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18	Apr 01/2005
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20	Apr 01/2005
21	Apr 01/2005
22	Apr 01/2005
23	Dec 15/2006
24	BLANK
51-50-02 GENERAL	
1	Aug 15/2006
2	Apr 01/2005
3	Apr 01/2005
4	Apr 01/2005
5	Apr 01/2005
6	Apr 01/2005
7	Apr 01/2005
8	Apr 01/2005
9	Apr 01/2005
10	Apr 01/2005
11	Apr 01/2005
12	Apr 01/2005
13	Apr 01/2005
14	BLANK
51-60-00 GENERAL	
1	Apr 01/2005
2	Aug 15/2006
3	Apr 01/2005
4	Apr 01/2005
5	Apr 01/2005
6	Apr 01/2005
7	Apr 01/2005
8	Apr 01/2005
9	Apr 01/2005
10	BLANK
51-60-01 GENERAL	
1	Apr 01/2005
2	Apr 01/2005
3	Apr 01/2005
4	Aug 15/2006
5	Aug 15/2008
6	Aug 15/2008
7	Apr 01/2005
8	Apr 01/2005
9	Apr 01/2005
10	Apr 01/2005
11	Apr 01/2005
12	Apr 01/2005
51-60-02 GENERAL	
1	Apr 01/2005
2	Apr 01/2005
3	Apr 01/2005
4	Apr 01/2005
5	Aug 15/2008
6	Apr 01/2005
7	Aug 15/2006
8	Apr 01/2005
51-60-03 GENERAL	
1	Dec 15/2005
2	Dec 15/2005
3	Dec 15/2005
4	Aug 15/2008
5	Apr 01/2005
6	Apr 01/2005
7	Apr 01/2005
8	BLANK
51-70-01 GENERAL	
1	Aug 15/2008
2	Apr 01/2005
3	Apr 01/2005
4	Apr 01/2005
5	Apr 01/2005
6	Apr 01/2005
7	Apr 01/2005
8	BLANK
51-70-02 GENERAL	
1	Apr 01/2005
2	Apr 01/2005
3	Apr 01/2005
4	Apr 01/2005
5	Apr 01/2005
6	Apr 01/2005
7	Apr 01/2005
8	Apr 01/2005
9	Apr 01/2005
10	Apr 01/2005
11	Apr 01/2005
12	Apr 01/2005
51-70-03 GENERAL	
1	Aug 15/2008
2	Aug 15/2008
3	Aug 15/2008
4	Aug 15/2008
5	Aug 15/2008
6	Aug 15/2008
7	Aug 15/2008
8	Aug 15/2008
9	Aug 15/2008
10	Aug 15/2008
11	Aug 15/2008
12	Aug 15/2008
13	Aug 15/2008
14	Aug 15/2008
15	Aug 15/2008
16	Aug 15/2008
17	Aug 15/2008
18	Aug 15/2008
19	Aug 15/2008
20	Apr 01/2005
21	Apr 01/2005
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28	Apr 01/2005	16	Apr 01/2005	51-70-05 GENERAL	
29	Apr 01/2005	17	Apr 01/2005	1	Aug 15/2008
30	Apr 01/2005	18	Apr 01/2005	2	Aug 15/2008
31	Apr 01/2005	19	Apr 01/2005	3	Aug 15/2006
32	Apr 01/2005	20	Dec 15/2005	4	Apr 15/2007
33	Apr 01/2005	21	Apr 01/2005	5	Apr 01/2005
34	Apr 01/2005	22	Apr 01/2005	6	Apr 01/2005
35	Apr 01/2005	23	Apr 01/2005	7	Apr 01/2005
36	Apr 01/2005	24	Apr 01/2005	8	Apr 01/2005
37	Apr 01/2005	25	Apr 01/2005	9	Apr 01/2005
38	Apr 01/2005	26	Apr 01/2005	10	Apr 01/2005
39	Apr 01/2005	27	Apr 01/2005	11	Apr 01/2005
40	Apr 01/2005	28	Apr 01/2005	12	Apr 01/2005
41	Apr 01/2005	29	Apr 01/2005	13	Apr 01/2005
42	Apr 01/2005	30	Apr 01/2005	14	Apr 01/2005
43	Apr 01/2005	31	Apr 01/2005	15	Apr 01/2005
44	Apr 01/2005	32	Apr 01/2005	16	Apr 01/2005
45	Apr 01/2005	33	Apr 01/2005	17	Apr 01/2005
46	Apr 01/2005	34	Apr 01/2005	18	Apr 01/2005
47	Apr 01/2005	35	Apr 01/2005	19	Aug 15/2008
48	Apr 01/2005	36	Apr 01/2005	20	Aug 15/2008
49	Apr 01/2005	37	Apr 01/2005	21	Aug 15/2008
50	Apr 01/2005	38	Apr 01/2005	22	Aug 15/2008
51-70-04 GENERAL		39	Apr 01/2005	23	Apr 01/2005
1	Aug 15/2008	40	Apr 01/2005	24	Apr 01/2005
2	Aug 15/2008	41	Apr 01/2005	25	Apr 15/2005
3	Apr 01/2005	42	Apr 01/2005	26	Apr 01/2005
4	Apr 15/2007	43	Apr 01/2005	27	Apr 01/2005
5	Apr 15/2007	44	Apr 01/2005	28	Apr 01/2005
6	Apr 15/2007	45	Apr 01/2005	29	Apr 01/2005
7	Apr 01/2005	46	Apr 01/2005	30	Apr 01/2005
8	Apr 01/2005	47	Apr 01/2005	31	Apr 01/2005
9	Apr 01/2005	48	Apr 01/2005	32	Apr 01/2005
10	Apr 01/2005	49	Apr 01/2005	33	Apr 01/2005
11	Apr 01/2005	50	Apr 01/2005	34	Apr 01/2005
12	Apr 01/2005	51	Apr 01/2005	35	Apr 01/2005
13	Apr 01/2005	52	Apr 01/2005	36	Apr 01/2005
14	Apr 01/2005	53	Apr 01/2005	37	Apr 01/2005

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40	Apr 01/2005
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42	Apr 01/2005
43	Apr 01/2005
44	Apr 01/2005
45	Apr 01/2005
46	Apr 01/2005
47	Apr 01/2005
48	Apr 01/2005
49	Apr 01/2005
50	Apr 01/2005
51	Apr 01/2005
52	Apr 01/2005
51-70-06 GENERAL	
1	Aug 15/2008
2	Aug 15/2008
3	Aug 15/2008
4	Aug 15/2008
5	Aug 15/2008
6	Aug 15/2008
7	Aug 15/2008
8	Aug 15/2008
9	Aug 15/2008
10	Aug 15/2008
11	Aug 15/2008
12	Aug 15/2008
13	Aug 15/2008
14	Aug 15/2008
15	Aug 15/2008
16	Aug 15/2008
17	Aug 15/2008
18	Aug 15/2008
19	Aug 15/2008
20	Aug 15/2008
21	Aug 15/2008
22	Aug 15/2008
23	Aug 15/2008
51-70-06 GENERAL (cont)	
24	Aug 15/2008
25	Aug 15/2008
26	Aug 15/2008
27	Aug 15/2008
28	Aug 15/2008
29	Aug 15/2008
30	Aug 15/2008
31	Aug 15/2008
32	Aug 15/2008
33	Aug 15/2008
34	Aug 15/2008
35	Aug 15/2008
36	Aug 15/2008
37	Aug 15/2008
38	Aug 15/2008
39	Aug 15/2008
40	Aug 15/2008
41	Aug 15/2008
42	Aug 15/2008
43	Aug 15/2008
44	Aug 15/2008
45	Aug 15/2008
46	Aug 15/2008
47	Aug 15/2008
48	Aug 15/2008
49	Aug 15/2008
50	Aug 15/2008
51	Aug 15/2008
52	BLANK
51-70-07 GENERAL	
1	Aug 15/2008
2	Aug 15/2008
3	Aug 15/2008
4	Apr 01/2005
5	Apr 15/2007
6	Apr 01/2005
7	Apr 01/2005
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51-70-07 GENERAL (cont)	
10	Apr 01/2005
11	Apr 15/2006
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13	Apr 01/2005
14	Apr 01/2005
15	Apr 01/2005
16	Apr 01/2005
17	Apr 01/2005
18	Apr 01/2005
19	Aug 15/2008
20	Aug 15/2008
21	Apr 01/2005
22	Apr 01/2005
23	Apr 01/2005
24	Apr 01/2005
25	Apr 01/2005
26	Apr 01/2005
27	Apr 15/2005
28	Apr 01/2005
29	Apr 01/2005
30	Apr 01/2005
31	Apr 01/2005
32	Apr 01/2005
33	Apr 01/2005
34	Apr 01/2005
35	Apr 01/2005
36	Apr 01/2005
37	Apr 01/2005
38	Apr 01/2005
39	Apr 01/2005
40	Apr 01/2005
41	Apr 01/2005
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43	Apr 01/2005
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50	Apr 01/2005	36	Apr 01/2005	222	Aug 15/2007
51	Apr 01/2005	37	Apr 01/2005	223	Aug 15/2007
52	BLANK	38	Apr 01/2005	224	Aug 15/2007
51-70-08 GENERAL		39	Apr 01/2005	225	Aug 15/2007
1	Aug 15/2008	40	Apr 01/2005	226	Aug 15/2007
2	Aug 15/2008	41	Apr 01/2005	227	Aug 15/2007
3	Aug 15/2008	42	Apr 01/2005	228	Aug 15/2007
4	Aug 15/2008	43	Apr 01/2005	229	Aug 15/2007
5	Apr 01/2005	44	Apr 01/2005	230	Aug 15/2007
6	Apr 01/2005	45	Apr 01/2005	231	Aug 15/2007
7	Apr 01/2005	46	Apr 01/2005	232	Aug 15/2007
8	Apr 01/2005	51-70-09 GENERAL		233	Aug 15/2007
9	Apr 01/2005	1	Aug 15/2007	234	Aug 15/2007
10	Apr 01/2005	2	BLANK	235	Aug 15/2007
11	Apr 01/2005	51-70-10 GENERAL		236	Aug 15/2007
12	Apr 01/2005	1	Aug 15/2007	237	Aug 15/2007
13	Apr 01/2005	2	BLANK	238	Dec 15/2007
14	Apr 01/2005	51-70-10 REPAIR GENERAL		239	Dec 15/2007
15	Apr 01/2005	201	Aug 15/2007	240	Aug 15/2007
16	Apr 01/2005	202	Dec 15/2008	241	Aug 15/2007
17	Apr 01/2005	203	Aug 15/2007	242	Aug 15/2007
18	Apr 01/2005	204	Aug 15/2007	243	Aug 15/2007
19	Apr 01/2005	205	Aug 15/2007	244	Aug 15/2007
20	Apr 01/2005	206	Aug 15/2007	245	Aug 15/2007
21	Apr 01/2005	207	Aug 15/2007	246	Aug 15/2007
22	Apr 01/2005	208	Aug 15/2007	247	Aug 15/2007
23	Apr 01/2005	209	Aug 15/2007	248	Aug 15/2007
24	Apr 01/2005	210	Aug 15/2007	249	Aug 15/2007
25	Apr 01/2005	211	Aug 15/2007	250	Aug 15/2007
26	Apr 01/2005	212	Aug 15/2007	251	Aug 15/2007
27	Apr 01/2005	213	Aug 15/2007	252	Aug 15/2007
28	Apr 01/2005	214	Aug 15/2007	253	Aug 15/2007
29	Apr 01/2005	215	Aug 15/2007	254	Aug 15/2007
30	Apr 01/2005	216	Aug 15/2007	255	Aug 15/2007
31	Apr 01/2005	217	Aug 15/2007	256	Aug 15/2007
32	Apr 01/2005	218	Aug 15/2007	257	Aug 15/2007
33	Apr 01/2005	219	Aug 15/2007	258	Aug 15/2007
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260	Aug 15/2007
261	Aug 15/2007
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265	Aug 15/2007
266	Aug 15/2007
267	Aug 15/2007
268	Aug 15/2007
269	Aug 15/2007
270	Aug 15/2007
271	Aug 15/2007
272	Aug 15/2007
273	Aug 15/2007
274	Aug 15/2007
275	Aug 15/2007
276	Aug 15/2007
277	Aug 15/2007
278	Aug 15/2007
279	Aug 15/2007
280	Aug 15/2007
281	Aug 15/2007
282	Aug 15/2007
283	Aug 15/2007
284	Aug 15/2007
285	Aug 15/2007
286	Aug 15/2007
287	Aug 15/2007
288	Aug 15/2007
289	Aug 15/2007
290	Aug 15/2007
291	Aug 15/2007
292	Aug 15/2007
293	Aug 15/2007
294	Aug 15/2007
295	Aug 15/2007
296	BLANK
51-70-10 REPAIR 1	
201	Apr 15/2005
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202	Apr 15/2005
51-70-10 REPAIR 2	
201	Apr 15/2005
202	Aug 15/2007
203	Aug 15/2007
204	Aug 15/2007
205	Apr 15/2005
206	Aug 15/2007
51-70-10 REPAIR 3	
201	Aug 15/2007
202	Aug 15/2007
203	Aug 15/2007
204	Aug 15/2007
205	Aug 15/2007
206	Aug 15/2007
207	Aug 15/2007
208	Aug 15/2007
209	Aug 15/2007
210	Aug 15/2007
211	Aug 15/2007
212	Aug 15/2007
51-70-10 REPAIR 4	
201	Aug 15/2007
202	Apr 15/2005
203	Apr 15/2005
204	Apr 15/2005
205	Apr 15/2005
206	Aug 15/2007
207	Apr 15/2005
208	Apr 15/2005
209	Apr 15/2005
210	Aug 15/2007
211	Apr 15/2005
212	Apr 15/2005
213	Apr 15/2005
214	Apr 15/2005
215	Aug 15/2007
216	Apr 15/2005
217	Apr 15/2005
51-70-10 REPAIR 4 (cont)	
218	Apr 15/2005
219	Apr 15/2005
220	Aug 15/2007
221	Aug 15/2007
222	BLANK
51-70-11 GENERAL	
1	Aug 15/2005
2	Apr 01/2005
3	Apr 01/2005
4	Apr 01/2005
5	Apr 01/2005
6	Apr 01/2005
7	Apr 01/2005
8	Apr 01/2005
9	Apr 01/2005
10	Apr 01/2005
51-70-12 GENERAL	
1	Apr 01/2005
2	Apr 01/2005
3	Apr 01/2005
4	Apr 01/2005
5	Apr 01/2005
6	Apr 01/2005
7	Apr 01/2005
8	Apr 01/2005
9	Apr 01/2005
10	Apr 01/2005
11	Apr 01/2005
12	Apr 01/2005
13	Apr 01/2005
14	Apr 01/2005
15	Apr 01/2005
16	Apr 01/2005
51-70-13 GENERAL	
1	Apr 01/2005
2	Apr 01/2005
3	Apr 01/2005
4	Apr 01/2005
5	Apr 01/2005

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6	BLANK	2	Apr 01/2005	4	Dec 15/2008
51-70-14 GENERAL		3	Apr 01/2005	5	Apr 15/2007
1	Apr 01/2005	4	Apr 01/2005	6	Apr 15/2007
2	Apr 01/2005	5	Apr 01/2005	7	Apr 01/2005
3	Apr 01/2005	6	Apr 01/2005	8	Apr 01/2005
4	Apr 01/2005	7	Apr 01/2005	9	Apr 01/2005
5	Apr 01/2005	8	Apr 01/2005	10	Apr 01/2005
6	Apr 01/2005	9	Apr 01/2005	11	Apr 01/2005
7	Apr 01/2005	10	Apr 01/2005	12	Apr 01/2005
8	Apr 15/2005	11	Apr 01/2005	13	Apr 01/2005
9	Apr 01/2005	12	Apr 01/2005	14	Apr 01/2005
10	Apr 01/2005	13	Apr 01/2005	15	Apr 01/2005
11	Apr 01/2005	14	Apr 01/2005	16	Apr 01/2005
12	Apr 01/2005	15	Apr 01/2005	17	Apr 01/2005
13	Apr 01/2005	16	Apr 01/2005	18	Apr 01/2005
14	Apr 01/2005	17	Apr 01/2005	19	Apr 01/2005
15	Apr 01/2005	18	Apr 01/2005	20	Apr 01/2005
16	Apr 01/2005	19	Apr 01/2005	21	Apr 01/2005
17	Apr 01/2005	20	Apr 01/2005	22	Apr 01/2005
18	Apr 01/2005	21	Apr 01/2005	23	Apr 01/2005
19	Apr 15/2005	22	Apr 01/2005	24	Apr 01/2005
20	Apr 15/2005	23	Apr 01/2005	25	Apr 01/2005
21	Apr 01/2005	24	Apr 01/2005	26	Apr 01/2005
22	Apr 15/2005	25	Apr 01/2005	27	Apr 01/2005
23	Apr 15/2005	26	Apr 01/2005	28	Apr 01/2005
24	Apr 15/2005	27	Apr 01/2005	29	Apr 01/2005
25	Apr 15/2005	28	Apr 01/2005	30	Apr 01/2005
26	Apr 15/2005	29	Apr 01/2005	31	Apr 01/2005
27	Apr 15/2005	30	Apr 01/2005	32	Apr 01/2005
28	Apr 15/2005	31	Apr 01/2005	33	Apr 01/2005
29	Apr 15/2005	32	Apr 01/2005	34	Apr 01/2005
30	Apr 15/2005	33	Apr 01/2005	35	Apr 01/2005
31	Apr 15/2005	34	Apr 01/2005	36	Apr 01/2005
32	Apr 15/2005	35	Apr 01/2005	37	Apr 01/2005
51-70-15 GENERAL		36	BLANK	38	Apr 01/2005
1	Apr 01/2005	51-70-17 GENERAL		39	Apr 01/2005
2	Apr 01/2005	1	Aug 15/2006	40	Apr 01/2005
51-70-16 GENERAL		2	Apr 01/2005	41	Apr 01/2005
1	Apr 01/2005	3	Apr 01/2005	42	Apr 01/2005

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51-70-17 GENERAL (cont)					
43	Apr 01/2005				
44	Apr 01/2005				
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47	Apr 01/2005				
48	Apr 01/2005				
49	Apr 01/2005				
50	Apr 01/2005				
51	Apr 01/2005				
52	Apr 01/2005				
53	Apr 01/2005				
54	Apr 01/2005				
55	Apr 01/2005				
56	Apr 01/2005				
51-70-18 GENERAL					
1	Apr 01/2005				
2	Apr 01/2005				
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GENERAL - Structural Classification	
STRUCTURAL REPAIR CROSS REFERENCES	51-00-05
GENERAL - Cross References for Boeing Source Documents	
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GENERAL - Structural Repair Definitions	
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CHAPTER 51
STRUCTURES

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CHAPTER 51
STRUCTURES

SUBJECT	CHAPTER SECTION SUBJECT
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CHAPTER 51
STRUCTURES

SUBJECT	CHAPTER SECTION SUBJECT
TYPICAL METAL OVERLAY REPAIRS TO COMPOSITE PANELS	51-70-18
GENERAL - Typical Metal Overlay Repairs to Composite Panels	

GENERAL - STRUCTURES

1. General

A. This chapter describes general repair practices, materials and typical repairs which are applicable throughout the subsequent chapters of the manual. In addition, data regarding support of the airplane in the jigged position, symmetry check, aerodynamic smoothness, and control surface balancing is included.

B. Some of the procedures in this manual identify tools or equipment. You can use alternative tools that are equivalent unless the procedure tells you the specified tool or equipment item is mandatory. If you use alternative tools or equipment, make sure they give the same results and are as safe to the parts and personnel as the tools or equipment specified in the procedure.

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 subsequent chapters of this manual.

B. Refer to Table 1/GENERAL for the general abbreviations that are applicable to airplane reference data for the fuselage, wing, vertical stabilizer, horizontal stabilizer and nacelle.

Table 1: General Abbreviations for the Fuselage, Wing, Vertical Stabilizer, Horizontal Stabilizer and Nacelle

FUSELAGE	
BBL or BL	**Body (Fuselage) Buttock Line**
RBL or RBBL	**Right Buttock Line**
LBL or LBBL	**Left Buttock Line**
STA 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**
WING	
FSS	**Front Spar Station**
IFSS	**Inboard Front Spar Station**
ISS	**Inboard Slat Station**
LES	**Leading Edge Station**
MAC	**Mean Aerodynamic Chord**
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**
WTS	**Wing Tip Station**
VERTICAL STABILIZER	
FIN STA	**Vertical Stabilizer (Fin) Station**
RUD STA	**Rudder Station**
FSS	**Front Spar Station**
HORIZONTAL STABILIZER	
ELEV STA	**Elevator Station**
HS BL	**Horizontal Stabilizer Buttock Line**
STAB STA	**Horizontal Stabilizer Station**
FS STA	**Front Spar Station**
RS STA	**Rear Spar Station**
NACELLE	
NAC BL	**Nacelle Buttock Line**
NAC STA	**Nacelle Station**
NAC WL	Nacelle Waterline

C. Refer to Table 2/GENERAL for a list of general abbreviations used in this Structural Repair Manual (SRM).

Table 2: General Abbreviations Used in the Structural Repair Manual (SRM)

GENERAL	
AL or al	aluminum
APPROX or approx	approximate(ly)
ASSY or assy	assembly
AISI	American Iron and Steel Institute
BMS	Boeing Material Specification
BHD oe bhd	bulkhead
CAD	cadmium
CG	center of gravity
CHAM or cham	chamfer(ed)
CL	centerline
CRES or cres	corrosion-resistant steel
CSK or csk	countersink
D	diameter of fastener
DIA or dia	diameter
DWG or dwg	drawing(s)
F	Fahrenheit
FIG. or fig.	figure(s)
FS	front spar
FT or ft	feet (foot)
FTG or ftg	fitting
FWD or fwd	forward
HORIZ or horiz	horizontal
HT TR or ht tr	heat-treat
IN. or in.	inch
INBD or inbd	inboard
INSTL or instl	install(ation)
KSI or ksi	kilopounds per square inch
LB or lb	pound(s)
LE	leading edge
LE STA	leading edge station
LWR or lwr	lower
MAX or max	maximum
MIN or min	minimum
No.	number(s)
OPTL or optl	optional
OUTBD or outbd	outboard
PAR. or par.	paragraph

Table 2: General Abbreviations Used in the Structural Repair Manual (SRM) (Continued)

GENERAL	
PH	precipitation hardening
PSI or psi	pounds per square inch
QTY or qty	quantity
R or r	radius
REF or ref	reference
RS	rear spar
STA	station
SYM or sym	symmetrical
TYP or typ	typical
UPR or upr	upper

D. Refer to Table 3/GENERAL for the general fuselage definitions

Table 3: General Definitions - Fuselage

ABBREVIATION	DEFINITION
B STA	**Body (Fuselage) Station. A vertical plane perpendicular to the fuselage centerline, located by its distance from a point 92.50 inches forward of the nose.**
BBL	**Body (Fuselage) Buttock Line. A vertical plane parallel to the fuselage vertical centerline plane, BBL 0.00, located by its perpendicular distance from the fuselage centerline plane.**
BWL	**Body (Fuselage) Waterline. A horizontal plane located by its perpendicular distance from parallel, imaginary plane BWL 0.00, 106.73 inches below the lowest fuselage surface.**
BRP	Body (Fuselage) Reference Plane. Horizontal plane, BWL 199.50, at the top surface of the main deck floor beams.

Table 4: General Definitions - Vertical Stabilizer (See Detail I)

ABBREVIATION	DEFINITION
FIN STA	Fin Station. Plane perpendicular to the centerline of the vertical stabilizer rear spar. Distance is measured from Fin Station 0.00, intersection of rear spar centerline extension and body waterline 299.46.
FSS	Front Spar Station. Plane perpendicular to the vertical stabilizer front spar, measured from the fin front spar station 0.00, intersection of the front spar centerline extension and body waterline 299.46.
RUD STA	Rudder Station. Plane perpendicular to the rudder hinge centerline, measured from Rudder Station 0.00, intersection of rudder hinge centerline and body waterline 299.46.

Table 5: General Definitions - Horizontal Stabilizer (See Detail II)

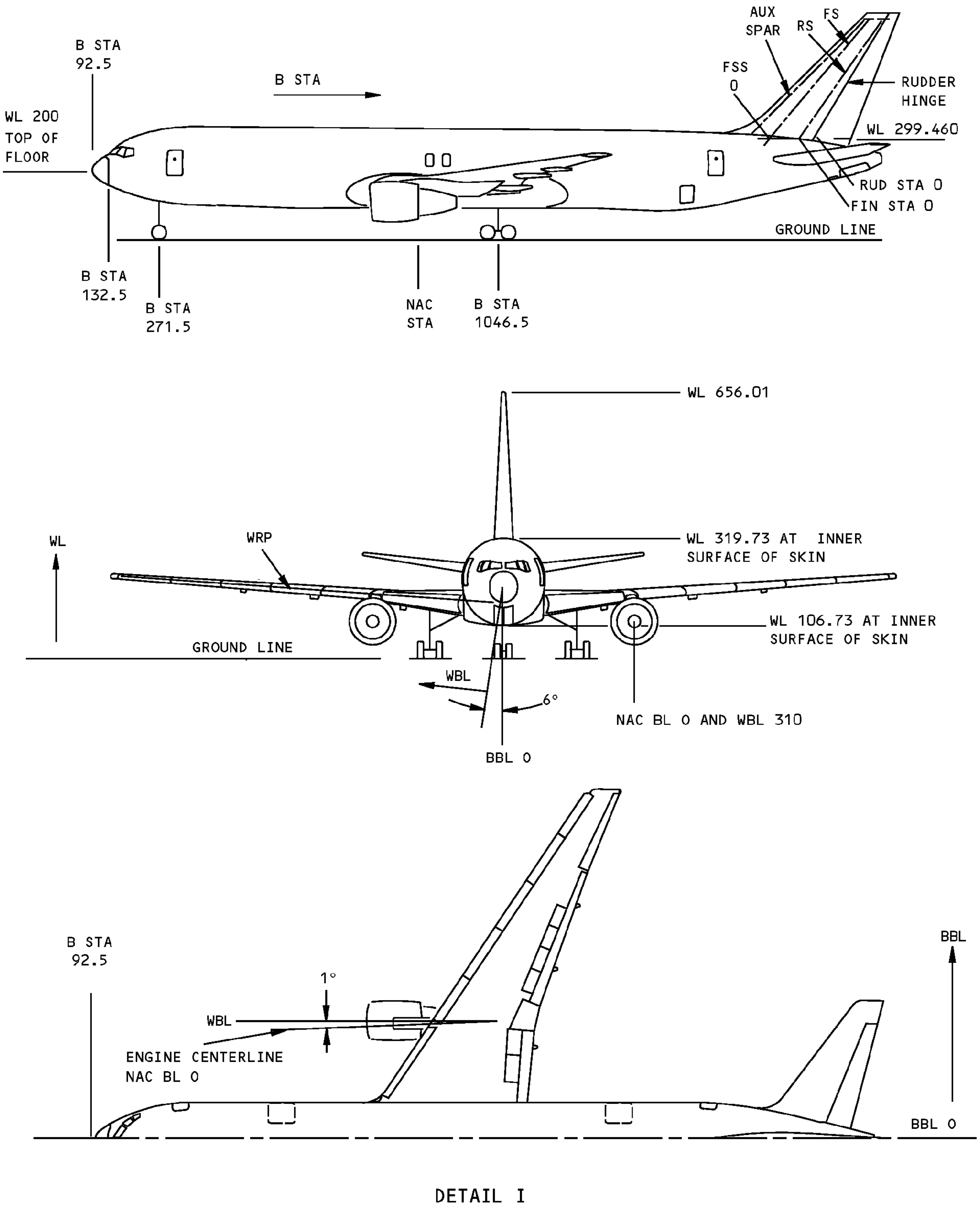
AUX SPAR STA	**Auxiliary Spar Station. Plane perpendicular to the horizontal stabilizer auxiliary spar, measured from Auxiliary Spar Station 0.00, intersection of auxiliary spar extension and stabilizer buttock line 0.00.**
ELEV STA	**Elevator Station. Plane perpendicular to the elevator hinge centerline measured from intersection of elevator hinge centerline and stabilizer buttock line 0.00.**
FS STA	**Front Spar Station. Plane perpendicular to the horizontal stabilizer front spar, measured from Front Spar Station 0.00, intersection of front spar and trace of body buttock line 41.50 at horizontal stabilizer reference plane.**
HSBL	**Stabilizer Buttock Line. Plane perpendicular to the horizontal stabilizer reference plane and parallel to the trace of the fuselage centerline. It is measured from stabilizer Buttock Line 0.00, intersection of horizontal stabilizer reference plane and body buttock line 0.00.**
HSRP	**Horizontal Stabilizer Reference Plane. Datum plane of the horizontal stabilizer which is inclined 7° degrees up at BBL 0 in the rear elevation.**
LE STA	**Leading Edge Station. Plane perpendicular to the horizontal stabilizer leading edge, measured from Stabilizer Leading Edge Station 0.00, intersection of leading edge line extension and stabilizer buttock line 0.00.**
RS STA	**Rear Spar Station. Plane perpendicular to the horizontal stabilizer rear spar, measured from Rear Spar Station 0.00, intersection of rear spar and trace of body buttock line 41.50 at horizontal stabilizer reference plane.**
STAB STA	Stabilizer Station. Plane perpendicular to the stabilizer rear spar and horizontal stabilizer reference plane. Stabilizer station 0.00 is at the intersection of the leading edge extension, body buttock line 0.00 and the horizontal stabilizer reference plane.

Table 6: General Definitions - Wing (See Detail III)

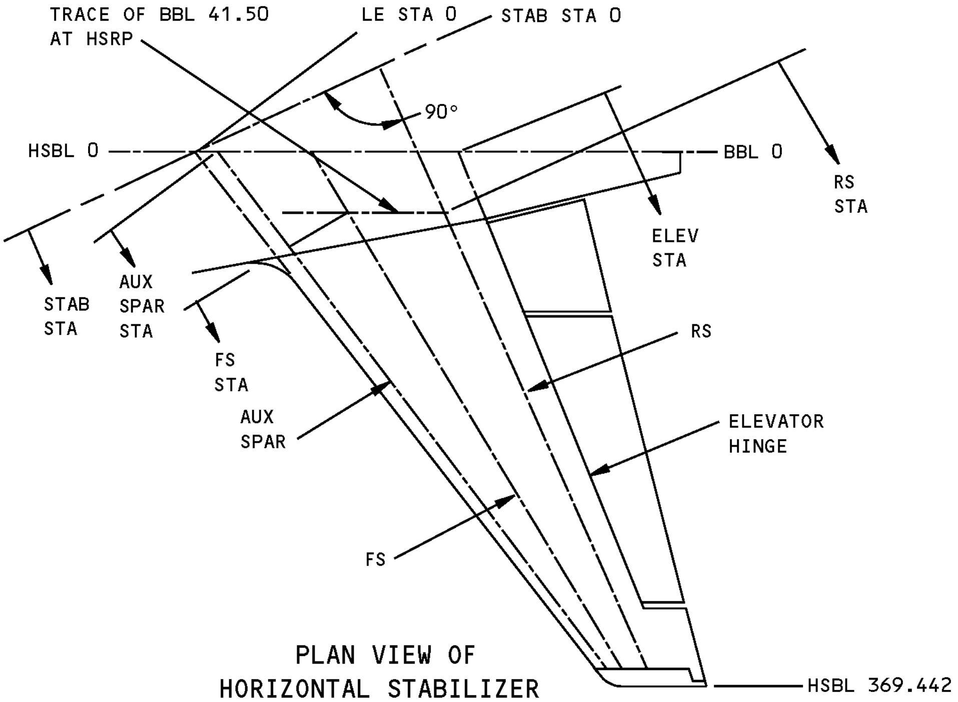
MAC	**Mean Aerodynamic Chord. Chord of section of imaginary airfoil on the wing which would have vectors throughout the flight range identical to those of the actual wing.**
WRP	**Wing Reference Plane. Datum plane of the wing which is inclined at 6 degrees to BBL 0 in rear elevation.**
W STA	**Wing Station. Plane perpendicular to the wing reference plane and the plane of the rear spar, measured from intersection of extended leading edge and wing buttock line 0.00.**
WBL	**Wing Buttock Line. Plane perpendicular to the wing reference plane and parallel to the trace of the fuselage centerline. It is measured from intersection of wing reference plane and body buttock line 0.00.**
FS or RS	**Wing Front Spar or Rear Spar. Principal spanwise transverse members of the wing structure, perpendicular to the wing reference plane.**
IFSS	**Inboard Front Spar Station. Plane perpendicular to the wing reference plane and the plane of the inboard front spar, measured from intersection of leading edge extension and wing buttock line 0.00.**
ISS	**Inboard Slat Stations. Plane perpendicular to inboard leading edge slats, measured from intersection of the slat rotation axis and a plane perpendicular to the wing reference plane.**
OFSS	**Outboard Front Spar Station. Plane perpendicular to the wing reference plane and the plane of the outboard front spar, measured from intersections of leading edge extension and wing buttock line 0.00.**
OSS	**Outboard Slat Stations. Plane perpendicular to outboard leading edge slats, measured from intersection of the slat rotation axis and a plane perpendicular to the wing reference plane.**
LES	**Leading Edge Station. Plane perpendicular to the wing reference plane and the leading edge, measured from intersection of leading edge extension and wing buttock line 0.00.**
WTS	Wing Tip Station. Plane perpendicular to the wing reference plane and wing buttock line 0.00, measured from intersection of leading edge and wing buttock line 0.00.

Table 7: Nacelle Definitions (See Details IV thru VI)

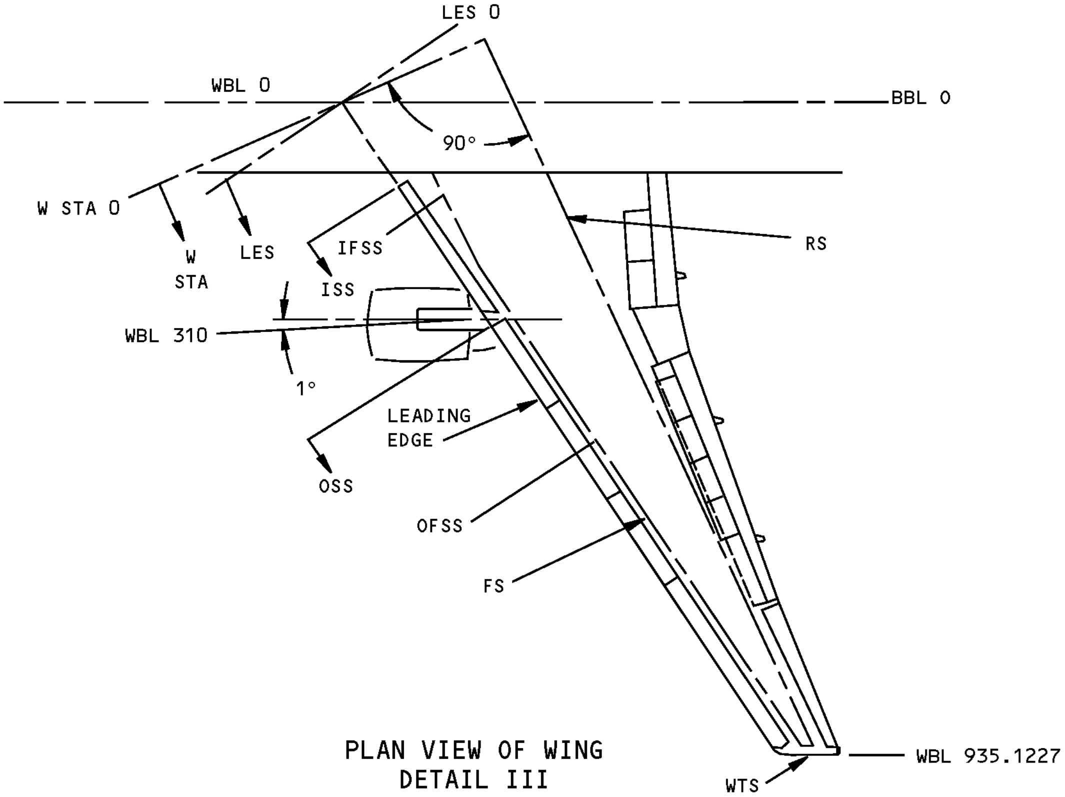
NAC BL	**Nacelle Buttock Line. Nacelle Buttock Line 0.00 for the engine is 1 degree inboard from Wing Buttock Line 310.00 at wing leading edge.**
NAC WL	**Nacelle Waterline. A plane inclined 2.40534 degrees upward from the wing reference plane. NAC WL 100.00 is the centerline of the engine.**
NAC STA	Nacelle Station. A vertical plane perpendicular to the nacelle centerline located by its distance from a point forward of the face of the engine fan (95.45 inches for the JT9D-7R4 and PW4000 engines, 145.56 inches for the CF6-80A engine, 142.10 inches for the CF6-80C2 engine and 72.75 inches for the RB211-524H engine.)



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



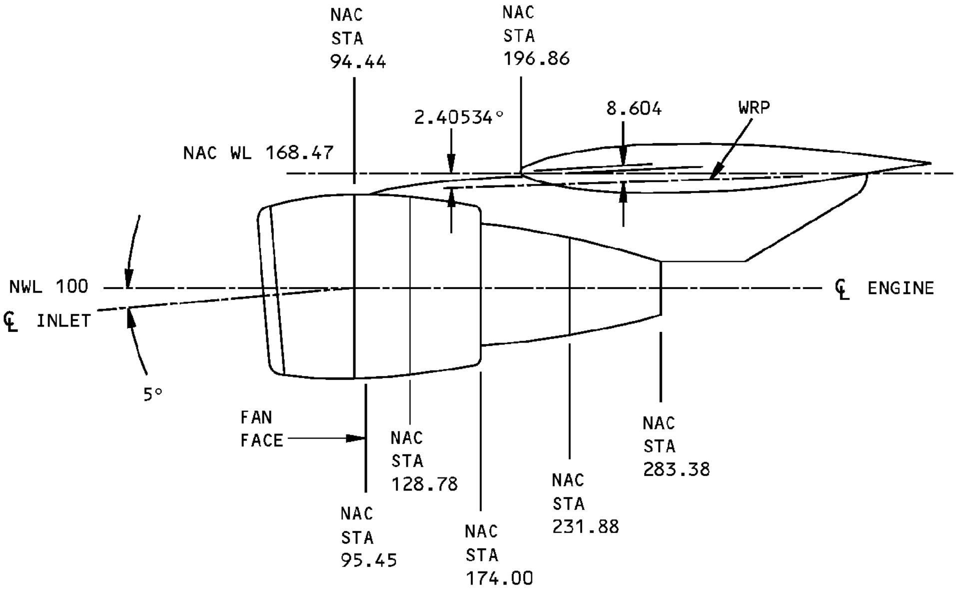
PLAN VIEW OF
HORIZONTAL STABILIZER
DETAIL II



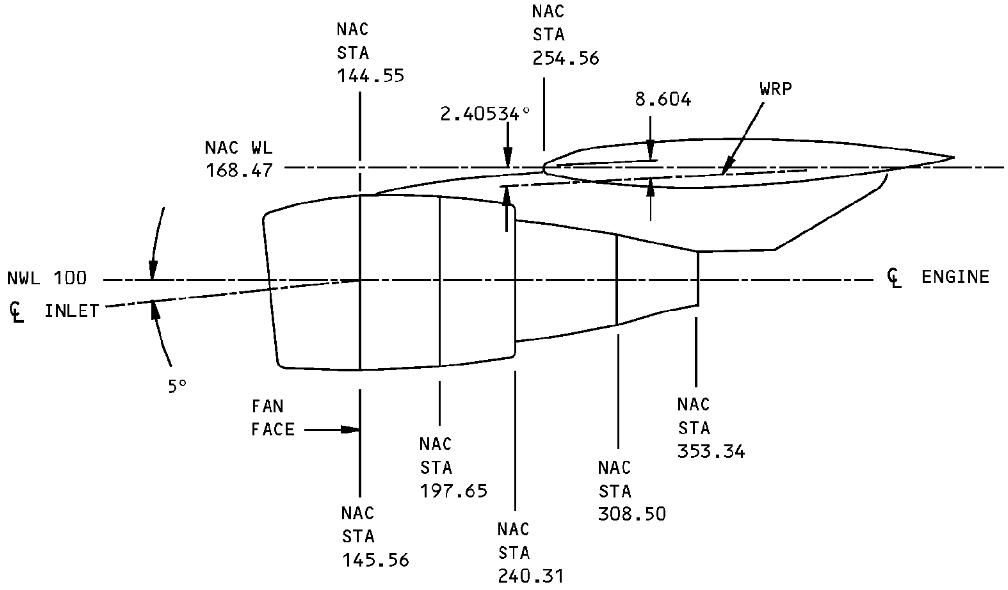
PLAN VIEW OF WING
DETAIL III

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

REF DWG
011T4000

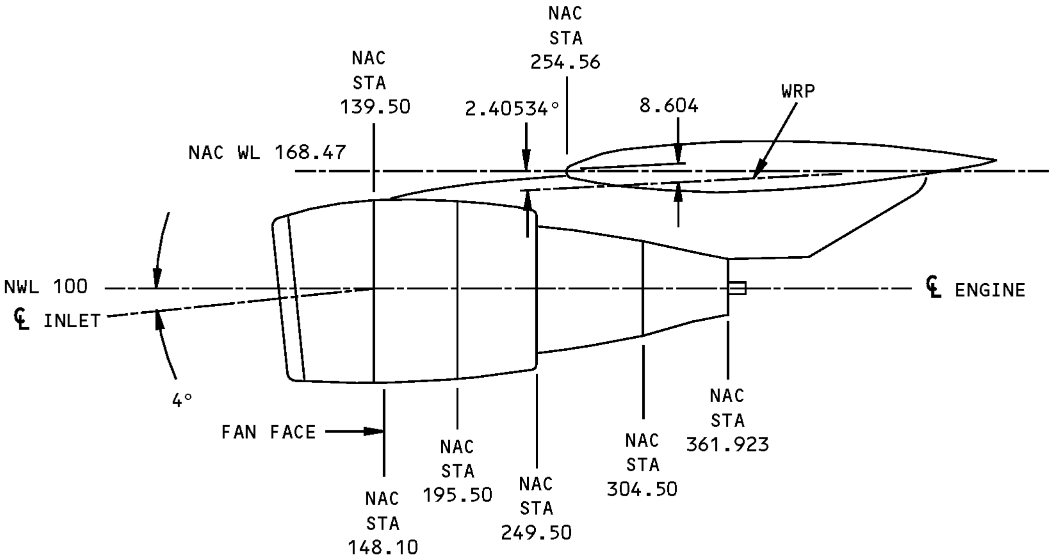


LEFT SIDE VIEW OF NACELLE FOR JT9D-7R4 ENGINE

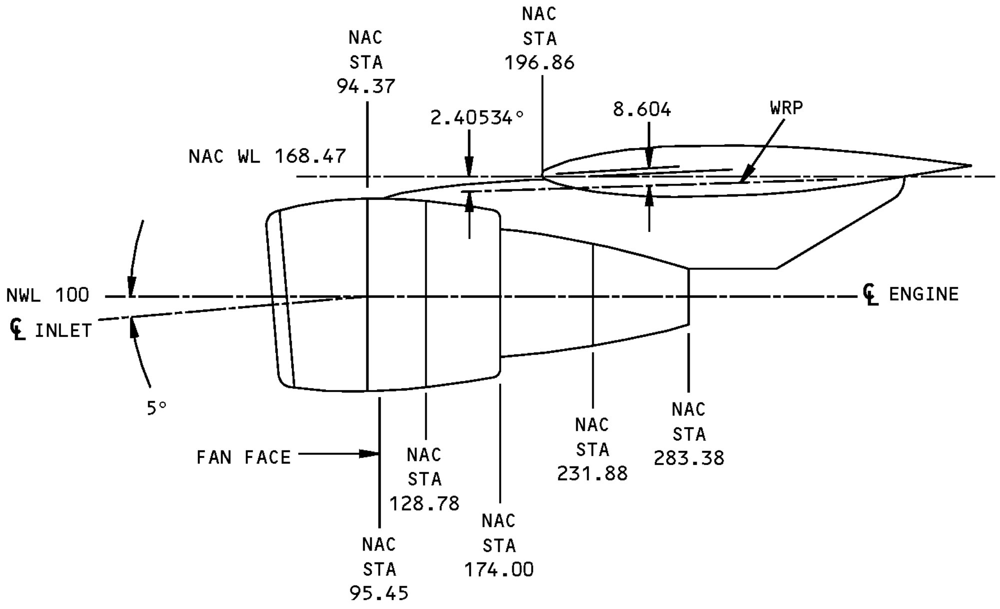


LEFT SIDE VIEW OF NACELLE FOR CF6-80A ENGINE
DETAIL IV

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



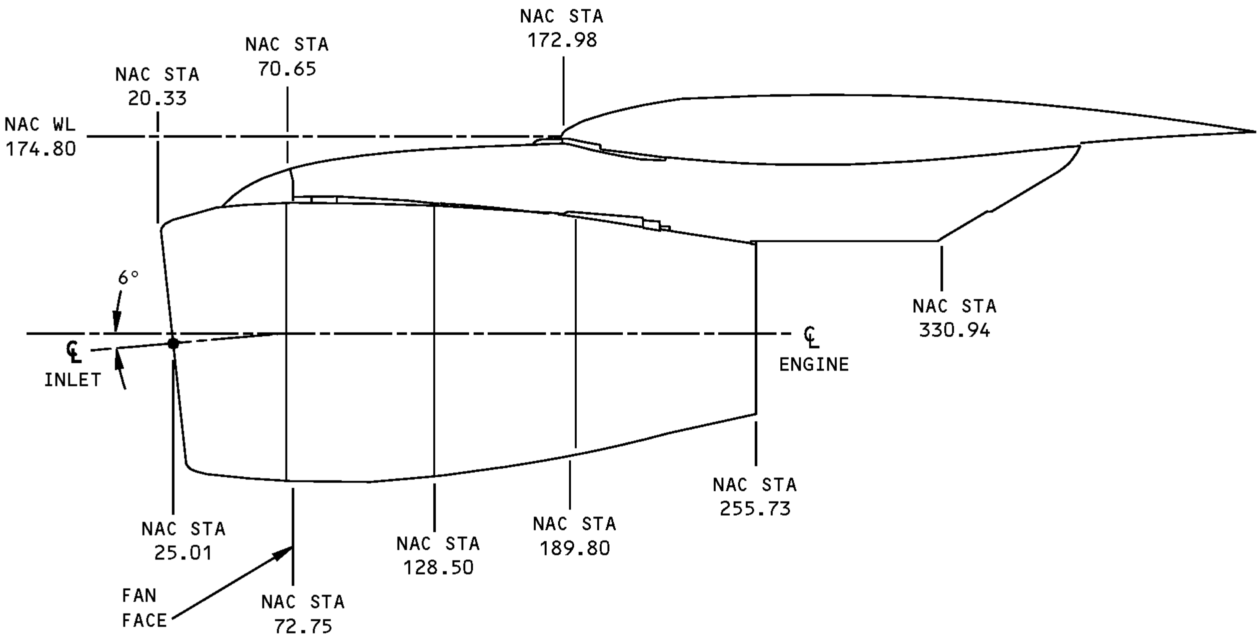
LEFT SIDE VIEW OF NACELLE FOR CF6-80C2 ENGINE



LEFT SIDE VIEW OF NACELLE FOR PW4000 ENGINE

DETAIL V

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

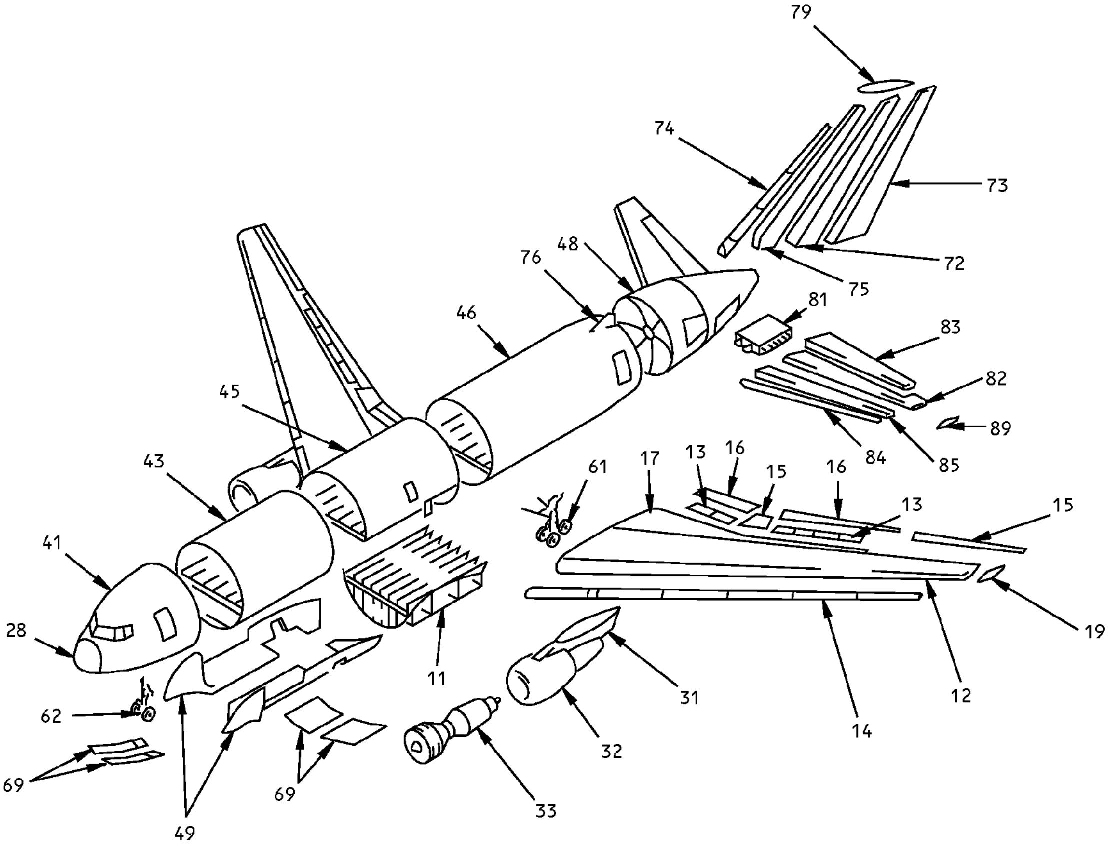


LEFT SIDE VIEW OF NACELLE FOR RB211-524H ENGINE
DETAIL VI

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

GENERAL - MAJOR ASSEMBLY AND INSTALLATION BREAKDOWN

REF DWG
012T1000



NOTES

- SEE 51-00-04 FOR STRUCTURAL CLASSIFICATION DIAGRAM

A FOR PRATT AND WHITNEY JT9D-7R4 ENGINE

B FOR GENERAL ELECTRIC CF6-80A ENGINE

C FOR GENERAL ELECTRIC CF6-80C ENGINE

D FOR PRATT AND WHITNEY PW4000 ENGINE

E FOR ROLLS ROYCE RB211-524 ENGINE

Major Assembly and Installation Breakdown
Figure 1 (Sheet 1 of 3)

IDENTIFICATION	DRAWING TITLE	DRAWING NUMBER
11	WING CENTER SECTION ASSY	111T0000
12	OUTBOARD WING ASSY	112T0000
13	INBOARD SPOILER INSTL	113T4000
	OUTBOARD SPOILER INSTL	113T5000
14	INBOARD LEADING EDGE SLAT INSTL	114T3000
	OUTBOARD LEADING EDGE SLAT INSTL	114T4000
15	INBOARD AILERON INSTL	113T6000
	OUTBOARD AILERON INSTL	113T7000
16	INBOARD TRAILING EDGE FLAP INSTL	113T2000
	OUTBOARD TRAILING EDGE FLAP INSTL	113T3000
17	INBOARD FIXED TRAILING EDGE INSTL	113T1600
	OUTBOARD FIXED TRAILING EDGE INSTL	113T1650
19	WING TIP INSTALLATION	119T0001
28	NOSE RADOME INSTL	284T0052
31	STRUT ASSY $\boxed{A}$ $\boxed{D}$	311T3000
	STRUT ASSY $\boxed{B}$	311T1000
	STRUT ASSY $\boxed{C}$	311T2000
	STRUT ASSY $\boxed{E}$	311T5000
32	COWL INSTL $\boxed{A}$	310T3080
	COWL INSTL $\boxed{B}$	310T1080
	COWL INSTL $\boxed{C}$	310T2080
	COWL INSTL $\boxed{D}$	310T4080
33	POWER PLANT INSTL $\boxed{A}$	310T3005
	POWER PLANT INSTL $\boxed{B}$	310T1005
	POWER PLANT INSTL $\boxed{C}$	310T2010
	POWER PLANT INSTL $\boxed{D}$	310T4010
	POWER PLANT INSTL $\boxed{E}$	312U0504
41	BODY INSTL - SECTION 41	141T0001
43	BODY INSTL - SECTION 43	143T0001
45	BODY INSTL - SECTION 45	145T0001
46	BODY INSTL - SECTION 46	146T0001
48	BODY INSTL - SECTION 48	148T0001
49	WING/BODY FAIRING INSTL	149T7100
61	MAIN LANDING GEAR INSTL	161T0000
62	NOSE LANDING GEAR INSTL	162T0000
69	NOSE LANDING GEAR DOOR INSTL	141T6900
	MAIN LANDING GEAR DOOR INSTL	149T6910

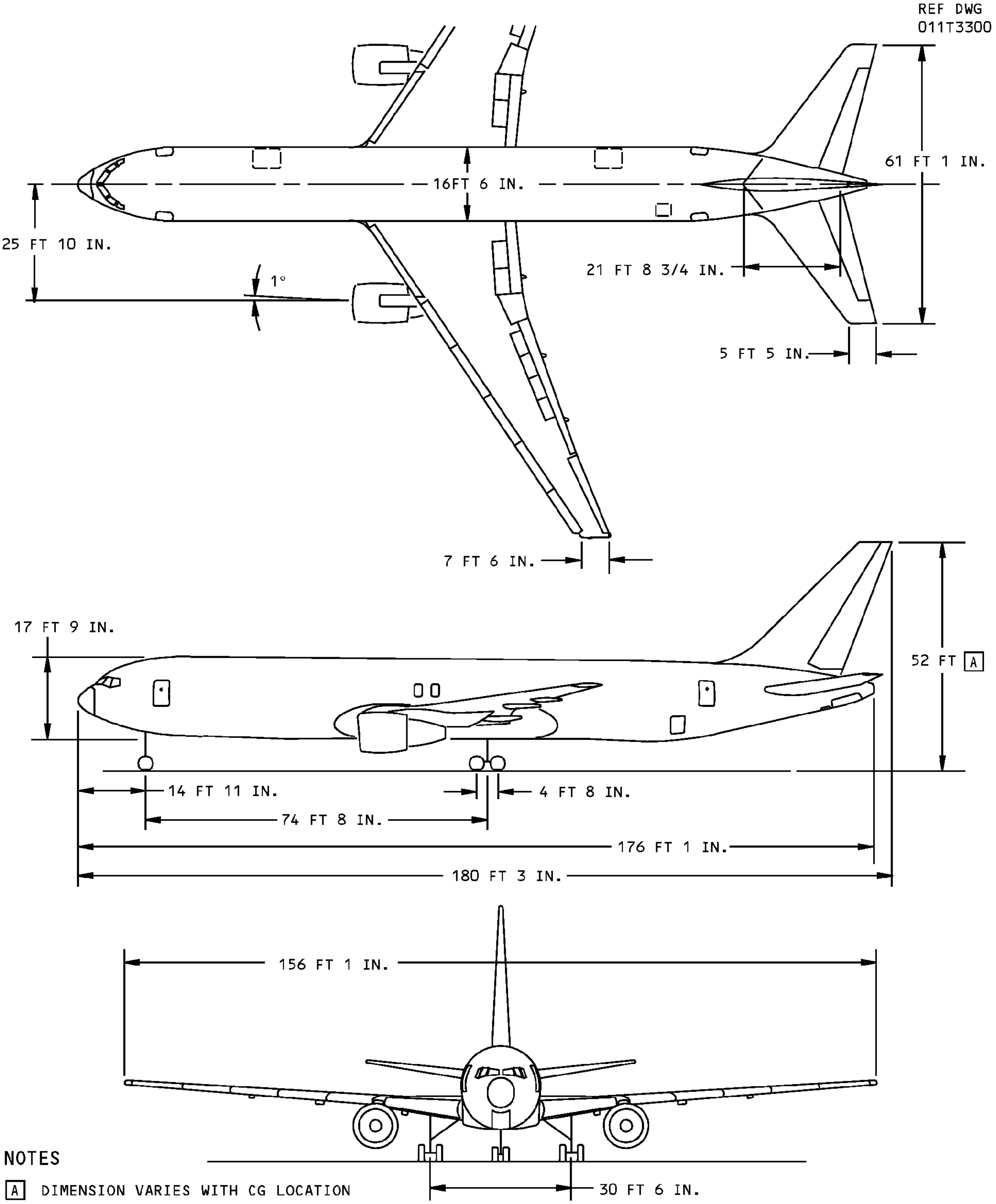
Major Assembly and Installation Breakdown
Figure 1 (Sheet 2 of 3)

IDENTIFICATION	DRAWING TITLE	DRAWING NUMBER
72	VERTICAL STABILIZER AFT TORQUE BOX INSTL	172T0000
	VERTICAL STABILIZER FIXED TE INSTL	173T1000
73	RUDDER ASY	173T1201
74	VERTICAL STABILIZER LE INSTL	174T1000
75	VERTICAL STABILIZER FWD TORQUE BOX INSTL	175T0000
76	DORSAL FIN ASSY	146T0800
79	VERTICAL STABILIZER TIP INSTL	179T0001
81	HORIZONTAL STABILIZER CENTER SECTION ASSY	181T0000
82	HORIZONTAL STABILIZER MAIN BOX ASSY	182T0000
83	HORIZONTAL STABILIZER TE ASSY	183T1000
84	HORIZONTAL STABILIZER LE INSTL	184T0000
85	HORIZONTAL STABILIZER FORWARD TORQUE BOX ASSY	185T0000
89	HORIZONTAL STABILIZER TIP INSTL	189T0001

LIST OF MAJOR ASSEMBLIES AND INSTALLATIONS

Major Assembly and Installation Breakdown
Figure 1 (Sheet 3 of 3)

GENERAL - PRINCIPAL DIMENSIONS

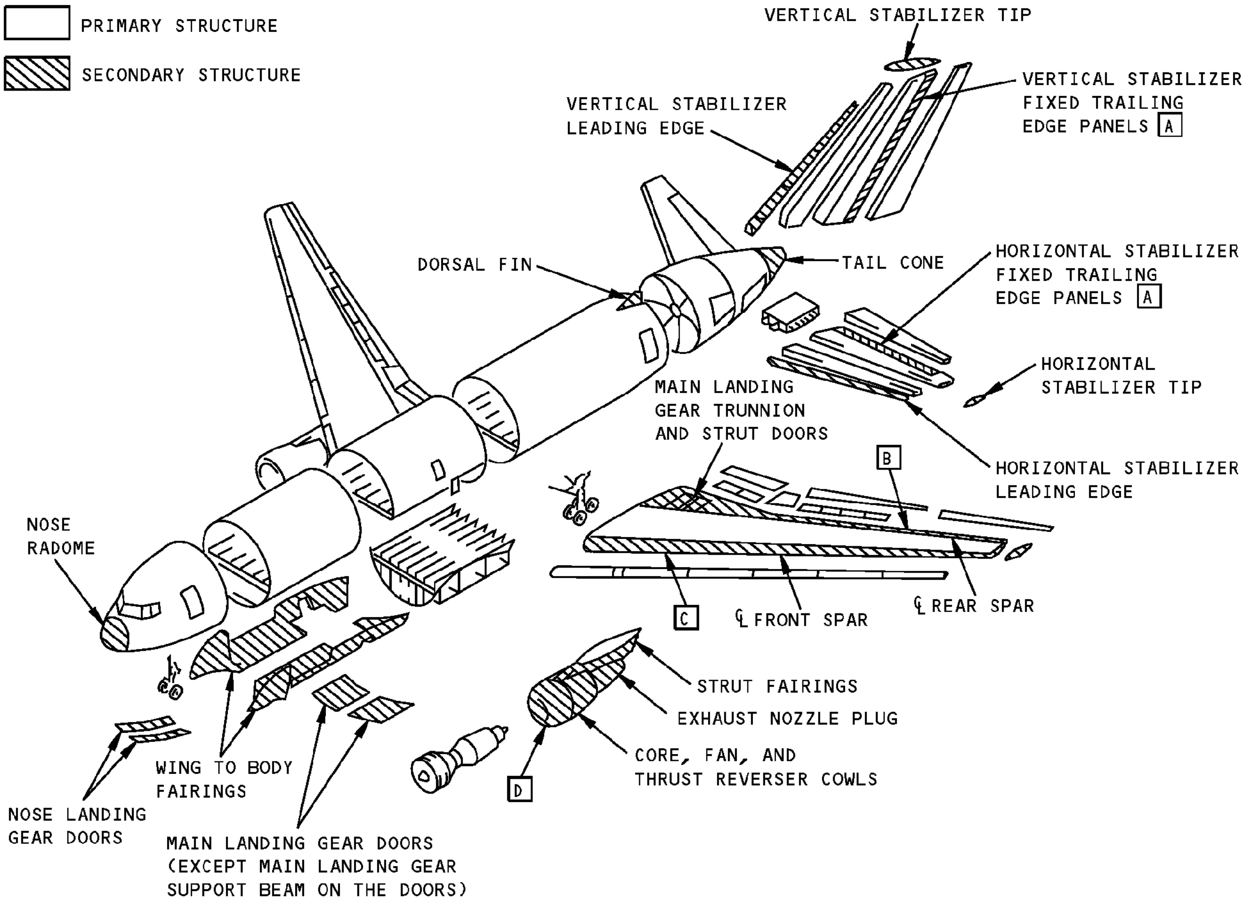


NOTES

A DIMENSION VARIES WITH CG LOCATION AND LOADING

Principle Dimensions
Figure 1

GENERAL - STRUCTURAL CLASSIFICATION



NOTES

- REFER TO 51-00-02 FOR MAJOR ASSEMBLY AND INSTALLATION BREAKDOWN.
- AREAS INDICATED ARE CLASSED AS SECONDARY STRUCTURE. THESE COMPONENTS, THOUGH NOT PRIMARY LOAD CARRYING UNITS, ARE SUBJECTED TO AERODYNAMIC LOADS. DAMAGE, WHICH MAY AFFECT PRIMARY STRUCTURE AND ENGINES OR ADVERSELY AFFECT AERODYNAMIC CHARACTERISTICS AND/OR SURFACE STIFFNESS, MUST BE EVALUATED.
- WITHIN PRIMARY STRUCTURE ARE PRINCIPAL STRUCTURAL ELEMENTS (SEE FIGURE 2, TABLE I). PRINCIPAL STRUCTURAL ELEMENTS (PSE'S) ARE THOSE WHICH CONTRIBUTE SIGNIFICANTLY TO CARRYING FLIGHT, GROUND AND PRESSURIZATION LOADS.

A HORIZONTAL AND VERTICAL STABILIZER FIXED TRAILING EDGE PANELS
- PRIMARY STRUCTURE IN THIS AREA IS DEFINED AS THAT STRUCTURE WHICH SUPPORTS THE ELEVATOR AND RUDDER

B WING TRAILING EDGE
- PRIMARY STRUCTURE IN THIS AREA IS DEFINED AS THAT STRUCTURE WHICH GIVES SUPPORT TO THE FLAPS, AILERONS, AND SPOILERS; LANDING GEAR SUPPORT BEAM, AND LANDING GEAR TRUNNION

C WING LEADING EDGE
- PRIMARY STRUCTURE IN THIS AREA IS LIMITED TO THE LEADING EDGE SLAT SUPPORT STRUCTURE

D ENGINE INLET AND EXTERIOR PANELS
- NOSE COWL LEADING EDGES, ACOUSTIC PANELS, INTERIOR SKIN PANELS, EXTERIOR SKIN, AND ACCESS PANELS AFT OF THE LEADING EDGE ARE SECONDARY STRUCTURE.
- HOWEVER IF THE NOSE COWL LEADING EDGES, ACOUSTIC PANELS OR INTERIOR SKIN PANELS FAIL, THE RESULT CAN BE DAMAGE TO THE ENGINE.

Structural Classification Diagram
Figure 1

STRUCTURAL AREA	STRUCTURAL ELEMENT
FUSELAGE	FUSELAGE SKIN AND STRINGERS BS 132.5 TO BS 1843 FUSELAGE CIRCUMFERENTIAL SPLICES FUSELAGE LAP SPLICES FUSELAGE SKIN AT CORNERS OF CUTOUTS MAIN DECK FRAMES BS 132.5 TO BS 1560 LOWER LOBE FRAMES BS 132.5 TO BS 786 OVERWING STUB FRAMES BS 808 TO BS 933 AND BS 977 FUSELAGE FRAMES BS 808 TO BS 933 AND BS 977 TO BS 1043 LOWER LOBE FRAMES BS 1087 TO BS 1560 FUSELAGE FRAMES BS 1605.5 TO BS 1629 UPPER LOBE FRAMES BS 1746.125 TO BS 1788.375 LOWER LOBE FRAMES BS 1746.125 TO BS 1788.375 ENTRY DOOR CUTOUT STRUCTURES INCLUDING STOPS AND FITTINGS SERVICE DOOR CUTOUT STRUCTURES INCLUDING STOPS AND FITTINGS MAIN AND BULK CARGO DOOR CUTOUT STRUCTURES INCLUDING STOPS AND FITTINGS EMERGENCY EXIT HATCH CUTOUT STRUCTURES INCLUDING STOPS AND FITTINGS E/E ACCESS HATCH CUTOUT STRUCTURES NOSE LANDING GEAR WHEEL WELL CUTOUT STRUCTURE - SIDE PANELS AND BULKHEADS MISCELLANEOUS FUSELAGE CUTOUT STRUCTURES IN PRESSURIZED AREA FUSELAGE UPPER CROWN CREASE BEAM STRUCTURE FLOOR BEAM STRUCTURE STRINGER/FRAME ATTACHMENTS TRANSVERSE FLOOR BEAMS (WHEELWELL) BULKHEAD BS 132.5 (FORWARD PRESSURE) FUSELAGE BS 168.49 BULKHEAD (NWW FORWARD BULKHEAD) FUSELAGE BS 287 BULKHEAD FUSELAGE BS 786 BULKHEAD (FRONT SPAR BULKHEAD) FUSELAGE BS 955 BULKHEAD (REAR SPAR BULKHEAD) FUSELAGE BS 1065 BULKHEAD FUSELAGE BS 1582 BULKHEAD (AFT PRESSURE BULKHEAD) FUSELAGE BS 1654.5 BULKHEAD FUSELAGE BS 1678 BULKHEAD FUSELAGE BS 1702 BULKHEAD FUSELAGE BS 1725.5 BULKHEAD FUSELAGE BS 1809.5 BULKHEAD FUSELAGE BS 1832.0 BULKHEAD

TABLE I

Principal Structural Elements
Figure 2 (Sheet 1 of 5)

STRUCTURAL AREA	STRUCTURAL ELEMENT
FUSELAGE (CONT)	LONGERON BEAM FROM BS 955 TO BS 1065 OVERWING LONGERON EXTENSIONS, FORWARD OF BS 786 AND AFT OF BS 1065 UNDERWING LONGERON EXTENSIONS, FORWARD OF BS 786 OVERWHEEL WELL FLOOR BEAMS FROM BS 977 TO BS 1043 HORIZONTAL PRESSURE DECK FROM BS 955 TO BS 1065 KEEL BEAM STRUCTURE KEEL BEAM CHORD EXTENSION STRUCTURE FORWARD OF BS 786 AND AFT OF BS 1065 SIDE OF BODY INTERCOSTALS FROM BS 808 TO BS 933 BETWEEN THE SIDE OF BODY AND THE BL 74.75 OVERWHEEL WELL FLOOR BEAM LANDING GEAR ATTACHMENT AND BACKUP STRUCTURE SECTION 48 UPPER AND LOWER SHEAR DECKS JACK SCREW SUPPORT STRUCTURE FIN TO BODY ATTACHMENT FITTINGS STABILIZER HINGE AND SUPPORT STRUCTURE WINDOW FORGINGS CREW WINDOW CABIN CUTOUT STRUCTURE ENTRY DOORS EMERGENCY EXIT DOORS SERVICE DOORS CARGO DOORS

TABLE I

Principal Structural Elements
Figure 2 (Sheet 2 of 5)

STRUCTURAL AREA	STRUCTURAL ELEMENT
EMPENNAGE	FIN
	FRONT SPAR CHORDS, STIFFENERS, AND WEB
	REAR SPAR CHORDS, STIFFENERS AND WEB
	SKIN AND STRINGERS
	INSPAR RIBS
	ACTUATOR SUPPORT STRUCTURE
	FIN TO BODY ATTACHMENT
	RUDDER HINGES AND HINGE SUPPORT STRUCTURE
	FORWARD TORQUE BOX SKINS AND RIBS
	RUDDER
	FRONT SPAR
	REAR SPAR
	SKIN PANELS
	ACTUATOR RIBS
	ACTUATOR FITTINGS
	HINGE RIBS
	HINGE FITTINGS
	HORIZONTAL STABILIZER
	CENTER SECTION REAR SPAR
	CENTER SECTION JACKSCREW SUPPORT FITTING
	CENTER SECTION JACKSCREW FITTING SUPPORT RIBS AT B.L. 13.833
	HINGE FITTINGS
	HINGE RIBS
	UPPER SURFACE SPLICE PLATES AT HINGE RIBS
	LOWER SURFACE SPLICE PLATES AT HINGE RIBS
	INSPAR RIBS
	FRONT SPAR TERMINAL FITTING AT HINGE RIBS
	REAR SPAR TERMINAL FITTING AT HINGE RIBS
	REAR SPAR UPPER CHORD, RIB 1 TO RIB 3 (SIDE OF BODY)
	UPPER AND LOWER INSPAR SKINS AND STRINGERS
	OUTBOARD FRONT SPAR CHORDS, WEB AND STIFFENERS
	OUTBOARD REAR SPAR CHORDS, WEB AND STIFFENERS
	ELEVATOR HINGE FITTINGS
	ELEVATOR HINGE SUPPORT RIBS
	AUXILIARY SPAR CHORD, WEB AND STIFFENERS
	FORWARD TORQUE BOX SKINS AND RIBS
	ELEVATOR
	FRONT SPAR
	SKIN PANELS
	ACTUATOR RIBS
	ACTUATOR FITTINGS
	HINGE RIBS
	HINGE FITTINGS
	ATTACHMENT POINTS
	FIN-TO-BODY ATTACHMENT BOLTS
	CENTER SECTION-TO-BODY HINGE PINS
	JACKSCREW SUPPORT FITTING-TO-JACKSCREW GIMBAL
	JACKSCREW SUPPORT FITTING-TO-CENTER SECTION BOLTS
	ELEVATOR HINGE PINS
	HORIZONTAL STABILIZER PIVOT FITTING

TABLE I

Principal Structural Elements
Figure 2 (Sheet 3 of 5)

STRUCTURAL AREA	STRUCTURAL ELEMENT
WING	CENTER SECTION FRONT SPAR CHORDS, WEB, AND STIFFENERS
	CENTER SECTION REAR SPAR CHORDS, WEB, AND STIFFENERS
	CENTER SECTION LOWER PANEL SKIN AND STRINGERS
	CENTER SECTION UPPER PANEL SKIN AND STRINGERS
	CENTER SECTION UPPER AND LOWER SKIN SPLICE STRINGERS
	CENTER SECTION SPANWISE BEAMS
	CENTER SECTION KEEL BEAMS
	CENTER SECTION LOWER BEAMS AT BBL 40.25 & BBL 62.05
	LOWER SURFACE BBL 97.42 SPLICE
	UPPER SURFACE BBL 97.42 SPLICE
	WING-TO-BODY JOINT UPPER CHORD, INCLUDING OVERWING LONGERON
	BBL 97.42 RIB CHORDS, WEB, STIFFENERS, AND TERMINAL FITTINGS
	UNDERWING LONGERON AFT OF BS 784
	REAR SPAR CHORDS, WEB, AND STIFFENERS
	FRONT SPAR CHORDS, WEB, AND STIFFENERS
	LOWER PANEL SKIN AND STRINGERS
	UPPER PANEL SKIN AND STRINGERS
	UPPER AND LOWER PANEL SKIN SPLICE STRINGERS
	SPAR CHORDS TO LOWER WING SKIN ATTACHMENT
	LOWER PANEL CUTOUTS
	TYPICAL RIBS
	SHEAR TIED RIBS
	WING LANDING GEAR SUPPORT STRUCTURE
	WING LANDING GEAR BEAM
	PRIMARY FLAP SUPPORT RIBS
	LEADING EDGE SLAT
	LEADING EDGE SLAT TRAILING EDGE WEDGE
	LEADING EDGE SLAT TRACKS
	LEADING EDGE SLAT ACTUATOR CONTROL RODS
	LEADING EDGE SLAT SUPPORT RIBS
	TRAILING EDGE FLAP CARRIER BEAMS AND SUPPORT STRUCTURE
	TRAILING EDGE FLAP BOX STRUCTURE
	TRAILING EDGE FLAP MECHANISM & SUPPORT STRUCTURE
	OVERWING FLOOR BEAMS AND INTERCOSTALS
	ENGINE SUPPORT STRUCTURE
	OUTBOARD AILERON SPAR, WEDGE AND ATTACH FITTINGS
	INBOARD AILERON SPAR, RIBS SKIN PANELS AND ATTACH FITTINGS
	INBOARD AND OUTBOARD AILERON SUPPORT STRUCTURE
POWER PLANT	FORWARD ENGINE MOUNT FITTINGS, LINKS, AND SUPPORT STRUCTURE
	AFT ENGINE MOUNT FITTINGS, LINKS, AND SUPPORT STRUCTURE
	THRUST LINKS AND SUPPORT STRUCTURE
	UPPER LINK AND UPPER SPAR FITTING
	MIDSPAR FITTINGS AND BULKHEAD
	SIDE BRACE FITTING AND SIDE LINKS
	DIAGONAL BRACE AND LOWER SPAR FITTING
	MIDSPAR CHORDS
	PINS

TABLE I

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Principal Structural Elements
Figure 2 (Sheet 4 of 5)

STRUCTURAL AREA	STRUCTURAL ELEMENT
LANDING GEAR	MAIN LANDING GEAR OUTER CYLINDER INNER CYLINDER TRUNNION UPPER AND LOWER DRAG STRUT PINS, DRAG STRUT DRAG STRUT SPINDLES TORSION LINKS PINS, TORSION LINK UPPER AND LOWER SIDE STRUT SIDE STRUT SPINDLES PINS, SIDE BRACE JURY STRUT JURY STRUT PINS ORIFICE SUPPORT TUBE ORIFICE PLATE METERING PIN GLAND NUT
	NOSE LANDING GEAR OUTER CYLINDER INNER CYLINDER TRUNNION PINS TORSION LINKS PINS, TORSION LINK STEERING COLLAR PINS, STEERING COLLAR STEERING SUPPORT PLATES PINS, SUPPORT PLATES LOCK LINK ASSY UPPER AND LOWER DRAG STRUT PINS, DRAG STRUT ORIFICE SUPPORT TUBE ORIFICE PLATE METERING PIN GLAND NUT

TABLE I

Principal Structural Elements
Figure 2 (Sheet 5 of 5)

NOTES

- THIS FIGURE SHOWS THE AIRWORTHINESS LIMITATION ITEMS (ALI'S) FOR THE FUSELAGE, EMPENNAGE AND WING AS THEY ARE GIVEN IN THE MAINTENANCE PLANNING DATA DOCUMENT (MPD), D622T001, SECTION 9. THIS DATA IS USED TO FIND IF A REPAIR HAS AN EFFECT ON AN ALI. IF:
  - THE REPAIR DOES HAVE AN EFFECT ON AN ALI AND,
  - SPECIFIC SRM REPAIRS ARE NOT GIVEN, THEN THE OPERATOR CAN MAKE A REFERENCE TO THE APPLICABLE ALI WHEN THEY ASK FOR REPAIR INSTRUCTIONS.
- REFER TO THE MPD FOR THE FULL INSPECTION INSTRUCTIONS THAT INCLUDE ALL GENERAL AND ALI INSPECTIONS.
- SINCE SOME ALI'S HAVE BEEN REMOVED FROM THE MPD, THEIR NUMBERS WILL NOT ALWAYS FOLLOW IN SEQUENCE.
- FOR REPAIRS THAT HAVE AN EFFECT ON AN ALI, YOU MUST MAKE A RECORD AS GIVEN IN 14 CFR 91.417(a)(2)(v), OR 14 CFR 121.380(a)(2)(vi).

[A] ALL OF THE ITEMS ARE APPLICABLE TO THE LEFT AND RIGHT SIDES EXCEPT FOR DOORS AND DOOR CUTOUTS.

[B] THIS ALI IS APPLICABLE TO ALL 767 AIRPLANES WITH LINE NUMBER 1 THRU 757.

[C] THIS ALI IS APPLICABLE TO ALL 767 AIRPLANES WITH LINE NUMBER 758 AND ON.

[D] THIS ALI IS APPLICABLE TO AIRPLANES WITH LINE NUMBER 424 AND ON. REFER TO SB 767-53-0026 FOR AIRPLANES WITH LINE NUMBER 001 THRU 423.

[E] THIS ALI IS APPLICABLE TO AIRPLANES WITH LINE NUMBER 176 AND ON. REFER TO SB 767-53-0026 FOR AIRPLANES WITH LINE NUMBER 001 THRU 175.

[F] REFER TO SB 767-53-0078 FOR AIRPLANES WITH LINE NUMBER 001 THRU 709.

[G] REFER TO SB 767-55-0005 FOR AIRPLANES WITH LINE NUMBER 001 THRU 098.

[H] THIS ALI IS APPLICABLE TO ALL 767-300ER AIRPLANES.

ALI TABLES INDEX

STRUCTURE	TABLE NO.	DETAIL NO.
FUSELAGE SECTION 41	II	I, XIV
FUSELAGE SECTION 43	III	II THRU V
FUSELAGE SECTION 45	IV	VI, VII, VIII, XV THRU XVIII, XXVIII
FUSELAGE SECTION 46	V	IX THRU XII, XIX
FUSELAGE SECTION 48	VI	XIII, XX THRU XXVII
EMPENNAGE	VII	XXIX THRU XXXVII
WING	VIII	XXXVIII THRU XLIV

TABLE I

Airworthiness Limitation Items
Figure 3 (Sheet 1 of 51)

SSI NUMBER	TITLE	APPLICABILITY
53-10-I07A	SKIN LONGITUDINAL LAP SPLICES - UPPER ROW - CROWN AND UPPER LOBE, STRINGERS S-2R, S-8L/R, S-17L/R, FROM BS 246 TO BS 434	
53-10-I07B	SKIN LONGITUDINAL LAP SPLICES - LOWER ROW - CROWN AND UPPER LOBE, STRINGERS S-2R, S-8L/R, S-17L/R, FROM BS 246 TO BS 434	
53-10-I07C	SKIN LONGITUDINAL LAP SPLICES - UPPER ROW - BILGE AND LOWER LOBE, STRINGERS S-21L/R, S-30L/R, FROM BS 132.5 TO BS 246; S-26L/R FROM BS 246 TO BS 434; S-37L/R FROM BS 287 TO BS 434	
53-10-I07D	SKIN LONGITUDINAL LAP SPLICES - LOWER ROW - BILGE AND LOWER LOBE, STRINGERS S-21L/R, S-30L/R, FROM BS 132.5 TO BS 246; S-26L/R FROM BS 246 TO BS 434; S-37L/R FROM BS 287 TO BS 434	
53-10-I08B	FRAMES, ABOVE S-20L/R, FROM BS 246 TO BS 434	
53-10-I08C	FRAMES, AT S-20 AND BELOW, FROM BS 246 TO BS 434	
53-10-I10A	FORWARD PASSENGER ENTRY/SERVICE DOOR CUTOUT - EDGE FRAME - INNER CHORD DOOR STA 76.3, FROM S-7 TO S-12 AND FROM S-19 TO S-23 DOOR STA 123.7, FROM S-8 TO S-12 AND FROM S-19 TO S-23	
53-10-I10B	FORWARD PASSENGER ENTRY/SERVICE DOOR CUTOUT - UPPER MAIN SILL - INNER CHORD DOOR STA 100 TO DOOR STA 129.9	
53-10-I12	MAIN EQUIPMENT CENTER ACCESS DOOR CUTOUT, FROM BS 303 TO BS 325, FROM LBL 13.1 TO RBL 13.1	
53-10-I13	FORWARD EQUIPMENT BAY ACCESS DOOR CUTOUT, FROM BS 144.5 TO BS 163.2, FROM LBL 9 TO RBL 9	
53-10-I14A	WINDOW #1 CUTOUT STRUCTURE - AB POST	
53-10-I14B	WINDOW #1 CUTOUT STRUCTURE - BD SILL, FROM BL 0.0 TO BL 14.0 L/R	
53-10-I16	WINDOW #2 CUTOUT STRUCTURE - EF POST	
53-10-I18A	NLG WHEEL WELL CANTED BULKHEAD DETAILS - OUTER CHORD TYPICAL LOCATIONS BETWEEN STRINGERS S-32L AND S-32R	
53-10-I18B	NLG WHEEL WELL CANTED BULKHEAD DETAILS - OUTER CHORD HIDDEN LOCATIONS BETWEEN BL 10.6 L/R AND BL 25.0 L/R	
53-10-I20A	NLG WHEEL WELL - BL 25 SIDE PANEL DETAILS - VERTICAL BEAMS AND PANEL WEB FROM BS 180.5 TO BS 276	
53-10-I20B	NLG WHEEL WELL - TRUNNION SUPPORT FITTING AT TOP PANEL BEAM ATTACHMENT, BS 276, BL 30, FROM WL 181 TO WL 187	
53-10-I20C	NLG WHEEL WELL - TRUNNION SUPPORT FITTING AT STRAP ATTACHMENT, BS 276, BL 30, FROM WL 165 TO WL 169	
53-10-I21A	NLG WHEEL WELL - BS 287 BULKHEAD DETAILS - WL 159 BEAM AND BULKHEAD WEB FROM LBL 27 TO LBL 23, LBL 10 TO RBL 10, RBL 23 TO RBL 27	B
	NLG WHEEL WELL - BS 287 BULKHEAD DETAILS - WL 159 BEAM AND BULKHEAD WEB FROM LBL 10 TO RBL 10	C

FUSELAGE STRUCTURE - SECTION 41
TABLE II A

Airworthiness Limitation Items
Figure 3 (Sheet 2 of 51)

SSI NUMBER	TITLE	APPLICABILITY
53-10-I21B	NLG WHEEL WELL - BS 287 BULKHEAD DETAILS - OUTER CHORD TYPICAL LOCATIONS BETWEEN STRINGERS S-24L AND S-24R	
53-10-I21C	NLG WHEEL WELL - BS 287 BULKHEAD DETAILS - OUTER CHORD - STRINGER SPLICES BETWEEN STRINGERS S-24L AND S-24R	
53-10-I21D	NLG WHEEL WELL - BS 287 BULKHEAD DETAILS - OUTER CHORD - HIDDEN LOCATIONS AT STRINGERS S-36L, S-36R, AND S-27R	
53-10-I21E	NLG WHEEL WELL - BS 287 BULKHEAD DETAILS - WL 159 BEAM AND BULKHEAD WEB FROM LBL 27 TO LBL 23 AND RBL 23 TO RBL 27	$\boxed{C}$

FUSELAGE STRUCTURE - SECTION 41
TABLE II $\boxed{A}$

Airworthiness Limitation Items
Figure 3 (Sheet 3 of 51)

SSI NUMBER	TITLE	APPLICABILITY
53-30-I01	FUSELAGE CROWN STRINGERS - S-8L TO S-8R FROM BS 654 TO BS 786	
53-30-I04A	SKIN LONGITUDINAL LAP SPLICES - UPPER ROW - CROWN AND UPPER LOBE, STRINGERS S-2R, S-8L/R, S-17L/R, FROM BS 434 TO BS 786	
53-30-I04B	SKIN LONGITUDINAL LAP SPLICES - LOWER ROW - CROWN AND UPPER LOBE, STRINGERS S-2R, S-8L/R, S-17L/R, FROM BS 434 TO BS 786	
53-30-I04C	SKIN LONGITUDINAL LAP SPLICES - UPPER ROW - BILGE AND LOWER LOBE, STRINGERS S-26L/R, S-36L/R, FROM BS 434 TO BS 786	
53-30-I04D	SKIN LONGITUDINAL LAP SPLICES - LOWER ROW - BILGE AND LOWER LOBE, STRINGERS S-26L/R, S-36L/R, FROM BS 434 TO BS 786	
53-30-I05, 53-30-I21, 53-30-I27	FUSELAGE CIRCUMFERENTIAL SPLICES IN THE BODY CROWN AT: - BS 786 FROM S-7L TO S-7R, BS 654 FROM S4L TO S-4R	
53-30-I14A	FORWARD MAIN CARGO DOOR CUTOUT - EDGE FRAMES - FRAMES AT STA 539.5 AND 615.5; FROM STRINGERS S-17R TO S-21R AND S-28R TO S-36R	
53-30-I14C	FORWARD MAIN CARGO DOOR CUTOUT - EDGE FRAMES - OUTER CHORD (BEAR STRAP) AT BS 539.5 AND BS 615.5 BETWEEN UPPER AND LOWER SILLS	
53-30-I14D	FORWARD MAIN CARGO DOOR CUTOUT - UPPER MAIN SILL - INNER CHORD (CHORD AND STRAP) FROM BS 522 TO BS 544	
53-30-I14E	FORWARD MAIN CARGO DOOR CUTOUT - LOWER MAIN SILL - INNER CHORD (CHORD AND STRAP) FROM BS 610 TO BS 632	
53-30-I19A	FORWARD LARGE CARGO DOOR CUTOUT - EDGE FRAME INNER CHORD (CHORD AND STRAP) AT BS 478 FROM S-23R TO S-28R, AND AT BS 618 FROM S-27R TO S-28R AND S-29R TO S-30R	
53-30-I19B	FORWARD LARGE CARGO DOOR CUTOUT - EDGE FRAME INNER CHORD (CHORD AND STRAP) AT BS 478 FROM S-26R TO S-27R, AND AT BS 618 FROM S-29R TO S-30R	
53-30-I19C	FORWARD LARGE CARGO DOOR CUTOUT - EDGE FRAME (CHORD AND STRAP) AT BS 618 FROM S-28R TO S-29R	
53-30-I19D	FORWARD LARGE CARGO DOOR CUTOUT - LOWER SILL (CHORD AND STRAP) FROM BS 610 TO BS 632, UPPER SILL FROM BS 456 TO 478 AND BS 482 TO BS 493	
53-30-I19E	FORWARD LARGE CARGO DOOR CUTOUT - UPPER SILL (CHORD AND STRAP) FROM BS 478 TO 482	
53-30-I19F	FORWARD LARGE CARGO DOOR CUTOUT - UPPER SILL AT BS 480	
53-30-I19G	FORWARD LARGE CARGO DOOR CUTOUT - UPPER SILL FROM BS 482 TO BS 493	
53-30-I20A	FORWARD LARGE CARGO DOOR CUTOUT - LOWER LATCH BACKUP STRUCTURE - LATCH SUPPORT FITTING AT BS 487.7 AND BS 608.3	
53-30-I22C	MID PASSENGER ENTRY/SERVICE DOOR CUTOUT - EDGE FRAME INNER CHORD AT BS 654+44 FROM S-8 TO S-15; AT BS 654+91.4 FROM S-8 TO S-20	
53-30-122D	MID PASSENGER ENTRY/SERVICE DOOR CUTOUT - UPPER MAIN SILL INNER CHORD	
53-30-124A	FRAMES, ABOVE S-20 L/R FROM: - BS 654 TO BS 786	
53-30-124B	FRAMES, ABOVE S-20 L/R FROM: - BS 434 TO BS 654	
53-30-124C	FRAMES, AT S-20 AND BELOW, FROM BS 434 TO BS 786	

FUSELAGE STRUCTURE - SECTION 43
TABLE III A

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Airworthiness Limitation Items
Figure 3 (Sheet 4 of 51)

SSI NUMBER	TITLE	APPLICABILITY
53-50-I01	FUSELAGE CROWN STRINGERS - S-8L TO S-8R, FROM BS 786 TO BS 1065	
53-50-I01A, 53-50-I02A	FRAMES ABOVE S-20 L/R FROM BS 786 TO BS 1065	
53-50-I03	FUSELAGE CIRCUMFERENTIAL SPLICES IN THE BODY CROWN - AT BS 786 FROM S-7L TO S-7R AND BS 1065 FROM STRINGERS S-9L TO S-9R	
53-50-I11	BS 1043 FRAME SPLICE WITH THE LANDING GEAR FITTING - BS 1043, BL 92, WL 193 TO WL 199 (FRAME, WEB, AND FITTING)	
53-50-I13B	FUSELAGE REAR SPAR BULKHEAD - BULKHEAD FITTING INNER CHORD FROM S-20 TO S-21 AT SEAT TRACK BRACKET	
53-50-I13C	FUSELAGE REAR SPAR BULKHEAD - INBOARD CHORD FLANGE - BS 955, BL 91, FROM S-18 TO S-20	
53-50-I14A	AFT WHEEL WELL BULKHEAD BS 1065 - VERTICAL BEAM BL 26 INTERCOSTAL UPPER CHORD SPLICE AT BL 26, WL 124.5 BETWEEN BS 1082 AND BS 1087 (SEE DETAILS VII AND VIII)	
53-50-I14B	AFT WHEEL WELL BULKHEAD BS 1065 - HIDDEN DETAILS AT OUTER CHORD SPLICES FROM S-27 TO S-28 AND S-35 TO S-36. (SEE DETAILS VII AND VIII)	
53-50-I14C	AFT WHEEL WELL BULKHEAD BS 1065 - OUTER CHORD AT STRINGER SPLICES/ATTACHMENT FITTINGS BETWEEN S-29 AND S-34 (SEE DETAILS VII AND VIII)	
53-50-I18, 53-50-I24, 53-50-I28	FRAME INNER CHORD AT STUB BEAM FROM BS 808 TO BS 933	
53-50-I19	MLG WHEEL WELL - BS 1021 TRANSVERSE FLOOR BEAM LOWER CHORD - FROM LBL 33 TO LBL 60 AND RBL 33 TO RBL 60	
53-50-I22A	DUAL EMERGENCY EXIT CUTOUT - FRAME INNER CHORDS AT BS 859.5 FROM S-12 TO S-14, AT BS 883.5 FROM S-15 TO S-20, AT BS 903.5 FROM S-11 TO S-20, AT BS 927.5 FROM S-14 TO S-20	
53-50-I22B	DUAL EMERGENCY EXIT CUTOUT - FRAME INNER CHORD AT SILL INTERSECT AT UPPER SILL BS 859.5 AND BS 903.5, AT LOWER SILL BS 883.5, BS 903.5, AND BS 927.5	
53-50-I22C	DUAL EMERGENCY EXIT CUTOUT - SILL INNER CHORD (CHORD AND STRAP) AT UPPER SILL FROM BS 840 TO BS 871.5 AND BS 885 TO BS 916, AT LOWER SILL FROM BS 875 TO BS 894	
53-50-I22D	DUAL EMERGENCY EXIT CUTOUT - SILL INNER CHORD AT FRAME INTERSECT AT UPPER SILL BS 859.5 AND BS 903.5, AT LOWER SILL BS 883.5, BS 903.5, AND BS 927.5	
53-50-I22E	DUAL EMERGENCY EXIT CUTOUT - UPPER SILL INNER CHORD (STRAP) AT BS 859.5 AND BS 903.5	
53-50-I22F	DUAL EMERGENCY EXIT CUTOUT - SILL OUTER CHORD AND BEAR STRAP AROUND CUTOUTS (UPPER AND LOWER SILL)	
53-50-I22G	DUAL EMERGENCY EXIT CUTOUT - SILL OUTER CHORD AT FRAME INTERSECT AT UPPER SILL BS 859.5 AND BS 903.5, AT LOWER SILL BS 883.5 AND BS 927.5	

FUSELAGE STRUCTURE - SECTION 45
TABLE IV A

Airworthiness Limitation Items
Figure 3 (Sheet 5 of 51)

SSI NUMBER	TITLE	APPLICABILITY
53-50-I25A	SINGLE AFT EMERGENCY EXIT CUTOUT - FRAME INNER CHORDS AT BS 903.5 FROM S-11 TO S-20, AT BS 927.5 FROM S-14 TO S-19	
53-50-I25B	SINGLE AFT EMERGENCY EXIT CUTOUT - FRAME INNER CHORD (STRAP) AT SILL INTERSECT AT UPPER SILL BS 903.5, AT LOWER SILL BS 903.5 AND BS 927.5	
53-50-I25C	SINGLE AFT EMERGENCY EXIT CUTOUT - SILL INNER CHORD (CHORD AND STRAP) AT UPPER SILL FROM BS 871.5 TO BS 920	
53-50-I25D	SINGLE AFT EMERGENCY EXIT CUTOUT - SILL INNER CHORD AT FRAME INTERSECT AT UPPER SILL BS 903.5, AT LOWER SILL BS 903.5 AND BS 927.5	
53-50-I25E	SINGLE AFT EMERGENCY EXIT CUTOUT - UPPER SILL INNER CHORD (STRAP) AT BS 903.5	
53-50-I25F	SINGLE AFT EMERGENCY EXIT CUTOUT - SILL OUTER CHORD AND BEAR STRAP AROUND CUTOUTS (UPPER AND LOWER SILL)	
53-50-I25G	SINGLE AFT EMERGENCY EXIT CUTOUT - SILL OUTER CHORD AT FRAME INTERSECT AT UPPER SILL BS 903.5, AT LOWER SILL BS 927.5	

FUSELAGE STRUCTURE - SECTION 45
TABLE IV A

Airworthiness Limitation Items
Figure 3 (Sheet 6 of 51)

SSI NUMBER	TITLE	APPLICABILITY
53-60-I01	FUSELAGE CROWN STRINGERS - S-8L TO S-8R FROM BS 1065 TO BS 1395	
53-60-I03, 53-60-I26	FUSELAGE CIRCUMFERENTIAL SPLICES IN THE BODY CROWN AT: - BS 1065 FROM S-9L TO S-9R - BS 1219 FROM S-4L TO S-4R	
53-60-I05A	SKIN LONGITUDINAL LAP SPLICES - UPPER ROW - CROWN AND UPPER LOBE, STRINGERS S-2R, S-8L/R, S-17L/R, FROM BS 1065 TO BS 1582	
53-60-I05B	SKIN LONGITUDINAL LAP SPLICES - LOWER ROW - CROWN AND UPPER LOBE, STRINGERS S-2R, S-8L/R, S-17L/R, FROM BS 1065 TO BS 1582	
53-60-I05C	SKIN LONGITUDINAL LAP SPLICES - UPPER ROW - BILGE AND LOWER LOBE, STRINGERS S-26L/R, S-36L/R, FROM BS 1065 TO BS 1582	
53-60-I05D	SKIN LONGITUDINAL LAP SPLICES - LOWER ROW - BILGE AND LOWER LOBE, STRINGERS S-26L/R, S-36L/R, FROM BS 1065 TO BS 1582	
53-60-I06B	AFT MAIN CARGO DOOR CUTOUT - EDGE FRAMES - INNER CHORD (CHORD AND FAIL-SAFE STRAP) AT BS 1270 FROM S-23R TO S-29R AND AT BS 1346 FROM S-23R TO S-29R	
53-60-I06C	AFT MAIN CARGO DOOR CUTOUT - EDGE FRAMES - OUTER CHORD (BEAR STRAP) AT BS 1270 AND BS 1346 BETWEEN UPPER AND LOWER SILLS	
53-60-I06D	AFT MAIN CARGO DOOR CUTOUT - UPPER MAIN SILL - INNER CHORD (CHORD AND STRAP) FROM BS 1346 TO BS 1395	
53-60-I06E	AFT MAIN CARGO DOOR CUTOUT - LOWER MAIN SILL - INNER CHORD (CHORD AND STRAP) FROM BS 1263 TO BS 1270	
53-60-I08A	FRAMES ABOVE S-20 L/R FROM BS 1065 TO BS 1582	
53-60-I08C	FRAMES, AT S-20 AND BELOW, FROM BS 1065 TO BS 1582	
53-60-I10A	BULK CARGO DOOR CUTOUT - EDGE FRAMES INNER CHORD/FAIL- SAFE STRAP AT BS 1417 FROM S-26L TO S-33L AND AT BS 1461 FROM S-21L TO S-24L AND S-27L TO S-30L	
53-60-I10B	BULK CARGO DOOR CUTOUT - FRAME SPLICE - AFT EDGE FRAME, BS 1461, INNER CHORD AND FAIL-SAFE STRAP FROM S-24L TO S- 26L	
53-60-I14E	AFT PASSENGER ENTRY/SERVICE DOOR CUTOUT - EDGE FRAMES - INNER CHORD (CHORD AND FAIL-SAFE STRAP), DOOR STATION 876.3, FROM S-9 TO S-12 AND S-17 TO S-23 AND DOOR STATION 923.7, FROM S-8 TO S-13 AND S-21 TO S-23	
53-60-I14F	AFT PASSENGER ENTRY/SERVICE DOOR CUTOUT - UPPER MAIN SILL - INNER CHORD (CHORD AND FAIL-SAFE STRAP), FROM DOOR STATION 911 TO BS 1562	
53-60-I27A	TYPE I DOOR CUTOUT - EDGE FRAME - INNER CHORD (CHORD AND FAIL-SAFE STRAP) - AT BS 1153, FROM S-8 TO S-13 AND S-16 TO S-23 AND AT BS 1183.4, FROM S-8 TO S-13 AND S-16 TO S-23	
53-60-I27B	TYPE I DOOR CUTOUT - UPPER MAIN SILL - INNER CHORD (CHORD AND FAIL-SAFE STRAP), FROM BS 1131 TO BS 1197+22	
53-60-I27C	TYPE I DOOR CUTOUT - LOWER MAIN SILL - INNER CHORD (CHORD AND FAIL-SAFE STRAP), FROM BS 1131 TO BS 1175	

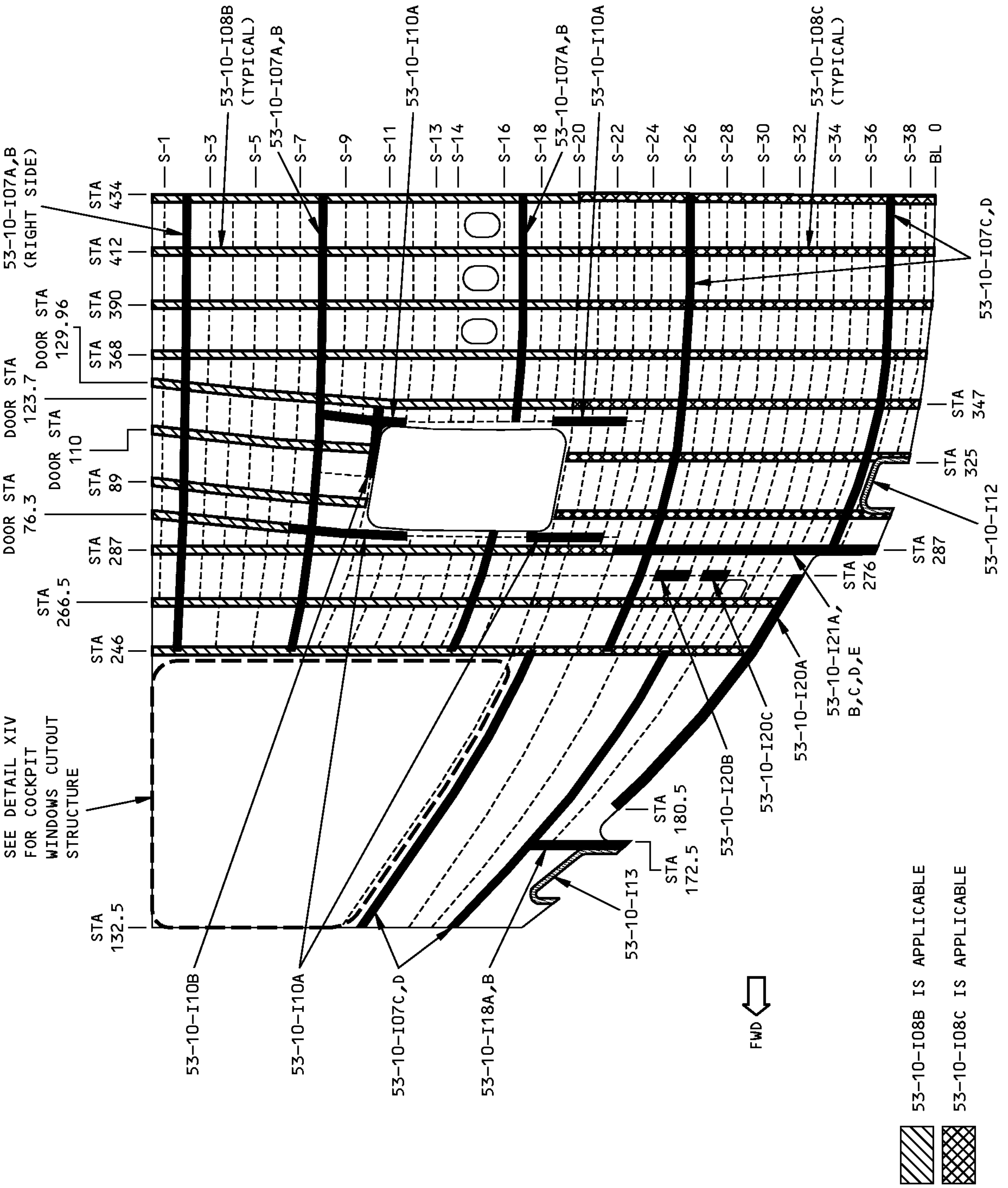
FUSELAGE STRUCTURE - SECTION 46
TABLE V [A]

Airworthiness Limitation Items
Figure 3 (Sheet 7 of 51)

SSI NUMBER	TITLE	APPLICABILITY
53-80-I01A	AFT PRESSURE BULKHEAD - CIRCUMFERENTIAL ATTACHMENT OF WEB TO Y-RING	D
53-80-I01B	AFT PRESSURE BULKHEAD - RADIAL WEB LAP SPLICES	E
53-80-I01C	AFT PRESSURE BULKHEAD - RADIAL WEB LAP SPLICES	E
53-80-I01D	AFT PRESSURE BULKHEAD - CIRCUMFERENTIAL TEAR STRAP SPLICE	E
53-80-I01E	AFT PRESSURE BULKHEAD - CIRCUMFERENTIAL TEAR STRAP SPLICE	E
53-80-I03	JACKSCREW FITTING LUG - UPPER BULKHEAD AT BS 1702	
53-80-I13	PIVOT FITTING LUG - UPPER BULKHEAD AT BS 1809.5	
53-80-I15, 53-80-I16, 53-80-I17	BS 1809.5 BULKHEAD OUTBOARD CHORD (OUTER CHORD AND ANGLE), FROM WL 240 TO WL 260	F
53-80-I25	HORIZONTAL STABILIZER FITTING HINGE PINS - BS 1809.5, BL 41.5	G

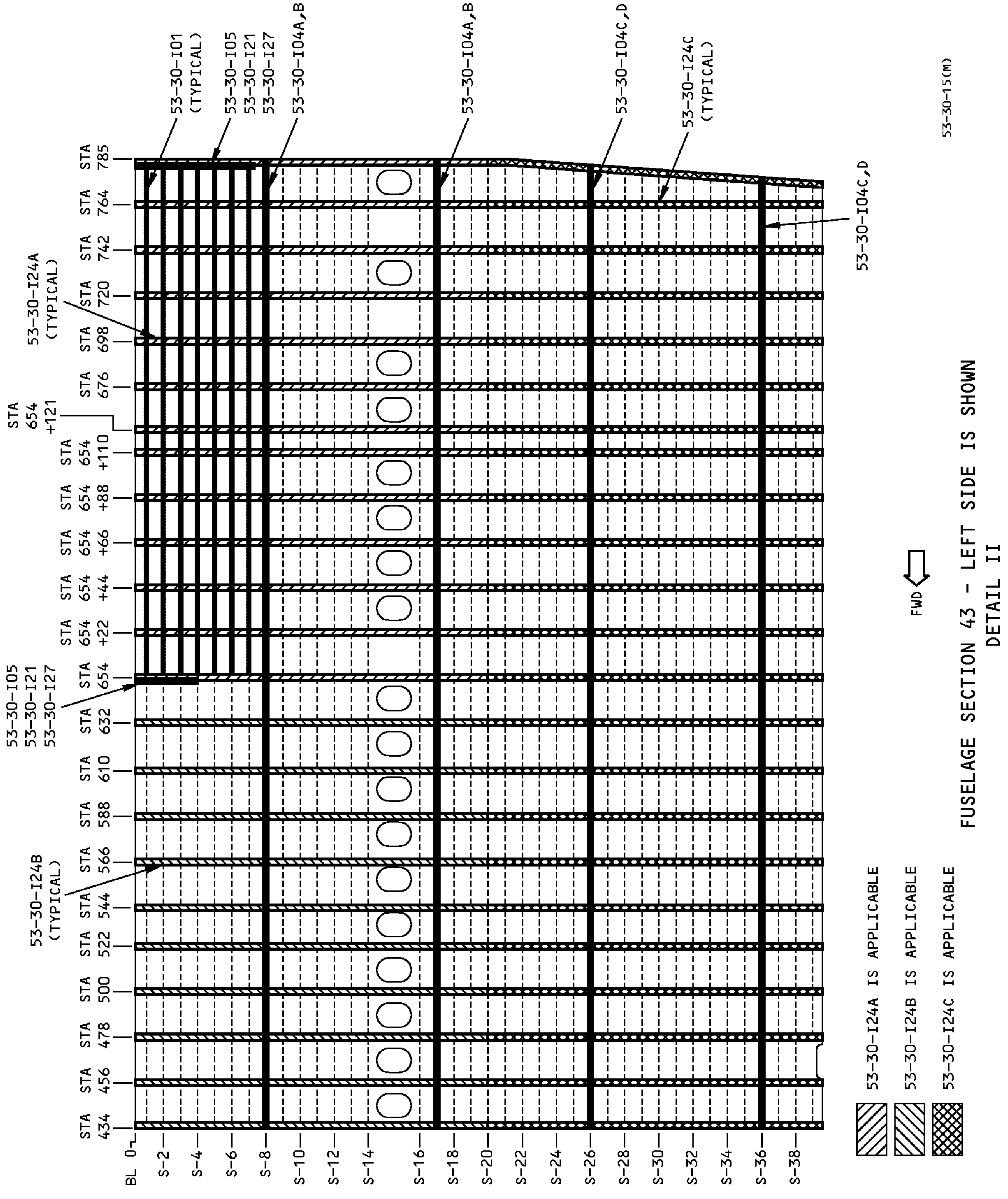
FUSELAGE STRUCTURE - SECTION 48
TABLE VI A

Airworthiness Limitation Items
Figure 3 (Sheet 8 of 51)



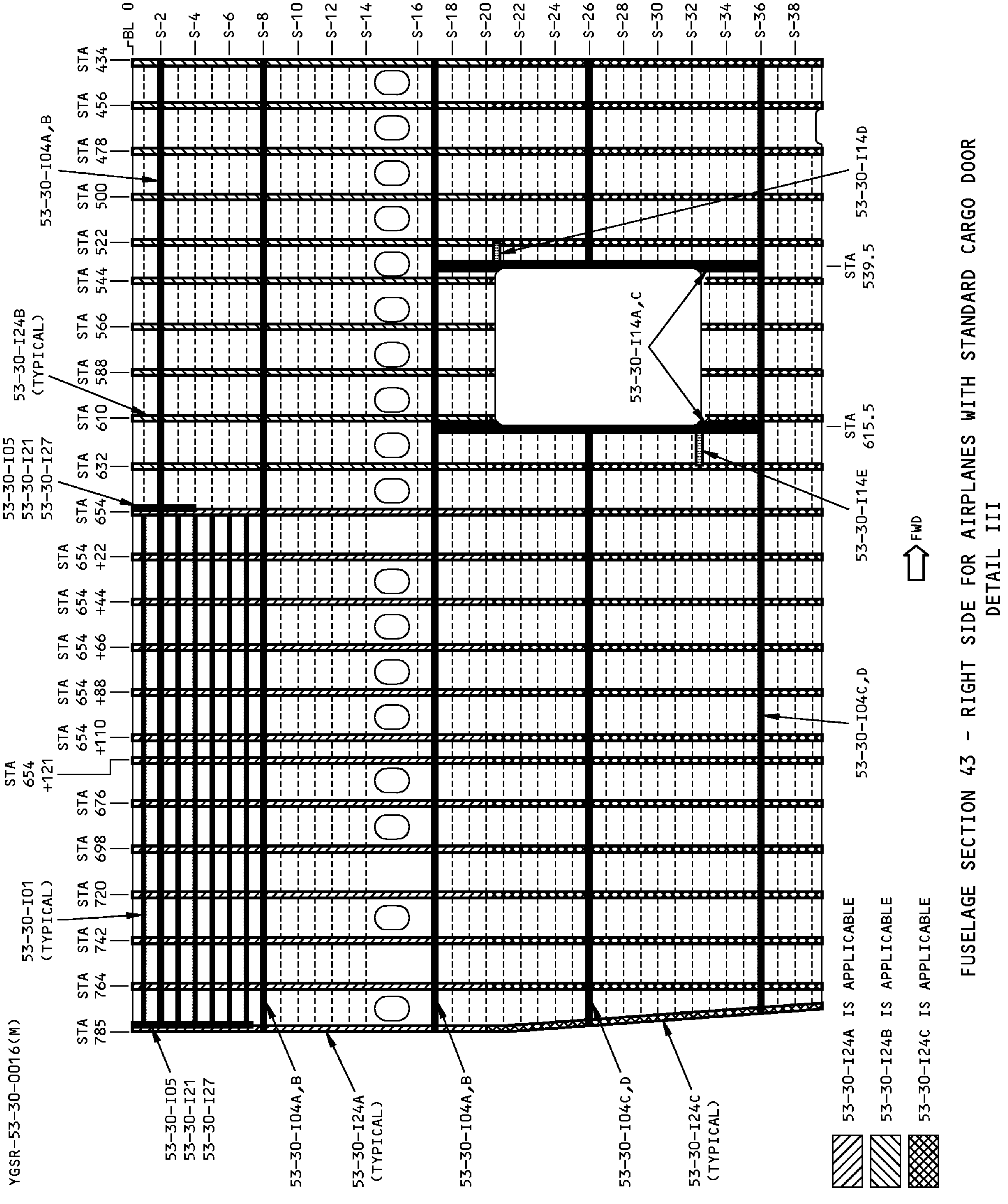
LEFT SIDE IS SHOWN, RIGHT SIDE IS OPPOSITE (EXCEPT AS NOTED)
FUSELAGE SECTION 41
DETAIL I

Airworthiness Limitation Items
Figure 3 (Sheet 9 of 51)



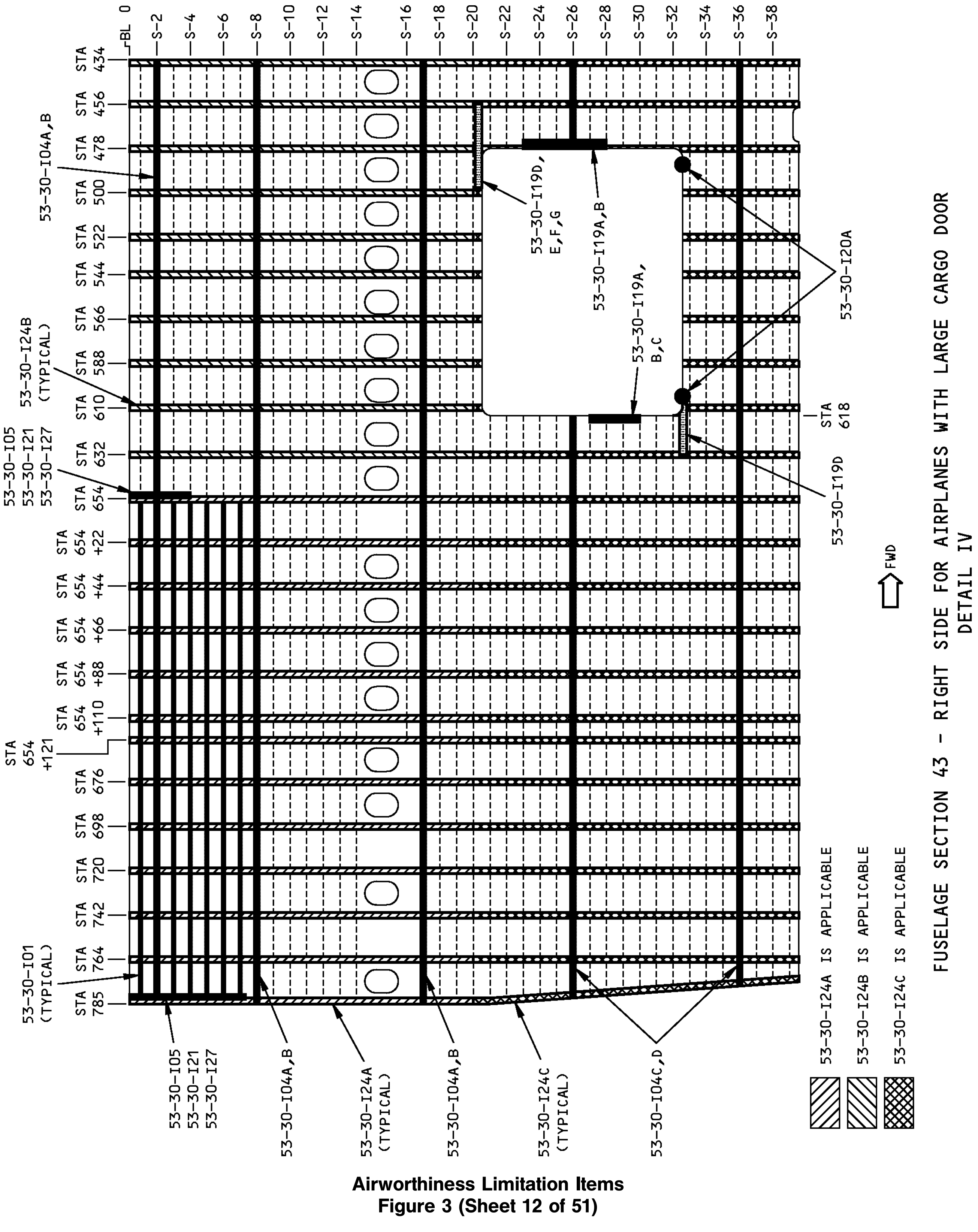
FUSELAGE SECTION 43 - LEFT SIDE IS SHOWN
DETAIL II

Airworthiness Limitation Items
Figure 3 (Sheet 10 of 51)



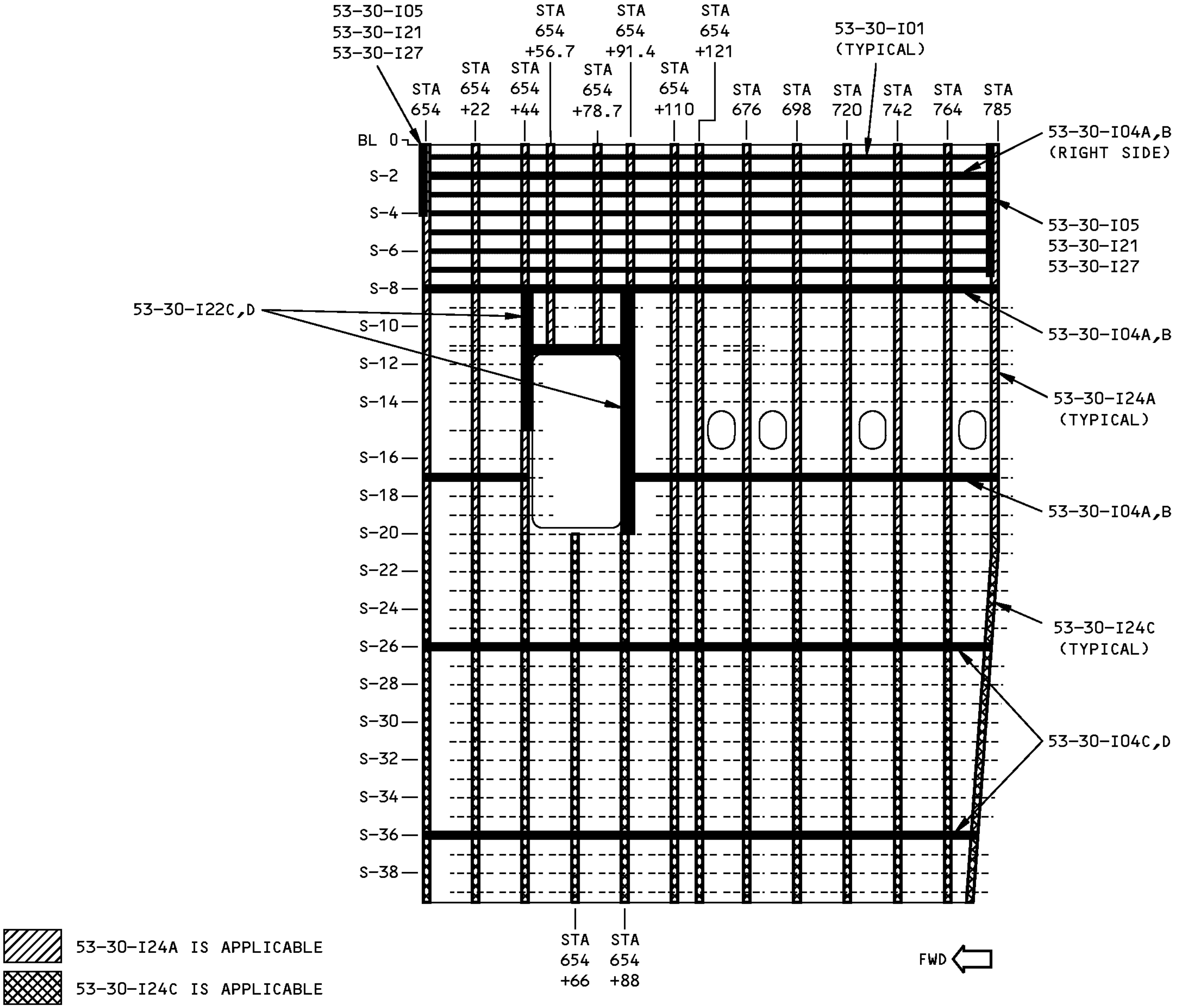
FUSELAGE SECTION 43 - RIGHT SIDE FOR AIRPLANES WITH STANDARD CARGO DOOR
DETAIL III

Airworthiness Limitation Items
Figure 3 (Sheet 11 of 51)



FUSELAGE SECTION 43 - RIGHT SIDE FOR AIRPLANES WITH LARGE CARGO DOOR
DETAIL IV

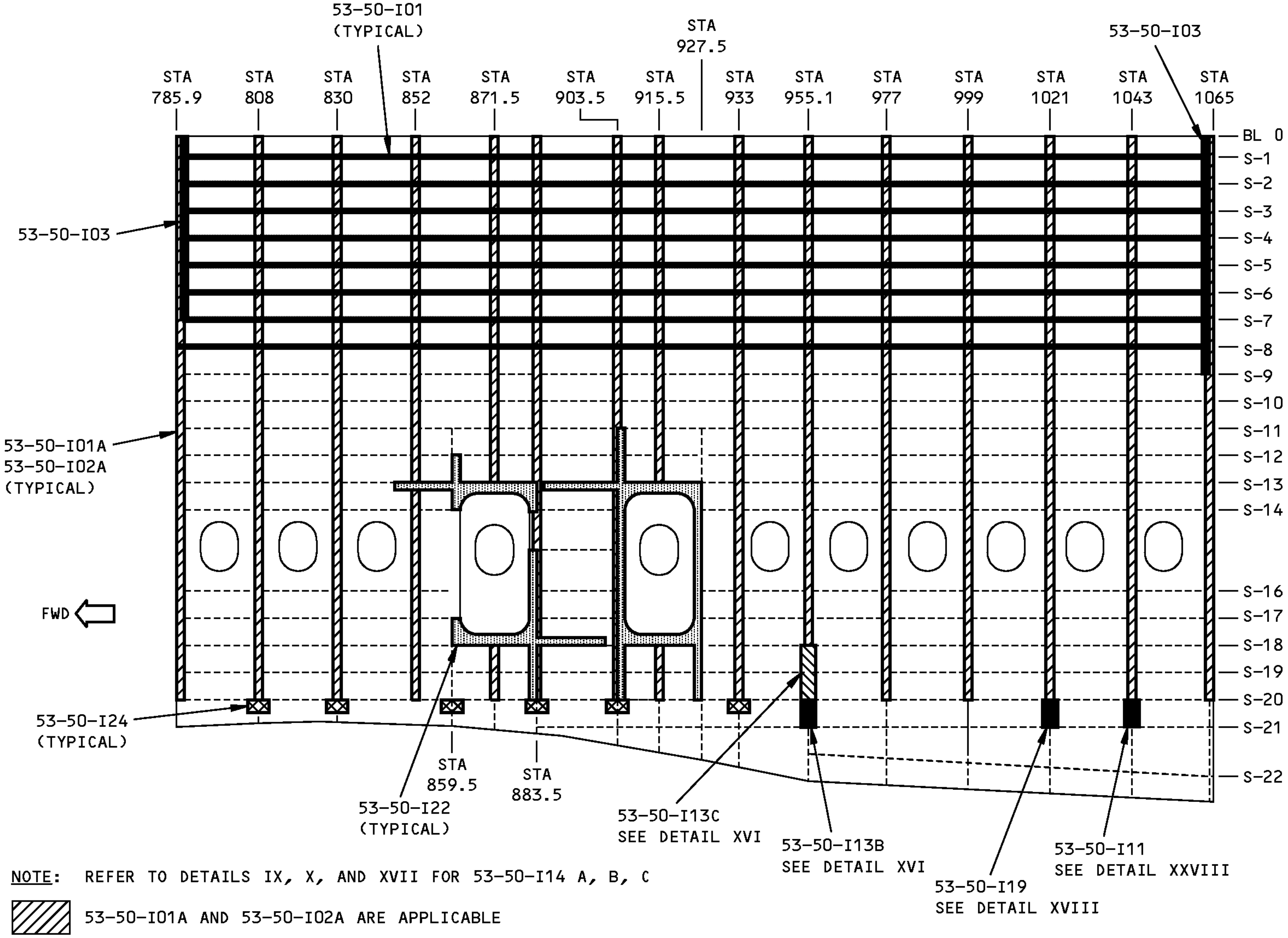
Airworthiness Limitation Items
Figure 3 (Sheet 12 of 51)



LEFT SIDE IS SHOWN, RIGHT SIDE IS OPPOSITE (EXCEPT AS NOTED)

FUSELAGE SECTION 43 - FOR AIRPLANES WITH MID ENTRY DOOR CONFIGURATION
DETAIL V

Airworthiness Limitation Items
Figure 3 (Sheet 13 of 51)



NOTE: REFER TO DETAILS IX, X, AND XVII FOR 53-50-I14 A, B, C

▨ 53-50-I01A AND 53-50-I02A ARE APPLICABLE

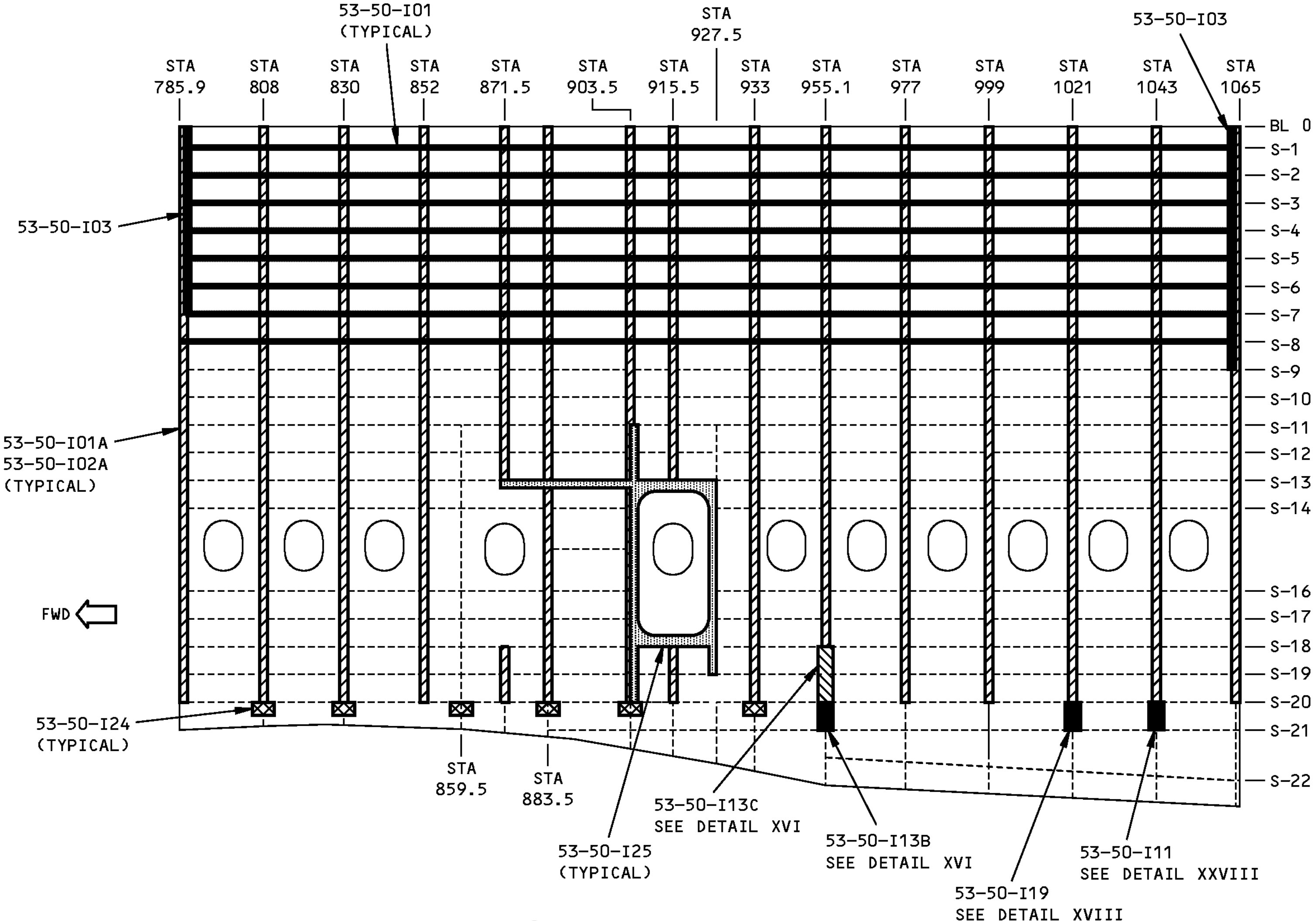
▩ 53-50-I24 IS APPLICABLE

░ 53-50-I22A THRU G ARE APPLICABLE

LEFT SIDE IS SHOWN, RIGHT SIDE IS OPPOSITE

FUSELAGE SECTION 45 - FOR AIRPLANES WITH DUAL OVERWING EXIT CONFIGURATION
DETAIL VI

Airworthiness Limitation Items
Figure 3 (Sheet 14 of 51)



NOTE: REFER TO DETAILS IX, X, AND XVII FOR 53-50-I14 A, B, C

▨ 53-50-I01A AND 53-50-I02A ARE APPLICABLE

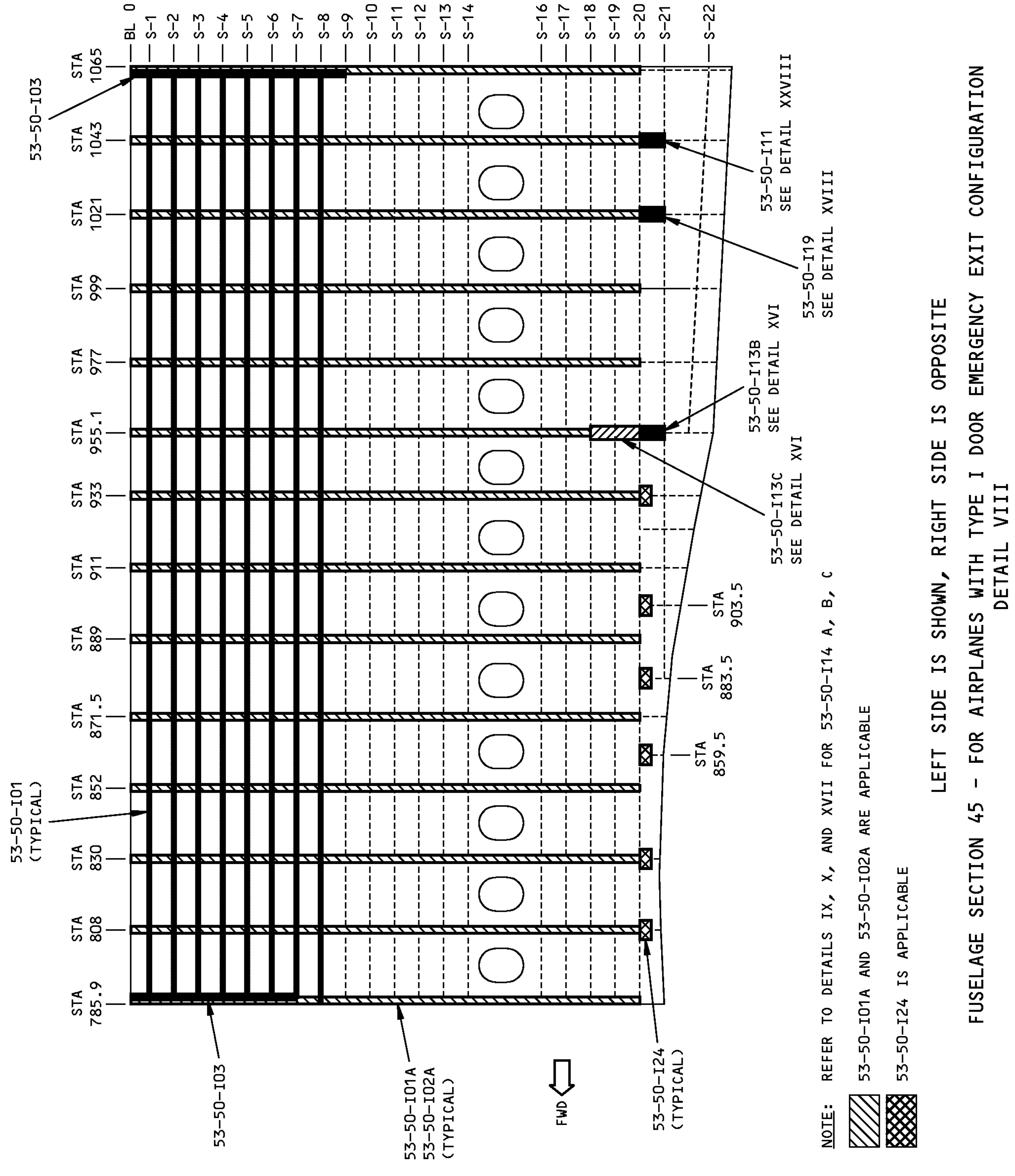
▦ 53-50-I25A THRU G ARE APPLICABLE

▩ 53-50-I24 IS APPLICABLE

LEFT SIDE IS SHOWN, RIGHT SIDE IS OPPOSITE

FUSELAGE SECTION 45 - FOR AIRPLANES WITH SINGLE AFT OVERWING EXIT (MID ENTRY DOOR) CONFIGURATION
DETAIL VII

Airworthiness Limitation Items
Figure 3 (Sheet 15 of 51)



NOTE: REFER TO DETAILS IX, X, AND XVII FOR 53-50-I14 A, B, C

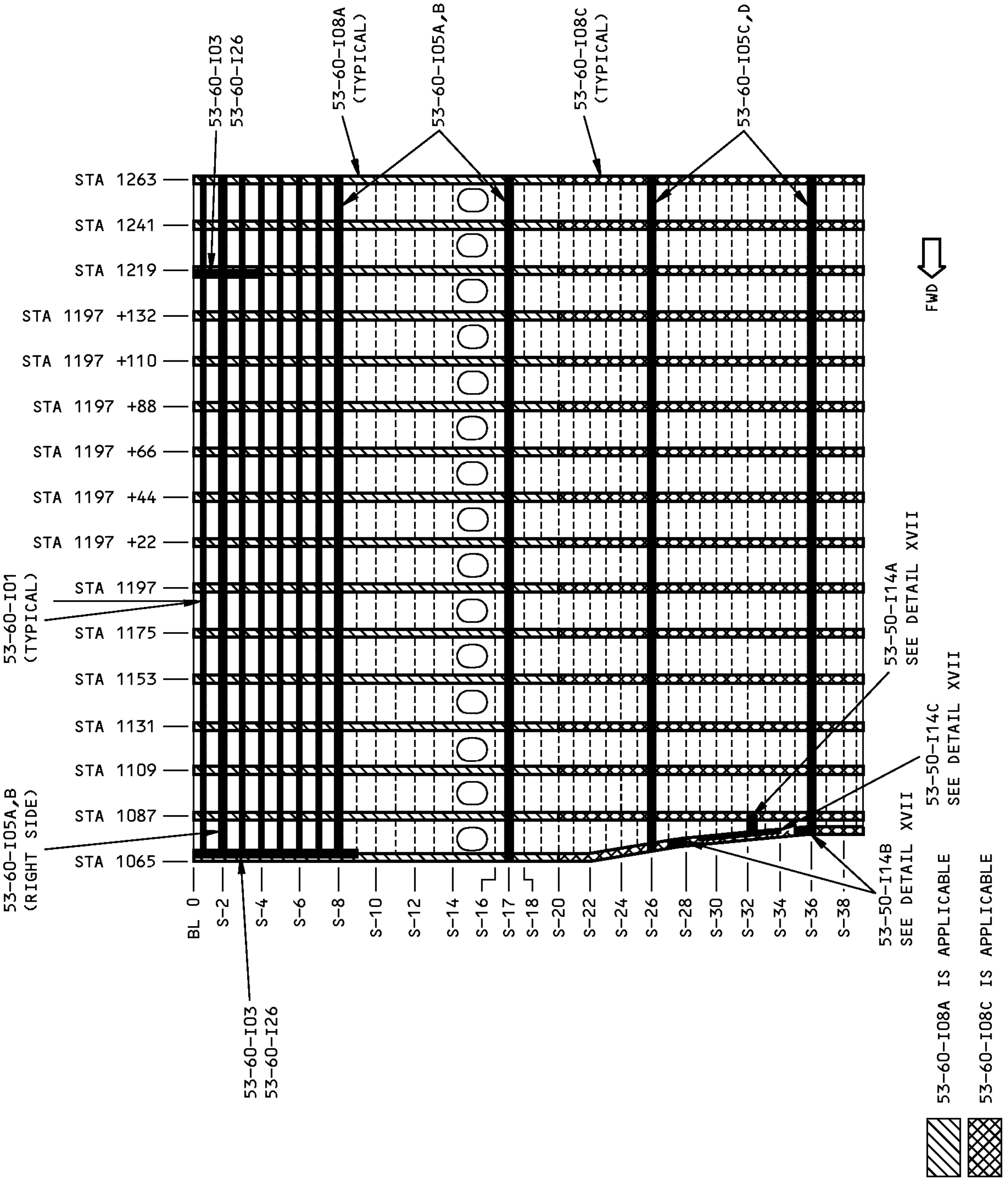
▨ 53-50-I01A AND 53-50-I02A ARE APPLICABLE

▩ 53-50-I24 IS APPLICABLE

LEFT SIDE IS SHOWN, RIGHT SIDE IS OPPOSITE

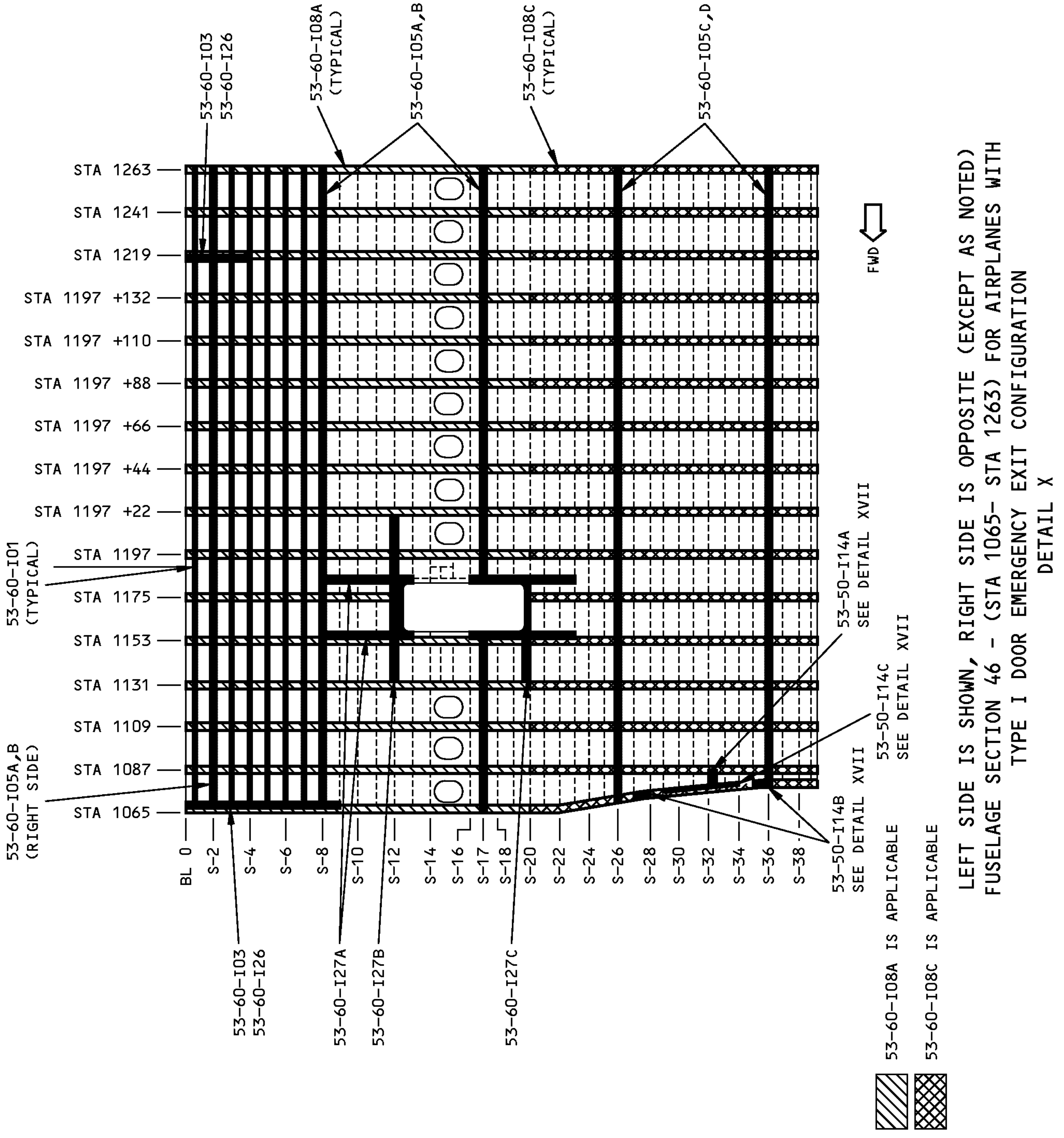
FUSELAGE SECTION 45 - FOR AIRPLANES WITH TYPE I DOOR EMERGENCY EXIT CONFIGURATION
DETAIL VIII

Airworthiness Limitation Items
Figure 3 (Sheet 16 of 51)



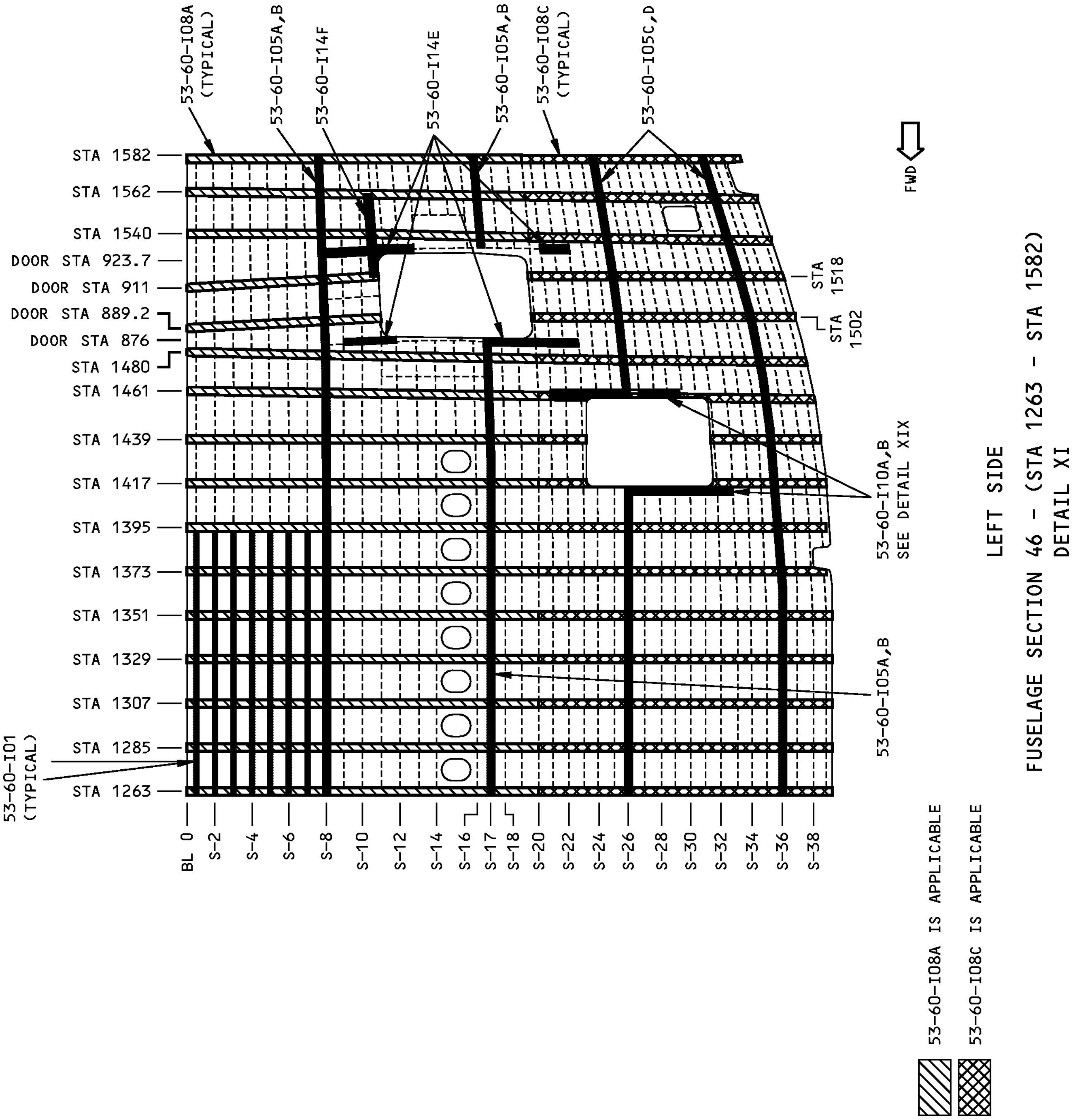
LEFT SIDE IS SHOWN, RIGHT SIDE IS OPPOSITE (EXCEPT AS NOTED)
FUSELAGE SECTION 46 - (STA 1065- STA 1263) FOR AIRPLANES WITHOUT
TYPE I DOOR EMERGENCY EXIT CONFIGURATION
DETAIL IX

Airworthiness Limitation Items
Figure 3 (Sheet 17 of 51)



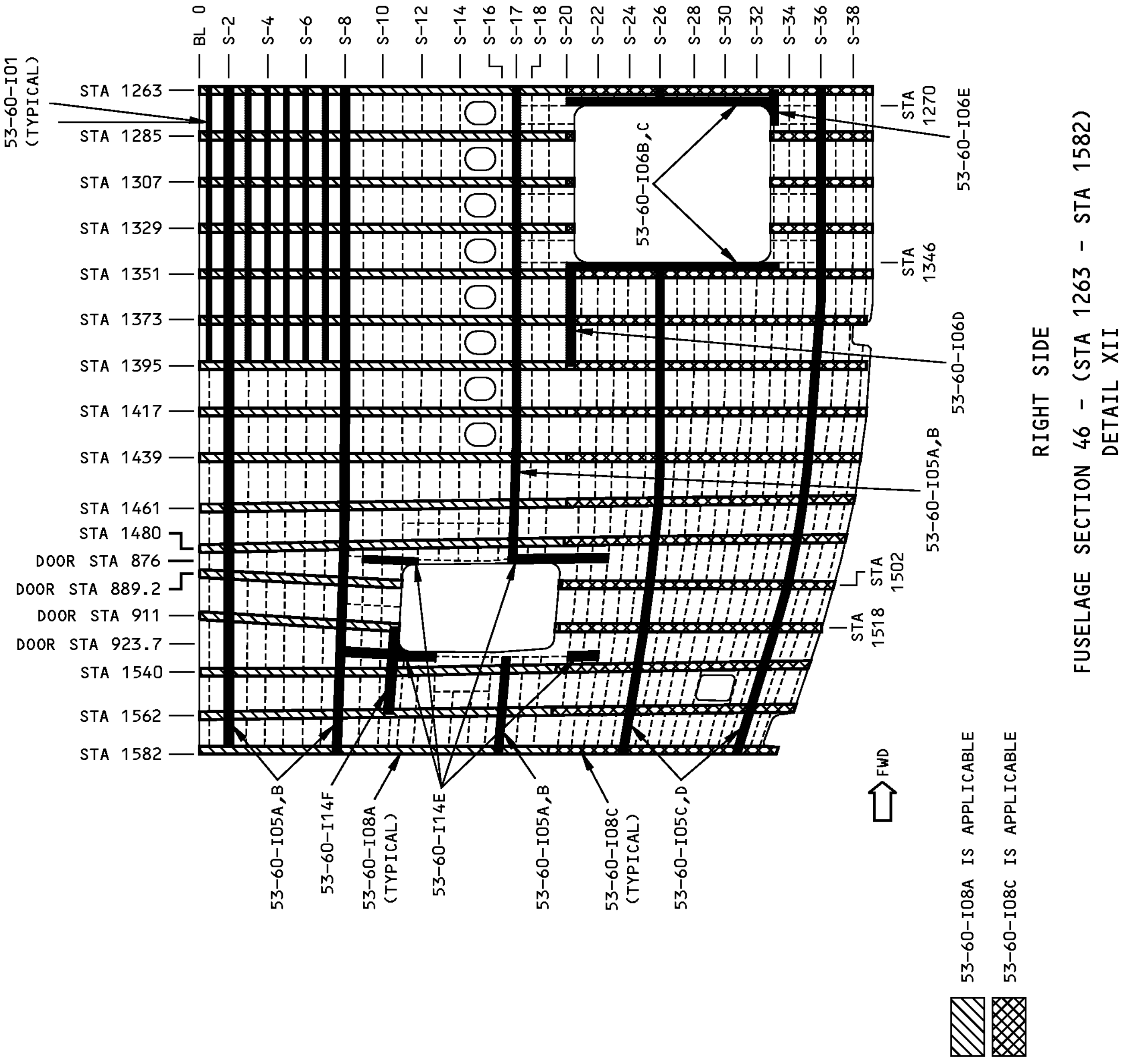
LEFT SIDE IS SHOWN, RIGHT SIDE IS OPPOSITE (EXCEPT AS NOTED)
FUSELAGE SECTION 46 - (STA 1065- STA 1263) FOR AIRPLANES WITH
TYPE I DOOR EMERGENCY EXIT CONFIGURATION
DETAIL X

Airworthiness Limitation Items
Figure 3 (Sheet 18 of 51)



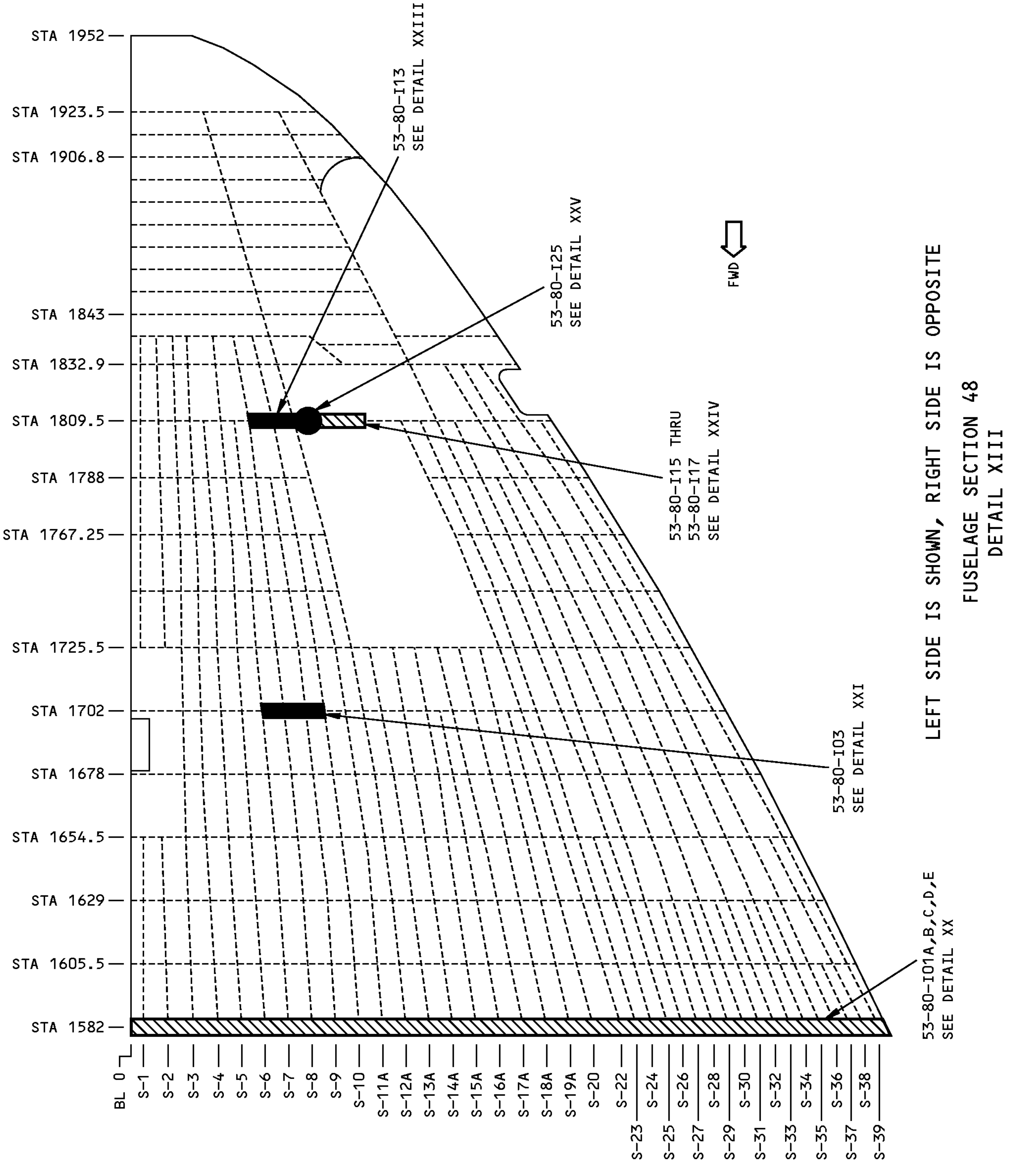
LEFT SIDE
FUSELAGE SECTION 46 - (STA 1263 - STA 1582)
DETAIL XI

Airworthiness Limitation Items
Figure 3 (Sheet 19 of 51)



RIGHT SIDE
FUSELAGE SECTION 46 - (STA 1263 - STA 1582)
DETAIL XII

Airworthiness Limitation Items
Figure 3 (Sheet 20 of 51)



53-80-I13
SEE DETAIL XXIII

53-80-I25
SEE DETAIL XXV

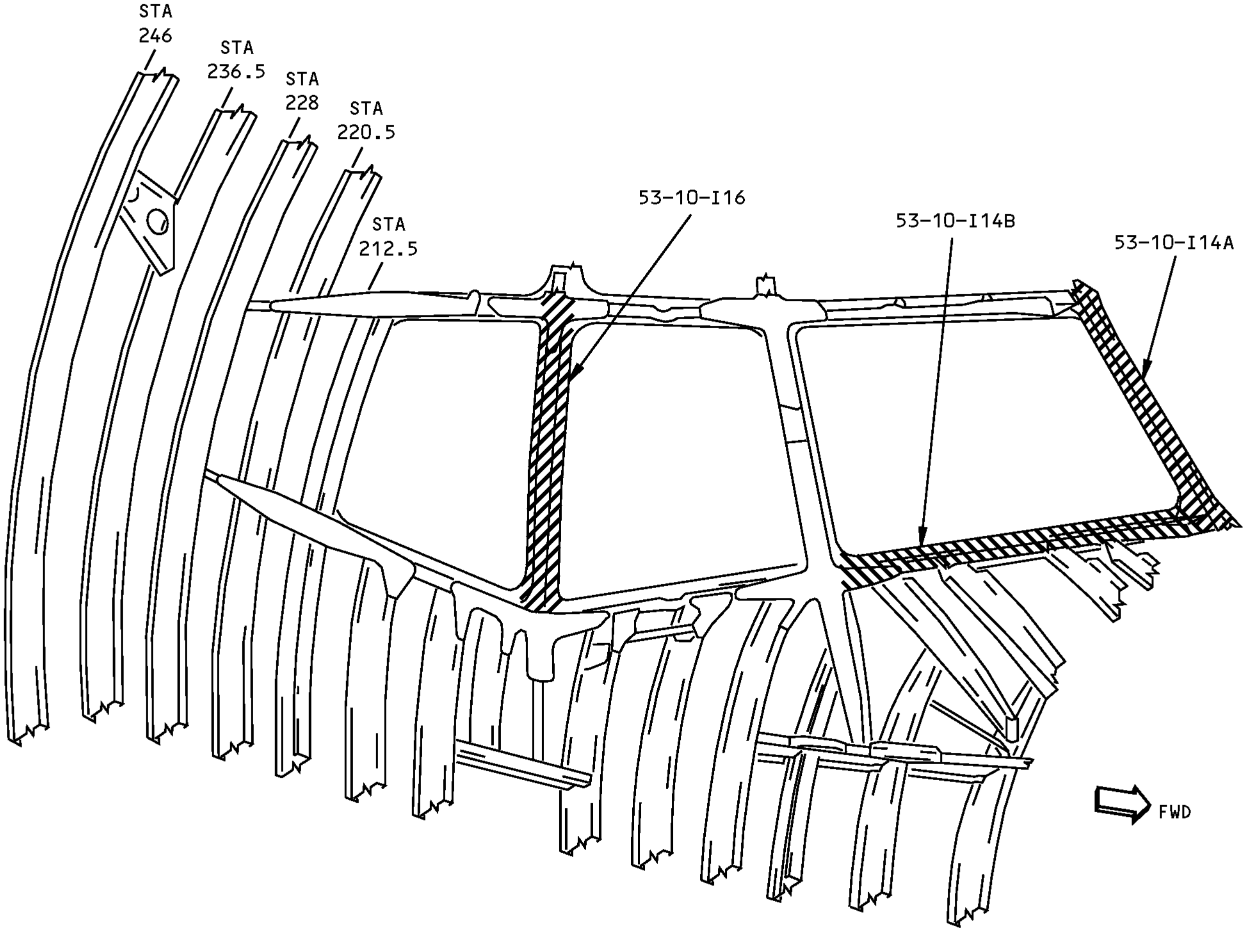
53-80-I15 THRU
53-80-I17
SEE DETAIL XXIV

53-80-I03
SEE DETAIL XXI

53-80-I01A,B,C,D,E
SEE DETAIL XX

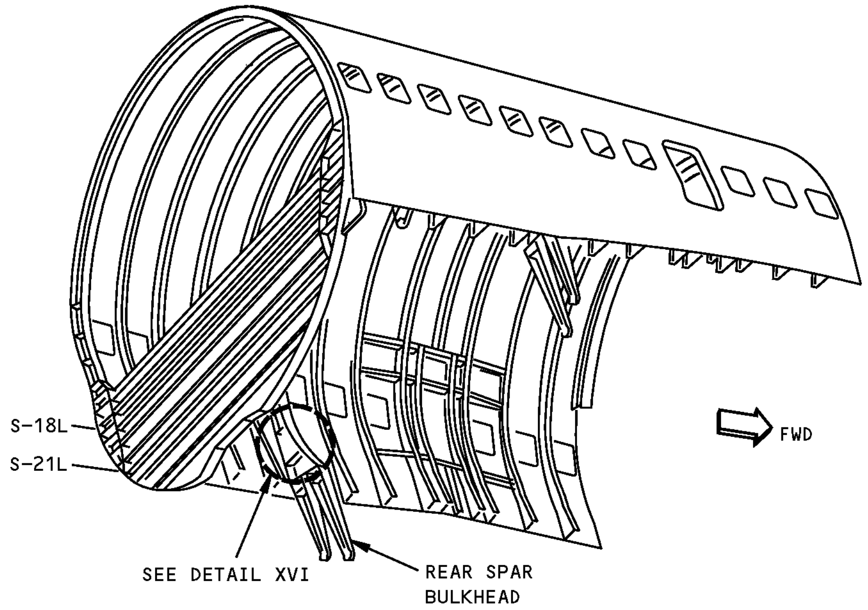
LEFT SIDE IS SHOWN, RIGHT SIDE IS OPPOSITE
FUSELAGE SECTION 48
DETAIL XIII

Airworthiness Limitation Items
Figure 3 (Sheet 21 of 51)

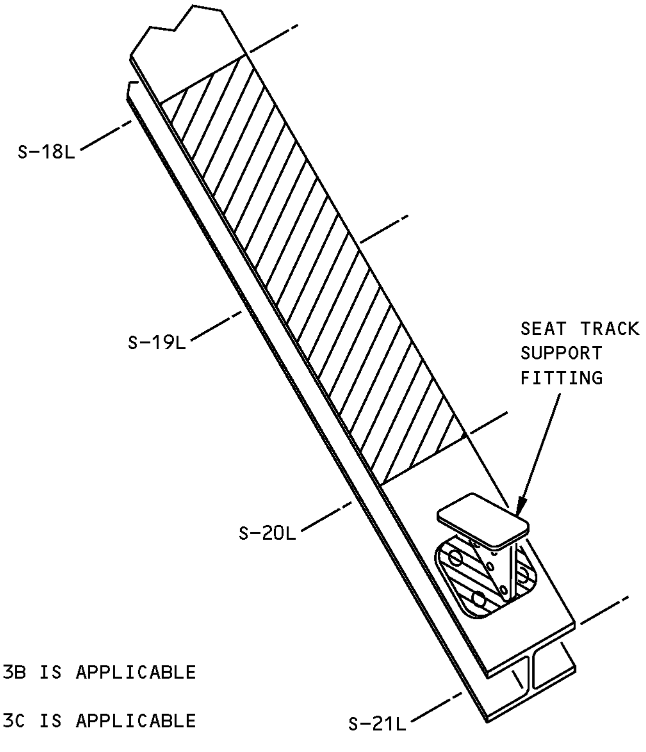


FUSELAGE SECTION 41 - COCKPIT WINDOWS CUTOUT STRUCTURE
DETAIL XIV

Airworthiness Limitation Items
Figure 3 (Sheet 22 of 51)



FUSELAGE REAR SPAR BULKHEAD
DETAIL XV



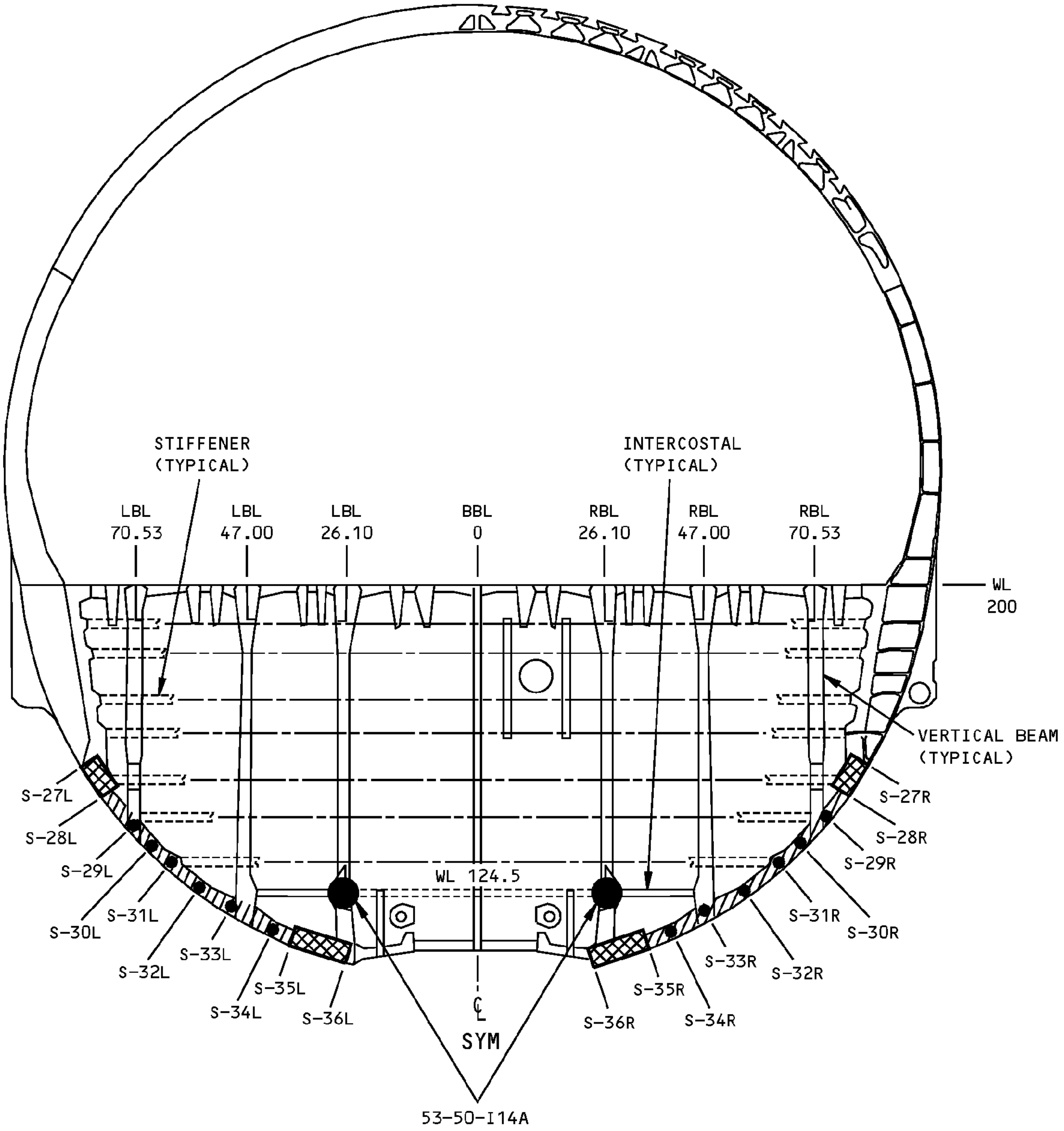
▨ 53-50-I13B IS APPLICABLE

▨ 53-50-I13C IS APPLICABLE

LEFT SIDE IS SHOWN, RIGHT SIDE IS OPPOSITE

53-50-I13B AND 53-50-I13C
DETAIL XVI

Airworthiness Limitation Items
Figure 3 (Sheet 23 of 51)



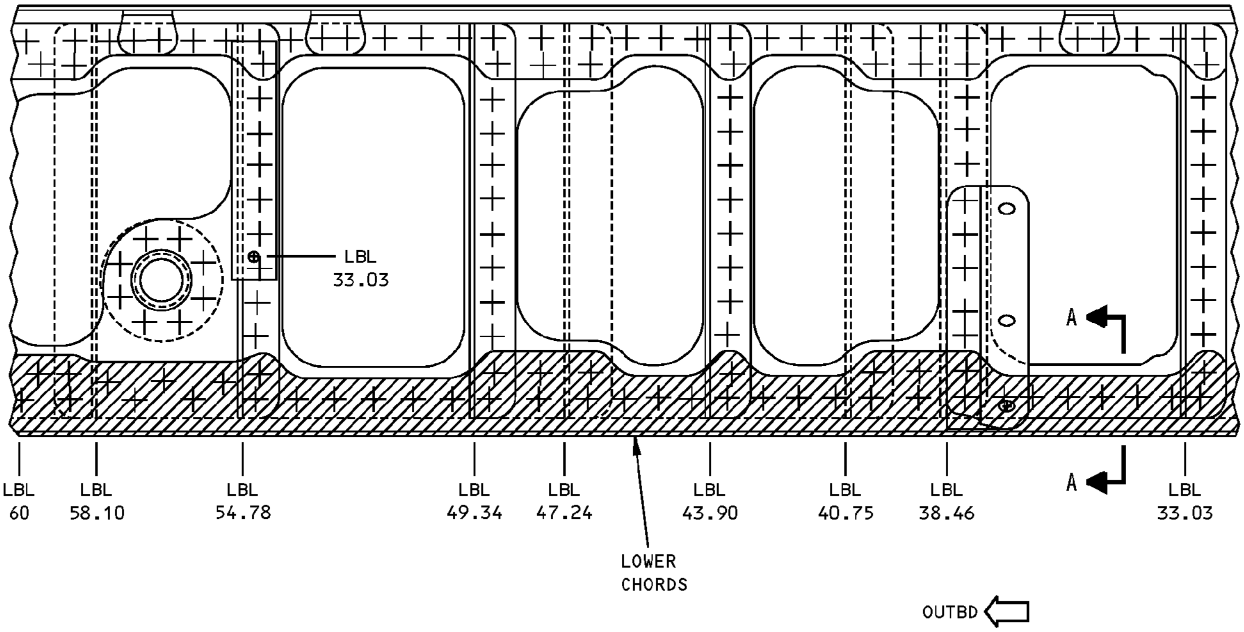
▩ 53-50-I14B IS APPLICABLE

▨ 53-50-I14C IS APPLICABLE

VIEW LOOKING FORWARD

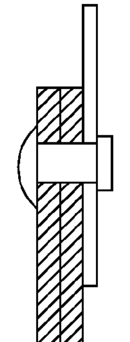
BODY STATION 1065 - AFT WHEEL WELL BULKHEAD
DETAIL XVII

Airworthiness Limitation Items
Figure 3 (Sheet 24 of 51)



LEFT SIDE IS SHOWN, RIGHT SIDE IS OPPOSITE

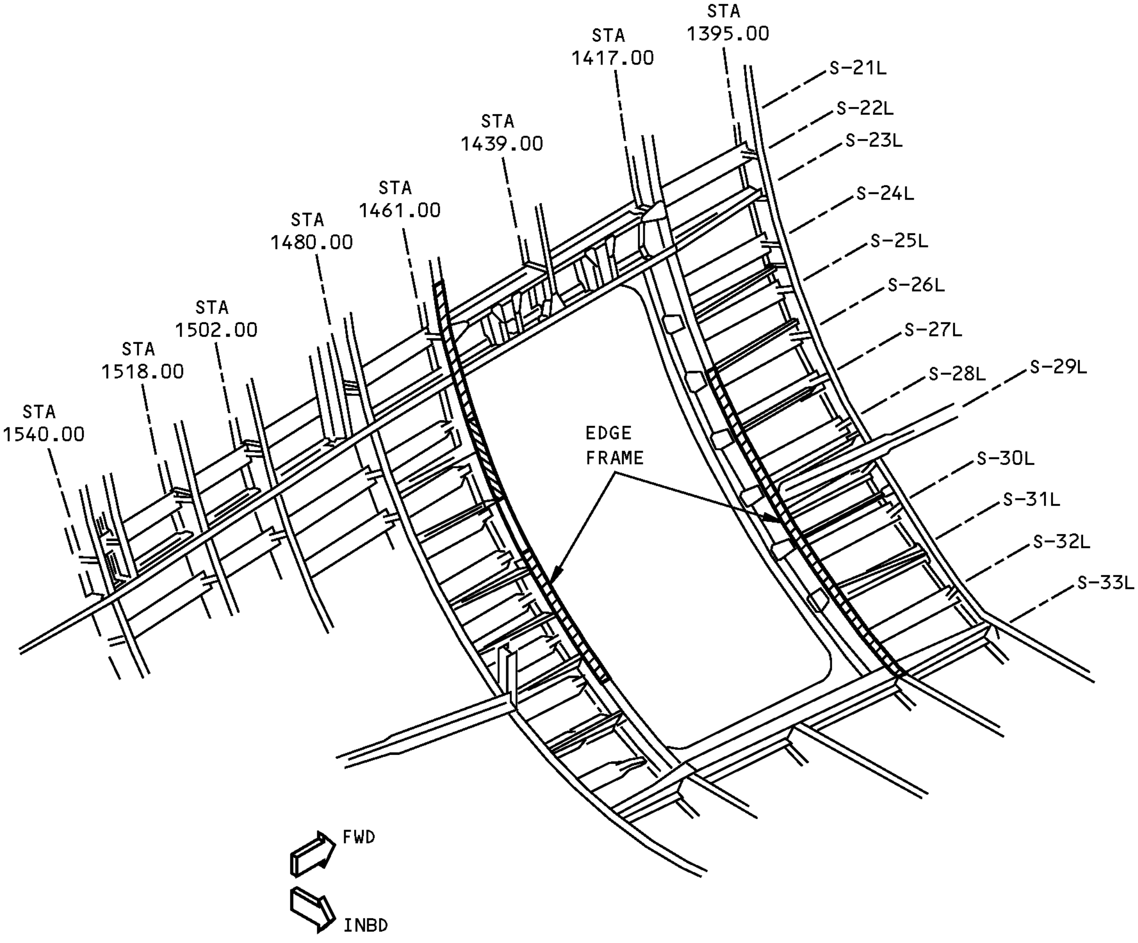
BS 1021 - TRANSVERSE FLOOR BEAM LOWER CHORD
DETAIL XVIII



LOWER CHORD
A-A

▨ 53-50-I19 IS APPLICABLE

Airworthiness Limitation Items
Figure 3 (Sheet 25 of 51)

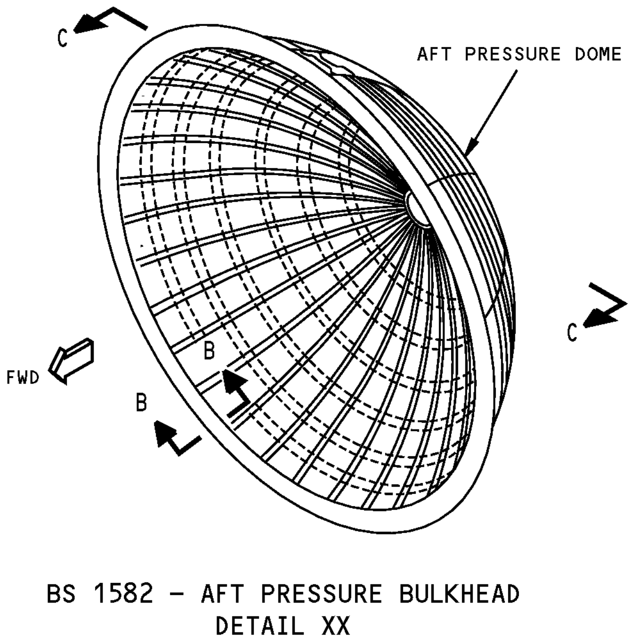


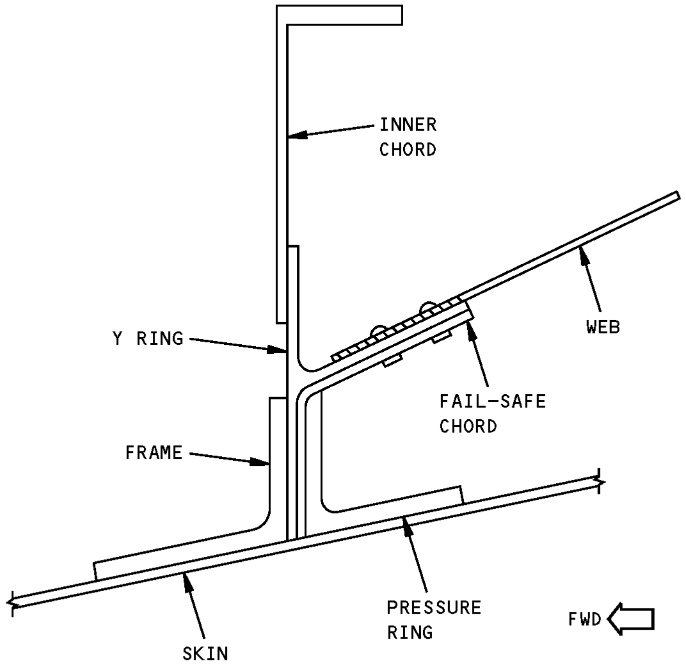
▨ 53-60-I10A IS APPLICABLE

▧ 53-60-I10B IS APPLICABLE

BULK CARGO DOOR CUTOUT
DETAIL XIX

Airworthiness Limitation Items
Figure 3 (Sheet 26 of 51)

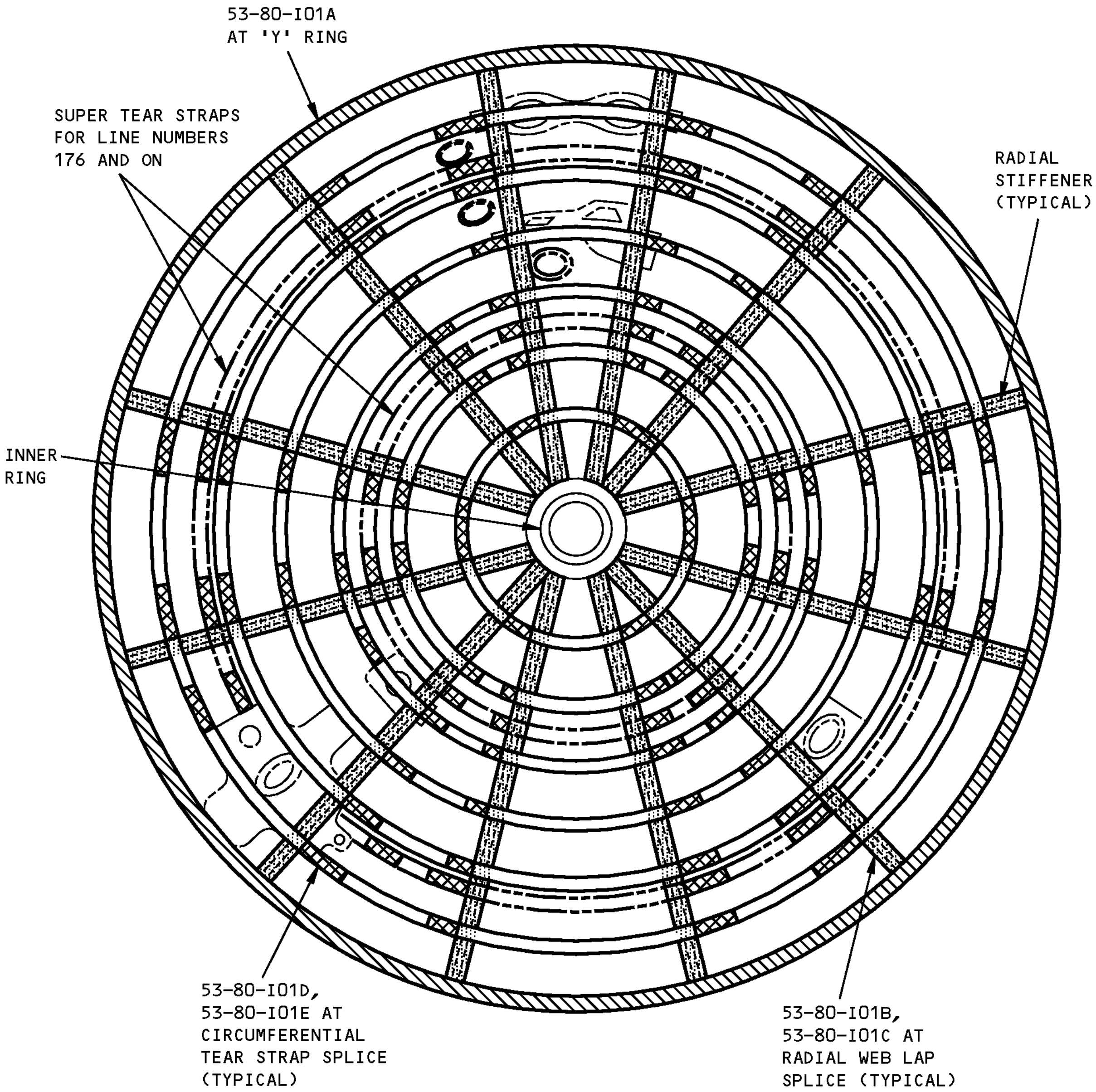




▧ 53-80-I01A IS APPLICABLE

B-B

Airworthiness Limitation Items
Figure 3 (Sheet 27 of 51)



▧ 53-80-I01A IS APPLICABLE

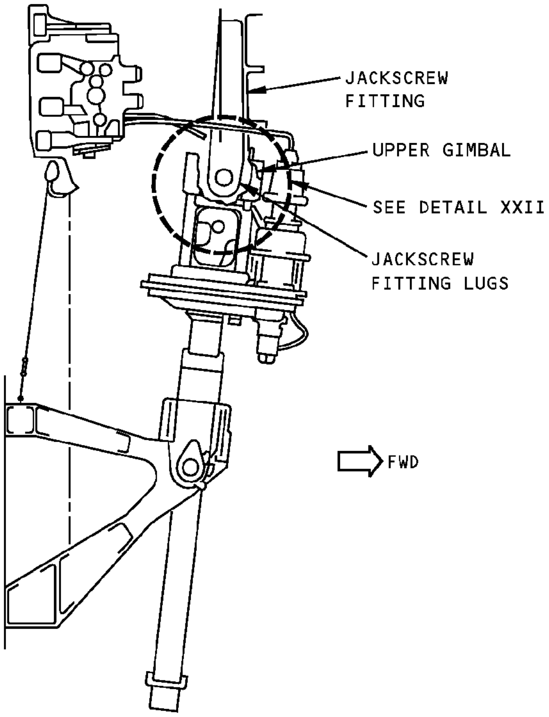
▦ 53-80-I01B AND 53-80-I01C ARE APPLICABLE

▒ 53-80-I01D AND 53-80-I01E ARE APPLICABLE

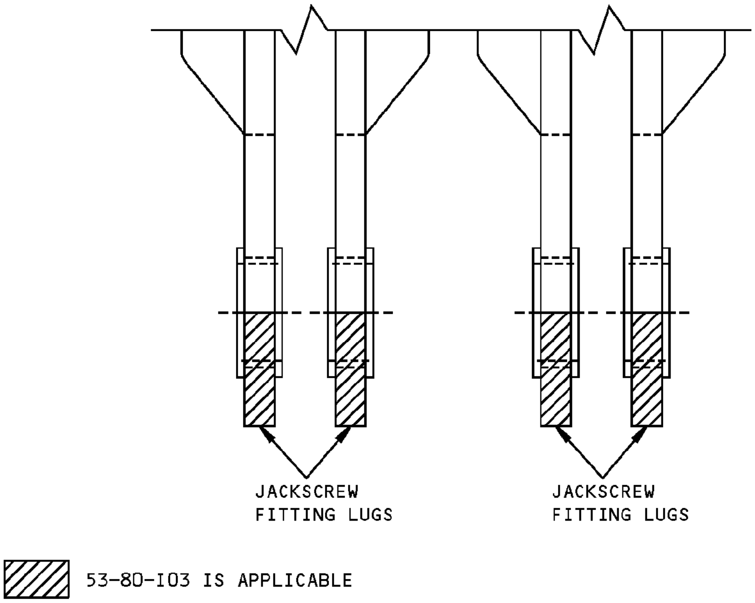
VIEW LOOKING FORWARD
(SHOWN FOR AIRPLANES WITH LINE NUMBERS 1 THRU 175
LINE NUMBERS 176 AND ON HAVE TWO ADDITIONAL SUPER TEAR STRAPS)

C-C

Airworthiness Limitation Items
Figure 3 (Sheet 28 of 51)



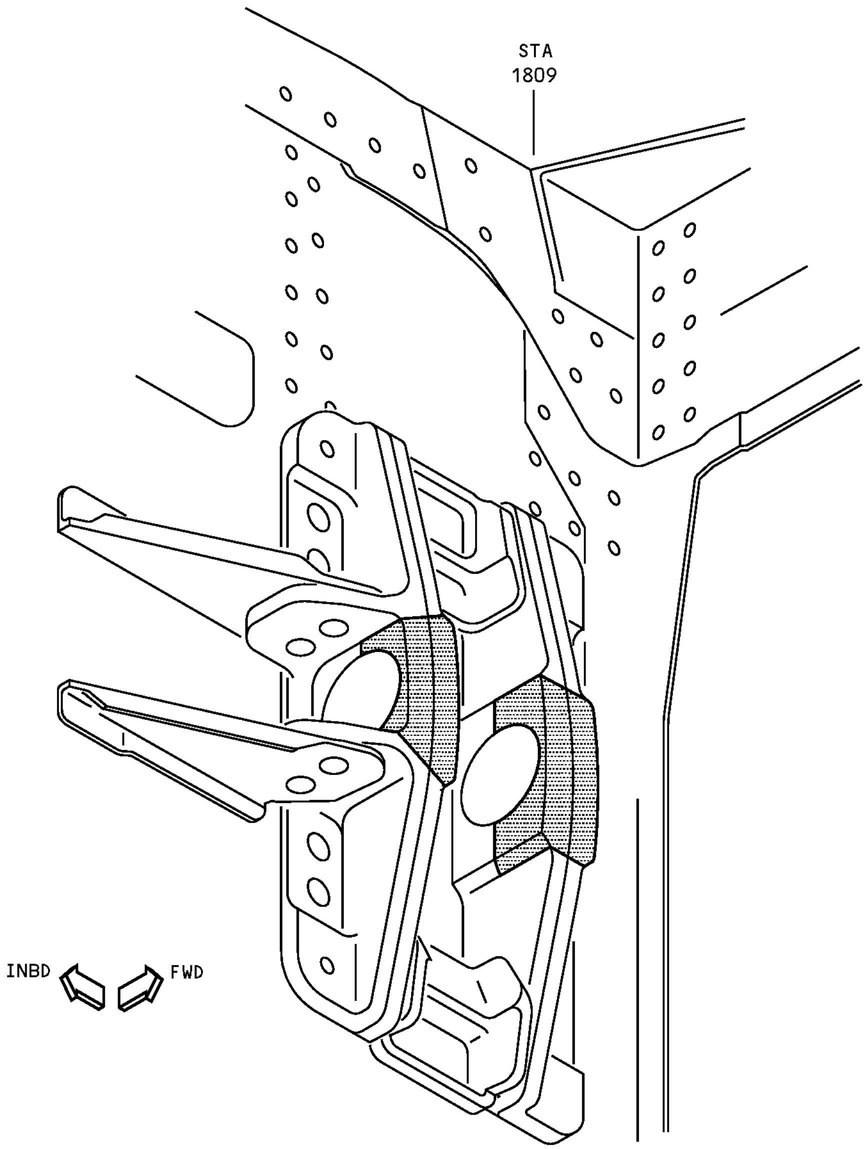
BS 1702 - JACKSCREW FITTING
AT UPPER BULKHEAD
DETAIL XXI



VIEW LOOKING AFT
(JACKSCREW MECHANISM IS NOT SHOWN)

DETAIL XXII

Airworthiness Limitation Items
Figure 3 (Sheet 29 of 51)

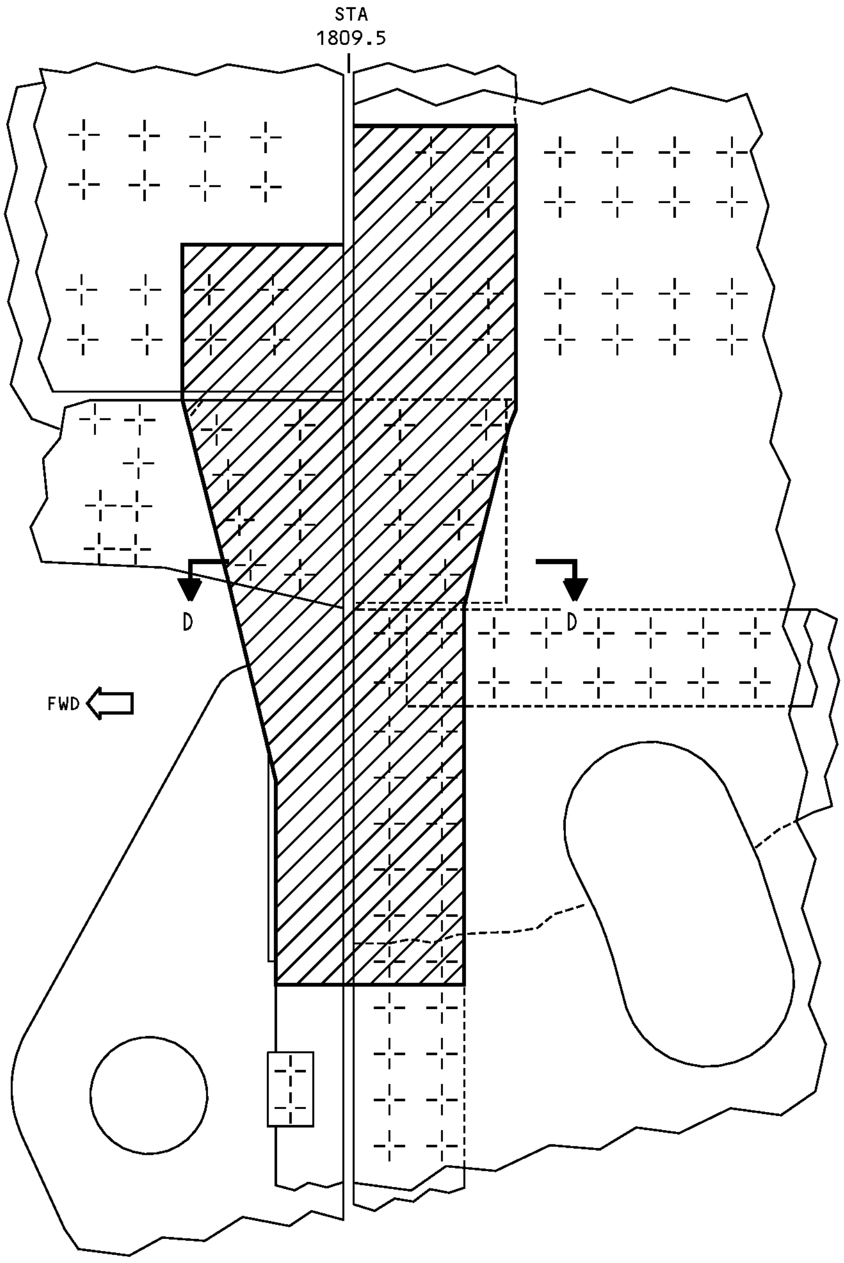


▨ 53-80-I13 IS APPLICABLE

LEFT SIDE IS SHOWN, RIGHT SIDE IS OPPOSITE

BS 1809.5 BULKHEAD - PIVOT FITTING LUGS
DETAIL XXIII

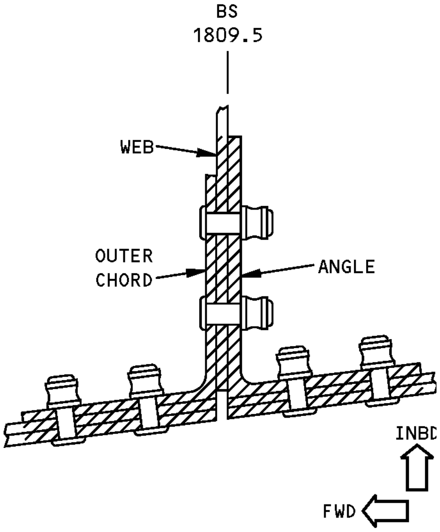
Airworthiness Limitation Items
Figure 3 (Sheet 30 of 51)



▨ 53-80-I15, 53-80-I16 AND 52-80-I17 ARE APPLICABLE

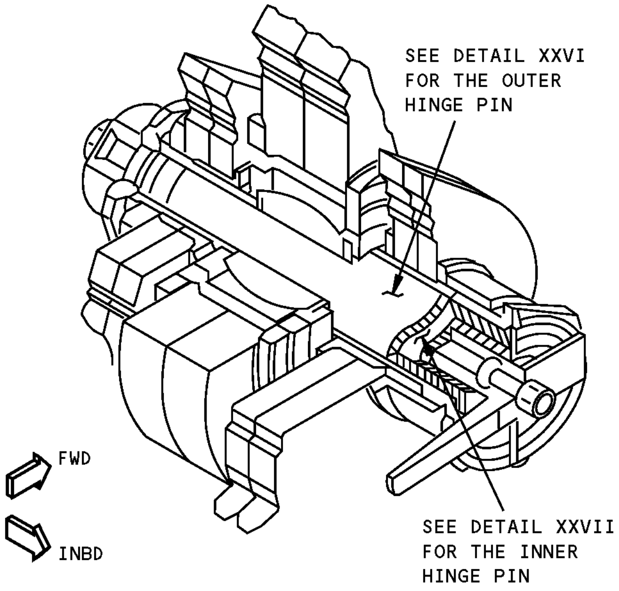
VIEW IS LOOKING FROM OUTSIDE OF THE AIRPLANE

BS 1809.5 - BULKHEAD OUTBOARD CHORD, WL 240 TO WL 260
DETAIL XXIV



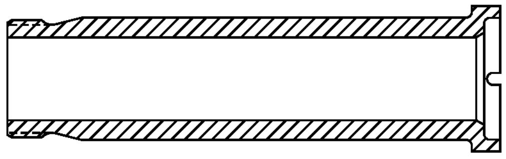
VIEW LOOKING DOWN
D-D

Airworthiness Limitation Items
Figure 3 (Sheet 31 of 51)

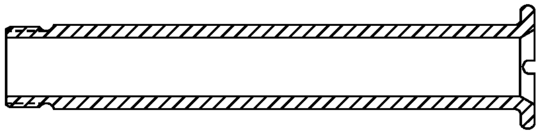


LEFT SIDE IS SHOWN, RIGHT SIDE OPPOSITE

HORIZONTAL STABILIZER FITTING HINGE PINS
DETAIL XXV



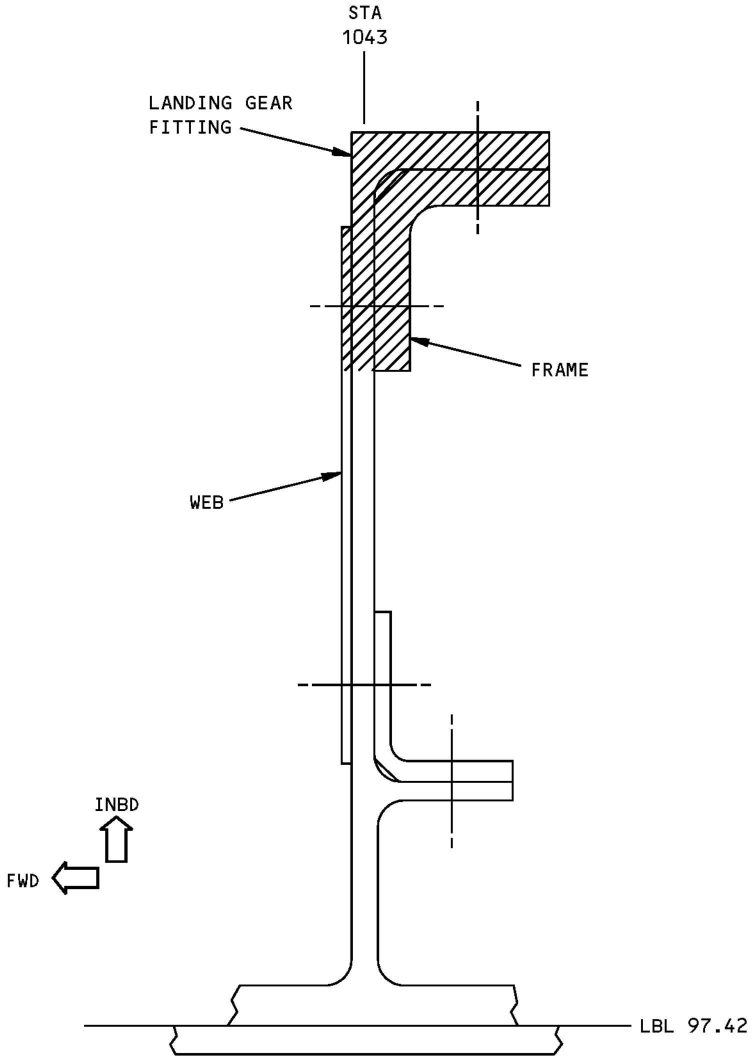
OUTER HINGE PIN
DETAIL XXVI



INNER HINGE PIN
DETAIL XXVII

▨ 53-80-I25 IS APPLICABLE

Airworthiness Limitation Items
Figure 3 (Sheet 32 of 51)



▨ 53-50-I11 IS APPLICABLE

LEFT SIDE IS SHOWN, RIGHT SIDE IS OPPOSITE

BODY STATION 1043 - FRAME SPLICE WITH
LANDING GEAR FITTING
DETAIL XXVIII

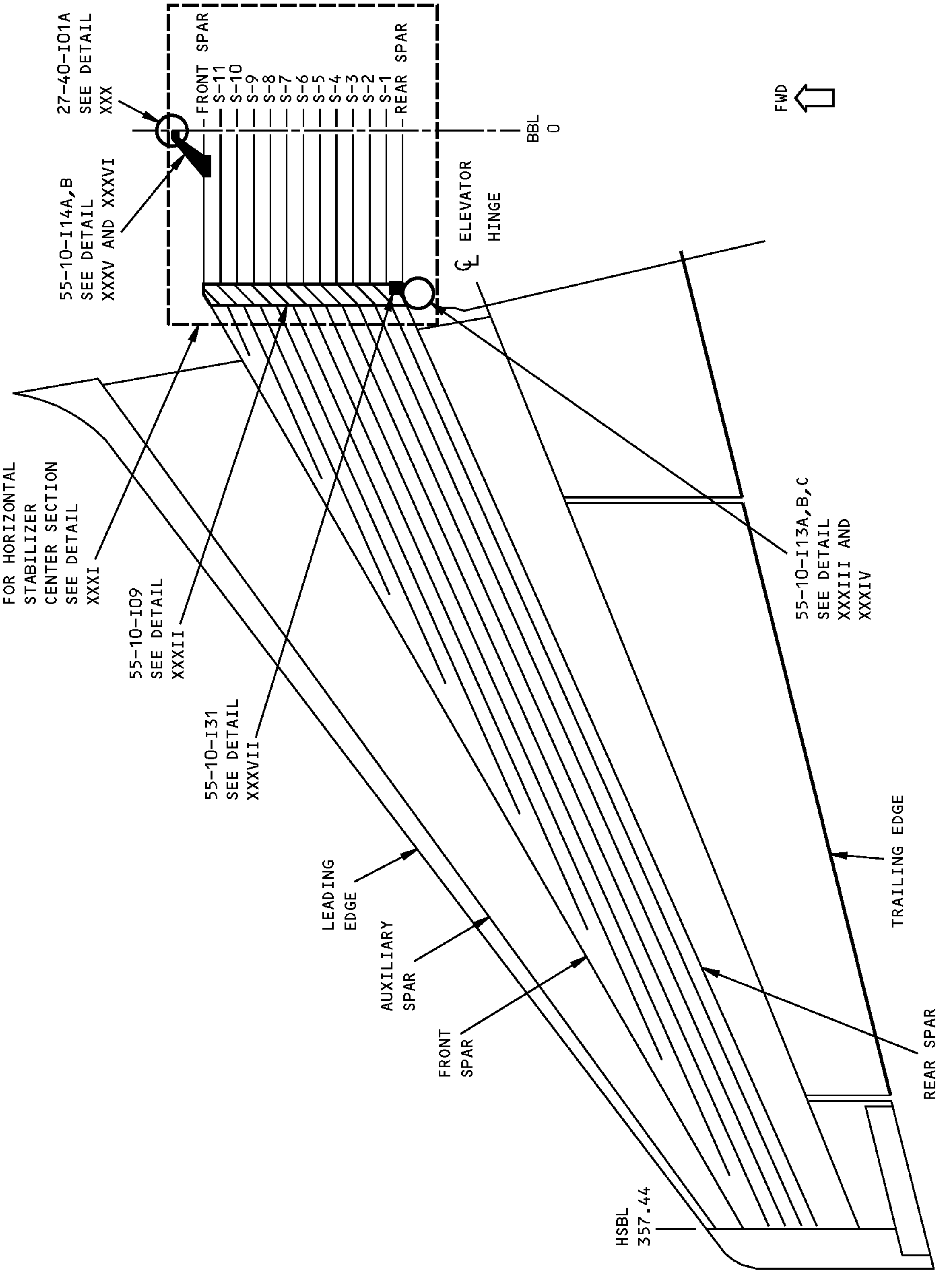
Airworthiness Limitation Items
Figure 3 (Sheet 33 of 51)

SSI NUMBER	TITLE	APPLICABILITY
27-40-I01A	HORIZONTAL STABILIZER TRIM ACTUATOR - LOWER GIMBAL LUG ASSY, BS 1708.5, WL 239.9, LBL 3.7 AND 5.6, AND RBL 3.7 AND 5.6	
55-10-I09	HORIZONTAL STABILIZER UPPER SKIN - AT BBL 41.5 SIDE OF BODY SPLICE	
55-10-I13A	HORIZONTAL STABILIZER PIVOT FITTING LUG	
55-11-I13B	HORIZONTAL STABILIZER PIVOT FITTING UPPER AND LOWER ATTACHMENTS	
55-10-I13C	HORIZONTAL STABILIZER PIVOT FITTING UPPER AND LOWER ATTACHMENTS	
55-10-I14A	HORIZONTAL STABILIZER JACKSCREW FITTING LUG	
55-10-I14B	HORIZONTAL STABILIZER JACKSCREW FITTING UPPER AND LOWER ATTACHMENTS	
55-10-I31	HORIZONTAL STABILIZER REAR SPAR UPPER CHORD AT SIDE-OF-BODY HIDDEN AREA	

EMPENNAGE STRUCTURE A
TABLE VII

M18102 S0006820503_V2

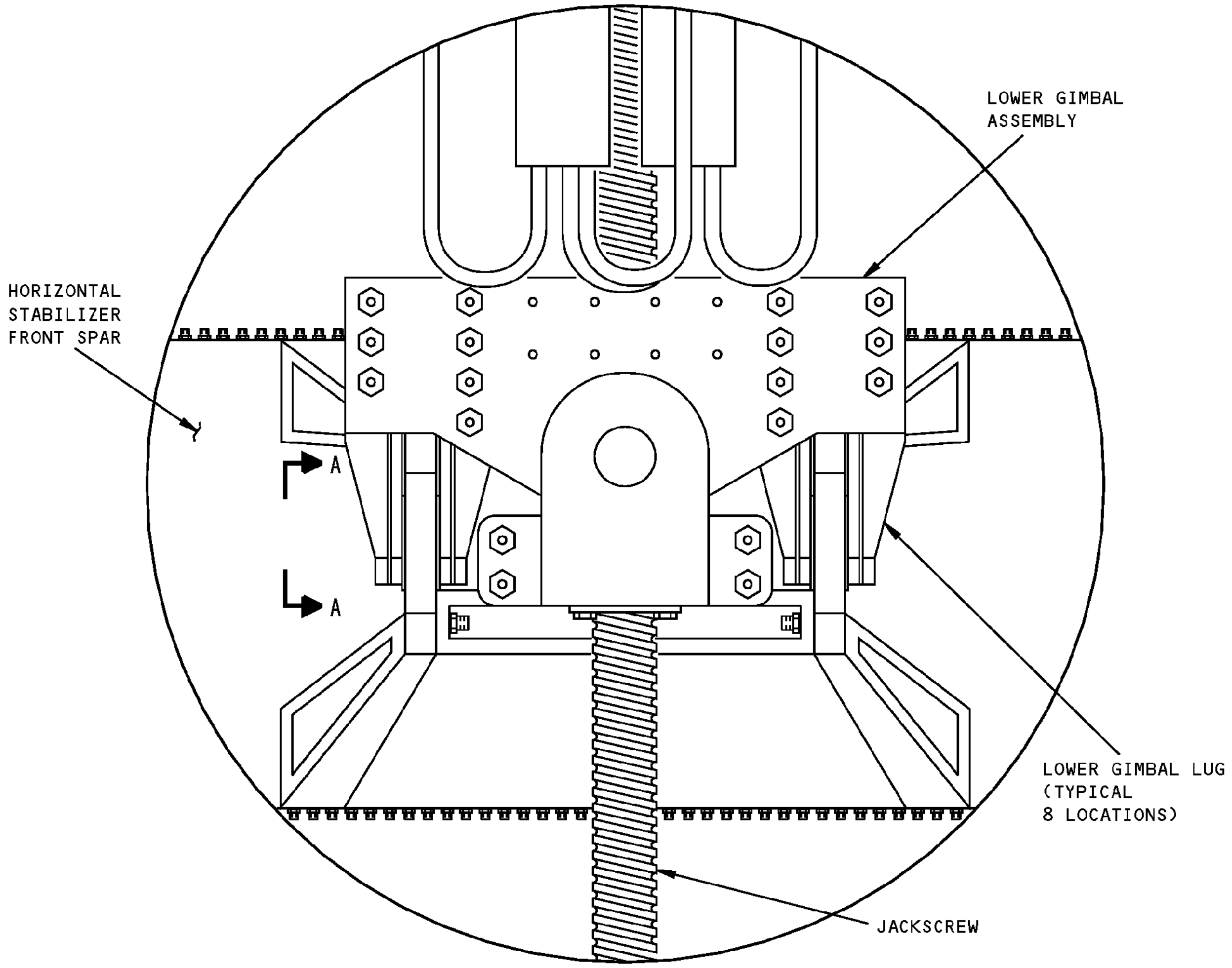
Airworthiness Limitation Items
Figure 3 (Sheet 34 of 51)



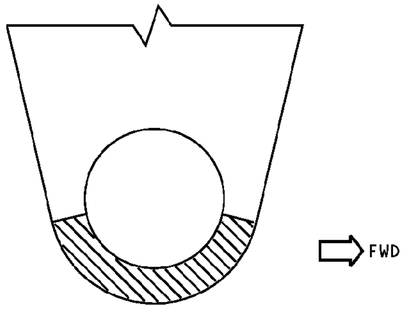
LEFT SIDE IS SHOWN, RIGHT SIDE IS OPPOSITE

EMPENNAGE STRUCTURE
DETAIL XXIX

Airworthiness Limitation Items
Figure 3 (Sheet 35 of 51)



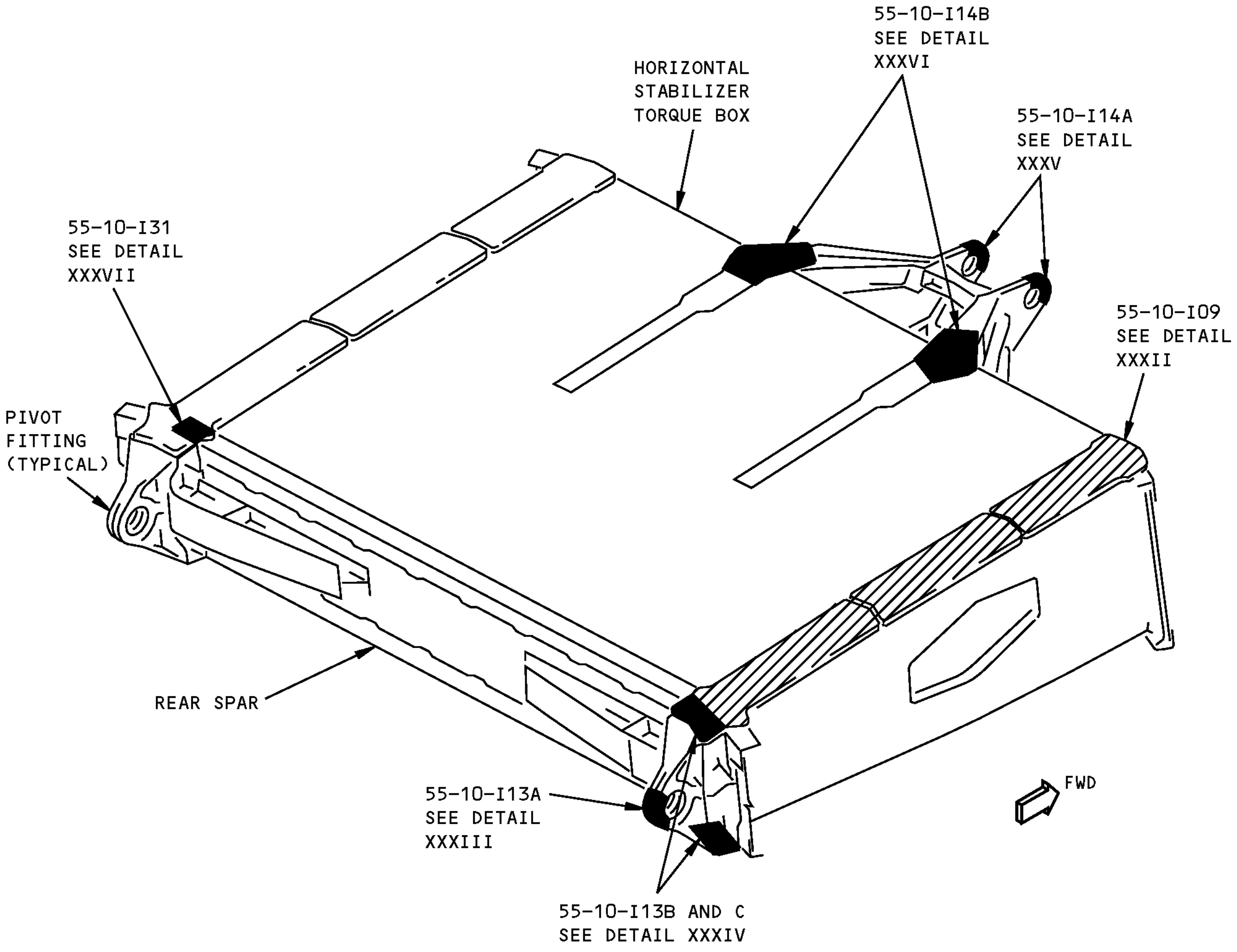
VIEW AS YOU LOOK AFT
HORIZONTAL STABILIZER TRIM ACTUATOR - LOWER GIMBAL ASSEMBLY
DETAIL XXX



▨ 27-40-101A IS APPLICABLE

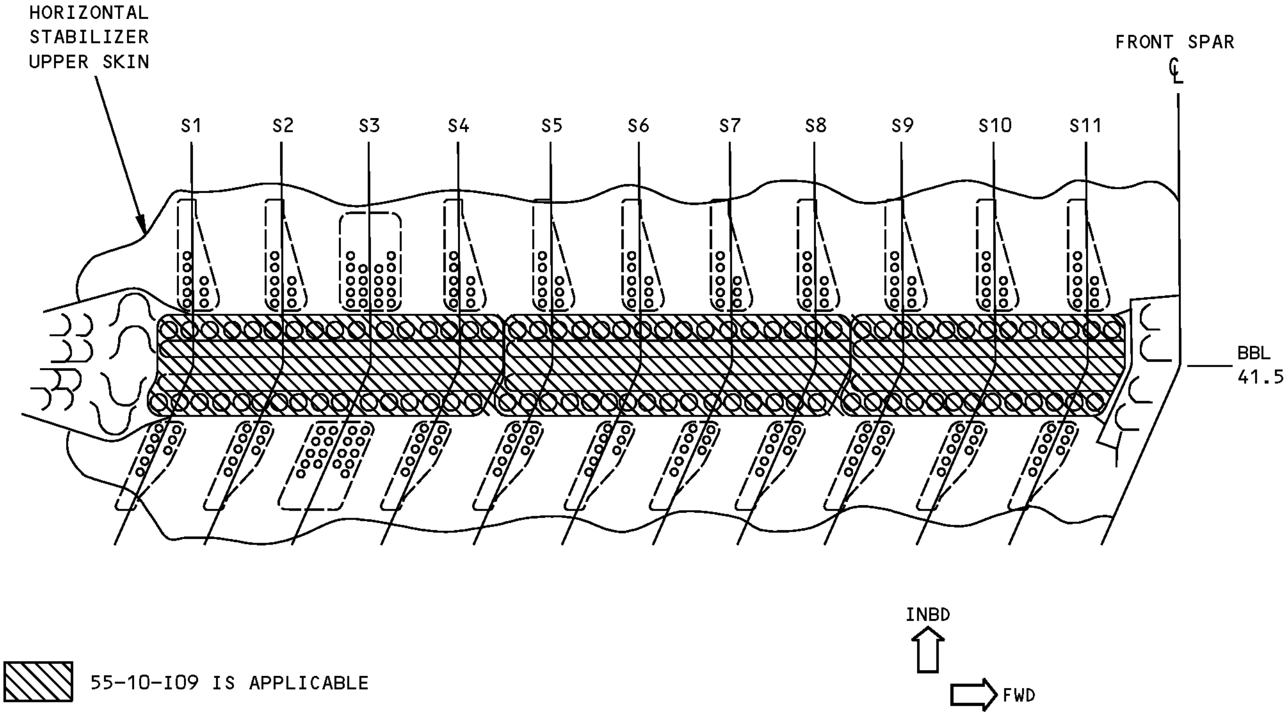
A-A

Airworthiness Limitation Items
Figure 3 (Sheet 36 of 51)



HORIZONTAL STABILIZER CENTER SECTION
DETAIL XXXI

Airworthiness Limitation Items
Figure 3 (Sheet 37 of 51)

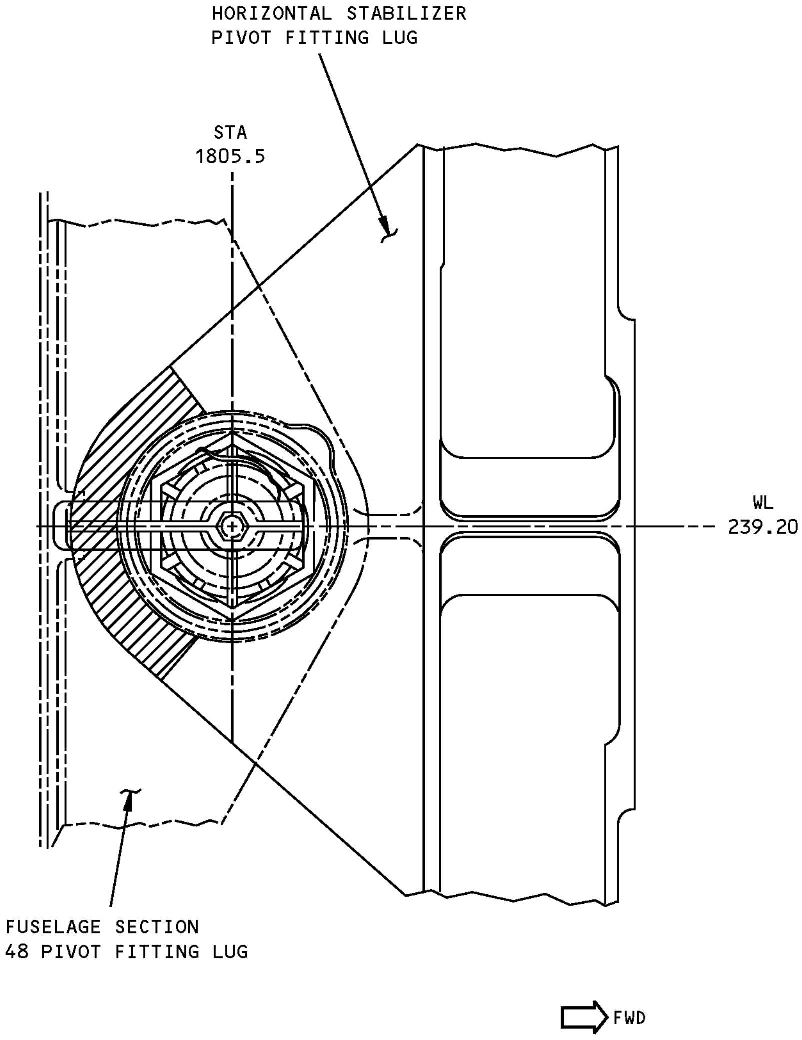


▨ 55-10-I09 IS APPLICABLE

RIGHT SIDE IS SHOWN, LEFT SIDE IS OPPOSITE

HORIZONTAL STABILIZER - BBL 41.5 SIDE-OF-BODY SPLICE
DETAIL XXXII

Airworthiness Limitation Items
Figure 3 (Sheet 38 of 51)

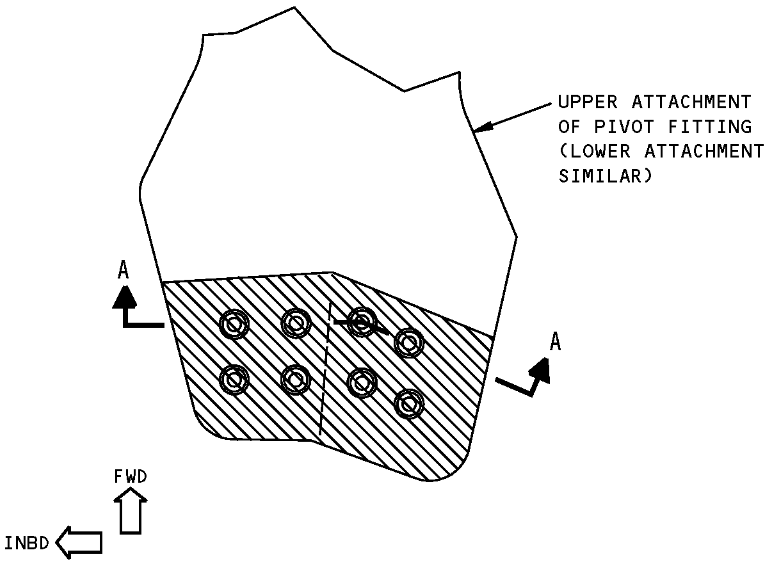


▨ 55-10-I13A IS APPLICABLE

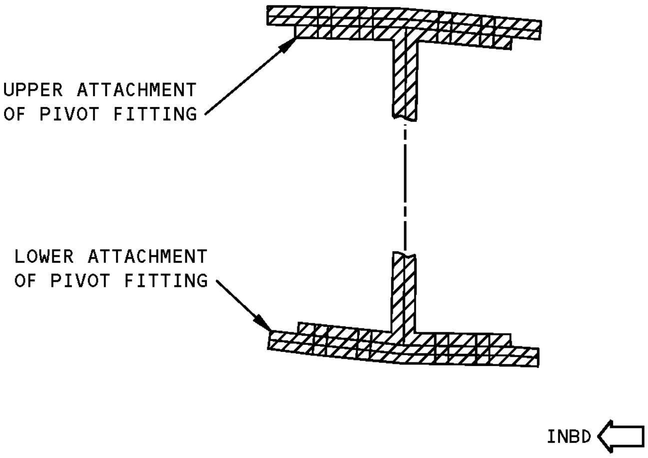
RIGHT SIDE IS SHOWN, LEFT SIDE IS OPPOSITE

HORIZONTAL STABILIZER - PIVOT FITTING LUG
DETAIL XXXIII

Airworthiness Limitation Items
Figure 3 (Sheet 39 of 51)



HORIZONTAL STABILIZER - PIVOT FITTINGS
DETAIL XXXIV

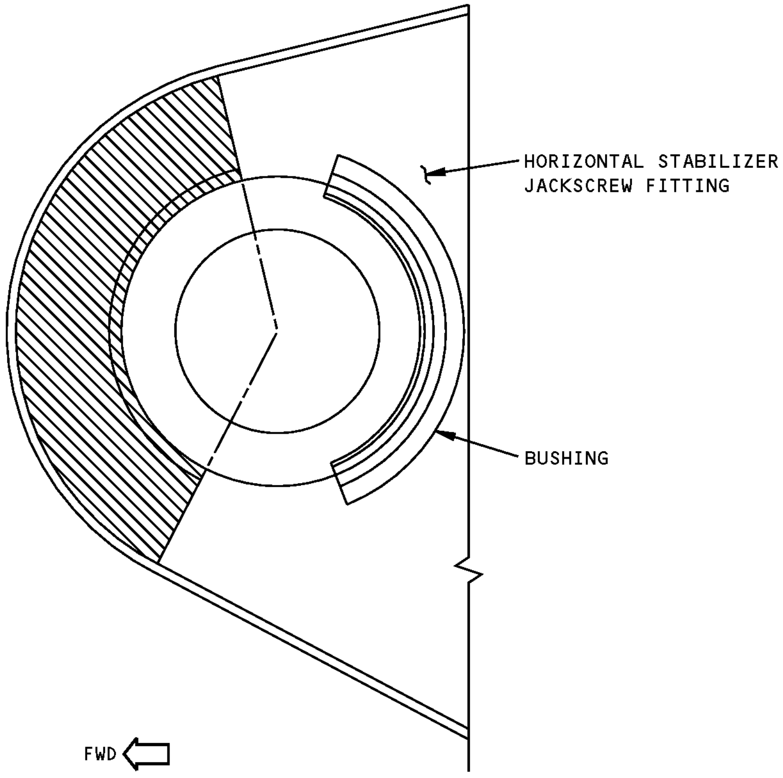


RIGHT SIDE SHOWN, LEFT SIDE OPPOSITE

A-A

▨ 55-10-I13B AND C ARE APPLICABLE

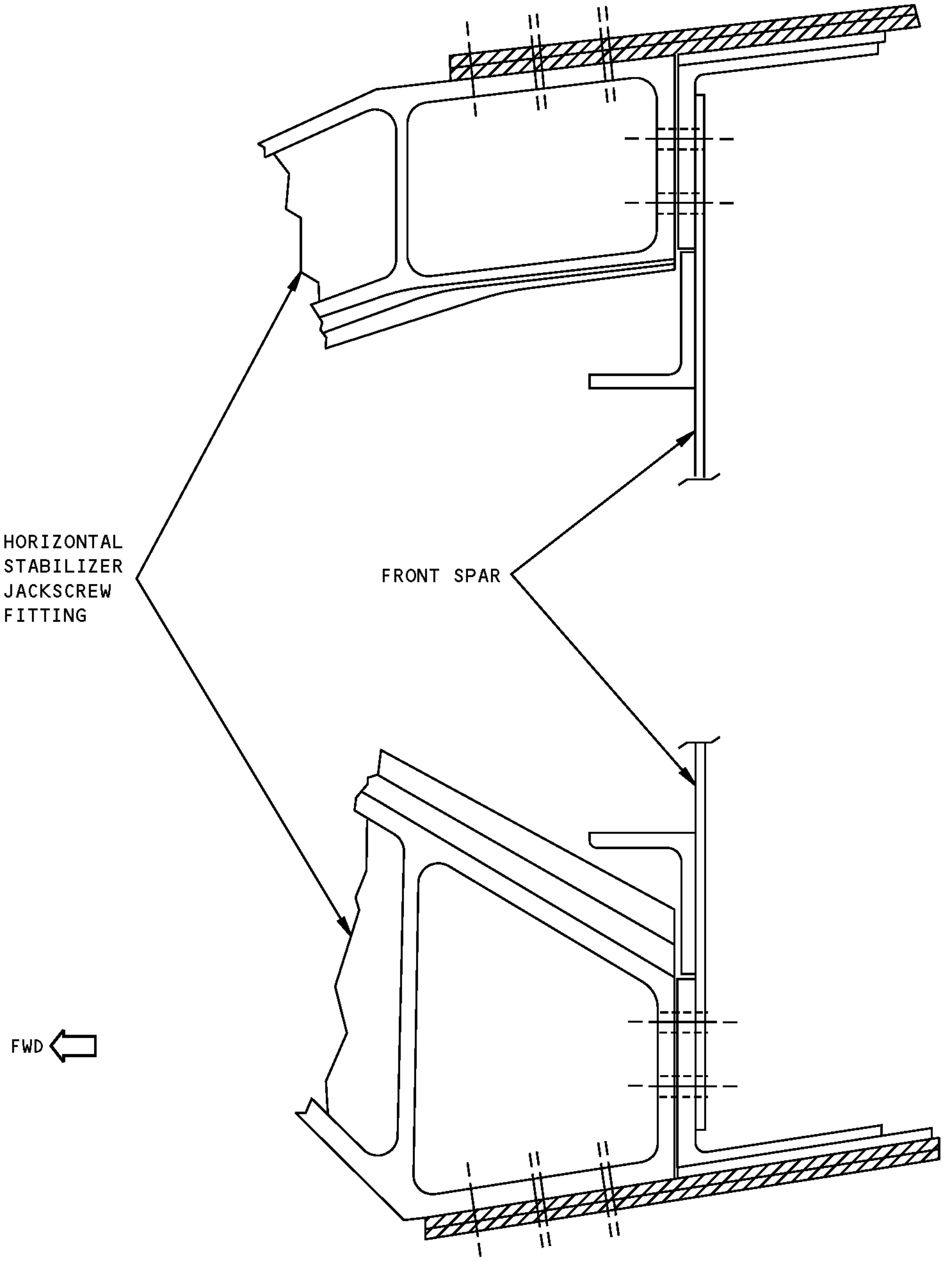
Airworthiness Limitation Items
Figure 3 (Sheet 40 of 51)



▨ 55-10-I14A IS APPLICABLE

HORIZONTAL STABILIZER JACKSCREW FITTING LUG
(TYPICAL 4 LOCATIONS)
DETAIL XXXV

Airworthiness Limitation Items
Figure 3 (Sheet 41 of 51)

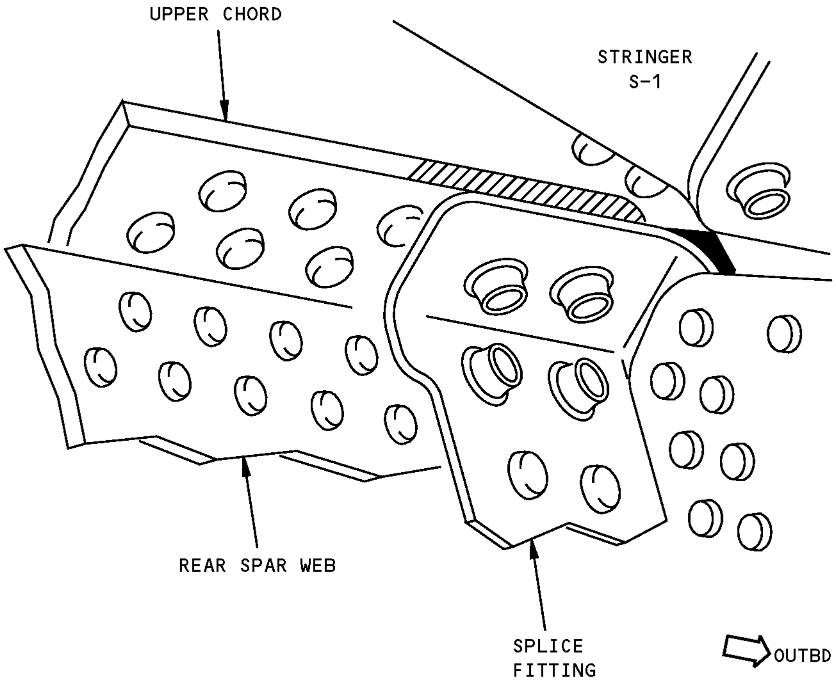


▨ 55-10-I14B IS APPLICABLE

LEFT SIDE IS SHOWN, RIGHT SIDE IS OPPOSITE

HORIZONTAL STABILIZER JACKSCREW FITTING - UPPER AND LOWER ATTACHMENTS
DETAIL XXXVI

Airworthiness Limitation Items
Figure 3 (Sheet 42 of 51)



▨ 55-10-I31 IS APPLICABLE

LEFT SIDE IS SHOWN, RIGHT SIDE IS OPPOSITE

HORIZONTAL STABILIZER REAR SPAR UPPER CHORD
DETAIL XXXVII

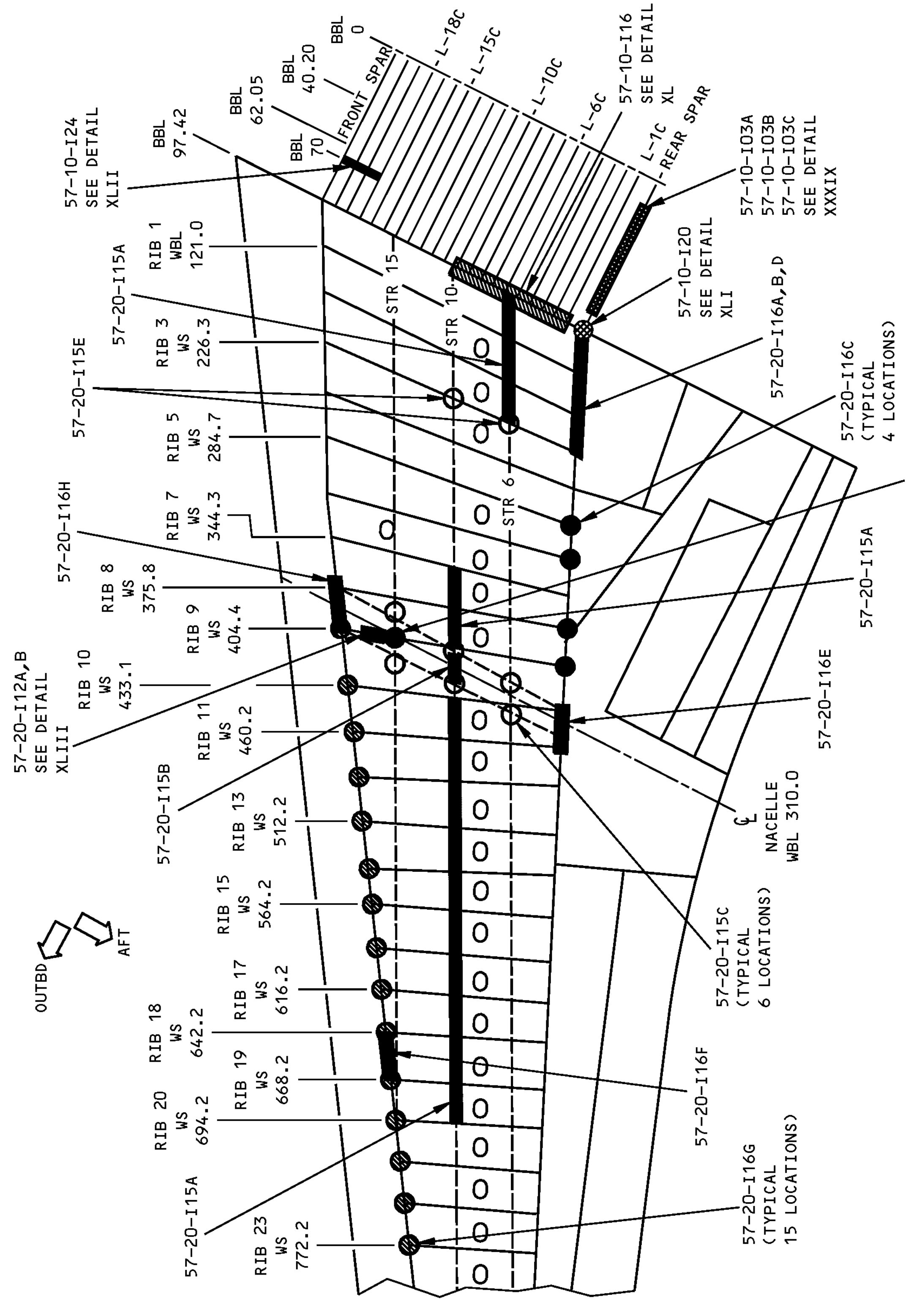
Airworthiness Limitation Items
Figure 3 (Sheet 43 of 51)

SSI NUMBER	TITLE	APPLICABILITY
57-10-I03A	REAR SPAR LOWER CHORD AND SKIN - WING CENTER SECTION TYPICAL FROM BBL 23.0 TO BBL 86.5	H
57-10-I03B	REAR SPAR LOWER CHORD AND SKIN - WING CENTER SECTION HIDEN LOCATION AT BBL 49.5, 62.05 AND 73.0	H
57-10-I03C	REAR SPAR LOWER CHORD AND SKIN - WING CENTER SECTION HIDEN LOCATION AT BBL 49.5, 62.05 AND 73.0	H
57-10-I16	LOWER SURFACE SIDE-OF-BODY SPLICE (SECTION 11 AND 12) - L-1 TO L-10 INBOARD AND OUTBOARD OF BBL 97.42	
57-10-I20	REAR SPAR LOWER CHORD SIDE-OF-BODY SPLICE (SECTION 11 AND 12) - CHORDS AT SPLICE FITTINGS INBOARD AND OUTBOARD OF BBL 97.42	
57-20-I24	UNDERWING LONGERON ATTACHMENT (CENTER SECTION STRUCTURE) - BBL 70 LONGERRON FROM FRONT SPAR LOWER CHORD TO STRINGER 18	H
57-20-I12A	OUTBOARD TYPICAL STRINGERS LOWER SURFACE - RIB 9, L-16 (DRY BAY) UNDER NACELLE FAIRING	
57-20-I12B	OUTBOARD TYPICAL STRINGERS LOWER SURFACE - RIB 9, L-17 AT OUTBOARD SIDE LOAD FITTING UNDER NACELLE FAIRING	
57-20-I15A	OUTBOARD WING LOWER SURFACE SPLICE STRINGER - L-6 FROM SIDE-OF-BODY TO RIB 3, L-10 BETWEEN RIB 7 AND 20 (EXCEPT UNDER NACELLE STRUT FAIRING)	
57-20-I15B	OUTBOARD WING LOWER SURFACE SPLICE STRINGER - L-10 UNDER NACELLE FAIRING	
57-20-I15C	OUTBOARD WING LOWER SURFACE SPLICE STRINGER - L-6, L-10, AND L-15 UNDER NACELLE STRUT AT EXTERNAL DOUBLERS, FITTINGS, AND ANGLES	
57-20-I15D	OUTBOARD WING LOWER SURFACE SPLICE STRINGER - L-15 UNDER NACELLE STRUT AT RIB 9 (SEAL PANS)	
57-20-I15E	OUTBOARD WING LOWER SURFACE SPLICE STRINGER - L-6 AND L-10 AT RIB 3	
57-20-I16A	REAR SPAR LOWER CHORD AND SKIN (OUTBOARD WING STRUCTURE) - TYPICAL DETAILS BETWEEN FAIRING AT SIDE-OF-BODY AND RIB 3	
57-20-I16B	REAR SPAR LOWER CHORD AND SKIN (OUTBOARD WING STRUCTURE) - DETAILS HIDDEN BY RIB SHEAR TIES SIDE-OF-BODY TO RIB 3	
57-20-I16C	REAR SPAR LOWER CHORD AND SKIN (OUTBOARD WING STRUCTURE) - HIDDEN DETAILS AT RIBS 5, 6, 8, AND 9 (NOT COVERED BY FAIRINGS)	
57-20-I16D	REAR SPAR LOWER CHORD AND SKIN (OUTBOARD WING STRUCTURE) - DETAILS OUTBOARD OF TERMINAL FITTING WING-TO-BODY FAIRING AREA	
57-20-I16E	REAR SPAR LOWER CHORD AND SKIN (OUTBOARD WING STRUCTURE) - HIDDEN DETAILS - TRUNNION, NACELLE, AND INBOARD FLAP FAIRING AREAS	

WING STRUCTURE A
TABLE VIII

M18765 S0006820543_V2

Airworthiness Limitation Items
Figure 3 (Sheet 44 of 51)



LEFT SIDE IS SHOWN, RIGHT SIDE IS OPPOSITE
WING STRUCTURE - LOWER SURFACE
DETAIL XXXVIII

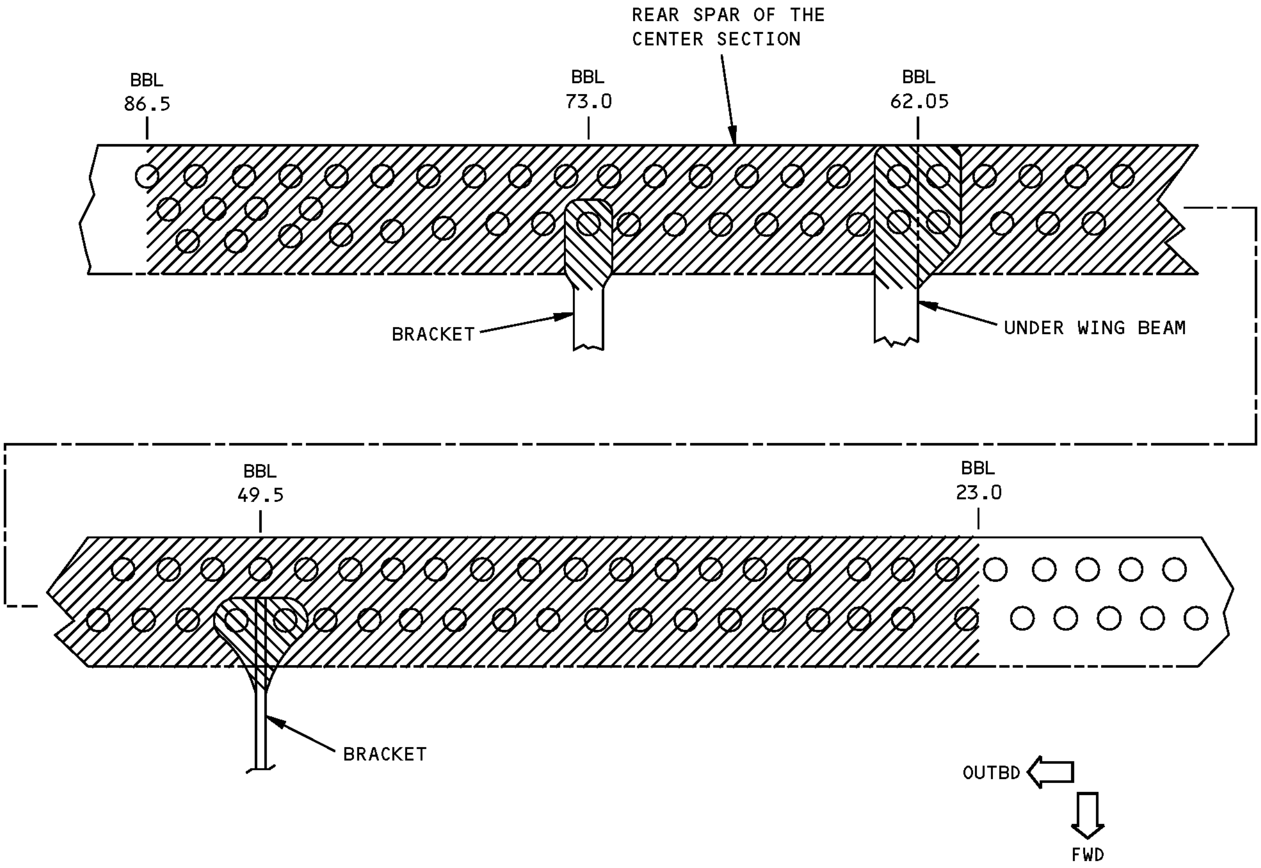
Airworthiness Limitation Items
Figure 3 (Sheet 45 of 51)

SSI NUMBER	TITLE	APPLICABILITY
57-20-I16F	FRONT SPAR LOWER CHORD AND SKIN (OUTBOARD WING STRUCTURE) - LOWER SKIN PANEL SPLICE LOCATION BETWEEN RIBS 18 AND 19 ONLY	
57-20-I16G	FRONT SPAR LOWER CHORD AND SKIN (OUTBOARD WING STRUCTURE) - DETAILS HIDDEN BY RIB SHEAR TIES RIB 9 TO AND INCLUDING RIB 23	
57-20-I16H	FRONT SPAR LOWER CHORD AND SKIN (OUTBOARD WING STRUCTURE) - HIDDEN DETAILS - RIBS 8, 9 AND AT SIDE BRACE FITTING BETWEEN RIBS 8 AND 9	

WING STRUCTURE A
TABLE VIII

1493582 S0000257451_V1

Airworthiness Limitation Items
Figure 3 (Sheet 46 of 51)



▨ 57-10-I03A IS APPLICABLE

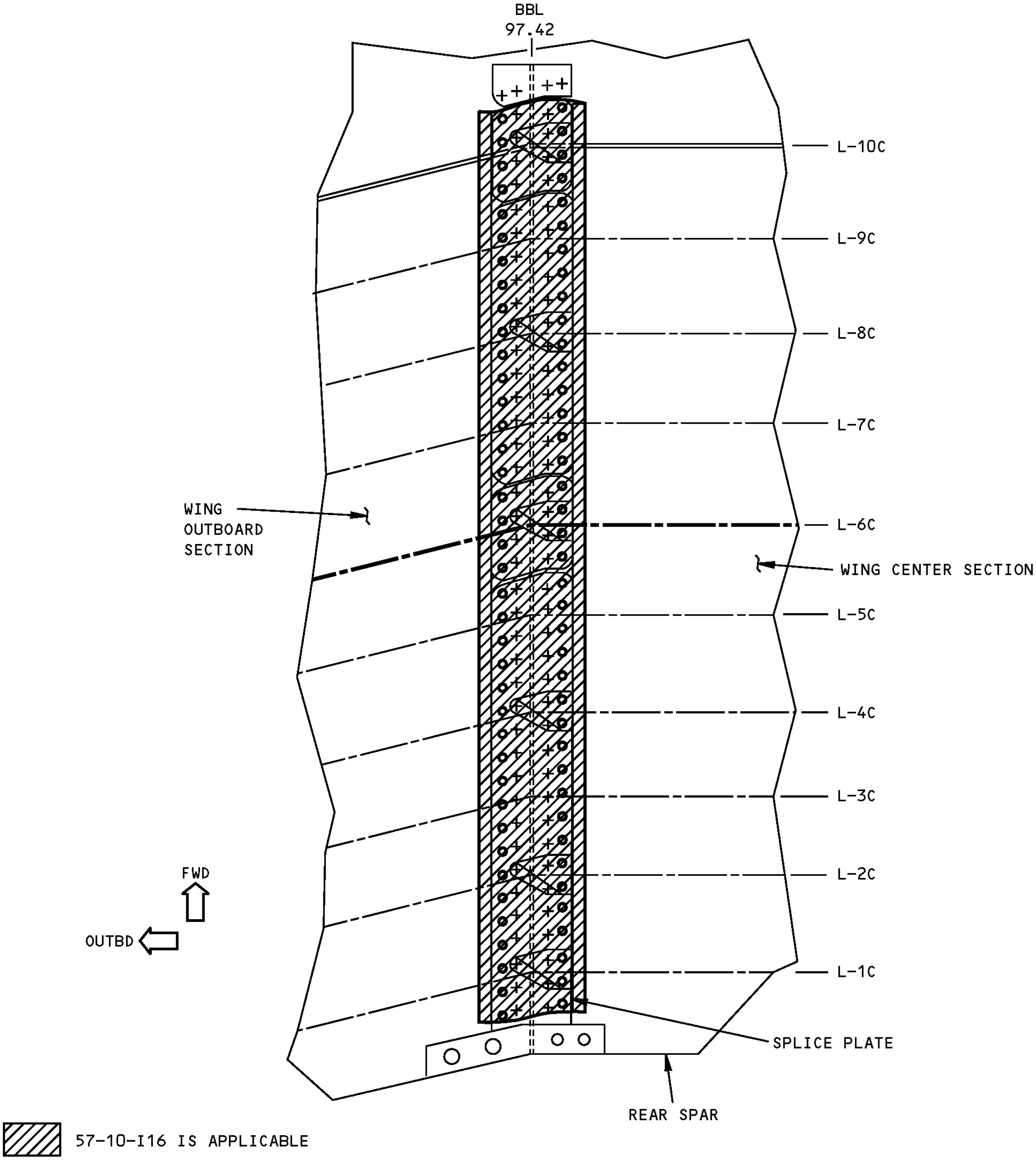
▧ 57-10-I03B AND C ARE APPLICABLE

VIEW AS YOU LOOK UP

LEFT SIDE IS SHOWN, RIGHT SIDE IS OPPOSITE

WING CENTER SECTION - REAR SPAR LOWER CHORD AND SKIN
DETAIL XXXIX

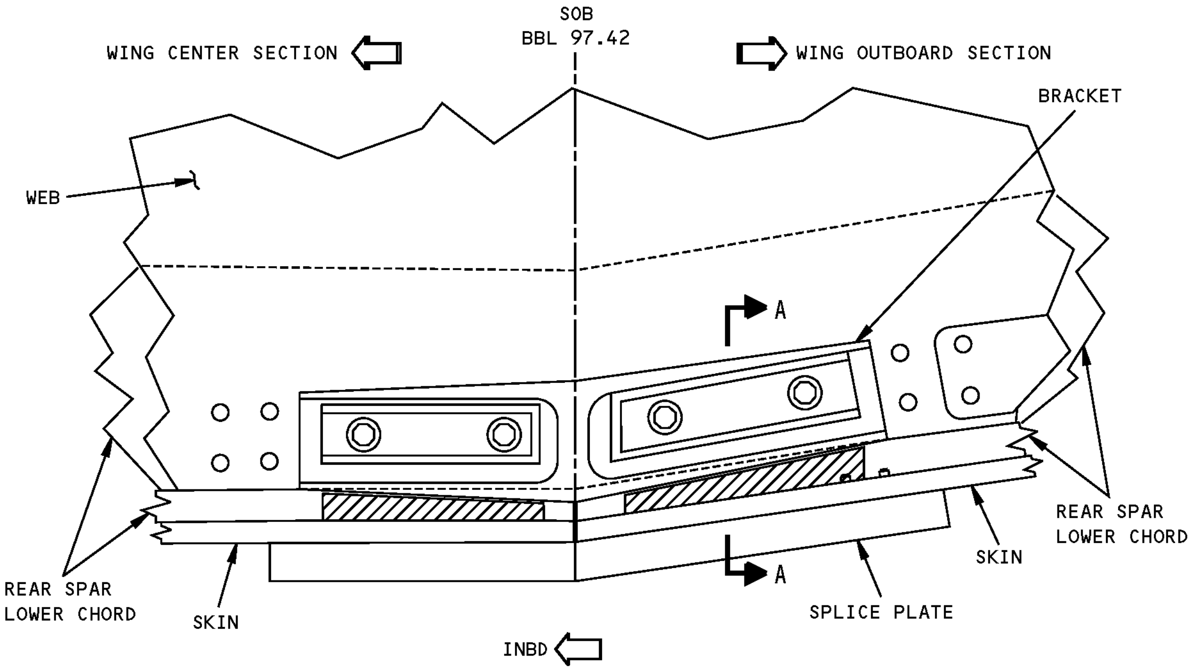
Airworthiness Limitation Items
Figure 3 (Sheet 47 of 51)



VIEW AS YOU LOOK UP
RIGHT SIDE IS SHOWN, LEFT SIDE IS OPPOSITE

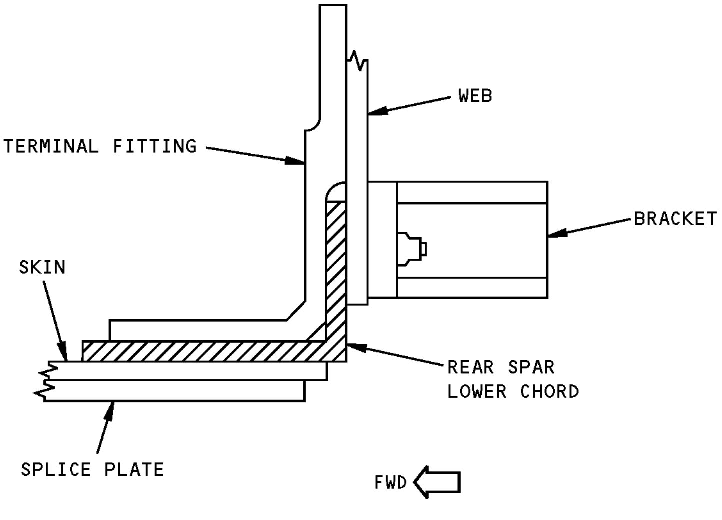
WING CENTER SECTION - LOWER SIDE-OF-BODY SPLICE
DETAIL XL

Airworthiness Limitation Items
Figure 3 (Sheet 48 of 51)



RIGHT SIDE IS SHOWN, LEFT SIDE IS OPPOSITE

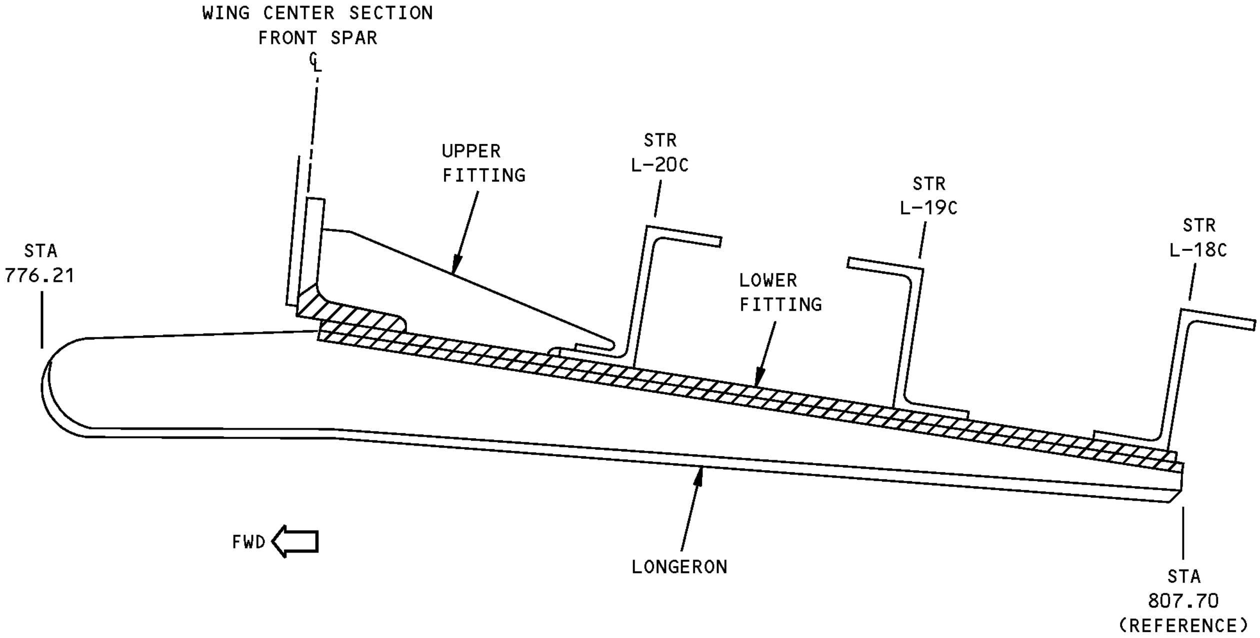
WING CENTER SECTION - REAR SPAR LOWER CHORD SIDE-OF-BODY SPLICE
DETAIL XLI



A-A

▨ 57-10-120 IS APPLICABLE

Airworthiness Limitation Items
Figure 3 (Sheet 49 of 51)

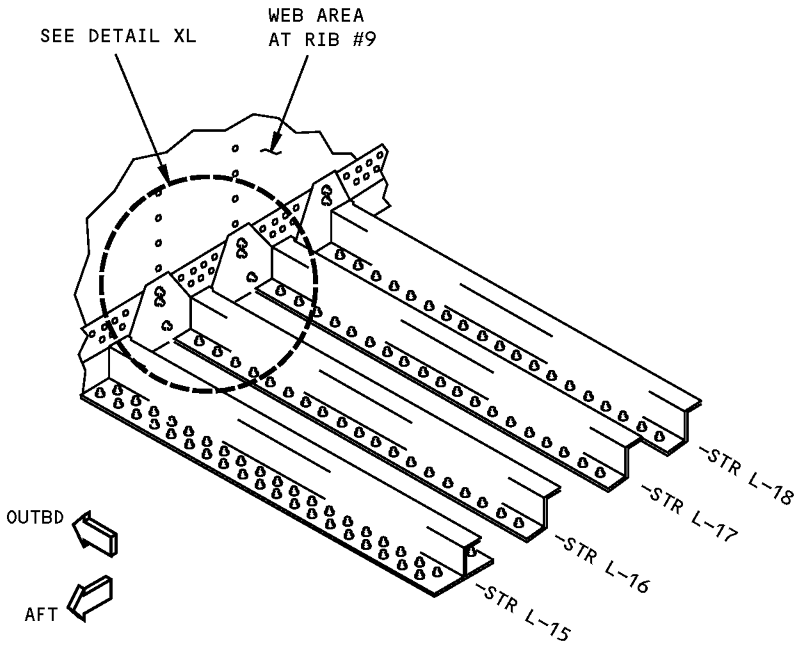


▨ 57-10-I24 IS APPLICABLE

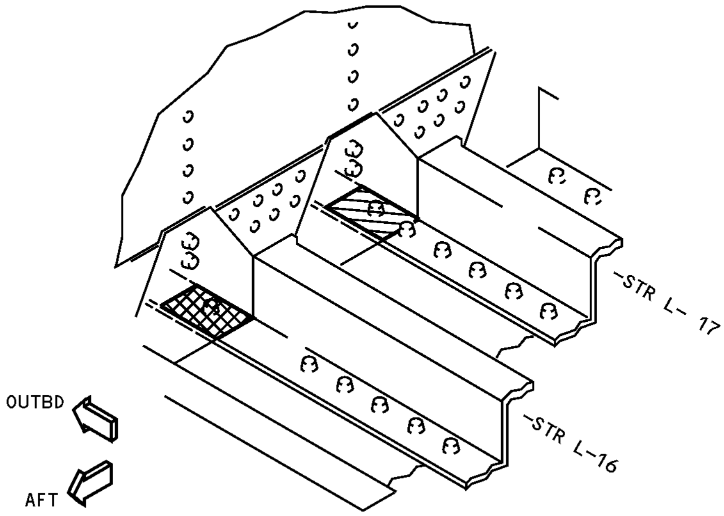
LEFT SIDE IS SHOWN, RIGHT SIDE IS OPPOSITE

WING CENTER SECTION - UNDERWING LONGERON
DETAIL XLII

Airworthiness Limitation Items
Figure 3 (Sheet 50 of 51)



STRINGERS L-16 AND L-17 AT RIB NO. 9
DETAIL XLIII



▦ 57-20-I12A IS APPLICABLE

▨ 57-20-I12B IS APPLICABLE

DETAIL XLIV

Airworthiness Limitation Items
Figure 3 (Sheet 51 of 51)

GENERAL - CROSS REFERENCES FOR BOEING SOURCE DOCUMENTS

1. References

Reference	Title
51-10-02, GENERAL	Inspection and Removal of Damage
51-20-02, GENERAL	Heat Treat Verification - Hardness and Conductivity Testing
51-20-05, GENERAL	Repair Sealing
51-20-06, GENERAL	Shot Peening
51-20-07, GENERAL	Freeze Plug Installation
51-30-01, GENERAL	Sheet Metal Materials
51-40-02, GENERAL	Fastener Installation and Removal
51-40-04, GENERAL	Torque Values
51-40-05, GENERAL	Fastener Hole Sizes
51-40-08, GENERAL	Countersinking
51-40-09, GENERAL	Coldworking of Holes for Fatigue Improvement
51-70-14, GENERAL	Allowable Damage and Repair of Flame-Sprayed Aluminum Coatings, Aluminum-Coated Glass Fabric (BMS 8-278), Aluminum Foil (BMS 8-289), and Expanded Aluminum Foil (BMS 8-336)
DOCUMENT D-18888-1	Boeing Process Specifications

2. General

A. Some Chapter 51 data has been derived from DOCUMENT D-18888-1, and other Boeing source documents. Refer to Table 1/GENERAL for a list of these source documents and the SRM ATA Number where the data is incorporated. If the source document is only referred to in an SRM ATA, the source document will not be listed.

