A7111 148A7131	53-80-70
Dorsal Fin Skin Panels	174A2100	55-30-01
Vertical Stabilizer Trailing Edge Skin Panels	172A6127 175A1702 175A1704 175A1803	55-30-01
Vertical Stabilizer Cove	175A3100	55-30-30
Wing-to-Body Fairing Skin Panels	149A7132 149A7137 149A7151 149A7155 149A7156 149A7157 149A7161 149A7351	53-30-70
Wing-to-Body Fairing Skin Panels	149A7255 149A7257 149A7258 149A7353 149A7651 149A7653 149A7654 149A7751 149A7755 149A7756	53-40-70
Wing-to-Body Fairing Skin Panels	149A7511 149A7521 149A7541 149A7548 149A7552 149A7553 149A7554 149A7555 149A7556 149A7557 149A7558 149A7559 149A7562	53-60-70

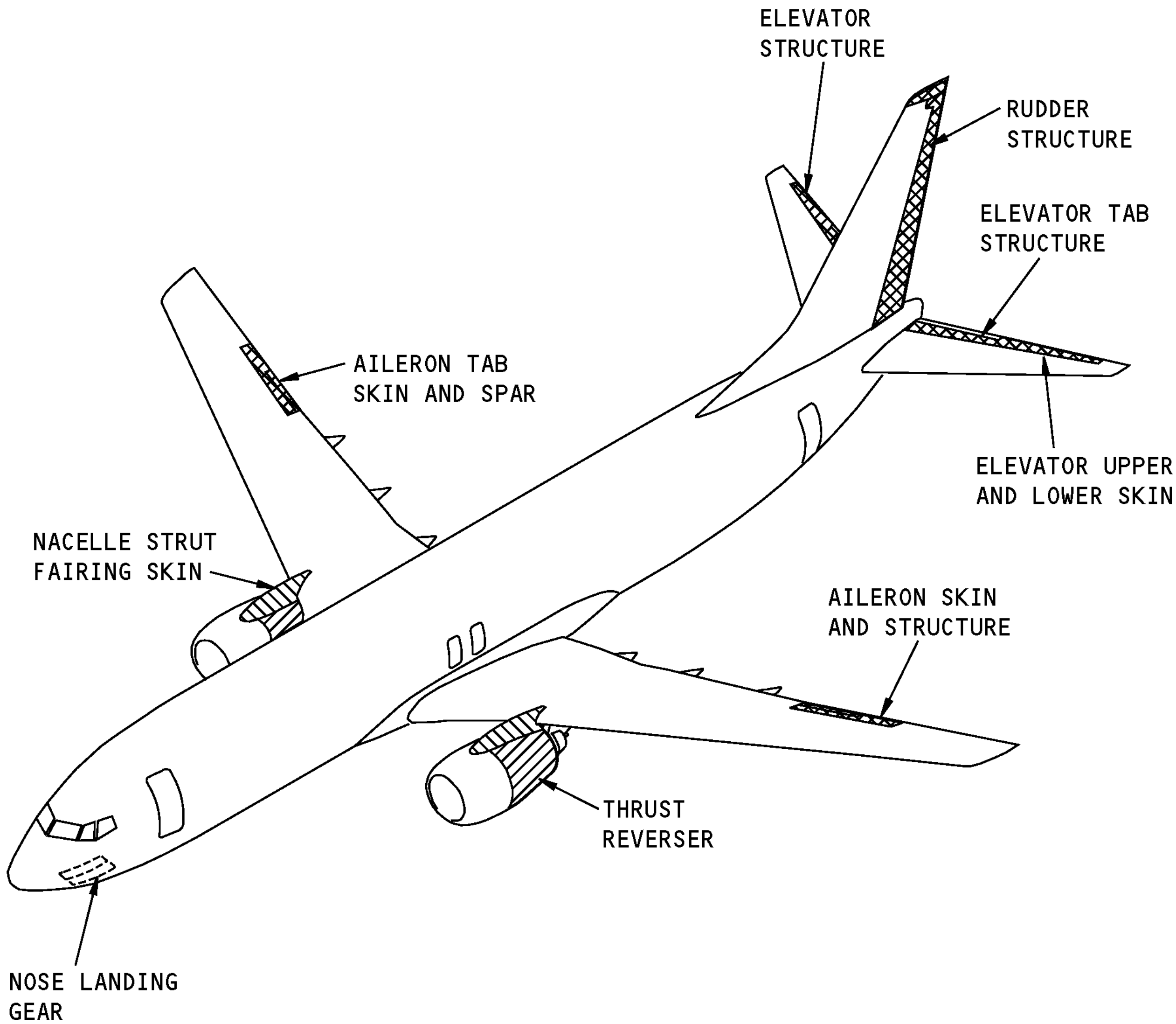
LOCATION OF THE PRINCIPAL GLASS FIBER REINFORCED PLASTIC (GFRP) MANUFACTURED AT 250°F (121°C)		
COMPONENT DESCRIPTION	REFERENCE DRAWINGS	SRM CHAPTER, SECTION, SUBJECT
Wing Outboard Fixed Trailing Edge Skin Panels	115A2520 115A2521 114A2522 115A2523 115A2524 115A2525 115A2526 115A2720 115A2721 115A2722 115A2723 115A2724 114A2725 115A2726 115A3920 115A3921 115A3922 115A4520 115A4521 114A4522 115A4720 115A4721 115A4722 115A4723 115A4724 115A4920 115A4921 115A4922 115A4923	57-51-01
Inboard Flap Upper Trailing Edge Cove Panel	113A2141	57-53-01
Forward Trailing Edge Flap Support Fairing Skin Panels	113A9111 113A9165 113A9211 113A9311 113A9153 113A9154 113A9256 113A9253 113A9254 113A9265 113A9353 113A9354 113A9356 113A9365	57-53-70

Table 5:

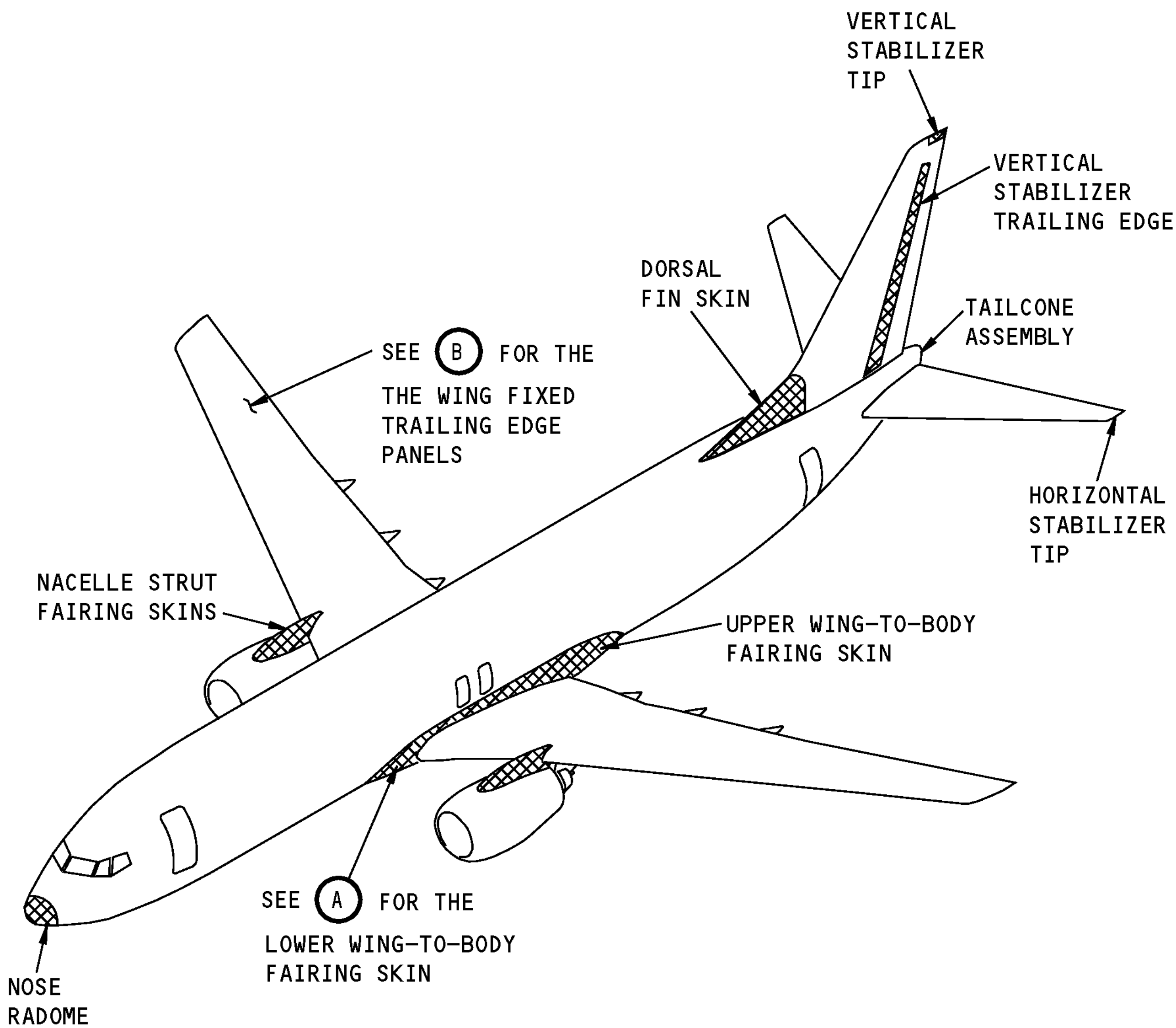
LOCATION OF THE PRINCIPAL CARBON FIBER/GLASS FIBER REINFORCED PLASTIC (GFRP)/(CFRP) AND GLASS FIBER REINFORCED HONEYCOMB STRUCTURES MANUFACTURED AT 250°F (121°C)		
COMPONENT DESCRIPTION	REFERENCE DRAWINGS	SRM CHAPTER, SECTION, SUBJECT
Aft Trailing Edge Flap Support Fairing Skin Panels	113A9151 113A9251	57-53-71

Table 6:

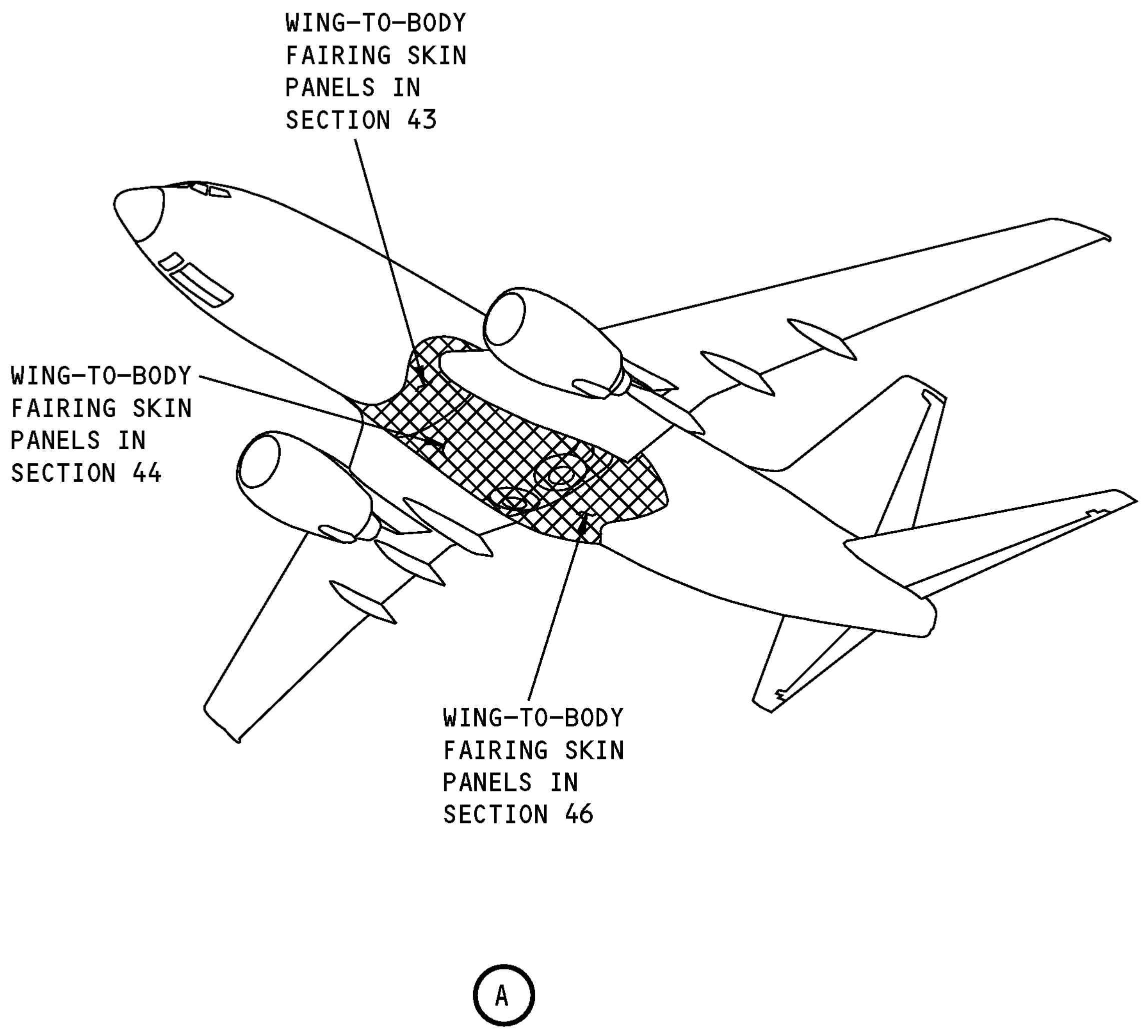
LOCATION OF THE PRINCIPAL CARBON FIBER/GLASS FIBER REINFORCED PLASTIC (GFRP)/(CFRP) AND GLASS FIBER REINFORCED HONEYCOMB STRUCTURES MANUFACTURED AT 350°F (177°C)		
COMPONENT DESCRIPTION	REFERENCE DRAWINGS	SRM CHAPTER, SECTION, SUBJECT
Aft Trailing Edge Flap Support Fairing Skin Panels	113A9351	57-53-71



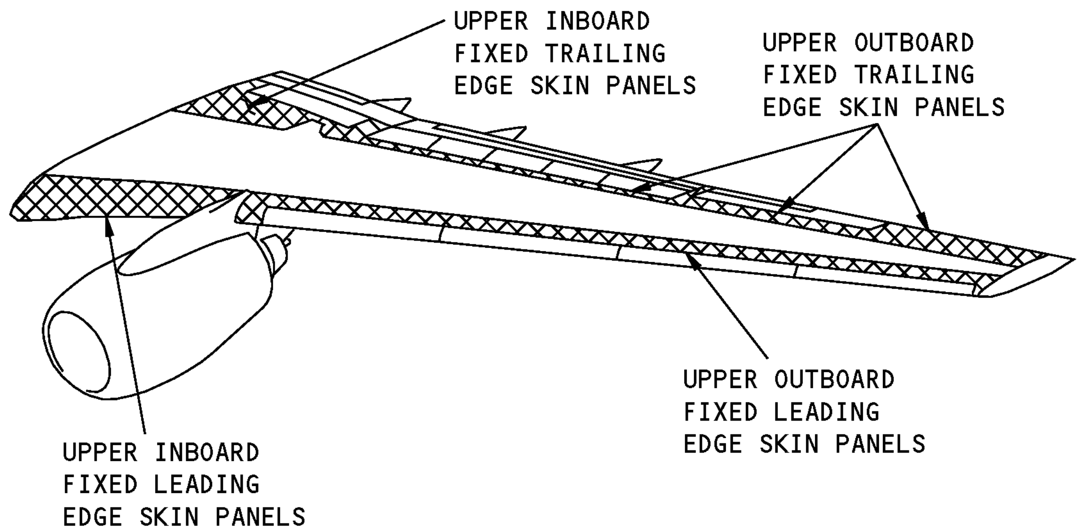
Locations of the Principal Composite Components Made of Carbon Fiber Reinforced Plastic (CFRP)
Figure 1



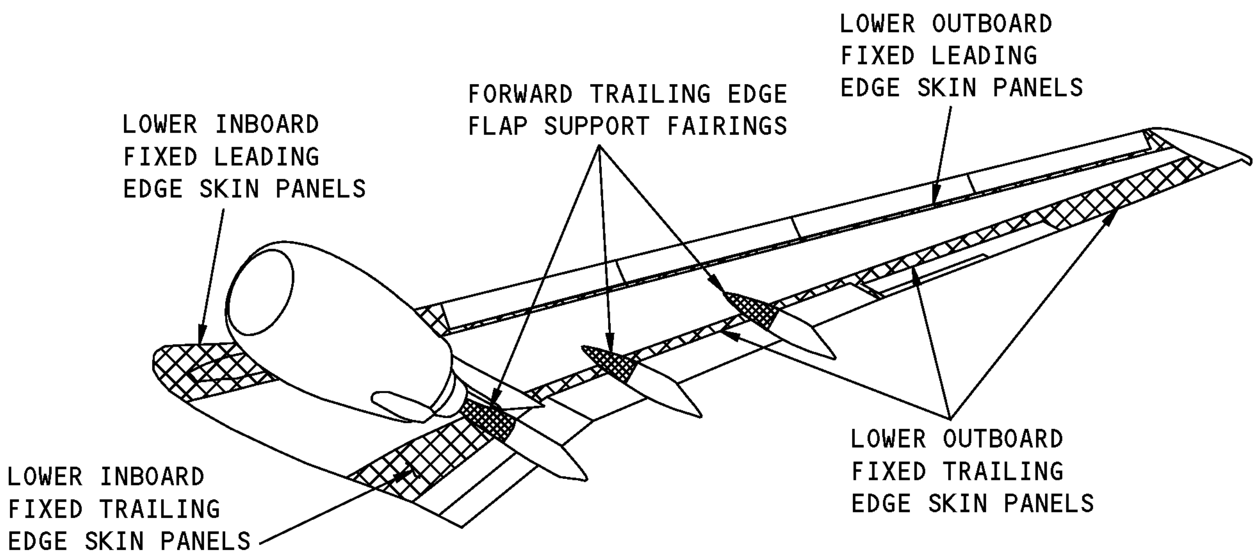
Locations of the Principal Composite Components Made of Glass Fiber Reinforced Plastic (GFRP)
Figure 2 (Sheet 1 of 3)



Locations of the Principal Composite Components Made of Glass Fiber Reinforced Plastic (GFRP)
Figure 2 (Sheet 2 of 3)



LEFT SIDE IS SHOWN, RIGHT SIDE IS OPPOSITE



LEFT SIDE IS SHOWN, RIGHT SIDE IS OPPOSITE

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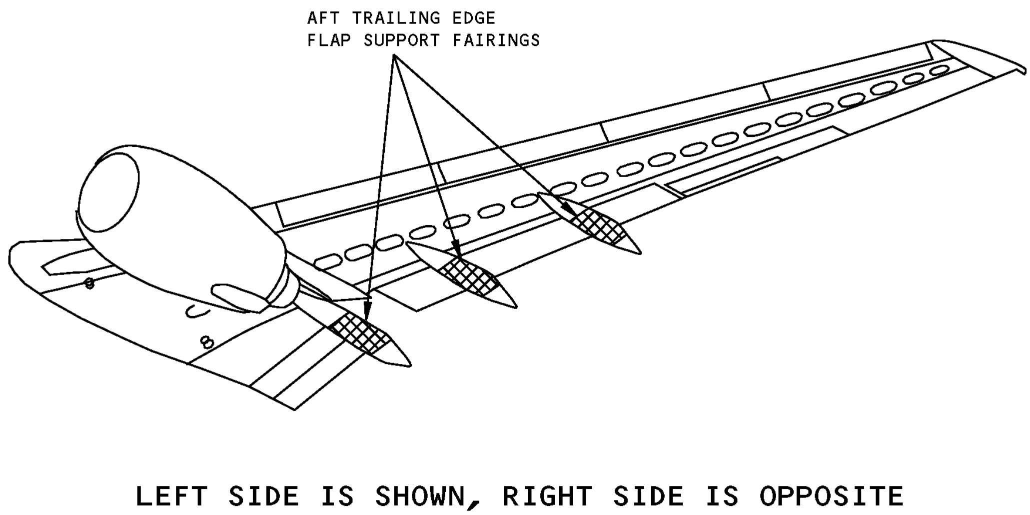
Locations of the Principal Composite Components Made of Glass Fiber Reinforced Plastic (GFRP)
Figure 2 (Sheet 3 of 3)



Locations of the Principal Hybrid CFRP/GFRP Bonded Composite Parts
Figure 3

GENERAL - COMPOSITE MATERIAL ALTERNATIVES

1. **Applicability**

   A. This subject helps you find alternative materials that you can use when you do composite repairs.

2. **General**

   A. Refer to Glass and Carbon Fiber Material Alternatives, Figure 1/GENERAL to find the fabrics and tapes you can use as alternatives to repair Glass Fiber Reinforced Plastic (GFRP) and Carbon Fiber Reinforced Plastic (CFRP) parts. These materials can be used when you can not use the same specification of material that was used in the initial manufacture of the part.

   B. There are no alternative cores you can use to repair parts made with BMS 8-339 (Pitch) or BMS 8-342 (Polyacrylonitrile (PAN) CFRP honeycomb core). You must use the same specification of core that was used in the initial manufacture of the part.

   C. Refer to Film Adhesive Repair Material Alternatives, Figure 2/GENERAL to find film adhesives you can use as alternatives. These materials can be used when you can not use the same specification of the material that was used in the initial manufacture of the product.

   D. Refer to Heat Resistant Honeycomb Core Material Alternatives, Figure 3/GENERAL to find alternative cores you can use to repair parts made with BMS 8-124, Class I, fiberglass honeycomb core. These cores can be used when you can not use the same specification of core that was used in the initial manufacture of the part.

   E. Refer to Non-Metallic Honeycomb Core Material Alternatives, Figure 4/GENERAL to find alternative cores you can use to repair parts made with BMS 8-124, Class IV or IV-A, non-metallic honeycomb core. These cores can be used when you can not use the same specification of core that was used in the initial manufacture of the part.

   F. Refer to High Modulus Non-Metallic Core Material Alternatives, Figure 5/GENERAL to find alternative cores you can use to repair parts made with BMS 8-124, Class VI non-metallic honeycomb core. These cores can be used when you can not use the same specification of core that was used in the initial manufacture of the part.

GLASS FABRIC REINFORCED PLASTIC (GFRP) AND CARBON FIBER REINFORCED PLASTIC (CFRP) REPAIR FIBER MATERIALS ALTERNATIVES		
MATERIAL TYPE	MATERIAL USED AT THE INITIAL MANUFACTURE	ALTERNATIVE REPAIR MATERIAL
DRY GLASS FIBER FABRIC	BMS 9-3:	BMS 9-3:
	1 PLY OF TYPE H-2 OR H-3	3 PLIES OF TYPE D OR D-1
	1 PLY OF TYPE H-2	1 PLY OF TYPE H-3
	1 PLY OF TYPE H-3	1 PLY OF TYPE H-2
	2 PLIES OF TYPE D OR D-1	1 PLY OF TYPE H-2 OR H-3
DRY CARBON FIBER FABRIC	BMS 9-8, TYPE I, CLASS 2: 1 PLY OF STYLE 3K-135-8H	BMS 9-8, TYPE I, CLASS 2: 2 PLIES OF STYLE 3K-70-PW
250°F (121°C) CURE PREIMPREGNATED GLASS FIBER FABRIC	BMS 8-79:	BMS 8-79:
	1 PLY OF STYLE 1581 OR 7781	3 PLIES OF STYLE 120
	1 PLY OF STYLE 1582	2 PLIES OF STYLE 1581
	1 PLY OF STYLE 1584	3 PLIES OF STYLE 1581
	2 PLIES OF STYLE 120	1 PLY OF STYLE 1581
350°F (177°C) CURE PREIMPREGNATED GLASS FIBER FABRIC	BMS 8-139:	BMS 8-139:
	1 PLY OF STYLE 1581 OR 7781	3 PLIES OF STYLE 120
	1 PLY OF STYLE 1582	2 PLIES OF STYLE 1581
	1 PLY OF STYLE 1584	3 PLIES OF STYLE 1581
	2 PLIES OF STYLE 120	1 PLY OF STYLE 1581
	1 PLY OF STYLE 108	1 PLY OF STYLE 120 OR 220
250°F (121°C) CURE PREIMPREGNATED CARBON FIBER FABRIC	BMS 8-168, TYPE II, CLASS 2: STYLE 3K-70-PW	BMS 8-168, TYPE II, CLASS 2: STYLE 3K-135-8H
	BMS 8-256, TYPE I OR IV, CLASS 1: 1 PLY OF GRADE 145	BMS 8-212, [2], CLASS 1: 1 PLY OF GRADE 190
	BMS 8-256, TYPE I OR IV, CLASS 1: 1 PLY OF GRADE 145	BMS 8-297, [2], CLASS 1: 1 PLY OF GRADE 190
250°F (121°C) CURE PREIMPREGNATED CARBON FIBER TAPE	BMS 8-168, TYPE II, CLASS 1: 1 PLY OF GRADE 145 OR 190	BMS 8-168, TYPE II, CLASS 1: 2 PLIES OF GRADE 95 OR 2 PLIES OF STYLE 3K-70-PW

Glass and Carbon Fiber Material Alternatives
Figure 1 (Sheet 1 of 2)

GLASS FABRIC REINFORCED PLASTIC (GFRP) AND CARBON FIBER REINFORCED PLASTIC (CFRP) REPAIR FIBER MATERIALS ALTERNATIVES		
MATERIAL TYPE	MATERIAL USED AT THE INITIAL MANUFACTURE	ALTERNATIVE REPAIR MATERIAL
350°F (177°C) CURE PREIMPREGNATED CARBON FIBER FABRIC	BMS 8-256, TYPE I OR IV, CLASS 2: 1 PLY OF STYLE 3K-70-PW	BMS 8-212, 2, CLASS 2 1 PLY OF STYLE 3K-70-PW OR BMS 8-297: 1 PLY OF STYLE 3K-70-PW
	BMS 8-256, TYPE I OR IV, CLASS 2: 1 PLY OF STYLE 3K-70-PW	BMS 8-297, 2, CLASS 2 1 PLY OF STYLE 3K-70-PW
	BMS 8-297, TYPE III OR IV: 2 PLIES OF CLASS 2, STYLE 3K-70-PW 1 PLY OF CLASS 2, STYLE 3K-70-8H	BMS 8-297, TYPE III OR IV: 1 PLY OF STYLE 3K-135-8H 2 PLIES OF STYLE 3K-70-PW
350°F (177°C) CURE PREIMPREGNATED CARBON FIBER TAPE	BMS 8-256, TYPE I,II OR IV, CLASS 1: 1 PLY OF GRADE 190	BMS 8-212, 2, CLASS 1: GRADE 190 1 OR BMS 8-297, 2, GRADE 190 1
	BMS 8-256, TYPE I,II OR IV, CLASS 1: 1 PLY OF GRADE 190	BMS 8-297, 2, CLASS 1: 1 PLY OF GRADE 190 1
	BMS 8-297, TYPE III, CLASS 1, GRADE 95	BMS 8-297: 1 PLY OF GRADE 190 FOR 2 PLIES OF GRADE 95
PREIMPREGNATED FIBERGLASS INSULATION	BMS 8-331	THERE IS NO ALTERNATIVE MATERIAL. REFER TO THE APPLICABLE REPAIR SECTION FOR AN ALTERNATIVE REPAIR.
350°F (177°C) CURE PREIMPREGNATED CARBON FIBER TAPE OR FABRIC	BMS 8-276	THERE IS NO ALTERNATIVE MATERIAL. REFER TO THE APPLICABLE REPAIR SECTION FOR AN ALTERNATIVE REPAIR.

1 CAUTION: USE 350°F (177°C) CURE PREIMPREGNATED CARBON FIBER MATERIALS FROM ONE SPECIFIED BOEING MATERIAL SPECIFICATION (BMS) AND ONE SUPPLIER FOR EACH CURE OF THE REPAIR. IF YOU DO NOT OBEY, THE REPAIR WILL BE UNSATISFACTORY.

2 USE THE SAME TYPE AS THE INITIAL MATERIAL.

Glass and Carbon Fiber Material Alternatives
Figure 1 (Sheet 2 of 2)

GLASS FABRIC REINFORCED PLASTIC (GFRP) AND CARBON FIBER REINFORCED PLASTIC (CFRP) ADHESIVE REPAIR MATERIALS ALTERNATIVES		
MATERIAL TYPE	MATERIAL USED AT THE INITIAL MANUFACTURE	ALTERNATIVE REPAIR MATERIAL
COMPOSITE SURFACING FILM [1]	BMS 8-341, TYPE II OR III	BMS 5-129 TYPE III, GRADE 5 ADHESIVE FOR 250°F (121°C) CURE PARTS BMS 5-154, TYPE II, CLASS 1, GRADE 03A OR 03 [1] ADHESIVE FOR 350°F (177°C) CURE PARTS
250°F (121°C) CURE FILM ADHESIVE	BMS 5-129, TYPE 2 OR 4:	BMS 5-101, TYPE II:
	1 PLY OF GRADE 5	1 PLY OF GRADE 5
	1 PLY OF GRADE 10	1 PLY OF GRADE 10
	1 PLY OF GRADE 15	1 PLY OF GRADE 15
350°F (177°C) CURE FILM ADHESIVE	BMS 5-70, TYPE II: 1 PLY	BMS 5-154, TYPE II, CLASS 1: 1 PLY OF GRADE 08
	BMS 5-137, TYPE II, CLASS 1:	BMS 5-137, TYPE II:
	2 PLIES OF GRADE 5	1 PLY OF GRADE 10, CLASS 1
	1 PLY OF GRADE 10	2 PLIES OF GRADE 5, CLASS 2
	BMS 8-145	THERE IS NO ALTERNATIVE MATERIAL. REFER TO THE APPLICABLE REPAIR SECTION FOR AN ALTERNATIVE REPAIR.
	BMS 5-154, TYPE II, CLASS 1:	BMS 5-154, TYPE II, CLASS 1:
	1 PLY OF GRADE 05	2 PLIES OF GRADE 03
	1 PLY OF GRADE 08	2 PLIES OF GRADE 05
	1 PLY OF GRADE 08	3 PLIES OF GRADE 03

[1] THIS MATERIAL IS USED IN THE MANUFACTURE OF THE PART

Film Adhesive Repair Material Alternatives
Figure 2

REPAIR MATERIAL ALTERNATIVES FOR NON-METALLIC HONEYCOMB CORE (BMS 8-124, CLASS I)					
MATERIAL USED AT THE INITIAL MANUFACTURE			ALTERNATIVE REPAIR MATERIAL		
TYPE	GRADE NOMINAL DENSITY PCF	CELL SIZE	MATERIAL (BMS 8-124, CLASS I)	GRADE NOMINAL DENSITY PCF	CELL SIZE
TYPE I	4.0	3/16	TYPE I TYPE II TYPE III	5.5 OR 8.0 4.5 4.5 OR 6.0	3/16 1/4 3/8
	5.5	3/16	TYPE I TYPE III	8.0 6.0	3/16 3/8
TYPE II	3.5	1/4	TYPE II TYPE III TYPE IV	4.5 4.5 OR 6.0 4.5	1/4 3/8 1/4 OX
	4.5	1/4	TYPE I TYPE III	5.5 6.0	3/16 3/8
TYPE III	3.5	3/8	TYPE I TYPE II TYPE III TYPE IV	4.0 OR 5.5 3.5 OR 4.5 4.5 OR 6.0 4.5	3/16 1/4 3/8 1/4 OX
	4.5	3/8	TYPE I TYPE II TYPE III	5.5 4.5 6.0	3/16 1/4 3/8
	6.0	3/8	TYPE I	5.5 OR 8.0	3/16
TYPE IV	4.5	1/4 OX	TYPE I TYPE II TYPE III	5.5 4.5 4.5 OR 6.0	3/16 1/4 3/8

NOTE: OX = OVEREXPANDED
PCF = POUNDS FOR EACH CUBIC FOOT

Heat Resistant Honeycomb Core Material Alternatives
Figure 3

REPAIR MATERIAL ALTERNATIVES FOR NON-METALLIC HONEYCOMB CORE (BMS 8-124, CLASS IV AND IV-A)						
MATERIAL USED AT THE INITIAL MANUFACTURE			ALTERNATIVE REPAIR MATERIAL			
TYPE	GRADE NOMINAL DENSITY PCF	CELL SIZE	MATERIAL (BMS 8-124, CLASS I,IV, OR IV-A)		GRADE NOMINAL DENSITY PCF	CELL SIZE
TYPE I	2.0	3/16	CLASS IV	TYPE I	3.4 OR 4.0	3/16
				TYPE IV	3.0	1/4 OX
				TYPE V	3.0 OR 4.0	1/8
				TYPE VI	3.0	3/16 OX
			CLASS IV-A	TYPE V	3.0	1/8 HFG
			CLASS I	TYPE I	4.0 OR 5.5	3/16
				TYPE II	3.5 OR 4.5	1/4
				TYPE III	3.5 OR 4.5	3/8
	3.0	3/16	CLASS IV	TYPE I	4.0	3/16
				TYPE V	3.0,4.0, OR 5.0	1/8
			CLASS IV-A	TYPE V	3.0	1/8 HFG
			CLASS I	TYPE I	4.0 OR 5.5	3/16
				TYPE II	3.5 OR 4.5	1/4
				TYPE III	3.5 OR 4.5	3/8
	4.0	3/16	CLASS IV	TYPE V	4.0,5.0, OR 8.0	1/8
			CLASS I	TYPE I	4.0 OR 5.5	3/16
				TYPE II	4.5	1/4
				TYPE III	4.5	3/8

NOTE: OX = OVEREXPANDED
HFG = HEAT FORMING GRADE
PCF = POUNDS FOR EACH CUBIC FOOT

Non-Metallic Honeycomb Core Material Alternatives
Figure 4 (Sheet 1 of 4)

REPAIR MATERIAL ALTERNATIVES FOR NON-METALLIC HONEYCOMB CORE (BMS 8-124, CLASS IV AND IV-A)						
MATERIAL USED AT THE INITIAL MANUFACTURE			ALTERNATIVE REPAIR MATERIAL			
TYPE	GRADE NOMINAL DENSITY PCF	CELL SIZE	MATERIAL (BMS 8-124, CLASS I,IV, OR IV-A)		GRADE NOMINAL DENSITY PCF	CELL SIZE
TYPE II	1.5	1/4	CLASS IV	TYPE I	2.0 OR 3.0	3/16
				TYPE II	2.0	1/4
				TYPE III	2.0	3/8
				TYPE IV	3.0	1/4 OX
				TYPE V	1.8 OR 3.0	1/8
				TYPE VI	3.0	3/16 OX
	2.0	1/4	CLASS IV	TYPE I	2.0 OR 3.0	3/16
				TYPE III	2.0	3/8
				TYPE IV	3.0	1/4 OX
				TYPE V	3.0 OR 4.0	1/8
TYPE III	1.5	3/8	CLASS IV	TYPE I	2.0 OR 3.0	3/16
				TYPE II	1.5 OR 2.0	1/4
				TYPE III	2.0	3/8
				TYPE IV	3.0	1/4 OX
				TYPE V	1.8 OR 3.0	1/8
				TYPE VI	3.0	3/16 OX
	2.0	3/8	CLASS IV	TYPE I	2.0 OR 3.0	3/16
				TYPE II	2.0	1/4
				TYPE IV	3.0	1/4 OX
				TYPE V	3.0 OR 4.0	1/8
TYPE IV	3.0	1/4 OX	CLASS IV	TYPE I	4.0	3/16
				TYPE V	4.0	1/8
				TYPE VI	3.0	3/16 OX
			CLASS I	TYPE I	4.0 OR 5.5	3/16
				TYPE II	3.5 OR 4.5	1/4
				TYPE III	3.5 OR 4.5	3/8

Non-Metallic Honeycomb Core Material Alternatives
Figure 4 (Sheet 2 of 4)

REPAIR MATERIAL ALTERNATIVES FOR NON-METALLIC HONEYCOMB CORE (BMS 8-124, CLASS IV AND IV-A)						
MATERIAL USED AT THE INITIAL MANUFACTURE			ALTERNATIVE REPAIR MATERIAL			
TYPE	GRADE NOMINAL DENSITY PCF	CELL SIZE	MATERIAL (BMS 8-124, CLASS I,IV, OR IV-A)		GRADE NOMINAL DENSITY PCF	CELL SIZE
TYPE V	1.8	1/8	CLASS IV	TYPE I TYPE II TYPE III TYPE IV TYPE V TYPE VI	2.0 OR 3.0 2.0 2.0 3.0 3.0 OR 4.0 3.0	3/16 1/4 3/8 1/4 OX 1/8 3/16 OX
	3.0	1/8	CLASS I	TYPE I TYPE II TYPE III	4.0 4.0 OR 5.0 3.0	3/16 1/4 3/8
			CLASS IV	TYPE I TYPE V	4.0 4.0 or 5.0	3/16 1/8
			CLASS IV-A	TYPE V	3.0	1/8 HFG
	4.0	1/8	CLASS IV	TYPE V	5.0 OR 8.0	1/8
			CLASS I	TYPE I TYPE II TYPE III	5.5 OR 8.0 4.5 4.5 OR 6.0	3/16 1/4 3/8
	5.0	1/8	CLASS IV	TYPE V	8.0 OR 9.0	1/8
			CLASS I	TYPE I TYPE III	5.5 OR 8.0 6.0	3/16 3/8
	8.0	1/8	CLASS IV	TYPE V	9.0	1/8
			CLASS I	TYPE I	8.0 OR 12.0	3/16
	9.0	1/8	CLASS I	TYPE I	12.0	3/16

Non-Metallic Honeycomb Core Material Alternatives
Figure 4 (Sheet 3 of 4)

REPAIR MATERIAL ALTERNATIVES FOR NON-METALLIC HONEYCOMB CORE (BMS 8-124, CLASS IV AND IV-A)						
MATERIAL USED AT THE INITIAL MANUFACTURE			ALTERNATIVE REPAIR MATERIAL			
TYPE	GRADE NOMINAL DENSITY PCF	CELL SIZE	MATERIAL (BMS 8-124, CLASS I,IV, OR IV-A)		GRADE NOMINAL DENSITY PCF	CELL SIZE
TYPE VI	1.8	3/16 OX	CLASS IV	TYPE I	2.0 OR 3.0	3/16
				TYPE II	2.0	1/4
				TYPE III	2.0	3/8
				TYPE IV	3.0	1/4 OX
				TYPE V	1.8, 3.0, OR 4.0	1/8
				TYPE VI	3.0	3/16 OX
	3.0	3/16 OX	CLASS I	TYPE I	4.0	3/16
				TYPE II	3.5	1/4
				TYPE III	4.5	3/8
				TYPE IV	4.5	1/4 OX
			CLASS IV	TYPE I	3.0	3/16
				TYPE IV	3.0	1/4 OX
				TYPE V	3.0	1/8
TYPE V	3.0	1/8 HFG	CLASS I	TYPE I	4.0	3/16
				TYPE II	3.5	1/4
				TYPE IV	4.5	1/4 OX
			CLASS IV	TYPE I	4.0	3/16
				TYPE V	4.0 OR 5.0	1/8

Non-Metallic Honeycomb Core Material Alternatives
Figure 4 (Sheet 4 of 4)

REPAIR MATERIAL ALTERNATIVES FOR NON-METALLIC HONEYCOMB CORE (BMS 8-124, CLASS VI)						
MATERIAL USED AT THE INITIAL MANUFACTURE			ALTERNATIVE REPAIR MATERIAL			
TYPE	GRADE NOMINAL DENSITY PCF	CELL SIZE	MATERIAL (BMS 8-124, CLASS I,IV, OR IV-A)		GRADE NOMINAL DENSITY PCF	CELL SIZE
TYPE V	3.0	1/8	CLASS 1	TYPE I	4.0	3/16
				TYPE II	4.5	1/4
				TYPE III	4.5	3/8
					6.0	3/8
				TYPE IV	4.5	1/4
			CLASS 4	TYPE I	4.0	3/16
				TYPE V	5.0	1/8
					8.0	1/8

NOTE: PCF = POUNDS FOR EACH CUBIC FOOT.

High Modulus Non-Metallic Core Material Alternatives
Figure 5

REPAIR GENERAL - REPAIR PROCEDURES FOR WET LAYUP MATERIALS

1. Applicability

WARNING: SOME OF THE EQUIPMENT USED TO HEAT CURE THESE REPAIRS CAN CAUSE A FIRE OR AN EXPLOSION WHEN USED NEAR AN AIRPLANE THAT CONTAINS OR HAS CONTAINED FUEL. USE EQUIPMENT THAT AGREES WITH THE FIRE CODES OF YOUR LOCAL FIRE AUTHORITY. IF YOU DO NOT OBEY, INJURY TO PERSONS AND DAMAGE TO THE AIRPLANE CAN OCCUR. DO NOT BREATHE THE VAPORS OR LET THE SOLVENTS GET ON YOUR SKIN, IN YOUR EYES, OR IN YOUR MOUTH. USE NEOPRENE GLOVES WITH COTTON LINERS, PROTECTIVE CLOTHING, AND EYE GOGGLES. IF THE CHEMICALS TOUCH YOUR SKIN, WASH THEM WITH CLEAN WATER. IF THE CHEMICALS GET IN YOUR EYES, FLUSH THEM WITH A LARGE QUANTITY OF CLEAN WATER AND GET MEDICAL AID. MAKE SURE THAT THERE IS A GOOD FLOW OF CLEAN AIR WHERE YOU DO THE WORK, OR USE RESPIRATORY EQUIPMENT WHEN YOU WORK IN A CONFINED SPACE. IF YOU DO NOT OBEY, INJURY TO PERSONS CAN OCCUR.

CAUTION: REFER TO THE SPECIFIED REPAIR SUBJECT FOR THE APPROVED REPAIRS AND LIMITS FOR THE DAMAGED COMPOSITE PART. IF YOU DO NOT OBEY, THE RESULT CAN BE AN UNSATISFACTORY REPAIR.

A. This subject contains repair data for components made from epoxy resin reinforced with layers of carbon or glass fiber. The procedures for repairs to the components made with glass or carbon fibers are the same. The cure cycle and the materials used for the repair can be different.

2. General

A. Repair General gives the repair data common to the components made from epoxy resin reinforced with layers of carbon or glass fiber. Refer to Table 201/REPAIR GENERAL for an index of the different numbered repairs found in this subject.

NOTE: Refer to 51-70-08 for the general resin sweep-fair procedures.

B. The specific repair subject (Example: 55-20-01, Repair 1, for elevator skins) will tell you the type of repair you are permitted to use. Table 202/REPAIR GENERAL and Table 203/REPAIR GENERAL give a list of materials that are used for each type of repair.

C. The cure temperature for these repairs is 150°F (66°C) or 200°F (93°C). The usual assembly is a two skin lamination divided by a honeycomb core. A solid laminate is used for some components, the edgebands and mating surfaces of honeycomb panels, and at fitting locations.

Table 201:

REPAIR INDEX	
REPAIR NUMBER	**TITLE**
1	Repair of Damage to One Skin of a Honeycomb Panel
2	Repair of Damage That is More Than 0.50 Inch in Diameter to One Skin and Honeycomb Core
3	Repair of Damage to One Skin and the Honeycomb Core Less Than 4.0 Inches in Diameter
4	Repair of Damage to the Two Skins and the Honeycomb Core
5	Repair of Damage to the Two Skins and the Honeycomb Core When Access is Limited to One Side
6	Repair of Damage to the Edgeband of a Honeycomb Panel
7	Repair of Damage to the Edgeband and the Honeycomb Core

REPAIR INDEX	
REPAIR NUMBER	TITLE
8	Moved data to SRM 51-70-05, Repair 8.
9	Repair of Damage to a Fastener Hole With Laminating Resin and Chopped Fiber
10	Repair of Damage That is More Than 0.50 Inch in Diameter to Solid Laminates
11	A Potted Core Repair
12	Repair of Damage to the Trailing Edge of a Honeycomb Panel With Full Depth Core
13	Repair of an Edge Delamination
14	Rework of Permitted Surface Dents With Potting Compound and a Fiberglass Patch

Table 202:

CARBON FIBER REINFORCED PLASTIC REPAIR MATERIALS		
REPAIR MATERIAL	150°F CURE OF 250°F OR 350°F CFRP COMPONENTS	200°F CURE OF 250°F OR 350°F CFRP COMPONENTS
Potting Compound	BMS 5-28, Type 6 or 7	BMS 5-28, Type 6 or 7
Laminating Resin	BMS 8-301, Class 2	BMS 8-301, Class 1
Repair Fabric	BMS 9-8, Style 3K-70-P or 3K-135-8H	BMS 9-8, Style 3K-70-P or 3K-135-8H
Fiberglass Isolation Ply	BMS 9-3, Type D	BMS 9-3, Type D
Sealing and Injection Resin	BMS 8-207, Type I	BMS 8-207, Type I
Honeycomb Core	BMS 8-124 or BMS 8-339	BMS 8-124 or BMS 8-339
Chopped Fibers	Milled glass fiber Milled glass fiber	Milled glass fiber Milled glass fiber

Table 203:

GLASS FABRIC REINFORCED PLASTIC REPAIR MATERIALS		
REPAIR MATERIAL	150°F CURE OF 250°F OR 350°F GFRP COMPONENTS	200°F CURE OF 250°F OR 350°F GFRP COMPONENTS
Potting Compound	BMS 5-28, Type 6 or 7	BMS 5-28, Type 6 or 7
Laminating Resin	BMS 8-301, Class 2	BMS 8-301, Class 1
Repair Fabric	BMS 9-3, Type H2, H3, or D	BMS 9-3, Type H2, H3. or D
Fiberglass Isolation Ply	BMS 9-3, Type D, Class 3, 4, 7, and 11	BMS 9-3, Type D, Class 3, 4, 7, and 11
Sealing and Injection Resin	BMS 8-207, Type I	BMS 8-207, Type I
Honeycomb Core	BMS 8-124	BMS 8-124
Chopped Fibers	Milled glass fiber Milled glass fiber	Milled glass fiber Milled glass fiber

D. When you repair large components, make sure that you use the applicable tool fixtures. This will help to prevent distortion or delamination of the structure.

E. Refer to Table 204/REPAIR GENERAL for the data about resins and potting compounds.

F. Refer to 51-70-03 for the list of alternative materials.

CAUTION: REFER TO THE APPLICABLE COMPONENT STRUCTURAL REPAIR SUBJECT FOR THE COMPONENT MATERIAL AND REPAIR LIMITS BEFORE YOU DO THESE REPAIR INSTRUCTIONS. REPAIRS THAT USE THE 150°F (66°C) CURE CYCLE DO NOT HAVE THE STRENGTH OR DURABILITY OF COMPONENTS INITIALLY MADE FROM 350°F (177°C) CURE MATERIALS. USE ONLY THE REPAIRS THAT ARE PERMITTED BY THE APPLICABLE STRUCTURAL REPAIR SECTION. IF YOU DO NOT OBEY, THE RESULT CAN BE AN UNSATISFACTORY REPAIR.

G. Refer to the applicable chapter-section-subject for the allowable damage limits, repair limits, and repair data of the specified components.

H. Make sure that you do the repair in a clean area. Do not do these repairs in locations where the air contains oil, mist, exhaust fumes, gasses, soot, rain, dust, or other unwanted materials. You can use a tent to isolate the repair location from contamination.

I. Prevent repair surface contamination. Do not touch the cleaned parts or the adhesives with your bare hands. Wear clean lint-free gloves when you work with these parts.

J. Refer to Resin Cure Data, Figure 201/REPAIR GENERAL and Typical Fairing Panel Parts, Figure 203/REPAIR GENERAL for the data about heat lamp usage.

Table 204:

RESIN AND POTTING COMPOUND DATA				
RESIN TYPE	**COMPONENTS**	**PARTS BY WEIGHT**	**POT LIFE**	**CURE TIME AND TEMPERATURE**
BMS 8-301, Class 1 (Laminating Resin)	EA 9390 Base Hardener	100 +/- 2% 56 +/- 0.5%	2 hours	Refer to Figure 214
BMS 8-301, Class 2 (Laminating Resin)	EY3804 Base Hardener	100 +/- 2% 66 +/- 2%	45 minutes	Refer to Figure 214
BMS 8-207, Type I (Sealing Resin)	EC1838A Resin EC1838B Hardener	Refer to the manufacturer's data	20 minutes	2 hours at 115°F (46°C) ±10°F
BMS 8-207, Type I (Sealing Resin)	MXR7774 Part A MXR7774 Part B	Refer to the manufacturer's data	20 minutes	2 hours at 115°F (46°C) ±10°F
BMS 8-207, Type I (Sealing Resin)	FR-40 Resin 5413C Hardener	Refer to the manufacturer's data	20 minutes	1 hour at 160°F (57°C) ±10°F
BMS 5-28, Type 7 (Potting Compound)	EPOCAST 89537 Part A EPOCAST 89537 Part B	Refer to the manufacturer's data	1 hour	6 hours at room temperature or 30 minutes at 150°F (66°C) ±10°F
BMS 5-28, Type 7 (Potting Compound)	CG-1305 Resin CG-1305 Hardener	Refer to the manufacturer's data	1 hour	6 hours at room temperature or 30 minutes at 150° (66°C) ±10°F

RESIN AND POTTING COMPOUND DATA				
RESIN TYPE	COMPONENTS	PARTS BY WEIGHT	POT LIFE	CURE TIME AND TEMPERATURE
BMS 5-28, Type 6 (Potting Compound)	EPOCAST 1636 Part A EPOCAST 1636 Part B	Refer to the manufacturer's data	1 hour	6 hours at room temperature or 30 minutes at 150°F (66°C) ±10°F
BMS 5-109, Type II (Adhesive Paste)	EA9394 Part A EA9394 Part B or EA934NA Part A EA934NA Part B	Refer to the Manufacturer's data	30 minutes	130 minutes ±10 minutes at 150°F (51°C) ±20°F

K. Keep the resin systems and potting compounds between 40°F (4°C) and 80°F (27°C) in sealed containers.

(1) Identify the container of the material with a label that has the data that follows:

(a) Boeing Material Specification (BMS)

(b) Type

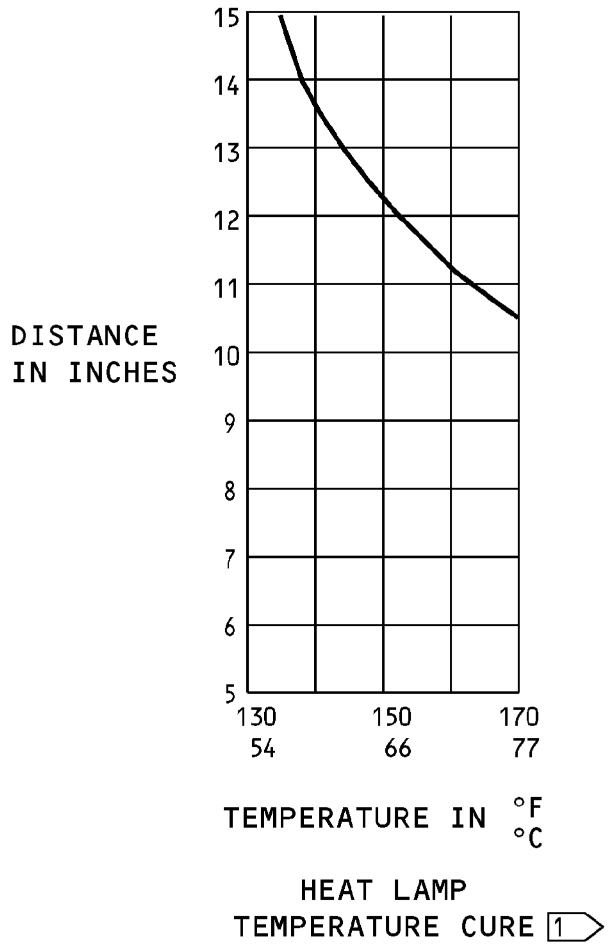
(c) Class

(d) Supplier name

(e) Batch number

(f) Date of preparation

(g) Date of expiration.



NOTES

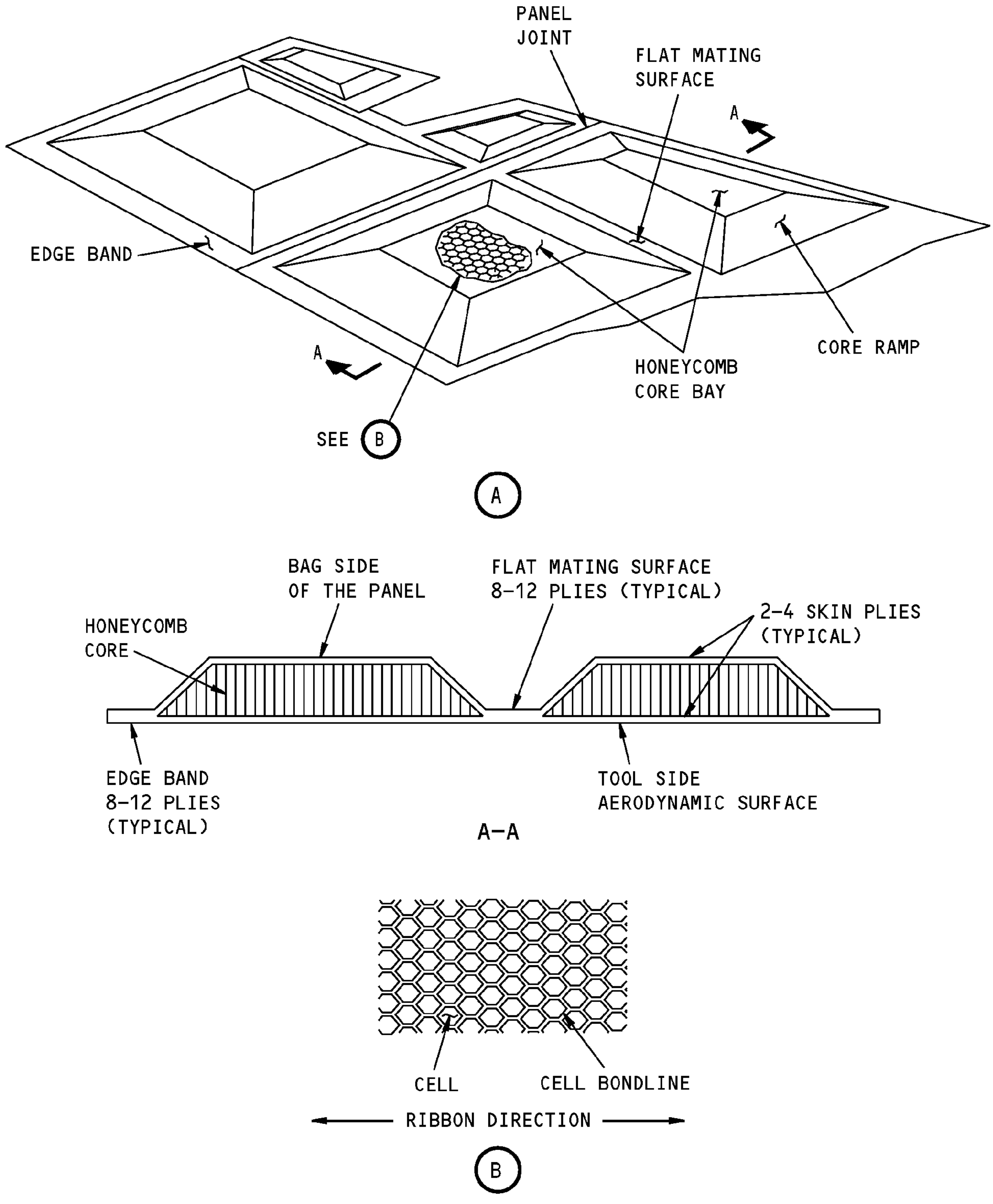
- USE THERMOCOUPLES TO MONITOR THE TEMPERATURE.
- THESE TEMPERATURES ARE APPROXIMATE FOR A TYPICAL HEAT LAMP OF 250 WATTS AT 120 VOLTS. THE HOTTEST AREA OF THE PART (THE LOCATION OF THE BRIGHTEST SPOT) CHANGES WITH THE DISTANCE FROM THE PART. IT IS RECOMMENDED THAT YOU USE THERMOCOUPLES TO MAKE SURE OF THE TEMPERATURE CHARACTERISTICS OF A SPECIFIC HEAT LAMP. THE TEMPERATURE OF THE PART IS ALSO CHANGED BY THE PRESENCE OR ABSENSE OF WIND.

1 BEFORE YOU DRILL HOLES OR APPLY THE FINISHES

Resin Cure Data
Figure 201

THIS FIGURE HAS
BEEN REMOVED

Resin Cure Data for BMS 8-201
Figure 202



Typical Fairing Panel Parts
Figure 203

3. References

Reference	Title
51-00-07, GENERAL	Definitions of Terms Used in the Structural Repair Manual (SRM)
51-10-01, GENERAL	Aerodynamic Smoothness Requirements
51-20-05	REPAIR SEALING
51-20-07	MACHINING AND DRILLING OF COMPOSITE STRUCTURES
51-30-03, GENERAL	Sources for Non-Metallic Repair Materials
51-60-00	CONTROL SURFACE BALANCING
51-70-01	REPAIRS FOR MINOR DENTS IN METALLIC SHEET MATERIALS
51-70-03	COMPOSITE MATERIALS ALTERNATIVES
51-70-05	REPAIR PROCEDURES FOR PREIMPREGNATED MATERIALS
51-70-06, REPAIR GENERAL	Room Temperature Cure Repairs With Wet Layup Materials For Glass Fabric Reinforced Plastic Solid Laminates and Honeycomb Core Panels
51-70-08	RESIN SWEEP-FAIR PROCEDURES
51-70-14	STRUCTURES WITH ALUMINUM COATINGS AND FOILS
55-20-01	ELEVATOR SKIN
AMM 51-21-00-100-801	Airplane Surface Preparation for Application of Finish (P/B 701)
AMM 51-21-71/701	Conductive Coating For External Surfaces - Cleaning/Painting
AMM 51-21-81/701	Abrasion-resistant Teflon Finish - Cleaning/Painting
SOPM 20-30-03	Standard Overhaul Practices Manual
737 NDT Part 1, 51-01-01	Inspection of Repairs to Composite Structure
737 NDT Part 1, 51-01-02	NDT Examination of Composite Structure for Impact Damage
737 NDT Part 1, 51-01-03	NDT Assessment of Lightning Strike Damage to Graphite/Epoxy Composite Structure
737 NDT Part 1, 51-05-01	Tap Test Inspection of Honeycomb Sandwich Structure

4. Repair Procedures That Are Common to the Different Repairs

CAUTION: DO NOT USE CHEMICAL PAINT STRIPPERS TO REMOVE THE PAINT BEFORE YOU DO AN ESTIMATE OF THE DAMAGE. THESE PAINT STRIPPERS WILL CAUSE DAMAGE TO THE RESIN SYSTEMS.

A. Find the level of the damage.

(1) Do a visual inspection to find the level of the damage.

(2) Examine the part for the entry of water, oil, fuel, or other unwanted material. You can find water with X-Ray procedures. Refer to NDT Part 2, 51-00-01 for the X-Ray inspection procedures for water detection in honeycomb structures.

(3) Examine the part for delaminations in the areas adjacent to the damage.

NOTE: You can find delamination with the instrumented Non-Destructive Test (NDT) procedures or with the tap test procedures. Refer to:

- 737 NDT Part 1, 51-01-02 for the inspection of impact damage
- 737 NDT Part 1, 51-01-03 for inspection of lightning strike damage
- 737 NDT Part 1, 51-05-01 for the tap test procedure for honeycomb sandwich structure.

B. Remove the damaged plies and core.

WARNING: DO NOT USE EQUIPMENT THAT CAUSES AN ARC OR A SPARK IN AN AREA WHERE THE IGNITION OF THE VAPOR IS POSSIBLE. IF YOU DO NOT OBEY, AN EXPLOSION CAN OCCUR AND CAUSE INJURY. USE A VACUUM TABLE OR A PORTABLE VACUUM WHEN YOU REMOVE THE DAMAGED MATERIAL. DO NOT BREATHE THE DUST. WHEN YOU SAND THE PLY LAYERS, A FINE DUST IS MADE THAT CAN BE HAZARDOUS. THE DUST CAN CAUSE SKIN AND EYE IRRITATION OR RESPIRATORY PROBLEMS.

CAUTION: DO NOT USE CHEMICAL PAINT STRIPPERS TO REMOVE THE PAINT. CHEMICAL PAINT STRIPPERS WILL CAUSE DAMAGE TO THE RESIN SYSTEMS. IF YOU DO NOT OBEY, THE REPAIR WILL BE UNSATISFACTORY.

C. Remove the damaged plies.

(1) Tape off the area that is 1.0 inch from the edge of where the largest repair ply will be applied. Refer to the applicable repair figure.

(2) Remove the damaged area of the facesheets in a smooth circular or oval shape with number 180-grit or smaller abrasive paper. Be careful not to cause damage to the facesheet and core which are not damaged.

(a) Make a list of the plies that you remove.

(3) Remove the finish inside the taped off area and make the surfaces rough with number 240-grit or smaller abrasive paper. Be careful not to cause damage to the plies that are not damaged.

(4) If the initial core in the damaged area will not be removed, then sand the adhesive that is over the core cells to open the core cells. Use number 240-grit or smaller abrasive paper. It is not necessary to remove the adhesive fillets from the core.

(5) Remove the tape.

D. Make the necessary taper.

(1) Tape off the area that is 1.0 inch from the edge of where the largest repair ply will be applied.

(2) Remove the finish inside the taped off area and make the surface rough with number 240-grit or smaller abrasive paper. Be careful not to cause damage to the plies that are not damaged.

(3) Make an even taper from the edge where the damage was removed as shown in Taper Sand That is Necessary for the Repair, Figure 207/REPAIR GENERAL. Use 180-grit or smaller abrasive paper.

(a) For solid laminates, use a 30 to 1 taper ratio. Refer to Table 205/REPAIR GENERAL for the necessary taper dimension.

(b) For honeycomb panels with facesheets of 5 or less plies, use a 50 to 1 taper ratio. Refer to Table 206/REPAIR GENERAL for the necessary taper dimension.

Table 205:

NECESSARY TAPER DIMENSION FOR A 30 TO 1 TAPER RATIO		
MATERIAL	STYLE OR GRADE OF INITIAL STRUCTURE	TAPER DIMENSION "X" INCHES (MILLIMETERS)
Tape	Grade 95	0.125 inch (3.2 mm)
Tape	Grade 145	0.187 inch (4.7 mm)
Tape	Grade 190	0.240 inch (6.1 mm)

NECESSARY TAPER DIMENSION FOR A 30 TO 1 TAPER RATIO		
MATERIAL	STYLE OR GRADE OF INITIAL STRUCTURE	TAPER DIMENSION "X" INCHES (MILLIMETERS)
Fabric	Style 3K-70-PW	0.260 inch (6.6 mm)
Fabric	Style 3K-135-8H	0.500 inch (12.7 mm)
Fabric	Style 120	0.125 inch (3.2 mm)
Fabric	Style 1581	0.300 inch (7.6 mm)

Table 206:

NECESSARY TAPER DIMENSION FOR A 50 TO 1 TAPER RATIO		
MATERIAL	STYLE OR GRADE OF INITIAL STRUCTURE	TAPER DIMENSION "X" INCHES (MILLIMETERS)
Fabric	Style 3K-70-PW	0.450 inch (11.4 mm)
Fabric	Style 3K-135-8H	0.750 inch (19.1 mm)
Fabric	Style 120	0.220 inch (5.6 mm)
Fabric	Style 1581	0.500 inch (12.7 mm)

Table 207:

NECESSARY TAPER DIMENSION FOR THE REPAIR PLIES FOR A 50 TO 1 TAPER RATIO		
MATERIAL	STYLE OF THE REPAIR PLY	OVERLAP (INCHES) (MILLIMETERS)
Fabric	Style 3K-70-PW	0.450 inch (11.4 mm)
Fabric	Style 3K-135-8H	0.750 inch (19.1 mm)

(c) For honeycomb panels with facesheets of 6 or more plies, use a 30 to 1 taper ratio. Refer to Table 205/REPAIR GENERAL for the necessary taper dimension.

(4) Carefully remove the damaged core (if necessary).

NOTE: When you do a potted core repair, it is not necessary to remove the damaged core unless the core has contamination such as corrosion, water, oil, fuel, or other unwanted material. You must fill the core cells with the potting compound.

(a) Remove the core to the same dimensions as the hole in the skin.

(b) Use care so that you do not cause damage to the opposite skin.

(c) Make sure that all of the damage (corrosion and mechanical damage) is removed.

(d) For core that is more than 1.0 inch thick, you can do a partial-depth core repair. The damage must not be more than 0.50 inch in depth. Remove the core a maximum depth of 0.50 inch.

(5) In locations where the contamination can not be cleaned as specified in 4.E.(4) or dried as given in 4.C and 4.D, remove the structure that has the contamination.

(6) Remove the sealant from the areas where heat will be used.

(7) If the inner surface of the opposite skin is also damaged, remove the damage to a smooth shape as specified in Paragraph 4.B./REPAIR GENERAL

(8) When you remove the core from the inner surface of the opposite skin, carefully remove the core down to the adhesive layer. Do not damage the fibers.

(9) Examine the cutout location to make sure that all the damage is removed. Use the NDT procedures.

CAUTION: YOU MUST REMOVE THE WATER THAT HAS BEEN ABSORBED INTO THE PART BEFORE A HOT BONDED REPAIR IS MADE. IF YOU DO NOT OBEY, YOU CAN CAUSE THE REPAIR TO BE UNSATISFACTORY.

CAUTION: DO NOT FULLY BAG COMPOSITE PARTS THAT ARE HOLLOW SUCH AS RUDDERS, FLAPS, AND ELEVATORS. A FULLY BAGGED PART THAT IS HOLLOW CAN BE CRUSHED WHEN YOU APPLY THE VACUUM DURING THE REPAIR. ATTACH THE VACUUM BAG TO ONE SIDE OF THE PART ONLY OR ATTACH DIFFERENT VACUUM BAGS TO EACH SIDE OF THE PART. REFER TO FIGURE 205.

E. Remove the water from the honeycomb sandwich structure. Refer to Water Removal Procedure for a Honeycomb Panel, Figure 204/REPAIR GENERAL.

NOTE: The area to be dried must be a minimum of 4 inches larger all around than the damaged area that was removed.

(1) Remove the skin plies to get access to the honeycomb core. Refer to Paragraph 4.B./REPAIR GENERAL

(2) Sand the adhesive to open the core cells. It is not necessary to remove the adhesive fillets from the core.

(3) Remove all the water that you can see with a vacuum or with compressed air that is free of oil.

(4) Apply a layer of glass fabric cloth or a metal mesh screen above the core.

(5) Put a thermocouple above the center of the core.

(6) Put one ply of glass fabric breather cloth above the screen and thermocouple. Use masking tape to hold the breather cloth in position.

(7) If you can get access to the side of the honeycomb panel opposite the damage, put the thermocouples and a heat blanket on that side. This is the preferred location of the heat blanket. If you can not get access to the opposite side of the honeycomb panel, or if you use only one heat blanket, do the step that follows:

(a) Put the heat blanket above the breather cloth and the thermocouple on the damaged side. This is the alternative location of the heat blanket.

(8) Install the vacuum probe and the vacuum gage above the breather cloth. Make sure that the vacuum probe and the vacuum gage touch the breather cloth.

(9) Apply the vacuum sealing compound around the damaged location. Seal the location with the vacuum bag material.

(10) Apply a minimum vacuum of 22 inches of mercury to the repair location.

CAUTION: DO NOT INCREASE THE TEMPERATURE OF THE ALUMINUM STRUCTURE ABOVE 180°F (82°C). HIGH TEMPERATURES CAN DECREASE THE STRENGTH OF ALUMINUM ALLOY PARTS.

(11) Increase the temperature at a rate between 1°F and 5°F (0.5°C and 3°C) for each minute until the temperature is between 160°F (71°C) and 180°F (82°C).

(12) Keep the temperature between 160°F (71°C) and 180°F (82°C) for a minimum of 1 hour.

(13) Decrease the temperature at a maximum rate of 5°F (3°C) for each minute.

(14) Remove the vacuum bag, heat blanket, thermocouple, breather cloth, and screen from the repair area.

(15) Do steps (4) thru (14) again if the repair area remains moist.

F. Remove the water from the solid laminate structure. Refer to Water Removal for a Solid Laminate, Figure 206/REPAIR GENERAL.

(1) Remove the damage as shown in Paragraph 4.B./REPAIR GENERAL

(2) To remove the water, use a vacuum or compressed air that is free of oil.

(3) Put the thermocouple above the center of the repair area.

(4) Put only one ply of glass fabric breather cloth above the area to be dried. Use masking tape to hold it in position.

(5) Put the heat blanket above the breather cloth and the thermocouple on the damaged side.

(6) Install the vacuum probe and the vacuum gage above the breather cloth. Make sure that the vacuum probe and the vacuum gage touch the breather cloth.

(7) Apply vacuum sealing compound around the damage location.

(8) Put the vacuum bag material on the repair area. Push it on the vacuum sealing compound.

(9) Apply a vacuum of 22 inches of mercury minimum to the repair location.

(10) Increase the temperature at a rate between 1°F and 5°F (0.5°C and 3°C) for each minute until the temperature is between 180°F (77°C) and 190°F (88°C). Hold this temperature range for 4 hours.

(11) Decrease the temperature at a rate of 5°F (3°C) maximum for each minute for 10 minutes.

(12) Remove the vacuum bag, heat blanket, thermocouple, and breather cloth from the repair area.

(13) Do steps (3) thru (13) again if water remains in the repair area.

G. Make the necessary taper

WARNING: USE A VACUUM TABLE OR A PORTABLE VACUUM WHEN YOU REMOVE THE DAMAGE. DO NOT BREATHE THE DUST WHEN YOU SAND THE PLY LAYERS. THE DUST IS HAZARDOUS. IT CAN CAUSE EYE IRRITATION AND RESPIRATORY PROBLEMS. USE AIR-POWERED EQUIPMENT WHERE THERE IS A POSSIBILITY OF THE IGNITION OF VAPORS. IF YOU DO NOT OBEY, AN EXPLOSION CAN OCCUR AND CAUSE INJURY TO PERSONS

(1) Find the number of plies that have been cut or sanded.

(a) If the number of plies is not apparent, refer to the applicable structure identification section or the engineering drawings.

(2) Tape off the area that is 1.0 inch from the edge of where the largest repair ply will be applied.

(3) Remove the finish inside the taped off area and make the surface rough with number 240-grit or smaller abrasive paper. Be careful not to cause damage to the plies that are not damaged.

(4) Make an even taper from the edge where the damage was removed as shown in Taper Sand That is Necessary for the Repair, Figure 207/REPAIR GENERAL. Use number 180-grit or smaller abrasive paper.

(a) For solid laminates, use a 30 to 1 taper ratio. Refer to Table 205/REPAIR GENERAL for the necessary taper dimension.

(b) For honeycomb panels with facesheets of 5 or less plies, use a 50 to 1 taper ratio. Refer to Table 206/REPAIR GENERAL for the necessary taper dimension.

(c) For honeycomb panels with facesheets of 6 or more plies, use a 30 to 1 taper ratio. Refer to Table 205/REPAIR GENERAL for the necessary taper dimension.

(d) Remove the outer finishes and conductive coatings from around the repair surfaces with the recommended number 240-grit or smaller Scotch-Brite abrasive or 180-grit abrasive paper. Do not sand in the fibers.

(5) Clean the repair area.

WARNING: KEEP SOLVENTS AWAY FROM SOURCES OF HEAT, FIRE, OR SPARKS. HEAT, FIRE, OR SPARKS CAN CAUSE AN EXPLOSION. DO NOT LET THE SOLVENTS GET IN YOUR EYES, ON YOUR SKIN, OR ON YOUR CLOTHING. USE EYE PROTECTION AND PROTECTIVE CLOTHING. MAKE SURE THAT YOU USE RESPIRATORY EQUIPMENT WHEN YOU WORK IN CLOSED LOCATIONS. IF YOU DO NOT OBEY, INJURY TO PERSONS CAN OCCUR.

CAUTION: DO NOT SOAK THE PARTS IN TRICHLOROETHANE SOLVENT. DO NOT LET THE SOLVENT STAY ON THE PARTS FOR MORE THAN 60 SECONDS. IF YOU DO NOT OBEY, DAMAGE TO THE PARTS CAN OCCUR.

(a) Remove all dust with a vacuum cleaner.

(b) Clean the surface of the repair area with a cloth moist with methyl isobutyl ketone (MIBK) or acetone. Refer to SOPM 20-30-03 for possible sources of the solvents.

(6) Clean the surface again until a new moist cloth shows no dirt after you use it.

(7) Remove the solvent from the surface before it dries.

(8) Remove the remaining solvent film before you continue the repair.

H. Cut out the core repair plug from the same honeycomb core material as the initial core. Refer to Table 202/REPAIR GENERAL and Table 203/REPAIR GENERAL, the identification section or the engineering drawings to find the type of honeycomb core that you can use.

NOTE: Refer to Repair 11 for a potted core repair.

(1) Align the ribbon direction of the core.

(2) For fiberglass, aramid, and aluminum cores, do the steps that follow:

(a) Cut the core repair plug to the depth necessary to be smooth with the initial core that was removed. Refer to 4.B.

NOTE: Add a sanding allowance to the core height for two-step repairs. A two-step repair is a repair in which the plies and the core are cured at different times. The two-step repair procedure is recommended.

(b) Cut the core repair plug so that it has the same shape and contour as the core that was removed. A maximum clearance of 0.025 inch is permitted between the core repair plug and the initial core before you apply the foaming adhesive. Make sure that the repair plug has a tight interference fit.

(c) Make sure that the core repair plug has a tight interference fit in the initial core after you apply the foaming adhesive.

(d) Remove all the burrs from the cut edges of the core.

I. Clean the honeycomb core plug.

(1) For fiberglass and aramid core, do the steps that follow:

(a) Soak the honeycomb core in alcohol, MIBK or acetone bath for a maximum of 60 seconds.

NOTE: If the core is still not clean, you can soak it again up to three more times for a maximum of 60 seconds each time. It is not necessary to clean the core unless it was open to contamination during storage or during the cutting operation.

(2) For aluminum core, vapor degrease as given in SOPM 20-30-03.

NOTE: It is not necessary to clean the core unless it was open to contamination during storage or during the cutting operation.

(3) Remove the solvent and dry the honeycomb core. Permit the core to drain on a cloth or use compressed air that is free of oil. Make sure that all the remaining solvent film is removed from all sides of the core.

J. Install the honeycomb core repair plug.

NOTE: As an alternative, you can make a core repair as given in 51-70-05. Also as an alternative, the core repair plug and the repair plies can be cured at the same time. However, you must carefully monitor the temperature with thermocouples that are put on the outer surfaces (the two outer sides) of the panel. The steps that follow are the procedures for a core repair plug that is cured without the ply layup (a two-step repair). This is the recommended procedure.

CAUTION: DO NOT TOUCH THE RESIN MATERIALS WITH YOUR BARE HANDS. USE CLEAN RUBBER GLOVES WHEN YOU USE THESE MATERIALS. KEEP THESE MATERIALS FREE OF CONTAMINATION. IF YOU DO NOT OBEY, YOU CAN CAUSE THE REPAIR TO BE UNSATISFACTORY.

(1) For a core repair plug that is less than the full thickness of the initial honeycomb core, do the steps that follow:

(a) Cut two plies of glass fabric impregnated with resin to the same dimension as the hole in the core. Use BMS 9-3, Type H-2 or H-3. Refer to Table 202/REPAIR GENERAL and Table 203/REPAIR GENERAL for the BMS Type and Class of laminating resin to use.

NOTE: As an alternative, you can use two plies of BMS 9-3, Type D glass fabric for each ply of BMS 9-3, Type H-2 or H-3.

(b) Remove the parting film from bottom of the first ply of fabric.

(c) Put the fabric in the hole in the core.

(d) Remove the parting film from the top ply of fabric.

(e) Remove the parting film from the bottom of the second ply of fabric.

(f) Put the second ply of fabric on the first ply.

(g) Remove the parting film from the top of the second ply.

(h) Apply a layer of potting compound to the edges of the initial core that will touch the edges of the core repair plug.

(2) To install a core repair plug which is equal to the full thickness of the initial core, do the steps that follow:

NOTE: If the bagside and the toolside of the part is damaged, use a caul plate on the toolside of the part to give support to the repair. Use clamps, tape, or vacuum bag to hold the caul plate in position.

(a) Cut one ply of glass fabric impregnated with resin to the same shape as the hole in the core. Use BMS 9-3, Type H-2 or H-3. Refer to Table 202/REPAIR GENERAL and Table 203/REPAIR GENERAL for the BMS Type and Class of laminating resin to use.

NOTE: As an alternative, you can use two plies of BMS 9-3, Type D glass fabric for each ply of BMS 9-3, Type H2 or H3 glass fabric.

(b) Apply a layer of potting compound on the edges of the core repair plug.

(c) Remove the parting film from the bottom of the first ply of fabric.

(d) Put the ply in the hole in the core.

(e) Remove the parting film from the top of the first ply of fabric.

(3) Apply a layer of potting compound to the sides of the initial core that will touch the edges of the core repair plug.

(4) Align the ribbon direction of the core repair plug with the core ribbon direction of the initial core.

(5) Carefully compress the repair core and put it in the hole in the core.

NOTE: Make sure that the core repair plug has a tight interference fit in the core hole.

(6) Fill the core cells adjacent to the bond line with potting compound.

(7) If you cure the repair plug without the repair ply layup, put the thermocouples at the adhesive bond lines.

(8) Apply the vacuum to the repair.

(a) Apply a vacuum of 22 inches of mercury minimum.

(b) Make a check of the vacuum bag system for leaks as given in Paragraph M.(14).

(c) Keep a minimum vacuum of 22 inches of mercury until the repair is cured.

K. Cure the core repair.

(1) Cure the potting compound for 30 minutes at 150°F to (66)°C.

(2) As an alternative you can cure the potting compound for 6 hours at room temperature.

L. Sand the repair core.

(1) For two-step repairs, sand the repair core plug smooth with the initial honeycomb core.

(2) For an overlay repair, sand the core repair plug smooth with the surface contours of the skin.

M. Remove all dust with a vacuum cleaner.

N. To make the repair plies, do the steps that follow:

(1) Fill all the fastener holes that the repair plies will cover with a mixture of epoxy resin and chopped fiber. Refer to Repair 9.

NOTE: Repair all the damaged holes as shown in Repair 8 or 9. As an alternative, you can fill the fastener holes with Teflon plugs. Remove the plugs after the repair plies are cured.

(2) Use one repair ply of fabric for each damaged ply of the panel plus one more ply, which is the largest and outer ply. Refer to 51-70-03 for the alternate materials that are applicable to the structure made with carbon tape.

NOTE: For hybrid (carbon-glass fabric) structure where the top ply is carbon fiber, the additional repair can be glass fabric or carbon fiber. Use the same type and style of fabric as used in the initial structure. If the damage is in a ply lap splice (not a structural lap splice) in the initial structure, it is not necessary to make an equivalent ply lap splice in the repair plies. If the initial core is not damaged, and there is a recess, fill the recess with filler plies before you lay up the repair plies.

(a) Refer to the structure repair section for the component to see if additional structural repair plies are necessary.

(b) Refer to the structure identification or the engineering drawing to find the material, zero degree ply direction, and the number of plies in the initial panel.

(c) Refer to Table 202/REPAIR GENERAL and SRM 51-70-03 for the repair ply materials and the alternative repair ply materials.

(3) Find the correct ply warp direction.

(a) Make sure that each ply has the same warp direction as the ply it replaces.

(b) Make sure the warp direction of the outer repair ply is the same as the surface ply immediately below it.

(c) If you use a filler ply, make the warp direction ±45 degrees.

NOTE: Filler plies are plies that fill a recess in the repair area. The filler ply can be on a small or a large part of a repair ply to make the repair smooth. Fillers must be smaller than the structural ply.

(4) Find the size and shape of the fabric that is necessary to make the repair plies. Refer to Table 205/REPAIR GENERAL through Table 207/REPAIR GENERAL for the necessary taper ratio.

NOTE: You can make a template to help locate and put the plies in the correct position. You can make the template from parting film or vacuum bag material.

(5) Impregnate the repair plies with BMS 8-301 laminating resin with the vacuum bag procedure. Refer to Recommended Vacuum Bag Procedure to Impregnate the BMS 9-3 Repair Plies with BMS 8-301 Resin, Figure 208/REPAIR GENERAL.

NOTE: For hybrid repairs, weigh and impregnate each fabric ply by itself.

(a) Cut two pieces of vacuum bag material. Make the bag material a minimum of 6 inches larger than the fabric that will be impregnated.

(b) Cut one piece of breather cloth that is two inches smaller than the vacuum bag material.

(c) Cut two pieces of solid parting film. Make them a minimum of 3 inches larger than the fabric.

1) Put one piece of vacuum bag material on a smooth surface. Hold the vacuum bag material in position with tape.

2) Apply vacuum sealing compound the edge of the vacuum bag material.

3) Place the second piece of vacuum bag material over the first and seal one edge.

4) Install a vacuum probe and gage.

(d) Put one piece of the solid parting film on the first piece of vacuum bag material.

(e) Weigh the fabric to be impregnated. Multiply the weight by 1.3 for carbon fabric or 1.0 for fiberglass fabric. The result gives the quantity of laminating resin necessary to impregnate the fabric.

(f) Mix the laminating resin as given in Table 204/REPAIR GENERAL or use the manufacturer's instructions. Refer to Table 202/REPAIR GENERAL and Table 203/REPAIR GENERAL for the laminating resin to use. Put the correct weight of laminating resin in a different container.

NOTE: The resin-to-fiber content will be approximately 1 to 1 by weight after the parting film is removed.

(g) Put the fabric over the parting film. Make sure the fabric is smooth.

(h) Put the resin in the center of the fabric.

(i) Put the second piece of solid parting film on the fabric. Make sure the parting film is smooth.

(j) Put the breather cloth over the parting film.

(k) Seal the vacuum bag.

(l) Apply full vacuum to the vacuum bag.

(m) Sweep the resin from the center to the edges of the fabric. Make the resin and the fabric smooth. Keep all of the resin in the fabric.

(n) Release the vacuum from the vacuum bag.

(o) Remove the vacuum bag.

(p) Cut the repair plies to the correct size and shape. Do not remove the solid parting film at this time.

(6) Impregnate the repair plies with BMS 8-301 laminating resin with this alternative procedure. Refer to Alternate Procedure to Impregnate the BMS 9-3 Repair Plies with BMS 8-301 Resin, Figure 209/REPAIR GENERAL.

(a) Cut two pieces of solid parting film. Make them 3 inches larger than the fabric.

(b) Put one piece of solid parting film on a smooth surface. Hold it in position with tape.

(c) Weigh the fabric to be impregnated. Multiply the weight by 1.3 for carbon fabric or 1.0 for fiberglass fabric. The result gives the laminating resin necessary to impregnate the fabric.

NOTE: The resin-to-fiber content will be approximately 1 to 1 by weight after the parting film is separated.

(d) Mix the laminating resin as given in Table 204/REPAIR GENERAL or use the manufacturer's instructions. Refer to Table 202/REPAIR GENERAL and Table 203/REPAIR GENERAL for laminating resin to use. Put the correct quantity of laminating resin in a different container.

(e) Put half of the resin in the center of the solid parting film.

(f) Put the fabric on the laminating resin on the solid parting film.

(g) Put the laminating resin that remains in the center of the fabric.

(h) Put the second piece of solid parting film on the fabric. Make sure that the parting film is smooth.

(i) Sweep the resin from the center to the edges of the fabric. Make the resin and the fabric smooth. Keep all of the resin in the fabric.

(j) Cut the repair plies to the correct size and shape. Do not remove the solid parting film at this time.

O. Cut out the repair plies. Cut the repair plies to the same shape and with the same warp direction as the plies they replace. Cut the repair plies larger to get the necessary overlap. Overlap is shown in Table 207/REPAIR GENERAL. The same conditions as taper sand.

NOTE: A recommended alternative is to add one ply of fabric as a sanding ply that is not structural. This sanding ply is the outer ply and covers all of the repair. After the repair is cured, this ply can be sanded to get a smooth surface. Do not sand in the structural plies below it.

P. Install the repair plies.

NOTE: If the damage is in a ply lap splice (not a structural lap splice) in the initial structure, it is not necessary to make an equivalent ply lap splice in the repair plies. If the initial core is not damaged, and there is a recess, fill the recess with filler plies before you lay up the repair plies.

CAUTION: REMOVE THE PARTING FILM FROM THE IMPREGNATED MATERIALS BEFORE YOU LAY UP AND CURE THE REPAIR. IF YOU DO NOT OBEY, THE REPAIR WILL BE UNSATISFACTORY.

(1) Install the repair plies and the sanding ply if it is used.

NOTE: Add filler plies as necessary to get a smooth repair. Do not use more than four filler plies on one repair ply.

(a) Install the smallest ply first.

(b) Make sure that the warp direction and overlap of each repair ply is correct.

(c) Remove the parting film from the bottom of the repair ply.

(d) Put the ply on the repair. Make the ply smooth and free of wrinkles.

(e) Remove the parting film from the top of the repair ply.

(f) Do steps (b) through (e) for each subsequent repair ply.

(2) Do steps (a) through (g) that follow, if you will cure the repair at room temperature or at a temperature that is higher that room temperature with an oven, heat lamps or autoclave.

(a) Refer to Vacuum Bag Instructions for the Cure of the Honeycomb Repair Core with an Oven, Heat Lamp, or Autoclave, Figure 210/REPAIR GENERAL for the vacuum bag system to use when you cure the repair core separately. Refer to Vacuum Bag Instructions for the Cure of the Repair Plies with an Oven, Heat Lamp, or Autoclave, Figure 211/REPAIR GENERAL for the vacuum bag system to use when you cure the repair plies.

(b) Put a layer of perforated parting film that is a minimum of 1.0 inch larger all around the repair area, above the repair area.

(c) If you cure the repair at a temperature that is higher than room temperature, put the thermocouples at the locations shown in Vacuum Bag Instructions for the Cure of the Honeycomb Repair Core with an Oven, Heat Lamp, or Autoclave, Figure 210/REPAIR GENERAL and Vacuum Bag Instructions for the Cure of the Repair Plies with an Oven, Heat Lamp, or Autoclave, Figure 211/REPAIR GENERAL. Connect the thermocouples to the applicable recorders.

(d) Put a layer of dry peel ply or glass fabric cloth (BMS 9-3, Types D, H-2, or H-3 or the equivalent) above the perforated parting film. This will be the surface bleeder.

(e) Put a layer of solid parting film over the surface bleeder that is 0.5 inch less all around than the surface bleeder.

(f) Put one layer of glass fabric cloth (BMS 9-3, Types D, H-2, or H-3, Classes 8, 9, 10, 11, 12, or 13 or the equivalent) that is the same size as the surface bleeder above the repair area. This will be the breather cloth.

NOTE: Make sure the breather cloth touches the surface bleeder when you put the layup together.

(g) Seal the repair with the vacuum bag material.

1) Put the bases for the vacuum line and the vacuum gage into position.

2) If necessary, apply the vacuum sealing compound around the layup.

3) Cut slits in the vacuum bag at the locations where the vacuum line and vacuum gage will be attached to the bases.

4) Install the vacuum line and the vacuum gage through the vacuum bag material and into the bases.

(3) Do steps (a) through (i) that follow if you will cure the repair at a temperature that is higher than room temperature with a heat blanket.

(a) Refer to Vacuum Bag Instructions for the Cure of the Honeycomb Repair Core with a Heat Blanket, Figure 212/REPAIR GENERAL for the vacuum bag system to use when you cure the repair core separately. Refer to Vacuum Bag Instructions for the Cure of the Repair Plies with a Heat Blanket, Figure 213/REPAIR GENERAL for the vacuum bag system to use when you cure the repair plies.

(b) Put a layer of perforated parting film that is a minimum of 1.0 inch larger all around the repair area, above the repair area.

(c) Put the thermocouples at the locations shown in Vacuum Bag Instructions for the Cure of the Honeycomb Repair Core with a Heat Blanket, Figure 212/REPAIR GENERAL and Vacuum Bag Instructions for the Cure of the Repair Plies with a Heat Blanket, Figure 213/REPAIR GENERAL. Connect the thermocouples to the applicable recorders

(d) Put a layer of dry peel ply or glass fabric cloth (BMS 9-3, Types D, H-2, or H-3 or the equivalent) above the perforated parting film. This will be the surface bleeder. The surface bleeder should be a minimum of 2.0 inches larger all around than the heat blanket

(e) Put a layer of solid parting film over the surface bleeder that is 0.5 inch less all around than the surface bleeder.

(f) Put a heat blanket above the solid parting film that is a minimum of 2.0 inches larger all around than the largest repair ply.

CAUTION: IT IS RECOMMENDED THAT YOU USE A MINIMUM OF ONE THERMOCOUPLE ON THE SIDE OF THE HEAT BLANKET THAT IS NEAREST TO THE REPAIR AREA. HEAT BLANKETS SOMETIMES BECOME DEFECTIVE AND CAN HEAT UP TOO QUICKLY OR GET TOO HOT. THE RESULT CAN BE AN UNSATISFACTORY REPAIR.

(g) Put one to four thermocouples on the side of the heat blanket that is nearest to the repair area.

(h) Put four to six layers of glass fabric cloth (BMS 9-3, Types D, H-2, or H-3 or the equivalent) that are the same size as the surface bleeder above the repair area. These will be the breather cloths.

(i) Seal the repair with the vacuum bag material.

1) Put the bases for the vacuum line and the vacuum gage into position.

2) If necessary, apply the vacuum sealing compound around the layup.

3) Cut slits in the vacuum bag at the locations where the vacuum line and vacuum gage will be attached to the bases.

4) Install the vacuum line and the vacuum gage through the vacuum bag material and into the bases.

CAUTION: DO NOT FULLY BAG COMPOSITE PARTS THAT ARE HOLLOW SUCH AS RUDDERS, AILERON, AND ELEVATORS. A FULLY BAGGED PART THAT IS HOLLOW CAN BE CRUSHED WHEN YOU APPLY THE VACUUM DURING THE REPAIR. ATTACH THE VACUUM BAG TO ONE SIDE OF THE PART ONLY OR ATTACH DIFFERENT VACUUM BAGS TO EACH SIDE OF THE PART. REFER TO FIGURE 205.

5) Examine the vacuum bag for leaks.

NOTE: A vacuum bag which has a leak, can cause porosity in the repair and subsequent bond failure.

(j) Apply a minimum vacuum of 22 inches of mercury.

(k) Remove the vacuum source.

(l) Monitor the vacuum gage. After 5 minutes, the total difference in vacuum must be less than 5.0 inches of mercury.

WARNING: SOME OF THE EQUIPMENT USED TO HEAT CURE THESE REPAIRS CAN CAUSE A FIRE OR AN EXPLOSION WHEN USED NEAR AN AIRPLANE THAT CONTAINS OR HAS CONTAINED FUEL. USE EQUIPMENT THAT AGREES WITH THE FIRE CODES OF YOUR LOCAL FIRE AUTHORITY. IF YOU DO NOT OBEY, INJURY TO PERSONS AND DAMAGE TO THE AIRPLANE CAN OCCUR.

CAUTION: DO NOT CURE MORE THAN TEN (10) PLIES DURING ONE CURE CYCLE. USE A RATE OF TEMPERATURE INCREASE OF 3°F (2°C) PER MINUTE MAXIMUM. IF THE REPAIR HAS MORE THAN 10 PLIES, YOU MUST USE MULTIPLE CURE CYCLES. IF YOU DO NOT OBEY, POROSITY AND BULGES CAN OCCUR AND THE SUBSEQUENT REPAIR WILL BE UNSATISFACTORY.

Q. Cure the repair.

NOTE: When you use a hot bond console, obey the manufacturer's operation instructions. Keep a minimum vacuum of 22 inches of mercury during the cure cycle. The usual procedure for these repairs is to cure the repair with a heat blanket.

(1) Use an autoclave, oven, or heat lamps to cure the repair. Refer to Autoclave, Heat Blanket, Heat Lamp, or Oven Cure Cycles for BMS 8-301, Laminating Resin, Figure 214/REPAIR GENERAL.

NOTE: Use three or more thermocouples to monitor the cure cycle. Monitor the temperature of the support tool and the part. Put the thermocouples at the locations where the temperature will increase the fastest and slowest. The temperature will increase slower at thicker areas of the part and tool. The caul plate and insulation are not necessary for autoclave or oven cures.

(a) Hold the part in a support tool to prevent damage to the part.

(b) If you use the autoclave, pressurize it to 45 psi.

1) Open the vacuum bag to the atmosphere when the pressure is 20 psi.

2) Keep the vacuum bag open and the autoclave pressurized until after the cure is complete and the temperature of the part has decreased to 125°F (52°C).

(c) Increase the temperature of the autoclave or the oven at a rate between 1°F and 5°F (0.5°C and 3°C) for each minute until it is at the cure temperature. Refer to Autoclave, Heat Blanket, Heat Lamp, or Oven Cure Cycles for BMS 8-301, Laminating Resin, Figure 214/REPAIR GENERAL.

(d) Hold the autoclave or oven at the cure temperature for the necessary cure time. Refer to Autoclave, Heat Blanket, Heat Lamp, or Oven Cure Cycles for BMS 8-301, Laminating Resin, Figure 214/REPAIR GENERAL.

(e) Decrease the autoclave or oven temperature at a maximum rate of 5°F (3°C) for each minute.

(f) When the temperature is less than 125°F (52°C), release the vacuum or autoclave pressure.

(g) Remove the vacuum bag equipment.

(2) If you use a heat blanket or heat lamps to cure the repair, do the steps that follow:

CAUTION: MAKE SURE THAT THE HEAT BLANKET GIVES AN EVEN TEMPERATURE AROUND ALL OF THE REPAIR. HOT AND COLD AREAS CAN CAUSE DAMAGE TO THE REPAIR AND ADJACENT STRUCTURE.

(a) Increase the temperature of the heat blanket at a rate between 1°F and 5°F (0.5°C and 3°C) for each minute until it is at the cure temperature. Refer to Autoclave, Heat Blanket, Heat Lamp, or Oven Cure Cycles for BMS 8-301, Laminating Resin, Figure 214/REPAIR GENERAL. Set the control of the heat blanket or heat lamps to the leading thermocouple.

(b) Put insulation on the side of the part opposite the repair area that is usually cooler. This will keep all areas of the repair in the cure cycle temperature range. The solid laminate areas of a part are usually cooler.

CAUTION: DO NOT INCREASE THE TEMPERATURE OF ALUMINUM STRUCTURE ABOVE 180°F (82°C). HIGH TEMPERATURES CAN CAUSE A DECREASE IN THE STRENGTH OF ALUMINUM ALLOYS.

(c) If the repair area is adjacent to or attached to metal structure, do the steps that follow:

1) Remove all the fasteners that cause the repair to have clamp up forces.

2) Remove or thermally isolate the aluminum structure from the areas that will get hot.

NOTE: For 7000 series aluminum in the T6XX and T7XX heat treat conditions you can increase the temperature to a maximum of 230°F (110°C).

3) Put thermocouples on the aluminum structure to make sure that the temperature does not get above 180°F (82°C).

4) If the insulation does not put all thermocouples in the cure cycle temperature, then you can use a heat gun can to increase the temperature in local areas. Add thermocouples to monitor the temperature.

(d) Cure the repair. Refer to Autoclave, Heat Blanket, Heat Lamp, or Oven Cure Cycles for BMS 8-301, Laminating Resin, Figure 214/REPAIR GENERAL for the necessary cure temperature and time.

NOTE: Cure time does not include the time necessary for the layup and the part to get to the cure temperature range. Cure time is the time after the part gets to the cure temperature range. All of the thermocouples must touch the part. All of the thermocouples must be in the cure temperature range before the cure time starts. If a thermocouple indication decreases below the cure temperature range, extend the cure cycle time by the time necessary to get the thermocouple into the cure temperature range.

(e) Decrease the temperature at a maximum rate of 5°F (3°C) for each minute.

(f) When the temperature decreases to less than 125°F (52°C), release the vacuum pressure.

(g) Remove the vacuum bag equipment.

R. Do the post-repair requirements.

(1) Do an inspection of the repair area to make sure that the repair is satisfactory. Refer to 737 NDT Part 1, 51-01-01.

NOTE: In the honeycomb areas with four repair plies or less, you can use the tap test inspection procedure as given in 737 NDT Part 1, 51-05-01 as an option.

(a) The inspection should include the areas where heat was applied plus a minimum width of 2 inches more around the heated area.

(b) If the inspection gives an unsatisfactory result, remove and install the repair again.

S. Apply the finish to the repair.

CAUTION: DO NOT SAND IN THE STRUCTURAL FIBERS. IF YOU DO NOT OBEY, THE RESULT WILL BE A DECREASE IN THE STRENGTH OF THE COMPONENT.

(1) Sand the outer ply to make the edges smooth with the initial surface.

NOTE: Do not sand through the sanding ply that is not structural and in the repair plies below it. Do not sand into the fibers of the top repair ply.

(2) To apply the finish to the repair area use the steps that follow:

(a) If clear Tedlar film surfaces have been removed, seal them with Resin System 1. Refer to Table 202/REPAIR GENERAL and Table 203/REPAIR GENERAL. Cure the resin system as given in 51-70-01.

(b) If a gray or white Tedlar film surface has been removed, seal the area with Resin System 1. Refer to Table 202/REPAIR GENERAL and Table 203/REPAIR GENERAL. Cure the resin system as given in 51-70-01. Apply one layer of BMS 10-11 or BMS 10-103 primer and then one layer of BMS 10-60 enamel.

(c) If BMS 10-21 conductive coating was removed, then apply it again as given in AMM 51-21-71/701.

(d) If the abrasion resistant Teflon finish was removed from the inner surface of the panel edgeband, then apply the Teflon again. Refer to AMM 51-21-81/701.

(e) If the initial paint was removed from the surface, apply the paint again as given in AMM TASK 51-21-00-100-801.

(f) If sealant was removed from around fittings or mating surfaces, apply one of the sealants that follow as given in 51-20-05:

1) BMS 5-95 in locations with temperatures less than or equal to 180°F (82°C)
2) BMS 5-26 in fuel cells and in locations with temperatures less than 200°F (93°C)
3) BMS 5-63 in locations with temperatures higher than 200°F (93°C).

(g) If BMS 8-336 aluminum foil mesh was removed, then repair it as given in 51-70-14.

(h) If BMS 8-278 aluminum coated glass fabric was repaired, apply aluminum flame spray as given in 51-70-14.

WARNING: FLIGHT CONTROL SURFACES MUST BE CORRECTLY BALANCED AFTER YOU REPAIR THEM. FAILURE TO DO SO CAN CAUSE FLUTTER AND DAMAGE TO THE STRUCTURE.

T. After you repair a flight control surface, do a check to see if it must be balanced again. Refer to 51-60-00.

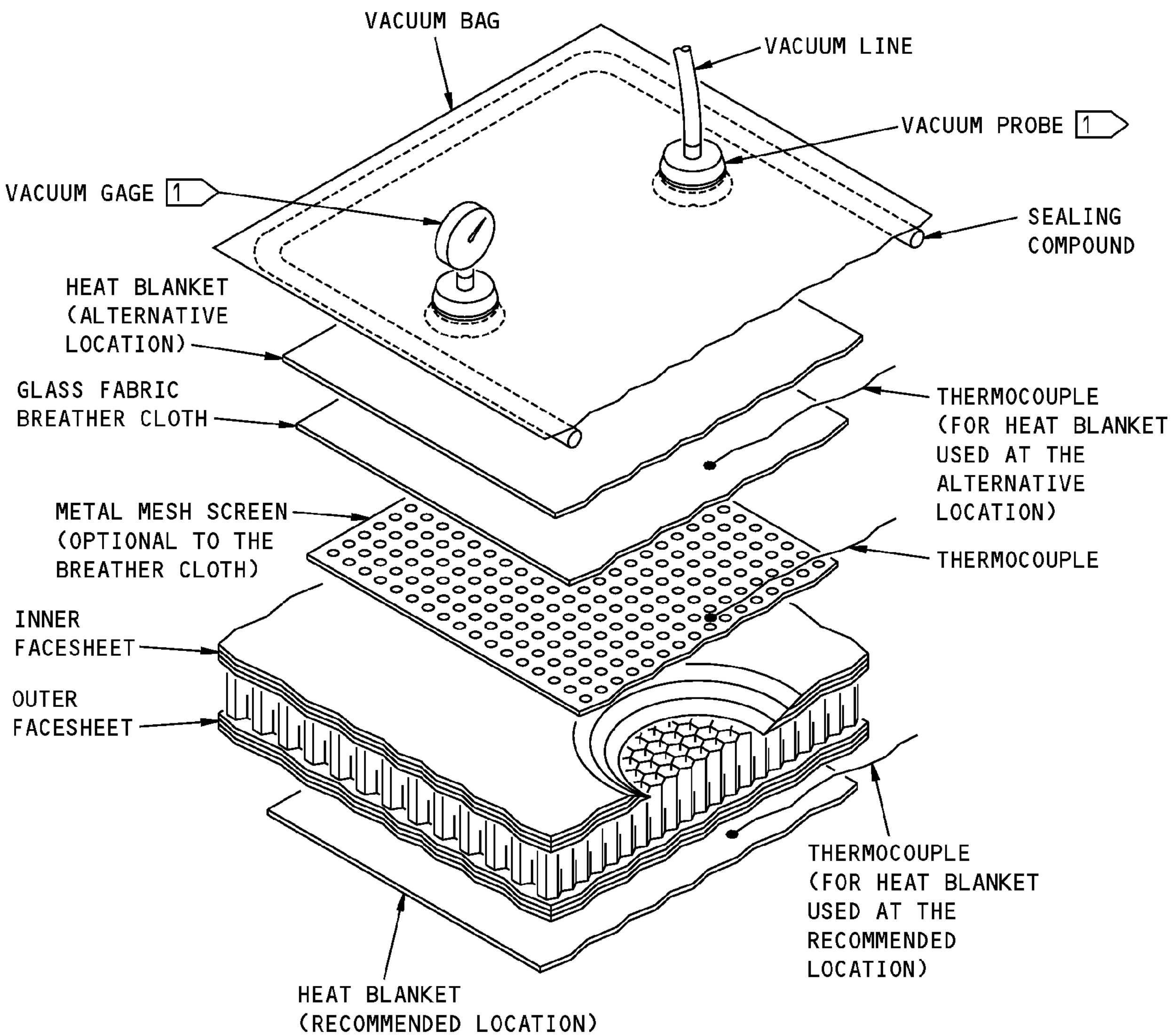
CAUTION: MAKE SURE THAT REPAIRS MADE TO CONTROL SURFACES AND/OR ADJACENT STRUCTURE DO NOT TOUCH EACH OTHER OR STOP THE OPERATION OF THE FLIGHT CONTROL SURFACES. IF YOU DO NOT OBEY, DAMAGE TO THE AIRPLANE STRUCTURE CAN OCCUR.

U. Do a check of the operation of the flight control surfaces. Make sure that the flight control surfaces do not hit the airplane structure and that there is sufficient clearance for the repaired parts.

V. Drill and countersink all fastener holes that were filled.

CAUTION: MAKE SURE THAT THE REPAIR DOES NOT CAUSE A BLOCKAGE OF THE DRAIN HOLES IN A PANEL. BLOCKED DRAIN HOLES CAN CAUSE WATER STAY IN THE STRUCTURE. IF YOU DO NOT OBEY, DAMAGE TO THE STRUCTURE CAN OCCUR.

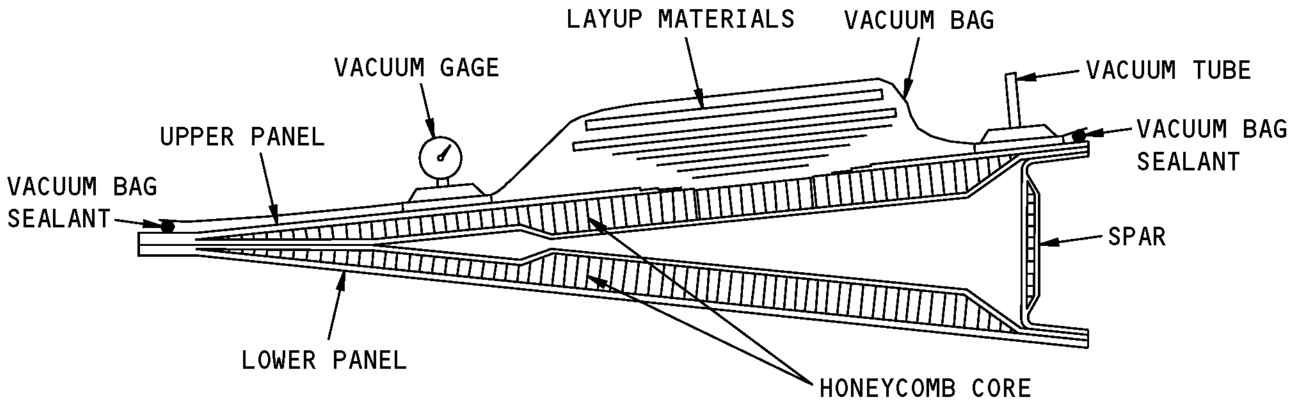
W. If the repair causes a blockage of a drain hole, drill through the repair at the drain hole position. Use the applicable size drill. Refer to 51-20-07 for the drill procedures.



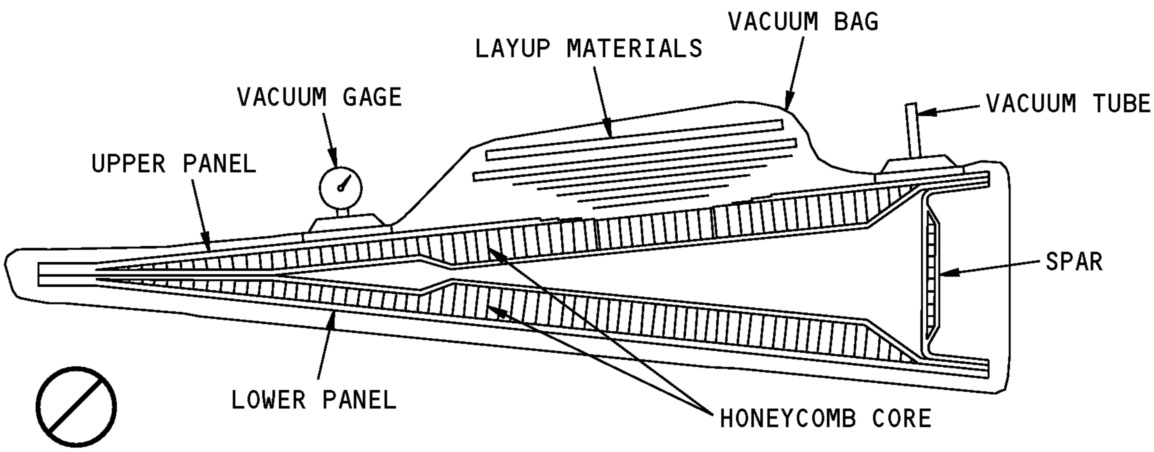
NOTES

1 THE VACUUM PROBE AND GAGE MUST TOUCH THE SURFACE OF THE BREATHER CLOTH OR METAL MESH SCREEN.

Water Removal Procedure for a Honeycomb Panel
Figure 204



SATISFACTORY - VACUUM BAG SEALED TO ONE SIDE ONLY



NOT SATISFACTORY - VACUUM BAG SEALED AROUND ALL OF THE PART

PARTS WHICH HAVE UPPER AND LOWER PANELS [1]

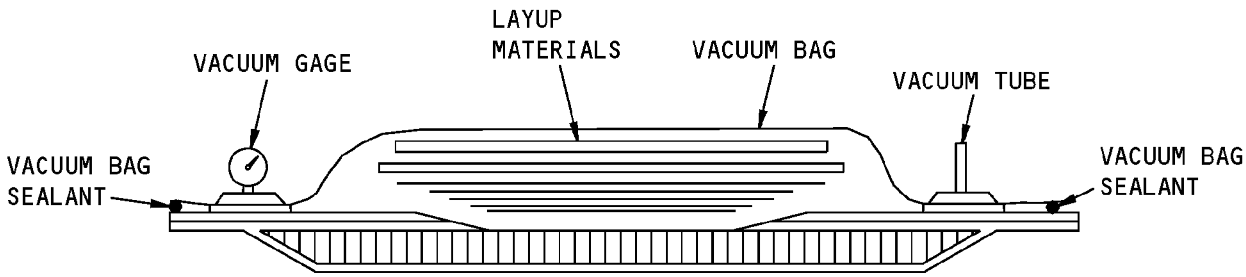
NOTES

- REFER TO PARAGRAPHS 4.L. AND 4.M. FOR LAYUP AND VACUUM BAG PROCEDURES.

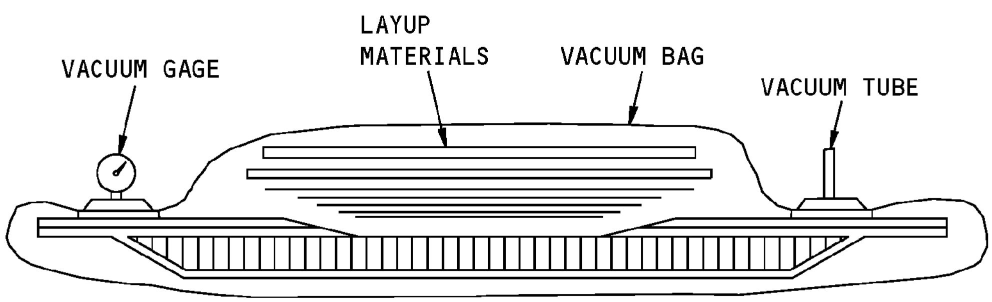
[1] THIS TYPE OF COMPONENT MUST NOT BE FULLY SEALED IN A VACUUM BAG. DAMAGE TO THE PART WILL OCCUR. USE A VACUUM BAG ONLY ON ONE SIDE OF THE COMPONENT.

[2] THIS TYPE OF COMPONENT CAN BE FULLY SEALED IN A VACUUM BAG OR CAN BE SEALED ON ONE SIDE ONLY.

Vacuum Bag Limits
Figure 205 (Sheet 1 of 2)



SATISFACTORY - VACUUM BAG SEALED TO ONE SIDE ONLY

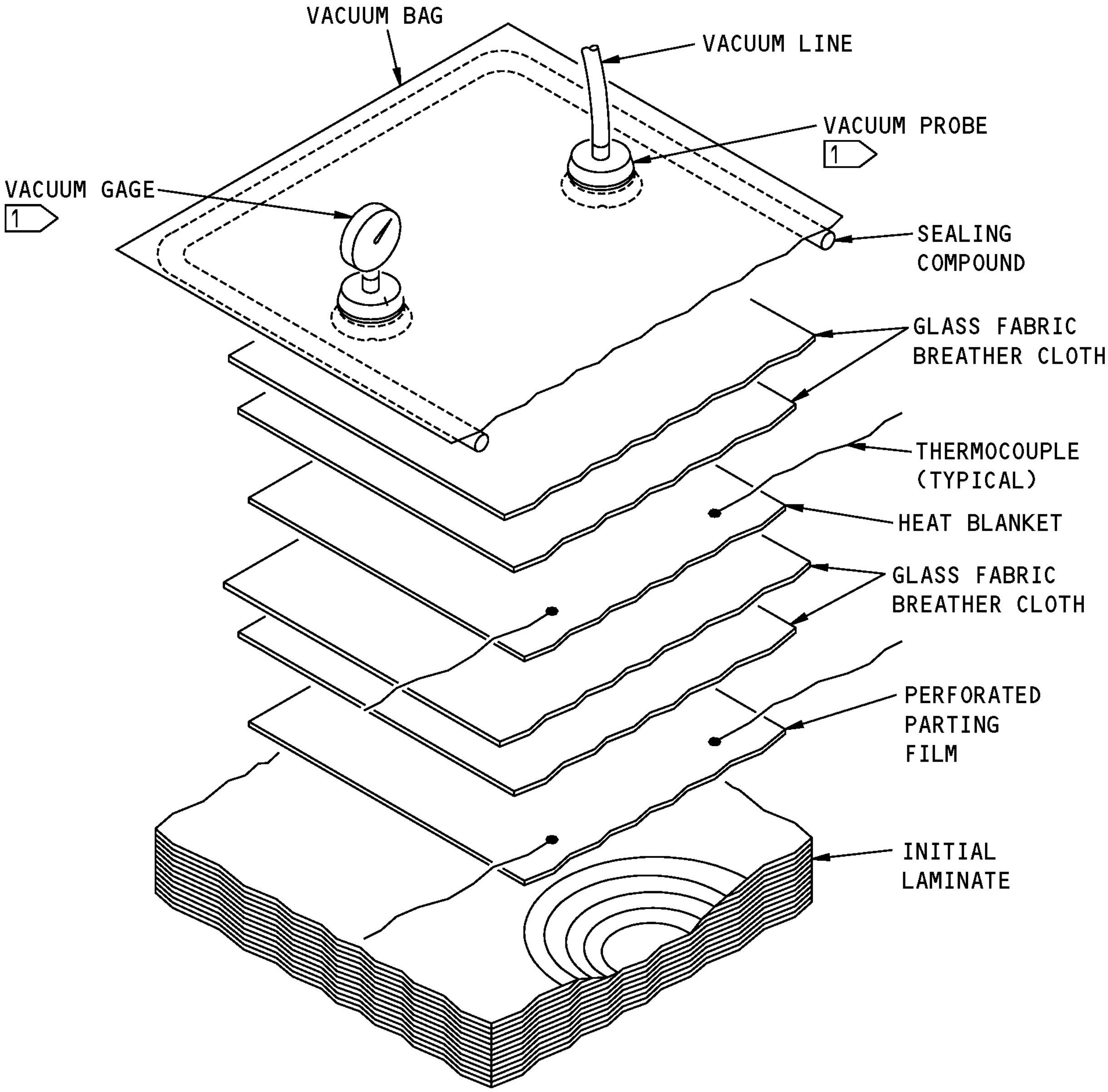


NOTE: THIS IS RECOMMENDED FOR 350°F (177°C) REPAIRS.

SATISFACTORY - VACUUM BAG SEALED AROUND ALL OF THE PART

PARTS WHICH HAVE ONLY ONE PANEL [2]

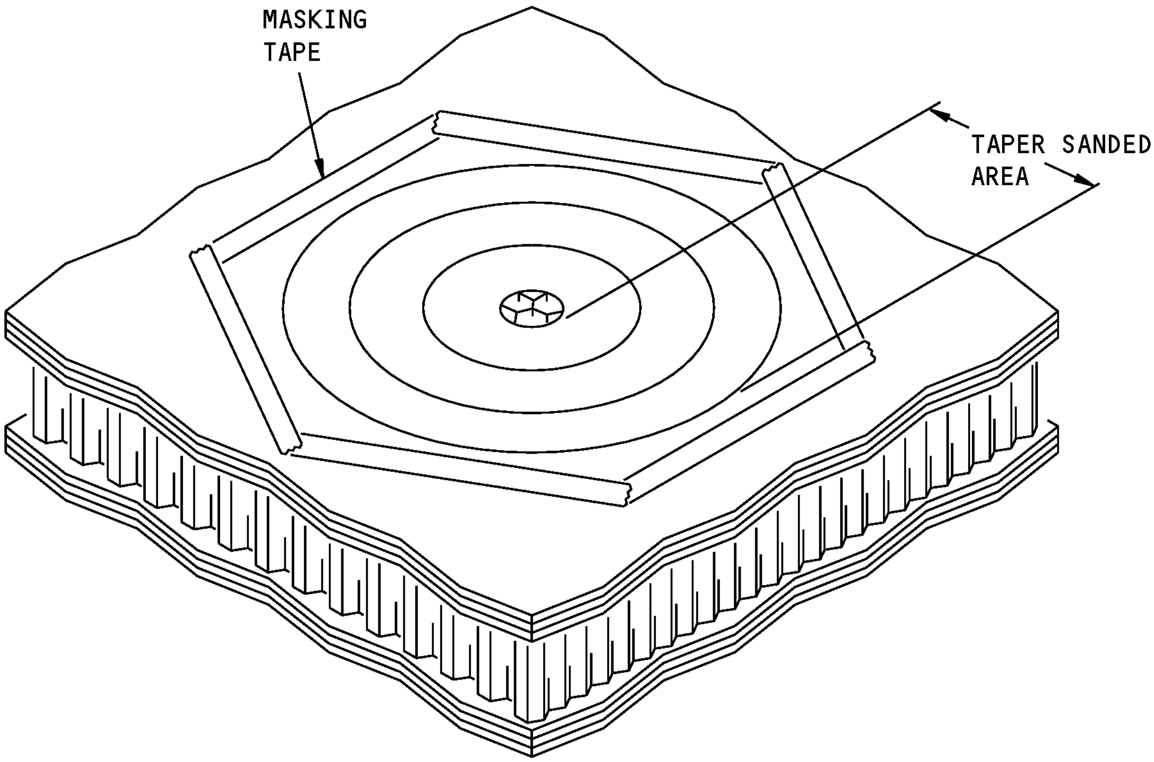
Vacuum Bag Limits
Figure 205 (Sheet 2 of 2)



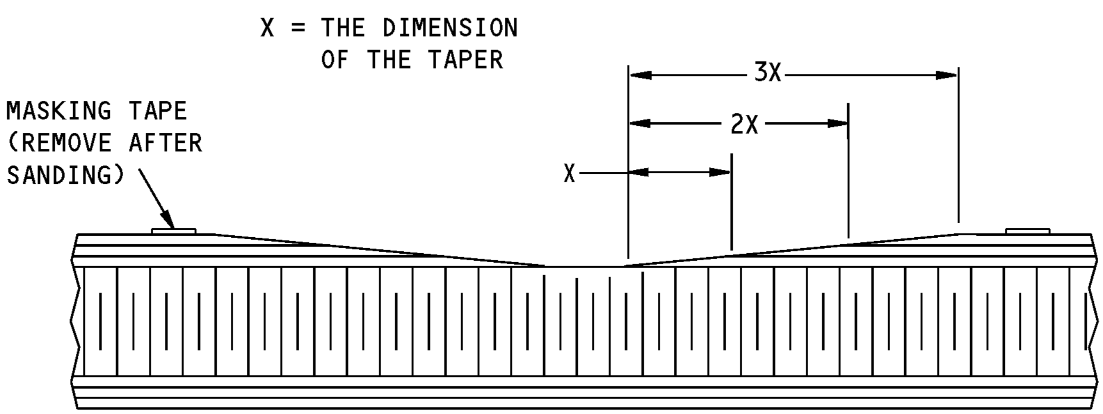
NOTES

1 THE VACUUM PROBE AND GAGE MUST TOUCH THE SURFACE OF THE BREATHER CLOTH.

Water Removal for a Solid Laminate
Figure 206



CIRCULAR SHAPE IS SHOWN, OVAL SHAPES ARE ALSO PARMITTED

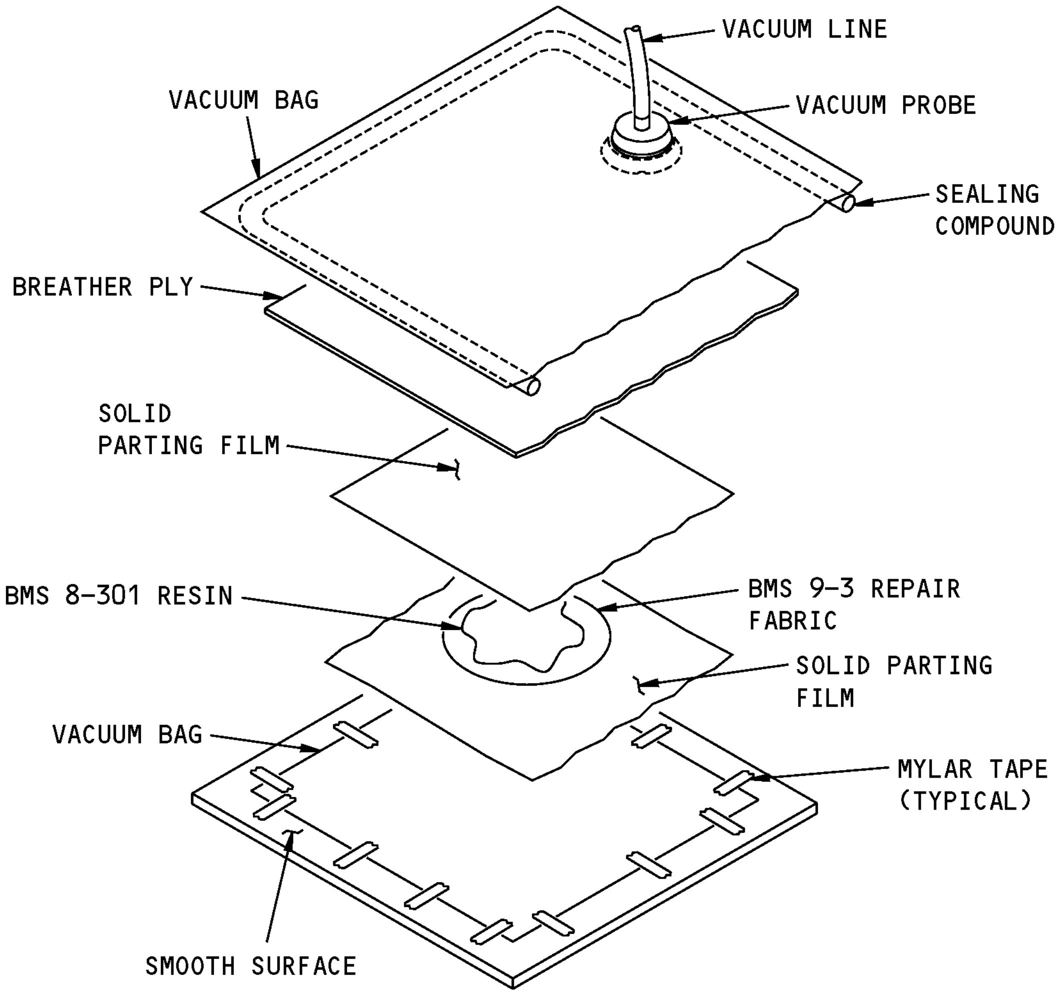


NOTES

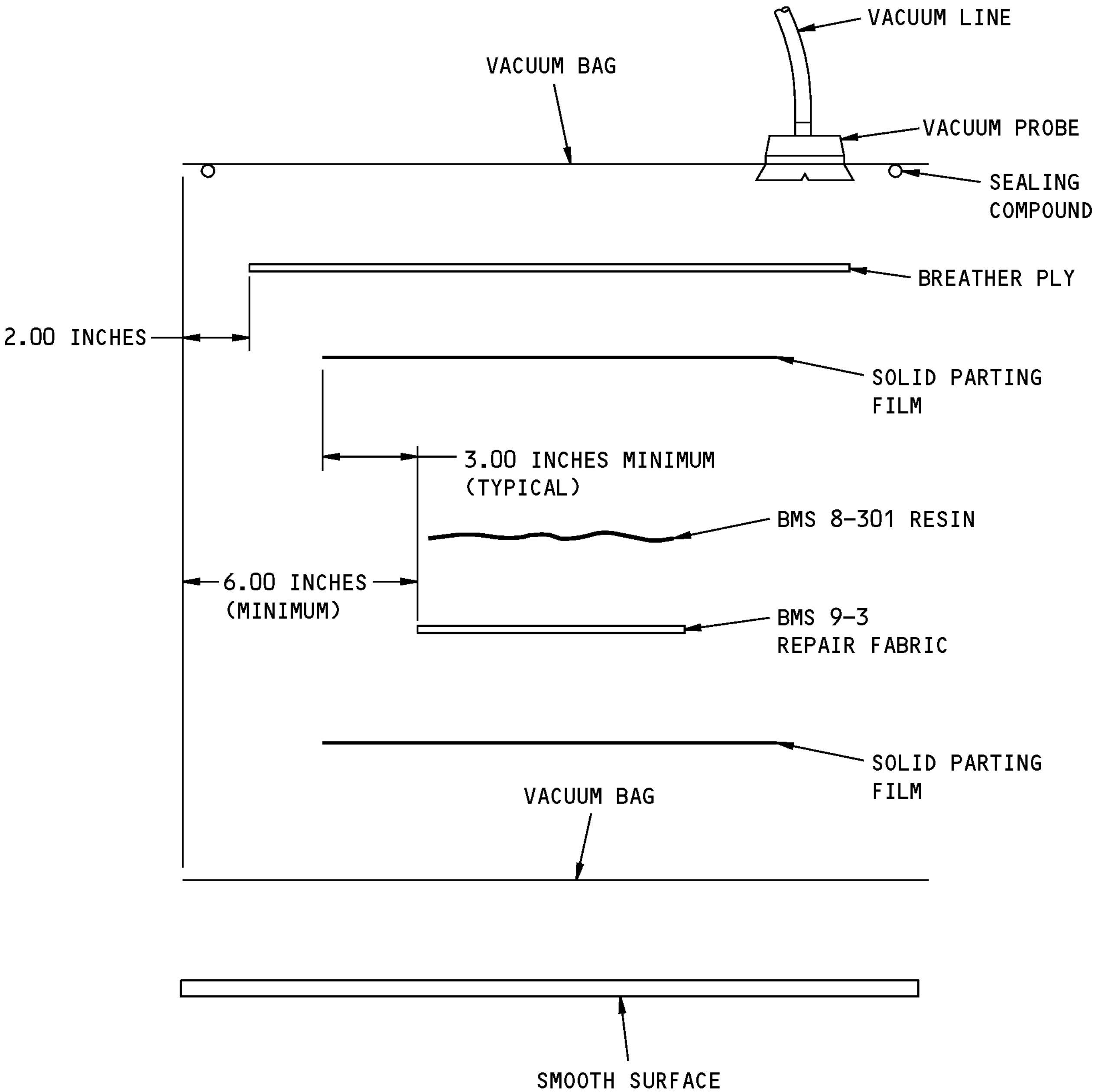
- REFER TO TABLES 205 AND 206 FOR THE NECESSARY TAPER.
- TAPER SAND IS SHOWN FOR A HONEYCOMB PANEL. THE TAPER SAND FOR A SOLID LAMINATE IS THE SAME.

SECTION THROUGH THE CENTER OF THE REPAIR

Taper Sand That is Necessary for the Repair
Figure 207

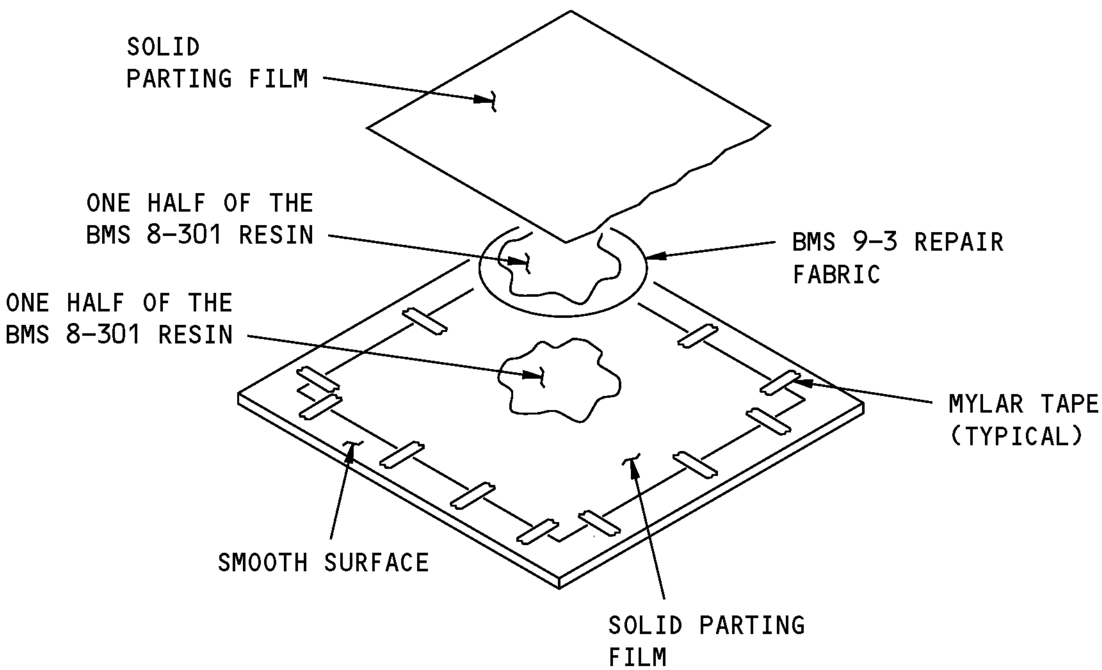


Recommended Vacuum Bag Procedure to Impregnate the BMS 9-3 Repair Plies with BMS 8-301 Resin
Figure 208 (Sheet 1 of 2)

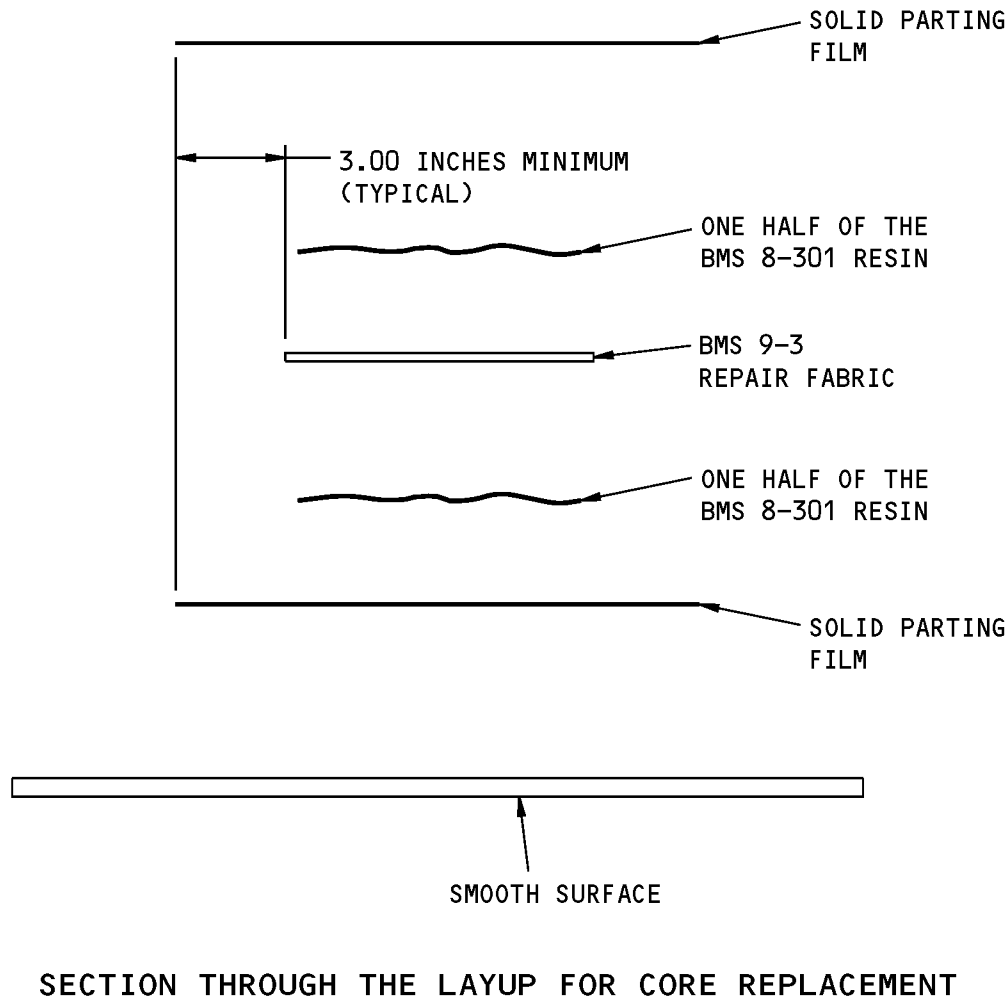


SECTION THROUGH THE LAYUP FOR CORE REPLACEMENT

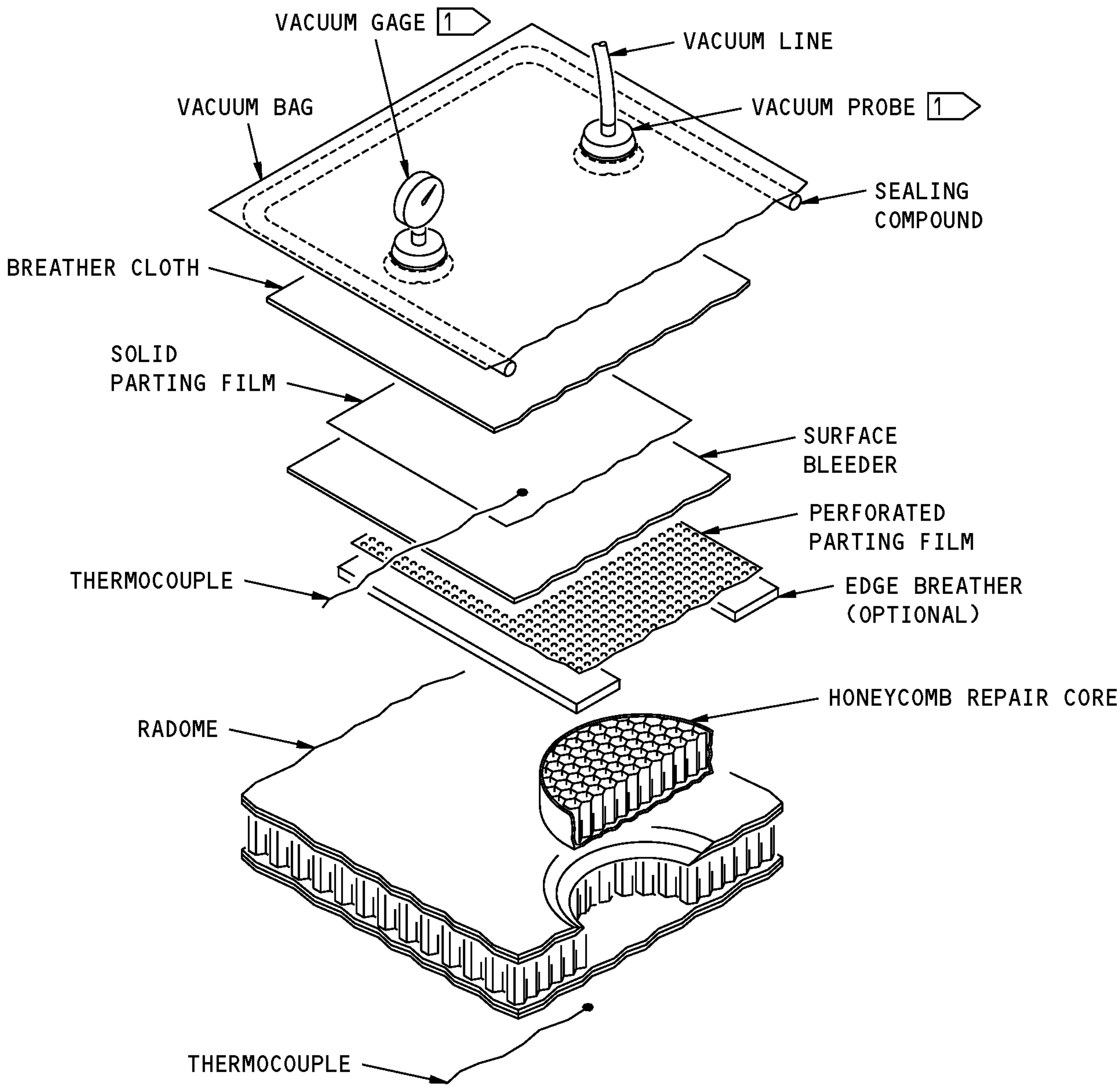
Recommended Vacuum Bag Procedure to Impregnate the BMS 9-3 Repair Plies with BMS 8-301 Resin
Figure 208 (Sheet 2 of 2)



Alternate Procedure to Impregnate the BMS 9-3 Repair Plies with BMS 8-301 Resin
Figure 209 (Sheet 1 of 2)



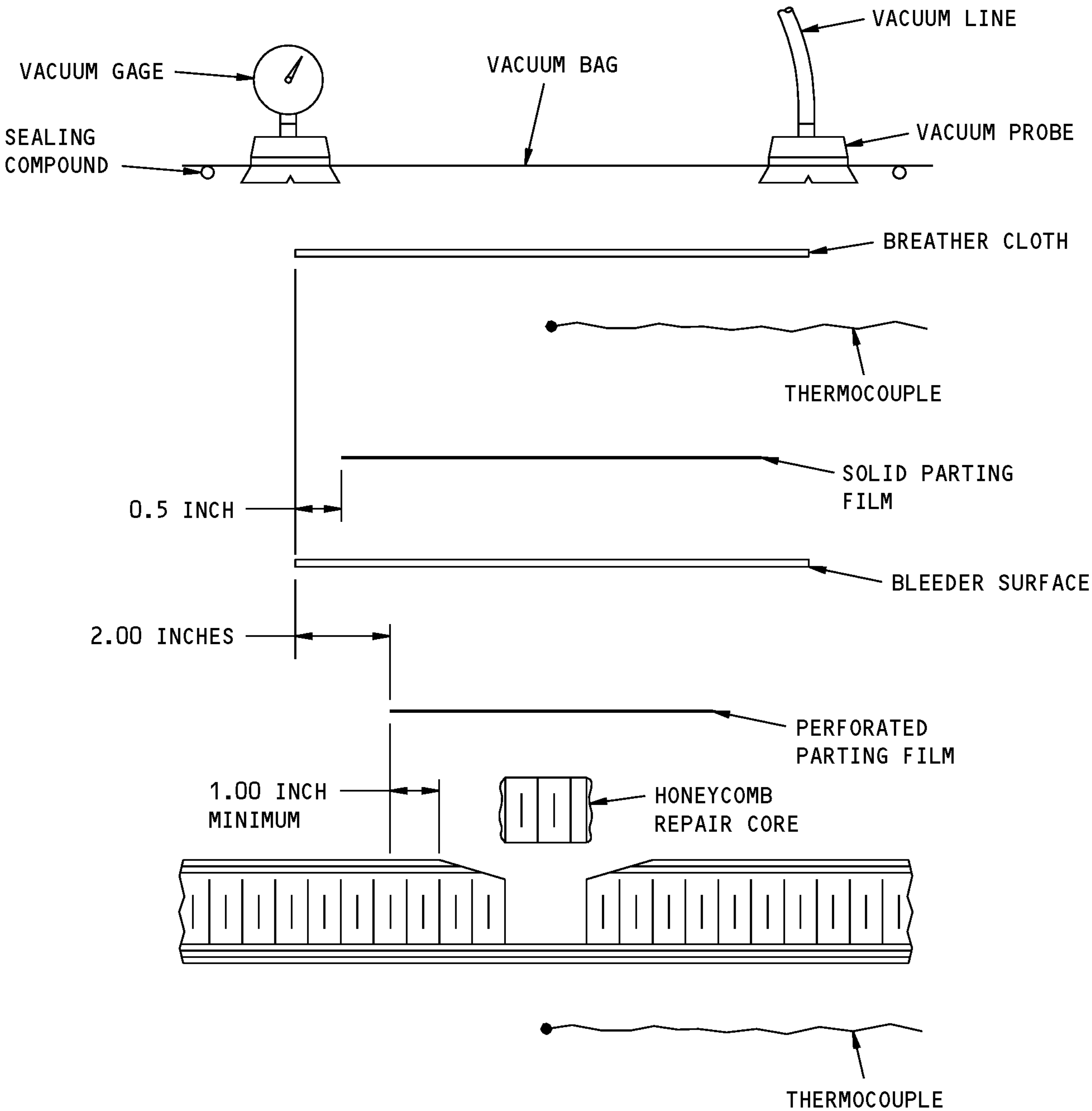
Alternate Procedure to Impregnate the BMS 9-3 Repair Plies with BMS 8-301 Resin
Figure 209 (Sheet 2 of 2)



NOTES

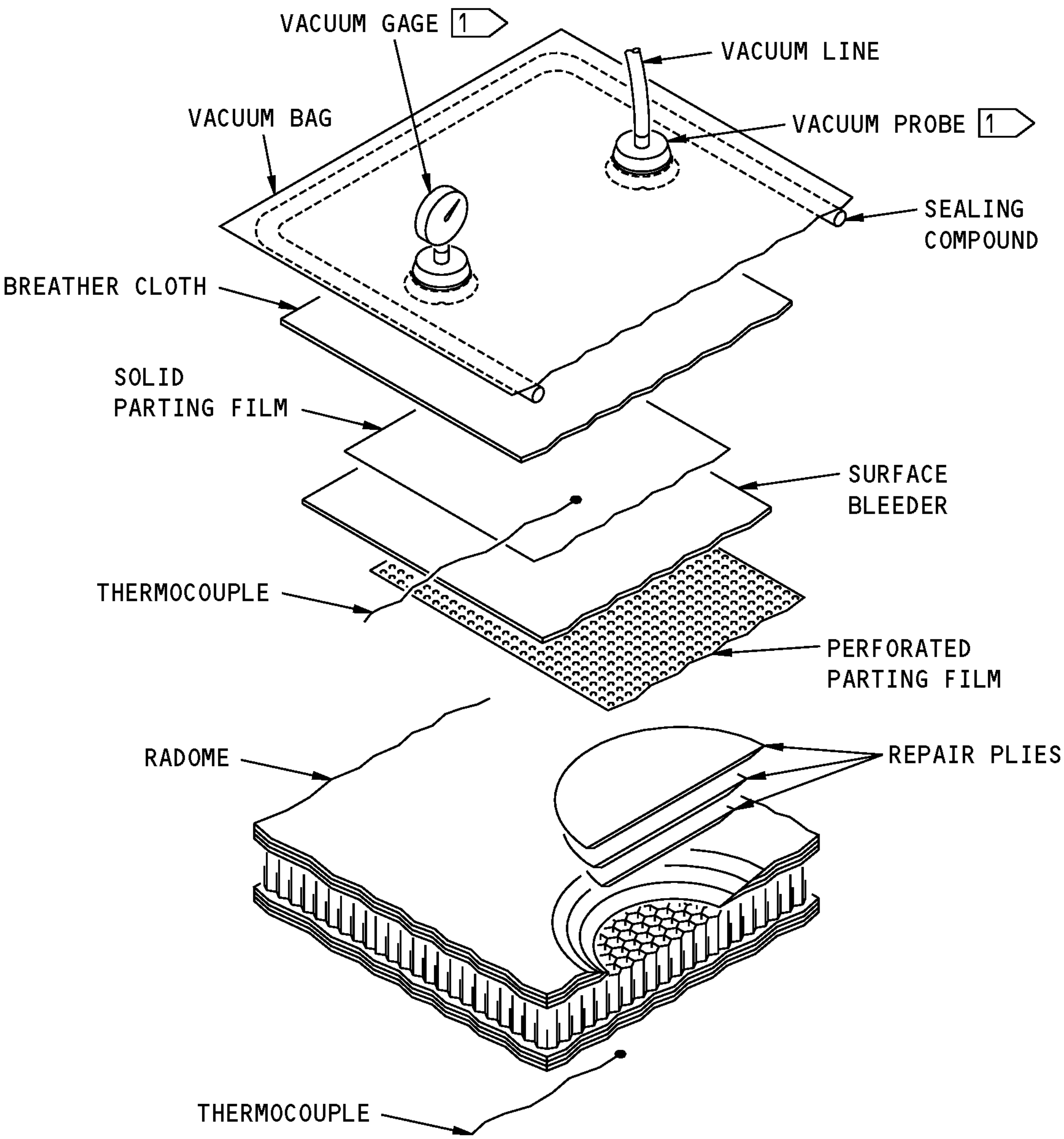
1 THE VACUUM PROBE AND GAGE MUST TOUCH THE SURFACE OF THE BREATHER PLY.

Vacuum Bag Instructions for the Cure of the Honeycomb Repair Core with an Oven, Heat Lamp, or Autoclave
Figure 210 (Sheet 1 of 2)



SECTION THRU THE VACUUM BAG SYSTEM

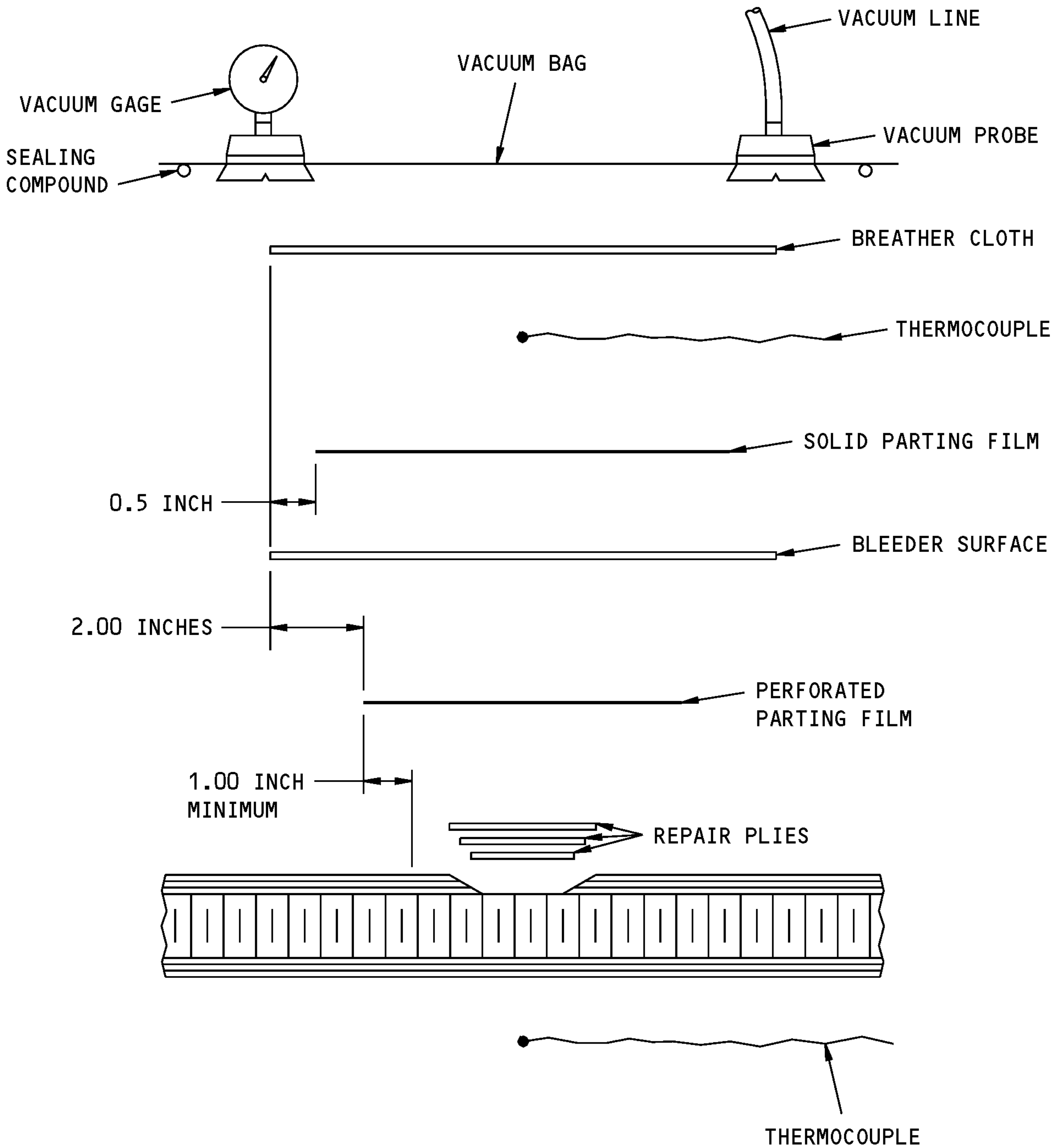
Vacuum Bag Instructions for the Cure of the Honeycomb Repair Core with an Oven, Heat Lamp, or Autoclave
Figure 210 (Sheet 2 of 2)



NOTES

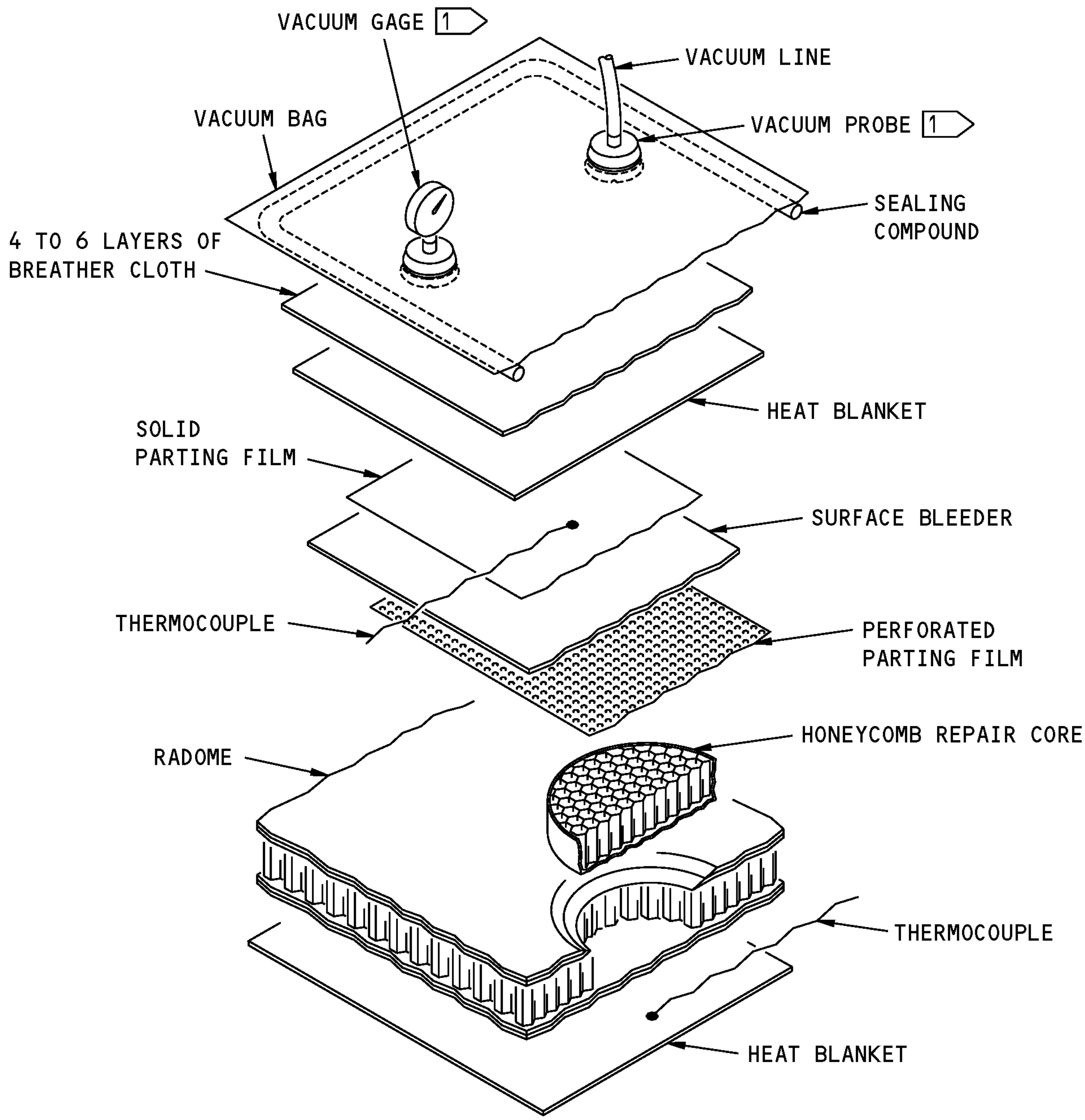
1 THE VACUUM PROBE AND GAGE MUST TOUCH THE SURFACE OF THE BREATHER PLY.

Vacuum Bag Instructions for the Cure of the Repair Plies with an Oven, Heat Lamp, or Autoclave
Figure 211 (Sheet 1 of 2)



SECTION THRU THE VACUUM BAG SYSTEM

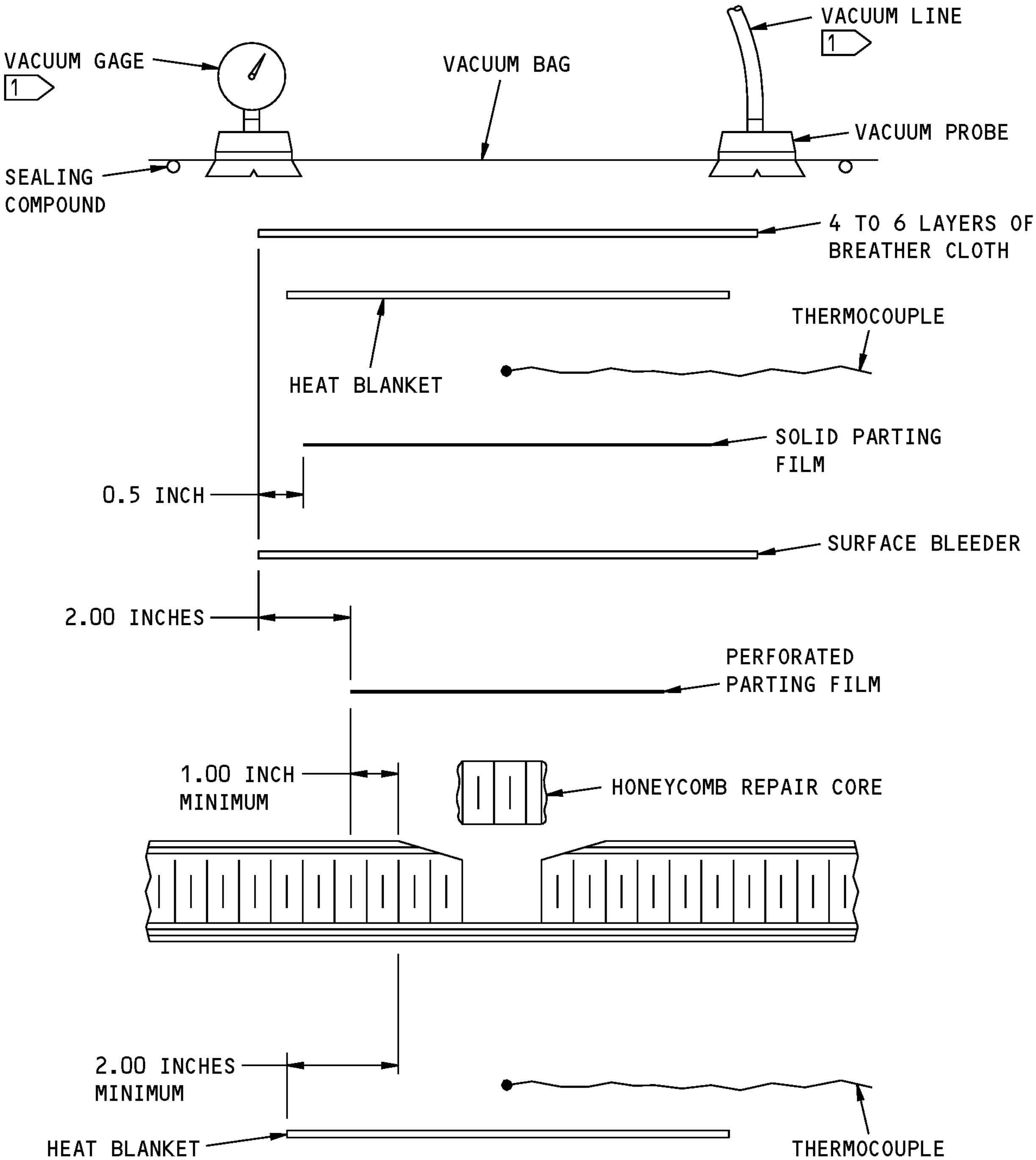
Vacuum Bag Instructions for the Cure of the Repair Plies with an Oven, Heat Lamp, or Autoclave
Figure 211 (Sheet 2 of 2)



NOTES

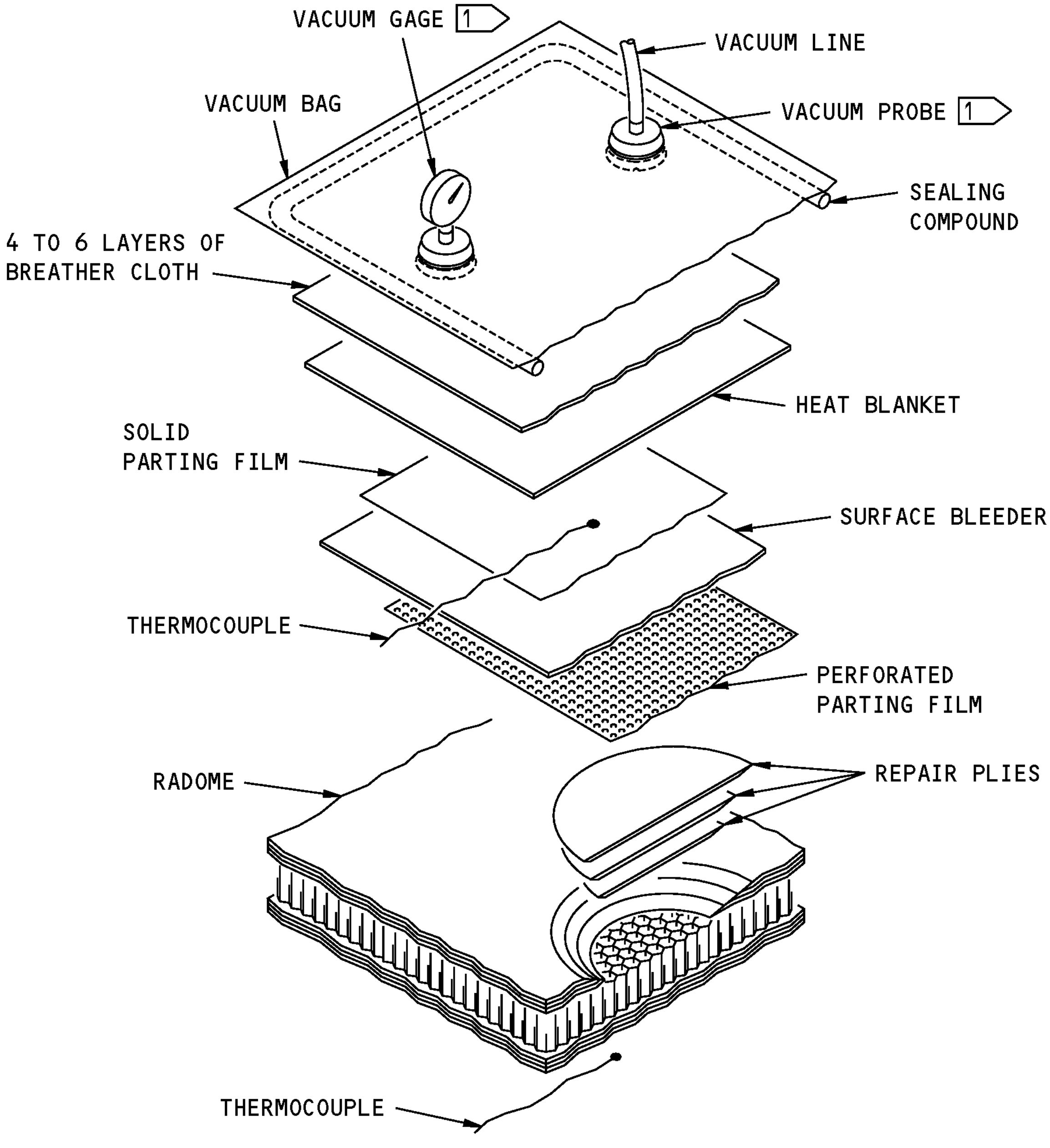
1 THE VACUUM PROBE AND GAGE MUST TOUCH THE SURFACE OF THE BREATHER PLY.

Vacuum Bag Instructions for the Cure of the Honeycomb Repair Core with a Heat Blanket
Figure 212 (Sheet 1 of 2)



SECTION THRU THE VACUUM BAG SYSTEM

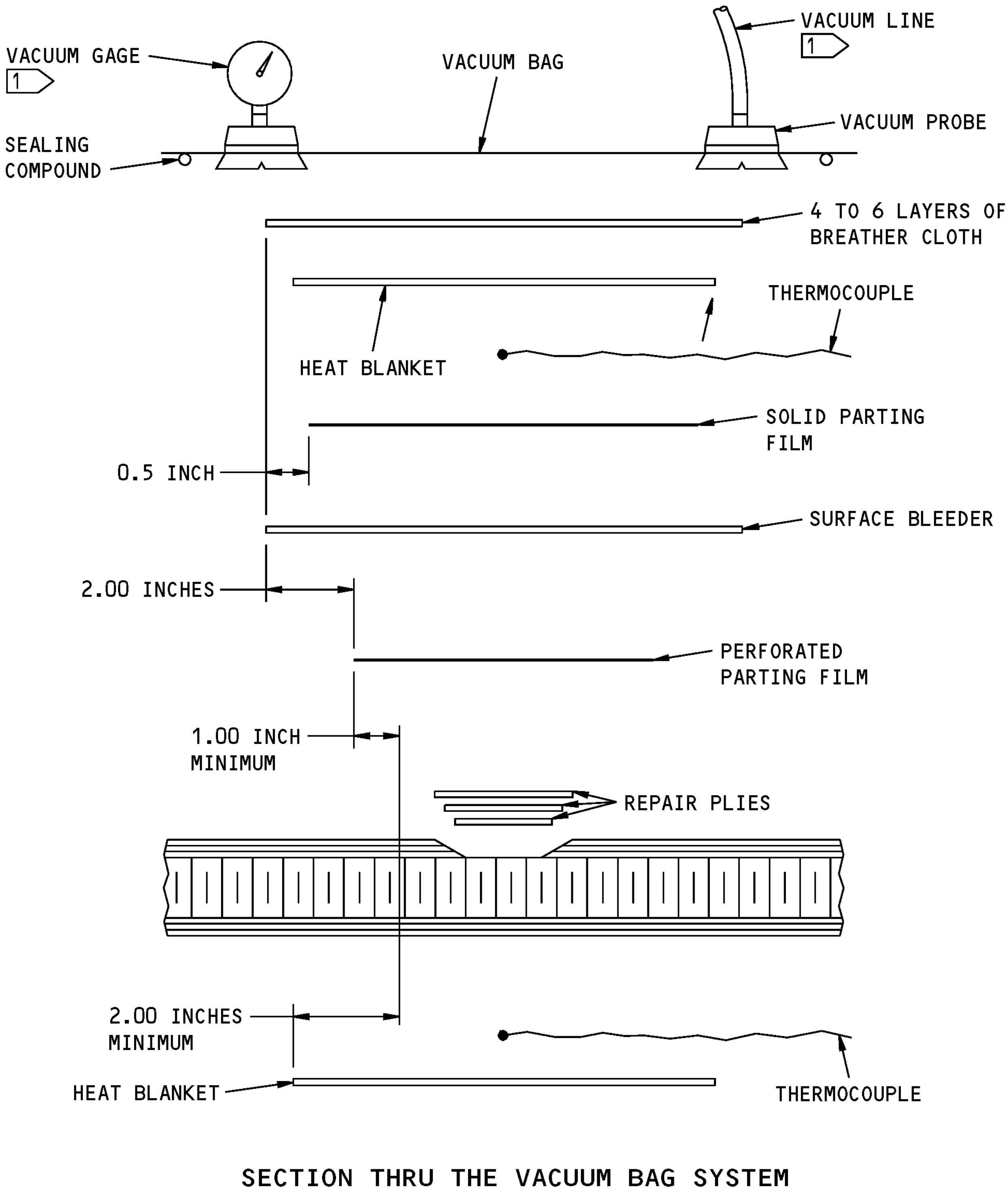
Vacuum Bag Instructions for the Cure of the Honeycomb Repair Core with a Heat Blanket
Figure 212 (Sheet 2 of 2)



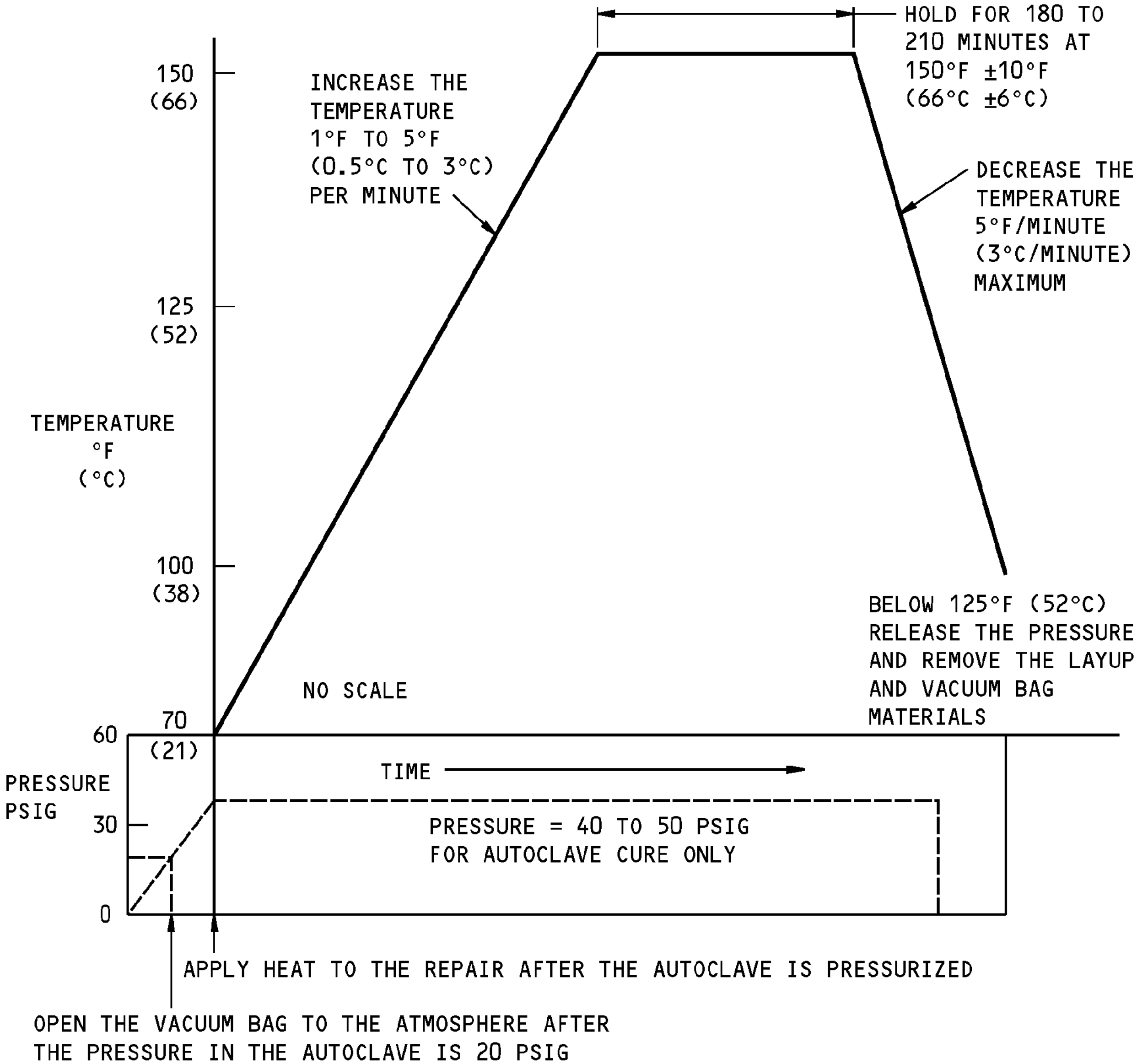
NOTES

1 THE VACUUM PROBE AND GAGE MUST TOUCH THE SURFACE OF THE BREATHER PLY.

Vacuum Bag Instructions for the Cure of the Repair Plies with a Heat Blanket
Figure 213 (Sheet 1 of 2)



Vacuum Bag Instructions for the Cure of the Repair Plies with a Heat Blanket
Figure 213 (Sheet 2 of 2)



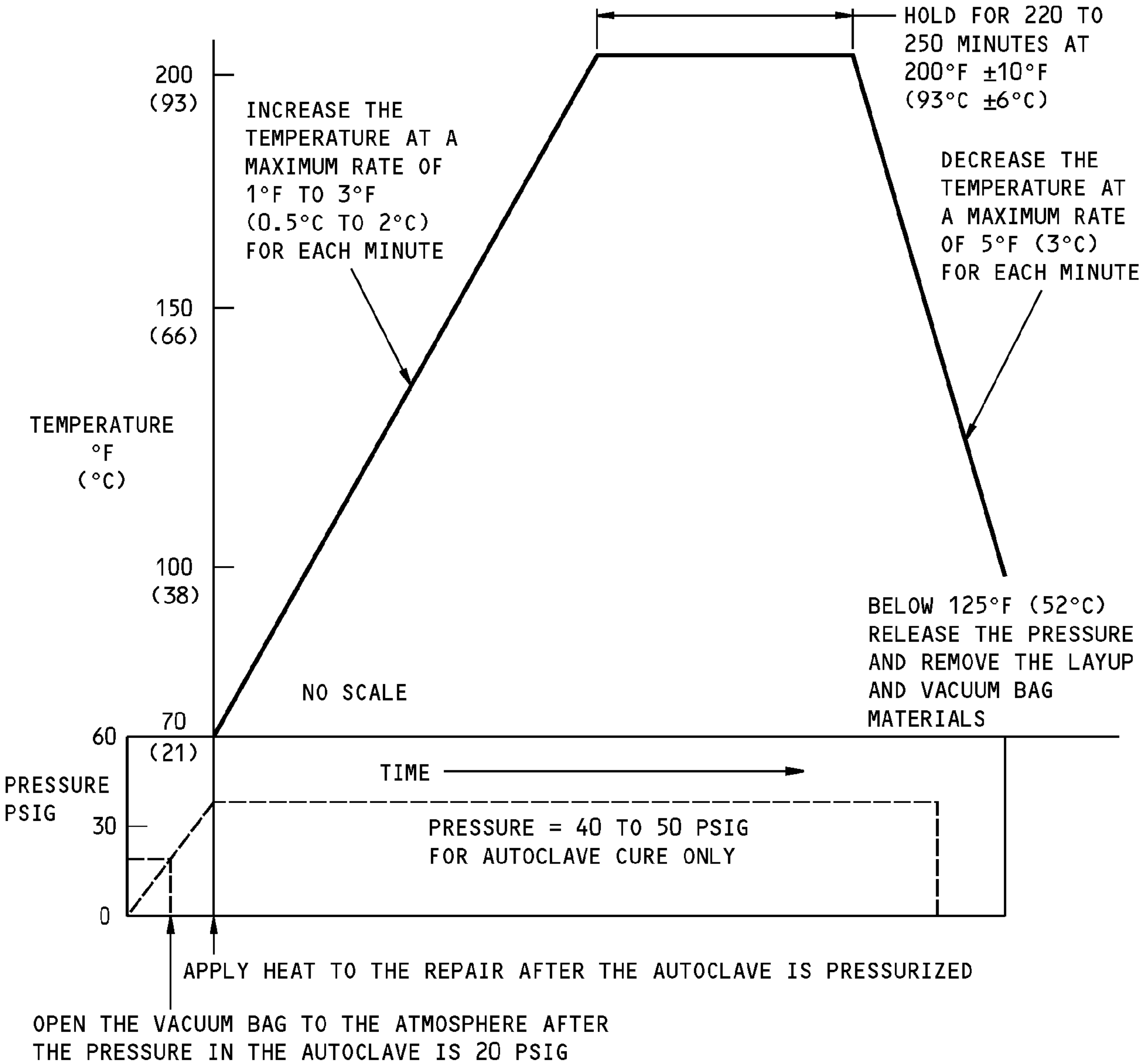
150°F (66°C) AUTOCLAVE, HEAT BLANKET, HEAT LAMP, OR OVEN CURE CYCLE FOR BMS 8-301, CLASS II LAMINATING RESIN REPAIRS [1]

NOTES

- FOR THE OVEN CURE, KEEP A MINIMUM VACUUM OF 22 INCHES OF MERCURY DURING THE FULL CURE CYCLE.

[1] IF YOU CURE THE CORE SEPARATELY FROM THE PLIES, YOU CAN CURE THE CORE FOR 30 MINUTES AT 150° (66°C), OR 6 HOURS AT ROOM TEMPERATURE. THEN YOU CAN SAND THE CORE.

Autoclave, Heat Blanket, Heat Lamp, or Oven Cure Cycles for BMS 8-301, Laminating Resin
Figure 214 (Sheet 1 of 2)



200°F (93°C) AUTOCLAVE, HEAT BLANKET, HEAT LAMP OR OVEN CURE CYCLE FOR BMS 8-301, CLASS I LAMINATING RESIN REPAIRS [1]

Autoclave, Heat Blanket, Heat Lamp, or Oven Cure Cycles for BMS 8-301, Laminating Resin
Figure 214 (Sheet 2 of 2)

REPAIR 1 - TYPICAL REPAIR OF DAMAGE TO ONE SKIN OF A HONEYCOMB PANEL

1. **Applicability**

WARNING: MAKE SURE THAT FLIGHT CONTROL SURFACES ARE CORRECTLY BALANCED AFTER THEY ARE REPAIRED. IF YOU DO NOT OBEY, FLUTTER CAN OCCUR AND THE RESULT CAN BE A STRUCTURAL FAILURE.

CAUTION: REFER TO THE SPECIFIED COMPONENT REPAIR SUBJECT FOR THE MATERIALS AND PROCEDURES APPROVED FOR THIS REPAIR. IF YOU DO NOT OBEY, THE REPAIR CAN BE UNSATISFACTORY.

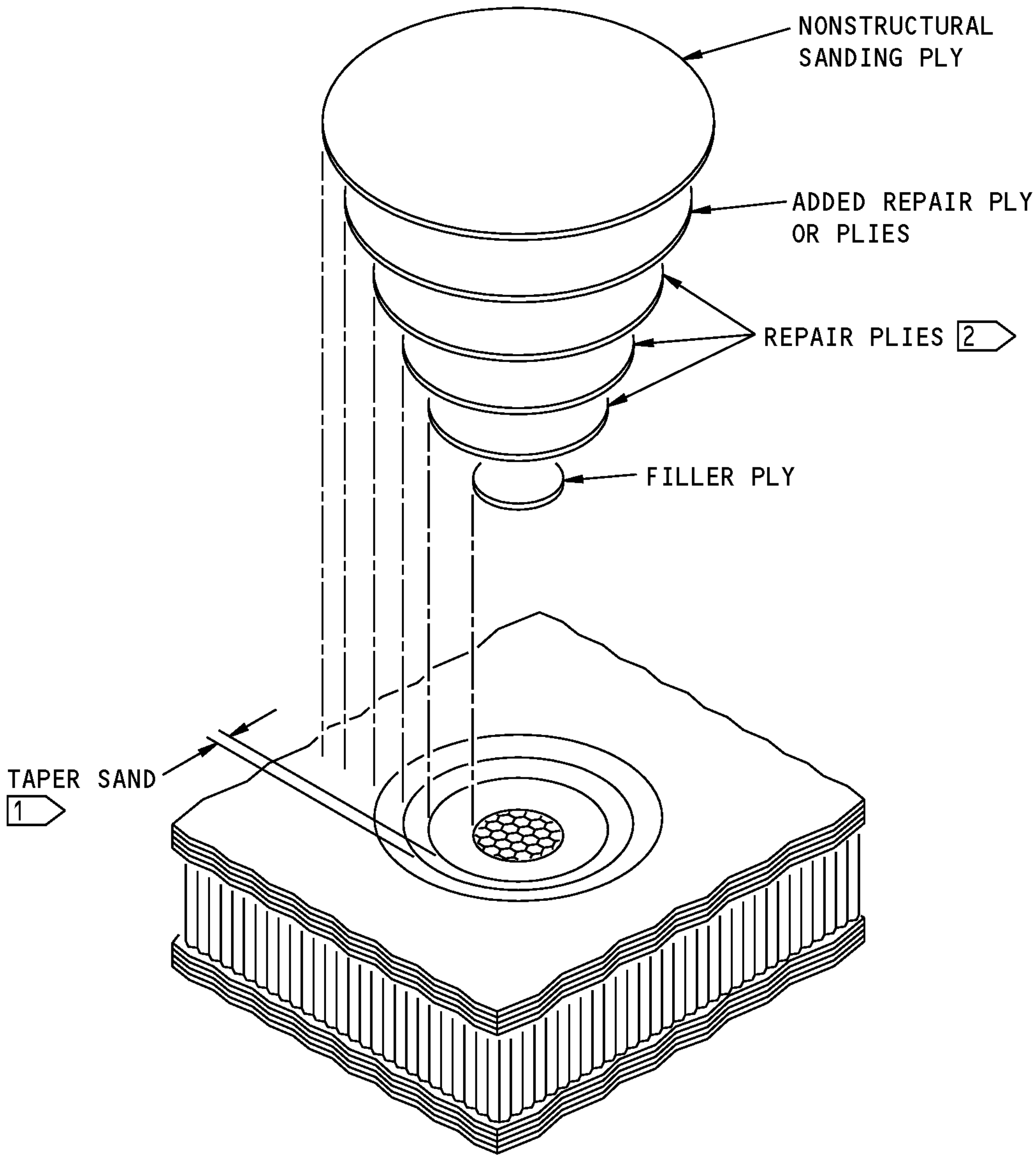
A. Repair 1 is applicable to damage to one skin of a honeycomb panel.

B. Repair 1 is not applicable to radomes or floor panels. Refer to 53-10-72 for radomes and 53-00-50 for floor panels.

2. **General**

A. Repair 1 is a Category A damage tolerant repair. Refer to 51-00-06 for the definitions of the different categories of repairs.

B. Refer to Repair 1 - Layout of the Repair Parts, Figure 201/REPAIR 1 for the layout of the repair parts.



NOTES

1 REFER TO REPAIR GENERAL FIGURE 207 FOR THE NECESSARY TAPER AND OVERLAP.

2 FIND THE NUMBER OF PLIES, PLY ORIENTATION, AND THE INITIAL MATERIAL IN THE SPECIFIED COMPONENT STRUCTURE IDENTIFICATION. REFER TO REPAIR GENERAL, TABLES 202 THROUGH 204 FOR THE REPAIR MATERIAL.

Repair 1 - Layout of the Repair Parts
Figure 201

3. References

Reference	Title
51-00-06	STRUCTURAL REPAIR DEFINITIONS
51-60-00	CONTROL SURFACE BALANCING
53-00-50	FUSELAGE FLOOR PANELS
53-10-72	FUSELAGE NOSE RADOME - SECTION 41

4. Repair Instructions

A. Find the limits of the damage. Refer to Paragraph 4.A./REPAIR GENERAL

B. Remove the damaged plies as given in Paragraph 4.B./REPAIR GENERAL Do not remove the core. Make sure that you remove all of the water or other unwanted material as given in Paragraph 4.C./REPAIR GENERAL The damaged area must be fully dry.

C. Prepare the damaged area as given in Paragraph 4.E./REPAIR GENERAL

D. Prepare the fabric repair plies as given in Paragraph 4.N./REPAIR GENERAL thru Paragraph 4.O./REPAIR GENERAL

E. Install the fabric repair plies and vacuum bag system as given in Paragraph 4.P./REPAIR GENERAL

F. Cure the repair as given in Paragraph 4.Q./REPAIR GENERAL

G. Examine the completed repair as given in Paragraph 4.R./REPAIR GENERAL

H. Apply the finish to the repair area as given in Paragraph 4.S./REPAIR GENERAL

I. After you make a repair of a flight control surface, check to see if it must be balanced again. Refer to 51-60-00 for the balance procedures.

REPAIR 2 - REPAIR OF DAMAGE TO ONE SKIN AND HONEYCOMB CORE THAT IS MORE THAN 0.50 INCH IN DIAMETER

1. Applicability

WARNING: MAKE SURE THAT FLIGHT CONTROL SURFACES ARE CORRECTLY BALANCED AFTER THEY ARE REPAIRED. IF YOU DO NOT OBEY, FLUTTER CAN OCCUR AND THE RESULT CAN BE A STRUCTURAL FAILURE.

CAUTION: REFER TO THE SPECIFIED COMPONENT REPAIR SUBJECT FOR THE MATERIALS AND PROCEDURES APPROVED FOR THIS REPAIR. IF YOU DO NOT OBEY, THE REPAIR CAN BE UNSATISFACTORY.

A. Repair 2 is a typical repair that is applicable to damage to one skin and the honeycomb core that is more than 0.50 inch in diameter.

B. Repair 2 is not applicable to radomes and floor panels. Refer to 53-10-72 for radomes and 53-00-50 for floor panels.

2. General

A. Repair 2 is a Category A damage tolerant repair. Refer to 51-00-06 for the definitions of the different categories of repairs.

B. Refer to Repair 2 - Layout of the Repair Parts, Figure 201/REPAIR 2 for the layout of the repair parts.

3. References

Reference	Title
51-00-06	STRUCTURAL REPAIR DEFINITIONS
51-60-00	CONTROL SURFACE BALANCING
53-00-50	FUSELAGE FLOOR PANELS
53-10-72	FUSELAGE NOSE RADOME - SECTION 41

4. Repair Instructions

A. Find the limits of the damage. Refer to Paragraph 4.A./REPAIR GENERAL

B. Remove the damaged plies as given in Paragraph 4.B./REPAIR GENERAL Make sure that you remove all of the water or other unwanted material as given in Paragraph 4.C./REPAIR GENERAL The damaged area must be fully dry.

C. Prepare the damaged area as given in Paragraph 4.E./REPAIR GENERAL

D. Cut out, clean, and install the honeycomb core repair plug as given in Paragraph 4.F./REPAIR GENERAL, Paragraph 4.G./REPAIR GENERAL, and Paragraph 4.H./REPAIR GENERAL

NOTE: Refer to Repair 11 for an alternative core repair procedure.

E. Cure the honeycomb core repair plug as given in Paragraph 4.I./REPAIR GENERAL, Paragraph 4.J./REPAIR GENERAL, and Paragraph 4.K./REPAIR GENERAL

F. Clean the repair surface as given in Paragraph 4.E./REPAIR GENERAL

G. Prepare the repair plies as given in Paragraph 4.N./REPAIR GENERAL through Paragraph 4.O./REPAIR GENERAL

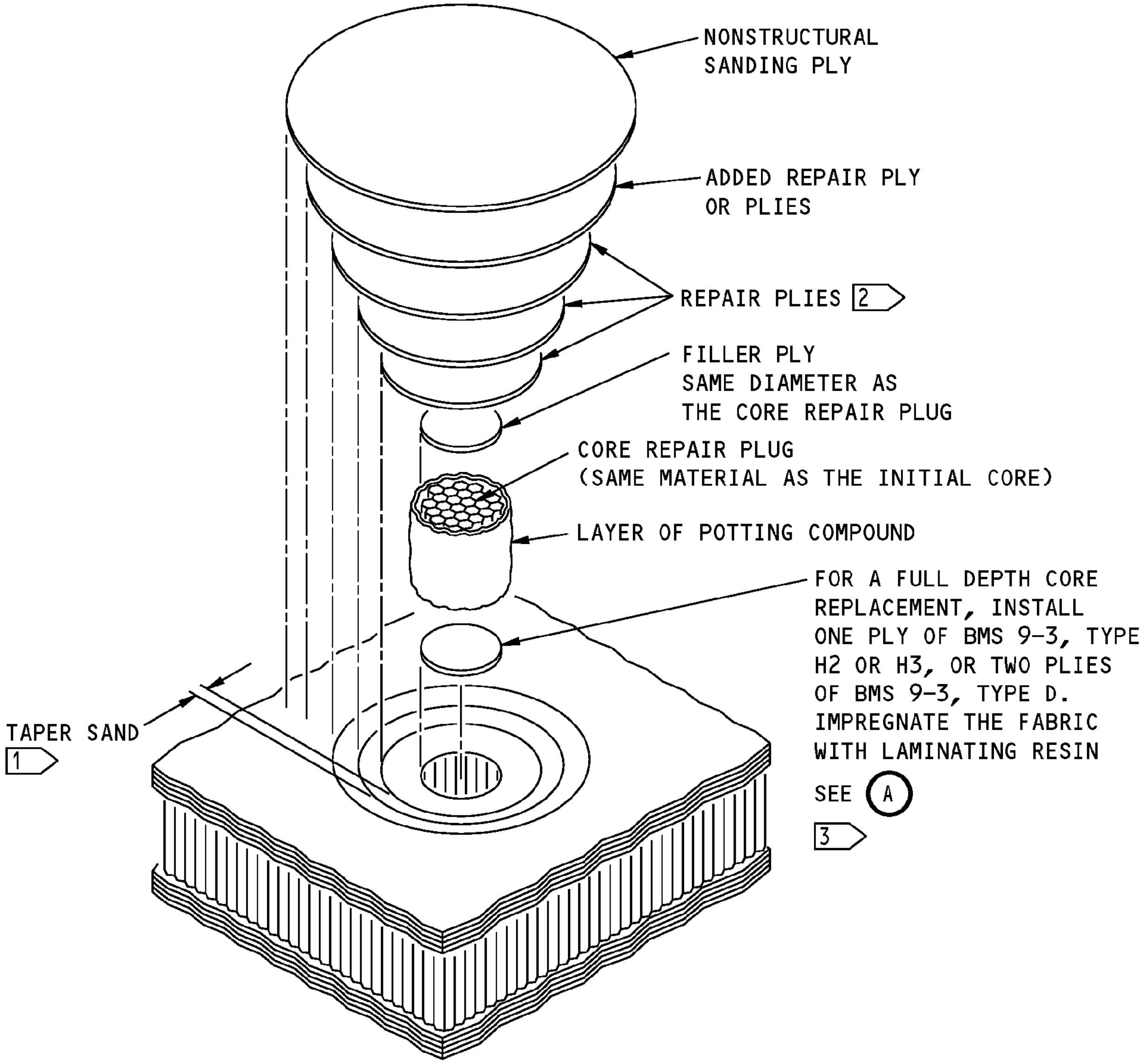
H. Install fabric repair plies and the vacuum bag system as given in Paragraph 4.P.

I. Cure the repair as given in Paragraph 4.Q./REPAIR GENERAL

J. Examine the completed repair as given in Paragraph 4.R./REPAIR GENERAL

K. Apply the finish to the repair area as given in Paragraph 4.S./REPAIR GENERAL

L. After repair of a flight control surface, check to see if it must be balanced again. Refer to 51-60-00 for the balance procedures.



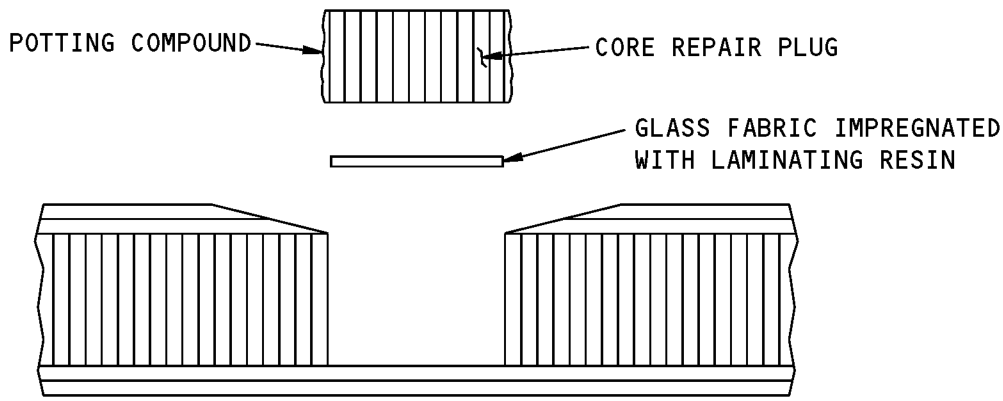
NOTES

1 REFER TO REPAIR GENERAL, FIGURE 207 FOR THE NECESSARY TAPER AND OVERLAP.

2 FIND THE NUMBER OF PLIES, PLY ORIENTATION, AND THE INITIAL MATERIAL IN THE SPECIFIED COMPONENT STRUCTURE IDENTIFICATION. REFER TO REPAIR GENERAL, TABLES 202 THROUGH 204 FOR THE REPAIR MATERIAL.

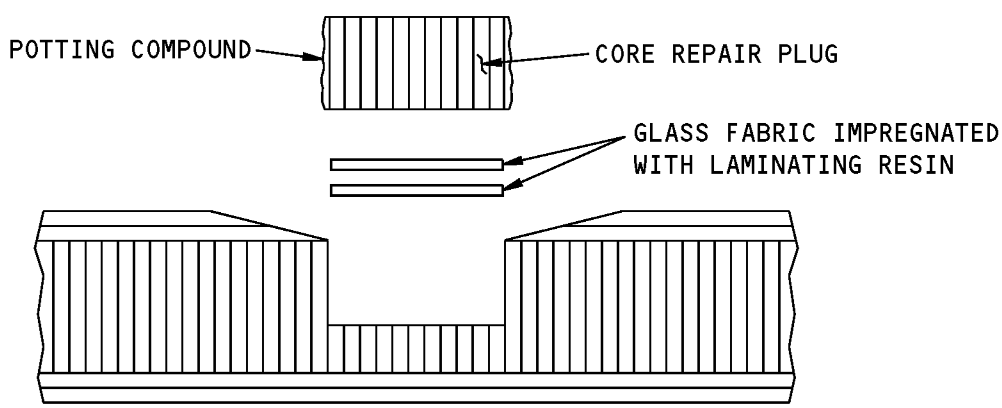
3 FOR LESS THAN FULL DEPTH CORE REPLACEMENT, USE TWO PLIES OF BMS 9-3, TYPE H-2 OR H-3, OR FOUR PLIES OF BMS 9-3, TYPE D. IMPREGNATE THE FABRIC WITH LAMINATING RESIN.
SEE B

Repair 2 - Layout of the Repair Parts
Figure 201 (Sheet 1 of 2)



SECTION THROUGH REPAIR AREA FOR A FULL DEPTH CORE REPLACEMENT

A



SECTION THROUGH REPAIR AREA FOR A PARTIAL DEPTH CORE REPLACEMENT

B

Repair 2 - Layout of the Repair Parts
Figure 201 (Sheet 2 of 2)

REPAIR 3 - OVERLAY REPAIR OF DAMAGE TO THE BAGSIDE SKIN AND THE HONEYCOMB CORE

1. Applicability

WARNING: MAKE SURE THAT FLIGHT CONTROL SURFACES ARE CORRECTLY BALANCED AFTER THEY ARE REPAIRED. IF YOU DO NOT OBEY, FLUTTER CAN OCCUR AND THE RESULT CAN BE A STRUCTURAL FAILURE.

CAUTION: DO NOT USE THIS REPAIR ON PANELS MADE WITH MORE THAN THREE SKIN PLIES. THIS REPAIR IS FOR DAMAGE TO THE BAGSIDE OF A PANEL WITH THREE SKIN PLIES OR LESS. DO NOT USE THIS REPAIR ON AERODYNAMIC SURFACES. IF YOU DO NOT OBEY, THE REPAIR WILL BE UNSATISFACTORY. REFER TO THE SPECIFIED COMPONENT REPAIR SUBJECT FOR THE MATERIALS AND PROCEDURES APPROVED FOR THIS REPAIR. IF YOU DO NOT OBEY, THE REPAIR CAN BE UNSATISFACTORY.

A. Repair 3 is a typical repair that is applicable to damage that is less than 4.0 inches in diameter.

B. Repair 3 is applicable to damage to the bagside skin and the honeycomb core.

C. Repair 3 is not applicable to radomes or floor panels. Refer to 53-10-72 for radomes and 53-00-50 for floor panels.

2. General

A. Repair 3 is a Category A damage tolerant repair. Refer to 51-00-06 for the definitions of the different categories of repairs.

B. Refer to Repair 3 - Layout of the Repair Parts, Figure 201/REPAIR 3 for the layout of the repair parts.

3. References

Reference	Title
51-00-06	STRUCTURAL REPAIR DEFINITIONS
51-60-00	CONTROL SURFACE BALANCING
53-00-50	FUSELAGE FLOOR PANELS
53-10-72	FUSELAGE NOSE RADOME - SECTION 41

4. Repair Instructions

A. Find the limits of the damage. Refer to Paragraph 4.A./REPAIR GENERAL

B. Remove the damage as given in Paragraph 4.B./REPAIR GENERAL Make sure that you remove all of the water or other unwanted material as given in Paragraph 4.C./REPAIR GENERAL The damaged area must be fully dry.

NOTE: Do not taper sand this repair.

C. Prepare the damaged area as given in Paragraph 4.E./REPAIR GENERAL

D. Cut out, clean, and install the honeycomb core plug as given in Paragraph 4.F./REPAIR GENERAL, Paragraph 4.G./REPAIR GENERAL, and Paragraph 4.H./REPAIR GENERAL Make the repair core plug even with the top initial ply.

NOTE: Refer to Repair 11 for an alternative core repair procedure.

E. Cure the honeycomb core plug as given in Paragraph 4.I./REPAIR GENERAL, Paragraph 4.J./REPAIR GENERAL, and Paragraph 4.K./REPAIR GENERAL

F. Clean the repair surface as given in Paragraph 4.E./REPAIR GENERAL

G. Prepare the repair plies as given in Paragraph 4.N./REPAIR GENERAL through Paragraph 4.O./REPAIR GENERAL

H. Install the repair plies above the surface of the repair area.

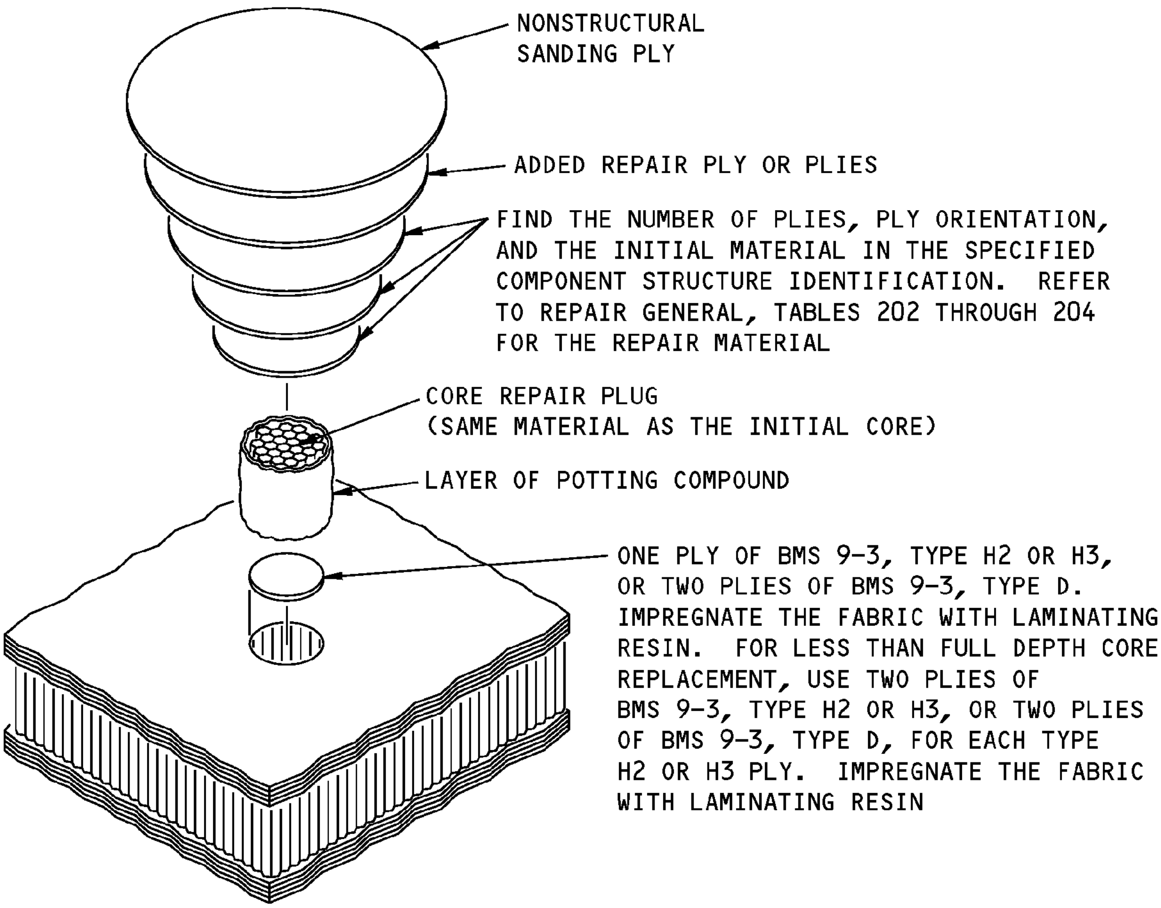
I. Install the fabric repair plies and the vacuum bag system as given in Paragraph 4.P./REPAIR GENERAL

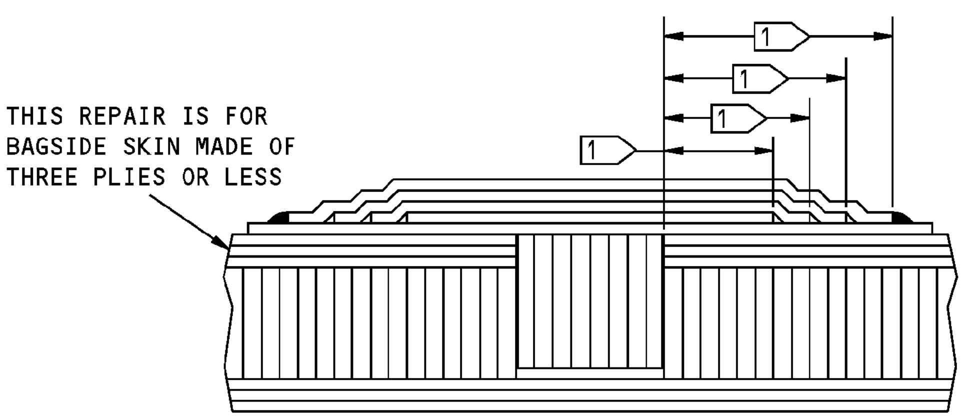
J. Cure the repair as given in Paragraph 4.Q./REPAIR GENERAL

K. Examine the completed repair as given in Paragraph 4.R./REPAIR GENERAL

L. Apply the finish to the repair area as given in Paragraph 4.S./REPAIR GENERAL

M. After repair of a flight control surface, check to see if it must be balanced again. Refer to 51-60-00 for the balance procedures.





SECTION THROUGH REPAIR

NOTES

1 REFER TO REPAIR GENERAL, FIGURE 207 FOR THE NECESSARY TAPER AND OVERLAP.

Repair 3 - Layout of the Repair Parts
Figure 201

REPAIR 4 - REPAIR OF DAMAGE TO THE TWO SKINS AND THE HONEYCOMB CORE

1. Applicability

WARNING: MAKE SURE THAT FLIGHT CONTROL SURFACES ARE CORRECTLY BALANCED AFTER THEY ARE REPAIRED. IF YOU DO NOT OBEY, FLUTTER CAN OCCUR AND THE RESULT CAN BE A STRUCTURAL FAILURE.

CAUTION: REFER TO THE SPECIFIED COMPONENT REPAIR SUBJECT FOR THE MATERIALS AND PROCEDURES APPROVED FOR THIS REPAIR. IF YOU DO NOT OBEY, THE REPAIR CAN BE UNSATISFACTORY.

A. Repair 4 is a typical repair that is applicable to damage to the two skins and the honeycomb core.

B. Repair 4 is not applicable to radomes and floor panels. Refer to 53-10-72 for radomes and 53-00-50 for floor panels.

2. General

A. Repair 4 is a Category A damage tolerant repair. Refer to 51-00-06 for the definitions of the different categories of repairs.

B. Repair 4 gives a 2-step cure procedure and is the recommended procedure for this type of damage. As an alternative, you can use a 3-step cure procedure. In this procedure, the core repair plug installation and the repair plies on each side of the core are bonded independently.

C. Refer to Repair 4 - Layout of the Repair Parts, Figure 201/REPAIR 4 for the layout of the repair parts.

3. References

Reference	Title
51-00-06	STRUCTURAL REPAIR DEFINITIONS
51-60-00	CONTROL SURFACE BALANCING
53-00-50	FUSELAGE FLOOR PANELS
53-10-72	FUSELAGE NOSE RADOME - SECTION 41

4. Repair Instructions

A. Find the limits of the damage. Refer to Paragraph 4.A./REPAIR GENERAL

B. Remove the damage as given in Paragraph 4.B./REPAIR GENERAL Make sure that you remove all of the water or other unwanted material as given in Paragraph 4.C./REPAIR GENERAL The damaged area must be fully dry.

C. Prepare the damaged area as given in Paragraph 4.E./REPAIR GENERAL

D. Cut out, clean, and install the honeycomb core plug as given in Paragraph 4.F./REPAIR GENERAL, Paragraph 4.G./REPAIR GENERAL, and Paragraph 4.H./REPAIR GENERAL It is not necessary to use the vacuum bag procedure at this time.

E. Prepare and install the repair plies to one surface of the panel as given in Paragraph 4.N./REPAIR GENERAL Use a caul plate on the opposite side of the panel to hold the core plug in position.

F. Install the vacuum bag system as given in Paragraph 4.O./REPAIR 4

G. Cure the repair as given in Paragraph 4.Q./REPAIR GENERAL Make sure that the temperature is equal on the two sides of the panel.

H. Make the core repair plug smooth with the initial core surface. Make an allowance for the slight core crush that occurs during the cure procedure.

I. Clean the repair surface as given in Paragraph 4.E./REPAIR GENERAL

J. Prepare and install the repair plies as given in Paragraph 4.N./REPAIR GENERAL through Paragraph 4.O./REPAIR GENERAL

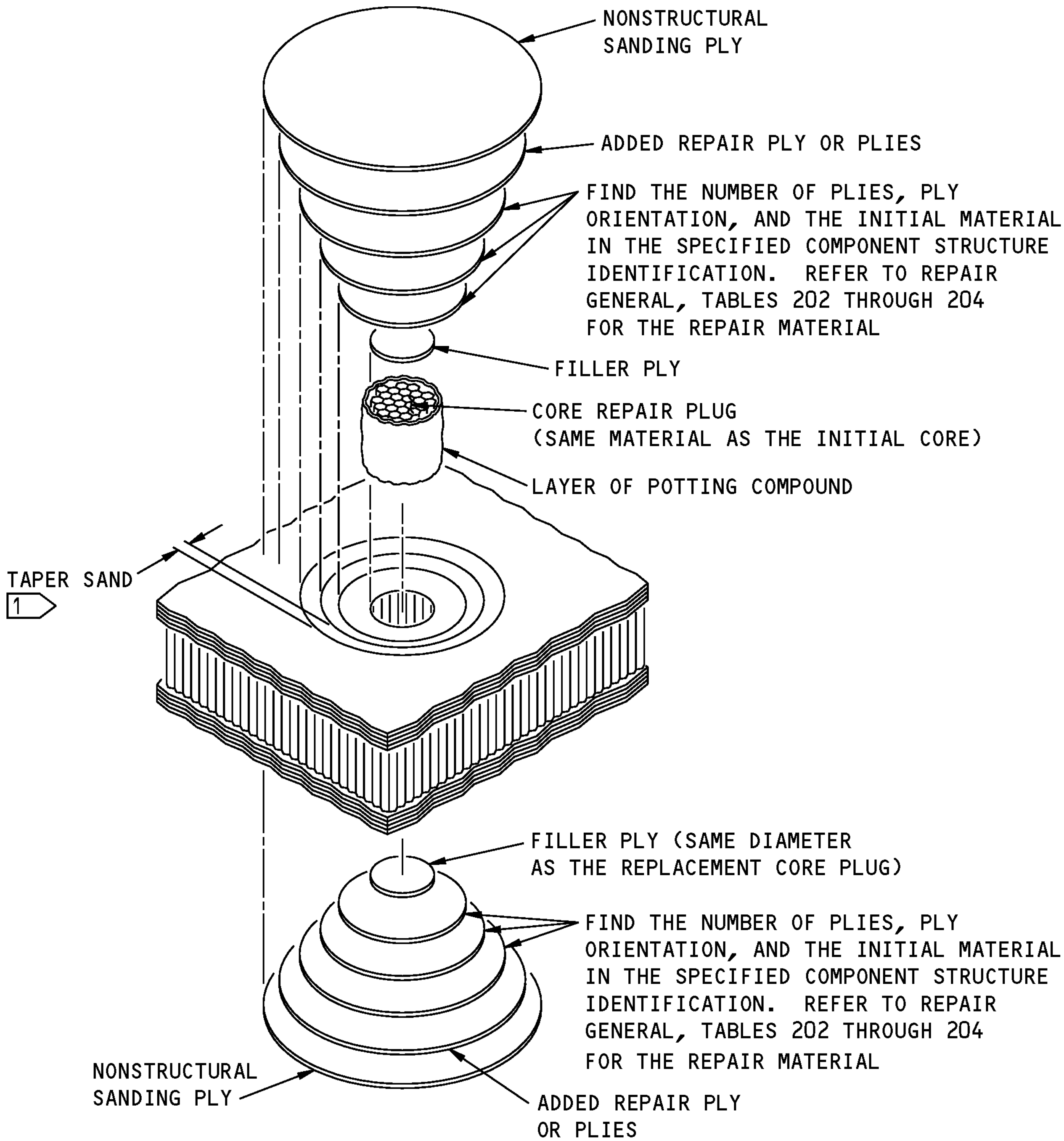
K. Install fabric repair plies and the vacuum bag system as given in Paragraph 4.P./REPAIR GENERAL

L. Cure the repair as given in Paragraph 4.Q./REPAIR GENERAL Make sure that the temperature is equal on the two sides of the panel.

M. Examine the completed repair as given in Paragraph 4.R./REPAIR GENERAL

N. Apply the finish to the repair area as given in Paragraph 4.S./REPAIR GENERAL

O. After repair of flight control surfaces, check to see if it must be balanced again. Refer to 51-60-00 for the procedures.



NOTES

1 REFER TO REPAIR GENERAL, FIGURE 207 FOR THE NECESSARY TAPER AND OVERLAP.

Repair 4 - Layout of the Repair Parts
Figure 201

REPAIR 5 - REPAIR OF DAMAGE TO THE TWO SKINS AND THE HONEYCOMB CORE WHEN ACCESS IS LIMITED TO ONE SIDE

1. Applicability

WARNING: MAKE SURE THAT FLIGHT CONTROL SURFACES ARE CORRECTLY BALANCED AFTER THEY ARE REPAIRED. IF YOU DO NOT OBEY, FLUTTER CAN OCCUR AND THE RESULT CAN BE A STRUCTURAL FAILURE.

CAUTION: REFER TO THE SPECIFIED COMPONENT REPAIR SUBJECT FOR THE MATERIALS AND PROCEDURES APPROVED FOR THIS REPAIR. IF YOU DO NOT OBEY, THE REPAIR CAN BE UNSATISFACTORY.

A. Repair 5 is a typical repair that is applicable to damage to the two skins and the honeycomb core with access to only one side.

B. Repair 5 is applicable to flat panels and where the damage goes fully through the panel with no access to the other side.

C. Repair 5 does is not applicable to radomes and floor panels. Refer to 53-10-72 for radomes and 53-00-50 for floor panels.

2. General

A. Repair 5 is a Category A damage tolerant repair. Refer to 51-00-06 for the definitions of the different categories of repairs.

B. Refer to Repair 5 - Layout of the Repair Parts, Figure 201/REPAIR 5 for the layout of the repair parts.

3. References

Reference	Title
51-00-06	STRUCTURAL REPAIR DEFINITIONS
51-20-05	REPAIR SEALING
51-60-00	CONTROL SURFACE BALANCING
53-00-50	FUSELAGE FLOOR PANELS
53-10-72	FUSELAGE NOSE RADOME - SECTION 41

4. Repair Instructions

A. Find the limits of the damage. Refer to Paragraph 4.A./REPAIR GENERAL

B. Remove the damage as given in Paragraph 4.B./REPAIR GENERAL and the steps that follow:

(1) Make the hole in the outer skin and core larger than the damaged area. The larger hole will let you repair the inner skin with the necessary overlap.

(2) Cut the damaged area in the inner skin to an oval shape.

NOTE: The larger diameter of the oval hole must be sufficiently large for the smaller diameter of the oval patch to go through.

C. Make sure that you remove water or other unwanted material as given in Paragraph 4.C./REPAIR GENERAL The damage area must be fully dry.

D. Put a cover on the oval hole on the inner skin to make an airtight patch.

(1) Use a thin gauge aluminum sheet or other smooth surface as a mold on which to lay up the patch.

(2) Put parting film or a release agent on the aluminum sheet.

(3) Prepare five plies of BMS 9-3 glass fabric cloth impregnated with laminating resin. Refer to Paragraph 4.L./REPAIR GENERAL The glass fabric type and the ply orientation are optional.

(4) Install the five plies of preimpregnated glass fabric on the mold.

(5) Install the vacuum bag system as given in Paragraph 4.O./REPAIR GENERAL

(6) Cure the ply layup patch as given in Paragraph 4.P./REPAIR GENERAL

(7) Remove the patch from the mold after it is cured.

(8) Cut the patch to an oval shape that will make an overlap with the oval hole in the inner skin by a minimum of 0.25 inch all around.

(9) Drill a 1/8 inch diameter hole through the center of the patch.

(10) Make the surface of the patch rough so that it will bond to the inner skin. Use No. 240-grit or smaller abrasive paper.

(11) Remove all of the sanding dust with a vacuum cleaner.

(12) Make a spring steel strip 1.0 inch by 10.0 inches. Drill a 1/8 inch diameter hole through the center of the strip.

(13) Assemble the patch and the spring steel strip with a 1/8 inch diameter temporary fastener.

E. Remove the Tedlar, if necessary, and make the underside of the inner skin rough 0.5 of an inch all around from the edge of the oval hole. Use No. 180-grit or smaller abrasive paper. Do not damage the initial ply fibers.

F. Clean the surface as given in Paragraph 4.E./REPAIR GENERAL

G. Bend the ends of the spring steel strip up and apply the BMS 5-109, Type II adhesive to the patch.

H. Hold the spring steel strip ends up and put the patch through the oval hole. Turn the patch so that it is fully over the hole. Release the spring steel strip so that it holds the patch tight against the inner skin.

I. Cure the adhesive as given in Repair General, Figures 201 and 202, and Table 204.

J. Remove the temporary fastener and the spring steel strip.

K. Fill the hole in the patch with BMS 5-109, Type II adhesive or BMS 5-95, Class B-1/2 sealant and let it cure.

NOTE: Cure BMS 5-109, Type II adhesive as given in Repair General, Figures 201 and 202, and Table 204 . Cure the BMS 5-95 sealant as given in 51-20-05.

L. Clean the repair area as given in Paragraph 4.E./REPAIR GENERAL

M. Prepare the repair plies on the inner skin as given in Paragraph 4.N./REPAIR GENERAL through Paragraph 4.O./REPAIR GENERAL Refer to Repair 5 - Layout of the Repair Parts, Figure 201/REPAIR 5 for the number of plies to use.

N. Cut out and clean the core repair plug as given in Paragraph 4.F./REPAIR GENERAL and Paragraph 4.G./REPAIR GENERAL

O. Install the core repair plug as given in Paragraph 4.H./REPAIR GENERAL

P. Clean the repair surface as given in Paragraph 4.E./REPAIR GENERAL

Q. Prepare and install the repair plies on the outer skin as given in Paragraph 4.N./REPAIR GENERAL

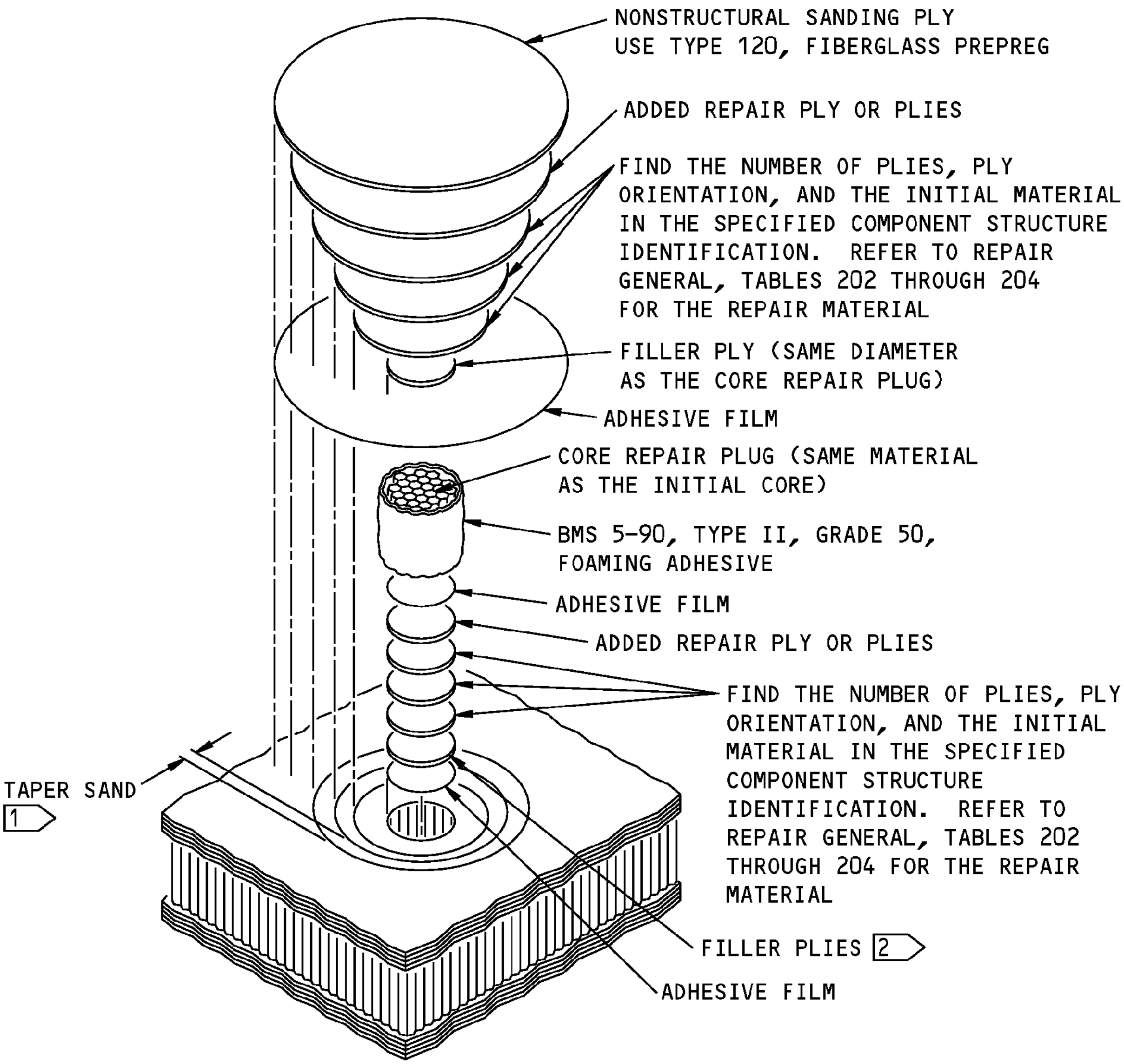
R. Install the fabric repair plies and the vacuum bag system as given in Paragraph 4.P./REPAIR GENERAL

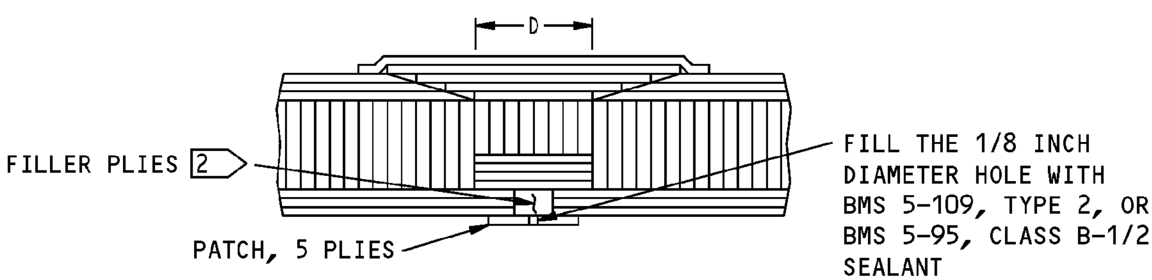
S. Cure the repair as given in Paragraph 4.Q./REPAIR GENERAL

T. Examine the completed repair as described in Paragraph 4.R./REPAIR GENERAL

U. Apply the finish to the repair area as given in Paragraph 4.S./REPAIR GENERAL

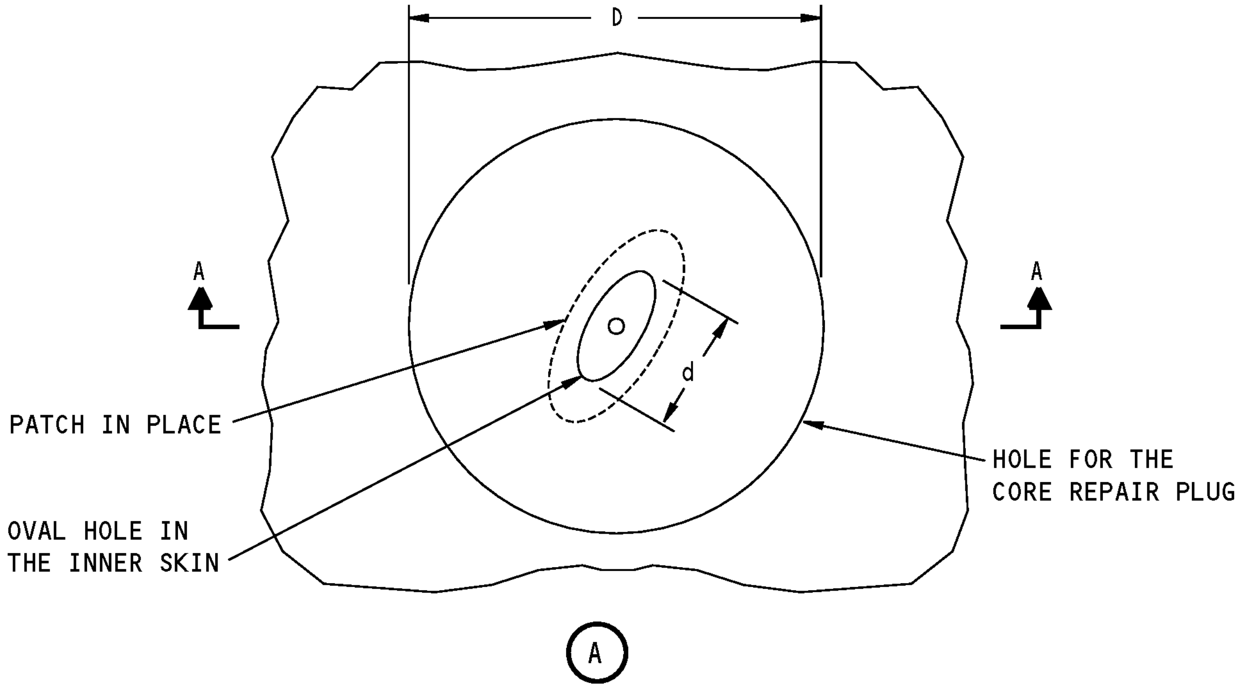
V. After repair of a flight control surface, check to see if it must be balanced again. Refer to 51-60-00 for the procedures.

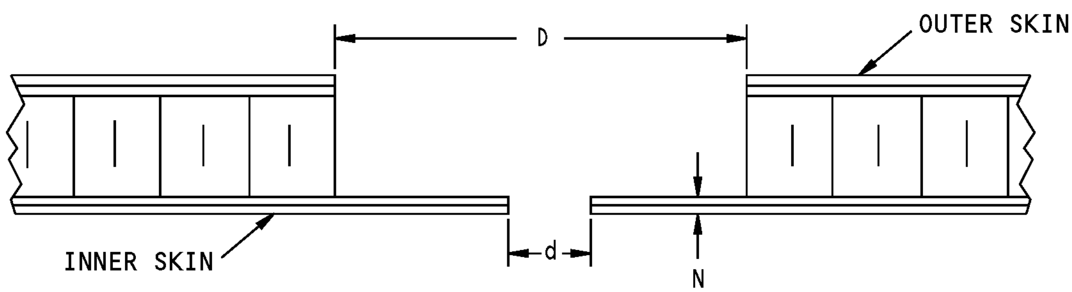




SECTION THROUGH REPAIR

Repair 5 - Layout of the Repair Parts
Figure 201 (Sheet 1 of 3)





NOTE: D IN INCHES = d + N + 1.
d = LARGER DIAMETER OF THE OVAL HOLE IN THE INNER SKIN.
N = NUMBER OF PLIES IN THE INNER SKIN.
D = DIAMETER OF THE HOLE FOR THE CORE REPAIR PLUG.