Table 1: Cross Reference Index for Boeing Source Documents

ATA NUMBER	SOURCE DOCUMENT	SUBJECT
51-10-02, GENERAL	D6-9002	Appearance Control of Clad Aluminum Exterior SKins
51-20-02, GENERAL	BAC 5946	Temper Inspection of Aluminum
51-20-05, GENERAL	BAC 5000 BACD2027	Fay and Fillet Seals Countersink Symbols and Dimensions
51-20-06, GENERAL	BAC 5730	Shot Peening
51-20-07, GENERAL	BAC 5063	Fastener Installation in Composite Structure
51-30-01, GENERAL	BAC 5300	Forming, Straightening, and Fitting of Metal Parts
51-40-02, GENERAL	BAC 5004-1 BAC 5004-2 BAC 5004-3 BAC 5009 BAC 5047 BAC 5060 BAC 5063	Installation of Solid Rivets Installation of Permanent Straight Shank Fasteners Installation of Blind Fasteners Bolt and Nut Installation Installation of Fluid-Tight Fasteners Installation of Interference Fit, Radius Lead-in Fasteners Fastener Installation in Composite Structure

Table 1: Cross Reference Index for Boeing Source Documents (Continued)

ATA NUMBER	SOURCE DOCUMENT	SUBJECT
51-40-04, GENERAL	BAC 5004-2 BAC 5009 BAC 5060 BAC 5063	Installation of Permanent Straight Shank Fasteners Bolt and Nut Installation Installation of Interference Fit, Radius Lead-in Fasteners Fastener Installation in Composite Structure
51-40-05, GENERAL	BAC 5004-1 BAC 5004-2 BAC 5004-3 BAC 5009 BAC 5047 BAC 5060 BAC 5063	Installation of Solid Rivets Installation of Permanent Straight Shank Fasteners Installation of Blind Fasteners Bolt and Nut Installation Installation of Fluid-Tight Fasteners Installation of Interference Fit, Radius Lead-in Fasteners Fastener Installation in Composite Structure
51-40-08, GENERAL	BACD2027 BAC 5004-1 BAC 5004-2 BAC 5004-3 BAC 5009 BAC 5047 BAC 5060 BAC 5063	Countersink Symbols and Dimensions Installation of Solid Rivets Installation of Permanent Straight Shank Fasteners Installation of Blind Fasteners Bolt and Nut Installation Installation of Fluid-Tight Fasteners Installation of Interference Fit, Radius Lead-in Fasteners Fastener Installation in Composite Structure
51-40-09, GENERAL	BAC 5768 BAC 5973	Mandrel Cold Working of Holes in Aluminum Sleeve Cold Working of Holes in Aluminum
51-40-09, GENERAL	D6-48758 BAC 5514 BAC 5514-589 BAC 5555	Structural Repair Bonding Common Bonding Requirements for Structural Adhesives Application of Corrosion Inhibiting Adhesive Primer Phosphoric Acid Anodizing of Aluminum for Structural Repair Bonding
51-70-14, GENERAL	BAC 5056 BAC 5598	Fabrication of Flame-Sprayed Aluminum Coatings 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 or secondary structures as applicable.

2. References

Reference	Title
51-10-02, GENERAL	Inspection and Removal of Damage
SOPM 20-20-01	Magnetic Particle Inspection
SOPM 20-20-02	Penetrant Methods of Inspection

3. General

A. The SRM is being updated incrementally to account for damage tolerance analysis improvements, testing, experience, Non-Destructive Inspection (NDI) technology improvements etc. As part of the update, new terminology will be introduced as defined below. When the update is complete, all repairs to Principal Structural Elements (PSE) will be classified as defined in Paragraph 3.B./GENERAL. During the transition, both types of terminology will exist.

B. The following definitions will be incrementally introduced for repairs to Principal Structural Elements (PSE) which require a damage tolerance analysis:

(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 or reworked within a specified time limit. Also supplemental inspections can be necessary at a specified threshold and repeat interval.

C. The following definitions will be used for repairs which are not critical for damage tolerance. They are classified as permanent, interim, or time-limited, based on the expected durability of the repair.

NOTE: If a repair is not identified as an interim or time-limited repair it is a permanent repair.

(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 airplane indefinitely. The repair must be inspected as 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 initial fastener holes before the repair is installed as given in 51-10-02, GENERAL. Zero-timing must only be used where specifically permitted in an SRM chapter-section-repair. Also zero-timing must not cause short edge-margins, or short fastener spacing, or knife-edging of the fastened material at the location of the repair fasteners.

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

(9) Zonal Inspection: General visual or surveillance inspection of each airplane 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 Inspection: A visual check of the exposed areas of the wing surface, fuselage, doors and door cutouts, and wheel wells that are visible without the use of ladders, workstands, etc.

(b) Surveillance Inspection: A visual check that will detect obvious unsatisfactory conditions, discrepancies in externally visible or internal structure or system and powerplant items. This type of inspection may require removal of fillets, fairings, access panels, doors, etc. Adequate lighting and normal inspection aids are to be used as required, such as a flashlight and/or inspection mirror.

(c) Detailed Inspection: An intensive visual examination of a specific structural area, system, 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.

(d) Special Detailed (Non-Destructive Testing) Inspection: 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 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 currents 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:

   a) High Frequency Eddy Current (HFEC) Inspection: Used to find surface cracks, porosity, and corrosion.
   b) 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 surface cracks.
   c) Low Frequency Eddy Current (LFEC) Inspection: Used to find surface cracks, and corrosion. Refer to Part 6 of the NDT Manual for the Eddy Current inspection procedures.

2) Ultrasonic: An NDT procedure which uses sound waves to find surface and 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 the 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 examied under ultraviolet light. Refer to SOPM 20-20-02 for the Penetrant inspection procedure procedures.

NOTE: The data for the Inspection and Removal of Damage has moved to 51-10-02.

GENERAL - AERODYNAMIC SMOOTHNESS REQUIREMENTS

1. General

A. The 767 airplane requires an aerodynamically clean shape and smooth exterior for high performance. Unrepaired damage, unfilled dents (51-70-01, GENERAL) or repairs which change the shape or roughen the surface will be reflected in reduced performance. Every effort should be made to maintain original contour and exterior surface smoothness.

B. Exterior surface aerodynamic smoothness is classified in three categories: extra-critical, critical and noncritical. See Figure 1/GENERAL.

  (1) Extra-critical aerodynamic surfaces are those surfaces where the airflow can have a direct effect on flight critical instruments, loss of local lift force, or excessive drag or thrust loss due to high-speed flow. The local-lift-force category includes the leading edge regions of components whose shape must be tightly controlled to prevent premature stalling, like the ailerons, elevators, or wing leading edge devices. The extra-critical areas are:

    (a) Surfaces near the pitot-static probes, angle-of-airflow sensors, and static pressure ports. See Figure 3/GENERAL, Details III and IV.

    (b) Surfaces forward of the wing leading edge splice straps common to the fixed leading edge, slats or other leading edge devices and wingtips. See Figure 1/GENERAL.

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

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

    (e) Surfaces on the primary exhaust and pylon as shown in Figure 6/GENERAL.

  (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 955.10 excluding the areas defined above as extra-critical, and excluding the area aft of station 785.9 (front spar) under the wing.

    (b) Wing upper surface from the leading edge to the rear spar centerline and the wing lower surface from the leading edge to the front spar centerline, and the forward 50 percent chord of the main tailing edge flaps, excluding the areas defined above as extra-critical.

    (c) Both sides of the horizontal (upper and lower) and vertical tail (left and right) external surfaces from the leading edge to the centerline of the rear spars, excluding the areas defined above as extra-critical.

    (d) Primary exhaust and pylon areas as shown in Figure 6/GENERAL.

  (3) All other surfaces are noncritical aerodynamic surfaces.

C. Protect the finish from scuffing, scratches, and other damage on the critical upper surfaces by wearing soft-soled shoes and by convering the areas adjacent to the work area. Refer to AMM 51-20-00 for the finish requirements. Repair all scuffed or damaged finish as soon as possible.

D. Skin repairs in the regions of extra-critical and critical aerodynamic smoothness should be of the flush type to maintain optimum performance; but external repairs can be used providing the limitations in these regions are observed. Accumulation of external repairs can result in significant performance penalty.

E. Refer to 51-10-03, GENERAL if the airplane is approved for Reduced Vertical Separation Minimum (RVSM) operation and has damage near the pitot-static probes.

2. References

Reference	Title
51-10-03, GENERAL	Skin Waviness Inspection for Reduced Vertical Separation Minimum (RVSM) Operation
51-11-01, GENERAL	Aerodynamic Smoothness CF6-80C2 Engine Nacelle
51-20-01, GENERAL	Protective Treatment of Metallic and Nonmetallic Repair Parts
51-70-01, GENERAL	Procedures to Rework and Fill Minor Dents in Metallic Parts on External Aerodynamic Surfaces
AMM 51-20-00	Aircraft Maintenance Manual
AMM 51-31-01	Aircraft Maintenance Manual

3. 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.

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).

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

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 +.003 to .005
- 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 +.001 to +.008.

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

4. Joints and Fasteners - Critical and Extra-Critical Areas

A. Except for the longitudinal lap splices of fuselage skins, all joints are flush within the regions of critical aerodynamic smoothness. Close control must be exercised to maintain head protrusion within the limits of Figure 3/GENERAL, Figure 4/GENERAL, Figure 5/GENERAL and Figure 6/GENERAL. All skins gaps and protruding permanently installed bolts and screws should be filled and faired with aerodynamic smoother (BMS 5-95) as detailed in AMM 51-31-01.

B. Use aerodynamic smoother (BMS 5-79) in areas which may come in contact with jet fuel.

5. Joints and Fasteners - Noncritical Areas

A. At all joints, except around some frequently used access panels, apply aerodynamic smoother. Chordwise lap joints are allowed aft of the wing rear spar and on control surfaces. Fastener flushness tolerances are sometimes greater in noncritical areas. No filler is required on screw and boltheads.

6. Aerodynamic Smoothness Requirements

A. Fuselage

(1) See Figure 3/GENERAL for details of smoothness requirements of fuselage and for limitation on repairs in region of static pressure ports, pitot-static probes, and angle of airflow sensors.

(2) Refer to 51-10-03, GENERAL if the airplane is approved for RVSM operation, and has damage near the pitot-static probes.

B. Horizontal and Vertical Stabilizer

(1) See Figure 4/GENERAL for the smoothness requirements of the stabilizers.

C. Wing

(1) See Figure 5/GENERAL for the smoothness requirements of the wing.

D. Primary Exhaust and Pylon

(1) See Figure 6/GENERAL for the smoothness requirements of the primary exhaust and pylon. Refer to 51-11-01, GENERAL for the smoothness requirements of the nacelle for the CF6-80C(2) engines.

7. Microshaving of Aluminum Alloy Rivets

A. A rivet microshaver shown in Figure 2/GENERAL is used to shave aluminum alloy rivets to meet surface flushness requirements. The microshaver is a pistol-grip air motor with an adjustable microstop. A cutter shaves the rivet head to within 0.002 in. (0.005 cm) of the sheet surface. Spring-loaded rubber feet, mounted in a free turning stabilizer, prevent slipping of the cutter.

B. When shaving rivets, the following practices must be observed in order to maintain rivet strength:

(1) Head protrusion shall not exceed H in Figure 2/GENERAL, Table II after driving and prior to shaving.

(2) Head diameter shall not be less than D in Figure 2/GENERAL, Table II, after shaving.

(3) Select a cutter larger in diameter than the rivet head. See Figure 2/GENERAL, Table I for recommended cutter diameters.

WARNING: DISCONNECT THE MICROSHAVER FROM THE AIR SOURCE BEFORE YOU ADJUST OR TOUCH THE CUTTER. IF YOU DO NOT, INJURY TO PERSONS CAN BE THE RESULT.

(4) Adjust the stop of the shaver to extend 0.001 to 0.002 inch beyond the cutter and test this setting on scrap stock prior to use, to avoid damaging sheet surface.

(5) Use steady pressure on the tool to obtain a constant speed.

(6) Rock the shaver lightly on contoured surface to trim all edges of the rivet.

(7) Refinish the shaved rivet heads as described in 51-20-01, GENERAL.

8. Microshaving of Rivets in Composites

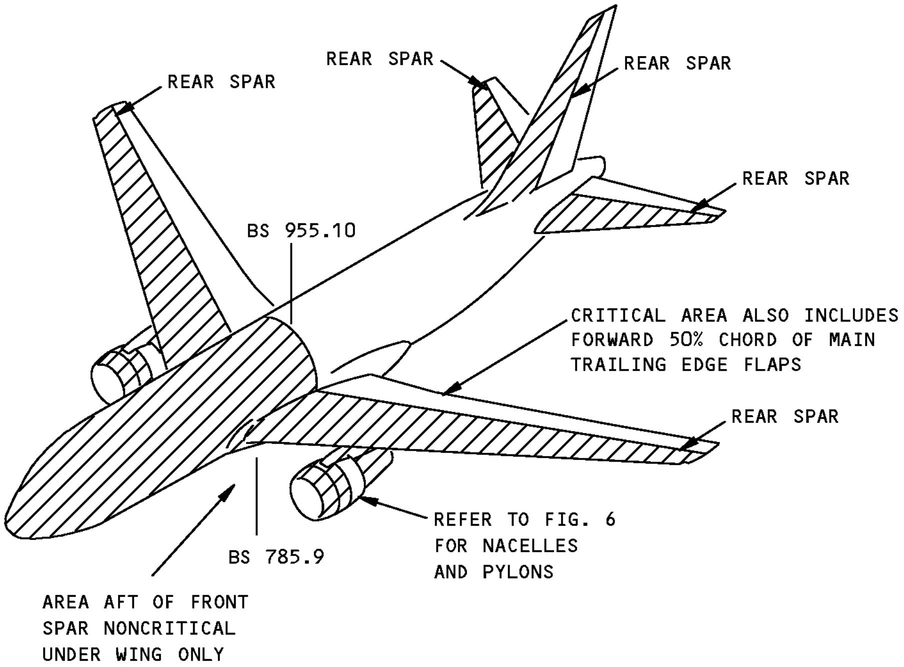
A. The following restrictions apply to shaving rivets installed in composite panels.

(1) Solid Shank - Flush Head Rivets, excluding BACR15CE, BACR15GF, BACR15FV and MS14218 rivets, can be microshaved as given in Paragraph 7.B./GENERAL

(2) Solid Shank - Flush Head Rivets may be microshaved when installed in fiberglass panels. The rivets cannot be shaved when installed in graphite, aramid, or hybrid aramid/graphite panels.

9. Microshaving BACR15GA Titanium Hollow-Ended Rivets

A. The flushness may not be reduced by more than 0.010 in. (0.025 cm) by shaving. The rivets may not be shaved below plus0.010 in. (0.025 cm) protrusion. No more than 25 percent of the BACR15GA rivets on any part may be shaved to attain the required flushness. No rivets may be shaved on the manufactured head side. Rivets must be removed that are swaged with the longitudinal axis of the die more than 0.040 in. (0.102 cm) off center from their axis on either the initial or final squeezing.



REFERENCE DRAWING

FUSELAGE	- 140T1530
WING	- 110T1541
STABILIZERS	- 180T1530
NACELLES AND PYLONS	
JT9D-7R4	- 300T1000
CF6-80A	- 300T1001
CF6-80C	- 300T2001
PW4000	- 301T4700
RB211-524	- 301T5700

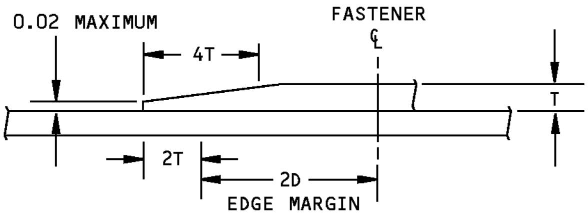
▨ CRITICAL AREA
HIGH DEGREE OF AERODYNAMIC SMOOTHNESS REQUIRED

CAUTION: SOFT SOLED SHOES OR RUBBER OVERSHOES MUST BE WORN WHEN WORKING OR WALKING IN CRITICAL AREAS TO PREVENT SCUFFING OR DAMAGE TO SKIN.

NOTES

- EXTRA-CRITICAL AREA (THE HIGHEST DEGREE OF AERODYNAMIC SMOOTHNESS REQUIRED). THOSE AREAS INCLUDE:
  - SURFACES NEAR PITOT-STATIC, AOA AND STATIC PRSESSURE SENSORS.
  - WING LE AND HORIZONTAL AND VERTICAL STABILIZER LE.
  - LE OF FLIGHT CONTROLS AND FLAPS
  - LE OF PRIMARY EXHAUST
- REFER TO FIG. 3 FOR LIMITATIONS ON REPAIRS IN REGION OF STATIC PRESSURE PORTS, PITOT-STATIC PROBES, AND ANGLE OF AIRFLOW SENSORS.
- DO THE PROCEDURES THAT ARE GIVEN IN SRM 51-10-03 WHEN THE AIRPLANE IS APPROVED FOR REDUCED VERTICAL SEPARATION MINIMUM (RVSM) AIRSPACE.

A FOR OPTIMUM PERFORMANCE REPLACE AN EXTERNAL REPAIR WITH A FLUSH REPAIR IN A REGION OF AERODYNAMIC SMOOTHNESS.



TYPICAL CHAMFERED EXTERNAL PATCH A

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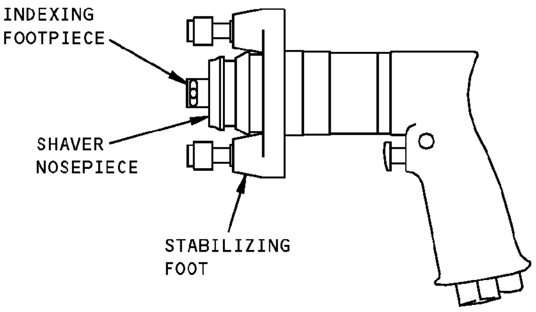
Aerodynamic Smoothness - Critical Areas
Figure 1



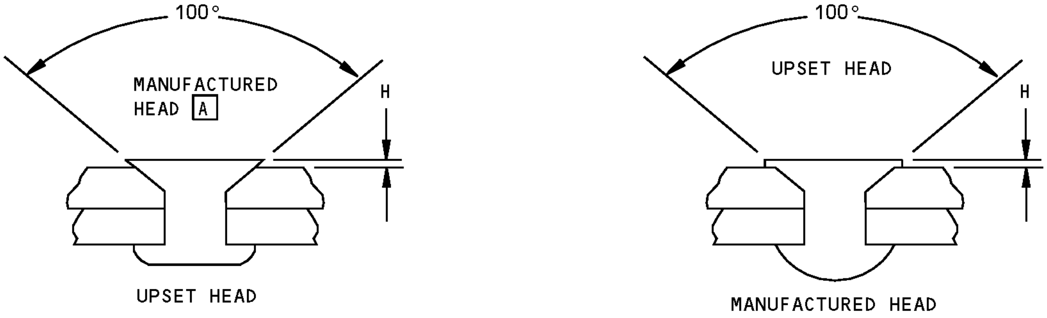
MICROSHAVER
DETAIL I

MICROSHAVER CUTTER DIMENSIONS (REFERENCE)	
RIVET DIA (INCHES)	CUTTER DIA (INCHES)
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 I

MICROSHAVER MODEL	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-OAD TD-300A-OAID TD-300-OAID	INGERSOLL-RAND CO. PAINTED POST PLANT HAMILTON ST. PAINTED POST, NEW YORK 14870

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



BEFORE RIVET SHAVING
DETAIL II

NOTES

A DO NOT MICROSHAVE BACR15CE, BACR15DS, BAC15GF, AND NAS1097 100° SHEAR HEAD RIVETS. DO NOT MICROSHAVE BACR15FV AND MS14218 120° MODIFIED HEAD RIVETS IF INSTALLED FOR THE FIRST TIME. OVERSIZE BACR15FV AND MS14218 RIVETS MAY BE MICROSHAVED IF THE SKIN IS THIN. REFER TO SRM 51-40-02, PARA. 2.

RIVET HEAD SHAVING DIMENSIONS (INCHES)		
RIVET DIA	BEFORE SHAVING	AFTER SHAVING
	H MAXIMUM (REFERENCE)	MINIMUM DIAMETER D
		STD CSK
	100°	100°
1/8	0.007	0.204
5/32	0.009	0.262
3/16	0.010	0.326
1/4	0.012	0.443
5/16	0.014	0.526
3/8	0.016	0.650

TABLE II

AFTER RIVET SHAVING
DETAIL III

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

REFERENCE DRAWING
140T1530

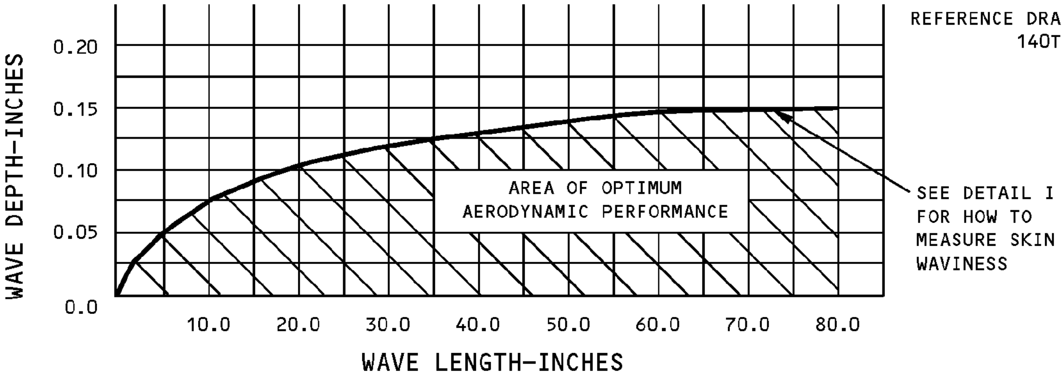
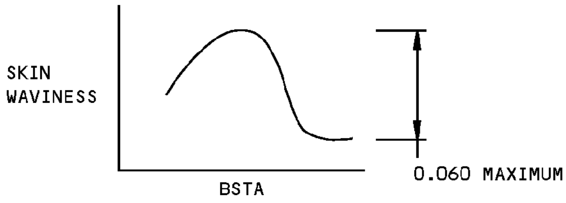


CHART I

THIS CHART SHOWS THE SKIN WAVINESS THAT GIVES OPTIMUM AERODYNAMIC PERFORMANCE. FUEL CONSUMPTION WILL BE MORE WHEN THE SKIN WAVINESS IS MORE THAN THE LIMITS. THE CHART IS FOR:

- CONTINUOUS SKIN
- STRAIGHT AREAS AND FOR CURVED AREAS
- CRITICAL REGIONS AND FOR NON-CRITICAL REGIONS.
- IF THE SKIN SMOOTHNESS IS WITHIN THE LIMITS OF SRM 53-00-01, FIGURE 101, BUT MORE THAN THE SKIN WAVINESS LIMIT SHOWN IN CHART I ABOVE, THE AIRPLANE CAN STILL FLY, BUT A LOSS OF AERODYNAMIC PERFORMANCE WILL OCCUR.

REFER TO CHART II FOR THE AREAS OF THE PITOT-STATIC PROBE AND STATIC PRESSURE PORTS.

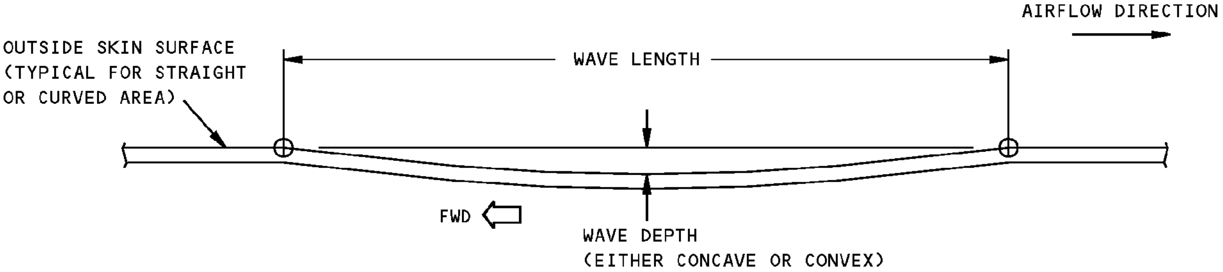


EXTRA-CRITICAL SMOOTHNESS REGION
CHART II

THE SKIN WAVINESS IN THE EXTRA-CRITICAL SMOOTHNESS REGION IS THE DIFFERENCE BETWEEN THE GIVEN CONTOUR AND THE MEASURED CONTOUR. (REFER TO SRM 51-10-03 FOR THE GIVEN CONTOUR). FOR ANY WAVELENGTH, THE SKIN WAVINESS MUST BE LESS THAN 0.060 INCHES.

REFER TO SRM 51-10-03 FOR PERMITTED SKIN WAVINESS FOR RVSM APPROVAL.

THE EXTRA-CRITICAL SMOOTHNESS REGION IS BETWEEN BSTA 157 TO BSTA 212.5 (WL170-WL220) AND BETWEEN BSTA 425 TO BSTA 489 (S26-S31). THESE ARE THE AREAS OF THE PITOT-STATIC PROBES, THE ANGLE-OF-AIRFLOW SENSOR, AND THE STATIC PRESSURE PORTS.

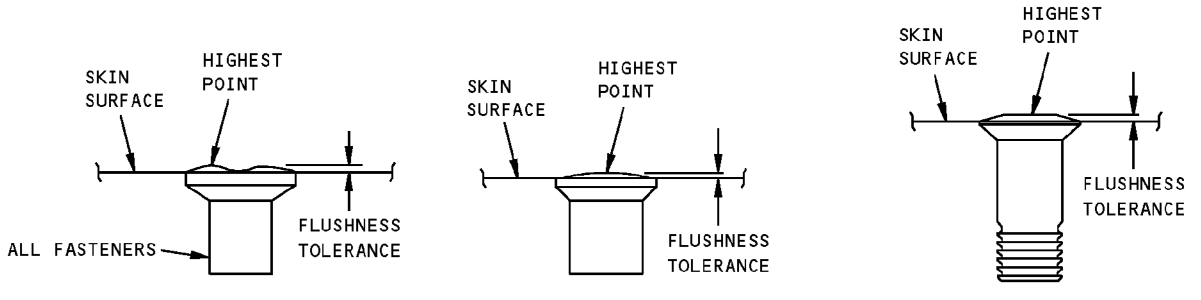


SKIN WAVINESS
DETAIL I

Aerodynamic Smoothness - Fuselage
Figure 3 (Sheet 1 of 4)

FASTENER TYPE	CRITICAL AREAS	NON-CRITICAL AREAS
MS20427 MONEL RIVETS	SHALL BE FLUSH WITHIN TOLERANCE 0.000 TO 0.003 HIGH	SHALL BE FLUSH WITHIN TOLERANCE 0.000 TO 0.007 HIGH
BACR15CE, BACR15GF, BACR15FV, MS14218 ALUMINUM REDUCED SHEAR HEAD RIVETS	SHALL BE FLUSH WITHIN TOLERANCE 0.0010 HIGH TO 0.0060 HIGH EXCEPT FOR 10% WHICH MAY BE WITHIN TOLERANCE 0.0061 HIGH TO 0.0080 HIGH.	SAME AS CRITICAL AREAS
HI-LOKS AND LOCKBOLTS FLAT HEAD STYLE	SHALL BE FLUSH WITHIN TOLERANCE 0.003 LOW TO 0.003 HIGH EXCEPT FOR 10% WHICH MAY BE WITHIN TOLERANCE 0.005 LOW TO 0.003 HIGH.	SHALL BE FLUSH WITHIN TOLERANCE 0.003 LOW TO 0.005 HIGH
BACB30XT, BACB30XU, BACB30YP DOMED, REDUCED SHEAR HEAD LOCKBOLTS AND HI-LOKS	SHALL BE FLUSH WITHIN TOLERANCE 0.0025 HIGH TO 0.0085 HIGH	SAME AS CRITICAL AREAS
SCREWS AND BOLTS	SHALL BE FLUSH WITHIN TOLERANCE 0.003 LOW TO 0.003 HIGH	SHALL BE FLUSH WITHIN TOLERANCE 0.010 LOW TO 0.005 HIGH
BLIND RIVETS	SHALL BE FLUSH WITHIN 0.003 LOW TO 0.005 HIGH	SHALL BE FLUSH WITHIN TOLERANCE 0.003 LOW TO 0.005 HIGH LOCKING RING AND PULL STEM MAY PROTRUDE 0.016 MAX ABOVE SKIN SURFACE
BACW10U WASHERS	A GAP OF 0.000 TO 0.016 IS PERMISSIBLE BETWEEN FLANGE OF WASHER AND FAIRING PANELS	

FASTENER FLUSHNESS
TABLE I

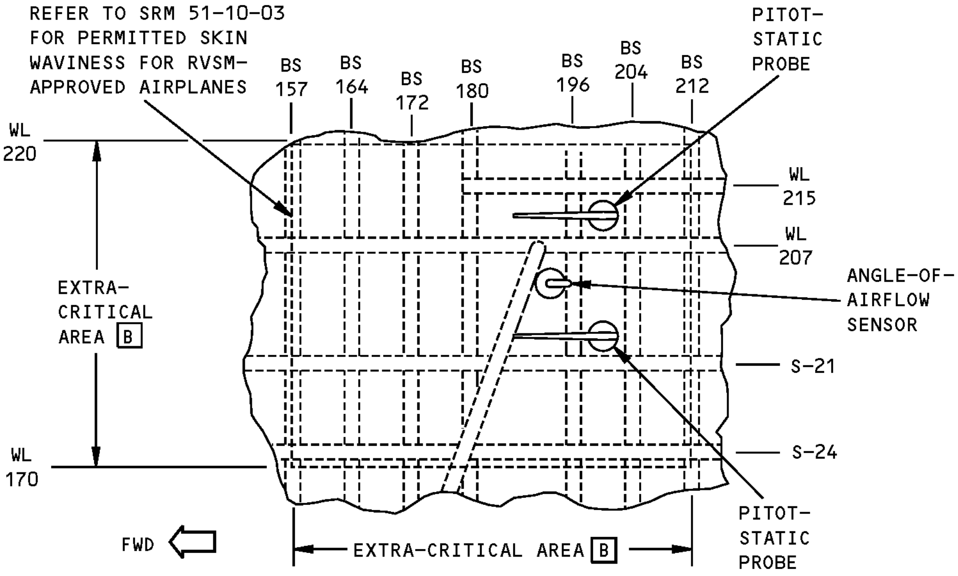


BACR15FV BACR15CE, BACR15GF BACB30YP, BACB30XT, BAC30XU

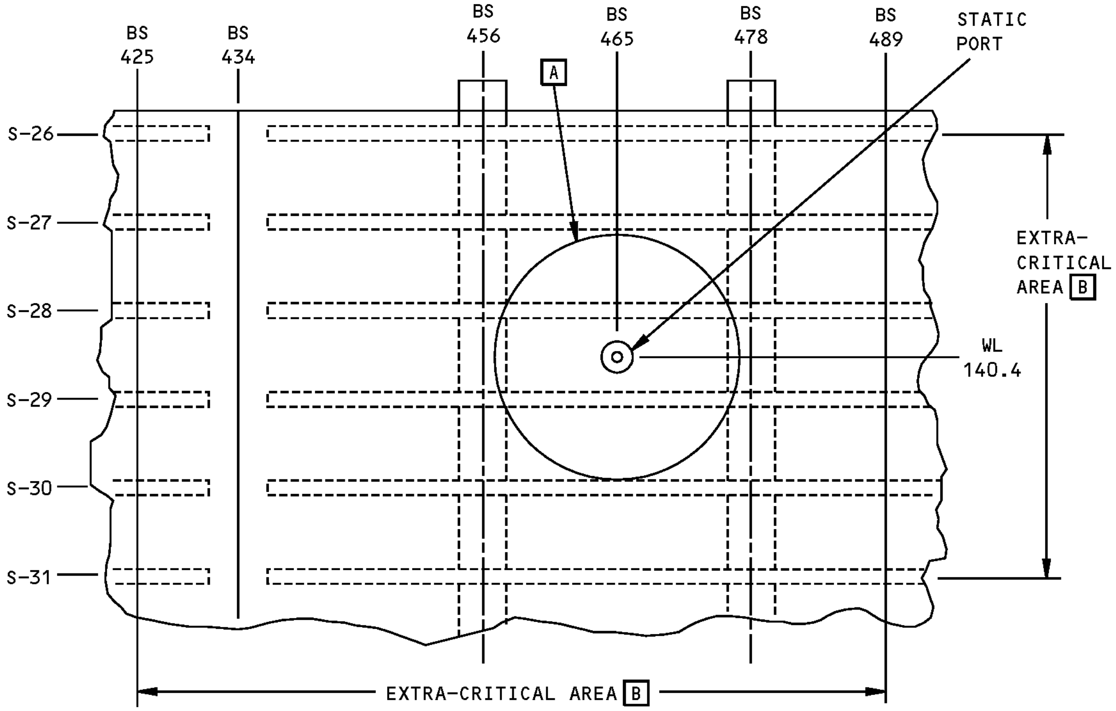
NOTE: FASTENER FLUSHNESS IS TO BE DETERMINED BY THE HIGHEST POINT OF THE INSTALLED FASTENER ABOVE THE SKIN SURFACE.

FOR CRITICAL AND NON-CRITICAL AREAS
DETAIL II

Aerodynamic Smoothness - Fuselage
Figure 3 (Sheet 2 of 4)



LOCATION OF PITOT-STATIC PROBES AND ANGLE-OF-AIRFLOW SENSOR
DETAIL III



LOCATION OF STATIC PORT
DETAIL IV

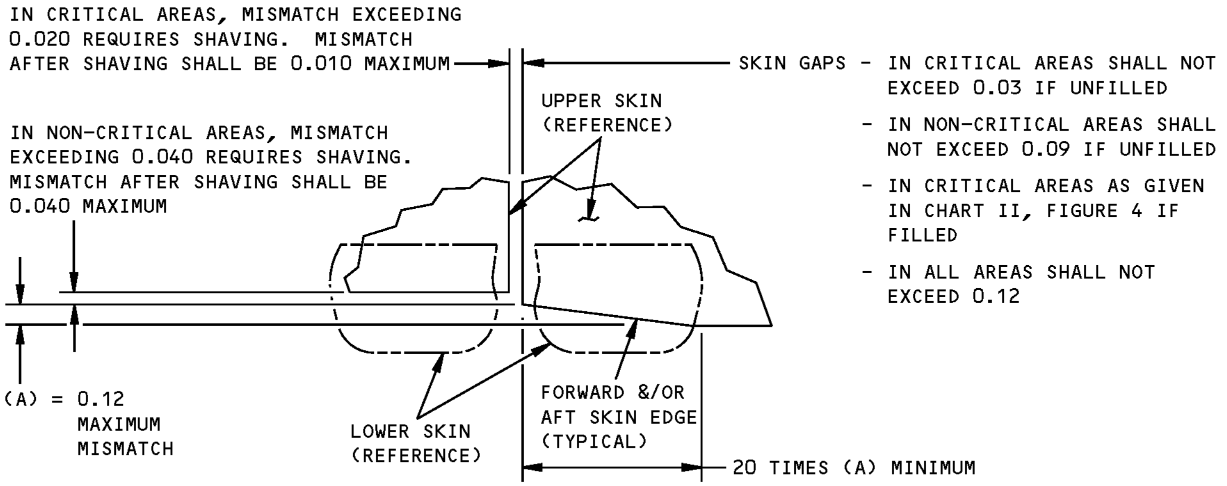
Aerodynamic Smoothness - Fuselage
Figure 3 (Sheet 3 of 4)

NOTES

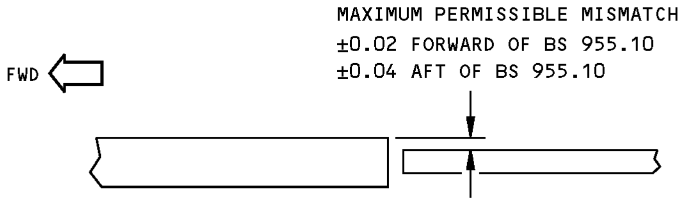
- DO NOT SHAVE STEEL OR TITANIUM FASTENERS, BACR15CE RIVETS, BACR15GF RIVETS, BACR15FV (BRILES) OR MS14218 RIVETS. BRILES RIVET HEADS MAY BE SHAVED ONLY IF OVERSIZED RIVETS ARE INSTALLED IN REWORKED HOLES. REFER TO SRM 51-40-02 FOR REWORK OF EXISTING BRILES RIVET INSTALLATIONS.
- FOR DETAILS OF CRITICAL AND NON-CRITICAL AREAS, SEE FIGURE 1.
- SEE DETAIL I FOR DETERMINING FLUSHNESS OF RIVETS.
- SURFACE FINISH IN CRITICAL AREAS SHALL BE 130 MICROINCHES (0.30 CUTOFF) OR BETTER.
- SURFACE FINISH IN NON-CRITICAL AREAS SHALL BE 180 MICROINCHES (0.30 CUTOFF) OR BETTER.

[A] WITHIN A RADIUS OF 3 INCHES FROM THE STATIC PORT THE SKIN SHALL NOT DEVIATE FROM ITS DESIGN CONTOUR BY MORE THAN ±0.010 INCH AS MEASURED BY PLACING A 6-INCH STAIGHTEDGE HORIZONTALLY ON THE SKIN. WITHIN A RADIUS OF 12 INCHES FROM STATIC PORT THE DEVIATION SHALL NOT BE MORE THAN ±0.020 INCH.

[B] EXTERNAL REPAIRS ARE NOT PERMITTED IN THIS AREA ON LEFT AND RIGHT SIDES OF THE BODY.



PERMISSIBLE MISMATCH AND GAP OF SKIN EDGES
DETAIL V



PERMISSIBLE MISMATCH AT SKIN BUTT JOINTS
DETAIL VI

Aerodynamic Smoothness - Fuselage
Figure 3 (Sheet 4 of 4)

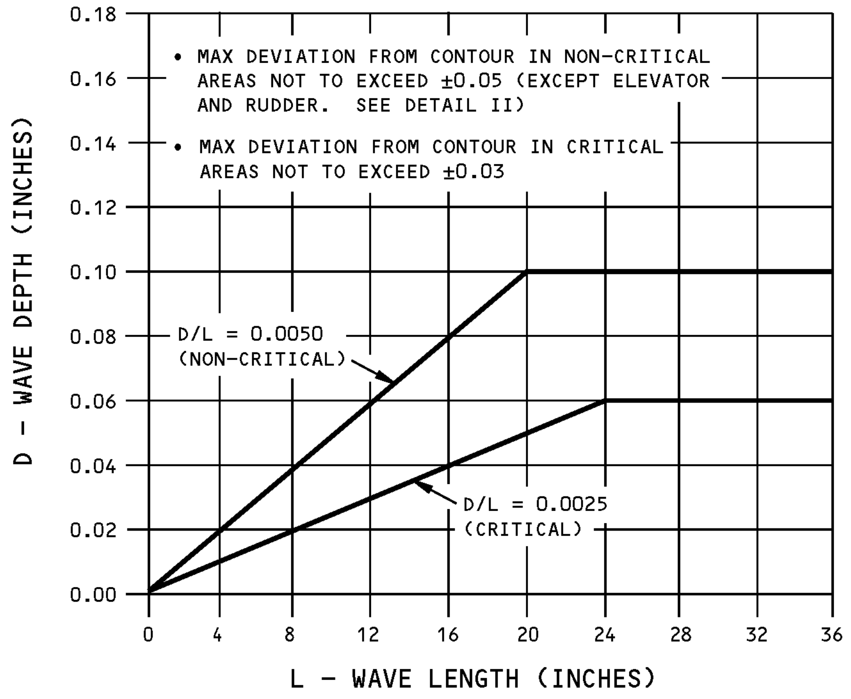
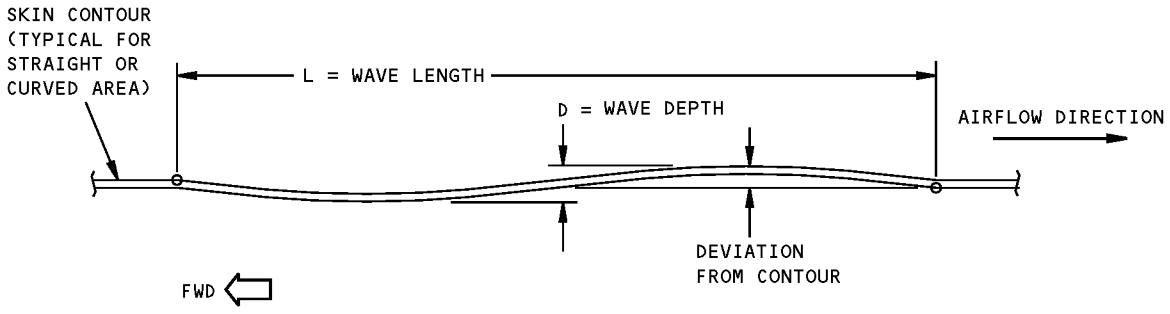
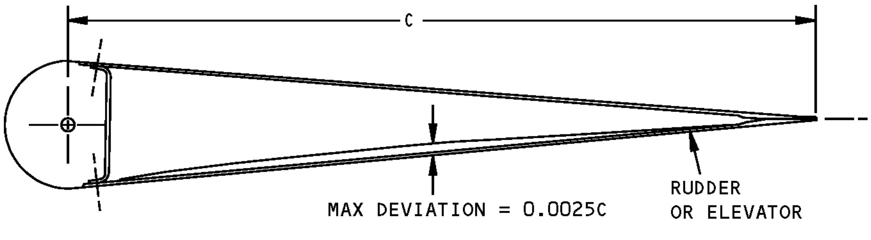


CHART I

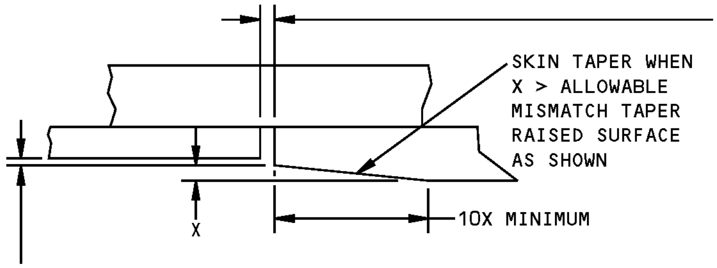


SKIN WAVINESS
DETAIL I



DETAIL II

Aerodynamic Smoothness - Horizontal and Vertical Stabilizer
Figure 4 (Sheet 1 of 4)



SKIN GAPS -

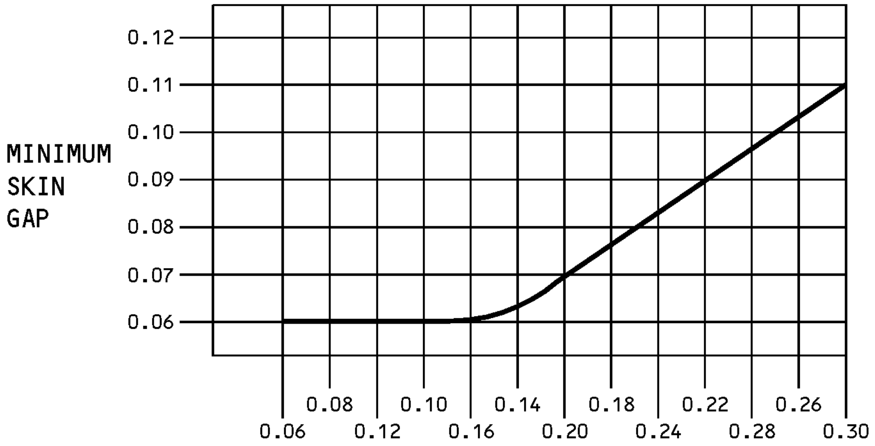
- IN NON-CRITICAL AREAS SHALL NOT EXCEED 0.09 IN WIDTH IF UNFILLED
- IN CRITICAL AREAS SHALL NOT EXCEED 0.03 IN WIDTH IF UNFILLED
- IN CRITICAL AREAS FILLED GAPS SHALL BE PER CHART II

ALLOWABLE MISMATCH -

- IN CRITICAL AREAS SHALL NOT EXCEED ±0.007 AT FRONT SPAR JOINTS, ±0.010 AT JOINTS AHEAD OF FRONT SPAR AND FORWARD 50% OF ELEVATOR AND RUDDER CHORDS, AND ±0.015 FOR JOINTS BETWEEN SPARS
- SHALL NOT EXCEED ±0.030 FOR NON-CRITICAL AREA JOINTS
- SPANWISE MISMATCH ALONG LEADING EDGE OF HORIZONTAL STABILIZER AND VERTICAL FIN SHALL BE ±0.03 AT SKIN SPLICES
- DORSAL FIN TO VERTICAL FIN MISMATCH SHALL BE ±0.030

DETAIL III

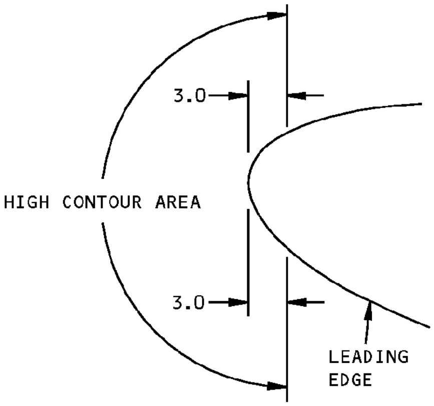
EXTERIOR GAPS



GAP CLEARANCE/DEPTH RATIO IS REQUIRED
TO PROVIDE ADEQUATE ADHESION FOR SEALANT

GAP DEPTH
CHART II

Aerodynamic Smoothness - Horizontal and Vertical Stabilizer
Figure 4 (Sheet 2 of 4)



LEADING EDGE HIGH CONTOUR AREA A
DETAIL IV

FASTENER TYPE	EXTRA-CRITICAL AREAS B	CRITICAL AREAS	NON-CRITICAL AREAS
ALUMINUM STANDARD HEAD RIVETS	SAME AS CRITICAL AREAS	SHALL BE FLUSH WITHIN TOLERANCE 0.001 HIGH TO 0.003 HIGH NOTE: (RIVET MAY BE SHAVED) A	SHALL BE FLUSH WITHIN TOLERANCE 0.002 LOW TO 0.007 HIGH.
BACR15CE BACR15GF BACR15FV MS14218 ALUMINUM REDUCE SHEAR HEAD RIVETS	SAME AS CRITICAL AREAS	SHALL BE FLUSH WITHIN TOLERANCE 0.0010 HIGH TO 0.0040 HIGH EXCEPT FOR 10% WHICH MAY BE WITHIN TOLERANCE 0.0005 HIGH TO 0.0060 HIGH.	SHALL BE FLUSH WITHIN TOLERANCE 0.0010 HIGH TO 0.0050 HIGH EXCEPT FOR 10% WHICH MAY BE WITHIN TOLERANCE 0.0010 HIGH TO 0.0070 HIGH.
HI-LOK AND LOCKBOLTS FLAT HEAD STYLE	SHALL BE FLUSH WITHIN TOLERANCE 0.0030 LOW TO 0.0030 HIGH EXCEPT FOR 10% WHICH MAY BE WITHIN TOLERANCE 0.0050 LOW TO 0.0030 HIGH	SAME AS EXTRA-CRITICAL AREAS	SHALL BE FLUSH WITHIN TOLERANCE 0.0030 LOW TO 0.0050 HIGH.
BACB30WQ BACB30XT BACB30XU BACB30YP DOMED, REDUCED SHEAR HEAD LOCKBOLTS AND HI-LOKS	SHALL BE FLUSH WITHIN TOLERANCE 0.0005 HIGH TO 0.0055 HIGH	-5 (5/32) AND -6 (3/16) SIZES: • SHALL BE FLUSH WITHIN TOLERANCE 0.0015 HIGH TO 0.0075 HIGH -8 (1/4), -10 (5/16) AND -12 (3/8) SIZES: • SHALL BE FLUSH WITHIN TOLERANCE 0.0025 HIGH TO 0.0085 HIGH	SAME AS CRITICAL AREAS
SCREWS AND BOLTS	SAME AS CRITICAL AREAS	SHALL BE FLUSH WITHIN TOLERANCE 0.005 LOW TO 0.003 HIGH EXCEPT FOR 10% WHICH MAY BE WITHIN TOLERANCE 0.008 LOW TO 0.003 HIGH.	SHALL BE FLUSH WITHIN TOLERANCE 0.010 LOW TO 0.005 HIGH

FASTENER FLUSHNESS
TABLE I

Aerodynamic Smoothness - Horizontal and Vertical Stabilizer
Figure 4 (Sheet 3 of 4)

NOTES

- DO NOT SHAVE STEEL OR TITANIUM FASTENERS, BACR15CE, BACR15GF, BACR15FV (BRILES), AND MS14218 RIVETS. BRILES RIVET HEADS MAY BE SHAVED ONLY IF OVERSIZED RIVETS ARE INSTALLED IN REWORKED HOLES. REFER TO SRM 51-40-02 FOR REWORK OF EXISTING BRILES RIVET HOLES.
- SEE FIGURE 1, FOR THE DETAILS OF CRITICAL AND NON-CRITICAL AREAS.
- SEE FIGURE 3, DETAIL I FOR DETERMINING FLUSHNESS OF RIVETS.
- THE SURFACE FINISH SHALL BE AN AVERAGE, NOT TO BE MORE THAN 110 MICROINCHES (0.10 CUTOFF). EXCEPT FOR THOSE SURFACES FINISHED WITH BMS 10-86 OR BMS 10-100, WHICH SHALL HAVE AN AVERAGE NOT TO BE MORE THAN 150 u-in. NO LOCALIZED AREA SHALL BE MORE THAN 300 MICROINCHES.

A IN HIGH CONTOUR AREA OF LEADING EDGE THE FLUSHNESS TOLERANCE ON FASTENERS IS 0.007 LOW TO 0.003 HIGH WITH RESPECT TO SKIN SURFACE. 20% SHALL BE WITHIN TOLERANCE 0.012 LOW TO 0.003 HIGH

B THE EXTRA-CRITICAL AREAS ARE DEFINED BELOW:

- EMPENNAGE
  - LEADING EDGE SURFACES FORWARD OF FRONT SPAR - HORIZONTAL AND VERTICAL TAILS

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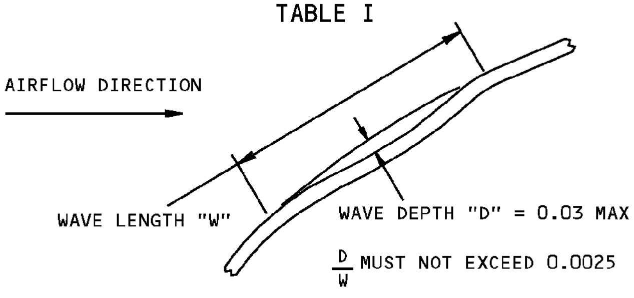
Aerodynamic Smoothness - Horizontal and Vertical Stabilizer
Figure 4 (Sheet 4 of 4)

FASTENER TYPE	EXTRA-CRITICAL AREAS [B]	CRITICAL AREAS	NON-CRITICAL AREAS
FLUID-TIGHT RIVETS	SAME AS CRITICAL AREAS	SHALL BE FLUSH WITHIN TOLERANCE 0.001 HIGH TO 0.003 HIGH	SAME AS CRITICAL AREAS
BACR15CE BACR15GF BACR15FV MS14218 ALUMINUM REDUCED SHEAR HEAD RIVETS	SAME AS CRITICAL AREAS	SHALL BE FLUSH WITHIN TOLERANCE 0.0010 HIGH TO 0.0040 HIGH EXCEPT FOR 10% WHICH MAY BE WITHIN TOLERANCE 0.0005 HIGH TO 0.0060 HIGH.	SHALL BE FLUSH WITHIN TOLERANCE 0.0010 HIGH TO 0.0050 HIGH EXCEPT FOR 10% WHICH MAY BE WITHIN TOLERANCE 0.0010 HIGH TO 0.0070 HIGH.
ALL OTHER ALUMINUM RIVETS	SAME AS CRITICAL AREAS	SHALL BE FLUSH WITHIN TOLERANCE 0.001 TO 0.003 HIGH (SHAVING PERMITED)	SHALL BE FLUSH WITHIN TOLERANCE 0.002 LOW TO 0.007 HIGH
HI-LOK AND LOCKBOLTS FLAT HEAD STYLE	SHALL BE FLUSH WITHIN TOLERANCE 0.0030 LOW TO 0.0030 HIGH EXCEPT FOR 10% WHICH MAY BE WITHIN TOLERANCE 0.0050 LOW TO 0.0030 HIGH	SAME AS EXTRA-CRITICAL AREAS	SHALL BE FLUSH WITHIN TOLERANCE 0.0030 LOW TO 0.0050 HIGH.
BACB30WQ BACB30XT BACB30XU BACB30YP DOMED, REDUCED SHEAR HEAD LOCKBOLTS AND HI-LOKS	SHALL BE FLUSH WITHIN TOLERANCE 0.0005 HIGH TO 0.0055 HIGH	-5 (5/32) AND -6 (3/16) SIZES: • SHALL BE FLUSH WITHIN TOLERANCE 0.0015 HIGH TO 0.0075 HIGH -8 (1/4), -10 (5/16) AND -12 (3/8) SIZES: • SHALL BE FLUSH WITHIN TOLERANCE 0.0025 HIGH TO 0.0085 HIGH	SAME AS CRITICAL AREAS
BACB30PT BOLT	SAME AS CRITICAL AREAS	SHALL BE FLUSH WITH TOLERANCE 0.0030 LOW TO 0.0060 HIGH	SAME AS CRITICAL AREAS
NONREMOVABLE SCREWS AND BOLTS	SAME AS CRITICAL AREAS	SHALL BE COUNTERSUNK WITHIN TOLERANCE 0.015 LOW TO 0.005 LOW, TO ALLOW FOR FILLER	FLUSH WITHIN TOLERANCE 0.010 LOW TO 0.005 HIGH
REMOVABLE SCREWS AND BOLTS [A]	SAME AS CRITICAL AREAS	SHALL BE FLUSH WITHIN TOLERANCE 0.010 LOW TO 0.002 HIGH	

FASTENER FLUSHNESS
TABLE I

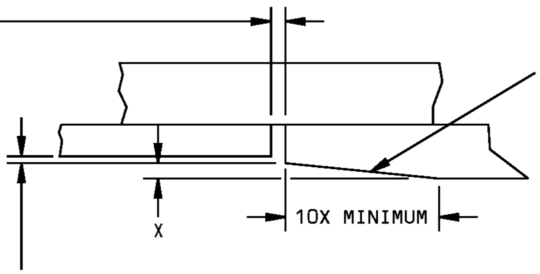


PERMISSIBLE LEADING EDGE SKIN WAVINESS STREAMWISE
DETAIL I

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

SKIN GAPS -

- IN NON-CRITICAL AREAS SHALL NOT EXCEED 0.09 IN WIDTH IF UNFILLED
- IN CRITICAL AREAS SHALL NOT EXCEED 0.03 IN WIDTH IF UNFILLED
- IN CRITICAL AREAS FILLED GAPS SHALL BE PER CHART II, FIGURE 4

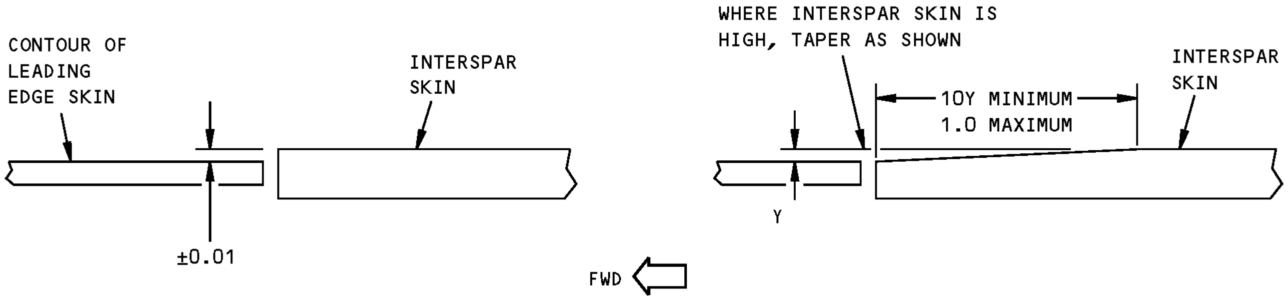


SKIN TAPER WHEN X > ALLOWABLE MISMATCH TAPER RAISED SURFACE AS SHOWN

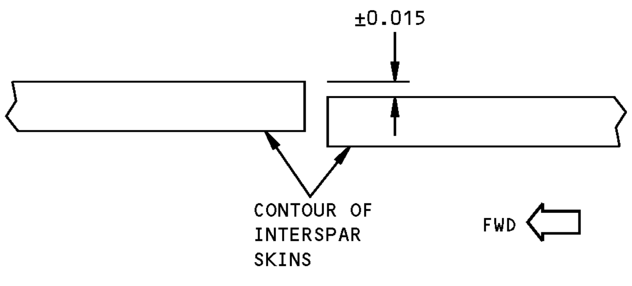
ALLOWABLE MISMATCH -

- IN CRITICAL AREAS SHALL NOT EXCEED 0.007 AT THE FRONT SPAR JOINTS, 0.010 AT JOINTS AHEAD OF FRONT SPAR AND 0.015 FOR BETWEEN SPAR JOINTS
- IN NON-CRITICAL AREAS SHALL NOT EXCEED 0.030

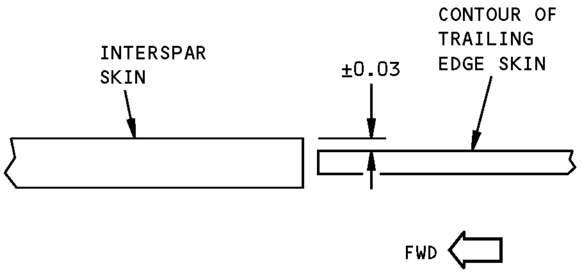
DETAIL II



PERMISSIBLE MISMATCH AT TOP AND BOTTOM SKIN SPLICES FWD OF FRONT SPAR
DETAIL III



PERMISSIBLE MISMATCH AT TOP AND BOTTOM INTERSPAR SKIN SPLICES
DETAIL IV



PERMISSIBLE MISMATCH AT TOP AND BOTTOM SKIN SPLICES AT AND AFT OF THE REAR SPAR
DETAIL V

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

NOTES

- REFER TO FIGURE 1 FOR THE DETAILS OF CRITICAL AND NON-CRITICAL AREAS.
- DO NOT SHAVE STEEL OR TITANIUM FASTENERS OR BACR15CE, BACR15GF, BACR15FV, AND MS14218 ALUMINUM RIVETS.
- REFER TO FIGURE 3, DETAIL I FOR DETERMINING FLUSHNESS FOR RIVETS.
- REFER TO APPLICABLE PERMITTED DAMAGE AND REPAIR DATA FOR TAPERING LIMITS OF COMPOSITE PANEL EDGEBANDS.
- THE SURFACE FINISH SHALL BE AN AVERAGE, NOT TO BE MORE THAN 110 u-in(0.10 CUTOFF). EXCEPT FOR THOSE SURFACES FINISHED WITH BMS 10-86 OR BMS 10-100, WHICH SHALL HAVE AN AVERAGE NOT TO BE MORE THAN 150 u-in. NO LOCALIZED AREA SHALL BE MORE THAN 300 u-in.

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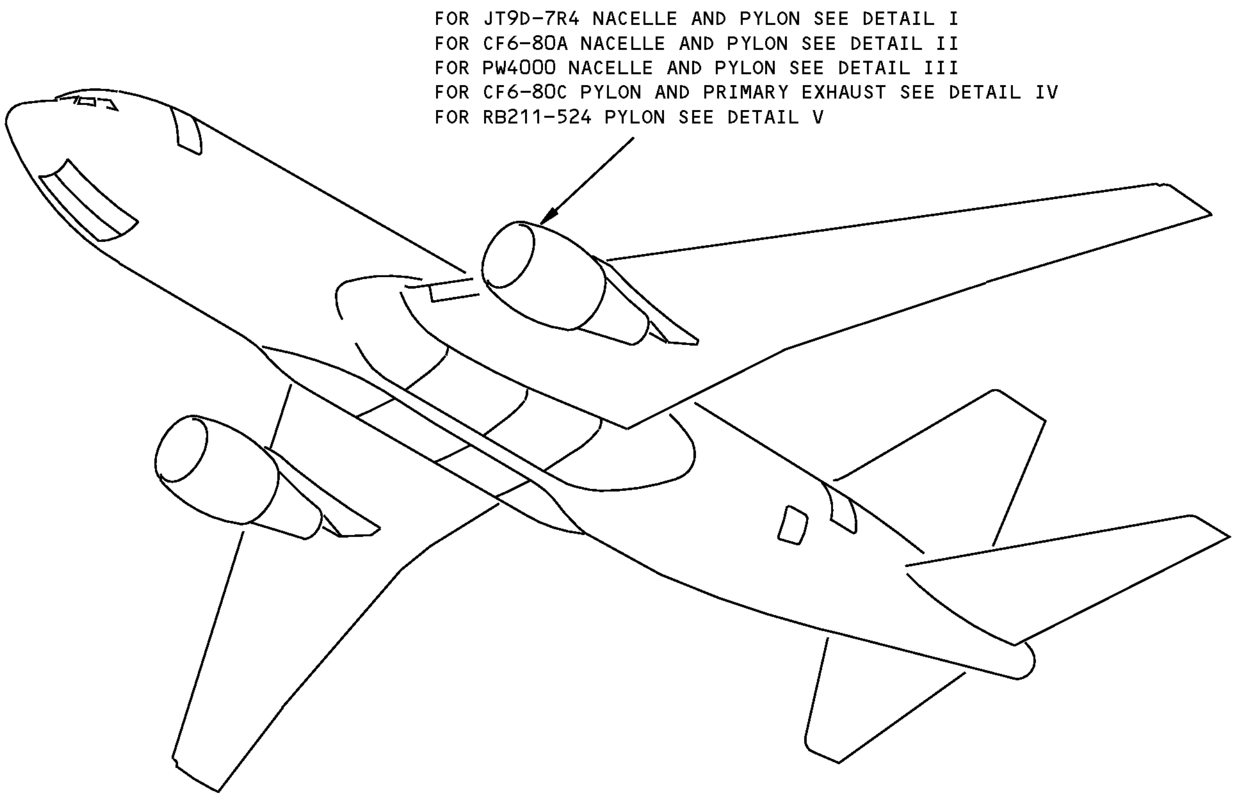
Aerodynamic Smoothness - Wing
Figure 5 (Sheet 3 of 3)



NOTES

- SEE TABLES I AND II FOR FASTENER FLUSHNESS.
- SEE TABLE III TO FIND AERODYNAMIC SMOOTHNESS REQUIREMENTS FOR DISHES AT FASTENERS AND WAVES.
- SEE TABLES IV,V AND VI TO FIND AERODYNAMIC SMOOTHNESS TOLERANCES FOR JOINTS.
- DO NOT SHAVE STEEL, TITANIUM, REMOVABLE FASTENERS OR BACR15CE RIVETS. REFER TO FIG. 3, DETAIL II FOR MEASUREMENT OF BACR15CE RIVETS.

A TO BE DETERMINED BY USE OF A 6.0 SPLINE AND FEELER GAGE.

B EXCEPTIONS TO THESE REQUIREMENTS ARE GIVEN IN TABLE V.

C FOR 10% OF INTERFACE

D FOR 15% OF INTERFACE

E 0.06 RADIUS REQUIRED ON CORE COWL SKIN PANEL EDGE WHEN MISMATCH EXCEEDS 0.045.

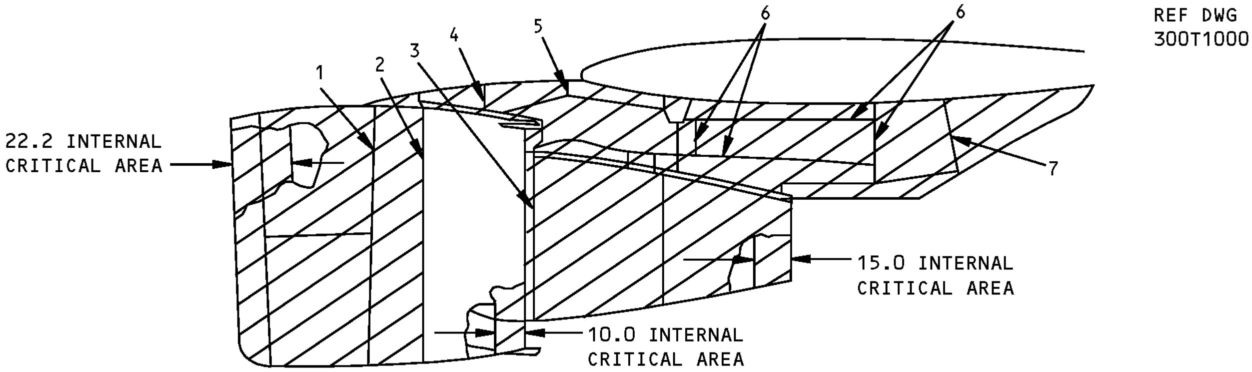
F FOR JT9D-7R4 AND PW4000 ENGINES ONLY.

G FOR JT9D-7R4 LOAD SHARING NACELLES AND PW4000 ENGINES ONLY.

H FOR ALL ENGINE NACELLES AND PYLONS EXCEPT THE RB211-524 NACELLE AND PYLON AND THE CF6-80C NACELLE.

I FOR ALL NACELLES AND PYLONS EXCEPT THE RB211-524 AND CF6-80C NACELLES.

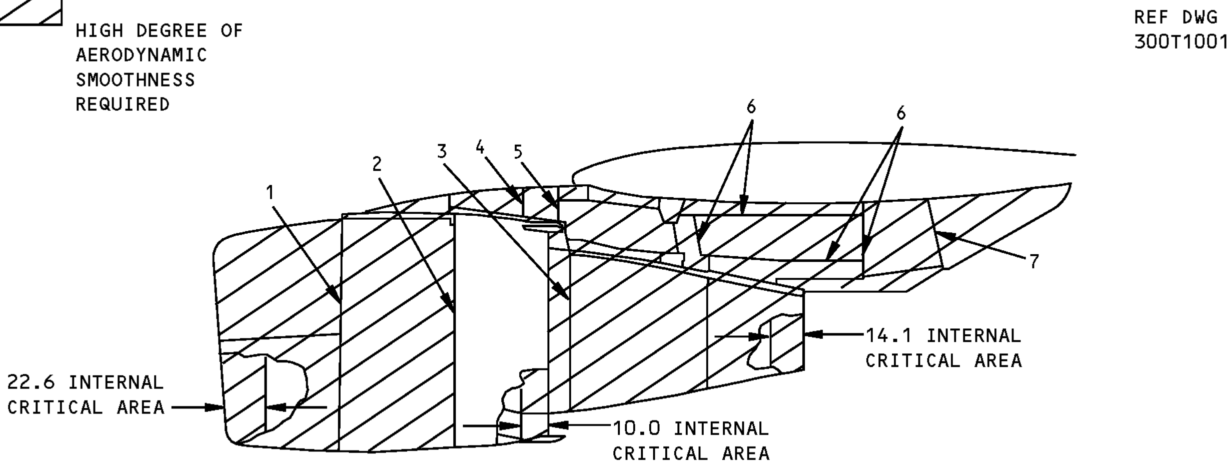
Aerodynamic Smoothness - Nacelle and Pylon
Figure 6 (Sheet 1 of 8)



LOCATION OF CRITICAL AREAS FOR JT9D-7R4 NACELLE AND PYLON
DETAIL I

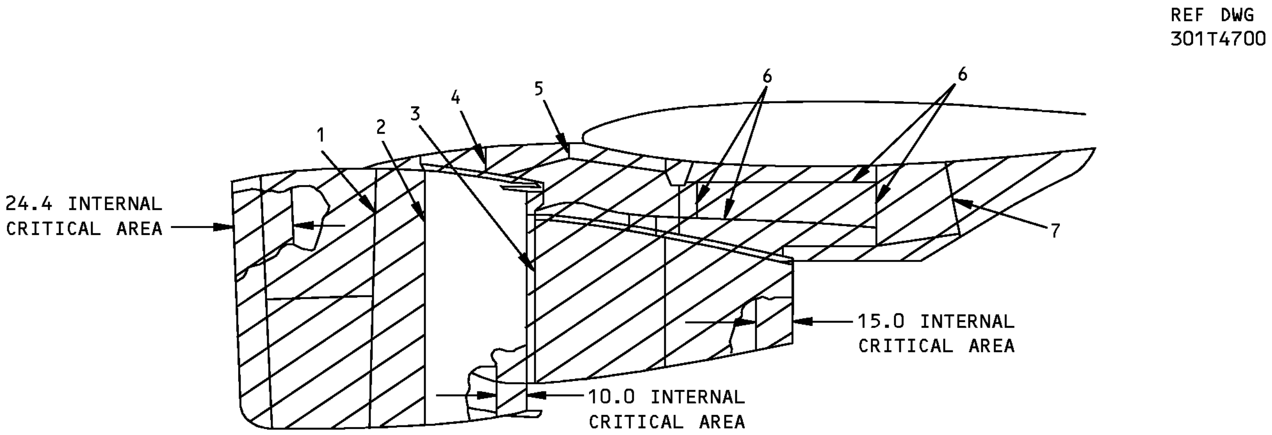
☐ NONCRITICAL AREA

▨ CRITICAL AREA
HIGH DEGREE OF AERODYNAMIC SMOOTHNESS REQUIRED



LOCATION OF CRITICAL AREAS FOR CF6-80A NACELLE AND PYLON
DETAIL II

Aerodynamic Smoothness - Nacelle and Pylon
Figure 6 (Sheet 2 of 8)

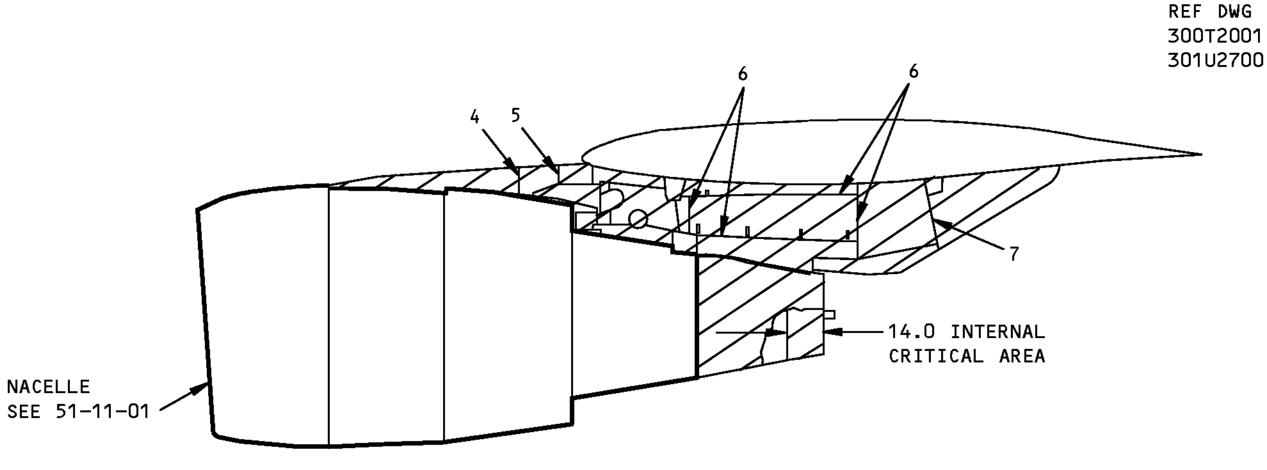


LOCATION OF CRITICAL AREAS FOR PW4000 NACELLE AND PYLON
DETAIL III

☐ NONCRITICAL AREA

▨ CRITICAL AREA

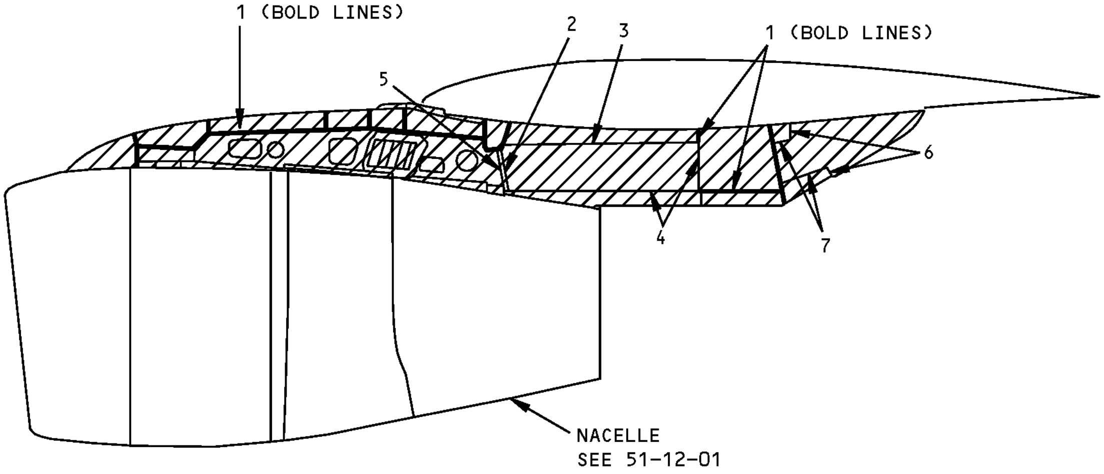
HIGH DEGREE OF AERODYNAMIC SMOOTHNESS REQUIRED



LOCATION OF CRITICAL AREAS FOR CF6-80C2 PYLON AND PRIMARY EXHAUST
DETAIL IV

Aerodynamic Smoothness - Nacelle and Pylon
Figure 6 (Sheet 3 of 8)

REF DWG
301T570



LOCATION OF CRITICAL AREAS FOR RB211-524 PYLON
DETAIL V

☐ NONCRITICAL AREA

▨ CRITICAL AREA
HIGH DEGREE OF AERODYNAMIC
SMOOTHNESS REQUIRED

Aerodynamic Smoothness - Nacelle and Pylon
Figure 6 (Sheet 4 of 8)

FASTENER TYPE	CRITICAL AREAS	NON-CRITICAL AREAS
FLUSH ALUMINUM ALLOY RIVETS	SHALL BE FLUSH WITHIN TOLERANCE 0.000 TO 0.004 HIGH EXCEPT FOR 10% WHICH MAY BE WITHIN TOLERANCE 0.001 LOW TO 0.007 HIGH	SHALL BE FLUSH WITHIN TOLERANCE 0.001 LOW TO 0.007 HIGH
SHEAR HEAD (BACR15CE) RIVETS	SHALL BE FLUSH WITHIN TOLERANCE 0.000 TO 0.004 HIGH EXCEPT FOR 10% WHICH MAY BE WITHIN TOLERANCE 0.001 LOW TO 0.007 HIGH	SHALL BE FLUSH WITHIN TOLERANCE 0.000 TO 0.005 HIGH EXCEPT FOR 10% WHICH MAY BE WITHIN TOLERANCE 0.005 LOW TO 0.007 HIGH
SCREWS AND BOLTS	ALL REMOVABLE SCREWS AND BOLTS SHALL BE FLUSH WITHIN TOLERANCE 0.003 LOW TO 0.003 HIGH. 15% MAY BE 0.006 LOW TO 0.005 HIGH	ALL COUNTERSUNK SCREWS AND BOLTS SHALL BE FLUSH WITHIN TOLERANCE 0.010 LOW TO 0.005 HIGH
HI-LOK FASTENERS AND LOCKBOLTS	SHALL BE FLUSH WITHIN TOLERANCE 0.003 LOW TO 0.003 HIGH EXCEPT FOR 10% WHICH MAY BE WITHIN TOLERANCE 0.005 LOW TO 0.006 HIGH	SHALL BE FLUSH WITHIN TOLERANCE 0.003 LOW TO 0.005 HIGH EXCEPT FOR 10% WHICH MAY BE WITHIN TOLERANCE 0.005 LOW TO 0.007 HIGH

FASTENER FLUSHNESS FOR ALL NACELLES AND PYLONS EXCEPT THE
RB211-524 NACELLE AND PYLON AND THE CF6-80C NACELLE
TABLE I

FASTENER TYPE	CRITICAL AREAS
FLUSH ALUMINUM ALLOY RIVETS	SHALL BE FLUSH WITHIN TOLERANCE 0.000 TO 0.003 HIGH
SHEAR HEAD (BACR15CE) RIVETS	SHALL BE FLUSH WITHIN TOLERANCE 0.000 TO 0.003 HIGH EXCEPT FOR 10% WHICH MAY BE WITHIN TOLERANCE 0.0005 LOW TO 0.005 HIGH. DO NOT SHAVE HEADS
SCREWS AND BOLTS	ALL REMOVABLE SCREWS AND BOLTS SHALL BE FLUSH WITHIN TOLERANCE 0.003 LOW TO 0.003 HIGH
HI-LOK FASTENERS AND LOCKBOLTS	SHALL BE FLUSH WITHIN TOLERANCE 0.003 LOW TO 0.003 HIGH EXCEPT FOR 10% WHICH MAY BE WITHIN TOLERANCE 0.005 LOW TO 0.003 HIGH. DO NOT SHAVE HEADS

FASTENER FLUSHNESS FOR RB211-524 PYLON
TABLE II

Aerodynamic Smoothness - Nacelle and Pylon
Figure 6 (Sheet 5 of 8)

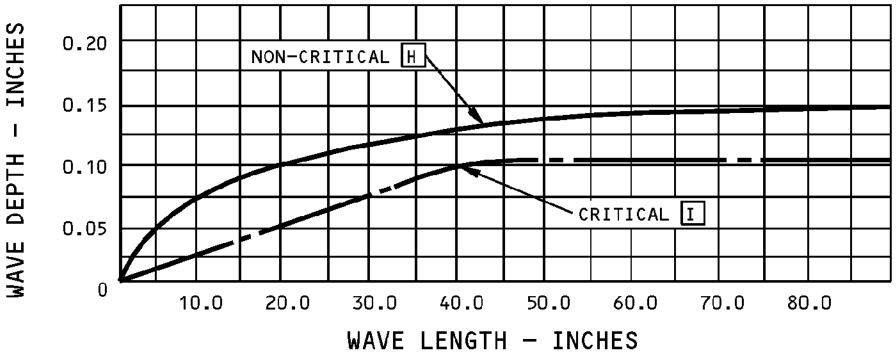


CHART I

CONDITION		LOCATION	CRITICAL	NONCRITICAL
1	WAVE DEPTH TO LENGTH RATIO	ALL SKINS	0.0025	SEE GRAPH
2	1.0 MAX DIA DISH AT FASTENERS (MAY BE ADDITIVE TO ABOVE)	AT FASTENERS	0.0050 $\boxed{A}$	0.0100 $\boxed{A}$

AERODYNAMIC SMOOTHNESS REQUIREMENTS FOR ALL ENGINE NACELLES AND PYLONS EXCEPT THE RB211-524 AND CF6-80C NACELLES
TABLE III

GAPS	LOCATION	CRITICAL AREAS	NON-CRITICAL AREAS
LONGITUDINAL (STREAMWISE) BUTT JOINTS-MAX. GAPS	REMOVABLE PANELS	0.060	0.060
	HINGED PANELS	0.080	0.080
	FIXED SKINS	0.040	0.040
TRANSVERSE (NORMAL TO AIRSTREAM) BUTT JOINT GAPS	FIXED SKINS	0.00 TO +0.03	0.00 TO +0.06
	REMOVABLE & HINGED PANELS	0.01 TO +0.07	+0.01 TO +0.07

FLUSHNESS	LOCATION	CRITICAL AREAS	NON-CRITICAL AREAS
LONGITUDINAL JOINT FLUSHNESS	FIXED SKINS	0.00 TO +0.03	0.00 TO +0.03
	REMOVABLE AND HINGED PANELS	0.00 TO +0.03	0.00 TO +0.03
TRANSVERSE JOINT FLUSHNESS	FIXED SKINS	-0.02 TO +0.00	-0.03 TO +0.02
	REMOVABLE AND HINGED PANELS	-0.035 TO +0.025	-0.04 TO +0.02

REQUIRED AERODYNAMIC SMOOTHNESS TOLERANCES FOR ALL NACELLES AND PYLONS EXCEPT RB211-524 NACELLE AND PYLON AND CF6-80C NACELLE $\boxed{B}$
TABLE IV

Aerodynamic Smoothness - Nacelle and Pylon
Figure 6 (Sheet 6 of 8)

	LOCATION OF PANEL	GAPS		FLUSHNESS (SEE DETAIL V)	
		LONGITUDINAL	TRANSVERSE	LONGITUDINAL	TRANSVERSE
1	INLET COWL TO FAN COWL	----------	0.02 TO 0.18 0.02 TO 0.24 C	----------	±0.05 -0.09 TO +0.05 D
2	FAN COWL TO FAN DUCT COWL	----------	0.08 TO 0.24 0.08 TO 0.30 C	----------	±0.05 -0.09 TO +0.05 D
3	FAN DUCT INNER WALL TO CORE COWL	----------	0.22 TO 0.42	----------	-0.06 TO +0.045 E -0.04 TO +0.030 G
4	FWD STRUT FAIRING PANEL-TO-PANEL	----------	0.08 ±0.06	----------	-0.045 TO +0.025 -0.065 TO +0.025 D F -0.080 TO +0.025 D F
5	FWD STRUT FAIRING TO UNDER-WING FAIRING	----------	0.08 ±0.06	----------	-0.035 TO +0.025
6	STRUT ACCESS PANEL TO FAIRING	0.06 TO 0.20	0.06 TO 0.20	±0.06	±0.04
7	AFT FAIRING TO TRAILING EDGE FAIRING	----------	0.06 ±0.03	----------	----------

GAP AND FLUSHNESS REQUIREMENTS FOR ALL NACELLE AND PYLON INTERFACES
EXCEPT RB211-524 NACELLE AND PYLON AND CF6-80C NACELLE
TABLE V

(+) POSITIVE STEP (-) NEGATIVE STEP

TRANSVERSE FLUSHNESS DEFINITION
DETAIL V

Aerodynamic Smoothness - Nacelle and Pylon
Figure 6 (Sheet 7 of 8)

	LOCATION OF PANEL	GAP	FLUSHNESS
1	FORWARD STRUT FAIRING, UNDERWING FAIRING AND STRUT SKIN, PANEL TO PANEL AFT PANEL TO TRAILING EDGE FAIRING AND AFT PANELS, PANEL TO PANEL	0.06 ±0.04	0.00 ±0.03
2	STRUT ACCESS PANEL	0.27 ±0.03	
3		0.12 ±0.03	
4		0.09 ±0.03	
5	STRUT SKIN AFT EDGE	0.05 ±0.03	
6	TRAILING EDGE FAIRING PANEL TO PANEL	0.05 ±0.03	
7		$0.03^{+0.03}_{-0.02}$	

GAP AND FLUSHNESS REQUIREMENTS FOR RB211-524 PYLON
TABLE VI

Aerodynamic Smoothness - Nacelle and Pylon
Figure 6 (Sheet 8 of 8)

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
51-00-06, GENERAL	Structural Repair Definitions
51-10-01, GENERAL	Aerodynamic Smoothness Requirements
51-10-05, REPAIR 1	Instructions to Make It Possible To Operate Airplanes With Missing Fasteners In Secondary Structure - Strut Fairing
51-20-01, GENERAL	Protective Treatment of Metallic and Nonmetallic Repair Parts
51-20-02, GENERAL	Heat Treat Verification - Hardness and Conductivity Testing
51-20-05, GENERAL	Repair Sealing
51-20-07, GENERAL	Freeze Plug Installation
51-40-02, GENERAL	Fastener Installation and Removal
51-40-05, GENERAL	Fastener Hole Sizes
51-60-00, GENERAL	Control Surface Balance Moment Determination
51-70-16, GENERAL	Hole Drilling and Machining of Composite Structures
AMM 51-20-00	Aircraft Maintenance Manual
AMM 51-21-00	Aircraft Maintenance Manual
CPM 20-40-00	Corrosion Removal
DOCUMENT D6-26100	Airline Maintenance Inspection Intervals Document
NDT Part 1, 51-00-00	General Data
NDT Part 1, 51-06-00	Eddy Current
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

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 judgement 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, scraping, 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 break 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 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 cutout 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 Chapters 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 this 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 906A1 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 Nondestructive Test Manual NDT for the applicable nondestructive 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

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.

A. Aluminum Metal Alloys

CAUTION: DO NOT USE A CARBON STEEL BRUSH OR STEEL WOOL ON ALUMINUM SURFACES. IF YOU DO NOT OBEY, METAL PARTICLES CAN BOND TO 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 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 51-20-00.

B. Titanium

WARNING: USE CARE WHEN YOU WORK WITH TITANIUM. SMALL PARTICLES 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 0.50 INCH (12.7MM) OR MORE ON THE AREA THAT IS ON FIRE. DO NOT USE FOAM, WATER, CARBON TETRACHLORIDE, OR CARBON DIOXIDE. WHEN WATER TOUCHES MOLTEN TITANIUM, A STEAM EXPLOSION CAN OCCUR.

(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 abrasive finish as follows:

    (a) Select the abrasive as given in 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) thick.

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

(e) Parts that show discoloration that cannot be removed with Series 80 solvent, must be rejected. Refer to SOPM 20-30-80 for 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 PERSONS.

CAUTION: DO NOT USE CARBON STEEL BRUSH OR STEEL WOOL ON MAGNESIUM SURFACES. TINY DISSIMILAR METAL PARTICLES WILL BECOME IMPEDDED IN THE MAGNESIUM CAUSING FURTHER CORROSION AND SUBSEQUENT DAMGE 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 below the surface, then do an eddy current inspection or a penetrant inspection on the repair area.

(c) To find damage below the surface, refer to NDT Part 1, 51-06-00 and NDT Part 1, 51-00-00 for eddy current inspections. Refer to SOPM 20-20-02 for the penetrant inspections.

(d) 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 51-70-16, GENERAL for specific machining methods of non-metallic composite materials.

(3) Also, see Figure 6/GENERAL for 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./GENERALfor 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 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 Paragraph 5./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.

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 THE 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 paragraph C. and D. below.

(2) Repairable internal region damage as applicable in repairs that are called out in subjects 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 C. 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 Paragraph 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 51-00-06, GENERAL for the correct definitions of these types of repairs.

(2) Category B (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 times are usually defined as flight hours, flight cycles or letter checks. The letter checks are different from model to model for Boeing airplanes.

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

(3) Category C (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. These times are usually defined 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, 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 the router and template (Figure 2/GENERAL), or the hole saw (Figure 3/GENERAL), to cut circular holes in aluminum honeycomb or fiberglass structure.

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 in51-20-01, 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 51-20-05, 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 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 51-20-05, GENERAL).

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

(e) Apply the protective finish if necessary as given in AMM 51-21-00.

(2) For flush repairs:

(a) Clean the mating surfaces.

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

(c) Install the repair parts.

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

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

(f) Apply the protective finish as necessary. Refer to AMM 51-21-00.

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 fastener 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 necessry 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 preventive 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 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 by the HFEC method. Refer to Part 6, 51-00-00 of the NDT Manual 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 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. 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 51-20-07, 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 a 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 an HFEC inspection of each drilled stop hole. Refer to Part 6, 51-00-00 of the NDT manual 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 SRM 51-10-05, REPAIR 1 to see if it is possible to operate an airplane with missing 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 judgement. 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 the 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.

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.

(2) To remove the corrosion, use a rotary file, a rubber-backed disc sander, a carbide-tipped scraper, or aluminum oxide abrasive as necessary. See Figure 5/GENERAL to find the permitted abrasives. Use air motors for all of the power tools. See 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 the Corrosion Prevention Manual (CPM) Part 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: ALL CORROSION MUST BE REMOVED TO PREVENT FURTHER CORROSION DAMAGE AND TO ESTABLISH THE APPROPRIATE REPAIR ACTION. CORROSION THAT IS NOT FULLY REMOVED WILL CONTINUE TO PROPAGATE EVEN IF THE PART IS REFINISHED. IN EXTREME CASES, CONTINUED CORROSION PROPAGATION COULD COMPROMISE STRUCTURAL INTEGRITY.

(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 material as given in CPM 20-40-00 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 Part 1, 51-06-00 and Part 6, 51-00-00 of the NDT Manual 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 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 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 IMBEDDED IN THE MAGNESIUM CAUSING FURTHER CORROSION AND SUBSEQUENT DAMAGE TO THE PART.

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 looks 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 6./GENERAL to remove light corrosion damage.

  (b) Refer to Paragraph 7./GENERAL to remove moderate to severe corrosion damage.

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

CAUTION: DO NOT USE THIS PROCEDURE 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.

  (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 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.

    3) Refer to Part 1, 51-06-00 and Part 6, 51-00-00 of the NDT Manual 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) 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 I primer. Refer to SOPM 20-41-02.

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

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

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

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 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 reapair 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 Part 1, 51-06-00 and Part 6, 51-00-00 of the NDT Manual 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 I to the reworked area. Refer to SOPM 20-41-02.

(f) Apply two layers of BMS 10-60, Type I or 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 having 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 paragraphs 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 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 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 faceshields 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:

- Methyl Alcohol
- Methyl Ethyl Ketone
- Methyl Isobutyl Ketone
- Toluene
- Trichloroethylene
- Epoxy resin
- Methylene Chloride
- Chemical conversion coatings
- Xylene
- Petroleum Naphthas
- Chromates

- Dichromates
- Acetates
- Cyclohexanone
- Cellosolve
- 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 make sure of complete washing.

(c) If a chemical is splashed on clothing or large areas of the body, immediately remove contaminated clothing and wash the 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:

- Hydrofluoric acid
- Nitric acid
- Phosphoric acid
- Phenol
- Cresols
- Tricresyl phosphate

WARNING: MAKE SURE THAT YOU USE PROTECTION FOR YOUR SKIN, EYES AND RESPIRATORY SYSTEM FROM THESE MATERIALS. THEY ARE HAZARDOUS. IF YOU DO NOT, INJURY WILL BE THE RESULT.

(4) Treat as follows:

(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 make sure of 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 aid 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, PARAGRAPH 14., PRIOR TO PERFORMING ANY CHEMICAL TESTING.

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 section, or when a plating material needs to 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 austentic 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 clad aluminum penetration test.

F. Chemical Spot Analysis of Magnetic Metals

(1) The magnetic metals usually employed in airplane 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 (Na2S) 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 (HN03) on a fresh spot. After 1 minute, add a drop of sodium sulfide (Na2S) to the drop of nitric acid (HN03).

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 (H2S04) 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 airplane 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. Make sure that the 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 16.F./GENERAL.

(c) If the results of step (b) preceding are negative, confirm the magnesium and aluminum tests by placing a drop of 10% sodium hydroxide (NaOH) 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 percent 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 placing 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) preceding, test for a plating material as specified in paragraph F.(2).

(g) If step (f) reveals the presence of plating on the nonmagnetic metal, 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 by Paragraph 16.I./GENERAL.

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 test solution. Allow no more than 1/32 inch bare metal around periphery of damage.

WARNING: DO NOT ALLOW TEST SOLUTION TO CONTACT 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 proportions:

(a) Potassium Nitrate = 200 grams

(b) Sodium Hydroxide = 100 grams

(c) Water to make one liter of solution

CAUTION: DO NOT ALLOW TEST SOLUTION TO CONTACT ANY OTHER AREA THAN THAT TO BE TESTED. THE TEST SOLUTION IS CAUSTIC AND WILL DAMAGE STRUCTURE.

(5) Apply 1 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

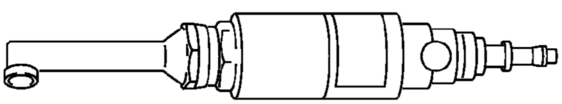
WARNING: THE REAGENTS USED IN THE CHEMICAL SPOT TEST ARE EXTREMELY CORROSIVE. OBSERVE THE SAFETY PRECAUTIONS OF PARAGRAPH 14. IF YOU DO, THEN INJURY TO PERSONNEL CAN OCCUR.

(1) After identification of the metal is completed, clean the area as follows:

(a) Blot any remaining chemicals with a dry cloth.

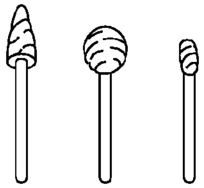
(b) Swab the area several times with a water-moistened cloth.

(c) Test the surface by placing a piece of litmus paper on the moistened surface.

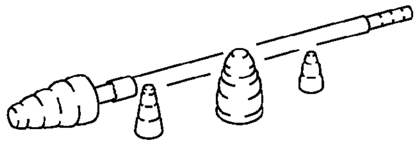


90° AIR MOTOR, 1800 TO 6000 RPM RANGE
MANUFACTURED BY COOPER POWER TOOLS
P.O. BOX 1410
670 INDUSTRIAL DRIVE
LEXINGTON, SOUTH CAROLINA 29071
TELEPHONE NUMBER 1-800-845-5629

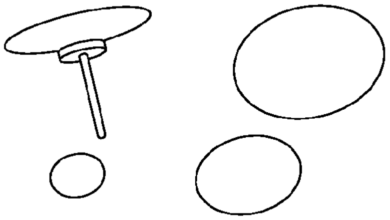
AS AN ALTERNATIVE, YOU CAN USE A
90° AIR MOTOR MANUFACTURED BY
DESOUTTER INCORPORATED
24415 HALSTEAD ROAD
FARMINGTON HILLS, MISSOURI 48335
TELEPHONE NUMBER 1-248-476-5358
OR AN EQUIVALENT SUPPLIER



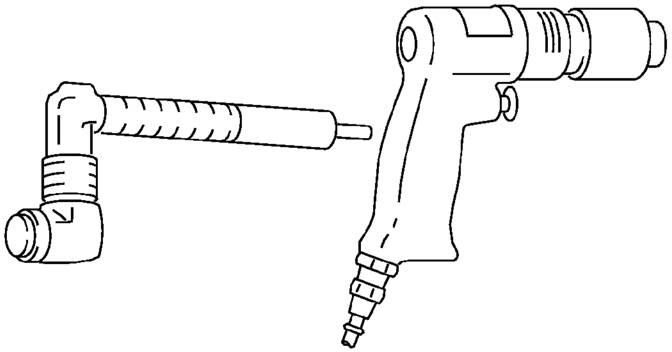
ROTARY FILES. BALL AND CONICAL SHAPES. MANUFACTURED BY AN INDUSTRIAL SUPPLIER OR AN EQUIVALENT TYPE OF SUPPLIER.



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.



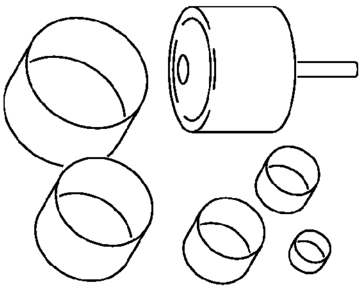
MUSHROOM SANDING PAD WITH 1,2, AND 3 INCH DIAMETER ALUMINUM OXIDE ABRASIVE DISCS. 1/4 INCH DIAMETER SHANK FOR AIR MOTOR. 1/4-28 SIZE THREADED SHANK FOR 90° AIR MOTOR MANUFACTURED BY AN INDUSTRIAL SUPPLIER OR AN EQUIVALENT TYPE OF SUPPLIER.



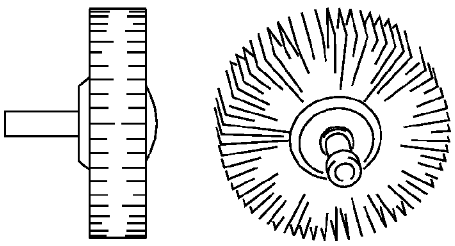
90° AIR MOTOR, 1800 TO 6000 RPM RANGE
MANUFACTURED BY COOPER POWER TOOLS
P.O. BOX 1410
670 INDUSTRIAL DRIVE
LEXINGTON, SOUTH CAROLINA 29071

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.



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.



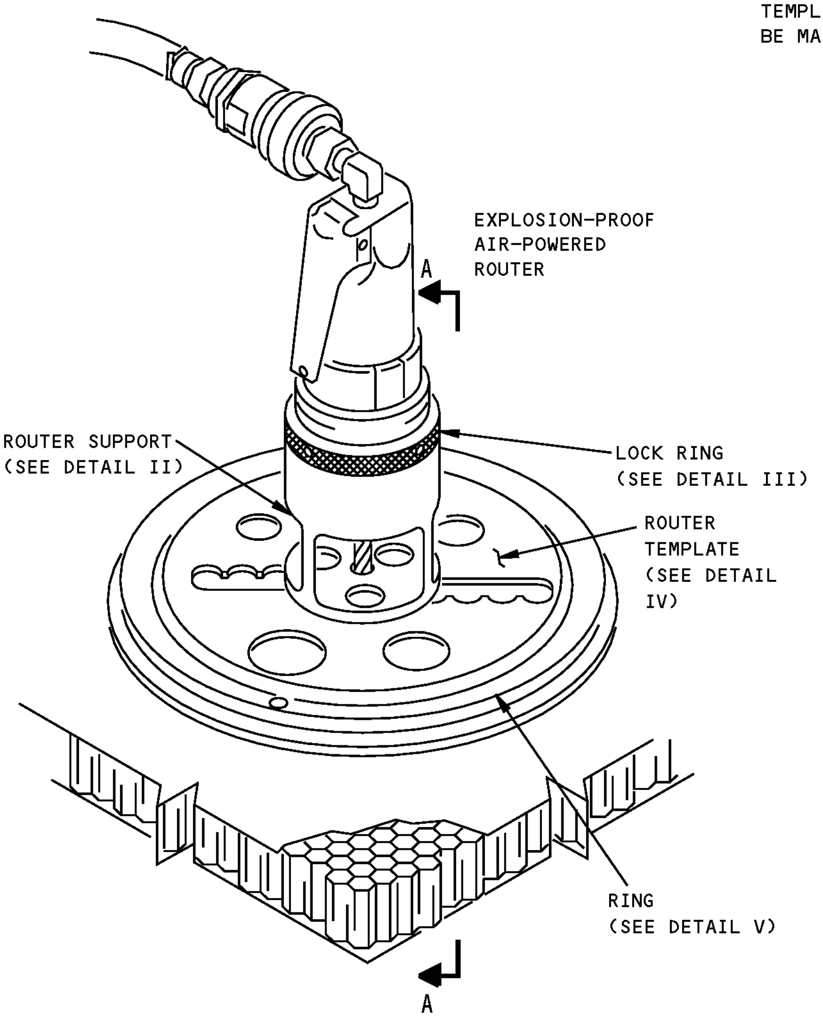
FLEXIBLE SANDING WHEEL. "GRIND-O-FLEX," 1/2 BY 2 INCHES AND 1 BY 3 INCHES. 80 GRIT, ALUMINUM OXIDE ABRASIVE. MANUFACTURED BY AN INDUSTRIAL SUPPLIER OR AN EQUIVALENT TYPE OF SUPPLIER.

Corrosion Removal Tools
Figure 1

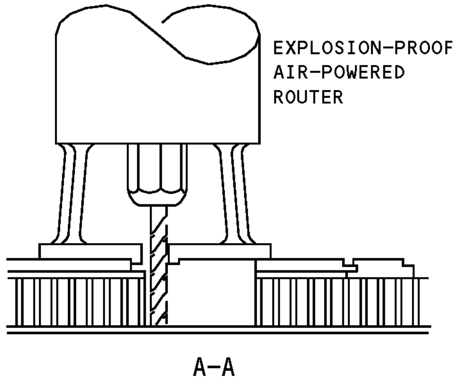
<u>WARNING</u>: WEAR A FACE SHIELD OR PROTECTIVE EYE GOGGLES WHEN YOU USE THIS ROUTER. DISCONNECT THE AIR SUPPLY WHEN YOU MOUNT OR ADJUST THE ROUTER HEIGHT. IF YOU DO NOT OBEY, INJURY TO PERSONNEL CAN OCCUR.

NOTES

- ALL DIMENSIONS ARE IN INCHES.
- 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 I.
  - 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 TRIM 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.

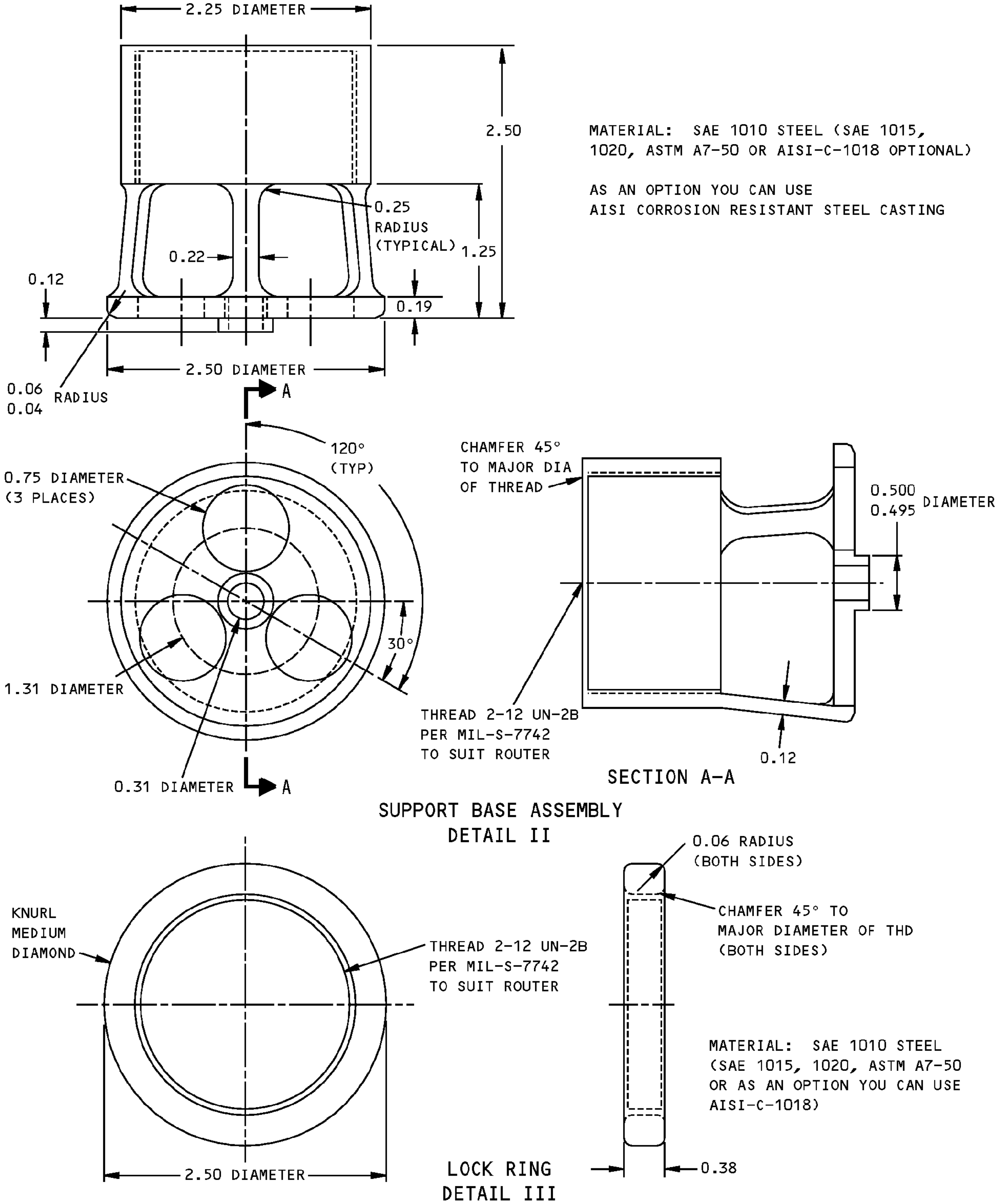


DETAIL I
TYPICAL ROUTER ASSEMBLY



A-A

Router and Template
Figure 2 (Sheet 1 of 4)



MATERIAL: SAE 1010 STEEL (SAE 1015, 1020, ASTM A7-50 OR AISI-C-1018 OPTIONAL)

AS AN OPTION YOU CAN USE AISI CORROSION RESISTANT STEEL CASTING

MATERIAL: SAE 1010 STEEL (SAE 1015, 1020, ASTM A7-50 OR AS AN OPTION YOU CAN USE AISI-C-1018)

Router and Template
Figure 2 (Sheet 2 of 4)

INSTRUCTIONS TO USE THE ROUTER TEMPLATE

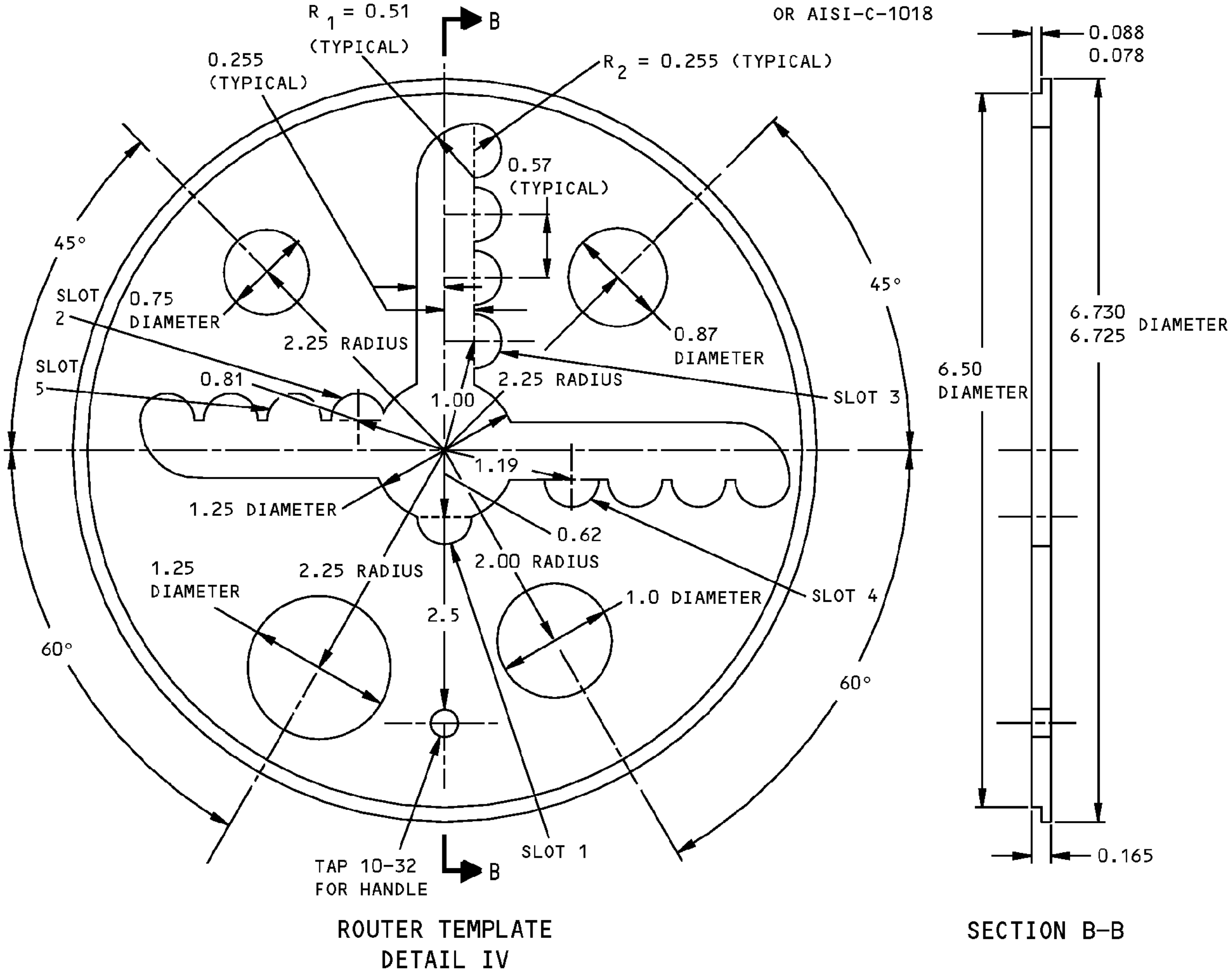
NOTE: The router template is designed to guide the air-powered router assembly while it cuts out damage in a circular outline with 0.25 inch router bit. See Detail IV.

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" shown in Detail IV.
4. Start the air-powered router and turn the template in a clockwise direction to remove the damage.

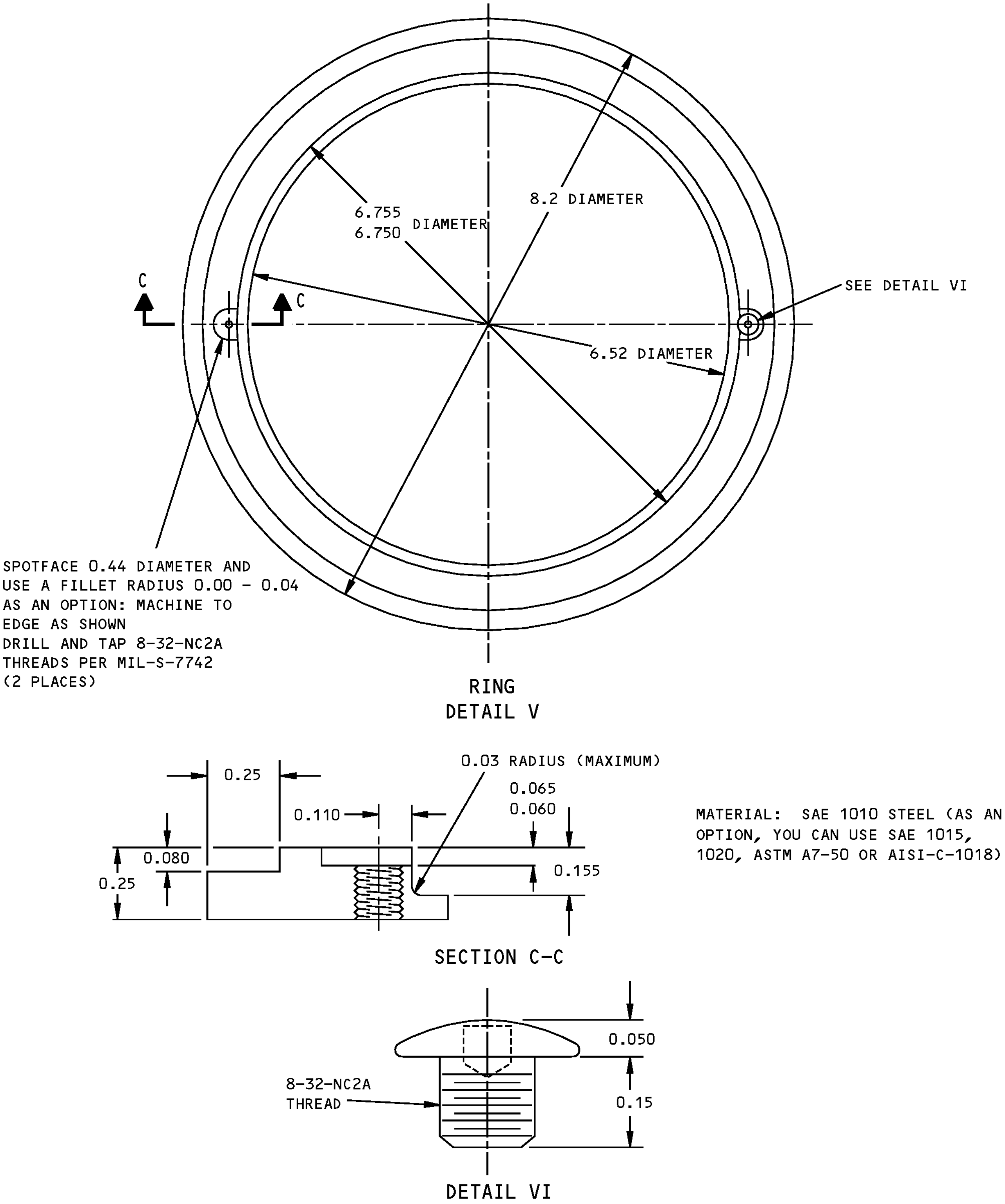
   NOTE: You can put a handle into the tapped hole to help turn the template in the correct direction.
5. After you complete the circle with the router in slot 1, then put the router into next numbered slot, shown in Detail IV as "Slot 2, Slot 3, Slot 4, Slot 5 and so on, until the damage is removed.

   NOTE: Use the router sequence given in Detail IV for each next larger slot diameter to cut out the damage.



MATERIAL: SAE 1010 STEEL (AS AN OPTION YOU CAN USE SAE 1015, 1020, ASTM A7-50 OR AISI-C-1018

Router and Template
Figure 2 (Sheet 3 of 4)



MATERIAL: SAE 1010 STEEL (AS AN OPTION, YOU CAN USE SAE 1015, 1020, ASTM A7-50 OR AISI-C-1018)

Router and Template
Figure 2 (Sheet 4 of 4)

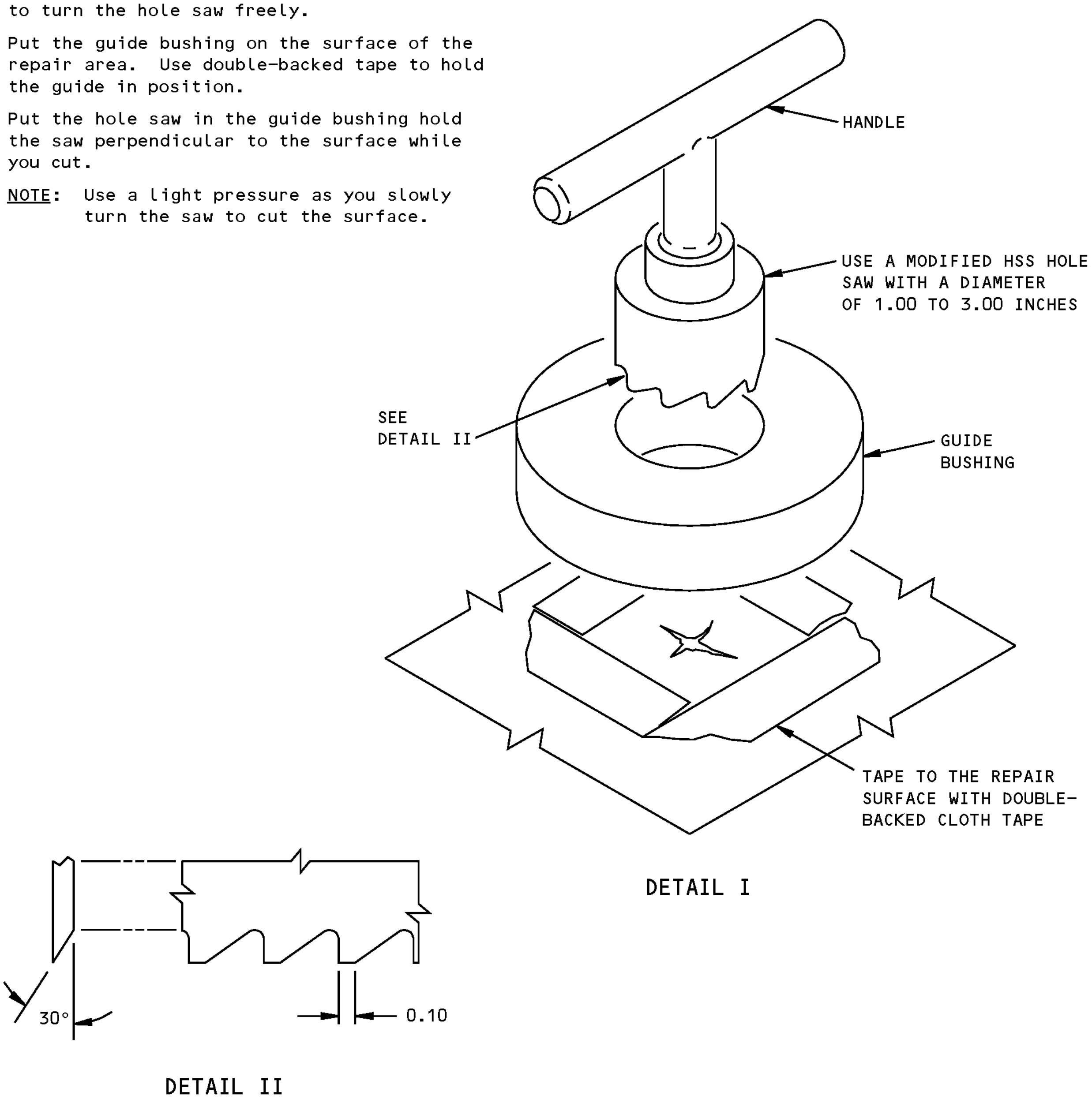
INSTRUCTIONS TO USE THE HOLE SAW

1. The hole saw and guide 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 out 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 surface while you cut.

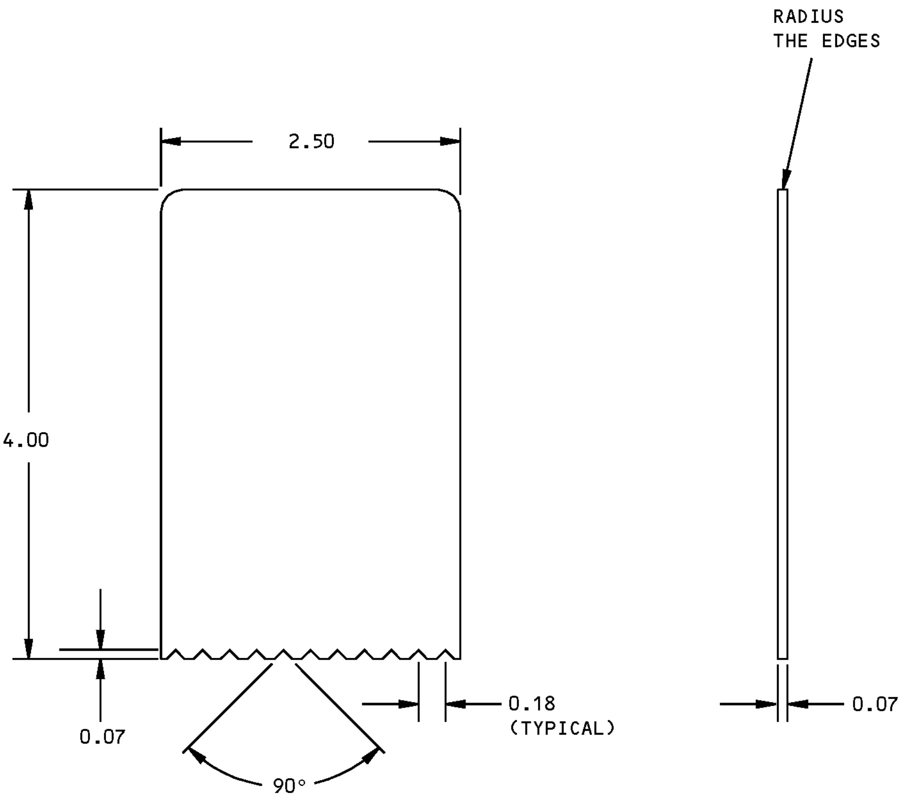
   NOTE: Use a light pressure as you slowly turn the saw to cut the surface.



The Use of the Hole Saw
Figure 3

INSTRUCTIONS TO USE THE SQUEEGEE

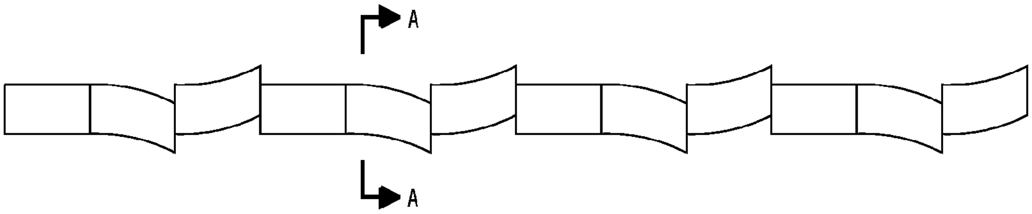
1. Make squeegee from 0.07 inch thick plexiglass or an equivalent material.
2. Use the edge with notches to impregnate fiberglass cloth with adhesive resin, or you can remove trapped air bubbles from a wet layup.



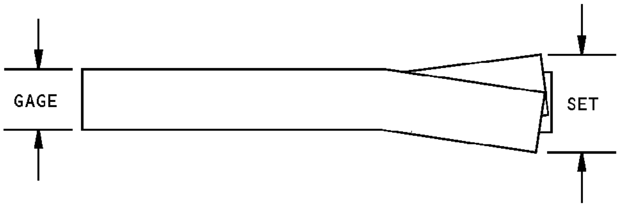
The Use of the Squeegee
Figure 4

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		ALUMI-NUM	STAIN-LESS 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 OR FINER	150 OR FINER		FINE TO ULTRAFINE	X	X	X	
		FINISHING	400				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 OR FINER	180 OR FINER		FINE TO ULTRAFINE	X	X	X	5A OR 7S MEDIUM
		FINISHING	400				X	X	X	7S FINE
ALUMINUM ALLOYS EXCEPT CLAD ALUMINUM	DO NOT USE SILICON CARBIDE ABRASIVE.	CORROSION REMOVAL OR FAIRING	60 OR FINER		7/0 OR FINER	VERY FINE AND ULTRAFINE	X		X	5A MEDIUM
		FINISHING	400				X		X	
CLAD ALUMINUM	SANDING LIMITED TO THE REMOVAL OF MINOR SCRATCHES.	CORROSION REMOVAL OR FAIRING	240 OR FINER		7/0 OR FINER	VERY FINE AND ULTRAFINE			X	
		FINISHING	400						X	
MAGNESIUM ALLOYS	DO NOT USE CARBON STEEL BRUSHES OR SILICON CARBIDE ABRASIVES.	CORROSION REMOVAL OR FAIRING	240 OR FINER			VERY FINE AND ULTRAFINE	X		X	
		FINISHING	400				X		X	
TITANIUM		CORROSION REMOVAL OR FAIRING	80 OR FINER	80 OR FINER				X	X	5A OR 7S MEDIUM
		CLEANING AND FINISHING	150 OR FINER	180 OR FINER				X	X	7S FINE

Abrasives for Sanding or Scouring
Figure 5



RAKER TOOTH FORM OF BAND SAW BLADE

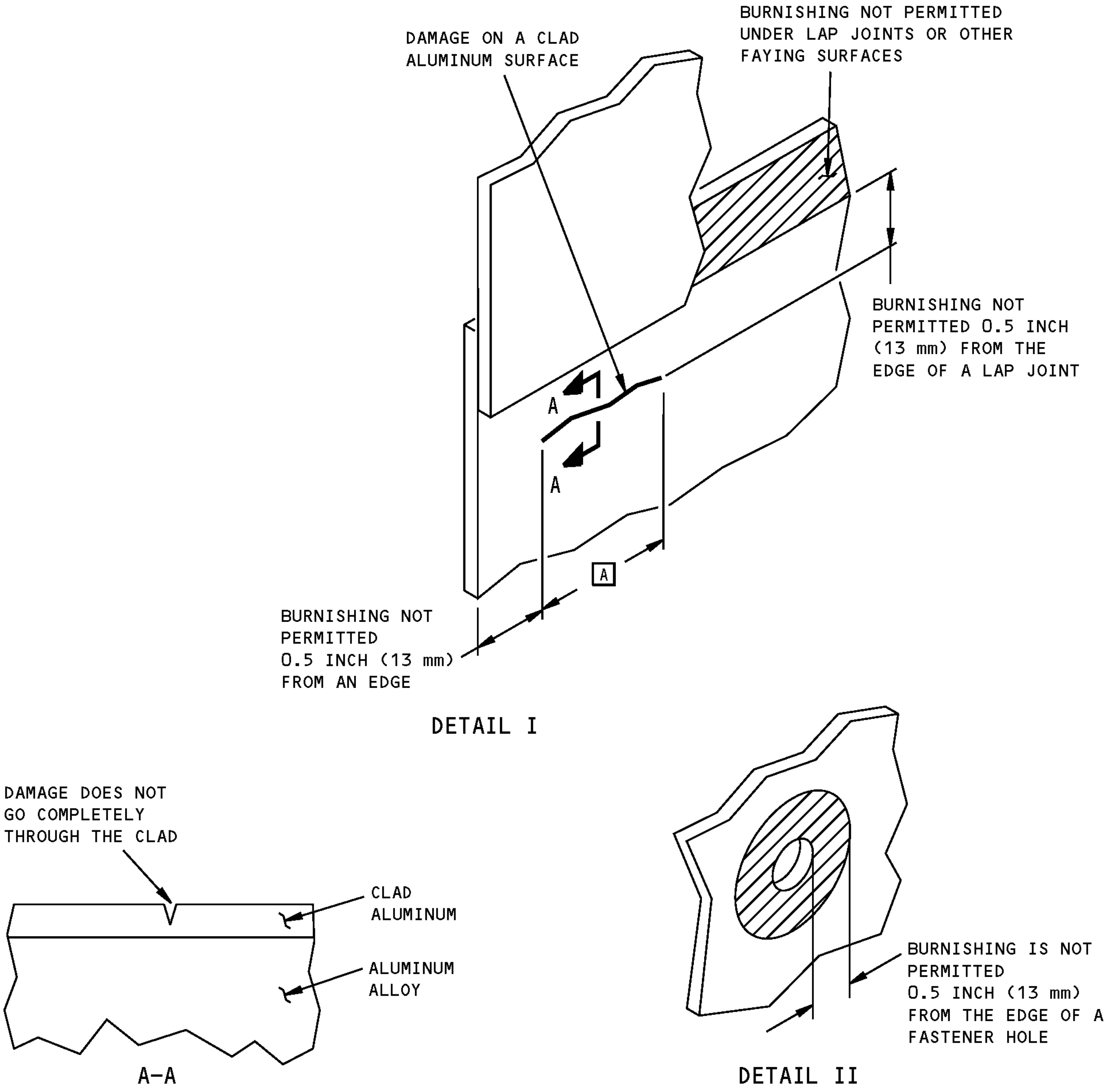


SECTION A-A

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

A 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 LIMITS SECTION.

Burnishing Restrictions on Primary Structure
Figure 7

GENERAL - SKIN WAVINESS INSPECTION FOR REDUCED VERTICAL SEPARATION MINIMUM (RVSM) OPERATION

1. General

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. RVSM airspace is an airspace or route between Flight Level 290 and 410 where airplanes have vertical separation of 1,000 feet (305m).

B. These procedures are for airplanes that are approved for flight in RVSM airspace. You cannot use these procedures to get the initial approval for the airplane for flight in RVSM airspace.

C. There is an area of extra-critical aerodynamic smoothness, as given in 51-10-01, GENERAL, that includes both the angle-of-airflow sensors and the pitot-static probes. These procedures tell you how to return a RVSM certified airplane to service after repair of damage inside the extra-critical aerodynamic smoothness area.

D. When you have damage in the extra-critical area of the pitot-static probes that exceeds the allowable damage limits given in Figure 101/51-10-03, ALLOWABLE DAMAGE GENERAL, you must measure the skin waviness. See Figure 1/GENERAL for the skin waviness measurement area.

E. You must also refer to AMM 51-10-00-6). The AMM will tell you:

  (1) How to set the measurement tool on the fuselage.

  (2) How to measure the skin waviness.

  (3) How to make an analysis of the results.

F. There are no special repairs for the area of the pitot-static probes in the SRM. For typical flush skin repairs, refer to FUSELAGE SKIN - GENERAL, 53-00-01.

G. External skin repairs are not permitted in the "extra-critical" area of the static pressure port.

2. References

Reference	Title
51-10-01, GENERAL	Aerodynamic Smoothness Requirements
53-00-01	FUSELAGE SKIN - GENERAL
AMM 51-10-00-6	Aircraft Maintenance Manual

3. Procedures for General Repairs

A. Refer to the SRM and do the repairs to the damaged parts. Drill the fastener holes for the repair, but do not install the fasteners.

B. Assemble the parts. Do not apply the finish.

C. Use Cleco fasteners (temporary fasteners) to hold the parts together in the completed configuration. Use Cleco fasteners that are short. They must not come out of the skin more than 4 inches. Hold the repair parts together tightly.

D. Measure the skin in the area of the pitot-static probes, over the repair. Refer to AMM 51-10-00-6. Instructions for the use of the skin measurement tool are also given in AMM 51-10-00-6. The tool has an index strip which goes over the skin at a frame. Refer to the instructions and read the values on the tool. Write the values on the worksheet and make an analysis of the skin values.

  (1) If the values are less than the limits that are shown on the worksheets, then the skin waviness is satisfactory. Refer to the SRM and do the steps that follow:

    (a) Apply the chemical conversion coating to the bare surfaces of the aluminum parts.

(b) Apply sealant between the mating surfaces.

(c) Install the fasteners and complete the repair.

(d) Apply the finish to the surface.

(e) Measure the skin waviness again, on the two sides of the airplane. If these values are satisfactory, then the airplane skin waviness requirements for RVSM operations are complete.

4. Procedures for Skin Waviness that is Unsatisfactory

A. If the skin waviness (from step 2) is unsatisfactory, do the steps that follow:

(1) Measure the skin waviness on the side of the airplane that is opposite from the repair, and record the results. Refer to AMM 51-10-00-6.

(2) Provide Boeing with the RVSM data as follows:

(a) The airplane serial number

(b) The number of hours on the airplane

(c) The number of flight cycles on the airplane

(d) Copies of the RVSM worksheets (767 Section 41 Measured Skin Contour; Left and Right Sides). You can give these data to a Boeing Field Service Representative or you can send it to:

Boeing Commercial Airplanes

P.O. Box 3707 Seattle, Washington 98124

Attn: Director 747/767 Service Engineering, Org. M-7240, Mail Stop 04-CR

B. Boeing can do a Computational Fluid Dynamics (CFD) analysis of the measurements. The values of the airplane skin waviness can be satisfactory for RVSM operation although the measured values are greater than the limits given in the worksheet. (This is because both sides of the airplane are included.)

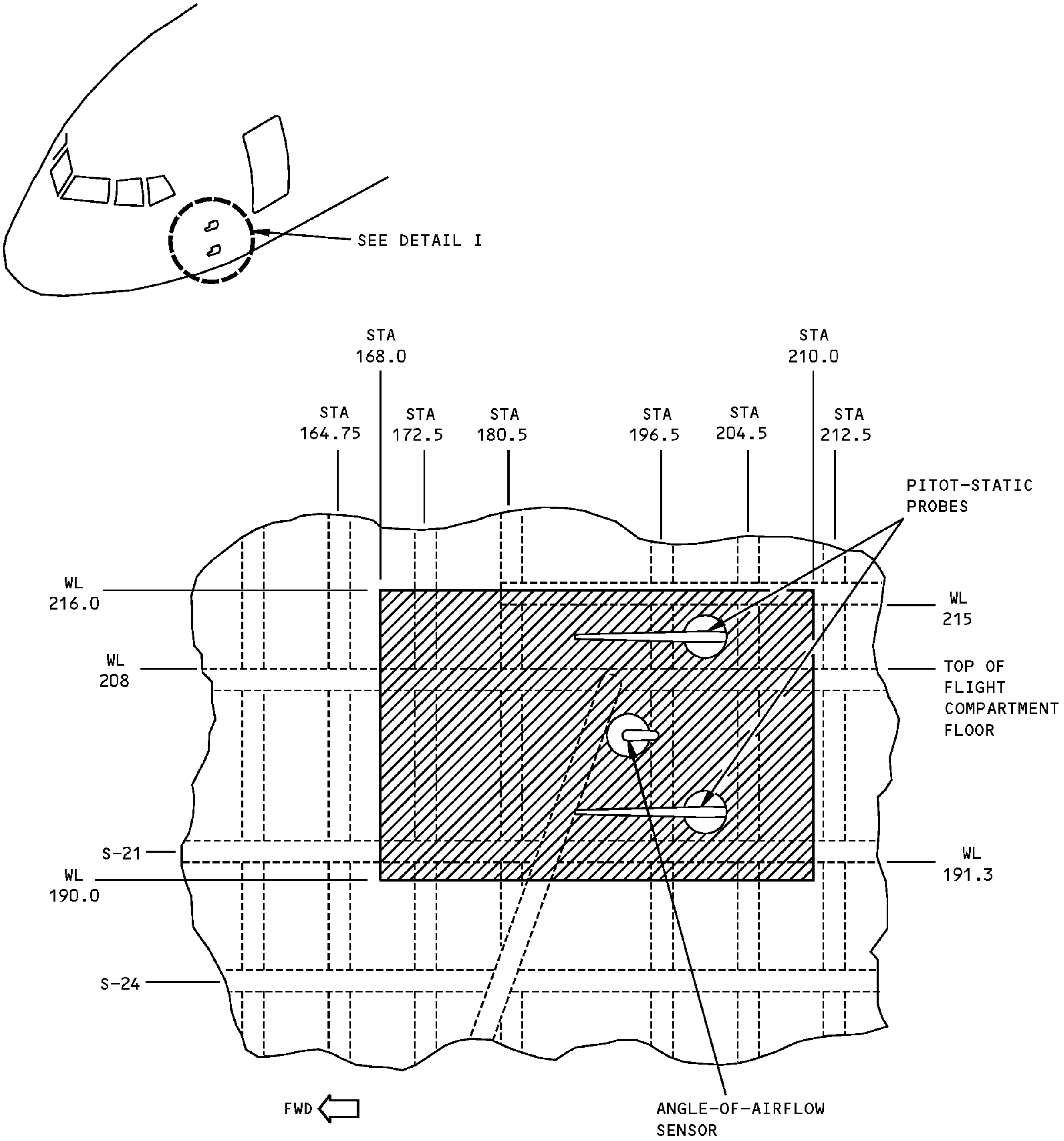
C. If the CFD analysis finds that the skin waviness will permit RVSM operation, Boeing will tell you. Refer to the SRM and complete the repair. After the repair is completed, measure the area of the pitot-static probe, on the side that was repaired, and send copies of the worksheets to Boeing. Boeing can do the CFD analysis again and will send you the results. These results will permit you to get approval for continued operation in RVSM airspace.

WARNING: THE PRECISION OF THE ALTIMETRY INDICATIONS IS CONNECTED TO THE SKIN WAVINESS. YOU MUST GET INSTRUCTIONS FROM BOEING TO CORRECT SKIN WAVINESS. DO NOT INSTALL SHIMS IN THE PITOT-STATIC PROBE AREA WITHOUT APPROVAL FROM BOEING.

D. If the analysis finds that the skin waviness is greater than the limits for RVSM operation, Boeing can:

(1) Give you instructions for the repair.

(2) Give you data for the installation of shims.



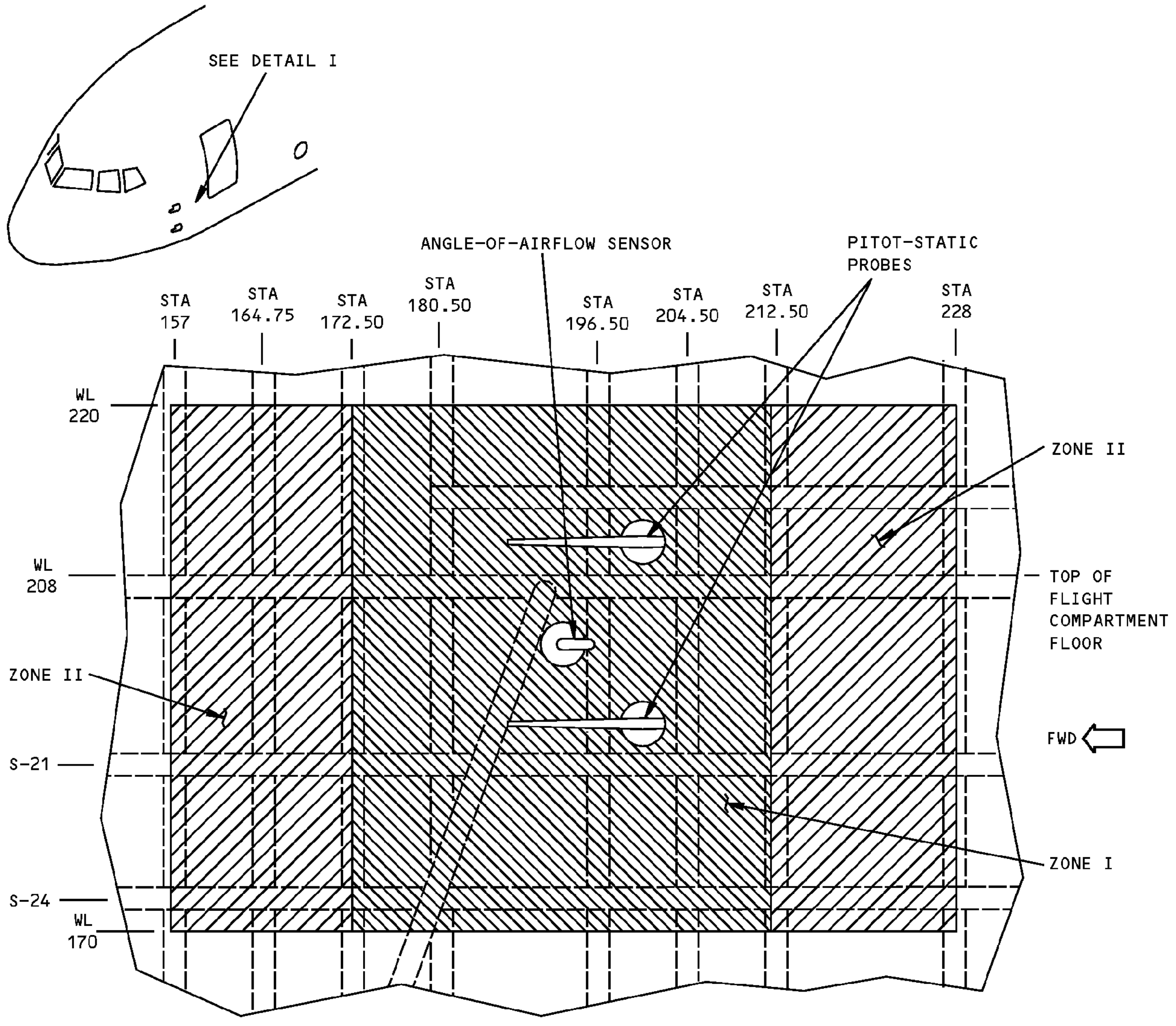
LEFT SIDE IS SHOWN, RIGHT SIDE IS OPPOSITE

▨ SKIN WAVINESS MEASUREMENT AREA

PITOT - STATIC PROBE AREA
DETAIL I

Skin Waviness Inspection For Reduced Vertical Separation Minimum (RVSM) Operation - Skin Waviness Measurement Area
Figure 1

ALLOWABLE DAMAGE GENERAL - ALLOWABLE DAMAGE IN THE EXTRA CRITICAL AERODYNAMIC SMOOTHNESS AREA FOR REDUCED VERTICAL SEPARATION MINIMUM (RVSM) CERTIFIED AIRCRAFT



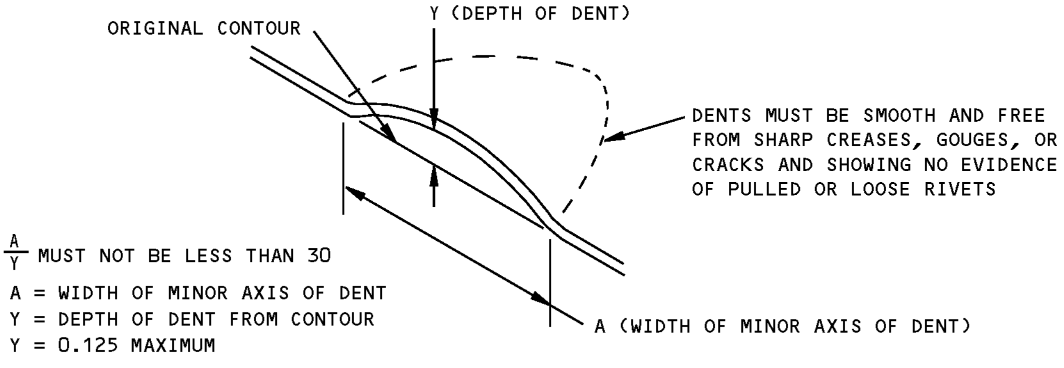
LEFT SIDE IS SHOWN, RIGHT SIDE IS OPPOSITE

PITOT-STATIC PROBE AREA

ITEM	CRACKS	NICKS, GOUGES AND CORROSION	DENTS $\boxed{C}$ $\boxed{D}$ $\boxed{E}$	HOLES AND PUNCTURES	EXTERNAL DOUBLER LIMITATIONS $\boxed{F}$ $\boxed{G}$
SKIN - ZONE I	NOT PERMITTED	NOT PERMITTED	SEE DETAILS II AND III	NOT PERMITTED	$\boxed{A}$
SKIN - ZONE II	NOT PERMITTED	NOT PERMITTED	SEE DETAILS II AND III	NOT PERMITTED	$\boxed{B}$

DETAIL I

**Allowable Damage in the Extra Critical Aerodynamic Smoothness Area for Reduced Vertical Separation Minimum (RVSM) Certified Aircraft
Figure 101 (Sheet 1 of 3)**



DETAIL II

CAUTION: AERODYNAMIC DENT FILLER COMPOUND IS NOT PERMITTED IN THE EXTRA CRITICAL AERODYNAMIC SMOOTHNESS AREA. DO NOT FILL DENTS OR FORM AERODYNAMIC FILLETS.

NOTES

- REFER TO SRM 53-00-01 FOR ALLOWABLE DAMAGE TO FUSELAGE SKIN IN THE AREAS OUTSIDE OF THE EXTRA CRITICAL AERODYNAMIC SMOOTHNESS AREA.
- REFER TO SRM 51-10-02 FOR INSPECTION AND REMOVAL OF DAMAGE
- REFER TO SRM 51-20-01 FOR PROTECTIVE TREATMENT OF METALLIC AND GRAPHITE MATERIALS.
- ALL INTERNAL DOUBLERS MUST NOT CHANGE THE ORIGINAL EXTERNAL CONTOUR IN THIS AREA.
- ALL FASTENERS MUST BE FLUSH IN THE EXTRA CRITICAL AERODYNAMIC SMOOTHNESS AREA.
- REFER TO SRM 51-10-01 FOR THE LOCATION OF THE EXTRA CRITICAL AERODYNAMIC SMOOTHNESS AREA.

$\boxed{A}$ EXTERNAL DOUBLERS ARE NOT PERMITTED IN ZONE I.

$\boxed{B}$ EXTERNAL DOUBLERS LESS THAN OR EQUAL TO 0.15 INCH THICK ARE PERMITTED IN ZONE II.

$\boxed{C}$ THE ALLOWABLE DEPTH OF A DENT IS DETERMINED BY THE DISTANCE OF THE DENT LOCATION FROM THE CLOSEST ANGLE-OF-AIRFLOW SENSOR OR THE STATIC PORTS OF THE PITOT-STATIC PROBE AND THE CONTOUR OF THE DENT. REFER TO DETAILS II AND III.

$\boxed{D}$ ONLY ONE DENT IS PERMITTED FOR EACH AIRPLANE SIDE IN ZONE I SHOWN IN DETAIL I.

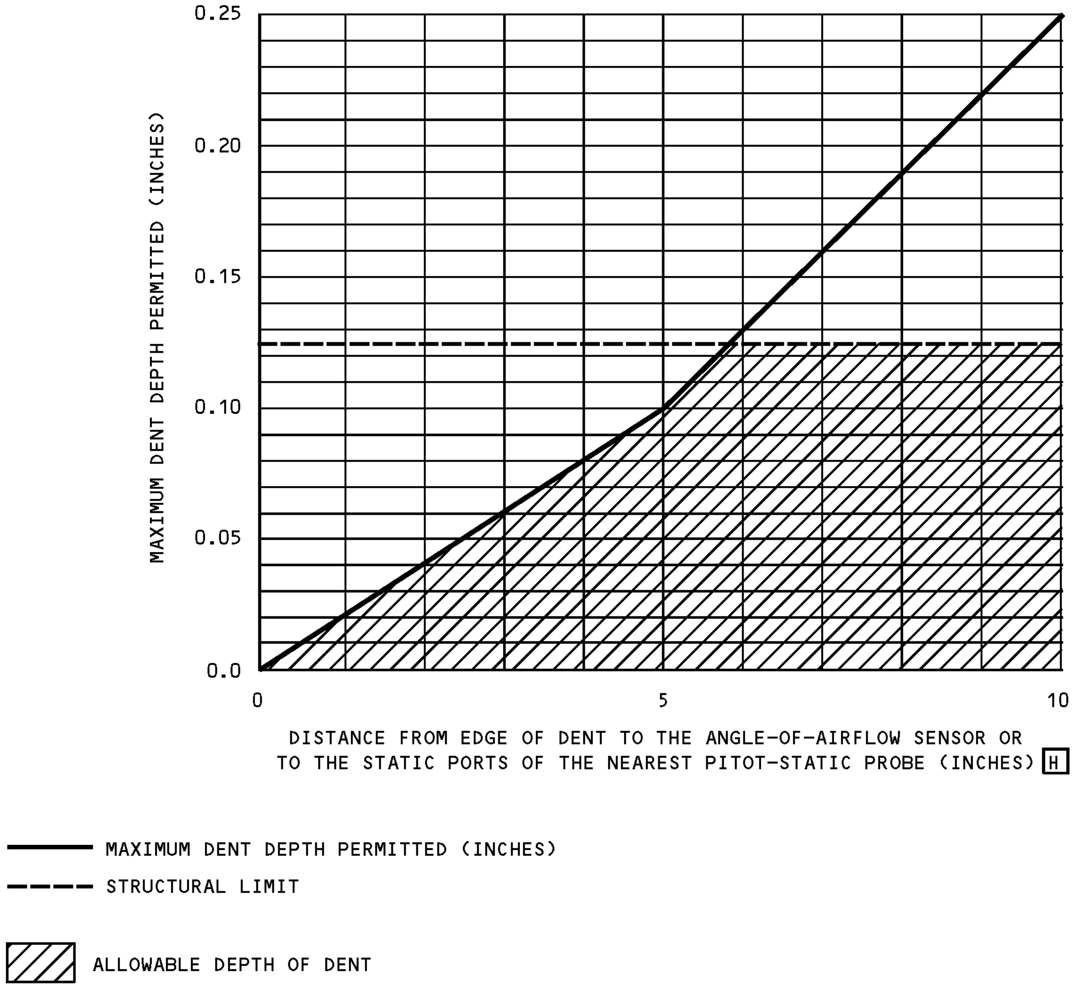
$\boxed{E}$ DO NOT FILL DENTS. AERODYNAMIC DENT FILLER COMPOUND IS NOT PERMITTED IN THE EXTRA CRITICAL AERODYNAMIC SMOOTHNESS AREA.

$\boxed{F}$ EXTERNAL DOUBLERS MUST BE CHAMFERED AT LEAST 4 TO 1. AERODYNAMIC SEALANT FILLETS ARE NOT PERMITTED.

$\boxed{G}$ ONLY ONE DOUBLER REPAIR IS PERMITTED FOR EACH AIRPLANE SIDE.

$\boxed{H}$ THE STATIC PORTS ARE LOCATED ON THE TUBE PART OF THE PROBE. THE LOCATION OF THESE PORTS IS AT BSTA 192, BWL 212 AND BWL 194.

Allowable Damage in the Extra Critical Aerodynamic Smoothness Area for Reduced Vertical Separation Minimum (RVSM) Certified Aircraft
Figure 101 (Sheet 2 of 3)



EXAMPLE: DEPTH OF DENT = 0.08 INCH, WIDTH OF MINOR AXIS OF DENT = 4 INCHES
DISTANCE FROM THE CLOSEST EDGE OF STATIC PROBE = 5 INCHES
FROM CHART: MAXIMUM DEPTH ALLOWED IS 0.1 INCH.
FROM DETAIL II: $\frac{A}{Y} = \frac{4}{0.08} = 50 > 30$
CONCLUSION: DENT IS ALLOWABLE

MAXIMUM DENT DEPTH NEAR PITOT-STATIC PROBES FOR RVSM OPERATION

DETAIL III

Allowable Damage in the Extra Critical Aerodynamic Smoothness Area for Reduced Vertical Separation Minimum (RVSM) Certified Aircraft
Figure 101 (Sheet 3 of 3)

ALLOWABLE DAMAGE GENERAL - THE ANALYSIS AND CONTINUED SERVICE OF AIRPLANES WITH ON-GROUND HAIL DAMAGE

1. General

A. On-ground hail damage is defined as multiple damage sites caused by a hailstorm while the airplane is on the ground.

B. This subject gives the allowable damage data necessary to help in the analysis and continued service of airplanes with on-ground hail damage. It collects the referenced Structural Repair Manual (SRM) subject's allowable damage limits into one subject. It is limited to the lightweight composite and aluminum structure on the exposed surfaces of the wing and the horizontal and vertical stabilizers.

C. This subject does not change the allowable damage limits in the referenced SRM subjects. It does however, give expanded allowable damage limits due to on-ground hail damage for the identified areas. Expanded allowable damage limits given in this subject can be more than the referenced SRM subjects allowable damage limits. However, you must do a permanent repair to these damage sites before 60 days from when the damage occurred.

D. All damage that occurred before the hailstorm must be included in the analysis of on-ground hail damage unless a permanent repair was done.

E. Some types of damage must be sealed as given in Paragraph 5./ALLOWABLE DAMAGE GENERAL The allowable damage limits are only applicable if a temporary repair or seal is done before the airplane is returned to service.

F. Refer to 51-10-01, GENERAL for the aerodynamic smoothness requirements. If the smoothness does not agree with the limits given in 51-10-01, GENERAL, refer to Paragraph 6./ALLOWABLE DAMAGE GENERAL for the effect on airplane performance.

G. Refer to 51-60-01, GENERAL for the control surface rebalancing requirements. The effect of a temporary repair or seal can change the balance condition of a control surface.

2. References

Reference	Title
51-10-01, GENERAL	Aerodynamic Smoothness Requirements
51-60-01, GENERAL	Outboard Aileron Rebalance Procedure
51-70-01, GENERAL	Procedures to Rework and Fill Minor Dents in Metallic Parts on External Aerodynamic Surfaces

3. Inspection

A. Refer to the flow chart in Figure 101/ALLOWABLE DAMAGE GENERAL for the analysis of airplanes with on-ground hail damage.

B. The on-ground hail damage to airplanes can vary from one airplane to another and on different surfaces of the same airplane. For this reason, all airplanes near a hailstorm must have a visual inspection of their lightweight composite and aluminum structure. You must do a closer inspection if you find indication of damage.

C. Do an inspection of the upper wing and horizontal and vertical stabilizer surfaces.

   (1) Use anti-fatigue mats to protect composite surfaces from more damage.

   (2) Do an inspection of the suspected damaged areas.

(3) Make a note of each damage site. Include (as a minimum): location; length; width; depth; edge-to-edge distance to other damage, fasteners, or panel edge; and delamination data.

NOTE: All damage that occurred before the hailstorm must be included in the analysis of on-ground hail damage unless a permanent repair was done.

(4) Do an inspection of the underlying structure if panel damage is found close to the internal supporting members. Analyze, for allowable damage, the internal structure as given in the applicable SRM subjects.

D. Find the allowable damage for the applicable individual component panels (Figure 102/ALLOWABLE DAMAGE GENERAL).

(1) Find, as shown on Figure 102/ALLOWABLE DAMAGE GENERAL, the applicable component and the reference to its individual figure number. The individual component figures (Figure 105/ALLOWABLE DAMAGE GENERAL-130) collect the referenced SRM subjects allowable damage limits and material data. If necessary, refer to the applicable SRM subjects for the complete data.

(2) Use the noted damage site data to see if it is satisfactory to the allowable damage limits.

NOTE: Where applicable, areas of high load transfer are shown on the individual component figures (105-130). Areas of high load transfer were not identified as critical areas or zones in the referenced SRM allowable damage subjects. However, damage to these areas must not be more than the limits in the applicable SRM subjects.

(3) Small damage sites with spacing less than permitted by the referenced SRM subjects can be put together as one damage site (Figure 103/ALLOWABLE DAMAGE GENERAL, Detail II). Use the maximum dimension of this larger damage site to find the allowable spacing.

E. Is the damage satisfactory to the component's referenced SRM subjects allowable damage limit (Figure 105-130)?

(1) If yes, go to Paragraph 5.A./ALLOWABLE DAMAGE GENERAL.

(2) If no, do what follows:

(a) Record the damage site data. This data will be used to do an analysis of the damage for final disposition of the airplane.

This data will also be used to determine if additional damage has occurred on subsequent inspection before permanent repairs are done.

(b) Go to Paragraph 4./ALLOWABLE DAMAGE GENERAL

4. Expanded Allowable Damage Limits for On-Ground Hail Damage

CAUTION: DO NOT USE THE EXPANDED ALLOWABLE DAMAGE LIMITS FOR DAMAGE SITES THAT ARE IN CRITICAL AREAS OR AREAS OF HIGH LOAD TRANSFER. DO NOT USE THE EXPANDED ALLOWABLE DAMAGE LIMITS FOR THE LEADING EDGE (SLAT) OR THE SLAT TRAILING EDGE WEDGE, THE VERTICAL TAIL LEADING EDGE, OR THE HORIZONTAL STABILIZER LEADING EDGE. THESE AREAS MUST HAVE PERMANENT REPAIRS DONE IF THE DAMAGE IS MORE THAN THE LIMITS GIVEN IN THE APPLICABLE SRM SUBJECTS.

A. Do what follows for damage that is not satisfactory to the referenced SRM subjects allowable damage limits (Figure 105-130).

(1) Find the allowable spacing for on-ground hail damage using the expanded allowable damage limits.

(a) Use the recorded damage site data found in Paragraph 3./ALLOWABLE DAMAGE GENERAL

(b) Find the required minimum edge-to-edge distance (s) for the recorded damage diameter (D) from the details as shown in Figure 103/ALLOWABLE DAMAGE GENERAL, Detail III.

NOTE: Use the average damage diameter ((D + d) divided by 2) as the damage diameter (D) to find the required minimum edge-to-edge distance between adjacent damage sites.

(c) Add, to the required minimum edge-to-edge distance (s), a correction factor (Figure 103/ALLOWABLE DAMAGE GENERAL) for damage sites that have a dent diameter to depth ratio (A/Y) less than 30.

B. Is the damage satisfactory to the expanded allowable damage limits (Figure 103/ALLOWABLE DAMAGE GENERAL)?

(1) If yes, go to Paragraph 4.C./ALLOWABLE DAMAGE GENERAL

(2) If no, repair the damage before the airplane is returned to service.

C. Is the damage satisfactory to the expanded allowable damage limits (Figure 103/ALLOWABLE DAMAGE GENERAL)?

(1) If yes, go to Paragraph 4.C./ALLOWABLE DAMAGE GENERAL.

(2) If no, repair the damage before the airplane is returned to service.

D. The example that follows gives the allowable spacing for a 1-inch diameter dent, with an A/Y ratio of 20.

(1) Refer to Figure 103/ALLOWABLE DAMAGE GENERAL, Detail III (Allowable Damage Spacing) and find the required minimum edge-to-edge distance (s) for a 1-inch dent.

(2) Add a correction factor, for a dent with an A/Y ratio of 20, to the required minimum edge-to-edge distance (s).

(3) The allowable spacing in this example is equal to 3.5 inches (2.5 inches from the graph plus a 1-inch correction factor).

E. See Figure 104/ALLOWABLE DAMAGE GENERAL for more example applications of the expanded allowable damage limits.

(1) Sheets 1 and 2 show an example of a damaged component that is satisfactory to the expanded allowable damage limits.

(2) Sheets 3 and 4 show an example of a damaged component that is not satisfactory to the expanded allowable damage limits.

5. Temporary Repair or Seal (if necessary)

A. Do what follows for damage that is satisfactory to the referenced SRM subjects allowable damage limits (Paragraph 3./ALLOWABLE DAMAGE GENERAL and Figure 105-130).

(1) Remove contaminants or water from the surface of the damaged area.

(2) For the aluminum sheet structure, do a temporary repair to holes and punctures.

(a) Clean out the holes and punctures to 0.25 inch diameter maximum.

(b) Fill the hole with a 2117-T3 or T4 aluminum rivet installed wet with BMS 5-95 sealant.

(c) Apply BMS 5-95 (chromate) sealant to the top of the area.

(3) For the aluminum honeycomb and composite structure, do a temporary seal to holes and punctures.

(a) Remove the moisture from the damaged area. Boeing recommends that you use vacuum and heat to remove the moisture from the honeycomb cells (maximum temperature of 125°F (52°C)).

(b) Apply an aluminum foil tape (speed tape). Make an overlap of 2 inches more than the edges of the damage as a minimum.

NOTE: As an option for a more durable temporary seal, apply BMS 5-95 sealant in the damage site before you apply the aluminum foil tape. It is not necessary to wait for the BMS 5-95 sealant to cure before the airplane is returned to service.

(c) Keep a record of the location.

(d) Do an inspection of the aluminum foil tape to make sure it is in satisfactory condition at the specified times for the individual components (Figure 105-130).

(e) Do a permanent repair of the damage at the specified times for the individual components. Refer to the applicable referenced SRM subjects for the repair information.

B. Do what follows for damage that is not satisfactory to the referenced SRM subjects allowable damage limits (Figure 105-130), but is satisfactory to the expanded allowable damage limits of this subject (Paragraph 4./ALLOWABLE DAMAGE GENERAL).

(1) Remove any contaminants or water from the surface of the damaged area.

(2) Fill all damage sites that are more than 1.5 inches in diameter with an A/Y ratio less than 30.

(a) For aluminum sheet structure, refer to 51-70-01, GENERAL for the filling of dents.

(b) For aluminum honeycomb and composite structure, apply BMS 5-95 sealant to restore the contour before the aluminum foil tape is applied.

(3) For the aluminum sheet structure, do a temporary repair to holes and punctures.

(a) Clean out the holes and punctures to 0.25 inch diameter maximum.

(b) Fill the hole with a 2117-T3 or T4 aluminum rivet installed wet with BMS 5-95 sealant.

(c) Apply BMS 5-95 (chromate) sealant to the top of the area.

(4) For the aluminum honeycomb and composite structure, do a temporary seal to holes and punctures.

(a) Remove the moisture from the damaged area. Boeing recommends that you use vacuum and heat to remove the moisture from the honeycomb cells (maximum temperature of 125° (52°C)).

(b) Apply aluminum foil tape (speed tape). Make an overlap of 2 inches more than the edges of the damage as a minimum.

NOTE: As an option for a more durable temporary seal, apply BMS 5-95 sealant in the damage site before you apply the aluminum foil tape. It is not necessary to wait for the BMS 5-95 sealant to cure before the airplane is returned to service.

(c) Keep a record of the location.

(5) Inspect the damage sites at each "A" check and do a permanent repair before 60 days from when the damage occurred. Refer to the applicable referenced SRM subjects for the repair information.

6. Effect on Airplane Performance as a Result from On-Ground Hail Damage

A. General

(1) Any deviation from a smooth aerodynamic surface will have an effect on the airflow over that surface. On-ground hail damage, if not repaired or filled, can increase drag and reduce control effectiveness. Compliance with FAA flight safety requirements can be satisfied if you apply performance restrictions (gross weight and center of gravity loading restrictions).

(2) The effect on stall speed is negligible from on-ground hail damage that is satisfactory to the allowable damage limits of this subject.

(3) Damage that is filled and sealed (aluminum foil tape) do not have a performance restriction. However, you must count the damage sites that are sealed but not filled. This is because the aluminum foil tape can bulge in flight.

(4) The performance restrictions in this subject are for on-ground hail damage and are not sufficient for damage caused by hail while in flight.

(5) The performance restrictions are given in the Airplane Flight Manual appendix titled Configuration Deviations List (CDL). Figure 101/ALLOWABLE DAMAGE GENERAL, Table I gives an example form that can be used to communicate the required damage information to the Dispatcher for calculation of the performance restrictions.

(6) All damage sites that are more than 1.5 inches in diameter with an A/Y ratio less than 30 must be filled. Refer to Paragraph 4.C.(2)/ALLOWABLE DAMAGE GENERAL

B. Performance Restrictions

NOTE: The performance restrictions for the rudder are not sufficient if there are more than 25 damage sites that are not filled with an A/Y ratio less than 30. Do a permanent repair or fill the damage sites that are more than this limit.

(1) Do what follows for the applicable component panels (Figure 101/ALLOWABLE DAMAGE GENERAL, Table I):

  (a) Count the number of damage sites that are not filled with an A/Y ratio less than 30.

  (b) Record, by placing an "X" on the form (Figure 101/ALLOWABLE DAMAGE GENERAL, Table I) in the applicable square, the panels that have more than three (3) damage sites with an A/Y ratio less than 30.

  (c) Complete the form for all applicable panels.

  (d) Count and record, for each line, the total number of panels with an "X".

  (e) Include on the form your name, the tail number of the airplane, and the date.

(2) Give the completed form to the Dispatcher for the calculation of the performance restrictions. The performance restrictions listed in the Airplane Flight Manual, CDL appendix, must be applied for each damaged panel indicated with an "X".

7. FAA Approval

A. These allowable damage limits and performance restrictions have FAA approval only if the inspections, sealing, and repairs as given in this subject are completed at the specified times.

8. FAA Approval

A. These allowable damage limits and performance restrictions have FAA approval only if the inspections, sealing, and repairs as given in this subject are completed at the specified times.

INSTRUCTIONS:

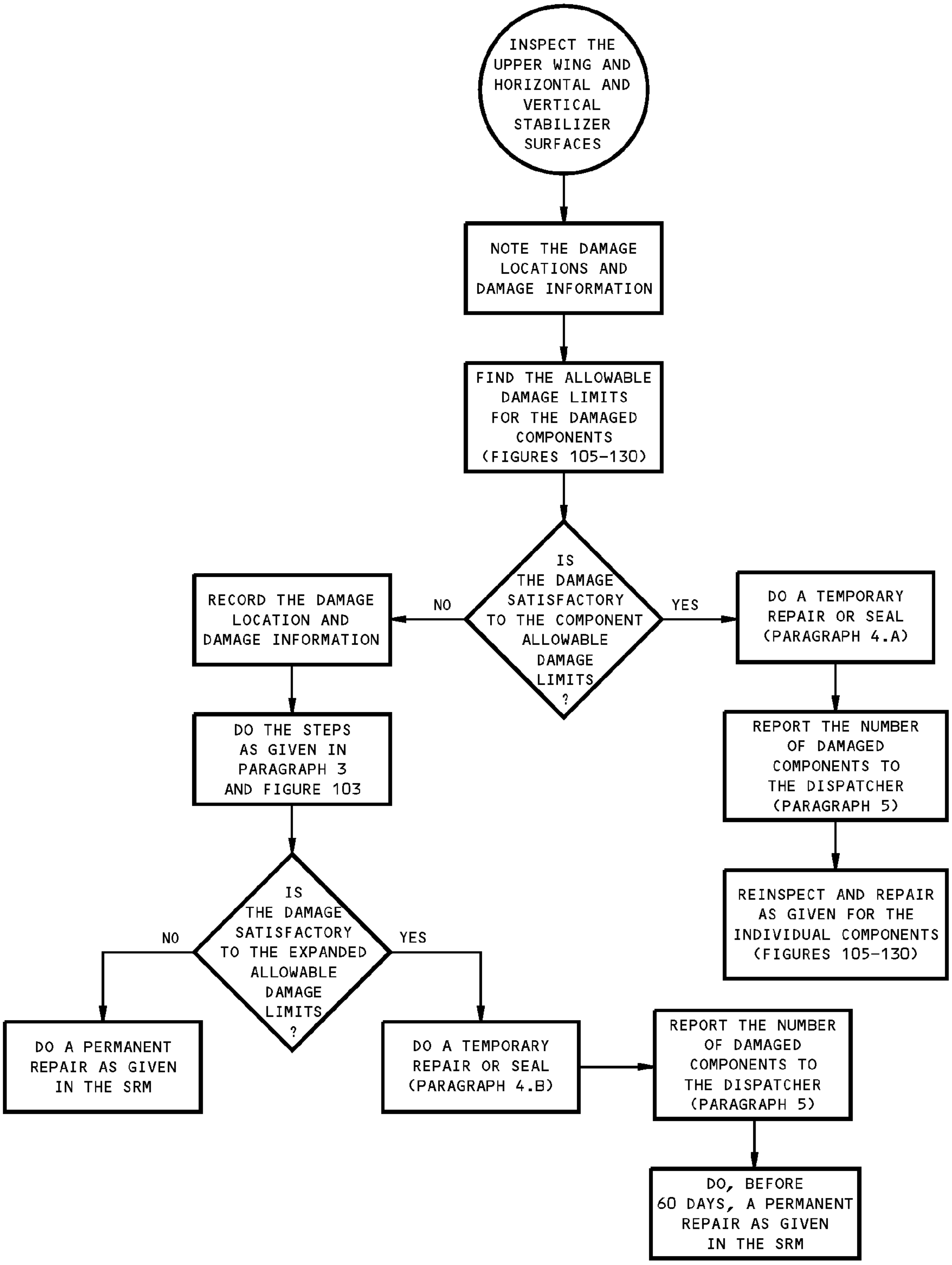
- For each panel, count the number of damage sites that are not filled and that have an A/Y ratio less than 30.
- Record, by placing an "X" in the applicable square, the panels that have more than three (3) damage sites with an A/Y ratio less than 30.
- Include your name, the tail number of the airplane, and the date. Give the Form to the Dispatcher for calculation of the performance restrictions.

COMPONENT	NUMBER OF PANELS												TOTAL
HORIZONTAL STABILIZER – AUXILIARY BOX – SRM 55-10-01 (FIGURE 121)	LEFT						RIGHT						
HORIZONTAL STABILIZER FIXED TRAILING EDGE – SRM 55-10-01 (FIGURE 122)	LEFT						RIGHT						
ELEVATOR – SRM 55-20-01 (FIGURE 123)	LEFT OUTBOARD			LEFT INBOARD			RIGHT INBOARD			RIGHT OUTBOARD			
VERTICAL STABILIZER – AUXILARY BOX – SRM 55-30-01 (FIGURE 126)	LEFT SIDE						RIGHT SIDE						
VERTICAL STABILIZER – FIXED TRAILING EDGE – SRM 55-30-01 (FIGURE 130)	LEFT SIDE						RIGHT SIDE						
RUDDER – SRM 55-40-01 (FIGURE 129)	MAXIMUM OF 25 DAMAGE SITES THAT ARE NOT FILLED (REFER TO PARAGRAPH 5.B)												
INSPAR UPPER WING PANEL – SRM 57-20-01 (FIGURE 115)	LEFT						RIGHT						
WING FIXED LEADING EDGE – SRM 57-41-01 (FIGURES 117 AND 119)	LEFT OUTBOARD			LEFT INBOARD			RIGHT INBOARD			RIGHT OUTBOARD			
WING SLAT TRAILING EDGE WEDGE PANEL – SRM 57-43-02 (FIGURES 116 AND 118)	1	2	3	4	5	6	7	8	9	10	11	12	
WING FIXED TRAILING EDGE PANEL – SRM 57-51-01 (FIGURES 105 AND 106)	LEFT OUTBOARD			LEFT INBOARD			RIGHT INBOARD			RIGHT OUTBOARD			
TRAILING EDGE FLAP PANEL – SRM 57-53-01 (FIGURES 107, 108 AND 111)	LEFT OUTBOARD			LEFT INBOARD			RIGHT INBOARD			RIGHT OUTBOARD			
AILERON – SRM 57-60-01 and -02 (FIGURES 110 AND 113)	LEFT OUTBOARD			LEFT INBOARD			RIGHT INBOARD			RIGHT OUTBOARD			
SPOILER PANEL – SRM 57-70-01 (FIGURES 109 AND 112)	1	2	3	4	5	6	7	8	9	10	11	12	

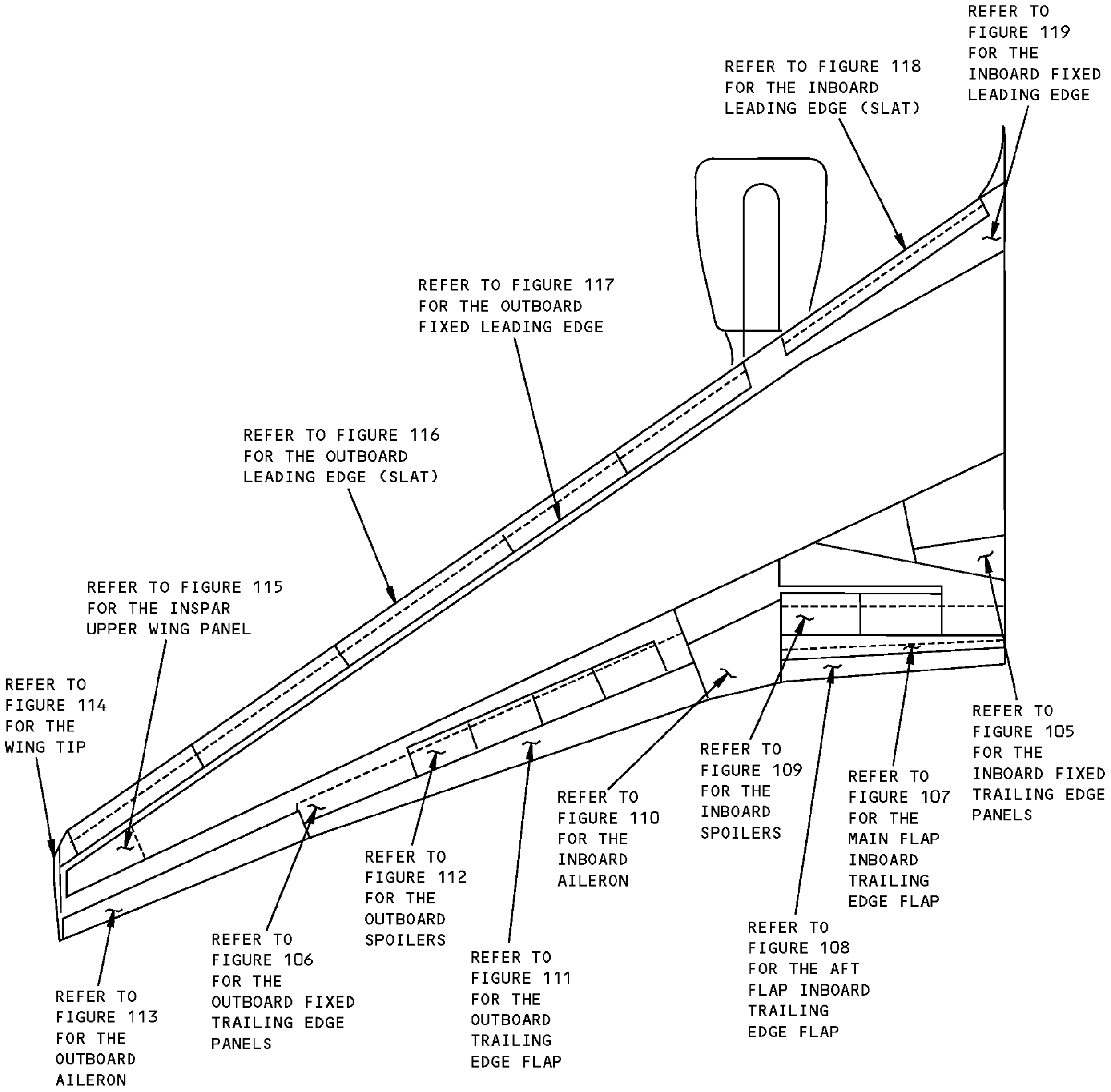
NAME: ______________________ AIRPLANE TAIL NUMBER: ______________________ DATE: ____________

TABLE I: EXAMPLE FORM – NUMBER OF DAMAGED PANELS

Analysis of Airplanes With On-Ground Hail Damage
Figure 101 (Sheet 1 of 2)

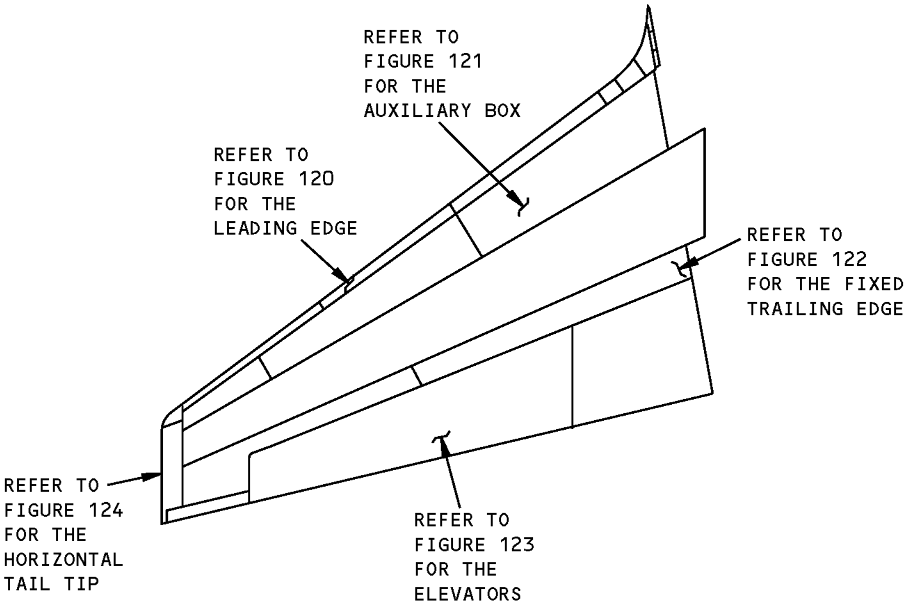


Analysis of Airplanes With On-Ground Hail Damage
Figure 101 (Sheet 2 of 2)

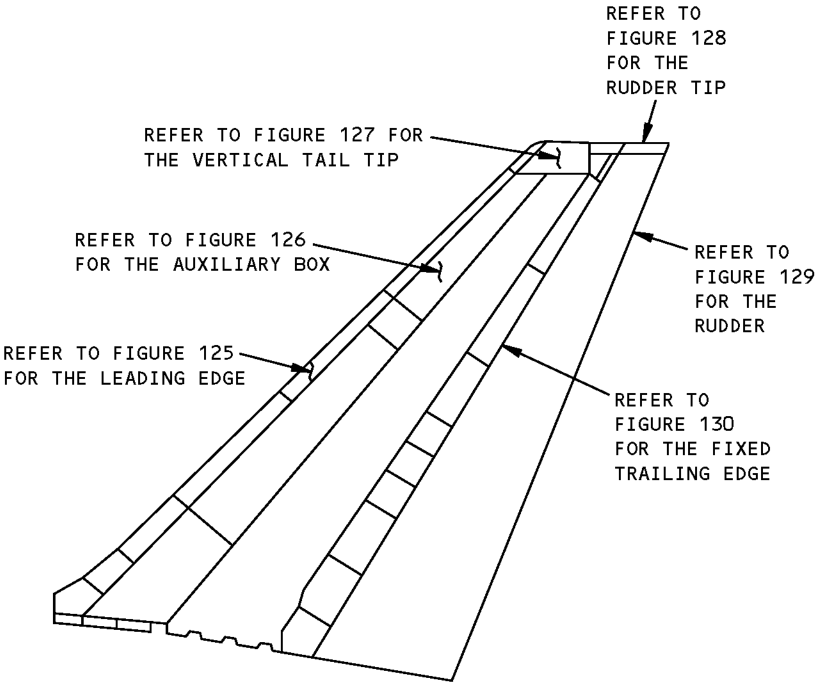


LEFT WING IS SHOWN,
RIGHT WING IS OPPOSITE

Applicable Components - On-Ground Hail Damage Analysis
Figure 102 (Sheet 1 of 2)

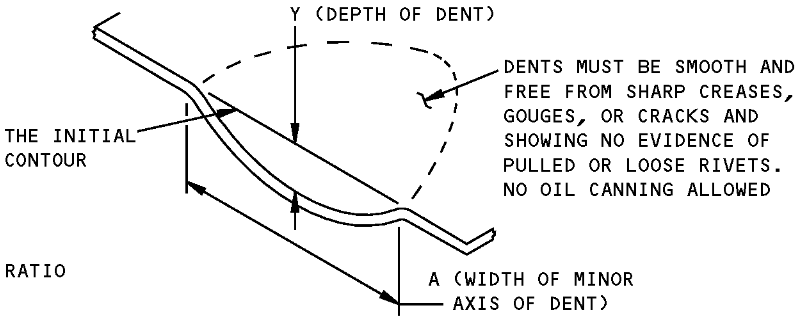


LEFT HORIZONTAL STABILIZER IS SHOWN,
RIGHT HORIZONTAL STABILIZER IS OPPOSITE



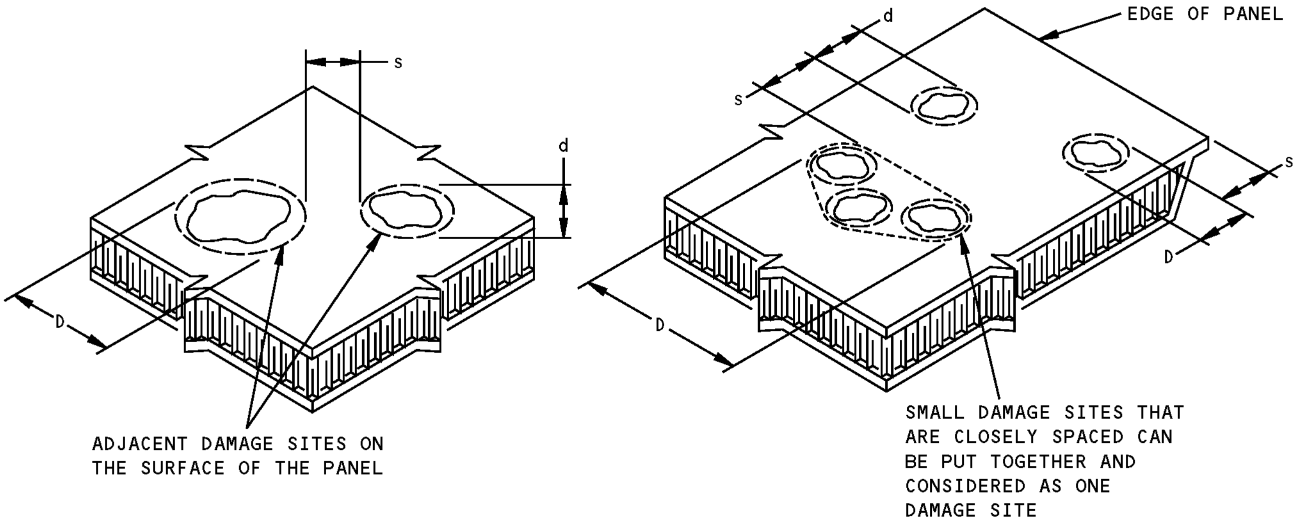
VERTICAL STABILIZER

Applicable Components - On-Ground Hail Damage Analysis
Figure 102 (Sheet 2 of 2)



- A/Y IS THE DENT TO DEPTH RATIO

ALLOWABLE DAMAGE FOR DENTS IN ALUMINUM PANELS
DETAIL I



- DAMAGE TO COMPOSITE PANELS EXPOSED TO MULTIPLE IMPACTS CAN BE DETECTED BY USING INSTRUMENTED NON-DESTRUCTIVE INSPECTION METHODS OR BY TAPPING THE SUSPECT DAMAGE AREA WITH A SMALL METALLIC DISK OBJECT. INSPECTION SHOULD COVER THE AREA WITHIN 3 DIAMETERS AROUND THE EDGE OF THE VISIBLE DAMAGE SITE. FOR TAP TEST, USE A SOLID METAL DISK AND TAP THE DAMAGE AREA LIGHTLY BUT FIRMLY. VOID AREAS SHOULD PRODUCE A DULL SOUND AS OPPOSED TO A SHARP RING ON A SOLID BONDED AREA
- A DAMAGE SITE IS ANY SINGLE AREA OF A PANEL WHERE A DENT, DELAMINATION, PUNCTURE OR ANY COMBINATION OF THESE EXIST. SMALL DAMAGE SITES THAT ARE CLOSELY SPACED CAN BE PUT TOGETHER AND CONSIDERED AS ONE DAMAGE SITE
- "D" IS DETERMINED BY MEASURING THE MAXIMUM DIMENSION OF A DAMAGE SITE
- "s" IS THE EDGE TO EDGE DISTANCE BETWEEN TWO ADJACENT DAMAGE SITES, EDGE OF DAMAGE TO A FASTENER OR EDGE OF DAMAGE TO THE EDGE OF PANEL
- "d" IS THE MAXIMUM DIMENSION OF THE SMALLER OF TWO ADJACENT DAMAGE SITES
- DAMAGE IS ALLOWED WHEN "s" IS EQUAL TO OR MORE THAN THE SPACING REQUIREMENT GIVEN FOR THE INDIVIDUAL COMPONENTS (FIGURES 105 - 130) OR FOUND IN DETAILS I THRU III

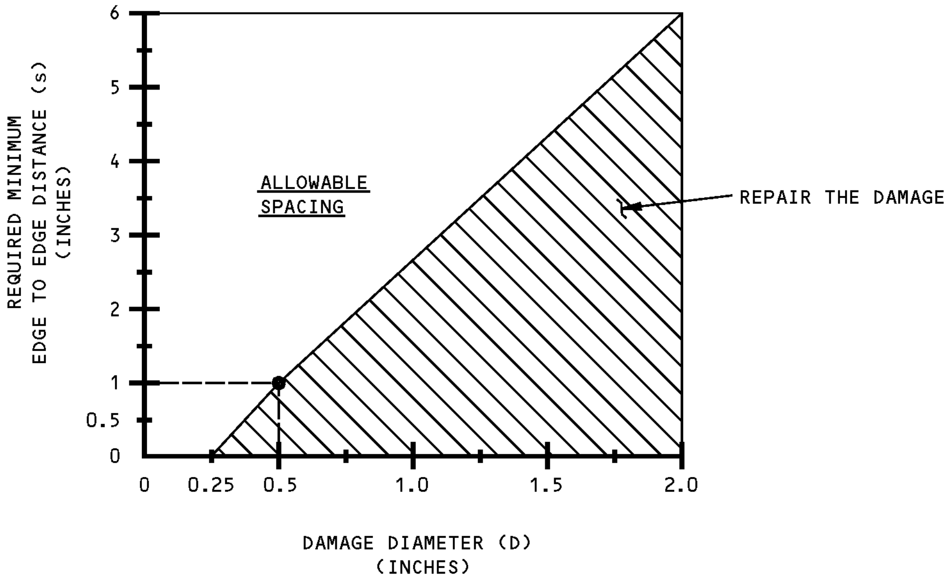
DAMAGE SIZING AND SPACING DATA
DETAIL II

Expanded Allowable Damage Limits
Figure 103 (Sheet 1 of 2)

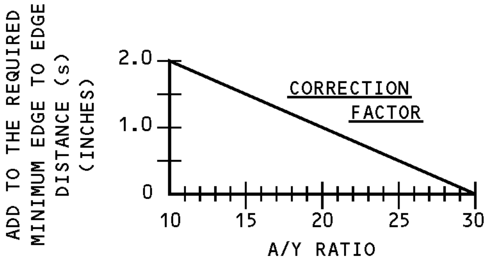
APPLICABILITY: WING - INBOARD AND OUTBOARD FIXED TRAILING EDGE PANELS - FIGURES 105 AND 106
MAIN FLAP - INBOARD TRAILING EDGE FLAP - FIGURE 107
AFT FLAP - INBOARD TRAILING EDGE FLAP - FIGURE 108
INBOARD AND OUTBOARD SPOILERS (NON-CRITICAL AREA ONLY) - FIGURES 109 AND 112
INBOARD AND OUTBOARD AILERON (NON-CRITICAL AREA ONLY) - FIGURES 110 AND 113
OUTBOARD TRAILING EDGE FLAP - FIGURE 111
WING TIP (FAIRING PANEL ONLY) - FIGURE 114
INSPAR UPPER WING PANEL - FIGURE 115
OUTBOARD FIXED LEADING EDGE - FIGURE 117
INBOARD FIXED LEADING EDGE - FIGURE 119

HORIZONTAL STABILIZER - AUXILIARY BOX - FIGURE 121
FIXED TRAILING EDGE - FIGURE 122
ELEVATORS (NON-CRITICAL AREA - ZONE 1 ONLY) - FIGURE 123
HORIZONTAL TAIL TIP (FAIRING ONLY) - FIGURE 124

VERTICAL STABILIZER - AUXILIARY BOX - FIGURE 126
VERTICAL TAIL TIP - FIGURE 127
RUDDER TIP - FIGURE 128
RUDDER - FIGURE 129
FIXED TRAILING EDGE - FIGURE 130

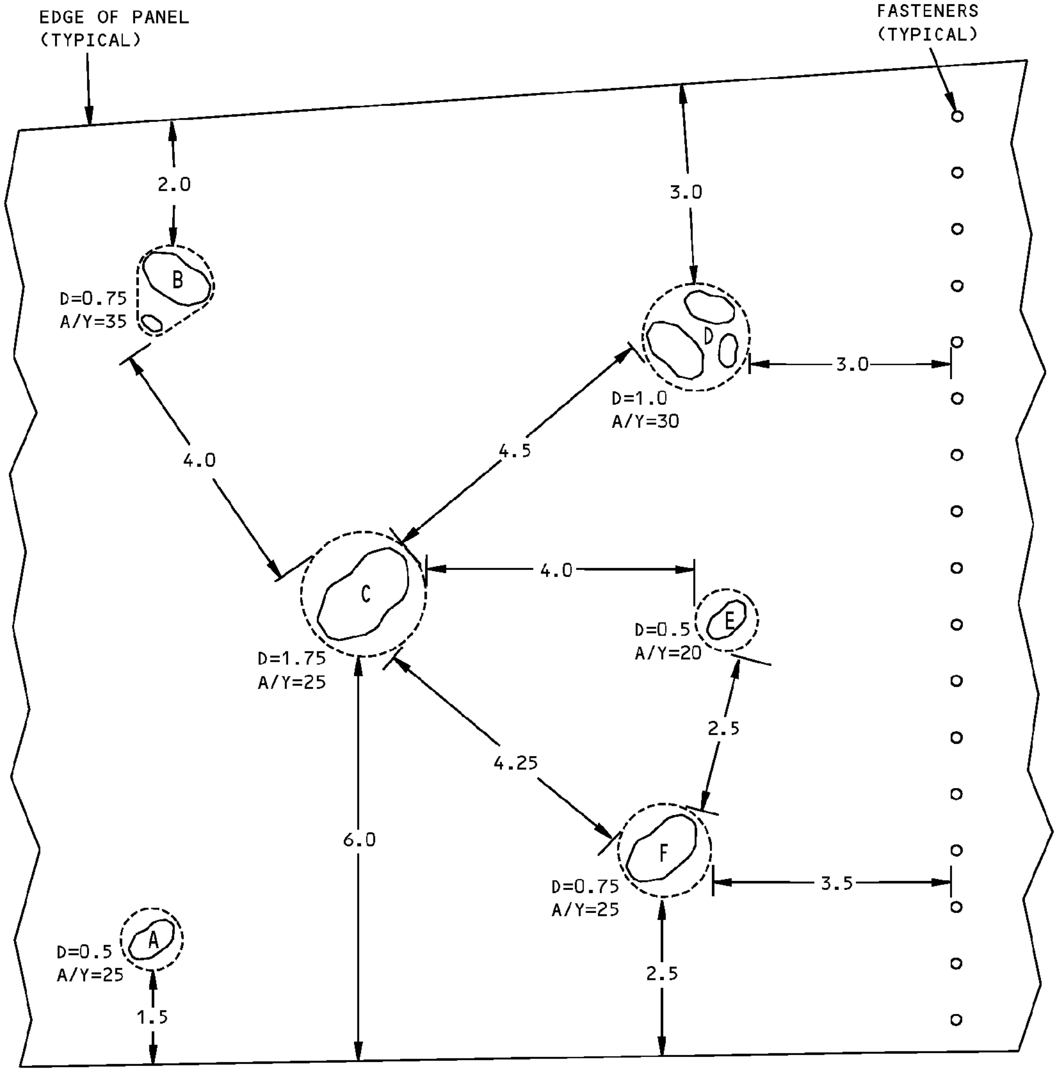


- USE "$\frac{D+d}{2}$" AS THE DAMAGE DIAMETER (D) TO FIND THE REQUIRED MINIMUM EDGE TO EDGE DISTANCE (s) BETWEEN ADJACENT DAMAGE SITES
- ADD A CORRECTION FACTOR TO THE REQUIRED MINIMUM EDGE TO EDGE DISTANCE (s), FOUND ON THE ABOVE GRAPH, FOR DENTS ON ALUMINUM PANELS WITH AN A/Y RATIO OF LESS THAN 30. USE THE LOWEST A/Y RATIO, BUT NOT LESS THAN 10, WHEN DAMAGE SITES ARE GROUPED TOGETHER



ALLOWABLE DAMAGE SPACING
DETAIL III

Expanded Allowable Damage Limits
Figure 103 (Sheet 2 of 2)



NOTES

- ALL DIMENSIONS ARE IN INCHES.

ASSUMPTIONS:

- DAMAGE IS NOT IN A CRITICAL AREA OR AREA OF HIGH LOAD TRANSFER.
- MINIMUM DISTANCE FROM THE DAMAGE TO EDGE OF PANEL, FASTENER, OR OTHER DAMAGE IS 3(D).

INSTRUCTIONS:

- PUT TOGETHER THE CLOSELY SPACED DAMAGE SITES.
- USE THE RECORDED DAMAGE INFORMATION AS SHOWN AND FIND THE REQUIRED MINIMUM EDGE TO EDGE DISTANCE (s) AS GIVEN IN THE EXPANDED ALLOWABLE DAMAGE LIMITS. REFER TO FIGURE 103, DETAIL III.
- USE "$\frac{D+d}{2}$" AS THE DAMAGE DIAMETER TO FIND THE REQUIRED MINIMUM EDGE TO EDGE DISTANCE (s) BETWEEN ADJACENT DAMAGE SITES.
- ADD A CORRECTION FACTOR TO THE DAMAGE SITES WITH AN A/Y RATIO LESS THAN 30.

Example - Expanded Allowable Damage Limits
Figure 104 (Sheet 1 of 4)

THE ANALYSIS OF DAMAGE SITE A

D = 0.5
A/Y = 25
1.5 (TO EDGE OF PANEL)

1. THE REQUIRED MINIMUM EDGE TO EDGE DISTANCE (s) FROM THE GRAPH, PLUS A CORRECTION FACTOR IS 1.5 (1.0+0.5).

THE ALLOWABLE SPACING BETWEEN DAMAGE SITE A TO THE EDGE OF THE PANEL IS SATISFACTORY.

THE ANALYSIS OF DAMAGE SITE B

D = 0.75
A/Y = 35
2.0 (TO EDGE OF PANEL)
4.0 (TO ADJACENT DAMAGE SITE C)

1. THE REQUIRED MINIMUM EDGE TO EDGE OF PANEL DISTANCE (s) FROM THE GRAPH IS 2.0.
2. THE REQUIRED MINIMUM EDGE TO EDGE OF DAMAGE SITE C DISTANCE (s) FROM THE GRAPH, PLUS A CORRECTION FACTOR IS 4.0 (3.5+0.5).

THE ALLOWABLE SPACING BETWEEN DAMAGE SITE B AND C, AND TO THE EDGE OF THE PANEL IS SATISFACTORY.

THE ANALYSIS OF DAMAGE SITE C

D = 1.75
A/Y = 25
6.0 (TO EDGE OF PANEL)
4.0 (TO ADJACENT DAMAGE SITE B)
4.5 (TO ADJACENT DAMAGE SITE D)
4.0 (TO ADJACENT DAMAGE SITE E)
4.25 (TO ADJACENT DAMAGE SITE F)

1. THE REQUIRED MINIMUM EDGE TO EDGE OF PANEL DISTANCE (s) FROM THE GRAPH PLUS A CORRECTION FACTOR IS 5.5 (5.0+0.5).
2. THE REQUIRED MINIMUM EDGE TO EDGE OF DAMAGE SITE B DISTANCE (s) IS 4.0. SEE ANALYSIS OF DAMAGE SITE B.
3. THE REQUIRED MINIMUM EDGE TO EDGE OF DAMAGE SITE D DISTANCE (s) FROM THE GRAPH, PLUS A CORRECTION FACTOR IS 4.5 (4.0+0.5).
4. THE REQUIRED MINIMUM EDGE TO EDGE OF DAMAGE SITE E DISTANCE (s) FROM THE GRAPH, PLUS A CORRECTION FACTOR IS 4.0 (3.0+1.0).
5. THE REQUIRED MINIMUM EDGE TO EDGE OF DAMAGE SITE F DISTANCE (s) FROM THE GRAPH, PLUS A CORRECTION FACTOR IS 4.0 (3.5+0.5).

THE ALLOWABLE SPACING BETWEEN DAMAGE SITE C AND B, D, E, F, AND TO THE EDGE OF THE PANEL IS SATISFACTORY.

THE ANALYSIS OF DAMAGE SITE D

D = 1.0
A/Y = 30
3.0 (TO EDGE OF PANEL)
4.5 (TO ADJACENT DAMAGE SITE C)
3.0 (TO FASTENER ROW)

1. THE REQUIRED MINIMUM EDGE TO EDGE OF THE PANEL OR FASTENER ROW DISTANCE (s) FROM THE GRAPH IS 2.5.
2. THE REQUIRED MINIMUM EDGE TO EDGE OF DAMAGE SITE C DISTANCE (s) IS 4.5. SEE ANALYSIS OF DAMAGE SITE C.

THE ALLOWABLE SPACING BETWEEN DAMAGE SITE D AND C, AND TO THE EDGE OF THE PANEL OR FASTENER ROW IS SATISFACTORY.