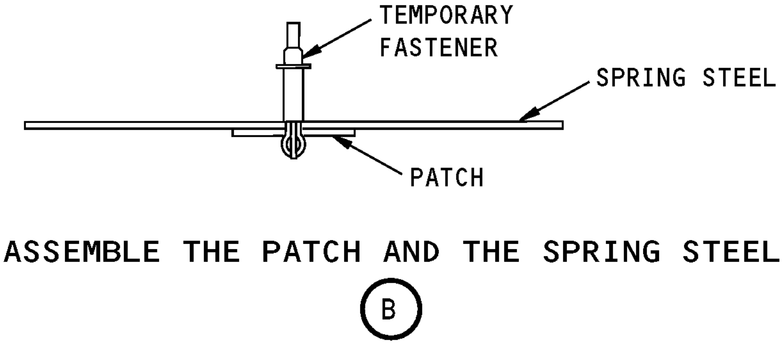
THE PATCH IS NOT SHOWN
A-A

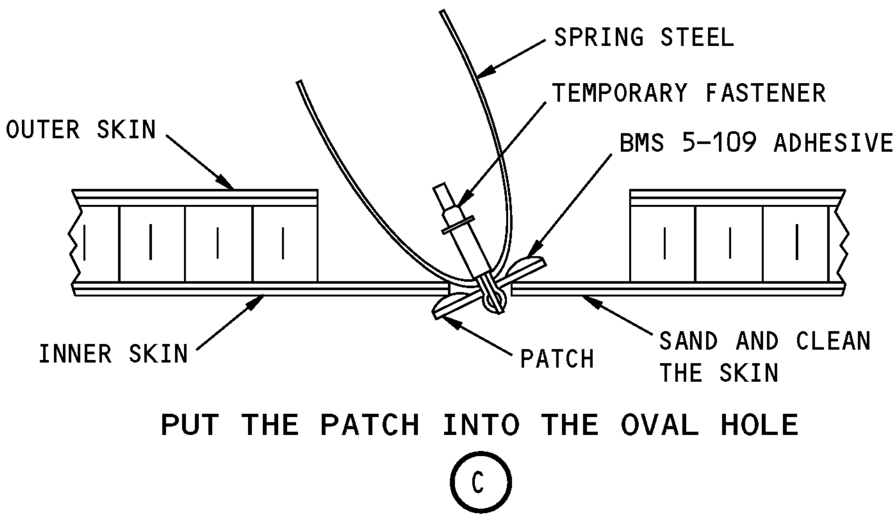
NOTES

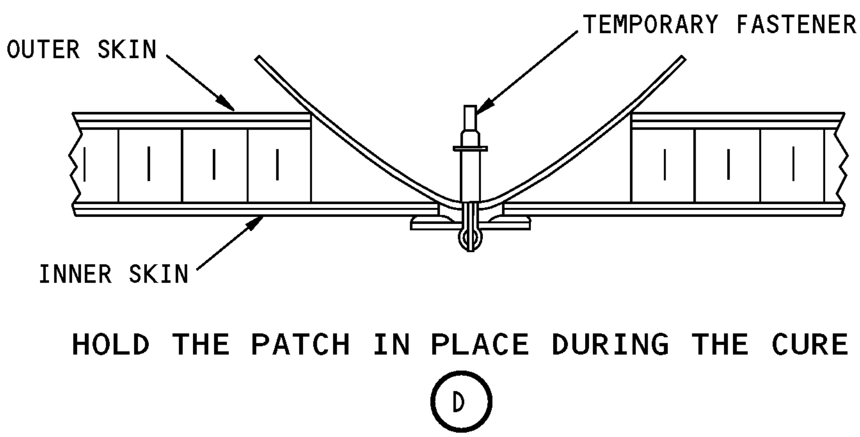
1 REFER TO REPAIR GENERAL, FIGURE 207 FOR THE NECESSARY TAPER AND OVERLAP.

2 THE NUMBER OF FILLER PLIES MUST BE EQUAL TO THE NUMBER OF PLIES IN THE INITIAL SKIN.

Repair 5 - Layout of the Repair Parts
Figure 201 (Sheet 2 of 3)







Repair 5 - Layout of the Repair Parts
Figure 201 (Sheet 3 of 3)

REPAIR 6 - REPAIR OF DAMAGE TO THE EDGEBAND OF A HONEYCOMB PANEL

1. Applicability

WARNING: MAKE SURE THAT FLIGHT CONTROL SURFACES ARE CORRECTLY BALANCED AFTER THEY ARE REPAIRED. IF YOU DO NOT OBEY, FLUTTER CAN OCCUR AND THE RESULT CAN BE A STRUCTURAL FAILURE.

CAUTION: REFER TO THE SPECIFIED COMPONENT REPAIR SUBJECT FOR THE MATERIALS AND PROCEDURES APPROVED FOR THIS REPAIR. IF YOU DO NOT OBEY, THE REPAIR CAN BE UNSATISFACTORY.

A. Repair 6 is a typical repair that is applicable to damage to the laminate edgeband of a honeycomb panel.

B. Repair 6 is not applicable to radomes and floor panels. Refer to 53-10-72 for radomes and 53-00-50 for floor panels.

2. General

A. Repair 6 is a Category A damage tolerant repair. Refer to 51-00-06 for the definitions of the different categories of repairs.

B. Refer to Repair 6 - Layout of the Repair Parts, Figure 201/REPAIR 6 for the layout of the repair parts.

3. References

Reference	Title
51-00-06	STRUCTURAL REPAIR DEFINITIONS
51-60-00	CONTROL SURFACE BALANCING
53-00-50	FUSELAGE FLOOR PANELS
53-10-72	FUSELAGE NOSE RADOME - SECTION 41

4. Repair Instructions

A. Find the limits of the damage. Refer to Paragraph 4.A./REPAIR GENERAL

B. Remove the damaged plies as given in Paragraph 4.B./REPAIR GENERAL, but cut out the damage in a rectangular shape.

C. Remove all contamination and water from the damaged area as given in Paragraph 4.D./REPAIR GENERAL Make sure the repair area is fully dry.

CAUTION: DO NOT SAND INTO THE CORE OR THE ADJACENT BOND PLY (REFER TO FIGURE 201). IF YOU DO NOT OBEY, THE RESULT CAN BE THE LOSS OF STRUCTURAL STRENGTH OF THE COMPONENT.

D. Prepare the damaged area as given in Paragraph 4.E./REPAIR GENERAL

E. Prepare the fabric repair plies as given in Paragraph 4.N./REPAIR GENERAL through Paragraph 4.O./REPAIR GENERAL

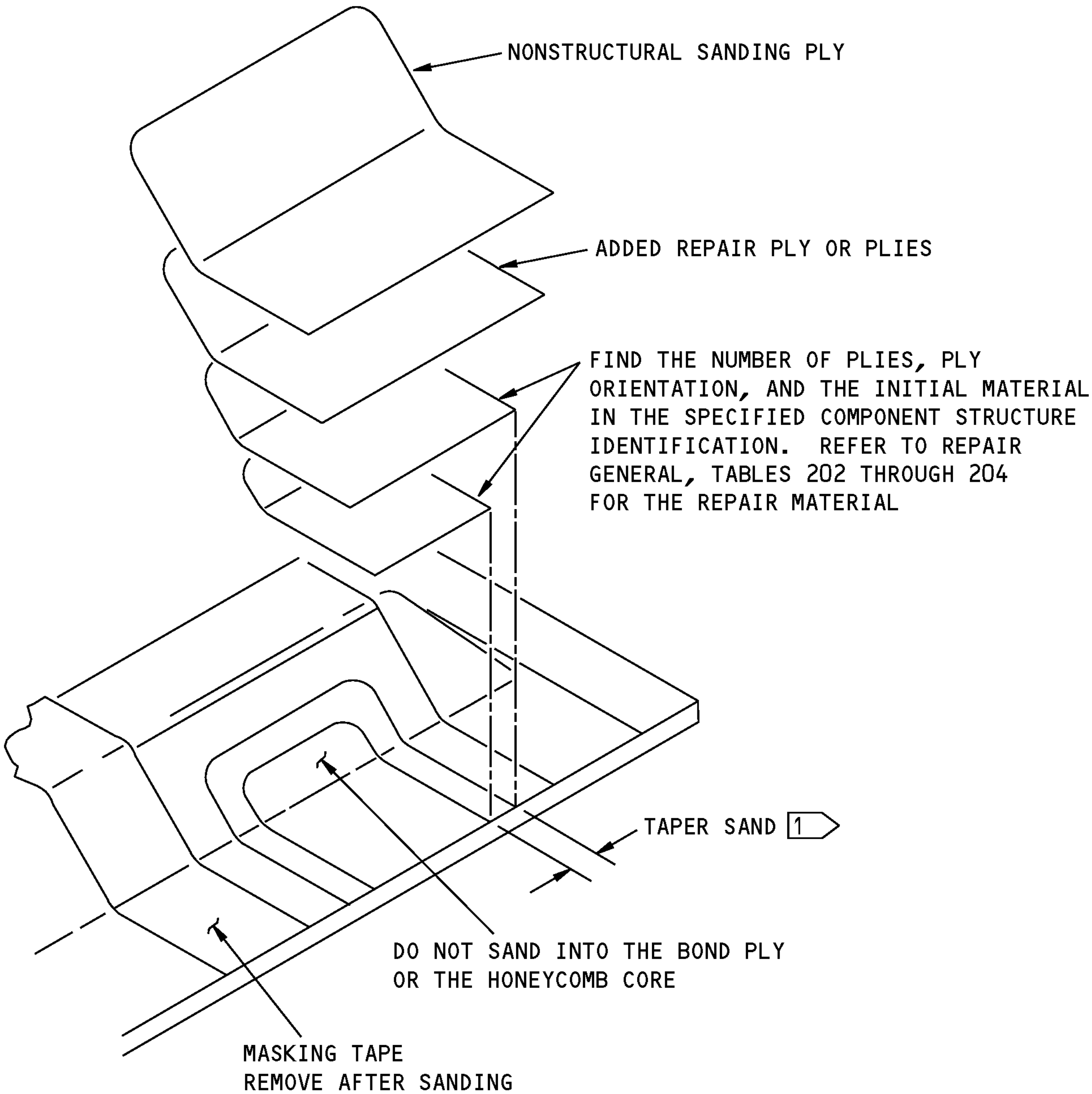
F. Install the fabric repair plies and the vacuum bag system as given in Paragraph 4.P./REPAIR GENERAL

G. Cure the repair as given in Paragraph 4.Q./REPAIR GENERAL

H. Examine the completed repair as given in Paragraph 4.R./REPAIR GENERAL

I. Apply the finish to the repair area as given in Paragraph 4.S./REPAIR GENERAL

J. After repair of a flight control surface, check to see if it must be balanced again. Refer to 51-60-00 for the procedures.



NOTES

1 REFER TO REPAIR GENERAL, FIGURE 207 FOR THE NECESSARY TAPER AND OVERLAP.

Repair 6 - Layout of the Repair Parts
Figure 201

REPAIR 7 - REPAIR OF DAMAGE TO THE EDGEBAND AND THE HONEYCOMB CORE

1. Applicability

WARNING: MAKE SURE THAT FLIGHT CONTROL SURFACES ARE CORRECTLY BALANCED AFTER THEY ARE REPAIRED. IF YOU DO NOT OBEY, FLUTTER CAN OCCUR AND THE RESULT CAN BE A STRUCTURAL FAILURE.

CAUTION: REFER TO THE SPECIFIED COMPONENT REPAIR SUBJECT FOR THE MATERIALS AND PROCEDURES APPROVED FOR THIS REPAIR. IF YOU DO NOT OBEY, THE REPAIR CAN BE UNSATISFACTORY.

A. Repair 7 is a typical repair that is applicable to damage to the edgeband and the honeycomb panel.

B. Repair 7 is not applicable to radomes and floor panels. Refer to 53-10-72 for radomes and 53-00-50 for floor panels.

2. General

A. Repair 7 is a Category A damage tolerant repair. Refer to 51-00-06 for the definitions of the different categories of repairs.

B. Refer to Repair 7 - Layout of the Repair Parts, Figure 201/REPAIR 7 for the layout of the repair parts.

3. References

Reference	Title
51-00-06	STRUCTURAL REPAIR DEFINITIONS
51-60-00	CONTROL SURFACE BALANCING
53-00-50	FUSELAGE FLOOR PANELS
53-10-72	FUSELAGE NOSE RADOME - SECTION 41

4. Repair Instructions

A. Find the limits of the damage. Refer to Paragraph 4.A./REPAIR GENERAL

B. Remove the damaged plies as given in Paragraph 4.B./REPAIR GENERAL

C. Remove all contamination and water from the damaged area as given in Paragraph 4.C./REPAIR GENERAL and Paragraph 4.D./REPAIR GENERAL Make sure the repair area is fully dry.

D. Prepare the damaged area as given in Paragraph 4.E./REPAIR GENERAL

E. Cut out, clean, and install the core repair plug as given in Paragraph 4.F./REPAIR GENERAL, Paragraph 4.G./REPAIR GENERAL, and Paragraph 4.H./REPAIR GENERAL

F. Cure the core repair plug as given in Paragraph 4.I./REPAIR GENERAL and Paragraph 4.J./REPAIR GENERAL

G. Clean the repair surfaces as given in Paragraph 4.E./REPAIR GENERAL

H. Prepare the repair plies as given in Paragraph 4.N./REPAIR GENERAL through Paragraph 4.O./REPAIR GENERAL

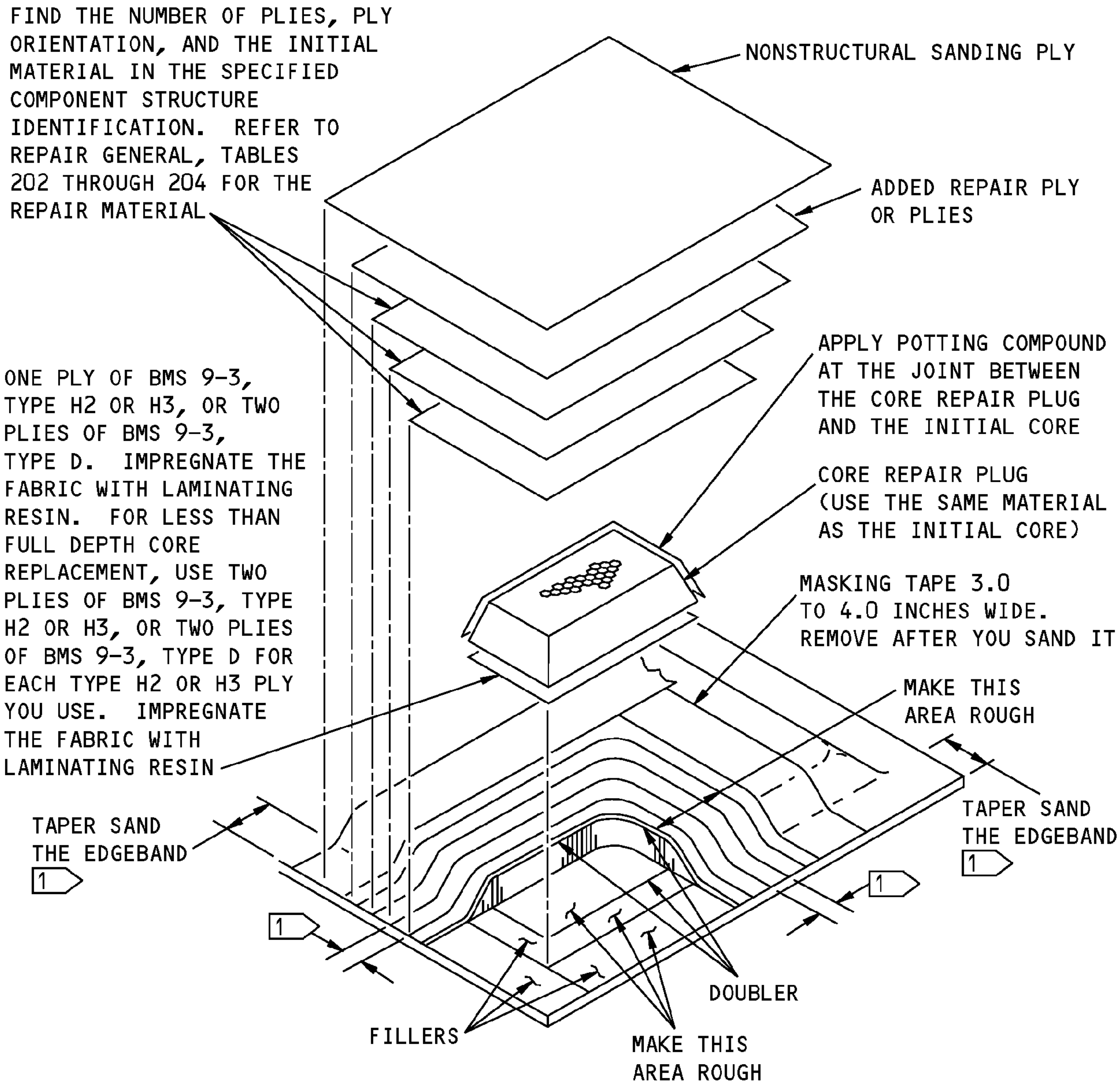
I. Install the fabric repair plies and the vacuum bag system as given in Paragraph 4.P./REPAIR GENERAL

J. Cure the repair as given in Paragraph 4.Q./REPAIR GENERAL

K. Examine the completed repair as given in Paragraph 4.R./REPAIR GENERAL.

L. Apply the finish to the repair area as given in Paragraph 4.S./REPAIR GENERAL

M. After repair of a flight control surface, check to see if it must be balanced again. Refer to 51-60-00 for the procedures.



NOTES

1 REFER TO REPAIR GENERAL, FIGURE 207 FOR THE NECESSARY TAPER AND OVERLAP.

Repair 7 - Layout of the Repair Parts
Figure 201

REPAIR 8 - DELETED

1. **Repair 8**

   A. The data for this repair have been moved to 51-70-05

REPAIR 9 - REPAIR OF DAMAGE TO A FASTENER HOLE WITH LAMINATING RESIN AND CHOPPED FIBER

1. Applicability

WARNING: MAKE SURE THAT FLIGHT CONTROL SURFACES ARE CORRECTLY BALANCED AFTER THEY ARE REPAIRED. IF YOU DO NOT OBEY, FLUTTER CAN OCCUR AND THE RESULT CAN BE A STRUCTURAL FAILURE.

CAUTION: REFER TO THE SPECIFIED COMPONENT REPAIR SUBJECT FOR THE MATERIALS AND PROCEDURES APPROVED FOR THIS REPAIR. IF YOU DO NOT OBEY, THE REPAIR CAN BE UNSATISFACTORY.

A. Repair 9 is a typical repair that is applicable to damage to a fastener hole.

B. Repair 9 can be used to repair a fastener hole that does not align with the mating structure.

C. Repair 9 is not applicable to radomes, floor panels, and to all thrust reverser components except as given in 54-30-01, Repair 4 for the thrust reverser blocker door panels. Refer to 53-10-72 for radomes, 53-00-50 for floor panels, and 54-30-01 for the thrust reverser.

2. General

A. Repair 9 is a Category A damage tolerant repair. Refer to 51-00-06 for the definitions of the different categories of repairs.

B. Refer to Repair 9 - Layout of the Repair Parts, Figure 201/REPAIR 9 for the layout of the repair parts.

3. References

Reference	Title
51-00-06	STRUCTURAL REPAIR DEFINITIONS
51-40-02	FASTENER INSTALLATION AND REMOVAL
51-60-00	CONTROL SURFACE BALANCING
53-00-50	FUSELAGE FLOOR PANELS
53-10-72	FUSELAGE NOSE RADOME - SECTION 41
54-30-01	FAN THRUST REVERSER COWL SKIN

4. Repair Instructions

A. Find the limits of the damage. Refer to Paragraph 4.A./REPAIR GENERAL

B. Remove all contamination and water from the damaged area as given in Paragraph 4.F./REPAIR GENERAL Make sure the repair area is fully dry.

C. Clean the repair surfaces as given in Paragraph 4.G./REPAIR GENERAL

D. Make a mixture of laminating resin and chopped fibers. Use 1 part by weight of laminating resin to 1 part by weight of chopped fibers. Refer to Repair General, Tables 202 and 203 for the repair materials.

NOTE: Use carbon fibers for carbon or hybrid structure. Use glass fibers for glass structure.

E. Fill the hole equal to or slightly more than the adjacent surface contour with the laminating resin and chopped fibers.

F. Cure the laminating resin as given in Figure 214/REPAIR GENERAL. A vacuum is not necessary for this step.

G. Make the surface contour of the repair equal to the initial surface contour around the repair to + 0.010 inch with No. 150-grit or smaller abrasive paper.

NOTE: Use a 0.010 inch thick aluminum template to give protection to the area around the repair when you use abrasive paper.

CAUTION: DO NOT SAND THE FIBERS OF THE INITIAL SURFACE AROUND THE REPAIR. IF YOU DO NOT OBEY, YOU CAN CAUSE MORE DAMAGE TO THE COMPONENT.

H. Make the surface around the repair rough with No. 150-grit or smaller abrasive paper.

I. Clean the repair area as given in Paragraph 4.F./REPAIR GENERAL

J. Prepare the fabric repair plies as given in Paragraph 4.N./REPAIR GENERAL through Paragraph 4.O./REPAIR GENERAL

K. Install fabric repair plies and the vacuum bag system as given in Paragraph 4.P./REPAIR GENERAL

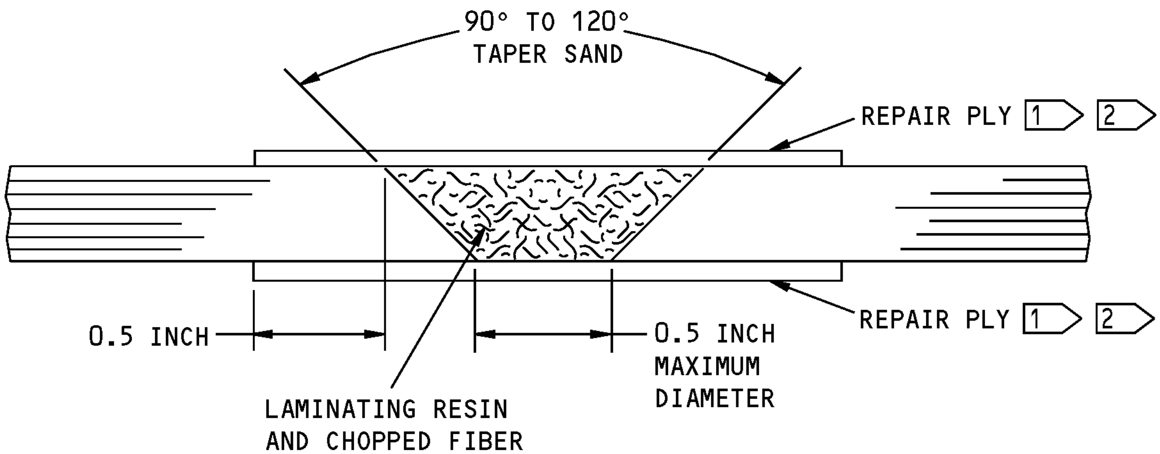
L. Cure the repair as given in Paragraph 4.Q./REPAIR GENERAL

M. If fastener holes were filled, drill and countersink them. Refer to 51-40-02.

N. Examine the completed repair as given in Paragraph 4.R./REPAIR GENERAL

O. Apply the finish to the repair area as given in Paragraph 4.S./REPAIR GENERAL

P. After repair of a flight control surface, check to see if it must be balanced again. Refer to 51-60-00 for the procedures.



NOTES

1 PREPARE AND INSTALL ONE PLY OF BMS 9-3, TYPE H2 OR H3 GLASS FABRIC AS GIVEN IN REPAIR GENERAL, PARAGRAPH 4.

2 THIS PLY IS NOT NECESSARY IF THE HOLE IS COVERED BY A DIFFERENT REPAIR.

Repair 9 - Layout of the Repair Parts
Figure 201

REPAIR 10 - REPAIR OF DAMAGE THAT IS MORE THAN 0.50 INCH IN SOLID LAMINATES

1. Applicability

WARNING: MAKE SURE THAT FLIGHT CONTROL SURFACES ARE CORRECTLY BALANCED AFTER THEY ARE REPAIRED. IF YOU DO NOT OBEY, FLUTTER CAN OCCUR AND THE RESULT CAN BE A STRUCTURAL FAILURE.

CAUTION: REFER TO THE SPECIFIED COMPONENT REPAIR SUBJECT FOR THE MATERIALS AND PROCEDURES APPROVED FOR THIS REPAIR. IF YOU DO NOT OBEY, THE REPAIR CAN BE UNSATISFACTORY.

A. Repair 10 is a typical repair that is applicable to damage to a fastener hole.

B. Repair 10 can be used to repair a fastener hole that does not align with the mating structure.

C. Repair 10 is not applicable to radomes and floor panels. Refer to 53-10-72 for radomes and 53-00-50 for floor panels.

2. General

A. Repair 10 is a Category A damage tolerant repair. Refer to 51-00-06 for the definitions of the different categories of repairs.

B. Refer to Repair 10 - Layout of the Repair Parts, Figure 201/REPAIR 10 for the layout of the repair parts.

3. References

Reference	Title
51-00-06	STRUCTURAL REPAIR DEFINITIONS
51-40-02, GENERAL	Fastener Installation and Removal
51-60-00	CONTROL SURFACE BALANCING
53-00-50	FUSELAGE FLOOR PANELS
53-10-72	FUSELAGE NOSE RADOME - SECTION 41

4. Repair Instructions

A. Find the limits of the damage. Refer to Paragraph 4.A./REPAIR GENERAL

B. Remove the damaged plies as given in Paragraph 4.B./REPAIR GENERAL Make sure that all of the water or other unwanted material is removed. The repair area must be fully dry.

C. Prepare the damaged area as given in Paragraph 4.E./REPAIR GENERAL

D. Prepare the fabric repair plies as given in Paragraph 4.N./REPAIR GENERAL through Paragraph 4.O./REPAIR GENERAL

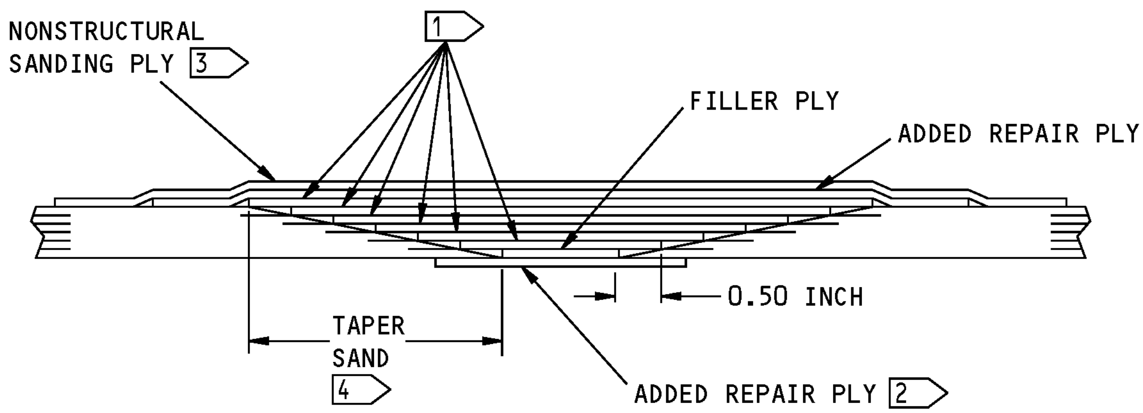
E. Install the fabric repair plies and the vacuum bag system as given in Paragraph 4.P./REPAIR GENERAL

F. Cure the repair as given in Paragraph 4.Q./REPAIR GENERAL

G. Examine the completed repair as given in Paragraph 4.R./REPAIR GENERAL

H. Apply the finish to the repair area as given in Paragraph 4.S./REPAIR GENERAL

I. After repair of a flight control surface, check to see if it must be balanced again. Refer to 51-60-00 for the procedures.



NOTES

1. FIND THE NUMBER OF PLIES, PLY ORIENTATION, AND THE INITIAL MATERIAL IN THE SPECIFIED COMPONENT STRUCTURE IDENTIFICATION. REFER TO REPAIR GENERAL, TABLES 202 THROUGH 204 FOR THE REPAIR MATERIAL.
2. USE ADDED REPAIR PLIES AT THIS LOCATION ONLY IF THE DAMAGE GOES THROUGH THIS SURFACE.
3. PUT ONE PLY OF BMS 9-3, TYPE D GLASS FABRIC ON THE REPAIR AS A SANDING PLY THAT IS NOT STRUCTURAL.
4. REFER TO REPAIR GENERAL, FIGURE 207 FOR THE NECESSARY TAPER AND OVERLAP.

Repair 10 - Layout of the Repair Parts
Figure 201

REPAIR 11 - POTTED CORE REPAIR

1. Applicability

WARNING: MAKE SURE THAT FLIGHT CONTROL SURFACES ARE CORRECTLY BALANCED AFTER THEY ARE REPAIRED. IF YOU DO NOT OBEY, FLUTTER CAN OCCUR AND THE RESULT CAN BE A STRUCTURAL FAILURE.

CAUTION: REFER TO THE SPECIFIED COMPONENT REPAIR SUBJECT FOR THE MATERIALS AND PROCEDURES APPROVED FOR THIS REPAIR. IF YOU DO NOT OBEY, THE REPAIR CAN BE UNSATISFACTORY.

A. Repair 11 is a an alternative procedure for the repair of honeycomb core. You must repair the plies that you remove as given in Repair 2.

B. Repair 11 is not applicable to radomes and floor panels. Refer to 53-10-72 for radomes and 53-00-50 for floor panels.

2. General

A. Repair 11 is a Category A damage tolerant repair. Refer to 51-00-06 for the definitions of the different categories of repairs.

B. Refer to Repair 11 - Layout of the Repair Parts, Figure 201/REPAIR 11 for the layout of the repair parts.

3. References

Reference	Title
51-00-06	STRUCTURAL REPAIR DEFINITIONS
53-00-50	FUSELAGE FLOOR PANELS
53-10-72	FUSELAGE NOSE RADOME - SECTION 41

4. Repair Instructions

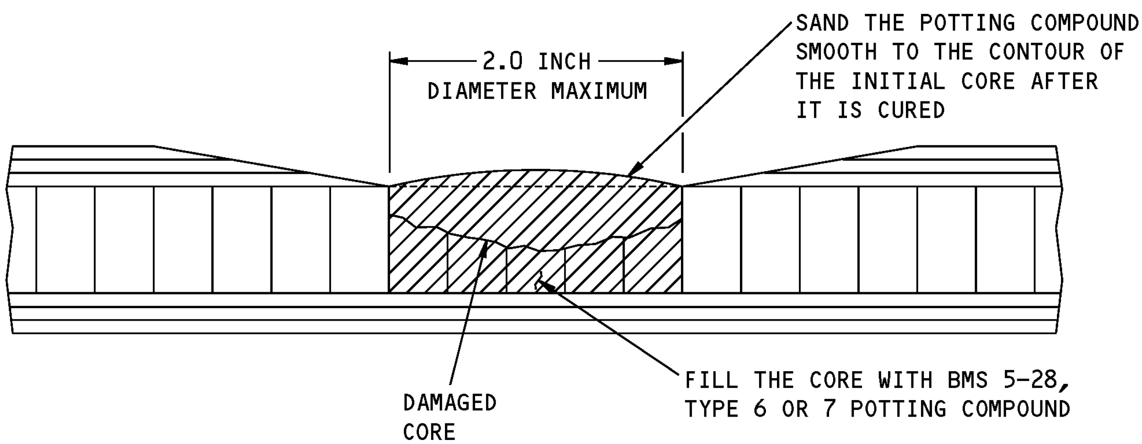
A. Fill the open honeycomb core with BMS 5-28, Type 6 or 7 potting compound.

NOTE: Use sufficient potting compound to fill the core to more than what is necessary for the repair. You will sand the potting compound smooth with the surface around the repair after it is cured.

B. Cure the potting compound for 1.5 hours at 250°F (121°C).

C. Sand the cured potting compound smooth with the surface contours of the initial core.

D. Clean the repair area. Refer to Paragraph 4.E.(4)/REPAIR GENERAL



Repair 11 - Layout of the Repair Parts
Figure 201

REPAIR 12 - REPAIR OF DAMAGE TO THE TRAILING EDGE OF A HONEYCOMB PANEL WITH FULL DEPTH CORE

1. Applicability

WARNING: MAKE SURE THAT FLIGHT CONTROL SURFACES ARE CORRECTLY BALANCED AFTER THEY ARE REPAIRED. IF YOU DO NOT OBEY, FLUTTER CAN OCCUR AND THE RESULT CAN BE A STRUCTURAL FAILURE.

CAUTION: REFER TO THE SPECIFIED COMPONENT REPAIR SUBJECT FOR THE MATERIALS AND PROCEDURES APPROVED FOR THIS REPAIR. IF YOU DO NOT OBEY, THE REPAIR CAN BE UNSATISFACTORY.

A. Repair 12 is applicable to damage to the full depth core and the two skins at the trailing edge of the panel.

B. Repair 12 is not applicable to radomes and floor panels. Refer to 53-10-72 for radomes and 53-00-50 for floor panels.

2. General

A. Repair 12 is a Category A damage tolerant repair. Refer to 51-00-06 for the definitions of the different categories of repairs.

B. Repair 12 is made in two sequences (Stages) of steps:

(1) Stage 1: A repair sequence for the lower surface and the honeycomb core.

(2) Stage 2: A repair sequence for the upper skin and the solid laminate wedge.

C. Refer to Repair 12 - Layout of the Repair Parts, Figure 201/REPAIR 12 for the layout of the repair parts.

3. References

Reference	Title
51-00-06	STRUCTURAL REPAIR DEFINITIONS
51-60-00	CONTROL SURFACE BALANCING
53-00-50	FUSELAGE FLOOR PANELS
53-10-72	FUSELAGE NOSE RADOME - SECTION 41

4. Repair Instructions

A. Stage 1: Repair the lower surface of the honeycomb core. Refer to Figure 201 (Sheet 2).

(1) Find the limits of the damage as given in Paragraph 4.A./REPAIR GENERAL

(2) Remove the damage as given in Paragraph 4.B./REPAIR GENERAL

NOTE: Do not taper sand the upper surface skin plies during Stage I of the repair.

(3) Remove all contamination and water from the damaged area as given in Paragraph 4.C./REPAIR GENERAL Make sure the area is fully dry.

(4) Prepare the repair area as given in Figure 201 (Sheet 2), and Repair General, Paragraph 4.E.

(5) Clean the repair area as given in Paragraph 4.E.(4)/REPAIR GENERAL

(6) Attach a caul plate to the upper surface of the panel. Refer to Figure 201 (Sheet 2).

NOTE: The caul plate must be a sufficient area that is 2 inches more all around than the damage cutout. The caul plate must extend aft of the initial trailing edge location.

(7) Cut out the core repair plug as given in Paragraph 4.F./REPAIR GENERAL Sand the core repair plug to a thickness that will be smooth with the repair plies of the lower surface skin. Taper the core to the same contour as the initial component.

NOTE: The core repair wedge must extend aft of the initial trailing edge location to keep the lower surface contour. The core ribbon direction of the repair wedge must be the same as the ribbon direction of the initial core.

(8) Clean the core repair wedge as given in Paragraph 4.G./REPAIR GENERAL

(9) Install the core repair wedge as given in Paragraph 4.H./REPAIR GENERAL

(10) Prepare the repair plies as given in Figure 201 (Sheet 2), and in Paragraph 4.N./REPAIR GENERAL through Paragraph 4.O./REPAIR GENERAL

NOTE: The repair plies must extend aft of the initial trailing edge location.

(11) Install the fabric repair plies and the vacuum bag system as given in Paragraph 4.P./REPAIR GENERAL

NOTE: Seal the caul plate to the lower skin surface or wrap the vacuum bag around the trailing edge.

(12) Cure the repair as given in Paragraph 4.Q./REPAIR GENERAL

(13) Remove the vacuum bag system and caul plate.

(14) Examine Stage I of the repair as given in Paragraph 4.R./REPAIR GENERAL

B. Stage 2: Repair the upper surface and the solid laminate wedge. Refer to Figure 201 (Sheet 3).

(1) Attach the caul plate to the lower skin surface.

NOTE: The caul plate must be a sufficient area that is one inch more all around than the damage cutout. The caul plate must extend a minimum of one inch aft of the initial trailing edge location. Refer to Figure 201 (Sheet 3).

(2) Taper Sand:

(a) The upper skin plies

(b) The core repair wedge

(c) The initial laminate wedge plies.

NOTE: Make a space for the wedge repair plies and the upper surface skin repair plies. Refer to Figure 201 (Sheet 3), and Repair General, Paragraph 4.E.

(3) Prepare the laminate wedge repair plies as given in Paragraph 4.N./REPAIR GENERAL and Paragraph 4.O./REPAIR GENERAL

(4) Prepare the upper surface skin repair plies as given in Paragraph 4.N./REPAIR GENERAL and Paragraph 4.O./REPAIR GENERAL

(5) Install the wedge repair plies and the upper surface skin repair plies as given in Repair 12 - Layout of the Repair Parts, Figure 201/REPAIR 12, and Repair General, Paragraph 4.P.

(6) Install the vacuum bag system as given in Paragraph 4.P.

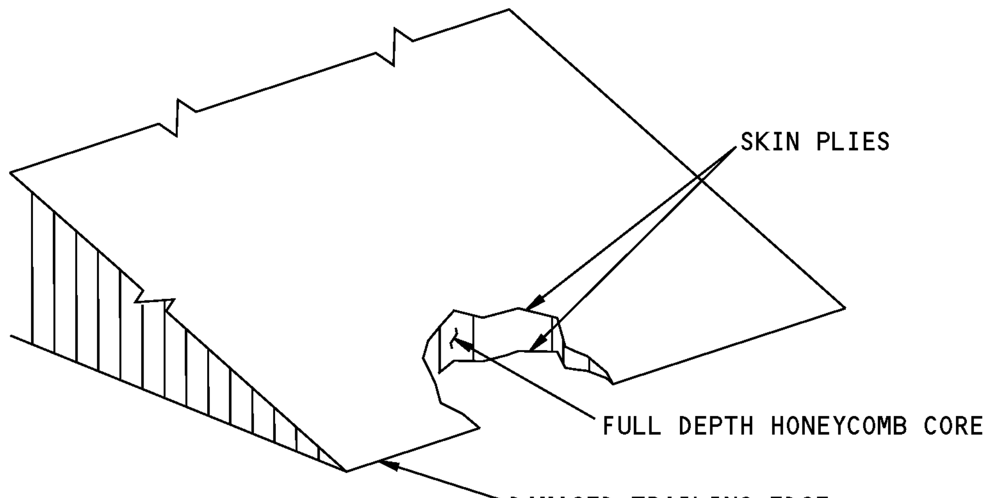
(7) Cure the repair as given in Paragraph 4.Q./REPAIR GENERAL

(8) Carefully cut the trailing edge of the repair to align with the initial trailing edge.

(9) Examine the completed repair as given in Examine the completed repair as given in Paragraph 4.R./REPAIR GENERAL

(10) Apply the finish to the repair area as given in Paragraph 4.S./REPAIR GENERAL

(11) After repair of a flight control surface, check to see if it must be balanced again. Refer to 51-60-00 for the procedures.



NOTES

1 THE TRAILING EDGE OF THE CORE REPAIR WEDGE MUST EXTEND AFT OF THE INITIAL TRAILING EDGE. THE WEDGE MUST BE TAPERED TO THE CONTOUR OF THE LOWER SKIN SURFACE. THE REPAIR CORE RIBBON DIRECTION MUST BE THE SAME DIRECTION AS THE INITIAL CORE RIBBON DIRECTION.

2 THE REPAIR PLIES MUST EXTEND AFT OF THE INITIAL TRAILING EDGE LOCATION.

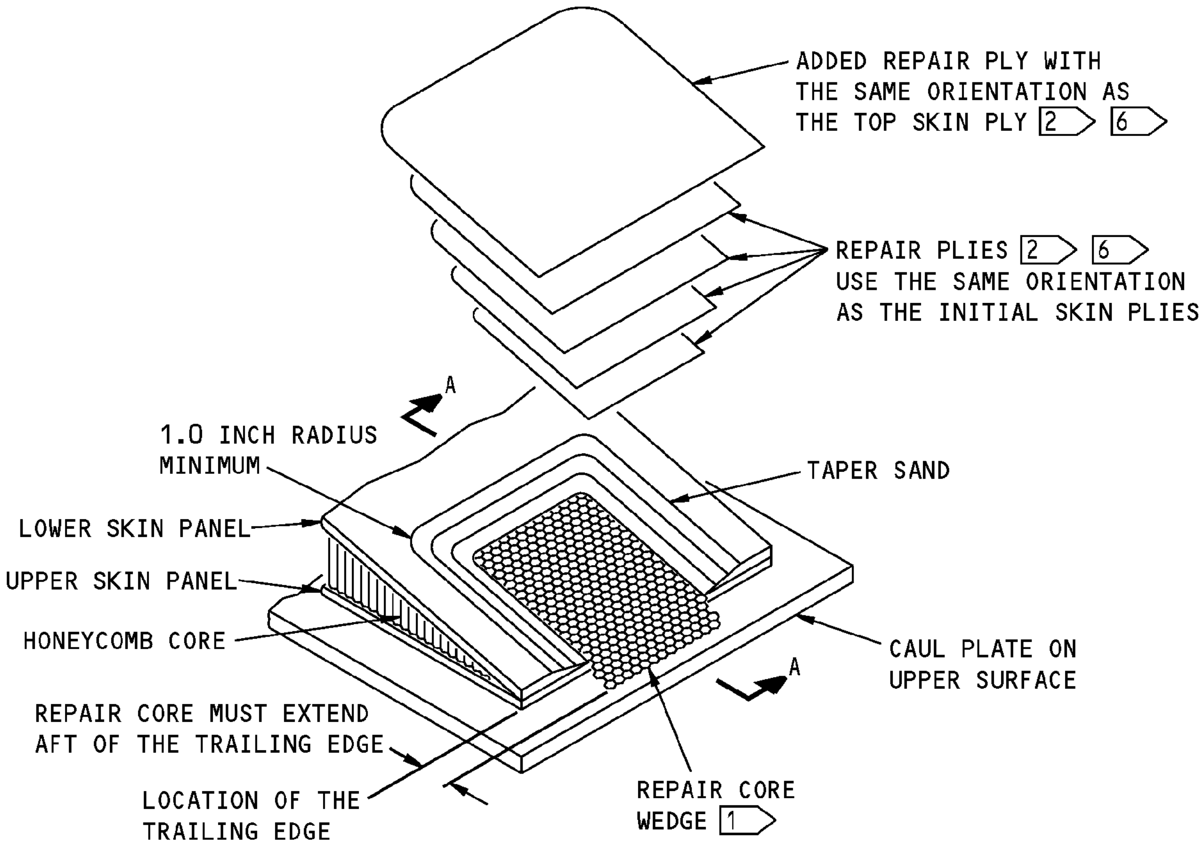
3 TAPER SAND THE REPAIR CORE WEDGE TO MAKE SPACE FOR THE WEDGE REPAIR PLIES. DO NOT SAND INTO THE LOWER SKIN PLIES.

4 THE WEDGE REPAIR PLIES MUST FILL THE SPACE OF THE INITIAL WEDGE THAT WAS REMOVED. MAKE ALLOWANCE FOR THE UPPER SKIN REPAIR PLIES AND KEEP THE INITIAL CONTOUR OF THE UPPER SKIN SURFACE.

5 REFER TO THE DRAWINGS FOR THE SPECIFIED COMPONENT TO FIND THE 0 DEGREE PLY DIRECTION.
LAYUP THE WEDGE REPAIRS AS FOLLOWS:
- 45° FOR THE PLY NEXT TO THE CORE.
- 0°,0°,45°,0°,0°,45° FOR ALL OTHER PLIES.
- DO THIS SEQUENCE AS NECESSARY.

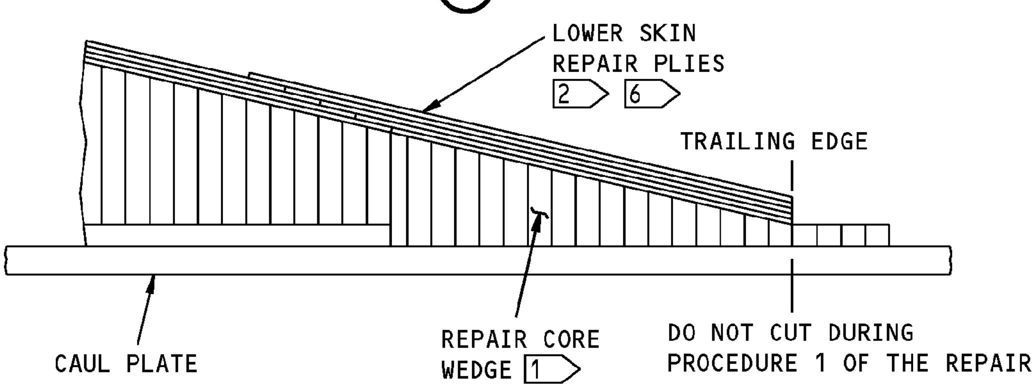
6 LAYUP THE REPAIR PLIES WITH THE SAME ORIENTATION AS THE INITIAL SKIN PLIES. REFER TO THE DRAWINGS FOR THE SPECIFIED COMPONENT TO FIND THE 0 DEGREE PLY DIRECTION.

Repair 12 - Layout of the Repair Parts
Figure 201 (Sheet 1 of 3)



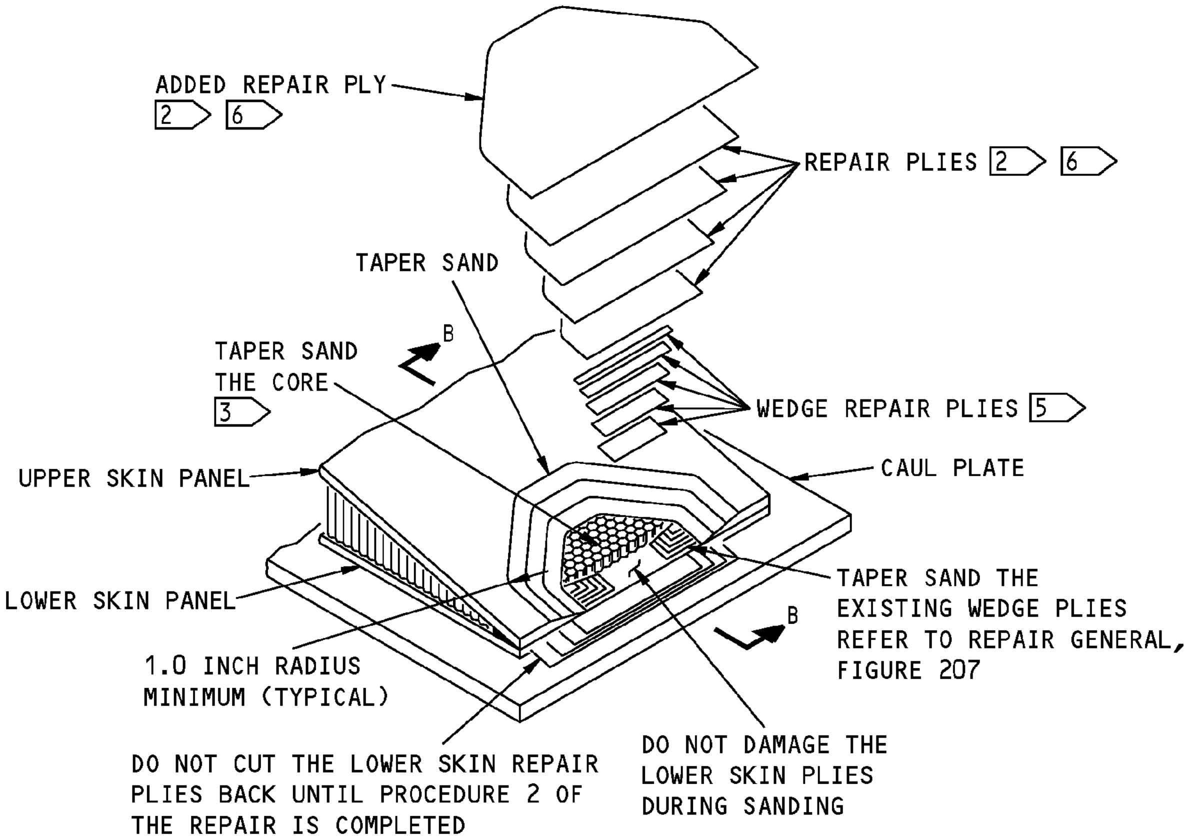
REPAIR OF THE LOWER SKIN PLIES AND THE TRAILING EDGE WEDGE
REPAIR PROCEDURE 1

A

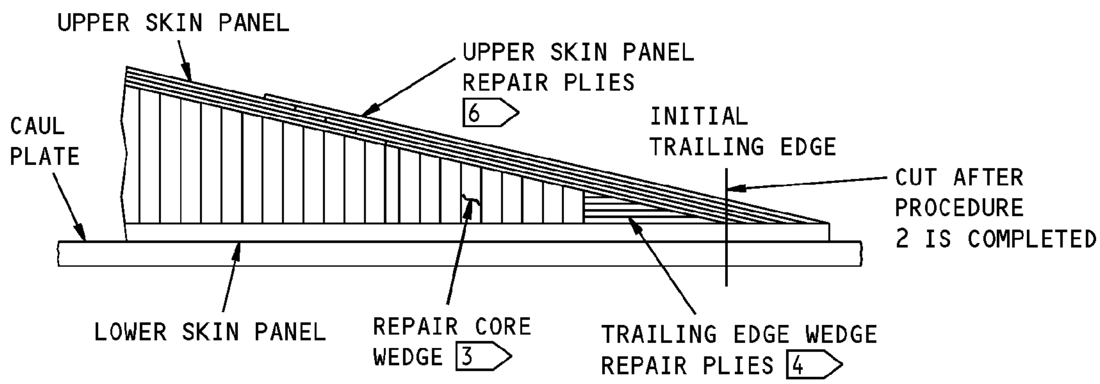


CROSS-SECTIONAL VIEW OF THE CENTER
OF THE PROCEDURE AFTER THE LAYUP
A-A

Repair 12 - Layout of the Repair Parts
Figure 201 (Sheet 2 of 3)



REPAIR OF THE UPPER SKIN PLIES AND THE TRAILING EDGE WEDGE
REPAIR PROCEDURE 2
(B)



SECTION THROUGH THE REPAIR
B-B

Repair 12 - Layout of the Repair Parts
Figure 201 (Sheet 3 of 3)

REPAIR 13 - REPAIR OF AN EDGE DELAMINATION

1. Applicability

WARNING: MAKE SURE THAT FLIGHT CONTROL SURFACES ARE CORRECTLY BALANCED AFTER THEY ARE REPAIRED. IF YOU DO NOT OBEY, FLUTTER CAN OCCUR AND THE RESULT CAN BE A STRUCTURAL FAILURE.

CAUTION: REFER TO THE SPECIFIED COMPONENT REPAIR SUBJECT FOR THE MATERIALS AND PROCEDURES APPROVED FOR THIS REPAIR. IF YOU DO NOT OBEY, THE REPAIR CAN BE UNSATISFACTORY.

A. Repair 13 is a typical repair that is applicable to a delamination at the edge of a panel.

B. Repair 13 is not applicable to radomes and floor panels. Refer to 53-10-72 for radomes and 53-00-50 for floor panels.

2. General

A. Repair 13 is a Category A damage tolerant repair. Refer to 51-00-06 for the definitions of the different categories of repairs.

B. Refer to Repair 13 - Layout of the Repair Parts, Figure 201/REPAIR 13 for the layout of the repair parts.

3. References

Reference	Title
51-00-06	STRUCTURAL REPAIR DEFINITIONS
51-60-00	CONTROL SURFACE BALANCING
53-00-50	FUSELAGE FLOOR PANELS
53-10-72	FUSELAGE NOSE RADOME - SECTION 41

4. Repair Instructions

A. Find the limits of the damage. Refer to Paragraph 4.A./REPAIR GENERAL

B. Remove all of the water or unwanted material as given in Paragraph 4.C./REPAIR GENERAL Make sure the repair area is fully dry.

C. Clean the repair surfaces as given in Paragraph 4.E./REPAIR GENERAL

D. Use force to push the injection resin into the delamination. Refer to Repair General, Tables 202 and 204 for the resin material.

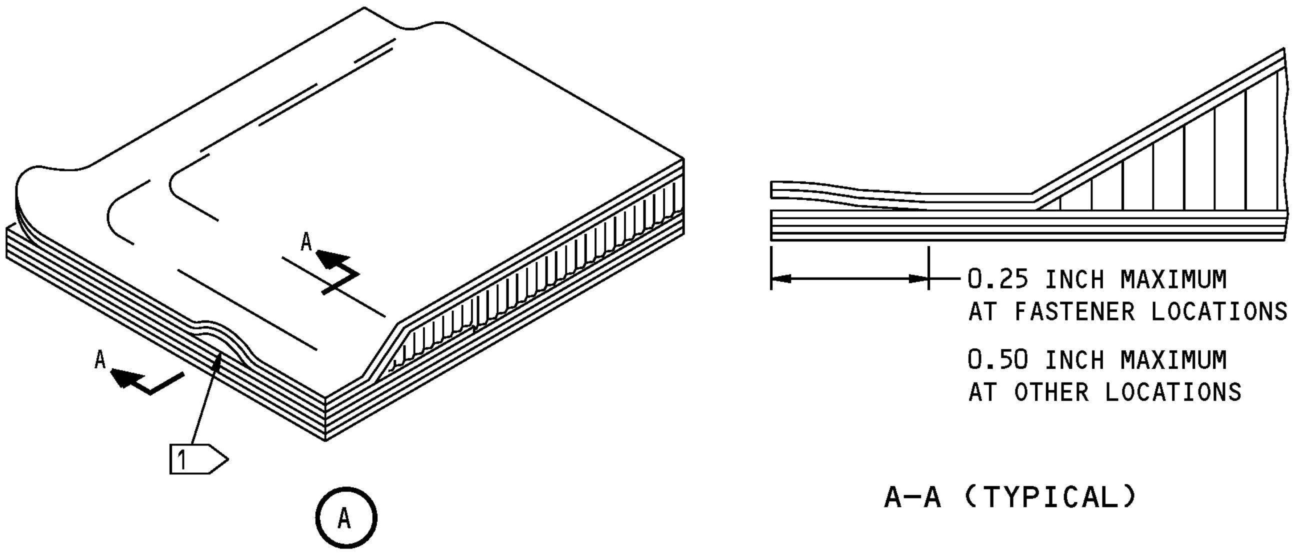
NOTE: Use a clamp to keep the plies together as shown in Repair 13 - Layout of the Repair Parts, Figure 201/REPAIR 13.

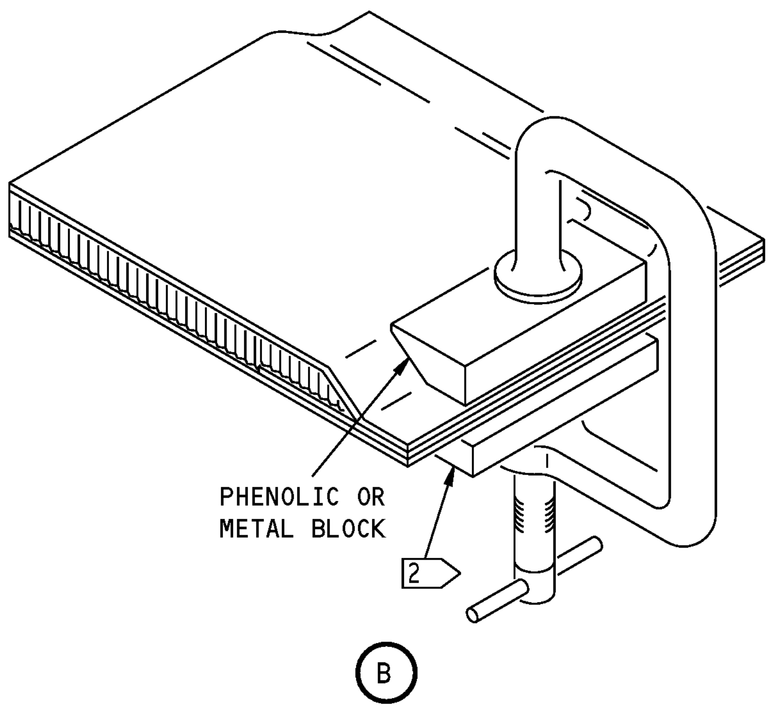
E. Cure the repair as given in Repair General, Figure 201 .

F. Examine the completed repair as Given in Paragraph 4.R./REPAIR GENERAL

G. Apply the finish to the repair as given in Paragraph 4.S./REPAIR GENERAL

H. After you make a repair of a flight control surface, check to see if it must be balanced again. Refer to 51-60-00 for the balance procedures.





NOTES

1 USE FORCE TO PUSH THE INJECTION RESIN INTO THE DELAMINATION.

2 USE A CLAMP TO KEEP THE PLIES TOGETHER.

Repair 13 - Layout of the Repair Parts
Figure 201

REPAIR 14 - REWORK OF PERMITTED SURFACE DENTS WITH POTTING COMPOUND AND A FIBERGLASS PATCH

1. Applicability

WARNING: MAKE SURE THAT FLIGHT CONTROL SURFACES HAVE THE CORRECT BALANCE AFTER THEY ARE REPAIRED. IF YOU DO NOT OBEY, FLUTTER CAN OCCUR AND THE RESULT CAN BE A STRUCTURAL FAILURE. REFER TO SRM 51-60-00 FOR THE CONTROL SURFACE BALANCING PROCEDURES

CAUTION: REFER TO THE SPECIFIED COMPONENT REPAIR SUBJECT FOR THE MATERIALS AND PROCEDURES APPROVED FOR THIS REPAIR. IF YOU DO NOT OBEY, THE REPAIR CAN BE UNSATISFACTORY.

A. Repair 14 is a typical repair that is applicable to surface dents on composite parts.

B. Repair 14 is applicable to dents on composite parts that are permitted by the applicable allowable damage subject.

C. Repair 14 is not applicable to radomes and floor panels. Refer to 53-10-72 for radomes and 53-00-50 for floor panels.

2. General

A. Repair 14 is a Category A damage tolerant repair. Refer to 51-00-06 for the definitions of the different categories of repairs.

3. References

Reference	Title
51-00-06	STRUCTURAL REPAIR DEFINITIONS
51-60-00	CONTROL SURFACE BALANCING
53-00-50	FUSELAGE FLOOR PANELS
53-10-72	FUSELAGE NOSE RADOME - SECTION 41
AMM 51-21-99 P/B 701	DECORATIVE EXTERIOR PAINT SYSTEM - CLEANING/PAINTING

4. Repair Instructions

A. Do a check for delamination and broken fibers. Refer to Paragraph 4.A./REPAIR GENERAL

NOTE: If the dent damage is more than what is permitted in the applicable allowable damage limits, you must repair the dent. Refer to the applicable repair subject in Repair General, Table 201 .

B. Remove all contamination and water from the damaged area as given in Paragraph 4.D./REPAIR GENERAL Make sure the repair area is fully dry.

C. Make a mark around the damage area that permits an overlap of 1.0 inch for the repair ply.

D. Clean the repair surfaces as given in Paragraph 4.E./REPAIR GENERAL

E. Apply masking tape around the repair area as shown in Layout of the Repair, Figure 201/REPAIR 14.

F. Remove the Tedlar or decorative finish. Use No. 240-grit or smaller Scotch-Brite abrasive or No. 150-grit or smaller abrasive paper.

G. Remove the masking tape.

H. Clean the repair area again.

I. Apply the BMS 5-28, Type 7 potting compound to the dent. Make the potting compound smooth or slightly higher than the surrounding surface contour. You will sand the potting compound after it is cured.

J. Cure the potting compound. Refer to Repair General, Table 204 for the repair materials.

CAUTION: DO NOT SAND THE FIBERS OF THE INITIAL SURFACE AROUND THE REPAIR. IF YOU DO NOT OBEY, YOU CAN CAUSE MORE DAMAGE TO THE COMPONENT.

K. Make the surface of the potting compound equal to the initial surface contour around the repair to +0.010 inch with No. 150-grit or smaller abrasive paper.

L. Clean the repair area again.

M. Prepare one ply of BMS 9-3, Type H2 or H3 glass fabric impregnated with BMS 8-301, Class 1 or 2 laminating resin as given in Paragraph 4.N./REPAIR GENERAL through Paragraph 4.O./REPAIR GENERAL Make the repair ply 1.0 inch larger all around than the potted area as shown in Layout of the Repair, Figure 201/REPAIR 14.

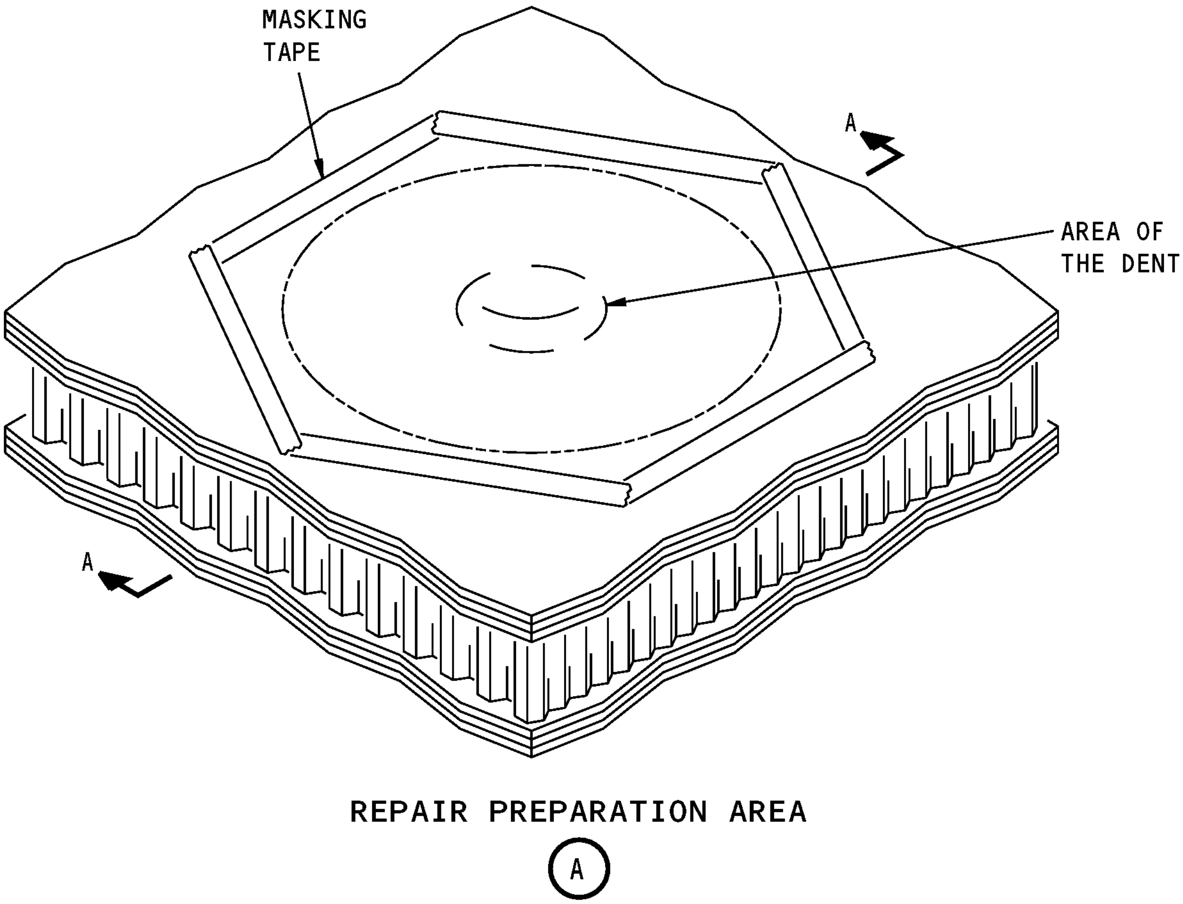
N. Install fabric repair plies and the vacuum bag system as given in Paragraph 4.P./REPAIR GENERAL

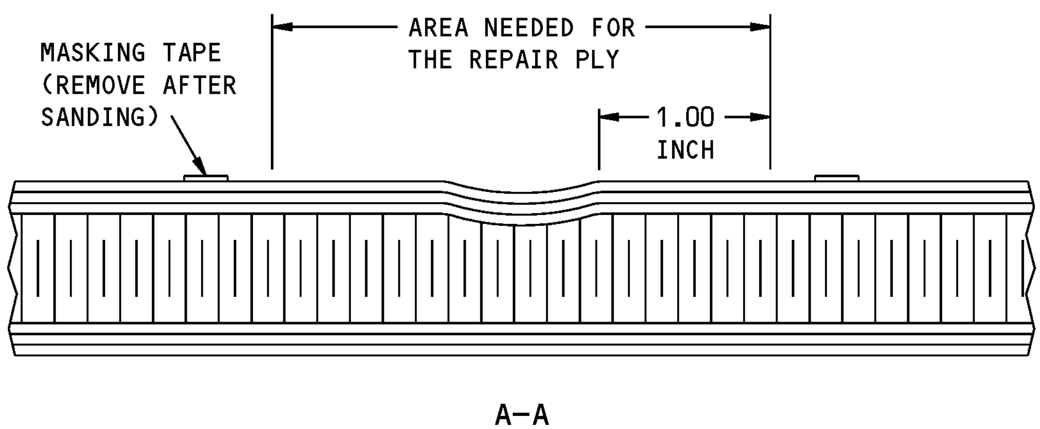
O. Cure the repair as given in Paragraph 4.Q./REPAIR GENERAL

P. Examine the completed repair as given in Paragraph 4.R./REPAIR GENERAL

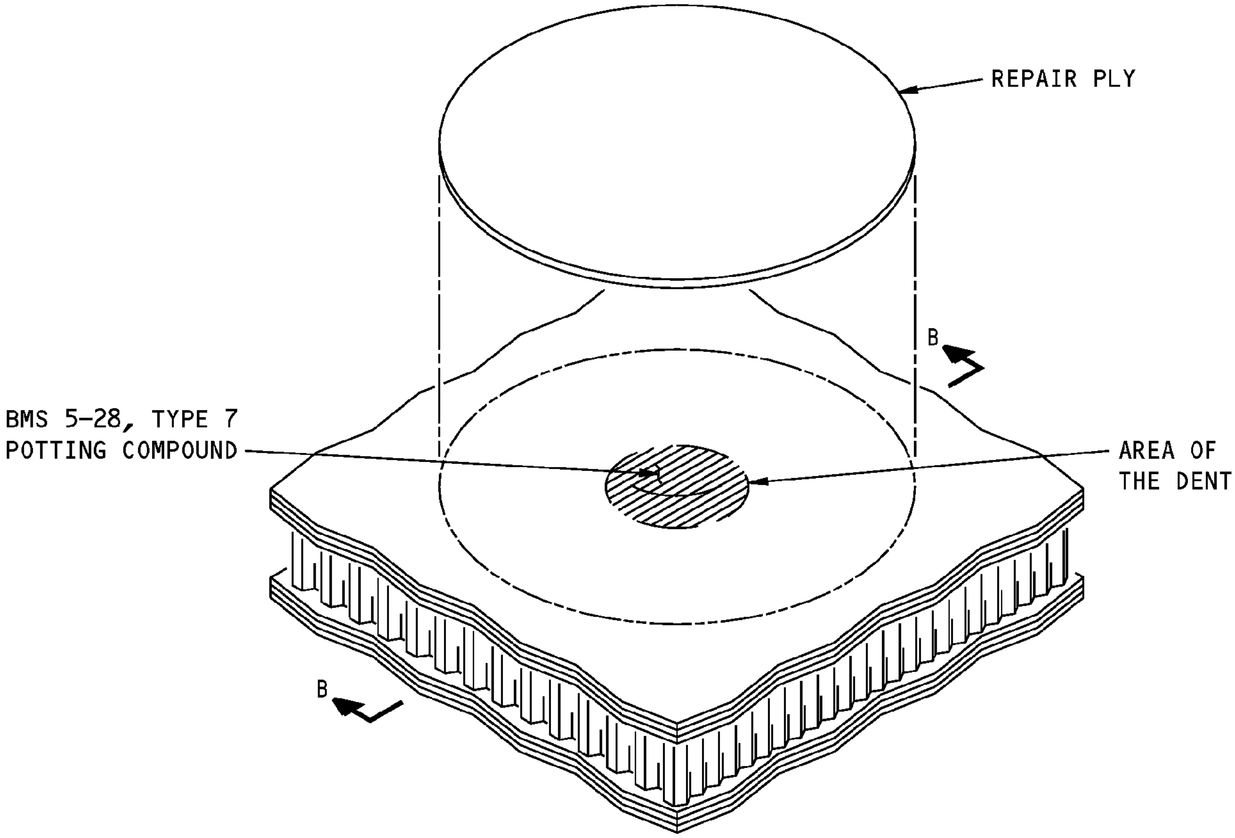
Q. Apply the decorative finish as necessary to the repair area. Refer to AMM PAGEBLOCK 51-21-99/701.

R. After you make a repair to a flight control surface, check to see if it must be balanced again. Refer to 51-60-00 for the balance procedures.



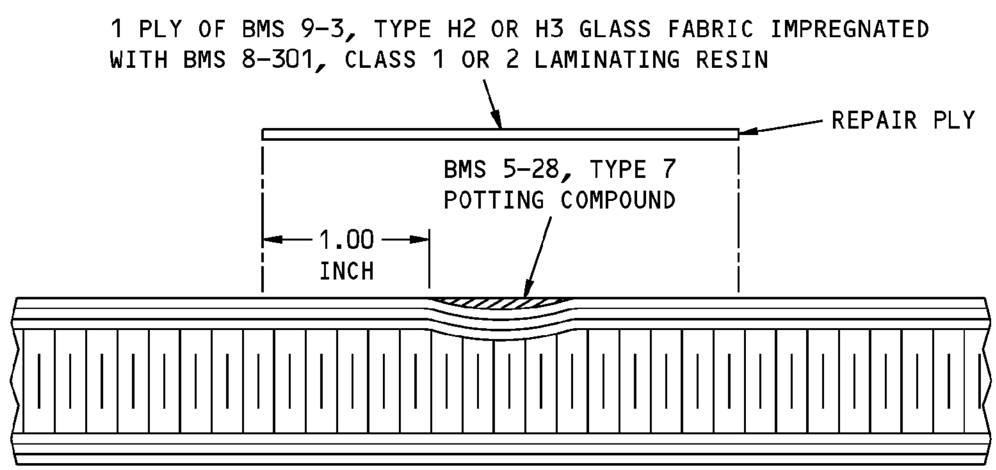


Layout of the Repair
Figure 201 (Sheet 1 of 2)



LAYUP OF THE REPAIR MATERIALS

B



B-B

Layout of the Repair
Figure 201 (Sheet 2 of 2)

REPAIR GENERAL - REPAIR PROCEDURES FOR PREIMPREGNATED MATERIALS

1. **Applicability**

WARNING: SOME OF THE EQUIPMENT USED TO HEAT CURE THESE REPAIRS CAN CAUSE A FIRE OR AN EXPLOSION WHEN USED NEAR AN AIRPLANE THAT CONTAINS OR HAS CONTAINED FUEL. USE EQUIPMENT THAT AGREES WITH THE FIRE CODES OF YOUR LOCAL FIRE AUTHORITY. IF YOU DO NOT OBEY, INJURY TO PERSONS AND DAMAGE TO THE AIRPLANE CAN OCCUR. DO NOT BREATHE THE VAPORS OR LET THE SOLVENTS TOUCH YOUR SKIN OR EYES. USE NEOPRENE GLOVES WITH COTTON LINERS, PROTECTIVE CLOTHING, AND EYE GOGGLES. IF THE CHEMICALS TOUCH YOUR SKIN, WASH WITH CLEAN WATER. IF THE CHEMICALS GET IN YOU EYES, FLUSH WITH A LARGE QUANTITY OF CLEAN WATER AND GET MEDICAL AID. MAKE SURE THAT THERE IS A GOOD FLOW OF CLEAN AIR WHERE YOU DO THE WORK, OR USE RESPIRATORY EQUIPMENT WHEN YOU WORK IN A CONFINED SPACE. IF YOU DO NOT OBEY, INJURY TO PERSONS CAN OCCUR.

CAUTION: REFER TO THE SPECIFIED REPAIR SUBJECT FOR THE APPROVED REPAIRS AND LIMITS OF THE DAMAGED COMPOSITE PART. IF YOU DO NOT OBEY, THE REPAIR WILL NOT BE FAA APPROVED DO NOT USE 350°F (177°C) CURE REPAIR MATERIALS ON 250°F (121°C) CURED PARTS. IF YOU DO NOT OBEY, THE REPAIR WILL BE UNSATISFACTORY.

A. This subject contains repair data for components made from epoxy resin reinforced with layers of carbon or glass fiber. The procedures for repairs to the components made with glass or carbon fibers are the same. The cure cycle and the materials used for the repair can be different.

B. Repair General gives the common repair data for the components made from resin reinforced with layers of carbon or glass fiber.

2. **General**

A. Refer to Table 201/REPAIR GENERAL for an index of the different numbered repairs found in this subject.

B. Refer to Typical Fairing Panel Parts, Figure 201/REPAIR GENERAL for a description of fairing panel parts and Sanding and Overlap Instructions, Figure 202/REPAIR GENERAL and Typical Sanding Instructions, Figure 203/REPAIR GENERAL for the typical sanding and overlap instructions.

C. Refer to 51-70-08 for the general resin sweep-fair procedures.

D. Refer to 51-00-07 for the definitions of the terms used in the Structural Repair Manual (SRM).

E. The specified repair subject (Example: 55-20-01, Repair 1, for elevator skins) will tell you the type of repair you are permitted to use. Table 202/REPAIR GENERAL and Table 203/REPAIR GENERAL give a list of materials that are used for each type of repair. Refer to 51-70-03 for a list of material alternatives.

Table 201:

REPAIR INDEX	
REPAIR NUMBER	**TITLE**
1	Repair of Damage to One Skin of a Honeycomb Panel
2	Repair of Damage That is More Than 0.50 Inch (12.70mm) in Diameter to One Skin and Honeycomb Core
3	Repair of Damage to the Bagside and the Honeycomb Core

REPAIR INDEX	
REPAIR NUMBER	TITLE
4	Repair of Damage to the Two Skins and the Honeycomb Core
5	Repair of Damage to the Two Skins and the Honeycomb Core With Access Limited to One Side
6	Repair of Damage to the Edgeband of a Honeycomb Panel
7	Repair of Damage to the Edgeband and the Honeycomb Core
8	Repair of Damage to a Fastener Hole With Prepreg Materials
9	Repair of Damage That is 0.50 Inch (12.70mm) or Less to Solid Laminates or a Fastener Hole
10	Repair of Damage That is More Than 0.50 Inch (12.70mm) in Diameter to Solid Laminates
11	A Potted Core Repair
12	Repair of a Trailing Edge Panel With Full Depth Honeycomb Core

Table 202:

CARBON FIBER REINFORCED PLASTIC REPAIR MATERIALS			
REPAIR MATERIALS	250°F CURE OF 250°F CURE COMPONENTS	250°F CURE OF 350°F CURE COMPONENTS	350°F CURE OF 350°F CURE COMPONENTS
Potting Compound	BMS 5-28, Type 6 or Type 7	BMS 5-28 Type 6 or Type 7	BMS 5-28, Type 6 or Type 7
Repair Fabric and Tape	BMS 8-168	BMS 8-168	BMS 8-256 or BMS 8-297, Type IV, Class 2, Style 3K-70-PW
Fiberglass Isolation Ply	BMS 8-79	BMS 8-79	BMS 8-139
Foaming Adhesive	BMS 5-90, Type III or IV, Grade 50, Class 250/350	BMS 5-90, Type III or IV, Grade 50, Class 250/350	BMS 5-90, Type III or IV, Grade 50, Class 250/350
Adhesive Film	BMS 5-129, Type II or IV, Grade 05, or BMS 5-101, Type II, Grade 05	BMS 5-129, Type II or IV, Grade 05 or BMS 5-101, Type II, Grade 05	BMS 8-245, Class 1 Type II, Grade 03A
Honeycomb Core	BMS 8-124	BMS 8-124	BMS 8-124

Table 203:

GLASS FIBER REINFORCED PLASTIC REPAIR MATERIALS			
REPAIR MATERIALS	250°F CURE OF 250°F CURE COMPONENTS	250°F CURE OF 350°F CURE COMPONENTS	350°F CURE OF 350°F CURE COMPONENTS
Potting Compound	BMS 5-28, Type 6 or Type 7	BMS 5-28 Type 6 or Type 7	BMS 5-28, Type 6 or Type 7
Repair Fabric	BMS 8-79	BMS 8-79	BMS 8-139
Foaming Adhesive	BMS 5-90, Type III or IV, Grade 50, Class 250/350	BMS 5-90, Type III or IV, Grade 50, Class 250/350	BMS 5-90, Type III or IV, Grade 50, Class 250/350
Adhesive Film	BMS 5-129, Type II or IV, Grade 05, or BMS 5-101, Type II, Grade 05	BMS 5-129, Type II or IV, Grade 05 or BMS 5-101, Type II, Grade 05	BMS 8-245, Grade 05 or BMS 8-145
Honeycomb Core	BMS 8-124	BMS 8-124	BMS 8-124

F. The cure temperature for these repairs is 250°F (121°C) or 350°F (177°C). The usual assembly is a two skin lamination divided by a honeycomb core. A solid laminate is used for some components at the edgeband and mating surface of honeycomb panels, and at fitting locations.

G. When you repair large components, make sure that you use the applicable tool fixtures. This will help to prevent a distortion of the structure.

CAUTION: REFER TO THE APPLICABLE COMPONENT STRUCTURAL REPAIR SUBJECT FOR THE COMPONENT MATERIAL AND REPAIR LIMITS BEFORE YOU DO THESE REPAIR PROCEDURES. REPAIRS THAT USE THE 250°F (121°C) CURE CYCLE DO NOT HAVE THE STRENGTH OR DURABILITY OF COMPONENTS INITIALLY MADE FROM 350°F (177°C) CURE MATERIALS. USE ONLY THE REPAIRS THAT ARE PERMITTED BY THE APPLICABLE STRUCTURAL REPAIR SECTION. IF YOU DO NOT OBEY, THE REPAIR WILL NOT BE FAA APPROVED.

H. Refer to the applicable chapter-section-subject for allowable damage limits, repair limits, and repair data of the specified components.

I. Make sure that you do the repair in a clean area. Do not do these repairs in locations where the air contains oil, mist, exhaust fumes, gasses, soot, rain, dust, or other unwanted materials. You can use a tent to isolate the repair location from contamination.

J. Prevent contamination of the repair surface. Do not touch the cleaned parts or the adhesives with your bare hands. Wear clean lint-free gloves when you work with these parts.

K. Keep the adhesive films and preimpregnated materials below 0°F (-18°C). Keep all the materials sealed in moisture-proof bags. Keep a record of the time when the materials are removed from cold storage. Let the materials get to room temperature before you open the bags. Make sure that you use the material during its handling life.

L. Keep the resin systems, adhesives, and potting compounds between 40°F (4°C) and 80°F (27°C) in sealed containers.

(1) Identify all the material containers with a label that contains the data that follows:

(a) Boeing Material Specification (BMS)

(b) Type

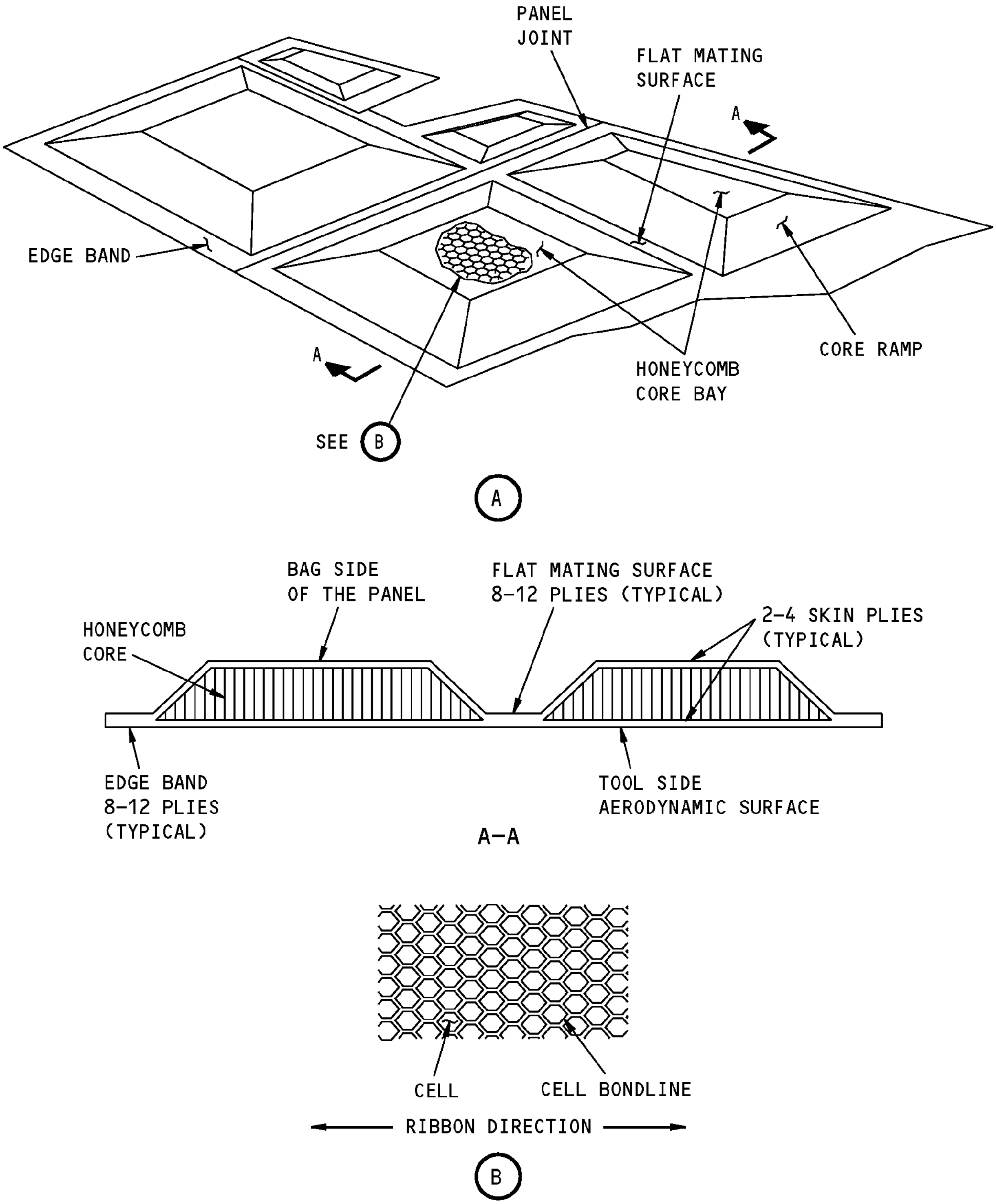
(c) Class

(d) Supplier name

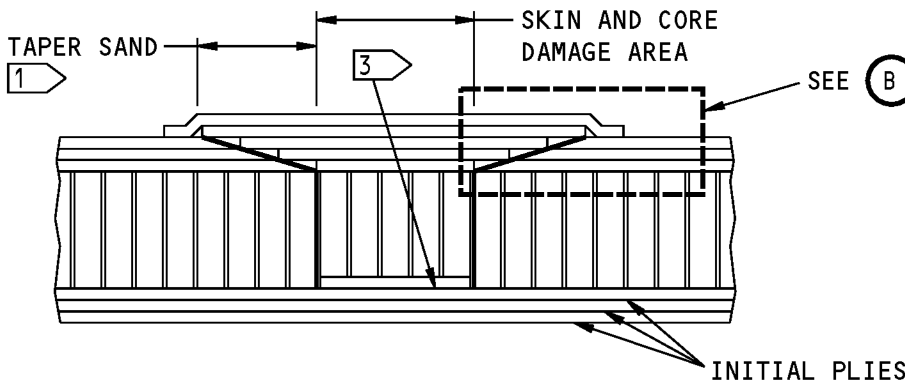
(e) Batch number

(f) Date of preparation

(g) Date of expiration.

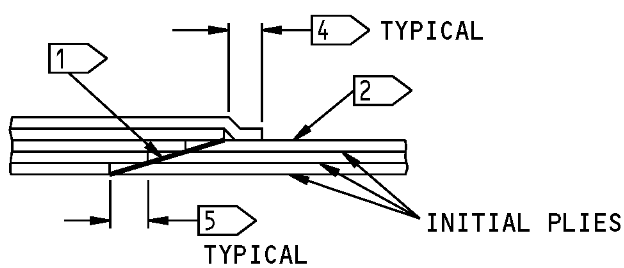


Typical Fairing Panel Parts
Figure 201



SECTION THROUGH TYPICAL REPAIR

A



TAPER SANDED SKIN

B

NOTES

- FOR SOME REPAIRS DONE WITH ALTERNATIVE REPAIR MATERIALS (AS GIVEN IN SRM 51-70-03), REPAIR PLIES WILL EXTEND INTO THE UNTAPERED AREA. ALTERNATIVE REPAIR MATERIALS CAN HAVE DIFFERENT THICKNESS, NUMBER OF PLIES AND OVERLAP REQUIREMENTS THAN THE INITIAL PLY MATERIAL.

1 TAPER SAND THE INITIAL PLIES AT A RATIO OF 30 TO 1 (50 TO 1, FOR SKINS THAT ARE 5 PLIES OR LESS).

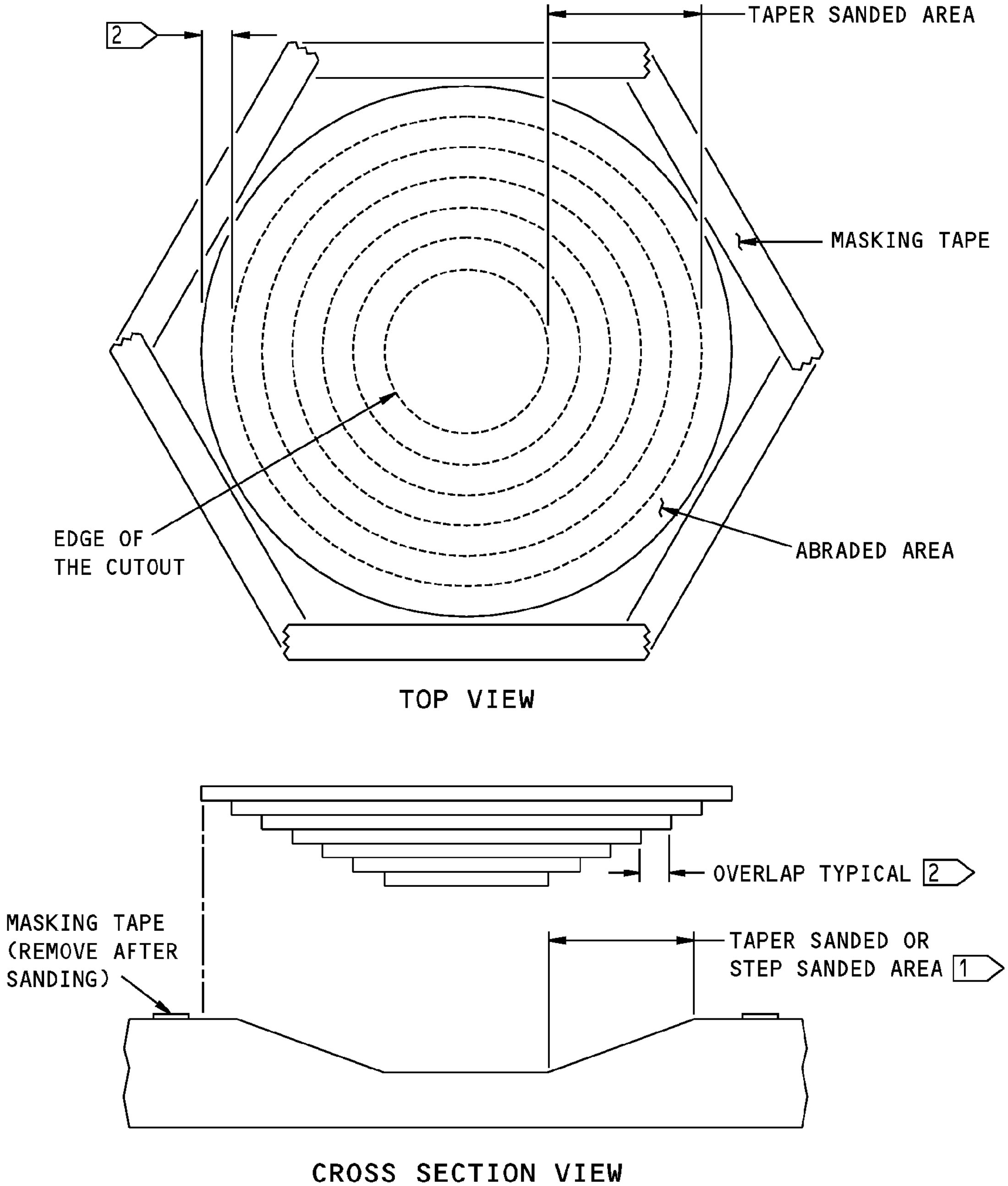
2 DO NOT DAMAGE THE FIBERS IN THE UNTAPERED AREA.

3 DO NOT DAMAGE THE FIBERS IN THE PLY BONDED TO THE INITIAL CORE.

4 THE TOP REPAIR PLY MUST OVERLAP THE REPAIR PLY THAT IS BELOW IT BY 0.5 INCH.

5 REFER TO TABLE 204, 205 AND 206 FOR THE NECESSARY OVERLAP.

Sanding and Overlap Instructions
Figure 202



NOTES

1 TAPER SANDING FOR SOLID LAMINATES IS SHOWN. SANDING FOR HONEYCOMB AREAS IS THE SAME.

2 REFER TO TABLES 204, 205 AND 206 FOR THE NECESSARY OVERLAP.

Typical Sanding Instructions
Figure 203

3. References

Reference	Title
51-00-07	DEFINITIONS OF TERMS
51-10-01, GENERAL	Aerodynamic Smoothness Requirements
51-20-05	REPAIR SEALING
51-20-07	MACHINING AND DRILLING OF COMPOSITE STRUCTURES
51-30-03	NON-METALLIC MATERIALS
51-60-00	CONTROL SURFACE BALANCING
51-70-03	COMPOSITE MATERIALS ALTERNATIVES
51-70-04	REPAIR PROCEDURES FOR WET LAYUP MATERIALS
51-70-04, REPAIR GENERAL	Repair Procedures for Wet Layup Materials
51-70-08	RESIN SWEEP-FAIR PROCEDURES
51-70-14	STRUCTURES WITH ALUMINUM COATINGS AND FOILS
55-20-01	ELEVATOR SKIN
AMM 51-21-99 P/B 701	DECORATIVE EXTERIOR PAINT SYSTEM - CLEANING/PAINTING
AMM 51-21-71/701	Conductive Coating For External Surfaces - Cleaning/Painting
AMM 51-21-81/701	Abrasion-resistant Teflon Finish - Cleaning/Painting
SOPM 20-30-03	Standard Overhaul Practices Manual
737 NDT Part 1, 51-01-01	Inspection of Repairs to Composite Structure
737 NDT Part 1, 51-05-01	Tap Test Inspection of Honeycomb Sandwich Structure
737 NDT Part 2, 51-00-01	Water Detection in Honeycomb Structure
737 NDT Part 9, 51-00-01	Non-Destructive Testing
737 NDT Part 9, 51-00-02	Inspection for Water in Honeycomb with Liquid Crystal Sheets

4. Repair Procedures That Are Common to the Different Repairs

CAUTION: DO NOT USE CHEMICAL PAINT STRIPPERS TO REMOVE THE PAINT. CHEMICAL PAINT STRIPPERS WILL CAUSE DAMAGE TO THE RESIN SYSTEMS.

A. Find the limits of the damage.

(1) Do a visual inspection to find the limits of the damage.

(2) Examine the part for the entry of water, oil, fuel, or other unwanted material. You can find water with X-Ray and thermographic inspection procedures. Refer to 737 NDT Part 2, 51-00-01, 737 NDT Part 9, 51-00-01, and 737 NDT Part 9, 51-00-02.

(3) Examine the part for delaminations around the damage.

NOTE: Delamination can be found by instrumented NDT procedures or with the tap test procedure.

CAUTION: REMOVE (FOR ALL THE TYPES OF CURE) OR ISOLATE (FOR THE HEAT BLANKET CURE) THE ALUMINUM STRUCTURE FOR THE CURE CYCLE. IF YOU DO NOT OBEY, THE RESULT CAN BE A LOSS OF STRENGTH IN THE ALUMINUM PARTS. KEEP ALL ALUMINUM ALLOYS (2219 IS NOT INCLUDED) BELOW 200°F (93°C). FOR ALUMINUM 2219, YOU CAN PERMIT UP TO 400°F (204°C). REMOVE THE SEALANT, PAINT, AND PRIMER FROM AREAS WHERE THE TEMPERATURE MAY GO HIGHER THAN THE MAXIMUM PERMITTED. REFER TO SRM 51-20-01 TO FIND THE MAXIMUM PERMITTED TEMPERATURES. IF YOU DO NOT OBEY, THE RESULT CAN BE AN UNSATISFACTORY REPAIR.

B. Remove the damaged plies and the damaged core.

WARNING: USE A VACUUM TABLE OR A PORTABLE VACUUM WHEN YOU REMOVE THE DAMAGE. DO NOT BREATHE THE DUST. WHEN YOU SAND THE PLY LAYERS, A FINE DUST IS MADE THAT CAN CAUSE SKIN AND EYE IRRITATION AND RESPIRATORY PROBLEMS.

(1) Remove the damaged plies.

(a) Make a list of the plies that you remove.

1) Make a smooth circular or oval shape.

2) Make sure that you do not cause damage to the plies, the core, or the adjacent structure which is not damaged.

3) Remove only the damaged plies, damaged doublers, and damaged fillers.

NOTE: Refer to Paragraph 4.E./REPAIR GENERAL to find the other procedures necessary to prepare for the repair.

(2) Carefully remove the core if it is also damaged.

(a) Remove the core to the same shape and size as the cutout in the skin.

(b) Do not cause damage to the opposite skin.

(c) Make sure that all of the damage is removed.

(d) Remove all of the core that has corrosion.

(e) For cores more than 1.0 inch thick, you can make a partial depth core repair. Remove a minimum of 0.5 inch in depth from the core.

NOTE: When you use a potted core repair, it is not necessary to remove the damaged core. You must fill the core cells fully with potting compound.

(3) In locations where the contamination cannot be cleaned as given in Paragraph 4.E.(3)/REPAIR GENERALP , or dried as specified in Paragraph 4.C./REPAIR GENERAL or Paragraph 4.D./REPAIR GENERAL, remove the structure that has contamination.

(4) Remove all of the sealant from the area where heat will be used.

(5) If the inner surface of the opposite skin is also damaged, cut out the damage to a smooth shape as specified in Paragraph 4.B.(1)/REPAIR GENERAL

(6) When you remove the core from the inner surface of the opposite skin, carefully remove the core down to the adhesive layer or to the first skin ply for parts without adhesive.

(7) Examine the cutout location to make sure that all of the damage is removed. Use Non-Destructive Test (NDT) procedures.

CAUTION: YOU MUST REMOVE THE WATER THAT WAS ABSORBED BY THE PART BEFORE A HOT BONDED REPAIR IS MADE. IF YOU DO NOT OBEY, AN UNSATISFACTORY REPAIR WILL BE THE RESULT.

C. Remove the water from the honeycomb sandwich structure. Refer to Water Removal From The Honeycomb Sandwich, Figure 204/REPAIR GENERAL.

NOTE: The dried area must be a minimum of 4 inches larger all around than the damage you removed.

(1) Remove the skin plies to get access to the honeycomb core. Refer to Paragraph 4.B./REPAIR GENERAL

(2) Sand the adhesive to open the core cells. It is not necessary to remove the adhesive fillets from the core.

(3) Remove all of the water with a vacuum or with compressed air that does not have oil.

(4) Apply a layer of fiberglass cloth or a metal mesh screen above the core.

(5) Put a thermocouple above the center of the core.

(6) Put one ply of fiberglass breather cloth above the screen and thermocouple.

(7) Hold the cloth in position with masking tape.

(8) If you can get access to the side of the honeycomb panel opposite the damage, install thermocouples and a heat blanket on that side.

(9) If you cannot get access to the opposite side of the honeycomb panel or if you use one heat blanket, put the heat blanket above the breather cloth and the thermocouple on the damaged side.

(10) Apply the vacuum sealing compound around the damage location. Seal the location with vacuum bag material. Install the vacuum gage and the vacuum probe. Make sure the vacuum probe touches the breather cloth.

(11) Apply a minimum vacuum of 22 inches of mercury to the repair location.

(12) Increase the temperature at a rate between 1°F and 5°F (1°C and 3°C) for each minute until the temperature is between 160°F (71°C) and 180°F (82°C).

(13) Keep the temperature between 160°F (71°C) and 180°F (82°C) for a minimum of 8 hours.

(14) Decrease the temperature at a maximum rate of 5°F (3°C) for each minute.

(15) Do steps (11) through (14) again if there is still water in the damage area.

NOTE: If the water cannot be removed, the material that has the contamination must be removed.

(16) Remove the vacuum bag, heat blanket, thermocouple, breather cloth, and screen from the repair location.

CAUTION: MAKE SURE THAT YOU REMOVE THE WATER THAT WAS ABSORBED BY THE PART BEFORE A HOT BONDED REPAIR IS MADE. IF YOU DO NOT OBEY, AN UNSATISFACTORY REPAIR WILL BE THE RESULT.

D. Remove the water from the solid laminate structure.

NOTE: The area to be dried must be a minimum of 4 inches larger all around than the damage you removed.

(1) Remove the damage as shown in Paragraph 4.B./REPAIR GENERAL. Remove the water with a vacuum or compressed air that does not have oil.

(2) Put a thermocouple above the center of the repair.

(3) Put one ply of fiberglass breather cloth above the area to be dried. Hold it in position with masking tape.

(4) Apply the vacuum sealing compound around the damage location.

(5) Seal the location with vacuum bag material.

(6) Install the vacuum gage and the vacuum probe above the breather cloth. Make sure the vacuum probe touches the breather cloth.

(7) Apply a minimum vacuum of 22 inches of mercury to the repair location.

(8) For the 250°F (121°C) cure parts:

(a) Increase the temperature at a rate between 1°F and 5°F (1°C and 3°C) for each minute until the temperature is between 180°F (82°C) and 200°F (93°C). Keep the part at this temperature for a minimum of 24 hours.

(9) For the 350°F (177°C) cure parts:

(a) Increase the temperature at a rate between 1°F and 5°F (1°C and 3°C) for each minute until the temperature is between 240°F (115°C) and 260°F (127°C). Keep the part at this temperature for 24 hours.

(10) Decrease the temperature at a rate of 5°F (3°C) maximum for each minute.

(11) Do steps (11) through (14) again if there is still water in the damage area.

NOTE: If the water cannot be removed, the material that has the contamination must be removed.

(12) Remove the vacuum bag, heat blanket, thermocouple, breather cloth, and screen from the repair location.

E. Prepare the damage location for the repair.

WARNING: USE A VACUUM TABLE OR A PORTABLE VACUUM WHEN YOU REMOVE THE DAMAGE. DO NOT BREATHE THE DUST. WHEN YOU SAND THE PLY LAYERS, DUST IS MADE THAT CAN CAUSE SKIN AND EYE IRRITATION AND RESPIRATORY PROBLEMS. USE AIR-POWERED EQUIPMENT WHERE THERE IS THE POSSIBILITY OF VAPOR IGNITION.

(1) Prepare the inner surfaces (bagside) and non-critical aerodynamic surfaces.

(a) Use No. 240-grit or smaller Scotch-Brite abrasive (recommended) or No. 180-grit or smaller abrasive paper to remove the finish or the Tedlar film.

(b) Taper sand the repair at a 30 to 1 ratio. Refer to Table 204/REPAIR GENERAL through Table 206/REPAIR GENERAL. Use No. 240-grit or smaller abrasive paper.

NOTE: If you use an alternative material, make sure that the taper aligns with the necessary overlap for the alternative material. Use a flexible disk sander, belt sander, pad sander, or equivalent milling equipment. For solid laminates or honeycomb with 6 or more plies, use a 30 to 1 taper sand ratio. For all others, use a 50 to 1 taper sand ratio.

(c) Lightly make the surfaces rough around the repair area with No. 180-grit abrasive paper. Do not sand into the fibers.

(2) Prepare the aerodynamic surfaces (toolside).

(a) Sand the damage area to a constant straight taper with No. 240-grit or smaller abrasive paper. Use a taper ratio of 30 to 1.

NOTE: If you use an alternative material, make sure that the taper aligns with the necessary overlap for the alternative material. Use a flexible disk sander, belt sander, pad sander, or equivalent milling equipment.

(b) Remove the outer finishes and conductive coatings from the surfaces around the repair with No. 240-grit or smaller Scotch-Brite (recommended) or abrasive paper. Do not sand into the fabric fibers.

Table 204:

NECESSARY OVERLAP FOR A 30 TO 1 TAPER RATIO		
MATERIAL	**STYLE OF THE REPAIR PLY**	**TAPER DIMENSION "X" INCHES (MILLIMETERS)**
Tape	Grade 95	0.125 inch (3.2 mm)
Tape	Grade 145	0.187 inch (4.7 mm)
Tape	Grade 190	0.240 inch (6.1 mm)
Fabric	3K-70-PW	0.260 inch (6.6 mm)
Fabric	3K-135-8H	0.500 inch (12.7 mm)
Fabric	Style 120	0.125 inch (3.2 mm)
Fabric	Style 1581 or 7781	0.300 inch (7.6 mm)

Table 205:

NECESSARY OVERLAP FOR THE REPAIR PLIES FOR A 30 TO 1 TAPER RATIO		
MATERIAL	**STYLE OF THE REPAIR PLY**	**TAPER DIMENSION "X" INCHES (MILLIMETERS)**
Fabric	3K-70-PW	0.250 inch (6.4 mm)
Fabric	3K-135-8H	0.500 inch (12.7 mm)

Table 206:

NECESSARY OVERLAP FOR THE REPAIR PLIES FOR A 50 TO 1 TAPER RATIO		
MATERIAL	**STYLE OF THE REPAIR PLY**	**TAPER DIMENSION "X" INCHES (MILLIMETERS)**
Fabric	3K-70-PW	0.450 inch (11.4 mm)
Fabric	3K-135-8H	0.750 inch (19.1 mm)

WARNING: KEEP THE SOLVENTS AWAY FROM SOURCES OF HEAT, FIRE, OR SPARKS. HEAT, FIRE, OR SPARKS CAN CAUSE AN EXPLOSION. DO NOT LET THE SOLVENTS GET IN YOUR EYES, ON YOUR SKIN, OR ON YOUR CLOTHING. USE EYE PROTECTION AND MECHANICAL AIR OR RESPIRATORY EQUIPMENT WHEN YOU DO WORK IN A CLOSED LOCATION. IF YOU DO NOT OBEY, INJURY TO PERSONS CAN OCCUR.

(WARNING PRECEDES)

CAUTION: DO NOT SOAK THE PARTS IN TRICHLOROETHANE SOLVENT OR LET THE SOLVENT STAY ON THE PARTS FOR MORE THAN 60 SECONDS. IF YOU DO NOT OBEY, DAMAGE TO THE PART CAN OCCUR.

(3) Clean the repair area.

(a) Remove all dust from the component with a vacuum cleaner.

(b) Clean the surfaces of the repair area with a cloth made moist with methyl isobutyl ketone (MIBK) or acetone. Refer to SOPM 20-30-03 for the general cleaning procedures. Clean the surface again until a new moist cloth is clean after it is used. Remove the solvent before it can dry and remove the remaining film before you continue with the repair.

F. Cut out a core repair plug from honeycomb core material that can be used with the initial honeycomb core. Refer to Table 202/REPAIR GENERAL and Table 203/REPAIR GENERAL.

NOTE: For the potted core repair, refer to Repair 11.

(1) Refer to the component structure identification section or the engineering drawing to find the type of honeycomb core used in the part.

(2) For fiberglass and aramid core, do the steps that follow:

(a) Cut the core repair plug to the depth necessary to be smooth with the initial core that was removed. Refer to Paragraph 4.B./REPAIR GENERAL.

NOTE: Add a sanding allowance to the core height for a two-stage repair. A two-stage repair is one in which the repair plies and the core are cured separately. The two-stage repair is the recommended procedure.

(b) Cut the core repair plug so that is has the same shape and size as the core you removed.

(c) A maximum clearance of 0.025 inch is permitted between the repair plug and the core cutout before it is wound with the foaming adhesive.

(d) The core repair plug must have a tight interference fit after it is wound with the foaming adhesive.

(3) For an aluminum core, do the steps that follow:

(a) Cut the core repair plug to the depth necessary to be smooth with the initial core that was removed. Refer to Paragraph 4.B./REPAIR GENERAL. Make sure that the core repair plug has the same shape and size as the core that was removed.

NOTE: Add a sanding allowance to the core height for a two-stage repair. A two-stage repair is one in which the repair plies and the core are cured separately. The two-stage repair is the recommended procedure.

(b) A maximum clearance of 0.025 inch is permitted between the repair plug and the core cutout before it is wound with the foaming adhesive.

(c) The core repair plug must have a tight interference fit after it is wound with the foaming adhesive.

(d) Remove all burrs from the edges of the aluminum core.

G. Clean the honeycomb core repair plug.

(1) For fiberglass and aramid core:

(a) Put the core repair plug into an alcohol, MIBK, or acetone bath until it is clean.

(b) Remove the solvent and dry the core repair plug. Use compressed air or drain the core on a cloth. Remove all remaining film from all sides of the core.

(2) For aluminum core, vapor degrease the core repair plug as given in SOPM 20-30-03.

H. Install the core repair plug.

(1) Before you open the adhesive film, foaming adhesive, or preimpregnated material containers, do the steps that follow:

(a) Let the materials stay at a temperature (60°F to 75°F (16°C to 24°C)) until no more condensation occurs on the container after you dry it with a clean cloth.

(b) When you use the adhesive or preimpregnated material rolls, make sure that they do not touch other objects.

(c) As an alternative, the core repair plug and the repair plies can be cured at the same time. You must monitor the temperature carefully with thermocouples installed on the outer surfaces (the two sides) of the panel.

CAUTION: DO NOT TOUCH THE ADHESIVE FILM, FOAMING ADHESIVE, OR PREIMPREGNATED MATERIALS WITH YOUR BARE HANDS OR OTHER PARTS OF YOUR BODY. USE CLEAN LINT-FREE GLOVES WHEN YOU TOUCH THESE MATERIALS. THESE MATERIALS MUST HAVE NO CONTAMINATION. DO NOT FOLD, PULL, OR MAKE THE ADHESIVE FILM THIN. MAKE SURE THAT YOU REMOVE THE SEPARATOR SHEET FROM THE ADHESIVES AND PREIMPREGNATED MATERIALS BEFORE INSTALLATION. KEEP ALL THE SEPARATOR SHEETS UNTIL THE LAYUP IS COMPLETE. COUNT THE SHEETS TO MAKE SURE THAT ONE WAS NOT INCLUDED IN THE LAYUP. IF YOU DO NOT OBEY, THE REPAIR WILL BE UNSATISFACTORY.

(2) To install a core repair plug which is less than the full thickness of the initial honeycomb core, do the steps that follow:

(a) Cut two plies of adhesive film to the same shape and size as the hole in the core. Refer to Table 202/REPAIR GENERAL and Table 203/REPAIR GENERAL for the BMS type and class.

(b) Cut one ply of Style 120 glass fabric to the same shape and size as the hole in the initial core. Refer to Table 202/REPAIR GENERAL and Table 203/REPAIR GENERAL for the BMS type and class.

(c) Put the first ply of adhesive film into the hole in the core. Remove the separator sheet from the ply of the adhesive film.

(d) Put the glass fabric into the hole in the core. Remove the separator sheet from the glass fabric.

(e) Put the second ply of adhesive film into the hole in the core. Remove the separator sheet from the second ply of adhesive film.

(3) To install a core repair plug which is equal to the full thickness of the initial core, do the steps that follow:

(a) Cut one ply of adhesive film to the same shape and size as the hole in the initial core. Refer to Table 202/REPAIR GENERAL and Table 203/REPAIR GENERAL for the BMS type and class.

(b) Put the adhesive film into the hole in the core. Remove the separator sheet from the adhesive film.

(4) If you cure the core repair plug without the repair ply layup, put the thermocouples at the adhesive bond lines.

(5) Cut a piece of BMS 5-90, Type III or IV, Class 250/350, Grade 50 or Grade 100 foaming adhesive to make one layer around the core repair plug.

(6) Remove the separator sheet. Wind the foaming adhesive around the core repair plug.

(7) Wind a non-stick flexible strip around the core repair plug and adhesive. Refer to 51-30-03 for suppliers of non-stick flexible strips.

(8) Align the ribbon direction of the core repair plug with that of the initial core. Carefully compress the core repair plug and put it into the core hole.

NOTE: The core repair plug must have a tight interference fit in the hole of the core after it is wound with the foaming adhesive.

(9) Remove the non-stick flexible strip.

NOTE: Make sure that you have removed the separator sheets from all of the adhesives.

(10) Install the vacuum bag system and equipment. Refer to Vacuum Bag Instructions for the Cure of the Repair Core, Figure 205/REPAIR GENERAL and Vacuum Bag Limits, Figure 206/REPAIR GENERAL.

(a) If the damage goes through two sides of the part, put a vacuum bag on the two sides of the part or put all of the part in a vacuum bag. Refer to Vacuum Bag Limits, Figure 206/REPAIR GENERAL.

(b) If the core repair plug is less than or equal to 0.50 inch thick do the steps that follow:

1) Put the heat blanket above the initial core on the open side.

2) Put a minimum of three thermocouples on the opposite surface at the core-to-core bondline.

3) If the core repair plug is more than 0.50 inch thick, and you can get access to both sides of the panel, put a heat blanket on each side. Put a minimum of four thermocouples on the near side at the bondline. Put four thermocouples on the opposite side at the bondline of the repair.

4) You can use one heat blanket. Put insulation on the opposite side of the panel. Put the thermocouples below the insulation. Put the control thermocouple above the heat blanket.

5) Put a layer of perforated parting film above the repair.

6) Put a layer of dry peel ply or Style 120 glass fabric cloth above the perforated parting film. This ply is the surface bleeder cloth.

NOTE: Cut the bleeder cloth sufficiently large to touch the breather cloth which will be applied later. Refer to Vacuum Bag Limits, Figure 206/REPAIR GENERAL.

7) Put a layer of solid parting film above the surface bleeder. Cut the solid parting film to the same shape and size as the perforated parting film.

8) Put one ply of breather cloth above the repair area.

9) Apply the vacuum sealing compound around the damage location. Seal the location with vacuum bag material. Install the vacuum gage and the vacuum probe above the breather cloth. Make sure the vacuum probe touches the breather cloth.

10) Apply a minimum vacuum of 22 inches of mercury to the repair. Do a check of the vacuum bag system for leaks. Refer to Paragraph 4.L./REPAIR GENERAL. Keep a minimum vacuum of 22 inches of mercury until the repair is cured.

I. Cure the core repair plug installation.

(1) Increase the temperature of the heat blanket at a rate between 1°F and 5°F (1°C and 3°C) for each minute until you get to the cure temperature. Refer to Vacuum Bag Cure Cycles, Figure 207/REPAIR GENERAL for the necessary cure temperature and time.

NOTE: The cure time does not include the time that is necessary to get the layup and the part in the cure temperature range. The cure time is the length of time that the layup and the part must stay at the cure temperature. All of the thermocouples must be in the cure temperature range before the cure time starts. If a thermocouple shows a decrease in the temperature below the cure temperature range during the cure cycle, extend the cure cycle time by the time necessary to get the thermocouple in the cure temperature range again.

(2) After the cure is completed, decrease the temperature at a rate of 5°F (3°C) maximum for each minute.

(3) When the temperature is less than 125°F (52°C), release the vacuum pressure. Remove the layup and vacuum bag equipment.

(4) For the two-stage repair, sand the core repair plug level with the initial honeycomb core or the surface of the skin.

(5) Remove all of the dust with a vacuum cleaner.

J. Cut out the repair plies.

(1) Find the number of plies that have been cut or sanded.

(2) Use one repair ply of fabric (or tape) for each damaged ply of the panel plus one more structural ply, which will be the largest and outer ply. Other structural plies can be necessary. Refer to the applicable component repair subjects.

(a) Refer to the structure identification section or the engineering drawing to find the material, the zero degree ply direction, and the number of plies in the initial panel.

(b) Refer to Table 202/REPAIR GENERAL and Table 203/REPAIR GENERAL for the repair ply materials and 51-70-03 for the alternative repair ply materials.

(c) Refer to the structure repair section for the component to find if more than one added structural repair ply is necessary.

1) Make each repair ply the same shape as the ply it replaces.

2) Make each repair ply larger than the ply it replaces to permit the necessary overlap.

(3) Refer to Table 204/REPAIR GENERAL through Table 206/REPAIR GENERAL for the necessary overlap.

(4) Find the correct ply warp direction.

NOTE: You can make a template to make sure that the repair plies have the correct warp direction. You can use vacuum bag material to make the template.

(a) Make sure each repair ply has the same warp direction as the ply it replaces.

(b) Make sure the warp direction of the outer repair ply is the same as the surface ply immediately below it.

(c) If you use a filler ply, make the warp direction +45 degrees or -45 degrees.

NOTE: Filler plies are plies that are used to fill a recess in the repair area. The filler ply can be on a small or a large part of a repair ply to make the repair smooth.

CAUTION: DO NOT TOUCH THE MATERIALS WITH YOUR BARE HANDS. REMOVE THE SEPARATOR SHEET FROM THE ADHESIVE FILM AND THE PREIMPREGNATED MATERIALS BEFORE YOU CURE THE REPAIR. IF YOU DO NOT OBEY, THE REPAIR WILL BE UNSATISFACTORY. FOR HEAT BLANKET AND OVEN CURES, DO NOT CURE MORE THAN TEN (10) PLIES DURING A SINGLE CURE CYCLE. FOR PARTS WITH MORE THAN TEN PLIES, TWO OR MORE CURE CYCLES WILL BE NECESSARY. IF YOU DO NOT OBEY, THE RESULT CAN BE BULGES AND POROSITY, WHICH WILL MAKE THE REPAIR UNSATISFACTORY.

K. Install the repair plies.

NOTE: If the damage is in a lap splice in the initial structure, it is not necessary to make an equivalent lap splice in the repair plies. If the initial core is not damaged and there is a recess, fill the recess with filler plies before you layup the repair plies.

(1) Make a temporary vacuum bag system. Refer to Ply Compaction Vacuum Bag System, Figure 208/REPAIR GENERAL.

NOTE: This vacuum bag is used to compress the repair plies and prevent contamination of the repair. Do not use this vacuum bag system for the repair cure.

(a) Put one layer of perforated parting film above the repair.

(b) Put one layer of glass fabric cloth as a surface breather above the repair.

(c) Apply the vacuum sealing compound around the repair area.

(d) Put the vacuum bag material on the repair area. Seal the edges with the vacuum sealing compound.

(e) Put a vacuum gage and a vacuum probe on the surface breather cloth. Make sure the vacuum probe touches the breather cloth.

(2) Cut one ply of Type 120 fiberglass, 1/8 inch more all around than the outer repair ply. Refer to Table 202/REPAIR GENERAL and Table 203/REPAIR GENERAL for the BMS type and class.

NOTE: This non-structural sanding ply is the outer ply and must cover all of the repair. After the repair is cured, this ply can be sanded to get a smooth surface. Do not sand into the structural repair plies below it.

(3) Fill all fastener holes that will be covered by the repair plies with a mixture of resin and chopped fibers. Refer to Repair 9.

NOTE: Repair all damaged holes as shown in Repair 8 or 9. You can fill the undamaged fastener holes with Teflon plugs. Remove the plugs after the repair plies are cured.

CAUTION: MAKE SURE THAT YOU REMOVED THE SEPARATOR SHEETS FROM ALL OF THE ADHESIVES AND PLIES. IF YOU DO NOT OBEY, THE REPAIR WILL BE UNSATISFACTORY.

(4) Remove the separator sheet from the adhesive film. Put the adhesive film on the repair area.

NOTE: You can make sure that you have removed the separator sheets if you keep them and count them when you install the plies.

(5) Install the repair plies and the sanding ply, if used.

NOTE: Add filler plies as necessary to get a smooth repair. Do not use more than four filler plies on one repair ply.

(a) Install the smallest repair ply first.

(b) Make sure that the warp direction of each repair ply that you put in the repair is correct and that the overlap is correct.

(c) Install the next ply. Make sure that it is smooth with no wrinkles.

(d) Remove the separator sheet.

(e) For the repairs that have one or more Carbon Fiber Reinforced Plastic (CFRP) repair plies, do the steps that follow:

NOTE: Although it is only necessary to compact repairs that contain CFRP repair plies, Boeing recommends that you compact all repairs.

1) Compact each ply, or plies with the temporary vacuum system:
- 1 minute for each ply (one ply at a time), or
- 2 minutes for each 2 plies (2 plies at a time) or
- 6 minutes for each 3 plies (3 plies at a time).

2) Do steps (b) through (e) again for all of the repair plies as necessary to complete the layup.

L. Assemble the vacuum bag system. Refer to Vacuum Bag Instructions for the Cure of the Repair Plies, Figure 209/REPAIR GENERAL.

(1) Put a layer of perforated parting film above the repair. Cut the perforated parting film to make sure the edges are 1 inch larger all around than the edges of the outer ply.

(2) Install the thermocouples. Refer to Typical Locations of Thermocouples for Heat Blanket Cure, Figure 210/REPAIR GENERAL.

(a) If you use an autoclave or an oven, install one or more thermocouples at a location where the temperature will increase the fastest, and one or more thermocouples where the temperature is likely to increase the slowest.

NOTE: Boeing recommends that you put one or more thermocouples at the thick areas of the part and the tool, and the thin areas of the part and the tool. Use more than two thermocouples if the repair covers more than 900 square inches on the panel surface.

(b) If you use a heat blanket, install three thermocouples (evenly spaced around the repair area) to the panel at the edge of the repair.

(c) Connect the thermocouples to the applicable temperature recorder devices.

(3) Put a layer of dry peel ply or BMS 9-3 Type D glass fabric cloth above the perforated parting film. This is the surface bleeder cloth.

NOTE: Cut the bleeder cloth sufficiently large to touch the breather cloth which will be applied later. If you use the BMS 9-3 Type D glass fabric, you can use it for the cure cycle verification after the cure is completed. Refer to 51-70-04, REPAIR GENERAL.

(4) Put a layer of solid parting film on the surface bleeder. Cut the solid parting film to the same shape and size as the perforated parting film.

(5) Put one layer of glass fabric cloth as a surface breather above the repair. Cut the breather cloth larger than the parting film to make sure it touches the bleeder cloth. Also, make sure that the breather cloth is larger than the caul plate if you use one.

NOTE: This layer is applicable for oven and autoclave cures only.

(6) If you use the heat blanket, place it over the repair area.

NOTE: Make sure that the heat blanket goes at least 2 inches past the edge of the repair patch. If the heat blanket is longer than 12 inches on one side of the repair, use an aluminum caul plate (1100-0 aluminum sheet that is 0.040 inch thick). If you use two or more pads, it is necessary that you use a caul plate.

(a) Make the caul plate the same shape and size as the heat blanket.

NOTE: Do not use a caul plate on repairs with a complex contour. Drill small holes in the caul plate, as necessary, to permit the thermocouples to touch the edge of the repair. The caul plate is used to keep the temperature difference to a minimum and to prevent thermocouple wire marks in the repair surface.

(b) If you do not use a caul plate, put thin (0.016 to 0.040 inch thick) aluminum strips, 1.0 inch in width, below the thermocouple wires.

NOTE: If you do not put the aluminum strips below the thermocouple wires they will put marks in the repair surface. Make sure that only the thermocouple junction touches the aluminum strips. Do not let the bare wires touch the strips.

(c) If the area to be repaired is near or attached to an aluminum structure that was not removed in Step 4.B:

1) Isolate the aluminum structures from the areas that will get hot.

2) Add one or more thermocouples to the aluminum structure. Make sure that the temperature does not go higher that 200°F (93°F).

3) You can put insulation around other metals to prevent cold areas in the repair.

(d) Put four to six layers of glass fabric cloth as insulation above the repair. Make sure that the insulation cloth is larger than the heat blanket.

NOTE: This is the breather ply for the heat blanket cure.

(7) Apply the vacuum sealing compound around the repair area.

(8) Put the vacuum bag material above the repair area. Seal the edges with the vacuum sealing compound. Put pads on all sharp objects and corners in the bag.

(9) Attach a vacuum gage and a vacuum probe above the surface breather. Make sure the vacuum probe touches the surface breather cloth. Use more than one vacuum probe for large repairs.

(10) Keep a vacuum of 22 inches of mercury minimum in the vacuum bag during the cure cycle.

(11) Examine the vacuum bag for leaks.

NOTE: A vacuum bag which has a leak can cause porosity in the repair and an unsatisfactory bond.

(a) Apply a minimum vacuum of 22 inches of mercury.

(b) Remove the vacuum source.

(c) Monitor the vacuum gage. After 5 minutes, the total difference in vacuum must be less than 5 inches of mercury.

M. Cure the repair. For the autoclave procedure, do Step 1. For the oven cure procedure, do Step 2. For the heat blanket procedure, do Step 3.

(1) For the autoclave procedure, Refer to Oven and Autoclave Cure Cycles, Figure 211/REPAIR GENERAL, and do the steps that follow:

NOTE: Boeing recommends that you use an autoclave that is certified when you do these procedures. You can use D6-49327 as a guide to certify your autoclave.

(a) For repairs that are to be cured at 250°F (121°C), do the steps that follow (For repairs cured at 350°F (177°C), do Step (b)):

1) Make sure that you use the applicable tool to hold in position, all of the parts to be repaired during the repair procedure. This includes parts that were cured at 250°F (121°C) at the initial manufacture. Further, Boeing recommends the same be applicable for parts cured at 350°F (177°C) at the initial manufacture. The applicable tool for the part must have the same dimensions (or slightly larger) as the part to be cured.

NOTE: In most (but not all) conditions, the tool must be the same contour as the part to be cured. Boeing recommends that the tool have the same thermal expansion properties as the materials found in the part. This will help keep the correct shape and contour during the cure.

2) Pressurize the autoclave to 40 to 50 psig (276 to 345 kPa gauge). Open the vacuum bag to the atmosphere when the autoclave pressure is above 20 psig (138 kPa gauge).

3) Increase the temperature of the autoclave until it gets to 130°F (54°C). When this occurs, increase the temperature at a rate of 2°F to 8°F (1°C to 5°C) for each minute until all the thermocouple indications show that they are in the correct temperature range.

(b) For the repairs to be cured at 350°F (177°C) do the steps that follow:

1) Make sure that you use the applicable tool to hold in position, all the parts to be repaired during the repair procedure. The applicable tool for the part must have the same dimensions (or slightly larger) as the part to be cured.

NOTE: In most (but not all) conditions, the tool must be the same contour as the part to be cured. Boeing recommends that the tool have the same thermal expansion properties as the materials found in the part. This will help keep the correct shape and contour during the cure.

2) Pressurize the autoclave to 40 to 50 psig (276 to 345 kPa gauge). Open the vacuum bag to the atmosphere when the autoclave pressure is above 20 psig (138 kPa gauge).

NOTE: Boeing recommends that you fill and pressurize the autoclave with an inert gas such as CO2 or N2 for cure cycle temperatures higher than 250°F (121°C).

3) Increase the temperature in the autoclave until it gets to 130°F (54°C). When this occurs, increase the temperature at a rate of 1°F to 5°F (0.5°C to 3°C) for each minute until all of the thermocouple indications show that they are in the correct cure temperature range.

NOTE: Boeing recommends that you increase the temperature at a rate of 1°F to 3°F (0.5°C to 1.7°C) when the stack of repair plies is more that 0.25 inch (6 mm) thick.

(c) Do the steps that follow for all autoclave cures:

1) Hold the cure temperature for the specified time as given in Oven and Autoclave Cure Cycles, Figure 211/REPAIR GENERAL.

   NOTE: The cure time does not include the time necessary to get the prepare the layup and get it to the cure temperature. The cure time starts when all of the thermocouple indications are in the cure temperature range. If a thermocouple shows a drop below the cure temperature, increase the cure time by the time necessary to get back to the cure temperature.

2) Keep the vacuum bag connection to the atmosphere open and pressure in the autoclave until the cure fully ends, and the temperature to the part has decreased to 125°F (52°C).
3) Decrease the autoclave temperature at a maximum rate of 5°F (3°C) for each minute.
4) When the autoclave temperature gets to less than 125°F (52°C), remove the pressure from the autoclave.
5) Remove the vacuum bag materials.

WARNING: USE HEAT CURE EQUIPMENT THAT IS APPROVED BY YOUR LOCAL FIRE PROTECTION AUTHORITIES. IF YOU DO NOT OBEY, THE RESULT CAN BE INJURY TO PERSONNEL.

(2) For the oven cure, refer to Oven and Autoclave Cure Cycles, Figure 211/REPAIR GENERAL, and do the steps that follow:

NOTE: Use a circulating oven that has equipment that can supply a vacuum and control the temperature.

(a) For repairs cured at 350°F (177°C) do Step (b). For repairs cured at 250°F (121°C), do the steps that follow:

1) Make sure that you use the applicable tool to hold in position, all of the parts to be repaired during the repair procedure. This includes parts that were cured at 250°F (121°C) at the initial manufacture. Further, Boeing recommends the same be applicable for parts cured at 350°F (177°C) at the initial manufacture. The applicable tool for the part must have the same dimensions (or slightly larger) as the part to be cured.

   NOTE: In most (but not all) conditions, the tool must be the same contour as the part to be cured. Boeing recommends that the tool have the same thermal expansion properties as the materials found in the part. This will help keep the correct shape and contour during the cure.

2) Apply a vacuum to the vacuum bag until you get it to a minimum of 22 inches (0.56M) of Mercury (Hg). Start to increase the temperature. Keep the vacuum at this minimum for all of the cure cycle.
3) Increase the temperature of the oven until it gets to 130°F (54°C). When this occurs, increase the temperature at a rate of 2°F to 8°F (1°C to 5°C) for each minute until all of the thermocouple indications show that they are in the correct temperature range.

(b) For repairs cured at 350°F (177°C) do the steps that follow:

1) Make sure that you use the applicable tool to hold in position, all of the parts to be repaired during the repair procedure. The applicable tool for the part must have the same dimensions (or slightly larger) as the part to be cured.

NOTE: In most (but not all) conditions, the tool must be the same contour as the part to be cured. Boeing recommends that the tool have the same thermal expansion properties as the materials found in the part. This will help keep the correct shape and contour during the cure.

2) Apply a vacuum to the vacuum bag until you get it to a minimum of 22 inches (0.56M) of Mercury (Hg). Start to increase the temperature. Keep the vacuum at this minimum for all of the cure cycle.

3) Increase the temperature of the oven until it gets to 130°F (54°C). When this occurs, increase the temperature at a rate of 1°F to 5°F (0.5°C to 3°C) for each minute until all of the thermocouple indications show that they are in the correct temperature range.

(c) Do the steps that follow for all oven cures:

1) Hold the cure temperature for the specified time as given in Oven and Autoclave Cure Cycles, Figure 211/REPAIR GENERAL.

NOTE: The cure time does not include the time necessary to prepare the layup and get it to the cure temperature. The cure time starts when all of the thermocouple indications are in the cure temperature range. If a thermocouple shows a drop below the cure temperature, increase the cure time by the time necessary to get back to the cure temperature.

2) Decrease the oven temperature at a maximum rate of 5°F (3°C) for each minute.

3) When the temperature gets to less than 125°F (52°C) remove the vacuum pressure.

4) Remove the vacuum bag equipment.

WARNING: USE HEAT CURE EQUIPMENT THAT IS APPROVED BY YOUR LOCAL FIRE PROTECTION AUTHORITIES. IF YOU DO NOT OBEY, THE RESULT CAN BE INJURY TO PERSONNEL.

(3) For the heat blanket cure, refer to Vacuum Bag Cure Cycles, Figure 207/REPAIR GENERAL, and do the steps that follow:

NOTE: Boeing recommends that you use a qualified heat blanket when you do this procedure. You can refer to D6-56273, Qualification of Heat Blankets for Hot Bonding, to certify your heat blanket equipment.

(a) Make sure there is a minimum of three thermocouples for each heat blanket you use. Refer to Paragraph 4.L./REPAIR GENERAL

(b) Apply a vacuum to the vacuum bag until you get it to a minimum of 22 inches (0.56M) of Mercury (Hg). Start to increase the temperature. Keep the vacuum at this minimum for all of the cure cycle.

(c) Increase the temperature of the heat blanket at a rate of 2°F to 8°F (1°C to 5°C) for each minute until all the thermocouple indications show 130°F (54°C). When this occurs, use the temperature increase rates that follow until all the thermocouples indications show that they are in the correct temperature range:

NOTE: Make sure that you obey the manufacturer's operation instructions when you use a hot bond console.

1) For the 250°F (121°C) cure: Use an increase rate of 2°F to 8°F (1°C to 5°C) for each minute
2) For the 350°F (177°C) cure: Use an increase rate of 1°F to 5°F (0.5°C to 3°C) for each minute

(d) If necessary, you can put insulation on the cool areas of the repair areas that are opposite the heat source.

(e) Hold the cure temperature for the specified time as given in Vacuum Bag Cure Cycles, Figure 207/REPAIR GENERAL.

NOTE: The cure time does not include the time necessary to prepare the layup and get it to the cure temperature. The cure time starts when all of the thermocouple indications are in the cure temperature range. If a thermocouple shows a drop below the cure temperature, increase the cure time by the time necessary to get back to the cure temperature.

(f) Decrease the heat blanket temperature at a maximum rate of 5°F (3°C) for each minute.

(g) When the temperature gets to less than 125°F (52°C), remove the vacuum pressure.

(h) Remove the vacuum bag equipment.

N. Do the Post-Repair requirements.

(1) Do an inspection of the repair to make sure that the repair is satisfactory. The inspection must include these areas:

NOTE: Post repair inspection is recommended. Examples of inspection are given in 737 NDT Part 1, 51-01-01.

(a) Examine all of the areas where heat was applied plus a minimum width of 2 inches more all around the heated area.

(b) If the inspection gives an unsatisfactory result, remove and install the repair again.

O. Apply the finish to the repair.

CAUTION: DO NOT SAND INTO THE INITIAL STRUCTURAL FIBERS. IF YOU DO NOT OBEY, A DECREASE IN THE STRENGTH OF THE COMPONENT CAN OCCUR.

(1) Sand the outer ply to make the edges smooth with the initial surface.

NOTE: Do not sand through the non-structural sanding ply and into the repair plies below it. Do not sand into the fibers of the repair ply on the top.

(2) To apply the finish to the repair area use the steps that follow, if applicable:

(a) If clear Tedlar film surfaces have been removed, seal them with Resin System 1 and cure as given in 51-70-04.

(b) If gray or white Tedlar film surfaces have been removed, seal them with Resin System 1 and cure as given in 51-70-04. Apply one layer of BMS 10-11 or BMS 10-103 primer and one layer of BMS 10-60 enamel.

(c) If BMS 10-21 conductive coating was removed, apply it again as given in AMM 51-21-71/701.

(d) If the abrasion resistant Teflon finish was removed from the inner surface of the panel edgeband, apply the Teflon again as given in AMM 51-21-81/701.

(e) If the initial paint was removed from the surface, then apply the paint again as given in AMM PAGEBLOCK 51-21-99/701.

(f) If sealant was removed from around fittings or mating surfaces, apply one of the sealants that follows as given in 51-20-05:

1) BMS 5-95 in locations with temperatures less than or equal to 180°F (82°C)
2) BMS 5-26 in fuel cells and in locations with temperatures less than 200°F (93°C)
3) BMS 5-63 in locations with temperatures higher than 200°F (93°C).

(g) If BMS 8-336 aluminum foil mesh was removed, then repair it as given in 51-70-14.

(h) If BMS 8-278 aluminum coated glass fabric was repaired, apply aluminum flame spray as given in 51-70-14.

CAUTION: MAKE SURE THAT THE REPAIR DOES NOT CAUSE A BLOCKAGE OF THE DRAIN HOLES IN A PANEL. BLOCKED DRAIN HOLES CAN CAUSE WATER TO ENTER AND STAY INSIDE THE STRUCTURE. IF YOU DO NOT OBEY, DAMAGE TO THE STRUCTURE CAN OCCUR.

P. If the repair causes a blockage of a drain hole, drill through the repair at the drain hole position. Use the applicable size drill. Refer to 51-20-07 for the drill procedures.

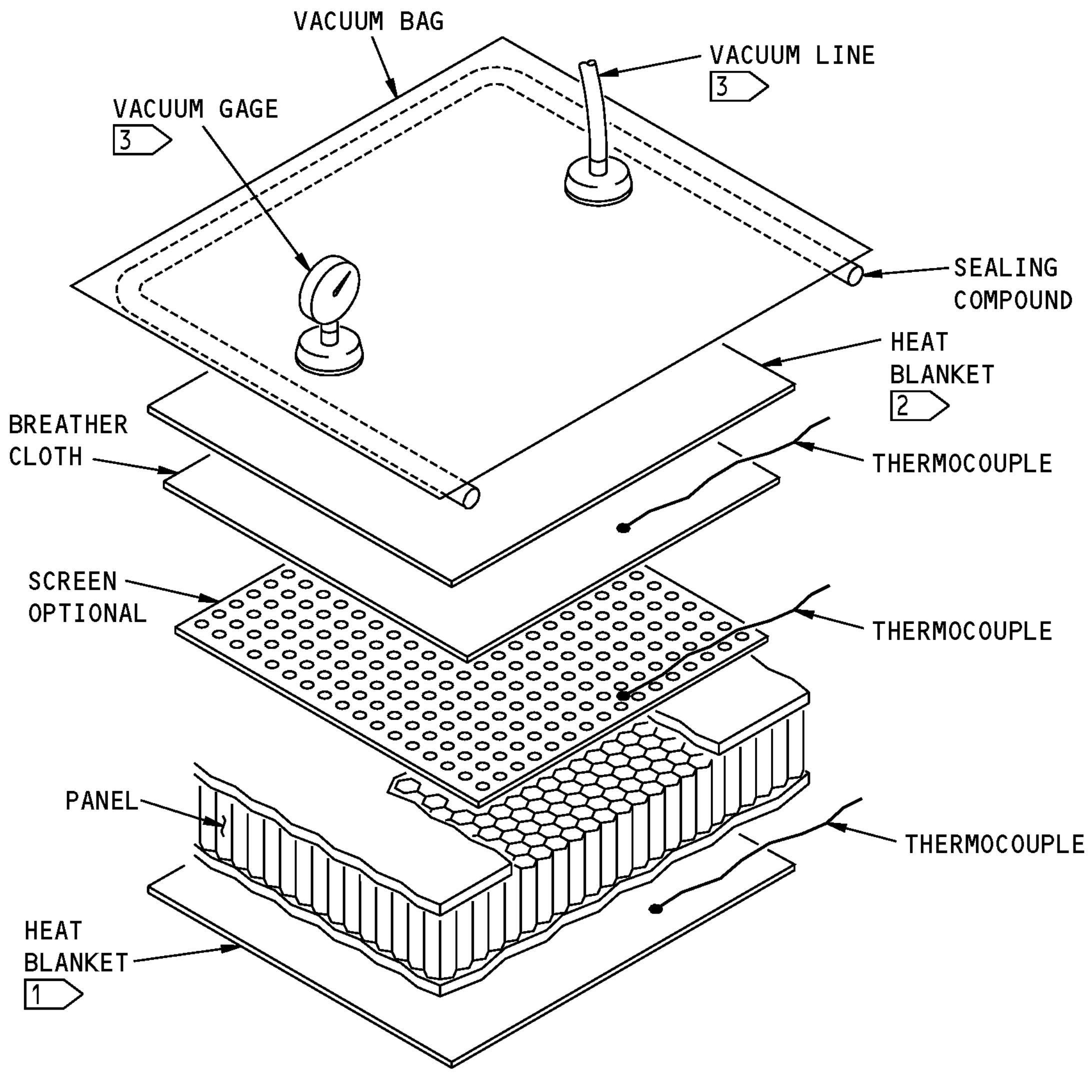
WARNING: FLIGHT CONTROLS MUST BE CORRECTLY BALANCED AFTER YOU REPAIR THEM. FAILURE TO DO SO CAN CAUSE FLUTTER AND DAMAGE TO THE STRUCTURE.

Q. After you repair a flight control surface, do a check to see if it must be balanced. Refer to 51-60-00.

CAUTION: MAKE SURE THAT REPAIRS MADE TO FLIGHT CONTROL SURFACES AND/OR ADJACENT STRUCTURE DO NOT TOUCH EACH OTHER OR STOP THE OPERATION OF THE FLIGHT CONTROL SURFACES. IF YOU DO NOT OBEY, DAMAGE TO THE AIRPLANE STRUCTURE CAN OCCUR.

R. Do a check of the operation of the flight control surfaces. Make sure that the flight control surfaces do not hit the airplane structure and that there is sufficient clearance for the repaired parts.

S. Drill and countersink all fastener holes that were filled.



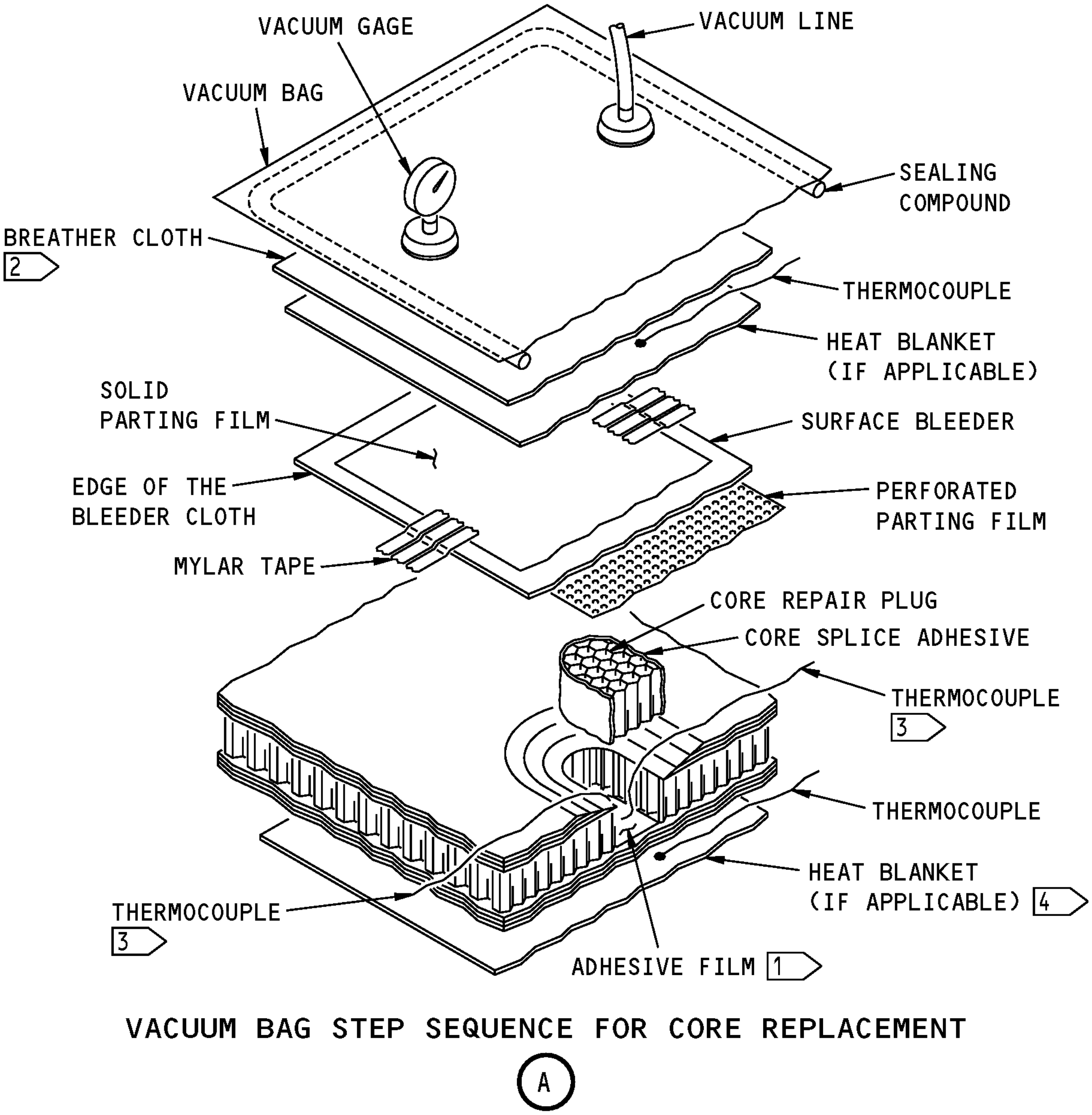
NOTES

1 THE BEST LOCATION OF THE HEAT BLANKET WHEN YOU CAN GET ACCESS TO THE OPPOSITE FACE.

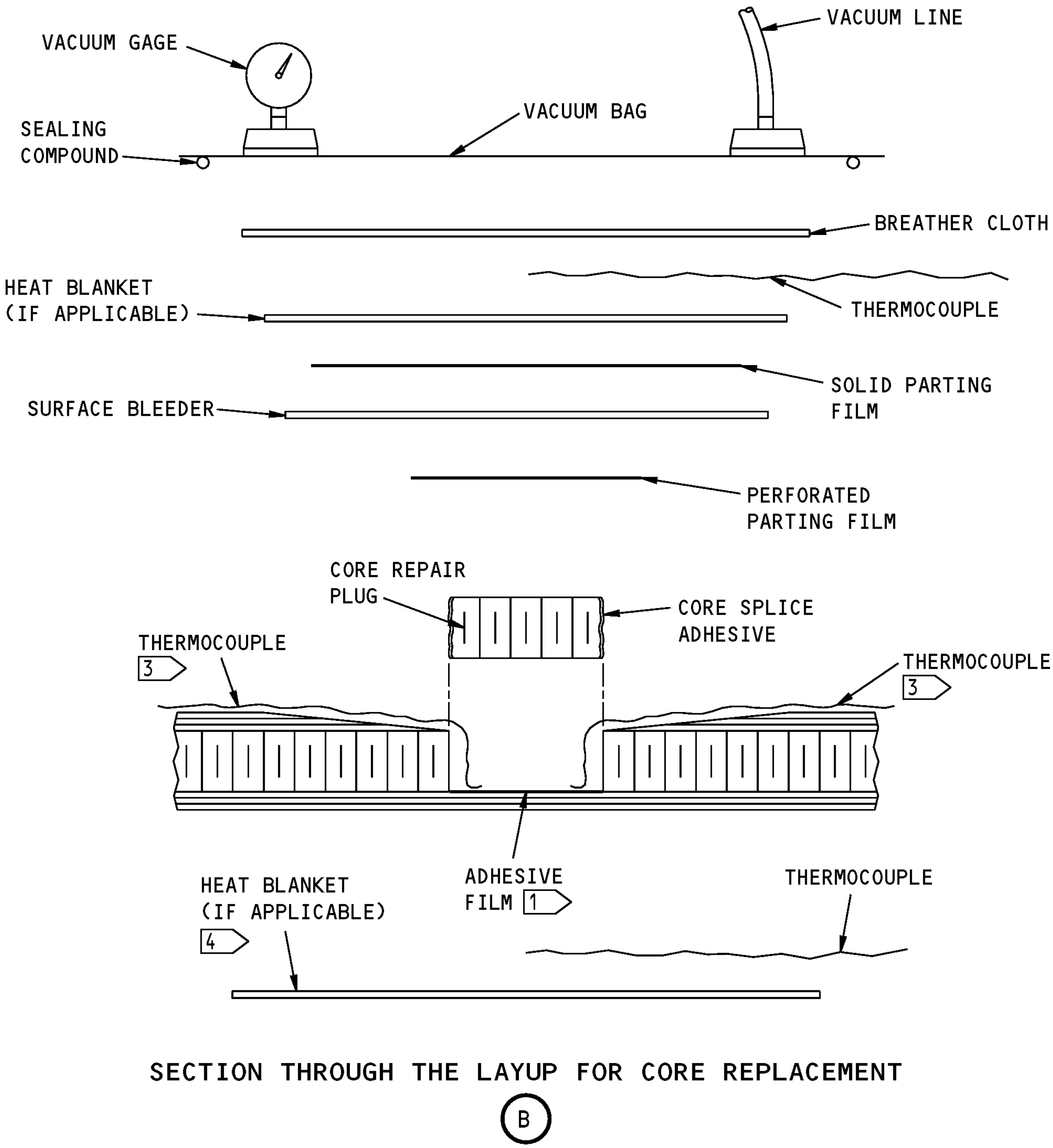
2 THE ALTERNATIVE LOCATION OF THE HEAT BLANKET WHEN YOU CAN NOT GET ACCESS TO THE OPPOSITE SIDE. THIS LOCATION MAY BE USED FOR A SECOND HEAT BLANKET TO INCREASE THE RATE OF WATER REMOVAL.

3 MAKE SURE THAT THE VACUUM PROBE AND GAGE TOUCH THE BREATHER CLOTH.

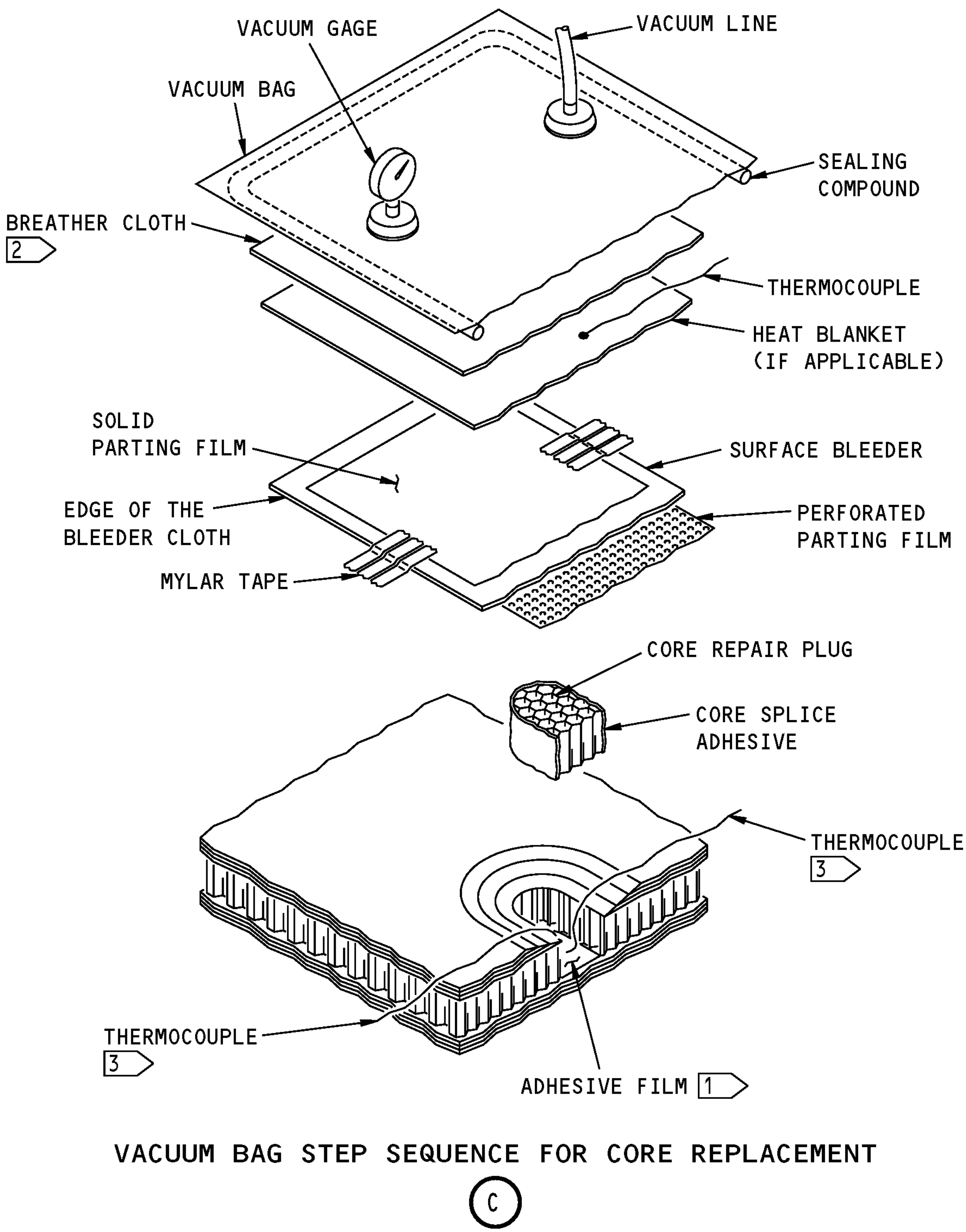
Water Removal From The Honeycomb Sandwich
Figure 204



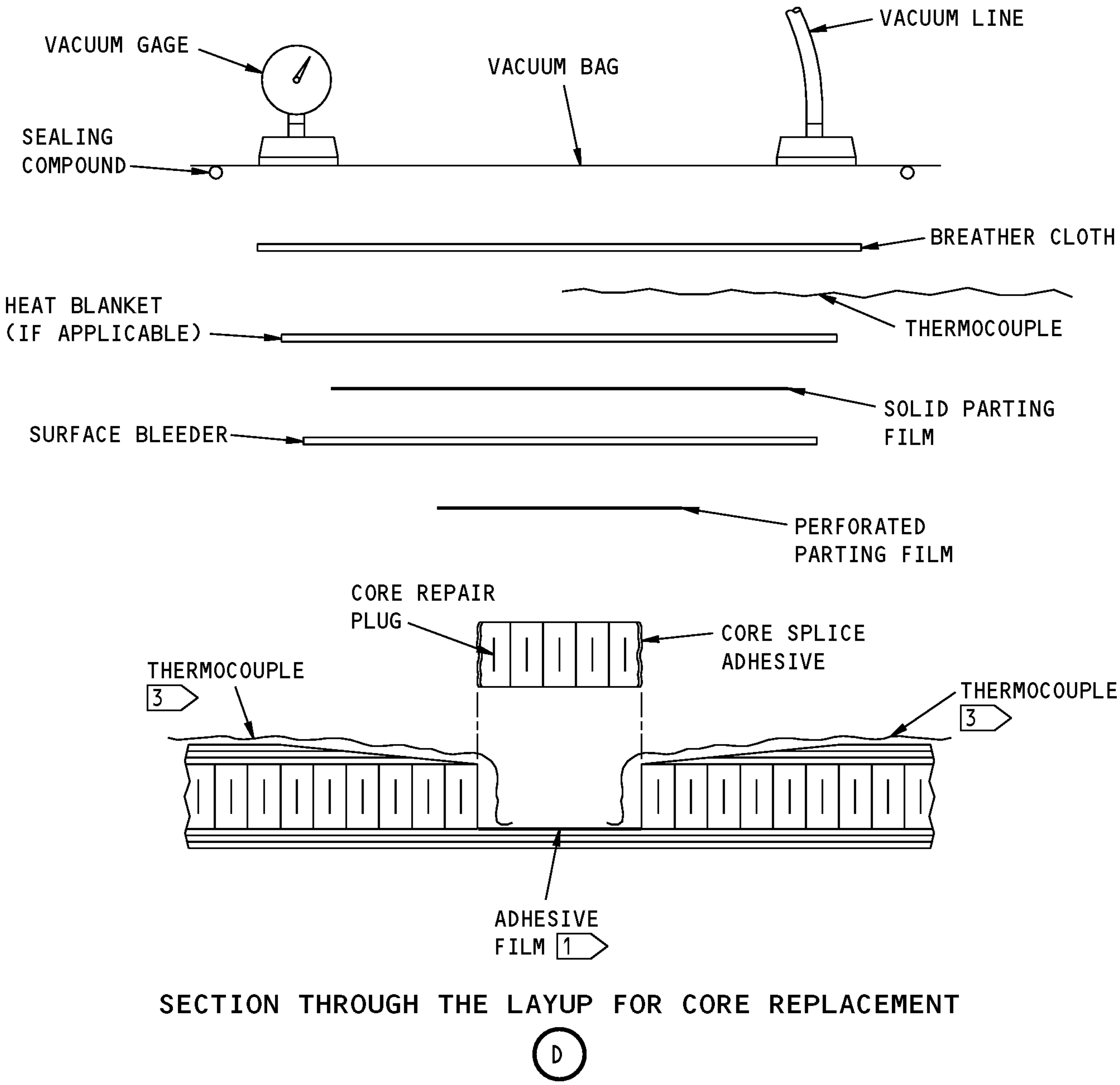
Vacuum Bag Instructions for the Cure of the Repair Core
Figure 205 (Sheet 1 of 5)



Vacuum Bag Instructions for the Cure of the Repair Core
Figure 205 (Sheet 2 of 5)



Vacuum Bag Instructions for the Cure of the Repair Core
Figure 205 (Sheet 3 of 5)



Vacuum Bag Instructions for the Cure of the Repair Core
Figure 205 (Sheet 4 of 5)

NOTES

- WHERE ACCESS IS NOT LIMITED TO ONE SIDE, REFER TO DETAIL A AND DETAIL B.
- WHERE ACCESS IS LIMITED TO ONE SIDE, REFER TO DETAIL C AND DETAIL D.

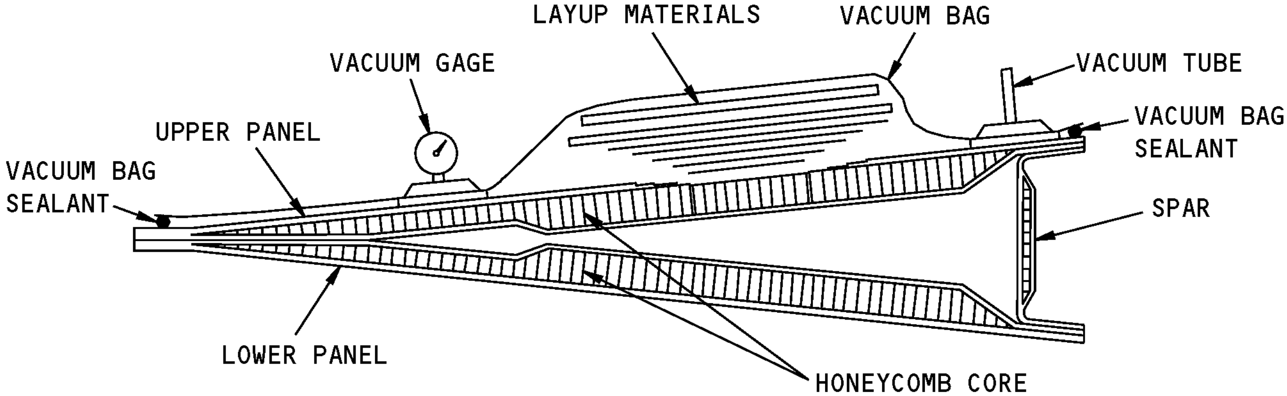
[1] USE ONE PLY OF ADHESIVE FILM FOR A FULL DEPTH CORE REPLACEMENT WHERE THE DAMAGE DOES NOT GO THROUGH THE TWO SKINS. FOR THE REPLACEMENT OF LESS THAN A FULL DEPTH CORE, USE TWO PLIES OF ADHESIVE FILM WITH ONE PLY OF TYPE 120 PREIMPREGNATED GLASS FABRIC BETWEEN THEM.

[2] WHEN YOU USE A HEAT BLANKET, USE 4 TO 6 LAYERS OF BREATHER MATERIAL AS INSULATION.

[3] FOR THERMOCOUPLE LOCATION, REFER TO PARAGRAPH 4.H.

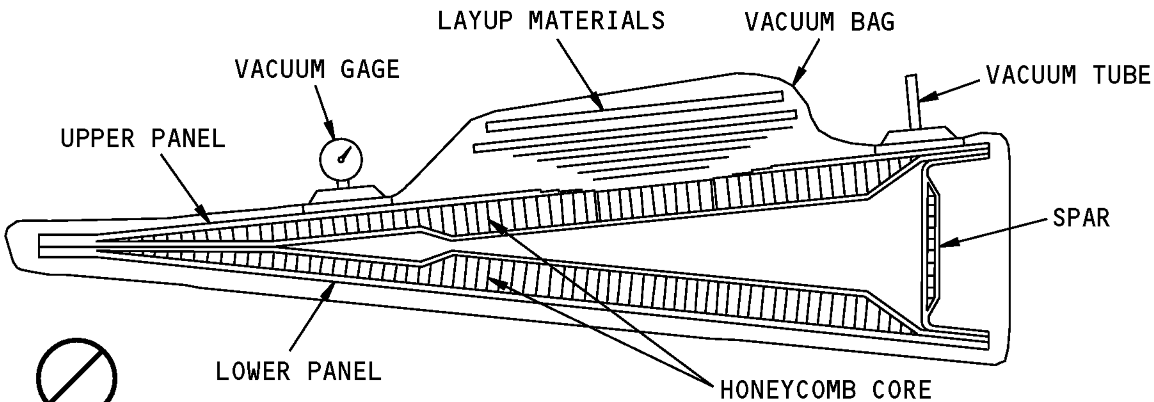
[4] WHEN A HEAT BLANKET IS USED ON THIS FACE, ALSO USE THE BREATHER CLOTH, VACUUM BAG, SEALING COMPOUND, VACUUM LINE AND VACUUM GAGE, AS SHOWN AT THE TOP OF DETAIL A.

Vacuum Bag Instructions for the Cure of the Repair Core
Figure 205 (Sheet 5 of 5)



NOTE: THIS IS BEST FOR LOW TEMPERATURE REPAIRS. IT IS NOT RECOMMENDED FOR 350°F (177°C) REPAIRS.

SATISFACTORY - VACUUM BAG SEALED TO ONE SIDE ONLY



NOT SATISFACTORY - VACUUM BAG SEALED AROUND ALL OF THE PART

PARTS WHICH HAVE UPPER AND LOWER PANELS [1]

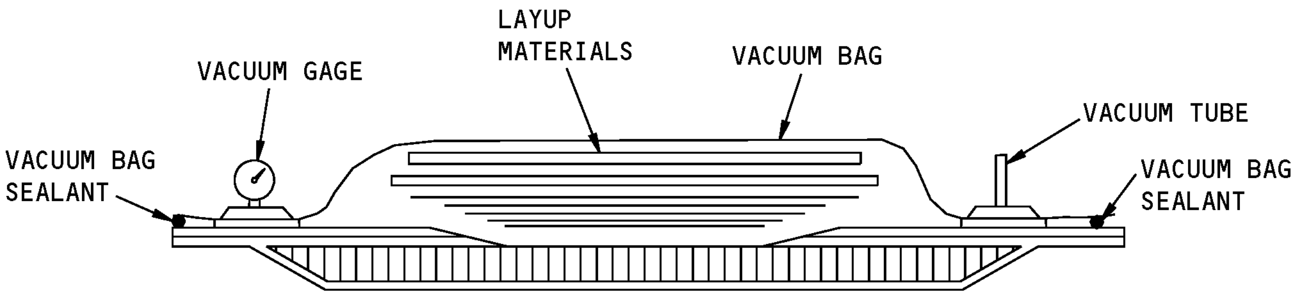
NOTES

- REFER TO PARAGRAPH 4.L. AND 4.M. FOR LAYUP AND VACUUM BAG PROCEDURES.

[1] THIS TYPE OF COMPONENT MUST NOT BE FULLY SEALED IN A VACUUM BAG. DAMAGE TO THE PART WILL OCCUR. USE A VACUUM BAG ONLY ON ONE SIDE OF THE COMPONENT.

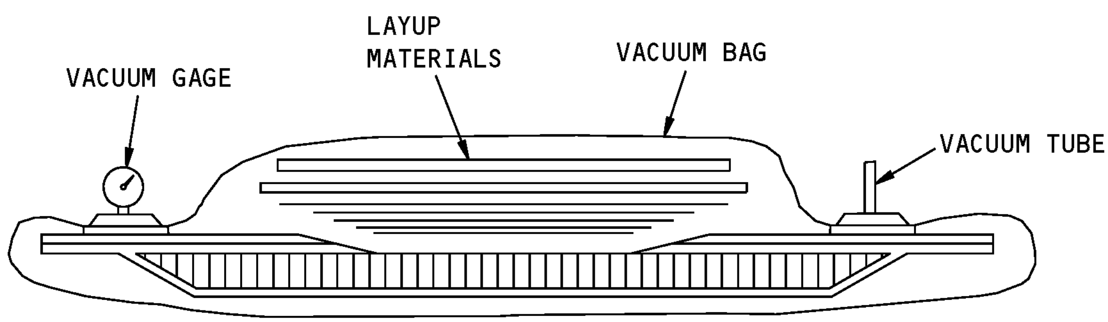
[2] THIS TYPE OF COMPONENT CAN BE FULLY SEALED IN A VACUUM BAG OR CAN BE SEALED ON ONE SIDE ONLY.

Vacuum Bag Limits
Figure 206 (Sheet 1 of 2)



NOTE: THIS IS BEST FOR LOW TEMPERATURE REPAIRS. IT IS NOT RECOMMENDED FOR 350°F (177°C) REPAIRS.

SATISFACTORY - VACUUM BAG SEALED TO ONE SIDE ONLY

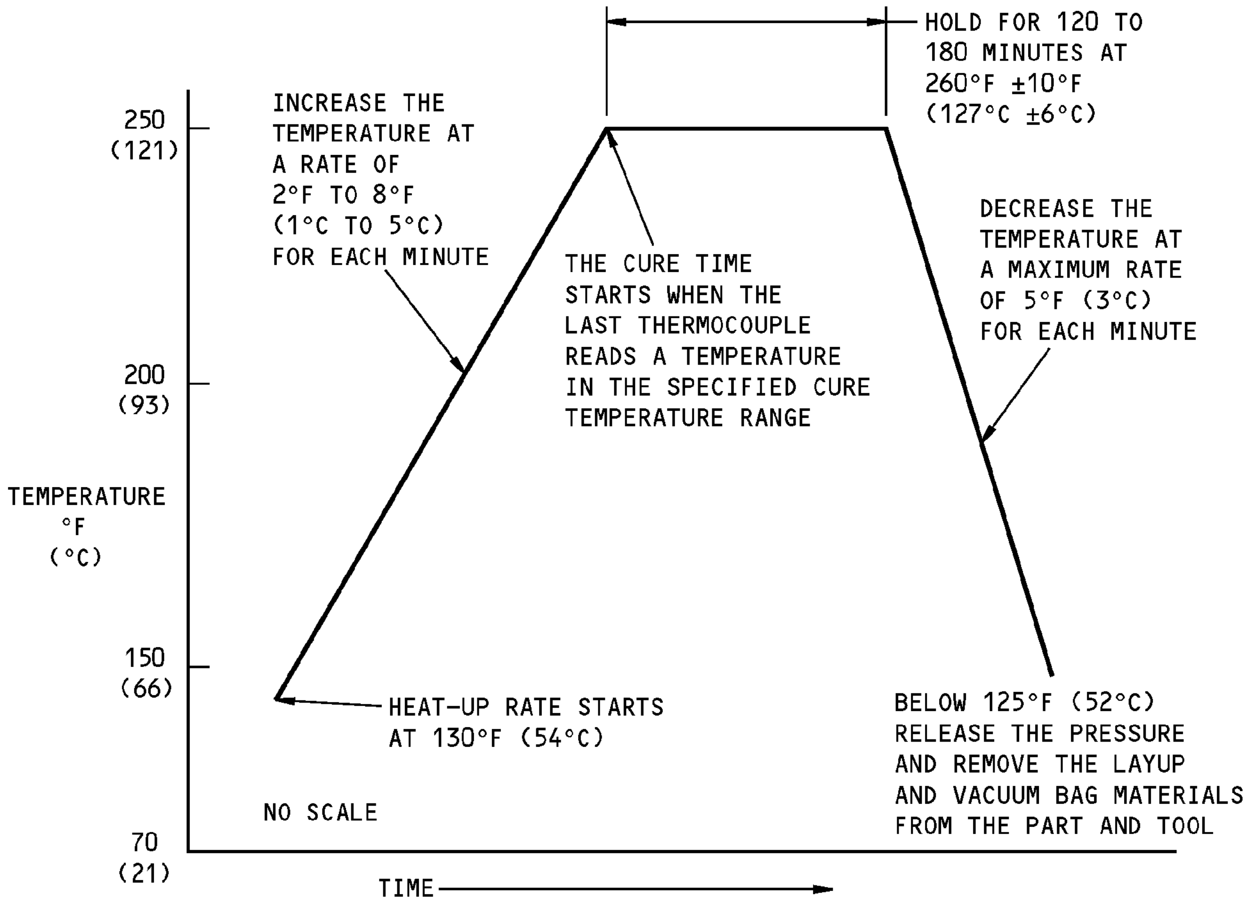


NOTE: THIS IS RECOMMENDED FOR 350°F (177°C) REPAIRS.

SATISFACTORY - VACUUM BAG SEALED AROUND ALL OF THE PART

PARTS WHICH HAVE ONLY ONE PANEL [2]

Vacuum Bag Limits
Figure 206 (Sheet 2 of 2)

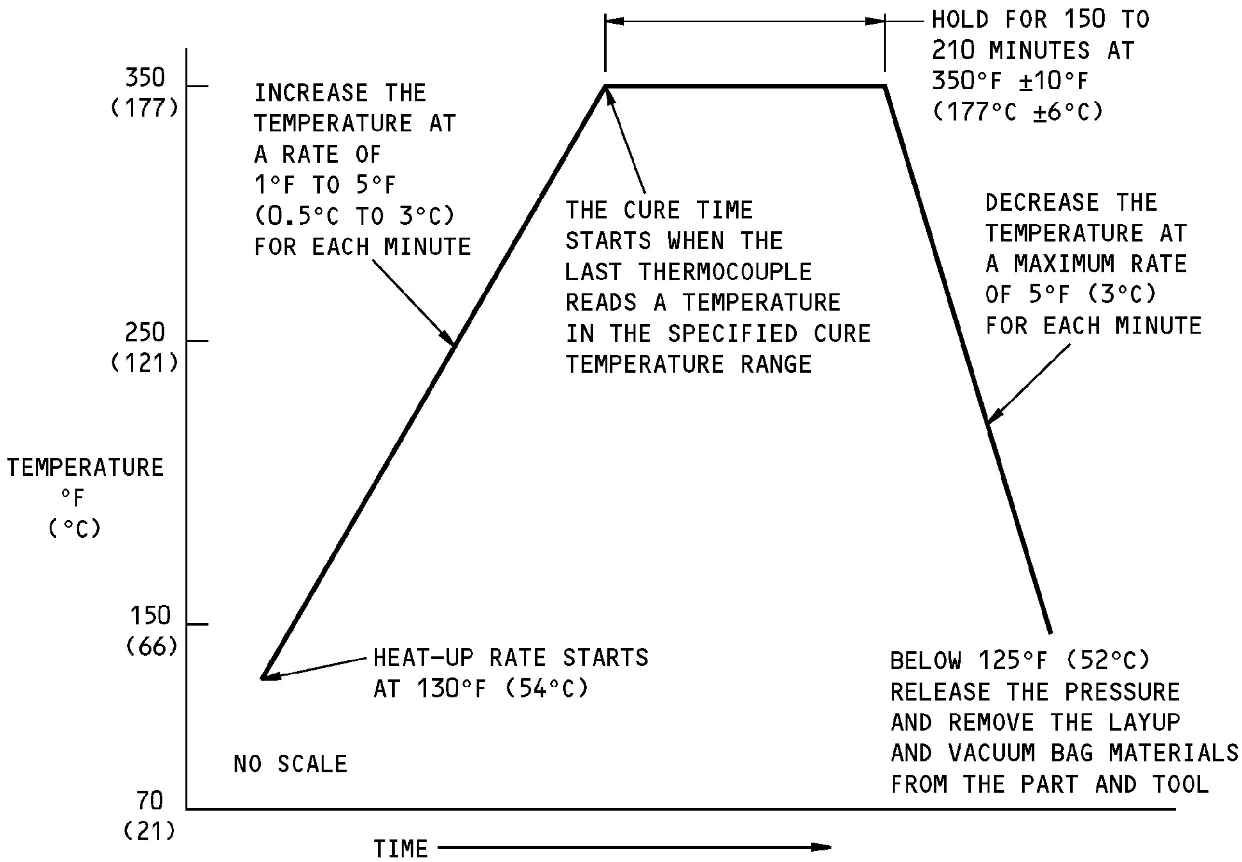


NOTES

- KEEP A MINIMUM VACUUM OF 22 INCHES (0.56 M) OF H_g (MERCURY) DURING THE FULL CURE CYCLE.

250°F (121°C) HEAT BLANKET CURE CYCLE

Vacuum Bag Cure Cycles
Figure 207 (Sheet 1 of 2)

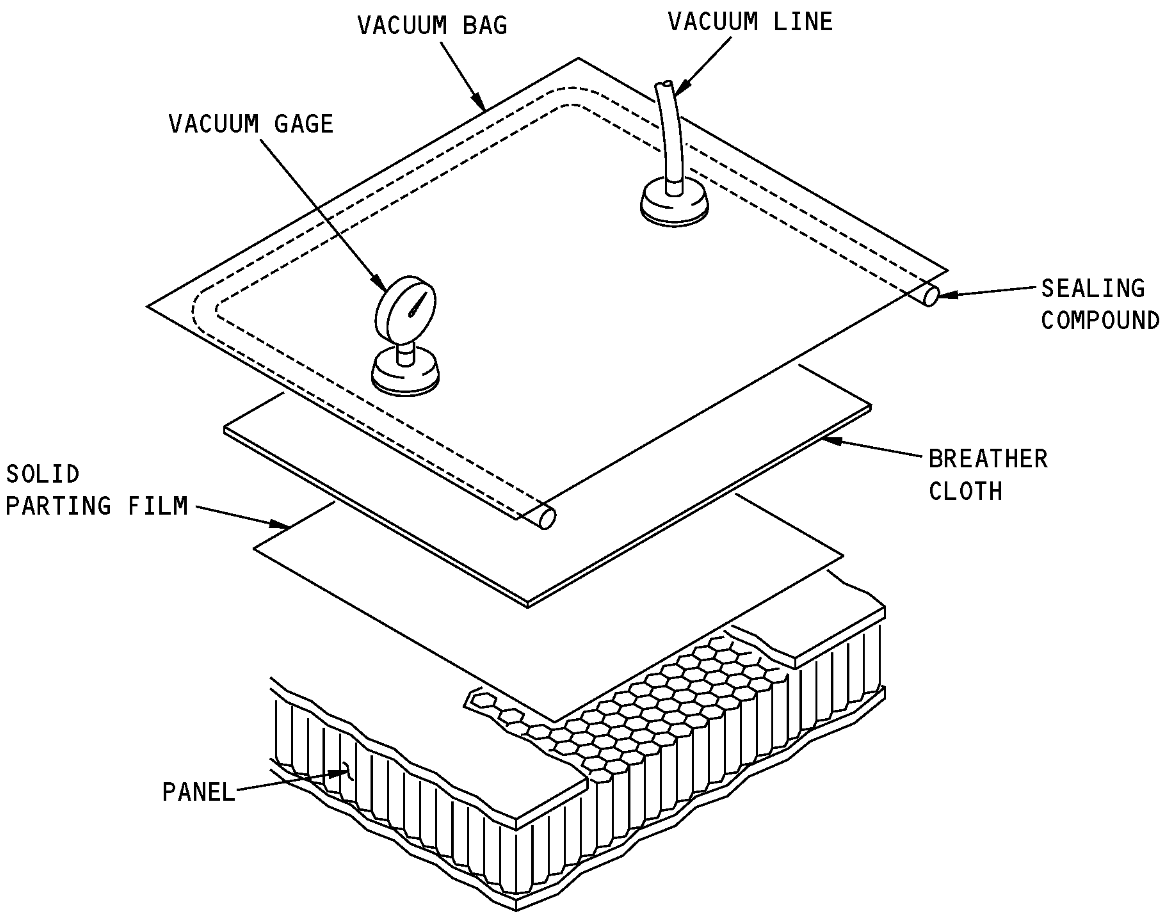


NOTES

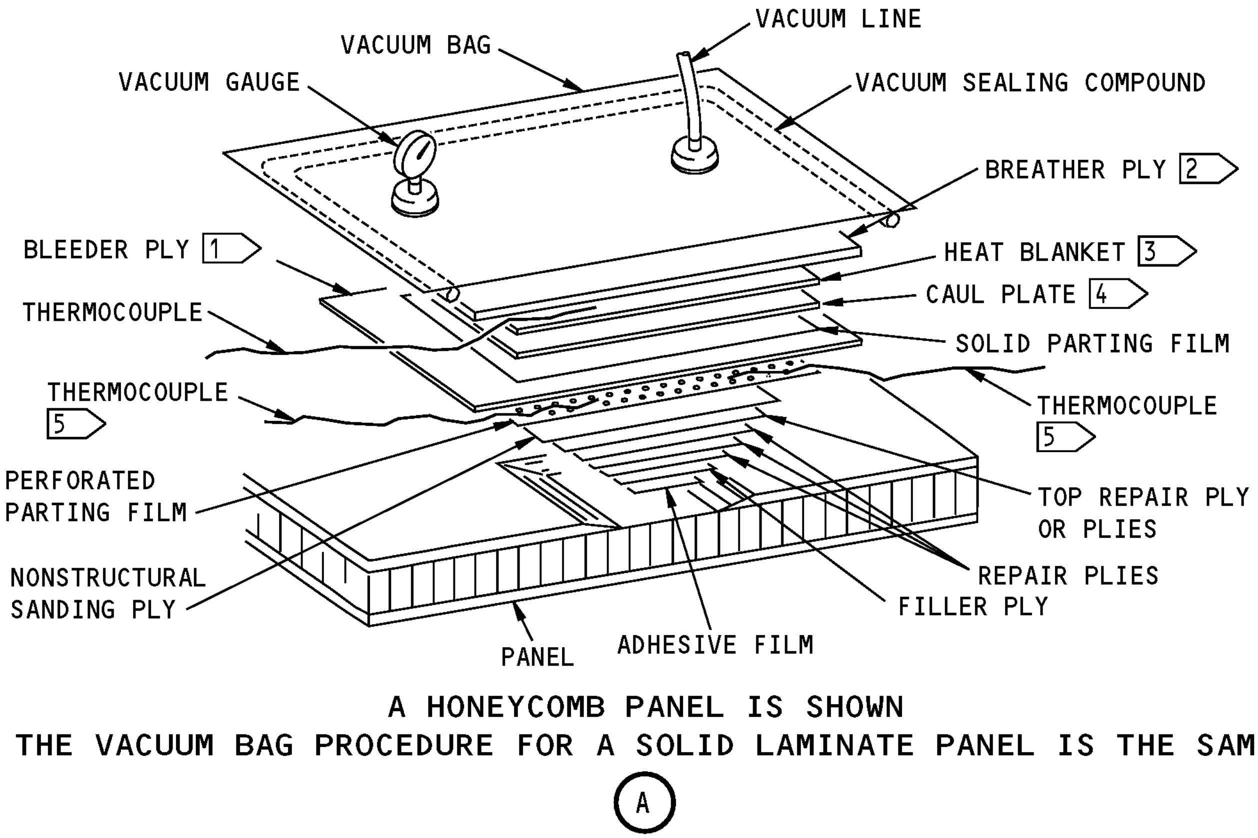
- KEEP A MINIMUM VACUUM OF 22 INCHES (0.56 M) OF H_g (MERCURY) DURING THE FULL CURE CYCLE.

350°F (177°C) HEAT BLANKET CURE CYCLE

Vacuum Bag Cure Cycles
Figure 207 (Sheet 2 of 2)



Ply Compaction Vacuum Bag System
Figure 208



NOTES

1 THE BLEEDER PLY MUST TOUCH THE SURFACE OF THE BREATHER CLOTH.

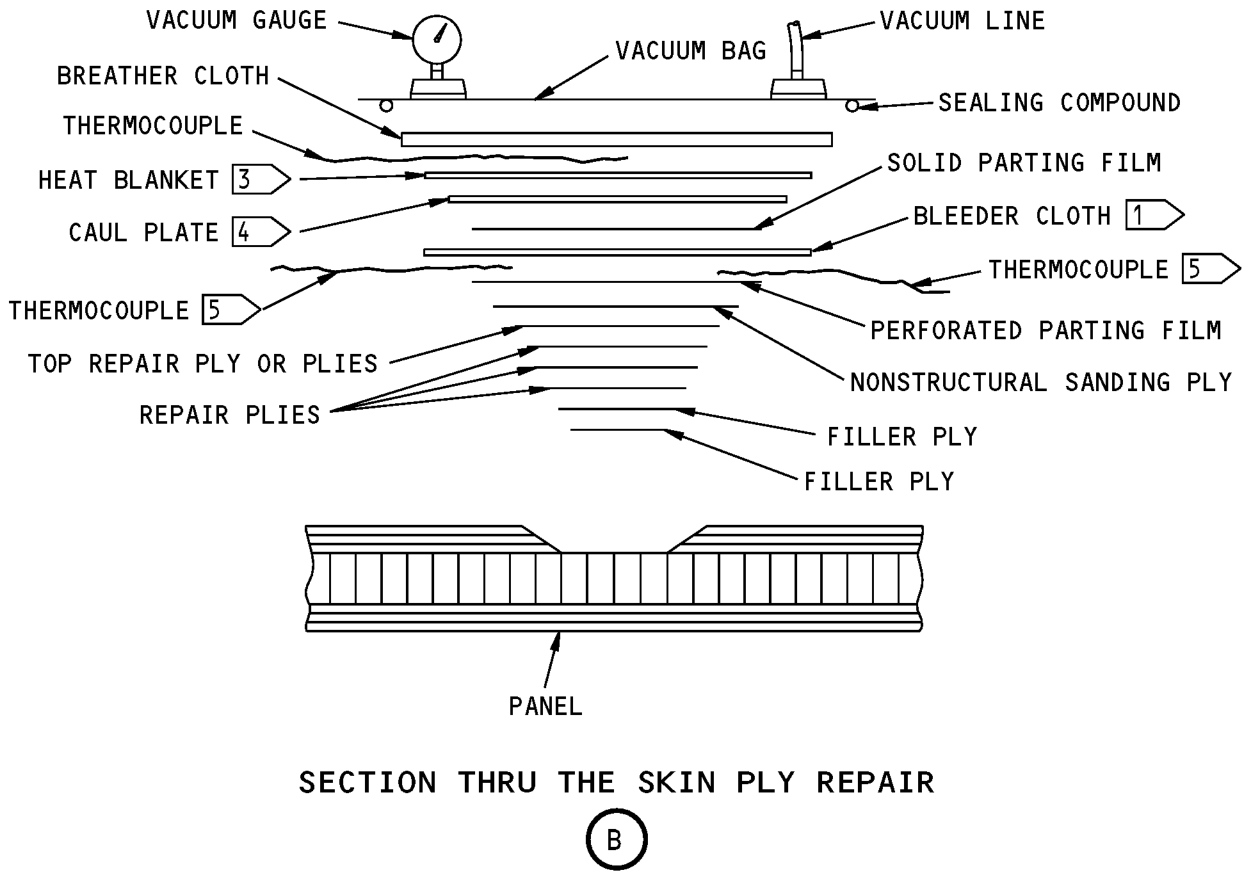
2 WHEN YOU USE A HEAT BLANKET, USE 4 TO 6 LAYERS OF BREATHER CLOTH TO PREVENT DAMAGE TO THE VACUUM BAG.

3 THE HEAT BLANKET MUST GO A MINIMUM OF 2 INCHES MORE THAN THE EDGE OF THE REPAIR PATCH.

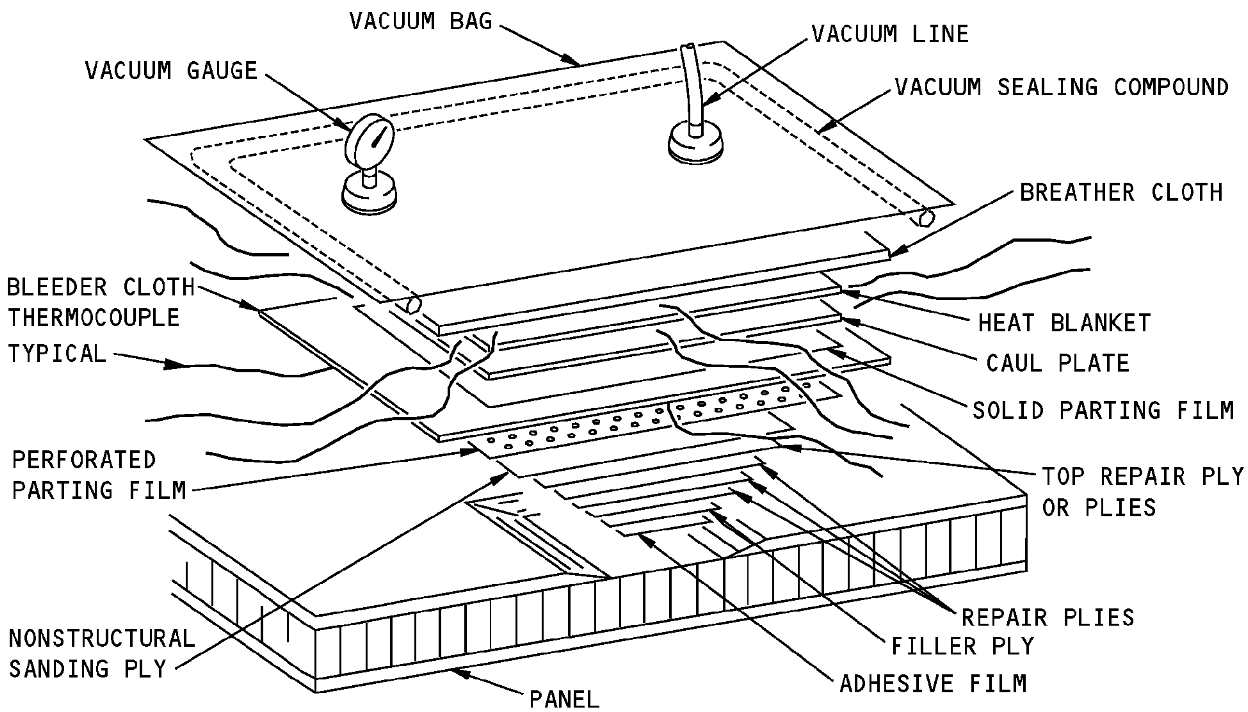
4 0.016-0.060 INCH THICK ALUMINUM SHEET 1100-0 IS RECOMMENDED.

5 FOR THE THERMOCOUPLE LOCATIONS REFER TO PARAGRAPH 4.L. AND FIGURE 210.

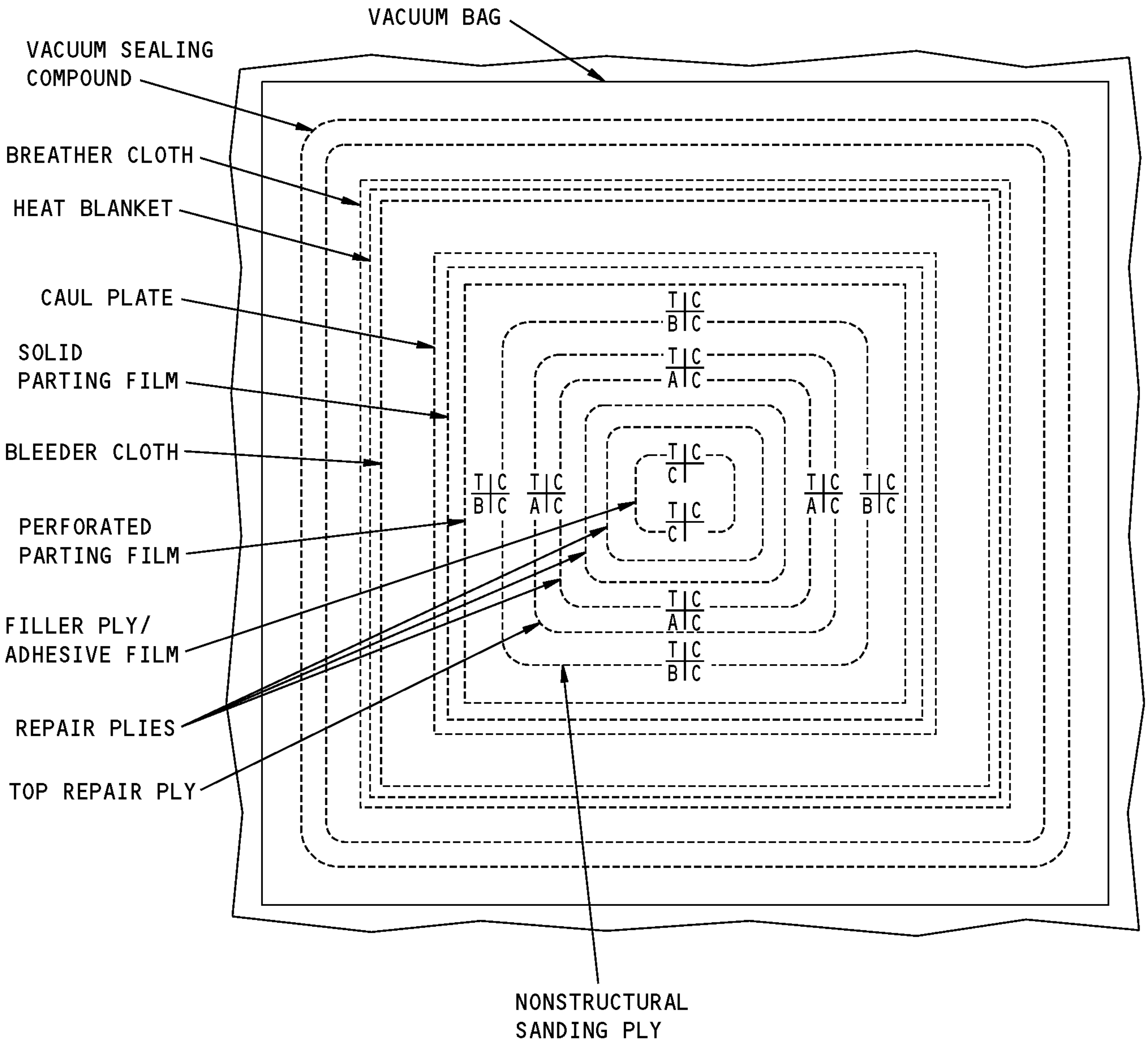
Vacuum Bag Instructions for the Cure of the Repair Plies
Figure 209 (Sheet 1 of 2)



Vacuum Bag Instructions for the Cure of the Repair Plies
Figure 209 (Sheet 2 of 2)



Typical Locations of Thermocouples for Heat Blanket Cure
Figure 210 (Sheet 1 of 3)

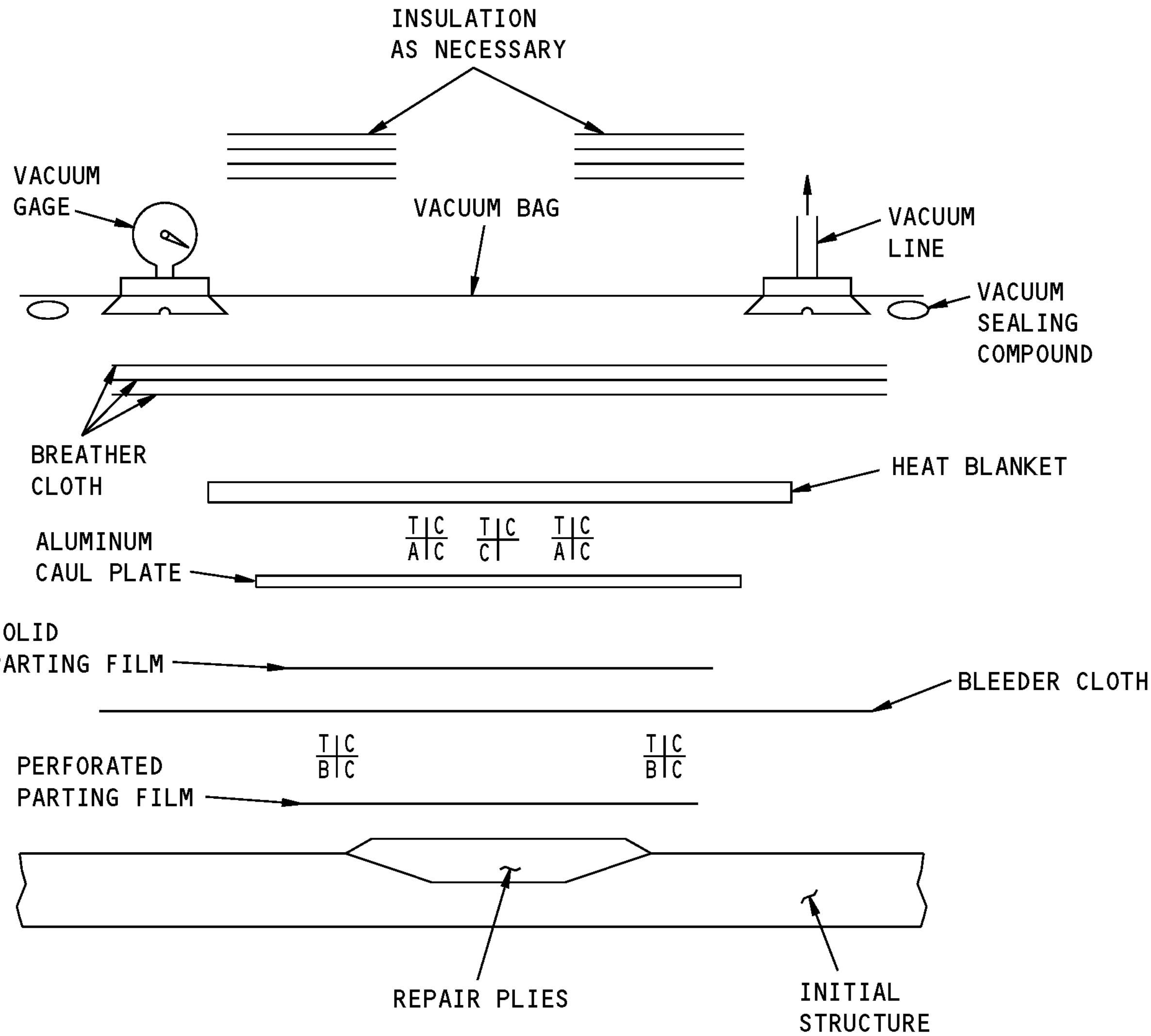


T/C B/C = ONE THERMOCOUPLE (MINIMUM) ABOVE THE PERFORATED PARTING FILM. THE OTHER THERMOCOUPLES ARE OPTIONAL AND RECOMMENDED.

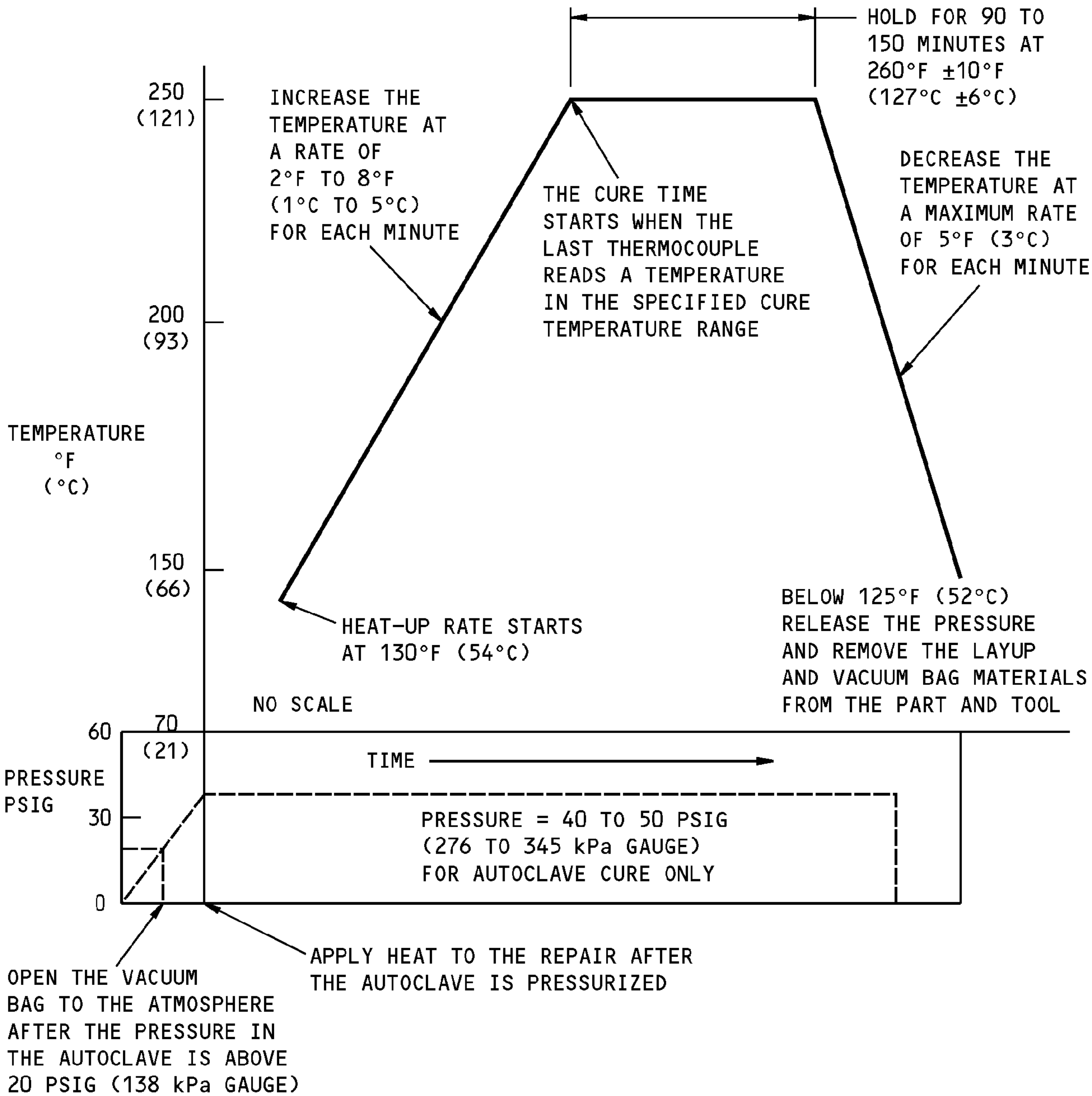
T/C A/C = ONE THERMOCOUPLE (MINIMUM) ABOVE THE CAUL PLATE OR ALUMINUM STRIPS. THE OTHER THERMOCOUPLES ARE OPTIONAL AND RECOMMENDED.

T/C C = THERMOCOUPLE ABOVE THE HEAT BLANKET.

Typical Locations of Thermocouples for Heat Blanket Cure
Figure 210 (Sheet 2 of 3)



Typical Locations of Thermocouples for Heat Blanket Cure
Figure 210 (Sheet 3 of 3)

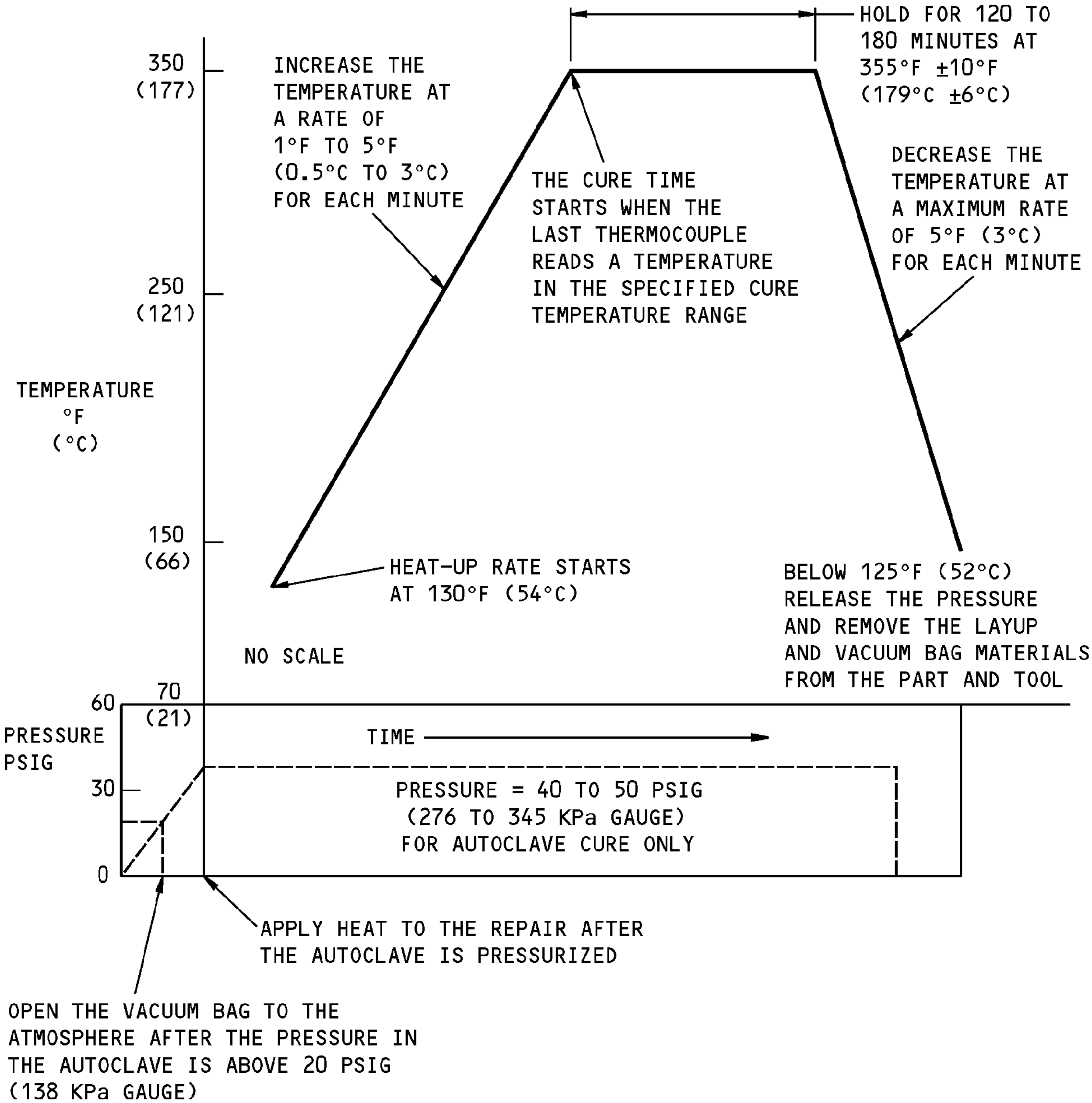


NOTES

- FOR THE OVEN CURE, KEEP A MINIMUM VACUUM OF 22 INCHES (0.56 M) OF H_g (MERCURY) DURING THE FULL CURE CYCLE.

250°F (121°C) AUTOCLAVE OR OVEN CURE CYCLE

Oven and Autoclave Cure Cycles
Figure 211 (Sheet 1 of 2)



NOTES

- FOR THE OVEN CURE, KEEP A MINIMUM VACUUM OF 22 INCHES (0.56 M) OF H_g (MERCURY) DURING THE FULL CURE CYCLE.

350°F (177°C) AUTOCLAVE OR OVEN CURE CYCLE

Oven and Autoclave Cure Cycles
Figure 211 (Sheet 2 of 2)

REPAIR 1 - REPAIR OF DAMAGE TO ONE SKIN OF A HONEYCOMB PANEL

1. Applicability

WARNING: MAKE SURE THAT THE FLIGHT CONTROL SURFACES ARE CORRECTLY BALANCED AFTER YOU REPAIR THEM. IF YOU DO NOT OBEY, FLUTTER CAN OCCUR AND CAUSE DAMAGE TO THE STRUCTURE. REFER TO SRM 51-60-00 FOR THE CONTROL SURFACE BALANCING PROCEDURES.

CAUTION: DO NOT USE 350°F (177°C) CURE REPAIR MATERIALS ON 250°F (121°C) CURED PARTS. IF YOU DO NOT OBEY, THE REPAIR WILL BE UNSATISFACTORY. REFER TO THE SPECIFIED COMPONENT REPAIR SUBJECT FOR THE MATERIALS AND PROCEDURES APPROVED FOR THIS REPAIR. IF YOU DO NOT OBEY, THE REPAIR WILL BE UNSATISFACTORY.

A. Repair 1 is applicable to damage to one skin of a honeycomb panel.

B. Repair 1 is a typical repair that is applicable to all fiber reinforced laminates and honeycomb sandwich components.

C. Repair 1 is not applicable to radomes or floor panels. Refer to 53-10-72 for radomes and 53-00-50 for floor panels.

2. General

A. Repair 1 is a Category A damage tolerant repair. Refer to 51-00-06 for the definitions of the different categories of repairs.

B. Refer to Repair 1 - Layout of the Repair Parts, Figure 201/REPAIR 1 for the layout of the repair parts.

3. References

Reference	Title
51-00-06	STRUCTURAL REPAIR DEFINITIONS
51-60-00, GENERAL	Control Surface Balance Procedures
53-00-50	FUSELAGE FLOOR PANELS
53-10-72	FUSELAGE NOSE RADOME - SECTION 41

4. Repair Instructions

A. Find the limits of the damage. Refer to Paragraph 4.A./REPAIR GENERAL

B. Remove the damaged plies and prepare the damaged area as given in Paragraph 4.B./REPAIR GENERAL and Paragraph 4.E./REPAIR GENERAL Do not remove the core. Make sure that you remove all of the water or other unwanted material as given in Paragraph 4.C./REPAIR GENERAL

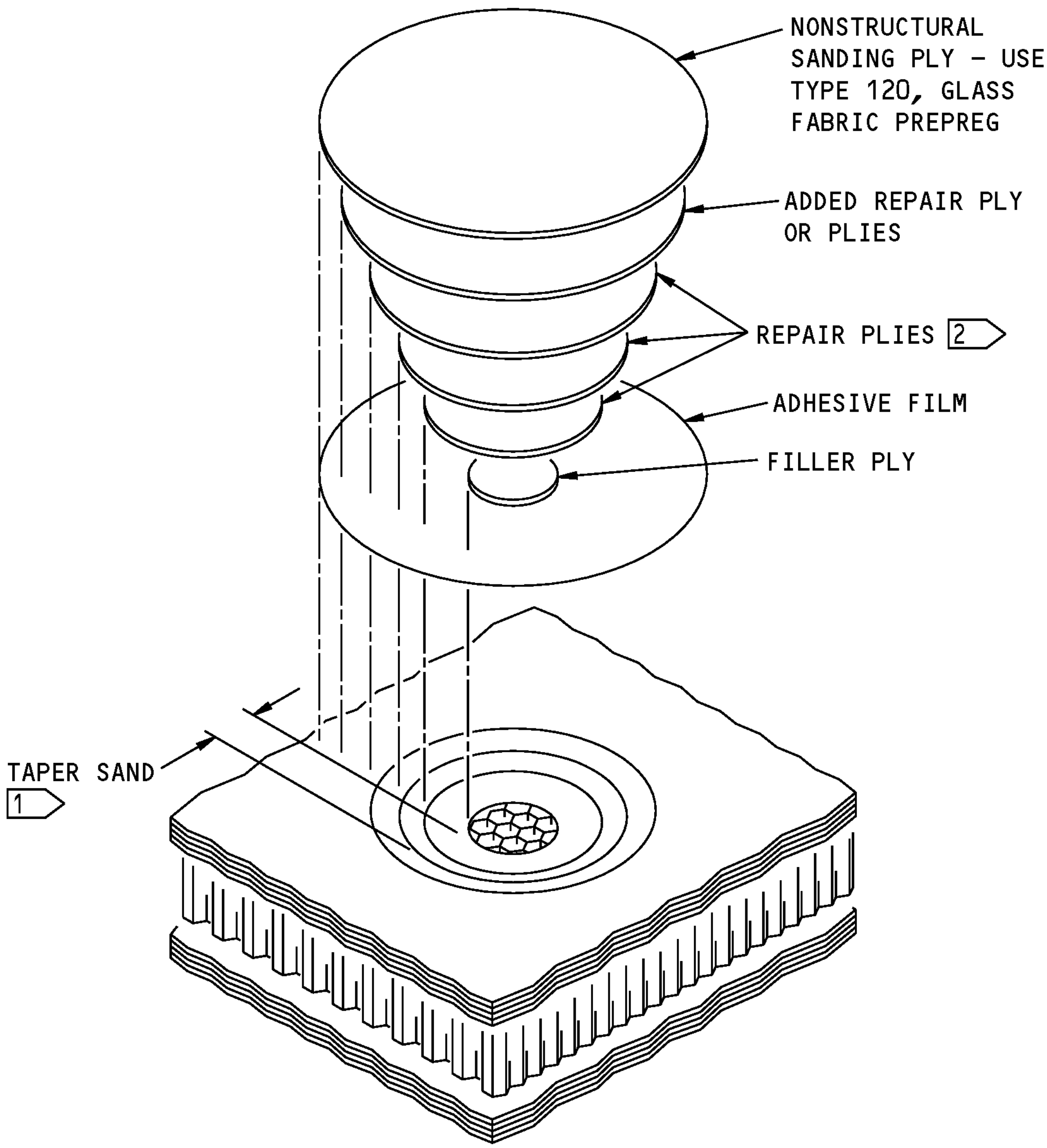
C. Prepare and apply the adhesive film and fabric repair plies as given in Paragraph 4.J./REPAIR GENERAL and Paragraph 4.K./REPAIR GENERAL

D. Install the vacuum bag system as given in Paragraph 4.L./REPAIR GENERAL

E. Cure the repair as given in Paragraph 4.M./REPAIR GENERAL

F. Examine the completed repair as given in Paragraph 4.N./REPAIR GENERAL

G. Apply the finish to the repair area as given in Paragraph 4.O./REPAIR GENERAL



NOTES

1 REFER TO REPAIR GENERAL, FIGURES 202 AND 203 FOR THE NECESSARY TAPER AND OVERLAP.

2 FIND THE NUMBER OF PLIES, PLY ORIENTATION, AND THE INITIAL MATERIAL IN THE SPECIFIED COMPONENT STRUCTURE IDENTIFICATION. REFER TO REPAIR GENERAL, TABLES 202 AND 203 FOR THE REPAIR MATERIALS.

Repair 1 - Layout of the Repair Parts
Figure 201

REPAIR 2 - REPAIR OF DAMAGE THAT IS MORE THAN 0.50 INCH (12.70 MM) IN DIAMETER TO ONE SKIN AND THE HONEYCOMB CORE

1. Applicability

WARNING: MAKE SURE THAT THE FLIGHT CONTROL SURFACES ARE CORRECTLY BALANCED AFTER YOU REPAIR THEM. IF YOU DO NOT OBEY, FLUTTER CAN OCCUR AND CAUSE DAMAGE TO THE STRUCTURE. REFER TO SRM 51-60-00 FOR THE CONTROL SURFACE BALANCING PROCEDURES.

CAUTION: DO NOT USE 350°F (177°C) CURE REPAIR MATERIALS ON 250°F (121°C) CURED PARTS. IF YOU DO NOT OBEY, THE REPAIR WILL BE UNSATISFACTORY. REFER TO THE SPECIFIED COMPONENT REPAIR SUBJECT FOR THE MATERIALS AND PROCEDURES APPROVED FOR THIS REPAIR. IF YOU DO NOT OBEY, THE REPAIR WILL BE UNSATISFACTORY.

A. Repair 2 is applicable to damage to one skin of a honeycomb panel.

B. Repair 2 is a typical repair that is applicable to all fiber reinforced laminates and honeycomb sandwich components.

C. Repair 2 is not applicable to radomes or floor panels. Refer to 53-10-72 for the data about radomes and 53-00-50 for the data about floor panels.

2. General

A. Repair 2 is a Category A damage tolerant repair. Refer to 51-00-06 for the definitions of the different categories of repairs.

B. Refer to Repair 2 - Layout of the Repair Parts, Figure 201/REPAIR 2 for the layout of the repair parts.

3. References

Reference	Title
51-00-06	STRUCTURAL REPAIR DEFINITIONS
51-60-00, GENERAL	Control Surface Balance Procedures
53-00-50	FUSELAGE FLOOR PANELS
53-10-72	FUSELAGE NOSE RADOME - SECTION 41

4. Repair Instructions

A. Find the limits of the damage. Refer to Paragraph 4.A./REPAIR GENERAL

B. Remove the damage as given in Paragraph 4.B./REPAIR GENERAL Make sure that you remove all of the water or other unwanted material as given in Paragraph 4.C./REPAIR GENERAL The damaged area must be fully dry.

C. Prepare the damaged area as given in Paragraph 4.E./REPAIR GENERAL

D. Cut out, clean, and install the honeycomb core plug as given in Paragraph 4.F./REPAIR GENERAL, Paragraph 4.G./REPAIR GENERAL, and Paragraph 4.H./REPAIR GENERAL

NOTE: Refer to Repair 11 for an alternative core repair procedure.

E. Cure the honeycomb core plug as given in Paragraph 4.I./REPAIR GENERAL

F. Clean the repair surface as given in Paragraph 4.E.(3)/REPAIR GENERAL

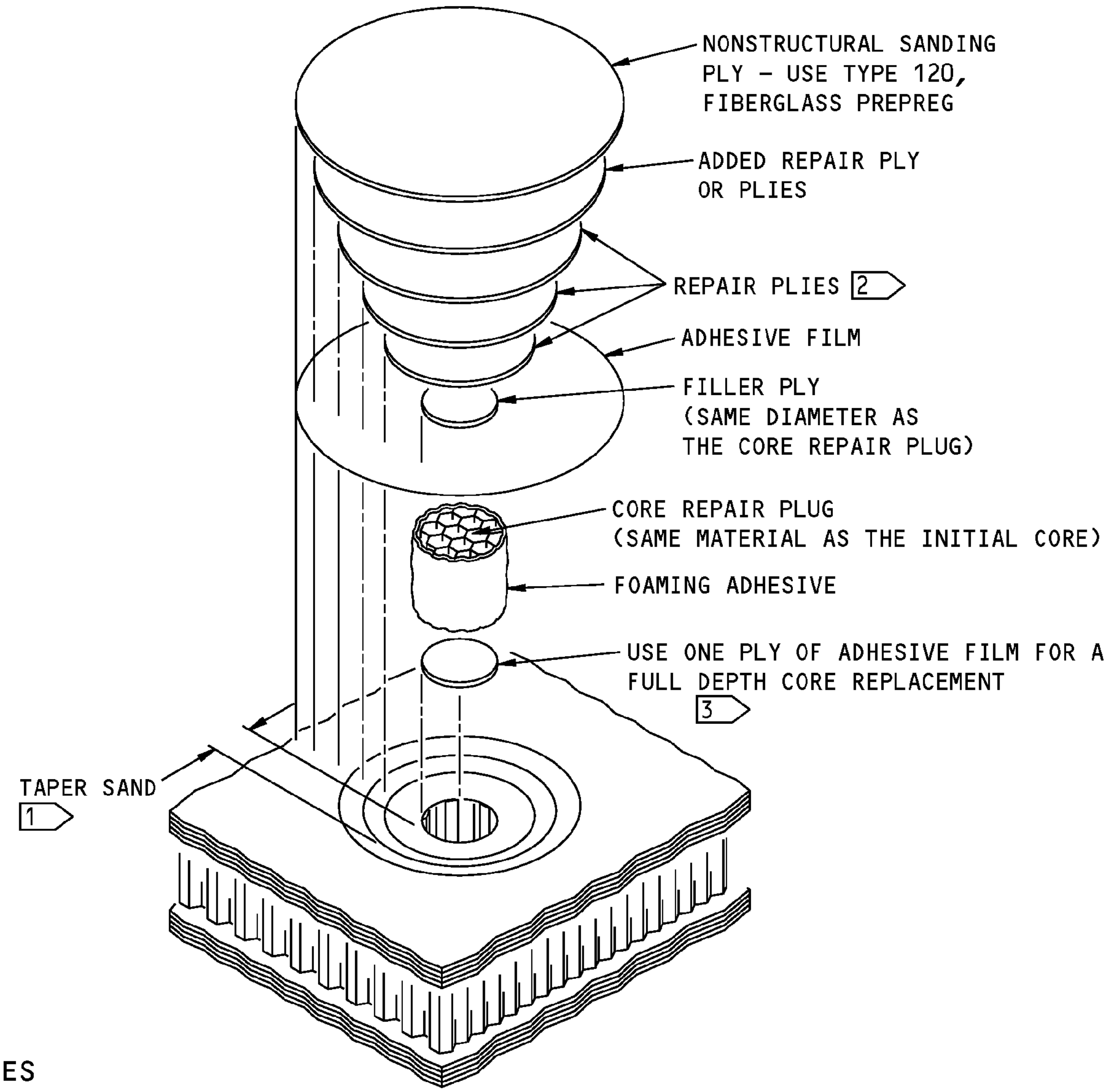
G. Prepare and install the adhesive film and repair plies as given in Paragraph 4.J./REPAIR GENERAL and Paragraph 4.K./REPAIR GENERAL

H. Install the vacuum bag system as given in Paragraph 4.L./REPAIR GENERAL

I. Cure the repair as given in Paragraph 4.M./REPAIR GENERAL

J. Examine the completed repair as given in Paragraph 4.N./REPAIR GENERAL

K. Apply the finish to the repair area as given in Paragraph 4.O./REPAIR GENERAL



NOTES

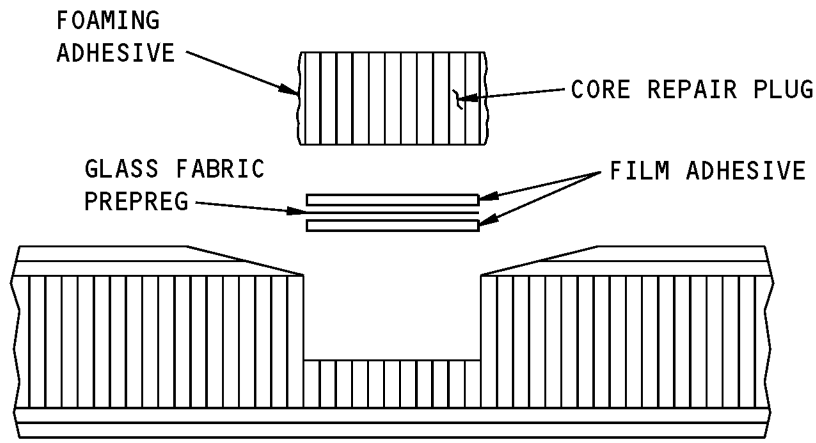
1 REFER TO REPAIR GENERAL, FIGURES 202 AND 203 FOR THE NECESSARY TAPER AND OVERLAP.

2 FIND THE NUMBER OF STRUCTURAL PLIES, PLY ORIENTATION, AND THE INITIAL MATERIAL IN THE SPECIFIED COMPONENT STRUCTURE IDENTIFICATION. REFER TO REPAIR GENERAL, TABLES 202 AND 203 FOR THE REPAIR MATERIALS.

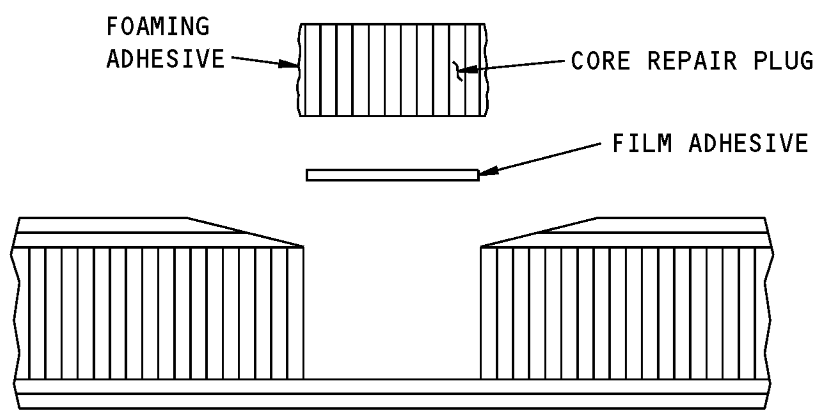
3 FOR A LESS THAN FULL DEPTH CORE REPLACEMENT:

- USE ONE PLY OF GLASS FABRIC BETWEEN TWO PLIES OF ADHESIVE FILM FOR ARAMID/NOMEX HONEYCOMB.
- USE ONE PLY OF CARBIN FABRIC BETWEEN TWO PLIES OF ADHESIVE FILM FOR CARBON HONEYCOMB.

Repair 2 - Layout of the Repair Parts
Figure 201 (Sheet 1 of 2)



SECTION THROUGH REPAIR AREA
LESS THAN FULL DEPTH CORE REPLACEMENT
A



SECTION THROUGH REPAIR AREA
FULL DEPTH CORE REPLACEMENT
B

Repair 2 - Layout of the Repair Parts
Figure 201 (Sheet 2 of 2)

REPAIR 3 - REPAIR OF DAMAGE TO THE BAGSIDE AND THE HONEYCOMB CORE

1. Applicability

WARNING: MAKE SURE THAT THE FLIGHT CONTROL SURFACES ARE CORRECTLY BALANCED AFTER YOU REPAIR THEM. IF YOU DO NOT OBEY, FLUTTER CAN OCCUR AND CAUSE DAMAGE TO THE STRUCTURE. REFER TO SRM 51-60-00 FOR THE CONTROL SURFACE BALANCING PROCEDURES.

CAUTION: DO NOT USE 350°F (177°C) CURE REPAIR MATERIALS ON 250°F (121°C) CURED PARTS. IF YOU DO NOT OBEY, THE REPAIR WILL BE UNSATISFACTORY. REFER TO THE SPECIFIED COMPONENT REPAIR SUBJECT FOR THE MATERIALS AND PROCEDURES APPROVED FOR THIS REPAIR. IF YOU DO NOT OBEY, THE REPAIR WILL BE UNSATISFACTORY.

A. Repair 3 is applicable to damage that is less than 4.0 inches (101.6 mm) in diameter.

B. Repair 3 is a typical repair that is applicable to all fiber reinforced laminates and honeycomb sandwich components.

C. Repair 3 is not applicable to radomes or floor panels. Refer to 53-10-72 for the data about radomes and 53-00-50 for the data about floor panels.

2. General

A. Repair 3 is a Category A damage tolerant repair. Refer to 51-00-06 for the definitions of the different categories of repairs.

B. Refer to Repair 3 - Layout of the Repair Parts, Figure 201/REPAIR 3 for the layout of the repair parts.

3. References

Reference	Title
51-00-06	STRUCTURAL REPAIR DEFINITIONS
51-60-00, GENERAL	Control Surface Balance Procedures
53-00-50	FUSELAGE FLOOR PANELS
53-10-72	FUSELAGE NOSE RADOME - SECTION 41

4. Repair Instructions

CAUTION: DO NOT USE THIS REPAIR ON PANELS MADE WITH MORE THAN THREE SKIN PLIES. THIS REPAIR IS FOR THE BAGSIDE OF A PANEL MADE WITH THREE SKIN PLIES OR LESS. DO NOT USE THIS REPAIR ON AERODYNAMIC SURFACES. IF YOU DO NOT OBEY, THE REPAIR WILL BE UNSATISFACTORY.

A. Find the limits of the damage. Refer to Paragraph 4.A./REPAIR GENERAL

B. Remove the damage as given in Paragraph 4.B./REPAIR GENERAL Make sure that you remove all of the water or other unwanted material as given in Paragraph 4.C./REPAIR GENERAL The damaged area must be fully dry.

NOTE: Do not taper sand this repair.

C. Prepare the damaged area for the repair as given in Paragraph 4.E./REPAIR GENERAL

D. Cut out, clean, and install the honeycomb core plug as given in Paragraph 4.F./REPAIR GENERAL, Paragraph 4.G./REPAIR GENERAL, and Paragraph 4.H./REPAIR GENERAL Make the repair core plug level with the top initial ply.