THE ANALYSIS OF DAMAGE SITE E

D = 0.5
A/Y = 20
4.0 (TO ADJACENT DAMAGE SITE C)
2.5 (TO ADJACENT DAMAGE SITE F)

1. THE REQUIRED MINIMUM EDGE TO EDGE OF PANEL DISTANCE (s) FROM THE GRAPH, PLUS A CORRECTION FACTOR IS 2.0 (1.0+1.0).
2. THE REQUIRED MINIMUM EDGE TO EDGE OF DAMAGE SITE C DISTANCE (s) IS 4.0. SEE ANALYSIS OF DAMAGE SITE C.
3. THE REQUIRED MINIMUM EDGE TO EDGE OF DAMAGE SITE F DISTANCE (s) FROM THE GRAPH, PLUS A CORRECTION FACTOR IS 2.5 (1.5+1.0).

THE ALLOWABLE SPACING BETWEEN DAMAGE SITE E AND C, F, AND TO THE EDGE OF THE PANEL IS SATISFACTORY.

THE ANALYSIS OF DAMAGE SITE F

D = 0.75
A/Y = 25
2.5 (TO EDGE OF PANEL)
4.25 (TO ADJACENT DAMAGE SITE C)
2.5 (TO ADJACENT DAMAGE SITE E)
3.5 (TO FASTENER ROW)

1. THE REQUIRED MINIMUM EDGE TO EDGE OF THE PANEL OR FASTENER ROW DISTANCE (s) FROM THE GRAPH, PLUS A CORRECTION FACTOR IS 2.5 (2.0+0.5).
2. THE REQUIRED MINIMUM EDGE TO EDGE OF DAMAGE SITE C DISTANCE (s) IS 4.0. SEE ANALYSIS OF DAMAGE SITE C.
3. THE REQUIRED MINIMUM EDGE TO EDGE OF DAMAGE SITE E DISTANCE (s) IS 2.5. SEE ANALYSIS OF DAMAGE SITE E.

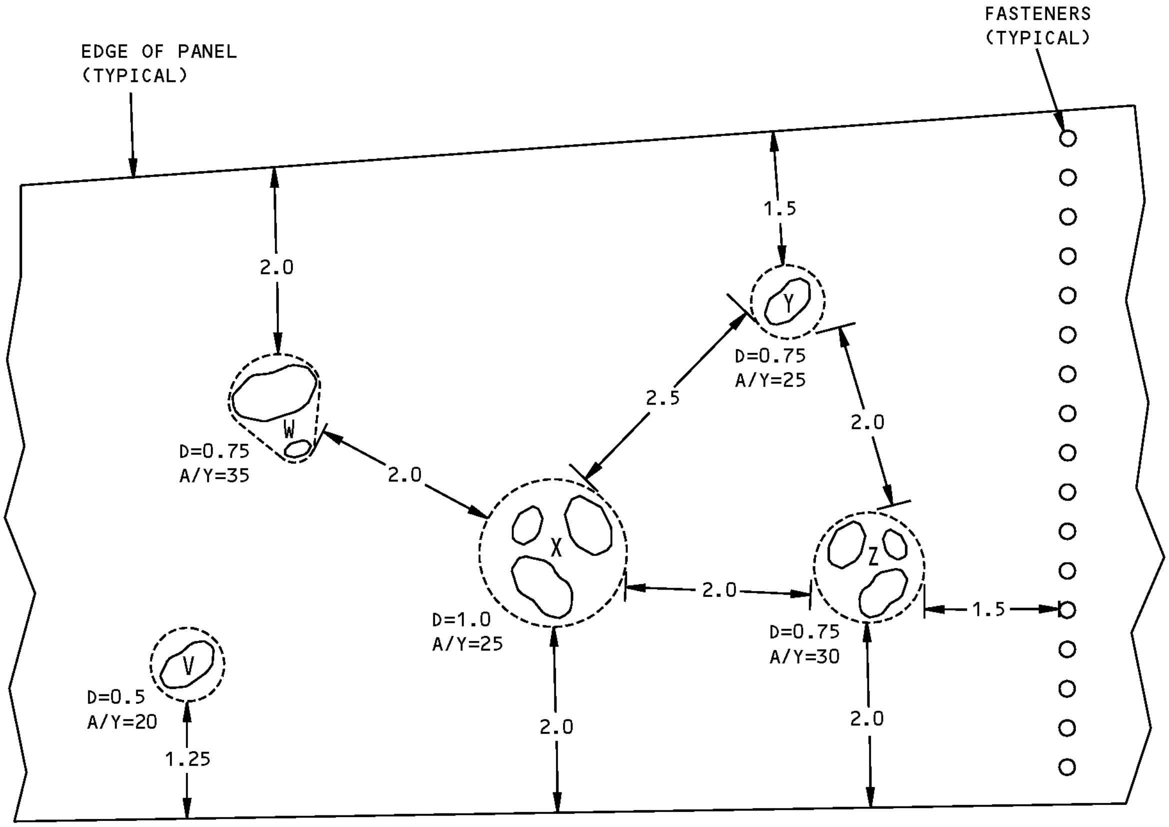
THE ALLOWABLE SPACING BETWEEN DAMAGE SITE F AND C, E, AND TO THE EDGE OF THE PANEL OR FASTENER ROW IS SATISFACTORY.

RESULTS OF THE ANALYSIS

THE ALLOWABLE SPACING BETWEEN DAMAGE SITES, FASTENERS, AND EDGE OF THE PANEL IS SATISFACTORY TO THE EXPANDED ALLOWABLE DAMAGE LIMITS. REFER TO PARAGRAPH 4.B FOR THE TEMPORARY REPAIR OR SEALING OF THE DAMAGE.

NOTE: DAMAGE SITE C MUST BE FILLED AS GIVEN IN SRM 51-70-01 BEFORE THE AIRPLANE IS RETURNED TO SERVICE.

Example - Expanded Allowable Damage Limits
Figure 104 (Sheet 2 of 4)



NOTES

- ALL DIMENSIONS ARE IN INCHES.

ASSUMPTIONS:

- DAMAGE IS NOT IN A CRITICAL AREA OR AREA OF HIGH LOAD TRANSFER.
- MINIMUM DISTANCE FROM THE DAMAGE TO THE EDGE OF PANEL, FASTENER, OR OTHER DAMAGE IS 3(D).

INSTRUCTIONS:

- PUT TOGETHER THE CLOSELY SPACED DAMAGE SITES.
- USE THE RECORDED DAMAGE INFORMATION AS SHOWN AND FIND THE EDGE TO EDGE DISTANCE (s) AS GIVEN IN THE EXPANDED ALLOWABLE DAMAGE LIMITS. REFER TO FIGURE 103, DETAIL III.
- USE "$\frac{D+d}{2}$" AS THE DAMAGE DIAMETER TO FIND THE REQUIRED MINIMUM EDGE TO EDGE DISTANCE (s) BETWEEN ADJACENT DAMAGE SITES.
- ADD A CORRECTION FACTOR TO DENTS WITH AN A/Y RATIO LESS THAN 30.

Example - Expanded Allowable Damage Limits
Figure 104 (Sheet 3 of 4)

THE ANALYSIS OF DAMAGE SITE V

D = 0.5
A/Y = 20
1.25 (TO EDGE OF PANEL)

1. THE REQUIRED MINIMUM EDGE TO EDGE DISTANCE (s) FROM THE GRAPH, PLUS A CORRECTION FACTOR IS 2.0 (1.0+1.0).

THE ALLOWABLE SPACING BETWEEN DAMAGE SITE V TO THE EDGE OF THE PANEL IS NOT SATISFACTORY.

THE ANALYSIS OF DAMAGE SITE W

D = 0.75
A/Y = 35
2.0 (TO EDGE OF PANEL)
2.0 (TO ADJACENT DAMAGE SITE X)

1. THE REQUIRED MINIMUM EDGE TO EDGE OF PANEL DISTANCE (s) FROM THE GRAPH IS 2.0.
2. THE REQUIRED MINIMUM EDGE TO EDGE OF DAMAGE SITE X DISTANCE (s) FROM THE GRAPH, PLUS A CORRECTION FACTOR IS 3.0 (2.5+0.5).

THE ALLOWABLE SPACING BETWEEN DAMAGE SITE W AND X IS NOT SATISFACTORY.

THE ANALYSIS OF DAMAGE SITE X

D = 1.0
A/Y = 25
2.0 (TO EDGE OF PANEL)
2.0 (TO ADJACENT DAMAGE SITE W)
2.5 (TO ADJACENT DAMAGE SITE Y)
2.0 (TO ADJACENT DAMAGE SITE Z)

1. THE REQUIRED MINIMUM EDGE TO EDGE OF PANEL DISTANCE (s) FROM THE GRAPH PLUS A CORRECTION FACTOR IS 3.0 (2.5+0.5).
2. THE REQUIRED MINIMUM EDGE TO EDGE OF DAMAGE SITE W DISTANCE (s) IS 3.0. SEE ANALYSIS OF DAMAGE SITE W.
3. THE REQUIRED MINIMUM EDGE TO EDGE OF DAMAGE SITE Y DISTANCE (s) FROM THE GRAPH, PLUS A CORRECTION FACTOR IS 3.0 (2.5+0.5).
4. THE REQUIRED MINIMUM EDGE TO EDGE OF DAMAGE SITE Z DISTANCE (s) FROM THE GRAPH, PLUS A CORRECTION FACTOR IS 3.0 (2.5+0.5).

THE ALLOWABLE SPACING BETWEEN DAMAGE SITE X AND W, Y, Z, AND TO THE EDGE OF THE PANEL IS NOT SATISFACTORY.

THE ANALYSIS OF DAMAGE SITE Y

D = 0.75
A/Y = 25
1.5 (TO EDGE OF PANEL)
2.5 (TO ADJACENT DAMAGE SITE X)
2.0 (TO ADJACENT DAMAGE SITE Z)

1. THE REQUIRED MINIMUM EDGE TO EDGE OF PANEL DISTANCE (s) FROM THE GRAPH, PLUS A CORRECTION FACTOR IS 2.5 (2.0+0.5).
2. THE REQUIRED MINIMUM EDGE TO EDGE OF DAMAGE SITE X DISTANCE (s) IS 3.0. SEE ANALYSIS OF DAMAGE SITE X.
3. THE REQUIRED MINIMUM EDGE TO EDGE OF DAMAGE SITE Z DISTANCE (s) FROM THE GRAPH, PLUS A CORRECTION FACTOR IS 2.5 (2.0+0.5).

THE ALLOWABLE SPACING BETWEEN DAMAGE SITE Y AND X, Z, AND TO THE EDGE OF THE PANEL IS NOT SATISFACTORY.

THE ANALYSIS OF DAMAGE SITE Z

D = 0.75
A/Y = 30
2.0 (TO EDGE OF PANEL)
2.0 (TO ADJACENT DAMAGE SITE X)
2.0 (TO ADJACENT DAMAGE SITE Y)
1.5 (TO FASTENER ROW)

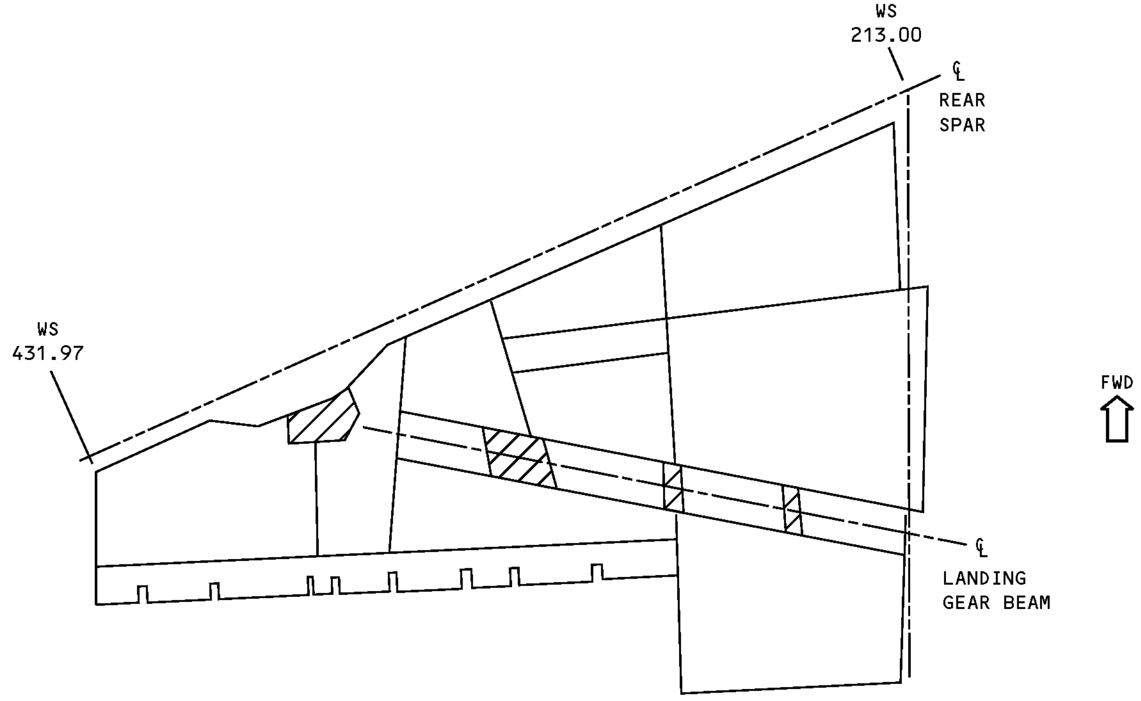
1. THE REQUIRED MINIMUM EDGE TO EDGE OF THE PANEL OR FASTENER ROW DISTANCE (s) FROM THE GRAPH IS 2.0.
2. THE REQUIRED MINIMUM EDGE TO EDGE OF DAMAGE SITE X DISTANCE (s) IS 3.0. SEE ANALYSIS OF DAMAGE SITE X.
3. THE REQUIRED MINIMUM EDGE TO EDGE OF DAMAGE SITE Y DISTANCE (s) IS 2.5. SEE ANALYSIS OF DAMAGE SITE Y.

THE ALLOWABLE SPACING BETWEEN DAMAGE SITE Z AND X, Y, AND TO THE EDGE OF THE FASTENER ROW AND PANEL IS NOT SATISFACTORY.

RESULTS OF THE ANALYSIS

THE ALLOWABLE SPACING BETWEEN DAMAGE SITES, FASTENERS, AND EDGE OF THE PANEL IS NOT SATISFACTORY TO THE EXPANDED ALLOWABLE DAMAGE LIMITS. REPAIR THE DAMAGE BEFORE THE AIRPLANE IS RETURNED TO SERVICE.

Example - Expanded Allowable Damage Limits
Figure 104 (Sheet 4 of 4)



MATERIAL:

☐ ARAMID/GRAPHITE/EPOXY OR GLASS FABRIC/GRAPHITE/EPOXY HONEYCOMB SANDWICH WITH NOMEX CORE-250°F (121°C) CURE

SRM 57-51-01 ALLOWABLE DAMAGE

- TREAT ALL DENTS AS A HOLE OR PUNCTURE
- DENTS, DELAMINATION, CRACKS OR PUNCTURES NOT GREATER THAN 2.0 INCHES IN DIAMETER
- DISTANCE BETWEEN ANY TWO DAMAGE SITES MUST NOT BE CLOSER THAN 1.5 TIMES THE DIAMETER OF THE LARGER DAMAGE
- REINSPECT AT EVERY "A" CHECK, REPAIR NO LATER THAN NEXT "C" CHECK
- REFER TO PARAGRAPH 4 FOR TEMPORARY REPAIR OR SEAL OF DAMAGE

DRAWING NO. 113T1600

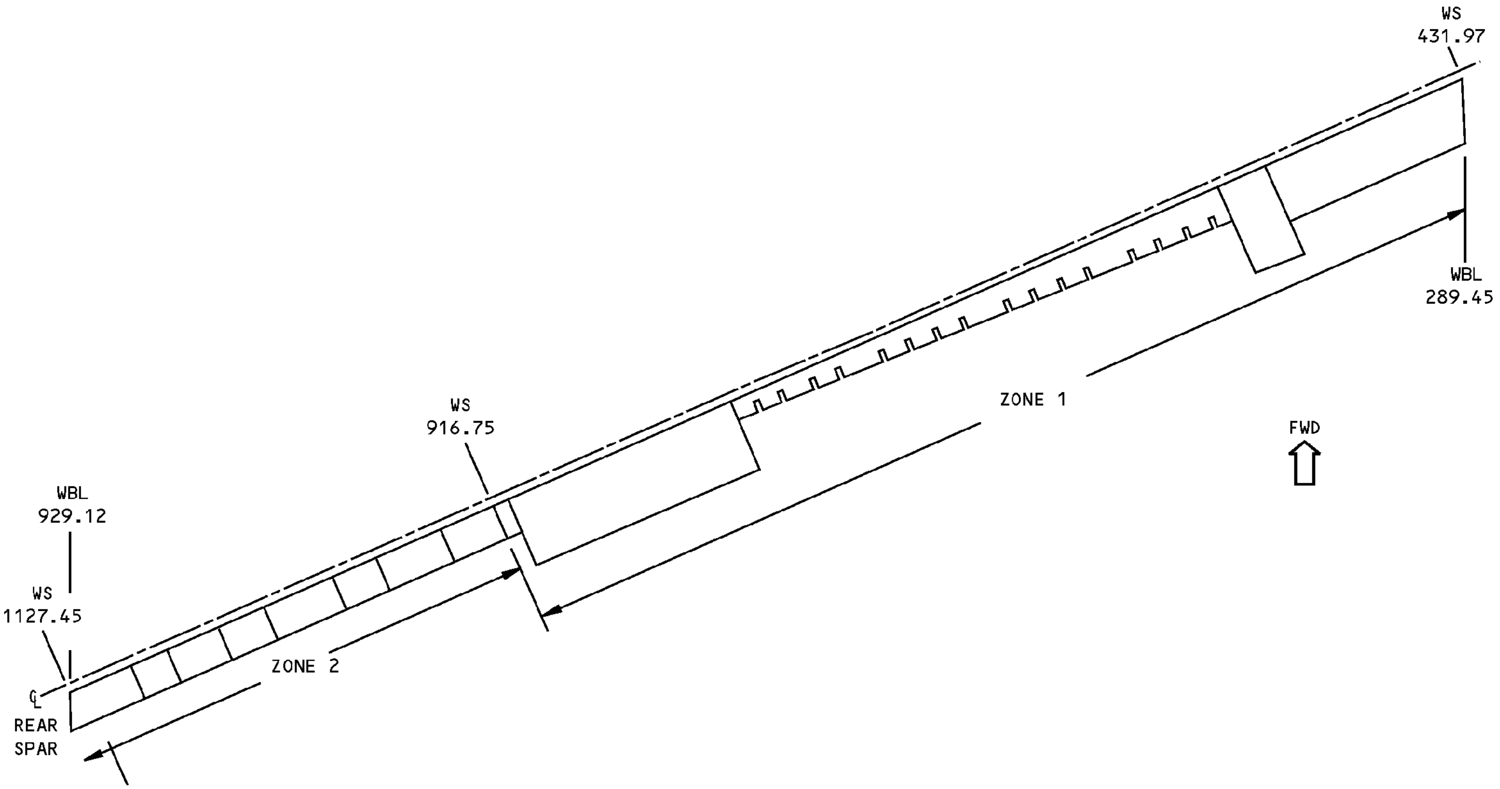
MATERIAL:

▨ ALUMINUM PLATE (7075-T7351)

SRM 57-51-01 ALLOWABLE DAMAGE

- DENTS MUST BE SMOOTH AND FREE OF ALL SHARP CREASES, GOUGES, OR CRACKS, AND SHOW NO EVIDENCE OF PULLED OR LOOSE RIVETS
- DENT DIAMETER TO DEPTH RATIO MUST BE 30 OR GREATER
- MINIMUM DISTANCE BETWEEN HOLES OR TO EDGE OF PANEL OR FASTENER IS 1.0 INCH
- CLEAN UP DAMAGE WITH 0.25 INCH MAXIMUM HOLE AND FILL WITH RIVET. ALL OTHER HOLES TO BE REPAIRED
- CRACKS ARE NOT PERMITTED EXCEPT FOR EDGE CRACKS WHICH MUST BE REMOVED
- SHOT PEEN REWORKED AREAS AS GIVEN IN SRM 51-20-06
- REFER TO PARAGRAPH 4 FOR TEMPORARY REPAIR OR SEAL OF DAMAGE

Wing-Inboard Fixed Trailing Edge Panels
Figure 105



MATERIAL:

☐ ARAMID/GRAPHITE/EPOXY OR GLASS FABRIC/EPOXY HONEYCOMB SANDWICH WITH NOMEX CORE-250°F (121°C) CURE

SRM 57-51-01 ALLOWABLE DAMAGE: ZONE 1

- TREAT ALL DENTS AS A HOLE OR PUNCTURE
- DENTS, DELAMINATION, CRACKS, OR PUNCTURES NOT GREATER THAN 2.0 INCHES IN DIAMETER
- DISTANCE BETWEEN ANY TWO DAMAGE SITES MUST NOT BE CLOSER THAN 1.5 TIMES THE DIAMETER OF THE LARGER DAMAGE
- REINSPECT AT EVERY "A" CHECK, REPAIR NO LATER THAN NEXT "C" CHECK
- REFER TO PARAGRAPH 4 FOR TEMPORARY REPAIR OR SEAL OF DAMAGE

DRAWING NO. 113T1600

MATERIAL:

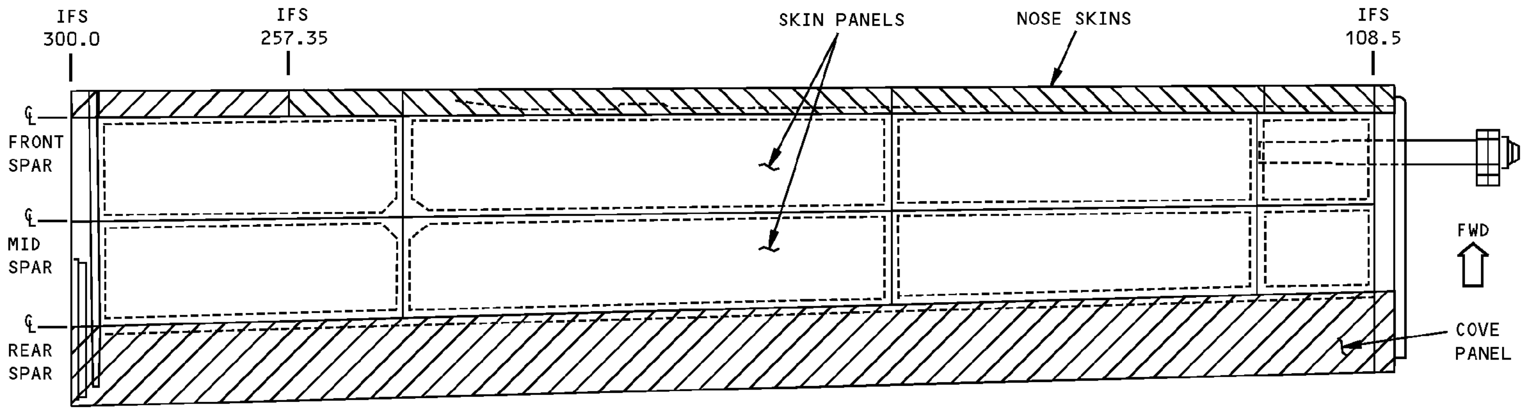
☐ ARAMID/GRAPHITE/EPOXY OR GLASS FABRIC/EPOXY HONEYCOMB SANDWICH WITH NOMEX CORE-250°F (121°C) CURE

SRM 57-51-01 ALLOWABLE DAMAGE: ZONE 2

SAME AS "ZONE 1" EXCEPT:

- DENTS, DELAMINATIONS, CRACKS, OR PUNCTURES NOT GREATER THAN 1.5 INCHES IN DIAMETER

Wing-Outboard Fixed Trailing Edge Panels
Figure 106



MATERIAL:

☐ ALUMINUM HONEYCOMB SANDWICH (2024-T3) WITH ALUMINUM CORE

SRM 57-53-01 ALLOWABLE DAMAGE

- DENTS MUST BE SMOOTH AND FREE OF ALL SHARP CREASES, GOUGES, OR CRACKS, AND SHOW NO EVIDENCE OF PULLED OR LOOSE RIVETS
- DENT DIAMETER TO DEPTH RATIO MUST BE 30 OR GREATER WITH A MAXIMUM DEPTH OF 0.10 INCH
- MAXIMUM HOLE OR PUNCTURE DIAMETER IS 0.25 INCH IF THE DISTANCE BETWEEN ADJACENT HOLES, OTHER DAMAGE OR EDGE IS 3 TIMES THE DIAMETER OF THE LARGE HOLE
- MINIMUM HOLE OR PUNCTURE DISTANCE TO EDGE OF FASTENER IS 3 TIMES THE DIAMETER OF THE HOLE
- MAXIMUM DELAMINATION DIAMETER IS 3.0 INCHES
- MINIMUM DISTANCE BETWEEN DELAMINATIONS 12.0 INCHES AND A MINIMUM OF 3.0 INCHES FROM A FASTENER
- REINSPECT HOLES AND PUNCTURES AT EVERY "2A" CHECK AND REPAIR NO LATER THAN NEXT "C" CHECK
- REFER TO PARAGRAPH 4 FOR TEMPORARY REPAIR OR SEAL OF DAMAGE

DRAWING NO. 113T2201

MATERIAL:

▨ ARAMID/GRAPHITE/GLASS FABRIC/EPOXY OR GRAPHITE/GLASS FABRIC/EPOXY HONEYCOMB SANDWICH WITH NOMEX CORE-250°F (121°C) CURE

SRM 57-53-01 ALLOWABLE DAMAGE

- TREAT ALL DENTS AS A HOLE OR PUNCTURE
- MAXIMUM HOLE OR DELAMINATION DIAMETER IS 1.5 INCHES
- MINIMUM DISTANCE BETWEEN MULTIPLE HOLES OR DELAMINATIONS IS 1.5 TIMES THE DIAMETER OF THE LARGER DAMAGE
- REMOVE EDGE DELAMINATIONS
- REINSPECT AT EVERY "A" CHECK, REPAIR NO LATER THAN 1200 FLIGHTS AFTER BEING DAMAGED
- REFER TO PARAGRAPH 4 FOR TEMPORARY REPAIR OR SEAL OF DAMAGE

MATERIAL:

▧ ALUMINUM SHEET (2024-T3)

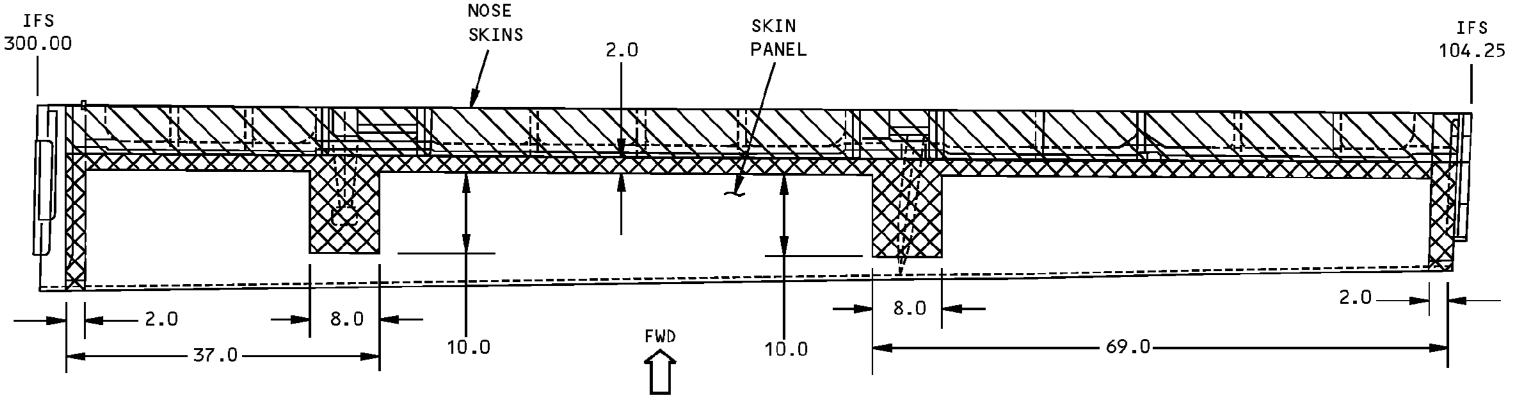
SRM 57-53-01 ALLOWABLE DAMAGE

- DENTS MUST BE SMOOTH AND FREE OF ALL SHARP CREASES, GOUGES, OR CRACKS, AND SHOW NO EVIDENCE OF PULLED OR LOOSE RIVETS
- DENT DIAMETER TO DEPTH RATIO MUST BE 30 OR GREATER WITH A MAXIMUM DEPTH OF 0.10 INCH
- MAXIMUM DENT DIAMETER IS 6.0 INCHES AND MUST BE A MINIMUM OF 3.0 INCHES FROM ANY OTHER DENT OR EDGE
- MAXIMUM HOLE OR PUNCTURE DIAMETER IS 0.25 INCH WHEN THE DISTANCE BETWEEN A FASTENER HOLE OR OTHER DAMAGE IS 1.0 INCH OR MORE
- REFER TO PARAGRAPH 4 FOR TEMPORARY REPAIR OR SEAL OF DAMAGE

Wing-Main Flap-Inboard Trailing Edge Flap
Figure 107

CAUTION:

AREAS OF HIGH LOAD TRANSFER DO NOT HAVE EXPANDED ALLOWABLE DAMAGE LIMITS



NOTES

- ALL DIMENSIONS ARE IN INCHES

MATERIAL:

☐ ▨ ALUMINUM HONEYCOMB SANDWICH (2024-T3) WITH ALUMINUM CORE

SRM 57-53-01 ALLOWABLE DAMAGE

- DENTS MUST BE SMOOTH AND FREE OF ALL SHARP CREASES, GOUGES, OR CRACKS, AND SHOW NO EVIDENCE OF PULLED OR LOOSE RIVETS
- DENT DIAMETER TO DEPTH RATIO MUST BE 30 OR GREATER WITH A MAXIMUM DEPTH OF 0.10 INCH
- MAXIMUM HOLE OR PUNCTURE DIAMETER IS 0.25 INCH IF THE DISTANCE BETWEEN ADJACENT HOLES, OTHER DAMAGE OR EDGE IS 3 TIMES DIAMETER OF LARGE HOLE
- MINIMUM HOLE OR PUNCTURE DISTANCE TO EDGE OF FASTENER IS 3 TIMES DIAMETER OF HOLE
- MAXIMUM DELAMINATION DIAMETER IS 3.0 INCHES
- MINIMUM DISTANCE BETWEEN DELAMINATIONS IS 12.0 INCHES AND A MINIMUM OF 3.0 INCHES FROM A FASTENER
- REINSPECT HOLES AND PUNCTURES AT EVERY "2A" CHECK AND REPAIR NO LATER THAN NEXT "C" CHECK
- REFER TO PARAGRAPH 4 FOR TEMPORARY REPAIR OR SEAL OF DAMAGE

DRAWING NO. 113T2301

▨ AREA OF HIGH LOAD TRANSFER

MATERIAL:

▧ ALUMINUM SHEET (2024-T3)

SRM 57-53-01 ALLOWABLE DAMAGE

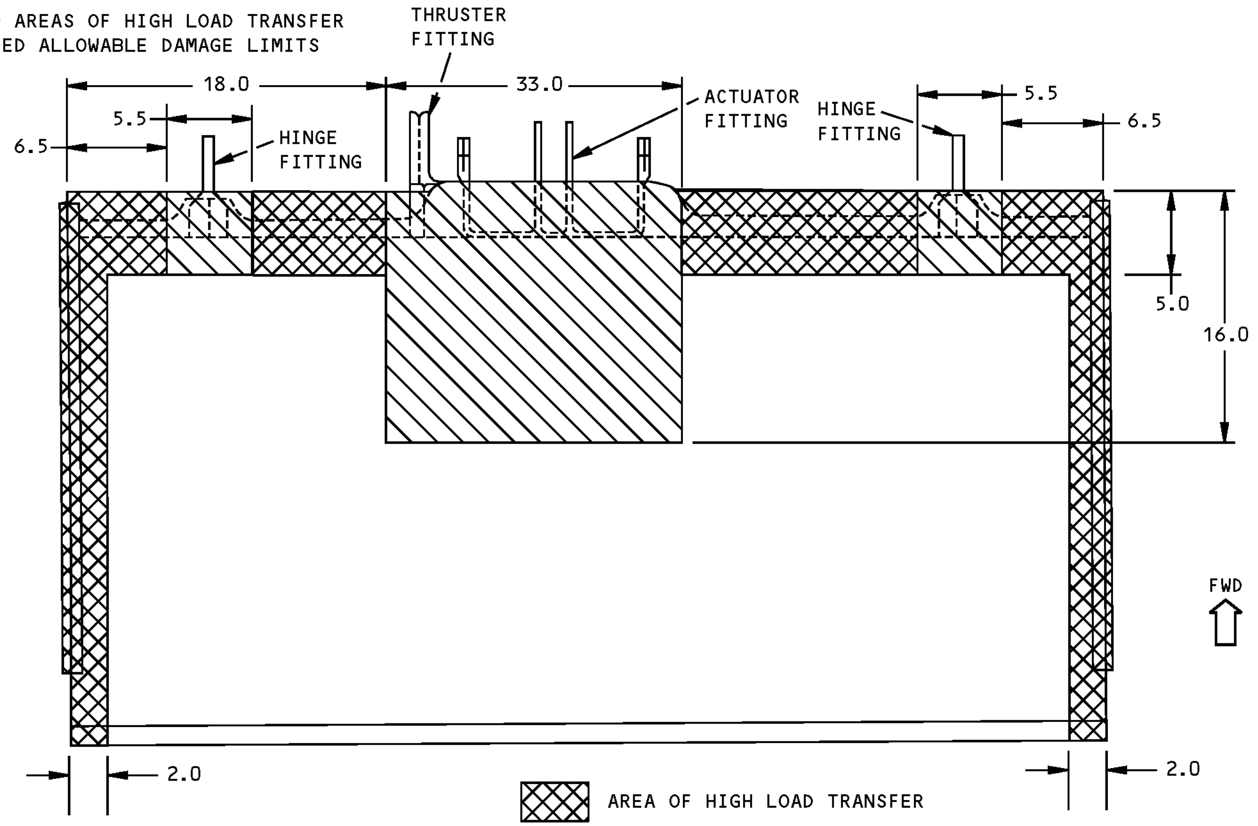
- DENTS MUST BE SMOOTH AND FREE OF ALL SHARP CREASES, GOUGES, OR CRACKS, AND SHOW NO EVIDENCE OF PULLED OR LOOSE RIVETS
- DENT DIAMETER TO DEPTH RATIO MUST BE 30 OR GREATER WITH A MAXIMUM DEPTH OF 0.10 INCH
- MAXIMUM DENT DIAMETER IS 6.0 INCHES AND MUST BE A MINIMUM OF 3.0 INCHES FROM ANY OTHER DENT OR EDGE
- MAXIMUM HOLE OR PUNCTURE DIAMETER IS 0.25 INCH WHEN THE DISTANCE BETWEEN A FASTENER HOLE OR OTHER DAMAGE IS 1.0 INCH OR MORE
- REFER TO PARAGRAPH 4 FOR TEMPORARY REPAIR OR SEAL OF DAMAGE

DRAWING NO. 113T2311

Wing-Aft Flap-Inboard Trailing Edge Flap
Figure 108

CAUTION:

CRITICAL AREAS AND AREAS OF HIGH LOAD TRANSFER DO NOT HAVE EXPANDED ALLOWABLE DAMAGE LIMITS



NOTES

- ALL DIMENSIONS ARE IN INCHES

▩ AREA OF HIGH LOAD TRANSFER

MATERIAL:

▨ GRAPHITE/EPOXY HONEYCOMB SANDWICH WITH NOMEX CORE-350°F (177°C) CURE

SRM 57-70-01 ALLOWABLE DAMAGE: CRITICAL AREA

- CONTACT BOEING FOR THE ALLOWABLE DAMAGE

MATERIAL:

☐ ▩ GRAPHITE/EPOXY HONEYCOMB SANDWICH WITH NOMEX CORE-350°F (177°C) CURE

SRM 57-70-01 ALLOWABLE DAMAGE: NON-CRITICAL AREA

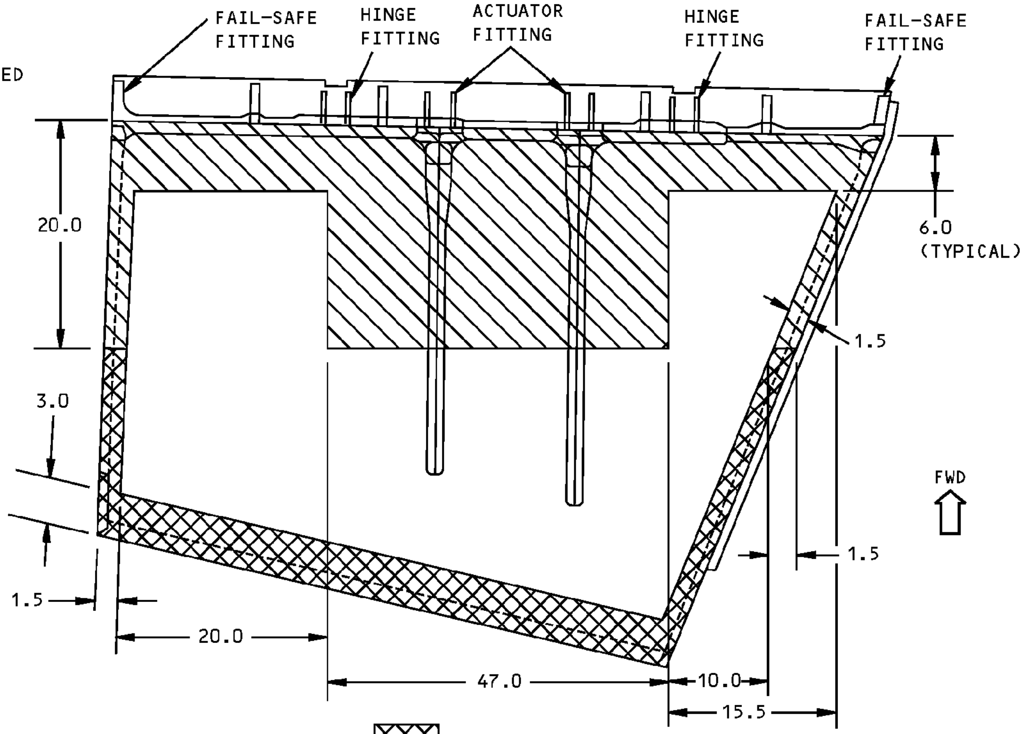
- TREAT ALL DENTS AS A HOLE OR PUNCTURE
- MAXIMUM HOLE OR DELAMINATION DIAMETER IS 1.5 INCHES
- MINIMUM DISTANCE BETWEEN MULTIPLE HOLES OR DELAMINATIONS IS 2 TIMES THE DIAMETER OF THE LARGER DAMAGE
- REMOVE EDGE DELAMINATIONS
- REINSPECT AT EVERY 100 FLIGHTS, REPAIR NO LATER THAN 600 FLIGHTS AFTER BEING DAMAGED
- REFER TO PARAGRAPH 4 FOR TEMPORARY REPAIR OR SEAL OF DAMAGE

DRAWING NO. 113T4100

Wing-Inboard Spoiler (Typical)
Figure 109

CAUTION:

CRITICAL AREAS AND AREAS OF HIGH LOAD TRANSFER DO NOT HAVE EXPANDED ALLOWABLE DAMAGE LIMITS



NOTES

- ALL DIMENSIONS ARE IN INCHES

▨ AREA OF HIGH LOAD TRANSFER

MATERIAL:

▧ GRAPHITE/EPOXY HONEYCOMB SANDWICH WITH NOMEX CORE-350°F (177°C) CURE

SRM 57-60-01 ALLOWABLE DAMAGE: CRITICAL AREA

- TREAT ALL DENTS AS A HOLE OR PUNCTURE
- DENTS, DELAMINATIONS OR PUNCTURES NOT GREATER THAN 0.25 INCH IN DIAMETER
- DISTANCE BETWEEN ANY TWO DAMAGE SITES MUST BE AT LEAST 8 TIMES THE DIAMETER OF THE LARGER DAMAGE
- DISTANCE FROM EDGE OF DAMAGE SITE TO EDGE OF PART OR NEAREST FASTENER MUST BE AT LEAST 3 TIMES THE DIAMETER OF THE LARGE DAMAGE
- REINSPECT AT EVERY "A" CHECK AND REPAIR THE AREA AT NEXT "C" CHECK. DO A REPAIR BEFORE 300 FLIGHT HOURS IF THERE IS DAMAGE TO MORE THAN ONE FASTENER HOLE AT THE HINGE FITTING ATTACH FASTENERS
- REFER TO PARAGRAPH 4 FOR TEMPORARY REPAIR OR SEAL OF DAMAGE

DRAWING NO. 113T6100

MATERIAL:

☐ ▨ GRAPHITE/EPOXY HONEYCOMB SANDWICH WITH NOMEX CORE-350°F (177°C) CURE

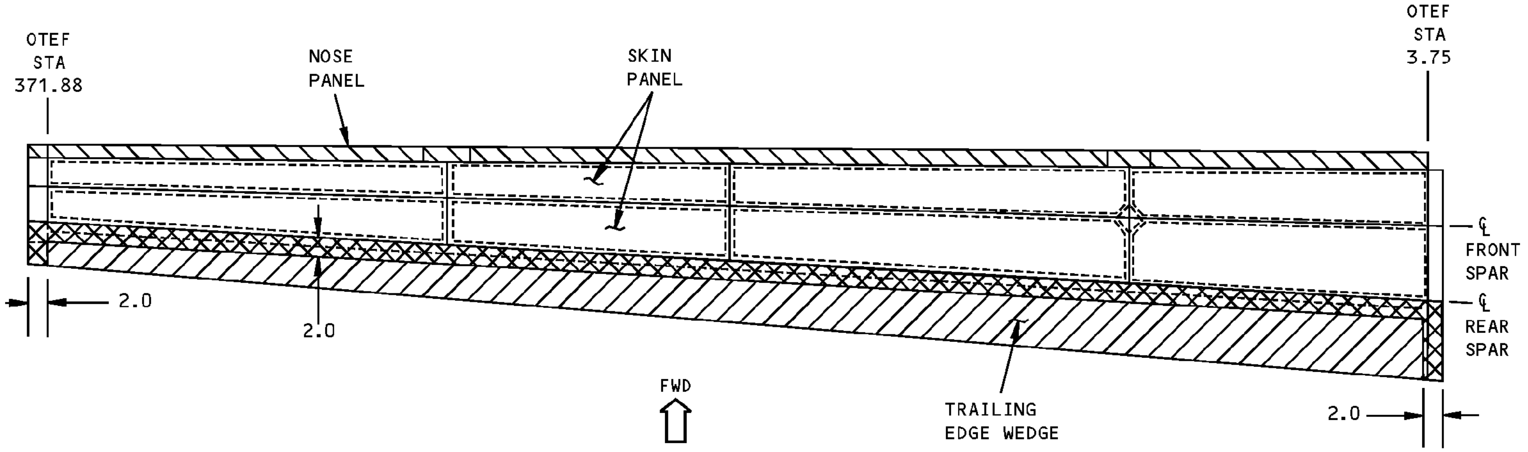
SRM 57-60-01 ALLOWABLE DAMAGE: NON-CRITICAL AREA

- TREAT ALL DENTS AS A HOLE OR PUNCTURE
- DENTS, DELAMINATIONS OR PUNCTURES NOT GREATER THAN 2.0 INCHES IN DIAMETER
- DISTANCE BETWEEN ANY TWO DAMAGE SITES MUST BE AT LEAST 2.5 TIMES THE DIAMETER OF THE LARGER DAMAGE, OR 3 TIMES THE DIAMETER OF THE SMALLER DAMAGE, WHICHEVER IS LARGER
- MINIMUM DISTANCE FROM ANY DAMAGE TO EDGE OF PANEL OR FASTENER IS 1.0 INCH
- REINSPECT AT EVERY "A" CHECK AND REPAIR NO LATER THAN NEXT "C" CHECK
- REFER TO PARAGRAPH 4 FOR TEMPORARY REPAIR OR SEAL OF DAMAGE

Wing-Inboard Aileron (Typical)
Figure 110

CAUTION:

AREAS OF HIGH LOAD TRANSFER DO NOT HAVE EXPANDED ALLOWABLE DAMAGE LIMITS



NOTES

- ALL DIMENSIONS ARE IN INCHES.

MATERIAL:

☐ ALUMINUM (7075-T6) HONEYCOMB SANDWICH WITH ALUMINUM CORE

SRM 57-53-01 ALLOWABLE DAMAGE

- DENTS MUST BE SMOOTH AND FREE OF ALL SHARP CREASES, GOUGES, OR CRACKS, AND SHOW NO EVIDENCE OF PULLED OR LOOSE RIVETS
- DENT DIAMETER TO DEPTH RATIO MUST BE 30 OR GREATER WITH A MAXIMUM DEPTH OF 0.10 INCH
- MAXIMUM HOLE OR PUNCTURE DIAMETER IS 0.25 INCH IF THE DISTANCE BETWEEN ADJACENT HOLES, OTHER DAMAGE OR EDGE IS 3 TIMES THE DIAMETER OF THE LARGE HOLE
- MINIMUM HOLE OR PUNCTURE DISTANCE TO EDGE OF FASTENER IS 3 TIMES THE DIAMETER OF THE HOLE
- MAXIMUM DELAMINATION DIAMETER IS 3.0 INCHES
- MINIMUM DISTANCE BETWEEN DELAMINATIONS IS 12.0 INCHES AND A MINIMUM OF 3.0 INCHES FROM A FASTENER
- REINSPECT HOLES AND PUNCTURES AT EVERY "2A" CHECK AND REPAIR NO LATER THAN NEXT "C" CHECK
- REFER TO PARAGRAPH 4 FOR TEMPORARY REPAIR OR SEAL OF DAMAGE

DRAWING NO. 113T3100

▩ AREA OF HIGH LOAD TRANSFER

MATERIAL:

▨ ▩ GLASS FABRIC/EPOXY HONEYCOMB SANDWICH WITH NOMEX CORE-250°F (121°C) CURE

▧ ARAMID/EPOXY HONEYCOMB SANDWICH WITH NOMEX CORE-250°F (121°C) CURE

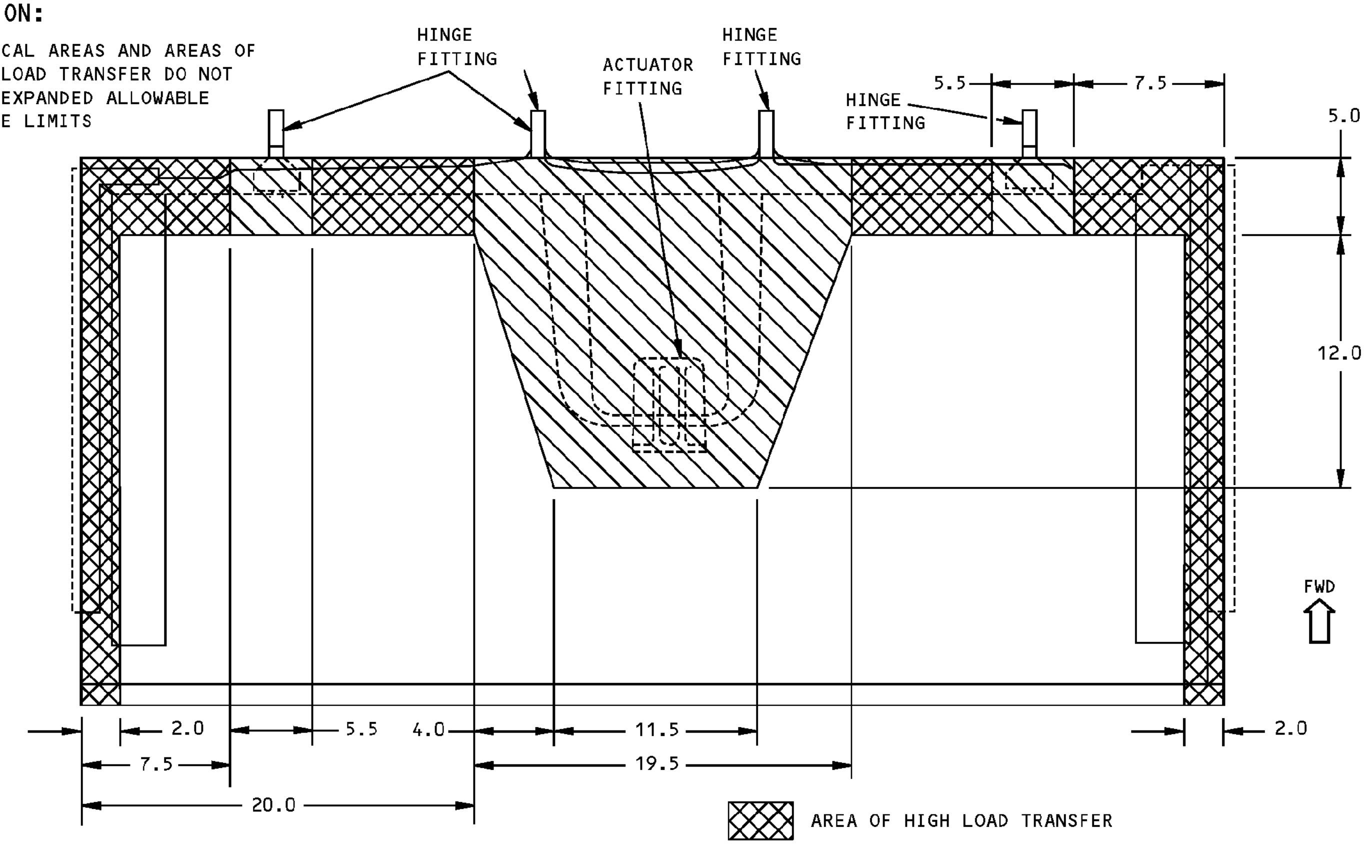
SRM 57-53-01 ALLOWABLE DAMAGE

- TREAT ALL DENTS AS A HOLE OR PUNCTURE
- MAXIMUM HOLE OR DELAMINATION DIAMETER IS 1.5 INCHES
- MINIMUM DISTANCE BETWEEN MULTIPLE HOLES OR DELAMINATIONS IS 1.5 TIMES THE DIAMETER OF THE LARGER DAMAGE
- REMOVE EDGE DELAMINATIONS
- REINSPECT AT EVERY "A" CHECK, REPAIR NO LATER THAN 1200 FLIGHTS AFTER BEING DAMAGED
- REFER TO PARAGRAPH 4 FOR TEMPORARY REPAIR OR SEAL OF DAMAGE

Wing-Outboard Trailing Edge Flap
Figure 111

CAUTION:

CRITICAL AREAS AND AREAS OF HIGH LOAD TRANSFER DO NOT HAVE EXPANDED ALLOWABLE DAMAGE LIMITS



NOTES

- ALL DIMENSIONS ARE IN INCHES

MATERIAL:

▨ GRAPHITE/EPOXY HONEYCOMB SANDWICH WITH NOMEX CORE-350°F (177°C) CURE

SRM 57-70-01 ALLOWABLE DAMAGE: CRITICAL AREA

- CONTACT BOEING FOR THE ALLOWABLE DAMAGE

DRAWING NO. 113T5102

▩ AREA OF HIGH LOAD TRANSFER

MATERIAL:

☐ ▩ GRAPHITE/EPOXY HONEYCOMB SANDWICH WITH NOMEX CORE-350°F (177°C) CURE

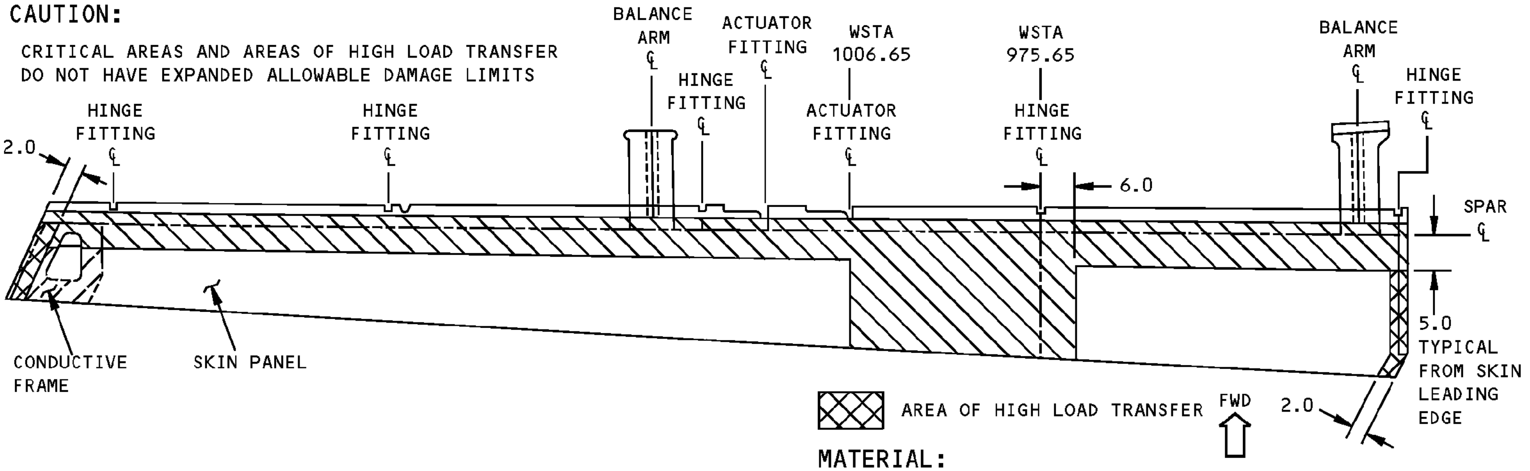
SRM 57-70-01 ALLOWABLE DAMAGE: NON-CRITICAL AREA

- TREAT ALL DENTS THE SAME AS HOLE OR PUNCTURE
- MAXIMUM HOLE OR DELAMINATION DIAMETER IS 1.5 INCHES
- MINIMUM DISTANCE BETWEEN MULTIPLE HOLES OR DELAMINATIONS IS 2 TIMES THE DIAMETER OF THE LARGER DIAMETER
- REMOVE EDGE DELAMINATIONS
- REINSPECT AT EVERY 100 FLIGHTS, REPAIR NO LATER THAN 600 FLIGHTS AFTER BEING DAMAGED
- REFER TO PARAGRAPH 4 FOR TEMPORARY REPAIR OR SEAL OF DAMAGE

Wing-Outboard Spoiler (Typical)
Figure 112

CAUTION:

CRITICAL AREAS AND AREAS OF HIGH LOAD TRANSFER DO NOT HAVE EXPANDED ALLOWABLE DAMAGE LIMITS



▩ AREA OF HIGH LOAD TRANSFER

MATERIAL:

☐ ▩ GRAPHITE/EPOXY HONEYCOMB SANDWICH WITH NOMEX CORE-350°F (177°C) CURE

SRM 57-60-02 ALLOWABLE DAMAGE: NON-CRITICAL AREA

- TREAT ALL DENTS AS A HOLE OR PUNCTURE
- DENTS, DELAMINATIONS OR PUNCTURES NOT GREATER THAN 1.5 INCHES IN DIAMETER
- MINIMUM DISTANCE BETWEEN MULTIPLE DAMAGE SITES IS 2 TIMES THE DIAMETER OF THE LARGER DAMAGE
- REMOVE EDGE DELAMINATIONS
- REINSPECT EVERY 50 FLIGHT HOURS, REPAIR THE AREA BY 300 FLIGHT HOURS
- REFER TO PARAGRAPH 4 FOR TEMPORARY REPAIR OR SEAL OF DAMAGE

MATERIAL:

▨ ALUMINUM SHEET (2024-T3)

SRM 57-60-02 ALLOWABLE DAMAGE (CONDUCTIVE FRAME)

- A PARTIALLY MISSING UPPER SURFACE CONDUCTIVE FRAME IS PERMITTED IF:
  - THE THREE ATTACH BOLTS THROUGH THE AILERON SPAR FLANGE AND THE GROUND STRAPS THAT ATTACH TO THE REAR SPAR ARE ATTACHED AND UNDAMAGED
  - YOU SMOOTHLY SAND THE EXPOSED ADHESIVE ON THE UPPER SURFACE
  - YOU APPLY A FILLET SEAL TO THE REST OF THE CONDUCTIVE FRAME EDGE WITH BMS 5-95 SEALANT
  - YOU REPLACE THE CONDUCTIVE FRAME AT THE SUBSEQUENT "C" CHECK, OR BEFORE 5000 FLIGHT HOURS

NOTES

- ALL DIMENSIONS ARE IN INCHES

MATERIAL:

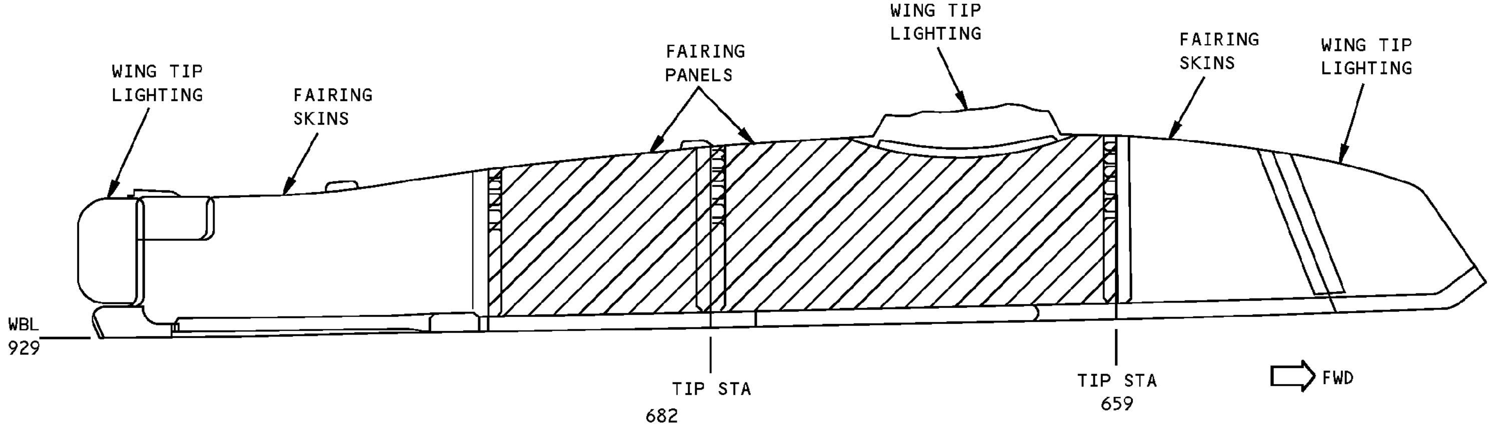
▧ GRAPHITE/EPOXY HONEYCOMB SANDWICH WITH NOMEX CORE-350°F (177°C) CURE

SRM 57-60-02 ALLOWABLE DAMAGE: CRITICAL AREA

- TREAT ALL DENTS AS A HOLE OR PUNCTURE
- DENTS, DELAMINATIONS OR PUNCTURES NOT GREATER THAN 0.25 INCH IN DIAMETER
- MINIMUM DISTANCE BETWEEN MULTIPLE DAMAGE SITES IS 8 TIMES THE DIAMETER OF THE LARGER DAMAGE
- DISTANCE FROM EDGE OF DAMAGE SITE TO EDGE OF PART OR NEAREST FASTENER MUST BE AT LEAST 3 TIMES THE DIAMETER OF THE DAMAGE
- REMOVE EDGE DELAMINATIONS
  REINSPECT EVERY 50 FLIGHT HOURS, REPAIR THE AREA BY 300 FLIGHT HOURS
- REFER TO PARAGRAPH 4 FOR TEMPORARY REPAIR OR SEAL OF DAMAGE

DRAWING NO. 113T7100

Wing-Outboard Aileron
Figure 113



MATERIAL:

☐ ALUMINUM SHEET (CLAD 2024-T3)

SRM 57-30-01 ALLOWABLE DAMAGE

- DENTS MUST BE SMOOTH AND FREE FROM ALL SHARP CREASES, GOUGES, OR CRACKS, AND SHOW NO EVIDENCE OF PULLED OR LOOSE RIVETS
- MAXIMUM HOLE, CRACK OR PUNCTURE DIAMETER IS 0.25 INCH
- DENT DIAMETER TO DEPTH RATIO MUST BE 30 OR GREATER
- MINIMUM DISTANCE BETWEEN HOLES OR PUNCTURES AND ANY FASTENER, OTHER DAMAGE, OR EDGE IS 1.0 INCH
- CLEAN UP HOLES AND PUNCTURES WITH 0.25 INCH MAXIMUM DIAMETER HOLE. FILL THE HOLE WITH A 2117-T3 OR T4 ALUMINUM RIVET INSTALLED WET WITH BMS 5-95 SEALANT
- MAXIMUM CRACK LENGTH IS 1.0 INCH IF IT IS 3.0 INCHES OR MORE FROM THE PANEL EDGE OR OTHER CRACK. DRILL 0.19 INCH DIAMETER STOP HOLES AT THE ENDS OF THE CRACK
- REMOVE EDGE CRACKS
- REFER TO PARAGRAPH 4 FOR TEMPORARY REPAIR OR SEAL OF DAMAGE

DRAWING NO. 119T0001

MATERIAL:

▨ ALUMINUM OUTER SKIN (2024-T3 OR 2024-T42), NOMEX CORE, AND GLASS FABRIC/EPOXY INNER SKIN SANDWICH

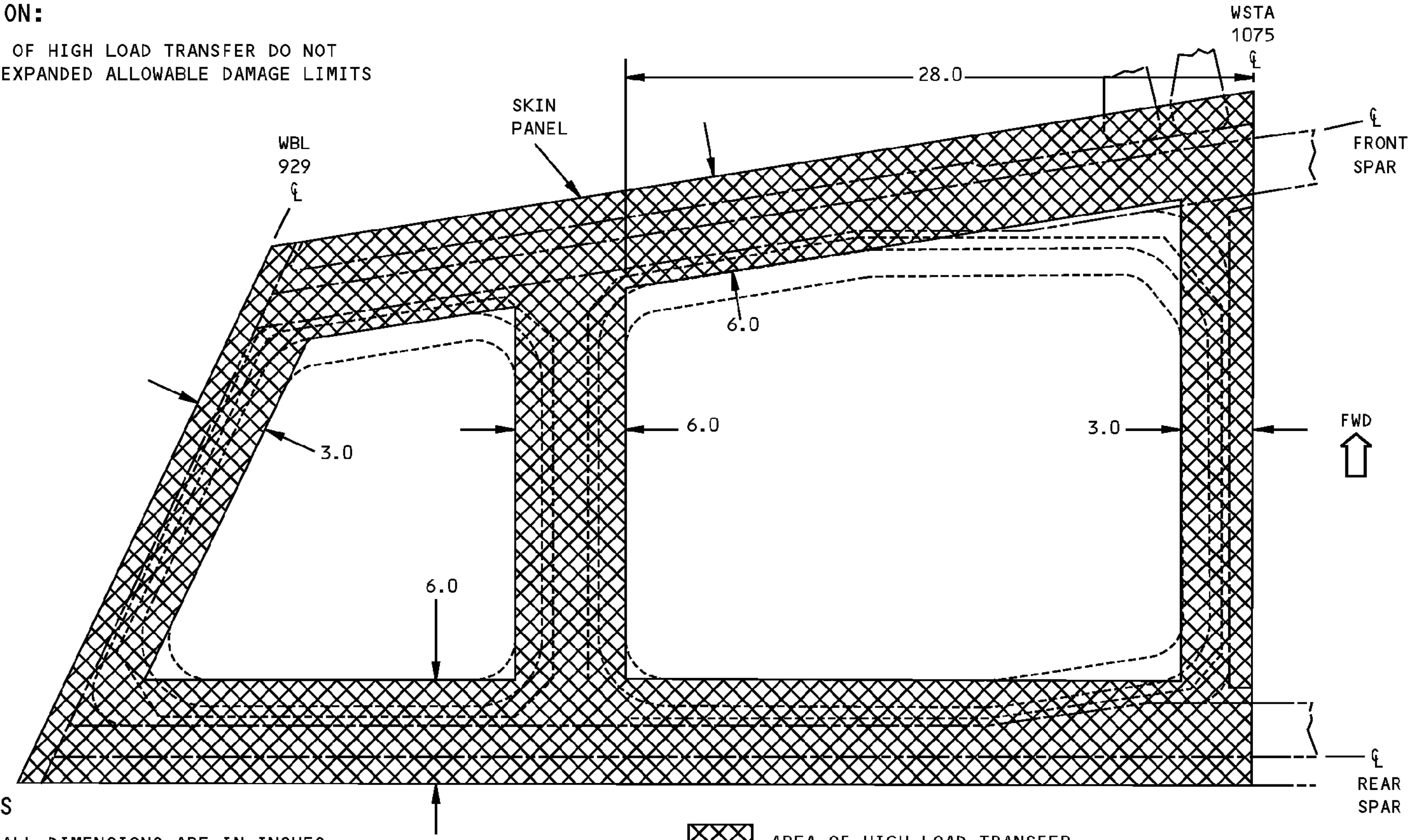
SRM 57-30-01 ALLOWABLE DAMAGE

- DENTS MUST BE SMOOTH AND FREE FROM ALL SHARP CREASES, GOUGES OR CRACKS
- DENT DIAMETER TO DEPTH RATIO MUST BE 30 OR GREATER
- MAXIMUM DENT, HOLE OR PUNCTURE DIAMETER IS 1.2 INCHES
- MINIMUM DISTANCE BETWEEN DENTS, HOLES OR PUNCTURES IS 2.5 TIMES THE DIAMETER OF THE LARGER DAMAGE
- MAXIMUM DELAMINATION DIAMETER IS 0.50 INCH WITH A MAXIMUM OF 0.03 INCH DELAMINATION FROM THE EDGE
- REINSPECT AT EVERY "A" CHECK AND REPAIR NO LATER THAN NEXT "C" CHECK
- REFER TO PARAGRAPH 4 FOR TEMPORARY REPAIR OR SEAL OF DAMAGE

Wing-Wing Tip
Figure 114

CAUTION:

AREAS OF HIGH LOAD TRANSFER DO NOT HAVE EXPANDED ALLOWABLE DAMAGE LIMITS



NOTES

- ALL DIMENSIONS ARE IN INCHES

MATERIAL:

☐	ALUMINUM HONEYCOMB SANDWICH (7075-T6) WITH ALUMINUM CORE
▨	AREA OF HIGH LOAD TRANSFER

SRM 57-20-01 ALLOWABLE DAMAGE

- DENTS MUST BE SMOOTH AND FREE FROM ALL SHARP CREASES, GOUGES OR CRACKS
- MAXIMUM DENT DIAMETER IS 2.0 INCHES
- MAXIMUM DENT DEPTH IS 0.12 INCH
- DENT DIAMETER TO DENT DEPTH MUST BE 10 OR GREATER
- MINIMUM DISTANCE FROM DENT TO DENT IS ONE TIMES THE DENT DIAMETER
- MINIMUM DISTANCE BETWEEN DENT AND EDGE IS 1.0 INCH

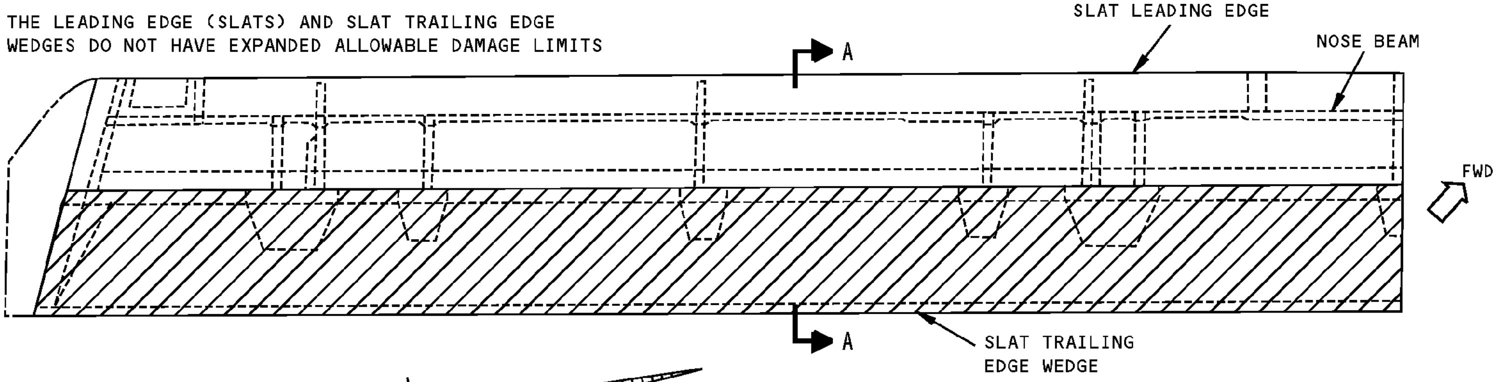
DRAWING NO. 112T3600

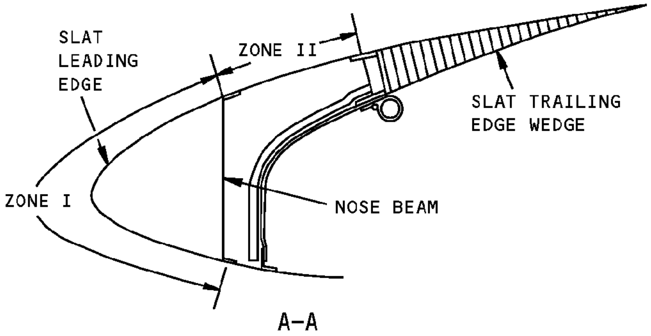
- HOLES IN THE EDGE BAND ARE NOT PERMITTED
- MAXIMUM HOLE OR PUNCTURE DIAMETER IS 0.50 INCH
- MINIMUM DISTANCE FROM HOLE OR PUNCTURE TO EDGE, FASTENER OR OTHER DAMAGE IS 2.5 INCHES
- MAXIMUM DELAMINATION DIAMETER IS 1.5 INCHES PER 1.0 SQUARE FOOT OF HONEYCOMB PANEL AREA
- MINIMUM DISTANCE BETWEEN DELAMINATION AND FASTENER HOLE, PANEL EDGE, OR OTHER DAMAGE IS 4 TIMES LARGER THAN THE DELAMINATION DIAMETER
- REINSPECT AT EVERY "A" CHECK
- REPAIR HOLES AND PUNCTURES NO LATER THAN 1200 FLIGHTS AFTER BEING DAMAGED
- REPAIR DELAMINATIONS IN HONEYCOMB AREA NO LATER THAN THE NEXT "C" CHECK
- REFER TO PARAGRAPH 4 FOR TEMPORARY REPAIR OR SEAL OF DAMAGE

Wing-Inspar Upper Wing Panel
Figure 115

CAUTION:

THE LEADING EDGE (SLATS) AND SLAT TRAILING EDGE WEDGES DO NOT HAVE EXPANDED ALLOWABLE DAMAGE LIMITS





MATERIAL:

☐ ALUMINUM SHEET (CLAD 7075-T6)

SRM 57-43-01 ALLOWABLE DAMAGE

- DENTS MUST BE SMOOTH AND FREE OF ALL SHARP CREASES, GOUGES, OR CRACKS, AND SHOW NO EVIDENCE OF PULLED OR LOOSE RIVETS
- ZONE I: MAXIMUM DENT DEPTH IS 0.06 INCH
- ZONE II: MAXIMUM DENT DEPTH IS 0.12 INCH
- DENT DIAMETER TO DENT DEPTH RATIO MUST BE 30 OR GREATER
- MAXIMUM TOTAL OF 10 DENTS FORWARD OF NOSE BEAM AND 10 DENTS AFT OF NOSE BEAM PER SLAT
- MINIMUM DISTANCE BETWEEN DENTS IS 0.5 TIMES THE MAJOR AXIS OF THE LARGER DENT
- HOLES AND PUNCTURES ARE NOT PERMITTED

DRAWING NO. 114T4101-114T4105, 114T4111-114T4115

MATERIAL:

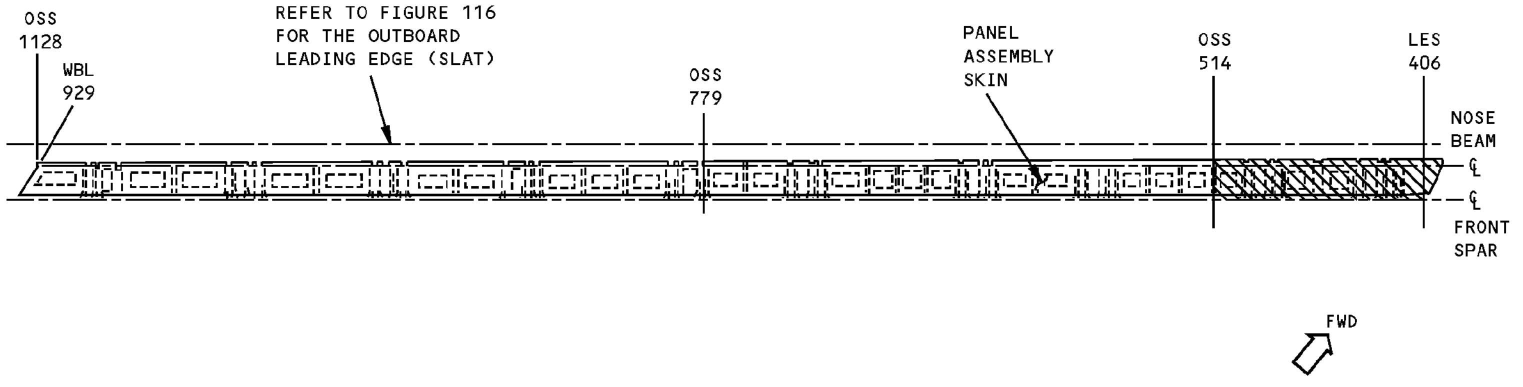
▨ ALUMINUM HONEYCOMB SANDWICH (5052-H38 OR 2024-T3) WITH ALUMINUM CORE

SRM 57-43-02 ALLOWABLE DAMAGE

- DENTS MUST BE SMOOTH AND FREE OF ALL SHARP CREASES, GOUGES, OR CRACKS, AND SHOW NO EVIDENCE OF PULLED OR LOOSE RIVETS
- MAXIMUM DENT DIAMETER IS 2.0 INCHES
- MAXIMUM DENT DEPTH IS 0.12 INCH
- DENT DIAMETER TO DEPTH RATIO MUST BE 10 OR GREATER
- DISTANCE BETWEEN DENTS MUST BE AT LEAST 1.75 TIMES THE DIAMETER OF THE LARGER DENT
- DENTS LESS THAN 1.0 INCH FROM AN EDGE ARE PERMITTED IF NO BONDS ARE BROKEN, THERE ARE NO CRACKS, AND PANEL IS IS CORRECTLY ATTACHED
- MAXIMUM 0.50 INCH HOLE OR PUNCTURE
- MINIMUM DISTANCE FROM HOLE OR PUNCTURE TO EDGE OF PANEL, OTHER DAMAGE OR FASTENER IS 2.5 INCHES
- MAXIMUM DELAMINATION DIAMETER IS 1.5 INCHES PER 1.0 SQUARE FOOT OF HONEYCOMB PANEL AREA
- MINIMUM DISTANCE BETWEEN DELAMINATIONS, OTHER DAMAGE, FASTENER HOLE OR PANEL EDGE IS 4 TIMES THE LARGER DELAMINATION DIAMETER
- REFER TO SB 57A0039 FOR DELAMINATIONS MORE THAN THESE LIMITS
- REINSPECT AT EVERY "A" CHECK
- REPAIR HOLES AND PUNCTURES NO LATER THAN 1200 FLIGHTS AFTER BEING DAMAGED
- REPAIR DELAMINATIONS IN HONEYCOMB AREA NO LATER THAN THE NEXT "C" CHECK
- REFER TO PARAGRAPH 4 FOR TEMPORARY REPAIR OR SEAL OF DAMAGE

DRAWING NO. 114T4112

Wing-Outboard Leading Edge (Slat)
Figure 116



MATERIAL:

▨ GLASS FABRIC/EPOXY HONEYCOMB SANDWICH WITH NOMEX CORE-350°F (177°C) CURE

☐ GLASS FABRIC/EPOXY HONEYCOMB SANDWICH WITH NOMEX CORE-250°F (121°C) CURE

SRM 57-41-01 ALLOWABLE DAMAGE

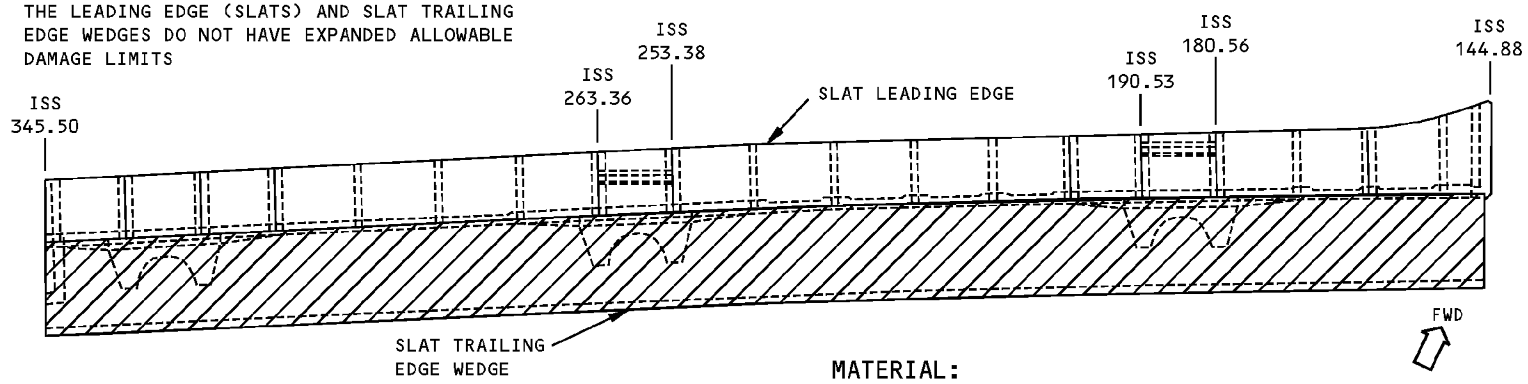
- TREAT ALL DENTS AS A HOLE OR PUNCTURE
- MAXIMUM ALLOWABLE PUNCTURE, HOLE OR DELAMINATION DIAMETER IS 2.0 INCHES
- MINIMUM DISTANCE BETWEEN ADJACENT HOLES, PUNCTURES, OR DELAMINATIONS IS 1.5 TIMES THE DIAMETER OF THE LARGER DAMAGE
- REMOVE EDGE DAMAGE
- REINSPECT AT EVERY "A" CHECK AND REPAIR NO LATER THAN NEXT "C" CHECK
- REFER TO PARAGRAPH 4 FOR TEMPORARY REPAIR OR SEAL OF DAMAGE

DRAWING NO. 114T2000

Wing-Outboard Fixed Leading Edge
Figure 117

CAUTION:

THE LEADING EDGE (SLATS) AND SLAT TRAILING EDGE WEDGES DO NOT HAVE EXPANDED ALLOWABLE DAMAGE LIMITS



MATERIAL:

☐ ALUMINUM SHEET (CLAD 7075-T6)

SRM 57-43-01 ALLOWABLE DAMAGE

- DENTS MUST BE SMOOTH AND FREE OF ALL SHARP CREASES, GOUGES, OR CRACKS, AND SHOW NO EVIDENCE OF PULLED OR LOOSE RIVETS
- MAXIMUM DENT DEPTH IS 0.06 INCH
- DENT DIAMETER TO DENT DEPTH RATIO MUST BE 30 OR GREATER
- MAXIMUM TOTAL OF 10 DENTS
- MINIMUM DISTANCE BETWEEN DENTS IS 0.5 TIMES THE MAJOR AXIS OF THE LARGER DENT
- HOLES AND PUNCTURES ARE NOT PERMITTED

DRAWING NO. 114T3100

MATERIAL:

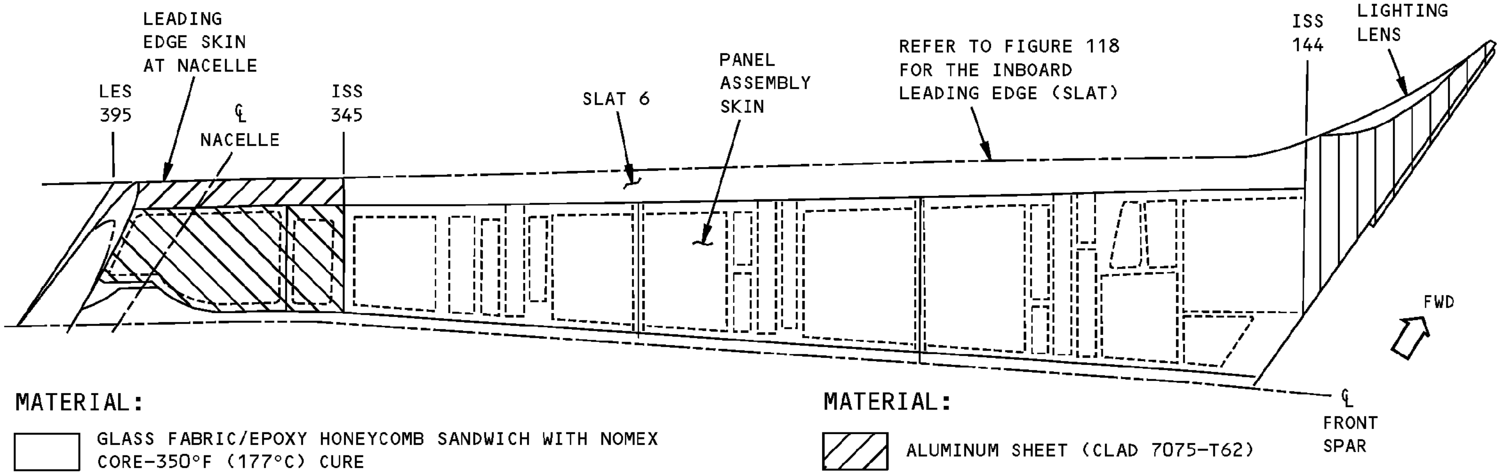
▨ ALUMINUM HONEYCOMB SANDWICH (5052-H38 OR 2024-T3) WITH ALUMINUM CORE

SRM 57-43-02 ALLOWABLE DAMAGE

- DENTS MUST BE SMOOTH AND FREE OF ALL SHARP CREASES, GOUGES, OR CRACKS, AND SHOW NO EVIDENCE OF PULLED OR LOOSE RIVETS
- MAXIMUM DENT DIAMETER IS 2.0 INCHES
- MAXIMUM DENT DEPTH IS 0.12 INCH
- DENT DIAMETER TO DEPTH RATIO MUST BE 10 OR GREATER
- DISTANCE BETWEEN DENTS MUST BE AT LEAST 1.75 TIMES THE DIAMETER OF THE LARGER DENT
- DENTS LESS THAN 1.0 INCH FROM AN EDGE ARE PERMITTED IF NO BONDS ARE BROKEN, THERE ARE NO CRACKS, AND PANEL IS CORRECTLY ATTACHED
- MAXIMUM 0.50 INCH HOLE OR PUNCTURE
- MINIMUM DISTANCE FROM HOLE OR PUNCTURE TO EDGE OF PANEL, OTHER DAMAGE OR FASTENER IS 2.5 INCHES
- MAXIMUM DELAMINATION DIAMETER IS 1.5 INCHES PER 1.0 SQUARE FOOT OF HONEYCOMB PANEL AREA
- MINIMUM DISTANCE BETWEEN DELAMINATIONS, OTHER DAMAGE, FASTENER HOLE OR PANEL EDGE IS 4 TIMES THE LARGER DELAMINATION DIAMETER
- REFER TO SB 57A0039 FOR DELAMINATIONS MORE THAN THESE LIMITS
- REINSPECT AT EVERY "A" CHECK
- REPAIR HOLES AND PUNCTURES NO LATER THAN 1200 FLIGHTS AFTER BEING DAMAGED
- REPAIR DELAMINATIONS IN HONEYCOMB AREA NO LATER THAN THE NEXT "C" CHECK
- REFER TO PARAGRAPH 4 FOR TEMPORARY REPAIR OR SEAL OF DAMAGE

DRAWING NO. 114T3110

Wing-Inboard Leading Edge (Slat)
Figure 118



MATERIAL:

☐ GLASS FABRIC/EPOXY HONEYCOMB SANDWICH WITH NOMEX CORE-350°F (177°C) CURE

SRM 57-41-01 ALLOWABLE DAMAGE

- TREAT ALL DENTS AS A HOLE OR PUNCTURE
- MAXIMUM ALLOWABLE PUNCTURE, HOLE OR DELAMINATION DIAMETER IS 2.0 INCHES
- MINIMUM DISTANCE BETWEEN ADJACENT HOLES, PUNCTURES OR DELAMINATIONS IS 1.5 TIMES THE DIAMETER OF THE LARGER DAMAGE
- REINSPECT AT EVERY "A" CHECK AND REPAIR NO LATER THAN NEXT "C" CHECK

MATERIAL:

▥ ALUMINUM SHEET (CLAD 7075-T62)

SRM 57-41-70 ALLOWABLE DAMAGE

- DENTS MUST BE SMOOTH AND FREE OF ALL SHARP CREASES, GOUGES, OR CRACKS, AND SHOW NO EVIDENCE OF PULLED OR LOOSE RIVETS
- DENT DIAMETER TO DEPTH RATIO MUST BE 30 OR GREATER
- MAXIMUM DENT DEPTH IS 0.125 INCH
- MAXIMUM HOLE OR PUNCTURE IS 0.25 INCH
- MINIMUM DISTANCE BETWEEN HOLES, EDGE OF PANEL, FASTENER OR OTHER DAMAGE IS 0.75 INCH
- CLEAN UP HOLE WITH 0.25 INCH MAXIMUM HOLE AND FILL WITH RIVET
- MAXIMUM CRACK LENGTH IS 1.0 INCH IF IT IS 3.0 INCHES OR MORE FROM THE EDGE OF THE PANEL OR OTHER CRACKS. DRILL 0.19 INCH DIAMETER STOP HOLES AT THE ENDS OF THE CRACKS
- REMOVE EDGE CRACKS
- REFER TO PARAGRAPH 4 FOR TEMPORARY REPAIR OR SEAL OF DAMAGE

DRAWING NO. 114T1300

MATERIAL:

▨ ALUMINUM SHEET (CLAD 7075-T62)

SRM 57-41-01 ALLOWABLE DAMAGE

- DENTS MUST BE SMOOTH AND FREE OF ALL SHARP CREASES, GOUGES, OR CRACKS, AND SHOW NO EVIDENCE OF PULLED OR LOOSE RIVETS
- DENT DIAMETER TO DEPTH RATIO MUST BE 30 OR GREATER
- MAXIMUM HOLE OR PUNCTURE IS 0.25 INCH
- MINIMUM DISTANCE BETWEEN HOLES, EDGE OF PANEL, FASTENER, OR OTHER DAMAGE IS 1.0 INCH
- CLEAN UP DAMAGE WITH 0.25 INCH MAXIMUM HOLE AND FILL WITH RIVET

MATERIAL:

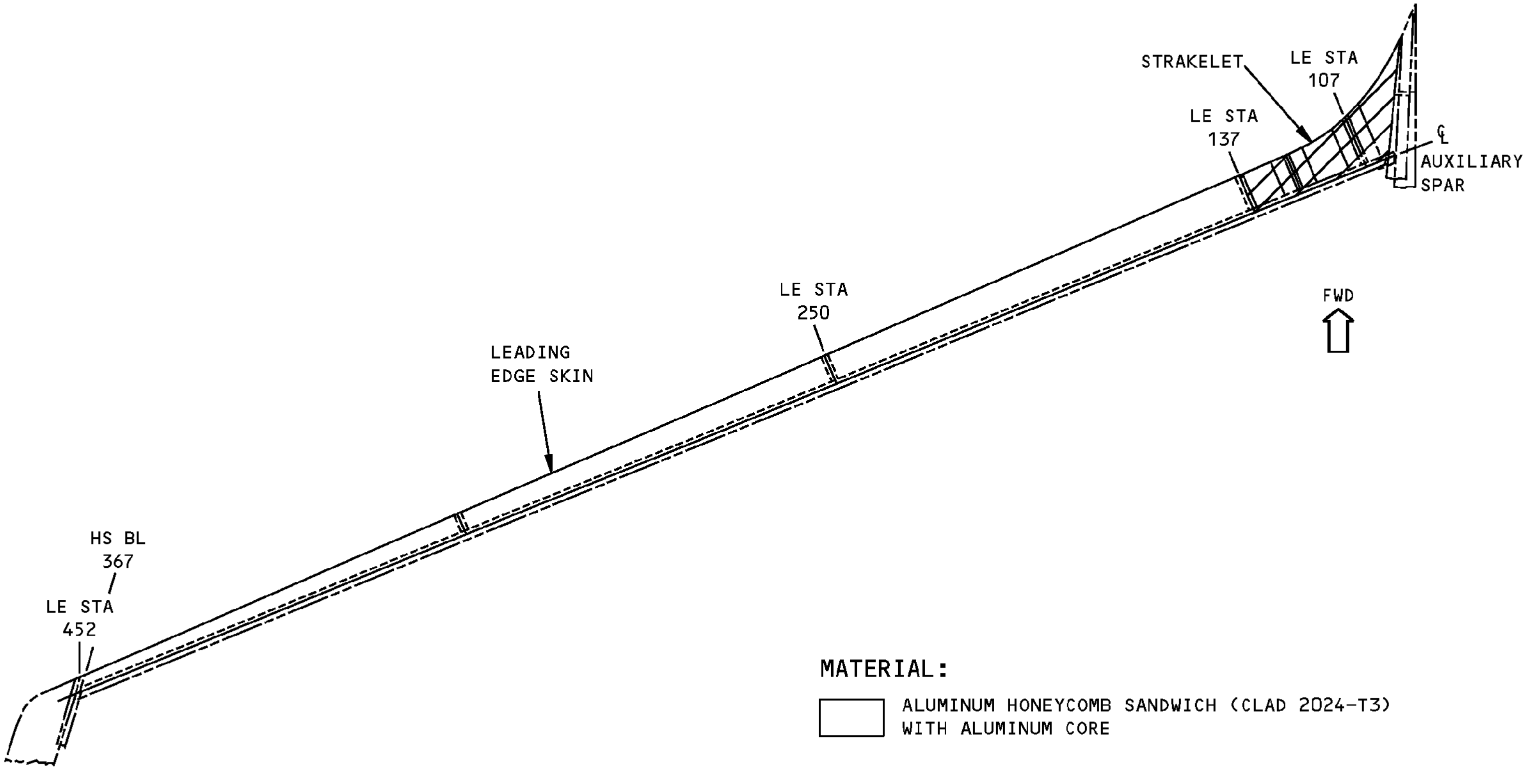
▧ ALUMINUM HONEYCOMB SANDWICH (CLAD 2024-T3 OR 2024-T3) WITH ALUMINUM CORE

SRM 57-41-01 ALLOWABLE DAMAGE

- DENTS MUST BE SMOOTH AND FREE OF ALL SHARP CREASES, GOUGES, OR CRACKS, AND SHOW NO EVIDENCE OF PULLED OR LOOSE RIVETS
- DENT DIAMETER TO DEPTH RATIO MUST BE 30 OR GREATER
- MAXIMUM HOLE OR PUNCTURE IS 0.25 INCH
- MINIMUM DISTANCE BETWEEN HOLES, EDGE OF PANEL, FASTENER, OR OTHER DAMAGE IS 1.0 INCH
- MAXIMUM DELAMINATION DIAMETER IS 0.50 INCH
- REINSPECT AT EVERY "A" CHECK AND REPAIR NO LATER THAN NEXT "C" CHECK
- REFER TO PARAGRAPH 4 FOR TEMPORARY REPAIR OR SEAL OF DAMAGE

DRAWING NO. 114T1000, 114T6000

Wing-Inboard Fixed Leading Edge
Figure 119



MATERIAL:

▨ ALUMINUM SHEET (CLAD 2024-T42)

SRM 55-10-71 ALLOWABLE DAMAGE

- ALL DENTS MUST BE SMOOTH AND FREE OF ALL SHARP CREASES, GOUGES, OR CRACKS, AND SHOW NO EVIDENCE OF PULLED OR LOOSE RIVETS
- MAXIMUM DENT DEPTH IS 0.125 INCH
- DENT DIAMETER TO DEPTH RATIO MUST BE 30 OR GREATER
- MAXIMUM HOLE IS 0.25 INCH
- MINIMUM DISTANCE BETWEEN HOLES IS 1.0 INCH
- CLEAN UP HOLE WITH 0.25 INCH DIAMETER HOLE AND FILL WITH RIVET
- REFER TO PARAGRAPH 4 FOR TEMPORARY REPAIR OR SEAL OF DAMAGE

DRAWING NO. 184T1001

MATERIAL:

☐ ALUMINUM HONEYCOMB SANDWICH (CLAD 2024-T3) WITH ALUMINUM CORE

SRM 55-10-01 ALLOWABLE DAMAGE

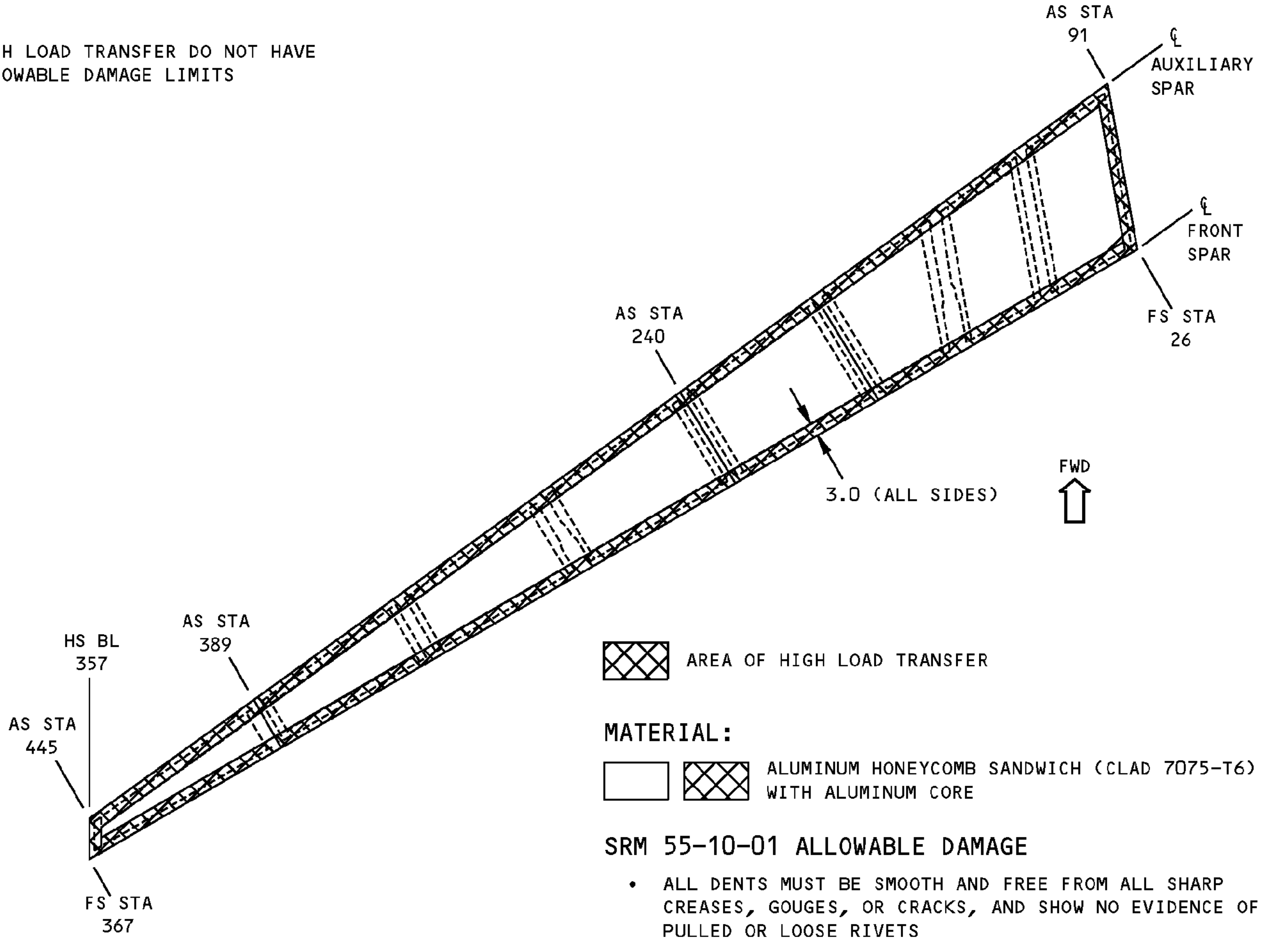
- ALL DENTS MUST BE SMOOTH AND FREE OF ALL SHARP CREASES, GOUGES, OR CRACKS, AND SHOW NO EVIDENCE OF PULLED OR LOOSE RIVETS
- MAXIMUM HOLE, CRACK OR PUNCTURE DIAMETER IS 0.25 INCH
- MINIMUM DISTANCE BETWEEN HOLES IS 1.0 INCH
- DENT DIAMETER TO DEPTH RATIO MUST BE 30 OR GREATER
- MAXIMUM DENT DEPTH IS 0.125 INCH WITHOUT REWORK
- DENTS WITH A DEPTH MORE THAN 0.125 INCH MUST BE FILLED WITH A POTTING COMPOUND AS SHOWN IS SRM 51-70-01
- MAXIMUM DELAMINATION DIAMETER IS 1.5 INCHES
- REMOVE EDGE DELAMINATIONS
- REINSPECT AT EVERY "A" CHECK AND REPAIR NO LATER THAN NEXT "C" CHECK
- REFER TO PARAGRAPH 4 FOR TEMPORARY REPAIR OR SEAL OF DAMAGE

DRAWING NO. 184T1006-184T1008

Horizontal Stabilizer-Leading Edge
Figure 120

CAUTION:

AREAS OF HIGH LOAD TRANSFER DO NOT HAVE EXPANDED ALLOWABLE DAMAGE LIMITS



▨ AREA OF HIGH LOAD TRANSFER

MATERIAL:

☐ ▨ ALUMINUM HONEYCOMB SANDWICH (CLAD 7075-T6) WITH ALUMINUM CORE

SRM 55-10-01 ALLOWABLE DAMAGE

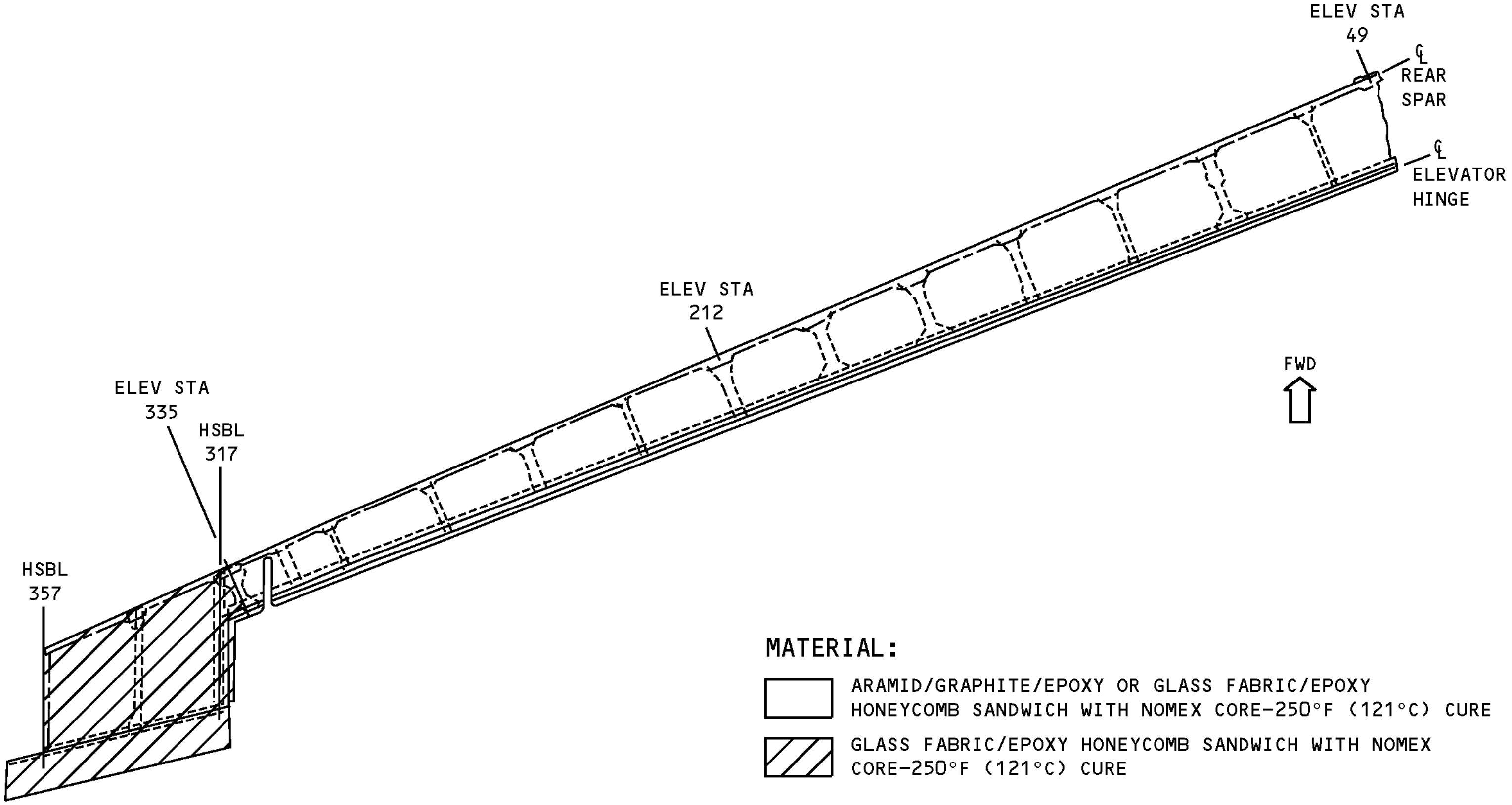
- ALL DENTS MUST BE SMOOTH AND FREE FROM ALL SHARP CREASES, GOUGES, OR CRACKS, AND SHOW NO EVIDENCE OF PULLED OR LOOSE RIVETS
- MAXIMUM HOLE, CRACK OR PUNCTURE DIAMETER IS 0.25 INCH
- DENT DIAMETER TO DEPTH RATIO MUST BE 30 OR GREATER
- MINIMUM DISTANCE BETWEEN HOLES IS 1.0 INCH
- MAXIMUM DENT DEPTH IS 0.125 INCH WITHOUT REWORK
- DENT WITH A DEPTH MORE THAN 0.125 INCH MUST BE FILLED WITH A POTTING COMPOUND AS SHOWN IN SRM 51-70-01
- MAXIMUM DELAMINATION DIAMETER IS 1.5 INCHES
- REMOVE EDGE DELAMINATIONS
- REINSPECT AT EVERY "A" CHECK AND REPAIR NO LATER THAN NEXT "C" CHECK
- REFER TO PARAGRAPH 4 FOR TEMPORARY REPAIR OR SEAL OF DAMAGE

NOTES

- ALL DIMENSIONS ARE IN INCHES

DRAWING NO. 185T1001, 185T1002, 185T1005

Horizontal Stabilizer-Auxiliary Box
Figure 121



MATERIAL:

▭ ARAMID/GRAPHITE/EPOXY OR GLASS FABRIC/EPOXY HONEYCOMB SANDWICH WITH NOMEX CORE-250°F (121°C) CURE

▨ GLASS FABRIC/EPOXY HONEYCOMB SANDWICH WITH NOMEX CORE-250°F (121°C) CURE

SRM 55-10-01 ALLOWABLE DAMAGE

- TREAT ALL DENTS AS A HOLE OR PUNCTURE
- MAXIMUM ALLOWABLE PUNCTURE, HOLE OR DELAMINATION DIAMETER IS 1.5 INCHES
- MINIMUM SPACING BETWEEN ADJACENT HOLES, PUNCTURES OR DELAMINATION IS 4.5 INCHES
- MAXIMUM EDGE DAMAGE IS 10 PERCENT OF THE EDGE BAND LENGTH PER SIDE
- MAXIMUM ONE FASTENER HOLE IN SIX MAY BE DAMAGED
- REINSPECT AT EVERY "A" CHECK AND REPAIR NO LATER THAN NEXT "C" CHECK
- REFER TO PARAGRAPH 4 FOR TEMPORARY REPAIR OR SEAL OF DAMAGE

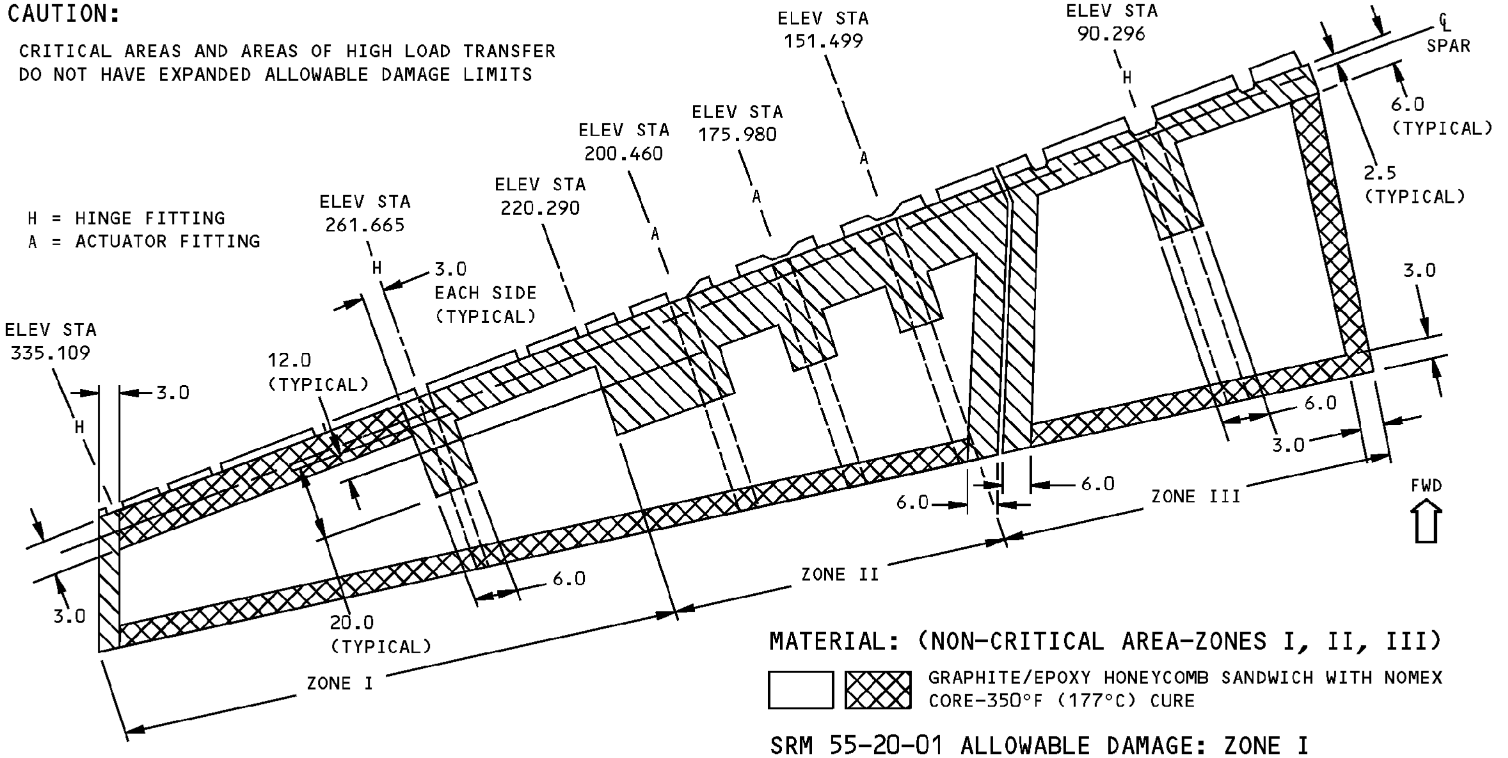
DRAWING NO. 183T1100, 183T1110, 183T1120, 183T1130, 183T1140

Horizontal Stabilizer-Fixed Trailing Edge
Figure 122

CAUTION:

CRITICAL AREAS AND AREAS OF HIGH LOAD TRANSFER DO NOT HAVE EXPANDED ALLOWABLE DAMAGE LIMITS

H = HINGE FITTING
A = ACTUATOR FITTING



▩ AREA OF HIGH LOAD TRANSFER

NOTES

- ALL DIMENSIONS ARE IN INCHES

MATERIAL: (CRITICAL AREA)

▨ GRAPHITE/EPOXY HONEYCOMB SANDWICH WITH NOMEX CORE-350°F (177°C) CURE

SRM 55-20-01 ALLOWABLE DAMAGE: CRITICAL AREA

- CONTACT THE BOEING COMPANY FOR ALLOWABLE DAMAGE

DRAWING NO. 183T2001, 183T3001

MATERIAL: (NON-CRITICAL AREA-ZONES I, II, III)

☐ ▩ GRAPHITE/EPOXY HONEYCOMB SANDWICH WITH NOMEX CORE-350°F (177°C) CURE

SRM 55-20-01 ALLOWABLE DAMAGE: ZONE I

- TREAT ALL DENTS AS A HOLE OR PUNCTURE
- REMOVE EDGE DAMAGE
- MAXIMUM ALLOWABLE HOLE, PUNCTURE OR DELAMINATION DIAMETER IS 2.0 INCHES
- MINIMUM DISTANCE BETWEEN ADJACENT HOLES, PUNCTURES OR DELAMINATIONS IS 3 TIMES THE DIAMETER OF THE LARGER DAMAGE
- REINSPECT EVERY 50 FLIGHTS, REPAIR THE AREA NO LATER THAN 300 FLIGHTS AFTER BEING DAMAGED
- REFER TO PARAGRAPH 4 FOR TEMPORARY REPAIR OR SEAL OF DAMAGE

SRM 55-20-01 ALLOWABLE DAMAGE: ZONE II

SAME AS "ZONE I" EXCEPT

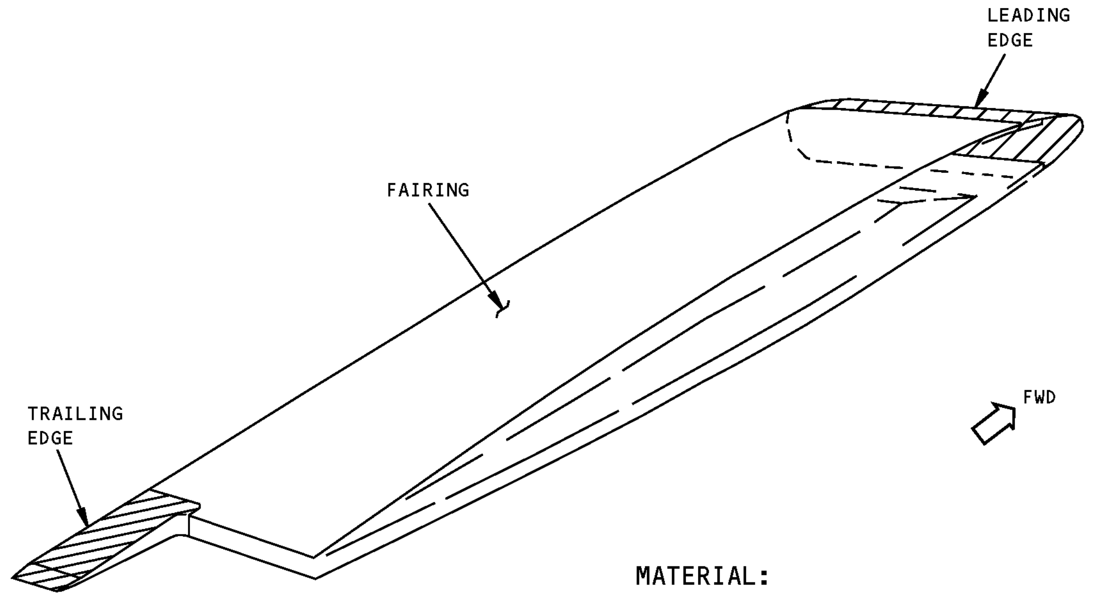
- MAXIMUM ALLOWABLE HOLE, PUNCTURE OR DELAMINATION DIAMETER IS 1.5 INCHES

SRM 55-20-01 ALLOWABLE DAMAGE: ZONE III

SAME AS "ZONE I" EXCEPT

- MAXIMUM ALLOWABLE HOLE, PUNCTURE OR DELAMINATION DIAMETER IS 1.2 INCHES

Horizontal Stabilizer-Elevator
Figure 123



MATERIAL:

☐ ARAMID/EPOXY OR GLASS FABRIC/EPOXY HONEYCOMB SANDWICH WITH NOMEX CORE-250°F (121°C) CURE

SRM 55-10-30 ALLOWABLE DAMAGE

- TREAT ALL DENTS AS A HOLE OR PUNCTURE
- MAXIMUM HOLE, PUNCTURE OR DELAMINATION DIAMETER IS 2.0 INCHES
- MINIMUM DISTANCE BETWEEN OTHER DAMAGE, FASTENER, HOLE OR PANEL EDGE IS 1.5 TIMES THE DIAMETER OF THE LARGER DAMAGE
- REINSPECT AT EVERY "A" CHECK AND REPAIR NO LATER THAN NEXT "C" CHECK
- REFER TO PARAGRAPH 4 FOR TEMPORARY REPAIR OR SEAL OF DAMAGE

DRAWING NO. 189T0001

MATERIAL:

▨ ALUMINUM SHEET (6061-T6)

SRM 55-10-30 ALLOWABLE DAMAGE

- DENTS MUST BE SMOOTH AND FREE OF ALL SHARP CREASES, GOUGES, OR CRACKS, AND SHOW NO EVINECE OF PULLED OR LOOSE RIVETS
- MAXIMUM DENT DEPTH IS 0.125 INCH
- DENT DIAMETER TO DEPTH RATIO MUST BE 30 OR GREATER
- MAXIMUM HOLE OR PUNCTURE IS 0.25 INCH
- MINIMUM DISTANCE BETWEEN HOLES OR FASTENERS IS 1.0 INCH
- CLEAN UP HOLES AND PUNCTURES WITH 0.25 INCH MAXIMUM DIAMETER HOLE. FILL THE HOLE WITH A 2117-T3 OR T4 ALUMINUM RIVET INSTALLED WET WITH BMS 5-95 SEALANT
- REFER TO PARAGRAPH 4 FOR TEMPORARY REPAIR OR SEAL OF DAMAGE

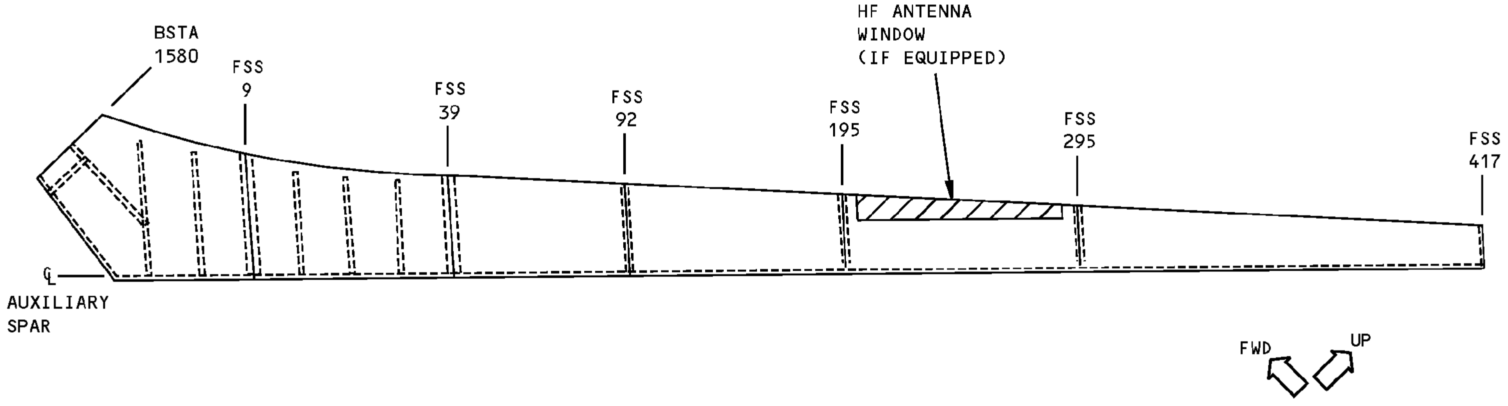
MATERIAL:

▨ ALUMINUM SHEET (6061-T6 OR 7075-T6511)

SRM 55-10-30 ALLOWABLE DAMAGE

SAME AS "LEADING EDGE" EXCEPT:
- MAXIMUM HOLE OR PUNCTURE IS 0.50 INCH
- NO FILLING OF THE HOLE OR PUNCTURE IS REQUIRED
- REPAIR NO LATER THAN NEXT "C" CHECK

Horizontal Stabilizer-Horizontal Tail Tip
Figure 124



MATERIAL:

☐ ALUMINUM SHEET (CLAD 2024-T3)

SRM 55-30-01 ALLOWABLE DAMAGE

- ALL DENT MUST BE SMOOTH AND FREE FROM ALL SHARP CREASES, GOUGES, AND CRACKS, AND SHOW NO EVIDENCE OF PULLED OR LOOSE RIVETS
- DENT DIAMETER TO DEPTH RATIO MUST BE 30 OR GREATER
- MAXIMUM DENT DEPTH IS 0.125 INCH
- MAXIMUM HOLE OR PUNCTURE DIAMETER IS 0.25 INCH. ALL OTHER HOLES OR PUNCTURES TO BE REPAIRED
- MINIMUM DISTANCE BETWEEN HOLES OR PUNCTURES IS 1.0 INCH
- MINIMUM EDGE MARGIN FOR A HOLE OR PUNCTURE IS 1.5 TIMES THE DIAMETER OF THE DAMAGE
- CLEAN UP HOLES AND PUNCTURES WITH 0.25 INCH DIAMETER HOLE AND FILL WITH A 2117-T4 ALUMINUM RIVET INSTALLED WET WITH BMS 5-95
- REFER TO PARAGRAPH 4 FOR TEMPORARY REPAIR OR SEAL OF DAMAGE

DRAWING NO. 174T1101-174T1104, 174T3100

MATERIAL:

▨ GLASS FABRIC/EPOXY WINDOW-250°F (121°C) CURE

SRM 55-30-01 ALLOWABLE DAMAGE

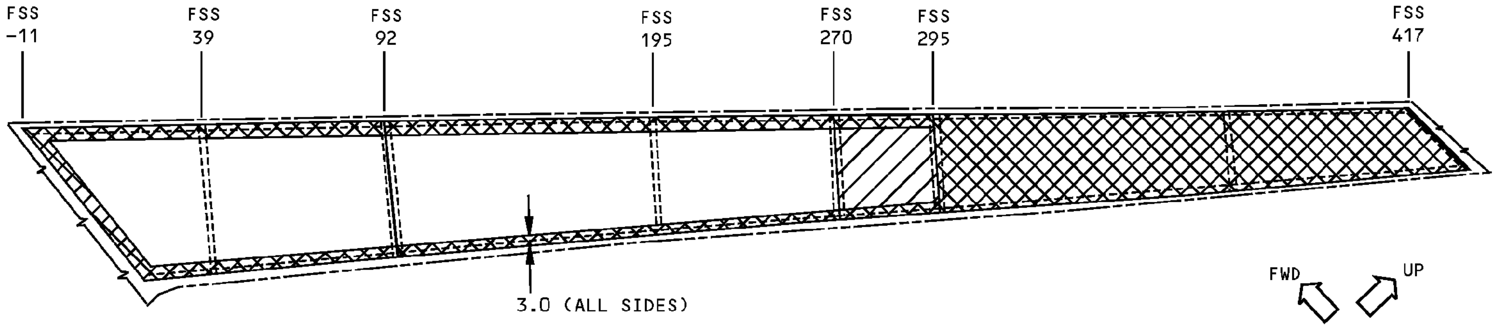
- MAXIMUM DENT DIAMETER IS 1.0 INCH, PROVIDED THERE IS NO FIBER DAMAGE OR DELAMINATION
- MAXIMUM OF ONE DENT PER SQUARE FOOT OF AREA AND A MINIMUM OF 6.0 INCHES FROM ANY OTHER DAMAGE, FASTENER OR PANEL EDGE
- MAXIMUM HOLE OR PUNCTURE DIAMETER IS 0.25 INCH
- MINIMUM DISTANCE BETWEEN HOLES OR PUNCTURES, OTHER DAMAGE OR EDGE IS 1.0 INCH
- MAXIMUM DELAMINATION DIAMETER IS 0.50 INCH
- SEAL DAMAGE WITH HF TRANSPARENT TAPE (NONMETALIZED - SCOTCHBRAND 853, PERMACAL P280, OR EQUIVALENT)
- REINSPECT AT EVERY "A" CHECK AND REPAIR NO LATER THAN NEXT "C" CHECK
- REFER TO PARAGRAPH 4 FOR TEMPORARY REPAIR OR SEAL OF DAMAGE

DRAWING NO. 174T1103

Vertical Stabilizer-Leading Edge
Figure 125

CAUTION:

AREAS OF HIGH LOAD TRANSFER DO NOT HAVE EXPANDED ALLOWABLE DAMAGE LIMITS



NOTES

- ALL DIMENSIONS ARE IN INCHES

▩ AREA OF HIGH LOAD TRANSFER

MATERIAL:

☐ ▩ ALUMINUM HONEYCOMB SANDWICH (CLAD 7075-T6) WITH ALUMINUM CORE

▨ ▩ ALUMINUM HONEYCOMB SANDWICH (CLAD 7075-T6) WITH NOMEX CORE

SRM 55-30-01 ALLOWABLE DAMAGE

- ALL DENTS MUST BE SMOOTH AND FREE FROM ALL SHARP CREASES, GOUGES, OR CRACKS, AND SHOW NO EVIDENCE OF PULLED OR LOOSE RIVETS
- MAXIMUM HOLE OR PUNCTURE DIAMETER IS 0.25 INCH
- MINIMUM DISTANCE BETWEEN HOLES, PUNCTURE OR DISTANCE FROM HOLE TO EDGE OF PART OR FASTENER IS 1.0 INCH
- MAXIMUM DENT DEPTH IS 0.125 INCH
- DENT DIAMETER TO DEPTH RATIO MUST BE 30 OR GREATER
- MAXIMUM DELAMINATION DIAMETER 4.0 INCHES
- REINSPECT AT EVERY "A" CHECK AND REPAIR NO LATER THAN NEXT "C" CHECK
- REFER TO PARAGRAPH 4 FOR TEMPORARY REPAIR OR SEAL OF DAMAGE

DRAWING NO. 175T2001, 175T2003

MATERIAL:

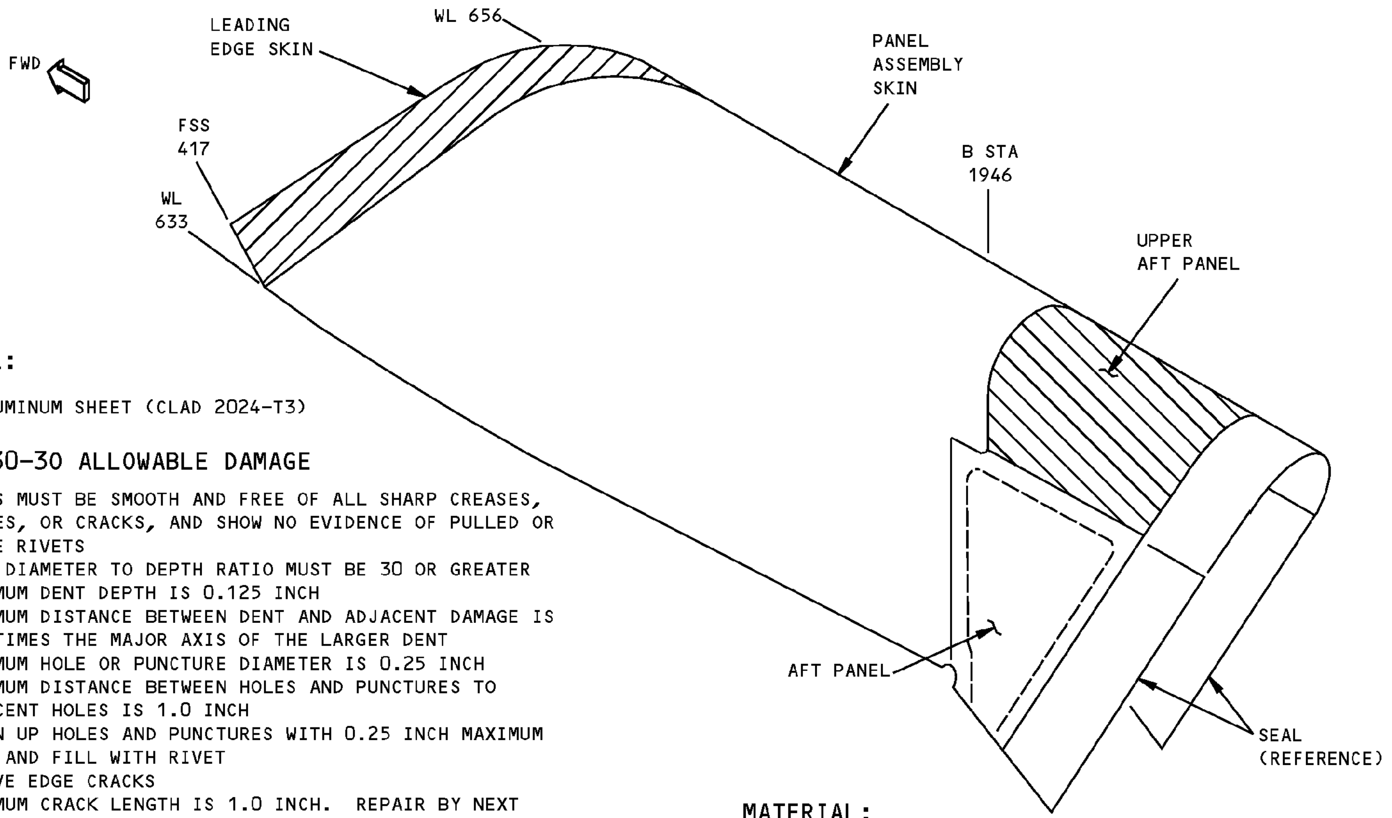
▩ GLASS FABRIC/EPOXY HONEYCOMB SANDWICH WITH NOMEX CORE-250°F (121°C) CURE

SRM 55-30-01 ALLOWABLE DAMAGE

- MAXIMUM DENT DIAMETER IS 1.0 INCH, PROVIDED THERE IS NO FIBER DAMAGE OR DELAMINATION
- MAXIMUM OF ONE DENT PER SQUARE FOOT OF AREA AND A MINIMUM OF 6.0 INCHES FROM ANY OTHER DAMAGE, FASTENER OR PANEL EDGE
- MAXIMUM HOLE OR PUNCTURE DIAMETER IS 0.25 HOLE
- MINIMUM DISTANCE BETWEEN HOLES OR PUNCTURES, OTHER DAMAGE OR EDGE IS 1.0 INCH
- MAXIMUM DELAMINATION IS 4.0 INCHES
- REINSPECT AT EVERY "A" CHECK AND REPAIR NO LATER THAN NEXT "C" CHECK
- REFER TO PARAGRAPH 4 FOR TEMPORARY REPAIR OR SEAL OF DAMAGE

DRAWING NO. 175T2002

Vertical Stabilizer-Auxiliary Box
Figure 126



MATERIAL:

▨ ALUMINUM SHEET (CLAD 2024-T3)

SRM 55-30-30 ALLOWABLE DAMAGE

- DENTS MUST BE SMOOTH AND FREE OF ALL SHARP CREASES, GOUGES, OR CRACKS, AND SHOW NO EVIDENCE OF PULLED OR LOOSE RIVETS
- DENT DIAMETER TO DEPTH RATIO MUST BE 30 OR GREATER
- MAXIMUM DENT DEPTH IS 0.125 INCH
- MINIMUM DISTANCE BETWEEN DENT AND ADJACENT DAMAGE IS 0.5 TIMES THE MAJOR AXIS OF THE LARGER DENT
- MAXIMUM HOLE OR PUNCTURE DIAMETER IS 0.25 INCH
- MINIMUM DISTANCE BETWEEN HOLES AND PUNCTURES TO ADJACENT HOLES IS 1.0 INCH
- CLEAN UP HOLES AND PUNCTURES WITH 0.25 INCH MAXIMUM HOLE AND FILL WITH RIVET
- REMOVE EDGE CRACKS
- MAXIMUM CRACK LENGTH IS 1.0 INCH. REPAIR BY NEXT "C" CHECK
- REFER TO PARAGRAPH 4 FOR TEMPORARY REPAIR OR SEAL OF DAMAGE

MATERIAL:

☐ ARAMID/EPOXY OR GLASS FABRIC/EPOXY HONEYCOMB SANDWICH WITH NOMEX CORE-250°F (121°C) CURE

SRM 55-30-30 ALLOWABLE DAMAGE

- TREAT ALL DENTS AS A HOLE OR PUNCTURE
- MAXIMUM HOLE, PUNCTURE OR DELAMINATION DIAMETER IS 2.0 INCHES
- MINIMUM DISTANCE BETWEEN HOLES, PUNCTURES OR DELAMINATIONS IS 1.5 TIMES THE DIAMETER OF THE LARGER DAMAGE
- REMOVE EDGE DELAMINATION DAMAGE
- REINSPECT AT EVERY "A" CHECK AND REPAIR NO LATER THAN NEXT "C" CHECK
- REFER TO PARAGRAPH 4 FOR TEMPORARY REPAIR OR SEAL OF DAMAGE

MATERIAL:

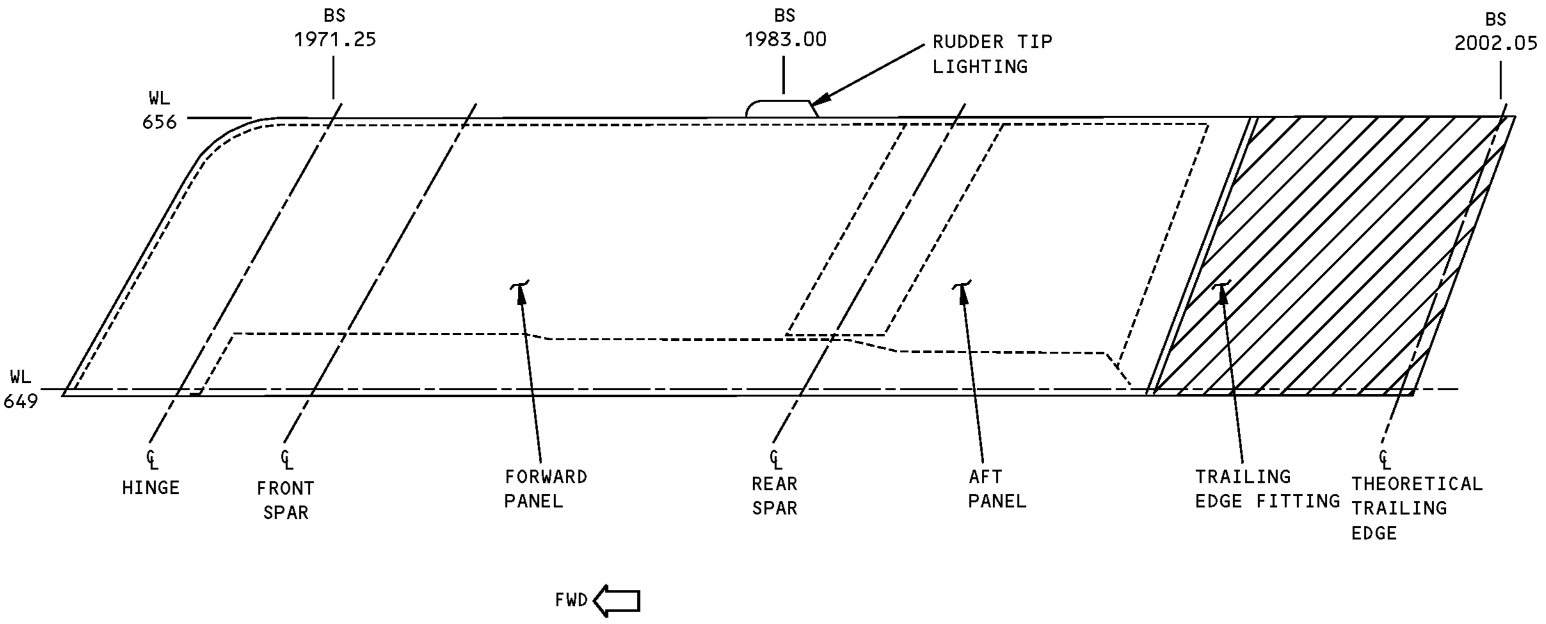
▨ GLASS FABRIC LAMINATE-250°F (121°C) CURE

SRM 55-30-30 ALLOWABLE DAMAGE

- TREAT ALL DENTS AS A HOLE OR PUNCTURE
- MAXIMUM HOLE, PUNCTURE OR DELAMINATION DIAMETER IS 1.0 INCH
- REMOVE EDGE DELAMINATION DAMAGE
- REMOVE EDGE CRACKS
- MAXIMUM CRACK LENGTH IS 1.0 INCH. REPAIR BY NEXT "C" CHECK
- REINSPECT AT EVERY "A" CHECK AND REPAIR NO LATER THAN NEXT "C" CHECK
- REFER TO PARAGRAPH 4 FOR TEMPORARY REPAIR OR SEAL OF DAMAGE

DRAWING NO. 179T1000

Vertical Stabilizer-Vertical Tail Tip
Figure 127



MATERIAL:

☐ GLASS FABRIC/GRAPHITE/EPOXY LAMINATE - 350°F (177°C) CURE

SRM 55-40-30 ALLOWABLE DAMAGE

- TREAT ALL DENTS AS A HOLE OR PUNCTURE
- MAXIMUM HOLE, PUNCTURE OR DELAMINATION IS 1.0 INCH
- MINIMUM DISTANCE BETWEEN HOLES, PUNCTURES OR DELAMINATIONS IS 2 TIMES THE DIAMETER OF THE LARGER DAMAGE
- REMOVE EDGE DAMAGE
- REINSPECT AT EVERY "A" CHECK, REPAIR NO LATER THAN NEXT "C" CHECK
- REFER TO PARAGRAPH 4 FOR TEMPORARY REPAIR OR SEAL OF DAMAGE

DRAWING NO. 173T2601

MATERIAL:

▨ ALUMINUM CASTING 356-T51

SRM 55-40-30 ALLOWABLE DAMAGE

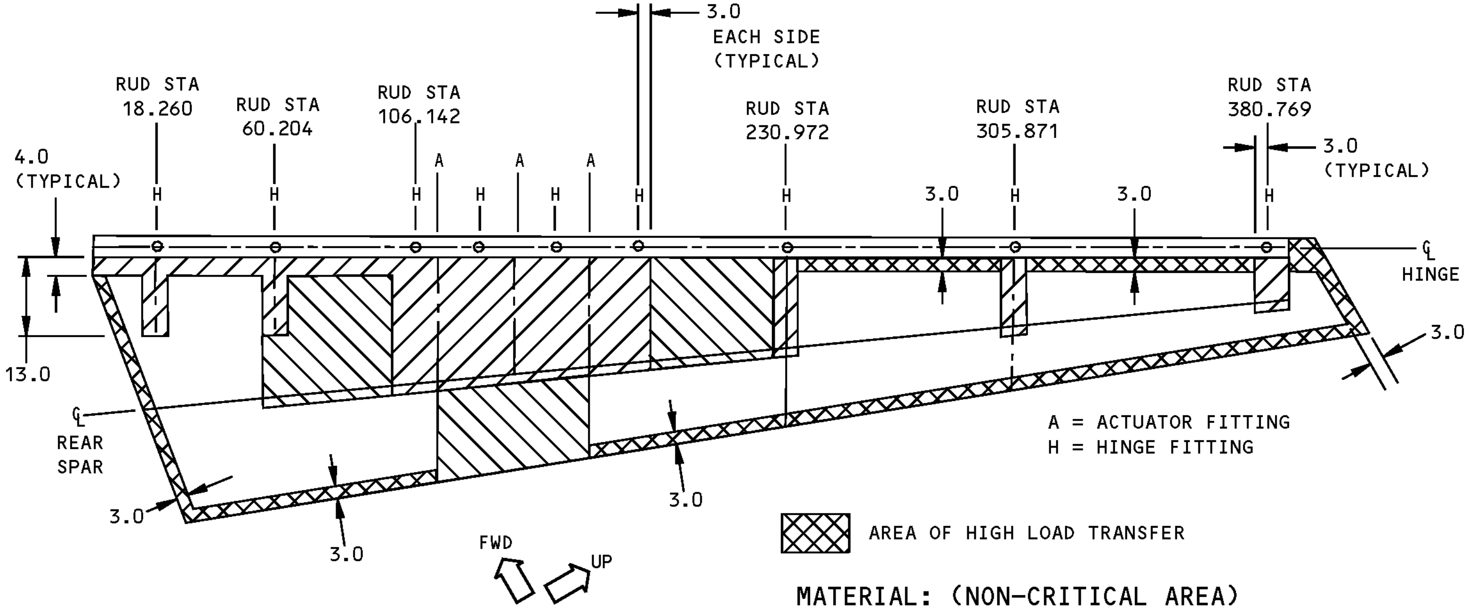
- ALL DENTS MUST BE SMOOTH AND FREE OF ALL SHARP CREASES, GOUGES, OR CRACKS, AND SHOW NO EVIDENCE OF PULLED OR LOOSE RIVETS
- DENT DIAMETER TO DEPTH RATIO MUST BE 30 OR GREATER
- MAXIMUM DENT DEPTH IS 0.125 INCH
- MAXIMUM HOLE OR PUNCTURE DIAMETER IS 0.50 INCH. REPAIR NO LATER THAN NEXT "C" CHECK
- REMOVE EDGE CRACKS
- MAXIMUM CRACK LENGTH IS 1.0 INCH. REPAIR NO LATER THAN NEXT "C" CHECK
- REFER TO PARAGRAPH 4 FOR TEMPORARY REPAIR OR SEAL OF DAMAGE

DRAWING NO. 173T2048

Vertical Stabilizer-Rudder
Figure 128

CAUTION:

CRITICAL AREAS AND AREAS OF HIGH LOAD TRANSFER DO NOT HAVE EXPANDED ALLOWABLE DAMAGE LIMITS



A = ACTUATOR FITTING
H = HINGE FITTING

▩ AREA OF HIGH LOAD TRANSFER

NOTES

- ALL DIMENSIONS ARE IN INCHES

MATERIAL: (CRITICAL AREA)

▨ GRAPHITE/EPOXY HONEYCOMB SANDWICH WITH NOMEX CORE-350°F (177°C) CURE

SRM 55-40-01 ALLOWABLE DAMAGE: CRITICAL ZONE

- CONTACT THE BOEING COMPANY FOR ALLOWABLE DAMAGE

MATERIAL: (NON-CRITICAL AREA)

▧ GRAPHITE/EPOXY HONEYCOMB SANDWICH WITH NOMEX CORE-350°F (177°C) CURE

SRM 55-40-01 ALLOWABLE DAMAGE: ZONE I

- TREAT ALL DENTS AS A HOLE OR PUNCTURE
- MAXIMUM HOLE, PUNCTURE OR DELAMINATION DIAMETER IS 1.0 INCH
- MINIMUM DISTANCE BETWEEN ADJACENT HOLES, PUNCTURES OR DELAMINATIONS IS 3 TIMES THE DIAMETER OF THE LARGER DAMAGE
- REINSPECT EACH 50 FLIGHTS, REPAIR NO LATER THAN 300 FLIGHTS AFTER BEING DAMAGED
- REFER TO PARAGRAPH 4 FOR TEMPORARY REPAIR OR SEAL OF DAMAGE

MATERIAL: (NON-CRITICAL AREA)

☐ ▩ GRAPHITE/EPOXY HONEYCOMB SANDWICH WITH NOMEX CORE-350°F (177°C) CURE

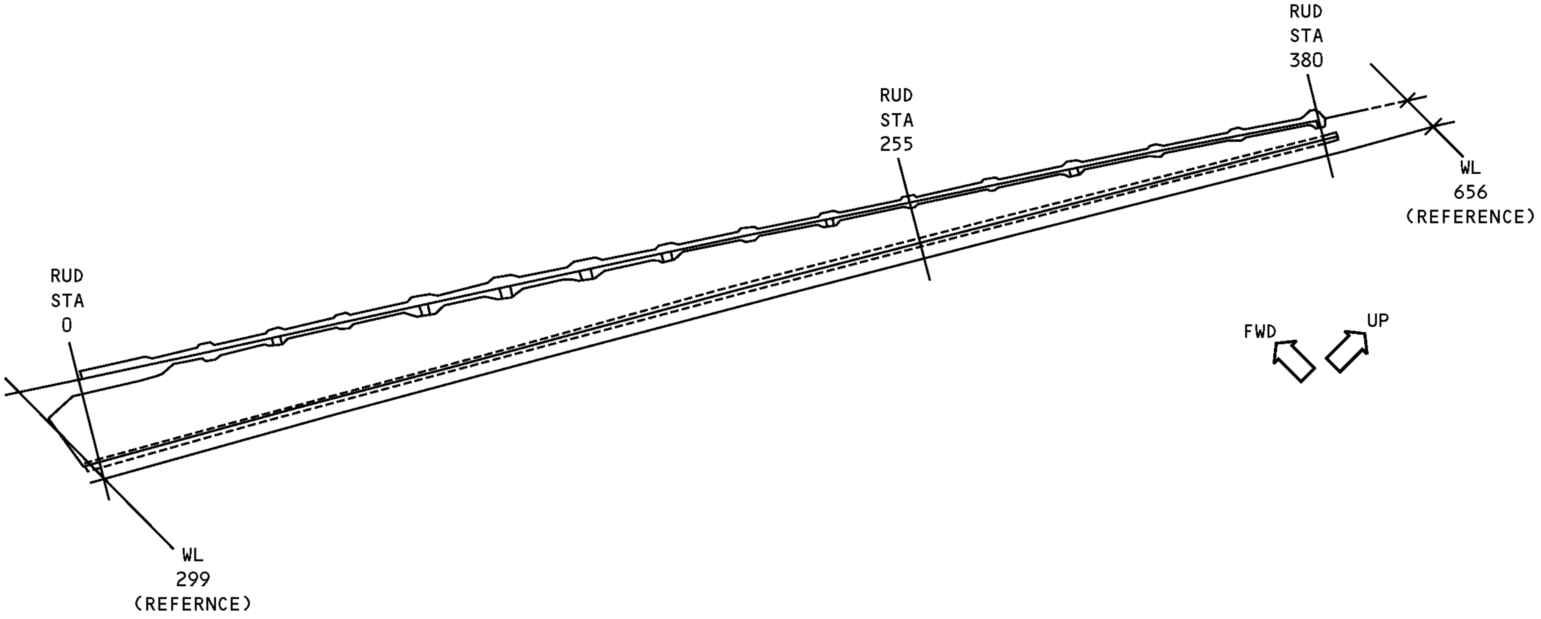
SRM 55-40-01 ALLOWABLE DAMAGE: ZONE II

SAME AS "ZONE I" EXCEPT

- MAXIMUM HOLE, PUNCTURE OR DELAMINATION DIAMETER IS 1.5 INCHES

DRAWING NO. 173T2001

Vertical Stabilizer-Rudder
Figure 129



MATERIAL:

▭ ARAMID/GRAPHITE/EPOXY HONEYCOMB SANDWICH WITH NOMEX CORE-250°F (121°C) CURE

SRM 55-30-01 ALLOWABLE DAMAGE

- MAXIMUM DENT DIAMETER IS 2.0 INCHES, PROVIDED THERE IS NO FIBER DAMAGE OR DELAMINATION
- MAXIMUM HOLE OR PUNCTURE DIAMETER IS 1.0 INCH
- MINIMUM DISTANCE BETWEEN ADJACENT HOLES, PUNCTURES, DELAMINATIONS OR PANEL EDGE IS 2.5 TIMES THE DIAMETER OF THE LARGER DAMAGE
- MAXIMUM DELAMINATION DIAMETER IS 4.0 INCHES AND NOT TO EXCEED 25 PERCENT OF HONEYCOMB CORE LENGTH PER SIDE
- MAXIMUM 0.10 INCH DELAMINATION FROM EDGE
- REINSPECT AT EVERY "A" CHECK AND REPAIR NO LATER THAN NEXT "C" CHECK
- REFER TO PARAGRAPH 4 FOR TEMPORARY REPAIR OR SEAL OF DAMAGE

DRAWING NO. 173T1101-173T1111

Vertical Stabilizer-Fixed Trailing Edge
Figure 130

REPAIR 1 - INSTRUCTIONS TO MAKE IT POSSIBLE TO OPERATE AIRPLANES WITH MISSING FASTENERS IN SECONDARY STRUCTURE - STRUT FAIRING

1. Applicability

A. Use this chapter-section-subject to see if it is possible to operate an airplane with missing fasteners in secondary structure.

(1) Examples of secondary structure where missing fasteners are permitted are: fairings, trailing edge panels, and access panels. Refer to 51-00-04, GENERAL.

B. The instructions in this chapter-section-subject do not apply to:

(1) Fasteners that attach primary structure to the airplane.

(2) Fasteners in engine cowls.

2. General

A. Paragraph 4./REPAIR 1 will help you make a decision to see 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 a correct fastener or approved substitute in each missing fastener location until the airplane is in the permitted dispatch condition.

NOTE: You can remove a threaded fastener from a different location, and then install the replacement fastener 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 that it will be installed at.
- Make sure that the instructions in Paragraph 4./REPAIR 1 let you have a missing fastener at the location where the fastener was removed.
- Record the location of the initial missing fastener. Inspect that location as specified in Paragraph 4./REPAIR 1 Make sure that at each inspection interval, that the fastener is not missing again.

(2) Tell an engineer who has the authority to do an analysis and make a decision.

(3) Call Boeing and ask for an analysis.

3. References

Reference	Title
51-00-04, GENERAL	Structural Classification
51-40-08, GENERAL	Countersinking
SOPM 20-41-02	Application of Chemical and Solvent Resistant Finishes

4. Permitted Dispatch Conditions

NOTE: The instructions in Paragraph 4./REPAIR 1 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 all of the data that follows applies:

NOTE: If a part fails one or more of the conditions that follow, see if the Master Minimum Equipment List (MMEL) allows an airplane to operate without the part (for example: small access doors and panels). Do not operate an airplane with one of these parts on the airplane unless all of the data that follows applies.

(1) All fasteners that were specified in Paragraph 1.B/REPAIR 1 are installed in the structure.

(2) Fasteners in panels that were specified in Paragraph 1.A/REPAIR 1 can be missing if the panels are in the conditions that follow:

(a) All electrical grounding and bonding fasteners must be installed and functional.

(b) All fasteners must be installed in the leading edge, which is open to the airflow. Refer to Figure 201/REPAIR 1, Detail I.

(c) All corner fasteners must be installed. Refer to Figure 201/REPAIR 1, Detail I.

(d) All fasteners must be installed on sides with eight or less fasteners. Refer to Figure 201/REPAIR 1, Detail I.

(e) One missing fastener in 10 is permitted on a side (but not on a leading edge open to the airflow).

NOTE: A side that has only nine fasteners can have the middle fastener missing. Refer to Figure 201/REPAIR 1, Detail I.

(f) No more than two adjacent missing fasteners are permitted (but not on a leading edge open to the airflow). Refer to Figure 201/REPAIR 1, Detail I.

(g) There must be three or more fasteners adjacent to a corner fastener. Refer to Figure 201/REPAIR 1, Detail I.

(h) There must be five or more fasteners installed adjacent to an attached fitting or primary load point. Refer to Figure 201/REPAIR 1, Detail II.

(i) BACB30FN(A) hex drive fasteners can be replaced with BACB30VW( ) CRES protruding head blind fasteners and the countersink washers in the strut aft fairing pan assembly for easier installation. Refer to Figure 201 (Sheet 3), Detail III.

Install the blind fasteners as follow:

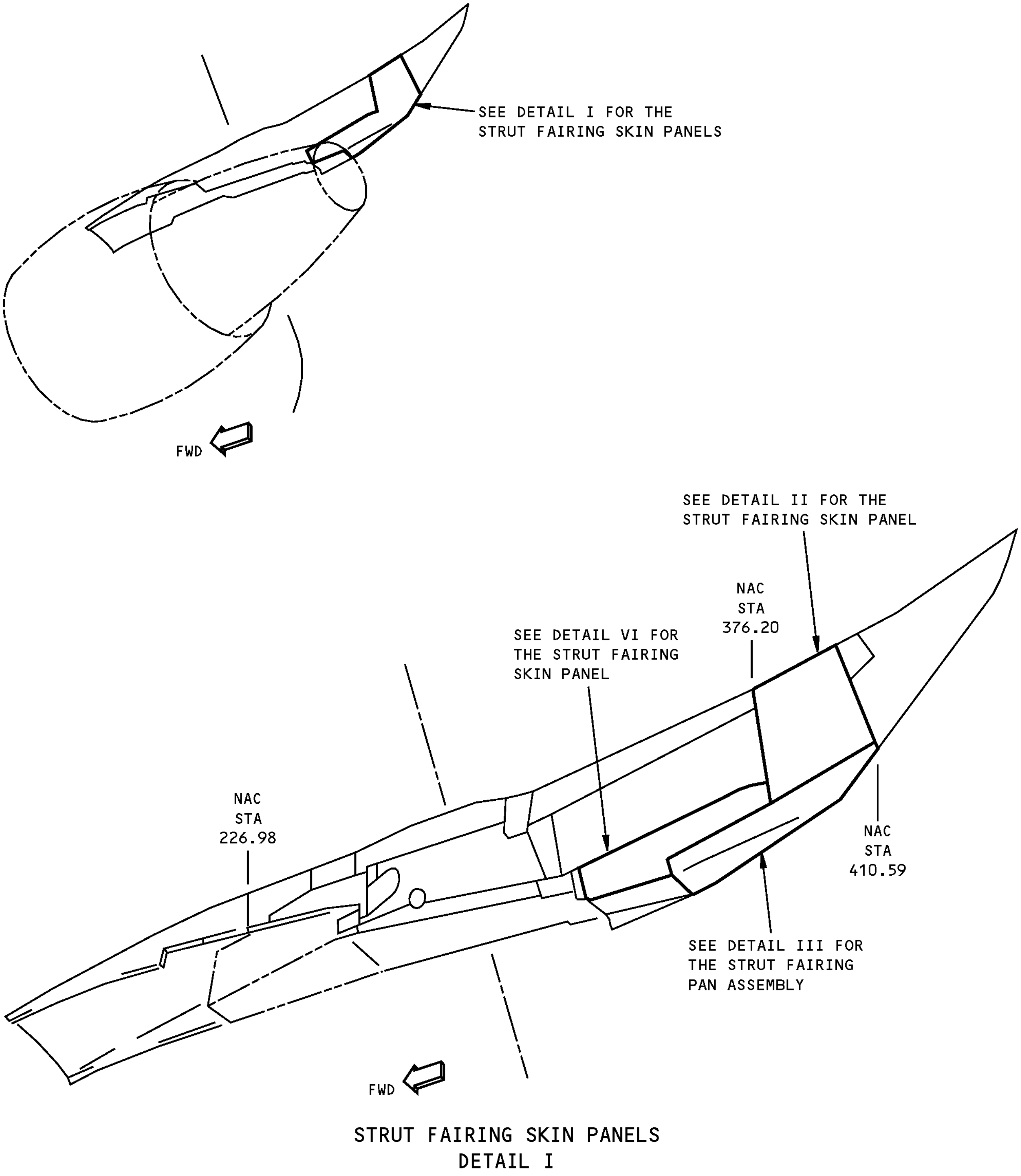
- Make the countersink repair washers. Refer to 51-40-08, GENERAL.
- Apply BMS 10–11, Type 1, primer to the repair washers
- Install the repair washers
- Install the passivated protruding head blind fasteners, BACB30VW5C( ) CRES, wet with BMS 5–95 sealant.

NOTE: MS21141( ) CRES blind fastener can be used as an option

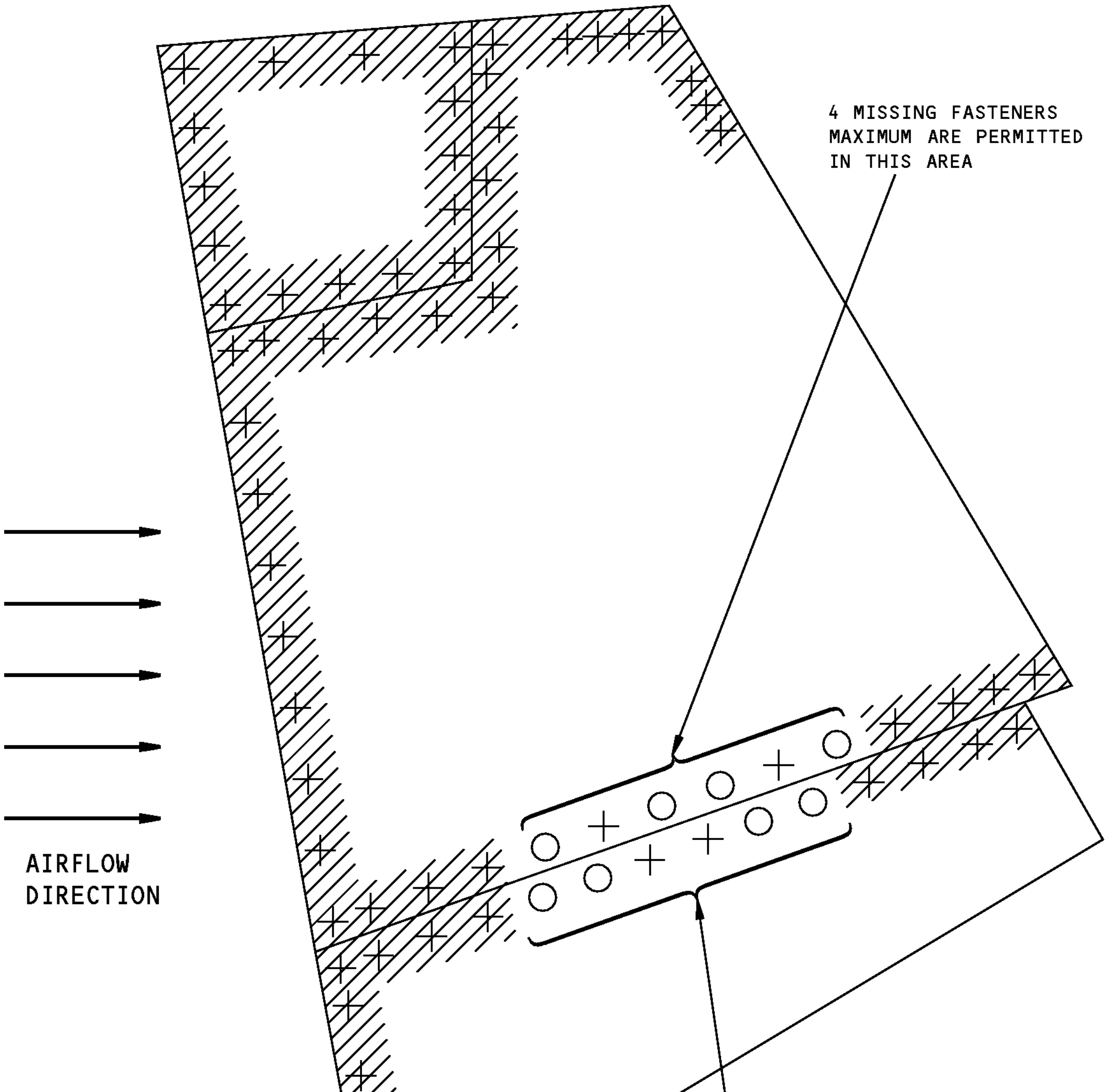
The following hole cleanup diameters are permitted at the missing fastener locations:

- 0.180 - 0.183 inch diameter for BACB30VW5C( )X
- 0.199 - 0.202 inch diameter for BACB30VW6C( )
- 0.215 - 0.218 inch diameter for BACB30VW6C( )x

- Apply one layer BMS 10–11, Type 1 primer to the repair area. Refer to SOPM 20-41-02
- Do a visual inspection of the blind fastener locations at the first 2A-check interval and then at C-checks thereafter. Look for signs of loose fasteners in relation to the material that it holds. A black or dark gray colored stain adjacent to or around the fastener head can show a loose fastener. A tipped fastener head can show looseness or slippage of the material. Replace blind fasteners that become loose.



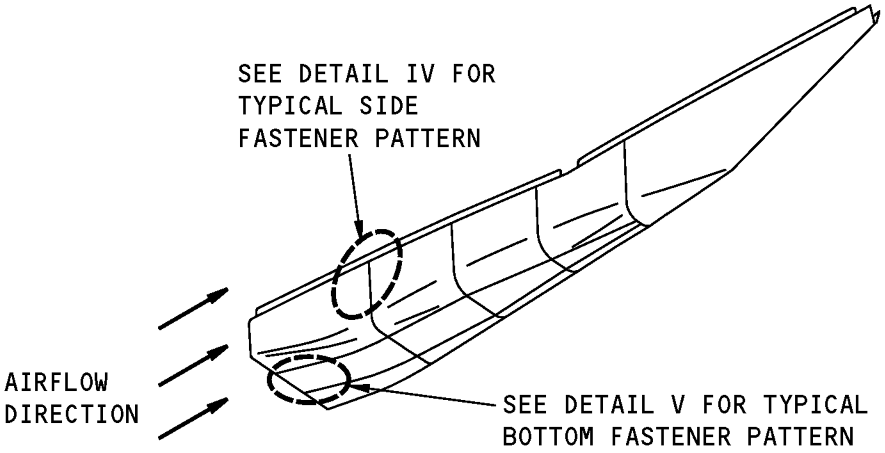
Possible Missing Fastener in Strut Fairing
Figure 201 (Sheet 1 of 4)



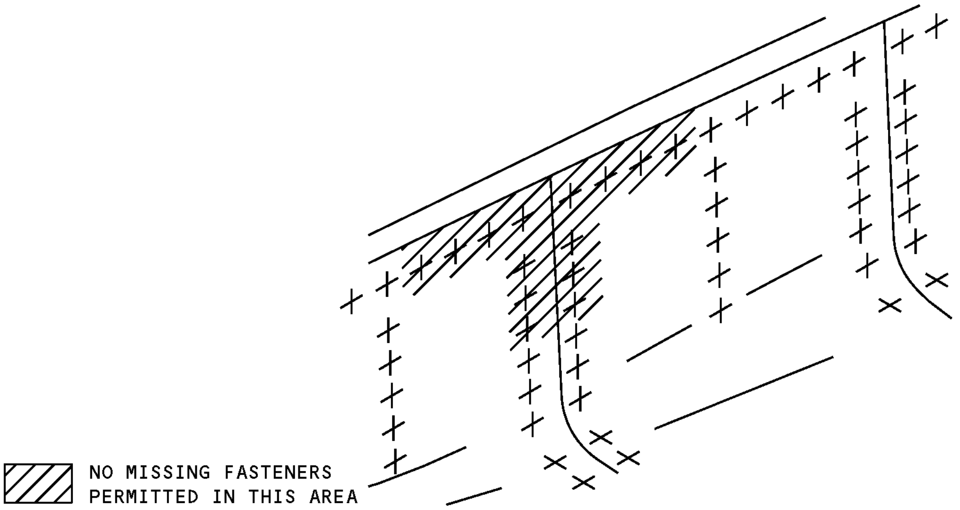
▨ NO MISSING FASTENERS PERMITTED IN THIS AREA

STRUT FAIRING SKIN PANELS
DETAIL II

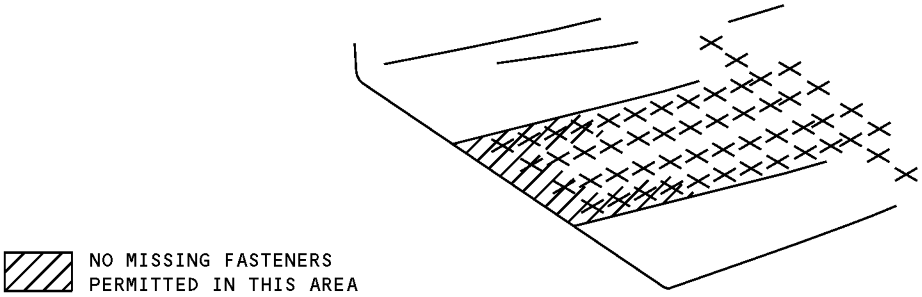
Possible Missing Fastener in Strut Fairing
Figure 201 (Sheet 2 of 4)



STRUT FAIRING PAN ASSEMBLY
DETAIL III

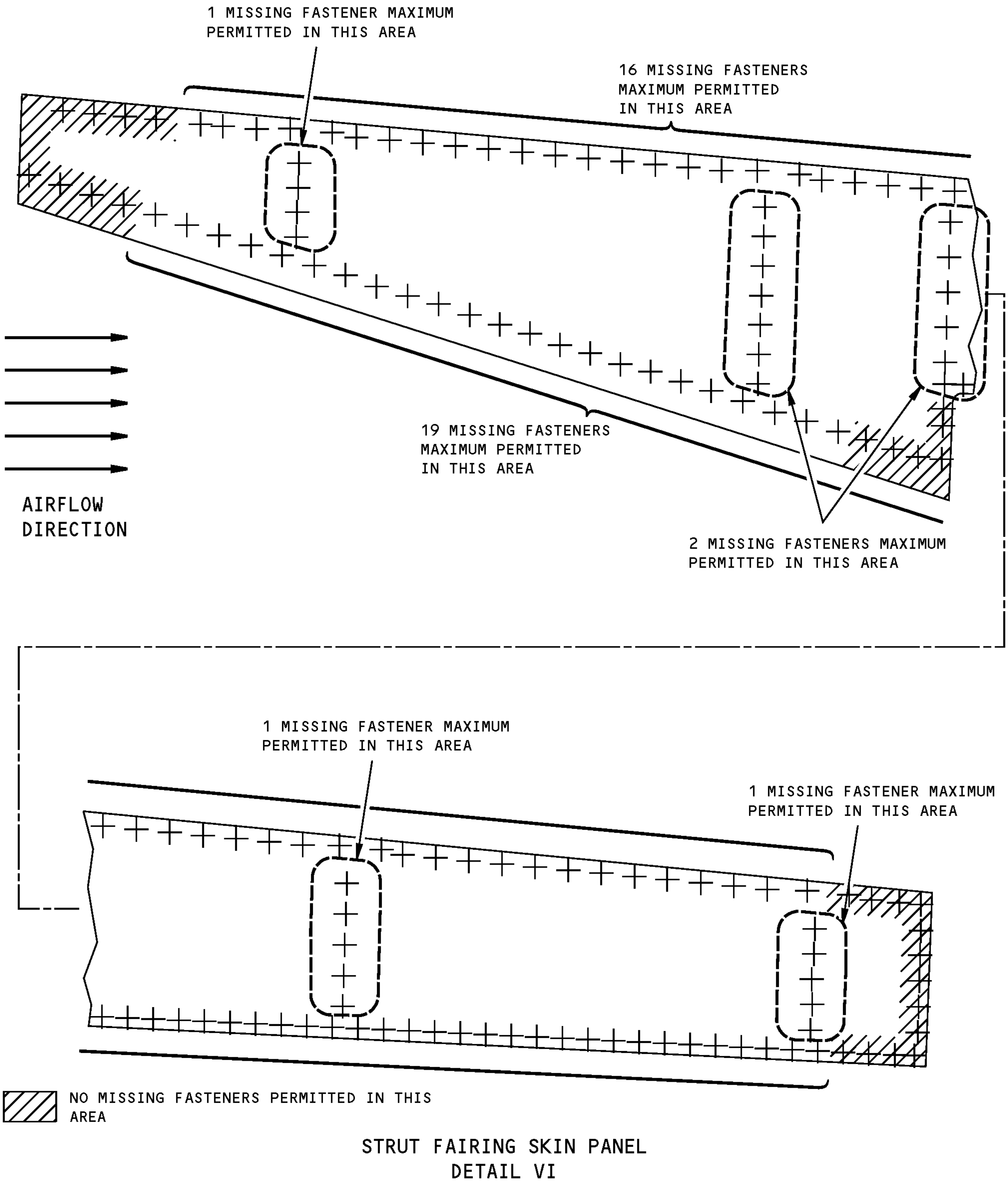


TYPICAL SIDE FASTENER PATTERN
DETAIL IV



TYPICAL BOTTOM FASTENER PATTERN
DETAIL V

Possible Missing Fastener in Strut Fairing
Figure 201 (Sheet 3 of 4)



Possible Missing Fastener in Strut Fairing
Figure 201 (Sheet 4 of 4)

GENERAL - DAMAGE CLEANUP - CF6-80C2 ENGINE NACELLE

1. General

A. This section applies to the CF6-80C(2) engine inlet cowl, fan cowl, and core cowl.

B. Damage as considered in this manual is any cross-sectional area change, permanent distortion, or physical or mechanical characteristic change of a structural member which affects its functional integrity (reducing its ability to perform the design function).

C. Panels, Plate and Sheet Metals

(1) Terms commonly used to describe visible evidence of damage to sheet metal structural parts and the external skin of the nacelle panel areas are:

(a) Abrasion - A damage area of any size due to scuffing, rubbing, or scraping. It is usually rough and irregular.

(b) Corrosion - Chemical or electro-chemical destruction of the surface or subsurface of a metal part. Results in partial replacement of material with rust or aluminum oxide produced by the chemical reaction.

(c) Crack - A partial fracture or complete separation of the material. It is usually an irregular line and is normally the result of metal fatigue or static stress failure.

(d) Crease - A damage area which is depressed or folded back upon itself in such a manner that its boundaries are sharp or well defined lines or ridges. Its loss of structural integrity is usually less than that of a crack.

(e) Dent - A surface area which has been depressed with respect to its normal contour. The area boundaries are smooth. It is generally the result of contact with a relatively smooth contoured object. There is no change in the cross-sectional area of the part except in the case of honeycomb structure where the core may crush without bending the opposite surface sheet.

Structural integrity is affected by the loss in stiffness of the affected panel.

(f) Gouge - A surface area which has been depressed resulting in a cross-sectional area change. Usually caused by a continuous sharp, or smooth channel-like groove in the material. The loss of structural integrity is less than that of a crack.

(g) Nick - A local gouge with sharp edges. A series of nicks in a line pattern produces a loss of structural integrity equivalent to that of a gouge.

(h) Scratch - A sharply defined continuous and very narrow line of damage in the surface of a part or assembly, which results in a cross-sectional area change. Usually caused by contact with a very sharp object. Stressing of the part tends to produce cracking of the material initiating at the scratch.

D. Composite Structures

(1) These structures are used in secondary structural applications such as cowlings, fairings, and enclosures for weight reduction purposes.

Commonly used terms to describe visible or invisible damage to laminated composite synthetic fabric and graphite fiber resin or epoxy bonded structures are:

(a) Crack - A fracture or complete separation of the material in one or more of the laminate plies.

(b) Delamination - A subsurface separation of two or more of the laminate plies. Visible only if it occurs along a panel edge.

(c) Dent - A surface area which has been depressed with respect to its normal contour. The area boundaries are smooth. Structural integrity is affected by the loss in stiffness of the damaged panel.

(d) Dimple - A local deformation of a laminated panel caused by fastener loading.

(e) Penetration - An incursion by a foreign object which passes through two or more plies of a laminated structure.

(f) Pit - A small local depression in the surface of a laminated structure.

(g) Puncture - A penetration by a foreign object which passes through all of the plies of a laminated structure.

(h) Splinter - A small section of a laminated panel adjacent to a hole or an edge of the part which is isolated by small parallel cracks through less than the full complement of laminate plies.

2. References

Reference	Title
51-21-01, GENERAL	Protective Treatment of Metallic and Nonmetallic Materials - CF6-80C2 Engine Nacelle
SOPM 20-30-88	Solvents For Final Cleaning Metal Before Non-Structural Bonding (Series 88)

3. Corrosion and Damage Removal

CAUTION: IN NO CASE SHOULD DEPTH OF CORROSION REMOVAL EXCEED LIMITS OF GOUGE REMOVAL APPLICABLE TO AREA (NORMALLY 10 PERCENT OF CROSS-SECTION OF MATERIAL).

A. There are two methods of removal of corrosion damage from metal surfaces; by chemical means, and by mechanical means.

WARNING: PREVENT STRIPPER FROM CONTACTING THE SKIN. STRIPPER WILL CAUSE SEVERE CHEMICAL BURNS. IN THE EVENT OF AN ACCIDENT, WASH CONTAMINATED AREA WITH WATER IMMEDIATELY AND OBTAIN MEDICAL TREATMENT.

B. Chemical Removal - Aluminum

(1) Remove all paint, lacquer or primer from area where corrosion has been detected, Apply Turco T-5351 (Turco Products, Wilmington, CA).

(2) Allow the stripper to work undisturbed for approximately 15 minutes.

(3) Agitate worked area with a fiber brush.

(4) If paint remains, reapply fresh stripper without rinsing the area. Allow fresh stripper to work undisturbed for another 15 minutes.

Agitate with fiber brush.

(5) Remove all traces of stripper by scrubbing with water and wiping.

(6) Repair mechanical damage. Rework cuts, gouges, pits, scratches, and dents by blending and smoothing, as described in general repair section of the manual.

WARNING: PHOSPHORIC ACID SOLUTION MUST BE USED WITH CARE TO AVOID BURNS. PERSONNEL MUST WEAR GOGGLES AND PROTECTIVE RUBBER GARMENTS. ACID CLEANERS MUST NOT BE ALLOWED TO CONTACT THE EYES OR SKIN. IF THIS OCCURS, THE ACID MUST BE WASHED OFF IMMEDIATELY WITH LARGE QUANTITIES OF WATER.

(WARNING PRECEDES)

CAUTION: USE WATERPROOF PAPER AND MASKING TAPE TO PROTECT ADJACENT AREAS. ACID CLEANING MATERIALS MUST NOT BE ALLOWED TO CONTACT HIGH-STRENGTH STEELS OR TO DRIP OR SPLASH ONTO ADJACENT SURFACES OR TO RUN INTO SEAMS, SKIN JOINTS, FAYING SURFACES, OR RECESSES. WET CLOTHS SHOULD BE AVAILABLE TO REMOVE EXCESS ACID.

(7) Mix one part Cee-Bee B-4, or equivalent, to three parts water.

(8) Apply mixture with a brush or soft cloth. Allow to remain for five or ten minutes. Then scrub lightly with a bristle brush. Do not use steel wool or steel wire brushes. Repeat if necessary.

(9) Rinse and apply (before surface dries) to parts that are not to be painted.

(10) Rinse with clear water and dry at room temperature. Compressed air may be used to speed drying.

(11) Apply alodine, primer, and finish coat, as required, to the reworked area.

C. Mechanical Removal - Aluminum

(1) Hand rubbing

Remove mild surface corrosion and light pitting by hand rubbing with aluminum wool and aluminum oxide abrasive paper. Dip aluminum wool in kerosene before rubbing. This method is particularly adaptable to items such as aluminum tubing, stringers, etc.

(2) Removal of Light Surface Corrosion by Buffing

(a) Using a cloth or brush, spread a thin coat of aluminum polishing compound over a small area. Avoid coating too large an area if compound dries out quickly.

CAUTION: EXCESSIVE FRICTION HEATING CAN ALTER HEAT TREATMENT OF ALUMINUM.

(b) Attach a cotton pad or lamb's wool cover to the buffing machine. Buff with a side-to-side motion to minimize heat generation.

(c) Remove residue around rivets and seams by hand polishing with the same compound.

(d) After buffing, wash the area with a one-to-one mixture of water and petroleum base solvent. Since such mixtures settle into two levels, dip cloth through the lighter solvent into the water below.

(e) Wipe surface dry and polish with soft cloth.

(3) Removal of Deep Pitting and Intergranular Corrosion by Scraping

(a) Use paint stripper to remove surface coating from area to be worked.

(b) Remove deep pitting and intergranular corrosion by using a carbide tip scraper.

(c) Use a 10-power magnifying glass to determine if all corrosion has been removed.

CAUTION: TO AVOID SETTING UP STRESS CONCENTRATIONS, BLEND SCRAPED AREA INTO SURROUNDING METAL TO FORM A SAUCER-SHAPED DEPRESSION.

(d) Scrape away an additional 0.002-inch of clean metal to ensure that removal was complete.

(e) After scraping, polish first with No. 280-grit aluminum oxide abrasive paper and then with No. 400-grit.

(f) Apply the chemical surface treatment and final protective finish indicated for the area.

(4) Removal of Surface Corrosion from Large Areas by Abrasive Blasting.

NOTE: Abrasive blasting may be considered only if a complete organic finish is to be applied. This is to avoid the possibility of removing cadmium plating from steel fasteners and cladding from aluminum.

(a) Remove general surface corrosion from large areas, including fasteners, by using abrasive-air-blasting equipment such as "Vacu-Blast".

CAUTION: TO PREVENT INTRODUCTION OF CONTAMINANTS INTO ALUMINUM, CONTAMINATION OF ABRASIVE SHOULD BE KEPT BELOW TWO PERCENT. ABRASIVES THAT HAVE BEEN USED ON STEEL MUST NEVER BE USED ON ALUMINUM.

(b) Use aluminum oxide or glass bead abrasive mater (never silicon carbide) particle-size 180 mesh (0.08 mm) for coarse rapid removal of heavy corrosion.

(c) Use aluminum oxide or glass bead abrasive material (never silicon carbide) particle-size 400 to 600 mesh (0.038 to 0.25 mm) for light corrosion and finish cleaning.

(d) If deep pits or sharp edges appear on the surface of the aluminum after the removal of the corrosion products, blend into surrounding metal with a carbide tip scraper and No. 280-grit aluminum oxide abrasive paper. Finish with No. 400-grit paper.

(e) Apply Alodine No. 1200S as given in 51-21-01, GENERAL.

D. Chemical removal - Steel

Phosphoric acid-type compounds may be used to remove corrosion on steel alloy assemblies, or installed parts not readily removed.

CAUTION: DO NOT USE ACIDS AND ACID CONTAINING COMPOUNDS ON ANY PRIMARY STRUCTURE. ACIDS AND ACID CONTAINING COMPOUNDS CAUSE SURFACE EMBRITTLEMENT IN HIGH-STRENGTH STEEL ALLOYS THROUGH ABSORPTION OF HYDROGEN DURING THE CHEMICAL REACTION.

(1) Mask off adjacent structure to prevent corrosion removal chemicals from contacting other structure or flowing into joints or inaccessible areas. Remover will strip cadmium plating.

(2) Lightly apply phosphoric acid-type corrosion remover, Turco WO-1 (Turco Products, Incl, Box 1055, Wilmington, CA), to rusted area with bristle brush or cloth until rust is removed.

(3) Rinse away rust remover with water.

(4) Rinse with denatured alcohol and wipe dry.

(5) Replaced corrosion protection coatings removed from part. If replating of previously plated surfaces cannot be accomplished, apply two coats of FR primer and one coat of FR aluminized finish coat.

CAUTION: DO NOT USE CHEMICAL RUST REMOVERS OR OTHER ACIDIC MATERIALS THAT COULD CAUSE HYDROGEN EMBRITTLEMENT OF HIGH-STRENGTH STEELS.

E. Mechanical Removal - Steel

Mechanical means of rust removal may be used only on high-strength steel alloys and primary structure.

(1) Clean surface with safety solvent C-50.

(2) Remove corrosion (rust) damage, and blend out minor scratches and surface damage with No. 150 grade silicon carbide paper.

(3) Clean surface with solvent, Series 88 (AMM/ SOPM 20-30-88).

(4) Replace corrosion protection coatings removed from part. If replating of previously plated surfaces cannot be accomplished, apply two coats of FR primer and one coat of FR aluminized topcoat.

4. Corrosion Prevention

A. Clean structural area to be checked with safety solvent C-50. In areas of engine exhaust gas impingement remove exhaust gas residue with B & B Carbon Remover (B & B Chemical Co., Inc., P. O. Box 796, Miami, FL) or equivalent cleaner.

B. Check for chips, cracks, peels, or cuts in the coating, or rough scaly surface which might indicate corrosion beneath the coating.

C. Clean up and repair damaged coatings with proper touch-up procedures.

D. Replace protective films used on interior surfaces and waxes/polishes used on exterior surfaces.

E. Corrosion prevention coatings which have been damaged can be cleaned and replaced or repaired in accordance with the instructions in 51-21-01, GENERAL.

5. Stop Drilling of Cracks

A. Propagation of a crack may be stopped by drilling a hole at the end of the crack as follows:

(1) Drill or counterbore a 0.25 in. (0.64 cm) diameter crack stop hole through structure at each end of a crack. Locate each stop hole so that the center of the hole is 0.10 in. (0.25 cm) beyond the visible end of the crack.

(2) Make an Eddy Current Method inspection of each stop-drilled hole to confirm that there is no further cracking on the side of the hole opposite the crack.

(a) If the crack has not continued to the other side of the hole, enlarge the hole to 0.312 in. (0.792 cm) diameter to ensure removal of fatigued material.

(b) If the crack has continued to the other side of the hole, enlarge the hole by additional 1/16-inch in diametral increments until the crack indication is removed. Enlarge the hole an additional 1/16 inch in diameter to remove any fatigue damaged material.

NOTE: The total amount that the stop drill hole may be enlarged must be determined for each specific case dependent upon the load pattern and stress level in that area.

(3) Install a 2017-T3 flush plug rivet in the stop drill hole, if required.

GENERAL - AERODYNAMIC SMOOTHNESS CF6-80C2 ENGINE NACELLE

1. General

A. This section covers the requirements for the aerodynamic smoothness of the nacelles that are exposed to airflow, both internal and external. The smoothness requirements are divided into three categories; mismatch at joints (including latches), waviness of skins, and protrusion of fasteners.

B. Surface aerodynamic smoothness is classified in three categories: Extra-critical, Critical, and Noncritical (Refer to Figure 1/GENERAL, Detail I.):

(1) Extra-critical aerodynamic surfaces are those surfaces where the airflow can have a direct effect on flight critical instruments, loss of local lift force, or excessive drag or thrust loss due to high-speed flow. Aerodynamic smoothness requirements for the extra-critical area of the nacelle and pylon are the same as those for the critical areas except for the domed-head bolt allowances. The local-lift-force category includes surfaces on the nacelle as follows:

(a) Fan nozzle trailing edge to primary nozzle trailing edge (afterbody).

(b) Internal and external sides of the inlet lip 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) External surface of the fan cowl as indicated in Detail I.

(3) All other surfaces are noncritical surfaces, unshaded in Detail I.

2. Mismatch Limitations (See Refer to Figure 1, Detail II)

NOTE: Mismatch is defined as an abrupt interruption in a surface from a flat or continuously curved contour. Mismatch is a positive step when an edge projects into the airstream, and is a negative step when the edge does not project into the airstream.

A. Allowable Mismatch at Riveted, Spotwelded or Bolted Joints

(1) Critical and Extra Critical Areas: ± 0.015

(2) Noncritical Areas: ± 0.025

B. Allowable Mismatch at Specific Critical Points

(1) Fan cowl doors and core cowl exposed latch handles: +0.040 to -0.050.

(2) Inner surface of inlet cowl to engine fan inlet (at flange joint):

+0.120 to -0.090 (average maximum 0.050).

(3) Longitudinal joint mismatch (at bottom of nacelle) of the fan cowl doors: ± 0.090 maximum (average maximum 0.050).

(4) Longitudinal joint mismatch (at bottom of nacelle) of the core cowl doors: ± 0.090 maximum (average maximum 0.039).

(5) Inlet cowl lip aft edge to forward edge of inlet cowl outer barrel and to forward edge of inlet cowl inner barrel: Mismatch +0.010 to -0.020.

(6) Fan cowl door at forward edge joint to inlet cowl and at aft edge joint to fan reverser: ± 0.120 maximum and 0.037 average. Average is to be determined as follows:

(a) Treat forward and aft edges separately when calculating average.

(b) Measure mismatch every 18 inches starting at top corner. Both left and right-hand sides.

(c) The average is the sum of the absolute values of the mismatch measurements (i.e., the measurement without a positive or negative sign) divided by the number of measurements.

NOTE: Each fan cowl door, left and right-hand, is to be considered separately.

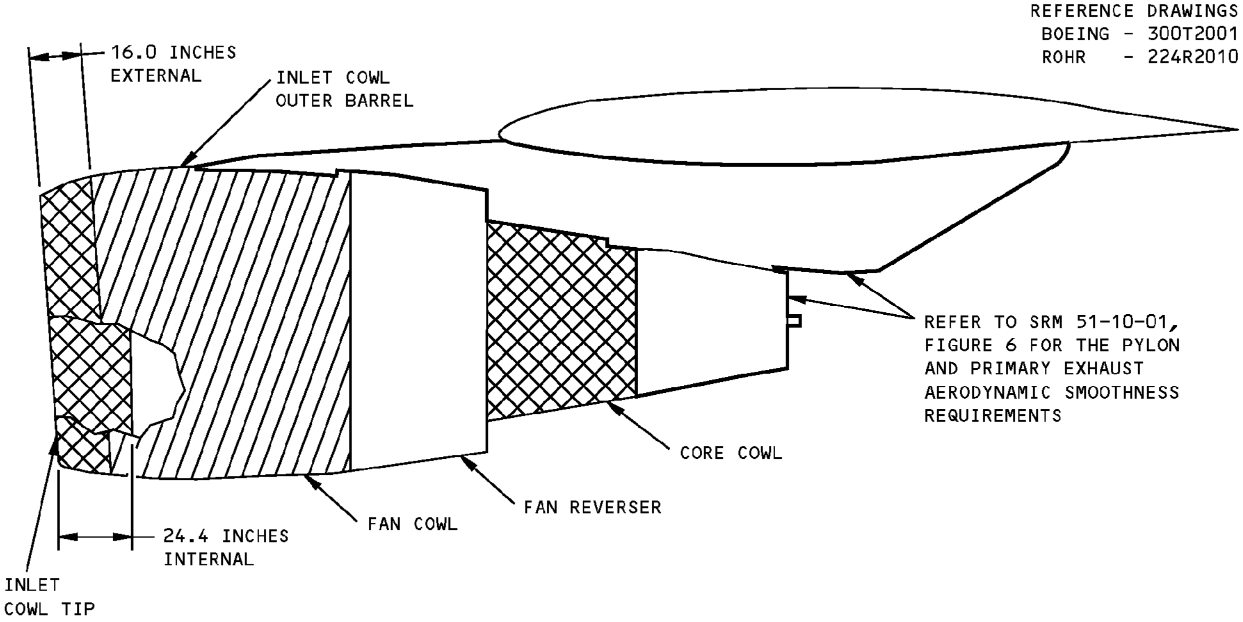
(7) Fan cowl and core cowl to pylon apron longitudinal mismatch ± 0.120 (average maximum core cowl 0.083).

3. Waviness of Skin Limitations

A. Waviness is defined as a smoothly varying interruption in a surface from a flat or continuously curved contour. The distance between adjacent high points in this variation is one wave length (Refer to Figure 1/GENERAL, Detail III.).

4. Protrusion of Fasteners

A. Refer to Figure 1/GENERAL, Table II.



▩ EXTRA-CRITICAL AREA: REQUIRES EXTRA HIGH DEGREE OF AERODYNAMIC SMOOTHNESS

▨ CRITICAL AREA: REQUIRES HIGH DEGREE OF AERODYNAMIC SMOOTHNESS

☐ NON-CRITICAL AREA

LOCATION OF DEFINED AREAS FOR CF6-80C(2) NACELLE
DETAIL I

(+) POSITIVE STEP

(-) NEGATIVE STEP

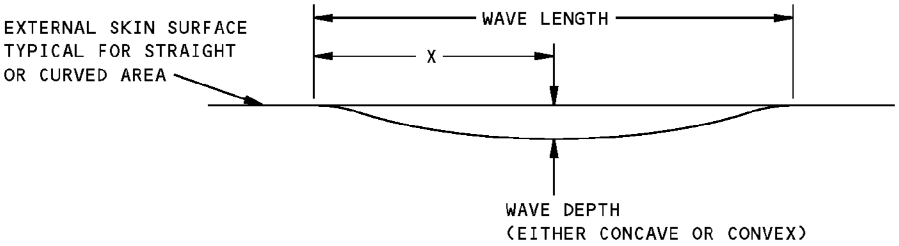
AERODYNAMIC MISMATCH CONDITIONS
DETAIL II

NOTES

A TO BE DETERMINED BY USE OF 6.0 SPLINE AND FEELER GAGE.

Aerodynamic Smoothness - Nacelle, CF6-80C(2) Engine
Figure 1 (Sheet 1 of 3)

1. DEVIATION FROM LOFT SURFACE: EXTRA-CRITICAL, CRITICAL, AND NON-CRITICAL ±0.030.
2. SKIN WAVINESS



DEVIATION FROM LOFT SURFACES AND POD WAVINESS
DETAIL III

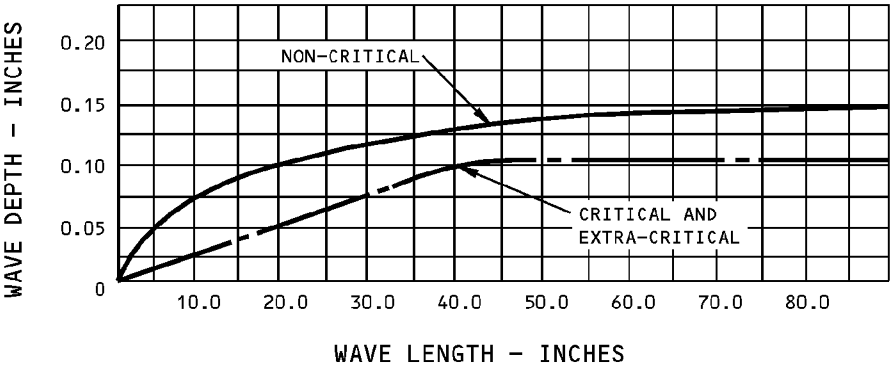


CHART I

	CONDITION	LOCATION	EXTRA-CRITICAL AND CRITICAL	NON-CRITICAL
1	WAVE DEPTH TO LENGTH RATIO	ALL SKINS	SEE CHART I	SEE CHART I
2	1.0 MAXIMUM DIAMETER DISH AT FASTENERS (MAY BE ADDITIVE TO ABOVE)	AT FASTENERS	0.0050 A	0.0100 A

AERODYNAMIC SMOOTHNESS REQUIREMENTS FOR NACELLES
TABLE I

Aerodynamic Smoothness - Nacelle, CF6-80C(2) Engine
Figure 1 (Sheet 2 of 3)

FASTENER TYPE	EXTRA-CRITICAL AREAS	CRITICAL AREAS	NON-CRITICAL AREAS
FLUSH ALUMINUM ALLOY RIVETS	SAME AS CRITICAL AREAS	SHALL BE FLUSH WITHIN TOLERANCE 0.001 TO 0.003 HIGH NOTE: RIVET MAY BE SHAVED	SHALL BE FLUSH WITH TOLERANCE 0.0020 LOW TO 0.07 HIGH NOTE: RIVET MAY BE SHAVED
BACR15CE BACR15GF BACR15FV MS14218 ALUMINUM REDUCED SHEAR HEAD RIVETS	SAME AS CRITICAL AREAS	SHALL BE FLUSH WITHIN TOLERANCE 0.0010 0.0040 HIGH EXCEPT FOR 10% WHICH MAY BE WITHIN TOLERANCE 0.0005 HIGH TO 0.0060 HIGH	SHALL BE FLUSH WITHIN TOLERANCE 0.0010 HIGH TO 0.0050 HIGH EXCEPT FOR 10% WHICH MAY BE WITHIN TOLERANCE 0.0010 TO 0.0070 HIGH
SCREWS AND BOLTS	SAME AS CRITICAL AREAS	ALL REMOVABLE SCREWS AND BOLTS SHALL BE WITHIN TOLERANCE 0.003 LOW TO 0.003 HIGH	ALL COUNTERSUNK SCREWS AND BOLTS SHALL BE FLUSH WITHIN TOLERANCE 0.010 LOW TO 0.005 HIGH
HI-LOK AND LOCKBOLTS FLAT HEAD STYLE	SHALL BE FLUSH WITHIN TOLERANCE 0.0030 LOW TO 0.0030 HIGH EXCEPT FOR 10% WHICH MAY BE WITHIN TOLERANCE 0.0050 LOW TO 0.0030 HIGH	SAME AS EXTRA-CRITICAL AREAS	SHALL BE FLUSH WITHIN TOLERANCE 0.0030 TO 0.0050 HIGH
BAC830XT BAC830XU BAC830YP DOMED, REDUCED SHEAR HEAD LOCKBOLTS AND HI-LOKS	SHALL BE FLUSH WITHIN TOLERANCE 0.0005 HIGH TO 0.0055 HIGH	-5 (5/32) AND -6 (3/16) SIZES: • SHALL BE FLUSH WITHIN TOLERANCE 0.0015 HIGH TO 0.0075 HIGH -8 (1/4), -10 (5/16) AND -12 (3/8) SIZES: • SHALL BE FLUSH WITHIN TOLERANCE 0.0025 HIGH TO 0.0085 HIGH	SAME AS CRITCAL AREAS

FASTENER FLUSHNESS FOR NACELLES
TABLE II

CAUTION: DO NOT SHAVE RIVET HEADS INSTALLED IN COMPOSITE PANELS. RIVET SHAVING CAN CAUSE COMPOSITE PANEL DAMAGE.

DO NOT SHAVE THE HEADS OF MANUFACTURED FASTENERS. SHAVING MANUFACTURED FASTENER HEADS CAN DAMAGE MICRO-SHAVER TOOLS.

NOTE: FASTENER FLUSHNESS IS TO BE DETERMINED BY THE HIGHEST POINT OF THE INSTALLED FASTENER ABOVE THE SKIN SURFACE.

Aerodynamic Smoothness - Nacelle, CF6-80C(2) Engine
Figure 1 (Sheet 3 of 3)

767-300
STRUCTURAL REPAIR MANUAL

GENERAL - AERODYNAMIC SMOOTHNESS RB211-524 ENGINE NACELLE

1. General

A. The RB211-524 nacelle is designed to give an areodynamically clean shape and a smooth exterior for high performance. Unrepaired damage which changes the original shape or smoothness of the surface will reflect in reduced performance. Performance deterioration will also result when repairs are effected which themselves change the original shape, i.e., external patch repairs, for this reason such repairs should be replaced by permanent patch repairs whenever possible.

B. This section covers the requirements for the aerodynamic smoothness of the external and internal portions of the nacelle which are exposed to airflow. The smoothness requirements are divided into three catagories:

(1) Mismatch at joints (including latches)

(2) Waviness of skins

(3) Protrusion of flush-type fasteners

2. Critical Areas

A. The aerodynamic smoothness of the complete nacelle is classified in two categories, critical ZONE 1 and non-critical ZONE 2, Refer to Figure 1/GENERAL.

B. These categories are in relationship to those parts of the nacelle which are covered in this Structrual Repair Manual, and are listed below:

- Inlet cowl
- Fan cowl side panels (RH and LH)
- Reverser cowl
- Integrated nozzle assembly

3. Types of Deviations

A. Contour deviation is the tolerance allowed above or below lofted contours using nominal profile as the datum.

B. Waviness is defined as a smoothly varying surface from a flat continuously curved contour. The distance between adjacent high points in this variation is one wavelength. Slope is defined as the degree of inclination from the nominal surface at any point on a wave (Refer to Figure 2/GENERAL.

Maximum slope permitted 0.024 inch/inch.

C. Mismatch is defined as an abrupt interruption in a surface from a flat or continuously curved contour. Mismatch is PLUS (+) when the trailing edge projects into the airstream and is MINUS (-) when the trailing edge is below the airstream (Refer to Figure 3/GENERAL).

4. Contour Deviation

A. Inlet Cowl, Fan Cowl, Reverser Cowl and Integrated Nozzle

(1) Outer skin

(a) Contour devation within +0.063 to -0.063 inch of nominal dimensions can be accepted.

5. Skin Waviness

A. Inlet cowl and fan cowl side panel (Refer to Figure 2/GENERAL).

(1) Local dishing, up to 1.000 inch diameter and to a depth of 0.010 inch, can be added to skin waviness standard.

B. Reverser cowl and integrated nozzle (Refer to Figure 2/GENERAL).

6. Gaps and Mismatches

NOTE: Small "into wind" steps, due to tolerances at butt joints, are acceptable but corners of potential "into wind" steps must be radiused or chamfered.

A. Permissable gaps and mismatches for nacelle cowls are defined in Figure 3/GENERAL.

(1) Specific critical points

(a) Fan cowl panels exposed latches +0.050 to -0.050 inch.

(b) Longitudinal joint of fan cowls (at bottom of nacelle)

Gap: 0.060 inch maximum Mismatch: 0.030 inch minimum to 0.150 inch maximum

(c) Longitudinal joint (at bottom of nacelle) of reverser cowl

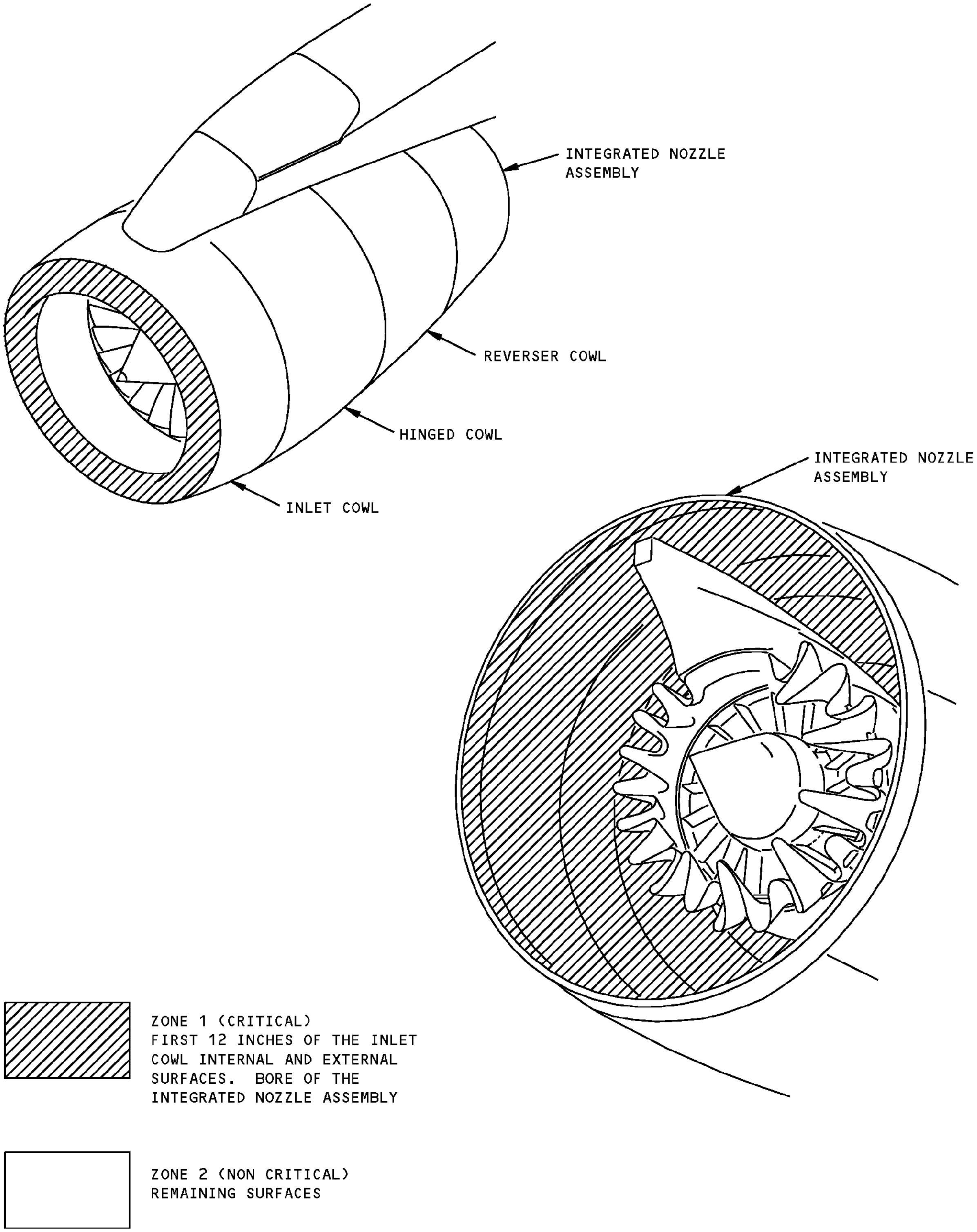
Gap: 0.080 inch maximum

(d) Cowling (fan cowl) edge joint to reverser cowl

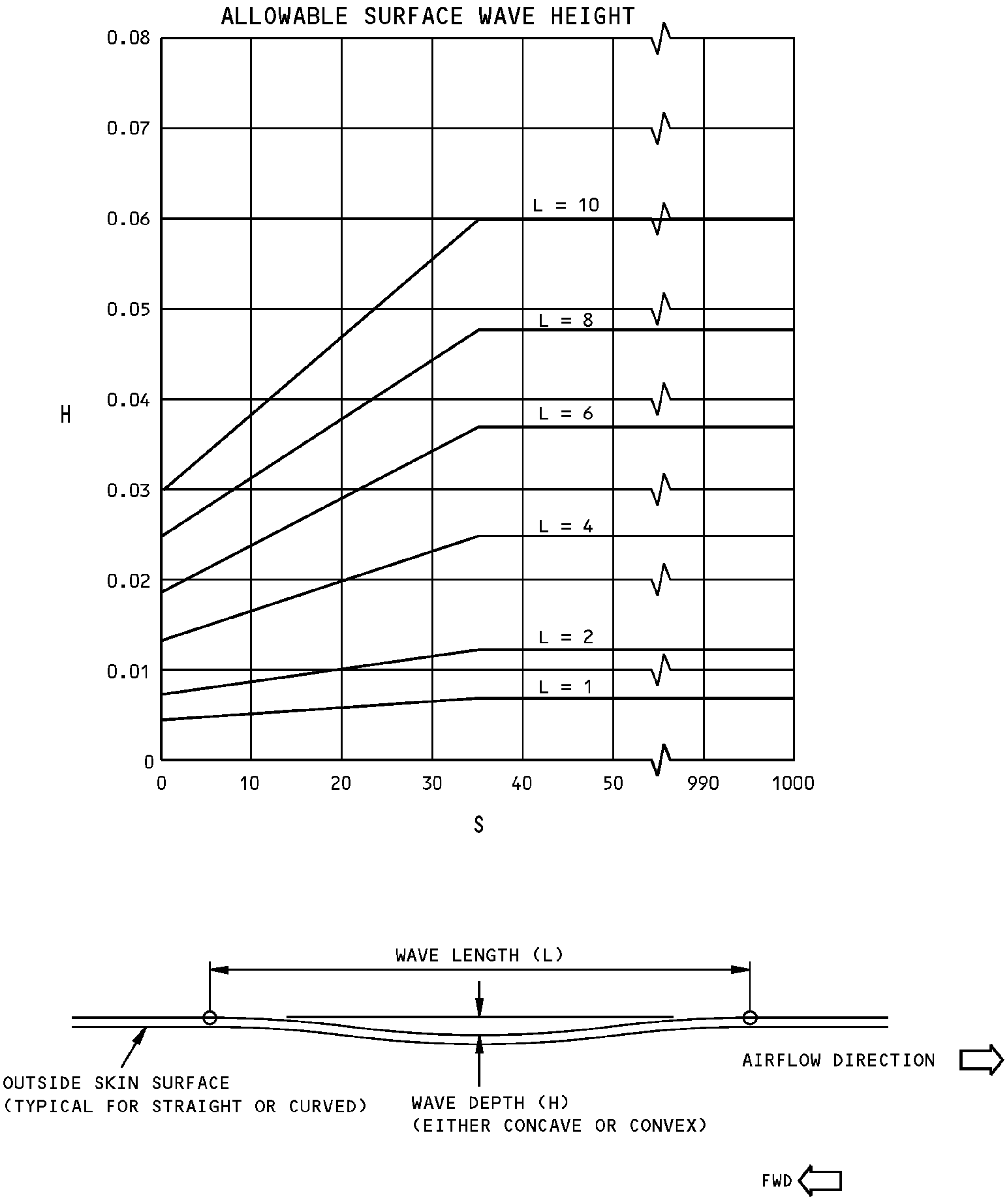
Gap: 0.250 inch maximum 0.050 inch minimum

7. Fastener Flushness

A. The acceptance standards for rivet, screw/bolt and camlock fastener flushness are defined in Figure 4/GENERAL.

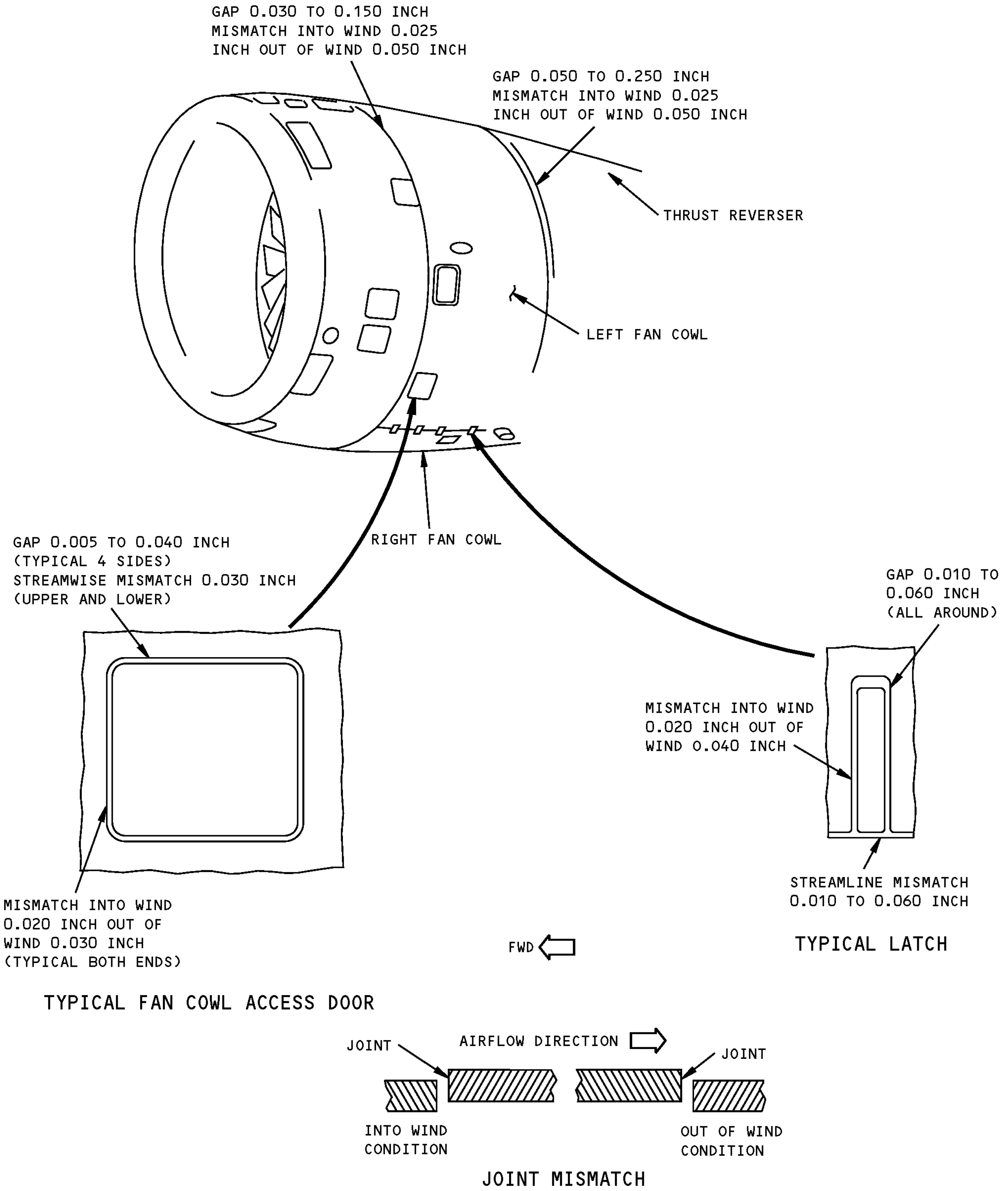


Aerodynamic Smoothness - Critical Areas - RB211-524 Engines
Figure 1

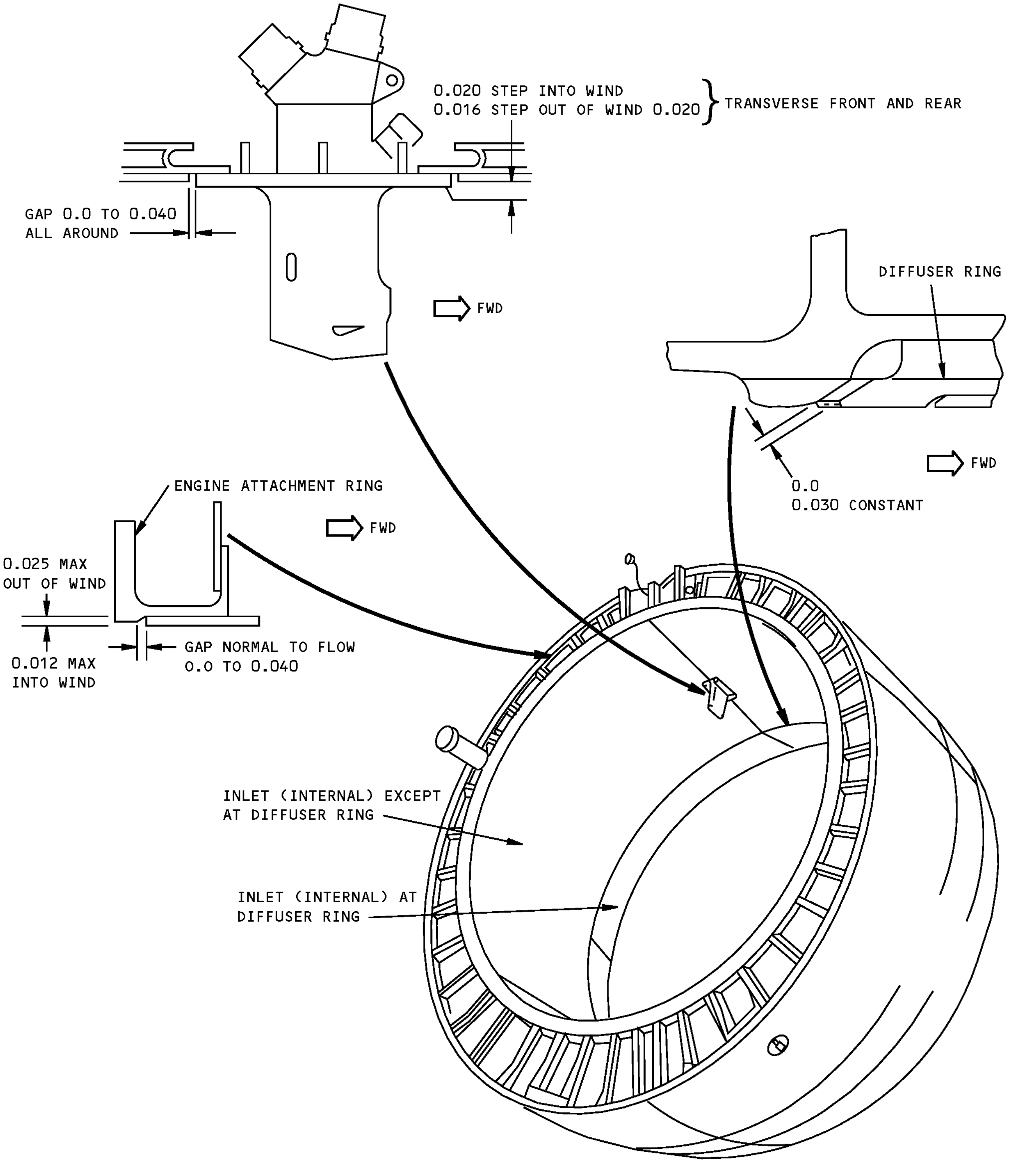


S = DISTANCE FROM INLET
COWL LEADING EDGE IN INCHES
H = WAVE HEIGHT IN INCHES
L = WAVE LENGTH IN INCHES

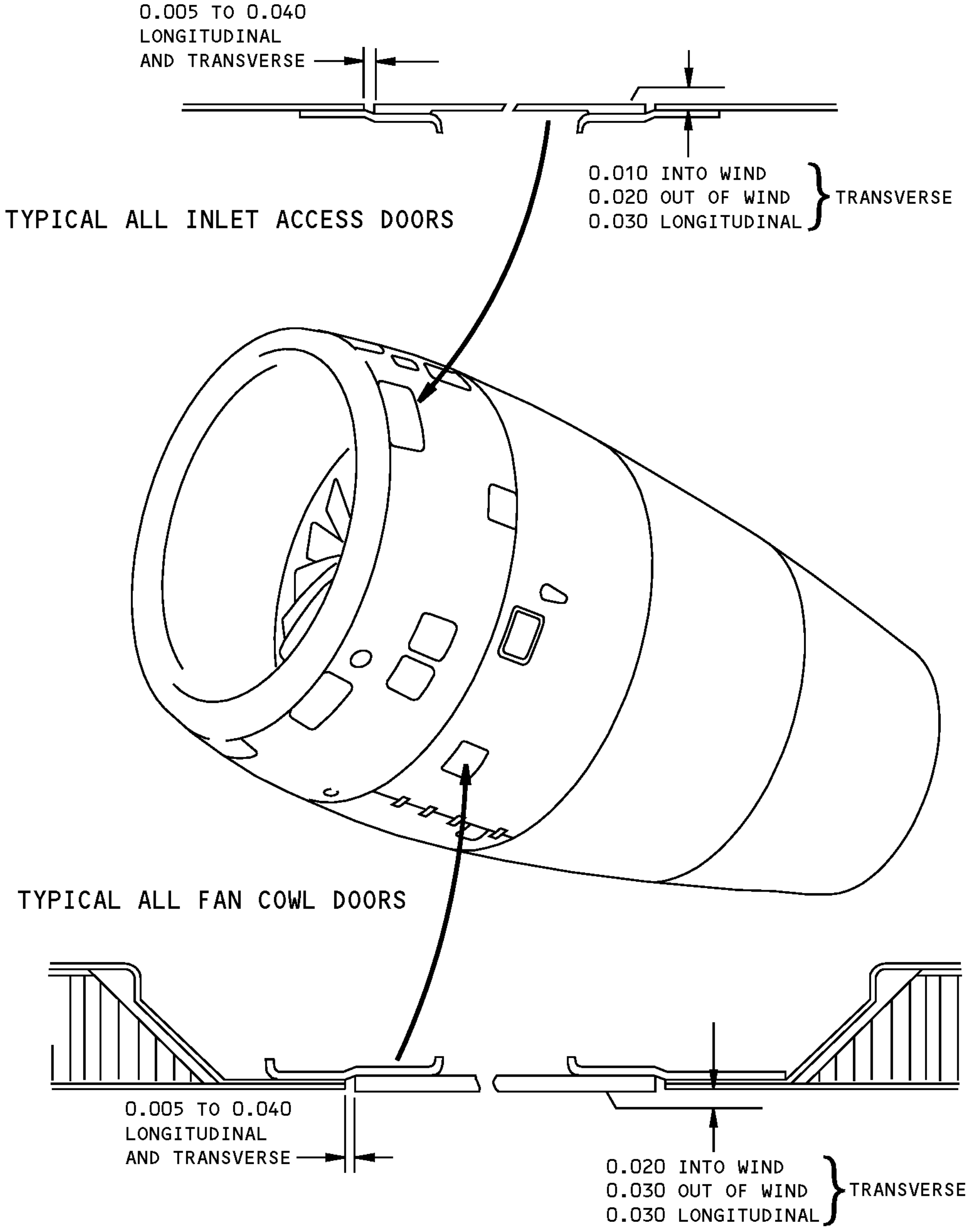
Aerodynamic Smoothness - Skin Waviness - RB211-524 Engines
Figure 2



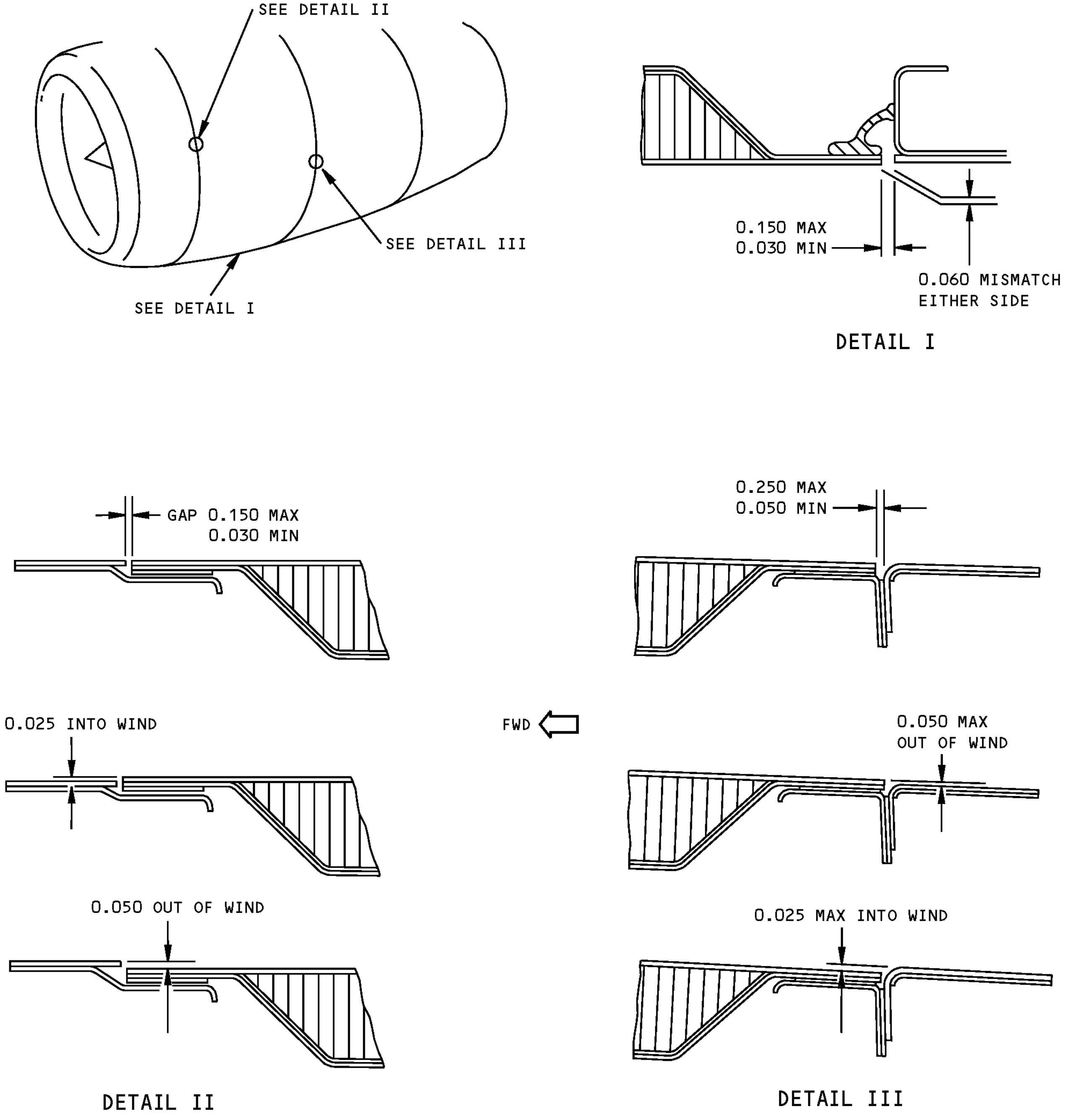
Aerodynamic Smoothness - Permissible Gaps and Mismatch
Figure 3 (Sheet 1 of 6)



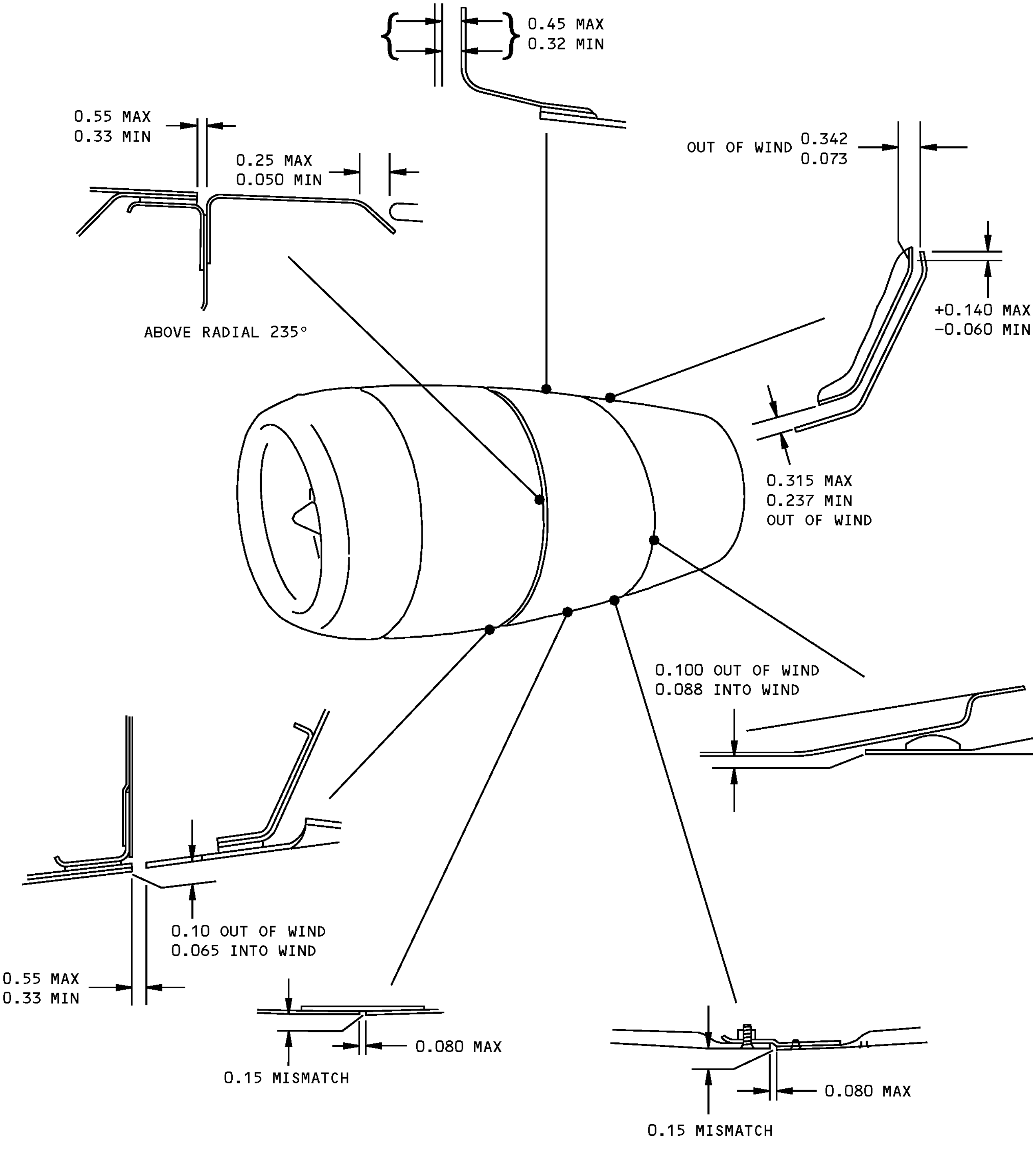
Aerodynamic Smoothness - Permissible Gaps and Mismatch
Figure 3 (Sheet 2 of 6)



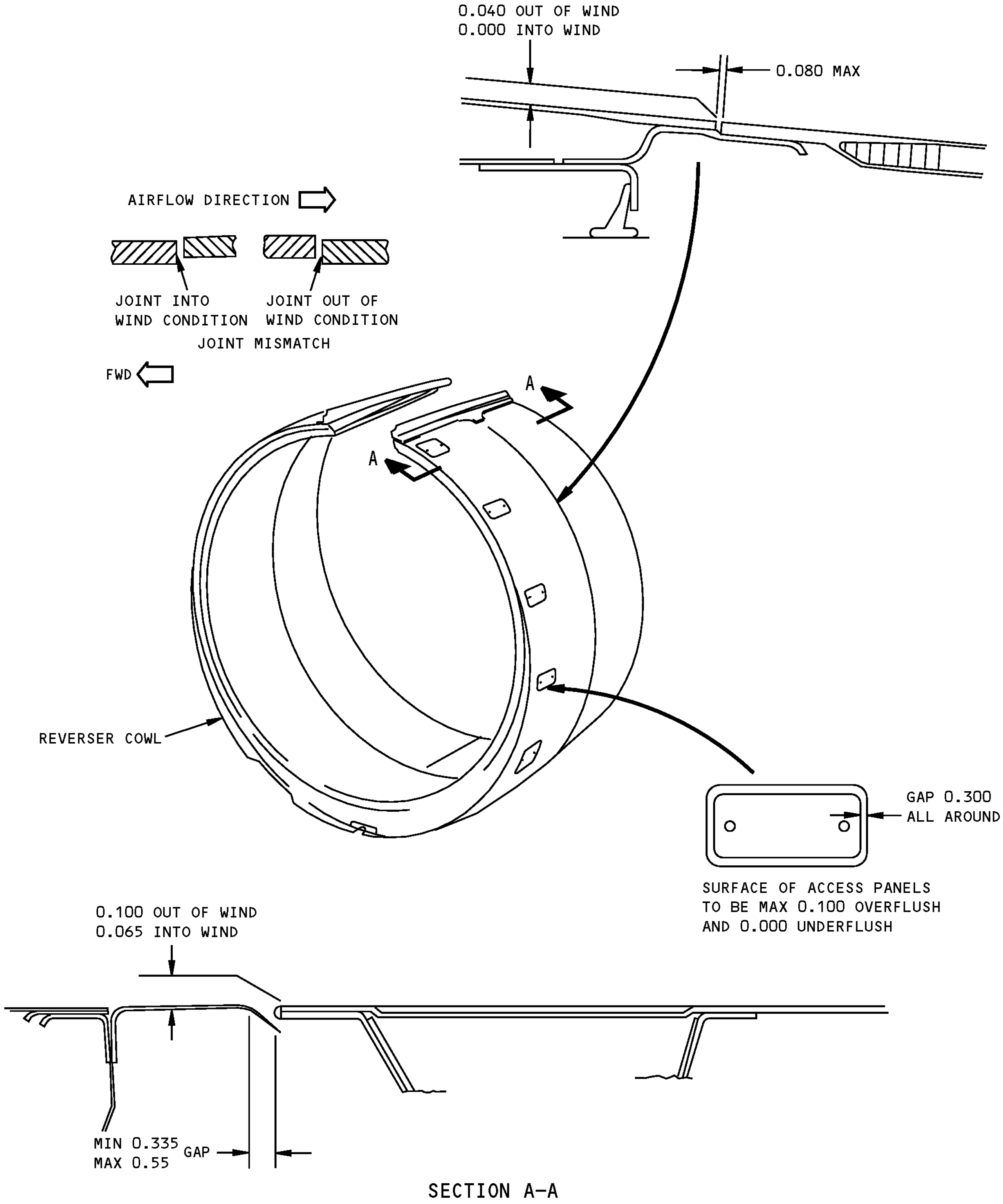
Aerodynamic Smoothness - Permissible Gaps and Mismatch
Figure 3 (Sheet 3 of 6)



Aerodynamic Smoothness - Permissible Gaps and Mismatch
Figure 3 (Sheet 4 of 6)



Aerodynamic Smoothness - Permissible Gaps and Mismatch
Figure 3 (Sheet 5 of 6)



Aerodynamic Smoothness - Permissible Gaps and Mismatch
Figure 3 (Sheet 6 of 6)

PERCENTAGE		95	90	85	15	10	4	1
RIVETS	ZONE 1 EXTERNAL	+0.003 -0.000					+0.004 $\boxed{A}$ -0.000	+0.005 $\boxed{A}$ -0.000
	ZONE 2 EXTERNAL			+0.004 -0.001	+0.006 $\boxed{A}$ -0.001			
	ZONE 1 INTERNAL	+0.003 -0.000					+0.004 -0.000	+0.005 -0.000
	ZONE 2 INTERNAL			+0.004 -0.001	+0.006 -0.001			
SCREWS AND BOLTS	ZONE 2 EXTERNAL		+0.003 -0.003			+0.003 -0.005		
FASTENERS (OTHER THAN) LATCHES	ZONE 2 EXTERNAL							

INLET COWL
TABLE I

NOTES

- FOR ZONE DEFINITION, REFER TO FIG. 1

$\boxed{A}$ RIVETS WITHIN THIS TOLERANCE BAND MUST BE EVENLY DISTRIBUTED

Aerodynamic Smoothness - Fastener Flushness - RB211-524 Engines
Figure 4 (Sheet 1 of 3)

PERCENTAGE		90	85	15	10
RIVETS	ZONE 1 EXTERNAL				
	ZONE 2 EXTERNAL		+0.004 -0.001	+0.006 $\boxed{A}$ -0.001	
	ZONE 1 INTERNAL				
	ZONE 2 INTERNAL				
SCREWS AND BOLTS	ZONE 2 EXTERNAL	+0.003 -0.003			+0.003 -0.005
FASTENERS (OTHER THAN) LATCHES	ZONE 2 EXTERNAL				

FAN AND REVERSER COWL
TABLE II

Aerodynamic Smoothness - Fastener Flushness - RB211-524 Engines
Figure 4 (Sheet 2 of 3)

PERCENTAGE		90	85	15	10
RIVETS	ZONE 1 EXTERNAL	+0.003 -0.001			+0.006 -0.001
	ZONE 2 EXTERNAL		+0.004 -0.001	+0.006 $\boxed{A}$ -0.001	
	ZONE 1 INTERNAL	+0.003 -0.001			+0.006 $\boxed{A}$ -0.001
	ZONE 2 INTERNAL				
SCREWS AND BOLTS	ZONE 2 EXTERNAL	+0.003 -0.003			+0.003 -0.005
FASTENERS (OTHER THAN) LATCHES	ZONE 2 EXTERNAL				

INTEGRATED NOZZLE ASSEMBLY
TABLE III

Aerodynamic Smoothness - Fastener Flushness - RB211-524 Engines
Figure 4 (Sheet 3 of 3)

GENERAL - PROCESSES AND PROCEDURES

1. General

A. The information contained in the following section details the appropriate methods for identifying damage due to corrosion, excessive heat or mercury spillage and prescribes the methods for protecting and sealing off repaired components from further damage.