E. Cure the honeycomb core plug as given in Paragraph 4.I./REPAIR GENERAL

F. Sand the repair core smooth as given in Paragraph 4.E.(1)(c)/REPAIR GENERAL

G. Clean the repair surface as given in Paragraph 4.E.(3)/REPAIR GENERAL

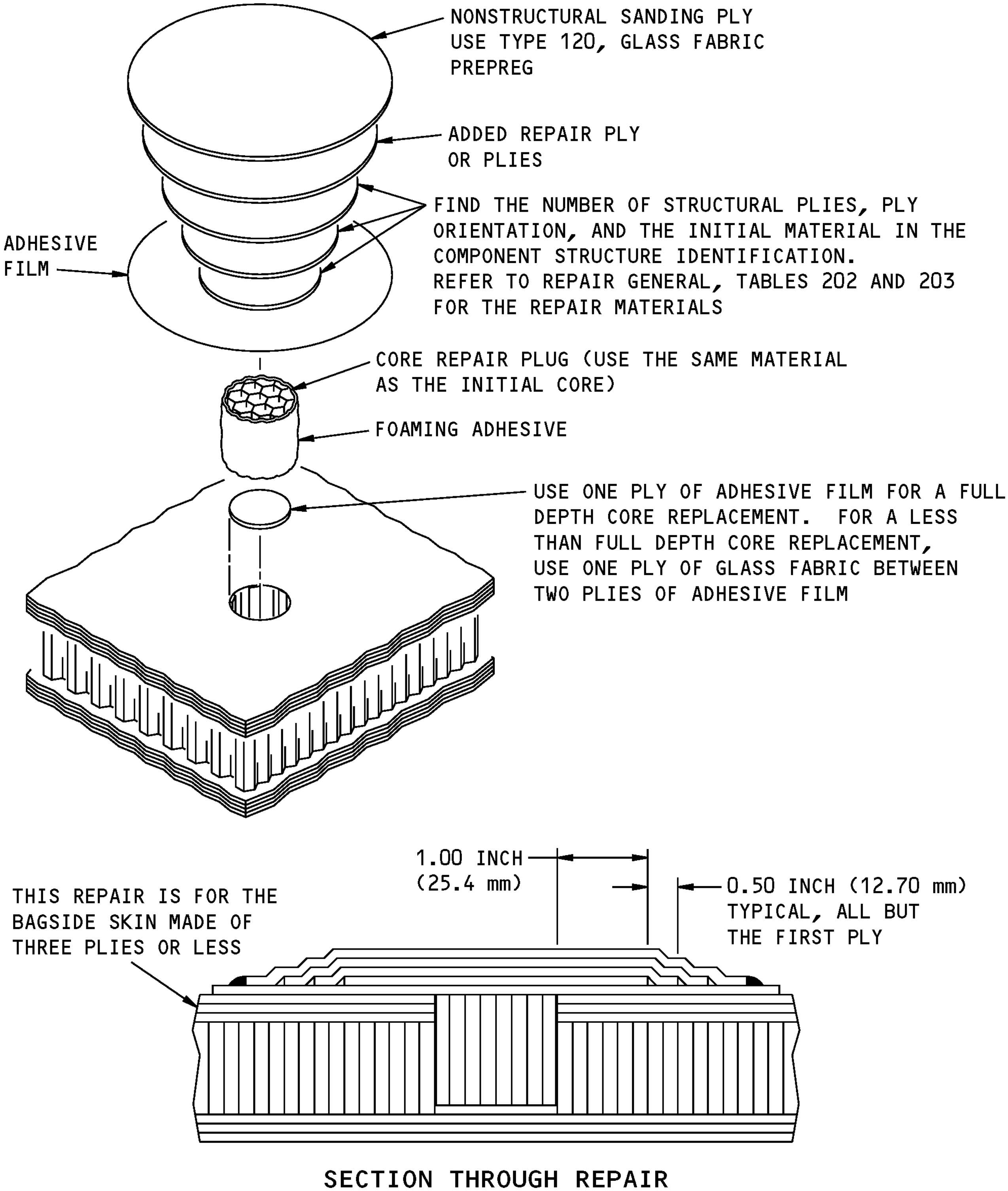
H. Prepare and apply the adhesive film and repair plies as given in Paragraph 4.J./REPAIR GENERAL and Paragraph 4.K./REPAIR GENERAL The repair plies are then installed above the surface of the repair area.

I. Install the vacuum bag system as given in Paragraph 4.L./REPAIR GENERAL

J. Cure the repair as given in Paragraph 4.M./REPAIR GENERAL

K. Examine the completed repair as given in Paragraph 4.N./REPAIR GENERAL

L. Apply the finish to the repair area as given in Paragraph 4.O./REPAIR GENERAL



Repair 3 - Layout of the Repair Parts
Figure 201

REPAIR 4 - REPAIR OF DAMAGE TO THE TWO SKINS AND THE HONEYCOMB CORE

1. Applicability

WARNING: MAKE SURE THAT THE FLIGHT CONTROL SURFACES ARE CORRECTLY BALANCED AFTER YOU REPAIR THEM. IF YOU DO NOT OBEY, FLUTTER CAN OCCUR AND CAUSE DAMAGE TO THE STRUCTURE. REFER TO SRM 51-60-00 FOR THE CONTROL SURFACE BALANCING PROCEDURES.

CAUTION: DO NOT USE 350°F (177°C) CURE REPAIR MATERIALS ON 250°F (121°C) CURED PARTS. IF YOU DO NOT OBEY, THE REPAIR WILL BE UNSATISFACTORY. REFER TO THE SPECIFIED COMPONENT REPAIR SUBJECT FOR THE MATERIALS AND PROCEDURES APPROVED FOR THIS REPAIR. IF YOU DO NOT OBEY, THE REPAIR WILL BE UNSATISFACTORY.

A. Repair 4 is applicable to damage that is less than 4.0 inches (101.6 mm) in diameter.

B. Repair 4 is a typical repair that is applicable to all fiber reinforced laminates and honeycomb sandwich components.

C. Repair 4 is not applicable to radomes or floor panels. Refer to 53-10-72 for the data about radomes and 53-00-50 for the data about floor panels.

2. General

A. Repair 4 is a Category A damage tolerant repair. Refer to 51-00-06 for the definitions of the different categories of repairs.

B. Refer to Repair 4 - Layout of the Repair Parts, Figure 201/REPAIR 4 for the layout of the repair parts.

3. References

Reference	Title
51-00-06	STRUCTURAL REPAIR DEFINITIONS
51-60-00, GENERAL	Control Surface Balance Procedures
53-00-50	FUSELAGE FLOOR PANELS
53-10-72	FUSELAGE NOSE RADOME - SECTION 41

4. Repair Instructions

NOTE: The two-step cure procedure that follows is the recommended procedure. As an alternative, you can use a three-step cure procedure in which the core plug installation and the repair plies on each side are bonded independently.

A. Find the limits of the damage. Refer to Paragraph 4.A./REPAIR GENERAL

B. Remove the damage as given in Paragraph 4.B./REPAIR GENERAL and prepare the damaged area for the repair as given in Paragraph 4.E./REPAIR GENERAL Make sure that you remove water or other unwanted material as given in Paragraph 4.C./REPAIR GENERAL The damage area must be fully dry.

C. Cut out, clean, and install the honeycomb core plug as given in Paragraph 4.F./REPAIR GENERAL, Paragraph 4.G./REPAIR GENERAL, and Paragraph 4.H./REPAIR GENERAL It is not necessary to use a vacuum bag procedure at this time.

D. Prepare and apply the adhesive film and repair plies to one surface of the panel as given in Paragraph 4.J./REPAIR GENERAL and Paragraph 4.K./REPAIR GENERAL Use a caul plate on the opposite side of the panel to keep the core plug in position.

E. Install the vacuum bag system as given in Paragraph 4.L./REPAIR GENERAL

F. Cure the repair as given in Paragraph 4.M./REPAIR GENERAL Make sure the repair is kept at the correct cure temperature on the two sides of the panel.

G. Sand the repair core smooth with the initial core surface. Make an allowance for small core crush during the cure procedure.

H. Clean the repair surface as given in Paragraph 4.E.(3)/REPAIR GENERAL

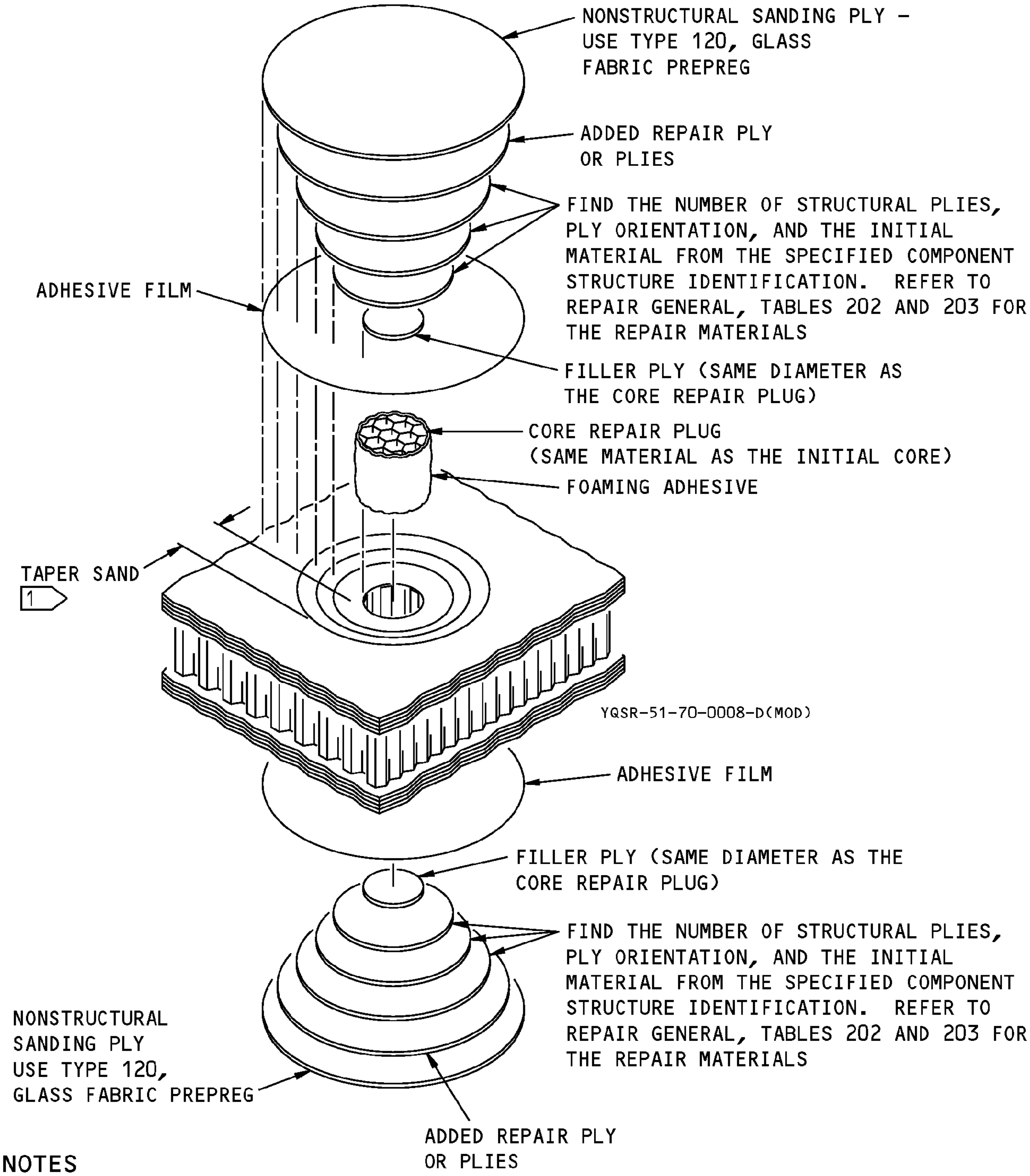
I. Prepare and install the adhesive film and repair plies to the other surface of the panel as given in Paragraph 4.J./REPAIR GENERAL and Paragraph 4.K./REPAIR GENERAL

J. Install the vacuum bag system as given in Paragraph 4.L./REPAIR GENERAL

K. Cure the repair as given in Paragraph 4.M./REPAIR GENERAL Make sure the repair is kept at the correct cure temperature and the temperature is equal on the two sides of the panel.

L. Examine the completed repair as given in Paragraph 4.N./REPAIR GENERAL

M. Apply the finish to the repair area as given in Paragraph 4.O./REPAIR GENERAL



NOTES

1 TAPER SAND THE TWO SIDES OF THE PANEL. REFER TO REPAIR GENERAL, FIGURES 202 AND 203 FOR THE NECESSARY TAPER AND OVERLAP.

Repair 4 - Layout of the Repair Parts
Figure 201

REPAIR 5 - REPAIR OF DAMAGE TO THE TWO SKINS AND THE HONEYCOMB CORE WITH ACCESS LIMITED TO ONE SIDE

1. Applicability

WARNING: MAKE SURE THAT THE FLIGHT CONTROL SURFACES ARE CORRECTLY BALANCED AFTER YOU REPAIR THEM. IF YOU DO NOT OBEY, FLUTTER CAN OCCUR AND CAUSE DAMAGE TO THE STRUCTURE. REFER TO SRM 51-60-00 FOR THE CONTROL SURFACE BALANCING PROCEDURES.

CAUTION: DO NOT USE 350°F (177°C) CURE REPAIR MATERIALS ON 250°F (121°C) CURED PARTS. IF YOU DO NOT OBEY, THE REPAIR WILL BE UNSATISFACTORY. REFER TO THE SPECIFIED COMPONENT REPAIR SUBJECT FOR THE MATERIALS AND PROCEDURES APPROVED FOR THIS REPAIR. IF YOU DO NOT OBEY, THE REPAIR WILL BE UNSATISFACTORY.

A. Repair 5 is applicable to damage that goes fully through a panel that is flat or almost flat.

B. Repair 5 is applicable to panels with no more than 3 plies on the inner skin.

C. Repair 5 is applicable where access is not available to repair the opposite side.

D. Repair 5 is a typical repair that is applicable to all fiber reinforced laminates and honeycomb sandwich components.

E. Repair 5 is not applicable to radomes or floor panels. Refer to 53-10-72 for the data about radomes and 53-00-50 for the data about floor panels.

2. General

A. Repair 5 is a Category A damage tolerant repair. Refer to 51-00-06 for the definitions of the different categories of repairs.

B. Refer to Repair 5 - Layout of the Repair Parts, Figure 201/REPAIR 5 for the layout of the repair parts.

3. References

Reference	Title
51-00-06	STRUCTURAL REPAIR DEFINITIONS
51-20-05	REPAIR SEALING
51-60-00, GENERAL	Control Surface Balance Procedures
51-70-04, REPAIR GENERAL	Repair Procedures for Wet Layup Materials
53-00-50	FUSELAGE FLOOR PANELS
53-10-72	FUSELAGE NOSE RADOME - SECTION 41

4. Repair Instructions

A. Find the limits of the damage. Refer to Paragraph 4.A./REPAIR GENERAL

B. Remove the damage as given in Paragraph 4.B./REPAIR GENERAL and the steps that follow:

(1) Make the hole in the outer skin and core larger than the damaged area. The larger hole will let you repair the inner skin with the necessary overlap as shown in Repair 5 - Layout of the Repair Parts, Figure 201/REPAIR 5.

(2) Cut the damaged area in the inner skin to an oval shape. The larger diameter of the oval hole must be sufficiently large for the smaller diameter oval patch to go through it.

C. Make sure that you remove water or other unwanted material as given in Paragraph 4.C./REPAIR GENERAL The damage area must be fully dry.

D. Make an air-tight patch to put a cover over the oval hole on the inner skin.

(1) Use a thin aluminum sheet or any smooth surface as a mold to lay up the patch.

(2) Put a cover on the mold with parting film or other release agent.

(3) Cut five plies of BMS 8-79 glass fabric cloth. The type and orientation are optional. Cut the plies equal to the minimum diameter D. Refer to Repair 5 - Layout of the Repair Parts, Figure 201/REPAIR 5.

CAUTION: MAKE SURE THAT YOU REMOVE THE SEPARATOR SHEETS FROM THE PREIMPREGNATED MATERIALS BEFORE YOU DO THE LAYUP AND CURE PROCEDURES. IF YOU DO NOT OBEY, YOU WILL CAUSE AN UNSATISFACTORY REPAIR.

(4) Remove the separator sheets and lay up the five plies of preimpregnated material on the mold.

NOTE: Keep the separator sheets and count the sheets as you remove them to make sure that all of them are removed.

(5) Install the vacuum bag system as given in Paragraph 4.L./REPAIR GENERAL

(6) Cure the patch as given in Paragraph 4.M./REPAIR GENERAL

(7) Remove the cured patch from the mold.

(8) Cut the patch to an oval shape that will make an overlap of the oval hole in the inner skin by a minimum of 0.25 inch (6.35 mm) all around.

(9) Drill a 1/8 inch diameter hole through the center of the patch.

(10) Make the surface of the patch rough so that the patch will bond to the inner skin. Use No. 180-grit or smaller abrasive paper.

(11) Remove all of the dust with a vacuum cleaner.

(12) Make a spring steel strip 1.0 inch (25.4 mm) by 10.0 inches (254.0 mm). Drill a 1/8 inch diameter hole through the center of the steel strip.

(13) Assemble the patch and the spring steel strip with a 1/8 inch diameter temporary fastener.

E. Remove the Tedlar, if necessary, and make the underside of the inner skin rough to 0.50 inch (6.35 mm) all around from the edge of the oval-shaped hole. Use No. 180-grit or finer abrasive paper. Do not damage the ply fibers.

F. Clean the two bonding surfaces as given in Paragraph 4.E.(3)/REPAIR GENERAL

G. Bend up the ends of the spring steel strip and apply the BMS 5-109 adhesive to the patch.

H. Hold the ends of the spring steel strip up and put the patch through the oval hole. Turn the patch so that it is fully over the hole. Release the spring steel strip so that it holds the patch tightly against the inner skin.

I. Cure the adhesive as given in 51-70-04, REPAIR GENERAL Repair General, Figures 201 and 202, and Table 204.

J. Remove the temporary fastener and the spring steel strip. Fill the hole in the patch with BMS 5-109 or BMS 5-95, Class B-1/2 sealant and let it cure.

NOTE: Cure the BMS 5-109 adhesives as shown in 51-70-04, REPAIR GENERAL, Figures 201 and 202, and Table 204. Cure the BMS 5-95 sealant as given in 51-20-05.

K. Clean the repair area as given in Paragraph 4.E.(3)/REPAIR GENERAL

L. Prepare and apply the adhesive film and repair plies to the inner skin as given in Paragraph 4.J./REPAIR GENERAL and Paragraph 4.K./REPAIR GENERAL Cut all of the plies to the diameter D. Refer to Repair 5 - Layout of the Repair Parts, Figure 201/REPAIR 5.

M. Cut two plies of adhesive film 0.10 inch (2.54 mm) larger than diameter D. Refer to REPAIR GENERALTables 202 and 203 for the BMS type and class.

N. Do the steps which follow to apply the adhesive film and the repair plies:

(1) Remove the separator film from one ply of adhesive film and put the adhesive film on the mating surface of the inner skin.

(2) Remove the separator film from each subsequent preimpregnated repair ply and put each repair ply in sequence on the repair area with the correct ply warp orientation.

(3) Remove the separator film from the second ply of adhesive film or fiberglass and put the adhesive film on the repair plies.

O. Cut out, clean, and install the core repair plug as given in Paragraph 4.F./REPAIR GENERAL, Paragraph 4.G./REPAIR GENERAL, and Paragraph 4.H./REPAIR GENERAL

P. Clean the repair surface as given in Paragraph 4.E.(3)/REPAIR GENERAL

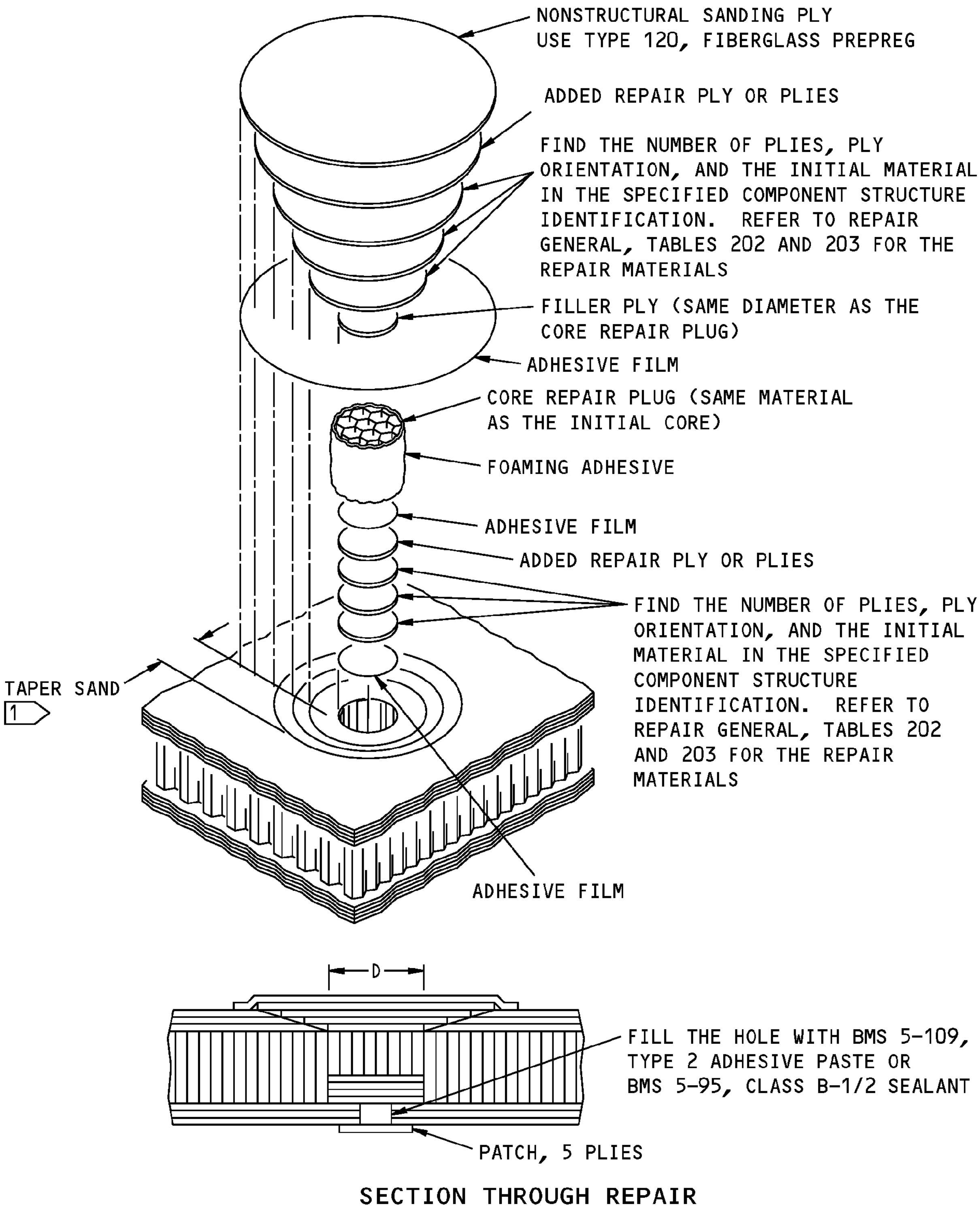
Q. Prepare and apply the repair plies to the outer skin as given in Paragraph 4.J./REPAIR GENERAL and Paragraph 4.K./REPAIR GENERAL

R. Install the vacuum bag system as given in Paragraph 4.L./REPAIR GENERAL

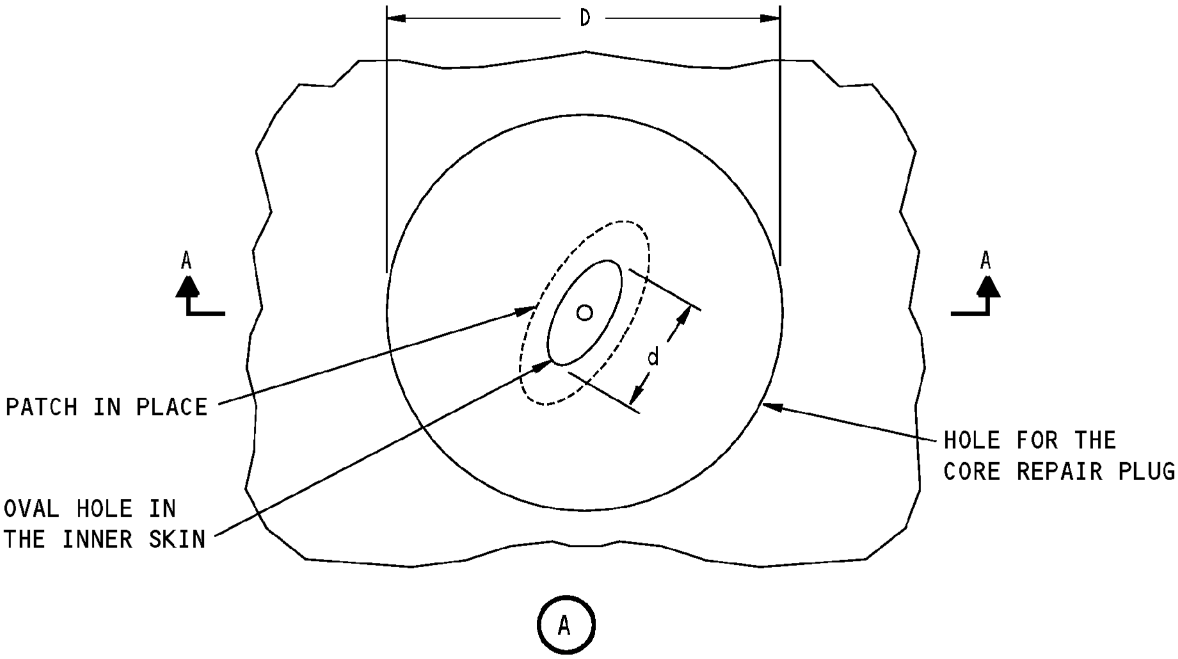
S. Cure the repair as given in Paragraph 4.M./REPAIR GENERAL

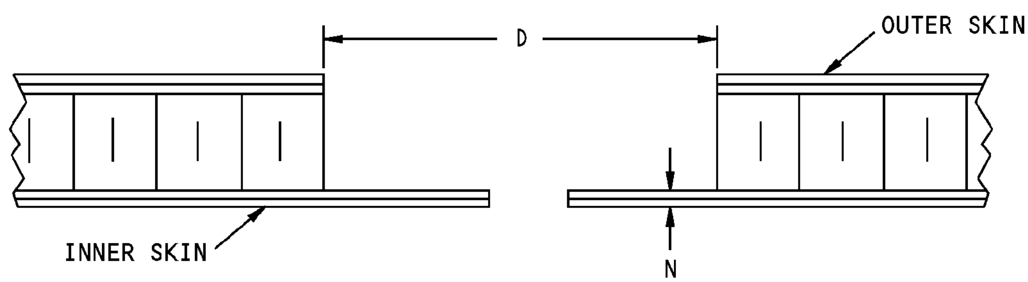
T. Examine the completed repair as given in Paragraph 4.N./REPAIR GENERAL

U. Apply the finish to the repair area as given in Paragraph 4.O./REPAIR GENERAL



Repair 5 - Layout of the Repair Parts
Figure 201 (Sheet 1 of 3)





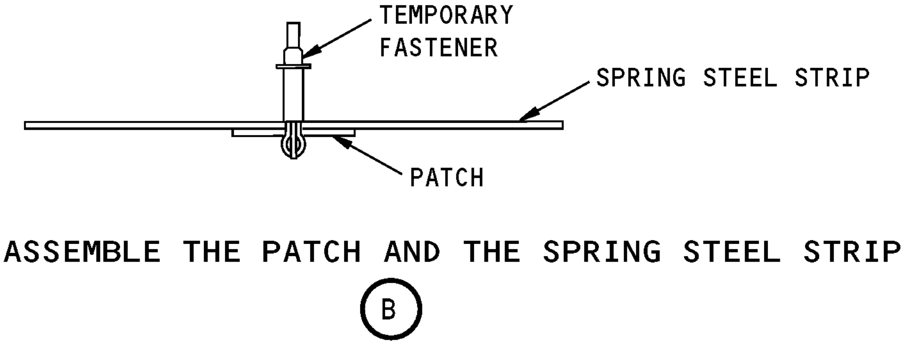
NOTE: D IN INCHES = d + N + 1 (D IN mm = d + N + 25.4).
d = LARGER DIAMETER OF THE OVAL HOLE IN THE INNER SKIN.
N = NUMBER OF PLIES IN THE INNER SKIN.
D = DIAMETER OF THE HOLE FOR THE CORE REPAIR PLUG.

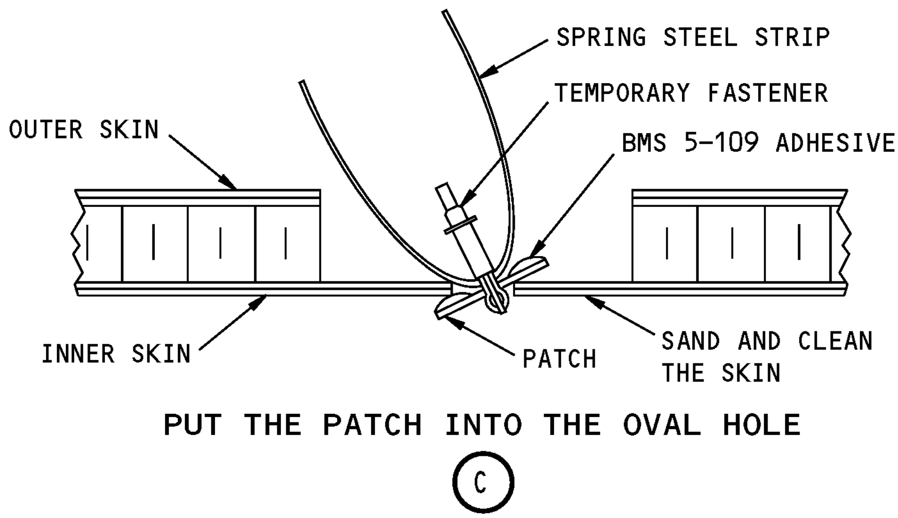
THE PATCH IS NOT SHOWN
A-A

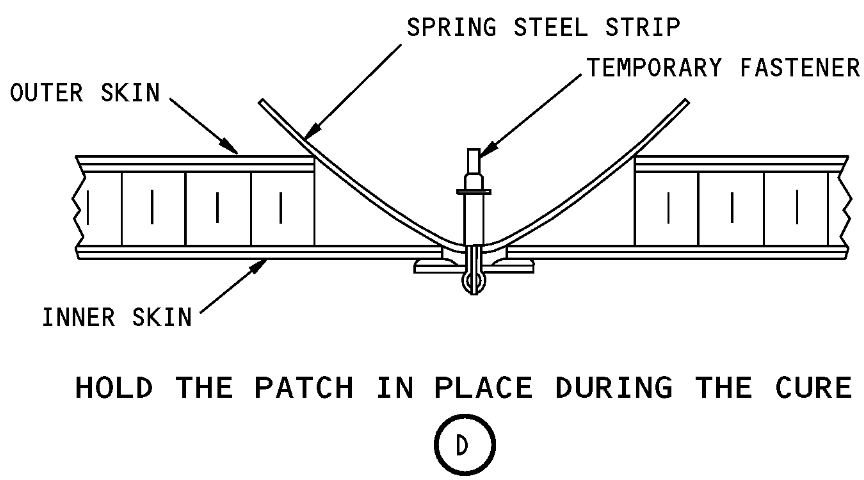
NOTES

1 REFER TO REPAIR GENERAL, FIGURES 202 AND 203 FOR THE NECESSARY TAPER AND OVERLAP

Repair 5 - Layout of the Repair Parts
Figure 201 (Sheet 2 of 3)







Repair 5 - Layout of the Repair Parts
Figure 201 (Sheet 3 of 3)

REPAIR 6 - REPAIR OF DAMAGE TO THE EDGEBAND OF A HONEYCOMB PANEL

1. Applicability

WARNING: MAKE SURE THAT THE FLIGHT CONTROL SURFACES ARE CORRECTLY BALANCED AFTER YOU REPAIR THEM. IF YOU DO NOT OBEY, FLUTTER CAN OCCUR AND CAUSE DAMAGE TO THE STRUCTURE. REFER TO SRM 51-60-00 FOR THE CONTROL SURFACE BALANCING PROCEDURES.

CAUTION: DO NOT USE 350°F (177°C) CURE REPAIR MATERIALS ON 250°F (121°C) CURED PARTS. IF YOU DO NOT OBEY, THE REPAIR WILL BE UNSATISFACTORY. REFER TO THE SPECIFIED COMPONENT REPAIR SUBJECT FOR THE MATERIALS AND PROCEDURES APPROVED FOR THIS REPAIR. IF YOU DO NOT OBEY, THE REPAIR WILL BE UNSATISFACTORY.

A. Repair 6 is applicable to damage goes fully through a honeycomb panel that is flat or almost flat.

B. Repair 6 is a typical repair that is applicable to all fiber reinforced laminates and honeycomb sandwich components.

C. Repair 6 is not applicable to radomes or floor panels. Refer to 53-10-72 for the data about radomes and 53-00-50 for data about floor panels.

2. General

A. Repair 6 is a Category A damage tolerant repair. Refer to 51-00-06 for the definitions of the different categories of repairs.

B. Refer to Repair 6 - Layout of the Repair Parts, Figure 201/REPAIR 6 for the layout of the repair parts.

3. References

Reference	Title
51-00-06	STRUCTURAL REPAIR DEFINITIONS
51-60-00, GENERAL	Control Surface Balance Procedures
53-00-50	FUSELAGE FLOOR PANELS
53-10-72	FUSELAGE NOSE RADOME - SECTION 41

4. Repair Instructions

A. Find the limits of the damage. Refer to Paragraph 4.A./REPAIR GENERAL

B. Remove the damaged plies as given in Paragraph 4.B./REPAIR GENERAL

C. Prepare the damaged area for the repair as given in Paragraph 4.E./REPAIR GENERAL

CAUTION: DO NOT SAND INTO THE CORE OR THE ADJACENT BOND PLY. REFER TO FIGURE 201. IF YOU DO NOT OBEY, A DECREASE IN THE STRUCTURAL STRENGTH OF THE COMPONENT CAN OCCUR.

D. Remove all contamination and water from the damaged area as given in Paragraph 4.D./REPAIR GENERAL Make sure the repair area is fully dry.

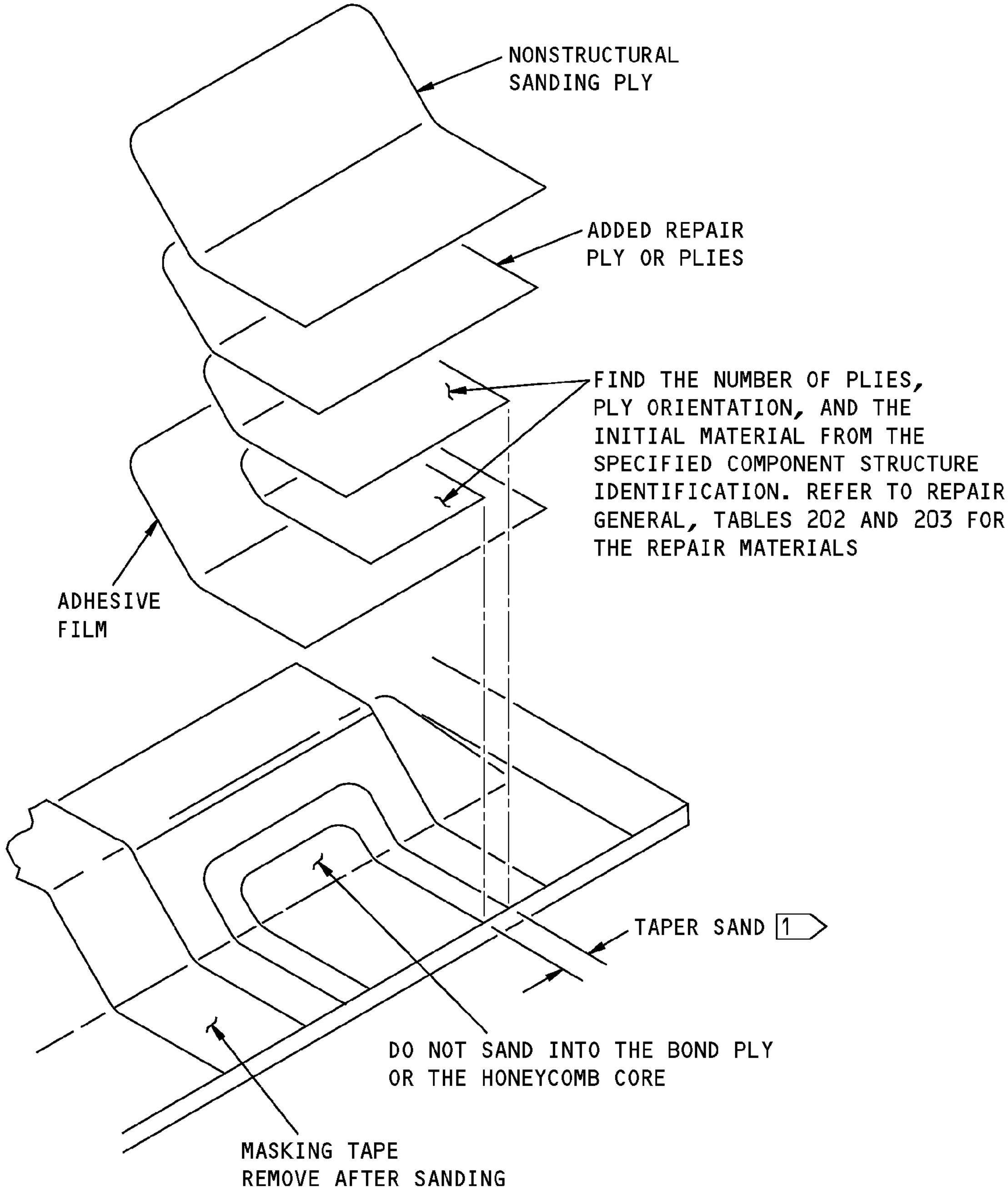
E. Prepare and apply the adhesive film and repair plies as given in Paragraph 4.J./REPAIR GENERAL and Paragraph 4.K./REPAIR GENERAL

F. Install the vacuum bag system as given in Paragraph 4.L./REPAIR GENERAL

G. Cure the repair as given in Paragraph 4.M./REPAIR GENERAL

H. Examine the completed repair as given in Paragraph 4.N./REPAIR GENERAL

I. Apply the finish to the repair area as given in Paragraph 4.O./REPAIR GENERAL



NOTES

1 REFER TO REPAIR GENERAL, FIGURES 202 AND 203 FOR THE NECESSARY TAPER AND OVERLAP.

Repair 6 - Layout of the Repair Parts
Figure 201

REPAIR 7 - REPAIR OF DAMAGE TO THE EDGEBAND AND THE HONEYCOMB CORE

1. Applicability

WARNING: MAKE SURE THAT THE FLIGHT CONTROL SURFACES ARE CORRECTLY BALANCED AFTER YOU REPAIR THEM. IF YOU DO NOT OBEY, FLUTTER CAN OCCUR AND CAUSE DAMAGE TO THE STRUCTURE. REFER TO SRM 51-60-00 FOR THE CONTROL SURFACE BALANCING PROCEDURES.

CAUTION: DO NOT USE 350°F (177°C) CURE REPAIR MATERIALS ON 250°F (121°C) CURED PARTS. IF YOU DO NOT OBEY, THE REPAIR WILL BE UNSATISFACTORY. REFER TO THE SPECIFIED COMPONENT REPAIR SUBJECT FOR THE MATERIALS AND PROCEDURES APPROVED FOR THIS REPAIR. IF YOU DO NOT OBEY, THE REPAIR WILL BE UNSATISFACTORY.

A. Repair 7 is applicable to damage to the edgeband and the honeycomb core.

B. Repair 7 is a typical repair that is applicable to all fiber reinforced laminates and honeycomb sandwich components.

C. Repair 7 is not applicable to radomes or floor panels. Refer to 53-10-72 for the data about radomes and 53-00-50 for the data about floor panels.

2. General

A. Repair 7 is a Category A damage tolerant repair. Refer to 51-00-06 for the definitions of the different categories of repairs.

B. Refer to Repair 7 - Layout of the Repair Parts, Figure 201/REPAIR 7 for the layout of the repair parts.

3. References

Reference	Title
51-00-06	STRUCTURAL REPAIR DEFINITIONS
51-60-00, GENERAL	Control Surface Balance Procedures
53-00-50	FUSELAGE FLOOR PANELS
53-10-72	FUSELAGE NOSE RADOME - SECTION 41

4. Repair Instructions

A. Find the limits of the damage. Refer to Paragraph 4.A./REPAIR GENERAL

B. Remove the damaged plies as given in Paragraph 4.B./REPAIR GENERAL

C. Prepare the damaged area for the repair as given in Paragraph 4.E./REPAIR GENERAL

D. Remove all the contamination and water from the damaged area as given in Paragraph 4.C./REPAIR GENERAL and Paragraph 4.D./REPAIR GENERAL Make sure the repair area is fully dry.

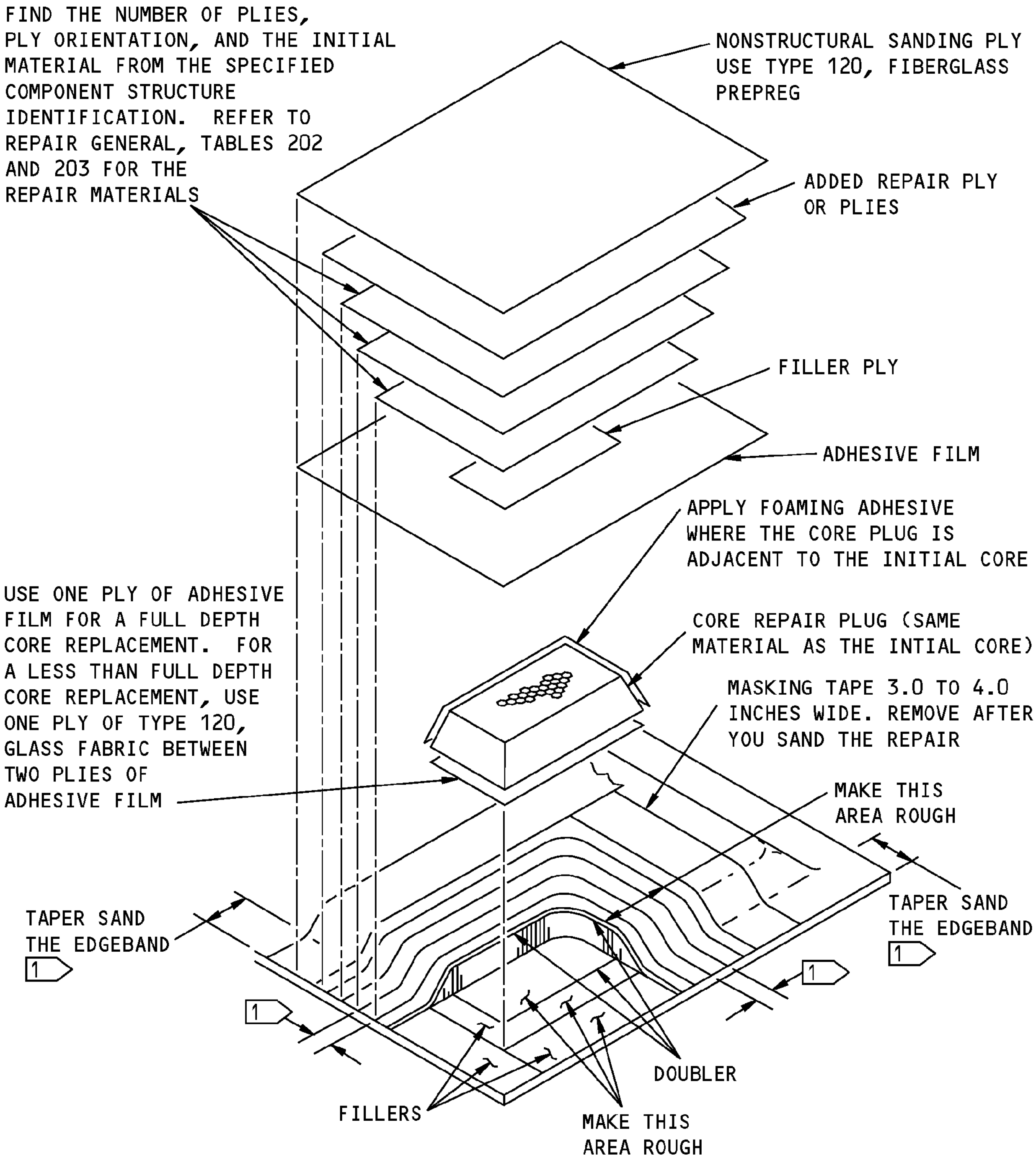
E. Cut out, clean, and install the core repair plug as given in Paragraph 4.F./REPAIR GENERAL, Paragraph 4.G./REPAIR GENERAL, and Paragraph 4.H./REPAIR GENERAL

F. Cure the honeycomb core plug as given in Paragraph 4.I./REPAIR GENERAL

G. Clean the repair surfaces as given in Paragraph 4.E.(3)/REPAIR GENERAL

H. Prepare and apply the adhesive film and repair plies as given in Paragraph 4.J./REPAIR GENERAL and Paragraph 4.K./REPAIR GENERAL

I. Install the vacuum bag system as given in Paragraph 4.L./REPAIR GENERAL
J. Cure the repair as given in Paragraph 4.M./REPAIR GENERAL
K. Examine the completed repair as given in Paragraph 4.N./REPAIR GENERAL
L. Apply the finish to the repair area as given in Paragraph 4.O./REPAIR GENERAL



NOTES

1 REFER TO REPAIR GENERAL, FIGURES 202 AND 203 FOR THE NECESSARY TAPER AND OVERLAP

Repair 7 - Layout of the Repair Parts
Figure 201

REPAIR 8 - REPAIR OF DAMAGE TO A FASTENER HOLE WITH PREPREG MATERIALS

1. Applicability

WARNING: MAKE SURE THAT FLIGHT CONTROL SURFACES ARE CORRECTLY BALANCED AFTER THEY ARE REPAIRED. IF YOU DO NOT OBEY, FLUTTER CAN OCCUR AND THE RESULT CAN BE A STRUCTURAL FAILURE.

CAUTION: REFER TO THE SPECIFIC COMPONENT REPAIR SUBJECT FOR THE MATERIALS AND PROCEDURES APPROVED FOR THIS REPAIR. IF YOU DO NOT OBEY, THE REPAIR CAN BE UNSATISFACTORY.

A. Repair 8 is a typical repair that is applicable to damage to a fastener hole.

B. Repair 8 can be used to repair a fastener hole that does not align with the mating structure.

C. Repair 8 is not applicable to radomes and floor panels. Refer to 53-10-72 for radomes and 53-00-50 for floor panels.

2. General

A. Repair 8 is a Category A damage tolerant repair. Refer to 51-00-06 for the definitions of the different categories of repairs.

B. Refer to Repair 8 - Layout of the Repair Parts, Figure 201/REPAIR 8 for the layout of the repair parts.

3. References

Reference	Title
51-00-06	STRUCTURAL REPAIR DEFINITIONS
51-40-02	FASTENER INSTALLATION AND REMOVAL
51-60-00	CONTROL SURFACE BALANCING
53-00-50	FUSELAGE FLOOR PANELS
53-10-72	FUSELAGE NOSE RADOME - SECTION 41

4. Repair Instructions

A. Find the limits of the damage. Refer to Paragraph 4./REPAIR GENERAL

B. Taper sand around the hole to remove the damage as given in Paragraph 4./REPAIR GENERAL

C. Remove all contamination and water from the damaged area as given in Paragraph 4./REPAIR GENERAL Make sure the repair area is fully dry.

D. Clean the repair surfaces as given in Paragraph 4./REPAIR GENERAL

E. Prepare and install the repair plies as given in Paragraph 4./REPAIR GENERAL

F. Install the vacuum bag system as given in Paragraph 4./REPAIR GENERAL

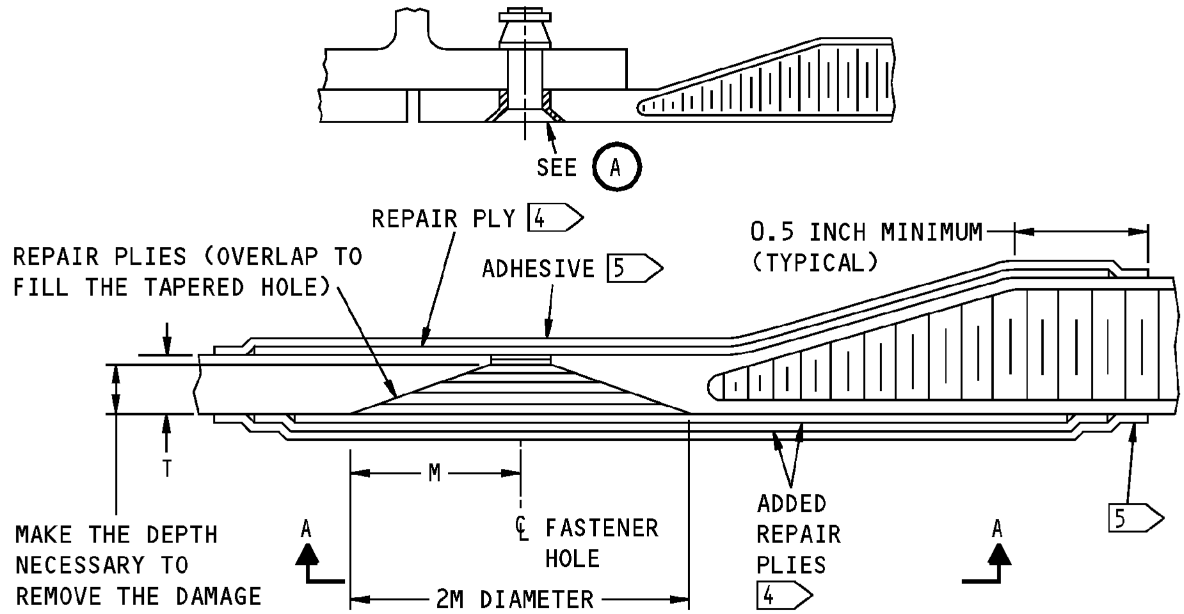
G. Cure the repair as given in Paragraph 4./REPAIR GENERAL

H. Drill and countersink the fastener holes. Refer to 51-40-02.

I. Do an inspection of the completed repair as given in Paragraph 4./REPAIR GENERAL

J. Apply the finish to the repair area as given in Paragraph 4./REPAIR GENERAL

K. If you repair a flight control surface, do a check to see if a re-balance to the control surface is necessary. If necessary, refer to 51-60-00 for the re-balance procedures.



REPAIR OF HONEYCOMB PANEL IS SHOWN
REPAIR OF THE SOLID LAMINATE PANEL IS THE SAME

A

NOTES

- THIS REPAIR IS APPLICABLE TO PANELS WITH UP TO 50% OF THE FASTENER HOLES DAMAGED ON EACH SIDE IF:
  - THE DIAMETER OF THE HOLES IS NOT LARGER THAN 1.5 TIMES THE INITIAL HOLE DIAMETER
  - THE PANEL IS ATTACHED TO THE STRUCTURE SUCH AS RIBS AND STRINGERS, BUT NOT TO A FITTING.
  - THE DISTANCE BETWEEN ADJACENT FASTENERS IS MORE THAN 5D (D = THE FASTENER DIAMETER)
- M = 5T MAXIMUM AS SHOWN, WHERE T IS THE THICKNESS OF THE EDGEBAND. DO NOT CUT INTO THE CORE. D = THE FASTENER DIAMETER.

1 INSTALL THE FILLER PLIES AS NECESSARY TO FILL THE DAMAGED AREA.

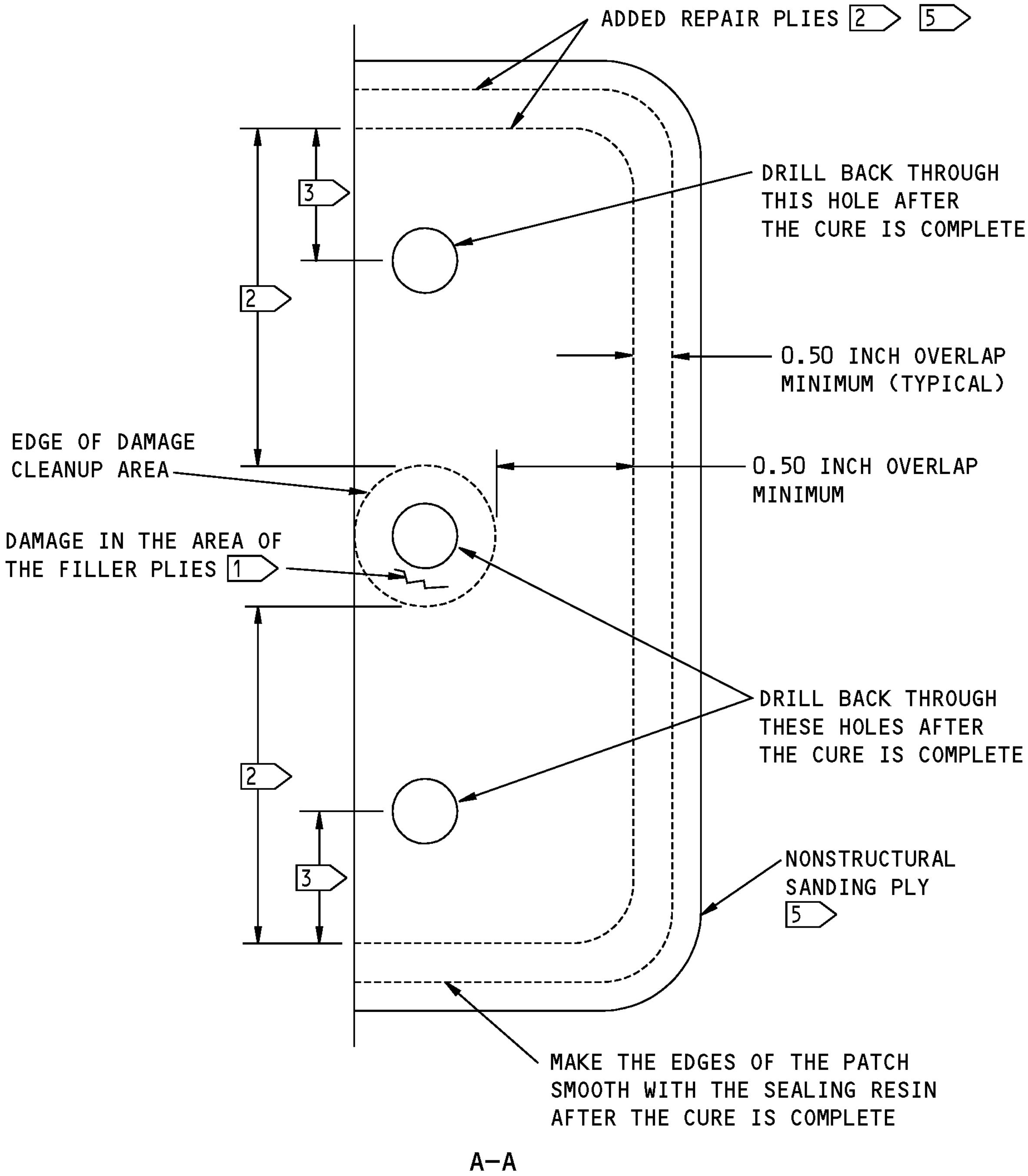
2 CUT THE ADDED REPAIR PLY AT LEAST 0.50 INCH MORE ALL AROUND THAN THE DAMAGED AREA.

3 CUT THE ADDED REPAIR PLY TO KEEP THE INITIAL FASTENER EDGE MARGIN, EXCEPT IT MUST NOT BE LESS THAN 2.5D (D = THE FASTENER DIAMETER) + 0.05 INCH.

4 ALIGN THE ADDED REPAIR PLIES IN THE SAME DIRECTION AS THE INITIAL OUTER PLY.

5 USE BMS 8-79 FIBERGLASS PREPREG OR BMS 5-129, TYPE 2, GRADE 10.

Repair 8 - Layout of the Repair Parts
Figure 201 (Sheet 1 of 2)



Repair 8 - Layout of the Repair Parts
Figure 201 (Sheet 2 of 2)

REPAIR 9 - REPAIR OF DAMAGE THAT IS 0.50 INCH (12.70 MM) OR LESS TO SOLID LAMINATES OR A FASTENER HOLE

1. Applicability

WARNING: MAKE SURE THAT THE FLIGHT CONTROL SURFACES ARE CORRECTLY BALANCED AFTER YOU REPAIR THEM. IF YOU DO NOT OBEY, FLUTTER CAN OCCUR AND CAUSE DAMAGE TO THE STRUCTURE. REFER TO SRM 51-60-00 FOR THE CONTROL SURFACE BALANCING PROCEDURES.

CAUTION: DO NOT USE 350°F (177°C) CURE REPAIR MATERIALS ON 250°F (121°C) CURED PARTS. IF YOU DO NOT OBEY, THE REPAIR WILL BE UNSATISFACTORY. REFER TO THE SPECIFIED COMPONENT REPAIR SUBJECT FOR THE MATERIALS AND PROCEDURES APPROVED FOR THIS REPAIR. IF YOU DO NOT OBEY, THE REPAIR WILL BE UNSATISFACTORY.

A. Repair 9 is applicable to the repair of fastener holes that do not align with the mating structure or to other holes that are damaged.

B. Repair 9 is a typical repair that is applicable to all fiber reinforced laminate components.

C. Repair 9 is not applicable to radomes or floor panels. Refer to 53-10-72 for the data about radomes and 53-00-50 for the data about floor panels.

D. Repair 9 is not applicable to thrust reverser or strut fairing panels.

2. General

A. Repair 9 is a Category A damage tolerant repair. Refer to 51-00-06 for the definitions of the different categories of repairs.

B. Refer to Repair 9 - Layout of the Repair Parts, Figure 201/REPAIR 9 for the layout of the repair parts.

3. References

Reference	Title
51-00-06	STRUCTURAL REPAIR DEFINITIONS
51-20-07	MACHINING AND DRILLING OF COMPOSITE STRUCTURES
51-60-00, GENERAL	Control Surface Balance Procedures
51-70-04, REPAIR GENERAL	Repair Procedures for Wet Layup Materials
53-00-50	FUSELAGE FLOOR PANELS
53-10-72	FUSELAGE NOSE RADOME - SECTION 41

4. Repair Instructions

A. Find the limits of the damage. Refer to Paragraph 4.A./REPAIR GENERAL

B. Remove the damage as given in Paragraph 4.B./REPAIR GENERAL

C. Clean the repair area as given in Paragraph 4.E.(3)/REPAIR GENERAL

D. Make a mixture of laminating resin and chopped fibers. Use 1 part of laminating resin to 1 part of chopped fibers by weight. Refer to 51-70-04, REPAIR GENERAL, Tables 202, 203, and 204 for laminating resin data.

E. Fill the hole level with or a small height above the initial surface around it with the laminating resin and chopped fibers.

F. Cure the repair as given in 51-70-04, REPAIR GENERAL, Figure 208. A vacuum is not necessary for this step.

G. If the fastener holes were filled, drill and countersink the fastener holes. Refer to 51-20-07 for hole drilling and machining of composite structure.

H. Make the surface of the repair smooth with the initial surface around the repair with abrasive paper.

NOTE: Use a 0.01 inch (0.25 mm) thick aluminum template to prevent damage to the area around the repair when you use the abrasive paper.

I. Make the surface around the repair rough with No. 150-grit or smaller abrasive paper.

J. Clean the repair area as given in Paragraph 4.E.(3)/REPAIR GENERAL

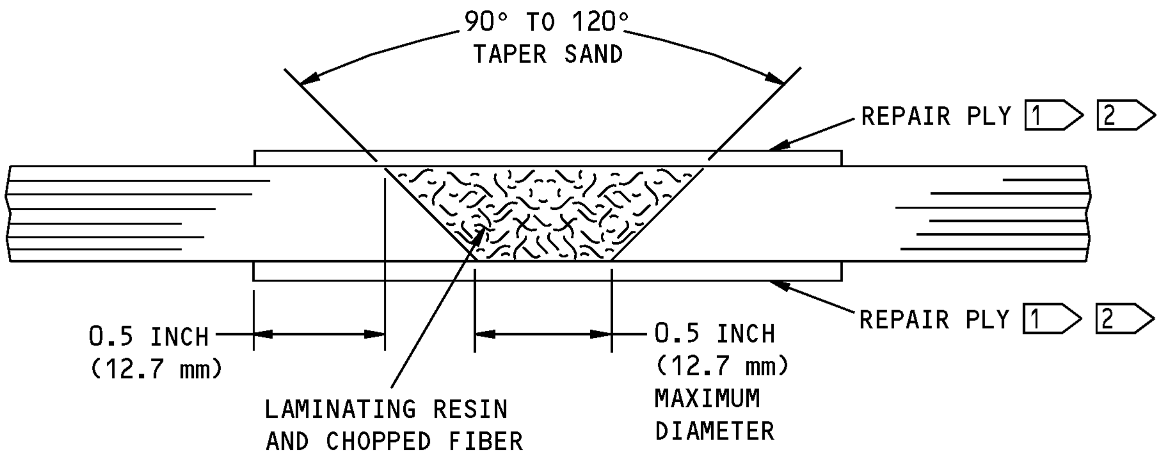
K. Prepare and apply the fabric repair plies as given in Paragraph 4.J./REPAIR GENERAL and Paragraph 4.K./REPAIR GENERAL

L. Install the vacuum bag system as given in Paragraph 4.L./REPAIR GENERAL

M. Cure the repair as given in Paragraph 4.M./REPAIR GENERAL

N. Examine the completed repair as given in Paragraph 4.N./REPAIR GENERAL

O. Apply the finish to the repair area as given in Paragraph 4.O./REPAIR GENERAL



NOTES

1 PREPARE AND APPLY ONE PLY OF BMS 9-3, TYPE H2 OR H3 GLASS FABRIC AS GIVEN IN SRM 51-70-04, REPAIR GENERAL, PARAGRAPH 4.

2 THIS PLY IS NOT NECESSARY IF THE HOLE IS COVERED BY A DIFFERENT REPAIR.

Repair 9 - Layout of the Repair Parts
Figure 201

REPAIR 10 - REPAIR OF DAMAGE THAT IS MORE THAN 0.50 INCH (12.70 MM) IN DIAMETER TO SOLID LAMINATES

1. Applicability

WARNING: MAKE SURE THAT THE FLIGHT CONTROL SURFACES ARE CORRECTLY BALANCED AFTER YOU REPAIR THEM. IF YOU DO NOT OBEY, FLUTTER CAN OCCUR AND CAUSE DAMAGE TO THE STRUCTURE. REFER TO SRM 51-60-00 FOR THE CONTROL SURFACE BALANCING PROCEDURES.

CAUTION: DO NOT USE 350°F (177°C) CURE REPAIR MATERIALS ON 250°F (121°C) CURED PARTS. IF YOU DO NOT OBEY, THE REPAIR WILL BE UNSATISFACTORY. REFER TO THE SPECIFIED COMPONENT REPAIR SUBJECT FOR THE MATERIALS AND PROCEDURES APPROVED FOR THIS REPAIR. IF YOU DO NOT OBEY, THE REPAIR WILL BE UNSATISFACTORY.

A. Repair 10 is applicable to damage to solid laminates that is more than 0.50 inch (12.70 mm) in diameter.

B. Repair 10 is a typical repair that is applicable to all fiber reinforced laminate components.

C. Repair 10 is not applicable to radomes or floor panels. Refer to 53-10-72 for the data about radomes and 53-00-50 for the data about floor panels.

2. General

A. Repair 10 is a Category A repair. Refer to 51-00-06 for the definitions of the different categories of repairs.

3. References

Reference	Title
51-00-06	STRUCTURAL REPAIR DEFINITIONS
51-60-00, GENERAL	Control Surface Balance Procedures
53-00-50	FUSELAGE FLOOR PANELS
53-10-72	FUSELAGE NOSE RADOME - SECTION 41

4. Repair Instructions

A. Find the limits of the damage. Refer to Paragraph 4.A./REPAIR GENERAL

B. Remove the damaged plies as given in Paragraph 4.B./REPAIR GENERAL

C. Prepare the damaged area for the repair as given in Paragraph 4.E./REPAIR GENERAL

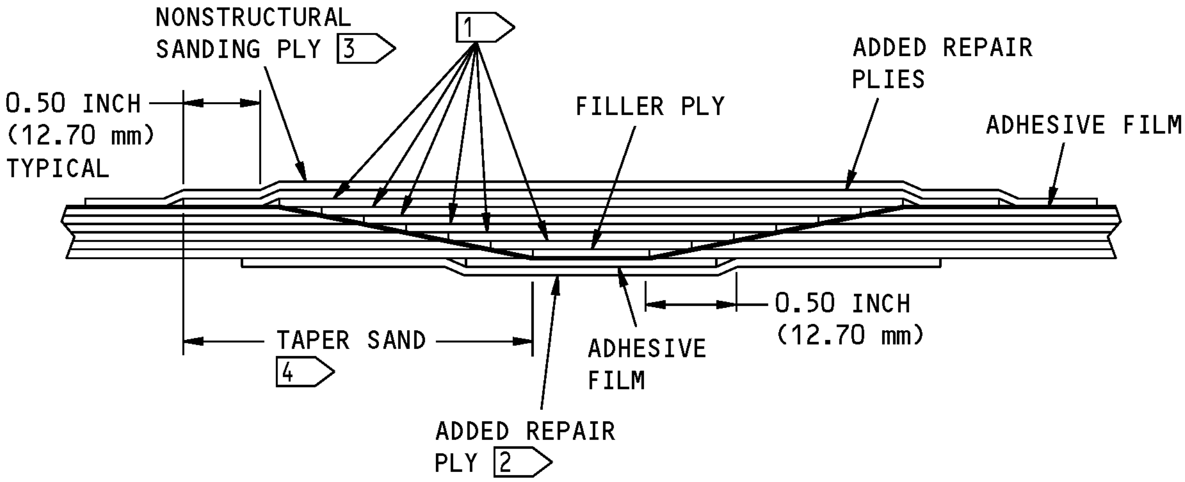
D. Prepare and apply the adhesive film and fabric repair plies as given in Paragraph 4.J./REPAIR GENERAL and Paragraph 4.K./REPAIR GENERAL

E. Install the vacuum bag system as given in Paragraph 4.L./REPAIR GENERAL

F. Cure the repair as given in Paragraph 4.M./REPAIR GENERAL

G. Examine the completed repair as given in Paragraph 4.N./REPAIR GENERAL

H. Apply the finish to the repair area as given in Paragraph 4.O./REPAIR GENERAL



NOTES

1 FIND THE NUMBER OF PLIES, PLY ORIENTATION, AND THE INITIAL MATERIAL IN THE SPECIFIED COMPONENT STRUCTURE IDENTIFICATION. REFER TO REPAIR GENERAL, TABLES 202 AND 203 FOR THE REPAIR MATERIAL.

2 USE ADDED REPAIR PLIES AT THIS LOCATION ONLY IF THE DAMAGE GOES THROUGH THIS SURFACE.

3 PUT ONE PLY OF ADHESIVE FILM OVER THE AREA BEFORE YOU APPLY THE REPAIR PLIES. PUT ONE PLY OF TYPE 120, GLASS FABRIC OVER THE REPAIR.

4 REFER TO REPAIR GENERAL, FIGURES 202 AND 203 FOR THE NECESSARY TAPER AND OVERLAP.

Repair 10 - Layout of the Repair Parts
Figure 201

REPAIR 11 - POTTED CORE REPAIR

1. Applicability

WARNING: MAKE SURE THAT THE FLIGHT CONTROL SURFACES ARE CORRECTLY BALANCED AFTER YOU REPAIR THEM. IF YOU DO NOT OBEY, FLUTTER CAN OCCUR AND CAUSE DAMAGE TO THE STRUCTURE. REFER TO SRM 51-60-00 FOR THE CONTROL SURFACE BALANCING PROCEDURES.

CAUTION: DO NOT USE 350°F (177°C) CURE REPAIR MATERIALS ON 250°F (121°C) CURED PARTS. IF YOU DO NOT OBEY, THE REPAIR WILL BE UNSATISFACTORY. REFER TO THE SPECIFIED COMPONENT REPAIR SUBJECT FOR THE MATERIALS AND PROCEDURES APPROVED FOR THIS REPAIR. IF YOU DO NOT OBEY, THE REPAIR WILL BE UNSATISFACTORY.

A. Repair 11 is applicable as an alternative repair for damage to honeycomb core only. You must remove and repair the skin plies as given in Repair 2.

B. Repair 11 is a typical repair that is applicable to all fiber reinforced honeycomb sandwich components.

C. Repair 11 is not applicable to radomes or floor panels. Refer to 53-10-72 for the data about radomes and 53-00-50 for the data about floor panels.

2. General

A. Repair 11 is a Category A damage tolerant repair. Refer to 51-00-06 for the definitions of the different categories of repairs.

B. Refer to Repair 11 - Layout of the Repair Parts, Figure 201/REPAIR 11 for the layout of the repair parts.

3. References

Reference	Title
51-00-06	STRUCTURAL REPAIR DEFINITIONS
51-60-00, GENERAL	Control Surface Balance Procedures
51-70-04, REPAIR GENERAL	Repair Procedures for Wet Layup Materials
53-00-50	FUSELAGE FLOOR PANELS
53-10-72	FUSELAGE NOSE RADOME - SECTION 41

4. Repair Instructions

A. Fill the open core with BMS 5-28 Type 6 or 7 potting compound. Use more potting compound than is necessary so that the level is higher than the level of the core. The potting compound will be sanded level with the core after it is cured.

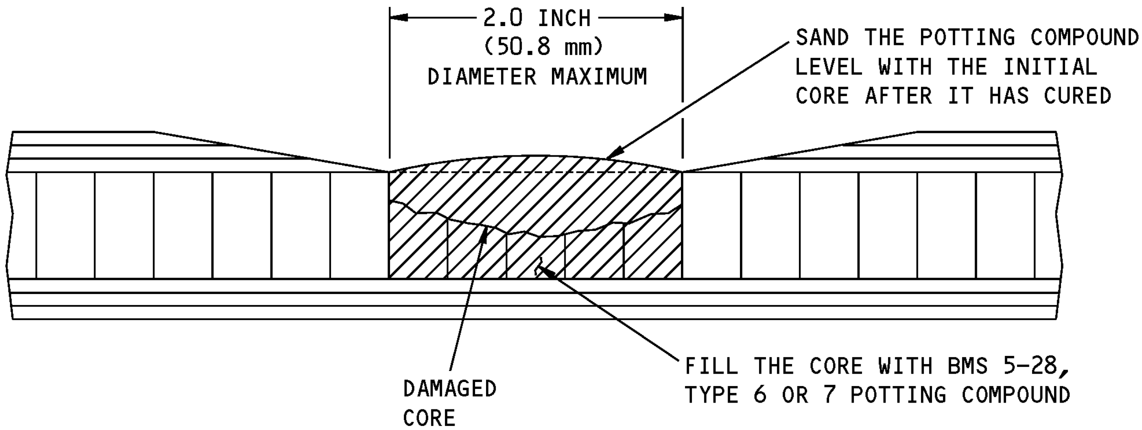
NOTE: Fill the core cavity from the bottom up to fill it fully.

B. Cure the potting compound. Refer to 51-70-04, REPAIR GENERAL, Table 204.

C. Sand the potting compound smooth to the level of the initial core.

D. Clean the repair area. Refer to Paragraph 4.E.(3)/REPAIR GENERAL

E. Repair the skin plies that you removed as given in Repair 2.



Repair 11 - Layout of the Repair Parts
Figure 201

REPAIR 12 - REPAIR OF A TRAILING EDGE PANEL WITH FULL DEPTH HONEYCOMB CORE

1. Applicability

WARNING: MAKE SURE THAT THE FLIGHT CONTROL SURFACES ARE CORRECTLY BALANCED AFTER YOU REPAIR THEM. IF YOU DO NOT OBEY, FLUTTER CAN OCCUR AND CAUSE DAMAGE TO THE STRUCTURE. REFER TO SRM 51-60-00 FOR THE CONTROL SURFACE BALANCING PROCEDURES.

CAUTION: DO NOT USE 350°F (177°C) CURE REPAIR MATERIALS ON 250°F (121°C) CURED PARTS. IF YOU DO NOT OBEY, THE REPAIR WILL BE UNSATISFACTORY. REFER TO THE SPECIFIED COMPONENT REPAIR SUBJECT FOR THE MATERIALS AND PROCEDURES APPROVED FOR THIS REPAIR. IF YOU DO NOT OBEY, THE REPAIR WILL BE UNSATISFACTORY.

A. Repair 12 is applicable the trailing edge panel made with full depth honeycomb core.

B. Repair 12 is a typical repair that is applicable to all fiber reinforced laminates and honeycomb sandwich components.

C. Repair 12 is not applicable to radomes or floor panels. Refer to 53-10-72 for the data about radomes and 53-00-50 for the data about floor panels.

2. General

A. Repair 12 is a Category A damage tolerant repair. Refer to 51-00-06 for the definitions of the different categories of repairs.

B. Repair 12 is a two-step repair.

(1) Step 1 is a repair sequence that is used for the lower surface and the honeycomb core.

(2) Step 2 is a repair sequence that is used for the upper skin and the solid laminate wedge.

C. Refer to Repair 12 - Layout of the Repair Parts, Figure 201/REPAIR 12 for the layout of the repair parts.

3. References

Reference	Title
51-00-06	STRUCTURAL REPAIR DEFINITIONS
51-60-00, GENERAL	Control Surface Balance Procedures
53-00-50	FUSELAGE FLOOR PANELS
53-10-72	FUSELAGE NOSE RADOME - SECTION 41

4. Repair Instructions

A. Step 1: Repair the lower surface and the honeycomb core with the steps that follow:

(1) Find the limits of the damage. Refer to Paragraph 4.A./REPAIR GENERAL

(2) Remove the damage as given in Paragraph 4.B./REPAIR GENERAL

NOTE: Do not taper-sand the upper surface skin plies during Step 1 of the repair.

(3) Remove all contamination and water from the damaged area as given in Paragraph 4.C./REPAIR GENERAL Make sure that the area is fully dry.

(4) Prepare the area for the repair as given is Paragraph 4.E./REPAIR GENERAL

(5) Clean the repair area as given in Paragraph 4.E.(3)/REPAIR GENERAL

(6) Put a caul plate on the upper surface.

NOTE: The size of the caul plate must be sufficiently large to be 2 inches (50.8 mm) more all around than the damage cutout. The caul plate must extend aft, past the initial trailing edge location.

(7) Cut out the honeycomb core plug as given in Paragraph 4.F./REPAIR GENERAL Sand the repair core to a thickness that will be level with the lower surface skin repair plies. Put a taper on the core to match the contour of the component.

NOTE: The honeycomb core repair wedge must extend aft of the initial trailing edge location to keep the lower surface contour. The core ribbon direction of the repair wedge must be in the same direction as the initial core ribbon direction.

(8) Clean the honeycomb core plug as given in Paragraph 4.G./REPAIR GENERAL

(9) Install the honeycomb core plug as given in Paragraph 4.H./REPAIR GENERAL

(10) Prepare and apply the adhesive film and repair plies as given in Paragraph 4.J./REPAIR GENERAL and Paragraph 4.K./REPAIR GENERAL, and Figure 201 (Sheet 2).

NOTE: Repair plies must extend past the initial trailing edge location.

(11) Install the vacuum bag system as given in Paragraph 4.L./REPAIR GENERAL

NOTE: Seal the caul plate to the lower surface or put the vacuum bag around the trailing edge.

(12) Cure the repair as given in Paragraph 4.M./REPAIR GENERAL

(13) Remove the vacuum bag system and caul plate.

(14) Examine Step 1 of the repair as given in Paragraph 4.N./REPAIR GENERAL

B. Step 2: Repair the upper surface and the solid laminate wedge with the steps that follow:

(1) Put the caul plate on the lower surface.

NOTE: The caul plate must be sufficiently large to be 1.0 inch (25.4 mm) more all around than the damage cutout. The caul plate must extend 1 inch (25.4 mm) aft, past the initial trailing edge location. Refer to Figure 201 (Sheet 3).

(2) Taper-sand the upper skin plies, the repair core wedge, and the initial laminate wedge plies to make space for the wedge repair plies and the upper surface skin repair plies. Refer to Paragraph 4.E./REPAIR GENERAL and Figure 201 (Sheet 3).

(3) Prepare the laminate wedge repair plies as given in Paragraph 4.J./REPAIR GENERAL

(4) Prepare the upper surface skin repair plies as given in Paragraph 4.J./REPAIR GENERAL

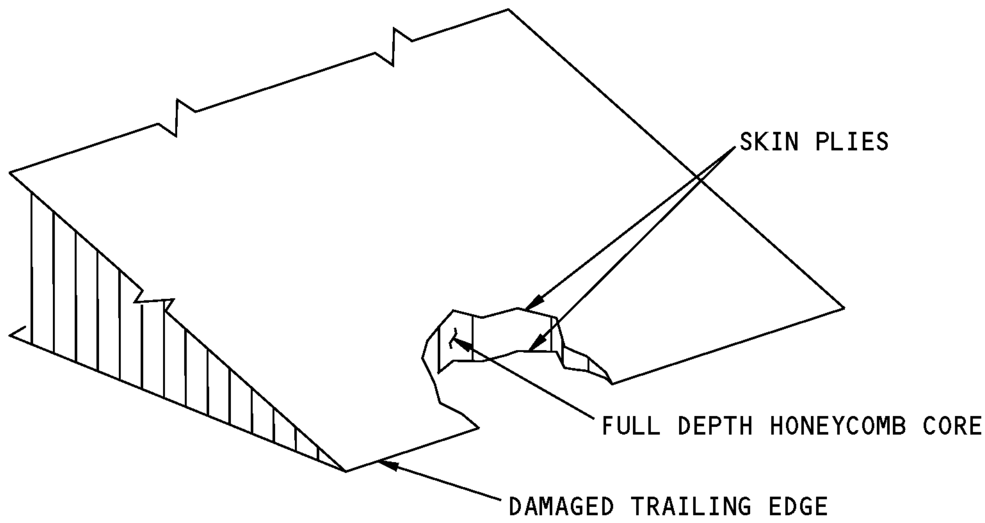
(5) Install the wedge adhesive film and repair plies and the upper surface skin repair plies as given in Paragraph 4.K./REPAIR GENERAL and Figure 201 (Sheet 1).

(6) Install the vacuum bag system as given in Paragraph 4.L./REPAIR GENERAL

(7) Cure the repair as given in Paragraph 4.M./REPAIR GENERAL

(8) Examine the completed repair as given in Paragraph 4.N./REPAIR GENERAL

(9) Apply the finish to the repair area as given in Paragraph 4.O./REPAIR GENERAL



NOTES

1 THE TRAILING EDGE OF THE CORE REPAIR WEDGE MUST EXTEND AFT, PAST THE INITIAL TRAILING EDGE. THE WEDGE MUST BE TAPERED TO THE CONTOUR OF THE LOWER SKIN SURFACE. THE RIBBON DIRECTION OF THE CORE REPAIR WEDGE MUST ALIGN WITH THE INITIAL CORE RIBBON DIRECTION.

2 THE REPAIR PLIES MUST EXTEND AFT, PAST THE INITIAL TRAILING EDGE LOCATION.

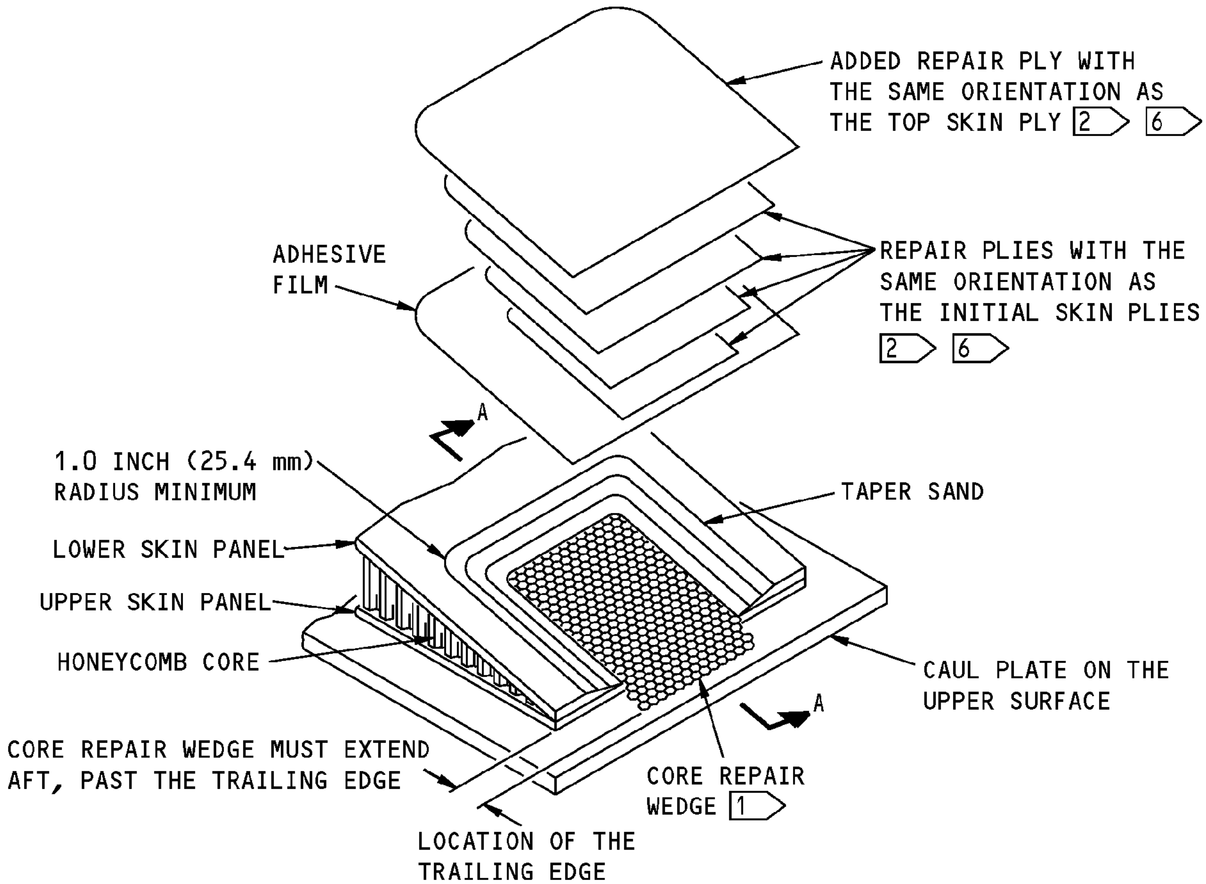
3 TAPER-SAND THE CORE REPAIR WEDGE TO MAKE SPACE FOR THE WEDGE REPAIR PLIES. DO NOT SAND INTO THE LOWER SKIN PLIES.

4 THE WEDGE REPAIR PLIES MUST USE THE SAME SPACE AS THE INITIAL WEDGE THAT WAS REMOVED. MAKE SPACE FOR THE UPPER SKIN REPAIR PLIES AND KEEP THE INITIAL CONTOUR OF THE UPPER SKIN SURFACE.

5 LAYUP THE WEDGE REPAIR PLIES AS FOLLOWS:
- 45° FOR THE PLY NEXT TO THE CORE.
- 0°,0°,45°,0°,0°,45° FOR ALL OTHER PLIES.
- DO THIS SEQUENCE AGAIN AS NECESSARY.

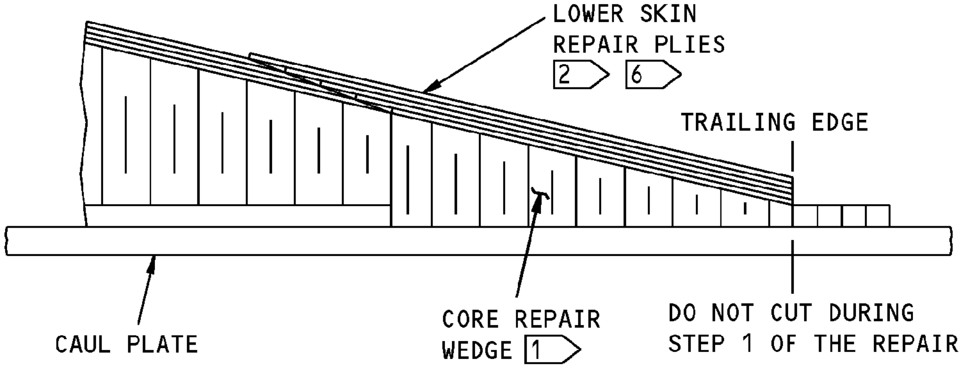
6 LAYUP THE REPAIR PLIES WITH THE SAME ORIENTATION AS THE INITIAL SKIN PLIES.

Repair 12 - Layout of the Repair Parts
Figure 201 (Sheet 1 of 3)



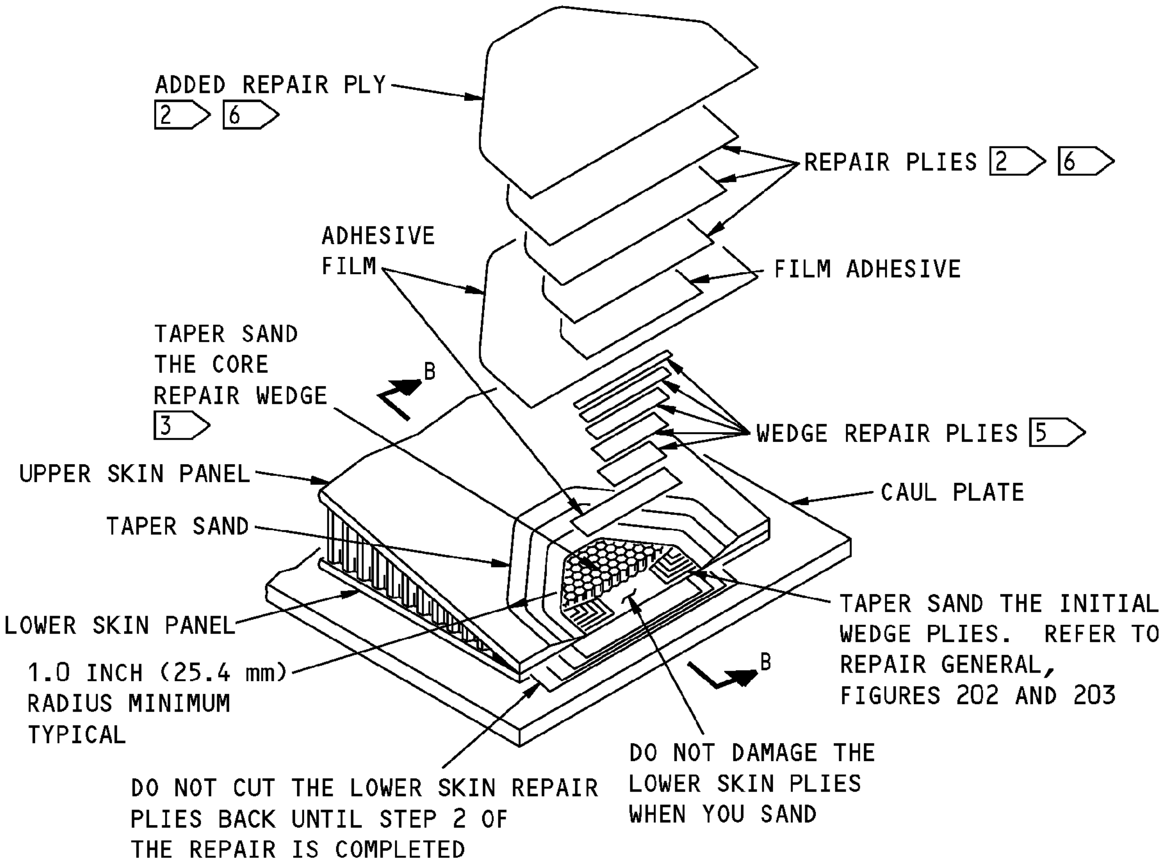
REPAIR OF THE LOWER SKIN PLIES AND THE TRAILING EDGE WEDGE
REPAIR STEP 1

A

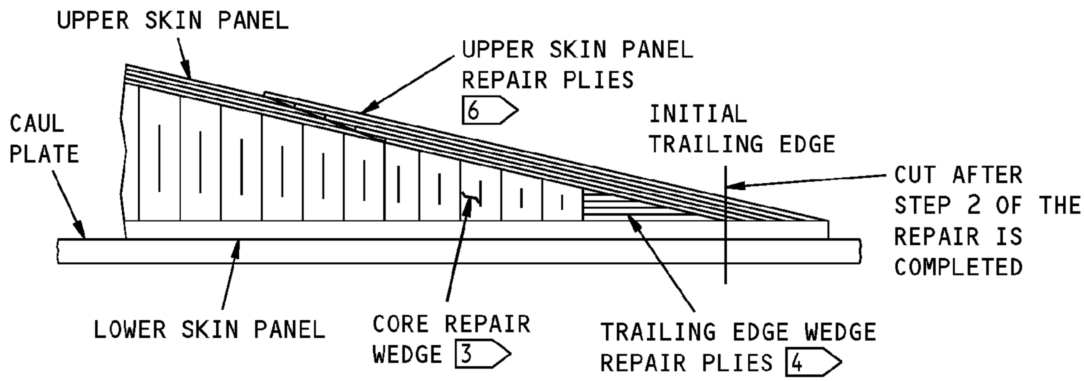


SECTION THROUGH THE REPAIR AFTER THE LAYUP
A-A

Repair 12 - Layout of the Repair Parts
Figure 201 (Sheet 2 of 3)



REPAIR OF THE UPPER SKIN PLIES AND THE TRAILING EDGE WEDGE
REPAIR STEP 2
B



SECTION THROUGH THE REPAIR AFTER THE LAYUP
B-B

Repair 12 - Layout of the Repair Parts
Figure 201 (Sheet 3 of 3)

REPAIR GENERAL - ROOM TEMPERATURE CURE REPAIRS WITH WET LAYUP MATERIALS FOR GLASS FABRIC REINFORCED PLASTIC SOLID LAMINATES AND HONEYCOMB CORE PANELS

1. **Applicability**

   A. This subject contains room temperature cure repair data applicable to components made from Glass Fiber Reinforced Plastic (GFRP).

2. **General**

   CAUTION: REFER TO THE APPLICABLE COMPONENT STRUCTURAL REPAIR SUBJECT FOR THE COMPONENT MATERIAL AND REPAIR LIMITS BEFORE YOU DO THESE REPAIR PROCEDURES. REPAIRS THAT USE THE ROOM TEMPERATURE CURE CYCLE DO NOT HAVE THE STRENGTH OR DURABILITY OF COMPONENTS INITIALLY MADE FROM 350°F (177°C) OR 250°F (121°C) CURE MATERIALS. USE ONLY THE REPAIRS THAT ARE PERMITTED BY THE APPLICABLE STRUCTURAL REPAIR SECTION. IF YOU DO NOT OBEY, THE REPAIR CAN BE UNSATISFACTORY.

   A. Repair General is applicable to damage that is more than the allowable damage limits given in the Chapter-Section-Subject of the damage part. Refer to the Chapter-Section-Subject of the damage part for:

      (1) The type and size of the damage that is permitted

      (2) The types of repairs that are permitted and the repair limits.

   B. The repairs in this subject are cured at room temperature and use wet layup materials.

   C. The repairs in this subject do not put the structure back to its initial strength or durability. An inspection plan for the repaired area can be necessary. Refer to the repair subject of the specified component for the necessary inspections and time limits on these repairs.

   D. Refer to Table 201/REPAIR GENERAL for an index of the different numbered repairs found in this subject.

   E. Make sure you do the repair in a clean area. Do not do these repairs in locations where the air contains oil mist, exhaust fumes, gasses, soot, rain, dust, or other unwanted materials. You can use a tent to isolate the repair location from contamination.

   F. Prevent contamination of the repair surface. Do not touch the cleaned parts or the adhesives with your bare hands. Wear clean, lint free gloves when you work with these parts.

   G. Refer to 51-00-07 for the definitions of the terms used in the Structural Repair Manual (SRM).

   H. Refer to Table 202/REPAIR GENERAL for the list of materials used in these repairs.

   I. Refer to Table 203/REPAIR GENERAL for the resin, adhesive, and potting compound data. Refer to 51-30-03 for a list of alternative materials.

Table 201:

REPAIR INDEX	
REPAIR NUMBER	TITLE
1	Repair of Damage to One Facesheet of a Honeycomb Panel
2	Repair of Damage That is 0.50 Inch or Less in Diameter to One Facesheet and the Core of a Honeycomb Panel
3	Repair of Damage to One Facesheet and the Core of a Honeycomb Panel
4	Repair of Damage to the Two Facesheets and the Core of a Honeycomb Panel
5	Repair of Damage to the Two Facesheets and the Core of a Honeycomb Panel With Access Limited to One Side

REPAIR INDEX	
REPAIR NUMBER	TITLE
6	Repair of delamination at an Edgeband of a Honeycomb Panel
7	Repair of Damage to the Plies on an Edge of a Honeycomb Panel
8	Repair of Damage to the Core on the Edge of a Honeycomb Panel
9	Repair of a Damaged Fastener Hole in a Honeycomb Panel or a Solid Laminate Panel
10	Repair of Damage That is 0.50 Inch or Less In Diameter to a Solid Laminate Panel
11	Repair of Damage That is More Than 0.50 Inch in Diameter to a Solid Laminate Panel
12	Repair of Dents in Honeycomb Panels
13	Repair of Lightning Strike Damage at the Trailing Edge of a Honeycomb Panel
14	Repair of Small Damage to One Facesheet of a Honeycomb Panel
15	Repair of Erosion Damage at the Edge of a Solid Laminate or Honeycomb Panel

Table 202:

REPAIR MATERIALS	
REPAIR MATERIALS	BOEING SPECIFICATION
Resin Mix 1 - Laminating Resin for Glass Fiber Repair Fabric	BMS 8-301, Class 2
Resin Mix 2 - Potting Compound	BMS 5-28, Type 7
Resin Mix 3	Resin Mix 2 mixed with microballoons
Resin Mix 4	Resin Mix 1 mixed with milled glass fibers
Resin Mix 5	Resin Mix 2 mixed with milled glass fibers
Resin Mix 6 - Sealing Resin	BMS 8-207, Type 1, Class 1 EC1838A Resin EC1838B Hardener
Resin Mix 6 - Sealing Resin	BMS 8-207, Type 1, Class 2 FR-40 Resin FR-5413C Hardener
Resin Mix 6 - Sealing Resin	Epibond 156A Resin Epibond 941 Hardener Epibond 156 Resin Epibond 156B Hardener FR 5318S Resin FR 5318C Hardener Epox-O Weld
Glass Fiber Repair Fabric	BMS 9-3, Type D, D-1, H-2 or H-3
Sealing Resin for Repair 13	BMS 8-207, Type 1, Classes I and II and other materials. Refer to Table 203
Honeycomb Repair Core	Use the same material as the initial core
Sealant	BMS 5-95, Class B-1/2
Adhesive Paste	BMS 5-25, Type II, Grade 1
Adhesive Paste	BMS 5-92, Type I
Adhesive Paste	BMS 5-109, Type II

Table 203:

RESIN AND POTTING COMPOUND DATA				
RESIN TYPE	**COMPONENTS**	**PARTS BY WEIGHT**	**POT LIFE**	**CURE TIME AT ROOM TEMPERATURE**
Resin Mix 1 BMS 8-301, Class 2 - Laminating Resin	EY3804 Resin - Part A Hardener - Part B	100 ±2% 66 ±2%	45 minutes	5 days
Resin Mix 2 BMS 5-28, Type 7 - Potting Compound	Epocast 89537 Part A Epocast 89537 Part B	100 ±1 22 ±1	60 minutes	12 hours
	CG-1305 Resin CG-1305 Hardener	100 ±5 22 ±1		
	FR 7162 Resin FR 7162 Hardener	100 ±5 40 ±2		
Resin Mix 3	Resin Mix 2 mixed with Microballoons	100 5	60 minutes	Same as Resin Mix 2
Resin Mix 4	Resin Mix 1 mixed with Milled Glass Fibers	80 20	45 minutes	Same as Resin Mix 1
Resin Mix 5	Resin Mix 2 mixed with Milled Glass Fibers	80 20	60 minutes	Same as Resin Mix 2
Resin Mix 6 Sealing Resin	BMS 8-207, Type 1, Class 1 EC1838A Resin EC1838B Hardener	50 50	20 minutes	12 hours
Resin Mix 6 Sealing Resin	BMS 8-207, Type 1, Class 2 FR-40 Resin FR-5413C Hardener	100 ±1 15 ±0.5	20 minutes	12 hours
Resin Mix 6 Sealing Resin	Epibond 156A Resin Epibond 941 Hardener	100 ±2 10 ±0.5	45 to 60 minutes	Refer to Figure 201
	Epibond 156 Resin Epibond 156B Hardener	100 ±2 6 ±0.3	15 to 25 minutes	12 hours
	FR 5318S Resin FR 5318C Hardener	100 ±2 50 ±1	45 to 60 minutes	Refer to Figure 201
	Epox-O Weld	Refer to the Manufacturer's data	45 to 60 minutes	Refer to Figure 201
BMS 5-25, Type II, Grade 1 - Adhesive Paste	Epibond 1539A Resin Epibond 1539B Hardener	113 ±5% 100 ±5%	60 minutes	12 hours
BMS 5-92, Type I - Adhesive Paste	EC 2216A Resin EC 2216B Resin		2 hours	24 hours
BMS 5-109 Type II - Adhesive Paste	EA934A Resin EA934B Hardener	100 33 ±1		7 days
	EA9394A Resin EA9394B Hardener	100 17 ±0.5	30 minutes	7 days

NOTE: Room Temperature is between 68°F and 90°F (20°C and 32°C).

J. Keep the resin systems, adhesives, and potting compounds at a temperature between 40°F and 80°F (4°C and 27°C) in sealed containers. Keep a record of the time when the materials are removed from cold storage. Let the materials stay at a temperature between 60°F and 75°F (16°C and 24°C) until no more condensation occurs on the container after you dry it with a clean cloth. Make sure you use the material during its handling life.

(1) Identify all the material containers with a label that has the data that follow:

(a) Boeing Material Specification (BMS)

(b) Type

(c) Class

(d) Supplier Name

(e) Batch Number

(f) Date of Preparation

K. Refer to Sealer Resin Cure Temperature and Heat Lamp Temperature Curve, Figure 201/REPAIR GENERAL for the cure temperature.

L. Refer to Typical Panel Parts, Figure 202/REPAIR GENERAL for a description of panel parts.

M. Refer to 51-30-06 to order the repair materials from the Boeing Company.

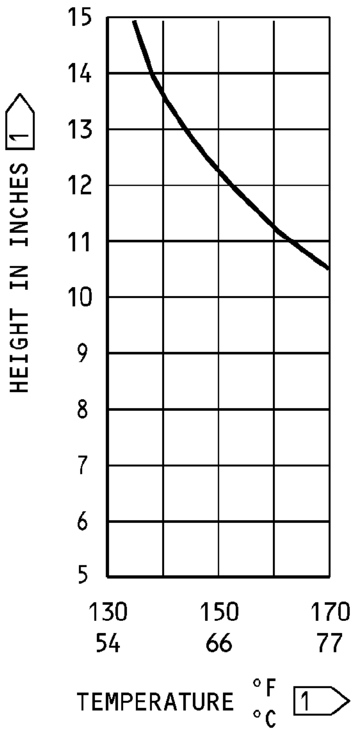
N. Refer to 51-10-01 for aerodynamic smoothness requirements.

O. Refer to 51-20-07 for hole drilling and machining of composite structure.

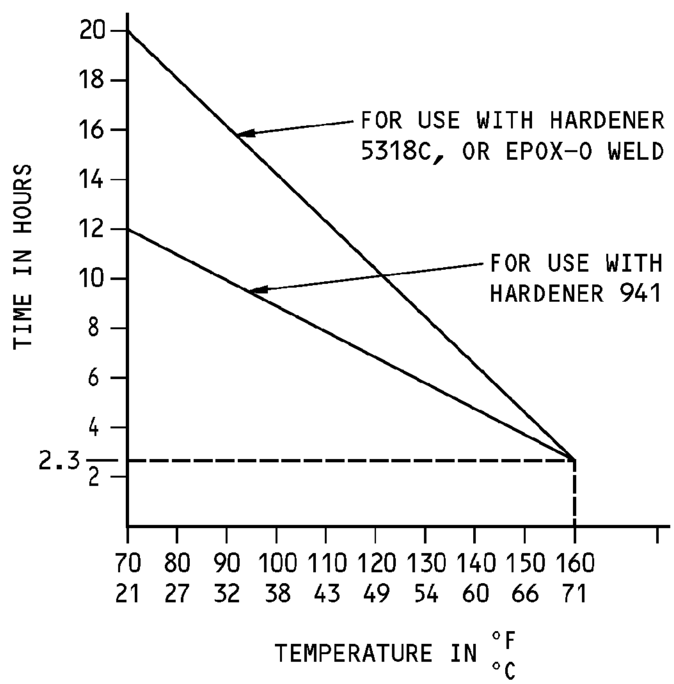
P. Refer to 51-30-01 for possible sources of repair materials and equipment.

Q. Refer to 51-70-03 for composite material alternatives.

R. Refer to 51-70-08 for the general resin sweep-fair procedures.



HEAT LAMP TEMPERATURE CURVE

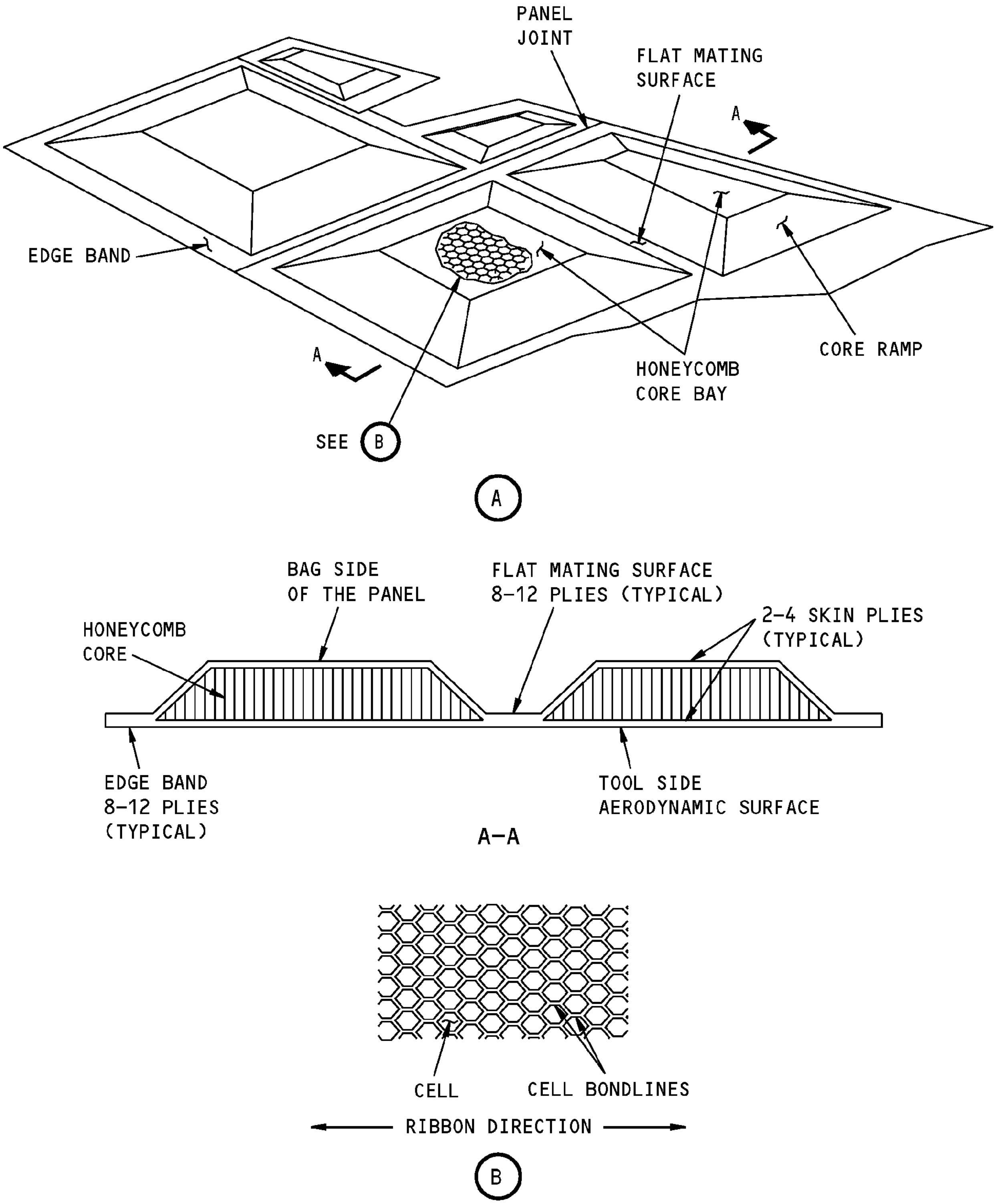


NOTES

- USE THERMOCOUPLE TO MONITOR THE TEMPERATURE.

1 THE HEIGHT IN INCHES OF A 250 WATT HEAT LAMP FROM THE SURFACES OF THE PATCH VERSUS TEMPERATURE AT THE SURFACE OF A PART.

Sealer Resin Cure Temperature and Heat Lamp Temperature Curve
Figure 201



Typical Panel Parts
Figure 202

3. **References**

Reference	Title
51-00-07	DEFINITIONS OF TERMS
51-10-01	AERODYNAMIC SMOOTHNESS
51-10-02	INSPECTION AND REMOVAL OF DAMAGE
51-20-05	REPAIR SEALING
51-20-07	MACHINING AND DRILLING OF COMPOSITE STRUCTURES
51-30-01	SHEET METAL MATERIALS
51-30-03	NON-METALLIC MATERIALS
51-30-06	COMPOSITE REPAIR MATERIALS
51-60-00	CONTROL SURFACE BALANCING
51-70-03	COMPOSITE MATERIALS ALTERNATIVES
51-70-04	REPAIR PROCEDURES FOR WET LAYUP MATERIALS
51-70-08	RESIN SWEEP-FAIR PROCEDURES
51-70-14	STRUCTURES WITH ALUMINUM COATINGS AND FOILS
AMM 51-21-00/701	Interior And Exterior Finishes - Cleaning/Painting
AMM 51-21-71/701	Conductive Coating For External Surfaces - Cleaning/Painting
AMM 51-21-81/701	Abrasion-resistant Teflon Finish - Cleaning/Painting
SOPM 20-30-03	Standard Overhaul Practices Manual
737 NDT Part 1, 51-01-01	Inspection of Repairs to Composite Structure
737 NDT Part 1, 51-05-01	Tap Test Inspection of Honeycomb Sandwich Structure
737 NDT Part 2, 51-00-01	Water Detection in Honeycomb Structure
737 NDT Part 4, 51-00-05	Bondline Delamination Inspection in Honeycomb Structure
737 NDT Part 9, 51-00-01	Non-Destructive Testing
737 NDT Part 9, 51-00-02	Inspection for Water in Honeycomb with Liquid Crystal Sheets

4. **Repair Procedures That Are Common to the Different Repairs**

A. Find the limits of the damage.

(1) Do a visual inspection to find the limits of the damage.

(2) Examine the part for the entry of water, oil, fuel, or other unwanted material.

NOTE: You can find water with X-Ray and thermographic inspection procedures. Refer to 737 NDT Part 2, 51-00-01, 737 NDT Part 9, 51-00-01, and 737 NDT Part 9, 51-00-02.

(3) Examine the damaged area for delamination.

NOTE: You can find a delamination with instrumented NDT procedures as given in 737 NDT Part 4, 51-00-05, or with a tap test as given in 737 NDT Part 1, 51-05-01.

WARNING: DO NOT USE EQUIPMENT THAT CAUSES AN ARC OR A SPARK IN AN AREA WHERE THE IGNITION OF THE VAPOR IS POSSIBLE. IF YOU DO NOT OBEY, AN EXPLOSION CAN OCCUR AND CAUSE INJURY. USE A PORTABLE VACUUM CLEANER WHEN YOU REMOVE THE DAMAGED MATERIAL. DO NOT BREATHE THE DUST. WHEN YOU SAND THE PLY LAYERS, A FINE DUST IS MADE THAT CAN BE HAZARDOUS. THE DUST CAN CAUSE SKIN AND EYE IRRITATION OR RESPIRATORY PROBLEMS.

(WARNING PRECEDES)

CAUTION: DO NOT USE CHEMICAL PAINT STRIPPERS TO REMOVE THE PAINT. CHEMICAL PAINT STRIPPERS WILL CAUSE DAMAGE TO THE RESIN SYSTEMS. IF YOU DO NOT OBEY, THE REPAIR WILL BE UNSATISFACTORY.

B. Remove the damaged plies.

(1) Tape off the area that is 1.0 inch from the edge of where the largest repair ply will be applied. Refer to the applicable repair figure.

(2) Remove the damaged area of the facesheets in a smooth circular or oval shape with No. 180 or finer abrasive paper. Be careful not to cause damage to the facesheet and core which are not damaged.

(3) Remove the finish inside the taped off area and make the surfaces rough with No. 240 or finer abrasive paper. Be careful not to cause damage to the plies that are not damaged.

(4) If the initial core in the damage area will not be removed, then sand the adhesive that is over the core cells to open the core cells. Use No. 240 or finer abrasive paper. It is not necessary to remove the adhesive fillets from the core.

(5) Remove the tape.

WARNING: DO NOT USE EQUIPMENT THAT CAUSES AN ARC OR A SPARK IN AN AREA WHERE THE IGNITION OF THE VAPOR IS POSSIBLE. IF YOU DO NOT OBEY, AN EXPLOSION CAN OCCUR AND CAUSE INJURY. USE A PORTABLE VACUUM CLEANER WHEN YOU REMOVE THE DAMAGED MATERIAL. DO NOT BREATHE THE DUST. WHEN YOU SAND THE PLY LAYERS, A FINE DUST IS MADE THAT CAN BE HAZARDOUS. THE DUST CAN CAUSE SKIN AND EYE IRRITATION OR RESPIRATORY PROBLEMS.

C. Remove the damaged or contaminated core.

(1) You can remove the core with a router. Refer to 51-10-02 for the instructions to use the router and template.

(2) Remove the core to the same shape and size as the cutout in the facesheet.

(a) For cores more than 1.0 inch thick, you do not have to remove the full thickness of the core. Remove a minimum of 0.5 inch in thickness from the core.

(3) Do not cause damage to the opposite facesheet.

(4) Make sure that you remove all of the damage.

CAUTION: YOU MUST REMOVE THE WATER THAT WAS ABSORBED BY THE PART BEFORE A REPAIR IS MADE. IF YOU DO NOT OBEY, AN UNSATISFACTORY REPAIR WILL BE THE RESULT.

D. Remove the water from the structure.

NOTE: The dried area must be a minimum of 4 inches larger all around than the damage you removed.

(1) Remove all the water and other unwanted material that you can with a vacuum or with compressed air that is free from oil.

(2) Do the steps that follow for honeycomb core areas:

(a) Put a layer of glass fabric or the equivalent (breather cloth) or a metal mesh screen over the area of the water contamination.

1) Use masking tape to hold the fabric or the screen in position.

2) Make sure the cloth or the screen is large enough to go below the vacuum line and gage. The vacuum line and gage must be located outside of the area of the water contamination.

(b) Put a thermocouple at the center of the area that has the water contamination as shown in Water Removal Procedure for a Honeycomb Panel, Figure 203/REPAIR GENERAL, and Water Removal for a Solid Laminate, Figure 204/REPAIR GENERAL.

1) If the glass fabric breather cloth is used, put the thermocouple below the cloth.

2) If you use the metal mesh screen, put the thermocouple above the screen.

(c) Put a heat blanket on the surface of the facesheet that is not damaged or at the alternative location shown in Water Removal Procedure for a Honeycomb Panel, Figure 203/REPAIR GENERAL, and Water Removal for a Solid Laminate, Figure 204/REPAIR GENERAL.

(d) Put a thermocouple adjacent to the heat blanket (on the facesheet side), at the center of the area that has the water contamination.

(e) Put the bases for the vacuum line and the vacuum gage into position. Make sure they touch the breather cloth (or metal screen) but do not go over the area that has the water contamination.

(f) Apply the vacuum sealing compound to the damaged facesheet around the layup.

CAUTION: FOR REPAIRS TO HOLLOW ASSEMBLIES SUCH AS ELEVATORS, RUDDERS, OR AILERONS, DO NOT FULLY VACUUM BAG THE PART. IF YOU DO NOT OBEY, THE VACUUM PRESSURE CAN CRUSH THE PART. REFER TO FIGURE 205 FOR THE LIMITS ON THE USE OF VACUUM BAGS.

(g) Seal the location with the vacuum bag material.

(h) Install the vacuum line and the vacuum gage through the vacuum bag material and into the bases.

NOTE: Use a desiccant indicator in the vacuum line to verify that the water removal is complete.

(i) Apply a minimum vacuum of 22 inches mercury.

(3) Increase the temperature at a rate between 1°F and 5°F (0.5°C and 3°C) for each minute until the temperature is between 150°F (65°C) and 170°F (76°C).

(4) Hold the temperature between 150°F (65°C) and 170°F (76°C) for 1 hour minimum.

NOTE: Turn the vacuum off and on again periodically so that dry air will enter the bag. This will prevent the air from becoming saturated with moisture.

(5) Decrease the temperature at a maximum rate of 5°F (3°C) for each minute

(6) Do steps (3) through (5) again if there is still water in the damage area.

NOTE: If the water cannot be removed, the material that has the contamination must be removed.

WARNING: DO NOT USE EQUIPMENT THAT CAUSES AN ARC OR A SPARK IN AN AREA WHERE THE IGNITION OF THE VAPOR IS POSSIBLE. IF YOU DO NOT OBEY, AN EXPLOSION CAN OCCUR AND CAUSE INJURY.

(WARNING PRECEDES)

USE A PORTABLE VACUUM CLEANER WHEN YOU REMOVE THE DAMAGED MATERIAL. DO NOT BREATHE THE DUST. WHEN YOU SAND THE PLY LAYERS, A FINE DUST IS MADE THAT CAN BE HAZARDOUS. THE DUST CAN CAUSE SKIN AND EYE IRRITATION OR RESPIRATORY PROBLEMS.

E. Make the necessary taper.

(1) Tape off the area that is 1.0 inch from the edge of where the largest repair ply will be applied.

(2) Remove the finish inside the taped off area and make the surface rough with No. 240 or finer abrasive paper. Be careful not to cause damage to the plies that are not damaged.

(3) Make an even taper from the edge where the damage was removed as shown in Taper Sand that is Necessary for the Repair, Figure 206/REPAIR GENERAL.

(a) Use 180-grit or finer abrasive paper.

(b) Sand a taper of 1.00 inch for each ply that is removed.

(4) Remove the tape.

WARNING: KEEP THE SOLVENTS AWAY FROM SOURCES OF HEAT, FIRE, OR SPARKS. HEAT, FIRE, OR SPARKS CAN CAUSE AN EXPLOSION. IF YOU DO NOT OBEY, INJURY TO PERSONS CAN OCCUR. DO NOT BREATHE THE VAPORS OR LET THE SOLVENTS TOUCH YOUR SKIN OR EYES. USE NEOPRENE GLOVES WITH COTTON LINERS, PROTECTIVE CLOTHING, AND EYE GOGGLES. IF THE CHEMICALS TOUCH YOUR SKIN, WASH WITH CLEAN WATER. IF THE CHEMICALS GET IN YOU EYES, FLUSH WITH A LARGE QUANTITY OF CLEAN WATER AND GET MEDICAL AID. MAKE SURE THAT THERE IS A GOOD FLOW OF CLEAN AIR WHERE YOU DO THE WORK, OR USE RESPIRATORY EQUIPMENT WHEN YOU WORK IN A CONFINED SPACE. IF YOU DO NOT OBEY, INJURY TO PERSONS CAN OCCUR.

CAUTION: DO NOT SOAK THE PARTS IN TRICHLOROETHANE SOLVENT OR LET THE SOLVENT STAY ON THE PARTS FOR MORE THAN 60 SECONDS. IF YOU DO NOT OBEY, DAMAGE TO THE PART CAN OCCUR.

F. Clean the repair area.

(1) Remove all dust from the component with a vacuum cleaner.

(2) Clean the surfaces of the repair area.

(a) Use a cloth made moist with methyl isobutyl ketone (MIBK) or acetone.

(b) Clean the surface again until a new moist cloth is clean after it is used.

(c) Remove the solvent before it can dry and remove the remaining film before you continue with the repair.

G. Make the honeycomb repair core.

(1) Make the repair core from the same material as the initial core.

(a) Refer to the radome identification section or the engineering drawings to find the initial core material.

(2) Cut the repair core to have the same perimeter dimension as the core you removed. Refer to 51-10-02 for the instructions to use the router and template.

NOTE: A maximum clearance of 0.125 inch is permitted between the repair core and the core hole.

(3) Cut the repair core to the thickness necessary to be a small distance higher than the outer surface of the initial facesheet.

(4) Clean the honeycomb repair core.

(a) Soak the core repair plug into an alcohol, MIBK or acetone bath for a maximum of 60 seconds.

NOTE: If the core is still dirty, you can soak it again up to three more times for a maximum of 60 seconds each.

(5) Dry the core repair plug.

(a) Use compressed air.

(b) Remove all remaining residue from all sides of the core.

(c) Let the core repair plug dry for approximately 15 minutes before you do a repair.

H. Make the repair plies.

(1) Find the number of plies that have been cut or sanded.

NOTE: If the number of plies is not apparent, refer to the applicable structure identification or engineering drawing. The ply edge locations can be seen if you wipe the sanded area with methyl isobutyl ketone (MIBK).

(2) Find the ply layup direction for each of the initial plies that were removed.

(3) Refer to Table 204/REPAIR GENERAL to find the glass fiber repair fabric you will use to make the repair plies.

(a) Use one repair ply for each damaged ply of the component plus one added repair ply.

1) If you use a substitute repair ply material, use the number of plies given in Table 204/REPAIR GENERAL for each damaged ply of the component.

2) Refer to the repair subject for the specified component to find if more than one added structural repair ply is necessary.

Table 204:

GLASS FIBER REPAIR FABRIC AND SUBSTITUTE GLASS FIBER REPAIR FABRIC		
INITIAL MATERIAL	**REPAIR PLY MATERIAL**	**SUBSTITUTE REPAIR PLY MATERIAL**
BMS 8-79, Style 120 or 220 BMS 8-139, Style 120 or 220 BMS 8-169, Type 120	1 ply of BMS 9-3, Type D or D-1 for each ply of the initial material	1 ply of BMS 9-3, Type H-2 or Type H-3 for each two plies of the initial material
BMS 8-79, Style 1581 or 7781 BMS 8-139, Style 1581 or 7781 BMS 8-169, Type 181	1 ply of BMS 9-3, Type H-2 or Type H-3 for each ply of the initial material	3 plies of BMS 9-3, Type D or D-1 for each ply of initial material

(b) Cut the repair plies to the same shape and ply layup direction as the initial plies they replace.

NOTE: You can make a template from vacuum bag material for each repair ply to make sure they will still have the correct ply layup direction when you apply them.

1) Make each repair ply 1.00 inch larger than the ply it replaces to permit the necessary overlap as shown in Repair Ply Overlap, Figure 207/REPAIR GENERAL.

2) The ply layup direction of the added repair plies must be + 45 degrees.

3) Splices that are in the plies of the initial structure are not required in the repair plies.

(c) If you use filler plies, use the same material as the adjacent repair ply. The zero degree ply direction is optional.

NOTE: Filler plies are plies that are used to fill a recess in the repair area. The filler ply can be on a small or a large part of a repair ply to make the repair smooth.

I. Impregnate the repair plies with resin.

(1) To impregnate the BMS 9-3 repair plies with the vacuum bag procedure, refer to Recommended Vacuum Bag Procedure to Impregnate the BMS 9-3 Repair Plies with BMS 8-301 Resin, Figure 208/REPAIR GENERAL and do the steps that follow.

(a) Cut two pieces of vacuum bag material. Make the bag material a minimum of 6 inches larger than the fabric that will be impregnated.

(b) Cut one piece of breather cloth that is two inches smaller than the vacuum bag material.

(c) Cut two pieces of solid parting film. Make them a minimum of 3 inches larger than the fabric.

1) Put one piece of vacuum bag material on a smooth surface. Hold the vacuum bag material in position with tape.

2) Apply vacuum sealing compound to the edge of the vacuum bag material.

3) Place the second piece of vacuum bag material over the first and seal one edge.

4) Install a vacuum probe and gage.

(d) Put one piece of the solid parting film on the first piece of vacuum bag material.

(e) Weigh the fabric to be impregnated. Multiply the weight by 1.0. The result gives you the laminating resin necessary to impregnate the fabric.

(f) Mix the BMS 8-301 laminating resin as given in Table 203/REPAIR GENERAL. Weigh the laminating resin to find the correct amount necessary to impregnate the fabric.

NOTE: The resin-to-fiber content will be approximately 1 to 1 by weight after the parting film is separated.

(g) Put the fabric over the parting film. Make sure the fabric is smooth.

(h) Put the resin in the center of the fabric.

(i) Put the second piece of solid parting film above the fabric. Make sure the parting film is smooth.

(j) Put the breather cloth over the parting film.

(k) Seal the vacuum bag.

(l) Apply full vacuum to the vacuum bag.

(m) Sweep the resin from the center to the edge of the fabric. Make the resin and the fabric smooth. Keep all of the resin in the fabric.

(n) Release the vacuum from the vacuum bag.

(o) Remove the vacuum bag.

(p) Cut the repair plies. Do not remove the solid parting film.

(2) To impregnate the BMS 9-3 repair plies with the alternate procedure, refer to Alternate Procedure to Impregnate the BMS 9-3 Repair Plies with BMS 8-301 Resin, Figure 209/REPAIR GENERAL and do the steps that follow.

(a) Cut two pieces of solid parting film. Make them 3 inches larger than the fabric.

(b) Put one piece of solid parting film on a smooth surface. Hold it in position with tape.

(c) Weigh the fabric to be impregnated. Multiply the weight by 1.0. The result gives you the laminating resin necessary to impregnate the fabric.

NOTE: The resin-to-fiber content will be approximately 1 to 1 by weight after the parting film is separated.

(d) Mix the BMS 8-301 laminating resin as given in Table 203/REPAIR GENERAL. Weigh the laminating resin to find the correct amount necessary to impregnate the fabric.

(e) Put half of the resin in the center of the solid parting film.

(f) Put the fabric above the solid parting film and the laminating resin.

(g) Put the laminating resin that remains over the fabric in the center.

(h) Put the second piece of solid parting film above the fabric. Make sure that the parting film is smooth.

(i) Sweep the resin from the center to the edge of the fabric. Make the resin and the fabric smooth. Keep all of the resin in the fabric.

(j) Cut the repair plies. Do not remove the solid parting film at this time.

J. Install the honeycomb repair core.

(1) Apply a layer of Resin Mix 3 on the sides and bottom of the initial honeycomb core edges that will touch when the plug is installed. Refer to Table 203/REPAIR GENERAL for the instructions to prepare Resin Mix 3.

(2) Align the ribbon direction of the core repair plug with that of the initial core.

(3) Carefully compress the repair core and put it into the core hole.

K. Apply the repair plies.

CAUTION: MAKE SURE THAT YOU DO THIS PROCEDURE IN A CLEAN AREA. DO NOT PERMIT THE CONTAMINATION OF THE REPAIR PARTS. IF YOU DO NOT OBEY, YOU CAN CAUSE AN UNSATISFACTORY REPAIR. REMOVE THE PARTING FILM FROM THE IMPREGNATED MATERIALS OR ADHESIVE BEFORE YOU LAY UP AND CURE THE REPAIR. IF YOU DO NOT OBEY, THE REPAIR WILL BE UNSATISFACTORY.

(1) Remove the first piece of parting film.

NOTE: Make sure that the zero degree ply direction of each repair ply that you put in the repair is correct.

(2) Put the ply on the repair. Make the ply smooth and free from wrinkles.

(3) Remove the second piece of parting film.

(4) Do steps (1) through (3) for each repair ply.

L. Install the vacuum bag system.

(1) Refer to Vacuum Bag Instructions for the Cure of the Honeycomb Repair Core at Room Temperature, Figure 210/REPAIR GENERAL for the vacuum bag system to use when you cure the repair core separately. Refer to Vacuum Bag Instructions for the Cure of the Repair Plies at Room Temperature, Figure 211/REPAIR GENERAL for the vacuum bag system to use when you cure the repair plies.

(2) Put a layer of perforated parting film that is a minimum of 1.0 inch larger all around the repair area, above the repair area.

(3) Put a layer of dry peel ply or glass fabric cloth (BMS 9-3, Types D, D-1, H-2, or H-3 or the equivalent) above the perforated parting film. This will be the surface bleeder.

(4) Put a layer of solid parting film over the surface bleeder that is 0.5 inch less all around than the surface bleeder.

(5) Put one layer of glass fabric cloth (BMS 9-3, Types D, D-1, H-2, or H-3, or the equivalent) that is the same size as the surface bleeder above the repair area. This will be the breather cloth.

NOTE: Make sure the breather cloth touches the surface bleeder when you put the layup together.

CAUTION: FOR REPAIRS TO HOLLOW ASSEMBLIES SUCH AS ELEVATORS, RUDDERS, OR AILERONS, DO NOT FULLY VACUUM BAG THE PART. IF YOU DO NOT OBEY, THE VACUUM PRESSURE CAN CRUSH THE PART. REFER TO FIGURE 205 FOR THE LIMITS ON THE USE OF VACUUM BAGS.

(6) Seal the repair with the vacuum bag material.

(a) Put the bases for the vacuum line and the vacuum gage into position.

(b) If necessary, apply the vacuum sealing compound around the layup.

(c) Cut slits in the vacuum bag at the locations where the vacuum line and vacuum gage will be attached to the bases.

(d) Install the vacuum line and the vacuum gage through the vacuum bag material and into the bases.

M. Do a check of the vacuum bag for leaks.

NOTE: A vacuum bag which has a leak can cause porosity in the repair and bond failure.

(1) Apply a minimum vacuum of 22 inches of mercury.

(2) Remove the vacuum source

(3) Monitor the vacuum gage. After 5 minutes, the total difference in vacuum must be less than 5 inches of mercury.

N. Apply the vacuum pressure for the cure.

(1) Apply and keep a vacuum to a minimum of 22 inches of mercury in the vacuum bag during the cure of the repair.

WARNING: SOME OF THE EQUIPMENT USED TO HEAT CURE THESE REPAIRS CAN CAUSE A FIRE OR AN EXPLOSION WHEN USED NEAR AN AIRPLANE THAT CONTAINS OR HAS CONTAINED FUEL. USE EQUIPMENT THAT HAS BEEN APPROVED BY THE LOCAL FIRE DEPARTMENT. IF YOU DO NOT OBEY, INJURY TO PERSONS AND DAMAGE TO THE AIRPLANE CAN OCCUR.

CAUTION: THE TEMPERATURE AT THE SURFACE OF THE PART MUST NOT BE MORE THAN 170°F (77°C). IF YOU DO NOT OBEY, DAMAGE TO THE STRUCTURE CAN OCCUR.

O. Cure the repair materials.

(1) Cure Resin Mixes 1 and 4 a minimum of 5 days at room temperature.

(2) Cure Resin Mixes 2, 3, and 5 a minimum of 12 hours at room temperature.

(3) Cure Resin Mixes 1 and 2 in one step for a minimum of 5 days at room temperature.

(4) Cure Resin Mixes 1 and 3 in one step for a minimum of 5 days at room temperature.

(5) Cure Resin Mix 6 as given in Table 203/REPAIR GENERAL.

(6) Cure BMS 5-25, Type II, Grade 1 adhesive paste of a minimum of 12 hours at room temperature.

(7) Cure BMS 5-92, Type I adhesive paste for a minimum of 24 hours at room temperature.

P. Do an inspection of the repair.

(1) Do an inspection of the repair to make sure that the repair is satisfactory. The inspection must include these areas:

NOTE: Post repair inspection is recommended. Examples of inspection are given in 737 NDT Part 1, 51-01-01.

(a) Examine all of the areas where heat was applied plus a minimum width of 2 inches more all around the heated area.

(b) If the inspection gives an unsatisfactory result, remove and install the repair again.

Q. Apply the finish to the repair.

CAUTION: DO NOT SAND INTO THE FIBERS. IF YOU DO NOT OBEY, A DECREASE IN THE STRENGTH OF THE COMPONENT CAN OCCUR.

(1) Sand the outer ply to make the edges flush with the initial surface.

(2) To apply the finish to the repair area use the steps that follow, if applicable:

(a) If clear Tedlar film surfaces have been removed, seal them with Resin System 1 and cure as given in 51-70-04.

(b) If gray or white Tedlar film surfaces have been removed, seal them with Resin System 1 and cure as given in 51-70-04.

(c) Apply one layer of BMS 10-11 or BMS 10-103 primer and one layer of BMS 10-60 enamel.

(d) If BMS 10-21 conductive coating was removed, apply it again as given in AMM 51-21-71/701.

(e) If the abrasion resistant Teflon finish was removed from the inner surface of the panel edgeband, apply the Teflon again as given in AMM 51-21-81/701.

(f) If the initial paint was removed from the surface, then apply the paint again as given in AMM 51-21-00/701.

(g) If sealant was removed from around fittings or mating surfaces, apply one of the sealants that follow as given in 51-20-05:

1) BMS 5-95 in locations with temperatures less than or equal to 180°F (82°C)

2) BMS 5-26 in fuel cells and in locations with temperatures less than 200°F (93°C)

3) BMS 5-63 in locations with temperatures higher than 200°F (93°C).

(h) If BMS 8-336 aluminum foil mesh was removed, then repair it as given in 51-70-14.

(i) If BMS 8-278 aluminum coated glass fabric was repaired, apply aluminum flame spray as given in 51-70-14.

CAUTION: MAKE SURE THAT THE REPAIR DOES NOT CAUSE A BLOCKAGE OF THE DRAIN HOLES IN A PANEL. BLOCKED DRAIN HOLES CAN CAUSE WATER TO ENTER AND STAY INSIDE THE STRUCTURE. IF YOU DO NOT OBEY, DAMAGE TO THE STRUCTURE CAN OCCUR.

R. If the repair causes a blockage of a drain hole, drill through the repair at the drain hole position.

NOTE: Use the applicable size drill as given in the drawing at the location of the drain hole.

S. Drill and countersink all fastener holes that were filled.

WARNING: FLIGHT CONTROLS MUST BE CORRECTLY BALANCED AFTER YOU REPAIR THEM. FAILURE TO DO SO CAN CAUSE FLUTTER AND DAMAGE TO THE STRUCTURE.

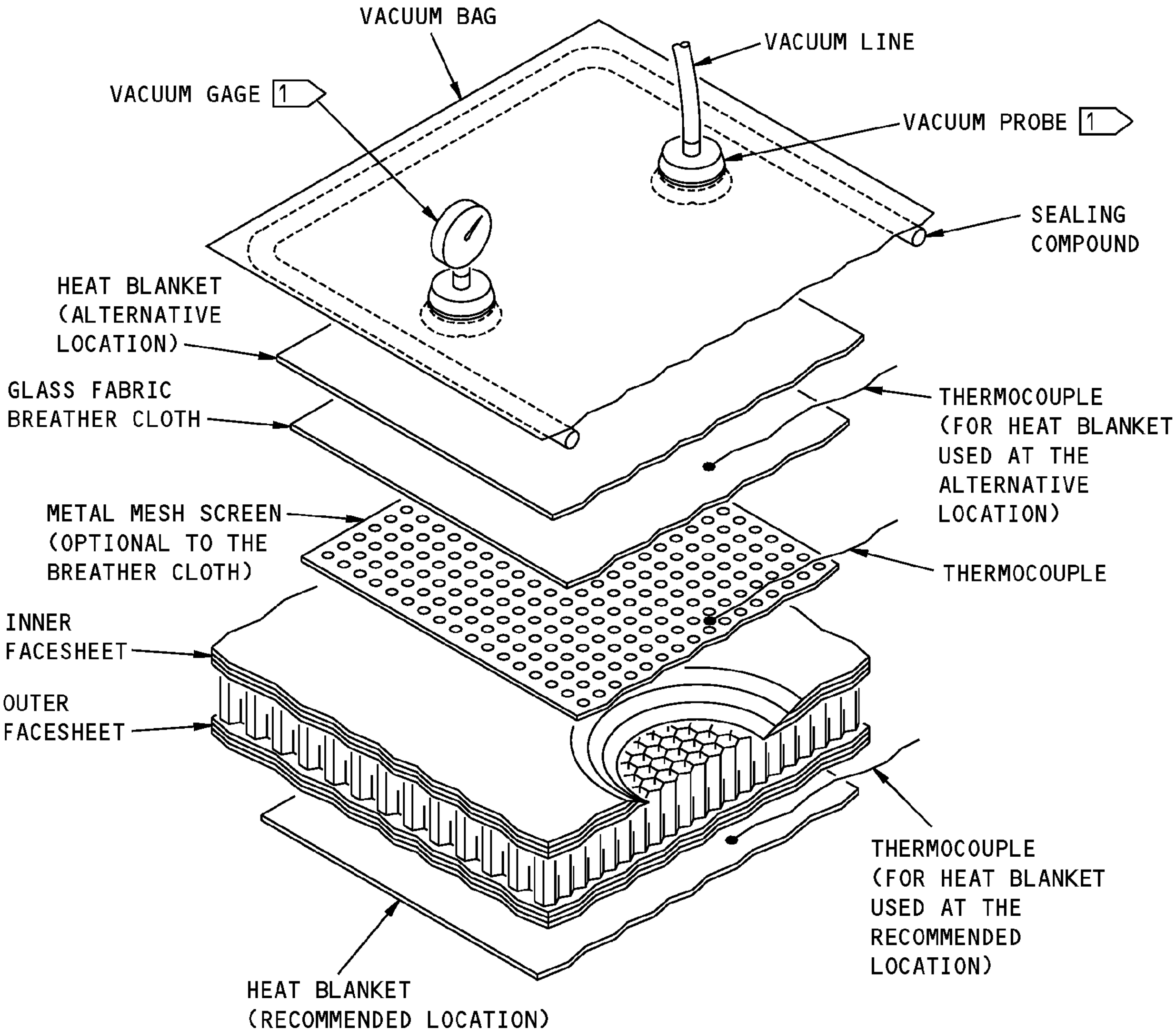
T. After you repair a flight control surface, do a check to see if it must be balanced. Refer to 51-60-00.

CAUTION: MAKE SURE THAT REPAIRS MADE TO FLIGHT CONTROL SURFACES AND/OR ADJACENT STRUCTURE DO NOT TOUCH EACH OTHER OR STOP THE OPERATION OF THE FLIGHT CONTROL SURFACES. IF YOU DO NOT OBEY, DAMAGE TO THE AIRPLANE STRUCTURE CAN OCCUR.

U. Do a check of the operation of the flight control surfaces.

(1) Make sure that the flight control surfaces do not hit the airplane structure.

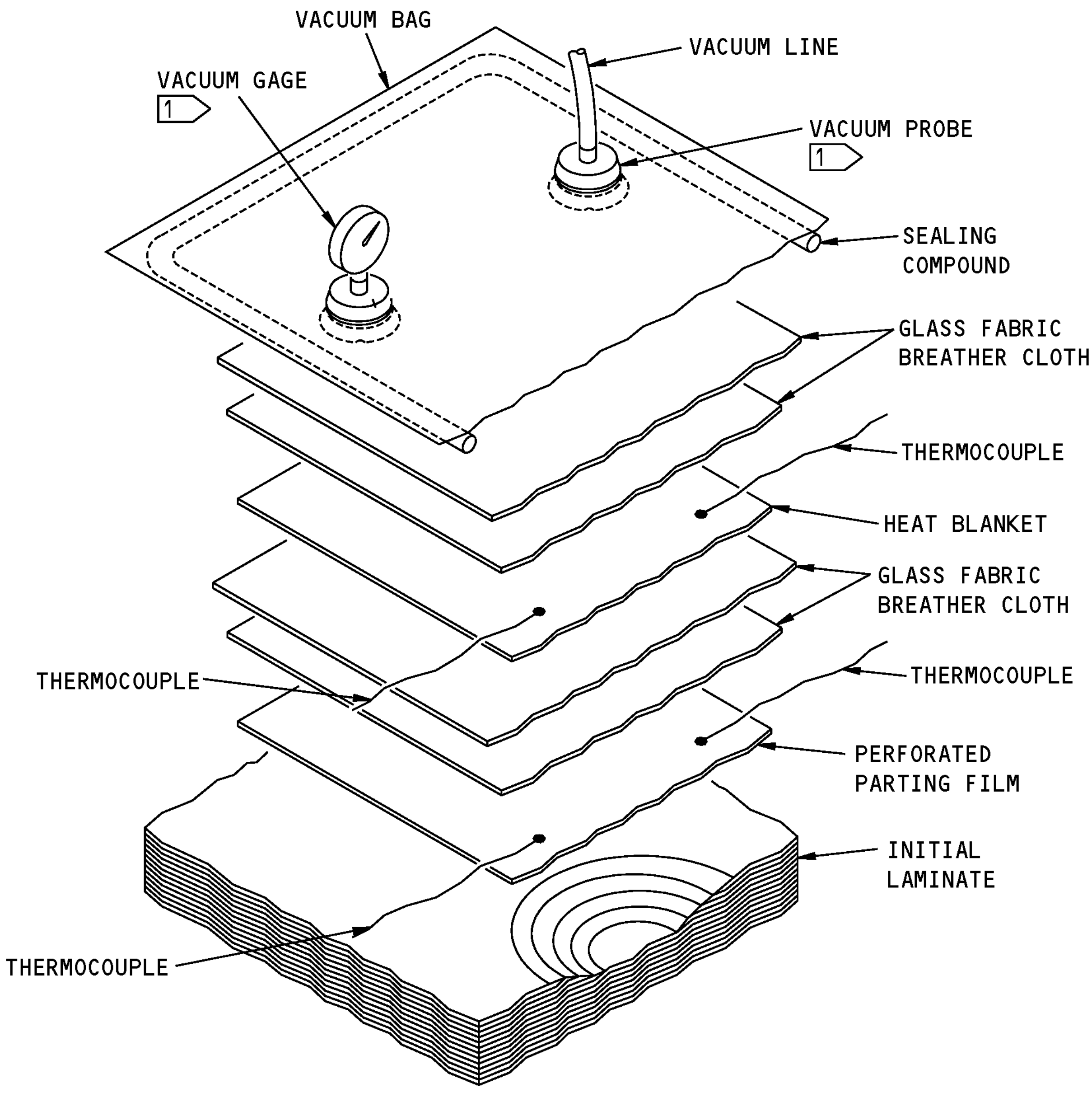
(2) Make sure that there is sufficient clearance for the repaired parts.



NOTES

1 THE VACUUM PROBE AND GAGE MUST TOUCH THE SURFACE OF THE BREATHER CLOTH OR METAL MESH SCREEN.

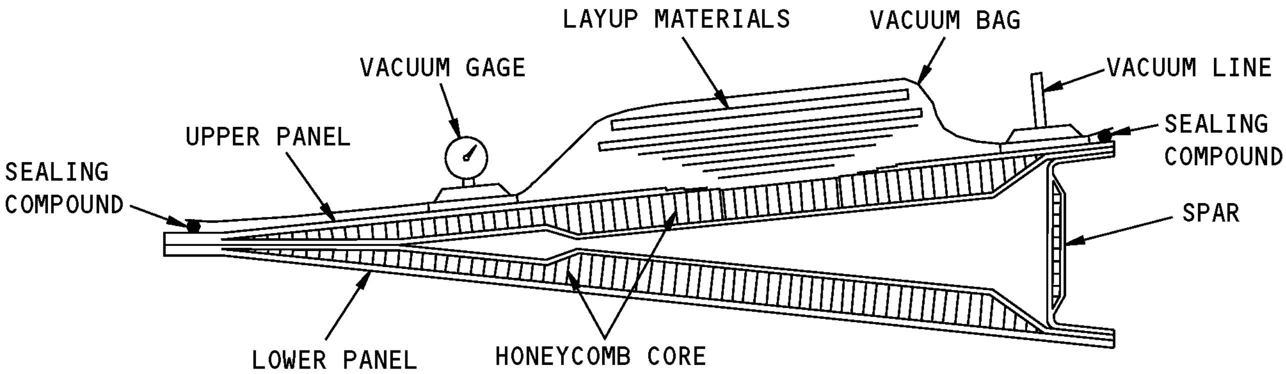
Water Removal Procedure for a Honeycomb Panel
Figure 203



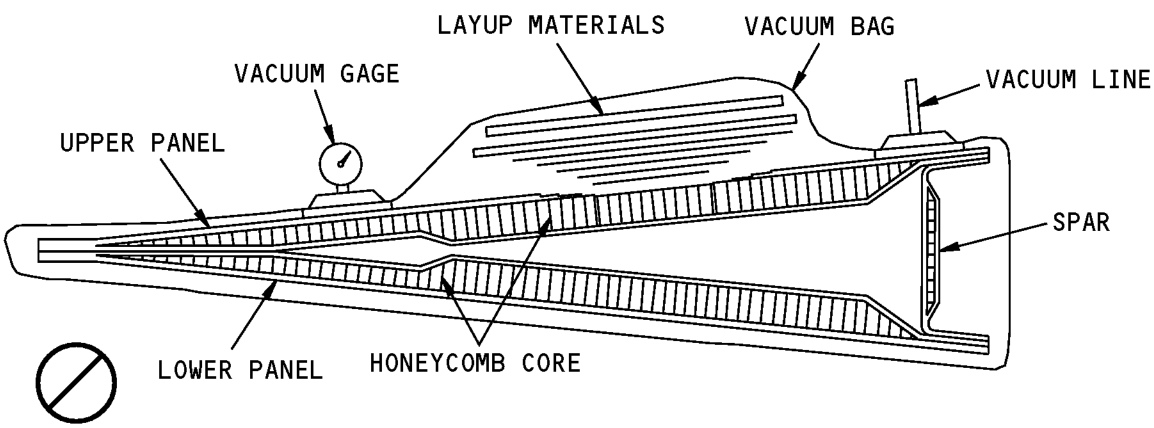
NOTES

1 THE VACUUM PROBE AND GAGE MUST TOUCH THE SURFACE OF THE BREATHER CLOTH.

Water Removal for a Solid Laminate
Figure 204



SATISFACTORY - VACUUM BAG SEALED TO ONE SIDE ONLY



NOT SATISFACTORY - VACUUM BAG SEALED AROUND ALL OF THE PART

PARTS WHICH HAVE UPPER AND LOWER PANELS [1]

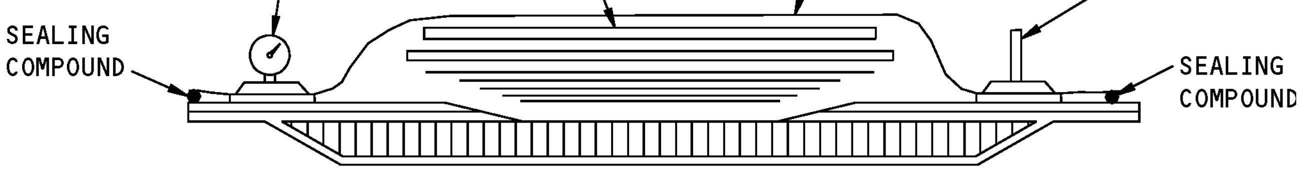
NOTES

- REFER TO PARAGRAPH 4.L. FOR THE VACUUM BAG PROCEDURES.

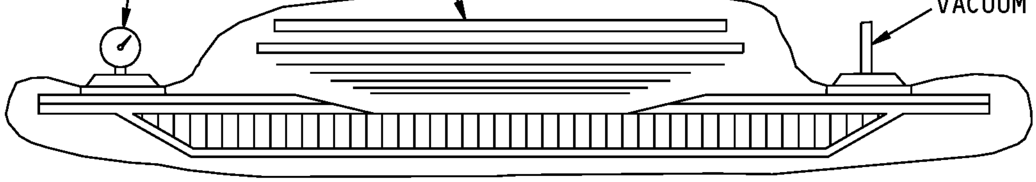
[1] THIS TYPE OF COMPONENT MUST NOT BE FULLY SEALED IN A VACUUM BAG. DAMAGE TO THE PART WILL OCCUR. USE A VACUUM BAG ONLY ON ONE SIDE OF THE COMPONENT.

[2] THIS TYPE OF COMPONENT CAN BE FULLY SEALED IN A VACUUM BAG OR CAN BE SEALED ON ONE SIDE ONLY.

Vacuum Bag Limits
Figure 205 (Sheet 1 of 2)



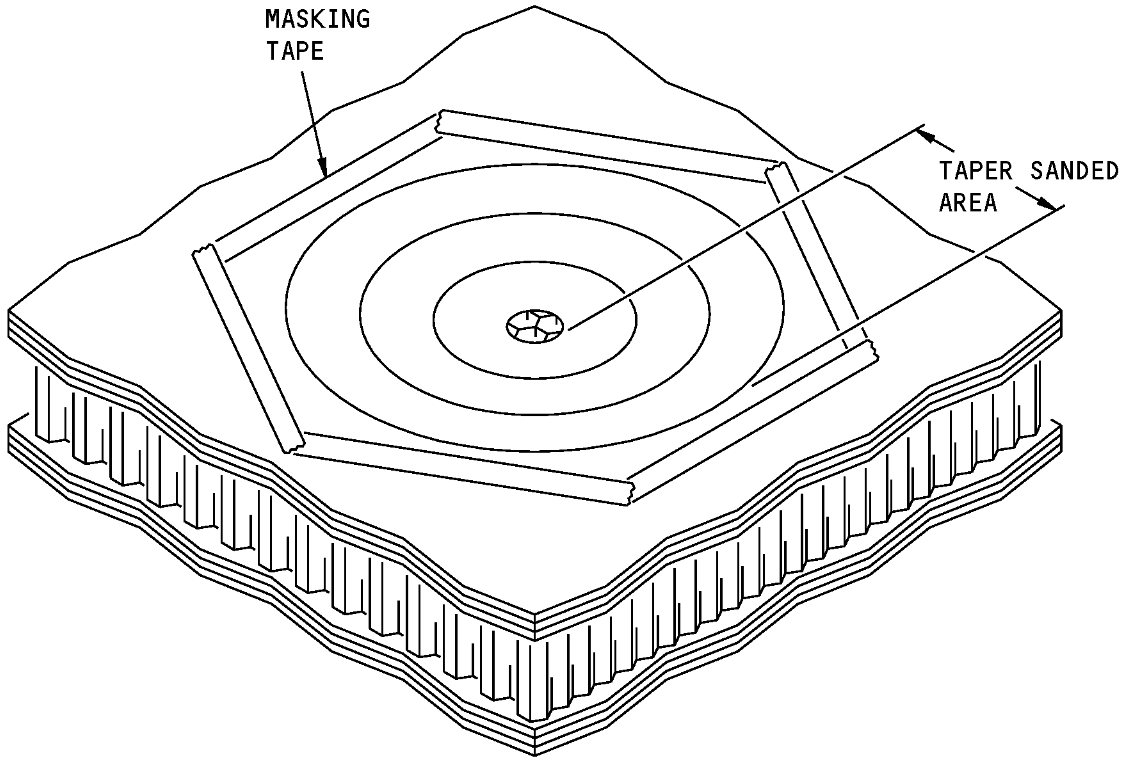
SATISFACTORY - VACUUM BAG SEALED TO ONE SIDE ONLY



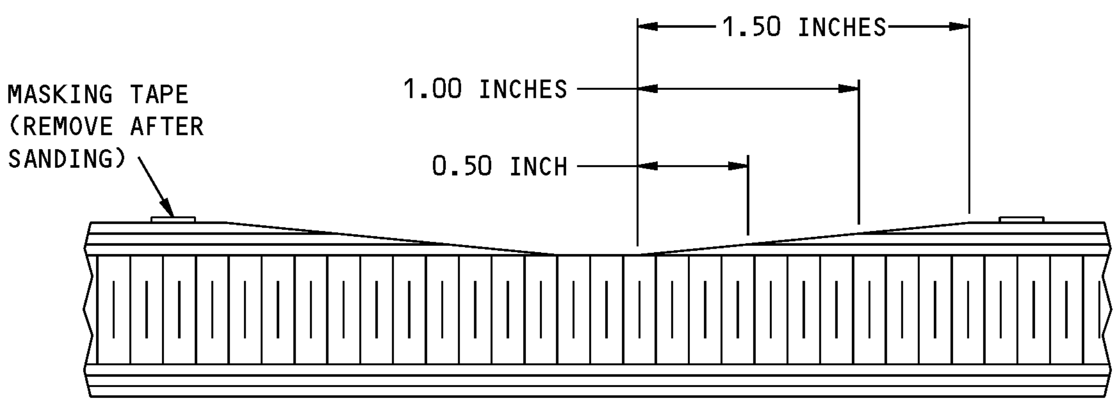
SATISFACTORY - VACUUM BAG SEALED AROUND ALL OF THE PART

PARTS WHICH HAVE ONLY ONE PANEL 2

Vacuum Bag Limits
Figure 205 (Sheet 2 of 2)



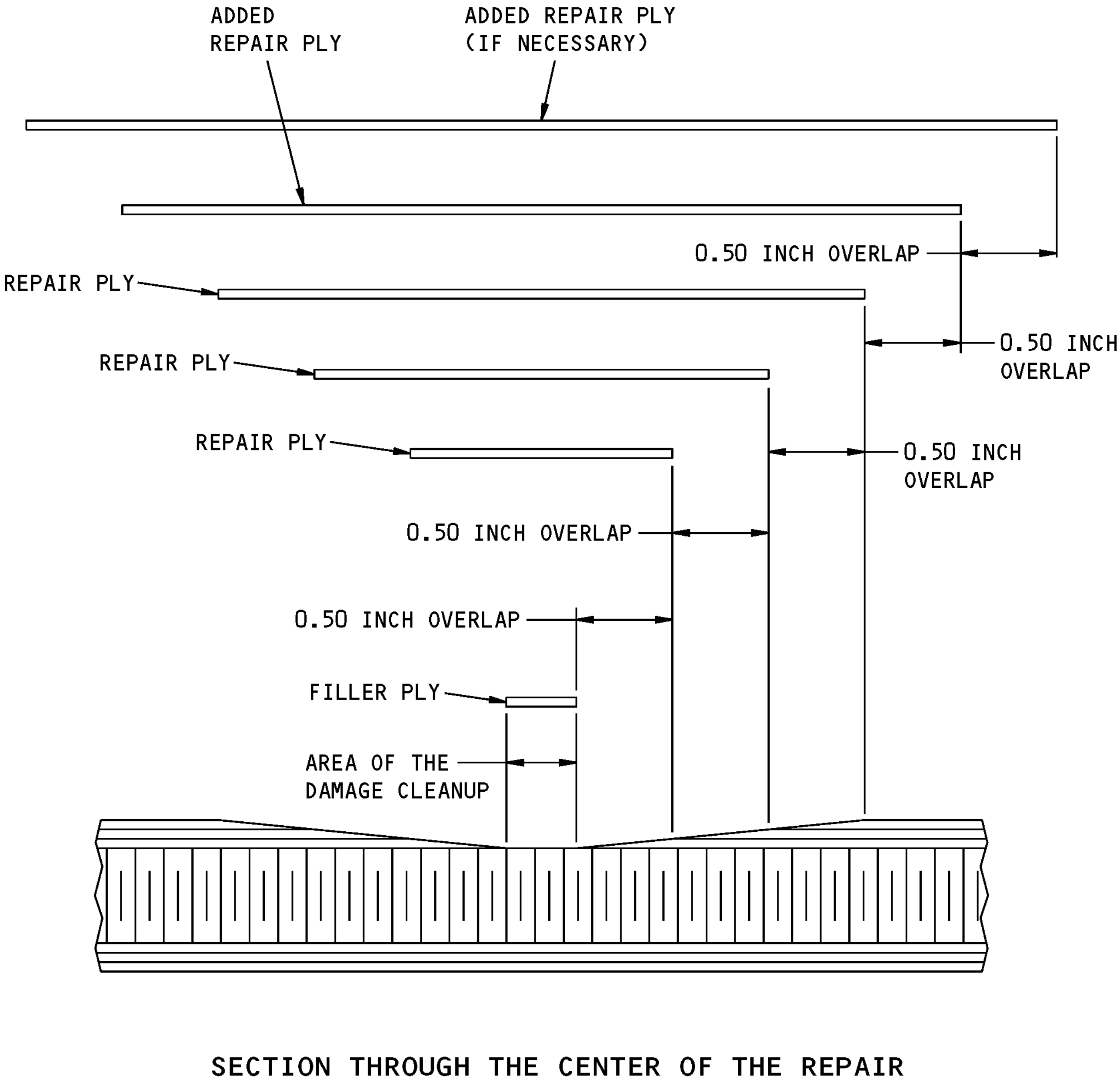
CIRCULAR SHAPE IS SHOWN, OVAL SHAPES ARE ALSO PERMITTED



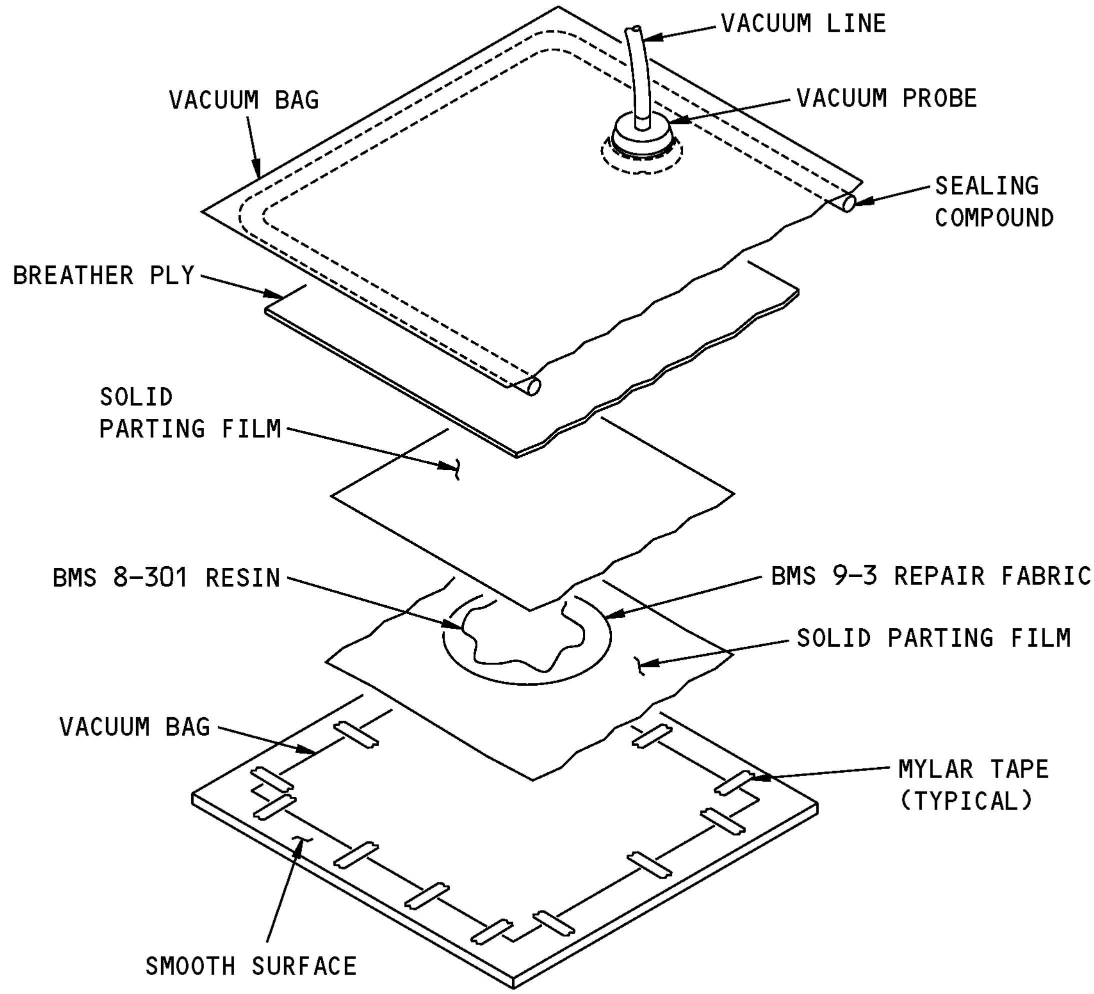
NOTE: TAPER SAND IS SHOWN FOR A HONEYCOMB PANEL. THE TAPER SAND FOR A SOLID LAMINATE IS THE SAME.

SECTION THROUGH THE CENTER OF THE REPAIR

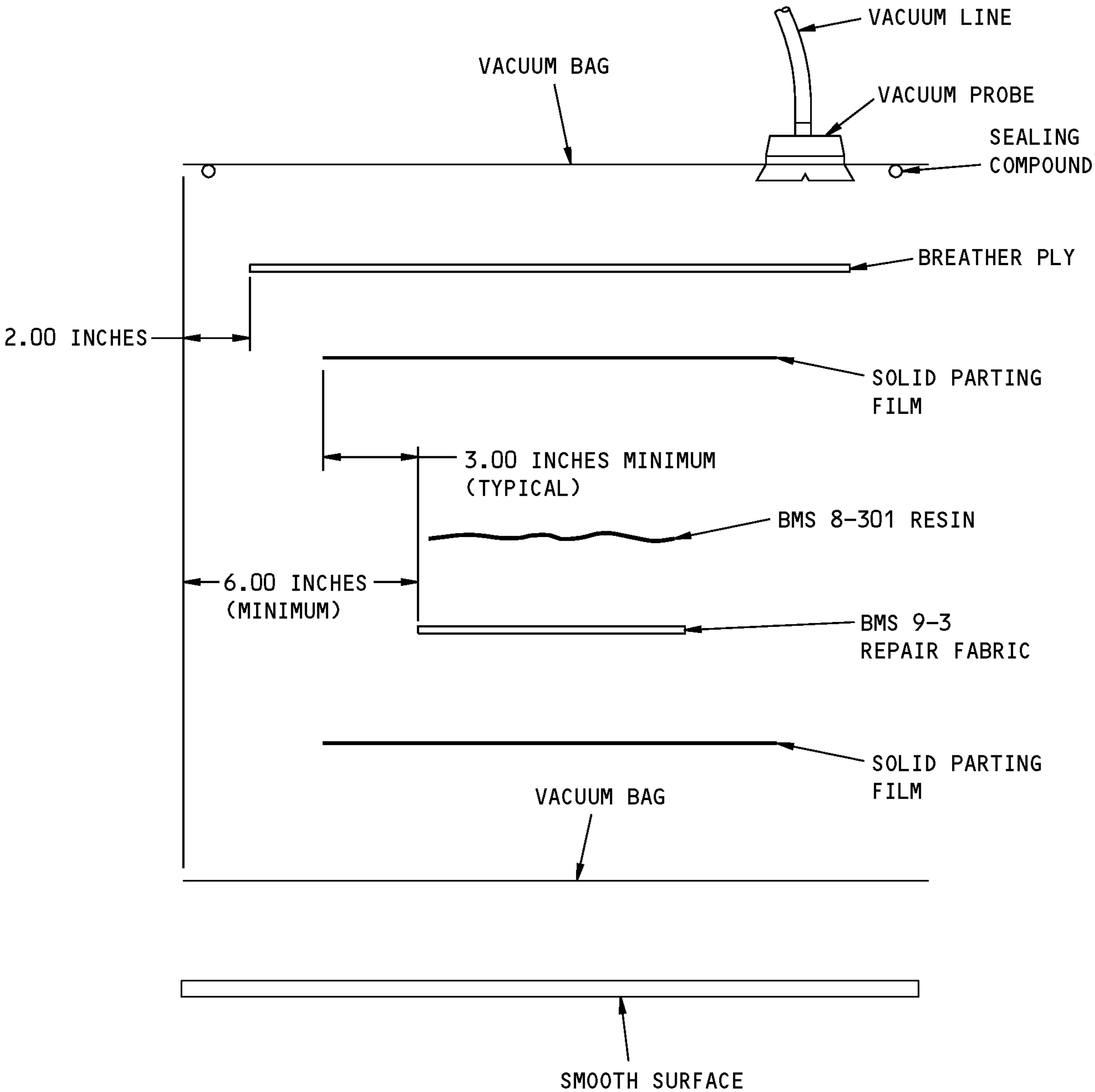
Taper Sand that is Necessary for the Repair
Figure 206



Repair Ply Overlap
Figure 207

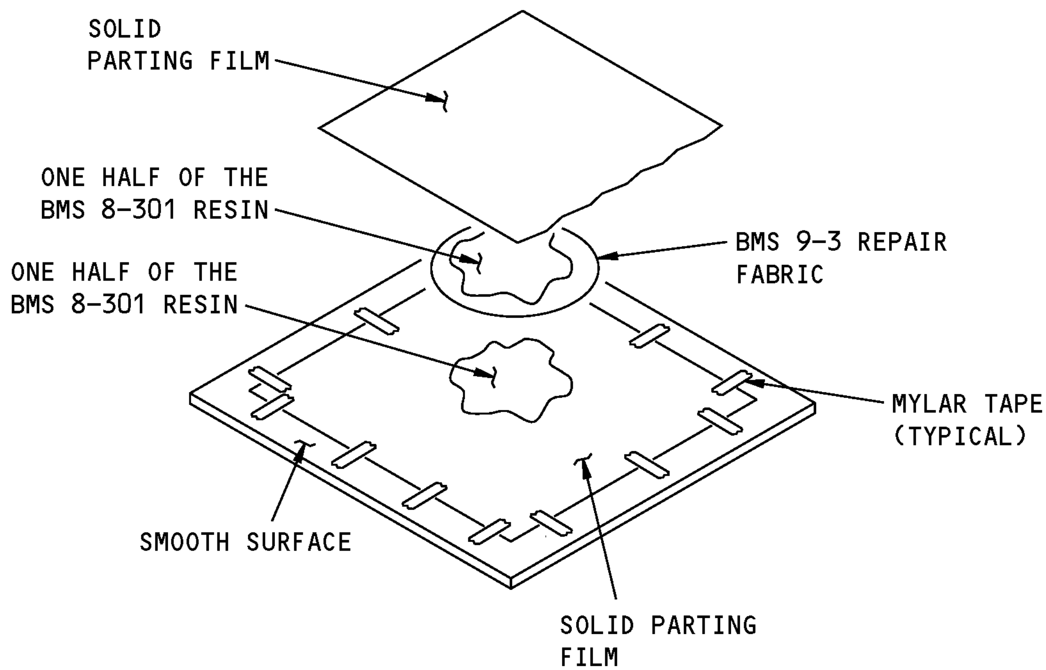


Recommended Vacuum Bag Procedure to Impregnate the BMS 9-3 Repair Plies with BMS 8-301 Resin
Figure 208 (Sheet 1 of 2)

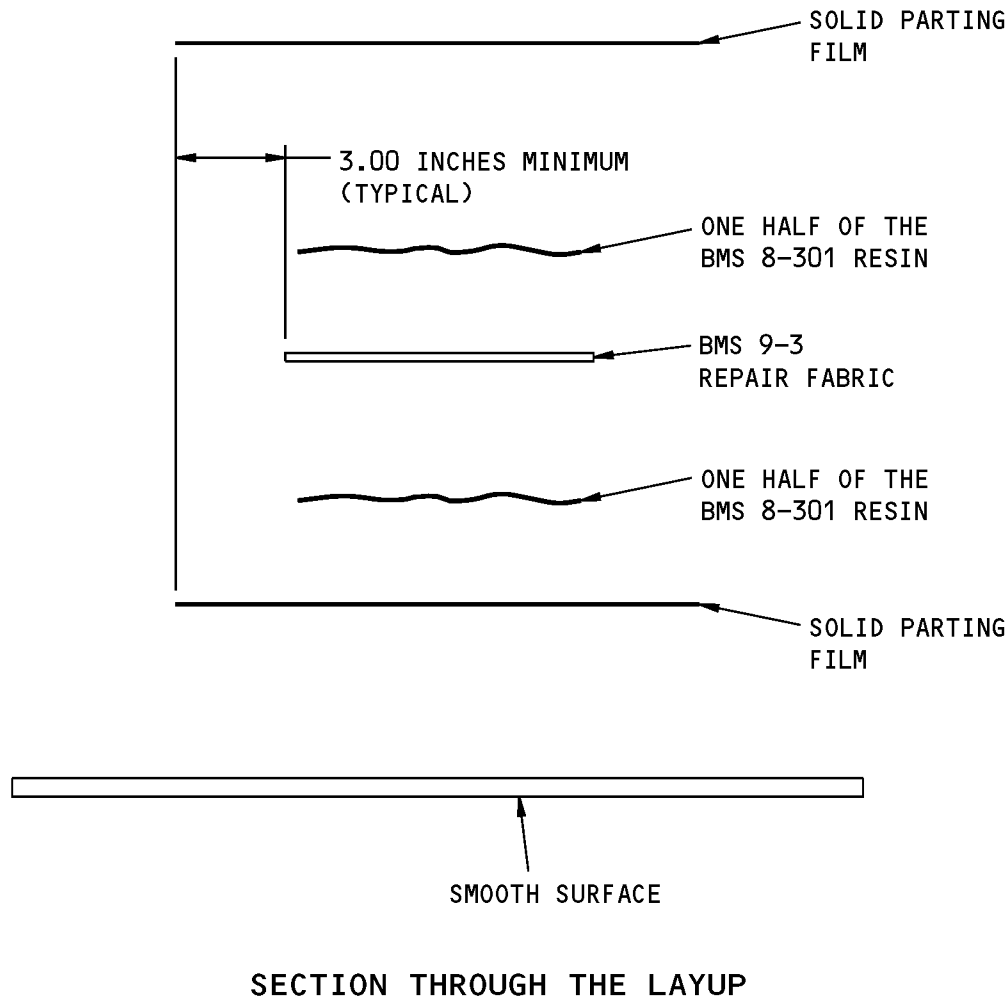


SECTION THROUGH THE LAYUP

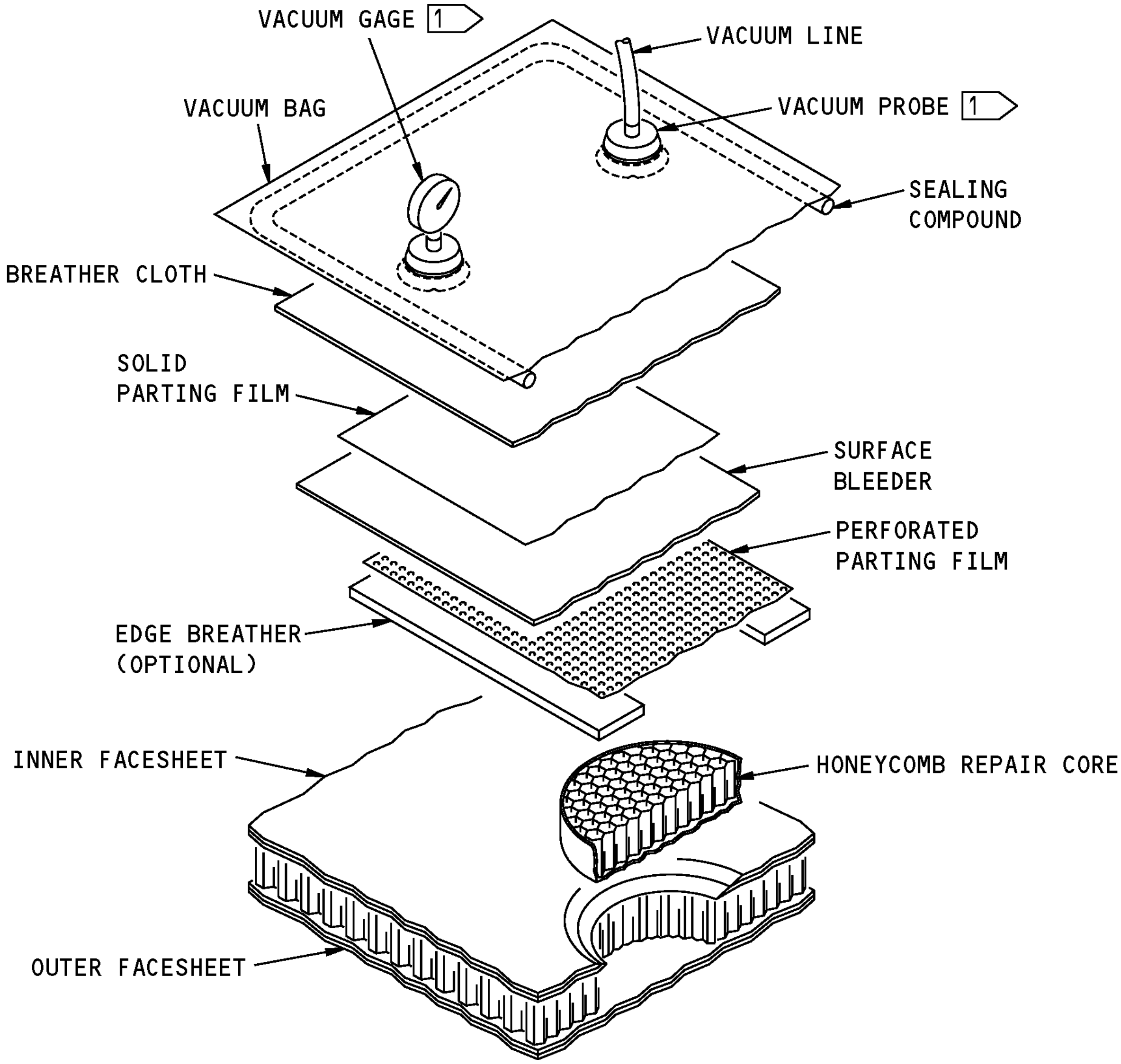
Recommended Vacuum Bag Procedure to Impregnate the BMS 9-3 Repair Plies with BMS 8-301 Resin
Figure 208 (Sheet 2 of 2)



Alternate Procedure to Impregnate the BMS 9-3 Repair Plies with BMS 8-301 Resin
Figure 209 (Sheet 1 of 2)



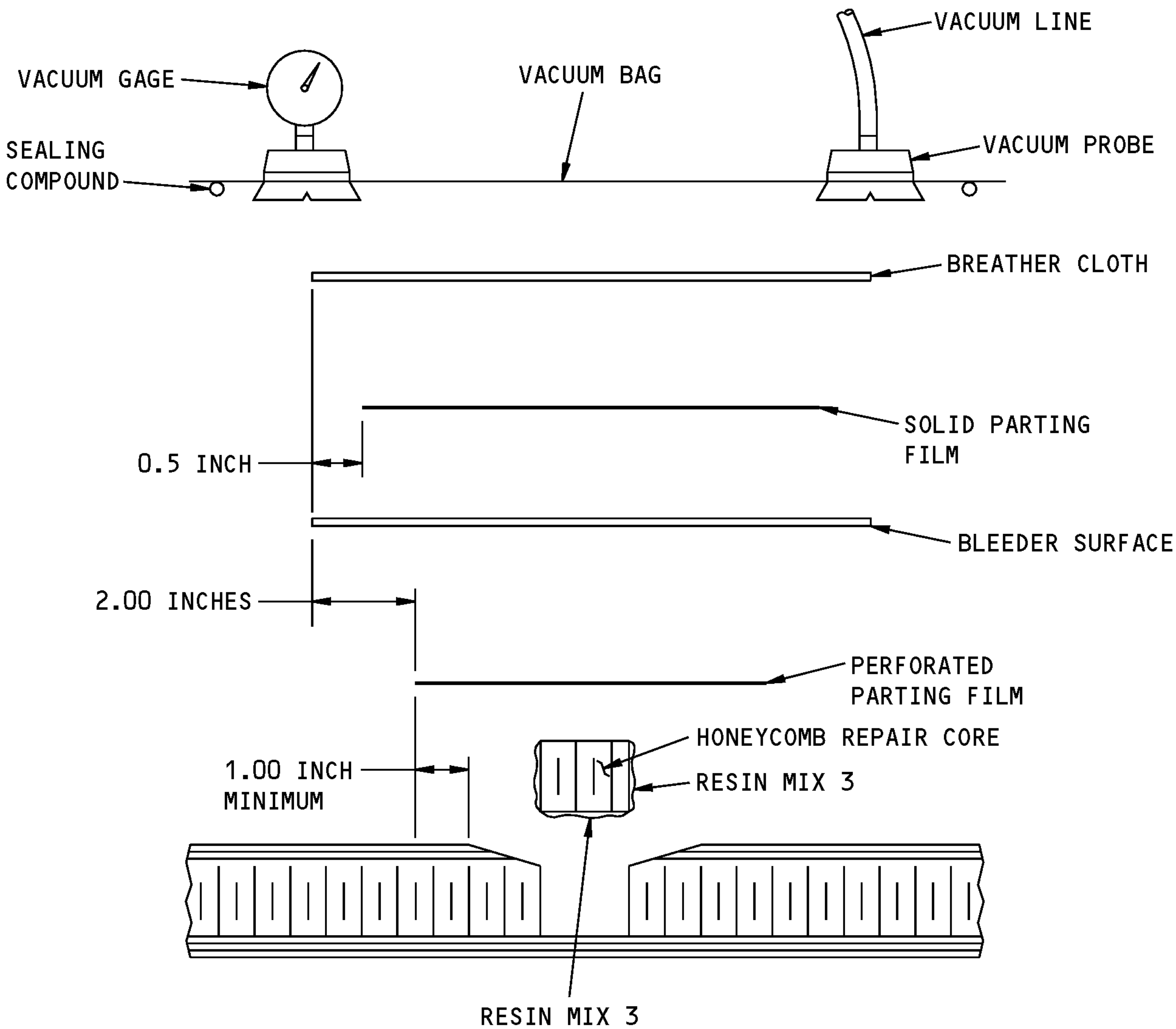
Alternate Procedure to Impregnate the BMS 9-3 Repair Plies with BMS 8-301 Resin
Figure 209 (Sheet 2 of 2)



NOTES

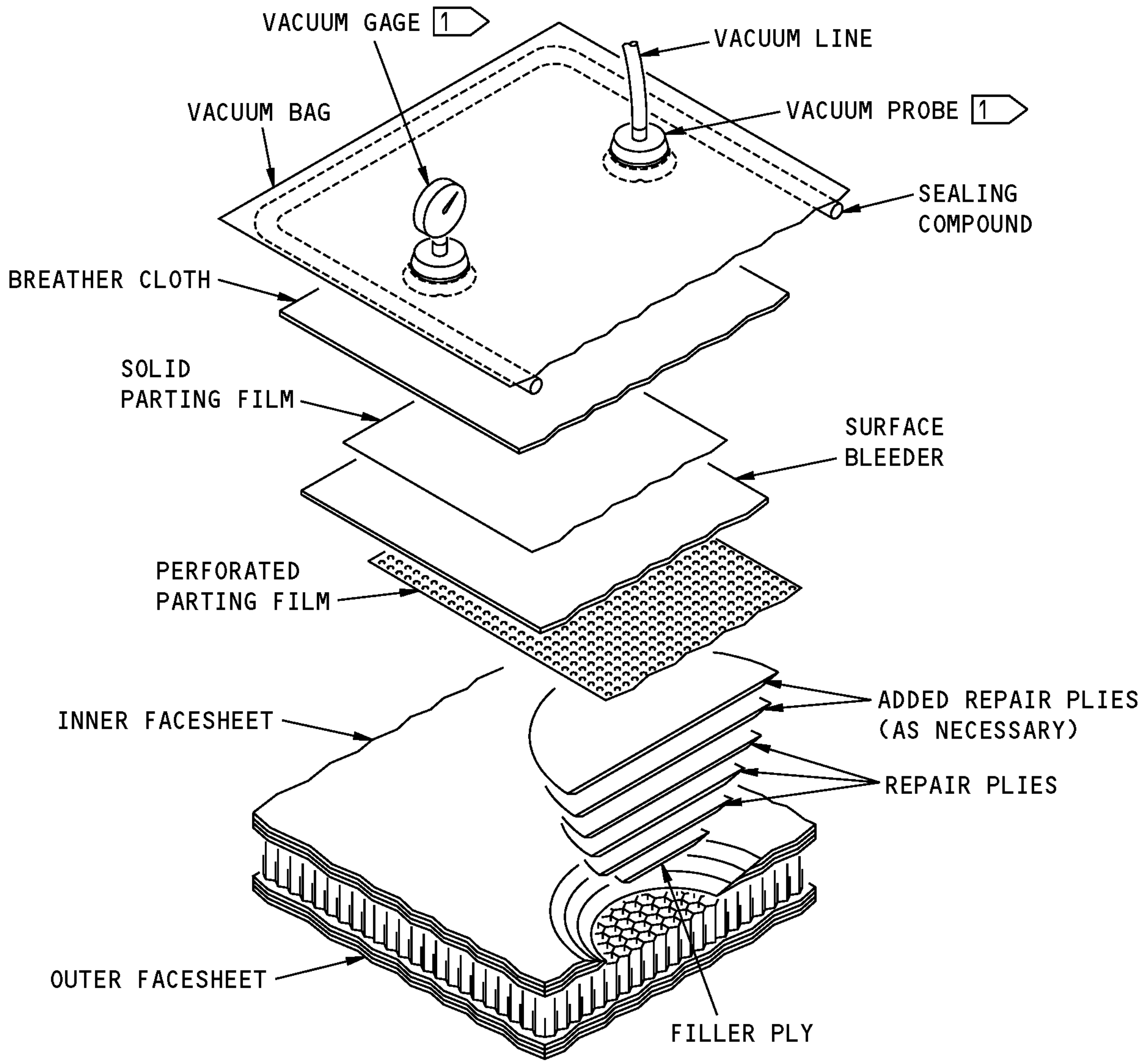
1 THE VACUUM PROBE AND GAGE MUST TOUCH THE SURFACE OF THE BREATHER CLOTH.

Vacuum Bag Instructions for the Cure of the Honeycomb Repair Core at Room Temperature
Figure 210 (Sheet 1 of 2)



SECTION THRU THE VACUUM BAG SYSTEM

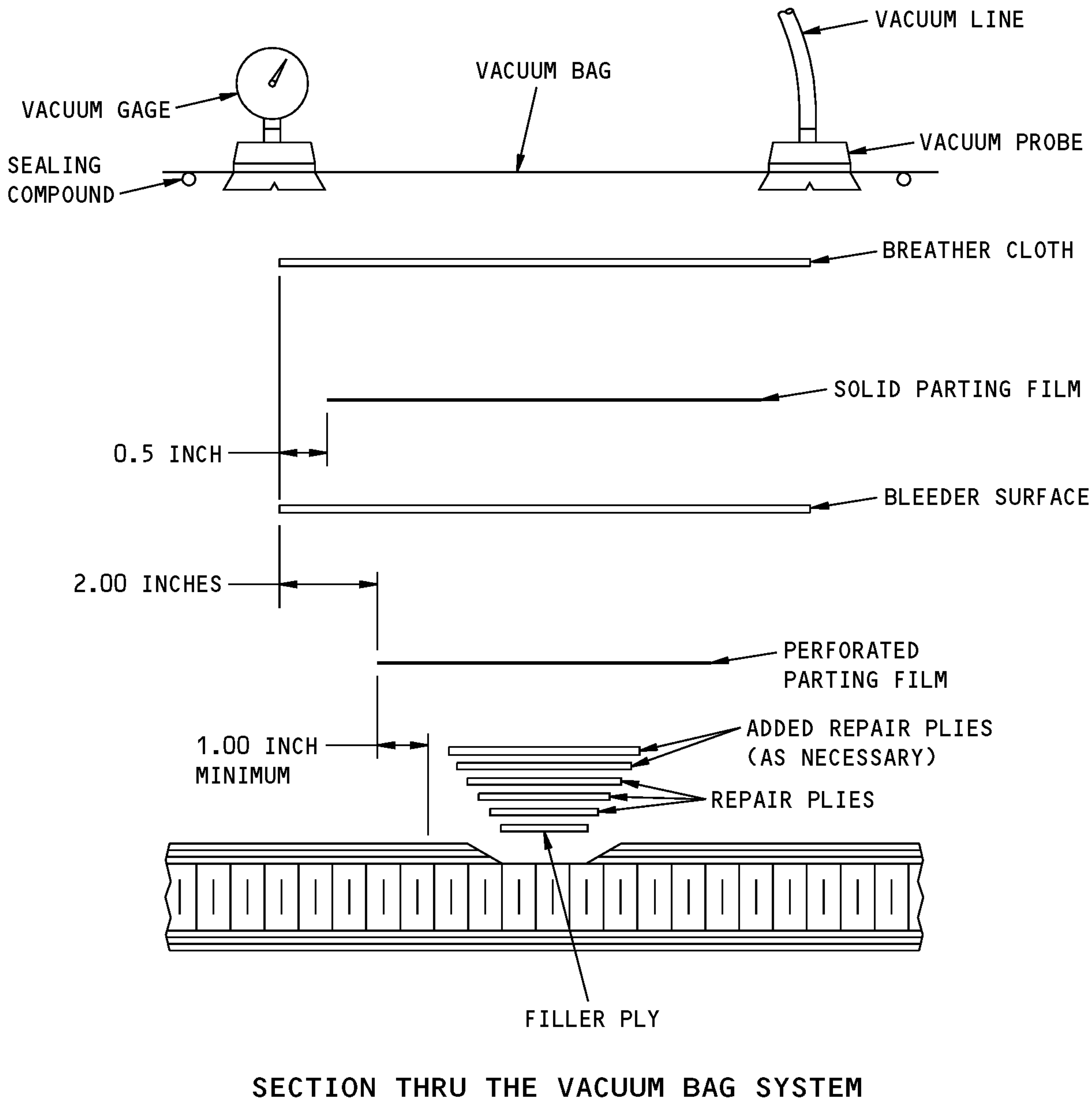
Vacuum Bag Instructions for the Cure of the Honeycomb Repair Core at Room Temperature
Figure 210 (Sheet 2 of 2)



NOTES

1 THE VACUUM PROBE AND GAGE MUST TOUCH THE SURFACE OF THE BREATHER CLOTH.

Vacuum Bag Instructions for the Cure of the Repair Plies at Room Temperature
Figure 211 (Sheet 1 of 2)



Vacuum Bag Instructions for the Cure of the Repair Plies at Room Temperature
Figure 211 (Sheet 2 of 2)

REPAIR 1 - REPAIR OF DAMAGE TO ONE FACESHEET OF A HONEYCOMB PANEL

1. Applicability

WARNING: MAKE SURE THAT THE FLIGHT CONTROL SURFACES ARE CORRECTLY BALANCED AFTER YOU REPAIR THEM. REFER TO SRM 51-60-00 FOR THE CONTROL SURFACE BALANCE REQUIREMENTS. IF YOU DO NOT OBEY, DAMAGE TO THE STRUCTURE CAN OCCUR.

CAUTION: REFER TO THE SPECIFIED COMPONENT REPAIR SUBJECT FOR THE MATERIALS AND PROCEDURES APPROVED FOR THIS REPAIR. IF YOU DO NOT OBEY, THE REPAIR WILL BE UNSATISFACTORY.

A. Repair 1 is applicable to damage to one skin of a honeycomb panel.

2. General

A. Repair 1 is a Category A repair. Refer to 51-00-06 for the definitions of the different categories of repairs.

B. The materials necessary for Repair 1 are given in Table 201.

Table 201:

REPAIR MATERIALS	
REPAIR MATERIALS	**BOEING SPECIFICATION**
Resin Mix 1 - Laminating Resin for Glass Fiber Repair Fabric	BMS 8-301, Type 1
Glass Fiber Repair Fabric	BMS 9-3, Type D, D-1, H-2 or H-3

3. References

Reference	Title
51-00-06	STRUCTURAL REPAIR DEFINITIONS
51-60-00, GENERAL	Control Surface Balance Procedures

4. Repair Instructions

A. Find the limits of the damage. Refer to Paragraph 4.A./REPAIR GENERAL.

B. Remove the damaged plies as given in Paragraph 4.B./REPAIR GENERAL.

C. Make the taper as given in Paragraph 4.E./REPAIR GENERAL.

D. Remove all of the water or other unwanted material as given in Paragraph 4.D./REPAIR GENERAL. The damaged area must be fully dry.

E. Clean the damaged area as given in Paragraph 4.F./REPAIR GENERAL.

F. Prepare the repair fabric as given in Paragraph 4.H./REPAIR GENERAL and Paragraph 4.I./REPAIR GENERAL. Refer to Repair 1 - Layout of the Repair Materials, Figure 201/REPAIR 1 for the layout of the repair parts.

G. Apply the fabric repair plies to one surface as given in Paragraph 4.K./REPAIR GENERAL.

H. Install the vacuum bag system as given in Paragraph 4.L./REPAIR GENERAL.

I. Do a check of the vacuum bag for leaks as given in Paragraph 4.M./REPAIR GENERAL.

J. Apply the pressure for the cure as given in Paragraph 4.N./REPAIR GENERAL.

K. Cure the repair plies.

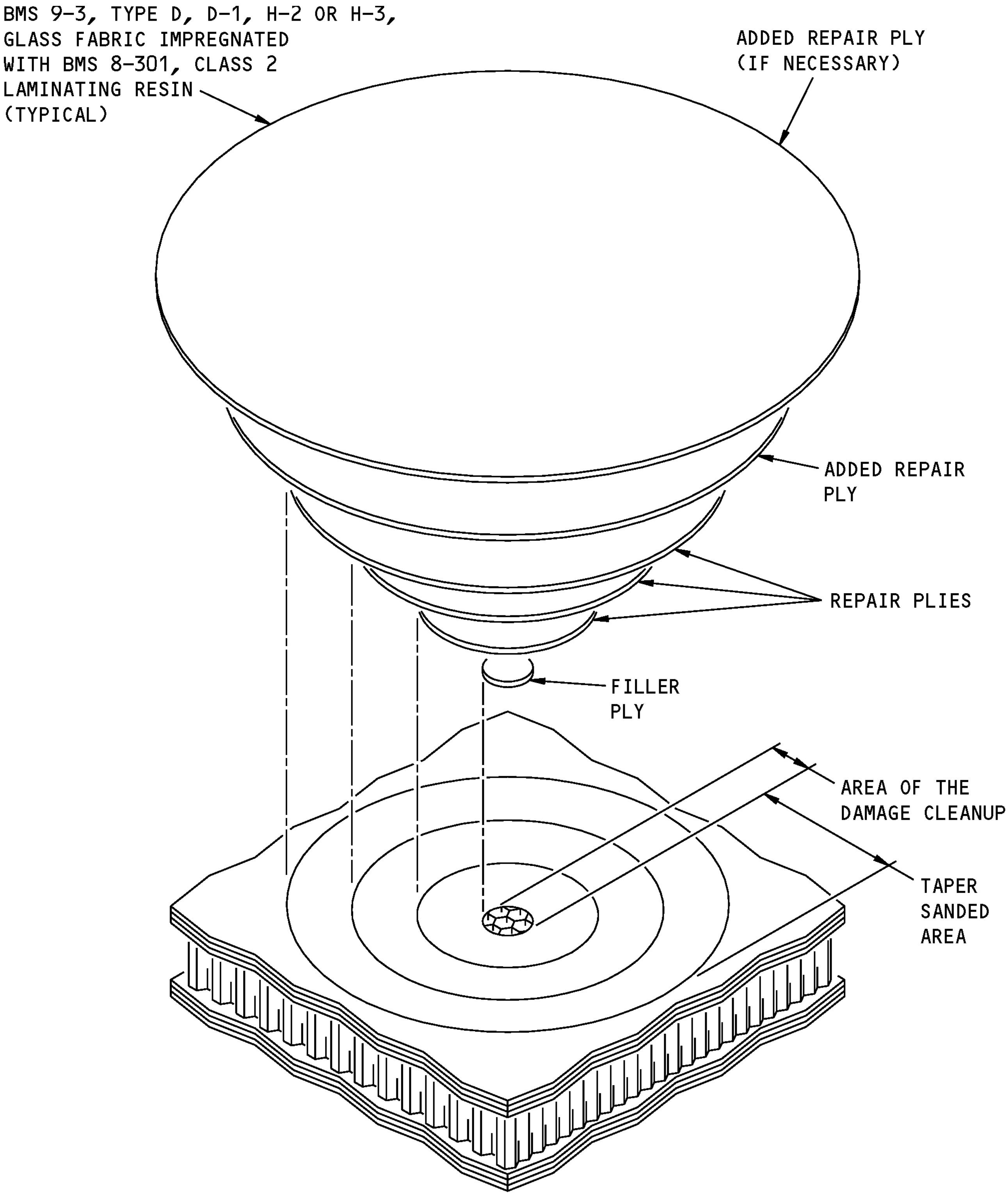
(1) Use the cure instructions for Resin Mix 1 as given in Paragraph 4.O.(1)/REPAIR GENERAL.

L. Examine the completed repair as given in Paragraph 4.P./REPAIR GENERAL.

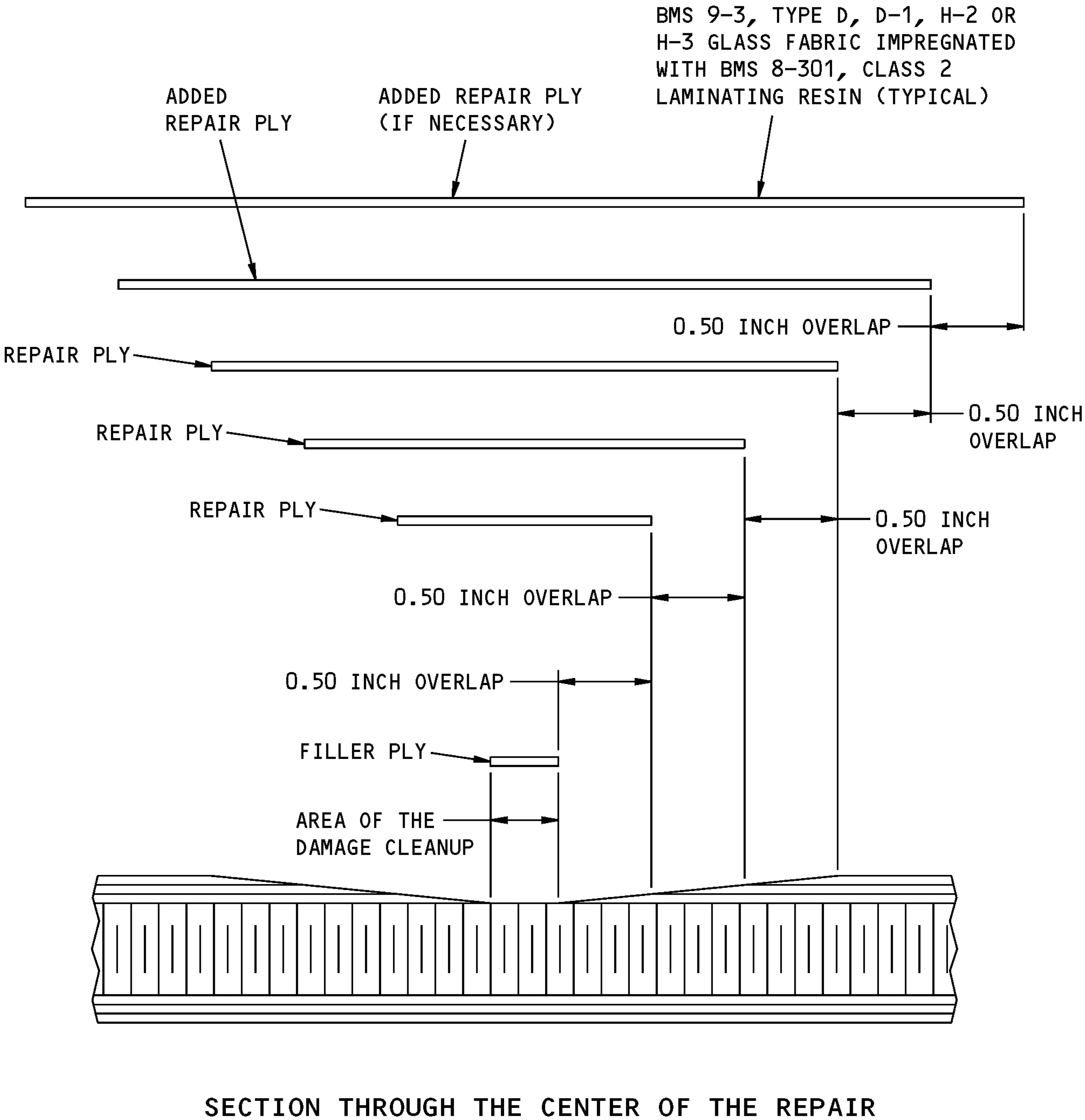
M. Apply the finish to the repair area as given in Paragraph 4.Q./REPAIR GENERAL.

N. Drill out drain and fastener holes, if they were filled, as given in Paragraph 4.R./REPAIR GENERAL and Paragraph 4.S./REPAIR GENERAL.

O. Do a check of the flight control surfaces as given in Paragraph 4.T./REPAIR GENERAL and Paragraph 4.U./REPAIR GENERAL.



Repair 1 - Layout of the Repair Materials
Figure 201 (Sheet 1 of 2)



Repair 1 - Layout of the Repair Materials
Figure 201 (Sheet 2 of 2)

REPAIR 2 - REPAIR OF DAMAGE THAT IS 0.50 INCH OR LESS IN DIAMETER TO ONE FACESHEET AND THE CORE OF A HONEYCOMB PANEL

1. Applicability

WARNING: MAKE SURE THAT THE FLIGHT CONTROL SURFACES ARE CORRECTLY BALANCED AFTER YOU REPAIR THEM. REFER TO SRM 51-60-00 FOR THE CONTROL SURFACE BALANCE REQUIREMENTS. IF YOU DO NOT OBEY, DAMAGE TO THE STRUCTURE CAN OCCUR.

CAUTION: REFER TO THE SPECIFIED COMPONENT REPAIR SUBJECT FOR THE MATERIALS AND PROCEDURES APPROVED FOR THIS REPAIR. IF YOU DO NOT OBEY, THE REPAIR WILL BE UNSATISFACTORY.

A. Repair 2 is applicable to damage to one facesheet and the core of a honeycomb panel.

B. Repair 2 is applicable to damage that is less than 0.50 Inch in diameter.

2. General

A. Repair 2 is a Category A repair. Refer to 51-00-06 for the definitions of the different categories of repairs.

B. The materials necessary for Repair 2 are given in Table 201.

Table 201:

REPAIR MATERIALS	
REPAIR MATERIALS	**BOEING SPECIFICATION**
Resin Mix 1 - Laminating Resin for Glass Fiber Repair Fabric	BMS 8-301, Class 2
Resin Mix 4	Resin Mix 1, mixed with milled glass fibers
Resin Mix 5	Resin Mix 2, mixed with milled glass fibers
Glass Fiber Repair Fabric	BMS 9-3, Type D, D-1, H-2 or H-3

3. References

Reference	Title
51-00-06	STRUCTURAL REPAIR DEFINITIONS
51-60-00, GENERAL	Control Surface Balance Procedures

4. Repair Instructions

A. Find the limits of the damage. Refer to Paragraph 4.A./REPAIR GENERAL.

B. Remove the damaged facesheet as shown in Repair 2 - Removal of the Damage, Figure 201/REPAIR 2. Do not make a taper.

C. Remove the damaged core as shown in Repair 2 - Removal of the Damage, Figure 201/REPAIR 2.

D. Remove all of the water or other unwanted material as given in Paragraph 4.D./REPAIR GENERAL. The damaged area must be fully dry.

E. Clean the damaged area as given in Paragraph 4.F./REPAIR GENERAL.

F. Fill the damaged area with Resin Mix 4 or Resin Mix 5 until the level on the resin mix is higher than the outer surface of the initial facesheet.

G. Cure the Resin Mix 4 or Resin Mix 5 as given in Paragraph 4.O.(1)/REPAIR GENERAL or Paragraph 4.O.(2)/REPAIR GENERAL, as applicable.

(1) A vacuum bag and vacuum pressure are not necessary when you cure the resin mix.

H. Sand the cured resin mix until it is smooth with the outer surface of the initial facesheet.

I. Clean the repair area as given in Paragraph 4.F./REPAIR GENERAL.

J. Prepare the repair fabric as given in Paragraph 4.H./REPAIR GENERAL and Paragraph 4.I./REPAIR GENERAL. Refer to Repair 2 - Layout of the Repair Parts, Figure 202/REPAIR 2 for the layout of the repair parts.

K. Apply the repair plies as given in Paragraph 4.K./REPAIR GENERAL.

L. Install the vacuum bag system as given in Paragraph 4.L./REPAIR GENERAL.

M. Do a check of the vacuum bag for leaks as given in Paragraph 4.M./REPAIR GENERAL.

N. Apply the pressure for the cure as given in Paragraph 4.N./REPAIR GENERAL.

O. Cure the repair plies.

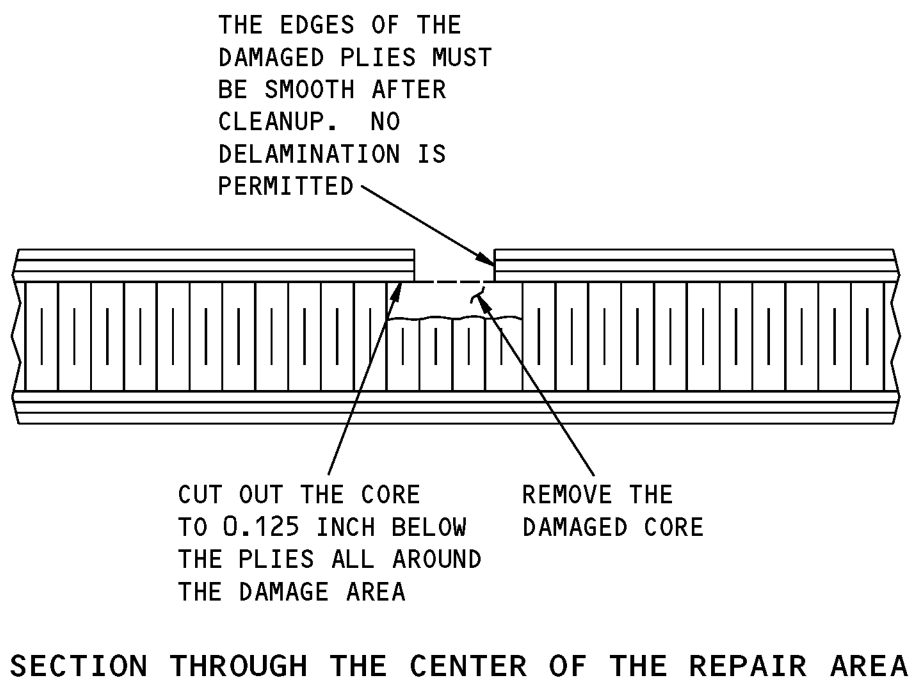
(1) Use the instructions for Resin Mix 1 as given in Paragraph 4.O.(1)/REPAIR GENERAL.

P. Examine the completed repair as given in Paragraph 4.P./REPAIR GENERAL.

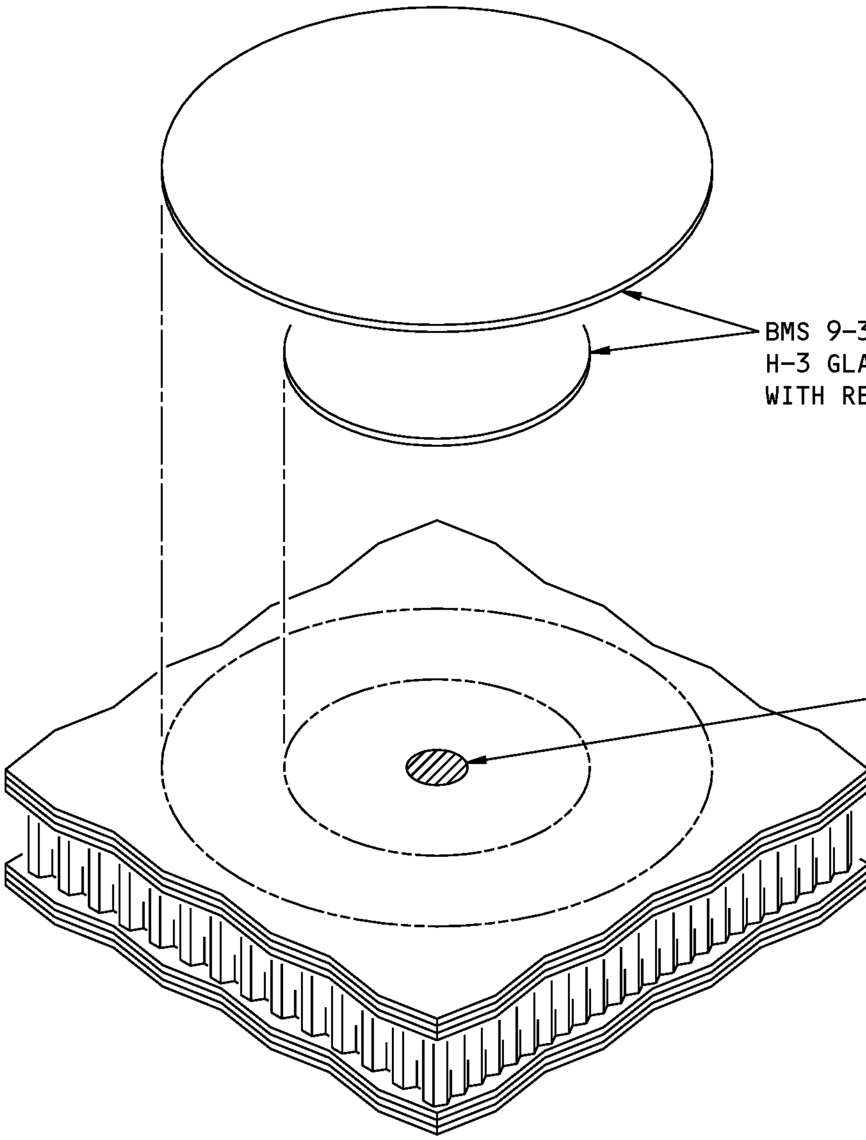
Q. Apply the finish to the repair area as given in Paragraph 4.Q./REPAIR GENERAL.

R. Drill out drain and fastener holes, if they were filled, as given in Paragraph 4.R./REPAIR GENERAL and Paragraph 4.S./REPAIR GENERAL.

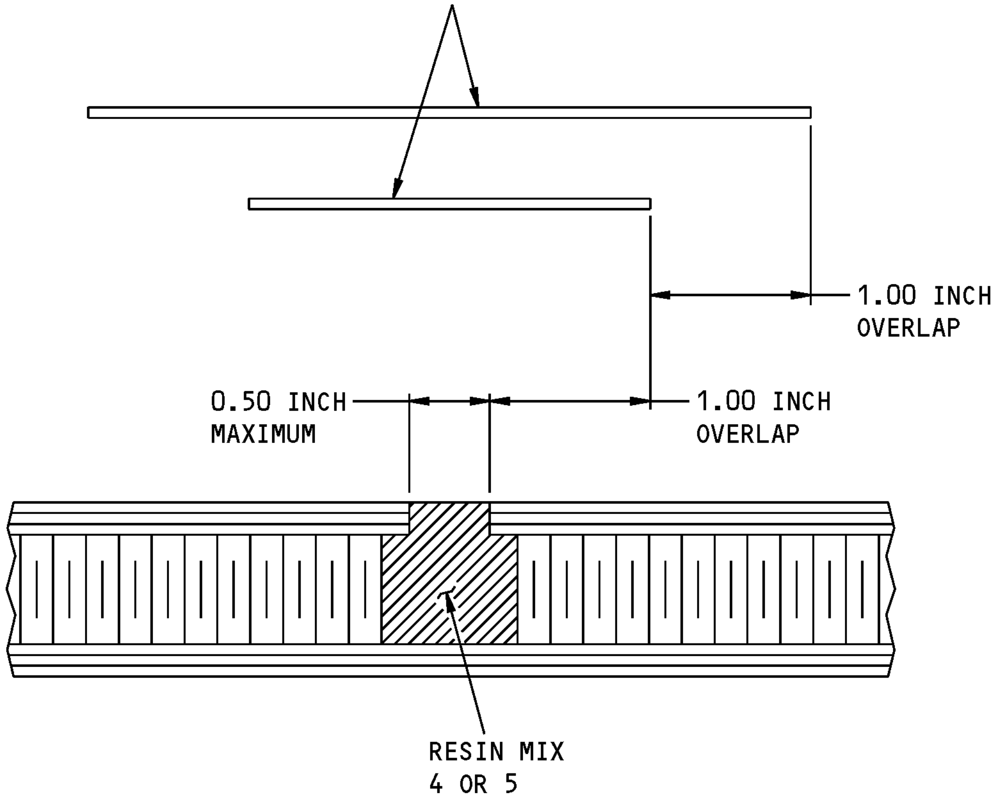
S. Do a check of the flight control surfaces as given in Paragraph 4.T./REPAIR GENERAL and Paragraph 4.U./REPAIR GENERAL.



Repair 2 - Removal of the Damage
Figure 201



Repair 2 - Layout of the Repair Parts
Figure 202 (Sheet 1 of 2)



SECTION THROUGH THE CENTER OF THE REPAIR AREA

Repair 2 - Layout of the Repair Parts
Figure 202 (Sheet 2 of 2)

REPAIR 3 - REPAIR OF DAMAGE TO ONE FACESHEET AND THE CORE OF A HONEYCOMB PANEL

1. **Applicability**

WARNING: MAKE SURE THAT THE FLIGHT CONTROL SURFACES ARE CORRECTLY BALANCED AFTER YOU REPAIR THEM. REFER TO SRM 51-60-00 FOR THE CONTROL SURFACE BALANCE REQUIREMENTS. IF YOU DO NOT OBEY, DAMAGE TO THE STRUCTURE CAN OCCUR.

CAUTION: REFER TO THE SPECIFIED COMPONENT REPAIR SUBJECT FOR THE MATERIALS AND PROCEDURES APPROVED FOR THIS REPAIR. IF YOU DO NOT OBEY, THE REPAIR WILL BE UNSATISFACTORY.

A. Repair 3 is applicable to damage to one facesheet and the core of a honeycomb panel.

2. **General**

A. Repair 3 is a Category A repair. Refer to 51-00-06 for the definitions of the different categories of repairs.

B. The materials necessary for Repair 3 are given in Table 201.

Table 201:

REPAIR MATERIALS	
REPAIR MATERIALS	**BOEING SPECIFICATION**
Resin Mix 1 - Laminating Resin for Glass Fiber Repair Fabric	BMS 8-301, Class 2
Resin Mix 3	Resin Mix 2, mixed with microballoons
Glass Fiber Repair Fabric	BMS 9-3, Type D, D-1, H-2 or H-3
Repair Core	Use the same material as the initial core

3. **References**

Reference	Title
51-00-06	STRUCTURAL REPAIR DEFINITIONS
51-60-00, GENERAL	Control Surface Balance Procedures

4. **Repair Instructions**

A. Find the limits of the damage. Refer to Paragraph 4.A./REPAIR GENERAL.

B. Remove the damaged facesheets as given in Paragraph 4.B./REPAIR GENERAL.

C. Remove the damaged core as given in Paragraph 4.C./REPAIR GENERAL.

D. Remove all of the water or other unwanted material as given in Paragraph 4.D./REPAIR GENERAL. The damaged area must be fully dry.

E. Make the taper as given in Paragraph 4.E./REPAIR GENERAL.

F. Clean the damaged area as given in Paragraph 4.F./REPAIR GENERAL.

G. Make the honeycomb repair core as given in Paragraph 4.G./REPAIR GENERAL. Refer to Repair 3 - Layout of the Repair Materials, Figure 201/REPAIR 3 for the layout of the repair parts.

H. Prepare the repair fabric as given in Paragraph 4.H./REPAIR GENERAL and Paragraph 4.I./REPAIR GENERAL. Refer to Repair 3 - Layout of the Repair Materials, Figure 201/REPAIR 3 for the layout of the repair parts.

I. Install the honeycomb repair core as given in Paragraph 4.J./REPAIR GENERAL.

J. Cure the repair core installation as given in Paragraph 4.O.(2)/REPAIR GENERAL.

NOTE: As an alternative, you can cure the repair core installation at the same time you cure the other repair materials.

K. Apply the repair plies as given in Paragraph 4.K./REPAIR GENERAL.

L. Install the vacuum bag system as given in Paragraph 4.L./REPAIR GENERAL.

M. Do a check of the vacuum bag for leaks as given in Paragraph 4.M./REPAIR GENERAL.

N. Apply the pressure for the cure as given in Paragraph 4.N./REPAIR GENERAL.

O. Cure the repair.

(1) If you will cure only the repair plies in this step, use the cure instructions for Resin Mix 1 given in Paragraph 4.O.(1)/REPAIR GENERAL.

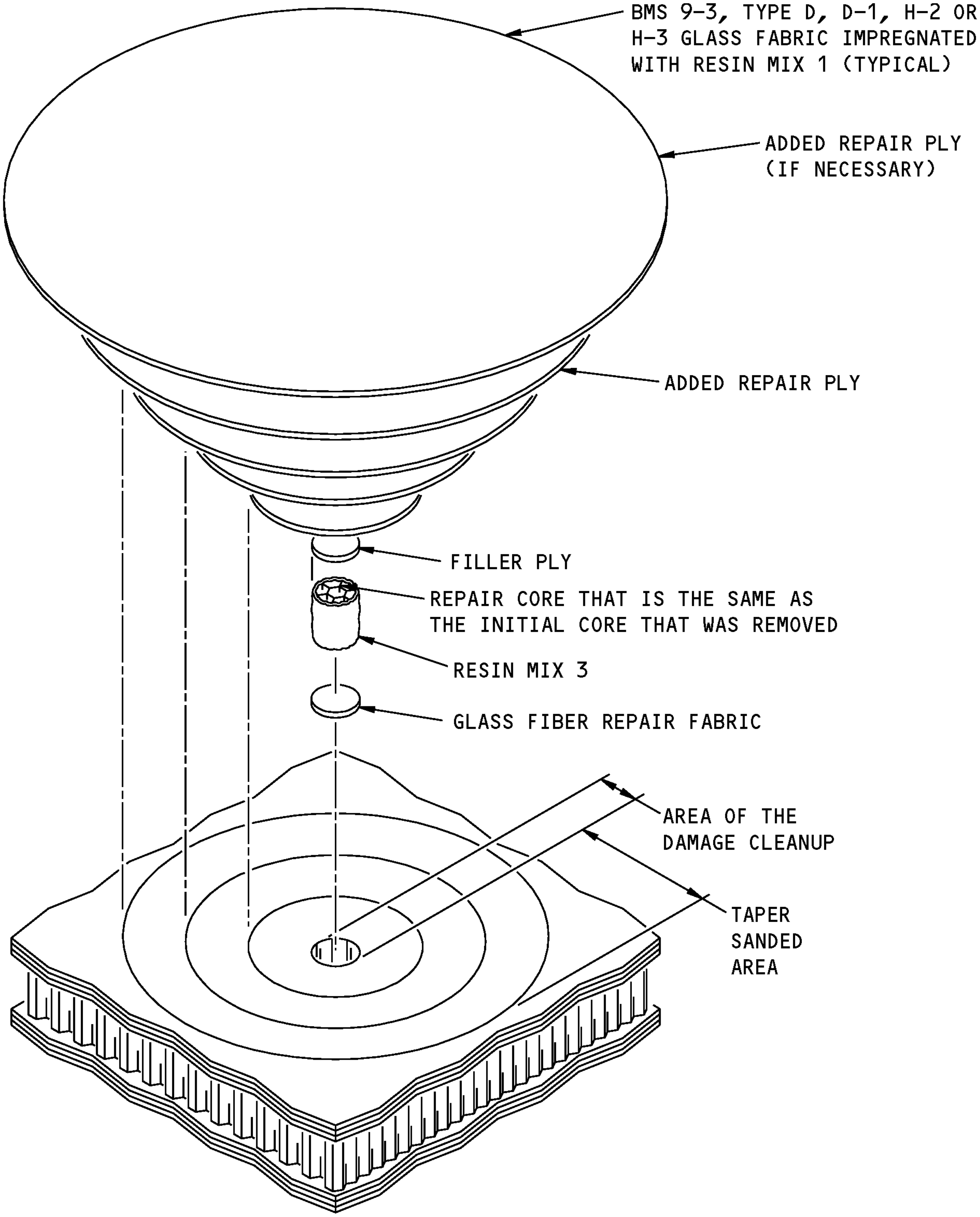
(2) If you will cure the repair core and the repair plies in this step, use the cure instructions for Resin Mix 3 given in Paragraph 4.O.(2)/REPAIR GENERAL.

P. Examine the completed repair as given in Paragraph 4.P./REPAIR GENERAL.

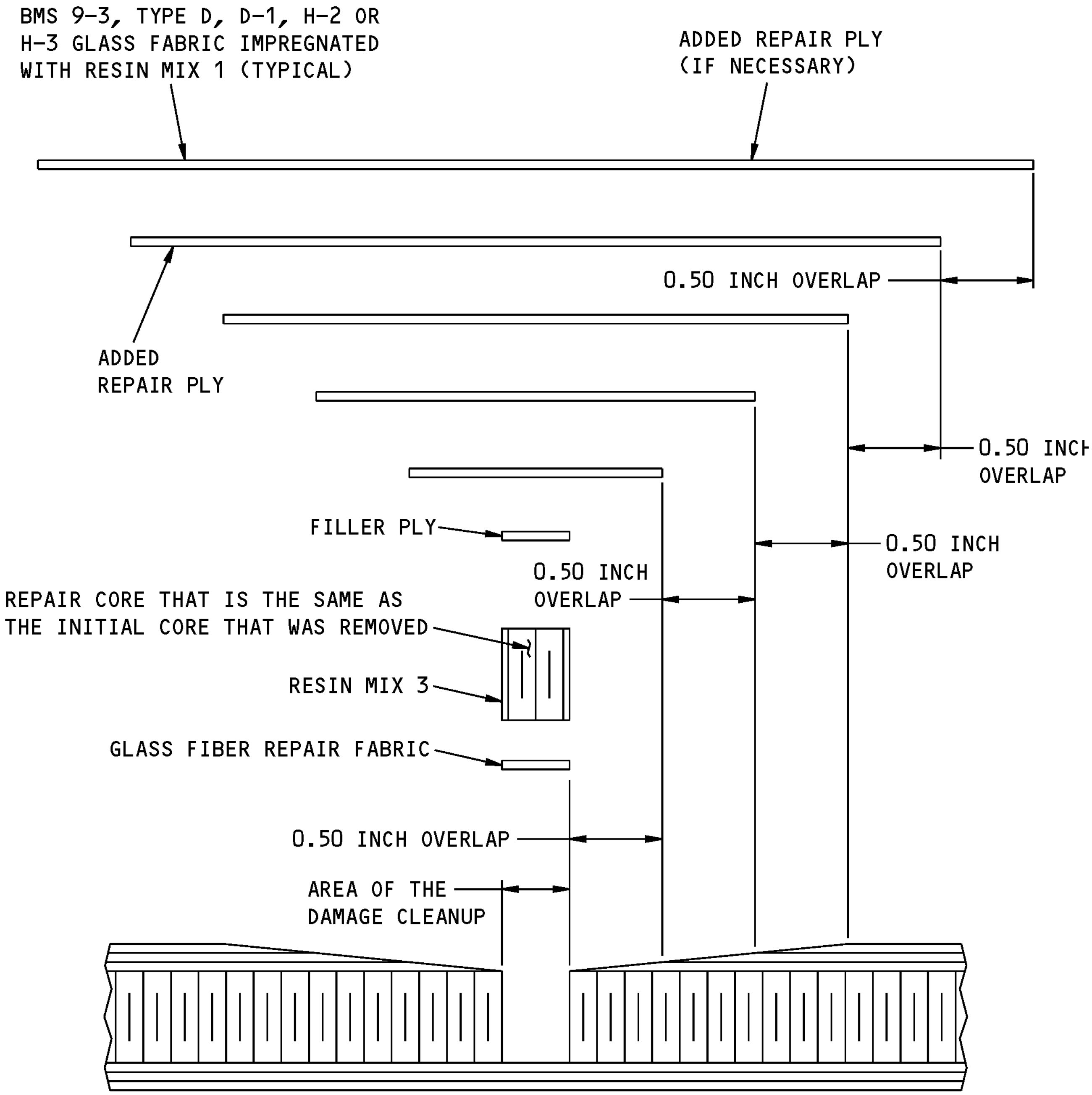
Q. Apply the finish to the repair area as given in Paragraph 4.Q./REPAIR GENERAL.

R. Drill out drain and fastener holes, if they were filled, as given in Paragraph 4.R./REPAIR GENERAL and Paragraph 4.S./REPAIR GENERAL.

S. Do a check of the flight control surfaces as given in Paragraph 4.T./REPAIR GENERAL and Paragraph 4.U./REPAIR GENERAL.



Repair 3 - Layout of the Repair Materials
Figure 201 (Sheet 1 of 2)



SECTION THROUGH THE CENTER OF THE REPAIR

Repair 3 - Layout of the Repair Materials
Figure 201 (Sheet 2 of 2)

REPAIR 4 - REPAIR OF DAMAGE TO THE TWO FACESHEETS AND THE CORE OF A HONEYCOMB PANEL

1. Applicability

WARNING: MAKE SURE THAT THE FLIGHT CONTROL SURFACES ARE CORRECTLY BALANCED AFTER YOU REPAIR THEM. REFER TO SRM 51-60-00 FOR THE CONTROL SURFACE BALANCING PROCEDURES. IF YOU DO NOT OBEY, DAMAGE TO THE STRUCTURE CAN OCCUR.

CAUTION: REFER TO THE SPECIFIED COMPONENT REPAIR SUBJECT FOR THE MATERIALS AND PROCEDURES APPROVED FOR THIS REPAIR. IF YOU DO NOT OBEY, THE REPAIR WILL BE UNSATISFACTORY.

A. Repair 4 is applicable to damage to the two facesheets and the core of a honeycomb core panel.

2. General

A. Repair 4 is a Category A repair. Refer to 51-00-06 for the definitions of the different categories of repairs.

B. The materials necessary for Repair 4 are given in Table 201.

Table 201:

REPAIR MATERIALS	
REPAIR MATERIALS	**BOEING SPECIFICATION**
Resin Mix 1 - Laminating Resin for Glass Fiber Repair Fabric	BMS 8-301, Class 2
Resin Mix 3	Resin Mix 2 (mixed with microballoons)
Glass Fiber Repair Fabric	BMS 9-3, Type D, D-1, H-2 or H-3
Honeycomb Repair Core Fabric	Use the same material as the initial core

3. References

Reference	Title
51-00-06	STRUCTURAL REPAIR DEFINITIONS
51-60-00, GENERAL	Control Surface Balance Procedures

4. Repair Instructions

NOTE: The two-step cure procedure that follows is the recommended procedure. As an alternative, you can use a three-step cure procedure in which the repair core installation and the repair plies on each side are cured independently.

A. Find the limits of the damage. Refer to Paragraph 4.A./REPAIR GENERAL.

B. Remove the damaged plies as given in Paragraph 4.B./REPAIR GENERAL.

C. Remove the damaged core as given in Paragraph 4.C./REPAIR GENERAL.

D. Make the taper as given in Paragraph 4.E./REPAIR GENERAL.

E. Remove all of the water or other unwanted material as given in Paragraph 4.D./REPAIR GENERAL. The damaged area must be fully dry.

F. Clean the damaged area as given in Paragraph 4.F./REPAIR GENERAL.

G. Make the honeycomb repair core as given in Paragraph 4.G./REPAIR GENERAL. Refer to Repair 4 - Layout of the Repair Materials, Figure 201/REPAIR 4 for the layout of the repair parts.

H. Prepare the repair fabric as given in Paragraph 4.H./REPAIR GENERAL and Paragraph 4.I./REPAIR GENERAL. Refer to Repair 4 - Layout of the Repair Materials, Figure 201/REPAIR 4 for the layout of the repair parts.

I. Install the honeycomb repair core as given in Paragraph 4.J./REPAIR GENERAL.

NOTE: It is not necessary to use a vacuum bag procedure at this time. Use a caul plate on the opposite side of the panel to keep the core repair plug in position.

J. Apply the repair plies to one surface as given in Paragraph 4.K./REPAIR GENERAL.

K. Install the vacuum bag system as given in Paragraph 4.L./REPAIR GENERAL.

L. Do a check of the vacuum bag for leaks as given in Paragraph 4.M./REPAIR GENERAL.

M. Apply the pressure for the cure as given in Paragraph 4.N./REPAIR GENERAL.

N. Cure the repair as given in Paragraph 4.O./REPAIR GENERAL.

(1) If you cure only the repair plies in this step, use the cure instructions for Resin Mix 1 given in Paragraph 4.O.(1)/REPAIR GENERAL.

(2) If you cure the repair core and the repair plies in this step, use the cure instructions for Resin Mix 2 given in Paragraph 4.O.(2)/REPAIR GENERAL.

O. Sand the repair core to be smooth with the inner surface of the initial facesheet.

P. Clean the repair area as given in Paragraph 4.F./REPAIR GENERAL.

Q. Apply the fabric repair plies to the opposite surface as given in Paragraph 4.K./REPAIR GENERAL.

R. Install the vacuum bag system as given in Paragraph 4.L./REPAIR GENERAL.

S. Do a check of the vacuum bag for leaks as given in Paragraph 4.M./REPAIR GENERAL.

T. Apply the pressure for the cure as given in Paragraph 4.N./REPAIR GENERAL.

U. Cure the repair plies.

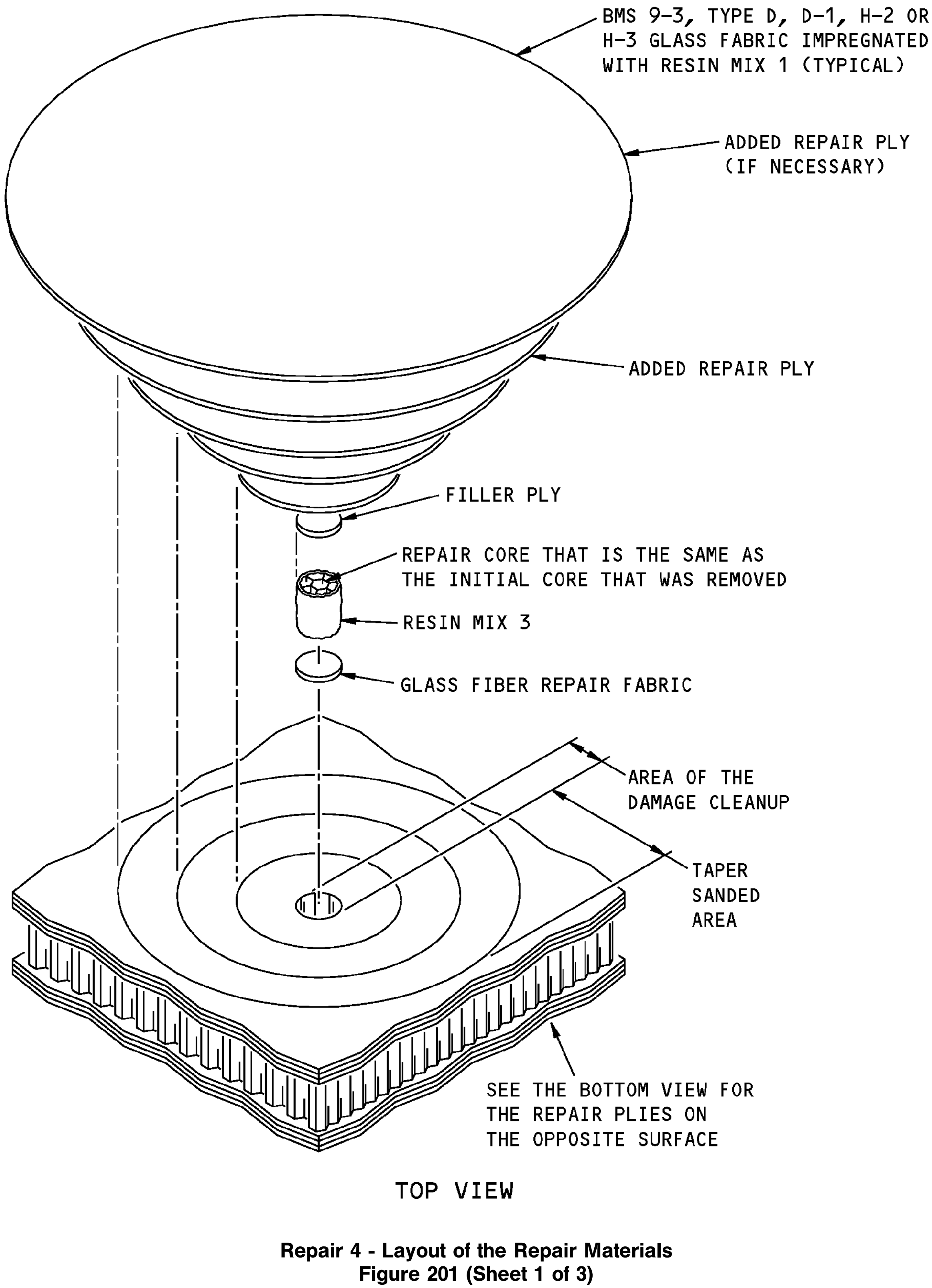
(1) Use the cure instructions for Resin Mix 1 given in Paragraph 4.O.(1)/REPAIR GENERAL.

V. Examine the completed repair as given in Paragraph 4.P./REPAIR GENERAL.

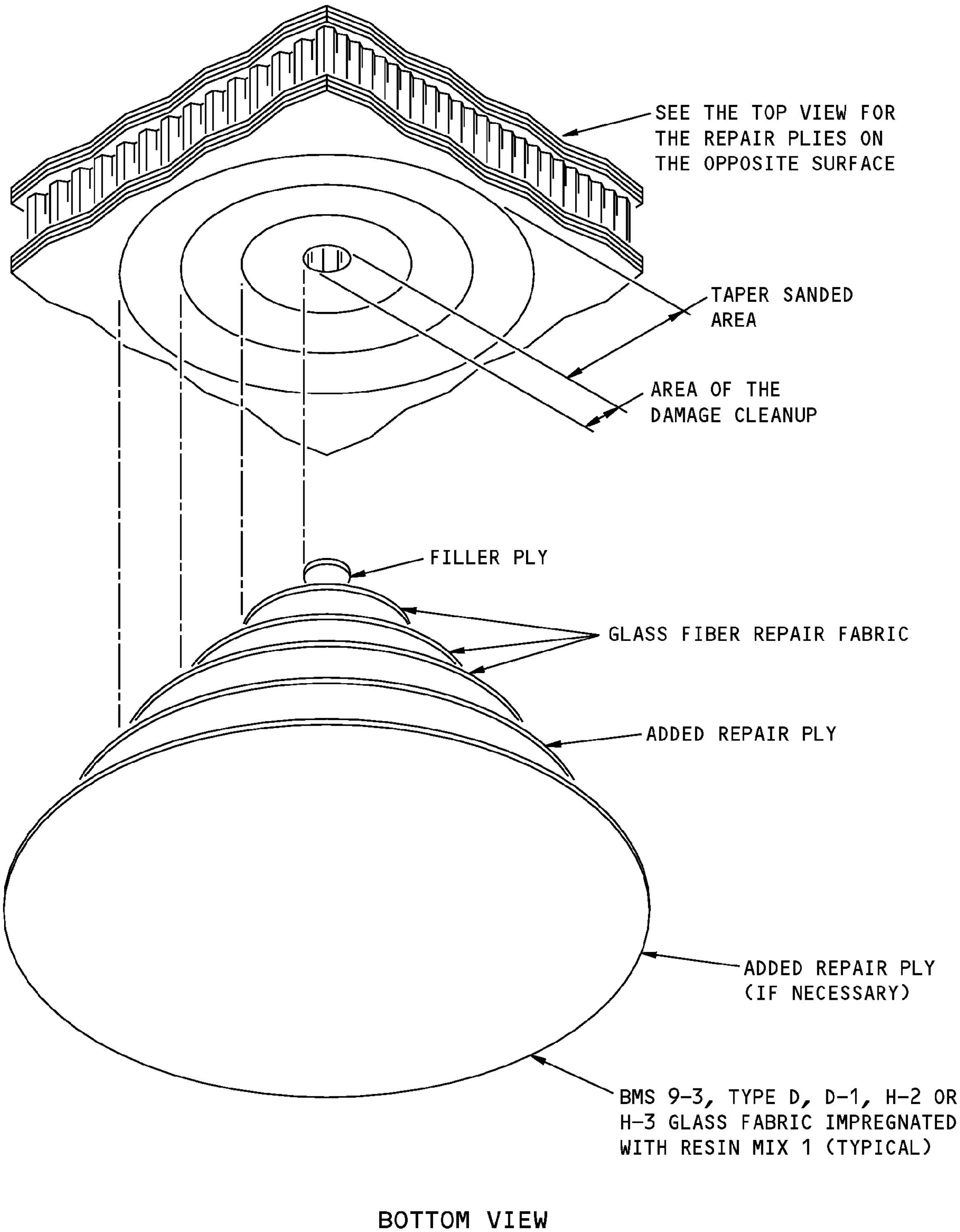
W. Apply the finish to the repair area as given in Paragraph 4.Q./REPAIR GENERAL.

X. Drill out drain and fastener holes, if they were filled, as given in Paragraph 4.R./REPAIR GENERAL and Paragraph 4.S./REPAIR GENERAL.

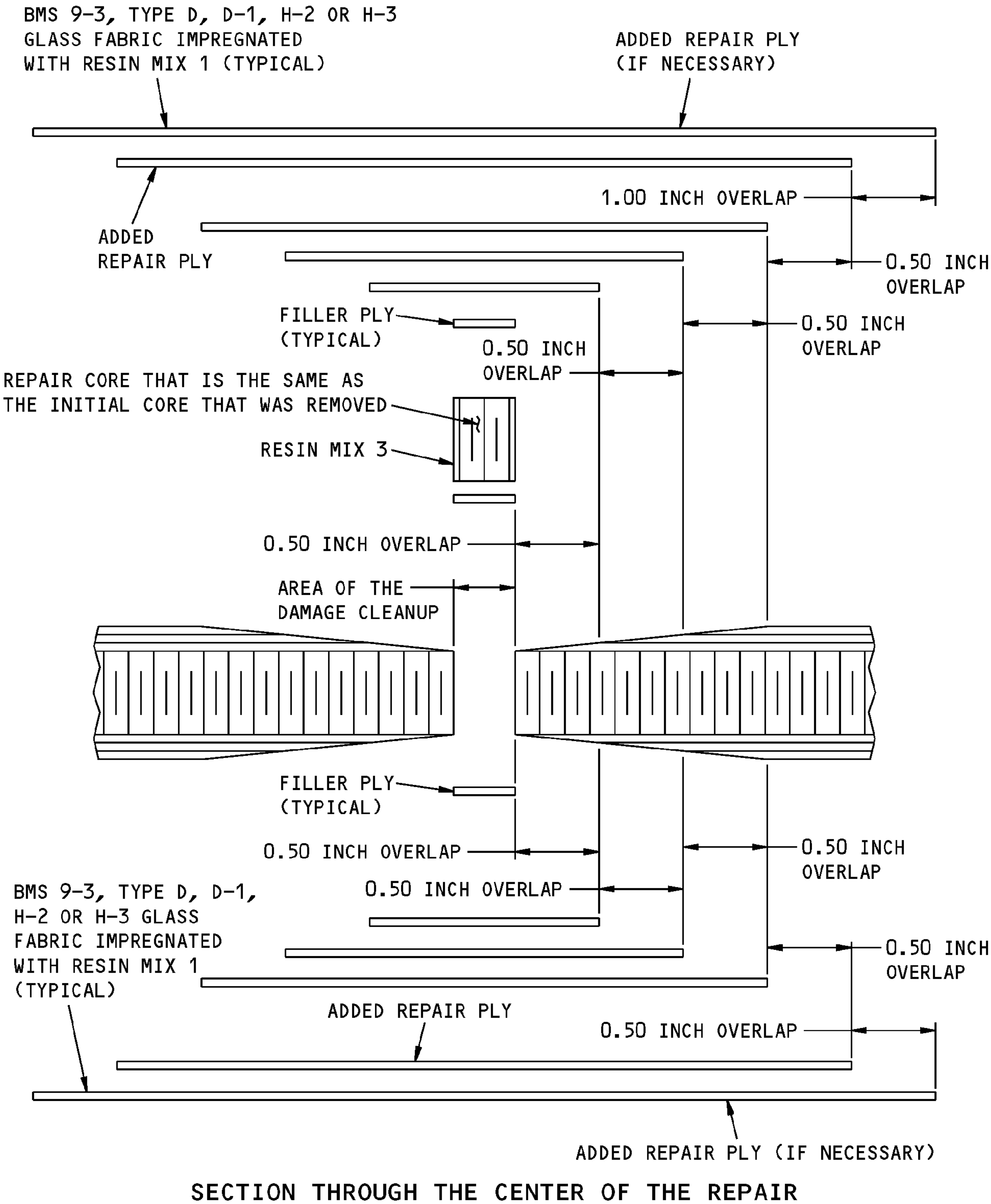
Y. Do a check of the flight control surfaces as given in Paragraph 4.T./REPAIR GENERAL and Paragraph 4.U./REPAIR GENERAL.



Repair 4 - Layout of the Repair Materials
Figure 201 (Sheet 1 of 3)



Repair 4 - Layout of the Repair Materials
Figure 201 (Sheet 2 of 3)



Repair 4 - Layout of the Repair Materials
Figure 201 (Sheet 3 of 3)

REPAIR 5 - REPAIR OF DAMAGE TO THE TWO FACESHEETS AND THE CORE OF A HONEYCOMB PANEL WITH ACCESS LIMITED TO ONE SIDE

1. **Applicability**

WARNING: MAKE SURE THAT THE FLIGHT CONTROL SURFACES ARE CORRECTLY BALANCED AFTER YOU REPAIR THEM. REFER TO SRM 51-60-00 FOR THE CONTROL SURFACE BALANCING PROCEDURES. IF YOU DO NOT OBEY, DAMAGE TO THE STRUCTURE CAN OCCUR.

CAUTION: REFER TO THE SPECIFIED COMPONENT REPAIR SUBJECT FOR THE MATERIALS AND PROCEDURES APPROVED FOR THIS REPAIR. IF YOU DO NOT OBEY, THE REPAIR WILL BE UNSATISFACTORY.

A. Repair 5 is applicable to damage that goes fully through a panel that is flat or almost flat.

B. Repair 5 is applicable to damage that is removed to a maximum of 1.0 inch in diameter.

C. Repair 5 is applicable where access is not available to repair the opposite side.

2. **General**

A. Repair 5 is a Category A repair. Refer to 51-00-06 for the definitions of the different categories of repairs.

B. The materials necessary for Repair 5 are given in Table 201.

Table 201:

REPAIR MATERIALS	
REPAIR MATERIALS	**BOEING SPECIFICATION**
Resin Mix 1 - Laminating Resin for Glass Fiber Repair Fabric	BMS 8-301, Class 2
Resin Mix 3	Resin Mix 2, mixed with microballoons
Glass Fiber Repair Fabric	BMS 9-3, Type D, D-1, H-2 or H-3
Honeycomb Repair Core	Use the same material as the initial core
Sealant	BMS 5-95, Class B-1/2
Adhesive Paste	BMS 5-25, Type II, Grade 1
Adhesive Paste	BMS 5-92, Class 4, Type I

3. **References**

Reference	Title
51-00-06	STRUCTURAL REPAIR DEFINITIONS
51-20-05	REPAIR SEALING
51-60-00, GENERAL	Control Surface Balance Procedures
51-70-04	REPAIR PROCEDURES FOR WET LAYUP MATERIALS

4. **Repair Instructions**

A. Find the limits of the damage. Refer to Paragraph 4.A./REPAIR GENERAL.

B. Remove the damage as given in Paragraph 4.B./REPAIR GENERAL and the steps that follow:

(1) Make the hole in the outer skin and core larger than the damaged area. The larger hole will let you repair the inner skin with the necessary overlap as shown in Repair 5 - Layout of the Repair Parts, Figure 201/REPAIR 5.

(2) Cut the damaged area in the inner skin to an oval shape. The larger diameter of the oval hole must be sufficiently large for the smaller diameter of the oval patch to go through.

C. Make sure that you remove water or other unwanted material as given in Paragraph 4.D./REPAIR GENERAL The damaged area must be fully dry.

D. Make an repair patch to put a cover over the oval hole on the inner skin.

(1) Use a thin aluminum sheet or any smooth surface as a mold to lay up the patch.

(2) Put a layer parting film or other release agent over the mold.

(3) Make five plies of BMS 9-3 glass fabric cloth.

(a) The Type of the glass fabric is optional.

(b) The zero degree directional of the plies is optional.

(c) Impregnate the repair fabric with Resin Mix 1 as given in Paragraph 4.H./REPAIR GENERAL and Paragraph 4.I./REPAIR GENERAL. Refer to Repair 5 - Layout of the Repair Parts, Figure 201/REPAIR 5 for the layout of repair parts.

(d) Remove the separator sheets and lay up the five plies of repair fabric on the mold.

NOTE: Keep the separator sheets and count the sheets as you remove them to make sure that all of them are removed.

(e) Install the vacuum bag system as given in Paragraph 4.L./REPAIR GENERAL.

(f) Do a check of the vacuum bag system for leaks as given in Paragraph 4.M./REPAIR GENERAL.

(g) Apply the vacuum bag pressure as given in Paragraph 4.N./REPAIR GENERAL.

(h) Cure the repair patch as given in Paragraph 4.O.(1)/REPAIR GENERAL.

(i) Remove the cured repair patch from the mold.

(j) Cut the patch to an oval shape that will make an overlap of the oval hole in the inner skin by a minimum of 0.25 inch all around.

(k) Drill a 1/8 inch diameter hole through the center of the patch.

(l) Make the surface of the patch rough so that the patch will bond to the inner skin. Use No. 240-grit or smaller abrasive paper.

(m) Remove all of the dust with a vacuum cleaner.

(n) Make a spring steel strip 1.0 inch by 10.0 inches.

(o) Drill a 1/8 inch diameter hole through the center of the steel strip.

(p) Assemble the patch and the spring steel strip with a 1/8 inch diameter temporary fastener.

E. Make the underside of the inner skin rough to 0.50 inch all around from the edge of the oval-shaped hole.

NOTE: Do not damage the ply fibers.

(1) Remove the Tedlar, if necessary. Use No. 180-grit or finer abrasive paper.

F. Clean the repair area as given in Paragraph 4.F./REPAIR GENERAL.

G. Bend up the ends of the spring steel strip and apply the BMS 5-25 or BMS 5-92 adhesive to the patch.

H. Install the patch. Refer to Repair 5 - Layout of the Repair Parts, Figure 201/REPAIR 5.

(1) Hold the ends of the spring steel strip up and put the patch through the oval hole.

(2) Turn the patch so that it is fully over the hole.

(3) Release the spring steel strip so that it holds the patch tightly against the inner skin.

I. Cure the adhesive paste as given in 51-70-04, Paragraph 4.O.(5)/REPAIR GENERAL or Paragraph 4.O.(6)/REPAIR GENERAL, as applicable.

J. Remove the temporary fastener and the spring steel strip.

K. Fill the hole in the patch with BMS 5-25, BMS 5-92, or BMS 5-95.

(1) Cure the BMS 5-25 adhesive paste as given in Paragraph 4.O.(5)/REPAIR GENERAL.

(2) Cure the BMS 5-92 adhesive paste as given in Paragraph 4.O.(6)/REPAIR GENERAL.

(3) Cure the BMS 5-95 sealant as given in 51-20-05.

L. Clean the repair area as given in Paragraph 4.F./REPAIR GENERAL.

M. Make the honeycomb repair core as given in Paragraph 4.G./REPAIR GENERAL. Refer to Repair 5 - Layout of the Repair Parts, Figure 201/REPAIR 5 for the layout of the repair parts.

N. Prepare the repair fabric as given in Paragraph 4.H./REPAIR GENERAL and Paragraph 4.I./REPAIR GENERAL. Refer to Repair 5 - Layout of the Repair Parts, Figure 201/REPAIR 5 for the layout of the repair parts.

O. Install the honeycomb repair core as given in Paragraph 4.J./REPAIR GENERAL.

P. Apply the repair plies as given in Paragraph 4.K./REPAIR GENERAL.

Q. Install the vacuum bag system as given in Paragraph 4.L./REPAIR GENERAL.

R. Do a check of the vacuum bag for leaks as given in Paragraph 4.M./REPAIR GENERAL.

S. Apply the pressure for the cure as given in Paragraph 4.N./REPAIR GENERAL.

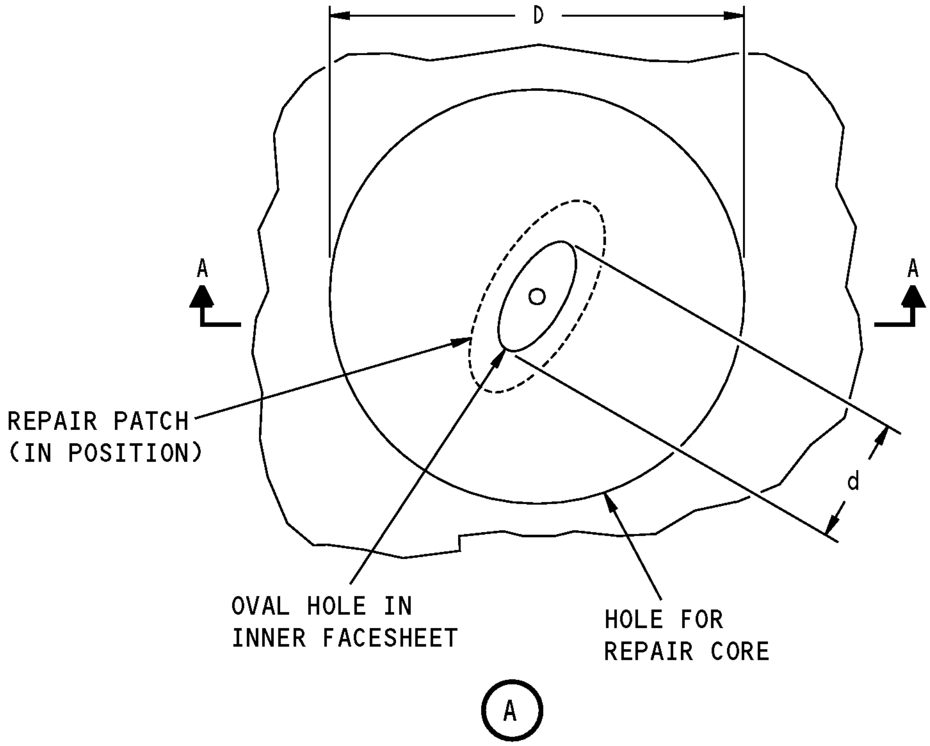
T. Cure the repair. Use the cure instructions for Resin Mix 1 given in Paragraph 4.O.(1)/REPAIR GENERAL.

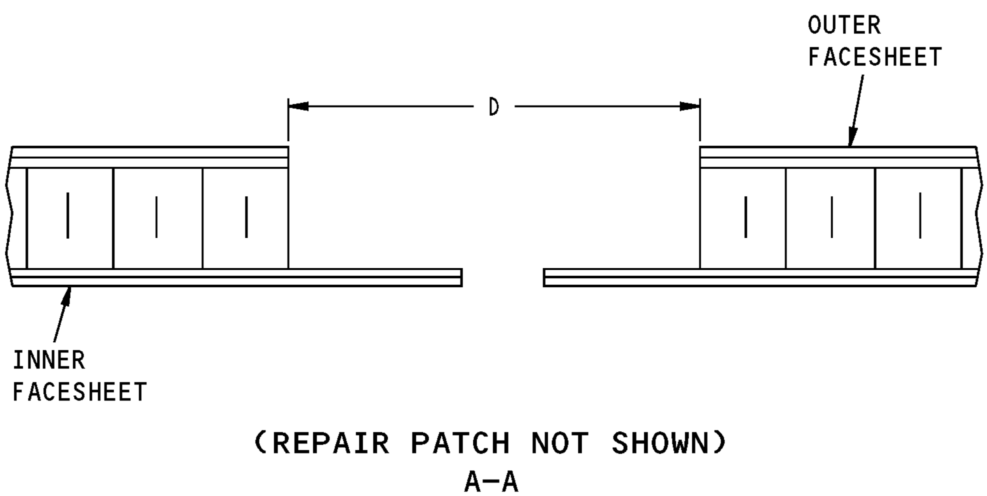
U. Examine the completed repair as given in Paragraph 4.P./REPAIR GENERAL.

V. Apply the finish to the repair area as given in Paragraph 4.Q./REPAIR GENERAL.

W. Drill out drain and fastener holes, if they were filled, as given in Paragraph 4.R./REPAIR GENERAL and Paragraph 4.S./REPAIR GENERAL.

X. Do a check of the flight control surfaces as given in Paragraph 4.T./REPAIR GENERAL and Paragraph 4.U./REPAIR GENERAL.





NOTES

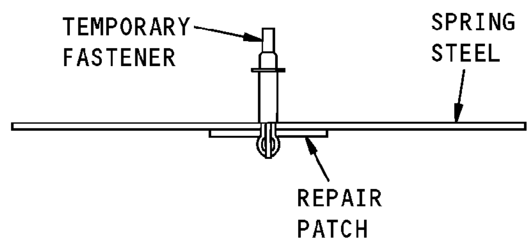
- D = d + N + 2

  d = MAJOR DIAMETER OF THE OVAL HOLE IN THE INNER SKIN (1.00 INCH MAXIMUM)

  N = NUMBER OF PLIES IN THE INNER SKIN

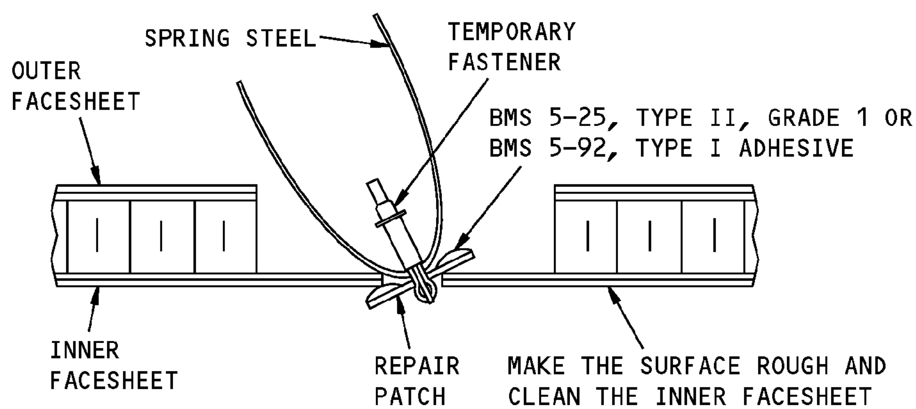
  D = DIAMETER OF THE HOLE FOR THE CORE REPAIR PLUG

Repair 5 - Layout of the Repair Parts
Figure 201 (Sheet 1 of 4)



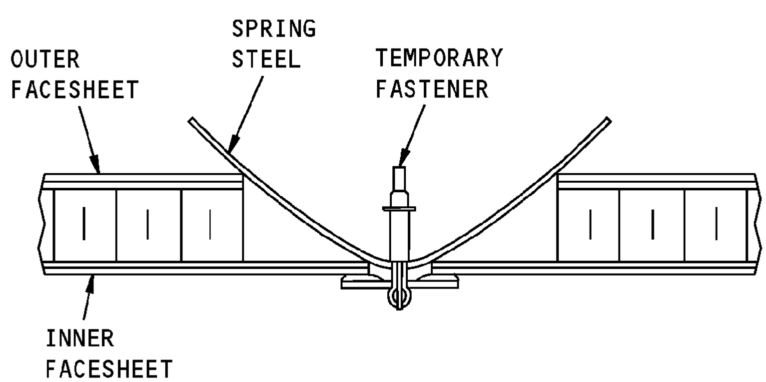
ASSEMBLY OF THE PATCH AND SPRING STEEL

B



PUT THE PATCH IN THE OVAL HOLE

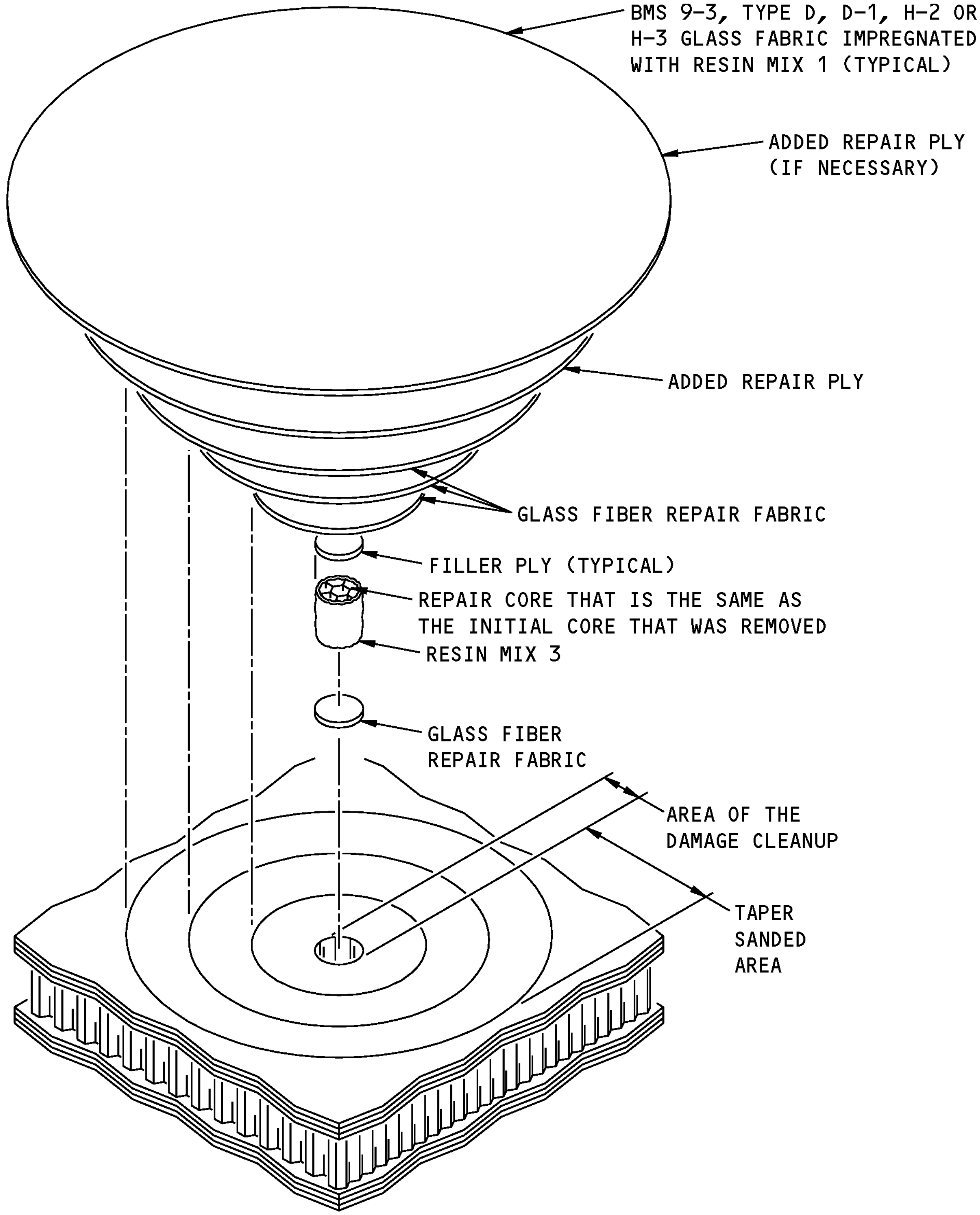
C



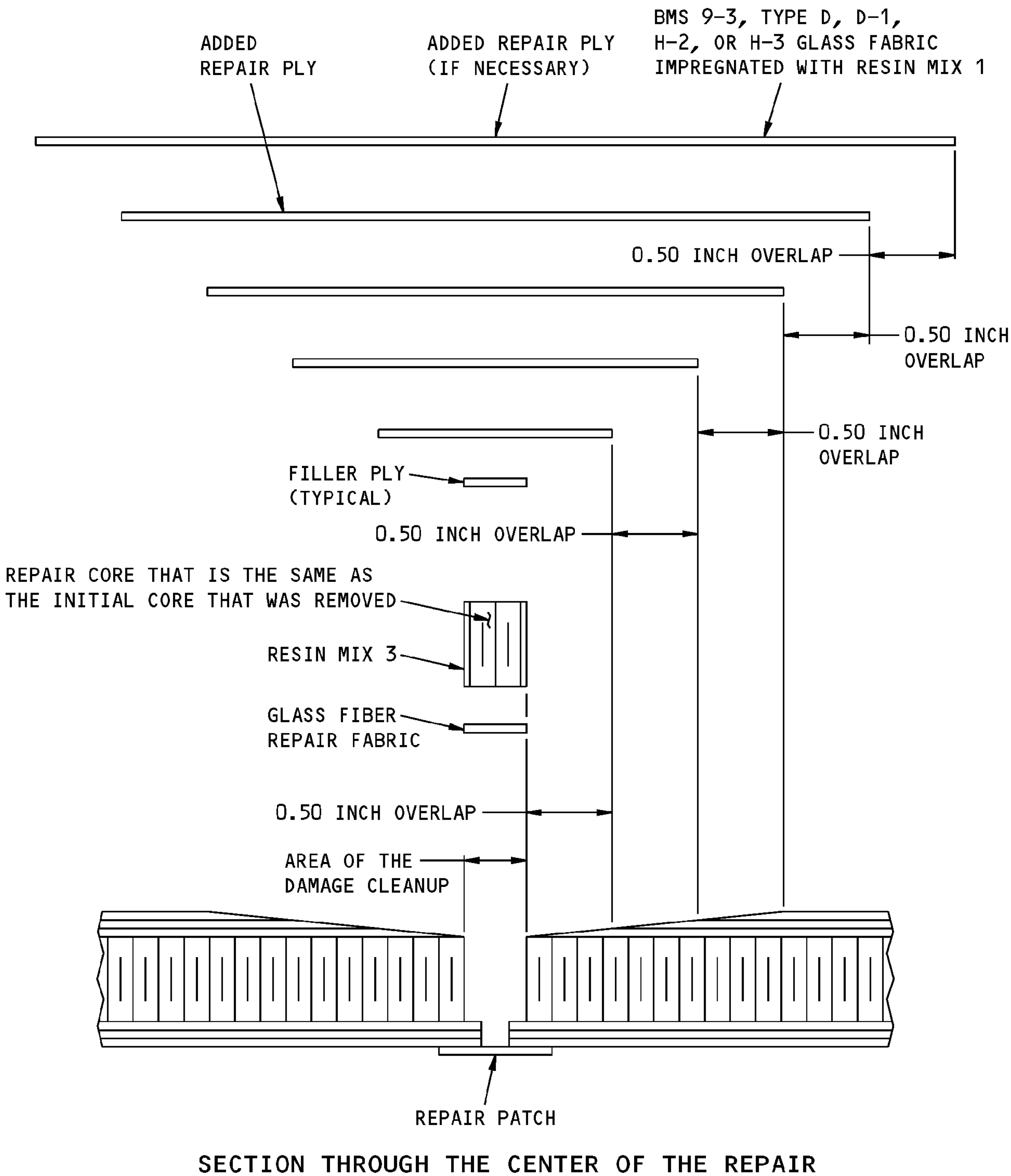
HOLD THE PATCH IN POSITION DURING THE CURE CYCLE

D

Repair 5 - Layout of the Repair Parts
Figure 201 (Sheet 2 of 4)



Repair 5 - Layout of the Repair Parts
Figure 201 (Sheet 3 of 4)



Repair 5 - Layout of the Repair Parts
Figure 201 (Sheet 4 of 4)

REPAIR 6 - REPAIR OF DELAMINATION AT AN EDGEBAND OF A HONEYCOMB PANEL

1. Applicability

WARNING: MAKE SURE THAT THE FLIGHT CONTROL SURFACES ARE CORRECTLY BALANCED AFTER YOU REPAIR THEM. REFER TO SRM 51-60-00 FOR THE CONTROL SURFACE BALANCING PROCEDURES. IF YOU DO NOT OBEY, DAMAGE TO THE STRUCTURE CAN OCCUR.

CAUTION: REFER TO THE SPECIFIED COMPONENT REPAIR SUBJECT FOR THE MATERIALS AND PROCEDURES APPROVED FOR THIS REPAIR. IF YOU DO NOT OBEY, THE REPAIR WILL BE UNSATISFACTORY.

A. Repair 6 is applicable to delamination damage at an edgeband of a honeycomb core panel.

2. General

A. Repair 6 is a Category A repair. Refer to 51-00-06 for the definitions of the different categories of repairs.

B. The materials necessary for Repair 6 are given in Table 201.

Table 201:

REPAIR MATERIALS	
REPAIR MATERIALS	**BOEING SPECIFICATION**
Resin Mix 1- Laminating Resin	BMS 8-301, Class 2

3. References

Reference	Title
51-00-06	STRUCTURAL REPAIR DEFINITIONS
51-60-00, GENERAL	Control Surface Balance Procedures

4. Repair Instructions

A. Find the limits of the damage. Refer to Paragraph 4.A./REPAIR GENERAL.

B. Remove all of the water or unwanted material as given in Paragraph 4.D./REPAIR GENERAL. The damaged area must be fully dry.

C. Put BMS 8-301 laminating resin into the area of delamination. Refer to Repair 6 - Layout of the Repair Parts, Figure 201/REPAIR 6.

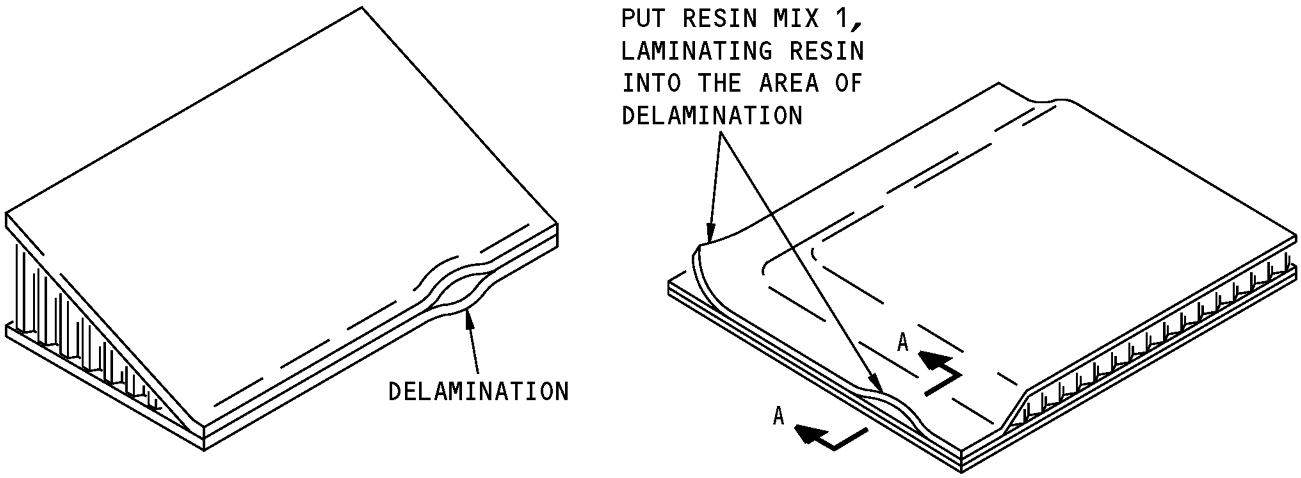
D. Hold the delamination area together with clamps.

E. Cure the BMS 8-301 laminating resin as given in Paragraph 4.O.(7)/REPAIR GENERAL.

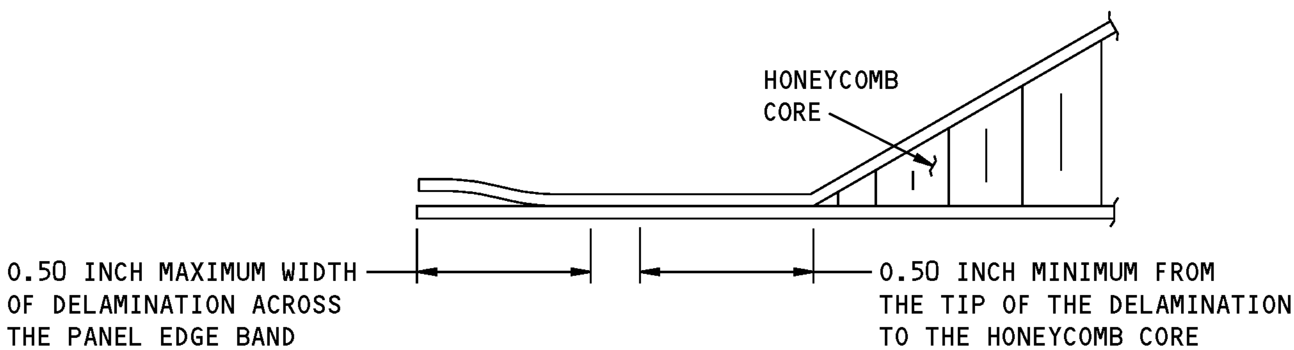
F. Examine the completed repair as given in Paragraph 4.P./REPAIR GENERAL.

G. Apply the finish to the repair area as given in Paragraph 4.Q./REPAIR GENERAL.

H. Do a check of the flight control surfaces as given in Paragraph 4.T./REPAIR GENERAL and Paragraph 4.U./REPAIR GENERAL.

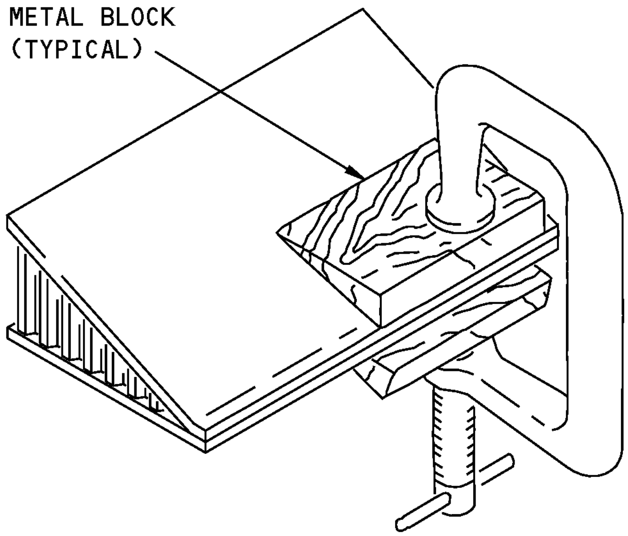


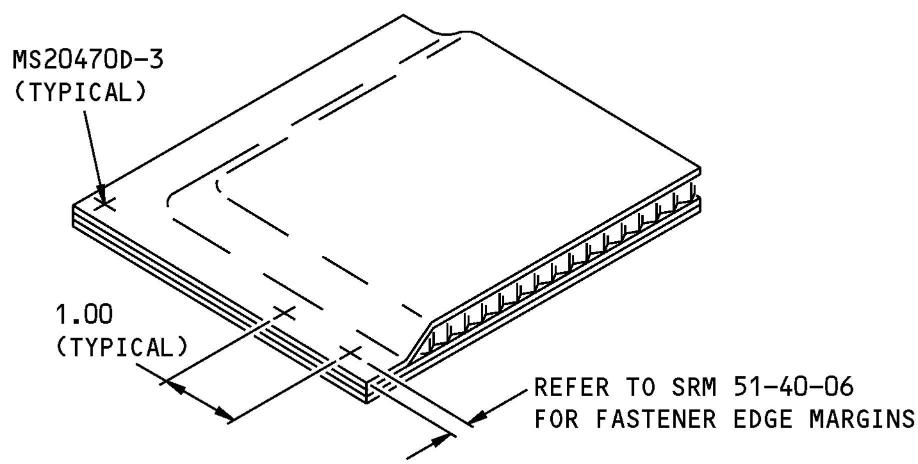
BEFORE THE REPAIR



A-A (TYPICAL)

Repair 6 - Layout of the Repair Parts
Figure 201 (Sheet 1 of 2)





AFTER CURE (OPTIONAL)

Repair 6 - Layout of the Repair Parts
Figure 201 (Sheet 2 of 2)

REPAIR 7 - REPAIR OF DAMAGE TO THE PLIES ON AN EDGE OF A HONEYCOMB PANEL

1. Applicability

WARNING: MAKE SURE THAT THE FLIGHT CONTROL SURFACES ARE CORRECTLY BALANCED AFTER YOU REPAIR THEM. REFER TO SRM 51-60-00 FOR THE CONTROL SURFACE BALANCING PROCEDURES. IF YOU DO NOT OBEY, DAMAGE TO THE STRUCTURE CAN OCCUR.

CAUTION: REFER TO THE SPECIFIED COMPONENT REPAIR SUBJECT FOR THE MATERIALS AND PROCEDURES APPROVED FOR THIS REPAIR. IF YOU DO NOT OBEY, THE REPAIR WILL BE UNSATISFACTORY.

A. Repair 7 is applicable to damage to the edgeband of a honeycomb core panel.

2. General

A. Repair 7 is a Category A repair. Refer to 51-00-06 for the definitions of the different classes of reports.

B. The materials necessary for Repair 7 are given in Table 201.

Table 201:

REPAIR MATERIALS	
REPAIR MATERIALS	**BOEING SPECIFICATION**
Resin Mix 1 - Laminating Resin for Glass Fiber Repair Fabric	BMS 8-301, Class 2
Glass Fiber Repair Fabric	BMS 9-3, Type D, D-1, H-2 or H-3

3. References

Reference	Title
51-00-06	STRUCTURAL REPAIR DEFINITIONS
51-60-00, GENERAL	Control Surface Balance Procedures

4. Repair Instructions

A. Find the limits of the damage. Refer to Paragraph 4.A./REPAIR GENERAL.

B. Remove the damage as given in Paragraph 4.B./REPAIR GENERAL.

C. Remove all of the water or other unwanted material as given in Paragraph 4.D./REPAIR GENERAL. The damaged area must be fully dry.

D. Make the taper as given in Paragraph 4.E./REPAIR GENERAL. Refer to Repair 7 - Layout of the Repair Parts, Figure 201/REPAIR 7.

E. Clean the damaged area as given in Paragraph 4.F./REPAIR GENERAL.

F. Prepare the repair fabric as given in Paragraph 4.H./REPAIR GENERAL and Paragraph 4.I./REPAIR GENERAL. Refer to Repair 7 - Layout of the Repair Parts, Figure 201/REPAIR 7 for the layout of the repair parts.

G. Apply the repair plies as given in Paragraph 4.K./REPAIR GENERAL.

H. Install the vacuum bag system as given in Paragraph 4.L./REPAIR GENERAL.

I. Do a check of the vacuum bag for leaks as given in Paragraph 4.M./REPAIR GENERAL.

J. Apply the pressure for the cure as given in Paragraph 4.N./REPAIR GENERAL.

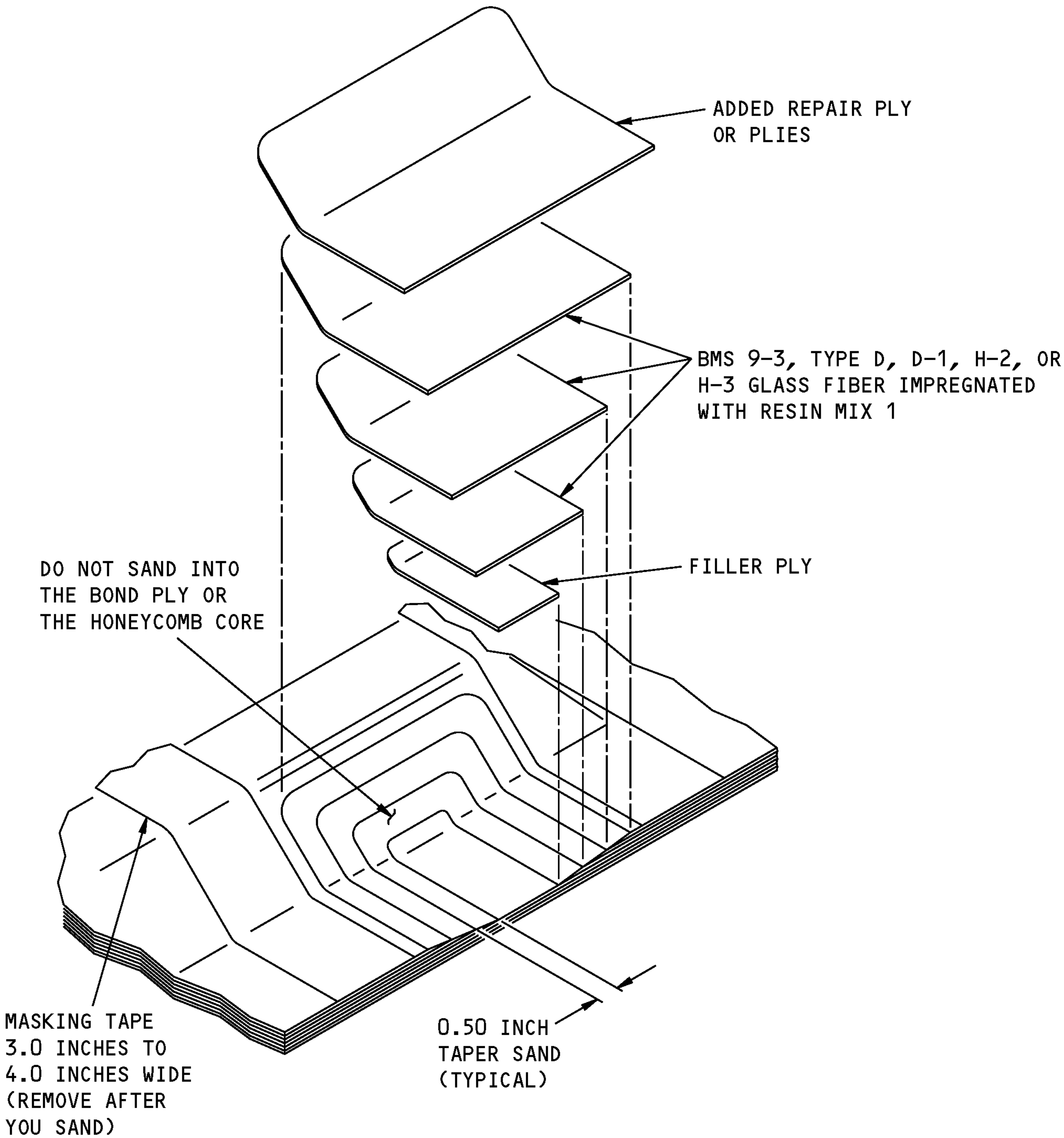
K. Cure the repair as given in Paragraph 4.O.(1)/REPAIR GENERAL.

L. Examine the completed repair as given in Paragraph 4.P./REPAIR GENERAL.

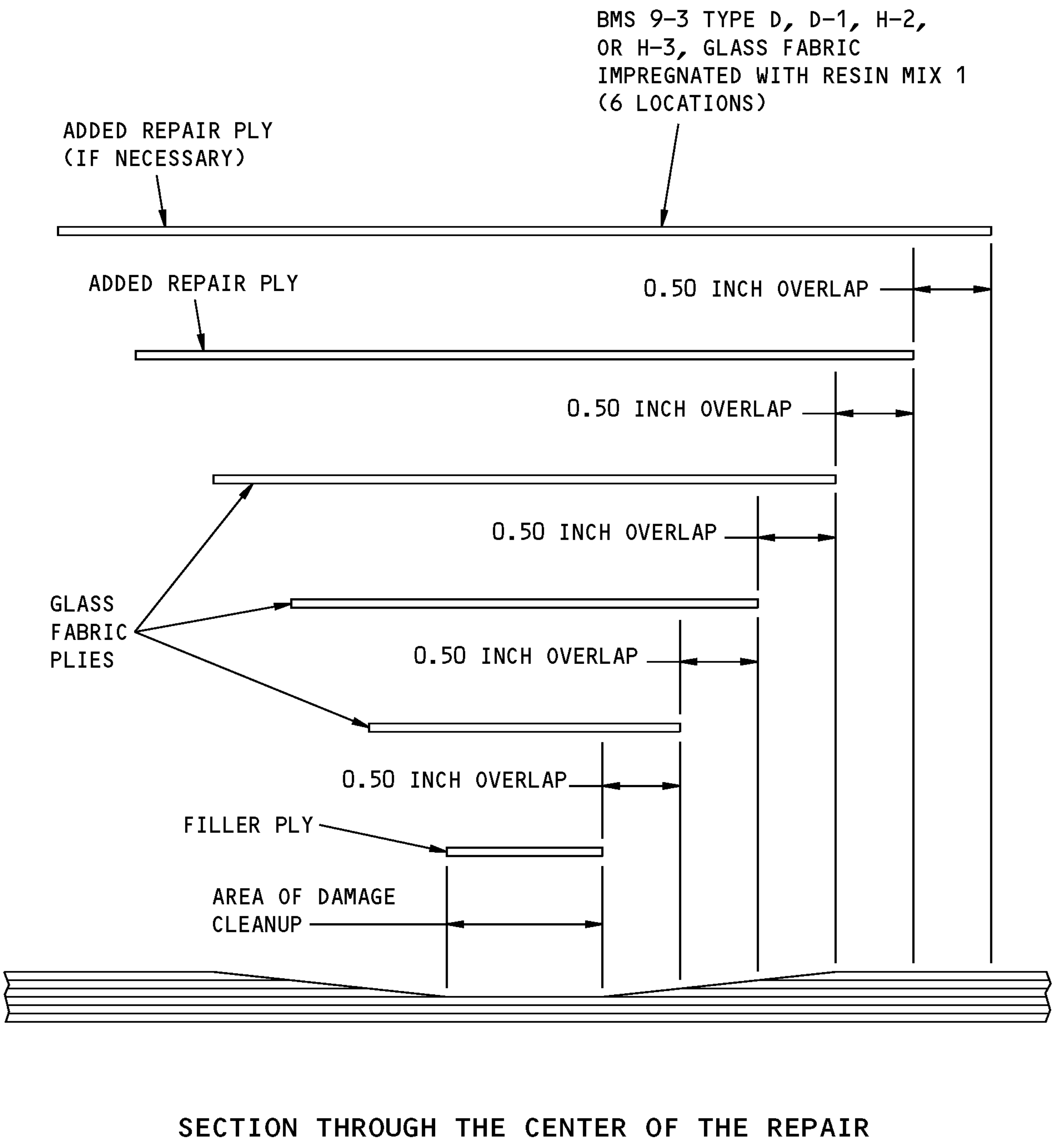
M. Apply the finish to the repair area as given in Paragraph 4.Q./REPAIR GENERAL.

N. Drill out drain and fastener holes, if they were filled, as given in Paragraph 4.R./REPAIR GENERAL and Paragraph 4.S./REPAIR GENERAL.

O. Do a check of the flight control surfaces as given in Paragraph 4.T./REPAIR GENERAL and Paragraph 4.U./REPAIR GENERAL.



Repair 7 - Layout of the Repair Parts
Figure 201 (Sheet 1 of 2)



Repair 7 - Layout of the Repair Parts
Figure 201 (Sheet 2 of 2)

REPAIR 8 - REPAIR OF DAMAGE TO THE CORE ON AN EDGE OF A HONEYCOMB PANEL

1. Applicability

WARNING: MAKE SURE THAT THE FLIGHT CONTROL SURFACES ARE CORRECTLY BALANCED AFTER YOU REPAIR THEM. REFER TO SRM 51-60-00 FOR THE CONTROL SURFACE BALANCING PROCEDURES. IF YOU DO NOT OBEY, DAMAGE TO THE STRUCTURE CAN OCCUR.

CAUTION: REFER TO THE SPECIFIED COMPONENT REPAIR SUBJECT FOR THE MATERIALS AND PROCEDURES APPROVED FOR THIS REPAIR. IF YOU DO NOT OBEY, THE REPAIR WILL BE UNSATISFACTORY.

A. Repair 8 is applicable to damage to the edgeband and the honeycomb core.

2. General

A. Repair 8 is a Category A repair. Refer to 51-00-06 for the definitions of the different categories of repairs.

B. The materials necessary for Repair 8 are given in Table 201.

Table 201:

REPAIR MATERIALS	
REPAIR MATERIALS	**BOEING SPECIFICATION**
Resin Mix 1 - Laminating Resin for BMS 9-3 Glass Fiber Fabric	BMS 8-301, Class 2
Glass Fiber Repair Fabric	BMS 9-3, Type D, D-1, H-2 or H-3

3. References

Reference	Title
51-00-06	STRUCTURAL REPAIR DEFINITIONS
51-60-00, GENERAL	Control Surface Balance Procedures

4. Repair Instructions

A. Find the limits of the damage. Refer to Paragraph 4.A./REPAIR GENERAL.

B. Remove the damage as given in Paragraph 4.B./REPAIR GENERAL.

C. Remove the damaged core as given in Paragraph 4.C./REPAIR GENERAL.

D. Remove all of the water or other unwanted material as given in Paragraph 4.D./REPAIR GENERAL. The damaged area must be fully dry.

E. Make the taper as given in Paragraph 4.E./REPAIR GENERAL. Refer to Repair 8 - Layout of the Repair Parts, Figure 201/REPAIR 8.

F. Clean the damaged area as given in Paragraph 4.F./REPAIR GENERAL.

G. Make the honeycomb repair core as given in Paragraph 4.G./REPAIR GENERAL. Refer to Repair 8 - Layout of the Repair Parts, Figure 201/REPAIR 8 for the layout of the repair parts.

H. Prepare the repair fabric as given in Paragraph 4.H./REPAIR GENERAL and Paragraph 4.I./REPAIR GENERAL. Refer to Repair 8 - Layout of the Repair Parts, Figure 201/REPAIR 8 for the layout of the repair parts.

I. Install the honeycomb repair core as given in Paragraph 4.J./REPAIR GENERAL.

J. Cure the repair core installation as given in Paragraph 4.O.(2)/REPAIR GENERAL.

NOTE: As an alternative, you can cure the repair core installation at the same time you cure the other repair materials.

K. Apply the repair plies as given in Paragraph 4.K./REPAIR GENERAL.

L. Install the vacuum bag system as given in Paragraph 4.L./REPAIR GENERAL.

M. Do a check of the vacuum bag for leaks as given in Paragraph 4.M./REPAIR GENERAL.

N. Apply the pressure for the cure as given in Paragraph 4.N./REPAIR GENERAL.

O. Cure the repair.

(1) If you will cure only the repair plies in this step, use the cure instructions for Resin Mix 1 given in Paragraph 4.O.(1)/REPAIR GENERAL.

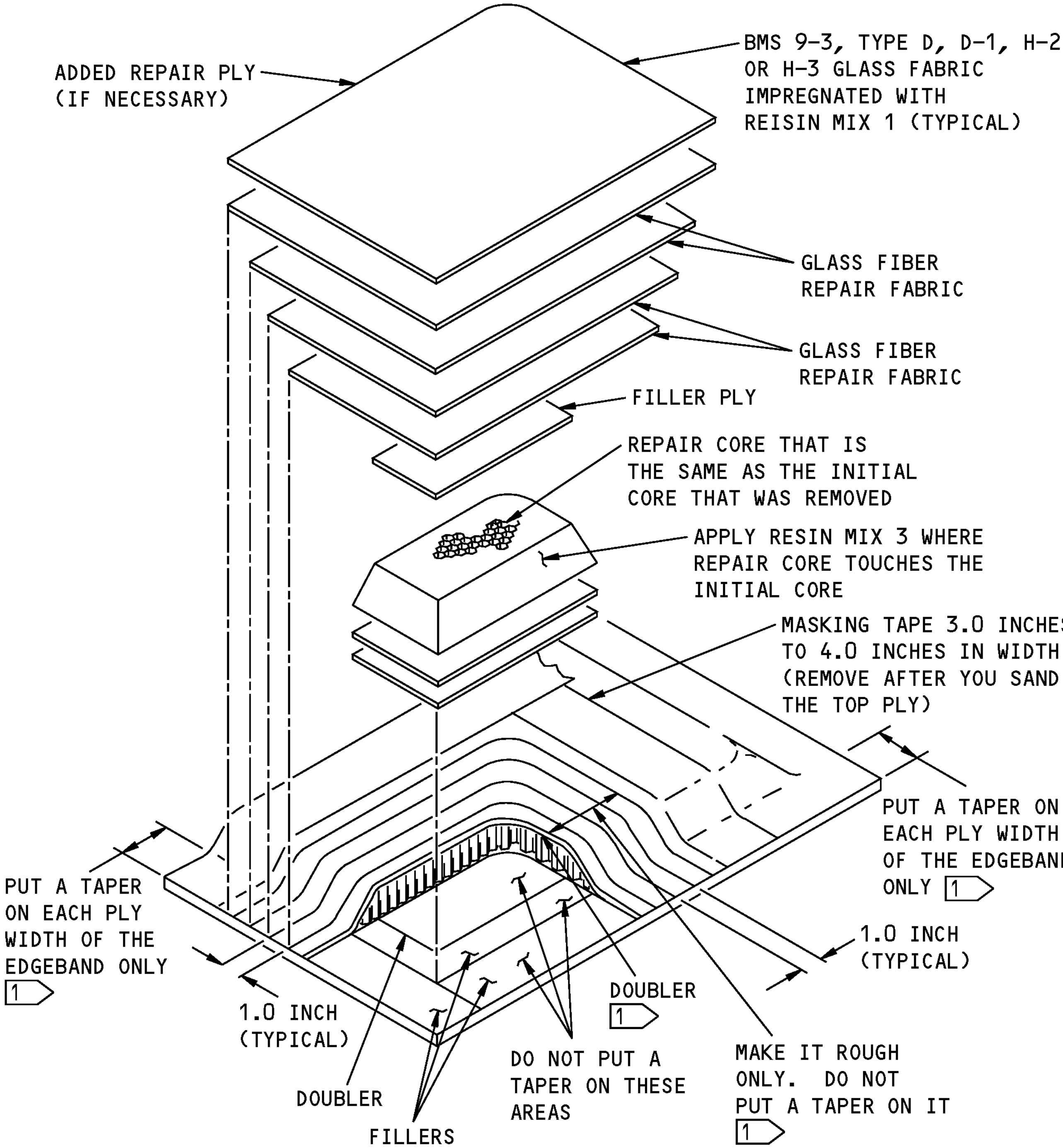
(2) If you will cure the repair core and the repair plies in this step, use the cure instructions for Resin Mix 3 given in Paragraph 4.O.(2)/REPAIR GENERAL.

P. Examine the completed repair as given in Paragraph 4.P./REPAIR GENERAL.

Q. Apply the finish to the repair area as given in Paragraph 4.Q./REPAIR GENERAL.

R. Drill out drain and fastener holes, if they were filled, as given in Paragraph 4.R./REPAIR GENERAL and Paragraph 4.S./REPAIR GENERAL.

S. Do a check of the flight control surfaces as given in Paragraph 4.T./REPAIR GENERAL and Paragraph 4.U./REPAIR GENERAL.



NOTES

1 DO NOT PUT A TAPER ON THE SKIN OR THE DOUBLER PLIES THAT ARE ABOVE THE CORE.

Repair 8 - Layout of the Repair Parts
Figure 201

REPAIR 9 - REPAIR OF A DAMAGED FASTENER HOLE IN A HONEYCOMB PANEL OR A SOLID LAMINATE PANEL

1. Applicability

WARNING: MAKE SURE THAT THE FLIGHT CONTROL SURFACES ARE CORRECTLY BALANCED AFTER YOU REPAIR THEM. REFER TO SRM 51-60-00 FOR THE CONTROL SURFACE BALANCING PROCEDURES. IF YOU DO NOT OBEY, DAMAGE TO THE STRUCTURE CAN OCCUR.

CAUTION: REFER TO THE SPECIFIED COMPONENT REPAIR SUBJECT FOR THE MATERIALS AND PROCEDURES APPROVED FOR THIS REPAIR. IF YOU DO NOT OBEY, THE REPAIR WILL BE UNSATISFACTORY.

A. Repair 9 is applicable to:

(1) Damage to fastener hole in a honeycomb core panel or a solid laminate.

(2) A maximum of 50 percent of the fastener holes on a side of the panel.

(3) A damaged fastener hole that is less than 1.5 times the diameter of the initial hole.

B. Repair 9 is applicable if the diameter of the damaged hole is not more than 1.5 times the diameter of the initial hole.

C. Repair 9 is not applicable to fastener holes where fittings are attached.

2. General

A. Repair 9 is a Category A damage tolerant repair. Refer to 51-00-06 for the definitions of the different categories of repairs.

B. The materials necessary for Repair 9 are given in Table 201.

Table 201:

REPAIR MATERIALS	
REPAIR MATERIALS	**BOEING SPECIFICATION**
Resin Mix 1 - Laminating Resin for Glass Fiber Repair Fabric	BMS 8-301, Class 2
Glass Fiber Repair Fabric	BMS 9-3, Type D, D-1, H-2 or H-3
Adhesive	BMS 5-129, Type 2, Grade 10

3. References

Reference	Title
51-00-06	STRUCTURAL REPAIR DEFINITIONS
51-60-00, GENERAL	Control Surface Balance Procedures

4. Repair Instructions

A. Find the limits of the damage. Refer to Paragraph 4.A./REPAIR GENERAL.

B. Remove all of the water or other unwanted material as given in Paragraph 4.D./REPAIR GENERAL. The damaged area must be fully dry.

C. Clean the damaged area as given in Paragraph 4.F./REPAIR GENERAL.

D. Prepare the repair fabric as given in Paragraph 4.H./REPAIR GENERAL and Paragraph 4.I./REPAIR GENERAL. Refer to Repair 9 - Layout of the Repair Parts, Figure 201/REPAIR 9 for the layout of the repair parts.

E. Apply the repair plies as given in Paragraph 4.K./REPAIR GENERAL.

F. Install the vacuum bag system as given in Paragraph 4.L./REPAIR GENERAL.

G. Do a check of the vacuum bag for leaks as given in Paragraph 4.M./REPAIR GENERAL.

H. Apply the pressure for the cure as given in Paragraph 4.N./REPAIR GENERAL.

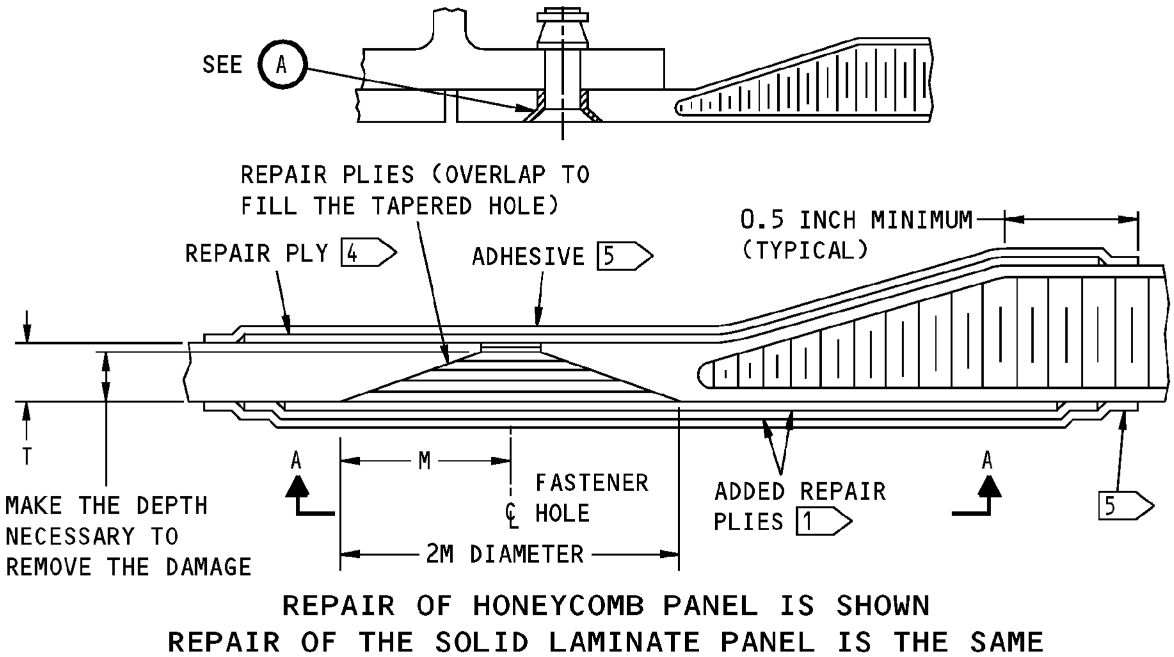
I. Cure the repair as given in Paragraph 4.O.(1)/REPAIR GENERAL.

J. Examine the completed repair as given in Paragraph 4.P./REPAIR GENERAL.

K. Apply the finish to the repair area as given in Paragraph 4.Q./REPAIR GENERAL.

L. Drill out drain and fastener holes, if they were filled, as given in Paragraph 4.R./REPAIR GENERAL and Paragraph 4.S./REPAIR GENERAL.

M. Do a check of the flight control surfaces as given in Paragraph 4.T./REPAIR GENERAL and Paragraph 4.U./REPAIR GENERAL.



NOTES

- THIS REPAIR IS APPLICABLE TO PANELS WITH UP TO 50% OF THE FASTENER HOLES DAMAGED ON EACH SIDE IF:
  - THE DIAMETER OF THE HOLES IS NOT LARGER THAN 1.5 TIMES THE INITIAL HOLE DIAMETER
  - THE PANEL IS ATTACHED TO THE STRUCTURE SUCH AS RIBS AND STRINGERS, BUT NOT TO A FITTING.
  - THE DISTANCE BETWEEN ADJACENT FASTENERS IS MORE THAN 5D (D = THE FASTENER DIAMETER)
- M = 5T MAXIMUM AS SHOWN, WHERE T IS THE THICKNESS OF THE EDGEBAND. DO NOT CUT INTO THE CORE. D = THE FASTENER DIAMETER.
- MAKE THE FILLER PLIES FROM BMS 9-3, TYPE D, D-1, H-2, OR H-3 IMPREGNATED WITH RESIN MIX 1.

[1] INSTALL THE FILLER PLIES AS NECESSARY TO FILL THE DAMAGED AREA.

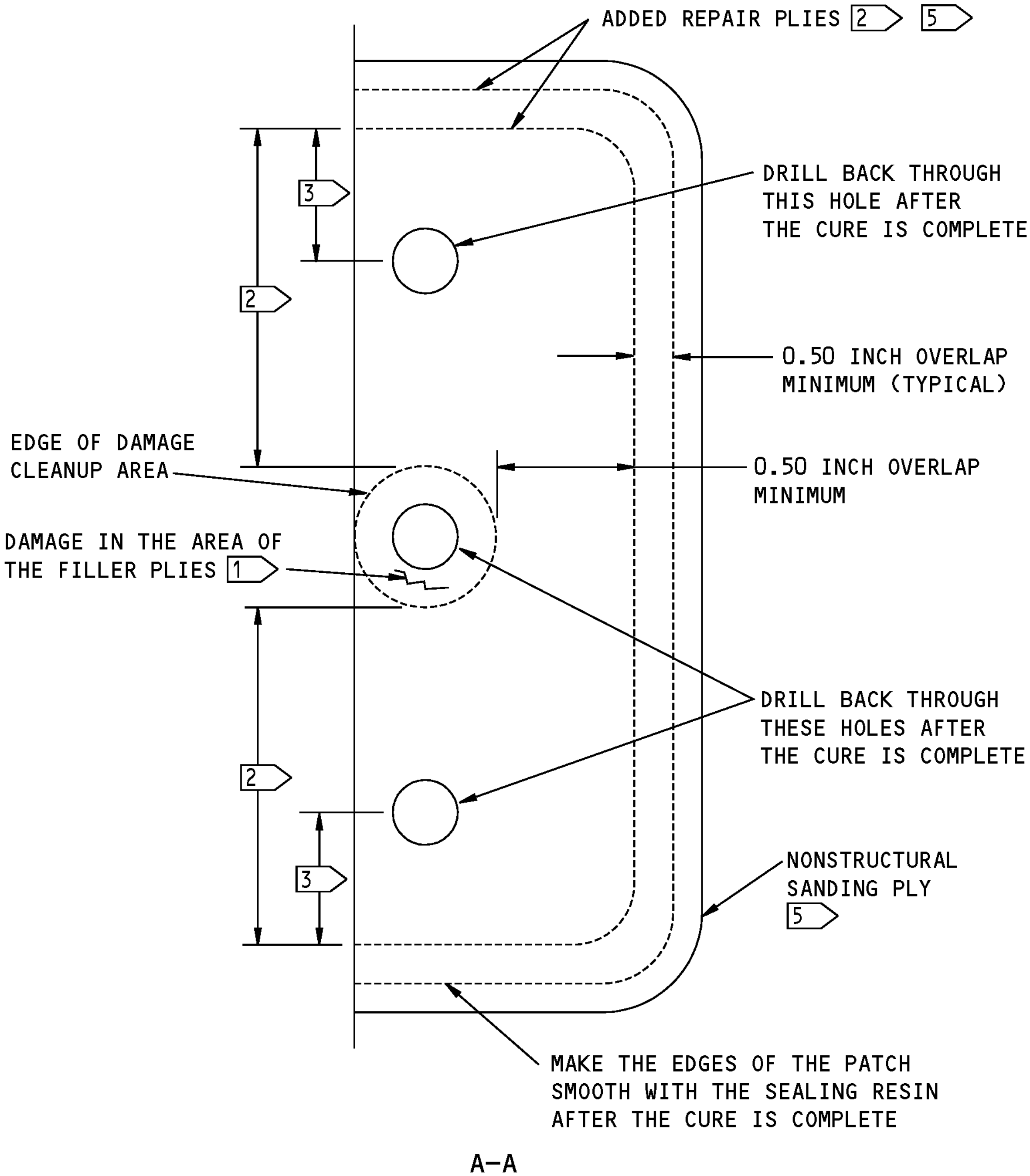
[2] CUT THE ADDED REPAIR PLY AT LEAST 0.50 INCH MORE ALL AROUND THAN THE DAMAGED AREA.

[3] CUT THE ADDED REPAIR PLY TO KEEP THE INITIAL FASTENER EDGE MARGIN, EXCEPT IT MUST NOT BE LESS THAN 2.5D (D = THE FASTENER DIAMETER) + 0.05 INCH.

[4] ALIGN THE ADDED REPAIR PLIES IN THE SAME DIRECTION AS THE INITIAL OUTER PLY.

[5] USE BMS 5-129, TYPE 2, GRADE 10.

Repair 9 - Layout of the Repair Parts
Figure 201 (Sheet 1 of 2)



Repair 9 - Layout of the Repair Parts
Figure 201 (Sheet 2 of 2)

REPAIR 10 - REPAIR OF DAMAGE THAT IS 0.50 INCH OR LESS IN DIAMETER TO A SOLID LAMINATE PANEL

1. Applicability

WARNING: MAKE SURE THAT THE FLIGHT CONTROL SURFACES ARE CORRECTLY BALANCED AFTER YOU REPAIR THEM. REFER TO SRM 51-60-00 FOR THE CONTROL SURFACE BALANCING PROCEDURES. IF YOU DO NOT OBEY, DAMAGE TO THE STRUCTURE CAN OCCUR.

CAUTION: REFER TO THE SPECIFIED COMPONENT REPAIR SUBJECT FOR THE MATERIALS AND PROCEDURES APPROVED FOR THIS REPAIR. IF YOU DO NOT OBEY, THE REPAIR WILL BE UNSATISFACTORY.

A. Repair 10 is applicable to damage that is 0.50 inch or less in diameter to solid laminates.

2. General

A. Repair 10 is a Category A damage tolerant repair. Refer to 51-00-06 for the definitions of the different categories of repairs.

B. The materials necessary for Repair 10 are given in Table 201.

Table 201:

REPAIR MATERIALS	
REPAIR MATERIALS	**BOEING SPECIFICATION**
Resin Mix 1 - Laminating Resin for Glass Fiber Repair Fabric	BMS 8-301, Class 2
Resin Mix 4	Resin Mix 1, mixed with milled glass fibers
Resin Mix 5	Resin Mix 2, mixed with milled glass fibers
Glass Fiber Repair Fabric	BMS 9-3, Type D, D-1, H-2 or H-3

3. References

Reference	Title
51-00-06	STRUCTURAL REPAIR DEFINITIONS
51-60-00, GENERAL	Control Surface Balance Procedures

4. Repair Instructions

A. Find the limits of the damage. Refer to Paragraph 4.A./REPAIR GENERAL.

B. Remove the damage as shown in Repair 10 - Layout of the Repair Parts, Figure 201/REPAIR 10.

C. Remove all of the water or other unwanted material as given in Paragraph 4.D./REPAIR GENERAL. The damaged area must be fully dry.

D. Clean the damaged area as given in Paragraph 4.F./REPAIR GENERAL.

E. Prepare the repair fabric as given in Paragraph 4.H./REPAIR GENERAL and Paragraph 4.I./REPAIR GENERAL. Refer to Repair 10 - Layout of the Repair Parts, Figure 201/REPAIR 10 for the layout of the repair parts.

F. Prepare the resin mix. Refer to REPAIR GENERAL, Table 203.

G. Fill the hole with the resin mix.

H. Cure the resin mix.

(1) If you used Resin Mix 4, use the cure instructions given in Paragraph 4.O.(1)/REPAIR GENERAL.

(2) If you used Resin Mix 5, use the cure instructions given in Paragraph 4.O.(2)/REPAIR GENERAL.

I. Sand the cured resin mix until it is smooth with the outer surface of the initial facesheet.

J. Clean the damaged area as given in Paragraph 4.F./REPAIR GENERAL.

K. Apply the repair plies as given in Paragraph 4.K./REPAIR GENERAL.

L. Install the vacuum bag system as given in Paragraph 4.L./REPAIR GENERAL.

M. Do a check of the vacuum bag for leaks as given in Paragraph 4.M./REPAIR GENERAL.

N. Apply the pressure for the cure as given in Paragraph 4.N./REPAIR GENERAL.

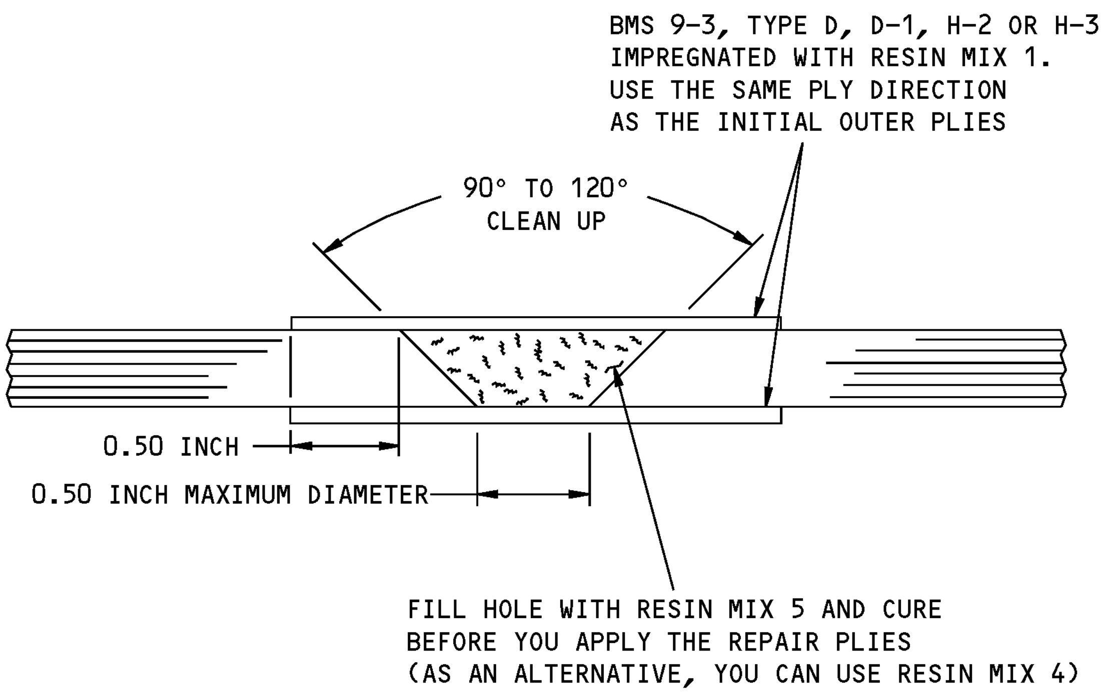
O. Cure the repair as given in Paragraph 4.O.(1)/REPAIR GENERAL.

P. Examine the completed repair as given in Paragraph 4.P./REPAIR GENERAL.

Q. Apply the finish to the repair area as given in Paragraph 4.Q./REPAIR GENERAL.

R. Drill out drain and fastener holes, if they were filled, as given in Paragraph 4.R./REPAIR GENERAL and Paragraph 4.S./REPAIR GENERAL.

S. Do a check of the flight control surfaces as given in Paragraph 4.T./REPAIR GENERAL and Paragraph 4.U./REPAIR GENERAL.



Repair 10 - Layout of the Repair Parts
Figure 201

REPAIR 11 - REPAIR OF DAMAGE THAT IS MORE THAN 0.50 INCH IN DIAMETER TO SOLID LAMINATE PANELS

1. **Applicability**

WARNING: MAKE SURE THAT THE FLIGHT CONTROL SURFACES ARE CORRECTLY BALANCED AFTER YOU REPAIR THEM. REFER TO SRM 51-60-00 FOR THE CONTROL SURFACE BALANCING PROCEDURES. IF YOU DO NOT OBEY, DAMAGE TO THE STRUCTURE CAN OCCUR.

CAUTION: REFER TO THE SPECIFIED COMPONENT REPAIR SUBJECT FOR THE MATERIALS AND PROCEDURES APPROVED FOR THIS REPAIR. IF YOU DO NOT OBEY, THE REPAIR WILL BE UNSATISFACTORY.

A. Repair 11 is applicable to damage that is more than 0.50 inch in diameter to solid laminate panels.

2. **General**

A. Repair 11 is a Category A repair. Refer to 51-00-06 for the definitions of the different categories of repairs.

B. The materials necessary for Repair 11 are given in Table 201.

Table 201:

REPAIR MATERIALS	
REPAIR MATERIALS	**BOEING SPECIFICATION**
Resin Mix 1 - Laminating Resin for Glass Fiber Repair Fabric	BMS 8-301, Class 2
Glass Fiber Repair Fabric	BMS 9-3, Type D, D-1, H-2 or H-3

3. **References**

Reference	Title
51-00-06	STRUCTURAL REPAIR DEFINITIONS
51-60-00, GENERAL	Control Surface Balance Procedures

4. **Repair Instructions**

A. Find the limits of the damage. Refer to Paragraph 4.A./REPAIR GENERAL.

B. Remove the damaged plies as given in Paragraph 4.B./REPAIR GENERAL.

C. Make the taper as given in Paragraph 4.E./REPAIR GENERAL.

D. Remove all of the water or other unwanted material as given in Paragraph 4.D./REPAIR GENERAL. The damaged area must be fully dry.

E. Clean the damaged area as given in Paragraph 4.F./REPAIR GENERAL.

F. Prepare the repair fabric as given in Paragraph 4.H./REPAIR GENERAL and Paragraph 4.I./REPAIR GENERAL. Refer to Repair 11 - Layout of the Repair Materials, Figure 201/REPAIR 11 for the layout of the repair parts.

G. Apply the fabric repair plies to one surface as given in Paragraph 4.K./REPAIR GENERAL.

H. Install the vacuum bag system as given in Paragraph 4.L./REPAIR GENERAL.

I. Do a check of the vacuum bag for leaks as given in Paragraph 4.M./REPAIR GENERAL.

J. Apply the pressure for the cure as given in Paragraph 4.N./REPAIR GENERAL.

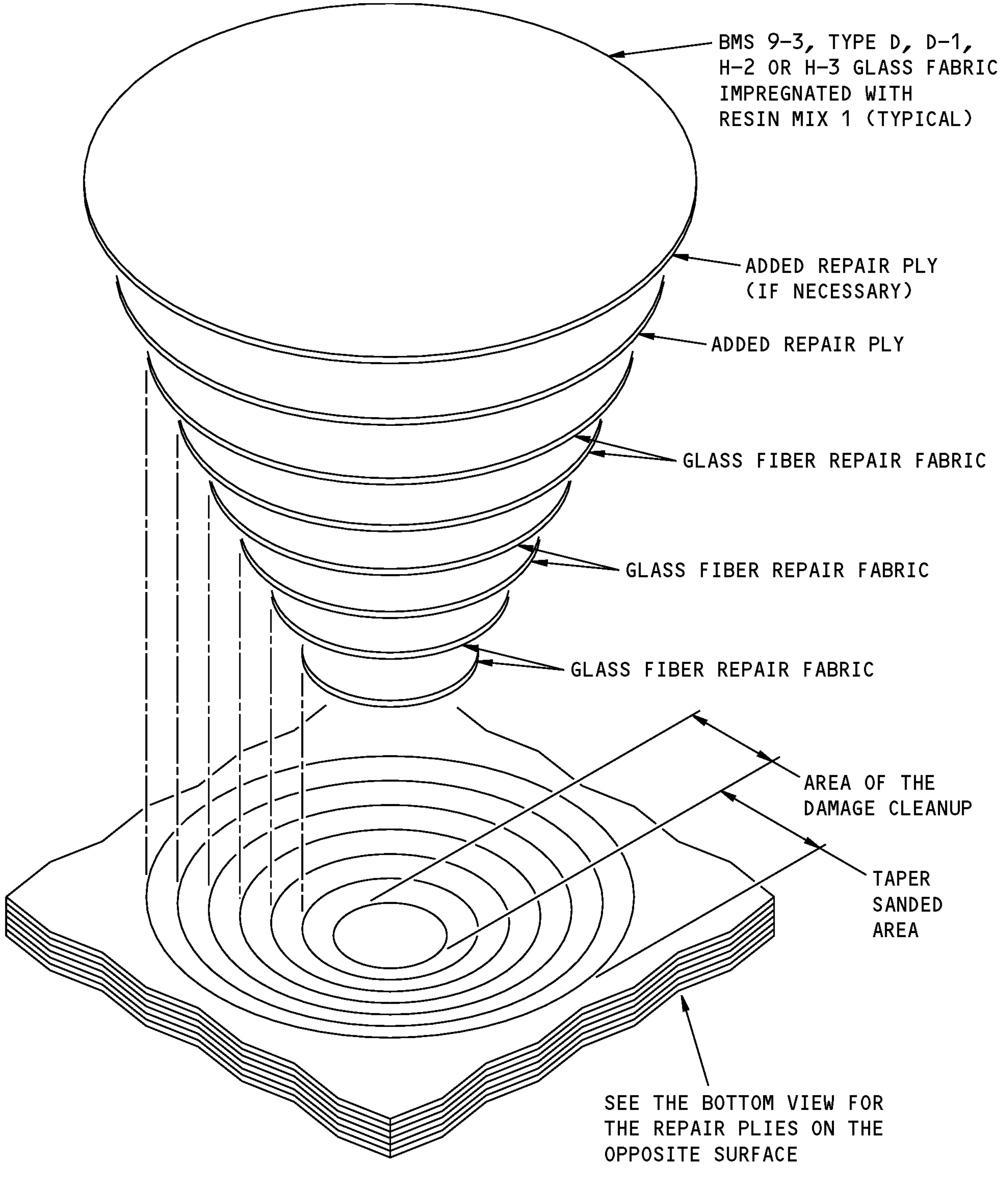
K. Cure the repair as given in Paragraph 4.O.(1)/REPAIR GENERAL.

L. Examine the completed repair as given in Paragraph 4.P./REPAIR GENERAL.

M. Apply the finish to the repair area as given in Paragraph 4.Q./REPAIR GENERAL.

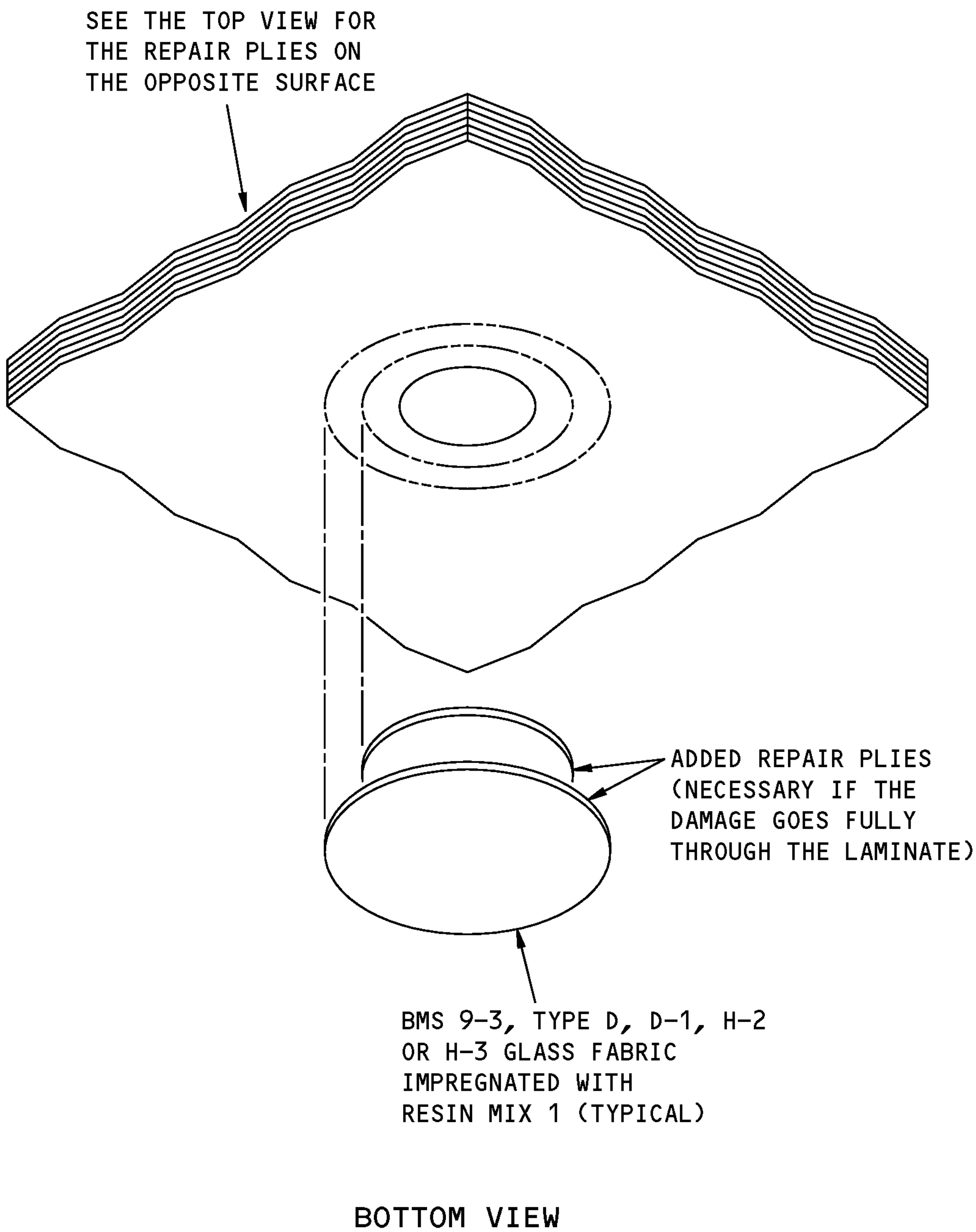
N. Drill out drain and fastener holes, if they were filled, as given in Paragraph 4.R./REPAIR GENERAL and Paragraph 4.S./REPAIR GENERAL.

O. Do a check of the flight control surfaces as given in Paragraph 4.T./REPAIR GENERAL and Paragraph 4.U./REPAIR GENERAL.

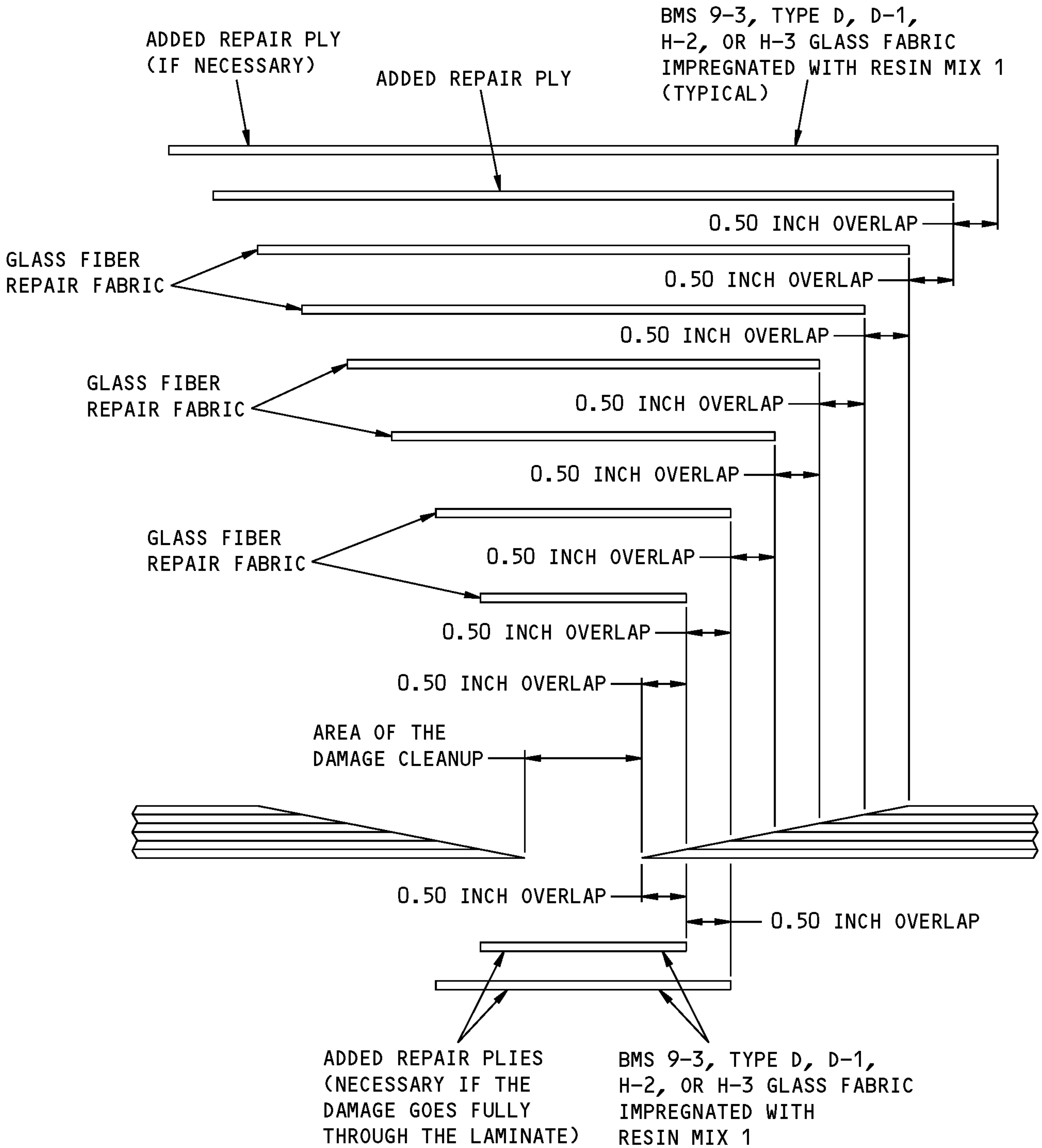


TOP VIEW

Repair 11 - Layout of the Repair Materials
Figure 201 (Sheet 1 of 3)



Repair 11 - Layout of the Repair Materials
Figure 201 (Sheet 2 of 3)



SECTION THROUGH THE CENTER OF THE REPAIR

Repair 11 - Layout of the Repair Materials
Figure 201 (Sheet 3 of 3)

REPAIR 12 - REPAIR OF DENTS IN HONEYCOMB PANELS

1. Applicability

WARNING: MAKE SURE THAT THE FLIGHT CONTROL SURFACES ARE CORRECTLY BALANCED AFTER YOU REPAIR THEM. REFER TO SRM 51-60-00 FOR THE CONTROL SURFACE BALANCING PROCEDURES. IF YOU DO NOT OBEY, DAMAGE TO THE STRUCTURE CAN OCCUR.

CAUTION: REFER TO THE SPECIFIED COMPONENT REPAIR SUBJECT FOR THE MATERIALS AND PROCEDURES APPROVED FOR THIS REPAIR. IF YOU DO NOT OBEY, THE REPAIR WILL BE UNSATISFACTORY.

A. Repair 12 is applicable to dent damage to a honeycomb core panel.

2. General

A. Repair 12 is a Category A repair. Refer to 51-00-06 for the definitions of the different categories of repairs.

B. The materials necessary for Repair 12 are given in Table 201.

Table 201:

REPAIR MATERIALS	
REPAIR MATERIALS	**BOEING SPECIFICATION**
Resin Mix 1 - Laminating Resin for Glass Fiber Repair Fabric	BMS 8-301, Class 2
Resin Mix 2 - Potting Compound	BMS 5-28, Type 7
Glass Fiber Repair Fabric	BMS 9-3, Type D, D-1, H-2 or H-3

3. References

Reference	Title
51-00-06	STRUCTURAL REPAIR DEFINITIONS
51-60-00, GENERAL	Control Surface Balance Procedures

4. Repair Instructions

A. Find the limits of the damage. Refer to Paragraph 4.A./REPAIR GENERAL.

B. Remove all of the water or other unwanted material as given in Paragraph 4.D./REPAIR GENERAL. The damaged area must be fully dry.

C. Put masking tape around the damaged area. Keep a space of 1.0 inch between the limits of the damaged area and the tape. Refer to Repair 12 - Layout of the Repair Parts, Figure 201/REPAIR 12.

D. Make the surface in the damaged area rough with No. 240 or finer abrasive paper. Be careful not to cause damage to the plies that are not damaged.

E. Prepare Resin Mix 2 as given in REPAIR GENERAL, Table 203.

F. Apply the Resin Mix 2 to the damaged area to be flush with the initial surface or a small height above it.

G. Cure the potting compound as given in Paragraph 4.O.(2)/REPAIR GENERAL.

H. Make the surface of the damaged area flush with the initial surface with No. 150-grit or finer abrasive paper.

I. Clean the damaged area as given in Paragraph 4.F./REPAIR GENERAL.

J. Prepare the repair fabric as given in Paragraph 4.H./REPAIR GENERAL and Paragraph 4.I./REPAIR GENERAL. Refer to Repair 12 - Layout of the Repair Parts, Figure 201/REPAIR 12 for the layout of the repair parts.

K. Apply the repair plies as given in Paragraph 4.K./REPAIR GENERAL.

L. Install the vacuum bag system as given in Paragraph 4.L./REPAIR GENERAL.

M. Do a check of the vacuum bag for leaks as given in Paragraph 4.M./REPAIR GENERAL.

N. Apply the pressure for the cure as given in Paragraph 4.N./REPAIR GENERAL.

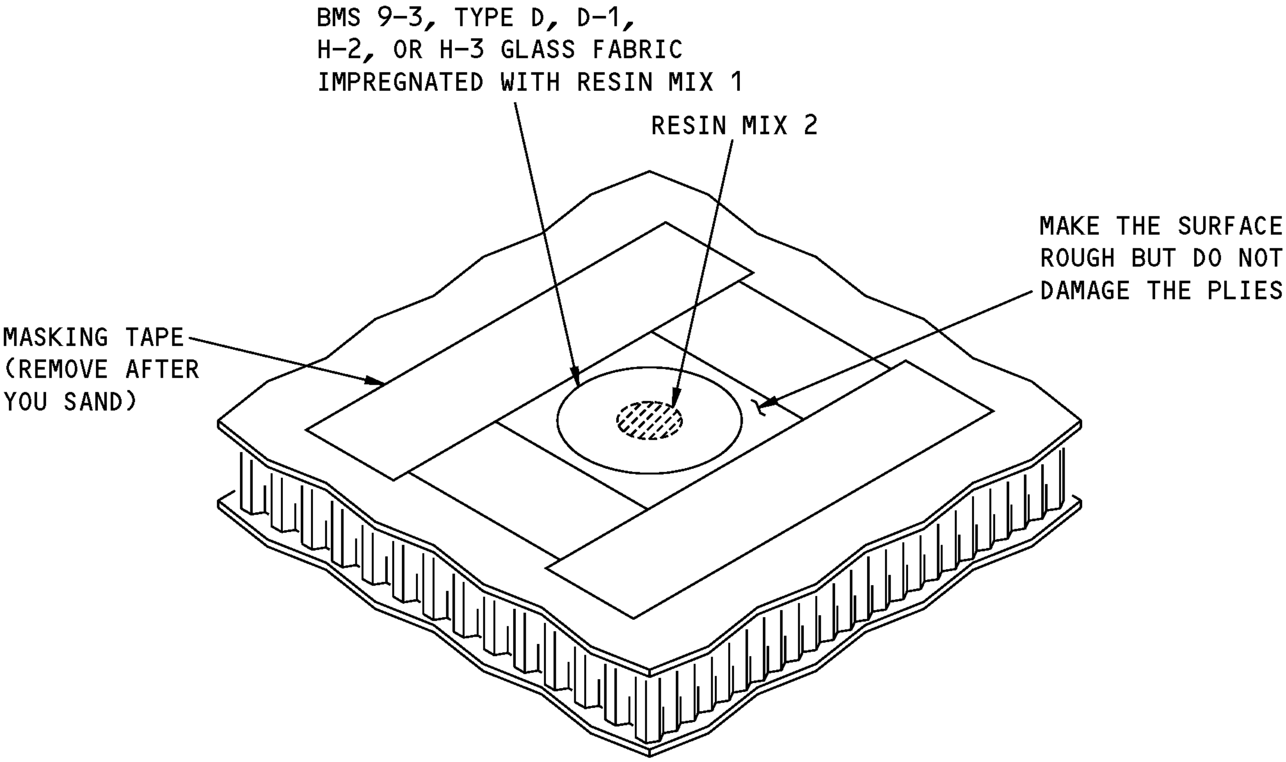
O. Cure the repair as given in Paragraph 4.O.(1)/REPAIR GENERAL.

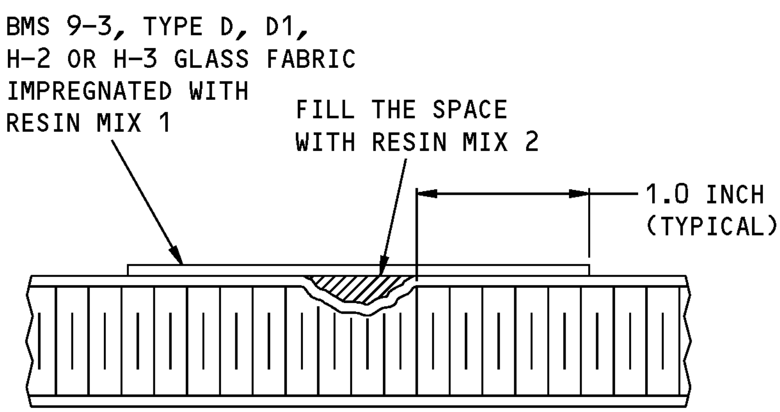
P. Examine the completed repair as given in Paragraph 4.P./REPAIR GENERAL.

Q. Apply the finish to the repair area as given in Paragraph 4.Q./REPAIR GENERAL.

R. Drill out drain and fastener holes, if they were filled, as given in Paragraph 4.R./REPAIR GENERAL and Paragraph 4.S./REPAIR GENERAL.

S. Do a check of the flight control surfaces as given in Paragraph 4.T./REPAIR GENERAL and Paragraph 4.U./REPAIR GENERAL.





Repair 12 - Layout of the Repair Parts
Figure 201

REPAIR 13 - REPAIR OF LIGHTNING STRIKE DAMAGE AT THE TRAILING EDGE OF A HONEYCOMB PANEL

1. **Applicability**

WARNING: MAKE SURE THAT THE FLIGHT CONTROL SURFACES ARE CORRECTLY BALANCED AFTER YOU REPAIR THEM. REFER TO SRM 51-60-00 FOR THE CONTROL SURFACE BALANCING PROCEDURES. IF YOU DO NOT OBEY, DAMAGE TO THE STRUCTURE CAN OCCUR.

CAUTION: REFER TO THE SPECIFIED COMPONENT REPAIR SUBJECT FOR THE MATERIALS AND PROCEDURES APPROVED FOR THIS REPAIR. IF YOU DO NOT OBEY, THE REPAIR WILL BE UNSATISFACTORY.

A. Repair 13 is applicable to damage to the trailing edge edgeband of a honeycomb core panel.

2. **General**

A. Repair 13 is a Category A repair. Refer to 51-00-06 for the definitions of the different categories of repairs.

B. The materials necessary for Repair 13 are given in Table 201.

Table 201:

REPAIR MATERIALS	
REPAIR MATERIALS	**BOEING SPECIFICATION**
Resin Mix 1 - Laminating Resin for Glass Fiber Repair Fabric	BMS 8-301, Class 2
Glass Fiber Repair Fabric	BMS 9-3, Type D, D-1, H-2 or H-3
Resin Mix 6 - Sealing Resin	BMS 8-207, Type 1, Classes I and II and other materials. Refer to Repair General, Table 203

3. **References**

Reference	Title
51-00-06	STRUCTURAL REPAIR DEFINITIONS
51-60-00, GENERAL	Control Surface Balance Procedures

4. **Repair Instructions**

A. Find the limits of the damage. Refer to Paragraph 4.A./REPAIR GENERAL.

B. Put masking tape around the damaged area. Keep a space of 1.0 inch between the limits of the damaged area and the tape. Refer to Repair 13 - Layout of the Repair Parts, Figure 201/REPAIR 13.

C. Prepare Resin Mix 6 as given in REPAIR GENERAL, Table 203.

D. Apply the Resin Mix 6 to the damaged area to be flush with the initial surface.

E. Cure the resin mix as given in Paragraph 4.O.(4)/REPAIR GENERAL.

F. Sand the cured resin mix until it is smooth with the outer surface of the initial facesheet.

G. Clean the damaged area as given in Paragraph 4.F./REPAIR GENERAL.

H. Prepare the repair fabric as given in Paragraph 4.H./REPAIR GENERAL and Paragraph 4.I./REPAIR GENERAL. Refer to Repair 13 - Layout of the Repair Parts, Figure 201/REPAIR 13 for the layout of the repair parts.

I. Apply the repair fabric as given in Paragraph 4.K./REPAIR GENERAL. The repair fabric ply must make an overlap on the damaged area of 1.0 inch all around.

NOTE: Use one ply of BMS 9-3, Type H-2 or Type H-3 glass fabric. The fiberglass ply must make an overlap on the damaged area of 1.0 inch all around.

J. Install the vacuum bag system as given in Paragraph 4.L./REPAIR GENERAL.

K. Do a check of the vacuum bag for leaks as given in Paragraph 4.M./REPAIR GENERAL.

L. Apply the pressure for the cure as given in Paragraph 4.N./REPAIR GENERAL.

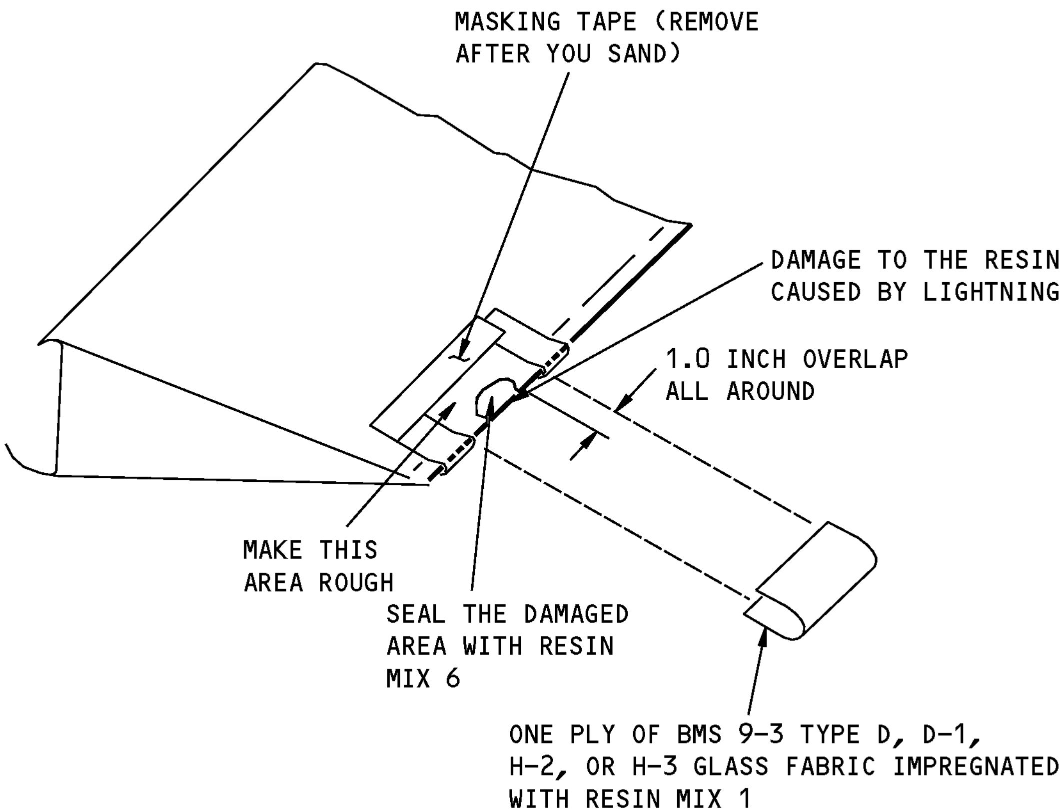
M. Cure the repair as given in Paragraph 4.O.(1)/REPAIR GENERAL.

N. Examine the completed repair as given in Paragraph 4.P./REPAIR GENERAL.

O. Apply the finish to the repair area as given in Paragraph 4.Q./REPAIR GENERAL.

P. Drill out drain and fastener holes, if they were filled, as given in Paragraph 4.R./REPAIR GENERAL and Paragraph 4.S./REPAIR GENERAL.

Q. Do a check of the flight control surfaces as given in Paragraph 4.T./REPAIR GENERAL and Paragraph 4.U./REPAIR GENERAL.



Repair 13 - Layout of the Repair Parts
Figure 201

REPAIR 14 - REPAIR OF SMALL DAMAGE TO ONE FACESHEET OF A HONEYCOMB PANEL

1. Applicability

WARNING: MAKE SURE THAT THE FLIGHT CONTROL SURFACES ARE CORRECTLY BALANCED AFTER YOU REPAIR THEM. REFER TO SRM 51-60-00 FOR THE CONTROL SURFACE BALANCING PROCEDURES. IF YOU DO NOT OBEY, DAMAGE TO THE STRUCTURE CAN OCCUR.

CAUTION: REFER TO THE SPECIFIED COMPONENT REPAIR SUBJECT FOR THE MATERIALS AND PROCEDURES APPROVED FOR THIS REPAIR. IF YOU DO NOT OBEY, THE REPAIR WILL BE UNSATISFACTORY.

A. Repair 14 is applicable to damage to one facesheet of a honeycomb panel.

2. General

A. Repair 14 is a Category A repair. Refer to 51-00-06 for the definitions of the different categories of repairs.

B. The materials necessary for Repair 14 are given in Table 201.

Table 201:

REPAIR MATERIALS	
REPAIR MATERIALS	**BOEING SPECIFICATION**
Resin Mix 1 - Laminating Resin for Glass Fiber Repair Fabric	BMS 8-301, Class 2
Glass Fiber Repair Fabric	BMS 9-3, Type D, D-1, H-2 or H-3

3. References

Reference	Title
51-00-06	STRUCTURAL REPAIR DEFINITIONS
51-60-00, GENERAL	Control Surface Balance Procedures

4. Repair Instructions

A. Find the limits of the damage. Refer to Paragraph 4.A./REPAIR GENERAL.

(1) Do not remove the damage.

B. Put masking tape around the damaged area. Keep a space of 1.0 inch between the limits of the largest repair ply and the tape. Refer to Repair 14 - Layout of the Repair Parts - Repair of Small Damage to One Skin, Figure 201/REPAIR 14.

C. Remove all of the water or other unwanted material as given in Paragraph 4.D./REPAIR GENERAL. The damaged area must be fully dry.

D. Clean the damaged area as given in Paragraph 4.F./REPAIR GENERAL.

E. Prepare the repair fabric as given in Paragraph 4.H./REPAIR GENERAL and Paragraph 4.I./REPAIR GENERAL. Refer to Repair 14 - Layout of the Repair Parts - Repair of Small Damage to One Skin, Figure 201/REPAIR 14 for the layout of the repair parts.

F. Apply the repair plies as given in Paragraph 4.K./REPAIR GENERAL.

G. Install the vacuum bag system as given in Paragraph 4.L./REPAIR GENERAL.

H. Do a check of the vacuum bag for leaks as given in Paragraph 4.M./REPAIR GENERAL.

I. Apply the pressure for the cure as given in Paragraph 4.N./REPAIR GENERAL.

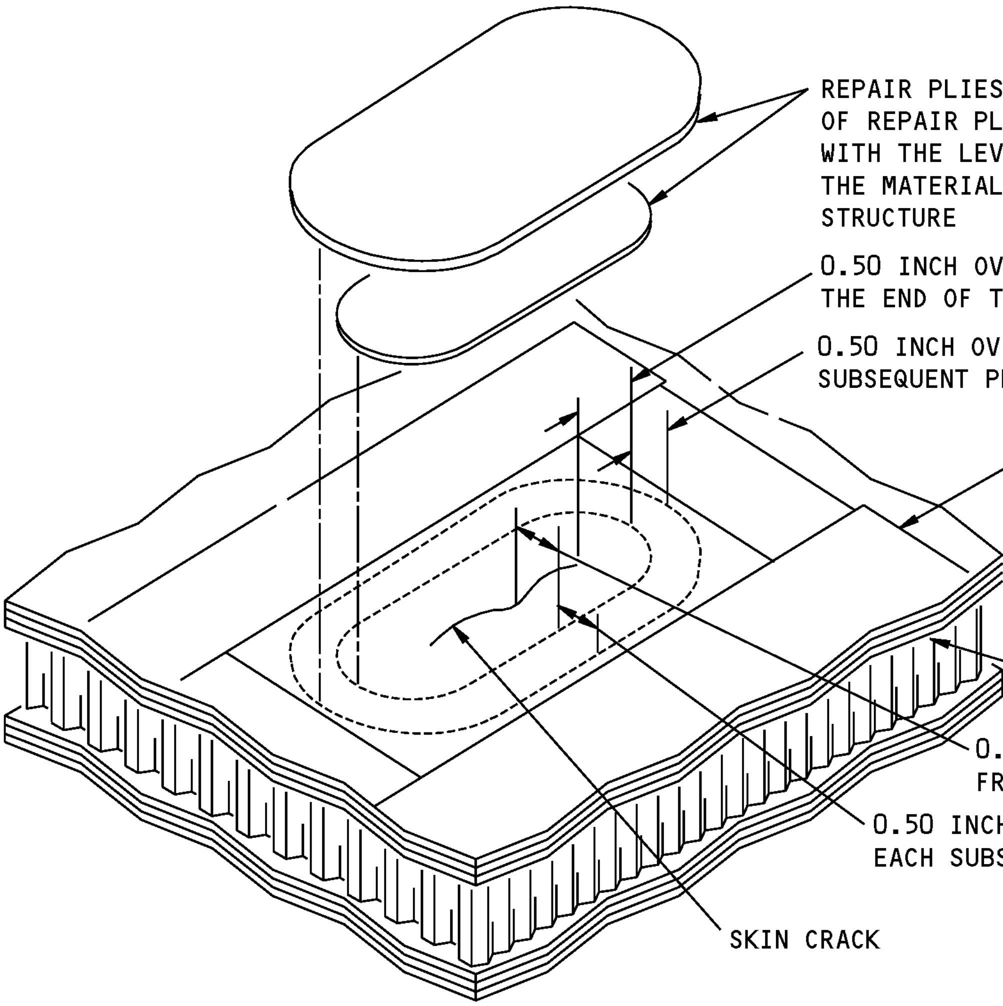
J. Cure the repair as given in Paragraph 4.O.(1)/REPAIR GENERAL.

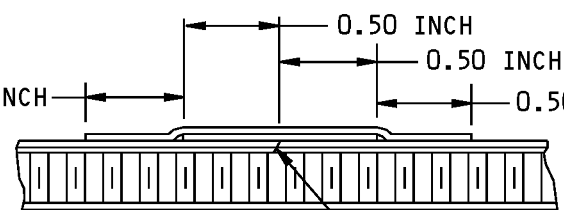
K. Examine the completed repair as given in Paragraph 4.P./REPAIR GENERAL.

L. Apply the finish to the repair area as given in Paragraph 4.Q./REPAIR GENERAL.

M. Drill out drain and fastener holes, if they were filled, as given in Paragraph 4.R./REPAIR GENERAL and Paragraph 4.S./REPAIR GENERAL.

N. Do a check of the flight control surfaces as given in Paragraph 4.T./REPAIR GENERAL and Paragraph 4.U./REPAIR GENERAL.





SECTION THROUGH THE REPAIR

Repair 14 - Layout of the Repair Parts - Repair of Small Damage to One Skin
Figure 201

REPAIR 15 - REPAIR OF EROSION DAMAGE AT THE EDGE OF A SOLID LAMINATE OR HONEYCOMB PANEL

1. Applicability

WARNING: MAKE SURE THAT THE FLIGHT CONTROL SURFACES ARE CORRECTLY BALANCED AFTER YOU REPAIR THEM. REFER TO SRM 51-60-00 FOR THE CONTROL SURFACE BALANCING PROCEDURES. IF YOU DO NOT OBEY, DAMAGE TO THE STRUCTURE CAN OCCUR.

CAUTION: REFER TO THE SPECIFIED COMPONENT REPAIR SUBJECT FOR THE MATERIALS AND PROCEDURES APPROVED FOR THIS REPAIR. IF YOU DO NOT OBEY, THE REPAIR WILL BE UNSATISFACTORY.

A. Repair 15 is applicable to damage to the surface resin on:

(1) The edgeband of a honeycomb core panel

(2) The edge of a solid laminate panel.

2. General

A. Repair 15 is a Category A repair. Refer to 51-00-06 for the definitions of the different categories of repairs.

B. The materials necessary for Repair 15 are given in Table 201.

Table 201:

REPAIR MATERIALS	
REPAIR MATERIALS	**BOEING SPECIFICATION**
Resin Mix 1 - Laminating Resin	BMS 8-301, Class 2

3. References

Reference	Title
51-00-06	STRUCTURAL REPAIR DEFINITIONS
51-60-00, GENERAL	Control Surface Balance Procedures

4. Repair Instructions

A. Find the limits of the damage. Refer to Repair 15 - Layout of the Repair Parts, Figure 201/REPAIR 15 and Repair General, Paragraph 4.A./REPAIR 15.

(1) If the damage is more than the limits shown in Repair 15 - Layout of the Repair Parts, Figure 201/REPAIR 15, do the repair as given in REPAIR 7.

(2) If there is delamination, do the repair as given in REPAIR 6.

B. Put masking tape around the damaged area. Keep a space of 1.0 inch between the limits of the damaged area and the tape.

C. Remove all of the water or other unwanted material as given in Paragraph 4.D./REPAIR GENERAL. The damaged area must be fully dry.

D. Put a taper on the surface of the damaged area with No. 180-grit or smaller abrasive paper. Refer to Repair 15 - Layout of the Repair Parts, Figure 201/REPAIR 15.

E. Clean the damaged area as given in Paragraph 4.E.(3)/REPAIR GENERAL.

F. Prepare Resin Mix 1 as given in REPAIR GENERAL, Table 203.

G. Apply the Resin Mix 1 to the damaged area.

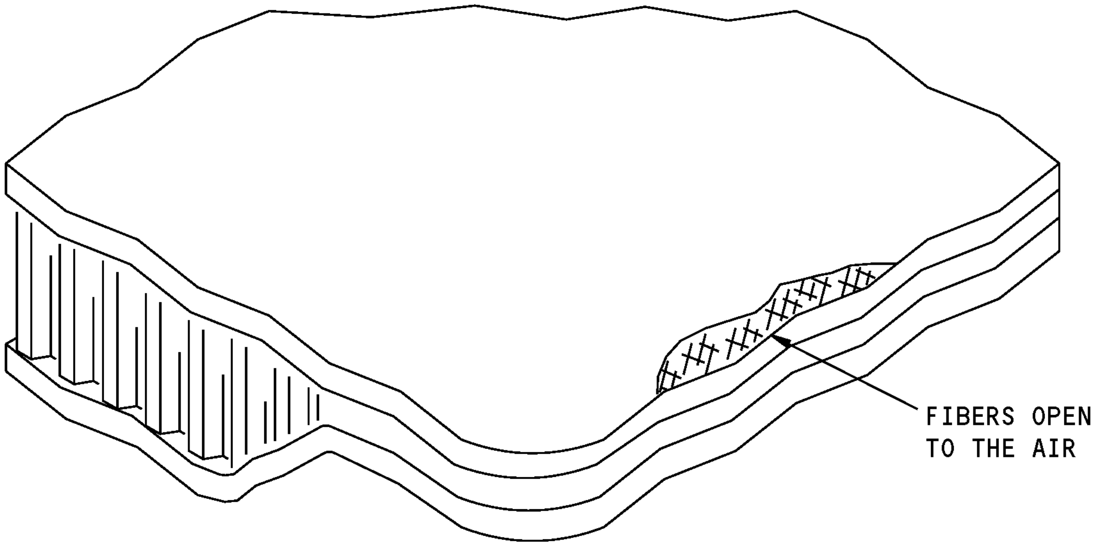
H. Cure the resin mix as given in Paragraph 4.O.(1)/REPAIR GENERAL.

I. Examine the completed repair as given in Paragraph 4.P./REPAIR GENERAL.

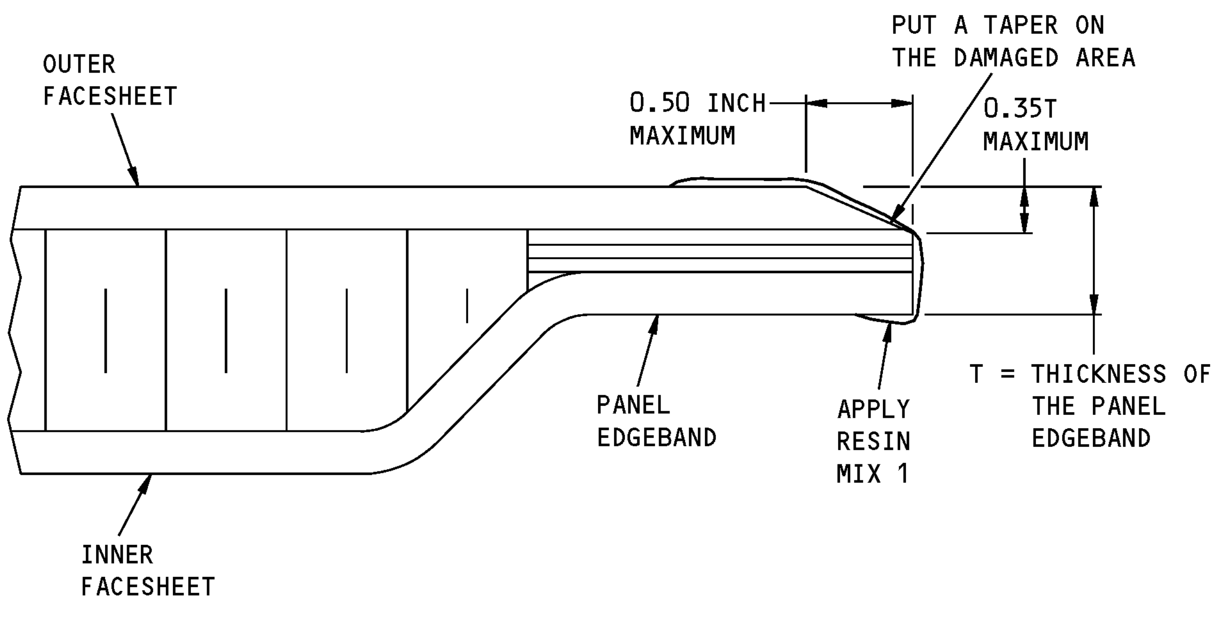
J. Apply the finish to the repair area as given in Paragraph 4.Q./REPAIR GENERAL.

K. Drill out drain and fastener holes, if they were filled, as given in Paragraph 4.R./REPAIR GENERAL and Paragraph 4.S./REPAIR GENERAL.

L. Do a check of the flight control surfaces as given in Paragraph 4.T./REPAIR GENERAL and Paragraph 4.U./REPAIR GENERAL.



EROSION DAMAGE ON A PANEL EDGE



SECTION THROUGH THE CENTER OF THE REPAIR
(HONEYCOMB PANEL IS SHOWN)

Repair 15 - Layout of the Repair Parts
Figure 201

GENERAL - RESIN SWEEP-FAIR PROCEDURES

1. Applicability

A. The Resin Sweep-Fair Procedures are applicable for the seal of damage and irregularities in composite parts damage as permitted by the applicable allowable damage sections in this manual.

NOTE: You can use the resin sweep-fair procedures to improve or make areas smoother.

2. References

Reference	Title
AMM 51-21-99 P/B 701	DECORATIVE EXTERIOR PAINT SYSTEM - CLEANING/PAINTING

3. Resin Sweep-Fair Procedures

CAUTION: MAKE SURE THAT YOU DO NOT CAUSE MORE DAMAGE TO THE FIBERS. IF YOU CAUSE MORE DAMAGE TO THE FIBERS, YOU WILL GET AN UNSATISFACTORY RESULT FROM THE RESIN SWEEP-FAIR PROCEDURE.

A. Sand the repair area. Make the surface rough. Use 150 grit or finer abrasive paper. Do not sand into the fibers.

WARNING: KEEP THE SOLVENTS AWAY FROM SOURCES OF HEAT, FIRE, OR SPARKS. IF YOU DO NOT OBEY, AN EXPLOSION CAN OCCUR. DO NOT LET THE SOLVENTS GET IN YOUR EYES, ON YOUR SKIN OR ON YOUR CLOTHING. USE EYE PROTECTION. USE RESPIRATORY PROTECTION EQUIPMENT WHEN YOU WORK IN A CONFINED SPACE. IF YOU DO NOT OBEY, INJURY TO PERSONS CAN BE THE RESULT.

CAUTION: DO NOT SOAK THE PARTS IN SOLVENT. DO NOT LET THE SOLVENT STAY ON THE PARTS FOR MORE THAT 60 SECONDS. IF YOU DO NOT OBEY, YOU CAN CAUSE DAMAGE TO THE PARTS.

B. Clean the damaged area.
   (1) Remove all the dust with a vacuum.
   (2) Clean the damaged area with a cloth made moist with.
      (a) Clean the surfaces again and again until a new moist cloth is clean after it is used.
      (b) Remove the solvent before it dries.
      (c) Remove the film that remains before you continue.

C. Mix the sealing resins. Refer to Table 1 for the resin data.

D. Apply the resin to the damaged area with a syringe or spatula.
   (1) Fill the areas that are not smooth.
   (2) Work the resin to make sure that you remove all the air bubbles.

CAUTION: MAKE SURE THE CURE TEMPERATURE IS NOT MORE THAN 200 DEG. F (93 DEG. C). IF YOU DO NOT OBEY, DAMAGE TO THE PART CAN OCCUR.

E. Cure the reworked area as given in Table 1.

F. Sand the reworked surface to be even with the adjacent surfaces.

G. Apply the decorative finish if necessary. Refer to AMM PAGEBLOCK 51-21-99/701.

Table 1:

SEALING RESIN DATA						
SPECIFICA˜ TION	**COMPONENTS**	**PARTS BY WEIGHT**	**WORK LIFE (POT LIFE)**	**GEL TIME**	**CURE TIME**	**CURE TEMPERATURE**
BMS 8-207, Type I, Class 1	EC1838; Part A Part B	 50 ± 2 50 ± 2	20 minutes at 77°F (25°C) ± 2°F (1°C)	20 minutes minimum at 77°F (25°C) ± 5°F (3°C)	2 hours	115°F (47°C) ±10°F (6°C)
BMS 8-207, Type I, Class 1	MX7774; Part A Part B	 50 ± 2 50 ± 2	20 minutes at 77°F (25°C) ± 2°F (1°C)	20 minutes minimum at 77°F (25°C) ± 5°F (3°C)	2 hours	115°F (47°C) ±10°F (6°C)
BMS 8-207, Type I, Class 2	Fiber resin FR-40 5413C	100 ± 1 15 ± 0.5	20 minutes at 77°F (25°C) ± 2°F (1°C)	20 minutes minimum at 77°F (25°C) ± 5°F (3°C)	12 hours 1 hour	75°F (24°C) ±10°F (6°C) 160°F (72°C) ±10°F (6°C)

GENERAL - METAL-TO-METAL STRUCTURAL REPAIR ADHESIVE BOND PROCEDURES

1. References

Reference	Title
51-70-10, REPAIR GENERAL	Aluminum Skin/Aluminum Honeycomb Panel Repairs

2. Obsolete Data

A. The data in this section was revised to show the newest technology and has been moved to 51-70-10, REPAIR GENERAL.

REPAIR GENERAL - TITANIUM SURFACE PREPARATION PROCEDURES FOR 250°F (121°C) CURE BOND

1. **Applicability**

   A. This subject gives instructions to prepare a titanium surface for bonding.

   B. Only use this procedure if an SRM repair section or an approved repair plan refers to this subject.

   C. Do not use this procedure for a rebuild or remanufacture of Boeing airplane structure.

2. **General**

   A. Refer to the SRM component repair section for:
   - The identification of the materials and the references to the engineering drawings
   - The allowable damage data
   - The references to this subject
   - The types of repairs that are permitted and/or the repair size limits (When applicable)
   - Other data that is not given in this subject

   B. In this subject are the instructions for:
   - Damage removal
   - Surface preparation procedures for titanium
   - Application of adhesive primers

3. **References**

Reference	Title
51-00-06, GENERAL	Structural Repair Definitions
51-10-02, GENERAL	Inspection and Removal of Damage
51-30-01, GENERAL	Sheet Metal Materials
51-70-04, REPAIR GENERAL	Repair Procedures for Wet Layup Materials
51-70-05, REPAIR GENERAL	Repair Procedures for Preimpregnated Materials
51-70-10, REPAIR GENERAL	Aluminum Skin/Aluminum Honeycomb Panel Repairs
SOPM 20-30-03	Standard Overhaul Practices Manual
737 NDT Part 1, 51-04-00	Ultrasonic
737 NDT Part 1, 51-05-01	Tap Test Inspection of Honeycomb Sandwich Structure

4. **Definitions**

   A. Boegel (AC130)

   (1) A type of complex inorganic polymer from the sol-gel family of chemical compounds.

   B. Damage

   (1) Change to the surface of a part that is caused by disbonds, erosion, dents, gouges, cracks, scratches, punctures and holes.

   C. Disbond

   (1) The failure of a bond adhesive that causes separation between a skin and doubler.

   D. Rebuild/Remanufacture

(1) The damage is too large to use repair procedures and materials (manufacturing procedures are necessary). Permission from Boeing and your local regulatory agency can be necessary because of intellectual property, certification, quality control, and safety rules.

NOTE: With permission, you can use the Boeing engineer drawings, material specifications, and process specifications.

E. More sources of definitions

(1) 51-00-06, GENERAL.

(2) 51-10-02, GENERAL.

5. Repair Summary

A. To make a satisfactory surface preparation, you must do what follows:

(1) Remove all the contamination from the part.

(2) Use the correct materials.

(3) Do the bond procedures in a clean, dry location.

(4) Make the bond surfaces clean.

(5) Do a satisfactory surface preparation.

(6) Make sure that all of the parts have the correct shape and dimensions.

(7) Make sure that the repair parts have the correct flatness or curvature. The parts must install correctly when you apply light finger pressure.

B. Identify the material containers with a label that contains the data that follows:

(1) BMS Specification

(2) Type

(3) Supplier Name

(4) Batch Number

(5) Date of preparation

C. Make sure that you do the bond procedures in a clean, dry location (a location that does not have contamination from exhaust fumes, rain, or other unwanted materials). Make sure that shop compressed air does not have water, oil, or other contamination. Use Boeing Specification Support Standard BSS 7217 ''Air Cleanliness, Shop Compressed Air'' (or the equivalent specification) to see if the shop compressed air is satisfactory.

NOTE: You can make a tent to seal the area from contamination.

WARNING: USE MECHANICAL AIRFLOW AND BREATHING PROTECTION WHEN YOU WORK IN A CLOSED SPACE OR AREA. MAKE SURE THAT THE FRESH AIR SUPPLY IS NOT BLOCKED. IF YOU GET FLUIDS IN YOUR EYES, FLUSH WITH WATER IMMEDIATELY AND GET MEDICAL AID.

D. Read the manufacturer's safety data sheet (MSDS) for each of the materials you use in this procedure. Wear protective clothing and equipment if it is specified in the MSDS.

E. Read each CAUTION in this procedure. They will help to prevent damage to the repair and prevent more damage to the airplane part.

F. Read each WARNING in this procedure. They will help to prevent injury to you and others.

6. Find the Limits of the Damage

A. Examine the damage in the repair area.

WARNING: DO NOT GET SOLVENTS IN YOUR MOUTH, YOUR EYES, OR ON YOUR SKIN. DO NOT BREATHE THE FUMES FROM SOLVENTS. SOLVENTS ARE DANGEROUS MATERIALS. SOLVENTS CAN BE FLAMMABLE OR CAUSE DAMAGE TO THE ENVIRONMENT. REFER TO THE MATERIAL SAFETY DATA SHEETS (MSDS) AND THE LOCAL SAFETY PRECAUTIONS.

(1) Clean the damaged area with a soft cloth moist with cleaning solvent. Refer to SOPM 20-30-03 for the applicable cleaning solvent and general cleaning procedures.

CAUTION: USE NON-DESTRUCTIVE PROCEDURES TO MAKE SURE THAT THERE IS NO WATER TRAPPED IN THE PART BEFORE YOU APPLY HEAT TO CURE THE ADHESIVES. DAMAGE TO THE PART WILL OCCUR IF THE WATER IS NOT REMOVED.

(2) Do a visual and NDI examination of the damaged area to find disbonds and other types of damage to the structure.

NOTE: Refer to 737 NDT Part 1, 51-04-00 for instrumented NDI procedures, or 737 NDT Part 1, 51-05-01 for tap test procedures.

B. Examine the initial adhesive primer (if applicable).

(1) It is not necessary to remove the initial adhesive primer from the bond surface if the primer has the conditions that follow:

(a) There is no contamination from paints, oils, chemicals, or other unwanted materials.

(b) There are no scratches or missing primer that:

1) Show more than 0.1 square inch (65 square mm) of bare metal.

2) Are more than 0.5 inch (13 mm) in length.

3) Are less than 0.5 inch (13 mm) from an edge.

4) Are less than 3.0 inches (75 mm) (edge-to-edge) apart.

(2) In these small areas where there is bare metal or missing primer, do the steps that follow:

(a) Clean the bare metal. Refer to SOPM 20-30-03 for the applicable solvents.

(b) Apply BMS 5-89 Type II adhesive primer to the bare metal. Refer to 51-70-10, REPAIR GENERAL for the primer application procedure.

(3) If more adhesive primer is damaged or removed than is permitted, then remove the primer and do the Boegel surface preparation and primer spray application again.

7. Remove the Damage

NOTE: Use a table or special tool to keep the part in the correct shape if you remove large areas of damage.

A. Remove the damaged metal from the repair area.

NOTE: As an alternative, you can do a surface preparation and apply the adhesive primer on the surface before you remove the damage. Make sure that you prepare an area that is larger than the necessary minimum bond area. This will give you a sufficient bond area if the removed damage is larger than the NDI indication.

WARNING: DO NOT USE EQUIPMENT THAT CAN CAUSE AN ARC OR A SPARK IN AN AREA WHERE THE IGNITION OF FUMES IS POSSIBLE. IF YOU DO, AN EXPLOSION CAN BE THE RESULT.

(1) If the metal is damaged or has disbonded areas, do the procedure that follows:

(a) Cut and remove the damaged skin in the disbonded areas.

(b) Separate the bonded structures (if applicable and necessary). Refer to Figure 201/REPAIR GENERAL for the steps that follow:

1) Make the wedge(s).

2) Use polyester tape to attach an approximately 0.02-0.06 inch (0.5-1.5 mm) thick metal or plastic sheet adjacent to the bonded area.

WARNING: USE DRY ICE OR COMPRESSED CARBON DIOXIDE GAS ONLY IN AN AREA WHERE THERE IS A SATISFACTORY FLOW OF AIR. HIGH LEVELS OF CARBON DIOXIDE CAN CAUSE INJURY. WEAR PROTECTIVE GLOVES. IF DRY ICE TOUCHES YOUR SKIN OR EYES, GET MEDICAL AID IMMEDIATELY.

3) Push the wedge(s) between the bonded structures. Lightly tap the wedge(s) if necessary.

a) If problems occur, you can apply heat, dry ice (solid carbon dioxide), compressed carbon dioxide gas, or liquid nitrogen to the bond area. This will make the adhesive resin brittle and easier to separate.

(c) Do a check to see if the bond is weak along the perimeter of the area to be repaired.

NOTE: Instrumented Non-destructive Inspection (NDI) procedures will not always find a bond that is weak but not broken.

1) Pull carefully on the edge of the bonded structure to see if the bond will break.

2) If the bond is easily broken, then continue to remove the bonded structure until the bonds are not easily broken.

(2) Remove all the nicks, scratches, gouges, burrs, sharp edges and other unwanted material to a smooth surface.

NOTE: A facesheet (skin) can have more than one sheet bonded together. Be careful not to cause damage to the sheet(s) below the damaged sheet(s).

(3) Examine the damaged area for signs of oil, fuel, dirt or other contamination. Remove all fluids, dirt and other contamination.

B. Make all the corners of large cutouts a minimum of 1.0 inch (25 mm) radius.

C. Refer to the component engineering drawings or use NDI procedures to find the locations of internal doublers and other repairs.

8. Make the repair parts

WARNING: USE ONLY EXPLOSION-PROOF EQUIPMENT WHEN YOU DO THESE TYPES OF REPAIRS. IF YOU DO NOT, PERSONAL INJURY AND DAMAGE TO ADJACENT EQUIPMENT CAN BE THE RESULT. WHEN YOU WORK WITH FLAMABLE MATERIALS, HEAT, FIRE OR SPARKS CAN CAUSE AN EXPLOSION.

A. Make the repair doublers and fillers from material that is the same or an equivalent alloy material and heat treatment as the initial skin. Refer to 51-30-01, GENERAL for the approved procedures for machining and bending of Titanium.

(1) Remove all the nicks, scratches, gouges, burrs, sharp edges, and other unwanted material from the repair doublers and fillers.

WARNING: DO NOT GET SOLVENTS IN YOUR MOUTH, YOUR EYES, OR ON YOUR SKIN. DO NOT BREATHE THE FUMES FROM SOLVENTS. SOLVENTS ARE DANGEROUS MATERIALS. SOLVENTS CAN BE FLAMMABLE OR CAUSE DAMAGE TO THE ENVIRONMENT. REFER TO THE MATERIAL SAFETY DATA SHEETS (MSDS) AND THE LOCAL SAFETY PRECAUTIONS.

B. Clean the repair doublers and fillers that do not have primer applied to the surface.

9. **The Boegel (AC-130) Prebond Treatment Procedure**

NOTE: The Boegel (AC-130) Prebond Treatment materials must be purchased from an approved Boeing licensed supplier.

A. Do a Boegel surface preparation procedure only on titanium surfaces that are not primed. Remove all unwanted primer and other material before you continue with the procedure.

B. The materials that you need are:

(1) AC-130 Sol-Gel Kit (Source: Advanced Chemistry and Technology, 7341 Anaconda Avenue, Garden Grove, CA 92841, 800-732-4470).

(2) Cheesecloth, gauze or clean cotton rags, or BMS 15-5, Class A wipers.

(3) Acetone or Methyl Propyl Ketone (MPK) Solvent.

(4) Scotch Brite, Type A, very fine pads or a high grade alumina sand paper (180-grit or finer).

(5) Aluminum oxide abrasive grit, 50 to 76 micron (No. 280 to No. 180 grit).

(6) BMS 5-89 Type II (BR 6747-1) Adhesive Primer.

C. Prepare the repair area for the Boegel (AC-130) Prebond Treatment procedure.

WARNING: DO NOT GET SOLVENTS IN YOUR MOUTH, YOUR EYES, OR ON YOUR SKIN. DO NOT BREATHE THE FUMES FROM SOLVENTS. SOLVENTS ARE DANGEROUS MATERIALS. SOLVENTS CAN BE FLAMMABLE OR CAUSE DAMAGE TO THE ENVIRONMENT. REFER TO THE MATERIAL SAFETY DATA SHEETS (MSDS) AND THE LOCAL SAFETY PRECAUTIONS.

(1) Do a solvent wipe with MPK or acetone as given in SOPM 20-30-03.

(2) Abrade the surfaces with Scotch Brite, Type A, very fine pads or a high grade alumina sand paper (180-grit or finer). The metal surface will look clean when you finish this step of the process.

(3) Remove the unwanted abrasive particles from the surface. Use clean dry air or nitrogen.

(4) Do a solvent wipe with MPK or acetone as given in SOPM 20-30-03.

WARNING: DO NOT DO GRIT BLAST PROCEDURES WITH ALUMINUM OXIDE ON TITANIUM IN AREAS WHERE THE IGNITION OF FUMES IS POSSIBLE. SPARKS FROM THE GRIT BLAST PROCEDURE CAN CAUSE AN EXPLOSION .

D. Fully abrade the repair area again.

NOTE: After the completion of this abrasion step, apply the Boegel (AC130) solution as soon as possible, but not later than 24 hours.

(1) Use fresh aluminum oxide abrasive grit, 50 to 76 micron (No. 280 to No. 180 grit) to grit-blast a surface area that is larger than the area to be bonded.

(a) Use 30 to 60 psi oil–free compressed air with the alumina grit.

(b) A blaster angle of 45 +/-15 degrees to the surface at a distance of 4.0 to 6.0 inches (10 to 15 cm) gives the best results.

(c) Slightly overlap the blast area with each pass across the surface to be bonded, until you see a matte appearance that looks the same everywhere.

NOTE: This procedure is necessary to make the surface reactive for the Boegel (AC-130).

(d) Make sure that all of the repair area is fully abraded, including the edges.

(2) Remove all loose grit residue with a clean, dry, natural bristle brush or with clean, oil–free compressed air. Keep the surface clean until you apply the Boegel (AC-130) Solution.

NOTE: Do not use water or solvents to remove the grit.

E. Mix the components of kit as given in the manufacturer's instructions. Use a kit size that is the best for the area to be treated. Example: approximately 50 ml of the Boegel (AC-130) solution is satisfactory to treat 200 square inches (1300 square cm) of bond zone. Scale it up if necessary.

(1) 30 minutes after you mix the components, you can apply Boegel (AC130) to the surface to be treated.

NOTE: 30 minutes is the minimum time necessary for the components to react.

(2) Use the mixture as soon as possible after the 30 minutes of reaction time, but not more than 10 hours after the components are mixed.

WARNING: DO NOT PERMIT THE BOEGEL (AC-130) SOLUTION TO TOUCH YOUR FACE OR EYES. USE APPROVED PROTECTION PROCEDURES. IF THE SOLUTION TOUCHES THESE AREAS, IRRITATION TO THE EYES AND SKIN CAN OCCUR.

F. Apply the Boegel (AC-130) solution.

(1) Isolate the mechanical fasteners and all the other areas that are not damaged. Use aluminum foil tape or a combination of aluminum foil tape and polyethylene film (or the equivalent). This will prevent contamination.

(2) Make sure that the temperature of the Boegel and titanium part stays between 50°F (10°C) and 100°F (38°C) during the procedure.

(3) Apply the solution to the bond surface to be treated with a clean, natural (non-metallic) bristle brush or with a sprayer.

(4) Apply a sufficient quantity of solution to cause the solution to drain from the bond surface. Keep the bond surface fully and continuously wet with the solution for 2 minutes, minimum.

NOTE: The wetted surface must look like a water-break-free surface. If the solution film does not stay continuous, there is surface contamination and you must do the cleaning, abrasion and application steps again.

(5) After the Boegel solution has remained on the bond surface for 2 minutes minimum, let the solution drain off the part and let the part dry. If solution remains in areas of the part which cannot drain, carefully remove the solution by absorbing it into a clean absorbent cloth (BMS 15-5 wipers or cheesecloth, for example) that is moistened with Boegel (AC-130). Do not rub or wipe the surface. Do not touch the surface with your bare skin or with gloves that have contamination on them.

NOTE: Absorbent cloth materials must not contain dyes, solvents, water, oil, grease, dust, metallic particles, alumina grit, or other contaminants.

G. Let the treated surfaces dry at room temperature for 60 minutes, minimum (but not more than 24 hours). You can use an oven, heat lamp, or forced air that is oil-free and is no hotter than160°F (71°C) to dry the parts.

H. Examine all of the treated surface. The surface must look dry and not have dust, fingerprints or other contamination. Use filtered forced air to remove dust. Do not use water or solvents to clean the surface. Water and solvents will contaminate the treated surface. If there is contamination that cannot be removed with forced air, then clean, abrade, and do the Boegel steps again.

NOTE: It is possible that you will see stains on the prepared surface after the surface is dry. These stains are permitted.

I. Keep the bond surface(s) clean and dry if you cannot apply the adhesive primer immediately.

(1) Do not touch the surface(s) with your bare skin, waxed paper, or material that has a release agent or other contamination.

(2) If protection of the surface(s) is necessary, then put vacuum bag film or unwaxed paper (without ink or other contamination on it) on the bond surface(s).

J. Apply BMS 5-89, Type II (BR 6747-1) adhesive primer not later than 24 hours after you apply the Boegel (AC-130) solution. Refer to 51-70-10, REPAIR GENERAL. Clean the bond surface and do the Boegel (AC-130) procedure again if the bond surface has contamination.

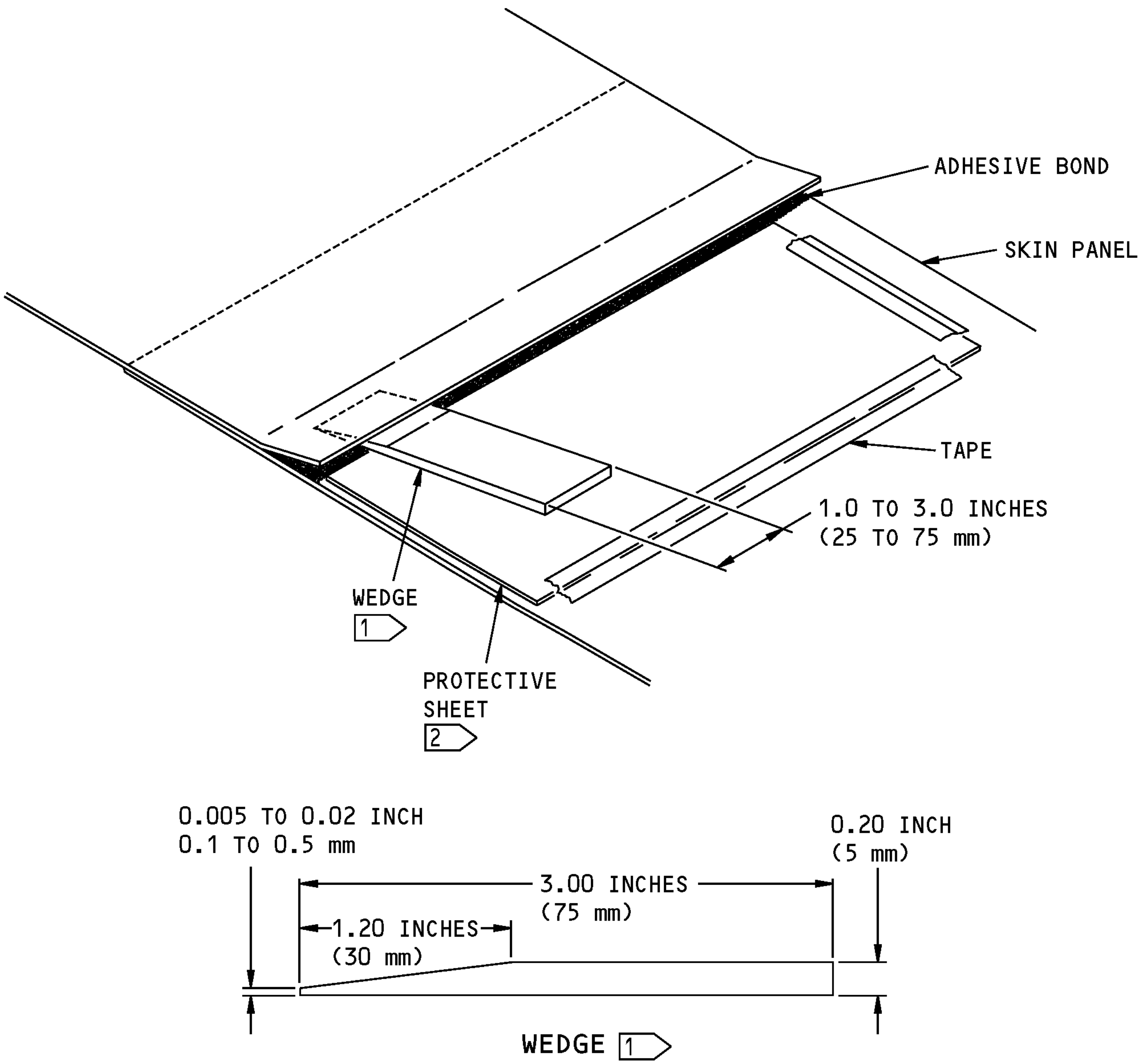
10. Application of Adhesive

A. If you are bonding metal to metal, then refer to 51-70-10, REPAIR GENERAL for the application of adhesive, vacuum bag layup, and cure cycle information.

B. If you do a preimpregnated (prepreg) repair (or replacement) to glass fiber reinforced plastic (GFRP) on the titanium, refer to 51-70-05, REPAIR GENERAL.

NOTE: Use BMS 5-101 Type II, Grade 10 instead of BMS 5-129 film adhesive when you apply prepreg GFRP on titanium.

C. Wet layup procedures as specified in 51-70-04, REPAIR GENERAL are also permitted for repair to GFRP on titanium.



SEPARATION OF THE BONDED PARTS WITH WEDGES

A

NOTES

1 WOOD OR PLASTIC ARE EXAMPLE MATERIALS

2 METAL OR PLASTIC ARE EXAMPLE MATERIALS

Damage Removal Procedures
Figure 201

GENERAL - ALUMINUM HONEYCOMB STRUCTURE

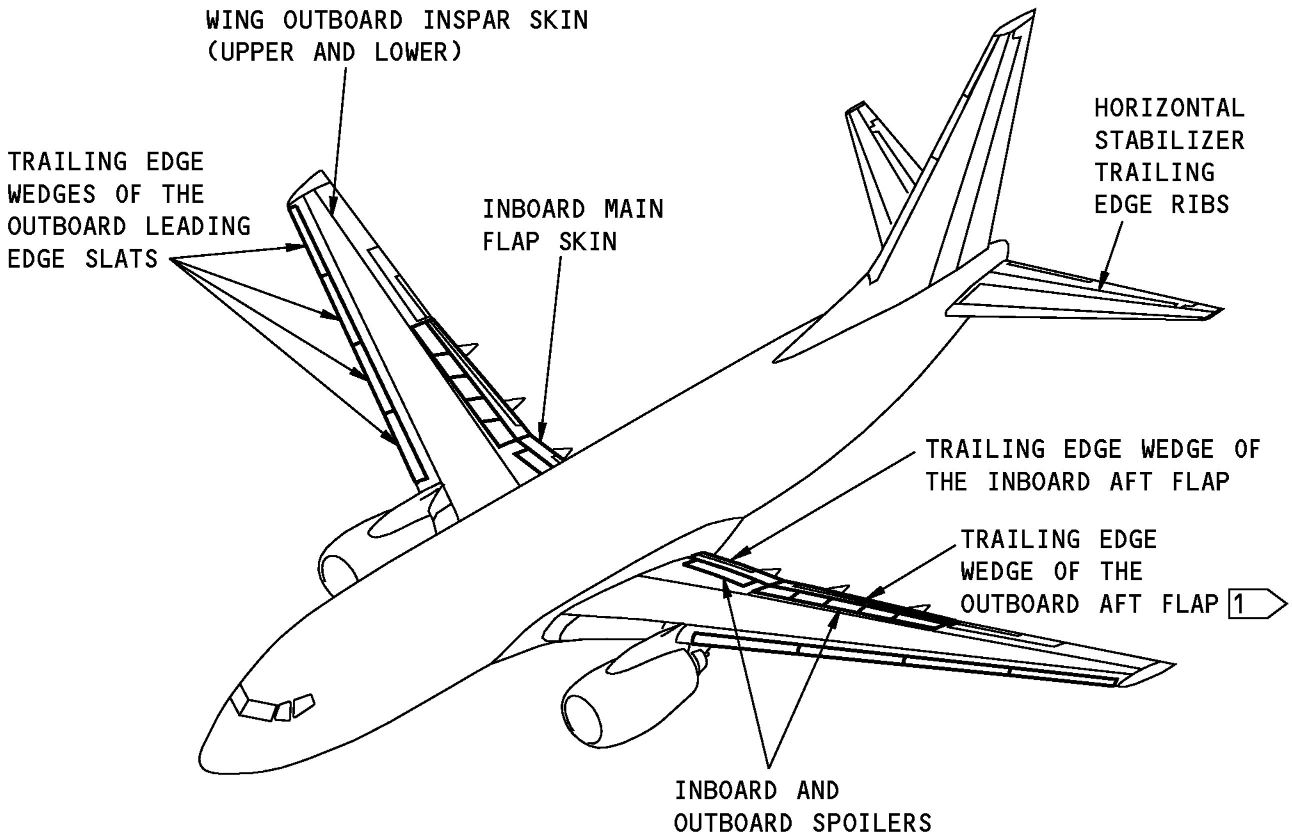
1. References

Reference	Title
51-70-10, REPAIR GENERAL	Aluminum Skin/Aluminum Honeycomb Panel Repairs

2. General

A. Refer to Figure 1/GENERAL and Figure 2/GENERAL for the locations of aluminum honeycomb structure.

B. Refer to 51-70-10, REPAIR GENERAL for the repair data for aluminum honeycomb structure.



NOTES

- REFER TO SPECIFIC IDENTIFICATION SUBJECT FOR PICTORIAL REPRESENTATION
- REFER TO SPECIFIC COMPONENT REPAIR SUBJECT FOR AUTHORIZED REPAIRS AND REPAIR LIMITS
- REFER TO SPECIFIC ALLOWABLE DAMAGE SUBJECT FOR ALLOWABLE DAMAGE DATA

1 REFER TO BOEING DRAWINGS FOR EFFECTIVITY

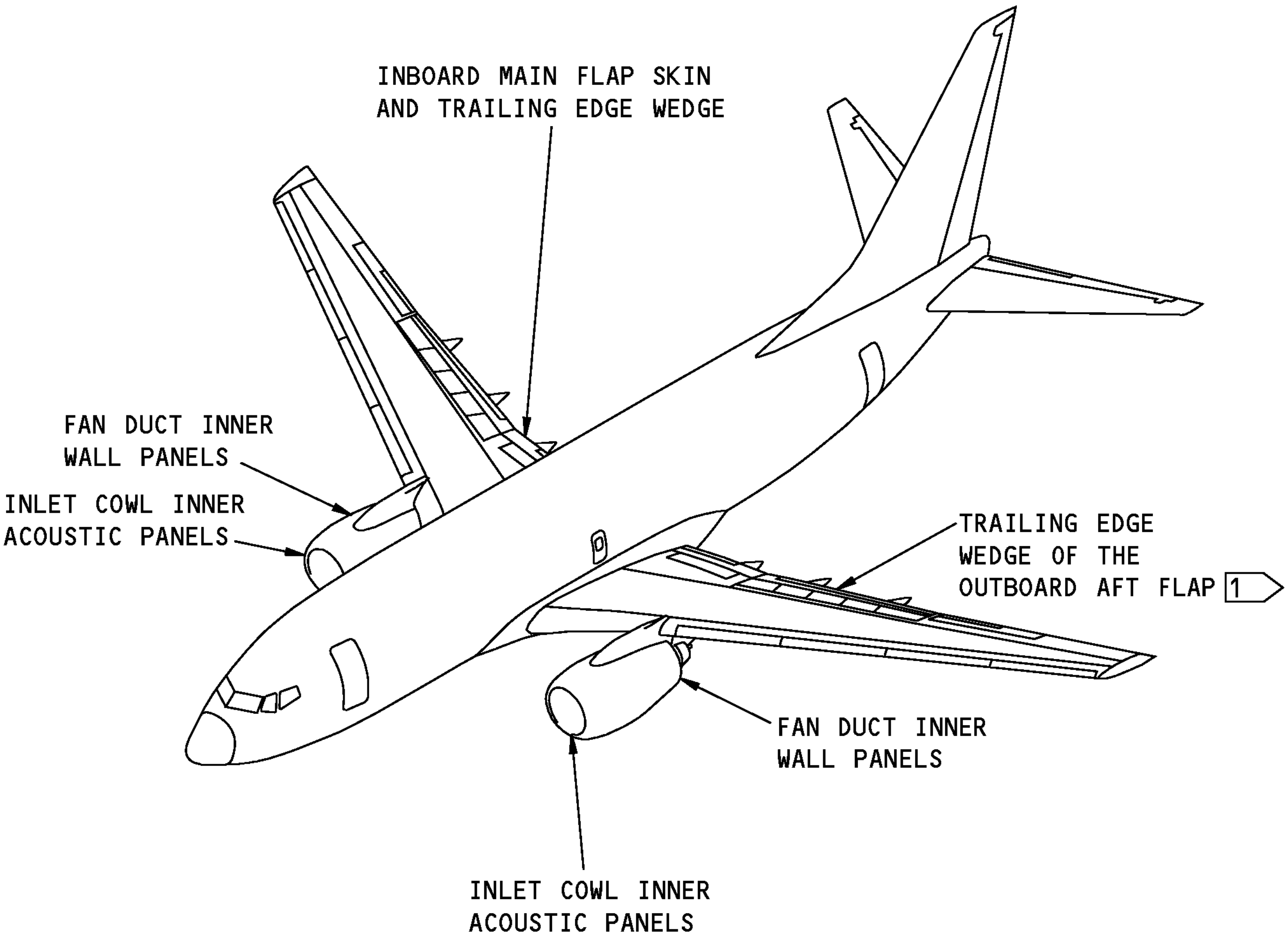
Locations of 250 Degrees F (121 Degrees C) Cure Aluminum Skin/Aluminum Honeycomb Sandwich Panels
Figure 1 (Sheet 1 of 2)

COMPONENT DESCRIPTION	REFERENCE DRAWING(S)	SPECIFIC COMPONENT REPAIR, ALLOWABLE DAMAGE, AND IDENTIFICATION SUBJECTS
SPOILERS - INBOARD - OUTBOARD	 113A4110 113A4210 113A4310 113A4410 113A4510 113A4610	57-70-01
WING OUTBOARD LEADING EDGE SLAT STRUCTURE - TRAILING EDGE WEDGE	114A6010 114A6020 114A6030 114A6040	57-42-01
HORIZONTAL STABILIZER TRAILING EDGE RIBS	185A1341 185A1351 185A1361	55-10-09
WING OUTBOARD INSPAR SKIN - UPPER - LOWER	 112A3602 112A4602	57-20-01
WING INBOARD MAIN FLAP - UPPER OUTBOARD SKIN PANEL - INSPAR LOWER OUTBOARD SKIN PANEL	 113A2143 113A2148	57-53-01
WING INBOARD AFT FLAP	113A2710	57-53-01
WING OUTBOARD AFT FLAP	113A3710	57-53-01 [1]

LOCATION OF ALUMINUM SKIN/ALUMINUM HONEYCOMB SANDWICH COMPOSITE COMPONENTS MANUFACTURED AT 250°F (121°C) CURE TEMPERATURE

TABLE I

Locations of 250 Degrees F (121 Degrees C) Cure Aluminum Skin/Aluminum Honeycomb Sandwich Panels
Figure 1 (Sheet 2 of 2)



NOTES

- REFER TO SPECIFIC IDENTIFICATION SUBJECT FOR PICTORIAL REPRESENTATION
- REFER TO SPECIFIC COMPONENT REPAIR SUBJECT FOR AUTHORIZED REPAIRS AND REPAIR LIMITS
- REFER TO SPECIFIC ALLOWABLE DAMAGE SUBJECT FOR ALLOWABLE DAMAGE DATA

1 REFER TO BOEING DRAWINGS FOR EFFECTIVITY

Locations of 350 Degrees F (177 Degrees C) Cure Aluminum Skin/Aluminum Honeycomb Sandwich Panels
Figure 2 (Sheet 1 of 2)

COMPONENT DESCRIPTION	REFERENCE DRAWING(S)	SPECIFIC COMPONENT REPAIR, ALLOWABLE DAMAGE, AND IDENTIFICATION SUBJECTS
INLET COWL INNER ACOUSTIC PANEL - UPPER - LOWER	 314-2121 314-2122	54-10-01
FAN DUCT INNER WALL PANEL - LEFT - RIGHT	 315A2101 315A2102	54-30-01
WING INBOARD MAIN FLAP - LOWER OUTBOARD AFT BONDED SKIN PANEL - TRAILING EDGE WEDGE	 113A2147 113A2500	57-53-01
WING OUTBOARD AFT FLAP	113A3710	57-53-01 [1]

LOCATION OF ALUMINUM SKIN/ALUMINUM HONEYCOMB SANDWICH COMPOSITE COMPONENTS MANUFACTURED AT 350°F (177°C) CURE TEMPERATURE

TABLE II

Locations of 350 Degrees F (177 Degrees C) Cure Aluminum Skin/Aluminum Honeycomb Sandwich Panels
Figure 2 (Sheet 2 of 2)

REPAIR GENERAL - ALUMINUM SKIN/ALUMINUM HONEYCOMB PANEL REPAIRS

1. Applicability

A. This subject gives instructions for repairs to bonded aluminum alloy skin and aluminum honeycomb core sandwich structure that was manufactured at 250°F (121°C) or 350°F (177°C).

B. Only use this procedure if an SRM repair section or an approved repair plan refers to this subject.

(1) Do not use this SRM procedure to rebuild or remanufacture bonded airplane structure. Different approved data will be necessary.

(2) A specific SRM repair section in Chapters 52 through 57, or a Boeing Service Bulletin, or other approved engineering data can have data that is different than what is shown in this procedure. You are permitted to use approved engineering data that permits a different process or repair size or repair configuration.

2. General

A. Refer to the SRM component repair section for:

- The identification of the materials and the references to the engineering drawings
- The allowable damage data
- The references to this subject
- The types of repairs that are permitted and/or the repair size limits (When applicable)
- Other data that is not given in this subject

B. In this subject are the instructions for:

- Damage removal
- Surface preparation procedures for aluminum alloys
- Application of adhesive primers
- Application of film and paste adhesives
- Aluminum honeycomb core splicing
- Vacuum bag procedures
- Cure procedures
- Bond inspection procedures
- Repair procedures

3. References

Reference	Title
51-00-06, GENERAL	Structural Repair Definitions
51-10-02, GENERAL	Inspection and Removal of Damage
51-20-01, GENERAL	Protective Treatment of Metallic and Composite Materials
51-20-05, GENERAL	Repair Sealing
51-30-01, GENERAL	Sheet Metal Materials
AMM 51-21-21 P/B 701	PREPAINT CLEANING AND TREATMENT - CLEANING/PAINTING
AMM 51-21-99 P/B 701	DECORATIVE EXTERIOR PAINT SYSTEM - CLEANING/PAINTING
BAC 5514	Common Bonding Requirements for Structural Adhesives
BAC 5514-589	Application of Corrosion Inhibiting Adhesive Primer
BAC 5555	Phosphoric Acid Anodizing of Aluminum For Structural Bonding
DOCUMENT BSS 7217	Air Cleanliness, Shop Compressed Air

(Continued)

Reference	Title
DOCUMENT D6-49327	Certification of Autoclaves for Metal Bonding and Curing of Composite Structure
DOCUMENT D6-56273	Qualification of Heat Blankets for Hot Bonding
SOPM 20-30-03	Standard Overhaul Practices Manual
SOPM 20-30-97	Solvents For Final Cleaning Before Structural Bonding (Series 97)
737 NDT Part 1, 51-01-01	Inspection of Repairs to Composite Structure
737 NDT Part 1, 51-04-00	Ultrasonic
737 NDT Part 1, 51-05-01	Tap Test Inspection of Honeycomb Sandwich Structure

4. **Definitions**

A. Boegel (AC130)

(1) A type of complex inorganic polymer from the sol-gel family of chemical compounds.

B. Damage

(1) Change to the surface of a part that is caused by deterioration, corrosion, disbonds, erosion, dents, gouges, cracks, scratches, punctures and holes.

C. Disbond

(1) The failure of a bond adhesive that causes separation between a skin and core or doubler.

D. Durability

(1) A low crack growth rate, a strong bond, and good corrosion protection.

E. Engineering Review

(1) Approval by a professional engineer with the experience, qualifications and authority to make decisions on structural repairs. The engineer will make sure that the repair design has the necessary airworthiness requirements (the repaired part has the necessary strength, durability, damage tolerance (if necessary), and will function on the airplane correctly). Boeing can also give an engineering review, if necessary.

F. One-Stage Cure

(1) The core and skins are bonded together at the same time. (One application of heat).

G. Rebuild/Remanufacture

(1) The damage is too large to use repair procedures and materials (manufacturing procedures are necessary). Permission from Boeing and your local regulatory agency can be necessary because of intellectual property, certification, quality control, and safety rules.

NOTE: With permission, you can use the Boeing engineer drawings, material specifications, and process specifications.

H. Repair Parts

(1) Doublers, triplers, fillers, tapered shims, replacement skin and/or replacement honeycomb core are repair parts. Primers, adhesives, and positioning fabric are not repair parts.

I. Two-Stage Cure

(1) When the repair parts are bonded in two cure steps (Two separate applications of heat).

(a) The first stage: The core is bonded into the repair and then cured with one side of the core open. (Before the last skin is put on and then cured).

(b) The second stage: The last skin (one or more doublers) is put on and then cured.

J. More sources of definitions

(1) 51-00-06, GENERAL.

(2) 51-10-02, GENERAL.

5. Repair Summary

A. Refer to Table 201/REPAIR GENERAL for an index of the paragraphs and figures.

Table 201: Repair General Index

REFERENCE	TITLE
Paragraph 6./REPAIR GENERAL	Find the Limits of the Damage
Paragraph 7./REPAIR GENERAL	Remove the Damage
Paragraph 8./REPAIR GENERAL	Make the repair parts
Paragraph 9./REPAIR GENERAL	Installation of the Honeycomb Repair Core
Paragraph 10./REPAIR GENERAL	Inspect the fit of the repair parts.
Paragraph 11./REPAIR GENERAL	Use of the Surface Preparation Procedures
Paragraph 12./REPAIR GENERAL	The Phosphoric Acid Containment System (PACS) Procedure
Paragraph 13./REPAIR GENERAL	The Phosphoric Acid Non-Tank Anodizing (PANTA) Procedure
Paragraph 14./REPAIR GENERAL	The Boegel (AC-130) Prebond Treatment Procedure
Paragraph 15./REPAIR GENERAL	Application of BMS5-89 or BMS5-137 Adhesive Primer to the Bond Surface
Paragraph 16./REPAIR GENERAL	Hydrofluoric Acid (HF) - Alodine Procedure
Paragraph 17./REPAIR GENERAL	Application of BAC5710, Type 60 Adhesive Primer
Paragraph 18./REPAIR GENERAL	Application of BMS5-101 or BMS5-137 Film Adhesive
Paragraph 19./REPAIR GENERAL	Application of BMS5-92 or BMS5-141 Paste Adhesive
Paragraph 20./REPAIR GENERAL	Cure the bond
Paragraph 21./REPAIR GENERAL	Do an examination of the bonded repair
Paragraph 22./REPAIR GENERAL	Clean, seal, and finish.
Figure 201/REPAIR GENERAL	Repair Options
Figure 202/REPAIR GENERAL	Flow Chart of the Repair Steps
Figure 203/REPAIR GENERAL	Damage Removal
Figure 204/REPAIR GENERAL	Phosphoric Acid Containment System (PACS)
Figure 205/REPAIR GENERAL	Phosphoric Acid Non-Tank Anodize (PANTA) Layup
Figure 206/REPAIR GENERAL	Polarized Light Test - Verification of Anodic Oxide Film
Figure 207/REPAIR GENERAL	Sanding Procedure Used for Boegel
Figure 208/REPAIR GENERAL	Repair Doubler Specifications for Flush Repairs
Figure 209/REPAIR GENERAL	Repair Doubler Specifications for External Patch Repairs
Figure 210/REPAIR GENERAL	Installation of the Repair Core
Figure 211/REPAIR GENERAL	Cure Time for BMS5-92, Two-part Paste Adhesive
Figure 212/REPAIR GENERAL	Cure Time for BMS5-141 Paste Adhesive
Figure 213/REPAIR GENERAL	Installation of the Repair Doubler
Figure 214/REPAIR GENERAL	Thermocouple Locations
Figure 215/REPAIR GENERAL	Layup of Vacuum Bagging Materials

B. The illustrations and instructions in this repair show different examples of repairs and types of damage. You can do repairs that put together one or more of these examples. Use the correct repair procedures for each type of example. For example, if a circular shaped repair is shown, you can use a non-circular shape as an alternative.

C. This subject contains four surface preparation procedures:

(1) The Phosphoric Acid Containment System (PACS) procedure

(2) The Phosphoric Acid Non-Tank Anodize (PANTA) procedure

(3) The Boegel (AC-130) Prebond Treatment procedure

(4) The Hydrofluoric Acid (HF) - Alodine procedure

D. There are three adhesive primer application procedures:

(1) BMS5-89 Type I or Type II application procedure

(2) BMS5-137 Type I, Class 2, 3, or 4 application procedure

(3) BAC5710, Type 60 application procedure

E. There are five metal-to-metal bond adhesives used in this subject.

(1) BMS5-101, Type II film adhesive, cured at 225°F to 260°F (107°C to 127°C).

(2) BMS5-137, Type II film adhesive, cured at 300°F to 320°F (149°C to 160°C) or 340°F to 360°F (171°C to 182°C).

(3) BMS5-92, Type I paste adhesive, cured at 70°F to 260°F (21°C to 127°C).

(4) BMS5-92, Type V paste adhesive, cured at 70°F to 180°F (21°C to 82°C).

(5) BMS5-141 paste adhesive, cured at 70°F to 200°F (21°C to 93°C).

F. To make a satisfactory repair, you must do what follows:

(1) Use the correct materials.

(2) Remove all the water and other contamination from the part.

(3) Do the bond procedures in a clean, dry location.

(4) Make the bond surfaces clean.

(5) Do a satisfactory surface preparation.

(6) Make sure that all of the parts have the correct shape and dimensions.

(7) Make sure that the repair parts have the correct flatness or curvature. The parts must install correctly when you apply light finger pressure.

(8) Make sure that the adhesive bondline thickness is correct.

(9) Remove some of the air and gases from the honeycomb core before you start a cure cycle. (Vacuum bagged repair procedure).

(10) Use sufficient pressure, time, and temperature to cure the repair.

G. Identify the material containers with a label that contains the data that follows:

- BMS Specification
- Type and Class
- Supplier Name
- Batch Number
- Date of preparation
- Shelf life or expiration date

H. Make sure that you do the bond procedures in a clean, dry location (a location that does not have contamination from exhaust fumes, rain, or other unwanted materials). Make sure that shop compressed air does not have water, oil, or other contamination. Use Boeing Specification Support Standard BSS7217 ''Air Cleanliness, Shop Compressed Air'' (or the equivalent specification) to see if the shop compressed air is satisfactory.

NOTE: You can make a tent to seal the area from contamination.

I. A phosphoric acid tank anodize procedure is a permitted alternative to the PAA non-tank procedures given in this section. Make sure that your tank facilities, chemicals, and procedures are satisfactory. Refer to Boeing Process Specification BAC5555, ''Phosphoric Acid Anodizing of Aluminum for Structural Bonding'' (or the equivalent specification).

J. If you use a heat blanket, make sure that it is qualified and will operate correctly. D6-56273, ''Qualification of Heat Blankets for Hot Bonding'', is a procedure that Boeing uses. You can refer to this procedure or use an equivalent procedure to qualify your heat blanket.

K. If you use an autoclave, make sure that your autoclave facilities and procedures are satisfactory. Refer to Boeing Process Specification BAC5514, ''Common Bonding Requirements for Structural Adhesives'' and D6-49327, ''Certification of Autoclaves for Metal Bonding and Curing Composite Structure'' (or the equivalent specifications).

L. If you use an oven, make sure that it has equipment that can circulate the heated air, supply a vacuum and control the temperature.

NOTE: Make sure that you have equipment that can monitor and record the temperature of the thermocouples.

WARNING: USE MECHANICAL AIRFLOW AND BREATHING PROTECTION WHEN YOU WORK IN A CLOSED SPACE OR AREA. MAKE SURE THAT THE FRESH AIR SUPPLY IS NOT BLOCKED. IF YOU GET FLUIDS IN YOUR EYES, FLUSH WITH WATER IMMEDIATELY AND GET MEDICAL AID.

M. Read the manufacturer's safety data sheet (MSDS) for each of the materials you use in this procedure. Wear protective clothing and equipment if it is specified in the MSDS.

N. Keep all resin and adhesive materials in the storage condition specified in the manufacturer's instructions or the Boeing specifications (as applicable). Do not keep the materials out of storage for longer than necessary.

O. Read each CAUTION in this procedure. They will help to prevent damage to the repair and prevent more damage to the airplane part.

P. Read each WARNING in this procedure. They will help to prevent injury to you and others.

Q. Refer to Figure 201/REPAIR GENERAL, Repair Options to help you make a decision on the correct repair procedure.

(1) If the panel to be repaired was initially manufactured at 250°F (121°C), and you want to do a permanent repair with a film adhesive, then use BMS5-101, Type II film adhesive and an applicable BMS5-89 adhesive primer and cure the repair for 90 minutes at 250°F (121°C).

NOTE: Refer to all of the applicable steps in this repair section for the 250°F (121°C) cure process.

(2) If the panel to be repaired was initially manufactured at 350°F (177°C), and you want to do a permanent repair with a film adhesive, then do one of the steps that follow:

- Use BMS5-137, Type II film adhesive and an applicable BMS5-137 adhesive primer and cure the repair for 90 minutes in an autoclave at 350°F (177°C), or

- Use BMS5-137 Type II, Class 1 (EA 9657) film adhesive and an applicable BMS5-137, Type I adhesive primer and cure the repair for 5 hours with a vacuum bag at 310°F (154°C).

NOTE: Refer to all of the applicable steps in this repair section for the 310°F (154°C) and 350°F (177°C) cure processes.

(3) If the damage is small, you can do an interim repair [250°F (121°C) and 350°F (177°C) manufactured panels]. Interim repair options are as follows:

- Do an HF Alodine surface preparation (you are permitted to use with a film or paste adhesive), or
- Use a paste adhesive (you are permitted to use with all types of adhesive primers).

NOTE: Refer to all of the applicable steps in this repair section for the interim repair processes.

R. Refer to Figure 202/REPAIR GENERAL, Flow Chart of the Repair Steps before you start the repair procedure.

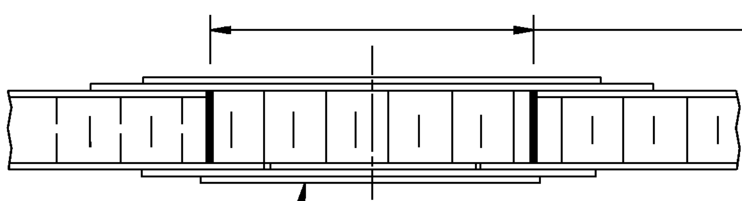
S. Refer to Table 202/REPAIR GENERAL and make a repair selection.

Table 202: Repair Examples

REPAIR 1 - Repair of a Disbond at an Edge of Aluminum Honeycomb Structure
REPAIR 2 - Repairs to Small Damage
REPAIR 3 - Septumized Core Repairs
REPAIR 4 - Repairs to Large Damage

SURFACE PREPARATION	REPAIR TYPE	PASTE ADHESIVES [9]	FILM ADHESIVES: VACUUM BAG CURE [1]	FILM ADHESIVES: AUTOCLAVE CURE [2]
		MAXIMUM DAMAGE SIZE [3] [7]		
HF ALODINE	INTERIM [4]	2.0 INCHES (50 mm) LENGTH OR DIAMETER	2.0 INCHES (50 mm) LENGTH OR DIAMETER	2.0 INCHES (50 mm) LENGTH OR DIAMETER
BOEGEL (AC-130)	INTERIM [4]	2.0 INCHES (50 mm) LENGTH OR DIAMETER	NOT APPLICABLE	NOT APPLICABLE
BOEGEL (AC-130)	PERMANENT	[5]	64 SQUARE INCHES (400 SQUARE cm) [6]	200 SQUARE INCHES (0.13 SQUARE METERS)
TANK PAA, PACS, PANTA	INTERIM [4]	2.0 INCHES (50 mm) LENGTH OR DIAMETER	NOT APPLICABLE	NOT APPLICABLE
TANK PAA, PACS, PANTA	PERMANENT	[5]	64 SQUARE INCHES (400 SQUARE cm) [6]	200 SQUARE INCHES (0.13 SQUARE METERS) OR SEE DETAIL A

TABLE A



ONE SIDE CAN HAVE A REPAIR FOR A DAMAGED SKIN AND CORE THAT IS LARGER THAN 200 SQUARE INCHES (0.13 SQUARE METERS) IF THE LONGEST DAMAGE DIMENSION IS LESS THAN 50% OF THE LARGEST SKIN DIMENSION. REFER TO REPAIR 4 FOR EXAMPLES OF LARGE REPAIRS THAT ARE PERMITTED.

THIS SIDE CAN BE REPAIRED ALSO, IF DAMAGE IS 200 SQUARE INCHES (0.13 SQUARE METERS) OR LESS

PERMITTED DAMAGE SIZES THAT CAN BE REPAIRED TO SURFACES PREPARED WITH TANK PAA (BAC5555), PACS OR PANTA AND CURED IN AN AUTOCLAVE [8]

A

Repair Options
Figure 201 (Sheet 1 of 2)

NOTES

1 OVEN, HEAT BLANKET, HEAT LAMPS OR FORCED HOT AIR ARE PERMITTED. REFER TO PARAGRAPH 20.

2 AUTOCLAVE MUST BE PRESSURIZED AS SPECIFIED IN PARAGRAPH 20.

3 AFTER YOU FIND AND REMOVE THE DAMAGE AS SPECIFIED IN PARAGRAPH 7. MAXIMUM DAMAGE SIZE IS APPLICABLE FOR EACH DAMAGED SKIN AND CORE.
IF YOU DO A FLUSH REPAIR: THE CUTOUT ON THE SIDE THAT WILL HAVE THE EXTERNAL DOUBLER MUST BE LESS THAN OR EQUAL TO THE SIZES IN THIS TABLE.

4 REFER TO SRM 51-00-06 FOR STRUCTURAL REPAIR DEFINITIONS. INTERIM REPAIRS MUST BE INSPECTED EACH 24 MONTHS OR LESS, OR EACH 3500 FLIGHT CYCLES OR LESS (NO LATER THAN THE INTERVAL THAT OCCURS FIRST).

5 THE MAXIMUM PERMITTED DAMAGE LENGTH (OR DIAMETER) IS 1.0 INCH (25 mm) OR THE ALLOWABLE DAMAGE LIMIT (THE SMALLER OF THE TWO). 9

6 YOU CAN INCREASE THE MAXIMUM SIZE TO 200 SQUARE INCHES (0.13 SQUARE METERS) IF YOU DO THE STEPS THAT FOLLOW:

- DO A TWO STAGE CURE REPAIR PROCEDURE (WHEN HONEYCOMB CORE IS DAMAGED)
- USE BMS 5-121 POSITIONING FABRIC WITH BMS 5-101 TYPE II FILM ADHESIVE OR USE BMS 5-137 TYPE II FILM ADHESIVE.

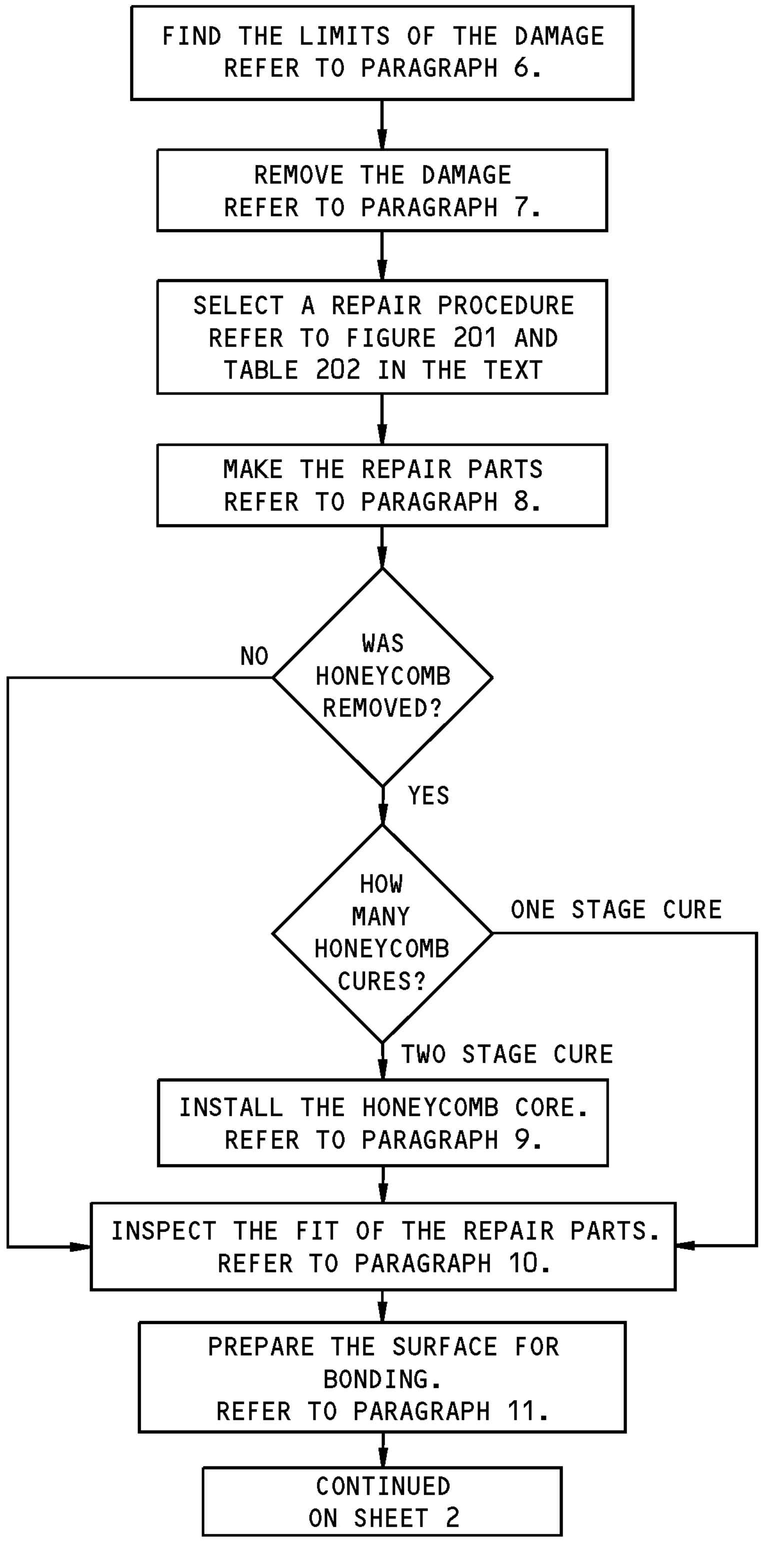
7 UNLESS SPECIFIED DIFFERENTLY IN THE SPECIFIC COMPONENT REPAIR SECTION.

8 LARGER DAMAGE CAN BE REPAIRED IF YOU DO ALL OF THE FOLLOWING:

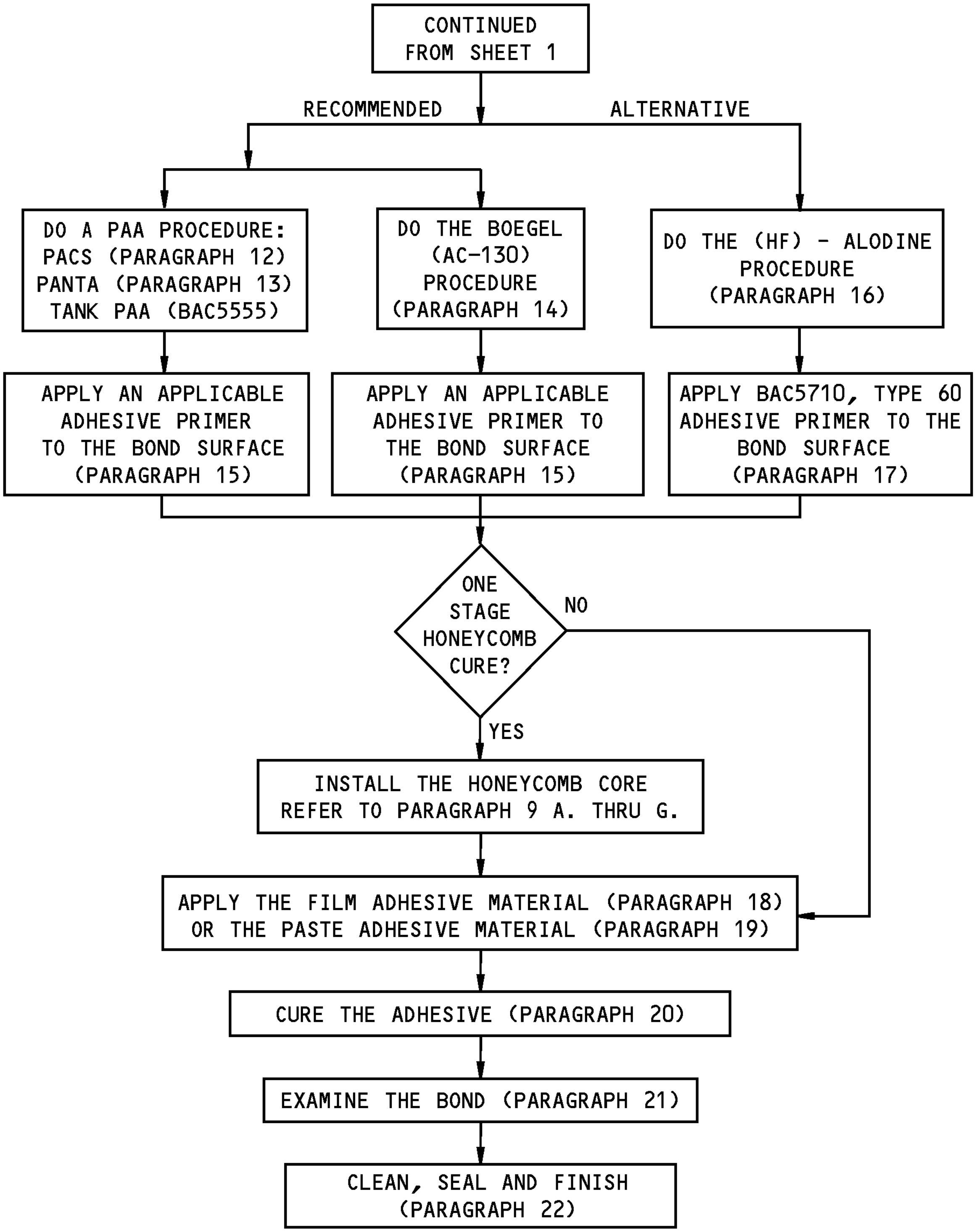
- GET AN ENGINEERING REVIEW
- USE APPROVED ENGINEERING DRAWINGS FOR THE COMPONENT
- USE APPROVED MATERIALS AND MANUFACTURING PROCESSES SPECIFIED IN THE COMPONENT ENGINEERING DRAWINGS.

9 BMS 5-92, TYPE V AND BMS 5-141 ARE PERMITTED IN BOTH INTERIM AND PERMANENT REPAIRS. BMS 5-92, TYPE I IS ONLY PERMITTED IN INTERIM REPAIRS.

Repair Options
Figure 201 (Sheet 2 of 2)



Flow Chart of the Repair Steps
Figure 202 (Sheet 1 of 2)



Flow Chart of the Repair Steps
Figure 202 (Sheet 2 of 2)

6. **Find the Limits of the Damage**

A. Examine the damage in the repair area.

WARNING: DO NOT GET SOLVENTS IN YOUR MOUTH, YOUR EYES, OR ON YOUR SKIN. DO NOT BREATHE THE FUMES FROM SOLVENTS. SOLVENTS ARE DANGEROUS MATERIALS. SOLVENTS CAN BE FLAMMABLE OR CAUSE DAMAGE TO THE ENVIRONMENT. REFER TO THE MATERIAL SAFETY DATA SHEETS (MSDS) AND THE LOCAL SAFETY PRECAUTIONS.

(1) Clean the damaged area with a soft cloth moist with cleaning solvent. Refer to SOPM 20-30-03 for the applicable cleaning solvent and general cleaning procedures.

CAUTION: USE NON-DESTRUCTIVE PROCEDURES TO MAKE SURE THAT THERE IS NO WATER TRAPPED IN THE PART BEFORE YOU APPLY HEAT TO CURE THE ADHESIVES. DAMAGE TO THE PART WILL OCCUR IF THE WATER IS NOT REMOVED.

(2) Do a visual and NDI examination of the damaged area to find disbonds and other types of damage to the structure.

NOTE: Refer to 737 NDT Part 1, 51-04-00 for instrumented NDI procedures, or 737 NDT Part 1, 51-05-01 for tap test procedures.

B. Examine the initial adhesive primer (if applicable).

(1) It is not necessary to remove the initial adhesive primer from the bond surface if the primer has the conditions that follow:

(a) There is no contamination from paints, oils, chemicals, or other unwanted materials.

(b) You are repairing a part that was initially manufactured with BMS5-101 film adhesive and you will be using BMS5-101 film adhesive to repair the damage.

(c) You are repairing a part that was initially manufactured with BMS5-137 film adhesive and you will be using BMS5-137 to repair the damage.

(d) Metal-to-metal bonding - there are no scratches or missing primer that:

1) Show more than 0.1 square inch (65 square mm) of bare metal.

2) Are more than 0.5 inch (13 mm) in length.

3) Are less than 0.5 inch (13 mm) from an edge.

4) Are less than 3.0 inches (75 mm) (edge-to-edge) apart.

(e) Core-to-skin bonding - there are no scratches or missing primer that:

1) Show more than 2.0 square inches (13 square cm) of bare metal at each location.

2) Show more than a cumulative total area of bare metal of 4.0 square inches (26 square cm).

3) Are less than 6.0 inches (150 mm) (edge-to-edge) apart.

NOTE: A group of bare metal areas in a 2.0 square inch (13 square cm) area can be specified as one bare metal area. A group must then be 6.0 inches (150 mm) (edge-to-edge) from a different bare area or group.

(2) In these small areas where there is bare metal or missing primer, do the steps that follow:

(a) Clean the bare metal. Refer to SOPM 20-30-03 for the applicable solvents.

(b) Apply adhesive primer to the bare metal as given in Paragraph 15./REPAIR GENERAL or Paragraph 17./REPAIR GENERAL.

(3) If more adhesive primer is damaged or removed than is permitted, then do step (a) or step (b), below, as applicable.

(a) If the damaged primer is on an outside surface (not a surface where there was honeycomb core removed) then you can remove the primer and do one of the surface preparations specified in Paragraph 11./REPAIR GENERAL. Then apply an applicable adhesive primer as specified in Paragraph 15./REPAIR GENERAL or Paragraph 17./REPAIR GENERAL.

(b) If the damaged primer is on an inside surface (where honeycomb core was removed), then do the steps that follow:

1) Remove the damaged primer. Do not remove more primer than is necessary.

2) Do a Boegel surface preparation procedure as specified in Paragraph 14./REPAIR GENERAL.

3) Apply an applicable adhesive primer as specified in Paragraph 15./REPAIR GENERAL.

7. Remove the Damage

NOTE: Use a table or special tool to keep the part in the correct shape if you remove large areas of damage.

A. Remove the damaged skin from the repair area.

NOTE: As an alternative, you can do a surface preparation and apply the adhesive primer on the surface before you remove the damage. Make sure that you prepare an area that is larger than the necessary minimum bond area. This will give you a sufficient bond area if the removed damage is larger than the NDI indication.

WARNING: DO NOT USE EQUIPMENT THAT CAN CAUSE AN ARC OR A SPARK IN AN AREA WHERE THE IGNITION OF FUMES IS POSSIBLE. IF YOU DO, AN EXPLOSION CAN BE THE RESULT.

(1) If the aluminum skin is damaged or has disbonded areas, do the procedure that follows:

(a) Cut and remove the damaged skin in the disbonded areas.

(b) Separate the bonded structures (if applicable and necessary). Refer to Figure 203/REPAIR GENERAL for the steps that follow:

1) Make the wedge(s).

2) Use polyester tape to attach an approximately 0.02-0.06 inch (0.5-1.5 mm) thick metal or plastic sheet adjacent to the bonded area.

WARNING: USE DRY ICE OR COMPRESSED CARBON DIOXIDE GAS ONLY IN AN AREA WHERE THERE IS A SATISFACTORY FLOW OF AIR. HIGH LEVELS OF CARBON DIOXIDE CAN CAUSE INJURY. WEAR PROTECTIVE GLOVES. IF DRY ICE TOUCHES YOUR SKIN OR EYES, GET MEDICAL AID IMMEDIATELY.

3) Push the wedge(s) between the bonded structures. Lightly tap the wedge(s) if necessary.

a) If problems occur, you can apply heat, dry ice (solid carbon dioxide), compressed carbon dioxide gas, or liquid nitrogen to the bond area.

NOTE: Very cold temperature will make the adhesive resin brittle and easier to separate the skins.

(c) Do a check to see if the bond is weak along the perimeter of the area to be repaired.

NOTE: Instrumented Non-destructive Inspection (NDI) procedures will not always find a bond that is weak but not broken.

1) Pull carefully on the edge of the skin to see if the bond will break.

2) If the bond is easily broken, then continue to remove the skin until the bonds are not easily broken.

(2) Remove all the nicks, scratches, gouges, burrs, sharp edges, corrosion and other unwanted material to a smooth surface. If you remove more than 10% of a sheet thickness, do one of the steps that follow:

(a) If the depth of the removed damage is less than 80% of the sheet thickness, refer to REPAIR 2.

(b) If the depth of the removed damage is more than 80% of the sheet thickness, cut out the damage. Refer to REPAIR 4.

NOTE: A facesheet (skin) can have more than one sheet bonded together. Be careful not to cause damage to the sheet(s) below the damaged sheet(s).

(3) Examine the damaged area for signs of water, oil, fuel, dirt or other contamination in the honeycomb. Remove all fluids, dirt and other contamination.

(a) Use a vacuum or oil-free compressed air to remove water.

(b) Dry the honeycomb core. You can heat the core or use hot air at the wet area for 1 hour (minimum) at 150°F (77°C). Make sure that the temperature does not increase more than 5°F (3°C) a minute. Dry again if necessary.

WARNING: DO NOT GET SOLVENTS IN YOUR MOUTH, YOUR EYES, OR ON YOUR SKIN. DO NOT BREATHE THE FUMES FROM SOLVENTS. SOLVENTS ARE DANGEROUS MATERIALS. SOLVENTS CAN BE FLAMMABLE OR CAUSE DAMAGE TO THE ENVIRONMENT. REFER TO THE MATERIAL SAFETY DATA SHEETS (MSDS) AND THE LOCAL SAFETY PRECAUTIONS.

(c) If a honeycomb core has oil in it, then spray on MEK, MIBK, MPK, or acetone solvent to remove the contamination. Be careful to prevent damage to the adhesive on the opposite skin. Immediately remove the solvent from the core. Let the core become completely dry.

(4) If you are repairing a crack you can do a stop-drill procedure or cut out the damage with a 0.25 inch (6 mm) minimum diameter router bit. Refer to 51-10-02, GENERAL and REPAIR 2 for the stop drill procedure.

(5) For small damage that has a 1.0 inch (25 mm) diameter or less, cut out the damage to a circular shape. Then put BMS5-28 Type 6 or 7 potting compound or BMS5-101 Type III liquid pourcoat adhesive in the hole. Refer to Table 203/REPAIR GENERAL and REPAIR 2.

B. If the aluminum honeycomb core is damaged, do one of the procedures that follow:

NOTE: If the opposite skin is not damaged, be careful to not cut into the opposite aluminum skin. Also, do not cause the bond area to get hot when you use the router.

(1) Full depth core damage:

(a) Remove all of the damaged core.

(b) Lightly abrade the adhesive surface at the bottom of the hole (where the core was).

NOTE: It is not necessary to remove all of the adhesive from the opposite facesheet unless it is in an unsatisfactory condition. The adhesive is unsatisfactory if it has damage from water or other fluids, or if bare metal shows.

(c) Use a vacuum cleaning device to remove dust and particles of the core from the adhesive surface.

(2) For core damage of partial depth, use a septum. See REPAIR 3 for repairs that use a septum.

C. Make all the corners of large cutouts in skins and honeycomb sandwich facesheets a minimum of 1.0 inch (25 mm) radius.

D. If you removed skin from above an open core (no core replacement), use a vacuum to remove dust and particles from the open core.

E. Refer to the component engineering drawings or use NDI procedures to find the locations of internal doublers and other repairs. Refer to REPAIR 4 for the doubler thicknesses and overlaps to use when cutouts are near a panel edgeband.

8. Make the repair parts

WARNING: USE ONLY EXPLOSION-PROOF EQUIPMENT WHEN YOU DO THESE TYPES OF REPAIRS. IF YOU DO NOT, PERSONAL INJURY AND DAMAGE TO ADJACENT EQUIPMENT CAN BE THE RESULT. WHEN YOU WORK WITH FLAMABLE MATERIALS, HEAT, FIRE OR SPARKS CAN CAUSE AN EXPLOSION.

A. Make the repair doublers and fillers from material that is the same or an equivalent alloy material and heat treatment as the initial skin. Refer to 51-30-01, GENERAL for the approved substitution materials.

(1) Do not make doublers and fillers from 7000 series aluminum that are clad on both sides. You can use 7000 series aluminum repair parts that are non-clad on one or both sides. Refer to the SRM Identification section, Boeing drawings, or do the clad penetration test as specified in 51-10-02, GENERAL.

NOTE: This procedure will only let you bond on a non-clad side of a 7000 series aluminum part. Do not use 7000 series aluminum fillers and internal doublers if a side is clad.

(2) As an alternative to the surface preparation and primer application steps in Paragraph 11./REPAIR GENERAL through Paragraph 17./REPAIR GENERAL, you can make your repair doublers and fillers from pre-primed aluminum (aluminum that has the correct surface preparation and adhesive primer on it).

(3) For flush repairs, refer to Figure 208/REPAIR GENERAL for the thickness and dimensions of the repair parts.

(4) For external doubler (non-flush) repairs, refer to Figure 209/REPAIR GENERAL for the thickness and dimensions of the repair parts. Make a chamfer around the edges of external repair doublers that are 0.032 or thicker gage. Refer to Figure 213/REPAIR GENERAL.

(5) Remove all the nicks, scratches, gouges, burrs, sharp edges, and other unwanted material from the repair doublers and fillers.

B. If a core repair plug is necessary, do the steps that follow:

(1) Use the same Boeing Material Specification (BMS) material or equivalent BMS-type and alloy as the initial core material.

NOTE: You can increase the durability of the repair if you purchase and use core that is phosphoric acid anodized (BMS4-4 Class NPA, for example).

(a) You can use the same grade or a one grade higher density core than the initial core material.

(b) If necessary, you can make a full depth core from two pieces that are less than full depth. Refer to REPAIR 3 for a repair that uses a septum to make a full depth core from two pieces.

(c) If necessary, you can make a partial depth core if you use a septum. Refer to REPAIR 3 for a repair that uses a septum to make a partial depth core.

(2) Make the repair core so that it has the same shape and size as the hole. Make sure that the core can be installed with the same ribbon direction as the initial core. Refer to Figure 210/REPAIR GENERAL for flushness and alignment specifications.

NOTE: The repair core will compress and move down during the cure.

(3) Put the repair core into the hole.

(4) Measure the gap between the outer edges of the initial core and the repair core. Make sure that the gap is less than 0.1 inch (2.5 mm). If the gap is too large, then make another repair core that has the correct fit.

(5) If necessary, cut or abrade the top of the core plug until the core height is –0.00 to +0.005 inch (–0.00 to +0.13 mm) above:

NOTE: If the two stage cure procedure will be used, you can wait until after the first stage is completed to sand the core.

(a) The surface of the adjacent core (when the skin has been removed from above an area of core that will not be replaced), or

(b) The undamaged skin (when the edge the undamaged core is adjacent to the edge of the undamaged skin).

(6) Carefully remove the repair core plug from the hole.

(7) Remove all the burrs and other unwanted material from the repair core.

(8) Use a vacuum cleaning device to remove all the dust and particles from the repair core.

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C. Clean the repair doublers and fillers that do not have primer applied to the surface.

D. Clean the aluminum honeycomb repair core, if used. Make sure that all unwanted materials are removed. Do a vapor de-grease as given in SOPM 20-30-03 or flush the honeycomb core with Series 97 solvent as given in SOPM 20-30-97.

NOTE: To flush the core with solvent, put the core fully into the solvent and leave it for a minimum of 30 seconds. Remove it and let it dry fully. The time to dry fully is approximately 1 hour.

E. Prepare the core mating surfaces.

(1) Abrade the adhesive layer at the bottom of the hole in the initial core to make the surface rough. Use Scotch Brite, Type A, No. 180 or finer pads (or the equivalent).

NOTE: If the adhesive is damaged, then look to see if the adhesive primer is also damaged. Refer to Paragraph 6.B./REPAIR GENERAL.

(2) Clean the mating surfaces of the initial core, repair core, and the facesheet at the bottom of the hole with a cleaning solvent. Refer to SOPM 20-30-03 for the applicable solvents.

(3) Continue to clean the surfaces until a new moist cloth is clean after it is used. Remove the solvent before it can dry.

(4) Do an inspection of the cleaned repair area. The area must show no signs of a glossy surface.

9. Installation of the Honeycomb Repair Core

NOTE: The steps that follow are applicable for the one-stage and two-stage cure procedures.

A. If you do the one-stage cure repair, then do a surface preparation as specified in Paragraph 11./REPAIR GENERAL. Then do the honeycomb installation procedure.

B. If you cut out damage through the top and bottom facesheets, then put the repair doubler(s) and filler(s) on one of the facesheets before you install the core. Refer to Figure 208/REPAIR GENERAL and Figure 209/REPAIR GENERAL.

C. If you are doing a core repair that is less than full depth, or if you make a thick core from two thin cores, then use a septum. Refer to REPAIR 3 for septumized core repairs.

D. To bond the repair core mating surfaces, you can use foaming adhesive, two-part paste adhesive, or potting compound. Refer to Table 203/REPAIR GENERAL for data on the adhesive materials.

Table 203: Cure Instructions for the Adhesives and Potting Compounds to Make a Core Repair

RESIN TYPE (RESIN USE)	POT LIFE	MINIMUM CURE TIME	CURE TEMPERATURE
BMS5-28, Type 6 or 7 (Potting Compound)	60 Minutes	90 Minutes	250° to 270°F (121° to 132°C)
		80 Minutes	290° to 310°F (143° to 154°C)
		60 Minutes	340° to 360°F (171° to 182° C)
BMS5-90, Type III, Class 1, Grade 50 or Grade 100 (Foaming Adhesive)	Not Applicable	90 Minutes	225° to 260°F (107° to 127°C)
		80 Minutes	280° to 310°F (138° to 154°C)
		60 Minutes	325° to 350°F (163° to 177° C)
BMS5-92, Type I, or V (Two-part Paste Adhesive)	Figure 211/REPAIR GENERAL	Figure 211/REPAIR GENERAL	Figure 211/REPAIR GENERAL
BMS5-101, Type III (Liquid Pour Coat Adhesive)	Not Applicable	90 Minutes	225° to 260°F (107° to 127°C)
BMS5-141 (Two-Part Paste Adhesive)	60 Minutes	Figure 212/REPAIR GENERAL	Figure 212/REPAIR GENERAL

NOTE: Before you open the film adhesive or a foaming adhesive container, let the adhesive stay at a temperature of 60°F to 80°F (16°C to 26°C). You can use the adhesive after there is no condensation.

E. To bond the core to the facesheet or repair doubler, you can use a film adhesive or a two-part paste adhesive. Refer to Paragraph 18./REPAIR GENERAL or Paragraph 19./REPAIR GENERAL for data on the adhesive materials.

F. Core Installation Options.

(1) The procedure in Paragraph 9.G.(1)/REPAIR GENERAL shows how to install the repair core with film adhesive and BMS5-90, Type III, Class 1, Grade 50 or 100 foaming adhesive.

(2) The procedure in Paragraph 9.G.(2)/REPAIR GENERAL shows how to install the repair core with film adhesive and BMS5-28 Type 6 of 7 potting compound.

(3) The procedure in Paragraph 9.G.(3)/REPAIR GENERAL shows how to install the repair core with BMS5-92 or BMS5-141 two-part paste adhesive.

(4) The procedure in Paragraph 9.G.(4)/REPAIR GENERAL shows how to seal a square edge with BMS5-101, Type III liquid pourcoat adhesive.

G. Core installation procedures.

NOTE: If you will not be able to apply heat to each side of the honeycomb panel, then put a thermocouple in the bottom of the hole. See the example in Figure 210/REPAIR GENERAL and Figure 215/REPAIR GENERAL Detail A for the one stage honeycomb repair configuration.

(1) Foaming adhesive core splice procedure. Do the steps that follow to install a repair core with film adhesive, and with BMS5-90, Type III, Class 1, Grade 50 or Grade 100 foaming adhesive.

(a) Prepare the facesheet before you bond the core.

1) Use one of the film adhesive Grades that follow:

NOTE: Use BMS5-101, Type II film adhesive for 250°F (121°C) cure applications. Use BMS5-137, Type II, Class 1 (EA 9657 only) film adhesive for 310°F (154°C) cure applications. Use BMS5-137, Type II, Class 1 (all qualified products can be used) for 350°F (177°C) cure applications.

- three plies of Grade 5, or
- two plies of Grade 10, or
- one ply of Grade 15

2) Cut the film adhesive to the same dimensions as the bottom surface of the repair core.

3) Put the ply (or plies) of film adhesive at the bottom of the hole in the initial core.

a) Remove the separator sheet from each film adhesive ply.

b) If one-side tacky (OST) adhesive is used, (adhesive that has the mat carrier cloth on one of the outer surfaces), put the non-tacky (cloth) side against the bottom of the repair core.

4) Push the adhesive smoothly and tightly in place. Do not trap air between the adhesive plies and the skin or repair doubler at the bottom of the hole.

(b) Cut a piece of BMS5-90, Type III or IV Class 1, Grade 50 or Grade 100 foaming adhesive.

NOTE: BMS5-90 Type IV extrudable adhesive is an alternative that can be used in a pressurized autoclave.

1) Cut the adhesive to a sufficient length to wind fully around the inner cell wall splice surfaces (of the hole in the initial core).

NOTE: Cut the BMS5-90, Type III, foaming adhesive to make each end attach in a butt-joint. You are also permitted to have a maximum 1/8 inch (3 mm) overlap.

2) If the adhesive has a separator sheet on each side, then remove one of them now. Keep the tacky side against the cell walls in the hole.

3) Wind the foaming adhesive around the inside of the hole in the initial core. Make sure that the adhesive touches all of the core splice surfaces.

4) Remove the separator sheet from the open side of the adhesive.

NOTE: The adhesive must fill a minimum of 3/4 of the clearance between the initial core and the repair core. If necessary, you can apply more than one layer of the BMS5-90 adhesive material to the repair core.

(c) Align the ribbon direction of the repair core in the same direction as the core to be repaired. Put the repair core inside the hole.

NOTE: The maximum error permitted is ±5 degrees in the vertical direction and the ribbon direction. See Figure 210/REPAIR GENERAL.

1) Make sure that the repair core plug is pushed into the adhesive at the bottom of the hole.

(2) Potting compound core splice procedure. Do the steps that follow to install a repair core with the adhesive film and BMS5-28, Type 6 or 7 potting compound.

(a) Prepare the facesheet for bonding the core.

1) Use one of the film adhesive Grades that follow:

NOTE: Use BMS5-101, Type II film adhesive for 250°F (121°C) cure applications. Use BMS5-137, Type II, Class 1 (EA 9657 only) film adhesive for 310°F (154°C) cure applications. Use BMS5-137, Type II, Class 1 (all qualified products can be used) for 350°F (177°C) cure applications.

- three plies of Grade 5, or
- two plies of Grade 10, or
- one ply of Grade 15.

2) Cut the film adhesive to the same dimension as the bottom surface of the repair core.

3) Put the ply (or plies) of film adhesive at the bottom of the hole in the initial core.

a) Remove the separator sheet from each film adhesive ply.

b) If one-side tacky (OST) adhesive is used, (adhesive that has the mat carrier cloth on one of the outer surfaces), put the non-tacky (cloth) side against the bottom of the repair core.

(b) Apply a sufficient quantity of BMS5-28, Type 6 or 7 potting compound to the mating sides of the initial and repair cores. The potting compound must fill all of the area between the repair core and the core to be repaired.

(c) Align the ribbon direction of the repair core in the same direction as the core to be repaired. Put the repair core inside the hole.

NOTE: The maximum error permitted is ±5 degrees in the vertical direction and the ribbon direction. See Figure 210/REPAIR GENERAL.

1) Make sure that the repair core has a tight interference in the core hole.

2) Make sure that the repair core plug is pushed into the adhesive at the bottom of the hole.

(3) Paste adhesive core splice and core to skin bond procedure. Do the steps that follow to install a repair core with BMS5-92, Type I or V, or BMS5-141 two-part paste adhesive.

(a) The edges of the repair core must be a minimum of 2.0 inches (50 mm) from attached fittings. The repair core must also be a minimum of 2.0 inches (50 mm) from the outer edges of the initial core.

(b) Prepare the facesheet for bonding the core. Apply a 0.04 to 0.08 inch (1.0 to 2.0 mm) thick layer of adhesive to the first surface that the core will be bonded to.

NOTE: Example: at the bottom of the hole in the initial core. As an alternative, you can wet two plies of BMS9-3 Type H-2 or H-3 dry glass fabric with the paste adhesive and put them in the bottom of the hole.

(c) Apply a sufficient quantity of adhesive to the mating sides of the initial and repair cores. The adhesive thickness must fill all of the area between the repair core and the core to be repaired.

(d) Align the ribbon direction of the repair core in the same direction as the core to be repaired. Put the repair core into the core hole.

NOTE: The maximum error permitted is ±5 degrees in the vertical direction and the ribbon direction. See Figure 210/REPAIR GENERAL.

1) Make sure that the repair core has a tight interference in the core hole.

2) Make sure that the repair core plug is pushed into the adhesive at the bottom of the hole.

(4) Seal procedure for a square edge panel assembly.

NOTE: Figure 202/REPAIR 4 shows examples of square edges of honeycomb core that are sealed.

(a) If PAA core is used, you can put BMS5-95 sealant on the open edges after the repair to the honeycomb panel is completed.

(b) On bare, unsealed edges of aluminum core, apply BMS5-101, Type III, liquid pourcoat adhesive to seal the square edge. Do what follows:

1) Clean the repair core again.

2) Measure 3 to 6 core cells in from the perimeter edge of the repair core. Apply the BMS5-101, Type III liquid pourcoat adhesive on the applicable cells of the repair core. You can dip the core cells into the adhesive or pour the adhesive on to the core cells.

NOTE: If you use the pour procedure, apply the adhesive to one side of the repair core first. Turn the core over and apply other side. Make sure that the adhesive fully covers the cell walls.

3) Put the repair core on clean, absorbent, oil-free paper.

NOTE: After the adhesive is applied, you have less than 3 minutes to drain the extra liquid adhesive from the cells.

a) If there is too much liquid adhesive in the core cells, let the extra adhesive drain away.

b) After the extra liquid adhesive has drained away, put the repair core on another clean oil-free paper to help the extra liquid adhesive continue to drain.

4) Let the repair core air-dry at ambient temperature on a clean oil-free paper for 30 to 40 minutes.

5) After the air dry time, oven dry the BMS5-101, Type III at 180°F to 190°F (82°C to 88°C) for 30 to 35 minutes before you install the repair core.

NOTE: Protect the core from contamination.

H. Two-stage honeycomb core cure repair procedure. Refer to Figure 210/REPAIR GENERAL for the steps that follow:

NOTE: If you do a one-stage honeycomb core cure repair procedure, then the steps that follow are not necessary. If the area to be repaired is 64 square inches (410 square cm) or more, then the two-stage cure is necessary. If a verifilm test is necessary, you can do the test at the same time that you cure the core. Refer to Paragraph 10.C./REPAIR GENERAL for the verifilm procedure.

(1) Bagging procedure:

(a) Put thermocouples at the edges of the core.

(b) Find a heat blanket that is larger, than the replacement core.

1) The heat blanket must be sufficient to extend 2.0 inches (50 mm) or more, from the edges of the replacement core.

2) Use the dimensions of the blanket to find the correct dimensions of the layup and vacuum bag materials.

(c) Cut a layer of perforated FEP release film to the same dimensions as the heat blanket. Put the release film on the open replacement core. Make sure that the edges of the release film are an equal distance from the edges of the replacement core.

(d) Cut a layer of dry peel ply or fiberglass bleeder material that is 2.0 inches (50 mm) larger, all around, than the dimensions of the heat blanket. Put the peel ply (or bleeder) on the perforated FEP. Make sure that the edges of the peel ply (bleeder) extend 2.0 inches (50 mm) from the edges of the FEP.

(e) Cut a layer of solid FEP release film, to the same dimension as the heat blanket. Put the release film on the peel ply (bleeder). Make sure that the edges of the release film are an equal distance from the edges of the dry peel ply (bleeder).

(f) Cut a layer of dry peel ply material that is 2.0 inches (50 mm) larger, all around, than the dimensions of the heat blanket. Put the peel ply on the solid FEP. Make sure that the edges of the peel ply extend 2.0 inches (50 mm) from the edges of the FEP.

(g) Put the heat blanket on the peel ply. Make sure that the edges of the heat blanket are an equal distance from the edges of the peel ply.

(h) You can put a thermocouple on the heat blanket (optional). If the heat blanket gets too hot, you can turn off the power before you damage the skin panel.

(i) If the heat blanket extends more than 3.0 inches (75 mm) from the edge of the cutout, you can do this recommended procedure:

NOTE: If a heat blanket gets too hot, it can cause damage to the repair and to the adhesive in the undamaged skin. To help prevent damage (if the heat blanket gets too hot), do not let the heat blanket touch more skin than is necessary. Insulation between the heat blanket and the skin is recommended.

1) Put the edge of the insulation 2.0 to 3.0 inches (50 to 75 mm) from the edge of the cutout in the top facesheet.

2) Let the insulation material extend to the end of the heat blanket (at a minimum).

(j) Put four to six layers of glass fabric (or two layers of 0.04 inch (1.0 mm) breather fabric, or one layer of 0.1 inch (2.5 mm) breather fabric) above the heat blanket as a breather. Make sure that the breather is sufficient to extend from the edges of the heat blanket.

(k) Put a vacuum base above the fiberglass breather cloth for each vacuum port and vacuum gage port.

(l) Put on the vacuum bag sealant.

(m) Make a hole in the outer vacuum bag at the vacuum base location for each vacuum port and vacuum gage port.

(n) Put the vacuum bag film on the repair area.

(o) Connect the vacuum port and vacuum gage ports to their vacuum bases.

(p) If necessary, put insulation material on the outer surface of the vacuum bag.

(2) Cure the repair.

(a) Refer to Table 203/REPAIR GENERAL for the cure instructions.

(b) When the cure time is completed, decrease the temperature at a rate of 5°F (3°C) a minute.

(3) When the temperature is less than 125°F (52°C), release the vacuum pressure and remove the vacuum bag equipment.

(4) Remove the thermocouple wires from the repair area.

NOTE: Part of the thermocouple wires can stay in the cured adhesive if you cannot remove them. Cut the thermocouple wires so that the ends of the wires are below the surface of the core.

(5) Abrade the top of the core until it is flush with the top of the adjacent core or skin (that which applies). Refer to Figure 210/REPAIR GENERAL.

(6) Use a vacuum cleaning device to remove dust and particles from the open core and the repair area.

(7) Do a visual inspection of the core splice. If you see areas that are not bonded, then fill the voids with a core splice adhesive or potting compound. Measure the length of the filled areas.

(a) If the total cumulative length of the filled areas is more than 2.0 inches (50 mm), then cure the core splice material and do Paragraph 9.H.(5)/REPAIR GENERAL through Paragraph 9.H.(7)/REPAIR GENERAL again.

(b) If the total cumulative length of the filled areas is 2.0 inches (50 mm) or less, then do all of the applicable steps that remain in this procedure.

10. Inspect the fit of the repair parts

A. See if light finger pressure can make all the areas of the repair part touch the surface to be bonded.

B. Examine and measure the bondline for all repair doublers that have an area of 64 square inches (410 square cm) or more.

(1) The verifilm test is a satisfactory procedure to make sure that you have the permitted bondline thickness. Other procedures are permitted if you can make sure that the bondline thickness is satisfactory.

C. If you do a verifilm test, do the steps that follow:

(1) Put a ply of 0.001 or 0.002 inch (0.025 or 0.050 mm) non-perforated FEP release film above the repair area.

NOTE: If there is open honeycomb core, use 0.004-0.007 inch (0.10 to 0.18 mm) thick PVC film. You can use a different material if:

- It does not cause contamination of the core, and
- It will let the honeycomb pattern (from the honeycomb core) show on the adhesive.

(2) Put on to the release film the same adhesive type that you use to do the repair.

NOTE: If a paste adhesive is used, make sure that you apply the adhesive at a constant thickness. If a film adhesive is used, make sure that you use the same number of plies and the same grade that you use in the repair.

(3) Put a ply of nonperforated FEP release film or PVC film above the adhesive.

(4) Put the repair doublers and fillers on the release film the same as you do for the repair.

(5) Apply a vacuum bag and cure the adhesive as specified in Paragraph 18./REPAIR GENERAL. You are permitted to cure the adhesive for half of the time specified for the repair.

(6) After the verifilm check is completed, disassemble the parts and do a visual inspection of the cured adhesive.

(a) Make sure that you have a bondline thickness for BMS5-101 of between 0.002 and 0.020 inch (0.05 to 0.50 mm). Make sure that you have a bondline thickness for BMS5-137 of between 0.002 and 0.030 inch (0.05 to 0.76 mm).

(b) Make sure that the parts did not move during the cure.

(c) Make the sure that there are no voids that are larger than 0.10 inch (2.5 mm) in diameter.

(d) If there is open honeycomb core, make sure that you can clearly see the honeycomb pattern on the adhesive for all of the open core. Make sure that the core is not crushed.

(7) If the test is satisfactory, then discard the cured adhesive and the used release film materials. If the test is not satisfactory, then do one or more of the steps that follow:

(a) Repeat the verifilm test with an additional ply of Grade 5 or 10 film adhesive. If the test is satisfactory, make sure that you use the same number of plies of adhesive and the same grades when you do the repair.

(b) Repeat the verifilm test with weight or pressure added. If the test is satisfactory, make sure that you use the same weight or pressure when you do the repair.

(c) Check the shape and fit-up of the repair parts. Adjust if necessary, and then repeat the verifilm test.

(d) Ask Boeing for help if necessary.

D. Apply the adhesive as given in Paragraph 18./REPAIR GENERAL or Paragraph 19./REPAIR GENERAL.

11. Use of the Surface Preparation Procedures

CAUTION: DO NOT BOND A CLAD SURFACE OF A CLAD 7000 SERIES ALUMINUM PART. THE RESULT CAN BE CORROSION AT THE BOND INTERFACE OF THE REPAIR.

A. Do a surface preparation procedure only on aluminum surfaces that are not primed. Remove all unwanted primer and other material before you continue with the procedure.

NOTE: Boeing does not recommend that you use phosphoric acid or Hydrofluoric Acid (HF) Alodine to prepare an interior surface at the bottom of a hole in a honeycomb core. These chemicals are difficult to completely remove, and the residue can cause corrosion. Use the Boegel surface preparation procedure or cut out the skin to the same dimension as the hole and then do a two sided skin repair.

B. Refer to Figure 201/REPAIR GENERAL for the permitted repair size limit for each surface preparation procedure.

NOTE: These procedures prepare the aluminum surfaces for metal-to-metal bonding and bonding metal face sheets to aluminum honeycomb core.