GENERAL - PROTECTIVE TREATMENT OF METALLIC AND NONMETALLIC REPAIR PARTS

1. General

A. Any repair process which breaks the surface of original structure requires a protective treatment. The treatment acts as a paint base and corrosion inhibiter when applied prior to the installation of repair parts. Unclad aluminum alloys of the original structure require protective treatment prior to primer application. Steel parts require cadmium plating. Unpainted clad aluminum surfaces require protective treatment with Alodine 1000. Refer to the Standard Overhaul Practices Manual, SOPM 20-43-03.

B. Structural components whose surfaces have not been damaged beyond the limits of allowable damage or whose surfaces have been damaged by corrosion must be refinished. Apply the decorative finish if applicable, as given in the Airplane Maintenance Manual (AMM).

C. Refer to 51-10-02, GENERAL for mechanical cleanup operations required for the elimination of burrs or sharp edges.

D. The maximum allowable temperatures of the following coatings, sealants, adhesives, primers, and paints are as follows:

Table 1: Coatings, Sealants, Adhesives, Primers and Paints - Temperature Data

MATERIAL	MAXIMUM TEMPERATURE ALLOWABLE °F (°C)
BMS 10-11, Type I & II Primer	300 (149)
BMS 10-60, Type I & II Paint	300 (149)
BMS 10-20, Type II Primer	300 (149)
BMS 3-27 Coating	160 (71)
BMS 10-79, Type I & II Sealant	300 (149)
BMS 10-21, Type III Antistatic Coating	300 (149)
BMS 10-86 (BAC 5710 Type 27) Teflon Coating	300 (149)
BMS 5-89 Primer	300 (149)
BMS 10-100, BAC 5797 Coating	200 (93)
BAC 5710, Type 47 PTFE Coating	700 (371) Peak 425 (218) Continuous
BMS 5-92 Adhesive	160 (71)
BMS 10-103 Primer	300 (149)
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 5-95 Sealant	200 (93)
BMS 5-126, Type II, III Potting Compound	160 (71)
BMS 5-26 Sealant	200 (93)
BMS 5-63 Sealant	450 (232)
DC93-006	450 (232)
BAC 5755 Aluminized Primer	450 (232)
BMS 14-4, Type IV Coating	550 (288)
Chemical Conversion Coating on Aluminum (Unpainted)	140 (60)

Table 1: Coatings, Sealants, Adhesives, Primers and Paints - Temperature Data (Continued)

MATERIAL	MAXIMUM TEMPERATURE ALLOWABLE °F (°C)
Chemical Conversion Coating on Aluminum (Painted)	300 (149)
Chemical Conversion Coating on Steel	200 (93)
Anodized or Hardcoat on Aluminum (Unpainted)	300 (149)
Anodized or Hardcoat on Aluminum (Painted)	400 (204)

2. References

Reference	Title
51-10-02, GENERAL	Inspection and Removal of Damage
51-20-05, GENERAL	Repair Sealing
51-30-01, GENERAL	Sheet Metal Materials
51-30-03, GENERAL	Nonmetallic Materials
51-70-03, GENERAL	Graphite and/or Aramid Reinforced Epoxy Laminates and Nonmetallic Honeycomb Sandwich Repairs - Room Temperature – 150°F (66°C) Cure (Wet Layup)
51-70-17, GENERAL	Repairs to 250°F (121°C) and 350°F (177°C) Cured Graphite/Aramid/Fiberglass Reinforced Epoxy Laminates and Nonmetallic Honeycomb Sandwich Structure - 200°F (93°C) to 230°F (110°C) Wet Layup Repair Method
AMM 20-41-01	Aircraft Maintenance Manual
AMM 51-21	Aircraft Maintenance Manual
AMM 51-21-00	Aircraft Maintenance Manual
SOPM 20-30-03	Standard Overhaul Practices Manual
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 20-44-01	Application of Special Purpose Coatings and Finishes

3. Aluminum Alloy-Brush Chemical Conversion Coating Process

WARNING: HANDLE BRUSH CHEMICAL CONVERSION COATING WITH THE USUAL PRECAUTIONS FOR CORROSIVE CHEMICALS. USE RESPIRATORS, GOGGLES, RUBBER OR NEOPRENE GLOVES, BOOTS AND APRONS MADE OF ACID-RESISTANT MATERIAL, WHEN HANDLING THE POWDER AND APPLYING THE SOLUTION. DO NOT ALLOW THE POWDER OR SOLUTION TO CONTACT THE SKIN. WASH OFF IMMEDIATELY. IF SOLUTION CONTACTS THE EYES, WASH WITH WATER FOLLOWED BY AN EYE WASH OR BORIC ACID. OBTAIN MEDICAL AID IMMEDIATELY. DO NOT ALLOW SWABS, PAPER, ETC., USED FOR APPLYING OR REMOVING THE CHEMICAL CONVERSION COATING SOLUTION, TO DRY OUT. THESE CONSTITUTE A FIRE HAZARD WHEN DRIED. IMMEDIATELY AFTER USE, SOAK THOROUGHLY IN WATER BEFORE DISCARDING.

A. Alodine is the registered trade name of a proprietary procedure marketed by the Parker-Amchem, Henkel Corp. Iridite is the registered trade name of a proprietary procedure marketed by the Allied-Kelite Products, Division of the Richardson Co., Turcoat Alumigold B is the registered trade name of a proprietary procedure marketed by Turco Products Division, Atochem, Inc. They are approved for the production of a chemical film on aluminum alloy. The film is softer than the anodic treatment but is satisfactory as a protective layer and a paint base. Treat repair parts and initial structure that have been cut or filed with one of these chemical conversion coatings. Use Alodine 600 when you treat parts previously primed with BMS 10-20 primer.

B. Materials Required

(1) Alodine 1200S powder or Iridite 14-2 powder or Turcoat Alumigold B (or 4178-6) powder or Alodine 600 powder

(2) Tycro wheels, Type 3A, very fine aluminum oxide wheels, Scotchbrite Pad, Type A, very fine aluminum oxide pads or 400-grit aluminum oxide paper

(3) Cheesecloth or new rags with less than 0.75 percent oil

(4) Methyl Ethyl Ketone (MEK), Isopropyl Alcohol, Ethyl Alcohol, CDG-211, MIL-C-81302, Type I, or BMS 11-9 (MPK)

(5) Alodine 1132, Touch-N-Prep pen

(6) Pressure sensitive tape

  (a) 212, 3M Company

  (b) 2090 Long-Mask, 3M Company

  (c) 733, Permacel

  (d) PG-57R, American Tape

C. Prepare the brush chemical conversion coating solution.

(1) Roll the contents of each container of chemical conversion coating powder thoroughly on clean paper prior to withdrawal of fraction to be used.

(2) Add 3 ounces of chemical conversion coating powder for each gallon of deionized or distilled water used.

(3) Mix in stainless steel or acid-resistant container. (Do not use lead or glass.)

(4) Stir well until powder is dissolved.

NOTE: Compliance with mixing procedure is required for a satisfactory solution. A small amount of material that may settle out of solution can be disregarded.

(5) Allow the solution to stand at least 1 hour before use.

NOTE: A dirty solution is unsatisfactory. Prepare the solution in small quantities. Discard the solution when it is not used for 24 hours, or it is dirty. If nondistilled water is used, add nitric acid to control the pH. For the Alodine products, the pH must be from 1.50 to 2.00. For the Iridite 14-2, the pH must be from 1.10 to 1.60. For the Turcoat Alumigold, the pH should be from 1.60 to 1.90. Use pHydrion papers to check the pH level.

WARNING: AVOID BREATHING VAPORS WHEN USING NITRIC ACID. USE MECHANICAL VENTILATION OR RESPIRATORY PROTECTION. AVOID CONTACT WITH SKIN, EYES AND CLOTHING. WEAR APPROVED ACID PROOF GLOVES, PROTECTIVE CLOTHING, GOGGLES AND FACE SHIELD. KEEP ACID AWAY FROM SOURCES OF HEAT, FIRE AND SPARKS. AVOID EXPOSURE TO OTHER MATERIALS. BREATHING NITRIC ACID OR ALLOWING ACID TO CONTACT SKIN OR EYES IS EXTREMELY HAZARDOUS. IN CASE OF CONTACT WITH EYES, DO NOT RUB. FLUSH WITH WATER FOR 15 MINUTES AND GET MEDICAL ATTENTION. IN CASE OF SKIN CONTACT, WASH AFFECTED AREA WITH LARGE AMOUNTS OF WATER AND GET MEDICAL ATTENTION. IF FUMES ARE INHALED OR ONLY SUSPECTED TO HAVE BEEN INHALED REPORT TO MEDICAL STATION IMMEDIATELY.

D. Prepare the surface for chemical conversion coating.

(1) Mask all surfaces likely to be affected by running, dripping, or splashing of the solution. Painted, anodized or previously chemical conversion coated surfaces need not be masked.

(2) Seal or plug all holes, gaps and inlets to assemblies containing honeycomb or foam plastic with suitable sealing or caulking material or rubber plugs to prevent entry of any solution.

(3) Clean area to be chemical conversion coated with a liquid solvent degreaser by using a clean brush or rags. Dry with warm air or wipe dry.

(4) Remove the existing organic and inorganic finish from the repair area. Remove the hydraulic fluid resistant finish at the same time the inorganic coating is stripped. Strip anodized, chemical conversion coated or other inorganic coatings mechanically with Tycro, Type 3A, very fine aluminum oxide unitized wheels attached to a drill motor, Scotchbrite Pad, Type A, or 400 grit aluminum oxide paper. Clean all signs of organic and inorganic coatings until a uniform, bright, shiny aluminum surface is obtained.

(5) Wipe with dry clean cheesecloth to remove loose particles and residue from the abraded area.

(6) Wipe with cheesecloth dampened (not saturated) with MEK, CDG-211, isopropyl alcohol or MIL-C-81302, type I, or BMS 11-9 (MPK). Repeat using clean cheesecloth until no visible residue transfers to the cheesecloth.

(7) Allow to dry for a minimum of 15 minutes.

(8) Remove any corrosion present per (1) thru (7) above.

(9) Refer to 51-20-05, GENERAL for cleaning structure and repair parts prior to the installation of sealant in integral fuel tanks.

E. Apply the chemical conversion coating solution.

(1) Apply the chemical conversion coating evenly and liberally with a fiber or nylon brush or clean cheesecloth.

(2) Allow the solution to remain for 3 to 4 minutes to form a coating. Keep the area from drying during this period by gently blotting with cheesecloth moistened with the solution.

CAUTION: EXERCISE CARE WHEN RINSING AND DRYING TO AVOID SCRATCHING OR REMOVING THE COATING, WHICH IS TENDER WHEN FRESHLY FORMED.

(3) Rinse with clean water by gently contacting the surface with wet (not saturated) clean cheesecloth. Contact for 1 to 2 minutes and repeat with clean cheesecloth.

(4) Gently contact the surface with clean dry cheesecloth to absorb excess liquid. Repeat as required.

(5) Air-dry thoroughly. Filtered hot air (130°F maximum) for 15 minutes is recommended.

(6) Apply Alodine 1132 to minor defects such as scratches, voids, and abrasions.

(7) Apply final finish or commence adhesive bonding in accordance with 51-70-09 as soon as possible after drying. Handle parts with clean gloves and keep parts clean and dry to avoid surface contamination.

4. Steel-Cadmium Plating

A. Noncorrosion resistant steel parts used in repairs must be cadmium plated or zinc-nickel plated for maximum corrosion protection. Refer to SOPM 20-42-01 and SOPM 20-42-05.

B. While corrosion resistant steels are not susceptible to oxidation, they are cathodic when in contact with dissimilar metals (Paragraph 5./GENERAL) and therefore they should also be cadmium plated or zinc-nickel plated.

C. As a temporary measure until the reworked surfaces of steel parts can be stylus cadmium plated, apply protective coating to reworked surfaces of steel parts which have been heat-treated to less than 220,000 psi as follows:

WARNING: WHEN USING ALCOHOLIC-PHOSPHORIC SOLUTIONS AVOID BREATHING VAPORS. USE MECHANICAL VENTILATION OR RESPIRATORY PROTECTION. AVOID CONTACT WITH SKIN, EYES AND CLOTHING. WEAR APPROVED GLOVES AND PROTECTIVE CLOTHING. WEAR EYE PROTECTION. BREATHING VAPORS OR ALLOWING SOLUTION TO CONTACT SKIN OR EYES IS HAZARDOUS. IN CASE OF CONTACT WITH EYES, FLUSH WITH PLENTY OF WATER FOR 15 MINUTES AND GET MEDICAL ATTENTION.

(1) Clean by wiping with a cloth or brush which has been dipped in one of the alcoholic-phosphoric solutions Turco Pre-Paint, Kelite polycote, or in an aqueous solution containing 10% by volume phosphoric acid (85%), 10% by volume butyl cellulose, and 0.1% by volume Triton X-100 wetting agent. Do not allow solution to dry on work.

(2) Rinse with a water-soaked rag.

(3) Wipe dry.

(4) Apply two coats of BMS 10-11, type I primer according to AMM 51-21.

5. Mating Surfaces

A. Each metal and metal alloy has an inherent electrical potential. When placed in contact with a material of different potential and in the presence of an electrolyte, galvanic corrosion may result with pitting or other damage occuring in the higher potential material.

B. Figure 1/GENERAL shows the protective treatments which are to be used on mating surfaces.

C. The protective treatments shown in Figure 1/GENERAL are considered to be acceptable for field type repairs where speed and simplicity is essential. For restoration of internal and external finish, refer to AMM 51-21-00.

D. Dissimilar materials are classified into four groups as shown in Figure 2/GENERAL. Classification is determined by the surface material, i.e., the base metal of a nonplated part, or the deposited metal of a plated or coated part.

E. Graphite is an electrically conductive material even though it is classed as a non-metal. It has an electrolytic reaction with metals from other groups with which it has a mating surface, or with fasteners fabricated from other groups of metals which pass through it. A ply of fiberglass fabric is often used as an electrolytic barrier between graphite and dissimilar material groups.

6. Fastener Installation

A. The requirement for protection from galvanic corrosion may be determined from Figure 3/GENERAL. Fasteners requiring protective coating should be installed wet with BMS 5-95 sealant, (preferred method), or with wet BMS 10-11, type I, primer with the following exceptions:

(1) Integral fuel tanks – Refer to 51-20-05, GENERAL.

(2) Removable close tolerance fasteners – Install fasteners with BMS 3-24 grease.

(3) Where dry fastener installation or BMS 5-26 and BMS 5-63 fastener sealant applications are required (Refer to 51-20-05, GENERAL and specific component repair sections).

(4) Fireshield areas – Install fasteners wet with DeSoto Hi-Temp primer (BAC 5710, Type 51). Refer to SOPM 20-44-01.

B. Permanent fasteners (hex-drive bolt, lockbolt, CRES bolt, titanium bolts, etc.) not made from aluminum alloy must be installed with BMS 5-95 sealant, (preferred method), or BMS 10-11, type 1 primer in the fastener holes and around the heads when they are located in fuselage external structure, where aluminum is attached to the graphite landing gear door, metal fairings and wheel well structures. Where BMS 10-11, type I primer is used, the fasteners must be installed within 4 hours of application. Where sealant is used, fasteners should be installed within the application life. Refer to 51-20-05, GENERAL.

C. Shaved heads of aluminum rivets in unpainted anodized aluminum alloy surfaces must have a clear coating of Alodine 1000 applied manually.

D. Permanent fasteners installed through a dissimilar metal stackup require installation with BMS 5-95 sealant.

7. The Use of Solvent-Dispersed Corrosion-Inhibiting Compounds for Corrosion Protection

A. General Information about Solvent-Dispersed Corrosion-Inhibiting Compounds

(1) Use solvent-dispersed corrosion-inhibiting compounds to stop corrosion when the finish is damaged. These compounds can get into very small cavities and push the water out. Thus, this compound can get between mating surfaces, or between fasteners and the fastener holes where the finish is broken.

(2) These compounds are volatile liquids which can be sprayed, swabbed or brushed on different surfaces. Corrosion inhibitors are durable materials that are not easily removed by normal use.

(3) When you use these compounds on the external surfaces of the airplane, they can be resistant to surface cleaning for a short amount of time. But after a specified amount of time, given by your airplane maintenance schedule, it will be necessary to replace the layer of solvent-dispersed corrosion-inhibiting compound.

NOTE: Do an analysis of your airplane's flight-cycle environment. Write down where you use all of the solvent-dispersed corrosion-inhibiting compounds on the airplane, and the schedule with which they were applied. This will make sure that the airplane has sufficient corrosion protection during its service life.

(4) The Boeing Company recommends that you use one of the following compounds.

(a) BMS 3-23

(b) BMS 3-29

(c) A layer of BMS 3-26 above BMS 3-23

NOTE: Some other type of solvent-dispersed corrosion-inhibiting compounds may be satisfactory, but only if it is approved for use as a solvent-dispersed corrosion-inhibiting compound. The airline operator can approve the use of their own solvent-dispersed corrosion-inhibiting compounds, if they have experience in the use of these materials.

(5) BMS 3-23, BMS 3-26 and BMS 3-29 are organic compounds. These compounds are nonvolatile base materials. They are mixed with a solvent to make the compound more liquid.

NOTE: These compounds do not contain silicones.

(6) BMS 3-23, BMS 3-26, and BMS 3-29 can be applied with an airless paint spray pump, an aerosol can, or with a brush.

(7) The three types of solvent-dispersed corrosion-inhibiting compounds are listed below.

(a) BMS 3-23

1) BMS 3-23 is a solvent-dispersed, water-displacing, corrosion-inhibiting compound. There are two types of BMS 3-23 compounds.

- Type I leaves a transparent, colorless film, which can be seen by the use of an ultraviolet light.
- Type II leaves a colored film, which can be seen under visible light by a visual inspection.

2) After BMS 3-23 dries, it leaves a thin layer of wax-like material on the surface.

3) Surfaces which have had certain types of BMS 3-23 products applied, will stay tacky,and will then collect unwanted material. Thus, those surfaces must be regularly cleaned, and then more of the BMS 3-23 must be applied.

NOTE: This does not include Dinitrol AV-8, LPS Hardcoat, or ZC023, which are not tacky after they dry.

4) The time interval to clean the surface, and then to apply more BMS 3-23 will change with its location on the airplane.

5) Refer to the Airline Maintenance Planning Document or the manufaturer's written instructions for specific application procedures.

(b) BMS 3-26

1) BMS 3-26 is a heavy-duty, solvent-dispersed, corrosion-inhibiting compound. There are two types of BMS 3-26 compounds.

- Type I leaves a continuous, medium-thick, colored film which can be seen under visible light by a visual inspection.
- Type II leaves a continuous, thick, colored film which can be seen under visible light by a visual inspection.

2) BMS 3-26 does not have the same ability to go into small cavities like BMS 3-23 or BMS 3-29.

3) Surfaces, which have had BMS 3-26 products applied, will become dry to the touch after approximately 6 hours.

4) After BMS 3-23 dries, it leaves a thick, translucent layer layer of wax-like material on the surface.

5) The layer of BMS 3-26 is not easily worn off. But it must be applied once again, if the surface has been cleaned.

(c) BMS 3-29

1) BMS 3-29 is an advanced, heavy duty, solvent-dispersed, water-displacing, corrosion-inhibiting compound. There is only one type of BMS 3-29 compound.

- It leaves a continuous, thick, colored film, which can be seen under visible light by a visual inspection.

2) Surfaces which have had BMS 3-29 products applied, will become dry to the touch after approximately 4 hours.

3) After BMS 3-29 dries, it leaves a thick, translucent layer of wax-like material on the surface.

4) The layer of BMS 3-29 is not easily worn off. But it must be applied once again, if the surface has been cleaned.

(8) Refer to 51-30-01, GENERAL, Figure 1/GENERAL, for the products and product suppliers that are qualified to BMS 3-23, BMS 3-26, and BMS 3-29.

(9) Solvent-dispersed corrosion-inhibiting compounds can be applied to those areas of the airplane structure, where corrosion has started or where it may occur at a later date.

(a) If corrosion is present, then apply the solvent-dispersed corrosion-inhibiting compound to the area.

(b) The application of these solvent-dispersed corrosion-inhibiting compounds is only a temporary measure, until the corrosion is removed from the area.

(10) Solvent-dispersed corrsoion-inhibiting compounds will not decrease the initial torque on fasteners. But, their application should be limited to those approved areas of aluminum structure where corrosion is likely to occur. Some examples of these type of areas include:

(a) Surfaces that are exposed to the atmosphere during operation. Examples: the wing leading edge and trailing edge cavities, the spar chords, and the faying surface edges between the chords and the spars.

(b) Structure, where water might collect and not drain away. Example: Fuselage bilge area.

(c) Structure, which can corrode due to contact with corrosive liquids. Examples: the structures below the galleys and the lavatories.

(d) Rivets and bolts after their installation, when no other type of finish has been applied.

(e) All faying surface edges, where the paint, the primer or the sealant can in any way deteriorate.

(f) Areas where the decorative paint film has broken down around the fasteners. (This is to inhibit "filiform" corrosion.)

(g) All other locations on the airplane where corrosion has been detected.

(11) During the manufacture of certain airplanes, solvent-dispersed corrosion-inhibiting compounds were applied to specified locations of the airframe structure for added protection against corrosion.

(12) If you do rework or repair in these areas, you should apply the solvent-dispersed corrosion-inhibiting compounds again. See Figure 4/GENERAL for the locations of these areas.

(13) For additional procedures on the use of solvent-dispersed corrosion-inhibiting compounds to control and prevent corrosion, refer to the Boeing Corrosion Prevention Manual, D634N401.

B. Precautions for the Use of solvent-dispersed corrosion-inhibiting Compounds

WARNING: SOLVENT-DISPERSED CORROSION-INHIBITING COMPOUNDS ARE APPROXIMATELY EQUAL TO KEROSENE OR ALIPHATIC NAPHTHA IN TOXICITY. TO PROTECT THE SKIN, USE THE SAME PRECAUTIONS AS FOR KEROSENE. IF YOU USE THESE COMPOUNDS IN AN EXTREMELY CONFINED AREA, MECHANICAL VENTILATION IS MANDATORY. RESPIRATORY AND SKIN PROTECTION IS ALSO NECESSARY. AS A FIRE SAFETY PRECAUTION, SOLVENT-DISPERSED CORROSION-INHIBITING COMPOUNDS SHOULD BE KEPT AWAY FROM ANY SURFACE THAT CAN GET TO TEMPERATURES HIGHER THAN RECOMMENDED BY THE MANUFACTURER FOR SAFETY. SOLVENT-DISPERSED CORROSION-INHIBITING COMPOUNDS CONTAIN FLAMMABLE COMPONENT MATERIALS. DO NOT PERMIT THESE MATERIALS TO COME IN CONTACT WITH OPEN FLAMES, ACTIVE ELECTRICAL CIRCUITS, OR OTHER ELECTRICAL COMPONENTS. IF YOU DO NOT OBEY, A POSSIBLE FIRE AND AN EXPLOSION CAN OCCUR. THESE COMPOUNDS ALSO CONTAIN VOLATILE CARRIER MATERIALS THAT ARE VERY FLAMMABLE. THUS, YOU MUST USE THE CORRECT SAFETY PRECAUTIONS UNTIL THE COMPOUND HAS FULLY DRIED. WHEN MIXED WITH OXYGEN, SOLVENT-DISPERSED CORROSION-INHIBITING COMPOUNDS ARE POTENTIALLY EXPLOSIVE. KEEP THEM CLEAR OF ALL TYPES OF OXYGEN-TYPE SYSTEM COMPONENTS. REFER TO THE MANUFACTURER'S MATERIAL SAFETY DATA SHEETS, OR SPEAK TO THE MANUFACTURER FOR THEIR HEALTH AND SAFETY INFORMATION PERTAINING TO THE USE OF THESE HAZARDOUS MATERIALS. TO DISCARD HAZARDOUS WASTE MATERIALS, SPEAK TO THE RESPONSIBLE POLLUTION CONTROL MONITORING ORGANIZATION FOR THEIR APPLICABLE PROCEDURES.

(1) Make sure that oxygen system components are shielded to protect them from any type of contamination.

(2) Protect electrical connectors and electrical contacts from possible contamination.

(3) Use a clean, dry rag to remove unwanted solvent-dispersed corrosion-inhibiting compounds from mechanisms, and their moving parts. A thin film is sufficient for corrosion protection while a buildup of these compounds can become hard at low temperatures. A large buildup can reduce the operating efficiency of the moving parts.

(4) Protect control cables, pulleys, Teflon bearings and lubricated surfaces from the direct application of corrosion-inhibiting compounds.

  (a) Some of the materials contain volatile hydrocarbons, which can act as a solvent on the lubricant.

  (b) Destruction of the lubricants can result in higher than normal wear on the parts.

(5) Use care when you apply solvent-dispersed corrosion-inhibiting compounds around seals or other areas that contain rubber materials.

  (a) Some locations include; the door and emergency hatch seals, the grease seals in bearing assemblies, and the rubber-lined clamps for tubing and wiring.

  (b) The solvent-dispersed corrosion-inhibiting compounds may cause the rubber seals to swell, and then cause the seals to fail.

(c) Hydraulic fluid (Skydrol) seals can also be affected. Thus, solvent-dispersed corrosion-inhibiting compounds are not applicable for use on any type of actuator rod.

(6) Do not apply these compounds near the engines, the engine cowling or other areas of high temperature, or where you use a firewall sealant. Solvent-dispersed corrosion-inhibiting compounds can cause deterioration to this type of sealant material.

CAUTION: REFER TO SOPM 20-41-05 IF THE INSULATION BLANKET HAS CONTAMINATION BY CORROSION-INHIBITING COMPOUNDS. THESE COMPOUNDS CAN CAUSE THE INSULATION BLANKET TO BE MORE FLAMMABLE.

(7) Protect insulation blankets from the solvent dispersed corrosion-inhibiting compounds. Solvent-dispersed corrosion-inhibiting compounds can decrease the function of these blankets to repel water.

C. Equipment and Materials for Applying Solvent-Dispersed Corrosion-Inhibiting Compounds

(1) Masking Tape

(2) Solvent Materials - P-D-680 or an equivalent solvent material, refer to 51-30-03, GENERAL.

(3) Solvent Wipes - Cheesecloth, gauze, new or laundered rags, tissue paper, or any other type of absorbent material

(4) Protective caps with an enclosure for the exposed oxygen system tubing

D. Surface Preparation

WARNING: IF THE AREA TO BE TREATED WITH SOLVENT-DISPERSED CORROSION-INHIBITING COMPOUNDS IS IN A VERY CONFINED AREA, THEN MECHANICAL VENTILATION IS MANDATORY. ALSO, RESPIRATORY AND SKIN PROTECTION IS NECESSARY.

CAUTION: DISCONNECT ALL SOURCES OF POWER WHEN YOU USE SOLVENT-DISPERSED CORROSION-INHIBITING COMPOUNDS. THESE POWER SOURCES CAN BE BATTERY-OPERATED OR ELECTRICAL EQUIPMENT. THIS IS VERY IMPORTANT TO REMEMBER WHEN YOU ARE NEAR ANY FLAMMABLE MATERIALS, OR WHEN IT IS NECESSARY TO USE A LARGE AMOUNT OF WATER. FAILURE TO DO THIS CAN CAUSE A DANGEROUS FIRE OR A SEVERE ELECTRICAL SHOCK. SOLVENT-DISPERSED CORROSION-INHIBITING COMPOUNDS, OR ANY TYPE OF HYDROCARBON, WHEN APPLIED TO A SILICONE OR ETHYLENE PROPYLENE RUBBER WILL CAUSE IT TO SWELL AND PREVENT IT FROM PERFORMING ITS FUNCTION CORRECTLY.

(1) Remove all external power sources.

(2) Statically ground the airplane. Refer to AMM 20-41-01 for Static Grounding Instructions.

(3) Vacuum all necessary surfaces to remove any unwanted materials.

(4) Clean the surface area with an applicable solvent material.

NOTE: Clean areas that are to be treated to increase the entry of the solvent-dispersed corrosion-inhibiting compound into exposed surfaces of the structure and also into faying surfaces.

(5) Isolate all areas that do not need to be treated with solvent-dispersed corrosion-inhibiting compounds. Use masking tape and paper, or a plastic film.

(6) Isolate all electrical connectors to prevent any contamination of the electrical contacts.

(7) Isolate oxygen system components from any direct or indirect contact when you apply the solvent-dispersed corrosion-inhibiting compound to the adjacent structure.

(8) Build a protective barrier around control cables, pulleys, bearings and lubricated surfaces to protect them from solvent-dispersed corrosion-inhibiting compounds.

(9) Allow new primer or paint to dry for a minimum of 8 hours before you apply a solvent-dispersed corrosion-inhibiting compound.

(10) Make sure a sealant has fully cured on a surface before you can apply a solvent-dispersed corrosion-inhibiting compound.

E. How to Apply Solvent-Dispersed Corrosion-Inhibiting Compounds

NOTE: Solvent-dispersed corrosion-inhibiting compounds usually contain hydrocarbons; thus, you are permitted to apply a different compound over the old compound. This will not cause a problem because the two compounds have equivalent chemical properties.

(1) Solvent-dispersed corrosion-inhibiting compounds contain a solvent carrier, with a low surface tension, which will help in displacing existing water from a metal surface.

(2) As the solvent dries, a thin film is left behind, to act as a barrier to prevent a chemical reaction that causes corrosion between the metal and water, or other substances in the environment.

  (a) Solvent-dispersed corrosion-inhibiting compound will go into cracks and crevices through capillary action. It is not necessary to use pressure spraying.

  (b) Refer to 51-30-03, GENERAL for sources of solvent-dispersed corrosion-inhibiting compounds.

(3) You can apply solvent-dispersed corrosion-inhibiting compounds to an area with only a general cleaning of the surface.

(4) Solvent-dispersed corrosion-inhibiting compounds can be applied with an airless paint spray pump, or by an aerosol can or a brush.

  (a) The location, and how well you can access an area, will show you the best method to apply a solvent-dispersed corrosion-inhibiting compound.

  (b) Apply one coat on top of another coat, but if the initial coat is contaminated with dirt or other solids, it must be cleaned before you apply another coat over it.

  (c) Refer to Paragraph 7.H.(3)/GENERAL for a list of solvents that you can use for cleaning solvent-dispersed corrosion-inhibiting compounds.

(5) Subsequent layers of solvent-dispersed corrosion-inhibiting compounds can be added if the surface is still clean. If the surface is not clean, it must be cleaned before another layer is applied.

&6) Solvent-dispersed corrosion-inhibiting compounds can only be applied to areas specified by applicable engineering data.

(6) When you apply additional finishes, such as paint, primer or sealant material, to a surface, it cannot be easily done. This is because of the penetrating properties of the solvent-dispersed corrosion-inhibiting compounds, and from possible bleed-out at the faying surfaces.

(7) Obey all the precautions given by the manufacturer, along with the precautions given in Paragraph 7.B./GENERAL, when you apply solvent-dispersed corrosion-inhibiting compounds.

(8) Apply BMS 3-23, Types I and II at a temperature range between 40 to 100°F (4 to 38°C).

(9) Apply BMS 3-26, Type I at a temperature range between 40 to 100°F (4 to 38°C).

(10) Apply BMS 3-26, Type II at a temperature range between 50 to 100°F (10 to 38°C).

(11) Apply BMS 3-29 at a temperature range between 40 to 100°F (4 to 38°C).

(12) Mechanical ventilation must be supplied when working in an enclosed area.

(13) Apply a continuous coat of solvent-dispersed corrosion-inhibiting compound so it will go into a jointed area by capillary action.

(14) Apply at a spray rate of 1 gallon per hour (3.79 liters per hour) to cover a surface at a rate of approximately 15 to 20 square feet per minute (1.4 to 1.9 square meters per minute).

(15) The 1 gallon per hour (3.79 liters per hour) spray rate will give a film thickness of:

(a) 0.002 to 0.006 inch (0.051 to 0.152 millimeter) for BMS 3-26, Type I

(b) 0.008 to 0.012 inch (0.203 to 0.305 millimeter) for BMS 3-26, Type II

(c) 0.006 to 0.010 inch (0.152 to 0.254 millimeter) for BMS 3-29

NOTE: Minimum coating thicknesses for BMS 3-23 have not been established, but use a continuous coating to cover the entire surface.

(16) These compounds can also be brushed, or swabbed to the thicknesses shown above.

(17) The use of pressure equipment to apply these compounds directly to the joints is recommended.

(a) Allow the solvent-dispersed corrosion-inhibiting compound to remain on the surface for 60 minutes before any unwanted compound is removed.

(b) This will make sure that the maximum quantity of compound will go into the jointed area where the compound has been applied.

(c) Refer to Paragraph 7.F./GENERAL for spraying procedures and pressure equipment.

(18) Remove any excess solvent-dispersed corrosion-inhibiting compound from a treated surface using a clean wiper or clean gauze.

NOTE: If you let more of the compound stay on the surface than is necessary, it will not give the area better corrosion protection.

(19) Remove all of the used masking tape, protective paper, or plastic film from the area.

(20) Give the area a good flow of air over the surface until the volatile solvents are removed.

(a) The cure time for BMS 3-23, Types I and II is approximately 1 hour.

(b) The cure time for BMS 3-26, Types I and II is approximately 6 hours.

(c) The cure time for BMS 3-29 is approximately 4 hours.

(21) Solvent-dispersed corrosion-inhibiting compounds contain wax compounds and are not to be applied to surfaces that have a temperature of more than 140°F (60°C).

F. Procedures to Apply BMS 3-23, BMS 3-26 and BMS 3-29

(1) The Spray Procedure

(a) The Boeing Company recommends that you apply this compound with an approved pressure pot system and an airless spray gun. The operating pressure should be approximately 45 pounds per square inch (310 KiloNewtons per square meter) or less.

NOTE: If necessary, you can use an aerosol can with a plastic nozzle extension, but The Boeing Company does not recommend this procedure to apply solvent-dispersed corrosion-inhibiting compounds. This is because of the cost and the amount of overspray supplied by the nozzle extension.

(b) Spray equipment can be purchased from the following suppliers:

1) Nordson Corporation, 555 Jackson St., Amhearst, Ohio, 44001-2408

2) Binks Manufacturing Company, 9201 West Belmont Ave, Franklin Park, Illinois, 60131-2807

3) Graco Incorporated, 60 11th Ave, NE, PO Box 1441, Minneapolis, Minnesota, 55440

4) ITW DeVilbiss Industrial Spray Equipment, 1724 Indian Wood Circle, Maumee, Ohio, 43537-4048

(c) You will be able to get better access to an area if you use a spray gun extension kit and a swivel adapter so that you can change the position of the nozzle.

(d) Use approved air atomizing equipment (a siphon or a pressure pot) when there is sufficient access to apply a wet coat of sealant. A spray with a nozzle-to-surface distance of no more than 12 inches (30.5 cm) is necessary for wet application, and can be done by the use of an applicable nozzle extension.

(2) The Brush Procedure

(a) Apply the compound with a paint brush or a clean cloth. Use this procedure for smaller areas, or where extreme caution is necessary. Do not apply the solvent-dispersed corrosion-inhibiting compound to an unwanted area.

(b) For larger areas, or where access is not a problem, the spray procedure is recommended.

G. Exterior Discoloration Caused by Solvent-Dispersed Corrosion-Inhibiting Compounds

(1) When you use a large amount of solvent-dispersed corrosion-inhibiting compound on the internal surfaces of the airplane, some discoloration of the external surfaces of the airplane may occur. This is called "bleed-through", and can occur because these materials can easily go through the mechanically fastened structural joints to the external surface of the airplane.

(2) A "bleed-through" situation can be expected at fastener locations that are not fluid-tight. This is normal and it is not necessary to replace the fasteners. The tiny passages will seal themselves in a short time.

(3) Solvent-dispersed corrosion-inhibiting compounds can bleed-through and stain the decorative finish of the airplane. A difference in oxidation that you can see on the external surface can occur between those areas where you apply the compound, and those areas where you do not.

(4) It is recommended that you frequently clean the airplane in those areas where streaking of the solvent-dispersed corrosion-inhibiting compound occurs, or if it looks like it will leave a permanent stain on the surface of the airplane.

H. Removal of Solvent-Dispensed Corrosion-Inhibiting Compound

NOTE: The complete removal of solvent-dispersed corrosion-inhibiting compound is necessary before you can try to paint or apply a sealant to a surface.

WARNING: SOLVENT-DISPERSED CORROSION-INHIBITING COMPOUNDS ARE APPROXIMATELY EQUAL TO KEROSENE OR ALIPHATIC NAPHTHA IN TOXICITY. TO PROTECT THE SKIN, USE THE SAME PRECAUTIONS AS FOR KEROSENE. IF YOU USE THESE COMPOUNDS IN AN EXTREMELY CONFINED AREA, MECHANICAL VENTILATION IS MANDATORY. RESPIRATORY AND SKIN PROTECTION IS ALSO NECESSARY. REFER TO THE MANUFACTURER'S MATERIAL SAFETY DATA SHEETS, OR SPEAK TO THE MANUFACTURER FOR THEIR HEALTH AND SAFETY INFORMATION PERTAINING TO THE USE OF THESE HAZARDOUS MATERIALS. TO DISCARD HAZARDOUS WASTE MATERIALS, SPEAK TO THE RESPONSIBLE POLLUTION CONTROL MONITORING ORGANIZATION FOR THEIR APPLICABLE PROCEDURES.

(1) A complete solvent cleaning is also necessary before you can do a penetrant inspection of the area.

(2) Give the area a good flow of air until all of the solvent material is gone.

(3) Use the following solvent materials to remove solvent-dispersed corrosion-inhibiting compounds:

  (a) Aliphatic Naphtha

  (b) Biogenic SE377C

  (c) Citra-Safe

  NOTE: Methyl Ethyl Ketone (MEK) or acetone is not recommended by The Boeing Company.

8. Repairs for Finish Cracks on Graphite Composite Parts

A. General

(1) If you have finish cracks:

- Moisture can go into the cracks in the finish, which can cause the finish to come off
- Sunlight can damage the bare composite surface at the locations where the finish has come off.

(2) Cracks in the resin without fiber damage are not a flight safety problem.

B. Interim Repair

NOTE: The outboard aileron, elevator and rudder have operational 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 for the balancing procedure.

If three interim repairs on a given component have been done one after the other, you must do a permanent repair, then measure the static balance moment.

(1) Find the level of damage.

WARNING: WHEN YOU WORK WITH SOLVENTS AND COMPOSITE MATERIALS, USE APPROVED GLOVES, PROTECTIVE CLOTHING, AND MECHANICAL VENTILATION OR RESPIRATORY PROTECTION. USE EYE PROTECTION. KEEP THE SOLVENTS AWAY FROM SOURCES OF HEAT, FIRE, OR SPARKS. AN EXPLOSION COULD OCCUR.

(WARNING PRECEDES)

CAUTION: DO NOT USE PAINT STRIPPERS TO REMOVE FINISH. PAINT STRIPPERS WILL CAUSE DAMAGE TO THE RESIN SYSTEM. WHEN THE SURFACE IS SANDED, FIBERS IN THE COMPOSITE OR THE SURFACE BELOW THE BARE COMPOSITE MUST NOT BE DAMAGED OR PERMITTED TO BE OPEN TO THE AIR. A DECREASE IN THE STRUCTURAL STRENGTH OF THE COMPONENT WILL OCCUR. FIBERS WHICH HAVE NO PROTECTION OR ARE DAMAGED MUST BE REPAIRED.

(2) Use No. 240 or finer Scotch-Brite or abrasive paper to remove cracks in the finish. Total removal of the top layer of finish is recommended but not necessary. Do not sand into the fibers.

NOTE: The recommended abrasive is No. 240 Scotch-Brite.

(3) Use a clean cheesecloth to clean the area with a 50/50 mixture (by volume) of Methyl Ethyl Ketone (MEK) and Toluene, Turco 4460, MEK:SEC-butyl alcohol (42:58), FCC-55, MPK, BMS 11-7, CDG-110, or CDG-211. Wipe the area dry with a clean cheesecloth before the solvent dries.

(4) Apply a finish to the repair area. Refer to 51-70-17, GENERAL, Paragraph 2.H.

C. Permanent Repairs

(1) General

(a) There are two permanent repair alternatives. The first repair alternative uses BMS 5-95 that can be applied with a spray gun. This will seal the cracks so that water cannot get into the composite. The second repair alternative uses a BMS 9-3 wet layup. Refer to 51-30-03, GENERAL for the sources of repair materials.

(2) Alternative 1: BMS 5-95 Permanent Repair

(a) Find the level of damage.

WARNING: WHEN YOU WORK WITH SOLVENTS AND COMPOSITE MATERIALS, USE APPROVED GLOVES, PROTECTIVE CLOTHING, AND MECHANICAL VENTILATIN OR RESPIRATORY PROTECTION. USE EYE PROTECTION. KEEP THE SOLVENTS AWAY FROM SOURCES OF HEAT, FIRE, OR SPARKS. AN EXPLOSION COULD OCCUR.

(WARNING PRECEDES)

CAUTION: DO NOT USE PAINT STRIPPERS TO REMOVE FINISH. PAINT STRIPPERS WILL CAUSE DAMAGE TO THE RESIN SYSTEM. WHEN THE SURFACE IS SANDED, FIBERS IN THE COMPOSITE OR THE SURFACE BELOW THE BARE COMPOSITE MUST NOT BE DAMAGED OR PERMITTED TO BE OPEN TO THE AIR. A DECREASE IN THE STRUCTURAL STRENGTH OF THE COMPONENT WILL OCCUR. FIBERS WHICH HAVE NO PROTECTION OR ARE DAMAGED MUST BE REPAIRED. WHEN YOU USE ALTERNATIVE MEDIA BLASTING PROCEDURES: THERE MUST BE NO FIBER DAMAGE WHEN A 10X MAGNIFIER IS USED. AFTER THE FINISH IS REMOVED, DO AN ULTRASONIC THROUGH TRANSMISSION TEST. REFER TO NDT PART 4, 51-00-03.

(b) Remove all finishes to the graphite composite surface. Use No. 240 or finer Scotch-Brite or abrasive paper to remove the finishes. Do not sand into the fibers.

NOTE: The recommended abrasive is No. 240 Scotch-Brite.

Use of alternative media blasting procedures for finish removal is structurally satisfactory. The procedure must agree with the requirements given in D6-55564, "Requirements for Alternative Paint Stripping Processes".

(c) Use a clean cheesecloth to clean the area with an applicable material. Refer to SOPM 20-30-03. Wipe the area dry with a clean cheesecloth before the solvent dries.

(d) There are two alternatives to find the level of damage:

1) Use a 10X magnifier to examine the bare composite surface for surface cracks.

2) Apply pinhole filler to the bare composite surface. Use a tool with a rigid, flat edge to remove the unwanted filler.

(e) There are cracks in the surface below the bare composite:

1) If you see a white pattern on the surface.

2) If that pattern did not occur when the surface was sanded.

(f) If there are no cracks, apply a finish to the repair area. Refer to 51-70-17, GENERAL, Paragraph 2.H.

(g) If there are cracks, continue the procedure.

(h) Mix BMS 5-95 Class F spray sealant base and accelerator to a ratio of 15 to 1 by weight (a ratio of 100 to 6.9 by volume). Add 20 percent of a 50/50 (by volume) mixture of MEK and Toluene to make the mixture thinner. The pot life of the material mixture is 1.5 hours at 75°F (24°C).

(i) Wipe the repair surface clean. Use BMS 11-7, BMS 11-9, Grade 2 (MPK), or a 50/50 mixture of MEK and Toluene. Use an air spray at a minimum of 50 psi to apply two layers of BMS 5-95 to the repair surface. Each layer must be applied continuously to a wet film thickness of 0.005-0.008 of an inch. Let the surface dry in the air for 15 minutes after the first layer is applied.

The dry film thickness of the two layers must be 0.006-0.010 of an inch.

(j) Let the surface dry for a minimum of 2 hours at 60-130°F (16-54°C) after the second layer is applied.

(k) Apply a finish to the repair area. Refer to 51-70-17, GENERAL, Paragraph 2.H. The use of primer is not necessary.

(3) Alternative II: BMS 8-301/BMS 9-3 Fiberglass Wet Layup Permanent Repair (Method 1)

(a) Find the level of damage.

WARNING: WHEN YOU WORK WITH SOLVENTS AND COMPOSITE MATERIALS, USE APPROVED GLOVES, PROTECTIVE CLOTHING, AND MECHANICAL VENTILATION OR RESPIRATORY PROTECTION. USE EYE PROTECTION. KEEP THE SOLVENTS AWAY FROM SOURCES OF HEAT, FIRE, OR SPARKS. AN EXPLOSION COULD OCCUR.

CAUTION: DO NOT USE PAINT STRIPPERS TO REMOVE FINISH. PAINT STRIPPERS WILL CAUSE DAMAGE TO THE RESIN SYSTEM. WHEN THE SURFACE IS SANDED, FIBERS IN THE COMPOSITE OR THE SURFACE BELOW THE BARE COMPOSITE MUST NOT BE DAMAGED OR PERMITTED TO BE OPEN TO THE AIR. A DECREASE IN THE STRUCTURAL STRENGTH OF THE COMPONENT WILL OCCUR. FIBERS WHICH HAVE NO PROTECTION OR ARE DAMAGED MUST BE REPAIRED. WHEN YOU USE ALTERNATIVE MEDIA BLASTING PROCEDURES: THERE MUST BE NO FIBER DAMAGE WHEN A 10X MAGNIFIER IS USED. AFTER THE FINISH IS REMOVED, DO AN ULTRASONIC THROUGH TRANSMISSION TEST. REFER TO NDT PART 4, 51-00-03.

(b) Remove all finishes from the graphite composite surface. Use No. 240 or finer Scotch-Brite or abrasive paper to remove the finishes. Do not sand into the fibers.

NOTE: The recommended abrasive is No. 240 Scotch-Brite.

Use of alternative media blasting procedures for finish removal is structurally satisfactory. The procedure must agree with the requirements given in D6-55564, "Requirements for Alternative Paint Stripping Processes".

(c) Use a clean cheesecloth to clean the area with an applicable material. Refer to SOPM 20-30-03. Wipe the area dry with a clean cheesecloth before the solvent dries.

(d) There are two alternatives to find the level of damage:

1) Use a 10X magnifier to examine the bare composite surface for surface cracks.

2) Apply pinhole filler to the bare composite surface. Use a tool with a rigid, flat edge to remove the unwanted filler.

(e) There are cracks in the surface below the bare composite:

1) If you see a white pattern on the surface.

2) If that pattern did not occur when the surface was sanded.

(f) If there are no cracks, apply a finish to the repair area. Refer to 51-70-17, GENERAL, Paragraph 2.H.

(g) If there are cracks, continue the procedure.

(h) Cut a piece of BMS 9-3 Style 120 fiberglass as large as the tool side surface area to be repaired. Weigh the piece of fiberglass. This is the weight of laminating resin necessary to impregnate the fabric.

(i) Weigh out the quantity of resin calculated in Paragraph 8.C.(3)(h). This resin must be used less than 2 hours after it is mixed.

(j) Mix the BMS 8-301 Class 1 (Hysol EA 9390A) or BMS 8-301 Class 2 (FR 7020) resin (part A) and hardener (part B) to the proportions given in the manufacturer’s instructions. Mix Parts A and B by hand for 2 to 3 minutes to cause a constant mixture.

(k) Brush-apply an initial thin layer of resin to fill in any cracks or areas that have been pushed in.

(l) Apply the BMS 9-3 Style 120 fiberglass. Put the remaining resin over the fiberglass. Use a tool with a rigid, flat edge to equally apply the resin over the fiberglass. Put one layer of solid FEP parting film over the side of the repair area that the tool is used on. Use the tool to apply the resin as equally as possible. Remove as much porosity as possible.

Push the surface resin to the edges.

(m) Vacuum bag the repair. Refer to 51-70-17, GENERAL, Paragraph 2.F. for Class 1 resin. Refer to 51-70-03, GENERAL, Paragraph 3.F. for Class 2 resin.

(n) Cure the repair. Refer to 51-70-17, GENERAL, Paragraph 2.G. for Class 1 resin. Refer to 51-70-03, GENERAL, Paragraph 3.G. for Class 2 resin.

NOTE: It is optional to cure the Class 1 resin repair at 180 ±10°F (82° ±6°C).

(o) Visually examine the repair for porosity on the surface.

(p) If there is porosity on the surface, make the surface rough with No. 240 or finer Scotch-Brite or abrasive paper. Apply resin to the surface. Use a tool with a rigid, flat edge to equally apply the resin. Cure the resin. Refer to 51-70-03, GENERAL, Paragraph 3.G. for Class 2 resin.

(q) Apply a finish to the repair area. Refer to 51-70-17, GENERAL, Paragraph 2.H. for Class 1 resin. Refer to 51-70-03, GENERAL, Paragraph 3.H. for Class 2 resin.

(4) Alternative II: BMS 8-301/BMS 903 Fiberglass Wet Layup Permanent Repair (Method 2)

(a) Find the level of damage.

WARNING: WHEN YOU WORK WITH SOLVENTS AND COMPOSITE MATERIALS, USE APPROVED GLOVES, PROTECTIVE CLOTHING, AND MECHANICAL VENTILATION OR RESPIRATORY PROTECTION. USE EYE PROTECTION. KEEP THE SOLVENTS AWAY FROM SOURCES OF HEAT, FIRE, OR SPARKS. AN EXPLOSION COULD OCCUR.

CAUTION: DO NOT USE PAINT STRIPPERS TO REMOVE FINISH. PAINT STRIPPERS WILL CAUSE DAMAGE TO THE RESIN SYSTEM. WHEN THE SURFACE IS SANDED, FIBERS IN THE COMPOSITE OR THE SURFACE BELOW THE BARE COMPOSITE MUST NOT BE DAMAGED OR PERMITTED TO BE OPEN TO THE AIR. A DECREASE IN THE STRUCTURAL STRENGTH OF THE COMPONENT WILL OCCUR. FIBERS WHICH HAVE NO PROTECTION OR ARE DAMAGED MUST BE REPAIRED. WHEN YOU USE ALTERNATIVE MEDIA BLASTING PROCEDURES: THERE MUST BE NO FIBER DAMAGE WHEN A 10X MAGNIFIER IS USED. AFTER THE FINISH IS REMOVED, DO AN ULTRASONIC THROUGH TRANSMISSION TEST. REFER TO NDT PART 4, 51-00-03.

(b) Remove all finishes to the graphite composite surface. Use No. 240 or finer Scotch-Brite or abrasive paper to remove the finishes. Do not sand into the fibers.

NOTE: The recommended abrasive is No. 240 Scotch-Brite.

Use of alternative media blasting procedures for finish removal is structurally satisfactory. The procedure must agree with the requirements given in D6-55564, "Requirements for Alternative Paint Stripping Processes".

(c) Use a clean cheesecloth to clean the area with acetone, BMS 11-7, MEK, BMS 11-9, Grade 2 (MPK), or a 50/50 mixture (by volume) of Methyl Ethyl Ketone (MEK) and Toluene. Wipe the area dry with a clean cheesecloth before the solvent dries.

(d) There are two alternatives to find the level of damage:

1) Use a 10X magnifier to examine the bare composite surface for surface cracks.

2) Apply pinhole filler to the bare composite surface. Use a tool with a rigid, flat edge to remove the unwanted filler.

(e) There are cracks in the surface below the bare composite:

1) If you see a white pattern on the surface.

2) If that pattern did not occur when the surface was sanded.

(f) If there are no cracks, apply a finish to the repair area. Refer to 51-70-17, GENERAL, Paragraph 2.H.

(g) If there are cracks, continue the procedure.

(h) Cut one piece of fabric the same dimension as the repair area. Cut two pieces of solid parting film, making them 3 inches larger than the fabric.

(i) Put one piece of solid parting film on a smooth surface. Hold the solid parting film to the surface with the tape.

(j) Weigh the fabric to be impregnated. Multiply the weight by 1.3. This is the weight of 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.

(k) Mix the BMS 8-301 Class 1 (Hysol EA 9390A) or BMS 8-301 Class 2 (FR 7020) resin (part A) and hardener (part B) to the proportions given in the manufacturer's instructions. Mix Parts A and B by hand for 2 to 3 minutes to cause a constant mixture.

(l) Put half of the laminating resin in the center of the solid parting film.

(m) Put the fabric above the solid parting film and laminating resin.

(n) Put the remaining laminating resin over fabric in the center.

(o) Put the second piece of solid parting film above the fabric. Make sure the solid parting film is smooth.

(p) Sweep the resin from the center to the edge of the fabric. Make the resin and fabric smooth. Keep all of the resin in the fabric.

(q) Transfer the repair fabric to the structure.

(r) Vacuum bag the repair. Refer to 51-70-17, GENERAL, Paragraph 2.F. for Class 1 resin. Refer to 51-30-03, GENERAL, Parageaph 3.F. for Class 2 resin.

(s) Cure the repair. Refer to 51-70-17, GENERAL, Paragraph 2.G. for Class 1 resin. Refer to 51-70-03, GENERAL, Paragraph 3.G. for Class 2 resin.

NOTE: It is optional to cure the Class 1 resin repair at 180 ±10°F (82 ±6°C).

(t) Visually examine the repair for porosity on the surface.

(u) If there is porosity on the surface, make the surface rough with No. 240 or finer Scotch-Brite or abrasive paper. Apply resin to the surface. Use a tool with a rigid, flat edge to equally apply the resin. Cure the resin. Refer to 51-70-03, GENERAL, Paragraph 3.G. for class 2 resin.

(v) Apply a finish to the repair area. Refer to51-70-17, GENERAL, Paragraph 2.H. for Class 1 resin. Refer to 51-70-03, GENERAL, Paragraph . 3.H. for Class 2 resin.

MATERIAL	TREATMENT OF MATING SURFACES OTHER THAN THOSE TO BE BONDED OR SITUATED IN INTEGRAL FUEL TANKS, INCLUDING THOSE EXPOSED TO HYDRAULIC FLUID [B] [C]		SURFACES TO BE STRUCTURALLY BONDED	SURFACES IN INTEGRAL FUEL TANKS
	SIMILAR MATERIALS [A]	DISSIMILAR [A] MATERIALS [D]		
ALUMINUM ALLOYS [E]	CHEMICAL CONVERSION COAT (SEE PARAGRAPH 3) AND APPLY ONE COAT OF BMS 10-11, TYPE 1 PRIMER TO EACH SURFACE. APPLY TWO COATS FOR PARTS LOCATED BELOW THE PASSENGER FLOOR.	CHEMICAL CONVERSION COAT (SEE PARAGRAPH 3) AND APPLY TWO COATS OF BMS 10-11, TYPE 1 PRIMER TO EACH SURFACE. [F]	REFER TO SRM 51-70-09	REFER TO SRM 51-20-05
NON-CORROSION RESISTANT STEEL	CADMIUM PLATE (REFER TO COMPONENT MAINTENANCE CHAPTER 20) AND APPLY ONE COAT OF BMS 10-11, TYPE 1 PRIMER TO EACH SURFACE.	CADMIUM PLATE [G] (REFER TO COMPONENT MAINTENANCE CHAPTER 20) AND APPLY TWO COATS OF BMS 10-11, TYPE 1 PRIMER TO EACH SURFACE.		
CORROSION RESISTANT STEEL (CRES)	NONE REQUIRED	CADMIUM PLATE [G] (REFER TO COMPONENT MAINTENANCE CHAPTER 20) AND APPLY TWO COATS OF BMS 10-11, TYPE 1 PRIMER TO EACH SURFACE.		
MATERIALS LISTED IN FIGURE 2 GROUP IV OTHER THAN	NONE REQUIRED	APPLY TWO COATS OF BMS 10-11, TYPE 1 PRIMER TO EACH SURFACE.		
GRAPHITE	NONE REQUIRED	BOND ONE PLY OF FIBERGLASS FABRIC AND APPLY ONE COAT OF BMS 10-11 TYPE I PRIMER TO EACH SURFACE UP TO 4.0 INCHES AWAY FROM DISSIMILAR MATERIAL. PROTECT CUT EDGES WITHIN 4.0 INCHES OF DISSIMILAR MATERIAL WITH BMS-5-92 ADHESIVE.	REFER TO SRM 51-70-03, SRM 51-70-04, SRM 51-70-05, OR SRM 51-70-17	

Protective Treatment of Mating Surfaces
Figure 1 (Sheet 1 of 2)

NOTES

A REFER TO FIGURE 2 FOR GROUPING OF SIMILAR AND DISSIMILAR MATERIALS.

B ALL NON-BONDED FUSELAGE, WING, AND ENGINE PYLON SKIN FAYING SURFACES REQUIRE A FAYING SURFACE SEAL APPLIED ACCORDING TO SRM 51-20-05 IN ADDITION TO PRIMER.

C HYDRAULIC FLUID, FIRE RESISTANT, BMS 3-11

D ALL NON-BONDED FAYING SURFACES OF DISSIMILAR METALS REQUIRE A FAYING SURFACE SEAL APPLIED ACCORDING TO SRM 51-20-05 IN ADDITION TO PRIMER. FAY SEALED SURFACES REQUIRE ONLY ONE PRIMER COAT.

E WHEN PRACTICAL, IT IS PREFERABLE THAT BARE ALUMINUM SURFACES BE CHROMIC ACID ANODIZED. REFER TO SOPM 20-43-01.

F ALUMINUM ALLOYS IN CONTACT WITH GRAPHITE REQUIRE A CHEMICAL CONVERSION COATING TREATMENT, ONE COAT OF BMS 10-79 TYPE III PRIMER AND ONE COAT OF BMS 10-60 TYPE I ENAMEL. DO NOT USE CLAD 7075 IN CONTACT WITH GRAPHITE.

G CADMIUM PLATE IS NOT PERMITTED TO BE IN CONTACT WITH GRAPHITE MATERIAL AND TITANIUM ALLOYS.

Protective Treatment of Mating Surfaces
Figure 1 (Sheet 2 of 2)

GROUP I	MAGNESIUM AND ITS ALLOYS.
GROUP II	CADMIUM, CADMIUM-TITANIUM, ZINC-NICKEL, ZINC, ALUMINUM AND THEIR ALLOYS $\boxed{A}$.
GROUP III	IRON, STEELS (EXCEPT CRES), LEAD, TIN AND THEIR ALLOYS $\boxed{B}$. DIFFUSED NICKEL-CADMIUM.
GROUP IV	COPPER, CHROMIUM, NICKEL AND NICKEL ALLOYS, SILVER, GOLD, PLATINUM, TITANIUM AND TITANIUM ALLOYS. CORROSION RESISTANT STEEL $\boxed{B}$. COBALT ALLOYS. TUNGSTEN, COPPER-NICKEL, COPPER-BERYLLIUM, BRASS, BRONZE (ALUMINUM BRONZE OR ALUMINUM-NICKEL-BRONZE). GRAPHITE FIBER, FABRIC, OR TAPE $\boxed{C}$.
MEMBERS OF ANY ONE GROUP ARE SIMILAR. MEMBERS OF DIFFERENT GROUPS ARE DISSIMILAR.	

NOTES

$\boxed{A}$ EXCEPT FOR 5056 RIVETS DRIVEN IN 2024, 2224 OR 2324 ALUMINUM ALLOYS

$\boxed{B}$ CORROSION RESISTANT STEEL CONTAINS 14% OR MORE CHROMIUM

$\boxed{C}$ GRAPHITE IS AN ELECTRICALLY CONDUCTIVE MATERIAL EVEN THOUGH IT IS CLASSIFIED AS A NON-METAL

Classification of Dissimilar Materials
Figure 2

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 GRAPHITE
ALUMINUM EXCEPT 5056	A	B	C	C
ALUMINUM ALLOY 5056	B	D	C	C
CADMIUM OR ZINC PLATED ALLOY STEEL	A	B INTERIOR C EXTERIOR	B INTERIOR C EXTERIOR	C
CADMIUM OR ZINC PLATE - CRES	A	B INTERIOR A EXTERIOR	B INTERIOR A EXTERIOR	B E
CHROME PLATE	A	A	A	B
UNPLATED CORROSION RESISTANT STEEL	A	A	A	B
BMS 10-85 COATED NICKEL BASE ALLOYS	A	B INTERIOR A EXTERIOR	B INTERIOR A EXTERIOR	B
BMS 10-85 COATED TITANIUM OR CRES	A	B INTERIOR A EXTERIOR	B INTERIOR A EXTERIOR	B

NOTES

- REFER TO PARAGRAPH 6 FOR REQUIRED PROTECTIVE TREATMENT

A PROTECTIVE TREATMENT IS NECESSARY

B PROTECTIVE TREATMENT IS NOT NECESSARY

C NOT PERMITTED

D PROTECTIVE TREATMENT IS UNNECESSARY EXCEPT FOR 5056 RIVETS DRIVEN IN 2024, 2224 AND 2324 ALUMINUM ALLOYS

E NOT PERMITTED IN GRAPHITE MATERIAL

Protective Treatment for Fastener Installation
Figure 3

FUSELAGE (REFERENCE DRAWING 140T6000)	INTERIOR	1. ALL MONOCOQUE STRUCTURES INCLUDING DOORS. 2. UPPER SURFACE OF THE PRESSURE DECK ASSEMBLY. 3. FORWARD AND AFT SURFACES OF THE FORWARD PRESSURE BULKHEAD ASSEMBLY. 4. AFT SURFACES OF THE AFT WHEEL WELL BULKHEAD 5. ALL METALLIC INTERIOR SURFACES OF THE SECTION 48 MONOCOQUE FORWARD OF THE APU FIREWALL. 6. FORWARD AND AFT SURFACES OF THE AFT PRESSURE BULKHEAD ASSEMBLY.
	EXTERIOR	1. EXTERIOR SIDE OF MONOCOQUE SKIN UNDER THE WING TO BODY FAIRING. 2. WING/BODY FAIRING ATTACHMENT STRUCTURE. 3. EXTERIOR WHEEL WELL STRUCTURE (OPTIONAL) 4. INSIDE OF THE KEEL BEAM.
EMPENNAGE (REFERENCE DRAWING 170T3240, 180T3240)	INTERIOR	1. ALL INTERNAL SURFACES OF THE VERTICAL FIN AND HORIZONTAL STABILIZER AFT TORQUE BOX, FORWARD TORQUE BOX AND BULLNOSE.
	EXTERIOR	1. FIXED TRAILING EDGE CAVITY (VERTICAL FIN AND HORIZONTAL STABILIZER)
WING CENTER SECTION (REFERENCE DRAWING 110T3103)	INTERIOR	1. UPPER AND LOWER SURFACES OF UPPER AND LOWER PANEL ASSEMBLIES (RESPECTIVELY) EXCEPT UPPER PANEL COATED WITH SECONDARY FUEL BARRIER. 2. DRY BAYS 3. FORWARD SURFACES OF FRONT SPAR ASSEMBLY, AFT SURFACES BELOW LOWER PANEL ASSEMBLY ONLY. 4. AFT SURFACES OF THE REAR SPAR ASSEMBLY.
OUTBOARD WING (REFERENCE DRAWING 110T3103)	INTERIOR	1. DRY BAYS 2. WING TIP (EXCEPT RAKED TIP) 3. FLAPS 4. SLATS
	EXTERIOR	1. FORWARD AND AFT SURFACES OF FRONT AND REAR SPAR ASSEMBLIES (RESPECTIVELY) AND INCLUDES ENTIRE SPAR CAVITY.

The Application of Sovent-Dispersed Corrosion-Inhibiting Compounds to the Aircraft Structure During the Assembly of the Airplane
Figure 4

GENERAL - HEAT TREAT VERIFICATION - HARDNESS AND CONDUCTIVITY TESTING

1. Applicability

A. This subject gives the procedures to verify the heat treat condition of metal. This section also gives a description of some of the equipment necessary for this testing and the applicable vendor data.

B. The information in this subject can be found in Boeing Process Specifications BAC5617 and BAC5946.

NOTE: Refer to Boeing Process Specification BAC5602 for heat treatment of aluminum alloys. Refer to Boeing Process Specification BAC5617 for heat treatment of alloy steels. Refer to Boeing Process Specification BAC5619 for heat treatment of corrosion resistant steel.

2. General

A. As an alternative to the procedure that follows, you can refer to NDT Part 6, 51-00-18 or BAC 5650.

B. The heat treat condition of materials can be identified by running comparative tests with samples of known conditions. Heat treat identification can be made with portable hardness testers which depress the part being tested or with eddy current conductivity tests. Both types of tests require access to only one side of the test part. In many cases, hardness tests alone do not always give satisfactory results and should be used in conjunction with conductivity tests, especially when assessing fire-damaged structure. Refer to 51-20-03, GENERAL for Fire Damage Evaluation.

NOTE: The portable hardness testers are not for acceptance testing of materials.

C. The portable hardness testers that follow, require access to only one side of the part. (Refer to Figure 1/GENERAL.)

(1) New Age Rockmate from New Age Industries, Willow Grove, PA (Detail I). The Rockmate can take readings in various hardness scales for use on both aluminum and steel. The Rockmate is the most accurate of the listed instruments.

(2) The Microdur from Krautkramer Branson, Lewiston, PA (Detail II). The Microdur can take readings in the Rockwell B (aluminum), and C (steel) scales.

(3) New Age MRD1 (formerly Ernst Portable Hardness Tester models RAR and RBR), from New Age Industries (Detail III). The MRD1 can take readings in the Rockwell A (steel) and B (aluminum) scales. It requires samples of known hardness for calibration.

(4) Barcol Tester from Barber-Coleman Co., Rockford, IL (Detail IV). The Barcol Tester does not give a direct hardness number. It does give a dial reading which must be compared to a dial reading taken on a sample of known hardness. The Barcol is not recommended for use on steel because of its limited dial range for hard materials.

3. References

Reference	Title
51-20-03, GENERAL	Fire Damage Evaluation
BAC 5650	Hardness Testing
NDT Part 6, 51-00-18	Electrical Conductivity Measurement for Aluminum

4. Procedure

A. Carry out hardness tests using the portable hardness tester as follows:

(1) Remove any protective finishes from an area approximately 1/2 inch in diameter to gain access to the bare metal.

CAUTION: GRINDING MUST NOT BE USED TO REMOVE PLATING MATERIALS. CHROMIUM OR NICKEL PLATING MAY HAVE BEEN EMPLOYED. IF PLATING RESISTS REMOVAL, REMOVE USING STANDARD METHODS AND PROCEDURES. IF NECESSARY, POSITIVELY IDENTIFY THE PLATING AS DESCRIBED IN SRM 51–10–02. DO NOT CHEMICAL SPOT TEST IN AREAS WHERE PLATING IS REMOVED.

(2) Check calibration of instrument per manufacturers instructions.

NOTE: The ASTM specifications that follow give data for the test blocks that are used as reference standards. These test blocks can also be purchased from the manufacturer of the test equipment. ASTM E 10 Brinell Hardness of Metallic Materials ASTM E 18 Rockwell Hardness and Rockwell Superficial Hardness of Metallic Materials

(a) For direct readout instruments, compare the calibration with similar materials of known hardness.

(b) For Barcol instruments, find the scale acceptance limits on materials of known hardness.

CAUTION: AVOID SIDE THRUST ON POINT OF INDENTER WHEN APPLYING PRESSURE.

(3) Hold the indenter perpendicular to the surface and apply pressure.

(4) Take several readings over the surface of the structure being tested.

(5) See if the material meets the heat treat requirements of the metal. Refer to Figure 2/GENERAL for aluminum materials and Figure 3/GENERAL for steel materials

B. Eddy current and variable frequency conductivity methods may also be used to evaluate heat treat for aluminum materials. Refer to Figure 2/GENERAL.

(1) Detailed procedures for the use of conductivity testing (equipment required, test area preparation, instrument calibration, inspection procedure) to evaluate the heat treat condition of aluminum are contained in NDT Part 6, 51-00-18.

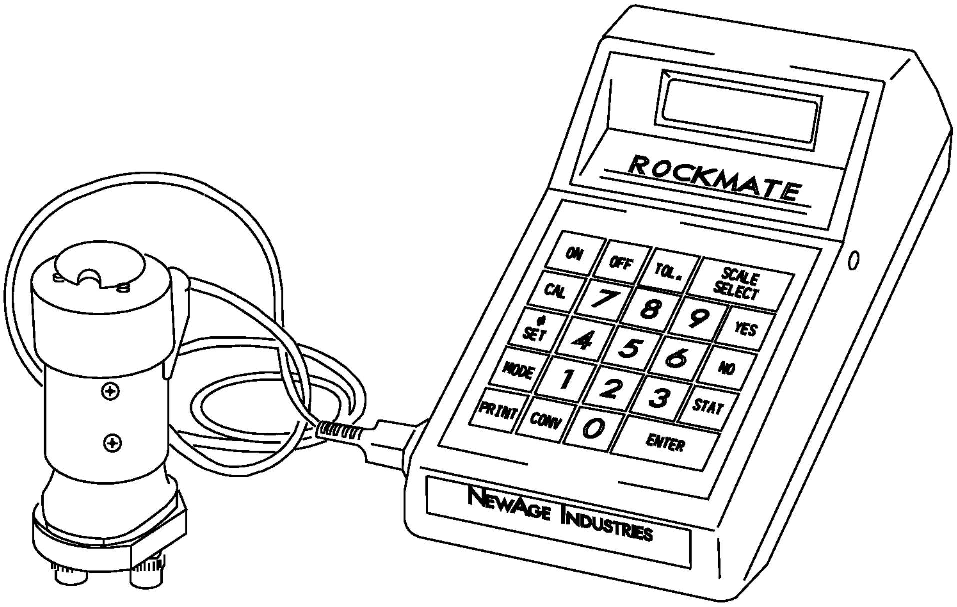
(2) Find the conductivity values (percent IACS) for the material to be tested.

C. Use these precautions when you use the portable hardness testers to prevent further damage to existing structures:

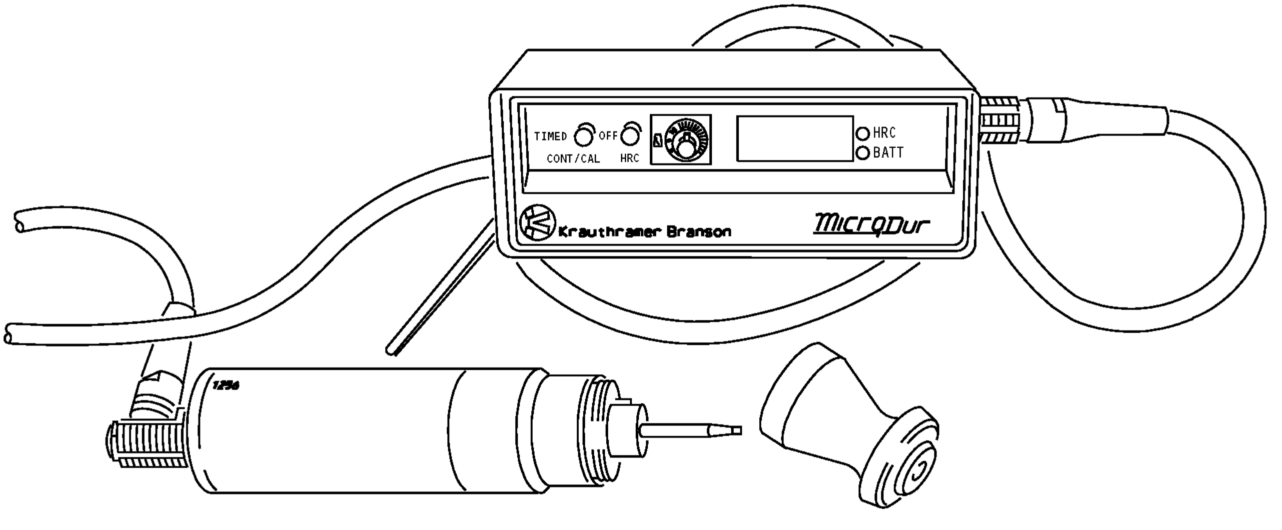
(1) Do not use these testers on material which is too thin to prevent distortion of the test piece under the impact of the indenter. Carry out tests on comparative samples.

(2) Do not apply the indenter too near the edge of material. Buckling can occur.

(3) Before you test clad aluminum alloys, remove the clad material from the areas to be tested. The pure aluminum of the clad surface will cause the indicated hardness values to be different from the specified values.

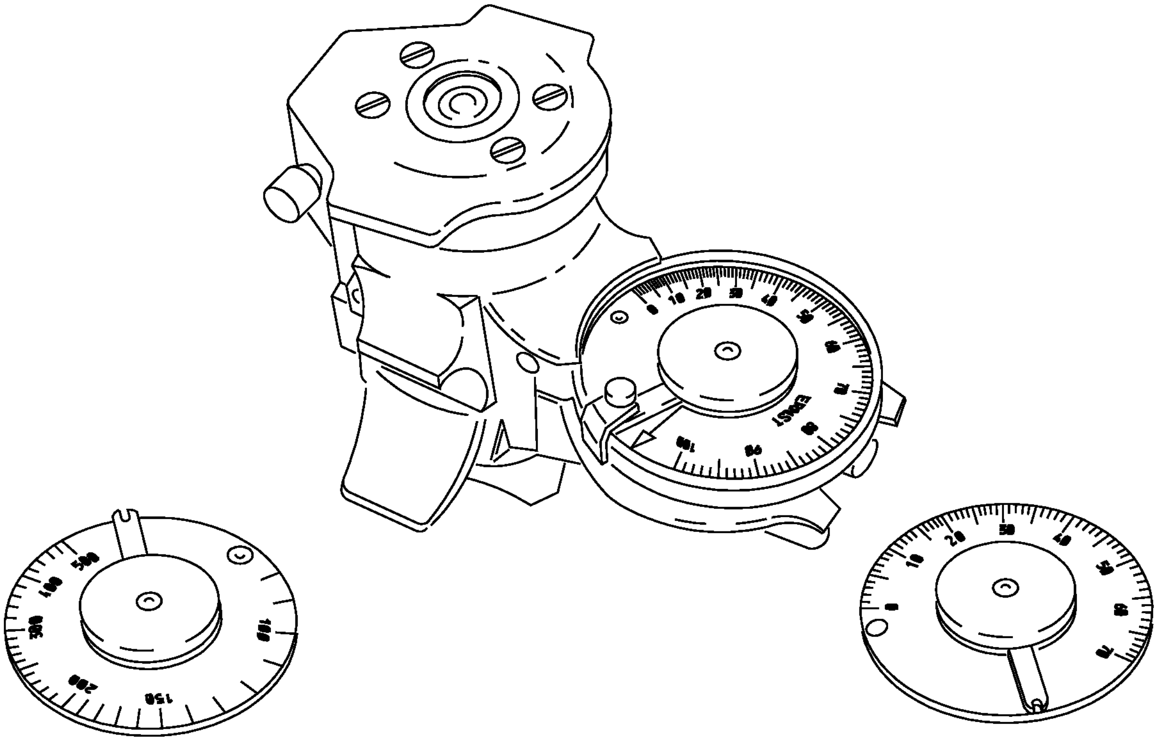


NEW AGE ROCKMATE
DETAIL I

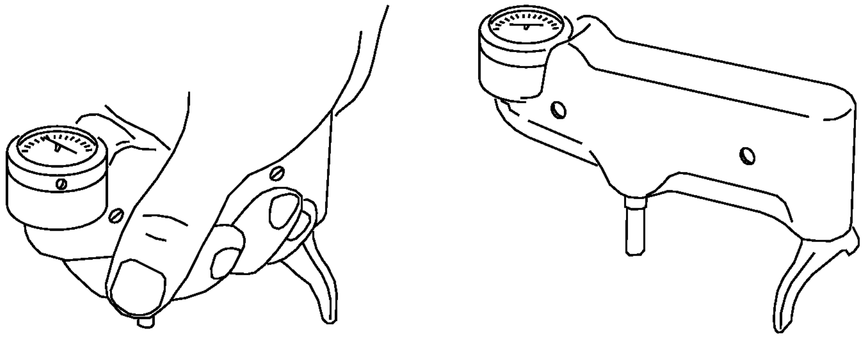


MICRODUR
DETAIL II

Portable Hardness Testers
Figure 1 (Sheet 1 of 2)



NEW AGE MRD1
DETAIL III



BARCOL PORTABLE HARDNESS TESTER
DETAIL IV

Portable Hardness Testers
Figure 1 (Sheet 2 of 2)

NOTES

- THE SOURCE OF INFORMATION FOR THIS FIGURE CAN BE FOUND IN BOEING PROCESS SPECIFICATION BAC5946
- MECHANICAL HARDNESS TESTING PROCEDURES MUST BE DONE ON A NON-CLAD SURFACE. IF ALL SURFACES OF A PART HAVE AN ALUMINUM CLAD COATING, THEN THE CLAD MUST BE REMOVED FROM THE TEST AREA.

A 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. IF THE SURFACE IS NOT FLAT, A CORRECTION FACTOR IS REQUIRED. REFER TO BSS7351 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, 51-00-18 FOR THE DETAILED PROCEDURE ON ELECTRICAL CONDUCTIVITY MEASUREMENTS FOR ALUMINUM. FOR ADDITIONAL INFORMATION ON EDDY CURRENT TESTING OF ALUMINUM ALLOYS REFER TO BOEING PROCESS SPECIFICATIONS BAC5946 AND BSS7351, OR ASK BOEING.

B VALID ONLY FOR PARTS WHICH HAVE BEEN SUPERPLASTIC FORMED (SPF) AND HEAT TREATED.

C CONDUCTIVITY MAXIMUM FOR 2024 RIVETS IS 33.5 PERCENT IACS.

D CONDUCTIVITY VALUES ARE FOR INFORMATION ONLY AND MUST NOT BE USED FOR REJECTION OF AL-LI ALLOYS.

E USE THE BRINELL (500KG) SCALE FOR HARDNESS TESTING. REFER TO BAC5650.

F UNLESS OTHERWISE SPECIFIED, DO NOT TEST WELDED PARTS IN WELD BEAD OR ADJACENT HEAT-AFFECTED AREA WHEN WELDED IN THE -T4 OR -W CONDITION AND SUBSEQUENTLY AGED TO THE -T6 CONDITION.

G IT IS POSSIBLE THAT ADDITIONAL RESTRICTIONS OR QUALIFICATIONS ARE IN BAC5602 OR THE MATERIAL SPEC- IFICATIONS FOR THE OVERAGED TEMPERS (T73, T73XX, T74XX, T76XX) OF THESE ALLOYS. TENSILE YIELD STRENGTH CAN LIMIT ACCEPTANCE OF MATERIALS THAT HAVE CONDUCTIVITY AND HARDNESS WITHIN THE ABOVE RANGES. REFER TO THE APPLICABLE SPECIFICATION.

H 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.

I TEMPER - T74XX (WAS DESIGNATED 767T736XXX)

J 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 BAC5602.
- 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).

(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.

Hardness and Conductivity Values of Aluminum Materials
Figure 2 (Sheet 1 of 9)

NOTES (CONT'D)

$\boxed{K}$ ELECTRICAL CONDUCTIVITY FOR 7050-T76XXX IN THE RANGE OF 37.0 TO 44.0 IS PERMITTED UNLESS:

- YOU VERIFY MATERIAL RESPONSE TO A SOLUTION HEAT TREATMENT AND AGING AS SPECIFIED IN BAC5602.
- 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) BAC5602: 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.

$\boxed{L}$ THE MINIMUM PERMITTED CONDUCTIVITY READING ON MACHINED SURFACES OF 7075-T7751 MUST BE 34.5 PERCENT IACS.

$\boxed{M}$ HARDNESS MUST BE MEASURED ON SURFACES WHICH ARE BETWEEN 1T/4 AND 3T/4 OF THE SOLUTION HEAT TREATED THICKNESS.

$\boxed{N}$ 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.

$\boxed{O}$ SUB-TEMPERS OF THE ALLOYS AND TEMPERS THAT FOLLOW DO NOT SHOW IMPORTANT DIFFERENCES TO PERMIT SEPARATION BY HARDNESS ALONE. FOR EXAMPLE, 2024-T3511 OT 7075-T73511 ARE INSPECTED TO THE VALUES SHOWN FOR 2024-T3 AND 7075-T73, RESPECTIVELY.

Hardness and Conductivity Values of Aluminum Materials
Figure 2 (Sheet 2 of 9)

ALLOY AND TEMPER		CONDUCTIVITY (PERCENT IACS) [A]		ROCKWELL HARDNESS			
		MINIMUM	MAXIMUM	SCALE	THICKNESS RANGE (INCH)	MINIMUM	MAXIMUM
1100	H42	---	---	E 15T	0.060 AND UP 0.026 TO 0.059	18 36.5	48 53.5
2004 [B]	T62	38.0	42.0	B 15T	0.040 AND UP 0.026 TO 0.039	55 78.5	75 85
2014	0	48.5	51.0	E 15T	0.060 AND UP 0.026 TO 0.059	--- ---	60.0 60.5
	T3XX	31.5	35.0	B 15T	0.040 AND UP 0.026 TO 0.039	68 82.5	80 86.5
	T4XXX	31.5	35.0	B 15T	0.040 AND UP 0.026 TO 0.039	68 82.5	80 86.5
	T6XXX	35.0	40.0	B 15T	0.040 AND UP 0.026 TO 0.039	78.5 86	89.5 89.5
2017	0	48.5	51.0	E 15T	0.060 AND UP 0.026 TO 0.059	--- ---	50 54
	T4XXX	31.5	35.0	B 15T	0.040 AND UP 0.026 TO 0.039	68 82.5	80 86.5
2024	0	45.5	49.0	E 15T	0.060 AND UP 0.026 TO 0.059	--- ---	62 61.5
	T3XXX	28.5	32.0	B 15T	0.040 AND UP 0.026 TO 0.039	63 81	83.5 88
	T4X	28.5	32.0 [C]	B 15T	0.040 AND UP 0.026 TO 0.039	63 81	83.5 87
	T6X	36.0	40.0	B 15T	0.040 AND UP 0.026 TO 0.039	72 84	86 88.5
	T8XXX	38.0	42.0	B 15T	0.040 AND UP 0.026 TO 0.039	74 84.5	86 88.5
2094 [D]	T3X	16.0	18.5	B 15T	0.040 AND UP 0.026 TO 0.039	34 69	49 74.5
	T83X	16.0	18.5	B 15T	0.040 AND UP 0.026 TO 0.039	80 86.5	90 90
	T86X	16.0	18.5	B 15T	0.040 AND UP 0.026 TO 0.039	80 86.5	90 90
2124	T8XXX	38.0	42.0	B 15T	0.040 AND UP 0.026 TO 0.039	74 84.5	86 88.5

CONDUCTIVITY AND HARDNESS ACCEPTANCE LIMITS
TABLE I

Hardness and Conductivity Values of Aluminum Materials
Figure 2 (Sheet 3 of 9)

ALLOY AND TEMPER		CONDUCTIVITY (PERCENT IACS) [A]		ROCKWELL HARDNESS			
		MINIMUM	MAXIMUM	SCALE	THICKNESS RANGE (INCH)	MINIMUM	MAXIMUM
2219	0	44.0	49.0	E 15T	0.060 AND UP 0.026 TO 0.059	--- ---	70 66
	T3XXX	26.0	31.0	B 15T	0.040 AND UP 0.026 TO 0.039	64.5 81.5	--- ---
	T37	27.0	31.0	B 15T	0.040 AND UP 0.026 TO 0.039	65.5 82	--- ---
	T4X	28.0	32.0	B 15T	0.040 AND UP 0.026 TO 0.039	61 80.5	--- ---
	T6X	32.0	35.0	B 15T	0.040 AND UP 0.026 TO 0.039	65.5 82	--- ---
	T8XXX	31.0	35.0	B 15T	0.040 AND UP 0.026 TO 0.039	73 84.5	--- ---
	T87	31.0	35.0	B 15T	0.040 AND UP 0.026 TO 0.039	77 85.5	--- ---
2224	T3511	29.5	33.5	B 15T	0.040 AND UP 0.026 TO 0.039	70 83.5	83.5 88
2324	T39	29.0	32.0	B 15T	0.040 AND UP 0.026 TO 0.039	77 85.5	86 88.5
2524 (C188)	T3XXX	28.5	32.0	B 15T	0.040 AND UP 0.026 TO 0.039	63 81	83.5 88
3003	0	44.5	50.5	H	---	---	65
5052	0	34.0	37.0	E 15T	0.060 AND UP 0.026 TO 0.059	--- ---	70 66
	H34	34.0	37.0	E 15T	0.060 AND UP 0.026 TO 0.059	66 64	--- ---
5083	0	---	---	E 15T	0.060 AND UP 0.026 TO 0.059	--- ---	75 69.5
	HXX	---	---	E 15T	0.060 AND UP 0.026 TO 0.059	80 72	--- ---
5154	0	---	---	E 15T	0.060 AND UP 0.026 TO 0.059	--- ---	51 55
	HXX	---	---	E 15T	0.060 AND UP 0.026 TO 0.059	55 57.5	80 72

CONDUCTIVITY AND HARDNESS ACCEPTANCE LIMITS
TABLE I (CONT)

Hardness and Conductivity Values of Aluminum Materials
Figure 2 (Sheet 4 of 9)

ALLOY AND TEMPER		CONDUCTIVITY (PERCENT IACS) $\boxed{A}$		ROCKWELL HARDNESS			
		MINIMUM	MAXIMUM	SCALE	THICKNESS RANGE (INCH)	MINIMUM	MAXIMUM
5456	0	---	---	$\boxed{E}$	---	---	70
	H112	---	---	$\boxed{E}$	---	70	---
	H311	---	---	$\boxed{E}$	---	75	---
	H321	---	---	$\boxed{E}$	---	90	---
	H323	---	---	$\boxed{E}$	---	90	---
	H343	---	---	$\boxed{E}$	---	94	---
6013	T4X	37.0	40.0	B 15T	0.040 AND UP 0.026 TO 0.039	41 74	60 80
	T6X	41.0	46.5	B 15T	0.040 AND UP 0.026 TO 0.039	64 79.5	79 86
6061	0	47.0	56.0	E 15T	0.060 AND UP 0.026 TO 0.059	--- ---	25 40.5
	T4XXX	36.0	45.5	E 15T	0.060 AND UP 0.026 TO 0.059	64 63	--- ---
	T42	36.0	45.5	E 15T	0.060 AND UP 0.026 TO 0.059	60 60.5	--- ---
	T6XXX $\boxed{F}$	40.0	51.0	B 15T	0.060 AND UP 0.026 TO 0.059	47 76	80 86.5
6063	0	57.0	65.0	H	---	---	70
	T1X	48.0	58.0	E 15T	0.060 AND UP 0.026 TO 0.059	37 47.5	--- ---
	T4X	48.0	58.0	E 15T	0.060 AND UP 0.026 TO 0.059	40 49	--- ---
	T5X	50.0	60.0	E 15T	0.060 AND UP 0.026 TO 0.059	44 51	--- ---
	T6X	50.0	60.0	E 15T	0.060 AND UP 0.026 TO 0.059	70 66	--- ---
7049 $\boxed{G}$	0	44.0	50.0	E 15T	0.060 AND UP 0.026 TO 0.059	--- ---	70 66
	T73XXX	40.0	44.0	B 15T	0.040 AND UP 0.026 TO 0.039	82 87	--- ---

CONDUCTIVITY AND HARDNESS ACCEPTANCE LIMITS
TABLE I (CONT)

Hardness and Conductivity Values of Aluminum Materials
Figure 2 (Sheet 5 of 9)

ALLOY AND TEMPER		CONDUCTIVITY (PERCENT IACS) A		ROCKWELL HARDNESS			
		MINIMUM	MAXIMUM	SCALE	THICKNESS RANGE (INCH)	MINIMUM	MAXIMUM
7050	0	44.0	50.0	E 15T	0.060 AND UP 0.026 TO 0.059	--- ---	70 66
	T735XX H	41.0	44.0	B 15T	0.040 AND UP 0.026 TO 0.039	82 87	92 90.5
	T74XX I J	40.0	44.0	B 15T	0.040 AND UP 0.026 TO 0.039	82 87	92 90.5
	T76XX K	39.0	44.0	B 15T	0.040 AND UP 0.026 TO 0.039	84 88	94 91.5
7055	T7751	35.5 L	38.0	B 15T	0.040 AND UP 0.026 TO 0.039	90.5 90	98 92.5
	T77511	35.5	38.0	B 15T	0.040 AND UP 0.026 TO 0.039	91.5 90.5	98 92.5
7075 G	0	44.0	47.5	E 15T	0.060 AND UP 0.026 TO 0.059	--- ---	65 63.5
	T6XXX	30.0	35.0	B 15T	0.040 AND UP 0.026 TO 0.039	83.5 88	94 91.5
	T73XX	38.0	42.5	B 15T	0.040 AND UP 0.026 TO 0.039	79.5 86.5	89 89.5
	T73511	38.0	42.5	B B 15T	1.500 AND UP 0.040 TO 1.499 0.026 TO 0.039	78.5 79.5 86.5	89 89 89.5
	T76XXX	38.0	42.0	B 15T	0.040 AND UP 0.026 TO 0.039	82 87	91 90.5
7079	T6XX	30.0	33.5	E 15T	0.040 AND UP 0.026 TO 0.039	84 88	94 91.5
7150	T651	34.0	39.5	E 15T	0.040 AND UP 0.026 TO 0.039	90 90	98 92.5
	T651X T651XP	32.0	37.5	E 15T	0.040 AND UP 0.026 TO 0.039	90 90	98 92.5
	T77511	35.5	39.0	B B B B 15T	0.750 TO 2.500 0.500 TO 0.749 0.250 TO 0.499 0.040 TO 0.249 0.026 TO 0.039	92 91 90.5 90 90.5	98 98 98 98 92.5

CONDUCTIVITY AND HARDNESS ACCEPTANCE LIMITS
TABLE I (CONT)

Hardness and Conductivity Values of Aluminum Materials
Figure 2 (Sheet 6 of 9)

ALLOY AND TEMPER		CONDUCTIVITY (PERCENT IACS) $\boxed{A}$		ROCKWELL HARDNESS			
		MINIMUM	MAXIMUM	SCALE	THICKNESS RANGE (INCH)	MINIMUM	MAXIMUM
7175 $\boxed{G}$	0	44.0	47.5	E 15T	0.060 AND UP 0.026 TO 0.059	--- ---	65 63.5
	T6x	30.0	34.0	B 15T	0.040 AND UP 0.026 TO 0.039	85 88.5	94 91.5
	T74XXX	38.0	42.5	B 15T	0.040 AND UP 0.026 TO 0.039	82 87	93 91
7178	0	43.0	47.0	E 15T	0.060 AND UP 0.026 TO 0.059	--- ---	65 63.5
	T6XXX	29.5	33.0	B 15T	0.040 AND UP 0.026 TO 0.039	87.5 89	94 91.5
	T76XXX	38.0	42.0	B 15T	0.040 AND UP 0.026 TO 0.039	84 88	--- ---
7475 $\boxed{B}$	T6X	30.0	35.0	B 15T	0.040 AND UP 0.026 TO 0.039	83.5 88	94 91.5
	T76X	37.0	42.0	B 15T	0.040 AND UP 0.026 TO 0.039	82 87	91 90.5
8090 $\boxed{D}$	T3X	14.5	16.5	B 15T	0.040 AND UP 0.026 TO 0.039	30 70.5	50 77

CONDUCTIVITY AND HARDNESS ACCEPTANCE LIMITS
TABLE I (CONT)

Hardness and Conductivity Values of Aluminum Materials
Figure 2 (Sheet 7 of 9)

ALLOY, TEMPER PRODUCT FORM	SOLUTION HEAT TREATED THICKNESS (INCHES)	ROCKWELL HARDNESS $\boxed{M}$ $\boxed{N}$	
		MINIMUM	MAXIMUM
7075-T73 PLATE, FORGINGS	0 TO 3.000	79.5	89
	3.001 TO 4.000	76.5	89
	4.001 TO 5.000	75	89
	5.001 AND UP	74	89
7075-T7351 PLATE	0.250 TO 2.000	79.5	89
	2.001 TO 2.500	75.5	89
	2.501 TO 3.500	74	89
	3.501 AND UP	73	89
7075-T73511 EXTRUSION	3.000 AND UP, AREA LESS THAN 20 SQUARE INCHES	77.5	89
	3.000 AND UP, AREA GREATER THAN 20 SQUARE INCHES	75.5	89
7075-T7352 FORGINGS	0 TO 3.000	79.5	89
	3.001 TO 4.000	75	89
	4.001 TO 5.000	74	89
	5.001 AND UP	73	89
7175-T74 FORGINGS	0 TO 3.000	82	93
	3.001 TO 4.000	80.5	93
	4.001 TO 5.000	78.5	93
	5.001 AND UP	77	93
7175-T7452 FORGINGS	0 TO 3.000	82	93
	3.001 TO 4.000	78.5	93
	4.001 TO 5.000	76	93
	5.001 AND UP	74.5	93

CENTERLINE HARDNESS ACCEPTANCE LIMITS FOR MACHINED WROUGHT
ALUMINUM ALLOYS
TABLE II

Hardness and Conductivity Values of Aluminum Materials
Figure 2 (Sheet 8 of 9)

ALLOY, TEMPER AND THICKNESS O	ROCKWELL HARDNESS THROUGH CLAD N		
	SCALE	MINIMUM	MAXIMUM
2024-O			
-T3XXX			
0.040 TO 0.079	B	58	83.5
0.080 TO 0.125	B	55	83.5
-T4X			
0.026 TO 0.032	15T	81	87
0.033 TO 0.039	15T	79.5	87
0.040 TO 0.079	B	57	83.5
0.080 TO 0.125	B	54	83.5
-T6X			
0.026 TO 0.032	15T	84	88.5
0.033 TO 0.039	15T	82.5	88.5
0.040 TO 0.079	B	70	86
0.080 TO 0.125	B	64	86
-T8XXX			
0.026 TO 0.032	15T	84	88.5
0.033 TO 0.039	15T	83	88.5
0.040 TO 0.079	B	71	86
0.080 TO 0.125	B	68	86
2219-T62			
0.026 TO 0.032	15T	80	-
0.033 TO 0.039	15T	78.5	-
0.040 TO 0.079	B	53	-
0.080 TO 0.125	B	51	-
2524-T3XX (C188)			
0.026 TO 0.079	B	58	83.5
0.080 to 0.125	B	55	83.5
7075-O G			
-T6XXX			
0.026 TO 0.032	15T	88	91.5
0.033 TO 0.039	15T	86.5	91.5
0.040 TO 0.079	B	79	94
0.080 TO 0.125	B	75	94
-T73XXX			
0.026 TO 0.032	15T	86.5	89.5
0.033 TO 0.039	15T	85	89.5
0.040 TO 0.079	B	77	89
0.080 TO 0.125	B	74	89

HARDNESS ACCEPTANCE LIMITS FOR CLAD WROUGHT ALUMINUM ALLOYS
TABLE III

Hardness and Conductivity Values of Aluminum Materials
Figure 2 (Sheet 9 of 9)

NOTES

- THE SOURCE OF INFORMATION FOR THIS FIGURE CAN BE FOUND IN BOEING PROCESS SPECIFICATION BAC5617

	ROCKWELL		SUPERFICIAL ROCKWELL			VICKERS		BRINELL 10MM BALL 3000 KG	
TENSILE STRENGTH KSI	C (150 KG)	A (60 KG)	45N (45 KG)	30N (30 KG)	15N (15 KG)	136 DEG DIAMOND PYRAMID 10 KG	KNOOP DIAMOND 500 GRAMS	TUNGSTEN CARBIDE BALL	STEEL BALL
	72	88	79.5	87	94.5	1245	1024		
	71	87	78.5	86.5	94	1160	988		
	70	86.5	77.5	86	94	1076	972		
	69	86	76.5	85	93.5	1004	946		
	68	85.5	75.5	84.5	93	940	920		
	67	85	74	83.5	93	900	895		
	66	84.5	73	83	92.5	865	870		
	65	84	72	82	92	832	846		
	64	83.5	71	81	92	800	822		
	63	83	70	80	91.5	772	799		
	62	82.5	69	79	91	746	776		
	61	82	67.5	78.5	90.5	720	754		
	60	81	66.5	77.5	90	697	732		
	59	80.5	65.5	76.5	89.5	674	710		
	58	80	64	75.5	89.5	653	690	615	
	57	79.5	63	75	89	633	670	595	
	56	79	62	74	88.5	613	650	577	
301	55	78.5	61	73	88	595	630	560	
292	54	78	59.5	72	87.5	577	612	543	
283	53	77.5	58.5	71	87	560	594	525	
273	52	77	57.5	70.5	86.5	544	576	512	
264	51	76.5	56	69.5	86	528	558	496	
255	50	76	55	68.5	85.5	513	542	481	
246	49	75	54	67.5	85	498	526	469	
238	48	74.5	52.5	66.5	84.5	484	510	455	
229	47	74	51.5	66	84	471	495	442	442
221	46	73.5	50	65	83.5	458	480	432	432
215	45	73	49	64	83	446	466	421	421
208	44	72.5	48	63	82.5	434	452	409	409
201	43	72	46.5	62	82	423	438	400	400
194	42	71.5	45.5	61.5	81.5	412	426	390	390

CONVERSION OF HARDNESS TO TENSILE STRENGTH
TABLE I

Hardness Values of Steel Materials
Figure 3 (Sheet 1 of 3)

TENSILE STRENGTH KSI	ROCKWELL		SUPERFICIAL ROCKWELL			VICKERS 136 DEG DIAMOND PYRAMID 10 KG	KNOOP DIAMOND 500 GRAMS	BRINELL 10MM BALL 3000 KG	
	C (150 KG)	A (60 KG)	45N (45 KG)	30N (30 KG)	15N (15 KG)			TUNGSTEN CARBIDE BALL	STEEL BALL
188	41	71	44.5	60.5	81	402	414	381	381
182	40	70.5	43	59.5	80.5	392	402	371	371
177	39	70	42	58.5	80	382	391	362	362
171	38	69.5	41	57.5	79.5	372	380	353	353
166	37	69	39.5	56.5	79	363	370	344	344
161	36	68.5	38.5	56	78.5	354	360	336	336
156	35	68	37	55	78	345	351	327	327
152	34	67.5	36	54	77	336	342	319	319
149	33	67	35	53	76.5	327	334	311	311
146	32	66.5	33.5	52	76	318	326	301	301
141	31	66	32.5	51.5	75.5	310	318	294	294
138	30	65.5	31.5	50.5	75	302	311	286	286
135	29	65	30	49.5	74.5	294	304	279	279
131	28	64.5	29	48.5	74	286	297	271	271
128	27	64	28	47.5	73.5	279	290	264	264
125	26	63.5	26.5	47	72.5	272	284	258	258
123	25	63	25.5	46	72	266	278	253	253
119	24	62.5	24	45	71.5	260	272	247	247
117	23	62	23	44	71	254	266	243	243
115	22	61.5	22	43	70.5	248	261	237	237
112	21	61	20.5	42.5	70	243	256	231	231
110	20	60.5	19.5	41.5	69.5	238	251	226	226

CONVERSION OF HARDNESS TO TENSILE STRENGTH
TABLE I (CONT)

Hardness Values of Steel Materials
Figure 3 (Sheet 2 of 3)

TENSILE STRENGTH KSI	ROCKWELL				VICKERS 136 DEG DIAMOND PYRAMID 10 KG	KNOOP DIAMOND 500 GRAMS	BRINELL 10MM BALL 3000 KG	
	A (60 KG)	G (150 KG)	B (150 KG)	F (60 KG)			TUNGSTEN CARBIDE BALL	STEEL BALL
109	60	79	98		228	241	226	226
104	59.5	77.5	97		222	236	222	222
102	58.5	76	96		216	231	216	216
100	58	74	95		210	226	210	210
98	57.5	72.5	94		205	221	205	205
94	57	71	93		200	216	200	200
92	56.5	69	92		195	211	195	195
90	56	67.5	91		190	206	190	190
89	55.5	66	90		185	201	185	185
88	55	64	89		180	196	180	180
86	54	62.5	88		176	192	176	176
84	53.5	61	87		172	188	172	172
82	52.5	57.5	85		165	180	165	165
81	52	56	84		162	176	162	162
80	51	54	83		159	173	159	159
77	50.5	52.5	82		156	170	156	156
73	50	51	81		153	167	153	153
70	49	47.5	79		147	161	147	147
68	48	44	77		141	155	141	141
67	47	42.5	76		139	152	139	139
65	46	39	74	99	135	147	135	135
63	45	36	72	98	130	143	130	130
62	44	34.5	71	97.5	127	141	127	127
59	43	29.5	68	95.5	121	135	121	121
57	42	26.5	66	94.5	117	131	117	117
54	41.5	23.5	64	93.5	114	127	114	114

CONVERSION OF HARDNESS TO TENSILE STRENGTH
TABLE II

Hardness Values of Steel Materials
Figure 3 (Sheet 3 of 3)

GENERAL - FIRE DAMAGE EVALUATION

1. Applicability

A. This subject 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 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, GENERAL	Heat Treat Verification - Hardness and Conductivity Testing
CPM 20-42-00	Corrosion Removal Techniques - Procedure After Fire Damage
NDT Part 1, 51-01-03	NDT Assessment of Lightning Strike Damage to Graphite / Epoxy Composite Structure
NDT Part 6, 51-00-03	Fire Damage on Aircraft Structure Investigation

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 NDT Part 6, 51-00-03.

    (b) Do a hardness test procedure as given in 51-20-02, GENERAL.

  (2) If visual damage occurs in composite parts, use instrumented NDI procedures to find other unseen damage. Inspect all the adjacent areas up to 6 inches away from the visual damage. Refer to NDT Part 1, 51-01-03 for Lightning Strike Damage procedure

B. Repair or replace all the weak or damaged structure immediately.

GENERAL - MERCURY SPILLAGE CORRECTIVE ACTION

1. References

Reference	Title
51-10-02, GENERAL	Inspection and Removal of Damage
AMM 05-51-21	Aircraft Maintenance Manual

2. General

A. It is assumed that any significant quantity of mercury on board an airplane is properly contained, packaged, and labeled for loading in a cargo compartment.

B. The spillage of mercury or a mercury compound within an airplane requires immediate action for its isolation and recovery to prevent possible corrosion damage to and weakening of aluminum alloy structural components. The presence of even small amounts of mercury can be detected by a "sniffer". This is an electronic device sensitive to mercury vapor. Refer to AMM 05-51-21, Mercury Spillage - Conditional Inspection, and 20-41-00 of the 767 Corrosion Prevention Manual D634T401 for procedures to be taken in case of mercury spillage.

C. Mercury, by the amalgamation process, can penetrate any break in the finish, paint, or sealing coating of a metal structural element. An oxide coating on a dry metallic surface will tend to inhibit an immediate action while a bright, polished, shining or scratched surface will hasten the process. Moisture will also promote the amalgamation process. Soils, greases, or other inert contaminants present on the metal surfaces will prevent the start of the action. The corrosion and embrittlement which results from an initial penetration can be extremely rapid in structural members under load. Once it has begun, there is no known method of stopping it. Complete destruction of the load carrying capacity of the metal will result.

D. Damage to an aluminum alloy structural component by mercury appears externally as a grayish, powdery dust or fuzzy coating. Corrosion may show up as tree-like forms penetrating a structural component. Such external evidence may be an indication of damage beyond an allowable amount by embrittlement. The extent of such damage should be determined by an X-ray examination. Refer to Part 2 of the 767 NDT Manual for procedures generally adaptable to mercury spillage and corrosion.

E. Damage which has been discovered by X-ray examination as in Paragraph 2.D./GENERAL above is not allowable. Refer to 51-10-02, GENERAL for definition of allowable damage.

F. Refer to Chapter 53 for repairs to fuselage structure which has been damaged.

GENERAL - REPAIR SEALING

1. Applicability

A. This subject contains the information and procedures necessary to seal structural repairs on the airplane.

2. References

Reference	Title
51-00-04, GENERAL	Structural Classification
AMM 28-11-00/801	Aircraft Maintenance Manual
AMM 51-31-01/201	Aircraft Maintenance Manual
AMM 51-41-00/201	Aircraft Maintenance Manual
SOPM 20-50-19	General Sealing

3. General

A. Some areas of the fuselage and wing are sealed to make a pressurized zone of the fuselage and the 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 51-31-01/201 for seals and sealing.

(2) Refer to AMM 28-11-00/801 for fuel tank repairs.

(3) Refer to SOPM 20-50-19 for sealing of repairs.

B. See Figure 1/GENERAL for substitute sealants. Sealants specified in repairs have been selected for their special qualities. Substitute sealants shown in Figure 1/GENERAL 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 COLLECT IN SOME AREAS. THE RESULT CAN BE CORROSION AND DAMAGE TO THE AIRPLANE.

C. The airplane has external drain holes and internal drain paths so that water and other moisture will not collect in areas around the airframe.

Do not fill or block these holes or drain paths when you seal repairs.

Refer to AMM 51-41-00/201 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. DAMAGE WILL REDUCE THE FATIGUE STRENGTH AND DURABLITY OF THE STRUCTURE. REFER TO FIGURE 2/GENERAL FOR SPECIAL PRECAUTIONS IF IT IS NECESSARY TO REMOVE SEALANT FROM A CLAD SURFACE ADJACENT TO A LAP JOINT OR WING-TO-BODY FAIRING, OR AT A BUTT JOINT.

D. If you remove sealant from a structural part, be careful not to cause damage to the part surface.

(1) Only use sealant removal tools that are made of hardwood or plastic material. Metal tools can cause damage to the part surface.

(2) Examine the structure after you remove the sealant to see if there are nicks, scratches, scribe marks or other damage. Tell 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 to a splice plate that is behind a butt joint. Refer to 51-00-04, GENERAL for structural classification. For all other damage, refer to instructions in the applicable allowable damage section of the SRM before you continue.

PERMITTED SUBSTITUTES FOR INITIAL SPECIFIED SEALANT

INITIAL SPECIFIED SEALANTS	PERMITTED ALTERNATIVE SEALANTS						
	BMS 5-45	BMS 5-63	BMS 5-95	BMS 5-142 [A]	PR-1826 [B]	PR-1828	BMS 5-150
BMS 5-19	YES	NO	NO	NO	YES	NO	NO
BMS 5-26	SEE TABLE III	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 II	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 I

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 II

NOTES

[A] THIS ALTERNATIVE IS NOT PERMITTED FOR MATING SURFACE SEAL, PRE-PACK SEALING, AND WET FASTENER INSTALLATION PROCEDURES.

[B] THIS SEALANT HAS A PRIMER THAT MUST ALSO BE USED.

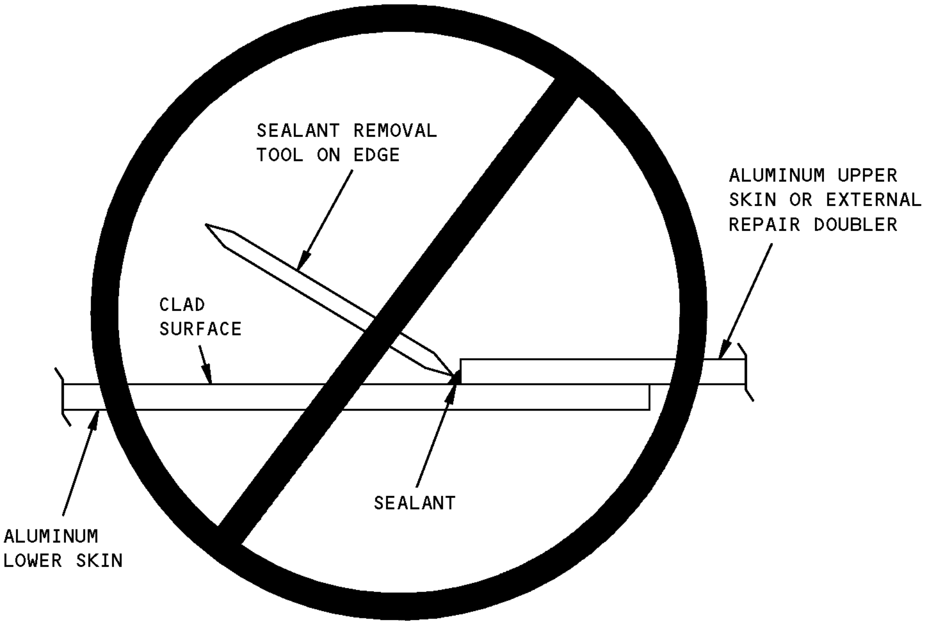
Alternative Sealants Data
Figure 1 (Sheet 1 of 2)

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 III

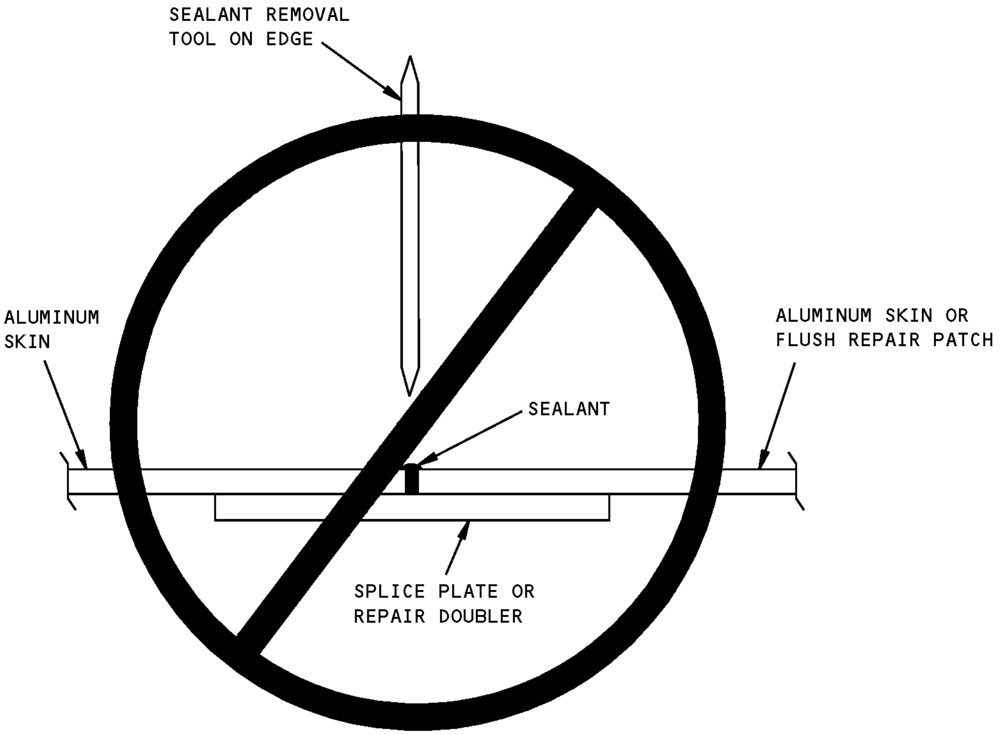
Alternative Sealants Data
Figure 1 (Sheet 2 of 2)

CAUTION: ONLY USE HARDWOOD OR PLASTIC MATERIAL FOR SEALANT REMOVAL TOOLS. BE VERY CAREFUL IF YOU REMOVE SEALANT FROM AREAS ADJACENT TO (OR ON) AN ALUMINUM CLAD SURFACE. (FOR EXAMPLE, CLAD ALUMINUM FUSELAGE SKIN ADJACENT TO A LAP JOINT, WING-TO-BODY FAIRING, OR TO A SPLICE PLATE BEHIND A BUTT JOINT. BE VERY CAREFUL ALSO, WHEN YOU REMOVE SEALANT FROM AROUND EXTERNAL PATCH REPAIRS AND JOINTS AROUND FLUSH PATCH REPAIRS). ALL TOOLS CAN CAUSE DAMAGE TO A CLAD SURFACE IF YOU ARE NOT CAREFUL. IT IS POSSIBLE FOR LIGHT PRESSURE ON THE SHARP EDGE OF A SEALANT REMOVAL TOOL TO CAUSE DAMAGE TO A CLAD SURFACE. SCRIBE MARKS AS SHALLOW AS 0.001 INCH (0.025 MM) CAN CAUSE FATIGUE CRACKS. TELL AN ENGINEER OR THE BOEING COMPANY IF THERE IS DAMAGE ADJACENT TO A LAP JOINT, WING-TO-BODY FAIRING OR TO A SPLICE PLATE THAT IS BEHIND A BUTT JOINT. SEE DETAILS I AND II.



LAP JOINT
DETAIL I

Special Precaution for Clad Aluminum Surfaces, Lap Joints, and Butt Joints
Figure 2 (Sheet 1 of 2)



BUTT JOINT
DETAIL II

Special Precaution for Clad Aluminum Surfaces, Lap Joints, and Butt Joints
Figure 2 (Sheet 2 of 2)

GENERAL - SHOT PEENING

1. Introduction

A. This subject provides information regarding shot peening of reworked aluminum, steel and titanium parts. Figure 1/GENERAL shows this information in chart form, stating minimum part thicknesses, intensities, and shot numbers.

2. References

Reference	Title
SOPM 20-10-03	General - Shot Peening Procedures

3. General

A. As part thickness is decreased due to damage removal, shot peening intensity may also decrease. It is important that the part thickness is determined after damage rework in order to specify the correct intensity.

B. Parts thinner than the minimum thickness indicated in the table shall not be shot peened. When shot peening a tapered area, do not shot peen past the point where minimum thickness is achieved.

C. Refer to SOPM 20-10-03, for additional shot peening information.

SHOT PEENING PARAMETERS

MATERIAL/HEAT TREAT	MINIMUM THICKNESS	INTENSITY	SHOT NUMBER
STEEL HEAT TREATED LESS THAN 150 KSI	0.04	.002A-.004A	230-780
	0.05	.002A-.005A	↓
	0.07	.003A-.006A	
	0.08	.004A-.007A	
	0.10	.006A	
	0.12	.008A	
	0.15	.010A	
	0.17	.012A	
	0.20	.014A	
	0.24 AND THICKER	.016A	230-780
STEEL HEAT TREATED BETWEEN 150 AND 240 KSI	0.01	.002A-.004A	170-460
	0.05	.003A-.005A	↓
	0.07	.003A-.006A	
	0.08	.006A	
	0.10	.008A	
	0.12	.010A	
	0.14	.012A	
	0.16	.014A	
	0.20 AND THICKER	.016A	170-460
STEEL HEAT TREATED BETWEEN 270 AND 300 KSI	0.03	.002A-.004A	170-460
	0.04	.003A-.005A	↓
	0.05	.006A	
	0.06	.008A	
	0.08	.010A	
	0.10	.012A	
	0.12	.014A	
	0.15 AND THICKER	.016A	170-460
ALUMINUM ALLOYS	0.05	.002A-.004A	230-550
	0.06	.003A-.005A	↓
	0.08	.004A-.007A	
	0.10	.006A	
	0.13	.008A	
	0.16	.010A	
	0.19	.012A	
	0.23 AND THICKER	.014A	230-550
TITANIUM ALLOYS	0.04	.002A-.004A	230-460
	0.05	.003A-.005A	↓
	0.07	.003A-.006A	
	0.08	.004A-.007A	
	0.10	.006A	
	0.12	.008A	
	0.15	.010A	
	0.17	.012A	
	0.20	.014A	
	0.24	.016A	230-460

Shot Peening Parameters
Figure 1

GENERAL - FREEZE PLUG INSTALLATION

1. General

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 for aluminum alloy material that is a minimum of 0.063 inch (1.60 mm) thick.

C. A freeze plug is a structural repair that can be used to repair aluminum structure. Because the freeze plug is installed with interference in a hole, it will transmit compressive loads. A freeze plug is better for durability than a non-interference plug or an open hole.

D. It is best to have parts on each side of the freeze plug to contain it. Refer to Figure 1/GENERAL, Detail I. When the freeze plug cannot be contained between two other parts, use straps, washers or countersinks. Refer to Figure 1/GENERAL, Detail II. If necessary, install the washers and straps with BMS 5-95 sealant between the mating surfaces. Refer to 51-20-05, GENERAL. Shims can be used temporarily between the structural members to make sure the freeze plugs are installed flush. Remove those shims after the freeze plug is installed. Apply BMS 5-95 sealant to the mating surfaces of the structure before the freeze plug is installed. If more than one structural member is damaged, a separate freeze plug must be used in each part. Skin and hot-bonded doublers can be plugged together if there is no delamination. Refer to Figure 1/GENERAL, Detail IV.

NOTE: To define the edge margin and the diameter of the freeze plug installation, use the diameter of the freeze plug hole and not the diameter of the fastener hole through the freeze plug.

2. References

Reference	Title
51-10-01, GENERAL	Aerodynamic Smoothness Requirements
51-20-01, GENERAL	Protective Treatment of Metallic and Nonmetallic Repair Parts
51-20-05, GENERAL	Repair Sealing
51-40-08, GENERAL	Countersinking

3. Freeze Plug Installation

A. Straight Shank Freeze Plug Installation

(1) Use the smallest diameter drill and reamer possible to remove the damage. Refer to 51-10-00. Remove the nicks, scratches, burrs, and sharp edges from the freeze plug hole. Make sure the freeze plug will have a minimum 0.05 inch wall thickness when the fastener hole is drilled through it. Refer to Figure 2/GENERAL, Detail I. Measure the diameter of the freeze plug hole to 4 decimal positions (.XXXX). The cylindricity tolerance on the freeze plug hole is 0.0003 inch. Refer to Figure 3/GENERAL for the definition of cylindricity. The surface finish of the freeze plug hole must be 63 microinches Ra or smoother. Measure the thickness of the damaged aluminum structure to 3 decimal positions (.XXX). Refer to Figure 2/GENERAL, Section A-A.

(2) The freeze plug shank diameter must be 1.0035 to 1.0040 times larger than the diameter of the hole. For example, if the hole has a diameter of 0.4500 inch, then the freeze plug diameter must be 0.4516/0.4518 inch. Make the straight shank freeze plug from 7075-T6 aluminum with a cylindricity tolerance of 0.0002 inch. Machine the freeze plug outer diameter to a surface finish of 63 microinches Ra or smoother. Measure the final outer diameter of the freeze plug to 4 decimal positions (.XXXX). Apply a chemical conversion coating to the freeze plug. Refer to 51-20-01.

(3) For freeze plugs in more than one structural member, chamfer the mating edges of the freeze plug 45° x 0.003/0.006 inch. Refer to Figure 4/GENERAL, Detail I.

(4) The thickness of the freeze plug must be the same or larger than the material thickness that is measured. Drill a pilot hole through the center of the freeze plug, if a fastener will be installed.

WARNING: LIQUID NITROGEN IS APPROXIMATELY MINUS 320°F (MINUS 196°C). WEAR PROTECTIVE CLOTHING, AND USE IN A WELL-VENTILATED AREA TO PREVENT INJURY.

(5) Put the freeze plug in liquid nitrogen for a minimum of 10 minutes immediately before installation. In thick structure, apply BMS 5-95 sealant to the edges of the hole to help the installation of the freeze plug. Install the freeze plug flush to +0.003/-0.000 inch. Microshave the freeze plug if necessary. Refer to 51-10-01, GENERAL51-10-01.

(6) For freeze plugs in more than one structural member, the freeze plug mating surface must be 0.003 inch or less above or below the structure mating surface. Refer to Figure 4/GENERAL, Detail I.

(7) Drill the fastener hole through the freeze plug pilot hole and the structure that is attached. Make sure the freeze plug has a minimum wall thickness of 0.05 inch. Refer to Figure 2/GENERAL, Detail I. Install a fastener through the freeze plug and the structure that is attached. Apply a finish to the bare surfaces of the freeze plug that is the same as the finish on the adjacent structure. Refer to 51-20-01, GENERAL.

B. Countersunk Freeze Plug Installation

CAUTION: COUNTERSUNK FREEZE PLUGS MAY BE UNACCEPTABLE IN CERTAIN SITUATIONS. GET APPROVAL FROM BOEING BEFORE A COUNTERSUNK FREEZE PLUG IS INSTALLED.

(1) Use the smallest diameter drill and reamer possible to remove the damage. Refer to 51-10-00. Remove the nicks, scratches, burrs, and sharp edges from the freeze plug hole. Make sure the freeze plug will have a minimum 0.05 inch wall thickness when the fastener hole is drilled through it. Refer to Figure 5/GENERAL, Section A-A. Measure the diameter of the freeze plug hole to 4 decimal positions (.XXXX). The cylindricity tolerance on the freeze plug hole is 0.0003 inch. Refer to Figure 3/GENERAL for the definition of cylindricity. The surface finish of the freeze plug hole must be 63 microinches Ra or smoother. Measure the thickness of the damaged aluminum structure to 3 decimal positions (.XXX). Refer to Figure 5/GENERAL, Section A-A.

(2) The freeze plug shank diameter must be 1.0035 to 1.0040 times larger than the diameter of the hole. For example, if the hole has a diameter of 0.4500 inch, then the freeze plug diameter must be 0.4516/0.4518 inch. Make the countersunk freeze plug from 7075-T6 aluminum with a cylindricity tolerance of 0.0002 inch. Machine the freeze plug to the countersink diameter given in Figure 6/GENERAL. The freeze plug must have a 100° countersink. Machine the freeze plug outer diameter to a surface finish of 63 microinches Ra or smoother. Measure the final shank diameter of the freeze plug to 4 decimal positions (.XXXX). Apply a chemical conversion coating to the freeze plug. Refer to 51-20-01, GENERAL.

NOTE: The countersink depth of the freeze plug must not be larger than 50 percent of the aluminum structure thickness.

(3) For freeze plugs in more than one structural member, chamfer the mating edges of the freeze plug 45° x 0.003/0.006. Refer to Figure 4/GENERAL, Detail I.

(4) The thickness of the freeze plug must be the same or larger than the material thickness that is measured. The thickness of clad freeze plugs must be within +0.003/-0.000 inch of the material thickness. Drill a pilot hole through the center of the freeze plug, if a fastener will be installed.

(5) Make a 100° countersink in the structure so that the diameter of the countersink is the same as the diameter of the freeze plug. If you are not sure that the adjustment of the countersink tool is correct, make a countersink in a piece of metal that has been discarded. You can do this to make sure that the depth of countersink in the structure will be correct. Refer to 51-40-08, GENERAL.

(6) Measure the countersink diameter in the structure, and make sure that it is the same as the diameter given in Figure 6/GENERAL.

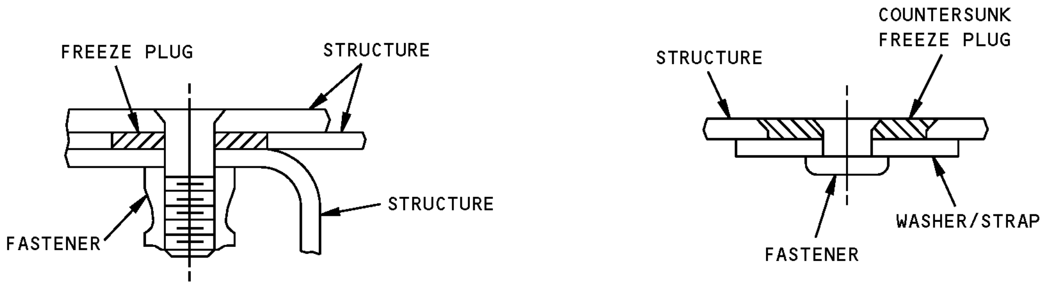
WARNING: LIQUID NITROGEN IS APPROXIMATELY MINUS 320°F (MINUS 196°C). WEAR PROTECTIVE CLOTHING, AND USE IN A WELL-VENTILATED AREA TO PREVENT INJURY.

(7) Put the freeze plug in liquid nitrogen for a minimum of 10 minutes immediately before installation. In thick structure, apply BMS 5-95 sealant to the edges of the hole to help the installation of the freeze plug. Install the freeze plug flush to +0.003/-0.000 inch. Microshave the freeze plug if necessary. Refer to51-10-01, GENERAL.

NOTE: Do not microshave the clad side of clad freeze plugs that will be installed in external surfaces that are not painted.

(8) For freeze plugs in more than one structural member, the freeze plug mating surface must be 0.003 inch or less above or below the structure mating surface. Refer to Figure 4/GENERAL, Detail I.

(9) Drill the fastener hole through the freeze plug pilot hole and the structure that is attached. Make sure the freeze plug has a minimum wall thickness of 0.05 inch. Refer to Figure 5/GENERAL. Install a fastener through the freeze plug and the structure that is attached. Apply a finish to the bare surfaces of the freeze plug that is the same as the finish on the adjacent structure. Refer to 51-20-01, GENERAL.

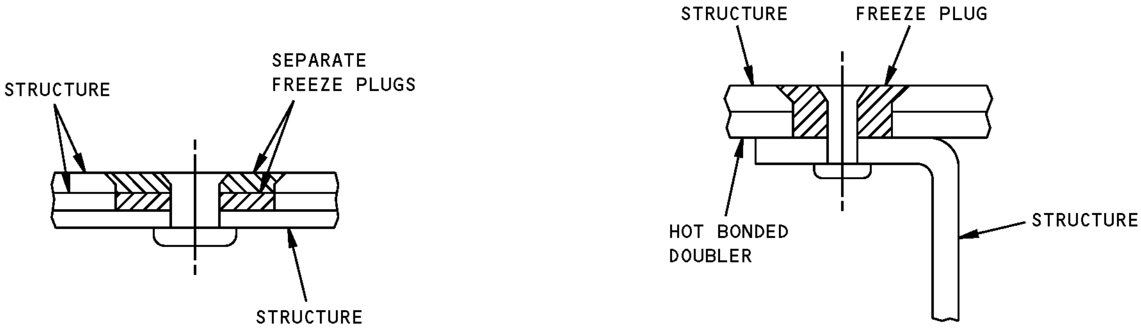


FREEZE PLUG THAT IS CONTAINED BETWEEN TWO OTHER PARTS

DETAIL I

FREEZE PLUG WITH WASHER/STRAP

DETAIL II



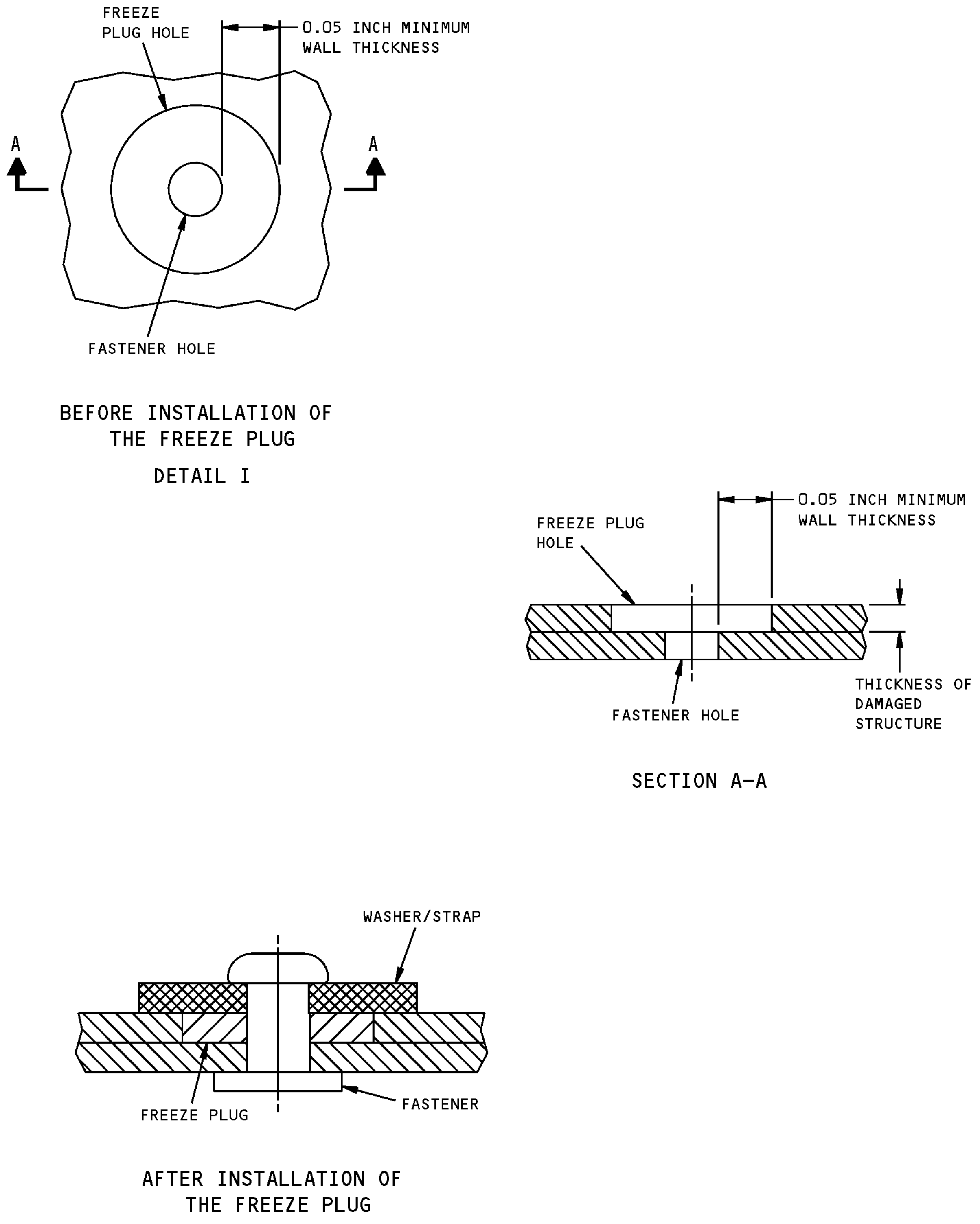
FREEZE PLUGS IN MORE THAN ONE STRUCTURAL MEMBER

DETAIL III

SINGLE FREEZE PLUG IN STRUCTURE WITH HOT BONDED DOUBLER

DETAIL IV

Examples of Freeze Plug Installation
Figure 1



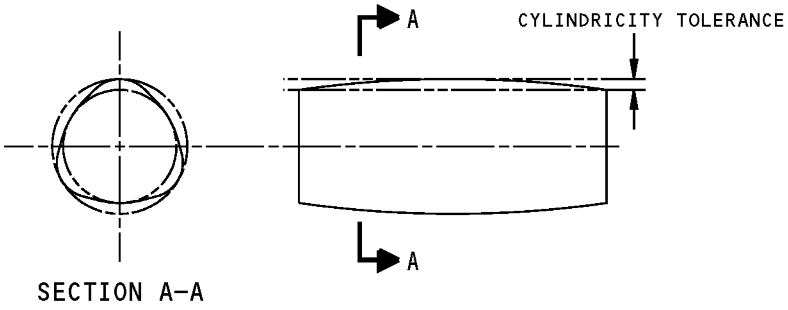
BEFORE INSTALLATION OF THE FREEZE PLUG

DETAIL I

SECTION A-A

AFTER INSTALLATION OF THE FREEZE PLUG

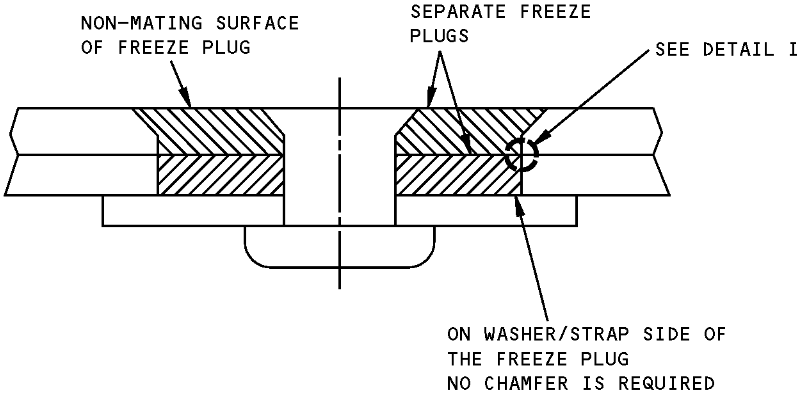
Straight Shank Freeze Plug Installation
Figure 2

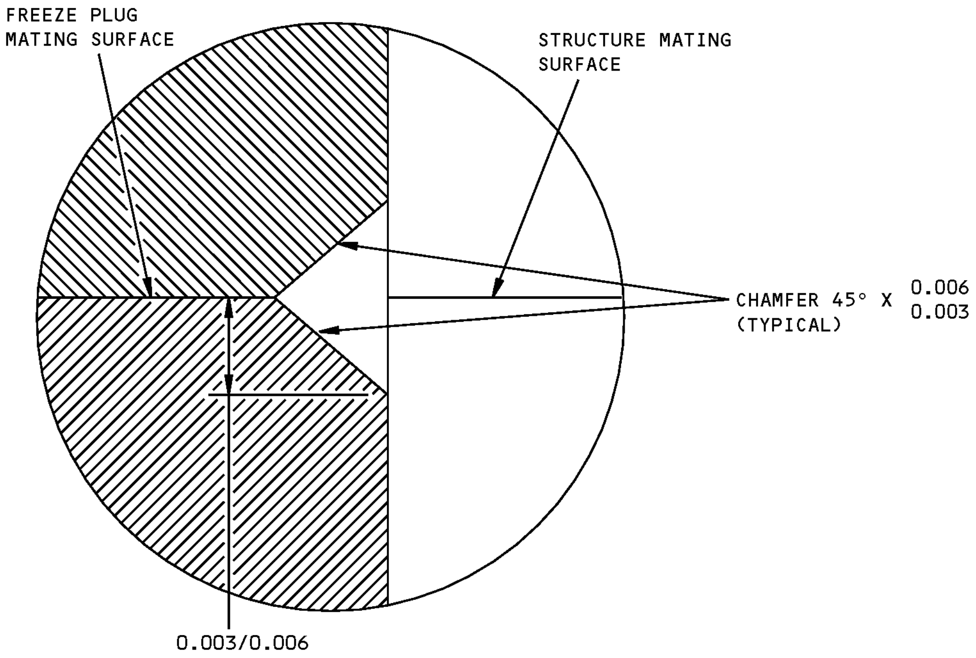


NOTES

- 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



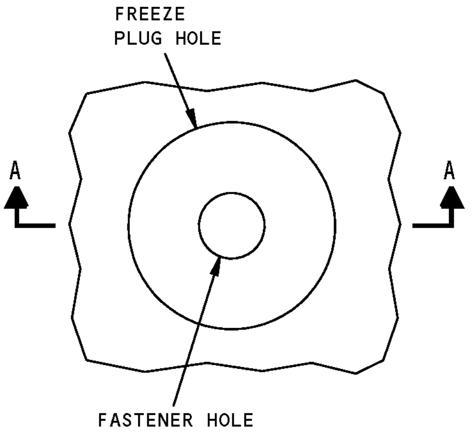


DETAIL I

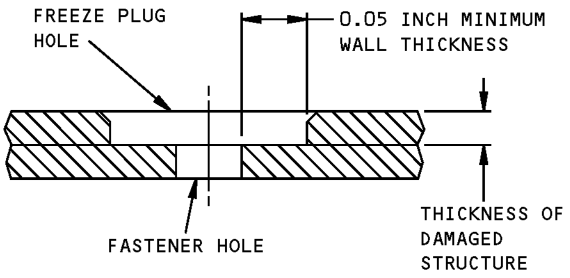
NOTES

- 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.

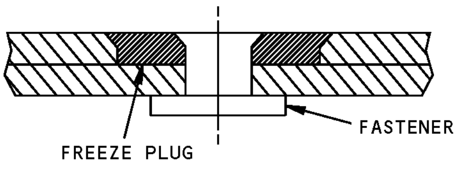
Freeze Plugs in More Than One Structural Member
Figure 4



BEFORE INSTALLATION OF
THE FREEZE PLUG
DETAIL I

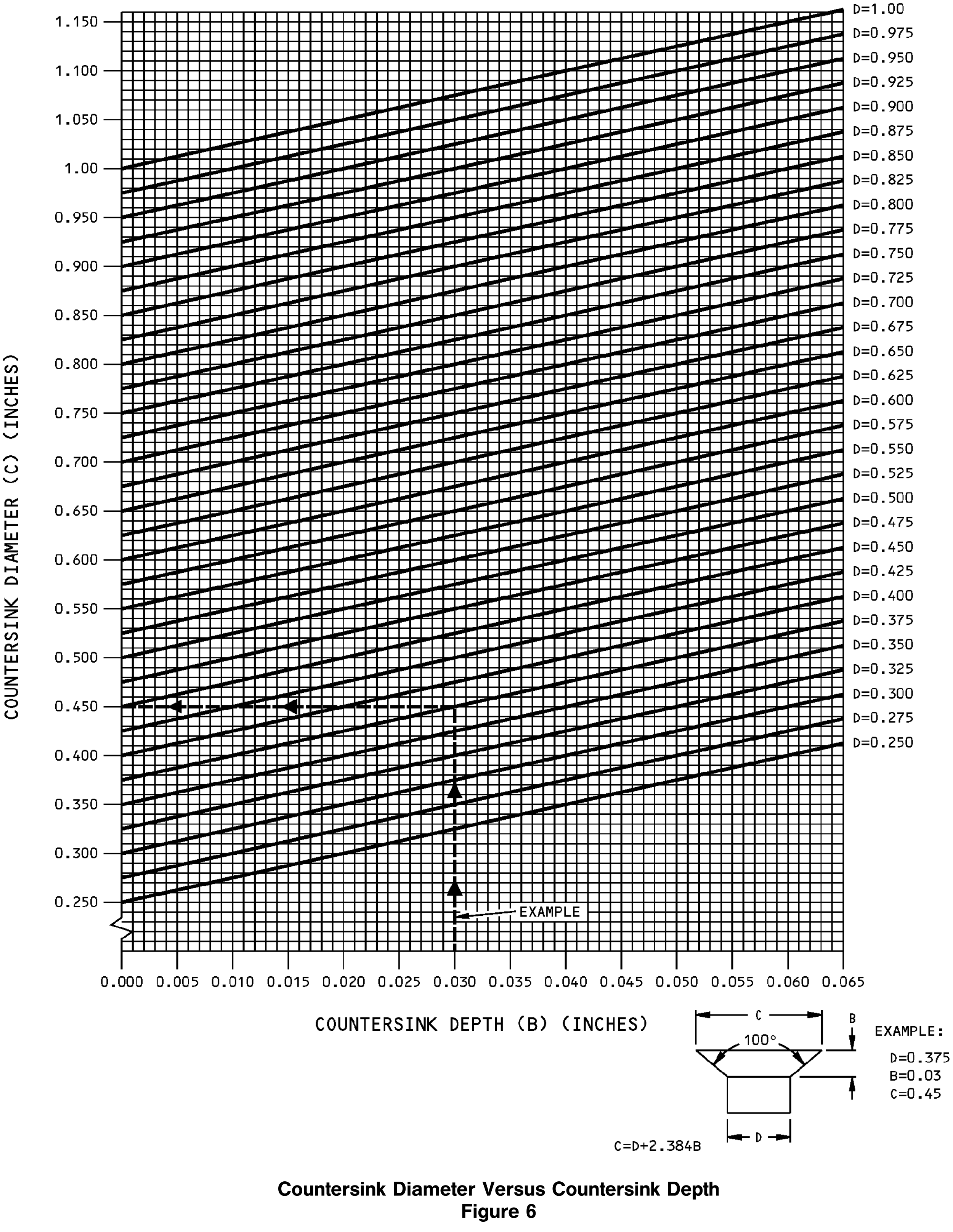


SECTION A-A



AFTER INSTALLATION OF
THE FREEZE PLUG

Countersunk Freeze Plug Installation
Figure 5



Countersink Diameter Versus Countersink Depth
Figure 6

GENERAL - DRIVEN RIVET BOND FOR ELECTRICALLY BONDED BRACKETS

1. Applicability

A. This subject is applicable to structures where electrical bonding of the brackets is required. The electrical bond of a bracket and structure is specified in WDM 91-05-05.

2. General

A. Complete the installation of the rivet bond in less than 24 hours after drilling the holes

3. References

Reference	Title
51-20-01, GENERAL	Protective Treatment of Metallic and Nonmetallic Repair Parts
51-40-02, GENERAL	Fastener Installation and Removal
51-40-05, GENERAL	Fastener Hole Sizes
SWPM 20-20-00	Electrical Bonds and Grounds
WDM 91-05-05	Master Bundls Matrix (W404 Thru W454)

4. Installation Procedures

A. Determine the number and the type of the rivets to be used for bonding the surfaces.

NOTE: Make sure that you use aluminum rivets applied with a chemical conversion coating. Refer to 51-20-01, GENERAL for the protective treatment of metallic and nonmetallic materials.

B. Drill the holes for the rivets. Drill through the two surfaces. Refer to 51-40-05, GENERAL for fastener hole sizes.

CAUTION: INSTALL THE RIVET BOND BEFORE 24 HOURS AFTER THE HOLES ARE DRILLED. MAKE SURE THAT THERE IS NO PRIMER, PAINT, OTHER FINISHES OR OTHER CONTAMINATION INSIDE THE RIVET HOLES. IF YOU DO NOT OBEY, IT CAN CAUSE THE MEASURED RESISTANCE OF THE ELECTRICAL MATING SURFACE BOND TO BE MORE THAN ITS RESISTANCE REQUIREMENTS.

C. Make sure that the surface inside the rivet hole is bare material.

D. Install the rivets. Refer to 51-40-02, GENERAL for fastener installation and removal.

E. Do the bond test of the bracket and the structure bond. Refer to SWPM 20-20-00

GENERAL - EXPANDED FIT BUSHING INSTALLATION GUIDLINES

1. Applicability

A. This section gives a list of final design and functional requirements for the expanded fit bushing installation applicable to the engine strut fitting lug hole repairs as given in Chapter 54. The expanded fit bushing installation is an option to the shrink-fit bushing installation procedure as published in the specific fitting lug hole section.

NOTE: It is the responsibility of the user and/or the manufacturer of the expanded fit tool kit to get certification for each specific application. This section outlines the minimum design and functional requirements for the bushing installation with the use of the expanded fit procedure. Boeing can assist the user and/or the manufacturer of the expanded fit bushing process to review and document the applicable technical data. The user and/or the manufacturer of the expanded fit bushing process must contact Boeing for this assistance.

2. General

A. The expanded fit bushing installation procedure installs bushings into lug housings with a mandrel which is larger than the bore of the installed bushing. The mandrel is pulled through the bore of the bushing, which makes the bushing outer diameter larger and expands the bushing to create interference with the lug bore. Refer to Figure 1/GENERAL for an example of a typical expanded fit bushing installation.

B. This bushing installation procedure is both tool and part critical. When the expanded fit procedure is used, it is necessary to get approval for the use of the special tools and bushings for each specific fitting. It is the responsibility of the user and the manufacturer of the expanded fit tool kit to make sure the requirements listed in this section are satisfied and certified for each specific application. The optional expanded fit bushing installation tools may be supplied by any manufacturer that can meet the requirements listed in Paragraph 4./GENERAL satisfactorily.

NOTE: The procedures to remove damage from the fitting lug hole, inspect the bore, prepare and finish the lug hole before the repair bushing is installed, are the same as that used for the shrink-fit bushing installation procedure.

3. References

Reference	Title
NDT Part 6, 51-00-01	Aluminum Part Surface Inspection (Meter Display)
SOPM 20-20-02	Penetrant Methods of Inspection

4. Installation Criteria for Expanded Fit Bushing Procedure

A. Special tools are necessary for each specific lug bore diameter and location. The tool kit shall include tools to remove, install, inspect, and test for bushing retention. In addition, the kit shall include tool instructions, installation procedures, rework allowances and specific tests as necessary to get the proper bushing retention for each application. You must also establish and certify a test program such that the following requirements are satisfied before you do the lug hole repair.

(1) Make sure that the final bushing installation has a minimum interference fit of 0.15% to a maximum interference fit of 0.40%. Make an analysis of the interference level from the test coupons and examine the test results for validation. Keep a record of all the bushing installation and push-out loads.

(2) Make sure the expansion level of the bushing inside diameter is not more than 1.5%. Measure and make a record of this dimension from the test coupons for validation.

(3) Make sure that the expanded fit bushing procedure will not increase the diameter of the lug hole permanently after the repair bushing is removed. Measure the test coupon fitting lug hole diameter without the mating repair bushing before and after the bushing installation for validation.

(4) Make sure there is clearance between the outside diameter of the repair bushing and the mating fitting lug hole (with finishes on lug and bushing) before you do the expanded fit bushing installation. Check the outside diameter of the mandrel and the inside diameter of the bushing before the bushing installation.

(5) Do the following inspection and test for the new bushings:

  (a) Do a high frequency eddy current inspection for cracks after final machining and prior to bushing installation. Refer to NDT Part 6, 51-00-01 for inspection procedures.

  (b) Use a 10-power magnifying glass and do a detailed visual inspection of the bushings to make sure there are no cracks after the mandrel is pulled through the bushings. As an alternative, do a penetrant inspection of the bushings. Use Type I, method C, sensitive level 3 or higher penetrant for the inspection. Refer to SOPM 20-20-02 for the penetrant inspection procedure.

  (c) Use lug test coupons to verify and validate bushing installation for the most critical dimensional tolerance condition. A list of some examples are: largest hole, smallest bushing outside diameter, largest percent expansion, largest hole chamfer, least lubrication on mandrel and/or bushing. Remove bushing and do a high frequency eddy current inspection for cracks or defects.

  NOTE: For flanged bushings which react mandrel forces, check for flange flatness after the bushings are installed. Bushing flange "cupping" is not permitted. Measure and make a record of the bushing installation and the push-out loads.

(6) Make sure that the force used to pull the mandrel through the fitting lug hole and the force used in "reseating" the bushing (if allowed) are evenly balanced through the lug thickness. No lug ear bending is permitted for either single lug or clevis applications.

(7) Part mark the repair bushing or the repair installation with part number for identification.

(8) Rework the lug hole again each time before the repair bushing is reinstalled. If the test and analysis can show that local cold-work around the lug hole will not increase the hole diameter permanently or cause any damage to the lug housing, then the repair bushing can be reinstalled without lug rework.

(9) "Wet" bushing installation that causes "hydraulic lock" is not permitted when the fluid stays in the bore as the mandrel is pulled through the bushing.

(10) Bushing "reseating" is not permitted. If the test and analysis can show that there is no damage to the lug bore during the "reseating" and or bushing removal procedure, then bushing "reseating" is permitted.

(11) The fit, function and the structural integrity requirements of the detailed parts, assembly and installation drawings of the lug-pin connection must be satisfied when the expanded fit bushing installation procedure is used.

(12) Make an analysis and test for the effect of adverse geometric tolerances and material properties. Make sure that all the requirements for expanded fit bushing installation listed above are satisfied.

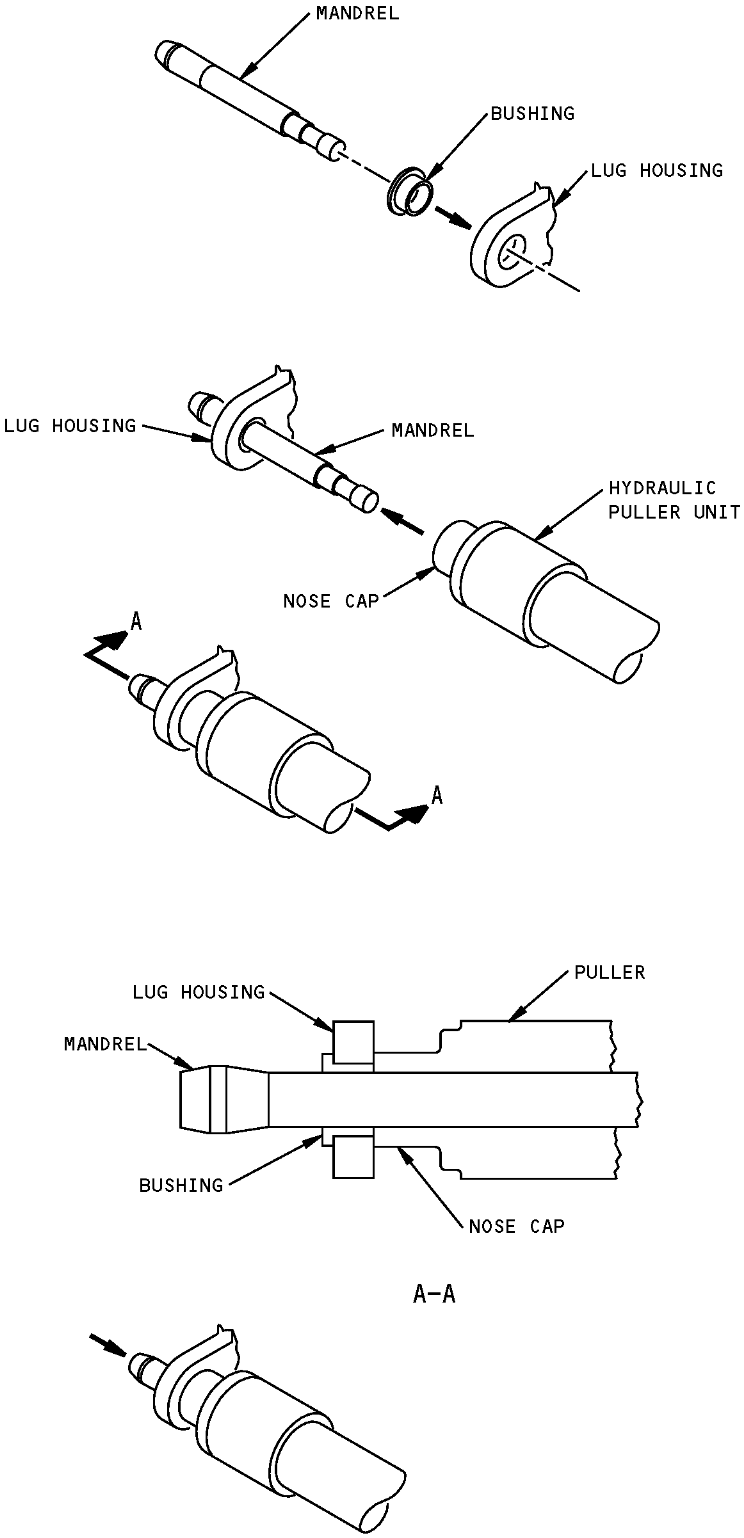
(13) Before you use the expanded fit bushing installation process on your engine strut fittings, the first-time users must demonstrate compliance with the requirements of this section.

(a) You must install, remove, and inspect bushings in test lug coupons used to develop the expanded fit bushing installation process.

(b) Keep a record of the validation test reports and any special procedures for expanded fit bushing removal, repair, inspection and installation. Make sure that all the requirements for expanded fit bushing installation listed in this section are satisfied.

(c) The user and/or the manufacturer of the expanded fit bushing process must get approval for its use on aircraft installation.

See the applicability note stated in this section.



1. PUT THE BUSHING INTO THE LUG HOLE.
2. PUT THE MANDREL UNIT INTO THE LUG HOLE.
3. PUT THE END OF THE MANDREL INTO THE PULLER, WITH THE NOSE CAP AGAINST THE HOUSING.
4. MAKE SURE THE NOSECAP IS AGAINST THE HOUSING.
5. OPERATE THE PULLER TO PULL THE MANDREL THROUGH THE BUSHING.

Typical Expanded Fit Bushing Installation
Figure 1

GENERAL - INSTALLATION OF NEW SHIMS

1. Applicability

A. This subject contains the data that is applicable to the installation of new shims.

B. A structural engineering review is necessary when structural shims:

(1) Are installed, unless they are approved as part of other repairs in this manual.

C. Shim configuration must be determined on a case-by-case basis. The use of structural shims must be subject to a structural evaluation. Boeing can provide assistance with that evaluation.

2. References

Reference	Title
51-20-01, GENERAL	Protective Treatment of Metallic and Nonmetallic Repair Parts
51-20-05, GENERAL	Repair Sealing
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
51-40-08, GENERAL	Countersinking
BAC 5300,	Forming, Straightening, and Fitting Metal Parts Blanking Sonic Area Edges
SOPM 20-41-02	Application of Chemical and Solvent Resistant Finishes

3. General

A. Refer to Figure 1/GENERAL when you install sheet metal shims to find what type of shim to use.

B. Refer to Figure 2/GENERAL when you trim laminated shims and solid shims.

SHIM USAGE			
SHIM THICKNESS AS A PERCENTAGE OF THE FASTENER DIAMETER	FASTENER TYPE AND MATERIAL	NON-STRUCTURAL SHIM $\boxed{B}\boxed{C}\boxed{G}$	STRUCTURAL SHIM $\boxed{A}\boxed{C}\boxed{G}$
LESS THAN 16%	Rivets (aluminum)	X	
16% AND MORE $\boxed{D}$			X
LESS THAN 21%	Shear lockbolts or hi-loks (steel or titanium)	X	
21% AND MORE $\boxed{E}$			X
LESS THAN 26%	Tension lockbolts, bolts, or hi-loks (steel or titanium)	X	
26% AND MORE $\boxed{F}$			X

EXAMPLE:
FOR A 0.040 INCH (1.016 mm) THICK SHIM AND A 5/32 INCH (0.1562 INCH) DIAMETER ALUMINUM ALLOY RIVET, THE SHIM THICKNESS AS A PERCENTAGE OF THE FASTENER DIAMETER

$$= \frac{\text{SHIM THICKNESS}}{\text{FASTENER DIAMETER}} \text{ X } 100\%$$

$$= \frac{0.040 \text{ INCH } (1.016 \text{ mm})}{0.1562 \text{ INCH } (3.967 \text{ mm})} \text{ X } 100\%$$

$$= 25.6\%$$

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 16%.

Instructions for the Use of Shims
Figure 1 (Sheet 1 of 2)

NOTES

[A] 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. A STRUCTURAL SHIM MUST CONTAIN NO LAMINATIONS (USE SOLID SHIMS ONLY).

[B] THE SHIM CAN BE BONDED TO THE REPAIR PART WITH BMS 5-95 SEALANT OR BAC5010, TYPE 70 ADHESIVE, TO MAKE THE INSTALLATION EASIER. FOR AREAS THAT WILL TOUCH FUEL, USE BMS 5-45 OR BMS 5-26, TYPE II SEALANT.

[C] THE SHIM CAN BE MADE FROM 2024-T3 OR 7075-T6 ALUMINUM SHEET.

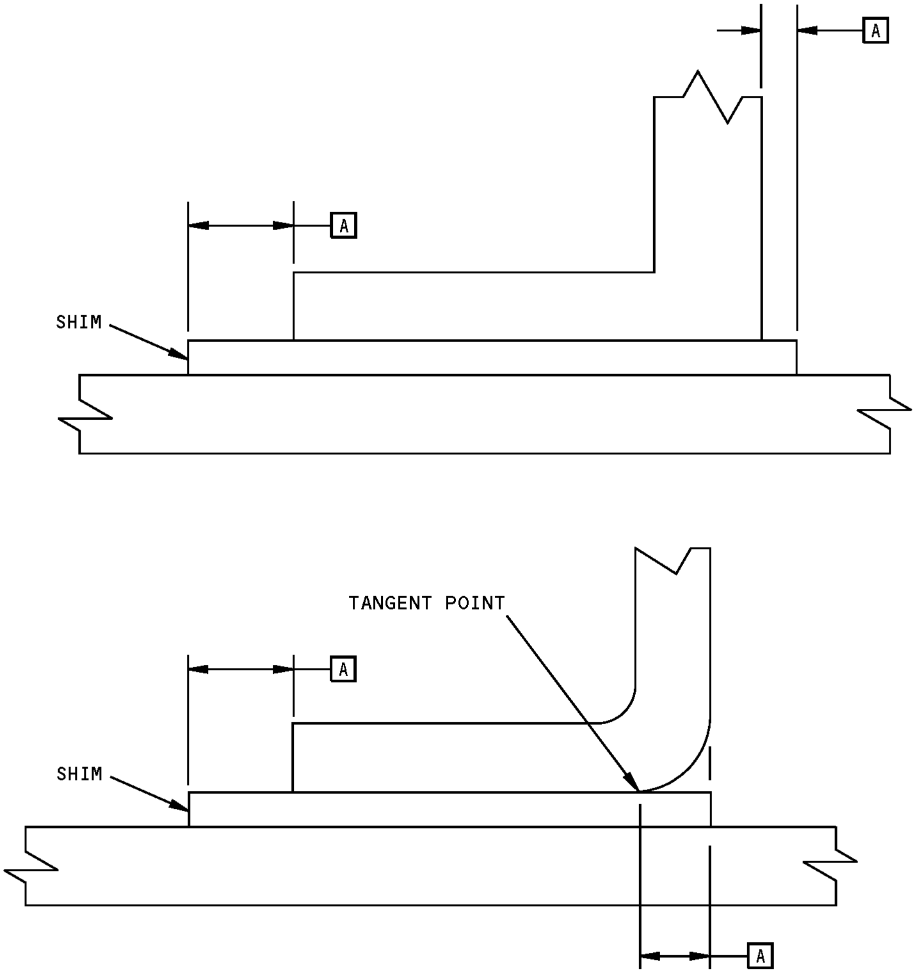
[D] IF THE TOTAL THICKNESS OF THE ASSEMBLED PARTS IS MORE THAN 2 TIMES THE RIVET DIAMETER, BOEING RECOMMENDS THAT YOU USE A BACB30VT()K() HEX DRIVE PROTRUDING HEAD (SHEAR) BOLT WITH A BACC30BL() COLLAR OR A BACB30VU()K() HEX DRIVE FLUSH HEAD (SHEAR) BOLT WITH A BACC30BL() COLLAR. REFER TO SRM 51-40-08 FOR THE MINIMUM MATERIAL THICKNESS NECESSARY WHEN YOU INSTALL COUNTERSINK FASTENERS. REFER TO SRM 51-40-03 FOR FASTENER SUBSTITUTIONS.

[E] 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 PROTRUDING HEAD (TENSION) BOLT WITH A BACC30BH() COLLAR OR A BACB30NY()K() HEX DRIVE FLUSH HEAD (TENSION) BOLT WITH A BACC30BH() COLLAR. REFER TO SRM 51-40-08 FOR THE MINIMUM MATERIAL THICKNESS NECESSARY WHEN YOU INSTALL COUNTERSINK FASTENERS. REFER TO SRM 51-40-03 FOR FASTENER SUBSTITUTIONS.

[F] THE TOTAL THICKNESS OF THE ASSEMBLED PARTS MUST NOT BE MORE THAN 3.5 TIMES THE FASTENER DIAMETER. REFER TO SRM 51-40-03 FOR FASTENER SUBSTITUTIONS.

[G] APPLY A CHEMICAL CONVERSION COATING TO THE SHIM AND THE BARE SURFACES OF THE PART. REFER TO SRM 51-20-01. APPLY ONE LAYER OF BMS 10-11, TYPE I PRIMER TO THE SHIM AND THE BARE SURFACES OF THE PART. REFER TO SOPM 20-41-02. FOR PARTS THAT TOUCH FUEL, APPLY BMS 5-45 OR BMS 5-26, TYPE II SEALANT, AS NECESSARY. FOR PARTS THAT DO NOT TOUCH FUEL, APPLY BMS 5-95 SEALANT, AS NECESSARY. REFER TO SRM 51-20-05.

Instructions for the Use of Shims
Figure 1 (Sheet 2 of 2)



NOTES

A FUEL TANK - NO FAY SEAL
0.00 TO 0.05 INCH (0.00 TO 1.27 mm)
LONGER THAN THE EDGE OF THE PART.

FUEL TANK - FAY SEAL
0.05 INCH (1.27 mm) LONGER THAN THE EDGE OF
THE PART, OR A 0.05 INCH (1.27 mm) RECESS.

ALL OTHER AREAS
0.00 TO 0.10 INCH (0.00 TO 2.54 mm)
LONGER THAN THE EDGE OF THE PART, OR A
0.00 TO 0.05 INCH (0.00 TO 1.27 mm) RECESS.

Edge Mismatch Limits for Laminated Shims and Solid Fillers
Figure 2

GENERAL - INSPECTION AND REPLACEMENT OF MIGRATED SHIMS

1. Applicability

A. This subject contains the data that is applicable to the inspection of damaged shims and the replacement of shims.

B. A structural engineering review is necessary when structural shims:

(1) Are found migrated, or

(2) Are installed, unless they are approved as part of other repairs in this manual.

C. Shim configuration must be determined on a case-by-case basis. The use of structural shims must be subject to a structural evaluation. Boeing can provide assistance with that evaluation.

2. General

A. Laminated shims are used to fill the gap between adjacent parts. Installation of the shims prevents a preload on the adjacent part when fasteners are installed. Usually, a laminated shim assembly is made up of a block of solid material to which are bonded several laminations of 0.003 inch (0.0762 mm) thick peelable shim material. The laminations are then trimmed to obtain the necessary thickness and contour.

B. As a result of service history or unique requirements at specific locations, special procedures for the inspection and installation of shims may be included in this subject or referenced in the applicable Chapter-Section-Subject of the parts where shims are installed.

C. It is recommended that operators tell The Boeing Company when and where shim migration occurs if:

(1) The shim thickness is more than 0.020 inch (0.508 mm), or

(2) The necessary inspections of shims for migration given in Paragraph 5./GENERAL are not satisfactory.

D. Refer to Figure 1/51-20-11, GENERAL, when you install sheet metal shims to find what type of shim to use.

E. Refer to Figure 2/51-20-11, GENERAL, when you trim laminated shims and solid shims.

3. References

Reference	Title
51-20-01, GENERAL	Protective Treatment of Metallic and Nonmetallic Repair Parts
51-20-05, GENERAL	Repair Sealing
51-20-11, GENERAL	Installation of New Shims
51-40-01, GENERAL	Fasteners
51-40-04, GENERAL	Torque Values
57-10-10, REPAIR 1	Wing Center Section Rear Spar Bulkhead to Upper Kick Load Fitting Shim Migration Inspection and Replacement

4. Movement of Shims (Shim Migration)

A. Definition of Shim Migration

(1) The individual shim laminations can move in relation to each other at the bond lines (or thin solid shims can move) because of shear forces at the joint. This movement is called shim migration. The laminations that migrated usually have broken apart at the fastener holes at the joint and will continue to move.

(2) Movement of a shim does not always decrease the service life of the joint. If the shim covers a minimum of 50% of the area below the fastener head, some fastener preload will remain. In some cases it may not be possible to determine if the remaining shim covers a minimum of 50% of the area below the fastener head. These repairs are still acceptable provided that the inspection steps in Paragraph 5./GENERAL are satisfactory. If the torque on the fastener is a minimum of 50% of the minimum design torque (minimum design torque is the minimum torque specified on the engineering drawing), the joint is structurally satisfactory.

(3) The limit for shim migration is based on the sum of the different occurrences of shim migration at that location. As a result, measure and make a record of the amount of shim migration at that location each time the migration occurs. Include the shape, thickness and dimensions (includes the gap dimension) in the record.

5. Inspection of Shims for Migration

A. For shim migration inspections at joints with taper shank bolts or hex drive bolts with collars, examine the condition of the shims.

(1) Do a visual inspection to see if a shim has migrated at the joint.

(2) Do a visual inspection of each fastener in the joint for looseness.

NOTE: When shims are examined in a joint with taper shank or hex drive fasteners, fastener torque cannot be used to make an analysis of the serviceability of the joint.

(3) Replace all loose fasteners (Refer to 51-40-01, GENERAL).

(4) If shim migration is found, then use a feeler gage to make sure that the conditions that follow are satisfactory.

(a) Partial gaps on a surface of the shim are not more than 0.005 inch (0.127 mm).

(b) Partial gaps do not extend more than half the distance between the edge of the part and the shank of the bolt.

(5) If the fastener is not loose and there are no gaps larger than described in 5.A.(4), then there will be some of the initial preload in the fastener. Do the steps that follow:

(a) Trim the edges of the laminations that have migrated. Refer to Paragraph 6./GENERAL.

(b) Apply a chemical conversion coating, a primer, and sealant to the bare edges of the migrated shim. Refer to 51-20-01, GENERAL and 51-20-05, GENERAL.

(c) Do a visual inspection of the fastener at each "C" check to see if there is more shim migration.

(6) If the conditions listed in Paragraph 5.A.(4)/GENERAL and Paragraph 5.A.(5)/GENERAL are not satisfactory, then replace the shim as given in Paragraph 8./GENERAL. As an alternative, contact the Boeing Company for assistance. Send a sketch of the information described in Paragraph 4.A.(3)/GENERAL.

B. For shim migration inspections at joints that have bolts with mating nuts, examine the condition of the shims.

(1) Do a visual examination to make sure that there is no evidence of fastener damage or local structural damage, or fuel leakage if in the wing area, that is caused by shim migration.

(2) If shim migration is found, then use a feeler gage to make sure that the conditions that follow are satisfactory.

(a) Partial gaps on a surface of the shim are not more than 0.005 inch (0.127 mm).

(b) Partial gaps do not extend more than half the distance between the edge of the part and the shank of the bolt.

(c) If these conditions Paragraph 5.B.(1)/GENERAL, Paragraph 5.B.(2)/GENERAL (a) and (b)) are not satisfactory, then replace the shim as given in Paragraph 8./GENERAL. As an alternative, contact the Boeing Company for assistance. Send a sketch of the information described in Paragraph 4.A.(3).

(3) If the conditions above Paragraph 5.B.(1)/GENERAL, Paragraph 5.B.(2)/GENERAL (a) and (b)) are met, then do the following:

CAUTION: SHIM MOVEMENT CAN DECREASE THE PRELOAD IN THE FASTENER. ALSO, TIGHTENING THE LOOSE FASTENER WITHOUT THE SHIM REPLACED CAN CAUSE PULL-UP STRESSES IN THE STRUCTURE.

(a) Do a check of the remaining torque on the bolt that contains the migrated shim. Make sure that it is a minimum of 50% of the minimum design torque as shown on the engineering drawing.

1) Tighten the nut gradually to increase the applied torque until either the 50% minimum torque value is obtained or nut rotation occurs.

2) If nut rotation occurs before the 50% minimum torque value is obtained, then replace the shim as given in Paragraph 8./GENERAL, or contact The Boeing Company, and provide the measured rotation torque.

NOTE: It can be easier to do the torque check using the bolthead. If this is done, add 10% to the necessary torque. Torque ranges are given in 51-40-04, GENERAL.

(b) Make sure that the shim is firmly in position and cannot be removed or pulled away from the fitting.

6. Trimming of Shims

CAUTION: USE SPECIAL CARE TO TRIM THE EDGES OF A MIGRATED SHIM. DO NOT SCRATCH THE ADJACENT STRUCTURES. IF YOU DAMAGE THE ADJACENT STRUCTURE, MORE REWORK WILL BE NECESSARY.

A. Trim the shim as follows:

(1) Trim the shim to the edge of the fitting. Use care when trimming the shim so that you do not damage the structure. Tears or cracks in the shim are not permitted.

(2) Record the amount of shim material that is removed for reference if future migration occurs. Include the shape, thickness and dimensions in the record.

B. Apply a chemical conversion coating to the cut edges of the shim then fillet seal the fittings. Refer to 51-20-01, GENERAL and 51-20-05, GENERAL.

7. Inspection of Trimmed Shims

CAUTION: MAKE SURE YOU DO A CHECK TO SEE IF SPECIAL AIRPLANE JACKING INSTRUCTIONS ARE NECESSARY TO REPLACE SOME SHIMS. IF YOU DO NOT OBEY, DAMAGE TO THE AIRPLANE CAN BE THE RESULT.

(CAUTION PRECEDES)

A. Do a visual inspection at each "C" check to see if there is more shim migration. If more shim migration is seen, then do a check of the torque as given in Paragraph 5./GENERAL

NOTE: Operators have the option to stop shim migration inspections if no migration has been seen after the fourth consecutive "C" check. If no migration occurs subsequent to the fourth consecutive "C" check, normal Maintenance Planning Document (MPD) inspections can be used to find shim migration.

8. Installation of Replacement Shims

NOTE: This procedure is not applicable to the shim between the rear spar upper chord kick fitting and the rear spar bulkhead. For the design gap details for this location, refer to 57-10-10, REPAIR 1. Tell The Boeing Company if excessive shim migration occurs at this location. This procedure is applicable to shim migratlons at the other locations. Tell The Boeing Company if shim migration occurs at other locations on the airplane. It is recommended that laminated shims be replaced with solid shims. Solid shims have less tendency to migrate. The maximum clamp-up gap before fastener installation must not be more than that permitted in the engineering drawing. Install shims with primer, sealants, or adhesive as specified in the engineering drawings.

A. Measure the gap between the parts at the edges of the parts.

B. Use a sufficient thickness of solid filler and/or laminations to limit the gap between the parts before the fasteners are installed. Refer to the engineering drawing for the gap that is permitted.

C. Shims or solid fillers that are subsequently attached permanently with fasteners can be temporarily bonded together with adhesive transfer tape as follows:

(1) Cut the tape to the necessary dimensions of the shim assembly. Use only one layer of adhesive film.

NOTE: The tape can be cut before or after you apply it to the shim assembly.

(2) Apply the tape to the surface of the shim assembly and press down firmly.

NOTE: The paper backing can remain on the adhesive film for approximately 2 months until ready for installation.

(3) Remove the paper backing from the adhesive, position the shim assembly on the part and press down firmly. Make sure the adhesive touches all areas.

(4) Temporarily assemble the joint and drill the fastener holes through the shim assembly.

(5) Disassemble the joint and remove the sharp edges from the shim assembly.

(6) Remove the adhesive from the shim assembly.

D. Assemble the joint and install the shim assembly. Refer to 51-20-11, GENERAL and the applicable engineering drawing.

E. After the shims are installed, use a feeler gage to verify that partial gaps on either side of the shim are not more than 0.005 inch (0.127 mm) and do not extend to the shank of the bolt.

GENERAL - SURFACE ROUGHNESS FINISH REQUIREMENTS

1. Applicability

A. This chapter-section-subject tells how to measure the surface roughness on a metal surface.

2. General

A. Surface roughness affects fatigue life. Smoother (finer) surface finishes improve 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. See Figure 1/GENERAL for the Arithmetic Average Deviation.

3. General Machining

A. Roughness Values

NOTE: The following are maximum acceptable roughness values for machine finishes. There are no limits to the smoothness unless specified by a lower limit.

(1) 500 micro-inch rough machine finish. Rough, low grade surfaces that result from heavy cuts and course feeds in milling, turning, shaping, boring and from very rough filing, rough disc grinding and snagging. Examples of this surface are sand castings or rough forgings or the ripple finish on parts made by Keller end milling.

   (a) Not permitted on critically loaded parts, the failure of which would be unsafe to 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. Coarse production surfaces that results from very coarse surface grind, rough file, disc grind, and from rapid feeds in turning, milling, shaping, drilling, boring, grinding, and so on, where definite tool marks are permitted. This roughness can also be produced on the natural surfaces of forgings, permanent mold castings, extrusions, and rolled surfaces.

   (a) Surfaces with this roughness value can be produced very economically and are used frequently for parts where stress requirements, appearance, conditions of operations, and design permit.

   (b) Not permitted on:

      1) Steel that is heat treated over 200,000 psi or in areas with high fatigue stresses.

      2) Aluminum alloys.

      3) Steel surfaces mated with aluminum alloys.

(3) 125 micro-inch machined finish on steel or aluminum surfaces.

   (a) The roughest surface recommended for parts with fatigue stress or vibration. This surface roughness is also permitted for bearing surfaces when the motion is slow and the loads are light or infrequent. This surface finish can also be on permanent 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 machine finish, produced under controlled production procedures that use high speeds and fine feeds 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 the loads are light or infrequent. This surface roughness can also be on aluminum extrusions, coldrolled surfaces, die castings, and permanent mold castings when tightly controlled. Can be used where close fits are required for stressed parts. 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 can be measured by one of the methods that follow:

(1) Physical cmparator 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 specified in a repair drawing.

  (b) Select the roughest area on the part surface to be measured.

  (c) Feel the comparator and the part with a fingernail.

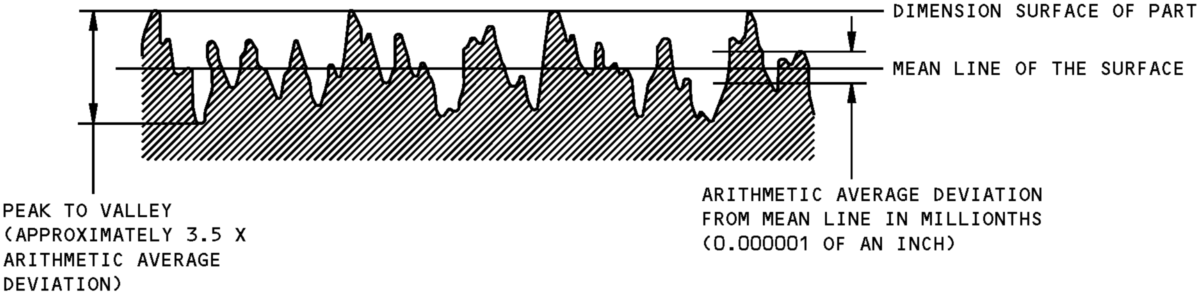
  (d) Select the direction on the comparator and the part surface which gives the highest roughness.

  (e) See if the part surface is as smooth as the comparator.

(2) Stylus-Type Inspection Instrument

  (a) This instrument must meet American National Standard (ANSI) B46.1 or equivalent standard for precision and accuracy.

  (b) Operate the stylus-type inspection instrument as specified in the manufacturer’s instructions.



Arithmetic Average Deviation
Figure 1

GENERAL - PROTECTIVE TREATMENT OF METALLIC AND NONMETALLIC MATERIALS - CF6-80C2 ENGINE NACELLE

1. General

A. This section applies to the CF6-80C(2) engine inlet cowl, fan cowl, and core cowl.

B. Any repair process which penetrates the surface of original structure requires a protective treatment. The following information is provided to assist in classifying the protective finish required for the type of repair shown in this manual. These finishes are considered to be acceptable for field-type repairs where speed and simplicity is essential.

C. Refer to 51-11-00, GENERAL General Damage Cleanup, prior to applying the required protective finish.

D. Mating Surfaces

(1) Galvanic corrosion occurs when dissimilar metal (metals having different electrochemical potentials) are coupled together in the presence of an electrolyte (electrically conducting solution). To prevent galvanic corrosion of dissimilar metals, a protective barrier is required between the contacting surfaces.

(2) Figure 1/GENERAL shows protective finishes to use on mating surfaces.

(3) Dissimilar metals are classified into four groups as shown in Figure 2/GENERAL. Classification is determined by the surface material of the part (i.e., the base metal of a nonplated part, or the deposited metal of a plated or coated part).

E. Fastener Installation

(1) The requirement for protection from galvanic corrosion may be determined from Figure 3/GENERAL. Fasteners requiring protective coating should be installed wet with CAT-A-LAC 463 fluid - resistant epoxy (FR) primer with the following exceptions:

NOTE: In areas where temperatures exceed 300°F (149°C), urethane primer 825-009 (DeSoto Chemical Co., Berkeley, CA 94710) must be substituted for CAT-A-LAC 463 FR primer in all cases.

(a) Removable fasteners on exterior unpainted surfaces - Install fasteners with MIL-C-16173, Grade 2, corrosion preventive compound.

(b) Torqued fasteners not in close tolerance holes - Coat hole with CAT-A-LAC 463 FR primer and allow to dry before installing fastener.

(c) Removable close tolerance fasteners - Install fasteners with MIL-C-16173, Grade 2, corrosion preventive compound.

(2) Shaved heads of aluminum rivets in unpainted anodized aluminum alloy surfaces must be coated with Alodine 1000.

2. References

Reference	Title
51-11-00, GENERAL	Damage Cleanup - CF6-80C2 Engine Nacelle
SOPM 20-30-85	Solvents For Final Cleaning of all Organic Coatings Before Painting (Series 85)

3. Brush Alodine Process

A. Bare (nonclad) aluminum alloys and chamfered edges of clad aluminum alloy repair parts or original structure require alodine. Treat repair parts and original structure that has been cut or filed with alodine. For appearance, use Alodine 1000 when treating exterior unpainted aluminum surfaces. On internal surfaces, the use of Alodine 1200S is preferred.

WARNING: PROTECTIVE GLOVES AND CHEMICAL GOGGLES MUST BE WORN TO PREVENT CONTACT WITH THE ALODINE SOLUTION. MIST OR DUST MAY CAUSE IRRITAITON TO THE NOSE, THROAT, AND LUNGS. ALODINE IS AN OXIDIZER; AVOID CONTACT WITH COMBUSTIBLE MATERIALS. SWABS OR CLOTH SATURATED WITH SOLUTION MUST BE RINSED THOROUGHLY WITH CLEAN, COLD WATER AFTER USE. THESE MATERIALS CONSTITUTE A FIRE HAZARD IF ALLOWED TO DRY.

B. Alodine Preparation

(1) Alodine 1000 Solution Preparation

(a) Add 0.5 ounce of Alodine 1000 powder to 1 gallon of distilled or deionized water in a polyethylene, stainless steel or equivalent container.

(b) Mix thoroughly until powder is dissolved.

(c) Allow the solution to stand at least 1 hour before use.

(2) Alodine 1200S Solution Preparation

(a) Mix 3 ounces of Alodine 1200S powder, 1/2 fluid ounce of concentrated nitric acid and 1 gallon of deionized or distilled water in a polyethylene, stainless steel or equivalent container.

(b) Add 1/8 fluid ounce of Activol 1357 wetting agent.

(c) Stir well until powder is dissolved.

(d) Allow the solution to stand at least 1 hour before use.

C. Surface Preparation

(1) Mask surface as necessary to prevent solution from contacting surfaces other than those to be treated.

(2) Seal or plug all holes, gaps or inlets to assemblies with suitable material to prevent entry of solution.

(3) Water-spray area to be treated and thoroughly abrade using abrasive nylon pads (Scotch-Brite, type A) or 400-grit aluminum oxide paper.

Continue to spray water while abrading to produce a water-break-free surface.

(4) Observe surfaces while wet to verify that a water-break-free condition of the surface has been achieved. While still wet, follow with the subsequent alodine procedure.

D. Chemical Conversion Coating Application

(1) Alodine 1000 Solution Application

(a) Apply Alodine 1000 solution with a fiber or nylon brush or clean cotton wipers.

(b) Agitate to keep the surface wet for approximately 3 to 4 minutes.

CAUTION: EXERCISE CARE WHEN RINSING AND DRYING TO AVOID SCRATCHING OR REMOVING THE COATING WHICH IS SOFT WHEN FRESHLY APPLIED.

(c) Rinse with clean water and wipe dry with clean, cotton wipers.

(d) Air-dry 1 to 3 hours.

(2) Alodine 1200S Solution Application

(a) Apply Alodine 1200S solution with a fiber or nylon brush or clean, cotton wiper.

(b) Agitate to the surface wet until a light golden or irridescent color develops (approximately 30 seconds).

CAUTION: EXERCISE CARE WHEN RINSING AND DRYING TO AVOID SCRATCHING OR REMOVING THE COATING WHICH IS SOFT WHEN FRESHLY APPLIED.

(c) Rinse with clean water and wipe dry with clean, cotton wipers.

(d) Air-dry 1 to 3 hours.

(e) Apply final finish or commence adhesive bonding as soon as possible after drying.

MATERIAL	FINISH ON MATING SURFACES	
	SIMILAR METALS A	DISSIMILAR METALS A
BARE ALUMIUM ALLOYS	ANODIZE AND APPLY ONE COAT OF CAT-A-LAC 463 PRIMER TO EACH SURFACE.	ANODIZE AND APPLY TWO COATS OF CAT-A-LAC 463 PRIMER TO EACH SURFACE.
STEEL (EXCEPT STAINLESS STEEL)	CADMIUM PLATE AND APPLY ONE COAT OF CAT-A-LAC 463 PRIMER TO EACH SURFACE.	CADMIUM PLATE AND APPLY TWO COATS OF CAT-A-LAC 463 PRIMER TO EACH SURFACE.
METAL LISTED IN FIG. 2, GROUP IV	NONE REQUIRED	APPLY TWO COATS OF CAT-A-LAC 463 PRIMER TO EACH SURFACE.
CLAD ALUMINUM ALLOY AND OTHER METALS NOT LISTED ABOVE	APPLY ALODINE AND ONE COAT OF CAT-A-LAC 463 PRIMER TO EACH SURFACE.	APPLY ALODINE AND TWO COATS OF CAT-A-LAC 463 PRIMER TO EACH SURFACE.

NOTES

- IN AREAS WHERE TEMPERATURES EXCEED 300°F, (149°C), DE SOTO 825-009 PRIMER MUST BE SUBSTITUTED FOR CAT-A-LAC 463 PRIMER IN ALL CASES

A SEE FIG. 2 FOR GROUPING OF SIMILAR AND DISSIMILAR METALS

Protective Treatment of Mating Surfaces
Figure 1

GROUP I	MAGNESIUM AND ITS ALLOYS. ALUMINUM ALLOYS 1100, 5052, 5056, 5356, 6061, 6063. BERYLIUM
GROUP II	CADMIUM, ZINC, ALUMINUM AND THEIR ALLOYS (INCLUDES GROUP I ALUMINUM ALLOYS) $\boxed{A}$
GROUP III	IRON, LEAD, TIN AND THEIR ALLOYS (EXCEPT CORROSION RESISTANT STEEL) $\boxed{B}$. DIFFUSED NICKEL-CADMIUM
GROUP IV	COPPER, CHROMIUM, NICKEL, SILVER, GOLD, PLATINUM, TITANIUM AND THEIR ALLOYS. CORROSION RESISTANT STEEL $\boxed{B}$. COBALT AND RHODIUM AND THEIR ALLOYS. MONEL, INCONEL, BRASS, BRONZE. GRAPHITE FIBER, FABRIC, OR TAPE $\boxed{C}$
MEMBERS OF ANY ONE GROUP ARE SIMILAR. MEMBERS OF DIFFERENT GROUPS ARE DISSIMILAR.	

NOTES

$\boxed{A}$ EXCEPT FOR 5056 RIVETS DRIVEN IN 2024, 2224 OR 2324 ALUMINUM ALLOYS

$\boxed{B}$ CORROSION RESISTANT STEEL CONTAINS 14% OR MORE CHROMIUM

$\boxed{C}$ GRAPHITE IS AN ELECTRICALLY CONDUCTIVE MATERIAL EVEN THOUGH IT IS CLASSIFIED AS A NON-METAL

Classification of Dissimilar Materials
Figure 2

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 GRAPHITE
ALUMINUM EXCEPT 5056	A	B	A	A D
ALUMINUM ALLOY 5056	B	G	A	A D
CADMIUM OR ZINC PLATE	A	C	A	A D E
CHROME PLATE	A	A	A	B D
UNPLATED CORROSION RESISTANT STEEL	A	A	A	F
NICKEL OR COBALT BASE ALLOYS	A	A	A	F
UNPLATED TITANIUM	A	A	A	B

NOTES

A PROTECTIVE TREATMENT IS NECESSARY

B PROTECTIVE TREATMENT IS NOT NECESSARY

C PROTECTIVE TREATMENT IS NOT NECESSARY EXCEPT FOR CADMIUM PLATED ALLOY STEEL BOLTS THROUGH ALUMINUM ALLOYS IN CRITICAL CORROSION AREAS

D NOT ALLOWED IN GRAPHITE MATERIAL

E DO NOT INSTALL CADMIUM PLATED FASTENERS IN TITANIUM STRUCTURE

F PROTECTIVE TREATMENT IS NOT NECESSARY EXCEPT FOR FASTENERS INSTALLED IN GRAPHITE MATERIAL

G PROTECTIVE TREATMENT IS NOT NECESSARY EXCEPT FOR 5056 RIVETS DRIVEN IN 2024,2224 AND 2324 ALUMINUM ALLOYS

Protective Treatment for Fastener Installation
Figure 3

4. Primer Application

A. Fluid-resistant epoxy (FR) primer is recommended for area where temperatures do not exceed 300°F (149°C).

(1) Application of FR primer.

(a) Mix primer and catalyst separately before measuring. To one part-by-volume of CAT-A-LAC 463 primer (Sikkens Aerospace Finishes, Torrance, CA 90502) add one part-by-volume of catalyst in a metal or glass container.

(b) Stir mixture thoroughly and let stand for 15 minutes. Material will remain usable for 8 hours if stored in closed container.

(c) Apply mixed FR primer to prepared surface with brush or spray.

(d) Air-dry or force dry FR primer with explosionproof heat lamp, using 350-watt infrared bulb.

B. Where temperatures exceed 300°F (149°C), urethane 825-009 primer (DeSoto, Inc., Carolina Plant, Greensboro, NC 27420) must be substituted for FR primer.

5. Steel-Cadmium Plating

A. Alloy steel parts used in repairs, which are not in an environment above 450°F (232°C), must be cadmium plated for maximum corrosion protection.

6. Surface Finish Restoration - Metal Repair Instructions

A. Smooth surface and feather-edges of paint coating with 280-grit or finer abrasive paper.

WARNING: DO NOT GET SOLVENTS IN YOUR MOUTH, OR YOUR EYES, OR ON YOUR SKIN. DO NOT BREATHE THE FUMES FROM SOLVENTS. SOLVENTS ARE HAZARDOUS MATERIALS. REFER TO PRODUCT MATERIAL SAFETY DATA SHEETS (MSDS) AND LOCAL REQUIREMENTS FOR PROPER HANDLING PRECEDURES.

B. Wipe surfaces clean with clean cloth moistened in methyl ethyl ketone (MEK), isopropyl alcohol, CDG-211, ethyl alcohol, or MIL-C-81302, Type I.

Wipe the surface dry before solvent evaporates.

WARNING: PROTECTIVE GLOVES AND CHEMICAL GOGGLES MUST BE WORN TO PREVENT CONTACT WITH ALODINE. ALODINE SOLUTION IS CORROSIVE AND MAY CAUSE SERIOUS BODILY HARM. MIST OR DUST MAY CAUSE IRRITATION TO THE NOSE, THROAT, AND LUNGS. ALODINE IS AN OXIDIZER; AVOID CONTACT WITH COMBUSTIBLE MATERIALS. SWABS OR CLOTH SATURATED WITH SOLUTION MUST BE RINSED THOROUGHLY WITH CLEAN, COLD WATER AFTER USE. THESE MATERIALS CONSTITUTE A FIRE HAZARD IF ALLOWED TO DRY.

C. Apply alodine chemical conversion coating to exterior and interior bare aluminum surfaces.

D. Rinse surface thoroughly with clean water and wipe dry, taking care not to penetrate coating. Wear clean, cotton gloves when holding parts after cleaning.

WARNING: PAINTS AND SOLVENTS SHOULD BE USED ONLY IN ACCORDANCE WITH THE MANUFACTURER SPECIFIC SAFETY AND HEALTH RECOMMENDATIONS. MANY PAINT MATERIALS AND SOLVENTS ARE CLASSIFIED AS HAZARDOUS MATERIALS WHICH MAY CAUSE INJURY OR ILLNESS IF NOT PROPERLY USED. PRIOR TO USE OF ANY PAINT OR SOLVENT PRODUCT, CAREFULLY READ THE APPLICABLE "MATERIAL SAFETY DATA SHEET" AND FOLLOW ALL LISTED SAFETY AND HEALTH PRECAUTIONS.

(WARNING PRECEDES)

CAUTION: DO NOT MIX DIFFERENT PAINT SYSTEMS OR MATERIALS FROM DIFFERENT MANUFACTURERS

E. Apply epoxy primer on parts located in areas where operating temperatures do not exceed 300°F (149°C).

  (1) Spray 0.5 to 0.7 mils of epoxy primer cross coat. Use primer base 463-6-11 with catalyst X315 and reducer TL65, or primer 463-6-27 with catalyst X337 and reducer TL52-66.

  (2) Air-dry coating for 2 hours at room temperature, 65°F-75°F (18°C-24°C), or force-dry for 15 minutes at 140°F-180°F (60°C-93°C).

F. Apply urethane primer on parts located in areas where operating temperatures exceed 300°F.

  (1) Spray urethane primer cross coat 0.8 to 1.5 mils thick. Use primer base 825-009, catalyst 910-175, and reducer 020-044.

  (2) Air-dry coating for 2-1/2 hours at room temperature or air-dry for 15 minutes at room temperature and force-dry for 30 minutes at 205°F-225°F (96°C-107°C).

G. Apply epoxy topcoat to primed exterior surface.

  (1) Clean primed surface with cloth moistened with solvent, Series 85 (AMM/ SOPM 20-30-85) if more than 72 hours have elapsed since application of prime coat. Wipe dry with clean cloth before solvent evaporates.

  (2) Spray a mist coat of epoxy topcoat on primed surface and allow to air-dry for 30 minutes at room temperature. Use topcoat base 463-3 with catalyst X304 and reducer TL29.

  (3) Air-dry topcoat 8 hours at room temperature or force-dry for 1 hour at 140°F-180°F (60°C-93°C).

H. Apply urethane topcoat to primed exterior surface.

  (1) Clean primed surface with cloth moistened with solvent, Series 85 (Ref AMM/ SOPM 20-30-85), if more than 72 hours have elapsed since application of primed coat. Wipe dry with clean cloth before solvent evaporates.

  (2) Spray a mist coat of polyurethane topcoat on primed surface and allow to air-dry for 30 minutes at room temperature. Use topcoat base 643-3-9 with catalyst X310A and reducer TL59, or topcoat base 822-315 with catalyst 910-331A and reducer 020-X310.

  (3) Spray a full, wet, second coat of epoxy topcoat 1.5 to 2.5 mils thick over the mist coat. Do not use cross coat application.

  (4) Air-dry topcoat 8 hours at room temperature or force-dry for 2 hours at 150°F-180°F (66°C-93°C).

7. Surface Finish Restoration of Graphite/Aramid/Epoxy Composite

WARNING: GLOVES, PROTECTIVE CLOTHING, REGULATORY AGENCY APPROVED DUST MASKS, AND APPROPRIATE EYE PROTECTION MUST BE WORN WHEN WORKING WITH COMPOSITE MATERIALS. BREATHING OF DUST OR PROLONGED CONTACT OF DUST WITH SKIN MUST BE AVOIDED. SANDING, CUTTING OR DRILLING OF COMPOSITE MATERIALS MAY PRODUCE DUST IN EXCESS OF ACCEPTABLE EXPOSURE LEVELS.

CAUTION: USE OF PAINT REMOVER COMPOUNDS ON GRAPHITE/ARAMID/EPOXY STRUCTURES IS PROHIBITED. THE COMPOUNDS ATTACK THE EPOXY BONDING ADHESIVES IN THE STRUCTURE AND WILL DEGRADE THE INTEGRITY OF THE PARENT COMPOSITE MATERIALS.

(CAUTION PRECEDES)

DO NOT TAPER OR BREAK GRAPHITE FIBERS FROM EXPOSED GRAPHITE PLY.

A. Remove surface finishes from graphite/aramid/epoxy structures with 150-180 grit abrasive paper.

B. Apply epoxy primer (yellow) to exterior surface of repair.

WARNING: DO NOT GET SOLVENTS IN YOUR MOUTH, OR YOUR EYES, OR ON YOUR SKIN. DO NOT BREATHE THE FUMES FROM SOLVENTS. SOLVENTS ARE HAZARDOUS MATERIALS. REFER TO PRODUCT MATERIAL SAFETY DATA SHEETS (MSDS) AND LOCAL REQUIREMENTS FOR PROPER HANDLING PRECEDURES.

(1) Use 180-grit abrasive paper and smooth the surface to a dull matte finish with all gloss removed. Remove sanding dust with solvent, Series 85 (AMM/ SOPM 20-30-85). Wipe dry with a clean cloth before solvent evaporates.

(2) Apply masking tape to repair area.

WARNING: AVOID SOURCES OF IGNITION. USE ONLY IN AREAS OF ADEQUATE VENTILATION. BASE, CONVERTER, AND THINNER ARE FLAMMABLE AND VAPOR IS HARMFUL. INHALATION OF SPRAY MIST MAY CAUSE SERIOUS BODILY HARM. WORK PERFORMED IN CONFINED AREA REQUIRES THE USE OF ADDITIONAL MECHANICAL FORCED VENTILATION. AVOID BREATHING OF VAPOR AND CONTACT WITH SKIN AND EYES. MAY CAUSE IRRITATION TO SKIN AND EYES. SEVERE OVEREXPOSURE MAY CAUSE FATIGUE, WEAKNESS, CONFUSION, HEADACHE, DIZZINESS, DROWSINESS, AND IMPAIRED JUDGEMENT. USE A REGULATORY AGENCY APPROVED RESPIRATORY PROTECTION FOR SPRAY APPLICATIONS. WASH HANDS WELL BEFORE EATING, DRINKING OR SMOKING. THIS PRODUCT CONTAINS LEAD, A CUMULATIVE POISON. PROTECTIVE GOGGLES SHOULD BE WORN DURING MIXING AND APPLICATION. PROLONGED OR REPEATED CONTACT WITH THIS EPOXY PRIMER MAY RESULT IN A PERMANENT SKIN ALLERGY TO BASE AND CONVERTER.

(3) Mix one part-by-volume of 463-7-26 primer base to one part-by-volume of X369 converter and thin with TL102 as required to obtain the proper spray consistency.

(4) Apply one coat of primer 0.0005 to 0.0010 inch (.0127 to .0254 mm) thick and allow to cure for 30 minutes at 75°F (24°C) or higher. Apply a second coat and cure before the application of the topcoat. Dried film thickness shall be 0.0006 to 0.0009 inch (.0152 to .0227 mm.)

C. Apply antistatic coating (black).

WARNING: SANDING, CUTTING, OR DRILLING OF COMPOSITE MATERIALS MAY PRODUCE DUST IN EXCESS OF ACCEPTABLE EXPOSURE LEVELS. GLOVES, PROTECTIVE CLOTHING, REGULATORY AGENCY APPROVED DUST MASKS, AND APPROPRIATE EYE PROTECTION MUST BE WORN WHEN WORKING WITH THESE MATERIALS. AVOID BREATHING OF DUST OR PROLONGED CONTACT OF DUST ON SKIN.

(WARNING PRECEDES)

WARNING: DO NOT GET SOLVENTS IN YOUR MOUTH, OR YOUR EYES, OR ON YOUR SKIN. DO NOT BREATHE THE FUMES FROM SOLVENTS. SOLVENTS ARE HAZARDOUS MATERIALS. REFER TO PRODUCT MATERIAL SAFETY DATA SHEETS (MSDS) AND LOCAL REQUIREMENTS FOR PROPER HANDLING PRECEDURES.

(1) If more than 72 hours have elapsed since application of primer coat, lightly abrade primed surface with 400-grit abrasive paper, solvent-clean with solvent, Series 85 (AMM/ SOPM 20-30-85), and apply a mist coat of primer, 0.0001 to 0.0003 inch thick. Air dry mist coat for 30 minutes at 75°F-85°F (24°C-29°C).

(2) Expose a strip of antistatic paint approximately 0.5 inch wide, surrounding the repair area, by feather-sanding with 280-320 grit silicon carbide abrasive paper to remove outer coat (topcoat) and any repair first coat (primer). Mask surrounding topcoat to prevent antistatic coating overspray.

NOTE: The repair middle coat (antistatic coating) must be blended with the middle coat, surrounding the repair area, to meet the resistance check to ground when the middle coat is fully cured.

WARNING: BASE, CONVERTER, AND THINNER ARE FLAMMABLE AND VAPOR IS HARMFUL. INHALATION OF SPRAY MIST MAY CAUSE SERIOUS BODILY HARM. AVOID SOURCES OF IGNITION. USE ONLY IN AREAS WITH ADEQUATE VENTILATION. WORK PERFORMED IN CONFINED AREA REQUIRES THE USE OF ADDITIONAL FORCED MECHANICAL VENTILATION. AVOID BREATHING OF VAPOR AND CONTACT WITH SKIN AND EYES. MAY CAUSE IRRITATION TO SKIN AND EYES. SEVERE OVER EXPOSURE MAY CAUSE FATIGUE, WEAKNESS, CONFUSION, HEADACHE, DIZZINESS, DROWSINESS, AND IMPAIRED JUDGEMENT. USE REGULATORY AGENCY APPROVED RESPIRATORY PROTECTION FOR SPRAY APPLICATIONS. THIS PRODUCT CONTAINS LEAD, A CUMULATIVE POISON. WASH HANDS WELL BEFORE EATING, DRINKING, OR SMOKING. PROTECTIVE GLOVES SHOULD BE WORN DURING MIXING APPLICATION. PROLONGED OR REPEATED CONTACT WITH THIS EPOXY PRIMER MAY RESULT IN A PERMANENT SKIN ALLERGY TO BASE AND CONVERTER.

(3) Mix three parts-by-volume of 463-6-14 antistatic coating base with one part-by-volume of CA97 converter and thin with TL52 (maximum 10 per cent) as required to obtain proper spray consistency.

(4) Apply antistatic coating to primed and feather-sanded repair area 0.0003 to 0.0008 inch thick and cure for 30 minutes at 75°F-85°F (24°C-29°C). Apply second coat if required to obtain dried film thickness of approximately 0.0010 inch. Remove mask.

NOTE: Longer cure time at higher temperatures lowers the resistivity of the coating.

(5) Check electrical conductance of anti-static coating with an ohmmeter of 1.0 megaohm capacity and electrical leads with contact pins, as follows:

   (a) Place one contact pin on surface in center of repair area and the other pin on wear strip, aft side of the inlet cowl attach flange.

   (b) The resistance must not exceed 50,000 ohms.

D. Apply polyurethane topcoat (gray).

WARNING: AVOID SOURCES OF IGNITION. BASE AND CONVERTER OF THE POLYURETHANE PAINT SYSTEM ARE FLAMMABLE. USE ONLY IN AREAS OF ADEQUATE VENTILATION. INHALATION OF VAPOR OR SPRAY MIST MAY CAUSE SERIOUS BODILY HARM INCLUDING LUNG IRRITATION AND ALLERGIC RESPIRATORY REACTION. WORK PERFORMED IN CONFINED AREAS REQUIRES THE USE OF ADDITIONAL MECHANICAL FORCED VENTILATION. AVOID BREATHING OF VAPOR CONTACT WITH SKIN AND EYES. SEVERE OVEREXPOSURE MAY CAUSE FATIGUE, WEAKNESS, CONFUSION, HEADACHE, DIZZINESS, DROWSINESS AND IMPAIRED JUDGEMENT. USE A REGULATORY AGENCY APPROVED RESPIRATORY PROTECTION FOR SPRAY APPLICATIONS. WASH HANDS WELL BEFORE EATING, DRINKING OR SMOKING. THIS PRODUCT CONTAINS LEAD, A CUMULATIVE POISON. BUTYL RUBBER, NEOPRENE OR NITRILE GLOVES SHOULD BE WORN DURING MIXING AND APPLICATION. THIS PRODUCT MAY CAUSE DERMATITIS BY REMOVING SKIN OILS. NONCOMPLIANCE COULD CAUSE PERSONNEL INJURY.

(1) Mix three parts-by-volume of 643-3-9 polyurethane coating base with one part-by-volume of X310A converter and thin with TL59 (maximum of 25 percent of total mix) to obtain proper spray consistency.

(2) Apply 0.0015 to 0.0025 thick polyurethane to the antistatic coating surface and extend a minimum of 1.0 inch past the edge of the antistatic coating. Cure the topcoat for 30 minutes at 65°F-75°F (18°C-24°C) with a minimum of 40 percent relative humidity. Dried film thickness shall be 0.0016 to 0.0018.

GENERAL - REPAIR SEALING - CF6-80C2 ENGINE NACELLE

1. General

A. This section applies to the CF6-80C2 engine inlet cowl, fan cowl and core cowl.

2. References

Reference	Title
51-20-05, GENERAL	Repair Sealing

3. Sealant Application

A. Use a plastic tool to remove sealant without damaging anodized coating on inlet cowl lip or on inlet cowl composite material.

WARNING: DO NOT GET SOLVENTS IN YOUR MOUTH, OR YOUR EYES, OR ON YOUR SKIN. NOT BREATHE THE FUMES FROM SOLVENTS. SOLVENTS ARE HAZARDOUS MATERIALS. REFER TO PRODUCT MATERIAL SAFETY DATA SHEETS (MSDS) AND LOCAL REQUIREMENTS FOR PROPER HANDLING PRECEDURES.

B. Clean repair area and remove sealant residue using methyl propyl ketone, BMS 11-7, FCC-55, or methyl ethyl ketone (MEK) and an abrasive pad.

NOTE: Some sealants use a necessary primer. Refer to Table 1, below to see if you must do the steps in Paragraph 3.

Table 1: Seralants Data

PERMITTED SEALANT	SLOW CURE TIME	FASTER CURE TIME	NECESSARY PRIMER
DC-006-1 (Hardness 30)	10 Hours At Room Temperature	2 Hours At Room Temperature Plus 2 Hours At 190°F (88°C)	DC1200
DC-006-6 (Hardness 35)	48 Hours At Room Temperature	2 Hours At Room Temperature Plus 2 Hours At 190°F (88°C) (Extend Cure As Necessary To Get Full Hardness)	DC1200
PR-1995 (Hardness 30)	24 Hours At Room Temperature	2 Hours At Room Temperature Plus 2 Hours At 190°F (88°C) (Extend Cure As Necessary To Get Full Hardness)	None
BMS 5-63, Type II, Class B-1/2	4 Hours At Room Temperature	Humidity and Temperature Can Affect Cure Time - See 51-20-05, GENERAL for more data.	None

4. Apply Primer

NOTE: Do not apply primer with PR-1995 or BMS 5-63 sealant.

A. Mask repair area to protect cowl for primer overspray.

WARNING: AVOID PROLONGED OR REPEATED SKIN CONTACT WITH PRIMER. USE ONLY IN AREAS WITH GOOD VENTILATION. VERY FLAMMABLE; KEEP AWAY FROM IGNITION SOURCES

B. Apply a thin coat of DC1200 primer to the repair area and allow to dry at room temperature until finish has dull appearance.

WARNING: USE SEALANT ONLY IN AREAS WITH GOOD VENTILATION. TAKE PRECAUTION TO PREVENT MATERIAL FROM COMING INTO CONTACT WITH THE SKIN.

C. Mix the sealant in accordance with the manufacturer’s instruction.

D. Apply the sealant to a level that is between 0.010 inch (2.5 mm) below the surface and a level even with the surface.

E. Cure the sealant. Refer to Table 1/GENERAL for cure temperature data.

F. Remove masking materials.

GENERAL - PROTECTIVE TREATMENT OF METALLIC AND NONMETALLIC MATERIALS - RB211-524 ENGINE NACELLE

1. General

A. Nonmetallic repair parts

This section establishes the requirement for application of exterior coating to repair parts during accomplishment of repairs. The coatings, including primers with or without topcoats, will provide resistance to acid, fuel, lubrication oil, hot di-ester oil 178 deg.C. (350 deg.F.) and solvents. The topcoat system consists of a two component epoxy primer and two component polyurethane coating.

B. Metallic repair parts

Any repair which breaks the protective surface treatment of metallic parts, thus exposing them to possible corrosion, must be protected as detailed in Paragraph 5./GENERAL. All areas to be protected must be thoroughly degreased. The protective treatment is a pre-treatment, primer and application of gloss enamel.

2. References

Reference	Title
51-21-01, GENERAL	Protective Treatment of Metallic and Nonmetallic Materials - CF6-80C2 Engine Nacelle
SOPM 20-30-85	Solvents For Final Cleaning of all Organic Coatings Before Painting (Series 85)
SOPM 20-30-88	Solvents For Final Cleaning Metal Before Non-Structural Bonding (Series 88)

3. Materials

A. For nonmetallic repair materials and their sources, refer to Protective Material Sources, Figure 1/GENERAL.

B. For metallic repair materials and their sources refer to Protective Material Sources, Figure 2/GENERAL.

4. Protective Treatment of Nonmetallic Parts

A. Surface preparation

(1) Surface preparation consists of the following three methods:

(a) Dry abrasion

(b) Wet abrasion

(c) Dry abrasive blast

(2) Dry abrasion

(a) Wash surface with MEK (Methyl Ethyl Ketone), MPK, CDG-110, CDG-211, ethyl alcohol, or isopropyl alcohol and clean wipers.

(b) Dry sand surface using waterproof abrasive paper, grit size 180 through 400.

(c) Use abrasive nylon web pads (Scotchbrite) to clean and remove gloss from indentations or depressions.

NOTE: Use a light circular sanding motion and avoid exposing fibers of composite material surfaces.

(d) Remove sanding residue with clean, dry compressed air.

CAUTION: DO NOT ALLOW SOLVENTS TO DRY ON SURFACE.

(e) Wash surface with MEK, CDG-110, CDG-211, MPK, Turco 6709, or FCC-55 and clean wipers; wipe dry.

(3) Wet abrasion

CAUTION: DO NOT ALLOW SOLVENT TO DRY ON SURFACE.

(a) Remove soil from surface using clean cotton wipers dampened with MEK, CDG-110, CDG-211, MPK, Turco 6709, or FCC-55.

(b) Dry with clean cotton wipers.

(c) Following preliminary solvent wash; water sand, using tap water and waterproof abrasive paper, grit size 180 through 400.

NOTE: All areas must present a matt appearance after sanding.

(d) Rinse with clean, tap water.

(e) Perform a water break test. Refer to par. (5).

(4) Dry abrasive blast

(a) Remove soil from surface using clean cotton wiper dampened with MEK, CDG-110, CDG-211, ethyl alcohol, or isopropyl alcohol.

(b) Abrasive blast, using 240 grit or fine aluminum oxide. The blast shall be directed at approximately a 45 degree angle to surface being abraded and air pressure at nozzle not to exceed 40 psi.

(c) Abrade composite material to produce a matt finish without exposing any of the reinforcement fibers.

(d) Remove abrasive residue using clean, dry compressed air and a brush or a clean dry cloth.

(5) Surface break test.

(a) Using a clean soft hair brush and the specified fluid, quickly apply a uniform film over the bonding area.

- NML 21 fluid
- Industrial or Ethly Alcohol - 25 to 30 ml. (OMat 155 or 156)
- Distilled water - 1000 ml.
- Crystal violet - 1 g. (OMat 1/59)

(b) Immediate observation must be made for any break in continuity of the film.

(c) If breaks occur within 30 seconds, the appropriate surface cleaning procedure must be repeated until a continuous film is observed.

(d) Remove the break test fluid by swabbing with clean acetone (OMat 1/13) and then allowing the surface to dry.

B. Application of protective treatment

(1) Apply coatings

(a) Remove peel ply from surface.

(b) Apply one cross coat of epoxy primer 513 x 319 base and 910 x 456 curing agent, 0.500 to 0.800 mm. (0.0197 to 0.0315 in.) thick.

NOTE: See Paragraph C. for mixing instructions.

(c) Cure for a minimum of two hours or a maximum of eight hours.

(d) Abrade surface of primer to remove matt appearance.

(e) Remove high spots to produce a smooth finish.

(f) Apply white filler putty 467-9/CA-41B to fill surface imperfections prior to application of surfacer, primer, and topcoat.

CAUTION: FILLER PUTTY, WHEN CATALIZED, HAS A USABLE WORK LIFE OF EIGHT HOURS AT TEMPERATURES BELOW 26.7 DEG.C. (80 DEG.F.).

(g) Work filler putty into surface defects with a putty knife, plastic squeegee or a pad of cheesecloth.

NOTE: 1. Use a knife or plastic squeegee with a firm criss-cross motion.

2. Use a pad of cheesecloth with a circular motion.

3. A pad of cheesecloth is preferred method.

(h) Before curing filler putty, remove all possible excess to prevent subsequent excessive abrading.

NOTE: A knife, razor blade or plastic squeegee is recommended for this purpose.

(i) Cure filler putty by one of the following methods before abrading:

1) Air dry at ambient 21 ±6°C (70 ±10°F) temperature for 6 hours minimum.

2) Force cure: Allow to air dry at ambient temperature approximately 45 minutes, then force cure at 71 to 82°C (160 to 180°F) for 60 to 90 minutes.

(j) Sand cured filler putty with 240 through 320 grit abrasive paper.

(k) Remove sanding residue with clean, dry, compressed air.

(l) Wash with MEK, CDG-110, CDG-211, FCC-55, MPK, or Turco 6709, and cheesecloth; wipe dry.

(m) Spray apply one uniform cross-coat of surfacer (464-3-1/CA-142).

NOTE: A mixed surfacer has a usable work life of 4 hours at temperatures below 27°C (80°F).

(n) Cure surfacer by one of the following methods before abrading:

1) Air dry at 21 ±6°C (70 ±10°F) for 6 hours.

2) Air dry at ambient temperature for 45 minutes minimum and force cure at 71 to 82°C (160 to 180°F) for 1 hour.

(o) Abrade cured surfacer using 240 through 400 grit abrasive paper, removing majority of surfacer without abrading through to substrate.

(p) Remove abrading residue with dry, filtered, compressed air and a brush or clean wipers.

CAUTION: DO NOT ALLOW SOLVENT TO DRY ON SURFACE.

(q) Wash with clean wipers dampened with MEK, CDG-110, CDG-211, FCC-55, MPK, or Turco 6709 to remove abrading residue.

(r) Wipe dry with clean wipers.

C. Mixing and thining protective coating

(1) Epoxy primer (513 x 319 base and 910 x 456 curing agent)

(a) Mix material to manufacturer's instructions.

(b) Allow mixture to catalize a minimum of 25 minutes before using.

NOTE: Immediately after mixing, mark containers with date and hour of mixing and pot life expiration date.

(c) Pot life is 8 hours in a closed container.

NOTE: 1. Mix only the amount of material which can be used immediately to avoid gelation in the pot.

2. Discard material after 8 hours.

(2) Topcoat

(a) Mix an equal amount of base and catalyst by volume.

(b) Add up to 10 per cent thinners (TL59) by volume to obtain spraying viscosity.

(c) Allow mixture to catalize 30 minutes before using.

NOTE: Immediately after mixing, mark containers with date and hour of mixing and pot life expiration date.

(d) Pot life is 8 hours in a closed container.

NOTE: 1. Mix only the amount of material which can be used immediately to avoid gelation in the pot.

2. Discard material after 8 hours.

D. Application procedures for protective coating

(1) Apply epoxy primer (513 X 329 base, 910 X 456 curing agent)

(a) Apply a coat of epoxy primer, 0.5 to 0.8 mm. (0.0197 to 0.0315 in.) thick.

(b) Topcoat (external surface) (822-315/910-331A or 643-3-9/ X 310A).

1) Apply a thin wet coat approximately 0.5 to 1.0 mm. (0.0197 to 0.0394 in.) thick and allow to dry for 60 minutes.

CAUTION: DO NOT APPLY A MIST OR FOG COAT, THIS WILL CAUSE A ROUGH SURFACE RESULTING IN LOSS OF GLOSS.

2) Apply a second wet coat to form total dry topcoat film thickness of 1.0 to 2.0 mm. (0.0394 to 0.079 in.).

(2) Apply topcoat (internal surface) 822-315/910-331A or 643-3-9/ X 310A.

(a) Apply directly over adhesive primed surfaces that have been solvent cleaned with solvent, Series 85 (AMM/ SOPM 20-30-85).

(b) Apply a topcoat to a dry film thickness of 0.8 to 1.0 mm. (0.0315 to 0.0394 in.).

E. Curing and drying protective coating

(1) Primer

(a) The minimum air dry time of the primer prior to application of a topcoat is 2 hours.

(b) The maximum allowable air dry time of the primer prior to application of a topcoat is 24 hours.

(2) Topcoat

(a) Full cure at ambient temperature is 14 days, or at 60 to 70 deg.C. (140 to 160 deg.F.) for 8 to 12 hours.

(b) Dry for stacking, handling, and taping.

1) At 71 to 82 deg.C. (160 to 180 deg.F.) for 1 hour.

OR

2) At 49 to 54 deg.C. (120 to 130 deg.F.) for 2 hours.

OR

3) At 27 to 32 deg.C. (80 to 90 deg.F.) for 5 hours.

5. Protective Treatment of Metallic Parts (Nose Cowl External Surface)

A. Clean surface in preparation for protective treatment.

WARNING: WHEN USING DEGREASING FLUID, ENSURE ADEQUATE VENTILATION, AVOID SKIN CONTACT AND AVOID INHALING VAPOR.

(1) Cold liquid degrease using solvent, Series 88 (AMM/ SOPM 20-30-88).

NOTE: It is important that a clean lint-free cloth is used for each separate degreasing operation and that the cloth is moistened by means of a suitable dispenser so that liquid runs on to cloth and thereby avoiding contamination of the bulk of liquid. It is essential that degreased areas remain free from any form of contamination due to handling and soiling.

(a) Moisten a clean, dry, lint-free cloth with degreasing liquid and swab surfaces to be cleaned.

CAUTION: IF DRYING TIME IS OMITTED, CORROSION CAN RESULT FROM BREAKDOWN OF ANY RESIDUAL LIQUID TRAPPED IN A RESTRICTED SPACE.

(b) Allow parts that have internal pockets or passage ways to dry for at least one hour.

B. Pretreat surfaces (refer to Protective Materials, Figure 2/GENERAL)

WARNING: USE GOOD VENTILATION TO PREVENT OPERATOR BREATHING THE FUMES. AVOID SKIN CONTACT BY WEARING P.V.C. GLOVES, APRON, AND GOGGLES. IF CONTACT OCCURS, WASH IMMEDIATELY WITH WATER.

(1) Degrease as detailed in Paragraph 4, operation A.

NOTE: Surfaces which have been wet or dry blasted do not require operations (2) to (5) being affected.

(2) Further clean area by brushing with Synperonic ’N’ solution.

(3) Swill area with clean, cold water.

(4) Brush on phosphoric acid etch solution.

(5) Swill area with clean, cold water.

(6) Brush on Alocrom 1200 solution until surface shows an irridescent gold to a light, golden brown color.

(7) Swill area with clean, cold water and dry off either by use of warm air blast or by carefully wiping with clean cloths.

C. Apply primer (463-6-5 Bostick Finch Yellow).

’Procedure to be issued later’

D. Apply polyurethane enamel gloss (653-3-9 Bostick Finch Grey).

’Procedure to be issued later’

MATERIAL	SOURCE	SUBJECT																			
		51-22-01																			
MATERIALS FOR PROTECTIVE TREATMENT																					
COATING COLOR 707 GREY 822 - 315/910 - 331A	A	X																			
COATING COLOR 707 GREY 643 - 3-9/X 310A	D	X																			
URETHANE PAINT	C	X																			
THINNERS TL 59	D	X																			
P33 POLYURETHANE PRIMER CATALYST CSH 3334	E I J	X																			
P33 POLYURETHANE PRIMER BASE CSH 3233	E I J	X																			
P33 POLYURETHANE THINNER TSL 3335	E I J	X																			
P66 POLYURETHANE FINISH BASE (GREY) SH3266	E I J	X																			
P66 POLYURETHANE FINISH CATALYST CSH 3367	E I J	X																			
P66 POLYURETHANE THINNERS TSL 3261A	E I J	X																			
PRIMERS																					
513 X 319 BASE		X																			
910 X 456 CURING AGENT	A	X																			
RMS 118 TYPE 1		X																			
FILLERS																					
WHITE FILLER PUTTY 467 - 9/CA - 41/B	D	X																			
WHITE SURFACER 464 - 3 - 1/CA - 142	D	X																			
FILLER TWO PACK EC3524B/A PART A, PART B	I K L (OR ANY APPROVED LOCAL AGENT)																				
CLEANERS																					
METHYL-ETHYL-KETONE H-N-95		X																			
TRICHLOROETHYLENE - INHIBITED 1.1.1 (CHLOROETHANE VG. BS 4487: 1969 MIL-T-81533	G H E	X																			
METHYL-ETHYL-KETONE M-M-95	LOCAL PURCHASE																				

Protective Material Sources (Nonmetallic)
Figure 1 (Sheet 1 of 3)

MATERIAL	SOURCE	SUBJECT																			
		51-22-01																			
MISCELLANEOUS ITEMS																					
ABRASIVE PAPER 120 TO 400 GRIT	$\boxed{B}$	X																			
NYLON WEB PADS		X																			
LINT-FREE COTTON WIPERS		X																			
METHYLATED SPIRIT BS 3951:1963	$\boxed{E}\boxed{F}\boxed{G}$ (OR LOCAL PURCHASE)	X																			
ETHYL ALCOHOL BS 507:1966	$\boxed{E}\boxed{F}\boxed{G}$ (OR LOCAL PURCHASE)	X																			
DISTILLED WATER	$\boxed{E}\boxed{F}\boxed{G}$ (OR LOCAL PURCHASE)	X																			
INDICATOR, CRYSTAL VIOLET	$\boxed{E}\boxed{F}$ (OR LOCAL PURCHASE)	X																			
ACETONE	$\boxed{E}\boxed{F}$ (OR LOCAL PURCHASE)	X																			
PVC SHEETING GRADE DO, UNEMBOSSED, GREEN 317, BS 1763	$\boxed{I}\boxed{M}$ (OR ANY APPROVED LOCAL AGENT)																				
SCOTCH BRITE TYPE A 7496 COARSE (LIGHT GREEN) FINE TO MEDIUM	$\boxed{I}\boxed{K}$	X																			
SURFACE INSPECTION FLUID NML21 MSRR9015	$\boxed{E}$	X																			
WATERPROOF SILICON CARBIDE SANDPAPER GRIT SIZE 400,360, 320,280,240 AND 220	$\boxed{E}\boxed{N}\boxed{O}\boxed{P}$ (OR LOCAL PURCHASE)	X																			

Protective Material Sources (Nonmetallic)
Figure 1 (Sheet 2 of 3)

NOTES

[A] DE SOTO INC., PACIFIC PLANT
FOURTH AND CEDER STS
BERKLEY, CA 94710
USA

[B] 3-M COMPANY
ST. PAUL, MN 55101
USA

[C] U.S. PAINT DIV, GROW GROUP
831 S. 21 STREET
ST. LOUIS, MO 63103
USA

[D] BOSTICK
20846 S NORMANDY AVE.
TORRANCE, CA 90502
USA

[E] MED-LAB LTD
COPELAND ST.
DERBY, DEL 2PU

[F] THE BRITISH DRUG HOUSES LTD
BDH LABORATORY CHEMICAL DIVISION
POOLE, DORSET OR BINKBECK STREET
LONDON, E2 SJW

[G] IMPERIAL CHEMICAL INDUSTRIES LTD
NEW YORK LTD, AMERICA INC.
444 MADISON AVE.
NEW YORK 22
USA

[H] IMPERIAL CHEMICAL INDUSTRIES LTD
ICI HOUSE
MILLBANK
LONDON SWIP 355

[I] INTERNATIONAL PAINT CO. LTD
(PINCHIN JOHNSON PAINT DIVISION)
380 RICHMOND ROAD,
KINGSTON, SURRY KT2 5PS
ENGLAND

[J] INTERNATIONAL PAINT CO., INC.
21 WEST STREET
NEW YORK CITY, NY 10006

[K] 3M'S (UK) LTD
3M HOUSE
PO BOSE 1
BRACKNELL, BERKSHIRE RG12 1JU

[L] CANADIAN GENERAL ELECTRIC
5000 JEAN TALON WEST
MONTREAL QUEBEC, CANADA

[M] WALLINGTON WESTON CO., LTD
FROME, SOMERSET BA11 3EQ
ENGLAND

[N] CARBORUNDUM CO., LTD
PO BOX 55
TRAFFORD PARK
MANCHESTER M17 1HP
ENGLAND

[O] ENGLISH ABRASIVES CORPORATION
MARSH LANE
TOTTENHAM, LONDON M17

[P] NORTON CO.
COATED ABRASIVES DIVISION
TROY, NY 12181

Protective Material Sources (Nonmetallic)
Figure 1 (Sheet 3 of 3)

6. Restoration of Surface Protection to Nose Cowl, Thrust Reverser and Fan Cowl Components

NOTE: This Repair details the restoration of surface condition by application of filler material to surface imperfections and application of exterior coating. Coatings, including primers with or without topcoats provide corrosion protection and resistance to acid, fuel, lubrication oil, hot diester oil and solvents. The topcoat system consists of a two component polyurethane primer and a two component polyurethane topcoat.

A. Clean repair area.

(1) Thoroughly degrease repair area, use solvent, Series 88 (AMM/ SOPM 20-30-88) and clean lint-free cloths.

(2) Dry area immediately using oil-free dry air supply.

CAUTION: AVOID EXPOSING FIBRES. USE LIGHT CIRCULAR MOTIONS AND ABRADE REPAIR SURFACES. USE GARNET PAPER 320 TO 400 OR 220 TO 230 (REF51-21-01, GENERAL).

(3) Clean surface and remove gloss from indentations and depressions. Use Scotch Brite.

(4) Remove sanding residue from repair area. Use oil-free air blast.

(5) Repeat step 1.

(6) Water break test surfaces (Ref51-21-01, GENERAL). If unsuccessful, repeat steps 4, 5, and 6.

NOTE: If component is not to be treated immediately cover prepared area with PVC sheeting. Avoid contaminating prepared area during this operation.

B. Application of Resin Filler

(1) Mix EC3524B/A resin filler. Measure one hundred (100) parts EC3524B (blue) to ninety-four (94) parts of EC3524A (white) by weight. Mix materials by kneading until uniform blue color, free of streaks is obtained (Ref). Remove PVC sheeting if previously used.

(2) Apply filler material to imperfections, slightly overfilling to allow for subsequent dressing.

C. Cure the resin filler

(1) Partially cure at 72°F (22°C) until resin filler starts to stiffen.

(2) Using clean warm pallet knife or similar, remove excess filler. Use a planing or burnishing action; clean blade before reheating.

(3) Complete cure for 24 hours at 72°F (22°C) or half an hour at 200°F (93°C).

(4) Blend filler material to contours. Use garnet 220 to 280 or 324 to 400.

(5) Remove sanding residue from area. Use oil-free air blast.

(6) Clean area again per Paragraph A, Steps 1 and 2.

NOTE: If surface is not to be coated immediately, cover prepared area with PVC sheeting.

D. Application of polyurethane primer

(1) Mix polyurethane primer constituents per manufactures' instructions.

NOTE: Viscosity of P33 polyurethane primer base and catalyst can be adjusted with P33 polyurethane thinner as required. If Rohr and Boeing system 513X329 (primer) and Rohr and Boeing system 910X456 (catalyst) are used in place of P33 polyurethane, thinners are not available. Pot life is 8 hours at 72°F 22°C.

(2) Remove PVC sheeting if previously used.

(3) Spray primer on prepared surface. Allow to air-dry for a minimum of 4 hours before applying topcoat.

NOTE: The recommended time between application of primer and topcoat is 24 hours. If this interval exceeds 72 hours then the surface must be reprepared and the primer reapplied.

E. Application of polyurethane topcoat.

(1) Use polyurethane topcoat as per manufacturers instructions.

NOTE: Viscosity of P66 polyurethane finish primer and catalyst can be adjusted with P66 polyurethane thinners as required if Rohr and Boeing system 643-3 finish base and Rohr and Boeing system 310A finish catalyst, are used. Viscosity can be adjusted using Rohr and Boeing system TL59 as required.

(2) Apply one wet or wet topcoat on primed surface with a minimum of 10-minute drying time between coats.

(3) Allow topcoat to air-dry for a minimum of 6 hours before handling.

MATERIAL	SUBJECT								SUPPLIER
	51-22-01								
MATERIALS FOR PROTECTIVE TREATMENT									
ENAMEL GLOSS BAC707 GREY 653-3-9	X								
THINNERS TL 59	X								B
TWO PACK EPOXY CLEAR ENAMEL									
BASE SL5459 PJP9110A 8000									A C D
CATALYST CSH5538 PJ92000.2.0538									A C D
PRIMER (EPOXY)									
YELLOW 463 - 6 - 5									
THINNERS TL 52									B
FILLERS									
RESIN FILLER EC3524BA									A E
SURFACE PRE-TREATMENT									
ALOCROM 1200 DTD900/4413 31g/1	X								A
SEALER									C F G H
HYLOMAR SQ 32M									
SYNPERONIC "N" SOLUTION	X								A
PHOSPHORIC ACID (H3 PO4 S.G.I. 65)	X								A
ETCH CLEANING									
NITRIC ACID SG-142 3ml/l	X								A
CLEANING SOLVENT									
DEOXIDE 624	X								A
INHIBITED 1.1.1. TRICHLOROETHANE	X								
MISCELLANEOUS ITEMS									
LINT-FREE COTTON WIPERS	X								
SUITABLE PAINT BRUSH	X								
POLYTHENE CONTAINER	X								
GARNET PAPER 60-80									

Protective Material Sources (Metallic)
Figure 2 (Sheet 1 of 2)

NOTES

A MED-LAB LIMITED
COPELAND STREET
DERBY
DE1 2PU
ENGLAND
OR
IMPERIAL CHEMICAL INDUSTRIES LTD.
I.C.I. HOUSE
MILLBANK
LONDON SW1
ENGLAND
OR
IMPERIAL CHEMICAL INDUSTRIES LTD.
NEW YORK LTD AMERICA INCORPORATED
444 MADISON AVENUE, NY
USA

B BOSTIK
20846 S NORMANDY AVE
TORRANCE CA 90502
USA

C PPG INDUSTRIES (U.K.) LTD.
AVIATION AND DEFENCE COATINGS
ROTTON PARK STREET
LADYWOOD
P.O. BOX 359
BIRMINGHAM BIB OAD
ENGLAND

D INTERNATIONAL PAINT CO. INC.
21 WEST STREET
NEW YORK CITY, NY 10006
USA

E 3M COMPANY
3M HOUSE
P.O. BOX 1
BRACKWELL
BERKSHIRE
RG12 1JU
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F MARSTON LUBRICANTS LIMITED
7-11 NAYLOR STREET
LIVERPOOL L3 6DS
ENGLAND

G VAN DUSSEN AIRCRAFT SUPPLIES
TETERBORO AIRPORT
500 INDUSTRIAL AVENUE
TETERBORO, NJ 07608
USA

H KINGSLEY AND KIETH (CANADA) LTD
310 VICTORIA AVENUE
P.O. BOX 140 VICTORIA STATION
MONTREAL 6
QUEBEC
CANADA

Protective Material Sources (Metallic)
Figure 2 (Sheet 2 of 2)

767-300
STRUCTURAL REPAIR MANUAL

GENERAL - REPAIR SEALING - RB211-524 ENGINE NACELLE

1. General

A. The procedures detailed in this section are to be used when fay surface sealing is instructed.

2. References

Reference	Title
51-21-01, GENERAL	Protective Treatment of Metallic and Nonmetallic Materials - CF6-80C2 Engine Nacelle

3. Materials

A. Refer to Sealing Materials, Figure 1/GENERAL.

4. Clean Area to be Sealed

A. Clean in as given in 51-21-01, GENERAL.

5. Details of Sealing Compound

A. The compound is obtained under the brand name "Hylomar PL_32M" (see Sealing Materials, Figure 1/GENERAL). The particular grade, suffix M, denotes the consistency to be used in any repairs. The compound is resistant to water, water/glycol and water/methanol mixtures, petroleum and synthetic ester based lubricants and kerosine fuels. It can be used for sealing components operating from -50°C (-58°F to +572°F.)

6. Application of Sealing Compound

A. The compound is to be applied, to both faces to be sealed, using a fairly stiff brush employing a stippling action.

B. A minimum of 10 minutes air drying time must be allowed before components are assembled.

MATERIAL	SUBJECT								SUPPLIER
	TBD								
SEALING COMPOUND HYLOMAR (PL 32M)	X								$\boxed{A}\boxed{B}\boxed{C}\boxed{D}$

NOTES

$\boxed{A}$ INDESTRUCTABLE PAINT CO. LTD.
43A THE AVENUE
ACOCKS GREEN
BIRMINGHAM B27 6NG
ENGLAND

$\boxed{B}$ MARSTON BENTLEY LTD.
HYLO HOUSE, COLE LANE
NEW SPRINGS WIGAN
WN2 1 JR. ENGLAND

$\boxed{C}$ MARSTON BENTLEY
1848 STAR BATT DRIVE
ROCHESTER HILLS
MI 48309
USA

$\boxed{D}$ VAN DUSEN AIRCRAFT SUPPLIES
TETERBORO AIRPORT
500 INDUSTRIAL AVENUE
TETERBORO, NJ 07608
USA

Sealing Material Sources
Figure 1

GENERAL - SHEET METAL MATERIALS

1. 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/GENERAL shows approximately equivalent strength materials.

B. If you repair the airplane structure, apply a finish that gives protection to all bare aluminum alloy parts and surfaces that were cut and drilled. Other metals like titanium, CRES, and inconel may also need finishes. 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. Tool Terminology

(1) A hand tool is a tool that you can hold and operate with your hands.

(2) A hand drill is a drill that:
- You can hold and operate in your hand
- Has adjustable speeds which you can change as you drill
- Does not have automatic feed control.

(3) RPM is an abbreviation for Revolutions Per Minute.

2. References

Reference	Title
51-20-01, GENERAL	Protective Treatment of Metallic and Nonmetallic Repair Parts
51-20-02, GENERAL	Heat Treat Verification - Hardness and Conductivity Testing
51-20-06, GENERAL	Shot Peening
BAC 5602	Heat Treat of Aluminum Alloys
SOPM 20-10-07	Machining of Titanium
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

3. Aluminum Alloys

A. You can identify aluminum alloys by symbols of the Aluminum Association four-digit index system. Two examples of an alloy identifier are 2024 and 7075.

B. The "TXXX" code that follows an alloy identifier shows how the alloy was heat-treated. If an "O" follows the alloy identifier, then the material has not been heat-treated. The alloy is in the annealed condition. You can form aluminum easily when it is annealed, but you must heat-treat the part before you install it on the airplane. Refer to 51-20-02, GENERAL.

C. The word "clad" before an alloy identifier shows that the alloy has a thin layer of near pure aluminum on it. The layer of aluminum was applied to the alloy before the last rolling procedure.

D. Figure 2/GENERAL shows alternative replacement materials. If the initial material is not available, then use one of the alternative materials shown. Figure 2/GENERAL also gives material replacement factors and an example of how they are used.

E. The aluminum alloy sheet metals most frequently used are 2024-T3 and 7075-T6. 7075-T6 is stronger than 2024-T3. The two materials have different minimum bend radii. The two materials have different forming properties. The minimum bend radius of 7075-T6 is larger than 2024-T3, so it is often formed in the annealed condition (7075-0). After the 7075 sheet is formed in the annealed condition, it is heat-treated to 7075-T62. 2024-T3 is usually formed in the heat-treated condition. The minimum bend radii of different aluminum sheet metal materials is given in Figure 3/GENERAL.

F. You must be careful with aluminum alloy material. Small damage, such as scratches, burrs, and nicks can cause a dangerous decrease in the fatigue strength of the aluminum alloy material.

G. If the alloy identifier has been removed from a sheet of aluminum, you can test it to identify the alloy. Use the hardness and conductivity tests given in 51-20-02, GENERAL.

4. Titanium Alloy

WARNING: KEEP TITANIUM PARTICLES AWAY FROM SOURCES OF IGNITION. SMALL PARTICLES OF TITANIUM BURN VERY EASILY. IN SUFFICIENT CONCENTRATION, THESE SMALL PARTICLES CAN CAUSE AN EXPLOSITON. IF WATER TOUCHES MOLTEN TITANIUM, A STEAM EXPLOSION COULD OCCUR. EXTINGUISH TITANIUM FIRES WITH DRY TALC, CALCIUM CARBONATE, SAND, OR GRAPHITE. APPLY THE POWDER ON THE BURNING METAL TO A DEPTH OF 1/2 INCH OR MORE. DO NOT USE FOAM, WATER, CARBON TETRACHLORIDE, OR CARBON DIOXIDE.

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 you usually do not need to apply a finish to it. But, you must isolate titanium from magnesium, aluminum, or alloy steel. If titanium contacts magnesium, aluminum or alloy steel, galvanic corrosion or oxidation will occur. Refer to 51-20-01, GENERAL, 51-20-06, GENERAL and SOPM 20-41-02 for finishes, treatments, and sealants that give protection.

C. Some SRM repairs use formed 6AL-4V annealed titanium sheet. The procedures used to form 6AL-4V annealed titanium sheet are given below.

  (1) Hot forming 6AL-4V annealed titanium.

    (a) Apply a scale inhibitor to the part before you heat it.

    (b) Heat the part to a temperature above 1200°F (649°C), but below 1500°F (816°C).

    (c) Form the titanium to the radii given in Figure 4/GENERAL. If you form to radii smaller than this, you must penetrant-inspect 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 Figure 4/GENERAL. Refer to SOPM 20-30-03 to etch titanium.

  (2) Cold forming 6AL-4V annealed titanium (room temperature forming).

    (a) Form the titanium to the radii given in Figure 4/GENERAL. If you form to radii smaller than this, you must penetrant-inspect the bend. Refer to SOPM 20-20-02.

    (b) Stress relieve the part as follows:

      1) Heat the part to a temperature above 1250°F (677°C), but below 1450°F (788°C).

      2) Keep the part at this temperature for more than 30 minutes but less than 10 hours.

D. Use a hand drill only when you have to. If you can, you should use positive-power-feed drills. Refer to SOPM 20-10-07, for information on drilling titanium with positive-power-feed drills. Figure 5/GENERAL shows equipment that can be used to hand drill titanium.

E. Use these guidelines when you drill titanium:

(1) If you use a hand drill, the largest diameter hole you can drill (in a single step) is 0.1563 inch. This is because:

- You must push on the drill with a large force
- When you push on the drill with each force, the larger diameter drill bits will not cut satisfactorily
- Drill bits that do not cut satisfactorily cause damage to the hole.

(2) Use a "pistol grip" type hand drill if you can because you can push harder with this type of drill.

(3) Holes with a diameter of 0.1875 inch and larger can be hand drilled if:

- You start with a hole with a diameter of 0.1563 inch
- Increase the diameter of the hole in 0.0313 or 0.0625 inch increments.

(a) If you use a hand drill with a 90-degree angle head, then you must use 0.0313-inch increments. If you use the standard "pistol grip" type hand drill, then you can use an increment of 0.0625. You can use the larger increment because you can push harder with the "pistol grip" type hand drill.

(b) Holes with diameters as large as 0.75 inch have been made using this procedure.

(4) We recommend you use the usual high-speed steel drill bits when you hand drill. When you hand drill titanium, we recommend the rpm (revolutions per minute) ranges showm in Table 1/GENERAL.

Table 1: Drill Speed Data

DRILL BIT DIAMETER	DRILL SPEED RANGE
0.0625	920 to 1830 RPM
0.125	460 to 920 RPM
0.1875	230 to 460 RPM

(5) The life of a drill bit is shorter when you drill titanium than when you drill steel. Do not:

- Use a blunt drill bit
- Let a drill bit rub the surface of the metal and not cut it.

(a) If one of these conditions occurs, the titanium surface will become work-hardened and it will be very difficult to start the drill again.

(6) When you hand drill two or more titanium parts at the same time, you must clamp them together tightly. To clamp them together, use temporary bolts, Cleco clamps, or tooling clamps. Put the clamps around the area that you will drill, and as near 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. If you do this, you will:

- Make good, clean holes
- Break fewer drill bits
- Make a smaller exit burr.

(8) Titanium has a low thermal conductivity. When it becomes hot, other metals will become easily attached to it. Particles of titanium will often 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 a water soluble coolant or sulphurized oil.

(9) Cutting Fluids

(a) If you use a cutting fluid when you drill:
- The holes will have a better tolerance
- The drill bit will last longer.

(b) If the hole has a depth larger than the diameter of the drill bit, use a cutting fluid. If the hole has a depth less than the diameter of the drill bit, you can drill with or without a cutting fluid.

(c) Cutting fluid types are listed below. If you use a cutting fluid, you must clean the repaired area before you apply paint or sealant. Refer to SOPM 20-41-02 and SOPM 20-50-12.

(d) If you can clean the repair area after you drill, we recommend you use one of the cutting fluids that follow:
- Daracool 706 (4% cutting fluid - 96% water mix)
- BOELUBE

NOTE: BOELUBE comes in liquid, solid, and paste forms.

(e) If you cannot clean the repair area after you drill, use BOELUBE as a cutting fluid.
- Daracool 706: W.R. Grace and Co. Davison Chemical Division 10 East Baltimore Street Baltimore MA 21202-1630
- BOELUBE: The Orelube Corp. 201 East Bethpage Road Plainview, NY 11803-4202

F. Use these guidelines when you ream titanium alloy with a hand tool.

(1) You can use straight-fluted-chucking reamers or reamers with minimum margins (0.010 inch or less). We recommend that you use the usual high-speed steel reamers when you ream with a hand tool.

(2) The drill should have a motor with 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 which will make a satisfactory finish. When you ream, the reamer must constantly cut the metal.

(4) If the hole has a depth less than the diameter of the drill bit, you can ream it with or without a cutting fluid. For more information on cutting fluids, see the guidelines for drilling titanium.

(5) When you ream a hole to the actual fastener dimension, you should remove as much material as possible. Remove at least 0.0156 inch from the hole when the diameter of the hole is less than 0.3125 inch. Remove at least 0.0313 inch from the hole when the diameter of the hole is 0.3125 inch and larger.

(6) Remove the reamer from the hole before you stop its rotation.

(7) When a reamer is made from a larger reamer, it is usually circle ground. When a reamer is circle ground, the reamer’s margin width increases. If the reamer’s margin width increases, then it will make a hole that is too large. To prevent oversize holes you must decrease the margin width to 0.010 to 0.015 inch.

G. Use these guidelines when you countersink titanium:

(1) When you countersink, use the same speeds and feed rate as when you drill.

(2) We recommend that you do not countersink into titanium with hand tools when the hole is greater than 0.1875 inch.

(3) Use the usual high-speed steel cutters to countersink into titanium.

(4) When you use a cutting fluid, the speed of the cutter should be 25 to 30 SRM (Surface Feet per Minute). When you do not use a cutting fluid, the speed of the cutter should be 20 to 25 SFM.

(5) For holes with a diameter of 0.1875 or less, you can use a microstop countersink tool.

H. Follow these guidelines when you cut titanium with a hand tool:

(1) Tools which shear metal, like roller shears or nibblers, cut titanium well. But, most tools are designed for materials which are easy to cut, like aluminum or mild steel. To get good results when you cut titanium:

- you must use a tool that is designed to cut a material that is twice as thick
- you must slow the speed of the tool.

(2) Figure 5/GENERAL shows equipment that can be used to cut titanium.

(a) Roller Shears

1) For titanium sheets of gage 0.100 inch and less, roller shears cut well. For gages above 0.100, roller shears cause edge cracks.

(b) Nibblers

1) You can use nibblers to cut titanium sheet for gages up to 0.100. After the titanium is cut, the edge should be square, scalloped, and lightly burred. If there are many burrs, it is possible that the punch is damaged.

2) After you cut with nibblers, you must hand finish the edges. To make the edge clean, about 0.010 inch of the edge will usually need to be removed.

3) You should use a motor with a low speed (approximately 450 strokes per minutes).

4) If you use a motor with a low speed, you do not need a cutting fluid. If you use a motor with a high speed (above 600 strokes per minute), you must use a cutting fluid. A water soluble oil, like TJ-73 spray must be used.

(3) Routers and similar tools do not cut titanium well. It is difficult to hold the tool stable and keep the chip rate constant.

(4) Saber saws may be used when you cannot use other tools. But, they cut more slowly and the blades become blunt quickly.

I. Refer to SOPM 20-10-07 when you machine titanium with equipment that is not movable.

J. When you machine titanium, you must remove all of the sharp edges. Unless specified differently by a repair, remove all machined edges to a radius of 0.008 inch or more.

(1) A color that is darker than light straw caused by an increase in temperature must be removed by a machine procedure.

5. Corrosion-Resistant Steel (CRES)

A. Corrosion-resistant steel (CRES) sheet is used on some parts when high strength is necessary.

B. CRES must not touch magnesium, aluminum or cadmium. If it does, galvanic corrosion will occur. To isolate CRES from magnesium and aluminum, apply a finish that gives protection between their mating surfaces. Refer to 51-20-01, GENERAL for finishes that give protection.

C. The minimum bend radii of CRES sheet material is shown in Figure 6/GENERAL.

6. Nickel Alloy

A. Nickel alloy 625 and nickel alloy 718 are nickel-chromium alloys. Nickel alloy is corrosion-resistant and stays strong at high temperatures. Because of these properties, nickel alloy is frequently used in the power plant structure.

B. Do not drill nickel alloy 625 and 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.

(1) Do the steps that follow when you drill nickel alloy 625 and nickel alloy 618:

(a) Use power feed equipment to drill pilot holes in the parts before you assemble them.

(b) Put the repair parts temporarily into position and drill the pilot holes to the mating structure.

(c) 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 of all heat-treat conditions. To hand drill gages of 0.09 and less, use the procedure below:

(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) Feed

(a) Feed rates are not used when you hand drill. When you hand drill you must push hard on the drill, but stay at a constant chip rate. Example: for a No. 30 hole, push the drill with approximately 50 pounds of force.

(b) Holes with a diameter between 3/16 and 3/8 should be drilled in two steps. One step is sufficient for holes with a diameter less than 3/16 inch. You can use 1 inch-foot taper reamers to increase the diameter of the pilot hole to 0.1563 inch.

(3) Speed Refer to Table 2/GENERAL.

Table 2: Drill Speed - Maximum RPM Data

Drill Size	Maximum RPM
80-30	500
29-U	300
3/8	100

(4) Cutting Fluid

(a) A cutting fluid not necessary when you hand drill.

7. Flat Patterns

A. A flat pattern is the shape of a flat piece of sheet metal necessary to make a bent part. To make a flat pattern, measure the dimensions and the radii of the damaged part or the opposite part. To measure the dimensions and radii you can use one of the two procedures below:

- Bend a piece of soldering wire around the part

- Make a sketch of the part as shown in step (1).

B. The second procedure is more accurate. After you measure the dimensions, you can calculate the developed length and make the flat pattern.

(1) Make a sketch of the cross-section of the part. See Figure 7/GENERAL. Show these dimensions of the part:

- A = Developed Flange Width
- B = Set-Back (Fig. 8)
- C = Web Length
- D = Set-Back (Fig. 8)
- E = Developed Flange Width
- R = Bend Radius (Figure 3/GENERAL, Figure 4/GENERAL Figure 4/GENERALand Figure 6/GENERAL)
- F = Flange Angle
- G = Flange Angle
- T = Material Thickness

(2) Calculate the developed length. Use this formula:

Developed Length = A-X+C-X1+E X (See Figure 9/GENERAL) X1 (Refer to Figure 9/GENERAL).

CAUTION: DO NOT USE A METAL SCRIBER. THE SCRATCHES ON THE METAL CAN CAUSE CRACKS.

(3) Put the flat pattern on a flat sheet of repair material that has no pilot holes. See Figure 7/GENERAL. With a sharp crayon, make a line on the sheet of repair material all around the flat pattern. Cut the repair part out. The repair part can be bent to the shape of the damaged part.

MATERIAL		DOMESTIC SPECIFICATION (USA) (Acceptable Alternatives)		UNITED KINGDOM DESIGNATION
		MATERIAL	SPECIFICATION	SPECIFICATION
ALUMINUM	SHEET	CLAD 2024-T3	QQ-A-250/5	L109 $\boxed{A}$
		CLAD 2024-T42	QQ-A-250/5	L110
		BARE 2024-T3	QQ-A-250/4 or AMS-QQ-A-250/4	L70 $\boxed{A}$
		CLAD 2014-T6	QQ-A-250/3	L165 (Replaced L73)
		2219-T81	QQ-A-250/30	DTD5070
		5052	AMS 4017	2L55
		6061	AMS 4117	BS 1474
		CLAD 7075	QQ-A-250/13	L88
	PLATE	2024-T351	QQ-A-250/4	L97
	BAR AND ROD	2024-T4	QQ-A-225/6	L64 $\boxed{B}$
		2024-T6	QQ-A-225/6	L65
	CASTING	A357.0	MIL-A-21180 CLASS II	L92
		A356.0	MIL-A-21180	BS 1490
	DIE FORGING	2014-T6	QQ-A-367	L77
TITANIUM	SHEET	COMPURE-70	MIL-T-9046,TYPE 1, COMP B	TA6
		COMPURE-60	MIL-T-9046,TYPE 1, COMP C	DTD5323
		Ti-6Al-4V	MIL-T-9046	BS 2TA.10
	BAR FORGING	COMPURE-70	MIL-T-9047, COMP 1	TA9
	FORGING	Ti-6Al-4V	MIL-F-83142, COMP 6	DTD5323
	CASTING	Ti-6Al-4V	MIL-T-81915, TYPE III, COMP A	DTD5363
	BAR	Ti-6Al-2Sn-4Zr-2Mo	MIL-T-9047	BS TA.45
	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	AMS 6417	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

- A ADD 10% THICKNESS FOR EQUIVALENT STRENGTH
- B FOR t LESS THAN 4.0 INCHES ADD 10% EXTRA THICKNESS. FOR t GREATER THAN 4.0 INCHES ADD 20% EXTRA THICKNESS. t = MATERIAL THICKNESS

Approximately Equivalent Strength Materials
Figure 1 (Sheet 3 of 3)

FORM	ORIGINAL MATERIAL	SUBSTITUTES
0.016 TO 0.125 SHEET	CLAD 2024-T42	CLAD 2024-T3 2024-T3 CLAD 7075-T6 $\boxed{A}$ 7075-T6 $\boxed{A}$
	CLAD 2024-T3	2024-T3 CLAD 7075-T6 $\boxed{A}$ 7075-T6 $\boxed{A}$
	CLAD 7075-T6	7075-T6
FORMED OR EXTRUDED SECTION	2024-T42	7075-T6 $\boxed{A}$ $\boxed{B}$

MOST AVAILABLE STANDARD ALUMINUM SHEET METAL GAGES	
0.012	0.071
0.016	0.080
0.020	0.090
0.025	0.100
0.032	0.125
0.036	
0.040	0.160
0.045	
0.050	0.190
0.056	
0.063	0.200

SHEET MATERIAL TO BE REPLACED	MATERIAL SUBSTITUTION FACTOR									
	7075-T6	CLAD 7075-T6	2024-T3		CLAD 2024-T3		2024-T42		CLAD 2024-T42	
	$\boxed{C}$	$\boxed{C}$	$\boxed{D}$	$\boxed{E}$	$\boxed{D}$	$\boxed{E}$	$\boxed{D}$	$\boxed{E}$	$\boxed{D}$	$\boxed{E}$
7075-T6	1.00	1.10	1.25	$\boxed{F}$	1.33	$\boxed{F}$	$\boxed{F}$	$\boxed{F}$	$\boxed{F}$	$\boxed{F}$
CLAD 7075-T6	1.00	1.00	1.16	$\boxed{F}$	1.23	$\boxed{F}$	$\boxed{F}$	$\boxed{F}$	$\boxed{F}$	$\boxed{F}$
2024-T3	1.00 $\boxed{A}$	1.00 $\boxed{A}$	1.00	1.00	1.07	1.08	1.14	1.21	1.24	1.31
CLAD 2024-T3	1.00 $\boxed{A}$	1.00 $\boxed{A}$	1.00	1.00	1.00	1.00	1.07	1.18	1.16	1.29
2024-T42	1.00 $\boxed{A}$	1.00 $\boxed{A}$	1.00	1.00	1.00	1.00	1.00	1.00	1.09	1.09
CLAD 2024-T42	1.00 $\boxed{A}$	1.00 $\boxed{A}$	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

NOTES

- THE USE OF BARE MATERIAL WHEN SUBSTITUTED FOR CLAD MATERIAL MAY REQUIRE ADDITIONAL CORROSION PROTECTION (REF 51-20-01)

$\boxed{A}$ THESE MATERIALS MAY NOT BE USED AS SUBSTITUTES IN PRESSURIZED AREA NOR FOR WING INTERSPAR AND CENTER SECTION STRUCTURE

EXAMPLE:
TO REPLACE 0.040 7075-T6 MATERIAL WITH CLAD 7075-T6, MULTIPLY GAGE BY MATERIAL SUBSTITUTION FACTOR TO GET SUBSTITUTE GAGE (0.040 X 1.10 = 0.045 GAGE)

$\boxed{B}$ USE NEXT HIGHER STANDARD GAGE WHEN USING A FORMED SECTION AS A SUBSTITUTE FOR AN EXTRUSION

$\boxed{C}$ FOR FLAT SHEET AND FORMED SECTIONS ALL GAGES

$\boxed{D}$ FOR FLAT SHEET UP TO AND INCLUDING 0.063 GAGE

$\boxed{E}$ FOR FLAT SHEET 0.071 GAGE AND GREATER AND FOR FORMED SECTIONS

$\boxed{F}$ THESE MATERIALS ARE NOT TO BE USED AS SUBSTITUTES

Material Substitution
Figure 2

MINIMUM INNER BEND RADII					
GAGE	ALUMINUM				
	2024-0 5052-H34	2024-T3/T4	5052-0	7178-0 7075-0	7178-T6 7075-T6
A	0.03	0.06	0.03	0.03	0.09
0.016	0.03	0.06	0.03	0.03	0.09
0.018	0.03	0.06	0.03	0.03	0.09
0.020	0.03	0.06	0.03	0.03	0.09
0.022	0.06	0.09	0.03	0.06	0.12
0.025	0.06	0.09	0.03	0.06	0.12
0.028	0.06	0.09	0.03	0.06	0.16
0.032	0.06	0.12	0.03	0.06	0.16
0.036	0.06	0.16	0.06	0.06	0.19
0.040	0.06	0.16	0.06	0.06	0.19
0.045	0.09	0.19	0.06	0.09	0.25
0.050	0.09	0.19	0.06	0.09	0.25
0.056	0.12	0.22	0.06	0.12	0.28
0.063	0.12	0.22	0.06	0.12	0.31
0.071	0.12	0.28	0.09	0.12	0.38
0.080	0.16	0.31	0.09	0.19	0.44
0.090	0.19	0.38	0.09	0.19	0.50
0.100	0.22	0.44	0.12	0.22	0.62
0.112	0.25	0.50	0.12	0.28	0.75
0.125	0.25	0.56	0.12	0.28	0.88
0.140	0.34	0.62	0.12	0.38	1.00
0.160	0.38	0.75	0.16	0.44	1.12
0.180	0.44	0.88	0.19	0.50	1.25
0.190	0.50	0.88	0.19	0.56	1.25

NOTES

A ALL GAGES BELOW 0.016

Minimum Inner Radii for Straight Line Bends in Aluminum Sheet
Figure 3

THICKNESS	MINIMUM BEND RADII	
	Ti-6Al-4V ANNEALED COLD FORMED	Ti-6Al-4V ANNEALED HOT FORMED A
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

STRESS RELIEVING TEMPERATURE °F (°C)	MINIMUM DEPTH OF METAL TO BE REMOVED (INCH)			
	LENGTH OF TIME FOR STRESS RELIEVING			
	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

NOTES

- DIMENSIONS ARE IN INCHES, EXCEPT AS NOTED.

A 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 Inner Radii for Straight Line Bends in Titanium Sheet
Figure 4

MANUFACTURER	MODEL	SPEED (RPM)	DRILL CAPACITY (INCH)	HANDLE TYPE
COOPER BUCKEYE	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	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	15CSL94-51	1600	3/8	OFFSET
	55CSS92-54	2150	1/4	OFFSET

DRILL MOTORS
TABLE I

TOOL TYPE	MANUFACTURER	MODEL
ROLLER SHEARS	COOPER-BUCKEYE	31U-113
PORTABLE NIBBLER	COOPER-BUCKEYE	31NR-502
SABER SAW	COOPER-BUCKEYE	31ZK-548

CUTTING TOOLS
TABLE II

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
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. THE FORCE NECESSARY TO MANUALLY CUT WITH A SABER SAW IS LARGE. THIS FORCE INCREASES AS THE SHEET THICKNESS INCREASES. THE LARGEST THICKNESS TITANIUM SHEET THAT CAN BE EASILY CUT IS 0.070 INCH.			

SABER SAW BLADE DATA
TABLE III

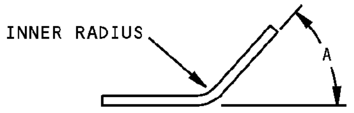
NOTES

COOPER INDUSTRIES
COOPER POWER TOOLS DIVISION
P.O. BOX 1410
LEXINGTON, SC 29071-1410

DEUTSCH AMERICAN PNEUMATIC TOOL CO.
14710 MAPLE AVENUE
GARDENA, CA 90248-1934

Equipment Used to Hand Drill and Cut Titanium
Figure 5

MINIMUM INNER BEND RADII										
GAGE	CORROSION RESISTANT STEEL								ALLOY STEEL	
	18-8 CRES (300 SERIES)					15-5 PH $\boxed{D}$	17-7 PH $\boxed{A}$ $\boxed{B}$		1020 1025 4130 8630 ANLD	4130 8630 NORM
	ANLD	QTR HARD	HALF HARD	THREE QTR HARD	FULL HARD	SOLUTION TREATED	COND A	COND TH1050		
$\boxed{C}$	0.06	0.06	0.06	0.09	0.09	---	0.03	0.16	0.06	0.06
0.016	0.06	0.06	0.06	0.09	0.09	---	0.03	0.16	0.06	0.06
0.018	0.06	0.06	0.06	0.09	0.11	---	0.03	0.16	0.06	0.06
0.020	0.06	0.06	0.06	0.09	0.12	---	0.03	0.16	0.06	0.06
0.022	0.06	0.06	0.06	0.09	0.14	---	0.03	0.16	0.06	0.06
0.025	0.06	0.06	0.06	0.09	0.16	---	0.03	0.16	0.06	0.06
0.028	0.06	0.06	0.09	0.12	0.19	---	0.03	0.19	0.06	0.09
0.032	0.06	0.06	0.09	0.12	0.19	---	0.03	0.25	0.06	0.09
0.036	0.06	0.09	0.12	0.16	0.22	---	0.03	0.31	0.09	0.12
0.040	0.06	0.09	0.12	0.16	0.25	---	0.06	0.31	0.09	0.12
0.045	0.06	0.09	0.12	0.19	0.31	---	0.06	0.38	0.09	0.16
0.050	0.06	0.09	0.12	0.22	0.31	0.19	0.06	0.38	0.09	0.16
0.056	0.06	0.12	0.16	0.22	0.34	0.22	0.06	0.44	0.09	0.19
0.063	0.06	0.12	0.19	0.25	0.38	0.22	0.09	0.50	0.09	0.19
0.071	0.09	0.16	0.22	0.31	0.44	0.25	0.09	0.62	0.09	0.22
0.080	0.09	0.16	0.22	0.34	0.50	0.38	0.09	0.62	0.12	0.25
0.090	0.09	0.19	0.25	0.38	0.62	0.44	0.09	0.75	0.12	0.28
0.100	0.12	0.22	0.28	0.44	0.62	0.44	0.12	0.88	0.16	0.31
0.112	0.12	0.22	0.31	0.50	0.75	0.50	0.12	---	0.16	0.34
0.125	0.12	0.25	0.34	0.50	0.75	0.63	0.12	---	0.16	0.38
0.140	0.16	0.31	0.38	0.62	0.88	0.63	0.16	---	0.19	0.38
0.160	0.16	0.34	0.44	0.62	1.00	0.63	0.16	---	0.22	0.44
0.180	0.19	0.38	0.50	0.75	1.12	0.75	0.19	---	0.28	0.50
0.190	0.19	0.38	0.50	0.88	1.25	0.75	0.19	---	0.34	0.50



$\boxed{A}$ THESE LIMITS APPLY TO 17-7 PH CRES:

- USE A MAXIMUM THICKNESS OF 0.090 INCH WHEN HEAT TREATED TO 150-170KSI.
- USE A MAXIMUM THICKNESS OF 0.063 INCH WHEN HEAT TREATED TO 180-200KSI.

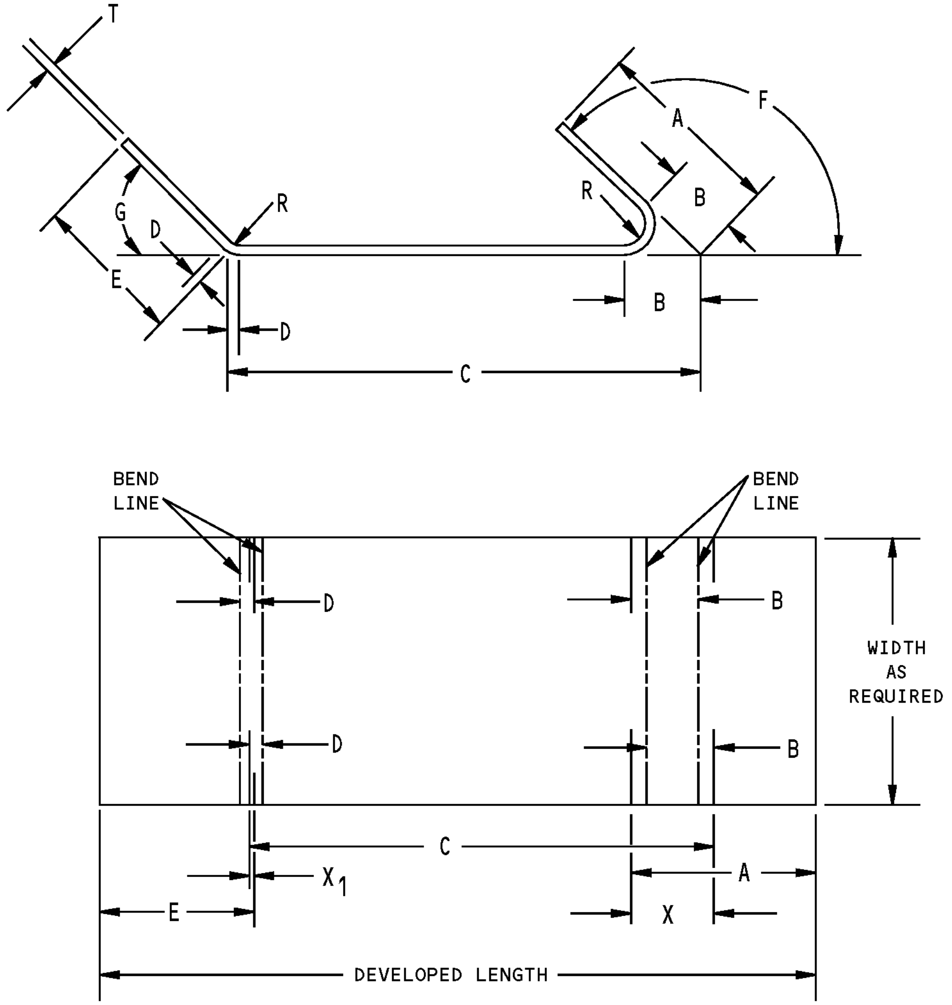
NOTE: 15-5 PH CRES STEEL IS RECOMMENDED FOR A SHEET THICKNESS OF 0.050 INCH OR THICKER.

$\boxed{B}$ AFTER YOU FORM THE RADIUS, DO A PENETRANT INSPECTION OF THE RADIUS. REFER TO SOPM 20-20-02.

$\boxed{C}$ ALL GAGES BELOW 0.016 INCH

$\boxed{D}$ IF ANGLE "A" IS LARGER THAN 90° YOU MUST DO A MAGNETIC PARTICLE INSPECTION. REFER TO SOPM 20-20-01.

Minimum Inner Radii for Straight Line Bends in Sheet Steel
Figure 6



FLAT PATTERN

EXAMPLE:

A = 1.20

B = 0.453 (SEE FIGURE 8)

C = 3.00

D = 0.078 (SEE FIGURE 8)

E = 1.00

F = 135°

G = 45°

T = 0.063

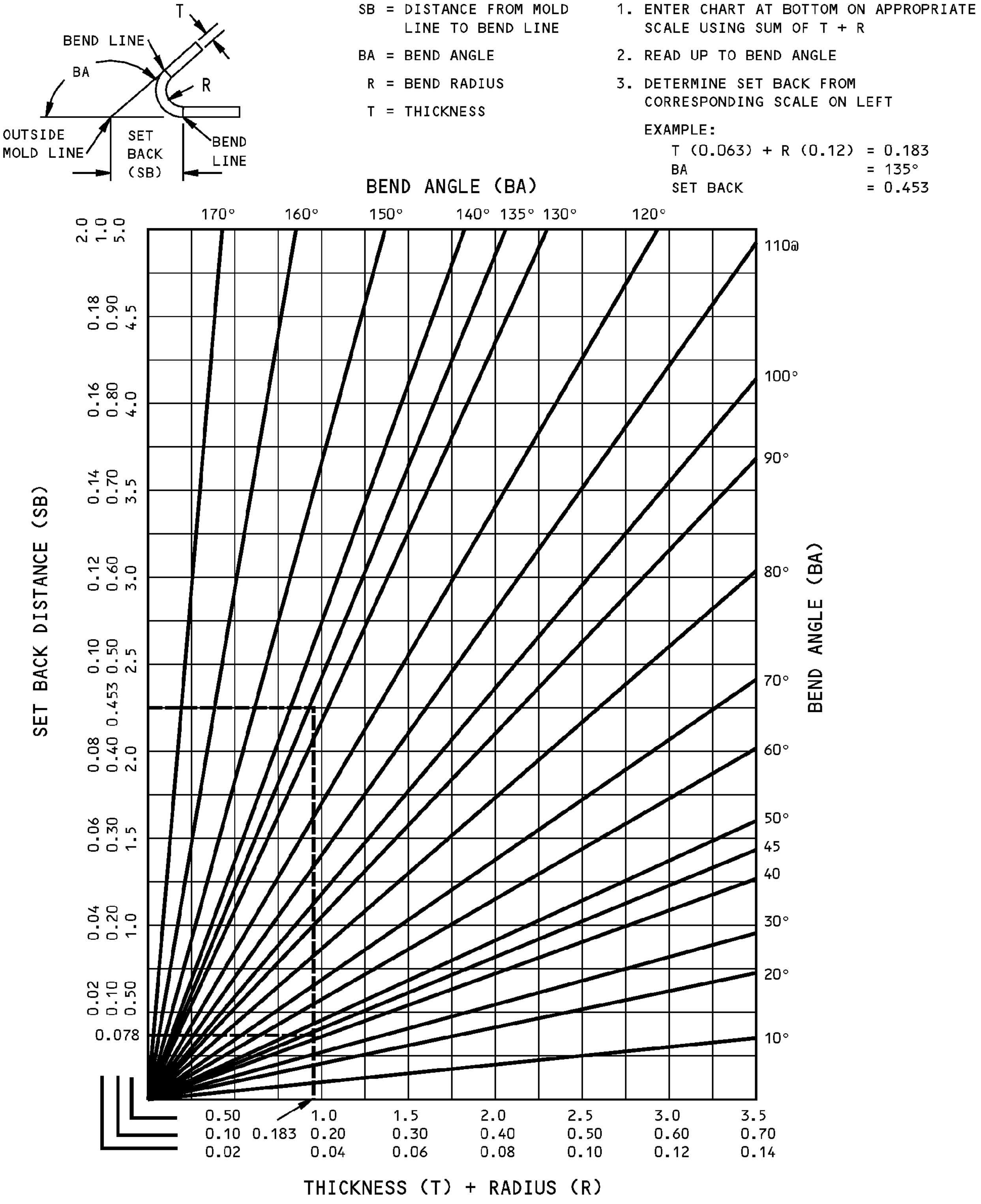
R = 0.12 (SEE FIGURE 3)

X = 0.55 (SEE FIGURE 9)

X_1= 0.035 (SEE FIGURE 9)

DEVELOPED LENGTH = 1.20 - 0.55 + 3.00 - 0.035 + 1.00 = 4.615 USE 4.62

Flat Pattern Layout
Figure 7



SB = DISTANCE FROM MOLD LINE TO BEND LINE

BA = BEND ANGLE

R = BEND RADIUS

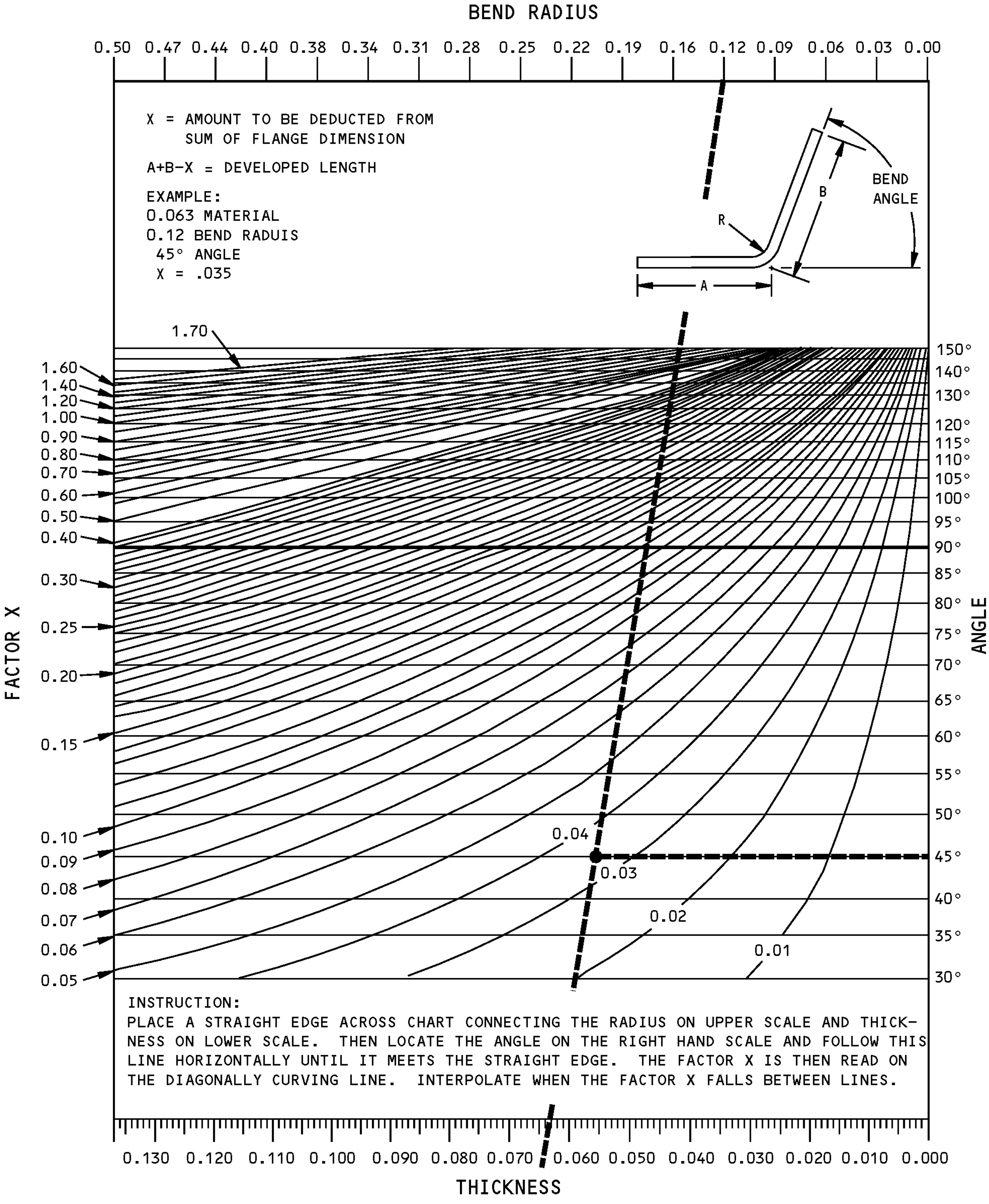
T = THICKNESS

1. ENTER CHART AT BOTTOM ON APPROPRIATE SCALE USING SUM OF T + R
2. READ UP TO BEND ANGLE
3. DETERMINE SET BACK FROM CORRESPONDING SCALE ON LEFT

EXAMPLE:

T (0.063) + R (0.12) = 0.183
BA = 135°
SET BACK = 0.453

Flat Pattern Set Back Graph
Figure 8



X = AMOUNT TO BE DEDUCTED FROM SUM OF FLANGE DIMENSION

A+B-X = DEVELOPED LENGTH

EXAMPLE:
0.063 MATERIAL
0.12 BEND RADUIS
45° ANGLE
X = .035

INSTRUCTION:
PLACE A STRAIGHT EDGE ACROSS CHART CONNECTING THE RADIUS ON UPPER SCALE AND THICKNESS ON LOWER SCALE. THEN LOCATE THE ANGLE ON THE RIGHT HAND SCALE AND FOLLOW THIS LINE HORIZONTALLY UNTIL IT MEETS THE STRAIGHT EDGE. THE FACTOR X IS THEN READ ON THE DIAGONALLY CURVING LINE. INTERPOLATE WHEN THE FACTOR X FALLS BETWEEN LINES.

Developed Length Graph
Figure 9

GENERAL - METALLIC MATERIALS

1. References

Reference	Title
51-20-05, GENERAL	Repair Sealing
51-30-03, GENERAL	Nonmetallic Materials

2. General

A. This section lists materials used when making repairs contained within the 767 Structural Repair Manual and also lists sources of supply. These materials are also called out with the applicable repair information.

The purpose of this list is to show which subject the materials are used in and if they are common to more than one subject. The materials listed are not only used in the actual repair, but also are used for preparation and accomplishment of repairs.

B. Figure 1/GENERAL is a list of formed and extruded metal sections used in repairs.

C. Figure 2/GENERAL contains the dimensioned section details listed in Figure 1/GENERAL.

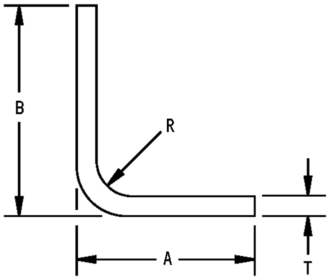
D. Figure 3/GENERAL is a table of metal honeycomb material and sources.

E. For nonmetallic materials refer to 51-30-03, GENERAL.

F. For sealant classifications and substitution data, refer to 51-20-05, GENERAL.

BAC/AND STOCK NUMBER	TYPE	DETAIL NUMBER	SUBJECT 53-00-03	53-00-51	53-00-52	53-00-53	53-50-12	54-50-70	54-51-70	54-52-70	54-53-70	57-41-13
AND10134-2001	CAP ANGLE	XVII		X								
AND10136-2401	TEE	XVIII					X					
AND10138-0605	ZEE	XV						X	X	X	X	
BAC1490-2556	FORMED ANGLE	I			X							
-2774				X								
-2836					X							
-2864					X							
BAC1493-412	CHANNEL	II	X									
-513		III	X									
BAC1498-131	HAT SECTION	IV	X									
-132			X									
-200		V	X									
-201			X									
-202			X									
-203			X									
-204			X									
-232		XIX	X									
-233			X									
-234			X									
-235			X									
-236			X									
BAC1500-6226	CHANNEL	VI			X							
BAC1503-1511	ANGLE	XVI										X
-100024		XX				X						
-5818		VII			X							
BAC1505-100333	TEE	VIII			X							
-101303				X								
BAC1511-10011	RADIUS FILLER	IX			X							
BAC1520-1545	SEAT TRACK	X			X							
-2192		XI			X							
-2193		XII			X							
-2194		XIII			X							
-2195		XIII			X							
-2196		XIV			X							

List of Metal Repair Sections
Figure 1



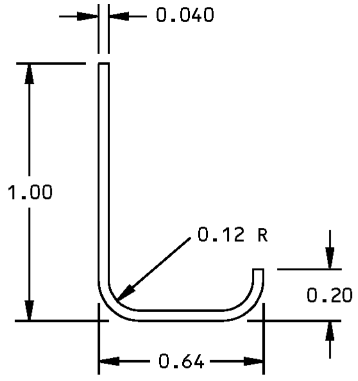
BAC1490-2556,-2774,-2836,-2864

DASH NO.	A	B	T	R
2556	1.00	1.28	0.091	0.19
2774	1.00	1.20	0.080	0.19
2836	1.00	1.25	0.071	0.12
2864	1.52	2.93	0.090	0.19

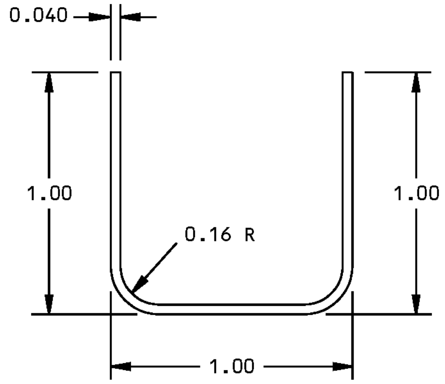
ALL DIMENSIONS ARE IN INCHES EXCEPT AS NOTED

BAC1490-2556,-2774,-2836,-2864
DETAIL I

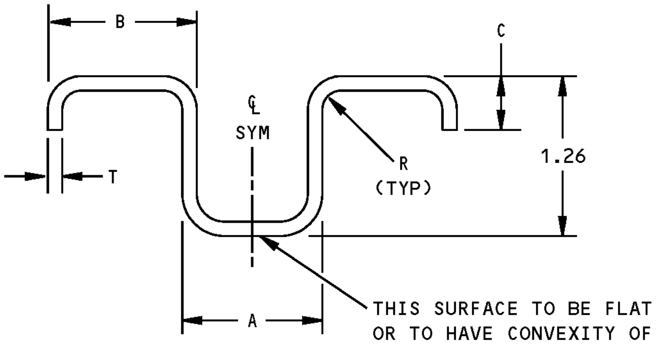
Metal Section Details
Figure 2 (Sheet 1 of 10)



BAC1493-412
DETAIL II



BAC1493-513
DETAIL III



THIS SURFACE TO BE FLAT OR TO HAVE CONVEXITY OF NOT LESS THAN 10.00 R

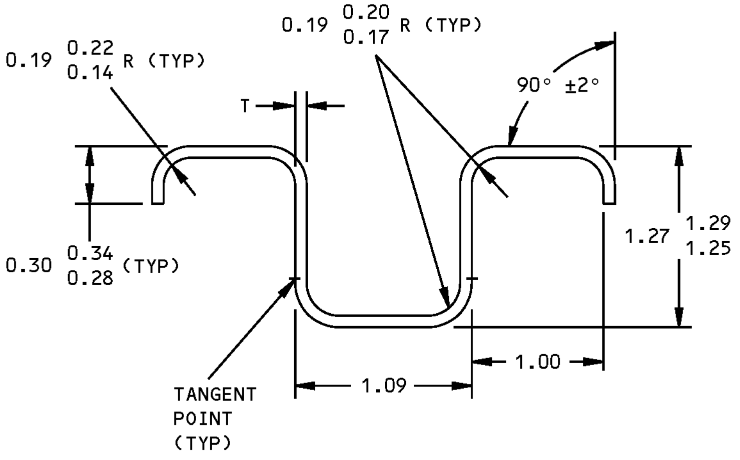
BAC1498

DASH NO.	A	B	C	T	R
132	0.99	1.10	0.35	0.063	0.16
131	0.99	1.10	0.40	0.090	0.19

ALL DIMENSIONS ARE IN INCHES EXCEPT AS NOTED

BAC1498-131,-132
DETAIL IV

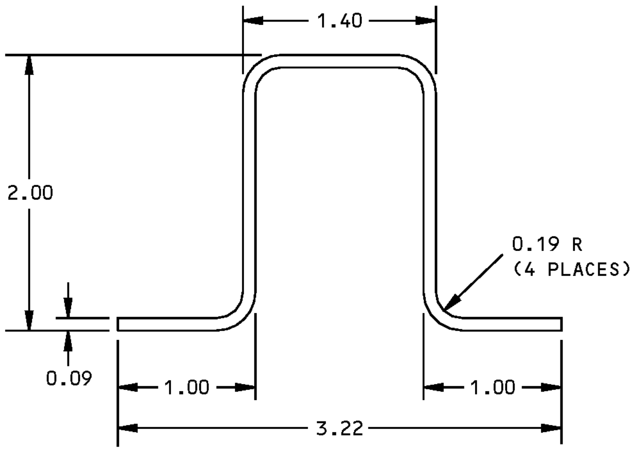
Metal Section Details
Figure 2 (Sheet 2 of 10)



DASH NO.	T
200	0.036
201	0.040
202	0.050
203	0.063
204	0.090

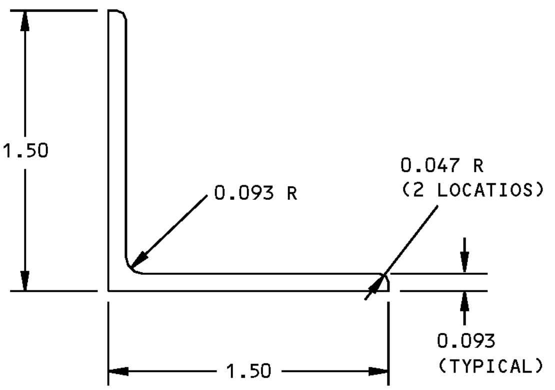
ALL DIMENSIONS ARE IN INCHES
EXCEPT AS NOTED

BAC1498-200 THRU -204
DETAIL V

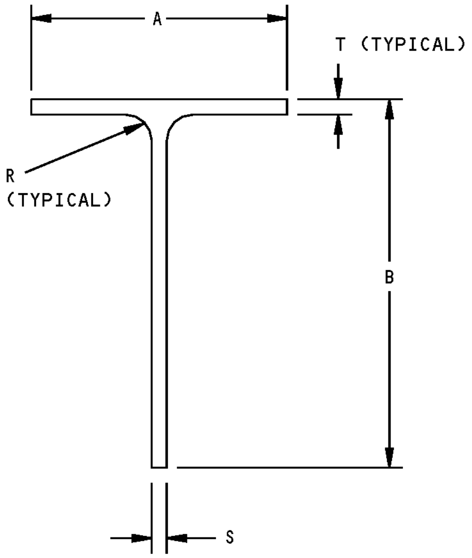


BAC1500-6226
DETAIL VI

Metal Section Details
Figure 2 (Sheet 3 of 10)

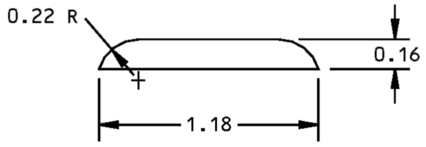


BAC 1503-5818
DETAIL VII



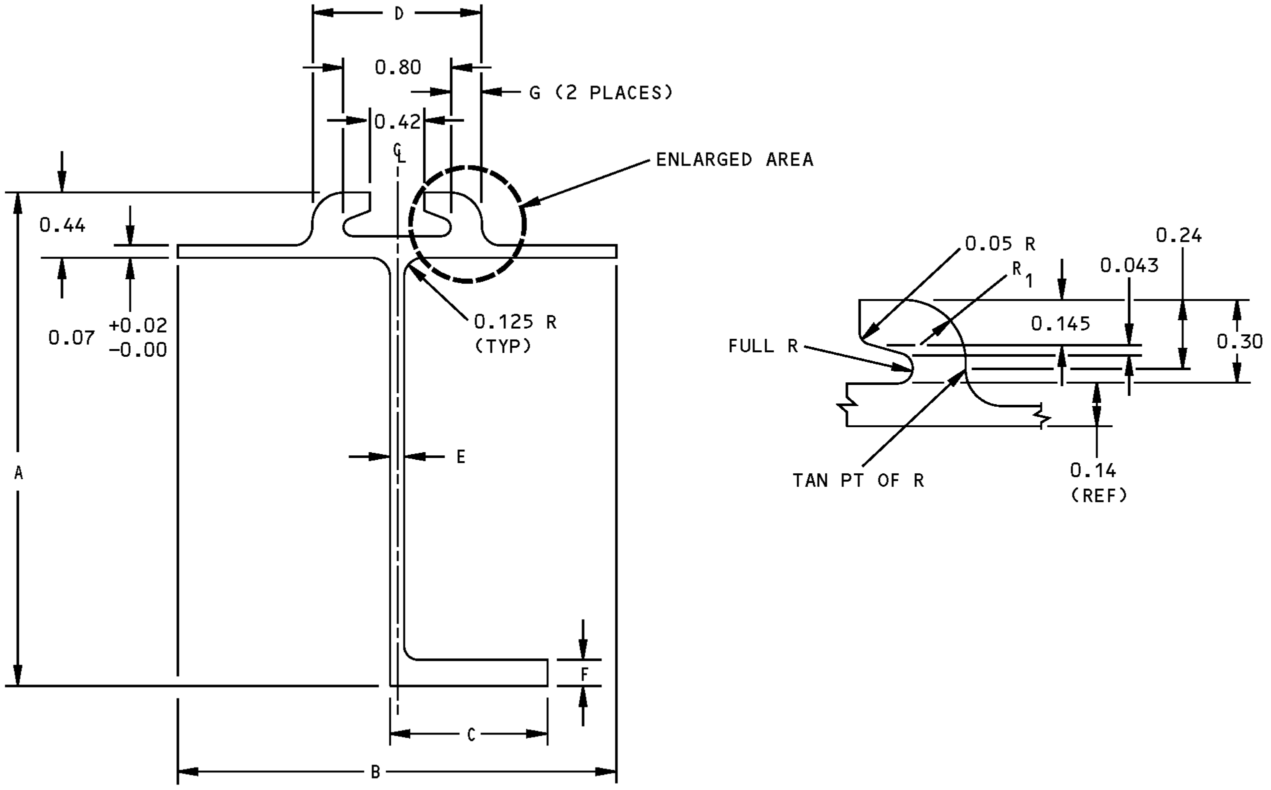
DASH NO.	A	B	T	R	S
100333	2.50	3.60	0.15	0.25	0.15
101303	2.50	3.60	0.10	0.12	0.07

BAC 1505-100333,-101303
DETAIL VIII



BAC 1511-10011
DETAIL IX

Metal Section Details
Figure 2 (Sheet 4 of 10)

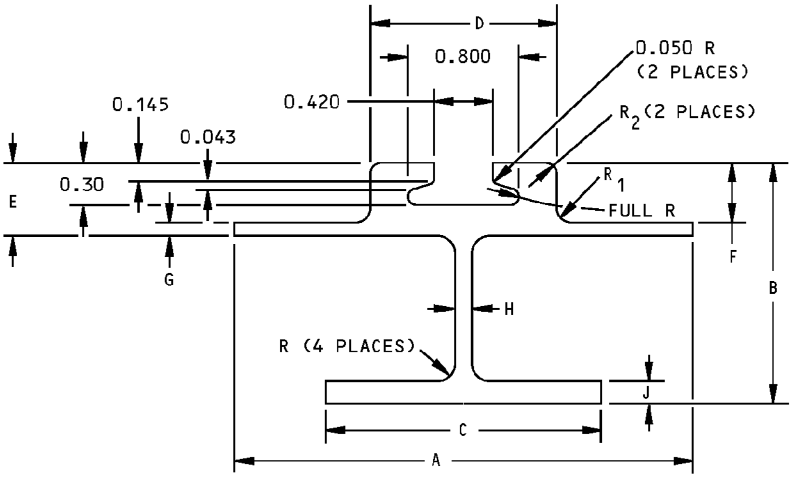


DASH NO.	A	B	C	D	E	F	G	R_1
1545 (8)	3.44	3.12 (138)	1.10	1.18	0.08	0.17	0.19	0.26

ALL DIMENSIONS ARE IN INCHES EXCEPT AS NOTED

BAC 1520-1545
DETAIL X

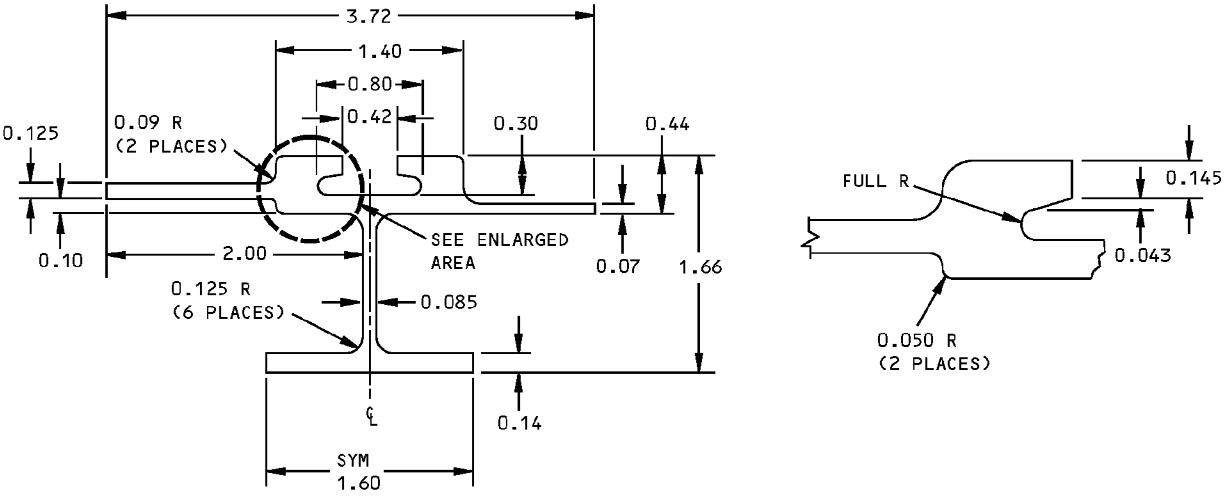
Metal Section Details
Figure 2 (Sheet 5 of 10)



DASH NO.	A	B	C	D	E	F	G	H	J	R	R_1	R_2
2192 (8)	3.38	1.66	1.60	1.34	0.44	0.37	0.07	0.085	0.14	0.125	0.09	0.09

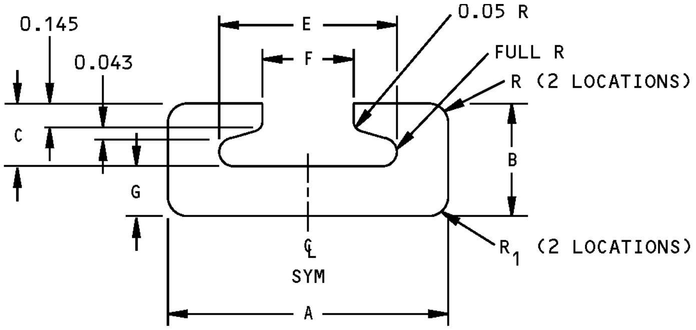
ALL DIMENSIONS ARE IN INCHES EXCEPT AS NOTED

BAC1520-2192
DETAIL XI



BAC1520-2193
DETAIL XII

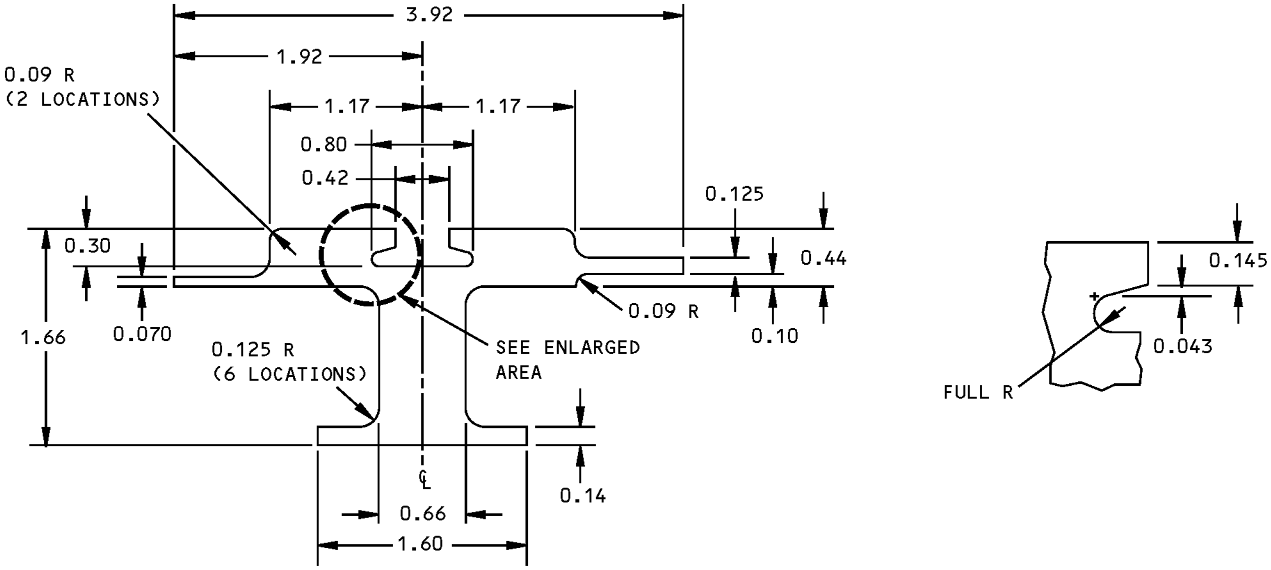
Metal Section Details
Figure 2 (Sheet 6 of 10)



DASH NO.	A	B	C	E	F	G	R	R1
2195 (8)	1.18	0.44	0.30	0.80	0.42		0.20	0.09
2194 (8)	1.26	0.50		0.80	0.42	0.20	0.09	0.09

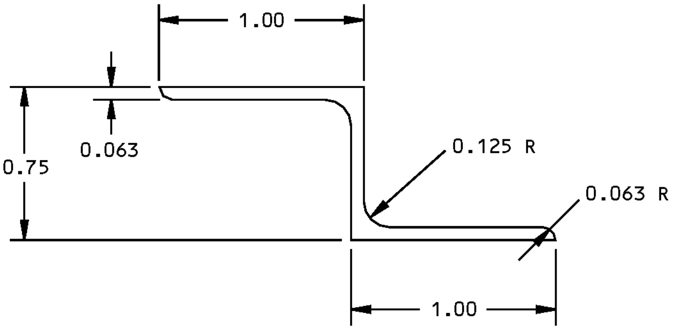
ALL DIMENSIONS ARE IN INCHES EXCEPT AS NOTED

BAC1520-2194,-2195
DETAIL XIII

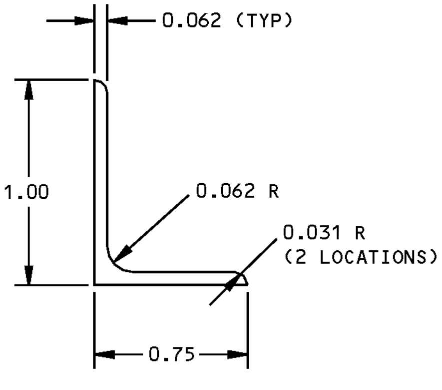


BAC1520-2196
DETAIL XIV

Metal Section Details
Figure 2 (Sheet 7 of 10)

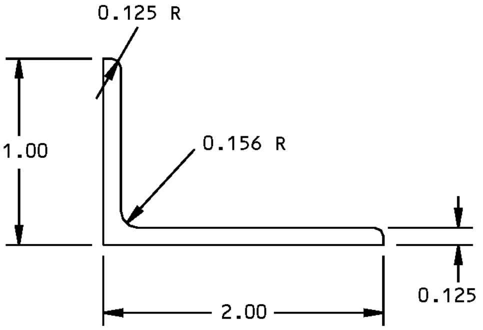


AND10138-0605
DETAIL XV

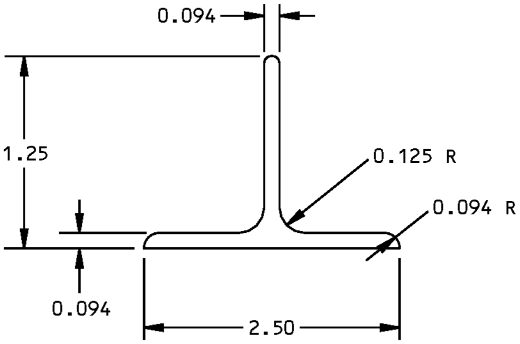


BAC1503-1511
DETAIL XVI

Metal Section Details
Figure 2 (Sheet 8 of 10)

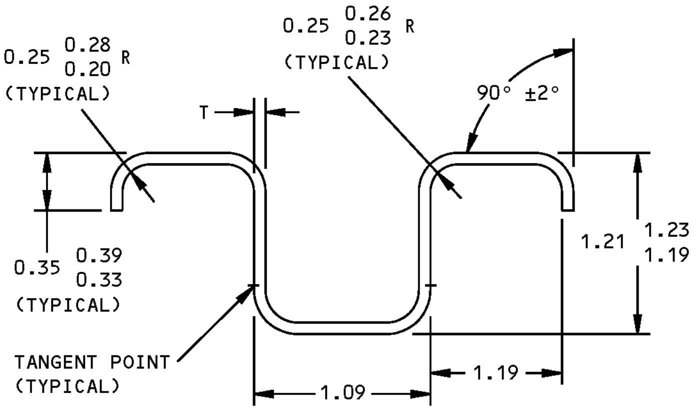


AND10134-2001
DETAIL XVII



AND10136-2401
DETAIL XVIII

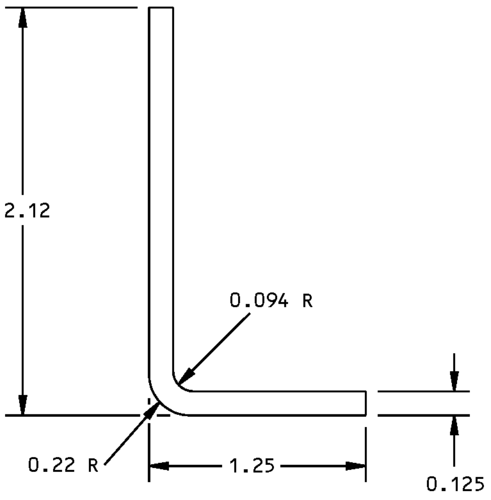
Metal Section Details
Figure 2 (Sheet 9 of 10)



DASH NO.	T
232	0.036
233	0.040
234	0.050
235	0.063
236	0.090

ALL DIMENSIONS ARE IN INCHES
EXCEPT AS NOTED

BAC1498-232 THRU -236
DETAIL XIX



BAC1503-100024
DETAIL XX

Metal Section Details
Figure 2 (Sheet 10 of 10)

MATERIAL	SUBJECT																					SOURCE
	52-80-02	54-10-01	54-11-01	54-13-01	54-30-01	54-31-01	54-33-01	54-40-30	54-41-30	54-43-30	54-50-70	54-51-70	54-52-70	54-53-70	55-10-01	57-20-01	57-41-01	57-43-02	57-53-01	57-53-02		
ALUMINUM HONEYCOMB CORE BMS 4-4 TYPE 6-40N					X	X	X															A C D E F G H
BMS 4-4 TYPE 3-10N	X														X				X	X		
BMS 4-4 TYPE 3-15N	X										X	X	X	X		X				X		
BMS 4-4 TYPE 3-25N																	X					
BMS 4-4 TYPE 4-25N															X							
FLEXIBLE ALUMINUM HONEYCOMB CORE BMS 4-6 CLASS I, TYPE 5.7-37				X	X	X	X															A
BMS 4-6 CLASS I, TYPE 4.1-25		X	X	X														X				F
CRES (PH15-7) HONEYCOMB CORE TRE 3200-1A-3/8C-15-7/15-7/1818-15-7/30/025								X	X	X												B
TRE 3300-1A-3/8C-15-7/15-7PX-2020-15-7/150/041								X	X	X												
ALUMINUM HONEYCOMB CORE AL H/C (5052) 22.1-1/8-60N MIL-C-7438E											X	X	X	X								
12.0-1/8-30 MIL-C-7438																		X				

A HEXCEL CORPORATION
11711 DUBLIN BLVD.
DUBLIN, CALIFORNIA 94566

B ASTECH DIVISION
TRE CORPORATION
3030 SOUTH REDHILL AVE
SANTA ANA, CALIFORNIA 92711

C SHOWA AIRCRAFT INDUSTRY CO. LTD.
600 TANAKA MACHI
AKISHIMA-SHI
TOKYO, 196-8522, JAPAN

D ALLORE INC.
1324 BRASS MILL ROAD,
BELLCAMP, MD 21017

E HEXCEL SA
PARK INDUSTIAL
B-4840 WELKENRAEDT
BELGIUM

F HEXCEL CORPORATION
GILA BEND HIGHWAY
CASA GRANDE, AZ 85222

G HEXCEL CORPORATION
BAYVIEW INDUSTRIAL PARK
1310 STEEL RD,
BURLINGTON, WA

H HEXCEL CORPORATION
ST CLAIR INDUSTRIAL PARK
POTTSVILLE, PA 17901

Metallic Materials Sources
Figure 3

GENERAL - NONMETALLIC MATERIALS

1. References

Reference	Title
51-20-05, GENERAL	Repair Sealing

2. General

A. This section lists materials used when making repairs contained within the 767 Structural Repair Manual and also lists sources of supply. These materials are also called out with the applicable repair information.

The purpose of this list is to show which subject the materials are used in and if they are common to more than one subject. The materials listed are not only used in the actual repair, but are often used for preparation and accomplishment of repairs.

B. Various materials, including resins and prepreg materials used for composite repairs, have a limited shelf life and require special storage conditions. This information is available from the material suppliers.

C. Refer to Table 1/GENERALfor an index of figures for the lists of materials.

Table 1: List of Materials Index

MATERIAL	LOCATION
Protective Coatings, Sealants, Adhesives and Cleaners	Figure 1/GENERAL
Glass Fabrics, Aramid Fabrics, Graphite Tapes, Graphite Fabrics, and Nonmetallic Honeycomb Cores	Figure 2/GENERAL
Abrasives	Figure 3/GENERAL
Miscellaneous Materials	Figure 4/GENERAL

D. For sealant classifications and substitution data, refer to 51-20-05, GENERAL.

NOTES

A AMCHEM PRODUCTS INCORPORATED
300 BROOKSIDE AVE
AMBLER, PA 19002-3436

B PUREX CORPORATION
TURCO PRODUCTS DIVISION
24600 S MAIN ST
CARSON, CA 90749

C WITCO CHEMICAL CORPORATION
WITCO-ALLIED-KELITE DIVISION
1250 N MAIN ST
P.O. BOX 2917 TERMINAL ANNEX
LOS ANGELES, CA 90012

D TEMPO PAINT AND VARNISH COMPANY
205 FENMAR DR
WESTON, ONTARIO
CANADA M9L2X4

E DE SOTO INCORPORATED PACIFIC PLANT
1608 FOURTH ST
BERKELEY, CA 94710

F MINNESOTA MINING AND MANUFACTURING COMPANY
3M CENTER
ST. PAUL, MN 55144-1000

G GIBSON CHEMICALS, LTD.
350 RESERVE RD
CHELTENHAM VICTORIA
3192 AUSTRALIA

H SIKKINS AEROSPACE FINISHES
20846 S NORMANDIE AVE
TORRANCE, CA 90502

I ESSEX CHEMICAL CORPORATION
COAST PRO-SEAL DIVISION
19451 SUSANA RD
COMPTON, CA 90221

J PRODUCTS RESEARCH AND CHEMICAL CORPORATION
5454 SAN FERNANDO RD
GLENDALE, CA 91209

K D. AIRCRAFT PRODUCTS COMPANY
1191 HAWK CIRCLE
ANAHEIM, CA 92708

L UNION OIL COMPANY OF CALIFORNIA
P.O. BOX 76
SEATTLE, WA 98111

M UNION 76 DIVISION WESTERN REGION
461 S BOYLSTON ST
P.O. BOX 7600
LOS ANGELES, CA 90017-1443

N 3M TILLOY
B.P. 415 TILLOY-LEZ-CAMBRAI
59404 CAMBRAI, CEDEX, FRANCE

O FURANE AEROSPACE PRODUCTS
CIBA-GEIGY CORPORATION
5121 SAN FERNANDO ROAD W
LOS ANGELES, CA 90039-1011

P CIBA-GEIGY (UK) LTD
BONDED STRUCTURES DIVISION
DUXFORD, CAMBRIDGE
ENGLAND CB242D

Q PERMACEL, INC.
JOHNSON & JOHNSON DIVISION
P.O. BOX 671
NEW BRUNSWICK, NJ 08903

R CYTEC INDUSTRIES
CYTEC ENGINEERED MATERIALS
HAVRE DE GRACE, MD 21078

S FIBER-RESIN CORPORATION
170 W PROVIDENCIA AVE
P.O. BOX 4187
BURBANK, CA 91503

T CIBA-GEIGY CORP.
REN PLASTICS
BLDG D, FISHER INDUSTRIAL PARK
KENT, WA 98032

U DEXTER AEROSPACE INCORPORATED
DEXTER CORPORATION
2850 WILLOW PASS RD
P.O. BOX 312
PITTSBURG, CA 94565-3237

V UNION CARBIDE CORP.
CHEMICAL AND PLASTICS DIVISION
BOUND BROOK, NJ 08805

W TRITON MANUFACTURING CO.
DIVISION OF TRITON INDUSTRIES INC.
P.O. BOX 361
EAST HADDAM, CT 06423

X MAGNAFLUX CORPORATION
6935 W 62ND ST
CHICAGO, IL 60638

Y CABOT CORP.
125 HIGH ST
BOSTON, MA 02110-2721

Z FIBER RESIN CORPORATION
C/O ATACS PRODUCTS, INC.
14040 INTERURBAN AVE S
TUKWILA, WA 98168-4723

AA OWENS CORNING FIBERGLASS CORP.
608 MADISON AVE
TOLEDO, OH 43604

AB DINOL INTERNATIONAL
20600 EUREKA RD, SUITE 414
TAYLOR, MI 48180-5306

AC SHELL OIL CO.
1 SHELL PLAZA
P.O. BOX 2463
HOUSTON, TX 77001

Protective Coatings, Sealants, Adhesives and Cleaners
Figure 1 (Sheet 1 of 13)

NOTES (CONT)

AD MANUFACTURING PLANT
INTERNATIONAL LUBE CORP.
P.O. BOX 51118
NEW ORLEANS, LA 70150

AE THE DEXTER CORPORATION
HYSOL DIVISION
P.O. BOX 54601
LOS ANGELES, CA 90054

AF ARDROX PYRENE LIMITED
BRENT CHEMICALS RIDGEWAY
IVER BUCKS SLO 9JJ, UNITED KINGDOM

AG ATACS PRODUCTS, INC.
14040 INTERURBAN AVE S
TUKWILA, WA 98168-4723

AH THE DEXTER CORPORATION
HYSOL DIVISION
211 FRANKLIN ST
OLEAN, NY 14760

AI BMS 5-79 IS SUPERSEDED BY BMS 5-95.
SEE SRM 51-20-05, FIG. 8 FOR SUBSTITUTES

AJ TURCO PRODUCTS INCORPORATED
24700 S MAIN ST
P.O. BOX 6200
CARSON, CA 90749

AK MAGNOLIA PLASTICS INCORPORATED
5547 PEACHTREE INDUSTRIAL BLVD
CHAMBLEE, GA 30341-2234

AL CYTEC INDUSTRIES
CYTEC ENGINEERED MATERIALS
1440 N KRAEMER BLVD
ANAHEIM, CA 92806

AM SOVEREIGN ENGINEERED ADHESIVES
ADHESIVE SYSTEMS DIVISION
123 W BARTGES ST
AKRON, OH 44311-1081

AN 3M/AEROSPACE MATERIALS DEPARTMENT
3211 E CHESTNUT EXPRESSWAY
SPRINGFIELD, MO 65802

Protective Coatings, Sealants, Adhesives and Cleaners
Figure 1 (Sheet 2 of 13)

MATERIAL	SOURCE	SUBJECT																			
		51-20-01	51-70-03	51-70-04	51-70-05	51-70-06	51-70-07	51-70-08	51-70-09	51-70-10	51-70-14	51-70-17	54-10-01	54-11-01	54-13-01	54-30-02	54-31-02	54-33-02	54-40-01	54-41-01	54-43-01
MATERIALS FOR <u>PROTECTIVE TREATMENT</u>																					
ALCOHOL - PHOSPHORIC SOLUTION		X																			
TURCO PREPAINT	B	X																			
KELITE POLYLOTE	C	X																			
CAB-O-SIL 10 TO 12% GRADE M-5 GRADE PTG	Y								X	X		X									
PHOSPHORIC ACID	ANY SOURCE								X	X											
HYDROFLUORIC ACID	ANY SOURCE								X	X											
BUTYL CELLUSOLVE	ANY SOURCE	X																			
TRITON X-100 WETTING AGENT	W	X																			
BMS 10-11, TYPE I PRIMER	D E H	THIS PRIMER IS USED IN MANY SUBJECTS																			
BMS 10-21 TYPE I CONDUCTIVE COATING	D E H										X										
BMS 10-60, TYPE II ENAMEL	E					X	X	X			X										
BMS 10-79, TYPE II OR III PRIMER	E										X										
BAC5710 TYPE 51 (DESOTO HI-TEMP) PRIMER BASE: 825:009 CATALYST: 910:175 THINNER: 020:044	E AE												X	X	X				X	X	X
EC-843 TOPCOAT SPRAY	F	X																			
IRIDITE 14-2	C	X																			
MIL-C-11796, CLASS 3 CORROSION-PREVENTATIVE COMPOUND	ANY SOURCE															X	X	X			
MIL-C-5541 ALODINE 1000	A	X																			
MIL-C-5541 ALODINE 1200S	A	X							X												
MIL-C-5591 ALODINE 600	A	X																			
MYLAR TAPE	ANY SOURCE		X	X	X																

Protective Coatings, Sealants, Adhesives and Cleaners
Figure 1 (Sheet 3 of 13)

MATERIAL	SOURCE	SUBJECT																			
		51-20-01	51-20-05	51-70-18	54-20-00	54-30-02	54-31-02	54-33-02	54-50-01	54-50-02	54-51-01	54-51-02	54-52-01	54-53-01	54-53-02	57-00-03	57-10-01	57-20-01			
MATERIALS FOR PROTECTIVE TREATMENT (CONT)																					
NITRIC ACID PHYDRION PAPERS NO. 60781	ANY SOURCE	X																			
TURCOAT ALUMIGOLD	AJ	X																			
SEALANTS																					
SILICONE SEALING COMPOUND	ANY SOURCE		X																		
NONSILICONE (POLYURE- THANE/POLYSULPHIDE)	ANY SOURCE		X																		
BMS 3-26, TYPE II ARDROX 3322 DINITROL AV 100 D	 AF AB	X	X																		
BMS 3-24	AC AD		X	X																	
BMS 5-26 TYPE II, CLASS A-2, B-2,C-24 PRO-SEAL 890 A-2,B-2, C-24 PR1440 A-2,B-2	I		X		X								X			X	X				
PERMAPOL P3 PR-1826	J		X																		
PERMAPOL P3 PR-1828	J		X																		
BMS 5-32	J		X																		
BMS 5-63, B-4	K		X			X	X	X	X	X	X	X	X	X	X						
BMS 5-79 CLASS B-1/2,B-2,B-4 PRO-SEAL 898 B-1/2, 3C-414 B1/2 PRO-SEAL 898 B-2, 3C-414 B-2 PRO-SEAL 898 B-4, 3C-414 B-4	AI	COMMON REPAIR SEALANT (FUEL RESISTANT)																			
BMS 5-95 CLASS B-1/2,B-2,B-4, C-20 PR1436G B-1/2 PR1436G B-2, PRO-SEAL 870 B-2 PR1436G TYPE I, PRO-SEAL 870 C-20	J	COMMON CHROMATE-LOADED REPAIR SEALANT																			

Protective Coatings, Sealants, Adhesives and Cleaners
Figure 1 (Sheet 4 of 13)

MATERIAL	SOURCE	SUBJECT																				
		51-20-01	51-20-05	51-40-08	51-70-06	51-70-08	51-70-09	51-70-10	51-70-14	51-70-17	53-00-50	53-50-12	54-00-01	54-20-00	54-20-01	54-21-01	54-23-01	57-00-03	57-10-01	57-10-03	57-20-01	57-20-09
CORROSION INHIBITORS																						
MIL-C-16173, GRADE 3	ANY SOURCE	X																				
MIL-C-11796, CLASS 3	ANY SOURCE											X										
BMS 3-23, TYPE I BOESHIELD T-9	G	X																				
BMS 3-23, TYPE II BOESHIELD T-9 DINITROL AV8	G AB	X																				
BMS 3-26, TYPE II ARDROX 3322 DINITROL AV 100 D	AF AB	X																				
BMS 3-29 DINITROL AV30	AB	X																				
BMS 10-20, TYPE II	H		X															X	X	X	X	X
BMS 5-89 CIAP	F R						X	X														
DESOTO 513-707 CIAP	E						X	X														
ADHESIVES																						
BMS 5-14	I			X																		
BMS 5-25 GRADE 1, EA 901 PASTE	U				X	X				X												
BMS 5-92, TYPE I OR III EC 2216 A/B	F				X	X			X	X	X				X	X	X					
BMS 5-107	P										X											
BMS 5-109 TYPE II CLASS II	S AE												X	X								
BMS 5-123, TYPE I	O AG AH														X	X	X					

Protective Coatings, Sealants, Adhesives and Cleaners
Figure 1 (Sheet 5 of 13)

MATERIAL	SOURCE	SUBJECT			
		51-70-05	51-70-07	51-70-10	53-10-72
<u>ADHESIVE FILMS</u>					
BMS 5-51 TYPE II SUPERCEDED BY BMS 5-129 FOR COMPOSITES AND BMS 5-101, TYPE II FOR METAL BOND				X	X
BMS 5-51 TYPE III SUPERCEDED BY BMS 5-101, TYPE III				X	
BMS 5-90 TYPE III, CLASS 250/ 350-10-10, ALL GRADES FM-490A MA-562 PL-685	 R AM AM	X	X	X	X
BMS 5-90 TYPE IV, CLASS 250/ 350-10-10 PL-460	 AM	X	X	X	X

Protective Coatings, Sealants, Adhesives and Cleaners
Figure 1 (Sheet 6 of 13)

MATERIAL	SOURCE	SUBJECT																			
		51-70-04	51-70-05	51-70-07	51-70-08	51-70-09	51-70-10														
ADHESIVE FILMS (CONT)																					
BMS 5-101 TYPE II, GRADE 5 OR 10 FM-73M EA-9628NW AF-163-2 OST	R U N AN					X	X														
BMS 5-101 TYPE II, GRADE 15 FM-73M AF-163-2M	R AN					X	X														
BMS 5-101 TYPE III EC-3903	N AN					X	X														
BMS 5-129 TYPE 2, CLASS IA AF-126	AN		X	X																	
BMS 5-129 TYPE 2, CLASS IIA AF-126-2	AN		X	X																	
BMS 5-129 TYPE 2, CLASS IIB FM-123-2	R		X	X																	
BMS 5-129 TYPE 4, GRADE 10 AF-163-2OST EA-9628 NW	N AN U		X	X																	
BMS 5-154 TYPE II, CLASS 1 GRADE 03 ADHESIVE FILM METLBOND 1515-3M 03 PSF METLBOND 1515-3M-HT 03 PSF PL-795 03 PSF	AL AL AM	X																			
BMS 5-154 TYPE II, CLASS 1, GRADE 05 ADHESIVE FILM METLBOND 1515-3M 05 PSF METLBOND 1515-3M-HT 05 PSF PL-795 05 PSF	AL AL AM	X																			
BMS 8-145 TYPE I AF-131-2 FM-355	AN R				X																

Protective Coatings, Sealants, Adhesives and Cleaners
Figure 1 (Sheet 7 of 13)

MATERIAL	SOURCE	SUBJECT																			
		51-70-01	51-70-03	51-70-06	51-70-09	51-70-10	51-70-14	54-00-01	54-50-70	54-51-70	54-52-70	54-53-70	57-30-01								
POTTING COMPOUNDS AND RESINS																					
BMS 5-28 TYPE 3 EC 1511A WITH EC 1511B HARDENER	O	X					X	X													
BMS 5-28 TYPE 6 EC 1636A WITH EC 1636B HARDENER	O		X	X	X	X			X	X	X	X	X								
BMS 5-28 TYPE 7, CLASS 1 CG 1305 WITH CG 1305 HARDENER	T	THIS MATERIAL IS USED IN MANY SUBJECTS																			
FR 7162A WITH FR 7162B HARDENER	Z																				
TYPE 7, CLASS 2 EC 89537A WITH EC 89537B HARDENER	O																				
BMS 5-28 TYPE 13 EC 938	J	X					X	X													
BMS 5-28 TYPE 15 EC 1615A WITH EC 1615B HARDENER	O		X			X															

Protective Coatings, Sealants, Adhesives and Cleaners
Figure 1 (Sheet 8 of 13)

MATERIAL	SOURCE	SUBJECT																			
		51-70-03	51-70-06	51-70-10	53-00-50	53-10-72	54-50-70	54-51-70	54-52-70	54-53-70											
<u>POTTING COMPOUNDS AND RESINS</u> (CONT)																					
BMS 5-28 TYPE 17 EC 1617A WITH EC 1617B HARDENER	O		X			X															
MAGNOBOND 91A WITH MAGNOBOND 91B HARDENER	AK																				
BMS 5-28 TYPE 19 EC 1619A WITH EC 1619B HARDENER	O		X		X																

Protective Coatings, Sealants, Adhesives and Cleaners
Figure 1 (Sheet 9 of 13)

MATERIAL	SOURCE	SUBJECT																			
		51-70-03	51-70-04	51-70-05	51-70-06	51-70-07	51-70-08	51-70-14	51-70-17	52-50-02	53-00-50	53-10-72									
<u>POTTING COMPOUNDS</u> <u>AND RESINS</u> (CONT)																					
BMS 8-207 TYPE I, CLASS 1 EC 1838A: 50 PBW EC 1838B: 50 PBW	F	X	X			X		X													
TYPE I, CLASS 2 FR-40 WITH FR 5413C HARDENER	S	X	X			X	X	X													
FIBER-RESIN 5318S 5318C	S		X	X	X	X	X	X													
EPIBOND 156A WITH EPIBOND 941 HARDENER	O	X	X	X	X	X	X	X			X										
EPIBOND 156A WITH EPIBOND 156B HARDENER	O	X	X	X	X	X	X	X													
EPOX-O WELD KIT	S			X	X	X	X	X													
MILLED GLASS FIBERS	AA	X			X				X												
PHENOLIC MICROBALLOONS	V	X			X				X												

Protective Coatings, Sealants, Adhesives and Cleaners
Figure 1 (Sheet 10 of 13)

MATERIAL	SOURCE	SUBJECT																			
		51-70-03	51-70-06	51-70-08	51-70-14	51-70-17															
POTTING COMPOUNDS AND RESINS (CONT)																					
BMS 8-301 TYPE I EA 9390A WITH EA 9390B HARDENER	$\boxed{U}$			X		X															
BMS 8-301 TYPE II FR 7020A BASE FR 7020B HARDENER EY 3804 PART A BASE EY 3804 PART B HARDENER	$\boxed{Z}$	X	X																		

Protective Coatings, Sealants, Adhesives and Cleaners
Figure 1 (Sheet 11 of 13)

MATERIAL	SOURCE	SUBJECT		
		51-70-10	53-10-72	55-30-01
TAPES				
3M-Y436 ALUMINUM FOIL TAPE	F	THIS MATERIAL IS USED IN MANY SUBJECTS		
PERMACEL P280 POLYESTER TAPE	Q		X	X
SCOTCHBRAND NO. 853	F		X	X
BLACK PLASTIC TAPE NO. 472	F	X		

Protective Coatings, Sealants, Adhesives and Cleaners
Figure 1 (Sheet 12 of 13)

MATERIAL	SOURCE	SUBJECT																			
		SRM 51-20-01	SRM 51-20-05	SRM 51-40-02	SRM 51-40-08	SRM 51-70-03	SRM 51-70-04	SRM 51-70-05	SRM 51-70-06	SRM 51-70-07	SRM 51-70-08	SRM 51-70-09	SRM 51-70-10	SRM 51-70-14	SRM 51-70-17	SRM 51-70-18	SRM 53-00-50	SRM 53-10-72			
<u>SOLVENTS</u>																					
NAPHTHA	$\boxed{F}$	X																			
METHYL ETHYL KETONE (MEK)	ANY SOURCE	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			
METHYL ISOBUTYL KETONE (MIBK)	ANY SOURCE					X	X	X	X	X	X	X	X	X	X	X	X				
PERCHLOROETHYLENE, O-T-236	ANY SOURCE	X																			
TRICHLOROETHYLENE	ANY SOURCE	X																			
ACETONE	ANY SOURCE					X	X	X	X	X	X	X	X	X	X	X	X	X			
BMS 3-2	$\boxed{L}$	X		X																	
BMS 11-7	$\boxed{M}$		X									X	X								

Protective Coatings, Sealants, Adhesives and Cleaners
Figure 1 (Sheet 13 of 13)

NOTES

A HEXCEL CORPORATION
VALLEY INDUSTRIAL PARK
P.O. BOX 66
CASA GRANDE, ARIZONA 85222

B CIBA-GEIGY CORPORATION
COMPOSITE MATERIALS DEPARTMENT
3550 NW 49TH STREET
MIAMI, FLORIDA 33142

C CIBA-GEIGY (UK), LTD.
BONDED STRUCTURES DIVISION
DUXFORD, CAMBRIDGE CB24QD, ENGLAND

D HEXCEL CORPORATION
338 N. PENNSYLVANIA
GRAHAM, TEXAS 76046

E CIBA-GEIGY
COMPOSITE MATERIALS DEPARTMENT
10910 TALBERT AVE.
FOUNTAIN VALLEY, CALIFORNIA 92708

F HEXCEL CORPORATION
STRUCTURAL PRODUCTS DIVISION
10 TREVARNO ROAD
LIVERMORE, CALIFORNIA 94550

G FIBERITE WEST COAST CORP.
645 N. CYPRESS STREET
P.O. BOX 738
ORANGE, CALIFORNIA 92669

H CELANESE CORPORATION
NARMCO MATERIALS DIVISION
1440 NORTH KRAEMER BLVD
ANAHEIM, CALIFORNIA 92806

I AMERICAN CYANAMID COMPANY
INDUSTRIAL CHEMICALS AND PLASTICS DIV.
BLOOMINGDALE PLANT
OLD POST ROAD
HAVRE DE GRACE, MARYLAND 21078

J HEXCEL CORP.
11711 DUBLIN BLVD
DUBLIN, CALIFORNIA 94566

K CLARK-SCHWEBEL FIBER GLASS CORP.
5 CORPORATE PARK DRIVE
WHITE PLAINS, NEW YORK 10604

L J.P. STEVENS AND COMPANY, INC.
STEVENS TOWER
1185 AVENUE OF THE AMERICAS
NEW YORK, NEW YORK 10036

M FIBERITE CORPORATION
501 W. THIRD STREET
WINONA, MINNESOTA 55987

N YOKOHAMA RUBBER CO., LTD.
AEROSPACE DIVISION
P.O. BOX 20, HIRATSUKA-SHI
KANAGAWA-KEN, 254 JAPAN

O BURLINGTON INDUSTRIES
BURLINGTON GLASS FABRICS CO.
1345 AVENUE OF THE AMERICAS
NEW YORK, NEW YORK 10019

P HEXCEL CORPORATION
815 LAWRENCE STREET
P.O. BOX 668
LANCASTER, OHIO 43130

Q HEXCEL CORPORATION S.A.
RUE DES 3, BOURDONS 50
PARC INDUSTRIEL
4840 WELKENRAEDT, BELGIUM

R YOKOHAMA RUBBER CO., LTD.
C/O TORAY INDUSTRIES, INC.
SHIGA PLANT
3-1, 3-CHROME, SONOYAMA
OTSU-SHI, SHIGA-KEN
520 JAPAN

S CELANESE CORPORATION
CEM NARMCO ET CIE
29, CHEMIN DE LA LIGNE DE L'EST
69, VILLEURBANNE, FRANCE

T HERCULES INC.
BACCHUS WORKS
GRAPHITE FIBERS BUSINESS CENTER
P.O. BOX 98
MAGNA, UTAH 84044

U HITCO
WOVEN STRUCTURES DIVISION
618 WEST CAROB STREET
COMPTON, CALIFORNIA 90220

V TEXTILE PRODUCTS, INC.
2512 W. WOODLAND DRIVE
ANAHEIM, CALIFORNIA 92801

W SAKAI COMPOSITES CORP.
1349-1 HOSOJIMA, SHIMADA-CITY,
SHIZUOKA-PREF., 427 JAPAN

Glass Fabrics, Aramid Fabrics, Graphite Tapes, Graphite Fabrics, and Nonmetallic Honeycomb Cores
Figure 2 (Sheet 1 of 13)

NOTES (CONT)

X J. BROCHIER ET FILS
70 COURS TOLSTOI
BOITE POSTALE 3007
69605 VILLEURBANNE, SEDEX FRANCE

Y STEVENS - GENIN, S.A.
38360 LES AVENIERES
FRANCE

Z TERANA, INC.
2512 W. WOODLAND DRIVE
ANAHEIM, CALIFORNIA 92801

AA FOTHERGILL AND HARVEY LTD.
INDUSTRIAL TEXTILES DIVISION
SUMMIT LITTLEBOROUGH
LANCASHIRE, ENGLAND
GL I5 9QP

AB UNIGLASS INDUSTRIES
UNITED MERCHANTS
P.O. BOX 871
STATESVILLE, NORTH CAROLINA 28677

AC CLARK-SCHEBEL INTERNATIONAL S.A.
BATTICE, BELGIUM

AD KANEBO FIBER GLASS COMPANY LTD.
3-12 MOTO-AKASAKA 1-CHOME
MINATO-KU, TOKYO 107, JAPAN

AE ARISAWA MFG CO., LTD.
5-5, 1-CHOME MINAMI HONCHO
JOETSU-CITY, NIIGATA-PREFECTURE
JAPAN

AF SHOWA AIRCRAFT INDUSTRY CO. LTD.
NO. 600 TANAKA-MACHI
AKISHIMA-SHI, TOKYO, JAPAN

AG DELETED

AH PERMALI GLOUCESTER LTD.
BRISTOL ROAD
GLOUCESTER GL15TT
ENGLAND

AI GENERAL VENEER MANUFACTURING COMPANY
8652 OTIS STREET
SOUTH GATE, CALIFORNIA 90280

AJ NORDAM DIVISION
R. H. SIEGFRIED, INC.
510 SOUTH LANSING
P.O. BOX 3365
TULSA, OKLAHOMA 74120

AK AMERICAN CYNAMID COMPANY
AEROSPACE PRODUCTS DEPT.
21444 GOLDEN TRIANGLE ROAD
SAUGUS, CALIFORNIA 91350

Glass Fabrics, Aramid Fabrics, Graphite Tapes, Graphite Fabrics, and Nonmetallic Honeycomb Cores
Figure 2 (Sheet 2 of 13)

MATERIAL	SOURCE	SUBJECT						
		51-70-04	51-70-05	51-70-07	51-70-08	51-70-15	53-00-50	53-10-72
<u>GLASS FABRIC</u>								
BMS 8-79								
TYPE 120, CLASS III, GRADE I			X	X		X		
120-F155-5-F69	A F P							
120-F255-1-F69	F							
NARMCO-3203-120,Z6040	H							
NARMCO-3203F-120,Z6040	S							
NARMCO-3203-120,VOLAN A	H							
MXB 7701-120-Z6040	G							
120-F155-5-CS272	Q							
G120/F6986S03-S920NM	N							
BMS 8-79								
TYPE 1581, CLASS III, GRADE I			X	X		X	X	X
1581-F155-5-F69	A F P							
1581-F255-1-F69	F							
NARMCO-3203-1581,Z6040	H S							
NARMCO-3203F-1581,Z6040	S							
NARMCO-3203-1581,VOLAN A	H							
MXB 7701-1581-Z6040	G							
1581-F155-5-CS272	Q							
G1581/F6986S03-S920NM	N							
BMS 8-79								
TYPE 7781, CLASS III, GRADE I			X	X		X	X	X
7781-F155-5-F69	A F P							
7781-F255-1-F69	F							
NARMCO-3203-7781,Z6040	H							
NARMCO-3203F-7781,Z6040	S							
NARMCO-3203-7781,VOLAN A	H							
MXB 7701-7781-Z6040	G							
7781-F155-5-CS272	Q							
G7781/F6986S03-S920NM	N							
BMS 8-139								
TYPE 120, CLASS I		X			X	X		
120-F161-108-F50	A F							
NARMCO-588-120,VOLAN A	H							

Glass Fabrics, Aramid Fabrics, Graphite Tapes, Graphite Fabrics, and Nonmetallic Honeycomb Cores
Figure 2 (Sheet 3 of 13)

MATERIAL	SOURCE	SUBJECT																			
		51-70-03	51-70-04	51-70-06	51-70-07	51-70-08	51-70-14	51-70-15	51-70-17	52-50-02	53-00-50	53-10-72									
GLASS FABRIC (CONT)																					
BMS 8-139 TYPE 1581, CLASS I 181-F161-108-F50 NARMCO-588-181, VOLAN A	 A F H		X			X		X													
BMS 8-151 TYPE I (STYLE 120) GRADE A CYCOM 5131-120 MXB 7251/120 G 120/F21003	 AK G N									X											
TYPE IV (STYLE 8800) GRADE A MXB 7251/8800 JMSNB-151-8800 G 8800/F21003	 G AE N									X											
BMS 8-169 TYPE 120 CYCOM 919-120	 I AK				X			X													
BMS 9-3 TYPE D (ALL CLASSES EXCEPT CLASSES 1 AND 15)	 J K L O AB AC AD	X		X					X												
TYPE H (ALL CLASSES EXCEPT CLASSES 1 AND 15)	J K L O AB AC						X					X									
TYPE H-2 (ALL CLASSES EXCEPT CLASSES 1 AND 15)	J K L O AB AC AD	X		X			X		X	X		X									
TYPE H-3 (ALL CLASSES EXCEPT CLASSES 1 AND 15)	J K L O AB AC AD AE	X		X			X		X	X		X									
PRECURED FIBERGLASS SHEET PERMAGLASS XERTT6/9	 AH										X										

Glass Fabrics, Aramid Fabrics, Graphite Tapes, Graphite Fabrics, and Nonmetallic Honeycomb Cores
Figure 2 (Sheet 4 of 13)

MATERIAL	SOURCE	SUBJECT																			
		52-50-02																			
DECORATIVE LAMINATE																					
BAC5596 TYPE I BMS 8-143 TYPE 100 (NOMEX)	THE BOEING COMPANY	X																			
TYPE II BMS 8-143 TYPE 181 (FIBERGLASS)	THE BOEING COMPANY	X																			
TYPE III BMS 8-176 (NON-REINFORCED)	THE BOEING COMPANY	X																			

MATERIAL	SOURCE	SUBJECT																			
		51-70-04	51-70-05	51-70-15																	
ARAMID FABRIC																					
BMS 8-218 STYLE 285 KEVLAR 49-285 F161-188 MXM 7880/KEVLAR 49-285 CYCOM 985 K285 R-9369-285K	F G I E	X		X																	
BMS 8-219 STYLE 120 KEVLAR 49-120 F155-71 MXM 7714/KEVLAR 49-120 K120/F6986S03-KE-420 CYCOM 919 K120 R-9269-120K	J G N I E		X	X																	
STYLE 285 KEVLAR 49-285 F155-71 MXM 7714/KEVLAR 49-285 K285/F6986S03-KE-420 CYCOM 919 K285 R-9269-285K	J G N I E		X	X																	

Glass Fabrics, Aramid Fabrics, Graphite Tapes, Graphite Fabrics, and Nonmetallic Honeycomb Cores
Figure 2 (Sheet 5 of 13)

MATERIAL	SOURCE	SUBJECT																			
		51-70-04	51-70-05	51-70-15																	
GRAPHITE TAPE																					
BMS 8-168																					
CLASS 1,TYPE II,GRADE 95			X	X																	
T3T-95-12-F155-76	F																				
T6C-95-12-F155-76	F																				
T2C-95-12-F155-76	F																				
HYE-10714AC(95)	M																				
CYCOM 919GT-3095	I																				
R-6268-C3K-95-40	E																				
CLASS 1,TYPE II,GRADE 145			X	X																	
T3T-145-12-F155-76	F																				
T6C-145-12-F155-76	F																				
T2C-145-12-F155-76	F																				
HYE-10714AC(145)	M																				
HY-E 16714AD(145)II	M																				
CYCOM 919GT-3145	I																				
R-6268-C12K-145-40	E																				
CLASS 1,TYPE II,GRADE 190			X	X																	
T3T-190-12-F155-76	F																				
T6C-190-12-F155-76	F																				
T2C-190-12-F155-76	F																				
HYE-10714AC(190)	M																				
HY-E 16714AD(190)II	M																				
C3U190/F6986S03	R																				
CYCOM 919GT-3190	I																				
R-6268-C12K-190-40	E																				
BMS 8-212																					
CLASS 1,TYPE III,GRADE 190		X	X																		
RIGIDITE 5208-300-190-35 PERCENT	H																				
RIGIDITE 5208-C3000-190-35 PERCENT	H																				
RIGIDITE 5208FT-300-190-35 PERCENT	S																				
HYE-1034C(190)-II	M																				
T3T190-12-F263-2	F																				
T5T190-12-F263-2	F																				
T6C190-12-F263-2	F																				
T2C190-12-F263-2	F																				
AS43501-5A	T																				

Glass Fabrics, Aramid Fabrics, Graphite Tapes, Graphite Fabrics, and Nonmetallic Honeycomb Cores
Figure 2 (Sheet 6 of 13)

MATERIAL	SOURCE	SUBJECT																			
		51-70-04	51-70-15																		
GRAPHITE TAPE (CONT)																					
BMS 8-212																					
CLASS 1,TYPE III,GRADE 95		X	X																		
RIGIDITE 5208-C3000-95-37 PERCENT	H																				
RIGIDITE 5208-C6000-95-37 PERCENT	H																				
HYE-1034C(95)-III	M																				
HYE-3034C(95)-III	M																				
T6C95-12-F263-7	F																				
T2C95-12-F263-7	F																				
T3T95-12-F263-7	F Q																				
T3G95-12-F263-7	F																				
AS4/3501-5A	T																				
CYCOM 985GT3095	I																				
FIBREDUX 922C-TS-3.6-37%	C																				
R922-C3K-95-37	E																				
CLASS 1,TYPE III,GRADE 145		X	X																		
RIGIDITE 5208-C3000-145-37 PERCENT	H																				
RIGIDITE 5208-C6000-145-37 PERCENT	H																				
HYE-1034C(145)-III	M																				
HYE-3034C(145)-III	M																				
HYE-3034K(145)-III	M																				
T6C145-12-F263-7	F																				
T2C145-12-F263-7	F																				
T3T145-12-F263-7	F Q																				
T3G145-12-F263-7	F																				
AS4/3501-5A	T																				
CYCOM 985GT3145	I																				
FIBREDUX 922C-TS-5.5-37%	C																				
R922-C12K-145-37	E																				

Glass Fabrics, Aramid Fabrics, Graphite Tapes, Graphite Fabrics, and Nonmetallic Honeycomb Cores
Figure 2 (Sheet 7 of 13)

MATERIAL	SOURCE	SUBJECT	
		51-70-04	51-70-05
GRAPHITE FABRIC			
BMS 8-168 CLASS 2,TYPE II, STYLE 3K-70-PW			X
W3T-282-42-F155-76	F		
W3C-282-42-P155-76	F		
HMF-322/7714AC	M		
C3WPW/F6986S03	N		
C3BWPW/F6986S03	N		
CYCOM 919GF-3070PW	I		
R-6268-C3K-70-PW-42	E		
BMS 8-212 CLASS 2,TYPE III, STYLE 3K-135-8H		X	
RIGIDITE 5208 WOVEN T-300 STYLE 3K-135-8H-37 PERCENT	H		
RIGIDITE 5208 WOVEN C3000 STYLE 3K-135-8H-37 PERCENT	H		
RIGIDITE 5208F WOVEN T-300 STYLE 3K-135-8H-37 PERCENT	S		
HMF-133/34-III	M		
F3T-584-42-F263-7	F Q		
F3C-584-42-F263-7	F		
A370-8H/3501-5AD	T		
CYCOM 985GF3135H8	I		
FIBREDUX 922C-815-37%	C		
R922-C3K1358H-37	E		

Glass Fabrics, Aramid Fabrics, Graphite Tapes, Graphite Fabrics, and Nonmetallic Honeycomb Cores
Figure 2 (Sheet 8 of 13)

MATERIAL	SOURCE	SUBJECT																			
		51-70-04	51-70-05	51-70-15																	
GRAPHITE FABRIC (CONT)																					
BMS 8-212 CLASS 2,TYPE IV, STYLE 3K-70-PW		X		X																	
RIGIDITE 5208 WOVEN T-300 STYLE 3K-70-PW-40 PERCENT	$\boxed{H}$																				
RIGIDITE 5208 WOVEN C3000 STYLE 3K-70-PW-40 PERCENT	$\boxed{H}$																				
RIGIDITE 5208F WOVEN T-300 STYLE 3K-70-PW-40 PERCENT	$\boxed{S}$																				
HMF-322/34C-IV	$\boxed{M}$																				
HMF-1322/34C-IV	$\boxed{M}$																				
W3C-282-42-F263-8	$\boxed{F}$																				
W3T-282-42-F263-8	$\boxed{Q}$																				
A193-P/3501-5AD	$\boxed{T}$																				
CYCOM 985GF3070PW	$\boxed{I}$																				
FIBREDUX 922C-B14NT-40%	$\boxed{C}$																				
R922-C3K70PW-40	$\boxed{E}$																				
BMS 8-258 CLASS 2, STYLE 3K-70-PW			X	X																	
CYCOM 919GF3070PW-42	$\boxed{I}$																				

Glass Fabrics, Aramid Fabrics, Graphite Tapes, Graphite Fabrics, and Nonmetallic Honeycomb Cores
Figure 2 (Sheet 9 of 13)

MATERIAL	SOURCE	SUBJECT																			
		51-70-03	51-70-17																		
GRAPHITE FABRIC (CONT)																					
BMS 9-8 TYPE I,CLASS 2, STYLE 3K-70-P		X	X																		
W-134	M																				
W-322	M																				
W-422	M																				
W-1134	M																				
W-1322	M																				
ES-1434	U																				
ES-1475	U																				
F3T-282	J																				
F3C-282	J																				
4163	V																				
4133	V																				
7373	W																				
G814NT	X																				
43193/1/107 cm	Y																				
9610	Z																				
9820	Z																				
A0039/000	AA																				
CGG-100	E																				
TYPE I,CLASS 2, STYLE 3K-135-8H		X	X																		
W-133	M																				
W-401	M																				
W-1133	M																				
ES-1433	U																				
ES-1480	U																				
F3T-584	J																				
F3C-584	J																				
4243	V																				
4245	V																				
G815	X																				
43364/1/107 cm	Y																				
9650	Z																				
9860	Z																				
A0053/000	AA																				
CGG-104	E																				

Glass Fabrics, Aramid Fabrics, Graphite Tapes, Graphite Fabrics, and Nonmetallic Honeycomb Cores
Figure 2 (Sheet 10 of 13)

MATERIAL	SOURCE	SUBJECT																			
		52-40-02	52-50-02	52-80-02	53-00-50	53-10-72	53-60-70	53-80-70	54-50-70	54-51-70	54-52-70	54-53-70	57-41-01	57-41-09	57-41-70	57-50-01					
ALUMINIZED GLASS FABRIC																					
BMS 8-278 TYPE II, CLASS 350	F										X										
NONMETALLIC HONEYCOMB																					
HRH-10F/50-5.0	F					X															
HRP/F50-4.5	J							X													
BMS 8-124 CLASS I,TYPE I,GRADE 4.0 HRP-3/16-4.0 HTP-3/16-4.0	A D B	X		X	X		X						X	X	X						
CLASS I,TYPE I,GRADE 5.5 HRP-3/16-5.5 HTP-3/16-5.5	A D B	X				X															
CLASS I,TYPE I,GRADE 8.0 HRP-3/16-8.0 HTP-3/16-8.0	D B	X														X					
CLASS I,TYPE I,GRADE 12.0 HRP-3/16-12.0 HTP-3/16-12.0	D B			X					X	X	X	X									
CLASS IV,TYPE I,GRADE 2.0 HRH-3/16-2.0 HMX-3/16-2.0	A B		X																		

Glass Fabrics, Aramid Fabrics, Graphite Tapes, Graphite Fabrics, and Nonmetallic Honeycomb Cores
Figure 2 (Sheet 11 of 13)

MATERIAL	SOURCE	SUBJECT 52-40-02	52-80-02	54-10-01	54-11-01	54-13-01	54-20-01	54-21-01	54-23-01	54-30-01	54-31-01	54-33-01	54-50-70	54-51-70	54-52-70	54-53-70	55-10-30	55-30-30	57-30-01	57-53-01	57-53-70
NONMETALLIC HONEYCOMB (CONT)																					
BMS 8-124 (CONT)																					
CLASS IV,TYPE I,GRADE 4.0		X		X	X	X	X	X	X												
HRH-3/16-4.0	A																				
HMX-3/16-4.0	B																				
CLASS IV,TYPE V,GRADE 3.0		THIS MATERIAL IS USED IN MANY SUBJECTS																			
HRH-10-1/8-3.0	A D																				
HMX-1/8-3.0	B																				
HFT-1/8-3.0	A																				
A-1-48-3	C																				
HRH10-1/8-3.0	Q																				
SAH-1/8-3.0	AF																				
CLASS IV,TYPE V,GRADE 4.0													X	X	X	X					
HRH-10-1/8-4.0	A																				
HFT-1/8-4.0	A																				
A-1-64-3	C																				
HMX-1/8-4.0	B																				
CLASS IV,TYPE V,GRADE 5.0			X							X	X	X					X		X		
HRH-10-1/8-5	A																				
HMX-1/8-5	B																				
SAM-1/8-5.0	AF																				
CLASS IV,TYPE V,GRADE 8.0		X																			
HRH-10-1/8-8	A																				
HMX-1/8-8	B																				
HFT-1/8-8.0	A																				
SAH-1/8-8.0	AF																				
CLASS IV,TYPE V,GRADE 9.0										X		X									
HRH-10-1/8-9	A																				
HMX-1/8-9	B																				
SAH-1/8-9.0	AF																				
CLASS IV,TYPE VI,GRADE 3.0													X	X	X	X	X	X		X	X
HRH-10-3/16OX-3.0	A																				
HMX-3/16-OX-3.0	B																				
HRH10-3/16-OX-3.0	Q																				

Glass Fabrics, Aramid Fabrics, Graphite Tapes, Graphite Fabrics, and Nonmetallic Honeycomb Cores
Figure 2 (Sheet 12 of 13)

MATERIAL	SOURCE	SUBJECT 53-00-50	 53-10-54	 53-30-53	 53-60-53
<u>FLOOR PANEL</u>					
BMS 4-10 ALUMINUM FACED, BALSA CORE SANDWICH TYPE 1, GRADE 8	C AI AJ			X	X
BMS 4-17 FIBERGLASS FACED NOMEX HONEYCOMB CORE SANDWICH,		X	X	X	X
TYPE I					
FIBERLAM GR 5	E				
GENEERCO FLOOR NO. 6 TYPE 8A	AI				
DURALAM 1	AJ				
TYPE II					
FIBERLAM GR 1	E				
GENERCO FLOOR NO. 6 TYPE 9A	AI				
DURALAM 2	AJ				
FIBERLAM DD14	E				
GENERCO FLOOR NO. 6 TYPE 17A	AI				
DURALAM 5	AJ				
69B15779 FIBERGLASS FACED NOMEX HONEYCOMB CORE SANDWICH TYPE VI	E	X			
BMS 4-20 GRAPHITE FACED NOMEX HONEYCOMB CORE SANDWICH		X			
FIBERLAM 2000W GRADE 1	E				
HEXLITE I	J				
TYPE II					
FIBERLAM 2000W GRADE 2	E				
HEXLITE II	J				
FIBERLAM 2000W GRADE 3	E				
HEXLITE III	J				

Glass Fabrics, Aramid Fabrics, Graphite Tapes, Graphite Fabrics, and Nonmetallic Honeycomb Cores
Figure 2 (Sheet 13 of 13)

MATERIAL	SOURCE	SUBJECT																			
		51-10-00	51-20-01	51-20-05	51-70-01	51-70-03	51-70-04	51-70-05	51-70-06	51-70-07	51-70-08	51-70-14	51-70-17	53-00-50	53-10-72	54-00-30					
ABRASIVES																					
ALUMINUM OXIDE ABRASIVE PAPER NO. 80 GRIT	ANY SOURCE	X			X	X	X	X	X	X	X		X								
NO. 150 GRIT	ANY SOURCE	X			X	X	X	X	X	X	X		X								
NO. 180 GRIT	ANY SOURCE											X		X	X						
NO. 320 GRIT	ANY SOURCE		X	X		X	X	X	X	X	X		X								
NO. 400 GRIT	ANY SOURCE	X	X			X	X	X	X	X	X		X								
SCOTCHBRITE PAD TYPE A NO. 150	A		X			X	X														
NO. 240	A					X	X		X	X	X		X		X						
SILICA SAND, NO. 1	ANY SOURCE					X	X	X													
SILICONE CARBIDE PAPER NO. 80 GRIT	ANY SOURCE	X																			
NO. 150 GRIT	ANY SOURCE	X																			
NO. 180 GRIT	ANY SOURCE	X																			
NO. 240 GRIT	ANY SOURCE								X	X	X	X	X			X					
GARNET ABRASIVE PAPER 7/0	ANY SOURCE	X																			
SODA LIME GLASS BEADS NO. 60 GRIT	ANY SOURCE					X	X	X													
STEEL SHOT, NO. 230 (VACUBLAST)	ANY SOURCE					X	X	X		X	X										
TYCRO ALUMINUM OXIDE WHEELS TYPE 3A	A		X																		
TYPE 5A MED, FINE	A		X																		
TYPE 7S MED, FINE	A		X																		
WOOL ALUMINUM	ANY SOURCE	X																			
STAINLESS STEEL	ANY SOURCE	X																			
PUMICE 350 MESH	ANY SOURCE	X																			

NOTES

A MINNESOTA MINING AND MANUFACTURING CO.
3M CENTER ST.
ST. PAUL, MINNESOTA 55101

Abrasives
Figure 3

NOTES

A WEST COAST PAPER CO.
2203 FIRST AVE. S
SEATTLE, WA 98134

B FISHER BAG CO.
1560 FIRST AVE. S
SEATTLE, WA 98134

C THE ORELUBE CORPORATION
201 E BETHPAGE RD
PLAINVIEW, NY 11803

D E.I. DUPONT DE NEMOURS AND CO., INC.
1007 MARKET ST
WILMINGTON, DE 19898

E AIRTECH INTERNATIONAL INC.
2542 E DE LAMO BLVD
P.O. BOX 6207
CARSON, CA 90749

F COLLINS AND AIKMAN CORP.
210 MADISON AVE.
NEW YORK, NY 10016

G HILL INDUSTRIES, INC.
1005 17TH ST NW
PUYALLUP, WA 98371

H EXMET CORPORATION
7 GREAT HILL RD
P.O. BOX 1266
NAUGATUCK, CT 06770

Miscellaneous Materials
Figure 4 (Sheet 1 of 2)

MATERIAL	SOURCE	SUBJECT																			
		51-20-01	51-20-05	51-40-02	51-40-09	51-70-03	51-70-04	51-70-05	51-70-06	51-70-07	51-70-08	51-70-09	51-70-10	51-70-14	51-70-16	51-70-17	51-70-18	52-50-02	53-00-50	53-10-72	54-52-70
CHEESECLOTH	ANY SOURCE	X	X			X	X	X	X	X	X	X	X	X		X	X		X	X	
BLEEDER CLOTH OSNABURG CLOTH UNBLEACHED CCC-C-429	A B					X	X	X	X	X	X	X	X	X		X				X	
GAUZE	ANY SOURCE					X	X	X	X	X	X	X	X	X		X					
CETYL ALCOHOL	ANY SOURCE			X	X																
LAURIC ACID	ANY SOURCE				X																
BOELUBE 100A	C			X											X				X		
FREON TB-1	D			X																	
SOLID FEP PARTING FILM	ANY SOURCE					X	X	X	X	X	X			X	X	X			X	X	
PERFORATED FEP PARTING FILM	ANY SOURCE					X	X	X	X	X	X			X	X	X			X	X	
VACUUM BAG MATERIAL	ANY SOURCE					X	X	X	X	X	X	X	X	X	X	X			X	X	
TEFLON PARTING FILM	ANY SOURCE					X			X						X	X			X		
AIRWEAVE SS	E					X	X	X	X	X	X				X	X					
EXTRUDED SEALING COMPOUND	ANY SOURCE					X	X	X	X	X	X			X	X	X			X	X	
BMS 8-64 TYPE I FLOW RESISTANT ACOUSTIC FABRIC DACRON BATISTE LOT 3070	F																	X			
BMS 8-289 TYPE O, CLASS 250, GRADE 2 C-CLAD H250/350 -002	G							X		X				X							
BMS 8-289 TYPE O, CLASS 350, GRADE 2 C-CLAD H250/350 -002	G						X				X			X							X
BMS 8-336 TYPE I, CLASS 1, GRADE 016, FORM A	H													X							

Miscellaneous Materials
Figure 4 (Sheet 2 of 2)

GENERAL - HAZARDOUS MATERIALS

1. References

Reference	Title
51-10-02, GENERAL	Inspection and Removal of Damage
51-30-01, GENERAL	Sheet Metal Materials
SOPM 20-10-09	Machining of Copper Beryllium Alloys
SOPM 20-50-03	Bearing and Bushing Replacement

2. Copper-Beryllium Alloy

A. Certain bushings used on this airplane are made from copper-beryllium. The dust and fumes from this material when machined are toxic and work of this nature must only be undertaken where the appropriate facilities exist. Refer to SOPM 20-10-09 for the practices and precautions when working with beryllium and beryllium alloys, and SOPM 20-50-03 for further information on bushings.

3. Magnesium Alloys

A. Dust and particles of magnesium alloys present a fire hazard. For details of practices and precautions when working with magnesium refer to 51-10-02, GENERAL.

4. Titanium Alloys

A. Dust and particles of titanium alloys present a fire hazard. For details of practices and precautions when working with titanium refer to 51-10-02, GENERAL and 51-30-01, GENERAL.

GENERAL - EQUIPMENT AND TOOLS FOR REPAIRS

1. General

A. Refer to the following figures for lists of tools and equipment. Miscellaneous Equipment Figure 1/GENERAL Hand Tools Figure 2/GENERAL

B. This section lists the equipment and hand tools used when making repairs and also lists sources of supply. The purpose of this list is to provide information pertaining to item description and use.

C. Some of the procedures in this manual identify tools or equipment. You can use alternative tools that are equivalent unless the procedure tells you the specified tool or equipment item is mandatory. If you use alternative tools or equipment, make sure they give the same results and are as safe to the parts and personnel as the tools or equipment specified in the procedure.

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, KANSAS 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 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	TO PROVIDE HEAT FOR CURING ADHESIVE

Miscellaneous Equipment
Figure 1 (Sheet 1 of 5)

TOOL	MANUFACTURER'S DESIGNATION	MANUFACTURER	REMARKS
CLEANER, VACUUM $\boxed{B}$	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 DUST AND DEBRIS
CONTAINERS, 1 LITER BEAKER-TYPE, POLYETHYLENE	#13915-679 SHERWOOD OR EQUIV	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 EQUIV	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
CUTTER, HONEYCOMB, VALVE STEM TYPE, TWO-PIECE	30-030-1 HOLDER $\boxed{D}$ 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 $\boxed{C}$ 31-015 0.75 DIA $\boxed{C}$ 31-020 1.0 DIA $\boxed{C}$ 31-025 1.5 DIA $\boxed{D}$ 31-030 2.0 DIA $\boxed{D}$	OR ANY OTHER COMMERCIAL SOURCE	ALUMINUM HONEYCOMB CUTTER
DRILL MOTOR $\boxed{B}$	ELECTRIC 600 RPM, MODEL 15C 1489 OR EQUIVALENT	AERO INDUSTRIAL TOOL 482 EAST 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 EAST MEADOW AVE. E. MEADOW, NY 11554	CONVENTIONAL DRILLING, SANDING, OR CIRCULAR SAWING
GAUGE, AIR PRESSURE	0 TO 100 PSI, MODEL J4654 OR EQUIVALENT	MARSH DISTRIBUTOR P.O. BOX 361 ANTIOCH, IL 60002	TO INDICATE AIR LINE PRESSURE
GAUGE, VACUUM	0 TO 32 IN. HG	MARSH DISTRIBUTOR P.O. BOX 361 ANTIOCH, IL 60002	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
HEATER ASSEMBLY $\boxed{B}$	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

Miscellaneous Equipment
Figure 1 (Sheet 2 of 5)

TOOL	MANUFACTURER'S DESIGNATION	MANUFACTURER	REMARKS
HEATER, AIR B	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, EXPLOSIONPROOF, 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 BLEEDER CLOTH
MOTOR ASSEMBLY, PNEUMATIC	ARBOR SAW/MOTOR	AERO INDUSTRIAL TOOL 482 EAST 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
PEENING TOOL, POWER B	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 EQUIV.		USE AS 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 REGULATE 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	MEASURING VACUUM AT THE ASSEMBLY

Miscellaneous Equipment
Figure 1 (Sheet 3 of 5)

TOOL	MANUFACTURER'S DESIGNATION	MANUFACTURER	REMARKS
SAFETY FACE SHIELD	TRU-SAFE #199-1 OR SAFELINE #6799 (10 BY 18-1/4) OR EQUIV	COMMERCIAL - ANY SOURCE	FOR FACE AND EYE PROTECTION
SAFETY FACE SHIELD HOLDER	RICE HEAD SHIELD #707 OR EQUIVALENT		HOLDS REPLACEABLE FACE SHIELD
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	
TEMPERATURE CONTROLLER CONSOLE, PORTABLE SELF-CONTAINED $\boxed{A}$ $\boxed{B}$		ATACS PRODUCTS, INC. 14040 INTERURBAN AVE. S. TUKWILA, WA 98168 GMI 9 RUE BUFFAULT 75009 PARIS, FRANCE -OR- GMI/EMPTECH 5957 GLENDALE DRIVE CHILLIWACK, B.C., CANADA V2R 3A5	USE WITH HEAT BLANKETS, THERMOCOUPLES, AND VACUUM UNIT FOR APPLICATION AND RECORDING OF HEAT AND PRESSURE

Miscellaneous Equipment
Figure 1 (Sheet 4 of 5)

TOOL	MANUFACTURER'S DESIGNATION	MANUFACTURER	REMARKS
		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 90630 WICHITECH INDUSTRIES, INC. OAKLAND CENTER 8990 RT. 108 COLUMBIA, MD 21045	
TRANSFORMER, PORTABLE [B]	VARIABLE CONTROL 115-VOLT, 60-CYCLE		USE WITH HEATING BLANKETS AS A POWER SUPPLY
VACUUM UNIT [B]	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 ROAD HUNTINGTON BEACH, CA 92647	USE FOR EVACUATION OF AIR INSIDE BAG FILM

NOTES

[A] 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 END OF CURE TIME

[B] THE USE OF ELECTRICAL EQUIPMENT IS HAZARDOUS WHEN USED IN PROXIMITY OF FUEL AND OTHER VOLATILE MATERIALS. OBSERVE ALL SAFETY PRECAUTIONS

[C] 0.25 SHANK

[D] 0.50 SHANK

Miscellaneous Equipment
Figure 1 (Sheet 5 of 5)

TOOL	MANUFACTURER'S DESIGNATION	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. PHILADELPHIA, 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, 16 OZ., #16057-120 OR EQUIV USE SPOUT CAP, 28 MM, #H-16657 OR EQUIV	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, SOLVENTS, 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 FOR MARKING CUTOUTS ON ALUMINUM OR TITANIUM SURFACES AND DETAIL FABRICATION
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 SO. GARFIELD AVE. LOS ANGELES, CA 90040	FOR SETTING DRILL DEPTH
FILE, HAND, FLAT MILL	6-,8-,10-, OR 12-IN.	COMMERCIAL - ANY SOURCE	USE FOR DEBURRING AND SIZING DETAILS
FILE, HAND, ROUND (RAT-TAIL)	1/8-,1/4-,3/8-, OR 1/2-IN.	COMMERCIAL - ANY SOURCE	USE FOR DEBURRING AND FILING HOLES
FILE, HAND, ROTARY	1/2-,3/4-, OR 1-IN. DIA ROUND END	COMMERCIAL - ANY SOURCE	USE FOR REMOVING METAL AND HONEYCOMB CORE
FILE, HAND, FLAT VIXON	12- OR 14-IN.	COMMERCIAL - ANY SOURCE	USE FOR HEAVY ROUGH CUT IN METAL REMOVAL

Hand Tools
Figure 2 (Sheet 1 of 5)

TOOL	MANUFACTURER'S DESIGNATION	MANUFACTURER	REMARKS
FUNNELS, POLY-ETHYLENE, 28 MM OPENING, SHORT STEM	3-IN. DIA # 3-2050-040 6-IN. DIA # 3-2050-084 6-IN. DIA # 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, MISC 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
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 ALUM ALLOY PLATE OR EQUIV	COMMERCIAL - ANY SOURCE	USE FOR PRESSURE APPLICATION DURING THE CURE CYCLE
PHENOLIC SHEET	0.125 TEMPLATE STOCK MIL-P-15035 OR EQUIV	COMMERCIAL - ANY SOURCE	USE FOR ROUTER TEMPLATES
PIPET, STRAIGHT TIP MEDICINE DROPPER	#52950-002 OR EQUIV	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 EQUIV MIL-P-5425A	COMMERCIAL - ANY SOURCE	USE FOR DRILL TEMPLATES
PLASTIC SHEET, MYLAR	0.0075 IN. 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 2 of 5)

TOOL	MANUFACTURER'S DESIGNATION	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 EQUIV	COMMERCIAL-ANY SOURCE	USE FOR ROUTER TEMPLATES
ROD, STIRRING	0.125 THRU 0.375-IN. DIA STEEL, GLASS, OR POLYETHYLENE	COMMERCIAL-ANY SOURCE	USE FOR MIXING OR STIRRING LIQUIDS AND COMPOUNDS
ROLLER	WOOD OR HARD RUBBER, 6 INCHES LONG, 2-IN. DIA	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 SO. STA. CRUZ ST. ANAHEIM, CA 92805	HAND-ROUTING OF 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.MCMASTER.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. STA. CRUZ ST. ANAHEIM, CA 92805	USE FOR DAMAGE REMOVAL; SEE "ROUTER ATTACHMENT" FOR QRC ROUTERS
	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. STA. CRUZ ST. ANAHEIM, CA 92805	USE #881390 ROUTER ATTACHMENT INCLUDES SETBACK BUSHING
ROUTER, BITS	1/4-IN. DIA, 2-FLUTE LH SPIRAL, HI-SPEED STEEL FOR ALUMINUM; 1/4-IN. DIA, 3-FLUTE LH SPIRAL, CARBIDE FOR TITANIUM OR EQUIVALENT	COMMERCIAL-ANY SOURCE	USE WITH ANY ROUTER MOTOR

Hand Tools
Figure 2 (Sheet 3 of 5)

TOOL	MANUFACTURER'S DESIGNATION	MANUFACTURER	REMARKS
SAFETY FACE SHIELD	TRU-SAFE #119-1 OR SAFELINE #6799 (10 BY 18-1/4) OR EQUIV	COMMERCIAL - ANY SOURCE	FOR FACE AND EYE PROTECTION
SAFETY FACE SHIELD HOLDER	RICE HEAD SHIELD #707 OR EQUIV	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 A	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. DIA 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	COMMERCIAL - ANY SOURCE	USE FOR REMOVAL OR DAMAGED MATERIAL
SAW BLADE HOLDER		COMMERCIAL - ANY SOURCE	HOLDER FOR HACKSAW BLADES
SAW, CIRCULAR WITH ADAPTER AND BLADE	CP-3017-OKS-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 SOURCE	CUTTER FOR ARBOR SAW
SAW, HOLE	1/2-,1-,2-,3-, AND 4-IN.	COMMERCIAL - ANY SOURCE	USE FOR REMOVAL OF DAMAGED MATERIAL
SAW, RECIPROCATING WITH BLADES	FOR ALUMINUM OR TI SKINS, CP-3017-FO OR EQUIVALENT	CHICAGO PNEUMATIC 1800 OVERVIEW DR. ROCKHILL, SC 29730	USE TO REMOVE DAMAGED MATERIAL-FROM BONDED PANELS
SAW, SLOTTING	1/4-IN. DIA ARBOR HOLE, 2-IN. BLADE	COMMERCIAL - ANY SOURCE	USE FOR REMOVAL OF DAMAGED MATERIAL
SCALE, FLEXIBLE	12-IN. #338R TEMPERED OR EQUIV	COMMERCIAL - ANY SOURCE	DETERMINING SIZES
SCREEN WIRE	#16 MESH 0.018 DIA WIRE CRS TYPE 304	PACIFIC NORTHWEST WIRE 18623 89TH PLACE 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-IN. 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-IN. GROOVED BLADE, STYLE "BP"	COMMERCIAL - ANY SOURCE	MARKING DETAILS
SQUEEGE, FLAT	SYNTHETIC RUBBER, PHENOLIC LAMINATE, OR PLEXIGLASS	COMMERCIAL - ANY SOURCE	USE FOR SMOOTHING RESINS OR COMPOUNDS

Hand Tools
Figure 2 (Sheet 4 of 5)

TOOL	MANUFACTURER'S DESIGNATION	MANUFACTURER	REMARKS
TONGUE DEPRESSORS	WOOD	COMMERCIAL - ANY SOURCE	MIXING AND SPREADING COMPOUNDS AND ADHESIVES

NOTE

A 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 5 of 5)

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. This section gives a list of materials that are used to make the composite repairs given in this manual.

B. The data given here includes the order numbers and the units of measure for materials that are available in small quantities through Boeing Spares. Refer to Paragraph 4./GENERAL for the order information. If you need a material that is not included in this section, you can still order it through Boeing Spares. It is possible that Boeing Spares will have to purchase the material from a vendor with a minimum buy limit. Also, the vendor source information for nonmetallic materials is given in 51-30-03, GENERAL.

C. The shelf life of some materials is limited and special procedures for the storage and shipment of some materials is necessary. You can get the appicable data from the supply source.

D. If you need the materials immediately, 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.

3. References

Reference	Title
51-30-03, GENERAL	Nonmetallic Materials

4. Order Information

A. Table I 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:

- 767 SRM 51–30–06

D. Order all of the preimpregnated materials as AOG or Critical.

Table 1: Composite Repair Materials - Order Data

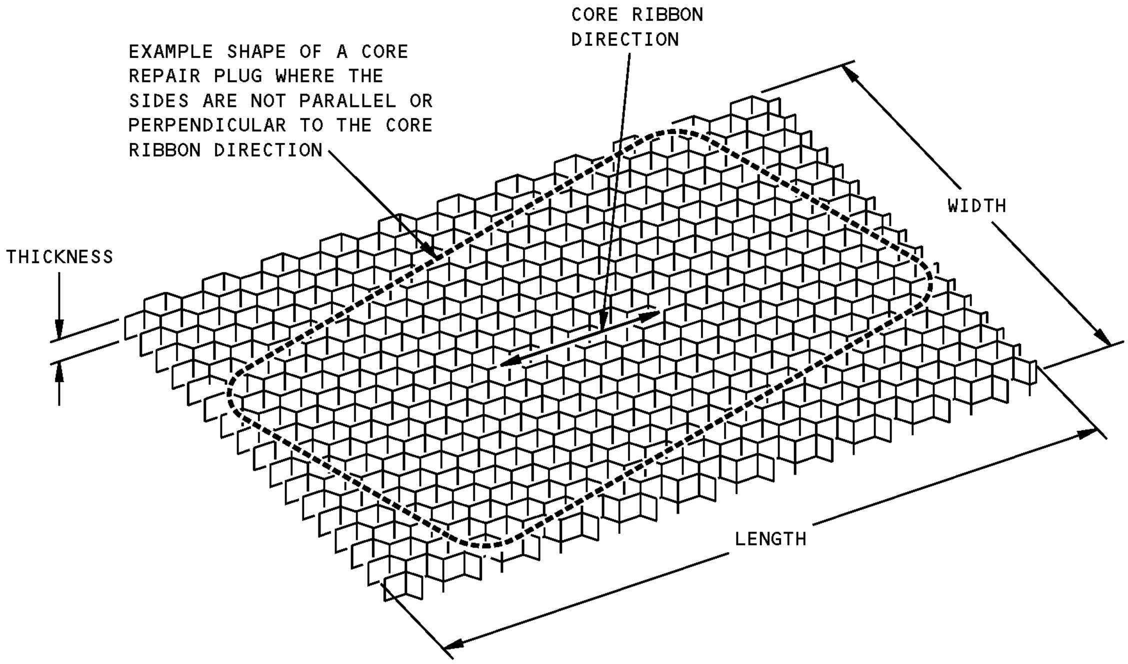
MATERIAL	ORDER NUMBER	UNIT OF MEASURE	REMARKS
BMS 5-28, Type 6 (Potting Compound)	BMS5-28TY6	1 quart kit	
	BMS5-28TYPE6	1 pint kit	
	5522360051	1 gallon each	
BMS 5-28, Type 7, Class 1 (Potting Compound)	BMS5-28TY7CL1	1 quart kit	
	5522360052	1 gallon each	
BMS 5-28, Type 7, Class 2 (Potting Compound)	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	

Table 1: Composite Repair Materials - Order Data (Continued)

MATERIAL	ORDER NUMBER	UNIT OF MEASURE	REMARKS
BMS 5-90, Type III, Class 250, Grade 50 (Foaming Film Adhesive)	BMS5-90TY3CL250GR50	2 square foot sheet	Ship and store frozen
BMS 5-90, Type III, Class 350, Grade 50 (Foaming Film Adhesive)	BMS5-90TY3CL350GR50	10-inch by 24-inch sheet	Ship and store frozen
BMS 5-90, Type IV, Class 350, Grade 50 (Foaming Extrudable Adhesive)	BMS5-90TY4CL350GR50	6 ounce cartridge	Ship and store frozen
MATERIAL	ORDER NUMBER	UNIT OF MEASURE	REMARKS
BMS 5-92, Type I - EC2216 A/B (Adhesive)	BMS5-92TY1	1 quart kit	
	BMS5-92TYPE1	6 ounces each	
BMS 5-101, Type II, Grade 10 (Adhesive)	BMS5-101TY2GR10	Length by the yard (36 inches wide)	Ship and store frozen
BMS 5-129, Type 2, Class IA, Grade 10 (Adhesive)	BMS5-129TY2CL1AGR10	Length by the yard (36 inches wide)	Ship and store frozen
BMS 5-129, Type 4, Grade 5 (Adhesive)	BMS5-129TY4GR5	Length by the yard (36 inches wide)	Ship and store frozen
BMS 5-141 (Adhesive)	BMS5-141	1 quart kit	
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)	BMS8-139TY120CL1	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)	BMS8-145TYPE1	Length by the yard (40 inches wide)	Ship and store frozen
BMS 8-168, Class 1, Type II, Grade 145 (Carbon Fiber Reinforced Plastic (CFRP) Tape)	BMS8-168T2C1GR145	Length by the yard (12 inches wide)	Ship and store frozen
BMS 8-168, Class 1, Type II, Grade 190 (CFRP Tape)	BMS8-168T2C1GR190	Length by the yard (12 inches wide)	Ship and store frozen
BMS 8-168, Class 2, Type II, Style 3K-70-PW (CFRP Fabric)	BMS8-168T2C2ST3K70PW	Length by the yard (42 inches wide)	Ship and store frozen
BMS 8-212, Type II, Class 1, Grade 95 (CFRP Tape)	BMS8-212TY2CL1GR95	Length by the yard (12 inches wide)	Ship and store frozen
BMS 8-212, Type II, Class 1, Grade 190 (CFRP Tape)	BMS8-212TY2CL1GR190	Length by the yard (12 inches wide)	Ship and store frozen
BMS 8-212, Type III, Class 1, Grade 145 (CFRP Tape)	BMS8-212TY3CL1GR145	Length by the yard (12 inches wide)	Ship and store frozen
BMS 8-212, Type III, Class 1, Grade 190 (CFRP Tape)	BMS8-212TY3CL1GR190	Length by the yard (12 inches wide)	Ship and store frozen
BMS 8-212, Type II, Class 2, Style 3K-135-8H (CFRP Fabric)	BMS8-212T2C2-3K1358H	Length by the yard (42 inches wide)	Ship and store frozen

Table 1: Composite Repair Materials - Order Data (Continued)

MATERIAL	ORDER NUMBER	UNIT OF MEASURE	REMARKS
BMS 8-212, Type IV, Class 2, Style 3K-70-PW (CFRP Fabric)	BMS8-212T4C2ST3K70PW	Length by the yard (42 inches wide)	Ship and store frozen
BMS 8-256, Type II, Class 1, Grade 190 (CFRP Tape)	BMS8-256TY2CL1GR190 (This material is not always available at Boeing)	Length by the foot (12 inches wide)	Ship and store frozen
BMS 8-256, Type IV, Class 2, Style 3K-70-PW (CFRP Fabric)	BMS8-256T4C2ST3K70PW	Length by the yard (42 inches wide)	Ship and store frozen
BMS 8-212, Type II, Class 1, Grade 95 (CFRP Tape)	BMS8-212TY2CL1GR95	Length by the yard (12 inches wide)	Ship and store frozen
BMS 8-212, Type II, Class 1, Grade 190 (CFRP Tape)	BMS8-212TY2CL1GR190	Length by the yard (12 inches wide)	Ship and store frozen
BMS 8-212, Type III, Class 1, Grade 145 (CFRP Tape)	BMS8-212TY3CL1GR145	Length by the yard (12 inches wide)	Ship and store frozen
BMS 8-212, Type III, Class 1, Grade 190 (CFRP Tape)	BMS8-212TY3CL1GR190	Length by the yard (12 inches wide)	Ship and store frozen
BMS 8-212, Type II, Class 2, Style 3K-135-8H (CFRP Fabric)	BMS8-212T2C2-3K1358H	Length by the yard (42 inches wide)	Ship and store frozen
BMS 8-212, Type IV, Class 2, Style 3K-70-PW (CFRP Fabric)	BMS8-212T4C2ST3K70PW	Length by the yard (42 inches wide)	Ship and store frozen
BMS 8-256, Type II, Class 1, Grade 190 (CFRP Tape)	BMS8-256TY2CL1GR190 (This material is not always available at Boeing)	Length by the foot (12 inches wide)	Ship and store frozen
BMS 8-256, Type IV, Class 2, Style 3K-70-PW (CFRP Fabric)	BMS8-256T4C2ST3K70PW	Length by the yard (42 inches wide)	Ship and store frozen
BMS 9-8, Type I, Class 2, Style 3K-70-P (Carbon Fiber Fabric)	BMS9-8T1C2S3K70P	Length by the yard (42 inches wide)	
CAB-O-SIL (Filler)	CABOSILGRADEM5	10 pounds minimum	
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)	BJ0-0930	1 bag each (17-pound bag)	



<u>NOTE</u>: 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

GENERAL - NONMETALLIC MATERIALS - CF6-80C2 ENGINE NACELLE

1. General

A. This section lists materials used when making repairs to the CF6-80C(2) inlet cowl, fan cowl, and core cowl and also lists sources of supply. The purpose of this list is to show which subject the materials are used in and if they are common to more than one subject. The materials listed are not only used in the actual repair, but are often used for preparation and accomplishment of repairs.

B. Refer to Table 1/GENERAL for an index for the lists of materials.

Table 1: Protective Coatings, Sealants, Adhesives and Cleaners Data

MATRIAL	LOCATION
Protective Coatings, Sealants, Adhesives and Cleaners	Figure 1/GENERAL
Fiberglass and Graphite Fabrics	Figure 2/GENERAL
Miscellaneous Materials	Figure 3/GENERAL

NOTES

A SIKKENS AEROSPACE FINISHES
20846 S. NORMANDIE AVENUE
TORRANCE, CALIFORNIA 90502

B DOW CORNING CORPORATION
S. SAGINAW ROAD
MIDLAND, MICHIGAN 48460

C DESOTO CHEMICAL AND PAINT CO.
FOURTH AND CEDAR STREETS
BERKELEY, CALIFORNIA 94710

D AMCHEM CORPORATION
300 BROOKSIDE AVENUE
AMBLER, PENNSYLVANIA 19002

E GENERAL ELECTRIC
SILICONE PRODUCTS DEPT.
WATERFORD, NEW YORK 12188

F THE DEXTER CORPORATION
HYSOL DIVISION
15051 E. DON JULIAN ROAD
INDUSTRY, CALIFORNIA 91744

G THE DEXTER CORPORATION
HYSOL DIVISION
2850 WILLOW PASS ROAD
P.O. BOX 312
PITTSBURG, CALIFORNIA 94565

H 3M CO.
3M CENTER
ST. PAUL, MINNESOTA 55101

Protective Coatings, Sealants, Adhesives, and Cleaners
Figure 1 (Sheet 1 of 4)

MATERIAL	SOURCE	SUBJECT																			
		51-11-00	51-21-01	54-12-01	54-12-02	54-15-01	54-15-02		54-42-01	54-42-02	54-45-01	54-45-02									
MATERIALS FOR <u>PROTECTIVE TREATMENT</u>																					
ACTIVAL, 1357 WETTING AGENT	ANY SOURCE		X																		
PRIMER, EPOXY (GREEN) BASE 463-6-11 CONVERTER X315 THINNER TL165	A		X																		
PRIMER, EPOXY (GREEN) BASE 463-6-27 CONVERTER X337 REDUCER TL52	A		X																		
PRIMER, EPOXY (YELLOW) BASE 463-7-26 CONVERTER X369 THINNER TL102	A	X X X	X X X																		
PRIMER, PHENOLIC 204-001 (OVER 300°F)	C		X																		
PRIMER, CAT-A-LAC 463	A		X																		
PRIMER, POLYURETHANE (GREY) BASE 467-7-26 CONVERTER X369 THINNER TL102	A	X																			
PRIMER, URETHANE (TYPE 51) BASE 825-009 CATALYST 910-175 REDUCER 020-044	C		X						X	X	X	X									
PRIMER, SILICONE DC1200	B			X	X	X	X		X	X	X	X									

Protective Coatings, Sealants, Adhesives, and Cleaners
Figure 1 (Sheet 2 of 4)

MATERIAL	SOURCE	SUBJECT																			
		51-11-00	51-21-01	54-12-01	54-12-02	54-15-01	54-15-02		54-42-01	54-42-02	54-45-01	54-45-02									
MATERIALS FOR PROTECTIVE TREATMENT (CONT)																					
TOPCOAT, EPOXY (FLAT) BASE 463-3 CATALYST X304 REDUCER TL29	$\boxed{A}$	X																			
TOPCOAT, POLYURETHANE BASE 643-3-9 CATALYST X310A REDUCER TL59	$\boxed{A}$		X																		
TOPCOAT, POLYURETHANE (GREY) BASE 822-315 CATALYST 910-331A REDUCER 020-X310	$\boxed{C}$		X																		
CORROSION PREVENTIVE MIL-C-16173, GRADE 2	ANY SOURCE		X																		
ALODINE, MIL-C-5541	$\boxed{D}$		X	X		X															
NO. 1000L			X	X		X															
NO. 1200S			X						X	X	X	X									
SEALANT, SILICONE RTV157	$\boxed{E}$			X		X															
SEALANT DC93-006	$\boxed{B}$				X		X		X	X	X	X									

Protective Coatings, Sealants, Adhesives, and Cleaners
Figure 1 (Sheet 3 of 4)

MATERIAL	SOURCE CODE	SUBJECT																			
		51-11-00	51-21-00	51-21-05	54-12-01	54-15-01	54-22-01	54-25-01													
RESINS																					
EA956 EPOXY BASE PART A CATALYST PART B	F	X			X	X	X	X													
EA934NA	F	X			X	X	X	X													
EA9390 BASE PART A CATALYST PART B	G				X	X	X	X													
TAPES																					
TEFLON TAPE 2-INCHES	H	X		X	X	X															
SOLVENTS																					
METHYL ETHYL KETONE TT-M-261	ANY SOURCE	X		X	X	X	X	X													
TOLUENE TT-T-548	ANY SOURCE	X		X	X	X															
SAFETY SOLVENT C-50	ANY SOURCE	X																			
ABRASIVES																					
ALUMINUM OXIDE	ANY SOURCE																				
240-GRIT			X																		
280-GRIT			X																		
400-GRIT		X	X																		
SILICONE CARBIDE	ANY SOURCE																				
80-GRIT					X	X	X	X													
150-GRIT		X	X		X	X	X	X													
180-GRIT		X	X		X	X	X	X													
240-GRIT		X			X	X	X	X													
280-GRIT			X		X	X	X	X													
320-GRIT		X			X	X	X	X													
SCOTCHBRITE TYPE A	ANY SOURCE		X																		

Protective Coatings, Sealants, Adhesives, and Cleaners
Figure 1 (Sheet 4 of 4)

MATERIAL	SOURCE	SUBJECT																			
		54-12-01	54-15-01	54-22-01	54-25-01																
FABRIC																					
GLASS FABRIC (FIBERGLASS)																					
TYPE 120	ANY SOURCE	X	X	X	X																
TYPE 181	ANY SOURCE	X	X	X	X																
CARBON FABRIC (GRAPHITE) 5HSW, AS4-6K CONSTRUCTION IIXII STYLE ES-1506	A	X	X	X	X																

NOTES

A HITCO CORPORATION
WOVEN STRUCTURES DIVISION
618 W CAROB STREET
COMPTON, CALIFORNIA 90200

Fiberglass and Graphite Fabrics
Figure 2

NOTES

A ATACS PRODUCTS, INC.
1120 S.W. 16TH STREET
RENTON, WASHINGTON 98055

B SCHNEE-MOREHEAD
111 N. NURSERY
IRVING, TEXAS 76060

C SIKKENS AEROSPACE FINISHES
20846 S. NORMANDIE AVENUE
TORRANCE, CALIFORNIA 90502

D UNION CARBIDE CORP.
CHEMICAL AND PLASTIC DIVISION
BOUND BROOK PLANT
RIVER ROAD
P. O. BOX 181
BOUND BROOK, NEW JERSEY 08805

E OWENS CORNING FIBERGLASS CORP.
608 MADISON AVENUE
TOLEDO, OHIO 43604

F DEXTER CORP.
PRODUCTS DIVISION
1 DEXTER DRIVE
SEABROOK, NH 03874

Miscellaneous Materials
Figure 3 (Sheet 1 of 2)

MATERIAL	SOURCE CODE	SUBJECT																			
		51-11-00	51-21-00	51-21-05	54-12-01	54-15-01	54-22-01	54-25-01													
<u>MISCELLANEOUS MATERIALS</u>																					
CLOTH, COTTON WIPER	ANY SOURCE	X	X	X	X	X	X	X													
BRUSH, NYLON	ANY SOURCE	X	X	X	X	X	X	X													
GLOVES, NEOPRENE OR VINYL CHLORIDE	ANY SOURCE	X	X	X	X	X	X	X													
MASK, DUST REGULATORY APPROVED	ANY SOURCE	X		X	X	X	X	X													
FREKOTE 33	F				X	X															
<u>MATERIALS FOR LAYUP, BAGGING, AND CURING</u>																					
HEAT BLANKET 0°-250°F 10" W/IN.2	A	X			X	X	X	X													
HEAT LAMP 180-200°F	ANY SOURCE	X		X	X	X	X	X													
PROBE TEMP. 0°-250°F	ANY SOURCE	X			X	X	X	X													
FILM, PARTING																					
NONPOROUS (FEP)	ANY SOURCE				X	X	X	X													
POROUS	ANY SOURCE		X																		
RUBBER SHEET 0.062-0.125-IN.	ANY SOURCE				X	X	X	X													
SEALANT BAG TACKY TAPE	B				X	X	X	X													
<u>POTTING COMPOUNDS AND RESINS</u>																					
FILLER, PUTTY CATALYST 467-9 BASE 41B	C	X																			
PHENOLIC MICROBALLOONS 135 MICRON	D	X			X	X	X	X													
MILLED GLASS FIBERS	E				X	X	X	X													

Miscellaneous Materials
Figure 3 (Sheet 2 of 2)

GENERAL - SHEET METAL MATERIALS - RB211-524 ENGINE NACELLE

1. General

A. Most of the sheet metal materials used in the RB211-524 nacelles are aluminum alloy. In addition, commercially pure titanium sheet is used. Figure 1/GENERAL shows approximate equivalent materials.

2. Aluminum Alloys

A. Whenever the word ’clad’ precedes material description, it indicates that material is coated with pure aluminum. The ’T’ number that follows material description indicates heat treatment condition.

3. Titanium

WARNING: SMALL PARTICLES AND FINE SHAVINGS OF TITANIUM IGNITE EASILY AND PRESENT AN EXTREME FIRE HAZARD. TITANIUM DUST IS HIGHLY FLAMMABLE, AND IN THE RIGHT CONCENTRATION CAN CAUSE AN EXPLOSION. WATER IN CONTACT WITH MOLTEN TITANIUM PRESENTS A STEAM EXPLOSION HAZARD. EXTINGUISH FIRES OF TITANIUM WITH ABSOLUTELY DRY TALC, CALCIUM CARBONATE, SAND OR GRAPHITE BY APPLYING THE POWDER TO A DEPTH OF HALF AN INCH OR MORE OVER THE BURNING METAL. DO NOT USE FOAM, WATER, CARBON TETRACHLORIDE, OR CARBON DIOXIDE.

A. Refer to Figure 1/GENERAL
Figure 1/GENERALfor data applicable to all RB211-524 Engines.

MATERIAL		DOMESTIC DESIGNATION (USA) (Acceptable Alternative)		UNITED KINGDOM DESIGNATION
		MATERIAL	SPECIFICATION	SPECIFICATION
ALUMINUM ALLOY	SHEET	CLAD 2024-T3 OR CLAD 2024-T42	QQ-A-250/5	L163
				L164
		CLAD 2014-T6	QQ-A-250/3	L165
		2219-T81		DTD5070
	PLATE	2024-T351	QQ-A-250/4	DTD5010
	BARS EXTRUS			DTD5014
ALUMINUM ALLOY	CASTING PREMIUM	A357.0 T61	MIL-A-21180 CLASS II	L92
ALUMINUM	DIE FORGING	2014-T6	QQ-A-367	L77
TITANIUM	SHEET	COMPURE - 70	MIL-T-9046, TYPE 1 COMP B	TA6
		COMPURE - 60	MIL-T-9046, TYPE 1 COMP C	DTD5023
	BAR FORGING	COMPURE - 70	MIL-T-9047, COMP 1	TA9
ALLOY STEEL	SHEET	347 ANNEALED	QQ-S-766	BSS527
	FORGING	4340 (QUENCH AND TEMP - HT 125-145 KSI)	MIL-S-5000B, COMP F	BSS154

Approximately Equivalent Strength Materials, All RB211-524 Engines
Figure 1

767-300
STRUCTURAL REPAIR MANUAL

GENERAL - NONMETALLIC MATERIALS - RB211-524 ENGINE NACELLE

1.

A. The purpose of this section is to provide a list of repair materials used during the repair of composite non-metallic components. Also included are the handling instructions for the various materials.

2. List of Repair Materials

A. Refer to Figure 1/GENERAL for list of materials and sources.

3. General Requirements for Composite Material Handling

A. Adhesive Primer (HYSOL EA-9205)

(1) Use requirements

(a) Shelf life is six months when stored at a temperature of -18°C (0°F).

(b) Designated to be used with adhesive (EA-9649) and to be spray applied.

(c) To cure, primer EA-9205 should be flashed by exposing surfaces to ambient conditions for 30 minutes followed by 93°C (200°F) for 30 minutes in a forced air oven.

(2) Health hazards

WARNING: DANGER! EXTREMELY FLAMMABLE! KEEP AWAY FROM HEAT, SPARKS AND OPEN FLAME! THIS MATERIAL HAS A FLASH POINT OF 13°C (55°F), THEREFORE MUST BE CONSIDERED VERY FLAMMABLE. KEEP CONTAINER CLOSED! USE WITH ADEQUATE VENTILATION! AVOID PROLONGED OR REPEATED CONTACT WITH SKIN!

(a) EA-9205 primer carries ANSI Classification 2. As sold, it contains both M.E.K. (2-butaone) and tetrahydrafuran, both flammable solvents.

B. Adhesive Thermofoam 3050

(1) Use Requirements

(a) Thermofoam 3050 has a limited life of 5 days at 32°C (90°F); 7 days at 24°C (75°F); 30 days at 0°C (32°F); and a minimum of 6 months at -18°C (0°F) or below.

(b) This product can be cured at either:

1) At 121°C (250°F) for 1 hour.

2) At 177°C (350°F) for 30 minutes using a heat-up rate of 8 to 17°C (46° to 62°F) per minute. Thermofoam 3050 will cure at temperatures as low as 107°C (225°F) in 90 minutes.

(c) Avoid strong oxidizing agents.

(2) Health hazards

WARNING: THIS PRODUCT CONTAINS ASBESTOS FIBERS. AVOID CREATING DUST. BREATHING IT CAN CAUSE SERIOUS BODILY HARM. WHEN SANDING, USE REGULATORY AGENCY APPROVED FACE MASK. USE GOOD VENTILATION. PREVENT ALL CONTACT WITH SKIN; IF CONTACT OCCURS, WASH IMMEDIATELY WITH SOAP AND WATER.

C. Epoxy Adhesive Film (HYSOL Adhesive EA-9649)

(1) Use requirements

(a) Working life is 30 days when stored at 32°C (90°F). The tack to cleaned metal surfaces is retained up to 15 days.

(b) Storage life in excess of six months is possible, when material is kept in dessicant bag provided, at -18°C (0°F) or below.

(c) Cure in an autoclave at 162° to 192°C (323° to 377°F) at 55 psi for 60 minutes. Adjust input temperature to ensure maximum temperature is not exceeded.

(2) Health hazards

WARNING: USE WITH ADEQUATE VENTILATION AND REGULATORY AGENCY APPROVED FACE MASK, PARTICULARLY IF HEATED OR SPRAYED. AVOID PROLONGED OR REPEATED CONTACT WITH SKIN. EA-9649 CAN CAUSE SKIN SENSITIZATION OR OTHER ALLERGIC RESPONSES. AVOID INHALATION OF VAPOR. PREVENT ALL CONTACT WITH SKIN. IF CONTACT OCCURS, WASH IMMEDIATELY WITH SOAP AND WATER.

(3) Environmental requirements

(a) Allow all material to thaw to room temperature before removing from desiccant bag.

(b) Clean all surfaces to be bonded.

(c) Area must be adequately ventilated.

(d) Work areas and other surfaces can be cleaned of uncured adhesive by wiping with a cloth saturated in a solution of acetone.

D. Laminating Resin Adhesive (HYSOL Adhesive EA-956)

(1) Using requirements

(a) The pot life is 30 minutes at 24°C (75°F), for 454 grams (one pound).

(b) Shelf life Time (Refer to Table 1/GENERAL).

Table 1: Laminating Resin Adhesive (HYSOL Adhesive EA-956) Shelf Life Data

Temperature	Part A	Part B
38°C (100°F)	3 months	over 2 years
27°C (80°F)	3 months	over 2 years
4°C (40°F)	1 year	over 2 years
-18°C (0°F)	2 years	over 2 years

(c) Cure at 24°C (75°F) for 5 to 7 days to obtain full strength, or at 82°C (180°F) to 93°C (200°F) for one hour. 75 percent strength is obtained at 24°C (75°F) in 24 hours. Heat-up time for higher temperature cure is not critical.

CAUTION: MATERIAL TEMPERATURE BEFORE AND DURING MIXING MUST BE AT ROOM TEMPERATURE.

(d) Combine by weight, 100 parts A with 58 parts B, and mix thoroughly. Temperatures before and during mixing must be at room temperature.

(2) Health hazards

WARNING: AVOID INHALATION OF VAPOR. GOOD VENTILATION MUST BE USED WHEN HEATED OR SPRAYED. PREVENT ALL CONTACT WITH SKIN, IF CONTACT OCCURS, WASH IMMEDIATELY WITH SOAP AND WATER. THIS PRODUCT CAN CAUSE SKIN SENSITIZATION OR OTHER ALLERGIC RESPONSES. THIS PRODUCT CARRIES ANSI CLASSIFICATION 4, CLASSIFIED ACCORDING TO "GUIDES FOR CLASSIFYING AND LABELING EPOXY PRODUCTS ACCORDING TO THEIR HAZARDOUS POTENTIALITIES" PREPARED AND PUBLISHED BY THE AMERICAN STANDARDS INSTITUTE, INC.

(3) Environmental requirements of working area.

(a) Temperature and humidity controls are not critical.

(b) Work area and other surfaces can be cleaned of uncured adhesive material by wiping with a cloth saturated in a solution of denatured alcohol.

E. Potting compound (EPOCAST H-1843-A/B, Type 4, Grade B)

(1) Use requirements

(a) The storage life is 12 months at 5° to 27°C (41° to 81°F) in unopened containers.

(b) Cure at room temperature for 3 hours, at 77°C (170°F) for 30 minutes, or at 121°C (250°F) for one hour.

(c) To 100 parts by weight of Part A, add 15 parts by weight of part B.

NOTE: Before blending Parts A and B, stir contents of each container to ensure uniformity. Blend resin (Part A) with hardener (Part B) thoroughly in required ratio.

(2) Health hazards

WARNING: AVOID CONTACT OF RESIN OR HARDENER WITH SKIN. APPLY UNDER CONDITIONS OF GOOD VENTILATION.

F. Potting Compound (HYSOL Adhesive EA-934)

(1) Use requirements

(a) Combine by weight, 100 parts A with 33 parts B, and mix thoroughly. Thinners must not be used. Temperatures prior to and during mixing are not critical but should be close to 24°C (75°F).

(b) Pot life at 24°C (75°F) is 40 minutes for 454 grams (one pound).

(c) Cure at 24°C (75°F) for 5 to 7 days or at 93°C (200°F) for one hour to obtain full strength. 75 percent full strength cure is obtained at 24°C (75°F) in24 hours. Heat-up time for higher temperature is not critical.

(2) Health hazards

WARNING: THIS PRODUCT CONTAINS ASBESTOS FIBERS. AVOID CREATING DUST. BREATHING IT CAN CAUSE SERIOUS BODILY HARM. AVOID INHALATION OF FUMES. THIS PRODUCT CAN CAUSE SKIN SENSITIZATION. USE GOOD VENTILATION AND REGULATORY AGENCY APPROVED FACE MASK PARTICULARLY IF HEATED OR SPRAYED. PREVENT ALL CONTACT WITH SKIN. IF CONTACT OCCURS, WASH IMMEDIATELY WITH SOAP AND WATER.

(3) Environmental requirements

(a) When applying material, temperature and humidity controls are not critical.

G. Pre-Impregnated Graphite Fabric (A320-5H/3501-5A)

(1) Facility requirements

  (a) The ambient temperature and applicable working surfaces must be maintained at 18° to 32°C (65° to 90°F), and maximum relative humidity must be 70 percent.

  (b) The lay-up must be maintained in an orderly and clean condition.

  (c) Unapproved agents such as silicone base release agents, lubricants, hand creams, talcum powder, waxes, oils, or other materials which could affect laminating process or bondability of laminate, must not be permitted in lay-up area for any purpose.

(2) Use requirements

  (a) Shelf life of graphite fabric is 6 months when stored at a temperature designated by manufacturer.

  (b) Working life of material is 10 days, from storage removal until initiation of cure, when exposed to 16° to 27°C (60 to 80°F) at a relative humidity of 65 percent or less, under a protective dust cover or when vacuum bagged for 48 hours of that period.

  (c) Pre-impregnated graphite fabric removed from cold storage must be warmed to ambient temperature before removal from protective cover.

  (d) Lay-up is performed in a clean and orderly environment maintained at 18 to 27°C (65 to 80°F) and 70 percent maximum relative humidity.

(3) Health hazards

  (a) Persons having a sensitivity to epoxy polymers and their associated curing agents, modifiers, etc., must not be certified as operators to this process.

H. Blue Filler EC3524 B/A

(1) General

  (a) EC3524 is a two part low density void filling compound. Part A is a white heavy consistency paste and Part B is a blue heavy consistency paste.

  (b) Weight out 100 parts of Part B and 94 parts of Part A.

  (c) Mix the materials by kneading until a uniform blue color, without streaks, is obtained.

  This provides a working life of approximately one hour at 22°C (72°F).

  NOTE: Operators should wear plastic gloves during preparation and application to avoid skin contact.

(2) Blue Filler EC3524 B/A

  (a) Refer to (1) for mixing instructions

  (b) Apply the filler

  NOTE: Operators should wear plastic gloves during preparation and application to avoid skin contact.

    1) Use a spatula, pallet knife, small trowel or pressure gun to apply the material.

    2) If the material tends to adhere to the tool it is permissible to very slightly moisten the blade with cold water when finally smoothing air washed sur faces.

    NOTE: Avoid using too much water as it reacts with the filler as a plasticiser.

    3) Remove excess material as soon as it is hard to the touch. Use tool blade in a burnishing action.

(c) Cure the filler for the time and temperature shown in Table 2/GENERAL.

NOTE: 1. The minimum cure time is 1/2 hour.

2. The material will not cure before 12°C (54°F).

3. Maximum temperature which may be applied to filler is 150°C (302°F). Above this temperature surface scorching and exothermic heat reaction may occur.

4. Remove scorching by hand abrading.

Table 2: Filler Cure Data

Time - Hours	96	72	36	24	16	8	4	2	1	1/2
Temperature (°C)	12	15	20	22	25	30	35	45	60	100
Tempperature (°F)	54	59	68	72	77	86	95	113	140	212

MATERIAL	SOURCE	SUBJECT																			
		51-22-01	51-22-05	51-32-03																	
PRIMERS	A B C D																				
EA9205 20%				X																	
ADHESIVES																					
EA956 PARTS A AND B	A			X																	
EA934 PARTS A AND B	A			X																	
EA934NA	A R																				
EA9649	A			X																	
EPOCAST H-1843 (TYPE 4 GRADE B) PARTS A AND B	B			X																	
REPAIR MATERIALS																					
BREATHER FABRIC OSNABURG	H																				
MYLAR, TEDLAR F.E.P.	--			X																	
NYLON VACUUM FILM HF800	D			X																	
SEALANT TAPE 9151	E			X																	
THERMOFOAM 3050	A			X																	
DOUBLE-BACK TAPE	--			X																	
GLASS CLOTH 181, 1581 or 7781 VOLAN A	C			X																	
GRAPHITE FABRIC A320-5H/3501 5A	F			X																	
GRAPHITE FABRIC A370-5H/3501-5A	F																				
GRAPHITE FABRIC A310-5H/3501-5A	F																				
SPEED TAPE	--																				
TEFLON TAPE NO. 61 (BLUE)	J K																				
CLEANERS	J S OR																				
METHYL-ETHYL KETONE M.E.K.	ANY SOURCE																				
H-N-95 AND TT-M-261	--			X																	
INHIBITED TRICHLOROETHANE	ANY SOURCE			X																	
SEALANT																					
PR1431G	G			X																	
HYLOMAR SQ 32M	L M N O		X																		

Non-Metallic Repair Material Sources
Figure 1 (Sheet 1 of 3)

MATERIAL	SOURCE	SUBJECT																			
		51-22-01	51-22-05	51-32-03																	
MISCELLANEOUS ITEMS																					
ACETONE	--			X																	
ABRASIVE PAPER 120 TO 400	--			X																	
DENATURED ALCOHOL	--			X																	
WEIGHTS OR SANDBAGS	--			X																	
GARNET PAPER 60 TO 80																					
CLEAN COTTON CLOTH	ANY SOURCE																				
CLEAN COTTON GLOVES	ANY SOURCE																				
TEFLON TAPE - TYGAFLOR COATED GLASS FABRIC	$\boxed{J}$ $\boxed{T}$																				
FILLER																					
RESIN FILLER EC3524BA	$\boxed{J}$ $\boxed{K}$			X																	
MATERIALS FOR PROTECTIVE TREATMENT																					
TWO PACK EPOXY CLEAR ENAMEL BASE, SL5459 PJP9110C 8000 CATALYST, CSH5538, PJP2000.2.0538		X																			
SURFACE PRETREATMENT																					
ALOCHROM 1200 DTD 900/4413 OR ALODINE 1200 DTD 900/4413		X																			

Non-Metallic Repair Material Sources
Figure 1 (Sheet 2 of 3)

NOTES

A HYSOL DIV, DEXTER CORP
2850 WILLOW PASS ROAD
P.O. BOX 132
PITTSBURGH, CA 94365
U.S.A.

B M AND T CHEMICALS, INC
5121 SAN FERNANDO RD WEST
LOS ANGELES, CA 90039

C J.P. STEVENS CO
16040 STEPHENS ST,
INDUSTRY, CA 91749
U.S.A.

D RICO PLASTICS
P.O. BOX 8677
SAN DIEGO, CA 92138
U.S.A.

E SCHNEE - MOREHEAD CHEMICALS INC
8835 S DICE
SANTA FE SPRINGS, CA 90241
U.S.A.

F HERCULES INC
BACCHUS WORKS
MAGNA, UT 84044
U.S.A.

G PRODUCTS RESEARCH AND CHEMICAL CO
5454 SAN FERNANDO ROAD
GLENDALE, CA 91205
U.S.A.

H WEST COAST PAPER CO
2203 FIRST AVE SO
SEATTLE, WA 98134
U.S.A.

J MED-LAB LIMITED
COPELAND STREET,
DERBY, DE1 2PU
ENGLAND

K 3M COMPANY
3M HOUSE,
P.O. BOX 1
BRACKNELL
BERKSHIRE
RG12 1JU
ENGLAND

OR

3M COMPANY
3M CENTRE
ST PAUL
MINNESOTA 55101
U.S.A.

L PPG INDUSTRIES (UL) LTD.
AVIATION AND DEFENCE COATINGS
ROTTON PARK STREET
LADYWOOD
P.O. BOX 359
BIRMINGHAM B16 0AD
ENGLAND

M MARSTON LUBRICANTS LIMITED
7-11 NAYLOR STREET
LIVERPOOL L3 6DS
ENGLAND

N KINGSLEY AND KIETH (CANADA) LTD
310 VICTORIA AVENUE
P.O. BOX 140 VICTORIA STATION
MONTREAL 6
QUEBEC
CANADA

O VAN DUSSEN AIRCRAFT SUPPLIES
TETERBORO AIRPORT
500 INDUSTRIAL AVENUE
TETERBORO NJ 07608
U.S.A.

P INTERNATIONAL PAINT COMPANY, INC.
21 WEST STREET
NEW YORK CITY, NY 10006
USA

Q IMPERIAL CHEMICAL INDUSTRIES LTD
NEW YORK LTD
444 MADISON AVENUE
NEW YORK CITY, NY 10022
USA

R AERO CONSULTANTS LTD
P.O. BOX 2117
8600 DUBENDORF
ZURICH
SWITZERLAND

S THE BRITISH DRUG HOUSES LTD
BDH LABORATORY CHEMICAL DIVISION
POOLE, DORSET, OR BIRKBECK STREET
LONDON
E2 SJW

T FOTHERGILL AND HARVEY
SUMMIT
LITTLEBOROUGH
LANCASHIRE 015 9QT

Non-Metallic Repair Material Sources
Figure 1 (Sheet 3 of 3)

GENERAL - FASTENERS

1. Applicability

A. This section gives general information about Boeing approved fasteners used on this airplane. It also gives information about inspecting for loose fasteners.

2. General

A. Fastener Codes and Symbols

(1) The Boeing Drawing system for the airplane model in this Structural Repair Manual uses a fastener symbol system as specified in NAS523 and Boeing Design Detail Standard BACD2074. Figure 1/GENERAL shows some examples of fastener symbols used in Boeing engineer drawings.

(2) Boeing approved fasteners and fastener/mating part combinations have specific fastener codes. Fastener codes are not used in this manual, but are used on the Boeing engineer 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 for Boeing approved fasteners can be found in the Qualified Products List (QPL) of each Boeing Fastener Specification.

C. Loose Fasteners

(1) Loose fasteners must be replaced. Loose fasteners have the properties that follow:

(a) The fastener moves in relation to the material that it holds.

(b) Tipped fastener heads 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 Figure 2/GENERAL.

3. References

Reference	Title
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
51-40-07, GENERAL	Strength of Fasteners
51-40-08, GENERAL	Countersinking
51-40-09, GENERAL	Coldworking of Holes for Fatigue Improvement

4. Fastener Types

A. This section gives some general data about the usual types of mechanical fasteners found on this airplane.

B. Fasteners can be grouped as either permanent or removable as follows:

(1) Permanent fasteners are used in the assembly of sructure 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 removed hex-drive bolts to see if they continue to be serviceable as specified in 51-40-02, GENERAL. These types of fasteners are permanent:

- solid rivets
- lockbolts
- hex-drive bolts
- radius lead-in bolts
- blind rivets
- blind bolts
- sandwich panel inserts

(2) Removable fasteners are used in the assembly of sructure 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 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 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, GENERAL for 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 hex-drive bolts because they:

(a) Have a shank with a radius lead-in area under the head.

(b) Have a 0.006-inch diameter oversize shank.

(c) Are driven into high interference-fit holes during installation.

F. Blind Rivets and Blind Bolts

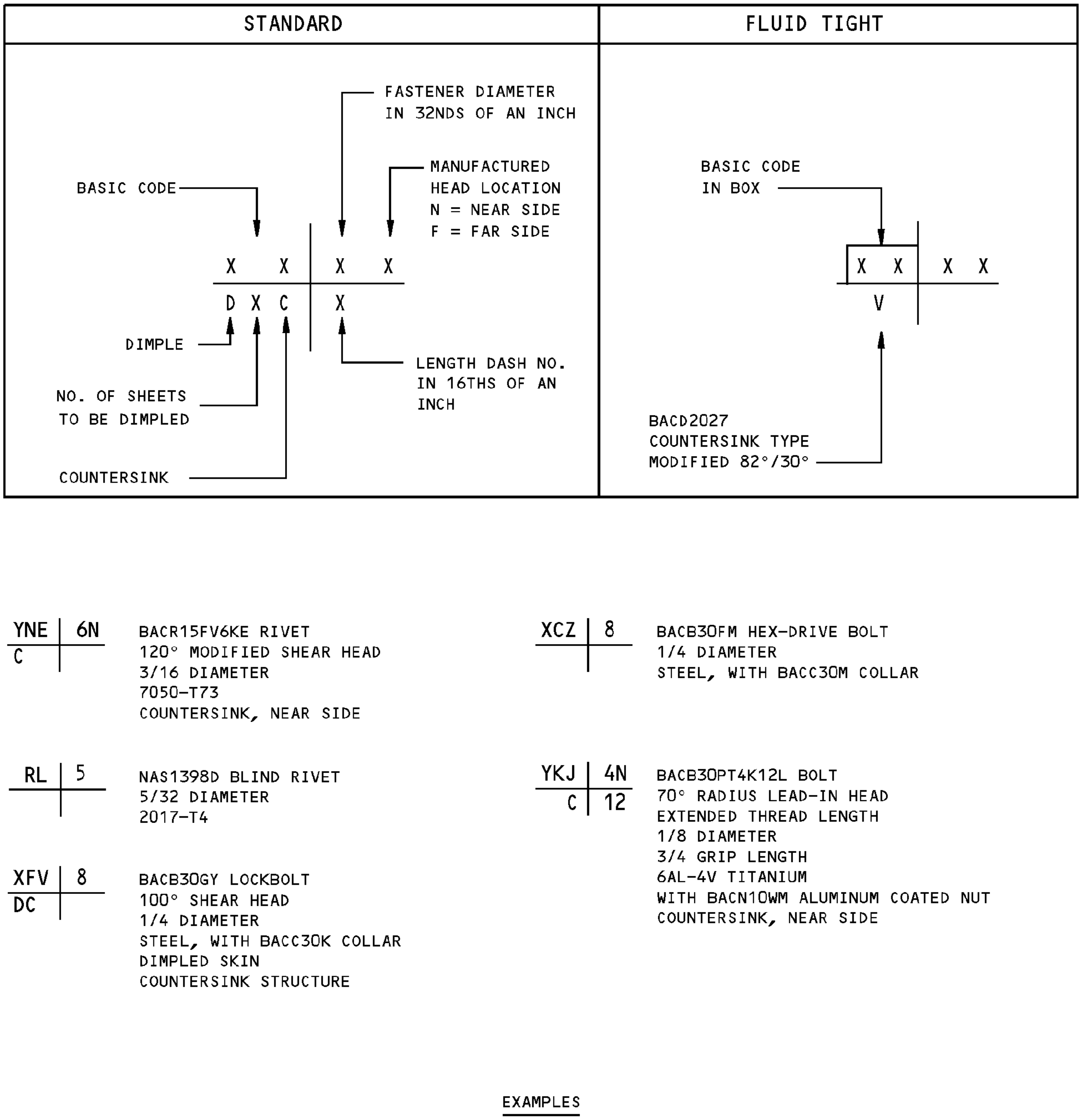
CAUTION: DO NOT USE BLIND FASTENERS AT THESE LOCATIONS:

- WHERE THE HEADS CAN BE PRIED
- FLUID-TIGHT JOINTS
- WING ATTACHMENT FITTINGS
- PYLON ATTACH FITTINGS
- LANDING GEAR FITTINGS
- CONTROL SURFACE HINGE BRACKETS
- CONTROL SURFACE ATTACHMENT FITTINGS
- FIXED TAIL SURFACE ATTACHMENT FITTINGS
- OTHER TENSION OR HIGHLY STRESSED LOCATIONS

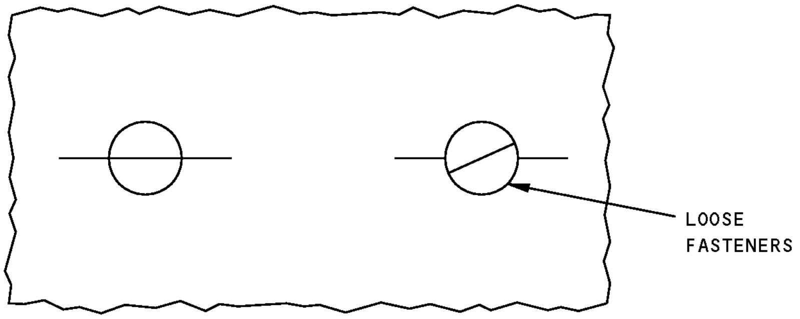
BLIND FASTENERS CAN FAIL IF YOU USE THEM IN THESE LOCATIONS.

(1) Blind fasteners are fasteners that you can install when you have access to only one side of the structure. In some locations, you can use blind rivets where access is not available to mke the upset head of a 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 an FAA approved repair. Although blind fasteners are permitted in some conditions as alternatives to solid fasteners, a larger number of fasteners or a larger diameter of 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, GENERAL for approved alternatives. In some repairs there will be specified time-limits for replacement with permanent fasteners, or inspections, or both.

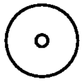
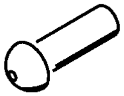
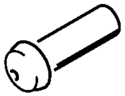
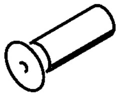
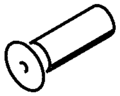
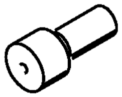
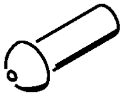
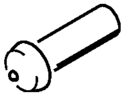
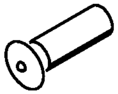
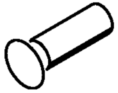
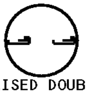
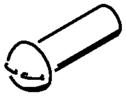
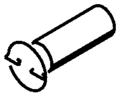
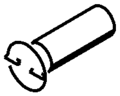
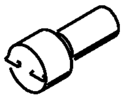
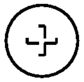
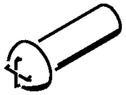
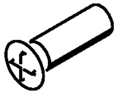
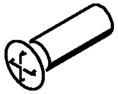
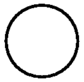
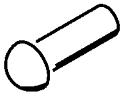
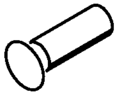
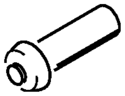
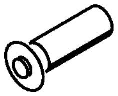
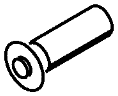
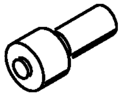
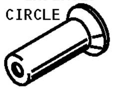
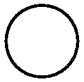
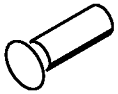


Fastener Symbols
Figure 1



MARK A RED LINE ACROSS THE FASTENER
HEAD AND THE ADJACENT MATERIAL.
CHECK THE LINE AT THE NEXT INSPECTION.
ANY LOOSENING OF THE FASTENER WILL
BREAK THE LINE AS INDICATED.

Red Lining of Fasteners
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 section gives procedures for the removal and installation of structural fasteners in metallic and non-metallic structure.

2. General

A. Some of the information in this subject can be found in Boeing Process Specifications BAC5004-1, BAC5004-2, BAC5004-3, BAC5009, BAC5047, and BAC5060.

B. Hole Finder

(1) You can use a hole finder to find the position 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 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, GENERAL for the procedure to drill in metal structures. Refer to 51-70-16, GENERAL for the procedure to drill in advanced composite structures.

D. Refer to 51-40-05, GENERAL for hole size dimensions and hole quality specifications.

E. When you install flush head fasteners, refer to Figure 2/GENERAL for fastener flushness specifications. Refer to 51-40-08, GENERAL for countersinking and counterbore procedures.

F. Refer to 51-40-09, GENERAL if it is necessary to cold work fastener holes.

3. References

Reference	Title
51-10-01, GENERAL	Aerodynamic Smoothness Requirements
51-20-01, GENERAL	Protective Treatment of Metallic and Nonmetallic Repair Parts
51-20-05, GENERAL	Repair Sealing
51-30-01, GENERAL	Sheet Metal Materials
51-40-01, GENERAL	Fasteners
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
51-40-07, GENERAL	Strength of Fasteners
51-40-08, GENERAL	Countersinking
51-40-09, GENERAL	Coldworking of Holes for Fatigue Improvement
51-70-16, GENERAL	Hole Drilling and Machining of Composite Structures
SOPM 20-50-19	General Sealing

4. Solid Shank Rivets

A. General

(1) The solid shank rivets in general use on this airplane are made from 7050, 2017 or 2117 aluminum alloy. In some locations, rivets made from 5056 or 2024 aluminum alloy, or nickel-copper alloy are used.

(a) 2017, 2117, 5056, and 7050 aluminum alloy rivets and monel rivets may be stored and used at room temperature.

(b) Rivets made from 2024 aluminum alloy must be heat-treated and then stored at a temperature of -10°F (-23°C), or lower. After removal from cold storage the rivets must be completely driven within 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 asssembly. 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, GENERAL for replacement of rivets in the integral fuel tank.

B. Installation of Solid Rivets

(1) Solid rivets can be installed with a rivet gun and bucking bar or an applicable squeeze riveting tool. Some rivets (for example, the BACR15FT rivet) are installed with tools that can be different than tools for most rivets. Make sure that you have the proper tools for each type of rivet that you install.

(a) Rivet guns and bucking bars must be large enough to drive the rivets quickly. Three to four seconds duration is best. Seven seconds is the maximum.

(b) Do not over-drive rivets as this can cause diagonal cracks. It is recommended that bucking bars be very smooth when you install all types of rivets. But, smooth bucking bars are very important when you drive 7050 and 2017 aluminum alloy rivets.

(c) Use heavy, slow speed rivet guns and heavier bucking bars for nickel-copper alloy rivets.

(2) 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 told to do differently in a specific repair procedure.

(3) 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.

(4) 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 rivets is always formed on the seal plane of the integral fuel tank.

(5) Make sure that BACR15FV and MS14218 rivet heads are seated correctly in the counterbores before you drive the rivets.

NOTE: When seated in the counterbore, the rivet head will protrude above the skin surface. After driving, the rivet head will continue to protrude. See Figure 2/GENERAL for flushness specifications.

C. Do the inspections that follow after you install the rivets:

(1) Measure the button dimensions as shown in Figure 3/GENERAL or Figure 4/GENERAL, as applicable.

(2) Inspect the heads and buttons for cracks as shown in Figure 6/GENERAL.

(3) Inspect the gaps under the heads of installed rivets as shown in 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 in 51-40-05, GENERAL, 51-40-08, GENERAL, or 51-70-16, GENERAL. Reworked holes must comply with the same quality specifications as the initial hole.

(2) It is permitted to rework holes to 1/32 inch oversize for rivets other than BACR15FV and MS14218 rivets.

(3) It is permitted to rework holes to 1/32 inch oversize for BACR15FV and MS14218 rivets if:

(a) The edge margin is twice the diameter of the initial fastener, or greater. Refer to 51-40-06, GENERAL.

(b) The replacement rivet complies with the specifications shown in one of the steps that follow:

1) If the skin is thin (where the next larger diameter rivet does not meet the requirements shown in Figure 5/GENERAL), install the next larger diameter rivet. Drill the hole to the diameter necessary for the larger diameter rivet. Countersink the hole to the same depth as the original rivet. See Figure 5/GENERAL, Detail I and 51-40-08, GENERAL. Drive the rivet only until it is tight in the hole. Microshave the head as specified in Figure 5/GENERAL. Complete driving of the rivet. No additional microshaving is required.

2) If the skin is thick (where the next larger diameter rivet still meets the requirements shown in Figure 5/GENERAL, Table I), install the next larger diameter rivet in accordance with Figure 5/GENERAL, Detail II and 51-40-08, GENERAL.

E. Refer to Figure 8/GENERAL for the procedures to remove solid shank rivets.

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, GENERAL 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 cannot be installed with the same pulling head of the tool.

(2) Check for correct installation as follows:

(a) The heads of protruding type must be seated so that a 0.002 inch thick shim cannot contact the rivet shank.

(b) The heads of flush type 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 contact the rivet shank.

(c) Check that stem and collar protrusions are within limits shown in Figure 9/GENERAL,Table I.

C. Removal

(1) If the removal of blind rivets is necessary, refer to 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, GENERAL for limitations 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 boltheads as shown in Figure 9/GENERAL.

(b) Check that stem and collar protrusions are within limits shown in Figure 9/GENERAL.

C. Removal

(1) Remove blind bolts using the steps shown in 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. But, the cadmium plating is a sacrificial coating, and in a corrosive environment can come off of 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 the bolt is installed.

(5) Install fasteners wet with sealant.

NOTE: Refer to 51-20-05, GENERAL and SOPM 20-50-19 to install fasteners in the integral fuel tank and other procedures to apply sealant.

(6) All lockbolts and hex-drive bolts must have the manufactured head fully seated to 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 (Figure 13/GENERAL)

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 (that can be used with Hex-drive bolts). Too many washers can cause unwanted eccentricity and can cause fasteners to become loose. But, 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, GENERAL for the classification of dissimilar materials. The correct washer material and part number numbers to use are given in 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 protruding head fasteners.

(b) One washer, maximum, can be used for fillet relief.

(c) Only use washers that have a side with a fillet relief or countersink.

(d) Put the fillet relief (or countersunk) side of the washer under the head of the fastener.

(2) Corrosion Protection and Grip Length Adjustment Washers

NOTE: The maximum number of these types of washer that can be used is two, with a maximum thickness of 1/16 inches (1.6 mm).

(a) Only use standard washers (no countersunk washers) unless the grip adjustment washer is put directly under a protruding head (then a fillet relief or countersunk 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 are used (BACN10MT with a BACW10AU), or
- a self-sealing collar is used (BACC30BP), or
- a self-sealing nut is used (BACN10WM), or
- a self-aligning collar-washer assembly is used (BACC30BQ or BACC30AG).
- 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. See 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 length 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, H600).

(a) Make sure that all of 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 (0.8 mm) inch 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, only use 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, BACB30YL, BACB30YM, BACB30YN, HLT420, HLT421, HLT422, and HLT423) do the applicable step that follows:

1) For bolt sizes that are 1/4 inch diameter or less, 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, only use 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 a third oversize bolt is not fully above the end of the nut, only use two 1/16 inch (1.6 mm) thick washers.

3) For bolt sizes that are 3/4 inch or larger 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, only use two 1/16 inch (1.6 mm) thick washers.

C. Lockbolt Installation and Removal

(1) The "pull type" lockbolt is installed with a type of pneumatic pulling gun. The gun pulls on end of the shank, known as the pintail, and at the same time, swages a collar on to the shank. The pintail breaks off at the correct load.

(2) Before you install the lockbolt collar, remove the 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 operation, to prevent elongation of the holes. As an alternative the collars can be milled off.

D. Hex-Drive Bolt Installation and Removal

(1) Hex-drive bolts are a threaded fastener 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 removes 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 hexagonal recess and make sure that 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 (Figure 12/GENERAL).

(3) Where access is not available for the installation of the special collar, it is permissible to use locknuts. This special collar is manufactured with a counterbore which allows for the bolt to fit into the recess in the collar. Counterbore substitution washers are necessary with non-counterbored locknuts. Refer to Paragraph 7.B./GENERAL and Figure 13/GENERAL for locknut selection and washer requirements. Refer to Paragraph 7.D.(5)/GENERAL for torque procedure.

(4) After the collar is installed, inspect the bolt as follows:

(a) Examine the pin protrusion as given in Figure 14/GENERAL.

(b) Examine the gaps under the bolt head and collar as given in Figure 12/GENERAL.

(c) Examine head dishing in flush head fasteners as given in 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 nuts is not specified), do not tighten adjacent bolts in a sequence.

1) If the bolts are in a circle: first hand-tighten opposite bolts in a sequence. Then torque all bolts in an alternating pattern, all around the circle.

2) If five or more bolts are in a row: first hand-tighten the end bolts, then the bolts that remain. Then torque all fasteners in an alternating pattern, all along the row.

(b) Torque nuts to the values given in 51-40-04, GENERAL.

(6) Hex-drive bolts are removed by inserting a hexagonal key in the pin and gripping and turning the collar with locking pliers.

8. Radius Lead-In Bolts (Figure 15/GENERAL)

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 and 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 may be produced using either of the following methods:

1) Hole produced in one operation with the specified size ST7044 precision drill. Drill the hole at 2000 rpm with a feed rate at 8 to 12 seconds for 2.0 inch free travel.

2) Hole produced from pilot hole.

a) Drill pilot hole 1/64 inch under the size of the ST1219Y-1RCA reamer pilot. Maintain perpendicularity of pilot hole to part surface within ± 1/2°.

b) Ream the pilot to the size of the ST1219Y-1RCA reamer pilot.

c) With the required size of ST1219Y-1RCA reamer/countersink installed in the ST1219X-Y tripod, adjust the depth setting for proper countersink depth.

d) Attach a hand feed drill motor to the tripod unit and ream hole using a steady hand feed at 500 rpm.

NOTE: Apply enough pressure to fully countersink the hole in one operation. The pressure exerted must be constant from hole to hole to maintain countersink depth control.

(b) Use a cutting and lubricating medium when drilling and reaming holes. A recommended cutting and lubricating medium is Cetyl Alcohol or BOELUBE, which comes in liquid, solid, paste or spray form.

(c) Before producing holes in the airplane structure drill and ream a minimum of 5 holes to the requirements of par. (d) (below).

(d) Before you install the fastener, inspect the hole to make sure that it agrees with the specifications in 51-40-05, GENERAL.

NOTE: Inspect the hole diameter before you inspect for straightness.

(2) Oversize Holes

NOTE: When a 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, GENERAL.

(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, GENERAL.

C. Installation

(1) Select a bolt with the required grip length and thread protrusion as given in Figure 15/GENERAL.

(2) If the thread protrusion requirements of Figure 15/GENERAL, are not as specified, a grip adjustment washer can be used as shown in Figure 15/GENERAL.

(3) Apply an applicable sealant to the underside of the bolt head. If the bolt has a flush head, you can apply sealant to the countersink as an alternative. Refer to 51-40-05, GENERAL for seals and sealing.

(4) Drive or press the bolt into the hole. The parts must be clamped together and the structure supported with an applicable bucking bar during this operation.

NOTE: A maximum interface separation of 0.004 inch is permissible at the bolt shank in fay seal areas, and in non faying seal areas a separation of less than 0.002 inch is permissible. To facilitate installation, holes may also be lubricated with cetyl alcohol.

(5) Install nuts and washers as given in Paragraph 8./GENERAL and Figure 15/GENERAL.

(6) Torque Procedure

(a) When the engineering drawing specifies a multiple bolt installation (and the sequence to tighten the nuts is not specified), do not tighten adjacent bolts in a sequence.

1) If the bolts are in a circle: first hand-tighten opposite bolts in a sequence. Then torque all bolts, in an alternating pattern, all around the circle.

2) If the bolts are five or more in a row: first hand-tighten the end bolts, then the bolts that remain. Then torque all bolts in an alternating pattern, all along the row.

(b) Torque nuts to the values given in 51-40-04, GENERAL.

(7) Clean the threads of sealant or any other residue and install the nut to the torque wrench values specified in 51-40-04, GENERAL. The installation of all bolts through parts assembled with faying surface seals must be completed with at least 60 minutes of the sealant application life left. After at least 20 minutes from the initial torque application, retorque the nuts to the maximum torque value +00 to -20 pound-inches (+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 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, GENERAL, (unless specified differently in an engineering drawing).

NOTE: Additional driving of the bolt to get correct flushness is permitted. Make sure that the nut is retightened as given in 51-40-04, GENERAL.

(10) Make sure that the shank protrusion is in the specified limits given in Figure 15/GENERAL.

(11) Examine the gaps under the bolt head and nut as given in Figure 15/GENERAL.

D. Use of Washers

NOTE: See Figure 15/GENERAL, Tables I through III for washer sizes and types.

(1) Seal 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) Only use 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 head of the fastener.

(3) Grip Adjustment Washers

(a) A maximum of one washer is permitted for grip adjustment. Only use standard washers (no countersink washers) unless the grip adjustment washer is put directly under the head of a BACB30WR fastener (then a fillet relief washer or countersunk 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: 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 1/16 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 BACW10AU 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 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 can 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. But, the cadmium plating is a sacrificial coating, and in a corrosive environment can come off of 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) Fasteners are installed wet with sealant.

NOTE: Refer to 51-20-05, GENERAL 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 (0.8 mm) 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) 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, corrosion protection or counterbore substitution is three. Too many washers can cause unwanted eccentricity and can cause fasteners to become loose. But, 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, GENERAL for the classification of dissimilar materials. The correct washer material and part number numbers to use are given in 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) Only use washers that have a side with a fillet relief or countersink.

(d) Put the fillet relief (or countersunk) side of the washer under the head of the fastener.

(2) Corrosion Protection and Grip Length Adjustment Washers

NOTE: The maximum number of these types of washer that can be used is two.

(a) Only use standard washers (no countersunk washers) unless the grip adjustment washer is put directly under a protruding head (then a fillet relief or countersunk 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 are used (BACN10MT with a BACW10AU).

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 a installation of multiple bolts or screws (and the sequence to tighten the nuts is not specified), do not tighten adjacent fasteners in a sequence.

(a) If the fasteners are in a circle: first hand-tighten opposite fasteners in a sequence. Then torque all fasteners, in an alternating pattern, all around the circle.

(b) If the fasteners are five or more in a row: first hand-tighten the end fasteners, then the fasteners that remain. Then torque all fasteners in an alternating pattern, all along the row.

(2) Torque nuts to the values given in 51-40-04, GENERAL.

(3) Clean the threads of sealant or any other residue and install the nut to the torque wrench values specified in 51-40-04, GENERAL. The installation of all bolts through parts assembled with faying surface seals must be completed with at least 60 minutes of the sealant application life left. After at least 20 minutes from the initial torque application, retorque the nuts to the maximum torque value +00 to -20 pound-inches (+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 sealant materials.

E. Evaluate gaps under the bolt head and nut as given in Figure 16/GENERAL.

10. Installation of Fasteners in Composites

A. Refer to 51-70-16, GENERAL for drilling, countersinking, and machining of composites, treatment of fastener holes, and fastener hole quality.

B. Refer to Paragraph 11./GENERAL for installation of BACR15GA rivets in composites.

C. Carbon Fiber Reinforced Plastic (CFRP) panel installed on CFRP panel or CFRP structure.

(1) Remove any loose fasteners.

(2) Drill holes, if necessary, per specific component repair instructions.

(3) Install CRES or titanium fasteners dry. Use of aluminum fasteners in CFRP or hybrid aramid/ CFRP structures is not recommended; corrosion may result.

D. Aramid or Fiberglass Reinforced Plastic (AFRP or GFRP) panels

(1) Remove any loose fasteners.

(2) Drill holes, if necessary, per specific component repair instructions.

(3) Install 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 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 AS FOLLOWS, 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 the panel to prevent breakout damage. Refer to 51-70-16, GENERAL for breakout limits.

(4) Countersink holes as specified in 51-70-16, GENERAL. Refer to 51-40-08, GENERAL for BACR15GA rivet countersink dimensions.

C. Installation (Figure 17/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 Figure 17/GENERAL for squeeze force settings.

(c) The following forming dies shall be used for flaring the hollow end of the rivet into the countersink:

1) Single-stage installations use ST1157G flaring tool. (preferred method)

2) Double-stage installations use ST1157A flaring tool for 140° initial angle and 160° final angle or 120° initial angle and 140° final angle (alternate method).

(2) Inspect rivets after installation for the following:

  (a) Visible cracks in the flared end of the rivet are not allowed.

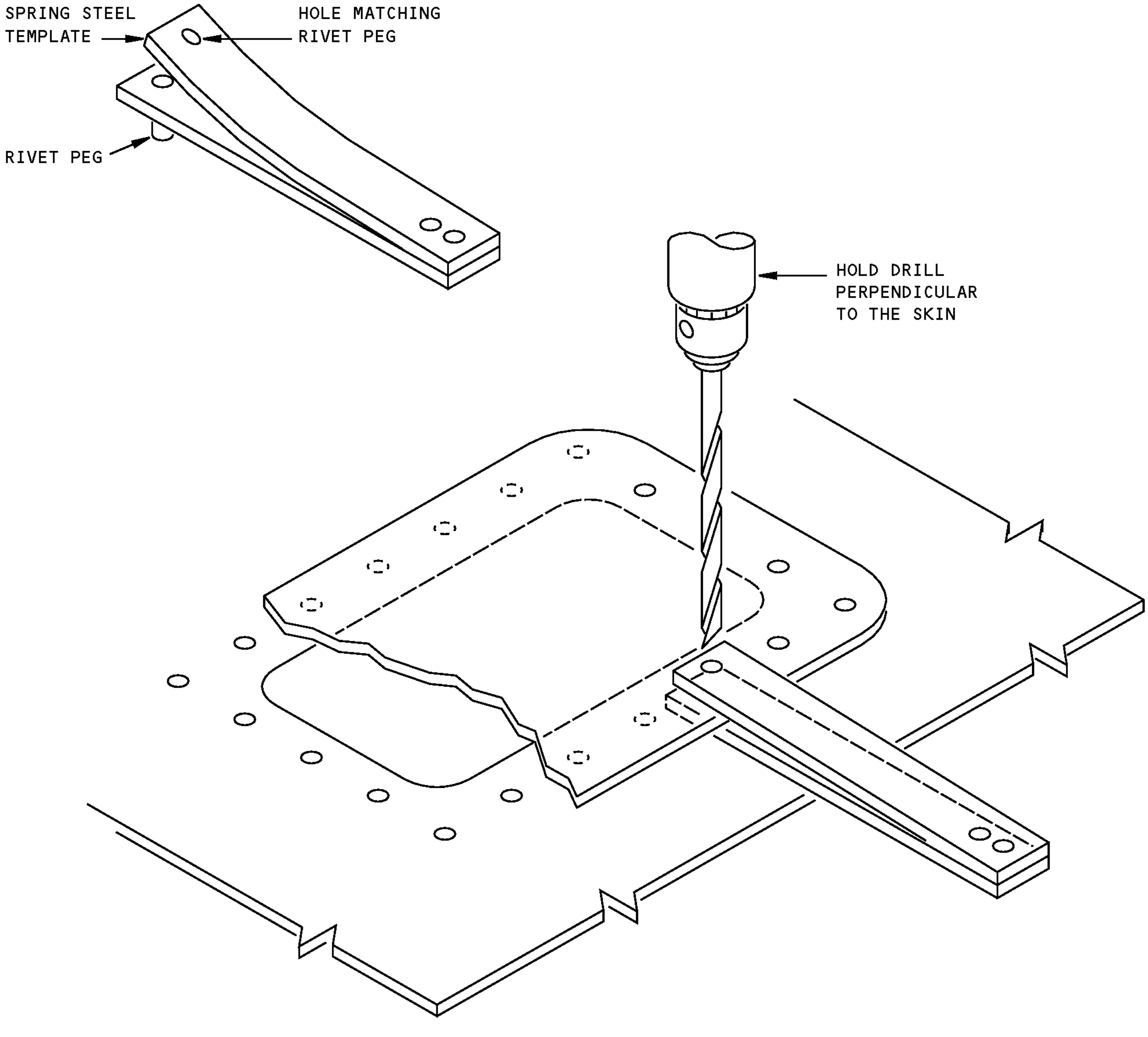
  (b) Rivets must be flush within 0.000 to +0.015 for both ends of rivet.

    1) Flared end of rivet may be shaved to not less than +0.010 protrusion.

    2) Shaving of more than 25% of rivets in a single component is not allowed.

  (c) Flared end of rivet must not be off center by more than 0.04.

D. Removal of BACR15GA rivets can be accomplished by procedures used for solid shank rivets. See Figure 8/GENERAL.



Hole Finder
Figure 1

NOTES

- SEE DETAIL I FOR INSPECTION OF FLUSHNESS.
- IF A FASTENER HEAD CAN CAUSE INTERFERENCE WITH A MATING PART, THE MAXIMUM HEAD HEIGHT PERMITTED IS +0.005 INCH (+0.13 mm)

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 +0.006 INCH (-0.00 TO +0.15 mm). (2) BACR15FV AND MS14218 RIVETS MUST BE FLUSH +0.001 TO +0.006 INCH (+0.03 TO +0.15 mm). (3) ALL OTHER COUNTERSUNK RIVETS MUST BE FLUSH -0.000 TO +0.010 INCH (-0.00 TO +0.25 mm). • 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 +0.006 INCH. (+0.03 TO +0.15 mm) (2) BACR15FV AND MS14218 RIVETS MUST BE FLUSH +0.001 TO +0.006 INCH (+0.03 TO +0.15 mm). (3) ALL OTHER FLUSH HEAD RIVETS MUST BE FLUSH -0.001 TO +0.002 INCH (-0.03 TO +0.05 mm). • BACR15FV, MS14218, BACR15GF, NAS1097, AND BACR15CE RIVET HEADS MUST NOT BE SHAVED OR MODIFIED TO AGREE WITH FLUSHNESS SPECIFICATIONS (UNLESS PERMITTED FOR REWORK OF BACR15FV AND MS14218 RIVETS AS SPECIFIED IN FIGURE 5). • RIVETS OTHER THAN BACR15FV, NAS1097, BACR15GF, BACR15CE AND MS14218 RIVETS CAN BE SHAVED AS SPECIFIED IN SRM 51-10-01 TO AGREE WITH FLUSHNESS SPECIFICATIONS.
BLIND FASTENERS	• FLUSHNESS SPECIFICATION FOR FLUSH-HEAD FASTENERS SHALL BE -0.005 TO +0.010 INCH (-0.03 TO +0.25 mm) 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, BACR15FP, AND BACR15FR RIVETS CAN BE SHAVED A MAXIMUM OF 0.010 INCH (0.25 mm) 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.

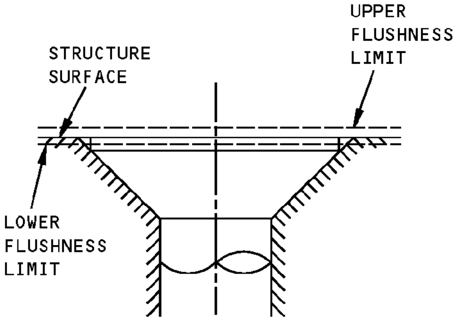
TABLE I

Fastener Flushness Specifications
Figure 2 (Sheet 1 of 3)

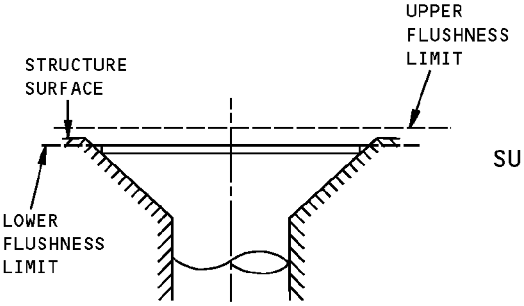
FASTENER	HEAD HEIGHT SPECIFICATIONS FOR FLUSH HEAD FASTENERS
LOCKBOLTS AND HEX-DRIVE BOLTS	• FLUSH HEAD FASTENERS MUST BE FLUSH -0.005 TO +0.010 INCH (-0.13 TO +0.25 mm) UNLESS SPECIFIED DIFFERENTLY IN SRM 51-10-01 OR ON THE ENGINEER DRAWING. • DOMED HEAD FASTENERS (BACB30XT, BACB30XU AND BACB30YP) MUST BE FLUSH +0.0025 TO +0.0085 INCH (+0.06 to +0.22 mm) 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 (-0.13 TO +0.38 mm). • 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.
BOLTS	• FLUSH HEAD FASTENERS MUST BE FLUSH -0.005 TO +0.010 INCH (-0.13 TO +0.25 mm) 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 (-0.13 TO +0.38 mm). • 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 (+0.00 TO +0.15 mm), 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 I (CONT)

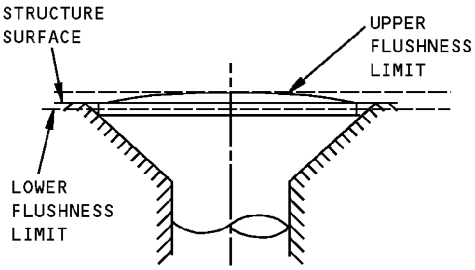
Fastener Flushness Specifications
Figure 2 (Sheet 2 of 3)



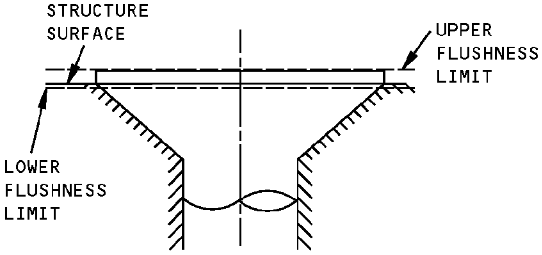
FASTENER HEAD HAS A CONTINUOUS SURFACE WITH THE STRUCTURE (ZERO VALUE)



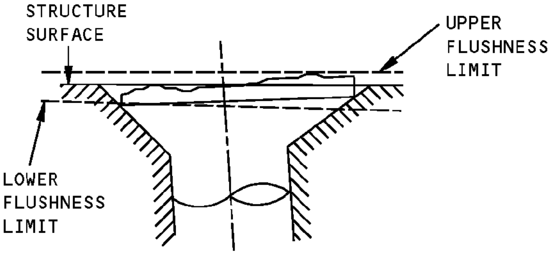
FASTENER EXACTLY AT LOWER FLUSHNESS LIMIT (NEGATIVE VALUE)



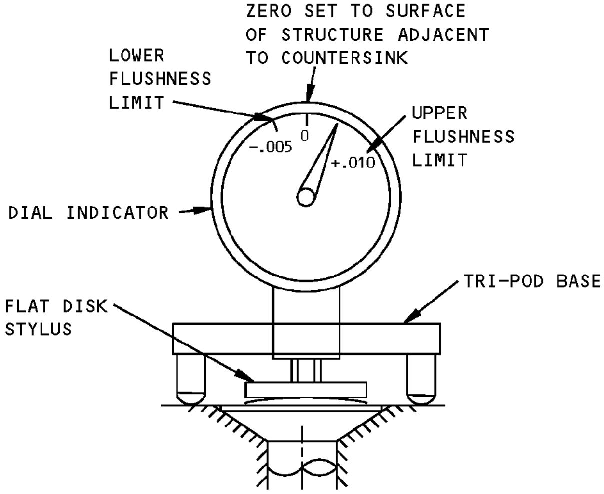
FASTENER WITH CROWN (OR DOME) ON TOP OF HEAD. FASTENER FLUSHNESS JUST MEETS FLUSHNESS LIMITS



FASTENER HEAD IS AT UPPER FLUSHNESS LIMIT (POSITIVE VALUE)



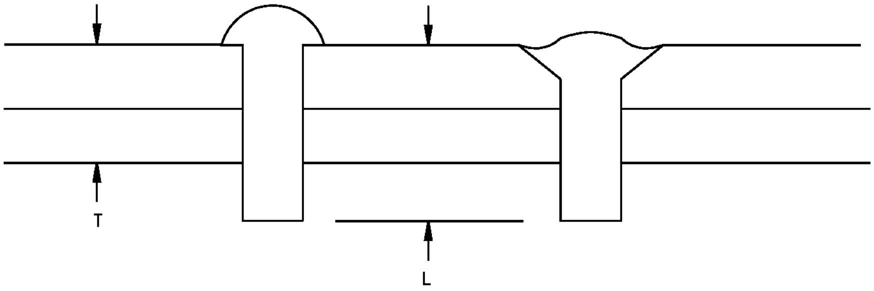
FASTENER HOLE NOT PERPENDICULAR TO STRUCTURE SURFACE. TOP OF FASTENER HEAD NOT PERPENDICULAR TO SHANK. TOP OF FASTENER HEAD NOT FLAT. ALL EDGES ARE AT OR IN BETWEEN THE UPPER AND LOWER FLUSHNESS LIMITS.



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
DETAIL I

Fastener Flushness Specifications
Figure 2 (Sheet 3 of 3)



RIVET LENGTH (L) AND GRIP (T) DIMENSIONS FOR STANDARD ALUMINUM SOLID RIVETS
DETAIL I

NOTES

- THE SOURCE OF INFORMATION FOR THIS FIGURE CAN BE FOUND IN BOEING PROCESS SPECIFICATION BAC5004-1
- SEE TABLE I FOR GRIP RANGES AND RIVET LENGTHS.
- SEE TABLES II AND III FOR BUTTON DIMENSIONS.
- REFER TO FIGURES 6 AND 7 FOR ANALYSIS OF THE RIVET HEAD AND BUTTON AFTER INSTALLATION.

A 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.

B 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.

C 1/32 OVERSIZE REPLACEMENTS

D WHEN NORMAL DRIVING STANDARDS ARE SPECIFIED

E WHEN OVER-DRIVING IS SPECIFIED

F 1/64 OVERSIZE REPLACEMENTS

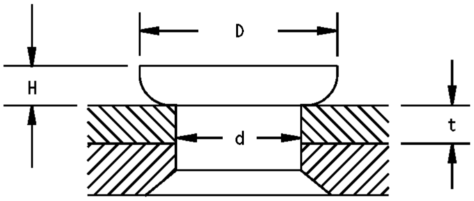
Dimensions for Driving Non-Fluid-Tight Solid Shank Rivets
Figure 3 (Sheet 1 of 3)

RIVET LENGTH L [A]		GRIP T RANGES FOR RIVET LENGTHS AND DIAMETERS [B]								
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	0.320 0.377	0.294 0.352	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

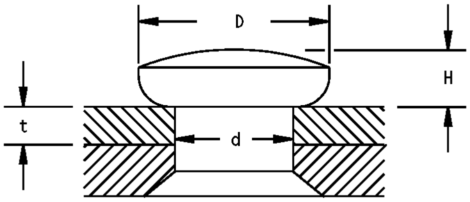
GRIP RANGES AND RECOMMENDED RIVET LENGTHS FOR STANDARD ALUMINUM SOLID RIVETS

TABLE I

Dimensions for Driving Non-Fluid-Tight Solid Shank Rivets
Figure 3 (Sheet 2 of 3)



STANDARD FLAT DRIVEN HEAD



UNIVERSAL DRIVEN HEAD

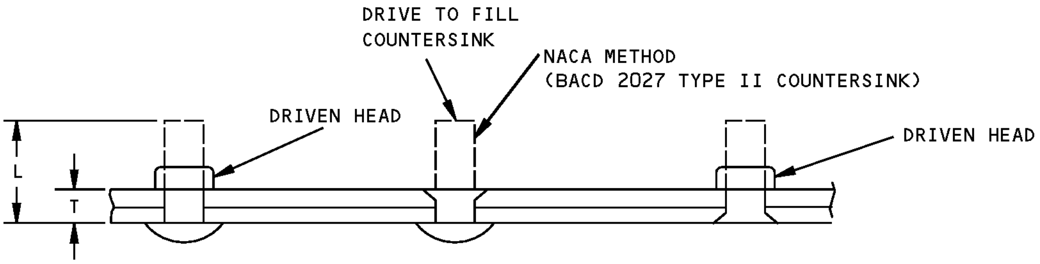
NOMINAL RIVET DIAMETER	D MINIMUM DRIVEN RIVET BUTTON DIAMETER				H DRIVEN RIVET BUTTON THICKNESS OR HEIGHT		
	ALL RIVETS EXCEPT AS NOTED MINIMUM		BACR15GF AND HAND DRIVEN 7050 ALUMINUM ALLOY RIVETS		BACR15GF BACR15CE BACR15DS BACR15FV MS14218 NAS1097	ALL OTHER RIVETS	ALL RIVETS
	1.3d [D]	1.4d [E]	1.4d [D]	1.5d [E]	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
13/64 [F]					0.065		0.130
7/32 [C]	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
17/64 [F]					0.085		0.170
9/32 [C]	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 [C]	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 [C]	0.530	0.569	0.569	0.609	0.165	0.165	0.215

TABLE II

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 III

Dimensions for Driving Non-Fluid-Tight Solid Shank Rivets
Figure 3 (Sheet 3 of 3)



RIVET LENGTH (L) AND GRIP (T) DIMENSIONS
DETAIL I

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

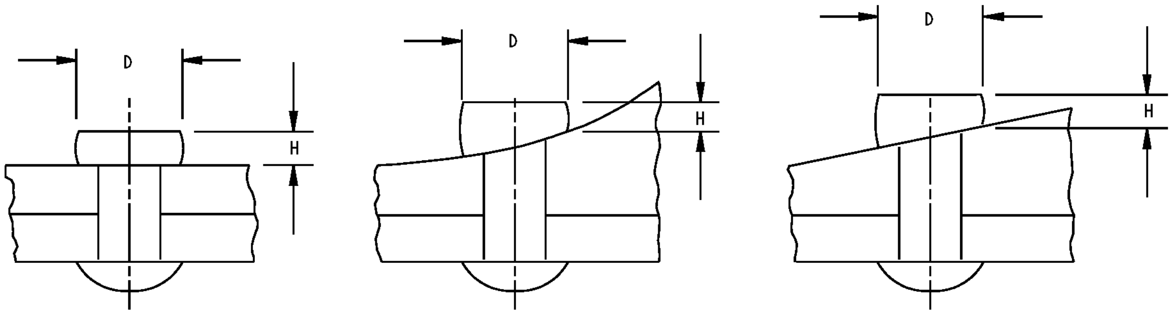
NOMINAL RIVET LENGTH L AND APPROXIMATE GRIP T-INCHES
TABLE I

NOTES

- THE SOURCE OF INFORMATION FOR THIS FIGURE CAN BE FOUND IN BOEING PROCESS SPECIFICATION BAC5047
- REFER TO FIGURES 6 AND 7 FOR ANALYSIS OF THE RIVET HEAD AND BUTTON AFTER INSTALLATION

A OVERSIZE REPLACEMENT

Dimensions for Driving Fluid-Tight Solid Shank Rivets
Figure 4 (Sheet 1 of 2)



FLAT DRIVEN HEAD
CURVED DRIVEN HEAD
TAPERED DRIVEN HEAD

DRIVEN RIVET BUTTON DIMENSIONS
DETAIL II

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 A	0.285	0.311	0.085	0.140
0.2500	1/4	0.325	0.350	0.100	0.160
0.2810	9/32 A	0.365	0.397	0.110	0.180
0.3125	5/16	0.406	0.438	0.125	0.200
0.3440	11/32 A	0.450	0.482	0.135	0.210
0.3750	3/8	0.488	0.525	0.150	0.210
0.4060	13/32 A	0.530	-- --	0.165	0.215
0.4370	7/16	0.570	-- --	0.175	0.220
0.4690	15/32 A	0.610	-- --	0.190	0.230

HAND OR MACHINE DRIVEN RIVET BUTTON DIMENSIONS
TABLE II

Dimensions for Driving Fluid-Tight Solid Shank Rivets
Figure 4 (Sheet 2 of 2)

IN THIS SKIN THICKNESS MEASURED AT THE HOLE	THE LARGEST DIAMETER RIVET ALLOWED IS:
0.050	5/32
0.056	3/16
0.072	7/32
0.081	1/4
0.090	9/32

BACR15FV AND MS14218 RIVET REPLACEMENT
TABLE I

NOTES

- THE SOURCE OF INFORMATION FOR THIS FIGURE CAN BE FOUND IN BOEING PROCESS SPECIFICATION BAC5004-1
- REFER TO FIGURE 3 FOR GRIP RANGE, RIVET LENGTH, AND BUTTON DIMENSIONS
- REFER TO FIGURES 6 AND 7 FOR ANALYSIS OF THE RIVET HEAD AND BUTTON AFTER INSTALLATION

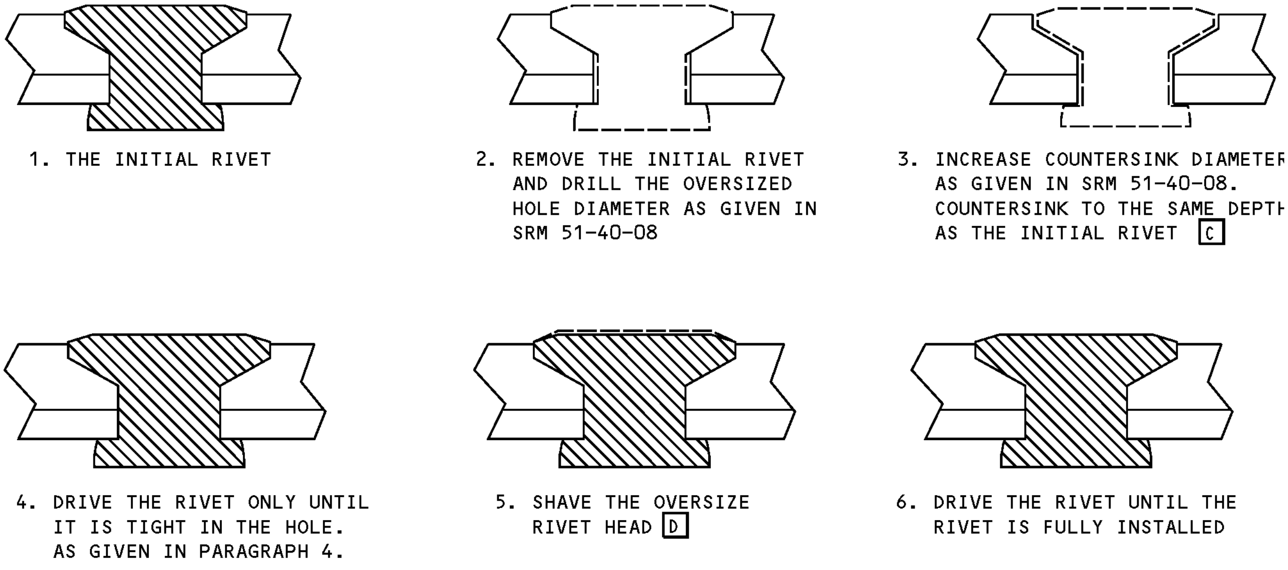
A THE OVERSIZE RIVET IS LARGER THAN THE LIMITS SPECIFIED IN TABLE I.