C. Phosphoric Acid Anodized (PAA) aluminum gives the best surface preparation for bonding. You can get PAA repair parts from the list that follows:

(1) Purchase parts that come with the PAA surface and the adhesive primer on them.

(2) Do a tank PAA procedure as specified in Boeing Process Specification BAC5555 ''Phosphoric Acid Anodizing of Aluminum for Structural Bonding''.

(3) Do the PACS or PANTA surface preparation procedure.

D. The PACS and PANTA procedures are PAA alternatives to tank PAA procedures to prepare an aluminum surface for bonding. Refer to Paragraph 12./REPAIR GENERAL for the PACS procedure and Paragraph 13./REPAIR GENERAL for the PANTA procedure.

E. As an alternative to the PANTA or PACS procedures, you can use the Boegel (AC-130) procedure. Refer to Paragraph 14./REPAIR GENERAL for the Boegel procedure.

F. The Hydrofluoric Acid (HF) - Alodine procedure can only be used for small, interim repairs. Refer to Paragraph 16./REPAIR GENERAL for the HF-Alodine procedure.

12. The Phosphoric Acid Containment System (PACS) Procedure

NOTE: The Phosphoric Acid Containment System (PACS) procedure is covered by U.S. patent numbers 4,882,016 and 4,988,414 and other patent applications assigned to The Boeing Company. Repair stations that have Boeing licenses and operators of Boeing aircraft are permitted to use this procedure. For data regarding licensing for non-Boeing applications, call the Chief Patent Counsel, The Boeing Company.

A. The necessary PACS materials are:

(1) Phosphoric Acid, 75-80% (by weight), as given in Federal Specification A-A-55820

(2) Copper Wire

(3) Corrosion Resistant Steel (300 Series CRES) Wire Mesh

(4) DC Power Supply

(5) Vacuum Sealing Compound

(6) Nylon Vacuum Bag Film

(7) Solvent and Acid Resistant Tape

(8) 3M Scotch Brite Pads, Type A, Very Fine

(9) Fiberglass Breather Cloth

(10) Nylon Breather Material

(11) Aluminum Foil Tape

(12) Solid FEP

(13) Blue Litmus Paper

(14) Acetone or Methyl Propyl Ketone (MPK) Solvent

(15) Plastic Film (Mylar, acetate, polyester or equivalent plastic material)

WARNING: KEEP ACIDS AWAY FROM HEAT, FIRE, AND SPARKS. ACID FUMES ARE FLAMMABLE AND TOXIC. INJURY TO PERSONNEL CAN BE THE RESULT. DO NOT PERMIT ACIDS TO MIX WITH OTHER MATERIALS. MAKE SURE THAT THE AIR SUPPLY TO THE AREA IS NOT BLOCKED.

WARNING: USE RUBBER GLOVES, PROTECTIVE CLOTHING AND EYE PROTECTION.WHEN YOU WORK WITH PHOSPHORIC ACID. THE ACID CAN BURN YOUR EYES AND SKIN AND CAUSE INJURY. IF THE ACID TOUCHES THESE AREAS, FLUSH WITH A LARGE QUANTITY OF WATER AND GET MEDICAL AID IMMEDIATELY.

B. Make the phosphoric acid solution.

(1) Calculate how much solution is necessary.

NOTE: In this step, you have a minimum of two times as much solution than is needed for the anodize process. This is because it is necessary to have sufficient solution on the area to be anodized:

- During the time needed to get the specified voltage, and
- To make sure that the solution flows for a minimum of 20 minutes.

(a) Make sure that a minimum of 1.0 gallon (4.0 liters) of phosphoric acid solution for each 100 square inches (645 square cm) of treatment area is prepared and connected.

(b) As an alternative, you can circulate the acid and use it two times on the bond surface. Start with a minimum of 1/2 gallon (2.0 liters) of solution for each 100 square inches (645 square cm) of treatment area.

WARNING: ALWAYS ADD ACID TO WATER WHEN YOU MIX THEM. IF YOU ADD WATER TO ACID, THE ACID WILL BECOME VERY HOT AND WILL NOT BE STABLE. THIS CAN CAUSE INJURY TO PERSONS.

(2) To make the phosphoric acid solution, add 14 ± 1/3 fluid ounces (410 ± 10 ml) of 75-80% phosphoric acid to each 135 ± 2 fluid ounces (4.0 liters ± 60 ml) of distilled water.

C. Clean and abrade the repair surfaces.

WARNING: DO NOT GET SOLVENTS IN YOUR MOUTH, YOUR EYES, OR ON YOUR SKIN. DO NOT BREATHE THE FUMES FROM SOLVENTS. SOLVENTS ARE DANGEROUS MATERIALS. SOLVENTS CAN BE FLAMMABLE OR CAUSE DAMAGE TO THE ENVIRONMENT. REFER TO THE MATERIAL SAFETY DATA SHEETS (MSDS) AND THE LOCAL SAFETY PRECAUTIONS.

(1) Do a solvent wipe with MPK or acetone as given in SOPM 20-30-03.

(2) Abrade the surfaces with Scotch Brite, Type A, very fine pads or a high grade alumina sand paper (180-grit or finer). The metal surface will look clean when you finish this step of the process.

(3) Remove the unwanted abrasive particles from the surface. Use clean, dry air or nitrogen.

(4) Do a solvent wipe with MPK or acetone as given in SOPM 20-30-03.

(5) Isolate the mechanical fasteners and all the areas that are not damaged. Use aluminum foil tape or a combination of aluminum foil tape and polyethylene film (or the equivalent).

(6) Put on a mask to seal all areas where the damage goes through a skin. To make the mask: put aluminum foil tape, solid FEP or other satisfactory material on top of the honeycomb.

NOTE: If you do a one-stage repair, you can temporarily fill the hole before you put on the mask. Example: you can put the honeycomb repair core in the hole (without the core splice adhesive) or you can put in a solid plug.

(7) Flush with clean water. You can also wipe with a clean, wet, lint-free cloth until no residue shows on the cloth.

D. Do a visual inspection for a water-break-free surface.

(1) Flush the surface with clean (mineral-free or de-ionized) water. Do this for 30 seconds or until the surface has a continuous water film on all of the repair area.

NOTE: The preferred water temperature is between 50° and 100°F (10° and 38°C).

(2) After the flush procedure is completed, the water film on the bond surface must stay continuous for a minimum of 30 seconds.

NOTE: The water surface tension at the edges of an aluminum skin can cause the water film to pull away from the edge a small distance. This condition is permitted unless it is caused by surface contamination or incorrect abrading.

(3) If the film does not stay continuous for a minimum of 30 seconds, do Paragraph 12.C./REPAIR GENERAL and Paragraph 12.D./REPAIR GENERAL again.

E. Put a layer of plastic film (Mylar, acetate, polyester or an equivalent material) on the bench tops and other work areas. This will help to prevent the contamination of the repair parts.

F. Assemble the PACS immediately after you clean the repair surface. Refer to Figure 204/REPAIR GENERAL.

CAUTION: DO NOT USE A STAINLESS STEEL SCREEN IF IT SHOWS CORROSION OR OTHER DETERIORATION. IF YOU DO, IT IS POSSIBLE THAT THERE WILL NOT BE THE NECESSARY AMOUNT OF CURRENT FLOW THROUGH THE SCREEN.

(1) Cut a piece of the stainless steel screen to the shape and dimensions of the surface area to be anodized. Use 300 series alloy CRES with a wire gauge that is a minimum of American Wire Gauge (AWG) #20 (0.03 inch (0.8 mm) diameter) and a maximum of #14 (0.06 inch (1.5 mm) diameter).

NOTE: AWG #18 (0.04 inch (1.0 mm) diameter) is the usual type of stainless steel screen used.

(2) Make a record of the dimensions of the area to be anodized and do a calculation of the area. This data will be used later to make a calculation of the volume of acid divided by the area that was anodized.

(3) Attach conductive negative (–) cathode wire(s) to the stainless steel screen. Make sure that there is a minimum of one wire for each 30 square inches (200 square cm) of the repair area. Use a sufficient length of wire to prevent tension in the wire between the power supply and the PACS assembly. Put the same space between each of the wires.

NOTE: The negative (–) cathode wire must have a good electrical conductivity with the stainless steel screen. Make sure that the wires and clamps are sufficiently large to transmit the necessary electrical current.

(4) Cut three or four ply layers of non-woven mat breather material. Each layer must be a minimum of 1.0 inch (25 mm) larger than the stainless steel screen (to make sure that the screen will not touch the surface of the part).

(5) Put two layers of the breather material on the area to be anodized. Align each layer with each other. Make sure that the breather material extends 0.5 inch (13 mm) from each edge of the area to be anodized.

NOTE: On repair areas that are vertical or not easy to get to, use tape to attach each breather cloth layer.

CAUTION: MAKE SURE THAT THE STAINLESS STEEL SCREEN AND CATHODE WIRE DOES NOT TOUCH THE ALUMINUM REPAIR SURFACE. THE RESULT CAN BE DAMAGE TO THE PARTS.

(6) Put the screen on the breather material. Make sure that the edges of the screen are 0.5 inch (13 mm) from the edges of the breather material.

(7) Put one or two layers of breather material on the screen. (Two layers above the screen are recommended for areas larger than 64 square inches (410 square cm). Have the edges align with the edges of the breather material below.

(8) Put acid inlet tube(s) between the breather cloth layers at one edge. Do not put the inlet tube on the stainless steel screen. If you use two or more inlet tubes, put the tubes sufficiently far apart to make the surface fully wet.

NOTE: Use two or more acid solution inlet tubes for repair sizes that are larger than 64 square inches (410 square cm). This is necessary to keep the bond surface fully wet during the anodize procedure.

(9) Put the vacuum outlet tube(s) between the breather cloths at the opposite edge. Do not put the outlet tube on the stainless steel screen.

(10) Apply vacuum sealing compound on the aluminum part 1.0 inch (25 mm) or less from the edges of the breather cloth.

(11) Cut a piece of vacuum bag film that is approximately 5.0 inches (130 mm) larger than the breather cloths. Put it fully around the repair area.

(12) Remove all the wrinkles in the vacuum bag.

(13) Seal the cathode wire(s) and the inlet tube(s).

(14) Connect the outlet tube between the vacuum probe and the catch basin.

(15) Attach the three-way valve to the inlet tube(s).

(a) Turn the valve to the closed position (no flow of water or acid solution).

(b) Connect one valve line to a container with the phosphoric acid solution that you made in Paragraph 12.B./REPAIR GENERAL.

(c) Connect a second valve line to the water supply.

(16) If the surface to be anodized is vertical or face down, then Boeing recommends that you use two vacuum bags (an inner bag and an outer bag). The outer vacuum bag will contain the acid if there is leakage from the inner vacuum bag. If the surface is face up (as shown in Figure 204/REPAIR GENERAL) then the outer vacuum bag is not necessary.

(a) If the outer vacuum bag is necessary, go to Paragraph 12.F.(17)/REPAIR GENERAL.

(b) If the outer vacuum bag will not be used, then do the steps that follow:

1) Start a vacuum in the vacuum bag and seal all the leaks.

NOTE: The vacuum is through the drain line from the catch basin to the outlet tube.

2) Go to Paragraph 12.F.(18)/REPAIR GENERAL.

(17) When you use two vacuum bags, do the steps that follow:

(a) Put a minimum of four continuous plies of fiberglass breather cloth around the inner vacuum bag.

(b) Put a vacuum base above the fiberglass breather cloth.

(c) Cut a second piece of vacuum bag film for the outer vacuum bag. Make sure that it is larger than the inner bag and fiberglass breather cloth.

(d) Put the outer vacuum bag above the fiberglass breather cloth and the inner bag layup. Seal it to the metal surface. Make sure that the outer bag is sealed. Remove all the wrinkles.

NOTE: Make sure that the cathode wire, inlet tube(s), and outlet tube(s) go below the outer bag. Seal it at the edge of the bag.

(e) Make a hole in the outer vacuum bag at the vacuum base location for the vacuum port.

(f) Connect the vacuum port and vacuum gage port to the vacuum base.

(g) Start a vacuum in the inner bag and seal all the leaks.

NOTE: The vacuum is through the drain line from the catch basin to the outlet tube.

(h) Start a vacuum in the outer bag and seal all the leaks.

NOTE: The vacuum in the outer bag will hold the inner bag and the parts in their positions.

(18) Connect the wires to a DC power supply.

NOTE: Use a battery or a DC power supply as the power source for the anodizing procedure. The power source must have a capacity of 10 volts, minimum. The power source must also have a capacity of 8 amps/square foot (86 amps/square meter), minimum.

(a) Connect the negative (-) cathode wire that is attached to the stainless steel screen, to the negative lead on the power source.

(b) Connect the positive (+) anode wire to the aluminum part surface to be anodized, and to the positive (+) lead on the power source.

G. Do the PACS anodize procedure.

(1) Before you let the acid solution flow:

(a) Make a record of the initial quantity (in fluid ounces or liters, as applicable) of the acid in the container.

NOTE: This record will be necessary for the calculation in Paragraph 12.G.(9)(a)/REPAIR GENERAL.

(b) If you recycle the acid solution, you must have a procedure to measure or calculate the total quantity of solution that flowed on the bond surface.

(2) Make sure that the temperature of the acid and aluminum part stays between 70° and 85°F (21° and 29°C) during the anodizing procedure.

(3) Open the three-way valve to let the phosphoric acid solution flow from its container to the inner vacuum bag.

(a) Let a sufficient quantity of acid to flow in until the non-woven mat breather material becomes soaked. Make sure that you keep a sufficient and continuous acid solution flow rate.

(b) Use a minimum of 0.03 fluid ounce (1.0 ml) a minute for each square inch (1.5 ml a minute for each 10 square cm) to be anodized. This quantity is necessary to keep the surface fully wet.

(4) Do the steps that follow (as soon as possible) in the sequence that follows:

(a) Set the voltage and current positions to zero on the electrical power supply.

(b) Start the electrical power supply.

(c) Increase the current adjustment to the full open position.

(d) Slowly increase the voltage (approximately 5 volts for each minute) until it is between 9.5 to 10 volts (DC).

(e) Do a check of the amperage after it gets to the correct voltage.

NOTE: A fast increase in the current (more than 20% of the stable value) could be a sign that the surface is burning. Add more acid solution. If this is an unsatisfactory solution, an electrical short could be the cause. Stop the procedure and look for the problem.

1) In one minute or less, the current will become stable.

2) The current density at 9.5 to 10 volts (DC) must be in a range that is between 0.014 and 0.048 amperes/square inches (0.0022 and 0.0074 amperes/square cm).

(f) Apply the 9.5 to 10 volts (DC) for 18 to 22 minutes.

CAUTION: DO NOT LET THE ASSEMBLY BECOME DRY. THE RESULT CAN BE A BURNED SURFACE OR A SURFACE TREATMENT THAT IS UNSATISFACTORY. ADD MORE ACID AS NECESSARY TO KEEP THE SURFACE FULLY WET.

(5) Make sure that there is a steady flow of acid over all of the surface of the part during the anodizing procedure. Signs that the acid flow rate is not sufficient or signs of local dry areas are:

- An increase in current after it has stabilized, or
- A significant increase in temperature, or
- A lightening of the color of the breather cloth.

NOTE: The breather cloth will change to a darker color when it becomes soaked with the phosphoric acid.

(6) Stop the electrical power after the specified anodizing time.

(7) Quickly, make a record of the quantity of phosphoric acid that stays in the container.

NOTE: This record will be necessary for the calculation in Paragraph 12.G.(9)(a)/REPAIR GENERAL.

(8) Immediately, turn the three-way valve to let the rinse water flow from the container to the inner bag.

(a) Flush with a quantity of water equal to 0.03 fluid ounces (1.0 ml) a minute for each square inch (1.5 ml a minute for each 10 square cm) that was anodized.

(b) The rinse water must flush freely against all of the anodized surface.

(9) Flush the bag with rinse water for a minimum of 5 minutes. Do the steps that follow, while the rinse water flushes the anodized surface:

(a) Calculate the quantity of phosphoric acid that was used.

(b) Subtract the quantity of phosphoric acid (the record you made in Paragraph 12.G.(9)(a)/REPAIR GENERAL) from the initial quantity (the record you made in Paragraph 12.G.(1)/REPAIR GENERAL).

(c) Divide the volume of phosphoric acid that was used, by the area that was anodized (Use the data from the record you made in Paragraph 12.F.(2)/REPAIR GENERAL).

(d) If the calculated quantity of phosphoric acid used is less than 1/3 fluid ounce (10 ml) for each square inch (15 ml for each 10 square cm) of area that was anodized, then do Paragraph 12.G.(1)/REPAIR GENERAL through Paragraph 12.G.(7)/REPAIR GENERAL again.

(e) Stop the flow of rinse water if the calculated quantity of phosphoric acid used is sufficient.

H. Quickly, disassemble the PACS layup.

(1) Stop the vacuum and disconnect all of the tubing.

(2) Remove the outer vacuum bag and the fiberglass breather cloth. Be careful to not let contamination or other unwanted material get on the anodized surface.

NOTE: Do not touch the anodized surface with your bare skin or with gloves that have contamination on them. Do not let the adhesive tape touch the anodized surface.

(3) Remove the inner vacuum bag, the breather cloths, and the stainless steel screen layup.

(4) Discard the tape, the inner bag, the breather cloth, and the stainless steel screen in an approved container. Make sure to discard these materials by a procedure that is permitted by local health, safety, and environmental authorities.

I. Flush the anodized surface with clean (mineral-free or de-ionized) water for 5 minutes. This will remove all possible phosphoric acid solution.

NOTE: Do not wipe or rub the repair surfaces.

J. Let the anodized surface fully dry at room temperature. As an alternative, you can dry the parts with forced, clean, dry, filtered air that is a maximum of 160°F (71°C) until the surface is fully dry.

NOTE: You must apply the adhesive primer in less than 24 hours after the surface is anodized. Prevent the contamination of the anodized surface by moisture, dust, oil fumes, engine exhaust, or other unwanted material. Do not touch the dried anodized surfaces. Do not apply tape to the anodized surfaces.

K. Examine the anodized surface. You can use a Phosphoric Acid Anodize Detector (dichroscope) or do the polarized filter color inspection test that follows:

NOTE: You can purchase a Phosphoric Acid Anodize Detector (part number WCI-AD55) from West Coast Industries, Inc., 14900 Whitman Ave N, Seattle, WA 98133.

(1) Polarized filter color inspection test.

(a) Use a fluorescent light source on the anodized area.

(b) Put a polarizing filter between yourself and the treated surface and look at the reflected light (from the surface) at an angle of 5 degrees or less. It can be helpful to put the light source at a glancing angle. Refer to Figure 206/REPAIR GENERAL.

(c) While you look at the surface through the polarizing filter, turn the filter 90 degrees. A correctly anodized surface gives a constant change in color (on all areas of the anodized surface) when you look through the filter. The colors seen most frequently are purple, yellow, and green.

NOTE: It is not easy to see the colors on a rough or contoured surface. To find out if a surface is anodized correctly, change the view angle of the polarizing filter to see if the anodic coating is satisfactory.

(2) The anodize procedure is not successful if you find one or more of the conditions that follow:

(a) There are sudden changes in color as a result of stains, contamination, fingerprints, or other parts that touched the surface.

(b) There are electrical burns or pits.

(c) There are areas of the surface to be bonded that are not anodized.

(3) The surface is fully anodized if you see a constant change in color (with the polarizing filter) on all the areas of the anodized surface.

(4) If the color inspection test on a rough or contoured surface is not successful, you can do alternative tests to make sure you have a good anodized surface. Do one or more of the tests that follow:

(a) Use an ohmmeter to do a resistance test of the anodized surface. Make sure that the ohmmeter probes are clean.

1) Carefully, put the ohmmeter probes on the anodized surface. Make sure that you do not damage the anodized surface with the ohmmeter probes.

2) Carefully touch the surface with the sides of the probes first, then lay them down. If the surface has a resistance of more than 20,000 ohms (20 kohms) the test is successful.

(b) Do an infrared filter test to measure the weight of the anodize coating. Use an infrared filter device that is tuned to measure phosphoric acid anodize oxides. If the infrared filter test shows an anodized coating that is more than 20mg/square foot (215mg/square Meter), the test is successful.

NOTE: A source for the infrared filter is as follows: Personal Instruments, LLC 18 Commerce Road Newton, CT 06470 (203) 426-0152.

(c) The surface is fully anodized if you see a constant change in color (with the polarizing filter) on 90 percent or more of the anodized surface and one or more of the alternative tests are satisfactory.

(5) If the anodize procedure is not successful, you must do all of the steps in Paragraph 12./REPAIR GENERAL again. (You must remove the unsatisfactory anodic oxide by abrasion as given in Paragraph 12.C./REPAIR GENERAL).

L. If you put a mask on open honeycomb core during Paragraph 12.C.(6)/REPAIR GENERAL, then remove it now. Make sure that you do not touch or contaminate the surfaces that have been anodized. Do not let moisture get into the core cells.

(1) Do a visual check for moisture in the cells. If you see moisture, use blue litmus paper to make sure that there is no acid contamination.

(a) If the litmus paper changes to a red color, there is acid contamination in the core cells. Flush the core with water. Use more blue litmus paper and do a check for acid again.

(b) If the litmus paper stays blue, there is no acid in the core. Remove the moisture, then continue with the procedure.

(2) Make sure that the core is fully dry before you apply the adhesive primer.

M. Keep the bond surface(s) clean if you cannot apply the adhesive primer immediately.

(1) Do not touch the surface(s) with your bare skin, waxed paper, or material that has a release agent or other contamination.

(2) If protection of the surface(s) is necessary, then put vacuum bag film or unwaxed paper (without ink or other contamination on it) on the bond surface(s).

N. Apply the adhesive primer in less than 24 hours after the anodize procedure is completed. Refer to Paragraph 15./REPAIR GENERAL.

13. The Phosphoric Acid Non-Tank Anodizing (PANTA) Procedure

A. The materials that you need are:

(1) Phosphoric Acid, 75-80% (by weight), as given in Federal Specification A-A-55820 or (optional) pre-mixed phosphoric acid gel

(2) (Optional) Floculated Silica (Cab-o-Sil, Grade M-5, or PTG)

(3) Copper Wire

(4) Corrosion Resistant Steel (300 Series CRES) Wire Mesh

(5) Gauze or Cheesecloth (Cotton, Clean and lint-free)

(6) DC Power Supply

(7) Solvent and Acid Resistant Tape

(8) 3M Scotch Brite Pads, Type A, Very Fine

(9) Aluminum Foil Tape

(10) Solid FEP

(11) Blue Litmus Paper

(12) Acetone or Methyl Propyl Ketone (MPK) Solvent

(13) Plastic Film (Mylar, acetate, polyester or equivalent plastic material)

WARNING: KEEP ACIDS AWAY FROM HEAT, FIRE, AND SPARKS. ACID FUMES ARE FLAMMABLE AND TOXIC. INJURY TO PERSONNEL CAN BE THE RESULT. DO NOT PERMIT ACIDS TO MIX WITH OTHER MATERIALS. MAKE SURE THAT THE AIR SUPPLY TO THE AREA IS NOT BLOCKED.

(WARNING PRECEDES)

WARNING: USE RUBBER GLOVES, PROTECTIVE CLOTHING AND EYE PROTECTION.WHEN YOU WORK WITH PHOSPHORIC ACID. THE ACID CAN BURN YOUR EYES AND SKIN AND CAUSE INJURY. IF THE ACID TOUCHES THESE AREAS, FLUSH WITH A LARGE QUANTITY OF WATER AND GET MEDICAL AID IMMEDIATELY.

B. Make the phosphoric acid solution (or gel).

WARNING: ALWAYS ADD ACID TO WATER WHEN YOU MIX THEM. IF YOU ADD WATER TO ACID, THE ACID WILL BECOME VERY HOT AND WILL NOT BE STABLE. THIS CAN CAUSE INJURY TO PERSONS.

(1) To make the phosphoric acid solution, add 14 ± 1/3 fluid ounces (410 ± 10 ml) of 75-80% phosphoric acid to each 135 ± 2 fluid ounces (4.0 liters ± 60 ml) of distilled water.

(2) As an option, you can make the phosphoric acid solution thicker. Mix flocculated silica (Cab-O-Sil, Grade M-5 or PTG) with the phosphoric acid until the acid solution and silica become a gel.

NOTE: You can also get the phosphoric acid gel mixture from a vender (supplier).

C. Clean and abrade the repair surfaces.

WARNING: DO NOT GET SOLVENTS IN YOUR MOUTH, YOUR EYES, OR ON YOUR SKIN. DO NOT BREATHE THE FUMES FROM SOLVENTS. SOLVENTS ARE DANGEROUS MATERIALS. SOLVENTS CAN BE FLAMMABLE OR CAUSE DAMAGE TO THE ENVIRONMENT. REFER TO THE MATERIAL SAFETY DATA SHEETS (MSDS) AND THE LOCAL SAFETY PRECAUTIONS.

(1) Do a solvent wipe with MPK or acetone as given in SOPM 20-30-03.

(2) Abrade the surfaces with Scotch Brite, Type A, very fine pads or a high grade alumina sand paper (180-grit or finer). The metal surface should look clean when you finish this step of the process.

(3) Remove the unwanted abrasive particles from the surface. Use clean dry air or nitrogen.

(4) Do a solvent wipe with MPK or acetone as given in SOPM 20-30-03.

(5) Isolate the mechanical fasteners and all the areas that are not damaged. Use aluminum foil tape or a combination of aluminum foil tape and polyethylene film (or the equivalent). This will prevent acid contamination.

(6) Put on a mask to seal all areas where the damage goes through a skin. To make the mask, put aluminum foil tape, solid FEP or other satisfactory material on top of the honeycomb.

NOTE: If you do a one-stage repair, make sure that the hole is filled before you put on the mask. Example: you can put the honeycomb repair core in the hole (without the core splice adhesive) or you can put in a solid plug.

(7) Flush with clean water and/or wipe with a clean, wet, lint-free cloth until no visible residue appears on the cloth.

D. Do a visual inspection for a water-break-free surface.

(1) Flush the surface with clean (mineral-free or de-ionized) water. Do this for 30 seconds or until the surface has a continuous water film on all of the repair area.

NOTE: The preferred water temperature is between 50° and 100°F (10° and 38°C).

(2) After the flush procedure is completed, the water film on the bond surface must stay continuous for a minimum of 30 seconds.

NOTE: The water surface tension at the edges of an aluminum skin can cause the water film to pull away from the edge a small distance. This condition is permitted unless it is caused by visible surface contamination or incorrect abrading.

(3) If the film does not remain continuous for a minimum of 30 seconds, do Paragraph 13.C./REPAIR GENERAL and Paragraph 13.D./REPAIR GENERAL again.

E. Put a layer of plastic film (Mylar, acetate, polyester or an equivalent material) on the bench tops and other work areas. This will help to prevent the contamination of the repair parts.

F. Assemble the PANTA system immediately after you clean the repair surfaces. Refer to Figure 205/REPAIR GENERAL when you do the steps that follow:

(1) Make a dam to prevent the acid solution (or gel) and rinse water from going into the adjacent structure. To make the dam, build up aluminum foil, acid resistant tape, solid FEP, or other acceptable material around the surface to be treated.

CAUTION: DO NOT USE A STAINLESS STEEL SCREEN IF IT SHOWS CORROSION OR OTHER DETERIORATION. IF YOU DO, IT IS POSSIBLE THAT THERE WILL NOT BE THE NECESSARY AMOUNT OF CURRENT FLOW THROUGH THE SCREEN.

(2) Cut a piece of the stainless steel screen to the shape and dimensions of the surface area to be treated. Use a 300 series alloy CRES with a wire gauge that is a minimum of American Wire Gauge (AWG) #20 (0.03 inch (0.8 mm) diameter) and a maximum of #14 (0.06 inch (1.5 mm) diameter).

NOTE: AWG #18 (0.04 inch (1.0 mm) diameter) is the usual type of stainless steel screen used.

(3) Set up an acid drain and rinse water recovery basin to hold the waste acid and rinse water after the anodize procedure is completed.

(4) Apply the acid and layup materials.

NOTE: You have 30 minutes maximum after you apply the phosphoric acid to start the anodize procedure.

(a) Make sure the temperature of the aluminum part and the acid solution (or gel) during the anodizing procedure is between 70° and 85°F (21° and 29°C).

(b) Keep the surface wet with acid solution (or gel) at all times. If the surface starts to dry, add more acid solution (or gel).

WARNING: KEEP ACIDS AWAY FROM HEAT, FIRE, AND SPARKS. ACID FUMES ARE FLAMMABLE AND TOXIC. INJURY TO PERSONNEL CAN BE THE RESULT. DO NOT PERMIT ACIDS TO MIX WITH OTHER MATERIALS. MAKE SURE THAT THE AIR SUPPLY TO THE AREA IS NOT BLOCKED.

WARNING: USE RUBBER GLOVES, PROTECTIVE CLOTHING AND EYE PROTECTION.WHEN YOU WORK WITH PHOSPHORIC ACID. THE ACID CAN BURN YOUR EYES AND SKIN AND CAUSE INJURY. IF THE ACID TOUCHES THESE AREAS, FLUSH WITH A LARGE QUANTITY OF WATER AND GET MEDICAL AID IMMEDIATELY.

(c) Apply a smooth layer of phosphoric acid solution (or gel) to the aluminum surfaces.

(d) Cut a layer of gauze (or the equivalent absorbent, porous material) that is larger than the area to be anodized.

1) Put the gauze on the acid layer. Extend the gauze 0.5 inch (13 mm) minimum, from the edges of the area to be anodized. Do this until two or three layers of the gauze are assembled.

2) Keep the thickness to a minimum to prevent gasses from being trapped (but make sure that there is enough so that the screen will not touch the surface to be anodized).

3) Remove the wrinkles. If necessary you can use a paint brush or a plastic sweeper to make sure the acid fully soaks the gauze.

NOTE: You can pre-soak the gauze. The gauze can be pre-soaked by squeezing the acid gel solution through the gauze by hand. Use rubber gloves for protection.

CAUTION: MAKE SURE THAT THE STAINLESS STEEL SCREEN AND CATHODE WIRE DOES NOT TOUCH THE ALUMINUM REPAIR SURFACE. THE RESULT CAN BE DAMAGE TO THE PARTS.

(e) Put the stainless steel screen on the layers of gauze and acid.

CAUTION: MAKE SURE THAT THE SURFACE OF THE REPAIR AREA IS OPEN TO THE AIR TO PERMIT THE RELEASE OF UNWANTED GASES. IF YOU DO NOT, THE REPAIR WILL BE UNSATISFACTORY.

(f) Add a layer of phosphoric acid solution (or gel) to the stainless steel screen to make sure that the solution fully covers the screen.

(5) Make the electrical connections.

(a) Attach a conductive negative (–) cathode wire to the stainless steel screen. Make sure that there is a minimum of one wire for each 30 square inches (200 square cm) of the repair area. The length of the wire must be sufficient so that there is no tension between the power supply and the PANTA assembly. The wires must be evenly spaced apart.

NOTE: The negative (–) cathode wire must have a good electrical conductivity with the stainless steel screen. Make sure that the wires and clamps are large enough to carry the necessary electrical current.

(b) Connect the negative (–) cathode wire that is attached to the stainless steel screen to the negative lead on the power source. Connect the positive (+) anode wire to the aluminum part surface to be anodized, and to the positive (+) lead on the power source.

NOTE: Use a battery or a DC power supply as the power source for the anodizing procedure. The power source must have a capacity of 10 volts, minimum. The power source must also have a capacity of 8 amps/square foot (86 amp/square meter), minimum.

CAUTION: DO NOT LET THE ASSEMBLY BECOME DRY. THE RESULT CAN BE A BURNED SURFACE OR A SURFACE TREATMENT THAT IS UNSATISFACTORY. ADD MORE ACID AS NECESSARY TO KEEP THE SURFACE FULLY WET.

G. Do the PANTA procedure.

(1) Do the steps that follow in the sequence that follows:

NOTE: You have less than 30 minutes to start the electricity after you apply the acid.

(a) Set the voltage and current positions to zero on the electrical power supply.

(b) Start the electrical power supply.

(c) Increase the current adjustment to the full open position.

(d) Slowly increase the voltage (approximately 5 volts for each minute) until it is between 9.5 to 10 volts (DC).

(e) Do a check of the amperage after it gets to the correct voltage.

NOTE: A fast increase in the current (more than 20% of the stable value) could be a sign that the surface is burning. Add more acid solution (or gel). If this is an unsatisfactory solution, an electrical short could be the cause. Stop the procedure and look for the problem.

1) In one minute or less, the current will become stable.

2) The current density at 9.5 to 10 volts (DC) must be in a range that is between 0.014 and 0.048 amperes/square inches (0.0022 and 0.0074 amperes/square cm).

(f) Apply the 9.5 to 10 volts (DC) for 10 to 12 minutes.

CAUTION: DO NOT LET THE ASSEMBLY BECOME DRY. THE RESULT CAN BE A BURNED SURFACE OR A SURFACE TREATMENT THAT IS UNSATISFACTORY. ADD MORE ACID AS NECESSARY TO KEEP THE SURFACE FULLY WET.

(2) Stop the electrical power after the specified time.

(3) Immediately, remove the screen and the gauze breather cloth. Discard these materials. Use a method to discard these materials that is permitted by your local safety, health, and environmental authorities.

(4) Immediately, flush the phosphoric acid from the anodized surfaces with clean water. The time interval between power shut-off and the start of the flush must not be more than 2.5 minutes. Flush with clean (mineral free or de-ionized) water for a minimum of 5 minutes.

NOTE: Do not rub or wipe the repair surface.

H. Let the anodized surface fully dry at room temperature. As an alternative, you can dry the parts with forced, clean, dry, filtered air that is a maximum of 160°F (71°C) until the surface is fully dry.

NOTE: You must apply the adhesive primer in less than 24 hours after the surface is anodized. Prevent the contamination of the anodized surface by moisture, dust, oil fumes, engine exhaust or other unwanted material. Do not touch the dried anodized surfaces. Do not apply tape to the anodized surfaces.

I. Examine the anodized surface. You can use a Phosphoric Acid Anodize Detector (dichroscope) or do the polarized filter color inspection test that follows:

NOTE: You can purchase a Phosphoric Acid Anodize Detector (part number WCI-AD55) from West Coast Industries, Inc., 14900 Whitman Ave N, Seattle, WA 98133.

(1) Polarized filter color inspection test.

(a) Use a fluorescent light source on the anodized area.

(b) Put a polarizing filter between yourself and the treated surface and look at the reflected light (from the surface) at an angle of 5 degrees or less. It can be helpful to put the light source at a glancing angle. Refer to Figure 206/REPAIR GENERAL.

(c) While you look at the surface through the polarizing filter, turn the filter 90 degrees. A correctly anodized surface gives a constant change in color (on all areas of the anodized surface) when you look through the filter. The colors seen most frequently are purple, yellow, and green.

NOTE: It is not easy to see the colors on a rough or contoured surface. To find out if a surface is anodized correctly, change the view angle of the polarizing filter to see if the anodic coating is satisfactory.

(2) The anodize procedure is not successful if you find one or more of the conditions that follow:

(a) There are sudden changes in color as a result of stains, contamination, fingerprints, or other parts that touched the surface.

(b) There are electrical burns or pits.

(c) There are areas of the surface to be bonded that are not anodized.

(3) The surface is fully anodized if you see a constant change in color (with the polarizing filter) on all the areas of the anodized surface.

(4) If the color inspection test on a rough or contoured surface is not successful, you can do alternative tests to make sure you have a good anodized surface. Do one or more of the tests that follow:

(a) Use an ohmmeter to do a resistance test of the anodized surface. Make sure that the ohmmeter probes are clean.

1) Carefully, put the ohmmeter probes on the anodized surface. Make sure that you do not damage the anodized surface with the ohmmeter probes.

2) Carefully touch the surface with the sides of the probes first, then lay them down. If the surface has a resistance of more than 20,000 ohms (20 kohms) the test is successful.

(b) Do an infrared filter test to measure the weight of the anodize coating. Use an infrared filter device that is tuned to measure phosphoric acid anodize oxides. If the infrared filter test shows an anodized coating that is more than 20mg/square foot (215mg/square Meter), the test is successful.

NOTE: A source for the infrared filter is as follows: Personal Instruments, LLC 18 Commerce Road Newton, CT 06470 (203) 426-0152.

(c) The surface is fully anodized if you see a constant change in color (with the polarizing filter) on 90 percent or more of the anodized surface and one or more of the alternative tests are satisfactory.

(5) If the anodize procedure is not successful, you must do all of the steps in Paragraph 13./REPAIR GENERAL again. (You must remove the unsatisfactory anodic oxide by abrasion as given in Paragraph 13.C./REPAIR GENERAL).

J. If you put a mask on open honeycomb core during Paragraph 13.C.(6)/REPAIR GENERAL, then remove it now. Make sure that you do not touch or contaminate the surfaces that have been anodized. Do not let moisture get into the core cells.

(1) Do a visual check for moisture in the cells. If you see moisture, use blue litmus paper to make sure that there is no acid contamination.

(a) If the litmus paper changes to a red color, there is acid contamination in the core cells. Flush the core with water. Use more blue litmus paper and do a check for acid again.

(b) If the litmus paper stays blue, there is no acid in the core. Remove the moisture, then continue with the procedure.

(2) Make sure that the core is fully dry before you apply the adhesive primer.

K. Keep the bond surface(s) clean if you cannot apply the adhesive primer immediately.

(1) Do not touch the surface(s) with your bare skin, waxed paper, or material that has a release agent or other contamination.

(2) If protection of the surface(s) is necessary, then put vacuum bag film or unwaxed paper (without ink or other contamination on it) on the bond surface(s).

L. Apply adhesive primer in less than 24 hours after the anodize procedure is completed. Refer to Paragraph 15./REPAIR GENERAL.

14. The Boegel EP-II (AC-130) Surface Preparation Procedure

A. Boegel EP-II is a water-based, metal adhesion promoter based on sol gel (a type of inorganic polymer) chemistry. The Boegel EP-II system is commercially available as AC-130 (Four part kit) and AC-130-2 (Two part kit).

B. The materials that you need are:

(1) AC-130 Sol-Gel Kit (Source: Advanced Chemistry and Technology, 7341 Anaconda Avenue, Garden Grove, CA 92841, 800-732-4470).

(2) Cheesecloth, gauze or clean cotton rags, or BMS15-5, Class A wipers.

(3) Acetone or Methyl Propyl Ketone (MPK) Solvent.

(4) Scotch Brite, Type A, very fine pads or a high grade alumina sand paper (180-grit or finer) for cleaning.

(5) Abrasive material for making the surface reactive to Boegel.

NOTE: Sandpaper must be #180 grit and must be one of the approved products specified below. Smaller grit numbers (larger grit dimensions) can cause damage to the metal surface. It is possible that larger grit numbers (smaller grit dimensions) will not remove all of the oxidation. Different grit, paper, or adhesive materials can cause an unsatisfactory chemical bond between the AC-130 and the bare metal.

- Merit Shur Stik ALO Resin Bond, #180-grit Abrasive Papers (Source: Merit Abrasives, Customer Service, 2770 W. Washington St., Stephenville, TX 76401-3798, Tel: 800 763-7999, Fax: 800 472-3094, website: www.meritabr.com). Refer to Table 204/REPAIR GENERAL for product identification.

Table 204: Merit Sandpaper Ordering Information

ALO Resin Bond 180 Grit Sanding Discs				
Disc Diameter	Quick-Change PowerLock Discs			ShurStik Adhesive Backed Discs
1/2 inch (13 mm)	N/A	N/A	N/A	08834171108
3/4 inch (19 mm)	08834161010	08834165109	08834164325	08834171122
1 inch (25 mm)	08834161023	08834165124	08834166252	08834171137
1 1/2 inches (38 mm)	08834161036	08834165139	08834166251	08834171152
2 inches (51 mm)	08834161050	08834165154	08834164916	08834171167
3 inches (76 mm)	08834161064	08834165169	08834166187	08834171182
4 inches (102 mm)	08834161078	08834165184	08834164843	08834171197
5 inches (127 mm)	N/A	N/A	N/A	08834172024
6 inches (152 mm)	N/A	N/A	N/A	08834172053

- 3M Corporation, St. Paul, MN, USA. Tel: 1-888-364-3577, Website: http://www.3m.com/aerospace. Local distributers are available globally. Refer to Table 205/REPAIR GENERAL for product identification.

Table 205: 3M Sandpaper Ordering Information

3M™ Roloc™ Quick Change P180 Grit Sanding Discs	
Disc Diameter	777F (Regalite™ Grit) Ordering Information
1 inch (25 mm)	051144-94188-9 777F ROLOC 1 INCH TR P180 GRIT
1 1/2 inches (38 mm)	051144-94188-9 777F ROLOC 1.5 INCH TR P180 GRIT
2 inches (51 mm)	051144-83474-7 777F ROLOC 2 INCH TR P180 GRIT
3 inches (76 mm)	051144-94188-9 777F ROLOC 3 INCH TR P180 GRIT
Disc Diameter	361F (Aluminum Oxide Grit) Ordering Information
1 inch (25 mm)	051111-61023-7 361F ROLOC 1 INCH TR P180 GRIT
1 1/2 inches (38 mm)	051135-14039-0 361F ROLOC 1.5 INCH TR P180 GRIT
2 inches (51 mm)	051144-13873-9 361F ROLOC 2 INCH TR P180 GRIT
3 inches (76 mm)	051135-14039-0 361F ROLOC 3 INCH TR P180 GRIT
3M Stikit™ 180 Grit Sanding Discs	
Disc Diameter	300D (Aluminum Oxide Grit) Ordering Information
5 inches (127 mm)	051111-50454-3 300D STIKIT 5 INCH 180 GRIT
6 inches (152 mm)	051111-50463-5 300D STIKIT 6 INCH 180 GRIT
Disc Diameter	900DZ (Cubitron™ Ceramic Grit) Ordering Information
5 inches (127 mm)	051111-49642-8 900DZ STIKIT 5 INCH 180 GRIT
6 inches (152 mm)	051111-29351-5 900DZ STIKIT 6 INCH 180 GRIT

C. Prepare the repair area for the Boegel (AC-130) Prebond Treatment procedure.

WARNING: DO NOT GET SOLVENTS IN YOUR MOUTH, YOUR EYES, OR ON YOUR SKIN. DO NOT BREATHE THE FUMES FROM SOLVENTS. SOLVENTS ARE DANGEROUS MATERIALS. SOLVENTS CAN BE FLAMMABLE OR CAUSE DAMAGE TO THE ENVIRONMENT. REFER TO THE MATERIAL SAFETY DATA SHEETS (MSDS) AND THE LOCAL SAFETY PRECAUTIONS.

(1) Do a solvent wipe with MPK or acetone as given in SOPM 20-30-03.

(2) Abrade the surfaces with Scotch Brite, Type A, very fine pads or a high grade alumina sand paper (180-grit or finer). The metal surface will look clean when you finish this step of the process.

(3) Remove the unwanted abrasive particles from the surface. Use clean dry air or nitrogen.

(4) Do a solvent wipe with MPK or acetone as given in SOPM 20-30-03.

D. Mix the components of kit as given in the manufacturer’s instructions. Use a kit size that is the best for the area to be treated. Example: approximately 50 ml of the Boegel (AC-130) solution is satisfactory to treat 200 square inches (1300 square cm) of bond zone. Scale it up if necessary.

(1) 30 minutes after you mix the components, you can apply Boegel (AC130) to the surface to be treated.

NOTE: 30 minutes is the minimum time necessary for the components to react.

(2) Use the mixture after the abrade steps that follow, but not after 10 hours.

CAUTION: USE THE SANDPAPER THAT IS SPECIFIED IN THIS PROCEDURE. SOME TYPES OF SANDPAPER CAN CAUSE A WEAK BOND.

E. Fully abrade the repair area again.

NOTE: This procedure is necessary to remove the metal oxide layer on the aluminum and make the surface reactive for the Boegel (AC-130).

(1) Use a random orbital sander or die grinder.

(a) Make sure that the sander or grinder will not get oil contamination on the sandpaper or the bond surface.

(b) Only use a sander or grinder that has a vented or filtered exhaust for the dust particles.

(2) Get approved sandpaper specified in Paragraph 14.B.(5)/REPAIR GENERAL. Use 2.0 inch (50 mm) diameter discs for the procedure that follows or refer to Figure 207/REPAIR GENERAL for alternative disc diameters and sanding procedures.

(3) Refer to Figure 207/REPAIR GENERAL and do the steps that follow for a 40 square inch (260 square cm) surface area:

(a) With a 2.0 inch (50 mm) diameter disc, move the sander/grinder in one direction on the panel surface.

(b) Change the sandpaper after 30 seconds. Change the direction of movement by 90 degrees.

(c) Make sure that all of the repair area is fully abraded, including the edges.

(d) After all of the surface has been abraded, change the sandpaper and fully abrade the surface again. Move the sander in a diagonal direction (with a grinder) or random direction (with a sander) on all of the panel surface.

(4) If you are doing a surface preparation on more than 40 square inches (260 square cm) you can do the diagonal or random pattern with one sheet of sandpaper. Example: If you treat a section that is 80 square inches (520 square cm) do the steps that follow:

(a) Abrade the surface in one direction for a minimum of 30 seconds.

(b) Change the sandpaper, and then abrade in a 90 degree direction for a minimum of 30 seconds. Then change the sandpaper again. Repeat this for a total treatment time of 2 minutes, minimum (with 4 sheets of sandpaper).

(c) Then, change the sandpaper and abrade all of the surface for 30 seconds more in a diagonal direction (with a grinder) or a random direction (with a sander).

NOTE: You can abrade a maximum of 200 square inches (1300 square cm) with the last sheet of sandpaper. Do not abrade the surface for more than 30 seconds with this last sheet of sandpaper. See Figure 207/REPAIR GENERAL for an example of how to prepare a surface of 200 square inches (1300 square cm).

(5) Do a visual inspection. The surface should have a fully abraded appearance. If not, do the abrade steps again.

(6) Remove the loose grit residue with clean, dry compressed nitrogen or air.

NOTE: Do not do a water-break-free test . Do not rinse off the loose grit. Do not touch the surface of the abraded area with your bare hands. Keep the surface clean and dry until you apply the Boegel (AC-130) Solution.

(7) Apply the Boegel (AC-130) solution in less than 30 minutes after you complete the abrade steps.

NOTE: After 30 minutes the surface will begin to oxidize. If you do not apply the Boegel (AC-130) in less than 30 minutes after you completed the abrade steps, you will need to do the abrade steps again to remove the oxide layer.

WARNING: DO NOT PERMIT THE BOEGEL (AC-130) SOLUTION TO TOUCH YOUR FACE OR EYES. USE APPROVED PROTECTION PROCEDURES. IF THE SOLUTION TOUCHES THESE AREAS, IRRITATION TO THE EYES AND SKIN CAN OCCUR.

F. Apply the Boegel (AC-130) solution.

(1) Put on a mask to seal all areas where the damage goes through a skin. To make the mask, put aluminum foil tape, solid FEP or other satisfactory material on top of the honeycomb.

NOTE: If you do a one-stage repair, make sure that the hole is filled before you put on the mask. Example: you can put the honeycomb repair core in the hole (without the core splice adhesive) or you can put in a solid plug.

(2) Isolate the mechanical fasteners and all the other areas that are not damaged. Use aluminum foil tape or a combination of aluminum foil tape and polyethylene film (or the equivalent). This will prevent contamination.

(3) Make sure that the temperature of the Boegel and aluminum part stays between 50° and 100°F (10° and 38°C) during the procedure.

(4) Apply the solution to the bond surface to be treated with a clean, natural (non-metallic) bristle brush or with a sprayer.

(5) Apply a sufficient quantity of solution to cause the solution to drain from the bond surface. Keep the bond surface fully and continuously wet with the solution for 2 minutes, minimum.

(6) When the 2 minutes is completed, the wetted surface must look like a water-break-free surface.

NOTE: The solution surface tension at the edges of an aluminum skin can cause the solution film to pull away from the edge a small distance. This condition is permitted unless it is caused by surface contamination or incorrect abrading.

(a) The solution film on the bond surface must stay continuous for a minimum of 30 seconds.

(b) If the solution film does not stay continuous for a minimum of 30 seconds, there is surface contamination. Do the cleaning, abrasion and application steps again.

(7) If the break-free surface test is satisfactory, then drain off the remaining solution.

(8) If you see drops of solution in crevices, pockets, or other contained areas, then they must be removed.

(a) Lightly blow off the drops of solution with filtered dry air, or

(b) Carefully remove the drops with clean cheesecloth or other absorbent material that is moist with Boegel (AC-130).

NOTE: Do not rub or wipe the surface. Do not touch the surface with your bare skin or with gloves that have contamination on them.

G. Let the treated surfaces dry at room temperature for 60 minutes, minimum. You can use an oven, heat lamp, or forced air that is oil-free and is no hotter than 160°F (71°C) to dry the parts.

H. Examine all of the treated surface. The surface must look dry and not have dust, fingerprints or other contamination. Use filtered forced air to remove dust. If there is contamination that cannot be removed with forced air, then clean, abrade, and do the Boegel steps again.

NOTE: It is possible that you see stains on the prepared surface after the surface is dry. These stains are permitted.

I. If you put a mask on open honeycomb core during Paragraph 14.F.(1)/REPAIR GENERAL, then remove it now. Make sure that you do not touch the surface to be bonded. Do not let moisture get into the core cells. Make sure that the core is fully dry before you apply the adhesive primer.

J. Keep the bond surface(s) clean if you cannot apply the adhesive primer immediately.

(1) Do not touch the surface(s) with your bare skin, waxed paper, or material that has a release agent or other contamination.

(2) If protection of the surface(s) is necessary, then put vacuum bag film or unwaxed paper (without ink or other contamination on it) on the bond surface(s).

K. If the bond surface gets contamination on it before you apply the primer, then clean the bond surface and do the Boegel (AC-130) procedure again.

L. Apply BMS5-89, Type II or BMS5-137 Type I, Class 3 adhesive primer not later than 24 hours after you apply the Boegel (AC-130) solution. Refer to Paragraph 15./REPAIR GENERAL.

15. Application of BMS5-89 or BMS5-137 Adhesive Primer to the Bond Surface

A. Applicability and Limitations

(1) Use BMS5-89 adhesive primer on surfaces to be bonded with BMS5-101 film adhesive.

(2) Use BMS5-137 adhesive primer on surfaces to be bonded with BMS5-137 film adhesive.

(3) Use only BMS5-89 Type II or BMS5-137 Type I, Class 3 adhesive primer on surfaces that used Boegel (AC-130) for the surface preparation.

NOTE: BR6747-1 primer (BMS5-89 Type II or BMS5-137 Type I, Class 3) is a one-part heat cured primer. The solids content in this primer can settle out of the solution. It must be thoroughly and completely mixed before use and it must be constantly agitated (shake each 3- 5 seconds) when you do the spray application.

(4) Do not mix different types or classes of adhesive primer in the same container or apply different types or classes on the same bond surface.

(5) Make sure that all spray equipment and other application tools are completely clean before you use them to apply an adhesive primer.

B. Remove the primer from storage. Do not open the container until it is between 65° and 90°F (18° and 32°C).

NOTE: Refer to Boeing Process Specification BAC5514-589 ‘‘Application of Corrosion Inhibiting Adhesive Primer’’ or BAC5514-5137 ‘‘Structural Bonding with BMS5-137 Adhesives’’ for the storage and shelf life specifications. Do not use the primer if it has lumps, gelatin or other signs of deterioration.

WARNING: DO NOT GET SOLVENTS IN YOUR MOUTH, YOUR EYES, OR ON YOUR SKIN. DO NOT BREATHE THE FUMES FROM SOLVENTS. SOLVENTS ARE DANGEROUS MATERIALS. SOLVENTS CAN BE FLAMMABLE OR CAUSE DAMAGE TO THE ENVIRONMENT. REFER TO THE MATERIAL SAFETY DATA SHEETS (MSDS) AND THE LOCAL SAFETY PRECAUTIONS.

(WARNING PRECEDES)

WARNING: DO NOT USE SOLVENT BASED PRIMERS IN AREAS WITH EQUIPMENT THAT PRODUCE HEAT OR A SPARK. IF YOU DO, AN EXPLOSION CAN OCCUR AND CAUSE INJURY.

CAUTION: PREVENT CONTAMINATION OF THE PARTS AFTER YOU DO A SURFACE PREPARATION. WEAR CLEAN GLOVES, OR USE HOOKS TO MOVE THE PARTS. DO NOT APPLY THE PRIMER IF THE TEMPERATURE IS LESS THAN 50°F (10°C) OR MORE THAN 85 PERCENT OF THE RELATIVE HUMIDITY. IF YOU DO NOT OBEY, THE RESULT CAN BE AN UNSATISFACTORY BOND.

C. Mix the adhesive primer. Use the manufacturer's instructions, or Boeing Process Specification BAC5514-589 ''Application of Corrosion Inhibiting Adhesive Primer'' for mixing BMS5-89 primer or BAC5514-5137 ''Structural Bonding with BMS5-137 Adhesives'' for mixing BMS5-137 primer.

D. Apply the adhesive primer.

NOTE: BMS5-89 and BMS5-137 must be baked after it is applied. Because you cannot measure the thickness until after you bake, you need sufficient training or experience to know what a good thickness looks like (You can also use a visual reference standard, or you can do an experiment on an aluminum part that will not be used for the repair). It is permitted for you to apply BMS5-89 or BMS5-137 primer on painted surfaces adjacent to the bare aluminum surface. It is not necessary to measure the thickness of the primer that is applied to the painted surfaces adjacent to the bare aluminum. It is not necessary to measure the thickness of the primer on the edges of the repair parts or the edges of the removed damage area. You have a maximum of 120 hours to start the baking procedure.

(1) Apply the primer to a thickness that will cure to the specified thickness range after baking. Refer to Paragraph 15.H./REPAIR GENERAL.

NOTE: It can be necessary to apply the primer two or more times to get it to the specified thickness. Continuously shake the container (that has the primer) each 3 to 5 seconds until the procedure is completed.

(2) Apply the primer to the edges of the repair parts and the edges at the removed damage area.

CAUTION: DO NOT USE FORCED AIR ON THE WET SURFACE. DEFECTS AND DAMAGE TO THE PRIMER CAN OCCUR. PROTECT THE PRIMER FROM DUST OR OTHER CONTAMINATION. IF YOU DO NOT, THE STRENGTH OF THE REPAIR CAN BE REDUCED.

E. Let the primer dry. If more than one side will have primer, make sure that the first side is dry before you apply primer to the second side.

(1) BMS5-89, Type I solvent based primer can be dried for 30 minutes at room temperature. As an alternative, you can dry the primer with a heat lamp that is no hotter than 200°F (93°C) until the primer is hard (tack-free).

(2) BMS5-89, Type II or III and BMS5-137 Type I, Class 2 and 3 water based primer can be dried at room temperature, or with a heat lamp until all of the water that you see is gone (the primer does not look wet).

NOTE: You can heat stabilize wet BMS5-89 Type II or BMS5-137 Type I, Class 3 primer on the first surface before you apply primer to the other surface. Apply 200°F (93°C) heat for 15 minutes. (Do not use forced air on wet primer). Then apply primer to the surface on the second side.

(3) After BMS5-89 Type III or BMS5-137 Type I, Class 4 primer has dried, wait 15 more minutes (minimum) before you start to bake.

CAUTION: MAKE SURE THAT YOU KEEP DUST AND OTHER CONTAMINATION FROM THE PRIMED SURFACE BEFORE AND AFTER THE PRIMER IS CURED. THE PRIMER MAY NOT FULLY CURE UNTIL AFTER THE ADHESIVE FILM IS APPLIED AND CURED. IF YOU REMOVE CONTAMINATION FROM A PRIMED SURFACE THAT IS NOT FULLY CURED, YOU CAN CAUSE DAMAGE TO THE PRIMER.

F. Bake the primer with an oven, heat lamp, or hot air. Refer to Table 206/REPAIR GENERAL:

NOTE: As an alternative, you can do a two stage cure. First, bake the primer at 175°F (80°C) for 2 hours minimum. Then do the layup. The cure will be complete when the adhesive is cured.

Table 206: Cure Instructions for Adhesive Primers

PRIMER	CURE TEMPERATURE RANGE	CURE TIME
BMS5-89 Type I or Type II	240° ±20°F (116° ±12°C)	30 to 120 minutes
BMS5-89 Type III	250° ±20°F (121° ±12°C)	30 to 120 minutes
BMS5-137 Type I, Class 2	285° ±15°F (141° ±8°C)	60 to 120 minutes
BMS5-137 Type I, Class 3	260° ±10°F (127° ±6°C)	60 to 120 minutes
BMS5-137 Type I, Class 4	315° ±10°F (157° ±6°C)	60 to 120 minutes

NOTE: If a part with a primed surface will be stored before you apply the film adhesive, or if there is a possibility for damage or contamination to the primer, then: (1) Bake the primer at the highest temperature and longest time that is shown in Table 206/REPAIR GENERAL and (2) put a clean, protective cover over the primed surface (for example: you can use unwaxed, unprinted paper or vacuum bag material).

G. Calibrate your primer thickness measurement tool.

NOTE: You can use an eddy current procedure, or a procedure that gives the equivalent satisfactory results. There are electronic coating thickness gauges available that use eddy current, ultrasound, and other technology that are not sold by The Boeing Company. You are permitted to use any applicable technology that can accurately and precisely measure paint thickness. Make sure that you follow the manufacturer's instructions.

(1) Do a calibration test on a measurement tool every time that you do a repair procedure. Do a calibration test for each metal alloy and gage thickness. Do a calibration test every time you measure the thickness of a different primer type.

(a) Measure the primer thickness on a primer thickness standard that has the same metal gage thickness and the same aluminum alloy as the airplane or repair part that has primer to be measured.

(b) Make sure that the primer thickness on the primer thickness standard is precisisely known and is of the same primer type as the primer on the airplane or repair part.

(2) If the measurement agrees with the known primer thickness on the primer thickness standard, then you are permitted to use the measuring tool on airplane and repair parts.

H. Measure the primer thickness after the primer has cooled to ambient temperature.

NOTE: If you are not sure if the primer was baked sufficiently, you can do a solvent wipe test. Put a small amount of MEK solvent on the primed surface and let it stay for approximately 5 seconds. Rub the solvent off with a clean cloth. Continue to rub the surface for approximately 5 seconds. Some primer will come off on to the cloth. This is permitted if bare metal does not show. If bare metal shows after the surface is rubbed, then the primer must be removed from all of the surface to be bonded, and you must do the surface preparation and primer procedure again.

(1) Refer to the baked thickness ranges that follow for the different primer options:

(a) BMS5-89, all Types: 0.00015 and 0.00040 inch (0.004 and 0.010 mm)

(b) BMS5-137 Type I, Class 2: 0.00020 and 0.00035 inch (0.005 and 0.009 mm)

(c) BMS5-137 Type I, Class 3: 0.00015 and 0.00035 inch (0.004 and 0.009 mm)

(d) BMS5-137 Type I, Class 4: 0.00015 and 0.00040 inch (0.004 and 0.010 mm)

(2) If the primer is not at the specified thickness, then you must remove the primer.

(a) Do one of the applicable surface preparations in Paragraph 11./REPAIR GENERAL and put adhesive primer on the bond surface again.

(b) Bake the primer. Let the primer cool to ambient temperature and measure the thickness again.

(3) If the thickness is satisfactory, apply the adhesive as given in Paragraph 18./REPAIR GENERAL or Paragraph 19./REPAIR GENERAL.

16. Hydrofluoric Acid (HF) - Alodine Procedure

NOTE: This surface preparation procedure has size limits. Refer to Figure 201/REPAIR GENERAL.

A. The materials that you need are:

(1) Hydrofluoric Acid (HF)

(2) 3M Scotch-Brite, Type A, very fine pads or a high grade alumina sandpaper (180-grit or finer)

(3) Aluminum Foil Tape

(4) Solid FEP

(5) Cheesecloth, gauze or clean cotton rags, or BMS5-15 Class A wipers

(6) Blue litmus paper

(7) Alodine 1200

(8) Acetone or Methyl Propyl Ketone (MPK) Solvent

B. Clean and abrade the repair surfaces.

WARNING: DO NOT GET SOLVENTS IN YOUR MOUTH, YOUR EYES, OR ON YOUR SKIN. DO NOT BREATHE THE FUMES FROM SOLVENTS. SOLVENTS ARE DANGEROUS MATERIALS. SOLVENTS CAN BE FLAMMABLE OR CAUSE DAMAGE TO THE ENVIRONMENT. REFER TO THE MATERIAL SAFETY DATA SHEETS (MSDS) AND THE LOCAL SAFETY PRECAUTIONS.

(1) Do a solvent wipe with MPK or acetone as given in SOPM 20-30-03.

(2) Abrade the surfaces with Scotch Brite, Type A, very fine pads or a high grade alumina sand paper (180-grit or finer). The metal surface should look clean when you finish this step of the process.

(3) Remove the unwanted abrasive particles from the surface. Use clean dry air or nitrogen.

(4) Do a solvent wipe with MPK or acetone as given in SOPM 20-30-03.

CAUTION: DO NOT PERMIT THE ACID SOLUTION TO TOUCH OTHER SURFACES ADJACENT TO THE REPAIR BOND AREAS. IF IT DOES, THE RESULT CAN BE DAMAGE TO THE PAINT AND ADHESIVE SYSTEMS.

(5) Isolate the mechanical fasteners and all the areas that are not damaged, with aluminum foil tape or a combination of aluminum foil tape and polyethylene film (or the equivalent). This will prevent acid contamination.

(6) Put on a mask to seal all areas where the damage goes through a skin. To make the mask, put aluminum foil tape, solid FEP or other satisfactory material on top of the honeycomb.

NOTE: If you do a one-stage repair, make sure that the hole is filled before you put on the mask. Example: you can put the honeycomb repair core in the hole (without the core splice adhesive) or you can put in a solid plug.

(7) Flush with clean water and/or wipe with a clean, lint-free cloth until no visible residue appears on the cloth.

C. Do a visual inspection for a water-break-free surface.

(1) Flush the surface with clean (mineral-free or de-ionized) water. Do this for 30 seconds or until the surface has a continuous water film on all of the repair area.

NOTE: The preferred water temperature is between 50° and 100°F (10° and 38°C).

(2) After the flush procedure is completed, the water film on the bond surface must stay continuous for a minimum of 30 seconds.

NOTE: The water surface tension at the edges of an aluminum skin can cause the water film to pull away from the edge a small distance. This condition is permitted unless it is caused by visible surface contamination or incorrect abrading.

(3) If the film does not remain continuous for a minimum of 30 seconds, do Paragraph 16.B./REPAIR GENERAL and Paragraph 16.C./REPAIR GENERAL again.

WARNING: DO NOT BREATHE THE FUMES WHEN YOU DO WORK WITH HYDROFLUORIC ACID SOLUTIONS. USE MECHANICAL AIRFLOW AND RESPIRATORY PROTECTION. DO NOT LET THE SOLUTIONS TOUCH YOUR EYES OR SKIN. WEAR GLOVES AND PROTECTIVE CLOTHING. IF YOU DO NOT OBEY, YOU CAN CAUSE SKIN IRRITATION OR INJURY. IF THE SOLUTION TOUCHES YOUR EYES, CLEAN WITH A LARGE QUANTITY OF WATER AND GET MEDICAL AID IMMEDIATELY.

D. Prepare the Alodine 1200 solution as given in 51-20-01, GENERAL. Let it stay mixed for one hour before you use it.

NOTE: A dirty solution is not satisfactory for use. Prepare the solution in small quantities. Discard the solution if you do not use it before 24 hours or if the solution is dirty. If you use non-distilled water, then add nitric acid to control the pH of the solution. For the Alodine 1200 product, the pH must be between 1.5 and 2.0. Use pHydrion papers to check the pH of the solution.

E. Do the HF acid etch procedure.

(1) Make sure that the temperature of the HF acid and the aluminum part stays between 50° and 100°F (10° and 38°C) during the etch procedure.

(2) Make a clean cloth moist, but do not soak it, with a 2 percent solution of HF acid. Rub the bond mating surface area with the moist cloth. Let the solution stay on the surface for 15 to 30 seconds.

(3) Quickly rub mating surfaces of the bond area with the moist cloth.

(4) Let the HF solution stay on the surface for approximately 15 to 30 seconds.

(5) Quickly remove the solution with a cloth moist with clean water.

NOTE: Do not permit the cloth to touch the etched surface for more than 2 minutes. Do not permit the cloth to touch surfaces that were not etched with the HF solution and then to touch the etched surfaces. This will cause contamination of the etched surfaces.

F. Apply the Alodine solution to the etched area as given in 51-20-01, GENERAL.

NOTE: Do not permit the etched surfaces to dry before you apply the chemical conversion coating.

(1) Make sure that the temperature of the Alodine and the aluminum part stays between 50° and 100°F (10° and 38°C) during the procedure.

(2) Apply the Alodine solution to the etched area in less than 60 seconds after the HF acid etch procedure is completed.

(a) Apply the Alodine solution with a fiber or nylon brush, or clean, dry cheesecloth.

NOTE: Make sure that you apply a sufficient quantity of chemical conversion coating to give a smooth layer.

(b) Make sure that the etched area stays moist with Alodine solution for 3 to 4 minutes.

CAUTION: USE CARE WHEN YOU RINSE THE COATED SURFACE. IF YOU DO NOT, THE RESULT CAN BE AN UNSATISFACTORY CHEMICAL CONVERSION COATING. THE NEW COATING IS FRAGILE AND CAN BE EASILY DAMAGED.

(3) Rinse the area with a moist, but not soaked, cheesecloth. Make sure that the cheesecloth and water are clean.

NOTE: Lightly touch the surface for 1 to 2 minutes. Then, do it again with another clean moist cheesecloth to remove more of the solution from the surface. Do not wipe the surface.

(4) Do a check of the repair area to see if acid remains on the surface.

(a) Look at the repair surface and all of the crevices in the repair area.

(b) If you see moisture, use blue litmus paper to make sure that there is no acid on the surface or in the crevices.

NOTE: If the litmus paper remains blue then remove the moisture and continue with the procedure. If the litmus paper changes to a red color, then acid remains on the surface. You must do Paragraph 16.F.(3)/REPAIR GENERAL and Paragraph 16.F.(4)/REPAIR GENERAL again until the litmus paper remains blue.

CAUTION: USE CARE WHEN YOU DRY THE COATED SURFACE. DO NOT WIPE OR RUB THE SURFACE. THE NEW COATING IS FRAGILE AND CAN BE EASILY DAMAGED.

(5) Carefully dry the surface with clean dry cheesecloth to remove the rinse water. If necessary, do this again to remove the water from the surface.

WARNING: DO NOT PERMIT THE CHEMICAL CONVERSION COATING TO DRY ON THE BRUSHES OR CHEESECLOTH. MAKE SURE THAT YOU WASH ALL OF THE COATING FROM THE FROM THESE MATERIALS BEFORE IT IS DRY. WRING OUT THE MATERIALS AND PUT THEM INTO A FIRE-PROOF CONTAINER. IF YOU DO NOT, THE RESULT CAN BE A CHEMICAL FIRE CAUSED BY SPONTANEOUS COMBUSTION.

(6) Do not put materials that have Alodine on them in the same container with materials that have solvent on them.

(a) Wash all of the Alodine from the materials used for the application, before the materials are discarded.

(b) Discard the materials in an approved container. Use a procedure to discard these materials that is permitted by your local safety, health, and environmental authorities.

(7) Permit the surfaces to fully air-dry. You are permitted to use filtered hot air up to a maximum of 130°F (54°C). A minimum 15 minutes is recommended.

NOTE: You must apply the final finish or start the adhesive procedures as soon as possible after the chemical conversion coating is dry. Wear clean gloves to keep contamination from the part.

G. Do a visual check of the repair surface for a powdery coating. All Alodine coatings must be free of powder.

(1) If you find a powdery coating on the surface, then you must do Paragraph 16.F.(3)/REPAIR GENERAL through Paragraph 16.F.(7)/REPAIR GENERAL and Paragraph 16.G./REPAIR GENERAL again until the surface is free of powder.

(2) If the surface is free of powder, then continue with the procedure.

H. If you put a mask on open honeycomb core during Paragraph 16.B.(6)/REPAIR GENERAL, then remove it now. Make sure that you do not touch the surface to be anodized. Do not let moisture get into the core cells.

(1) Do a visual check for moisture in the cells. If you see moisture, use blue litmus paper to make sure that there is no acid contamination.

(a) If the litmus paper changes to a red color, there is acid contamination in the core cells. Flush the core with water. Use more blue litmus paper and do a check for acid again.

(b) If the litmus paper stays blue, there is no acid in the core. Remove the moisture, then continue with the procedure.

(2) Make sure that the core is fully dry before you apply the adhesive primer.

I. Keep the bond surface(s) clean if you cannot apply the adhesive primer immediately.

NOTE: If the bond surface becomes contaminated before you apply the primer, then clean the bond surface and do the HF - Alodine procedure again.

(1) Do not touch the surface(s) with your bare skin, waxed paper, or material that has a release agent or other contamination.

(2) If protection of the surface(s) is necessary, then put vacuum bag film or unwaxed paper (without ink or other contamination on it) on the bond surface(s).

J. Apply the BAC5710, Type 60 adhesive primer not later than 24 hours after you apply the Alodine. Refer to Paragraph 17./REPAIR GENERAL.

17. Application of BAC5710, Type 60 Adhesive Primer

WARNING: DO NOT GET SOLVENTS IN YOUR MOUTH, YOUR EYES, OR ON YOUR SKIN. DO NOT BREATHE THE FUMES FROM SOLVENTS. SOLVENTS ARE DANGEROUS MATERIALS. SOLVENTS CAN BE FLAMMABLE OR CAUSE DAMAGE TO THE ENVIRONMENT. REFER TO THE MATERIAL SAFETY DATA SHEETS (MSDS) AND THE LOCAL SAFETY PRECAUTIONS.

WARNING: DO NOT USE SOLVENT BASED PRIMERS IN AREAS WITH EQUIPMENT THAT PRODUCE HEAT OR A SPARK. IF YOU DO, AN EXPLOSION CAN OCCUR AND CAUSE INJURY.

A. Mix the Courtaulds Aerospace 515X346 primer with 910X520 catalyst and the 020-702 thinner. Refer to Table 207/REPAIR GENERAL for the mixture ratio of the primer components.

Table 207: Necessary Mix Ratio for the BAC5710, Type 60 Primer Components

COMPONENTS	MIX RATIO BY VOLUME
515X346 Base	4 parts
910X520 Catalyst	1 part
020-702 Thinner	4 parts

B. Prepare the mixture as given in the manufacturer's instructions.

(1) Permit the mixture to stay at room temperature for 30 minutes before you apply it to the surface.

(2) Apply the primer before 60 minutes after you apply the chemical conversion coating to the repair area.

NOTE: Do not apply the primer if its pot-life has expired (8 hours at 77°F (25°C)).

CAUTION: PREVENT CONTAMINATION OF THE PARTS AFTER YOU DO A SURFACE PREPARATION. WEAR CLEAN GLOVES, OR USE HOOKS TO MOVE THE PARTS. DO NOT APPLY THE PRIMER IF THE TEMPERATURE IS LESS THAN 50°F (10°C) OR MORE THAN 85 PERCENT OF THE RELATIVE HUMIDITY. IF YOU DO NOT OBEY, THE RESULT CAN BE AN UNSATISFACTORY BOND.

C. Apply a layer of primer to the surface to give a 0.0002 to 0.0008 inch (0.005 to 0.020 mm) dry film thickness.

D. Measure the primer thickness with an eddy current procedure, or a procedure that uses a visual standard, or with a procedure that gives the equivalent satisfactory results.

NOTE: If the primer is more than the specified thickness, then you must remove the primer, do the HF - Alodine procedure, and apply the primer again. Do not continue unless you have the correct primer thickness. If a second layer of the primer is necessary, permit the first layer to air dry for 1 hour before you apply the second layer.

E. Permit the primer to air dry at a temperature between 70°F and 90°F (21°C and 32°C) for 60 to 90 minutes before you apply the adhesive.

(1) Keep the primed mating surfaces free from contamination and sunlight.

(2) Do not store the primed mating surfaces for more than 7 days before you make the bond.

(3) Do not wipe the primed mating surfaces with solvent before you make the bond.

F. Apply the adhesive as given in Paragraph 18./REPAIR GENERAL or Paragraph 19./REPAIR GENERAL as applicable. Refer to Figure 201/REPAIR GENERAL for repair size limitations.

18. Application of BMS5-101 or BMS5-137 Film Adhesive

A. Applicability and Limitations

(1) 250°F (121°C) Repair - Use BMS5-101 Type II Film Adhesive. This repair option can be used on panels that were initially manufactured at 250°F (121°C).

(2) 310°F (154°C) Repair - Use BMS5-137 Type II (EA 9657 only). This repair option can be used on panels that were initially manufactured at 350°F (177°C).

(3) 350°F (177°C) Repair - Use BMS5-137 Type II Film Adhesive. This repair option can be used on panels that were initially manufactured at 350°F (177°C).

NOTE: Use a pressurized autoclave when you do the 350°F (177°C) cure.

B. Make a clear plastic template that shows the size and shape of the largest external doubler and the damage cutout. Use the template to make ink marks on the primed surface where the largest external doubler must be put.

NOTE: Use a water-resistant, alcohol based ink pen that will not contaminate or damage the primer or the adhesive. You can use a Sharpie™ SAN30000, SAN35000, or SAN37000 Series fine point pen (or an equivalent pen). Sharpie™ pens are a trademark of the Sanford Corporation.

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C. Make sure that you do these application steps in a clean area. Use a tabletop or other non-airplane component work surface when you cut adhesive film.

(1) Clean all the work surfaces, templates, and tools with solvent. Remove all contamination. Refer to SOPM 20-30-03.

(2) If necessary, you can put clean vacuum bag film on the work surface to keep contamination off the adhesive.

D. BMS5-121 Positioning Fabric applicability and limitations.

(1) BMS5-101 Type II film adhesive:

(a) BMS5-121 positioning fabric will be necessary when you use BMS5-101 Type II film adhesive and the vacuum bag procedure on an external doubler that has more than 64 square inches (400 square cm) of surface area. (You can also use positioning fabric with doublers that have less than 64 square inches (400 square cm) of surface area).

NOTE: Positioning fabric does not improve nor harm a repair that is cured in an autoclave.

(b) If two sides of a honeycomb panel are repaired with external doublers, it is not necessary to use positioning fabric on more than one side of the honeycomb core. If you do a flush repair, put the positioning fabric on the side of the honeycomb core that has the external doubler.

NOTE: Positioning fabric will be necessary on each side of the panel if two or more external doublers are necessary for each side of the panel. Refer to Paragraph 18.E.(2)/REPAIR GENERAL.

(2) BMS5-137 Type II film adhesive:

(a) Do not use BMS5-121 positioning fabric over open core when you use BMS5-137 Type II film adhesive.

NOTE: BMS5-137 film adhesive does not flow through positioning fabric sufficiently to make good core fillets.

(b) BMS5-121 positioning fabric will be necessary when you use BMS5-137 Type II film adhesive and the vacuum bag procedure on an external doubler that has more than 64 square inches (400 square cm) of surface area and no open core. (You can also use positioning fabric with doublers that have less than 64 square inches (400 square cm) of surface area).

NOTE: Positioning fabric does not improve nor harm a repair that is cured in an autoclave.

(c) BMS5-121 positioning fabric will be necessary when you use BMS5-137 Type II film adhesive when you use a vacuum bag procedure on an external overlap of more than 3.0 inches (75 mm) from open honeycomb core and the total doubler area is 64 square inches (400 square cm) (or more) of surface area.

E. Do the step that follows if BMS5-121 positioning fabric is necessary. Refer to Figure 213/REPAIR GENERAL and the steps that follow:

(1) Put a layer of BMS5-121 positioning fabric between the surface to be repaired and the repair doubler. Cut the fabric so that the edge of the fabric is 0.5 inch (13 mm) minimum, from all edges of the repair doubler.

(2) Put positioning fabric between each doubler when more than one doubler is necessary for the repair. Cut the fabric so that the edge of the fabric is 0.5 inch (13 mm) minimum, from all edges of each repair doubler.

F. Cut the film adhesive. Refer to Figure 213/REPAIR GENERAL for the steps that follow:

(1) Use only certified film adhesives from the Boeing Material Specification Qualified Products List (QPL).

NOTE: A manufacturer can make an adhesive film material that can be qualified to BMS5-129 and/or to BMS5-101 and be listed in each Qualified Products List (QPL). Do not use a BMS5-129 material for a metal bond repair unless the material has been tested and certified to the BMS5-101 specification also.

(2) Keep the bag that contains the roll of film adhesive at room temperature until there is no condensation on the bag.

NOTE: Do not touch the adhesive with your bare skin. Wear gloves to protect the adhesive from contamination.

(3) Put the film adhesive on a clean work surface. Make sure that the film adhesive side that is against the work surface has a separator sheet.

(a) If you use BMS5-101 Type II, OST with BMS5-121 positioning fabric, make sure that the mat side is up, tacky side down, against the work surface. If you use OST without the positioning fabric, make sure that the tacky side is up, mat side down, against the work surface.

NOTE: OST film adhesive has a mat carrier cloth on one of the outer surfaces, thus producing one side that is more tacky than the other side. Non–OST mat or knit film adhesive has a carrier cloth in the middle of the adhesive, thus both sides are equally tacky. Both OST and Non-OST can be used with BMS5-121 positioning fabric.

(b) If you are using Grade 5 film adhesive, then put two plies on the work surface. Make sure that you remove the separator sheet (or sheets) between the plies.

(c) If you are using Grade 10 or 15 film adhesive, then put one ply on the work surface.

NOTE: Do not use Grade 15 film adhesive to bond parts that have a gage thickness of 0.020 inch or less.

(4) Put the repair part with the surface to be bonded against the adhesive. If there is a separator sheet on top of the adhesive, make sure that it is removed.

(5) Cut the film adhesive all around the repair part with a sharp knife. Let the film adhesive extend 0.01 to 0.1 inch (0.3 to 2.5 mm) from the edge of the repair part.

(6) If you are using Grade 5 or 10 film adhesive, and the repair has an open core, then cut a piece of adhesive to the same dimensions as the open core. (Do not do this step if you are using a Grade 15 film adhesive).

G. Put the BMS5-121 positioning fabric (when specified) on to the area to be repaired. Make sure that the edges of the fabric go past the marks that were made in Paragraph 18.B./REPAIR GENERAL a minimum of 0.5 inches (13 mm).

NOTE: If you can not see the marks through the fabric, then use the template again to make marks that will show the position of the largest external doubler.

H. Put each of the repair parts (one at a time and in the correct sequence) on to the surface to be repaired. Refer to Figure 213/REPAIR GENERAL and the applicable repair procedure in Table 202/REPAIR GENERAL.

(1) Remove the separator sheet from each repair part before it is installed.

(2) Apply equal and light finger pressure to each repair part as it is installed.

(3) Apply small pieces of high-temperature polyester tape (or equivalent) to the edges of the repair part(s) to hold the part(s) on to the part to be repaired.

I. Do the instructions that follow to assemble the vacuum bag. Refer to Figure 215/REPAIR GENERAL.

(1) Put a breather strip all around and against the edges of the largest external repair doubler.

NOTE: Put the breather strips on the BMS5-121 positioning fabric (when the fabric is specified).

(2) Put a minimum of four thermocouples at the edges of the repair doubler(s) as given in Figure 214/REPAIR GENERAL.

NOTE: Use thermocouples and a measurement system that can measure temperature to a minimum accuracy of $\pm 5^{\circ}$F ($\pm 3^{\circ}$C).

(3) Connect the thermocouples to the applicable temperature recorder devices.

(4) Get a heat blanket that is a minimum 2 inches (50 mm) larger all around than the largest repair doubler.

(5) Use the heat blanket dimensions to find the correct dimensions of the layup and bagging materials.

(a) Cut two layers of dry peel ply that are 2 inches (50 mm) larger all around than the dimensions of the heat blanket. Put one of the dry peel plies on the repair part(s). Make sure that the edges of the peel ply extend an equal distance from the edges of the largest repair doubler.

(b) Cut a layer of solid or perforated FEP parting film to the same dimensions as the heat blanket. Put the parting film on to the dry peel ply. Make sure that the edges of the parting film are an equal distance from the edges of the peel ply.

(c) Put the second dry peel ply on to the first peel ply and the parting film. Make sure that the edges of the second peel ply are against the edges of the first peel ply.

(6) Protect the component to be repaired from too much heat.

(a) If there are attached fittings on the part to be repaired, then put insulation material between the attached fittings and the heat blanket.

(b) If the heat blanket extends more than 3.0 inches (75 mm) from the edge of the damage cutout, you can do this recommended procedure:

NOTE: If a heat blanket gets too hot, it can cause damage to the repair and to the adhesive in the undamaged skin. To help prevent damage (if the heat blanket gets too hot), do not let the heat blanket touch more skin than is necessary. Insulation between the heat blanket and the skin is recommended.

1) Put one edge of each insulation material on the skin, 2.0 to 3.0 inches (50 to 75 mm) from the edge of the damage cutout.

2) Put the opposite edge of each insulation material where the edges of the heat blanket will be.

(7) Put the heat blanket on to the top peel ply. Make sure that edges of the heat blanket are an equal distance from the edges of the peel ply (and the insulation, if applicable).

(8) Put four to six layers of glass fabric (or two layers of 0.04 inch (1.0 mm) breather fabric, or one layer of 0.1 inch (2.5 mm) breather fabric) above the heat blanket as a breather. Make sure that the breather is 2 inches (50 mm) larger all around than the heat blanket.

(9) Put a vacuum base above the fiberglass breather cloth for each vacuum port and vacuum gage port.

(10) Put on the vacuum bag sealant.

(a) You can put the vacuum bag sealant all around the area to be repaired, or

(b) If you use an envelope bag procedure, then seal the open part of the bag with the sealant.

(11) Make a hole in the outer vacuum bag at the vacuum base location for each vacuum port and vacuum gage port.

(12) Put the vacuum bag film on the repair area.

(13) Connect the vacuum port and vacuum gage ports to their vacuum bases.

NOTE: A procedure to remove the vacuum source will be necessary, that will not decrease the vacuum in the bag. If necessary, put a valve on the vacuum line between the vacuum bag and the vacuum source.

(14) If necessary, put insulation material on the outer surface of the vacuum bag.

19. Application of BMS5-92 or BMS5-141 Paste Adhesive

NOTE: Only small repair sizes can use these adhesives. Refer to Figure 201/REPAIR GENERAL for permitted repair sizes.

A. Make a clear plastic template that shows the size and shape of the largest external doubler and the damage cutout. Use the template to make ink marks on the primed surface where the largest external doubler must be put.

NOTE: Use a water-resistant, alcohol based ink pen that will not contaminate or damage the primer or the adhesive. You can use a Sharpie™ SAN30000, SAN35000, or SAN37000 Series fine point pen (or an equivalent pen). Sharpie™ pens are a trademark of the Sanford Corporation.

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CAUTION: MAKE SURE THAT YOU DO THIS PROCEDURE IN A CLEAN AREA. DO NOT LET CONTAMINATION OF THE REPAIR PARTS OCCUR. IF YOU DO NOT OBEY, YOU CAN CAUSE AN UNSATISFACTORY REPAIR.

B. Clean the work area, templates, and tools with solvent before you start to apply the adhesive. Refer to SOPM 20-30-03 for the applicable solvents and procedures.

CAUTION: DO NOT MIX MORE THAN 450 GRAMS OF BMS 5-141 AT ONE TIME. IF YOU DO, AN EXOTHERMIC REACTION (A BUILD-UP OF HEAT) CAN OCCUR. THE RESULT CAN BE DAMAGE TO THE ADHESIVE.

C. Use one of the adhesives that follow:

(1) BMS5-92

(a) Type V, Class 1 or Class 2 (preferred).

(b) Type I, Class 4 (alternative).

(2) BMS5-141

D. Refer to the manufacturer's instructions to mix paste adhesives. Tap the container or use a satisfactory procedure to remove air bubbles from the mixture.

NOTE: As an aid to make sure that you get the necessary thickness on the bond surface, you can add up to 1 percent by weight of 0.005 inch (0.13 mm) diameter glass beads. Mix the glass beads with the Part B hardener before you add the Part A base.

E. Apply a thin, smooth layer of paste adhesive to all of the mating surfaces.

NOTE: Do not touch the adhesive with your bare skin. Wear gloves to protect the adhesive from contamination.

(1) Make sure that the mating surfaces have adhesive primer on them before you apply the paste adhesive.

(2) After you mix the adhesive, apply the mixture to the repair parts as soon you can, but not after the pot-life has expired. Make sure that the mating surfaces have sufficient adhesive so that it will squeeze out from the edges of the repair part(s) when you mate them.

(3) After you apply the adhesive, you have a maximum of 5 minutes to mate the repair parts(s). (After 5 minutes, the adhesive will get a thin, cured skin layer on it, that will make it difficult to get a good bond).

F. Install the repair parts.

(1) Put the repair parts into their correct positions.

NOTE: Use a satisfactory procedure to remove air bubbles from that can be below each repair part. For example, you can put one edge of the repair part on the component. Then slowly put the repair part on the adhesive.

(2) Apply a equal and continuous pressure of 1 psi (7 kPa) minimum, to the surface of the repair parts. Let the adhesive squeeze out all around the edges.

WARNING: DO NOT GET SOLVENTS IN YOUR MOUTH, YOUR EYES, OR ON YOUR SKIN. DO NOT BREATHE THE FUMES FROM SOLVENTS. SOLVENTS ARE DANGEROUS MATERIALS. SOLVENTS CAN BE FLAMMABLE OR CAUSE DAMAGE TO THE ENVIRONMENT. REFER TO THE MATERIAL SAFETY DATA SHEETS (MSDS) AND THE LOCAL SAFETY PRECAUTIONS.

G. Clean all of the unwanted adhesive from the repair parts with solvent before you continue with the cure. Refer to SOPM 20-30-03 for the applicable solvents and procedures. Remove all of the contamination.

NOTE: Do not permit the solvent to get in the bond line.

20. Cure the bond

A. If you use an autoclave or oven:

NOTE: Go to step Paragraph 20.B./REPAIR GENERAL if you will do a heat blanket cure. Do not cure paste adhesives in a pressurized autoclave. Use an oven or go to step Paragraph 20.C./REPAIR GENERAL if you are curing a paste adhesive.

(1) Remove all aluminum attached fittings and hinges from the panel to be repaired. If the panel (to be repaired) is attached to other structure that does not need a bonded repair, then disassemble the parts. Put only the panel (to be repaired) inside of an oven or autoclave.

(2) Make sure that you use an applicable tool to hold all of the parts in their positions during the repair procedure.

NOTE: In most (but not all) conditions, the tool must be the same contour as the part to be cured.

(3) If an oven is used, then use a circulating oven that has equipment that can supply a vacuum and control the temperature. If you are curing a paste adhesive, use a tool or weight to put 1 psi (7 kPa) minimum pressure on the part. Use the vacuum bag procedure as specified in Paragraph 18.I./REPAIR GENERAL (but without the heat blanket). Then go to step Paragraph 20.B./REPAIR GENERAL.

(4) If an autoclave is used, then increase the pressure and temperature in the autoclave as specified in Boeing Process Specification BAC5514 ''Common Bonding Requirements for Structural Adhesives'' (or equivalent procedure).

(5) Cure the bond as given in Table 208/REPAIR GENERAL.

(6) After the cure is completed, decrease the pressure and temperature in the autoclave as specified in Boeing Process Specification BAC5514 ''Common Bonding Requirements for Structural Adhesives'' (or equivalent procedure).

(7) Examine the repair as specified in Paragraph 21./REPAIR GENERAL.

B. Vacuum bag and heat blanket procedure for film adhesives.

(1) Remove some of the air out of the honeycomb core before you start the cure.

(a) Use an initial vacuum of 3 to 5 inches (7.6 to 12.7 cm) of mercury (Hg) for 15 minutes.

(b) Apply a vacuum to a minimum of 22 inches (56 cm) of mercury (Hg) for 1 minute.

(2) Do an inspection of the vacuum bag. Look for leaks in the vacuum bag.

NOTE: A vacuum bag that has a leak can cause porosity in the adhesive and a weak bond.

(a) Remove the vacuum source.

NOTE: Do not disconnect the vacuum line(s). This can cause a loss of vacuum in the bag.

(b) Monitor the vacuum gage. After 5 minutes, the total difference in the vacuum must be less than 5 inches of (12.7 cm) of mercury (Hg).

WARNING: USE ONLY EXPLOSION-PROOF EQUIPMENT WHEN YOU DO THESE TYPES OF REPAIRS. IF YOU DO NOT, PERSONAL INJURY AND DAMAGE TO ADJACENT EQUIPMENT CAN BE THE RESULT. WHEN YOU WORK WITH FLAMABLE MATERIALS, HEAT, FIRE OR SPARKS CAN CAUSE AN EXPLOSION.

(3) Cure the bond as given in Table 208/REPAIR GENERAL.

(a) You can use hot air, heat lamps, or a radiant heater with the heat blankets, if necessary.

(b) Start to measure the cure time after the thermocouples show the bond to be at the specified cure temperature.

Table 208: Adhesive Cure Data

ADHESIVE SPECIFICATION	POT LIFE	CURE TEMPERATURE	CURE TIME (MINIMUM)	RATE OF TEMPERATURE INCREASE PER MINUTE
BMS5-92, Type I or V Adhesive Resin	Refer to Figure 211/REPAIR GENERAL	Refer to Figure 211/REPAIR GENERAL	Refer to Figure 211/REPAIR GENERAL	Not Applicable
BMS5-101 Adhesive Film	Not Applicable	225°F to 260°F (107°C to 127°C)	90 Minutes	3 ± 2°F (2 ± 1 °C)
BMS5-137 Type II, Class 1 (EA 9657)	Not Applicable	300°F to 320°F (149°C to 160°C)	5 Hours	Between 2 and 3°F (1 and 2°C)
BMS5-137 Type II, Class 1 (All Products)	Not Applicable	340°F to 360°F (171°C to 182°C)	90 Minutes	Between 2 and 10°F (1 and 5°C)
BMS5-141 Adhesive Paste	60 Minutes	Refer to Figure 212/REPAIR GENERAL	Refer to Figure 212/REPAIR GENERAL	Not Applicable

(4) Apply and keep a vacuum at a minimum of 20 inches (50 cm) of mercury (Hg) during the cure cycle.

(5) If it is necessary to add more pressure, put shot-bags, clamps or other mechanical pressure on to the repair area.

NOTE: If the repair is on a honeycomb panel, this pressure can prevent a disbond, (during the cure cycle) between the undamaged skin and core.

(a) The pressure must be applied equally to all the areas. The total pressure on a honeycomb panel must not be more than 25 psi (170 kPa).

(b) Use cast ceramic, plaster, or plastic tools when you apply pressure to the outer skin on a contoured or rounded panel.

(6) When the cure time is completed, decrease the temperature at a rate of 5°F (3°C) a minute.

(7) Let the repaired part decrease in temperature to 150°F (66°C) or less before you release the pressure.

NOTE: If a temperature indication goes below the specified cure temperature, then extend the cure time before you decrease the temperature. Continue at the specified cure temperature for a minimum time equal to the time that the indication was below the specified cure temperature.

(8) Examine the repair as specified in Paragraph 21./REPAIR GENERAL.

C. Paste adhesives.

(1) Continue to apply 1 psi (7 kPa) minimum pressure.

(2) You can decrease the cure times for paste adhesives if you increase the cure temperature of the repair. Refer to Figure 211/REPAIR GENERAL and Figure 212/REPAIR GENERAL for the time-temperature cure charts. You can use an oven, hot air, heat lamps, or a radiant heater to increase the cure temperature.

21. Do an examination of the bonded repair

A. Use a synthetic fiber material (Scotchbrite™ pads, for example) to remove all fabric, plastic film, and thermocouple materials that are bonded to the outside of the repair. Make sure that you do not scratch the aluminum or remove clad material.

B. Do a visual inspection of the repair doubler(s).

(1) Look for a continuous bead of cured adhesive around the edges of each repair doubler. Look for disbonds, gaps, or a failure of the bond line. No disbonds, gaps or failures at the bond line (that you can see) are permitted. If some of the bead is missing or not fully cured, the repair is unsatisfactory.

NOTE: A bead that is not fully cured will be soft and tacky.

(2) Look to see if a repair doubler moved during the cure. Movement of 0.06 inches (1.5 mm) or less is permitted.

C. A post repair Non-Destructive Inspection (NDI) of the repair area is recommended.

(1) If a heat blanket was used, then do an NDI of the area that was below the heat blanket. If you use NDI procedures, refer to 737 NDT Part 1, 51-01-01 and 737 NDT Part 1, 51-04-00. Other NDI procedures, if they are satisfactory, are also permitted.

NOTE: You can use a tap test procedure as an alternative inspection procedure for a skin thickness that is a 0.040 inch (1.0 mm) or less. Use the tap test as given in 737 NDT Part 1, 51-05-01.

(2) Continue to use NDI to examine the area 8 inches (20 cm) from where the edges of the heat blanket were.

(3) If you find an NDI indication that shows a possible disbond, you can do additional tests and analysis to verify that it is a disbond. If tests and analysis verify that the repair has a disbond, then the repair is unsatisfactory.

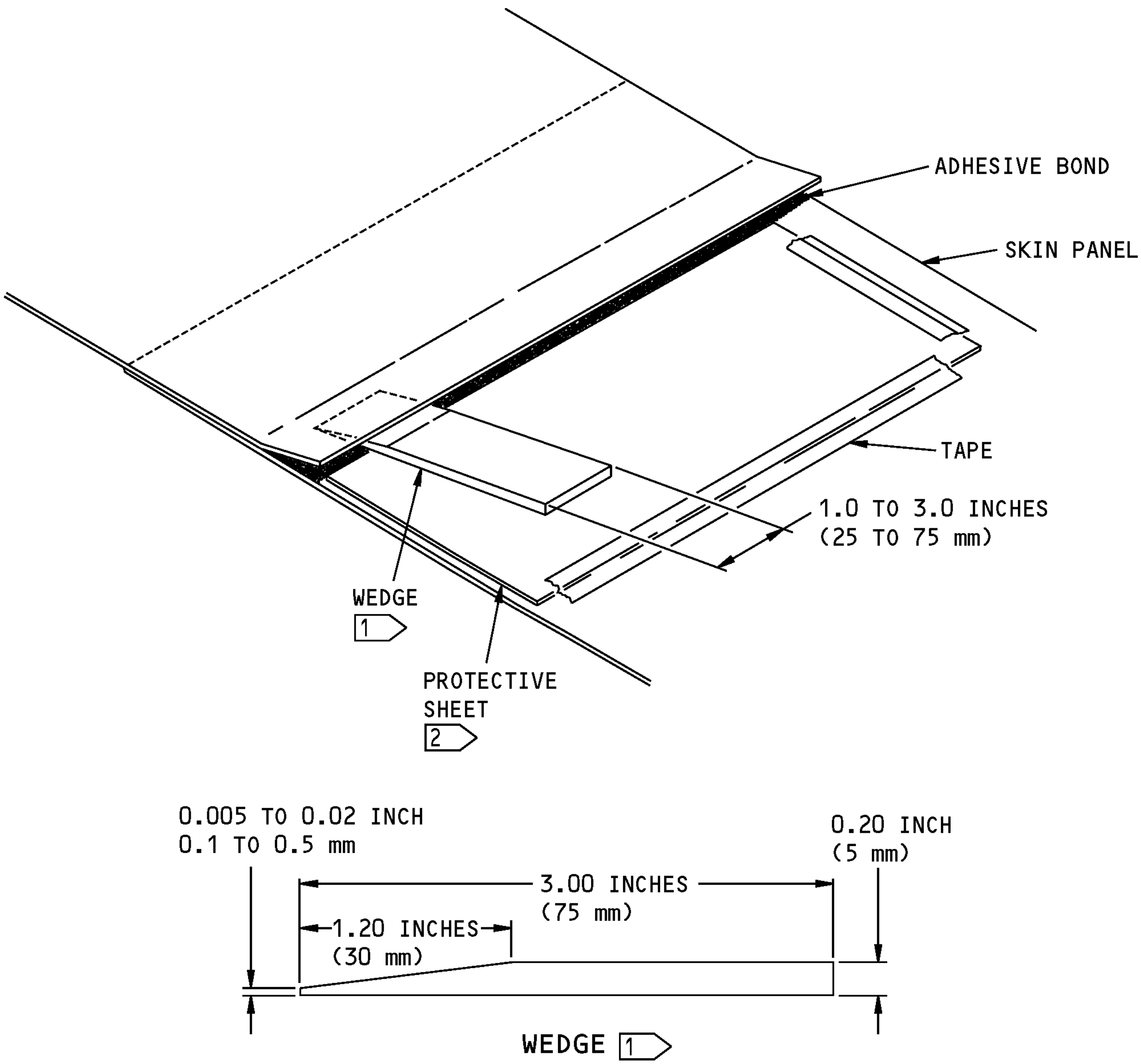
D. Remove all repair parts that have an unsatisfactory bond or cut out and repair the area that is disbonded. Do all of the necessary repair steps to make the repair satisfactory.

22. Clean, seal and finish

A. If the repair is satisfactory, then clean the surfaces that are to be sealed and finished. Refer to AMM PAGEBLOCK 51-21-21/701.

B. Seal all of the gaps and edges of the doubler(s) as given in 51-20-05, GENERAL.

C. Apply a protective finish to the bare surfaces as given in AMM PAGEBLOCK 51-21-99/701.



SEPARATION OF THE BONDED PARTS WITH WEDGES

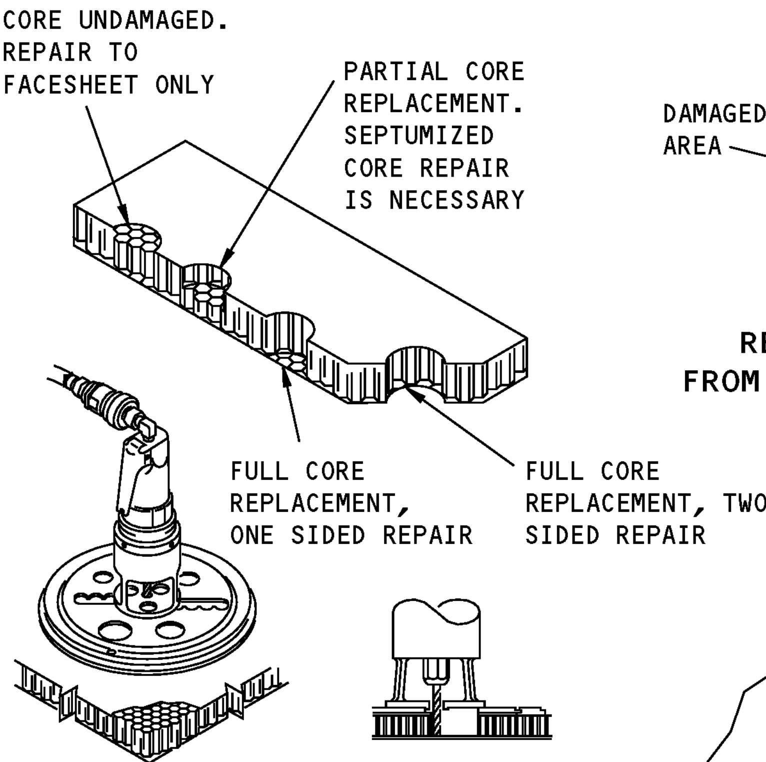
A

NOTES

1 WOOD OR PLASTIC ARE EXAMPLE MATERIALS

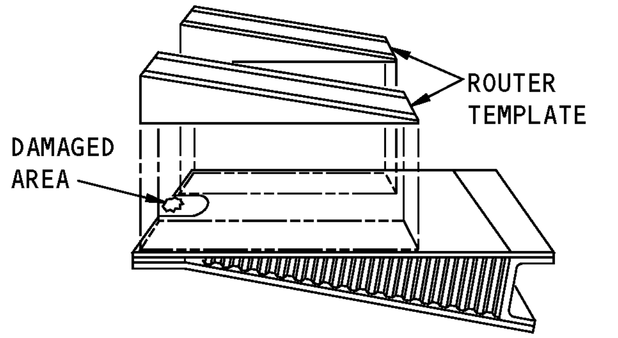
2 METAL OR PLASTIC ARE EXAMPLE MATERIALS

Damage Removal Procedures
Figure 203 (Sheet 1 of 2)



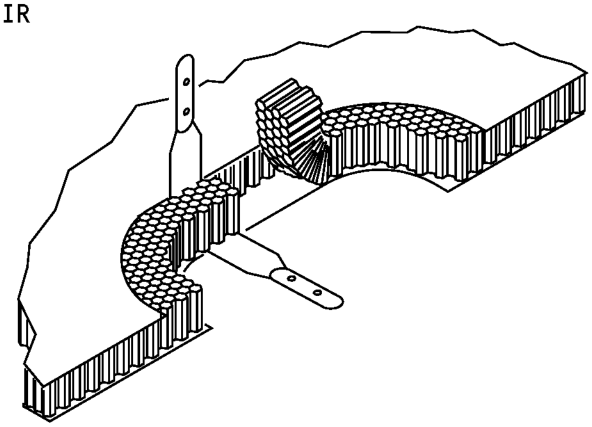
HONEYCOMB CORE REMOVAL

B



REMOVING HONEYCOMB CORE
FROM A TAPERED CONTROL SURFACE

C



REMOVAL OF CORE WITH CORE KNIFE

D

INSTRUCTIONS

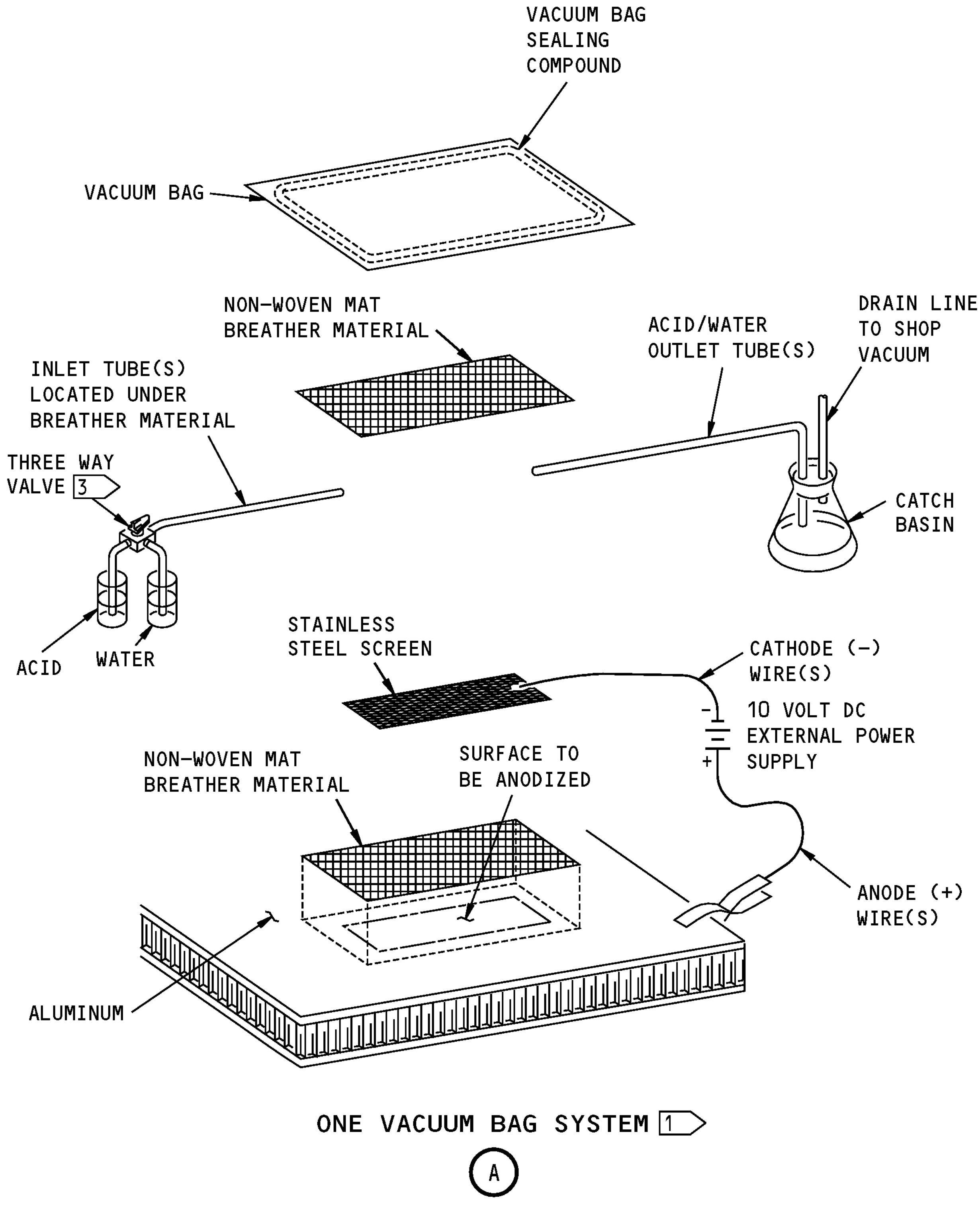
1. Remove the face sheet and/or core with a power router, using a router template to protect the undamaged part of the face sheet. Refer to SRM 51-10-02 for instructions on the use of a router and template.

   NOTE: The router can be adjusted to remove: One of the face sheets only, a face sheet and part of the core, a face sheet and all of the core, or both the face sheets and core. See Detail B.

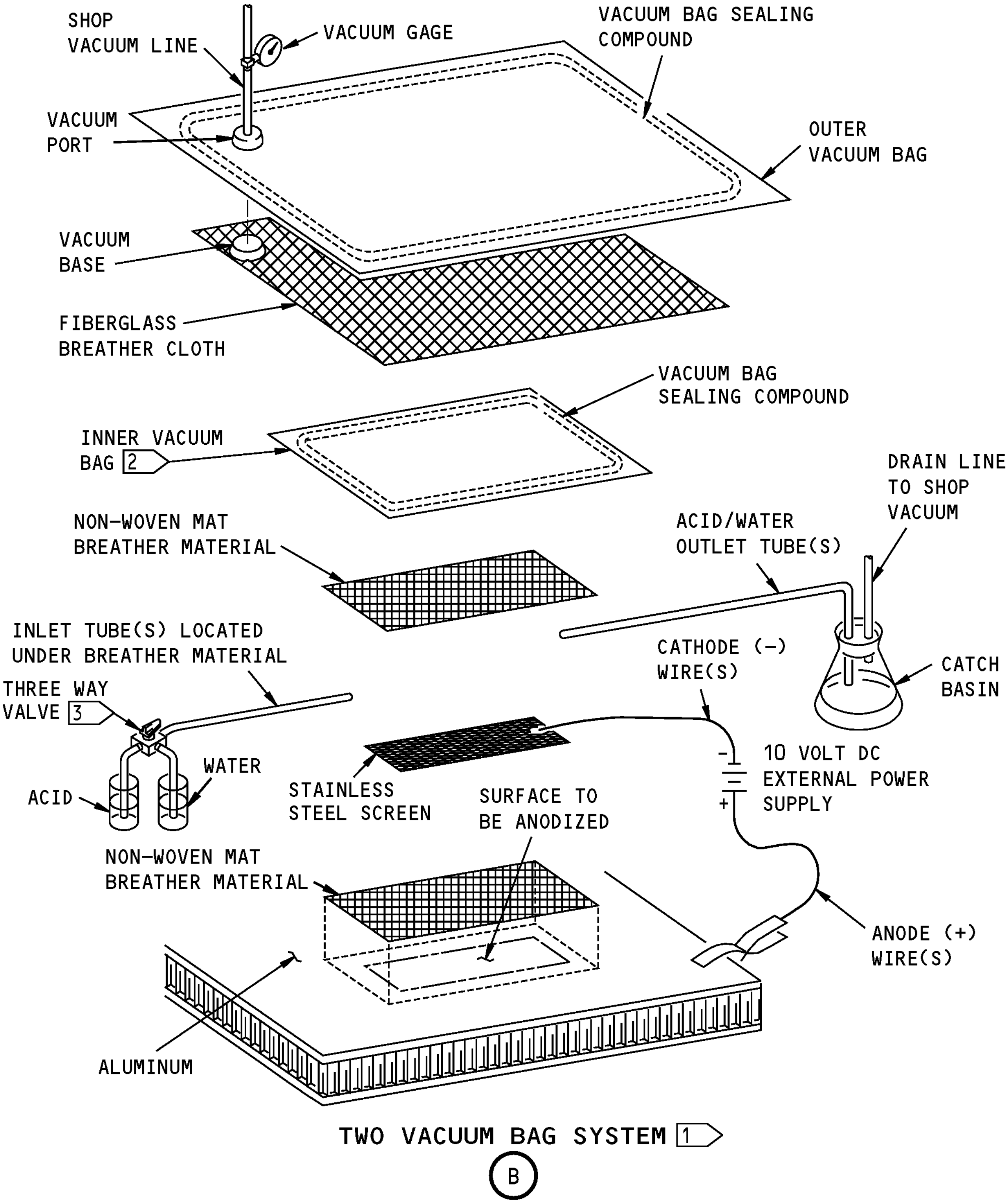
2. If you are routing a tapered part, you can use wedge shaped router templates. This will permit the router to cut the core material parallel with the lower surface. See Detail C.

3. It is permitted to remove honeycomb core with a core knife. See Detail D.

Damage Removal Procedures
Figure 203 (Sheet 2 of 2)



Phosphoric Acid Containment System (PACS)
Figure 204 (Sheet 1 of 3)



Phosphoric Acid Containment System (PACS)
Figure 204 (Sheet 2 of 3)

NOTES

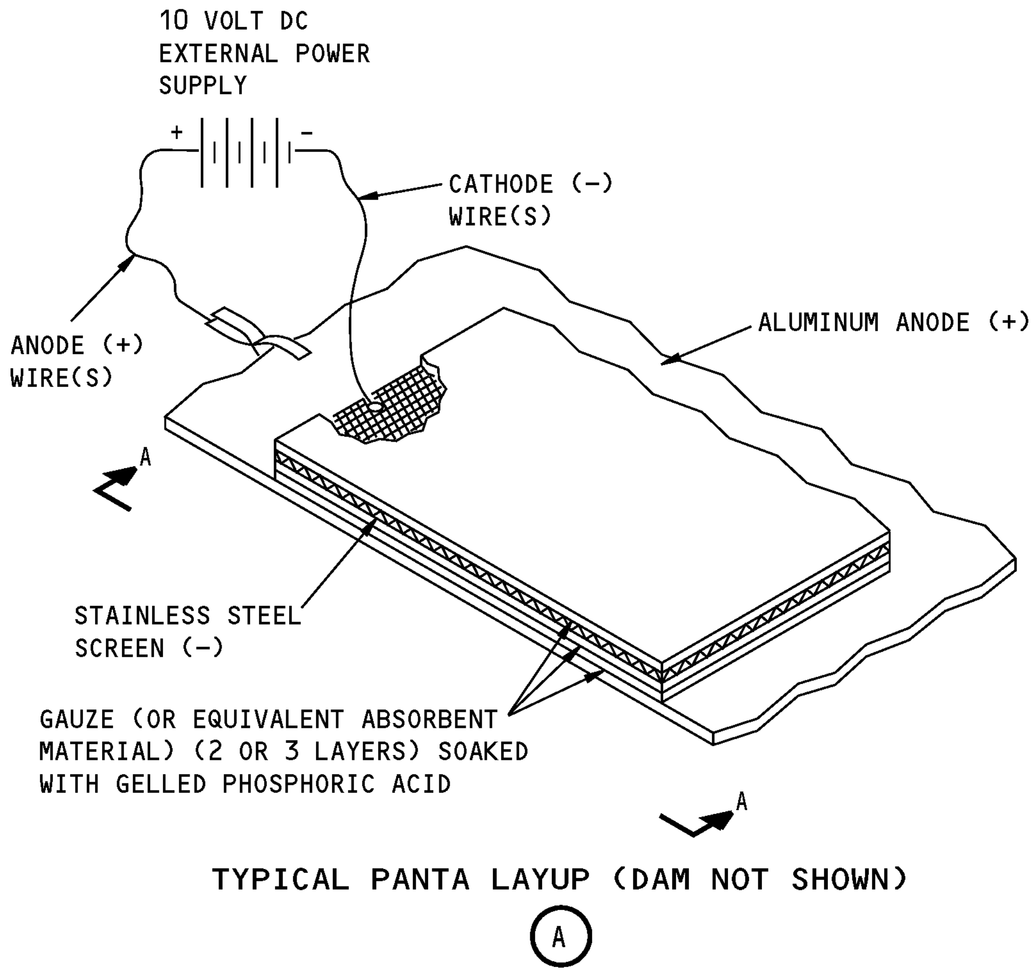
1 WHEN THE SURFACE TO BE ANODIZED IS FACE UP (AS SHOWN IN THIS FIGURE), THE SECOND, OUTER VACUUM BAG IS OPTIONAL. IF THE SURFACE TO BE ANODIZED IS FACE DOWN OR IF THE SURFACE IS VERTICAL, THEN BOEING RECOMMENDEDS THAT YOU USE AN OUTER VACUUM BAG. THE OUTER VACUUM BAG WILL CONTAIN THE ACID IF THERE IS LEAKAGE FROM THE INNER VACUUM BAG. SEE DETAIL A FOR THE ONE VACUUM BAG SYSTEM, SEE DETAIL B FOR THE TWO VACUUM BAG SYSTEM.

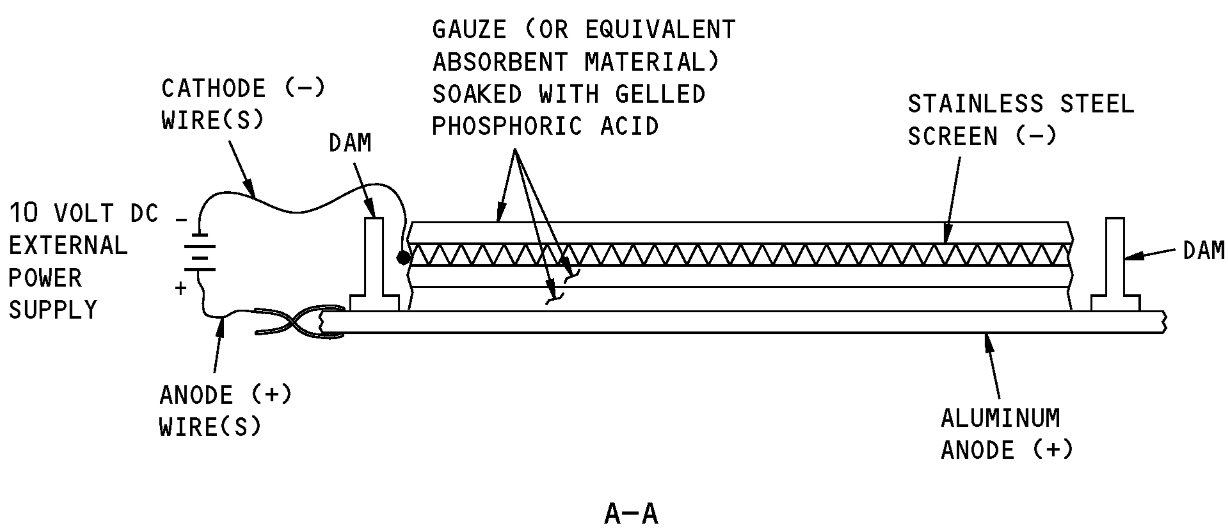
2 AFTER YOU ARE FINISHED WITH THE PACS PROCEDURE, DO A CHECK FOR ACID LEAKAGE BEFORE YOU REMOVE THE INNER VACUUM BAG. IF THERE WAS ACID LEAKAGE, RINSE AND REMOVE ALL OF THE ACID AND OTHER CONTAMINATION FROM THE ALUMINUM FIRST. THEN REMOVE THE INNER VACUUM BAG.

3 THE THREE-WAY VALVE OPERATION MUST PERMIT THE CONDITIONS THAT FOLLOW:

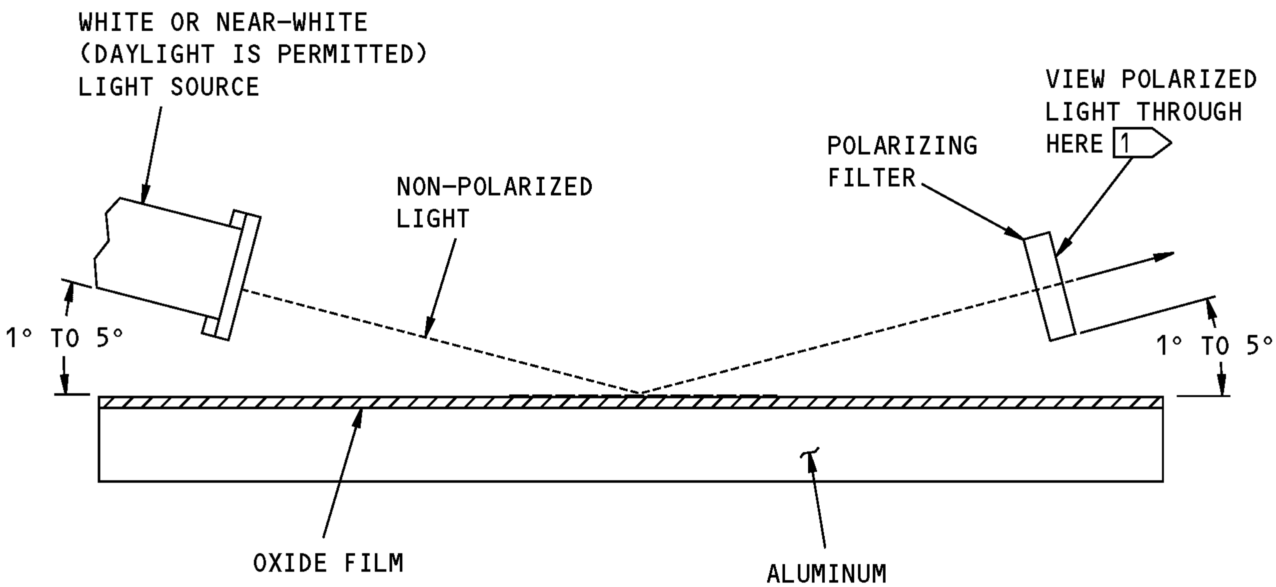
- NO FLOW (OFF)
- FLOW OF ACID ONLY
- FLOW OF RINSE WATER ONLY

Phosphoric Acid Containment System (PACS)
Figure 204 (Sheet 3 of 3)





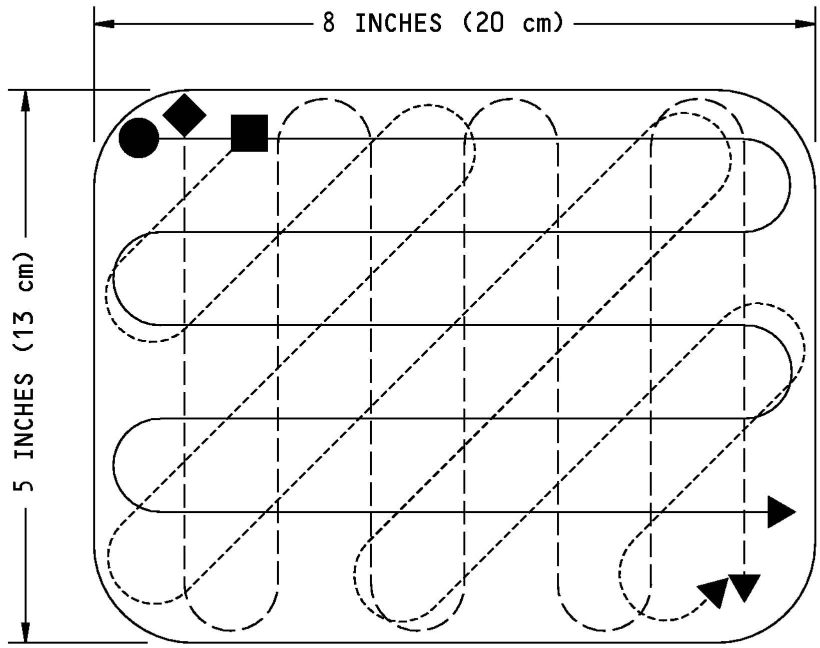
Phosphoric Acid Non-Tank Anodize (PANTA) Layup
Figure 205



NOTES

1 VIEW THE LIGHT AS YOU ROTATE (TURN) THE FILTER 90° TO INSPECT FOR A COLOR CHANGE

Polarized Light Test - Verification of Anodic Oxide Film
Figure 206



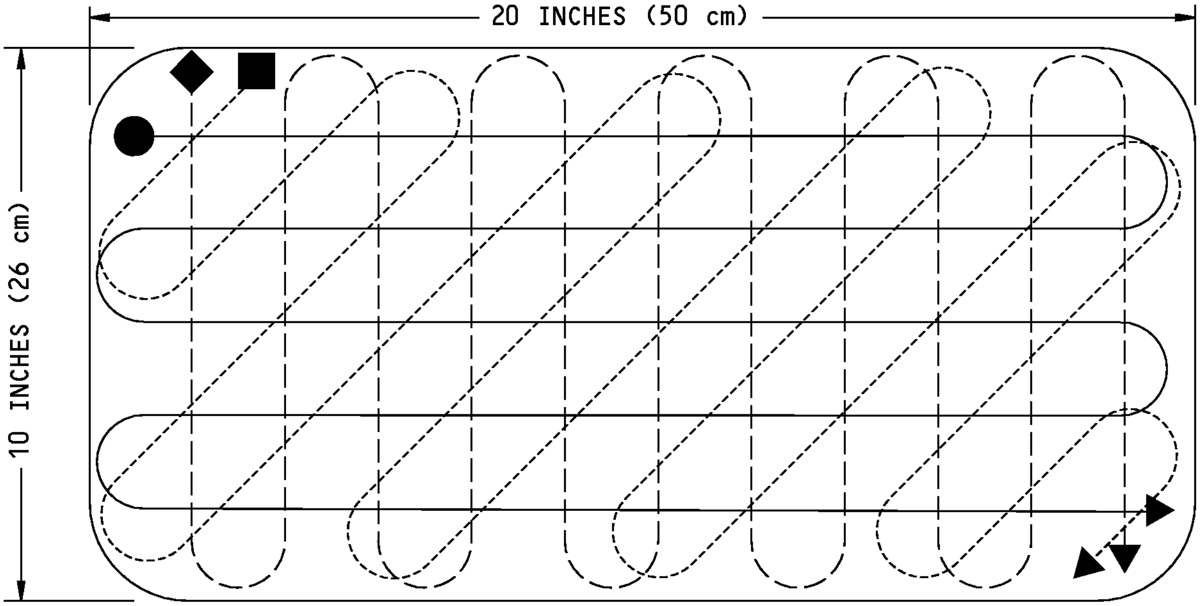
AREA SANDING PATTERN (SMALL SECTION)- THREE DISC EXAMPLE
(2.0 INCHES (50 mm) DIAMETER DISCS) 1

A

SANDING PROCEDURES FOR BOEGEL	
TIME SANDPAPER USED	30 SECONDS FIRST DIRECTION 30 SECONDS/⊥ DIRECTION 30 SECONDS (MAX) DIAGONAL DIRECTION (GRINDER) OR RANDOM DIRECTION (SANDER)

TABLE A

Sanding Procedure Used for Boegel
Figure 207 (Sheet 1 of 5)



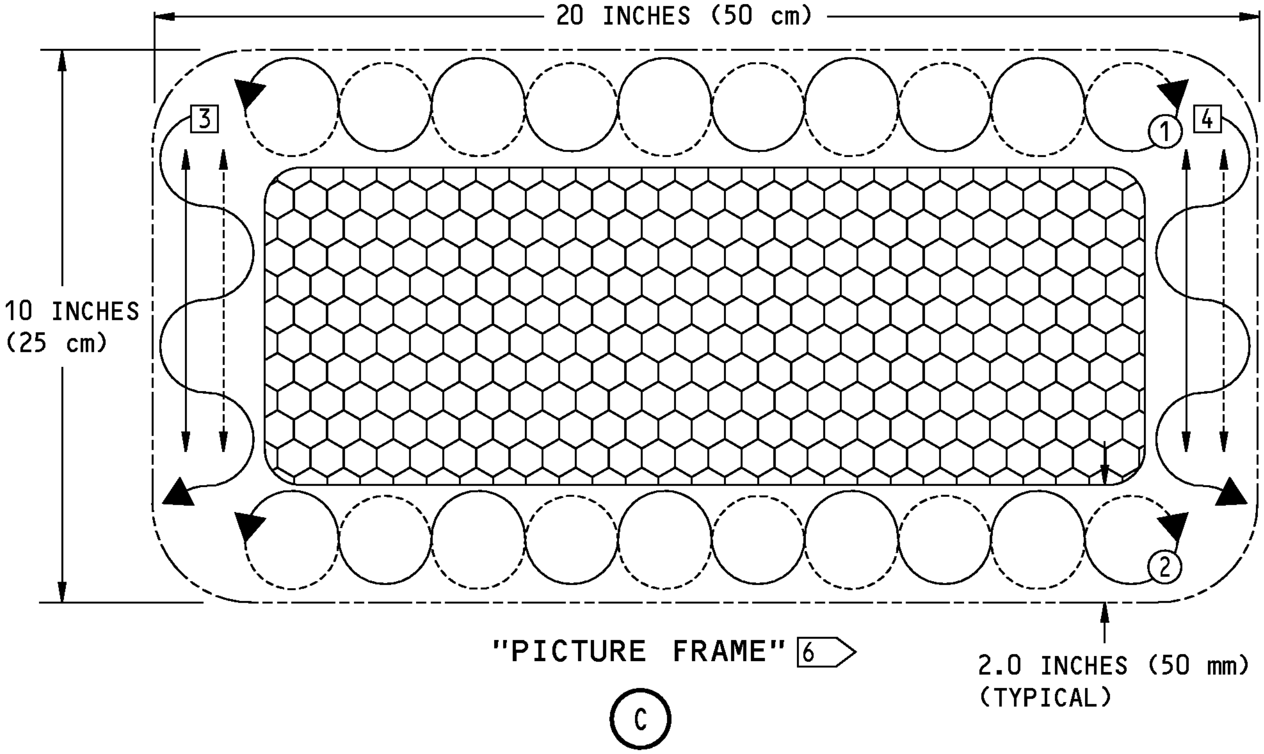
AREA SANDING PATTERN (LARGE SECTION)- 11 DISC EXAMPLE
(2.0 INCHES (50 mm) DIAMETER DISCS) 1

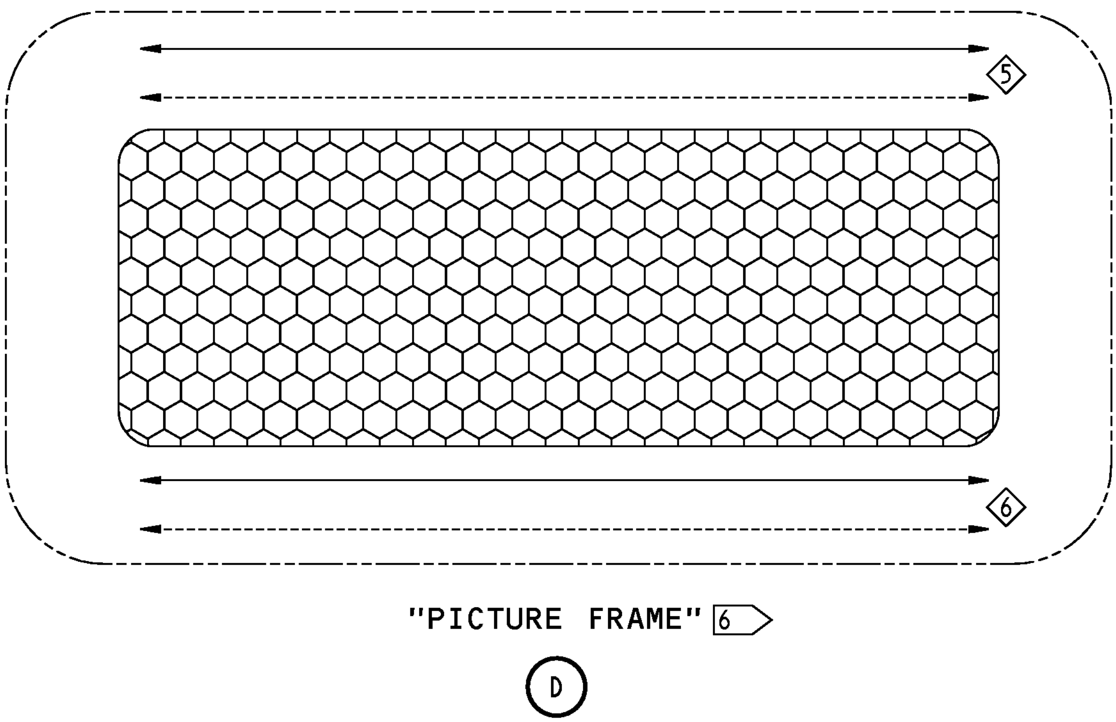
B

SANDING PROCEDURES FOR BOEGEL (DETAILS A AND B)			
SANDPAPER SEQUENCE	DIRECTION	TIME	TOOL
1ST PIECE	0 DEGREES	30 SECONDS	GRINDER OR SANDER
2ND PIECE	90 DEGREES	30 SECONDS	GRINDER OR SANDER
3RD PIECE	0 DEGREES	30 SECONDS	GRINDER OR SANDER
4TH PIECE	90 DEGREES	30 SECONDS	GRINDER OR SANDER
5TH PIECE	0 DEGREES	30 SECONDS	GRINDER OR SANDER
6TH PIECE	90 DEGREES	30 SECONDS	GRINDER OR SANDER
7TH PIECE	0 DEGREES	30 SECONDS	GRINDER OR SANDER
8TH PIECE	90 DEGREES	30 SECONDS	GRINDER OR SANDER
9TH PIECE	0 DEGREES	30 SECONDS	GRINDER OR SANDER
10TH PIECE	90 DEGREES	30 SECONDS	GRINDER OR SANDER
LAST PIECE	45 DEGREES	30 SECONDS	GRINDER
(WITH GRINDER OR SANDER)	RANDOM	30 SECONDS	SANDER

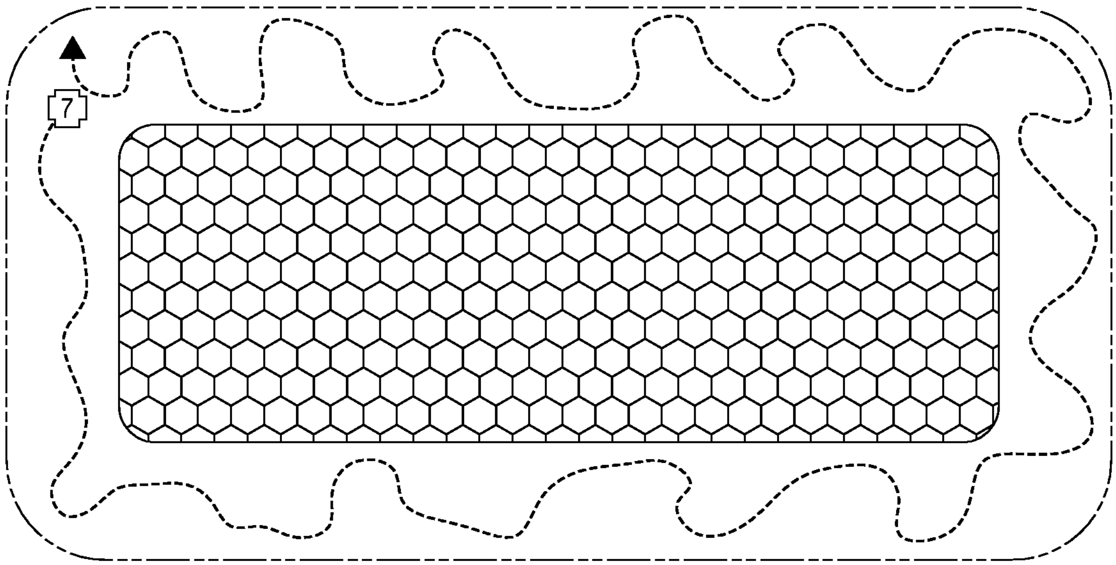
TABLE B

Sanding Procedure Used for Boegel
Figure 207 (Sheet 2 of 5)





Sanding Procedure Used for Boegel
Figure 207 (Sheet 3 of 5)



"PICTURE FRAME" 6

E

SANDING PATTERNS FOR A "PICTURE FRAME" (DETAILS C, D, AND E) USING A DIE GRINDER WITH A 2 INCH (50 mm) DISK		
SANDPAPER SEQUENCE	PATTERN	TIME
1ST PIECE 1	SINE WAVES	30 SECONDS
2ND PIECE 2	SINE WAVES	30 SECONDS
3RD PIECE 3	SINE WAVES AND THEN STRAIGHT LINES	30 SECONDS
4TH PIECE 4	SINE WAVES AND THEN STRAIGHT LINES	30 SECONDS
5TH PIECE 5	STRAIGHT LINES	30 SECONDS
6TH PIECE 6	STRAIGHT LINES	30 SECONDS
7TH PIECE 7	RANDOM	30 SECONDS

TABLE C

Sanding Procedure Used for Boegel
Figure 207 (Sheet 4 of 5)

180 GRIT SANDING DISCS [2]			
DISC DIAMETER	SHEETS NECESSARY TO SAND AREAS 10 SQUARE INCHES (64 SQUARE cm) OR LESS	SHEETS NECESSARY TO SAND AREAS 11 TO 21 SQUARE INCHES (70 TO 135 SQUARE cm)	SHEETS NECESSARY TO SAND AREAS 22 TO 42 SQUARE INCHES (140 TO 270 SQUARE cm)
3/4 INCH (19 mm)	2 [3]	NOT PERMITTED	NOT PERMITTED
1.0 INCH (25 mm)	2 [3]	NOT PERMITTED	NOT PERMITTED
1 1/2 INCHES (38 mm)	NOT PERMITTED	2 [3]	NOT PERMITTED
2.0 INCHES (50 mm)	NOT PERMITTED	2 [3]	3 [4]
3.0 INCHES (75 mm)	NOT PERMITTED	2 [3]	2 [3]
4.0 INCHES (100 mm)	NOT PERMITTED	2 [3]	2 [3]
5.0 INCHES (125 mm)	NOT PERMITTED	NOT PERMITTED	2 [3]
6.0 INCHES (150 mm)	NOT PERMITTED	NOT PERMITTED	[3] [5]

TABLE D

NOTES

[1] REFER TO TABLE D FOR ALTERNATIVE DISC DIAMETERS.

[2] REFER TO DETAIL B WHEN MORE THAN THREE SHEETS ARE NECESSARY. ALWAYS USE THE LAST SHEET IN A DIAGONAL DIRECTION (GRINDER) OR RANDOM DIRECTION (SANDER).

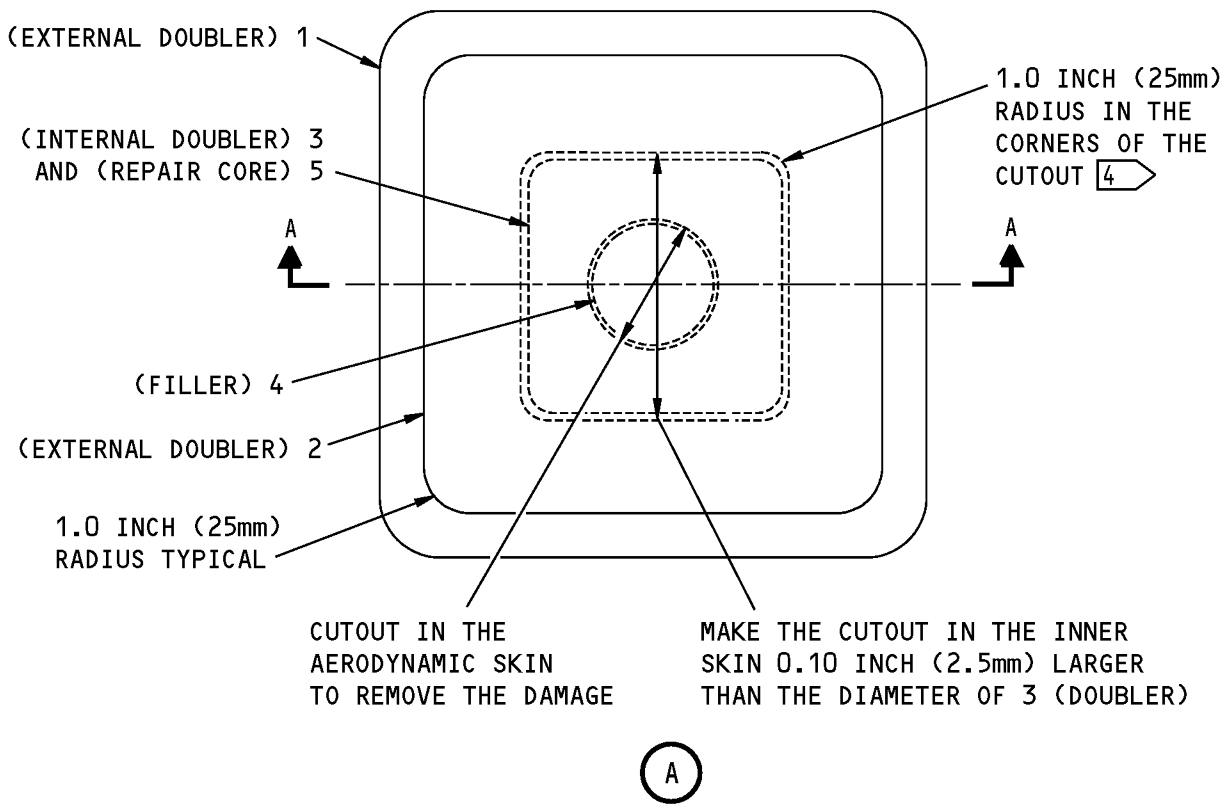
[3] FIRST SHEET:
DO 20 SECONDS IN THE ⇔ DIRECTION AND 10 SECONDS IN THE ⊥ DIRECTION.
SECOND SHEET:
DO 10 SECONDS IN THE ⊥ DIRECTION AND 20 SECONDS IN A DIAGONAL DIRECTION (GRINDER) OR RANDOM DIRECTION (SANDER).

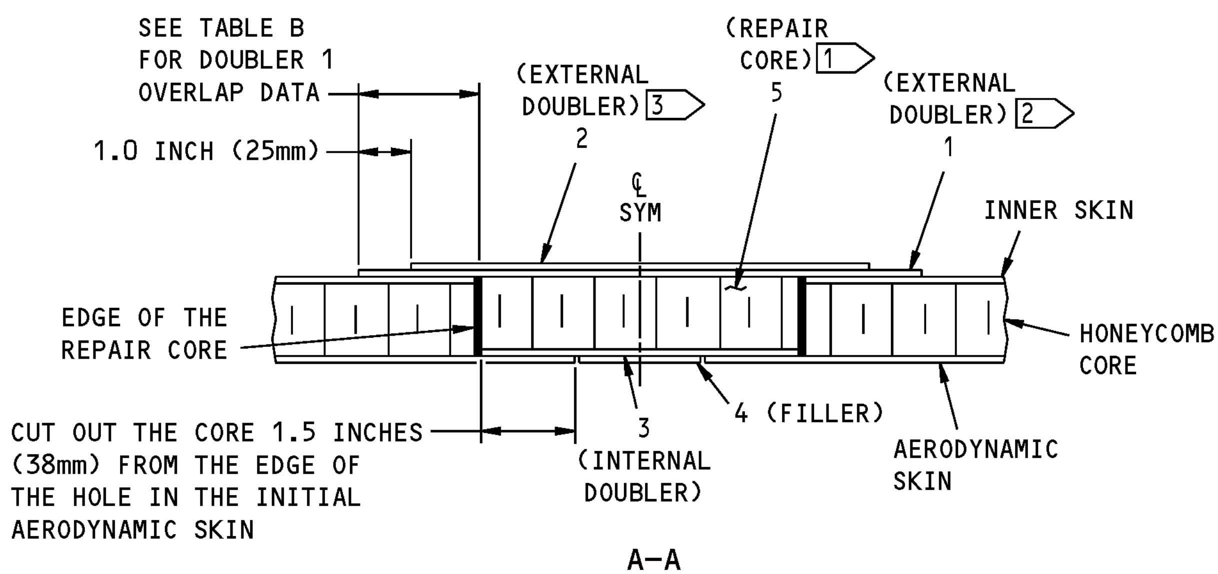
[4] REFER TO DETAIL A.

[5] NOT PERMITTED FOR AREAS LESS THAN 40 SQUARE INCHES (260 cm)
USE TWO SHEETS TO SAND AREAS THAT ARE 40 TO 50 SQUARE INCHES (260 TO 320 SQUARE cm).

[6] A "PICTURE FRAME" DESCRIBES THE AREA ALONG THE EDGES OF A CUTOUT. REFER TO TABLE C.

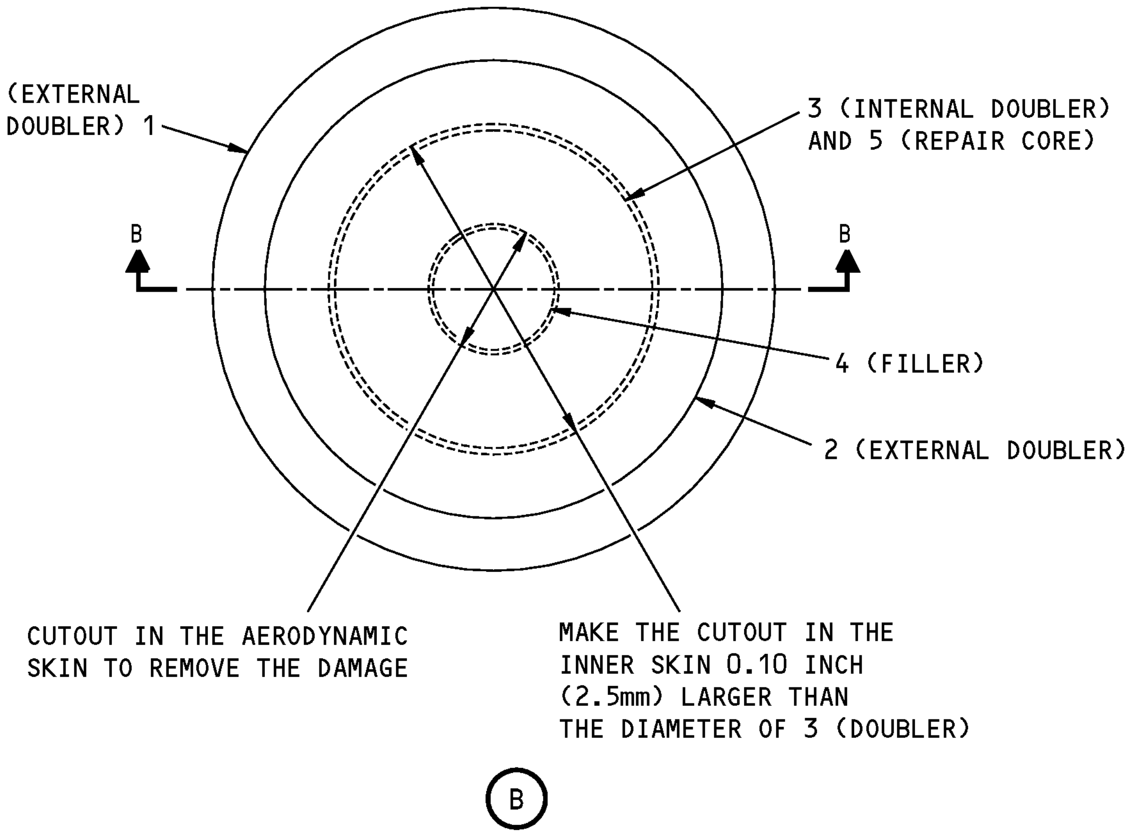
Sanding Procedure Used for Boegel
Figure 207 (Sheet 5 of 5)

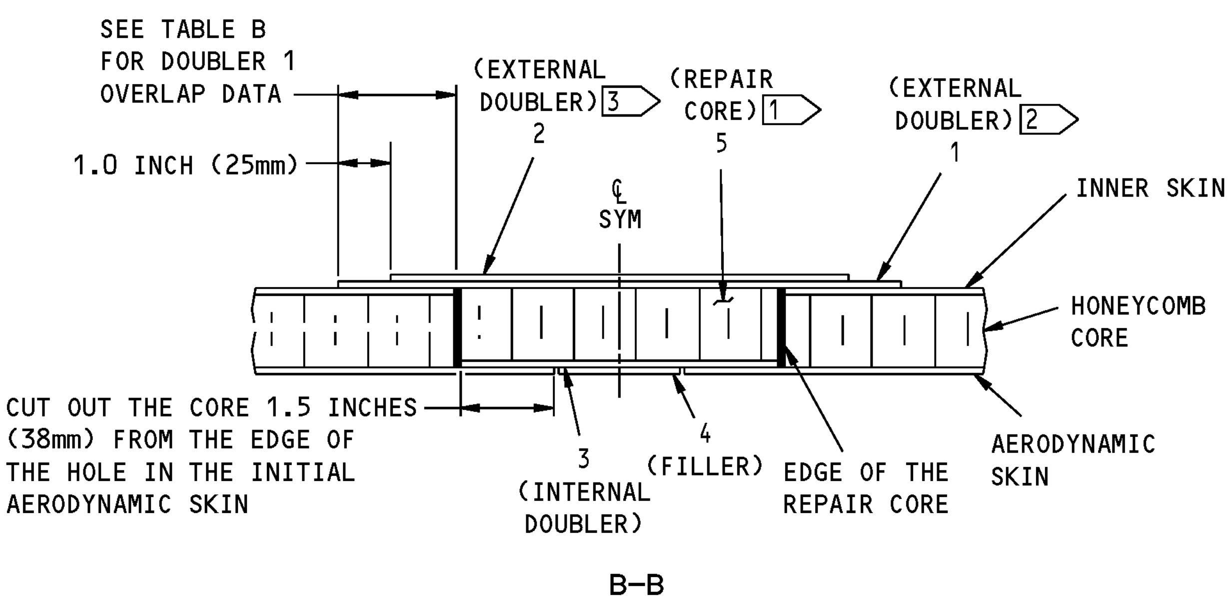




A-A

Repair Doubler Specifications for Flush Repairs
Figure 208 (Sheet 1 of 4)





Repair Doubler Specifications for Flush Repairs
Figure 208 (Sheet 2 of 4)

REPAIR PART THICKNESS (INCHES) FOR BONDED REPAIRS				
INITIAL SKIN GAGE RANGE	PART 1 EXTERNAL DOUBLER	PART 2 EXTERNAL DOUBLER	PART 3 INTERNAL DOUBLER	PART 4 FILLER
0.012 TO 0.020	SAME AS THE INITIAL SKIN	NOT NECESSARY	SAME AS THE AERODYNAMIC SKIN [5]	SAME AS THE AERODYNAMIC SKIN [5]
0.021 TO 0.025	0.025 [2]	[2]		
0.026 TO 0.032	0.032 [2]	[2]		
0.033 TO 0.041	0.016 [5]	0.025 [5]		
0.042 TO 0.045	0.020 [5]	0.025 [5]		
0.046 TO 0.050	0.025 [5]	0.025 [5]		
0.051 TO 0.057	0.025 [5]	0.032 [5]		
0.058 TO 0.064	0.032 [5]	0.032 [5]		
0.065 TO 0.072	0.032 [5]	0.040 [5]		
0.073 TO 0.080	0.040 [5]	0.040 [5]		

TABLE A

INITIAL SKIN THICKNESS	THE MINIMUM OVERLAP DIMENSION OF DOUBLER 1
0.00 TO 0.032	1.5 INCHES (38 mm)
> 0.032	2.5 INCHES (63 mm)

TABLE B

REPAIR PART THICKNESS (INCHES) FOR HIGH CURVATURE REPAIRS		
INITIAL SKIN	PART 1 EXTERNAL DOUBLER	PART 2 EXTERNAL DOUBLER
0.021 TO 0.028	0.012	0.016
0.029 TO 0.032	0.012	0.020

TABLE C

Repair Doubler Specifications for Flush Repairs
Figure 208 (Sheet 3 of 4)

NOTES

- USE THIS FIGURE TO DETERMINE THE DOUBLER DIMENSIONS ONLY.
- THE MATERIAL FOR THE REPAIR PARTS MUST BE EQUIVALENT TO THE SAME BOEING MATERIAL SPECIFICATION (BMS) AND HEAT TREAT AS THE SKIN TO BE REPAIRED.
- BONDING SURFACES OF 2000 SERIES ALUMINUM DOUBLERS CAN BE CLAD OR NON-CLAD (BARE). BONDING SURFACES OF 7000 SERIES ALUMINUM DOUBLERS MUST BE NON-CLAD (BARE).

[1] MAKE THE PART 5 REPAIR CORE LEVEL WITH THE OUTER SURFACE OF THE SKIN TO BE REPAIRED. (UNLESS SPECIFIED DIFERENTLY IN A SPECIFIC REPAIR).

[2] FOR THE INITIAL SKIN THICKNESSES THAT ARE 0.021 TO 0.032 GAGE, THE PART 2 (EXTERNAL DOUBLER) IS NOT NECESSARY IF THE SKIN IS FLAT, OR IF THE PART 1 DOUBLER CAN TOUCH ALL OF THE BOND SURFACE WITH ONLY LIGHT FINGER PRESSURE.

IF THE SKIN SURFACE HAS A HIGH CURVATURE, YOU CAN DO ONE OF THE STEPS THAT FOLLOW:

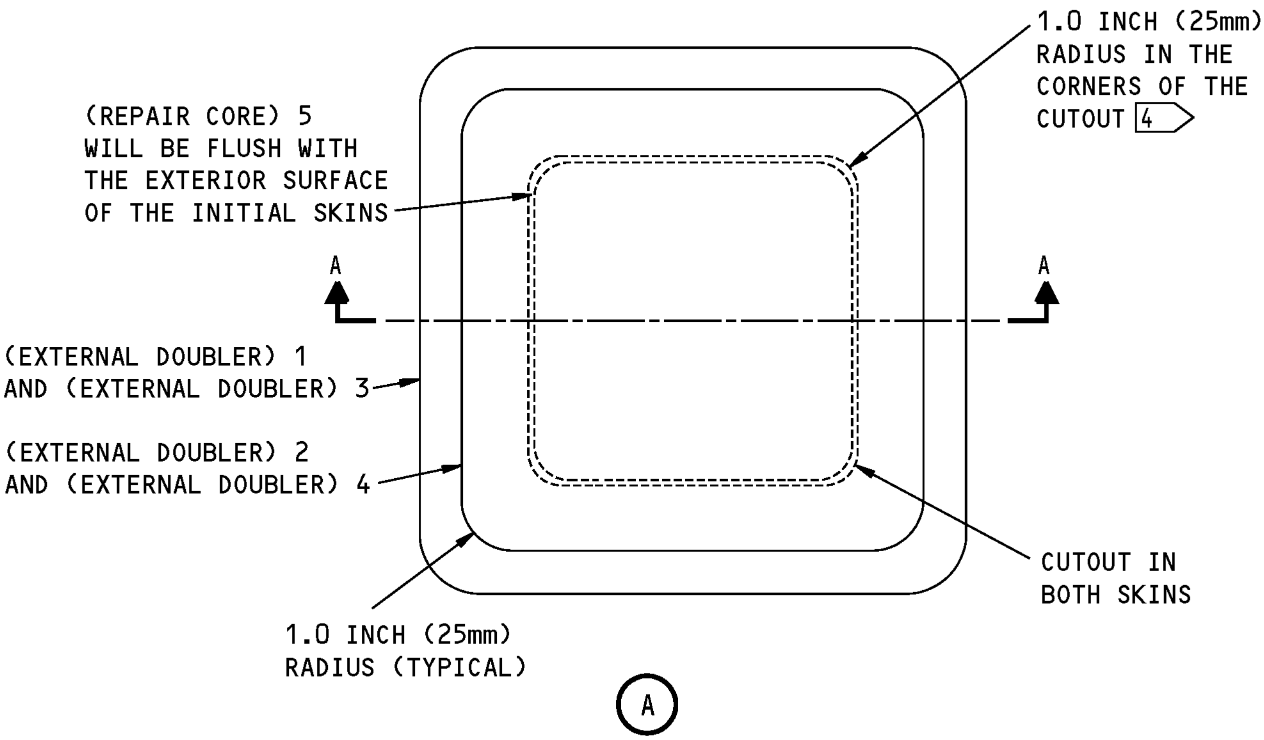
- MAKE THE PART 1 DOUBLER TO THE SAME CURVATURE AS THE SKIN SURFACE, SO THAT LIGHT FINGER PRESSURE MAKES THE DOUBLER TOUCH ALL OF THE SKIN SURFACE, OR
- MAKE THE PART 1 DOUBLER FROM 0.012 GAGE, AND MAKE THE PART 2 DOUBLER FROM THE THICKNESS SPECIFIED IN TABLE C.

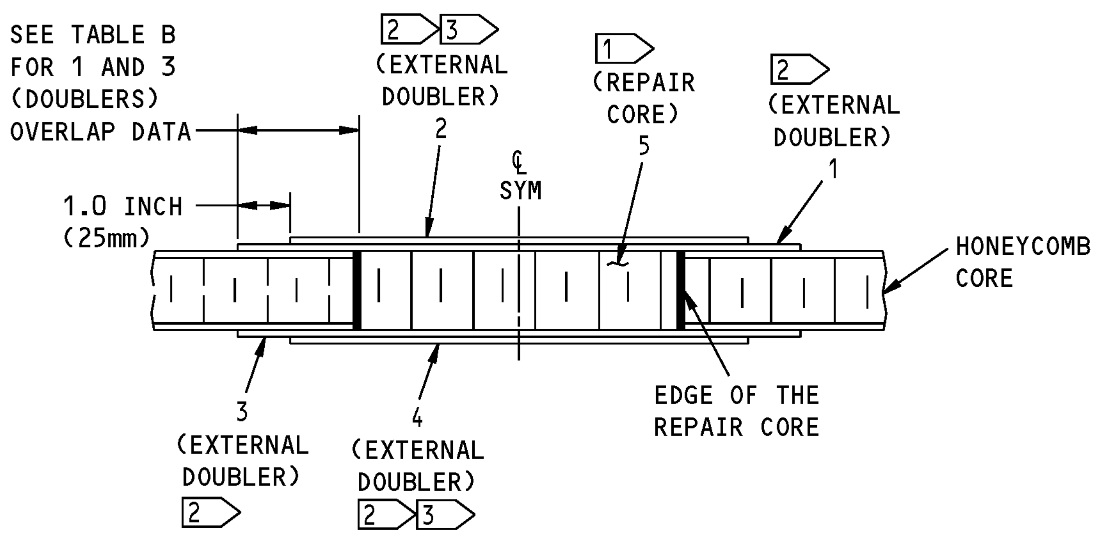
[3] WHEN YOU USE THE PART 2 (EXTERNAL DOUBLER), MAKE THE PART 2 (EXTERNAL DOUBLER) 1.0 INCH (25 mm) SMALLER ALL AROUND THAN THE PART 1 (EXTERNAL DOUBLER).

[4] IF YOU ARE REPAIRING A CRACK, GOUGE, OR SMALL HOLE, YOU CAN USE A MINIMUM RADIUS THAT IS 0.25 INCH (6 mm).

[5] IF A SKIN TO BE REPAIRED HAS A HIGH CURVATURE AND A GAGE OF 0.033 OR THICKER, THEN MAKE THE REPAIR DOUBLERS TO THE SAME CURVATURE AS THE SKIN SURFACE. MAKE SURE THAT LIGHT FINGER PRESSURE CAN MAKE THE DOUBLERS TOUCH ALL OF THE SKIN SURFACE.

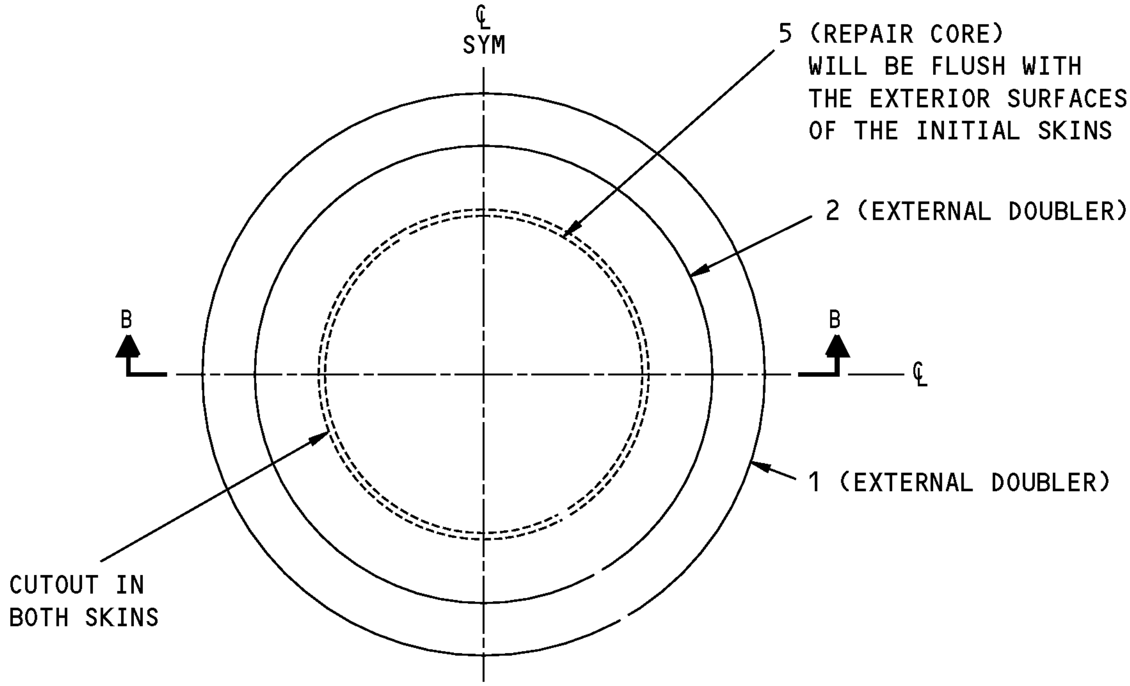
Repair Doubler Specifications for Flush Repairs
Figure 208 (Sheet 4 of 4)



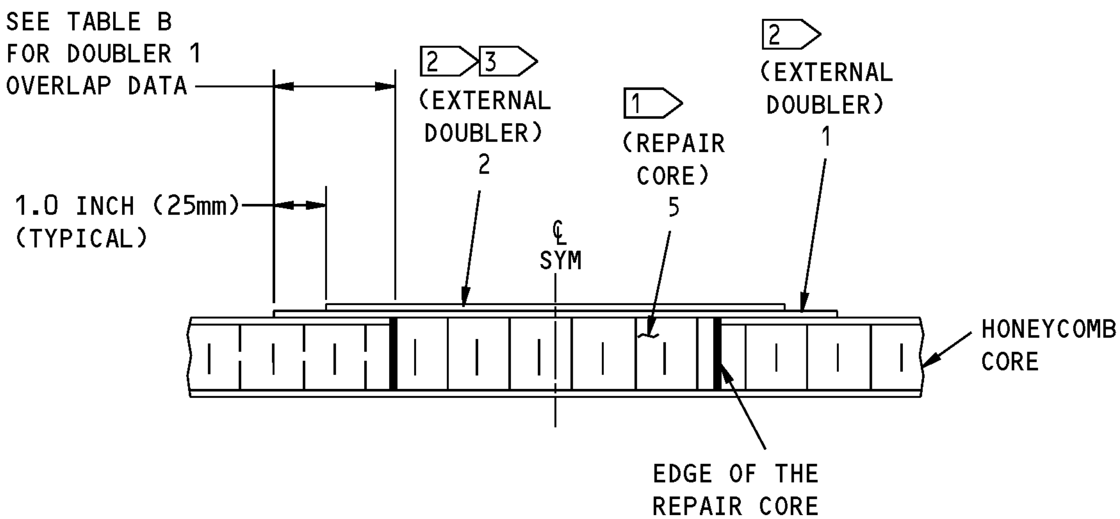


TWO-SIDED REPAIR SHOWN
SEE DETAIL B FOR ONE SIDED REPAIR
A-A

Repair Doubler Specifications for External Patch Repairs
Figure 209 (Sheet 1 of 4)



B



ONE-SIDED REPAIR SHOWN
SEE DETAIL A FOR TWO-SIDED REPAIR
B-B

Repair Doubler Specifications for External Patch Repairs
Figure 209 (Sheet 2 of 4)

REPAIR PART THICKNESS (INCHES) FOR BONDED REPAIRS		
INITIAL SKIN GAGE RANGE	PART 1 AND 3 DOUBLER	PART 2 AND 4 DOUBLER
0.012 TO 0.020	SAME AS THE INITIAL SKIN	NOT NECESSARY
0.021 TO 0.025	0.025 [2]	[2]
0.026 TO 0.032	0.032 [2] [5]	[2]
0.033 TO 0.041	0.016 [6]	0.025 [6]
0.042 TO 0.045	0.020 [6]	0.025 [6]
0.046 TO 0.050	0.025 [6]	0.025 [6]
0.051 TO 0.057	0.025 [6]	0.032 [5] [6]
0.058 TO 0.064	0.032 [5] [6]	0.032 [5] [6]
0.065 TO 0.072	0.032 [5] [6]	0.040 [5] [6]
0.073 TO 0.080	0.040 [5] [6]	0.040 [5] [6]

TABLE A

INITIAL SKIN THICKNESS	THE MINIMUM OVERLAP DIMENSION OF DOUBLERS 1 AND 3
0.00 TO 0.032	1.5 INCHES (38mm)
> 0.032	2.5 INCHES (63mm)

TABLE B

REPAIR PART THICKNESS (INCHES) FOR HIGH CURVATURE REPAIRS		
INITIAL SKIN	PART 1 AND 3 DOUBLER	PART 2 AND 4 DOUBLER
0.021 TO 0.028	0.012	0.016
0.029 TO 0.032	0.012	0.020

TABLE C

Repair Doubler Specifications for External Patch Repairs
Figure 209 (Sheet 3 of 4)

NOTES

- USE THIS FIGURE TO DETERMINE THE DOUBLER DIMENSIONS ONLY.
- THE MATERIAL FOR THE REPAIR PARTS MUST BE EQUIVALENT TO THE SAME BOEING MATERIAL SPECIFICATION (BMS) AND HEAT TREAT AS THE SKIN TO BE REPAIRED.
- BONDING SURFACES OF 2000 SERIES ALUMINUM DOUBLERS CAN BE CLAD OR NON-CLAD (BARE). BONDING SURFACES OF 7000 SERIES ALUMINUM DOUBLERS MUST BE NON-CLAD (BARE).

[1] MAKE THE PART 5 REPAIR CORE TO BE LEVEL WITH THE OUTER SURFACE OF THE SKIN TO BE REPAIRED (UNLESS SPECIFIED DIFFERENTLY IN A SPECIFIC REPAIR).

[2] FOR THE INITIAL SKIN THICKNESSES THAT ARE BETWEEN 0.021 AND 0.032 GAGE, THE PARTS 2 AND 4 DOUBLERS ARE NOT NECESSARY IF THE INITIAL SKIN IS FLAT OR IF THE PARTS 1 AND 3 DOUBLERS CAN TOUCH ALL OF THE BOND SURFACE WITH ONLY LIGHT FINGER PRESSURE.

IF THE SKIN SURFACE HAS A HIGH CURVATURE, YOU CAN DO ONE OF THE STEPS THAT FOLLOW:

- MAKE THE PARTS 1 AND 3 DOUBLERS TO THE SAME CURVATURE AS THE SKIN SURFACE, SO THAT LIGHT FINGER PRESSURE MAKES THE DOUBLERS TOUCH ALL OF THE SKIN SURFACE, OR
- MAKE THE PARTS 1 AND 3 DOUBLERS FROM 0.012 GAGE, AND MAKE THE PARTS 2 AND 4 DOUBLERS FROM THE THICKNESS SPECIFIED IN TABLE C.

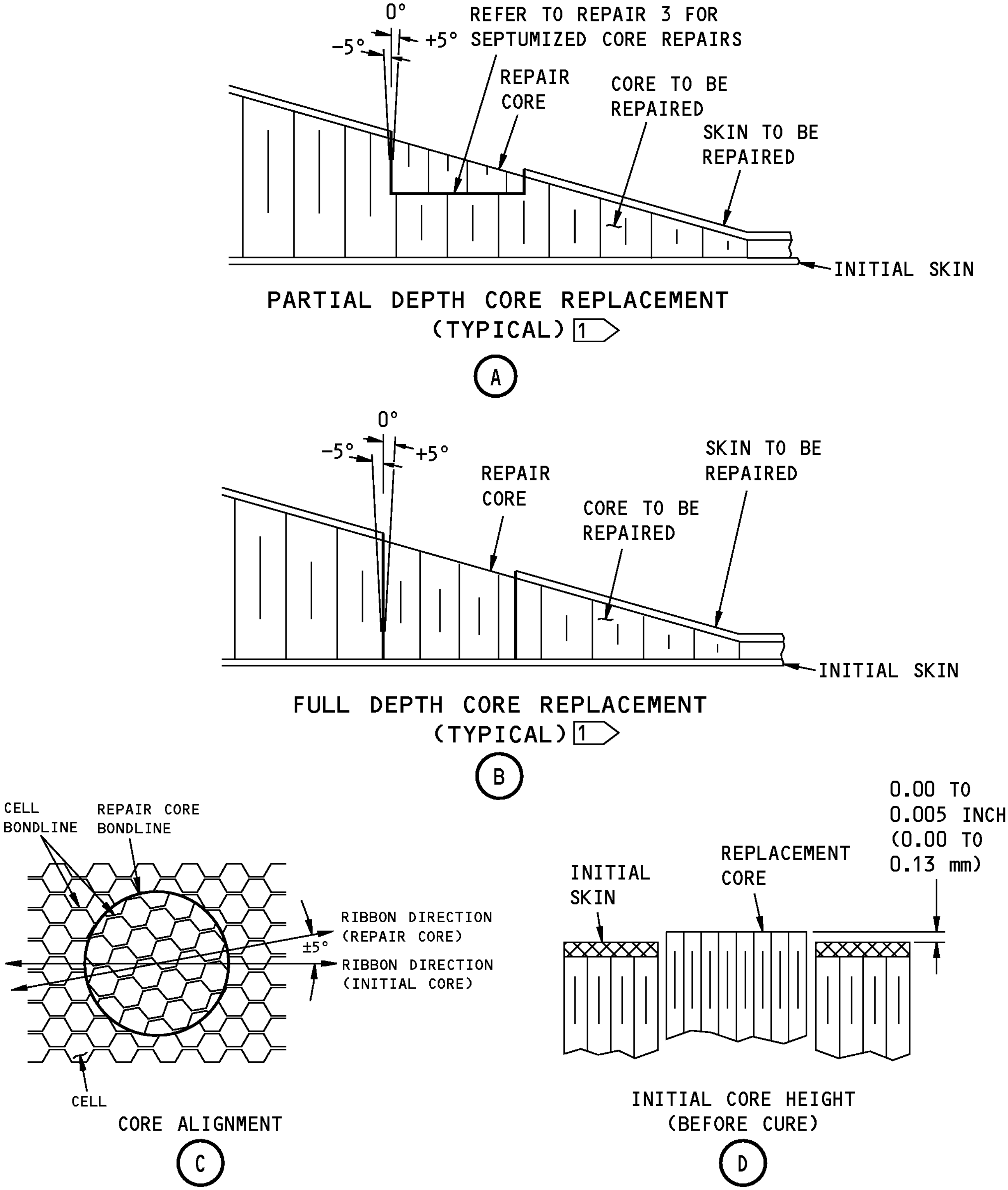
[3] WHEN YOU USE THE PART 2 AND 4 DOUBLERS, MAKE THE PARTS 2 AND 4 DOUBLERS 1.0 INCH (25 mm) SMALLER ALL AROUND THAN THE PARTS 1 AND 3 DOUBLERS.

[4] IF YOU ARE REPAIRING A CRACK, GOUGE, OR SMALL HOLE, YOU CAN USE A MINIMUM RADIUS THAT IS 0.25 INCH (6 mm).

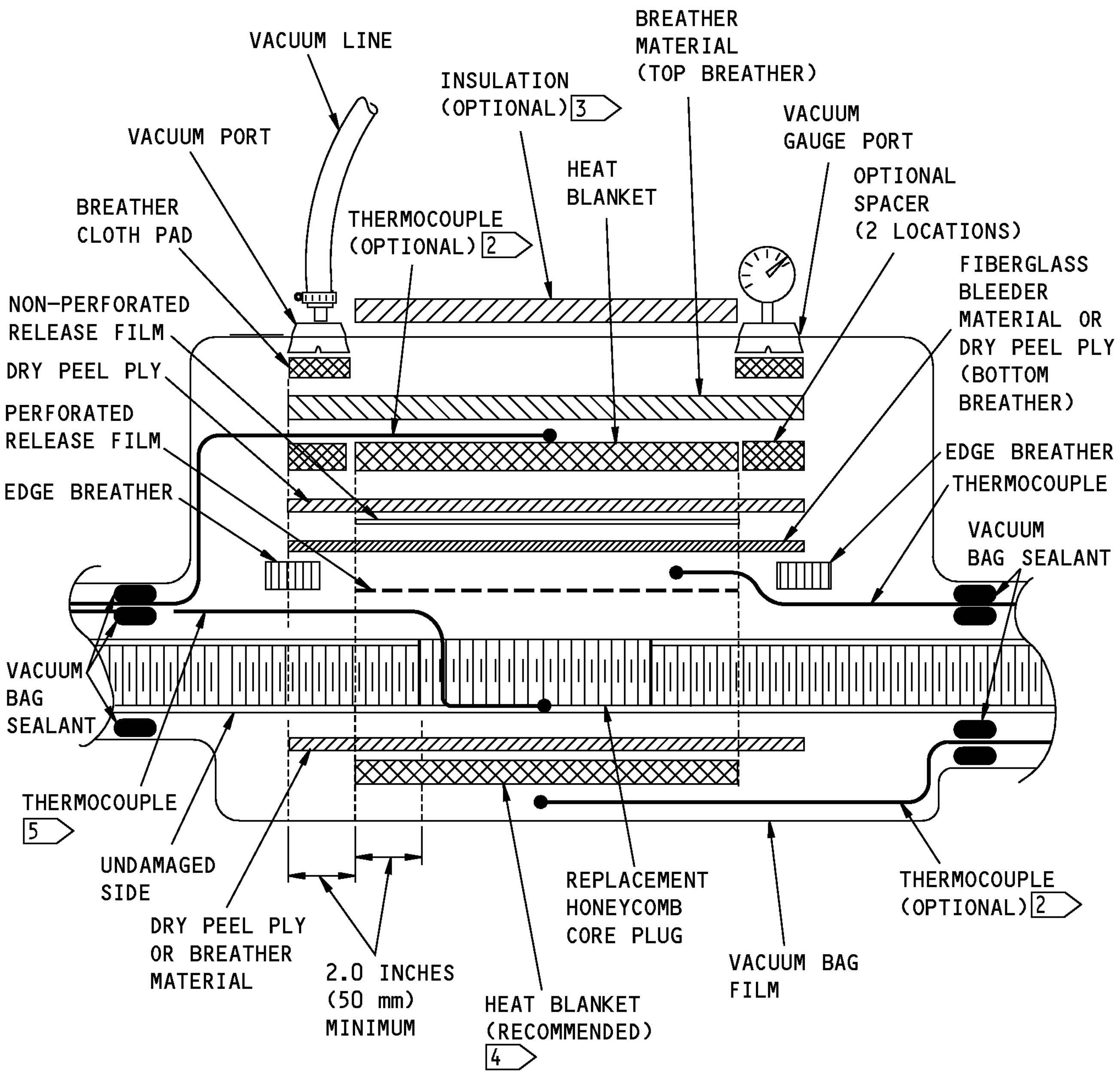
[5] CHAMFER ALL EDGES OF THE DOUBLER AS SHOWN IN FIGURE 213 FOR DOUBLERS 0.032 GAGE AND THICKER (AERODYNAMIC SURFACES ONLY. CHAMFER OF DOUBLERS ON NON-AERODYNAMIC SURFACES IS PERMITTED BUT IS NOT NECESSARY).

[6] IF A SKIN TO BE REPAIRED HAS A HIGH CURVATURE AND A GAGE OF 0.033 OR THICKER, THEN MAKE THE REPAIR DOUBLERS TO THE SAME CURVATURE AS THE SKIN SURFACE. MAKE SURE THAT LIGHT FINGER PRESSURE CAN MAKE THE DOUBLERS TOUCH ALL OF THE SKIN SURFACE.

Repair Doubler Specifications for External Patch Repairs
Figure 209 (Sheet 4 of 4)



Installation of the Repair Core
Figure 210 (Sheet 1 of 3)



VACUUM BAG PROCEDURE FOR REPLACEMENT CORE
WHEN THE TWO STAGE CURE PROCEDURE IS USED

E

Installation of the Repair Core
Figure 210 (Sheet 2 of 3)

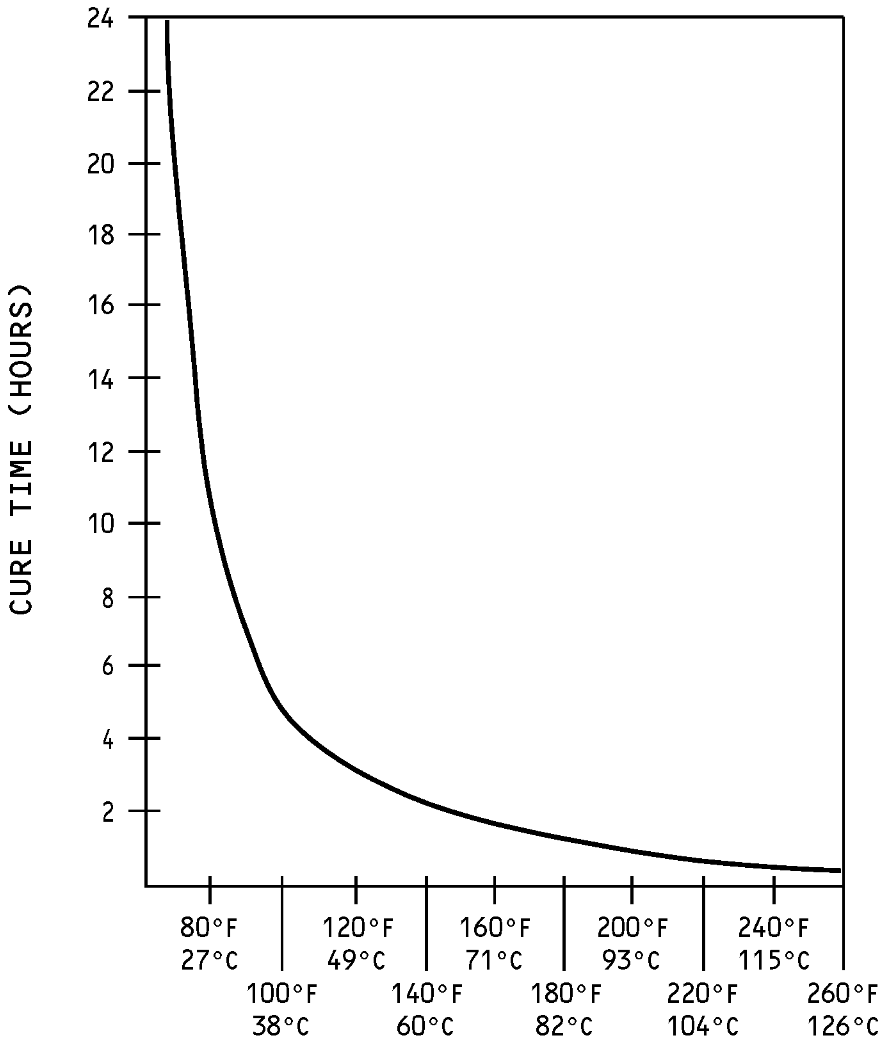
NOTES

1. MAXIMUM ERROR OF THE CELL WALLS AFTER INSTALLATION OF THE REPAIR CORE.
2. YOU CAN USE THESE THERMOCOUPLES TO MAKE SURE THAT IF THE HEAT BLANKET GETS TOO HOT, YOU CAN TURN OFF THE POWER SUPPLY BEFORE YOU DAMAGE THE SKIN PANEL.
3. 4-8 PLIES OF BREATHER MATERIAL IS AN EXAMPLE. YOU CAN USE OTHER INSULATION MATERIALS ALSO. THIS WILL KEEP THE HEAT IN THE REPAIR AREA.
4. IF YOU USE A HEAT BLANKET ON THE UNDAMAGED SIDE, MAKE SURE THAT THE HEAT BLANKET CAN BE HELD AGAINST THE PART. A VACUUM BAG CAN BE USED TO HOLD THE HEAT BLANKET, OR YOU CAN PUT THE PART ON A TOOL SURFACE (WITH INSULATION BETWEEN THE HEAT BLANKET AND THE TOOL SURFACE.
5. THERMOCOUPLE CONFIGURATION WHEN HEAT IS NOT APPLIED TO THE UNDAMAGED SIDE. IT IS PERMITTED TO LET THE THERMOCOUPLE STAY IN POSITION AFTER THE COMPLETION OF THE CURE CYCLE. CUT OFF THE WIRE AT THE TOP OF THE CORE.

Installation of the Repair Core
Figure 210 (Sheet 3 of 3)

CLASS	POT LIFE AT LESS THAN 80°F (27°C)	PARTS BY WEIGHT PART A (BASE)		PARTS BY WEIGHT PART B (HARDENER)
		TYPE I	TYPE V	TYPE I AND V
1	20 MINUTES MAXIMUM	140	49	100
2	60 MINUTES MAXIMUM	140	49	100
3	90 MINUTES MAXIMUM	140	---	100
4	120 MINUTES MAXIMUM	140	---	100

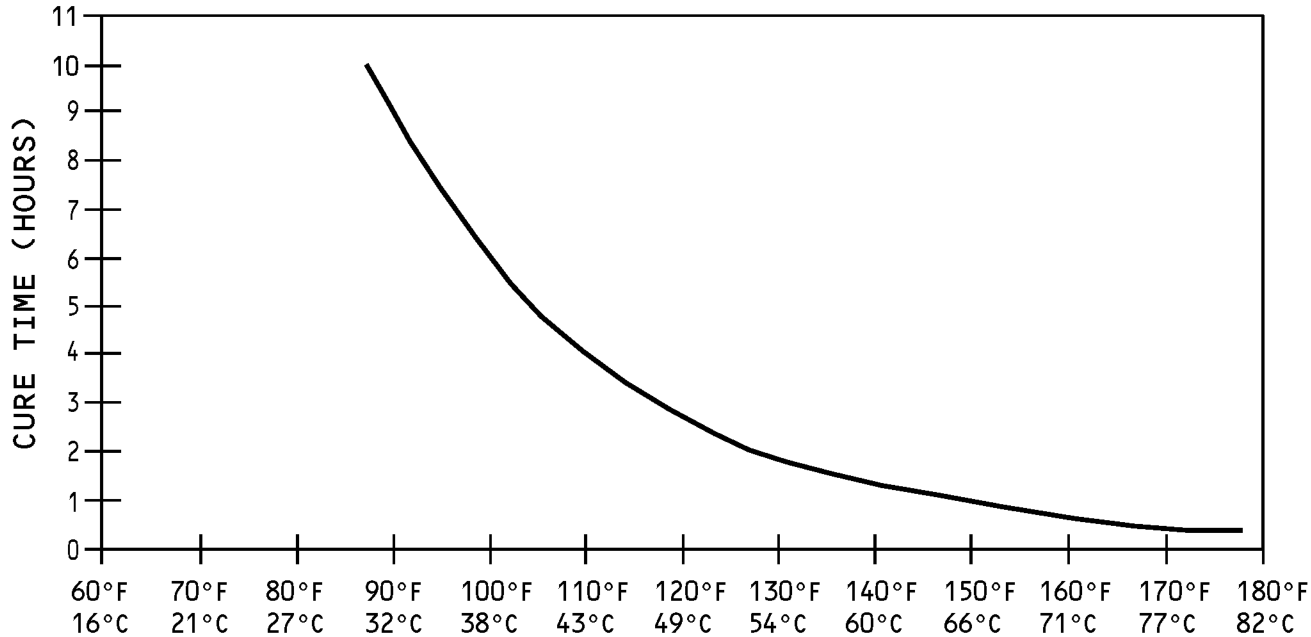
BMS 5-92 TWO-PART PASTE ADHESIVE MIXTURE DATA
TABLE A



BMS 5-92, TYPE I CURE TEMPERATURE

A

Cure Time for BMS5-92, Two-part Paste Adhesive
Figure 211 (Sheet 1 of 2)



BMS 5-92, TYPE V, CLASS 2 CURE TEMPERATURE

B

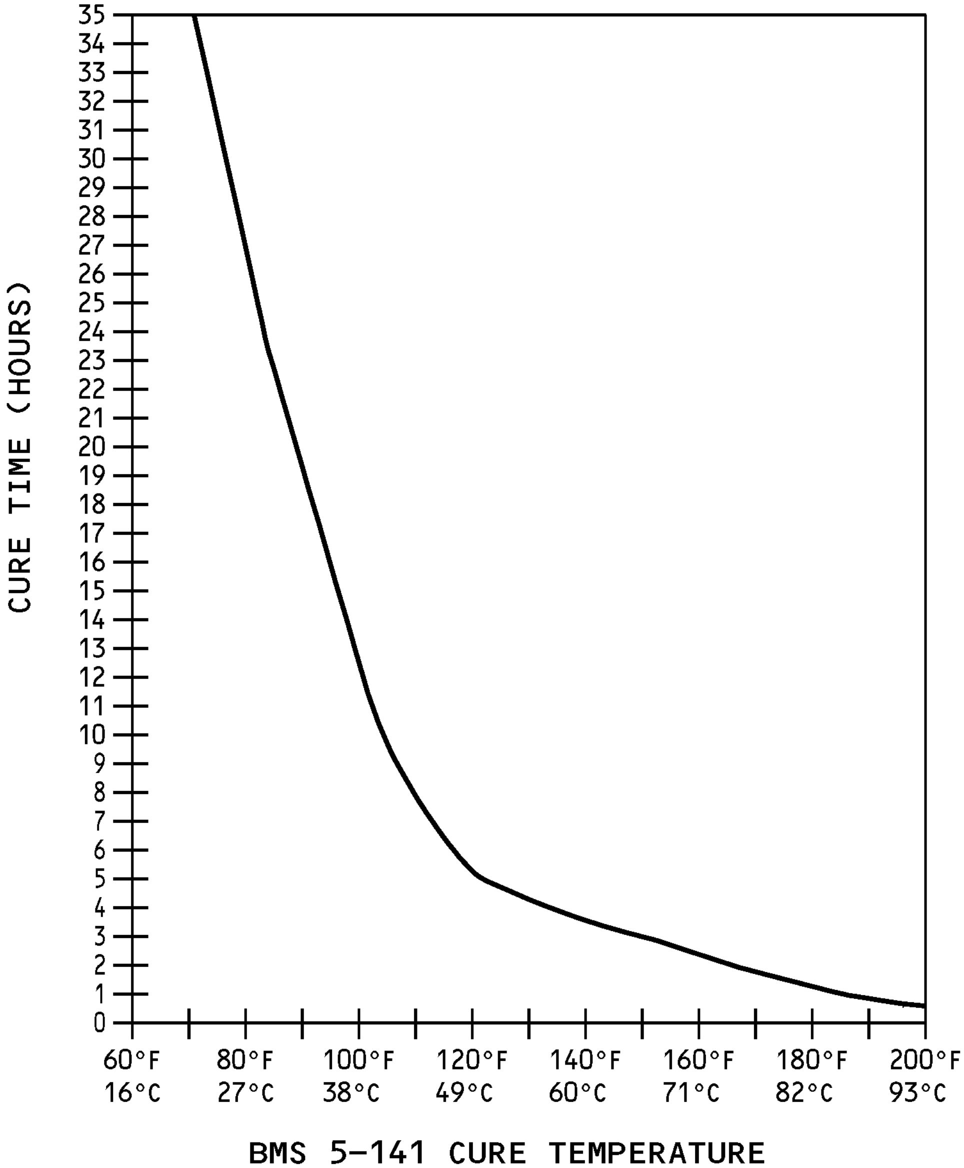
NOTES

- IF A TYPE IS NOT SPECIFIED IT IS PREFERRED THAT YOU USE TYPE V.
- CURE UNDER PRESSURE AS FOLLOWS:

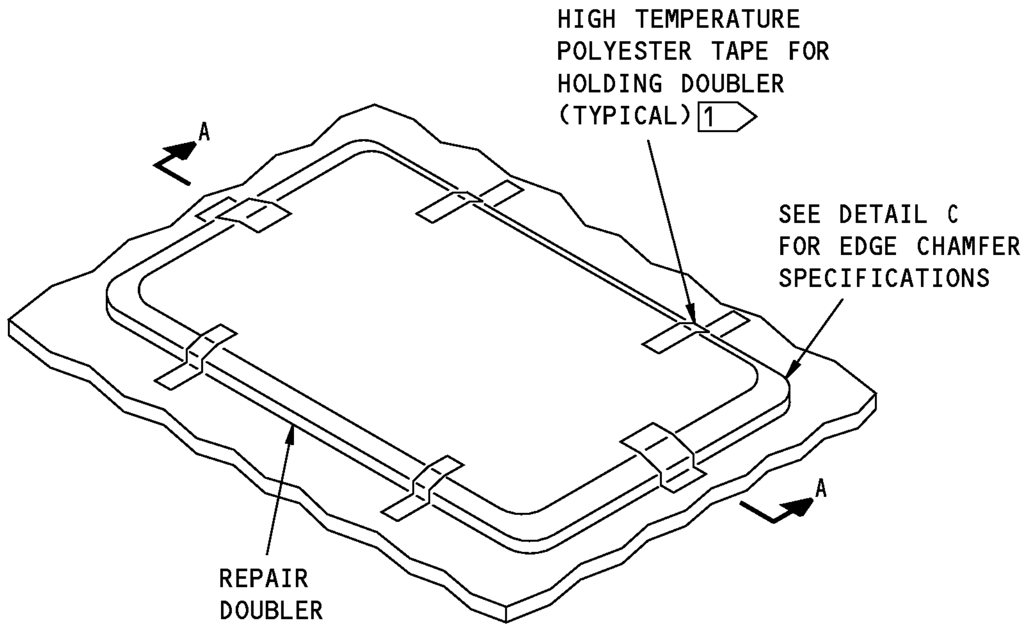
  (1) BMS5-92, TYPE V, CLASS 1 ADHESIVE:
  3 HOURS MINIMUM AT 70 TO 100°F (21 TO 38°C), OR
  2 HOURS MINIMUM AT 120 TO 130°F (49 TO 54°C).

  (2) BMS5-92, TYPE V, CLASS 2 ADHESIVE:
  7 HOURS MINIMUM AT 70 TO 100°F (21 TO 38°C) OR SEE CHART B.

Cure Time for BMS5-92, Two-part Paste Adhesive
Figure 211 (Sheet 2 of 2)

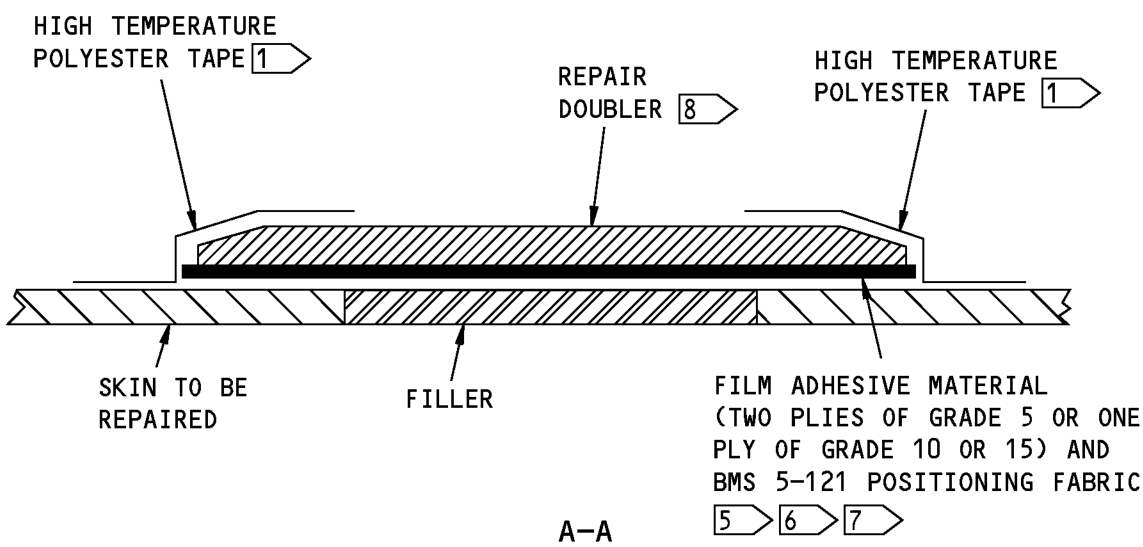


Cure Time for BMS5-141 Paste Adhesive
Figure 212



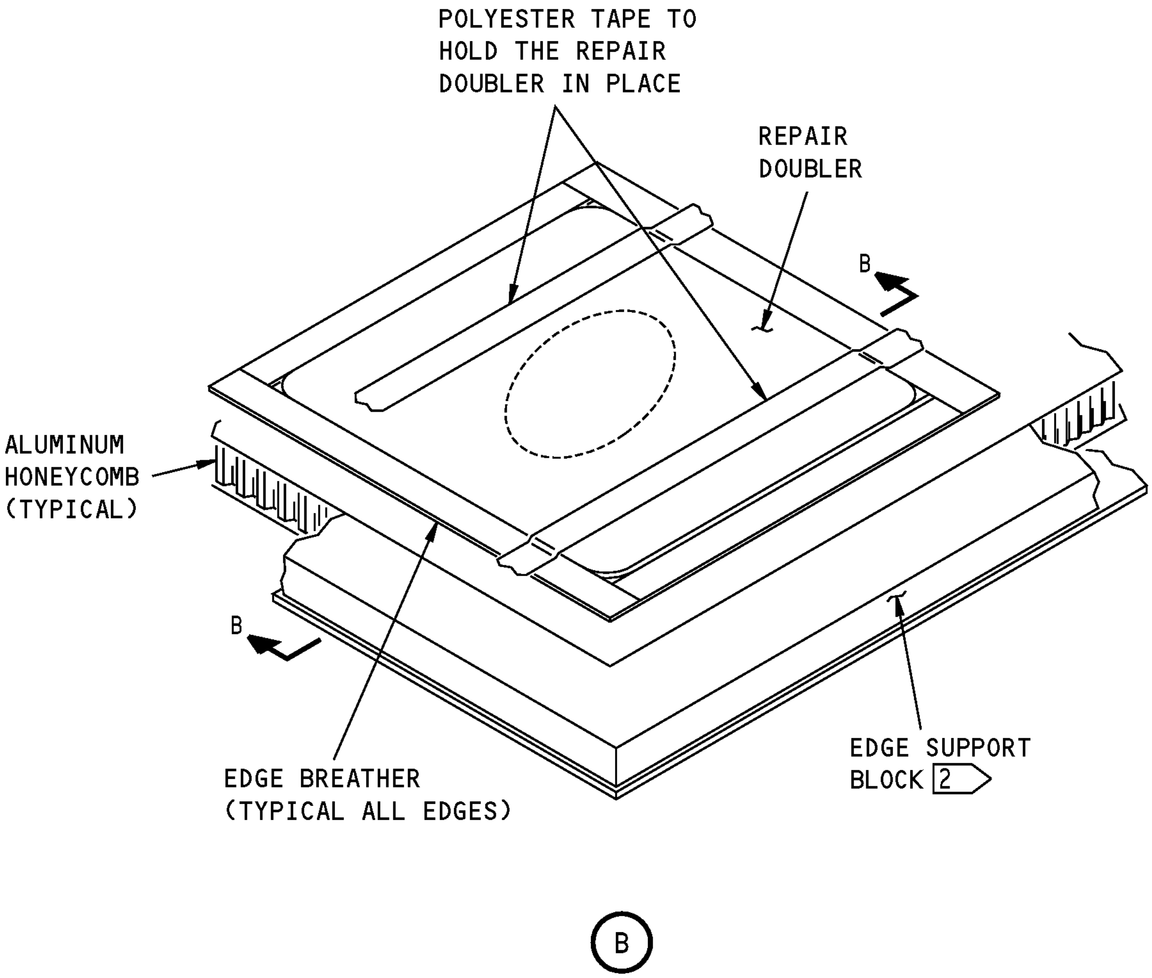
METAL TO METAL
(NO HONEYCOMB)

A

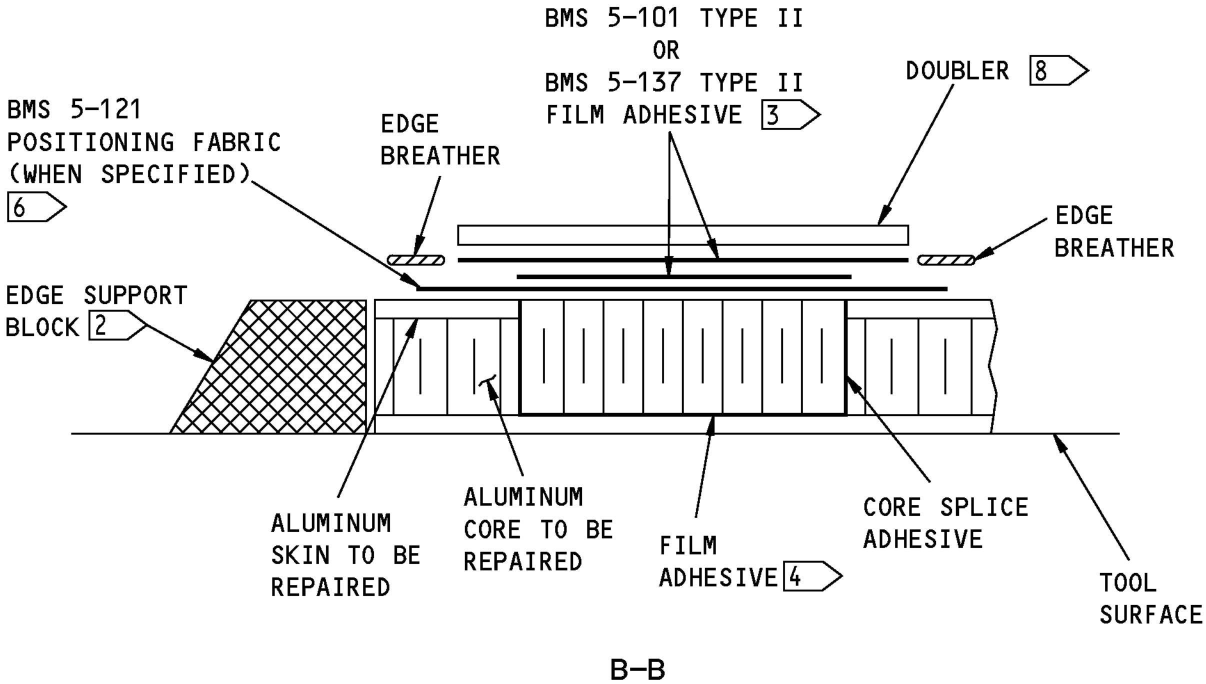


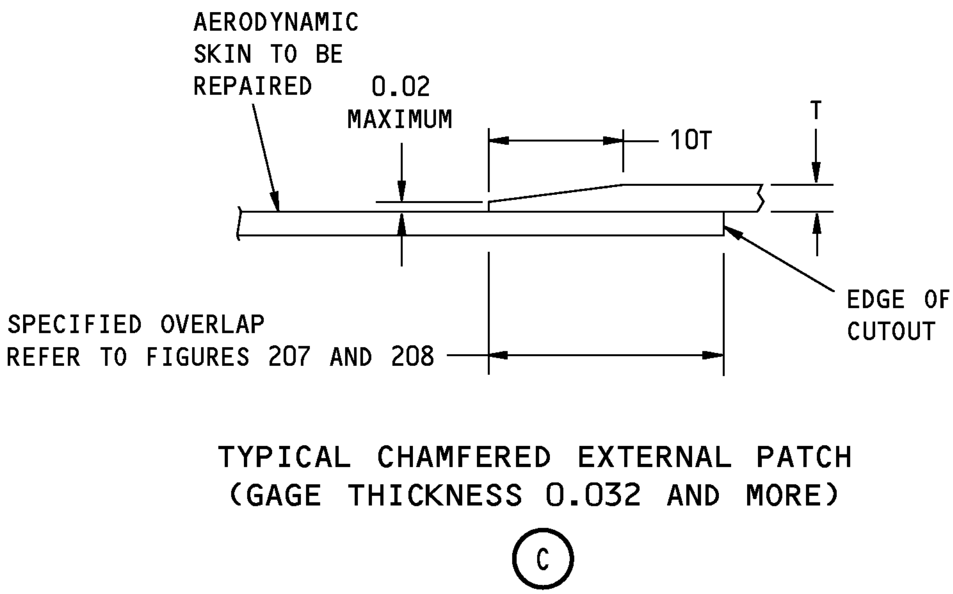
A-A

Installation of the Repair Doubler
Figure 213 (Sheet 1 of 6)

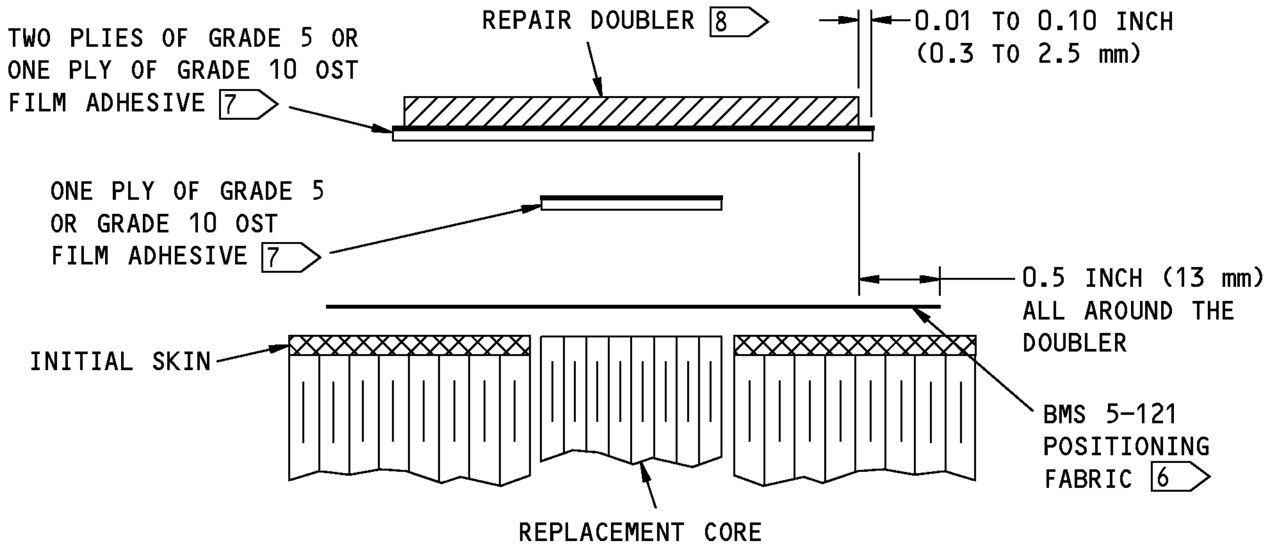


Installation of the Repair Doubler
Figure 213 (Sheet 2 of 6)

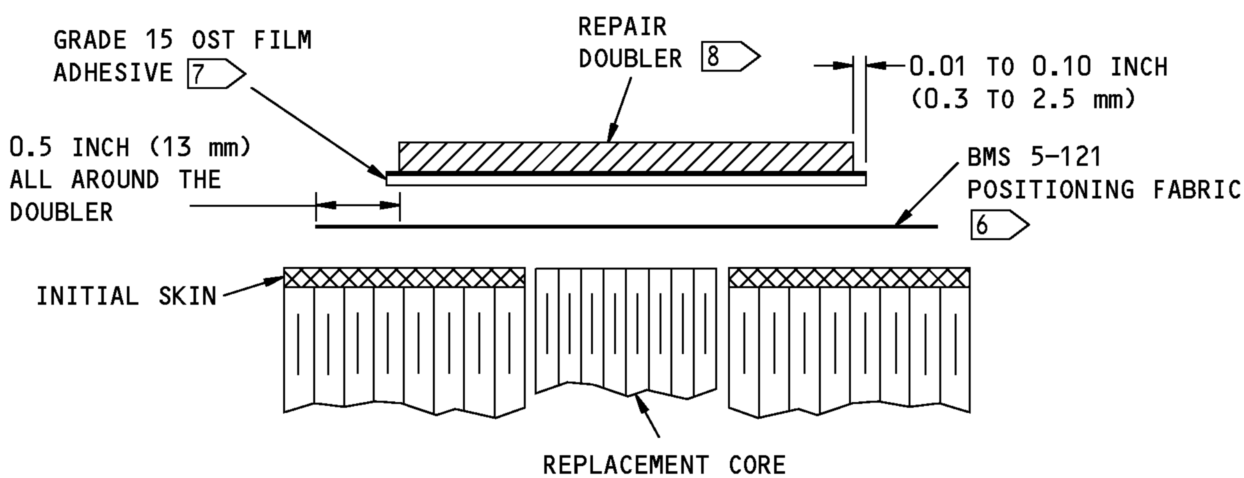




Installation of the Repair Doubler
Figure 213 (Sheet 3 of 6)



INSTALLATION OF EXTERNAL DOUBLER AND GRADE 5
OR GRADE 10 OST FILM ADHESIVE

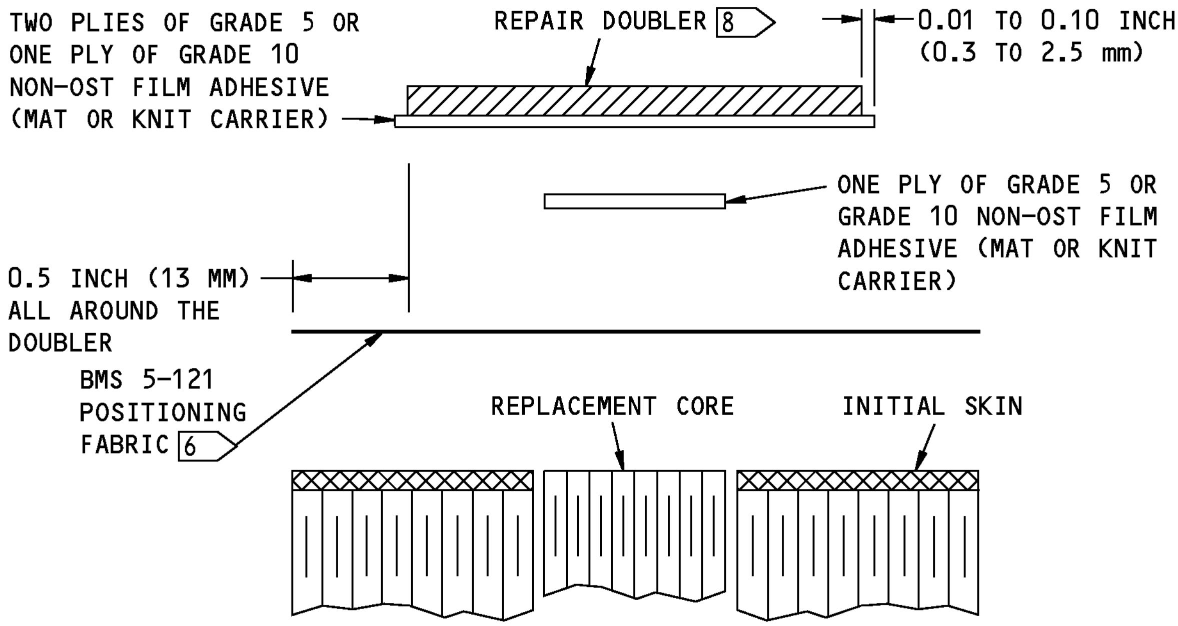


INSTALLATION OF EXTERNAL DOUBLER AND
GRADE 15 OST FILM ADHESIVE 5

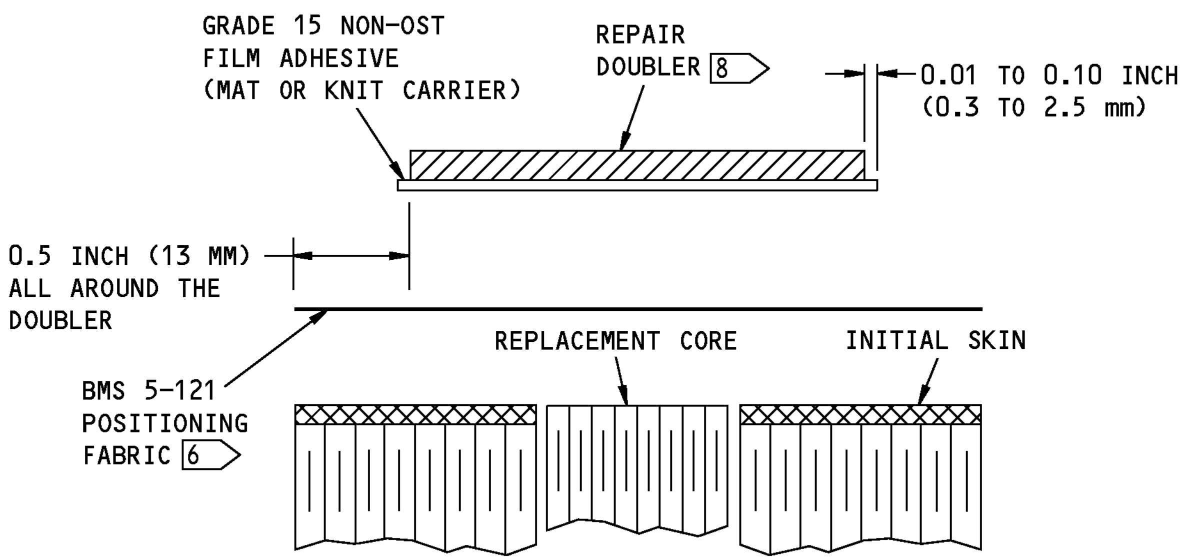
INSTRUCTIONS TO APPLY ONE-SIDE-TACKY (OST)
FILM ADHESIVE 7

D

Installation of the Repair Doubler
Figure 213 (Sheet 4 of 6)



INSTALLATION OF EXTERNAL DOUBLER AND GRADE 5
OR GRADE 10 NON-OST FILM ADHESIVE



INSTALLATION OF EXTERNAL DOUBLER GRADE 15
NON-OST FILM ADHESIVE 5

INSTRUCTIONS TO APPLY NON-OST FILM ADHESIVE

E

Installation of the Repair Doubler
Figure 213 (Sheet 5 of 6)

NOTES

- THIS IS APPLICABLE FOR THE FILM ADHESIVE BOND PROCEDURE.
- MAKE SURE THAT ALL SEPARATOR SHEETS ARE REMOVED BEFORE YOU ASSEMBLE THE REPAIR PARTS.

1 APPLY TAPE TO HOLD THE REPAIR DOUBLER IN POSITION DURING THE CURE. DO NOT SEAL THE EDGES OF THE PANEL. IF YOU SEAL THE EDGES OF THE PANEL WITH TAPE, IT CAN PREVENT THE FLOW OF THE ADHESIVE MATERIAL AND THE REMOVAL OF AIR DURING THE FINAL STAGE OF THE CURE. APPLY LESS THAN 25 PERCENT OF THE EDGE LENGTH OF THE REPAIR DOUBLER WITH TAPE.

2 ONLY NECESSARY FOR SQUARE EDGED HONEYCOMB PANELS.

3 USE THREE PLIES OF GRADE 5, TWO PLIES OF GRADE 10 OR ONE PLY OF GRADE 15 BETWEEN THE REPAIR DOUBLER AND THE CORE. IF GRADE 5 OR GRADE 10 IS USED, MAKE THE BOTTOM PLY THE SAME DIMENSIONS AS THE CORE. MAKE THE TOP PLY (PLIES) THE SAME SIZE AS THE THE DOUBLER. SEE DETAIL D AND DETAIL E.

4 USE THREE PLIES OF GRADE 5, TWO PLIES OF GRADE 10 OR ONE PLY OF GRADE 15 CUT TO THE SAME DIMENSIONS AS THE HOLE.

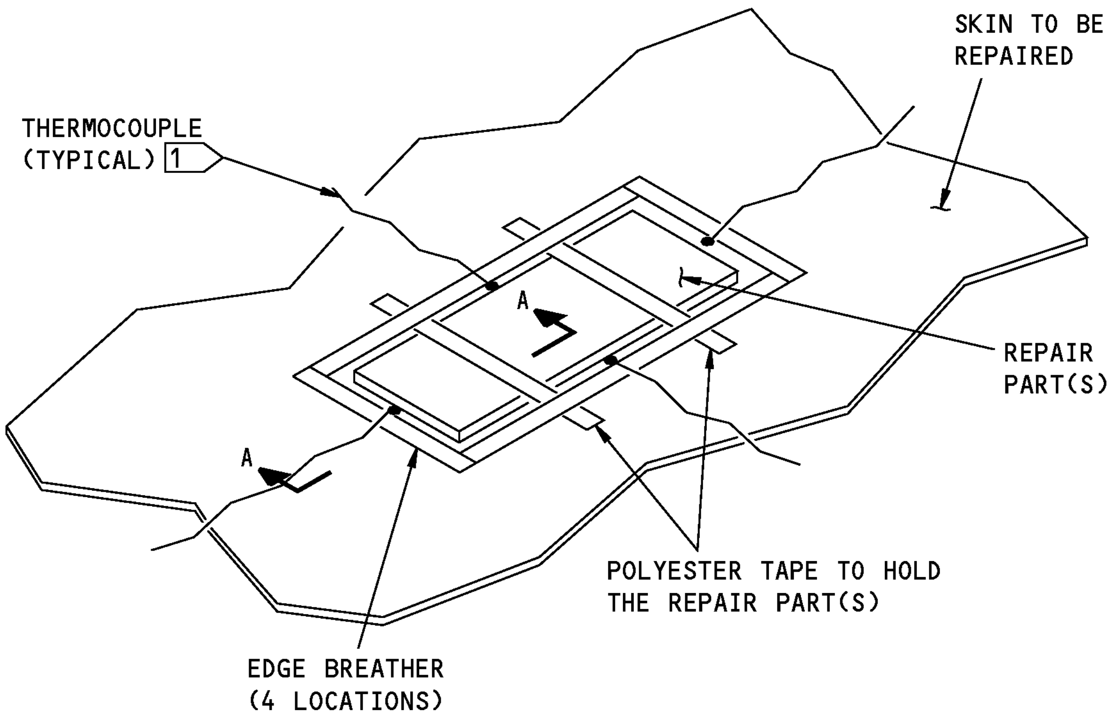
5 DO NOT USE GRADE 15 FILM ADHESIVE IF THE DOUBLER TO BE BONDED IS ≤ 0.020 GAGE

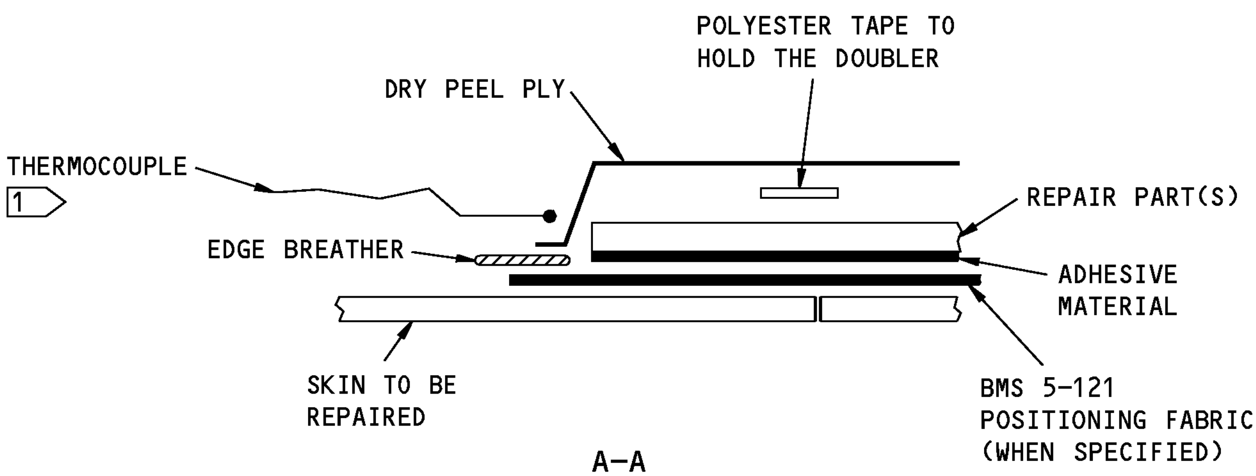
6 REFER TO PARAGRAPH 18 FOR POSITIONING FABRIC APPLICABILITY AND LIMITATIONS.

7 IF BMS 5-101 TYPE II OST IS INSTALLED WITH BMS 5-121 POSITIONING FABRIC, THEN PUT THE TACKY SIDE DOWN AGAINST THE POSITIONING FABRIC. IF OST IS INSTALLED WITHOUT POSITIONING FABRIC (WHEN THERE IS 64 SQUARE INCHES (400 SQUARE cm) OR LESS OF OPEN CORE) THEN PUT THE MAT SIDE DOWN AGAINST THE OPEN CORE.

8 IF MORE THAN ONE DOUBLER IS NECESSARY, THEN PUT FILM ADHESIVE MATERIAL (TWO PLIES OF GRADE 5 OR ONE PLY OF GRADE 10 OR 15) AND BMS 5-121 POSITIONING FABRIC BETWEEN EACH DOUBLER. 6 7

Installation of the Repair Doubler
Figure 213 (Sheet 6 of 6)

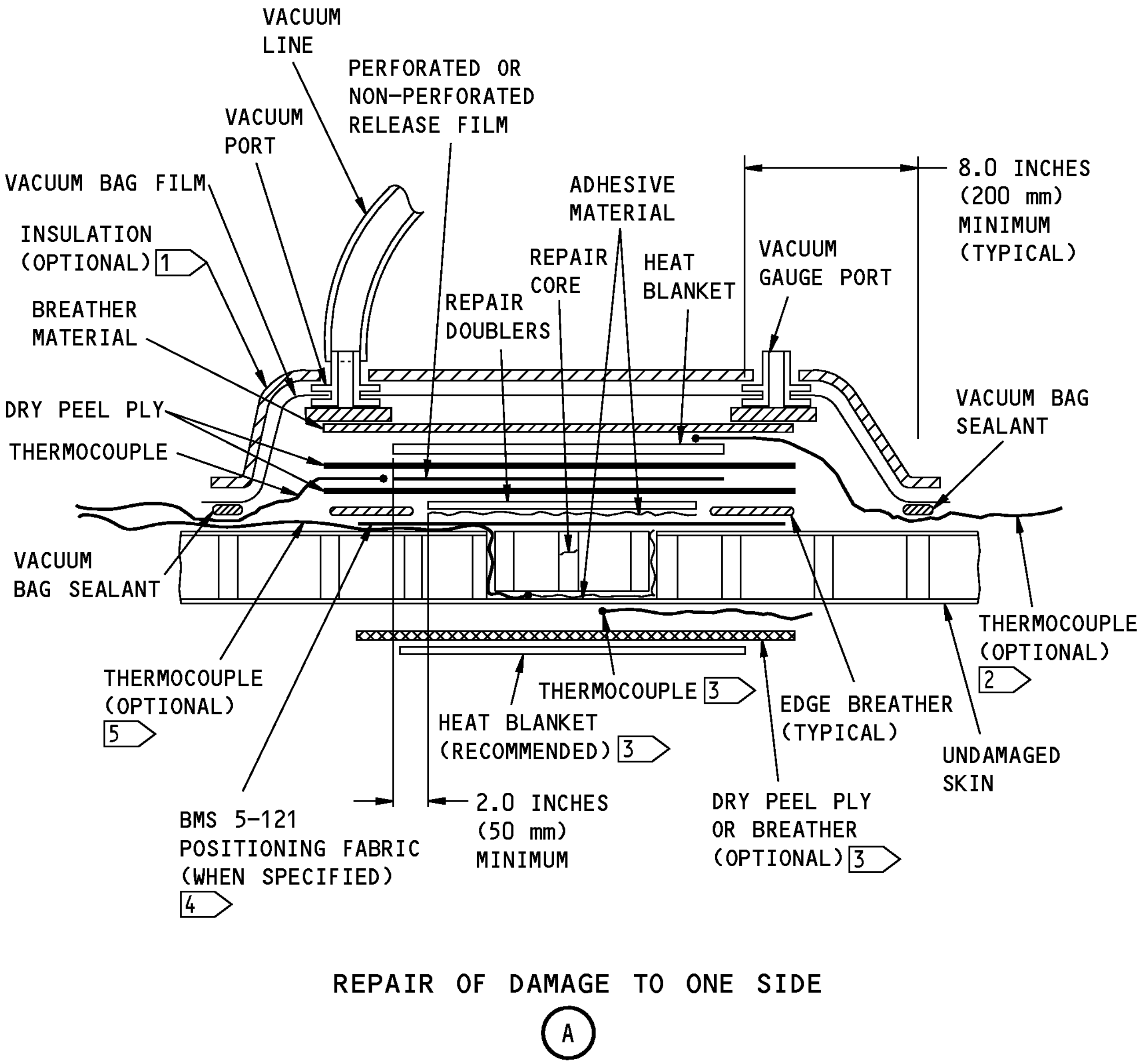




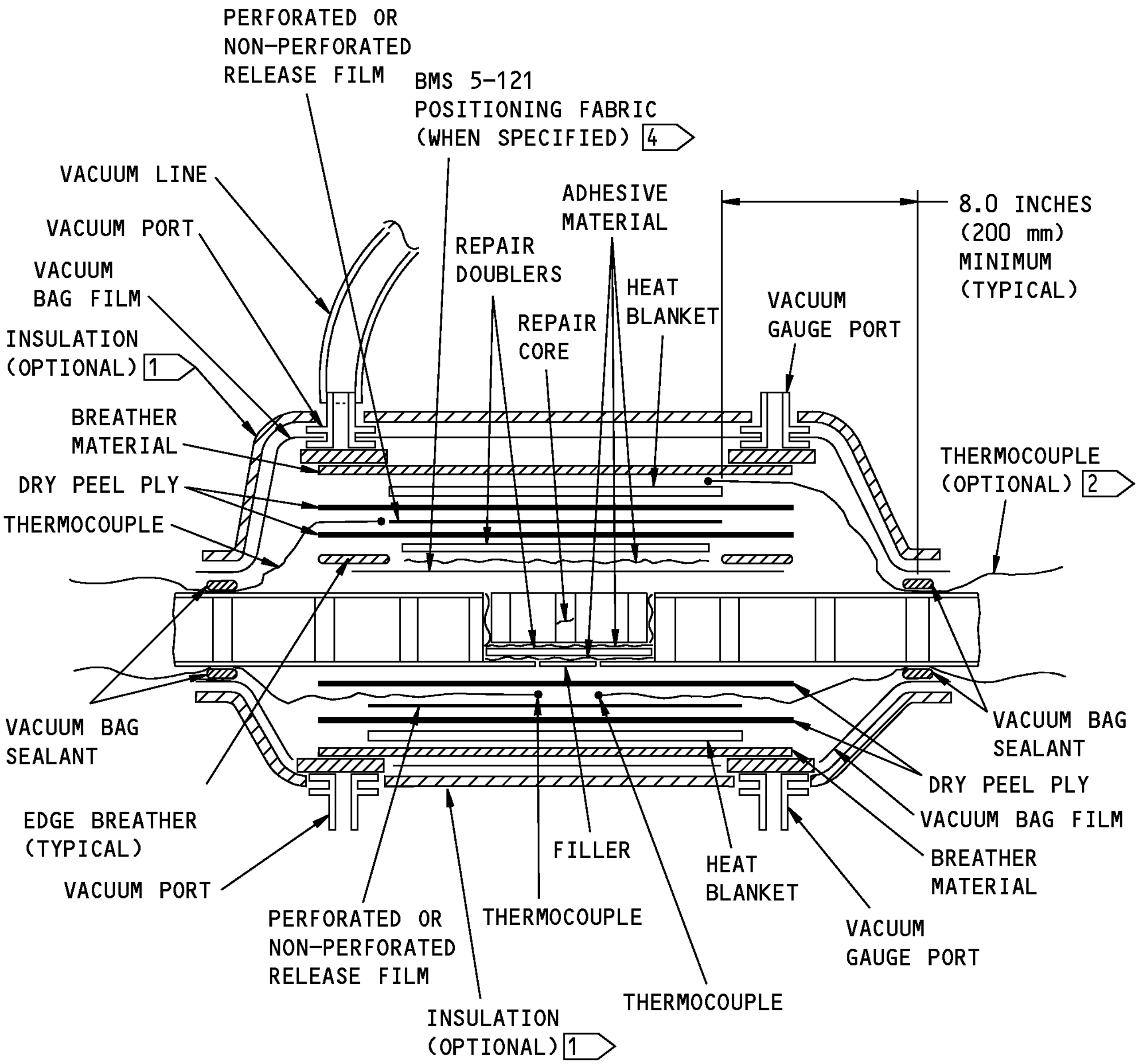
A-A

1 REPAIRS MUST HAVE A MINIMUM OF FOUR THERMOCOUPLES AT THE EDGES OF THE LARGEST REPAIR PART. SPACE THE THERMOCOUPLES EQUAL DISTANCES AROUND THE REPAIR PART(S).