B THE OVERSIZE RIVET IS WITHIN THE LIMITS SPECIFIED IN TABLE I.

C IF THE ORIGINAL COUNTERSINK WAS CUT TOO DEEP, THEN DO NOT MAKE THE OVERSIZE RIVET THE SAME DEPTH. OVERSIZE THE HOLE AND THEN COUNTERSINK TO THE CORRECT DEPTH.

D REFER TO FIGURE 2 OR THE ENGINEER DRAWING FOR THE FASTENER FLUSHNESS SPECIFICATIONS

Installation of BACR15FV and MS14218 Oversize Rivets
Figure 5 (Sheet 1 of 2)



1. THE INITIAL RIVET

2. REMOVE THE INITIAL RIVET AND DRILL THE OVERSIZED HOLE DIAMETER AS GIVEN IN SRM 51-40-08

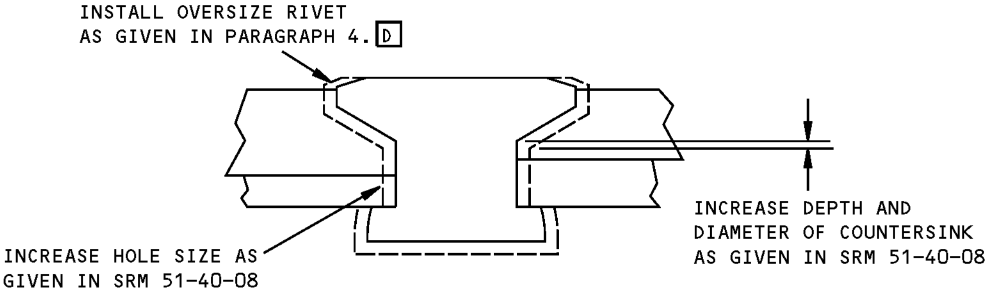
3. INCREASE COUNTERSINK DIAMETE AS GIVEN IN SRM 51-40-08. COUNTERSINK TO THE SAME DEPT AS THE INITIAL RIVET C

4. DRIVE THE RIVET ONLY UNTIL IT IS TIGHT IN THE HOLE. AS GIVEN IN PARAGRAPH 4.

5. SHAVE THE OVERSIZE RIVET HEAD D

6. DRIVE THE RIVET UNTIL THE RIVET IS FULLY INSTALLED

OVERSIZE RIVET IN THIN SKIN A
DETAIL I



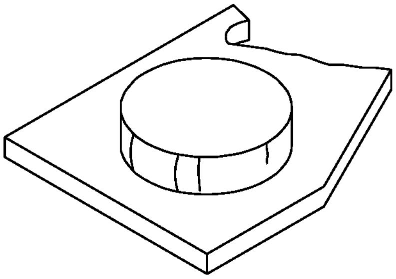
INSTALL OVERSIZE RIVET AS GIVEN IN PARAGRAPH 4. D

INCREASE DEPTH AND DIAMETER OF COUNTERSINK AS GIVEN IN SRM 51-40-08

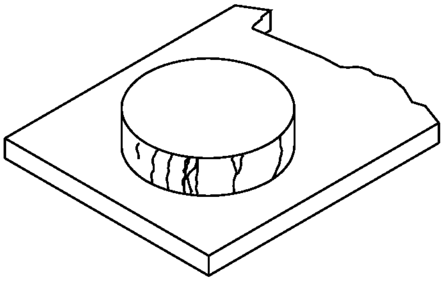
INCREASE HOLE SIZE AS GIVEN IN SRM 51-40-08

OVERSIZE RIVET IN THICK SKIN B
DETAIL II

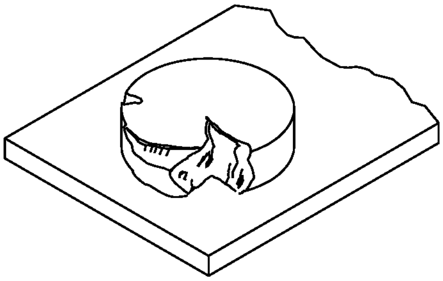
Installation of BACR15FV and MS14218 Oversize Rivets
Figure 5 (Sheet 2 of 2)



VERTICAL CRACKS DUE TO LAPS
IN THE MATERIAL IS SATISFACTORY
DETAIL I



VERTICAL CRACKS IN CRES ALLOY,
NICKEL-COPPER ALLOY, AND TITANIUM RIVETS
DETAIL II

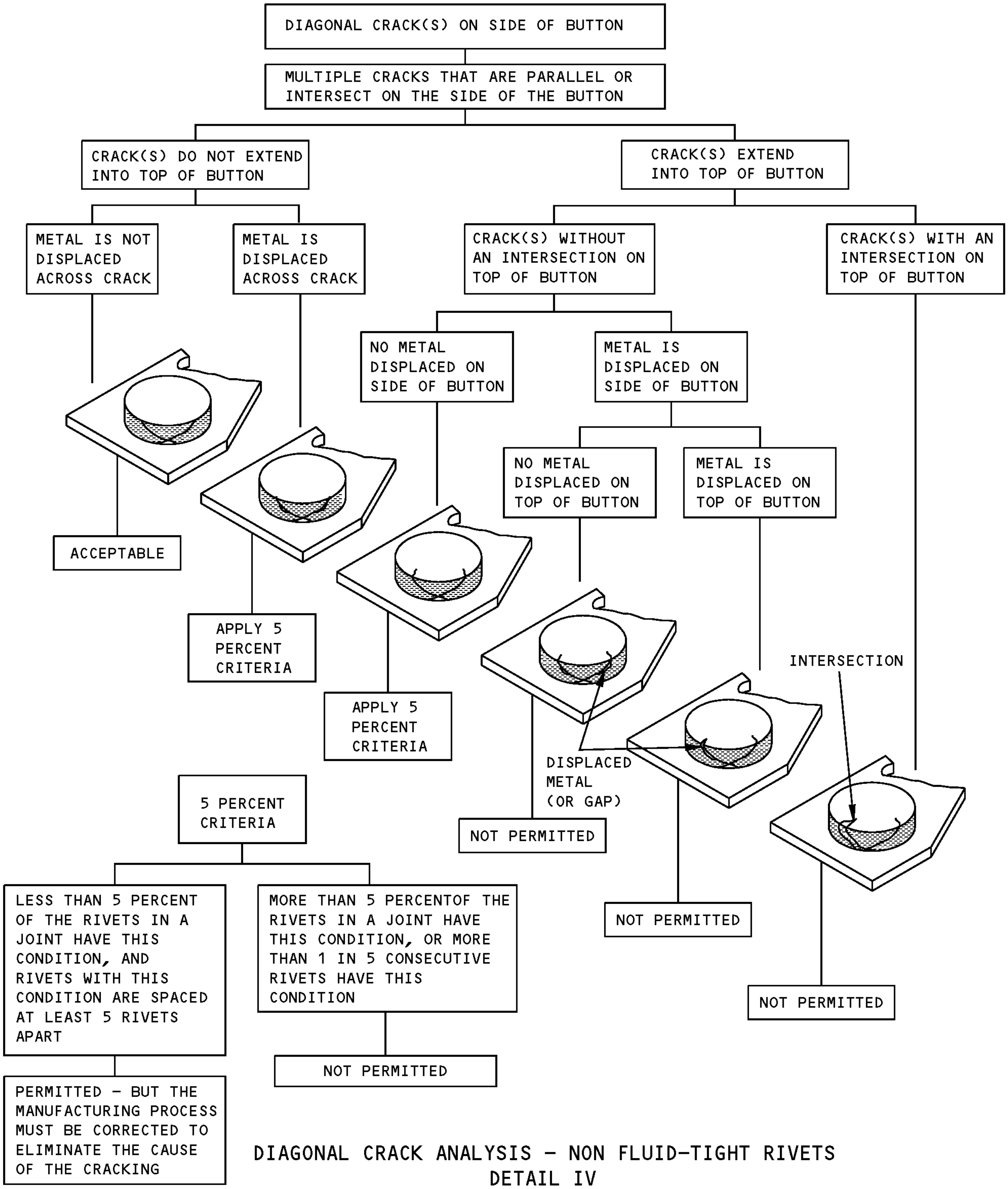


VERTICAL CRACKS DUE TO OVERHEATING
DURING HEAT TREATMENT
IS UNSATISFACTORY
DETAIL III

NOTES

- THE SOURCE OF INFORMATION FOR THIS FIGURE CAN BE FOUND IN BOEING PROCESS SPECIFICATIONS BAC5004-1 AND BAC5047
- SEE DETAILS I THRU III FOR VERTICAL CRACKS IN FLUID-TIGHT AND NON FLUID-TIGHT RIVETS
- SEE DETAIL IV FOR DIAGONAL CRACKS IN NON FLUID-TIGHT RIVETS
- SEE DETAIL V FOR DIAGONAL CRACKS IN FLUID-TIGHT RIVETS

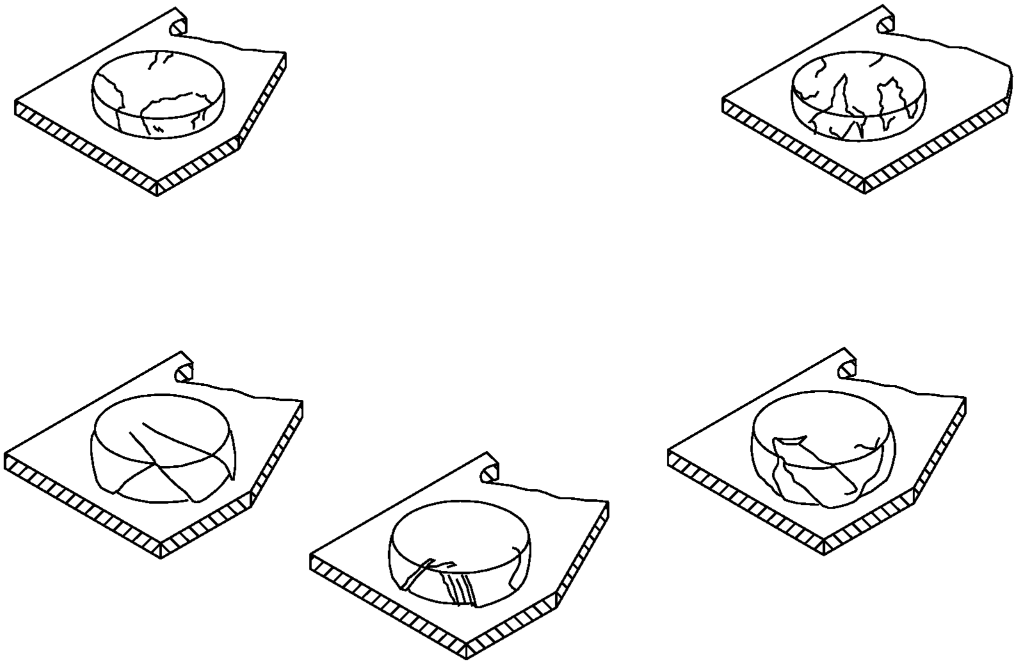
Analysis of Cracks in the Buttons of Solid Shank Rivets
Figure 6 (Sheet 1 of 3)



DIAGONAL CRACK ANALYSIS - NON FLUID-TIGHT RIVETS
DETAIL IV

Analysis of Cracks in the Buttons of Solid Shank Rivets
Figure 6 (Sheet 2 of 3)

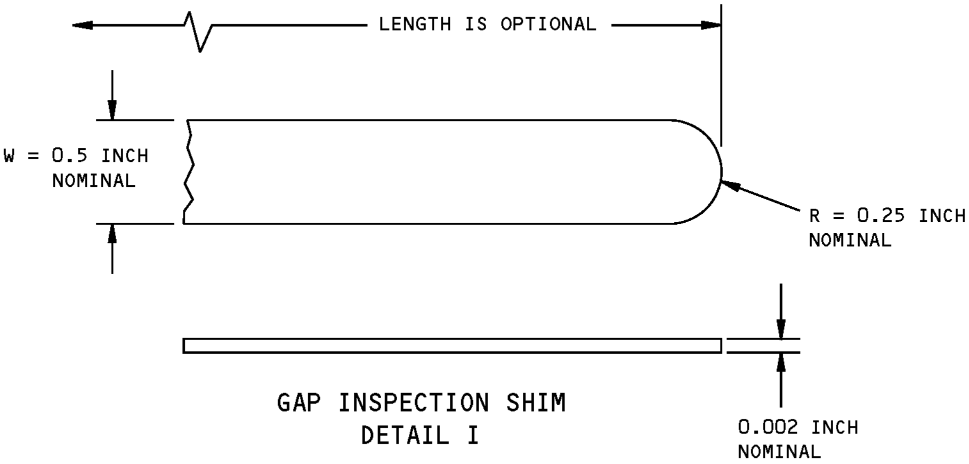
SATISFACTORY
NO DISPLACED METAL (OR GAPS)



UNSATISFACTORY
DISPLACED METAL OR CRACKS WITH AN INTERSECTION
ON THE FLAT SURFACE

DIAGONAL CRACKS – FLUID-TIGHT RIVETS
DETAIL V

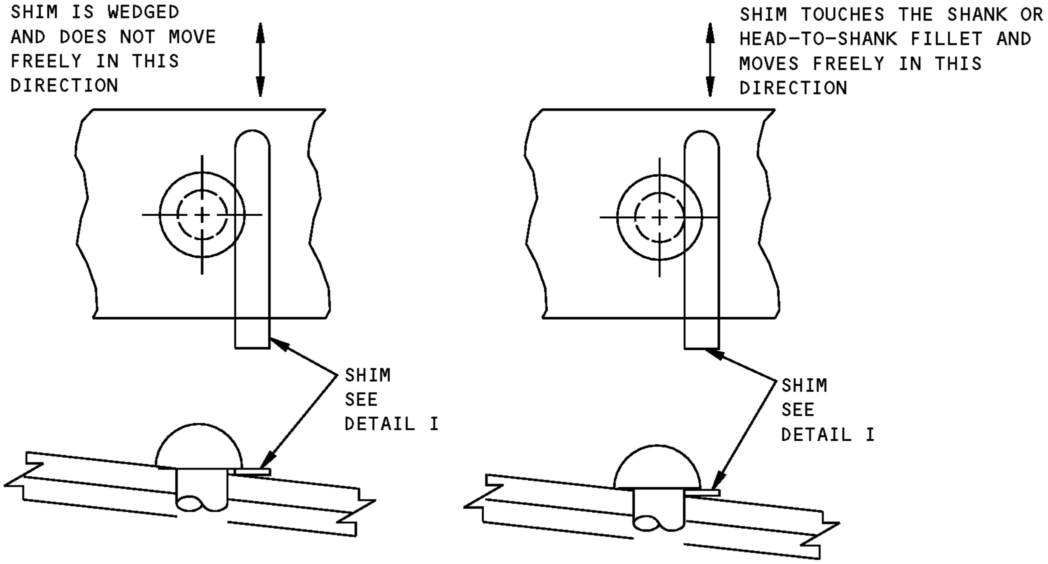
Analysis of Cracks in the Buttons of Solid Shank Rivets
Figure 6 (Sheet 3 of 3)



INSPECTION	GAP ANALYSIS (REFERENCE BAC5004-1 AND BAC5047)
PROTRUDING HEADS	• SEE DETAIL II
FLUSH HEADS	• SEE DETAIL III FOR NON-FLUID-TIGHT RIVETS • SEE DETAIL IV FOR FLUID-TIGHT RIVETS • SEE DETAIL V FOR BACR15FV AND MS14218 RIVETS
NON-FLUSH DRIVEN BUTTONS (ALL RIVETS)	• SEE DETAIL VI
FLUSH DRIVEN BUTTONS (ALL RIVETS)	• SEE DETAIL VII

TABLE I

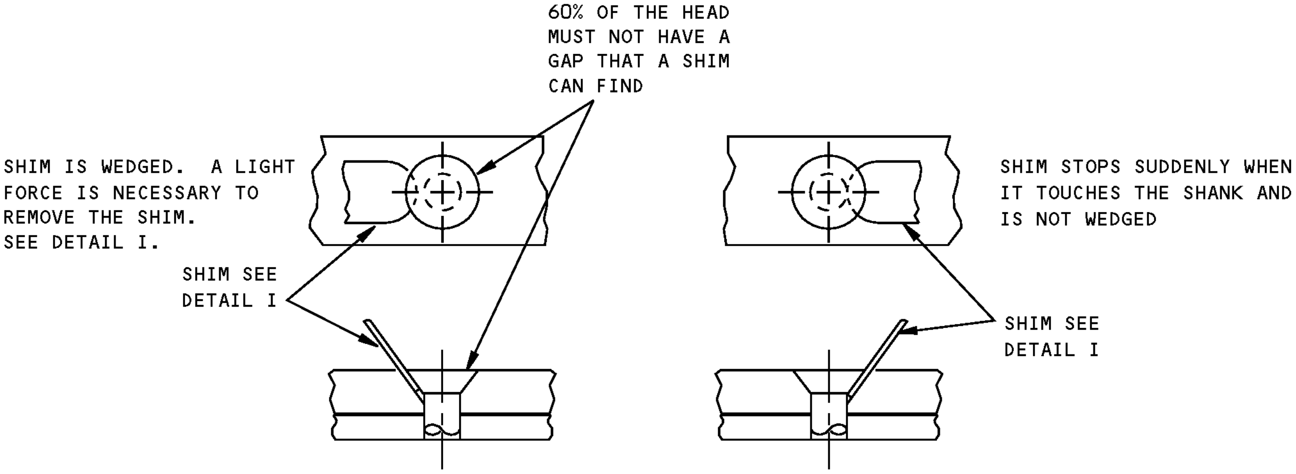
Gap Analysis for Rivet Heads and Buttons
Figure 7 (Sheet 1 of 3)



SATISFACTORY

UNSATISFACTORY

PROTRUDING HEAD GAP INSPECTION METHOD
DETAIL II

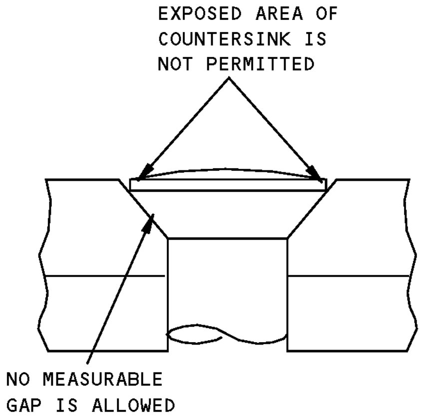


SATISFACTORY

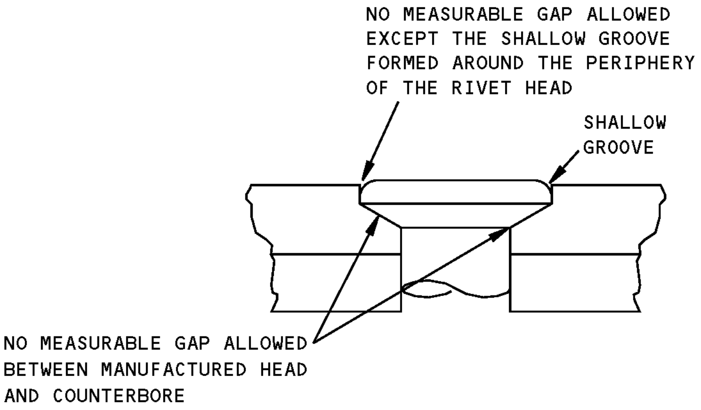
UNSATISFACTORY

GAP INSPECTION METHOD FOR FLUSH HEAD NON-FLUID-TIGHT RIVETS
DETAIL III

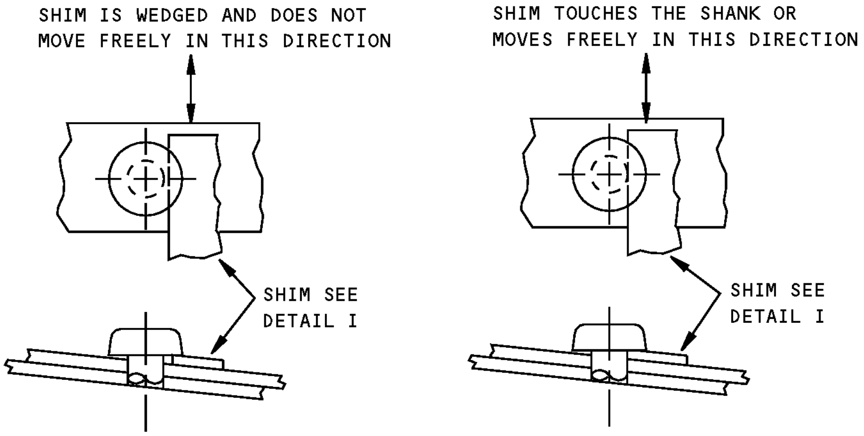
Gap Analysis for Rivet Heads and Buttons
Figure 7 (Sheet 2 of 3)



GAP INSPECTION METHOD FOR
FLUSH HEAD FLUID-TIGHT RIVETS
DETAIL IV



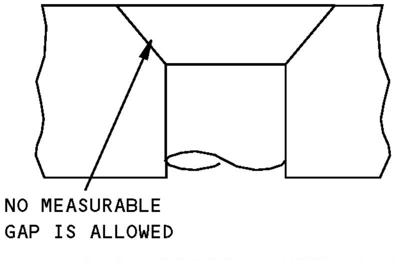
GAP INSPECTION METHOD FOR
BACR15FV AND MS14218 RIVET HEADS
DETAIL V



SATISFACTORY

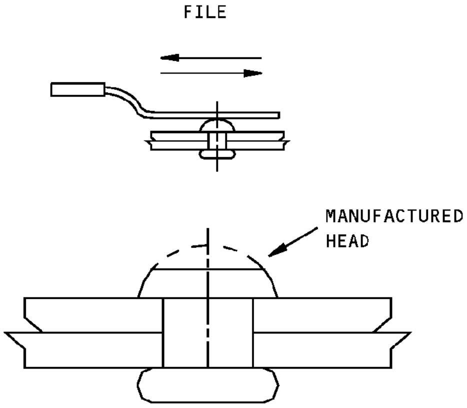
UNSATISFACTORY

GAP INSPECTION METHOD FOR NON-FLUSH DRIVEN BUTTONS (ALL RIVETS)
DETAIL VI



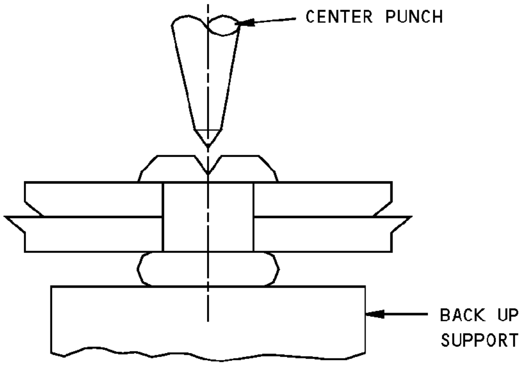
GAP INSPECTION METHOD FOR
FLUSH DRIVEN BUTTONS (ALL RIVETS)
DETAIL VII

Gap Analysis for Rivet Heads and Buttons
Figure 7 (Sheet 3 of 3)



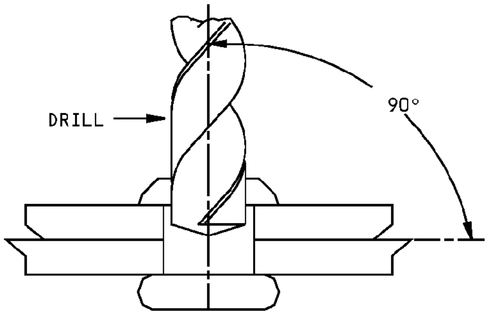
STEP NO. 1

FILE A FLAT AREA ON THE MANUFACTURED HEAD WITH A FILE



STEP NO. 2

CENTER PUNCH THE CENTER OF THE MANUFACTURED HEAD. FOR BOTH FLUSH AND NON-FLUSH RIVETS USE A BLOCK OF WOOD OR A BUCKING BAR AS A BACKUP SUPPORT



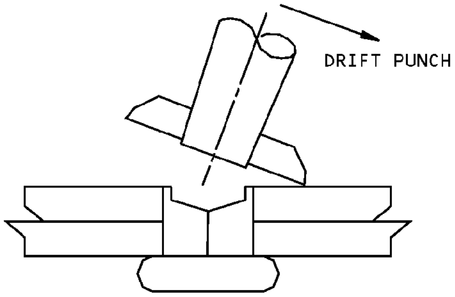
STEP NO. 3

CAUTION: TO PREVENT CRACKED DIMPLES OR DAMAGED UNDERSTRUCTURE, WHEN REMOVING RIVETS FROM DIMPLED HOLES, DRILL A HOLE INTO THE RIVET SHANK BEFORE DRIVING IT OUT

DRILL THROUGH THE HEAD OF THE RIVET SO THAT THE DRILL DOES NOT DAMAGE THE SKIN OR CUT THE SIDES OF THE RIVET HOLE.

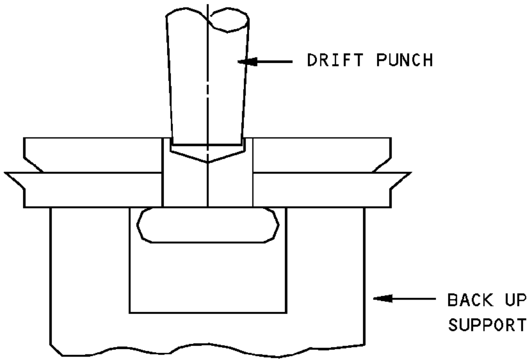
NOTE: START THE DRILL BY HAND.

USE A DRILL BIT 1/32 INCH DIAMETER SMALLER THAN THE RIVET SHANK.



STEP NO. 4

INSERT A DRIFT PUNCH INTO THE HOLE DRILLED IN THE RIVET AND TILT THE PUNCH TO BREAK OFF THE RIVET HEAD

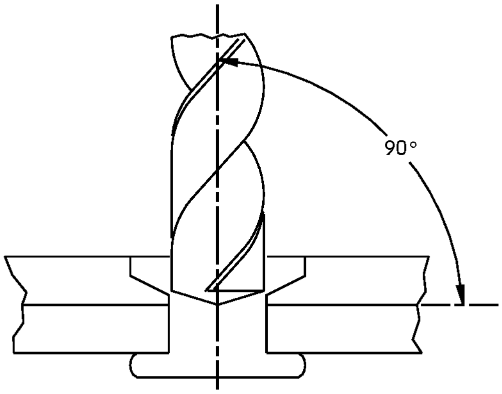


STEP NO. 5

DRIVE OUT THE RIVET SHANK WITH A DRIFT PUNCH AND HAMMER. USE A BLOCK OF WOOD OR A BUCKING BAR AS A BACKUP SUPPORT.

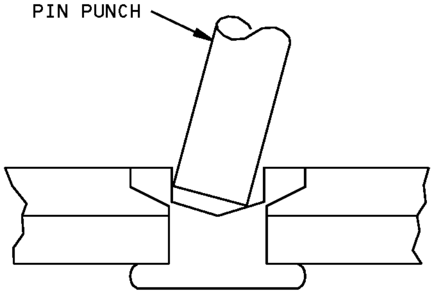
REMOVAL OF PROTRUDING HEAD RIVETS
DETAIL I

Removal of Solid Shank Rivets
Figure 8 (Sheet 1 of 2)



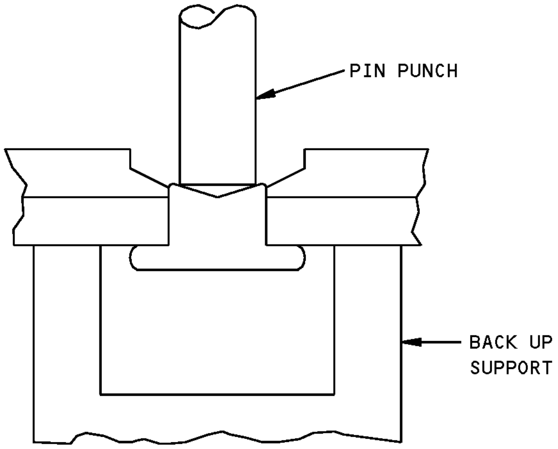
STEP NO. 1

SELECT A DRILL THE SAME SIZE AS THE RIVET HOLE. CENTER THE DRILL ON THE MANUFACTURED HEAD AND DRILL THROUGH THE HEAD OF THE RIVET AS SHOWN.



STEP NO. 2

INSERT A PIN PUNCH INTO THE HOLE DRILLED IN THE RIVET AND EXERT A PRYING MOTION TO BREAK OFF THE MANUFACTURED HEAD OF THE RIVET.



STEP NO. 3

USE A PIN PUNCH AND HAMMER TO DRIVE OUT THE RIVET SHANK WHILE SUPPORTING THE OPPOSITE SIDE OF THE STRUCTURE.

<u>NOTE</u>: WHEN REMOVING RIVETS IT IS IMPORTANT TO AVOID DAMAGING THE INITIAL COUNTERBORE, HOLE, OR ADJACENT STRUCTURE.

REMOVAL OF BACR15FV AND MS14218 RIVETS
DETAIL II

Removal of Solid Shank Rivets
Figure 8 (Sheet 2 of 2)

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 I $\boxed{A}$

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 II $\boxed{A}$

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 III $\boxed{A}$ $\boxed{B}$

NOTES

- THE SOURCE OF INFORMATION FOR THIS FIGURE CAN BE FOUND IN BOEING PROCESS SPECIFICATION BAC5004-3
- SEE TABLES I THRU III FOR STEM AND COLLAR PROTRUSION
- SEE DETAILS IV AND V FOR GAP ANALYSIS

$\boxed{A}$ SEE DETAILS I AND II 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

$\boxed{B}$ SEE DETAIL III FOR THE LOCKRING FLASH POSITION

$\boxed{C}$ EVALUATE GAPS AS FOLLOWS:

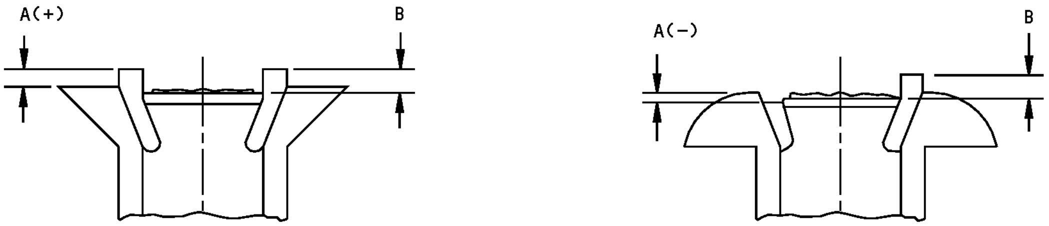
A. THE HEADS OF ALL PROTRUDING-HEAD FASTENERS MUST SEAT SO THAT A 0.003-INCH THICK SHIM DOES NOT CONTACT THE FASTENER SHANK WHEN INSPECTED AS SHOWN IN DETAIL V. CONTACT WITH THE SHANK IS INDICATED WHEN THE SHIM DOES NOT WEDGE AND WILL SLIDE FREELY UNDER THE HEAD AS SHOWN IN DETAIL V. THE HEADS OF PROTRUDING-HEAD 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 V USING THE SHIM THICKNESS SHOWN IN TABLE IV.

B. THE HEADS OF ALL FLUSH-HEAD FASTENERS MUST SEAT SO THAT:

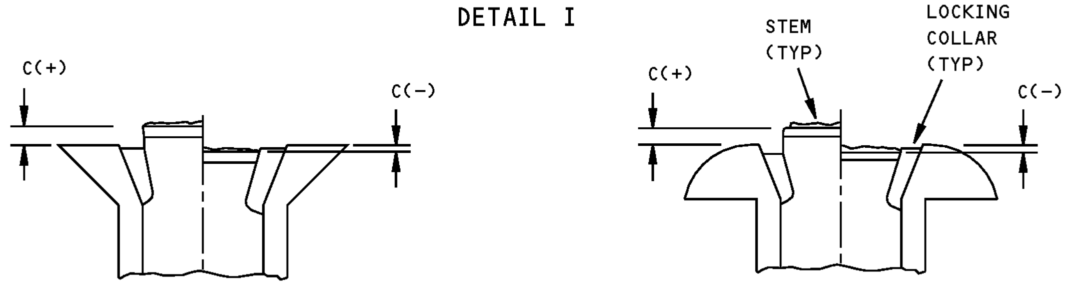
  (1) A 0.003-INCH THICK SHIM CANNOT BE INSERTED BETWEEN THE FASTENER HEAD AND THE COUNTERSINK FOR MORE THAN 40 PERCENT OF THE CIRCUMFERENCE OF THE HEAD.

  (2) A 0.003-INCH THICK SHIM DOES NOT CONTACT THE FASTENER SHANK WHEN INSPECTED AS SHOWN IN DETAIL VI.

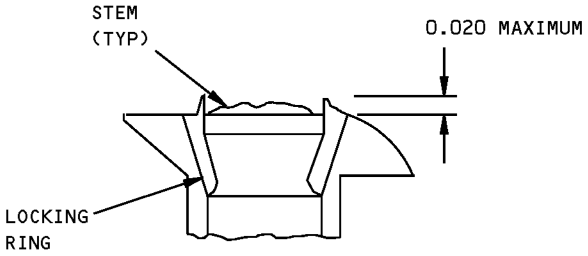
Installation of Blind Bolts and Blind Rivets
Figure 9 (Sheet 1 of 3)



LOCKING COLLAR PROTRUSION LIMITS
DETAIL I

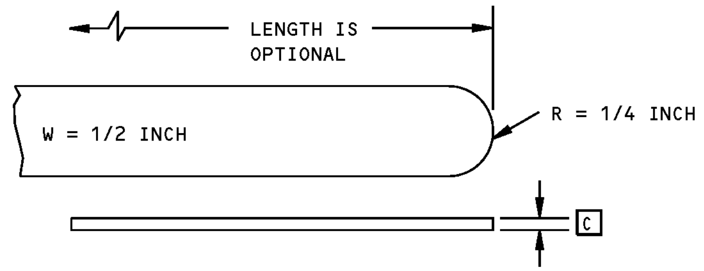


STEM PROTRUSION LIMITS
DETAIL II



LOCKING RING FLASH POSITION (BACR15FP AND BACR15FR)
DETAIL III

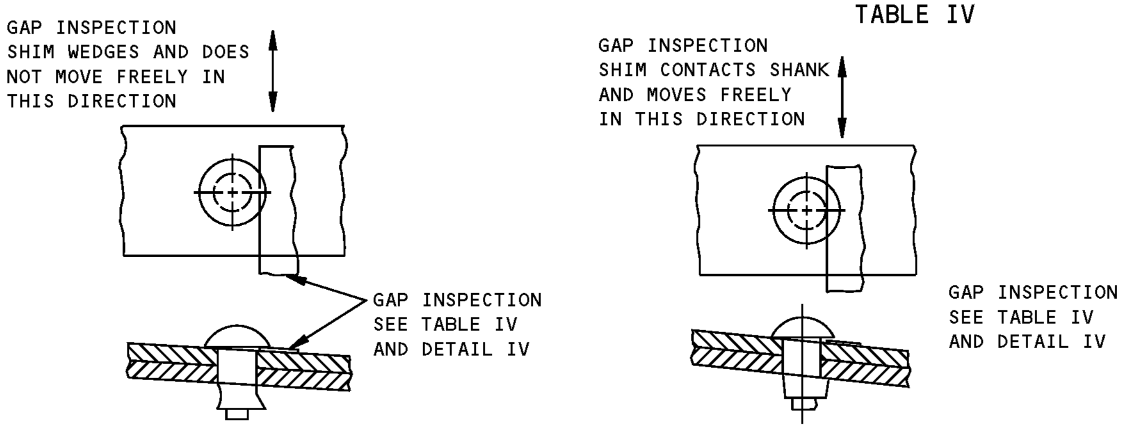
Installation of Blind Bolts and Blind Rivets
Figure 9 (Sheet 2 of 3)



GAP INSPECTION SHIM
DETAIL IV

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

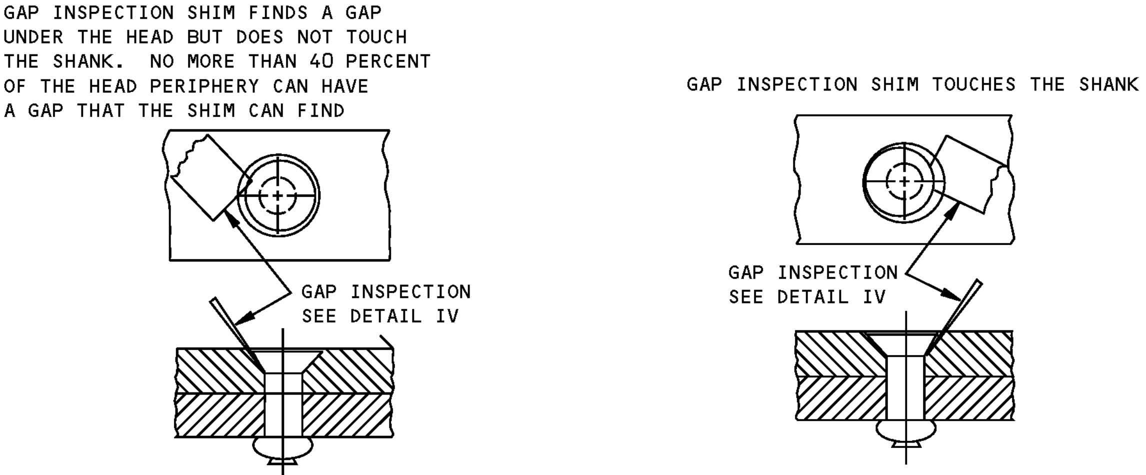
SHIM THICKNESS FOR BLIND BOLTS
TABLE IV



SATISFACTORY

UNSATISFACTORY

GAP ANALYSIS FOR PROTRUDING HEAD FASTENERS
DETAIL V



SATISFACTORY

UNSATISFACTORY

GAP ANALYSIS FOR FLUSH HEAD FASTENERS
DETAIL VI

Installation of Blind Bolts and Blind Rivets
Figure 9 (Sheet 3 of 3)

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. Refer to Detail I.

   <u>NOTE</u>: 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.

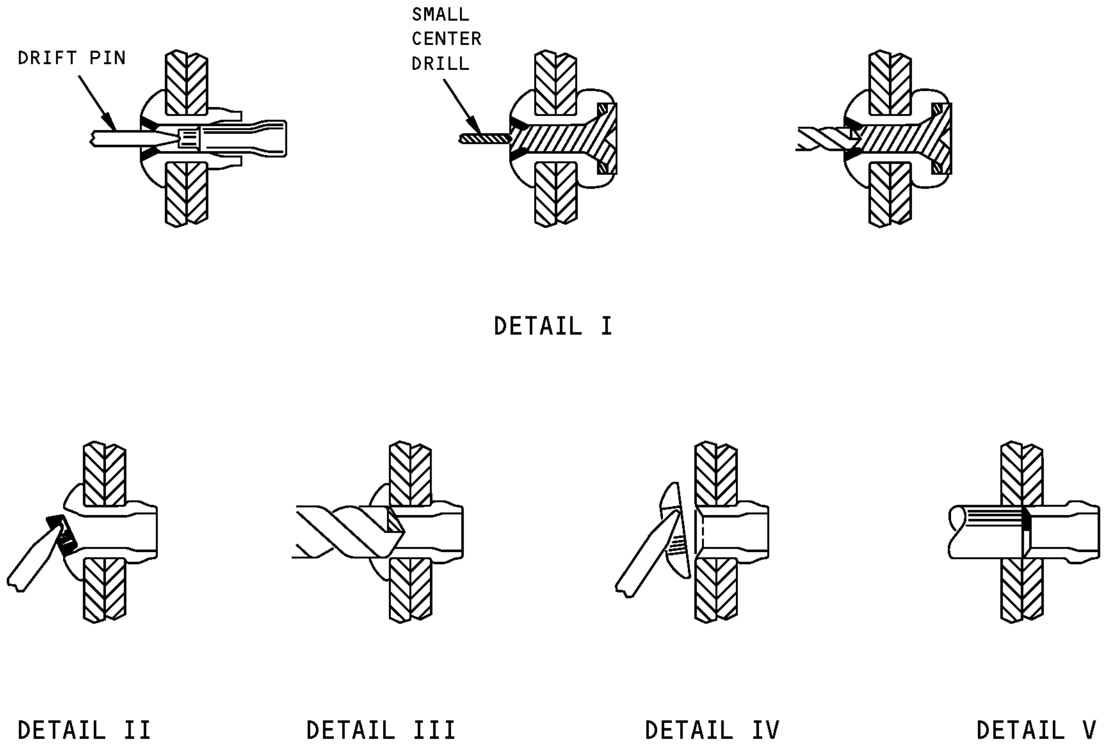
2. Pry the rest of the locking collar out of the rivet head with the drift pin. Refer to Detail II.

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. Refer to Detail III.

4. Break off the rivet head. Use the drift pin as a pry tool. Refer to Detail IV.

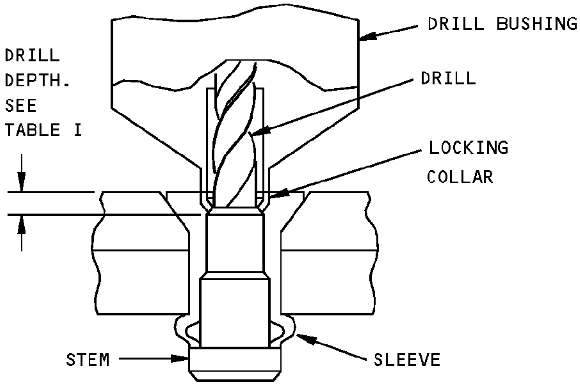
5. Drive out the rivet shank that remains with a pin that has the same diameter as the rivet shank. Refer to Detail V.



DETAIL I

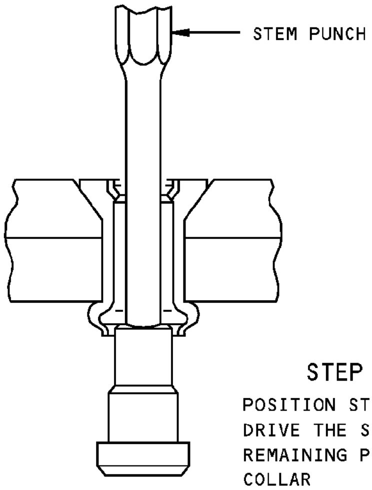
DETAIL II DETAIL III DETAIL IV DETAIL V

Removal of Blind Rivets
Figure 10



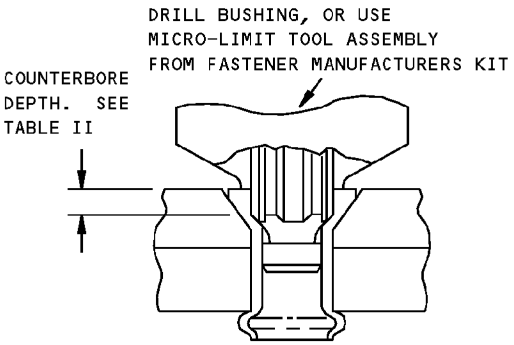
STEP NO. 1

PLACE DRILL BUSHING SQUARELY ON THE LOCKING COLLAR AND DRILL THE STEM TO THE DEPTH SHOWN IN TABLE I



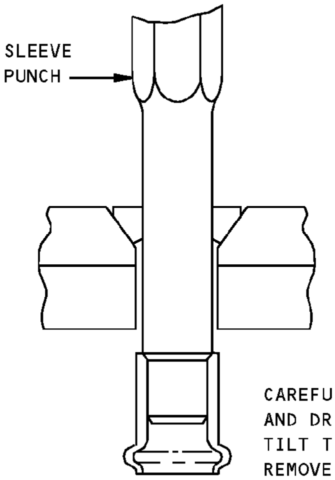
STEP NO. 2

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 II



STEP NO. 4

CAREFULLY POSITION SLEEVE PUNCH AND DRIVE OUT THE SLEEVE. TILT THE PUNCH SLIGHTLY AND REMOVE FASTENER HEAD.

NOTE: WHEN USING DRILL BUSHING, ENSURE THAT CONCENTRICITY IS MAINTAINED WITH DIAMETER OF BOLT

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 I

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 II

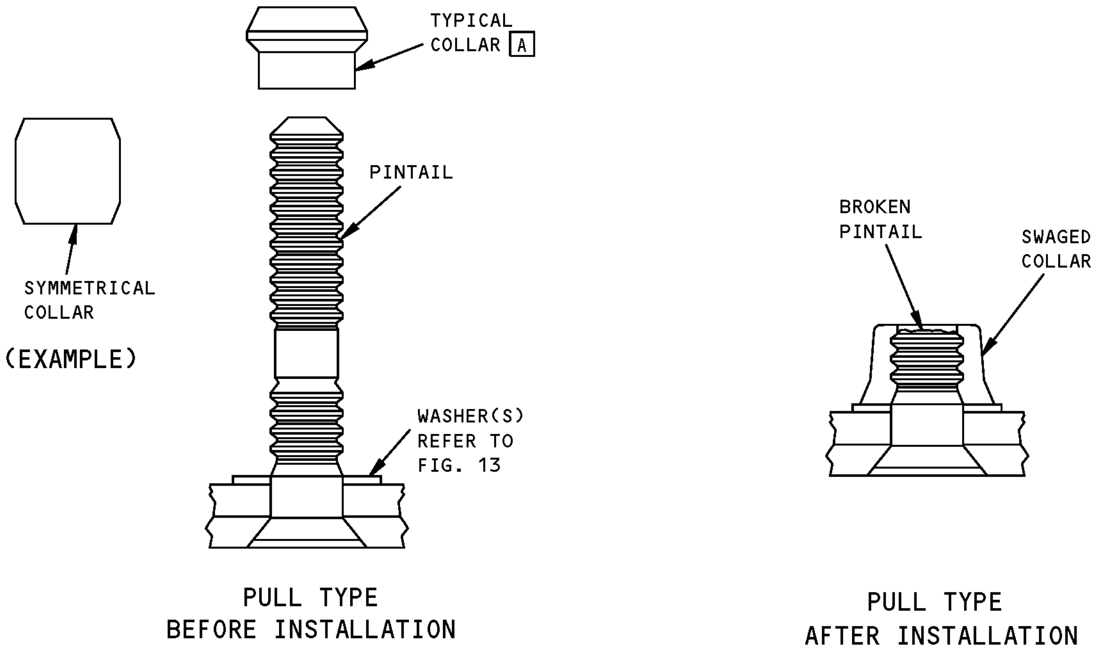
Removal of Blind Bolts
Figure 11

NOTES

- THE SOURCE OF INFORMATION FOR THIS FIGURE CAN BE FOUND IN BOEING PROCESS SPECIFICATION BAC5004-2.
- SEE DETAIL I FOR LOCKBOLT INSTALLATION.
- SEE DETAILS II AND III 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 I AND DETAIL IV (OR EQUIVALENT TOOLS).
- SEE TABLE II AND DETAIL V FOR HEAD DISHING SPECIFICATIONS.
- SEE TABLE III AND DETAILS VI AND VII 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.

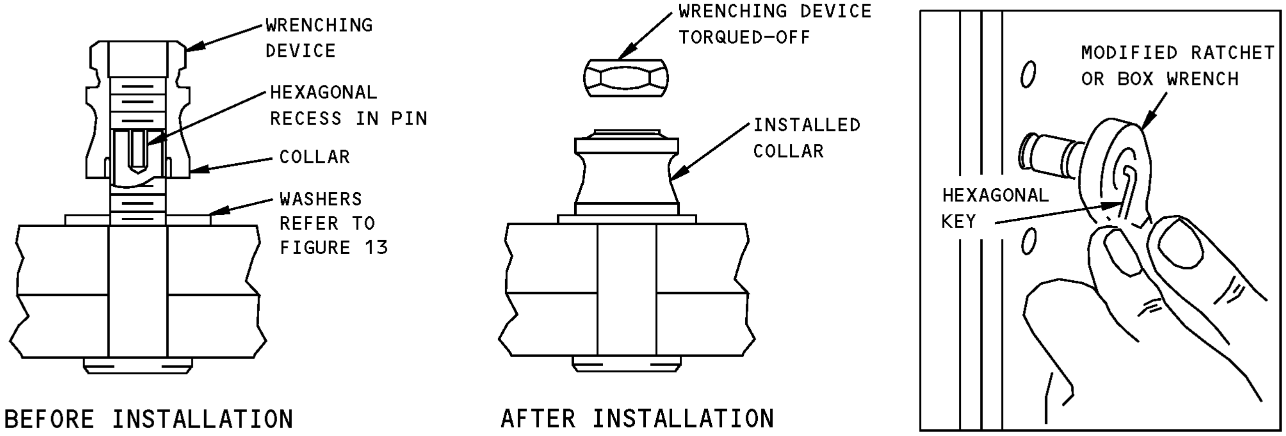
A TYPICAL COLLARS ARE NOT SYMMETRICAL AND MUST BE INSTALLED AS SHOWN IN DETAIL I. IF THE COLLAR IS SYMMETRICAL IN SHAPE, IT WILL NOT BE IMPORTANT WHICH END IS AGAINST THE STRUCTURE. EXAMPLES OF SYMMETRICAL COLLARS ARE: BACC30BE, BACC30BF, BACC30L, BACC30K, BACC30BK, NAS1080C04, NAS1080C05, NAS1080E04, NAS1080E05, NAS1080MG04, NAS1080MG05, AND NAS1080K

Lockbolt and Hex-Drive Bolt Installation
Figure 12 (Sheet 1 of 6)



LOCKBOLT INSTALLATION

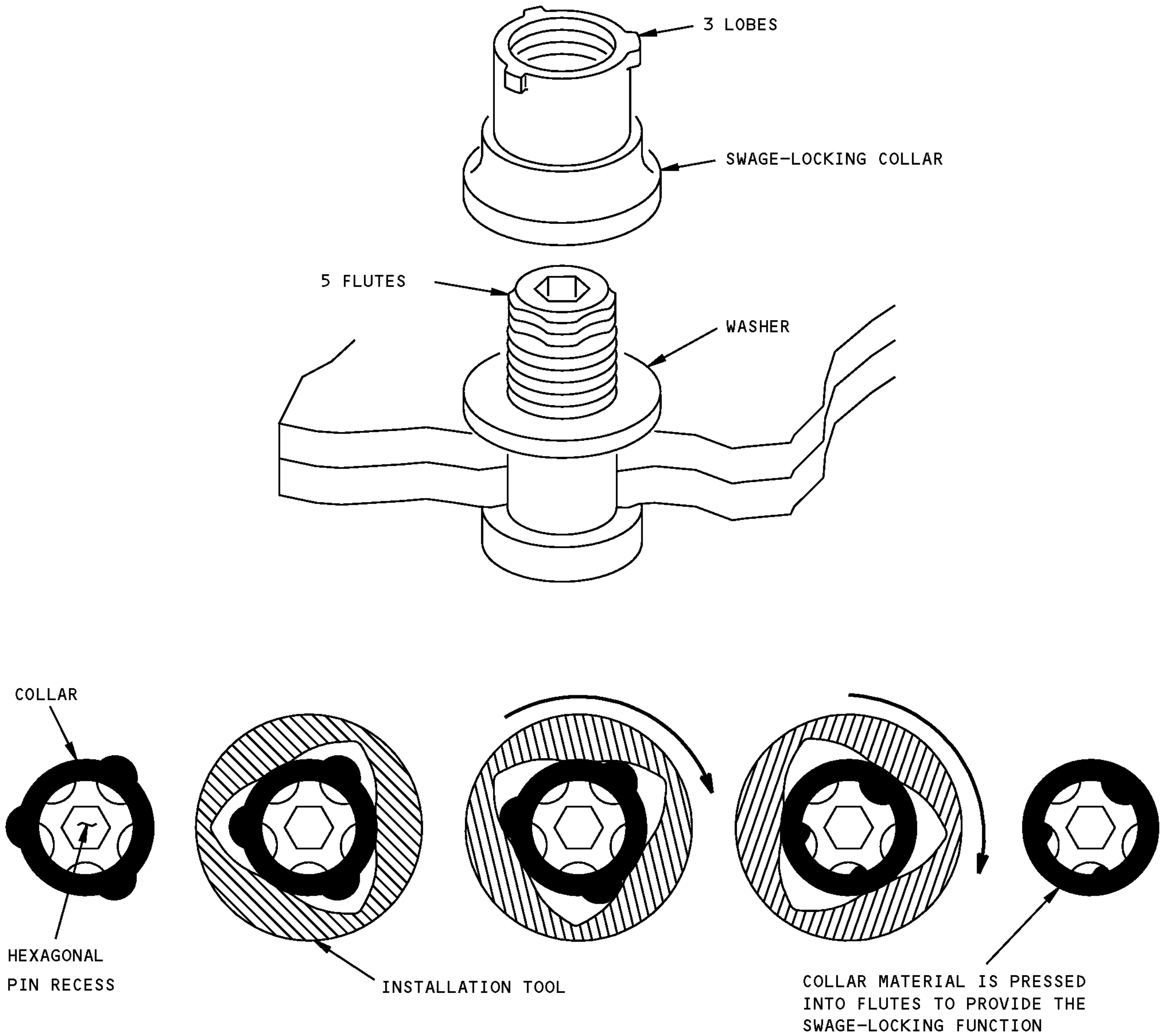
DETAIL I



HEX-DRIVE BOLT INSTALLATION

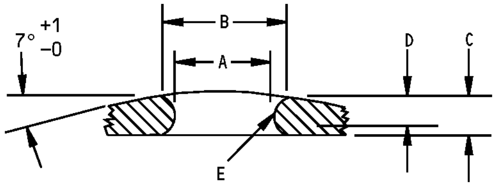
DETAIL II

Lockbolt and Hex-Drive Bolt Installation
Figure 12 (Sheet 2 of 6)



INSTALLATION WITH SWAGE-LOCKING COLLAR AND
SWAGE-LOCKING (FLUTED SHANK) BOLT
DETAIL III

Lockbolt and Hex-Drive Bolt Installation
Figure 12 (Sheet 3 of 6)



LIGHTWEIGHT LOCKBOLT SWAGE DIE DIMENSIONS
DETAIL IV

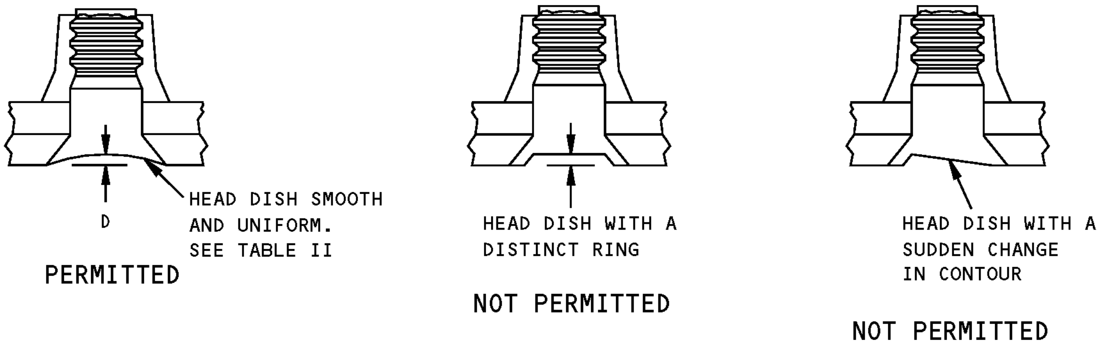
NOMINAL DIAMETER	A +0.0010 −0.0000	B +0.0030 −0.0000	C +0.0015 −0.0005	D REFERENCE	E +0.0010 −0.0000 RADIUS
5/32	0.2219	0.2580	0.103	0.0661	0.121
3/16	0.2450	0.2813	0.120	0.0670	0.130
1/4	0.3241	0.3722	0.157	0.0928	0.188
5/16	0.4062	0.4667	0.195	0.1201	0.250
3/8	0.4797	0.5525	0.233	0.1469	0.311

LIGHTWEIGHT LOCKBOLT SWAGE DIE DIMENSIONS (INCH)
TABLE I

Lockbolt and Hex-Drive Bolt Installation
Figure 12 (Sheet 4 of 6)

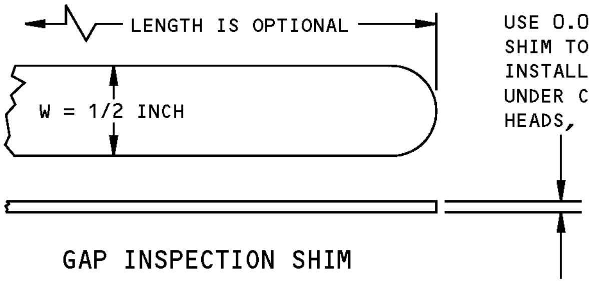
FASTENER TYPE	FASTENER MATERIAL	NOMINAL DIAMETER	D (MAX)
PULL TYPE SHEAR HEAD LOCKBOLTS	ALUMINUM AND ALLOY STEEL	3/16	0.012
		1/4	0.012
		5/16	0.010
		3/8 AND LARGER	0.007
	A286 CRES	ALL	0.008
PULL-TYPE TENSION HEAD LOCKBOLTS	TITANIUM	ALL	0.004
ALL OTHERS	ALL	ALL	0.004

FASTENER HEAD DISH LIMITS
TABLE II



HEAD DISHING LIMITATIONS FOR FLUSH HEAD LOCKBOLTS
AND HEX-DRIVE BOLTS
DETAIL V

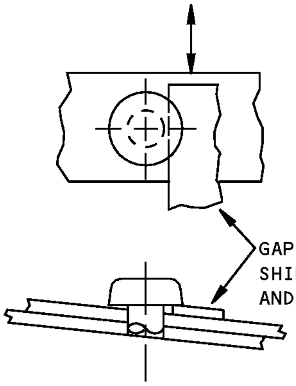
Lockbolt and Hex-Drive Bolt Installation
Figure 12 (Sheet 5 of 6)



USE 0.003 -0.0000/+0.0005 INCH SHIM TO FIND GAPS AROUND INSTALLED FLUSH HEADS. FOR GAPS UNDER COLLARS, NUTS AND PROTRUDING HEADS, SEE TABLE III

GAP INSPECTION SHIM
DETAIL VI

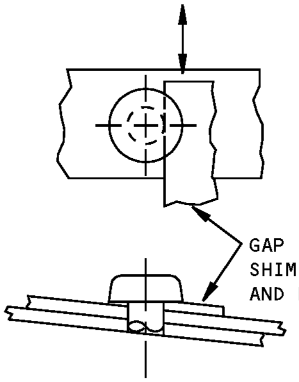
GAP INSPECTION SHIM WEDGES AND DOES NOT MOVE FREELY IN THIS DIRECTION



GAP INSPECTION SHIM SEE TABLE III AND DETAIL VI

SATISFACTORY
FOR PROTRUDING HEADS, AND
NON SELF-ALIGNING NUTS AND
COLLARS FOR HEX-DRIVE BOLTS

GAP INSPECTION SHIM TOUCHES SHANK OR MOVES FREELY IN THIS DIRECTION

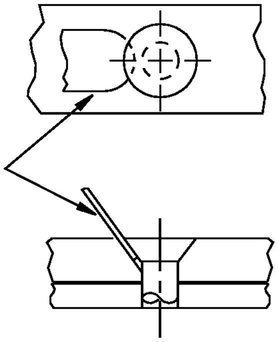


GAP INSPECTION SHIM SEE TABLE III AND DETAIL VI

UNSATISFACTORY
FOR PROTRUDING HEADS, AND
NON SELF-ALIGNING NUTS,
AND COLLARS

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

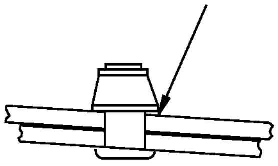
SHIM STOCK SIZE FOR
COLLARS, NUTS AND
PROTRUDING HEADS OF
LOCKBOLTS AND HEX-DRIVE
FASTENERS
TABLE III



GAP INSPECTION SHIM (0.003 INCH THICK) FINDS A GAP UNDER THE HEAD. SEE DETAIL VI

UNSATISFACTORY
FOR FLUSH HEADS

INSPECTION FINDS A GAP UNDER THE NUT OR COLLAR



UNSATISFACTORY
FOR LOCKBOLTS AND SELF-ALIGNING
NUTS AND COLLARS FOR HEX-DRIVE BOLTS

GAP ANALYSIS FOR LOCKBOLTS AND HEX-DRIVE BOLTS
DETAIL VII

Lockbolt and Hex-Drive Bolt Installation
Figure 12 (Sheet 6 of 6)

NOTES

- THE SOURCE OF INFORMATION FOR THIS FIGURE CAN BE FOUND IN BOEING PROCESS SPECIFICATION BAC5004-2
- SEE DETAILS I AND II FOR WASHER LIMITATIONS

A SEE TABLE I FOR THE CORRECT WASHER MATERIAL. SEE TABLE II FOR WASHER PART NUMBERS.

B DO NOT USE MORE THAN TWO WASHERS UNDER A LOCKBOLT COLLAR. (THIS INCLUDES THE CORROSION PROTECTION WASHER). SEE DETAILS III AND IV FOR ADDITIONAL INFORMATION ON WASHERS USED WITH LOCKNUTS AND HEX-DRIVE BOLTS.

C ALUMINUM WASHERS MUST BE ALODINE COATED AS GIVEN IN SRM 51-20-01

D LOCATE CORROSION PROTECTION WASHER NEXT TO STRUCTURE WHEN A SECOND WASHER IS USED FOR GRIP ADJUSTMENT (EXCEPT AS NOTED)

E LOCATE GRIP ADJUSTMENT WASHER NEXT TO COLLAR WHEN USED WITH A CORROSION PROTECTION WASHER

F USE AN UNPLATED CRES WASHER NEXT TO STRUCTURE AND A CAD PLATED CRES WASHER NEXT TO COLLAR

G A MAXIMUM OF TWO WASHERS IS ALLOWED UNDER COLLAR

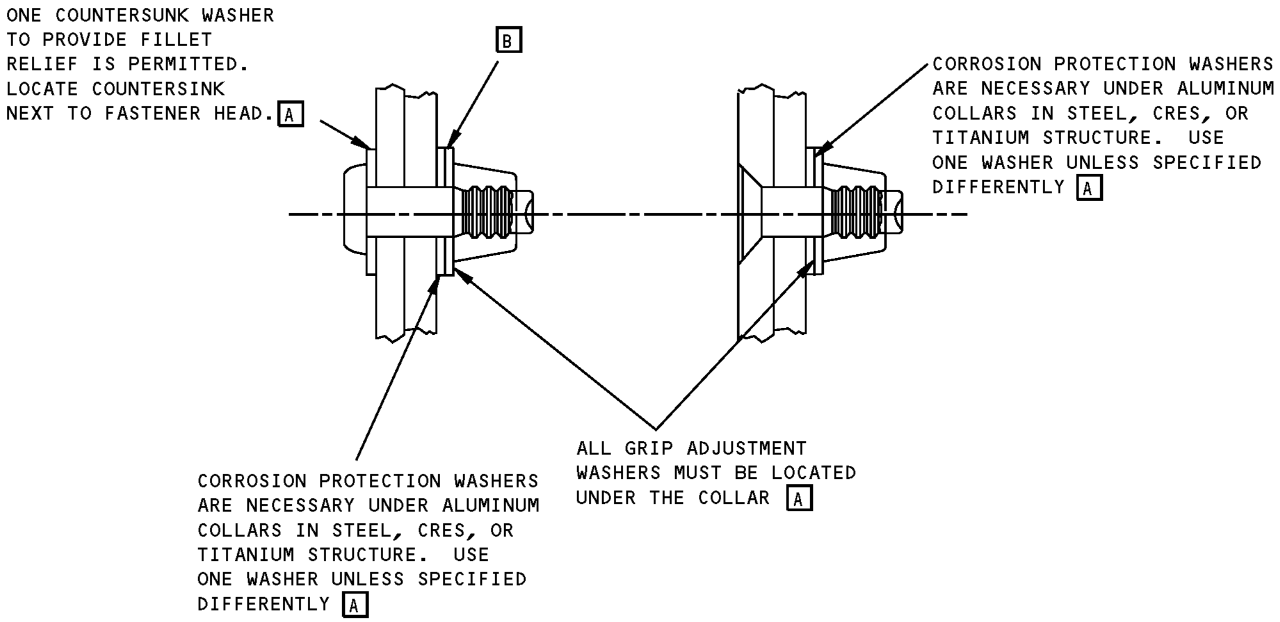
H FOR MAXIMUM HEAD DISHING (D) ALLOWED SEE TABLE II

I 5052 ALUMINUM WASHER IS MANDATORY UNDER PROTRUDING FASTENER HEAD IF HEAD END BEARS ON MAGNESIUM.

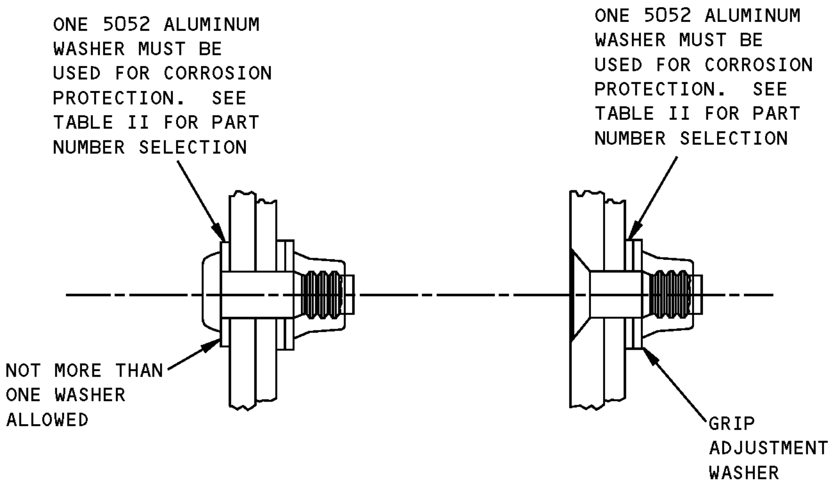
J CAD PLATED WASHER MUST NOT COME IN CONTACT WITH THE TITANIUM STRUCTURE. IT IS TO BE USED BETWEEN THE CRES UNPLATED WASHER AND THE ALUMINUM COLLAR OR NUT.

K 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)

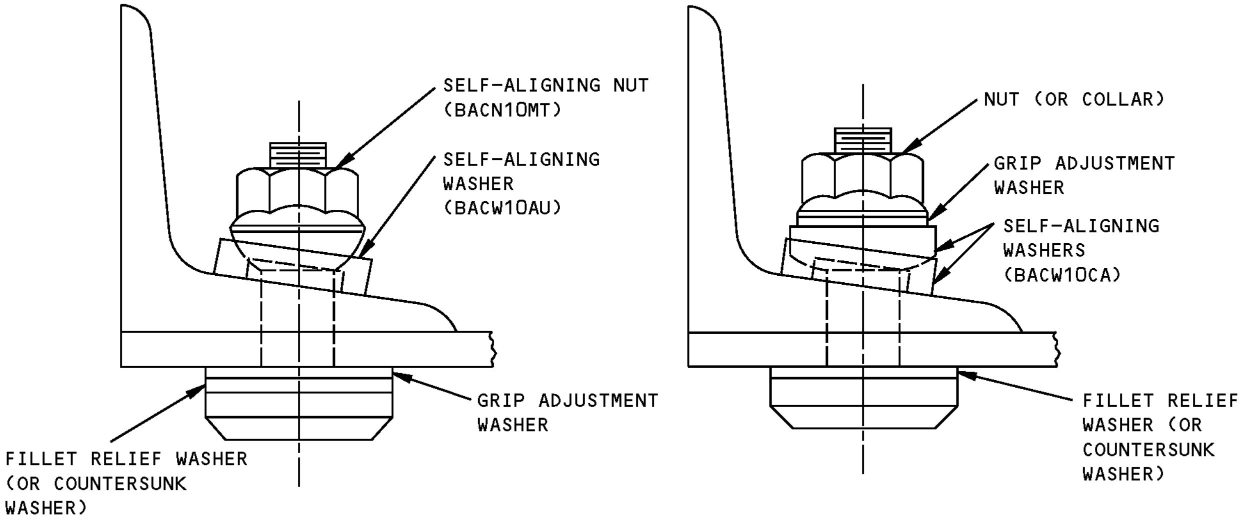


WASHER LIMITATIONS FOR STEEL, ALUMINUM, AND TITANIUM STRUCTURES
DETAIL I

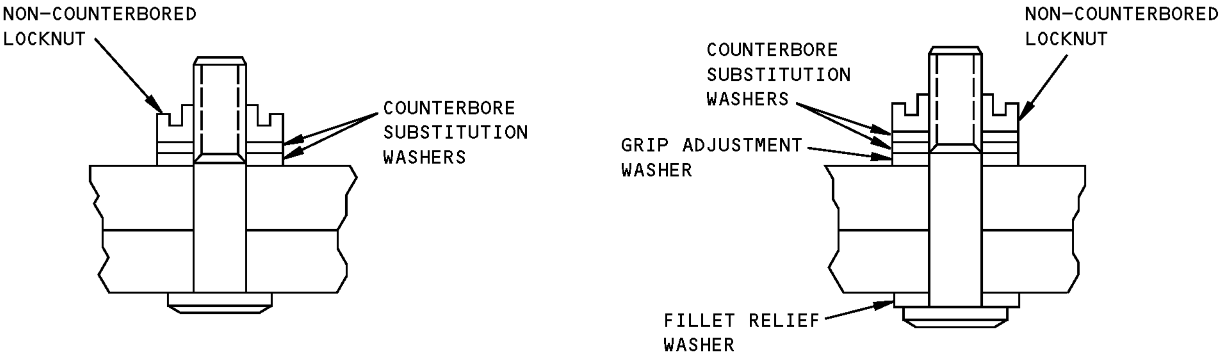


WASHER LIMITATIONS FOR MAGNESIUM STRUCTURES
DETAIL II

Washers with Lockbolts and Hex-Drive Bolts
Figure 13 (Sheet 2 of 5)



USE OF WASHERS WITH SELF-ALIGNING NUTS AND SELF-ALIGNING WASHERS
DETAIL III



USE OF COUNTERBORE SUBSTITUTION WASHERS
DETAIL IV

Washers with Lockbolts and Hex-Drive Bolts
Figure 13 (Sheet 3 of 5)

COLLAR OR NUT MATERIAL	STRUCTURE MATERIAL	CORROSION PROTECTION WASHER MATERIAL $\boxed{D}$ $\boxed{G}$ (MANDATORY)	COUNTERBORE SUBSTITUTION OR GRIP ADJUSTMENT WASHER MATERIAL $\boxed{E}$ $\boxed{G}$	FILLET RELIEF WASHER (LOCATE NEXT TO STRUCTURE)	SELF-ALIGNING WASHER (LOCATE NEXT TO STRUCTURE)
ALUMINUM	ALUMINUM	NONE	2024 AL $\boxed{C}$ OR CAD PLATED CRES	2024 OR 7075	CAD PLATED CRES
	STEEL	CAD PLATED CRES	2024 AL $\boxed{C}$ OR CAD PLATED CRES	CAD PLATED CRES	CAD PLATED CRES
	CRES	CAD PLATED CRES	2024 AL $\boxed{C}$ OR CAD PLATED CRES	UNPLATED CRES	CAD PLATED CRES $\boxed{J}$
	TITANIUM	$\boxed{F}$ $\boxed{J}$	2024 AL $\boxed{C}$ OR CAD PLATED CRES	UNPLATED CRES	CAD PLATED CRES $\boxed{J}$
	MAGNESIUM	5052 AL $\boxed{I}$	2024 AL $\boxed{C}$	5052 AL $\boxed{I}$	---
CAD PLATED STEEL, CAD PLATED CRES, OR CAD PLATED NICKEL-COPPER ALLOY	ALUMINUM	NONE	2024 AL $\boxed{C}$ 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 $\boxed{I}$	2024 AL $\boxed{C}$ OR CAD PLATED CRES	5052 AL $\boxed{I}$	---
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 $\boxed{I}$	CAD PLATED CRES	5052 AL $\boxed{I}$	---

WASHER MATERIAL $\boxed{K}$
TABLE I

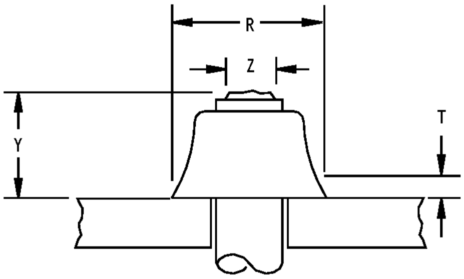
Washers with Lockbolts and Hex-Drive Bolts
Figure 13 (Sheet 4 of 5)

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 BACW10AW10()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 $\boxed{K}$
TABLE II

Washers with Lockbolts and Hex-Drive Bolts
Figure 13 (Sheet 5 of 5)



- R = SWAGED COLLAR REFERENCE DIA.
- T = MAXIMUM HEIGHT OF R DIA ABOVE SHEET OR WASHER.
- Y = PIN PROTRUSION-HEIGHT OF Z DIA ABOVE SHEET OR WASHER.
- Z = REFERENCE DIA LOCATES MEASURING POINT FOR Y.

TENSION, PULL TYPE LOCKBOLTS AND COLLARS [A]
DETAIL I

NOTES

- THE SOURCE OF INFORMATION FOR THIS FIGURE IS FOUND IN BOEING PROCESS SPECIFICATION BAC5004-2.
- SEE DETAIL I FOR LOCKBOLTS
- SEE DETAILS VI AND VII FOR HEX-DRIVE BOLTS

[A] SEE TABLE I FOR LIGHTWEIGHT LOCKBOLTS AND TABLE II FOR TENSION, PULL TYPE LOCKBOLTS. SEE TABLE III FOR SHEAR, PULL TYPE LOCKBOLTS.

[B] SEE DETAIL III FOR HG85-10, HG99-(), AND HG100-().

[C] BOTH ENDS OF THE GAGE MUST ACCEPT.

[D] 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 IV.

[E] 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 IV.

[F] PIN PROTRUSION IS MEASURED FROM THE PIN END ABOVE THE SHEET OR WASHER.
SEE TABLE V

[G] 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 12)

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 I

Pin and Collar Limits for Installed Lockbolts and Hex-Drive Bolts
Figure 14 (Sheet 2 of 12)

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 II

Pin and Collar Limits for Installed Lockbolts and Hex-Drive Bolts
Figure 14 (Sheet 3 of 12)

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
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

STANDARD TENSION, PULL TYPE LOCKBOLT INSPECTION DIMENSION
TABLE II (CONT)

Pin and Collar Limits for Installed Lockbolts and Hex-Drive Bolts
Figure 14 (Sheet 4 of 12)

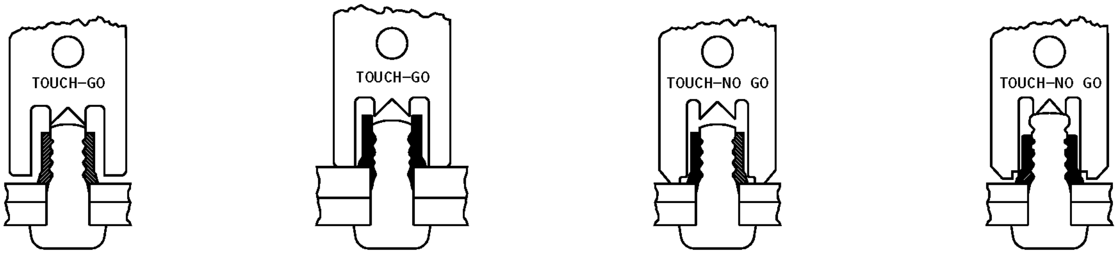
LOCKBOLT PART NO.	COLLAR PART NO.	Y	Z	R	T	GAGE NO.
BACB30GX10 NAS1470 NAS1480 (STEEL)	NAS1080R10 (STEEL)	0.492 0.404	0.268	0.473	0.110	HG85-8 ST8711F-10
BACB30TY10 BACB30TZ10 (TITANIUM)	BACC30BE10 (2024-T73)	0.496 0.385	0.278	0.462	0.150	HG99-10 ST8728B-10
BACB30UA12 BACB308B12 (TITANIUM)	BACC30BF12 (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
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 II (CONT)

Pin and Collar Limits for Installed Lockbolts and Hex-Drive Bolts
Figure 14 (Sheet 5 of 12)

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 III



POINTS TOUCH PIN. LEGS OF GAGE CLEAR SHEET LINE. PIN IS ACCEPTABLE. GAGE PIN WITH TOUCH-NO-GO END

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

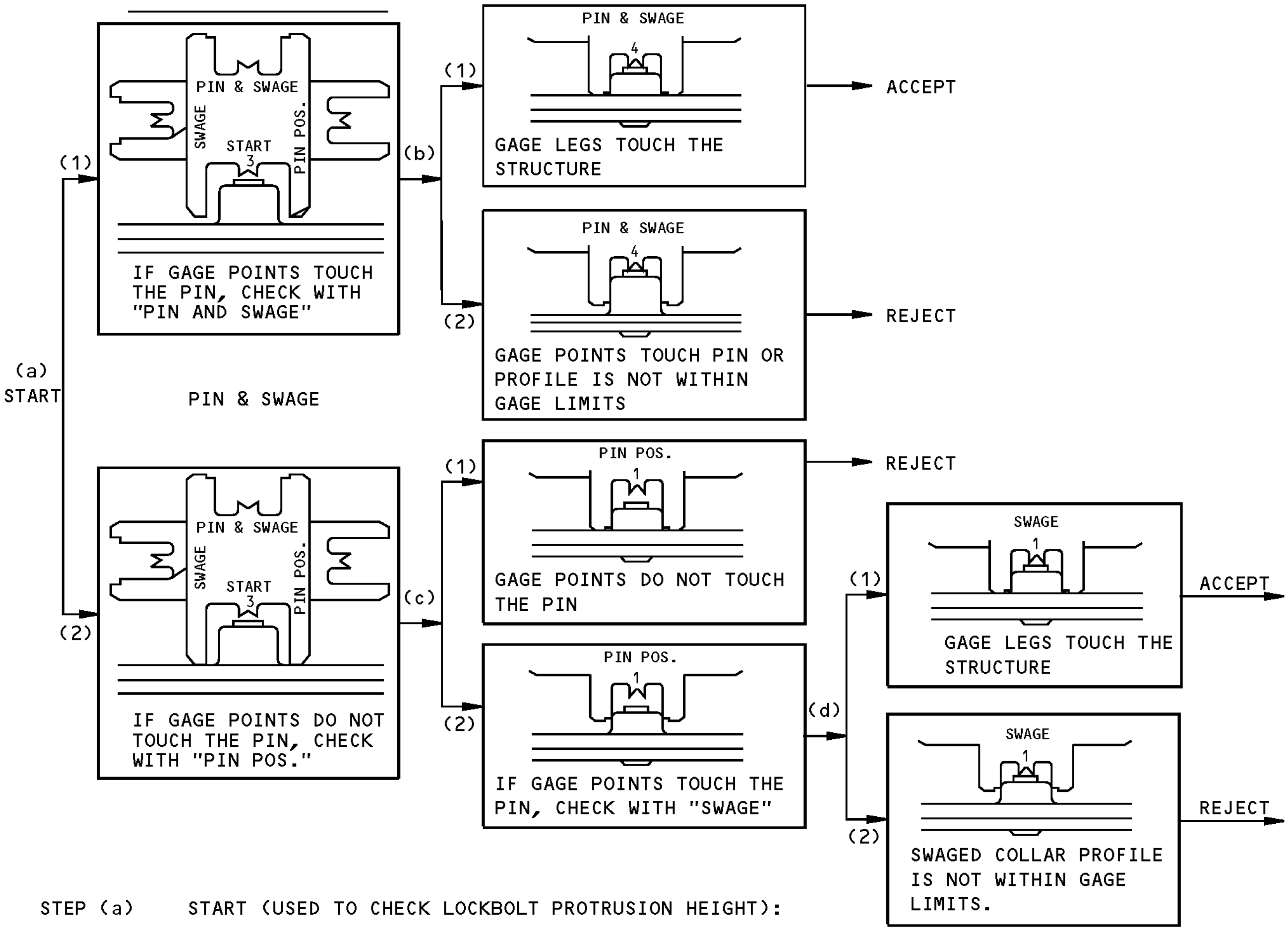
ACCEPT

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-() $\boxed{B}\boxed{C}$
DETAIL II

Pin and Collar Limits for Installed Lockbolts and Hex-Drive Bolts
Figure 14 (Sheet 6 of 12)



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):

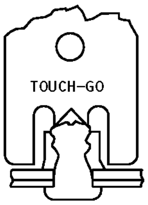
1. Reject if gage points do not touch the pin (protrusion height shorter than minimum).
2. If gage points touch the pin, check swage profile with Swage (Step (d)).

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.

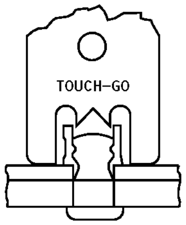
USE OF HG85-10, HG99-(), AND HG100-()
DETAIL III

Pin and Collar Limits for Installed Lockbolts and Hex-Drive Bolts
Figure 14 (Sheet 7 of 12)



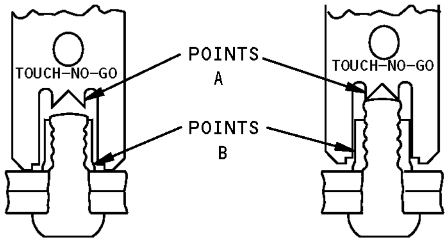
POINTS TOUCH PIN. LEGS OF GAGE CLEAR SHEET LINE. PIN IS ACCEPTABLE. GAGE PIN WITH TOUCH-NO-GO END

ACCEPT



POINTS DO NOT TOUCH PIN. LEGS OF GAGE CLEAR SHEET LINE. PIN GRIP IS TOO SHORT

REJECT



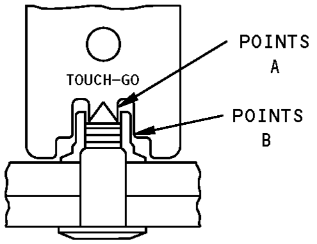
POINTS A DOES NOT TOUCH PIN. LEGS OF GAGE CLEAR SHEET LINE. POINTS B DO NOT TOUCH COLLAR. PIN GRIP AND COLLAR SWAGE IS ACCEPTABLE.

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

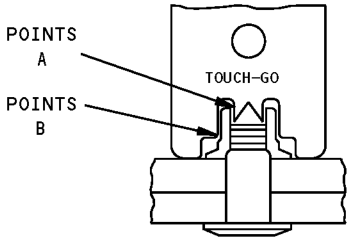
REJECT

USE OF HG77-()A $\boxed{C}$
DETAIL IV



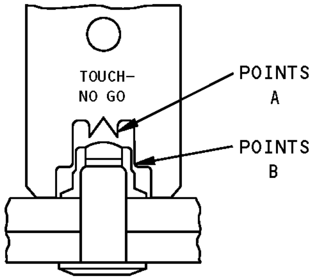
POINTS A TOUCH PIN. GRIP LENGTH IS NOT TOO SHORT. POINTS B DO NOT TOUCH COLLAR- COLLAR IS SWAGED ENOUGH

ACCEPT



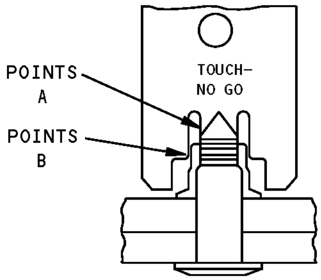
POINTS A DO NOT TOUCH PIN. GRIP LENGTH IS TOO SHORT AND/OR POINTS B TOUCH COLLAR - COLLAR IS NOT SWAGED ENOUGH

REJECT



POINTS A DO NOT TOUCH PIN. GRIP LENGTH IS NOT TOO LONG. POINTS B DO NOT TOUCH COLLAR - COLLAR IS SWAGED ENOUGH

ACCEPT

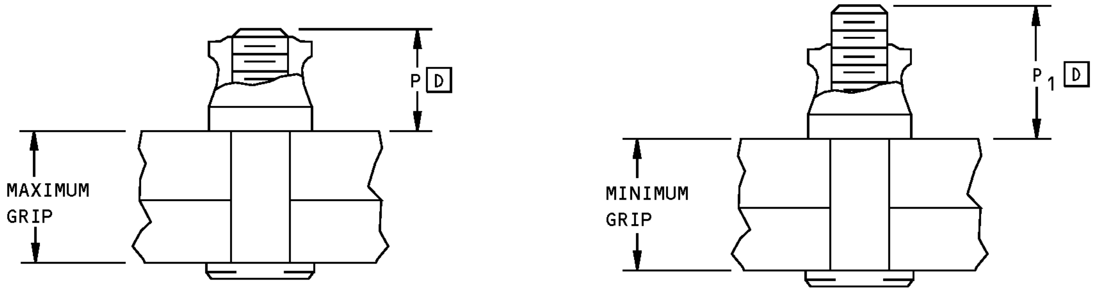


POINTS A TOUCH PIN. GRIP LENGTH IS TOO LONG AND/OR POINTS B TOUCH COLLAR - COLLAR IS NOT SWAGED ENOUGH

REJECT

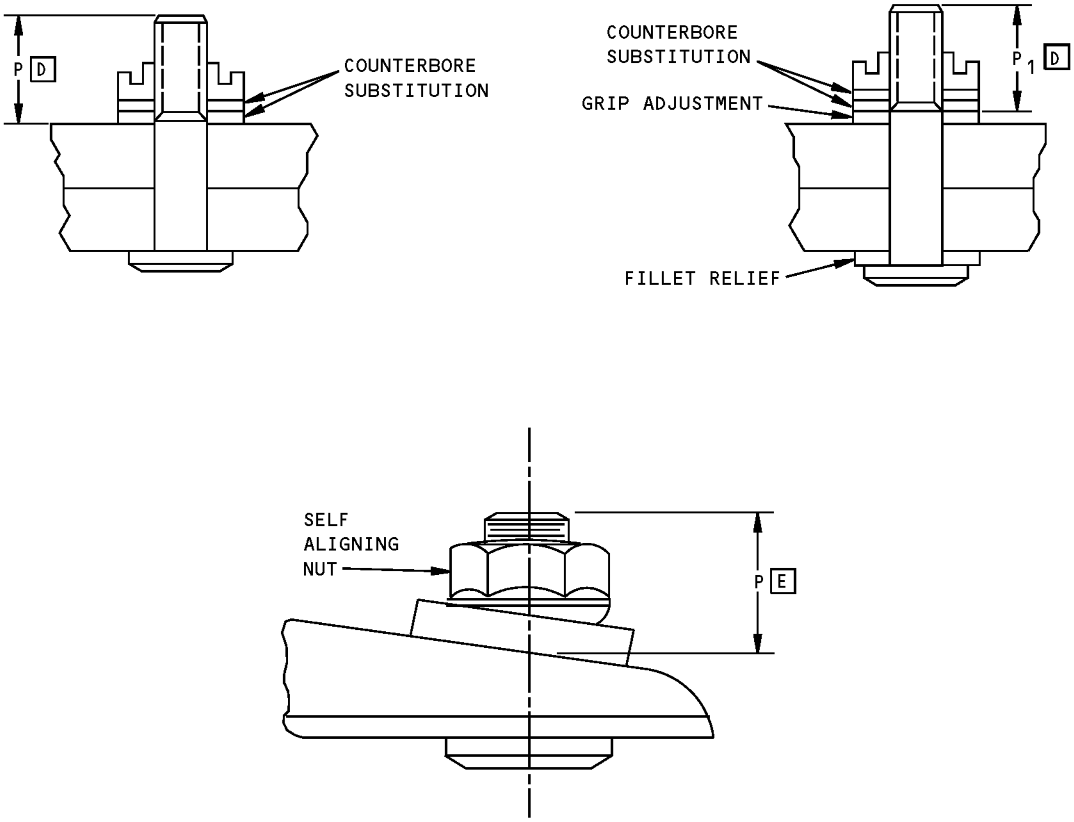
USE OF HG110-() $\boxed{C}$
DETAIL V

Pin and Collar Limits for Installed Lockbolts and Hex-Drive Bolts
Figure 14 (Sheet 8 of 12)



MAXIMUM GRIP
(MINIMUM PROTRUSION)

MINIMUM GRIP
(MAXIMUM PROTRUSION)



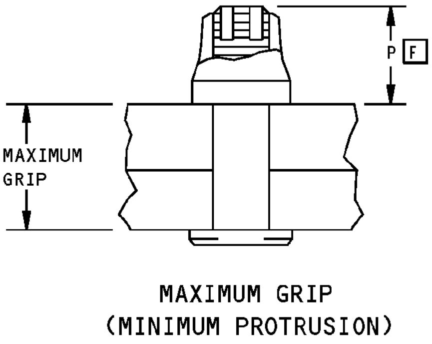
PIN PROTRUSION LIMITS FOR INSTALLED HEX-DRIVE BOLTS
DETAIL VI

Pin and Collar Limits for Installed Lockbolts and Hex-Drive Bolts
Figure 14 (Sheet 9 of 12)

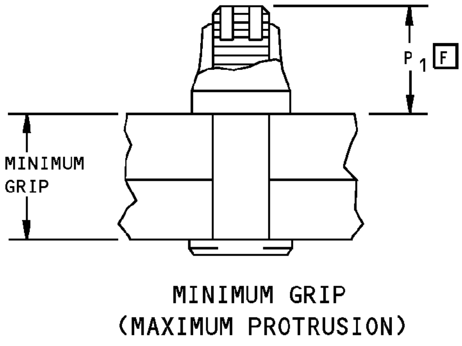
FASTENER		STANDARD							LIGHTWEIGHT		
		NOMINAL, 0.0156 AND 0.0312 OVERSIZE, INCH			0.0468 OVERSIZE, INCH				NOMINAL, INCH		
		SHEAR AND TENSION		ST8712 PROT GAGE DASH NO. (2-1522) PROT GAGE SIZE NO.	SHEAR		TENSION		SHEAR		ST8712 PROT GAGE DASH NO. (2-1522) PROT GAGE SIZE NO.
DASH NO.	NOMINAL THREAD	P MIN (MINIMUM PROTRUSION)	P MIN (MAXIMUM PROTRUSION)		P		P		P		
					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 IV

Pin and Collar Limits for Installed Lockbolts and Hex-Drive Bolts
Figure 14 (Sheet 10 of 12)



MAXIMUM GRIP
(MINIMUM PROTRUSION)



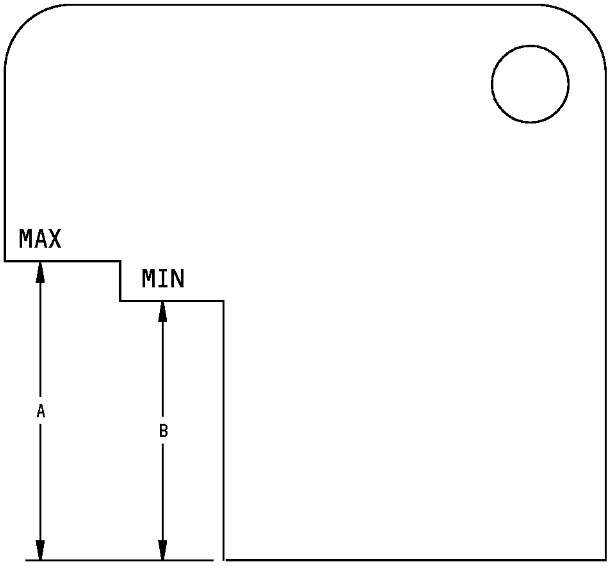
MINIMUM GRIP
(MAXIMUM PROTRUSION)

PIN PROTRUSION LIMITS FOR INSTALLED SWAGE-LOCKING HEX DRIVE BOLTS
DETAIL VII

NOMINAL BOLT DIAMETER	STANDARD AND 0.0156 OVERSIZE BOLTS		INSPECTION GAGE SEE DETAIL VIII	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

PIN PROTRUSION LIMITS FOR SWAGE-LOCKING HEX DRIVE BOLTS
TABLE V

Pin and Collar Limits for Installed Lockbolts and Hex-Drive Bolts
Figure 14 (Sheet 11 of 12)



PROTRUSION GAGE (SEE TABLE VI)

DETAIL VIII

GAGE NUMBER G	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 VI

Pin and Collar Limits for Installed Lockbolts and Hex-Drive Bolts
Figure 14 (Sheet 12 of 12)

NOTES

- THE SOURCE OF INFORMATION FOR THIS FIGURE CAN BE FOUND IN BOEING PROCESS SPECIFICATION BAC5060.
- SEE DETAIL I FOR BOLT ALIGNMENT AND DETAIL II FOR THREAD PROTRUSION.
- SEE TABLE I FOR NUT PART NUMBERS, TABLES II AND III FOR WASHERS, AND TABLES IV AND V FOR THREAD PROTRUSION LIMITS.
- SEE DETAILS II AND III FOR WASHER USE.

A DO NOT INSTALL BACN10TN, BACN10WM, BACN10HY, OR BACN10SZ NUTS ON SLOPE ANGLES GREATER THAN 2 DEGREES. USE BACN10MT NUT AND BACW10AU SELF-ALIGNING WASHER ON SLOPES BETWEEN 2 AND 6 DEGREES.

B DO NOT USE BACN10WM OR BACN10TN SEALNUTS WITH OVERSIZE BOLTS. DO NOT USE WASHERS WITH BACN10WM AND BACN10TN SEALNUTS.

C FOR BACN10TN AND BACN10WM SEALNUTS, THE TEFLON SEAL MUST NOT EXTRUDE BEYOND THE PERIPHERY OF THE NUT BASE.

D FILLET RELIEF WASHER MUST BE A COUNTERSUNK 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 III.

E COUNTERBORE SUBSTITUTION WASHERS FOR OVERSIZE FASTENERS CAN ADD ONE ADDITIONAL 0.032 THICK WASHER TO THIS INSTALLATION. SEE TABLE I.

F 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.

G 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.

H ONE 0.063 INCH NOMINAL THICKNESS PLAIN COUNTERBORE SUBSTITUTION WASHER IS NECESSARY.

I 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 ALLOWED WITH NOMINAL OR OVERSIZE BACB30PT BOLTS.

J SEE TABLE III FOR CORRECT WASHER.

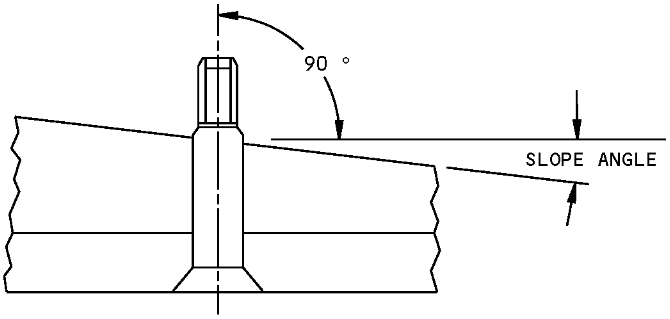
K IT IS NECESSARY THAT BACN10MT()X BE USED WITH THE NEXT FULL SIZE OF BACW10AU() WASHER, (FOR EXAMPLE, THE BACN10MX4X NUT USES THE BACW10AU5 WASHER).

DO NOT USE BACN10MT()X WITH BACB30PT NOMINAL OR OVERSIZES.

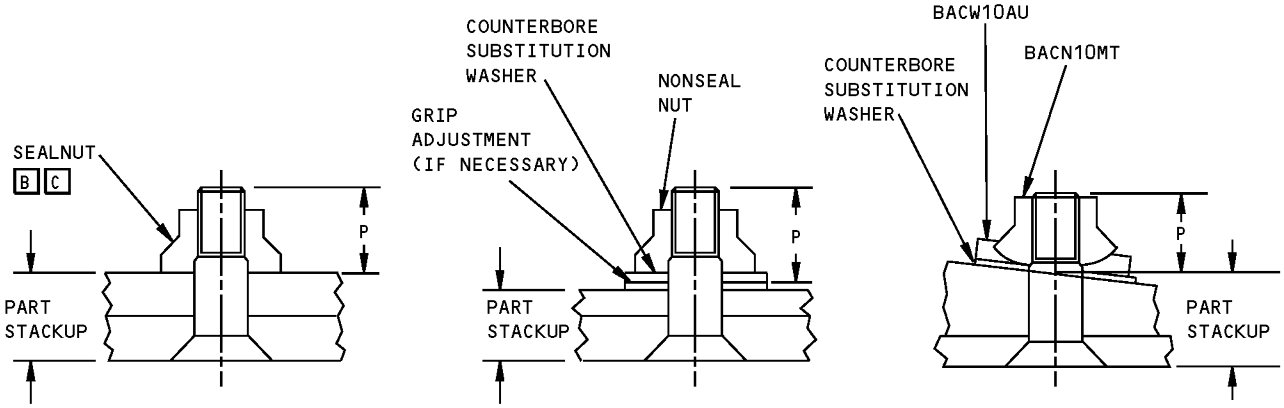
L WHEN OVERSIZE NUTS ARE USED WITH OVERSIZE BOLTS, PROTRUSION VALUES ARE NOT AFFECTED. SEE TABLE II FOR WASHER THICKNESS SELECTION. SEE TABLE III FOR GRIP ADJUSTMENT.

M 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 III). 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.

Installation of Radius Lead-In Bolts
Figure 15 (Sheet 1 of 7)



ANGULAR MEASUREMENT BETWEEN BOLT AND STRUCTURE MATERIAL
FOR PROPER NUT SELECTION
DETAIL I A

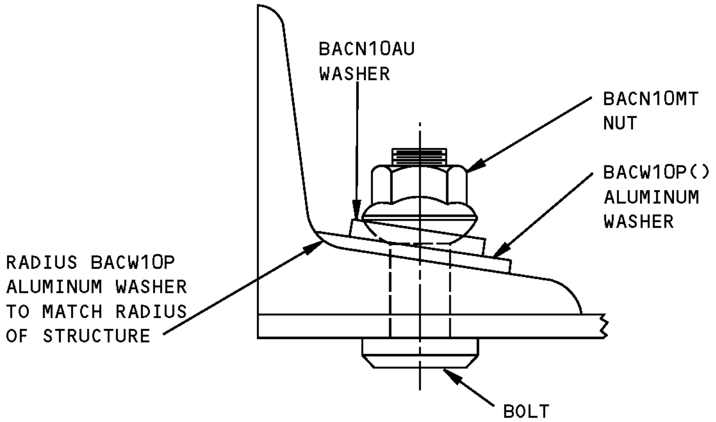


FOR SEAL AREAS

FOR NONSEAL AREAS

FOR NONSEAL AREAS

THREAD PROTRUSION AND WASHER USE
DETAIL II



RADIUSED WASHER WITH THE SELF-ALIGNING NUT
DETAIL III

Installation of Radius Lead-In Bolts
Figure 15 (Sheet 2 of 7)

NUT ON STANDARD SIZE BOLT $\boxed{J}$	NUT ON FIRST OVERSIZE BOLT $\boxed{J}$	NUT ON SECOND OVERSIZE BOLT $\boxed{J}$
BACN10HY()M	BACN10HY()M $\boxed{F}$	BACN10HY()MX $\boxed{G}$
BACN10HY()AC	BACN10HY()AC $\boxed{F}$	BACN10HY()ACX $\boxed{G}$
BACN10MY() AND BACW10AU()	BACN10MT() AND BACW10AU() $\boxed{H}$	BACN10MY()X AND BACW10AU() $\boxed{I}$
BACN10TN()K $\boxed{B}$	BACN10SZ() $\boxed{F}$ BACN10HY()M $\boxed{F}$ BACN10HY()AC $\boxed{F}$	BACN10HY()MX $\boxed{G}$ BACN10HY()ACX $\boxed{G}$
BACN10WM() $\boxed{B}$	BACN10HY()AC $\boxed{F}$	BACN10HY()MX $\boxed{G}$ BACN10HY()ACX $\boxed{G}$

NOMINAL AND OVERSIZE NUT PART NUMBERS
TABLE I

Installation of Radius Lead-In Bolts
Figure 15 (Sheet 3 of 7)

NOMINAL DIA. NUT AND BOLT COMBINATIONS	WASHER TYPE			TOTAL QUANTITY OF WASHERS [E]
	FILLET RELIEF	COUNTERBORE SUBSTITUTION [E]	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 III)	ONE 0.032 OR 0.063 THICK WASHER IS PERMITTED (SEE TABLE III)	2 MAXIMUM
BACB30WR()K()L WITH BACN10TN()K	ONE 0.063 THICK WASHER IS PERMITTED [D]	NOT PERMITTED	ONE 0.032 OR 0.063 THICK WASHER IS PERMITTED (SEE TABLE III)	2 MAXIMUM
BACB30WR()K()L WITH ALL NON-SEAL NUTS	ONE 0.063 THICK WASHER IS PERMITTED [D]	ONE 0.063 THICK WASHER IS NECESSARY (SEE TABLE III)	ONE 0.032 OR 0.063 THICK WASHER IS PERMITTED (SEE TABLE III)	3 MAXIMUM

THE QUANTITY OF NECESSARY AND PERMITTED WASHERS ON A NOMINAL DIAMETER FASTENER

TABLE II

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() K
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 M 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 III

Installation of Radius Lead-In Bolts
Figure 15 (Sheet 5 of 7)

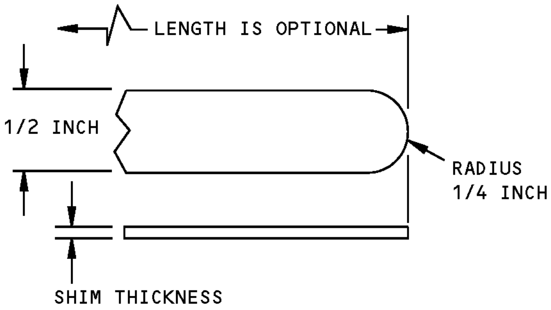
BOLT PART NUMBERS	1st DASH NUMBER	NOMINAL THREAD SIZE	NUT PART NUMBERS	MINIMUM PROTRUSION (P MIN)	MAXIMUM PROTRUSION (P MIN)
BACB30PT()K()L	4	0.2500-28	BACN10TN	0.428	0.510
	5	0.3125-24	BACN10WM	0.503	0.585
	6	0.3750-24		0.528	0.610
	4	0.2500-28		0.381	0.454
BACB30WQ()K()L	5	0.3125-24	BACN10TN	0.435	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 IV

BOLT PART NUMBERS	1st DASH NUMBER	NOMINAL THREAD SIZE	NUT PART NUMBERS L	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 V

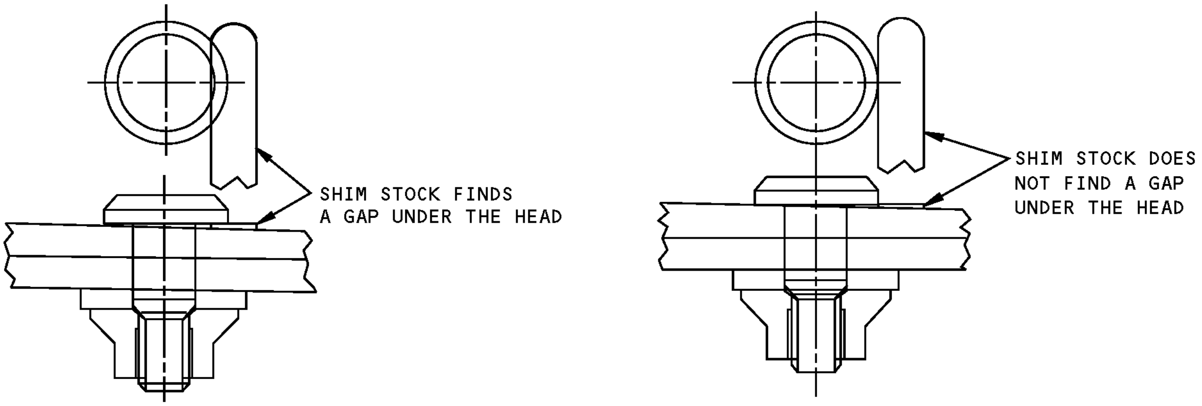
Installation of Radius Lead-In Bolts
Figure 15 (Sheet 6 of 7)



SHIM CONFIGURATION
DETAIL IV

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 VI



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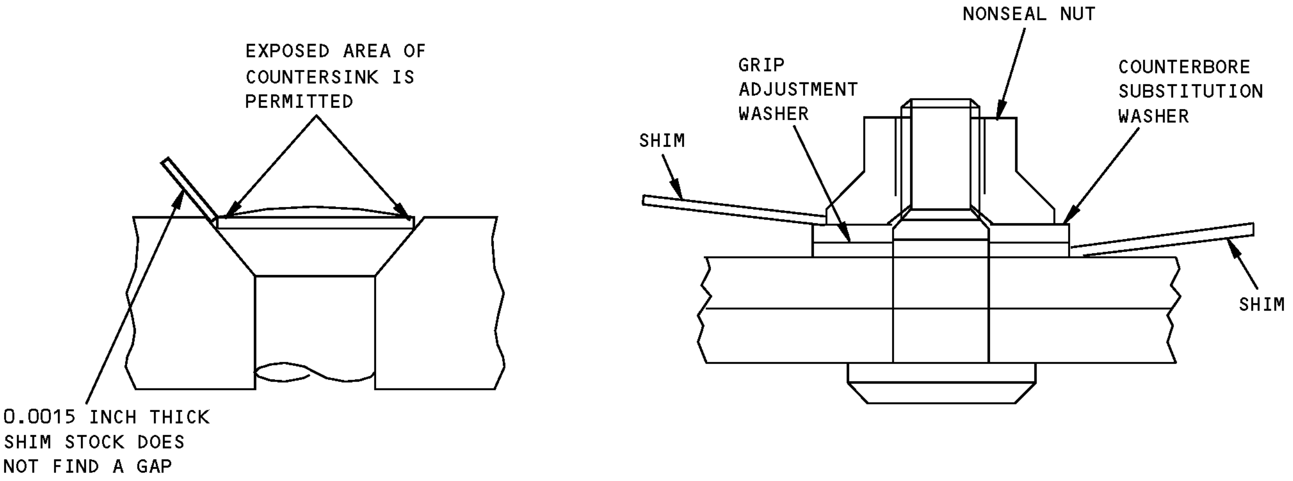
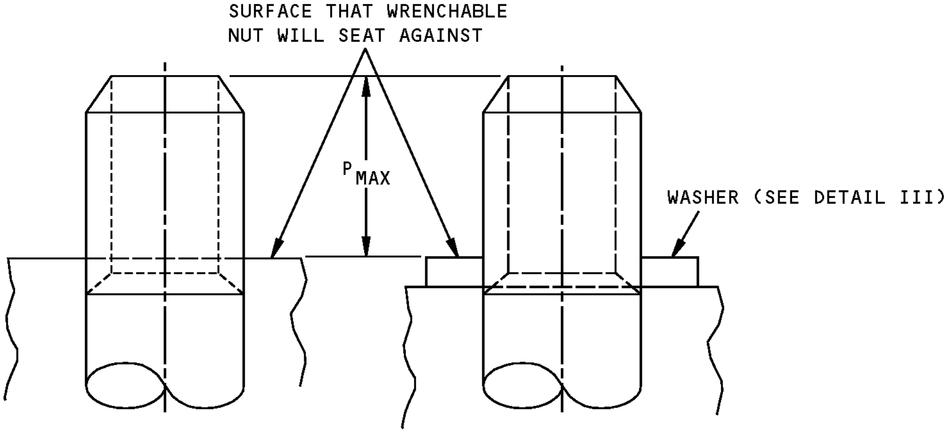


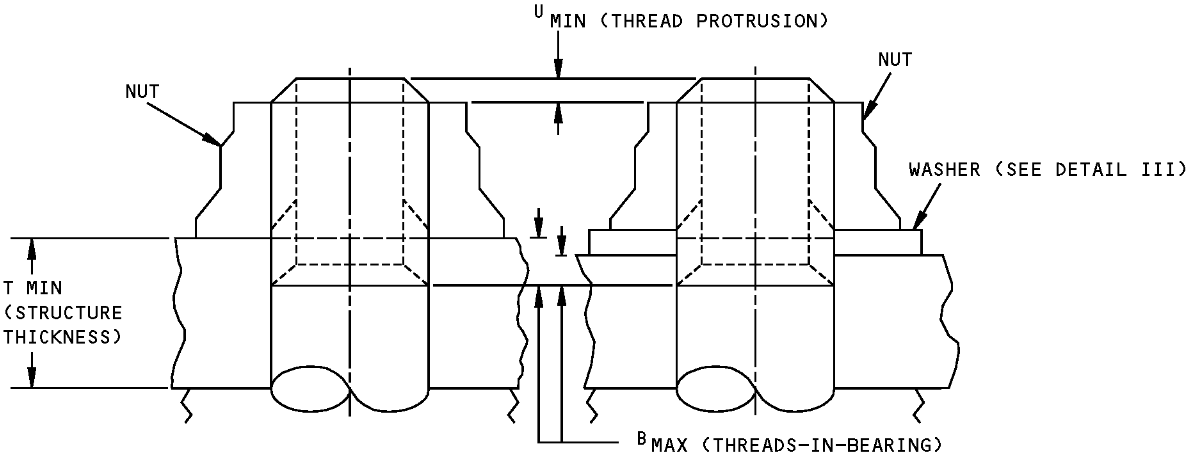
SHIM THICKNESS UNDER INSTALLED NUTS AND
HEADS OF RADIUS LEAD-IN BOLTS
DETAIL V

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 I)

DETAIL I



MINIMUM BOLT THREAD PROTRUSION THROUGH THE NUT AND FOR THREADS-IN-BEARING (SEE TABLE II)

DETAIL II

NOTES:

- THE SOURCE OF INFORMATION FOR THIS FIGURE CAN BE FOUND IN BOEING PROCESS SPECIFICATION BAC5009.
- SEE DETAILS I AND II FOR THREAD PROTRUSION
- SEE DETAIL III AND TABLE III FOR WASHER USEAGE
- SEE DETAILS IV AND V AND TABLE IV FOR GAP ANALYSIS

$\boxed{A}$ 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).

$\boxed{B}$ NOT APPLICABLE TO BOLTS WITH CASTELLATED NUTS. NOT APPLICABLE TO PLATE NUTS. NOT APPLICABLE TO BARREL NUTS. NOT APPLICABLE TO FULLY THREADED SCREWS.

$\boxed{C}$ 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 6)

NOMINAL THREAD SIZE	THREAD PROTRUSION "P MAX" NOMINAL SIZE BOLTS $\boxed{A}$					THREAD PROTRUSION "P MAX" 0.0156 O.S. BOLTS $\boxed{A}$				
	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 $\boxed{B}$

TABLE I

Installation of Bolts
Figure 16 (Sheet 2 of 6)

NOMINAL THREAD SIZE	THREAD PROTRUSION "P MAX" 0.0312 O.S.BOLTS $\boxed{A}$				
	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 $\boxed{B}$

TABLE I (CONTD)

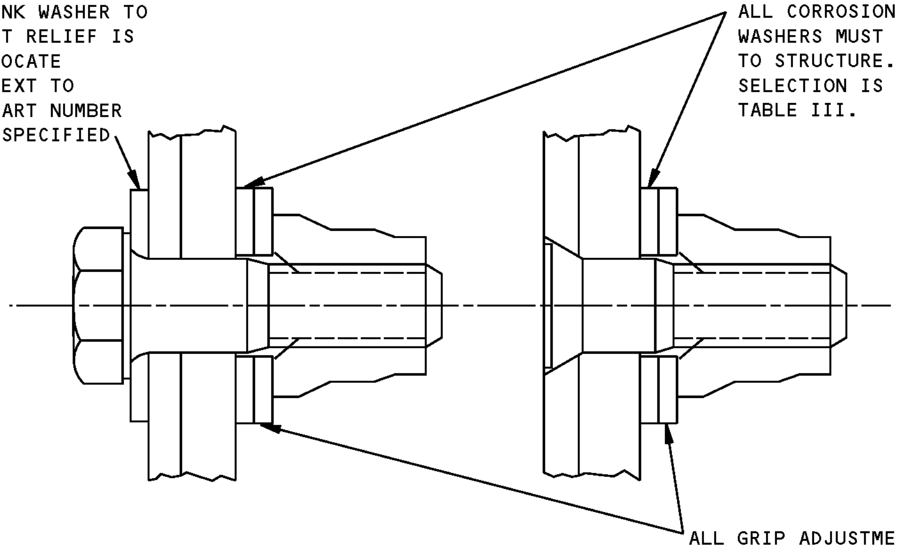
Installation of Bolts
Figure 16 (Sheet 3 of 6)

NOMINAL THREAD SIZE	MINIMUM THREAD PROTRUSION THROUGH THE NUT			THREADS IN BEARING FOR STRUCTURE THICKNESS UNDER THE NUT								THREADS-IN-BEARING $\boxed{C}$
				STRUCTURE THICKNESS T MIN								
	U MIN			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	$\boxed{A}$ VF (ONLY)	$\boxed{A}$ 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 II

Installation of Bolts
Figure 16 (Sheet 4 of 6)



ONE COUNTERSUNK WASHER TO PROVIDE FILLET RELIEF IS PERMITTED. LOCATE COUNTERSINK NEXT TO BOLT HEAD. PART NUMBER SELECTION IS SPECIFIED IN TABLE III.

ALL CORROSION PROTECTION WASHERS MUST BE LOCATED NEXT TO STRUCTURE. PART NUMBER SELECTION IS SPECIFIED IN TABLE III.

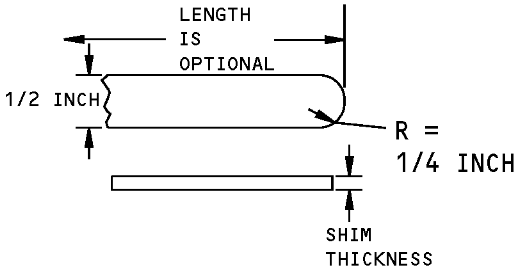
ALL GRIP ADJUSTMENT AND COUNTERBORE SUBSTITUTION WASHERS MUST BE LOCATED NEXT TO NUT. PART NUMBER SELECTION IS SPECIFIED IN TABLE III

USE OF WASHERS
DETAIL III

EXAMPLE BOLT PART NUMBERS	STRUCTURE MATERIAL	PLAIN WASHER UNDER NUT	COUNTERSUNK WASHER UNDER BOLT HEAD
BACB30 TYPE EM, FD, GU, 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()J	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 III

Installation of Bolts
Figure 16 (Sheet 5 of 6)

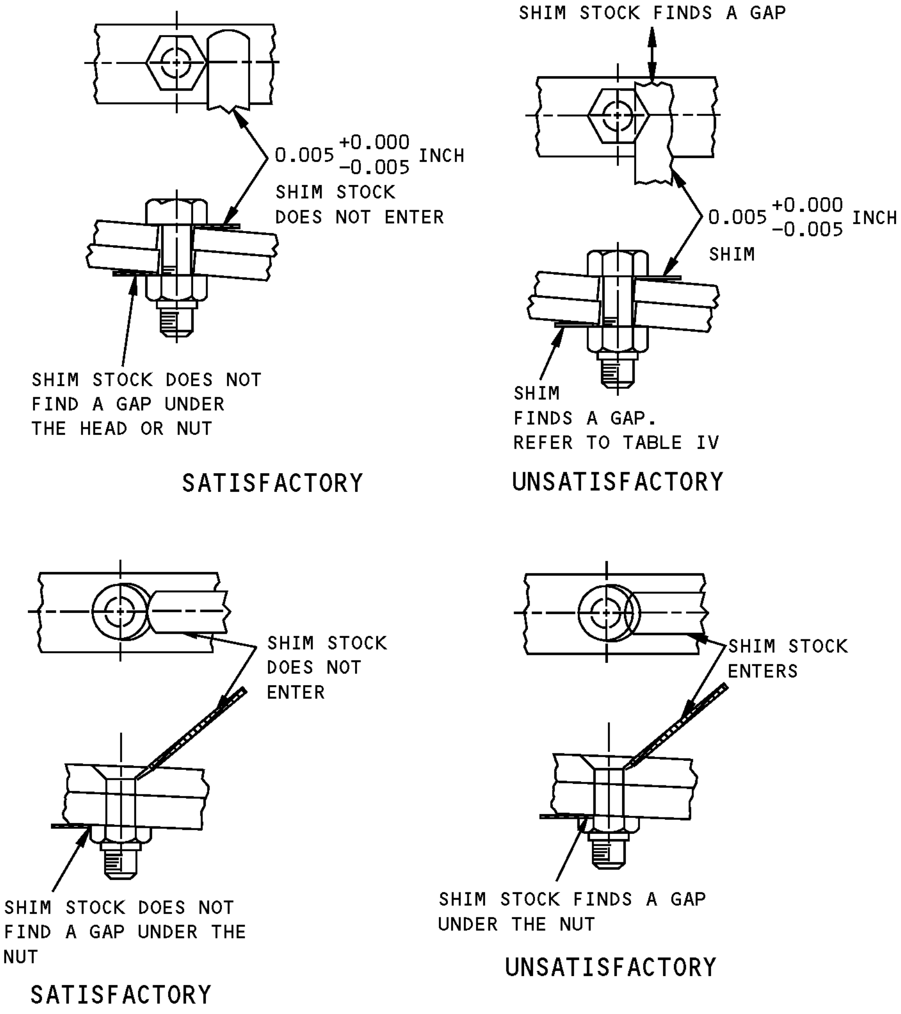


GAP INSPECTION SHIM
DETAIL IV

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 IV



SATISFACTORY

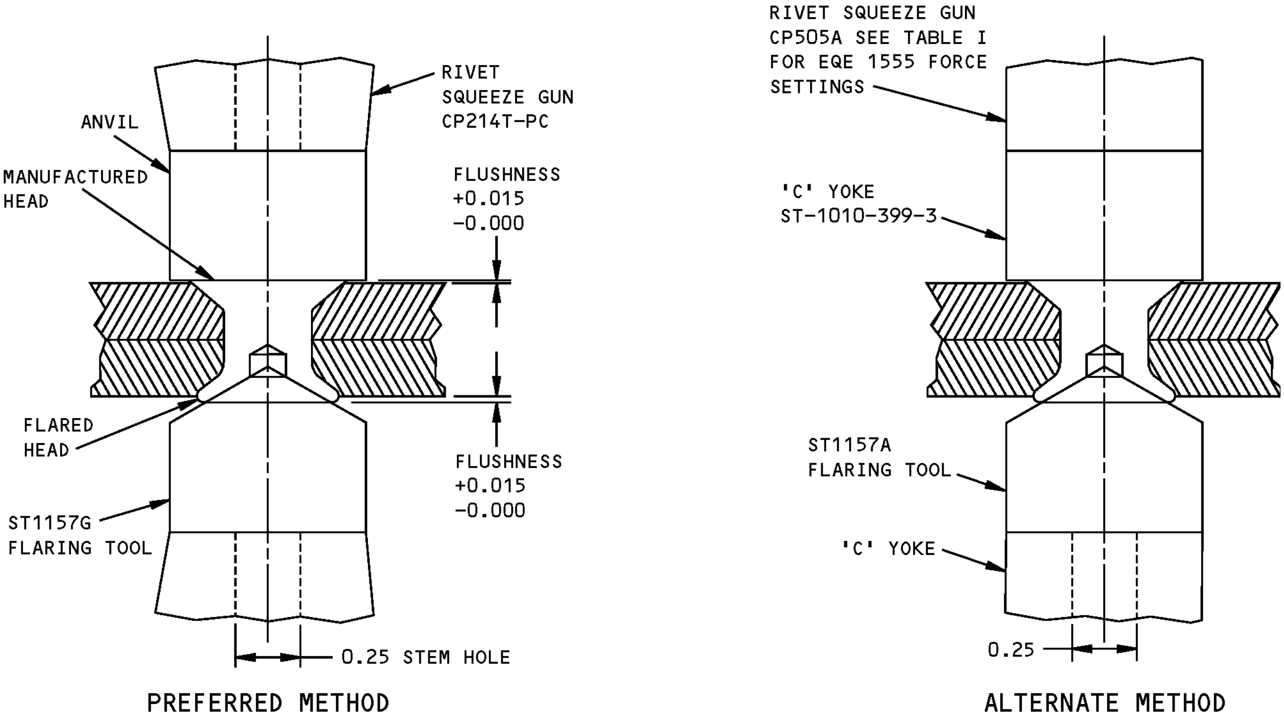
UNSATISFACTORY

SATISFACTORY

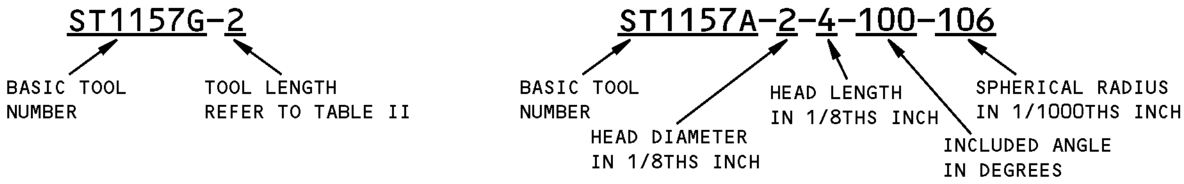
UNSATISFACTORY

GAP ANALYSIS FOR REMOVABLE FASTENERS (BOLTS)
DETAIL V

Installation of Bolts
Figure 16 (Sheet 6 of 6)



TOOL AND FLUSHNESS REQUIREMENTS FOR HOLLOW-ENDED (BACR15GA) RIVETS
DETAIL I



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 [A]
TABLE I

TOOL LENGTH NUMBER	TOOL LENGTH 'L' (INCHES)
-1	0.150
-2	0.300
-3	0.500
-4	0.750

TOOL LENGTH NUMBERS
TABLE II

NOTES

[A] POWER SUPPLY UNIT IS AVAILABLE FROM
E. F. BAILEY CO
5610 4TH AVE SO
SEATTLE, WA 98108
SPECIFY BOEING STANDARD PUMP SPL 1555-7-1

Installation of Hollow-Ended (BACR15GA) Rivets
Figure 17

12. Rivetless Nutplate Removal and Installation

A. These instructions are for installing size 10 rivetless nutplates and size 10 oversize nutplates with a standard hand tool or a field tool into a countersunk hole. To install these rivetless nutplates, contact Huck International at the first address. To get the necessary tools for nutplate installation, contact Huck International at the second address.

- 1) Huck International, PO Box 6010 Lakewood, Ca 90714
- 2) Huck International, PO Box 2270 Kingston, NY 12401

B. Tooling (Figure 18/GENERAL)

(1) The removal and installation of the rivetless nutplate requires the list of tools that follow:

(a) Hand installation tool, refer to Detail I. This tool pushes the lobes into the hole and bends the ends of the sleeves into the countersink on the back side. The tool consists as follows:

1) a handle

2) a puller assembly

(2) Nut element removal tool. Refer to Detail V.

(3) Microstop. This tool is used for sleeve removal which counter- sinks the nutplate at the flared end.

(4) A 0.002-inch feeler gage or equivalent thickness shim. This tool is used make sure that the nutplate is installed correctly and flush.

C. Nut Element Removal and Installation (Figure 19/GENERAL)

(1) To remove the nut element, pry it loose with the nut element removal tool, RB6527-(). Refer to Detail I.

(2) To replace the nut element, tap into place with a hammer. Refer to Detail II.

D. Rivetless Nutplate Removal

(1) To remove the entire rivetless nutplate assembly, the flare must be machined off.

(a) Adjust a countersink tool inside of a microstop to mill off almost all of the sleeve flare inside of the countersink.

(b) Mill the flare of the nutplate sleeve but do not remove any material from the keel chord.

(c) Use a punch and mallet to remove the rest of the assembly from the keel chord.

E. Rivetless Nutplate Installation in a Reworked Area

(1) If the hole is not damaged, a new nutplate of the same diameter may be installed. Align the sleeve lobes with the grooves in the hole left by the previous nutplate assembly.

(2) If the sleeve has rotated in the hole, then the hole is damaged and the first repair nutplate RFF6010 must be installed. The hole does not have to be reworked, the sleeve lobes on the repair nutplate are slightly larger than on the original nutplate.

NOTE: A second repair nutplate RRFF6010 is also available. At any stage a standard riveted nutplate may be installed.

(3) Install both the standard and the oversize repair rivetless nutplates as given in Paragraph 12.E./GENERAL.

F. Rivetless Nutplate Installation with the Standard Hand Tool (Figure 18/GENERAL)

(1) Select nutplate sleeve length based on the keel chord flange thickness. Refer to Table I.

(2) Select the assembled puller length corresponding to the sleeve length selected in Table I.

NOTE: If the length "L" as shown in Detail II does not match the puller length selected in Table I, then the puller length must be adjusted.

(3) Puller length adjustment. Refer to Figure 20/GENERAL, Tables I and II.

(a) Disassemble the hand tool to isolate the puller assembly.

(b) From Table I, select the pull stud length of the disassembled puller assembly corresponding to the sleeve length of step E.(1).

(c) From Table II, based on the nut height or the nut height code, select the appropriate nut height correction and add that number to the length obtained in step (b).

(d) Rotate the pull stud clockwise to retract or counterclockwise to extend it to the total length obtained in step (c).

(e) Once the proper length is obtained, turn the pull stud clockwise until the flat aligns with the setscrew hole.

(f) Tighten the setscrew to prevent further pull stud rotation.

(4) The puller must also match the nutplate in three additional ways.

(a) The diameter of the puller threads must match the diameter of the nutplate threads.

(b) The puller thread type must match the nutplate thread type: unified national, single, double, quad lead, or metric. The original nutplates on the keel chord are single lead.

WARNING: THE USE OF LOCKING PULLERS ON NON-LOCKING NUTS IS NOT RECOMMENDED. SINCE THERE MIGHT NOT BE ENOUGH ENGAGEMENT TO DEVELOP THE REQUIRED PULL STRENGTH, THE NUT THREADS MIGHT STRIP, ENDANGERING PERSONNEL WITH THE EJECTED NUT. THE USE OF NON-LOCKING PULLERS ON LOCKING NUTS IS NOT RECOMMENDED FOR THE SAME REASON.

(c) The puller is specifically designed to fit either the locking nutplates or the non-locking nutplates but not both. The original nutplates on the keel chord are locking.

NOTE: The pullers for locking nutplates have reduced end threads to an undersize pitch diameter to overcome the self-locking action of the nut element. All locking pullers are color-coded black on the end.

(d) The hand tool performs two operations. The first is to seat the nutplate into the hole and the second is to flare the end of the sleeve into the countersink. See Figure 21/GENERAL for the steps that follow:

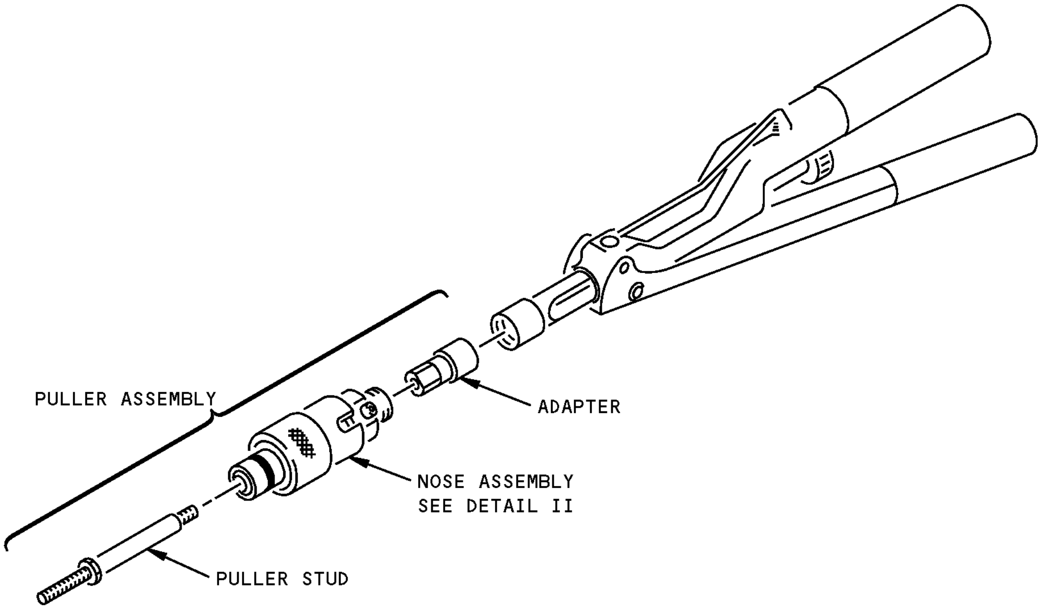
1) To seat the nutplate, retract the flaring tip up inside the pressure pad to ensure that the flaring tip does not engage the sleeve in this step. To retract the flaring tip, rotate the housing until a ring is just visible behind the knurled end of the housing. Refer to Detail I.

2) Place the nutplate into the hole in the keel chord flange and insert the threaded puller into the hole through the nutplate sleeve until it contacts the nut element. Thread the puller into the nut until 0.01 to 0.03 inch of the puller extends through the other side of the nut. Refer to Detail II.

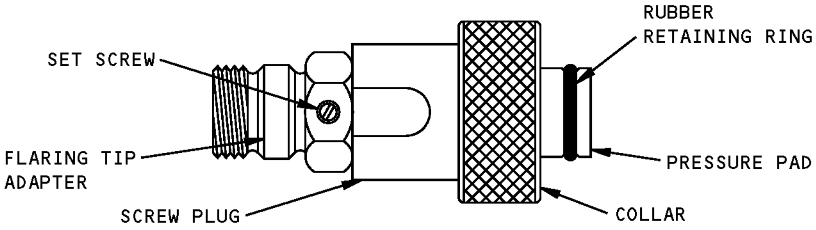
3) Squeeze the handles, pulling the sleeve lobes into the hole until the nut basket is fully seated against the flange and the lobes are engaged.

4) Without disengaging the tool, release the handles and rotate the housing to fully expose the flaring tip. Refer to Detail III.

5) Squeeze the handles again with enough pressure to form a countersink upset.

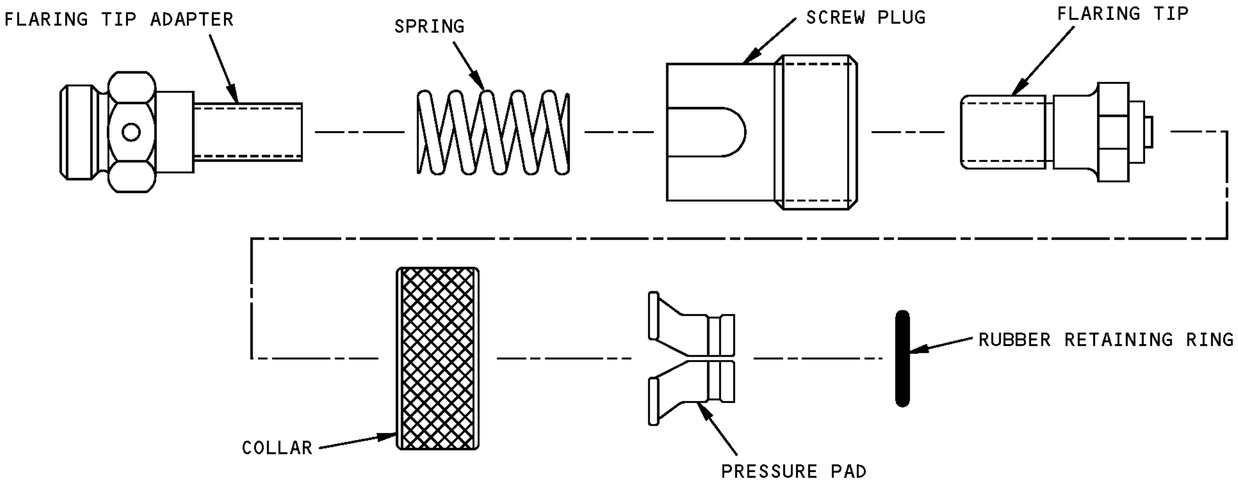


STANDARD HAND TOOL
DETAIL I

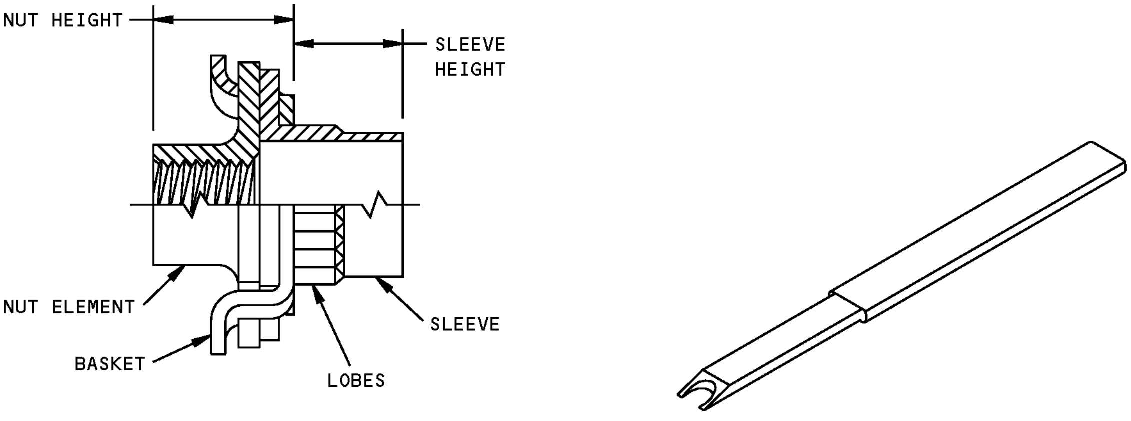


DETAIL II
(FOR INDIVIDUAL COMPONENTS SEE DETAIL III)

Rivetless Nutplate Tooling
Figure 18 (Sheet 1 of 2)



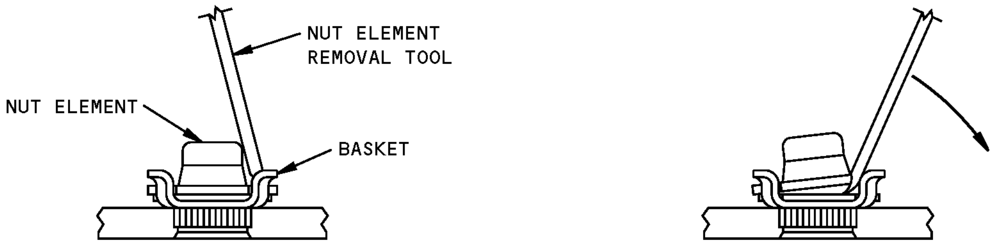
COMPONENTS FOR NOSE PIECE
DETAIL III



RIVETLESS NUTPLATE
DETAIL IV

NUT ELEMENT REMOVAL TOOL
DETAIL V

Rivetless Nutplate Tooling
Figure 18 (Sheet 2 of 2)



STEP NO. 1

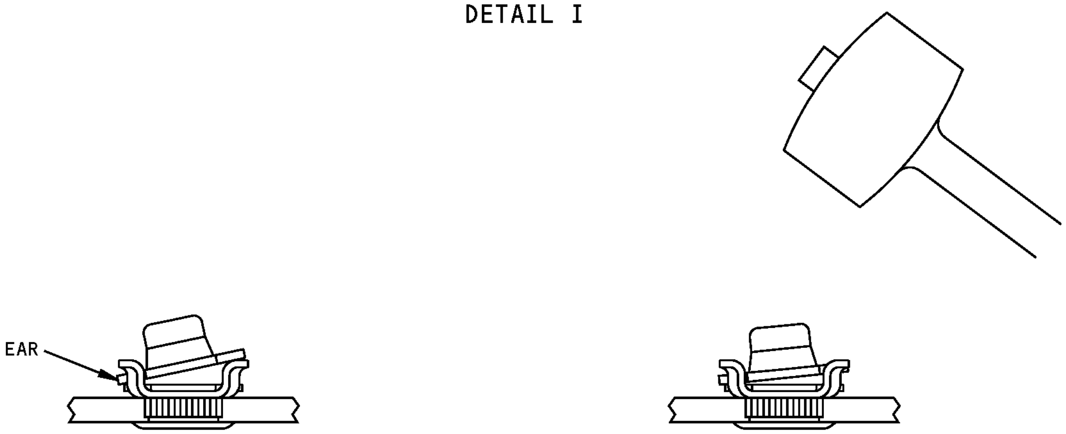
INSERT THE PRONGS OF THE NUT ELEMENT REMOVAL TOOL BETWEEN THE BASE OF THE NUT ELEMENT AND THE BASKET AS SHOWN.

STEP NO. 2

CAUTION: DO NOT OPEN THE BASKET EXCESSIVELY OR IT WILL TAKE A SET AND REMAIN OPEN OR IT MAY CRACK.

APPLYING A DOWNWARD FORCE, PRY THE NUT ELEMENT OUT BY SWINGING THE TOOL AGAINST THE BASKET TO OPEN IT.

NUT ELEMENT REMOVAL
DETAIL I



STEP NO. 1

PLACE THE NUT ELEMENT INTO THE BASKET ONE EAR FIRST.

STEP NO. 2

STRIKE THE TOP OF THE NUT LIGHTLY WITH A HAMMER OR MALLET TO SNAP THE SECOND EAR INTO THE BASKET.

NUT ELEMENT REPLACEMENT
DETAIL II

Rivetless Nutplate Nut Element Removal and Installation
Figure 19

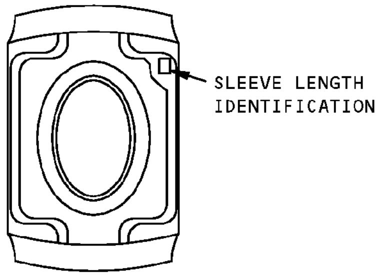
CODE	CHORD FLANGE THICKNESS	SLEEVE LENGTH	POWER LENGTH "L" ±0.015 FOR NUT SIZE 10	
			HAND TOOL ASSEMBLED (DETAIL I)	PULLER ASSEMBLY REMOVED FROM HAND TOOL (DETAIL II)
AA	0.055-0.073	0.073	0.461	0.978
A	0.074-0.106	0.099	0.519	1.036
B	0.107-0.133	0.130	0.550	1.067
C	0.134-0.165	0.161	0.581	1.098
D	0.166-0.196	0.192	0.612	1.129
E	0.197-0.227	0.223	0.643	1.160
F	0.228-0.258	0.254	0.674	1.191
G	0.259-0.289	0.285	0.705	1.222
H	0.290-0.320	0.316	0.736	1.253
J	0.321-0.351	0.347	0.767	1.284

PULLER LENGTH
TABLE 1

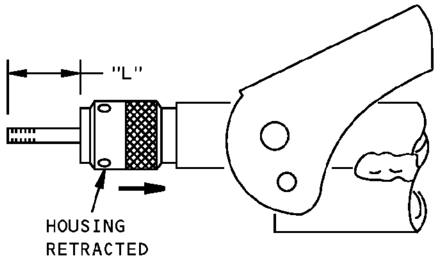
FGD6010-( )-( )-( ) AND FGDG6010-( )-( )-( )
NOTE: The last parenthesis is the nut height code.

NUT HEIGHT CODE	NUT HEIGHT FOR SIZE 10 NUT	NUT HEIGHT CORRECTION
1	0.233	0.062
2	0.295	0.124
3	0.357	0.186
4	0.420	0.248

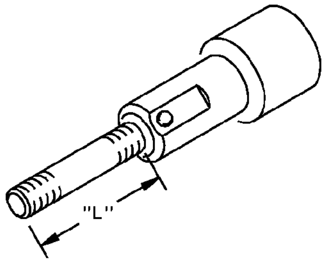
NUT HEIGHT
TABLE II



SLEEVE LENGTH
DETAIL I

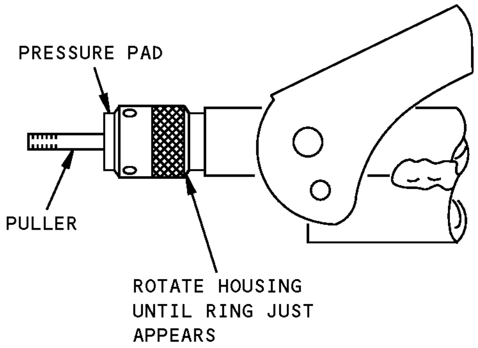


PULLER LENGTH "L" FOR
HAND TOOL ASSEMBLED
DETAIL II

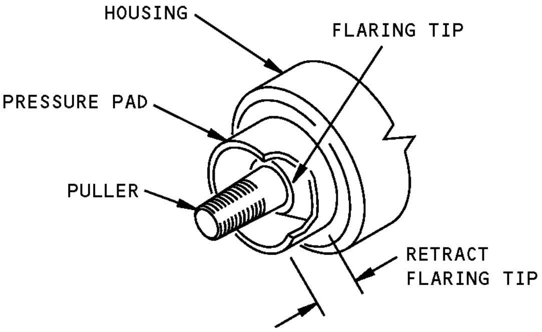


PULLER LENGTH "L" FOR PULLER
ASSEMBLY REMOVED FROM HAND TOOL
DETAIL III

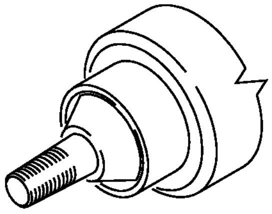
Rivetless Nutplate Sleeve and Puller Length Selection
Figure 20



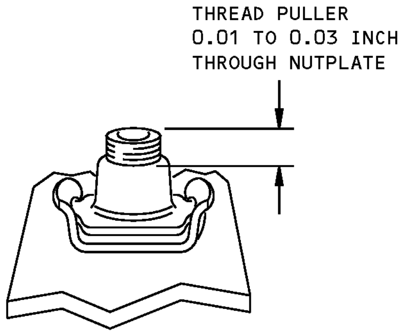
HOUSING POSITION TO SEAT NUTPLATE
DETAIL I



FLARING TIP RETRACTED
DETAIL II



FLARING TIP EXTENDED
DETAIL III



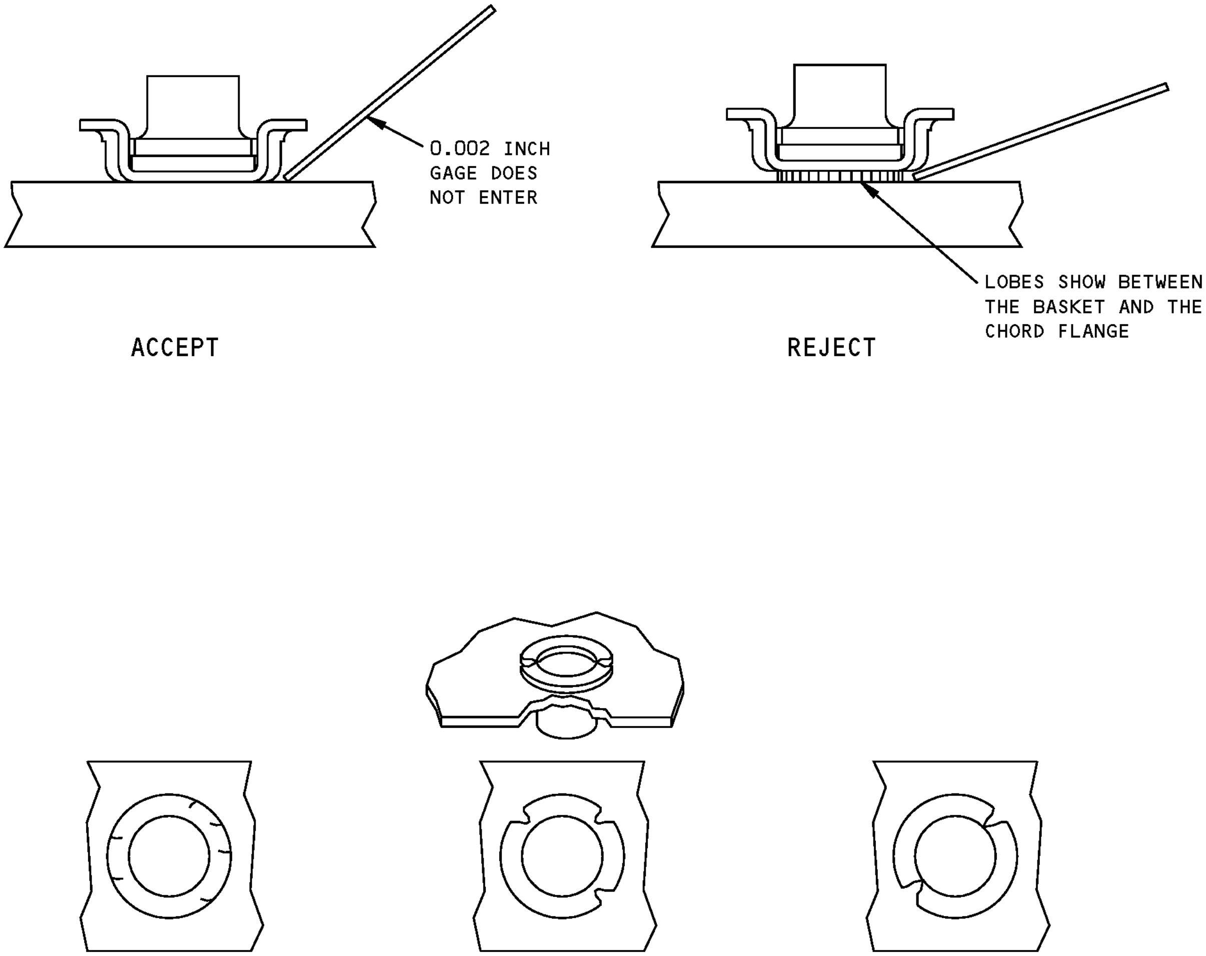
PULLER THREADED THROUGH NUTPLATE
DETAIL IV

Rivetless Nutplate Standard Hand Tool Operation
Figure 21

	NUT SIZE	DIA	NUT ENTRY SIDE PREP	UPSET SIDE PREP	ADD'NL THRU HOLE TREATMENT
0.051-UP	10	0.280-0.285	BREAK EDGE 0.010 MAX	MAY BE CTSK DOWN TO 0.051	DICHROMATE (ALUMINUM)
0.055-0.074	10	0.281-0.286	NONE	0.343	NONE

HOLE PREPARATION
TABLE I

**Rivetless Nutplate Installation
Figure 22**



LIGHT CRACKS

CRACKS ARE CLOSED
AND ARE ON THE
PERIPHERY OF THE
PART.

MEDIUM CRACKS

CRACKS ARE OPEN
AND EXTEND INWARDS
ON THE FLARED PART
OF THE SLEEVE.

SEVERE CRACKS

CRACKS ARE OPEN
AND EXTEND INTO THE
CYLINDRICAL PART
OF THE SLEEVE.

Rivetless Nutplate Installation Inspection
Figure 23

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 repairs on the airplane.

2. General

A. When the repairs given in this manual are adapted for in-service repair, 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 Figure 1, 2, and 3.

3. References

Reference	Title
51-40-06, GENERAL	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, YOU WILL NOT HAVE AN APPROVED REPAIR.

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) Nonmagnetic fasteners are necessary and the alternative 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 an alternative 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 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, II, IIA, III or IV Supersession.

NOTE: A Class IV Supersession fastener and a fastener that it supersedes, are not interchangeable.

B. If a fastener has been superseded by a Class V Supersession, Boeing recommends that you use an alternative fastener.

Table 1: Index to Fastener Substitution Tables

Fastener Substitution - Rivets	Figure 1/GENERAL
Fastener Substitution - Bolts	Figure 2/GENERAL
Fastener Substitution - Lockbolts	Figure 3/GENERAL

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 51-30-01 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	NO EQUIVALENT	[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	NO EQUIVALENT	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	NO EQUIVALENT	BACR15DR()P() [E] [I] [J] [K] BACR15DR()PAC() [E] [I] [J]
BACR15BB()B()	5056-H32 AL, ANODIZED OR CONVERION COATED, CLOSE TOLERANCE SHANK	NO EQUIVALENT	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	NO EQUIVALENT	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	NO EQUIVALENT	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	NO EQUIVALENT	NASM20615-()M()
BACR15DX()-()	A286 CRES UNIVERSAL HEAD CLOSE TOLERANCE SHANK	NO EQUIVALENT	NAS1198()-()
BACR15ET()AD()	2117-T4 AL, ANODIZED, UNIVERSAL HEAD, CLOSE TOLERANCE SHANK, 0.031 OVERSIZE	NO EQUIVALENT	NAS1242AD
BACR15ET()B()	5056-H32 AL, ANODIZED, UNIVERSAL HEAD, CLOSE TOLERANCE SHANK, 0.031 OVERSIZE	NO EQUIVALENT	NAS1242B
BACR15ET()D()	2017-T4 AL, ANODIZED, UNIVERSAL HEAD, CLOSE TOLERANCE SHANK, 0.031 OVERSIZE	NO EQUIVALENT	NAS1242D NAS1242DD
BACR15ET()DD()	2024-T4 AL, ANODIZED, UNIVERSAL HEAD, CLOSE TOLERANCE SHANK, 0.031 OVERSIZE	NO EQUIVALENT	NAS1242DD
BACR15FT()AD()	2117-T4 AL, ANODIZED, MODIFIED UNIVERSAL HEAD, CLOSE TOLERANCE SHANK	NO EQUIVALENT	BACR15BB()AD() [N] BACR15BB()AD()C [N] MS20470AD [N]
BACR15FT()D()	2017-T4 AL, ANODIZED, MODIFIED UNIVERSAL HEAD, CLOSE TOLERANCE SHANK	NO EQUIVALENT	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	$\boxed{F}$
BACR15BA()A()	1100F AL, ANODIZED, 100° HEAD, CLOSE TOLERANCE SHANK	MS20426A	BACR15DR()-() $\boxed{E}$ $\boxed{I}$ $\boxed{J}$ $\boxed{K}$ BACR15DR()AC() $\boxed{E}$ $\boxed{I}$ $\boxed{J}$
BACR15BA()A()C	1100-F AL, CONVERSION COATED, 100° PRECISION HEAD, CLOSE TOLERANCE SHANK	NO EQUIVALENT	BACR15DR()-() $\boxed{E}$ $\boxed{I}$ $\boxed{J}$ $\boxed{K}$ BACR15DR()AC() $\boxed{E}$ $\boxed{I}$ $\boxed{J}$
BACR15BA()AD()	2117-T4 AL, ANODIZED OR CONVERSION COATED, 100° PRECISION HEAD, CLOSE TOLERANCE SHANK	MS20426AD	BACR15BA()AD()C BACR15DR()AC() $\boxed{E}$ $\boxed{I}$ $\boxed{J}$ BACR15DR()-() $\boxed{E}$ $\boxed{I}$ $\boxed{J}$ $\boxed{K}$ BACR15GE()CW() $\boxed{E}$ $\boxed{I}$ $\boxed{J}$
BACR15BA()AD()C	2117-T4 AL, CONVERSION COATED, 100° PRECISION HEAD, CLOSE TOLERANCE SHANK	NO EQUIVALENT	BACR15DR()-() $\boxed{E}$ $\boxed{I}$ $\boxed{J}$ $\boxed{K}$ BACR15DR()AC() $\boxed{E}$ $\boxed{I}$ $\boxed{J}$ BACR15GE()CW() $\boxed{E}$ $\boxed{I}$ $\boxed{J}$

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	NO EQUIVALENT	BACR15BA()AD() $\boxed{E}$ BACR15BA()D() $\boxed{E}$ MS20426AD $\boxed{E}$ MS20426B $\boxed{E}$ MS20426D $\boxed{E}$
BACR15BA()B()C	5056-H32 AL, CONVERSION COATED, 100° PRECISION HEAD, CLOSE TOLERANCE SHANK	NO EQUIVALENT	BACR15DR()-() $\boxed{E}$ $\boxed{I}$ $\boxed{J}$ $\boxed{K}$ BACR15DR()AC() $\boxed{E}$ $\boxed{I}$ $\boxed{J}$
BACR15BA()D()	2017-T3 AL, CONVERSION COATED, 100° PRECISION HEAD, CLOSE TOLERANCE SHANK	MS20426D	BACR15BA()D()C BACR15BA()DD() BACR15DR()-() $\boxed{E}$ $\boxed{I}$ $\boxed{J}$ $\boxed{K}$ BACR15DR()AC() $\boxed{E}$ $\boxed{I}$ $\boxed{J}$ MS20426DD
BACR15BA()DD()	2024-T4 AL, ANODIZED, 100° PRECISION HEAD, CLOSE TOLERANCE SHANK	MS20426DD	BACR15DR()-() $\boxed{E}$ $\boxed{I}$ $\boxed{J}$ $\boxed{K}$ BACR15DR()AC() $\boxed{E}$ $\boxed{I}$ $\boxed{J}$
BACR15CE()AD()	2117-T4 AL, ANODIZED, 100° SHEAR HEAD	NO EQUIVALENT	BACR15BA()AD $\boxed{A}$ MS20426AD $\boxed{A}$ NAS1097AD
BACR15CE()B()	5056-H32 AL, ANODIZED, 100° SHEAR HEAD	NO EQUIVALENT	BACR15BA()B $\boxed{A}$ MS20426B $\boxed{A}$ NAS1097B
BACR15CE()D()	2017-T4 AL, CONVERSION COATED, 100° SHEAR HEAD	NO EQUIVALENT	BACR15BA()D() $\boxed{A}$ BACR15BA()DD() $\boxed{A}$ BACR15GF()D() MS20426D $\boxed{A}$ MS20426DD $\boxed{A}$ NAS1097D
BACR15CE()M()	MONEL, 100° SHEAR HEAD	NO EQUIVALENT	NAS1200M MS20427M $\boxed{A}$ $\boxed{O}$

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 $\boxed{D}$ BACR15DR()PAC() BACR15FT()D() $\boxed{D}$ MS20470D $\boxed{D}$
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()-() $\boxed{C}$	5056 AL SLEEVE, LOCKED SPINDLE, PARTIAL SERRATED STEM, MAX TEMP 250°F, UNIVERSAL HEAD	CHERRY CR2263-()-() ALLFAST AF2050-()-()	NAS1398D()-() $\boxed{C}$ $\boxed{E}$ NAS398D()A() $\boxed{C}$ $\boxed{E}$ NAS1738E $\boxed{B}$ BACR15FR()E() $\boxed{B}$ BACR15FR()E()R $\boxed{B}$ NAS1738B $\boxed{B}$

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()-() C	MONEL SLEEVE, LOCKED SPINDLE, PARTIAL SERRATED STEM, MAX TEMP 900°F (482°C)	ALLFAST AF2090M-()-() CHERRY CR2563M-()-()	BACR15FR()M() B BACR15FR()M()R B NAS1398M()A() C NAS1738M B
NAS1398M()A() C	MONEL SLEEVE, LOCKED SPINDLE, FULL SERRATED STEM, MAX TEMP 900°F (482°C)	ALLFAST RV1290M-()-() CHERRY CR2573-()-()	BACR15FR()M() B BACR15FR()M()R B NAS1398M()-() C NAS1738M B
NAS1398MW()-() C	MONEL SLEEVE, CADMIUM PLATED, LOCKED SPINDLE, PARTIAL SERRATED STEM, MAX TEMP 450°F (232°C)	ALLFAST AF2090W-()-() CHERRY CR2563-()-()	NAS1398MW()A() C NAS1738MW B
NAS1398MW()A() C	MONEL SLEEVE, CADMIUM PLATED, LOCKED SPINDLE, FULL SERRATED STEM, MAX TEMP 450°F (232°C)	ALLFAST RV1290-()-() CHERRY CR2573P-()-()	NAS1398MW()-() C NAS1738MW 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() 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 $\boxed{D}$ BACR15BA()D()C $\boxed{D}$ 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() $\boxed{C}$	5056 AL SLEEVE, LOCKED SPINDLE, 100° HEAD, FULL SERRATED STEM, MAX TEMP 250°F (121°C)	CHERRY CR2272-()-() ALLFAST RV1251-()-() CHERRY CR2262-()-()	BACR15FP()E() $\boxed{B}$ BACR15FP()E()R $\boxed{B}$ NAS1399B()-() $\boxed{C}$ NAS1399D()-() $\boxed{C}$ $\boxed{E}$ NAS1399D()A() $\boxed{C}$ $\boxed{E}$ NAS1739B $\boxed{B}$ NAS1739E $\boxed{B}$
NAS1399B()-() $\boxed{C}$	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() $\boxed{B}$ BACR15FP()E()R $\boxed{B}$ NAS1399B()A() $\boxed{C}$ NAS1399D()-() $\boxed{C}$ $\boxed{E}$ NAS1399D()A() $\boxed{C}$ $\boxed{E}$ NAS1739B $\boxed{B}$ NAS1739E $\boxed{B}$

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() $\boxed{C}$	MONEL SLEEVE, LOCKED SPINDLE, 100° HEAD, FULL SERRATED STEM, MAX TEMP 900°F	CHERRY CR2572-()-() ALLFAST RV1291M-()-() CHERRY CR2562M-()-()	BACR15FP()M() $\boxed{B}$ BACR15FP()M()R $\boxed{B}$ NAS1399M()-() $\boxed{C}$ NAS1739M $\boxed{B}$
NAS1399MW()-() $\boxed{C}$	MONEL SLEEVE, CADMIUM PLATED, LOCKED SPINDLE, 100° HEAD, PARTIAL SERRATED STEM, MAX TEMP 450°F	CHERRY CR2562-()-() ALLFAST AF2091W-()-()	NAS1739MW $\boxed{B}$ NAS1399MW()A() $\boxed{C}$
NAS1399MW()A() $\boxed{C}$	MONEL SLEEVE, CADMIUM PLATED, LOCKED SPINDLE, 100° HEAD, FULL SERRATED STEM, MAX TEMP 450°F	ALLFAST RV1291-()-() CHERRY CR2572P-()-() CHERRY CR2562-()-()	NAS1399MW()-() $\boxed{C}$ NAS1739MW $\boxed{B}$
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() $\boxed{M}$

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 51-30-01 FOR THE NECESSARY PROTECTIVE TREATMENT FOR FASTENER INSTALLATION.
- DO NOT USE CADMIUM PLATED FASTENERS IN TITANIUM OR GRAPHITE (CARBON FIBER) STRUCTURE.

$\boxed{A}$ 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

$\boxed{B}$ 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.

$\boxed{C}$ ASK THE BOEING COMPANY FOR FASTENER ALTERNATIVES.

$\boxed{D}$ 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.

$\boxed{E}$ WHEN A H-11 STEEL BOLT IS REMOVED FOR ANY REASON, ALWAYS REPLACE THE BOLT WITH AN ALTERNATIVE FASTENER.

$\boxed{F}$ THESE FASTENERS ARE PERMITTED ONLY IN CLOSE REAM OR LARGER HOLES (NON-INTERFERENCE HOLES).

$\boxed{G}$ WHEN A PH13-8Mo CRES BOLT IS REMOVED FOR ANY REASON, ALWAYS REPLACE THE BOLT WITH AN ALTERNATIVE FASTENER.

$\boxed{H}$ WHEN A CADMIUM PLATED TITANIUM BOLT IS REMOVED FOR ANY REASON, ALWAYS REPLACE THE BOLT WITH AN ALTERNATIVE FASTENER.

$\boxed{I}$ 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.

$\boxed{J}$ THIS FASTENER IS ONLY PERMITTED IN METAL-TO-METAL ASSEMBLIES. DO NOT USE THESE FASTENERS IN COMPOSITE-TO-COMPOSITE OR COMPOSITE-TO-METAL ASSEMBLIES.

$\boxed{K}$ THIS FASTENER IS NOT PERMITTED IN AREAS WHERE THE TEMPERATURE IS MORE THAN 450°F (232°C).

$\boxed{L}$ 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.

NOTE: 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.

$\boxed{M}$ 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.

$\boxed{N}$ THIS FASTENER IS PERMITTED FOR FASTENERS THAT ARE 0.625 INCH OR LESS IN DIAMETER.

$\boxed{O}$ THESE COLLARS CAN BE USED ON SURFACES THAT HAVE A SLOPE OF 7 DEGREES (OR LESS) ANGLE.

$\boxed{P}$ THE PART WITH D-CODE (DRIVE NUT) IS RECOMMENDED.

$\boxed{Q}$ 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.

$\boxed{R}$ A WASHER IS NECESSARY FOR THIS TYPE OF INSTALLATION. REFER TO SRM 51-40-02.

$\boxed{S}$ SUBSTITUTION IS PERMITTED FOR 0.3125 AND 0.375 DIAMETER FASTENERS ONLY.

$\boxed{T}$ THE FASTENER MUST BE INSTALLED WITH TORQUE CONTROLLED TOOLING. REFER TO SRM 51-40-04.

$\boxed{U}$ 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		BACB30MB()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()	NO EQUIVALENT	BACB30FM()-() L M	BACC30M()
					BACN10XJ() T
				BACB30MY()K()	BACC30M()
					BACN10XJ() T
				BACB30VT()K()	BACC30BL()
					BACN10YZ() T
				BACB30FM()AK()	BACC30M()
					BACN10XJ() T
		BACC30AG()	NO EQUIVALENT	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()-() $\boxed{AA}$	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() $\boxed{H}$ $\boxed{AA}$	6AL-4V TITANIUM CADMIUM PLATED, 95 KSI SHEAR, CETYL ALCOHOL LUBRICATED, MAX TEMP 450°F (232°C)	BACC30AB()C	NO EQUIVALENT	BACB30FM()AK() $\boxed{I}$	BACC30AB()C
					BACN10YT()CD $\boxed{T}$
				BACB30MB()AK() $\boxed{I}$	BACC30X()
					BACN10BH()
					BACN10YT()CD $\boxed{T}$
				BACB30MY()K() $\boxed{I}$	BACC30AB()C
					BACN10YT()CD $\boxed{T}$
				BACB30NX()K() $\boxed{I}$	BACC30BH()
					BACC30X()
					BACN10YT()CD $\boxed{T}$
				BACB30VT()K() $\boxed{I}$	BACC30BS()
		BACC30AG()		BACB30FM()-() $\boxed{A}$ $\boxed{L}$	BACC30AG()
					BACN10ZZ()D $\boxed{T}$
				BACB30FM()A()	BACC30AG()
					BACN10ZZ()D $\boxed{T}$
				BACB30FM()AK() $\boxed{I}$	BACC30AG()
					BACN10ZZ()D $\boxed{T}$
				BACB30MY()K() $\boxed{I}$	BACC30AG()
					BACN10ZZ()D $\boxed{T}$
				BACB30VN()K() $\boxed{I}$ $\boxed{J}$	BACC30BK()
				BACB30VT()K() $\boxed{I}$	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 SPS HL10VAZ HUCK HL10VAZ FAIRCHILD HL10VAZ DEUTSCH HL10VAZ AIC HL10VAZ WEST COAST HL10VAZ	BACB30VT()K()	BACC30BS()
		BACC30AB()S		BACB30FM()AK()	BACC30AB()S
					BACN10YT()CS T
					BACN10YT()CSA T
				BACB30MB()AK()	BACC30X()S
					BACN10BH()S
				BACB30NM()K() F	BACN10GW()AS
					NAS1805-() R
				BACB30NX()K()	BACC30BH()S R
					BACC30X()S
		BACC30AG()	NO EQUIVALENT	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 SPS HL10VAZ HUCK HL10VAZ FAIRCHILD HL10VAZ DEUTSCH HL10VAZ AIC HL10VAZ WEST COAST HL10VAZ	BACB30FM()-() [A] [L] [M]	BACC30AB()C
					BACC30AG()
					BACC30M()
					BACN10XJ() [T]
					BACN10YT()CD [T]
					BACN10ZZ()D [T]
				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 SPS HL10VRA HUCK HL10VRA FAIRCHILD HL10VRA DEUTSCH HL10VRA AIC HL10VRA WEST COAST HL10VRA	BACB30MY()K() I	BACC30AG()
		BACC30M()		BACB30MY()K() I	BACC30M() BACN10XJ() T
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 SPS HST108AG AIC HST108AG FAIRCHILD VL310AG HUCK VL310AG	BACB30VT5K()	
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 SPS HST10AG AIC HST10AG FAIRCHILD VL10AG HUCK VL10AG	BACB30MY()K()	BACC30AB()C BACC30AG() BACC30M()
				BACB30VN()K() J	BACC30BK() O
		BACC30BP()		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		NO EQUIVALENT	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() $\boxed{AA}$	A286 CRES, CADMIUM PLATED, 95 KSI SHEAR, CETYL ALCOHOL LUBRICATED, 100° (MS20426) HEAD, MAX TEMP 450°F (232°C)	BACC30AG()	HI-SHEAR HL445PB SPS HL445PB HUCK HL445PB DEUTSCH HL445PB FAIRCHILD HL445PB WEST COAST HL445PB	BACB30ND()-() $\boxed{A}$ $\boxed{L}$	BACC30AG()
					BACN10ZZ()D $\boxed{T}$
				BACB30NZ()K() $\boxed{I}$	BACC30AG()
					BACN10ZZ()D $\boxed{T}$
		BACC30M()		BACB30ND()-() $\boxed{A}$ $\boxed{L}$	BACC30M()
				BACB30NZ()K() $\boxed{I}$	BACC30M()
BACB30ND()A()U $\boxed{AA}$	A286 CRES, PASSIVATED, 95 KSI SHEAR, CETYL ALCOHOL LUBRICATED, 100° (MS20426) HEAD, MAX TEMP 900°F (482°C)	BACC30AB()P	HI-SHEAR HL445 SPS HL445 HUCK HL445 DEUTSCH HL445 FAIRCHILD HL445 WEST COAST HL445	NO ALTERNATIVE	
BACB30NW()C() $\boxed{H}$ $\boxed{AA}$	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()-() $\boxed{A}$ $\boxed{L}$	BACC30AB()C
					BACN10YT()CD $\boxed{T}$
				BACB30FN()A()	BACC30AB()C
					BACN10YT()CD $\boxed{T}$
				BACB30FN()AK() $\boxed{I}$	BACC30AB()C
					BACN10YT()CD $\boxed{T}$
				BACB30VU()K() $\boxed{I}$	BACC30BS()
				BACB30YP()K() $\boxed{I}$	BACC30BS()
		BACC30AG()		BACB30FN()-() $\boxed{A}$ $\boxed{L}$	BACC30AG()
					BACN10ZZ()D $\boxed{T}$
				BACB30FN()A()	BACC30AG()
					BACN10ZZ()D $\boxed{T}$
				BACB30FN()AK() $\boxed{I}$	BACC30AG()
					BACN10ZZ()D $\boxed{T}$
				BACB30NW()K() $\boxed{I}$	BACC30AG()
					BACN10ZZ()D $\boxed{T}$
				BACB30TY()K() $\boxed{I}$ $\boxed{J}$	BACC30BE()
				BACB30VM()K() $\boxed{I}$ $\boxed{J}$	BACC30BK()
				BACB30VU()K() $\boxed{I}$	BACC30BQ()
				BACB30YP()K() $\boxed{I}$	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() $\boxed{AA}$	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() $\boxed{J}$	BACC30BE()
				BACB30VM()K() $\boxed{J}$	BACC30BK()
				BACB30VU()K()	BACC30BL()
					BACN10YZ() $\boxed{T}$
		BACN10YT()CS		BACB30VU()K()	BACC30BS()S $\boxed{W}$
				BACB30YP()K()	BACC30BS()S $\boxed{W}$
		BACN10YT()CD		BACB30VU()K()	BACC30BS() $\boxed{W}$
				BACB30YP()K()	BACC30BS() $\boxed{W}$
BACB30NW()R() $\boxed{AA}$	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() $\boxed{I}$	BACC30BQ()
				BACB30YP()K() $\boxed{I}$	BACC30BQ()
		BACC30M()		BACB30VU()K() $\boxed{I}$	BACC30BL()
					BACN10YZ() $\boxed{T}$
				BACB30YP()K() $\boxed{I}$	BACC30BL()
					BACN10YZ() $\boxed{T}$
BACB30NW()S() $\boxed{AA}$	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() $\boxed{H}$ $\boxed{AA}$	6AL-4V TITANIUM, CAD PLATED 95 KSI SHEAR, CETYL ALCOHOL LUBRICATED, 100° (MS20426) HEAD, MAX TEMP 450°F (232°C)	BACC30M()	NO EQUIVALENT	BACB30ND()-() $\boxed{A}$ $\boxed{L}$	BACC30M()
				BACB30ND()A()	BACC30M()
				BACB30NZ()K() $\boxed{I}$	BACC30M()
		BACC30AG()		BACB30ND()-() $\boxed{A}$ $\boxed{L}$	BACC30AG()
					BACN10ZZ()D $\boxed{T}$
				BACB30ND()A()	BACC30AG()
					BACN10ZZ()D $\boxed{T}$
				BACB30NZ()K() $\boxed{I}$	BACC30AG()
					BACN10ZZ()D $\boxed{T}$
		BACC30AB()C		BACB30ND()A()	BACC30AB()C
				BACB30NZ()K() $\boxed{I}$	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 D S
		BACC30CH()		BACB30NZ()K()	BACC30AB()S WITH BACW10CA()CCU AND BACW10CA()PVU
		BACC30CK()		BACB30NZ()K()	BACC30M()
					BACN10YR()CD 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 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() 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() T
				BACB30VM()K() J	BACC30BK() O
				BACB30XT()K() J	BACC30BK() O
				BACB30VU()K()	BACC30BL()
					BACN10YZ() T
		BACC30BP()		BACB30VM()K() J	BACC30BK() O
				BACB30XT()K() J	BACC30BK() 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()	NO EQUIVALENT	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		NO EQUIVALENT	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 $\boxed{I}$	
HL645AP-()-() $\boxed{G}$	PH13-8 Mo STAINLESS STEEL, 100° FLUSH HEAD, ALUMINUM PIGMENTED COATING, CETYL ALCOHOL LUBRICATED		NO EQUIVALENT	BACB30YN()K() HLT421AP-()-()	
HL645PB-()-() $\boxed{G}$	PH13-8 Mo STAINLESS STEEL, 100° FLUSH HEAD, CADMIUM PLATED, CETYL ALCOHOL LUBRICATED		NO EQUIVALENT	BACB30YN()K() $\boxed{I}$ HLT421AP-()-() $\boxed{I}$	
HL645TB-()-() $\boxed{G}$	PH13-8 Mo STAINLESS STEEL, 100° FLUSH HEAD, SOLID FILM, CETYL ALCOHOL LUBRICATED		NO EQUIVALENT	BACB30YN()K() $\boxed{I}$ HLT421AP-()-() $\boxed{I}$	
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()-() $\boxed{A}$ $\boxed{L}$	BACC30BH() BACC30X() BACN10YT()CD $\boxed{T}$
				BACB30MB()A()	BACC30BH() BACC30X() BACN30YT()CD $\boxed{T}$
				BACB30MB()AK() $\boxed{I}$	BACC30BH() BACC30X() BACN30YT()CD $\boxed{T}$
				BACB30NX()K() $\boxed{I}$	BACC30BH() BACC30X() BACN30YT()CD $\boxed{T}$
BACB30XH()K()	6AL-4V TITANIUM, LIGHTWEIGHT, AL COATED, CETYL ALCOHOL LUBRICATED, SWAGE LOCKING	BACC30CG()	NO EQUIVALENT	BACB30NX()K()	BACC30AB()S BACN10YR()CM $\boxed{D}$ $\boxed{S}$
				BACB30VT()K() $\boxed{J}$	BACC30BS()S
		BACC30CH()		BACB30NX()K()	BACC30AB()S WITH BACW10CA()CCU AND BACW10CA()PVU
		BACC30CJ()		BACB30NX()K()	BACC30BH()S
		BACC30CK()		BACB30NX()K()	BACC30M() BACN10YR()CD $\boxed{D}$
				BACB30VT()K() $\boxed{J}$	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 $\boxed{D}$ $\boxed{S}$
		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		NO EQUIVALENT	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		
HLT622PB-()-()	NICKEL ALLOY 718, CADMIUM PLATED, 1/64 OVERSIZE, CETYL ALCOHOL LUBRICATED		NO EQUIVALENT	BACB30YK()K()X $\boxed{I}$	

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
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	BACB30YK()K()Y [I]	

BOLT - HEX DRIVE - PROTRUDING HEAD (TENSION)
TABLE IV

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() $\boxed{H}$ $\boxed{AA}$	6AL-4V TITANIUM, 160 KSI TENSION, CADMIUM PLATED, CETYL ALCOHOL, LUBRICATED MAX TEMP 450°F (232°C)	BACC30X() OR BACC30BH()	NO EQUIVALENT	BACB30JC()-() $\boxed{A}$ $\boxed{L}$	BACC30BH()
					BACC30X()
					BACN10YT()CD $\boxed{T}$
				BACB30JC()A()	BACC30BH()
					BACC30X()
					BACN10YT()CD $\boxed{T}$
				BACB30JC()AK() $\boxed{I}$	BACC30BH()
					BACC30X()
					BACN10YT()CD $\boxed{T}$
				BACB30NY()K() $\boxed{I}$	BACC30BH()
					BACC30X()
					BACN10YT()CD $\boxed{T}$
BACB30NY()K() $\boxed{AA}$	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()-() $\boxed{A}$ $\boxed{L}$ $\boxed{M}$	BACC30BH()
					BACC30X()
					BACN10YT()CD $\boxed{T}$
				BACB30JC()A() $\boxed{M}$	BACC30BH()
					BACC30X()
					BACN10YT()CD $\boxed{T}$
				BACB30JC()AK()	BACC30BH()
					BACC30X()
					BACN10YT()CD $\boxed{T}$
				BACB30NY()K()	BACN10YT()CD $\boxed{T}$
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 OVERSIZE, CADMIUM PLATED, CETYL ALCOHOL LUBRICATED		NO EQUIVALENT	BACB30YM()K()Y $\boxed{I}$	

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() $\boxed{I}$ BACB30US()P() BACB30US()K() $\boxed{I}$	
BACB30GE()-()	HEX CLOSE TOL 160,000 PSI SHORT THREAD		NO EQUIVALENT	BACB30LE()-() $\boxed{B}$ BACB30LE()K() $\boxed{B}$ $\boxed{I}$ BACB30LJ()-() BACB30LM()-() BACB30LT()-() BACB30MR()K() $\boxed{B}$ $\boxed{I}$ BACB30NE()-() $\boxed{A}$ $\boxed{L}$ BACB30NF()-() BACB30NM()K() $\boxed{I}$ BACB30NR()K() $\boxed{I}$ $\boxed{V}$ BACB30US()K() $\boxed{B}$ $\boxed{I}$ BACB30US()P() $\boxed{B}$ 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() $\boxed{I}$ BACB30US()K() $\boxed{I}$ 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() $\boxed{B}$ BACB30PN()-() $\boxed{B}$ BACB30US()-() $\boxed{B}$ $\boxed{U}$ 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() $\boxed{B}$ BACB30PN()-() $\boxed{B}$ BACB30US()-() $\boxed{B}$ 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()-() $\boxed{B}$ BACB30LE()K() $\boxed{B}$ $\boxed{I}$ BACB30MR()K() $\boxed{B}$ $\boxed{I}$ BACB30NM()K() $\boxed{I}$ BACB30US()K() $\boxed{B}$ $\boxed{I}$	
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() $\boxed{B}$ BACB30LM()U() BACB30PN()-() $\boxed{B}$ BACB30US()-() $\boxed{B}$ 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() $\boxed{B}$ BACB30PN()-() $\boxed{B}$ BACB30US()-() $\boxed{B}$ $\boxed{U}$	
BACB30LT()-()	A286 CRES, CADMIUM PLATED, 12 POINT HEAD, SHORT THREAD, 110 KSI SHEAR, MAX TEMP 450°F (232°C)		NO EQUIVALENT	BACB30LE()-() $\boxed{B}$ BACB30LE()K() $\boxed{B}$ $\boxed{I}$ BACB30US()K() $\boxed{B}$ $\boxed{I}$ BACB30US()P() $\boxed{B}$ BACB30LT()K() $\boxed{I}$	

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() $\boxed{M}$	$\boxed{X}$
				BACB30US()K()D $\boxed{B}$	$\boxed{X}$
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()-() $\boxed{M}$	
				BACB30US()K() $\boxed{B}$	
				BACB30US()P() $\boxed{B}$ $\boxed{M}$	
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() $\boxed{H}$	6AL-4V TITANIUM, CAD PLATED, 12 POINT, HEAD LONG THREADED. 95 KSI MAX TEMP 450°F (232°C)		NO EQUIVALENT	BACB30LE()K() $\boxed{I}$	
				BACB30MR()K() $\boxed{I}$	
				BACB30US()K() $\boxed{I}$	
				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()-() $\boxed{M}$	
				BACB30LE()K()	
				BACB30US()K()	
				BACB30US()P() $\boxed{M}$	

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() BACB30US()K()D	[X] [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() $\boxed{G}$	PH13-8Mo CRES, PASSIVATED, 12 POINT HEAD, SHORT THREAD, 125 KSI SHEAR, DRY FILM LUBRICATED, MAX TEMP 450°F (232°C)		NO EQUIVALENT	BACB30US()-() $\boxed{B}$	
BACB30NL()U() $\boxed{G}$	PH13-8Mo CRES, PASSIVATED, 12 POINT HEAD, SHORT THREAD, 125 KSI SHEAR, MAX TEMP 600°F (316°C)		NO EQUIVALENT	BACB30US()-() $\boxed{B}$	
BACB30NM()C() $\boxed{H}$	6AL-4V TITANIUM, CADMIUM PLATED, HEX HEAD, LONG THREAD, 160 KSI TENSION, MAX TEMP 450°F (232°C)		NO EQUIVALENT	BACB30LE()K() $\boxed{B}$ $\boxed{I}$ BACB30MR()K() $\boxed{B}$ $\boxed{I}$ BACB30NM()K() $\boxed{I}$ BACB30US()K() $\boxed{B}$ $\boxed{I}$ BACB30US()P() $\boxed{B}$	
BACB30NM()K()	6AL-4V TITANIUM, ALUMINUM PIGMENTED COATING, HEX HEAD, LONG THREAD, 160 KSI TENSION, MAX TEMP 350°F (177°C)		NO EQUIVALENT	BACB30LE()-() $\boxed{B}$ $\boxed{M}$ BACB30LE()K() $\boxed{B}$ BACB30MR()K() $\boxed{B}$ BACB30US()K() $\boxed{B}$ BACB30US()P() $\boxed{B}$ $\boxed{M}$	
BACB30NR()C() $\boxed{H}$	6AL-4V TITANIUM, CADMIUM PLATED, HEX HEAD, SHORT THREAD, 95 KSI SHEAR, MAX TEMP 450°F (232°C)		NO EQUIVALENT	BACB30LE()K() $\boxed{B}$ $\boxed{I}$ BACB30MR()K() $\boxed{B}$ $\boxed{I}$ BACB30NM()K() $\boxed{I}$ BACB30NR()K() $\boxed{I}$ BACB30US()K() $\boxed{B}$ $\boxed{I}$ BACB30US()P() $\boxed{B}$	

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()-() $\boxed{B}$	
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() $\boxed{B}$ BACB30US()P() $\boxed{B}$ $\boxed{M}$ BACB30UU()P() $\boxed{M}$	
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() $\boxed{B}$ BACB30US()K() $\boxed{B}$ $\boxed{I}$ BACB30UU()K() $\boxed{I}$	
BACB30XJ()K()	6AL-4V TITANIUM, HEX HEAD, 150 KSI TENSILE, LONG THREAD, ALUMINUM PIGMENTED COATING	NAS1805-()L	NO EQUIVALENT	BACB30XL()K() $\boxed{B}$	NAS1805-()L $\boxed{R}$

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()-() $\boxed{B}$	
				BACB30LE()K() $\boxed{B}$ $\boxed{I}$	
				BACB30LJ()-()	
				BACB30LM()-()	
				BACB30LT()-()	
				BACB30NE()-() $\boxed{A}$ $\boxed{L}$	
				BACB30NF()-()	
				BACB30NR()K() $\boxed{I}$ $\boxed{V}$	
				BACB30US()K() $\boxed{B}$ $\boxed{I}$	
				BACB30US()P() $\boxed{B}$	
				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()-() $\boxed{B}$	
				BACB30LE()K() $\boxed{B}$ $\boxed{I}$	
				BACB30LM()-()	
				BACB30MR()K() $\boxed{B}$ $\boxed{I}$	
				BACB30NF()-()	
				BACB30NM()K() $\boxed{I}$	
				BACB30US()K() $\boxed{B}$ $\boxed{I}$	
				BACB30US()P() $\boxed{B}$	
				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() $\boxed{B}$	

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)		NO EQUIVALENT	BACB30LH()D() BACB30LR()D() BACB30LU()D()	$\boxed{X}$
BACB30AB-P()-()A	ALLOY STEEL 100° CLOSE TOLERANCE 160 KSI PHILLIPS RECESS, SHORT THREAD, UNDRILLED, CADMIUM PLATED, MAX TEMP 450°F (232°C)		NO EQUIVALENT	BACB30LH()-() BACB30LP()-() BACB30LR()-() BACB30LU()-() BACB30MS()K() $\boxed{I}$ BACB30NN()K() $\boxed{I}$	
BACB30EL()-()	ALLOY STEEL, CADMIUM PLATED, HI-TORQUE RECESS, 100° REDUCED HEAD, SHORT THREAD, 95 KSI SHEAR, MAX TEMP 450°F (232°C)		NO EQUIVALENT	BACB30EL()C() BACB30EL()CN() BACB30NU()K() $\boxed{I}$ BACB30VF()K() $\boxed{I}$ 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)		NO EQUIVALENT	BACB30NU()K() $\boxed{I}$ BACB30VF()K() $\boxed{I}$ NAS8703 THRU NAS8712 $\boxed{K}$	
BACB30FA()-()P	ALLOY STEEL, CADMIUM PLATED, HI-TORQUE RECESS, SELF-LOCKING, 100° HEAD, MAX TEMP 450°F (232°C)		NO EQUIVALENT	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-() $\boxed{A}$ $\boxed{L}$ $\boxed{M}$ 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()-() $\boxed{A}$ $\boxed{L}$ BACB30MS()K() $\boxed{I}$ BACB30NN()K() $\boxed{I}$	
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)		NO EQUIVALENT	BACB30LP()-()	
				BACB30LU()-() A L	
				BACB30NN()K() 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)		NO EQUIVALENT	BACB30LP()-() M	
				BACB30LR()-() M	
				BACB30LU()-() A L M	
				BACB30MS()K() V	
				BACB30NN()K()	
BACB30LR()DK()		BACN10JD() OR BACN11N() OR MS14144		BACB30LR()D() M	X
BACB30LR()U()	A286 CRES, 100° HEAD, CROSS RECESS, LONG THREAD, CLOSE TOLERANCE, PASSIVATED, 160 KSI TENSION, MAX TEMP 900°F (482°C)		NO EQUIVALENT	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)		NO EQUIVALENT	BACB30LP()-()	
				BACB30LR()-()	
				BACB30NN()K() 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() $\boxed{H}$	6AL-4V TITANIUM, 100° HEAD, DOVETAIL RECESS, LONG THREAD, CADMIUM PLATED, 160 KSI TENSION, MAX TEMP 350°F (177°C)		NO EQUIVALENT	BACB30MS()K() $\boxed{I}$ BACB30NN()K() $\boxed{I}$ BACB30WP()K()R $\boxed{I}$	
BACB30MS()K()	6AL-4V TITANIUM, 100° HEAD, DOVETAIL RECESS, LONG THREAD, ALUMINUM PIGMENTED COATING, 160 KSI TENSION, MAX TEMP 350°F (177°C)		NO EQUIVALENT	BACB30NN()K() BACB30WP()K()R	
BACB30NN()C() $\boxed{H}$	6AL-4V TITANIUM, 100° HEAD, CROSS RECESS, LONG THREAD, CADMIUM PLATED, 160 KSI, TENSION, MAX TEMP 450°F (232°C)		NO EQUIVALENT	BACB30MS()K() $\boxed{I}$ $\boxed{Y}$ BACB30NN()K() $\boxed{I}$ BACB30WP()K()R $\boxed{I}$	
BACB30NN()K()	6AL-4V TITANIUM, 100° HEAD, CROSS RECESS, LONG THREAD, ALUMINUM PIGMENTED COATING, 160 KSI TENSION, MAX TEMP 350°F (177°C)		NO EQUIVALENT	BACB30MS()K() $\boxed{Y}$ 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() $\boxed{H}$	6AL-4V TITANIUM, 100° REDUCED HEAD, DOVETAIL RECESS, SHORT THREAD, 95 KSI SHEAR, CADMIUM PLATED, MAX TEMP 450°F (232°C)		NO EQUIVALENT	BACB30NU()K() $\boxed{I}$ BACB30VF()K() $\boxed{I}$	
BACB30NU()K()	6AL-4V TITANIUM, 100° REDUCED HEAD, DOVETAIL RECESS, SHORT THREAD, 95 KSI SHEAR, ALUMINUM PIGMENTED COATING, MAX TEMP 350°F (177°C)		NO EQUIVALENT	BACB30VF()K()	
BACB30NU()R()	6AL-4V TITANIUM, 100° REDUCED HEAD, DOVETAIL RECESS, SHORT THREAD, 95 KSI SHEAR, PHOSPHATE FLUORIDE COATED, CETYL ALCOHOL LUBRICATED		NO EQUIVALENT	BACB30NU()K() $\boxed{I}$ BACB30VF()K() $\boxed{I}$ BACB30VF()R()	
BACB30SW()-() $\boxed{E}$	H-11 STEEL, DIFFUSED NICKEL CADMIUM PLATED,100° HEAD, HI-TORQUE, 125 KSI SHEAR, LONG THREAD		NO EQUIVALENT	$\boxed{C}$	
BACB30SW()K() $\boxed{E}$	H-11 STEEL, ALUMINUM PIGMENTED COATING, 100° HEAD, HI-TORQUE, 125 KSI SHEAR, LONG THREAD		NO EQUIVALENT	$\boxed{C}$	

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)		NO EQUIVALENT	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)		NO EQUIVALENT	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)		NO EQUIVALENT	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() $\boxed{B}$	
				BACB30LJ()U()	
				BACB30LM()U()	
				BACB30LT()U()	
				BACB30US()-() $\boxed{B}$	
				NAS6703U THRU NAS6720U	
BACB30NT()C() $\boxed{H}$	6AL-4V TITANIUM, CAD PLATED, PHILLIPS RECESS SHORT THREADED. 95 KSI MAX TEMP 450°F (232°C)		NO EQUIVALENT	BACB30LE()K() $\boxed{B}$ $\boxed{I}$	
				BACB30LK()-()	
				BACB30MR()K() $\boxed{B}$ $\boxed{I}$	
				BACB30NJ()K() $\boxed{I}$	
				BACB30NM()K() $\boxed{I}$	
				BACB30NR()K() $\boxed{I}$	
				BACB30NT()K() $\boxed{I}$	
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()-() $\boxed{B}$ $\boxed{M}$	
				BACB30LE()K() $\boxed{B}$	
				BACB30LJ()-() $\boxed{M}$	
				BACB30LK()-() $\boxed{M}$	
				BACB30LM()-() $\boxed{M}$	
				BACB30LT()-() $\boxed{M}$	
				BACB30MR()K() $\boxed{B}$	
				BACB30NE()-() $\boxed{A}$ $\boxed{L}$ $\boxed{M}$	
				BACB30NF()-() $\boxed{A}$ $\boxed{L}$ $\boxed{M}$	
				BACB30NM()K()	
				BACB30NR()K()	
				BACB30US()K() $\boxed{B}$	
				BACB30US()P() $\boxed{B}$ $\boxed{M}$	
				NAS6603 THRU NAS6620 $\boxed{A}$ $\boxed{L}$ $\boxed{M}$	
				NAS6703 THRU NAS6720 $\boxed{M}$	

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()-() $\boxed{B}$ BACB30LE()K() $\boxed{B}$ $\boxed{I}$ BACB30LJ()-() BACB30LK()-() BACB30LM()-() BACB30LT()-() BACB30MR()K() $\boxed{B}$ $\boxed{I}$ BACB30NM()K() $\boxed{I}$ BACB30NR()K() $\boxed{I}$ BACB30NT()K() $\boxed{I}$	
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()-() $\boxed{B}$ BACB30LE()K() $\boxed{B}$ $\boxed{I}$ BACB30LJ()-() BACB30LK()-() BACB30LM()-() BACB30LT()-() BACB30MR()K() $\boxed{B}$ $\boxed{I}$ BACB30NM()K() $\boxed{I}$ BACB30NR()K() $\boxed{I}$ BACB30NT()T() $\boxed{I}$ NAS623-()-() $\boxed{L}$	

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()-() $\boxed{P}$ 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()-() $\boxed{P}$ BACB30VL()C()D	
BACB30VL()C()D	LOW PROFILE HEAD, SHEAR, LIGHTWEIGHT, 304 CRES SLEEVE, A-286 SS NUT, DISPOSABLE DRIVE NUT		NO EQUIVALENT	BACB30VL()-() $\boxed{P}$ 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 51-30-01 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()-() H	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()A()	A-286 CRES, C.T. SHANK, 1.0 PINTAIL, (PULL TYPE, GUN DRIVEN), CADMIUM PLATED	BACC30K()	NO EQUIVALENT	BACB30VN()K() C	BACC30BK()
				BACB30VT()K() C	BACC30BL() A B
					BACC30BP() B
					BACN10YZ() A B G
					BACC30BQ() A
		NAS1080E()		BACB30FM()A()	BACC30AB()C A B
					BACC30AG() A E
				BACB30VN()K() C	BACC30BK() E
				BACB30VT()K() C	BACC30BL() A B E
					BACC30BP() B E
					BACC30BQ() A E
					BACC30BS() A B
					BACN10YZ() A B G 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() $\boxed{C}$ $\boxed{D}$	BACC30BL() $\boxed{A}$ $\boxed{B}$
					BACC30BP() $\boxed{B}$
					BACC30BQ() $\boxed{A}$
					BACN10YZ() $\boxed{A}$ $\boxed{B}$ $\boxed{G}$
				BACB30XT()K() $\boxed{C}$ $\boxed{D}$	BACC30BK()
		NAS1080E		BACB30VU()K() $\boxed{C}$ $\boxed{D}$	BACC30BL() $\boxed{A}$ $\boxed{B}$ $\boxed{E}$
					BACC30BP() $\boxed{B}$ $\boxed{E}$
					BACC30BQ() $\boxed{A}$ $\boxed{E}$
					BACC30BS() $\boxed{A}$ $\boxed{B}$
					BACN10YZ() $\boxed{A}$ $\boxed{B}$ $\boxed{E}$ $\boxed{G}$
				BACB30XT()K() $\boxed{C}$ $\boxed{D}$	BACC30BK() $\boxed{E}$
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 $\boxed{A}$ $\boxed{B}$
BACB30GY()D()N	ALLOY STEEL, NICKEL-CADMIUM PLATED, 95 KSI SHEAR, LUBRICATED, PULL TYPE, MAX TEMP 600°F (316°C)	NAS1080E	NO EQUIVALENT	$\boxed{J}$	

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() $\boxed{A}$ $\boxed{B}$
					BACN10XJ() $\boxed{A}$ $\boxed{B}$ $\boxed{G}$
				BACB30VU()K()	BACC30BL() $\boxed{A}$ $\boxed{B}$
					BACC30BP() $\boxed{B}$
					BACC30BQ() $\boxed{A}$
					BACN10YZ() $\boxed{A}$ $\boxed{B}$ $\boxed{G}$
				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() $\boxed{A}$ $\boxed{B}$
				BACB30VU()K()	BACC30BP() $\boxed{B}$
					BACC30BL() $\boxed{A}$ $\boxed{B}$
					BACC30BQ() $\boxed{A}$
					BACB10YZ() $\boxed{A}$ $\boxed{B}$ $\boxed{G}$
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() $\boxed{A}$ $\boxed{B}$
				BACB30VU()K()	BACC30BL() $\boxed{A}$ $\boxed{B}$
					BACC30BP() $\boxed{B}$
					BACC30BQ() $\boxed{A}$
					BACN10YZ() $\boxed{A}$ $\boxed{B}$ $\boxed{G}$

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	$\boxed{J}$	
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() $\boxed{A}$ $\boxed{B}$ BACC30X() $\boxed{A}$ $\boxed{B}$ BACN10YT()CD $\boxed{A}$ $\boxed{B}$ $\boxed{G}$
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)

INITIAL FASTENER OR SPECIFIED REPAIR FASTENER			FASTENER SUBSTITUTION		
PART NUMBER	DESCRIPTION	MATING PART	EQUIVALENT	ALTERNATIVE	MATING PART
BACB30GX()-()	ALLOY STEEL, CADMIUM PLATED, 160 KSI TENSION, LUBRICATED, 100° (AN509) HEAD, PULL TYPE, MAX TEMP 250°F (121°C)	NAS1080 OR NAS1080P OR NAS1080R	NO EQUIVALENT	BACB30JC()-() H	BACC30BH() A B
					BACC30X() A B
					BACN10YT()CD A B G
				BACB30JC()A()	BACC30BH() A B
					BACC30X() A B
					BACN10YT()CD A B G
BACB30GX()-()X	ALLOY STEEL, CAD PLATED, UNLUBRICATED 95 KSI SHEAR MAX TEMP 450°F (232°C)	NAS1080 OR NAS1080P OR NAS1080R	NO EQUIVALENT	J	
BACB30GX()D()N	ALLOY STEEL, DIFFUSED NICKEL-CADIUM PLATED, 160 KSI TENSION, LUBRICATED, 100° (AN509) HEAD, PULL TYPE, MAX TEMP 600°F (316°C)		NO EQUIVALENT	J	
BACB30HD()-()	ALLOY STEEL, CADMIUM PLATED, 160 KSI TENSION, LUBRICATED, 100° (MS20426) HEAD, STUMP TYPE, MAX TEMP 250°F (121°C)	NAS1080	NO EQUIVALENT	BACB30DY()-()	NAS1080
				BACB30DY()A()	NAS1080
		NAS1080R		BACB30DY()-()	NAS1080R
				BACB30DY()A()	NAS1080R
BACB30HD()A()	A286 CRES, CADMIUM PLATED, 160 KSI TENSION, LUBRICATED, 100° (AN509) HEAD, STUMP TYPE, MAX TEMP 250°F (121°C)	NAS1080	NO EQUIVALENT	BACB30DY()A()	NAS1080
		NAS1080R		BACB30DY()A()	NAS1080R
		BACC30Q()		BACB30DY()A()	BACC30Q()

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()-() $\boxed{H}$	BACC30X() $\boxed{A}$ $\boxed{B}$
				BACB30NY()K() $\boxed{C}$	BACC30X() $\boxed{A}$ $\boxed{B}$
				BACB30UA()K() $\boxed{C}$	BACC30BF()
		NAS1080R		BACB30JC()-() $\boxed{H}$	BACC30X() $\boxed{A}$ $\boxed{B}$
				BACB30NY()K() $\boxed{C}$	BACC30X() $\boxed{A}$ $\boxed{B}$
BACB30UA()K()	6AL-4V TITANIUM, 100° HEAD, 160 KSI TENSION, ALUMINUM PIGMENTED COATING, CETYL ALCOHOL LUBRICATED	BACC30BF()	NO EQUIVALENT	BACB30NY()K()	BACC30BH() $\boxed{A}$ $\boxed{B}$
					BACC30X() $\boxed{A}$ $\boxed{B}$
					BACN10YT()CD $\boxed{A}$ $\boxed{B}$ $\boxed{G}$

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 section can be used for fasteners in structural repairs, (unless a Service Bulletin or Engineer Drawing shows 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 Figure 1/GENERAL.

B. The torque values for hex-drive bolts in metallic materials are given in Figure 2/GENERAL.

C. The torque values for radius lead-in bolts in metallic materials are given in Figure 3/GENERAL.

D. The torque values for fasteners in composite materials are given in Figure 4/GENERAL.

E. Refer to 51-40-02, GENERAL for procedures on how to install bolts, washers, nuts, and locknuts.

3. References

Reference	Title
51-40-02, GENERAL	Fastener Installation and Removal

4. Torque Wrench Adapters and Extensions

A. Torque wrench adpaters and/or extensions are used when it is difficult to apply the torque wrench directly.

B. When you use adapters and/or extensions, a corrected torque wrench reading is necessary. Follow the examples in Figure 5/GENERAL to find the corrected torque wrench reading.

C. Only use adapters on rigid frame torque wrenches.

D. Apply force to the torque wrench handle or handle extension, perpendicular to the handle and in its plane of rotation.

NUT PART NUMBER AND STYLE	BACN10JC (THREAD SIZES 1/2 THRU 1-1/2), 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 [A]	TORQUE RANGE IN-LBS [A]
	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	—
1.2500 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 [E]
TABLE I [D]

NOTES

- THE SOURCE OF INFORMATION FOR THIS FIGURE CAN BE FOUND IN BOEING PROCESS SPECIFICATION BAC5009.

[A] 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.

[B] WHEN AN UNLUBRICATED BOLT IS USED, USE THE DRY BOLT COLUMN FOR TORQUE VALUES. (THIS INCLUDES IF WET SEALANT IS ON THE BOLT THREADS).

[C] 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-23827 GREASE APPLIED TO THE THREADS.

[D] SEE TABLE II FOR REDUCED SHEAR HEAD BOLTS.

[E] 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.

[F] INSTALLATION TORQUE FOR 3/4-16 BACB30MR, BACB30XL, BACB30NM, BACB30XJ, BACB30MS, BACB30NN, BACB30XK, AND BACB30XM IS 1000 TO 2200IN-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 4)

NUT PART NUMBER AND STYLE	BACN10HR (12 POINT), BACN10JG (12 POINT), BACN10HC (BARREL NUT), BACN10YN (12 POINT, VESPEL)	NAS1804 (12 POINT), NAS1805 (12 POINT), BACN10B (12 POINT), BACN10GW (12 POINT), BACN10JA (PLATE NUT), BACN10JB (PLATE NUT), BACN10RM (PLATE NUT), NAS577 (BARREL NUT), BACN10JD (CASTELLATED-THICK STYLE)			
BOLT HEAD STYLE	12 POINT	12 POINT	HEX	PAN	100 DEG
BOLT PART NUMBER	BACB30NH BACB30US BACB30MT BACB30TR -- -- -- -- -- -- -- -- --	BACB30FD BACB30LE BACB30MR BACB30XL BACB30PN MS21250 -- -- -- -- -- -- --	BACB30NM BACB30XJ BACB30NE BACB30LM NAS6603 THRU NAS6620 NAS6703 THRU NAS6720 NAS6803 THRU NAS6820	BACB20LN BACB30NS BACB30EM NAS1216 -- -- -- -- -- -- -- -- --	BACB30LP BACB30EM BACB30LU BACB30LR BACB30MS BACB30NN BACB30XK BACB30XM BACB30SW BACB30XA -- -- --

THREAD SIZE AND BASIC MAJOR DIAMETER	TORQUE RANGE IN-LBS $\boxed{A}$		TORQUE RANGE IN-LBS $\boxed{A}$	
	DRY BOLT $\boxed{B}$	LUBED BOLT $\boxed{C}$	DRY BOLT $\boxed{B}$	LUBED BOLT $\boxed{C}$
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	70 TO 100	50 TO 60	30 TO 35	20 TO 25
0.2500 1/4-28	90 TO 125	70 TO 80	60 TO 100	50 TO 75
0.3125 5/16-24	180 TO 250	145 TO 180	130 TO 200	90 TO 125
0.3750 3/8-24	300 TO 500	275 TO 330	220 TO 410	150 TO 250
0.4375 7/16-20	510 TO 840	370 TO 440	370 TO 690	260 TO 425
0.5000 1/2-20	870 TO 1300	500 TO 650	630 TO 1070	440 TO 650
0.5625 9/16-18	1300 TO 1800	800 TO 1000	1000 TO 1470	700 TO 920
0.6250 5/8-18	1900 TO 2300	1350 TO 1650	1400 TO 1900	1000 TO 1200
0.7500 3/4-16	3300 TO 4300	2800 TO 3300	$\boxed{F}$	$\boxed{F}$
0.8750 7/8-14	5100 TO 6700	3900 TO 4500	3700 TO 5500	2600 TO 3400
1.0000 1-12 OR 1-14	7000 TO 10900	6200 TO 7000	5100 TO 8900	3600 TO 5500
1.1250 1-1/8-12	9500 TO 13000	8300 TO 9400	6900 TO 10700	4900 TO 6700
1.2500 1-1/4-12	15800 TO 19200	11000 TO 12000	11500 TO 15700	7500 TO 9700
1.3750 1-3/8-12	20000 TO 24000	16000 TO 17000	--	--
1.5000 1-1/2-12	--	--	--	--

NUT INSTALLATION TORQUE RANGE $\boxed{E}$
TABLE I $\boxed{D}$ (CONT)

Torque Values for External Wrenching Bolts in Metallic Materials
Figure 1 (Sheet 2 of 4)

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)				
BOLT HEAD STYLE	12 PT	HEX	PAN	100 DEG	SOCKET
BOLT PART NUMBER	BACB30LT, BACB30NL, BACB30UU, BACB30NJ	BACB30LJ, BACB30NR, BACB30NF, BACS12BG, BACB30PU, BACB30PW, BACB30XN, NAS563, NAS572, NAS1801, NAS1802, NAS6203 THRU NAS6220, NAS428, BACS12CB, BACS12GU	BACB30LK, BACB30NT, BACB30BE, BACS12BG, NAS1217, NAS1218, NAS600 THRU NAS623, BACS12CK, NAS8200 THRU NAS8206, BACS12FA	BACB30PC, BACB30LH, BACB30RF, BACB30SW, BACB30WP, BACS12BP, BACS12ER, BACS12GM, BACS12GR, NAS514, NAS517, BACS12GP, BACB30TP, BACS12BF, BACS12GX	MS21262 MS24678 NAS1351 NAS1352

THREAD SIZE AND BASIC MAJOR DIA.	TORQUE RANGE IN-LBS [A]	
	DRY BOLT [B]	LUBED BOLT [C]
0.0860 2-56 OR 2-64	3.4 TO 4.5	3.4 TO 4.5
0.1120 4-40 OR 4-48	6 TO 8	6 TO 8
0.1380 6-32 OR 6-40	12 TO 15	12 TO 15
0.1640 8-32 OR 8-36	15 TO 20	15 TO 17
0.1900 10-32	25 TO 35	20 TO 25
0.2500 1/4-28	50 TO 80	50 TO 75
0.3125 5/16-24	100 TO 150	90 TO 125
0.3750 3/8-24	160 TO 240	150 TO 200
0.4375 7/16-20	250 TO 350	240 TO 300
0.5000 1/2-20	480 TO 790	440 TO 650
0.5625 9/16-18	800 TO 1150	700 TO 920
0.6250 5/8-18	1100 TO 1500	1000 TO 1200
0.7500 3/4-16	2300 TO 3000	1700 TO 2150
0.8750 7/8-14	2500 TO 4500	2600 TO 3400
1.0000 1-12 OR 1-14	3700 TO 7500	3600 TO 5500
1.1250 1-1/8-12	5000 TO 9000	4900 TO 6700
1.2500 1-1/4-12	9000 TO 13000	7500 TO 9700
1.3750 1-3/8-12	--	--
1.5000 1-1/2-12	--	--

NUT INSTALLATION TORQUE RANGE [E]
TABLE I [D] (CONT)

Torque Values for External Wrenching Bolts in Metallic Materials
Figure 1 (Sheet 3 of 4)

NUT PART NUMBER AND STYLE		ALL
BOLT STYLE		100 DEGREE REDUCED SHEAR HEAD
PART NUMBER-BOLT		BACB30EL BACB30DP BACB30FB BACB30LL BACB30NU BACB30RF BACB30UW BACB30VF BACB30UR NAS1581 NAS1992 THRU NAS2000 NAS8703 THRU NAS8716 BACB30XD
THREAD SIZE AND BASIC MAJOR DIA.		TORQUE-RANGE IN-LBS [A]
		DRY BOLT [B]
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
1.1250	1-1/8-12	--
1.2500	1-1/4-12	--
1.3750	1-3/8-12	--
1.5000	1-1/2-12	--

REDUCED SHEAR HEAD BOLTS
TABLE II

Torque Values for External Wrenching Bolts in Metallic Materials
Figure 1 (Sheet 4 of 4)

FASTENER DIAMETER AND THREAD SIZE (INCH)	TORQUE RANGE (POUND-INCH)					
	SHEAR-TYPE HEX DRIVE BOLTS:					TENSION-TYPE HEX DRIVE BOLTS:
BOLT	BACB30YP BACB30VT BACB30VU		BACB30FM BACB30FN BACB30MY BACB30NW BACB30ND BACB30NZ BACB30YL BACB30YN HL360 HL834 HL420 HL421			BACB30JC BACB30MB BACB30NX BACB30NY BACB30YK BACB30YM HLT422 HLT423
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	NAS1804 NAS1805 BACN10GW KFN305 BACN10MT KFN511 MS21042 BACN10YT BACN11E
	TORQUE INCH-POUNDS					
5/32-32	15-25	15-25			15-25	25-35
3/16-32	25-35	25-35			23-28	30-40
1/4-28	60-80	60-80		60-80	60-75	80-95
5/16-24	110-140	130-160		125-145	120-150	150-200
3/8-24	160-200	200-240		200-210	180-210	260-360
7/16-20		270-330			270-330	390-480
1/2-20		370-430			370-430	640-800
9/16-18		500-575				740-900
5/8-18		625-700				800-1000
3/4-16		900-1000				1300-1650

TORQUE VALUES FOR LOCKNUTS ON HEX DRIVE BOLTS
TABLE I

Torque Values for Hex-Drive Bolts in Metallic Materials
Figure 2

NOMINAL THREAD SIZE	INSTALLATION TORQUE (INCH-POUNDS)					
	NUTS ON BACB30PT BOLTS				NUTS ON BACB30WQ AND BACB30WR 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 I

NOTES

- THE SOURCE OF INFORMATION FOR THIS FIGURE CAN BE FOUND IN BOEING PROCESS SPECIFICATION BAC5060.
- 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

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		---	23 TO 28	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 [A]
TABLE I

NOTES:

- THE SOURCE OF INFORMATION FOR THIS FIGURE CAN BE FOUND IN BOEING PROCESS SPECIFICATION BAC5063.

[A] 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.

[B] 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.

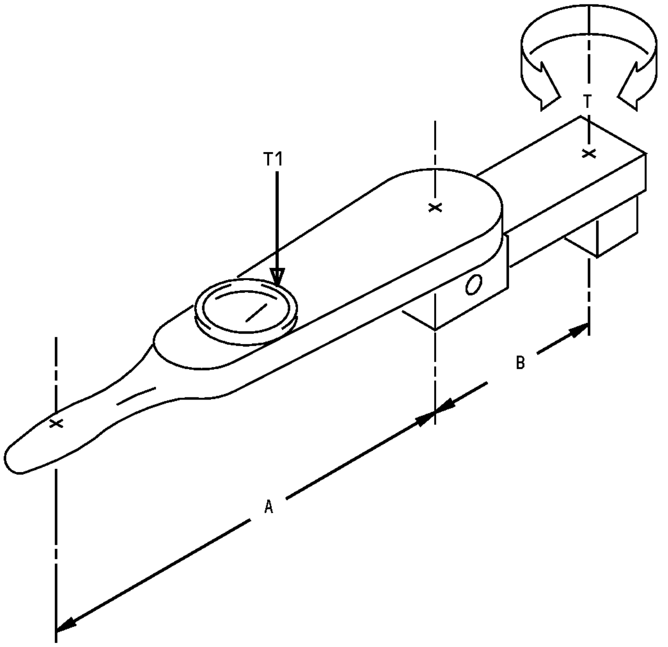
[C] THIS TABLE DOES NOT APPLY TO INSTALLATIONS WHERE A NUT, BOLT HEAD, OR WASHER BEARS DIRECTLY ON UNREINFORCED (EXAMPLE: NYLON) THERMOPLASTIC MATERIALS.

Torque Values for Fasteners in Composite Materials
Figure 4 (Sheet 1 of 2)

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 BACB30XL BACB30PN MS21250	BACB30NM BACB30XJ BACB30LM NAS6603 THRU NAS6620 NAS6703 THRU NAS6720 NAS6803 THRU NAS6820	NAS1216	BACB30LP BACB30LU BACB30LR BACB30MS BACB30NN BACB30XK BACB30XM S12GP
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	$\boxed{B}$			
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 $\boxed{A}$ $\boxed{C}$
TABLE II

Torque Values for Fasteners in Composite Materials
Figure 4 (Sheet 2 of 2)



A = LENGTH OF TORQUE WRENCH

B = LENGTH OF ADAPTER, AND EXTENSION BETWEEN ADAPTER AND TORQUE WRENCH IF USED.

T = ACTUAL TORQUE ON NUT

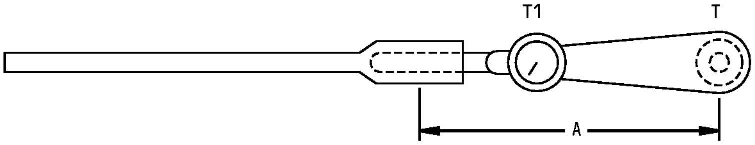
T1 = INDICATED TORQUE ON WRENCH (CORRECTED TORQUE WRENCH READING)

FOR THE FOLLOWING EXAMPLES ASSUME THAT:

A = 10 IN.
B = 10 IN.
C = 10 IN.
T = 150 POUND-INCHES

USING HANDLE EXTENSION ONLY
NO CORRECTION IS NECESSARY

T1 = T



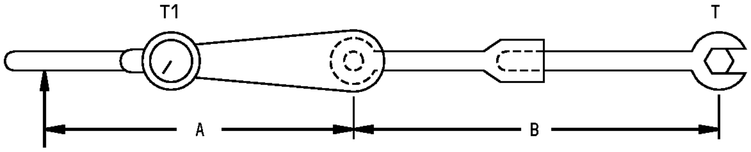
METHOD I

USING ADAPTER WITH EXTENSION BETWEEN ADAPTER AND WRENCH BOTH IN LINE WITH WRENCH. A CORRECTION IS NECESSARY

$$T1 = \frac{T \times A}{A + B}$$

$$T1 = \frac{150 \times 10}{10 + 10}$$

T1 = 75 POUND-INCHES



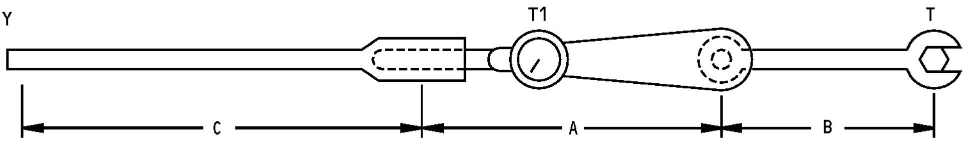
METHOD II

USING BOTH HANDLE EXTENSION AND 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

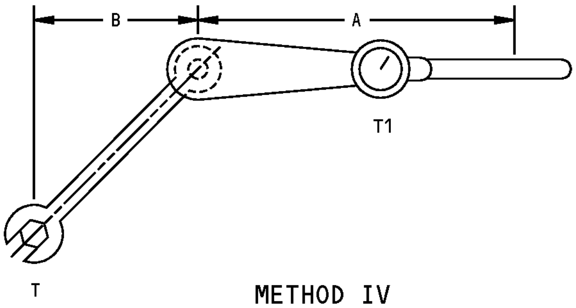
Torque Wrench Adapters and Extensions
Figure 5 (Sheet 1 of 2)

USING ADAPTER AT ANGLE OTHER THAN 90°.
A CORRECTION IS NECESSARY

$$T1 = \frac{T \times A}{A + B}$$

$$T1 = \frac{150 \times 10}{10 + 10}$$

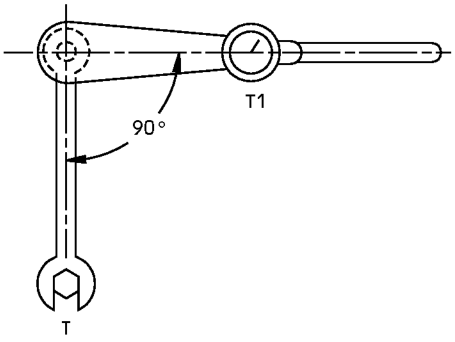
T1 = 75 POUND-INCHES



METHOD IV

USING ADAPTER AT RIGHT ANGLE TO THE
WRENCH. NO CORRECTION IS NECESSARY.

T1 = T



METHOD V

Torque Wrench 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 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
51-40-08, GENERAL	Countersinking
51-40-09, GENERAL	Coldworking of Holes for Fatigue Improvement
51-70-16, GENERAL	Hole Drilling and Machining of Composite Structures

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 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 hole is not used frequently 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	BAC5004
SOLID RIVETS	3	BAC5004-1
PERMANENT STRAIGHT SHANK FASTENERS	4	BAC5004-2
BLIND RIVETS AND BOLTS	5	BAC5004-3
BOLTS	6	BAC5009
FLUID-TIGHT FASTENERS	7	BAC5047
RADIUS LEAD-IN BOLTS	8	BAC5060
HOLES IN COMPOSITES	9	BAC5063

INDEX FOR 51-40-05 AND CROSS REFERENCE TO BOEING PROCESS SPECIFICATIONS

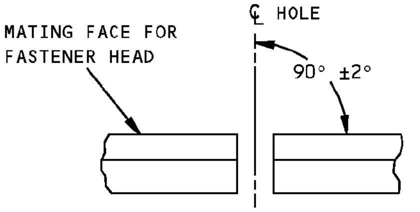
NOTES

- REFER TO SRM 51-40-08 FOR BACR15FV AND MS14218 RIVET HOLE SIZES.
- 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
TABLE I



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
DETAIL I

NOTES

- THE SOURCE OF INFORMATION FOR THIS FIGURE CAN BE FOUND IN BOEING PROCESS SPECIFICATIONS BAC5004, BAC5009, BAC5047, AND BAC5060.
- THE DATA IN THIS FIGURE APPLIES TO FIGURES 3 THRU 8. REFER TO SRM 51-70-16 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	0	(0.316)	0.316	0.327	0	(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
(EXCEPT FOR BACR15FV, MS14218 AND NASM-83459 RIVETS)
TABLE I [A]

ORIGINAL RIVET DIAMETER	(-6) 3/16		(-8) 1/4		(-10) 5/16		(-12) 3/8	
OVERSIZE RIVET DIAMETER (1/64 OVERSIZE)	(-61) 13/64		(-81) 17/64		-----------		-----------	
	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX
BACR15GF	0.205	0.209	0.268	0.272	--	--	--	--
OVERSIZE RIVET DIAMETER (1/64 OVERSIZE)	(-7) 7/32		(-9) 9/32		(-11) 11/32		(-13) 13/32	
	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX
BACR15GF BACR15DS	0.223	0.229	0.286	0.293	--	--	--	--
BACR15BA BACR15BB BACR15FT MS20426 MS20470 NAS1242	0.221	0.233	0.284	0.296	0.346	0.358	0.407	0.421

OVERSIZE HOLE DIMENSIONS FOR SOLID RIVETS
(EXCEPT FOR BACR15FV, MS14218 AND NASM-83459 RIVETS)
TABLE II [A]

NOTES

- THE SOURCE OF INFORMATION FOR THIS FIGURE CAN BE FOUND IN BOEING PROCESS SPECIFICATION BAC5004-1.
- THIS DATA APPLIES TO NON FLUID-TIGHT RIVETS.
- HOLE DIAMETERS IN THIS FIGURE CAN BE USED UNLESS AN APPLICABLE ENGINEER DRAWING SHOWS DIFFERENTLY.

[A] REFER TO SRM 51-40-08 FOR CONTERSINK AND HOLE DIMENSIONS FOR BACR15FV AND MS14218 RIVETS. NASM-83459 RIVETS ARE NOT USED ON THIS AIRPLANE.

Solid Rivet Fastener Holes
Figure 3

NOTES

- THE SOURCE OF INFORMATION FOR THIS FIGURE CAN BE FOUND IN BOEING PROCESS SPECIFICATION BAC5004-2.
- THIS DATA APPLIES TO PERMANENT TYPE, NONFLUID TIGHT, STRAIGHT SHANK FASTENERS (LOCKBOLTS AND HEX-DRIVE BOLTS).
- HOLE DIAMETERS IN THIS FIGURE CAN BE USED UNLESS AN APPLICABLE ENGINEER DRAWING SHOWS DIFFERENTLY.
- SEE TABLE I FOR INITIAL HOLE SIZES. SEE TABLES II AND III FOR OVERSIZE FASTENERS.
- CLOSE REAM HOLE DIAMETERS ARE APPLICABLE TO THE FOLLOWING STRUCTURES:
  - TITANIUM
  - STEEL
  - ALUMINUM AND TITANIUM
  - ALUMINUM AND STEEL.
- SEE DETAIL I AND TABLE IV FOR FINISHED HOLE SPECIFICATIONS FOR PROTRUDING HEAD FASTENERS. REFER TO SRM 51-40-08 FOR EQUIVALENT COUNTERSINK FASTENER SPECIFICATIONS.

A FOR 5/32 (0.164) INCH DIAMETER BACB30DX, BACB30DY, BACB30GP, AND BACB30GQ FASTENERS, THE HOLE DIAMETER LIMITS ARE 0.162 TO 0.165 INCH.

B IF THE EDGE MARGIN IS LESS THAN TWO DIAMETERS, TELL AN ENGINEER WHO HAS THE AUTHORITY TO DO AN ANALYSIS AND MAKE A DECISION.

C OVERSIZE FASTENER IS NOT AVAILABLE

D USE A 3/16 FASTENER IN A STANDARD SIZE HOLE.

E FOR PROPER INSTALLATION HOLE DIAMETER, REFER TO THE ENGINEERING DRAWING OR SERVICE BULLETIN TO FIND THE INITIAL HOLE SIZE.

F 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.

G TELL AN ENGINEER WHO HAS THE AUTHORITY TO DO AN ANALYSIS AND MAKE A DECISION.

H MAKE THE RADIUS BLEND SMOOTHLY WITH THE SHANK DIAMETER.

I FOR 1/64 OVERSIZE, ADD 0.016 INCH TO EACH OF THE MIN AND MAX DIAMETERS.

FOR 1/32 OVERSIZE, ADD 0.031 INCH TO EACH OF THE MIN AND MAX DIAMETERS.

J 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 5)

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 $\boxed{A}$	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 I

Permanent Straight Shank Fastener Holes
Figure 4 (Sheet 2 of 5)

		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	C	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	C	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 B	TRANSITION FIT	D	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	D	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 B	TRANSITION FIT	C	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	C	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

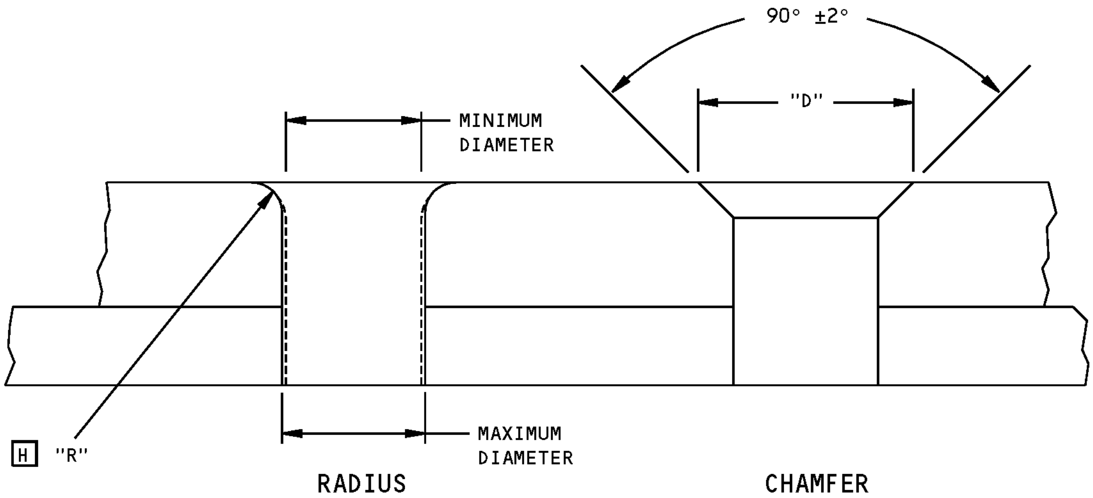
OVERSIZE FASTENER HOLE DIAMETER LIMITS (TRANSITION FIT AND CLOSE REAM)
TABLE II

Permanent Straight Shank Fastener Holes
Figure 4 (Sheet 3 of 5)

NOMINAL AND OVERSIZE FASTENER	HOLE SIZE-INITIAL AND OVERSIZE INTERFERENCE FIT [E]				NOMINAL AND OVERSIZE	HOLE SIZE-INITIAL AND OVERSIZE INTERFERENCE FIT [E]			
	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 0.1625	0.1600 0.1620	0.1590 0.1620	0.1595 0.1615	7/16 (-14)	0.4340 0.4360	0.4335 0.4355	0.4325 0.4355	0.4330 0.4350
1/64	[C]	[C]	[C]	[C]	1/64 [F]	0.4496 0.4516	0.4491 0.4511	0.4481 0.4511	0.4486 0.4506
1/32 [G]	[D]	[D]	[D]	[D]	1/32 [G]	0.4652 0.4672	0.4647 0.4667	0.4637 0.4667	0.4642 0.4662
3/16 (-6)	0.1865 0.1885	0.1860 0.1880	0.1850 0.1880	0.1855 0.1875	1/2 (-16)	0.4965 0.4985	0.4960 0.4980	0.4950 0.4980	0.4955 0.4975
1/64 [F]	0.1996 0.2016	0.1991 0.2011	0.1981 0.2011	0.1986 0.2006	1/64 [F]	0.5121 0.5141	0.5116 0.5136	0.5106 0.5136	0.5111 0.5131
1/32 [G]	0.2152 0.2172	0.2147 0.2167	0.2137 0.2167	0.2142 0.2162	1/32 [G]	0.5277 0.5297	0.5272 0.5292	0.5262 0.5292	0.5267 0.5287
1/4 (-8)	0.2465 0.2485	0.2460 0.2480	0.2450 0.2480	0.2455 0.2475	9/16 (-18)	0.5585 0.5605	0.5580 0.5600	0.5570 0.5600	0.5575 0.5595
1/64 [F]	0.2621 0.2641	0.2616 0.2636	0.2606 0.2636	0.2611 0.2631	1/64 [F]	0.5741 0.5761	0.5736 0.5766	0.5726 0.5756	0.5731 0.5751
1/32 [G]	0.2777 0.2797	0.2772 0.2792	0.2762 0.2792	0.2767 0.2787	1/32 [G]	0.5897 0.5917	0.5892 0.5912	0.5882 0.5912	0.5887 0.5907
5/16 (-10)	0.3090 0.3110	0.3085 0.3105	0.3075 0.3105	0.3080 0.3100	5/8 (-20)	0.6210 0.6230	0.6205 0.6225	0.6195 0.6225	0.6200 0.6220
1/64 [F]	0.3246 0.3266	0.3241 0.3261	0.3231 0.3261	0.3236 0.3256	1/64 [F]	0.6366 0.6386	0.6361 0.6381	0.6351 0.6381	0.6356 0.6376
1/32 [G]	0.3402 0.3422	0.3397 0.3417	0.3387 0.3417	0.3392 0.3412	1/32 [G]	0.6522 0.6542	0.6517 0.6537	0.6507 0.6537	0.6512 0.6532
3/8 (-12)	0.3715 0.3735	0.3710 0.3730	0.3700 0.3730	0.3705 0.3725	3/4 (-24)	0.7460 0.7480	0.7455 0.7475	0.7445 0.7475	0.7450 0.7470
1/64 [F]	0.3871 0.3891	0.3866 0.3886	0.3856 0.3886	0.3861 0.3881	1/64 [F]	0.7616 0.7636	0.7611 0.7631	0.7601 0.7631	0.7606 0.7626
1/32 [G]	0.4027 0.4047	0.4012 0.4042	0.4012 0.4042	0.4017 0.4037	1/32 [G]	0.7772 0.7792	0.7767 0.7787	0.7757 0.7787	0.7762 0.7782

OVERSIZE FASTENER HOLE DIAMETER LIMITS (INTERFERENCE FIT)
TABLE III

Permanent Straight Shank Fastener Holes
Figure 4 (Sheet 4 of 5)



DETAIL I

NOMINAL FASTENER DIAMETER	IN ALL METAL STRUCTURE		IN ALUMINUM AND MAGNESIUM STRUCTURE			IN ALL OTHER METAL STRUCTURE		
	"R" RADIUS		"D" I J CHAMFER DIA		MIN SHEET THICKNESS TO BE CHAMFERED OR RADIUSED	"D" CHAMFER DIA I		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 IV

Permanent Straight Shank Fastener Holes
Figure 4 (Sheet 5 of 5)

HOLE DIAMETERS FOR NAS 1738, NAS 1739, 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 I

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 II

NOTES

- THE SOURCE OF INFORMATION FOR THIS FIGURE CAN BE FOUND IN BOEING SPECIFICATION BAC5004-3.
- REFER TO TABLE I FOR BLIND RIVETS AND TABLES II THRU IV 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 III

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 IV

Holes for Blind Rivets and Bolts
Figure 5 (Sheet 2 of 2)

TYPE OF FASTENER HOLE	TABLE
CLOSE REAM HOLES	I
CLASS I HOLES	II
CLASS II HOLES	III
CLASS III HOLES	IV

INDEX FOR FIGURE 6

NOTES

- THE SOURCE OF INFORMATION FOR THIS FIGURE CAN BE FOUND IN BOEING PROCESS SPECIFICATION BAC5009.
- 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 I THRU IV FOR OVERSIZE HOLE DIMENSIONS.
- SEE DETAIL I AND TABLE V FOR FILLET RELIEF SPECIFICATIONS FOR PROTRUDING HEAD FASTENERS. REFER TO SRM 51-40-08 FOR EQUIVALENT COUNTERSINK FASTENER SPECIFICATIONS.

A MAKE THE RADIUS BLEND SMOOTHLY WITH THE SHANK DIAMETER.

B 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.

C 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.

D IF THE EDGE MARGIN IS LESS THAN TWO DIAMETERS, TELL AN ENGINEER WHO HAS THE AUTHORITY TO DO AN ANALYSIS AND MAKE A DECISION.

Holes for Bolts
Figure 6 (Sheet 1 of 11)

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 I $\boxed{D}$

Holes for Bolts
Figure 6 (Sheet 2 of 11)

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 I D

Holes for Bolts
Figure 6 (Sheet 3 of 11)

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 I $\boxed{D}$

Holes for Bolts
Figure 6 (Sheet 4 of 11)

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 II D

Holes for Bolts
Figure 6 (Sheet 5 of 11)

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 II D

Holes for Bolts
Figure 6 (Sheet 6 of 11)

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 II $\boxed{D}$

Holes for Bolts
Figure 6 (Sheet 7 of 11)

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 III $\boxed{D}$

Holes for Bolts
Figure 6 (Sheet 8 of 11)

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 III $\boxed{D}$

Holes for Bolts
Figure 6 (Sheet 9 of 11)

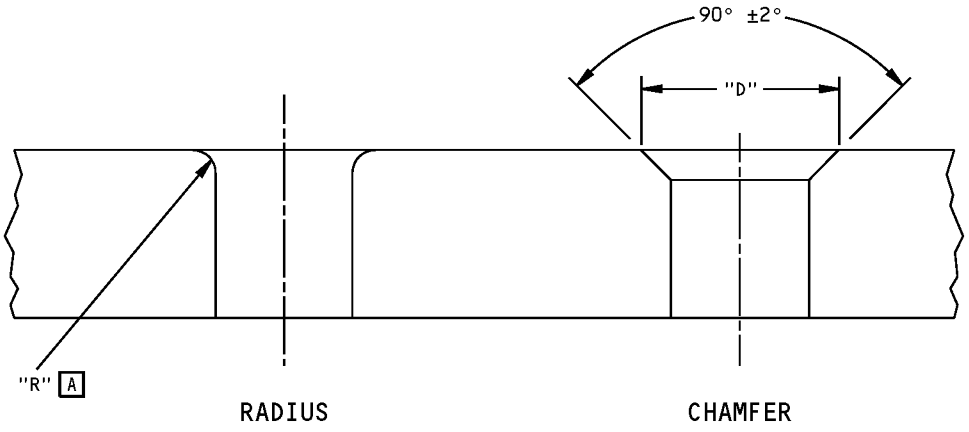
OVERSIZE FASTENER	NOMINAL OVERSIZE	LIMIT	1 (1.0000)	1-1/8 (1.1250)	1-1/4 (1.2500)	1-3/8 (1.3750)	1-1/2 (1.5000)
CLASS II HOLE							
--	INITIAL HOLE SIZE	MAX	1.026	1.155	1.280	1.405	1.530
		MIN	1.000	1.125	1.250	1.375	1.500
BACB30G	1/64 (0.0156)	MAX	--	--	--	1.421	1.546
		MIN	--	--	--	1.391	1.516
BACB30AC	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 III $\boxed{D}$

OVERSIZE FASTENER	NOMINAL OVERSIZE	LIMIT	3/4 (0.7500)	7/8 (0.8750)	1 (1.0000)	1-1/8 (1.1250)	1-1/4 (1.2500)	1-3/8 (1.3750)	1-1/2 (1.5000)
CLASS III HOLE									
--	INITIAL HOLE SIZE	MAX	0.797	0.922	1.047	1.172	1.297	1.422	1.547
		MIN	0.778	0.903	1.028	1.153	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	0.814	--	--	--	--	--	--
		MIN	0.795	--	--	--	--	--	--
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 IV $\boxed{D}$

Holes for Bolts
Figure 6 (Sheet 10 of 11)



DETAIL I

NOMINAL FASTENER DIAMETER	BACB30FD, BACB30LE, BACB30MR, BACB30MT, BACB30NH, BACB30PN, BACB30TR, BACB30UG, BACB30US, BACB30XL MS21250		ALL OTHER PROTRUDING HEAD BOLTS	
	"R" B RADIUS	"D" C CHAMFER DIA	"R" B RADIUS	"D" C 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 V

Holes for Bolts
Figure 6 (Sheet 11 of 11)

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 I

NOTES

- THE SOURCE OF INFORMATION FOR THIS FIGURE CAN BE FOUND IN BOEING PROCESS SPECIFICATION BAC5047.
- 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 BAC5060.
- HOLE DIAMETERS IN THIS FIGURE CAN BE USED UNLESS AN APPLICABLE ENGINEER DRAWING SHOWS DIFFERENTLY.
- SEE DETAIL I AND TABLE VI FOR FINISHED HOLE SPECIFICATIONS FOR PROTRUDING HEAD FASTENERS. REFER TO 51-40-08 FOR EQUIVALENT COUNTERSINK FASTENER SPECIFICATIONS.
- SEE TABLES I AND II FOR BACB30PT BOLTS. SEE TABLES III THRU V FOR BACB30WQ AND BACB30WR BOLTS.

A 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.

B COLD WORK THE HOLE AS A CLASS I, HIGH INTERFERENCE HOLE, AS SPECIFIED IN SRM 51-40-09.

C HOLES FOR FIRST AND SECOND OVERSIZE FASTENERS MUST HAVE THE SAME BOLT INTERFERENCE AS SPECIFIED FOR THE INITIAL HOLE.

D 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.

E IF COLD WORKING IS NECESSARY FOR AN OVERSIZE HOLE, THEN USE THE MANDREL-TO-HOLE INTERFERENCE AS SPECIFIED IN THE ENGINEER DRAWING.

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 I

Holes for Radius Lead-In Bolts
Figure 8 (Sheet 1 of 6)

NOMINAL THREAD SIZE	FIRST OVERSIZE		SECOND OVERSIZE	
	HOLE DIAMETER		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 II

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 III

Holes for Radius Lead-In Bolts
Figure 8 (Sheet 2 of 6)

NOMINAL THREAD SIZE	FIRST OVERSIZE HOLE DIAMETER $\boxed{A}$		SECOND OVERSIZE HOLE DIAMETER $\boxed{B}$	
	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

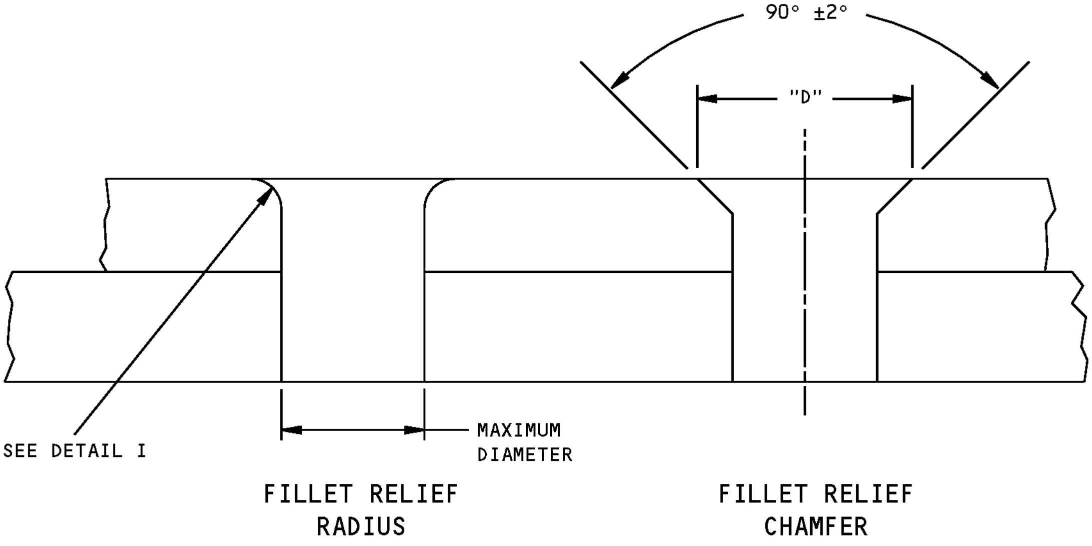
OVERSIZE HOLE DIMENSIONS FOR BACB30WQ AND BACB30WR
100 DEGREE RADIUS LEAD-IN BOLTS IN COLD WORKED HOLES
TABLE IV $\boxed{E}$

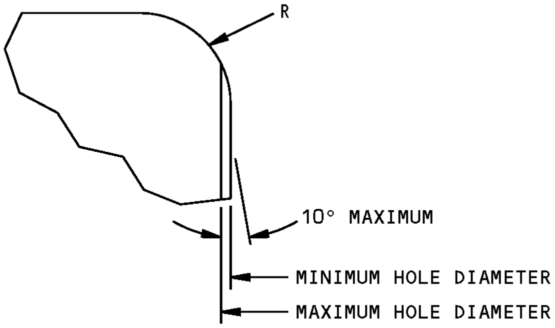
Holes for Radius Lead-In Bolts
Figure 8 (Sheet 3 of 6)

BOEING STANDARD NUMBER	BOLT INTERFACE	INITIAL OVERSIZE HOLE DIAMETER		FIRST OVERSIZE HOLE DIAMETER $\boxed{C}$		SECOND OVERSIZE HOLE DIAMETER $\boxed{C}$	
		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 V

Holes for Radius Lead-In Bolts
Figure 8 (Sheet 4 of 6)



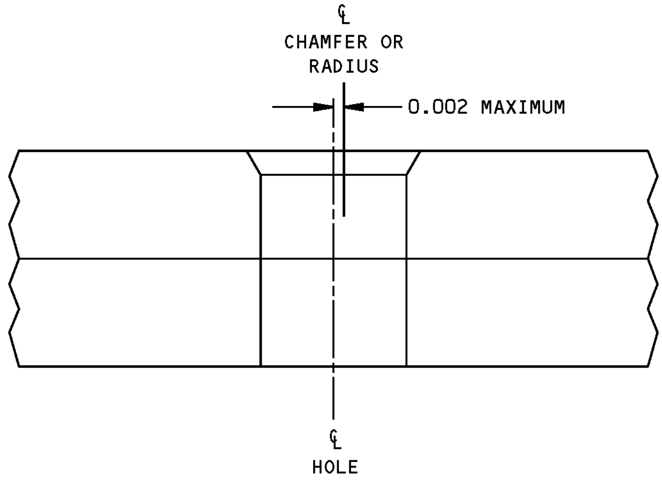


DETAIL I

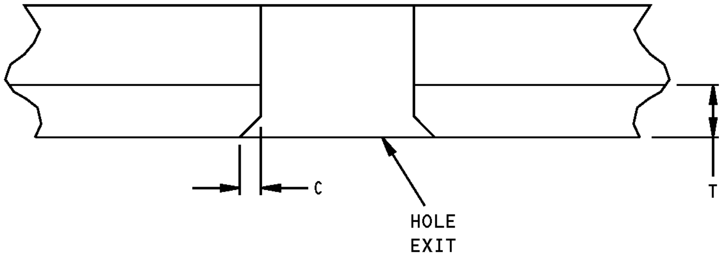
NOMINAL THREAD SIZE	PROTRUDING HEAD				
	"R" RADIUS		"D" CHAMFER DIA D		MIN SHEET THICKNESS TO BE CHAMFERED OR RADIUSED
	MIN	MAX	MIN	MAX	
0.1900-32	0.015	0.025	0.226	0.236	0.060
0.2500-28	0.015	0.025	0.286	0.296	0.060
0.3125-24	0.020	0.030	0.358	0.368	0.060
0.3750-24	0.020	0.030	0.421	0.431	0.060
0.4375-20	0.020	0.030	0.483	0.493	0.080

FILLET RELIEF LIMITS FOR PROTRUDING HEAD RADIUS LEAD-IN BOLT HOLES
TABLE VI

Holes for Radius Lead-In Bolts
Figure 8 (Sheet 5 of 6)



CONCENTRICITY SPECIFICATION
DETAIL II



THICKNESS T	RADIUS OR CHAMFER C AT HOLE EXIT
UP TO 0.091	0.005
OVER 0.091	0.010

DEBURR SPECIFICATION
DETAIL III

Holes for Radius Lead-In Bolts
Figure 8 (Sheet 6 of 6)

SUBJECT	TABLE
SOLID ALUMINUM RIVETS	I
NON-ALUMINUM RIVETS	II
BLIND RIVETS	III
SEMI-TUBULAR AND HOLLOW ENDED RIVETS	IV
BOLTS	V AND VI
LOCKBOLTS AND HEX-DRIVE FASTENERS	VII AND VIII
BLIND BOLTS	IX, X, AND XI

INDEX FOR FIGURE 9

NOTES

- THE SOURCE OF INFORMATION FOR THIS FIGURE CAN BE FOUND IN BOEING PROCESS SPECIFICATION BAC5063.
- HOLE DIAMETERS IN THIS FIGURE CAN BE USED UNLESS AN APPLICABLE ENGINEER DRAWING SHOWS DIFFERENTLY.
- REFER TO SRM 51-70-16 FOR MORE INFORMATION ON HOLE SPECIFICATIONS.
- HOLES AND COUNTERSINKS MUST BE 90° TO THE PART SURFACE, ±2°.

A DO NOT USE ALUMINUM FASTENERS IN COMPOSITE STRUCTURE THAT HAS CARBON FIBER (GRAPHITE) MATERIAL UNLESS ALLOWED BY THE ENGINEER DRAWING. CARBON MATERIAL CAN CAUSE ALUMINUM FASTENERS TO CORRODE.

B THIS TABLE DOES NOT APPLY TO NICKEL ALLOY MS16535 RIVETS. SEE TABLE II FOR NICKEL ALLOY MS16535 RIVETS.

C 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 7)

RIVET TYPE [A]	NOMINAL RIVET DIA (INCH)	HOLE SIZE (INCH)					
		ARAMID/EPOXY TAPE OR FABRIC		ARAMID/EPOXY WITH ALUMINUM OR FIBERGLASS WITH AND WITHOUT ALUMINUM		THERMOPLASTIC	
		MIN	MAX	MIN	MAX	MIN	MAX
BACR15CE, BACR15GF	3/32	0.098	0.103	0.098	0.103	0.098	0.103
	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, BACR15BB, BACR15FT	3/32	0.098	0.103	0.098	0.103	0.098	0.103
	1/8	0.130	0.137	0.128	0.135	0.128	0.135
	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 I

RIVET TYPE [A]	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	
		MIN	MAX	MIN	MAX	MIN	MAX
MS16535 (NICKEL ALLOY, SEMI-TUBULAR)	3/32	0.091	0.095	0.093	0.098	0.091	0.095
	1/8	0.125	0.129	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 II

Fastener Hole Sizes in Composites
Figure 9 (Sheet 2 of 7)

RIVET TYPE	NOMINAL FASTENER DIAMETER	HOLE SIZE (INCH)	
		MINIMUM	MAXIMUM
BACR15DA,	3/32	0.098	0.101
BACR15DR,	1/8	0.129	0.132
BACR15GE,	5/32	0.160	0.164
NAS1398,	3/16	0.192	0.196
NAS1399			
BACR15FR,	1/8	0.143	0.146
BACR15FP,	5/32	0.176	0.180
	3/16	0.205	0.209

HOLE SIZES FOR BLIND RIVETS
TABLE III

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 [B]
AND HOLLOW-ENDED BACR15GA RIVETS
TABLE IV

Fastener Hole Sizes in Composites
Figure 9 (Sheet 3 of 7)

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 V

NOMINAL FASTENER DIAMETER	FIRST OVERSIZE		SECOND OVERSIZE	
	MIN	MAX	MIN	MAX
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 VI

Fastener Hole Sizes in Composites
Figure 9 (Sheet 4 of 7)

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 VII

NOMINAL FASTENER DIAMETER	FIRST OVERSIZE		SECOND OVERSIZE	
	MIN	MAX	MIN	MAX
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 VIII

Fastener Hole Sizes in Composites
Figure 9 (Sheet 5 of 7)

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 IX

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 X

Fastener Hole Sizes in Composites
Figure 9 (Sheet 6 of 7)

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() OB100-EU()() BACB30VJ()CD() OB100-EU()()CD BACB30VH()C() OBP-EU()() BACB30VH()CD() OBP-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 XI

Fastener Hole Sizes in Composites
Figure 9 (Sheet 7 of 7)

GENERAL - FASTENER EDGE MARGINS

1. References

Reference	Title
51-40-05, GENERAL	Fastener Hole Sizes
51-70-16, GENERAL	Hole Drilling and Machining of Composite Structures

2. General

A. Fastener edge margin as used in this manual is the distance from the center of the hole to the nearest edge of a sheet. Refer to Figure 1/GENERAL.

B. Examples of joints in single shear and double shear are shown in Figure 2/GENERAL.

C. Minimum fastener edge margins for metal structural applications are tabulated in Table 1/GENERAL as follows:

Table 1: Minimum Fastener Edge Margins for Metal Structures

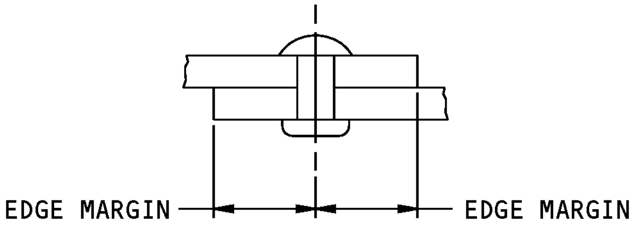
Table I	- Edge margins for aluminum alloy protruding head rivets in aluminum alloys
Table II	- Edge margins for aluminum alloy flush head rivets in aluminum alloys.
Table III	- Edge margins for nickel-copper alloy rivets in steel alloys
Table IV	- Edge margins for: - Protruding head bolts and screws - Tension protruding head lockbolts and hex-drive bolts
Table V	- Edge margins for: - 100 degree head bolts, screws, lockbolts and hex-drive bolts - Shear protruding head lockbolts and hex-drive bolts - Protruding and flush head blind fasteners
Table VI	- Edge Margins for 5/32-inch diameter aluminum rivets in aft pressure bulkhead structure.

D. Minimum fastener edge margins for composite structural applications can can be generally represented by the formula 3.0 D + 0.05 inches where "D" is the fastener diameter.

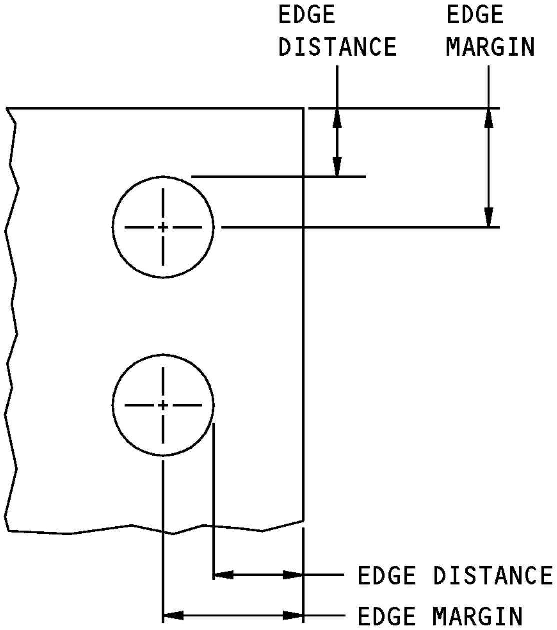
E. Refer to 51-40-05, GENERAL for fastener hole sizes in metal structures.

F. Refer to 51-70-16, GENERAL for fastener hole sizes in composite structures.

G. Edge margins for fastener diameters between those shown in the Fastener Edge Margin tables can be interpolated from the data in those tables.

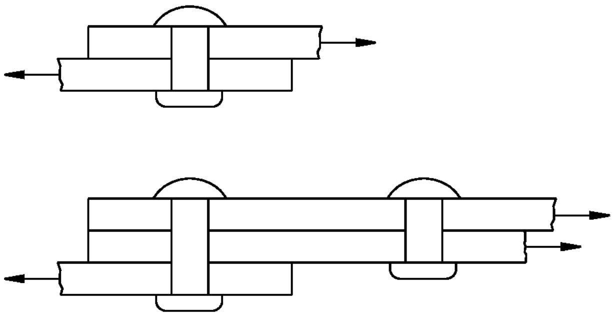


DETAIL I

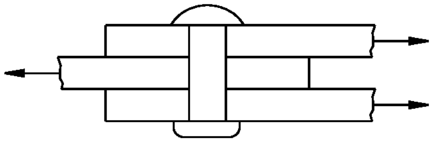


DETAIL II

Fastener Edge Margin and Edge Distance
Figure 1



SINGLE SHEAR EDGE MARGIN
DETAIL I



DOUBLE SHEAR EDGE MARGIN
DETAIL II

Joint Examples
Figure 2

HEAD STYLE		ALUMINUM ALLOY PROTRUDING HEAD RIVETS													
LOADING		SINGLE SHEAR							DOUBLE SHEAR						
RIVETED MATERIAL		RIVET DIAMETERS													
ALLOY	GAGE	3/32	1/8	5/32	3/16	1/4	5/16	3/8	3/32	1/8	5/32	3/16	1/4	5/16	3/8
		EDGE MARGIN (± 0.05)													
ALL ALUMINUM ALLOYS EXCEPT CASTINGS	0.012	0.21							0.21	0.27	0.32				
	0.016	0.21	0.27						0.21	0.27	0.32				
	0.018	0.21	0.27						0.21	0.27	0.32				
	0.020	0.21	0.27	0.32					0.21	0.27	0.32				
	0.022	0.21	0.27	0.32					0.21	0.27	0.32				
	0.025	0.21	0.27	0.32					0.21	0.27	0.32				
	0.028	0.21	0.27	0.32					0.21	0.27	0.32				
	0.032	0.20	0.27	0.32	0.37				0.21	0.27	0.32				
	0.036	0.19	0.26	0.32	0.37				0.21	0.27	0.32				
	0.040	0.18	0.26	0.32	0.37	0.48			0.21	0.27	0.32	0.37	0.48		
	0.045	0.17	0.24	0.32	0.37	0.48			0.21	0.27	0.32	0.37	0.48		
	0.050	0.17	0.23	0.32	0.37	0.48	0.58		0.21	0.27	0.32	0.37	0.48		
	0.056	0.17	0.22	0.29	0.37	0.48	0.58		0.21	0.27	0.32	0.37	0.48	0.58	
	0.063	0.17	0.21	0.28	0.36	0.48	0.58	0.69	0.20	0.27	0.32	0.37	0.48	0.58	0.69
	0.071		0.21	0.26	0.33	0.48	0.58	0.69		0.27	0.32	0.37	0.48	0.58	0.69
	0.080		0.21	0.25	0.31	0.47	0.58	0.69		0.26	0.32	0.37	0.48	0.58	0.69
	0.090		0.21	0.25	0.29	0.44	0.58	0.69		0.25	0.32	0.37	0.48	0.58	0.69
	0.100		0.21	0.25	0.29	0.41	0.58	0.69		0.23	0.31	0.37	0.48	0.58	0.69
	0.112			0.25	0.29	0.39	0.54	0.69			0.29	0.37	0.48	0.58	0.69
	0.125			0.25	0.29	0.37	0.50	0.67			0.28	0.36	0.48	0.58	0.69
	0.140			0.25	0.29	0.37	0.47	0.62			0.26	0.33	0.48	0.58	0.69
	0.160			0.25	0.29	0.37	0.46	0.57			0.24	0.31	0.47	0.58	0.69
	0.180				0.29	0.37	0.46	0.54				0.29	0.44	0.58	0.69
	0.190				0.29	0.37	0.46	0.54				0.29	0.43	0.58	0.69
	0.200				0.29	0.37	0.46	0.54				0.29	0.41	0.58	0.69
	0.224				0.29	0.37	0.46	0.54				0.29	0.39	0.54	0.68
	0.250				0.29	0.37	0.46	0.54				0.29	0.37	0.50	0.67
ADD FOR CASTINGS		0.10			0.20			0.30	0.10			0.20			0.30

TABLE I

NOTES

- SEE TABLE VI FOR MINIMUM EDGE MARGIN CRITERIA FOR 5/32 RIVETS IN AFT PRESSURE BULKHEAD STRUCTURE

Fastener Edge Margins
Figure 3 (Sheet 1 of 5)

HEAD STYLE		100° HEAD AND 120° MODIFIED HEAD				
LOADING		SINGLE SHEAR				
RIVETED MATERIAL		ALUMINUM RIVET DIAMETER				
ALLOY	GAGE	1/8	5/32	3/16	1/4	5/16
		EDGE MARGIN (± 0.05)				
ALUMINUM ALLOY EXCEPT CASTINGS	ALL	0.31	0.37	0.43	0.55	0.67
ADD FOR CASTINGS		0.10		0.20		

TABLE II

HEAD STYLE		PROTRUDING HEAD					100° HEAD		
LOADING		SINGLE SHEAR							
RIVETED MATERIAL		NICKEL-COPPER RIVET DIAMETERS							
ALLOY	GAGE	3/32	1/8	5/32	3/16	1/4	1/8	5/32	3/16
		EDGE MARGINS (± 0.05)							
CORROSION RESISTANT STEEL SHEET, AISI 301 AND 302 ALSO ALLOY STEEL HT TO 100,000 PSI 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	0.31		
	0.022	0.18	0.25	0.30	0.35	0.45	0.31		
	0.025	0.18	0.25	0.30	0.35	0.45	0.31	0.37	
	0.028	0.18	0.24	0.30	0.35	0.45	0.31	0.37	
	0.032	0.18	0.23	0.30	0.35	0.45	0.31	0.37	0.43
	0.036	0.18	0.23	0.29	0.35	0.45	0.31	0.37	0.43
	0.040	0.18	0.23	0.28	0.35	0.45	0.31	0.37	0.43
	0.045	0.18	0.23	0.27	0.35	0.45	0.31	0.37	0.43
	0.050	0.17	0.23	0.27	0.32	0.45	0.31	0.37	0.43
	0.056	0.17	0.22	0.27	0.32	0.41	0.31	0.37	0.43
	0.063	0.17	0.21	0.27	0.32	0.41	0.31	0.37	0.43
	0.071	0.17	0.21	0.27	0.32	0.41	0.31	0.37	0.43
	0.080	0.17	0.21	0.25	0.32	0.40	0.31	0.37	0.43
	0.090		0.21	0.25	0.29	0.40	0.31	0.37	0.43
	0.100			0.25	0.29	0.40	0.31	0.37	0.43
	0.112			0.25	0.29	0.39	0.31	0.37	0.43
	0.125				0.29	0.37	0.31	0.37	0.43

TABLE III

Fastener Edge Margins
Figure 3 (Sheet 2 of 5)

HEAD STYLE		PROTRUDING HEAD (BOLTS AND SCREWS) TENSION PROTRUDING HEAD (LOCKBOLTS AND HEX-DRIVE BOLTS)							
LOADING		SINGLE SHEAR							
BOLTED MATERIAL		BOLT DIAMETERS							
ALLOY	GAGE	3/16	1/4	5/16	3/8	7/16	1/2	9/16	5/8
		EDGE MARGIN (± 0.05)							
ALUMINUM	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	0.58	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 IV

Fastener Edge Margins
Figure 3 (Sheet 3 of 5)

HEAD STYLE		100 DEGREE HEAD (BOLTS, SCREWS, LOCKBOLTS AND HEX-DRIVE BOLTS) SHEAR PROTRUDING HEAD (LOCKBOLTS AND HEX-DRIVE BOLTS) PROTRUDING AND FLUSH HEAD BLIND FASTENERS									
LOADING		SINGLE SHEAR									
BOLTED MATERIAL		BOLT DIAMETERS									
ALLOY	GAGE	1/8	5/32	3/16	1/4	5/16	3/8	7/16	1/2	9/16	5/8
		EDGE MARGINS (± 0.05)									
ALL ALUMINUM ALLOYS, CORROSION RESISTANT STEELS AND TITANIUM	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 V

Fastener Edge Margins
Figure 3 (Sheet 4 of 5)

STRUCTURE DESCRIPTION	MINIMUM EDGE MARGIN FOR 5/32 ALUMINUM RIVET
WEB LAP SPLICE	0.24
TEAR STRAP - GENERAL	0.22
TEAR STRAP SPLICE (AT FIRST ROW AT ENDS OF SPLICE - 2 PLACES PER SPLICE)	0.30
DOUBLER	0.24
STIFFENER	0.22

EDGE MARGINS FOR 5/32 ALUMINUM RIVETS
IN AFT PRESSURE BULKHEAD STRUCTURE

TABLE VI

Fastener Edge Margins
Figure 3 (Sheet 5 of 5)

767-300
STRUCTURAL REPAIR MANUAL

GENERAL - STRENGTH OF FASTENERS

1. References

Reference	Title
51-40-05, GENERAL	Fastener Hole Sizes
51-40-06, GENERAL	Fastener Edge Margins

2. General

A. The fastener strength values given in this subject will not be more than the bearing strength of the material in which the fasteners are installed. Thus, if the material will fail in bearing before fastener failure, the lower value will be shown as the strength of the fasteners.

B. The fastener strength values assume that the correct holes sizes have been used (Ref: 51-40-05, GENERAL) and that edge margin requirements have been met (Ref: 51-40-06, GENERAL).

C. The fastener substitution factors for the MS20470D/BACR15BB()D rivets and the MS20426D/ BACR15BA()D rivets are given in Figure 6/GENERAL and Figure 7/GENERAL.

(1) The quantity of substitute rivets is calculated by multiplying the initial fastener data by the quantity factor given in the applicable fastener table.

(2) Make sure that you have sufficient edge margin if you use an alternative rivet that has a larger diameter than the initial rivet.

(3) In areas where there is minimum edge margins, then you must refer to 51-40-06, GENERAL.

(4) Use the riveted material gage that gives the highest multiplication factor when you look for fastener substitutions in Figure 6/GENERALand Figure 7/GENERAL.

NOTE: The substitution tables given in Figure 6/GENERAL and Figure 7/GENERAL do not apply to these areas on the airplane.

- Skin, stringers and circumferential frames in the airplane fuselage
- Wing interspar skins and stiffeners, or any other areas where pressure or fuel tank sealing is specified
- Wing leading edge skins
- Vertical and horizontal stabilizer interspar skins
- Interspar skins on the trailing edge flaps
- Horizontal and vertical stabilizer leading edge skin

If they are permitted, alternative fasteners that are necessary for repairs in the above areas can be found in the applicable SRM repair.

D. Refer to Table 1/GENERAL, for fastener strength data.

Table 1: Index to Tables for Fastener Strength Data

FASTENER		SHEET OR PLATE MATERIAL	LOCATION	
TYPE	PART NUMBER		FIGURE	TABLE
RIVET, UNIVERSAL HEAD, AL	BACR15BB*D BACR15BB*AD BACR15BB*DD BACR15FT*KE MS20470D	2024-T3	Figure 1/GENERAL	I
		2024-T4	Figure 1/GENERAL	II
		2024-T42	1Figure 1/GENERAL	II
		2024-T42 TUBE	Figure 1/GENERAL	II
		7075-T6	Figure 1/GENERAL	III
		7075-T6, -T6510, -T6511 EXTRUSIONS	Figure 1/GENERAL	III
RIVET, FLUSH HEAD, AL	BACR15BA*D BACR15BA*AD BACR15BA*DD BACR15CE*D BACR15FV*KE MS20426D	2024-T3	Figure 1/GENERAL	IV
		2024-T42	Figure 1/GENERAL	IV
		7075-T6	Figure 1/GENERAL	IV
RIVET, UNIVERSAL HEAD, MONEL	MS20615M	301-1/4 HARD CRES	Figure 1/GENERAL	V
RIVET, 100° FLUSH HEAD, MONEL	MS20427M	301-1/4 HARD - CRES 301-1/2 HARD - CRES 301-FULL HARD - CRES 302-ANNEALED - CRES	Figure 1/GENERAL	V
RIVET, BLIND, UNIVERSAL HEAD, 5056 AL SLEEVE	NAS1398B	2024-T3	Figure 2/GENERAL	I
RIVET, BLIND, UNIVERSAL HEAD, 2017 AL SLEEVE	NAS1398D	2024-T3	Figure 2/GENERAL	I
RIVET, BLIND, 100° FLUSH HEAD, 5056 AL SLEEVE	NAS1399B	2024-T3	Figure 2/GENERAL	I
RIVET, BLIND, 100° FLUSH HEAD, 2017 AL SLEEVE	NAS1399D	2024-T3	Figure 2/GENERAL	I
RIVET, BLIND, UNIVERSAL HEAD	NAS1738E	2024-T3 7075-T6	Figure 2/GENERAL	II
RIVET, BLIND, 100° FLUSH HEAD	NAS1739E	2024-T3 7075-T6	Figure 2/GENERAL	II
BOLT, BLIND, UNIVERSAL HEAD	MS90353	2024-T3	Figure 2/GENERAL	III
		7075-T6	Figure 2/GENERAL	IV
BOLT, BLIND, 100° FLUSH HEAD	MS90354	2024-T3	Figure 2/GENERAL	III
		7075-T6	Figure 2/GENERAL	IV

Table 1: Index to Tables for Fastener Strength Data (Continued)

FASTENER		SHEET OR PLATE MATERIAL	LOCATION	
TYPE	PART NUMBER		FIGURE	TABLE
PROTRUDING HEAD BOLTS, LOCKBOLTS, HEX-DRIVE BOLTS	BACB30DX BACB30NT BACB30LJ BACB30NX BACB30LK BACB30PF BACB30LM BACB30PW BACB30LN MS20004-24 BACB30MB NAS623 BACB30MR NAS673-678 BACB30NE NAS1218 BACB30NF NAS1223-1235 BACB30NM NAS1303-1320 BACB30NR NAS1465-1472 NAS6965-6972	2024-T3	3Figure 3/GENERAL	I
		2024-T42 2024-T4 2024-T42 TUBE	Figure 3/GENERAL	II
		7075-T6 7075-T6, -T6510, -T6511 EXTRUSION	Figure 3/GENERAL	III
STANDARD FLUSH HEAD BOLTS, LOCKBOLTS, HEX-DRIVE BOLTS	BACB30AB BACB30NN BACB30EM BACB30NY BACB30FL BACB30PC BACB30GX NAS333-340 BACB30JC NAS517 BACB30LH NAS583-590 BACB30LP NAS563-668 BACB30LR NAS1221 BACB30LU NAS1456-1462 BACB30MS	2024-T3	Figure 4/GENERAL	I
		7075-T6	Figure 4/GENERAL	II
SHEAR FLUSH HEAD BOLTS, SHEAR FLUSH AND PROTRUDING HEAD LOCKBOLTS, AND HEX-DRIVE BOLTS	BACB30EL BACB30NW BACB30FB NAS1436-1442 BACB30FM NAS1446-1452 BACB30FN BACB30GW BACB30GY BACB30LL BACB30MY BACB30NU	2024-T3	Figure 5/GENERAL	I
		7075-T6	Figure 5/GENERAL	II
FASTENER SUBSTITUTION FOR MS20470D AND BACR15BB()D UNIVERSAL HD RIVETS			Figure 6/GENERAL	
FASTENER SUBSTITUTION FOR MS20426D AND BACR15BA()D RIVETS IN COUNTERSUNK HOLES			Figure 7/GENERAL	

Table 1: Index to Tables for Fastener Strength Data (Continued)

FASTENER		SHEET OR PLATE MATERIAL	LOCATION	
TYPE	PART NUMBER		FIGURE	TABLE
RIVET, UNIVERSAL HEAD, AL	BACR15BB*AD BACR15BB*AD*C BACR15BB*D BACR15BB*D*C BACR15BB*DD BACR15FT*KE*C MS20470D	2024-T3	Figure 1/GENERAL	I
		2024-T4	Figure 1/GENERAL	II
		2024-T42	Figure 1/GENERAL	II
		2024-T42 TUBE	Figure 1/GENERAL	II
		7075-T6	Figure 1/GENERAL	III
		7075-T6, -T6510, -T6511 EXTRUSIONS	Figure 1/GENERAL	III
RIVET, FLUSH HEAD, AL	BACR15BA*AD BACR15BA*AD*C BACR15BA*D BACR15BA*D*C BACR15BA*DD BACR15CE*D BACR15FV*KE MS20426D	2024-T3	Figure 1/GENERAL	IV
		2024-T42	Figure 1/GENERAL	IV
		7075-T6	Figure 1/GENERAL	IV
RIVET, UNIVERSAL HEAD, MONEL	MS20615M	301-1/4 HARD CRES	Figure 1/GENERAL	V
RIVET, 100° FLUSH HEAD, MONEL	MS20427M	301-1/4 HARD - CRES 301-1/2 HARD - CRES 301-FULL HARD - CRES 302-ANNEALED - CRES	Figure 1/GENERAL	V
RIVET, BLIND, UNIVERSAL HEAD, 5056 AL SLEEVE	NAS1398B	2024-T3	Figure 2/GENERAL	I
RIVET, BLIND, UNIVERSAL HEAD, 2017 AL SLEEVE	NAS1398D	2024-T3	Figure 2/GENERAL	I
RIVET, BLIND, 100° FLUSH HEAD, 5056 AL SLEEVE	NAS1399B	2024-T3	Figure 2/GENERAL	I
RIVET, BLIND, 100° FLUSH HEAD, 2017 AL SLEEVE	NAS1399D	2024-T3	Figure 2/GENERAL	I
RIVET, BLIND, UNIVERSAL HEAD	NAS1738E	2024-T3 7075-T6	Figure 2/GENERAL	II
RIVET, BLIND, 100° FLUSH HEAD	NAS1739E	2024-T3 7075-T6	Figure 2/GENERAL	II
BOLT, BLIND, UNIVERSAL HEAD	MS90353	2024-T3	Figure 2/GENERAL	III
		7075-T6	Figure 2/GENERAL	IV
BOLT, BLIND, 100° FLUSH HEAD	MS90354	2024-T3	Figure 2/GENERAL	III
		7075-T6	Figure 2/GENERAL	IV

Table 1: Index to Tables for Fastener Strength Data (Continued)

FASTENER		SHEET OR PLATE MATERIAL	LOCATION	
TYPE	PART NUMBER		FIGURE	TABLE
PROTRUDING HEAD BOLTS, LOCKBOLTS, HEX-DRIVE BOLTS	BACB30DX BACB30NX BACB30LJ BACB30PF BACB30LK BACB30PW BACB30LM BACB30UB BACB30LN MS20004-24 BACB30MB NAS623 BACB30MR NAS673-678 BACB30NE NAS1218 BACB30NF NAS1223-1235 BACB30NM NAS1303-1320 BACB30NR NAS1465-1472 BACB30NT NAS6965-6972	2024-T3	3Figure 3/GENERAL	I
		2024-T42 2024-T4 2024-T42 TUBE	Figure 3/GENERAL	II
		7075-T6 7075-T6, -T6510, -T6511 EXTRUSION	Figure 3/GENERAL	III
STANDARD FLUSH HEAD BOLTS, LOCKBOLTS, HEX-DRIVE BOLTS	BACB30AB BACB30NN BACB30EM BACB30NY BACB30FL BACB30PC BACB30GX BACB30UA BACB30JC NAS333-340 BACB30LH NAS517 BACB30LP NAS583-590 BACB30LR NAS663-668 BACB30LU NAS1221 BACB30MS NAS1456-1462	2024-T3	Figure 4/GENERAL	I
		7075-T6	Figure 4/GENERAL	II
SHEAR FLUSH HEAD BOLTS, SHEAR FLUSH AND PROTRUDING HEAD LOCKBOLTS, AND HEX-DRIVE BOLTS	BACB30EL BACB30NW BACB30FB BACB30VN BACB30FM BACB30VR BACB30FN BACB30VT BACB30GW BACB30XT BACB30GY BACB30XU BACB30LL BACB30YP BACB30MY NAS1436-1442 BACB30NU NAS1446-1452	2024-T3	Figure 5/GENERAL	I
		7075-T6	Figure 5/GENERAL	II
FASTENER SUBSTITUTION FOR MS20470D AND BACR15BB()D UNIVERSAL HD RIVETS			Figure 6/GENERAL	
FASTENER SUBSTITUTION FOR MS20426D AND BACR15BA()D RIVETS IN COUNTERSUNK HOLES			Figure 7/GENERAL	

RIVET DIAMETER		1/8				5/32				3/16			
RIVET MATERIAL		2117	2017			2117	2017	2024	7050	2117	2017	2024	7050
CODE		XC	BM XZK			XC	BM XZK	XD	YTN	XC	BM XZK	XD	YTN
SINGLE SHEAR (LBS)		369	467			575	730	785	785	830	1050	1130	1130
SINGLE SHEAR ALLOWABLE (LBS)	0.025	319	319										
	0.032	356	408			510	510	510	510				
	0.040	367	465			555	635	635	635	765	765	765	765
	0.050					570	725	780	780	805	955	955	955
	0.056					575	730	785	785	815	1030	1070	1070
	0.063									830	1050	1130	1130
	0.071												
	0.080												
	0.090												
	0.100												
	0.112												
	0.125												
	0.140												
	0.160												
DOUBLE SHEAR ALLOWABLE (LBS)	0.050	635	635			795	795	795	795	955	955	955	955
	0.056	670	715			890	890	890	890	1070	1070	1070	1070
	0.063	690	825			1000	1030	1030	1030	1240	1240	1240	1240
	0.071	715	900			1040	1160	1160	1160	1400	1400	1400	1400
	0.080	730	925			1080	1310	1310	1310	1480	1570	1570	1570
	0.090	738	934			1110	1410	1480	1480	1530	1770	1770	1770
	0.100					1140	1450	1560	1560	1580	1970	1970	1970
	0.112					1150	1460	1570	1570	1620	2050	2200	2200
	0.125									1660	2100	2260	2260
	0.160												
	0.190												
	0.250												
	0.312												

FASTENER CODE:
XC = BACR15BB*AD
BM = MS20470D
XD = BACR15BB*DD
XZK = BACR15BB*D
YTN = BACR15FT*KE

UNIVERSAL HEAD RIVETS IN CLAD OR BARE 2024-T3 SHEET

TABLE I

Strength of Solid Rivets
Figure 1 (Sheet 1 of 8)

RIVET DIAMETER		1/4				5/16				3/8			
RIVET MATERIAL		2117	2017	2024	7050	2117	2017	2024	7050	2117	2017	2024	7050
CODE		YOO XC YOF	BM XZK	XD	YTN	XC	BM XZK	XD	YTN	XC	BM XZK	XD	YTN
SINGLE SHEAR (LBS)		1470	1870	2010	2010	2290	2910	3140	3140	3300	4180	4510	4510
SINGLE SHEAR ALLOWABLE (LBS)	0.025												
	0.032												
	0.040												
	0.050	1270	1270	1270	1270								
	0.056	1380	1430	1430	1430								
	0.063	1410	1650	1650	1650	2070	2070	2070	2070				
	0.071	1440	1830	1860	1860	2160	2330	2330	2330	2800	2800	2800	2800
	0.080	1460	1860	2000	2000	2210	2620	2620	2620	3080	3150	3150	3150
	0.090	1470	1870	2010	2010	2250	2850	2950	2950	3140	3540	3540	3540
	0.100					2280	2890	3120	3120	3210	3940	3940	3940
	0.112					2290	2910	3140	3140	3300	4120	4410	4410
	0.125										4180	4510	4510
	0.140												
	0.160												
DOUBLE SHEAR ALLOWABLE (LBS)	0.050	1270	1270	1270	1270								
	0.056	1430	1430	1430	1430								
	0.063	1650	1650	1650	1650	2070	2070	2070	2070				
	0.071	1860	1860	1860	1860	2330	2330	2330	2330	2800	2800	2800	2800
	0.080	2100	2100	2100	2100	2630	2620	2620	2620	3150	3150	3150	3150
	0.090	2360	2360	2360	2360	2970	2950	2950	2950	3540	3540	3540	3540
	0.100	2560	2620	2620	2620	3280	3280	3280	3280	3940	3940	3940	3940
	0.112	2660	2940	2940	2940	3670	3670	3670	3670	4410	4410	4410	4410
	0.125	2750	3230	3280	3280	3980	4100	4100	4100	4920	4920	4910	4520
	0.160	2920	3710	3990	3990	4310	5300	5300	5300	5900	6300	6300	6300
	0.190	2940	3740	4020	4020	4490	5700	6150	6150	6200	7500	7500	7500
	0.250					4580	5820	6280	6280	6600	8360	9020	9020
	0.312												

FASTENER CODE:
XC = BACR15BB*AD
BM = MS20470D
XD = BACR15BB*DD
XZK = BACR15BB*D
YTN = BACR15FT*KE

UNIVERSAL HEAD RIVETS IN CLAD OR BARE 2024-T3 SHEET

TABLE I (Cont)

Strength of Solid Rivets
Figure 1 (Sheet 2 of 8)

RIVET DIAMETER		1/8				5/32				3/16			
RIVET MATERIAL		2117	2017			2117	2017	2024	7050	2117	2017	2024	7050
CODE		XC	BM XZK			XC	BM XZK	XD	YTN	XC	BM XZK	XD	YTN
SINGLE SHEAR (LBS)		369	467			575	730	785	785	830	1050	1130	1130
SINGLE SHEAR ALLOWABLE (LBS)	0.025	244	244										
	0.032	312	312			390	390	390	390				
	0.040	367	390			487	487	487	487	585	585	585	585
	0.050		467			570	610	610	610	730	730	730	730
	0.056					575	680	680	680	815	820	820	820
	0.063						730	785	785	830	990	990	990
	0.071										1050	1120	1120
	0.080											1130	1130
	0.090												
	0.100												
	0.112												
	0.125												
	0.140												
	0.160												
DOUBLE SHEAR ALLOWABLE (LBS)	0.050	487	487			610	610	610	610	730	730	730	730
	0.056	545	545			680	680	680	680	820	820	820	820
	0.063	660	660			825	825	825	825	990	990	990	990
	0.071	715	745			730	930	930	930	1120	1120	1120	1120
	0.080	730	840			1050	1050	1050	1050	1260	1260	1260	1260
	0.090	738	934			1110	1180	1180	1180	1420	1420	1420	1420
	0.100					1140	1310	1310	1310	1570	1570	1570	1570
	0.112					1150	1460	1470	1470	1620	1760	1760	1760
	0.125							1570	1570	1660	1970	1970	1970
	0.160										2100	2260	2260
	0.190												
	0.250												
	0.312												

FASTENER CODE:
XC = BACR15BB*AD
BM = MS20470D
XD = BACR15BB*DD
XZK = BACR15BB*D
YTN = BACR15FT*KE

UNIVERSAL HEAD RIVETS IN CLAD OR BARE 2024-T4 SHEET,
CLAD OR BARE 2024-T42 SHEET, 2024-T42 TUBE
TABLE II

Strength of Solid Rivets
Figure 1 (Sheet 3 of 8)

RIVET DIAMETER		1/4				5/16				3/8			
RIVET MATERIAL		2117	2017	2024	7050	2117	2017	2024	7050	2117	2017	2024	7050
CODE		XC	BM XZK	XD	YTN	XC	BM XZK	XD	YTN	XC	BM XZK	XD	YTN
SINGLE SHEAR (LBS)		1470	1870	2010	2010	2290	2910	3140	3140	3300	4180	4510	4510
SINGLE SHEAR ALLOWABLE (LBS)	0.025												
	0.032												
	0.040												
	0.050	975	975	975	975								
	0.056	1090	1040	1090	1090								
	0.063	1320	1320	1320	1320	1650	1650	1650	1650				
	0.071	1420	1490	1490	1490	1860	1860	1860	1360	2240	2240	2240	2240
	0.080	1460	1680	1680	1680	2100	2100	2100	2100	2520	2520	2520	2520
	0.090	1470	1870	1890	1890	2250	2360	2360	2360	2830	2830	2830	2830
	0.100			2010	2010	2280	2620	2620	2620	3150	3150	3150	3150
	0.112					2270	2910	2940	2940	3300	3530	3530	3530
	0.125							3140	3140		3940	3940	3940
	0.140										4180	4410	4410
	0.160											4510	4510
DOUBLE SHEAR ALLOWABLE (LBS)	0.050	975	975	975	975								
	0.056	1090	1090	1090	1090								
	0.063	1320	1320	1320	1320	1650	1650	1650	1650				
	0.071	1490	1490	1490	1490	1860	1860	1860	1860	2240	2240	2240	2240
	0.080	1680	1680	1680	1680	2100	2100	2100	2100	2520	2520	2520	2520
	0.090	1890	1890	1890	1890	2360	2360	2360	2360	2830	2830	2830	2830
	0.100	2100	2100	2100	2100	2620	2620	2620	2620	3150	3150	3150	3150
	0.112	2350	2350	2350	2350	2940	2940	2940	2940	3530	3530	3530	3530
	0.125	2620	2620	2620	2620	3280	3280	3280	3280	3940	3940	3940	3940
	0.160	2920	3360	3360	3360	4200	4200	4200	4200	5050	5050	5050	5050
	0.190	2940	3740	3990	3990	4490	4990	4990	4990	6000	6000	6000	6000
	0.250			4020	4020	4530	5620	6200	6200	6600	7450	7450	7450
	0.312							6280	6280		8360	9020	9020

FASTENER CODE:
XC = BACR15BB*AD
BM = MS20470D
XD = BACR15BB*DD
XZK = BACR15BB*D
YTN = BACR15FT*KE

UNIVERSAL HEAD RIVETS IN CLAD OR BARE 2024-T4 SHEET,
CLAD OR BARE 2024-T42 SHEET, 2024-T42 TUBE
TABLE II (Cont)

Strength of Solid Rivets
Figure 1 (Sheet 4 of 8)

RIVET DIAMETER		1/8				5/32				3/16			
RIVET MATERIAL		2117	2017			2117	2017	2024	7050	2117	2017	2024	7050
CODE		XC	BM XZK			XC	BM XZK	XD	YTN	XC	BM XZK	XD	YTN
SINGLE SHEAR (LBS)		369	467			575	730	785	785	830	1050	1130	1130
SINGLE SHEAR ALLOWABLE (LBS)	0.025	334	353										
	0.032	356	450			530	565	565	565				
	0.040	367	465			555	705	720	720	775	860	860	860
	0.050					570	725	780	780	805	1020	1080	1080
	0.056					575	730	785	785	815	1030	1110	1110
	0.063									830	1050	1130	1130
	0.071												
	0.080												
	0.090												
	0.100												
	0.112												
	0.125												
	0.140												
	0.160												
DOUBLE SHEAR ALLOWABLE (LBS)	0.050	640	720			900	900	900	900	1080	1080	1080	1080
	0.056	670	805			960	1010	1010	1010	1210	1210	1210	1210
	0.063	690	875			1000	1140	1140	1140	1340	1370	1370	1370
	0.071	715	900			1040	1290	1290	1290	1410	1540	1540	1540
	0.080	730	925			1080	1370	1450	1450	1480	1740	1740	1740
	0.090	738	934			1110	1410	1520	1520	1530	1940	1960	1960
	0.100					1140	1450	1560	1560	1580	2000	2150	2150
	0.112					1150	1460	1570	1570	1620	2050	2210	2210
	0.125									1660	2100	2260	2260
	0.160												
	0.190												
	0.250												
	0.312												

FASTENER CODE:
XC = BACR15BB*AD
XD = BACR15BB*DD
BM = MS20470D
XZK = BACR15BB*D
YTN = BACR15FT*KE

UNIVERSAL HEAD RIVETS IN CLAD OR BARE 7075-T6 SHEET, 7075-T6, -T6510,-T6511 EXTRUSION (LESS THAN 0.188 THICK)
TABLE III

Strength of Solid Rivets
Figure 1 (Sheet 5 of 8)

RIVET DIAMETER		1/4				5/16				3/8			
RIVET MATERIAL		2117	2017	2024	7050	2117	2017	2024	7050	2117	2017	2024	7050
CODE		XC	BM XZK	XD	YTN	XC	BM XZK	XD	YTN	XC	BM XZK	XD	YTN
SINGLE SHEAR (LBS)		1470	1870	2010	2010	2290	2910	3140	3140	3300	4180	4510	4510
SINGLE SHEAR ALLOWABLE (LBS)	0.025												
	0.032												
	0.040												
	0.050	1310	1440	1440	1440								
	0.056	1380	1610	1610	1610								
	0.063	1410	1800	1830	1830	2110	2280	2280	2280				
	0.071	1440	1830	1970	1970	2160	2570	2570	2570	2930	3090	3090	3090
	0.080	1460	1860	2000	2000	2210	2810	2900	2900	3080	3480	3480	3480
	0.090	1470	1870	2010	2010	2250	2850	3080	3080	3140	3910	3910	3910
	0.100					2280	2890	3120	3120	3210	4060	4350	4350
	0.112					2290	2910	3140	3140	3300	4120	4450	4450
	0.125										4180	4510	4510
	0.140												
	0.160												
DOUBLE SHEAR ALLOWABLE (LBS)	0.050	1440	1440	1440	1440								
	0.056	1610	1610	1610	1610								
	0.063	1830	1830	1830	1830	2280	2280	2280	2280				
	0.071	2060	2060	2060	2060	2570	2570	2570	2570	3090	3090	3090	3090
	0.080	2320	2320	2320	2320	2900	2900	2900	2900	3480	3480	3480	3480
	0.090	2450	2610	2610	2610	3260	3260	3260	3260	3910	3910	3910	3910
	0.100	2560	2900	2900	2900	3610	3620	3620	3620	4350	4350	4350	4350
	0.112	2660	3250	3250	3250	3810	4060	4060	4060	4370	4870	4870	4870
	0.125	2750	3500	3620	3620	3980	4530	4530	4530	5300	5450	5450	5450
	0.160	2920	3710	3990	3990	4310	5500	5800	5800	5900	7000	6950	6950
	0.190	2940	3740	4020	4020	4470	5720	6150	6150	6200	7850	8450	8450
	0.250					4580	5820	6280	6280	6600	8360	9020	9020
	0.312												

FASTENER CODE:
XC = BACR15BB*AD
BM = MS20470D
XD = BACR15BB*DD
XZK = BACR15BB*D
YTN = BACR15FT*KE

UNIVERSAL HEAD RIVETS IN CLAD OR BARE 7075-T6 SHEET, 7075-T6,
-T6510,-T6511 EXTRUSION (LESS THAN 0.188 THICK)
TABLE III (Cont)

Strength of Solid Rivets
Figure 1 (Sheet 6 of 8)

		100° COUNTERSUNK HEAD								100° SHEAR HEAD				120° MODIFIED SHEAR HEAD						
RIVET DIAMETER		5/32		3/16			1/4		5/16	1/8	5/32	3/16	1/4	1/8	5/32	3/16	7/32	1/4	9/32	5/16
MATERIAL		2117	2017	2117	2017	2024	2017	2024	2017	2017				7050						
CODE		XA	BE XZG	XA	BE XZG	XB	BE XZG	XB	BE XZG	XF				YNE [A]						
SINGLE SHEAR (LBS)		575	730	830	1050	1130	1870	2010	2910	467	730	1050	1870	505	785	1130	1540	2010	2550	3140
SINGLE SHEAR ALLOWABLE (LBS)	0.025									195				215						
	0.028									230				254						
	0.032	300								280	315			307	346					
	0.036	349								325	375			369	410					
	0.040	398	405	409						360	435	485		434	478	530				
	0.045	435	455	525						395	500	575		497	575	630	690			
	0.050	481	520	585	630	760				430	560	665	780	505	670	730	805	860		
	0.056	495	550	655	680	830				467	620	760	925		760	875	950	1020	1080	
	0.063	525	600	705	775	885	915	1210	1630		675	840	1090		780	1045	1135	1200	1285	
	0.071	540	690	740	835	940	1050	1350	1760		730	925	1280		785	1110	1365	1445	1530	1630
	0.080	560	720	770	935	990	1180	1470	1970			1010	1440			1130	1540	1735	1835	1930
	0.090	575	730	795	1010	1030	1290	1580	2040			1050	1580					1990	2200	2320
	0.100			820	1050	1070	1520	1670	2460				1720					2010	2525	2725
	0.112			830		1130	1700	1780	2520				1870						2550	3140
	0.125						1770	1880	2580											
	0.160						1870	2000	2740											
	0.180							2010	2880											

FASTENER CODE:

XA = BACR15BA*AD
BE = MS20426D
XB = BACR1513A*DD
XF = BACR15CE*D
XZG = BACR15BA*D
YNE = BACR15FV*KE

TABLE IV
COUNTERSUNK HEAD RIVETS IN:

CLAD OR BARE 2024-T3
CLAD OR BARE 2024-T42
CLAD OR BARE 7075-T6

NOTES:

[A] GOOD ONLY IN 2024-T3 CLAD AND BARE

Strength of Solid Rivets
Figure 1 (Sheet 7 of 8)

	MS20615M				MS20427M								
	CODE: LN				CODE: BF								
	UNIVERSAL HEAD IN 301-1/4 HARD CRES SHEET				100° FLUSH HEAD IN 301-1/4 HARD CRES SHEET			100° FLUSH HEAD IN 301-1/2 HARD AND 301 FULL HARD CRES SHEET			100° FLUSH HEAD IN 302 ANNEED CRES SHEET		
RIVET DIAMETER	1/8	5/32	3/16	1/4	1/8	5/32	3/16	1/8	5/32	3/16	1/8	5/32	3/16
SINGLE SHEAR (LBS)	605	940	1350	2410	605	940	1350	605	940	1350	605	940	1350
MATERIAL GAGE	SINGLE SHEAR ALLOWABLES (LBS)												
0.020					300			321			193		
0.025	555				361	463		396	496		243	295	
0.032	585	870			431	590	705	431	625	765	309	384	457
0.040	600	905	1260		439	665	860	439	665	915	388	481	580
0.050	605	935	1310	2220	468	675	955	447	675	955	486	605	720
0.063		940	1350	2320	595	730	970	540	690	970	605	760	905
0.071				2360	605	830	990	605	740	985		855	1030
0.080				2400		935	1120		850	995		940	1160
0.090				2410		940	1250		940	1130			1300
0.100							1350			1280			1350
0.125										1350			

MS20615M AND MS20427M RIVETS IN CRES SHEET
TABLE V

Strength of Solid Rivets
Figure 1 (Sheet 8 of 8)

	UNIVERSAL HEAD								100° RIVETS IN COUNTERSUNK HOLES							
	NAS1398B				NAS1398D				NAS1399B				NAS1399D			
	CODE: RK				CODE: RL				CODE: RO				CODE: RP			
RIVET DIAMETER	1/8	5/32	3/16	1/4	1/8	5/32	3/16	1/4	1/8	5/32	3/16	1/4	1/8	5/32	3/16	1/4
SINGLE SHEAR (LBS)	388	595	860	1550	495	755	1090	1970	388	595	860	1550	495	755	1090	1970
TENSION (LBS)	230	375	540	1000	230	375	540	1000	230	375	540	1000	230	375	540	1000
67% TENSION (LBS)	154	251	361	670	154	251	361	670	154	251	361	670	154	251	361	670
MATERIAL GAGE	SINGLE SHEAR ALLOWABLES (LBS)															
0.020	155	180			155	180			35	45			35	45		
0.025	210	240	260		215	245	260		50	60	65		50	60	70	
0.032	260	325	375	445	270	340	375	445	70	75	90	110	70	75	95	115
0.036	285	365	430	530	300	380	455	530	80	90	100	125	80	90	105	130
0.040	305	405	490	620	320	415	510	620	95	105	115	145	95	105	140	150
0.045	330	450	545	705	345	460	570	750	115	125	140	175	120	130	155	180
0.050	350	475	595	805	370	495	625	840	135	150	165	195	150	160	180	200
0.056	370	515	655	905	395	535	680	935	170	175	190	230	190	200	235	240
0.063		545	700	1010	425	580	735	1050	200	215	230	265	230	245	310	320
0.071		570	760	1110	450	610	795	1160	250	260	280	320	290	295	390	400
0.080			810	1210	480	650	845	1250	330	340	350	375	340	360	490	500
0.090			815	1290		700	910	1350	370	405	415	455	415	455	580	625
0.100				1380		740	965	1450		510	520	540	480	535	695	755
0.112				1440			1030	1540		570	635	650		630	850	915
0.125							1060	1640			815	825		740	985	1090
0.140								1750				980			1060	1370
0.160								1870				1320				1670

NOTES

- MINIMUM BLIND SIDE SHEET THICKNESS ALLOWED IS EQUAL TO 1/4 RIVET DIAMETER. FOR THINNER MATERIAL USE NAS1736C OR NAS1739E RIVETS (SEE TABLE II).
- ALLOWABLES ABOVE THE THICK LINE ARE FOR GAGES LESS THAN THE RECOMMENDED MINIMUM.
- USE 67% TENSION FOR PRIMARY STRUCTURE OR WHERE REVERSING LOADS ARE EXPECTED.

NAS1398 AND NAS1399 RIVETS IN 2024-T3 BARE OR CLAD SHEET
TABLE I

Strength of Blind Fasteners
Figure 2 (Sheet 1 of 4)

	NAS1739E			NAS1738E					
	CODE: AAV			CODE: AAP					
	100° FLUSH HEAD IN 2024-T3 OR 7075-T6, BARE OR CLAD			UNIVERSAL HEAD IN 2024-T3, BARE OR CLAD			UNIVERSAL HEAD IN 7075-T6, BARE OR CLAD		
RIVET DIAMETER	1/8	5/32	3/16	1/8	5/32	3/16	1/8	5/32	3/16
SINGLE SHEAR (LBS)	620	935	1260	620	935	1260	620	935	1260
TENSION (LBS)	345	530	710	345	530	710	345	530	710
67% TENSION (LBS)	232	356	476	232	356	476	232	356	476
MATERIAL GAGE	SINGLE SHEAR ALLOWABLES (LBS)								
0.020				157			268		
0.025				200	244		292	409	
0.032	201			252	318	361	328	454	570
0.036	228	277		286	351	411	355	477	600
0.040	256	309	352	316	394	454	372	500	630
0.045	286	352	410	354	435	510	396	535	675
0.050	324	394	454	396	486	570	426	565	710
0.056	360	445	510	447	545	635	459	615	755
0.063	407	500	575	486	620	720	500	665	815
0.071	449	560	660	530	685	810	540	710	875
0.080	497	635	740	580	750	920	590	770	940
0.090	545	695	835	615	820	1000	615	840	1020
0.100	600	765	915		895	1080		900	1110
0.112	615	840	1000		935	1170		935	1200
0.125		920	1090			1260			1260
0.140		935	1210						
0.160			1260						

NOTES

- ACTUAL RIVET DIAMETERS ARE APPROX 1/64 LARGER THAN NOMINAL SIZE SHOWN.
- ALLOWABLES ABOVE THE THICK LINE ARE FOR GAGES LESS THAN THE RECOMMENDED MINIMUM.
- USE 67% TENSION FOR PRIMARY STRUCTURE OR WHERE REVERSING LOADS ARE EXPECTED.

NAS1738E AND NAS1739E RIVETS IN 7075-T6 AND 2024-T3 BARE OR CLAD SHEET
TABLE II

Strength of Blind Fasteners
Figure 2 (Sheet 2 of 4)

FASTENER	BLIND BOLT MS90353,MS90354				
HEAD	100° FLUSH AND UNIVERSAL HEAD				
FASTENER DIAMETER	5/32	3/16	1/4	5/16	3/8
SHEAR (LBS)	2340	3450	5900	8500	12200
TENSION (LBS)	1350	2100	3650	5200	7500
67% TENSION (LBS)	905	1407	2445	3484	5025
MATERIAL GAGE	SINGLE SHEAR ALLOWABLES (LBS)				
0.040	327				
0.045	402				
0.050	498	520			
0.056	590	640			
0.063	710	755	800		
0.071	825	960	995		
0.080	980	1130	1240	1280	
0.090	1150	1300	1540	1650	1660
0.100	1300	1510	1790	1840	1960
0.112	1510	1770	2090	2370	2480
0.125	1720	2000	2440	2730	3000
0.140	1880	2320	2830	3240	3510
0.160	2020	2730	3340	3810	4330
0.190	2200	3000	4140	4810	5350
0.250	2340	3450	5150	6700	7750
0.312			5900	7600	9950
0.375				8500	11000
0.437					11900
0.500					12200

NOTES

- USE 67% TENSION FOR PRIMARY STRUCTURE OR WHERE REVERSING LOADS ARE EXPECTED
- ALLOWABLES ABOVE THE THICK LINE ARE FOR GAGES LESS THAN THE RECOMMENDED MINIMUM (100° FLUSH HEAD ONLY)

MS90353,MS90354 BLIND BOLTS IN 2024-T3 CLAD OR BARE SHEET
TABLE III

Strength of Blind Fasteners
Figure 2 (Sheet 3 of 4)

FASTENER	BLIND BOLT MS90353,MS90354				
HEAD	100° FLUSH AND UNIVERSAL HEAD				
FASTENER DIAMETER	5/32	3/16	1/4	5/16	3/8
SINGLE SHEAR (LBS)	2340	3450	5900	8500	12200
TENSION (LBS)	1350	2100	3650	5200	7500
67% TENSION (LBS)	905	1407	2445	3484	5025
MATERIAL GAGE	SINGLE SHEAR ALLOWABLES (LBS)				
0.040	384				
0.045	520				
0.050	635				
0.056	765	815			
0.063	960	1020			
0.071	1130	1240	1240		
0.080	1290	1510	1590		
0.090	1450	1780	1990	2080	
0.100	1580	1980	2390	2590	2590
0.112	1690	2140	2840	3100	3100
0.125	1850	2390	3260	3750	3820
0.140	1980	2550	3660	4370	4750
0.160	2160	2870	4000	4980	5800
0.190	2340	3200	4620	5700	7050
0.250		3450	5500	7050	8700
0.312			5900	8100	10400
0.375				8500	11700
0.437					12200

NOTES

- USE 67% TENSION FOR PRIMARY STRUCTURE OR WHERE REVERSING LOADS ARE EXPECTED
- ALLOWABLES ABOVE THE THICK LINE ARE FOR GAGES LESS THAN THE RECOMMENDED MINIMUM (100° FLUSH HEAD ONLY)

MS90353,MS90354 BLIND BOLTS IN 7075-T6 CLAD OR BARE SHEET
TABLE IV

Strength of Blind Fasteners
Figure 2 (Sheet 4 of 4)

FASTENER PART NUMBERS			[A] BACB30DX BACB30LJ BACB30LK BACB30LM BACB30LN [B] BACB30MB BACB30MR		BACB30NE BACB30NF BACB30NM BACB30NR BACB30NT [B] BACB30NX BACB30PF		BACB30PU BACB30PW MS20004-24 NAS623 NAS673-678 NAS1218 NAS1223-1235		NAS1303-1320 [A] NAS1465-1472 [A] NAS6965-6972	
FASTENER DIAMETER			3/16	1/4	5/16	3/8	7/16	1/2	9/16	5/8
SINGLE SHEAR (LBS)			2690	4650	7250	10400	14200	18600	23600	29150
SINGLE SHEAR BEARING STRENGTH (LBS)	MATERIAL GAGE	0.063	1260	1650	2070					
		0.071	1420	1860	2330	2800				
		0.080	1600	2100	2620	3150	3670			
		0.090	1790	2360	2950	3540	4130			
		0.100	1990	2620	3280	3940	4600	5250		
		0.112	2230	2940	3670	4410	5150	5900	6600	
		0.125	2490	3280	4100	4920	5750	6550	7400	8200
		0.140	2690	3710	4640	5550	6500	7400	8350	9250
		0.160		4240	5300	6350	7400	8500	9550	10600
		0.180		4650	5950	7150	8350	9550	10700	11900
		0.200			6600	7950	9250	10600	11900	13200
		0.224			7250	8900	10400	11900	13400	14800
		0.250				9900	11600	13200	14900	16600
		0.312				10400	14200	16500	18600	20700
		0.375						18600	22400	24800
		0.500							23600	29150
		0.562								
		0.625								

NOTES

[A] DIA UP TO .375 INCLUSIVE

[B] DIA UP TO .500 INCLUSIVE

95 KSI PROTRUDING HEAD BOLTS, LOCKBOLTS AND HEX-DRIVE BOLTS IN:
2024-T3 CLAD OR BARE, SHEET OR PLATE
TABLE I

Strengths of Protruding Head Bolts, Lockbolts, and Hex-Drive Bolts
Figure 3 (Sheet 1 of 3)

FASTENER PART NUMBERS			A BACB30DX BACB30LJ BACB30LK BACB30LM BACB30LN B BACB30MB BACB30MR BACB30NE BACB30NF BACB30NM BACB30NR BACB30NT B BACB30NX BACB30PF BACB30PU BACB30PW MS20004-24 NAS623 NAS673-678 NAS1218 NAS1223-1235 NAS1303-1320 A NAS1465-1472 A NAS6965-6972							
FASTENER DIAMETER			3/16	1/4	5/16	3/8	7/16	1/2	9/16	5/8
SINGLE SHEAR (LBS)			2690	4650	7250	10400	14200	18600	23600	29150
SINGLE SHEAR BEARING STRENGTH (LBS)	MATERIAL GAGE	0.063	1000	1320	1650					
		0.071	1130	1490	1860	2240				
		0.080	1280	1680	2100	2520				
		0.090	1440	1890	2360	2830	3310	3780	4250	
		0.100	1600	2100	2620	3150	3670	4200	4720	
		0.112	1790	2350	2940	3530	4120	4900	5300	
		0.125	1990	2620	3280	3940	4590	5250	5900	6550
		0.140	2230	2940	3670	4410	5150	5900	6600	7350
		0.160	2550	3360	4200	5050	5900	6700	7550	8400
		0.180	2690	3780	4720	5650	6600	7550	8500	9450
		0.200		4200	5250	6300	7350	8400	9450	10500
		0.224		4650	5900	7050	8250	9400	10600	11800
		0.250			6200	7450	9000	9950	11200	12400
		0.312			7250	9300	10900	12400	14000	15500
		0.375				10400	13000	14900	16800	18600
		0.500					14200	18600	22400	24800
		0.562							23600	27900
		0.625								29150

95 KSI PROTRUDING HEAD BOLTS, LOCKBOLTS AND HEX-DRIVE BOLTS IN:
2024-T42 CLAD OR BARE, SHEET OR PLATE
2024-T4 CLAD SHEET OR PLATE
2024-T42 TUBE

TABLE II

Strengths of Protruding Head Bolts, Lockbolts, and Hex-Drive Bolts
Figure 3 (Sheet 2 of 3)

FASTENER PART NUMBERS			A BACB30DX BACB30LJ BACB30LK BACB30LM BACB30LN B BACB30MB BACB30MR		BACB30NE BACB30NF BACB30NM BACB30NR BACB30NT B BACB30NX BACB30PF		BACB30PU BACB30PW MS20004-24 NAS623 NAS673-678 NAS1218 NAS1223-1235		NAS1303-1320 A NAS1465-1472 A NAS6965-6972	
FASTENER DIAMETER			3/16	1/4	5/16	3/8	7/16	1/2	9/16	5/8
SINGLE SHEAR (LBS)			2690	4650	7250	10400	14200	18600	23600	29150
SINGLE SHEAR BEARING STRENGTH (LBS)	MATERIAL GAGE	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		
		0.112	2470	3250	4060	4870	5700	6500		
		0.125	2690	3620	4530	5450	6350	7250	8150	9050
		0.140		4060	5050	6100	7100	8100	9150	10100
		0.160		4640	5800	6950	8100	9300	10400	11600
		0.180		4650	6500	7850	9150	10400	11700	18000
		0.200			7250	8900	10400	11900	13400	14900
		0.224				10000	11700	13300	15000	16700
		0.250				10400	12500	14200	16000	17800
		0.312					14200	17800	20000	22200
		0.375						18600	23600	26900
		0.500								29180
		0.562								
		0.625								

95 KSI PROTRUDING HEAD BOLTS, LOCKBOLTS AND HEX-DRIVE BOLTS IN:
7075-T6 CLAD OR BARE, SHEET OR PLATE
7075-T6, -T6510, -T6511 EXTRUSION (LESS THAN 0.185 THICK)
TABLE III

Strengths of Protruding Head Bolts, Lockbolts, and Hex-Drive Bolts
Figure 3 (Sheet 3 of 3)

FASTENER PART NUMBERS			BACB30AB BACB30EM BACB30FL A BACB30GX A BACB30JC BACB30LH BACB30LP BACB30LR BACB30LU BACB30MS BACB30NN A BACB30NY BACB30PC NAS333-340 NAS517 NAS583-590 NAS663-668 NAS1221 A NAS1456-1462						
FASTENER DIAMETER			3/16	1/4	5/16	3/8	7/16	1/2	9/16
SINGLE SHEAR (LBS)			2690	4650	7250	10400	14200	18600	23600
SINGLE SHEAR BEARING STRENGTH (LBS)	MATERIAL GAGE	0.063	1080	1430					
		0.071	1220	1630	1920				
		0.080	1380	1840	2250				
		0.090	1550	2070	2580	2950			
		0.100	1720	2300	2870	3350	3750	4900	
		0.125	2150	2870	3590	4310	5000	5600	
		0.140	2410	3220	4020	4830	5650	6450	7250
		0.160	2690	3680	4600	5500	6450	7350	8250
		0.180		4140	5150	6200	7250	8300	9300
		0.190		4320	5400	6550	7650	8750	9800
		0.200		4480	5750	6900	8050	9200	10300
		0.224		4650	6450	7700	9000	10300	11600
		0.250			6900	8600	10000	11500	12900
		0.312			7250	10400	12500	14300	16100
		0.375					14200	17100	19400
		0.438						18600	22200
		0.500							23600

NOTES

A DIA UP TO .375 INCLUSIVE

95 KSI STANDARD FLUSH HEAD BOLTS, LOCKBOLTS, AND HEX-DRIVE BOLTS IN:
CLAD OR BARE 2024-T3 SHEET OR PLATE
TABLE I

Strengths of Standard Flush Head Bolts, Lockbolts, and Hex Drive Bolts
Figure 4 (Sheet 1 of 2)

FASTENER PART NUMBERS			BACB30AB BACB30EM BACB30FL $\boxed{A}$ BACB30GX $\boxed{A}$ BACB30JC BACB30LH BACB30LP BACB30LR BACB30LU BACB30MS BACB30NN $\boxed{A}$ BACB30NY BACB30PC NAS333-340 NAS517 NAS583-590 NAS663-668 NAS1221 $\boxed{A}$ NAS1456-1462						
FASTENER DIAMETER			3/16	1/4	5/16	3/8	7/16	1/2	9/16
SINGLE SHEAR (LBS)			2690	4650	7250	10400	14200	18600	23600
SINGLE SHEAR BEARING STRENGTH (LBS)	MATERIAL GAGE	0.063	1180	1690	1900				
		0.071	1270	1870	2390	2570			
		0.080	1420	2020	2700	3000			
		0.090	1590	2170	2980	3640	3940		
		0.100	1800	2370	3180	4050	4720	5000	
		0.125	2460	2920	3710	4680	5800	6750	7600
		0.140	2690	3370	4140	5050	6200	7450	8500
		0.160		4080	4770	5600	6800	8100	9500
		0.180		4640	5450	6250	7400	8750	10300
		0.190		4650	5950	6650	7700	9100	10600
		0.200			6350	7100	8100	9500	11000
		0.224			7240	8300	9100	10400	11700
		0.250			7250	9900	10600	11800	13200
		0.312				10400	14200	15600	17100
		0.375						18500	22000
		0.500						18600	23600

95 KSI STANDARD FLUSH HEAD BOLTS, LOCKBOLTS, AND HEX-DRIVE BOLTS IN:
CLAD OR BARE 7075-T6 SHEET OR PLATE
TABLE II

Strengths of Standard Flush Head Bolts, Lockbolts, and Hex Drive Bolts
Figure 4 (Sheet 2 of 2)

FASTENER PART NUMBERS		D BACB30EL D BACB30FB B BACB30FM C BACB30FN			E BACB30GW E BACB30GY D BACB30LL B BACB30MY			D BACB30NU C BACB30NW E NAS1436-1442 E NAS1446-1452
FASTENER DIAMETER		3/16	1/4	5/16	3/8	7/16	1/2	9/16	5/8
SINGLE SHEAR (LBS)		2690	4650	7250	10400	14200	18600	23600	29150
SINGLE SHEAR BEARING STRENGTH (LBS)	MATERIAL GAGE								
	0.040 A	690	920	1150					
	0.050 A	860	1150	1430					
	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		
	0.100	1720	2300	2870	3450	4030	4600	5150	
	0.125	2020	2870	3590	4310	5050	5750	6450	7200
	0.140	2130	3220	4020	4830	5650	6450	7250	8050
	0.160	2170	3490	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

NOTES

A COUNTERSUNK FASTENERS ARE TO BE AVOIDED WHEN POSSIBLE

B DIA UP TO .5625 INCLUSIVE

C DIA UP TO .500 INCLUSIVE

D DIA UP TO .625 INCLUSIVE

E DIA UP TO .375 INCLUSIVE

95 KSI SHEAR FLUSH HEAD BOLTS, SHEAR FLUSH AND PROTRUDING HEAD LOCKBOLTS AND HEX-DRIVE BOLTS IN:
CLAD OR BARE 2024-T3 SHEET OR PLATE
TABLE I

Strengths of Shear Flush Head Bolts, Shear Flush and Protruding Head Lockbolts and Hex-Drive Bolts
Figure 5 (Sheet 1 of 2)

FASTENER PART NUMBERS			$\boxed{D}$ BACB30EL $\boxed{D}$ BACB30FB $\boxed{B}$ BACB30FM $\boxed{C}$ BACB30FN $\boxed{E}$ BACB30GW $\boxed{E}$ BACB30GY $\boxed{D}$ BACB30LL $\boxed{B}$ BACB30MY $\boxed{D}$ BACB30NU $\boxed{C}$ BACB30NW $\boxed{E}$ NAS1436-1442 $\boxed{E}$ NAS1446-1452							
FASTENER DIAMETER			3/16	1/4	5/16	3/8	7/16	1/2	9/16	5/8
SINGLE SHEAR (LBS)			2690	4650	7250	10400	14200	18600	23600	29150
SINGLE SHEAR BEARING STRENGTH (LBS)	MATERIAL GAGE	0.063	1270	1700	1980					
		0.071	1430	1910	2390	2570				
		0.080	1620	2150	2700	3120	3780			
		0.090	1820	2430	3030	3640	4250	4850		
		0.100	2020	2700	3370	4050	4720	5400	6050	
		0.125	2530	3370	4220	5050	5900	6750	7600	8450
		0.140	2660	3780	4720	5650	6600	7550	8500	9450
		0.160	2690	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								

95 KSI SHEAR FLUSH HEAD BOLTS, SHEAR FLUSH AND PROTRUDING HEAD LOCKBOLTS AND HEX-DRIVE BOLTS IN:
CLAD OR BARE 7075-T6 SHEET OR PLATE
TABLE II

Strengths of Shear Flush Head Bolts, Shear Flush and Protruding Head Lockbolts and Hex-Drive Bolts
Figure 5 (Sheet 2 of 2)

SUBSTITUTE RIVET	RIVETED MATERIAL	RIVET DIAMETER		RIVETED MATERIAL GAGE														
		INITIAL MS20470D OR BACR15BB-D	SUBSTITUTE RIVET	.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 6 (Sheet 1 of 2)

SUBSTITUTE RIVET	RIVETED MATERIAL	RIVET DIAMETER		RIVETED MATERIAL GAGE														
		INITIAL MS20470D OR BACR15BB-D	SUBSTITUTE RIVET	.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 51-40-05 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 6 (Sheet 2 of 2)

SUBSTITUTE RIVET	RIVETED MATERIAL	RIVET DIAMETER		RIVETED MATERIAL GAGE													
		INITIAL MS20426D OR BACR15BA-D	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 51-40-05 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 Countersunk Holes
Figure 7

GENERAL - COUNTERSINKING

1. Applicability

A. The instructions given in this subject are applicable to countersink holes in metal structures.

B. Refer to 51-70-16, GENERAL to find the instructions to countersink holes in composite structures.

2. General

A. Some of the information in this subject can be found in Boeing Process Specifications BAC5004-1, BAC5004-2, BAC5004-3, BAC5009, BAC5047, and BAC5060.

B. Refer to the Boeing Engineer Drawings and 51-10-01, GENERAL for fastener head flushness specifications.

3. References

Reference	Title
51-10-01, GENERAL	Aerodynamic Smoothness Requirements
51-40-02, GENERAL	Fastener Installation and Removal
51-70-16, GENERAL	Hole Drilling and Machining of Composite Structures

4. The Use of the Countersink-microstop Tool

A. Use the countersink-microstop tool that is fitted with a removable cutter. Refer to Figure 1/GENERAL for 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 on to 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 Figure 1/GENERAL.

5. Instructions to use the Countersink-microstop Tool

NOTE: To cut a 120 degree countersink for a BACR15FV or MS14218 Rivet, refer to Paragraph 6./GENERAL for the procedure.

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 fo 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 the countersink on a piece of scrap material to verify the adjustment before you do it on 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 stop to spin on the repair material.

(5) Install the repair fasteners as shown in 51-40-02, GENERAL.

(6) Inspect for the correct fastener-head height as shown in 51-40-02, GENERAL.

(7) When you can install the fasteners correctly in the piece of scrap metal, you can use the countersink-microstop tool to do the repair.

6. Instructions to use the Countersink-microstop Tool and ST1221V Cutter to Make a Counterbore-countersink for BACR15FV Rivets.

A. To make the counterbore-countersink for the BACR15FV rivets, do the steps that follow:

(1) Use the ST1221V counterbore-countersink cutter and the ST1221 countersink-microstop tool to make counterbore-countersink holes in a piece of scrap metal.

NOTE: Use a piece of scrap metal that is the same alloy and thickness as the initial or repair part.

CAUTION: MAKE SURE THAT THE COUNTERSINK DEPTH IS NOT GREATER THAN THE MAXIMUM DEPTH "B" AS SHOWN IN FIGURE 3/GENERAL. IF YOU DO NOT OBEY, YOU CAN CAUSE A KNIFE EDGE CONDITION IN THE SKIN.

(2) Inspect the countersink depth as shown in Figure 3/GENERAL. If the countersink depth is incorrect, adjust the countersink-microstop tool and do steps (1) and (2) again.

CAUTION: IF YOU ENTER THE COUNTERBORE AGAIN TO ADJUST THE DEPTH, DO NOT START THE CUTTER ROTATION UNTIL THE CUTTER IS SEATED IN THE COUNTERBORE. IF YOU DO NOT OBEY, YOU CAN CAUSE AN OUT-OF-ROUND COUNTERBORE. AFTER THE CUTTER IS SEATED, START IT SLOWLY AND INCREASE THE SPEED UP TO THE RECOMMENDED MAXIMUM OF 3,000 RPM.

(3) Inspect the countersink depth as shown in Figure 3/GENERAL again.

(4) If the counterbore diameter is still incorrect, install a new ST1221V cutter in the countersink-microstop tool and do steps (1) through (3) again.

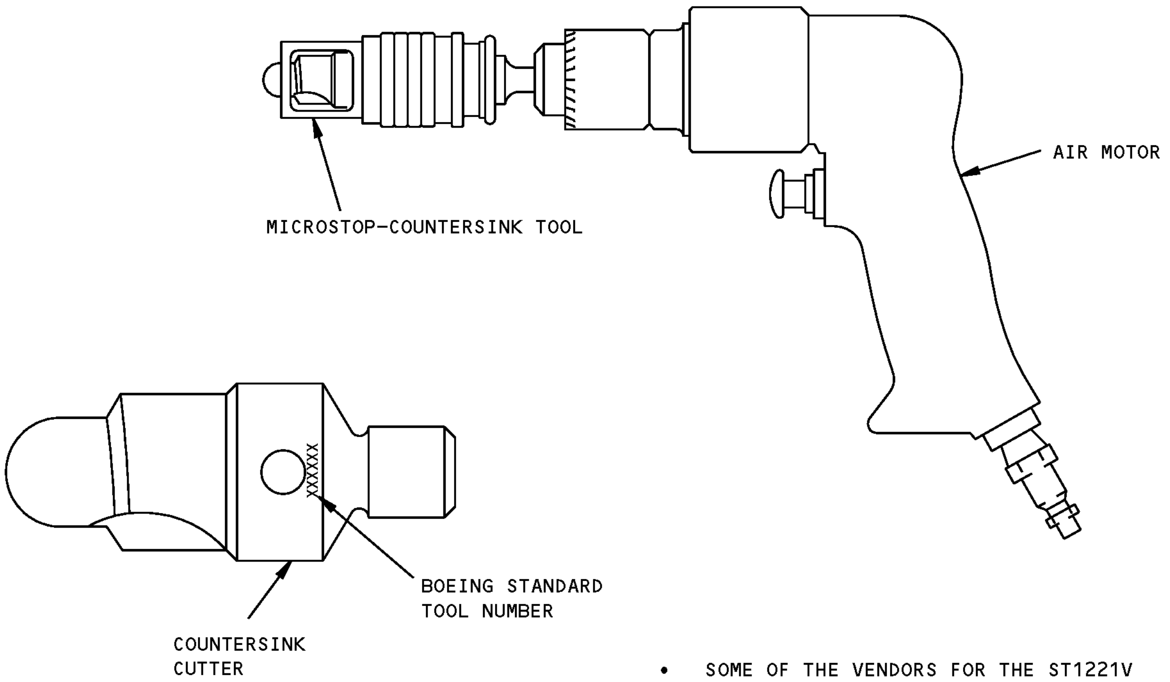
NOTE: Do not sharpen the ST1221V counterbore-countersink cutter. You must remove it from service.

(5) Install a minimum of five BACR15FV rivets in the piece of scrap metal as shown in 51-40-02, GENERAL. Use the standard rivet gun, flush die set, and bucking bar.

(6) Inspect the fasteners for the correct fastener head height as shown in 51-40-02, GENERAL.

NOTE: If the fastener head height is incorrect, strike the fastener head again and do step (6) again. If the head height is still incorrect, do steps (2) through (6) again.

B. When you can install the fasteners correctly in the piece of scrap metal, you can use the countersink-microstop tool to do the repair.



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.
- SOME OF THE VENDORS FOR THE ST1221V COUNTERSINK CUTTER FOR BACR15FV AND MS14218 RIVETS ARE:

  CRAIG TOOLS, INC
  142 LOMITA STREET
  EL SEGUNDO, CA 90245

  E.F. BAILEY COMPANY
  5610 - 4TH AVE. S.
  SEATTLE, WA 98108

  GENERAL TOOLS
  5614 - 7TH AVE S.
  SEATTLE, WA 98108

  MAGNAVON INDUSTRIES
  801 SOUTH RICHFIELD ROAD
  PLACENTIA, CA 92670

  PACIFIC DISTRIBUTING, INC.
  7118 BEACON AVE S.
  SEATTLE, WA 98108

  WEST COAST INDUSTRIES
  14900 WHITMAN AVE. N.
  SEATTLE, WA 98133
- SOME OF THE VENDORS FOR THE ST1219, ST1221B, ST1222B AND ST1223B MICROSTOP-COUNTERSINK TOOLS ARE:

  AIRTECH INTERNATIONAL INC.
  2542 E. DE LAMO BLVD
  CARSON, CA 90749

  PACIFIC DISTRIBUTING, INC
  7118 BEACON AVE. S.
  SEATTLE, WA 98108

The Microstop-Countersink Tool
Figure 1

REPAIR INSTRUCTIONS

NOTE: Use this special repair washer to plug existing countersinks for repairs where called out in this manual. A typical repair application is illustrated in Detail I.

For BACR15FV or MS14218 repair washer, any of the following may be done. Drill out rivet and plug the countersink with a standard repair washer (Ref Dwg 66-2955), machine washer from dimensions in Table I, or refer to 53-00-01 for using the rivet head as a repair washer.

1. Fabricate the countersink repair washer to match the original countersunk hole. See Tables I and II.
2. Solvent Clean:

   WARNING: WHEN USING MEK (METHYL ETHYL KETONE) AVOID BREATHING OF VAPOR OR CONTACT WITH SKIN. WEAR RUBBER GLOVES. WHEN WORKING IN A CONFINED SPACE, ADEQUATE VENTILATION OR RESPIRATORY PROTECTION MUST BE PROVIDED. INJURY TO PERSONNEL MAY OCCUR.

   A. Clean countersink and the washer with MEK.

   B. Wipe off MEK before it has evaporated with a clean cloth.

   C. Repeat applications of clean solvent as necessary to remove oils.
3. Apply Sealant:

   A. Apply BMS 5-95 sealant between the mating surfaces of the countersink and the washer.

   B. Attach the surfaces with sufficient pressure to make sure the washer bonds correctly.

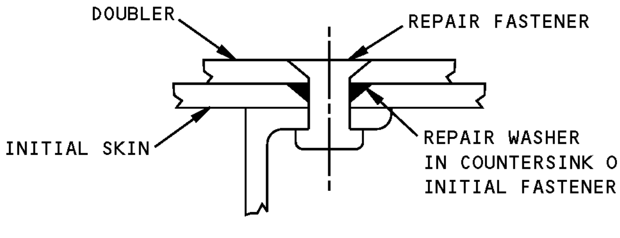
   C. The assembly may be moved immediately. 48 hours or more after the washer is installed, the assembly will have maximum strength.

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 MATERIALS
  - SRM 51-20-05 FOR REPAIR SEALING

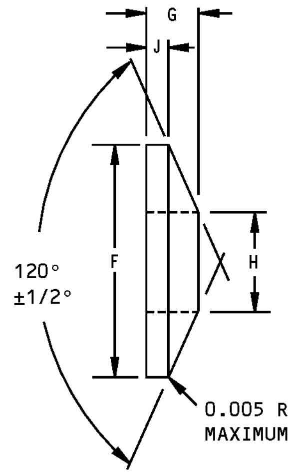
A APPLY A CHEMICAL CONVERSION COATING AS GIVEN IN SRM 51-20-01

B OTHER SIZES CAN BE FOUND IN BOEING DRAWING 66-2955



DETAIL I

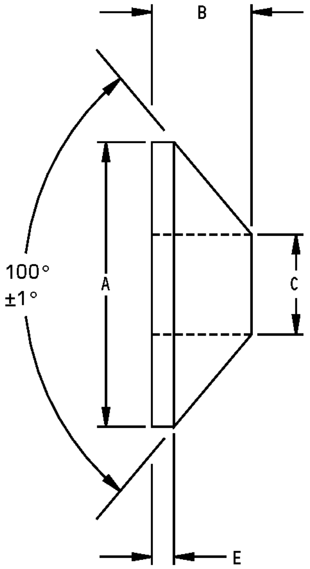
Countersink Repair Washer
Figure 2 (Sheet 1 of 3)



	NOM. RIVET DIA	F +0.000 -0.002	G REF	H MIN.	H MAX.	J MIN.	MATERIAL [A]
BACR15FV MS14218	0.125	0.162	0.027	0.128	0.135	0.014	2024-T4 BAR
	0.156	0.210	0.035	0.161	0.167	0.017	
	0.188	0.258	0.044	0.193	0.200	0.021	
	0.219	0.312	0.053	0.228	0.235	0.024	
	0.250	0.358	0.061	0.257	0.265	0.027	
	0.281	0.405	0.069	0.290	0.298	0.030	

120° HEAD COUNTERSINK REPAIR WASHERS
TABLE I

INITIAL FASTENER TYPE	DIA.	COUNTERSINK REPAIR WASHER [B]				
				DIMENSIONS		MATERIAL [A]
		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()D 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	
	1/4	0.382	0.060	0.254/0.265	0.006	
BACR15BA BACB30ND BACB30NZ BACB30DY BACB30HD BACB30HA NAS1399	1/8	0.216	0.043	0.128/0.135	0.006	2024-T4 BAR OR MAKE FROM BACR15BA()D 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	

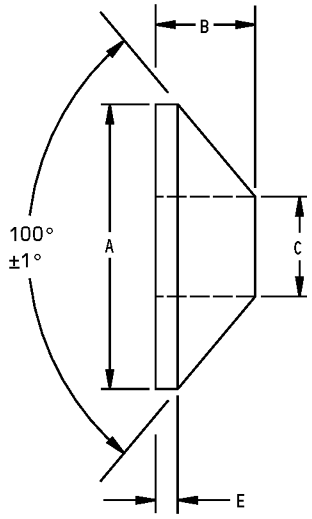


100° HEAD COUNTERSINK REPAIR WASHERS
TABLE II

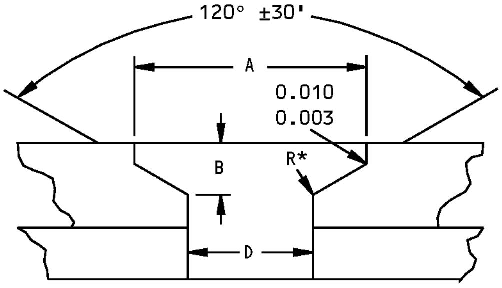
Countersink Repair Washer
Figure 2 (Sheet 2 of 3)

INITIAL FASTENER TYPE	DIA.	COUNTERSINK REPAIR WASHER B				
		DIMENSIONS				MATERIAL A
		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	
BACB30JC BACB30NY BACB30LU BACB30MS	3/16	0.344	0.079	0.191/0.194	0.015	
	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	

100° HEAD COUNTERSINK REPAIR WASHERS
TABLE II (CONT.)



Countersink Repair Washer
Figure 2 (Sheet 3 of 3)



NOMINAL RIVET DIA	A		B	D		STD DRILL NO.	R*±0.004
	MIN.	MAX.	MAX.	MIN.	MAX.		
1/8 (0.125)	0.1625	0.1655	0.028	0.128	0.135	30	0.008
5/32 (0.156)	0.2105	0.2140	0.035	0.159	0.167	21	0.009
3/16 (0.188)	0.2585	0.2625	0.044	0.190	0.200	11	0.012
7/32 (0.219)	0.3125	0.3170	0.053	0.228	0.235	1	0.015
1/4 (0.250)	0.3585	0.3640	0.061	0.255	0.261	F	0.018
9/32 (0.281)	0.4055	0.4110	0.069	0.290	0.298	L	0.020
5/16 (0.313)	0.4545	0.4600	0.078	0.316	0.327	0	0.022

COUNTERSINK FOR BACR15FV AND MS14218 RIVETS
DETAIL I

STANDARD TOOL NUMBER	FUNCTION	SUPPLIER
ST8703XA OR ST8703XB	GAGE, COUNTERSINK, DEPTH	A B
ST8703GF	GAGE, COUNTERBORE DIAMETER, GO-NO-GO	

BACR15FV AND MS14218 RIVET COUNTERSINK/COUNTERBORE MEASUREMENT
TABLE I

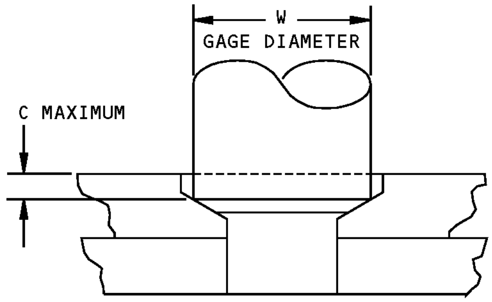
NOTES

- THE SOURCE OF INFORMATION FOR THIS FIGURE CAN BE FOUND IN BOEING PROCESS SPECIFICATION BAC5004-1

A THE BOEING COMPANY

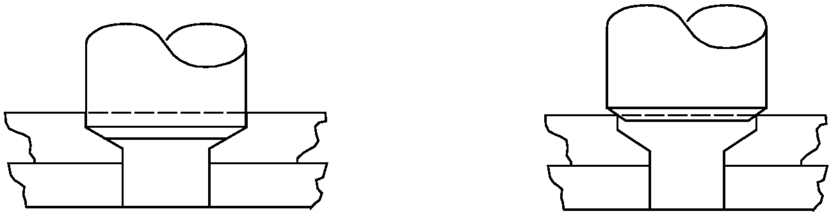
B WEST COAST INDUSTRIES
14900 WHITMAN AVE N.
SEATTLE, WA 98133

BACR15FV and MS14218 Solid Rivets
Figure 3 (Sheet 1 of 2)



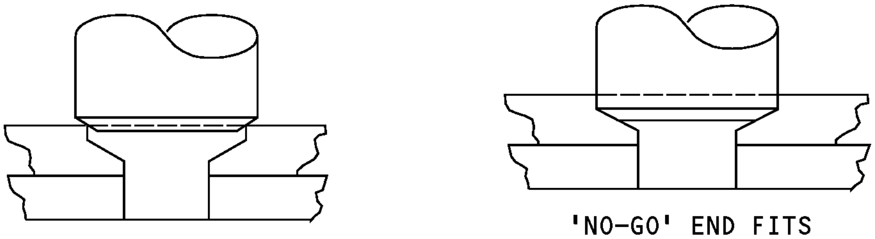
NOMINAL RIVET DIAMETER	W DIAMETER		C MAXIMUM
	MINIMUM	MAXIMUM	
1/8	0.1523	0.1525	0.0204
5/32	0.2003	0.2005	0.0229
3/16	0.2483	0.2485	0.0269
7/32	0.3023	0.3025	0.0313
1/4	0.3483	0.3485	0.0337
9/32	0.3953	0.3955	0.0382
5/16	0.4243	0.4245	0.0464

USE OF ST8703XB COUNTERSINK DEPTH GAGE
FOR BACR15FV AND MS14218 RIVETS
DETAIL II



'GO' END FITS
(ACCEPTABLE CONDITION -
TRY THE 'NO-GO' END)

'GO' END DOES NOT FIT
(UNACCEPTABLE CONDITION -
COUNTERBORE IS TOO SMALL)

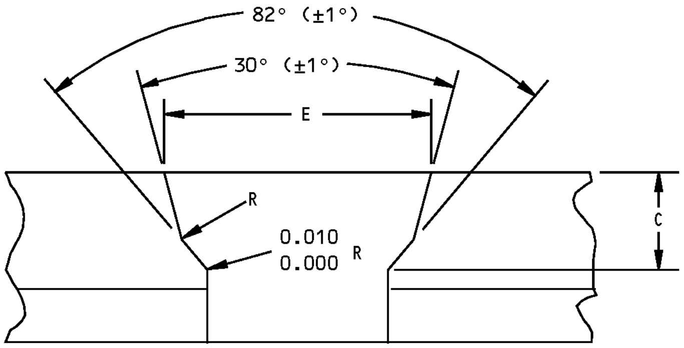


'NO-GO' END DOES NOT FIT
(ACCEPTABLE CONDITION)

'NO-GO' END FITS
(UNACCEPTABLE CONDITION -
COUNTERBORE IS TOO LARGE)

USE OF ST8703GF COUNTERBORE DIAMETER
'GO-NO-GO' GAGE FOR BACR15FV AND MS14218 RIVETS
DETAIL III

BACR15FV and MS14218 Solid Rivets
Figure 3 (Sheet 2 of 2)



COUNTERSINK DIMENSIONS
DETAIL I

NOTES

- ALL DIMENSIONS ARE IN INCHES
- SEE TABLE I FOR BACR15FH AND BACR15GH RIVETS
- SEE TABLE II FOR BACR15FH AND BACR15GH OVERSIZE RIVETS

Dimensions of Modified 82/30 Degree Countersink
Figure 4 (Sheet 1 of 2)

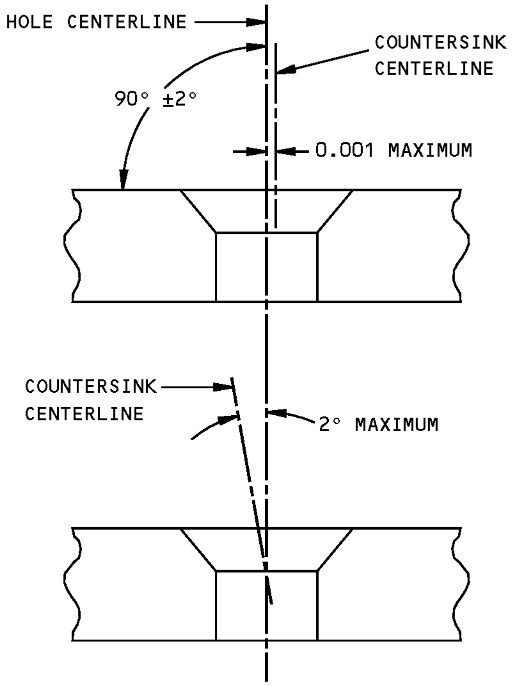
COUNTERSINK TYPE	RIVET DIAMETER	DIMENSION C		DIMENSION E		RADIUS R	
		MIN.	MAX.	MIN.	MAX.	MIN.	MAX.
IV	1/4	0.089	0.100	0.349	0.354	0.09	0.12
	5/16	0.099	0.110	0.419	0.424	0.09	0.12
	3/8	0.105	0.120	0.479	0.484	0.09	0.12
V	5/32	0.060	0.070	0.219	0.224	0.03	0.05
	3/16	0.075	0.085	0.270	0.275	0.09	0.12
	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 AND BACR15GH RIVETS
TABLE I

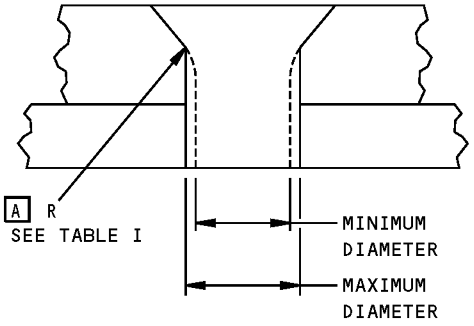
COUNTERSINK TYPE	RIVET DIAMETER	DIMENSION C		DIMENSION E		RADIUS R	
		MIN.	MAX.	MIN.	MAX.	MIN.	MAX.
IV	7/32	0.075	0.085	0.300	0.305	0.09	0.12
	9/32	0.090	0.100	0.379	0.384	0.09	0.12
	11/32	0.100	0.110	0.449	0.454	0.09	0.12
	13/32	0.107	0.117	0.509	0.514	0.09	0.12
	7/16	0.115	0.125	0.549	0.554	0.09	0.12
V	7/32	0.075	0.085	0.300	0.305	0.09	0.12
	9/32	0.102	0.112	0.385	0.390	0.09	0.12
	11/32	0.128	0.138	0.464	0.469	0.09	0.12
	13/32	0.154	0.164	0.533	0.538	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 OVERSIZE BACR15FH AND BACR15GH RIVETS
TABLE II

Dimensions of Modified 82/30 Degree Countersink
Figure 4 (Sheet 2 of 2)



PERMITTED COUNTERSINK MISALIGNMENT AND ECCENTRICITY
DETAIL I



FILLET RELIEF
DETAIL II

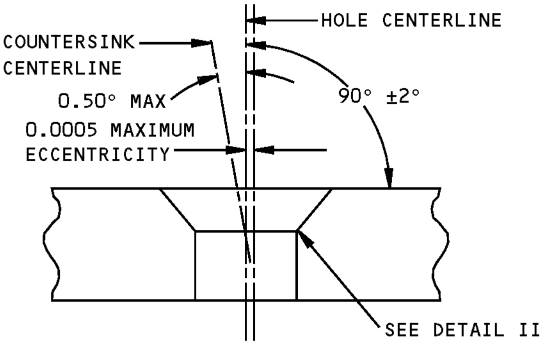
FASTENER SIZE	RADIUS R	
	MIN	MAX
5/32 3/16 1/4	0.030	0.040
5/16 3/8	0.040	0.050
7/16 1/2 9/16 5/8 3/4 7/8 1	0.050	0.060

TABLE I

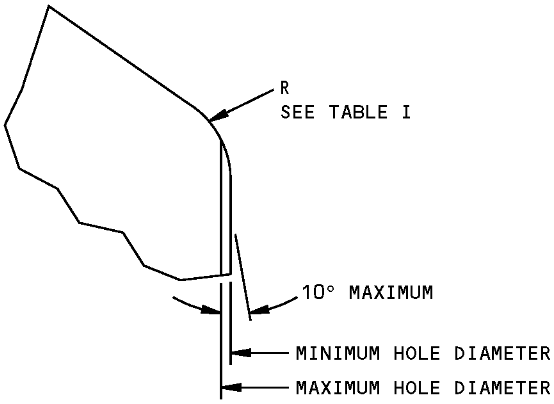
NOTE

A MAKE THE RADIUS BLEND SMOOTHLY WITH THE SHANK DIAMETER.

Countersink Detail for Flush Head Lockbolts and Hex-Drive Bolts
Figure 5



PERMISSIBLE COUNTERSINK MISALIGNMENT
ECCENTRICITY AND FILLET RELIEF
DETAIL I



DETAIL II

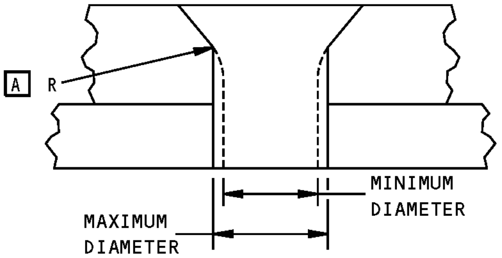
NOMINAL THREAD SIZE	FLUSH HEAD			
	BACB30WQ "R" RADIUS		BACB30PT "R" RADIUS	
	MIN	MAX	MIN	MAX
0.1900-32	0.020	0.030	-	-
0.2500-28	0.020	0.030	0.050	0.060
0.3125-24	0.030	0.040	0.050	0.060
0.3750-24	0.030	0.040	0.050	0.060
0.4375-20	0.030	0.040	-	-

FILLET RELIEF LIMITS FOR FLUSH HEAD RADIUS LEAD-IN BOLT HOLES
TABLE I

NOTES:

- THE COUNTERSINK IS CUT AT THE SAME TIME THE HOLE IS DRILLED.

Countersink Detail for Flush Head Radius Lead-In Bolts
Figure 6



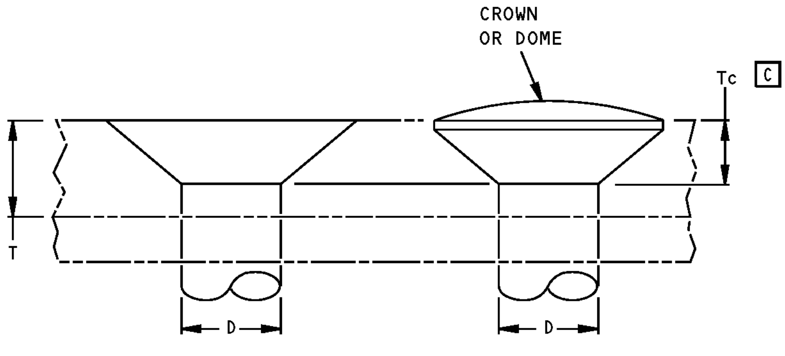
MAX SHANL DIA	100° FLUSH HEAD BOLT AND SCREW PART NUMBER SERIES									
	BACB30EM, BACB30FB, BACB30DL, BACB30DP, BACB30DY, BACB30FA, BACB30GD, BACB30MN, BACB30LH, BACB30LL, BACB30LP, BACB30LR, BACB30LU, BACB30NN, BACB30NU, BACB30MS, BACB30PC, BACB30RF, BACB30SW, BACB30TP, BACB30UW, BACB30VF, BACB30XK, 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

NOTES

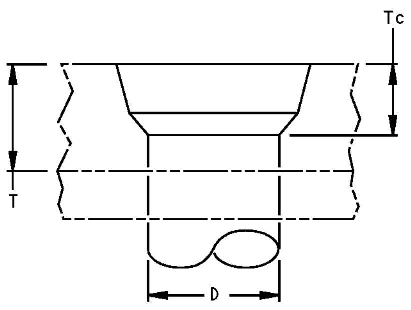
A MAKE THE RADIUS BLEND SMOOTHLY WITH THE SHANK DIAMETER.

Fillet Relief for Bolts
Figure 7



Tc = COUNTERSINK HEAD DIMENSION

DETAIL I A



Tc = COUNTERSINK DIMENSION
(SEE FIGURE 4 FOR COUNTERSINK DATA)

DETAIL II B

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 COUNTERSUNK 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 "Tc" 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.
- FOR THE APPLICABLE DATA TO INSTALL BACR15FV RIVETS, REFER TO SRM 51-40-02.
- 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 I 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.

A TO INSTALL ALL FASTENER TYPES GIVEN IN TABLE I EXCEPT BACR15FH AND BACR15GH RIVETS

B TO INSTALL BACR15FH AND BACR15GH TYPE IV AND V RIVETS.

C 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 4)

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		
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			0.065	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 I

Minimum Sheet Thickness for Countersinking of Fasteners
Figure 8 (Sheet 2 of 4)

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
NAS87()		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
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 I (CONTINUED)

Minimum Sheet Thickness for Countersinking of Fasteners
Figure 8 (Sheet 3 of 4)

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
	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		

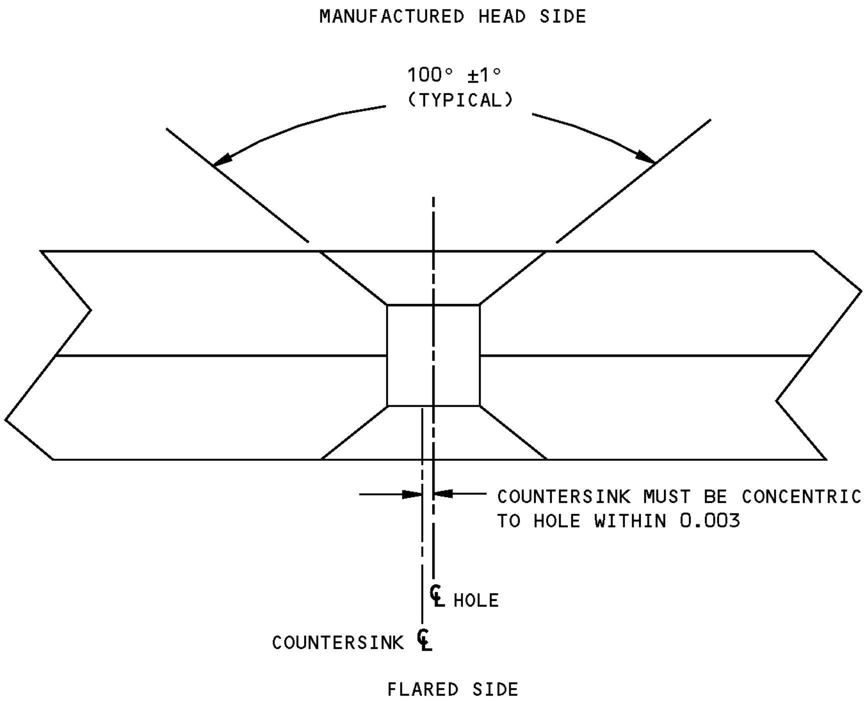
MINIMUM SHEET THICKNESS FOR COUNTERSINKING OF 100° HEAD FASTENERS

TABLE I (CONTINUED)

MAXIMUM RIVET DIAMETER	MINIMUM SHEET THICKNESS
5/32	0.050
3/16	0.056
7/32	0.072
1/4	0.081
9/32	0.090

MINIMUM SHEET THICKNESS FOR COUNTERSINKING OF BACR15FV RIVETS
TABLE II

Minimum Sheet Thickness for Countersinking of Fasteners
Figure 8 (Sheet 4 of 4)



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 DIMENSION FOR FLARED SIDE OF RIVET

Countersink Dimensions for BACR15GA Rivets
Figure 9

GENERAL - COLDWORKING OF HOLES FOR FATIGUE IMPROVEMENT

1. General

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 7060-T76XX FINISHED MACHINE PARTS THAT HAVE SIMILAR FLANGES, SUCH AS ANGLES, TO DETERMINE THE GRAIN DIRECTION RELATIVE TO EACH FLANGE BEFORE COLD WORKING.

A. The fatigue properties of aluminum structures can be improved by compressing the material locally around the periphery of fastener holes. This is achieved by pulling a mandrel through an undersize hole, thus enlarging the hole and compressing the metal. The cold working operation causes a radial plastic flow of metal and produces a residual compressive stress in the area surrounding the hole which, in the case of the high interference cold working process, extends approximately half the hole diameter from the edge of the hole.

NOTE: See Figure 1/GENERAL for the cold working limits in 7050-T74XX and 7050-T76XX materials.

B. There are two types of cold working used, the high interference process and the low interference process. The low interference process compresses the metal to a lesser degree than the high interference process. For the high interference process and as an option in the low interference process a disposble steel sleeve is interposed between the mandrel and the hole. This prelubricated sleeve is not reuseable.

C. To be effective an edge margin of twice the hole diameter is required on cold worked holes. Smaller edge margin would result in less compressive stress around the hole.

D. Any countersinking or countersink enlargement necessary should not be carried out until the cold working process has been completed.

E. Where broaches are used to provide close tolerance holes a suitable broach puller will be required.

F. Each of the puller kits specified in Figure 1/GENERAL anf Figure 2/GENERAL require a hydraulic power source such as 4MITBAC5973 or equivalent.

G. For suppliers of cold working tools, see Figure 3/GENERAL.

2. High Interference Cold Working Process

A. The sequence of operations for the high interference cold working process is as follows. A simplified pictorial sequence of operation is shown in Figure 1/GENERAL.

(1) Ensure that the parts to be cold worked are firmly held together by clamps or fasteners. It should not be possible to insert a 0.002 inch feeler gauge between parts and contact a fastener.

(2) Enlarge the existing hole, or introduce a new hole as appropriate, to the required starting hole size shown in Figure 1/GENERAL, Table I for the size of fastener to be used. To achieve a hole within the tolerances given with the required surface finish of 125 microinches or better, reaming or broaching will normally be necessary. Cetyl alcohol or lauric acid may be used as a lubricant.

NOTE: Hole inspection criteria for starting holes are the same as those specified for finished holes as described in Paragraph 2.B./GENERAL

(3) Select the appropriate tools from Figure 1/GENERAL, Table II, or III or any commercially available equivalent. The length of disposable sleeve selected must be equal or greater than the thickness of material to be cold worked.

(4) Slide the sleeve over the mandrel up to the nose piece of the puller.

CAUTION: AVOID GETTING LUBRICANT ON THE OUTSIDE OF THE SLEEVE.

(5) Insert the mandrel and sleeve into the hole.

(6) Actuate the puller to pull the mandrel through the sleeve.

(7) Remove the sleeve from the hole and discard it.

(8) Broach or ream the hole to the finished hole size specified in Figure 1/GENERAL, Table I, with a surface finish of 125 microinches or better. A suitable broach puller will be required for use with a broach. Cetyl alcohol or lauric acid may be used as a lubricant.

B. Inspect the hole to ensure that it meets the following criteria:

(1) Holes shall be normal to the surface within 2 degrees.

(2) Holes shall be free from burrs at the interface.

(3) Holes shall be free from scratches, nicks or cuts with the exception of the following surface defects which are acceptable:

(a) 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.

(b) Helical scratches which are a minimum of 1/16 inch or 25% of the part thickness from the surface of the part, whichever is smaller.

(c) Longitudinal scratches not more than 50% of length of hole in any one part and which neither start nor end within 1/16 inch or 25% of the part thickness from the surface of the part, whichever is smaller.

(d) Surface roughness which does not exceed 125 microinches.

(e) The finished hole may contain a region near the entry, exit or interface that does not totally clean up during the final sizing operation. The hole will be acceptable provided the region does not extend 0.020 inch or 10% of the detail thickness, whichever is less.

C. Holes failing to meet the inspection requirements may be enlarged by 1/64 inch without further cold working, using special reamers.

3. Low Interference Cold Working Process

A. Low interference cold working may be achieved either with or without a sleeve interposed between the mandrel and the hole. The sequence of operations is as follows. A simplified pictorial sequence of operations is shown in Figure 2/GENERAL.

(1) Ensure that the parts to be cold worked are firmly held together by clamps or fasteners. It should not be possible to insert a 0.002-inch feeler gauge between parts and contact a fastener.

(2) Enlarge the existing hole, or introduce a new hole as appropriate, to the required starting hole size shown in Figure 2/GENERAL, Table I for the size of fastener to be used. A finish of 125 microinches is required where the sleeve process is to be used and 63 microinches for the nonsleeve process. Reaming or broaching will be required to achieve the tolerance and finish required. Cetyl alcohol or lauric acid may be used as a lubricant.

NOTE: The nonsleeve process necessitates a closer tolerance starting hole than the sleeve process. Hole inspection criteria for starting holes are the same as those specified for finished holes as described in Paragraph 3.B./GENERAL except for the finish requirement given above.

(3) Select the appropriate tools from Figure 2/GENERAL, Table II or III. Where the sleeve process is chosen, the length of disposable sleeve selected must be equal to or greater than the thickness of material to be cold worked.

CAUTION: AVOID GETTING LUBRICANT ON THE OUTSIDE OF THE SLEEVE. DAMAGE TO EQUIPMENT MAY RESULT.

(4) For the sleeve process only, slide the sleeve over the mandrel up to the nose piece of the puller.

(5) Insert the mandrel or mandrel and sleeve assembly, as appropriate, into the hole.

(6) Actuate the puller to pull the mandrel through the hole. Cetyl alcohol or lauric acid should be used as a lubricant on both mandrel and hole in the case of the nonsleeve process.

(7) Remove the sleeve, if used, from the hole and discard it.

(8) The hole should not require any further work unless it fails to meet the inspection requirements of Paragraph 3.B./GENERAL.

B. Inspect the hole to ensure that it meets the following criteria:

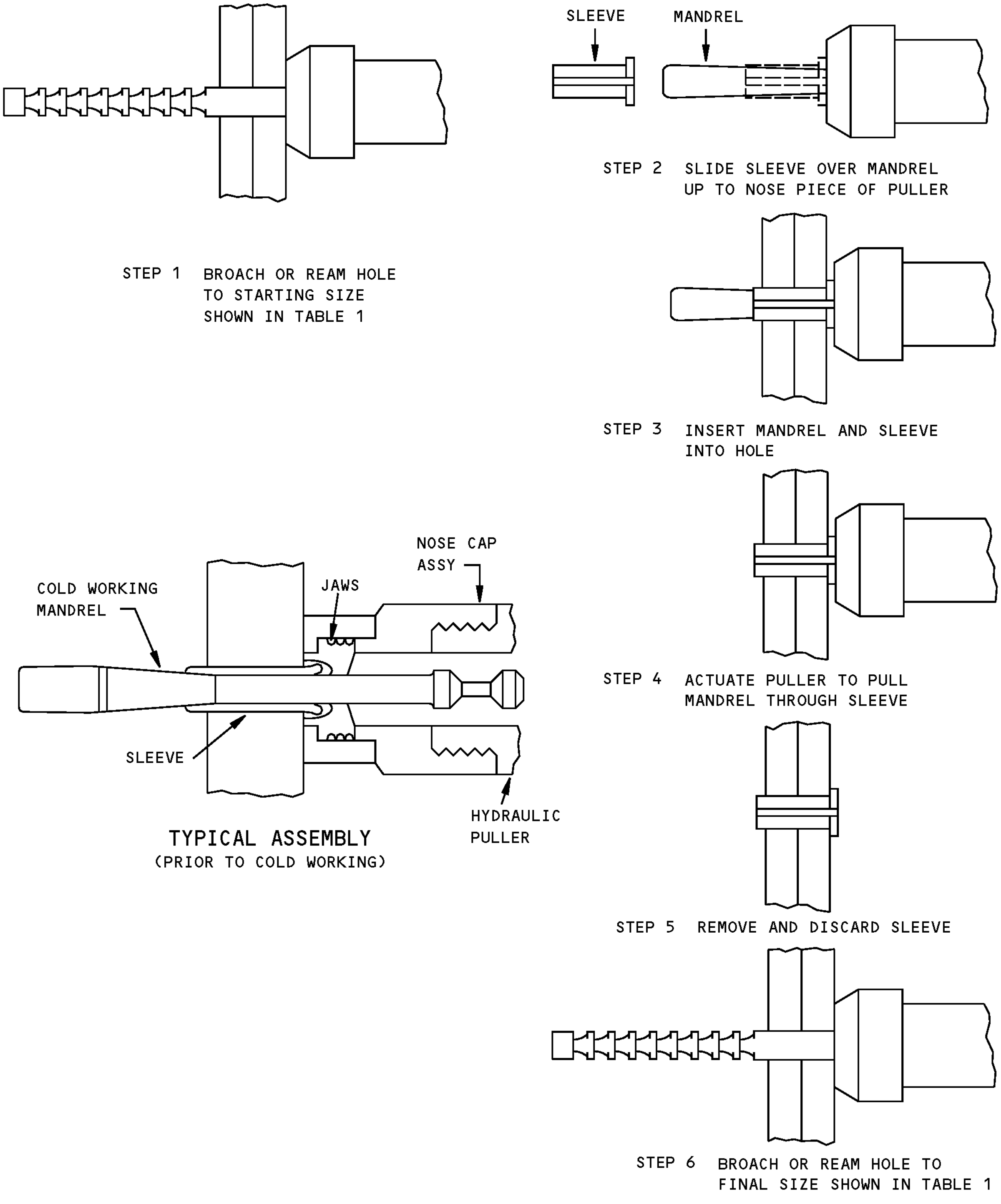
(1) Hole shall be normal to the surface within 2 degrees unless otherwise specified.

(2) A surface finish of 125 microinches or better is required.

(3) Tapering of the hole when the sleeve process is used is acceptable provided that it does not exceed a maximum of 0.001 inch above the maximum diameter of the finished hole size.

(4) Longitudinal ridges left by cold working sleeves are acceptable.

(5) Holes shall be free from longitudinal scratches and rifling which intersect the shear plane.



SIMPLIFIED SEQUENCE OF OPERATIONS
(REFER TO TEXT FOR COMPREHENSIVE SEQUENCE OF OPERATIONS)

High Interference Cold Working Process
Figure 1 (Sheet 1 of 8)

NOMINAL FASTENER SIZE J	STARTING HOLE SIZE	FINISHED HOLE SIZE
5/32	0.146 0.143	HOLE SIZE VARIES WITH TYPE OF FASTENER INSTALLED. REFER TO 51-40-05 UNLESS HOLE SIZE IS SPECIFIED ON DRAWING OR REPAIR
11/64	0.162 0.159	
3/16	0.180 0.177	
13/64	0.196 0.193	
7/32	0.212 0.209	
15/64	0.228 0.225	
1/4	0.238 0.235	
17/64	0.254 0.251	
9/32	0.269 0.266	
19/64	0.286 0.283	
5/16	0.300 0.297	
21/64	0.316 0.313	
11/32	0.331 0.328	
23/64	0.347 0.344	
3/8	0.362 0.359	
25/64	0.378 0.375	
13/32	0.394 0.391	
27/64	0.409 0.406	
7/16	0.424 0.421	
29/64	0.440 0.437	
15/32	0.453 0.450	
31/64	0.468 0.465	
1/2	0.477 0.474	
33/64	0.493 0.490	
17/32	0.508 0.506	
35/64	0.524 0.521	HOLE SIZE VARIES WITH TYPE OF FASTENER INSTALLED. REFER TO 51-40-05 UNLESS HOLE SIZE IS SPECIFIED ON DRAWING OR REPAIR
9/16	0.540 0.537	
37/64	0.556 0.553	
19/32	0.571 0.568	
39/64	0.586 0.583	
5/8	0.600 0.597	
41/64	0.616 0.613	
21/32	0.634 0.631	
43/64	0.649 0.646	
11/16	0.662 0.659	
45/64	0.678 0.675	
23/32	0.693 0.690	
47/64	0.709 0.706	
3/4	0.721 0.718	
49/64	0.737 0.734	
25/32	0.752 0.749	
51/64	0.768 0.765	
13/16	0.785 0.782	
53/64	0.801 0.798	
27/32	0.814 0.811	
55/64	0.829 0.826	
7/8	0.844 0.841	
57/64	0.860 0.857	
29/32	0.882 0.879	
59/64	0.897 0.894	

HOLE SIZES FOR HIGH INTERFERENCE COLD WORKED HOLES
TABLE I

High Interference Cold Working Process
Figure 1 (Sheet 2 of 8)

NOMINAL FASTENER SIZE	STARTING HOLE SIZE	FINISHED HOLE SIZE
15/16	0.904 0.901	HOLE SIZE VARIES WITH TYPE OF FASTENER INSTALLED. REFER TO 51-40-05 UNLESS HOLE SIZE IS SPECIFIED ON DRAWING OR REPAIR
61/64	0.920 0.917	
31/32	0.936 0.933	
63/64	0.952 0.949	
1	0.968 0.965	
1	0.952 0.949 G	
1-1/64	0.984 0.981	
1-1/64	0.968 0.965 G	
1-1/32	1.000 0.997	
1-3/64	1.016 1.013	
1-1/8	1.078 1.075	
1-1/8	1.062 1.059 G	
1-9/64	1.094 1.091	
1-9/64	1.078 1.075 G	
1-5/32	1.110 1.107	
1-11/64	1.126 1.123	
1-3/16	1.140 1.136	
1-3/16	1.124 1.120 G	
1-13/64	1.156 1.152	
1-13/64	1.139 1.136 G	
1-7/32	1.172 1.168	
1-15/64	1.188 1.184	
1-1/4	1.203 1.199	
1-1/4	1.187 1.183 G	
1-17/64	1.219 1.215	

NOMINAL FASTENER SIZE J	STARTING HOLE SIZE	FINISHED HOLE SIZE
1-17/64	1.202 1.199 G	HOLE SIZE VARIES WITH TYPE OF FASTENER INSTALLED. REFER TO 51-40-05 UNLESS HOLE SIZE IS SPECIFIED ON DRAWING OR REPAIR
1-9/32	1.235 1.231	
1-19/64	1.251 1.247	
1-3/8	1.320 1.316	
1-3/8	1.304 1.300 G	
1-25/64	1.340 1.336	
1-25/64	1.324 1.320 G	
1-13/32	1.356 1.352	
1-27/64	1.372 1.368	
1-1/2	1.431 1.427	
1-1/2	1.415 1.411 G	
1-33/64	1.447 1.443	
1-33/64	1.431 1.427 G	
1-17/32	1.463 1.459	
1-35/64	1.479 1.475	
1-5/8	1.563 1.559	
1-5/8	1.547 1.543 G	
1-41/64	1.579 1.575	
1-41/64	1.563 1.559 G	
1-21/32	1.595 1.591	
1-43/64	1.611 1.607	

HOLE SIZES FOR HIGH INTERFERENCE COLD WORKED HOLES
TABLE I (CONT)

High Interference Cold Working Process
Figure 1 (Sheet 3 of 8)

NOMINAL FASTENER SIZE	MANDREL ST5300-CBM F I	SLEEVE ST5300-CBS A	UNIVERSAL KIT NO. MITBAC 5973 D			UNIVERSAL KIT NO. 2MITBAC 5973 D		
			NOSE CAP ST5300-CBC	JAW ASSY ST5300-CBC B	CHUCK ASSY ST1350A	NOSE CAP ST1350A-C	JAW ASSY ST5300-CBC B	CHUCK ASSY ST5300-C
5/32	-5-0-N-"E"	-5-0-N-"A"-"B"	-3	-"C"-23	-29	-12	-"C"-23	-227
11/64	-5-1-N-"E"	-5-1-N-"A"-"B"	-3	-"C"-23	-29	-12	-"C"-23	-227
3/16	-6-0-N-"E"	-6-0-N-"A"-"B"	-3	-"C"-24	-29	-12	-"C"-24	-227
13/64	-6-1-N-"E"	-6-1-N-"A"-"B"	-3	-"C"-24	-29	-12	-"C"-24	-227
7/32	-6-2-N-"E"	-6-2-N-"A"-"B"	-3	-"C"-24	-29	-12	-"C"-24	-227
15/64	-6-3-N-"E"	-6-3-N-"A"-"B"	-3	-"C"-24	-29	-12	-"C"-24	-227
1/4	-8-0-N-"E"	-8-0-N-"A"-"B"	-3	-"C"-25	-29	-12	-"C"-25	-227
17/64	-8-1-N-"E"	-8-1-N-"A"-"B"	-3	-"C"-25	-29	-12	-"C"-25	-227
9/32	-8-2-N-"E"	-8-2-N-"A"-"B"	-3	-"C"-25	-29	-12	-"C"-25	-227
19/64	-8-3-N-"E"	-8-3-N-"A"-"B"	-3	-"C"-25	-29	-12	-"C"-25	-227
5/16	-10-0-N-"E"	-10-0-N-"A"-"B"	-3	-"C"-26	-29	-12	-"C"-26	-227
21/64	-10-1-N-"E"	-10-1-N-"A"-"B"	-3	-"C"-26	-29	-12	-"C"-26	-227
11/32	-10-2-N-"E"	-10-2-N-"A"-"B"	-3	-"C"-26	-29	-12	-"C"-26	-227
23/64	-10-3-N-"E"	-10-3-N-"A"-"B"	-3	-"C"-26	-29	-12	-"C"-26	-227
3/8	-12-0-N-"E"	-12-0-N-"A"-"B"	-3	-"C"-27	-29	-12	-"C"-27	-227
25/64	-12-1-N-"E"	-12-1-N-"A"-"B"	-3	-"C"-27	-29	-12	-"C"-27	-227
13/32	-12-2-N-"E"	-12-2-N-"A"-"B"	-3	-"C"-27	-29	-12	-"C"-27	-227
27/64	-12-3-N-"E"	-12-3-N-"A"-"B"	-3	-"C"-27	-29	-12	-"C"-27	-227

COLD WORKING TOOLS FOR HOLES LESS THAN 7/16-INCH DIAMETER - HIGH INTERFERENCE, SLEEVE TYPE

TABLE II

High Interference Cold Working Process
Figure 1 (Sheet 4 of 8)

NOMINAL FASTENER SIZE	MANDREL ST5300-CBM [C] [I]	SLEEVE ST5300-CBS [A]	UNIVERSAL KIT NO. 2 MITBAC 5973			
			NOSECAP ST1350A-C	JAW ASSY ST5300-CBC	CHUCK ASSY [E]	
					3-JAW ST1350A-C	THREADED ST1350A-C
7/16	-14-0-N-"D"	-14-0-N-"A"-"B"	-12	-28-S	-21	-33
29/64	-14-1-N-"D"	-14-1-N-"A"-"B"	-12	-28-S	-21	-33
15/32	-14-2-N-"D"	-14-2-N-"A"-"B"	-12	-28-S	-21	-33
31/64	-14-3-N-"D"	-14-3-N-"A"-"B"	-12	-28-S	-21	-33
1/2	-16-0-N-"D"	-16-0-N-"A"-"B"	-12	-29-S	-21	-33
33/64	-16-1-N-"D"	-16-1-N-"A"-"B"	-12	-29-S	-21	-33
17/32	-16-2-N-"D"	-16-2-N-"A"-"B"	-12	-29-S	-21	-33
35/64	-16-3-N-"D"	-16-3-N-"A"-"B"	-12	-29-S	-21	-33
9/16	-18-0-N-"D"	-18-0-N-"A"-"B"	-12	-30-S	-21	-33
37/64	-18-1-N-"D"	-18-1-N-"A"-"B"	-12	-30-S	-21	-33
19/32	-18-2-N-"D"	-18-2-N-"A"-"B"	-12	-30-S	-21	-33
39/64	-18-3-N-"D"	-18-3-N-"A"-"B"	-12	-30-S	-21	-33
5/8	-20-0-N-"D"	-20-0-N-"A"-"B"	-12	-31-S	-21	-33
41/64	-20-1-N-"D"	-20-1-N-"A"-"B"	-12	-31-S	-21	-33
21/32	-20-2-N-"D"	-20-2-N-"A"-"B"	-12	-31-S	-21	-33
43/64	-20-3-N-"D"	-20-3-N-"A"-"B"	-12	-31-S	-21	-33
11/16	-22-0-N-3	-22-0-N-"A"-"B"	-12	-32-S	-	-33
45/64	-22-1-N-3	-22-1-N-"A"-"B"	-12	-32-S	-	-33
23/32	-22-2-N-3	-22-2-N-"A"-"B"	-12	-32-S	-	-33
47/64	-22-3-N-3	-22-3-N-"A"-"B"	-12	-32-S	-	-33
3/4	-24-0-N-3	-24-0-N-"A"-"B"	-12	-33-S	-	-33
49/64	-24-1-N-3	-24-1-N-"A"-"B"	-12	-33-S	-	-33
25/32	-24-2-N-3	-24-2-N-"A"-"B"	-12	-33-S	-	-33
51/64	-24-3-N-3	-24-3-N-"A"-"B"	-12	-33-S	-	-33
13/16	-26-0-N-3	-26-0-N-"A"-"B"	-12	-34-S	-	-33
53/64	-26-1-N-3	-26-1-N-"A"-"B"	-12	-34-S	-	-33
27/32	-26-2-N-3	-26-2-N-"A"-"B"	-12	-34-S	-	-33
55/64	-26-3-N-3	-26-3-N-"A"-"B"	-12	-34-S	-	-33
7/8	-28-0-N-3	-28-0-N-"A"-"B"	-12	-35-S	-	-33
57/64	-28-1-N-3	-28-1-N-"A"-"B"	-12	-35-S	-	-33
29/32	-28-2-N-3	-28-2-N-"A"-"B"	-12	-35-S	-	-33
59/64	-28-3-N-3	-28-3-N-"A"-"B"	-12	-35-S	-	-33
15/16	-30-0-N-3	-30-0-N-"A"-"B"	-12	-36-S	-	-33
61/64	-30-1-N-3	-30-1-N-"A"-"B"	-12	-36-S	-	-33

COLD WORKING TOOLS FOR HOLES 7/16-INCH DIAMETER
AND GREATER - HIGH INTERFERENCE, SLEEVE TYPE
TABLE III

High Interference Cold Working Process
Figure 1 (Sheet 5 of 8)

NOM FASTENER SIZE	MANDREL ST5300-CBM [C] [I]	SLEEVE ST5300-CBS [A]	UNIVERSAL KIT NO. 2 MITBAC 5973			
			NOSECAP ST1350A-C	JAW ASSY ST5300-CBC	CHUCK ASSY [E]	
					3-JAW ST1350A-C	THREADED ST1350A-C
31/32	-30-2-N-3	-30-2-N-"A"-"B"	-12	-36-S	-	-33
63/64	-30-3-N-3	-30-3-N-"A"-"B"	-12	-36-S	-	-33
1	-32-0-N-3	-32-0-N-"A"-"B"	-12	-305-S	-	-33
1 [H]	-32-0-S-3	-32-0-S-"A"-"B"	-12	-305-S	-	-33
1-1/64	-32-1-N-3	-32-1-N-"A"-"B"	-12	-305-S	-	-33
1-1/64 [H]	-32-1-S-3	-32-1-S-"A"-"B"	-12	-305-S	-	-33
1-1/32	-32-2-N-3	-32-2-N-"A"-"B"	-12	-305-S	-	-33
1-3/64	-32-3-N-3	-32-3-N-"A"-"B"	-12	-305-S	-	-33
1-1/8	-36-0-N-3	-36-0-N-"A"-"B"	-12	-307-S	-	-33
1-1/8 [H]	-36-0-S-3	-36-0-S-"A"-"B"	-12	-307-S	-	-33
1-9/64	-36-1-N-3	-36-1-N-"A"-"B"	-12	-307-S	-	-33
1-9/64 [H]	-36-1-S-3	-36-1-S-"A"-"B"	-12	-307-S	-	-33
1-5/32	-36-2-N-3	-36-2-N-"A"-"B"	-12	-307-S	-	-33
1-11/64	-36-3-N-3	-36-3-N-"A"-"B"	-12	-307-S	-	-33
1-3/16	-38-0-N-3	-38-0-N-"A"-"B"	-12	-308-S	-	-33
1-3/16 [H]	-38-0-S-3	-38-0-S-"A"-"B"	-12	-308-S	-	-33
1-13/64	-38-1-N-3	-38-1-N-"A"-"B"	-12	-308-S	-	-33
1-13/64 [H]	-38-1-S-3	-38-1-S-"A"-"B"	-12	-308-S	-	-33
1-7/32	-38-2-N-3	-38-2-N-"A"-"B"	-12	-308-S	-	-33
1-15/64	-38-3-N-3	-38-3-N-"A"-"B"	-12	-308-S	-	-33
1-1/4	-40-0-N-3	-40-0-N-"A"-"B"	-12	-309-S	-	-33
1-1/4 [H]	-40-0-S-3	-40-0-S-"A"-"B"	-12	-309-S	-	-33
1-17/64	-40-1-N-3	-40-1-N-"A"-"B"	-12	-309-S	-	-33
1-17/64 [H]	-40-1-S-3	-40-1-S-"A"-"B"	-12	-309-S	-	-33
1-9/32	-40-2-N-3	-40-2-N-"A"-"B"	-12	-309-S	-	-33
1-19/64	-40-3-N-3	-40-3-N-"A"-"B"	-12	-309-S	-	-33
1-3/8	-44-0-N-3	-44-0-N-"A"-"B"	-12	-311-S	-	-33
1-3/8 [H]	-44-0-S-3	-44-0-S-"A"-"B"	-12	-311-S	-	-33
1-25/64	-44-1-N-3	-44-1-N-"A"-"B"	-12	-311-S	-	-33
1-25/64 [H]	-44-1-S-3	-44-1-S-"A"-"B"	-12	-311-S	-	-33
1-13/32	-44-2-N-3	-44-2-N-"A"-"B"	-12	-311-S	-	-33
1-27/64	-44-3-N-3	-44-3-N-"A"-"B"	-12	-311-S	-	-33
1-1/2	-48-0-N-3	-48-0-N-"A"-"B"	-12	-313-S	-	-33
1-1/2 [H]	-48-0-S-3	-48-0-S-"A"-"B"	-12	-313-S	-	-33

COLD WORKING TOOLS FOR HOLES 7/16 INCH DIAMETER
AND GREATER - HIGH INTERFERENCE, SLEEVE TYPE
TABLE III (CONT)

High Interference Cold Working Process
Figure 1 (Sheet 6 of 8)

NOM FASTENER SIZE	MANDREL ST5300-CBM $\boxed{C}$ $\boxed{I}$	SLEEVE ST5300-CBS $\boxed{A}$	UNIVERSAL KIT NO. 2 MITBAC 5973			
			NOSECAP ST1350A-C	JAW ASSY ST5300-CBC	CHUCK ASSY $\boxed{E}$	
					3-JAW ST1350A-C	THREADED ST1350A-C
1-33/64	-48-1-N-3	-48-1-N-"A"-"B"	-12	-313-S	-	-33
1-33/64 $\boxed{H}$	-48-1-S-3	-48-1-S-"A"-"B"	-12	-313-S	-	-33
1-17/32	-48-2-N-3	-48-2-N-"A"-"B"	-12	-313-S	-	-33
1-35/64	-48-3-N-3	-48-3-N-"A"-"B"	-12	-313-S	-	-33
1-5/8	-52-0-N-3	-52-0-N-"A"-"B"	-12	-315-S	-	-33
1-5/8 $\boxed{H}$	-52-0-S-3	-52-0-S-"A"-"B"	-12	-315-S	-	-33
1-41/64	-52-1-N-3	-52-1-N-"A"-"B"	-12	-315-S	-	-33
1-41/64 $\boxed{H}$	-52-1-S-3	-52-1-S-"A"-"B"	-12	-315-S	-	-33
1-21/32	-52-2-N-3	-52-2-N-"A"-"B"	-12	-315-S	-	-33
1-43/64	-52-3-N-3	-52-3-N-"A"-"B"	-12	-315-S	-	-33

COLD WORKING TOOLS FOR HOLES 7/16 INCH DIAMETER
AND GREATER - HIGH INTERFERENCE, SLEEVE TYPE
TABLE III (CONT)

High Interference Cold Working Process
Figure 1 (Sheet 7 of 8)

NOTES

A "A" IS THE LENGTH OF THE SLEEVE IN 1/16 OF AN INCH WHICH MUST EQUAL OR EXCEED THE HOLE DEPTH. SLEEVES ARE MADE IN 1/4-INCH INCREMENTS ONLY, FROM 3/4 INCH TO 1-1/2 INCHES LONG. SLEEVES MAY BE STAKED FOR DEEP HOLES.

"B" IS THE TYPE OF SLEEVE DENOTED BY THE SUFFIX F FOR FLARED TYPE OR S FOR STRAIGHT TYPE. FOR HOLES LESS THAN 7/16 DIA THE FLARED TYPE IS PREFERRED, BUT IF STACKED THE ADDITIONAL SLEEVES MUST BE OF THE STRAIGHT TYPE. FOR HOLE SIZES 7/16 DIA AND GREATER ONLY THE STRAIGHT TYPE WILL BE USED.

EXAMPLE: ST5300-CBS-10-0-N-8-F

THIS IS A FLARED SLEEVE (INDICATED BY -F) FOR A 5/16 DIA HOLE WITH A LENGTH OF 1/2 INCH (INDICATED BY -8).

B "C" IS THE TYPE OF JAW ASSEMBLY REQUIRED TO SUIT THE TYPE OF SLEEVE BEING USED. USE THE SUFFIX F FOR FLARED TYPE OR S FOR STRAIGHT TYPE.

C "D" IS THE TYPE OF MANDREL REQUIRED TO SUIT THE CHUCK. SPECIFY 2 FOR THE TYPE II MANDRELS USED WITH A 3-JAW CHUCK OR 3 FOR THE TYPE III MANDRELS USED WITH A THREADED CHUCK. TYPE III MANDRELS ARE REQUIRED FOR HOLES 11/16 DIA AND LARGER.

EXAMPLE: ST5300-CBM-18-0-N-2

THIS IS A MANDREL FOR A 9/16-INCH DIAMETER HOLE FOR USE WITH A 3-JAW CHUCK (INDICATED BY -2).

D KIT #MITBAC5973 AND KIT #2MITBAC5973 ARE ALTERNATIVES.

E 3-JAW CHUCKS OR THREADED CHUCKS ARE ALTERNATIVES FOR SIZES LESS THAN 11/16-INCH DIAMETER.

F "E" IS THE TYPE OF MANDREL REQUIRED TO SUIT THE CHUCK. SPECIFY 1 FOR THE TYPE I MANDRELS USED WITH A 3-JAW CHUCK OR 1A FOR THE TYPE 1A MANDRELS USED WITH A THREADED CHUCK.

EXAMPLE: ST5300-CBM-12-0-N-1

THIS IS A MANDREL FOR A 3/8-INCH DIAMETER HOLE FOR USE WITH A 3-JAW CHUCK (INDICATED BY -1).

G STARTING HOLE SIZE FOR SPECIAL SLEEVES.

H INDICATIVE OF SPECIAL MANDRELS TO BE USED IN CONJUNCTION WITH SPECIAL SLEEVES.

I MANDREL MATERIAL MUST BE SPECIFIED. SPECIFY H FOR H-11 OR H-13 TOOL STEEL OR V FOR VASCOJET TOOL STEEL. USE H-11 OR H-13 (H) TOOL STEEL FOR COLD WORKING HOLES IN ALUMINUM. USE VASCOJET (VO TOOL STEEL FOR COLD WORKING HOLES IN STEEL OR ALUMINUM.

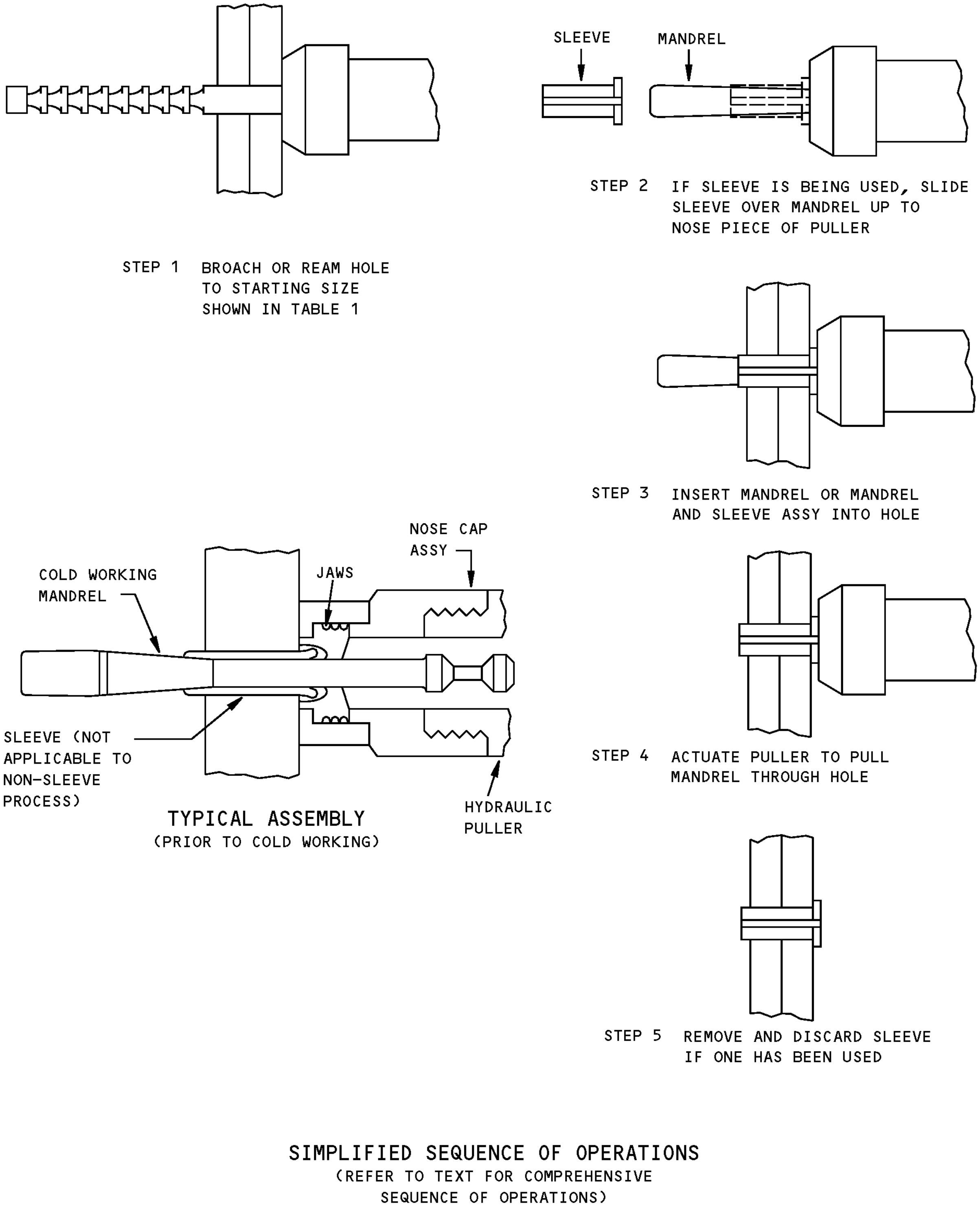
EXAMPLE: ST5300-CBM-22-0-N-3-V

THIS IS A MANDREL MADE FROM VASCOJET TOOL STEEL.

J IN SOME CONDITIONS, IT IS PERMITTED TO DO THESE STEPS:

1. COLD WORK THE HOLE AS IF THE FINISHED HOLE DIAMETER WAS 1/64 INCH SMALLER.
2. REAM THE HOLE TO THE CORRECT FINISHED DIAMETER. THE FINISHED DIAMETER MUST NOT BE LARGER THAN THE MAXIMUM PERIMITTED HOLE DIAMETER.

High Interference Cold Working Process
Figure 1 (Sheet 8 of 8)



Low Interference Cold Working Process
Figure 2 (Sheet 1 of 17)

OM OLE IZE	BOLTS AND OPEN HOLES			LOCKBOLTS AND HI-LOKS			RIVETS		
	FINISHED HOLE SIZE	STARTING HOLE SIZE (SLEEVE PROCESS)	STARTING HOLE SIZE (NON-SLEEVE PROCESS)	FINISHED HOLE SIZE	STARTING HOLE SIZE (SLEEVE PROCESS)	STARTING HOLE SIZE (NON-SLEEVE PROCESS)	FINISHED HOLE SIZE	STARTING HOLE SIZE (SLEEVE PROCESS)	STARTING HOLE SIZE (NON-SLEEVE PROCESS)
/16	0.1922 0.1894	0.1880 0.1850	0.1880 0.1870	0.190 0.187	0.1860 0.1830	0.1860 0.1850	0.193 0.190	0.1895 0.1865	0.1895 0.1885
13/64	0.2078 0.2050	0.2036 0.2006	0.2036 0.2026	0.203 0.200	0.1990 0.1960	0.1990 0.1980			
/32	0.2234 0.2206	0.2192 0.2162	0.2192 0.2182	0.219 0.216 J	0.2135 0.2105 J	0.2135 0.2125 J	0.223 0.220	0.2190 0.2160	0.2190 0.2180
15/64	0.2392 0.2364	0.2349 0.2319	0.2344 0.2339						
/4	0.2548 0.2520	0.2505 0.2475	0.2505 0.2495	0.250 0.247	0.2460 0.2430	0.2460 0.2450	0.256 0.253	0.2525 0.2495	0.2525 0.2515
17/64	0.2704 0.2676	0.2661 0.2631	0.2661 0.2651	0.266 0.263	0.2620 0.2590	0.2620 0.2610			
/32	0.2861 0.2833	0.2817 0.2787	0.2817 0.2807	0.281 0.278 J	0.2755 0.2725 J	0.2755 0.2745 J	0.286 0.283	0.2815 0.2785	0.2815 0.2805
19/64	0.3018 0.2990	0.2974 0.2944	0.2974 0.2964						
/16	0.3175 0.3145	0.3130 0.3100	0.3130 0.3120	0.313 0.309	0.3085 0.3055	0.3085 0.3075	0.320 0.317	0.3145 0.3115	0.3145 0.3135
1/64	0.3331 0.3301	0.3286 0.3256	0.3286 0.3276	0.328 0.325	0.3235 0.3205	0.3235 0.3225			
11/32	0.3488 0.3458	0.3442 0.3412	0.3442 0.3432	0.344 0.341 J	0.3385 0.3335 J	0.3385 0.3375 J	0.348 0.345	0.3440 0.3410	0.3440 0.3430
3/64	0.3647 0.3615	0.3599 0.3569	0.3599 0.3589						
/8	0.3803 0.3771	0.3755 0.3725	0.3755 0.3745	0.375 0.371	0.3700 0.3670	0.3700 0.3690	0.381 0.378	0.3755 0.3725	0.3755 0.3745
5/64	0.3960 0.3928	0.3911 0.3881	0.3911 0.3901	0.391 0.388	0.3870 0.3830	0.3870 0.3860			
13/32	0.4117 0.4083	0.4067 0.4037	0.4067 0.4057	0.406 0.403 J	0.4020 0.3990 J	0.4020 0.4010 J	0.411 0.408	0.4065 0.4035	0.4065 0.4055

SIZES FOR LOW INTERFERENCE COLD WORKED HOLES
TABLE I

Low Interference Cold Working Process
Figure 2 (Sheet 2 of 17)

NOM HOLE SIZE	BOLTS AND OPEN HOLES			LOCKBOLTS AND HI-LOKS			RIVETS		
	FINISHED HOLE SIZE	STARTING HOLE SIZE (SLEEVE PROCESS)	STARTING HOLE SIZE (NON-SLEEVE PROCESS)	FINISHED HOLE SIZE	STARTING HOLE SIZE (SLEEVE PROCESS)	STARTING HOLE SIZE (NON-SLEEVE PROCESS)	FINISHED HOLE SIZE	STARTING HOLE SIZE (SLEEVE PROCESS)	STARTING HOLE SIZE (NON-SLEEVE PROCESS)
27/64	0.4275 0.4241	0.4224 0.4194	0.4224 0.4214						
7/16	0.4432 0.4396	0.4380 0.4350	0.4380 0.4370	0.438 0.434	0.4315 0.4285	0.4315 0.4305	0.444 0.441	0.4370 0.4340	0.4370 0.4360
29/64	0.4589 0.4551	0.4536 0.4530	0.4536 0.4526	0.453 0.450	0.4465 0.4435	0.4465 0.4455			
15/32	0.4746 0.4708	0.4692 0.4662	0.4692 0.4682	0.469 0.466 J	0.4630 0.4600 J	0.4630 0.4620 J			
31/64	0.4905 0.4865	0.4849 0.4819	0.4849 0.4839						
1/2	0.5064 0.5020	0.5005 0.4975	0.5005 0.4995						
33/64	0.5220 0.5176	0.5161 0.5131	0.5161 0.5151						
17/32	0.5376 0.5332	0.5317 0.5287	0.5317 0.5307						
35/64	0.5533 0.5489	0.5474 0.5444	0.5474 0.5464						
9/16	0.5691 0.5647	0.5630 0.5600	0.5630 0.5620						
37/64	0.5847 0.5803	0.5786 0.5756	0.5786 0.5776						
19/32	0.6003 0.5959	0.5942 0.5912	0.5942 0.5932						
39/64	0.6160 0.6116	0.6094 0.6064	0.6094 0.6084						
5/8	0.6316 0.6272	0.6255 0.6225	0.6255 0.6245						

SIZES FOR LOW INTERFERENCE COLD WORKED HOLES
TABLE I

Low Interference Cold Working Process
Figure 2 (Sheet 3 of 17)

NOMINAL HOLE SIZE		MANDREL ST5300-CWM A	SLEEVE ST5300-CWS B	UNIVERSAL KIT NO. MITBAC5973 D				UNIVERSAL KIT NO. 2 MITBAC 5973 D			
				NOSE CAP ST5300 -CBC	JAW ASSY ST5300 -CBC C	CHUCK ASSY		NOSE CAP ST1350A -C	JAW ASSY ST5300 -CBC C	CHUCK ASSY	
						3-JAW ST1350A	THREADED ST1350A			3-JAW ST5300-C	THREADED ST1350A-C
1/8	0.1281	-B1267-"E"-"F"	-B1267-"G"-"H"	-3	-"C"-23	-29	-38	-12	-"C"-23	-227	-35
9/64	0.1437	-B1423-"E"-"F"	-B1423-"G"-"H"	-3	-"C"-23	-29	-38	-12	-"C"-23	-227	-35
5/32	0.1594	-B1580-"E"-"F"	-B1580-"G"-"H"	-3	-"C"-23	-29	-38	-12	-"C"-23	-227	-35
11/64	0.1751	-B1737-"E"-"F"	-B1737-"G"-"H"	-3	-"C"-24	-29	-38	-12	-"C"-24	-227	-35
3/16	0.1908	-B1894-"E"-"F"	-B1894-"G"-"H"	-3	-"C"-24	-29	-38	-12	-"C"-24	-227	-35
13/64	0.2064	-B2050-"E"-"F"	-B2050-"G"-"H"	-3	-"C"-24	-29	-38	-12	-"C"-24	-227	-35
7/32	0.2220	-B2206-"E"-"F"	-B2206-"G"-"H"	-3	-"C"-24	-29	-38	-12	-"C"-24	-227	-35
15/64	0.2378	-B2364-"E"-"F"	-B2364-"G"-"H"	-3	-"C"-25	-29	-38	-12	-"C"-25	-227	-35
1/4	0.2534	-B2520-"E"-"F"	-B2520-"G"-"H"	-3	-"C"-25	-29	-38	-12	-"C"-25	-227	-35
17/64	0.2690	-B2676-"E"-"F"	-B2676-"G"-"H"	-3	-"C"-25	-29	-38	-12	-"C"-25	-227	-35
9/32	0.2847	-B2833-"E"-"F"	-B2833-"G"-"H"	-3	-"C"-26	-29	-38	-12	-"C"-26	-227	-35
19/64	0.3004	-B2990-"E"-"F"	-B2990-"G"-"H"	-3	-"C"-26	-29	-38	-12	-"C"-26	-227	-35
5/16	0.3160	-B3145-"E"-"F"	-B3145-"G"-"H"	-3	-"C"-26	-29	-38	-12	-"C"-26	-227	-35
21/64	0.3316	-B3301-"E"-"F"	-B3301-"G"-"H"	-3	-"C"-26	-29	-38	-12	-"C"-26	-227	-35
11/32	0.3473	-B3458-"E"-"F"	-B3458-"G"-"H"	-3	-"C"-27	-29	-38	-12	-"C"-27	-227	-35
23/64	0.3631	-B3615-"E"-"F"	-B3615-"G"-"H"	-3	-"C"-27	-29	-38	-12	-"C"-27	-227	-35
3/8	0.3787	-B3771-"E"-"F"	-B3717-"G"-"H"	-3	-"C"-27	-29	-38	-12	-"C"-27	-227	-35
25/64	0.3944	-B3928-"E"-"F"	-B3928-"G"-"H"	-3	-"C"-28	-29	-38	-12	-"C"-28	-227	-35
13/32	0.4100	-B4083-"E"-"F"	-B4083-"G"-"H"	-3	-"C"-28	-29	-38	-12	-"C"-28	-227	-35
27/64	0.4258	-B4241-"E"-"F"	-B4241-"G"-"H"	-3	-"C"-28	-29	-38	-12	-"C"-28	-227	-35
7/16	0.4414	-B4396-"E"-"F"	-B4396-"G"-"H"	-3	-"C"-28	-29	-38	-12	-"C"-28	-227	-35
29/64	0.4570	-B4551-"E"-"F"	-B4551-"G"-"H"	-3	-"C"-29	-29	-38	-12	-"C"-29	-227	-35
15/32	0.4727	-B4708-"E"-"F"	-B4708-"G"-"H"	-3	-"C"-29	-29	-38	-12	-"C"-29	-227	-35

BOLTS AND OPEN HOLES - LOW INTERFERENCE SLEEVE TYPE COLD WORKING TOOLS
TABLE II

Low Interference Cold Working Process
Figure 2 (Sheet 4 of 17)

NOMINAL HOLE SIZE		MANDREL ST5300-CWM A	SLEEVE ST5300-CWS B	UNIVERSAL KIT NO. D MITBAC5973				UNIVERSAL KIT NO. 2 D MITBAC 5973			
				NOSE CAP ST5300 -CBC	JAW ASSY ST5300 -CBC C	CHUCK ASSY		NOSE CAP ST1350A -C	JAW ASSY ST5300 -CBC C	CHUCK ASSY	
						3-JAW ST1350A	THREADED ST1350A			3-JAW ST5300-C	THREADED ST1350A-C
31/64	0.4885	-B4865-"E"-"F"	-B4865-"G"-"H"	-3	-"C"-29	-29	-38	-12	-"C"-29	-227	-35
1/2	0.5042	-B5020-"E"-"F"	-B5050-"G"-"H"	-3	-"C"-29	-29	-38	-12	-"C"-29	-227	-35
33/64	0.5198	-B5176-"E"-"F"	-B5176-"G"-"H"	-3	-"C"-30	-29	-38	-12	-"C"-30	-227	-35
17/32	0.5354	-B5332-"E"-"F"	-B5332-"G"-"H"	-3	-"C"-30	-29	-38	-12	-"C"-30	-227	-35
35/64	0.5511	-B5489-"E"-"F"	-B5489-"G"-"H"	-3	-"C"-30	-29	-38	-12	-"C"-30	-227	-35
9/16	0.5669	-B5647-"E"-"F"	-B5647-"G"-"H"	-3	-"C"-31	-29	-38	-12	-"C"-31	-227	-35
37/64	0.5825	-B5803-"E"-"F"	-B5803-"G"-"H"	-3	-"C"-31	-29	-38	-12	-"C"-31	-227	-35
19/32	0.5981	-B5959-"E"-"F"	-B5959-"G"-"H"	-3	-"C"-31	-29	-38	-12	-"C"-31	-227	-35
39/64	0.6138	-B6116-"E"-"F"	-B6116-"G"-"H"	-3	-"C"-31	-29	-38	-12	-"C"-31	-227	-35
5/8	0.6294	-B6272-"E"-"F"	-B6272-"G"-"H"	-3	-"C"-31	-29	-38	-12	-"C"-31	-227	-35
41/64	0.6451	-B6429-"E"-"F"	-B6429-"G"-"H"	-3	-"C"-32	-29	-38	-12	-"C"-32	-227	-35
21/32	0.6607	-B6585-"E"-"F"	-B4865-"G"-"H"	-3	-"C"-32	-29	-38	-12	-"C"-32	-227	-35
43/64	0.6764	-B6742-"E"-"F"	-B6742-"G"-"H"	-3	-"C"-32	-29	-38	-12	-"C"-32	-227	-35
11/16	0.6921	-B6899-"E"-"F"	-B6899-"G"-"H"	-3	-"C"-33	-29	-38	-12	-"C"-33	-227	-35
45/64	0.7077	-B7055-"E"-"F"	-B7055-"G"-"H"	-3	-"C"-33	-29	-38	-12	-"C"-33	-227	-35
23/32	0.7234	-B7212-"E"-"F"	-B7212-"G"-"H"	-3	-"C"-33	-29	-38	-12	-"C"-33	-227	-35
47/64	0.7391	-B7369-"E"-"F"	-B7369-"G"-"H"	-3	-"C"-33	-29	-38	-12	-"C"-33	-227	-35
3/4	0.7548	-B7525-"E"-"F"	-B7525-"G"-"H"	-3	-"C"-33	-29	-38	-12	-"C"-33	-227	-35
49/64	0.7704	-B7681-"E"-"F"	-B7681-"G"-"H"	-3	-"C"-34	-29	-38	-12	-"C"-34	-227	-35
25/32	0.7860	-B7837-"E"-"F"	-B7837-"G"-"H"	-3	-"C"-34	-29	-38	-12	-"C"-34	-227	-35
51/64	0.8018	-B7995-"E"-"F"	-B7995-"G"-"H"	-3	-"C"-34	-29	-38	-12	-"C"-34	-227	-35
13/16	0.8174	-B8151-"E"-"F"	-B8151-"G"-"H"	-3	-"C"-35	-29	-38	-12	-"C"-35	-227	-35
53/64	0.8317	-B8307-"E"-"F"	-B8307-"G"-"H"	-3	-"C"-35	-29	-38	-12	-"C"-35	-227	-35

BOLTS AND OPEN HOLES - LOW INTERFERENCE SLEEVE TYPE COLD WORKING TOOLS
TABLE II (CONT)

Low Interference Cold Working Process
Figure 2 (Sheet 5 of 17)

NOMINAL HOLE SIZE		MANDREL ST5300-CWM A	SLEEVE ST5300-CWS B	UNIVERSAL KIT NO. MITBAC5973 D				UNIVERSAL KIT NO. 2 MITBAC 5973 D			
				NOSE CAP ST5300 -CBC	JAW ASSY ST5300 -CBC C	CHUCK ASSY		NOSE CAP ST1350A -C	JAW ASSY ST5300 -CBC C	CHUCK ASSY	
						3-JAW ST1350A	THREADED ST1350A			3-JAW ST5300-C	THREADED ST1350A-C
7/32	0.8487	-B8464-"E"-"F"	-B8464-"G"-"H"	-3	-"C"-35	-29	-38	-12	-"C"-35	-227	-35
5/64	0.8644	-B8621-"E"-"F"	-B8621-"G"-"H"	-3	-"C"-35	-29	-38	-12	-"C"-35	-227	-35
7/8	0.8801	-B8778-"E"-"F"	-B8778-"G"-"H"	-3	-"C"-36	-29	-38	-12	-"C"-36	-227	-35
7/64	0.8957	-B8934-"E"-"F"	-B8934-"G"-"H"	-3	-"C"-36	-29	-38	-12	-"C"-36	-227	-35
9/32	0.9114	-B9091-"E"-"F"	-B9091-"G"-"H"	-3	-"C"-36	-29	-38	-12	-"C"-36	-227	-35
9/64	0.9271	-B9248-"E"-"F"	-B9248-"G"-"H"	-3	-"C"-36	-29	-38	-12	-"C"-36	-227	-35
5/16	0.9428	-B9404-"E"-"F"	-B9404-"G"-"H"	-3	-"C"-36	-29	-38	-12	-"C"-36	-227	-35
1/64	0.9584	-B9560-"E"-"F"	-B9560-"G"-"H"	-3	-"C"-36	-29	-38	-12	-"C"-36	-227	-35
1/32	0.9740	-B9716-"E"-"F"	-B9716-"G"-"H"	-3	-"C"-36	-29	-38	-12	-"C"-36	-227	-35
3/64	0.9898	-B9874-"E"-"F"	-B9874-"G"-"H"	-303	-"C"-36	-29	-38	-12	-"C"-36	-227	-35
1	1.0054	-B10030-"E"-"F"	-B10030-"G"-"H"	-303	-"C"-36	-29	-38	-12	-"C"-36	-227	-35
-1/64	1.0211	-B10187-"E"-"F"	-B10187-"G"-"H"	-303	-"C"-36	-29	-38	-12	-"C"-36	-227	-35
-1/32	1.0367	-B10343-"E"-"F"	-B10343-"G"-"H"	-303	-"C"-36	-29	-38	-12	-"C"-36	-227	-35

BOLTS AND OPEN HOLES - LOW INTERFERENCE SLEEVE TYPE COLD WORKING TOOLS
TABLE II (CONT)

Low Interference Cold Working Process
Figure 2 (Sheet 6 of 17)

NOMINAL HOLE SIZE		MANDREL ST5300-CWM A	SLEEVE ST5300-CWS B	UNIVERSAL KIT NO. D MITBAC5973				UNIVERSAL KIT NO. 2 D MITBAC 5973			
				NOSE CAP ST5300 -CBC	JAW ASSY ST5300 -CBC C	CHUCK ASSY		NOSE CAP ST1350A -C	JAW ASSY ST5300 -CBC C	CHUCK ASSY	
						3-JAW ST1350A	THREADED ST1350A			3-JAW ST5300-C	THREADED ST1350A-C
3/16	0.1885	-H1870-"E"-"F"	-H1870-"G"-"H"	-3	-"C"-24	-29	-38	-12	-"C"-24	-227	-35
13/65	0.2015	-H2000-"E"-"F"	-H2000-"G"-"H"	-3	-"C"-24	-29	-38	-12	-"C"-24	-227	-35
7/32	0.2175	-H2160-"E"-"F"	-H2160-"G"-"H"	-3	-"C"-25	-29	-38	-12	-"C"-25	-227	-35
1/4	0.2485	-H2470-"E"-"F"	-H2470-"G"-"H"	-3	-"C"-25	-29	-38	-12	-"C"-25	-227	-35
17/64	0.2645	-H2630-"E"-"F"	-H2630-"G"-"H"	-3	-"C"-25	-29	-38	-12	-"C"-25	-227	-35
9/32	0.2795	-H2780-"E"-"F"	-H2780-"G"-"H"	-3	-"C"-26	-29	-38	-12	-"C"-26	-227	-35
5/16	0.3110	-H3090-"E"-"F"	-H3090-"G"-"H"	-3	-"C"-26	-29	-38	-12	-"C"-26	-227	-35
21/64	0.3265	-H3250-"E"-"F"	-H3250-"G"-"H"	-3	-"C"-26	-29	-38	-12	-"C"-26	-227	-35
11/32	0.3425	-H3410-"E"-"F"	-H3410-"G"-"H"	-3	-"C"-27	-29	-38	-12	-"C"-27	-227	-35
3/8	0.3730	-H3710-"E"-"F"	-H3710-"G"-"H"	-3	-"C"-27	-29	-38	-12	-"C"-27	-227	-35
25/64	0.3895	-H3880-"E"-"F"	-H3880-"G"-"H"	-3	-"C"-27	-29	-38	-12	-"C"-27	-227	-35
13/32	0.4055	-H4030-"E"-"F"	-H4030-"G"-"H"	-3	-"C"-28	-29	-38	-12	-"C"-28	-227	-35
7/16	0.4360	-H4340-"E"-"F"	-H4340-"G"-"H"	-3	-"C"-28	-29	-38	-12	-"C"-28	-227	-35
29/64	0.4515	-H4500-"E"-"F"	-H4500-"G"-"H"	-3	-"C"-28	-29	-38	-12	-"C"-28	-227	-35
15/32	0.4675	-H4660-"E"-"F"	-H4660-"G"-"H"	-3	-"C"-29	-29	-38	-12	-"C"-29	-227	-35

HEX-DRIVE BOLTS AND LOCKBOLTS - LOW INTERFERENCE SLEEVE TYPE COLD WORKING TOOLS
TABLE II (CONT)

Low Interference Cold Working Process
Figure 2 (Sheet 7 of 17)

NOMINAL HOLE SIZE		MANDREL ST5300-CWM A	SLEEVE ST5300-CWS B	UNIVERSAL KIT NO. D MITBAC5973				UNIVERSAL KIT NO. 2 D MITBAC 5973			
				NOSE CAP ST5300 -CBC	JAW ASSY ST5300 -CBC C	CHUCK ASSY		NOSE CAP ST1350A -C	JAW ASSY ST5300 -CBC C	CHUCK ASSY	
						3-JAW ST1350A	THREADED ST1350A			3-JAW ST5300-C	THREADED ST1350A-C
1/8	0.1295	-R1280-"E"-"F"	-R1280-"G"-"H"	-3	-"C"-23	-29	-38	-12	-"C"-23	-227	-35
5/32	0.1605	-R1590-"E"-"F"	-R1590-"G"-"H"	-3	-"C"-23	-29	-38	-12	-"C"-23	-227	-35
3/16	0.1915	-R1900-"E"-"F"	-R1900-"G"-"H"	-3	-"C"-24	-29	-38	-12	-"C"-24	-227	-35
7/32	0.2215	-R2200-"E"-"F"	-R2200-"G"-"H"	-3	-"C"-24	-29	-38	-12	-"C"-24	-227	-35
1/4	0.2545	-R2530-"E"-"F"	-R2530-"G"-"H"	-3	-"C"-25	-29	-38	-12	-"C"-25	-227	-35
9/32	0.2845	-R2830-"E"-"F"	-R2830-"G"-"H"	-3	-"C"-25	-29	-38	-12	-"C"-25	-227	-35
5/16	0.3185	-R3170-"E"-"F"	-R3170-"G"-"H"	-3	-"C"-26	-29	-38	-12	-"C"-26	-227	-35
11/32	0.3465	-R3450-"E"-"F"	-R3450-"G"-"H"	-3	-"C"-26	-29	-38	-12	-"C"-26	-227	-35
3/8	0.3795	-R3780-"E"-"F"	-R3780-"G"-"H"	-3	-"C"-27	-29	-38	-12	-"C"-27	-227	-35
13/32	0.4095	-R4080-"E"-"F"	-R4080-"G"-"H"	-3	-"C"-27	-29	-38	-12	-"C"-27	-227	-35
7/16	0.4425	-R4410-"E"-"F"	-R4410-"G"-"H"	-3	-"C"-28	-29	-38	-12	-"C"-28	-227	-35

RIVETS - LOW INTERFERENCE SLEEVE TYPE COLD WORKING TOOLS
TABLE II (CONT)

Low Interference Cold Working Process
Figure 2 (Sheet 8 of 17)

NOMINAL HOLE SIZE		MANDREL						UNIVERSAL KIT NO. MITBAC5973 I		UNIVERSAL KIT NO. 2MITBAC5973 I		KIT NO. 3MITBAC 5973 I
		ST5300A E	ST5300B E	ST5300J G	ST5300K H K	ST5300-A K	ST5300-AB	NOSE CAP ST1350A	CHUCK ST1350A	NOSE CAP ST1350A-C	CHUCK ST5300-C	CHUCK ST5300J-C
1/8	0.1281	-1281	—	—	—	—	—	-12	-29	-12	-227	-5
		—	—	—	-1281-"M"	—	—	-12	-21	—	—	—
9/64	0.1437	-1437	—	—	—	—	—	-12	-29	-12	-227	-5
		—	—	—	-1437-"M"	—	—	-12	-21	—	—	—
5/32	0.1594	-1594	—	—	—	—	—	-12	-29	-12	-227	-5
		—	—	—	-1594-"M"	—	—	-12	-21	—	—	—
11/64	0.1751	-1751	—	—	—	—	—	-12	-29	-12	-227	-5
		—	—	—	-1751-"M"	—	—	-12	-21	—	—	—
3/16	0.1908	-1908	—	—	—	—	—	-12	-29	-12	-227	-5
		—	—	—	-1908-"M"	—	—	-12	-21	—	—	—
13/64	0.2064	-2064	—	—	—	—	—	-12	-29	-12	-227	-5
		—	—	—	-2064-"M"	—	—	-12	-21	—	—	—
7/32	0.2220	-2220	—	—	—	—	—	-12	-29	-12	-227	-5
		—	—	—	-2220-"M"	—	—	-12	-21	—	—	—
15/64	0.2378	-2378	—	—	—	—	—	-12	-29	-12	-227	-5
		—	—	—	-2378-"M"	—	—	-12	-21	—	—	—
1/4	0.2534	-2534	—	—	—	—	—	-12	-29	-12	-227	-5
		—	—	-2534	—	—	—	—	—	—	—	-4
		—	—	—	-2534-"M"	—	—	-12	-21	—	—	—
17/64	0.2690	-2690	—	—	—	—	—	-12	-29	-12	-227	-5
		—	—	—	-2690-"M"	—	—	-12	-21	—	—	—
9/32	0.2847	-2847	—	—	—	—	—	-12	-29	-12	-227	-5
		—	—	—	-2847-"M"	—	—	-12	-21	—	—	—

BOLTS AND OPEN HOLES - LOW INTERFERENCE NON-SLEEVE PULL TYPE COLD WORKING TOOLS

TABLE III

Low Interference Cold Working Process
Figure 2 (Sheet 9 of 17)

NOMINAL HOLE SIZE		MANDREL						UNIVERSAL KIT NO. MITBAC5973 $\boxed{I}$		UNIVERSAL KIT NO. 2MITBAC5973 $\boxed{I}$		KIT NO. 3MITBAC 5973 $\boxed{I}$
		ST5300A $\boxed{E}$	ST5300B $\boxed{E}$	ST5300J $\boxed{G}$	ST5300K $\boxed{H}\boxed{K}$	ST5300-A $\boxed{K}$	ST5300-AB	NOSE CAP ST1350A	CHUCK ST1350A	NOSE CAP ST1350A-C	CHUCK ST5300-C	CHUCK ST5300J-C
19/64	0.3004	-3004	—	—	—	—	—	-12	-29	-12	-227	-5
		—	—	—	-3004-"M"	—	—	-12	-21			
5/16	0.3160	-3160	—	—	-3160-"M"	—	—	-12	-29	-12	-227	-5
		—	—	-3160	—	—	—	-12				-4
21/64	0.3316	-3316	—	—	-3316	—	—	-12	-29	-12	-227	-5
11/32	0.3473	-3473	—	—	-3473	—	—	-12	-29	-12	-227	-5
23/64	0.3631	-3631	—	—	-3631	—	—	-12	-29	-12	-227	-5
3/8	0.3787	-3787	—	—	-3787-"M"	—	—	-12	-29	-12	-227	-5
		—	—	-3787	—	—	—					-5
25/64	0.3944	-3944	—	—	-3944	—	—	-12	-29	-12	-227	-5
13/32	0.4100	-4100	—	—	-4100	—	—	-12	-29	-12	-227	-5
27/64	0.4258	-4258	—	—	-4258	—	—	-12	-29	-12	-227	-5
7/16	0.4414	-4414	—	—	-4414	—	—	-12	-29	-12	-227	-5
29/64	0.4570	-4570	—	—	-4570	—	—	-12	-29	-12	-227	-5

BOLTS AND OPEN HOLES - LOW INTERFERENCE NON-SLEEVE PULL TYPE COLD WORKING TOOLS
TABLE III (CONT)

Low Interference Cold Working Process
Figure 2 (Sheet 10 of 17)

NOMINAL HOLE SIZE		MANDREL						UNIVERSAL KIT NO. MITBAC5973 I		UNIVERSAL KIT NO. 2MITBAC5973 I		KIT NO. 3MITBAC 5973 I
		ST5300A E	ST5300B E	ST5300J G	ST5300K H K	ST5300-A K	ST5300-AB	NOSE CAP ST1350A	CHUCK ST1350A	NOSE CAP ST1350A-C	CHUCK ST5300-C	CHUCK ST5300J-C
15/32	0.4727	-4727	—	—	-4727-"M"	—	—	-12	-29	-12	-227	-5
31/64	0.4885	-4885	—	—	-4885-"M"	—	—	-12	-29	-12	-227	-5
1/2	0.5042	-5042	—	—	-5042-"M"	—	—	-12	-29	-12	-227	-5
33/64	0.5198	-5198	-5198	—	—	-5198	—	-12	-29	-12	-227	-5
17/32	0.5354	-5354	-5354	—	—	-5354	—	-12	-29	-12	-227	-5
35/64	0.5511	—	-5511	—	—	-5511	—	-12	-29	-12	-227	-5
9/16	0.5669	—	-5669	—	—	-5669	—	-12	-29	-12	-227	-5
37/64	0.5825	—	-5825	—	—	-5825	—	-12	-29	-12	-227	-5
19/32	0.5981	—	-5981	—	—	-5981	—	-12	-29	-12	-227	-5
39/64	0.6138	—	-6138	—	—	-6138	—	-12	-29	-12	-227	-5
5/8	0.6294	—	-6294	—	-6294	-6294	—	-12	-29	-12	-227	-5

BOLTS AND OPEN HOLES - LOW INTERFERENCE NON-SLEEVE PULL TYPE COLD WORKING TOOLS
TABLE III (CONT)

Low Interference Cold Working Process
Figure 2 (Sheet 11 of 17)

NOMINAL HOLE SIZE		MANDREL						UNIVERSAL KIT NO. MITBAC5973 I		UNIVERSAL KIT NO. 2MITBAC5973 I		KIT NO. 3MITBAC 5973 I
		ST5300A E	ST5300B E	ST5300J G	ST5300K H K	ST5300-A K	ST5300-AB	NOSE CAP ST1350A	CHUCK ST1350A	NOSE CAP ST1350A-C	CHUCK ST5300-C	CHUCK ST5300J-C
1/64	0.6451	—	-6451	—	-6451-"M"	-6451	—	-12	-29	-12	-227	-5
21/32	0.6607	—	-6607	—	-6607-"M"	-6607	—	-12	-29	-12	-227	-5
3/64	0.6764	—	-6764	—	—	-6764	—	-12	-29	-12	-227	-5
11/16	0.6921	—	-6921	—	—	-6921	—	-12	-29	-12	-227	-5
5/64	0.7077	—	-7077	—	—	-7077	—	-12	-29	-12	-227	-5
23/32	0.7234	—	-7234	—	—	-7234	—	-12	-29	-12	-227	-5
7/64	0.7391	—	-7391	—	—	-7391	—	-12	-29	-12	-227	-5
3/4	0.7548	—	-7548	—	—	-7548	-7548	-12	-29	-12	-227	-5
9/64	0.7704	—	-7704	—	—	-7704	-7704	-12	-29	-12	-227	-5
25/32	0.7860	—	-7860	—	—	-7860	-7860	-12	-29	-12	-227	-5
1/64	0.8018	—	-8018	—	—	-8018	-8018	-12	-29	-12	-227	-5

BOLTS AND OPEN HOLES - LOW INTERFERENCE NON-SLEEVE PULL TYPE COLD WORKING TOOLS
TABLE III (CONT)

Low Interference Cold Working Process
Figure 2 (Sheet 12 of 17)

NOMINAL HOLE SIZE		MANDREL						UNIVERSAL KIT NO. MITBAC5973 I		UNIVERSAL KIT NO. 2MITBAC5973 I		KIT NO. 3MITBAC 5973 I
		ST5300A E	ST5300B E	ST5300J G	ST5300K H K	ST5300-A K	ST5300-AB	NOSE CAP ST1350A	CHUCK ST1350A	NOSE CAP ST1350A-C	CHUCK ST5300-C	CHUCK ST5300J-C
13/16	0.8174	—	-8174	—	—	-8174	-8174	-12	-29	-12	-227	-5
53/64	0.8330	—	-8330	—	—	-8330	—	-12	-29	-12	-227	-5
27/32	0.8487	—	-8487	—	—	-8487	—	-12	-29	-12	-227	-5
55/64	0.8644	—	-8644	—	—	-8644	—	-12	-29	-12	-227	-5
7/8	0.8801	—	-8801	—	—	-8801	—	-12	-29	-12	-227	-5
57/64	0.8957	—	-8957	—	—	-8957	—	-12	-29	-12	-227	-5
29/32	0.9114	—	-9114	—	—	-9114	—	-12	-29	-12	-227	-5
59/64	0.9271	—	-9271	—	—	-9271	—	-12	-29	-12	-227	-5
15/16	0.9428	—	-9428	—	—	-9428	—	-12	-29	-12	-227	-5
61/64	0.9584	—	-9584	—	—	-9584	—	-12	-29	-12	-227	-5
31/32	0.9740	—	-9740	—	—	-9740	—	-12	-29	-12	-227	-5

BOLTS AND OPEN HOLES - LOW INTERFERENCE NON-SLEEVE PULL TYPE COLD WORKING TOOLS
TABLE III (CONT)

Low Interference Cold Working Process
Figure 2 (Sheet 13 of 17)

NOMINAL HOLE SIZE		MANDREL						UNIVERSAL KIT NO. MITBAC5973 I		UNIVERSAL KIT NO. 2MITBAC5973 I		KIT NO. 3MITBAC 5973 I
		ST5300A E	ST5300B E	ST5300J G	ST5300K H	ST5300-A K	ST5300-AB	NOSE CAP ST1350A	CHUCK ST1350A	NOSE CAP ST1350A-C	CHUCK ST5300-C	CHUCK ST5300J-C
63/64	0.9898	—	-9898	—	—	-9898	—	-12	-29	-12	-227	-5
1	1.0054	—	-10054	—	—	-10054	—	-12	-29	-12	-227	-5
-1/64	1.0211	—	-10211	—	—	-10211	—	-12	-29	-12	-227	-5
-1/32	1.0367	—	-10367	—	—	-10367	—	-12	-29	-12	-227	-5
-7/32	1.2229	—	-12229	—	—	-12229	-12229	-12	-29	-12	-227	-5

BOLTS AND OPEN HOLES - LOW INTERFERENCE NON-SLEEEVE PULL TYPE COLD WORKING TOOLS
TABLE III (CONT)

Low Interference Cold Working Process
Figure 2 (Sheet 14 of 17)

NOMINAL HOLE SIZE		MANDREL			UNIVERSAL KIT NO. MITBAC5973 I		UNIVERSAL KIT NO. 2MITBAC5973 I		KIT NO. 3MITBAC 5973 I
		ST5300A E	ST5300A-A F	ST5300K H K	NOSE CAP ST1350A	CHUCK ST1350A	NOSE CAP ST1350A-C	CHUCK ST5300-C	CHUCK ST5300J-C
3/16	0.1885	-1885	-1885 -"L"-"X"	—	-12	-29	-12	-227	-5
		—	—	-1885 -"M"	-12	-21	—	—	—
13/64	0.2015	-2015	-2015 -"L"-"X"	—	-12	-29	-12	-227	-5
		—	—	-2015 -"M"	-12	-21	—	—	—
7/32	0.2175	—	-2175 -"L"-"X"	—	-12	-29	-12	-227	-5
		—	—	-2175 -"M"	-12	-21	—	—	—
1/4	0.2485	-2485	-2485 -"L"-"X"	—	-12	-29	-12	-227	-5
		—	—	-2485 -"M"	-12	-21	—	—	—
17/64	0.2645	-2645	-2645 -"L"-"X"	—	-12	-29	-12	-227	-5
		—	—	-2645 -"M"	-12	-21	—	—	—
9/32	0.2795	—	-2795 -"L"-"X"	—	-12	-29	-12	-227	-5
		—	—	-2795 -"M"	-12	-21	—	—	—
5/16	0.3110	-3110	-3110 -"L"-"X"	—	-12	-29	-12	-227	-5
		—	—	-3110 -"M"	-12	-21	—	—	—
21/64	0.3265	-3265	-3265 -"L"-"X"	-3265 -"M"	-12	-29	-12	-227	-5
11/32	0.3425	—	-3425 -"L"-"X"	-3425 -"M"	-12	-29	-12	-227	-5
3/8	0.3730	-3730	-3730 -"L"-"X"	-3730 -"M"	-12	-29	-12	-227	-5
25/64	0.3895	-3895	-3895 -"L"-"X"	-3895 -"M"	-12	-29	-12	-227	-5

HEX-DRIVE BOLTS AND LOCKBOLTS - LOW INTERFERENCE NON-SLEEVE PULL TYPE COLD WORKING TOOLS
TABLE III (CONT)

Low Interference Cold Working Process
Figure 2 (Sheet 15 of 17)

NOMINAL HOLE SIZE		MANDREL			UNIVERSAL KIT NO. MITBAC5973 $\boxed{I}$		UNIVERSAL KIT NO. 2MITBAC5973 $\boxed{I}$		KIT NO. 3MITBAC 5973 $\boxed{I}$
		ST5300A $\boxed{E}$	ST5300A-A $\boxed{F}$	ST5300K $\boxed{H}\boxed{K}$	NOSE CAP ST1350A	CHUCK ST1350A	NOSE CAP ST1350A-C	CHUCK ST5300-C	CHUCK ST5300J-C
13/32	0.4045	—	-4045-"L"-"X"	-4045-"M"	-12	-29	-12	-227	-5

HEX-DRIVE BOLTS AND LOCKBOLTS - LOW INTERFERENCE NON-SLEEVE PULL TYPE COLD WORKING TOOLS
TABLE III (CONT)

Low Interference Cold Working Process
Figure 2 (Sheet 16 of 17)

NOTES

A "E" IS MATERIAL STACKUP IN 1/16 OF AN INCH. -24 FOR STACKUP OF 1-1/2 INCHES TO BE USED WITH -1 OR -1A MANDREL AND -48 FOR STACKUP OF 3 INCHES TO BE USED WITH -2 OR -3 MANDREL

"F" IS THE TYPE OF MANDREL REQUIRED. -1 OR -1A MANDREL IS REQUIRED TO SUIT A SMALL 3 JAW OR THREADED (1/2 - 20) CHUCK, RESPECTIVELY AND -2 OR -3 MANDREL IS REQUIRED TO SUIT A LARGE 3 JAW OR THREADED (7/8 - 14) CHUCK, RESPECTIVELY. A THREADED CHUCK IS PREFERRED FOR SIZES OVER 0.4045 DIA

EXAMPLE: ST5300-CWM-R1280-24-1A

THIS IS A MANDREL FOR STACKUPS LESS THAN 1-1/2 INCHES (INDICATED BY -24) FOR USE WITH A THREADED CHUCK (INDICATED BY -1A) FOR COLD WORKING A RIVET HOLE WITH A NOMINAL SIZE OF 0.1280 DIA

B "G" IS THE LENGTH OF THE SLEEVE IN 1/16 OF AN INCH WHICH MUST EQUAL OR EXCEED THE HOLE DEPTH. SLEEVES ARE MADE IN 1/4-INCH INCREMENTS ONLY, FROM 3/4 INCH TO 1-1/2 INCHES LONG. SLEEVES MAY BE STACKED FOR DEEP HOLES

"H" IS THE TYPE OF SLEEVE DENOTED BY THE SUFFIX F FOR FLARED TYPE OR S FOR STRAIGHT TYPE. FLARED SLEEVES ARE PREFERRED FOR HOLES UP TO 0.3447 DIA, BUT IF STACKED, THE ADDITIONAL SLEEVES MUST BE THE STRAIGHT TYPE

EXAMPLE: ST5300-CWS-R1280-8-F

THIS IS A FLARED SLEEVE (INDICATED BY -F) FOR A 0.1280 DIA RIVET HOLE WITH A LENGTH OF 1/2 INCH (INDICATED BY -8)

C "C" IS THE TYPE OF JAW ASSY REQUIRED TO SUIT THE TYPE OF SLEEVE BEING USED. USE THE SUFFIX F FOR FLARED TYPE OR S FOR STRAIGHT TYPE

D KIT MITBAC5973 AND KIT 2MITBAC5973 ARE ALTERNATIVES

E THIS MANDREL FOR USE IN EXTREMELY LIMITED ACCESS AREAS ONLY WHERE MATERIAL STACKUP DOES NOT EXCEED 5/8 INCH

F "L" IS THE THICKNESS OF MATERIAL STACKUP IN 1/8 OF AN INCH INCREMENTS

"X" IS TYPE-1 FOR NORMAL USE OR TYPE-2 IF REQUIRED FOR USE WITH THE OFFSET PULLER INCLUDED WITH KIT MITBAC5973

BOTH TYPE-1 AND TYPE-2 MANDRELS ARE FOR USE IN LIMITED ACCESS AREAS ONLY

G THIS MANDREL FOR USE WHERE MATERIAL STACKUP DOES NOT EXCEED 3/8 INCH

H "M" IS THE PILOT LENGTH IN 1/4-INCH INCREMENTS. THE PILOT LENGTH IS NOT CRITICAL FOR THE PROCESS DESCRIBED IN THIS SUBJECT

I KITS ARE ALTERNATIVES PROVIDED THAT THE CORRECT CORRESPONDING MANDREL IS USED

J FOR HI-LOKS ONLY

K SUITABLE FOR GENERAL USE WHERE ACCESS IS AVAILABLE

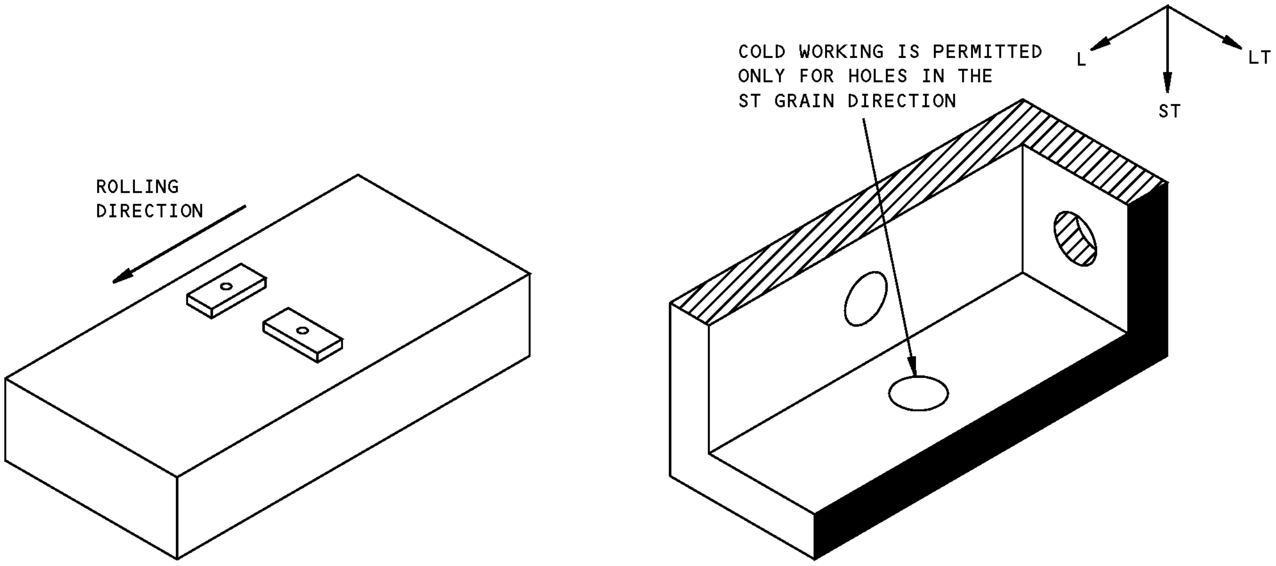
Low Interference Cold Working Process
Figure 2 (Sheet 17 of 17)

TOOL NOMENCLATURE AND NUMBER	SOURCE
SLEEVE ST5300-CBS ST5300-CWS ALL DASH NUMBERS	FATIGUE TECHNOLOGY 150 ANDOVER PARK WEST P.O. BOX C-88388 TUKWILA, WASHINGTON 98188
MANDREL ST5300-CBM ST5300-CWM MANDREL PULLER KIT A MITBAC5973 2MITBAC5973 3MITBAC5973	WEST COAST INDUSTRIES 14900 WHITMAN AVE. NORTH SEATTLE, WASHINGTON 98133 PACIFIC TOOL INCORPORATED 15235 NE 92ND REDMOND, WASHINGTON 98052 FATIGUE TECHNOLOGY 150 ANDOVER PARK WEST P.O. BOX C-88388 TUKWILA, WASHINGTON 98188
POWER SOURCE (4MITBAC5973) POWER UNIT MODEL NO. H&A MODIFIED PA130	HYDRAULIC AND AIR EQUIPMENT CO. 4401 AIRPORT WAY SO. SEATTLE, WASHINGTON 98108

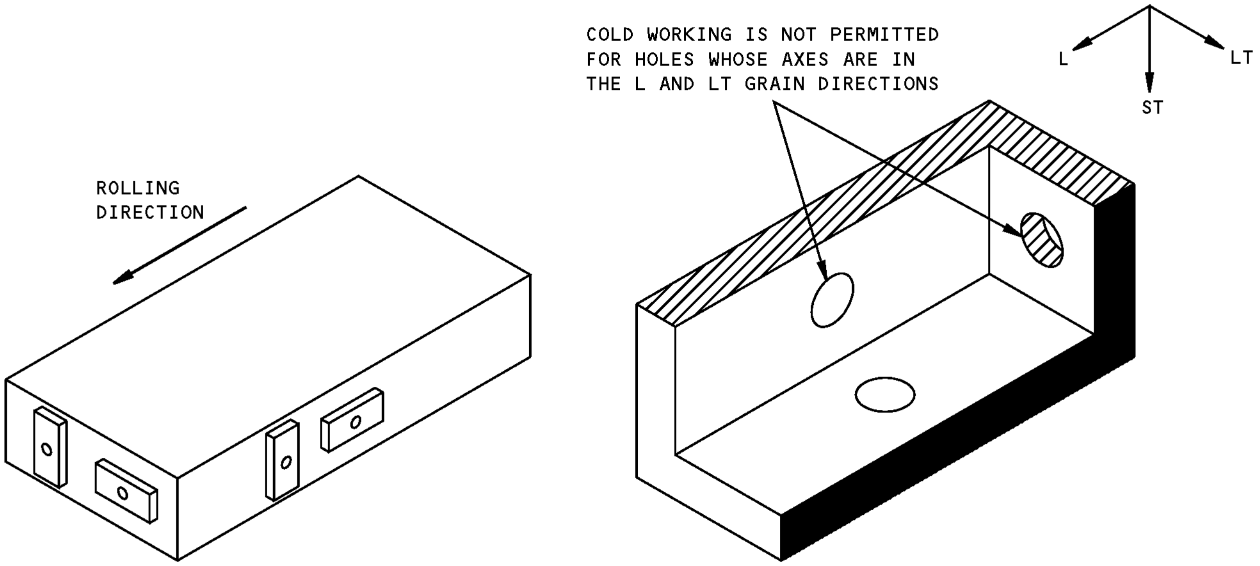
NOTES

A KIT INCLUDES HYDRAULIC PULLER COMPLETE WITH THREADED NOSE CAP ASSEMBLIES, CHUCKS AND THREADED ADAPTER, OFFSET ADAPTER, QUICK-DISCONNECT FITTINGS, SET OF JAW ASSEMBLIES, AND SET OF DRAWINGS OF TOOL DETAILS.

Tools for Cold Working of Holes
Figure 3



APPROVED



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 4

GENERAL - FASTENER TYPES - RB211-524 ENGINES

1. General

A. Three basic types of fasteners are used in the construction of the RB211-524 engine nacelle inlet cowl, fan cowls, reverser cowls and integrated nozzle. The fastener types are rivets, fastener pins and collars, and threaded fastener pins and nuts.

2. References

Reference	Title
51-40-01, GENERAL	Fasteners
51-40-02, GENERAL	Fastener Installation and Removal
51-42-02, GENERAL	Fastener Installation and Removal - RB211-524 Engines

3. Rivets

A. Solid rivets made from aluminum alloy are used to fasten together structural parts of the nacelle where structural loads, temperature ranges, and galvanic corrosion conditions permit. Solid rivets of titanium are used in titanium structures, 2219 aluminum alloy structures, graphite composite structures, stainless steel, Monel and Inconel parts. Solid rivets of bi-metal construction with a hard titanium alloy body and a ductile titanium alloy tail reduce the pressures required for installation. Solid rivets of Monel are used in steels, stainless steels, titanium, graphite epoxy composite structures and Inconel parts where temperature and stress ranges are high. The installation and removal of solid rivets are described in 51-40-02 except for titanium alloy Cherry-Buck and E-Z Buck rivets which are described in 51-42-02, GENERAL.

B. Blind rivets are used where access is not available to form the driven head of a solid rivet. Blind rivets are of two-piece construction, with a hollow sleeve and a solid spindle (with an interference fit) which is pulled into the sleeve until rivet and spindle are locked in place. The sleeves and spindles of blind rivets are of various materials and their selection depends on the heat range, strength requirements and dissimilar metal characteristics of the material in which they are used. Blind rivets must not be used in areas subject to vibration, or in fluid-tight joints. Installation and removal instructions for blind rivets which are used in the Boeing 767 airplane and the RB211-524 nacelle are described in 51-40-02, GENERAL. Installation and removal instructions for blind rivets used only in the RB211-524 nacelle area described in 51-42-02, GENERAL.

NOTE: Blind rivets used in repair are time limited and must be checked at frequent intervals for looseness.

4. Fastener Pins

A. Lockbolt fastener pins are installed by swaging a collar on to the serrated end of the pin. The installation is usually an interference fit operation with the fastener hole being slightly smaller in diameter than the fastener pin. A tool pulls the pin into the fastener hole until the fastener head seats, the collar is swaged on to the serrated end of the pin and the pin-tail breaks off at the proper tension load. The pin size and fastener hole size must be carefully controlled to assure proper installation. Installation and removal instructions for lockbolts are described in 51-40-02, GENERAL.

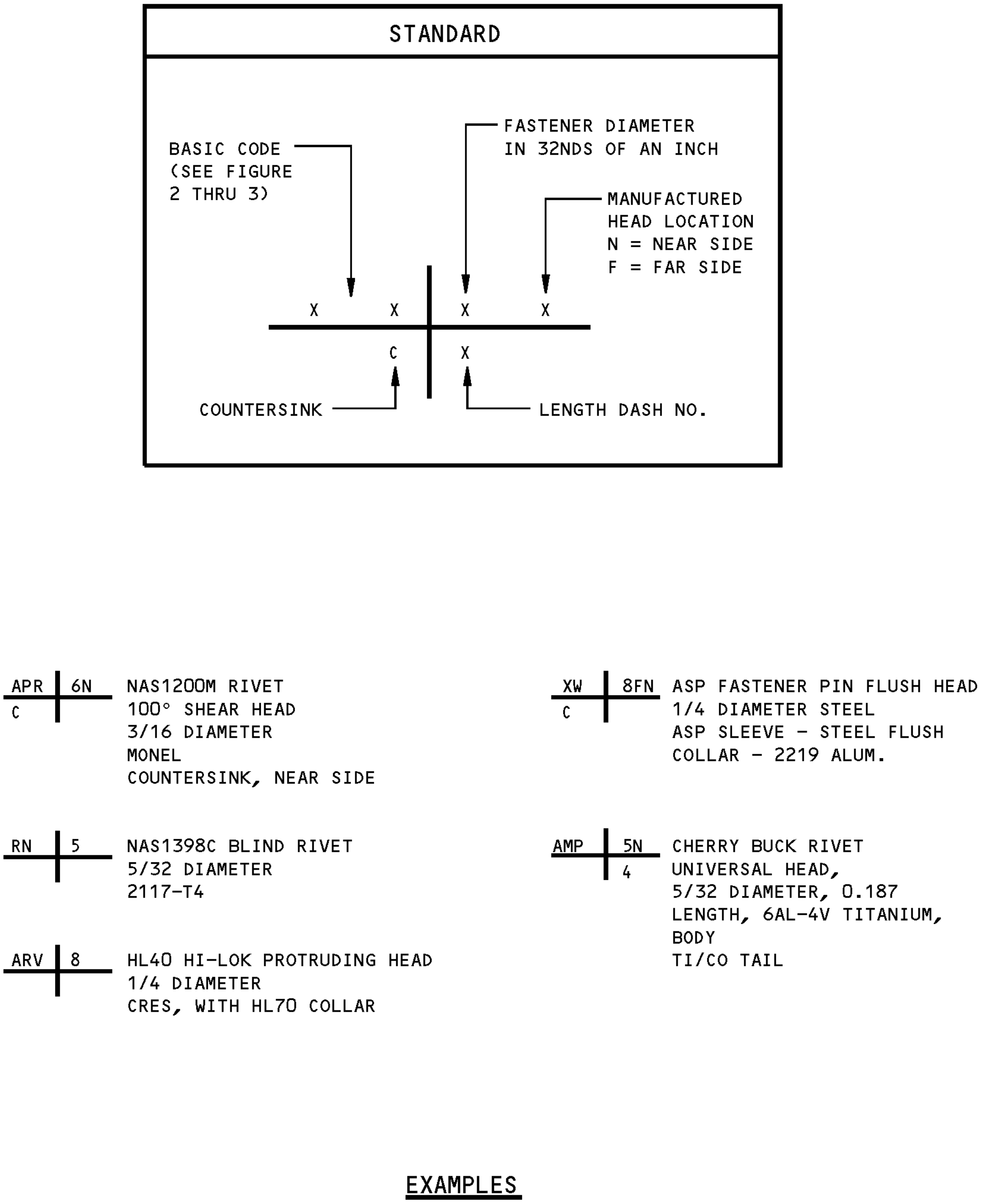
5. Threaded Fasteners

A. Bolts and screws are the standard threaded fastners used in the RB211-524 nacelle structure. They are used in combination with threaded nuts or directly installed into helical threads tapped into a structure member or part. There are several different combinations of bolts, screws, and nuts; most of which contain a locking device to prevent relative movement of the bolt and nut once it has been installed and torqued to the proper tension. Unlike rivets which are used almost exclusively in shear application, bolts are used also in tension to hold structural members clamped together. Hexagonal (Hex-Drive) bolt heads and nuts are used to rotate the fastener combination and apply the torque required to properly install the threaded fastener. Standard and oversize Hex-Drive bolts used on the Boeing 767 airplane are described in 51-40-01, GENERAL, and their installation and removal described in 51-40-02, GENERAL. The installation and removal of threaded fasteners which are used only in the RB211-524 engine nacelle are described in 51-40-02, GENERAL.

B. Blind bolts and blind nuts using protruding or flush head core bolts are used where access is limited to one side of the work. The fastener hole is reamed to accept a sleeve with a countersunk head. An expander threaded on to a core bolt precedes the sleeve through the fastener hole which has been coutersunk to accept the sleeve countersunk head. Rotation of the core bolt pulls the serrated expander up into the sleeve causing it to expand against the underside of the part in which the sleeve is installed. The bottom of the sleeve closes around the serrated expander which serves as a nut, permitting the core bolt to be removed while the sleeve and nut remain locked in place. The core bolt is installed through the material or part to be attached, threaded back through the blind nut, and torqued to installation tension requirements. By use of a longer sleeve two pieces of material can be held together by the blind nut even when the core bolt is removed. Installation and removal instructions are provided in 51-40-02, GENERAL.

C. A fastener system supplied by Huck Manufacutring Company called ASP fasteners provides a means of fastening metal surfaces to soft-core material in the RB211-524 nacelle without crushing the sandwich honeycomb core, and without the need for potting, bushing, inserts or step hole preparation. The fasteners are available as either protruding head fastener and sleeve, flush fastener and sleeve or a combination of protruding and flush component. A shouldered pintailed threaded faster is installed in one side of a fastener hole in a honeycomb sandwich panel, and a threaded sleeve installed over the pintail from the other side of the panel and tightened until the heads on both fastener and sleeve are properly seated. A locking collar is placed over the pintail and swaged into place between the pintail and the sleeve head. The collar swages into longitudinal grooves in the fastener threads and prevents the sleeve from loosening due to rotation on the pin threads. The pintail breaks off when the locking collar is properly swaged into place. Installation and removal instructions are provided in 51-42-02, GENERAL.

D. A fastener system supplied by Huck Manufacturing Company provides a wide flush shear head sleeve of AISI4027 or AISI4037 alloy steel with a shouldered pin of AISI8740 alloy. The sleeve and pin are cadmium plated. A locking collar can be obtained in carbon steel, alloy steel, or A286 CRES steel. The fastener is installed as a blind bolt fastener into a 100 degrees countersink recess in the top surface of the part sandwich. The fastener is tool installed and the locking collar swaged into place as the pintail breaks off. The sleeve expands against the undersurface of the part sandwich to lock the fastener into place.



Fastener Symbols - RB211-524 Engines
Figure 1

TYPE	CODE	PART NUMBER		MATERIAL ALLOY AND TEMPER	DESCRIPTION
		STANDARD	VENDOR		
SOLID SHANK PROTRUDING HEAD	LN	MS20515M		MONEL	UNIVERSAL HEAD
	CX	MS20470DD		2024-T31	UNIVERSAL HEAD
	AMY		CSR903B [A]	TI/COLUMBIUM	UNIVERSAL HEAD
	AMP		CSR925 [A]	6AL-4V TI BODY	FLAT HEAD
	MM	NAS1198		A286 CRES	UNIVERSAL HEAD
SOLID SHANK FLUSH HEAD	AMO	NAS1097	CSR924 [A]	6AL-4V TI BODY	100° SHEAR HEAD
	LZ	NAS1097AD		2117-T3	100° SHEAR HEAD
	MA	NAS1097B		5056-H32	100° SHEAR HEAD
	MN	NAS1199		A286 CRES	100° HEAD
	MO	NAS1200		A286 CRES	100° SHEAR HEAD
	APR	NAS1200M		MONEL	100° SHEAR HEAD
	DH	MS20427F		CRES	100° HEAD
	BF	MS20427M		MONEL	100° HEAD
	--		4B100T [C]	STEEL ALLOY	100° SHEAR HEAD
	--		S7B100T [B]	STEEL ALLOY	100° SHEAR HEAD
	ANE	MS20426	CSR902B [A]	TI/COLUMBIUM	100° HEAD
	AMN	MS20426	CSR922 [A]	6AL-4V TI BODY	100° HEAD
BLIND PROTRUDING HEAD	AMS		CCR274CS [A]	A286 CRES	UNIVERSAL HEAD
	XK		CR3523 [A]	MONEL	UNIVERSAL HEAD BULBED CHERRY MAX, LOCKED SPINDLE
	RN	NAS1398C	CR2663 [A]	A286 CRES	LOCK SPINDLE
	AAR	NAS1738M	CR2539 [A]	MONEL	BULBED RIVET LOCKED SPINDLE
	--	NAS1738C	CR2839 [A]	INCONEL	LOCKED SPINDLE
BLIND UNISINK	--		CR2554 [A]	MONEL	100° HEAD PROTRUDING

STANDARD RIVETS
TABLE I

NOTES

- THE CODE USED IN THE FASTENER TABLES IN 51-42-01 TO IDENTIFY THE FASTENER VENDORS IS THE SAME AS THAT USED IN 51-40-01

[A] TOWNSEND COMPANY
CHERRY RIVET DIVISION
1224 EAST WARNER AVE.
SANTA ANA, CALIFORNIA 92707

[B] HUCK MANUFACTURING CO.
2650 BELLVUE AVE.
DETROIT, MICHIGAN 48207

[C] HIGH SHEAR CORPORATION
2600 SKYPARK DRIVE
TORRANCE, CALIFORNIA 90509

Fastener Codes - Rivets - RB211-524 Engines
Figure 2 (Sheet 1 of 3)

TYPE	CODE	PART NUMBER		MATERIAL ALLOY AND TEMPER	DESCRIPTION
		STANDARD	VENDOR		
BLIND FLUSH HEAD	AMC		CCR264SS3 [A]	STEEL	100° HEAD, NON-STRUCTURE
	ADD		CR2164 [A]	2017 ALUM	2017-T4, LOCKED SPINDLE, NAS1097 HEAD STYLE
	ADE		CR2564 [A]	MONEL	CAD PLATE, LOCKED SPINDLE, NAS1097 HEAD STYLE
	ADF		CR2664 [A]	A286 CRES	NAS1097 HEAD STYLE
	XJ		CR3522 [A]	MONEL	100° HEAD, LOCKED SPINDLE
	XR		CR2564M [A]	MONEL	100° SHEAR HEAD, NAS1097 HEAD STYLE
	RS	NAS1399C	CR2662 [A]	A286 CRES	100° HEAD, LOCKED SPINDLE
	AAX	NAS1739MW	CR2538P [A]	MONEL	100° HEAD, CAD PLATED, LOCKED SPINDLE
	AAW	NAS1739M	CR2538 [A]	MONEL	100° HEAD, LOCKED SPINDLE
	AJN	NAS1739A	CR2838 [A]	2219-T62	100° HEAD, LOCKED SPINDLE
	ATT	NAS1739B	CR2248 [A]	5056F	100° HEAD, LOCKED SPINDLE

STANDARD RIVETS
TABLE I (CONT)

Fastener Codes - Rivets - RB211-524 Engines
Figure 2 (Sheet 2 of 3)

TYPE	ORIGINAL FASTENER		OVERSIZE FASTENER		
	CODE	PART NO.	CODE	PART NO.	NOMINAL OVERSIZE
BLIND PROTRUDING HEAD	XK	CR3523		CR3553	1/64 IN.
BLIND FLUSH HEAD	XJ	CR3522		CR3552	1/64 IN.

NOTES

- CHERRY BUCK CSR922, CSR924 OR CSR925 RIVETS OF THE SAME DASH NUMBER CAN BE USED AS OVERSIZE FOR E-Z BUCK CSR902B, CSR903B OR CSR904B RIVETS. i.e.,

  <u>E-Z BUCK</u>

  -5 ACTUAL DIA. 0.1560
  -6 ACTUAL DIA. 0.1870

  <u>CHERRY BUCK</u>

  -5 ACTUAL DIA. 0.1640
  -6 ACTUAL DIA. 0.1895
- CHERRYLOCK RIVETS (NAS1398 AND NAS1399) ARE SMALLER IN ACTUAL DIAMETER THAN BULBED CHERRYLOCK RIVETS (NAS1738 AND NAS1739) OF CORRESPONDING DASH NUMBERS WITH EXCEPTION OF NAS1097 RIVET HEAD CONFIGURATIONS.
- FOR OVERSIZE APPLICATION A CHERRYLOCK RIVET (NAS1398 OR NAS1399) CAN BE REPLACED BY A BULBED CHERRLOCK (NAS1738 OR NAS1739) OF THE SAME DASH NUMBER AND A BULBED CHERRY-LOCK CAN BE REPLACED BY THE NEXT HIGHER DASH NUMBER CHERRYLOCK RIVET.

OVERSIZE RIVETS
TABLE II

Fastener Codes - Rivets - RB211-524 Engines
Figure 2 (Sheet 3 of 3)

CODE	PART NUMBER	VENDOR	MATERIAL	DESCRIPTION
--	LGPL9SC-V	A	TITANIUM	130° FLUSH HEAD
--	LGPL9SP-V	A	TITANIUM	PROTRUDING HEAD
--	LGPL2SC-V	A	TITANIUM	100° FLUSH SHEAR HEAD
--	LGPL2SP-V	A	TITANIUM	PROTRUDING SHEAR HEAD

LIGHTWEIGHT GP PINS
TABLE I

NOTES

A HUCK MANUFACTURING CO.
900 WATSON CENTER RD.
CARSON, CA 90745

Fastener Code - Pins - RB211-524 Engines
Figure 3

100° FLUSH HEAD

CODE	PART NUMBER	VENDOR	MATERIAL	DESCRIPTION	COLLAR	1/64 IN. OVERSIZE PART NUMBER	1/32 IN. OVERSIZE PART NUMBER
AOW	HL13	A	TITANIUM, 160 KSI	TENSION HEAD, HEX-DRIVE	HL75 HL86 HL198 HL280	HL113	NONE LISTED
	HL15	A	STEEL, 156 KSI	SHEAR HEAD, HEX-DRIVE	HL288 HL574	HL215	HL715
ARR ALH ALS	HL41	A	CRES, 95 KSI	SHEAR HEAD, HEX-DRIVE	HL70 HL79 HL82 HL94 HL97 HL297	HL141	HL241
	HL641	A	CRES, 95 KSI	SHEAR HEAD, HEX-DRIVE 3/32 GRIP VARIATION	HL579 HL694	HL643	NONE LISTED
	HL49	A	CRES, 160 KSI	TENSION HEAD	HL75 HL78 HL86	HL249	NONE LISTED
	HL31	A	CRES, 125 KSI	SHEAR HEAD	HL70 HL79 HL82 HL94 HL97 HL297	HL67	NONE LISTED
	HL34	A	CRES, 125 KSI	SHEAR HEAD			

STANDARD AND OVERSIZE HI-LOK FASTENERS
TABLE I

Fastener Code - Threaded Fasteners - RB211-524 Engines
Figure 4 (Sheet 1 of 5)

PROTRUDING HEAD

CODE	PART NUMBER	VENDOR	MATERIAL	DESCRIPTION	COLLAR	1/65 IN. OVERSIZE PART NUMBER	1/32 IN. OVERSIZE PART NUMBER
NO VF ABE AAB	HL10	A	TITANIUM, 95 KSI	SHEAR HEAD, HEX-DRIVE	HL70 HL79 HL82 HL94 HL97 HL379	HL110	HL410
AOY	HL12	A	TITANIUM, 160 KSI	TENSION HEAD, HEX-DRIVE	HL75 HL86 HL198 HL280	HL112	NONE LISTED
SL	HL30	A	CRES, 125 KSI	SHEAR HEAD, HEX-DRIVE	HL70 HL79 HL82 HL94 HL97 HL175	HL66	HL58
ARV ALF ALR	HL40	A	CRES, 95 KSI	SHEAR HEAD, HEX-DRIVE	HL70 HL79 HL82 HL94 HL97 HL297	HL140	HL240
AKK	HL644	A	CRES, 125 KSI	TENSION HEAD, HEX-DRIVE	HL70 HL79 HL82 HL94 HL97 HL175	HL744	NONE LISTED
	HL48	A	CRES, 160 KSI	TENSION HEAD, HEX-DRIVE	HL75 HL78 HL86	HL248	NONE LISTED
	HL32	A	CRES, 125 KSI	TENSION HEAD, HEX-DRIVE	HL73 HL75 HL86 HL89 HL273	HL36	NONE LISTED

STANDARD AND OVERSIZE HI-LOK FASTENERS
TABLE I (CONT)

Fastener Code - Threaded Fasteners - RB211-524 Engines
Figure 4 (Sheet 2 of 5)

CODE	PART NUMBER	VENDOR	MATERIAL	DESCRIPTION	SLEEVE	COLLAR	1/65 IN. OVERSIZE PART NO.	1/32 IN. OVERSIZE PART NO.
	100° FLUSH HEAD PIN							
AAA	ASP-FF-DT	B	STEEL, 108 KSI	SHEAR HEAD PIN AND SLEEVE, CAD. PLATE	ASPF-S-DT	ASP-LC-2AC	OASPFF-DT	
	ASPF-DT	B	STEEL, 108 KSI	SHEAR HEAD PIN, PROTRUDING SLEEVE, CAD. PLATE	2ASP-S-DT	ASP-LC-2AC	OASPFP-DT	
	ASP100P-DT	B	STEEL, 108 KSI	SHEAR HEAD PIN, PROTRUDING SLEEVE, CAD. PLATE	2ASP-S-DT	ASP-LC-2AC	OASP100-DT	
XW	2ASPFF-DT	B	STEEL, 108 KSI	SHEAR HEAD PIN AND SLEEVE, CAD. PLATE	2ASPF-S-DT	ASP-LC-2AC	02ASPFF-DT	
	2ASP509F-DT	B	STEEL, 108 KSI	TENSION HEAD PIN AND SLEEVE, CAD. PLATE	2ASPF-S-DT	ASP-LC-2AC	02ASP509F-DT	
	2ASP509P-DT	B	STEEL, 108 KSI	TENSION HEAD, PROTRUDING SLEEVE, CAD. PLATE	2ASPP-S-DT	ASP-LC-2AC	02ASP509P-DT	
	PROTRUDING HEAD PIN							
	2ASPPF-DT	B	STEEL, 108 KSI	FLAT HEAD PIN, FLUSH SLEEVE, CAD. PLATE	2ASPP-S-DT	ASP-LC-2AC	02ASPPF-DT	

STANDARD AND OVERSIZE ASP FASTENERS
TABLE II

Fastener Code - Threaded Fasteners - RB211-524 Engines
Figure 4 (Sheet 3 of 5)

CODE	PART NUMBER	VENDOR	MATERIAL	DESCRIPTION	SLEEVE	COLLAR	1/65 IN. OVERSIZE PART NO.	1/32 IN. OVERSIZE PART NO.
	100° FLUSH HEAD CORE BOLT AND SLEEVE							
	BB301	A	CRES, 125 KSI	CORE BOLT				
	BB309	A	CRES, 95 KSI	CORE BOLT				
HE	BB351-8	A	CRES BOLT AND SLEEVE, 125 KSI	BLIND BOLT ASSEMBLY	BB321 BB321PB	BB341 BB341G BB341PB	BB321.64	BB321.32
HE	BB351-10	A	CRES BOLT AND SLEEVE, 125 KSI	BLIND BOLT ASSEMBLY	BB321 BB321PB	BB341 BB341G BB341PB	BB321.64	BB321.32
	NB1101	A	STEEL, 160 KSI, CAD. PLATE	CORE BOLT				
	NB1114	A	CRES, 160-180 KSI	CORE BOLT				
	PROTRUDING HEAD CORE BOLT AND SLEEVE							
	BB302	A	CRES, 125 KSI	CORE BOLT				
	BB352	A	CRES BOLT AND SLEEVE, 125 KSI	BLIND BOLT ASSEMBLY	BB322 BB322PB	BB341 BB341G BB341PB	BB322.64	BB322.32
	NB1102	A	STEEL, 160 KSI CAD. PLATE	CORE BOLT				

STANDARD AND OVERSIZE BLIND BOLTS
TABLE III

Fastener Code - Threaded Fasteners - RB211-524 Engines
Figure 4 (Sheet 4 of 5)

CODE	PART NUMBER	VENDOR	MATERIAL	DESCRIPTION	TENSILE STRENGTH	SHEAR STRENGTH
	NAS1581A		ALLOY STEEL	100° FLUSH SHEAR-HEAD BOLT	160-180 KSI	95-108 KSI
	NAS1581E		A286 CRES	100° FLUSH SHEAR-HEAD BOLT	160-180 KSI	95-108 KSI
	NAS1581V		6AL-4V TITANIUM	100° FLUSH SHEAR-HEAD BOLT	160-180 KSI	95-108 KSI

100° FLUSH REDUCED HEAD BOLT
TABLE IV

NOTES

- THE CODE USED IN THE FASTENER TABLES IN 51-42-01 TO IDENTIFY THE FASTENER VENDORS IS THE SAME AS THAT USED IN 51-40-01.

A HI-SHEAR CORPORATION
2600 SKYPARK DRIVE
TORRANCE, CALIFORNIA 90509

B HUCK MANUFACTURING CO.
900 WATSON CENTER RD
CARSON, CA 90745

Fastener Code - Threaded Fasteners - RB211-524 Engines
Figure 4 (Sheet 5 of 5)

GENERAL - FASTENER INSTALLATION AND REMOVAL - RB211-524 ENGINES

1. References

Reference	Title
51-40-02, GENERAL	Fastener Installation and Removal
51-40-04, GENERAL	Torque Values
51-42-01, GENERAL	Fastener Types - RB211-524 Engines
51-42-05, GENERAL	Fastener Hole Sizes - RB211-524 Engines
51-42-06, GENERAL	Fastener Edge Margins - RB211-524 Engines
51-42-08, GENERAL	Countersinking - RB211-524 Engines

2. Solid Shank Rivets

A. General

(1) The solid shank rivets that are used in RB211-524 engine nacelle inlet cowl, fan cowls, reverser cowl and integrated nozzle are made of titanium bi-metallic construction, monel, steels and aluminum alloys. Rivet part numbers have a suffix denoting the material, while the rivet head has identification marks. These materials are shown in Table 1/GENERAL:

Table 1: Rivet Part Number Suffix Designations

Material	Suffix	Head Marking
2024	DD	Two raised dashes
2117	AD	Dimple
5056	B	Raised cross
A286CRES	None	One raised dot
Ti/Co	B	Dimple and depressed dot
6AL-4VTi	None	Double dimple

(2) Rivets made from 2017, 2117 and 5056 aluminum alloy can be stored and used at room temperature.

(3) Rivets made from 2024 aluminum alloy must be heat-treated and then stored at a temperature of -10°F or lower. After removal from cold storage, the rivets must completely driven within 15 minutes. These rivets must not be returned to cold storage once they have been removed.

(4) Refer to 51-42-05, GENERAL for hole sizes.