Thermocouple Locations
Figure 214

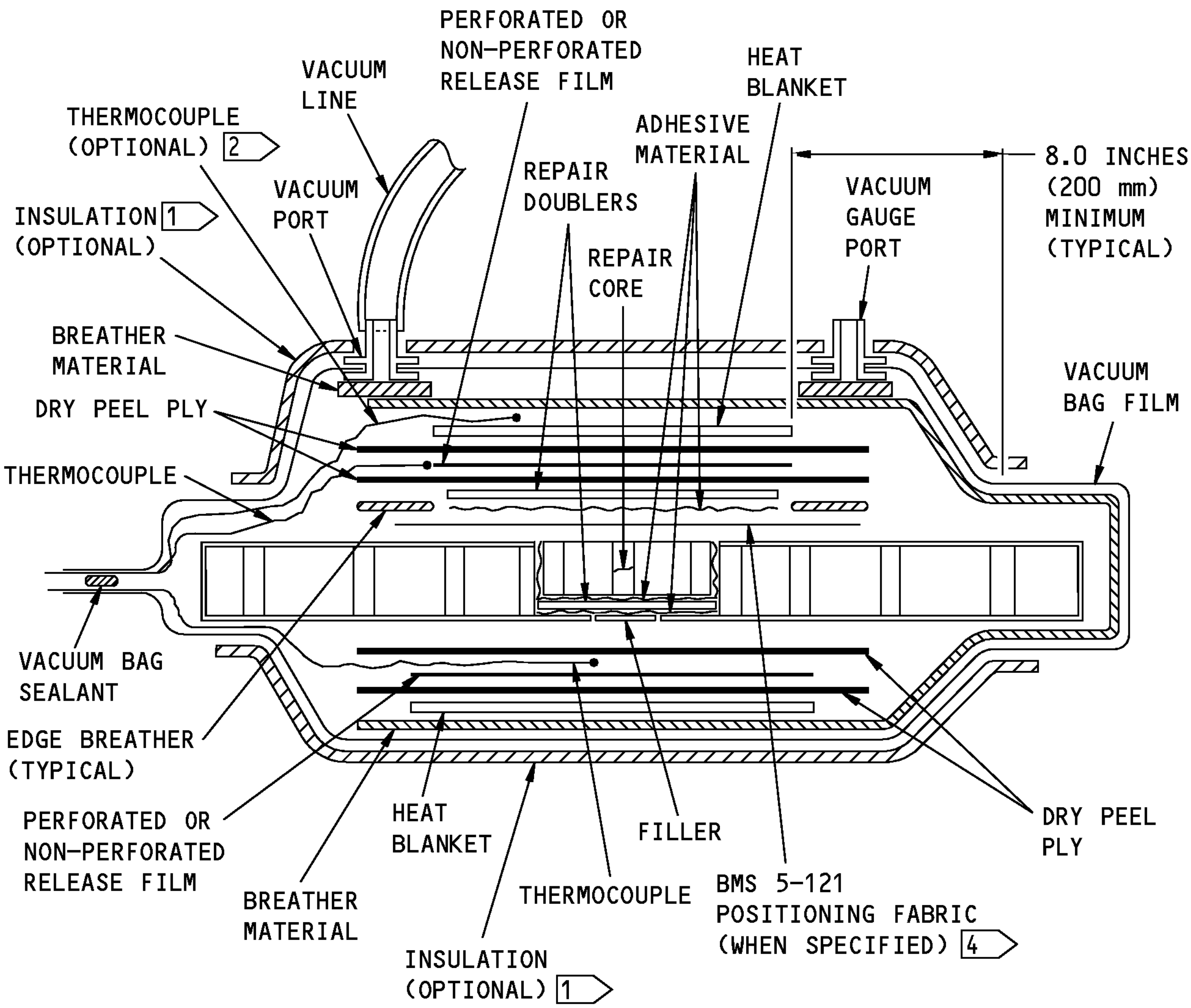


Layup of Vacuum Bagging Materials
Figure 215 (Sheet 1 of 5)



REPAIR OF DAMAGE TO BOTH SIDES
(SEPARATE VACCUM BAGS)
B

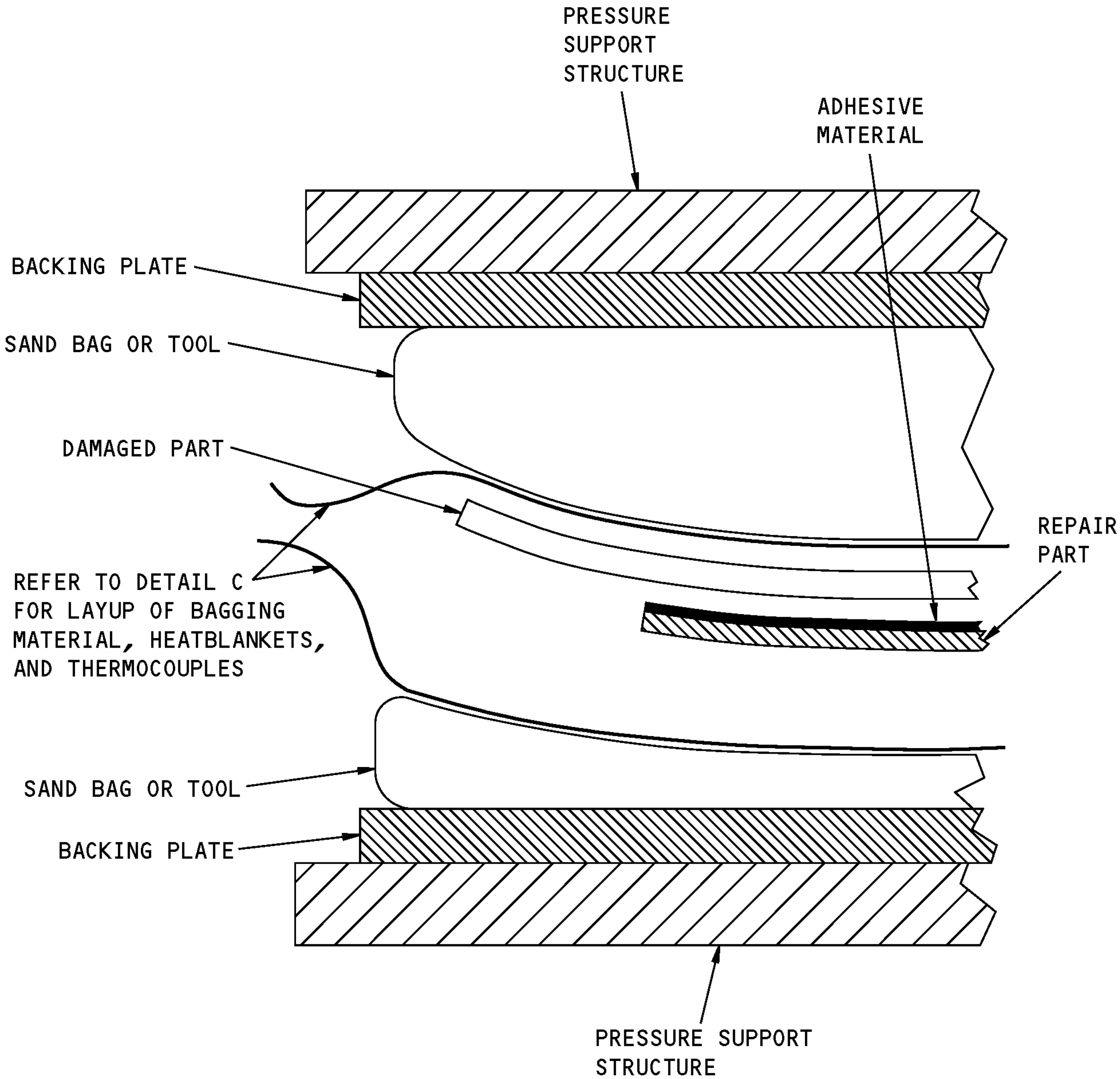
Layup of Vacuum Bagging Materials
Figure 215 (Sheet 2 of 5)



REPAIR OF DAMAGE TO BOTH SIDES
(ENVELOPE BAG)

C

Layup of Vacuum Bagging Materials
Figure 215 (Sheet 3 of 5)



APPLICATION OF PRESSURE FOR ROUNDED OR CONTOURED PANELS

D

Layup of Vacuum Bagging Materials
Figure 215 (Sheet 4 of 5)

NOTES

- THIS FIGURE SHOWS THE LAYUP FOR A ONE STAGE CURE PROCEDURE. THE LAYUP FOR THE SECOND STAGE OF A TWO STAGE CURE PROCEDURE IS ALMOST THE SAME. REFER TO FIGURE 210 FOR THE INSTRUCTIONS TO DO THE FIRST STAGE OF A TWO STAGE CURE PROCEDURE.
- REFER TO FIGURE 208 AND FIGURE 209 FOR REPAIR DOUBLER SPECIFICATIONS.
- REFER TO FIGURE 210 FOR CORE ALIGNMENT AND HEIGHT SPECIFICATIONS.

[1] 4-8 PLIES OF BREATHER MATERIAL IS AN EXAMPLE. YOU CAN USE OTHER INSULATING MATERIALS ALSO. THIS WILL KEEP THE HEAT IN THE REPAIR AREA.

[2] YOU CAN USE THESE THERMOCOUPLES TO MAKE SURE THAT IF THE HEAT BLANKET GETS TOO HOT, YOU CAN TURN OFF THE POWER SUPPLY BEFORE YOU DAMAGE THE SKIN PANEL.

[3] IF YOU DO A TWO STAGE CURE PROCEDURE TO REPAIR THE CORE, REFER TO FIGURE 210 FOR THE FIRST STAGE OF THE PROCEDURE. IF YOU DO THE ONE STAGE CURE PROCEDURE, THEN YOU MUST HAVE ACCESS TO EACH SIDE OF THE HONEYCOMB PANEL.

- PUT A THERMOCOUPLE ON THE UNDAMAGED FACESHEET AT THE LOCATION OF THE REPAIR CORE. IT IS RECOMMENDED THAT YOU PUT A DRY PEEL PLY OR BREATHER AND HEAT BLANKET ABOVE THE THERMOCOUPLE ON THE UNDAMAGED SKIN.

TWO STAGE CURE PROCEDURE IS NECESSARY TO REPAIR THE CORE IF:

- THE DAMAGE IS LARGER THAN 64 SQUARE INCHES (0.041 SQUARE METERS) OR,
- IF YOU CAN NOT PUT A THERMOCOUPLE AT THE REPAIR CORE LOCATION ON EACH SIDE OF THE HONEYCOMB PANEL.

[4] REFER TO FIGURE 213 TO SEE WHEN AND HOW TO USE POSITIONING FABRIC.

[5] THERMOCOUPLE CONFIGURATION WHEN HEAT IS NOT APPLIED TO THE UNDAMAGED SIDE. IT IS PERMITTED TO LET THE THERMOCOUPLE STAY IN POSITION AFTER THE COMPLETION OF THE CURE CYCLE. CUT OFF THE WIRE AT THE EDGE OF THE DOUBLER.

Layup of Vacuum Bagging Materials
Figure 215 (Sheet 5 of 5)

REPAIR 1 - REPAIR OF A DISBOND AT THE EDGE OF ALUMINUM HONEYCOMB STRUCTURE

1. **Applicability**

   A. Repair 1 is a typical repair that is applicable to damage on the edge of an aluminum honeycomb panel.

2. **General**

   A. The illustrations and instructions in this repair show different examples of repairs and types of damage. You can do repairs that put together one or more of these examples. Use the correct repair procedures for each type of example.

   B. Refer to Figure 201/REPAIR 1 for this procedure.

      (1) A disbond of a facesheet can not be deeper 0.50 inch (12.5mm) into the panel edgeband.

      (2) The cumulative (total) length of multiple disbonds can not be longer than 30 percent of the length of the edge.

      (3) The initial adhesive primer (between the separated skins) must be satisfactory.

3. **Repair Procedures**

   A. Find the limits of the damage. If you have cracks or corrosion to the edge, then refer to Paragraph 6./REPAIR GENERAL Repairs to Large Damage, for the repair instructions.

   B. Remove all of the water and other contamination, in and around the damaged area.

   NOTE: The area must be fully dry before you continue on with this repair procedure. If necessary, you can dry the area at a faster rate with an external heat source. Limit the temperature to a maximum of 150°F (66°C).

   C. Inspect the primer to make sure that it has not been damaged as given in Paragraph 6.B./REPAIR GENERAL.

   D. Prepare and apply a two part paste adhesive in the disbonded area as given in Paragraph 19./REPAIR GENERAL.

   E. Use a clamp to hold the skins together. Use a light clamping pressure to hold the skins together.

   NOTE: To apply the clamping pressure equally, use wood, metal, or phenolic wedges (or blocks, if more applicable) between the skin and clamps.

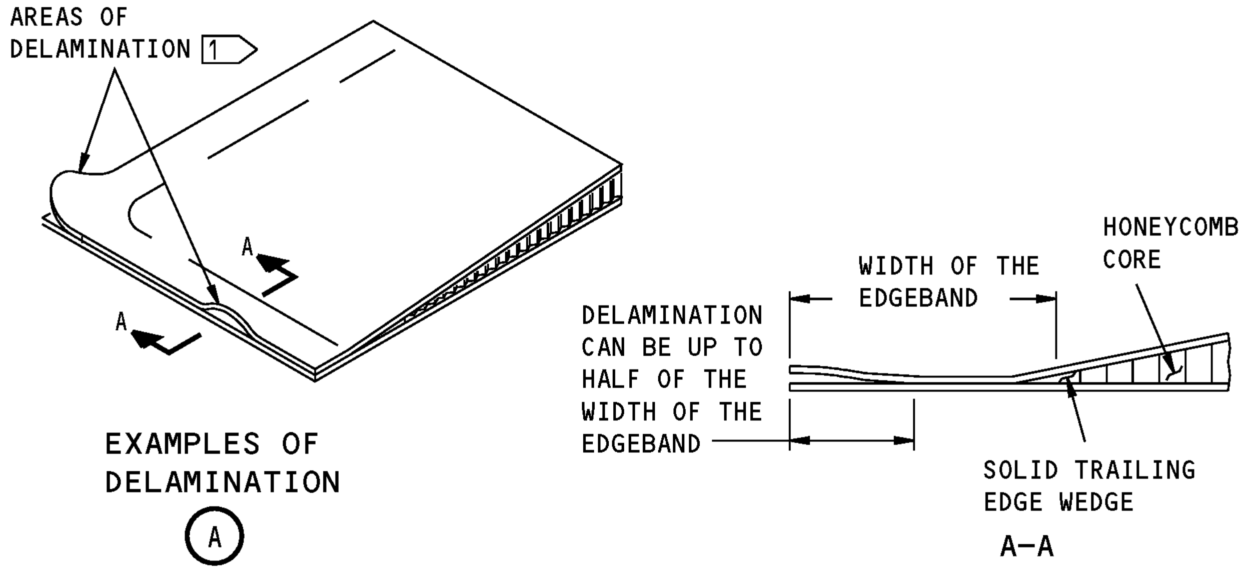
      (1) Make sure that there is no air caught in-between the adhesive material and the skins.

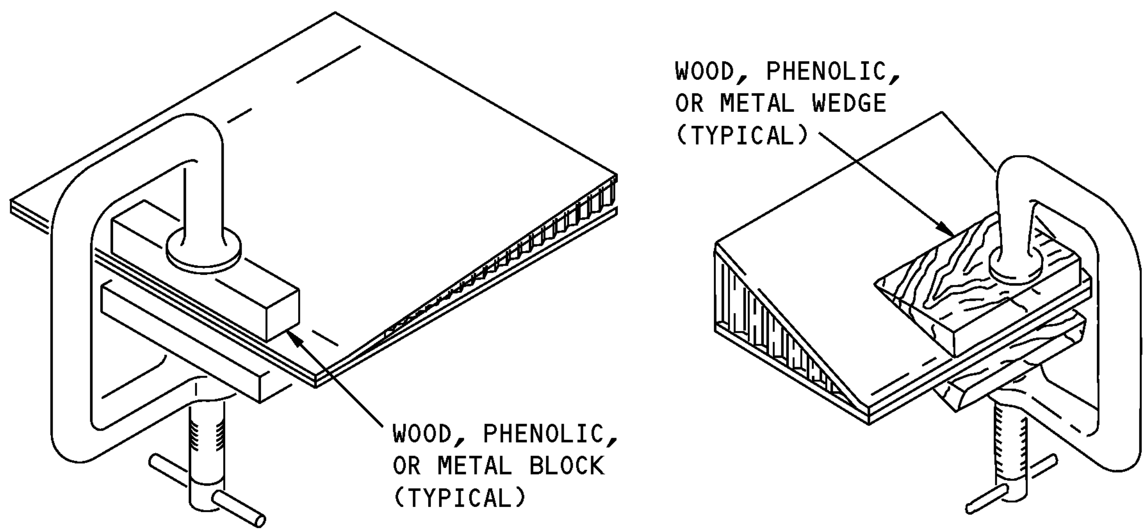
      (2) Remove unwanted adhesive material that can appear from the edge of the disbonded area.

   F. Cure the repair as given in Paragraph 20./REPAIR GENERAL.

   G. Examine the repair as given in Paragraph 21./REPAIR GENERAL.

   H. Clean, seal and finish as given in Paragraph 22./REPAIR GENERAL.





EXAMPLES OF ALUMINUM SKINS THAT
ARE HELD TOGETHER WITH CLAMPS

B

NOTES

1 THE DISBOND MUST NOT GO INTO THE HONEYCOMB CORE. DISBONDS AT FASTENER HOLES ARE NOT PERMITTED. THE CUMULATIVE (TOTAL) LENGTH OF MULTIPLE DISBONDS MUST BE LESS THAN 30% OF THE LENGTH OF THE EDGEBAND.

Repair of Disbonds at an Edge
Figure 201

REPAIR 2 - REPAIRS TO SMALL DAMAGE

1. Applicability

A. Repair 2 has typical repairs that are applicable to dents, nicks, creases, gouges, cracks and small holes on one side of a aluminum honeycomb sandwich structure. Refer to 51-10-02, GENERAL for the damage definitions.

NOTE: These repairs are limited to damage that is 2.0 inches (50 mm) or less in length and diameter. These repairs are interim when paste adhesive is used. Inspect paste adhesive repairs each 24 months or less, or each 3500 flight cycles or less (no later than the interval that occurs first). Refer to Figure 201/REPAIR GENERAL for other repair options.

B. Refer to REPAIR 4 for all damage that is larger than 2.0 inches (50 mm) in length and diameter.

2. General

A. The illustrations and instructions in this repair show different examples of repairs and types of damage. You can do repairs that put together one or more of these examples. Use the correct repair procedures for each type of example.

B. Proximity of repairs.

(1) Repair doublers must be a minimum of 2.0 inches (50 mm) apart, edge to edge.

(2) If a repair doubler will be closer than 2.0 inches (50 mm) to an adjacent repair doubler, then use one doubler for the multiple damage areas.

NOTE: If the repair doubler will be too close to a doubler from an old repair, then you can remove the old doubler. Then use one large doubler for the old damage and the new damage.

C. Refer to Figure 201/REPAIR GENERAL for repair sizes and options.

(1) Refer to Figure 201/REPAIR 2 for the layout of a dent repair.

(2) Refer to Figure 202/REPAIR 2 for the layout of a repair to a nick, gouge or crack in the skin.

(3) Refer to Figure 203/REPAIR 2 for the layout of a small hole repair.

D. Refer toTable 203/REPAIR GENERAL for the cure information for the adhesive.

3. References

Reference	Title
51-10-02, GENERAL	Inspection and Removal of Damage
737 NDT Part 1, 51-04-00	Ultrasonic
737 NDT Part 1, 51-05-01	Tap Test Inspection of Honeycomb Sandwich Structure

4. Repair Instructions

A. Do a non-destructive inspection (NDI) to find the limits of the visible damage. If there is delaminated skin then cut out the damaged area and do a hole repair. Refer to 737 NDT Part 1, 51-05-01 or 737 NDT Part 1, 51-04-00.

B. Remove the surface finish and all contamination as specified in REPAIR GENERAL.

C. Repair to a surface that has a crack.

(1) Stop drill the ends of cracks as specified in 51-10-02, GENERAL.

(2) If there is an adhesive primer on the surface then do an inspection as specified in Paragraph 6.B./REPAIR GENERAL. If the primer is in a satisfactory condition, then permit the primer to remain. Clean the primer with a clean cloth that is moist with MEK. Some primer will come off on to the cloth. This is permitted if bare metal does not show. If bare metal shows after the surface is rubbed, then the primer must be removed from all of the surface to be bonded, and you must do the surface preparation and primer procedure again.

(3) If there is no adhesive primer, or if the primer is not in a satisfactory condition, then do a surface preparation procedure as specified in Paragraph 11./REPAIR GENERAL.

D. Repair to a surface that has a small hole.

(1) Remove the damaged skin and core.

(2) The maximum size of a hole that can be filled with potting compound is 1.0 inch (25 mm) in diameter. If the hole is larger than 1.0 inch (25 mm), then make and install a repair core as specified inParagraph 8./REPAIR GENERAL and Paragraph 9./REPAIR GENERAL.

(3) If there is an adhesive primer on the surface then do an inspection as specified in Paragraph 6.B./REPAIR GENERAL. If the primer is in a satisfactory condition, then permit the primer to remain. Clean the primer as specified in Paragraph 6.B./REPAIR GENERAL.

(4) If there is no adhesive primer, or if the primer is not in a satisfactory condition, then do a surface preparation procedure as specified in Paragraph 11./REPAIR GENERAL.

E. Repair of dents.

(1) If the depth of a dent is equal or deeper than two times the skin thickness, then the dent repair is time-limited. Remove the doubler at 24 months (or less) or each 3500 flight cycles or less (no later than the interval that occurs first) and do a hole repair.

(2) Apply strong finger pressure to the damaged area to see if the core compresses. If the core compresses, then the dent repair is time-limited. Remove the doubler at 24 months (or less) or each 3500 flight cycles or less (no later than the interval that occurs first) and do a hole repair.

(3) If there is an adhesive primer on the surface then do an inspection as specified in Paragraph 6.B./REPAIR GENERAL. If the primer is in a satisfactory condition, then permit the primer to remain. Clean the primer as specified in Paragraph 6.B./REPAIR GENERAL.

(4) Fill the dent. Do one of the procedures that follow:

(a) Potting compound procedure.

1) Abrade the area of the dent with 180 grit sandpaper. Fill with BMS 5-28 Type 6 or 7 potting compound.

2) Cure as specified in Table 203/REPAIR GENERAL.

3) Abrade the potting compound until it is flush with the undamaged skin. If there is adhesive primer on the surface to be bonded, do not damage the primer during the sanding procedure.

4) If there is no adhesive primer on the surface to be bonded, or if the primer is not in a satisfactory condition, then do a surface preparation procedure as specified in Paragraph 11./REPAIR GENERAL.

(b) Paste adhesive procedure. .

1) If there is no adhesive primer on the surface to be bonded, or if the primer is not in a satisfactory condition, then do a surface preparation procedure as specified in Paragraph 11./REPAIR GENERAL.

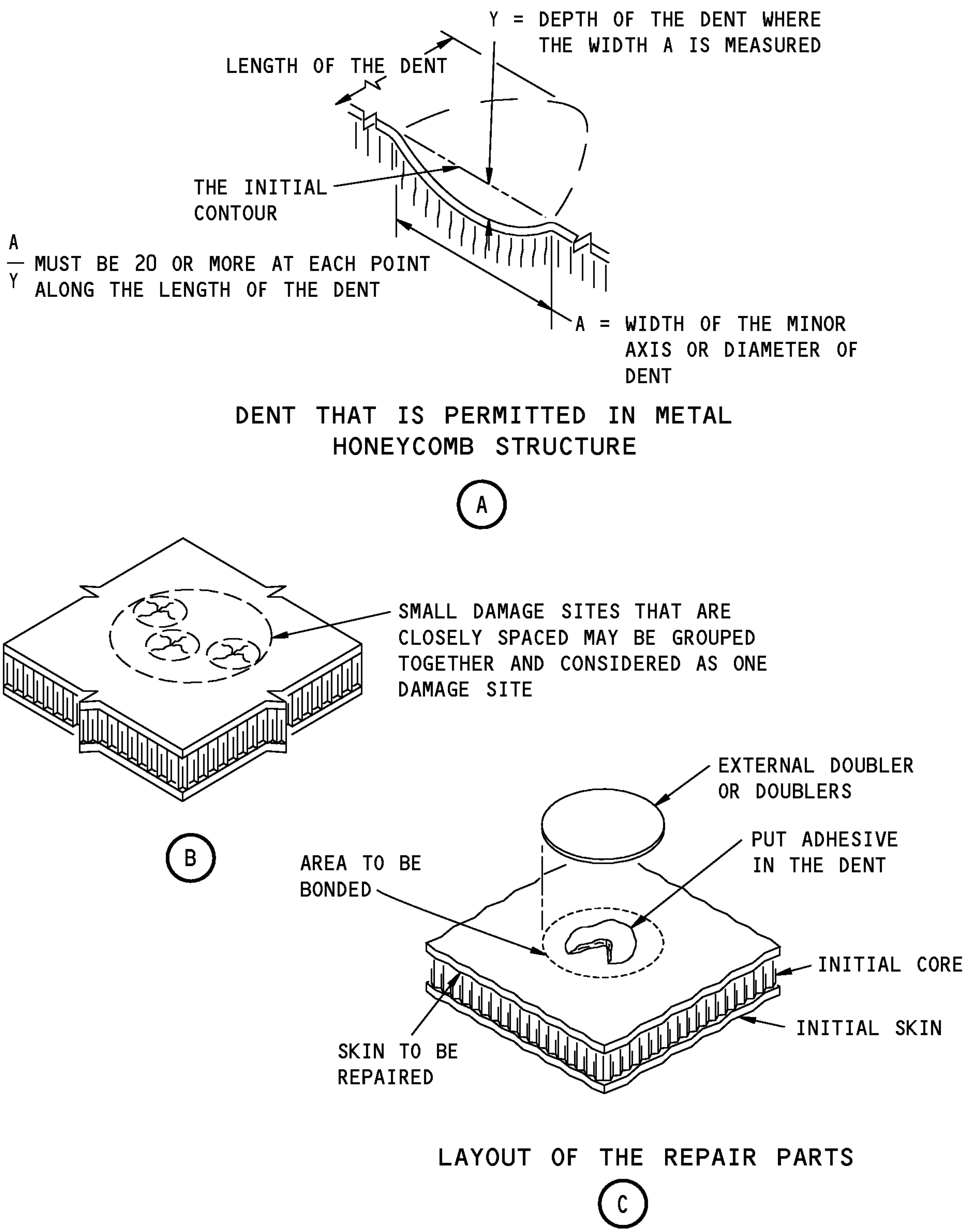
2) Fill the dent with the same paste adhesive that will be used to bond the doubler.

(c) Film adhesive procedure.

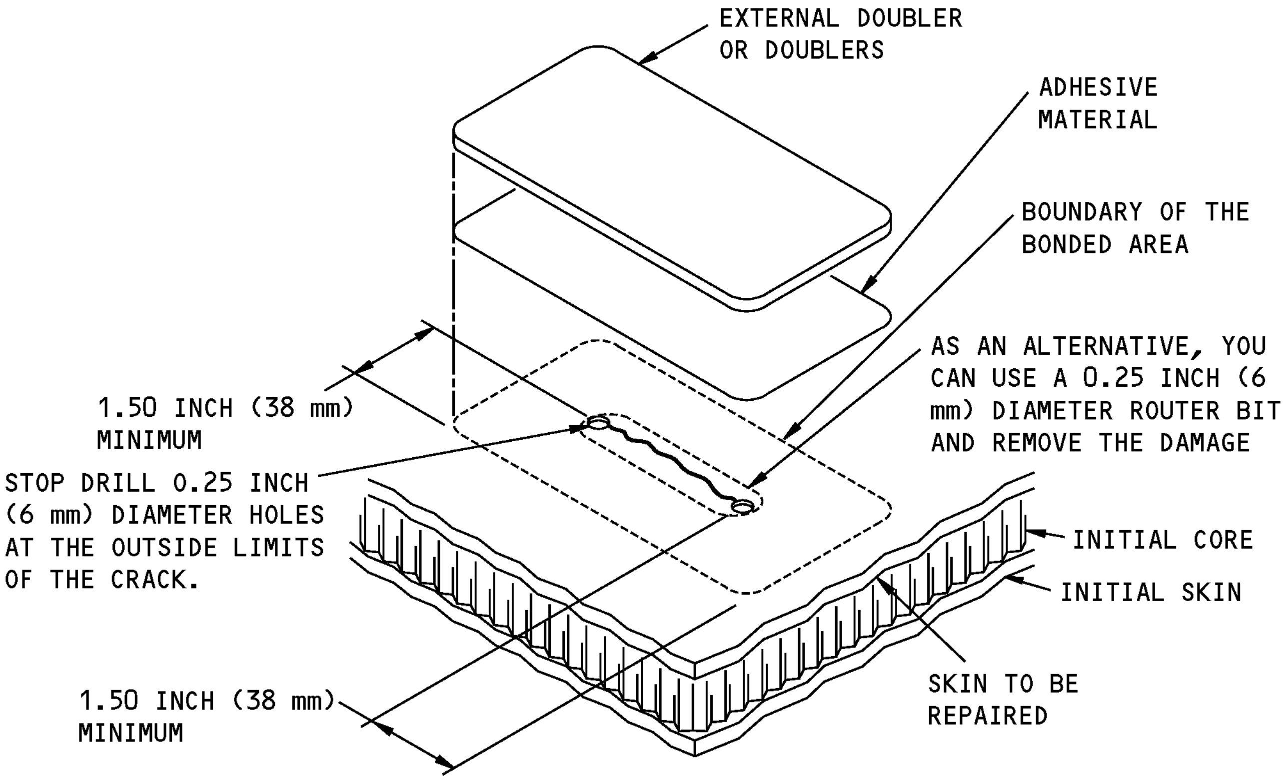
1) If there is no adhesive primer on the surface to be bonded, or if the primer is not in a satisfactory condition, then do a surface preparation procedure as specified in Paragraph 11./REPAIR GENERAL.

2) Fill the dent with the same film adhesive that will be used to bond the doubler. You can add BMS 5-121 positioning fabric to the adhesive inside the dent, (if necessary).

F. Refer to REPAIR GENERAL for the bonding procedure and other repair steps.

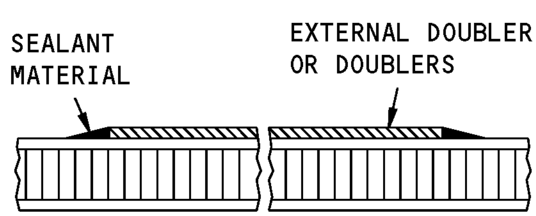


External Doubler Repair of a Dent
Figure 201



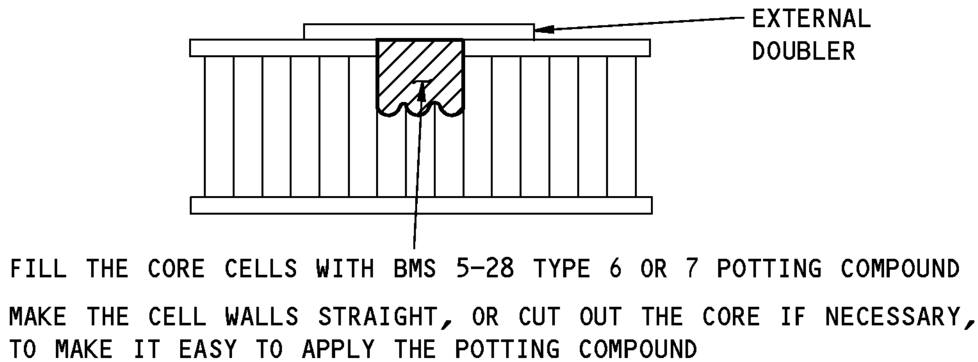
LAYOUT OF THE REPAIR PARTS

A



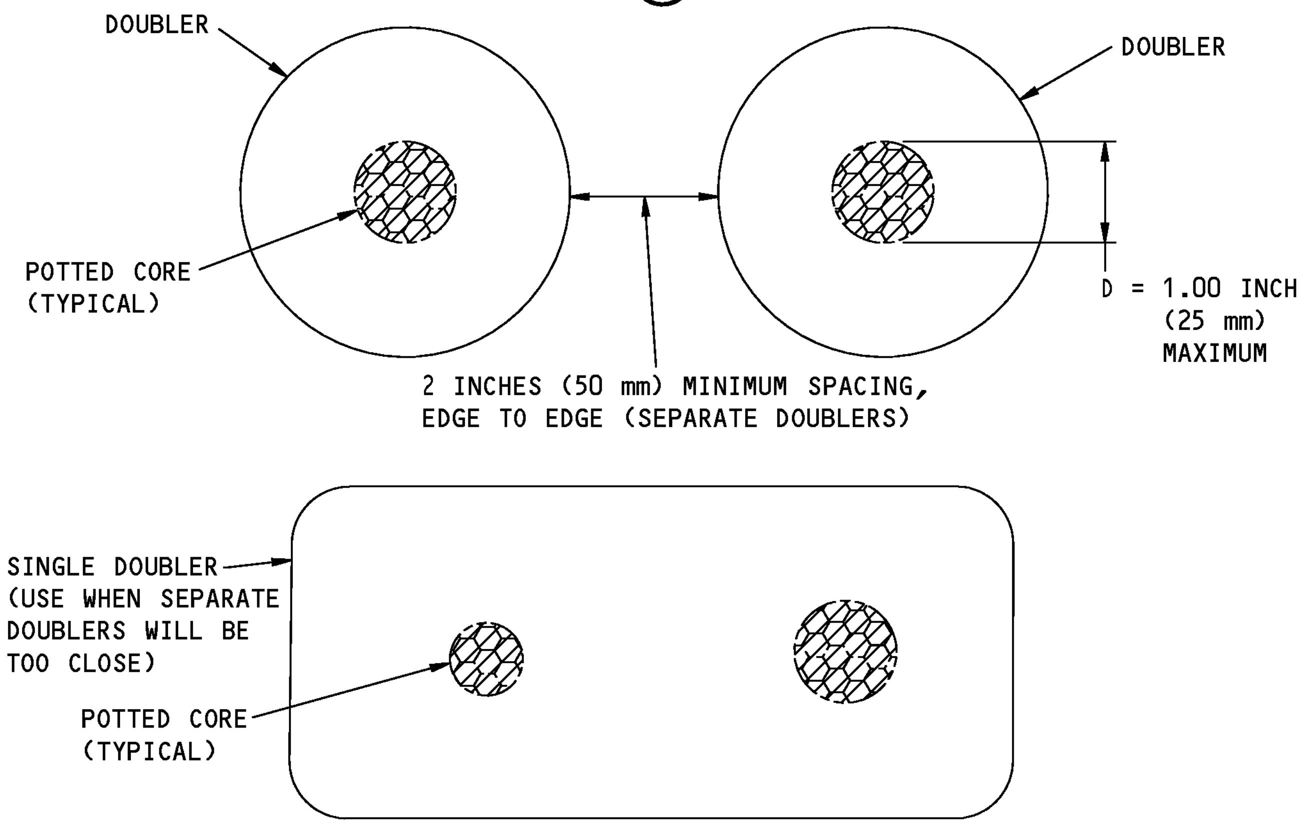
SECTION THROUGH THE REPAIR (TYPICAL)

External Doubler Repair of a Nick, Gouge, or Crack in the Skin
Figure 202



PERMITTED DEPTH OF POTTING COMPOUND

A



PERMITTED SPACING OF POTTED AREAS

B

Potted Core Repair for Small Damage
Figure 203

REPAIR 3 - SEPTUMIZED CORE REPAIRS

1. Applicability

A. Repair 3 is an alternative to the full depth honeycomb core repair.

B. This repair uses a septum:

(1) To bond a partial depth core to an initial core, or

(2) To bond two separate cores together to make a full depth core.

2. General

A. The illustrations and instructions in this repair show different examples of repairs and types of damage. You can do repairs that put together one or more of these examples. Use the correct repair procedures for each type of example.

B. Refer to REPAIR GENERAL and REPAIR 4 Repairs to Large Damage, to repair the removed skin.

C. Refer to Figure 201/REPAIR 3 for the configuration of the repair parts in a partial depth core replacement.

D. Refer to Figure 202/REPAIR 3 for the configuration of the repair parts in a full depth core replacement.

3. References

Reference	Title
51-70-04, REPAIR GENERAL	Repair Procedures for Wet Layup Materials
51-70-05, REPAIR GENERAL	Repair Procedures for Preimpregnated Materials
51-70-05, REPAIR P/B REPAIR	REPAIR PROCEDURES FOR PREIMPREGNATED MATERIALS

4. Remove the Damage

A. Find the size limits for the damage as given in Paragraph 6./REPAIR GENERAL.

B. Remove the damage as given in Paragraph 7./REPAIR GENERAL.

(1) If the core material removed is less than 1/3 the full depth of the core, then remove a sufficient quantity of the core so that the repair septum will be located at a depth of 1/3 to 2/3 the full depth of the core. Then do the steps in Paragraph 5./REPAIR 3.

(2) If the core material removed is more than 2/3 the full depth of the core, then do one of the steps that follow:

(a) Do the full depth septumized core steps in Paragraph 6./REPAIR 3 or,

(b) Do a full depth core repair steps as specified in Paragraph 9./REPAIR GENERAL.

5. Partial Depth Septumized Core Repair

NOTE: This repair is cured in two stages.

A. Make the repair septum from pre-cured BMS9-3 glass fabric impregnated with BMS8-301 Class 1 epoxy resin, or pre-cured BMS8-79 or BMS8-139 glass fabric reinforced plastic (GFRP), or an aluminum alloy sheet.

(1) Applicability and Limitations.

(a) The septum options that follow, are permitted in aluminum honeycomb panels that were initially manufactured at 250°F (121°C):

1) GFRP septum made from BMS9-3 dry fabric with BMS8-301 Class 1 resin. Refer to 51-70-04, REPAIR GENERAL and Paragraph 5.A.(2)/REPAIR 3 for the procedure.

2) GFRP septum made from BMS8-79 preimpregnated (prepreg) fabric and BMS5-129 film adhesive. Refer to 51-70-05, REPAIR GENERAL and Paragraph 5.A.(2)/REPAIR 3 for the procedure.

3) Aluminum and BMS5-101 film adhesive. Refer to Paragraph 5.A.(3)/REPAIR 3 for the procedure.

(b) The septum options that follow, are permitted in aluminum honeycomb panels that were initially manufactured at 350°F (177°C):

1) GFRP septum made from BMS8-139 preimpregnated (prepreg) fabric and BMS5-154 film adhesive. Refer to 51-70-05, REPAIR GENERAL and Paragraph 5.A.(2)/REPAIR 3 for the procedure.

2) Aluminum and BMS5-137 film adhesive (cured at 310°F (154°C)). Refer to Paragraph 5.A.(3)/REPAIR 3 for the procedure.

(2) Refer to 51-70-04, REPAIR GENERAL or 51-70-05, REPAIR GENERAL to make pre-cured GFRP.

(a) Lightly abrade the surface resin with 180-grit or finer abrasive paper to remove the glossy surface from the pre-cured GFRP.

(b) Do not sand into the glass fibers.

(3) If you use an aluminum sheet septum, then refer to REPAIR GENERAL and do the steps that follow:

NOTE: Do not use clad 7000 series alloy aluminum as a septum.

(a) Do a surface preparation on each side of the septum, then

(b) Put an adhesive primer on each side of the septum.

B. Make the honeycomb repair core. Refer to Paragraph 8./REPAIR GENERAL.

C. Apply the adhesive materials. Refer to Figure 201/REPAIR 3 for the applicable adhesive and the steps that follow:

(1) Put film adhesive into the hole. Refer to Paragraph 9./REPAIR GENERAL.

(2) Put the septum in the hole.

(3) Put a layer of film adhesive on the septum as specified in Figure 201/REPAIR 3.

(4) Install the honeycomb repair core. Refer to Paragraph 9./REPAIR GENERAL.

D. Do the first stage of the two stage cure. Refer to Paragraph 9./REPAIR GENERAL.

E. Do a visual inspection of the repair area after the cure is completed and the thermocouples have been removed.

(1) Look for areas of disbond in the adhesive bond between the repair core and the initial core. There must be no gaps or disbonds in these areas.

NOTE: If you find disbonds in the adhesive surface, then fill them with BMS5-28, Type 6 or Type 7 potting compound. Cure the BMS5-28 potting compound during the final stage of the cure.

(2) Look for disbonds in the adhesive materials between the septum and the repair core.

(a) If the diameter of the repair septum is larger than 2.0 inches, (50 mm) and you find disbonds that are larger than 3/8 inch (10 mm) in diameter, then the repair is not satisfactory.

(b) If the diameter of the repair septum is less than 2.0 inches (50 mm), then no visible disbonds are permitted.

6. **Full Depth Septumized Core Repair**

NOTE: This repair is cured in three stages.

A. Cut two pieces of honeycomb core that are a minimum of 1.0 inch (25 mm) diameter larger than the hole in the component to be repaired.

B. Each piece of honeycomb core must be a minimum of 1/3 the depth of the hole and a maximum of 2/3 the depth of the hole.

C. The core/septum assembly must be higher than the depth of the hole.

NOTE: This will permit you to abrade the top of the core to make it flush with the skin surface.

D. Make the repair septum from pre-cured BMS9-3 glass fabric impregnated with BMS8-301 Class 1 epoxy resin, or pre-cured BMS8-79 or BMS8-139 glass fabric reinforced plastic (GFRP), or an aluminum alloy sheet. Make the septum approximately the same size as the repair core blankets.

(1) Applicability and Limitations.

(a) The septum options that follow, are permitted in aluminum honeycomb panels that were initially manufactured at 250°F (121°C):

1) GFRP septum made from BMS9-3 dry fabric with BMS8-301 Class 1 resin. Refer to 51-70-04, REPAIR GENERAL and Paragraph 6.D.(2)/REPAIR 3 for the procedure.

2) GFRP septum made from BMS8-79 preimpregnated (prepreg) fabric and BMS5-129 film adhesive. Refer to 51-70-05, REPAIR GENERAL and Paragraph 6.D.(2)/REPAIR 3 for the procedure.

3) Aluminum and BMS5-101 film adhesive. Refer to Paragraph 6.D.(3)/REPAIR 3 for the procedure.

(b) The septum options that follow, are permitted in aluminum honeycomb panels that were initially manufactured at 350°F (177°C):

1) GFRP septum made from BMS8-139 preimpregnated (prepreg) fabric and BMS5-154 film adhesive. Refer to 51-70-05, REPAIR GENERAL and Paragraph 6.D.(2)/REPAIR 3 for the procedure.

2) Aluminum and BMS5-137 Type II (EA 9657 only) film adhesive cured at 310°F (154°C). Refer to Paragraph 6.D.(3)/REPAIR 3 for the procedure.

(2) Refer to 51-70-04, REPAIR GENERAL or 51-70-05, REPAIR GENERAL to make pre-cured GFRP laminate.

(a) Lightly abrade the surface resin of the pre-cured GFRP laminate with180-grit or finer abrasive paper to remove the glossy surface.

(b) Do not sand into the glass fibers.

(3) If you use an aluminum sheet septum, then refer to REPAIR GENERAL and do the steps that follow:

NOTE: Do not use clad 7000 series alloy aluminum as a septum.

(a) Do a surface preparation on each side of the septum, then

(b) Put an adhesive primer on each side of the septum.

E. Apply the adhesive materials. Refer to Figure 202/REPAIR 3 for the applicable adhesive and the steps that follow:

(1) Put film adhesive on the mating surface of the first honeycomb core blanket that you will bond the septum to.

(2) Put the septum on the first honeycomb core blanket.

(3) Put film adhesive on the septum.

(4) Put the second honeycomb core blanket on to the septum. Make sure that the ribbon direction is the same as the bottom core.

F. Cure the honeycomb core/septum assembly. Refer to Figure 202/REPAIR 3.

(1) Put the assembly on a clean, hard, and flat surface.

(2) Put edge support blocks against the edges of the assembly.

(3) Do the vacuum bag layup.

(4) Cure the assembly as specified in REPAIR PROCEDURES FOR PREIMPREGNATED MATERIALS, PAGEBLOCK 51-70-05, REPAIR if the GFRP septum is used or Paragraph 20./REPAIR GENERAL if the aluminum septum is used.

G. Cut the core/septum assembly to the necessary shape. (A core cylinder, for example).

H. Look for disbonds in the adhesive materials between the septum and the two honeycomb repair cores.

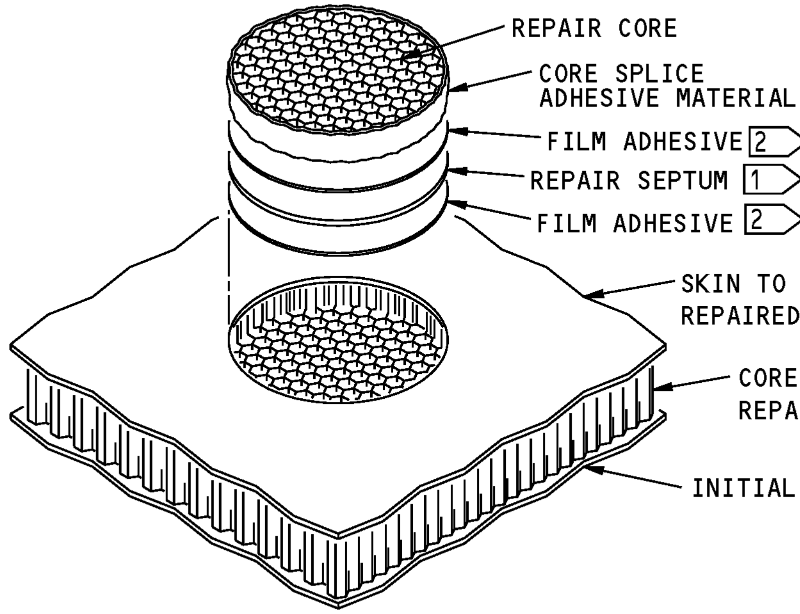
(1) If the diameter of the repair septum is larger than 2.0 inches, (50 mm) and you find disbonds that are larger than 3/8 inch (10 mm) in diameter, then the repair is not satisfactory.

(2) If the diameter of the repair septum is less than 2.0 inches (50 mm), then no visible disbonds are permitted.

I. Install the honeycomb repair core/septum assembly and do the second stage of the three stage cure. Refer to Paragraph 9./REPAIR GENERAL.

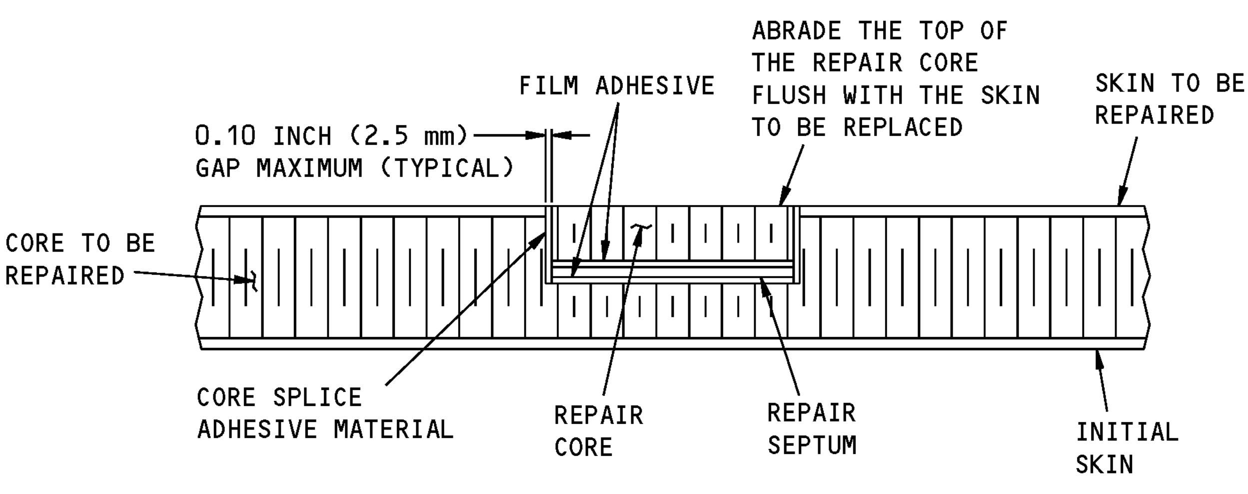
7. Complete the Repair

A. Complete the repair as specified in REPAIR GENERAL and REPAIR 4 Repairs to Large Damage.



LAYOUT OF THE REPAIR PARTS

A



SECTION THROUGH THE CENTER OF THE REPAIR AREA

Bonded Doubler Repair That Uses an Internal Septum For a Less Than Full Depth Core Replacement
Figure 201 (Sheet 1 of 3)

NOTES

- REFER TO REPAIR GENERAL FOR REPAIR CORE INSTALLATION PROCEDURES.

[1] MAKE THE SEPTUM OUT OF PRE-CURED GLASS FABRIC REINFORCED PLASTIC (GFRP) LAMINATE OR AN ALUMINUM ALLOY SHEET:

A. TO MAKE A PRE-CURED GFRP LAMINATE FROM DRY FABRIC, REFER TO SRM 51-70-04. MAKE ONE OF THE LAMINATES THAT FOLLOW:

- IMPREGNATE AND THEN CURE TWO PLIES OF BMS 9-3, TYPE H-2 GLASS FABRIC AND BMS 8-301, CLASS I EPOXY RESIN, OR
- IMPREGNATE AND THEN CURE THREE PLIES OF BMS 9-3, TYPE D GLASS FABRIC AN BMS 8-301. CLASS I EPOXY RESIN.

B. TO MAKE A PRE-CURED 250°F (121°C) GFRP PREPREG LAMINATE, REFER TO SRM 51-70-05. MAKE ONE OF THE LAMINATES THAT FOLLOW:

- TWO PLIES OF BMS 8-79, CLASS III, STYLE 1581 OR 7781, OR
- THREE PLIES OF BMS 8-79, CLASS III, STYLE 120 OR 220.

C. TO MAKE A PRE-CURED 350° F (177°C) GFRP PREPREG LAMINATE, REFER TO SRM 51-70-05. MAKE ONE OF THE LAMINATES THAT FOLLOW:

- TWO PLIES OF BMS 8-139, CLASS 1, STYLE 1581 OR 7781, OR
- THREE PLIES OF BMS 8-139, CLASS 1, STYLE 120 OR 220.

D. TO MAKE AN ALUMINUM ALLOY SHEET SEPTUM, USE 0.012 - 0.020 INCH THICK ALUMINUM.

- USE THE SAME BOEING MATERIAL SPECIFICATION (BMS) ALUMINUM MATERIAL, (OR AN EQUIVALENT ALUMINUM MATERIAL). USE THE SAME (OR SIMILAR) HEAT-TREAT AS THE INITIAL ALUMINUM SKIN THAT IS TO BE REPAIRED.
- DO NOT USE 7000 SERIES ALUMINUM THAT HAS A CLAD SURFACE. IF THE SKIN TO BE REPAIRED IS A CLAD 7000 SERIES ALUMINUM, THEN USE AN UNCLAD 7000 SERIES ALUMINUM.
- DO A PHOSPHORIC ACID OR BOEGEL SUFACE PREPARATION.

Bonded Doubler Repair That Uses an Internal Septum For a Less Than Full Depth Core Replacement
Figure 201 (Sheet 2 of 3)

NOTES (CONT.)

2 APPLY THE ADHESIVE MATERIALS TO THE TWO MATING SURFACES OF THE REPAIR SEPTUM AS FOLLOWS:

A. FOR THE PRE-CURED 250°F (121°C) GFRP SEPTUM:

- APPLY TWO LAYERS OF BMS 5-129, TYPE IV, GRADE 10 ADHESIVE FILM.

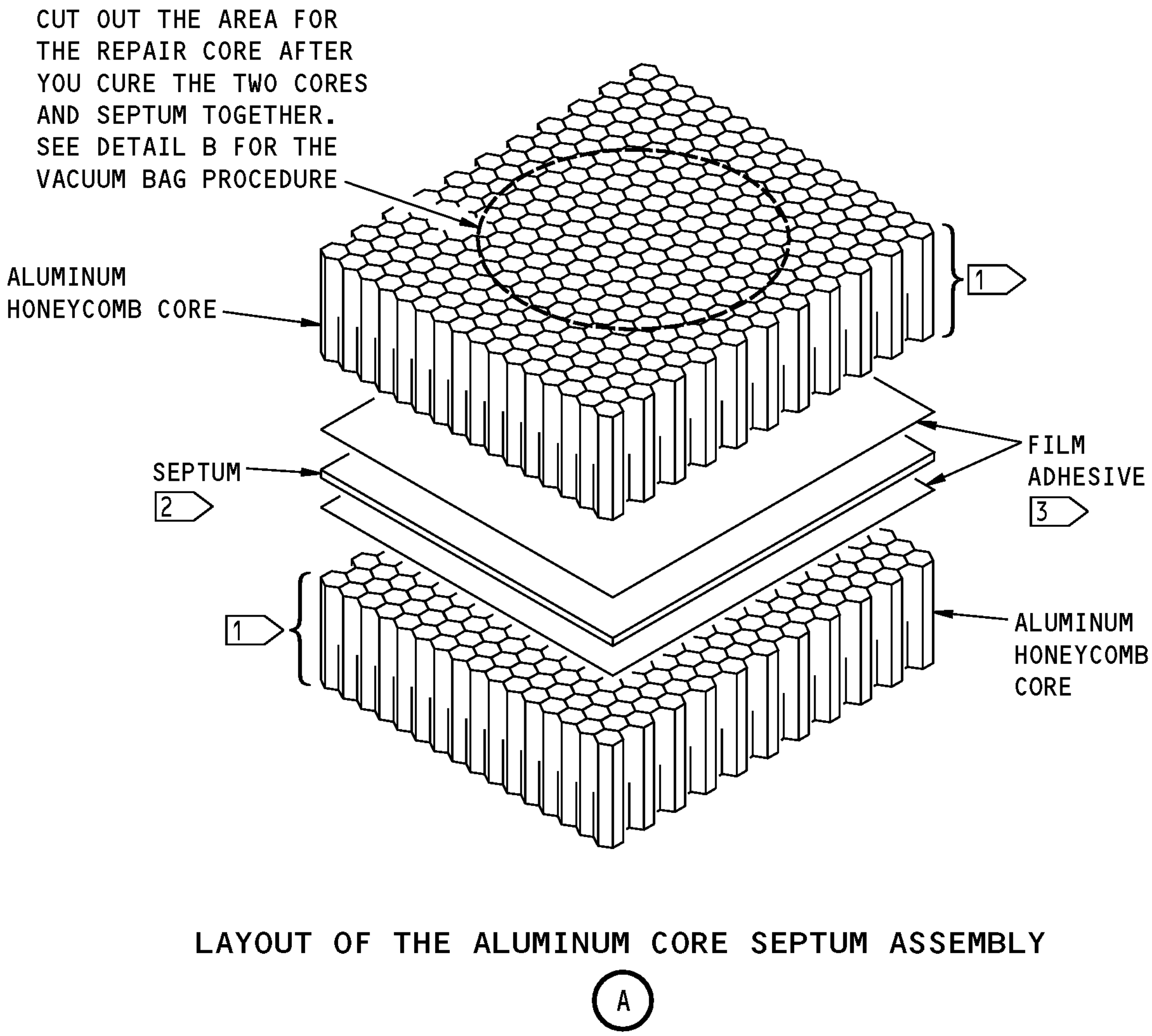
B. FOR THE PRE-CURED 350°F (177°C) GFRP SEPTUM:

- APPLY THREE LAYERS OF BMS 5-154, GRADE 5 ADHESIVE FILM.

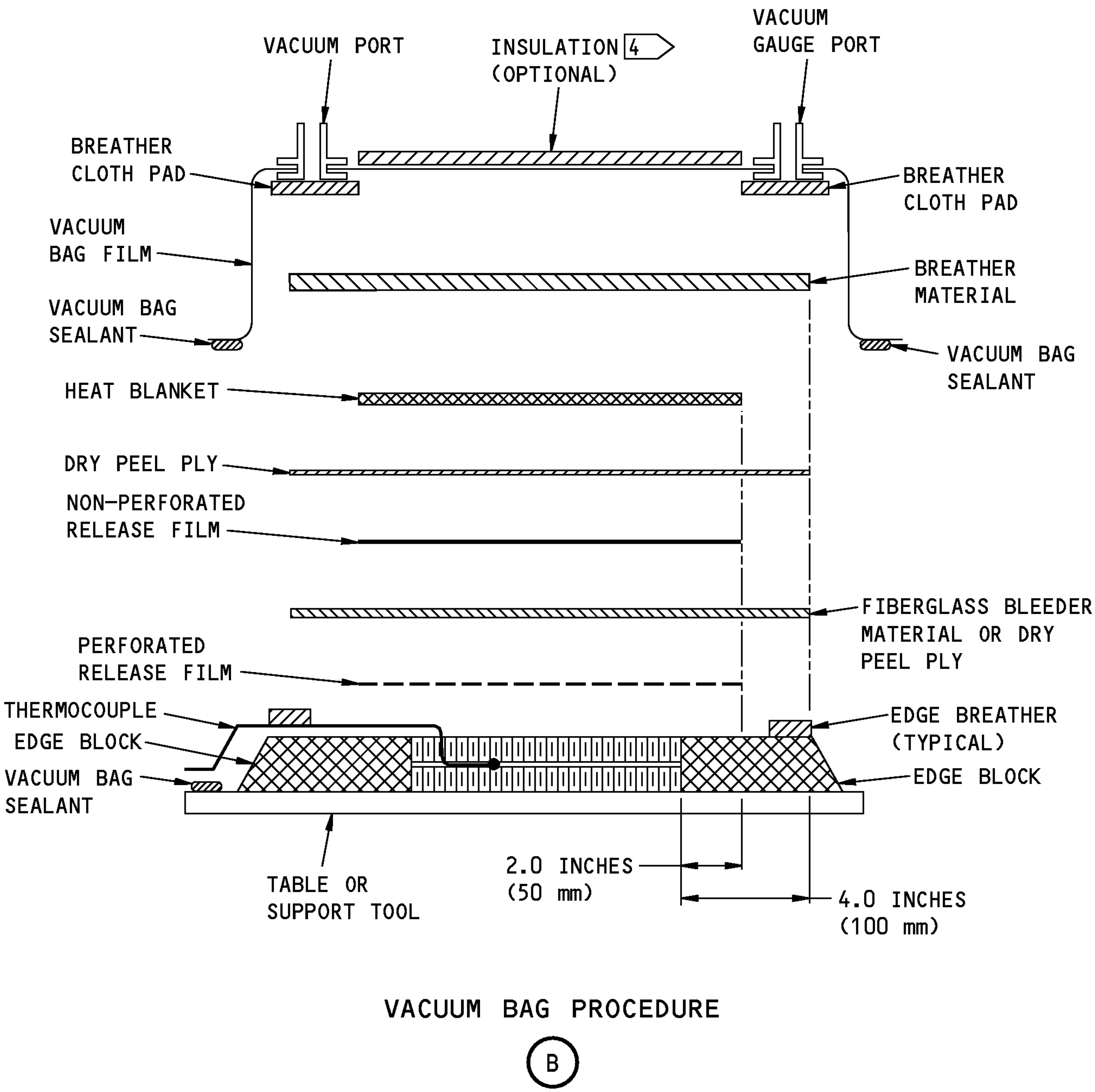
C. FOR THE ALUMINUM SEPTUM:

- APPLY TWO LAYERS OF BMS 5-101, GRADE 10 OR ONE LAYER OF BMS 5-101, GRADE 15 ADHESIVE FILM (250°F (121°C) CURE), OR
- APPLY TWO LAYERS OF BMS 5-137, TYPE II, GRADE 10 OR ONE LAYER OF BMS 5-137, TYPE II, GRADE 15 ADHESIVE FILM (310°F (154°C) CURE).

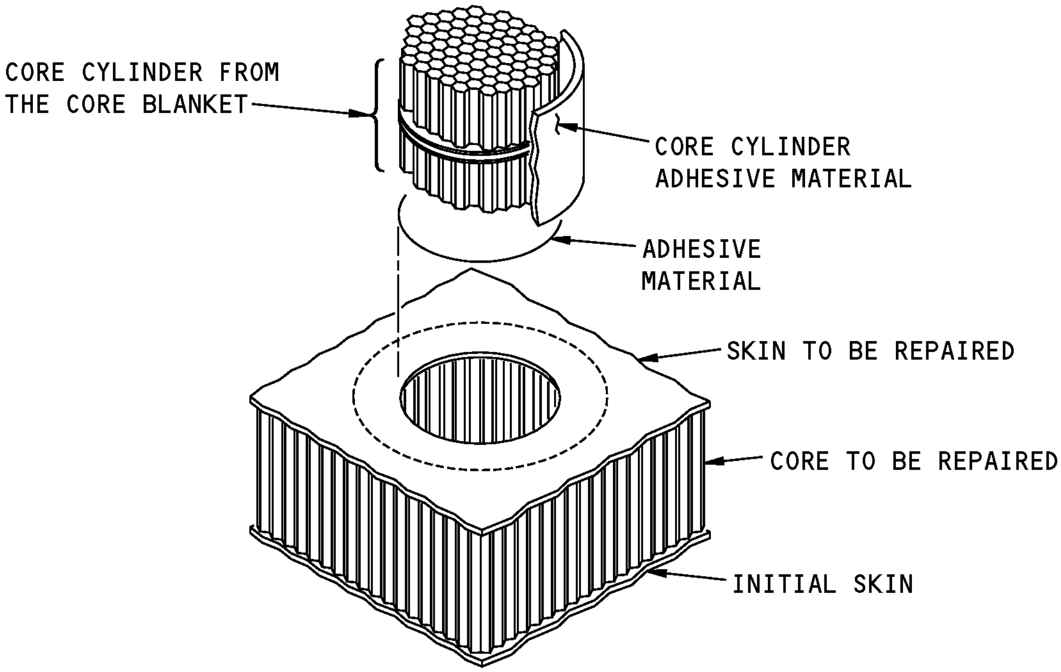
Bonded Doubler Repair That Uses an Internal Septum For a Less Than Full Depth Core Replacement
Figure 201 (Sheet 3 of 3)



Bonded Doubler Repair That Uses Two Cores and an Internal Septum for Full Core Replacement
Figure 202 (Sheet 1 of 5)

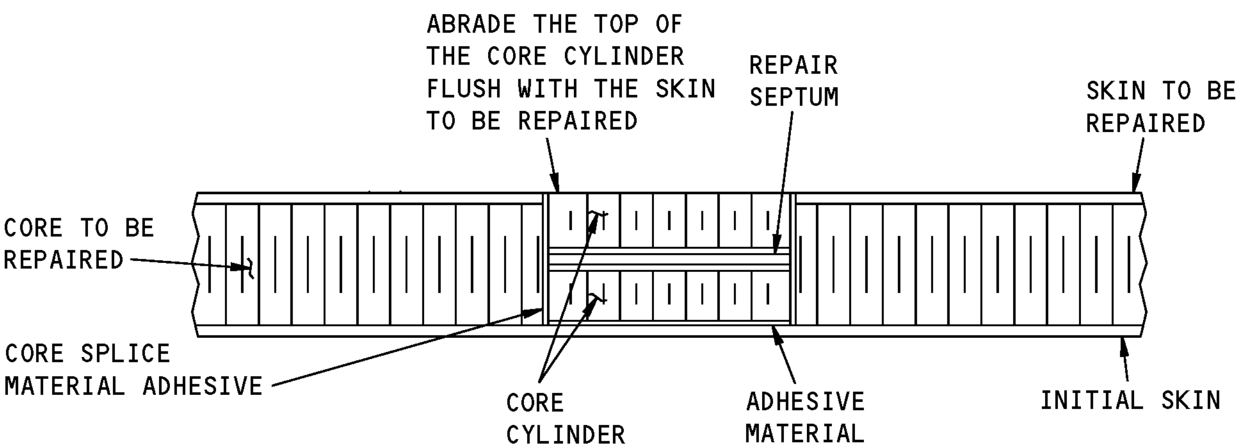


Bonded Doubler Repair That Uses Two Cores and an Internal Septum for Full Core Replacement
Figure 202 (Sheet 2 of 5)



LAYOUT OF THE REPAIR PARTS FOR DAMAGE TO FULL DEPTH CORE AND ONE SKIN

C



SECTION THROUGH THE CENTER OF THE REPAIR AREA

Bonded Doubler Repair That Uses Two Cores and an Internal Septum for Full Core Replacement
Figure 202 (Sheet 3 of 5)

NOTES

1 THE HEIGHT OF EACH CORE MUST BE A MINIMUM OF 1/3 THE DEPTH OF THE HOLE AND A MAXIMUM OF 2/3 THE DEPTH OF THE HOLE.

2 MAKE THE SEPTUM OUT OF PRE-CURED GLASS FABRIC REINFORCED PLASTIC (GFRP) LAMINATE OR AN ALUMINUM ALLOY SHEET:

A. TO MAKE A PRE-CURED GFRP LAMINATE FROM DRY FABRIC, REFER TO SRM 51-70-04. MAKE ONE OF THE LAMINATES THAT FOLLOW:

- IMPREGNATE AND THEN CURE TWO PLIES OF BMS 9-3, TYPE H-2 GLASS FABRIC AND BMS 8-301, CLASS I EPOXY RESIN, OR

- IMPREGNATE AND THEN CURE THREE PLIES OF BMS 9-3, TYPE D GLASS FABRIC AND BMS 8-301, CLASS I EPOXY RESIN.

B. TO MAKE A PRE-CURED 250°F (121°C) GFRP PREPREG LAMINATE, REFER TO SRM 51-70-05. MAKE ONE OF THE LAMINATES THAT FOLLOW:

- TWO PLIES OF BMS 8-79, CLASS III, STYLE 1581 OR 7781, OR

- THREE PLIES OF BMS 8-79, CLASS III, STYLE 120 OR 220.

C. TO MAKE A PRE-CURED 350°F (177°C) GFRP PREPREG LAMINATE, REFER TO SRM 51-70-05. MAKE ONE OF THE LAMINATES THAT FOLLOW:

- TWO PLIES OF BMS 8-139, CLASS 1, STYLE 1581 OR 7781, OR

- THREE PLIES OF BMS 8-139, CLASS 1, STYLE 120 OR 220.

D. TO MAKE AN ALUMINUM ALLOY SHEET SEPTUM, USE 0.012 - 0.020 INCH THICK ALUMINUM.

- USE THE SAME BOEING MATERIAL SPECIFICATION (BMS) ALUMINUM MATERIAL, (OR AN EQUIVALENT ALUMINUM MATERIAL). USE THE SAME (OR SIMILAR) HEAT-TREAT AS THE INITIAL ALUMINUM SKIN THAT IS TO BE REPAIRED.

- DO NOT USE 7000 SERIES ALUMINUM THAT HAS A CLAD SURFACE. IF THE SKIN TO BE REPAIRED IS A CLAD 7000 SERIES ALUMINUM, THEN USE AN UNCLAD 7000 SERIES ALUMINUM.

- DO A PHOSPHORIC ACID OR BOEGEL SURFACE PREPARATION.

Bonded Doubler Repair That Uses Two Cores and an Internal Septum for Full Core Replacement
Figure 202 (Sheet 4 of 5)

NOTES: (CONT.)

3 APPLY THE ADHESIVE MATERIALS TO THE TWO MATING SURFACES OF THE REPAIR SEPTUM AS FOLLOWS:

A. FOR THE PRE-CURED 250°F (121°C) GFRP SEPTUM:

- APPLY TWO LAYERS OF BMS 5-129, TYPE IV, GRADE 10 ADHESIVE FILM.

B. FOR THE PRE-CURED 350°F (177°C) GFRP SEPTUM:

- APPLY THREE LAYERS OF BMS 5-154, GRADE 5 ADHESIVE FILM.

C. FOR THE ALUMINUM SEPTUM:

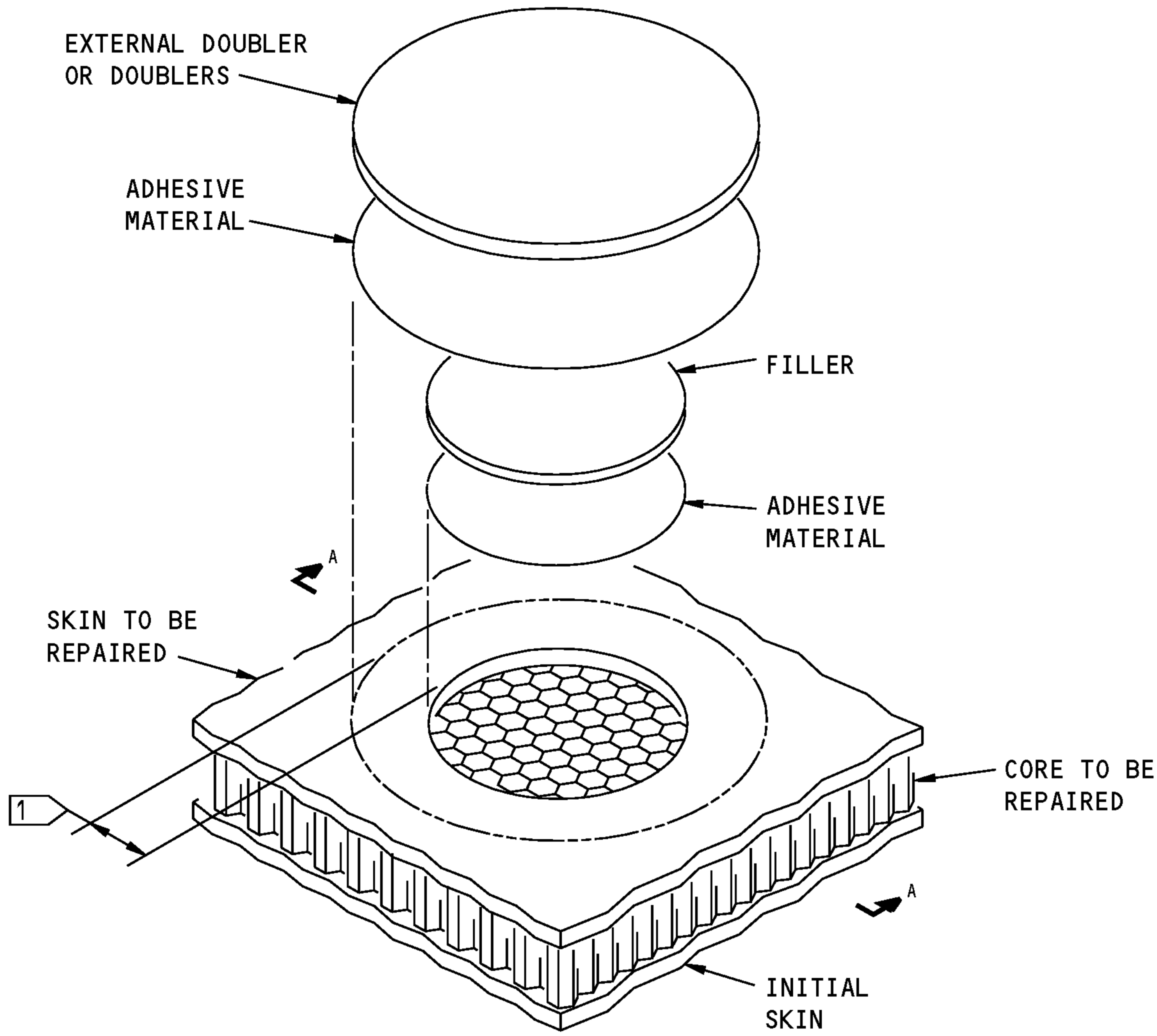
- APPLY TWO LAYERS OF BMS 5-101, GRADE 10 OR ONE LAYER OF BMS 5-101, GRADE 15 ADHESIVE FILM (250°F (121°C) CURE), OR
- APPLY TWO LAYERS OF BMS 5-137, TYPE II, GRADE 10 OR ONE LAYER OF BMS 5-137, TYPE II, GRADE 15 ADHESIVE FILM (310°F (154°C) CURE).

4 4 - 8 PLIES OF BREATHER MATERIAL FOR EXAMPLE. YOU CAN USE OTHER INSULATION MATERIALS ALSO. THIS WILL KEEP THE HEAT IN THE REPAIR AREA.

Bonded Doubler Repair That Uses Two Cores and an Internal Septum for Full Core Replacement
Figure 202 (Sheet 5 of 5)

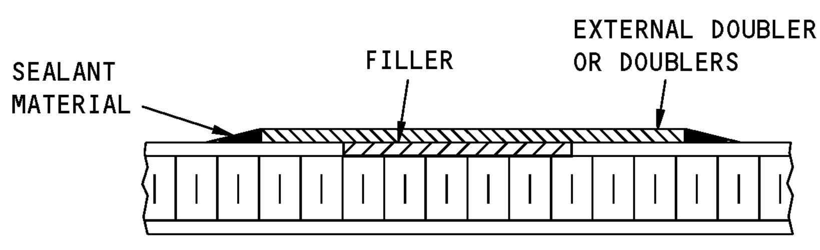
REPAIR 4 - REPAIRS TO LARGE DAMAGE

1. **Applicability**
   A. Repair 4 has typical repairs for aluminum honeycomb sandwich structure with large damage.
   B. In these repairs, it will be necessary to remove and replace the damaged area of the skin and/or core.
2. **General**
   A. The illustrations and instructions in this repair show different examples of repairs and types of damage. You can do repairs that put together one or more of these examples. Use the correct repair procedures for each type of example.
   B. If you have damage to the skin and core away from the edge, then refer to Figure 201/REPAIR 4 for the layout of the repair parts.
   C. If you have damage at the edge, then refer to Figure 202/REPAIR 4 for the layout of the repair parts.
   D. If you have damage from an edge to an edge, then refer to Figure 203/REPAIR 4 for the layout of the repair parts.
   E. Refer to Figure 204/REPAIR 4 for permitted spacing of adjacent repairs.
3. **Repair Instructions**
   A. Find and remove the damage as specified in Paragraph 6./REPAIR GENERAL and Paragraph 7./REPAIR GENERAL.
   B. Refer to the component engineering drawings or use NDI procedures to find the locations of internal doublers and other repairs. Refer to the repair figures for the doubler thicknesses and overlaps to use when cutouts are near a panel edgeband.
   C. If the edge of a cutout is less than 3.0 inches (75mm) from a fitting or attached structure then do one or more of the steps that follow:
      (1) Remove the fitting or attached structure. Then remove enough skin so that all cut edges will be 3.0 inches (75mm) or more from the fitting. Then reattach the fitting.
      (2) You can get an engineering review and replace the skin as specified in the engineering drawings.
      (3) If you are not sure, or if these instructions will not give a satisfactory repair, then ask Boeing for help.
   D. Refer to REPAIR GENERAL for the repair steps.



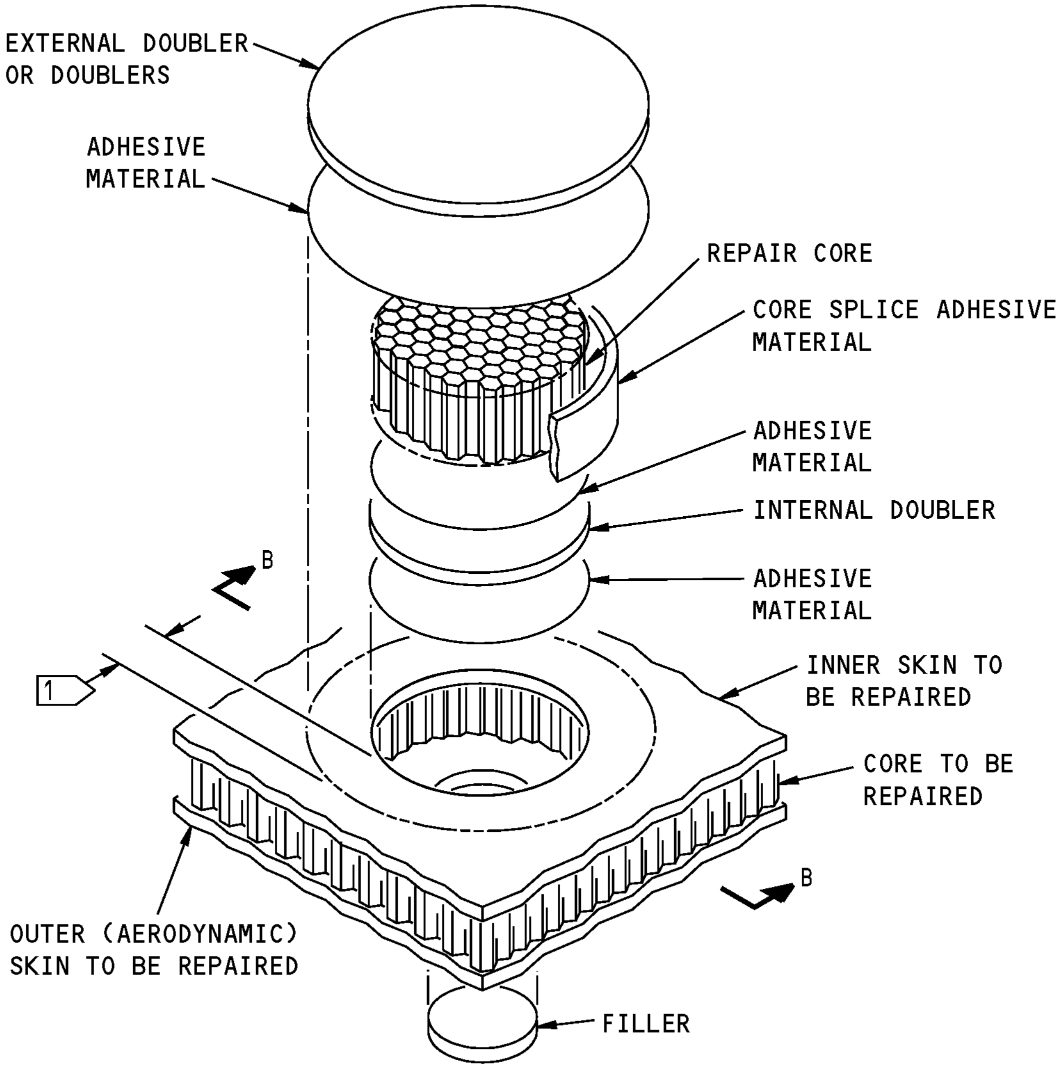
EXTERNAL DOUBLER AND FILLER REPAIR TO ONE SKIN

A



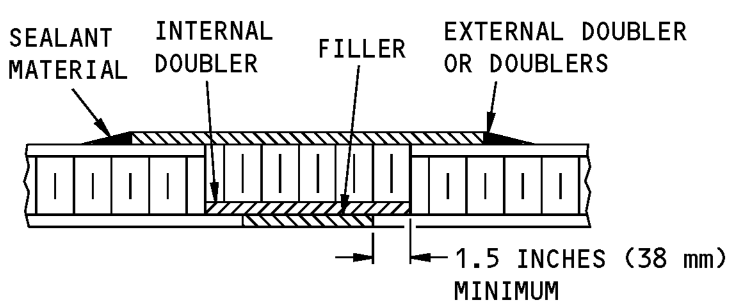
A-A

Repair of Damage Away From the Panel Edges
Figure 201 (Sheet 1 of 5)



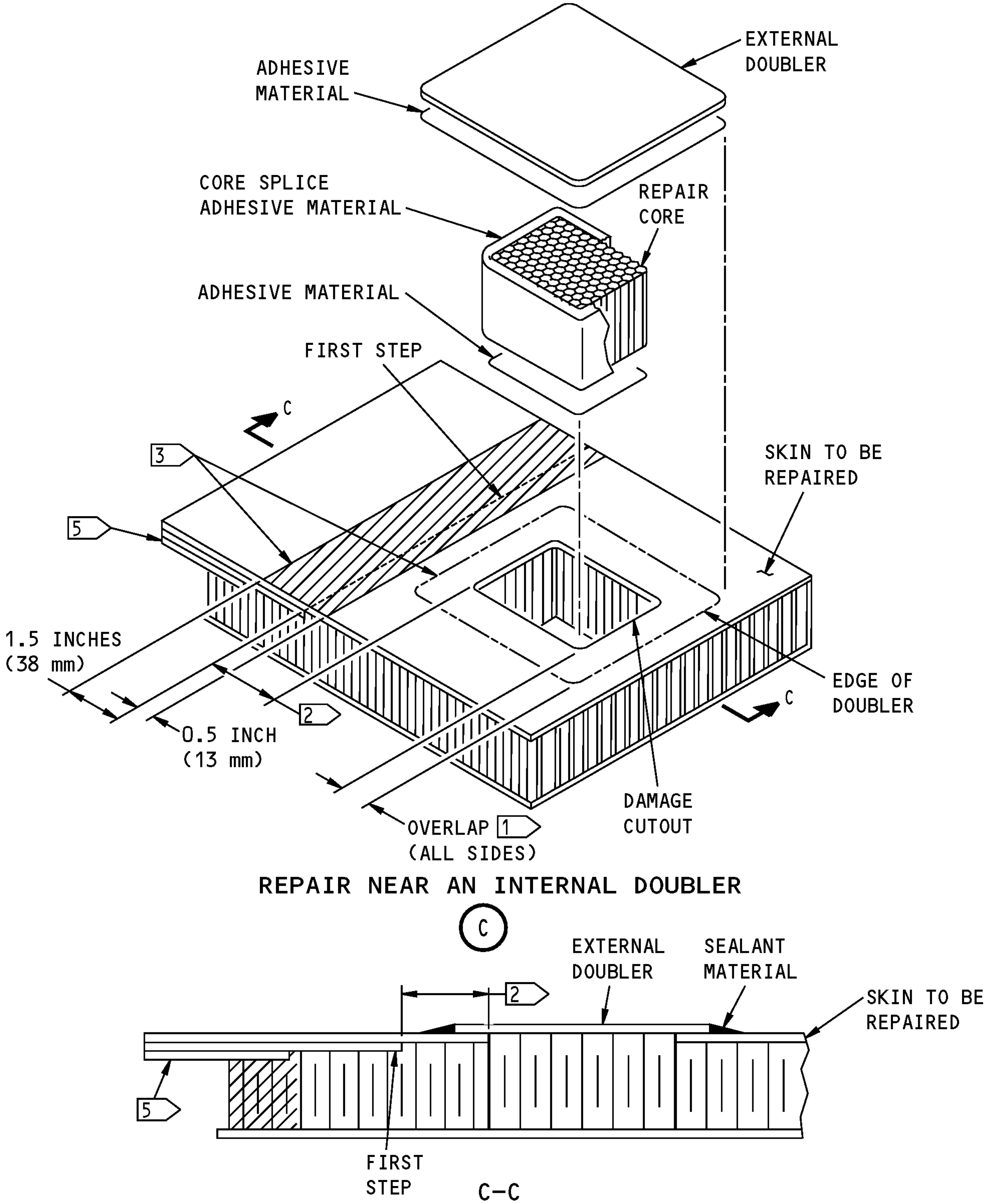
REPAIR TO CORE AND TWO SKINS

B

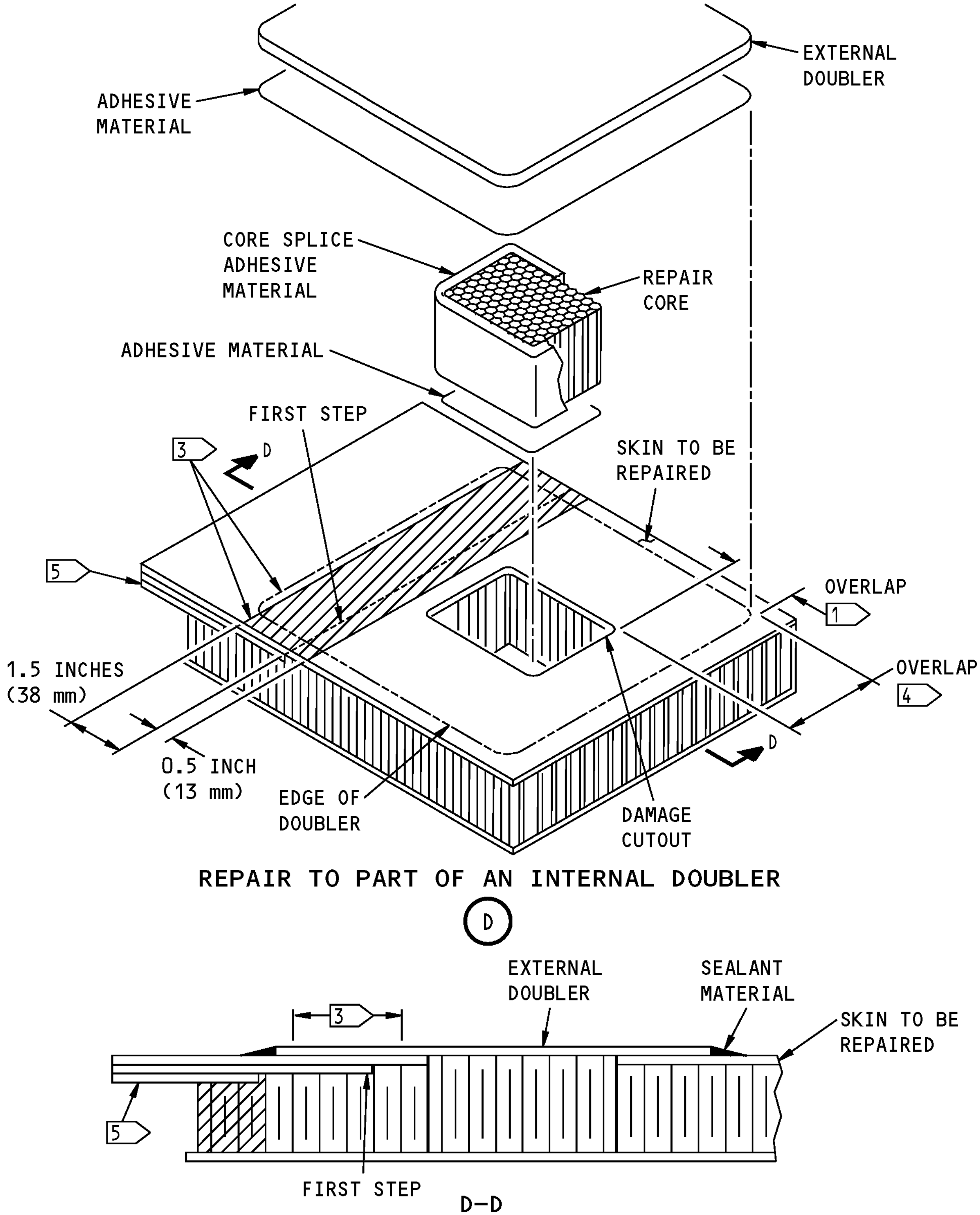


B-B

Repair of Damage Away From the Panel Edges
Figure 201 (Sheet 2 of 5)



Repair of Damage Away From the Panel Edges
Figure 201 (Sheet 3 of 5)



Repair of Damage Away From the Panel Edges
Figure 201 (Sheet 4 of 5)

NOTES

- REFER TO REPAIR GENERAL FOR THE REPAIR STEPS.
- IT IS PERMITTED TO USE NDI PROCEDURES OR ENGINEERING DRAWINGS TO FIND THE LOCATIONS OF INTERNAL DOUBLERS AND MACHINED STEPS.

1 > REFER TO REPAIR GENERAL, FIGURE 208 OR 209 (AS APPLICABLE) FOR THE MINIMUM OVERLAP DIMENSION.

2 > IF THE EDGE OF THE CUTOUT IS CLOSER THAN 0.5 INCHES (13 mm) TO THE EDGE OF AN INTERNAL DOUBLER (OR THE EDGE OF A CHEM-MILLED OR MACHINED STEP) THEN DO ONE OF THE STEPS THAT FOLLOW:

- REFER TO THE SPECIFIC COMPONENT REPAIR SECTION TO SEE IF THERE IS AN APPLICABLE REPAIR.
- CUT OUT THE DAMAGE TO THE EDGE OF THE PANEL AND THEN DO ONE OF THE REPAIRS IN REPAIR 4, FIGURE 202.
- ASK BOEING

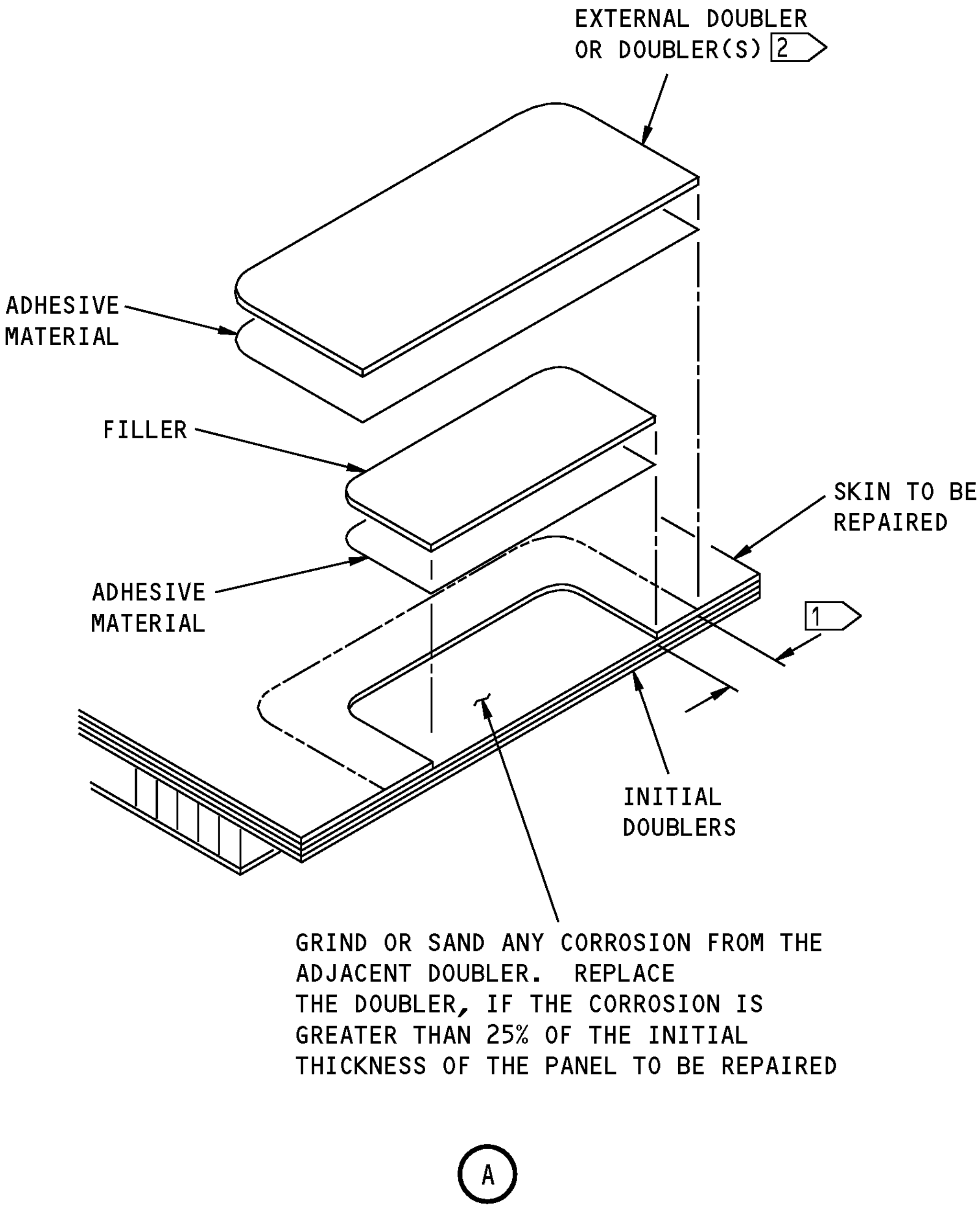
3 > IF THE EDGE OF AN EXTERNAL DOUBLER WILL BE CLOSER THAN 0.5 INCH (13 mm) TO THE FIRST STEP, OR WILL NOT BE FARTHER THAN 1.5 INCHES (38 mm) PAST THE FIRST STEP, THEN SEE DETAIL D AND DO THE STEPS THAT FOLLOW:

- EXTEND THE EXTERNAL DOUBLER SO THAT THE EDGE OF THE DOUBLER WHICH IS CLOSEST TO THE FIRST STEP IS FARTHER THAN 1.5 INCHES (38 mm) PAST THE EDGE OF THE FIRST STEP.

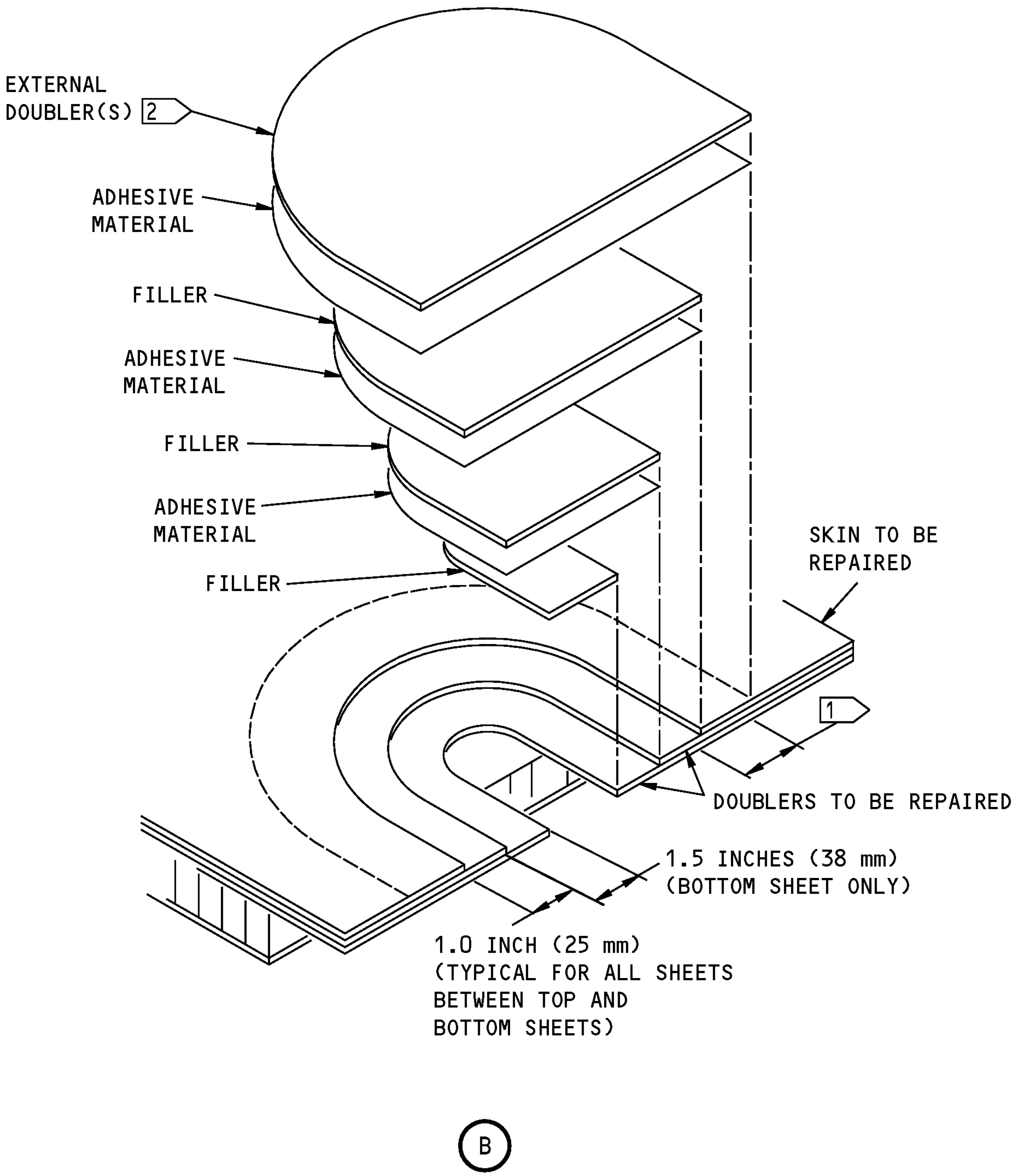
4 > INCREASE THE OVERLAP ON BOTH SIDES OF THE CUTOUT BY 0.5 INCH (13 mm).

5 > A PANEL WITH AN EDGEBAND THAT WAS MANUFACTURED WITH MULTIPLE DOUBLERS IS SHOWN. USE THE SAME PROCEDURE TO REPAIR A PANEL WITH A MACHINED OR CHEM-MILLED SKIN. IF AN INTERNAL DOUBLER IS DAMAGED, SEE 2 >.

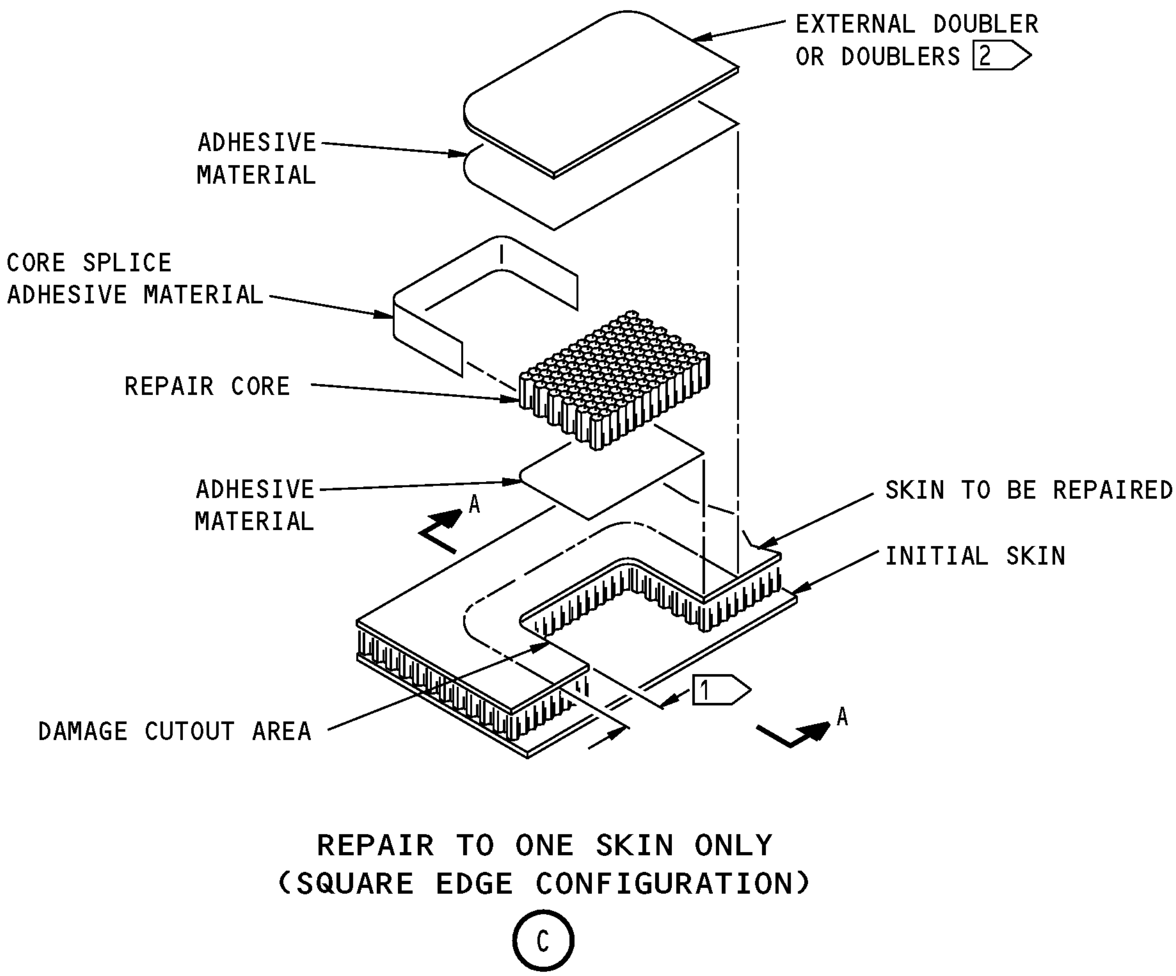
Repair of Damage Away From the Panel Edges
Figure 201 (Sheet 5 of 5)

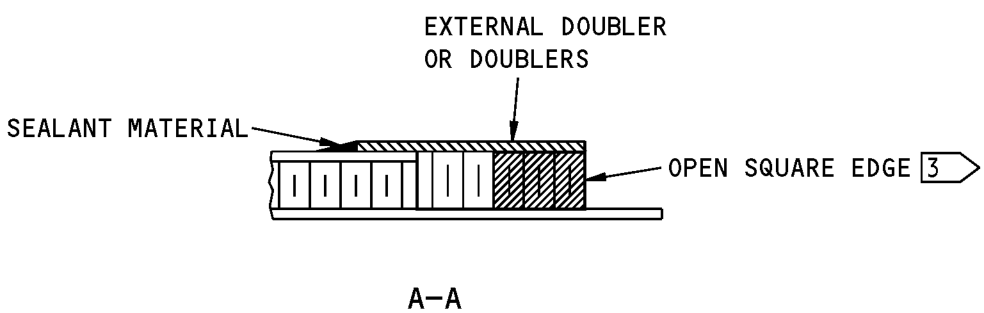


Repair of Damage at the Edge of a Panel
Figure 202 (Sheet 1 of 9)

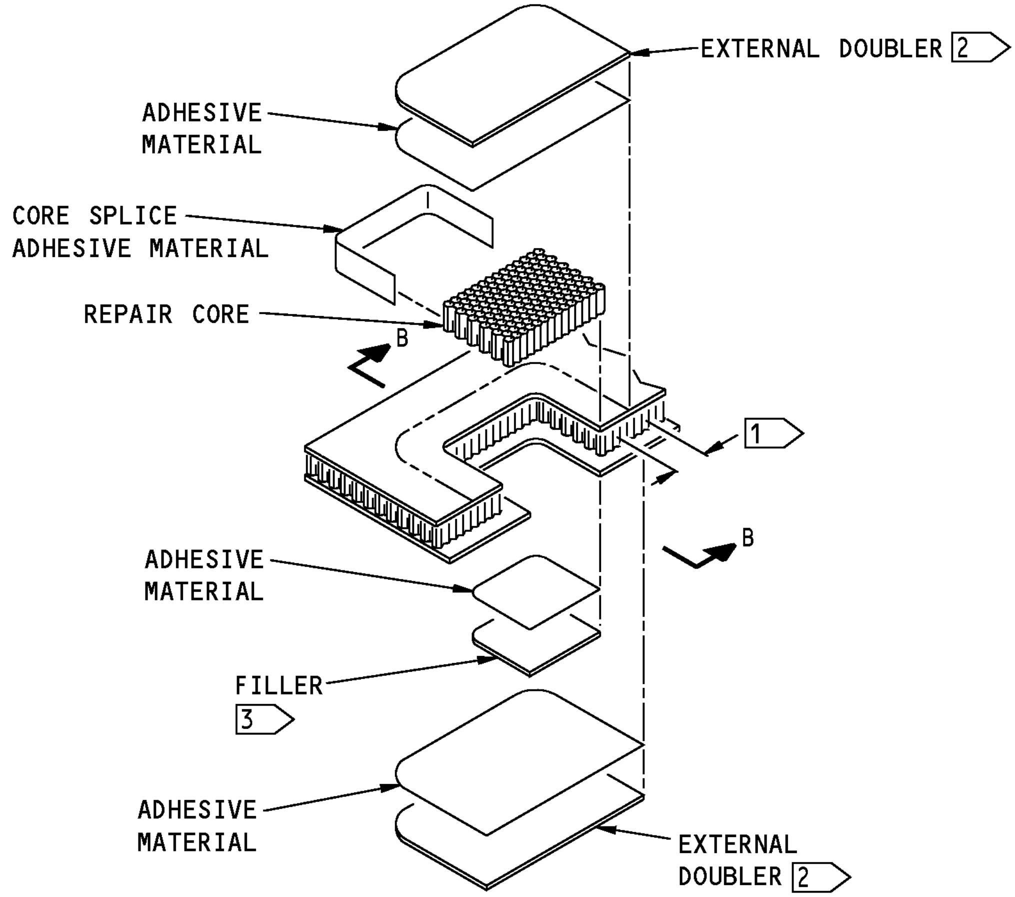


Repair of Damage at the Edge of a Panel
Figure 202 (Sheet 2 of 9)



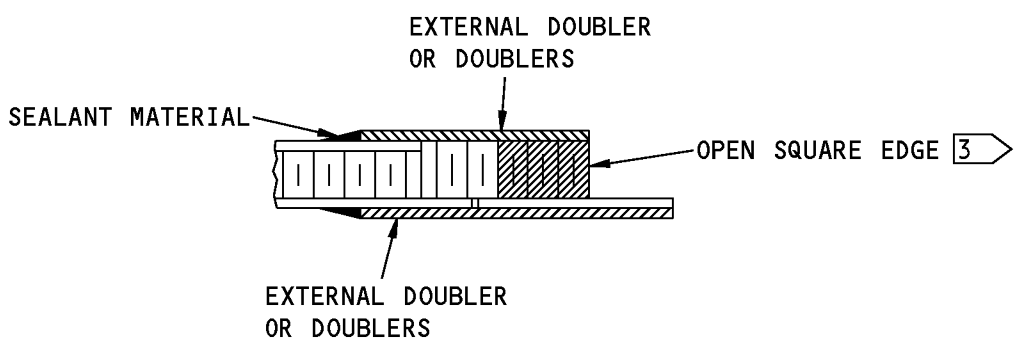


Repair of Damage at the Edge of a Panel
Figure 202 (Sheet 3 of 9)



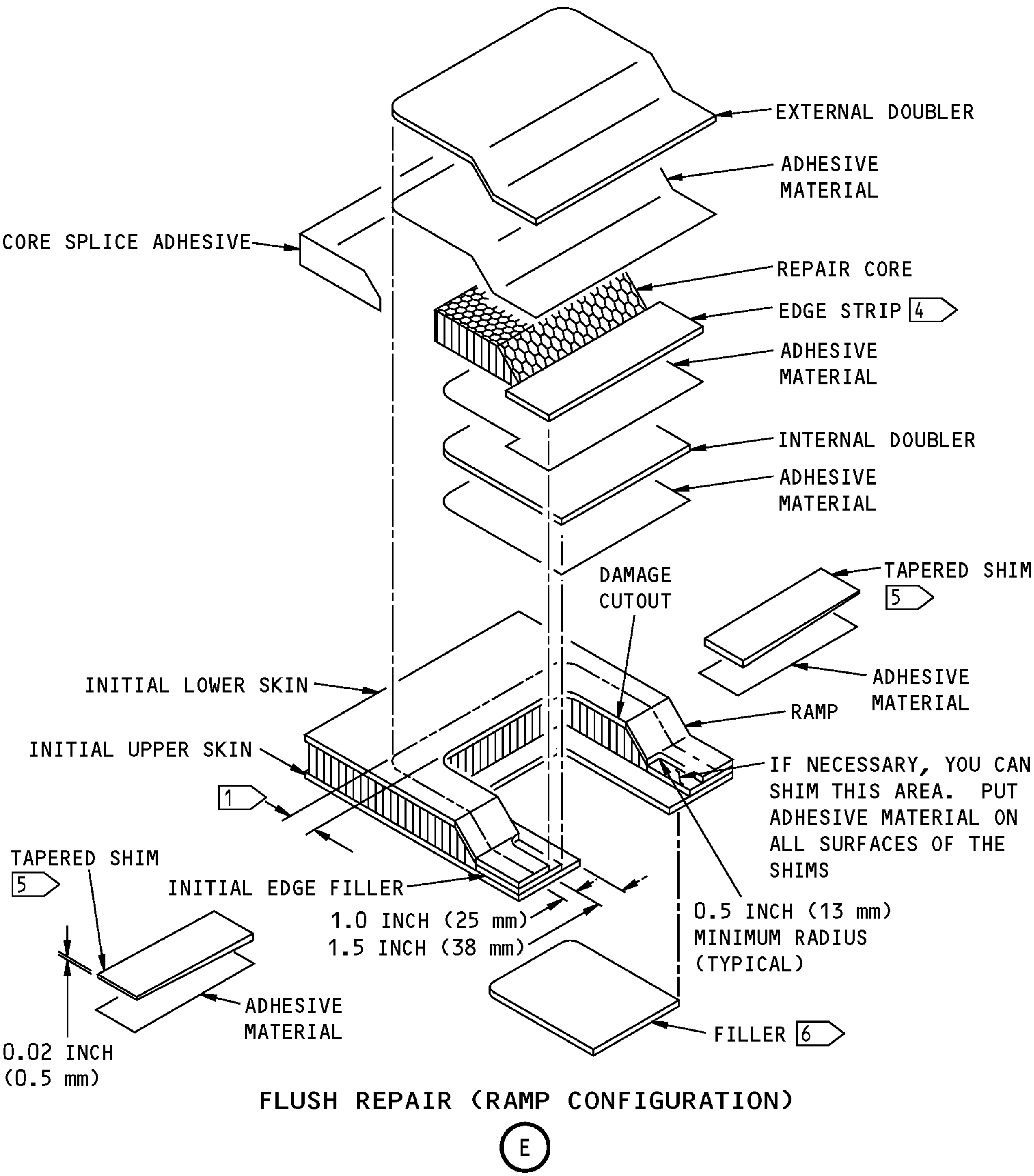
REPAIR TO BOTH SKINS
(SQUARE EDGE CONFIGURATION)

D

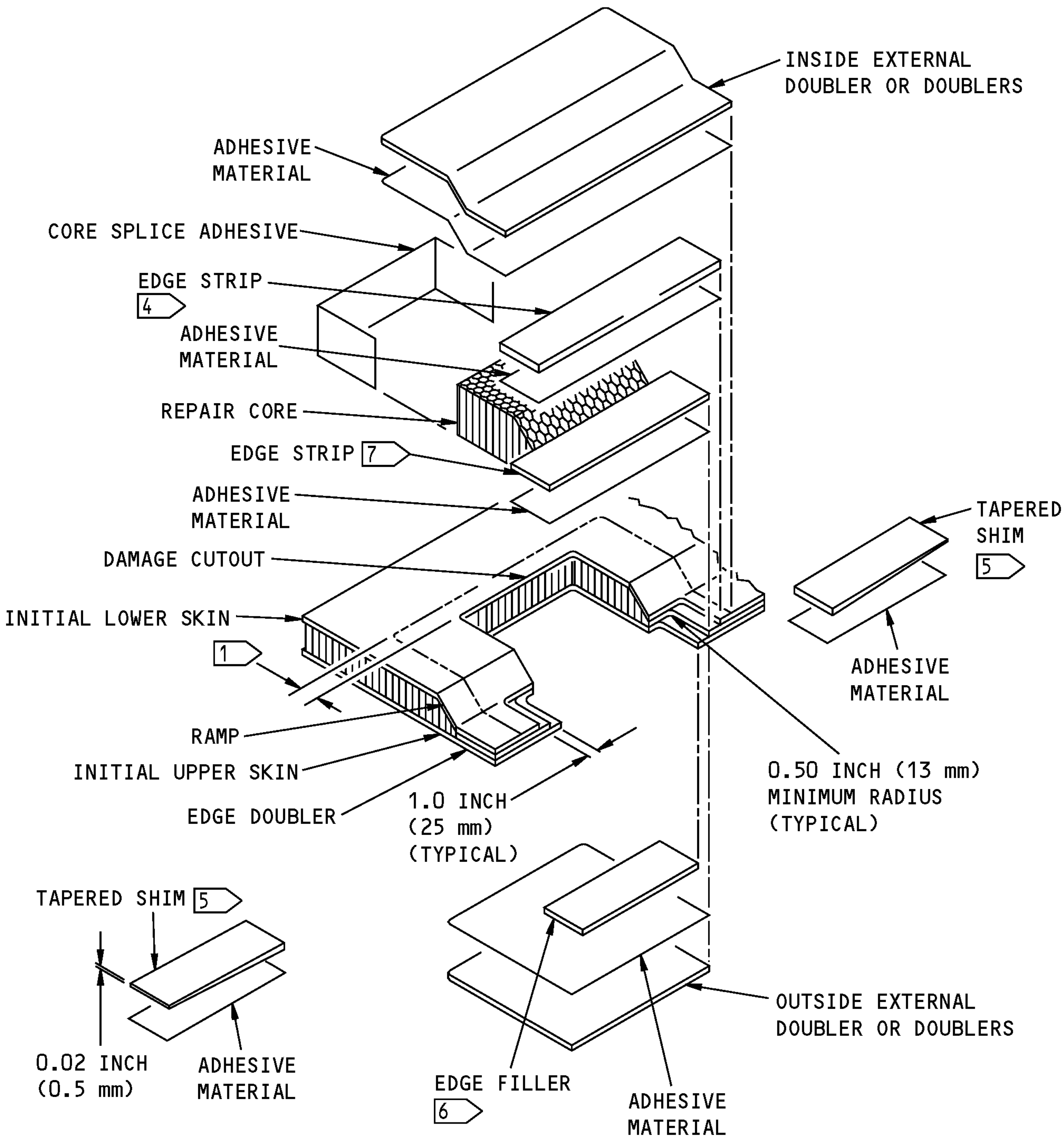


B–B

Repair of Damage at the Edge of a Panel
Figure 202 (Sheet 4 of 9)



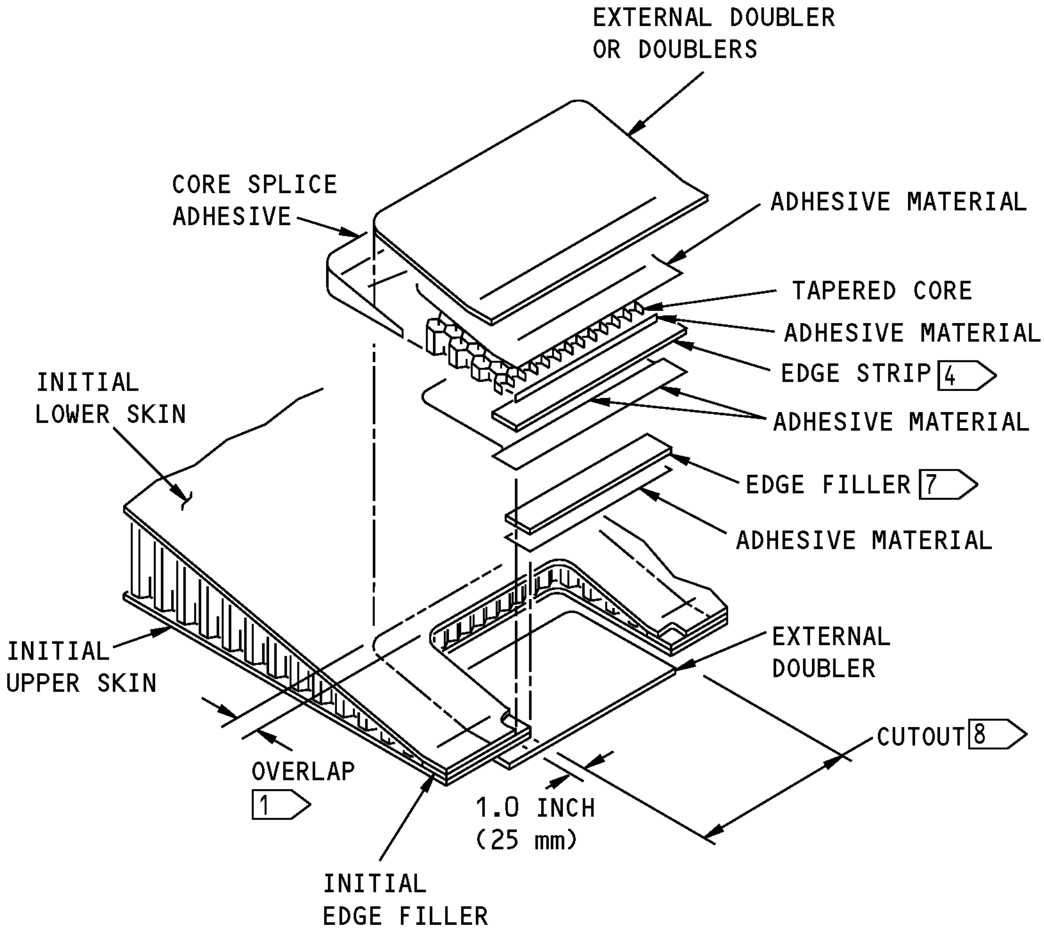
Repair of Damage at the Edge of a Panel
Figure 202 (Sheet 5 of 9)



NON-FLUSH REPAIR (RAMP CONFIGURATION)

F

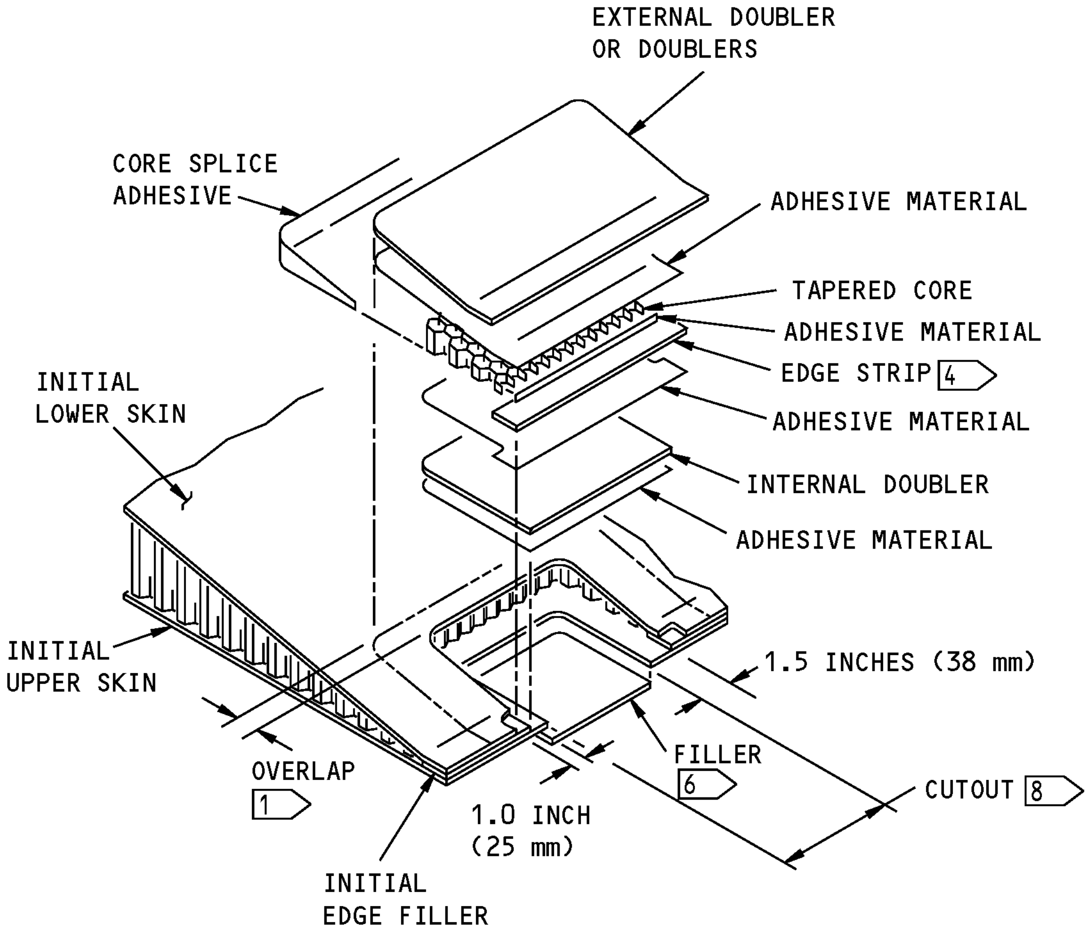
Repair of Damage at the Edge of a Panel
Figure 202 (Sheet 6 of 9)



TRAILING EDGE REPAIR WITH TWO EXTERNAL DOUBLERS

G

Repair of Damage at the Edge of a Panel
Figure 202 (Sheet 7 of 9)



TRAILING EDGE REPAIR WITH AN EXTERNAL AND INTERNAL DOUBLER

H

Repair of Damage at the Edge of a Panel
Figure 202 (Sheet 8 of 9)

NOTES

- REFER TO REPAIR GENERAL FOR THE REPAIR STEPS

1 REFER TO REPAIR GENERAL, FIGURE 208 OR FIGURE 209 (AS APPLICABLE) FOR THE MINIMUM OVERLAP DIMENSION.

2 IF THE LENGTH OR WIDTH OF THE MATERIAL THAT IS REMOVED FROM THE OUTER SKIN IS 1.0 INCH (25 mm) OR LESS, THEN USE AN EXTERNAL DOUBLER(S) THICKNESS AS SPECIFIED IN REPAIR GENERAL, FIGURE 209.

IF THE LENGTH OR WIDTH OF THE MATERIAL THAT IS REMOVED FROM THE OUTER SKIN IS MORE THAN 1.0 INCH (25 mm), THEN USE AN EXTERNAL DOUBLER(S) THICKNESS AS SPECIFIED IN REPAIR GENERAL, FIGURE 209 FOR AN INITIAL SKIN THICKNESS THAT IS ONE GAGE RANGE THICKER.

3 SEAL THE OPEN EDGE OF THE REPAIR CORE AS GIVEN IN REPAIR GENERAL, PARAGRAPH 9.G (4)

4 MAKE THE EDGE FILLER FROM THE SAME BOEING MATERIALS SPECIFICATION (BMS) MATERIAL OR AN EQUIVALENT MATERIAL THAT IS THE SAME THICKNESS AS THE INITIAL UPPER OR LOWER SKIN AS APPLICABLE.

5 PUT THE TAPERED SHIMS NEXT TO THE INSIDE EXTERNAL DOUBLER ON THE EDGE BAND.

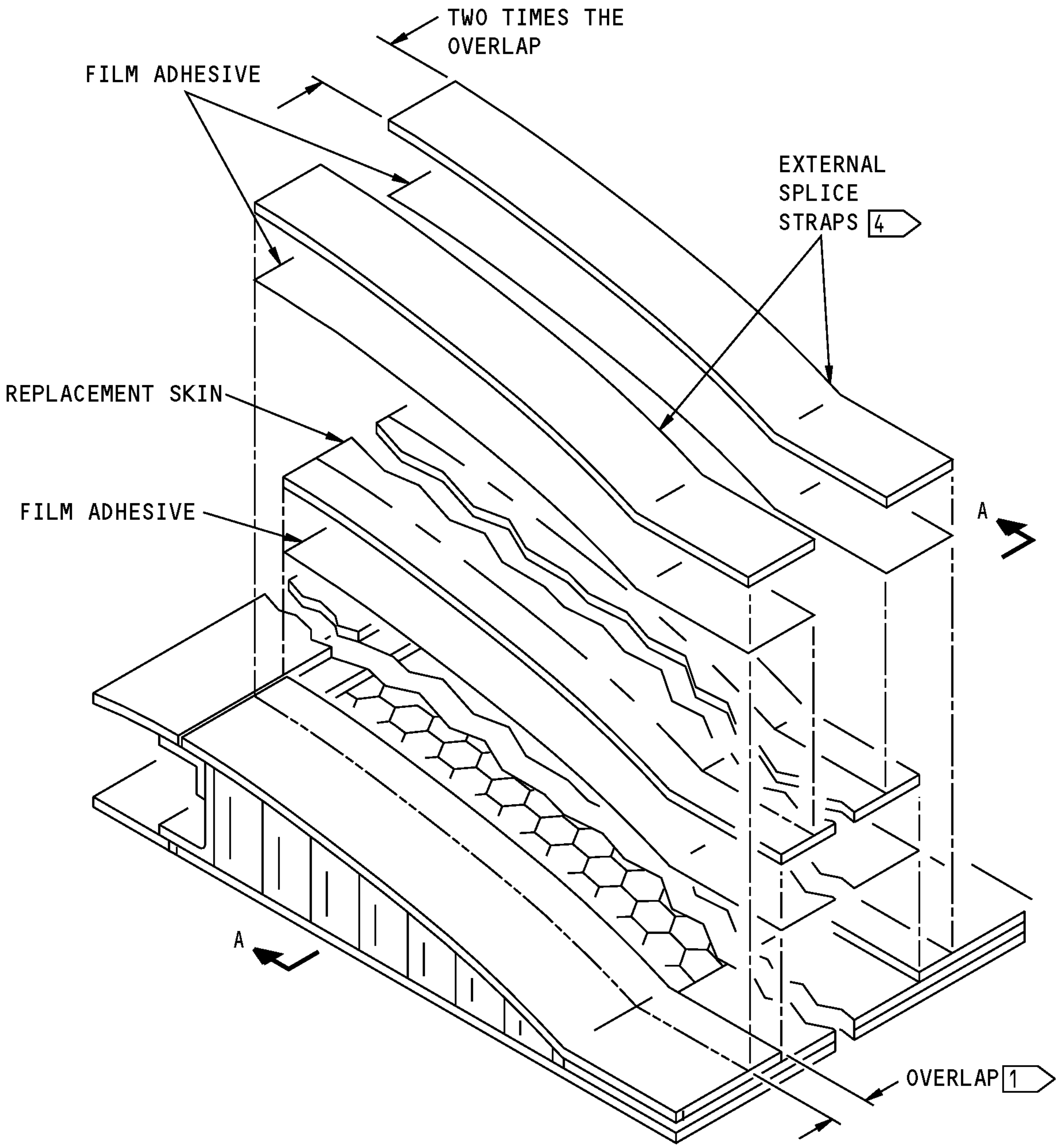
6 MAKE THE FILLER FROM THE SAME BOEING MATERIALS SPECIFICATION (BMS) MATERIAL OR AN EQUIVALENT MATERIAL THAT IS THE SAME THICKNESS AS THE INITIAL UPPER OR LOWER SKIN AS APPLICABLE.

7 MAKE THE EDGE FILLER FROM THE SAME THICKNESS AS THE INITIAL EDGE FILLER.

8 THE LENGTH OF THE CUTOUT ALONG THE TRAILING EDGE MUST NOT BE MORE THAN 50% OF THE LENGTH OF THE TRAILING EDGE (FOR ALL REPAIR PROCEDURES TO INCLUDE ALL TYPES OF SURFACE PREPARATIONS, ADHESIVES USED, CURE TEMPERATURES, AND PRESSURE APPLICATIONS SHOWN IN REPAIR GENERAL) AND NOT MORE THAN THE LIMITS SHOWN IN REPAIR GENERAL, FIGURE 201. TO REPAIR A CUTOUT THAT IS MORE THAN 50% OF THE LENGTH OF THE TRAILING EDGE, DO THE STEPS THAT FOLLOW:

- GET AN ENGINEERING REVIEW
- USE APPROVED ENGINEERING DRAWINGS FOR THE COMPONENT
- USE APPROVED MATERIALS AND MANUFACTURING PROCESSES SPECIFIED IN THE COMPONENT ENGINEERING DRAWINGS.

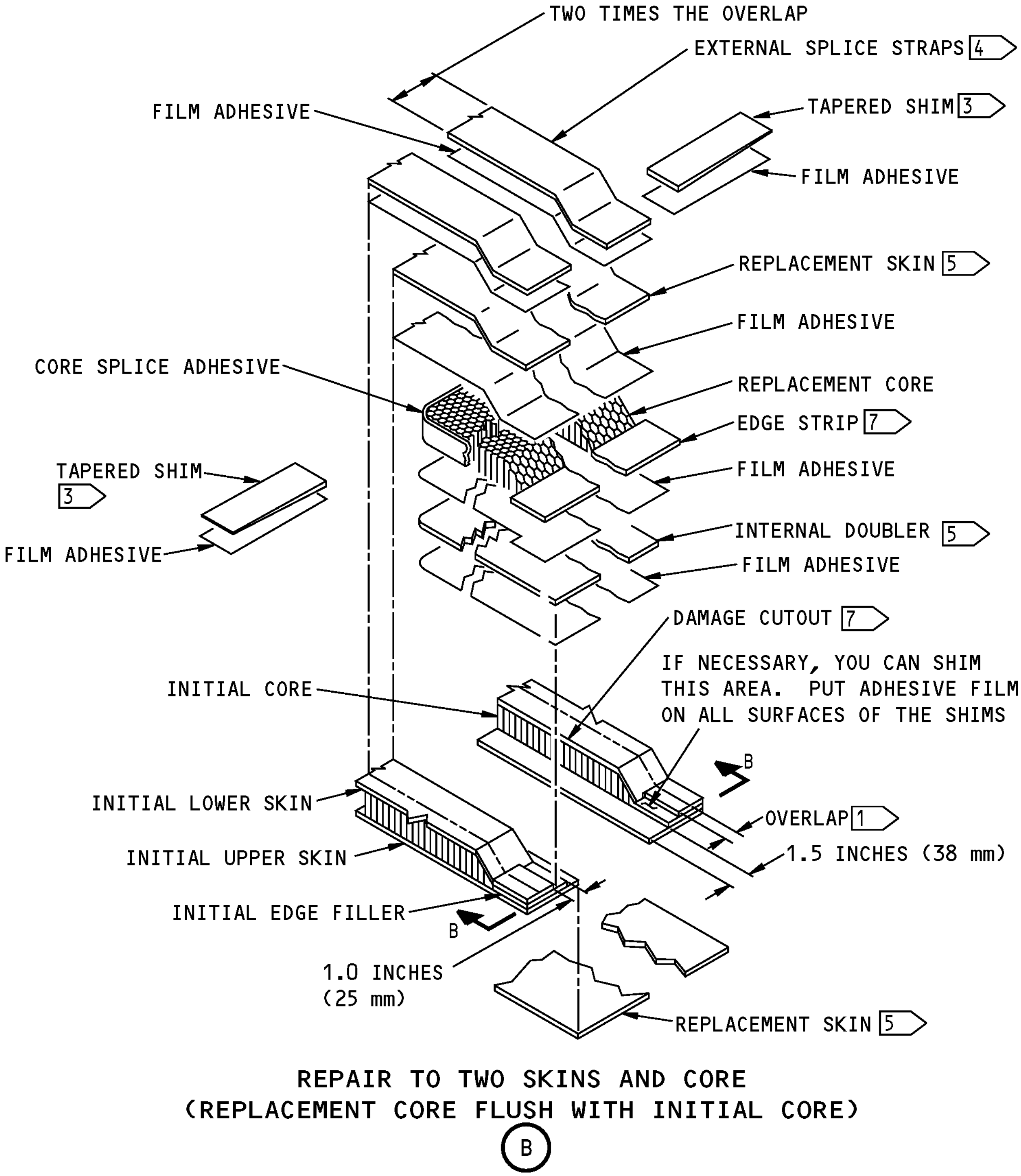
Repair of Damage at the Edge of a Panel
Figure 202 (Sheet 9 of 9)



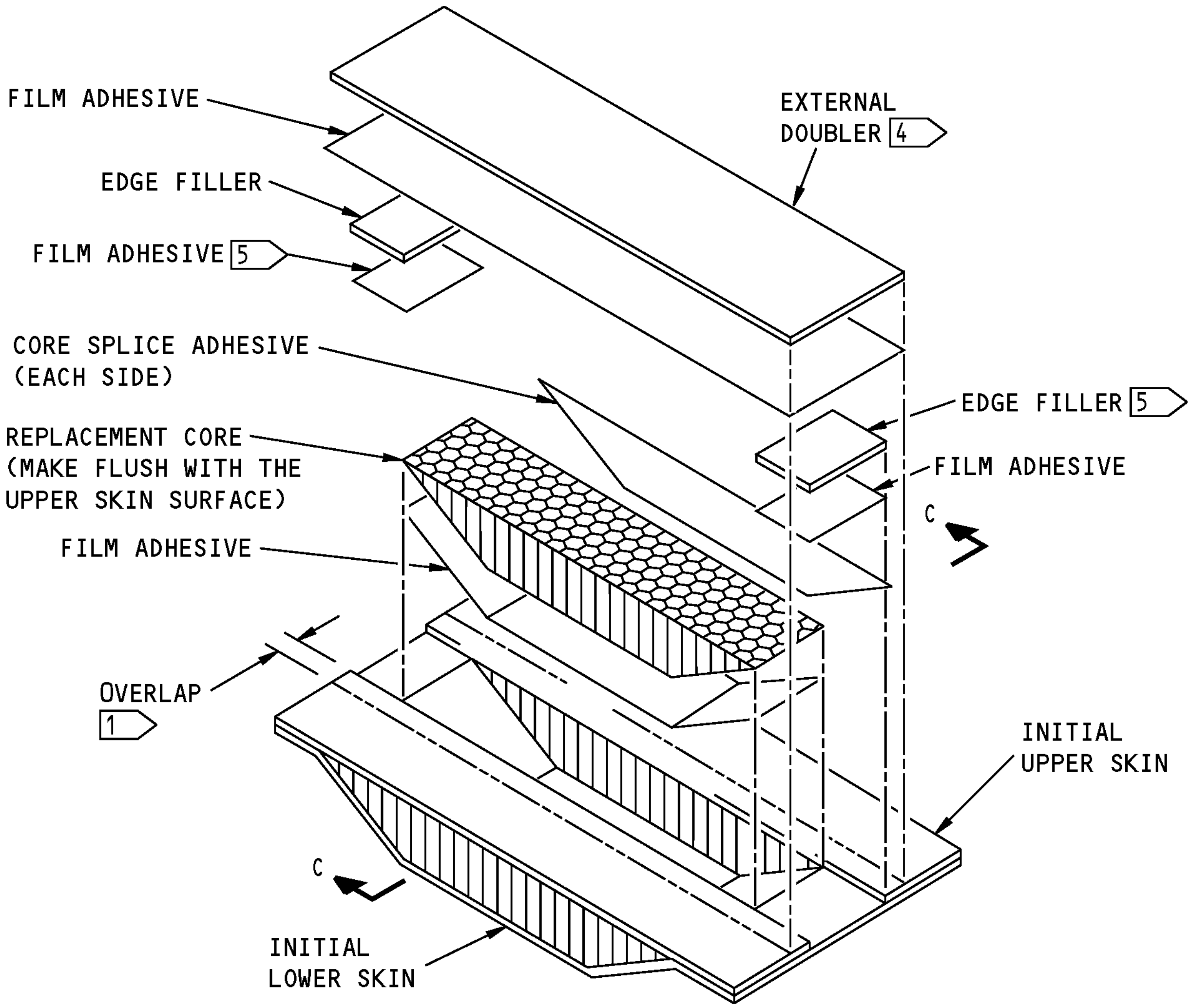
REPAIR TO ONE SKIN ONLY

A

Repair of Damage That is from Edge to Edge
Figure 203 (Sheet 1 of 5)



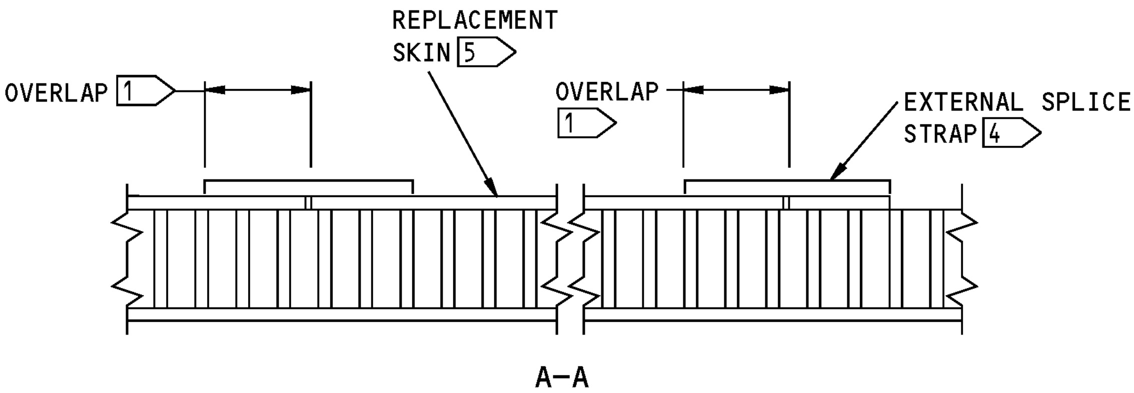
Repair of Damage That is from Edge to Edge
Figure 203 (Sheet 2 of 5)

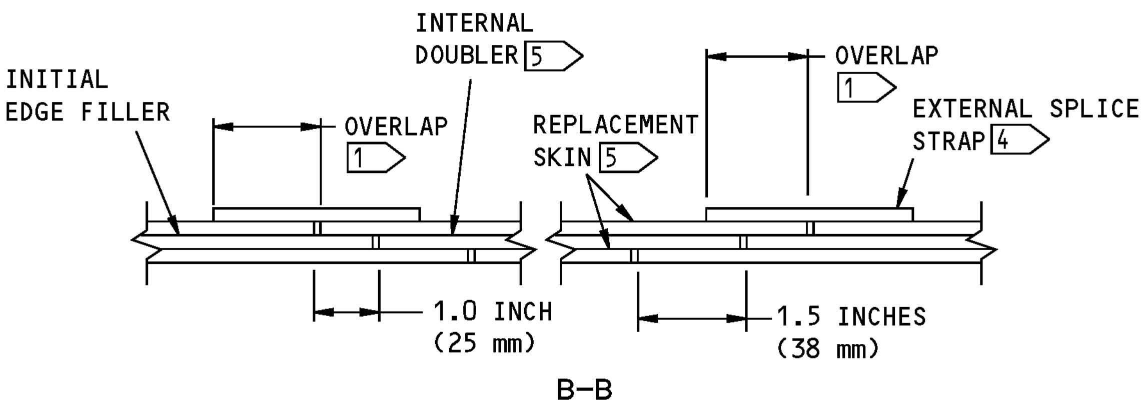


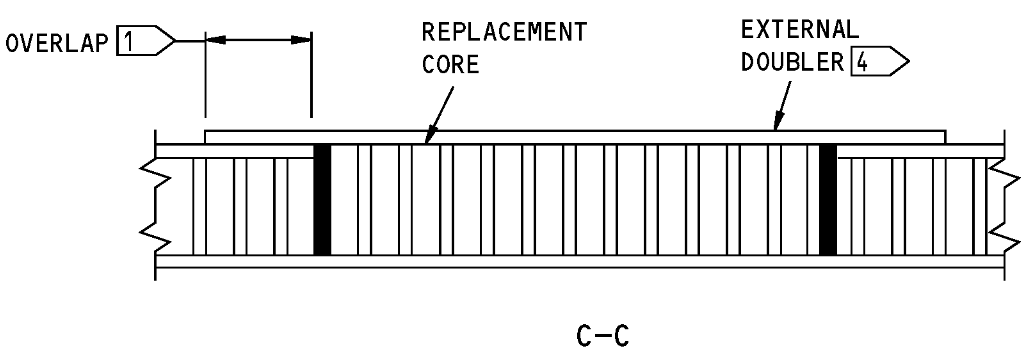
REPAIR TO ONE SKIN AND CORE
(REPLACEMENT CORE FLUSH WITH AN INITIAL SKIN)

C

Repair of Damage That is from Edge to Edge
Figure 203 (Sheet 3 of 5)







Repair of Damage That is from Edge to Edge
Figure 203 (Sheet 4 of 5)

NOTES

- REFER TO REPAIR GENERAL FOR THE REPAIR STEPS.

1 REFER TO REPAIR GENERAL, FIGURE 208 OR FIGURE 209 (AS APPLICABLE) FOR THE MINIMUM OVERLAP DIMENSION.

2 USE SHIMS IF NECESSARY.

3 PUT A TAPERED SHIM NEXT TO EACH OF THE INSIDE EXTERNAL DOUBLERS ON THE EDGEBAND.

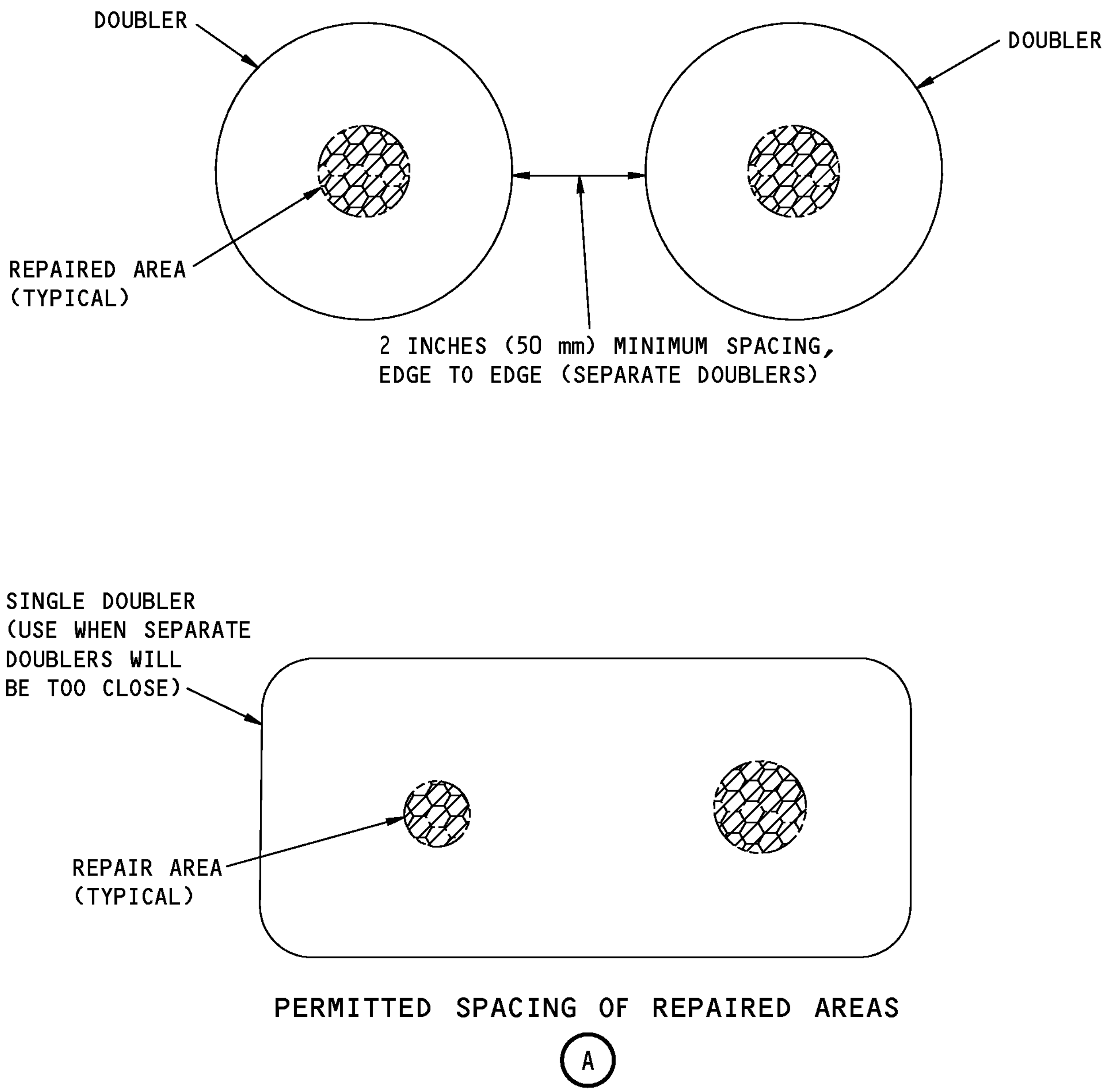
4 REFER TO REPAIR GENERAL, FIGURE 208 OR 209 FOR DOUBLER THICKNESS.

5 MAKE FROM THE SAME BOEING MATERIALS SPECIFICATION (BMS) MATERIAL OR AN EQUIVALENT MATERIAL THAT IS THE SAME THICKNESS AS THE INITIAL UPPER OR LOWER SKIN AS APPLICABLE.

6 MAKE FROM THE SAME THICKNESS AS THE INITIAL EDGE FILLER.

7 AS AN ALTERNATIVE, YOU CAN CUT THE INITIAL SKIN AWAY FROM THE EDGE OF THE CORE. THERE IS NO MINIMUM OR MAXIMUM DISTANCE FROM THE EDGE OF THE THE SKIN TO THE EDGE OF THE CORE.

Repair of Damage That is from Edge to Edge
Figure 203 (Sheet 5 of 5)



Permitted Spacing
Figure 204

REPAIR 5 - EXTERNAL DOUBLER REPAIR OF THE HONEYCOMB EDGE WITH DAMAGE THROUGH THE SKIN AND DOUBLERS

1. **Procedure**

   A. This procedure has been moved to REPAIR 4.

REPAIR 6 - EXTERNAL DOUBLER REPAIR ON THE SQUARE EDGE OF A PANEL WITH PUNCTURE DAMAGE

1. **Procedure**

   A. This procedure has been moved to REPAIR 4.

REPAIR 7 - EXTERNAL DOUBLER REPAIR OF DAMAGE TO ONE SKIN AND THE ALUMINUM HONEYCOMB CORE

1. Procedure

A. This procedure has been moved to REPAIR 4.

REPAIR 8 - FLUSH REPAIR OF DAMAGE TO ONE SKIN AND THE ALUMINUM HONEYCOMB CORE

1. Procedure

A. This procedure has been moved to REPAIR 4.

REPAIR 9 - EXTERNAL DOUBLER REPAIR THAT USES A REPAIR CORE AND AN INTERNAL SEPTUM FOR LESS THAN A FULL-DEPTH CORE REPLACEMENT

1. **Procedure**
   A. This procedure has been moved to REPAIR 3.

REPAIR 10 - BONDED DOUBLER REPAIR THAT USES TWO CORES OF EQUAL DEPTH AND AN INTERNAL SEPTUM FOR FULL-DEPTH CORE REPLACEMENT

1. Procedure

A. This procedure has been moved to REPAIR 3.

REPAIR 11 - EXTERNAL DOUBLER REPAIR OF DAMAGE TO ONE ALUMINUM SKIN AND THE ALUMINUM HONEYCOMB CORE AT THE EDGE OF A PANEL

1. **Procedure**
   A. This procedure has been moved to REPAIR 4.

REPAIR 12 - EXTERNAL DOUBLER REPAIR OF DAMAGE TO TWO ALUMINUM SKINS AND THE ALUMINUM HONEYCOMB CORE AT THE EDGE OF A PANEL

1. **Procedure**

   A. This procedure has been moved to REPAIR 4.

REPAIR 13 - EXTERNAL DOUBLER REPAIR OF DAMAGE TO ONE ALUMINUM SKIN, THE INTERNAL DOUBLER, AND THE ALUMINUM HONEYCOMB CORE

1. **Procedure**

   A. This procedure has been moved to REPAIR 4.

REPAIR 14 - REPAIR OF THE ALUMINUM HONEYCOMB CORE AT THE TRAILING EDGE

1. **Procedure**

   A. This procedure has been moved to REPAIR 4.

REPAIR 15 - REPAIR OF THE ALUMINUM HONEYCOMB CORE WITH DAMAGE TO A SINGLE LOWER SKIN

1. **Procedure**

   A. This procedure has been moved to REPAIR 4.

REPAIR 16 - REPAIR OF ALUMINUM HONEYCOMB CORE WITH DAMAGE TO A SINGLE LOWER SKIN AND THE INTERNAL DOUBLER

1. **Procedure**

   A. This procedure has been moved to REPAIR 4.

REPAIR 17 - REPAIR OF THE ALUMINUM HONEYCOMB CORE WITH DAMAGE TO TWO SKINS BY THE USE OF AN EXTERNAL DOUBLER AND AN INTERNAL DOUBLER

1. Procedure

A. This procedure has been moved to REPAIR 4.

REPAIR 18 - REPAIR OF ALUMINUM HONEYCOMB CORE WITH DAMAGE TO TWO SKINS BY THE USE OF TWO EXTERNAL DOUBLERS

1. Procedure

A. This procedure has been moved to REPAIR 4.

REPAIR 19 - REPAIR OF ALUMINUM HONEYCOMB CORE WITH DAMAGE TO TWO SKINS AND TWO DOUBLERS BY THE USE OF TWO INTERNAL DOUBLERS AND A FLUSH FILLER

1. Procedure

A. This procedure has been moved to REPAIR 4.

REPAIR 20 - REPAIR OF ALUMINUM HONEYCOMB CORE WITH DAMAGE TO TWO SKINS BY THE USE OF EXTERNAL DOUBLERS ON EACH SKIN

1. Procedure

A. This procedure has been moved to REPAIR 4.

REPAIR 21 - REPAIR OF THE HONEYCOMB PANEL WITH DAMAGE OR DELAMINATION TO THE OUTER SURFACE

1. **Procedure**

   A. This procedure has been moved to REPAIR 4.

REPAIR 22 - REPAIR OF THE ALUMINUM HONEYCOMB PANEL WITH MAJOR SKIN DAMAGE OR DELAMINATION

1. Procedure

A. This procedure has been moved to REPAIR 4.

REPAIR 23 - REPAIR OF DAMAGE TO THE HONEYCOMB CORE AND THE SKIN

1. **Procedure**

   A. This procedure has been moved to REPAIR 4.

REPAIR 24 - EXTERNAL DOUBLER TEMPORARY REPAIR OF THE FLAP TRAILING EDGE WEDGE

1. **Procedure**

   A. This procedure has been deleted. Refer to REPAIR 4 for typical repairs.

REPAIR GENERAL - TYPICAL FORMED SECTION REPAIR

1. Applicability

A. Repair General applies to damage on formed sections.

B. For airplanes that have completed Service Bulletin 737-21-1149 this repair is not approved for use on any part of the horizontal stabilizer or horizontal stabilizer center section beams unless:

(1) It is referenced by the applicable SRM section which contains the data about the structure and includes supplemental inspection methods and intervals.

C. For airplanes that have completed Service Bulletin 737-21-1149 contact The Boeing Company if the damage is 20 inches (508 mm) or less away from the edge of a door or access cutout.

D. For airplanes that have completed Service Bulletin 737-21-1149 and the damage is 10 inches (254 mm) or less away from the edge of an existing repair then:

(1) Remove the existing repair and make one repair that includes the two areas of damage.

2. General

A. For airplanes that have completed Service Bulletin 737-21-1149 this repair is a Category B repair. Refer to the inspection instructions paragraph for the inspection requirements. The inspection instructions do not apply for airplanes that have not completed Service Bulletin 737-21-1149.

3. References

Reference	Title
51-00-04	STRUCTURAL CLASSIFICATION
51-00-06, GENERAL	Structural Repair Definitions
51-10-02	INSPECTION AND REMOVAL OF DAMAGE
51-20-01	PROTECTIVE TREATMENT OF METALLIC AND COMPOSITE MATERIALS
51-20-05	REPAIR SEALING
51-40-02	FASTENER INSTALLATION AND REMOVAL
51-40-03, GENERAL	Fastener Substitution
51-40-04, GENERAL	Torque Values
51-40-05, GENERAL	Fastener Hole Sizes
51-40-06	FASTENER EDGE MARGINS
SOPM 20-41-02	Application of Chemical and Solvent Resistant Finishes

4. Repair Instructions

A. Get access to the damaged area.

B. Cut and remove the damaged part of the formed section. Refer to 51-10-02 for the procedure to remove the damage.

(1) Make all the cut surfaces 125 microinches Ra or smoother.

(2) For damage that would result in a loss in cross-sectional area of less than 50 percent after the damage has been cut away, do as follows:

(a) Remove the damaged area from the formed part.

(b) Refer to Layout of the Repair Parts for a Formed Part that is Not Fully Cut Through, Figure 201/REPAIR GENERAL for the repair.

(3) For damage that would result in a loss in cross-sectional area of 50 percent or more after the damage has been cut away, do as follows:

(a) Remove the damaged section from the formed part.

(b) Refer to Layout of the Repair Parts for a Formed Part that is Fully Cut Through , Figure 202/REPAIR GENERAL for the repair.

(4) Be careful that you do not damage the adjacent structure.

(5) If necessary, remove additional fasteners to give clearance when you assemble the repair parts. Refer to Layout of the Repair Parts for a Formed Part that is Not Fully Cut Through, Figure 201/REPAIR GENERAL or Layout of the Repair Parts for a Formed Part that is Fully Cut Through , Figure 202/REPAIR GENERAL, as applicable.

NOTE: Layout of the Repair Parts for a Formed Part that is Not Fully Cut Through, Figure 201/REPAIR GENERAL and Layout of the Repair Parts for a Formed Part that is Fully Cut Through , Figure 202/REPAIR GENERAL show the repair parts installed on the inner side of the formed section. You can install the repair parts on the outer side of the formed section if there is sufficient clearance.

C. Find the fastener pitch and row spacing. Refer to Fastener Data, Figure 203/REPAIR GENERAL, Table A for the fastener pitch and row spacing for repair fasteners.

D. Find the number of fasteners that are necessary in each inch of width.

(1) Refer to Fastener Data, Figure 203/REPAIR GENERAL, Table B for fasteners in 2024-T3 or 2024-T4 material.

(2) Refer to Fastener Data, Figure 203/REPAIR GENERAL, Table C for fasteners in 7075-T6 material.

(3) Refer to Example 1 for the fasteners necessary to repair a formed section that has not been fully cut through.

(4) Refer to Example 2 for the fasteners necessary to repair a formed section that has been fully cut through.

Table 201:

REPAIR MATERIAL FOR A FORMED PART THAT IS NOT FULLY CUT THROUGH			
ITEM	**PART**	**QUANTITY**	**MATERIAL**
[1]	Angle	1	Use the same material that is one standard sheet metal gage thicker than the initial formed section
[2]	Filler	As Necessary	Use the same material and thickness as the initial formed section
[3]	Angle	1	Use the same material that is one standard sheet metal gage thicker than the initial formed section
[4]	Channel	1	Use the same material that is one standard sheet metal gage thicker than the initial formed section

Table 202:

REPAIR MATERIAL FOR A FORMED PART THAT IS FULLY CUT THROUGH			
ITEM	**PART**	**QUANTITY**	**MATERIAL**
[1]	Filler	As Necessary	Use the same material and thickness as the initial formed section.
[2]	Angle	1	Use the same material that is one standard sheet metal gage thicker than the initial formed section
[3]	Angle	1	Use the same material that is one standard sheet metal gage thicker than the initial formed section

REPAIR MATERIAL FOR A FORMED PART THAT IS FULLY CUT THROUGH			
ITEM	PART	QUANTITY	MATERIAL
[4]	Angle	1	Use the same material that is one standard sheet metal gage thicker than the initial formed section
[5]	Channel	1	Use the same material that is one standard sheet metal gage thicker than the initial formed section
[6]	Channel	1	Use the same material that is one standard sheet metal gage thicker than the initial formed section

E. Example 1: Find the number of fasteners necessary to repair a formed section that has not been fully cut through. Refer to Example of a Formed Part that is Not Fully Cut Through, Figure 204/REPAIR GENERAL.

(1) For this example, the damage is in a 2024-T3 aluminum channel, 0.071 inch thick.

(2) Measure along the outer surface to find the width of the damage.

(3) For this example, the developed width of the damage is 1.58 inches.

(4) Refer to Fastener Data, Figure 203/REPAIR GENERAL, Table B for the number of fasteners that are necessary for each inch of width.

(5) For this example, the repair is to be made with 3/16 inch diameter BACR15FT()D() rivets.

(6) Fastener Data, Figure 203/REPAIR GENERAL, Table B shows that four 3/16 inch diameter BACR15FT()D() rivets are necessary for each inch of width.

(7) Find the total number of fasteners that are necessary on each side of the cutout.

(a) Multiply the width of the damage by the number of fasteners shown in Fastener Data, Figure 203/REPAIR GENERAL, Table B .

(b) Use the next higher whole number.

(c) Thus, 1.58 inches multiplied by four = 6.32 rivets. Use seven rivets on each side of the damage.

F. Example 2: Find the number of fasteners necessary to repair a formed section that has been fully cut through. Refer to Example of a Formed Part that is Fully Cut Through, Figure 205/REPAIR GENERAL.

(1) For this example, the damage is in a 7075-T6 aluminum channel, 0.063 inch thick.

(2) Measure along the outer surface to find the width of the damage.

(3) For this example, the developed width of the damage is 5.82 inches.

(4) Refer to Fastener Data, Figure 203/REPAIR GENERAL, Table C for the number of fasteners that are necessary for each inch of width.

(5) For this example, the repair is to be made with 3/16 inch diameter BACR15FT()D() rivets.

(6) Fastener Data, Figure 203/REPAIR GENERAL, Table C shows that five 3/16 inch diameter BACR15FT()D() rivets are necessary for each inch of width.

(7) Find the total number of fasteners that are necessary on each side of the cutout.

(a) Multiply the width of the damage by the number of fasteners shown in Fastener Data, Figure 203/REPAIR GENERAL, Table C .

(b) Use the next higher whole number.

(c) Thus, 5.82 inches multiplied by five = 29.10 rivets. Use thirty rivets on each side of the damage.

G. Make the repair parts.
   (1) Refer to Table 201/REPAIR GENERAL for a formed part that is not fully cut through.
   (2) Refer to Table 202/REPAIR GENERAL for a formed part that is fully cut through.
   (3) Each damaged flange must be repaired.
   (4) Make the repair parts from the same material and a minimum of one gage thicker than the initial formed section.
   (5) Make the edges of the repair parts 125 microinches Ra or smoother.

H. Assemble the repair parts.

I. Drill the fastener holes. Refer to 51-40-02 thru 51-40-06 for other fastener data.

J. Disassemble the repair parts.

K. Remove the nicks, scratches, gouges, burrs, and sharp edges from the repair parts and the initial formed section. Refer to 51-10-02.
   (1) Break all sharp edges to a radius of 0.15 inch to 0.30 inch.

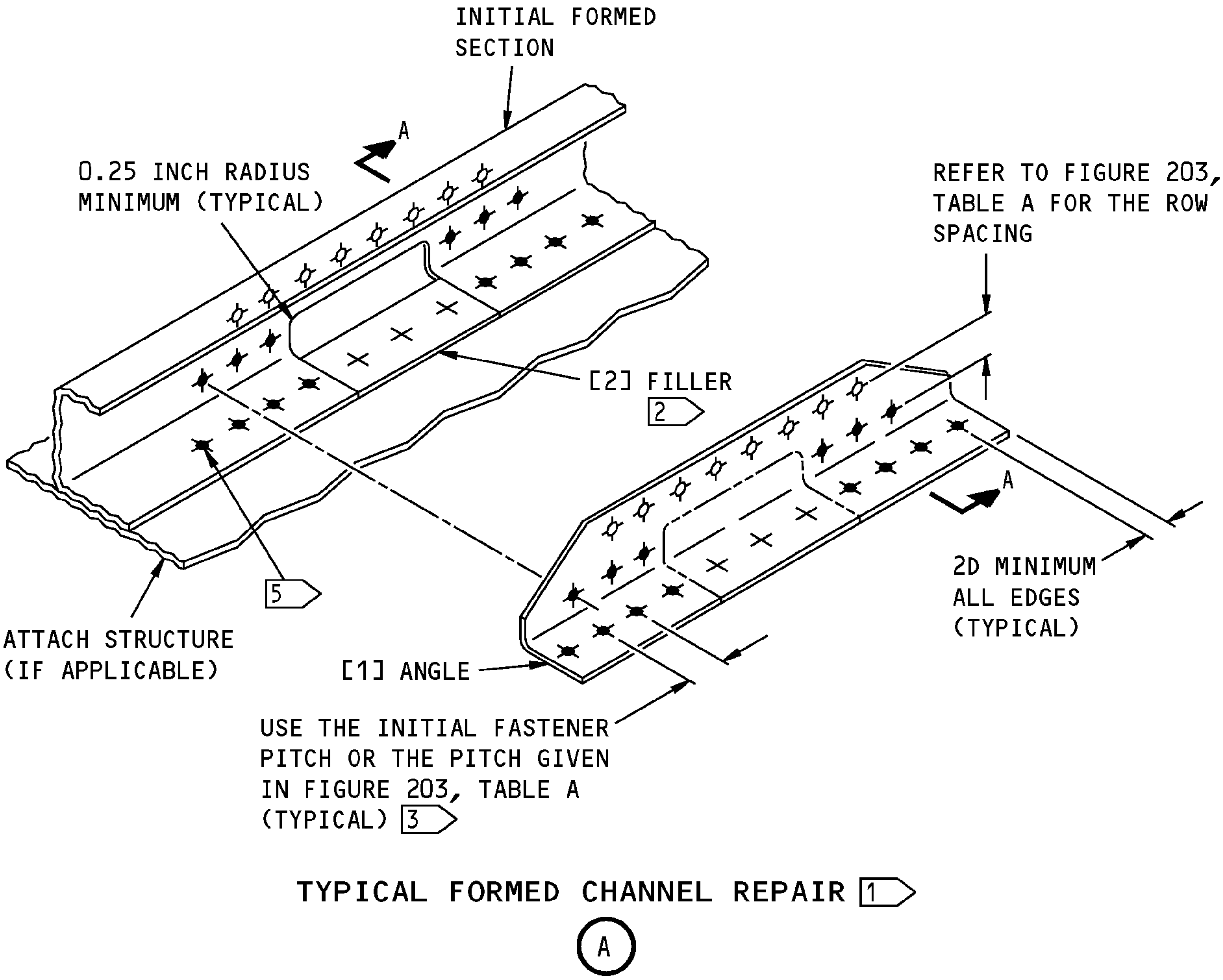
L. Apply a chemical conversion coating to the repair parts and to the bare surfaces of the initial formed section. Refer to 51-20-01.

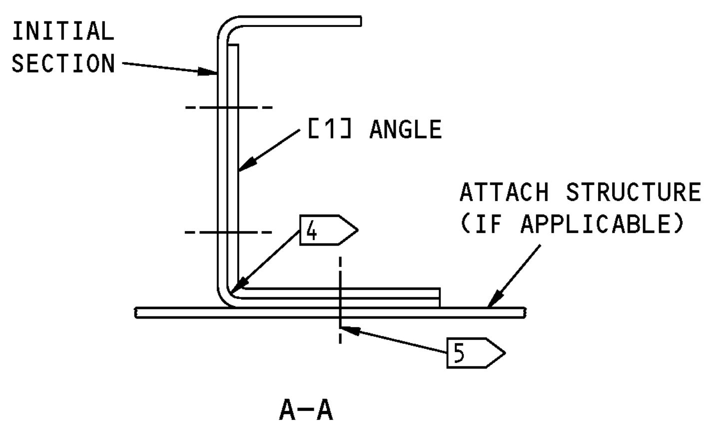
M. Apply two layers of BMS 10-11, Type I primer to the repair parts and the bare surfaces of the initial formed section. Refer to SOPM 20-41-02.

N. Install the repair parts with sealant between the mating surfaces. Refer to 51-20-05. Use one of the sealants that follow:
   - BMS 5-95 - in areas with an operating temperature below 180°F (83°C) or,
   - BMS 5-26 - in areas with an operating temperature between 180°F and 200°F (83°C and 121°C) or,
   - BMS 5-63 - in areas with an operating temperature above 200°F (121°C).

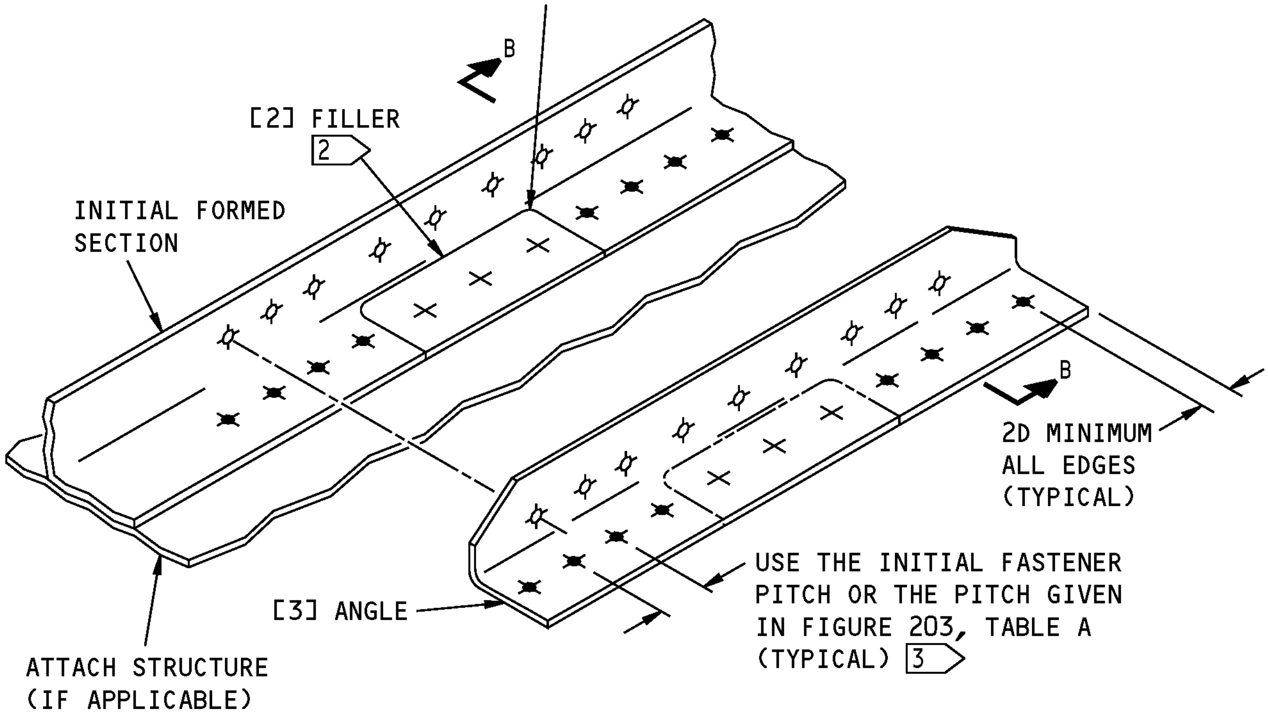
O. Install the fasteners. Fasteners that are not made of aluminum must be installed wet with sealant. Refer to 51-20-05. Use one of the sealants that follows:
   - BMS 5-95 - in areas with an operating temperature below 180°F (83°C) or,
   - BMS 5-26 - in areas with an operating temperature between 180°F and 200°F (83°C and 121°C) or,
   - BMS 5-63 - in areas with an operating temperature above 200°F (121°C).

P. Apply BMS 3-23 corrosion inhibiting compound to the repair area.



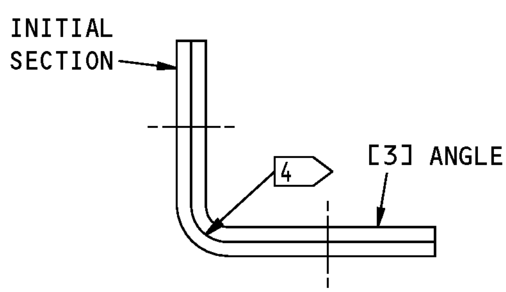


Layout of the Repair Parts for a Formed Part that is Not Fully Cut Through
Figure 201 (Sheet 1 of 4)



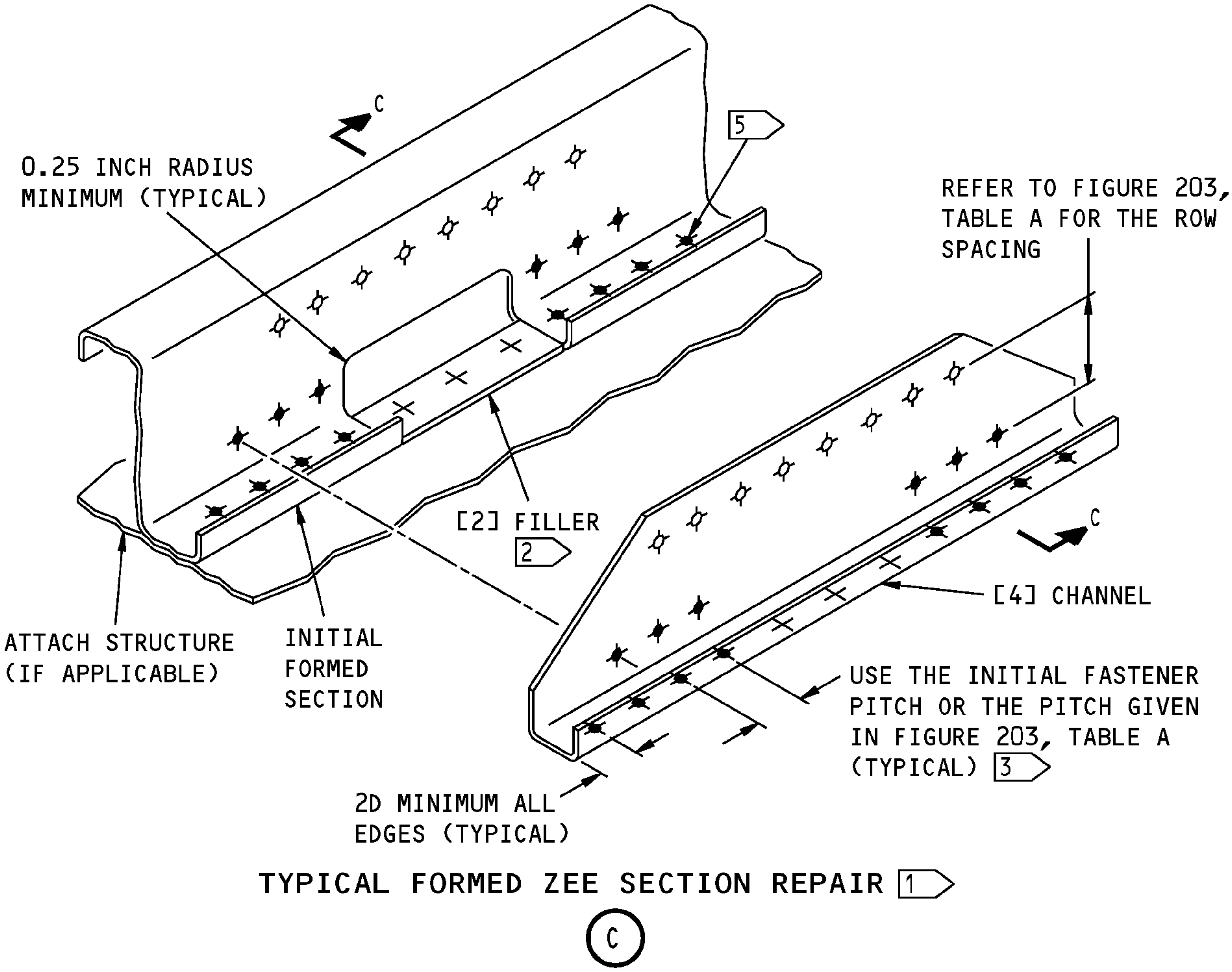
TYPICAL FORMED ANGLE REPAIR 1

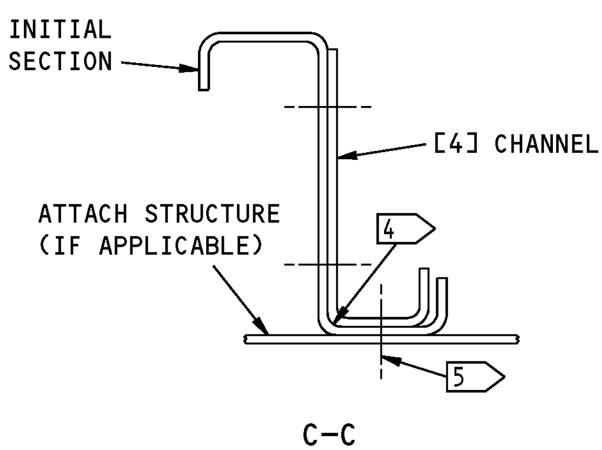
B



B-B

Layout of the Repair Parts for a Formed Part that is Not Fully Cut Through
Figure 201 (Sheet 2 of 4)





Layout of the Repair Parts for a Formed Part that is Not Fully Cut Through
Figure 201 (Sheet 3 of 4)

NOTES

- D = FASTENER DIAMETER.

1 THIS REPAIR IS FOR DAMAGE WHERE LESS THAN 50 PERCENT OF THE CROSS SECTIONAL AREA IS REMOVED. REFER TO FIGURE 202 FOR THE REPAIR OF DAMAGE THAT IS MORE THAN 50 PERCENT.

2 INSTALL THE FILLER WHERE A FLANGE OR A WEB ATTACH TO THE OTHER STRUCTURE.

3 DO NOT USE LESS THAN THREE FASTENERS IN A ROW.

4 THE OUTER RADIUS OF THE REPAIR PART MUST BE EQUAL TO OR LARGER THAN THE INSIDE RADIUS OF THE INITIAL FORMED SECTION.

5 THIS REPAIR IS NOT APPLICABLE IF YOU WILL NOT BE ABLE TO EXAMINE THE FASTENERS ON THE INITIAL FLANGE BETWEEN THE REPAIR ANGLE AND THE ATTACH STRUCTURE.

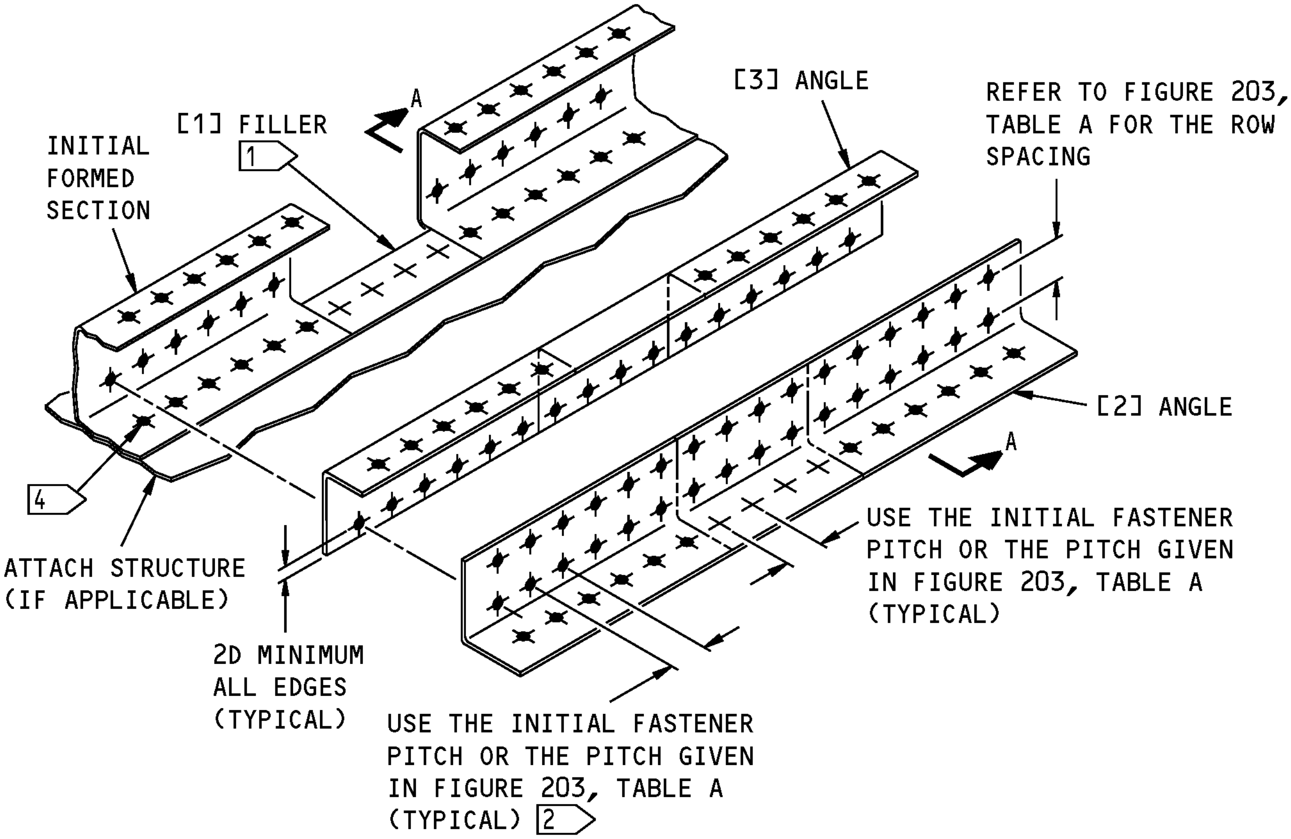
FASTENER SYMBOLS

+ INITIAL FASTENER LOCATION. IF THE INSTALLATION OF AN OVERSIZE FASTENER IS NECESSARY, INSTALL A 1/32 INCH DIAMETER OVERSIZE FASTENER.

⯁ INITIAL OR REPAIR FASTENER LOCATION.

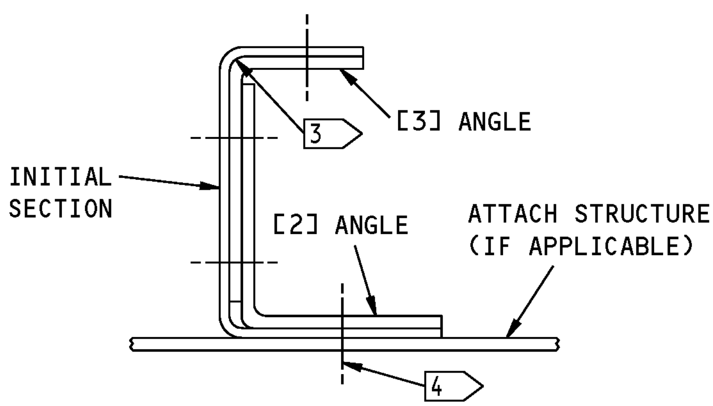
⌖ REPAIR FASTENER LOCATION. THIS ROW OF FASTENERS IS NECESSARY FOR THE COMPRESSION STABILITY OF THE REPAIR ANGLE. EXTEND THE ROW A MINIMUM OF TWO FASTENER LOCATIONS BEYOND THE CUT AREA AS SHOWN IN DETAILS A, B, AND C. DO NOT INCLUDE THESE FASTENERS IN THE NUMBER OF FASTENERS NECESSARY TO MAKE THE REPAIR.

Layout of the Repair Parts for a Formed Part that is Not Fully Cut Through
Figure 201 (Sheet 4 of 4)



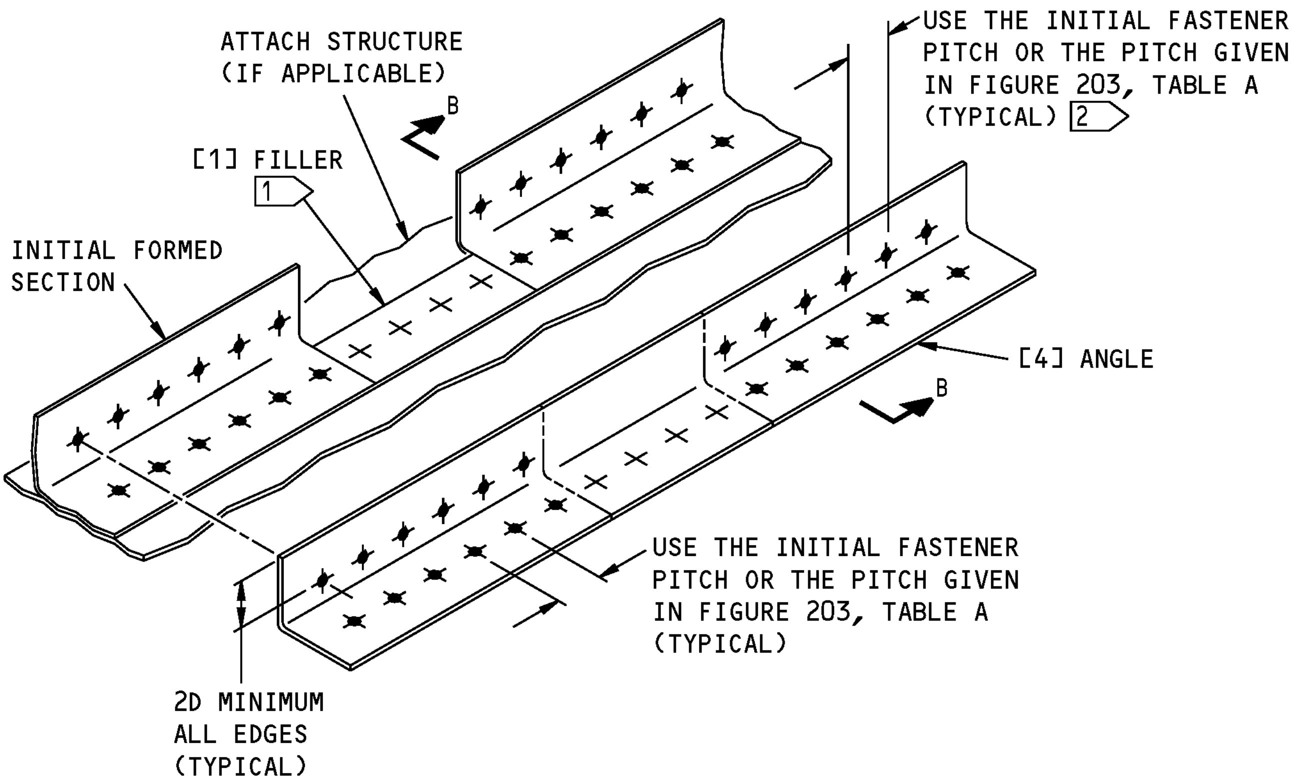
TYPICAL FORMED CHANNEL REPAIR

A



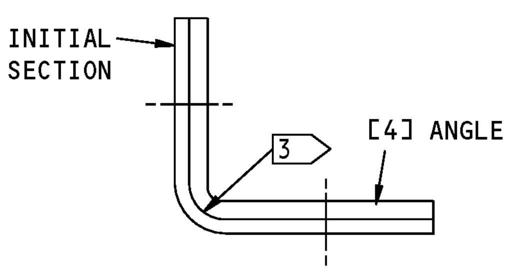
A-A

Layout of the Repair Parts for a Formed Part that is Fully Cut Through
Figure 202 (Sheet 1 of 4)



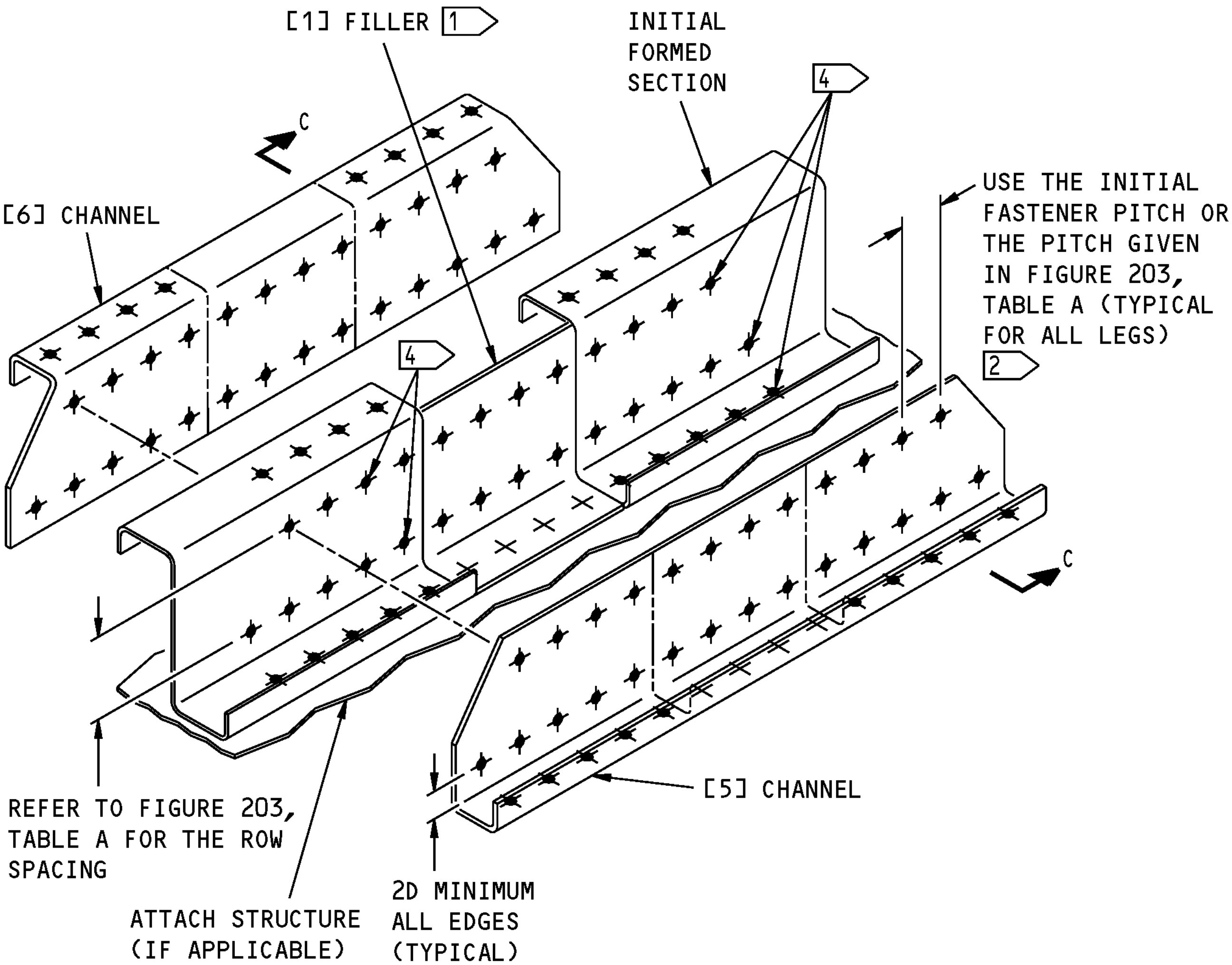
TYPICAL FORMED ANGLE REPAIR

B



B-B

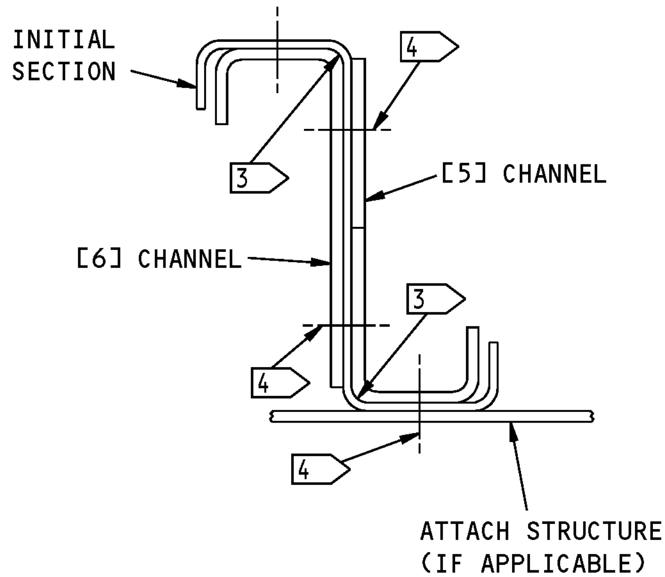
Layout of the Repair Parts for a Formed Part that is Fully Cut Through
Figure 202 (Sheet 2 of 4)



TYPICAL FORMED ZEE REPAIR

C

Layout of the Repair Parts for a Formed Part that is Fully Cut Through
Figure 202 (Sheet 3 of 4)



C-C

NOTES

1 INSTALL THE FILLER WHERE A FLANGE OR A WEB ATTACH TO THE OTHER STRUCTURE.

2 DO NOT USE LESS THAN THREE FASTENERS IN A ROW.

3 THE OUTER RADIUS OF THE REPAIR PART MUST BE EQUAL TO OR LARGER THAN THE INSIDE RADIUS OF THE INITIAL FORMED SECTION.

4 THIS REPAIR IS NOT APPLICABLE IF YOU WILL NOT BE ABLE TO EXAMINE THE FASTENERS ON THE INITIAL FLANGE BETWEEN THE REPAIR CHANNELS OR THE ATTACH STRUCTURE.

FASTENER SYMBOLS

+ INITIAL FASTENER LOCATION. IF THE INSTALLATION OF AN OVERSIZE FASTENER IS NECESSARY, INSTALL A 1/32 INCH DIAMETER OVERSIZE FASTENER.

⌖ INITIAL OR REPAIR FASTENER LOCATION.

Layout of the Repair Parts for a Formed Part that is Fully Cut Through
Figure 202 (Sheet 4 of 4)

FASTENER PITCH AND ROW SPACING						
INITIAL FORMED SECTION THICKNESS (INCHES)	5/32-INCH DIA FASTENERS			3/16-INCH DIA FASTENERS		
	FASTENER PITCH (INCHES)		ROW SPACING (INCHES)	FASTENER PITCH (INCHES)		ROW SPACING (INCHES)
	MIN	MAX	MIN	MIN	MAX	MIN
0.032 0.036	0.60 0.60	0.70 0.70	0.93 0.93	0.75 0.75	0.85 0.85	1.12 1.12
0.040 0.045	0.60 0.60	0.70 0.75	0.93 0.93	0.75 0.75	0.85 0.85	1.12 1.12
0.050 0.056	0.60 0.60	0.85 0.95	0.93 0.93	0.75 0.75	0.85 0.95	1.12 1.12
0.063 0.071	0.60 0.60	0.95 0.95	0.93 0.93	0.75 0.75	1.05 1.20	1.12 1.12
0.080 0.090	0.60	0.95	0.93	0.75 0.75	1.20 1.20	1.12 1.12
0.100 0.112				0.75 0.75	1.20 1.20	1.12 1.12
0.125 0.140				0.75 0.75	1.20 1.20	1.12 1.12
0.160 0.180				0.75 0.75	1.20 1.20	1.12 1.12

TABLE A

Fastener Data
Figure 203 (Sheet 1 of 6)

FASTENER PITCH AND ROW SPACING						
INITIAL FORMED SECTION THICKNESS (INCHES)	1/4-INCH DIA FASTENERS			5/16-INCH DIA FASTENERS		
	FASTENER PITCH (INCHES)		ROW SPACING (INCHES)	FASTENER PITCH (INCHES)		ROW SPACING (INCHES)
	MIN	MAX	MIN	MIN	MAX	MIN
0.032 0.036						
0.040 0.045						
0.050 0.056	1.00 1.00	1.10 1.10	1.50 1.50			
0.063 0.071	1.00 1.00	1.10 1.20	1.50 1.50	1.20 1.20	1.30 1.30	1.87 1.87
0.080 0.090	1.00 1.00	1.35 1.50	1.50 1.50	1.20 1.20	1.35 1.50	1.87 1.87
0.100 0.112	1.00 1.00	1.50 1.50	1.50 1.50	1.20 1.20	1.70 1.90	1.87 1.87
0.125 0.140	1.00 1.00	1.50 1.50	1.50 1.50	1.20 1.20	1.90 1.90	1.87 1.87
0.160 0.180	1.00 1.00	1.50 1.50	1.50 1.50	1.20 1.20	1.90 1.90	1.87 1.87

TABLE A (CONTINUED)

Fastener Data
Figure 203 (Sheet 2 of 6)

NUMBER OF FASTENERS NEEDED FOR EACH INCH OF WIDTH OF 2024-T3 OR T4 MATERIAL							
SHEET THICKNESS (INCHES)	PROTRUDING HEAD						
	BACR15BB()D, OR MS20470D(), OR BACR15FT()D				BACB30VT()K() BACC30BL()		
	5/32-INCH DIA	3/16-INCH DIA	1/4-INCH DIA	5/16-INCH DIA	3/16-INCH DIA	1/4-INCH DIA	5/16-INCH DIA
0.032 0.036	4 4						
0.040 0.045	4 4	3 3			3 3		
0.050 0.056	4 5	3 3	3 3		3 3	3 3	
0.063 0.071	5 6	4 4	3 3	3 3	3 3	3 3	3 3
0.080 0.090		5 5	3 3	3 3	3 3	3 3	3 3
0.100 0.112		6	3 4	3 3	3 3	3 3	3 3
0.125 0.140			4 5	3 3	3 3	3 3	3 3
0.160 0.180			5 6	4 4	4 4	3 3	3 3

TABLE B

Fastener Data
Figure 203 (Sheet 3 of 6)

NUMBER OF FASTENERS NEEDED FOR EACH INCH OF WIDTH OF 2024-T3 OR T4 MATERIAL							
SHEET THICKNESS (INCHES)	100° COUNTERSUNK (SHEAR) HEAD						
	BACR15CE()D OR BACR15GF()D				BACB30VU()K() BACC30BL()		
	5/32-INCH DIA	3/16-INCH DIA	1/4-INCH DIA	5/16-INCH DIA	3/16-INCH DIA	1/4-INCH DIA	5/16-INCH DIA
0.032							
0.036							
0.040							
0.045							
0.050							
0.056							
0.063	5				3		
0.071	6	4			3		
0.080	7	5			3		
0.090		5			3		
0.100		6	4	3	3	3	3
0.112			4	3	3	3	3
0.125			4	3	3	3	3
0.140			5	3	3	3	3
0.160			5	4	4	3	3
0.180			6	4	4	3	3

TABLE B (CONTINUED)

Fastener Data
Figure 203 (Sheet 4 of 6)

NUMBER OF FASTENERS NEEDED FOR EACH INCH OF WIDTH OF 7075-T6 MATERIAL							
SHEET THICKNESS (INCHES)	PROTRUDING HEAD						
	BACR15BB()D, OR MS20470D(), OR BACR15FT()D				BACB30VT()K() BACC30BL()		
	5/32-INCH DIA	3/16-INCH DIA	1/4-INCH DIA	5/16-INCH DIA	3/16-INCH DIA	1/4-INCH DIA	5/16-INCH DIA
0.032	4	3					
0.036	4	3					
0.040	4	3					
0.045	5	3					
0.050	5	4	3		3	3	
0.056	6	4	3		3	3	
0.063		5	3	3	3	3	3
0.071		5	3	3	3	3	3
0.080		6	3	3	3	3	3
0.090			4	3	3	3	3
0.100			4	3	3	3	3
0.112			5	3	3	3	3
0.125			5	3	4	3	3
0.140			6	4	4	3	3
0.160				4	5	3	3
0.180				5	5	3	3

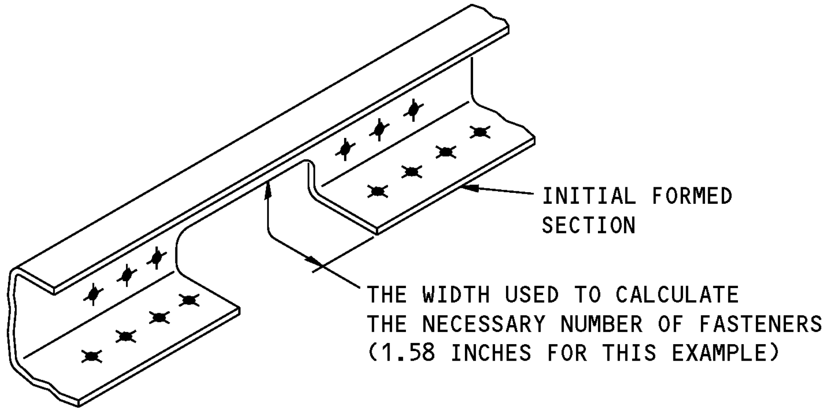
TABLE C

Fastener Data
Figure 203 (Sheet 5 of 6)

NUMBER OF FASTENERS NEEDED FOR EACH INCH OF WIDTH OF 7075-T6 MATERIAL						
SHEET THICKNESS (INCHES)	100° COUNTERSUNK (SHEAR) HEAD					
	BACR15CE()D OR BAC15GF()D			BACB30VU()K() BACC30BL()		
	3/16- INCH DIA	1/4- INCH DIA	5/16- INCH DIA	3/16- INCH DIA	1/4- INCH DIA	5/16- INCH DIA
0.032 0.036						
0.040 0.045						
0.050 0.056						
0.063 0.071	 5			3 3		
0.080 0.090	6 6			3 3		
0.100 0.112		4 5	3 3	3 3	3 3	3 3
0.125 0.140		5 6	3 4	4 4	3 3	3 3
0.160 0.180			4 5	5 5	3 3	3 3

TABLE C (CONTINUED)

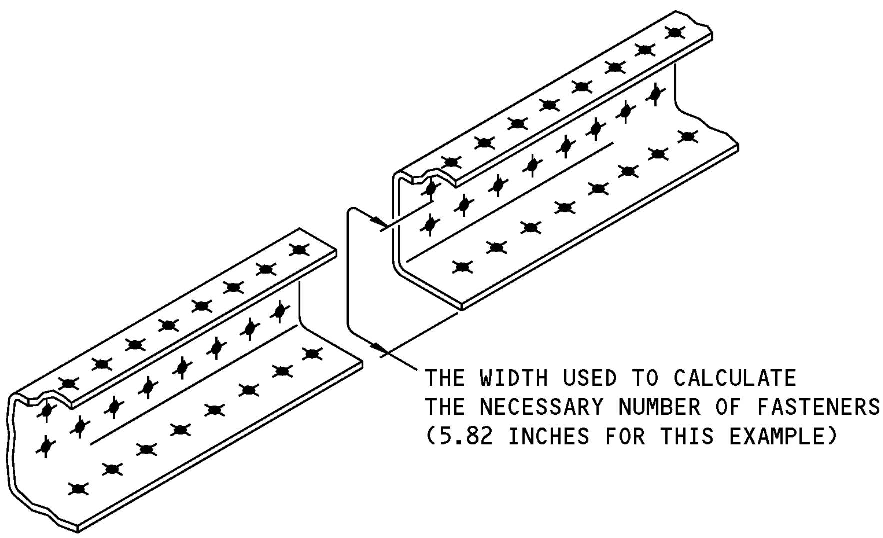
Fastener Data
Figure 203 (Sheet 6 of 6)



FASTENER SYMBOLS

⌖ INITIAL OR REPAIR FASTENER LOCATION.

Example of a Formed Part that is Not Fully Cut Through
Figure 204



FASTENER SYMBOLS

⌖ INITIAL OR REPAIR FASTENER LOCATION.

Example of a Formed Part that is Fully Cut Through
Figure 205

5. Inspection Instructions

A. For airplanes that have completed Service Bulletin 737-21-1149 follow the inspection instructions as described below.

B. Refer to Table 203 for the inspection requirements. Table 203 is only applicable to Principal Structural Elements (PSE's). Refer to 51-00-04 for all Principal Structural Elements (PSE's). Supplemental inspections are not necessary for non-Principal Structural Elements.

Table 203:

CATEGORY B REPAIR INSPECTION REQUIREMENTS			
INSPECTION THRESHOLD	REPEAT INSPECTION ALTERNATIVES		
	METHOD	INTERVAL	REFERENCE
22,500 flight cycles	See note below	See note below	

NOTE: Contact The Boeing Company in 30 days or less after you install this repair to receive installation specific inspection methods and intervals. An assessment is necessary from The Boeing Company to review a complete technical description of the actual installation.

REPAIR GENERAL - TYPICAL EXTRUDED SECTION REPAIRS

1. References

Reference	Title
51-00-06, GENERAL	Structural Repair Definitions
51-10-02, GENERAL	Inspection and Removal of Damage
51-40-02, GENERAL	Fastener Installation and Removal
51-40-03, GENERAL	Fastener Substitution
51-40-04, GENERAL	Torque Values
51-40-05, GENERAL	Fastener Hole Sizes
51-40-06, GENERAL	Fastener Edge Margins
51-40-08, GENERAL	Countersink Data and Procedures for Metal Structures

2. Applicability

A. Additional references that are applicable to this procedure are:
- 51-00-06, GENERAL, 51-10-02, GENERAL, 51-40-02, GENERAL, 51-40-03, GENERAL, 51-40-04, GENERAL, 51-40-05, GENERAL, 51-40-06, GENERAL, 51-40-08, GENERAL.

B. This general section gives typical repairs for extruded sections in primary and secondary structures, as referenced in applicable SRM chapter-section- subject.

(1) Refer to Repair 1 for the thin extruded sections.

(a) The thin extruded sections that have thicknesses of 0.080 inch (2.03 mm) or less.

(2) Refer to Repair 2 for the thick extruded sections.

(a) The thick extruded sections that have thicknesses of more than 0.080 inch (2.03 mm).

REPAIR 1 - TYPICAL EXTRUDED SECTIONS - 0.080 INCH OR LESS IN THICKNESS

1. Applicability

A. Repair 1 is applicable to damage to extruded sections. Some examples include damage to stringers and stiffeners.

B. Repair 1 is not applicable to damage to the wing structures.

C. Repair 1 is not applicable if there is a special repair in this manual for the damaged part.

D. For airplanes that have completed Service Bulletin 737-21-1149, Repair 1 is not applicable to damage to the horizontal stabilizer or the horizontal stabilizer center section beams

E. For airplanes that have completed Service Bulletin 737-21-1149, contact The Boeing Company if the damage is 20 inches (508 mm) or less away from the edge of a door or access cutout.

F. For airplanes that have completed Service Bulletin 737-21-1149, if the damage is 10 inches (254 mm) or less away from the edge of an existing repair then:

(1) Remove the existing repair and make one repair that includes the two areas of damage.

2. General

A. For the repair of damage to extruded sections that are more than 0.080 inch thick, refer to Repair 2.

B. For airplanes that have completed Service Bulletin 737-21-1149 Repair 1 is a Category B repair. Refer to paragraph 7 for the inspection requirements.

3. References

Reference	Title
51-00-04	STRUCTURAL CLASSIFICATION
51-00-06, GENERAL	Structural Repair Definitions
51-10-02	INSPECTION AND REMOVAL OF DAMAGE
51-10-02, GENERAL	Inspection and Removal of Damage
51-20-01	PROTECTIVE TREATMENT OF METALLIC AND COMPOSITE MATERIALS
51-20-05	REPAIR SEALING
51-30-01	SHEET METAL MATERIALS
51-40-02, GENERAL	Fastener Installation and Removal
51-40-03, GENERAL	Fastener Substitution
51-40-04, GENERAL	Torque Values
51-40-05, GENERAL	Fastener Hole Sizes
51-40-06, GENERAL	Fastener Edge Margins
51-40-08, GENERAL	Countersink Data and Procedures for Metal Structures
AMM 51-21-99 P/B 701	DECORATIVE EXTERIOR PAINT SYSTEM - CLEANING/PAINTING
SOPM 20-41-02	Application of Chemical and Solvent Resistant Finishes

4. Definition of Terms

A. The definitions of terms related to these repairs are as follows:

(1) Total Cross-sectional Area The measure of a planar surface of the initial extruded section. To calculate this area, multiply the total length of the flanges and web of the extrusion by the thickness of the extrusion.

(2) Total Minimum Cross-sectional Area The smallest cross-sectional area of the repair parts that is permitted for a satisfactory repair of the damaged extruded section. The minimum cross-sectional area must not be less than the cross-sectional area of the initial extruded section.

(3) D = The diameter of a fastener.

5. Repair Instructions

A. Remove the initial fasteners as necessary.

B. Cut and remove the damaged length of the extruded section. Refer to Layout of the Repair Parts, Figure 201/REPAIR 1.

NOTE: Use care not to damage the structure that is adjacent to the repair area.

(1) Make all the cut surfaces 125 microinches Ra or smoother.

C. Calculate the total minimum cross-sectional area of the repair parts. Refer to Paragraph 6.A./REPAIR 1 for an example procedure.

(1) Calculate the total cross-sectional area of the initial extruded section.

(2) Calculate the total minimum cross-sectional area of the repair angles [1] and [2] as follows:

(a) Make a selection of one repair material for the repair parts.

(b) Multiply the cross-sectional area of the initial extruded section by the repair material factor shown in Table 201/REPAIR 1.

Table 201:

REPAIR MATERIAL FACTOR		
INITIAL SECTION MATERIAL	REPAIR PART MATERIAL	REPAIR MATERIAL FACTOR
EXTRUDED 2024-T3	SHEET BARE 2024-T3	1.25
EXTRUDED 2024-T3	SHEET CLAD 2024-T3	1.25
EXTRUDED 7075-T6	SHEET BARE 7075-T6	1.35
EXTRUDED 7075-T6	SHEET CLAD 7075-T6	1.35

D. Find the dimensions for part [1] and part [2] given in Table 202/REPAIR 1 and shown in Layout of the Repair Parts, Figure 201/REPAIR 1. Refer to Paragraph 6.B./REPAIR 1 for an example procedure.

Table 202:

REPAIR MATERIALS			
ITEM	PART	QUANTITY	MATERIAL
[1]	Angle	As Necessary	Use 2024-T3 sheet or 7075-T6 sheet that is 0.040 inch to 0.063 inch thick
[2]	Angle	As Necessary	Use 2024-T3 sheet or 7075-T6 sheet that is 0.040 inch to 0.063 inch thick
[3]	Filler	As Necessary	Use 2024-T3 sheet or 7075-T6 sheet. Make the thickness the same as the initial extruded Section
[4]	Filler	As Necessary	Use 2024-T3 sheet or 7075-T6 sheet. Make the thickness as necessary

(1) Find the dimensions for the part [1] angle.

(a) Refer to Table 202/REPAIR 1 for the minimum thickness for the part [1] angle.

NOTE: Find the thickness of the part [1] angle together with the thickness of the part [2] angle. The sum of the thicknesses of the part [1] and [2] angles must be larger than the sum of the thickness of the initial extruded section multiplied by the repair material factor.

(b) Refer to Layout of the Repair Parts, Figure 201/REPAIR 1 for the maximum flange widths of the part [1] angle.

(c) Calculate the total cross-sectional area of the part [1] angle.

(2) Find the dimensions of the part [2] angle.

(a) Find the thickness for the part [2] angle.

1) Measure the fastener spacing of the initial extruded section at a location that is adjacent to the damage.

2) Find the minimum thickness of the part [2] angle from Table 203/REPAIR 1.

Table 203:

MINIMUM THICKNESS FOR THE PART [2] ANGLE	
FASTENER SPACING IN INITIAL EXTRUDED SECTION (INCHES)	MINIMUM THICKNESS FOR THE PART [2] ANGLE (INCHES)
Up to 0.75	0.040
0.76 to 0.84	0.056
0.85 to 1.10	0.063
1.10 to 1.75	0.071

(b) Make the width of the flanges of the part [2] angle equal to or less than the flange widths of the part [1] angle. Refer to Layout of the Repair Parts, Figure 201/REPAIR 1.

(c) Calculate the total cross-sectional area of the part [2] angle.

(3) Make sure that the sum of the areas of the repair parts is equal to or larger than the minimum cross-sectional area that is necessary. If the sum of the areas of the repair parts is smaller, then increase the dimensions of the repair parts.

E. Find the minimum number of fasteners on each side of the removed section necessary to install the part [2] angle to the initial extruded section. Refer to Paragraph 6.C./REPAIR 1 for an example procedure.

(1) Measure the total section dimension of all parts of the initial extruded section. Refer to Layout of the Repair Parts, Figure 201/REPAIR 1 for the total section dimension to be measured.

(2) Refer to Table 204/REPAIR 1 for the number of repair fasteners for each inch of the total section dimension.

Table 204:

NUMBER OF FASTENERS FOR EACH INCH OF SECTION DIMENSION		
FASTENER DIAMETER (INCH)	2024 INITIAL EXTRUDED SECTION	7075 INITIAL EXTRUDED SECTION
5/32	5.0	5.3
3/16	4.2	4.4
1/4	3.1	3.3

(a) Use the fasteners with the same diameter as the initial fasteners in the initial extruded section.

NOTE: If the hole is damaged use a fastener that has a diameter 1/64 inch oversize, as given in Table 205/REPAIR 1.

Table 205:

REPAIR FASTENERS			
FASTENER TYPE	**HEAD STYLE**	**STANDARD SIZE**	**1/64 INCH DIAMETER OVERSIZE**
Hex-Drive Bolt	Protruding - Shear	Bolt: BACB30MY()K Collar: BACC30M	Bolt: BACB30MY()K()X Collar: BACC30M
Hex-Drive Bolt	Protruding - Tension	Bolt: BACB30NX()K Collar: BACC30X	Bolt: BACB30NX()K()X Collar: BACC30X
Hex-Drive Bolt	Flush - Shear	Bolt: BACB30NW()K Collar: BACC30M	Bolt: BACB30NW()K()X Collar: BACC30M
Hex-Drive Bolt	Flush - Tension	Bolt: BACB30NY()K Collar: BACC30X	Bolt: BACB30NY()K()X Collar: BACC30X

(3) Multiply the number of fasteners from Table 204/REPAIR 1 by the total section dimension measured.

(4) Divide this number of fasteners by the number of the rows. If the result is not a whole number then use the subsequent higher whole number. Refer to Layout of the Repair Parts, Figure 201/REPAIR 1 for the location of these fasteners.

F. Add two more repair fasteners in each row on the part [1] angle. Refer to Layout of the Repair Parts, Figure 201/REPAIR 1 for the location of these fasteners.

G. Make the repair parts as shown in Layout of the Repair Parts, Figure 201/REPAIR 1.

(1) You can make the repair parts from:

(a) Sheet metal

(b) BAC1490 formed sections

(c) Extruded sections.

(2) Make the edges of the repair parts 125 microinches Ra or smoother.

(3) Make the repair parts so that there is a clearance between the radii of mating parts. Refer to 51-30-01 for the minimum bend radii for aluminum alloys.

NOTE: The outside radius of the inner repair angle must be greater than the inside radius of the adjacent part.

(4) Use a radius filler if necessary so that the fastener heads will not touch the bend radius.

H. Assemble the repair parts.

I. Drill the fastener holes.

J. Disassemble the repair parts.

K. Remove the nicks, scratches, gouges, burrs, and sharp edges from the repair parts and the initial extruded section. Refer to 51-10-02.

L. Apply a chemical conversion coating to the repair parts and the bare surfaces of the initial extruded section. Refer to 51-20-01.

M. Apply two layers of BMS 10-11, Type I primer to the repair parts. Refer to SOPM 20-41-02.

N. Install the repair parts with BMS 5-95 sealant between the mating surfaces. Refer to 51-20-05.

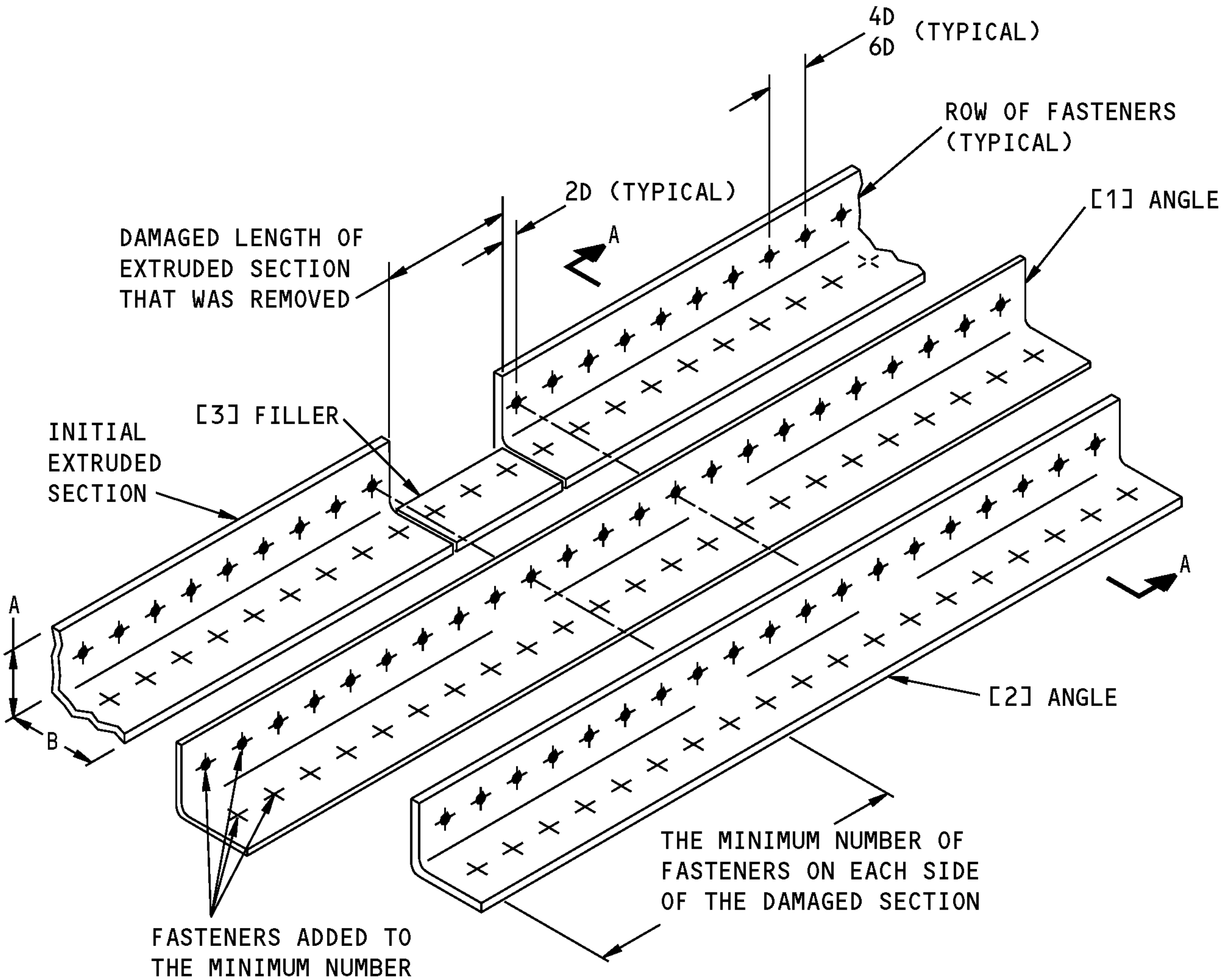
O. Install the fasteners.

(1) Install aluminum fasteners without sealant.

(2) Install non-aluminum fasteners wet with BMS 5-95 sealant. Refer to 51-20-05.

P. Fill the space between the parts with BMS 5-95 sealant if necessary.

Q. Apply the finish if necessary. Refer to AMM PAGEBLOCK 51-21-99/701.



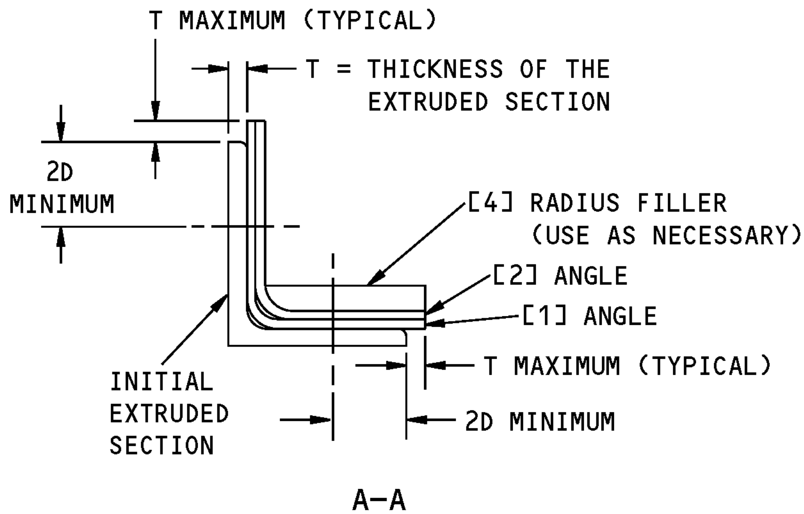
A + B = TOTAL SECTION DIMENSION

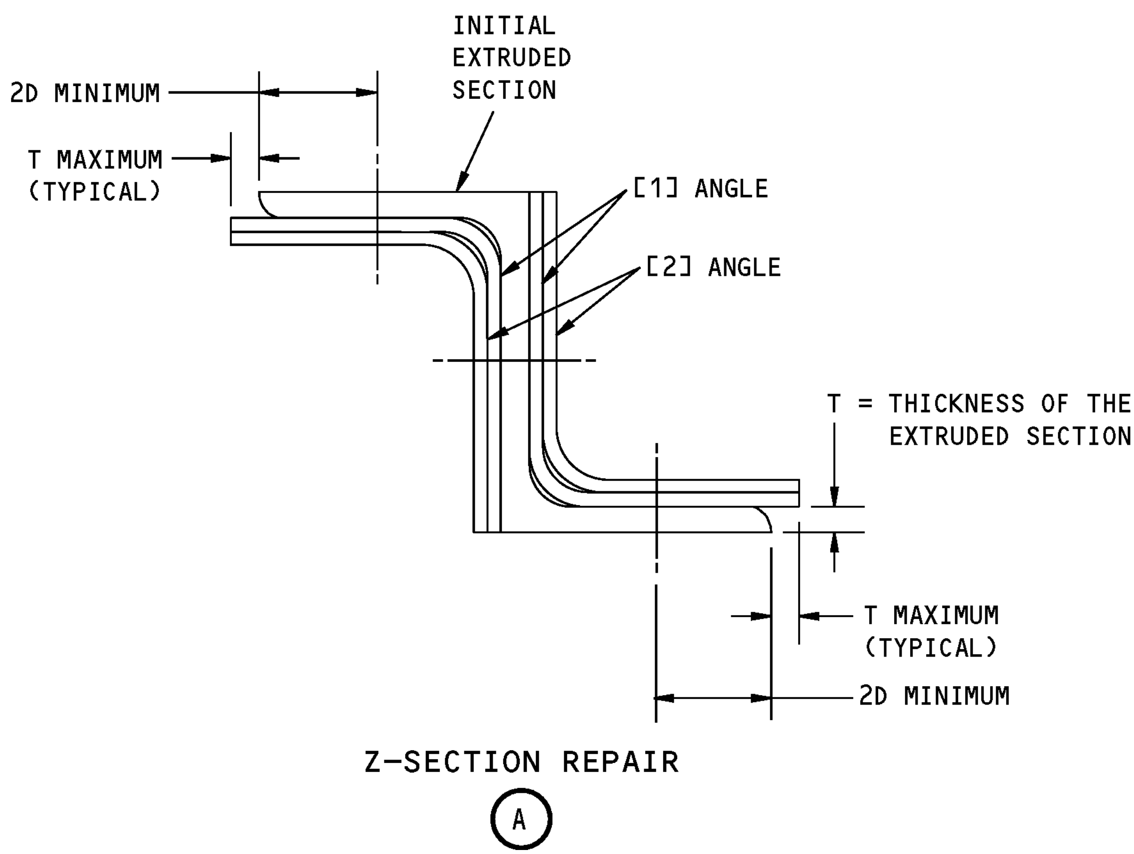
TYPICAL EXTRUDED SECTION REPAIR

NOTES

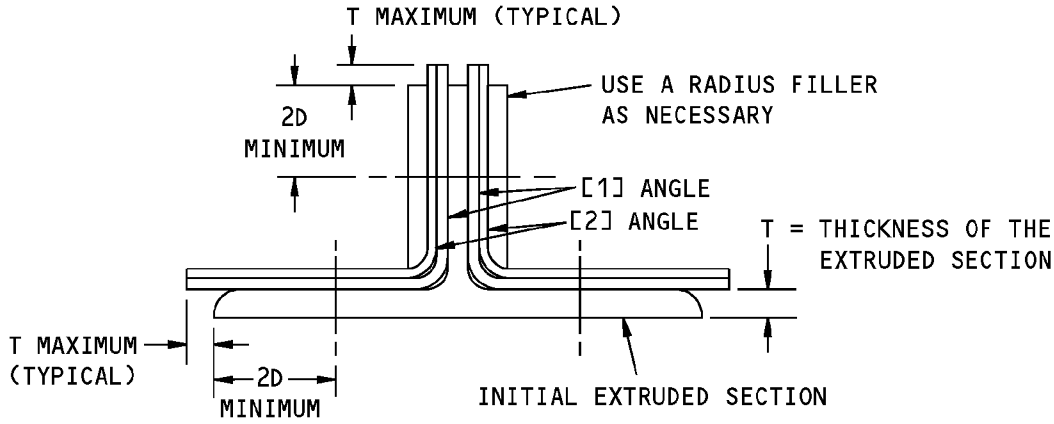
- D = FASTENER DIAMETER
- CHANGE THE FASTENER PATTERN IF NECESSARY TO MAKE SURE THAT FASTENERS DO NOT TOUCH OTHER FASTENERS. THIS IS PERMITTED ONLY IF THE PATTERN AGREES WITH THE SPECIFIED DIMENSIONS.

Layout of the Repair Parts
Figure 201 (Sheet 1 of 3)



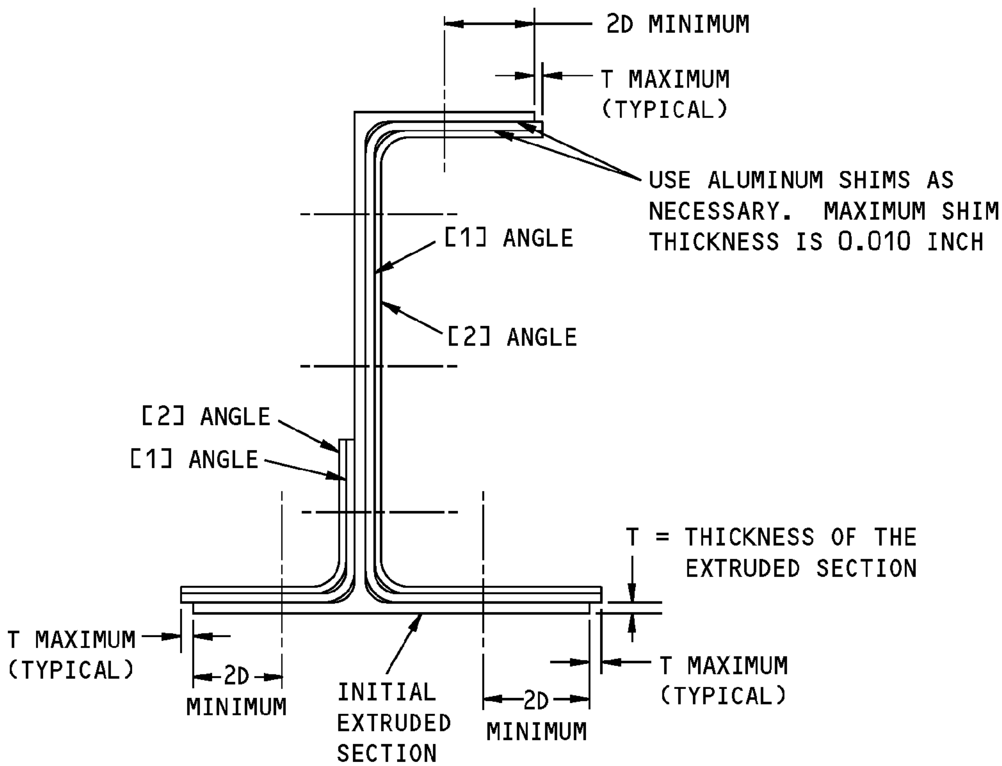


Layout of the Repair Parts
Figure 201 (Sheet 2 of 3)



T-SECTION REPAIR

B



J-SECTION REPAIR

C

Layout of the Repair Parts
Figure 201 (Sheet 3 of 3)

6. **Example Procedure to Calculate Areas and Fastener Quantity**

A. Calculate the total minimum cross-sectional area necessary for the repair parts. Refer to Examples for Extruded Section and Repair Angles, Figure 202/REPAIR 1, Detail A for the initial extruded section, and Examples for Extruded Section and Repair Angles, Figure 202/REPAIR 1, Detail B and Detail C for the repair parts.

(1) Calculate the total cross-sectional area of the initial extruded section.

(a) The width of the base flange is 2.00 inches.

(b) The width of the vertical flange is 1.50 inches.

(c) The thickness of the flanges are 0.071 inch.

(d) The radius is 0.16 inch.

(e) The cross-sectional area is: $(1.5 + 2.0) \times 0.071 - (0.071)^2 + [(4 - \pi) \times (0.16)^2] / 4 = 0.25$ square inch

(2) Find the applicable repair material and material factor in Table 201/REPAIR 1.

(a) The material for the repair parts will be made from a 2024-T3 clad sheet.

(b) The material factor for the 2024-T3 clad sheet is 1.25.

(3) Calculate the total minimum cross-sectional area of the repair parts.

(a) 0.25 square inch x 1.25 = 0.31 square inch

B. Find the dimensions for the repair parts.

(1) Find the dimensions for the part [1] angle.

(a) Find the thickness for the part [1] angle. Refer to Table 202/REPAIR 1.

1) 0.040 inch is selected for the thickness of the part [1] angle.

(b) Find the width of each flange of the part [1] angle. Refer to Examples for Extruded Section and Repair Angles, Figure 202/REPAIR 1, Detail B for the maximum flange widths permitted.

1) 2.00 inches is selected as the width of the base flange.

2) 1.50 inches is selected as the width of the vertical flange.

(c) Find the inner bend radius of the part [1] angle. Refer to 51-30-01.

1) 0.16 inch is selected as the inner bend radius.

(d) Calculate the total cross-sectional area of the repair part [1] angle.

1) Area $= 0.040 \times [1.50 + 2.00 - (2 \times 0.16) - (2 \times 0.040)] + \pi \times [(2 \times 0.16 \times 0.040) + (0.040)^2] / 4 = 0.14$ square inch

(2) Find the dimensions for the part [2] angle.

(a) Find the thickness of the part [2] angle. Refer to Table 203/REPAIR 1.

1) For an initial fastener spacing of 0.75 inch, Table 203/REPAIR 1 gives the minimum thickness of the part [2] angle as 0.040 inch. However, 0.063 inch is selected for the part [2] angle to get the necessary repair cross section area.

(b) Find the width of each flange of the part [2] angle. Refer to Examples for Extruded Section and Repair Angles, Figure 202/REPAIR 1, Detail C for the maximum flange widths permitted.

1) 1.89 inches is selected as the width of the base flange.

2) 1.39 inches is selected as the width of the vertical flange.

(c) Find the inner bend radius of the part [2] angle. Refer to 51-30-01.

1) 0.22 inch is selected as the inner bend radius.

(d) Calculate the total cross-sectional area of the repair part [2] angle.

1) Area $= 0.063 \times [1.39 + 1.89 - (2 \times 0.22) - (2 \times 0.063)] + \pi \times [(2 \times 0.22 \times 0.063) + (0.063)^2] / 4 = 0.20$ square inch

(3) Compare the sum of the areas of the repair angles with the minimum area that you calculated in Paragraph 6.A./REPAIR 1

(a) Calculate the sum of the cross-sectional areas of the part [1] and [2] angles.

1) Total Area = 0.14 + 0.20 = 0.34 square inch

(b) Compare the sum of the cross-sectional areas with the minimum cross-sectional area.

1) The total area is 0.34 square inch which is larger than the minimum cross-sectional area of 0.31 square inch. Thus, the dimensions of the repair angles are sufficient.

C. Find the number of fasteners necessary on each side of the removed section to install the part [2] angle to the initial extruded section.

(1) Find the repair fastener diameter.

(a) 3/16 inch is selected as the repair fastener diameter same as the initial fasteners in the initial extruded section.

(2) Measure the total section dimension of the initial extruded section.

(a) The total section dimension which is the sum of the widths of the base and vertical flanges is 3.50 inches. Refer to Examples for Extruded Section and Repair Angles, Figure 202/REPAIR 1, Detail A .

(3) The number of fasteners necessary for 3/16 inch diameter fasteners is 4.2 as given in Table 204/REPAIR 1.

(4) Multiply the number of fasteners you found from Table 204/REPAIR 1 by the total section dimension measured.

(a) 4.2 fasteners for each inch x 3.50 inches = 14.7 fasteners.

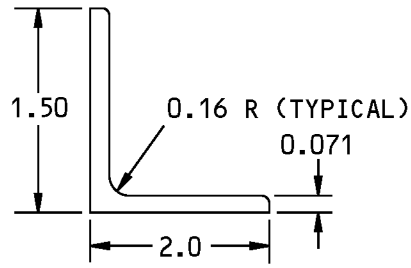
(5) Divide the number of the fasteners by the number of the rows.

(a) There will be two rows of fasteners on the repair section. One row is on the base flange, the other row is on the vertical flange. Refer to Layout of the Repair Parts, Figure 201/REPAIR 1 for the location of these rows.

(b) 14.7 fasteners divided by 2 rows gives 7.35 fasteners in each row on each side.

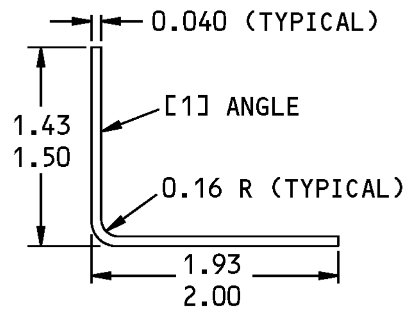
(c) The subsequent whole number higher than 7.35 is 8.

(d) Thus, use a minimum of 8 fasteners in each row on each side of the removed section to fasten the part [2] angle, and 10 fasteners in the part [1] angle.



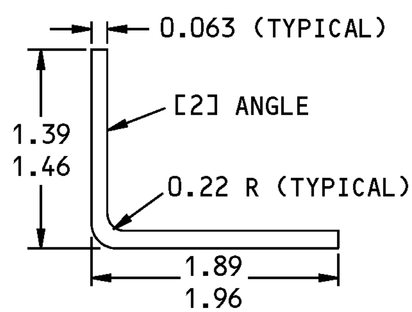
EXAMPLE OF AN EXTRUDED SECTION

A



EXAMPLE OF A PART [1] ANGLE

B



EXAMPLE OF A PART [2] ANGLE

C

Examples for Extruded Section and Repair Angles
Figure 202

7. Inspection Instructions

A. For airplanes that have completed Service Bulletin 737-21-1149, follow the inspection requirements as given below. The inspections as given below do not apply for airplanes that have not completed Service Bulletin 737-21-1149.

B. Refer to Table 206 for the inspection requirements. Table 206 is only applicable to Principal Structural Elements (PSE's). Refer to 51-00-04 for all Principal Structural Elements (PSE's). Supplemental inspections are not necessary for non-Principal Structural Elements.

Table 206:

CATEGORY B REPAIR INSPECTION REQUIREMENTS			
INSPECTION THRESHOLD	REPEAT INSPECTION ALTERNATIVES		
	METHOD	INTERVAL	REFERENCE
22,500 flight cycles	See note below	See note below	

NOTE: Contact The Boeing Company in 30 days or less after you install this repair to receive installation specific inspection methods and intervals. An assessment is necessary from The Boeing Company to review a complete technical description of the actual installation.

REPAIR 2 - TYPICAL REPAIRS FOR THICK EXTRUDED SECTIONS

1. **Applicability**

   A. Repair 2 is applicable to extruded sections. Some examples include damage to stringers and stiffeners.

   B. Repair 2 is not applicable to wing structure.

   C. Repair 2 is not applicable if there is a special repair in this manual for the damaged part.

   D. For airplanes that have completed Service Bulletin 737-21-1149, Repair 2 is not applicable to damage to the horizontal stabilizer or the horizontal stabilizer center section beams.

   E. For airplanes that have completed Service Bulletin 737-21-1149, contact The Boeing Company if the damage is 20 inches (508 mm) or less away from the edge of a door or access cutout.

   F. For airplanes that have completed Service Bulletin 737-21-1149, if the damage is 10 inches (254 mm) or less away from the edge of an existing repair then:

      (1) Remove the existing repair and make one repair that includes the two areas of damage.

2. **General**

   A. For airplanes that have completed Service Bulletin 737-21-1149, Repair 2 is a Category B repair. Refer to paragraph 7 for the inspection requirements.

   B. For airplanes that have not completed Service Bulletin 737-21-1149, Repair 2 is a permanent repair. Refer to 51-00-06 for the definitions of the different categories of repairs.

3. **References**

Reference	Title
51-00-04	STRUCTURAL CLASSIFICATION
51-00-06	STRUCTURAL REPAIR DEFINITIONS
51-00-06, GENERAL	Structural Repair Definitions
51-10-02	INSPECTION AND REMOVAL OF DAMAGE
51-10-02, GENERAL	Inspection and Removal of Damage
51-20-01	PROTECTIVE TREATMENT OF METALLIC AND COMPOSITE MATERIALS
51-20-05	REPAIR SEALING
51-30-01	SHEET METAL MATERIALS
51-40-02, GENERAL	Fastener Installation and Removal
51-40-03, GENERAL	Fastener Substitution
51-40-04, GENERAL	Torque Values
51-40-05, GENERAL	Fastener Hole Sizes
51-40-06, GENERAL	Fastener Edge Margins
51-40-08, GENERAL	Countersink Data and Procedures for Metal Structures
AMM 51-21-99 P/B 701	DECORATIVE EXTERIOR PAINT SYSTEM - CLEANING/PAINTING
SOPM 20-41-02	Application of Chemical and Solvent Resistant Finishes

4. **Definition of Terms**

   A. The definitions of terms related to these repairs are as follows:

(1) Total Cross-sectional area The measure of a planar surface of the initial extruded section. To calculate this area, multiply the total length of the flanges and web of the extrusion by the thickness of the extrusion.

(2) Total Minimum Cross-sectional Area The smallest cross-sectional area of the repair parts that is permitted for a satisfactory repair of the damaged extruded section. The minimum cross-sectional area must not be less than the cross-sectional area of the initial extruded section.

(3) D = The diameter of a fastener.

5. Repair Instructions

A. Remove the initial fasteners as necessary.

B. Cut and remove the damaged part of the extruded section. Refer to Layout of the Repair Parts, Figure 201/REPAIR 2.

NOTE: Use care not to damage the structure that is adjacent to the repair area.

(1) Make all the cut surfaces 125 microinches Ra or smoother.

C. Calculate the total minimum cross-sectional area of the repair parts. Refer to Paragraph 6.A./REPAIR 2 for an example procedure.

(1) Calculate the total cross-sectional area of the initial extruded section.

(2) Calculate the total minimum cross-sectional area of the repair angles [1], [2], and [3] as follows:

(a) Make a selection of one repair material for the repair parts.

(b) Multiply the cross-sectional area of the initial extruded section by the repair material factor given in Table 201/REPAIR 2.

Table 201:

REPAIR MATERIAL FACTOR		
INITIAL SECTION MATERIAL	REPAIR PART MATERIAL	REPAIR MATERIAL FACTOR
EXTRUDED 2024-T3	SHEET BARE 2024-T3	1.25
EXTRUDED 2024-T3	SHEET CLAD 2024-T3	1.25
EXTRUDED 7075-T6	SHEET BARE 7075-T6	1.35
EXTRUDED 7075-T6	SHEET CLAD 7075-T6	1.35

D. Find the dimensions for part [1], part [2], and part [3] given in Table 202/REPAIR 2 and shown in Layout of the Repair Parts, Figure 201/REPAIR 2. Refer to Paragraph 6.B./REPAIR 2 for an example procedure.

Table 202:

REPAIR MATERIALS			
ITEM	PART	QUANTITY	MATERIAL
[1]	Angle	As Necessary	Use 2024-T3 sheet or 7075-T6 sheet that is 0.040 inch thick
[2]	Angle	As Necessary	Use 2024-T3 sheet or 7075-T6 sheet that is 0.040 inch to 0.063 inch thick
[3]	Angle	As Necessary	Use 2024-T3 sheet or 7075-T6 sheet that is 0.050 inch to 0.125 inch thick
[4]	Filler	As Necessary	Use 2024-T3 sheet or 7075-T6 sheet. Make the thickness the same as the initial extruded section
[5]	Filler Radius	As Necessary	Use 2024-T3 sheet or 7075-T6 sheet. Make the thickness as necessary

(1) Find the dimensions for the part [1] angle.

(a) Refer to Table 202/REPAIR 2 for the minimum thickness for the part [1] angle.

(b) Refer to Layout of the Repair Parts, Figure 201/REPAIR 2 for the maximum flange widths of the part [1] angle.

(c) Calculate the total cross-sectional area of the part [1] angle.

(2) Find the dimensions of the part [2] angle.

(a) Refer to Table 202/REPAIR 2 for the minimum thickness for the part [2] angle.

NOTE: Find the thickness of the part [2] angle together with the thicknesses of the part [1] and [3] angles. The sum of the thicknesses of these angles must be larger than the sum of the thickness of the initial extruded section multiplied by the repair material factor.

(b) Make the width of the flanges of the part [2] angle equal to or less than the flange widths of the part [1] angle. Refer to Layout of the Repair Parts, Figure 201/REPAIR 2.

(c) Calculate the total cross-sectional area of the part [2] angle.

(3) Find the dimensions of the part [3] angle.

(a) Find the thickness for the part [3] angle.

1) Measure the fastener spacing of the initial extruded section at a location that is adjacent to the damage.

2) Find the minimum thickness of the part [3] angle from Table 203/REPAIR 2.

Table 203:

MINIMUM THICKNESS FOR THE PART [3] ANGLE	
FASTENER SPACING IN INITIAL EXTRUDED SECTION (INCHES)	MINIMUM THICKNESS FOR THE PART [3] ANGLE (INCHES)
Up to 0.75	0.050
0.76 to 0.84	0.056
0.85 to 0.94	0.063
0.95 to 1.06	0.071
1.07 to 1.20	0.080
1.21 to 1.35	0.090
1.36 to 1.50	0.100
1.51 to 1.68	0.112
1.69 to 1.77	0.125

(b) Make the width of the flanges of the part [3] angle equal to or less than the flange widths of the part [1] and part [2] angles. Refer to Layout of the Repair Parts, Figure 201/REPAIR 2.

(c) Calculate the total cross-sectional area of the part [3] angle.

(4) Make sure that the sum of the areas of the repair angles is equal to or larger than the minimum cross-sectional area that is necessary. If the sum of the areas of the repair parts is smaller, then increase the dimensions of the repair parts.

E. Find the minimum number of fasteners necessary on each side of the removed section to install the part [3] angle to the initial extruded section. Refer to Paragraph 6.C./REPAIR 2 for an example procedure.

(1) Measure the total section dimension of all parts of the initial extruded section. Refer to Layout of the Repair Parts, Figure 201/REPAIR 2 for the total section dimension to be measured.

(2) Refer to Table 204/REPAIR 2 for the number of repair fasteners for each inch of the total section dimension.

(a) Use the fasteners with the same diameter as the initial fasteners in the initial extruded section.

NOTE: If the hole is damaged, use a fastener that has a diameter 1/64 inch oversize as given in Table 205/REPAIR 2.

Table 204:

NUMBER OF FASTENERS FOR EACH INCH OF SECTION DIMENSION		
FASTENER DIAMETER (INCH)	**2024 INITIAL EXTRUDED SECTION**	**7075 INITIAL EXTRUDED SECTION**
5/32	5.0	5.3
3/16	4.2	4.4
1/4	3.1	3.3

Table 205:

REPAIR FASTENERS			
FASTENER TYPE	**HEAD STYLE**	**STANDARD SIZE**	**1/64 INCH DIAMETER OVERSIZE**
Hex-Drive Bolt	Protruding - Shear	Bolt: BACB30MY()K Collar: BACC30M	Bolt: BACB30MY()K()X Collar: BACC30M
Hex-Drive Bolt	Protruding - Tension	Bolt: BACB30NX()K Collar: BACC30X	Bolt: BACB30NX()K()X Collar: BACC30X
Hex-Drive Bolt	Flush - Shear	Bolt: BACB30NW()K Collar: BACC30M	Bolt: BACB30NW()K()X Collar: BACC30M
Hex-Drive Bolt	Flush - Tension	Bolt: BACB30NY()K Collar: BACC30X	Bolt: BACB30NY()K()X Collar: BACC30X

(3) Multiply the number of fasteners from Table 204/REPAIR 2 by the total section dimension measured.

(4) Divide this number of fasteners by the number of the rows. If the result is not a whole number, then use the subsequent higher whole number. Refer to Layout of the Repair Parts, Figure 201/REPAIR 2 for the location of these fasteners.

F. Add two more repair fasteners in each row on the part [1] and [2] angles. Refer to Layout of the Repair Parts, Figure 201/REPAIR 2 for the location of these fasteners.

G. Make the repair parts as shown in Layout of the Repair Parts, Figure 201/REPAIR 2.

(1) You can make the repair parts from:

(a) Sheet metal

(b) BAC1490 formed sections

(c) Extruded sections.

(2) Make the edges of the repair parts 125 microinches Ra or smoother.

(3) Make the repair parts so that there is a clearance between the radii of mating parts. Refer to 51-30-01 for the minimum bend radii for aluminum alloys.

NOTE: The outside radius of the inner repair angle must be greater than the inside radius of the adjacent part.

(4) Use a radius filler if necessary so that the fastener heads will not touch the bend radius.

H. Assemble the repair parts.

I. Drill the fastener holes.

J. Disassemble the repair parts.

K. Remove the nicks, scratches, gouges, burrs, and sharp edges from the repair parts and the initial extruded section. Refer to 51-10-02.

L. Apply a chemical conversion coating to the repair parts and the bare surfaces of the initial extruded section. Refer to 51-20-01.

M. Apply two layers of BMS 10-11, Type I primer to the repair parts. Refer to SOPM 20-41-02.

N. Install the repair parts with BMS 5-95 sealant between the mating surfaces. Refer to 51-20-05.

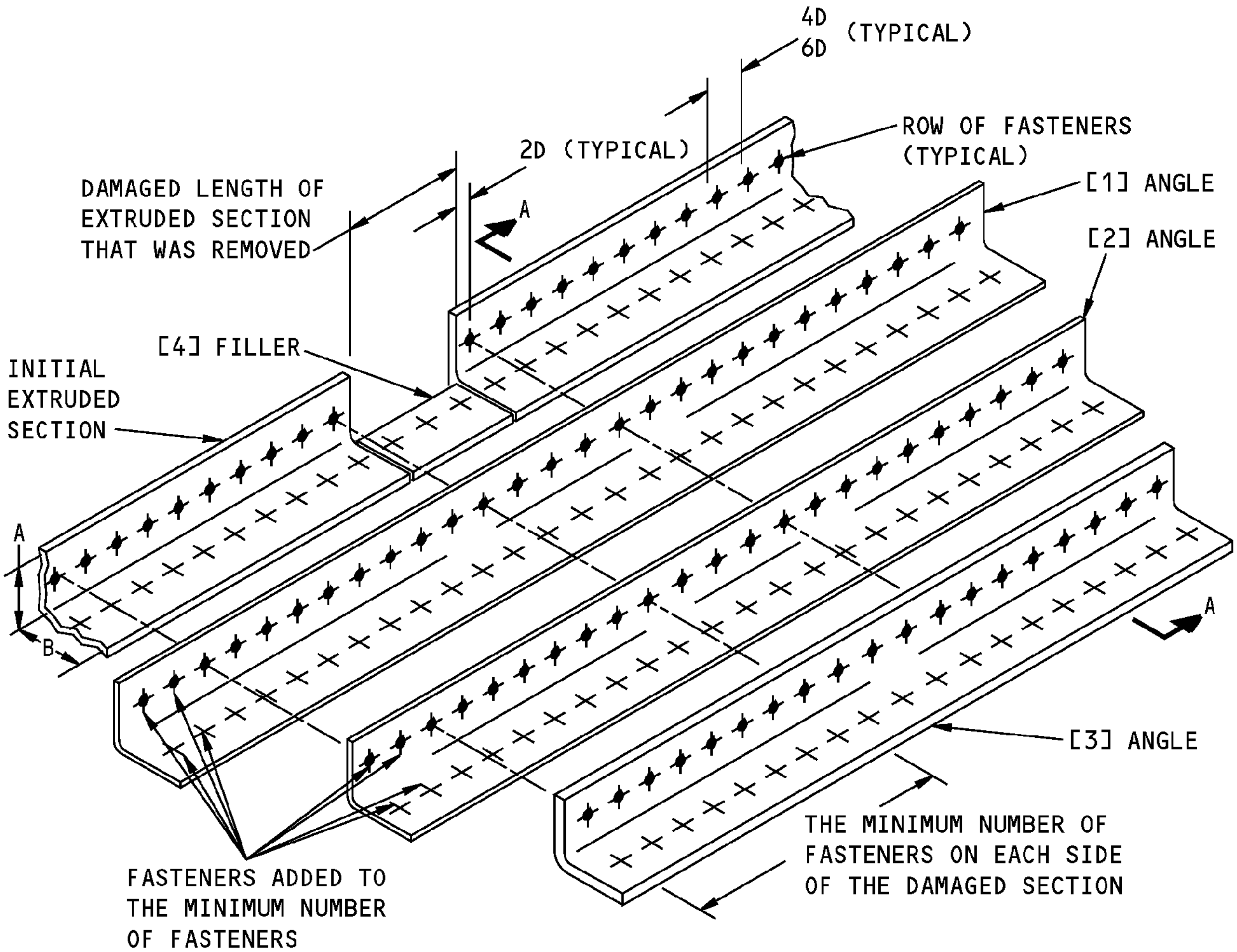
O. Install the fasteners.

(1) Install aluminum fasteners without sealant.

(2) Install non-aluminum fasteners wet with BMS 5-95 sealant. Refer to 51-20-05.

P. Fill the space between the parts with BMS 5-95 sealant if necessary.

Q. Apply the finish if necessary. Refer to AMM PAGEBLOCK 51-21-99/701.



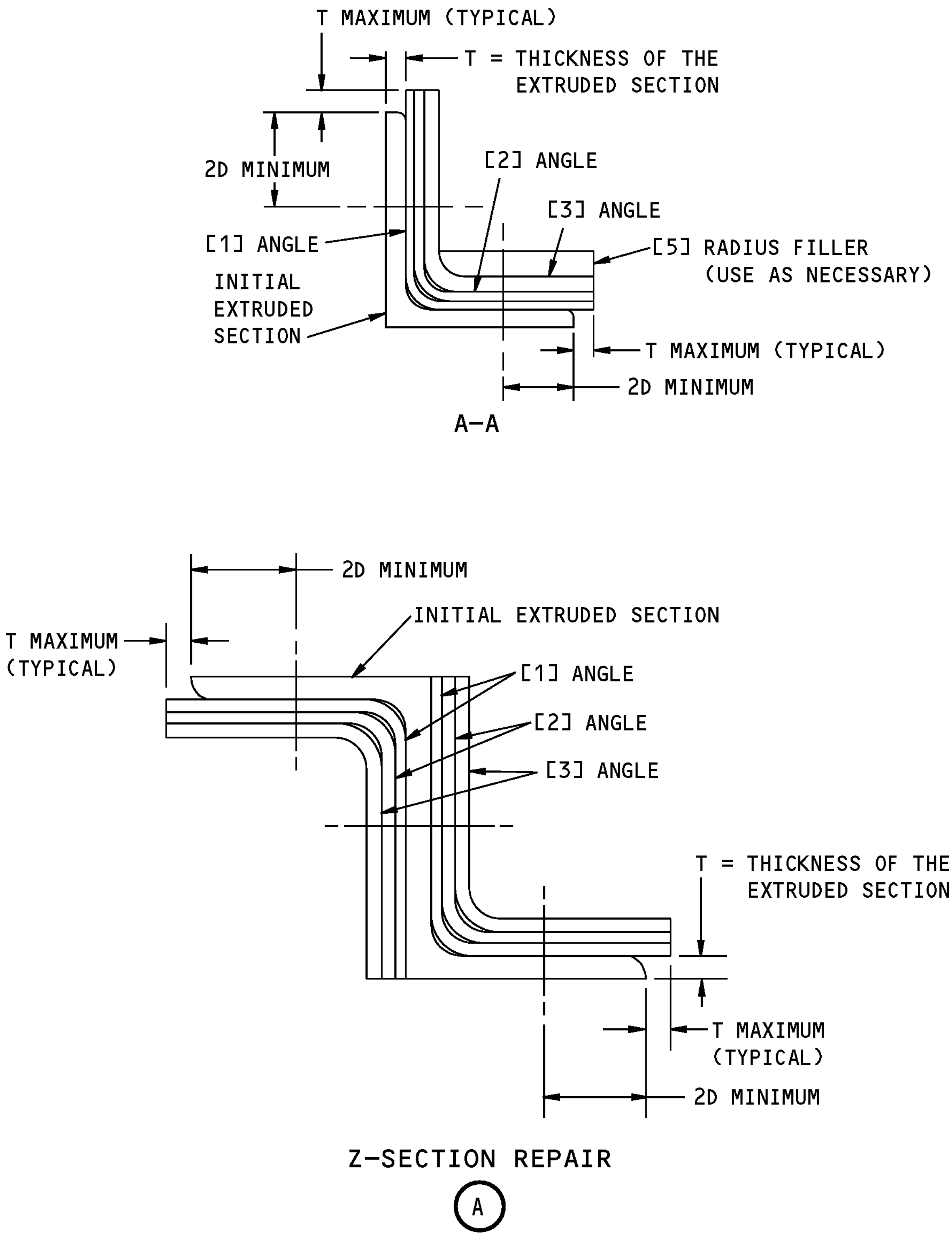
NOTE: A + B = TOTAL SECTION DIMENSION

TYPICAL EXTRUDED SECTION REPAIR

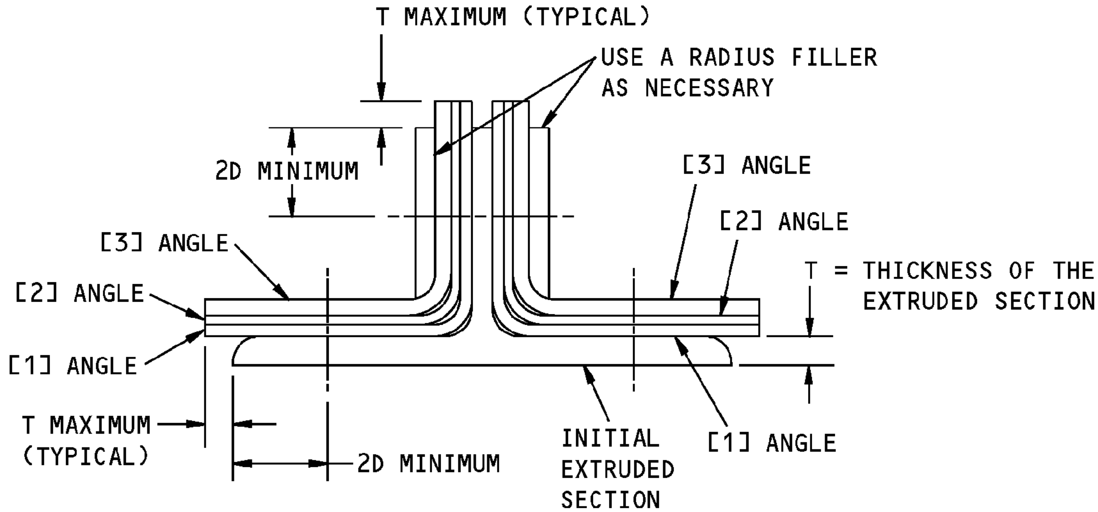
NOTES

- D = FASTENER DIAMETER
- CHANGE THE FASTENER PATTERN IF NECESSARY TO MAKE SURE THAT FASTENERS DO NOT TOUCH OTHER FASTENERS. THIS IS PERMITTED ONLY IF THE PATTERN AGREES WITH THE SPECIFIED DIMENSIONS.

Layout of the Repair Parts
Figure 201 (Sheet 1 of 3)

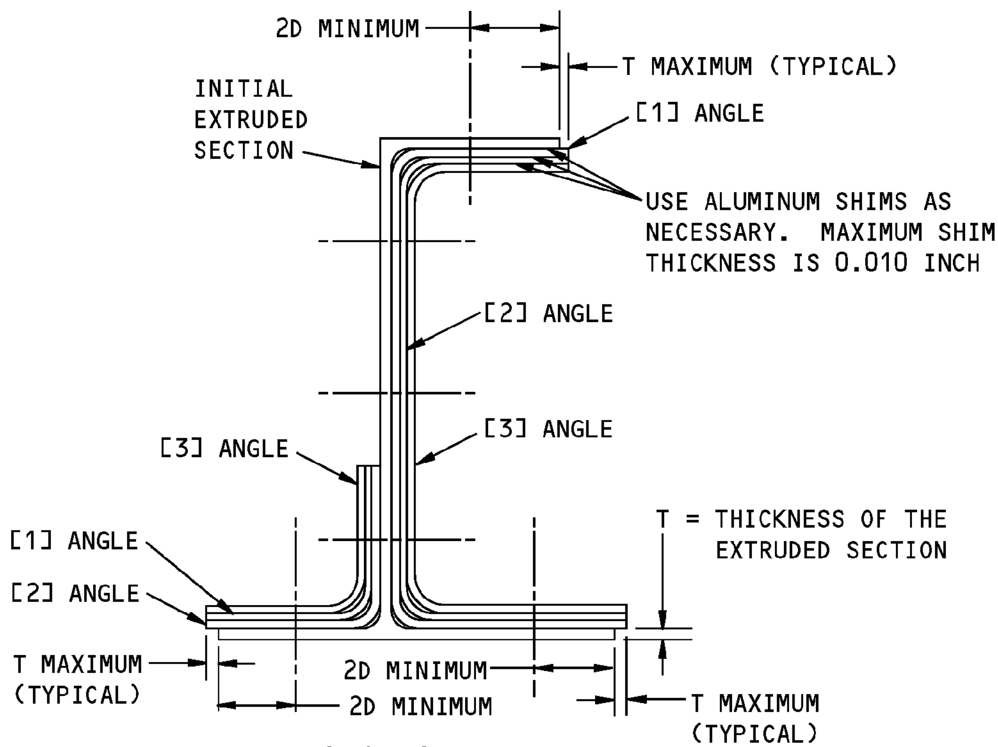


Layout of the Repair Parts
Figure 201 (Sheet 2 of 3)



T-SECTION REPAIR

B



J-SECTION REPAIR

C

Layout of the Repair Parts
Figure 201 (Sheet 3 of 3)

6. **Example Procedure to Calculate Areas and Fastener Quantity**

A. Calculate the total minimum cross-sectional area necessary for the repair parts. Refer to Examples for Extruded Section and Repair Angles, Figure 202/REPAIR 2, Detail A for the initial extruded section, and Examples for Extruded Section and Repair Angles, Figure 202/REPAIR 2, Detail B , Detail C , and Detail D for the repair parts.

(1) Calculate the total cross-sectional area of the initial extruded section.

(a) The width of the base flange is 2.00 inches.

(b) The width of the vertical flange is 1.50 inches.

(c) The thickness of the flanges are 0.125 inch.

(d) The radius is 0.16 inch.

(e) The cross-sectional area is: $(1.5 + 2.0) \times 0.125 - (0.125)^2 + [(4 - \pi) \times (0.16)^2] / 4 = 0.43$ square inch

(2) Find the applicable repair material and material factor in Table 201/REPAIR 2.

(a) The material for the repair parts will be made from a 2024-T3 clad sheet.

(b) The material factor for the 2024-T3 clad sheet is 1.25.

(3) Calculate the total minimum cross-sectional area of the repair parts.

(a) 0.43 square inch x 1.25 = 0.54 square inch.

B. Find the dimensions for the repair parts.

(1) Find the dimensions for the part [1] angle.

(a) Find the thickness for the part [1] angle. Refer to Table 202/REPAIR 2.

1) The thickness for the part [1] angle is given as 0.040 inch in Table 202/REPAIR 2.

(b) Find the width of each flange of the part [1] angle. Refer to Examples for Extruded Section and Repair Angles, Figure 202/REPAIR 2, Detail B for the maximum flange widths permitted.

1) 2.00 inches is selected as the width of the base flange.

2) 1.50 inches is selected as the width of the vertical flange.

(c) Find the inner bend radius of the part [1] angle. Refer to 51-30-01.

1) 0.16 inch is selected as the inner bend radius.

(d) Calculate the total cross-sectional area of the repair part [1] angle.

1) Area $= 0.040 \times [1.50 + 2.00 - (2 \times 0.16) - (2 \times 0.040)] + \pi \times [(2 \times 0.16 \times 0.040) + (0.040)^2] / 4 = 0.14$ square inch

(2) Find the dimensions for the part [2] angle.

(a) Find the thickness for the part [2] angle. Refer to Table 202/REPAIR 2.

1) 0.050 inch is selected as the thickness for the part [2] angle.

(b) Find the width of each flange of the part [2] angle. Refer to Examples for Extruded Section and Repair Angles, Figure 202/REPAIR 2, Detail C for the maximum flange widths permitted.

1) 1.96 inches is selected as the width of the base flange.

2) 1.46 inches is selected as the width of the vertical flange.

(c) Find the inner bend radius of the part [2] angle. Refer to 51-30-01.

1) 0.19 inch is selected as the inner bend radius.

(d) Calculate the total cross-sectional area of the repair part [2] angle.

1) Area = $0.050 \times [1.46 + 1.96 - (2 \times 0.19) - (2 \times 0.050)] + \pi \times [(2 \times 0.19 \times 0.050) + (0.050)^2] / 4 = 0.16$ square inch

(3) Find the dimensions for the part [3] angle.

(a) Find the thickness of the part [3] angle. Refer to Table 203/REPAIR 2.

1) For an initial fastener spacing of 0.75 inch, Table 203/REPAIR 2 gives the minimum thickness of the part [3] angle as 0.050 inch. However, 0.080 inch is selected to get the necessary repair cross section area.

(b) Find the width of each flange of the part [3] angle. Refer to Examples for Extruded Section and Repair Angles, Figure 202/REPAIR 2, Detail D for the maximum flange widths permitted.

1) 1.91 inches is selected as the width of the base flange.

2) 1.41 inches is selected as the width of the vertical flange.

(c) Find the inner bend radius of the part [3] angle. Refer to 51-30-01.

1) 0.34 inch is selected as the inner bend radius.

(d) Calculate the total cross-sectional area of the repair part [3] angle.

1) Area = $0.080 \times [1.41 + 1.91 - (2 \times 0.34) - (2 \times 0.080)] + \pi \times [(2 \times 0.34 \times 0.080) + (0.080)^2] / 4 = 0.25$ square inch

(4) Compare the sum of the areas of the repair parts with the minimum area that you calculated in Paragraph 6.A./REPAIR 2

(a) Calculate the sum of the cross-sectional areas of the part [1], part [2] and [3] angles.

1) Total Area = 0.14 + 0.16 + 0.25 = 0.55 square inch.

(b) Compare the sum of the cross-sectional areas with the minimum cross-sectional area.

1) The total area is 0.55 square inch which is larger than the minimum cross-sectional area of 0.54 square inch. Thus, the dimensions of the repair angles are sufficient.

C. Find the number of fasteners necessary on each side of the removed section to install the part [3] angle to the initial extruded section.

(1) Find the repair fastener diameter.

(a) 3/16 inch is selected as the repair fastener diameter same as the initial fasteners in the initial extruded section.

(2) Measure the total section dimension of the initial extruded section.

(a) The total section dimension which is the sum of the widths of the base and vertical angles is 3.50 inches. Refer to Examples for Extruded Section and Repair Angles, Figure 202/REPAIR 2, Detail A .

(3) The minimum number of fasteners necessary for 3/16 inch diameter fasteners is 4.2 as given in Table 204/REPAIR 2.

(4) Multiply the number of fasteners you found from Table 204/REPAIR 2 by the total section dimension measured.

(a) 4.2 fasteners for each inch x 3.5 inches = 14.7 fasteners.

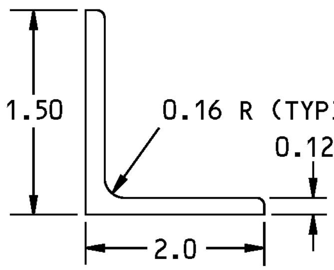
(5) Divide the number of fasteners by the number of the rows.

(a) There will be two rows of fasteners on the repair section. One row is on the base flange, the other row is on the vertical flange. Refer to Layout of the Repair Parts, Figure 201/REPAIR 2 for the location of these rows.

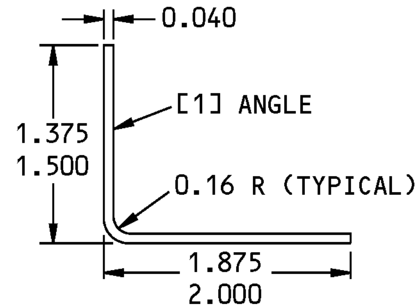
(b) 14.7 fasteners divided by 2 rows gives 7.35 fasteners in each row on each side.

(c) The subsequent whole number higher than 7.35 is 8.

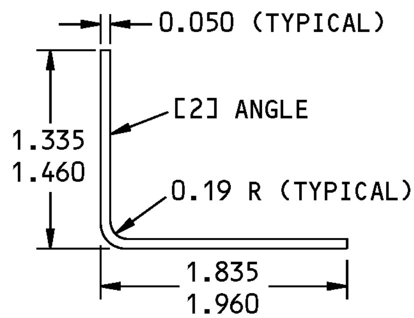
(d) Thus, use a minimum of 8 fasteners in each row on each side of the removed section to fasten the part [3] angle. Use 10 fasteners on each side of the [2] angle and 12 fasteners on each side of the [1] angle.



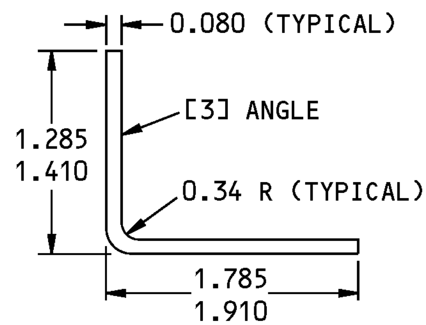
EXAMPLE OF AN EXTRUDED SECTION
A



EXAMPLE OF A PART [1] ANGLE
B



EXAMPLE OF A PART [2] ANGLE
C



EXAMPLE OF A PART [3] ANGLE
D

Examples for Extruded Section and Repair Angles
Figure 202

7. Inspection Instructions

A. For airplanes that have completed Service Bulletin 737-21-1149, follow the inspection requirements as given below. The inspections as given below do not apply for airplanes that have not completed Service Bulletin 737-21-1149.

B. Refer to Table 206 for the inspection requirements. Table 206 is only applicable to Principal Structural Elements (PSE's). Refer to 51-00-04 for all Principal Structural Elements (PSE's). Supplemental inspections are not necessary for non-Principal Structural Elements.

Table 206:

CATEGORY B REPAIR INSPECTION REQUIREMENTS			
INSPECTION THRESHOLD	REPEAT INSPECTION ALTERNATIVES		
	METHOD	INTERVAL	REFERENCE
22,500 flight cycles	See note below	See note below	

NOTE: Contact The Boeing Company in 30 days or less after you install this repair to receive installation specific inspection methods and intervals. An assessment is necessary from The Boeing Company to review a complete technical description of the actual installation.

REPAIR 1 - TYPICAL WEB REPAIR - REPAIR OF DAMAGE TO THE CENTER AREA OF A WEB

1. Applicability

A. Repair 1 is applicable to damage to the center area of a web.

B. Refer to Repair 2 for damage to a small area of the web from one chord to another chord.

C. Refer to Repair 3 for damage from the center area of a web to one of the chords.

D. Refer to Repair 4 for a splice repair for a large area of the web, from one chord to the other chord.

E. Repair 1 is not applicable to:
- Bulkhead webs at Body Stations 178, 540, 663.75, 727, 1016, 1088, and 1156
- Center and outer wing spar and rib webs
- Beaded pressure webs
- Webs in horizontal and vertical stabilizers
- Machined webs that are part of chords.

F. For airplanes that have completed Service Bulletin 737-21-1149, contact The Boeing Company if the damage is 20 inches (508 mm) or less away from the edge of a door or access cutout

G. For airplanes that have completed Service Bulletin 737-21-1149, if the damage is 10 inches (254 mm) or less away from the edge of an existing repair then:

(1) Remove the existing repair and make one repair that includes the two areas of damage.

2. General

A. Repair 1 can be used along with the typical formed or extruded section repairs that are given in 51-70-11 and 51-70-12.

(1) For approved chord repairs, refer to 51-70-11 and 51-70-12.

B. This repair does not apply to machined webs where the web and the chords are one part.

C. Maintain a minimum of 6 inches between the edge of the chord repair parts and the edge of the web repair parts.

D. For airplanes that have completed Service Bulletin 737-21-1149, Repair 1 is a Category B repair. Refer to STRUCTURAL REPAIR DEFINITIONS, PAGEBLOCK 51-00-06, GENERAL for the definitions of the different categories of repairs. Refer to Paragraph 5 for the Inspection Instructions.

3. References

Reference	Title
51-00-04	STRUCTURAL CLASSIFICATION
51-00-06, GENERAL	Structural Repair Definitions
51-00-06, GENERAL P/B GENERAL	STRUCTURAL REPAIR DEFINITIONS
51-10-01, GENERAL	Aerodynamic Smoothness Requirements
51-20-01	PROTECTIVE TREATMENT OF METALLIC AND COMPOSITE MATERIALS
51-20-05	REPAIR SEALING
51-30-01	SHEET METAL MATERIALS
51-40-02, GENERAL	Fastener Installation and Removal
51-70-11	TYPICAL FORMED SECTION REPAIRS
51-70-12	EXTRUDED SECTION REPAIRS
AMM 34-23-00	Aircraft Maintenance Manual

(Continued)

Reference	Title
AMM 51-21-00/701	Interior And Exterior Finishes - Cleaning/Painting
SOPM 20-41-02	Application of Chemical and Solvent Resistant Finishes

4. **Repair Instructions**

A. Cut and remove the damaged part of the web.

(1) Use care so you do not cause damage to the structure adjacent to the damage.

(2) Make the corner radii of the cut a minimum of 0.50 inch.

(3) Make the cut edges smooth with a surface finish of 63 microinches Ra.

B. Make the part [1] doubler. Refer to Repair 1 - Layout of the Repair Parts, Figure 201/REPAIR 1 and Table 201.

Table 201:

REPAIR MATERIAL			
ITEM	**PART**	**QUANTITY**	**MATERIAL**
[1]	Doubler	1	Use material that is the same alloy and one gage thicker than the initial web
[2]	Shim	1	Use material that is the same alloy as the initial web. Use a thickness that is necessary to fill the gap between the initial web and the part [1] doubler

(1) Use the same alloy as the initial web. Use clad (recommended) or bare material.

C. Put the part [1] doubler in position.

D. Drill the fastener holes. Refer to Figure 202 for the fastener and fastener hole data.

E. Remove the repair part.

F. Remove all the nicks, scratches, burrs, and sharp edges from the initial structure and the part [1] doubler.

G. Make a 0.01 inch to 0.03 inch chamfer on the edges of the part [1] doubler.

H. Apply a chemical conversion coating to the part [1] doubler and the bare edges of the initial web. Refer to 51-20-01.

I. Apply two layers of BMS 10-11, Type I primer to the part [1] doubler and the bare edges of the initial web. Refer to SOPM 20-41-02.

NOTE: For webs that are in or at a fuel cell, apply one layer of BMS 10-20, Type II primer. Refer to AMM 51-21-00/701.

J. Apply BMS 5-95 sealant to the mating surfaces. Refer to 51-20-05.

NOTE: For fuel areas, apply BMS 5-26 sealant. For high temperature areas, apply BMS 5-63 sealant.

K. Install the part [1] doubler.

(1) If an edge of the repair is less than 2.0 feet from a standby compass, do not install fasteners made of steel. For the locations and requirements of a standby compass, refer to AMM 34-23-00.

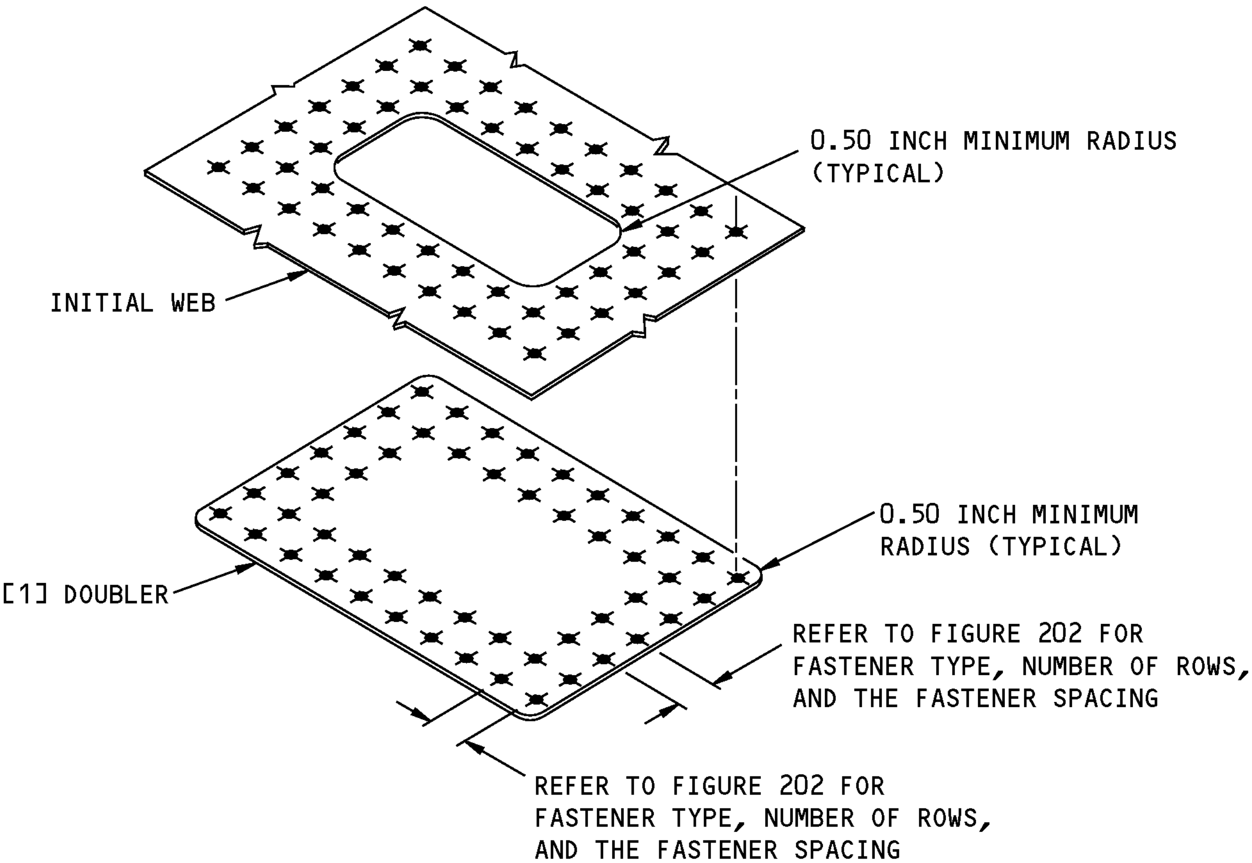
(2) For fuel areas, install the fasteners wet with BMS 5-26 sealant. Refer to 51-20-05.

(3) In areas other than the fuel areas, install non-aluminum fasteners wet with BMS 5-95 sealant.

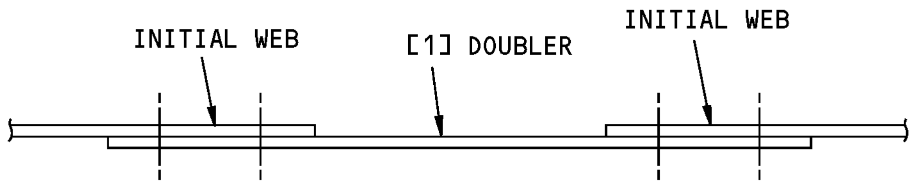
(4) For chem-milled webs, it is recommended that you install the part [1] doubler on the side that is opposite the chem-milled area.

(5) If you must install the part [1] doubler on the chem-milled side, put the part [2] shim between the part [1] doubler and the initial web to make the surface flat. Refer to Repair 1 - Layout of the Repair Parts, Figure 201/REPAIR 1. Refer to 51-30-01 for instructions for the use of shims.

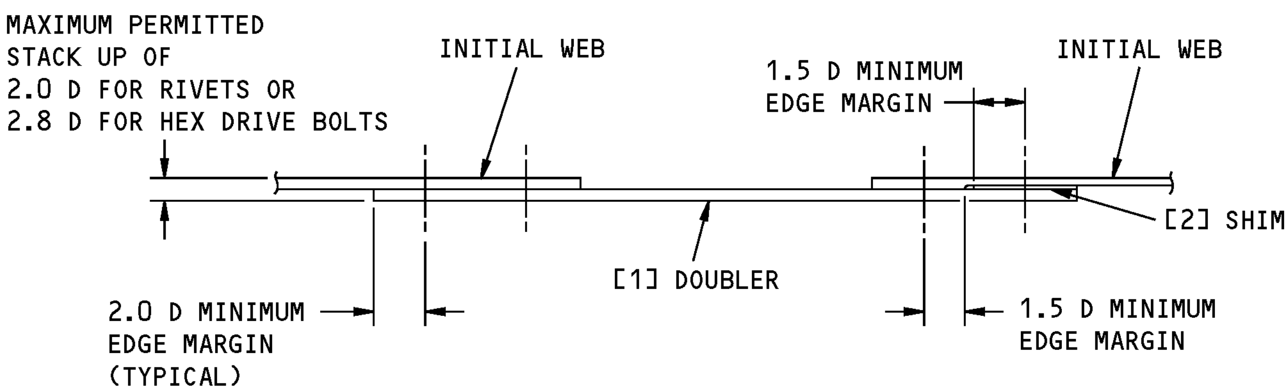
L. Apply the finish to the repair area. Use the same finish that was used on the initial structure. Refer to AMM 51-21-00/701.



Repair 1 - Layout of the Repair Parts
Figure 201 (Sheet 1 of 2)



SECTION THROUGH THE REPAIR OF A NON-CHEM-MILLED WEB



NOTE: D = DIAMETER

SECTION THROUGH THE REPAIR OF A CHEM-MILLED WEB

Repair 1 - Layout of the Repair Parts
Figure 201 (Sheet 2 of 2)

GAGE OF THE INITIAL WEB		INITIAL WEB MATERIAL [5]							
		2024-T3							
		TYPE OF FASTENERS							
		RIVETS [1] [3]					BOLTS [2]		
		1/8	5/32	3/16	1/4	5/16	3/16	1/4	5/16
0.020	NECESSARY ROWS								
	SPACING MIN								
	SPACING MAX								
0.022	NECESSARY ROWS								
	SPACING MIN								
	SPACING MAX								
0.025	NECESSARY ROWS	1							
	SPACING MIN	0.43							
	SPACING MAX	0.58							
0.028	NECESSARY ROWS	1							
	SPACING MIN	0.43							
	SPACING MAX	0.54							
0.032	NECESSARY ROWS	1	1						
	SPACING MIN	0.43	0.54						
	SPACING MAX	0.53	0.66						
0.036	NECESSARY ROWS	1	1						
	SPACING MIN	0.43	0.54						
	SPACING MAX	0.51	0.63						
0.040	NECESSARY ROWS	1	1	1					
	SPACING MIN	0.43	0.54	0.65					
	SPACING MAX	0.46	0.61	0.74					
0.045	NECESSARY ROWS	2	1	1					
	SPACING MIN	0.43	0.54	0.65					
	SPACING MAX	0.80	0.60	0.72					
0.050	NECESSARY ROWS	2	1	1	1				
	SPACING MIN	0.43	0.54	0.65	0.86				
	SPACING MAX	0.70	0.55	0.70	0.94				

Repair 1 - Fastener Data
Figure 202 (Sheet 1 of 5)

GAGE OF THE INITIAL WEB		INITIAL WEB MATERIAL [5]							
		2024-T3							
		TYPE OF FASTENERS							
		RIVETS [1] [3]					BOLTS [2]		
		1/8	5/32	3/16	1/4	5/16	3/16	1/4	5/16
0.056	NECESSARY ROWS	2	2	1	1				
	SPACING MIN MAX	0.43 0.60	0.54 0.94	0.65 0.67	0.86 0.90				
0.063	NECESSARY ROWS	2	2	2	1	1			
	SPACING MIN MAX	0.43 0.52	0.54 0.80	0.65 1.15	0.86 0.88	1.07 1.09			
0.071	NECESSARY ROWS		2	2	2	1	2		
	SPACING MIN MAX		0.54 0.70	0.65 1.00	0.86 1.70	1.07 1.07	0.65 1.28		
0.080	NECESSARY ROWS		2	2	2	2	2	2	
	SPACING MIN MAX		0.54 0.60	0.65 0.86	0.86 1.50	1.07 2.04	0.65 1.22	0.86 1.62	
0.090	NECESSARY ROWS			2	2	2	2	2	
	SPACING MIN MAX			0.65 0.72	0.86 1.30	1.07 1.98	0.65 1.18	0.86 1.58	
0.100	NECESSARY ROWS			3	2	2	2	2	2
	SPACING MIN MAX			0.89 1.05	1.17 1.25	1.47 1.92	0.89 1.25	1.17 1.68	1.47 2.08
0.112	NECESSARY ROWS			3	3	2	2	2	2
	SPACING MIN MAX			0.89 0.94	1.17 1.67	1.47 1.74	0.89 1.25	1.17 1.67	1.47 2.08
0.125	NECESSARY ROWS				3	2	2	2	2
	SPACING MIN MAX				1.17 1.50	1.47 1.56	0.89 1.22	1.17 1.67	1.47 2.08

Repair 1 - Fastener Data
Figure 202 (Sheet 2 of 5)

GAGE OF THE INITIAL WEB		INITIAL WEB MATERIAL [5]							
		7075-T6							
		TYPE OF FASTENERS							
		RIVETS [1] [4]					BOLTS [2]		
		1/8	5/32	3/16	1/4	5/16	3/16	1/4	5/16
0.020	NECESSARY ROWS	1	1						
	SPACING MIN MAX	0.41 0.59	0.51 0.74						
0.022	NECESSARY ROWS	1	1						
	SPACING MIN MAX	0.41 0.57	0.51 0.72						
0.025	NECESSARY ROWS	1	1						
	SPACING MIN MAX	0.41 0.56	0.51 0.70						
0.028	NECESSARY ROWS	1	1						
	SPACING MIN MAX	0.41 0.55	0.51 0.67						
0.032	NECESSARY ROWS	1	1	1					
	SPACING MIN MAX	0.41 0.53	0.51 0.66	0.62 0.80					
0.036	NECESSARY ROWS	1	1	1					
	SPACING MIN MAX	0.41 0.45	0.51 0.63	0.62 0.77					
0.040	NECESSARY ROWS	2	1	1	1				
	SPACING MIN MAX	0.41 0.80	0.51 0.62	0.62 0.75	0.82 1.00				
0.045	NECESSARY ROWS	2	1	1	1				
	SPACING MIN MAX	0.41 0.68	0.51 0.52	0.62 0.72	0.62 1.00				
0.050	NECESSARY ROWS	2	2	1	1				
	SPACING MIN MAX	0.41 0.58	0.51 0.92	0.62 0.66	0.82 0.89				

Repair 1 - Fastener Data
Figure 202 (Sheet 3 of 5)

GAGE OF THE INITIAL WEB		INITIAL WEB MATERIAL [5]							
		7075-T6							
		TYPE OF FASTENERS							
		RIVETS [1] [4]					BOLTS [2]		
		1/8	5/32	3/16	1/4	5/16	3/16	1/4	5/16
0.056	NECESSARY ROWS			2	1		1	1	
	SPACING MIN			0.62	0.82		0.62	0.82	
	SPACING MAX			1.14	0.89		0.67	0.90	
0.063	NECESSARY ROWS			2	1	1	1	1	
	SPACING MIN			0.62	0.82	1.02	0.62	0.82	
	SPACING MAX			0.94	0.84	1.05	0.64	0.90	
0.071	NECESSARY ROWS			2	2	1	2	1	
	SPACING MIN			0.62	0.82	1.02	0.62	0.82	
	SPACING MAX			0.82	1.48	1.04	1.24	0.90	
0.080	NECESSARY ROWS			2	2	2	2	1	
	SPACING MIN			0.62	0.82	1.02	0.62	0.82	
	SPACING MAX			0.70	1.27	1.02	1.20	0.90	
0.090	NECESSARY ROWS			2	2	2	2	1	
	SPACING MIN			0.62	0.82	1.02	0.62	0.82	
	SPACING MAX			0.62	1.10	1.70	1.17	0.90	
0.100	NECESSARY ROWS				3	3	2	2	2
	SPACING MIN				1.34	1.68	1.02	1.34	1.68
	SPACING MAX				1.47	2.30	1.04	1.36	1.82
0.112	NECESSARY ROWS				3	3	3	2	2
	SPACING MIN				1.34	1.68	1.02	1.34	1.68
	SPACING MAX				1.34	2.05	1.46	1.34	1.82
0.125	NECESSARY ROWS					3	3	2	2
	SPACING MIN					1.68	1.02	1.34	1.68
	SPACING MAX					1.84	1.69	1.34	1.70

Repair 1 - Fastener Data
Figure 202 (Sheet 4 of 5)

1 USE BACR15BB(*)D(*)C, BACR15FT(*)D(*), OR MS20470D(*) RIVETS

2 USE BACB30VT(*)K HEX DRIVE BOLTS WITH BACC30BL(*) COLLARS

3 AS AN ALTERNATIVE FOR BACR15BB(*)DD(*) RIVETS, IT IS PERMITTED TO USE BACR15BB(*)D(*)C RIVETS IN THIN 2024-T3 WEBS AS FOLLOWS:

- UP TO AN INITIAL WEB THICKNESS OF 0.045 FOR 5/32 RIVETS
- UP TO AN INITIAL WEB THICKNESS OF 0.050 FOR 3/16 RIVETS
- UP TO AN INITIAL WEB THICKNESS OF 0.063 FOR 1/4 RIVETS

4 AS AN ALTERNATIVE FOR BACR15BB(*)DD(*) RIVETS, IT IS PERMITTED TO USE BACR15BB(*)D(*)C RIVETS IN THIN 7075-T6 WEBS AS FOLLOWS:

- UP TO AN INITIAL WEB THICKNESS OF 0.036 FOR 5/32 RIVETS
- UP TO AN INITIAL WEB THICKNESS OF 0.045 FOR 3/16 RIVETS
- UP TO AN INITIAL WEB THICKNESS OF 0.056 FOR 1/4 RIVETS

5 THIS FASTENER DATA IS APPLICABLE TO AIRPLANES THAT HAVE NOT COMPLETED SERVICE BULLETIN 737-21-1149.

Repair 1 - Fastener Data
Figure 202 (Sheet 5 of 5)

GAGE OF THE INITIAL WEB		INITIAL WEB MATERIAL 2024-T3 TYPE OF FASTENERS							
		RIVETS [1] [3]					BOLTS [2]		
		1/8	5/32	3/16	1/4	5/16	3/16	1/4	5/16
0.020	NECESSARY ROWS								
	SPACING MIN / MAX								
0.022	NECESSARY ROWS								
	SPACING MIN / MAX								
0.025	NECESSARY ROWS	2							
	SPACING MIN / MAX	0.43 / 0.58							
0.028	NECESSARY ROWS	2							
	SPACING MIN / MAX	0.43 / 0.54							
0.032	NECESSARY ROWS	2	2						
	SPACING MIN / MAX	0.43 / 0.53	0.54 / 0.66						
0.036	NECESSARY ROWS	2	2						
	SPACING MIN / MAX	0.43 / 0.51	0.54 / 0.63						
0.040	NECESSARY ROWS	2	2	2					
	SPACING MIN / MAX	0.43 / 0.46	0.54 / 0.61	0.65 / 0.74					
0.045	NECESSARY ROWS	2	2	2					
	SPACING MIN / MAX	0.43 / 0.80	0.54 / 0.60	0.65 / 0.72					
0.050	NECESSARY ROWS	2	2	2	2				
	SPACING MIN / MAX	0.43 / 0.70	0.54 / 0.55	0.65 / 0.70	0.86 / 0.94				

Fastener Data If You Have Completed Service Bulletin 737-21-1149
Figure 203 (Sheet 1 of 5)

GAGE OF THE INITIAL WEB		INITIAL WEB MATERIAL 2024-T3 — TYPE OF FASTENERS							
		RIVETS [1] [3]					BOLTS [2]		
		1/8	5/32	3/16	1/4	5/16	3/16	1/4	5/16
0.056	NECESSARY ROWS	2	2	2	2				
	SPACING MIN	0.43	0.54	0.65	0.86				
	SPACING MAX	0.60	0.94	0.67	0.90				
0.063	NECESSARY ROWS	2	2	2	2	2			
	SPACING MIN	0.43	0.54	0.65	0.86	1.07			
	SPACING MAX	0.52	0.80	1.15	0.88	1.09			
0.071	NECESSARY ROWS		2	2	2	2	2		
	SPACING MIN		0.54	0.65	0.86	1.07	0.65		
	SPACING MAX		0.70	1.00	1.70	1.07	1.28		
0.080	NECESSARY ROWS		2	2	2	2	2	2	
	SPACING MIN		0.54	0.65	0.86	1.07	0.65	0.86	
	SPACING MAX		0.60	0.86	1.50	2.04	1.22	1.62	
0.090	NECESSARY ROWS			2	2	2	2	2	
	SPACING MIN			0.65	0.86	1.07	0.65	0.86	
	SPACING MAX			0.72	1.30	1.98	1.18	1.58	
0.100	NECESSARY ROWS			2	2	2	2	2	2
	SPACING MIN			0.89	1.17	1.47	0.89	1.17	1.47
	SPACING MAX			1.05	1.25	1.92	1.25	1.68	2.08
0.112	NECESSARY ROWS			2	2	2	2	2	2
	SPACING MIN			0.89	1.17	1.47	0.89	1.17	1.47
	SPACING MAX			0.94	1.67	1.74	1.25	1.67	2.08
0.125	NECESSARY ROWS				2	3	2	2	2
	SPACING MIN				1.17	1.47	0.89	1.17	1.47
	SPACING MAX				1.50	1.56	1.22	1.67	2.08

Fastener Data If You Have Completed Service Bulletin 737-21-1149
Figure 203 (Sheet 2 of 5)

GAGE OF THE INITIAL WEB		INITIAL WEB MATERIAL							
		7075-T6							
		TYPE OF FASTENERS							
		RIVETS [1] [4]					BOLTS [2]		
		1/8	5/32	3/16	1/4	5/16	3/16	1/4	5/16
0.020	NECESSARY ROWS	1	2						
	SPACING MIN MAX	0.41 0.59	0.51 0.74						
0.022	NECESSARY ROWS	1	2						
	SPACING MIN MAX	0.41 0.57	0.51 0.72						
0.025	NECESSARY ROWS	1	2						
	SPACING MIN MAX	0.41 0.56	0.51 0.70						
0.028	NECESSARY ROWS	1	2						
	SPACING MIN MAX	0.41 0.55	0.51 0.67						
0.032	NECESSARY ROWS	1	2	2					
	SPACING MIN MAX	0.41 0.53	0.51 0.66	0.62 0.80					
0.036	NECESSARY ROWS	1	2	2					
	SPACING MIN MAX	0.41 0.45	0.51 0.63	0.62 0.77					
0.040	NECESSARY ROWS	2	2	2	1				
	SPACING MIN MAX	0.41 0.80	0.51 0.62	0.62 0.75	0.82 1.00				
0.045	NECESSARY ROWS	2	2	2	1				
	SPACING MIN MAX	0.41 0.68	0.51 0.52	0.62 0.72	0.62 1.00				
0.050	NECESSARY ROWS	2	2	2	1				
	SPACING MIN MAX	0.41 0.58	0.51 0.92	0.62 0.66	0.82 0.89				

Fastener Data If You Have Completed Service Bulletin 737-21-1149
Figure 203 (Sheet 3 of 5)

GAGE OF THE INITIAL WEB		INITIAL WEB MATERIAL 7075-T6 — TYPE OF FASTENERS							
		RIVETS [1] [4]					BOLTS [2]		
		1/8	5/32	3/16	1/4	5/16	3/16	1/4	5/16
0.056	NECESSARY ROWS			2	1		2	1	
	SPACING MIN			0.62	0.82		0.62	0.82	
	SPACING MAX			1.14	0.89		0.67	0.90	
0.063	NECESSARY ROWS			2	2	2	2	1	
	SPACING MIN			0.62	0.82	1.02	0.62	0.82	
	SPACING MAX			0.94	0.84	1.05	0.64	0.90	
0.071	NECESSARY ROWS			2	2	2	2	1	
	SPACING MIN			0.62	0.82	1.02	0.62	0.82	
	SPACING MAX			0.82	1.48	1.04	1.24	0.90	
0.080	NECESSARY ROWS			2	2	2	2	1	
	SPACING MIN			0.62	0.82	1.02	0.62	0.82	
	SPACING MAX			0.70	1.27	1.02	1.20	0.90	
0.090	NECESSARY ROWS			2	2	2	2	1	
	SPACING MIN			0.62	0.82	1.02	0.62	0.82	
	SPACING MAX			0.62	1.10	1.70	1.17	0.90	
0.100	NECESSARY ROWS				2	2	2	2	2
	SPACING MIN				1.34	1.68	1.02	1.34	1.68
	SPACING MAX				1.47	2.30	1.04	1.36	1.82
0.112	NECESSARY ROWS				2	2	3	2	2
	SPACING MIN				1.34	1.68	1.02	1.34	1.68
	SPACING MAX				1.34	2.05	1.46	1.34	1.82
0.125	NECESSARY ROWS					3	3	2	2
	SPACING MIN					1.68	1.02	1.34	1.68
	SPACING MAX					1.84	1.69	1.34	1.70

Fastener Data If You Have Completed Service Bulletin 737-21-1149
Figure 203 (Sheet 4 of 5)

1 USE BACR15BB(*)D(*)C, BACR15FT(*)D(*), OR MS20470D(*) RIVETS

2 USE BACB30VT(*)K HEX DRIVE BOLTS WITH BACC30BL(*) COLLARS

3 AS AN ALTERNATIVE FOR BACR15BB(*)DD(*) RIVETS, IT IS PERMITTED TO USE BACR15BB(*)D(*)C RIVETS IN THIN 2024-T3 WEBS AS FOLLOWS:

- UP TO AN INITIAL WEB THICKNESS OF 0.045 FOR 5/32 RIVETS
- UP TO AN INITIAL WEB THICKNESS OF 0.050 FOR 3/16 RIVETS
- UP TO AN INITIAL WEB THICKNESS OF 0.063 FOR 1/4 RIVETS.

4 AS AN ALTERNATIVE FOR BACR15BB(*)DD(*) RIVETS, IT IS PERMITTED TO USE BACR15BB(*)D(*)C RIVETS IN THIN 7075-T6 WEBS AS FOLLOWS:

- UP TO AN INITIAL WEB THICKNESS OF 0.036 FOR 5/32 RIVETS
- UP TO AN INITIAL WEB THICKNESS OF 0.045 FOR 3/16 RIVETS
- UP TO AN INITIAL WEB THICKNESS OF 0.056 FOR 1/4 RIVETS.

Fastener Data If You Have Completed Service Bulletin 737-21-1149
Figure 203 (Sheet 5 of 5)

5. Inspection Instructions

A. Inspections as given below are only applicable to airplanes that have completed Service Bulletin 737-21-1149. The inspections as given below do not apply to airplanes that have not completed Service Bulletin 737-21-1149.

B. Refer to Table 202 for the inspection requirements. Table 202 is only applicable to Principal Structural Elements (PSE's). Refer to 51-00-04 for all Principal Structural Elements (PSE's). Supplemental inspections are not necessary for non-Principal Structural Elements.

Table 202:

CATEGORY B REPAIR INSPECTION REQUIREMENTS			
INSPECTION THRESHOLD	REPEAT INSPECTION ALTERNATIVES		
	METHOD	INTERVAL	REFERENCE
22,500 flight cycles	See note below	See note below	

NOTE: Contact The Boeing Company in 30 days or less after you install this repair to receive installation specific inspection methods and intervals. An assessment is necessary from The Boeing Company to review a complete technical description of the actual installation.

REPAIR 2 - TYPICAL WEB REPAIR - REPAIR OF DAMAGE TO THE WEB FROM CHORD TO CHORD

1. **Applicability**

   A. Repair 2 is applicable for damage to a small area of the web from one chord to another chord.

   B. Refer to Repair 1 for damage to the center area of a web.

   C. Refer to Repair 3 for damage from the center area of a web to one of the chords.

   D. Refer to Repair 4 for a splice repair for a large area of the web, from one chord to the other chord.

   E. Repair 2 is not applicable to:
   - Bulkhead webs at Body Stations 178, 540, 663.75, 727, 1016, 1088, and 1156
   - Center and outer wing spar and rib webs
   - Beaded pressure webs
   - Webs in horizontal and vertical stabilizers
   - Machined webs that are part of chords.

   F. For airplanes that have completed Service Bulletin 737-21-1149, contact The Boeing Company if the damage is 20 inches (508 mm) or less away from the edge of a door or access cutout.

   G. For airplanes that have completed Service Bulletin 737-21-1149, if the damage is 10 inches (254 mm) or less away from the edge of an existing repair then:

      (1) Remove the existing repair and make one repair that includes the two areas of damage.

2. **General**

   A. Repair 2 can be used along with the typical formed or extruded section repairs that are given in 51-70-11 and 51-70-12.

      (1) For approved chord repairs, refer to 51-70-11 and 51-70-12.

   B. This repair does not apply to machined webs where the web and the chords are one part.

   C. Keep a minimum of 6 inches between the edge of the chord repair parts and the edge of the web repair parts.

   D. For airplanes that have completed Service Bulletin 737-21-1149, Repair 2 is a Category B repair. Refer to STRUCTURAL REPAIR DEFINITIONS, PAGEBLOCK 51-00-06, GENERAL for the definitions of the different categories of repairs. Refer to Paragraph 5 for the Inspection Instructions.

3. **References**

Reference	Title
51-00-04	STRUCTURAL CLASSIFICATION
51-00-06, GENERAL	Structural Repair Definitions
51-00-06, GENERAL P/B GENERAL	STRUCTURAL REPAIR DEFINITIONS
51-10-01, GENERAL	Aerodynamic Smoothness Requirements
51-20-01	PROTECTIVE TREATMENT OF METALLIC AND COMPOSITE MATERIALS
51-20-05	REPAIR SEALING
51-30-01	SHEET METAL MATERIALS
51-40-02, GENERAL	Fastener Installation and Removal
51-70-11	TYPICAL FORMED SECTION REPAIRS
51-70-12	EXTRUDED SECTION REPAIRS

(Continued)

Reference	Title
AMM 34-23-00	Aircraft Maintenance Manual
AMM 51-21-00/701	Interior And Exterior Finishes - Cleaning/Painting
SOPM 20-41-02	Application of Chemical and Solvent Resistant Finishes

4. **Repair Instructions**

A. Cut and remove the damaged part of the web.

(1) Use care so you do not cause damage to the structure adjacent to the damage.

(2) Make the corner radii of the cut a minimum of 0.50 inch.

(3) Make the cut edges smooth with a surface finish of 63 microinches Ra.

B. Make the repair parts. Refer to Repair 2 - Layout of the Repair Parts, Figure 201/REPAIR 2 and Table 201.

(1) Use the same alloy as the initial web. Use clad (recommended) or bare material.

(2) For webs that are less than 0.071 inch thick:

(a) Make the part [1] doubler as shown in Repair 2 - Layout of the Repair Parts, Figure 201/REPAIR 2, Detail A .

(b) Make the part [2] tapered filler if an initial fastener is in the area of the joggle.

(3) For webs that are 0.071 inch and thicker:

(a) Make the part [1] doubler as shown in Repair 2 - Layout of the Repair Parts, Figure 201/REPAIR 2, Detail B .

(b) If the web is thicker than 20 percent of the rivet diameter or 25 percent of the hex drive bolt diameter, make the part [3] filler a structural shim. Refer to 51-30-01.

Table 201:

REPAIR MATERIAL			
ITEM	PART	QUANTITY	MATERIAL
[1]	Doubler	1	Use the same material as the initial web that is one gage thicker
[2]	Tapered Filler (Refer to Figure 201, Detail A)	4	Use the same material as the initial web
[3]	Filler or Structural Shim (Refer to Figure 201, Detail B)	2	Use the same material and thickness as the initial web

C. Put the part [1] doubler and the filler in position.

D. Drill the fastener holes. Refer to Repair 1, Figure 202 for the fastener and fastener hole data.

E. Remove the repair parts.

F. Remove all the nicks, scratches, burrs, and sharp edges from the initial structure and the repair parts.

G. Apply a chemical conversion coating to the repair parts and the cut edges of the initial web. Refer to 51-20-01.

H. Apply two layers of BMS 10-11, Type I primer to the part [1] doubler and the bare edges of the initial web. Refer to SOPM 20-41-02.

NOTE: For webs that are in or at a fuel cell, apply one layer of BMS 10-20, Type II primer. Refer to AMM 51-21-00/701.

I. Apply BMS 5-95 sealant to the mating surfaces. Refer to 51-20-05.

NOTE: For fuel areas, apply BMS 5-26 sealant. For high temperature areas, apply BMS 5-63 sealant.

J. Install the repair parts

(1) If an edge of the repair is less than 2.0 feet from a standby compass, do not install fasteners made of steel. For the locations and requirements of a standby compass, refer to AMM 34-23-00.

(2) For fuel areas, install the fasteners wet with BMS 5-26 sealant. Refer to 51-20-05.

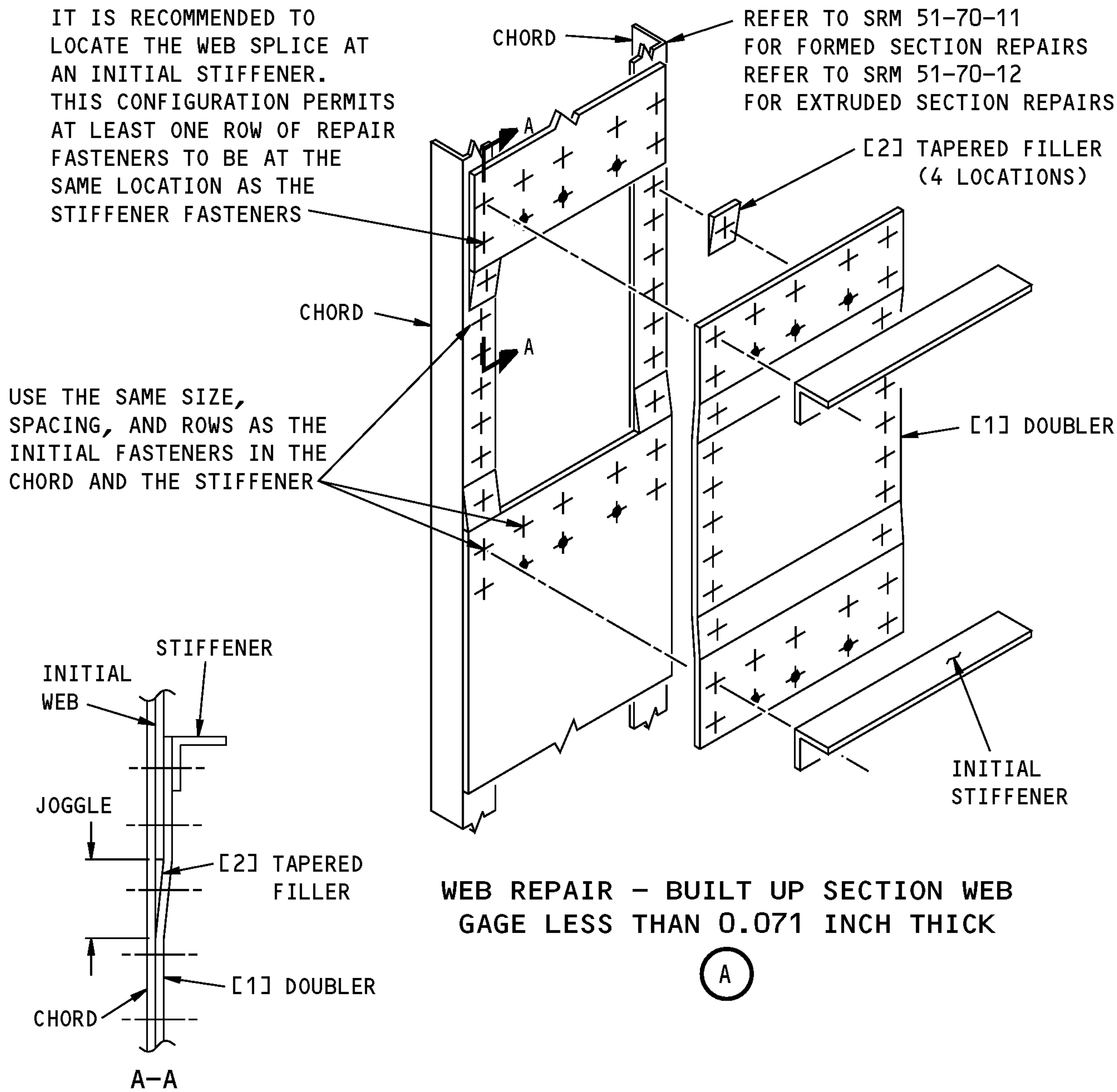
(3) In areas other than the fuel areas, install non-aluminum fasteners wet with BMS 5-95 sealant.

(4) For chem-milled webs, it is recommended that you install the part [1] doubler on the side that is opposite the chem-milled area.

(5) If you must install the part [1] doubler on the chem-milled side, put the part [3] shim between the part [1] doubler and the initial web to make the surface flat. Refer to Repair 2 - Layout of the Repair Parts, Figure 201/REPAIR 2. Refer to 51-30-01 for instructions for the use of shims.

(6) Keep an edge margin of at least two times the fastener diameter for all fastener locations.

K. Apply the finish to the repair area. Use the same finish that was used on the initial structure. Refer to AMM 51-21-00/701.

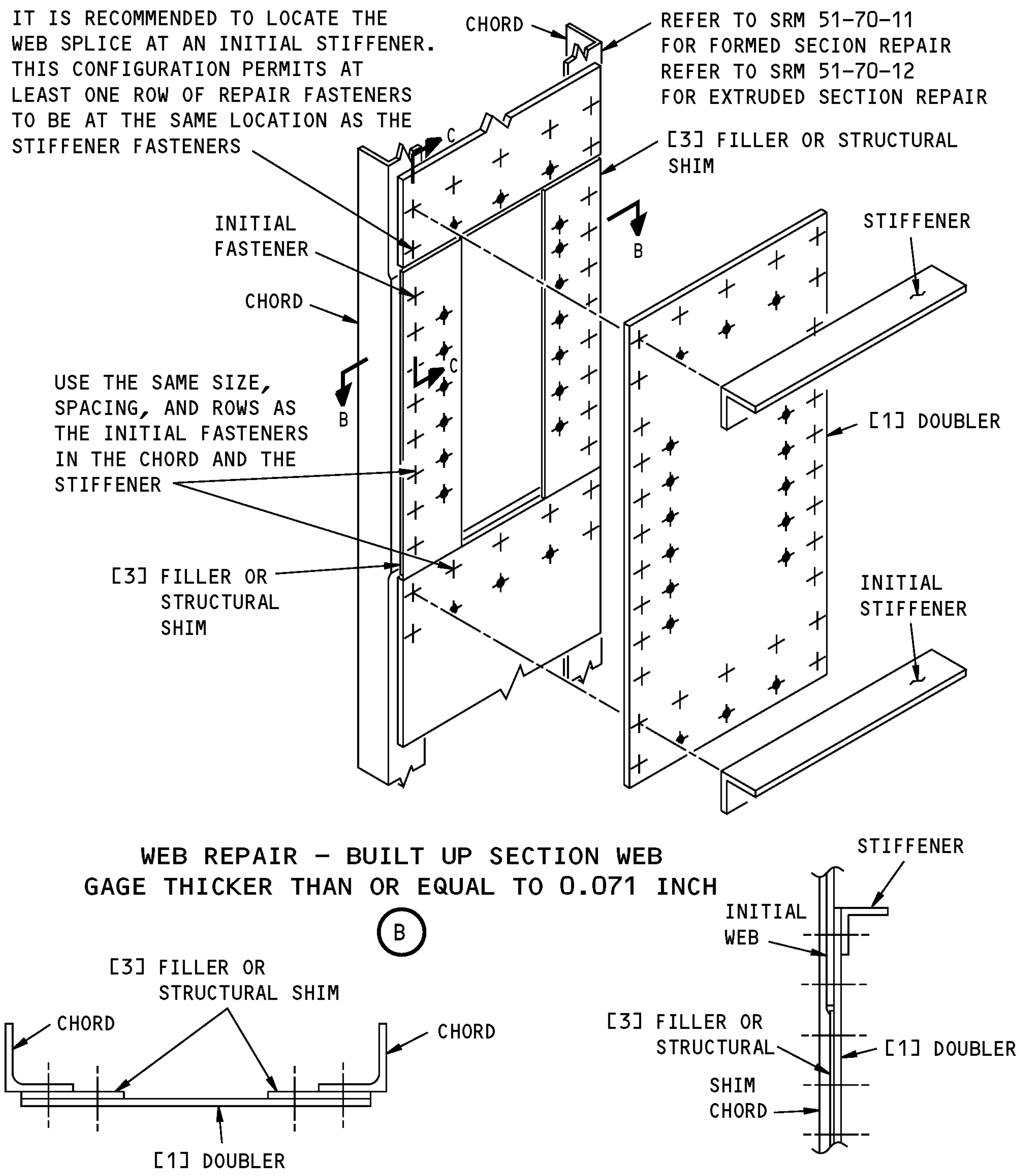


FASTENER SYMBOLS

+ INITIAL FASTENER LOCATION. USE THE INITIAL FASTENER SIZE AND TYPE OR APPROVED SUBSTITUTE FASTENER. 1/32 OVERSIZING FOR RIVETS AND 1/64 OVERSIZING TO HI-LOKS IS PERMITTED.

⌖ REPAIR FASTENER LOCATION. REFER TO FIGURE 202 OF REPAIR 1 FOR THE FASTENER SPACING. USE THE SAME SIZE AND TYPE AS THE INITIAL FASTENERS IN THE CHORD AND THE STIFFENER.

Repair 2 - Layout of the Repair Parts
Figure 201 (Sheet 1 of 2)



Repair 2 - Layout of the Repair Parts
Figure 201 (Sheet 2 of 2)

5. **Inspection Instructions**

A. Inspections as given below are applicable to airplanes that have completed Service Bulletin 737-21-1149. The inspections as given below are not applicable to airplanes that have not completed Service Bulletin 737-21-1149.

B. Refer to Table 202 for the inspection requirements. Table 202 is only applicable to Principal Structural Elements (PSE's). Refer to 51-00-04 for all Principal Structural Elements (PSE's). Supplemental inspections are not necessary for non-Principal Structural Elements.

Table 202:

CATEGORY B REPAIR INSPECTION REQUIREMENTS			
INSPECTION THRESHOLD	REPEAT INSPECTION ALTERNATIVES		
	METHOD	INTERVAL	REFERENCE
22,500 flight cycles	See note below	See note below	

NOTE: Contact The Boeing Company in 30 days or less after you install this repair to receive installation specific inspection methods and intervals. An assessment is necessary from The Boeing Company to review a complete technical description of the actual installation.

REPAIR 3 - TYPICAL WEB REPAIR - REPAIR OF DAMAGE TO THE CENTER AREA OF A WEB AND ONE CHORD

1. **Applicability**

   A. Repair 3 is applicable for damage from the center area of a web and one of the chords.

   B. Refer to Repair 1 for damage to the center area of a web.

   C. Refer to Repair 2 for damage to a small area of the web from one chord to another chord.

   D. Refer to Repair 4 for a splice repair for a large area of the web, from one chord to the other chord.

   E. Repair 3 is not applicable to:

   - Bulkhead webs at Body Stations 178, 540, 663.75, 727, 1016, 1088, and 1156
   - Center and outer wing spar and rib webs
   - Beaded pressure webs
   - Webs in horizontal and vertical stabilizers
   - Machined webs that are part of chords.

   F. For airplanes that have completed Service Bulletin 737-21-1149, contact The Boeing Company if the damage is 20 inches (508 mm) or less away from the edge of a door or access cutout.

   G. For airplanes that have completed Service Bulletin 737-21-1149, if the damage is 10 inches (254 mm) or less away from the edge of an existing repair then:

   (1) Remove the existing repair and make one repair that includes the two areas of damage.

2. **General**

   A. Repair 3 can be used along with the typical formed or extruded section repairs that are given in 51-70-11 and 51-70-12.

   (1) For approved chord repairs, refer to 51-70-11 and 51-70-12.

   B. This repair does not apply to machined webs where the web and the chords are one part.

   C. Maintain a minimum of 6 inches between the edge of the chord repair parts and the edge of the web repair parts.

   D. For airplanes that have completed Service Bulletin 737-21-1149, Repair 3 is a Category B repair. Refer to STRUCTURAL REPAIR DEFINITIONS, PAGEBLOCK 51-00-06, GENERAL for the definitions of the different categories of repairs. Refer to Paragraph 5 for the Inspection Instructions.

3. **References**

Reference	Title
51-00-04	STRUCTURAL CLASSIFICATION
51-00-06, GENERAL	Structural Repair Definitions
51-00-06, GENERAL P/B GENERAL	STRUCTURAL REPAIR DEFINITIONS
51-10-01, GENERAL	Aerodynamic Smoothness Requirements
51-20-01	PROTECTIVE TREATMENT OF METALLIC AND COMPOSITE MATERIALS
51-20-05	REPAIR SEALING
51-30-01	SHEET METAL MATERIALS
51-40-02, GENERAL	Fastener Installation and Removal
51-70-11	TYPICAL FORMED SECTION REPAIRS
51-70-12	EXTRUDED SECTION REPAIRS

(Continued)

Reference	Title
AMM 34-23-00	Aircraft Maintenance Manual
AMM 51-21-00/701	Interior And Exterior Finishes - Cleaning/Painting
SOPM 20-41-02	Application of Chemical and Solvent Resistant Finishes

4. **Repair Instructions**

A. Cut and remove the damaged part of the web.

(1) Use care so you do not cause damage to the structure adjacent to the damage.

(2) Make the corner radii of the cut a minimum of 0.50 inch.

(3) Make the cut edges smooth with a surface finish of 63 microinches Ra.

B. Make the repair parts. Refer to Repair 3 - Layout of the Repair Parts, Figure 201/REPAIR 3 and Table 201.

(1) Use the same alloy as the initial web. Use clad (recommended) or bare material.

Table 201:

REPAIR MATERIAL			
ITEM	**PART**	**QUANTITY**	**MATERIAL**
[1]	Doubler	1	Use the same material as the initial web that is one gage thicker
[2]	Filler	1	Use the same material that is the same thickness as the part [1] doubler. For a non-structural shim, the filler thickness must be less than or equal to 20 percent of the rivet diameter or 25 percent of the hex drive bolt diameter
[3]	Shim	1	Use material that is the same alloy as the initial web. Use a thickness that is necessary to fill the gap between the initial web and the part [1] doubler

C. Put the part [1] doubler and the part [2] filler in position.

D. Drill the fastener holes. Refer to Repair 1, Figure 202 for the additional fastener hole data for airplanes that have completed Service Bulletin 737-21-1149.

E. Drill the fastener holes. Refer to Repair 1, Figure 202 for the fastener and fastener hole data for airplanes that have not completed Service Bulletin 737-21-1149.

F. Remove the repair parts.

G. Remove all the nicks, scratches, burrs, and sharp edges from the initial structure and the repair parts.

H. Apply a chemical conversion coating to the repair parts and the cut edges of the initial web. Refer to 51-20-01.

I. Apply two layers of BMS 10-11, Type I primer to the part [1] doubler and the bare edges of the initial web. Refer to SOPM 20-41-02.

NOTE: For webs that are in or at a fuel cell, apply one layer of BMS 10-20, Type II primer. Refer to AMM 51-21-00/701.

J. Apply BMS 5-95 sealant to the mating surfaces. Refer to 51-20-05.

NOTE: For fuel areas, apply BMS 5-26 sealant. For high temperature areas, apply BMS 5-63 sealant.

K. Install the repair parts

(1) If an edge of the repair is less than 2.0 feet from a standby compass, do not install fasteners made of steel. For the locations and requirements of a standby compass, refer to AMM 34-23-00.

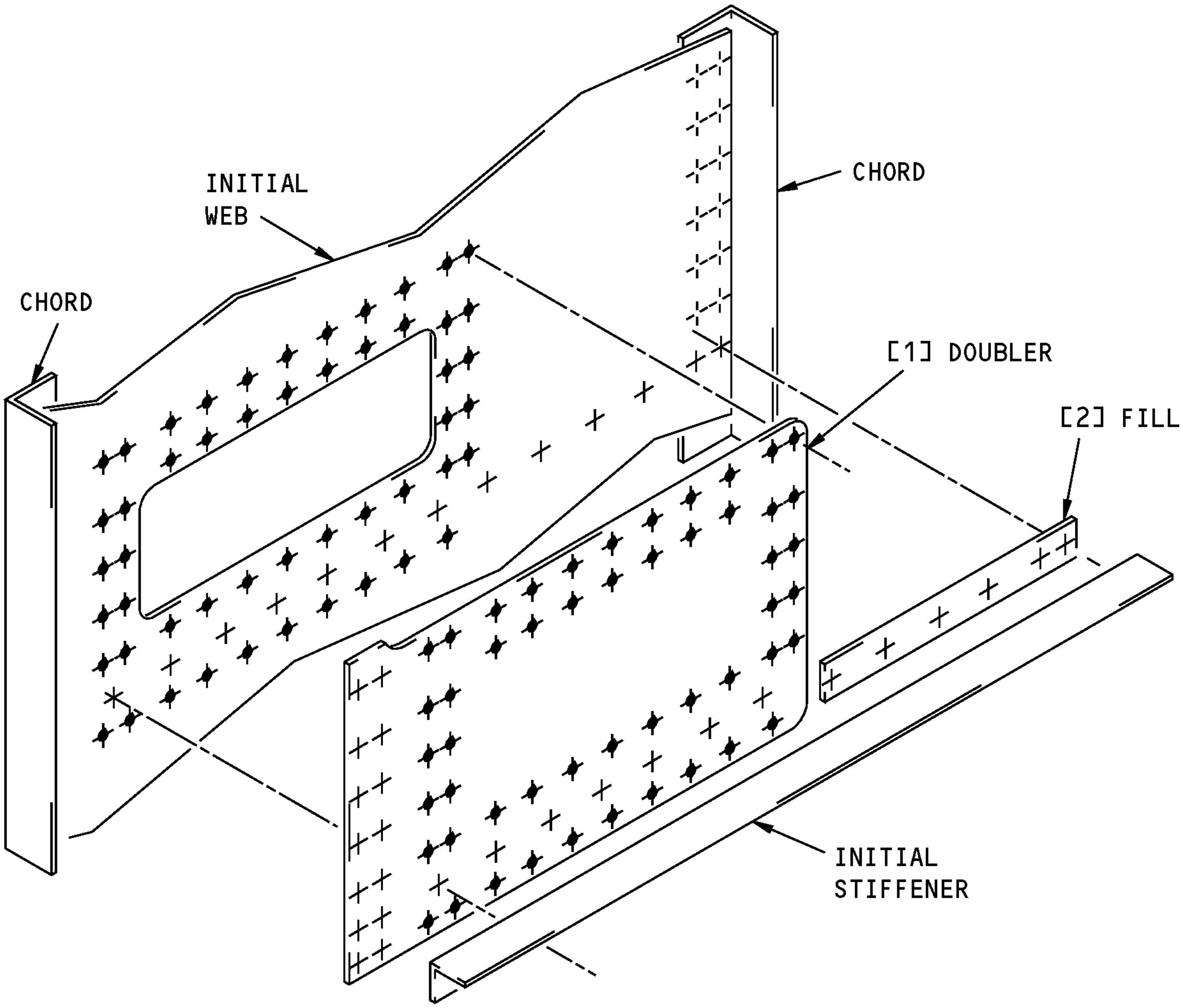
(2) For fuel areas, install the fasteners wet with BMS 5-26 sealant. Refer to 51-20-05.

(3) For areas other than fuel areas, install non-aluminum fasteners wet with BMS 5-95 sealant.

(4) For chem-milled webs, it is recommended that you install the part [1] doubler on the side that is opposite the chem-milled area.

(5) If you must install the part [1] doubler on the chem-milled side, put the part [3] shim between the part [1] doubler and the initial web to make the surface flat. Refer to Repair 3 - Layout of the Repair Parts, Figure 201/REPAIR 3. Refer to 51-30-01 for instructions for the use of shims.

L. Apply the finish to the repair area. Use the same finish that was used on the initial structure. Refer to AMM 51-21-00/701.



NOTES

- D = THE FASTENER DIAMETER
- SEE DETAIL A FOR THE INSTALLED REPAIR

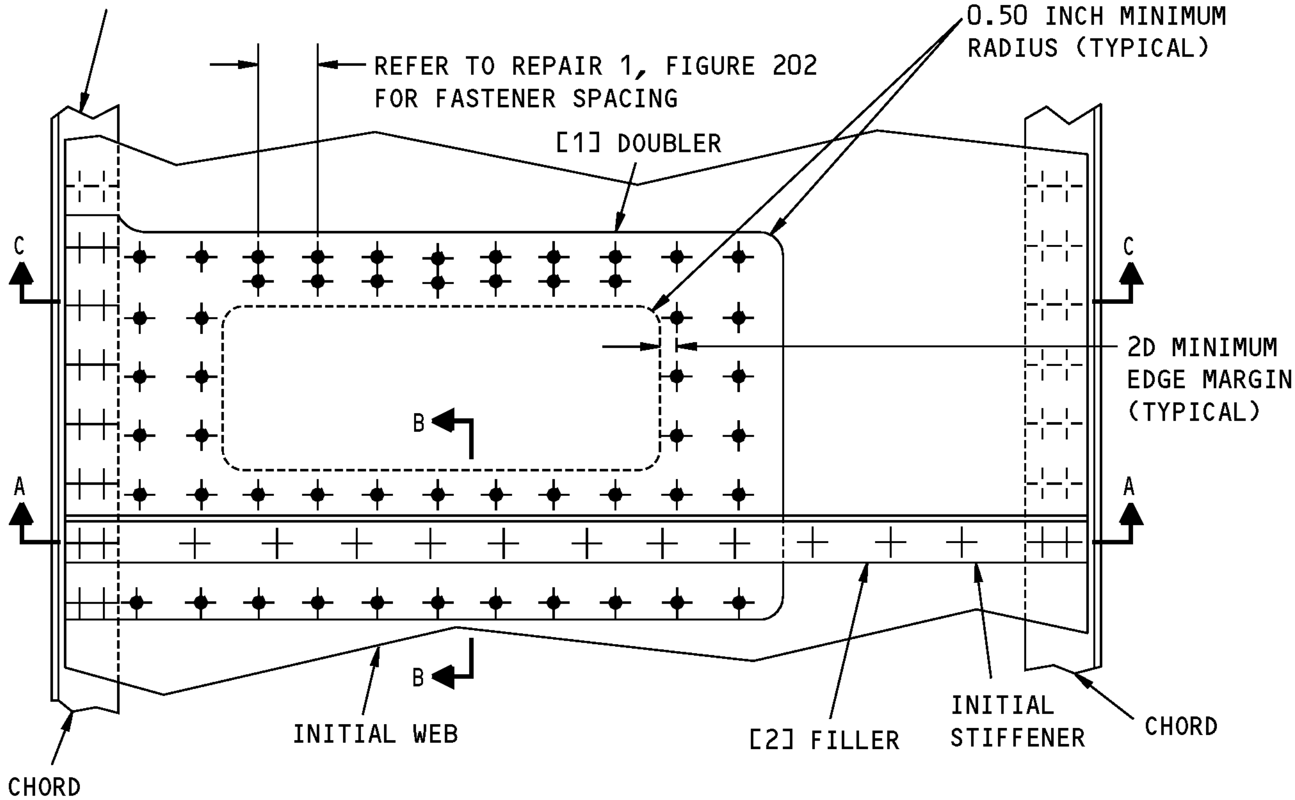
FASTENER SYMBOLS

-¦- REFERENCE FASTENER LOCATION.

+ INITIAL FASTENER LOCATION. USE THE INITIAL FASTENER SIZE AND TYPE OR APPROVED SUBSTITUTE FASTENER. 1/32 OVERSIZING FOR RIVETS AND 1/64 OVERSIZING TO HI-LOKS IS PERMITTED.

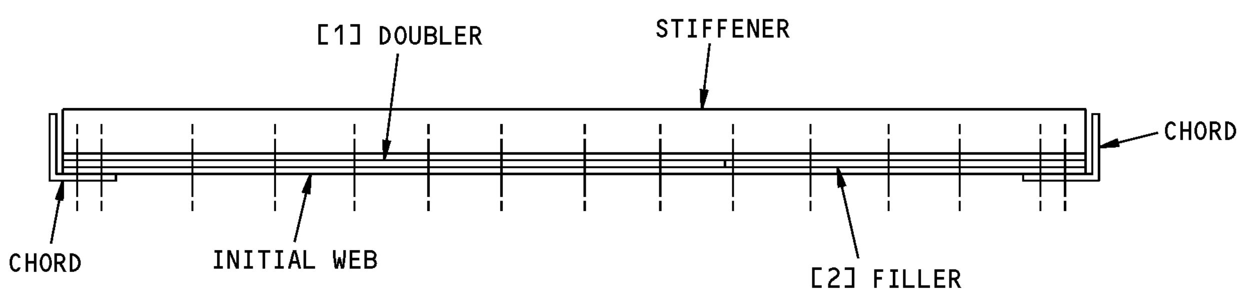
◆ REPAIR FASTENER LOCATION. REFER TO FIGURE 202 OF REPAIR 1 FOR THE FASTENER SPACING. USE THE SAME SIZE AND TYPE AS THE INITIAL FASTENERS IN THE CHORD AND THE STIFFENER.

Repair 3 - Layout of the Repair Parts
Figure 201 (Sheet 1 of 3)



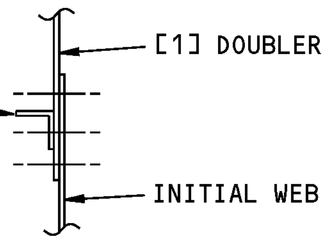
INSTALLED REPAIR (PLAN VIEW)

A

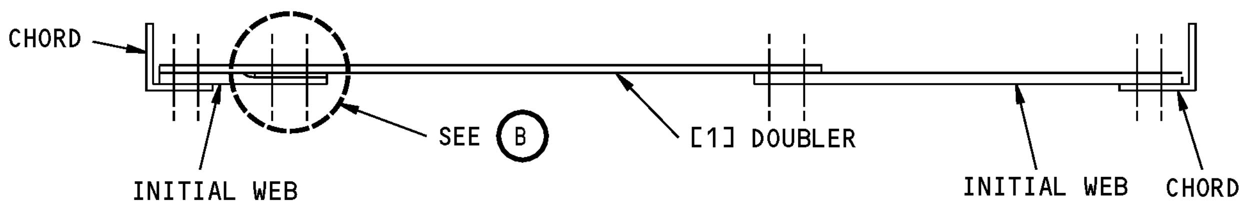


A-A

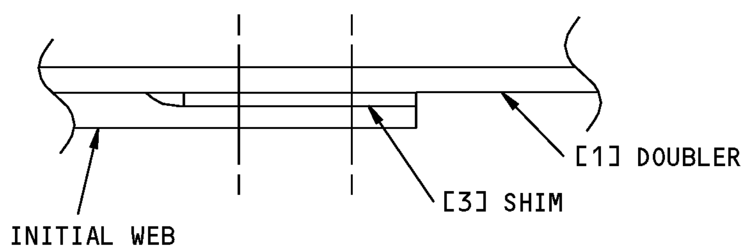
Repair 3 - Layout of the Repair Parts
Figure 201 (Sheet 2 of 3)



B-B



C-C



B

Repair 3 - Layout of the Repair Parts
Figure 201 (Sheet 3 of 3)

5. **Inspection Instructions**

A. Inspections as given below are applicable to airplanes that have completed Service Bulletin 737-21-1149. Inspections as given below are not applicable to airplanes that have not completed Service Bulletin 737-21-1149.

B. Refer to Table 202 for the inspection requirements. Table 202 is only applicable to Principal Structural Elements (PSE's). Refer to 51-00-04 for all Principal Structural Elements (PSE's). Supplemental inspections are not necessary for non-Principal Structural Elements.

Table 202:

CATEGORY B REPAIR INSPECTION REQUIREMENTS			
INSPECTION THRESHOLD	REPEAT INSPECTION ALTERNATIVES		
	METHOD	INTERVAL	REFERENCE
22,500 flight cycles	See note below	See note below	

NOTE: Contact The Boeing Company in 30 days or less after you install this repair to receive installation specific inspection methods and intervals. An assessment is necessary from The Boeing Company to review a complete technical description of the actual installation.

REPAIR 4 - TYPICAL WEB REPAIR - SPLICE REPAIR OF THE WEB FROM CHORD TO CHORD

1. Applicability

A. Repair 4 is applicable as a splice repair for a large area of the web, from one chord to the other chord.

B. Refer to Repair 1 for damage to the center area of a web.

C. Refer to Repair 2 for damage to a small area of the web from one chord to the other chord.

D. Refer to Repair 3 for damage from the center area of a web to one of the chords.

E. Repair 4 is not applicable to:

- Bulkhead webs at Body Stations 178, 540, 663.75, 727, 1016, 1088, and 1156
- Center and outer wing spar and rib webs
- Beaded pressure webs
- Webs in horizontal and vertical stabilizers
- Machined webs that are part of chords.

F. For airplanes that have completed Service Bulletin 737-21-1149, contact The Boeing Company if the damage is 20 inches (508 mm) or less away from the edge of a door or access cutout.

G. For airplanes that have completed Service Bulletin 737-21-1149, If the damage is 10 inches (254 mm) or less away from the edge of an existing repair then:

(1) Remove the existing repair and make one repair that includes the two areas of damage.

2. General

A. Repair 4 can be used along with the typical formed or extruded section repairs that are given in 51-70-11 and 51-70-12.

(1) For approved chord repairs, refer to 51-70-11 and 51-70-12.

B. This repair does not apply to machined webs where the web and the chords are one part.

C. Keep a minimum of 6 inches between the edge of the chord repair parts and the edge of the web repair parts.

D. For airplanes that have completed Service Bulletin 737-21-1149, Repair 4 is a Category B repair. Refer to STRUCTURAL REPAIR DEFINITIONS, PAGEBLOCK 51-00-06, GENERAL for the definitions of the different categories of repairs. Refer to Paragraph 5 for the Inspection Instructions.

3. References

Reference	Title
51-00-04	STRUCTURAL CLASSIFICATION
51-00-06, GENERAL P/B GENERAL	STRUCTURAL REPAIR DEFINITIONS
51-10-01, GENERAL	Aerodynamic Smoothness Requirements
51-20-01	PROTECTIVE TREATMENT OF METALLIC AND COMPOSITE MATERIALS
51-20-05	REPAIR SEALING
51-30-01	SHEET METAL MATERIALS
51-40-02, GENERAL	Fastener Installation and Removal
51-70-11	TYPICAL FORMED SECTION REPAIRS
51-70-12	EXTRUDED SECTION REPAIRS
AMM 34-23-00	Aircraft Maintenance Manual

(Continued)

Reference	Title
AMM 51-21-00/701	Interior And Exterior Finishes - Cleaning/Painting
SOPM 20-41-02	Application of Chemical and Solvent Resistant Finishes

4. **Repair Instructions**

A. Cut and remove the damaged part of the web.

(1) Use care so you do not cause damage to the structure adjacent to the damage.

(2) Make the cut edges smooth with a surface finish of 63 microinches Ra.

B. Make the repair parts. Refer to Repair 4 - Layout of the Repair Parts, Figure 201/REPAIR 4 and Table 201.

Table 201:

REPAIR MATERIAL			
ITEM	PART	QUANTITY	MATERIAL
[1]	Web Splice	2	Use the same material as the initial web that is one gage thicker
[2]	Repair Web	1	Use the same material and thickness as the initial web

(1) Use the same alloy as the initial web. Use clad (recommended) or bare material.

C. Put the part [1] web splices and the part [2] web in position.

D. Drill the fastener holes. Refer to Repair 1, Figure 202 for the additional fastener hole data for airplanes that have completed Service Bulletin 737-21-1149.

(1) Make the space between the fasteners the same as the chord to web or the stiffener to web joint.

E. Drill the fastener holes. Refer to Repair 1, Figure 202 for the fastener or fastener hole data for airplanes that have not completed Service Bulletin 737-21-1149.

(1) Make the space between the fasteners the same as the chord to web or the stiffener to web joint.

F. Remove the repair parts.

G. Remove all the nicks, scratches, burrs, and sharp edges from the initial structure and the repair parts.

H. Apply a chemical conversion coating to the repair parts and the cut edges of the initial web. Refer to 51-20-01.

I. Apply two layers of BMS 10-11, Type I primer to the part [1] doubler and the bare edges of the initial webs. Refer to SOPM 20-41-02.

NOTE: For webs that are in or at a fuel cell, apply one layer of BMS 10-20, Type II primer. Refer to AMM 51-21-00/701.

J. Apply BMS 5-95 sealant to the mating surfaces. Refer to 51-20-05.

NOTE: For fuel areas, apply BMS 5-26 sealant. For high temperature areas, apply BMS 5-63 sealant.

K. Install the repair parts

(1) If an edge of the repair is less than 2.0 feet from a standby compass, do not install fasteners made of steel. For the locations and requirements of a standby compass, refer to AMM 34-23-00.

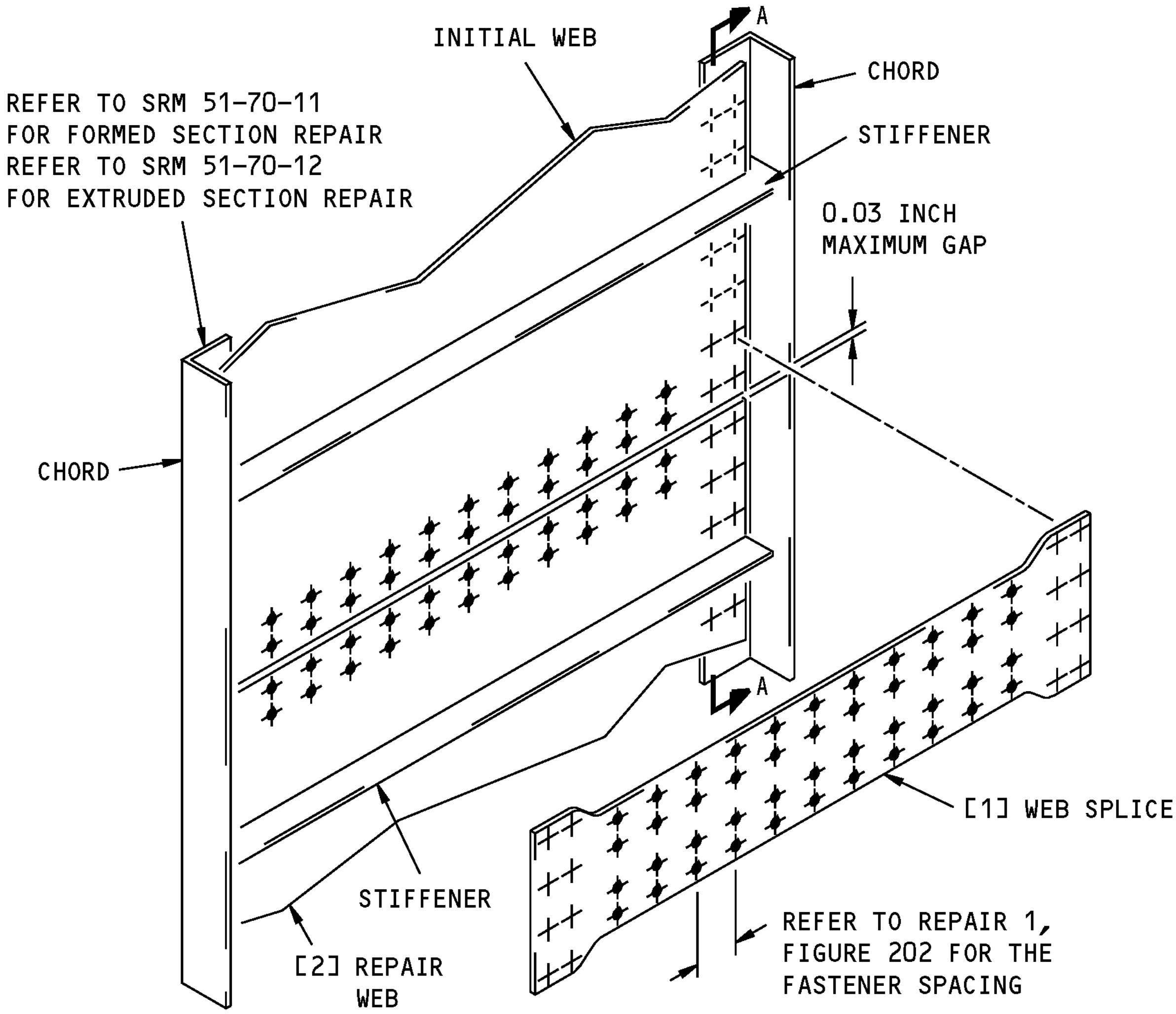
(2) For fuel areas, install the fasteners wet with BMS 5-26 sealant. Refer to 51-20-05.

(3) In areas other than the fuel areas, install the non-aluminum fasteners wet with BMS 5-95 sealant.

(4) For chem-milled webs, it is recommended that you install the part [1] web on the side that is opposite the chem-milled area.

(5) If you must install the part [1] web splice on the chem-milled side, put the part [3] shim between the part [1] web splices and the initial web to make the surface flat. Refer to Repair 4 - Layout of the Repair Parts, Figure 201/REPAIR 4. Refer to 51-30-01 for instructions for the use of shims.

L. Apply the finish to the repair area. Use the same finish that was used on the initial structure. Refer to AMM 51-21-00/701.



NOTES

- SEE DETAIL A FOR THE INSTALLED REPAIR

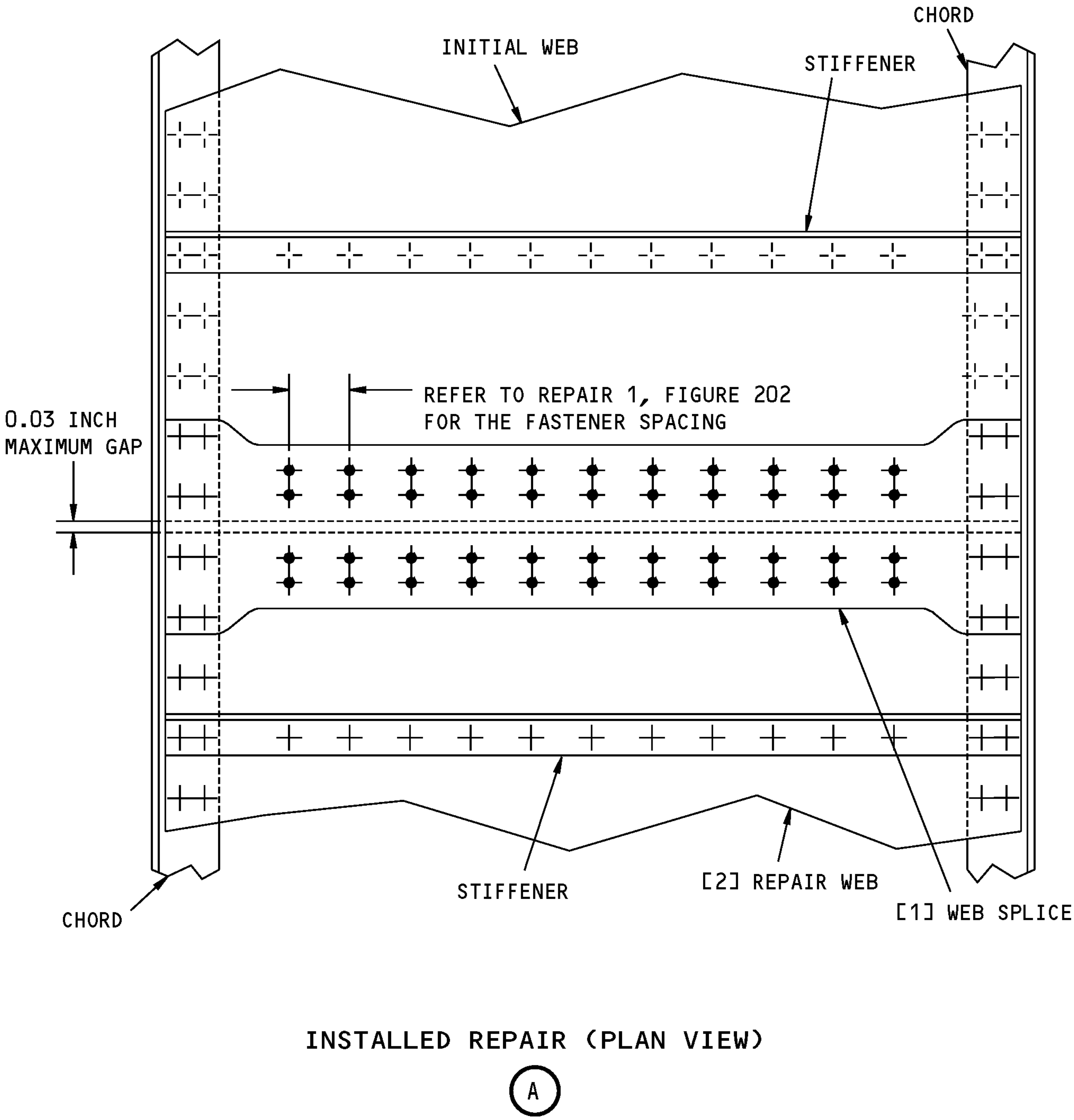
FASTENER SYMBOLS

REFERENCE FASTENER LOCATION.

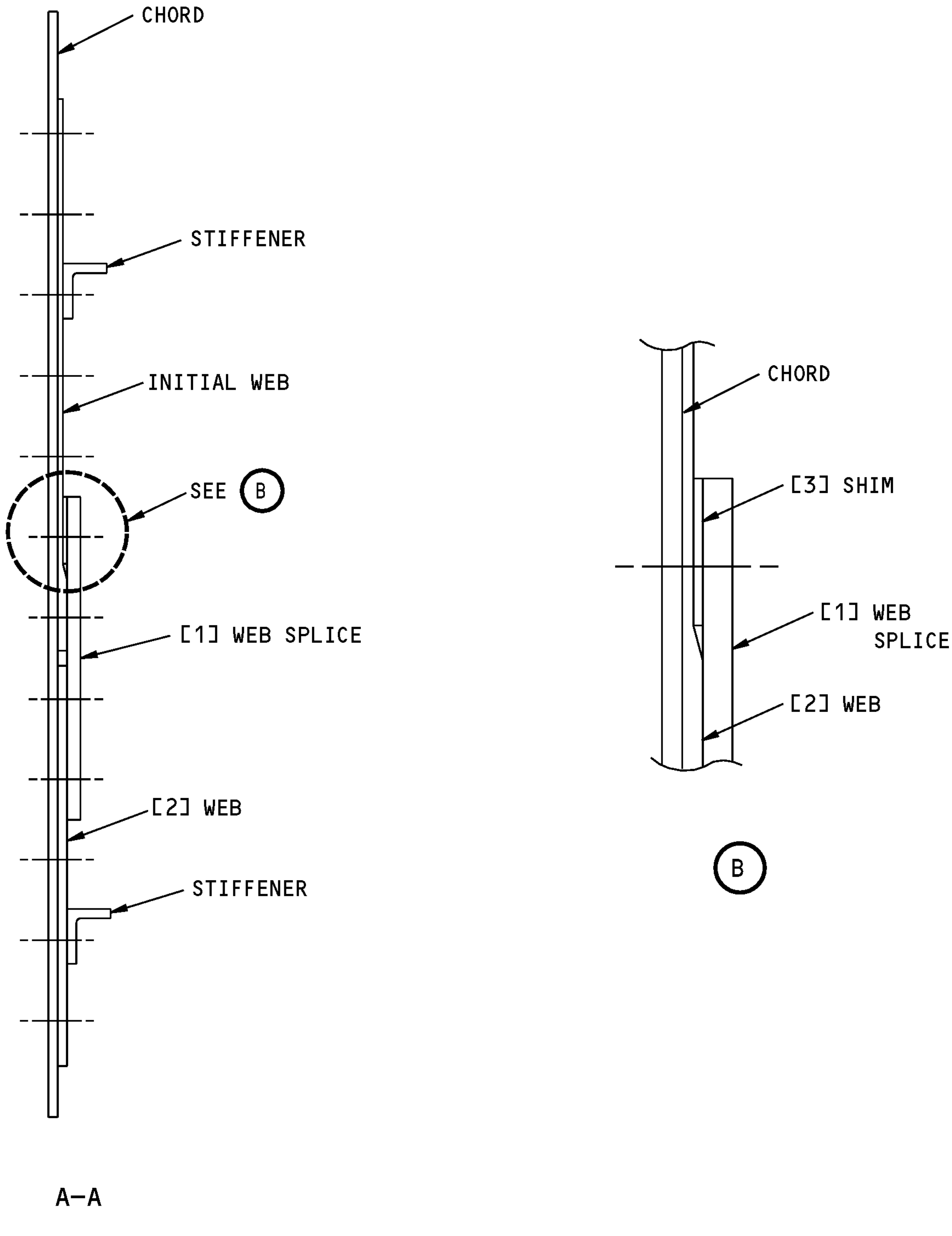
INITIAL FASTENER LOCATION. USE THE INITIAL FASTENER SIZE AND TYPE OR APPROVED SUBSTITUTE FASTENER. 1/32 OVERSIZING FOR RIVETS AND 1/64 OVERSIZING TO HI-LOKS IS PERMITTED.

REPAIR FASTENER LOCATION. REFER TO FIGURE 202 OF REPAIR 1 FOR THE FASTENER ROWS AND SPACING. USE THE SAME SIZE AND TYPE AS THE INITIAL FASTENERS IN THE CHORD AND THE STIFFENER.

Repair 4 - Layout of the Repair Parts
Figure 201 (Sheet 1 of 3)



Repair 4 - Layout of the Repair Parts
Figure 201 (Sheet 2 of 3)



Repair 4 - Layout of the Repair Parts
Figure 201 (Sheet 3 of 3)

5. **Inspection Instructions**

A. Inspections as given below are only applicable to airplanes that have completed Service Bulletin 737-21-1149. Inspections as given below do not apply to airplanes that have not completed Service Bulletin 737-21-1149.

B. Refer to Table 202 for the inspection requirements.Table 202 is only applicable to Principal Structural Elements (PSE's). Refer to 51-00-04 for all Principal Structural Elements (PSE's). Supplemental inspections are not necessary for non-Principal Structural Elements.

Table 202:

CATEGORY B REPAIR INSPECTION REQUIREMENTS			
INSPECTION THRESHOLD	REPEAT INSPECTION ALTERNATIVES		
	METHOD	INTERVAL	REFERENCE
22,500 flight cycles	See note below	See note below	

NOTE: Contact The Boeing Company in 30 days or less after you install this repair to receive installation specific inspection methods and intervals. An assessment is necessary from The Boeing Company to review a complete technical description of the actual installation.

GENERAL - STRUCTURES WITH ALUMINUM COATINGS AND FOILS

1. **Applicability**

   A. This subject gives the locations of aluminum coatings and foils as follows:

      (1) Aluminum Flame-Spray Coating

      (2) Aluminum Coated Glass Fabric (BMS 8-278)

      (3) Bonded Aluminum Foil (BMS 8-289)

      (4) Expanded Aluminum Foil Mesh (BMS 8-336)

2. **General**

   A. Refer to Table 1/GENERAL for the references for the aluminum coatings and foils.

Table 1:

PARAGRAPH REFERENCES FOR ALUMINUM COATINGS AND FOILS	
COATING OR FOIL	PARAGRAPH
ALUMINUM FLAME-SPRAY COATING	2.B
ALUMINUM COATED GLASS FABRIC (BMS 8-278)	2.C
BONDED ALUMINUM FOIL (BMS 8-289)	2.D
EXPANDED ALUMINUM FOIL MESH (BMS 8-336)	2.E

   B. Table 2/GENERAL gives the drawing numbers for the components that have flame spray coating. Refer to Locations of Components with Aluminum Flame Sprayed Coating, Figure 1/GENERAL for the locations of these components.

Table 2:

COMPONENTS THAT HAVE ALUMINUM FLAME SPRAY COATING	
DRAWING NUMBER	TITLE
149A7255	Bonded Part - Front Spar to Rear Spar, Environmental Control System Bay
149A7751	Bonded Part - BSTA 534.9 to BSTA 572, Under Keel
149A7752	Panel Assembly - BSTA 572 to BSTA 649, Under Keel
149A7755	Bonded Part - BSTA 572.1 to BSTA 649.6, Under Keel
149A7756	Bonded Part - BSTA 649.7 to BSTA 660.7, Under Keel
313A2810	Pan Casting - Heat Shield, Aft Fairing, (CFM56-7 Engine)
65-45677	Tailcone Installation - Body Section 48

   C. Table 3/GENERAL gives the drawing numbers for the components that have BMS 8-278 aluminum coated glass fabric. Refer to Locations of Components with Aluminum Coated Glass Fabric (BMS 8-278) , Figure 2/GENERAL for the locations of these components.

Table 3:

COMPONENTS THAT HAVE ALUMINUM COATED GLASS FABRIC (BMS 8-278)	
DRAWING NUMBER	TITLE
116A1210	Bond Assembly - Upper Removable Access Panel, Inboard Leading Edge
116A1310	Removable Panel Assembly - Lower Panel, Inboard Leading Edge

COMPONENTS THAT HAVE ALUMINUM COATED GLASS FABRIC (BMS 8-278)	
DRAWING NUMBER	TITLE
116A2132	Bond Assembly - Lower Panel, Inboard Fixed Leading Edge
116A5411	Bond Assembly - Upper Panel, Slat 1, Outboard Fixed Leading Edge
116A5421	Bond Assembly - Upper Panel, Slat 2, Outboard Fixed Leading Edge
116A5431	Bond Assembly - Upper Panel, Slat 3, Outboard Fixed Leading Edge
116A5441	Bond Assembly - Upper Panel, Slat 4, Outboard Fixed Leading Edge
116A8501	Bond Assembly - Access Doors, Outboard Fixed Leading Edge
116A9111	Bond Assembly - Lower Panels, Type I, Outboard Fixed leading Edge
116A9121	Bond Assembly - Lower Panels, Type II, Outboard Fixed Leading Edge

D. Table 4/GENERAL gives the drawing numbers for the components that have BMS 8-289 bonded aluminum foil. Refer to Locations of Components with Bonded Aluminum Foil (BMS 8-289), Figure 3/GENERAL for the locations of these components.

Table 4:

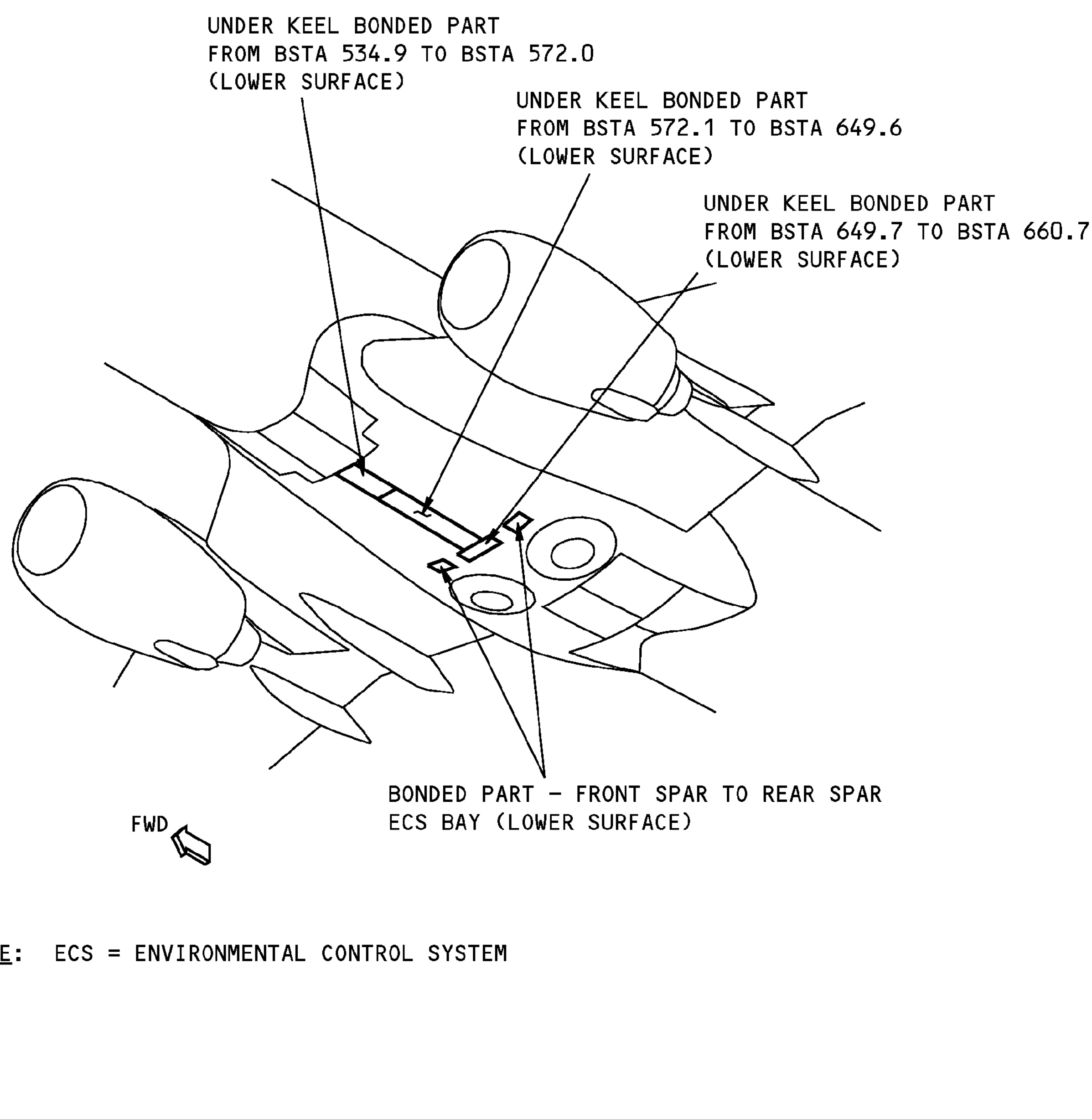
COMPONENTS THAT HAVE BONDED ALUMINUM FOIL (BMS 8-289)	
DRAWING NUMBER	TITLE
116A1210	Bond Assembly - Upper Removable Access Panel, Inboard Leading Edge
116A1310	Removable Panel Assembly - Lower Panel, Inboard Leading Edge
116A2132	Bond Assembly - Lower Panel, Inboard Fixed Leading Edge
116A5411	Bond Assembly - Upper Panel, Slat 1, Outboard Fixed Leading Edge
116A5421	Bond Assembly - Upper Panel, Slat 2, Outboard Fixed Leading Edge
116A5431	Bond Assembly - Upper Panel, Slat 3, Outboard Fixed Leading Edge
116A5441	Bond Assembly - Upper Panel, Slat 4, Outboard Fixed Leading Edge
116A8501	Bond Assembly - Access Doors, Outboard Fixed Leading Edge
116A9111	Bond Assembly - Lower Panels, Type I, Outboard Fixed leading Edge
116A9121	Bond Assembly - Lower Panels, Type II, Outboard Fixed Leading Edge
313A2111	Thumbnail Assembly - Bonded Panel
313A2121	Panel Assembly - Forward Fairing
313A2211	Panel Assembly - Outboard Underwing Fairing
313A2231	Bond Assembly - Overwing Fairing Panel

E. Table 5/GENERAL gives the drawing numbers for the components that have expanded aluminum foil mesh (BMS 8-336). Refer to Locations of Components with Aluminum Expanded Mesh (BMS 8-336), Figure 4/GENERAL for the locations of these components.

Table 5:

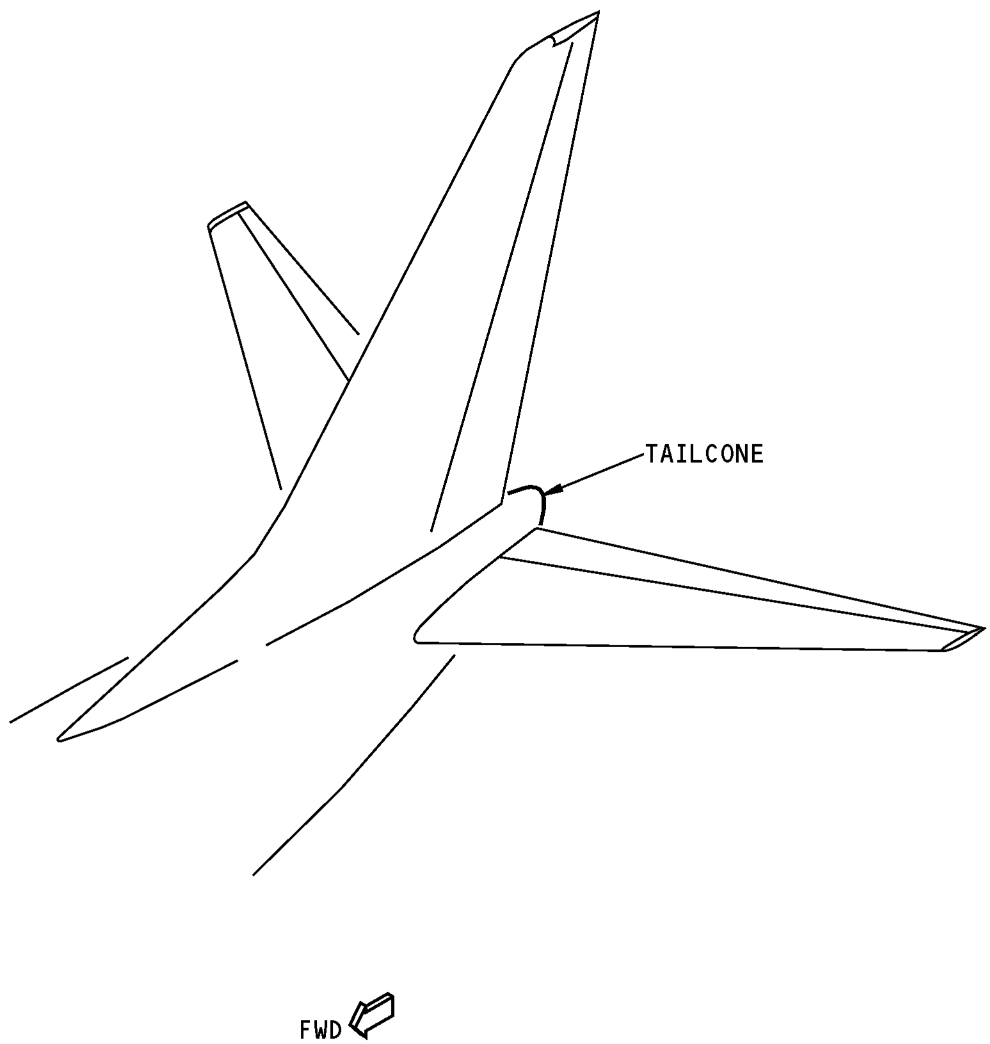
COMPONENTS THAT HAVE EXPANDED ALUMINUM FOIL MESH (BMS 8-336)	
DRAWING NUMBER	TITLE
115A2521	Panel - Bonded Part, Upper Inboard Fixed Trailing Edge

COMPONENTS THAT HAVE EXPANDED ALUMINUM FOIL MESH (BMS 8-336)	
DRAWING NUMBER	TITLE
115A2523	Panel - Bonded Part, Upper Inboard Fixed Trailing Edge
115A2524	Panel - Bonded Part, Upper Inboard Fixed Trailing Edge
115A2720	Panel - Bonded Part, Lower Inboard Fixed Trailing Edge
115A2722	Panel - Bonded Part, Lower Inboard Fixed Trailing Edge
115A2724	Panel - Bonded Part, Lower Inboard Fixed Trailing Edge
115A3523	Panel - Bonded Part, Upper Mid Span Fixed Trailing Edge
115A4920	Panel - Bonded Part, Upper Outboard Fixed Trailing Edge
115A4921	Panel - Bonded Part, Lower Outboard Fixed Trailing Edge
116A4923	Panel - Bonded Part, Lower Outboard Fixed Trailing Edge
116A1210	Bond Assembly - Upper Removable Access Panel, Inboard Leading Edge
116A1310	Removable Panel Assembly - Lower Panel, Inboard Leading Edge
116A2132	Bond Assembly - Lower Panel, Inboard Fixed Leading Edge
116A5411	Bond Assembly - Upper Panel, Slat 1, Outboard Fixed Leading Edge
116A5441	Bond Assembly - Upper Panel, Slat 4, Outboard Fixed Leading Edge
116A8501	Bond Assembly - Access Doors, Outboard Fixed Leading Edge
116A9111	Bond Assembly - Lower Panels, Type I, Outboard Fixed leading Edge
116A9121	Bond Assembly - Lower Panels, Type II, Outboard Fixed Leading Edge
149A7156	Bonded Part - BSTA 500A to FS Lower Forward Fairing
149A7157	Bonded Part - Mid Forward Fairing
149A7548	Bonded Part - Lower Aft Fairing, BSTA 727C and Aft
149A7554	Bonded Part - BSTA 727 + 2.7 to 727C, Lower Aft Fairing
149A7555	Bonded Part - BSTA 727 + 2.7 to 727C, Lower Aft Fairing
149A7562	Bonded Part - Brake Accumulator Access Door, Aft Fairing
149A7557	Bonded Part - Lower Aft Fairing, BSTA 727C and Aft
173A6210	Bonded Part - Upper Fairing, Rudder Tip
189A1001	Tip Cap Installation/Assembly - Horizontal Stabilizer
189A1002	Composite Tip - Tip Cap, Horizontal Stabilizer
313A2111	Thumbnail Assembly - Bonded Panel
313A2121	Panel Assembly - Forward Fairing
313A2211	Panel Assembly - Outboard Underwing Fairing
313A2221	Panel Assembly - Inboard Underwing Fairing
313A2231	Bond Assembly - Overwing Fairing Panel
313A2561	Outer Cowl Bond Assembly, Thrust Reverser Translating Sleeve

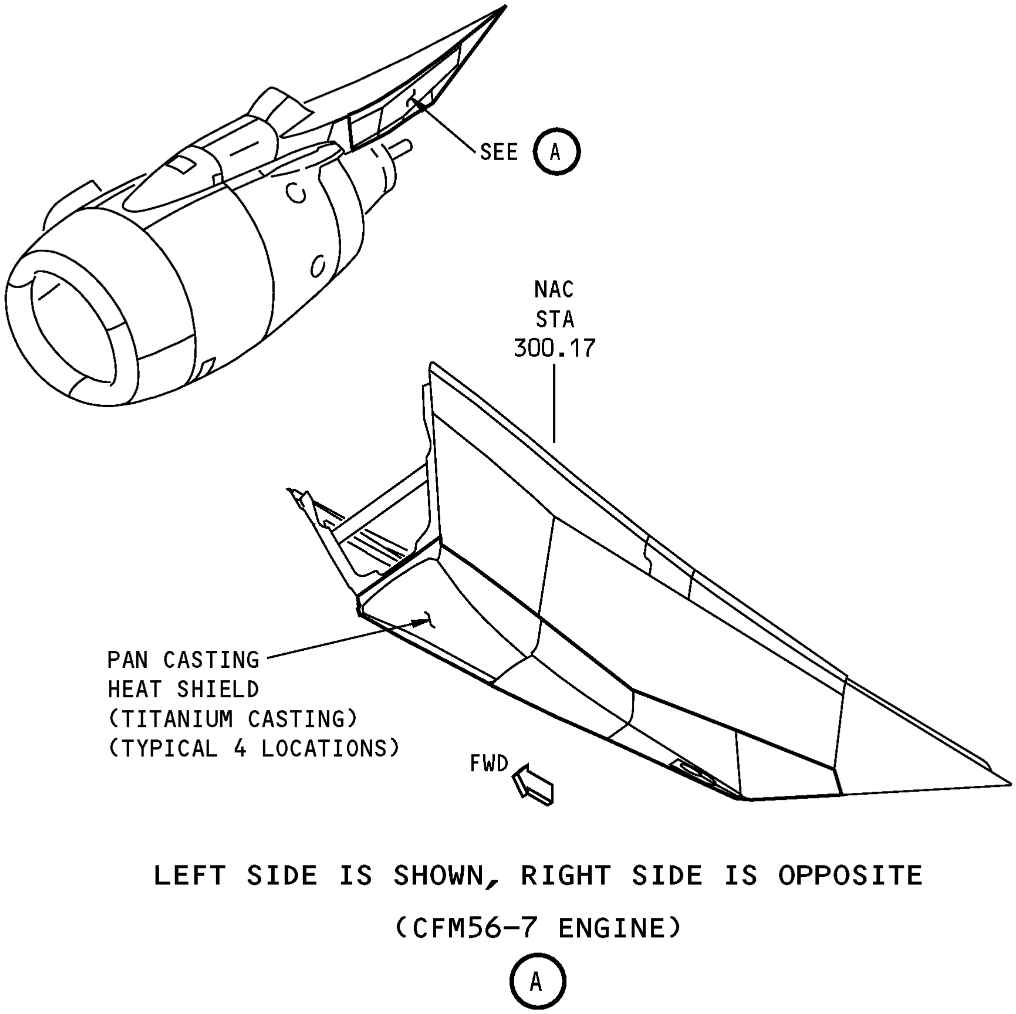


NOTE: ECS = ENVIRONMENTAL CONTROL SYSTEM

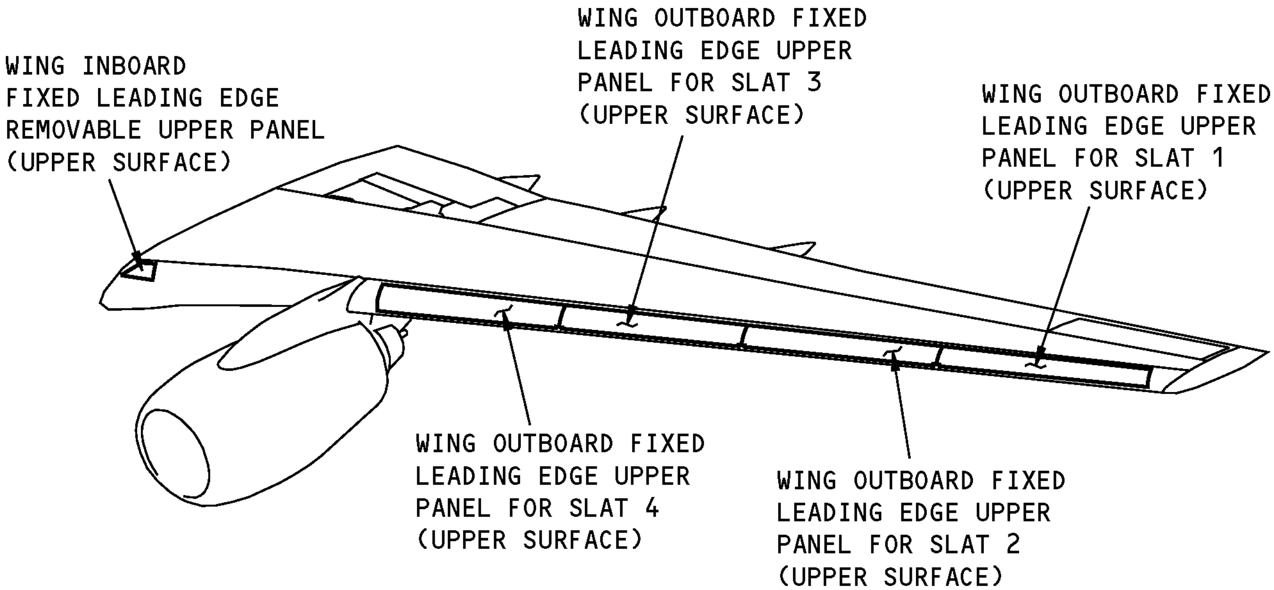
Locations of Components with Aluminum Flame Sprayed Coating
Figure 1 (Sheet 1 of 3)



Locations of Components with Aluminum Flame Sprayed Coating
Figure 1 (Sheet 2 of 3)



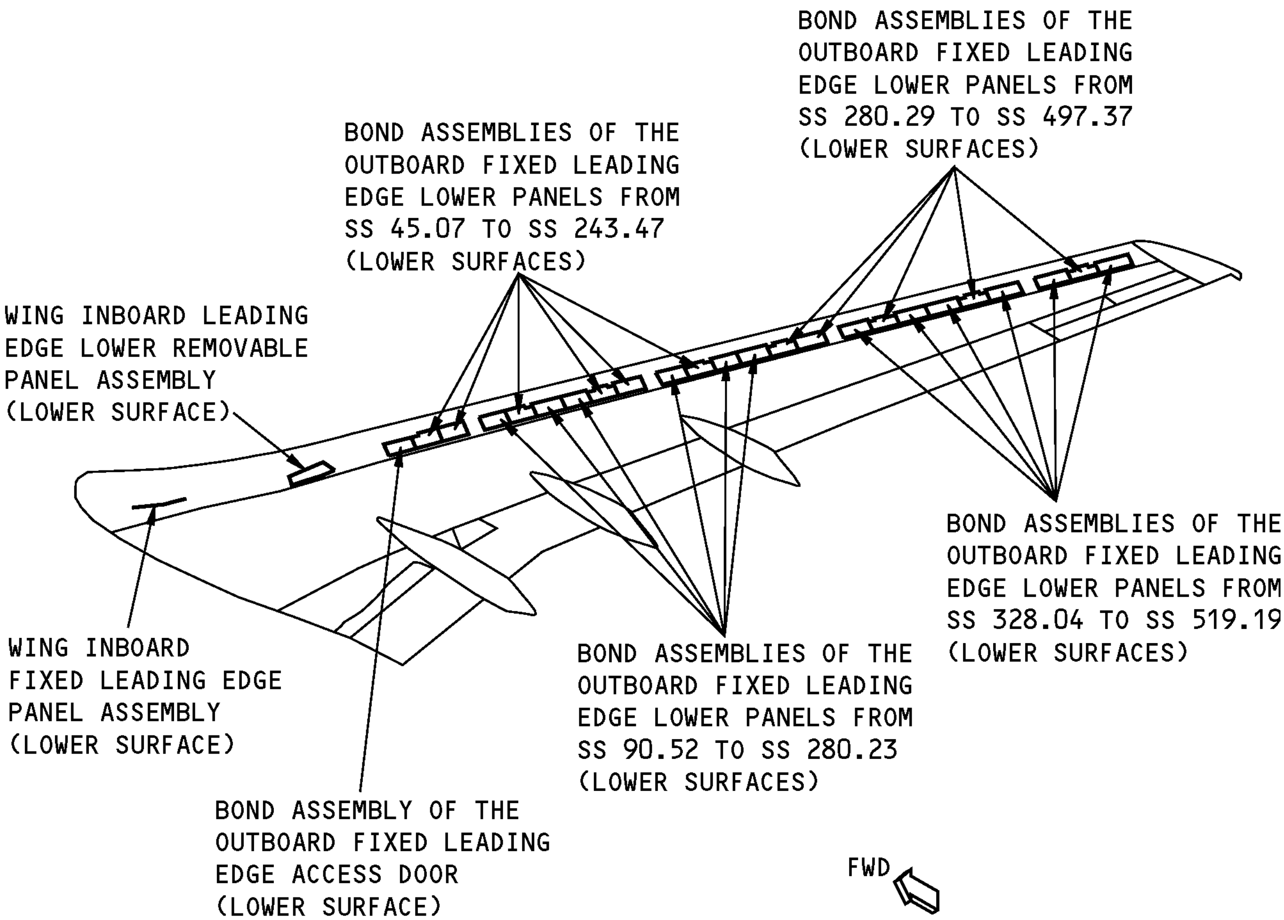
Locations of Components with Aluminum Flame Sprayed Coating
Figure 1 (Sheet 3 of 3)



NOTE: UPPER SURFACES OF SLATS ARE SHOWN. FOR LOWER SURFACES, SEE FIGURE 3.

LEFT SIDE IS SHOWN, RIGHT SIDE IS OPPOSITE

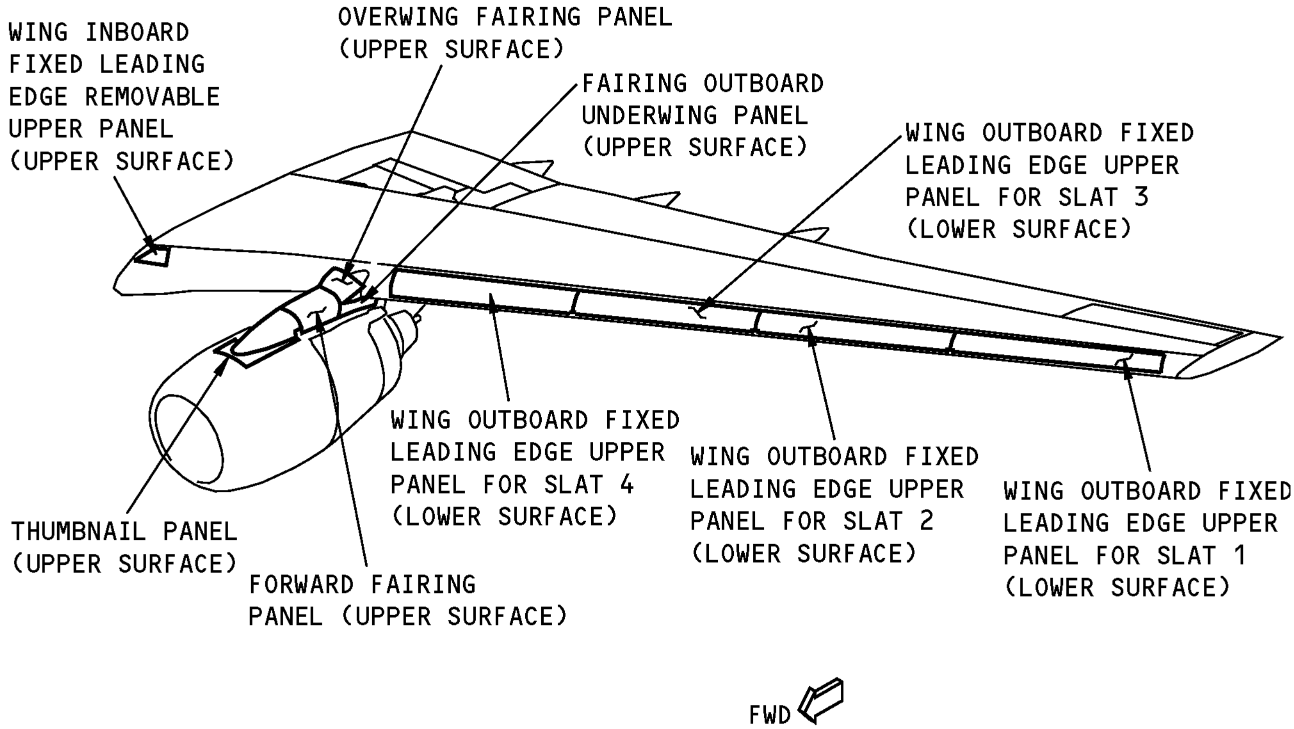
Locations of Components with Aluminum Coated Glass Fabric (BMS 8-278)
Figure 2 (Sheet 1 of 2)



NOTE: LOWER SURFACES OF SLATS ARE SHOWN. FOR UPPER SURFACES, SEE FIGURE 3

LEFT SIDE IS SHOWN, RIGHT SIDE IS OPPOSITE

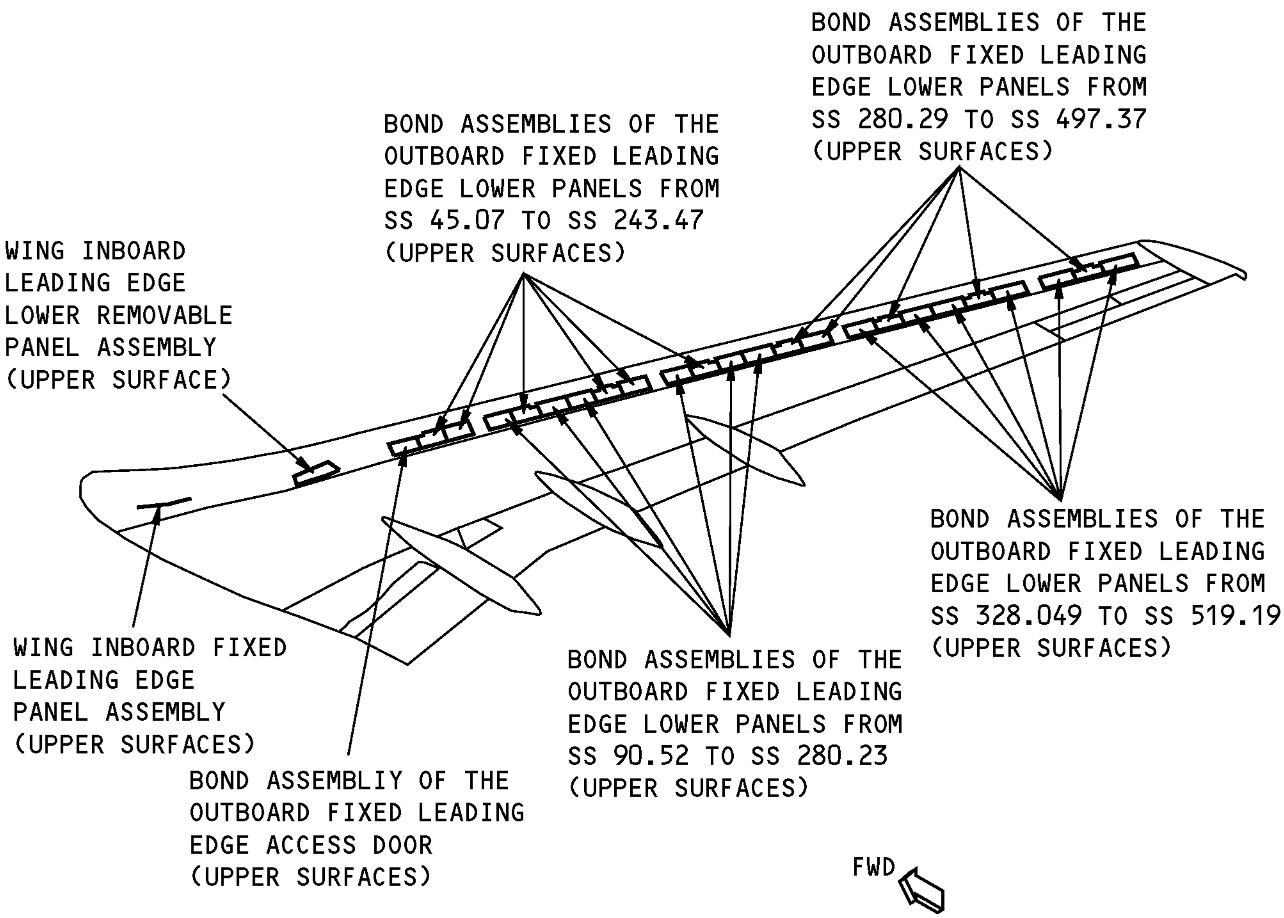
Locations of Components with Aluminum Coated Glass Fabric (BMS 8-278)
Figure 2 (Sheet 2 of 2)



NOTE: LOWER SURFACES OF SLATS ARE SHOWN. FOR UPPER SURFACES, SEE FIGURE 2.

LEFT SIDE IS SHOWN, RIGHT SIDE IS OPPOSITE

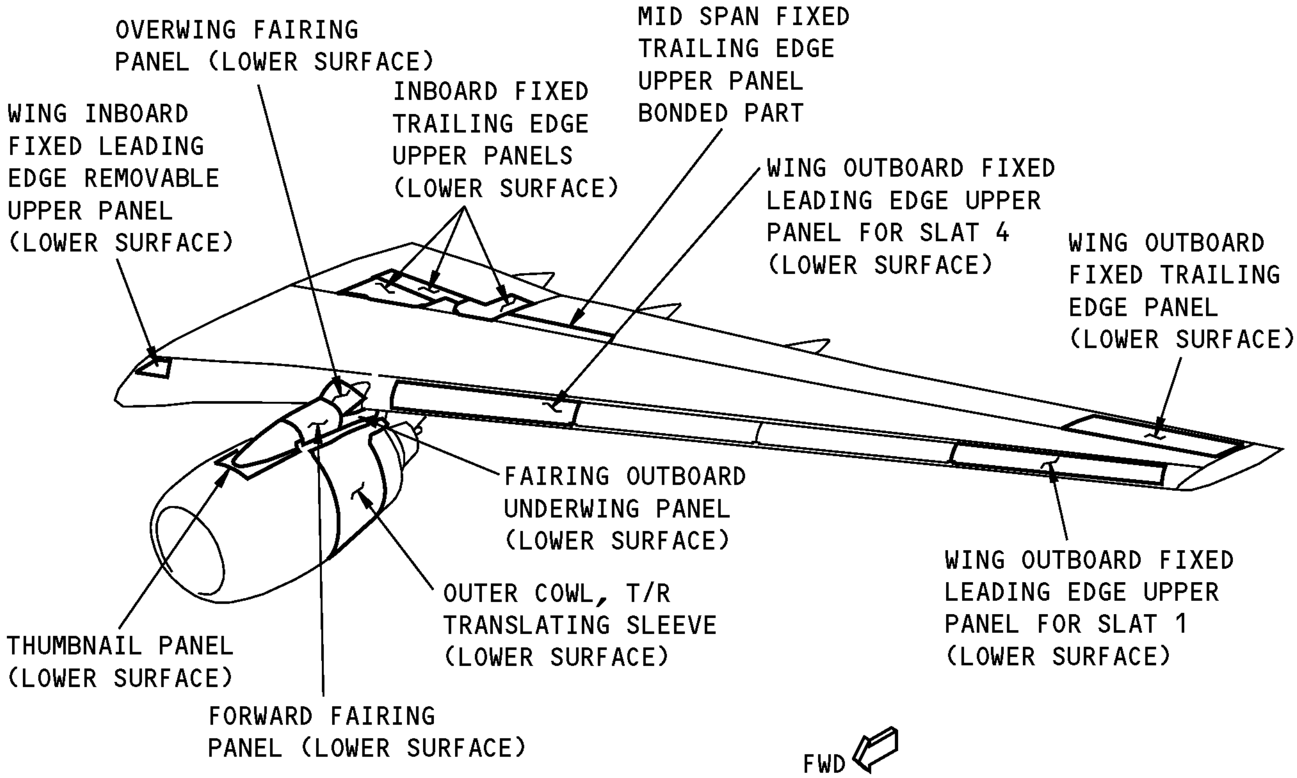
Locations of Components with Bonded Aluminum Foil (BMS 8-289)
Figure 3 (Sheet 1 of 2)



NOTE: UPPER SURFACES ARE SHOWN. FOR THE LOWER SURFACES, SEE FIGURES 2 AND 4.

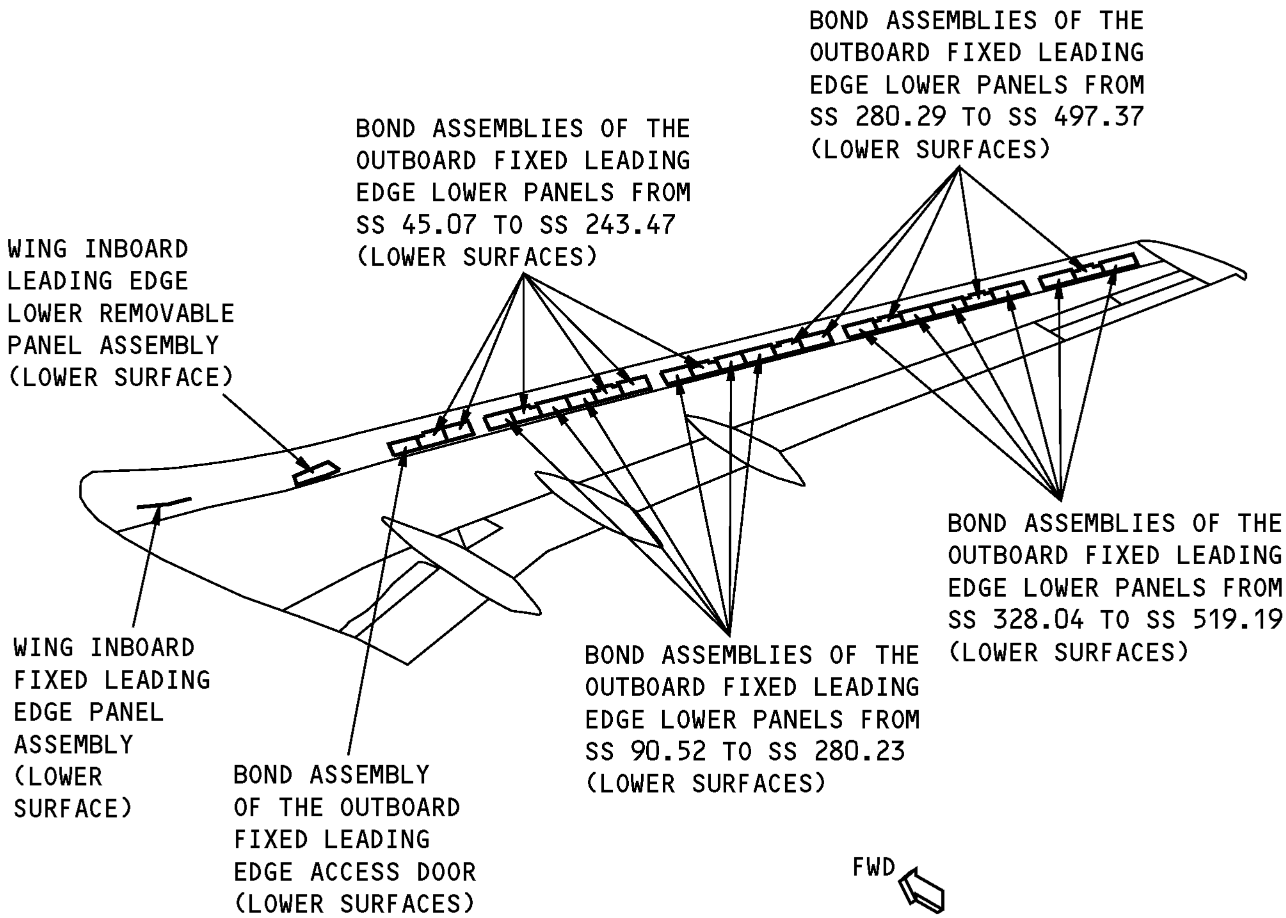
LEFT SIDE IS SHOWN, RIGHT SIDE IS OPPOSITE

Locations of Components with Bonded Aluminum Foil (BMS 8-289)
Figure 3 (Sheet 2 of 2)



LEFT SIDE IS SHOWN, RIGHT SIDE IS OPPOSITE

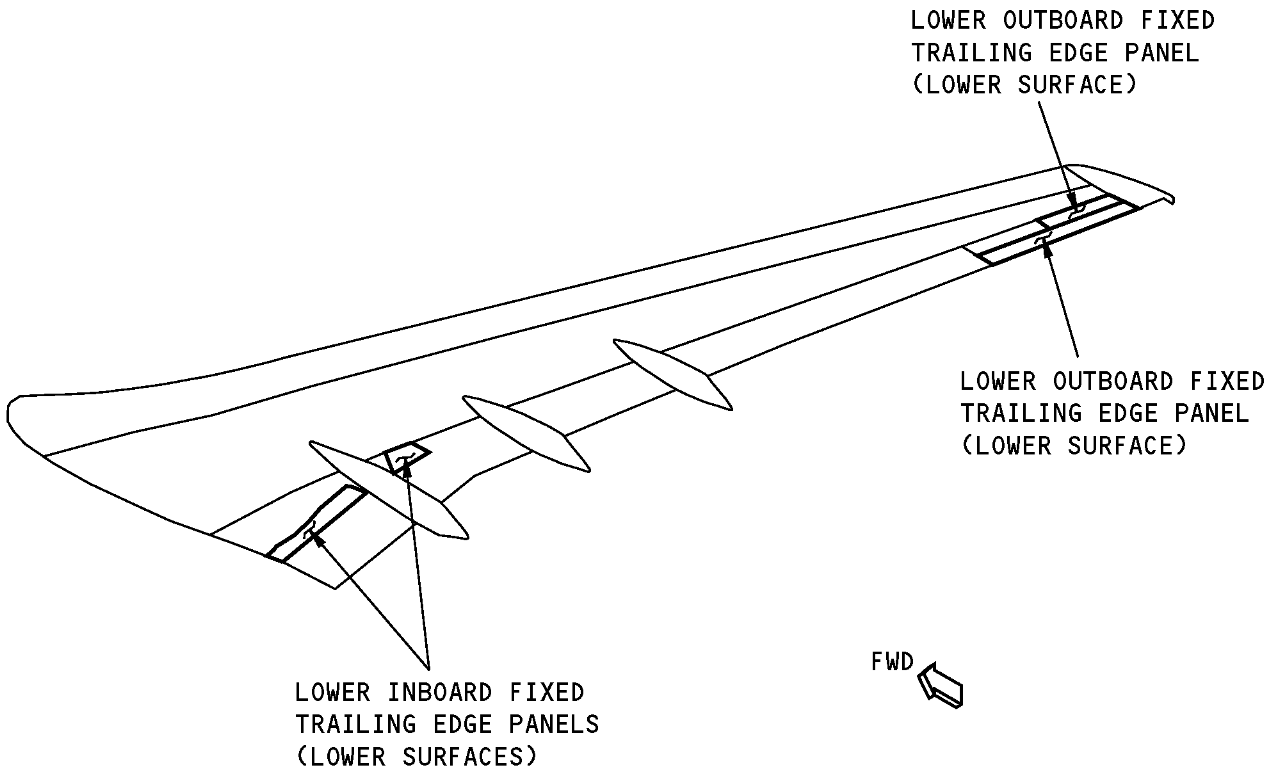
Locations of Components with Aluminum Expanded Mesh (BMS 8-336)
Figure 4 (Sheet 1 of 4)



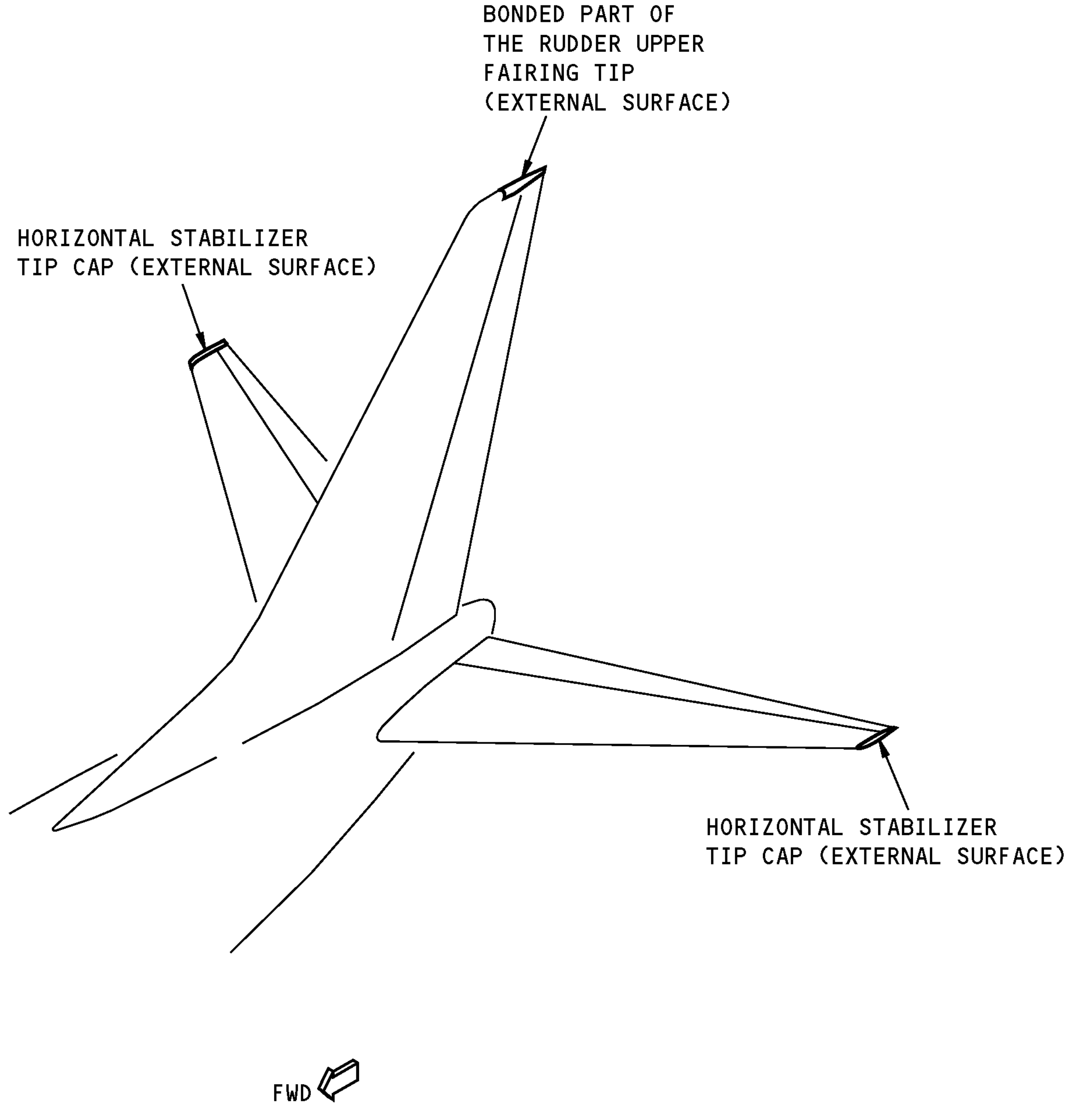
NOTE: LOWER SURFACES ARE SHOWN. SEE FIGURE 3 FOR UPPER SURFACES.

LEFT SIDE IS SHOWN, RIGHT SIDE IS OPPOSITE

Locations of Components with Aluminum Expanded Mesh (BMS 8-336)
Figure 4 (Sheet 2 of 4)



Locations of Components with Aluminum Expanded Mesh (BMS 8-336)
Figure 4 (Sheet 3 of 4)



Locations of Components with Aluminum Expanded Mesh (BMS 8-336)
Figure 4 (Sheet 4 of 4)

ALLOWABLE DAMAGE GENERAL - DAMAGE LIMITS AND SEALING INSTRUCTIONS FOR ALUMINUM COATINGS AND FOILS

1. Applicability

A. This subject gives the applicable allowable damage limits and the sealing instructions for the coatings or foils that follow:

(1) Aluminum Flame-Spray Coating

(2) Aluminum Coated Glass Fabric (BMS 8-278)

(3) Bonded Aluminum Foil (BMS 8-289)

(4) Expanded Aluminum Foil Mesh (BMS 8-336)

2. General

A. Refer to the 51-70-14, General - Structures with Aluminum Coatings and Foils, for the locations and drawing numbers of the applicable components.

B. Refer to Table 101/ALLOWABLE DAMAGE GENERAL for the of the allowable damage data for the applicable aluminum coating or foil.

Table 101:

PARAGRAPH INDEX FOR ALLOWABLE DAMAGE DATA	
TITLE	PARAGRAPH
Allowable Damage Limits for Aluminum Flame - Sprayed Coatings	4
Allowable Damage Limits for Aluminum Coated Glass Fabric (BMS 8-278)	5
Allowable Damage Limits for Bonded Aluminum Foil (BMS 8-289)	6
Allowable Damage Limits for Expanded Aluminum Foil Mesh (BMS 8-336)	7

C. Refer to the allowable damage and repair subjects that are applicable to the component for damage to the plies and core(s) under the aluminum coating or foil.

D. Do an inspection to find the length and area of the damaged aluminum coating or foil.

(1) The conductivity of electrically critical panels must be kept. Examine the coating or foil for damage that:

- Goes fully through the aluminum coating or foil
- Is not more than the allowable damage limits given.

(a) Do an electrical conductivity test with an ohmmeter (resistance meter) to ensure conductivity. The resistance should not be more than 1.0 ohm.

(b) Make sure that full electrical conductivity and continuity to fasteners are kept.

(c) Make sure that proper grounding to airplane structure is kept.

(2) If the electrical continuity of an electrically critical panel is not kept, then you must repair the coating or foil.

E. Remove all contamination, loose aluminum material, and water from the surface of the structure.

(1) Refer to 51-30-05 for the tools you can use to remove the damage.

(2) Refer to 51-70-04 for the cleanup procedures.

F. Seal all permitted damage areas with one of the methods that follows.

(1) Make a temporary seal.

(a) Remove the finish a minimum of 1.00 inch all around the damaged area to expose the surface of the aluminum coating or foil.

(b) Apply aluminum foil tape (3M 436 speed tape) with one of the two methods that follows.

1) Cover the damage fully with one layer of speed tape.

2) Apply two or more layers of speed tape.

a) Cover the damage fully with one layer of speed tape.

b) Apply more layers of speed tape as necessary.

- Make the dimensions of each subsequent layer of speed tape 2 inches more all around the edges of the last layer of speed tape applied.

(c) As an option, apply a fillet seal (BMS 5-95).

(d) Keep a record of the location.

(e) Make sure the tape is in satisfactory condition after each 400 flight hour interval or more frequently.

1) Replace the speed tape as necessary until you can make a permanent seal or a repair for the aluminum surfaces.

2) For the bonded aluminum foil, only replace the speed tape as necessary. A subsequent repair is not necessary.

(f) Repair the damage at or before 5000 flight hours from the time the seal was made for the aluminum surfaces that follow:

1) Aluminum flame-sprayed coating

2) Aluminum coated glass fabric (BMS 8-278)

3) Expanded aluminum foil mesh (BMS 8-336)

(2) Make a permanent seal. Refer to Speed Tape Permanent Seal, Figure 101/ALLOWABLE DAMAGE GENERAL.

(a) Remove the aluminum coating or foil from the damage area.

WARNING: KEEP THE SOLVENTS AWAY FROM SOURCES OF HEAT, FIRE OR SPARKS. IF YOU DO NOT OBEY, AN EXPLOSION CAN OCCUR. DO NOT PERMIT THE SOLVENTS TO TOUCH YOUR EYES, SKIN OR CLOTHING. WEAR EYE PROTECTION. DO NOT BREATHE THE VAPORS. IN A CONFINED SPACE, USE RESPIRATORY PROTECTION OR MECHANICAL VENTILATION. IF YOU DO NOT OBEY, AN INJURY TO PERSONS CAN OCCUR.

CAUTION: DO NOT SOAK THE PARTS IN TRICHLOROETHANE. DO NOT PERMIT SOLVENT TO STAY ON THE PARTS. IF YOU DO NOT OBEY, DAMAGE TO THE PARTS CAN OCCUR.

(b) Abrade and remove the initial primer from the surface of the aluminum coating or foil that remains.

NOTE: Use an abrasive paper that is 240-grit or smaller. Do not sand into the glass fabric of the composite structure in the area where you removed the aluminum coating or foil.

1) Lightly sand the surface a minimum of 3.0 inches around the edge of the aluminum coating or foil you removed.

2) Remove the primer from the surface a minimum of 1.0 inch around the edge of the aluminum coating or foil you removed.

WARNING: REPAIR MATERIALS ARE DANGEROUS. MAKE SURE THAT THERE IS A GOOD FLOW OF CLEAN AIR WHEN YOU WORK WITH THESE MATERIALS. BE CAREFUL TO PREVENT ALL CONTAMINATION OF YOUR SKIN, EYES, AND CLOTHING. IF YOU DO NOT OBEY, AN INJURY CAN OCCUR.

CAUTION: DO NOT USE WAXED CONTAINERS TO MIX THE RESIN COMPONENTS. IF YOU DO NOT OBEY, CONTAMINATION OF THE RESIN WILL OCCUR AND YOU WILL HAVE AN UNSATISFACTORY REPAIR.

(c) Wash the repair area to remove the sanding dust and unwanted materials with a clean cloth moist with:

1) Methyl Isobutyl Ketone (MIBK)

2) Acetone

(d) Fully mix the resin or potting compound as follows. Refer to Table 102/ALLOWABLE DAMAGE GENERAL.

1) If necessary refer to 51-30-03 for the sources of the materials given in Table 102/ALLOWABLE DAMAGE GENERAL.

2) For aluminum flame-sprayed coatings, mix the resin or potting compound as follows:

a) For 250°F (121°C) cured parts, mix BMS 5-28, Type 3 resin.

b) For 350°F (177°C) cured parts, mix BMS 8-207, Type II, Class 2 resin.

3) For aluminum coated glass fabric (BMS 8-278) and expanded aluminum foil mesh (BMS 8-336), mix Resin Mix 1.

(3) Store and identify the containers of resin or potting compound you use.

(a) Make sure there is a label on each container with the data that follows:

1) Boeing Material Specification (BMS)

2) Type

3) Class

4) Grade

5) Supplier's name and product designation

6) Batch number

7) Date of manufacture.

(b) Make sure that the resins or potting compound are kept at 40°F(5°C) to 80°F (27°C) in sealed containers.

(4) Apply the resin or potting compound to the repair area.

(a) Use a spatula to apply the resin or potting compound to a wider area than is needed. This will permit loss in volume of the resin or potting compound during the cure.

Table 102:

RESIN AND POTTING COMPOUND DATA				
RESIN TYPE	COMPONENTS	PARTS BY WEIGHT	POT LIFE	CURE TIME
RESIN MIX 1	Epibond 156A	100 ±2	45 to 60 minutes at 70°F (21°C)	6 to 8 hours at 70°F (21°C)
	Epibond 156B (Hardener)	5 ±0.3		
RESIN MIX 1 (ALTERNATIVE)	Fiber-Resin 5318S	100 ±2	45 to 60 minutes at 70°F (21°C)	Refer to Figure 101.
	Fiber-Resin 5318C	50 ±1		
RESIN MIX 1 (ALTERNATIVE)	EPOX-O WELD (Two component kit)	Refer to the manufacturer's instructions.	45 to 60 minutes at 70°F (21°C)	Refer to Figure 101.
RESIN MIX 1 (ALTERNATIVE)	Epibond 156	100 ±2	45 to 60 minutes at 70°F (21°C)	Refer to Figure 101.
	Epibond 941 (Hardener)	10 ±0.5		
BMS 5-28, TYPE 3	Epibond 1511A	100	20 minutes at 75° to 79°F (24° to 26°C)	5 hours at 120° to 130°F (49° to 54°C) or 24 hours at a minimum of 75°F (24°C).
	Epibond 1511B	15		
BMS 8-207 TYPE II, CLASS 2,	Fiber Resin FR8840A	100		24 hours at a minimum of 75°F (24°C), plus 1 hour at 300° to 350°F (149° to 176°C)
	FR8840B	15 to 20		

(5) Cure the resin or potting compound.

(a) Refer to Table 102/ALLOWABLE DAMAGE GENERAL and Figure 102 for the cure temperature and time for BMS 5-28, Type 3.

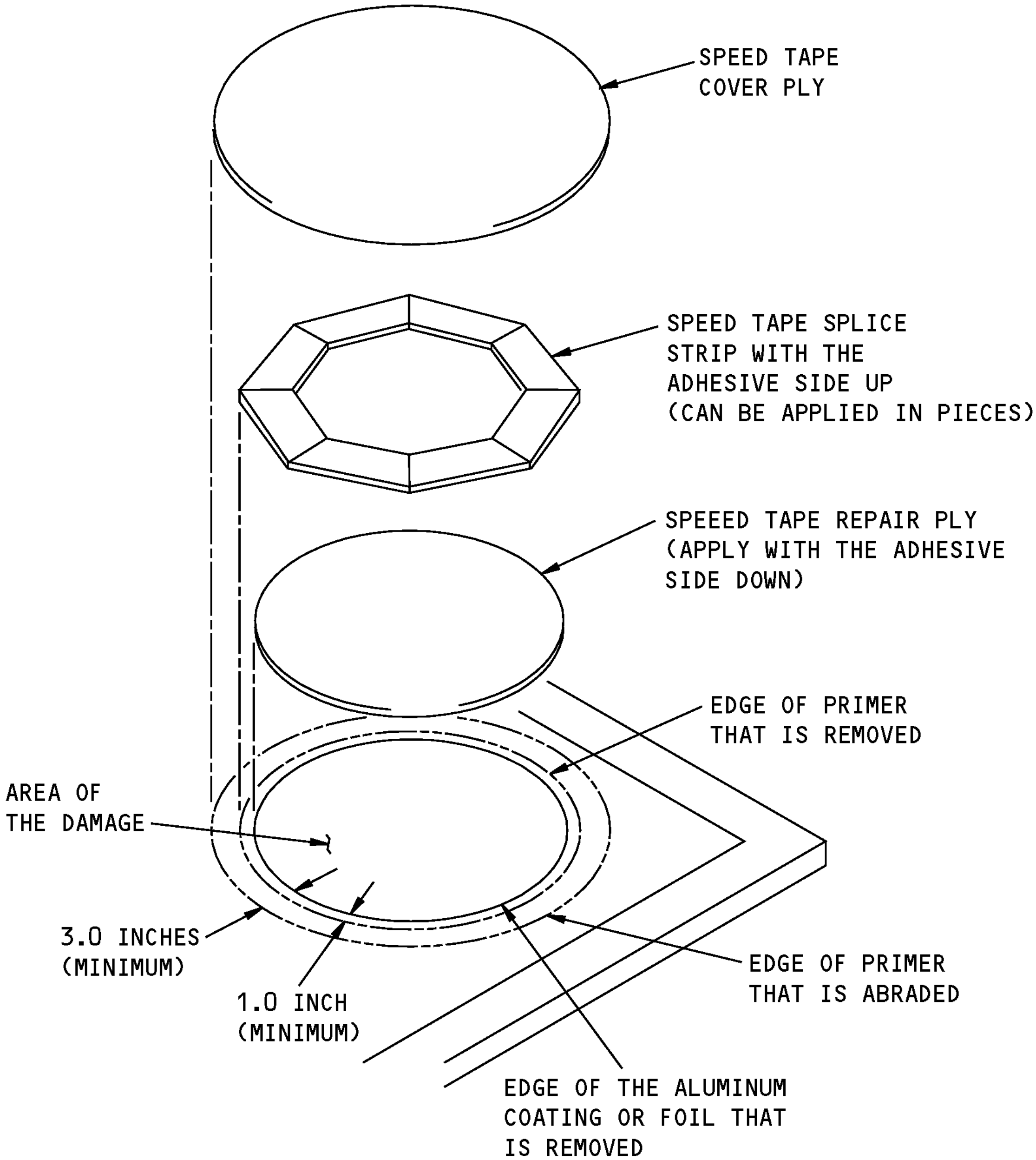
(b) Refer to Table 102/ALLOWABLE DAMAGE GENERAL and Figure 103 for the cure temperature and time for the other resins.

(c) Sand the potted area to a smooth surface that is flush with the surrounding surface.

1) Use an abrasive paper that is 240-grit or smaller.

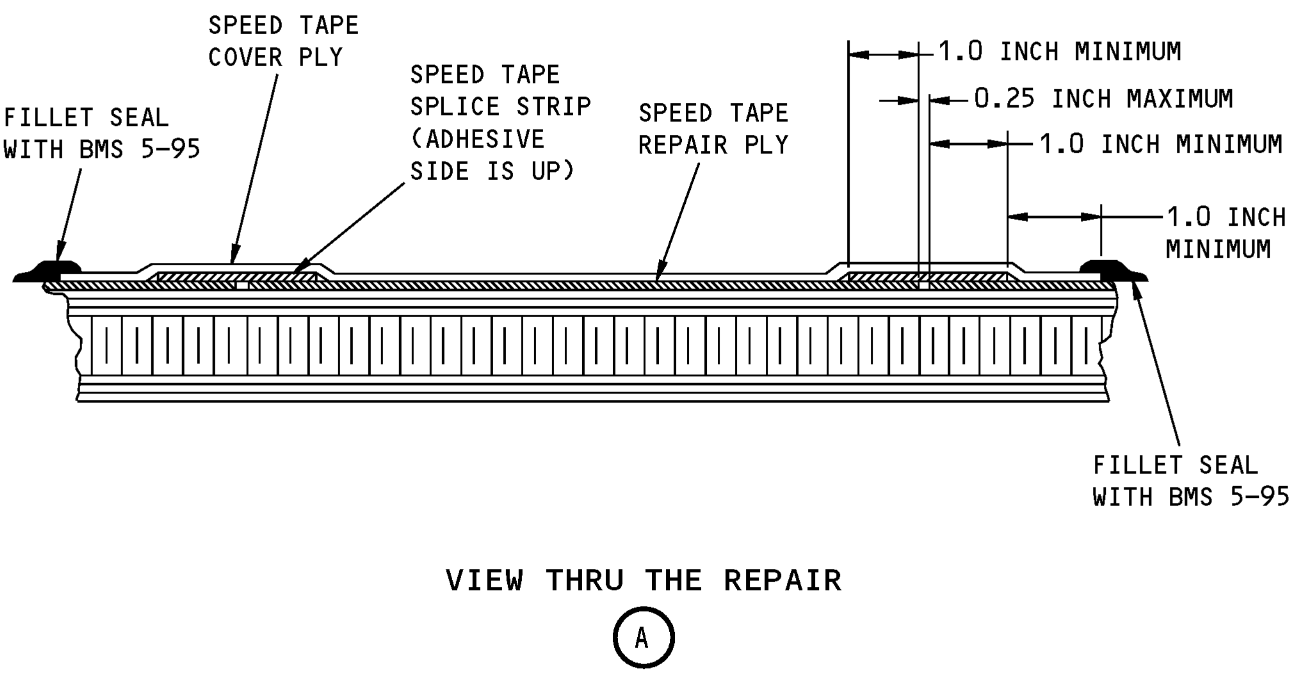
(d) Apply a chemical conversion coating to the aluminum coating or foil surface in the repair area. Refer to 51-20-01.

(e) Apply the decorative finish as necessary. Refer to AMM PAGEBLOCK 51-21-99/701.

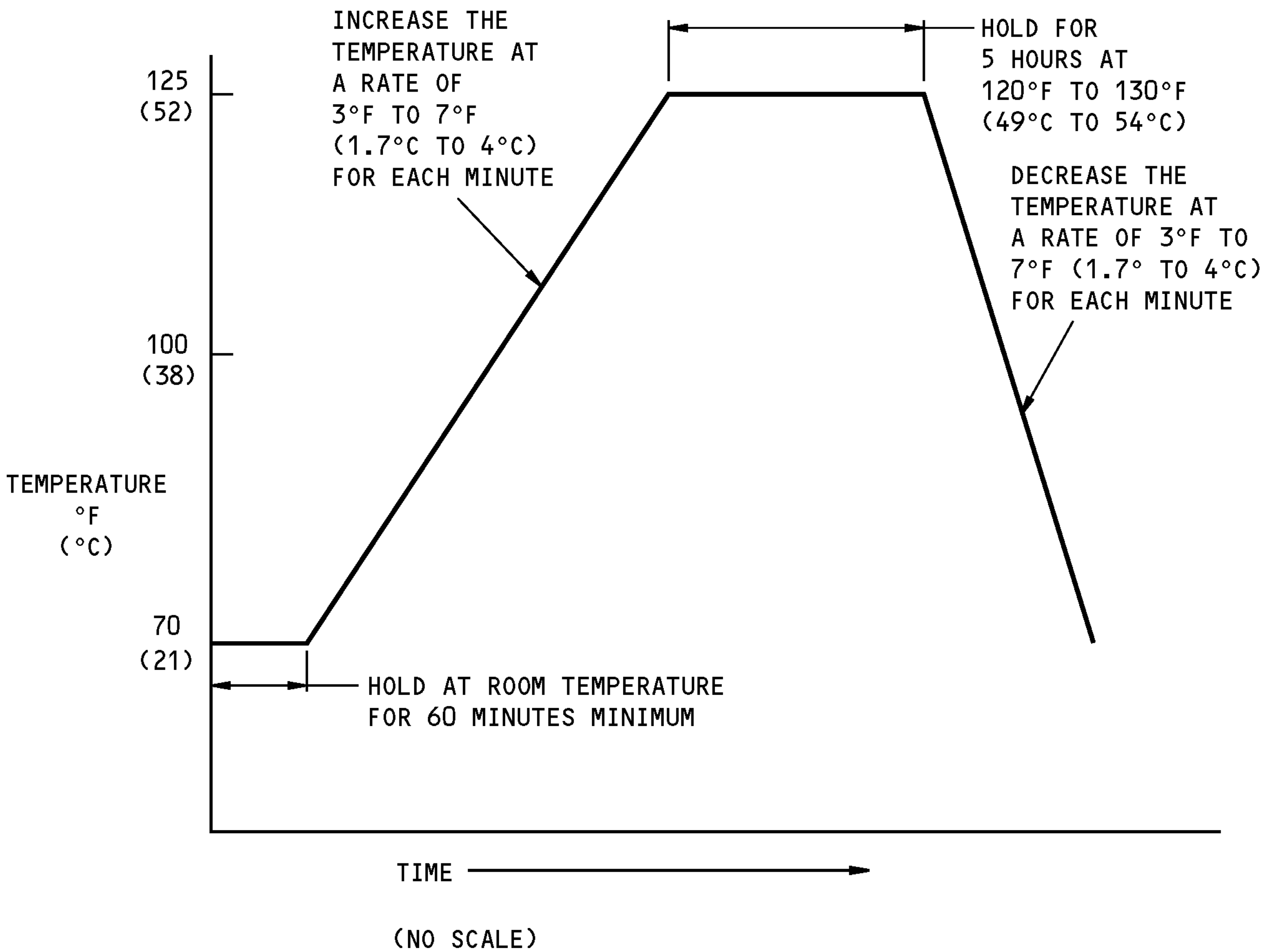


NOTE: REFER TO DETAIL A FOR THE VIEW THROUGH THE INSTALLED REPAIR.

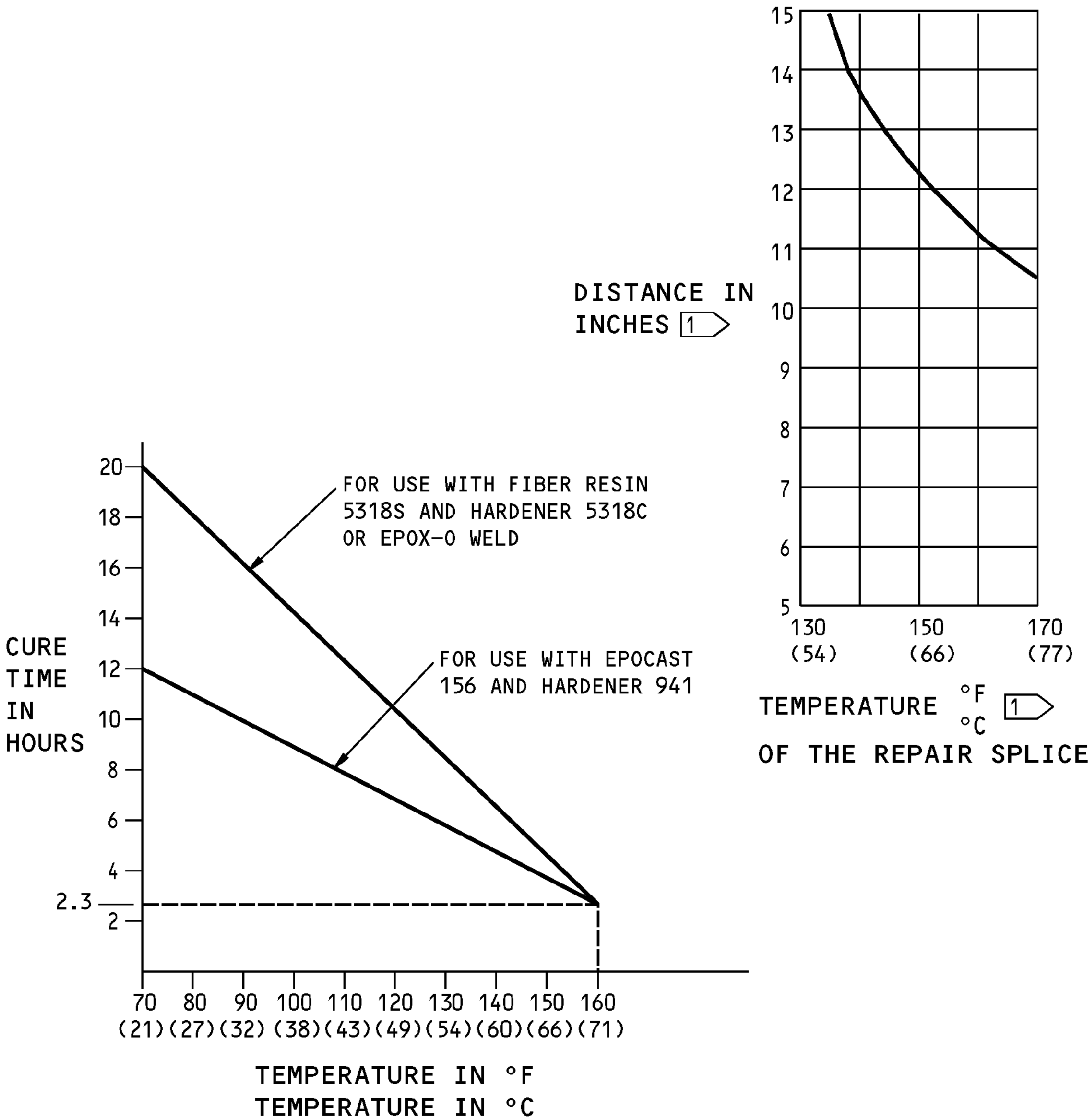
Speed Tape Permanent Seal
Figure 101 (Sheet 1 of 2)



Speed Tape Permanent Seal
Figure 101 (Sheet 2 of 2)



Cure Cycle for BMS 5-28, Type 3 Potting Compound
Figure 102



NOTES

- USE THERMOCOUPLES TO MONITOR THE TEMPERATURE.

1 THE DISTANCE IN INCHES OF A 250 WATT HEAT LAMP FROM THE SURFACE OF THE PART

Resin Cure Data
Figure 103

3. References

Reference	Title
51-20-01	PROTECTIVE TREATMENT OF METALLIC AND COMPOSITE MATERIALS
51-30-03	NON-METALLIC MATERIALS
51-30-05	EQUIPMENT AND TOOLS FOR REPAIRS
51-70-04	REPAIR PROCEDURES FOR WET LAYUP MATERIALS
51-70-14	STRUCTURES WITH ALUMINUM COATINGS AND FOILS
AMM 51-21-99 P/B 701	DECORATIVE EXTERIOR PAINT SYSTEM - CLEANING/PAINTING

4. Aluminum Flame-Sprayed Coating

A. Cracks:

(1) Damage up to 6.0 inches maximum length is permitted if:

(a) It does not extend from one edge to another edge of the panel

(b) It does not extend into the corners of the panel.

B. Nicks, Gouges, and Scratches:

(1) Damage is permitted if:

(a) The total area is not more than 4.0 square inches.

C. Holes and Punctures:

(1) Damage up to 4.0 inches in diameter is permitted if there is not more than one damage in a 12 inches by 12 inches area.

5. Aluminum Coated Glass Fabric (BMS 8-278)

A. Cracks:

(1) Damage up to 6.0 inches maximum length is permitted if:

(a) It does not extend from one edge to another edge of the panel

(b) It does not extend to the corners of the panel

(c) There is not more than one crack in a 12 inches by 12 inches area.

B. Nicks, Gouges, and Scratches:

(1) Damage is permitted if the total area of the damage is not more than 4.0 square inches.

C. Dents and delamination are permitted if there are no cracks, slits, or holes.

D. Holes and Punctures:

(1) Damage up to 4.0 inches in diameter is permitted if there is not more than one damage area in a 12 inches by 12 inches area.

6. Bonded Aluminum Foil (BMS 8-289)

A. Cracks:

(1) Damage up to 6.0 inches maximum length is permitted if:

(a) It is not more than 50 percent of the panel dimension

(b) It does not extend from one edge to another edge of the panel

(c) It does not extend to the corners of the panel

(d) There is not more than one crack in a 12 inches by 12 inches area.

B. Nicks, Gouges, and Scratches:

(1) Damage is permitted if the total area of damage is not more than 4.0 square inches.

C. Dents and Delamination are permitted if there are no cracks, slits, or holes.

D. Holes and Punctures:

(1) Damage up to 4.0 inches in diameter is permitted if:

(a) There is not more than one damage area in a 12 inches by 12 inches area.

7. Expanded Aluminum Foil Mesh (BMS 8-336)

A. Cracks:

(1) Damage up to 6.0 inches maximum length is permitted if:

(a) It does not extend from one edge to another edge of the panel

(b) It does not extend to the corners of the panel

(c) There is not more than one crack in a 12 inches by 12 inches area.

B. Nicks, Gouges, and Scratches:

(1) Damage is permitted if the total damage is not more than 4.0 square inches.

C. Dents and Delaminations are permitted if there are no cracks, slits, or holes.

D. Holes and Punctures:

(1) Damage up to 4.0 inches in diameter is permitted if there is not more than one damage in a 12 inches by 12 inches area.

REPAIR GENERAL - STRUCTURES WITH ALUMINUM COATINGS AND FOILS

1. **Applicability**

   A. Repair General gives wet layup and prepreg repairs for damage:

      (1) To the coatings and foils on composite panels as follows:

         (a) Aluminum Flame-Sprayed Coating

         (b) Aluminum Coated Glass Fabric (BMS 8-278)

         (c) Bonded Aluminum Foil (BMS 8-289)

         (d) Expanded Aluminum Foil Mesh (BMS 8-336).

      (2) That is more than the allowable damage limits given in Allowable Damage 1.

   B. Repair General puts back the full conductivity of the aluminum coatings and foils on composite panels.

   C. Repair General does not put back the initial strength or durability of composite panels. Refer to the applicable Chapter-Section-Subject for a repair to the damaged structure.

2. **General**

   A. Additional references that are applicable to this procedure are:

      - AMM PAGEBLOCK 51-21-71/701, SOPM 20-30-03, 51-70-08, GENERAL, 51-70-14, GENERAL, REPAIR 1, REPAIR 2, REPAIR 3, REPAIR 4, 51-20-07, GENERAL

   B. Do as follows before you do the repair.

      (1) Make an inspection of the composite panel for damage.

         (a) Refer to the applicable allowable damage section for the panel you inspect.

      (2) If you find that the damage is more than is permitted in the allowable damage section, then you must do a repair to the panel. Refer to the applicable repair section for the panel.

      (3) If you have removed fasteners and find that there is damage to the fastener holes in the panel, repair the fastener holes as given in the applicable composite repair subject in Chapter 51 (Example: 51-70-04 or 51-70-05, etc.).

   C. Refer to Table 201/REPAIR GENERAL for the repair references of the repairs you need for the aluminum coatings and foils.

Table 201:

REPAIR REFERENCES FOR ALUMINUM COATINGS AND FOILS	
COATING OR FOIL	**REPAIR**
ALUMINUM FLAME SPRAY COATING	1
ALUMINUM COATED GLASS FABRIC (BMS 8-278)	2
BONDED ALUMINUM FOIL (BMS 8-289)	3
EXPANDED ALUMINUM FOIL MESH (BMS 8-336)	4

   D. Refer to 51-10-01 for aerodynamic smoothness requiremennts.

   E. Refer to 51-20-07 for hole drilling and machining of composite structure.

   F. Refer to 51-30-03 for abrasives and other materials you can use to remove the damage.

   G. Refer to 51-30-05 for possible sources of repair materials and equipment.

   H. Refer to 51-30-06 to order the repair materials from the Boeing Company.

I. Make sure you do the repair in a clean area. Do not do these repairs in locations where the air contains oil mist, exhaust fumes, gasses, soot, rain, dust, or unwanted materials. You can use a tent to isolate the repair location from contamination.

J. Prevent contamination of the repair surface. Do not touch the cleaned parts or the adhesives with your bare hands. Wear clean, lint free gloves when you work with these parts.

K. Refer to the applicable repairs for the resins, adhesives, and potting compounds you will use.

L. Store and label the resin, adhesive, and potting compounds you will use in the specific repairs as follows:

(1) Keep the resin systems, adhesives, and potting compounds at a temperature between 40°F and 80°F (4°C and 27°C) in sealed containers.

NOTE: Keep the conductive coating material (BMS 10-21) between 40 to 90°F (4 to 32°C) in sealed containers.

(2) If you remove materials from cold storage, do as follows:

(a) Keep a record of the time when the materials are removed from cold storage.

(b) Let the materials stay at a temperature between 60°F and 75°F (16°C and 24°C) until no more condensation occurs on the container after you dry it with a clean cloth.

(3) Make sure you use the material during its handling life.

(4) Identify all the material containers with a label that has the data that follows:

(a) Boeing Material Specification (BMS)

(b) Type

(c) Class

(d) Name of supplier and product designation

(e) Batch Number.

M. After you do the repair, do as follows:

(1) Apply a finish to the repair area. Refer to AMM 51-21-00/701.

(2) Restore electrical conductivity to the fasteners.

(a) Lightly sand the area with 320 grit abrasive paper.

(b) Wipe the area with a clean cheesecloth or gauze moistened with Methyl Isobutyl Ketone (MIBK) or acetone to remove sanding dust and other contamination.

(c) Attach an aluminum foil strap (0.004 to 0.006 inch thick) to the fastener.

(d) Hold the strap in place with speed tape.

(e) With a resistance meter, make sure that the conductivity has been restored.

NOTE: The resistance should not be more than 1.0 ohm.

3. References

Reference	Title
51-10-01	AERODYNAMIC SMOOTHNESS
51-20-07	MACHINING AND DRILLING OF COMPOSITE STRUCTURES
51-20-07, GENERAL	The Machining and Drilling of Composite Structures and Composite-to-Metal Assemblies
51-30-03	NON-METALLIC MATERIALS
51-30-05	EQUIPMENT AND TOOLS FOR REPAIRS

(Continued)

Reference	Title
51-30-06	COMPOSITE REPAIR MATERIALS
51-70-04	REPAIR PROCEDURES FOR WET LAYUP MATERIALS
51-70-05	REPAIR PROCEDURES FOR PREIMPREGNATED MATERIALS
51-70-08, GENERAL	Resin Sweep-Fair Procedures
51-70-14, GENERAL	Structures With Aluminum Coatings and Foils
AMM 51-21-71 P/B 701	CONDUCTIVE COATING FOR EXTERNAL SURFACES - CLEANING/PAINTING
AMM 51-21-00/701	Interior And Exterior Finishes - Cleaning/Painting
SOPM 20-30-03	Standard Overhaul Practices Manual

4. **The Definition of Terms**

A. The definitions of terms related to the repair of aluminum coatings and foils are as follows:

(1) Bagside: The side of a part or assembly that was cured against the vacuum bag during the manufacture of the part.

(2) Bleeder Cloth: A porous material that supplies a continuous path above and around the part. The bleeder removes the unwanted resin and volatile gasses from the repair.

(3) Breakout: A fiber separation or broken fibers on the surface plies at drilled holes or machined edges.

(4) Breather Cloth: A porous material that supplies a continuous path above and around the part. The bleeder removes the unwanted resin and volatile gasses from the repair.

(5) Butt Splice: Two pieces of material that are adjacent to each other without an overlap to make a continuous surface.

(6) Compaction: The installation of a temporary vacuum bag and vacuum to compress the plies in the layup and remove trapped air.

(7) Cure Cycle: The time, temperature, pressure and the rates of temperature increase and decrease necessary to cure the resin system.

(8) Cure Time: The length of time that a part is at the cure temperature and pressure or vacuum.

(9) Handling Life: The total time that a material can be out of cold storage and still have its tack and drape for forming to the final contour.

(10) Inclusions: Unwanted material such as particles, chips, and films in a cured part.

(11) Instrumented NDT: An inspection that uses instrumentation to find internal defects or flaws in a material.

(12) Layup: The assembly and installation of repair plies impregnated with a laminating resin to a damaged part.

(13) Mechanical Life: The total time a material can be out of cold storage before the start of a cure cycle.

(14) Nondestructive Test (NDT): An inspection procedure that uses methods that do not cause damage to the part.

(15) Pot Life: The time during which a resin system or potting compound can be applied.

(16) Prepreg: Fabric or tape that has been impregnated by the manufacturer.

(17) Room Temperature: Ambient temperature conditions. For engineering functions, this temperature is 68°F (18°C) to 90°F (32°C).

(18) Wet Layup: Repairs made with dry fabric soaked with a laminating resin system.

5. Electrical Criticallity

A. A composite panel is called Electrically Critical if it gives protection from lightning strike damage to wires, fuel components, electrical components, fuel vapor zones, or antennae.

NOTE: You must repair the aluminum coating or foil of an electrically critical composite panel back to its initial conductivity.

B. A composite panel is called Electrically Non-Critical if it gives protection from lightning strike damage to the panel structure only and not to the underlying components.

NOTE: It is optional to repair the aluminum coating or foil of an electrically non-critical composite panel back to its initial conductivity. If you do not put these panels back to the initial conductivity, a subsequent lightning strike can cause more severe damage.

C. Refer to Table 202/REPAIR GENERAL for the references which give the Boeing production drawings for and identify the critical and non-critical panels.

Table 202:

PARAGRAPH REFERENCES FOR LIGHTNING PROTECTION MATERIAL	TABLE
ALUMINUM FLAME SPRAY COATING	203
ALUMINUM COATED GLASS FABRIC (BMS 8-278)	204
BONDED ALUMINUM FOIL (BMS 8-289)	205
EXPANDED ALUMINUM FOIL MESH (BMS 8-336)	206

Table 203:

COMPOSITE PANELS THAT HAVE ALUMINUM FLAME-SPRAYED COATINGS		
DRAWING NUMBER	CRITICAL	NON-CRITICAL
149A7255	X	
149A7751	X	
149A7752	X	
149A7755	X	
149A7756	X	
313A2810	X	
65-46577	X	

NOTE: Refer to Figure 1 of SRM 51-70-14 for a description and the locations of the composite panels.

Table 204:

COMPOSITE PANELS THAT HAVE ALUMINUM COATED GLASS FABRIC (BMS 8-278)		
DRAWING NUMBER	CRITICAL	NON-CRITICAL
116A1210		X
116A1310	X	
116A2132	X	
116A5411		X
116A5421		X

COMPOSITE PANELS THAT HAVE ALUMINUM COATED GLASS FABRIC (BMS 8-278)		
DRAWING NUMBER	CRITICAL	NON-CRITICAL
116A5431		X
116A5441		X
116A8501	X	
116A9111	X	
116A9121	X	

NOTE: Refer to Figure 2 of SRM 51-70-14 for a description and the locations of the composite panels.

Table 205:

COMPOSITE PANELS THAT HAVE BONDED ALUMINUM FOIL (BMS 8-289)		
DRAWING NUMBER	CRITICAL	NON-CRITICAL
116A1210		X
116A1310	X	
116A2132	X	
116A5411		X
116A5421		X
116A5431		X
116A5441		X
116A8501	X	
116A9111	X	
116A9121	X	
313A2111	X	
313A2121	X	
313A2211	X	
313A2231	X	

NOTE: Refer to Figure 3 of SRM 51-70-14 for a description and the locations of the composite panels.

Table 206:

COMPOSITE PANELS THAT HAVE EXPANDED ALUMINUM FOIL MESH (BMS 8-336)		
DRAWING NUMBER	CRITICAL	NON-CRITICAL
115A2521	X	
115A2523	X	
115A2524	X	
115A2720	X	
115A2722	X	
115A2724	X	
115A3523	X	
115A4920	X	

COMPOSITE PANELS THAT HAVE EXPANDED ALUMINUM FOIL MESH (BMS 8-336)		
DRAWING NUMBER	**CRITICAL**	**NON-CRITICAL**
115A4921	X	
115A4923	X	
116A1210		X
116A1310	X	
116A2132	X	
116A5411		X
116A5441		X
116A8501	X	
116A9111	X	
116A9121	X	
116A7156	X	
116A7157	X	
149A7548	X	
149A7552	X	
149A7554	X	
149A7555	X	
149A7557	X	
149A7562	X	
173A6210		X
189A1001	X	
189A1002		X
313A2111	X	
313A2121	X	
313A2211	X	
313A2221	X	
313A2231	X	
313A2561	X	

NOTE: Refer to Figure 4 of SRM 51-70-14 for a description and the locations of the composite panels.

D. Protection from lightning strike damage is applied to areas of the airplane. The effects of lightning strike can be direct or indirect.

(1) Usually the direct effects are the damage caused at points of attachment of the lightning column from heat or mechanical forces.

(2) The indirect effects of this type of damage are caused by lightning currents that flow through the airplane structure. This causes induced voltages (or coupling) to the electronic systems on the airplane. This can be a significant problem when it is associated with flight control wiring.

REPAIR 1 - DAMAGE TO ALUMINIM FLAME-SPRAY COATINGS ON COMPOSITE PANELS

1. **Applicability**

   A. Repair 1 restores electrical continuity to Aluminum Flame-Spray Coatings on Composite panels that:

      (1) Have damage that is more than permitted in 51-70-14, Allowable Damage General.

   B. Repair 1 is not applicable to the composite structure that is covered by the aluminum flame-spray coatings.

      (1) Refer to the applicable Chapter-Section-Subject for a repair to the composite panel.

2. **General**

   A. Repair 1 is:

      (1) Necessary for electrically critical panels with aluminum flame-spray coatings

      (2) Optional for electrically non-critical panels with aluminum flame-spray coatings.

   B. Refer to SRM 51-70-14, Repair General, Table 203 for the identification of the electrically critical and electrically non-critical panels.

   C. Remove the damage as follows:

      (1) Refer to 51-30-03 for the possible sources of abrasives and other materials you can use.

      (2) Refer to 51-30-05 for the possible sources of equipment and tools you can use to remove the damage.

      (3) Find the limits of the damage and prepare the repair area. Refer to Flame Spray Repair, Figure 201/REPAIR 1.

      CAUTION: DO NOT USE CHEMICAL PAINT STRIPPERS TO REMOVE THE DAMAGED ALUMINUM FLAME-SPRAY COATINGS ON COMPOSITE STRUCTURES. IF YOU DO NOT OBEY, YOU CAN DAMAGE THE PARTS.

         (a) Isolate the area. Apply masking tape.

         (b) Remove the fasteners, if necessary.

         (c) Remove the fasteners that give the electrical bond to the airplane structure.

         NOTE: The removal of the fasteners that give the electrical bond before you apply the aluminum flame-spray coating is optional. If these fasteners are removed after the coating is applied, it is possible that removal and repair of the coating on the fastener head is necessary.

      CAUTION: DO NOT SAND INTO THE PLIES BELOW THE FLAME-SPRAY COATING. IF YOU DO NOT OBEY, DAMAGE TO THE STRUCTURE WILL OCCUR.

         (d) Lightly sand the damaged area with 180-grit or finer abrasive paper. Remove all the loose flame-sprayed aluminum.

         (e) Remove the finish to a minimum of 1.00 inch around the edge of the damage with 240-grit or finer abrasive paper.

         NOTE: Do not sand through the flame-sprayed aluminum.

WARNING: KEEP THE SOLVENTS AWAY FROM SOURCES OF HEAT, FIRE OR SPARKS. IF YOU DO NOT OBEY, AN EXPLOSION CAN OCCUR. DO NOT PERMIT THE SOLVENTS TO TOUCH YOUR SKIN, EYES OR CLOTHING. DO NOT BREATHE THE VAPORS. WEAR PROTECTIVE CLOTHING AND EYE PROTECTION. MAKE SURE THERE IS A GOOD FLOW OF CLEAN AIR. IN A CONFINED SPACE, USE MECHANICAL VENTILATION OR RESPIRATORY PROTECTION. INJURY TO PERSONS CAN OCCUR.

CAUTION: DO NOT LET THE SOLVENTS STAY ON THE PARTS. IF YOU DO NOT OBEY, DAMAGE TO THE PARTS CAN OCCUR.

D. Clean the damaged areas with a clean cheesecloth that is made moist with Methyl Isobutyl Ketone (MIBK), trichloroethane, or acetone.

(1) Remove all unwanted materials.

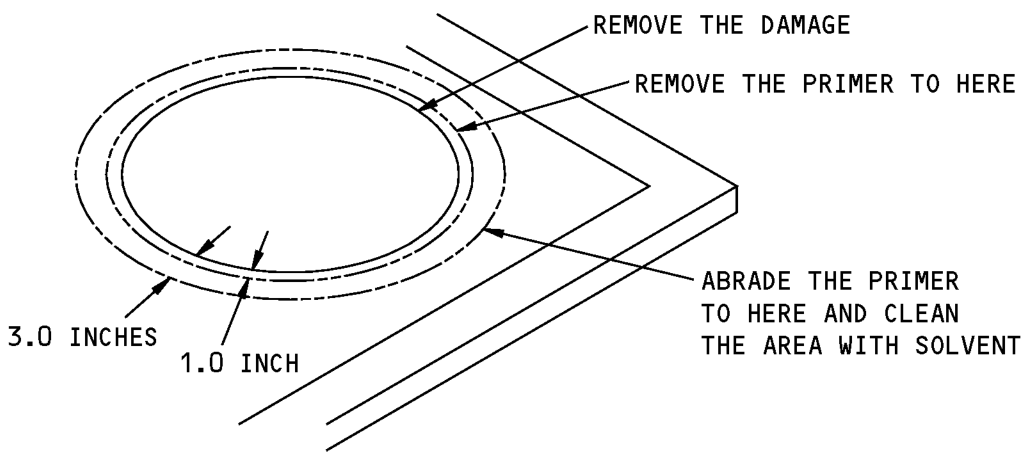
E. Apply a chemical conversion coating to all the exposed surfaces of the flame-sprayed aluminum. Refer to 51-20-01.

F. Do the repair. Refer to Table 201/REPAIR 1 for a list of references for the different types of repairs.

G. As an alternative, you can repair the aluminum flame-spray coating with expanded aluminum foil mesh (BMS 8-336). Refer to Repair 4 for the repair procedures.

Table 201:

PARAGRAPH REFERENCES FOR THE DIFFERENT TYPES OF REPAIRS THAT APPLY TO ALUMINUM FLAME-SPRAYED PARTS	
TYPE OF REPAIR	**PARAGRAPH**
Interim Repair	4
Permanent Repair With Flame-Spray	5
Permanent Repair With Aluminum Flame-Spray and PVA	6
Permanent Repair With Aluminum Foil (Speed Tape 3M-436)	7
Permanent Repair With Aluminum Foil Tape and BMS 5-95 Sealant	8



PREPARATION OF THE DAMAGE AREA

Flame Spray Repair
Figure 201

3. References

Reference	Title
51-20-01	PROTECTIVE TREATMENT OF METALLIC AND COMPOSITE MATERIALS
51-20-01, GENERAL	Protective Treatment of Metallic and Composite Materials
51-20-05	REPAIR SEALING
51-30-03	NON-METALLIC MATERIALS
51-30-03, GENERAL	Sources for Non-Metallic Repair Materials
51-30-05	EQUIPMENT AND TOOLS FOR REPAIRS
51-30-05, GENERAL	Equipment and Tools For Repairs
51-70-09	BONDED METAL STRUCTURE REPAIR PROCEDURES
51-70-09, GENERAL	Metal-To-Metal Structural Repair Adhesive Bond Procedures
51-70-14, GENERAL	Structures With Aluminum Coatings and Foils
AMM 51-21-81 P/B 701	ABRASION-RESISTANT TEFLON FINISH - CLEANING/PAINTING
AMM 51-21-99 P/B 701	DECORATIVE EXTERIOR PAINT SYSTEM - CLEANING/PAINTING
SOPM 20-10-06	Repair of Conductive Coatings
SOPM 20-41-02	Application of Chemical and Solvent Resistant Finishes
SOPM 20-44-04	Application of Urethane Compatible Primers

4. Interim Repair

A. Do an interim repair as shown in Interim Flame Spray Repair, Figure 202/REPAIR 1 if:

(1) It is not possible to do a permanent repair. Refer to Table 201/REPAIR 1 for the permanent repairs.

(2) The cracks on the damaged flame-spray coatings are less than 0.25 inch in width.

(3) The damage in one area is less than 4.0 square inches.

(4) The total damage for each panel is 10 percent or less.

(a) Do a permanent repair given in Table 201/REPAIR 1 if these limits are exceeded.

B. Find the limits of the damage and prepare the repair area as given in Paragraph 2.C./REPAIR 1

C. Mix the components of the conductive coating.

NOTE: The mixture is supplied in two-component kits with the base material and activator. Refer to Table 202/REPAIR 1 for the types of components. The addresses for the suppliers for the conductive coating are as follows:

- Supplier [1]: Courtaulds Aerospace, 1608 4th street, Berkely, CA 94710
- Supplier [2]: Crown Metro Aerospace, Dexter Aerospace Division, P.O.Box 5695, 315 Echelon Road, Donaldson Center, Greenville, S.C. 29606
- Supplier [3]: Akzo Coating Inc., 434 West Meats Blvd. Orange, CA 92661

Table 202:

MIXING RATIO AND POT LIFE FOR BMS 10-21, TYPE III			
SUPPLIERS	COMPONENTS	MIXING RATIO	POT LIFE
[1]	Base 528 X 310	1	4 hours at temperatures below 81°F (27°C)
	Activator 910 X 464	1	2 hours for temperatures from 81°F (27°C) to 100°F (37°C)

MIXING RATIO AND POT LIFE FOR BMS 10-21, TYPE III			
SUPPLIERS	COMPONENTS	MIXING RATIO	POT LIFE
[2]	Base 10-P2-3	3	8 hours at temperatures below 81°F (27°C)
	Activator EC-110	1	4 hours for temperatures from 81°F (27°C) to 100°F (37°C)
[3]	Base 463-6-84	3	4 hours at temperatures below 81°F (27°C)
	Activator X-566	1	2 hours for temperatures from 81°F (27°C) to 100°F (37°C)

(1) Shake the base material thoroughly on a paint shaker before you mix in the activator.

(2) Stir the base material. Add the activator to the base material while you stir.

(3) Label the container immediately after mixing with the information that follows:

(a) Date and time of mixing

(b) Pot life expiration time.

(4) Do not use materials that have exceeded their pot life.

(5) Allow mixture to stand a minimum of 30 minutes at 70°F (21°C) to 80°F (27°C) before you apply it.

(6) Cover the container to prevent contamination and loss of the mixture.

D. Apply the conductive coating mixture.

(1) Apply the conductive coating mixture by spray or brush to a dry film thickness of 0.0004 to 0.0008 inch. Make sure you have the thickness you need.

(a) Put the edge of a metallic panel against the damaged part so that the surfaces are flush.

(b) Apply the conductive coating to both parts.

(c) Measure the dry film thickness on the metallic panel.

(d) As an alternative, you can measure the coating that is on the installed fasteners or inserts.

E. Cure the repair.

WARNING: FOR A HIGH-TEMPERATURE CURE, USE HEAT CURING EQUIPMENT THAT AGREES WITH THE FIRE AND SAFETY CODES OF THE LOCAL FIRE PROTECTION AUTHORITIES. IF YOU DO NOT OBEY, INJURY TO PERSONS CAN OCCUR.

(1) If you cure the repair at a minimum of 125°F (52°C), use the cure cycle shown in Cure Cycle Data, Figure 203/REPAIR 1.

(2) If heat lamp is used as a heat source, refer to Resin Mix 1 Cure Data and Heat Lamp Temperature Data, Figure 204/REPAIR 1 for temperature data.

NOTE: For a high temperature cure, the flash-off time is 15 minutes at room temperature.

(3) For a high temperature cure, the cool-off time is 15 minutes at room temperature.

(4) Let the coating applied to countersink areas dry 20 minutes at 70°F (21°C) to 90°F (32°C) before you install the fasteners.

F. Measure the resistance of the coating.

(1) Measure the resistance for each square inch of the coating with an ohmmeter and 3M conductive electric tape. Take a minimum of three readings.

(a) Check the reading of the ohmmeter.

(b) Measure the electrical resistance of a test resistor.

(2) If the resistance is greater than 300,000 ohms, apply the conductive coating again as follows:

(a) Lightly abrade the area with 240-grit or smaller abrasive paper. Do not sand through the coating.

(b) Wipe the coated area with a clean cheesecloth moistened with Methyl Isobutyl Ketone (MIBK), trichloroethane, or acetone.

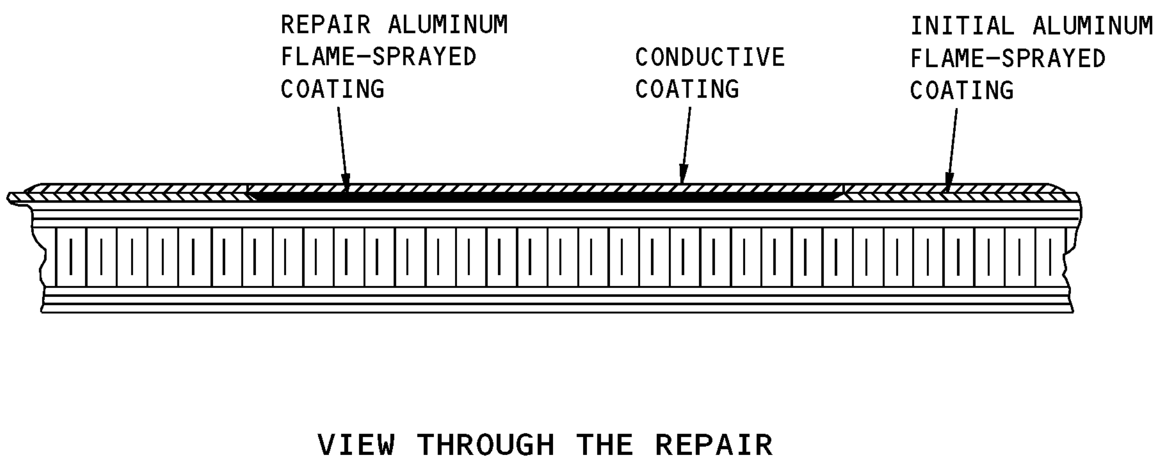
(c) Mix, apply, and cure the conductive coating as given in Paragraph 4.C./REPAIR 1 through Paragraph 4.E./REPAIR 1

(d) Measure the resistance as given in Paragraph 4.F./REPAIR 1

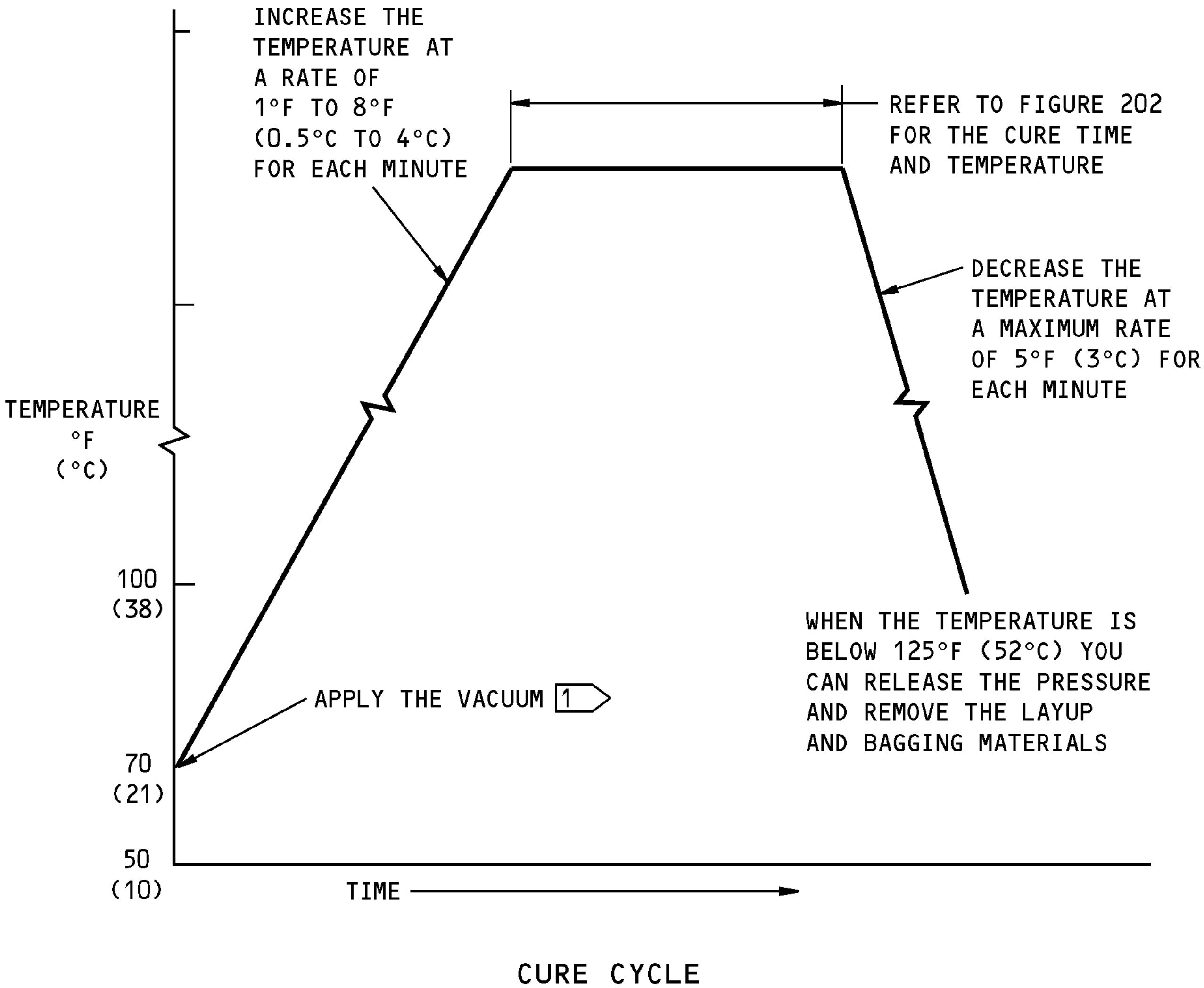
(e) Repeat the steps as necessary until the resistance is 300,000 ohms or less.

G. Apply a layer of BMS 10-103, Type I primer, as necessary.

H. Apply the finish to the repair area. Refer to AMM PAGEBLOCK 51-21-99/701.



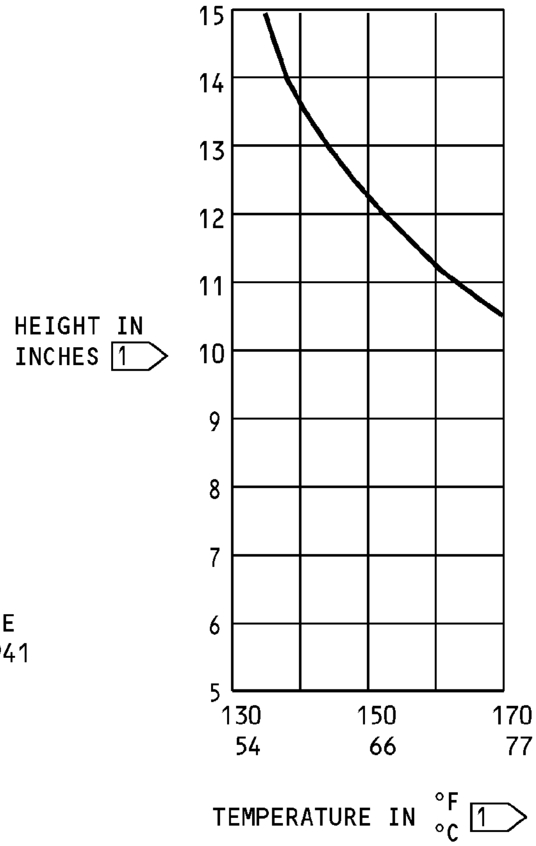
Interim Flame Spray Repair
Figure 202

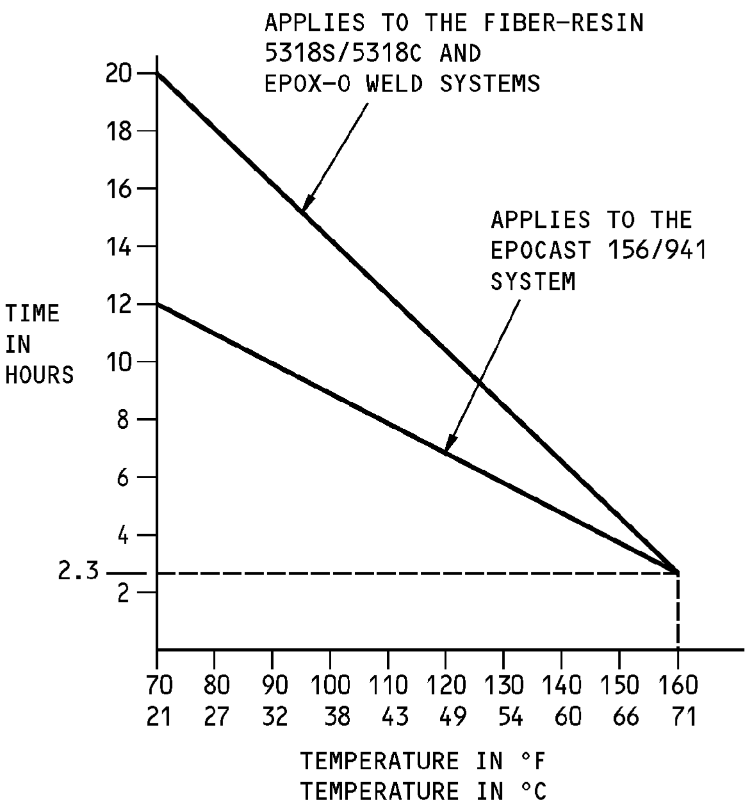


NOTES

1 KEEP A MINIMUM VACUUM OF 22 INCHES OF MERCURY DURING THE FULL CURE CYCLE AND FOLLOW THE TEMPERATURE PROFILE THAT IS SHOWN.

Cure Cycle Data
Figure 203





NOTES

- USE THERMOCOUPLES TO MONITOR THE TEMPERATURE.
- IF YOU CURE THE RESIN AT 125°F (52°C) OR HOTTER, USE THE CURE CYCLE SHOWN IN FIGURE 203.

1 THE HEIGHT IN INCHES OF A 250 WATT HEAT LAMP FROM THE SURFACE OF THE PART (WHERE THE RESIN HAS BEEN APPLIED) VERSUS THE TEMPERATURE AT THAT SURFACE.

Resin Mix 1 Cure Data and Heat Lamp Temperature Data
Figure 204

5. **Permanent Repair With Flame-Spray**

A. Do a permanent repair of the aluminum flame-spray coating with flame-spray as shown in Permanent Flame Spray Repair, Figure 205/REPAIR 1. Refer to Table 201/REPAIR 1 for other permanent repairs.

NOTE: As an alternative, you can do the permanent repair in Paragraph 6./REPAIR 1, or 8.

(1) Find the limits of the damage and prepare the repair area as given in Paragraph 2.C./REPAIR 1

(2) Apply the aluminum flame-spray.

(a) Apply aluminum flame-spray coating to a thickness of 0.010 to 0.012 inch to the damaged area.

(b) Apply the flame-spray coating with a 0.125 inch diameter pure aluminum wire as given in AMS 4180.

1) Use a Metco 8E or 11E gun or the equivalent. Refer to the vendor's instructions to apply the coating.

NOTE: The vendor for the Metco 8E and 11E guns is: Metco Inc. 1105 Prospect Avenue Westbury, NY 11590

(c) Apply the spray coating at a work distance (gun to surface) of 4.0 to 8.0 inches.

NOTE: If you spray with MAPP Gas, a maximum gun-to-surface distance of 10 inches is permitted.

CAUTION: DO NOT PERMIT THE SURFACE TEMPERATURE OF THE PART TO BE MORE THAN 120°F (49°C). AN UNSATISFACTORY COATING (BUCKLED, CRACKED OR LIFTED) CAN OCCUR.

(d) Use a surface pyrometer to monitor the temperature of the part.

(e) Apply the flame-spray aluminum coatings evenly.

1) Gradually add more coatings over the repair area.

2) Apply the coatings over and over at the rate of 10 to 22 inches per second.

3) Make an overlap on each past coatings by one-third of the spray width.

(f) Find the thickness of the flame-spray aluminum coating with one of the procedures that follows:

1) Measure the thickness of the material on the masking tape.

a) Remove the flame-spray material from the masking tape (outside the repair area).

b) Measure one sample for every 6 inches of flame-spray edge, or a minimum of two samples.

2) Measure the thickness of the material on a piece of laminate.

a) Measure the thickness of the laminate on the side opposite the surface to be flame-sprayed.

b) Make a record of the measurement.

c) After you apply the flame-spray, measure the thickness at that location again and calculate the thickness of the coating.

d) Do a check of the thickness every 6 inches or do a minimum of 2 measurements for each part.

(3) Remove the masking tape.

WARNING: THESE CHEMICALS ARE TOXIC. MAKE SURE THAT THERE IS A GOOD FLOW OF CLEAN AIR WHEN YOU WORK WITH THE COMPONENTS OF THE RESIN. USE CARE TO PROTECT YOUR SKIN, EYES, AND CLOTHING. IF CONTAMINATION DOES OCCUR, WASH WITH SOAP AND WARM WATER. DO NOT USE SOLVENTS TO CLEAN YOUR SKIN. IF YOU DO NOT OBEY, INJURY TO PERSONS CAN OCCUR.

CAUTION: DO NOT USE WAXED CONTAINERS TO MIX THE COMPONENTS OF THE RESIN. IF YOU DO, CONTAMINATION OF THE RESIN WILL OCCUR.

(4) Mix the components of BMS 8-207, Type 1, Class 1 resin systems as given in Table 203.

NOTE: You can make the EC1838 (BMS 8-207, Type 1, Class 1) thinner with up to 10 parts lacquer thinner (TT-T-266) per 100 parts catalyzed resin. This will make it easier to apply the resin.

Table 203:

RESIN DATA				
RESIN TYPE	**COMPONENTS**	**PARTS BY WEIGHT**	**POT LIFE**	**CURE TIME**
BMS 8-207, TYPE 1, CLASS 1	EC1838A (Resin)	50	20 minutes at 75 to 79°F (24 to 26°C)	2 hours at 105 to 125°F (41 to 52°C)
	EC1838B (Hardener)	50		

(5) Apply the resin smoothly and equally on all of the over-sprayed area.

WARNING: FOR A HIGH TEMPERATURE CURE, USE HEAT CURE EQUIPMENT THAT AGREES WITH THE FIRE AND SAFETY CODES PERMITTED BY THE LOCAL FIRE PROTECTION AUTHORITY. IF YOU DO NOT OBEY, INJURY TO PERSONS CAN OCCUR.

(6) Cure the resin as given in Table 203.

(a) If you cure the repair at a minimum of 125°F (52°C), use the cure cycle shown in Cure Cycle Data, Figure 206/REPAIR 1.

(7) Sand the flame-sprayed area to a smooth surface that is flush with adjacent area. Use 240-grit wet or dry abrasive paper.

WARNING: KEEP THE SOLVENTS AWAY FROM SOURCES OF HEAT, FIRE OR SPARKS. IF YOU DO NOT OBEY, AN EXPLOSION CAN OCCUR. DO NOT PERMIT THE SOLVENTS TO TOUCH YOUR SKIN, EYES OR CLOTHING. DO NOT BREATHE THE VAPORS. WEAR PROTECTIVE CLOTHING AND EYE PROTECTION. MAKE SURE THERE IS A GOOD FLOW OF CLEAN AIR. IN A CONFINED SPACE, USE MECHANICAL VENTILATION OR RESPIRATORY PROTECTION. INJURY TO PERSONS CAN OCCUR.

CAUTION: DO NOT LET THE SOLVENTS STAY ON THE PARTS. DAMAGE TO THE PARTS CAN OCCUR.

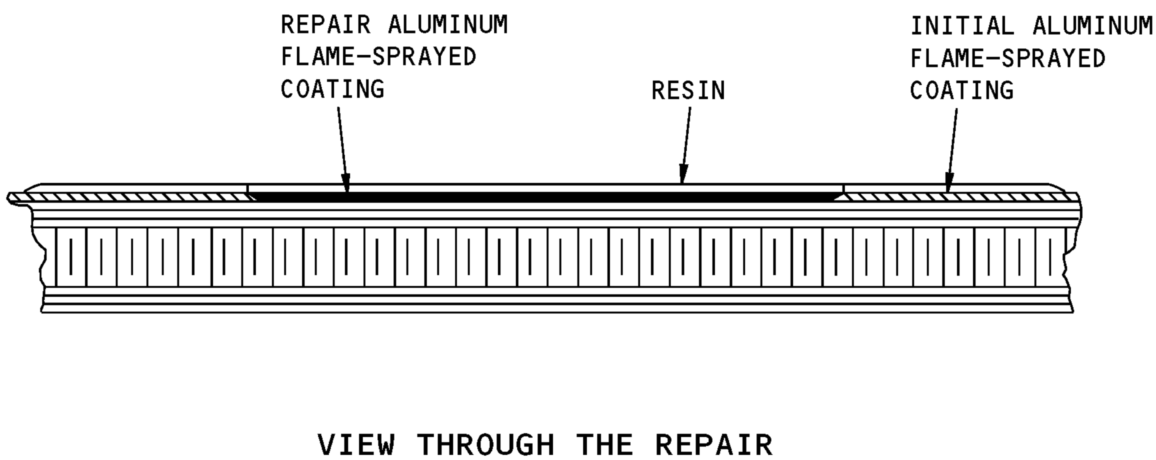
(8) Clean the area with a clean cheesecloth that is moist with Methyl Isobutyl Ketone (MIBK), trichloroethane, or acetone.

(9) Remove all of the sanding dust and other unwanted materials.

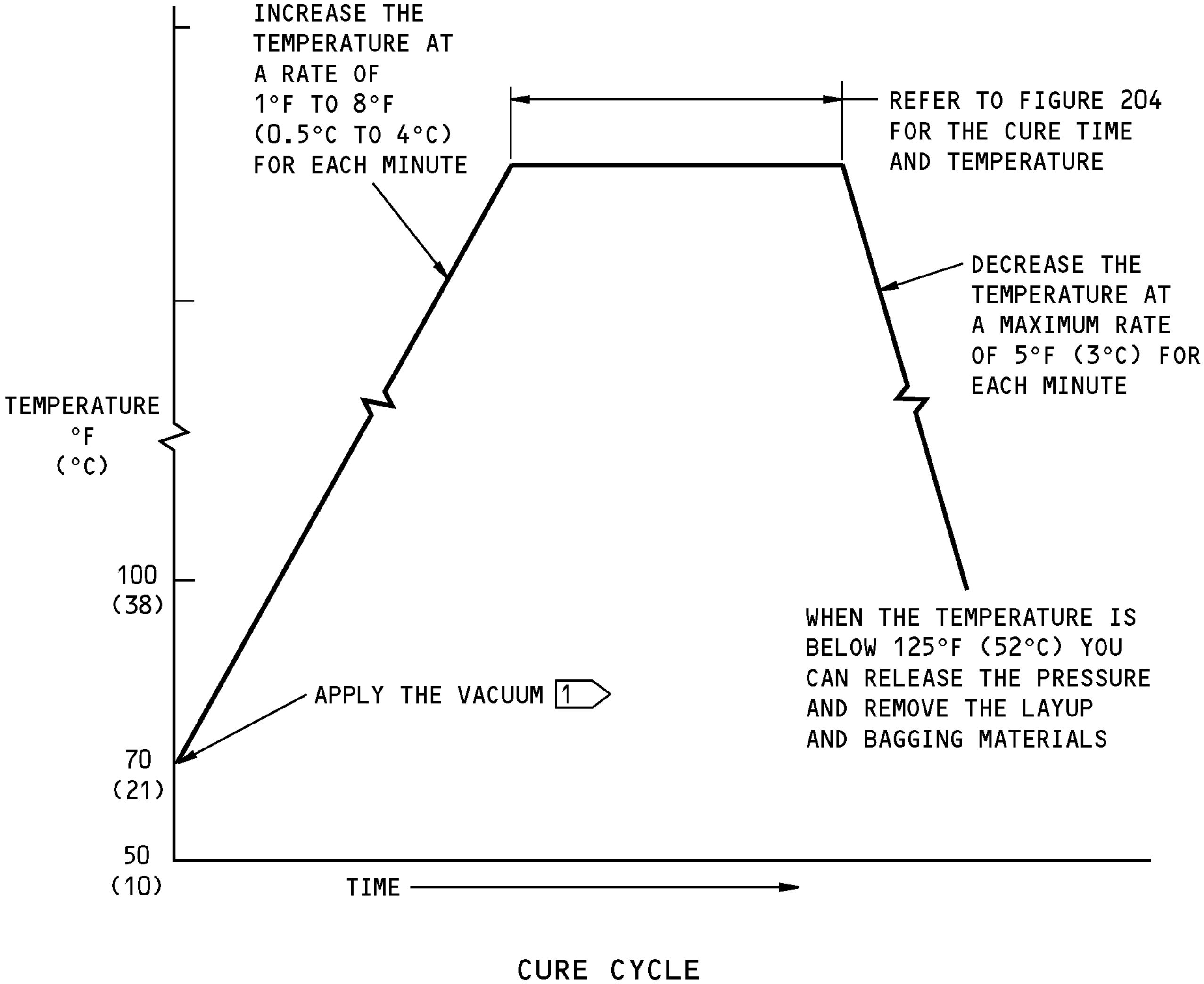
(10) Apply a chemical conversion coating to all of the exposed flame-sprayed surfaces. Refer to 51-20-01.

(11) Apply one layer of BMS 10-79, Type 3 primer as necessary. Refer to SOPM 20-44-04.

(12) Apply the finish to the repair area. Refer to AMM PAGEBLOCK 51-21-99/701.



Permanent Flame Spray Repair
Figure 205



NOTES

1 KEEP A MINIMUM VACUUM OF 22 INCHES OF MERCURY DURING THE FULL CURE CYCLE

Cure Cycle Data
Figure 206

THIS FIGURE HAS
BEEN REMOVED

Heat Lamp Temperature Data and BMS 8-201, Type II Resin Cure Data
Figure 207

6. Permanent Repair With Aluminum Flame-Spray and PVA

A. Do a permanent repair of the aluminum flame-spray coating with flame-spray and PVA as shown in Flame Spray Repair, Figure 208/REPAIR 1. Refer to Table 201/REPAIR 1 for other permanent repairs.

NOTE: As an alternative, you can do the permanent repair in Paragraph 5./REPAIR 1, or 8.

(1) Find the limits of the damage and prepare the repair area as given in Paragraph 2.C./REPAIR 1

(2) Apply a piece of PVA film to the repair area.

(a) Cut a piece of PVA film that is larger than the repair area. Use tape to fasten it to a smooth, flat surface.

(3) Apply the flame-spray aluminum coating and the sealing resin to the PVA film as given in Paragraphs 5.E thru 5.I.

(a) Cut the flame-sprayed PVA film to match the flame-spray area on the panel.

(b) Cut a 0.020 inch thick aluminum caul plate to the same size as the flame-sprayed PVA film.

(4) Apply a ply of glass fabric to the repair area.

(a) Cut a piece of BMS 9-3, Type H-2 or H-3 glass fabric that is larger than the initial glass fabric isolation ply.

(b) Cut two pieces of parting film that is 3 inches larger than the glass fabric.

(c) Use tape to hold one piece of parting film to a smooth surface.

(d) Put the glass fabric onto the parting film.

WARNING: THESE CHEMICALS ARE TOXIC. MAKE SURE THAT THERE IS A GOOD FLOW OF CLEAN AIR WHEN YOU WORK WITH THE COMPONENTS OF THE ADHESIVE. USE CARE TO PROTECT YOUR SKIN, EYES, AND CLOTHING. IF CONTAMINATION DOES OCCUR, WASH WITH SOAP AND WARM WATER. DO NOT USE SOLVENTS TO CLEAN YOUR SKIN. IF YOU DO NOT OBEY, INJURY CAN OCCUR.

CAUTION: DO NOT USE WAXED CONTAINERS TO MIX THE COMPONENTS OF THE ADHESIVE. IF YOU DO NOT OBEY, CONTAMINATION OF THE ADHESIVE WILL OCCUR.

(5) Mix the components of BMS 5-92, Type I adhesive as given in Table 204/REPAIR 1.

Table 204:

ADHESIVE DATA				
ADHESIVE TYPE	**COMPONENTS**	**PARTS BY WEIGHT**	**POT LIFE**	**CURE TIME**
BMS 5-92, TYPE 1	EC2216A (Gray)	140	2 hours below 100°F (38°C)	170 to 190 minute at 110 to 130°F (43 to 54°C) or 120 to 140 minute at 150 to 170°F (66 to 76°C)
	EC2216B (White)	100		

(a) Apply the adhesive smoothly and equally over the glass fabric.

(b) Apply a second piece of parting film over the glass fabric.

(c) Move the adhesive smoothly and equally with a squeegee or a roller to impregnate the fabric and to remove trapped air.

(d) Move the adhesive that is not needed to the edges of the fabric.

(e) Cut the impregnated glass fabric to the same dimension as the initial glass fabric isolation ply.

NOTE: The use of parting film on the two sides of the fabric will reduce fraying of the fabric edges while you cut the fabric.

(6) Remove the parting film from the glass fabric.

CAUTION: MAKE SURE THE PARTING FILM IS REMOVED FROM THE GLASS FABRIC BEFORE YOU DO THE LAYUP AND CURE THE REPAIR. IF YOU DO NOT OBEY, THE REPAIR WILL BE UNSATISFACTORY.

(a) Remove the parting film from one side of the glass fabric and put the face you have access to on the repair area.

(b) Remove the wrinkles and trapped air with a squeegee. Do not apply heavy pressure. The results could be unsatisfactory in the repair adhesive.

(c) Remove the second piece of parting film from the glass fabric.

(7) Apply the BMS 5-92, Type I adhesive

(a) Apply one layer of BMS 5-92, Type I adhesive to the aluminum surface of the flame-sprayed PVA film that is accessible.

(b) Put the flame-sprayed PVA film (with the PVA film outwards) on top of the glass fabric ply.

(c) Remove the wrinkles and trapped air with a squeegee or roller.

(8) Do the layup procedure, shown in Layout of the Vacuum Bag Materials - Full Replacement of an Aluminum Flame-Sprayed Area with Aluminum Flame-Spray and PVA, Figure 209/REPAIR 1, as follows:

(a) Put a layer of perforated FEP parting film (0.001 inch thick) over the repair area. Cut the FEP so that the edges go 3 inches past and all around past the edge of the repair area.

(b) For the high-temperature cure, install three thermocouples spaced evenly around the repair area. Connect the thermocouples to the applicable recorders.

(c) Put a layer of glass fabric over the perforated FEP for a surface breather. Cut the breather so that the edges go two inches past and all around the edge of the perforated FEP.

(d) Install a vacuum line on the edge of the surface breather.

(e) Put a layer of solid FEP parting film (0.002 inches thick) over the surface breather. Cut the solid FEP so that the edges are even with the perforated FEP.

(f) Put the aluminum caul plate over the solid FEP.

(9) Prepare the repair for the cure procedures.

WARNING: FOR A HIGH-TEMPERATURE CURE, USE HEAT CURING EQUIPMENT THAT AGREES WITH THE LOCAL FIRE PROTECTION AUTHORITIES. IF YOU DO NOT OBEY, INJURY TO PERSONS CAN OCCUR.

(a) If you use a heat blanket as a heat source, do the steps that follow:

NOTE: You can use a heat blanket, infrared heat lamp or the equivalent to accelerate the cure. If the structure is too small to permit the heat blanket to fit in the vacuum bag, do Steps 9.(b) thru 9.(f) and put the heat blanket over the vacuum bag.

(b) Put the heat blanket over the caul plate. The heat blanket must go a minimum of two inches beyond the edge of the repair.

(c) Put the thermocouple over the center of the heat blanket.

(d) Put four to six layers of glass fabric over the heat blanket.

NOTE: The glass fabric prevents the heat blanket from damages to the bagging film.

(e) Apply sealing compound around all of the edge of the repair area to approximately 6 inches outside the edge of the heat blanket.

(f) Put a piece of vacuum bag material fully over the repair area and seal the edge with sealing compound. Make folds in the bag material as necessary to prevent connections and subsequent breakage. Apply protective pads to all the sharp corners and edges to prevent breakage. As an option, put a vacuum bag material fully over the part.

NOTE: If the repair includes more that 15 percent of the panel area, you must fully put a vacuum bag material over the part. This will help prevent delamination and distortion of the part. If you use the heat source that is available, you must use devices that holds back and maintains the contour of the part. This is also true for large parts where sinking in the middle and distortion can occur from the weight of the part.

(10) Do a check of the vacuum bag for leaks.

NOTE: A vacuum bag which has leak can cause porosity in the repair and bond failure.

(a) Apply a minimum vacuum of 22 inches of mercury to the bag.

WARNING: FOR THE HIGH-TEMPERATURE CURE, USE HEAT CURING EQUIPMENT THAT AGREES WITH THE LOCAL FIRE PROTECTION AUTHORITIES. IF YOU DO NOT OBEY, INJURY TO PERSONS CAN OCCUR.

(11) Cure the repair.

(a) Refer to Table 204/REPAIR 1 for the cure temperature and time data.

NOTE: If you cure the adhesive at 125°F (52°C) or hotter, use the cure cycle shown in Cure Cycle Data, Figure 206/REPAIR 1. You can use a heat blanket, infrared heat lamp or the equivalent to accelerate the cure. The cure time does not include the time that is necessary for the part to get to the cure temperature. The cure time begins when the part is at the cure temperature.

(b) Use the measurement from the thermocouple with the lowest value at the edge of the repair as the cure temperature.

(c) Keep a vacuum of 22 inches of mercury minimum during the cure cycle.

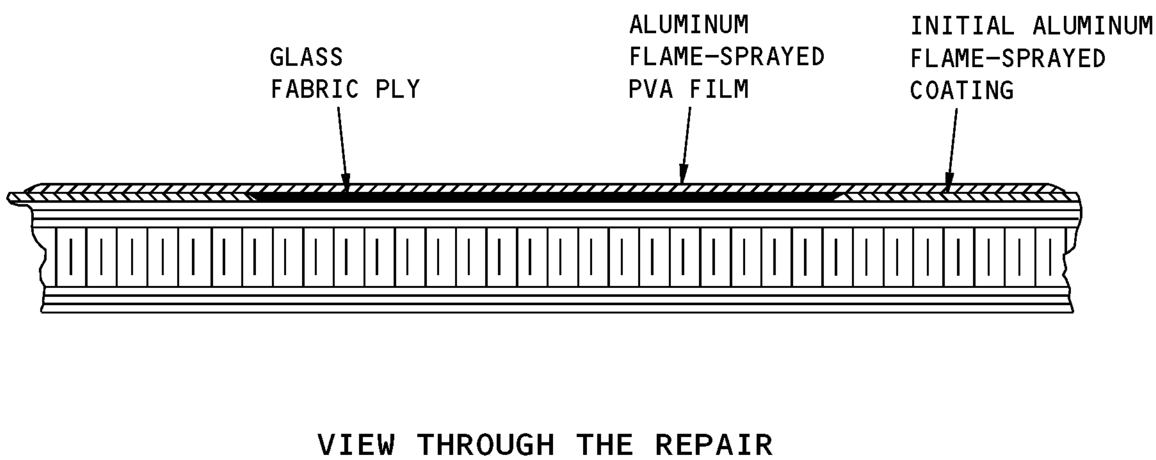
(12) Remove the vacuum bag materials.

(13) Remove the PVA film from the flame-spray area.

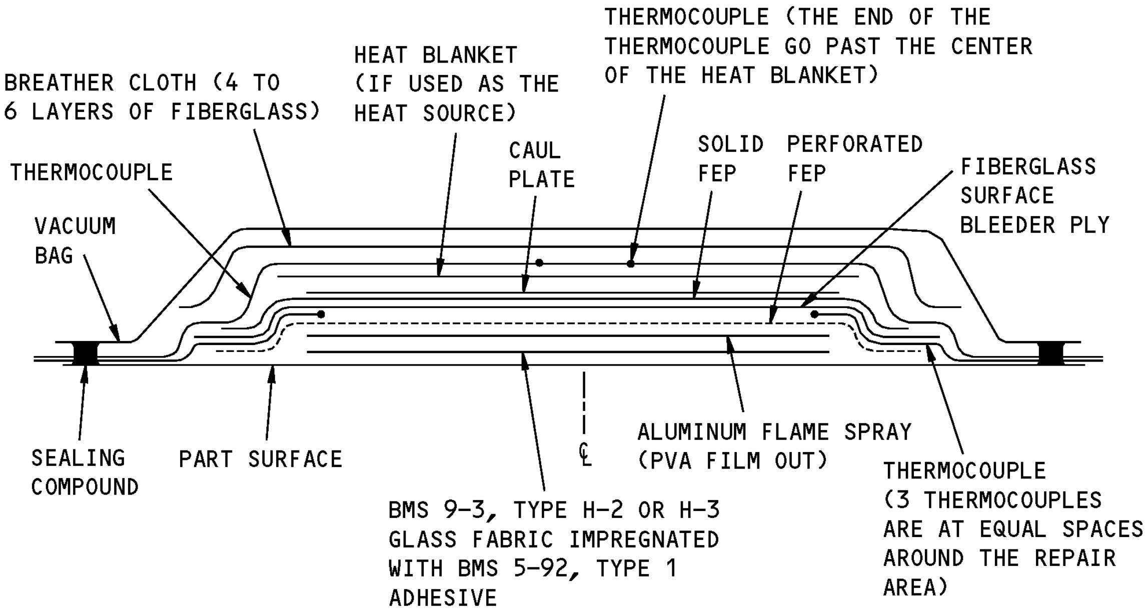
(14) Install the fasteners, as necessary.

(15) Apply a chemical conversion coating to the flame-spray aluminum surface. Refer to 51-20-01.

(16) Apply one layer of BMS 10-79, Type 3 primer as necessary. Refer to SOPM 20-44-04.



Flame Spray Repair
Figure 208



Layout of the Vacuum Bag Materials - Full Replacement of an Aluminum Flame-Sprayed Area with Aluminum Flame-Spray and PVA
Figure 209

7. Permanent Repair With Aluminum Foil (Speed Tape 3M-436)

A. Do a permanent repair of the aluminum flame-spray coating with aluminum foil as shown in Flame Spray Repair, Figure 210/REPAIR 1. Refer to Table 201/REPAIR 1 for other permanent repairs.

NOTE: As an alternative, you can do the permanent repair in Paragraph 5./REPAIR 1, or 8.

(1) Find the limits of the damage and prepare the repair area as given in Paragraph 2.C./REPAIR 1

(2) Make the repair parts. Refer to Table 205/REPAIR 1 for the materials.

Table 205:

REPAIR MATERIALS	
REPAIR MATERIALS	SPECIFICATION
Repair Ply	3M-436 Speed Tape
Glass Fabric Ply	BMS 9-3, Type H-2 or H-3
Adhesive Type 1	BMS 5-92

(3) Apply the repair ply.

(a) Cut a piece of 0.010 to 0.012 inch thick aluminum foil sheet to the same dimension as the initial flame-spray area.

(b) Clean and apply a chemical conversion layer to all the surfaces of the aluminum foil sheet. Refer to 51-70-09.

(4) Apply a ply of glass fabric to the repair area as given in Paragraph 6.I.

(5) Apply one layer of BMS 5-92, Type I adhesive to the repair area.

(6) Apply one layer of BMS 5-92, Type I adhesive to the mating surface of the aluminum foil sheet.

(7) Put the aluminum foil sheet with the adhesive coating on top of the glass fabric.

(8) Remove the wrinkles and trapped air with a squeegee or roller.

(9) Do the layup procedure as shown in Layout of the Vacuum Bag Materials - Full Replacement of an Aluminum Flame-Sprayed Area with Aluminum Foil, Figure 211/REPAIR 1.

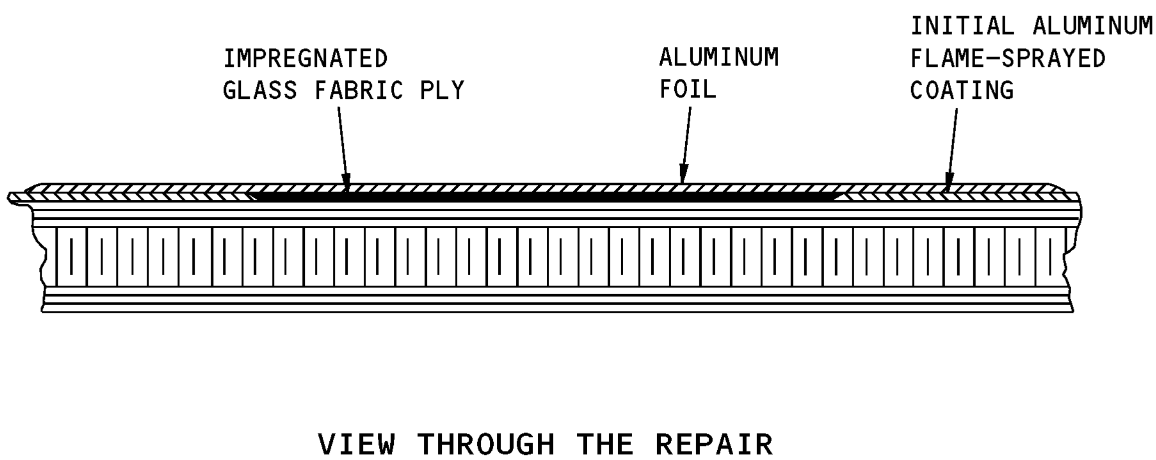
(10) Cure the repair as given in Paragraph 6./REPAIR 1

(a) Refer to Table 204/REPAIR 1 for the cure temperature and time data.

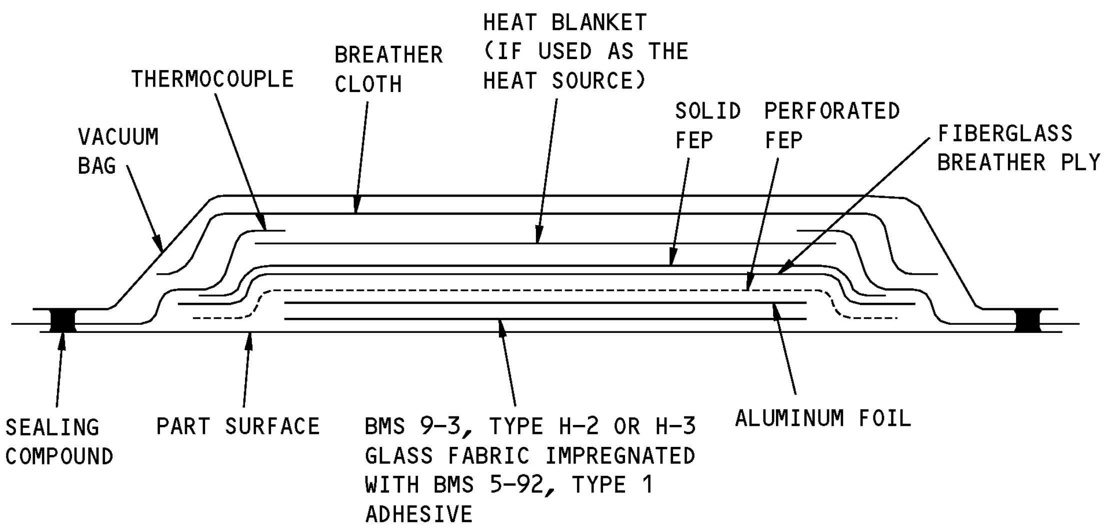
(11) Remove the vacuum bag materials.

(12) Install the fasteners, as necessary.

(13) Apply one layer of BMS 10-79, Type 3 primer as necessary. Refer to SOPM 20-44-04.



Flame Spray Repair
Figure 210



Layout of the Vacuum Bag Materials - Full Replacement of an Aluminum Flame-Sprayed Area with Aluminum Foil
Figure 211

8. **Permanent Repair With Aluminum Foil Tape and BMS 5-95 Sealant**

A. Do a permanent repair with aluminum foil tape and BMS 5-95 sealant as shown in Aluminum Foil Tape Repair, Figure 212/REPAIR 1. Refer to Table 201/REPAIR 1 for other permanent repairs.

NOTE: As an alternative, you can do the permanent repair in Paragraph 5./REPAIR 1, or 7.

(1) Find the limits of the damage and prepare the repair area as given in Paragraph 2.C./REPAIR 1

(2) Make the repair parts. Refer to Table 206/REPAIR 1 for the materials.

Table 206:

REPAIR MATERIALS	
REPAIR MATERIALS	SPECIFICATION
Repair Ply	3M-436 Speed Tape
Repair Splice	3M-436 Speed Tape
Cover Ply	3M-436 Speed Tape
Sealant	BMS 5-95

(3) Apply the repair ply already in the parts list to the damaged area.

(a) Make a butt-splice to the repair ply with no overlaps.

NOTE: A maximum separation of 0.25 inch is permitted.

(b) Apply pressure to the repair ply with a roller or squeegee to remove the air bubbles.

(c) Apply a chemical conversion layer to the repair ply and sanded aluminum coated glass fabric surfaces.

(4) Apply the repair splice already in the parts list.

(a) Apply a chemical conversion layer to the mating surfaces at the tape.

(b) Make holes in repair splice centerline that are 0.50 inch in diameter (nominal) and 2.00 inches apart (nominal, centerline to centerline) as shown in Aluminum Foil Tape Repair, Figure 212/REPAIR 1.

(c) With the adhesive side up, put the repair splice in the center of the butt-splice (overlap 1.00 inch each side).

(5) Apply the cover ply.

(a) Make an overlap of 1.00 inch to repair splice.

(b) Apply pressure to the cover ply with a roller or squeegee to remove the air bubbles.

(6) Measure the conductivity of the repair to the initial surface. The resistance must not be more than 0.10 ohms.

(7) Apply a chemical conversion layer to the cover ply and sanded aluminum coated glass fabric surfaces. Refer to 51-20-01.

(8) Fillet seal all around the edges of the cover ply with the BMS 5-95 sealant. Refer to 51-20-05.

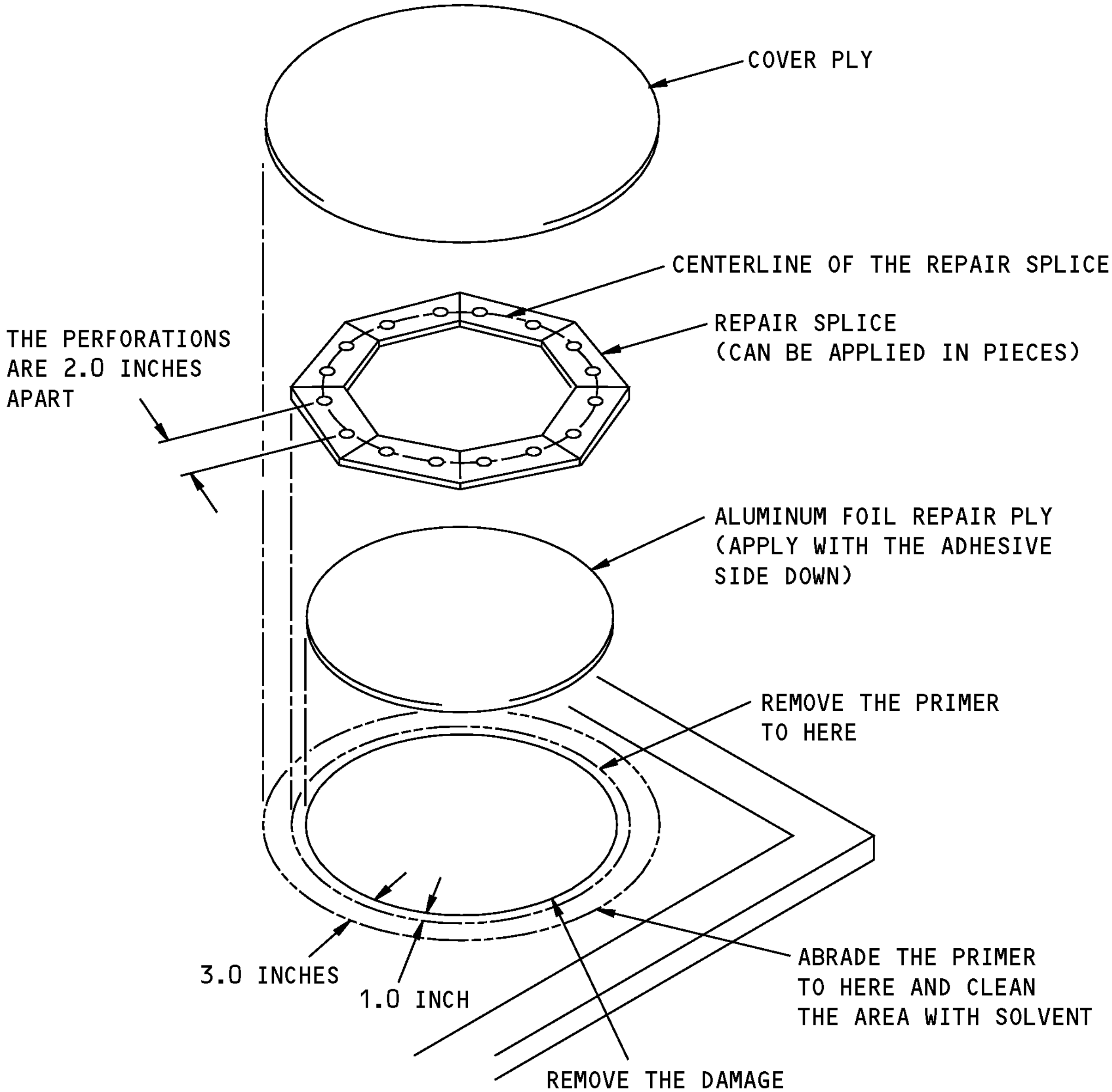
NOTE: A completed seal of the cover plies edge is very important. The quality of the repair can decrease if this procedure is not completed.

(a) To make the sealant cure faster, cure the sealant at 150°F (66°C).

(9) Install the fasteners, as necessary.

(10) Apply a layer of BMS 10-103, Type I primer, as necessary.

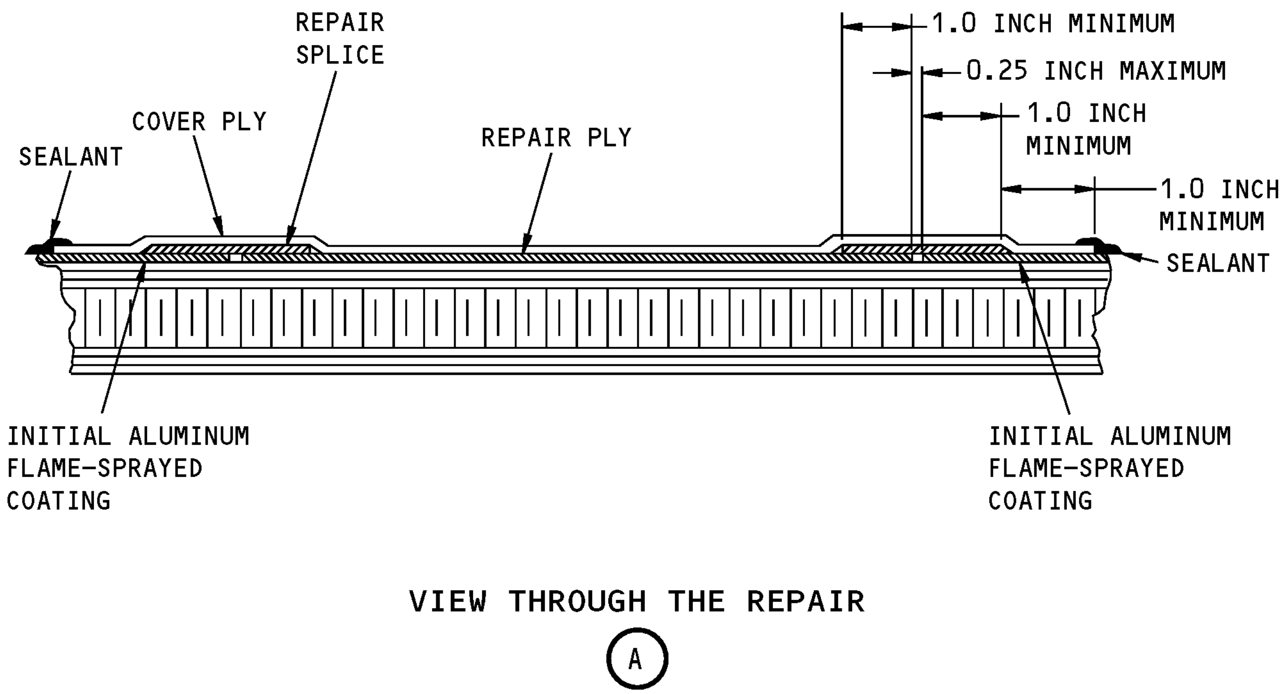
(11) Apply the finish to the repair area. Refer to AMM PAGEBLOCK 51-21-99/701.



NOTE: REFER TO DETAIL A FOR A VIEW THROUGH THE REPAIR.

REPAIR PLY LAYUP

Aluminum Foil Tape Repair
Figure 212 (Sheet 1 of 2)



Aluminum Foil Tape Repair
Figure 212 (Sheet 2 of 2)

REPAIR 2 - DAMAGE TO ALUMINUM COATED GLASS FABRIC (BMS 8-278) ON COMPOSITE PANELS

1. **Applicability**

   A. Repair 2 restores electrical continuity to Aluminum Coated Glass Fabric (BMS 8-278) on Composite Panels that:

      (1) Have damage that is more than permitted in 51-70-14, Allowable Damage General.

   B. Repair 2 is not applicable to the composite structure that is covered by the coated glass fabric.

      (1) Refer to the applicable Chapter-Section-Subject for a repair to the composite panel.

2. **General**

   A. Repair 2 is:

      (1) Necessary for electrically critical panels with coated glass fabric (BMS 8-278)

      (2) Optional for electrically non-critical panels with coated glass fabric (BMS 8-278).

   B. Refer to SRM 51-70-14, Repair General, Table 204 for the identification of the electrically critical and electrically non-critical panels.

   C. Refer to 51-30-03 for the possible sources of abrasives and other materials you can use.

   D. Refer to 51-30-05 for possible sources of the equipment and tools you can use to remove the damage.

   E. Refer to Table 201/REPAIR 2 for a list of references for the different types of repairs.

   F. As an alternative, you can repair aluminum coated glass fabric (BMS 8-278) with expanded aluminum foil mesh (BMS 8-336). Refer to Repair 4 for the repair procedures.

Table 201:

PARAGRAPH REFERENCES FOR THE DIFFERENT TYPES OF REPAIRS THAT APPLY TO ALUMINUM COATED GLASS FABRIC (BMS 8-278) ON COMPOSITE PANELS	
TYPE OF REPAIR	**PARAGRAPH**
Interim Repair	4.A
Permanent Repair (Aluminum Flame-Spray and Conductive Coating)	4.B
Permanent Repair (Aluminum Foil Tape and BMS 5-95 Sealant)	4.C

3. **References**

Reference	Title
51-20-01	PROTECTIVE TREATMENT OF METALLIC AND COMPOSITE MATERIALS
51-20-01, GENERAL	Protective Treatment of Metallic and Composite Materials
51-20-05	REPAIR SEALING
51-30-03	NON-METALLIC MATERIALS
51-30-03, GENERAL	Sources for Non-Metallic Repair Materials
51-30-05	EQUIPMENT AND TOOLS FOR REPAIRS
51-30-05, GENERAL	Equipment and Tools For Repairs
51-70-09, GENERAL	Metal-To-Metal Structural Repair Adhesive Bond Procedures
51-70-14, ALLOWABLE DAMAGE GENERAL	Damage Limits and Sealing Instructions for Aluminum Coatings and Foils
51-70-14, GENERAL	Structures With Aluminum Coatings and Foils
AMM 51-21-81 P/B 701	ABRASION-RESISTANT TEFLON FINISH - CLEANING/PAINTING

(Continued)

Reference	Title
AMM 51-21-99 P/B 701	DECORATIVE EXTERIOR PAINT SYSTEM - CLEANING/PAINTING
SOPM 20-10-06	Repair of Conductive Coatings
SOPM 20-41-02	Application of Chemical and Solvent Resistant Finishes

4. **Repair Instructions**

A. Do an interim repair if it is not possible to do a permanent repair given in Paragraph 4.A.(2)/REPAIR 2 or Paragraph 4.B./REPAIR 2

(1) Find the limits of the damage.

WARNING: KEEP THE SOLVENTS AWAY FROM SOURCES OF HEAT, FIRE OR SPARKS. IF YOU DO NOT OBEY, AN EXPLOSION CAN OCCUR. DO NOT PERMIT THE SOLVENTS TO TOUCH YOUR SKIN, EYES OR CLOTHING. DO NOT BREATHE THE VAPORS. WEAR PROTECTIVE CLOTHING AND EYE PROTECTION. MAKE SURE THERE IS A GOOD FLOW OF CLEAN AIR. IN A CONFINED SPACE, USE MECHANICAL VENTILATION OR RESPIRATORY PROTECTION. IF YOU DO NOT OBEY, INJURY TO PERSONS CAN OCCUR.

CAUTION: DO NOT LET THE SOLVENTS STAY ON THE PARTS. IF YOU DO NOT OBEY, DAMAGE TO THE PARTS CAN OCCUR.

(2) Prepare the repair area. Refer to Application of Conductive Coating to Repairs of Aluminum Coated Glass Fabric (BMS 8-278), Figure 201/REPAIR 2.

(a) Clean the damaged areas with a clean cheesecloth that is made moist with Methyl Isobutyl Ketone (MIBK), trichloroethane, or acetone.

(b) Remove all unwanted materials.

(3) Apply aluminum foil tape (speed tape 3M-436) to the damaged area.

(a) Clean the areas to be coated with conductive coating with a clean cheesecloth that is made moist with Methyl Isobutyl Ketone (MIBK), trichloroethane, or acetone.

1) Remove all unwanted materials.

(4) Mix the components of the conductive coating.

NOTE: The mixture is supplied in two-component kits with the base material and activator. Refer to Table 202/REPAIR 2 for the types of components. The addresses for the suppliers for the conductive coating are as follows:

- Supplier [1]: Courtaulds Aerospace 1608 4th Street Berkeley, CA 94710
- Supplier [2]: Crown Metro Aerospace Dexter Aerospace Division P.O. Box 5695 315 Echelon Road, Donaldson Center Greenville, SC 29606
- Supplier [3]: Akzo Coating Inc. 434 West Meats Blvd. Orange, CA 92661

Table 202:

MIXING RATIO AND POT LIFE FOR BMS 10-21, TYPE III			
SUPPLIERS	COMPONENTS	MIXING RATIO	POT LIFE
[1]	Base 528 X 310	1	4 hours at temperatures below 81°F (27°C)
	Activator 910 X 464	1	2 hours for temperatures from 81°F (27°C) to 100°F (37°C)
[2]	Base 10-P2-3	3	8 hours at temperatures below 81°F (27°C)

MIXING RATIO AND POT LIFE FOR BMS 10-21, TYPE III			
SUPPLIERS	COMPONENTS	MIXING RATIO	POT LIFE
	Activator EC-110	1	4 hours for temperatures from 81°F (27°C) to 100°F (37°C)
[3]	Base 463-6-84	3	4 hours at temperatures below 81°F (27°C
	Activator X-566	1	2 hours for temperatures from 81°F (27°C) to 100°F (37°C)

(a) Shake the base material thoroughly on a paint shaker before you mix in the activator.

(b) Stir the base material. Add the activator to the base material while you stir.

(c) Label the container immediately after mixing with the information that follows:

1) Date and time of mixing

2) Pot life expiration time.

(d) Do not use materials that have exceeded their pot life.

(e) Allow mixture to stand a minimum of 30 minutes at 70°F (21°C) to 80°F (27°C) before you apply it.

(f) Cover the container to prevent contamination and loss of the mixture.

(5) Apply the conductive coating mixture.

(a) Apply the conductive coating mixture by spray or brush to:

1) The aluminum foil tape and out to the dimpled washers as shown in Application of Conductive Coating to Repairs of Aluminum Coated Glass Fabric (BMS 8-278), Figure 201/REPAIR 2.

2) A dry film thickness of 0.0004 to 0.0008 inch. Make sure you have the thickness you need.

(b) Put the edge of a metallic panel against the damaged part so that the surfaces are flush.

(c) Apply the conductive coating to both parts.

(d) Measure the dry film thickness on the metallic panel.

(e) As an alternative, you can measure the coating that is on the installed fasteners or inserts.

(6) Cure the repair.

WARNING: FOR A HIGH-TEMPERATURE CURE, USE HEAT CURING EQUIPMENT THAT AGREES WITH THE FIRE AND SAFETY CODES OF THE LOCAL FIRE PROTECTION AUTHORITIES. IF YOU DO NOT OBEY, INJURY TO PERSONS CAN OCCUR.

(a) If you cure the repair at a minimum of 125°F (52°C), use the cure cycle shown in Cure Cycle Data, Figure 203/REPAIR 2.

(b) If heat lamp is used as a heat source, refer to Resin Mix 1 Cure Data and Heat Lamp Temperature Data, Figure 202/REPAIR 2 for temperature data.

NOTE: For a high temperature cure, the flash-off time is 15 minutes at room temperature.

(c) For a high temperature cure, the cool-off time is 15 minutes at room temperature.

(d) Let the coating applied to countersink areas dry 20 minutes at 70°F (21°C) to 90°F (32°C) before you install the fasteners.

(7) Measure the resistance of the coating.

(a) Measure the resistance for each square inch of the coating with an ohmmeter and 3M conductive electric tape. Take a minimum of three readings.

1) Check the reading of the ohmmeter.

2) Measure the electrical resistance of a test resistor.

(b) If the resistance is greater than 300,000 ohms, apply the conductive coating again as follows:

1) Lightly abrade the area with 240-grit or smaller abrasive paper. Do not sand through the coating.

2) Wipe the coated area with a clean cheesecloth moistened with Methyl Isobutyl Ketone (MIBK), trichloroethane, or acetone.

3) Mix, apply, and cure the conductive coating as given in paragraphs 4.A.(4) through 4.A.(6).

4) Measure the resistance as given in paragraph 4.A.(7).

5) Repeat the steps as necessary until the resistance is 300,000 ohms or less.

(8) Apply a layer of BMS 10-103, Type I primer, as necessary.

(9) Apply the finish to the repair area. Refer to AMM PAGEBLOCK 51-21-99/701.

B. Do a permanent repair with aluminum flame spray and conductive coating. Refer to Flame Spray Repair, Figure 204/REPAIR 2.

NOTE: As an alternative, you can do a permanent repair with aluminum foil tape and BMS 5-95 sealant as given in Paragraph 4.B./REPAIR 2

(1) Find the limits of the damage.

(2) Prepare the repair area.

(a) Isolate the repair area with masking tape.

CAUTION: USE CARE SO YOU DO NOT CAUSE DAMAGE TO THE GLASS FIBERS OF THE COMPONENT UNDER THE DAMAGED FOIL. IF YOU DO NOT OBEY, DAMAGE TO THE STRUCTURE WILL OCCUR.

(b) Remove the finish in the damaged area up to 1.00 inch all around the damage with 240-grit abrasive paper.

(c) Remove the damage with 150-grit or smaller abrasive paper.

WARNING: KEEP THE SOLVENTS AWAY FROM SOURCES OF HEAT, FIRE OR SPARKS. IF YOU DO NOT OBEY, AN EXPLOSION CAN OCCUR. DO NOT PERMIT THE SOLVENTS TO TOUCH YOUR SKIN, EYES OR CLOTHING. DO NOT THE BREATHE VAPORS. WEAR PROTECTIVE CLOTHING AND EYE PROTECTION. MAKE SURE THERE IS A GOOD FLOW OF CLEAN AIR. IN A CONFINED SPACE, USE MECHANICAL VENTILATION OR RESPIRATORY PROTECTION. IF YOU DO NOT OBEY, INJURY TO PERSONS CAN OCCUR.

CAUTION: DO NOT LET THE SOLVENTS STAY ON THE PART. IF YOU DO NOT OBEY, DAMAGE TO THE PART WILL OCCUR.

(d) Clean the exposed composite surface of the repair area with a clean cheesecloth that is made moist with Methyl Isobutyl Ketone (MIBK), trichloroethane, or acetone.

(e) Remove all of the sanding dust and other unwanted materials.

(3) Apply the aluminum flame-spray coating to a thickness of 0.010 to 0.012 inch. Refer to Repair 1 for the procedures.

(4) Remove the masking tape.

WARNING: THESE CHEMICALS ARE TOXIC. MAKE SURE THAT THERE IS A GOOD FLOW OF CLEAN AIR WHEN YOU WORK WITH THE COMPONENTS OF THE RESIN. USE CARE TO PROTECT YOUR SKIN, EYES, AND CLOTHING. IF CONTAMINATION DOES OCCUR, WASH WITH SOAP AND WARM WATER. DO NOT USE SOLVENTS TO CLEAN YOUR SKIN. IF YOU DO NOT OBEY, INJURY TO PERSONS CAN OCCUR.

CAUTION: DO NOT USE WAXED CONTAINERS TO MIX THE COMPONENTS OF THE RESIN. IF YOU DO NOT OBEY, CONTAMINATION OF THE RESIN WILL OCCUR.

(5) Mix the components of Resin Mix 1 given in Table 203/REPAIR 2.

Table 203:

RESIN MIX 1 DATA				
RESIN TYPE	**COMPONENTS**	**PARTS BY WEIGHT**	**POT LIFE**	**CURE TIME**
RESIN MIX 1	Epibond 156A	100 ±2	45 to 60 minutes 70°F (21°C)	6 to 8 hours at 70°F (21°C)
	Epibond 156B	5 ±0.3		
RESIN MIX 1 (ALTERNATIVE)	FR 4178A	100 ±2	45 to 60 minutes 70°F (21°C)	Refer to Figure 202
	FR 4178B	50 ±1		
RESIN MIX 1 (ALTERNATIVE)	EPOX-O WELD (Two component kit)	Refer to the manufacturer's instructions	45 to 60 minutes 70°F (21°C)	Refer to Figure 202
RESIN MIX 1 (ALTERNATIVE)	Epibond 156A	100 ±2	45 to 60 minutes 70°F (21°C)	Refer to Figure 202
	Epibond 941	10 ±0.5		

(6) Apply the resin to the repair area.

(7) Cure the resin as given in Table 203/REPAIR 2.

WARNING: FOR A HIGH-TEMPERATURE CURE, USE HEAT CURING EQUIPMENT THAT AGREES WITH THE FIRE AND SAFETY CODES OF THE LOCAL FIRE PROTECTION AUTHORITIES. IF YOU DO NOT OBEY, INJURY TO PERSONS CAN OCCUR.

(a) If you cure the repair at a minimum of 125°F (52°C), use the cure cycle shown in Cure Cycle Data, Figure 203/REPAIR 2.

(b) If heat lamp is used as a heat source, refer to Resin Mix 1 Cure Data and Heat Lamp Temperature Data, Figure 202/REPAIR 2 for temperature data.

(8) Sand the repair area with 240-grit or finer adhesive paper to a smooth surface that is flush with the adjacent surface.

(9) Apply the conductive coating mixture. Refer to paragraph 4.A.(4).

(a) Apply the conductive coating mixture by spray or brush to a dry film thickness of 0.0004 to 0.0008 inch.

(10) Refer to Paragraphs 4.A.(6) and 4.A.(7) for the cure and resistance measurement of the conductive coating.

(11) Apply a layer of BMS 10-103, Type I primer, as necessary.

(12) Apply the finish to the repair area. Refer to AMM PAGEBLOCK 51-21-99/701.

C. Do a permanent repair with aluminum foil tape and BMS 5-95 sealant. Refer to Aluminum Foil Tape Repair, Figure 205/REPAIR 2.

NOTE: As an alternative, you can do a permanent repair with aluminum flame spray and conductive coating as given in Paragraph 4.A.(2)/REPAIR 2

(1) Find the limits of the damage.

(2) Prepare the repair. Refer to Table 204/REPAIR 2 for the repair materials.

Table 204:

REPAIR MATERIALS	
REPAIR MATERIALS	SPECIFICATION
Repair Ply 1	3M-436 Speed Tape
Repair Splice	3M-436 Speed Tape
Cover Ply	3M-436 Speed Tape
Sealant	BMS 5-95

(a) Isolate the area that surrounds the damage with masking tape.

CAUTION: USE CARE SO YOU DO NOT CAUSE DAMAGE TO THE GLASS FIBERS OF THE COMPONENT UNDER THE DAMAGED FOIL. IF YOU DO NOT OBEY, DAMAGE TO THE STRUCTURE WILL OCCUR.

(b) Remove the finish in the damaged area up to 2.00 inches around the damage with 240-grit abrasive paper.

(c) Remove the damage with 150-grit or smaller abrasive paper.

WARNING: KEEP THE SOLVENTS AWAY FROM SOURCES OF HEAT, FIRE OR SPARKS. IF YOU DO NOT OBEY, AN EXPLOSION CAN OCCUR. DO NOT PERMIT THE SOLVENTS TO TOUCH YOUR SKIN, EYES OR CLOTHING. DO NOT BREATHE VAPORS. WEAR PROTECTIVE CLOTHING AND EYE PROTECTION. MAKE SURE THERE IS A GOOD FLOW OF CLEAN AIR. IN A CONFINED SPACE, USE MECHANICAL VENTILATION OR RESPIRATORY PROTECTION. IF YOU DO NOT OBEY, INJURY TO PERSONS CAN OCCUR.

CAUTION: DO NOT LET THE SOLVENTS STAY ON THE PART. IF YOU DO NOT OBEY, DAMAGE TO THE PART CAN OCCUR.

(d) Clean the exposed composite surface of the repair area with a clean cheesecloth that is moist with Methyl Isobutyl Ketone (MIBK), trichloroethane, or acetone.

(e) Remove all of the sanding dust and other unwanted materials.

(3) Apply a repair ply made from aluminum foil tape (speed tape 3M-436) to the damaged area.

(a) Make a butt-splice to the repair ply with no overlaps.

NOTE: A maximum separation of 0.25 inch is permitted.

(b) Apply pressure to the repair ply with a roller or squeegee to remove the air bubbles.

(c) Apply a chemical conversion layer to the repair ply and sanded aluminum coated glass fabric surfaces.

(4) Apply a 2.00 inch repair splice made from aluminum foil tape.

(a) Apply a chemical conversion layer to the surface of the tape.

(b) Make holes in repair splice centerline that are 0.50 inch in diameter (nominal) and 2.00 inches apart (nominal, centerline to centerline) as shown in Aluminum Foil Tape Repair, Figure 205/REPAIR 2.

(c) With the adhesive side up, put the repair splice in the center of the butt-splice (overlap 1.00 inch each side).

(5) Apply a cover ply made from aluminum foil tape to the damaged area.

(a) Make an overlap of 1.00 inch to repair splice.

(b) Apply pressure to the cover ply with a roller or squeegee to remove the air bubbles.

(6) Measure the conductivity of the repair to the initial surface. The resistance must not be more than 0.10 ohms.

(7) Apply a chemical conversion layer to the cover ply and sanded aluminum coated glass fabric surfaces. Refer to 51-20-01.

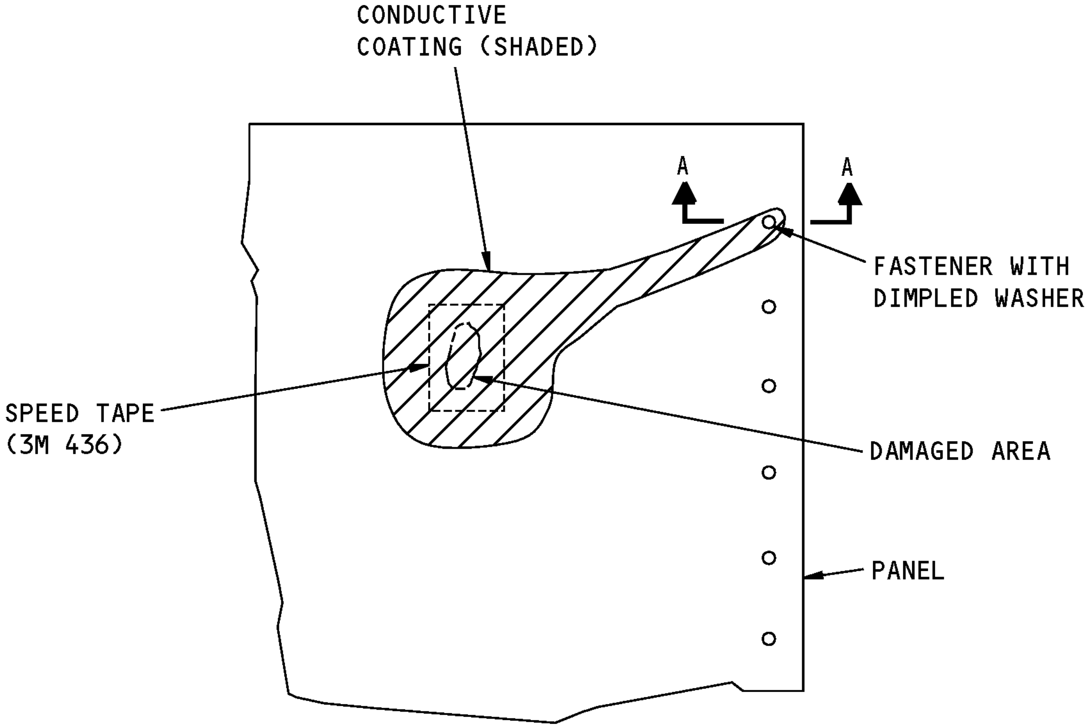
(8) Fillet seal all around the edges of the cover ply with the BMS 5-95 sealant. Refer to 51-20-05.

NOTE: A completed seal of the cover plies edge is very important. The quality of the repair can decrease if this procedure is not completed.

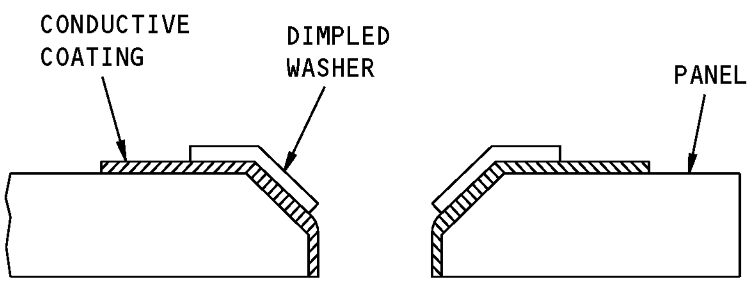
(a) To make the sealant cure faster, cure the sealant at 150°F (66°C).

(9) Apply a layer of BMS 10-103, Type I primer, as necessary.

(10) Apply the finish to the repair area. Refer to AMM PAGEBLOCK 51-21-99/701.



VIEW ON PANEL

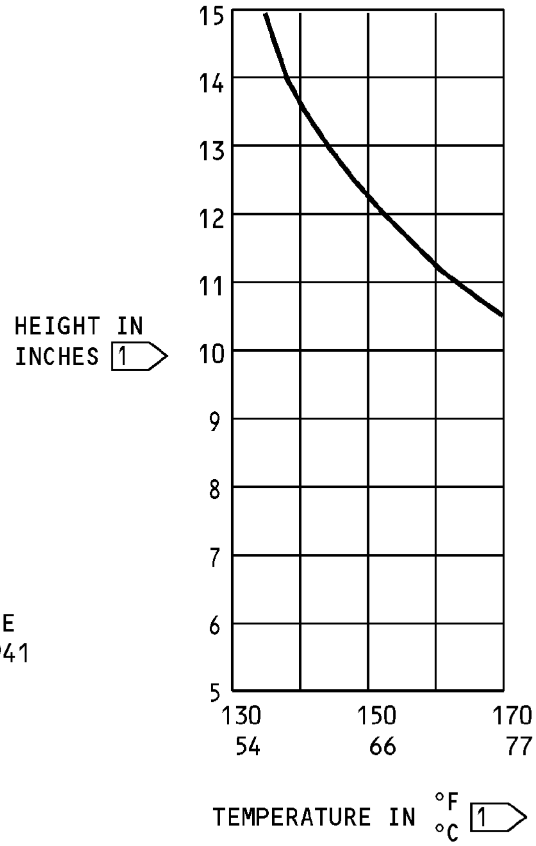


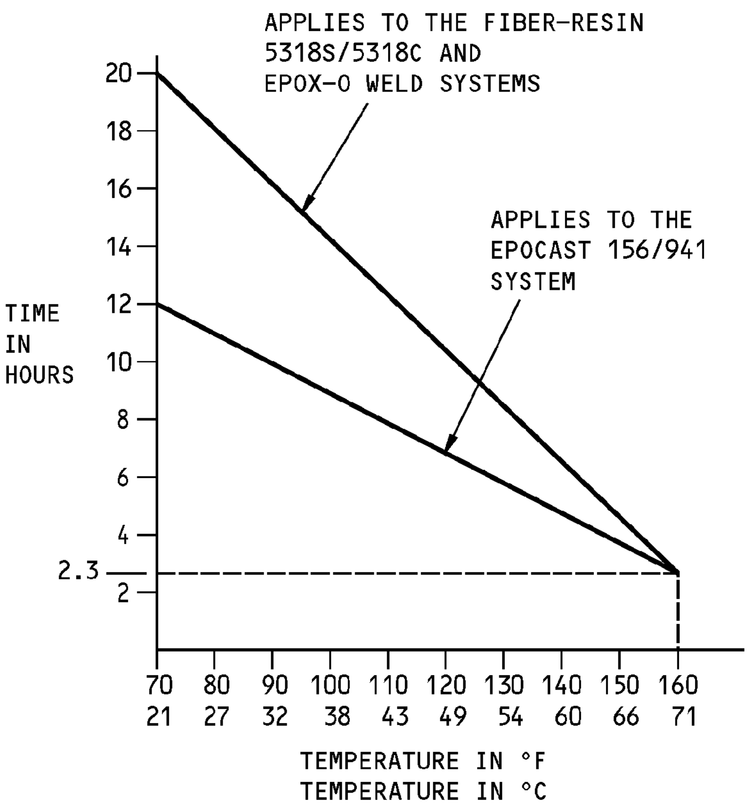
(THE FASTENER IS NOT SHOWN)
A-A

NOTES

- THE CONDUCTIVE COATING MUST GO UNDER THE DIMPLED WASHER.

Application of Conductive Coating to Repairs of Aluminum Coated Glass Fabric (BMS 8-278)
Figure 201



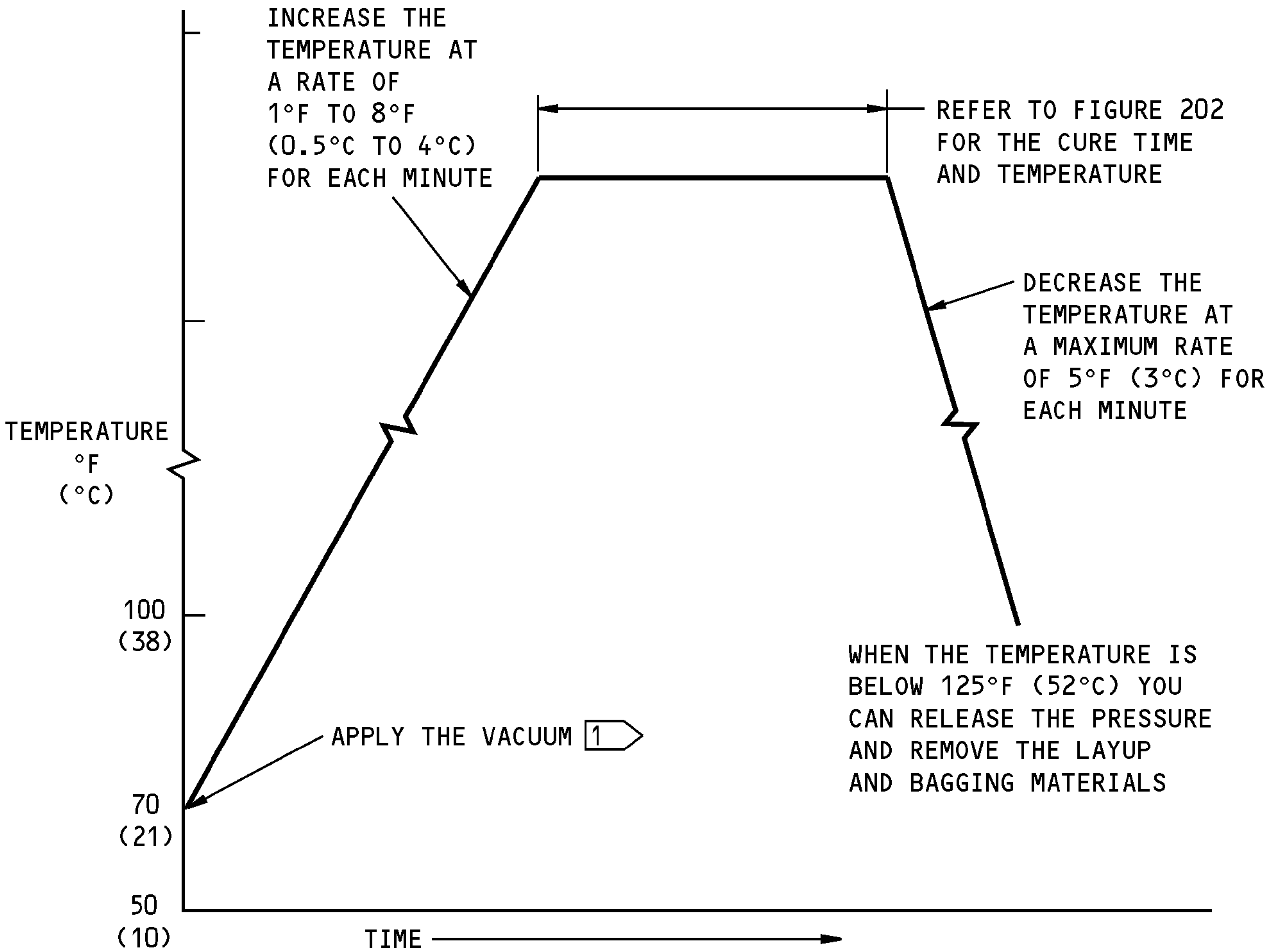


NOTES

- USE THERMOCOUPLES TO MONITOR THE TEMPERATURE.
- IF YOU CURE THE RESIN AT 125°F (52°C) OR HOTTER, USE THE CURE CYCLE SHOWN IN FIGURE 203.

[1] THE HEIGHT IN INCHES OF A 250 WATT HEAT LAMP FROM THE SURFACE OF THE PART (WHERE THE RESIN HAS BEEN APPLIED) VERSUS THE TEMPERATURE AT THAT SURFACE.

Resin Mix 1 Cure Data and Heat Lamp Temperature Data
Figure 202

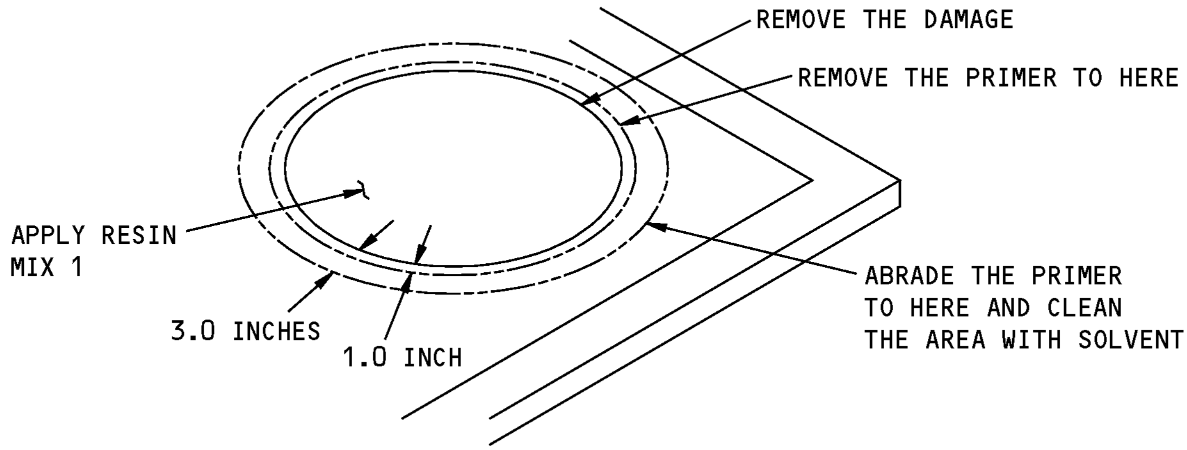


CURE CYCLE

NOTES

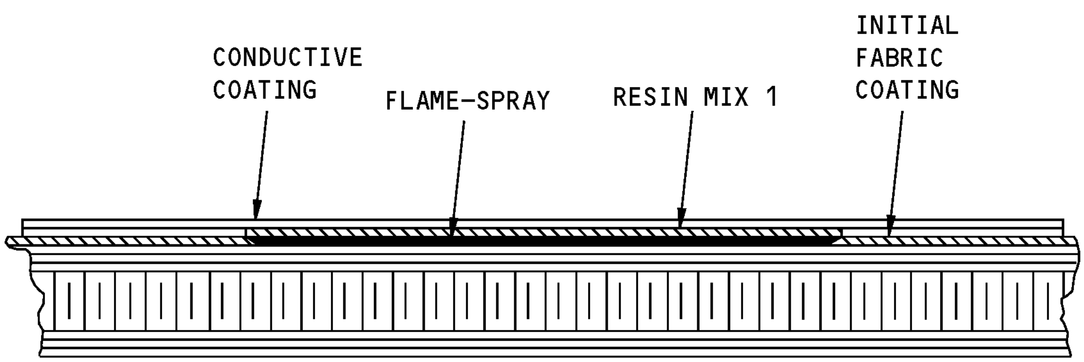
1 KEEP A MINIMUM VACUUM OF 22 INCHES OF MERCURY DURING THE FULL CURE CYCLE AND FOLLOW THE TEMPERATURE PROFILE THAT IS SHOWN.

Cure Cycle Data
Figure 203



NOTE: SEE DETAIL A FOR A VIEW THROUGH THE REPAIR.

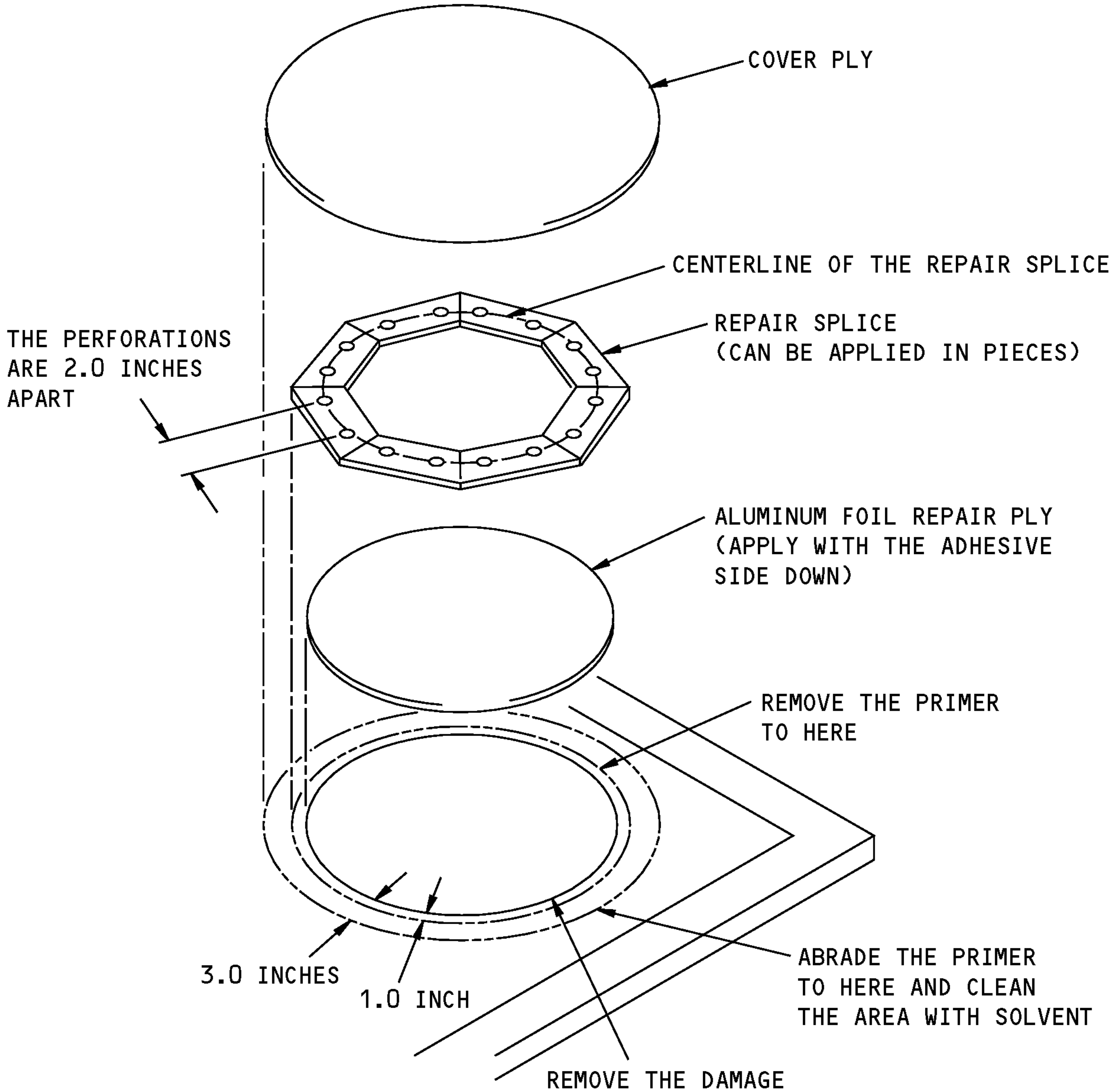
PREPARATION OF THE DAMAGE AREA BEFORE APPLICATION OF THE FLAME SPRAY



VIEW THRU THE REPAIR

A

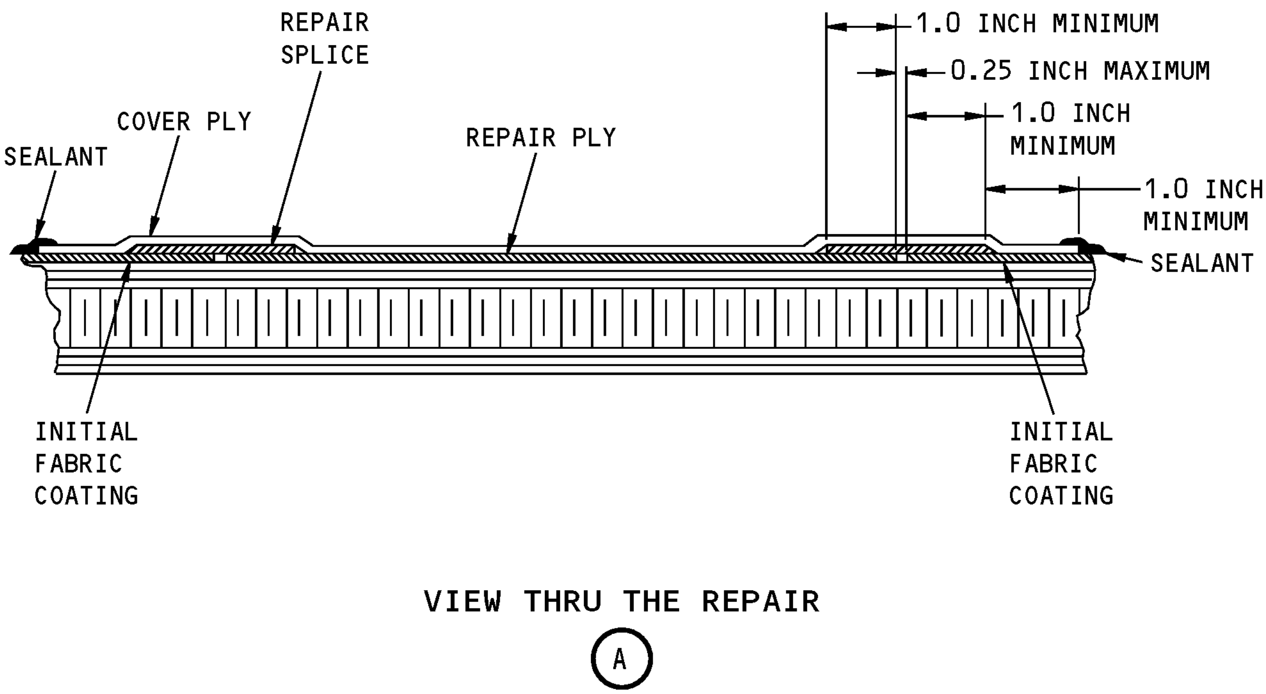
Flame Spray Repair
Figure 204



NOTE: SEE DETAIL A FOR A VIEW THROUGH THE REPAIR.

REPAIR PLY LAYUP

Aluminum Foil Tape Repair
Figure 205 (Sheet 1 of 2)



Aluminum Foil Tape Repair
Figure 205 (Sheet 2 of 2)

REPAIR 3 - DAMAGE TO BONDED ALUMINUM FOIL (BMS 8-289) ON COMPOSITE PANELS

1. Applicability

A. Repair 3 restores electrical continuity to Aluminum Foil (BMS 8-289) bonded to composite panels that:

(1) Has damage that is more than the limits permitted in 51-70-14, Allowable Damage General

(2) Is located at a splice area (such as on fan cowls)

(3) Did not use perforated foil in the initial design.

B. Repair 3 is not applicable to the composite structure that is covered by the bonded aluminum foil.

(1) Refer to the applicable Chapter-Section-Subject for a repair to the composite panel.

2. General

A. Repair 3 is:

(1) Necessary for electrically critical panels bonded with aluminum foil (BMS 8-289)

(2) Optional for electrically non-critical panels with aluminum foil (BMS 8-289).

B. Refer to SRM 51-70-14, Repair General, Table 205 for the Identification of the electrically critical and electrically non-critical panels.

C. Refer to 51-30-03 for the possible sources of abrasives and other materials you can use.

D. Refer to 51-30-05 for possible sources of the equipment and tools you can use to remove damage.

3. References

Reference	Title
51-20-01	PROTECTIVE TREATMENT OF METALLIC AND COMPOSITE MATERIALS
51-30-03	NON-METALLIC MATERIALS
51-30-05	EQUIPMENT AND TOOLS FOR REPAIRS
51-70-14	STRUCTURES WITH ALUMINUM COATINGS AND FOILS
51-70-14, ALLOWABLE DAMAGE GENERAL	Damage Limits and Sealing Instructions for Aluminum Coatings and Foils
AMM 51-21-99 P/B 701	DECORATIVE EXTERIOR PAINT SYSTEM - CLEANING/PAINTING

4. Repair Instructions

A. Find the limits of the damage.

B. Prepare the repair area as shown in Bonded Aluminum Foil Repair, Figure 201/REPAIR 3 or Bonded Aluminum Foil Repair at a Splice, Figure 202/REPAIR 3.

(1) Isolate the repair with masking tape applied in a circular shape.

CAUTION: USE CARE SO THAT YOU DO NOT CAUSE DAMAGE TO THE GLASS FIBERS OF THE COMPONENT UNDER THE DAMAGED FOIL. IF YOU DO NOT OBEY, DAMAGE TO THE STRUCTURE CAN OCCUR.

(2) Peel or abrade the damaged foil from the panel.

NOTE: If the repair area is at a splice or the initial design did not use perforated foil, remove only the coversheet and the repair splice. Do not remove the initial bonded aluminum foil (BMS 8-289), unless this foil has damage that is more than is permitted.

(3) Abrade the edge of the aluminum foil that remains with Scotch-Brite and solvent wipe the primer from:

(a) 3.00 inches all around the damage area as shown in Bonded Aluminum Foil Repair, Figure 201/REPAIR 3, or

(b) 3.00 inches on each side of the splice as shown in Bonded Aluminum Foil Repair at a Splice, Figure 202/REPAIR 3.

(4) Remove the primer a minimum of 1.0 inch all around the damage or splice area. Small traces of primer which cover up to 10 percent of the removed primer area are permitted to remain.

(5) If it was necessary to remove all of the aluminum foil, do as follows:

(a) Abrade the composite surface open to the air.

WARNING: KEEP THE SOLVENTS AWAY FROM SOURCES OF HEAT, FIRE OR SPARKS. IF YOU DO NOT, AN EXPLOSION CAN OCCUR. DO NOT PERMIT THE SOLVENTS TO TOUCH YOUR SKIN, EYES OR CLOTHING. DO NOT BREATHE THE VAPORS. WEAR PROTECTIVE CLOTHING AND EYE PROTECTION. MAKE SURE THERE IS A GOOD FLOW OF CLEAN AIR. IN A CONFINED SPACE, USE MECHANICAL VENTILATION OR RESPIRATORY PROTECTION. IF YOU DO NOT OBEY, INJURY TO PERSONS CAN OCCUR.

CAUTION: DO NOT LET THE SOLVENTS STAY ON THE PARTS. IF TOU DO NOT OBEY, DAMAGE TO THE PARTS CAN OCCUR.

(b) Clean the exposed fiberglass area with a clean cheesecloth that is made moist with Methyl Isobutyl Ketone (MIBK), trichloroethane, or acetone.

(c) Remove all the sanding dust and all unwanted materials.

WARNING: THESE CHEMICALS ARE TOXIC. MAKE SURE THAT THERE IS A GOOD FLOW OF CLEAN AIR WHEN YOU WORK WITH THE COMPONENTS OF THE RESIN OR ADHESIVE. USE CARE TO PROTECT YOUR SKIN, EYES, AND CLOTHING. IF CONTAMINATION DOES OCCUR, WASH WITH SOAP AND WARM WATER. DO NOT USE SOLVENTS TO CLEAN YOUR SKIN. IF YOU DO NOT OBEY, INJURY TO PERSONS CAN OCCUR.

CAUTION: DO NOT USE WAXED CONTAINERS TO MIX THE COMPONENTS OF THE RESIN OR ADHESIVE. IF YOU DO, CONTAMINATION OF THE RESIN OR ADHESIVE WILL OCCUR.

C. Mix the components of the resin or adhesive given in Table 201/REPAIR 3 that you will use to cover:

(1) The exposed fiberglass area and the cover ply for the repair shown in Bonded Aluminum Foil Repair, Figure 201/REPAIR 3, or

(2) The cover ply for the repair shown in Bonded Aluminum Foil Repair at a Splice, Figure 202/REPAIR 3.

Table 201:

RESIN AND ADHESIVE DATA				
TYPE	**COMPONENTS**	**PARTS BY WEIGHT**	**POT LIFE**	**CURE TIME AND TEMPERATURE**
BMS 8-301, Class 1 Resin	EA 9390 Resin-Part A	100 ±2	2 hours at 77°F (25°C)	220 minutes at 190 to 210°F (87 to 99°C) or 150 minutes at 240 to 260°F (115 to 127°C)
	EA 9390 Resin-Part B	56 ±0.5		
BMS 5-128 Adhesive (Alternative to BMS 8-301	EA-956 Part A	100	30 minutes at 72 to 82°F (22 to 28°C)	1 hour at 170 to 190°F (77 to 89°C) or 24 hours minimum at 70 to 100°F (21 to 38°C) and Handling strength for the full cure for the 5 days at 70 to 100°F (21 to 38°C)
	EA-956 Part B	58		

D. Apply part of the resin or adhesive you have mixed to:

(1) The exposed fiberglass area for the repair shown in Bonded Aluminum Foil Repair, Figure 201/REPAIR 3, or

(2) The initial aluminum foil for the repair shown in Bonded Aluminum Foil Repair at a Splice, Figure 202/REPAIR 3.

E. Make the repair ply and repair splice. Refer to Table 202/REPAIR 3 for the repair materials.

Table 202:

REPAIR MATERIALS	
REPAIR MATERIALS	BOEING SPECIFICATION
Repair Ply	BMS 8-289, Type 0/250 foil
Repair Splice	BMS 8-289, Type 0/250, Form II foil (Optional: BMS 8-289, Type 0/250, Form I foil)
Cover Ply	BMS 9-3, Type D fiber- glass
Resin	BMS 8-301, Class I
Adhesive (Optional to the Resin)	BMS 5-128

(1) Make the repair ply if you do the repair shown in Bonded Aluminum Foil Repair, Figure 201/REPAIR 3.

(a) Install the repair ply, adhesive side down, over the fiberglass and resin area.

(b) Make sure the edges of the repair ply butts against the edges of the initial aluminum foil.

(c) Make sure there is no overlap.

NOTE: Gaps up to 0.25 inch between the repair ply and initial foil are permitted.

WARNING: KEEP THE SOLVENTS AWAY FROM SOURCES OF HEAT, FIRE OR SPARKS. IF YOU DO NOT, AN EXPLOSION CAN OCCUR. DO NOT PERMIT THE SOLVENTS TO TOUCH YOUR SKIN, EYES OR CLOTHING. DO NOT BREATHE THE VAPORS. WEAR PROTECTIVE CLOTHING AND EYE PROTECTION. MAKE SURE THERE IS A GOOD FLOW OF CLEAN AIR. IN A CONFINED SPACE, USE MECHANICAL VENTILATION OR RESPIRATORY PROTECTION. IF YOU DO NOT OBEY, INJURY TO PERSONS CAN OCCUR.

(WARNING PRECEDES)

CAUTION: DO NOT LET THE SOLVENTS STAY ON THE PARTS. IF YOU DO NOT OBEY, DAMAGE TO THE PARTS CAN OCCUR.

(d) Press down to squeeze out the excess resin or adhesive.

(e) Remove the excess resin or adhesive with a clean cheesecloth that is made moist with Methyl Isobutyl Ketone (MIBK), trichloroethane, or acetone.

(2) Make the repair splice. Refer to Table 202/REPAIR 3 and Figures 201 or 202, as applicable.

(a) For the repair shown in Bonded Aluminum Foil Repair, Figure 201/REPAIR 3, cut the repair splice in the shape of a circular ring.

NOTE: As an alternative to a circular ring, you can cut the foil into pieces to fit the repair area. Refer to Bonded Aluminum Foil Repair, Figure 201/REPAIR 3, Detail B .

(b) Make the width of the ring a minimum of 2.0 inches.

1) If BMS 8-289, Type-0/250, Form I material is used:

a) Apply a chemical conversion layer to the non-adhesive side of the material. Refer to 51-20-01.

b) Make holes along the centerline of the repair splices.

c) Make the holes 0.50 inch in diameter and 2.00 inches apart as shown in Bonded Aluminum Foil Repair, Figure 201/REPAIR 3, Detail B .

(c) For the repair shown in Bonded Aluminum Foil Repair at a Splice, Figure 202/REPAIR 3, cut the repair splice in the shape of a rectanglar strip.

(d) Make the width of the strip a minimum of 2.25 inches.

F. Apply a chemical conversion layer to the mating surfaces of the repair ply and repair splice. Refer to 51-20-01.

G. Install the repair splice adhesive side up on the edges of the repair ply as shown in Bonded Aluminum Foil Repair, Figure 201/REPAIR 3 or on the splice as shown in Bonded Aluminum Foil Repair at a Splice, Figure 202/REPAIR 3.

(1) Make sure there is a minimum overlap of 1.0 inch on each side of the repair ply edges or splice line.

(2) Make sure that the outer edge of the splice strip is a minimum of 3.00 inches from the edge of the part.

(3) Make sure you do not install the repair splice on the edgeband of the part.

NOTE: You can use small spots of resin or adhesive on the non-adhesive side of the splice strip to help hold it in position. These spots should be about 0.25 inch in diameter and spaced 4.00 inches apart. Do not use a large amount of resin or adhesive for this.

H. Make the cover ply. Refer to Table 202/REPAIR 3, and Figures 201 or 202, as applicable.

(1) Make the dimensions of the cover ply larger than the final dimensions as necessary.

NOTE: The final dimensions for the repair shown in Bonded Aluminum Foil Repair, Figure 201/REPAIR 3 must be a minimum of 1.00 inch larger all around the edge of the repair splice. The final dimensions must be a minimum of 2.00 inches on each side of the splice for the repair shown in Bonded Aluminum Foil Repair at a Splice, Figure 202/REPAIR 3.

(a) Make the final cover ply, a minimum of 4.25 inches in width

(b) Make the cover ply overlap each side of the repair splice by a minimum of 1.0 inch.

I. Impregnate the cover ply as follows:

(1) Cut two pieces of parting film that are 3.00 inches larger all around than the cover ply.

(2) Use tape to hold one piece of parting film to a smooth surface.

(3) Install the glass fabric onto the parting film.

(4) Apply the resin or adhesive you mixed in Paragraph 4.C./REPAIR 3 smoothly and evenly to the cover ply.

(5) Install the second piece of parting film over the impregnated cover ply.

(6) Apply pressure to fully impregnate the cover ply with the resin or adhesive.

(a) Use a wiper or roller to fully and evenly impregnate the fabric and remove trapped air.

(b) Apply pressure to squeeze out the excess resin or adhesive at the edges of the glass fabric.

(7) Cut the impregnated cover ply and parting film to the final size that is a minimum of 1.00 inch larger all around than the outside edges of the repair splice.

NOTE: The parting film on the each side of the cover ply will reduce fraying while you cut it.

J. Install the cover ply on the repair.

(1) Remove the parting film from one side of the impregnated cover ply.

(2) Apply the remainder of the resin or adhesive on the repair area.

(3) Install the exposed surface of the cover ply on the repair area.

(4) Remove the wrinkles and trapped air with a roller or squeegee.

NOTE: Do not apply heavy pressure, otherwise you could remove the necessary amount of the resin or adhesive you need.

(5) Remove the second piece of parting film from the impregnated cover ply.

K. Assemble the vacuum bag system that will be used to cure the repair. Refer to Layout of the Repair Parts, Figure 203/REPAIR 3.

(1) Cut a piece of perforated FEP parting film (0.001 inch thick) so that the edges are 3.00 inches larger all around the repair area.

(2) Put the parting film over the repair area.

(3) For a cure temperature that is more than room temperature, install three thermocouples at equal spaces around the repair area. Connect the thermocouples to the applicable recorders.

(4) Put a layer of glass fabric cloth on the perforated FEP for a surface bleeder.

(a) Use BMS 9-3, Types D, D-1, H-2, or H-3, or the equivalent.

(5) Cut the surface bleeder so that the edges are 2.00 inches past the edge of the perforated FEP. Use BMS 9-3, Types D, D-1, H-2, or H-3, or the equivalent.

(6) Put a layer of solid FEP parting film (0.002 inch thick) on the surface bleeder.

(7) Cut the solid FEP so that the edges are even with the perforated FEP.

(8) If you use a heat blanket as a heat source, do the steps that follow:

NOTE: You can use a heat blanket, infrared heat lamp or the equivalent to accelerate the cure. If the structure is too small to permit the heat blanket to fit in the vacuum bag, do Steps 9.(b) through 9.(h) and put the heat blanket over the vacuum bag.

WARNING: FOR A HIGH TEMPERATURE CURE, USE HEAT CURE EQUIPMENT THAT AGREES WITH THE FIRE AND SAFETY CODES PERMITTED BY THE LOCAL FIRE PROTECTION AUTHORITY. IF YOU DO NOT OBEY, INJURY TO PERSONS CAN OCCUR.

(a) Cut a 0.020 inch thick aluminum caul plate to the same size as the cover ply.

(b) Put the aluminum caul plate on the solid FEP as permitted up to the contour of the part.

(c) Put the heat blanket on the caul plate.

NOTE: The heat blanket must be a minimum of 2.0 inches more than the edge of the repair.

(d) Put a minimum of two thermocouples on the center of the heat blanket.

(e) Put four to six layers of glass fabric on the heat blanket for the breather cloths.

NOTE: The glass fabric gives insulation for the heat blanket and also helps to prevent damage to the bagging film.

1) Use BMS 9-3, Types D, D-1, H-2, or H-3, or the equivalent.

2) Make the breather cloths the same dimensions as the surface bleeder.

(9) Seal the repair with the vacuum bag material.

(a) Install a vacuum line.

(b) Apply sealing compound around the layup area, approximately 6.00 inches outside the edge of the heat blanket.

(c) Put a piece of vacuum bag material fully over the repair area and seal the edge with sealing compound.

NOTE: If the repair is more that 15 percent of the panel area, you must put a vacuum bag material fully over the part. This will help prevent delamination and distortion of the part. Use devices that supports and keeps the contour of large parts which can sink in the middle and become distorted because of its own weight.

(d) Make some folds in the bag material as necessary to prevent bridging and subsequent breakage.

(e) Apply protective pads to all the sharp corners and edges to prevent breakage.

(f) As an option, put the vacuum bag material fully over the part.

(g) Cut slits in the vacuum bag at the locations where the vacuum line and vacuum gage will be attached to their bases.

(h) Install the vacuum line and the vacuum gage through the vacuum bag material and onto the bases.

(10) Do a check of the vacuum bag for leaks.

NOTE: A vacuum bag which has a leak can cause porosity in the repair and bond failure.

(a) Apply a minimum vacuum of 22 inches of mercury to the bag.

(b) Remove the vacuum source.

(c) Monitor the vacuum gage. After 5 minutes the total difference in the vacuum must be less than 5 inches of mercury.

(11) Cure the repair.

(a) Apply and keep a vacuum of a minimum of 22 inches of mercury in the vacuum bag during the cure cycle.

(b) Refer to Table 201/REPAIR 3 for the cure temperature and time data.

NOTE: If you cure the repair at a minimum 125°F (52°C), use the cure cycle shown in Cure Cycle Data, Figure 204/REPAIR 3. You can use a heat blanket, infrared heat lamp or the equivalent to cure the repair at a higher temperature than room temperature. If a heat lamp is used, refer to Heat Lamp Temperature Data, Figure 205/REPAIR 3 for the temperature data. The cure time does not include the time that is necessary for the part to heat up to the cure temperature. The cure time starts when the part is at the cure temperature.

(c) Monitor the temperature with the thermocouples.

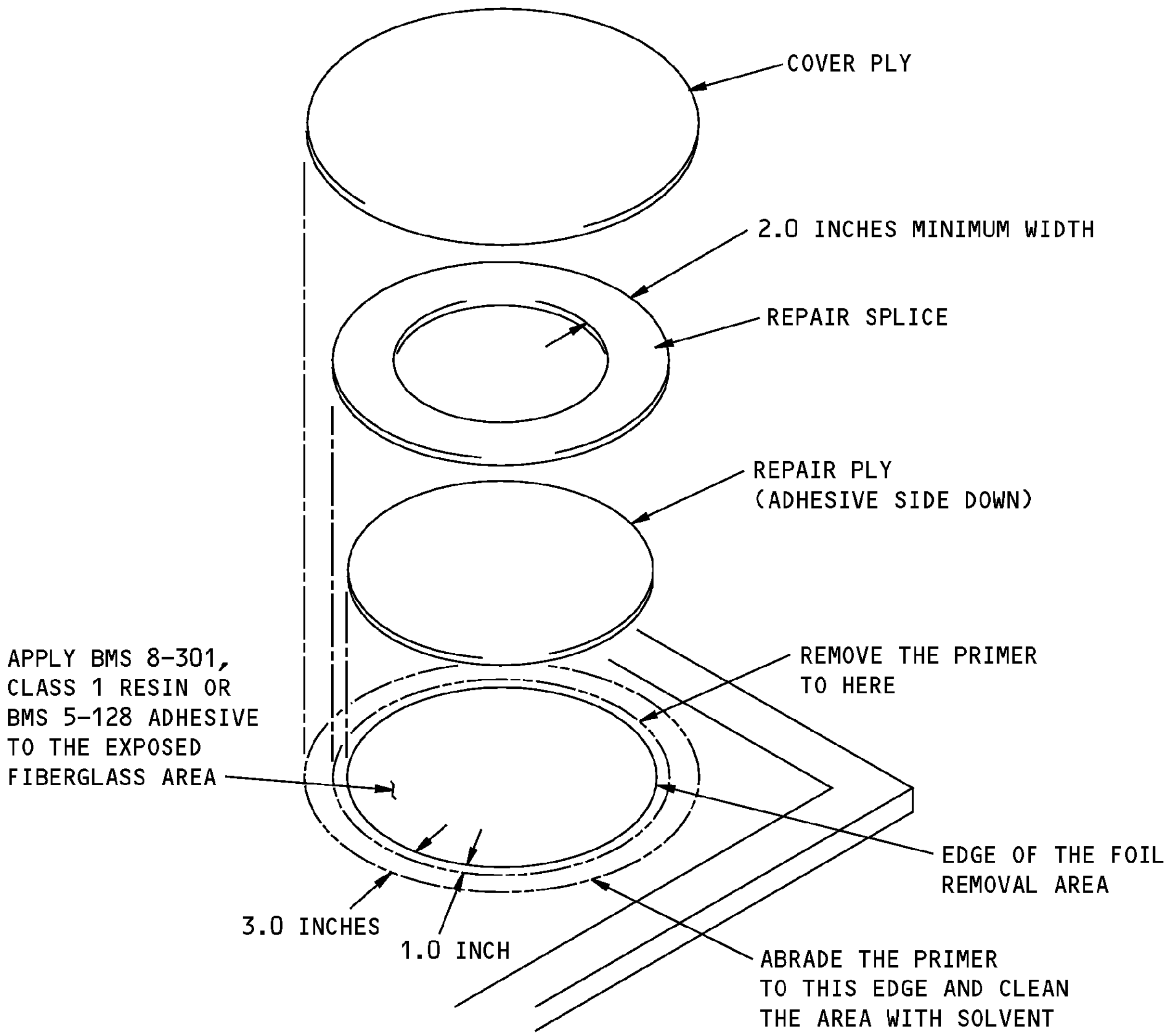
1) Use the measurement from the thermocouple with the lowest value at the edge of the repair as the cure temperature.

2) Make sure that the temperature does not increase at a rate more than 8°F (4.4°C) cycle.

(12) Remove the bagging material.

(13) Apply BMS 10-103, Type I primer if it was removed.

(14) Apply the finish to the repair area. Refer to AMM PAGEBLOCK 51-21-99/701.



PREFERRED REPAIR PLY LAYUP

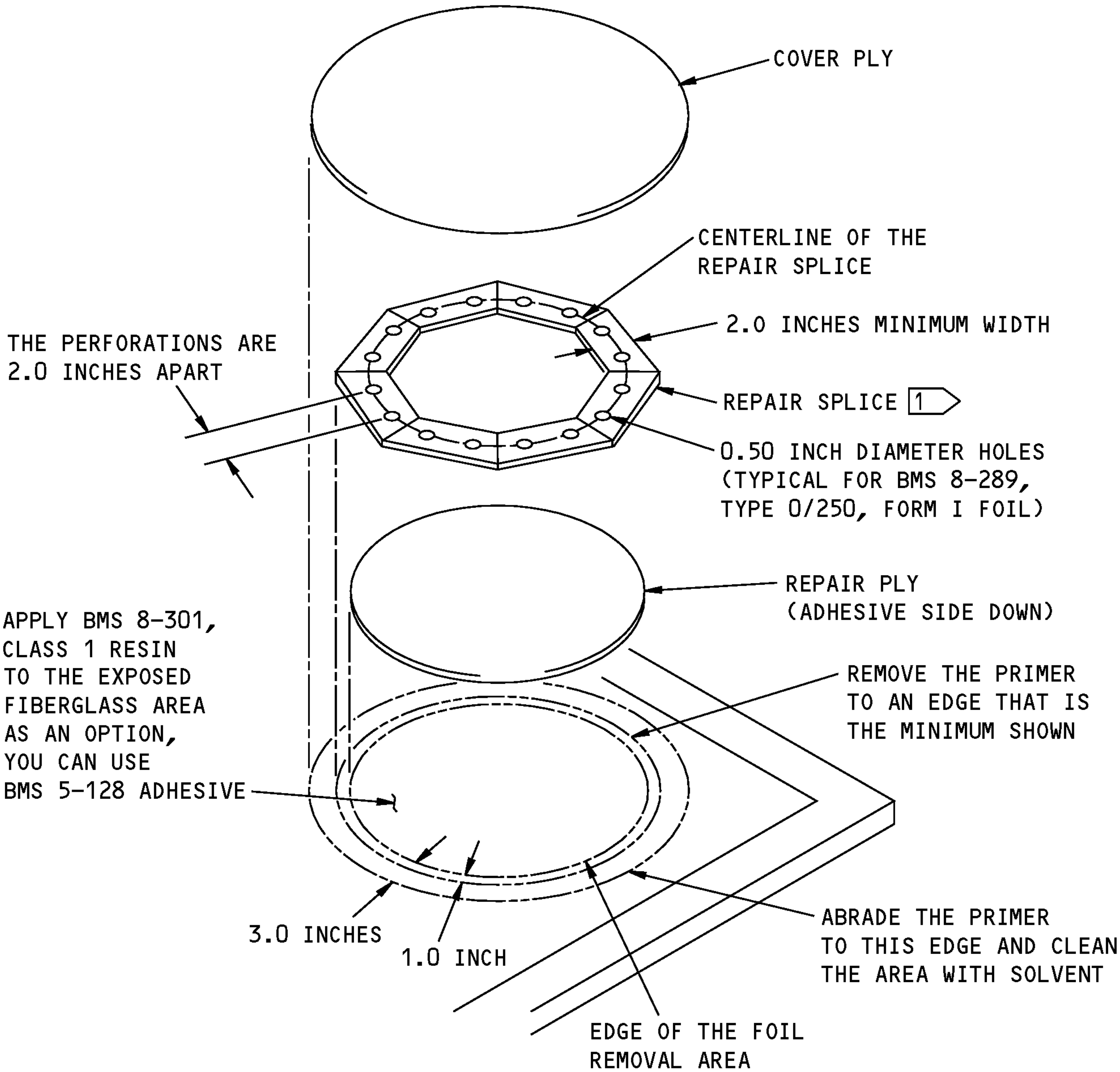
A

NOTES

- THE PREFERRED REPAIR SHOWN IN DETAIL A USES A REPAIR SPLICE MADE WITH THE FORM II FOIL.
- THE ALTERNATIVE REPAIR SHOWN IN DETAIL B USES A REPAIR SPLICE MADE WITH THE FORM I FOIL.
- REFER TO DETAIL C FOR A VIEW THROUGH THE REPAIRS.

1 BMS 8-289, TYPE 0/250 FORM 1 FOIL IS SHOWN CUT IN PIECES AND PERFORATED. IF YOU USE THE PREFERRED FORM II, DO NOT DO THE PERFORATIONS.

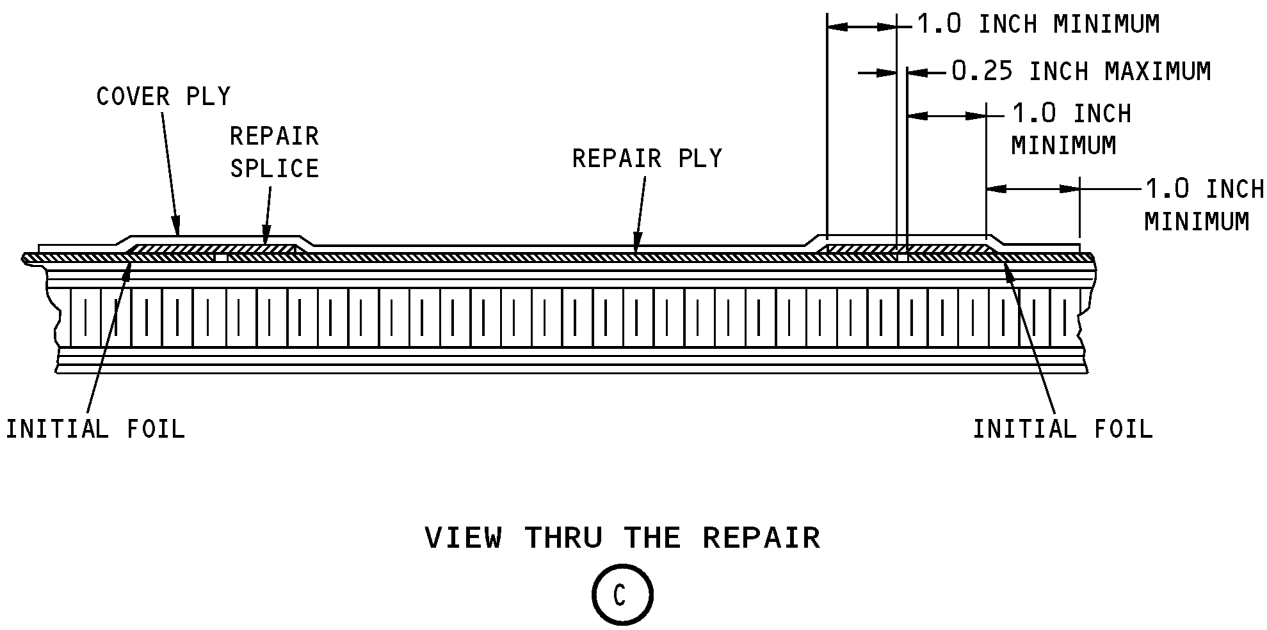
Bonded Aluminum Foil Repair
Figure 201 (Sheet 1 of 3)



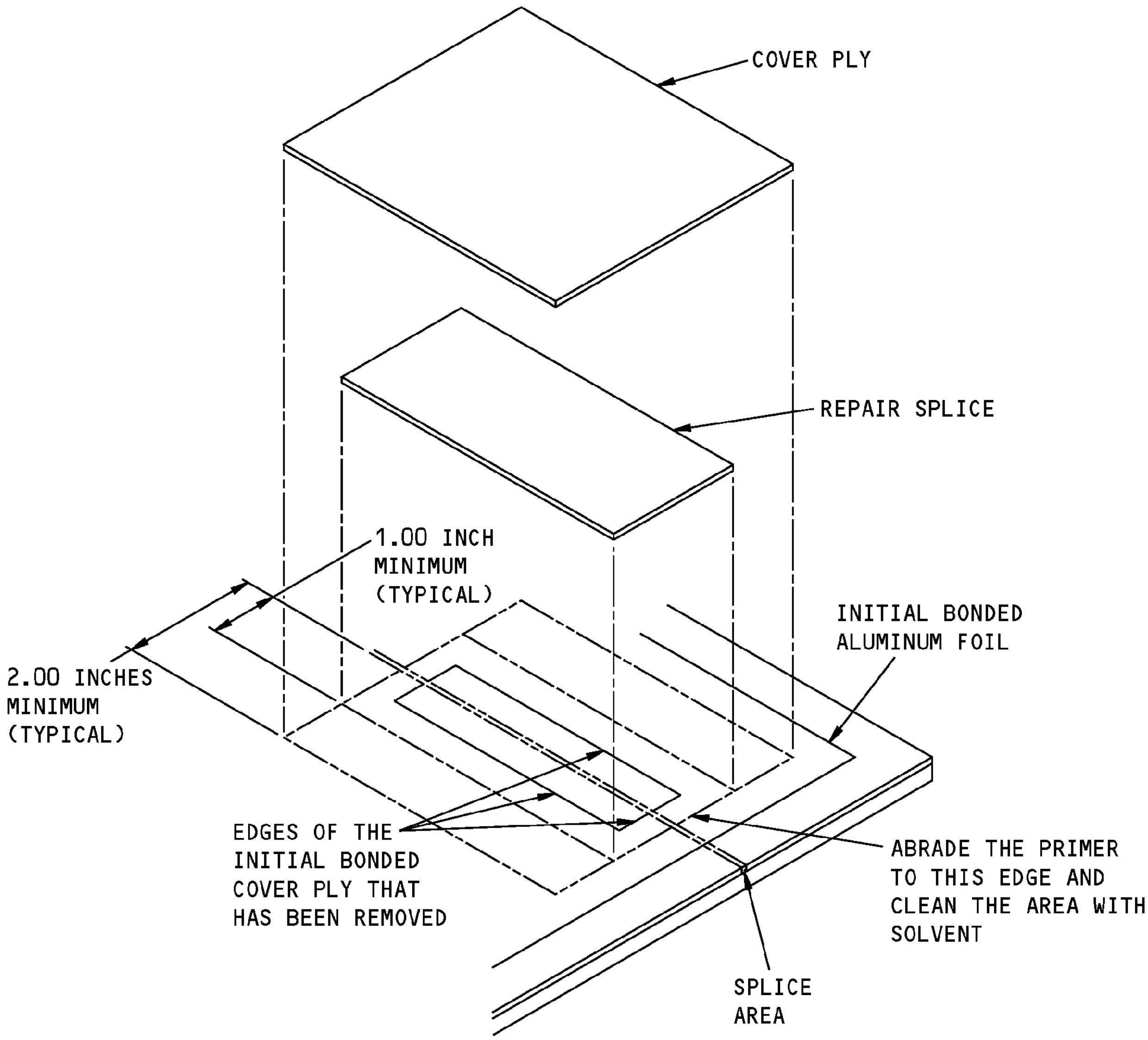
ALTERNATIVE REPAIR PLY LAYUP

B

Bonded Aluminum Foil Repair
Figure 201 (Sheet 2 of 3)



Bonded Aluminum Foil Repair
Figure 201 (Sheet 3 of 3)

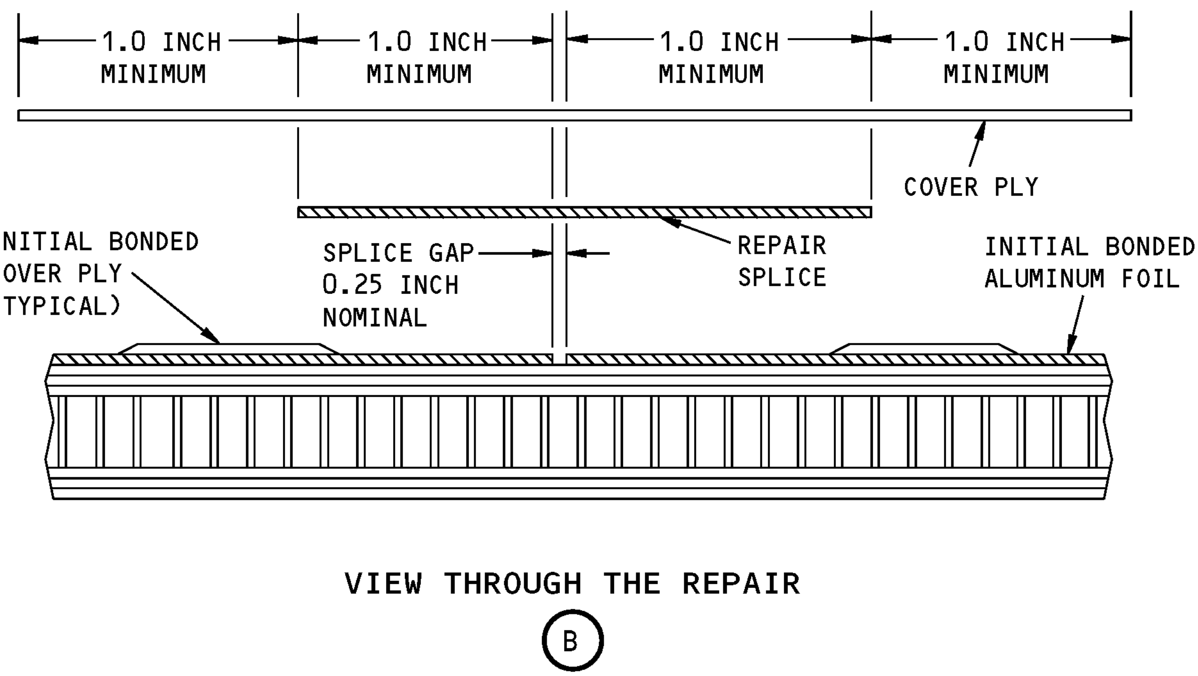


NOTE: REFER TO DETAIL B FOR A VIEW THROUGH THE REPAIR.

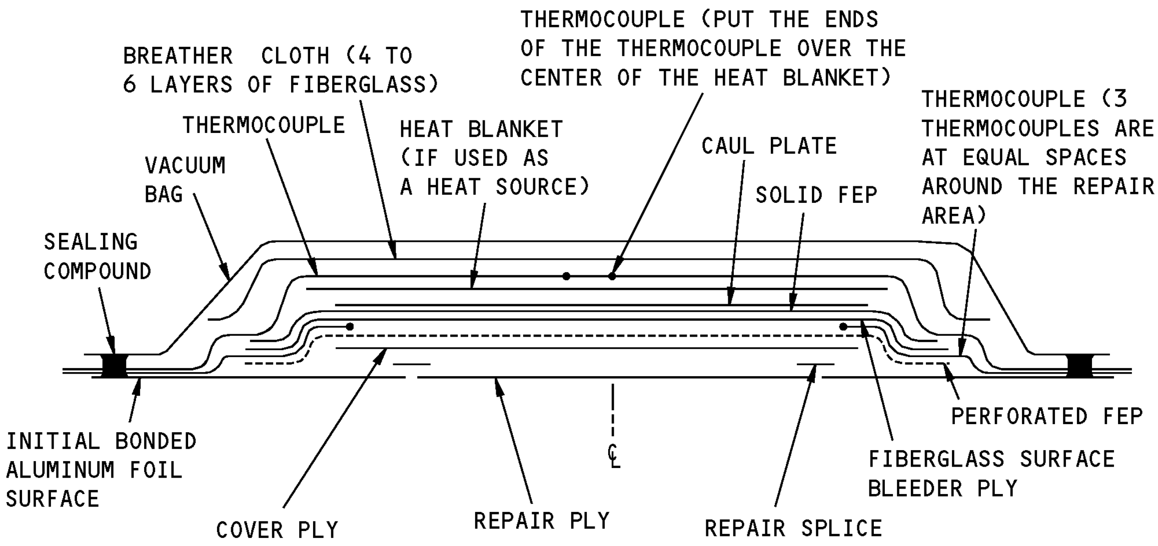
REPAIR PLY LAYUP

A

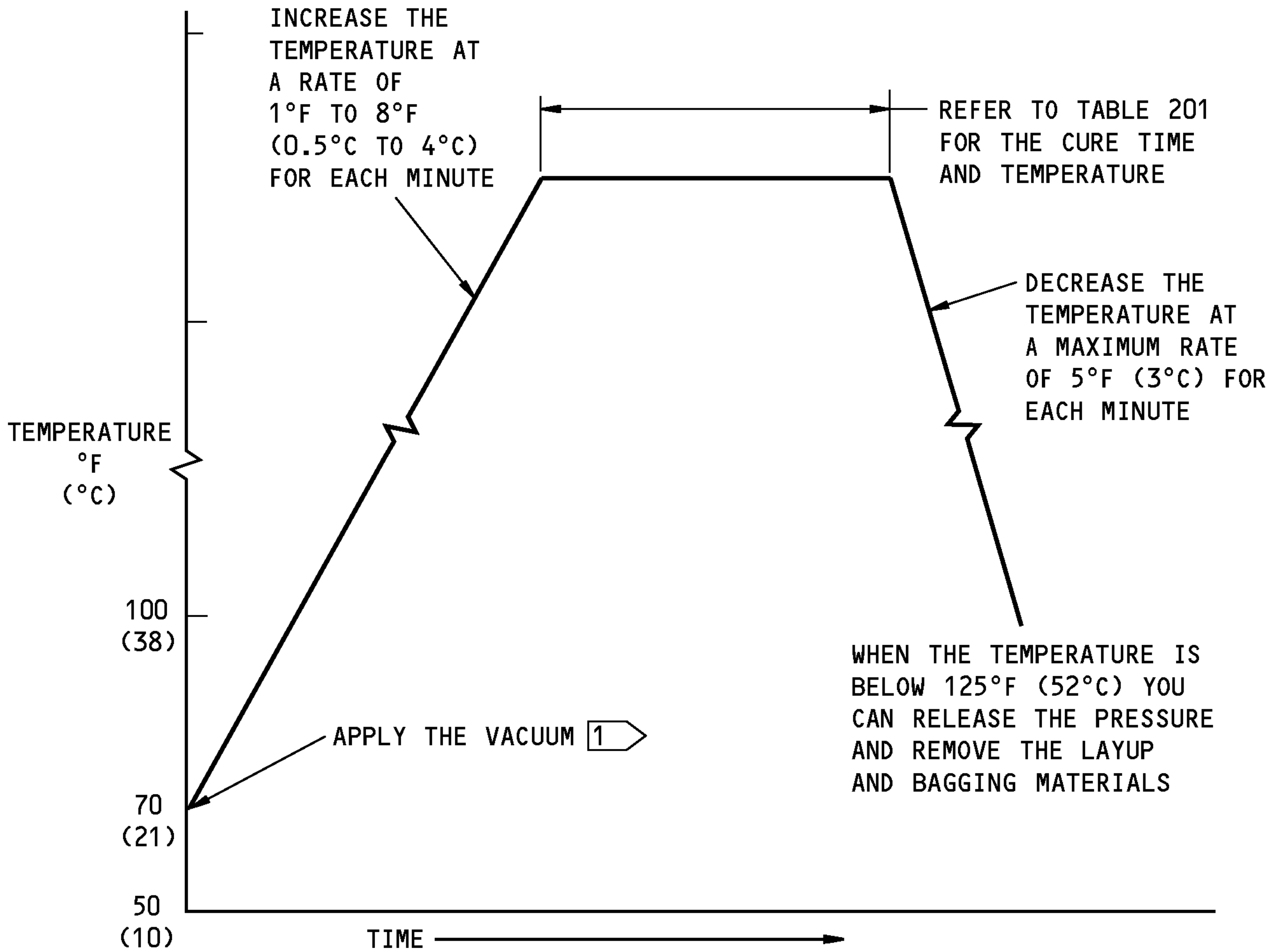
Bonded Aluminum Foil Repair at a Splice
Figure 202 (Sheet 1 of 2)



Bonded Aluminum Foil Repair at a Splice
Figure 202 (Sheet 2 of 2)



Layout of the Repair Parts
Figure 203



CURE CYCLE

NOTES

1 KEEP A MINIMUM VACUUM OF 22 INCHES OF MERCURY DURING THE FULL CURE CYCLE AND FOLLOW THE TEMPERATURE PROFILE THAT IS SHOWN.

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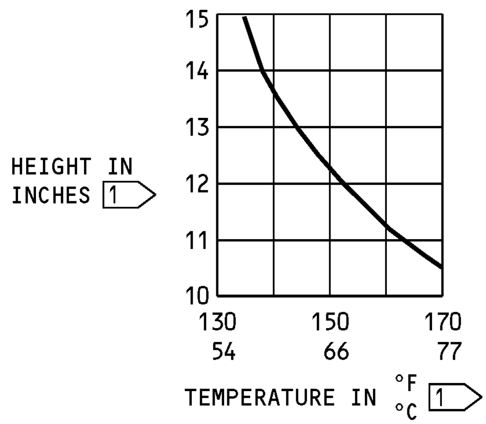
Cure Cycle Data
Figure 204



NOTES

- USE THERMOCOUPLES TO MONITOR THE TEMPERATURE.
- USE THE CURE CYCLE SHOWN IN FIGURE 204 WHEN YOU CURE THE RESIN OR ADHESIVE AT A TEMPERATURE THAT IS HOTTER THAN 125°F (52°C).

1 THE HEIGHT IN INCHES OF A 250 WATT HEAT LAMP FROM THE SURFACE OF THE PART (WHERE THE RESIN OR ADHESIVE HAS BEEN APPLIED) VERSUS THE TEMPERATURE AT THAT SURFACE.

Heat Lamp Temperature Data
Figure 205

REPAIR 4 - DAMAGE TO EXPANDED ALUMINUM FOIL MESH (BMS 8-336)

1. Applicability

A. Repair 4 restores electrical continuity to these coatings and foil that have damage that is more than permitted in 51-70-14, Allowable Damage General:

(1) Expanded Aluminum Foil Mesh (BMS 8-336) on Composite Panels

(2) Aluminum Flame Spray on Composite panels

(3) Aluminum Coated Glass Fabric (BMS 8-278) on Composite panels.

NOTE: Refer to 51-70-14, General for the locations and drawing numbers of the components with these coatings.

B. Repair 4 is not applicable to:

(1) Bonded Aluminum Foil (BMS 8-289)

(2) Electrically critical areas

(3) Damage to the composite structure that is covered by the coatings and foil given.

(a) Refer to the applicable Chapter-Section-Subject for a repair to the composite panel.

2. General

A. Repair 4 is:

(1) Necessary for electrically critical panels with expanded aluminum foil mesh (BMS 8-336)

(2) Optional for electrically non-critical panels with expanded aluminum foil mesh (BMS 8-336).

B. Refer to SRM 51-70-14, Repair General, Table 206 for the identification of the electrically critical and electrically non-critical panels.

C. Refer to 51-30-03 for the possible sources of abrasives and other materials you can use.

D. Refer to 51-30-05 for the sources of the equipment and tools you can use to remove the damage.

E. Do the repair. Refer to Table 201/REPAIR 4 for a list of references for the different types of repairs.

F. If the expanded aluminum foil is bare, use one of the two procedures that follows:

NOTE: It is recommended to use the anodize procedure.

(1) Anodize the expanded aluminum foil with phosphoric acid. Refer to 51-70-09.

(2) Apply a primer to the expanded aluminum foil in less than 72 hours after you apply the phosphoric acid.

(a) Apply a layer of BMS 5-89 primer to the 250°F (121°C) cured parts.

NOTE: Primer will appear glossy.

1) Apply the primer to a cured film thickness of 0.00015 to 0.0004 inch.

2) Air dry the primer a minimum of 30 minutes or infrared dry until tack-free at 200°F (93°C) maximum.

3) Cure the primer at 250 ±10°F (121 ±6°C) for 30 to 120 minutes.

(b) Apply a layer of BMS 5-137 primer to 350°F (177°C) cured parts.

1) Apply the primer to a cured film thickness of 0.00020 to 0.00035 inch.

2) Air dry the primer a minimum of 30 minutes at 65°F (18°C) to 90°F (32°C) or infrared dry for 5 to 10 minutes at 200°F (93°C) maximum.

(3) Apply a chemical conversion coating. Refer to 51-70-10.

Table 201:

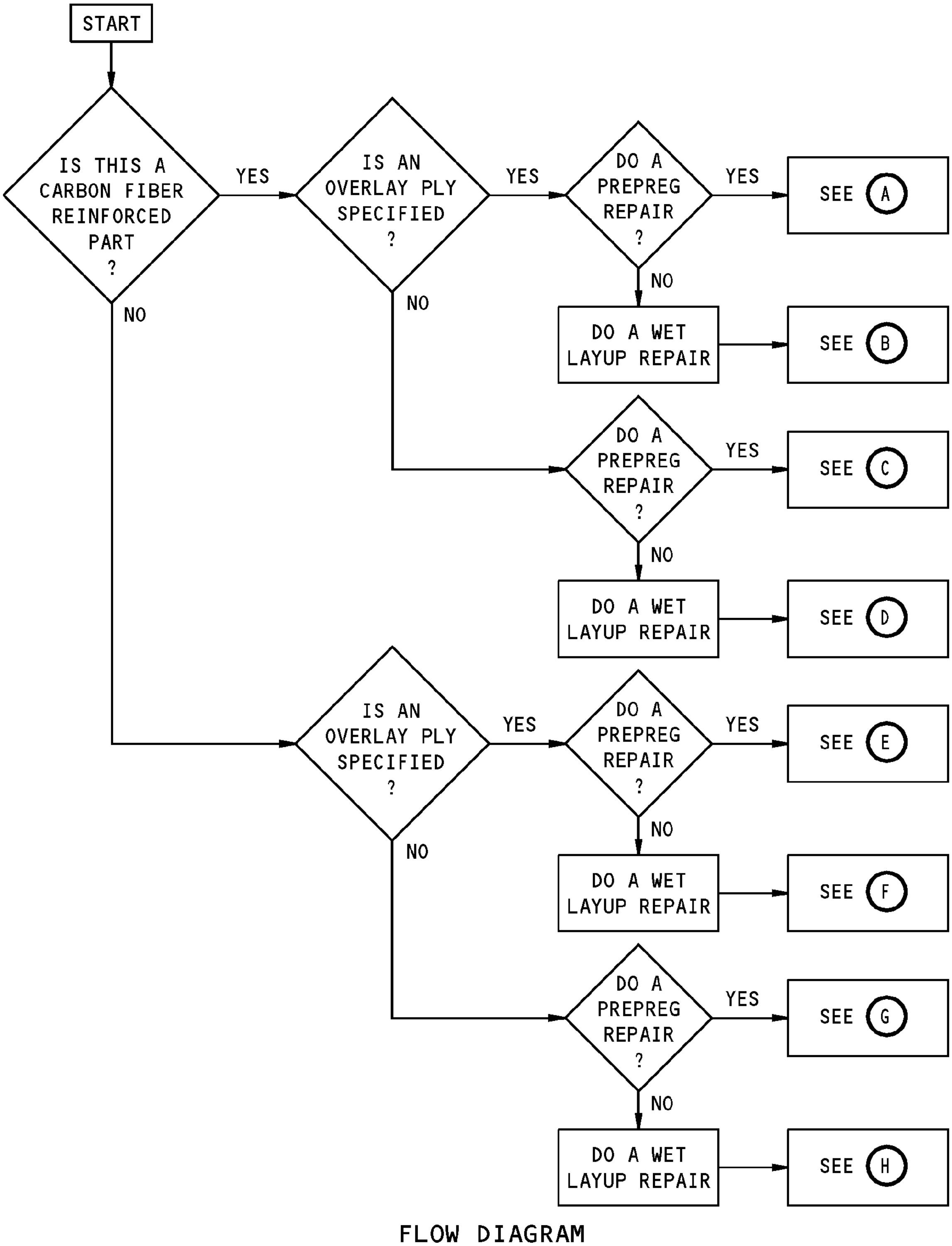
PARAGRAPH REFERENCES FOR THE DIFFERENT TYPES OF REPAIRS THAT APPLY TO EXPANDED ALUMINUM FOIL MESH (BMS 8-336) ON COMPOSITE PANELS	
TYPE OF REPAIR	**PARAGRAPH**
Permanent Repair - Wet Layup	5
Permanent Repair - Prepreg	6
Permanent Repair - Aluminum Foil Tape and Sealant BMS 5-95	7

3. References

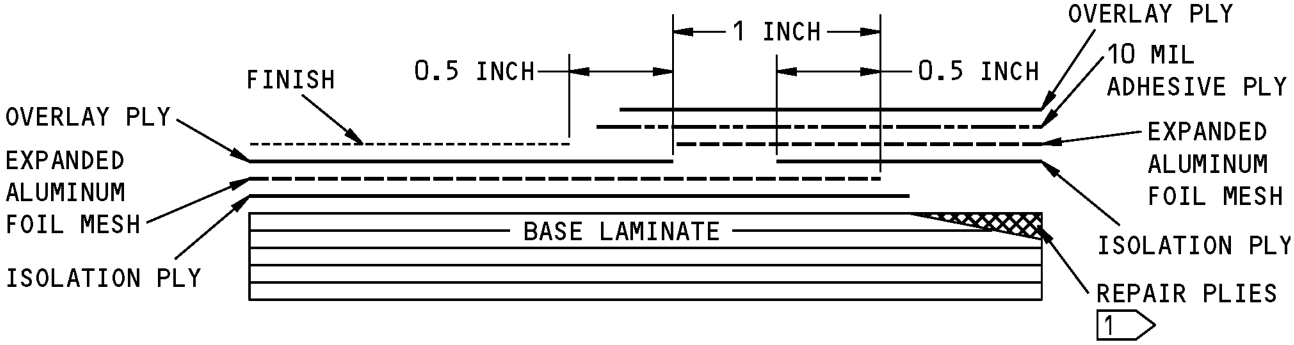
Reference	Title
51-20-01	PROTECTIVE TREATMENT OF METALLIC AND COMPOSITE MATERIALS
51-20-01, GENERAL	Protective Treatment of Metallic and Composite Materials
51-20-05	REPAIR SEALING
51-30-03	NON-METALLIC MATERIALS
51-30-05	EQUIPMENT AND TOOLS FOR REPAIRS
51-70-04, REPAIR GENERAL	Repair Procedures for Wet Layup Materials
51-70-05, REPAIR GENERAL	Repair Procedures for Preimpregnated Materials
51-70-09	BONDED METAL STRUCTURE REPAIR PROCEDURES
51-70-10	ALUMINUM HONEYCOMB STRUCTURE REPAIR PROCEDURES
51-70-14	STRUCTURES WITH ALUMINUM COATINGS AND FOILS
51-70-14, ALLOWABLE DAMAGE GENERAL	Damage Limits and Sealing Instructions for Aluminum Coatings and Foils
AMM 51-21-99 P/B 701	DECORATIVE EXTERIOR PAINT SYSTEM - CLEANING/PAINTING
SOPM 20-10-06	Repair of Conductive Coatings
SOPM 20-44-04	Application of Urethane Compatible Primers

4. Repair Instructions

A. Refer to Repair of Expanded Aluminum Foil Mesh (BMS 8-336), Figure 201/REPAIR 4 for a flow diagram and a layout of the repair parts for the wet layup and prepreg repairs given in Paragraph 5./REPAIR 4 and 6.

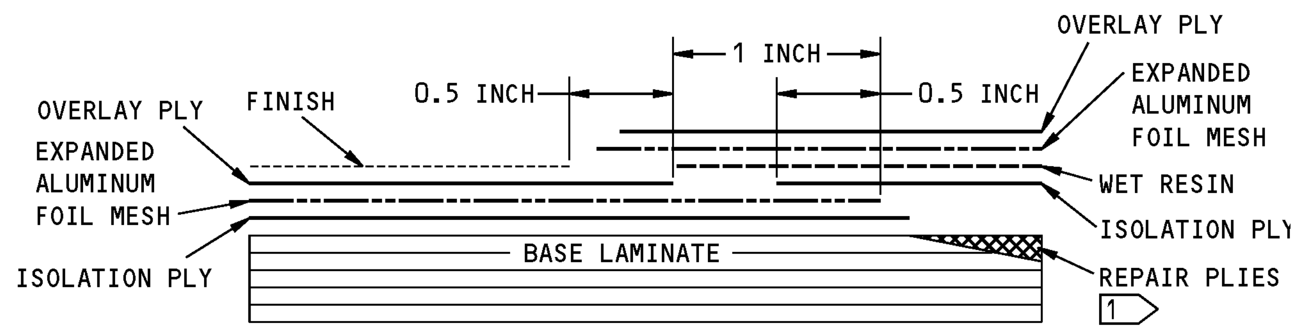


Repair of Expanded Aluminum Foil Mesh (BMS 8-336)
Figure 201 (Sheet 1 of 4)



CFRP PART, EXPANDED ALUMINUM FOIL, OVERLAY PLY, PREPREG REPAIR

A



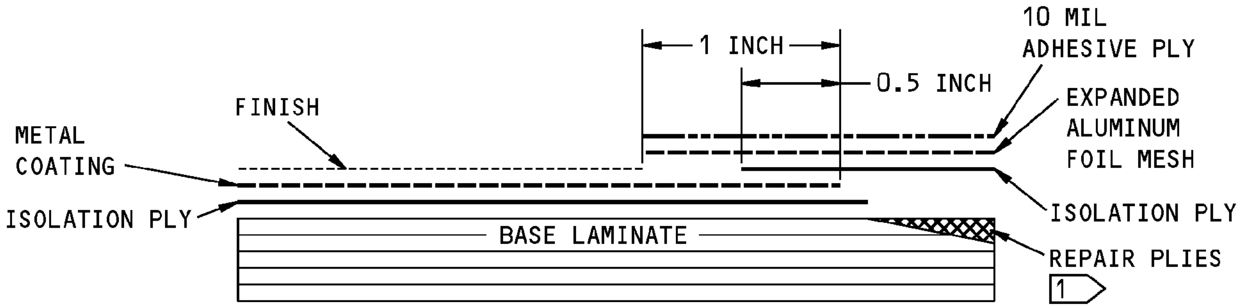
CFRP PART, EXPANDED ALUMINUM FOIL, OVERLAY PLY, WET LAYUP REPAIR

B

NOTES

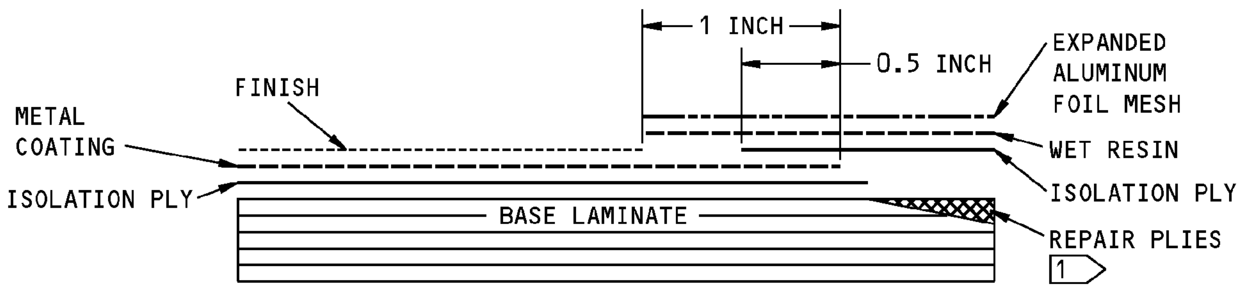
1 FOR REPAIRS TO THE COMPOSITE PLIES OF THE BASE LAMINATE, REFER TO THE APPLICABLE CHAPTER-SECTION-SUBJECT.

Repair of Expanded Aluminum Foil Mesh (BMS 8-336)
Figure 201 (Sheet 2 of 4)



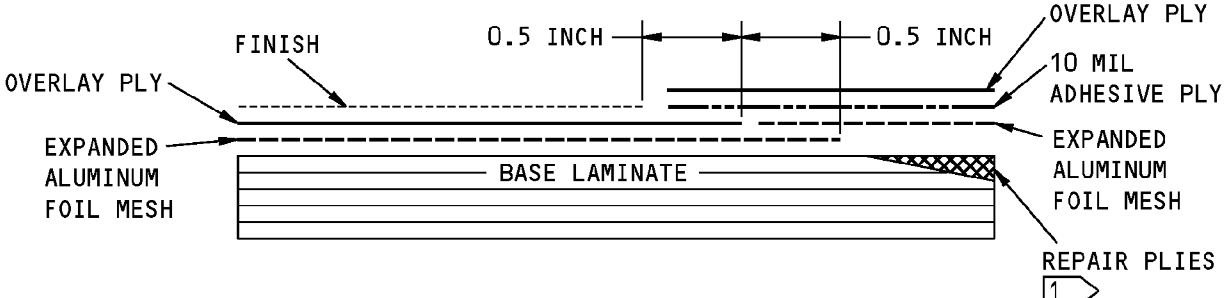
CFRP PART, ANY ALUMINUM COATING, NO OVERLAY PLY, PREPREG REPAIR

C



CFRP PART, ANY ALUMINUM COATING,
NO OVERLAY PLY, WET LAYUP REPAIR

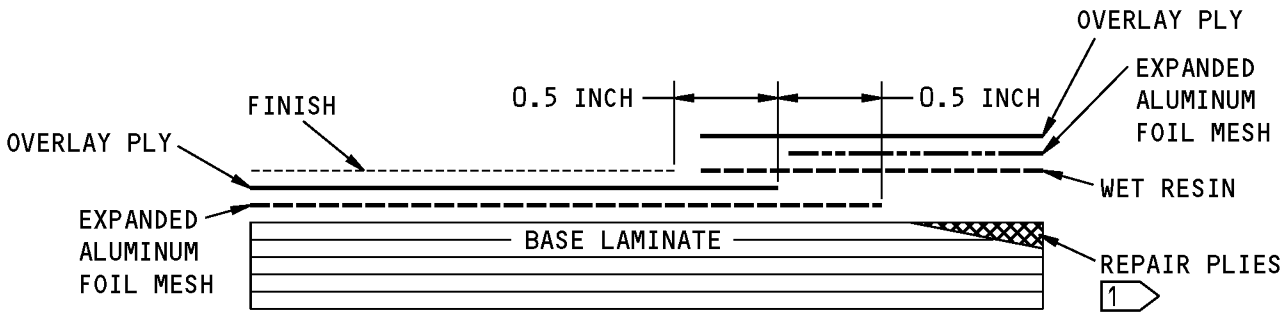
D



PART NOT MADE OF CFRP, EXPANDED FOIL,
OVERLAY PLY, PREPREG REPAIR

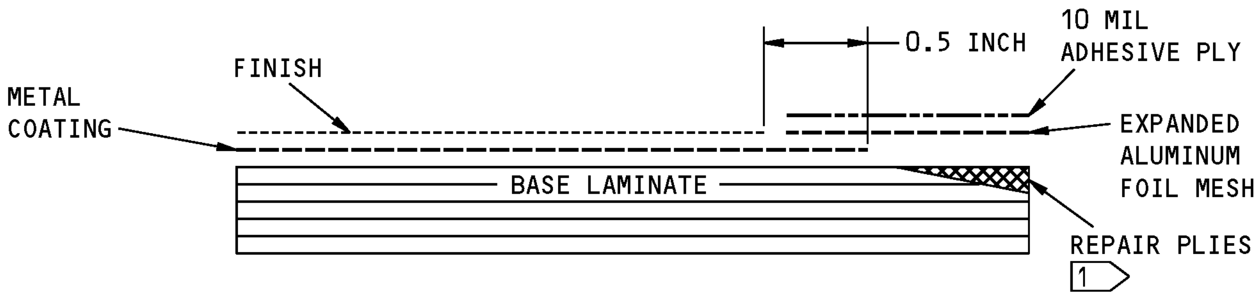
E

Repair of Expanded Aluminum Foil Mesh (BMS 8-336)
Figure 201 (Sheet 3 of 4)



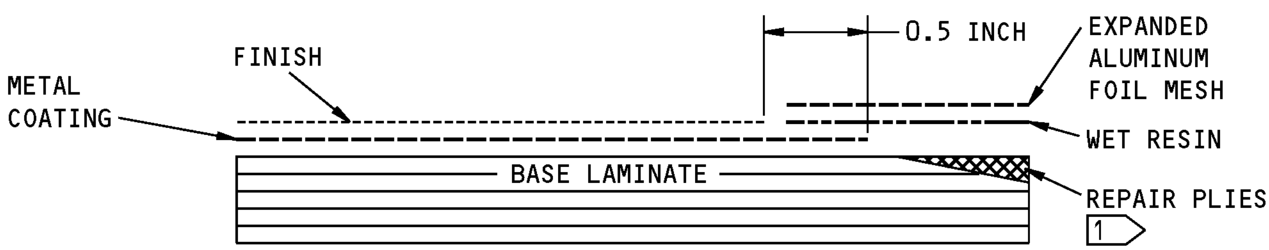
PART NOT MADE OF CFRP, EXPANDED ALUMINUM FOIL, OVERLAY PLY, WET LAYUP REPAIR

F



PART NOT MADE OF CFRP, ANY ALUMINUM COATING, NO OVERLAY PLY, PREPREG REPAIR

G



PART NOT MADE OF CFRP, ANY ALUMINUM COATING, NO OVERLAY PLY, WET LAYUP REPAIR

H

Repair of Expanded Aluminum Foil Mesh (BMS 8-336)
Figure 201 (Sheet 4 of 4)

5. **Permanent Repair - Wet Layup**

A. Find the limits of the damage.

B. Remove the damaged expanded aluminum foil mesh and all other damaged material. Refer to Repair of Expanded Aluminum Foil Mesh (BMS 8-336), Figure 201/REPAIR 4.

CAUTION: USE CARE SO THAT YOU DO NOT CAUSE DAMAGE TO THE GLASS FIBERS OF THE COMPONENT UNDR THE DAMAGED MESH. IF YOU DO NOT OBEY, DAMAGE TO THE STRUCTURE CAN OCCUR.

(1) Lightly sand the damaged area with 180-grit or finer abrasive paper.

(2) Remove the finish up to minimum of 1.00 inches around the edge of the damage with 240-grit or smaller abrasive paper.

WARNING: KEEP THE SOLVENTS AWAY FROM SOURCES OF HEAT, FIRE OR SPARKS. IF YOU DO NOT OBEY, AN EXPLOSION CAN OCCUR. DO NOT PERMIT THE SOLVENTS TO TOUCH YOUR SKIN, EYES OR CLOTHING. DO NOT BREATHE THE VAPORS. WEAR PROTECTIVE CLOTHING AND EYE PROTECTION. MAKE SURE THERE IS A GOOD FLOW OF CLEAN AIR. IN A CONFINED SPACE, USE MECHANICAL VENTILATION OR RESPIRATORY PROTECTION. INJURY TO PERSONS CAN OCCUR.

C. Clean the repair area with a clean cheesecloth that is made moist with Methyl Isobutyl Ketone (MIBK), trichloroethane or acetone.

(1) Remove all the sanding dust and other unwanted materials.

D. Make the repair. Refer to Table 202/REPAIR 4 for the repair materials.

Table 202:

REPAIR MATERIALS	
REPAIR MATERIALS	**BOEING SPECIFICATION**
Overlay ply	BMS 8-245
Isolation ply	BMS 8-79 Style 120 Glass Fiber
Isolation ply	BMS 8-139 Style 120 Glass Fiber
Expanded Foil Mesh	BMS 8-336
Resin Mix	BMS 8-301, Class 1

WARNING: THESE CHEMICALS ARE TOXIC. MAKE SURE THAT THERE IS A GOOD FLOW OF CLEAN AIR WHEN YOU WORK WITH THE COMPONENTS OF THE RESIN OR ADHESIVE. USE CARE TO PROTECT YOUR SKIN, EYES, AND CLOTHING. IF CONTAMINATION DOES OCCUR, WASH WITH SOAP AND WARM WATER. DO NOT USE SOLVENTS TO CLEAN YOUR SKIN. IF YOU DO NOT OBEY, INJURY CAN OCCUR.

CAUTION: DO NOT USE WAXED CONTAINERS TO MIX THE COMPONENTS OF THE RESIN OR ADHESIVE. IF YOU DO, CONTAMINATION OF THE RESIN OR ADHESIVE WILL OCCUR.

E. Mix the components of BMS 8-301, Class 1 resin as given in Table 203/REPAIR 4.

Table 203:

RESIN DATA				
RESIN TYPE	COMPONENTS	PARTS BY WEIGHT	POT LIFE	CURE TIME
BMS 8-301, CLASS 1	EA 9390 Resin Part A	100 ±2	2 hours at 77°F (25 °C)	220 minutes at 190°F to 210°F (87°C to 99°C) or 150 minutes at 240°F to 260°F (116°C to 127°C)
	EA 9390 Hardener Part B	56 ±0.5		

F. If an overlay ply is necessary, refer to Repair of Expanded Aluminum Foil Mesh (BMS 8-336), Figure 201/REPAIR 4 for the location and the necessary overlap requirements.

G. If an isolation ply is used, refer to Repair of Expanded Aluminum Foil Mesh (BMS 8-336), Figure 201/REPAIR 4 for the location.

H. Impregnate the isolation ply, expanded aluminum foil mesh and the overlay ply.

NOTE: Impregnate each separately as necessary or as required. You can add up to 3.5 percent by weight of Cabosil to make the BMS 8-301 Class 1 resin thicker. Do not impregnate more ply or mesh than can be cured within 8 hours after mixing the resin.

(1) Cut two pieces of parting film that are at least 4.00 inches larger in all direction than the plies or mesh.

(2) Use tape to hold one piece of parting film to a smooth surface.

(3) Apply half of the resin you mixed, smoothly and evenly on the parting film.

(4) Place the ply or mesh on the resin and pour the remaining resin on the ply or mesh.

NOTE: About 1 to 1.5 ounces of resin is preferred for each 1 ounce of ply or mesh that is impregnated.

(5) Install the second piece of parting film over the ply or mesh.

(6) Apply pressure to impregnate the ply or mesh with the resin.

(a) Use a wiper or roller to fully and evenly impregnate the ply or mesh to remove trapped air.

(b) Apply pressure to the excess resin at the edges.

(7) Cut the impregnated ply or mesh and parting film to the final size that is a minimum of 1.00 inch larger all around than the outside edges.

NOTE: The parting film on the each side of the ply or mesh will reduce fraying while you cut it.

I. Install the ply or mesh on the repair.

(1) Remove the parting film from one side of the impregnated ply or mesh.

(2) Apply the remainder of the resin over the repair area on the panel.

(3) Install the exposed surface of the ply or mesh on the repair area.

(4) Remove the wrinkles and trapped air with a roller or squeegee. Do not apply heavy pressure, otherwise you could remove the necessary amount of the resin you need.

(5) Remove the second piece of parting film from the impregnated ply or mesh.

J. Assemble the vacuum bag system that will be used to cure the repair. Refer to Layout of the Vacuum Bag Materials - Wet Layup Repair, Figure 202/REPAIR 4.

(1) Cut a piece of perforated FEP parting film (0.001 inch thick) so that the edges are 1.00 inch larger all around the repair area.

(2) Put the parting film over the repair area.

(3) For a cure temperature that is more than room temperature, install three thermocouples at 18 inch intervals maximum around the repair area. Connect the thermocouples to the applicable recorders.

(4) Put a layer of glass fabric cloth over the perforated FEP for a surface bleeder.

(a) Use BMS 9-3, Types D, D-1, H-2, or H-3, or the equivalent.

(5) Cut the surface bleeder so that the edges are 2.00 inches past the edge of the perforated FEP.

(6) Put a layer of solid FEP parting film (0.002 inch thick) over the surface bleeder.

(7) Cut the solid FEP so that the edges are even with the perforated FEP.

(8) If you use a heat blanket as a heat source, do the steps that follow:

NOTE: You can use a heat blanket, infrared heat lamp or the equivalent to accelerate the cure. If the structure is too small to permit the heat blanket to fit in the vacuum bag, do Steps I.(8)(a) through I.(8)(e) and put the heat blanket over the vacuum bag.

WARNING: FOR A HIGH TEMPERATURE CURE, USE HEAT CURE EQUIPMENT THAT AGREES WITH THE FIRE AND SAFETY CODES PERMITTED BY THE LOCAL FIRE PROTECTION AUTHORITY. IF YOU DO OBEY, INJURY TO PERSONS CAN OCCUR.

(a) Cut a 0.020 inch thick aluminum caul plate to the same size as the cover ply.

(b) Put the aluminum caul plate on the solid FEP as permitted up to the contour of the part.

(c) Put the heat blanket on the caul plate.

NOTE: The heat blanket must be a minimum of 2.0 inches more than the edge of the repair.

(d) Put a minimum of two thermocouples on the center of the heat blanket.

(e) Put four to six layers of glass fabric on the heat blanket for the breather cloths.

NOTE: The glass fabric gives insulation for the heat blanket and also helps to prevent damage from occurring to the bagging film.

1) Use BMS 9-3, Types D, D-1, H-2, H-3, or the equivalent.

2) Make the breather cloths the same dimensions as the surface bleeder.

(9) Seal the repair with the vacuum bag material.

(a) Install a vacuum line.

(b) Apply sealing compound around the layup area, approximately 6.00 inches outside the edge of the heat blanket.

(c) Put a piece of vacuum bag material fully over the repair area and seal the edge with sealing compound.

NOTE: If the repair is more that 15 percent of the panel area, you must put a vacuum bag material fully over the part. This will help prevent delamination and distortion of the part. Use devices that supports and keeps the contour of large parts which can sink in the middle and become distorted because of its own weight.

(d) Make some folds in the bag material as necessary to prevent bridging and subsequent breakage.

(e) Apply protective pads to all the sharp corners and edges to prevent breakage.

(f) As an option, put a vacuum bag material fully over the part.

(g) Cut slits in the vacuum bag at the locations where the vacuum line and vacuum gage will be attached to their bases.

(h) Install the vacuum line and the vacuum gage through the vacuum bag material and into their bases.

(10) Do a check of the vacuum bag for leaks.

NOTE: A vacuum bag which has a leak can cause porosity in the repair and bond failure.

(a) Apply a minimum vacuum of 22 inches of mercury to the bag.

(b) Remove the vacuum source.

(c) Monitor the vacuum gage. After 5 minutes the total difference in the vacuum must be less than 5 inches of mercury.

(11) Cure the repair

(a) Refer to Table 203/REPAIR 4 for the cure temperature and time data.

(b) Apply and keep a vacuum to a minimum of 22 inches of mercury in the vacuum bag during the cure of the repair.

(c) Refer to Oven and Autoclave Cure Cycles, Figure 203/REPAIR 4 for the cure temperature and time data.

NOTE: If you cure the repair at a minimum 125°F (52°C), use the cure cycle shown in Oven and Autoclave Cure Cycles, Figure 203/REPAIR 4. You can use a heat blanket, infrared heat lamp or the equivalent to cure the repair at a higher temperature than room temperature. If a heat lamp is used, refer to Heat Lamp Temperature Data, Figure 204/REPAIR 4 for the temperature data. The cure time does not include the time that is necessary for the part to heat up to the cure temperature. The cure time starts when the part is at the cure temperature.

(d) Monitor the temperature with the thermocouples.

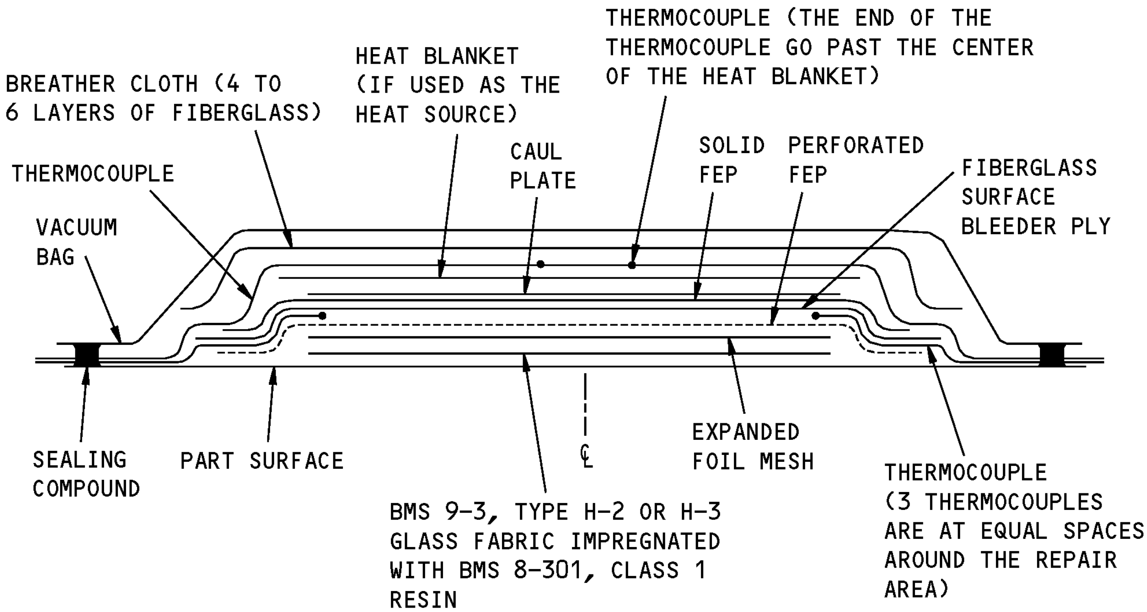
1) Use the measurement from the thermocouple with the lowest value at the edge of the repair as the cure temperature.

2) Make sure that the temperature does not increase at a rate more than 8°F (4.4°C) cycle.

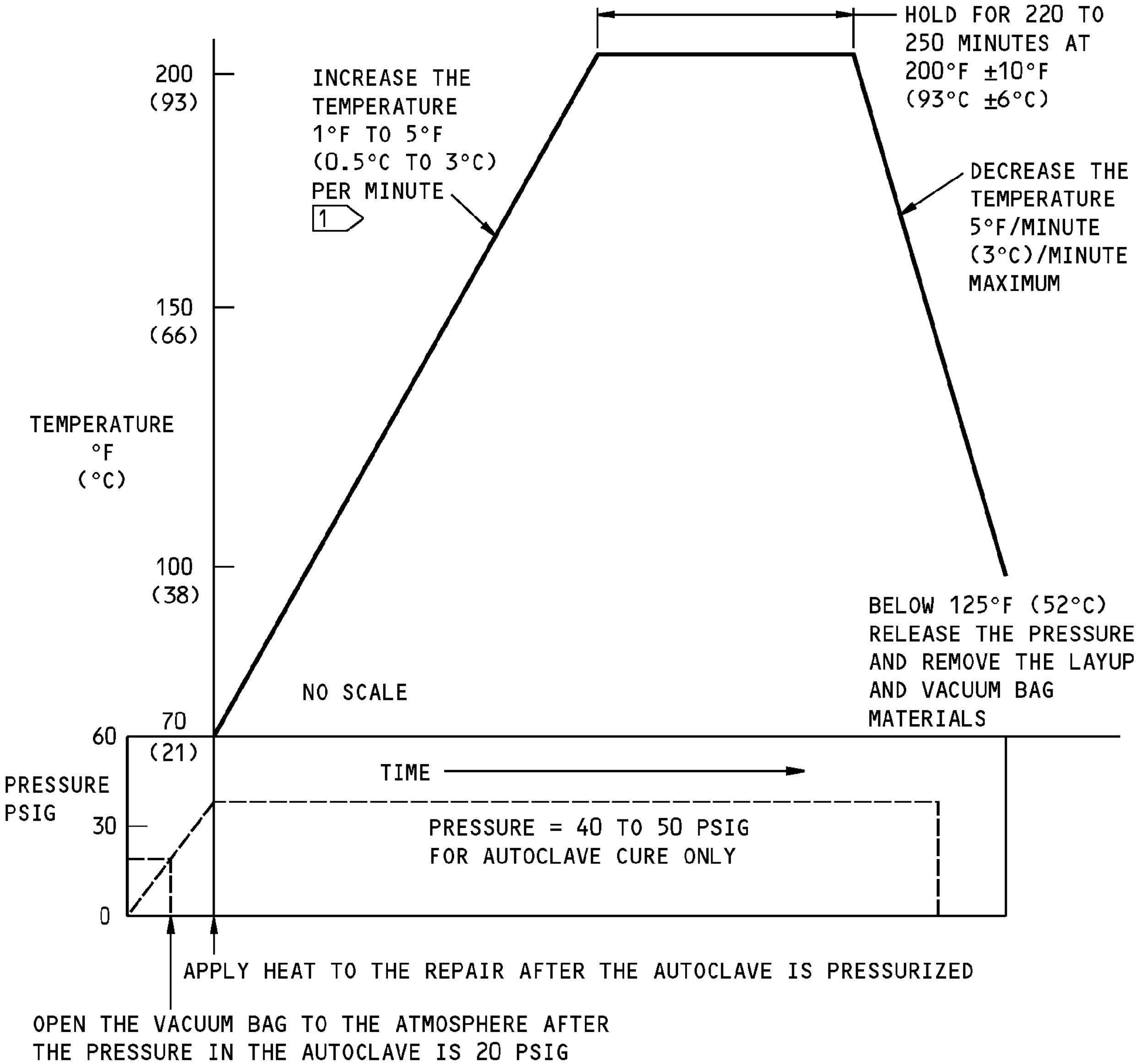
(12) Remove the bagging material.

(13) Apply BMS 10-103, Type I primer if it was removed.

(14) Apply the finish to the repair area. Refer to AMM PAGEBLOCK 51-21-99/701.



Layout of the Vacuum Bag Materials - Wet Layup Repair
Figure 202

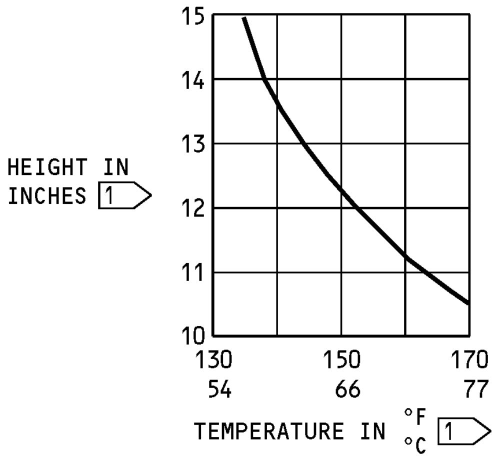


200°F (93°C) AUTOCLAVE OR OVEN CURE CYCLE FOR
BMS 8-301, CLASS I LAMINATING RESIN REPAIRS

NOTE: FOR THE OVEN CURE, KEEP A MINIMUM VACUUM OF 22 INCHES OF MERCURY DURING THE THE FULL CURE CYCLE

1 TO CURE A REPAIR PART THAT IS 0.10 INCH THICK OR THICKER, USE A HEAT RATE LIMIT OF 3°F FOR EACH MINUTE (FOR OVEN CURES).

Oven and Autoclave Cure Cycles
Figure 203



NOTES

- USE THERMOCOUPLES TO MONITOR THE TEMPERATURE.
- USE THE CURE CYCLE SHOWN IN FIGURE 203 WHEN YOU CURE THE RESIN.

1 THE HEIGHT IN INCHES OF A 250 WATT HEAT LAMP FROM THE SURFACE OF THE PART (WHERE THE RESIN HAS BEEN APPLIED) VERSUS THE TEMPERATURE AT THAT SURFACE.

Heat Lamp Temperature Data
Figure 204

6. **Permanent Repair - Prepreg**

CAUTION: THIS REPAIR PROCEDURE IS APPLICABLE TO DAMAGE TO THE EXPANDED ALUMINUM FOIL MESH ONLY. DAMAGE THAT GOES INTO THE STRUCTURAL PLIES, MUST BE REPAIRED FIRST. REFER TO THE APPLICABLE CHAPTER-SECTION-SUBJECT AS NECESSARY FOR THE REPAIR DATA FOR THE STRUCTURAL PLIES.

A. Find the limits of the damage.

B. Remove the damaged expanded aluminum foil mesh and all other damaged material. Refer to Repair of Expanded Aluminum Foil Mesh (BMS 8-336), Figure 201/REPAIR 4.

CAUTION: USE CARE SO THAT YOU DO NOT CAUSE DAMAGE TO THE GLASS FIBERS OF THE COMPONENT UNDR THE DAMAGED MESH. IF YOU DO NOT OBEY, DAMAGE TO THE STRUCTURE CAN OCCUR.

(1) Lightly sand the damaged area with 180-grit or finer abrasive paper.

(2) Remove the finish up to minimum of 1.00 inches around the edge of the damage with 240-grit or finer abrasive paper.

WARNING: KEEP THE SOLVENTS AWAY FROM SOURCES OF HEAT, FIRE OR SPARKS. IF YOU DO NOT OBEY, AN EXPLOSION CAN OCCUR. DO NOT PERMIT THE SOLVENTS TO TOUCH YOUR SKIN, EYES OR CLOTHING. DO NOT BREATHE THE VAPORS. WEAR PROTECTIVE CLOTHING AND EYE PROTECTION. MAKE SURE THERE IS A GOOD FLOW OF CLEAN AIR. IN A CONFINED SPACE, USE MECHANICAL VENTILATION OR RESPIRATORY PROTECTION. IF YOU DO NOT OBEY, INJURY TO PERSONS CAN OCCUR.

C. Clean the repair area with a clean cheesecloth that is made moist with Methyl Isobutyl Ketone (MIBK), trichloroethane or acetone.

(1) Remove all the sanding dust and other unwanted materials.

D. Make the repair. Refer to Table 204/REPAIR 4 for the repair materials.

Table 204:

REPAIR MATERIALS	
REPAIR MATERIALS	**BOEING SPECIFICATION**
Overlay ply	BMS 8-245
Isolation ply	BMS 8-79 Style 120 Glass Fiber
Isolation ply	BMS 8-139 Style 120 Glass Fiber
Expanded Foil Mesh	BMS 8-336
Adhesive, Type 1	BMS 5-92

WARNING: THESE CHEMICALS ARE TOXIC. MAKE SURE THAT THERE IS A GOOD FLOW OF CLEAN AIR WHEN YOU WORK WITH THE COMPONENTS OF THE RESIN OR ADHESIVE. USE CARE TO PROTECT YOUR SKIN, EYES, AND CLOTHING. IF CONTAMINATION DOES OCCUR, WASH WITH SOAP AND WARM WATER. DO NOT USE SOLVENTS TO CLEAN YOUR SKIN. IF YOU DO NOT OBEY, INJURY CAN OCCUR.

CAUTION: DO NOT USE WAXED CONTAINERS TO MIX THE COMPONENTS OF THE RESIN OR ADHESIVE. IF YOU DO, CONTAMINATION OF THE RESIN OR ADHESIVE WILL OCCUR.

E. Mix the components of BMS 5-92, adhesive as given in Table 205/REPAIR 4.

Table 205:

ADHESIVE DATA				
ADHESIVE TYPE	**COMPONENTS**	**PARTS BY WEIGHT**	**POT LIFE**	**CURE TIME**
BMS 5-92, Type I	EC 2216A Gray	140	2 hours below 100°F (38°C)	170 to 190 minutes at 110°F to 130°F (43°C to 54°C) or 120 to 140 minutes at 150°F to 170°F (66°C to 77°C)
	EC 2216B White	100		

F. If an overlay ply is necessary, refer to Repair of Expanded Aluminum Foil Mesh (BMS 8-336), Figure 201/REPAIR 4 for the location and the necessary overlap requirements.

G. If an isolation ply is used, refer to Repair of Expanded Aluminum Foil Mesh (BMS 8-336), Figure 201/REPAIR 4 for the location.

H. Impregnate the isolation ply, expanded aluminum foil mesh and the overlay ply.

NOTE: Impregnate each ply separately as necessary. You can add up to 3.5 percent by weight of Cabosil to make the BMS 8-301, Class 1 resin thicker. Do not impregnate more plies or mesh than can be cured within 8 hours after mixing the resin.

(1) Cut two pieces of parting film that are at least 4.00 inches larger all around than the plies or mesh.

(2) Use tape to hold one piece of parting film to a smooth surface.

(3) Apply half of the resin you mixed, smoothly and evenly on the parting film.

(4) Place the ply or mesh on the resin and pour the remaining resin on the ply or mesh.

NOTE: About 1 to 1.5 ounces of resin is preferred for each 1 ounce of ply or mesh that is impregnated

(5) Install the second piece of parting film on the ply or mesh.

(6) Apply pressure to impregnate the ply or mesh with the resin.

(a) Use a wiper or roller to fully and evenly impregnate the ply or mesh to remove trapped air.

(b) Start at the center of the ply or mesh and work outward to the edges.

(7) Cut the impregnated ply or mesh and parting film to the final size that is a minimum of 1.00 inch larger all around than the outside edges.

NOTE: The parting film on the each side of the ply or mesh will reduce fraying when you cut it.

I. Install the ply or mesh on the repair.

(1) Remove the parting film from one side of the impregnated ply or mesh.

(2) Apply the remainder of the resin to the repair area of the panel.

(3) Install the exposed surface of the ply or mesh on the repair area.

(4) Remove the wrinkles and trapped air with a roller or squeegee. Do not apply heavy pressure, otherwise you could remove the necessary amount of the resin you need.

(5) Remove the second piece of parting film from the impregnated ply or mesh.

J. Assemble the vacuum bag system that will be used to cure the repair. Refer to Layout of the Vacuum Bag Materials - Repair with Pre Preg Material , Figure 205/REPAIR 4.

(1) Cut a piece of perforated FEP parting film (0.001 inch thick) so that the edges are 1.00 inch larger all around the repair area.

(2) Put the parting film on the repair area.

(3) For a cure temperature that is more than room temperature, install three thermocouples at 18 inch intervals maximum around the repair area. Connect the thermocouples to the applicable recorders.

(4) Put a layer of glass fabric cloth on the perforated FEP for a surface bleeder.

(a) Use BMS 9-3, Types D, D-1, H-2, or H-3, or the equivalent.

(5) Cut the surface bleeder so that the edges are 2.00 inches past the edge of the perforated FEP.

(6) Put a layer of solid FEP parting film (0.002 inch thick) on the surface bleeder.

(7) Cut the solid FEP so that the edges are even with the perforated FEP.

(8) If you use a heat blanket as a heat source, do the steps that follow:

NOTE: You can use a heat blanket, infrared heat lamp or the equivalent to accelerate the cure. If the structure is too small to permit the heat blanket to fit in the vacuum bag, do Steps 6.I.(8)(a) through 6.I.(8)(e) and put the heat blanket on the vacuum bag.

WARNING: FOR A HIGH TEMPERATURE CURE, USE HEAT CURE EQUIPMENT THAT AGREES WITH THE FIRE AND SAFETY CODES PERMITTED BY THE LOCAL FIRE PROTECTION AUTHORITY. IF YOU DO OBEY, INJURY TO PERSONS CAN OCCUR.

(a) Cut a 0.020 inch thick aluminum caul plate to the same size as the cover ply.

(b) Put the aluminum caul plate on the solid FEP as permitted up to the contour of the part.

(c) Put the heat blanket on the caul plate.

NOTE: The heat blanket must be a minimum of 2.0 inches more than the edge of the repair.

(d) Put a minimum of two thermocouples on the center of the heat blanket.

(e) Put four to six layers of glass fabric on the heat blanket for the breather cloths.

NOTE: The glass fabric gives insulation for the heat blanket and also helps to prevent damage from occurring to the bagging film.

1) Use BMS 9-3, Types D, D-1, H-2, H-3, or the equivalent.

2) Make the breather cloths the same dimensions as the surface bleeder.

(9) Seal the repair with the vacuum bag material.

(a) Install a vacuum line.

(b) Apply sealing compound around the layup area, approximately 6.00 inches outside the edge of the heat blanket.

(c) Put a piece of vacuum bag material fully over the repair area and seal the edge with sealing compound.

NOTE: If the repair is more that 15 percent of the panel area, you must put a vacuum bag material fully over the part. This will help prevent delamination and distortion of the part. Use devices that supports and keeps the contour of large parts which can sink in the middle and become distorted because of its own weight.

(d) Make some folds in the bag material as necessary to prevent bridging and subsequent breakage.

(e) Apply protective pads to all the sharp corners and edges to prevent breakage.

(f) As an option, put a vacuum bag material fully over the part.

(g) Cut slits in the vacuum bag at the locations where the vacuum line and vacuum gage will be attached to their bases.

(h) Install the vacuum line and the vacuum gage through the vacuum bag material and into their bases.

(10) Do a check of the vacuum bag for leaks.

NOTE: A vacuum bag which has a leak can cause porosity in the repair and bond failure.

(a) Apply a minimum vacuum of 22 inches of mercury to the bag.

(b) Remove the vacuum source.

(c) Monitor the vacuum gage. After 5 minutes the total difference in the vacuum must be less than 5 inches of mercury.

(11) Cure the repair

(a) Refer to Table 203/REPAIR 4 for the cure temperature and time data.

(b) Apply and keep a vacuum to a minimum of 22 inches of mercury in the vacuum bag during the cure of the repair.

(c) Refer to Cure Cycle Data, Figure 206/REPAIR 4 for the cure temperature and time data.

NOTE: If you cure the repair at a minimum 125°F (52°C), use the cure cycle shown in Cure Cycle Data, Figure 206/REPAIR 4. You can use a heat blanket, infrared heat lamp or the equivalent to cure the repair at a higher temperature than room temperature. If a heat lamp is used, refer to Heat Lamp Temperature Data, Figure 207/REPAIR 4 for the temperature data. The cure time does not include the time that is necessary for the part to heat up to the cure temperature. The cure time starts when the part is at the cure temperature.

(d) Monitor the temperature with the thermocouples.

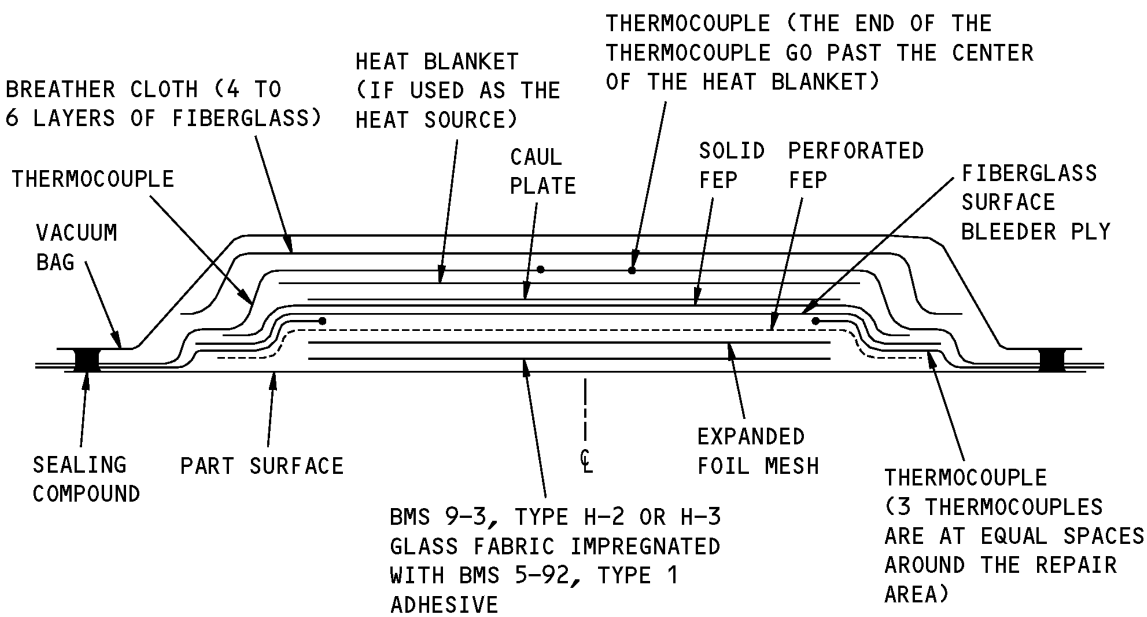
1) Use the measurement from the thermocouple with the lowest value at the edge of the repair as the cure temperature.

2) Make sure that the temperature does not increase at a rate more than 8°F (4.4°C) cycle.

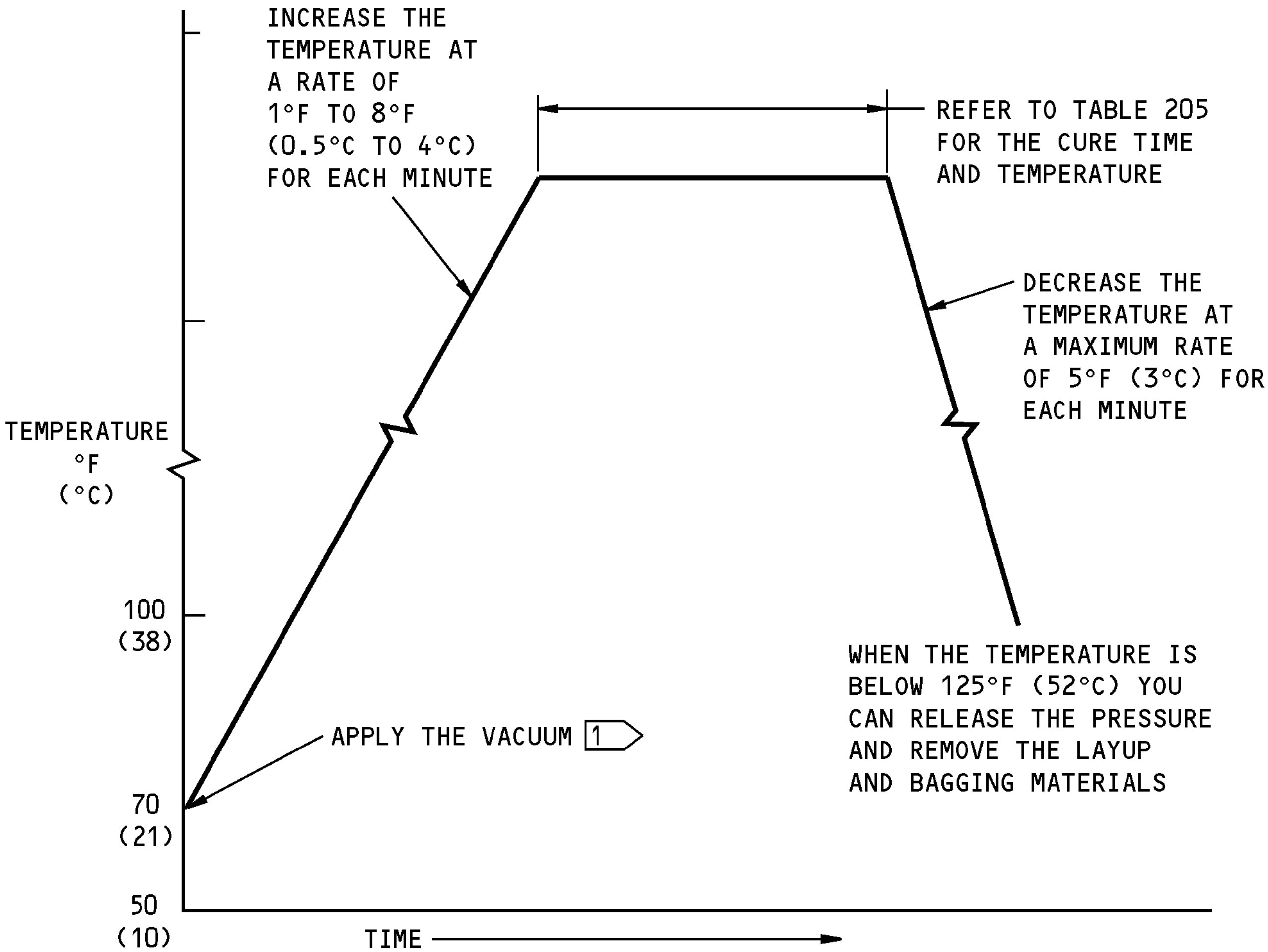
(12) Remove the bagging material.

(13) Apply BMS 10-103, Type I primer if it was removed.

(14) Apply the finish to the repair area. Refer to AMM PAGEBLOCK 51-21-99/701.



Layout of the Vacuum Bag Materials - Repair with Pre Preg Material
Figure 205

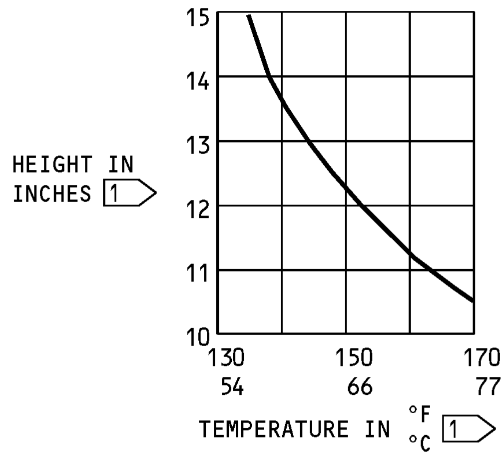


CURE CYCLE

NOTES

1 KEEP A MINIMUM VACUUM OF 22 INCHES OF MERCURY DURING THE FULL CURE CYCLE

Cure Cycle Data
Figure 206



NOTES

- USE THERMOCOUPLES TO MONITOR THE TEMPERATURE.
- USE THE CURE CYCLE SHOWN IN FIGURE 206 WHEN YOU CURE THE ADHESIVE AT A TEMPERATURE THAT IS HOTTER THAN 125°F (52°C).

1 THE HEIGHT IN INCHES OF A 250 WATT HEAT LAMP FROM THE SURFACE OF THE PART (WHERE THE ADHESIVE HAS BEEN APPLIED) VERSUS THE TEMPERATURE AT THAT SURFACE.

Heat Lamp Temperature Data
Figure 207

7. Permanent Repair - Aluminum Foil Tape and BMS 5-95 Sealant

CAUTION: THIS REPAIR PROCEDURE IS APPLICABLE TO DAMAGE TO THE EXPANDED ALUMINUM FOIL MESH ONLY. DAMAGE THAT GOES INTO THE STRUCTURAL PLIES, MUST BE REPAIRED FIRST. REFER TO THE APPLICABLE CHAPTER-SECTION-SUBJECT AS NECESSARY FOR THE REPAIR DATA FOR THE STRUCTURAL PLIES.

A. Find the limits of the damage.

B. Prepare the repair. Refer to Table 206/REPAIR 4 for the repair materials.

Table 206:

REPAIR MATERIALS	
REPAIR MATERIALS	**SPECIFICATION**
Repair Ply 1	3M-436 Speed Tape
Repair Splice	3M-436 Speed Tape
Cover Ply	3M-436 Speed Tape
Sealant	BMS 5-95

(1) Isolate the area that surrounds the damage with masking tape.

CAUTION: USE CARE SO YOU DO NOT CAUSE DAMAGE TO THE GLASS FIBERS OF THE COMPONENT UNDER THE DAMAGED FOIL. IF YOU DO NOT OBEY, DAMAGE TO THE STRUCTURE WILL OCCUR.

(2) Remove the finish in the damaged area up to 2.00 inches around the damage with 240-grit abrasive paper.

(3) Remove the damage with a 150-grit or smaller abrasive paper.

WARNING: KEEP THE SOLVENTS AWAY FROM SOURCES OF HEAT, FIRE OR SPARKS. IF YOU DO NOT OBEY, AN EXPLOSION CAN OCCUR. DO NOT PERMIT THE SOLVENTS TO TOUCH YOUR SKIN, EYES OR CLOTHING. DO NOT BREATHE VAPORS. WEAR PROTECTIVE CLOTHING AND EYE PROTECTION. MAKE SURE THERE IS A GOOD FLOW OF CLEAN AIR. IN A CONFINED SPACE, USE MECHANICAL VENTILATION OR RESPIRATORY PROTECTION. IF YOU DO NOT OBEY, INJURY TO PERSONS CAN OCCUR.

CAUTION: DO NOT LET THE SOLVENTS STAY ON THE PART. IF YOU DO NOT OBEY, DAMAGE TO THE PART CAN OCCUR.

(4) Clean the exposed composite surface of the repair area with a clean cheesecloth that is moist with Methyl Isobutyl Ketone (MIBK), trichloroethane, or acetone.

(5) Remove all of the sanding dust and other unwanted materials.

C. Apply a repair ply made from aluminum foil tape (speed tape 3M-Y436) to the damaged area.

(1) Make a butt-splice to the repair ply with no overlaps.

NOTE: A maximum separation of 0.25 inch is permitted.

(2) Apply pressure to the repair ply with a roller or squeegee to remove the air bubbles.

(3) Apply a chemical conversion layer to the repair ply and sanded aluminum coated glass fabric surfaces.

D. Apply a 2.00 inch repair splice made from aluminum foil tape.

(1) Apply a chemical conversion layer to the surfaces of the tape.

(2) Make holes in repair splice centerline that are 0.50 inch in diameter (nominal) and 2.00 inches apart (nominal, centerline to centerline) as shown in Aluminum Foil Tape Repair, Figure 208/REPAIR 4.

(3) With the adhesive side up, put the repair splice in the center of the butt-splice (overlap 1.00 inch each side).

E. Apply a cover ply made from aluminum foil tape to the damaged area.

(1) Make an overlap of 1.00 inch to repair splice.

(2) Apply pressure to the cover ply with a roller or squeegee to remove the air bubbles.

F. Measure the conductivity of the repair to the initial surface. The resistance must not be more than 0.10 ohms.

G. Apply a chemical conversion layer to the cover ply and sanded surfaces of the aluminum coated glass fabric. Refer to 51-20-01.

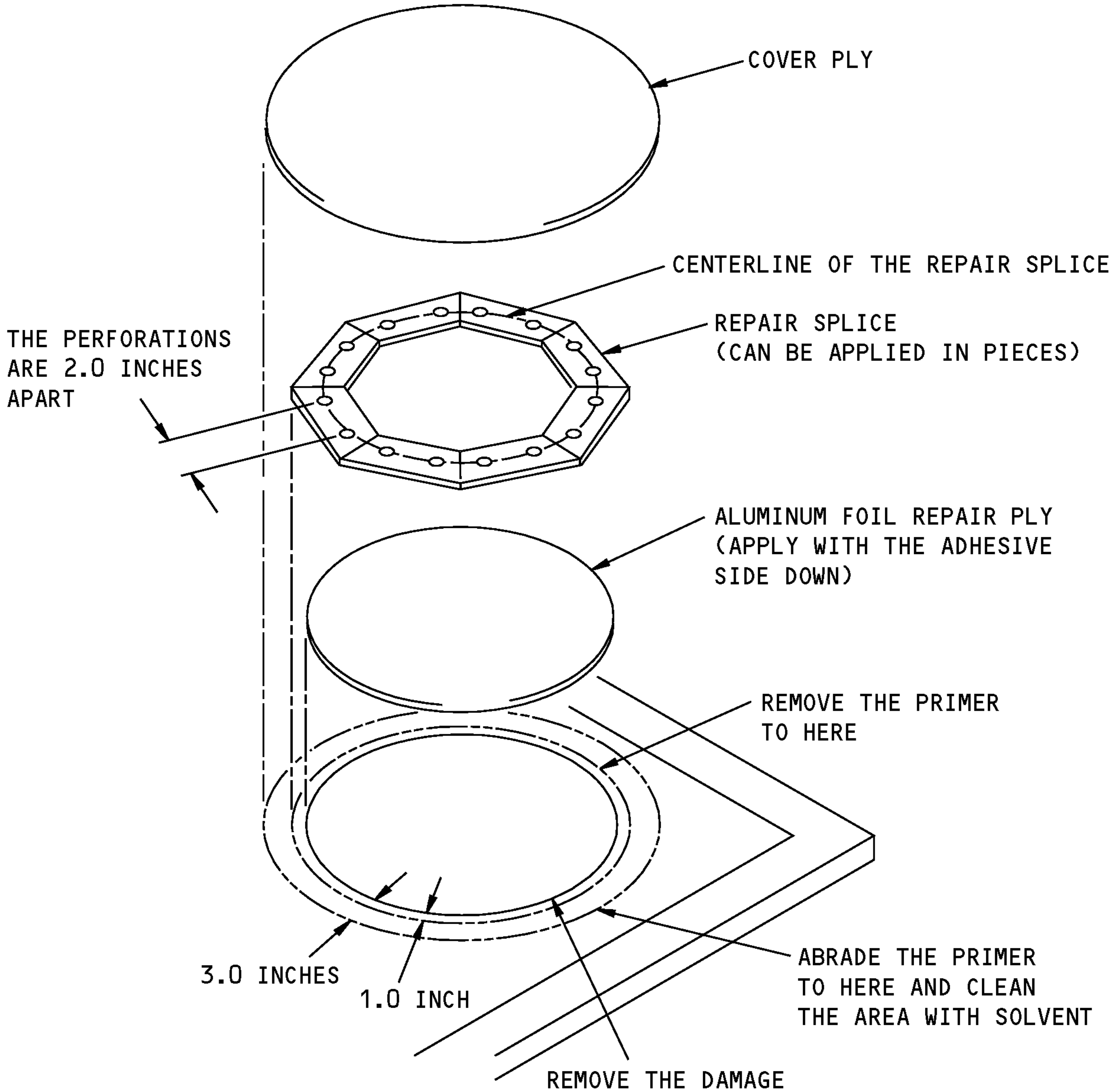
H. Apply a fillet seal all around the edges of the cover ply with the BMS 5-95 sealant. Refer to 51-20-05.

NOTE: A completed seal of the cover plies edge is very important. The quality of the repair can decrease if this procedure is not completed.

(1) To make the sealant cure faster, cure the sealant at 150°F (66°C).

I. Apply a layer of BMS 10-103, Type I primer, as necessary.

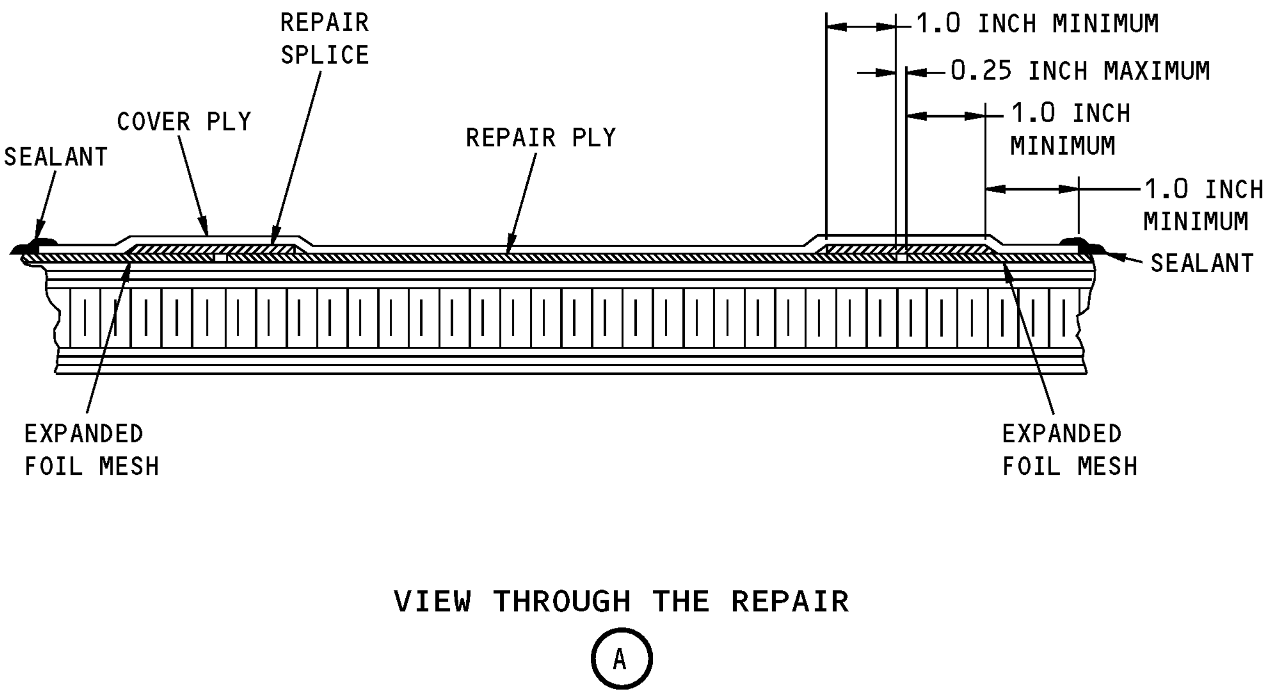
J. Apply the finish to the repair area. Refer to AMM PAGEBLOCK 51-21-99/701.



NOTE: REFER TO DETAIL A FOR A VIEW THROUGH THE REPAIR.

REPAIR PLY LAYUP

Aluminum Foil Tape Repair
Figure 208 (Sheet 1 of 2)



Aluminum Foil Tape Repair
Figure 208 (Sheet 2 of 2)

REPAIR GENERAL - TYPICAL METAL OVERLAY REPAIRS OF COMPOSITE PANELS

1. Applicability

CAUTION: THIS TIME-LIMITED METAL OVERLAY REPAIR WILL NOT PUT COMPOSITE STRUCTURE CURED TO 250°F (121°C) OR 350°F (177°C) BACK TO ITS INITIAL STRENGTH OR DURABILITY. WHEN YOU MAKE THIS REPAIR, YOU MUST REFER TO THE SPECIFIED CHAPTER-SECTION-SUBJECT FOR THE MATERIAL AND THE REPAIR LIMITS OF THE PART. IF YOU DO NOT OBEY, THE RESULT WILL BE AN UNSATISFACTORY REPAIR.

A. This time-limited repair is applicable to:

(1) Secondary structure composite panels made of Carbon Fiber Reinforced Plastic (CFRP) and Glass Fiber Glass Reinforced Plastic (GFRP) as follows:

(a) Wing-to-Body Fairings

(b) Wing Fixed Trailing Edges

(c) Stabilizer Trailing Edges

(d) Engine Strut Fairings

(e) Tailcone.

(2) Areas where the repair patch and the part surface have complete contact.

2. General

A. This subject gives the procedures for a time-limited sheet metal repair of a composite panel.

(1) Refer to Repair of a Composite Panel Away From an Edge, Figure 201/REPAIR GENERAL for the repair of damage in an area that is away from an edge.

(2) Refer to Repair of a Composite Panel at an Edge, Figure 202/REPAIR GENERAL for the repair of damage that is at an edge.

B. You must make an inspection of this repair and replace it with a Category A or B repair as given in Paragraph 6./REPAIR GENERAL

C. The maximum size of damage permitted by this repair is the smaller of the two conditions that follows:

(1) 1.5 times the largest dimension of the damage permitted in the specified allowable damage section of the part

(2) 0.75 times the largest dimension of the damage permitted in a Category B or C repair as given in the specified repair section of the part.

D. The damage must be a minimum of 3.0 times the maximum dimension, edge-to-edge, from adjacent damage, a hole, or edge of the panel.

3. References

Reference	Title
51-00-04, GENERAL	Structural Classification
51-00-06, GENERAL	Structural Repair Definitions
51-10-01, GENERAL	Aerodynamic Smoothness Requirements
51-10-02, GENERAL	Inspection and Removal of Damage
51-20-01, GENERAL	Protective Treatment of Metallic and Composite Materials
51-20-05, GENERAL	Repair Sealing

(Continued)

Reference	Title
51-30-05, GENERAL	Equipment and Tools For Repairs
51-40-00, GENERAL	Fasteners
51-40-02, GENERAL	Fastener Installation and Removal
51-40-03, GENERAL	Fastener Substitution
51-40-05, GENERAL	Fastener Hole Sizes
51-40-06, GENERAL	Fastener Edge Margins
51-70-04	REPAIR PROCEDURES FOR WET LAYUP MATERIALS
51-70-04, REPAIR GENERAL	Repair Procedures for Wet Layup Materials
AMM 51-21-99 P/B 701	DECORATIVE EXTERIOR PAINT SYSTEM - CLEANING/PAINTING
SOPM 20-30-03	Standard Overhaul Practices Manual
737 NDT Part 1, 51-01-02	NDT Examination of Composite Structure for Impact Damage
737 NDT Part 1, 51-05-01	Tap Test Inspection of Honeycomb Sandwich Structure

4. Preparation for the Repair

A. Find the limits of the damage.

(1) For delaminations, use instrumented Non-Destructive Test (NDT) methods to find the dimensions of the damage area. Refer to 737 NDT Part 1, 51-01-02 for the inspection procedures.

NOTE: Other equivalent inspection methods that have been examined and found to be satisfactory by the operator, can be used.

(a) For honeycomb core areas, the tap test is an alternative procedure to an instrumented NDT. Refer to 737 NDT Part 1, 51-05-01 for the procedures.

B. Remove water, dirt, or other unwanted material from the damaged area of the panel.

(1) If there is water in the honeycomb structure, refer to 51-70-04 for the procedures to remove the water.

C. Prepare the damaged area for the repair.

(1) Make a mark 2.0 inches (50.8 mm) larger all around the damaged area.

(2) Abrade the surface around the damaged area.

(a) Use an abrasive paper that is 240-grit or smaller, Scotch Brite, or the equivalent.

(b) Do not cause damage to the fibers.

(c) Make the surface smooth.

WARNING: KEEP SOLVENTS AWAY FROM SOURCES OF HEAT, FIRE , OR SPARKS. IF YOU DO NOT OBEY, AN EXPLOSION CAN OCCUR. DO NOT PERMIT THE SOLVENTS TO TOUCH YOUR EYES, SKIN, OR CLOTHING. WEAR EYE PROTECTION AND PROTECTIVE CLOTHING. DO NOT BREATHE THE VAPORS IN A CONFINED SPACE. USE RESPIRATORY PROTECTION OR MECHANICAL VENTILATION. IF YOU DO NOT OBEY, INJURY TO PERSONS CAN OCCUR.

(WARNING PRECEDES)

CAUTION: DO NOT USE PAINT STRIPPERS TO REMOVE THE FINISH. IF YOU DO NOT OBEY, DAMAGE TO THE ADHESIVE SYSTEM WILL OCCUR. DO NOT SOAK THE PARTS IN TRICHLOROETHANE SOLVENT. DO NOT PERMIT THE SOLVENT TO STAY ON THE PARTS FOR MORE THAN 60 SECONDS. IF YOU DO NOT OBEY, DAMAGE TO THE PARTS CAN OCCUR.

D. Wipe the area around the damage with a clean lint-free cloth moist with . Refer to SOPM 20-30-03 as necessary for the procedures.

5. **Repair Instructions**

A. Make a mark of the damaged area on the panel to find the size of the repair plate. Refer to Repair of a Composite Panel Away From an Edge, Figure 201/REPAIR GENERAL or Repair of a Composite Panel at an Edge, Figure 202/REPAIR GENERAL.

NOTE: In large bays that have more than one repair, the repairs can not be nearer, edge-to-edge, than six times the diameter of the largest damaged area.

WARNING: SMALL PARTICLES AND THIN CUTS OF TITANIUM ARE FLAMMABLE. IN A SUFFICIENT CONCENTRATION, AN EXPLOSION CAN OCCUR. EXTINGUISH ALL FIRES OF TITANIUM WITH FULLY DRY TALC, CALCIUM CARBONATE, SAND, OR GRAPHITE. APPLY THE POWDER TO A DEPTH OF 1/2 INCH (12.7 MM) OR MORE TO THE AREA THAT IS ON FIRE. DO NOT USE FOAM, WATER, CARBON TETRACHLORIDE, HALON, OR CARBON DIOXIDE. IF WATER TOUCHES TITANIUM THAT IS ON FIRE, A STEAM EXPLOSION CAN OCCUR.

B. Make the part [1] and part [2] Doublers. Refer to Table 201/REPAIR GENERAL.

Table 201:

REPAIR MATERIAL			
ITEM	PART	QUANTITY	MATERIAL
[1]	Doubler	1	Use 2024-T4 plate. Use a thickness of 0.063 to 0.080 inch (1.60 mm to 2.03 mm). (Optional: 7075-T6 plate, CRES plate, or Ti-6Al-4V titanium plate)
[2]	Doubler	1	Use 2024-T4 plate. Use a thickness of 0.040 inch (1.02 mm). (Optional: 7075-T6 plate, CRES plate, or Ti-6Al-4V titanium plate)

C. Assemble the part [1] and part [2] Doublers on the panel.

D. Drill the fastener holes through the part [1] and part [2] Doublers and the panel.

E. Remove the part [1] and part [2] Doublers from the panel.

F. Remove the debris.

(1) Remove the nicks, gouges, burrs, and sharp edges from the part [1] and part [2] Doublers.

(2) Remove all of the sanding dust from the panel with a portable vacuum cleaner.

G. For the part [1] and part [2] Doublers made of aluminum, do as follows:

NOTE: A finish to a CRES or titanium repair plate is not necessary.

(1) Apply a chemical conversion coating to the surfaces of the part [1] and part [2] Doublers.

(2) Apply one layer of BMS 10-79, Type II or Type III primer to all surfaces of the part [1] and part [2] Doublers.

H. Apply one layer of BMS 10-60, Type II enamel to all surfaces of the part [1] and part [2] Doublers.

I. Apply BMS 5-95 B-1/2 sealant to the surfaces of the panel below the part [1] and part [2] Doublers.

J. Assemble the part [1] and part [2] Doublers to the damaged area.

CAUTION: FASTENERS INSTALLED IN CARBON FIBER STRUCTURE MUST BE MADE OF BARE OR ALUMINUM COATED TITANIUM, CORROSION RESISTANT STEEL (CRES), OR CADMIUM PLATED CRES. ALUMINUM OR ALLOY STEEL FASTENERS ARE NOT PERMITTED IN CARBON FIBER STRUCTURES. IF YOU INSTALL THE INCORRECT FASTENERS IN THE STRUCTURE, CORROSION WILL OCCUR. WHEN YOU REINSTALL ALUMINUM FITTINGS ON CARBON FIBER STRUCTURES, MAKE SURE TO KEEP THE INITIAL CORROSION PROTECTION TREATMENT. INSTALL THE FITTINGS WITH A MATING SURFACE SEAL WITH BMS 5-63 IN FUEL TANKS AND BMS 5-95 IN ALL OTHER AREAS. DO NOT APPLY MORE TORQUE TO THE NUTS THAN IS NECESSARY. IF YOU DO NOT OBEY, YOU CAN CRUSH THE HONEYCOMB CORE.

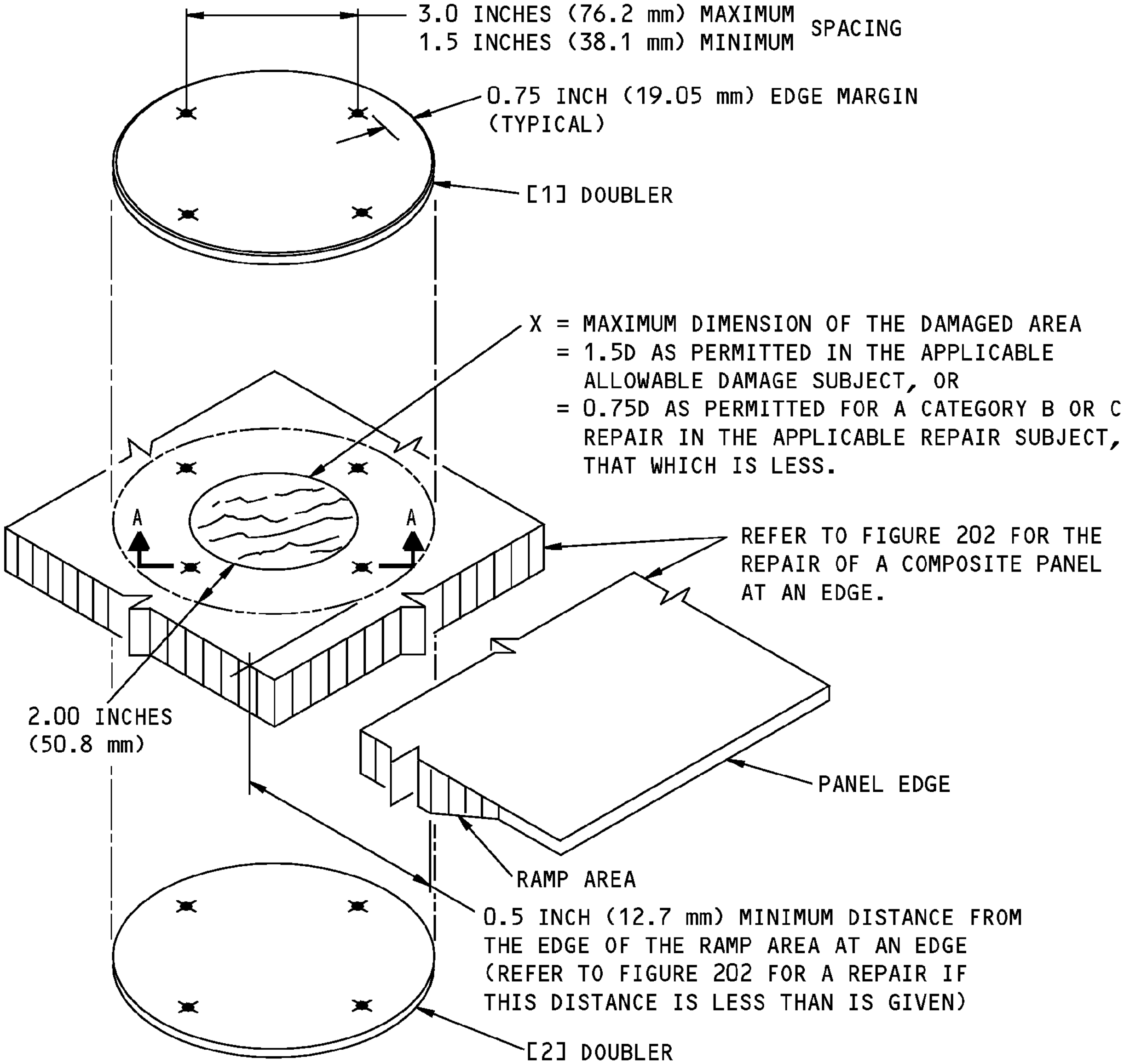
K. Install the fasteners wet with BMS 5-95 sealant or BMS 3-24 grease.

   (1) Install 0.75 inch (19.05 mm) washers below the nuts.

   (2) Apply a torque on the nuts that will not cause damage to the honeycomb core.

   (3) Apply BMS 5-95 sealant to the nuts and the heads of the bolts.

L. Apply a finish as given in AMM PAGEBLOCK 51-21-99/701.



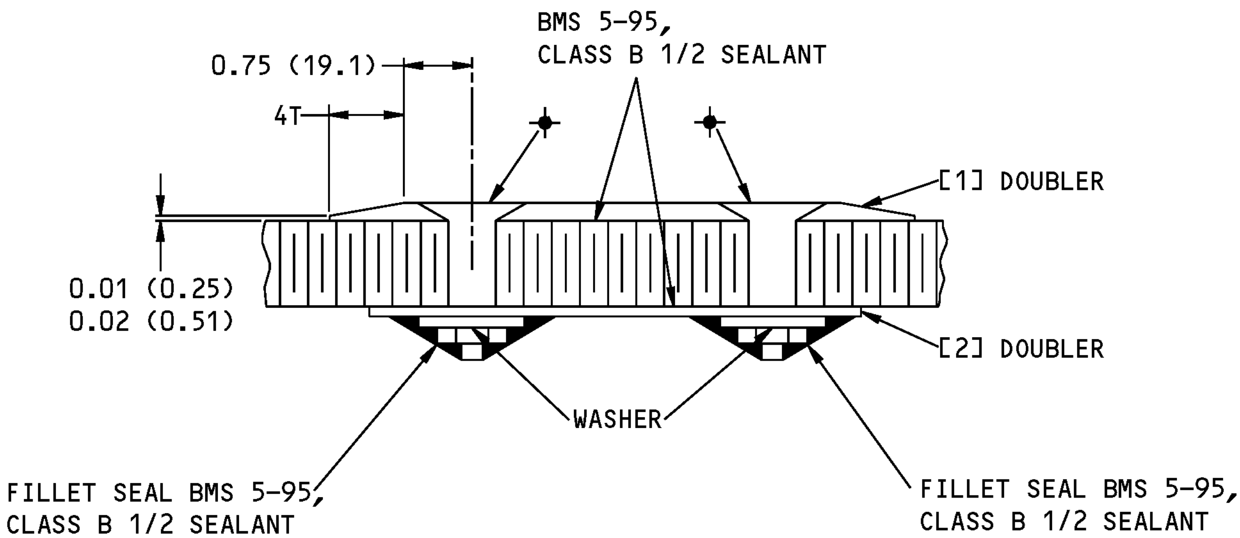
NOTES

- D = LARGEST DIMENSION OF THE DAMAGE
- A REPAIR TO THE HONEYCOMB STRUCTURE IS SHOWN. THIS REPAIR IS ALSO APPLICABLE TO SOLID LAMINATE STRUCTURE.

FASTENER SYMBOLS

⌖ REPAIR FASTENER LOCATION. INSTALL A 3/16 DIAMETER COUNTERSINK BOLT OR SCREW WITH A LOCKNUT AND AN ALUMINUM WASHER THAT IS 0.75 INCH DIAMETER X 0.06 INCH THICK. CAP AND FAY SEAL THE FASTENER HEAD AND NUT, AND THE WASHER.

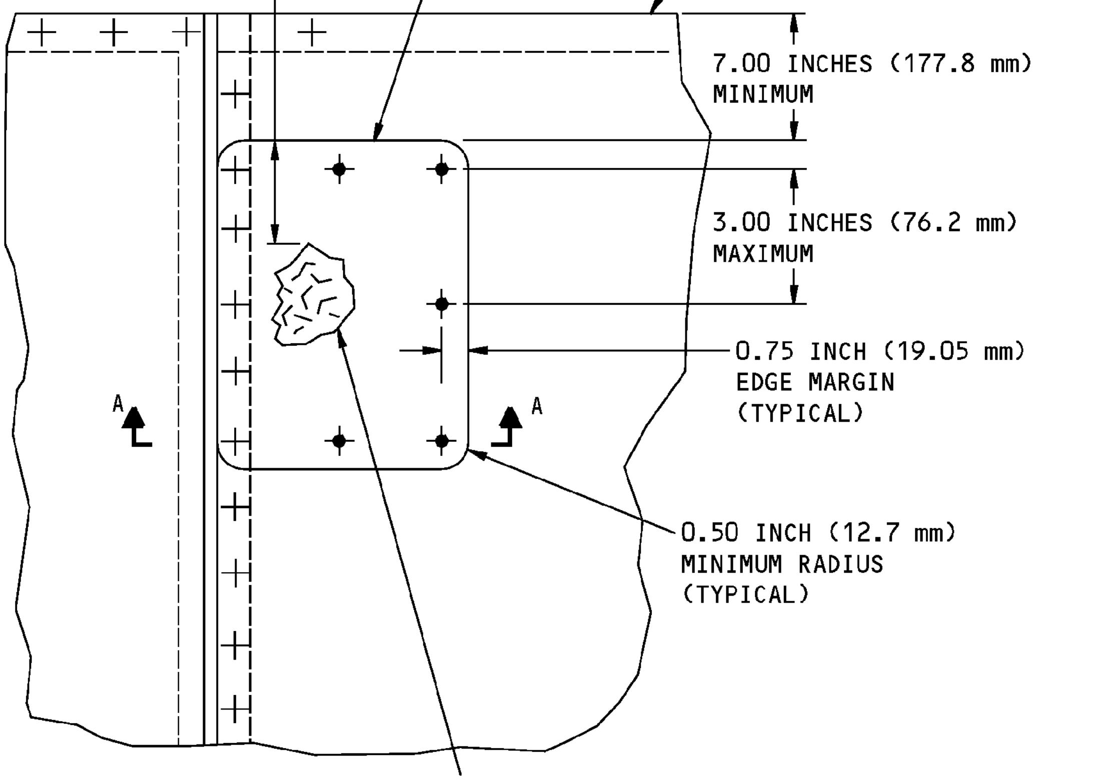
Repair of a Composite Panel Away From an Edge
Figure 201 (Sheet 1 of 2)



NOTE: ALL DIMENSIONS ARE IN INCHES (MILLIMETERS).

A-A

Repair of a Composite Panel Away From an Edge
Figure 201 (Sheet 2 of 2)



NOTES

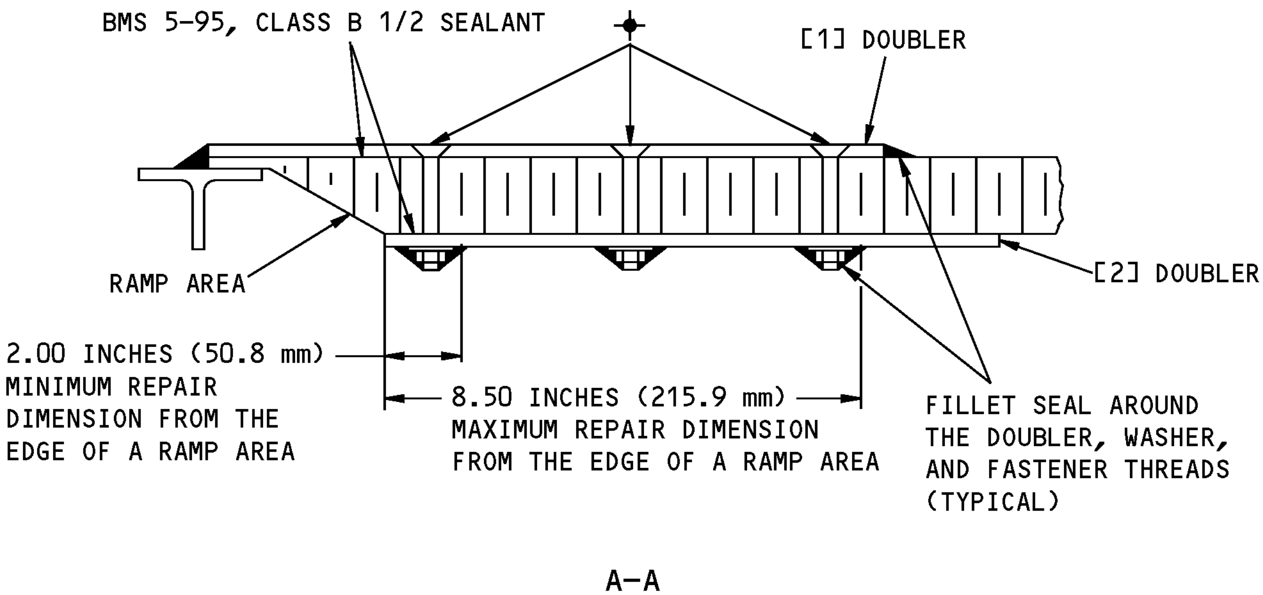
- D = LARGEST DIMENSION OF THE DAMAGE
- A REPAIR TO THE HONEYCOMB STRUCTURE IS SHOWN. THIS REPAIR IS ALSO APPLICABLE TO SOLID LAMINATE STRUCTURE.

FASTENER SYMBOLS

+ INITIAL FASTENER LOCATION. INSTALL A 3/16 INCH DIAMETER CRES OR TITANIUM HEX HEAD BOLT AND LOCKNUT, AND ALUMINUM WASHER.

⌖ REPAIR FASTENER LOCATION. INSTALL A 3/16 INCH DIAMETER CRES OR TITANIUM HEX HEAD BOLT AND LOCKNUT, AND AN ALUMINUM WASHER THAT IS 0.75 DIAMETER X 0.06 INCH THICK. CAP AND FAY SEAL THE FASTENER HEAD AND NUT, AND THE WASHER.

Repair of a Composite Panel at an Edge
Figure 202 (Sheet 1 of 2)



Repair of a Composite Panel at an Edge
Figure 202 (Sheet 2 of 2)

6. **Inspection and Removal of Time-Limited Repair**

A. Do an external detailed visual inspection of the repair:

(1) 400 flight hours after you install the repair on CFRP structure

(2) 1,200 flight hours after you install the repair on GFRP structure.

B. Replace the repair with a permanent repair:

(1) If you find deterioration

(2) At or before 5,000 flight hours or 18 months, that which occurs first, after you installed the repair.

C. Do the procedures that follow to remove the repair:

(1) Apply heat to the repair to a maximum temperature of 150°F (66°C).

(2) Remove the fasteners and the repair plate.

(a) Make sure that you do not cause damage to the composite structure.

(3) Remove the sealant.

(a) Make sure that you do not cause damage to the composite structure.

(b) If you use an abrasive, make sure you do not damage the fibers of the surface of the composite structure.