(5) Refer to 51-42-08, GENERAL for details of countersinking.

B. Installation of Solid Rivets

(1) Solid rivets can be installed by the use of a rivet gun and bucking bar or a suitable squeeze riveting tool. Rivet guns and bucking bars must be large enough to drive the rivets quickly. Three or four seconds driving duration is the optimum, while 7 seconds must be the maximum. Avoid overdriving rivets as this can cause diagonal cracks. Bucking bars must have very smooth driving faces, especially when driving the harder 2017 aluminum alloy rivets. Monel rivets generally require heavy, slow speed rivet guns and heavier bucking bars than those used on equivalent size aluminum rivets.

(2) Refer to Figure 1/GENERAL, Tables I, II and III for grip length ranges, shank projection before driving and driven head sizes for solid MS20615, MS20470, CSR902B, CSR903B, NAS1097, NAS1199 and NAS1200 rivets.

(3) Refer to Figure 1/GENERAL, Table I for grip length ranges for CSR922, and CSR924 and CSR925 rivets.

(4) Refer to Figure 1/GENERAL, Table II for CSR902B, CSR903B, CSR922, CSR924 and CSR925 rivet installation, equipment and pressures.

C. Fastener Corrosion Protection

(1) Appplication

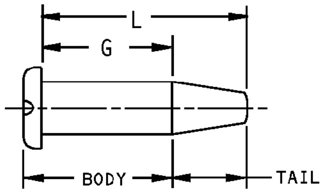
(a) Install fasteners with PR1431G (refer to Figure 1/51-32-03, GENERAL) sealant, a two part polysulfide compound soluble chromates.

(2) Curing

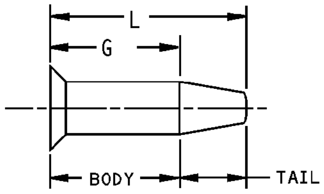
(a) Compound will cure at room temperature.

D. Refer to 51-40-02, GENERAL for cracks in driven heads.

E. Refer to Figure 22/51-40-02, GENERAL for solid shank rivet removal.



CSR925
PROTRUDING HEAD RIVET



CSR922 AND CSR924
FLUSH HEAD RIVET

PART NUMBER EXAMPLE:

CSR922 -6 -4 R
- R — HALF SIZE
- -4 — GRIP DASH NUMBER
- -6 — DIAMETER DASH NUMBER
- CSR922 — MS20426 FLUSH HEAD, 6AL-4V TI BODY WITH TI/CB TAIL

CSR924 -6 -4 R
- R — HALF SIZE
- -4 — GRIP DASH NUMBER
- -6 — DIAMETER DASH NUMBER
- CSR924 — NAS1097 FLUSH HEAD, 6AL-4V TI BODY WITH TI/CB TAIL

GRIP RANGE		G +.015	-5 (5/32)		-6 (3/16)		-8 (1/4)	
MIN.	MAX.	-.000	DASH NO.	L ±.010	DASH NO.	L ±.010	DASH NO.	L ±.010
0.094	0.125	0.093	5-2R	0.298				
0.126	0.156	0.125	5-3	0.330	6-3	0.347		
0.157	0.187	0.156	5-3R	0.361	6-3R	0.378	8-3R	0.423
0.188	0.218	0.187	5-4	0.392	6-4	0.410	8-4	0.455
0.219	0.250	0.218	5-4R	0.423	6-4R	0.441	8-4R	0.486
0.251	0.281	0.250	5-5	0.455	6-5	0.472	8-5	0.517
0.282	0.312	0.281	5-5R	0.486	6-5R	0.503	8-5R	0.548
0.313	0.343	0.312	5-6	0.517	6-6	0.535	8-6	0.580
0.344	0.375	0.343	5-6R	0.548	6-6R	0.566	8-6R	0.611
0.376	0.406	0.375	5-7	0.580	6-7	0.597	8-7	0.642
0.407	0.437	0.406	5-7R	0.611	6-7R	0.628	8-7R	0.673
0.438	0.468	0.437	5-8	0.642	6-8	0.660	8-8	0.705
0.469	0.500	0.468	5-8R	0.673	6-8R	0.691	8-8R	0.736
0.501	0.531	0.500	5-9	0.705	6-9	0.722	8-9	0.767
0.532	0.562	0.531	5-9R	0.736	6-9R	0.753	8-9R	0.798
0.563	0.593	0.562	5-10	0.767	6-10	0.785	8-10	0.830
0.594	0.625	0.593	5-10R	0.798	6-10R	0.816	8-10R	0.861
0.626	0.656	0.625	5-11	0.830	6-11	0.847	8-11	0.892
0.657	0.687	0.656	5-11R	0.861	6-11R	0.878	8-11R	0.923
0.688	0.718	0.687	5-12	0.892	6-12	0.910	8-12	0.955
0.719	0.750	0.718	5-12R	0.923	6-12R	0.941	8-12R	0.986
0.751	0.781	0.750	5-13	0.955	6-13	0.972	8-13	1.017
0.782	0.812	0.781	5-13R	0.986	6-13R	1.003	8-13R	1.048
0.813	0.843	0.812	5-14	1.017	6-14	1.035	8-14	1.080
0.844	0.875	0.843	5-14R	1.048	6-14R	1.066	8-14R	1.111
0.876	0.906	0.875	5-15	1.080	6-15	1.097	8-15	1.142
0.907	0.937	0.906	5-15R	1.111	6-15R	1.128	8-15R	1.173
0.938	0.968	0.937	5-16	1.142	6-16	1.160	8-16	1.205
0.969	1.000	0.968	5-16R	1.173	6-16R	1.191	8-16R	1.236

UNDRIVEN LENGTH AND GRIP RANGES FOR CSR922,CSR924 AND CSR925 RIVETS
TABLE I

Installation of Cherry Buck Rivets - RB211-524 Engines
Figure 1 (Sheet 1 of 3)

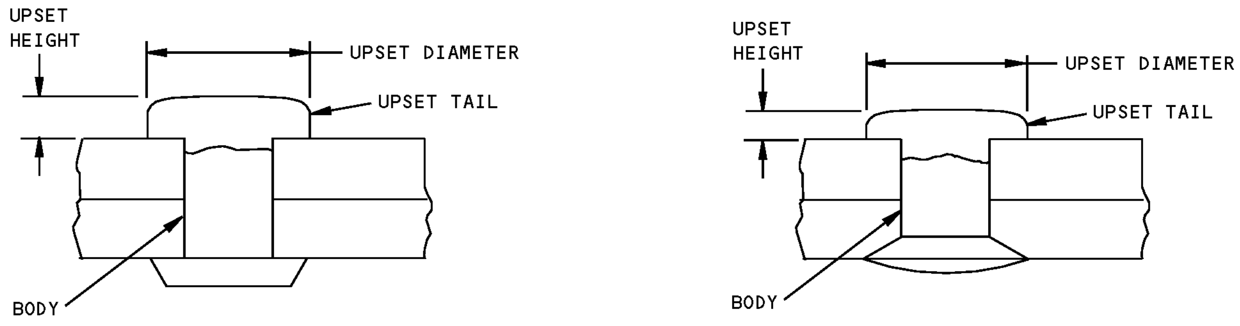
NOMINAL FASTENER DIAMETER	TYPICAL SQUEEZE LOAD (LBS.) [C]	RECOMMENDED RIVET HAMMERS [A]				BUCKING BAR WEIGHTS (LBS.)
		JIFFY	INGERSOLL RAND	CHICAGO PNEUMATIC	CLEVELAND PNEUMATIC	
3/32	1200	100	AVC10	Q-Y	E2	1-2
1/8	2150	200	AVC11	2X	E2	2-3
5/32	3700	300	AVC12	4XB	E4	3-5
3/16	5000	400	AVC13	5XB	E5	5-8
1/4	8600	400	AVC24	9XB	G5	8-12
5/16	15200	[B]	[B]	[B]	[B]	[B]
3/8	22000	[B]	[B]	[B]	[B]	[B]

RIVET INSTALLATION EQUIPMENT AND PRESSURES FOR CSR902B,CSR903B,
CSR922,CSR924 AND CSR925 RIVETS
TABLE II

NOMINAL DIAMETER	MIN. UPSET DIAMETER 1.3D	MIN. UPSET HEIGHT	
		CHERRY BUCK [D]	E-Z BUCK [E]
3/32	0.122	___	0.028
1/8	0.163	___	0.038
5/32	0.213	0.056	0.049
3/16	0.246	0.065	0.057
1/4	0.325	0.085	___
5/16	0.408	0.106	___
3/8	0.488	0.128	___

MINIMUM UPSET HEIGHT FOR CHERRY BUCK AND E-Z BUCK RIVETS
TABLE III

Installation of Cherry Buck Rivets - RB211-524 Engines
Figure 1 (Sheet 2 of 3)



NOTES

- A HAMMER SELECTION IS BASED ON 70-90 PSI AIR LINE PRESSURE
- B SQUEEZE ONLY
- C VALUES INDICATE TYPICAL LOADS REQUIRED TO ACHIEVE 1.3D UPSET DIAMETER AND APPLY TO CHERRY BUCK IN MAXIMUM GRIP AND E-Z BUCK WITH 1.0D INITIAL PROTRUSION. SQUEEZE LOADS ARE GUIDELINES AND MAY BE VARIED AS REQUIRED
- D CHERRY BUCK MIN. UPSET HEIGHT = 0.34D
- E E-Z BUCK MIN. UPSET HEIGHT = 0.3D

Installation of Cherry Buck Rivets - RB211-524 Engines
Figure 1 (Sheet 3 of 3)

3. Blind Rivets

A. General

(1) The blind rivets that are used in RB211-524 engine nacelle inlet cowl, fan cowls, and integrated nozzle assembly are made of aluminum alloy, Monel, A286CRS and steel.

(2) Refer to 51-42-01, GENERAL for limitations on the use of blind rivets.

(3) Refer to 51-42-05, GENERAL for hole sizes.

(4) Refer to 51-42-08, GENERAL for details of countersinking.

(5) Refer to Figure 2/GENERAL, Table I for grip length ranges for blind rivets.

B. Installation

(1) Blind rivets are installed with special tools usually supplied by the fastener manufacturer listed in 51-42-06, GENERAL.

NOTE: Blind rivets are supplied with different spindle configurations, full and partial serrations. Rivets having different spindle configurations cannot be installed with the same pulling head.

(2) Refer to Figure 2/GENERAL, Table II for installation of Cherrymax CR3522, CR3523, CR3552 and CR3553 rivets.

(3) Check that rivet stem and collar protrusions are within limits shown in Figure 2/GENERAL, Table III and IV.

S7B100T RIVET		
GRIP DASH NO.	GRIP RANGE	
	MIN.	MAX.
04	0.219	0.282
06	0.334	0.407
08	0.469	0.532
09	0.531	0.595
14	0.844	0.907
15	0.906	0.970
16	0.969	1.032
17	1.031	1.095
18	1.066	1.157
24	1.469	1.532

CCR264,CCR274,CR2164,CR2564,CR2664 NAS1738,NAS1739,NAS1398 AND NAS1399 RIVETS		
GRIP RANGE		GRIP DASH NO.
MIN.	MAX.	
0.126	0.187	-3
0.188	0.250	-4
0.251	0.312	-5
0.313	0.375	-6
0.376	0.437	-7
0.438	0.500	-8
0.501	0.562	-9
0.563	0.625	-10
0.626	0.687	-11

S4B100T RIVET		
GRIP DASH NO.	GRIP RANGE	
	MIN.	MAX.
03	0.125	0.188
04	0.187	0.251
05	0.250	0.313
06	0.312	0.376
07	0.375	0.438
08	0.437	0.501
09	0.500	0.563
10	0.562	0.626
11	0.625	0.688
12	0.687	0.751

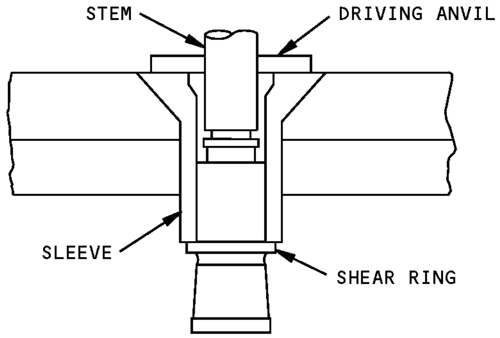
CR3522 RIVET	
FLUSH HEAD	
DASH NO.	MIN. GRIP
-4	0.063
-5	0.065
-6	0.080

CR3552 RIVET	
FLUSH HEAD	
DASH NO.	MIN. GRIP
-4	0.045
-5	0.063
-6	0.073

CR3523 AND CR3553 RIVETS	
FLUSH HEAD	
DASH NO.	MIN. GRIP
-4	0.025
-5	0.031
-6	0.037

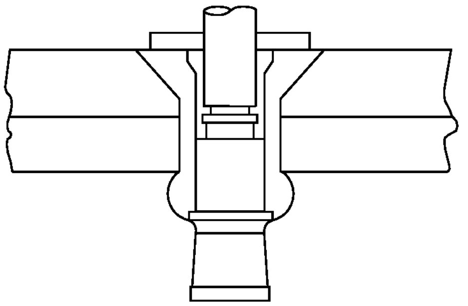
GRIP LENGTH RANGES - BLIND RIVETS
TABLE I

Installation of Blind Rivets - RB211-524 Engines
Figure 2 (Sheet 1 of 4)



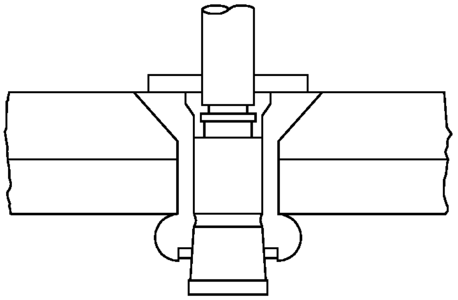
RIVET INSERTED INTO PREPARED ATTACH HOLE. PULLING SERRATIONS OF STEM ENGAGED IN JAWS OF PULLING HEAD.

STEP A



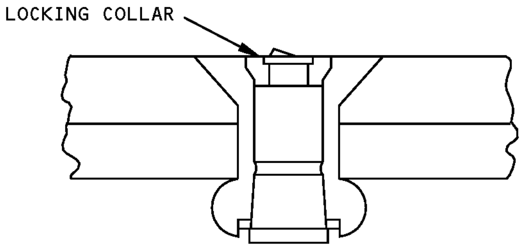
STEM IS PULLED INTO RIVET SLEEVE AND STARTS TO FORM A LARGE BULBED BLIND HEAD.

STEP B



SHEAR RING SHEARS FROM CONE TO ALLOW STEM TO PULL FURTHER INTO RIVET SLEEVE.

STEP C



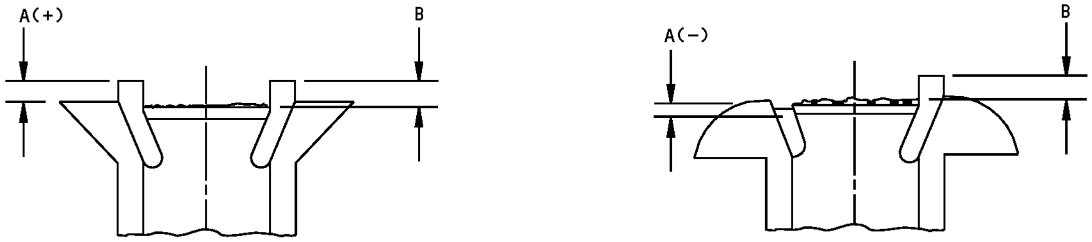
UPSET COMPLETED WITH FRACTURE OF STEM. LOCKING COLLAR IS IN COLLAR RECESS LOCKING STEM AND SLEEVE TOGETHER.

STEP D

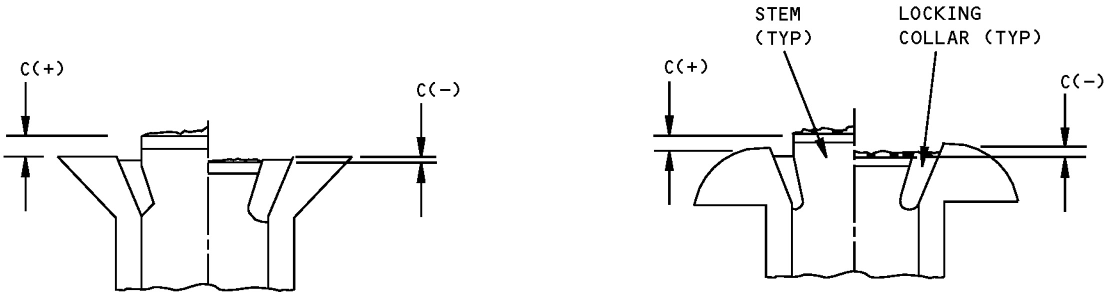
CHERRYMAX RIVET UPSET SEQUENCE

INSTALLATION OF CR3522, CR3523, CR3552 AND CR3553 RIVETS
TABLE III

Installation of Blind Rivets - RB211-524 Engines
Figure 2 (Sheet 2 of 4)



LOCKING COLLAR PROTRUSION LIMITS



STEM PROTRUSION LIMITS

A = MAXIMUM ALLOWABLE DISTANCE OF LOCKING COLLAR ABOVE (+) OR BELOW (-) FASTENER HEAD

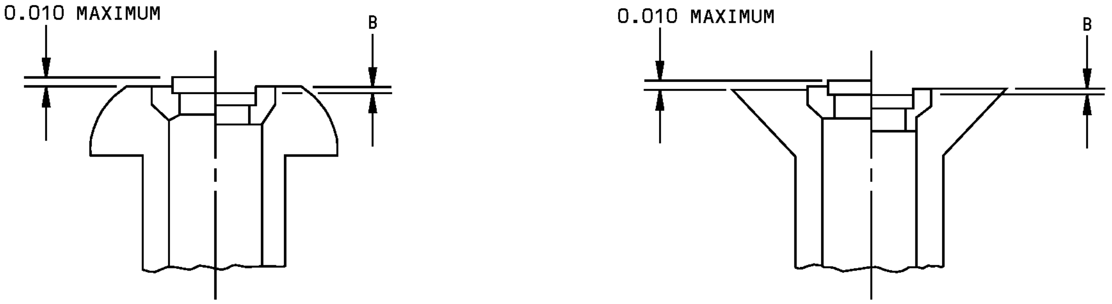
B = MAXIMUM ALLOWABLE DISTANCE OF LOCKING COLLAR ABOVE TOP LAND ON STEM

C = MAXIMUM ALLOWABLE DISTANCE OF TOP OF LAND ON STEM ABOVE (+) OR BELOW (-) FASTENER HEAD

STEM AND COLLLAR PROTRUSION LIMITS FOR NAS1398,NAS1399, NAS1738,NAS1739,CR2164,CR2564,CR2664 RIVETS				
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

CHERRYLOCK RIVET STEM AND COLLAR FLUSHNESS LIMITS
TABLE III

Installation of Blind Rivets - RB211-524 Engines
Figure 2 (Sheet 3 of 4)



RIVET DIA.	-4	-5	-6
B MAX.	0.015	0.020	0.020

RIVET STEM AND COLLAR FLUSHNESS LIMITS FOR CHERRYMAX RIVETS
CR3522,CR3523,CR3552 AND CR3553

TABLE IV

Installation of Blind Rivets - RB211-524 Engines
Figure 2 (Sheet 4 of 4)

4. Blind Bolts

CAUTION: BLIND BOLTS ARE NOT TO BE USED WHERE THEY COULD ENTER AN ENGINE AIR INTAKE IF THEY BECOME LOOSE.

A. General

(1) BB301, BB302, BB309, BB351, NB1101, NB1114 flush head and NB1102 protruding head blind bolts are approved for use in the RB211-524 engine nacelle.

(2) For temperature consideration, stainless steel blind bolts (e.g., BB351 or BB352) serve for general purpose use to 450°F (232°C).

(3) Refer to 51-42-05, GENERAL for hole sizes.

(4) Refer to 51-42-08, GENERAL for details of countersinking.

B. Installation

(1) Install blind bolts with special tools, usually supplied by the fastener manufacturer listed in 51-42-01.

(2) Install the bolt sleeve and expander on the gun mandrel and insert into hole. Push gun control button to pull the expander into the sleeve, wedging the sleeve into the hole.

C. Removal

(1) Drill the sleeve to a depth slightly beyond the head diameter using a drill diameter slightly smaller than that of the sleeve. Use moderate pressure when drilling to prevent turning of the sleeve.

(2) Pry off the head and drive out the sleeve, using a punch with a diameter slightly smaller than that of the sleeve.

5. Hex-drive Bolts

A. General

(1) A hex-drive bolt is a threaded fastener usually installed with a special nut consisting of a one-piece collar and hexagonal torquing device. The hexagonal torquing device breaks off at a predetermined load, thus eliminating the need for torque loading. Bolts and collars are factory lubricated and must not be degreased.

(2) Refer to 51-42-05, GENERAL for hole sizes.

(3) Refer to 51-42-08, GENERAL for details of countersinking.

B. Installation

(1) The bolts can be installed with power or hand tools. For repair purposes hand tools will normally be used as follows:

  (a) Insert the pin into the hole until the head is seated.

  (b) Screw collar on finger-tight.

  (c) Prevent pin from turning with a hexagonal key in the recess provided and tighten the collar with a modified ratchet and socket or a box wrench until the wrenching device is torqued off. Refer to 51-40-02, GENERAL, Figure 10 for installation.

(2) Where access is not available for the installation of the special nut, it is permissible to use BACN10JC for locknuts for shear head Hi-Lok bolts or BACN10GW for tension head Hi-Lok bolts assembled with a 0.062-inch thick standard washer. See 51-40-02, GENERAL, Figure 8 for criteria to be used in selection of washer material. Refer to 51-40-04, GENERAL for torque values.

(3) After the collar is installed check for the following:

  (a) Pin protrusion limits according to51-40-02, GENERAL Figure 10.

C. Removal

(1) Hex-drive bolts are removed by inserting a hexagonal key in the pin and gripping and turning the collar with locking pliers.

6. ASP Threaded Fasteners

A. General

(1) Threaded fasteners used in RB211-524 engine nacelle are ASPFF, 2ASPFF, ASPFP, 2ASPFP, ASP100P, 2ASP509F, 2ASPFP509P. The pins and sleeves are made of steel with cadmium plate.

(2) Refer to 51-42-05, GENERAL for hole sizes.

(3) Refer to 51-42-08, GENERAL for details of countersinking.

(4) Refer to Figure 3/GENERAL, Table V for grip length ranges.

B. Installation

(1) Threaded fasteners are installed with special tools usually supplied by the fastener manufacturer listed in 51-42-01, GENERAL.

  (a) Insert pin from one side of work.

  (b) Place sleeve over pintail and torque into position against work.

  (c) Place lock collar over pintail.

  (d) Place installation tool on pintail and form collar into recess to lock sleeve on pin.

(2) Check that pin protrusion and collar height are within limits shown in Figure 4/GENERAL, Tables I and II.

C. Removal

(1) Refer to Figure 5/GENERAL, Table I for threaded fastener lock removal.

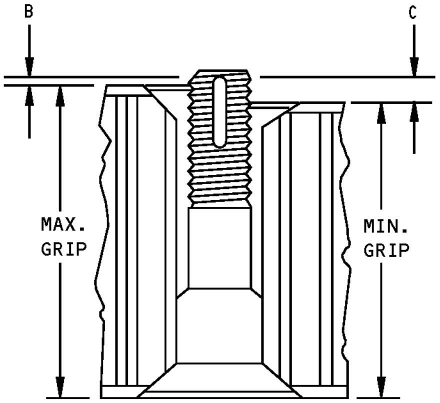
GRIP NUMBER	GRIP RANGE		GRIP NUMBER	GRIP RANGE	
	MIN.	MAX.		MIN.	MAX.
05	0.251	0.312	19	1.126	1.188
06	0.313	0.375	20	1.189	1.250
07	0.376	0.438	21	1.251	1.312
08	0.439	0.500	22	1.313	1.375
09	0.501	0.562	23	1.376	1.438
10	0.563	0.625	24	1.439	1.500
11	0.626	0.688	25	1.501	1.562
12	0.689	0.750	26	1.563	1.625
13	0.751	0.812	27	1.626	1.688
14	0.813	0.875	28	1.689	1.750
15	0.876	0.938	29	1.751	1.812
16	0.939	1.000	30	1.813	1.875
17	1.001	1.062	31	1.876	1.938
18	1.063	1.125	32	1.939	2.000

GRIP LENGTH FOR ASP THREADED FASTENERS
ASPFF,2ASPFF,ASPFP,2ASPFP,ASP100P,2ASP509F,2ASPFP509P
TABLE I

NOTE

- ASP FASTENERS = ADJUSTABLE CLAMPING FORCE POSITIVE LOCK FASTENERS USED PRIMARILY IN HONEYCOMB SANDWICH CONSTRUCTION

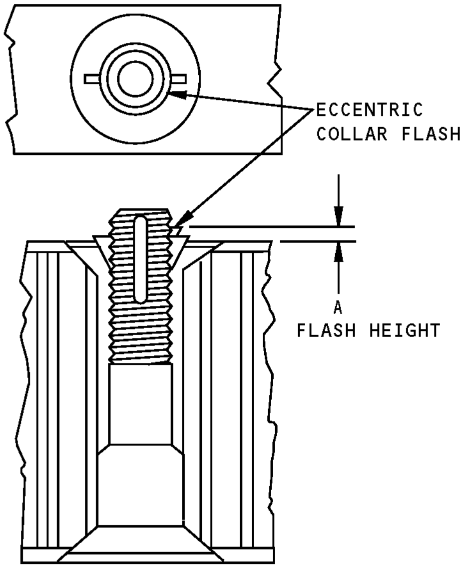
ASP Fastener Grip Range - RB211-524 Engines
Figure 3



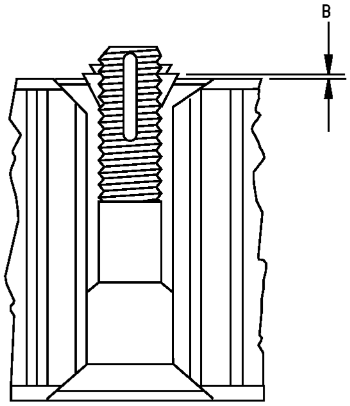
PIN PROTRUSION

FASTENER DIAMETER	B MIN. PIN PROTRUSION ABOVE SLEEVE	C MAX. PIN PROTRUSION ABOVE SLEEVE
13/64 (6)	0.020"	0.107"
17/64 (8)	0.030"	0.119"
21/64 (10)	0.035"	0.129"

ASP PIN PROTRUSION
TABLE I



COLLAR/FLASH HEIGHT

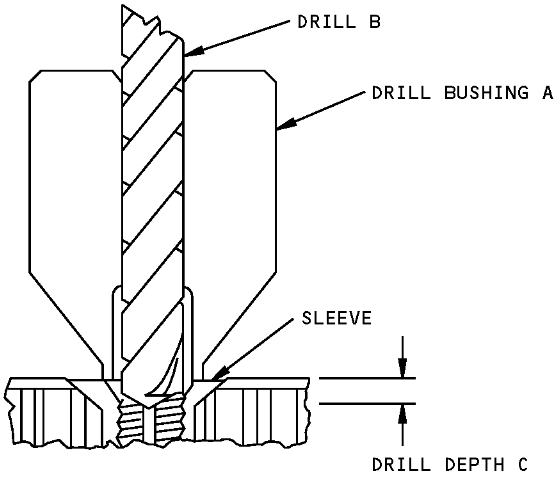


COLLAR HEIGHT

FASTENER DIAMETER	A MAX. FLASH HEIGHT (Widest Point)	B MAX. COLLAR HEIGHT (Not Including Flash)
13/64 (6)	0.020	0.010
17/64 (8)	0.030	0.013
21/64 (10)	0.040	0.016

ASP COLLAR HEIGHT
TABLE II

Pin Protrusion and Collar Height Limits for ASP Threaded Fasteners - RB211-524 Engines
Figure 4



FASTENER DIAMETER	A DRILL BUSHING HUCK P/N	B DRILL DIAMETER	C DRILL DEPTH
13/64 (6)	103617	0.1562	3/64"
17/64 (8)	103618	0.1875	1/16"
21/64 (10)	103619	0.2280	5/64"

ASP FASTENER LOCK REMOVAL
TABLE I

ASP Threaded Fastener Lock Removal - RB211-524 Engines
Figure 5

GENERAL - FASTENER SUBSTITUTION - RB211-524 ENGINES

1. General

A. The edge distance and spacing for the substitute fastener must be the same as the original attachment.

B. Substitutions must be made on a basis of the same size and grip length.

C. When pull-type lockbolts cannot be installed due to tool clearance, a short pintail lockbolt is the preferred substitution. If the short pintail lockbolt cannot be installed, a Hi-Lok can be substituted if an interference-fit hole is required; a bolt must be substituted if a clearance-fit hole is required. When bolts or Hi-Loks are used on a substitution basis, they must be used with self-aligning nuts.

D. Refer to Figure 1/GENERAL, Table 1, for substitution for Hi-Lok fasteners which are used only on RB211-524 engine nacelle. When the required grip length for a Hi-Lok is not obtainable, the next grip length can be used and a spacer/washer must be used under the collar or nut.

E. Substitute steel fasteners can be used for steel or titanium blts specified in the applicable figure, provided they are of equivalent or greater strength. Tension type fasteners are designed for use in tension and shear applications, but it is not acceptable to use shear fasteners in tension.

F. Substitution of rivets can be made provided proper consideration is given to the type, size, head style (flush or nonflush), features (standard or minimum pin clearance) and material.

FASTENER	EQUIVALENT
HL10	HL40
HL12	HL48
HL13	HL49
HL15	NOT AVAILABLE
HL30	HL644
HL40	HL10
HL41	HL641

HI-LOK FASTENERS SUBSTITUTION
TABLE I

Equivalent Fastener Substitution Data RB211-524 Engines
Figure 1

GENERAL - TORQUE VALUES - RB211-524 ENGINES

1. General

A. Torque values for nut tightening and bolt tightening are the same for RB211-524 engine nacelle inlet cowls, fan cowls, reverser cowl and integrated nozzle as those given in 51-40-04 for standard hexagonal and 12-point-head bolts and nuts.

B. Hi-Lok pins (bolts) are threaded fasteners which use a threaded drive collar with a hexagonal drive section which shears or breaks off when the proper wrenching torque is applied. Where access is not available for installation of a hex-drive collar, standard locknuts can be used and torqued to the values shown in 51-40-04, GENERAL, Figure 1, Table IV, for hex-drive bolts used in both the RB211-524 engine nacelle and the Boeing 747-400 airplane. For Hi-Lok bolts, used on the RB211-524 engine nacelle, refer to Figure 1/GENERAL, Table I.

C. Torque values for the installation of ASP fastener pins and sleeves are given in Figure 1/GENERAL, Table II.

D. Refer to Figure 1/GENERAL, Table III, for core bolt torque values for blind bolts used in the RB211-524 engine nacelle.

2. References

Reference	Title
51-40-04, GENERAL	Torque Values

3. Torque Wrench Adapters and Extensions

A. The use of torque wrench adapters and/or extensions is limited to those applications where the torque wrench cannot be applied directly.

B. When an adapter or extension is used with a torque wrench, a correction must be made to the torque reading obtained. If the centerline of the adapter or extension aligns with the centerline of the torque wrench (in a straight line), the correction to the torque wrench reading can be made as shown in 51-40-04, GENERAL, Figure 2 . If the adapter or extension centerline must misalign with centerline of the torque wrench in order to obtain the rotation required, the correction to the reading must be made as shown in Figure 2/GENERAL.

FASTENER DIAMETER AND THREAD SIZE		TORQUE (POUND-INCH)					
		LOCKNUT	LOCKNUT	LOCKNUT	LOCKNUT	LOCKNUT	LOCKNUT
		BACN10JC BACN10GW	BACN10GW	BACN10GW	BACN10JC BACN10GW	BACN10GW	BACN10GW
		100° COUNTERSUNK HEAD			PROTRUDING HEAD		
DIA. (IN.)	THD. PER INCH	SHEAR TYPE HI-LOK BOLTS		TENSION TYPE HI-LOK BOLTS	SHEAR TYPE HI-LOK BOLTS		TENSION TYPE HI-LOK BOLTS
		HL-41 HL-641	HL-15	HL-13 HL-49	HL-10 HL-40	HL-30	HL-12 HL-48 HL-644
5/32	32	7	10	10	7	10	10
3/16	32	12	16	16	12	16	16
1/4	28	26	26	26	26	26	26
5/16	24	40	40	40	40	40	40
3/8	24	50	50	50	50	50	50
7/16	20	70	70	70	70	70	70
1/2	20	100	100	100	100	100	100

TORQUE VALUES FOR LOCKNUTS ON HI-LOK BOLTS
TABLE I

Torque Values - RB211-524 Engines
Figure 1 (Sheet 1 of 3)

FASTENER DIAMETER		TORQUE RANGE (POUND-INCH)	
NOMINAL (IN.)	DASH NO.	MINIMUM	MAXIMUM
13/64	-6	10	20
17/64	-8	20	30
21/64	-10	30	40

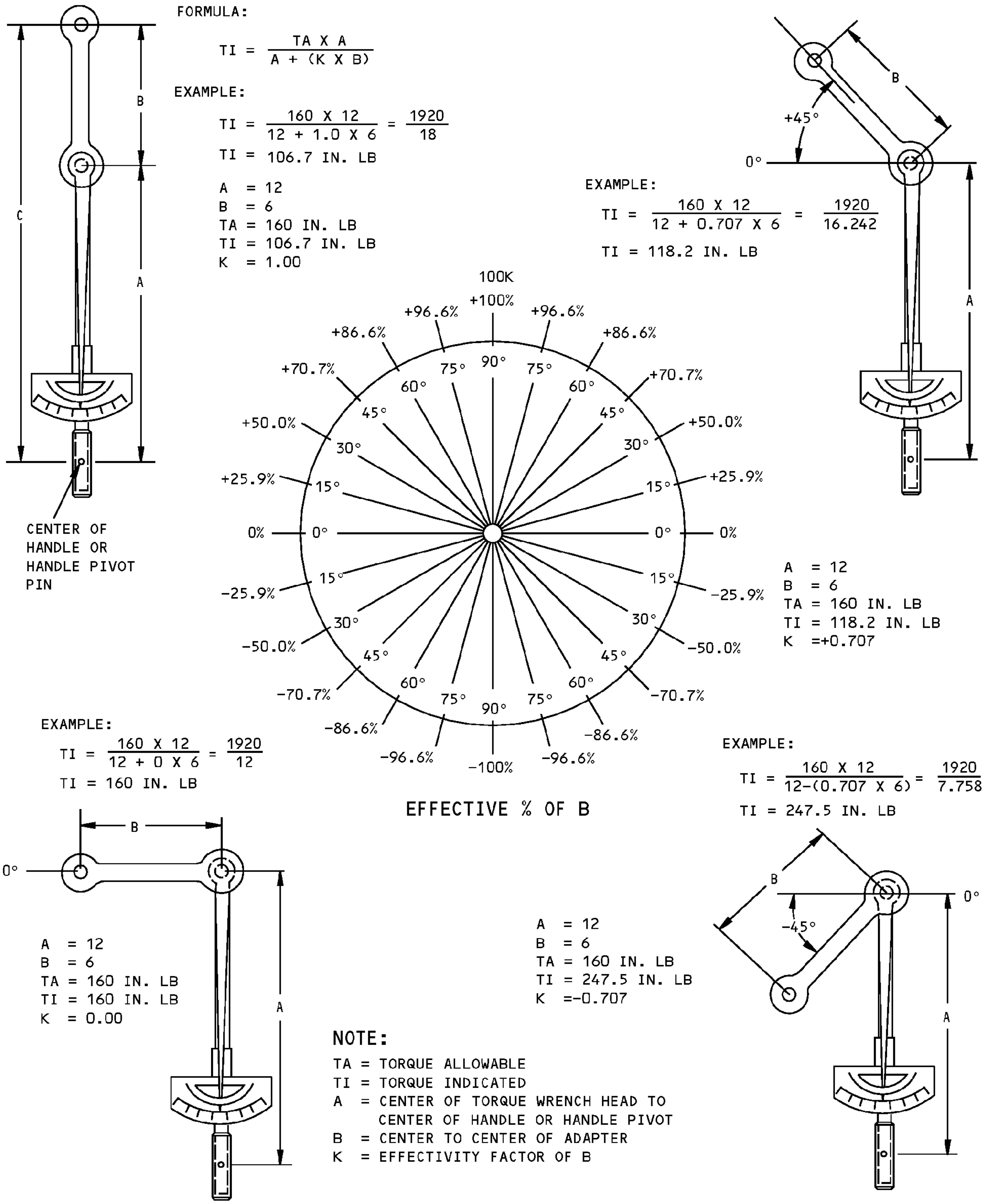
TORQUE VALUES FOR ASP FASTENERS
TABLE II

Torque Values - RB211-524 Engines
Figure 1 (Sheet 2 of 3)

CORE BOLT SHANK DIAMETER AND THREAD SIZE				TORQUE RANGE (POUND-INCH)		
				COUNTERSUNK HEAD FASTENER CORE BOLT		PROTRUDING HEAD FASTENER CORE BOLT
DASH NO.	NOM. DIA. (IN.)	SHANK DIA. (IN.)	THD PER INCH	BB309 (95 KSI)	BB301 (125 KSI)	BB302 (125 KSI)
-5	5/32	0.1120	40	4-5	7-9	7-9
-6	3/16	0.1240	40	5-7	9-11	9-11
-8	1/4	0.1650	32	9-12	15-19	15-19
-10	5/16	0.2180	28	16-20	27-34	27-34
-12	3/8	0.2490	28	21-26	35-44	35-44
-14	7/16	0.3110	24	33-41	55-69	55-69
-16	1/2	0.3740	24	48-60	80-99	80-99
					NB1101 (160 KSI)	NB1102 (160 KSI)
-5		0.1120	40		16-17	—
-6		0.1375	32		24-26	24-26
-8		0.1635	32		33-37	33-37
-1032		0.1895	32		45-50	45-50
-12		0.2495	28		80-100	80-100
-14		0.3120	24		145-200	145-200
-16		0.3745	24		240-280	240-280
-720		0.4370	20		650-720	—
-820		0.4995	20		700-1000	—
					NB1114 (160-180 KSI)	
-5		0.1993	32		45-50	

TORQUE VALUES FOR BLIND BOLT FASTENER CORE BOLTS
TABLE III

Torque Values - RB211-524 Engines
Figure 1 (Sheet 3 of 3)



FORMULA:

$$TI = \frac{TA \times A}{A + (K \times B)}$$

EXAMPLE:

$$TI = \frac{160 \times 12}{12 + 1.0 \times 6} = \frac{1920}{18}$$

TI = 106.7 IN. LB

A = 12
B = 6
TA = 160 IN. LB
TI = 106.7 IN. LB
K = 1.00

EXAMPLE:

$$TI = \frac{160 \times 12}{12 + 0.707 \times 6} = \frac{1920}{16.242}$$

TI = 118.2 IN. LB

A = 12
B = 6
TA = 160 IN. LB
TI = 118.2 IN. LB
K =+0.707

EXAMPLE:

$$TI = \frac{160 \times 12}{12 + 0 \times 6} = \frac{1920}{12}$$

TI = 160 IN. LB

A = 12
B = 6
TA = 160 IN. LB
TI = 160 IN. LB
K = 0.00

EXAMPLE:

$$TI = \frac{160 \times 12}{12-(0.707 \times 6)} = \frac{1920}{7.758}$$

TI = 247.5 IN. LB

A = 12
B = 6
TA = 160 IN. LB
TI = 247.5 IN. LB
K =-0.707

EFFECTIVE % OF B

CENTER OF HANDLE OR HANDLE PIVOT PIN

NOTE:

TA = TORQUE ALLOWABLE
TI = TORQUE INDICATED
A = CENTER OF TORQUE WRENCH HEAD TO CENTER OF HANDLE OR HANDLE PIVOT
B = CENTER TO CENTER OF ADAPTER
K = EFFECTIVITY FACTOR OF B

Torque Wrench Adapter Correction Factor - RB211-524 Engines
Figure 2

GENERAL - FASTENER HOLE SIZES - RB211-524 ENGINES

1. References

Reference	Title
51-40-05, GENERAL	Fastener Hole Sizes

2. General

A. Hole sizes for rivets, bolts, lockbolts and Hi-Lock bolts shown in 51-40-05, GENERAL, Figure 1 are usable for those fasteners which are common to the RB211-524 structures for inlet cowl, fan cowls, reverser cowl and integrated nozzle and to the Boeing 767 airplane. Hole sizes for rivets, fastener pins and threaded fastener pins and sleeves which are used only on the RB211-524 engine nacelle structures are given in Figure 1/GENERAL, Tables 1 to VIII.

B. Hole sizes for standard solid shank aluminum, titanium, CRES steel, and Monel rivets are given in Figure 1/GENERAL, Table I.

C. Hole sizes for CSR902, CSR903 (E-Z Buck) rivets and CSR922, CSR924, CSR925 (Cherry-Buck) rivets are given in Figure 1/GENERAL, Table II.

D. Hole sizes for low-profile shear head alloy steel blind bolts are given in Figure 1/GENERAL, Table III.

E. Hole sizes for Cherry-Lock blind rivets are given in Figure 1/GENERAL, Table IV, and hole sizes for Cherry-Max blind rivets are given in Figure 1/GENERAL, Table V.

F. Hole sizes for Hi-Shear blind bolts are given in Figure 1/GENERAL, Table VI.

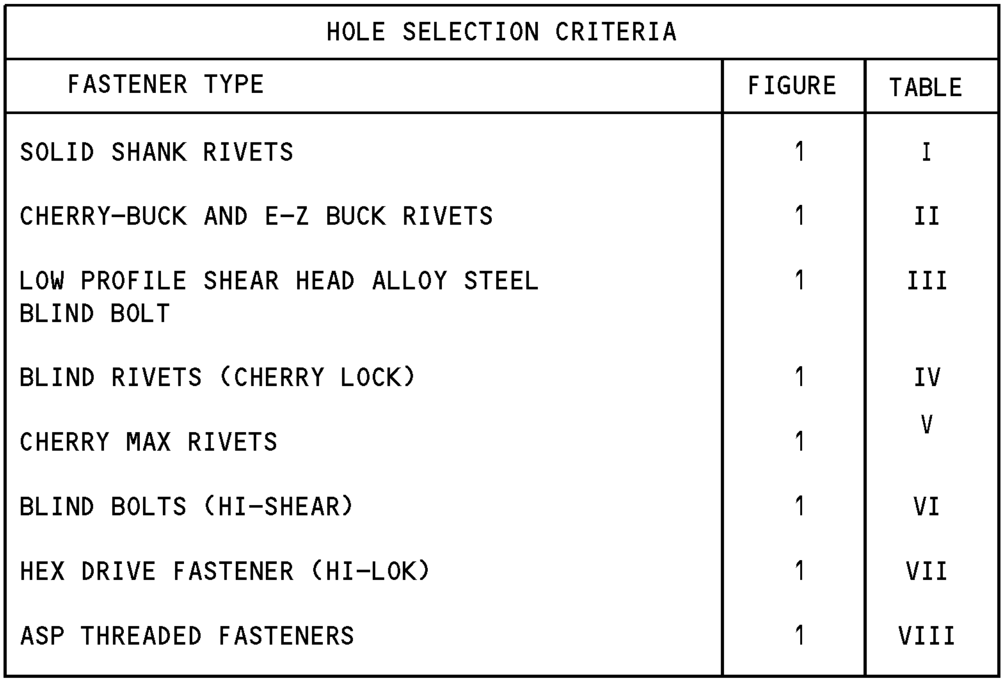
G. Hole sizes for the hexagon drive fasteners (Hi-Lok) bolts which are used on the RB211-524 engine nacelle are given in Figure 1/GENERAL, Table VII.

H. Hole sizes for Huck ASP (adjustable clamping force positive lock) threaded fasteners are given in Figure 1/GENERAL, Table VIII.

I. Refer to 51-40-05, GENERAL, Figure 2 for surface defect criteria for fastener holes.

J. Refer to 51-42-08 for countersinking and fillet relief for fastener holes of fasteners used only on the RB211-524 engine nacelle.

K. Refer to Figure 1 (Sheet 7), Detail I for fastener hole perpendicularity requirements.



HOLE SELECTION CRITERIA

FASTENER TYPE	FIGURE	TABLE
SOLID SHANK RIVETS	1	I
CHERRY-BUCK AND E-Z BUCK RIVETS	1	II
LOW PROFILE SHEAR HEAD ALLOY STEEL BLIND BOLT	1	III
BLIND RIVETS (CHERRY LOCK)	1	IV
CHERRY MAX RIVETS	1	V
BLIND BOLTS (HI-SHEAR)	1	VI
HEX DRIVE FASTENER (HI-LOK)	1	VII
ASP THREADED FASTENERS	1	VIII

Fastener Hole Sizes - RB211-524 Engines
Figure 1 (Sheet 1 of 7)

DASH NO.	NOMINAL DIAMETER	ACTUAL RIVET DIAMETER	HOLE DIAMETER LIMITS			
			STANDARD		0.0156 IN. OVERSIZE	
			MIN.	MAX.	MIN.	MAX.
-3	0.0937	0.094 +.003 -.001	0.098	0.103	---	---
-4	0.1250	0.125 +.003 -.001	0.128	0.135	---	---
-5	0.1562	0.156 +.004 -.001	0.159	0.171	---	---
-6	0.1875	0.187 +.004 -.001	0.191	0.202	0.221	0.233
-8	0.2500	0.250 +.004 -.001	0.254	0.265	0.284	0.296
-10	0.3125	0.312 +.004 -.001	0.316	0.327	0.346	0.358
-11	0.3750	0.375 +.004 -.001	0.377	0.390	0.407	0.421

HOLE SIZES FOR STANDARD SOLID SHANK ALUMINUM,
TITANIUM, CRES AND MONEL RIVETS
(MS20427, MS20470, MS20615, NAS1097, NAS1199, NAS1200)
TABLE I

Fastener Hole Sizes - RB211-524 Engines
Figure 1 (Sheet 2 of 7)

DASH NO.	NOMINAL DIAMETER	CHERRY BUCKS (CSR922,CSR924,CSR925)			E-Z BUCKS (CSR902,CSR903)		
		ACTUAL DIAMETER	HOLE DIAMETER		ACTUAL DIAMETER	HOLE DIAMETER	
			MIN.	MAX.		MIN.	MAX.
-3	0.0937	---	---	---	0.094 +.003 -.001	0.95	0.98
-4	0.1250	---	---	---	0.125 +.003 -.001	0.128	0.131
-5	0.1562	0.1640 +.0000 -.0005	0.1600	0.1630	0.156 +.003 -.001	0.158	0.161
-6	0.1875	0.1895 +.0000 -.0005	0.1855	0.1885	0.187 +.003 -.001	0.190	0.194
-8	0.2500	0.2495 +.0000 -.0005	0.2455	0.2485	---	---	---
-10	0.3125	0.3120 +.0000 -.0005	0.3080	0.3110	---	---	---
-12	0.3750	0.3745 +.0000 -.0005	0.3705	0.3735	----	---	---

HOLE SIZES FOR CHERRY BUCK AND E-Z BUCK RIVETS
(CSR922, CSR924, CSR925 AND CSR902, CSR903)
TABLE II

DASH NO.	NOMINAL SIZE	DIAMETER	HOLE SIZE
-6	0.1875	0.197-0.199	0.199-0.202
-8	0.2500	0.258-0.260	0.260-0.263

S4B100-T AND S7B100-T LOW PROFILE SHEAR HEAD ALLOY STEEL BLIND BOLT
(FOR THIN TOP SHEET APPLICATIONS)
TABLE III

Fastener Hole Sizes - RB211-524 Engines
Figure 1 (Sheet 3 of 7)

DASH NO.	NOMINAL RIVET DIAMETER	HOLE DIAMETER FOR NAS1398,NAS1399,CR2164,CR2564,CR2604		HOLE DIAMETER FOR NAS1738,NAS1739	
		MIN.	MAX.	MIN.	MAX.
-4	0.1250	0.129	0.132	0.144	0.148
-5	0.1562	0.159	0.163	0.177	0.181
-6	0.1875	0.191	0.195	0.205	0.209
-8	0.2500	0.257	0.261	0.272	0.276

HOLE SIZES FOR BLIND RIVETS (CHERRY LOCK)
TABLE IV

DASH NO.	DIAMETER OF ORIGINAL FASTENER CR3522,CR3523	HOLE SIZE	DIAMETER OF ORIGINAL FASTENER CR3552,CR3553	HOLE SIZE
-4	0.126 +.003 -.001	0.129-0.132	0.140 +.003 -.001	0.143-0.146
-5	0.157 +.003 -.001	0.160-0.164	0.173 +.003 -.001	0.176-0.180
-6	0.189 +.003 -.001	0.192-0.196	0.201 +.003 -.001	0.205-0.209

HOLE SIZES FOR NOMINAL AND OVERSIZE BLIND RIVETS
(CHERRY MAX CR3522, CR3523, CR3552, CR3553)
TABLE V

Fastener Hole Sizes - RB211-524 Engines
Figure 1 (Sheet 4 of 7)

DASH NO.	SLEEVE DIAMETER		HOLE DIAMETER	
	NOMINAL	ACTUAL	MINIMUM	MAXIMUM
-5	0.1562	0.166-0.169	0.170	0.173
-6	0.1875	0.193-0.196	0.197	0.201
-8	0.2500	0.254-0.257	0.258	0.264
-10	0.3125	0.335-0.338	0.339	0.345
-12	0.3750	0.387-0.390	0.391	0.397
-1032	0.3125	0.309-0.312	0.313	0.319

HOLE SIZES FOR HI SHEAR BLIND BOLTS
BB301, BB302, BB309, BB351, BB352, NB1101, NB1102 NB1114
(USING SLEEVES BB321, BB322, B335, BN330)
TABLE VI

Fastener Hole Sizes - RB211-524 Engines
Figure 1 (Sheet 5 of 7)

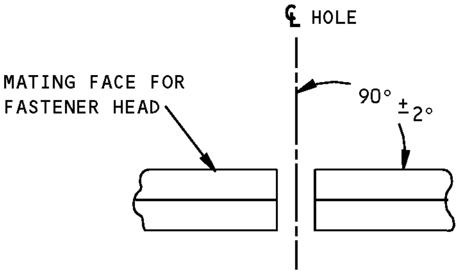
DASH NO.	DIAMETERS		HOLE SIZE	1/64 IN. OVERSIZE	1/32 IN. OVERSIZE	3/64 IN. OVERSIZE
	NOMINAL	SHANK				
-5	0.1562	0.1625-0.1635	0.157-0.160	0.169-0.172	0.185-0.188	0.200-0.204
-6	0.1875	0.1885-0.1895	0.187-0.190	0.200-0.203	0.216-0.219	0.231-0.234
-8	0.2500	0.2485-0.2495	0.247-0.250	0.263-0.266	0.278-0.281	0.294-0.297

HEX DRIVE FASTENERS (HI-LOK)
(HL10, HL12, HL13, HL15, HL30, HL40, HL41,
HL48, HL49, HL641, HL644
TABLE VII

DASH NO.	NOMINAL SIZE	ACTUAL SIZE	HOLE SIZE
-6	0.2031	0.2005-0.2025	0.203-0.208
-8	0.2656	0.2630-0.2650	0.266-0.271

ASP THREADED FASTENERS
(ASPFF, 2ASPFF, 2ASP509F, ASPFP, ASP100P, 2ASPFP, 2ASPFP509P)
TABLE VIII

Fastener Hole Sizes - RB211-524 Engines
Figure 1 (Sheet 6 of 7)



HOLES FOR ALL PROTRUDING AND FLUSH HEAD FASTENERS MUST BE WITHIN 2° OF PERPENDICULAR TO THE FACE ON WHICH THE FASTENER HEAD BEARS

FASTENER HOLE PERPENDICULARITY

DETAIL I

Fastener Hole Sizes - RB211-524 Engines
Figure 1 (Sheet 7 of 7)

GENERAL - FASTENER EDGE MARGINS - RB211-524 ENGINES

1. References

Reference	Title
51-40-06, GENERAL	Fastener Edge Margins

2. General

A. Fastener edge margin as used in this manual is the distance from the center of the fastener hole to the nearest edge of a sheet, plate, casting, forging or machined part. Edge margin is used as a guide for the installation of fastener holes along the edge of a part or structure. Unless minimum edge distance is maintained for fastener holes, the part will fail at less than the load for which the part or structure was designed.

B. Protruding head bolts, screws and rivets utilize the full tear-out strength of the material, if the gage of the sheet metal or thickness of the part is considered. The developed strength of a single fastener which joins two or more parts is a function of the strength of the fastener and the strength of the material or parts being joined. The shear strength of the thinner gages of sheet metal (or thickness of parts) are less than the shear strength of the fastener, so shear failure in the joint would occur at the shear limits of the materials being joined, rather than at the shear limits of the fastener. Tables showing the proper edge margins to use for single shear and double shear fastener application and the fastener/material combinations for metals used in the Boeing 767 airplane are applicable to the RB211-524 engine nacelle. The tables appear in 51-40-06, GENERAL.

C. Countersinking the fastener hole in the materials being joined by flush fasteners, encroaches on the tear-out material between the fastener hole and the edge of the part and requires that the edge margin must be increased to compensate for the loss of tear-out strength. Tables showing the proper edge margins to use for countersunk fasteners in single shear application and the fastener/material combinations for metals used in the Boeing 767 airplane are applicable to the RB211-524 engine nacelle. The tables appear in 51-40-06, GENERAL.

D. Composite materials used in the components of the RB211-524 engine nacelle, such as reverser cowl and integrated nozzle assembly, require the use of greater edge margin to fully develop the shear strength of each fastener/material joint. The following tables give the edge margin to be used for single shear application of protruding head and countersunk head fasteners. Refer to Figure 1/GENERAL, Tables I and II.

RIVETED OR BOLTED MATERIAL		EDGE MARGIN FOR PROTRUDING HEAD FASTENERS IN SINGLE SHEAR						
		FASTENER DIAMETER (INCH)						
		3/32	1/8	5/32	3/16	1/4	5/16	3/8
GRAPHITE FABRIC EPOXY COMPOSITE	LAMINATE THICKNESS (INCH)							
KEVLAR FABRIC EPOXY COMPOSITE	0.06	0.25	0.34	0.42	0.51	0.68	0.84	1.01
	0.09	0.25	0.34	0.42	0.51	0.68	0.84	1.01
	0.12	0.25	0.34	0.42	0.51	0.68	0.84	1.01
	0.15	0.25	0.34	0.42	0.51	0.68	0.84	1.01
	0.18	0.25	0.34	0.42	0.51	0.68	0.84	1.01
GRAPHITE/ KEVLAR EPOXY COMPOSITE	0.21	0.25	0.34	0.42	0.51	0.68	0.84	1.01
	0.24	0.25	0.34	0.42	0.51	0.68	0.84	1.01
	0.27	0.25	0.34	0.42	0.51	0.68	0.84	1.01
	0.30	0.25	0.34	0.42	0.51	0.68	0.84	1.01
	0.40	0.25	0.34	0.42	0.51	0.68	0.84	1.01
	0.50	0.25	0.34	0.42	0.51	0.68	0.84	1.01

EDGE MARGINS FOR PROTRUDING HEAD BOLTS,
RIVETS AND SCREWS IN COMPOSITE MATERIAL

TABLE I

Fastener Edge Margins - RB211-524 Engines
Figure 1 (Sheet 1 of 2)

RIVETED OR BOLTED MATERIAL		EDGE MARGIN FOR COUNTERSUNK HEAD FASTENERS IN SINGLE SHEAR						
		FASTENER DIAMETER (INCH)						
		3/32	1/8	5/32	3/16	1/4	5/16	3/8
GRAPHITE FABRIC EPOXY COMPOSITE	LAMINATE THICKNESS (INCH)							
KEVLAR FABRIC EPOXY COMPOSITE	0.06	0.28	0.38	0.47	0.56	0.75	0.94	1.13
	0.09	0.28	0.38	0.47	0.56	0.75	0.94	1.13
	0.12	0.28	0.38	0.47	0.56	0.75	0.94	1.13
	0.15	0.28	0.38	0.47	0.56	0.75	0.94	1.13
	0.18	0.28	0.38	0.47	0.56	0.75	0.94	1.13
GRAPHITE/ KEVLAR EPOXY COMPOSITE	0.21	0.28	0.38	0.47	0.56	0.75	0.94	1.13
	0.24	0.28	0.38	0.47	0.56	0.75	0.94	1.13
	0.27	0.28	0.38	0.47	0.56	0.75	0.94	1.13
	0.30	0.28	0.38	0.47	0.56	0.75	0.94	1.13
	0.40	0.28	0.38	0.47	0.56	0.75	0.94	1.13
	0.50	0.28	0.38	0.47	0.56	0.75	0.94	1.13

EDGE MARGINS FOR COUNTERSUNK HEAD BOLTS,
RIVETS AND SCREWS IN COMPOSITE MATERIAL

TABLE II

Fastener Edge Margins - RB211-524 Engines
Figure 1 (Sheet 2 of 2)

GENERAL - STRENGTH OF FASTENERS - RB211-524 ENGINES

1. References

Reference	Title
51-40-05, GENERAL	Fastener Hole Sizes
51-40-06, GENERAL	Fastener Edge Margins
51-42-05, GENERAL	Fastener Hole Sizes - RB211-524 Engines
51-42-06, GENERAL	Fastener Edge Margins - RB211-524 Engines
51-42-08, GENERAL	Countersinking - RB211-524 Engines

2. General

A. The fastener strength values given in this section are the unit developed fastener/material joint strength in shear loading or in tension applications. The unit developed fastener strength value takes into account the bearing strength of the material in which the fastener is installed. Where the material in bearing will fail before fastener shear failure, the lower value is shown as the shear strength of the installed fastener.

B. The fastener strength values given assume that the correct hole sizes have been used and that edge margin requirements have been met. Refer to 51-40-05, GENERAL for hole sizes of fasteners which are common to the RB211-524 engine nacelle and the Boeing 767 airplane. Refer to 51-42-05, GENERAL for hole sizes of fasteners which are used only on the RB211-524 engine nacelle. Refer to 51-40-06, GENERAL for edge margin requirements of fasteners which are common to the Boeing 767 airplane and the RB211-524 engine nacelle. Refer to 51-42-06, GENERAL for edge margin requirements of fasteners which are used only on the RB211-524 engine nacelle.

C. Refer to 51-40-08 for countersinking and hole fillet relief requirements for fasteners which are common to the RB211-524 engine nacelle and the Boeing 767 airplane. Refer to 51-42-08, GENERAL for countersinking and hole fillet requirements for fasteners which are used only on the RB211-524 engine nacelle.

D. To fully utilize the design strength of a fastener, the size and preparation of the fastener installation hole must be carefully controlled in the structural parts which the fastener joins together. Where design requirements permit some movement of misalignment of the attaching parts, a general clearance fit hole is used which can have a diameter as much as 0.0006-inch larger than the shank of the fastener. Where design requirements are more stringent, a close-reamed hole is used which can have a diameter 0.005 to 0.0010-inch larger than the fastener shank. Interference fit holes are used which are 0.001 to 0.003-inch smaller in diameter than the shank of the fastener. Special installation tools force the fastener into the interference fit hole expanding the hole in the process to create a very stable attachment.

E. An index of the figures and tables which contain the fastener strength data is provided to identify the location of the data for each type of fastener.Refer to Table 1/GENERAL.

Table 1: Index of Tables

Figure 1/GENERAL - Fastener/Material Joint Strength	
Table I	- Rivet/Sheet Material Shear Joint Strength Table Index
Figure 2/GENERAL- Fastner Shear Strength	
Table I	- Single Shear Strength of Solid Rivets
Table II	- Single Shear Strength of Blind Rivets

(Continued)

Table III	- Shear and Tension Strength of Hi-Lok Fastener Pins
Table IV	- Ultimate Single Shear Strength of Threaded Fasteners
Table V	- ASP Fasteners Shear Strength (108 KSI)
Table VI	- ASP Fasteners Tensile Strength
Table VII	- NAS1581 Shear and Tensile Strength
Table VIII	- Lightweight GP Pin Shear and Tensile Strength.
Figure 3/GENERAL- Material, Thickness and Applicable Fasteners	
Table I	- Single and Double Shear Joint Allowables for Protruding Head MS20470DD Rivets in Clad 2024-T42 and Higher Strength Aluminum Alloy Sheet
Table II	- Single Shear Joint Allowables for Protruding Head MS20615M Rivets in Pure Titanium Sheet
Table III	- Single Shear Joint Allowables for Protruding Shear Head Cherrybuck Fasteners in Clad 2024-T3 or Higher Strength Aluminum Alloy Sheet
Table IV	- Single Shear Joint Allowables for NAS1097AD Flush Crown Head Rivets in 100-Degree Machine Countersunk Clad 2024-T3 or Higher Strength Alloy
Table V	- Single Shear Joint Allowables for NAS1097 Flush Shear Head Rivets in 100-Degree Machine Countersunk Clad 2024-T3 or Higher Strength Aluminum Alloy
Table VI	- Single Shear Joint Allowables for NAS1199 and NAS1200 Flush Rivets in 100-Degree Machine Countersunk CRES Sheet
Table VII	- Single Shear Joint Allowables for NAS1200M and MS20427M Flush Rivets in 100-Degree Machine Countersunk Commercially Pure Titanium
Table VIII	- Single Shear Joint Allowables for CSR924 and CSR922 Cherrybuck Rivets in 100-Degree Machine Countersunk Clad 2024-T3 or Higher Strength Aluminum Alloy Sheet
Table IX	- Single Shear Joint Allowables for Protruding Head NAS1398C Rivets in Alloy Steel Sheet
Table X	- Single Shear Joint Allowables for NAS1738C and CR2839 Protruding Head Rivets in 95 KSI Titanium Sheet
Table XI	- Single Shear Joint Allowables for NAS1399C, CR2662 and CR2664 Rivets in 100-Degree Machine Countersunk Alloy Steel Sheet
Table XII	- Single Shear Joint Allowables for NAS1399C, NAS1739A, CR2248 and CR2838 Rivets in 100 degree Machine Countersunk Clad 2024-T3 and Higher Strength Aluminum Alloy Sheet
Table XIII	- Single Shear Joint Allowables for CR2164 Rivets in 100-Degree Machine Countersunk Clad 2024-T3 and Higher Strength Aluminum Alloy Sheet
Table XIV	- Single Shear Joint Allowables for CR2564 Rivets in 100-Degree Machine Countersunk Steel Sheet
Table XV	- Single Shear Joint Allowables for MS90353/B100-T Rivets in 100-Degree Machine Countersunk Clad or Bare 2024-T3 or 2024-T351 Aluminum Alloy Sheet
Table XVI	- Static Joint Strength of Protruding Head (NAS1198) A-286 Solid Rivets in A-286 Alloy Sheet
Table XVII	- Single Shear and Tensile Strength (LBS) in Steel Coupons for CR2545 Unisink Rivets
Figure 4/GENERAL - Blind Bolt Shear Strength	
Table I	- Blind Bolt Shear Strength in Installations NB1101, NB1102, NB1114

FASTENER				MATERIAL			
TYPE	PART NUMBER	MATERIAL	TYPE HEAD	2024	CRES	TI PURE	ALLOY STEEL
				TABLE			
SOLID RIVETS	CSR925	TITANIUM	PROTRUDING	11			
	MS20470DD	2024-T31	PROTRUDING	9			
	MS20615M	MONEL	PROTRUDING			10	
	CSR922	TITANIUM	100° FLUSH	16			
	CSR924	TITANIUM	100° FLUSH	16			
	MS20427F	A286	100° FLUSH		14		
	MS20427M	MONEL	100° FLUSH			15	
	NAS1097AD	2117-T3	100° FLUSH	12			
	NAD1097B	5056-H32	100° FLUSH	13			
	NAS1199	A286	100° FLUSH		14		
	NAS1200	A286	100° FLUSH		14		
	NAS1200M	MONEL	100° FLUSH			15	
BLIND RIVETS	CR2164	2017A	100° FLUSH	21			
	CR2564	MONEL	100° FLUSH				22
	CR2664	A286	100° FLUSH				19
	MS90353/B100T	STEEL	100° FLUSH	23			
	NAS1399C	A286	100° FLUSH				19
	NAS1739A	2219-T62	100° FLUSH	20			
	NAS1739B	5056F	100° FLUSH	20			
	NAS1398C	A286	PROTRUDING				17
	NAS1738C	INCONEL	PROTRUDING			18	

RIVET/SHEET MATERIAL SHEAR JOINT STRENGTH TABLE INDEX
TABLE I

Fastener/Material Joint Strength - RB211-524 Engines
Figure 1

DIAMETER OF RIVET (IN.)		1/16	3/32	1/8	5/32	3/16	1/4	5/16	3/8
RIVET MATERIAL	CODE	SHEAR ULTIMATE STRENGTH (Lb)							
5056F_{su} = 28 KSI [a]	B	99	203	363	556	602	1450	2290	3280
2117-T3F_{su} = 30 KSI [a]	AD	106	217	388	596	862	1550	2460	3510
2017-T3F_{su} = 38 KSI [a]	D	135	275	494	755	1090	1970	3110	4450
2024-T31F_{su} = 41 KSI [ab]	DD	145	296	531	815	1180	2120	3360	4800
A286F_{su} = 90 KSI		317	651	1170	1790	2580	4670	7370	10500
MONEL F_{su} = 49 KSI		173	355	635	973	1400	2540	4020	5730

NOTES

- (a) = VALUES ARE FOR AS DRIVEN CONDITION, ON A PROBABILITY BASIS (B VALUES).
- (b) = DRIVEN IN THE AS QUENCHED CONDITION.
- F_{su} = FORCE SHEAR ULTIMATE.

SINGLE SHEAR STRENGTH OF SOLID RIVETS
TABLE I

DIAMETER OF RIVET (IN.)	3/32	1/8	5/32
PART NUMBER	SINGLE SHEAR STRENGTH (Lb)		
CSR902B,CSR903B	362	648	993
CR3523,CR3522	730	1134	1626
CR2539,CR2538	895	1353	1823

SINGLE SHEAR STRENGTH OF BLIND RIVETS
TABLE II

Fastener Shear Strength - RB211-524 Engines
Figure 2 (Sheet 1 of 4)

HI-LOK NUMBER	SHEAR STRENGTH, KSI	TENSION STRENGTH, KSI
HL10	95	---
HL12	95	160
HL13	95	160
HL15	156	260
HL30	125	---
HL40	95	---
HL41	95	---
HL48	95	160
HL49	95	160
HL641	95	---
HL644	125	125

SHEAR AND TENSION STRENGTH OF HI-LOK FASTENER PINS
TABLE III

SHEAR STRESS, KSI			95	125	156	160
FASTENER SIZE		BASIC SHANK AREA (INCH^2)	ULTIMATE SINGLE SHEAR STRENGTH (Lb)			
IN.	A					
0.125	1/8	0.012272	1166	1534	1914	1964
0.138	# 6	0.014957	1421	1870	2333	2393
0.156	5/32	0.019175	1822	2397	2991	3068
0.164	# 8	0.021124	2007	2640	3295	3380
0.188	3/16	0.027612	2623	3452	4310	4418
0.190	# 10	0.028353	2694	3544	4420	4536
0.216	# 12	0.036644	3481	4580	5720	5863
0.219	7/32	0.037582	3570	4700	5860	6013
0.250	1/4	0.049087	4660	6140	7660	7854
0.312	5/16	0.076699	7290	9590	11970	12272

ULTIMATE SINGLE SHEAR STRENGTH OF THREADED FASTENERS
TABLE IV

NOTE

A FRACTIONAL EQUIVALENT OF SCREW NUMBER.

Fastener Shear Strength - RB211-524 Engines
Figure 2 (Sheet 2 of 4)

DASH NO.	DIAMETER (IN.) OF PIN SHANK	AREA OF PIN SHANK	SHEAR STRENGTH (Lb)
-6	13/64 (0.2031)	0.03240	3499
-8	17/64 (0.2656)	0.05540	5983
-10	21/64 (0.3281)	0.08455	9131

NOTE

ASP = ADJUSTABLE CLAMPING FORCE SELF-SUSTAINING POSITIVE LOCK (FOR HONEYCOMB SANDWICH CONSTRUCTION)

ASP FASTENERS SHEAR STRENGTH (108 KSI)
TABLE V

DASH NO.	DIAMETER (IN.)	2ASP509 (2ASPFP509P)	ASP100P	ASPFF (2ASPFF)	ASPFP (2ASPFP)
-6	13/64 (0.2031)	2210	1400	2210	2210
-8	17/64 (0.2656)	4080	----	4080	----
-10	21/64 (0.3281)	5350	----	5350	----

ASP FASTENERS TENSILE STRENGTH
TABLE VI

Fastener Shear Strength - RB211-524 Engines
Figure 2 (Sheet 3 of 4)

DASH NO.	SHANK AREA (INCH ^{2})	SHEAR STRENGTH (Lb)	BASIC MINOR AREA	TENSILE STRENGTH (Lb)
-3	0.0284	2977	0.0186	3441
-4	0.0491	5152	0.0342	6331

NAS1581 SHEAR AND TENSILE STRENGTH
TABLE VII

FASTENER	DOUBLE SHEAR STRENGTH IN LBS, USING 3SLC-C COLLAR				
PIN DIAMETER	0.164	0.190	0.250	0.312	0.375
LGPL2SC-V	4010	5380	9300	14600	21000
LGPL2SP-V	4010	5380	9300	14600	21000
LGPL9SC-V	4010	5380	9300	14600	21000
LGPL9SP-V	4010	5380	9300	14600	21000
	TENSILE STRENGTH IN LBS, USING SLFC-MV COLLAR				
LGPL2SC-V	1290	1600	3000	5000	7000
LGPL2SP-V	1400	1600	3000	5000	9000
LGPL9SC-V	1750	2000	3750	6250	8750
LGPL9SP-V	1750	2000	3750	6250	8750

LIGHTWEIGHT GP PIN SHEAR AND TENSILE STRENGTH
TABLE VIII

Fastener Shear Strength - RB211-524 Engines
Figure 2 (Sheet 4 of 4)

PROTRUDING HEAD

FASTENER - MS20470DD (2024-T31 AL)						
MATERIAL - CLAD 2024-T3 AND HIGHER STRENGTH AL ALLOY						
FASTENER NOMINAL DIAMETER (INCH)		3/32	1/8	5/32	3/16	1/4
SHEET THICKNESS (INCH) [B]		SHEAR ULTIMATE STRENGTH, Lb				
SINGLE SHEAR	0.020	175	235	291	---	---
	0.025	219	293	363	436	---
	0.032	296	376	465	559	752
	0.040	296	470	582	699	940
	0.050	---	529	727	874	1176
	0.063	---	---	815	1100	1481
	0.080	---	---	---	---	1881
	0.090	---	---	---	---	2120
DOUBLE SHEAR	0.020	175	235	---	---	---
	0.025	219	293	363	---	---
	0.032	281	376	465	559	---
	0.040	351	470	582	699	941
	0.050	439	587	727	874	1176
	0.080	---	940	1164	1398	1881
	0.090	---	1062	1309	1573	2116
	0.125	---	---	1630	2184	2939
MAXIMUM RIVET STRENGTH (SINGLE SHEAR)		296	529	815	1100	2120
MAXIMUM RIVET STRENGTH (DOUBLE SHEAR)		439	1062	1630	2184	2939

SINGLE AND DOUBLE SHEAR JOINT ALLOWABLES FOR PROTRUDING HEAD MS20470DD
RIVETS IN CLAD 2024-T42 AND HIGHER STRENGTH ALUMINUM ALLOY SHEET
TABLE I [A]

NOTES

[A] ALLOWABLES CORRESPOND TO SHEAR OR BEARING, WHICHEVER IS LOWER

[B] THINNEST SHEET IN SINGLE SHEAR OR MIDDLE SHEET IN DOUBLE SHEAR

[C] TEST DATA BASED ON 1.5 X YIELD

Material, Thickness and Applicable Fasteners - RB211-524 Engines
Figure 3 (Sheet 1 of 17)

PROTRUDING HEAD

FASTENER - PROTRUDING HEAD MONEL RIVET MS20615M				
MATERIAL - PURE TITANIUM SHEET				
FASTENER NOMINAL DIAMETER (INCH)	3/32	1/8	5/32	3/16
SHEET THICKNESS (INCH)	SHEAR ULTIMATE STRENGTH, Lb			
0.063	---	---	973	1400
MAXIMUM RIVET STRENGTH (SINGLE SHEAR)	335	635	973	1400

SINGLE SHEAR JOINT ALLOWABLES FOR PROTRUDING HEAD MS20615M RIVETS
IN PURE TITANIUM SHEET
TABLE II A

Material, Thickness and Applicable Fasteners - RB211-524 Engines
Figure 3 (Sheet 2 of 17)

PROTRUDING HEAD

FASTENER – CSR925			
MATERIAL – CLAD 2024-T3 OR HIGHER STRENGTH ALLOY			
FASTENER NOMINAL DIAMETER (INCH)	5/32	3/16	1/4
SHEET THICKNESS (INCH)	ULTIMATE STRENGTH, Lb		
0.050	807	--	--
0.063	1020	1180	--
0.071	1150	1335	--
0.080	1300	1505	1970
0.090	1465	1695	2220
0.100	1630	1885	2470
0.125	2007	2360	3095
0.160	--	2694	3975
0.190	--	--	4660
MAXIMUM RIVET SHEAR STRENGTH	2007	2694	4660
SHEET THICKNESS (INCH)	YIELD STRENGTH (Lb)		
0.050	619	--	--
0.063	747	889	--
0.071	827	981	--
0.080	916	1085	1495
0.090	1015	1200	1645
0.100	1115	1315	1795
0.125	1360	1600	2175
0.160	--	2000	2705
0.190	--	--	3155

SINGLE SHEAR JOINT ALLOWABLES FOR PROTRUDING SHEAR HEAD CHERRYBUCK FASTENERS IN CLAD 2024-T3 OR HIGHER STRENGTH ALUMINUM ALLOY SHEET
TABLE III $\boxed{A}$

Material, Thickness and Applicable Fasteners - RB211-524 Engines
Figure 3 (Sheet 3 of 17)

100° MACHINE COUNTERSUNK

FASTENER - FLUSH CROWN-HEAD AD RIVET, NAS1097AD			
MATERIAL - CLAD 2024-T3 OR HIGHER STRENGTH ALUMINUM ALLOY SHEET			
FASTENER NOMINAL DIAMETER (INCH)	1/8	5/32	3/16
SHEET THICKNESS (INCH)	SINGLE SHEAR ULTIMATE STRENGTH, Lb		
0.032	300	--	--
0.040	359	457	--
0.050	388	560	702
0.063	--	596	800
0.071	--	--	862
MAXIMUM RIVET STRENGTH (SINGLE SHEAR)	388	596	862

SINGLE SHEAR JOINT ALLOWABLES FOR NAS1097AD FLUSH CROWN-HEAD RIVETS IN 100° MACHINE COUNTERSUNK CLAD 2024-T3 OR HIGHER STRENGTH ALLOY
TABLE IV A

Material, Thickness and Applicable Fasteners - RB211-524 Engines
Figure 3 (Sheet 4 of 17)

100° MACHINE COUNTERSUNK

FASTENER - 100° FLUSH SHEAR HEAD, NAS1097B (5056 AL)						
MATERIAL - CLAD 2024-T3 AND HIGHER STRENGTH AL ALLOY						
FASTENER NOMINAL DIAMETER (INCH)	1/8		5/32		3/16	
	AD	B	AD	B	AD	B
SHEET THICKNESS (INCH) $\boxed{A}$	SINGLE SHEAR ULTIMATE STRENGTH, Lb					
0.020	---		---		---	
0.025	---		---		---	
0.032	300		---		---	
0.040	359		457		---	
0.050	388		560		702	
0.063	---		596		800	
0.080	---		---		862	
0.090	---		---		---	
0.125	---		---		---	
MAXIMUM RIVET STRENGTH (SINGLE SHEAR)	388	203	596	303	862	556

SINGLE SHEAR JOINT ALLOWABLES FOR NAS1097 FLUSH SHEAR HEAD
RIVETS IN 100° MACHINE COUNTERSUNK CLAD 2024-T3 OR
HIGHER STRENGTH ALUMINUM ALLOY
TABLE V $\boxed{A}$

Material, Thickness and Applicable Fasteners - RB211-524 Engines
Figure 3 (Sheet 5 of 17)

100° MACHINE COUNTERSUNK

FASTENER - NAS1199,NAS1200,NAS20427F				
MATERIAL - CRES SHEET				
FASTENER NOMINAL DIAMETER (INCH)	3/32	1/8	5/32	3/16
SHEET THICKNESS (INCH)	SINGLE SHEAR ULTIMATE STRENGTH, Lb			
0.160	1536	2056	2544	1400

SINGLE SHEAR JOINT ALLOWABLES NAS1199 AND NAS1200 FLUSH RIVETS IN 100° MACHINE COUNTERSUNK CRES SHEET
TABLE VI A

Material, Thickness and Applicable Fasteners - RB211-524 Engines
Figure 3 (Sheet 6 of 17)

100° MACHINE COUNTERSUNK

FASTENER - 100° FLUSH HEAD, NAS1200M,MS20427M (MONEL)			
MATERIAL - TITANIUM, COMMERCIALLY PURE			
FASTENER NOMINAL DIAMETER (INCH)	1/8	5/32	3/16
SHEET THICKNESS (INCH) B	SINGLE SHEAR ULTIMATE STRENGTH, Lb		
0.050 0.063 0.071	573 626 635	818 885 926	1118 1198 1242
MAXIMUM RIVET STRENGTH (SINGLE SHEAR)	635	973	1400

SINGLE SHEAR JOINT ALLOWABLES FOR NAS1200M AND MS20427M FLUSH RIVETS IN 100° MACHINE COUNTERSUNK COMMERCIALLY PURE TITANIUM
TABLE VII A

Material, Thickness and Applicable Fasteners - RB211-524 Engines
Figure 3 (Sheet 7 of 17)

100° MACHINE COUNTERSUNK

FASTENER - CSR924,CSSR922			
MATERIAL - CLAD 2024-T3 OR HIGHER STRENGTH ALLOY			
FASTENER NOMINAL DIAMETER (INCH)	5/32	3/16	1/4
SHEET THICKNESS (INCH)	ULTIMATE STRENGTH, Lb		
0.050	737	--	--
0.063	1019	1118	--
0.071	1152	1319	--
0.080	1279	1509	1837
0.090	1419	1673	2168
0.100	1560	1834	2500
0.125	1898	2242	3036
0.160	2007	2680	3786
0.190	--	2694	4404
0.250	--	--	4660
MAXIMUM RIVET SHEAR STRENGTH	2007	2694	4660
SHEET THICKNESS (INCH)	YIELD STRENGTH (Lb)		
0.050	511	--	--
0.063	712	778	--
0.071	786	922	--
0.080	840	1039	1276
0.090	900	1109	1513
0.100	960	1178	1750
0.125	1110	1352	1979
0.160	1321	1596	2300
0.190	--	1805	2575
0.250	--	--	3125

SINGLE SHEAR JOINT ALLOWABLES FOR CSR924 AND CSR922 CHERRYBUCK RIVETS IN 100° MACHINE COUNTERSUNK CLAD 2024-T3 OR HIGHER STRENGTH ALUMINUM ALLOY SHEET

TABLE VIII $\boxed{\text{A}}$

Material, Thickness and Applicable Fasteners - RB211-524 Engines
Figure 3 (Sheet 8 of 17)

PROTRUDING HEAD

FASTENER - NAS1738C,CR2663 (A286)			
MATERIAL - ALLOY STEEL F_{tu} 180 KSI			
FASTENER NOMINAL DIAMETER (INCH)	1/8	5/32	3/16
SHEET THICKNESS (INCH)	SHEAR ULTIMATE STRENGTH, Lb		
0.020	511	566	591
0.025	697	794	869
0.032	785	1112	1255
0.040	860	1211	1628
0.050	956	1325	1772
0.063	970	1480	1958
0.071	---	1490	2070
0.080	---	---	2150
MAXIMUM RIVET SHEAR STRENGTH	970	1490	2150

SINGLE SHEAR JOINT ALLOWABLES FOR PROTRUDING HEAD
NAS1398C RIVETS IN ALLOY STEEL SHEET
TABLE IX A

Material, Thickness and Applicable Fasteners - RB211-524 Engines
Figure 3 (Sheet 9 of 17)

PROTRUDING HEAD

FASTENER - NAS1738C,CR2839			
MATERIAL - TITANIUM, 95 KSI			
FASTENER NOMINAL DIAMETER (INCH)	1/8	5/32	3/16
SHEET THICKNESS (INCH)	SINGLE SHEET ULTIMATE STRENGTH, Lb		
0.050	605	725	865
0.063	760	940	1085
0.071	860	1055	1255

SINGLE SHEAR JOINT ALLOWABLES FOR NAS1738C AND CR2839 PROTRUDING HEAD RIVETS IN 95 KSI TITANIUM SHEET
TABLE X $\boxed{A}$

Material, Thickness and Applicable Fasteners - RB211-524 Engines
Figure 3 (Sheet 10 of 17)

100° MACHINE COUNTERSUNK

FASTENER - NAS1399C,CR2662,CR2664 (A286)			
MATERIAL - ALLOY STEEL F_{tu} >180 KSI			
FASTENER NOMINAL DIAMETER (INCH)	1/8	5/32	3/16
SHEET THICKNESS (INCH)	SHEAR ULTIMATE STRENGTH, Lb		
0.032	160 $\boxed{C}$	--	--
0.040	205 $\boxed{C}$	249 $\boxed{C}$	--
0.050	438 $\boxed{C}$	328 $\boxed{C}$	372 $\boxed{C}$
0.063	698	702 $\boxed{C}$	580 $\boxed{C}$
0.071	840	908	855 $\boxed{C}$
0.080	970	1108	1164 $\boxed{C}$
0.090	---	1333	1438
0.100	---	1490	1710
0.125	---	--	2150
MAXIMUM RIVET SHEAR STRENGTH	970	1490	2150

SINGLE SHEAR JOINT ALLOWABLES FOR NAS1399C, CR2662 AND CR2664
RIVETS IN 100° MACHINE COUNTERSUNK ALLOY STEEL SHEET
TABLE XI $\boxed{A}$

Material, Thickness and Applicable Fasteners - RB211-524 Engines
Figure 3 (Sheet 11 of 17)

100° MACHINE COUNTERSUNK

FASTENER - NAS1739A,NAS1739B,CR2248,CR2838			
MATERIAL - CLAD 2024-T3 AND HIGHER STRENGTH ALLOYS			
FASTENER NOMINAL DIAMETER (INCH)	1/8	5/32	3/16
SHEET THICKNESS (INCH)	SHEAR ULTIMATE STRENGTH, Lb $\boxed{C}$		
0.025	162	---	---
0.032	207	255	---
0.040	259	318	370
0.050	324	397	462
0.063	409	502	582
0.071	460	565	657
0.080	504	637	739
0.090	---	717	832
0.100	---	762	925
0.125	---	---	1026
FASTENER SHEAR STRENGTH	554	837	1128

SINGLE SHEAR JOINT ALLOWABLES FOR NAS1399C, NAS1739A, CR2248 AND CR2838 RIVETS IN 100° MACHINE COUNTERSUNK CLAD 2024-T3 AND HIGHER STRENGTH ALUMINUM ALLOY SHEET
TABLE XII $\boxed{A}$

Material, Thickness and Applicable Fasteners - RB211-524 Engines
Figure 3 (Sheet 12 of 17)

100° MACHINE COUNTERSUNK

FASTENER − CR2164			
MATERIAL − CLAD 2024−T3 AND HIGHER STRENGTH ALUMINUM ALLOYS			
FASTENER NOMINAL DIAMETER (INCH)	1/8	5/32	3/16
SHEET THICKNESS (INCH)	ULTIMATE STRENGTH, Lb		
0.020	---	---	---
0.025	---	---	---
0.032	142	---	---
0.040	178	220	---
0.050	223	274	330
0.063	319	349	418
0.071	379	420	471
0.080	423	506	547
0.090	459	600	660
0.100	494	652	775
0.125	---	755	969
0.160	---	---	1090
RIVET SHEAR STRENGTH	494	755	1090
SHEET NOMINAL THICKNESS (INCH)	YIELD STRENGTH (Lb)		
0.020	---	---	---
0.025	---	---	---
0.032	50	---	---
0.040	62	76	---
0.050	116	95	115
0.063	196	186	153
0.071	244	246	226
0.080	300	313	306
0.090	361	389	398
0.100	423	466	489
0.125	---	657	717
0.160	---	---	1034

SINGLE SHEAR JOINT ALLOWABLES FOR CR2164 RIVETS IN 100° MACHINE COUNTERSUNK CLAD 2024−T3 AND HIGHER STRENGTH ALUMINUM ALLOY SHEET
TABLE XIII $\boxed{A}$

Material, Thickness and Applicable Fasteners - RB211-524 Engines
Figure 3 (Sheet 13 of 17)

100° MACHINE COUNTERSUNK

FASTENER - CR2564			
MATERIAL - STEEL SHEET			
FASTENER NOMINAL DIAMETER (INCH)	1/8	5/32	3/16
SHEET THICKNESS (INCH)	SINGLE SHEET ULTIMATE STRENGTH, Lb		
0.125	---	1000	1310
0.156	---	1090	1490
0.187	---	---	1580
MAXIMUM RIVET STRENGTH (SINGLE SHEAR)	710	1090	1580

SINGLE SHEAR JOINT ALLOWABLES FOR CR2564 RIVETS IN
100° MACHINE COUNTERSUNK STEEL SHEET

TABLE XIV $\boxed{A}$

Material, Thickness and Applicable Fasteners - RB211-524 Engines
Figure 3 (Sheet 14 of 17)

100° MACHINE COUNTERSUNK

FASTENER - S4B100-T OR S7B100-T ALLOY STEEL (MS90353)					
MATERIAL - CLAD OR BARE 2024-T3 OR 2024-T351					
FASTENER NOMINAL DIAMETER (INCH)	5/32	3/16	1/4	5/16	3/8
SHEET THICKNESS (INCH)	SHEAR ULTIMATE STRENGTH, Lb				
0.040	320 [C]	624 [C]	---	---	---
0.050	586 [C]	823 [C]	---	---	---
0.063	789 [C]	976 [C]	1378 [C]	---	---
0.071	945 [C]	1071 [C]	1500 [C]	---	---
0.080	1132 [C]	1252 [C]	1638 [C]	---	---
0.090	1336 [C]	1492 [C]	1789 [C]	---	---
0.100	1543 [C]	1735 [C]	1983 [C]	---	---
0.125	1914	2343 [C]	2697 [C]	2829 [C]	---
0.160	2281	2935	3540 [C]	4290 [C]	3937 [C]
0.190	---	3062	4185	5542 [C]	5400 [C]
0.250	---	---	5300	7210	8400 [C]
0.312	---	---	---	8280	10530 [C]
0.375	---	---	---	---	11930
MAXIMUM RIVET SHEAR STRENGTH	2281	3062	5300	8280	11930

SINGLE SHEAR JOINT ALLOWABLES FOR MS90353/B100-T RIVETS IN 100° MACHINE COUNTERSUNK CLAD OR BARD 2024-T3 OR 2024-T351 ALUMINUM ALLOY SHEET
TABLE XV [A]

Material, Thickness and Applicable Fasteners - RB211-524 Engines
Figure 3 (Sheet 15 of 17)

FASTENER - NAS1198			
MATERIAL - A286 ALLOY, SOLUTION TREATED AND AGED			
FASTENER NOMINAL DIAMETER (INCH)	1/8	5/32	3/16
SHEET THICKNESS (INCH)	SHEAR ULTIMATE STRENGTH, Lb		
0.020	478	----	----
0.025	590	740	----
0.032	745	932	1132
0.040	923	1152	1397
0.050	1023	1428	1677
0.063	1131	1578	1821
0.071	1170	1660	1909
0.080	----	1752	2008
0.090	----	1790	2118
0.100	----	----	2229
0.125	----	----	2504
0.160	----	----	2580
RIVET SHEAR STRENGTH	1170	1790	2580

STATIC JOINT STRENGTH OF PROTRUDING HEAD (NAS1198)
A-286 SOLID RIVETS IN A-286 ALLOY SHEET

TABLE XVI

Material, Thickness and Applicable Fasteners - RB211-524 Engines
Figure 3 (Sheet 16 of 17)

FASTENER – UNISINK CR2545			
MATERIAL – STEEL COUPONS			
FASTENER NOMINAL DIAMETER (INCH)	1/8	5/32	3/16
SHEET THICKNESS (INCH)	SINGLE SHEAR STRENGTH, Lb		
0.093	895	1290	1575
0.125	895	1353	1823
0.156	895	1353	1823
0.187	---	1353	1823
0.219	---	----	1823
TENSILE STRENGTH, Lb	490	740	1000

SINGLE SHEAR AND TENSILE STRENGTH (LBS.) IN STEEL COUPONS
FOR CR2545 UNISINK RIVETS

TABLE XVII

Material, Thickness and Applicable Fasteners - RB211-524 Engines
Figure 3 (Sheet 17 of 17)

BLIND BOLT

DASH NO.	NOMINAL DIAMETER (IN.)	SHANK AREA (INCH^2)	SHEAR STRENGTH (Lb)		
			BB301,BB302,BB351 (125 KSI)	BB309 (95 KSI)	NB1101 (160 KSI)
-5	0.1562	0.0191624	2395	1820	3066
-6	0.1875	0.0276116	3452	2623	4418
-8	0.2500	0.0490873	6136	4663	7854
-10	0.3125	0.076699	9587	7286	12272
-12	0.3750	0.1104466	13806	10492	17672
-1032	0.3125	0.076699	9587	7286	12272

BLIND BOLT SHEAR STRENGTH IN INSTALLATIONS NB1101,NB1102,NB1114
TABLE I

Blind Bolt Shear Strength - RB211-524 Engines
Figure 4

GENERAL - COUNTERSINKING - RB211-524 ENGINES

1. General

A. The countersinking information presented in this section is for those fasteners used exclusively in the RB211-524 powerplant nacelle. The remaining fasteners in the nacelle are similar to those used in the Boeing 767 airplane and the required countersinking information is contained in section 51-40-08 of the Structural Repair Manual.

B. Countersinking dimensions are provided for the following fasteners:

   (1) Countersink dimensions for CSR902B (MS20426) and CSR904B (NAS1097) Cherry E-Z Buck rivets, refer to Figure 1/GENERAL.

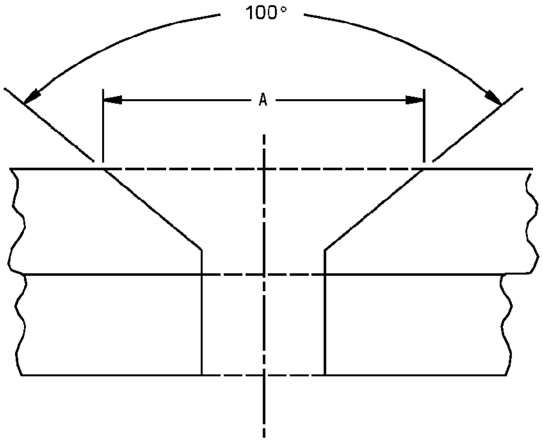
   (2) Countersink dimensions for CSR922 and CSR922F (MS20426) and for CRS924 and CSR924F (NAS1097) Cherry-Buck rivets, refer to Figure 2/GENERAL.

   (3) Rivet hole relief radius dimensions for CSR925 and CSR925F Cherry-Buck rivets, refer to Figure 3/GENERAL.

   (4) Countersink dimensions for 2ASP-FF-DT and 2ASP-509-DT pin and sleeve for ASP (adjustable clamping force positive lock) fasteners, refer to Figure 4/GENERAL.

   (5) Fastener hole relief radius dimensions for 2ASP-PP-DT pin and sleeve for ASP fasteners, refer to Figure 5/GENERAL.

   (6) Countersink dimensions for lightweight GP pins, refer to Figure 6/GENERAL.



COUNTERSINK FOR MS20426 AND NAS1097 TYPE FLUSH HEAD RIVETS
DETAIL I

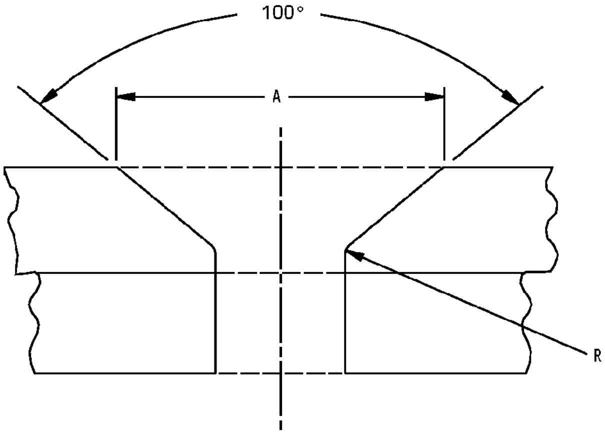
NOM RIVET DIA (INCH)	RIVET SHANK DIA (INCH)	INCLUDED HEAD ANGLE	COUNTERSINK DIA (A)		RELIEF RADIUS	
			MIN (IN)	MAX (IN)	MIN	MAX
0.0937	0.094	100°	0.165	0.179	N/A	N/A
0.1250	0.125	100°	0.207	0.225	N/A	N/A
0.1562	0.156	100°	0.263	0.286	N/A	N/A
0.1875	0.187	100°	0.330	0.353	N/A	N/A

COUNTERSINK DIMENSIONS FOR CSR902B (MS20426) RIVETS
TABLE I

NOM RIVET DIA (INCH)	RIVET SHANK DIA (INCH)	INCLUDED HEAD ANGLE	COUNTERSINK DIA (A)		RELIEF RADIUS	
			MIN (IN)	MAX (IN)	MIN	MAX
0.0937	0.094	100°	0.126	0.144	N/A	N/A
0.1250	0.125	100°	0.174	0.192	N/A	N/A
0.1562	0.156	100°	0.225	0.243	N/A	N/A
0.1875	0.187	100°	0.275	0.298	N/A	N/A

COUNTERSINK DIMENSIONS FOR CSR904B (NAS1097) RIVETS
TABLE II

Countersink Dimensions for Cherry E-Z Buck Rivets - RB211-524 Engines
Figure 1



COUNTERSINK FOR MS20426 AND NAS1097 TYPE FLUSH HEAD RIVETS
DETAIL I

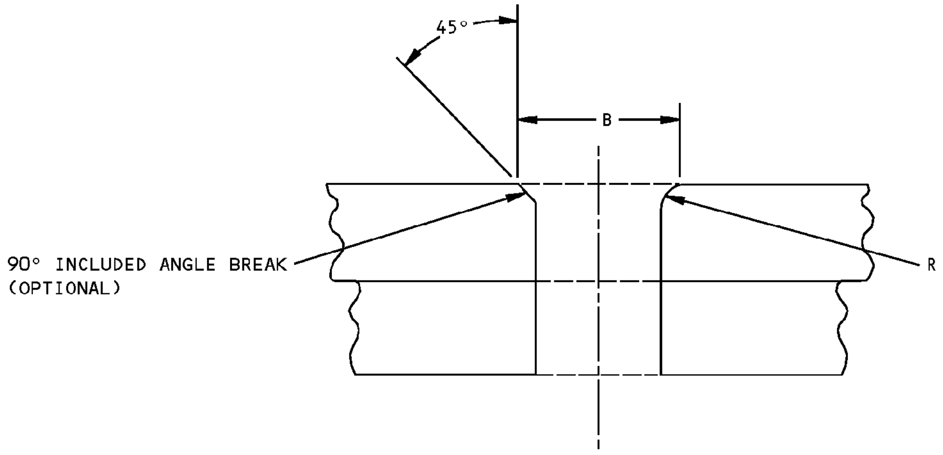
NOM RIVET DIA (INCH)	RIVET SHANK DIA (INCH)	INCLUDED HEAD ANGLE	COUNTERSINK DIA (A)		RELIEF RADIUS	
			MIN (IN)	MAX (IN)	MIN	MAX
0.1562	0.1640	100°	0.271	0.286	0.030	0.040
0.1875	0.1895	100°	0.336	0.353	0.035	0.045
0.2500	0.2495	100°	0.456	0.476	0.035	0.045
0.3125	0.3120	100°	0.540	0.564	0.045	0.055
0.3750	0.3745	100°	0.670	0.694	0.045	0.055

COUNTERSINK DIMENSIONS FOR CSR922 AND CSR922F (MS20426) RIVETS
TABLE I

NOM RIVET DIA (INCH)	RIVET SHANK DIA (INCH)	INCLUDED HEAD ANGLE	COUNTERSINK DIA (A)		RELIEF RADIUS	
			MIN (IN)	MAX (IN)	MIN	MAX
0.1562	0.1640	100°	0.230	0.244	0.030	0.040
0.1875	0.1895	100°	0.282	0.299	0.035	0.045
0.2500	0.2495	100°	0.373	0.392	0.035	0.045
0.3125	0.3120	100°	0.447	0.471	0.045	0.055
0.3750	0.3745	100°	0.534	0.558	0.045	0.055

COUNTERSINK DIMENSIONS FOR CSR924 AND CSR924F (NAS1097) RIVETS
TABLE II

Countersink Dimensions for Cherry Buck Rivets - RB211-524 Engines
Figure 2

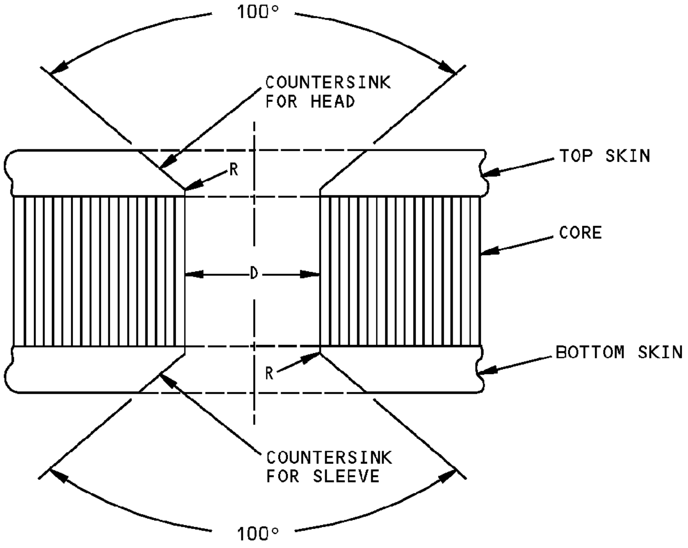


RIVET HOLE RELIEF RADIUS FOR PROTRUDING HEAD RIVETS
DETAIL I

NOM RIVET DIA (INCH)	RIVET SHANK DIA (INCH)	RELIEF ANGLE BREAK (B)		RELIEF RADIUS (R)	
		MIN (IN)	MAX (IN)	MIN (IN)	MAX (IN)
0.1562	0.1640	0.205	0.215	0.025	0.035
0.1875	0.1895	0.248	0.258	0.030	0.040
0.2500	0.2495	0.308	0.318	0.030	0.040
0.3125	0.3120	0.380	0.390	0.035	0.045
0.3750	0.3745	0.444	0.454	0.035	0.045

RELIEF DIMENSIONS FOR PROTRUDING HEAD CSR925 AND CSR925F RIVETS
TABLE I

Rivet Hole Relief Dimensions for Cherry Buck Rivets - RB211-524 Engines
Figure 3



COUNTERSINK HOLE FOR ASP FASTENER PIN AND SLEEVE
DETAIL I

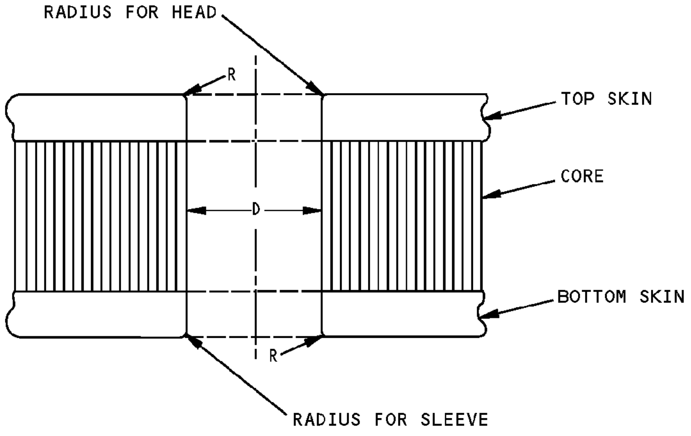
MAX PIN DIA (D)(IN)	MAX SLEEVE DIA (D)(IN)	HEAD ANGLE	COUNTERSINK DIA (A)		RELIEF RADIUS (R)	
			PIN (IN)	SLEEVE (IN)	PIN (IN)	SLEEVE (IN)
0.2025	0.2025	100°	0.302	0.302	0.025	0.025
0.2650	0.2650	100°	0.399	0.399	0.025	0.025
0.3275	0.3275	100°	0.479	0.479	0.025	0.025

COUNTERSINK DIMENSIONS FOR 2ASP-FF-DT PIN AND SLEEVE
TABLE I

MAX PIN DIA (D)(IN)	MAX SLEEVE DIA (D)(IN)	ANGLE	COUNTERSINK DIA (A)		RELIEF RADIUS (R)	
			PIN (IN)	SLEEVE (IN)	PIN (IN)	SLEEVE (IN)
0.2025	0.2025	100°	0.386	0.386	0.025	0.025
0.2650	0.2650	100°	0.507	0.507	0.025	0.025
0.3275	0.3275	100°	0.634	0.634	0.025	0.025

COUNTERSINK DIMENSIONS FOR 2ASP-509F-DT PIN AND SLEEVE
TABLE II

Countersink Dimensions for ASP Fasteners - RB211-524 Engines
Figure 4

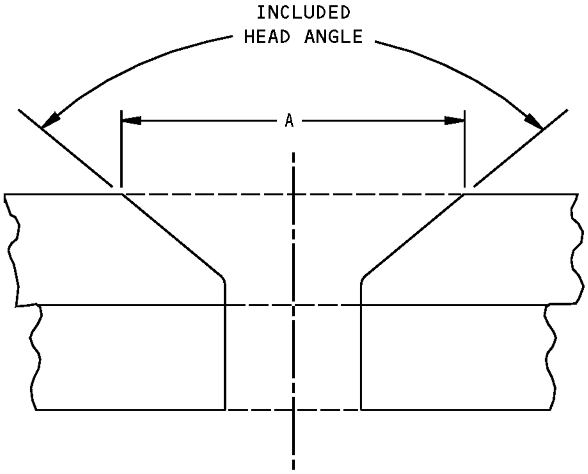


RELIEF RADIUS FOR PROTRUDING HEAD ASP PIN AND SLEEVE
DETAIL I

MAX PIN DIA (D)(IN)	MAX SLEEVE DIA A (D)(IN)	RELIEF RADIUS (R)	
		PIN (IN)	SLEEVE (IN)
0.2025	0.2025	0.025	0.025
0.2650	0.2650	0.025	0.025
0.3275	0.3275	0.025	0.025

RELIEF RADIUS DIMENTIONS FOR 2ASP-PP-DT PIN AND SLEEVE
TABLE I

Relief Radius Dimensions for ASP Protruding Head Fasteners - RB211-524 Engines
Figure 5



COUNTERSINK FOR GP LIGHTWEIGHT PINS
DETAIL I

LGP PIN PART NUMBER	NOMINAL DIAMETER	INCLUDED HEAD ANGLE	COUNTERSINK DIA (IN.)	
			MIN (IN.)	MAX (IN.)
LGPL2SC-V05	0.165	100°	0.2026	0.2028
LGPL2SC-V06	0.190	100°	0.2439	0.2441
LGPL2SC-V08	0.250	100°	0.3313	0.3315
LGPL2SC-V10	0.312	100°	0.4045	0.4047
LGPL2SC-V12	0.375	100°	0.4852	0.4854

COUNTERSINK DIMENSIONS FOR LGPL2SC-V PINS
TABLE I

LGP PIN PART NUMBER	NOMINAL DIAMETER	INCLUDED HEAD ANGLE	COUNTERSINK DIA (IN.)	
			MIN (IN.)	MAX (IN.)
LGPL9SC-V05B	0.165	130°	0.2558	0.2560
LGPL9SC-V06B	0.190	130°	0.2980	0.2982
LGPL9SC-V08B	0.250	130°	0.4048	0.4050
LGPL9SC-V10B	0.312	130°	0.4789	0.4791
LGPL9SC-V12B	0.375	130°	0.5940	0.5942

COUNTERSINK DIMENSIONS FOR LGPL9SC-V PINS
TABLE II

Countersink Dimensions for LGPL2SC-V and LGPL9SC-V Pins - RB211-524 Engines
Figure 6

GENERAL - COLDWORKING OF HOLES FOR FATIGUE IMPROVEMENT - RB211-524 ENGINES

1. General

A. The fatigue properties of an aluminum structure can be improved by compressing the material locally around the periphery of the fastener holes. The method used is known as cold working fo fastener holes. This is acheived by pulling mandrel through an undersize hole, thus enlarging the hole and compressing the surrounding metal.

B. Though the process is used elsewhere in the airplane structure, it is not used in the fan cowls, reverser cowls, or integrated nozzle structure of the RB211-524 powerplant nacelle components.

GENERAL - SYMMETRY AND INCIDENT CHECK PROCEDURES

1. General

A. Symmetry and incidence checks measure differences between selected points on the left and right sides of the airplane structure. These checks will aid in evaluating structural deformations that may have occurred on the airplane.

B. Symmetry and incidence checks may be made if structural deformation is suspected after heavy landings, severe flight maneuvers, unsatisfactory in-flight operation, or repairs to major structural components. Large variations between measurements may indicate major structural damage.

C. A symmetry check measures corresponding dimensions on the left and right sides of the airplane.

D. An incidence check measures wing and horizontal stabilizer angles of incidence.

2. References

Reference	Title
AMM 12-15-00	Aircraft Maintenance Manual
AMM 20-41-00	Aircraft Maintenance Manual
AMM 32-00-00	Aircraft Maintenance Manual

3. Prepare the Airplane

A. The airplane should be located in an enclosed area on a hard and level surface. Jacking and leveling of the airplane is not required. The area should be free of air movement and variations in temperature.

  (1) Shut off all fans and air conditioning equipment in the building.

  (2) Close all outside doors during windy weather.

B. If no enclosed area is available, do the following:

  (1) Position the airplane on a hard and level surface.

  (2) Head the airplane into wind, if applicable.

  (3) Do the checks:

    (a) when wind velocity is less than 10 knots.

    (b) at night, on cloudy days, or with shade covering the entire airplane.

C. Do not take measurements for at least 1 hour after airplane has been exposed to direct sunlight or after any engine has been in operation.

D. Statically ground airplane as given in AMM 20-41-00.

E. Install all landing gear ground locks and door locks as given in AMM 32-00-00.

F. Defueling is not required, but the fuel load must be equal on each side of the airplane.

NOTE: A minimum of 600 gallons of fuel in each wing tank is needed to cover the hydraulic system heat exchangers. Ground hydraulic power must be used if heat exchangers are not covered.

G. Setting flight control surfaces.

WARNING: BEFORE OPERATING, ALL PERSONNEL MUST BE CLEAR OF THE OPERATING ENVELOPE OF ALL CONTROL SURFACES AND MOVING PARTS. PERSONAL INJURY CAN OCCUR.

(WARNING PRECEDES)

CAUTION: TO PREVENT STRUCTURAL DAMAGE, ALL TOOLS, WORK STANDS, ETC., MUST BE CLEAR OF THE OPERATING ENVELOPE OF ALL CONTROL SURFACES AND MOVING PARTS.

(1) Retract leading edge slats, flaps, and spoilers. Position ailerons, rudder, and elevators in their neutral positions.

H. Measure the exposed inner cylinder on both main landing gear shock struts as shown in Figure 3/GENERAL. If a difference of over 1.00 inch exists between measurements, inflate or deflate the shock struts as given in AMM 12-15-00 to bring them within limits.

I. Close all entry and cargo doors.

J. Open core cowl panels to gain access to power plant symmetry point S11.

4. Symmetry Check

A. General

(1) A symmetry check requires the equipment shown in Figure 4/GENERAL.

(2) See Figure 1/GENERAL for the location of symmetry points and for the dimensions to be measured.

(3) Take measurements with a 150-foot steel tape and a 25-pound spring scale used to measure tape tension. The spring scale is attached to the steel tape. Measurements must be taken at identical tape tension to minimize tape sag differences between measurements on each side of the airplane.

B. Measurement Procedure

(1) Review the symmetry check diagram shown in Figure 1/GENERAL to identify measurements using common points. Sequence of measurements should be made to take advantage of measurements from a common point.

(2) Position lift devices, ladders, stands, etc. for access to the symmetry points.

(3) Attach the spring scale to the tape end to apply tension (see Paragraph 4.C./GENERAL for approximate distances). Place the other end of the tape against the selected symmetry point and apply 15 pounds of tension. Take readings to make sure that the tape is pulled past and against the point being measured.

(4) Attach the pointer tool shown in Figure 4/GENERAL, Detail I, to the tape and align the zero mark on the pointer with the foot-mark on the tape.

NOTE: The pointer tool is required when making measurements A, B and K (CF6-80A engine) only.

(5) Record the measurements.

(6) Calculate the difference after making measurements on a set of comparative points.

(7) Recheck the measurements if the actual difference is greater than the allowable values shown in Figure 5/GENERAL.

(8) See Paragraph 6./GENERAL for the interpretation of the results.

(9) Take measurements with a 150-foot steel tape and a 25-pound spring scale used to measure tape tension. The spring scale is attached to the steel tape. Measurements must be taken at identical tape tension to minimize tape sag differences between measurements on each side of the airplane.

C. Measurements

CAUTION: DO NOT STAND ON THE WINGS WHEN TAKING MEASUREMENTS. EXCESSIVE WEIGHT WILL CAUSE DEFLECTION AND CAN RESULT IN ERRONEOUS READING. USE A STANDARD ADJUSTABLE WORKSTAND OR SCAFFOLDING.

(1) Measurement A
  - (a) Symmetry points for this measurement are S5 and S6.
  - (b) Use of a pointer tool is required for this measurement.

    NOTE: Align the pointer tool parallel with tape for accurate readings.
  - (c) Point S5 is a common point for measurement B.
  - (d) Point S6 is a common point for measurement E.

(2) Measurement B

CAUTION: DO NOT STAND ON THE HORIZONTAL STABILIZERS WHEN TAKING MEASUREMENTS. EXCESSIVE WEIGHT WILL CAUSE DEFLECTION AND CAN RESULT IN ERRONEOUS READING. USE A STANDARD WORKSTAND OR SCAFFOLDING.

  - (a) Symmetry points for this measurement are S5 and S8.
  - (b) Use of a pointer tool is required for this measurement.

    NOTE: Align the pointer tool parallel with tape for accurate readings.
  - (c) Point S5 is a common point for measurement A.

(3) Measurement C
  - (a) Symmetry points for this measurement are S1 and S7.
  - (b) Point S7 is a common point for measurement D.

(4) Measurement D
  - (a) Symmetry points for this measurement are S3 and S7.
  - (b) Point S7 is a common point for measurement C.
  - (c) Point S3 is a common point for measurement H.

(5) Measurement E

CAUTION: DO NOT STAND ON THE WINGS WHEN TAKING MEASUREMENTS. EXCESSIVE WEIGHT WILL CAUSE DEFLECTION AND CAN RESULT IN ERRONEOUS READINGS. USE A STANDARD ADJUSTABLE WORKSTAND OR SCAFFOLDING.

  - (a) Symmetry points for this measurement are S6 and S9.
  - (b) Point S6 is a common point for measurement A.
  - (c) Point S9 is a common point for measurement F.

(6) Measurement F
  - (a) Symmetry points for this measurement are S4 and S9.
  - (b) Point S9 is a common point for measurement E.

(7) Measurement G
  - (a) Symmetry points for this measurement are S2 and S12.
  - (b) Point S12 requires the use of tow ring target as shown in Figure 4/GENERAL, Detail III.

(c) Point S2 is a common point for measurements J and K.

(8) Measurement H

(a) Symmetry points for this measurement are S3 and S13.

(b) Point S13 requires the use of tow ring target as shown in Figure 4/GENERAL, Detail III.

(c) Point S3 is a common point for measurement D.

(9) Measurement J

(a) Symmetry points for this measurement are S2 and S11.

(b) Point S2 is a common point for measurements G and K.

(10) Measurement K

(a) Symmetry points for this measurement are S2 and S10.

(b) Use of a pointer tool is required for this measurement on CF6-80A engines.

NOTE: Align the pointer tool parallel with tape for accurate readings.

(c) Point S2 is a common point for measurements G and J.

5. Incidence Check

A. General

(1) An incidence check requires the equipment as shown in Figure 4/GENERAL. Use a 72-inch support on wing measurements and a 36-inch support on horizontal stabilizer measurements.

(2) See Figure 2/GENERAL for the locations of incidence points I1 and I2.

B. Wing Incidence Measurement Procedure

CAUTION: MAKE SURE THAT NO MORE THAN TWO PERSONS ARE ON THE WING OR HORIZONTAL STABILIZER DURING THE AIRPLANE INCIDENCE CHECK. TOO MUCH WEIGHT CAN CAUSE A RESULT THAT IS NOT ACCURATE

(1) Determine a line of measurement as shown in Figure 2/GENERAL, Detail II.

(2) Position the inclinometer support along the measurement line with the forward pointer at I1. Make sure that the support is perpendicular to the wing surface.

NOTE: To make sure that comparative readings between the left and right side wings are made, mark the forward end of the inclinometer support with masking tape.

(3) Place the inclinometer on the support. Measure and record the angle of incidence dimension.

(4) Recheck both measurements (left and right side) if the difference is greater than the allowable values shown in Figure 5/GENERAL.

(5) Refer to Paragraph 7./GENERAL for the interpretation of the results.

(6) Measurement K

(a) Symmetry points for this measurement are S2 and S10.

(b) Point S2 is a common point for measurements G and J.

C. General

(1) An incidence check requires the equipment as shown in Figure 4/GENERAL. Use a 72-inch support on wing measurements and a 36-inch support on horizontal stabilizer measurements.

(2) See Figure 2/GENERAL for the locations of incidence points I1 and I2.

D. Wing Incidence Measurement Procedure

(1) Determine a line of measurement as shown in Figure 2/GENERAL, Detail II.

CAUTION: MAKE SURE THAT NO MORE THAN TWO PERSONS ARE ON THE WING OR HORIZONTAL STABILIZER DURING THE AIRPLANE INCIDENCE CHECK. TOO MUCH WEIGHT CAN CAUSE A RESULT THAT IS NOT ACCURATE

(2) Position the inclinometer support along the measurement line with the forward pointer at I1. Make sure that the support is perpendicular to the wing surface.

NOTE: To make sure that comparative readings between the left and right side wings are made, mark the forward end of the inclinometer support with masking tape.

(3) Place the inclinometer on the support. Measure and record the angle of incidence dimension.

(4) Recheck both measurements (left and right side) if the difference is greater than the allowable values shown in Figure 5/GENERAL.

(5) Refer to Paragraph 7./GENERAL for the interpretation of the results.

E. Horizontal Stabilizer Incidence Measurement Procedure

CAUTION: MAKE SURE THAT NO MORE THAN TWO PERSONS ARE ON THE WING OR HORIZONTAL STABILIZER DURING THE AIRPLANE INCIDENCE CHECK. TOO MUCH WEIGHT CAN CAUSE A RESULT THAT IS NOT ACCURATE

(1) Determine a line of measurement as shown in Figure 2/GENERAL, Detail III.

(2) Position the inclinometer support along the measurement line with the forward pointer at I2. Make sure that the support is perpendicular to the horizontal stabilizer surface.

NOTE: To make sure that comparative readings between the left and right side stabilizers are made, mark the forward end of the inclinometer support with masking tape.

(3) Place the inclinometer on the support. Measure and record the angle of incidence dimension.

(4) Recheck both measurements (left and right side) if the difference is greater than the allowable values shown in Figure 5/GENERAL.

(5) Refer to Paragraph 7./GENERAL for the interpretation of the results.

6. Terminating Procedure

A. Restore the airplane to normal as ginen in the 767 AMM.

7. Interpretation of Results

A. Where allowable differences are equal to or less than values shown in Figure 5/GENERAL, the airplane may be restored to normal and returned to service.

B. Where allowable differences are greater than values shown in Figure 5/GENERAL, more investigation is necessary. Analyze the dimensions to find possible areas of structural damage. Usual indications of structural damage are:

(1) Buckled or cracked skins, spar webs or chords, stiffeners, castings, forgings or machined parts.

(2) Loose or tilted fasteners.

(3) Fastener failure in tension or shear.

(4) Fuel leaks in the wing fuel tank areas.

(5) Excessive air leaks in pressurized body areas noted by stains on the body skin.

(6) Cracked paint indicating relative movement of components.

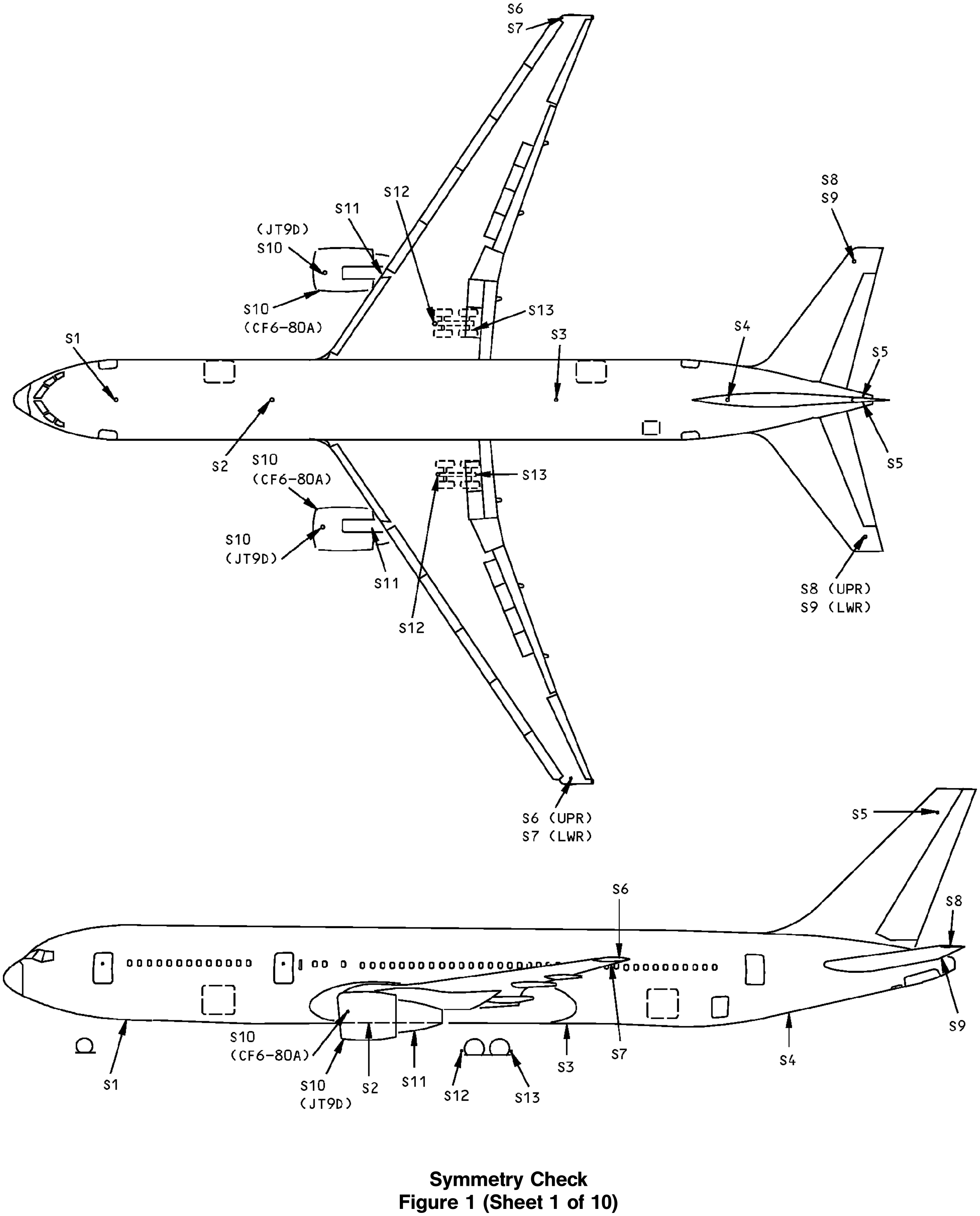
(7) Interference in door and access panel closures due to surrounding structural distortion.

(8) Interference of moving parts of a mechanism.

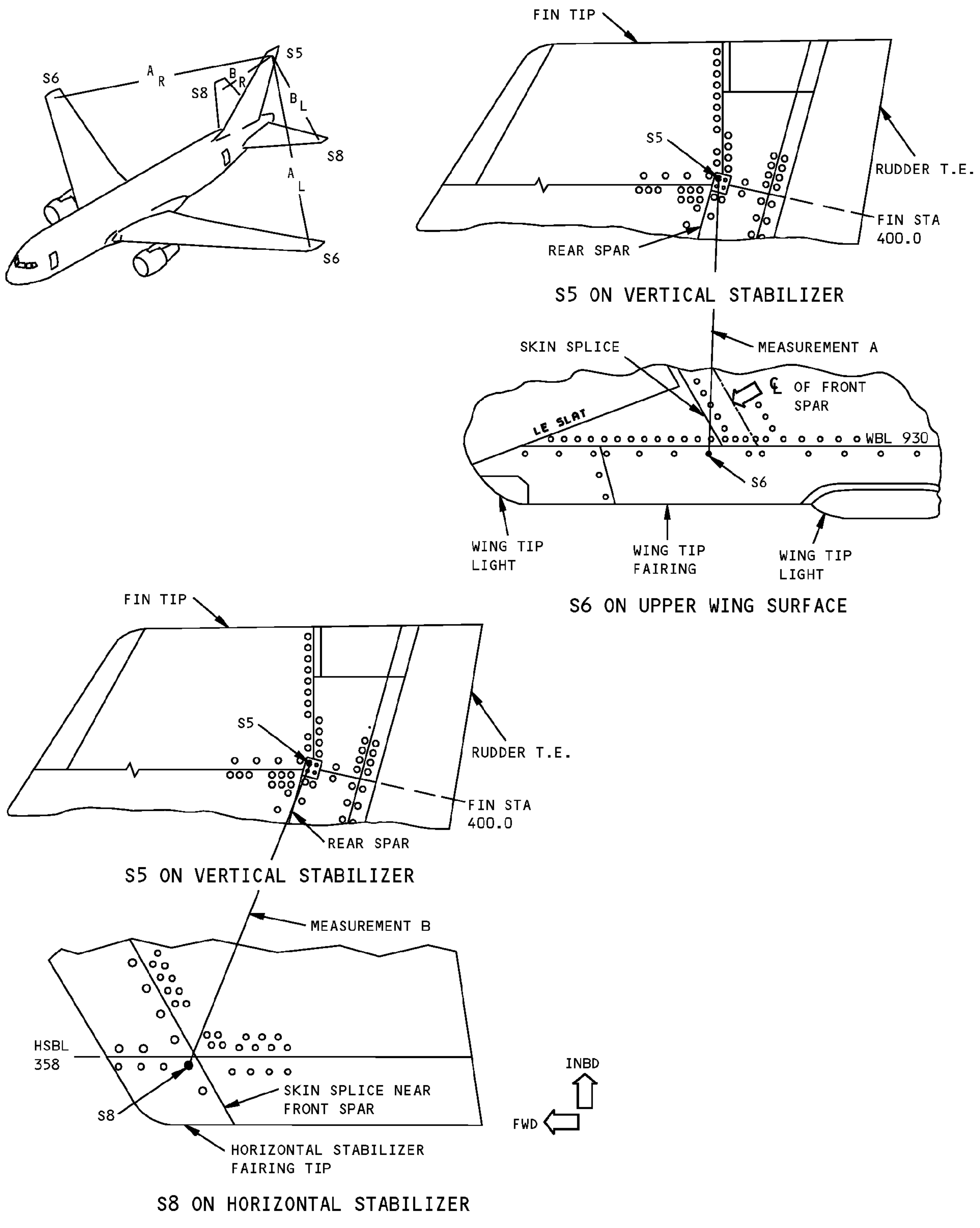
(9) Excessive control surface trim.

(10) Misalignment or overlapping of control surfaces.

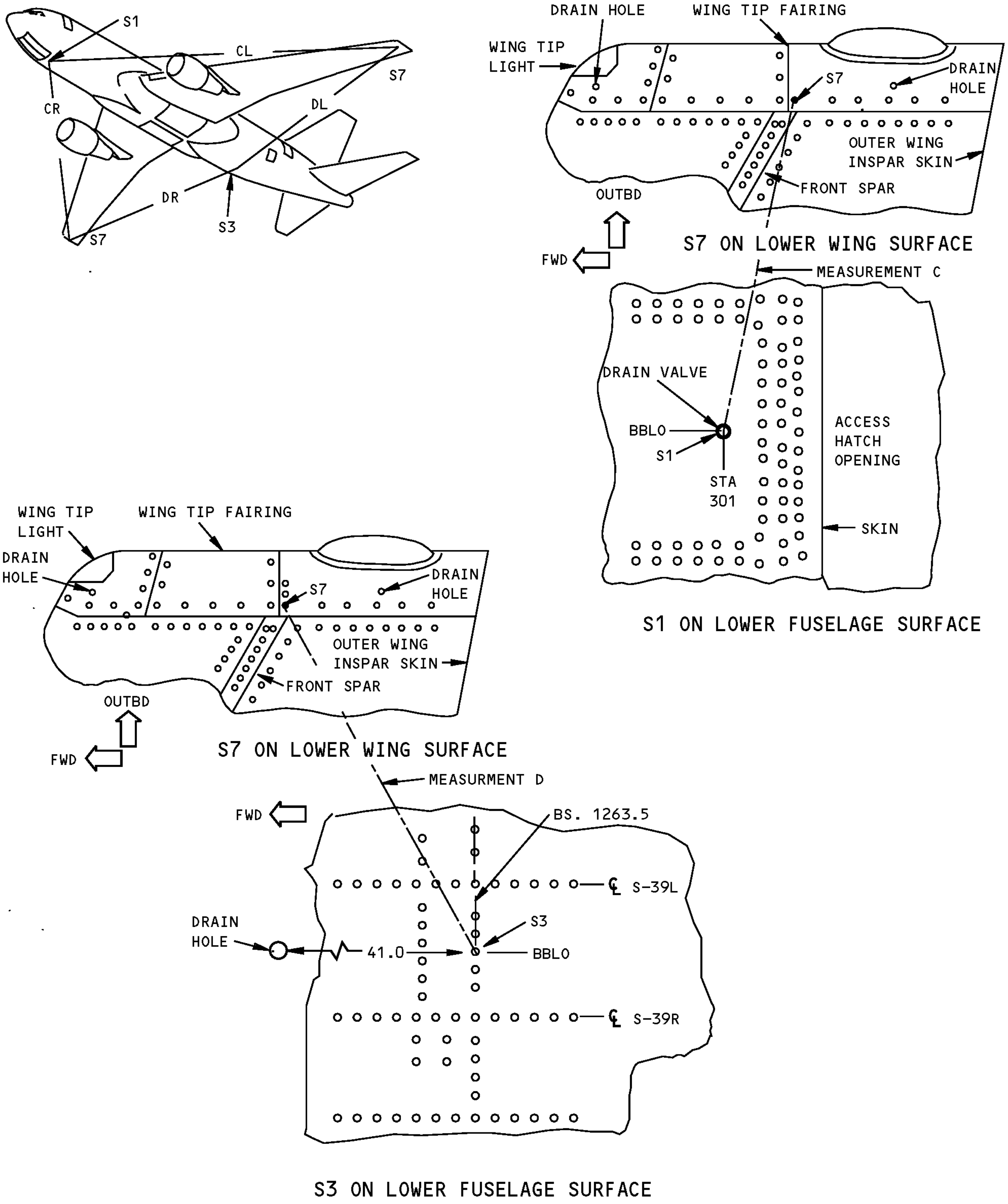
C. When inspection shows no signs of structural damage accounting for the measured difference found by the symmetry or incidence check, consult a qualified structural and/or aerodynamics engineer to determine if the airplane may be returned to service.



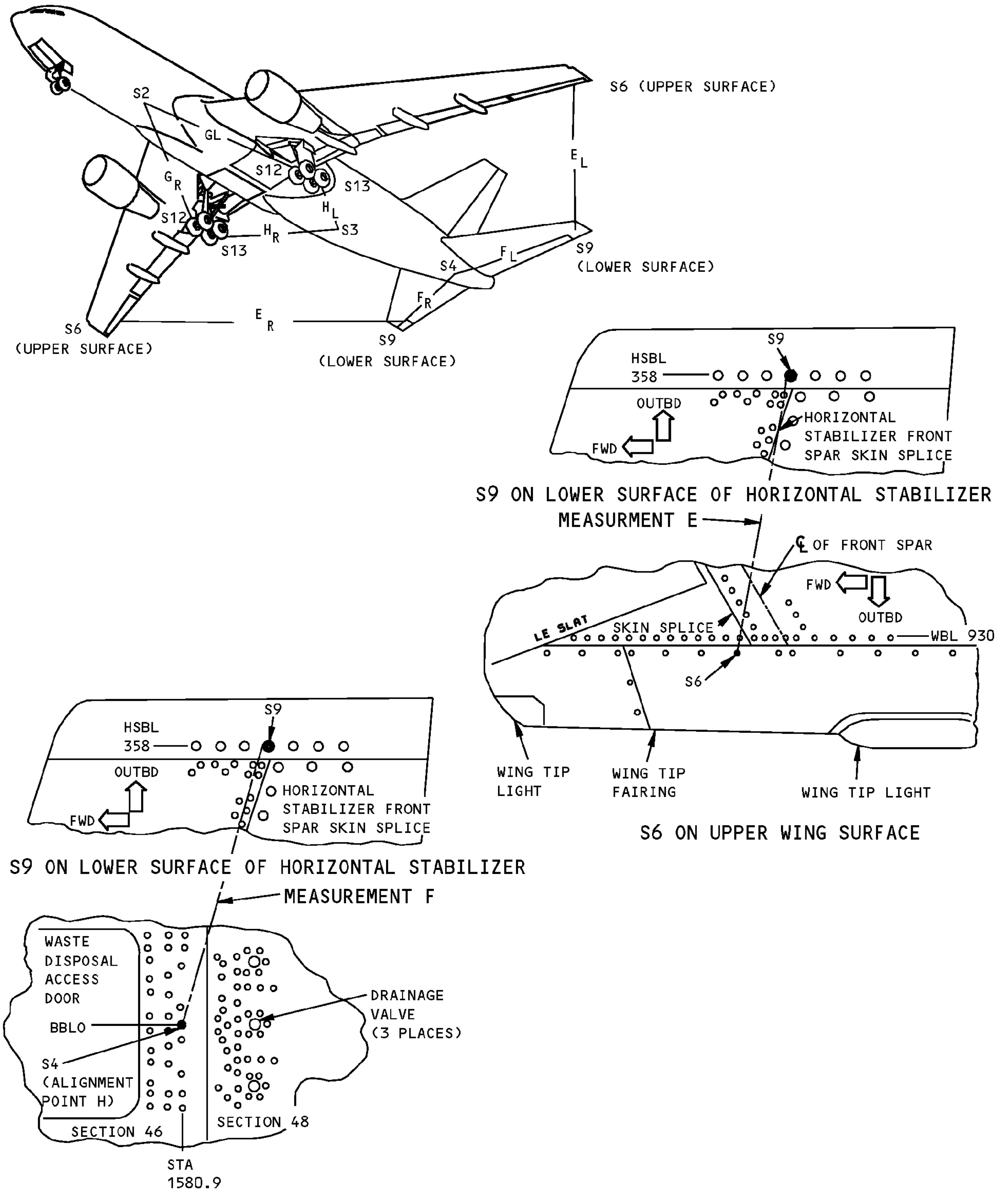
Symmetry Check
Figure 1 (Sheet 1 of 10)



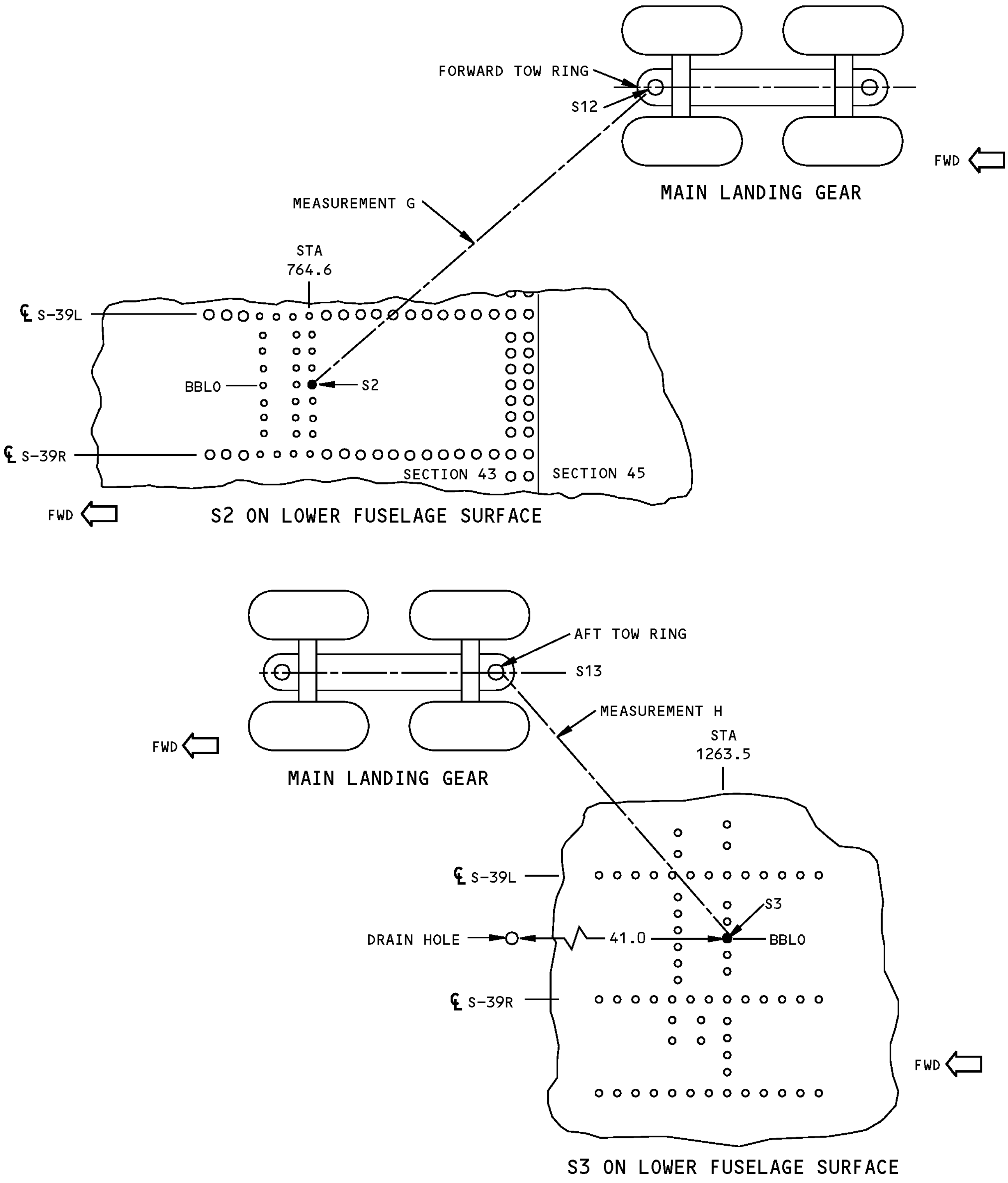
Symmetry Check
Figure 1 (Sheet 2 of 10)



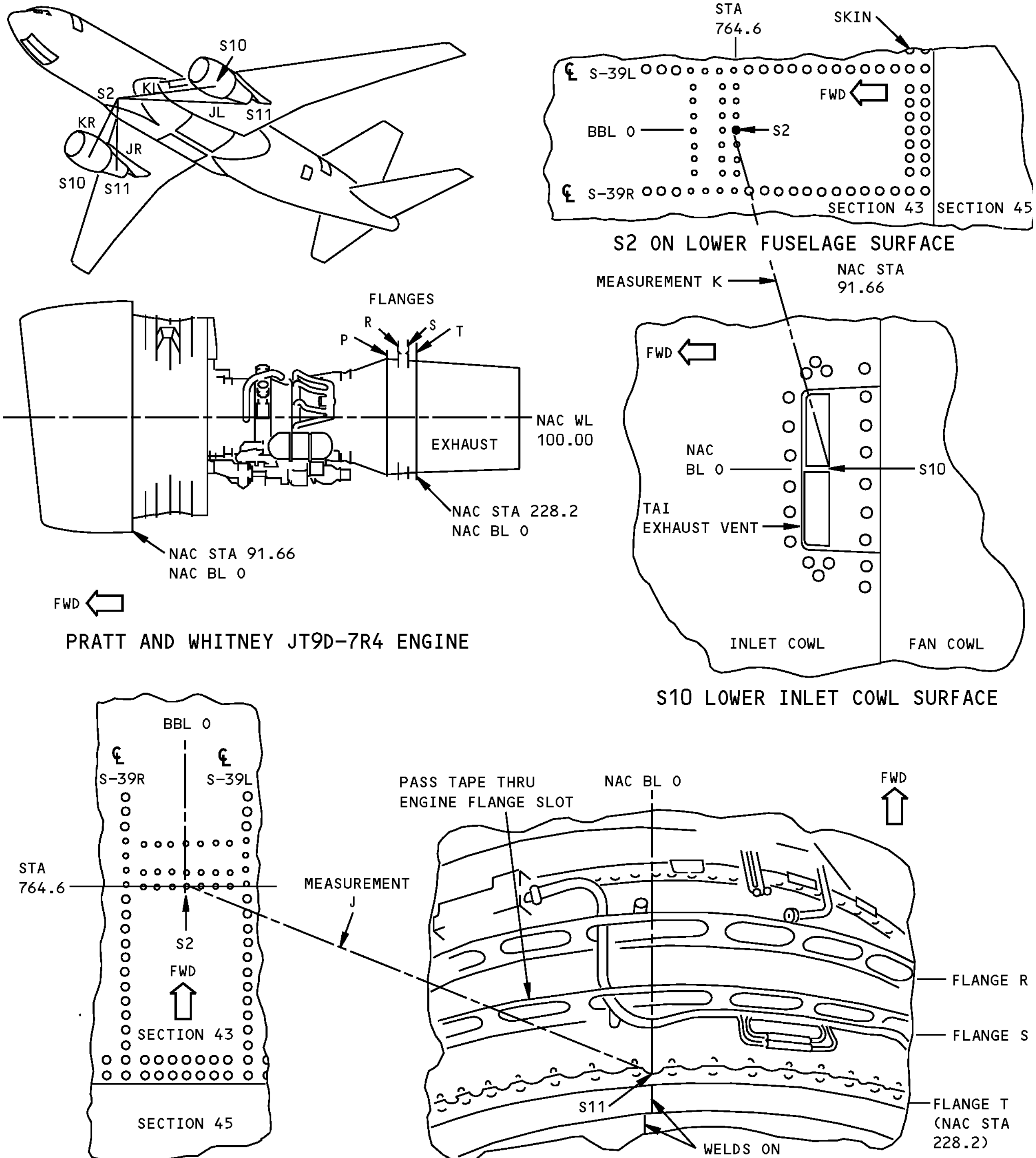
Symmetry Check
Figure 1 (Sheet 3 of 10)



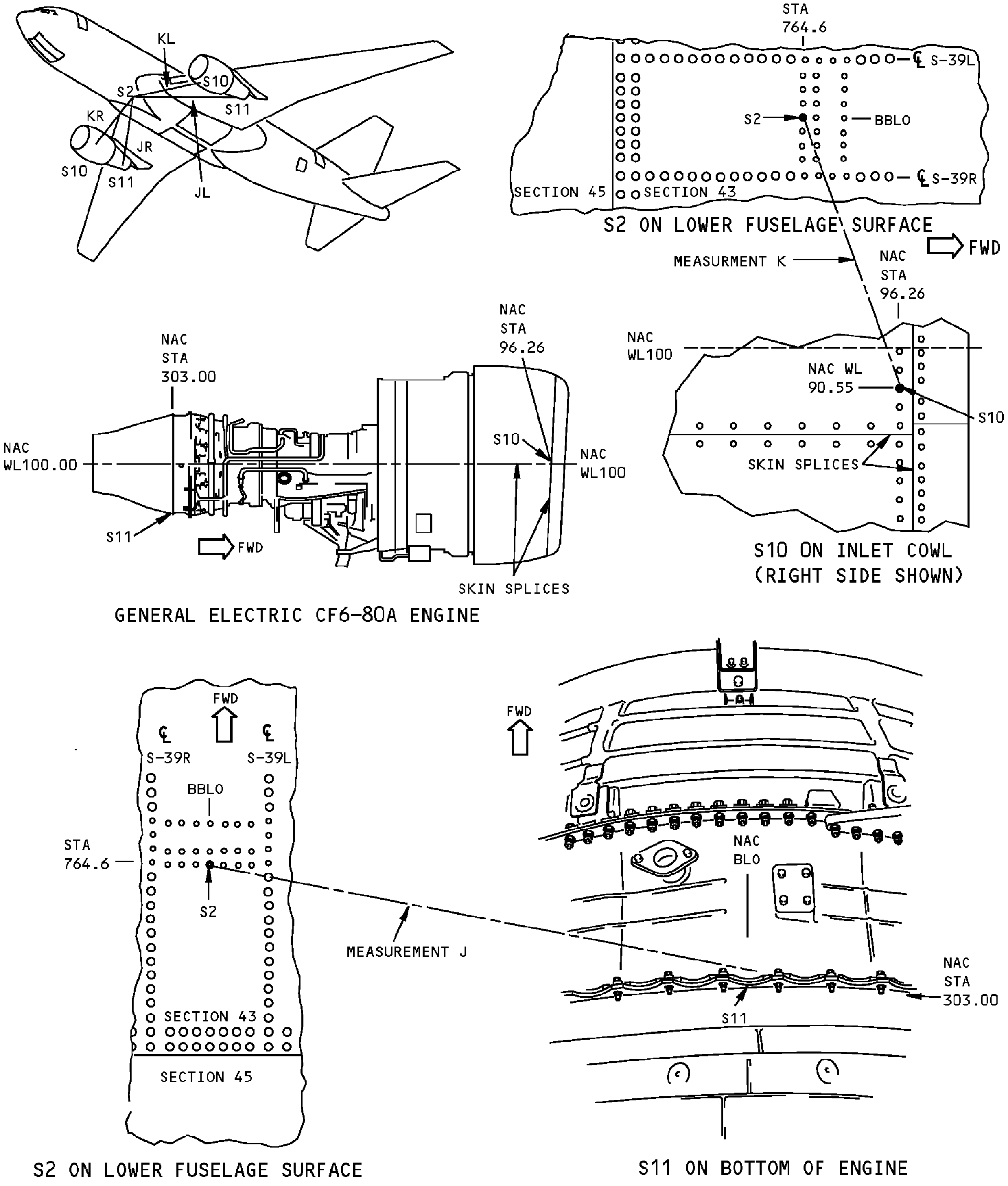
Symmetry Check
Figure 1 (Sheet 4 of 10)



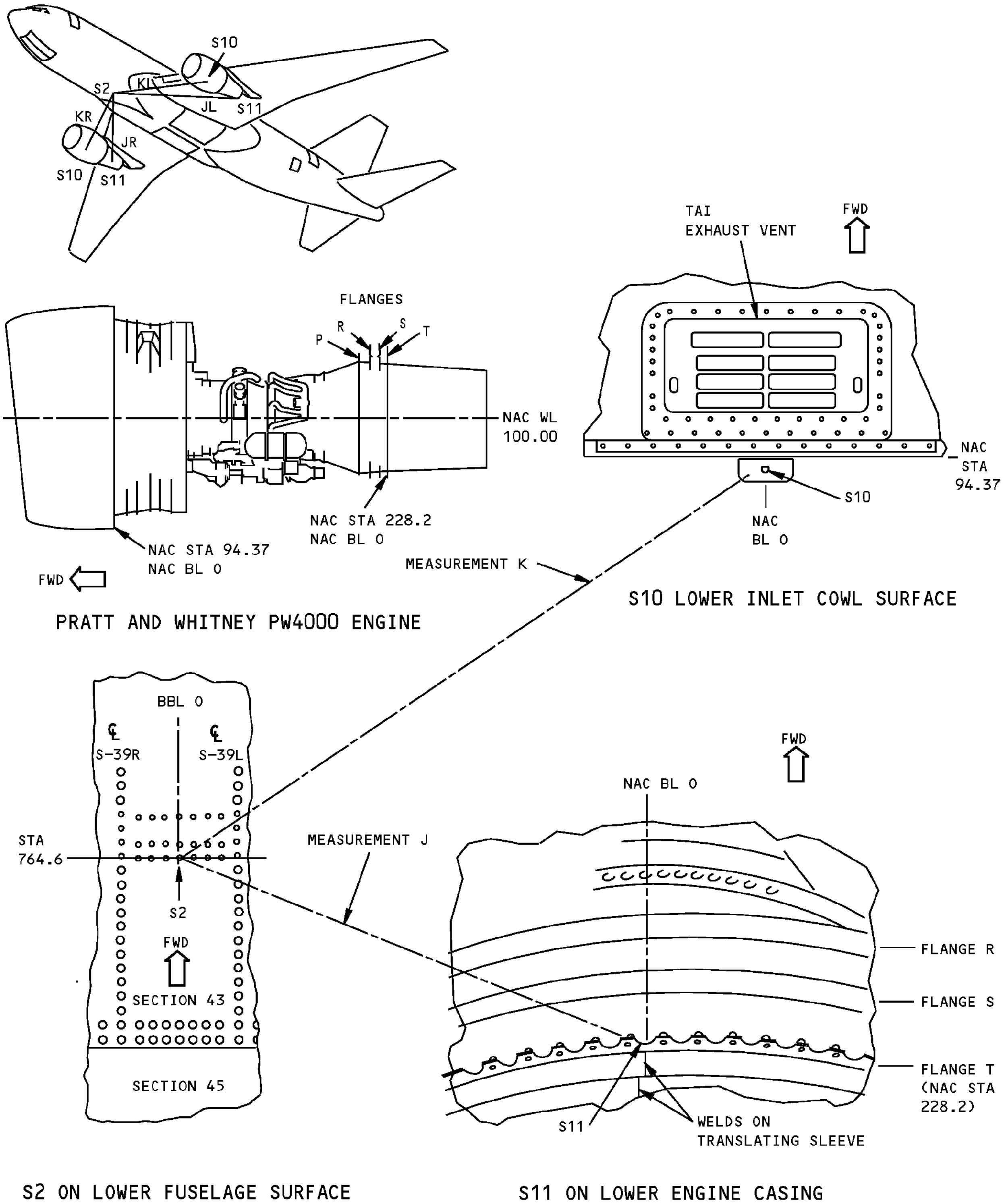
Symmetry Check
Figure 1 (Sheet 5 of 10)



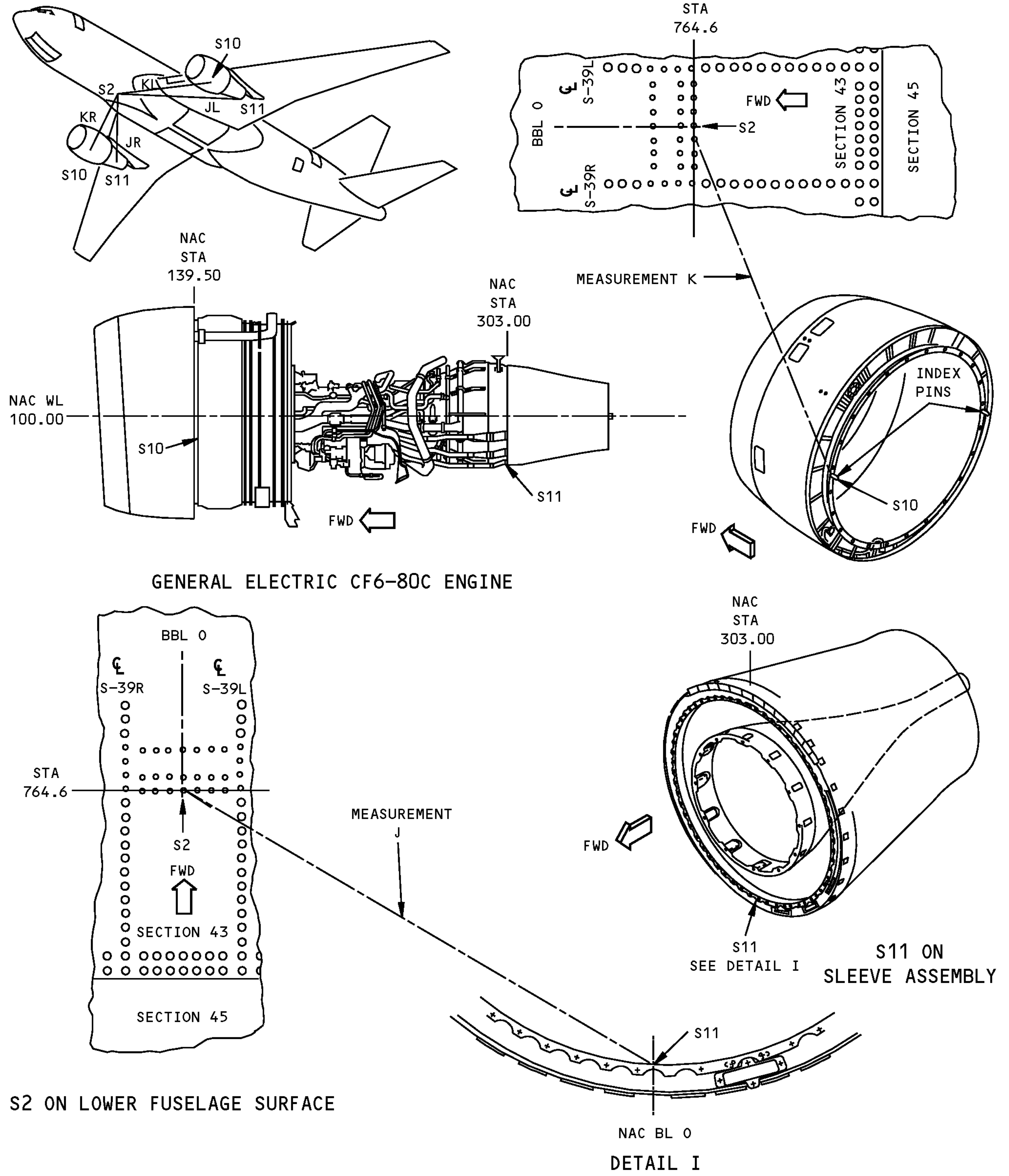
Symmetry Check
Figure 1 (Sheet 6 of 10)



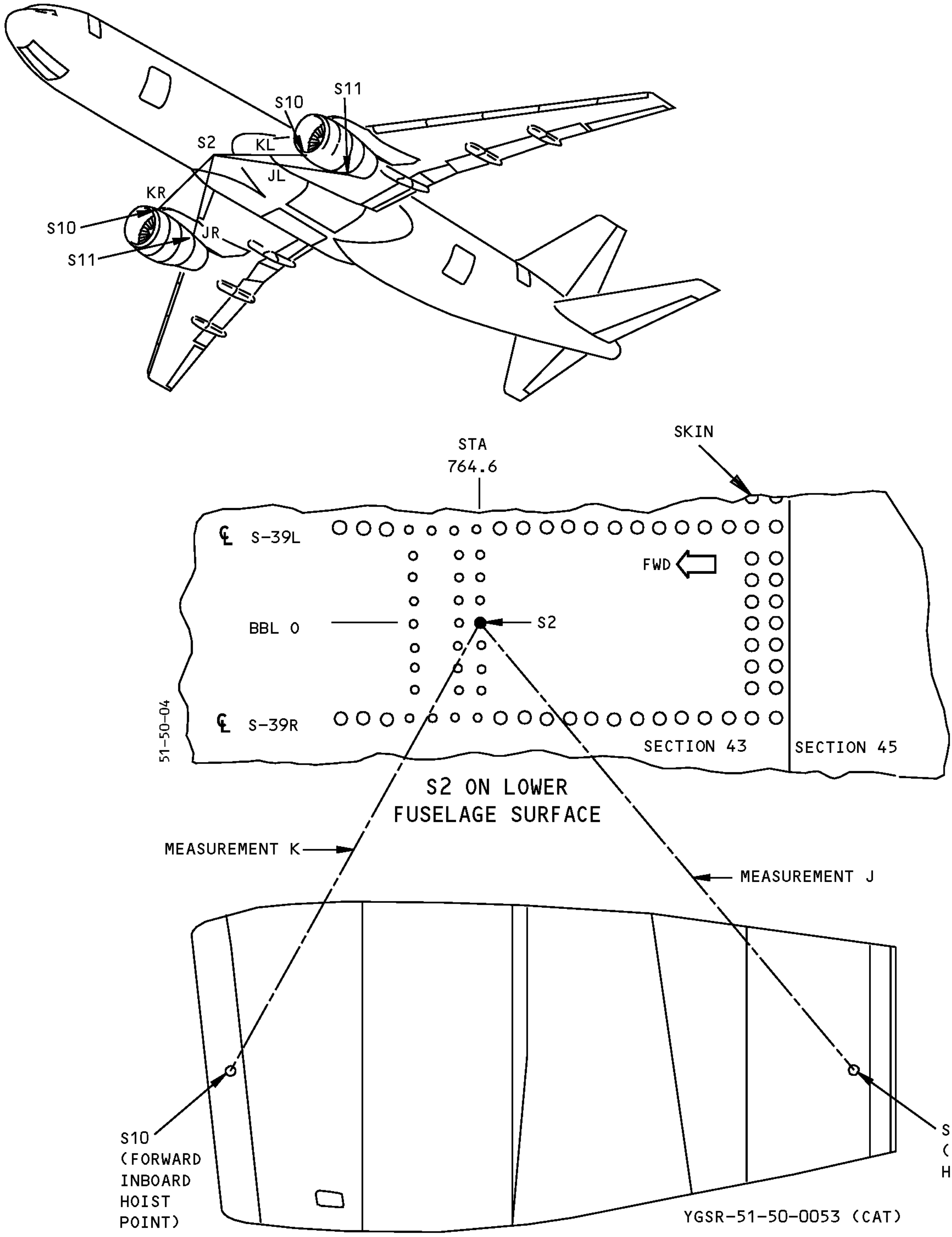
Symmetry Check
Figure 1 (Sheet 7 of 10)



Symmetry Check
Figure 1 (Sheet 8 of 10)

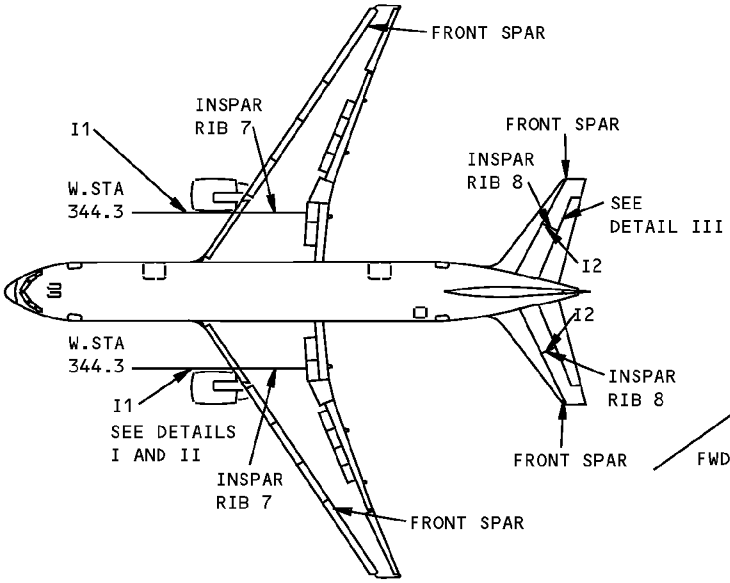


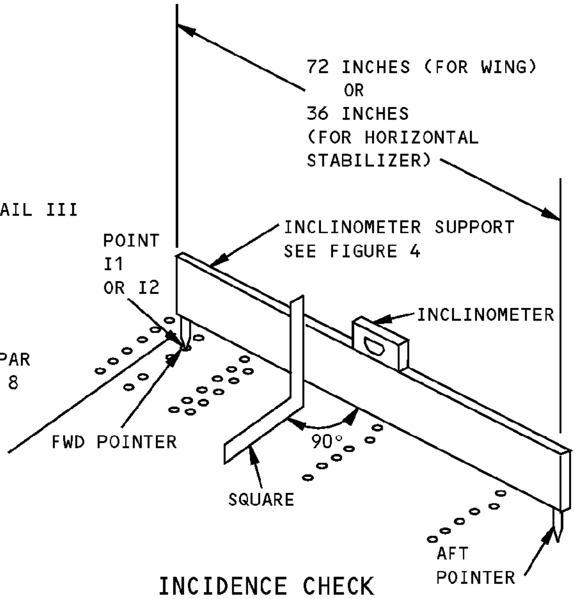
Symmetry Check
Figure 1 (Sheet 9 of 10)



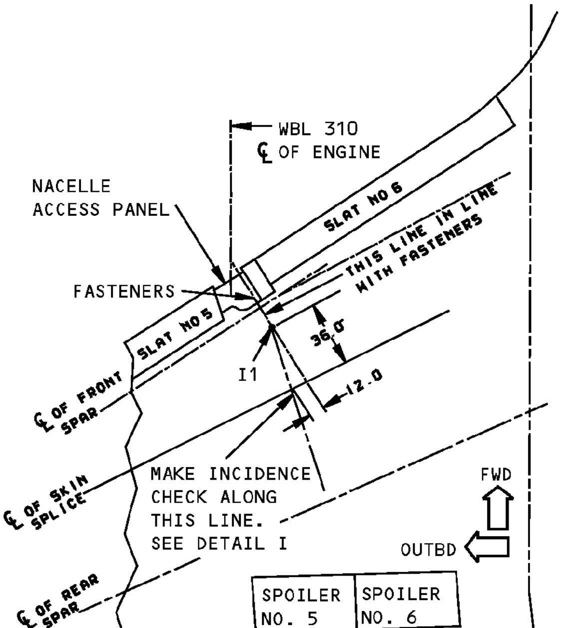
ROLLS-ROYCE
RB211-524 ENGINE

Symmetry Check
Figure 1 (Sheet 10 of 10)

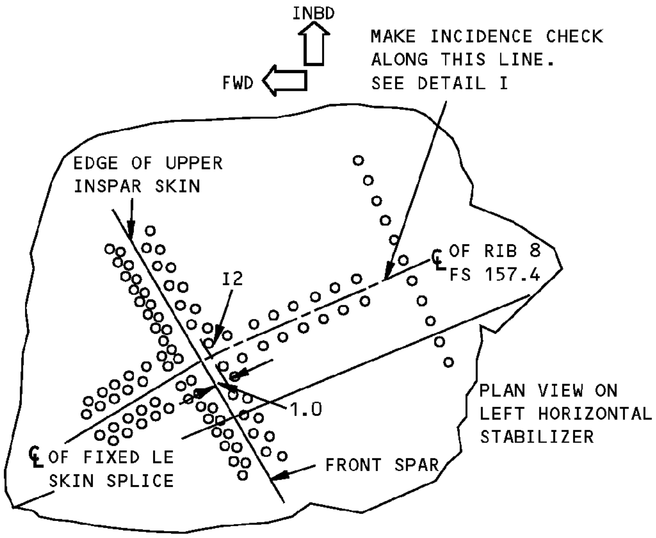




INCIDENCE CHECK
DETAIL I

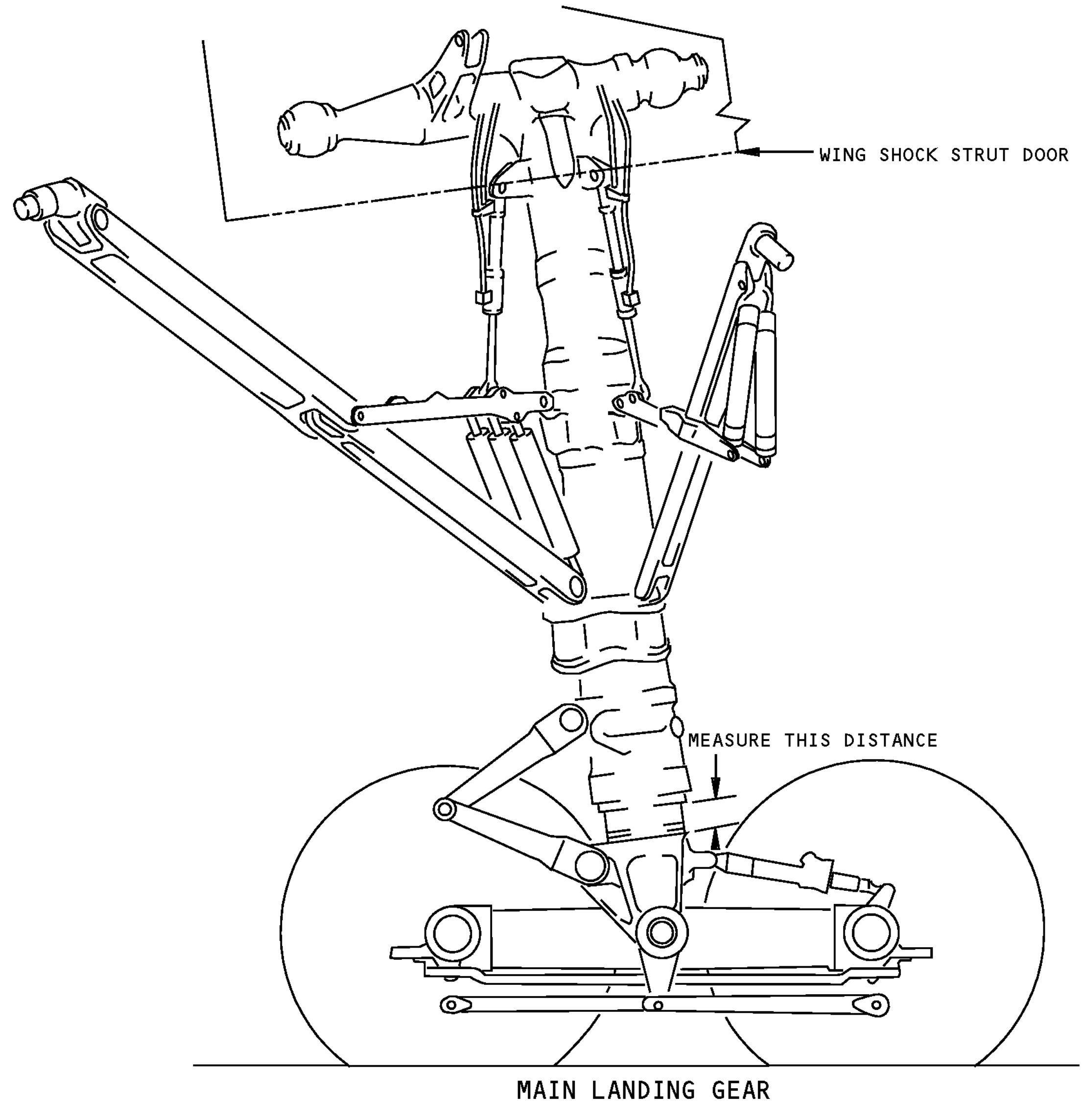


WING CHECK
DETAIL II



HORIZONTAL STABILIZER CHECK
DETAIL III

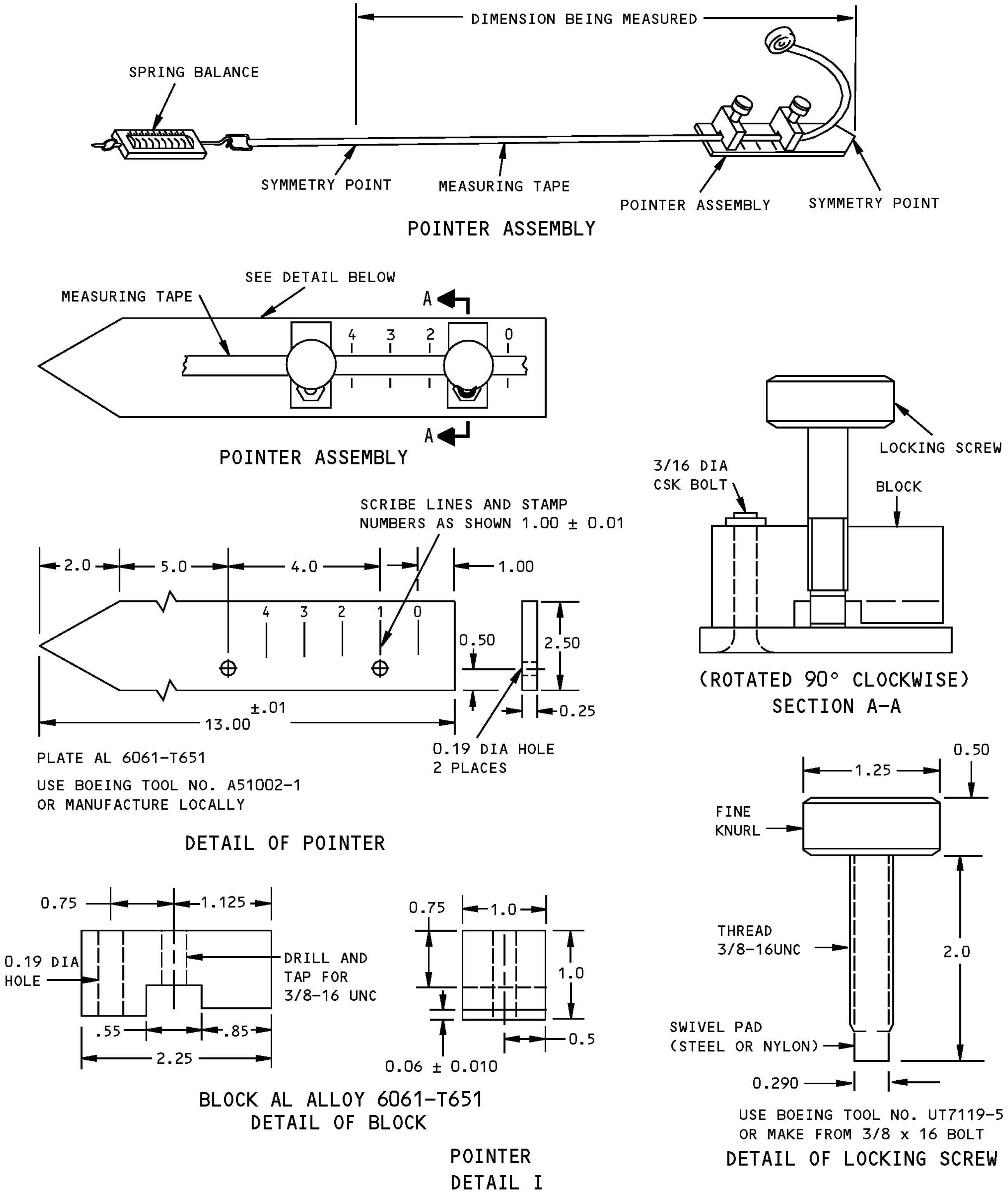
Incidence Check
Figure 2



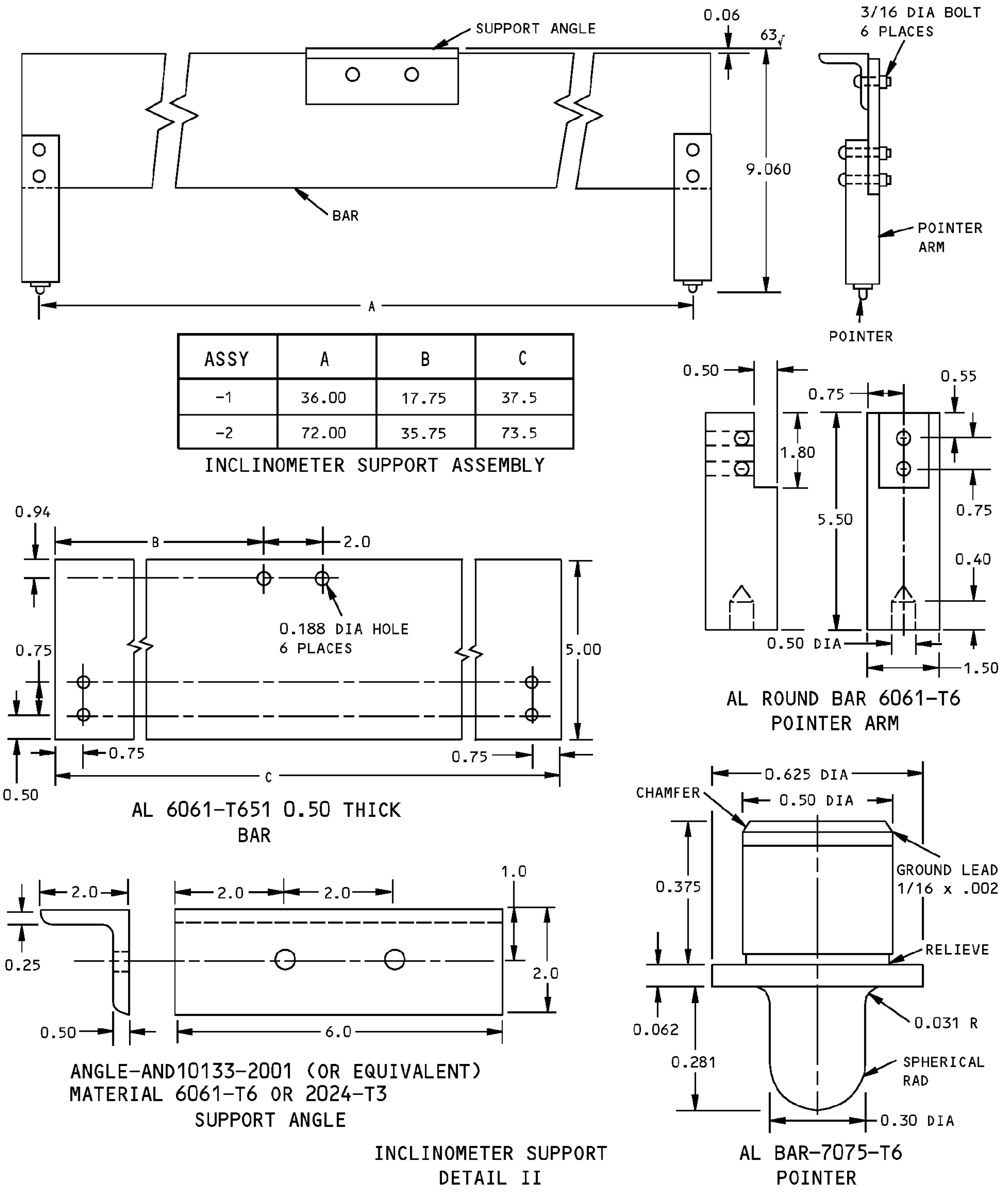
Main Landing Gear
Figure 3

ITEM	NO. REQ'D	IDENTIFICATION	SOURCE
SCAFFOLDING	2		ANY SOURCE
TAPE MEASURE, 150-FOOT STEEL	1	LUFKIN - MODEL HW226, GRADUATED IN 0.10 OF AN INCH OR EQUIVALENT	ANY SOURCE
25-POUND SPRING SCALE	1	CHATILLION	ANY SOURCE
INCLINOMETER	1	HIGER - MODEL TB108	ANY SOURCE
POINTER	1	DETAIL I	FABRICATE
INCLINOMETER SUPPORT 72"	1	DETAIL II	FABRICATE
INCLINOMETER SUPPORT 36"	1	DETAIL II	FABRICATE
TOW RING TARGET	1	DETAIL III	FABRICATE
SQUARE	1		ANY SOURCE

Symmetry and Incidence Check Equipment
Figure 4 (Sheet 1 of 4)



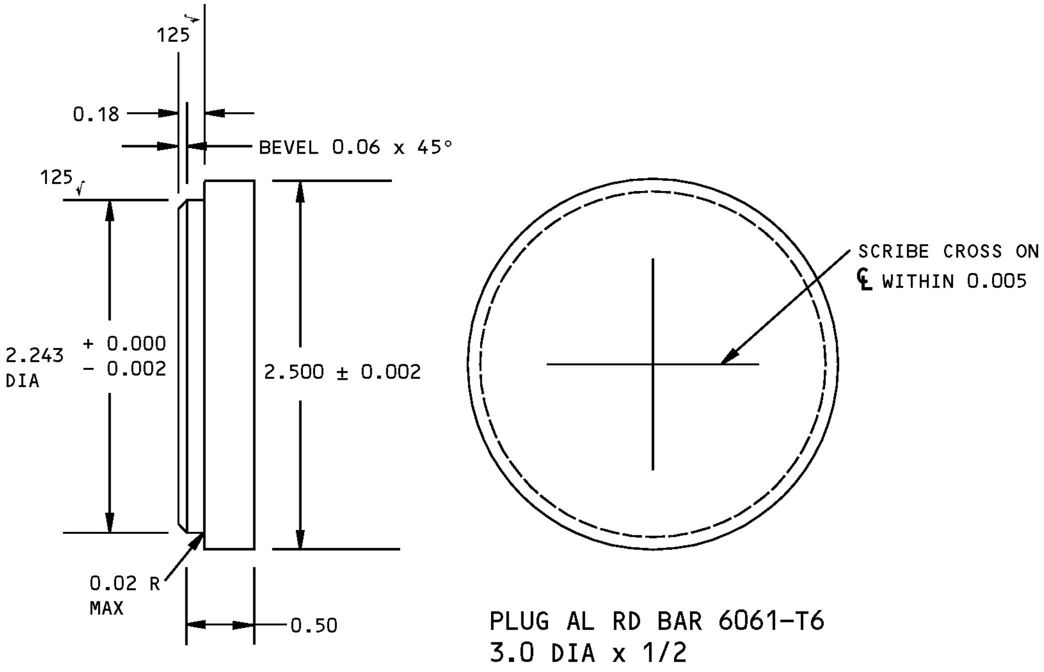
Symmetry and Incidence Check Equipment
Figure 4 (Sheet 2 of 4)



ASSY	A	B	C
-1	36.00	17.75	37.5
-2	72.00	35.75	73.5

INCLINOMETER SUPPORT ASSEMBLY

Symmetry and Incidence Check Equipment
Figure 4 (Sheet 3 of 4)



TOW RING TARGET
DETAIL III

Symmetry and Incidence Check Equipment
Figure 4 (Sheet 4 of 4)

DIMENSION	ALLOWABLE DIFFERENCE
A	3.00
B	1.20
C	1.30
D	1.00
E	1.50
F	1.00
G	1.00
H	1.50
J	1.00
K	1.00
I1	0°-20'
I2	0°-20'

Symmetry and Incidence Allowable Differences
Figure 5

GENERAL - SUPPORT OF AIRPLANE FOR REPAIRS

1. General

A. This subject covers the procedures for supporting the airplane in jig position prior to making major repairs to the fuselage, wing, and empennage.

B. The airplane should be located on the most level surface available which is capable of bearing loads imposed by airplane jacks and supplementary support equipment, Figure 3/GENERAL.

C. Refer to Figure 1/GENERAL for location of jacks and supplementary support equipment for supporting the airplane in jig position.

D. See Figure 2/GENERAL for location of airplane alignment points.

E. Refer to Paragraph 3./GENERAL for support of fuselage in jig position.

F. Refer to Paragraph 4./GENERAL for support of wing in jig position.

G. Statically ground the airplane (Refer to AMM 20-40-01).

2. References

Reference	Title
AMM 07-11-01	Aircraft Maintenance Manual
AMM 08-21-00	Aircraft Maintenance Manual
AMM 20-40-01	Aircraft Maintenance Manual
AMM 28-26-00	Aircraft Maintenance Manual

3. Support of Fuselage in Jig Position

A. Raise and level the airplane as given in AMM 07-11-01, AMM 07-11-01and AMM 08-21-00.

B. Level the airplane longitudinally as follows:

  (1) Set up engineers level and establish a water line plane below WL 106.63 Point G (Figure 2/GENERAL).

  (2) Take readings with leveling instruments at fuselage alignment points.

  (3) Subtract the reading for point G from readings taken from point H to obtain the height above WL 106.63.

  (4) Adjust the jack support at point C (Figure 1/GENERAL, Detail I) until point H is at the height specified in Figure 2/GENERAL, Table I. Refer to AMM 07-11-01 for maximum allowable loads at jack locations

  (5) As an alternative checking procedure, the readings at point H can be corrected after establishing a height difference between points F and G.

  (6) Check alignment point A for the correct height. If necessary, raise or lower the nose jack at point D for an additional check made at alignment point H.

C. Position supplementary fuselage supports at their respective locations shown in Figure 1/GENERAL and raise supports until they come in contact with the fuselage.

CAUTION: DO NOT TAKE LOAD OFF HYDRAULIC JACKS EXCEPT AS NOTED IN PAR.PARAGRAPH 3.D./GENERAL THE AFT FUSELAGE JACK POINT C IS OFFSET FROM BL 0.0 AND THEREFORE HAS A TENDENCY TO TWIST THE FUSELAGE WHEN JACKING THE AIRPLANE. BECAUSE THIS CAN CAUSE AN UNDESIRED EFFECT ON REPAIRS TO BE MADE, IT MAY BE NECESSARY TO REMOVE THE AFT FUSELAGE JACK AT C.

D. The aft fuselage jack at point C may be removed provided extreme caution is taken to ensure that all supplementary supports are in place and are not exceeding the allowable loads.

E. Make periodic checks of alignment point heights and plumb bob positions to ensure that distortion is not built up into the airplane structure while being supported. Any deviations in readings must be corrected before continuing repairs.

4. Support of Wing in Jig Position

A. Defuel the airplane in accordance with AMM 28-26-00.

B. Raise and level airplane as given in AMM 07-11-01.

C. Install the wing stabilizing jacks at jacking points E and F (Figure 1/GENERAL) so that the jacks fit snug against the jack adapters. Apply a minimum load of 3000 pounds to stabilize the wings. Refer to AMM 07-11-01 for jacking procedures.

D. Raise the wing stabilizing jack by hand jacking only until the wing is slightly above jig position.

E. Position the supplementary wing supports, Figure 1/GENERAL, either the cradle (Detail II or III) or the support fixture (Detail IV) whichever is the most convenient. Raise the supports until they come in contact with the lower wing surface. See Figure 1/GENERAL for theoretical loads at supplementary supports.

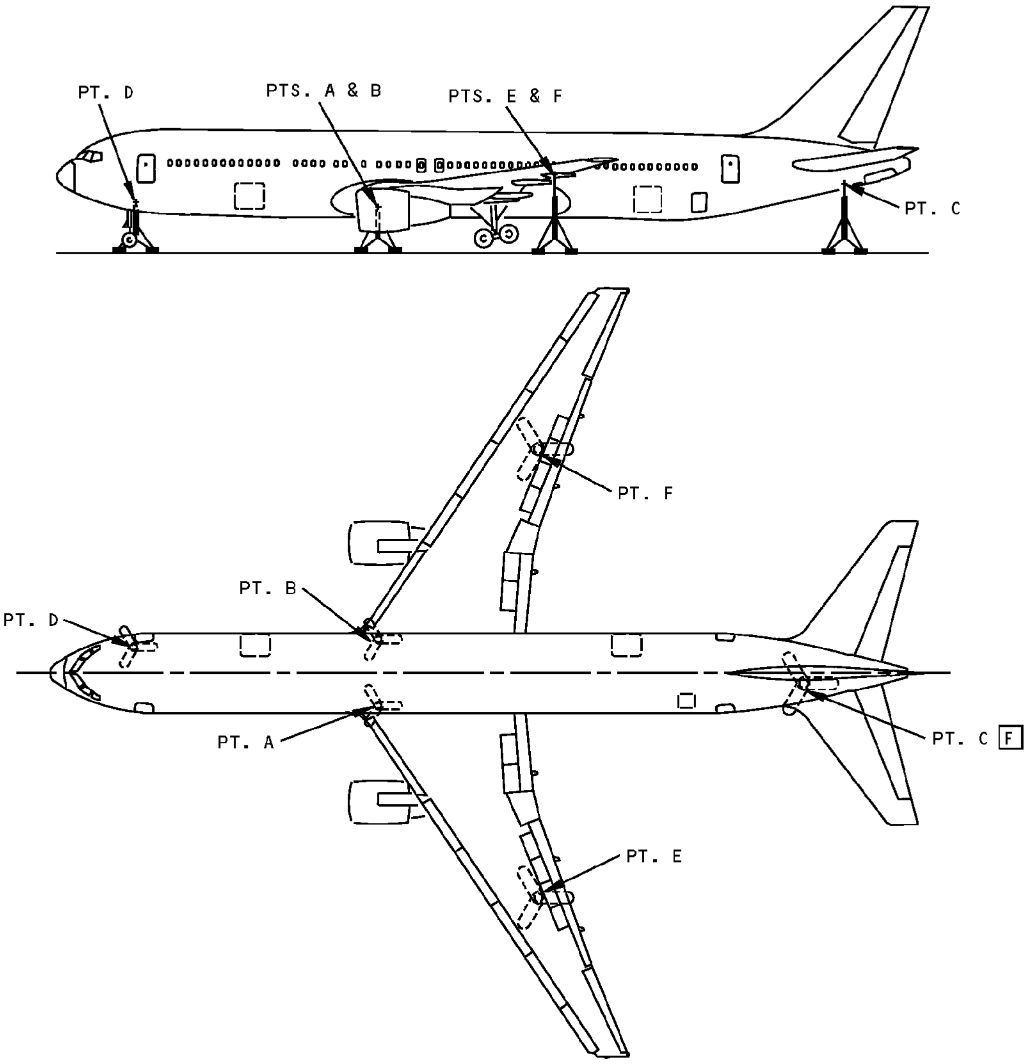
NOTE: Supplementary supports must be used if the engine has not been removed from the wing. Ensure that no distortion is being built into the wing box by overjacking either support.

F. For repairs to be made to the wing in the vicinity of the engine pylons the engine must be removed or supported.

G. Periodically check the location of water line values of the alignment points to ensure that no distortion is being built into the wing during repairs. Any deviation in readings must be corrected before continuing repair.

5. Support of Horizontal Stabilizer in Jig Position

A. When making a major repair to the horizontal stabilizer, supplementary supports may be used (Figure 3/GENERAL).

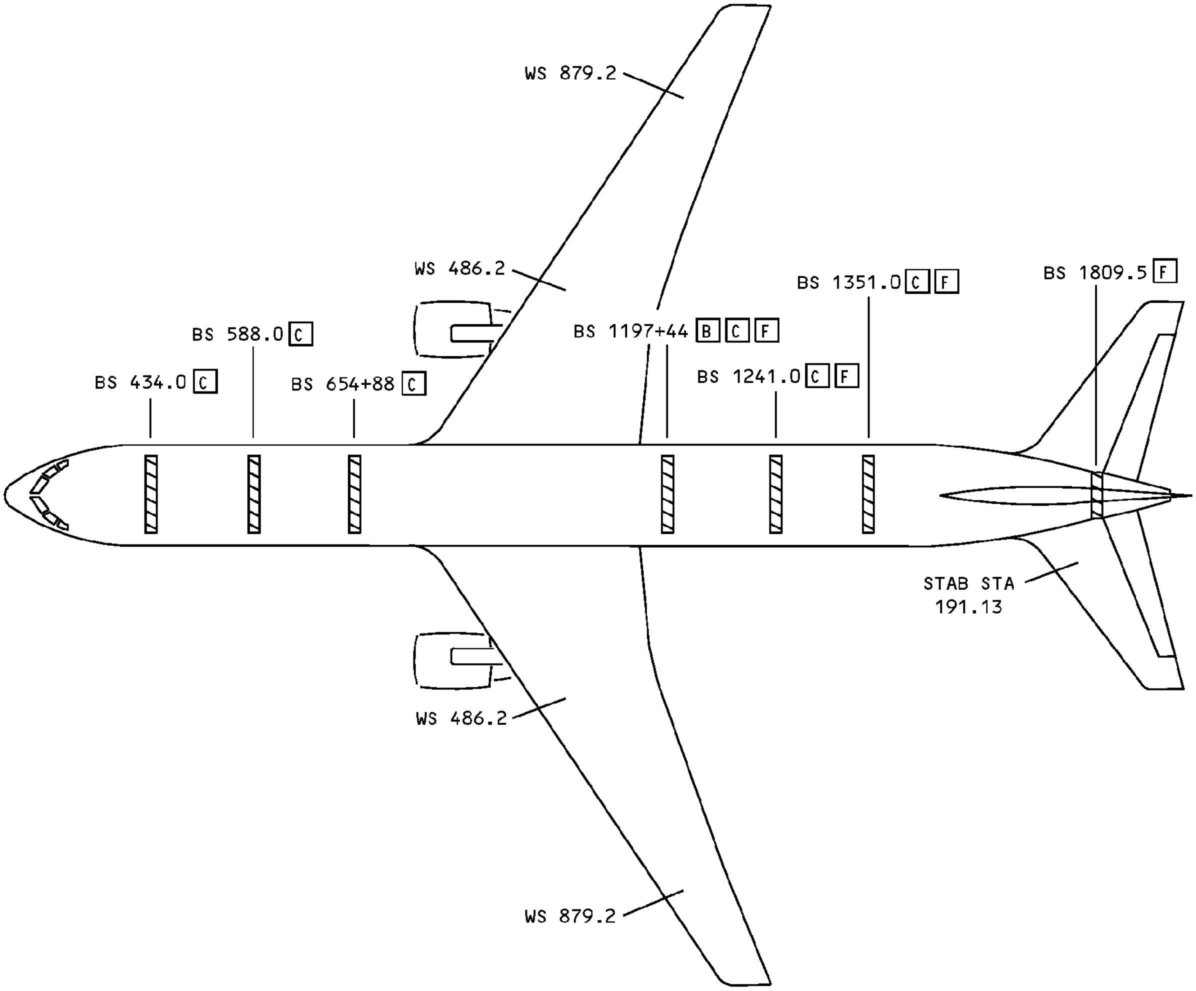


PRIMARY AND AUXILIARY JACK POINT LOCATIONS [A]
DETAIL I

NOTES

- [A] FOR JACKING LOADS AND JACKING INFORMATION REFER TO 07-11-01 OF THE MAINTENANCE MANUAL
- [B] REMOVE WING-TO-BODY FAIRING
- [C] EXAMPLE LOCATION
- [D] WITHIN THE CONSTANT SECTION (BS 422 TO BS 1352) CRADLES MAY BE CENTERED ON ANY FRAME AND LOADED TO A MAXIMUM OF 10,000 LBS OR TO 7,500 LBS FOR CRADLES CENTERED ON ADJACENT FRAMES. USE AS FEW OR AS MANY CRADLES AS REQUIRED IN THIS SECTION
- [E] NO SUPPLEMENTARY SUPPORTS ARE ALLOWED IN SECTION 48 (BS 1582.0 TO BS 1952.0) EXCEPT AT BODY STATION 1809.5
- [F] USE EXTREME CAUTION IF JACK IS REMOVED AT POINT C. SEE PAR 2.D.

Location of Jacking Points and Support Equipment for Airplane in Jig Position
Figure 1 (Sheet 1 of 2)



SUPPLEMENTARY SUPPORT
EQUIPMENT LOCATION
DETAIL II

SUPPLEMENTARY SUPPORT LOCATION E	MAXIMUM ALLOWABLE LOAD IN JIG POSITION
CONSTANT BODY SECTION (BODY STATION 434.0 TO BODY STATION 1351.0)	D

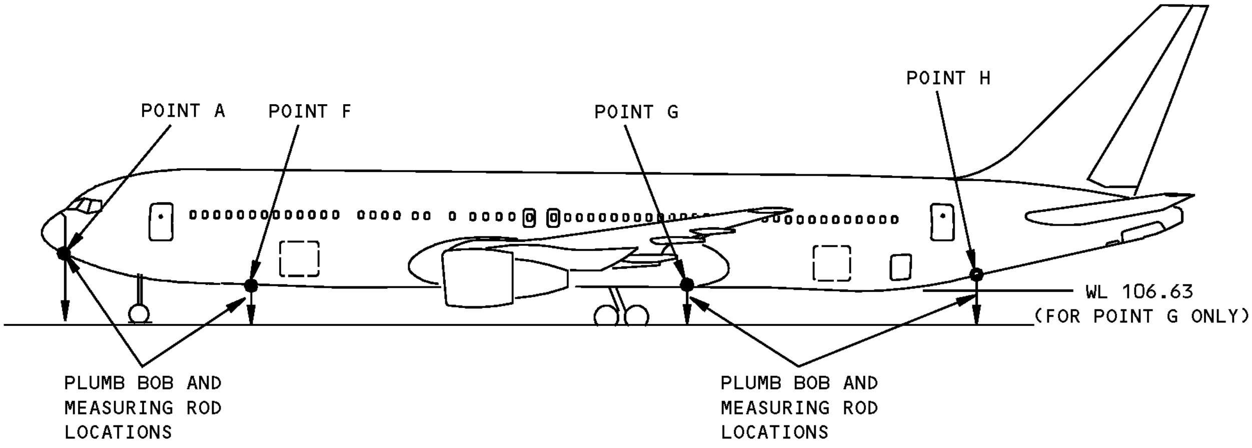
SUPPLEMENTARY SUPPORT LOADS

SUPPLEMENTARY SUPPORT LOCATION	MAXIMUM ALLOWABLE LOAD IN JIG POSITION
BODY STATION 1809.5	30,000 POUNDS
WING STATION 486.2	12,000 POUNDS
WING STATION 879.2	8,000 POUNDS

SUPPLEMENTARY SUPPORT LOADS

Location of Jacking Points and Support Equipment for Airplane in Jig Position
Figure 1 (Sheet 2 of 2)

REFERENCE DRAWING
012T2200



DETAIL I

ALIGNMENT CHECKPOINT	BODY STATION	BODY BUTTOCK LINE	BODY WATER LINE	HEIGHT ABOVE WATER LINE 106.63 (IN JIG POSITION)	
A	140.00	(R) 2.50	156.74	50.11	
F	500.50	0.00	106.73	0.10	
G	1197+130.28	0.00	106.63	0.00	DATUM
H	1580.90	0.00	139.30	32.67	

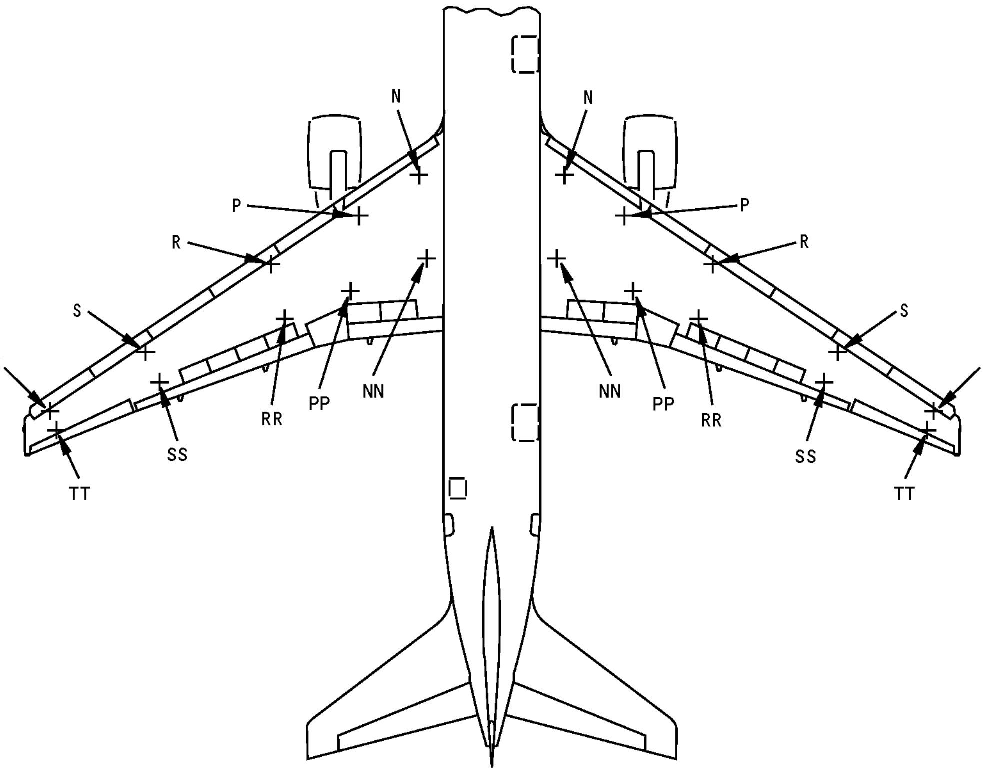
FUSELAGE ALIGNMENT POINT LOCATIONS
TABLE I

NOTES

- REFER TO 012T2200 FOR LIST OF ALIGNMENT CHECKPOINT DRAWINGS

Airplane Alignment Points in Jig Position
Figure 2 (Sheet 1 of 2)

REF DWG
012T2200

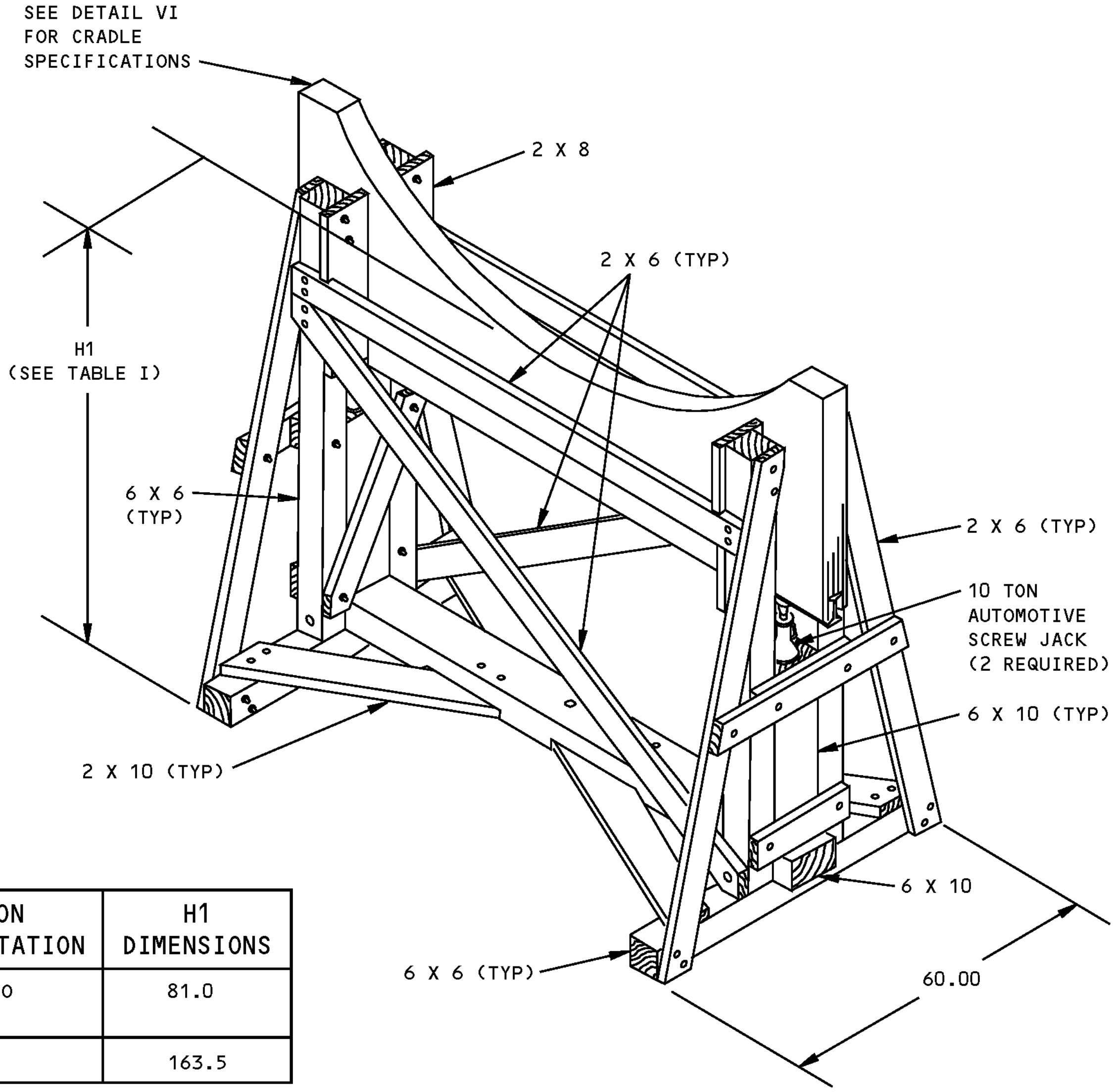


DETAIL II

ALIGNMENT CHECKPOINT	BODY STATION	BODY BUTTOCK LINE	BODY WATER LINE	HEIGHT ABOVE WATER LINE 144.25 (IN JIG POSITION)	
N	810.39	144.60	148.12	3.87	
NN	970.45	138.68	144.25	0.0	DATUM
P	873.80	259.19	171.49	27.24	
PP	1030.64	267.40	169.50	25.25	
R	1003.62	454.24	197.60	53.35	
RR	1099.54	411.25	191.08	46.83	
S	1180.61	717.35	224.69	80.44	
SS	1197+35.49	694.41	221.12	76.87	
T	1197+93.83	881.17	242.25	98.00	
TT	1197+118.17	870.19	240.94	96.69	

WING ALIGNMENT POINT LOCATIONS
TABLE II

Airplane Alignment Points in Jig Position
Figure 2 (Sheet 2 of 2)

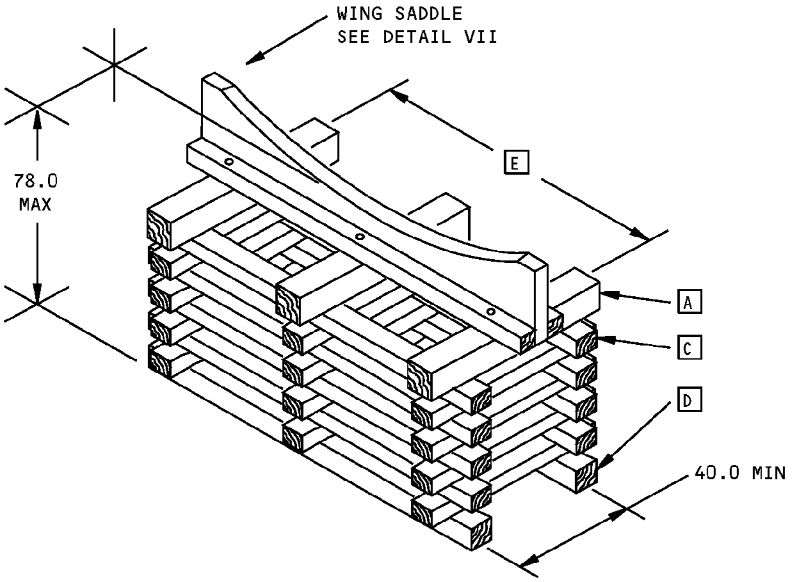


LOCATION BODY STATION	H1 DIMENSIONS
434.0, TO 1351.0	81.0
1809.5	163.5

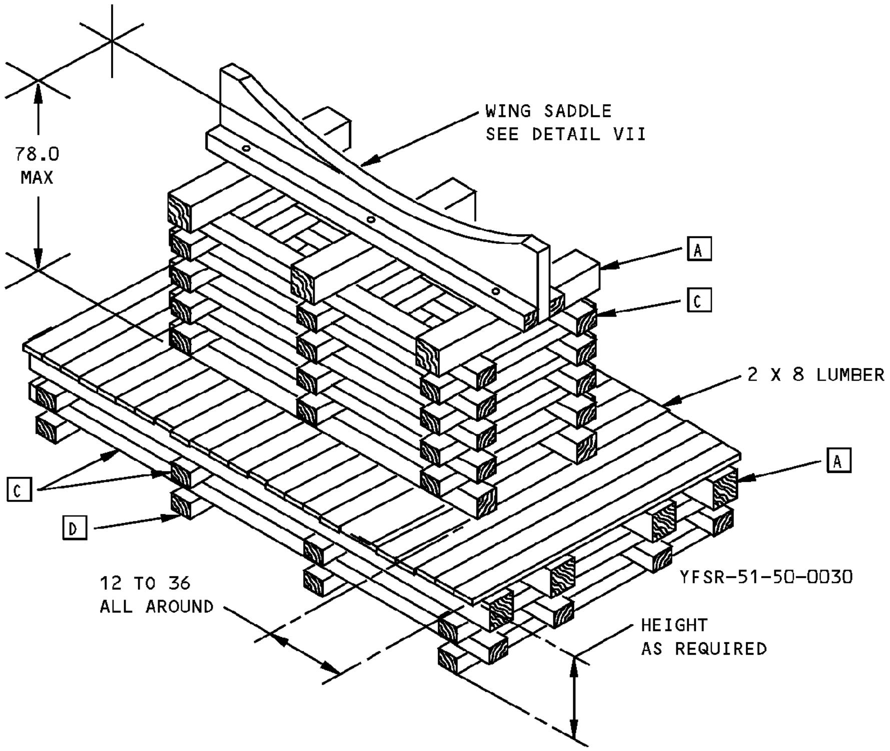
TABLE I

A-FRAME TYPE
FUSELAGE SUPPORT JIG
DETAIL I

Fuselage and Wing Cradle Support Equipment
Figure 3 (Sheet 1 of 7)



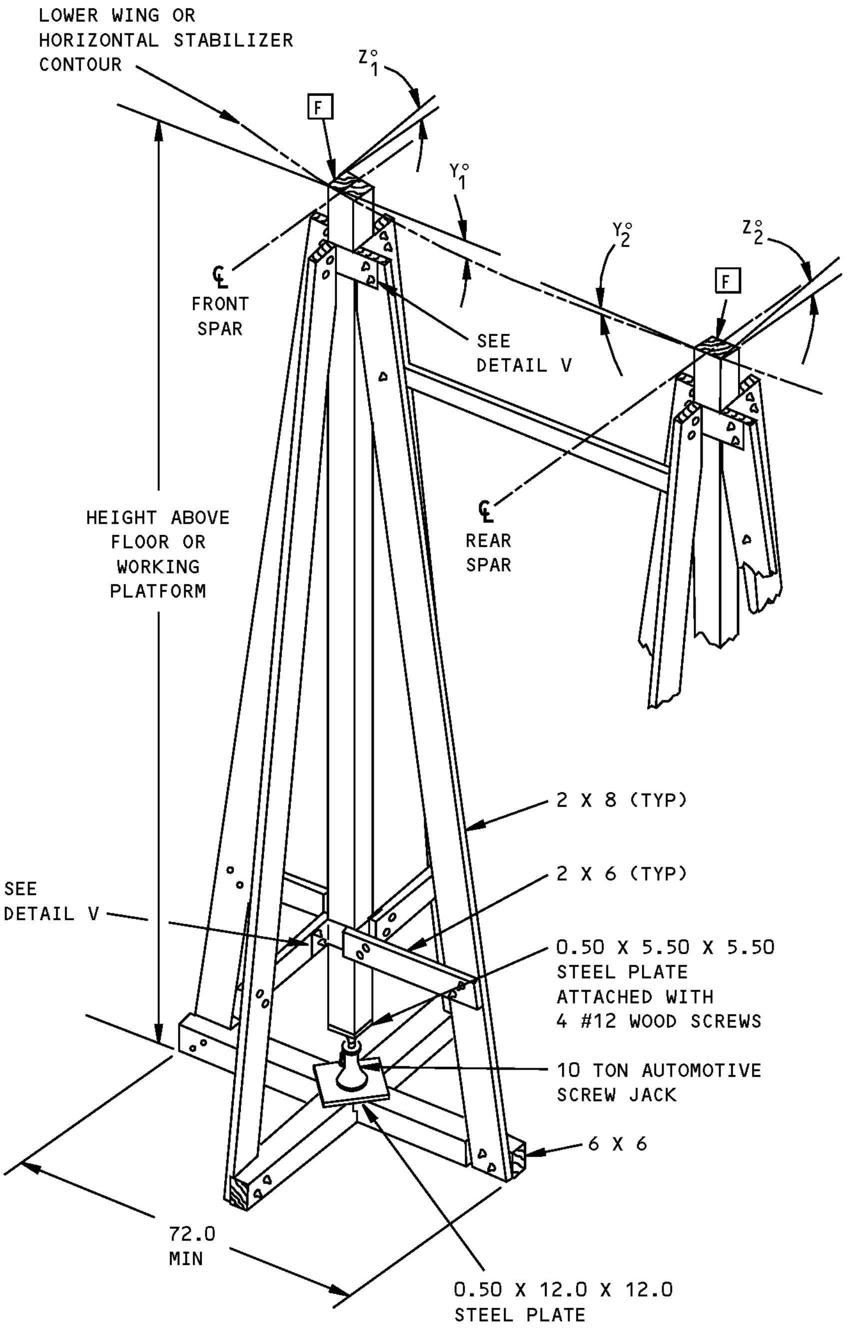
WING CRADLE BUILD-UP FOR HEIGHTS UP TO 78.0
DETAIL II



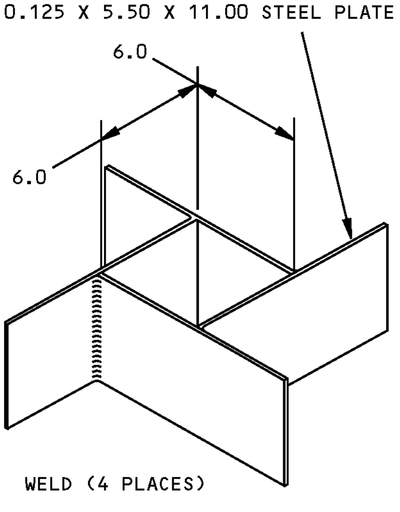
WING CRADLE BUILD-UP FOR HEIGHTS GREATER THAN 78.0
DETAIL III

Fuselage and Wing Cradle Support Equipment
Figure 3 (Sheet 2 of 7)

WING STA	$Y_1°$	$Y_2°$	$Z_1°$	$Z_2°$
486.2	8°	4°	5°30'	5°
879.2	5°	2°	5°30'	5°
HORIZONTAL STAB. STA				
191.13	0°	6°	2°	1°

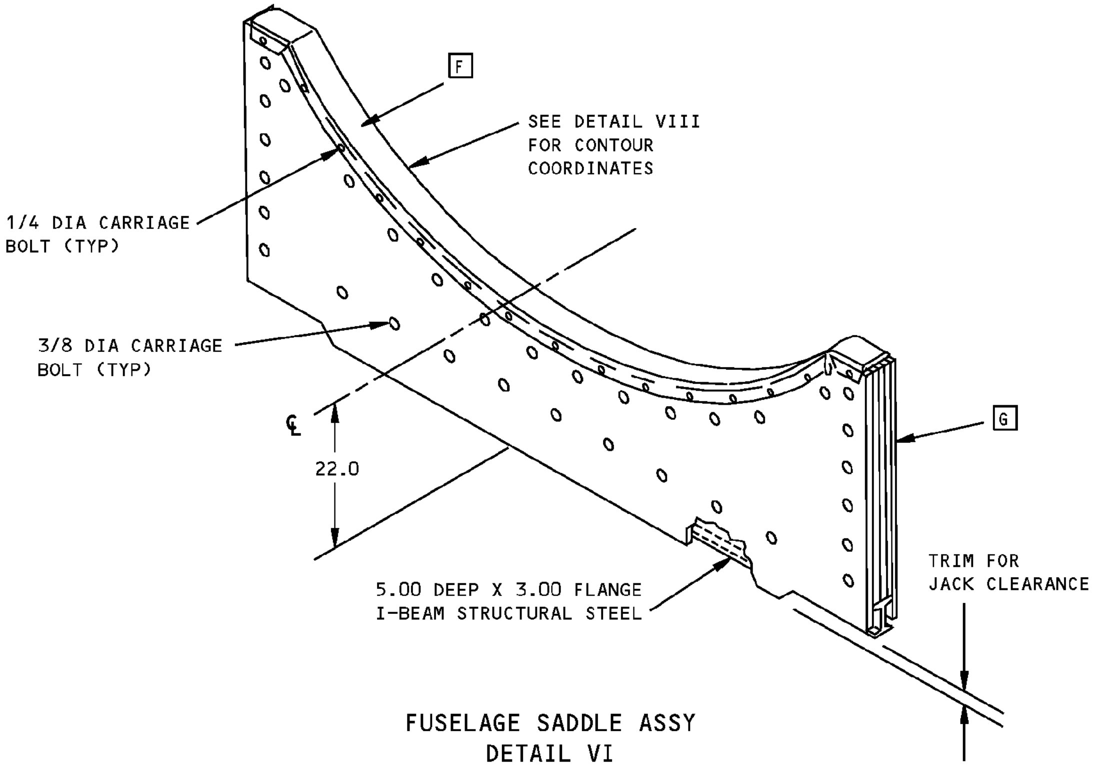


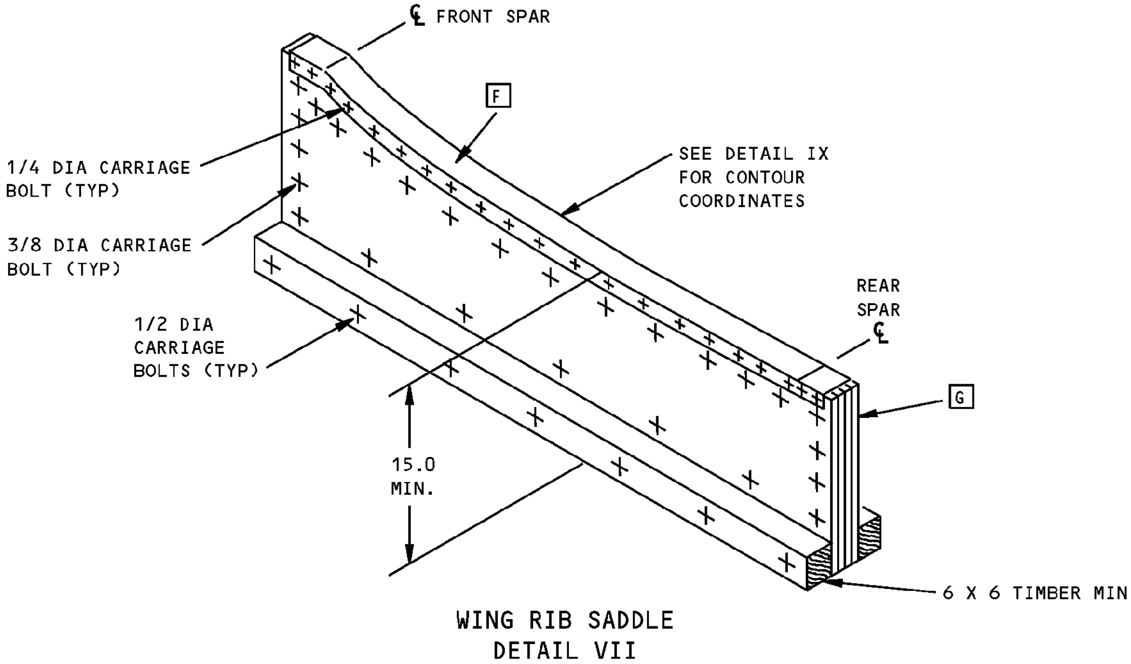
SUPPLEMENTARY SUPPORT
WING AND HORIZONTAL STABILIZER
DETAIL IV H



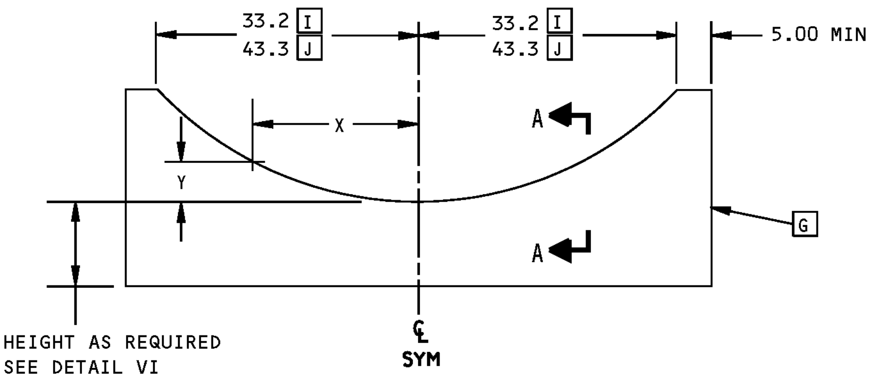
DETAIL V

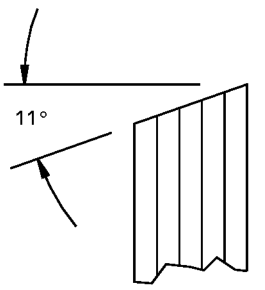
Fuselage and Wing Cradle Support Equipment
Figure 3 (Sheet 3 of 7)





Fuselage and Wing Cradle Support Equipment
Figure 3 (Sheet 4 of 7)





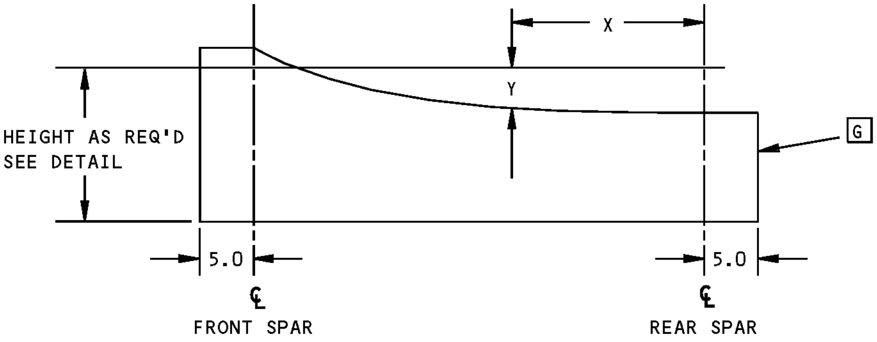
FOR BS 1809.5 ONLY
SECTION A-A

BODY STATION 434.0 TO BODY STATION 1351.0	
X DIM. (BBL)	Y DIM. (BWL)
0.0	0.0
0.9	0.0
1.6	0.0
3.1	0.1
4.8	0.1
7.3	0.3
8.9	0.4
10.6	0.6
13.1	0.9
14.7	1.1
17.2	1.5
18.8	1.9
20.5	2.2
22.9	2.8
25.3	3.4
27.0	3.8
29.3	4.6
30.9	5.1
33.3	5.9
34.9	6.5
37.2	7.4
38.7	8.1
41.0	9.1
43.3	10.2

BODY STATION 1809.5	
X DIM. (BBL)	Y DIM. (BWL)
0.0	0.0
3.0	0.1
6.0	0.2
8.9	0.5
11.0	0.8
13.1	1.1
15.1	1.5
17.1	2.0
19.0	2.5
20.9	2.9
22.7	3.7
24.4	4.3
26.1	5.0
27.6	5.7
29.1	6.5
30.6	7.3
31.9	8.1
33.2	9.0

COORDINATES FOR FUSELAGE SUPPORT CRADLES
DETAIL VIII

Fuselage and Wing Cradle Support Equipment
Figure 3 (Sheet 5 of 7)



WING STATION 486.2	
X DIM.	Y DIM.
0.0	- 2.4
4.6	- 2.7
8.2	- 2.9
14.8	- 3.3
20.5	- 3.5
25.6	- 3.8
30.2	- 3.9
40.6	- 4.2
50.1	- 4.2
60.8	- 4.1
64.4	- 4.0
71.6	- 3.6
77.2	- 3.3
79.2	- 3.2
84.3	- 2.8
89.1	- 2.4
92.2	- 2.1
95.4	- 1.7
98.8	- 1.3
102.6	- 0.9
106.8	- 0.3
109.2	- 0.2
111.8	+ 0.3
114.6	+ 0.7
119.1	+ 1.4

WING STATION 879.2	
X DIM.	Y DIM.
0.0	- 0.5
2.9	- 0.7
6.5	- 0.9
10.0	- 1.1
13.4	- 1.2
15.0	- 1.3
18.2	- 1.3
23.0	- 1.4
26.0	- 1.4
33.2	- 1.3
35.0	- 1.2
37.4	- 1.1
41.5	- 0.9
44.1	- 0.8
46.7	- 0.6
49.4	- 0.3
52.1	- 0.1
53.5	+ 0.1
54.9	+ 0.2
57.8	+ 0.6
58.4	+ 0.7

COORDINATES FOR WING SUPPORT CRADLES B
DETAIL IX

Fuselage and Wing Cradle Support Equipment
Figure 3 (Sheet 6 of 7)

NOTES

- PROCURE CLEAR LUMBER FREE FROM KNOTS, SHAKES OR CHECKS WITH PHYSICAL PROPERTIES EQUIVALENT TO STRUCTURAL GRADE DOUGLAS FIR, WEST COAST REGION, U.S.A.

$\boxed{A}$ 8 X 10 MINIMUM SIZE TIMBER

$\boxed{B}$ COORDINATES ORIGINATE AT REAR SPAR AND END AT FRONT SPAR

$\boxed{C}$ ALL CRIBBING BELOW CROSS BEAMS CAN BE ANY AVAILABLE TIMBER NOT LESS THAN 6 X 6

$\boxed{D}$ SPACING OF LOWEST TIMBERS DEPENDS UPON BEARING STRENGTH OF GROUND SURFACE. IF NOT ON CONCRETE USE SOLID ROWS OF TIMBERS SEVERAL LAYERS HIGH

$\boxed{E}$ EQUAL TO CONTOURED PORTION OF CRADLE

$\boxed{F}$ PAD WITH 1.0 TO 1.5 THICK RUBBER, DUROMETER OF 50 TO 60 AND COVER WITH 10 OZ. CANVAS DUCK

$\boxed{G}$ CONSTRUCT WITH FIVE 1.0 THICK AB GRADE OR BETTER EXTERIOR PLYWOOD

$\boxed{H}$ THIS SUPPORT MAY BE USED AS AN ALTERNATIVE TO CRADLE SUPPORTS SHOWN IN DETAILS II AND III

$\boxed{I}$ BS 1809.5

$\boxed{J}$ BS 434.0 TO BS 1351.0

Fuselage and Wing Cradle Support Equipment
Figure 3 (Sheet 7 of 7)

GENERAL - CONTROL SURFACE BALANCE MOMENT DETERMINATION

1. General

A. This subject gives the general balance instructions, serviceability, definition of terms, sign conventions, measuring accuracy, special tools and equipment, and estimation of repair material weights for the aileron, elevator, and rudder.

B. There are three categories of balance requirements for Control Surfaces. Refer to Table 1/GENERAL for the category, balance limits, Repair Capability, and SRM subject location for each Control Surface.

(1) Category I: Surfaces that can be adjusted to meet the necessary Operational Static Balance Limits.

(2) Category II: Surfaces that cannot be adjusted to meet the necessary Operational Static Balance Limits but have a built-in rework allowance for a moderate amount of Reworks.

(3) Category III: Surfaces with no balance requirements.

Table 1: Static Balance Limits

CONTROL SURFACE (SRM SUBJECT)	CATEGORY	STATIC BALANCE LIMITS (POUND-INCHES)			MAXIMUM REPAIR CAPABILITY (POUND-INCHES)
		MANUFACTURE	CALCULATED	OPERATIONAL	
OUTBOARD AILERON (51-60-01, GENERAL)	I	(-) 80	(-) 45	(-) 30	NOT APPLICABLE
TOTAL ELEVATOR (51-60-02, GENERAL)	II	(+) 5,200	(+) 5,500	(+) 5,600	(+) 400
OUTBOARD ELEVATOR (51-60-02, GENERAL)	II	(+) 2,800	(+) 3,000	(+) 3,050	(+) 250
INBOARD ELEVATOR (51-60-02, GENERAL)	II	(+) 2,350	(+) 2,450	(+) 2,500	(+) 150
RUDDER (51-60-03, GENERAL)	II	(+) 10,000	(+) 10,400	(+) 10,500	(+) 500
INBOARD AILERON	III	NO BALANCE REQUIREMENT	NOT APPLICABLE	NO BALANCE REQUIREMENT	NOT APPLICABLE

WARNING: IF THE BALANCE MOMENT OF A CATEGORY I OR II FLIGHT CONTROL SURFACE IS MORE THAN ITS OPERATIONAL STATIC BALANCE LIMIT, A CONDITION DANGEROUS TO FLIGHT SAFETY MAY OCCUR.

C. There are two ways to find the Balance Moment for a Category I or II Control Surface.

(1) On the airplane (calculated with equations only).

(2) Off the airplane (weight reaction found in a balance fixture and calculated).

D. Each time a Category I and II Control Surface is Reworked, you must add all of the Rework Moments to the Static Balance Moment and make sure that the total moments are not more than the Operational Limit.

(1) We recommend that Category I and II Control Surfaces be removed from the airplane when their Balance Moments are more than their Calculated Limits or if you are not sure of their Balance Moments.

After finding their Balance Moments in a balance fixture, subsequent rework calculations can be used up to the Operational Limit.

NOTE: We recommend that Category I and II Control Surfaces be removed at their Calculated Limits to protect against possible calculation errors.

(2) Category I and II Control Surfaces must have an aluminum foil moment marker attached which contains the Manufacture Limit, Operational Limit, and the Static Balance Moment. Make an entry of the Rework Moment and the data on the marker. Refer to the applicable Control Surface subject for the location of the marker.

(3) Make an entry of the Rework operation in a Rework Record. Each Category I or II Control Surface must have its balance condition kept up-to-date throughout its service life to make sure that the Balance Moments are not more than their Operational Limits.

E. We recommend that if a Category I or II Control Surface is removed from the airplane for Rework or other purpose, the Control Surface be put in a balance fixture and its Balance Moment found.

2. References

Reference	Title
51-60-01, GENERAL	Outboard Aileron Rebalance Procedure
51-60-02, GENERAL	Elevator Operational Balance Requirements and Procedures
51-60-03, GENERAL	Rudder Operational Balance Requirements and Procedures
51-70-03, GENERAL	Graphite and/or Aramid Reinforced Epoxy Laminates and Nonmetallic Honeycomb Sandwich Repairs - Room Temperature – 150°F (66°C) Cure (Wet Layup)
51-70-04, GENERAL	Graphite and/or Aramid Reinforced Epoxy Laminates and Nonmetallic Honeycomb Sandwich Repairs - 350°F (177°C) Cure
51-70-05, GENERAL	Graphite/Aramid/Hybrid Reinforced Epoxy Laminates and Nonmetallic Honeycomb Sandwich Repairs - 250°F (121°C) Cure

3. Serviceability of Category I and II Control Surfaces

A. The Control Surface is no longer serviceable when it has a Balance Moment more than its Operational Limit and, for a Category I Control Surface, all of the Balance Adjust Weights have been added.

B. A Control Surface is no longer serviceable when the sum of the total Repair moments are more than its maximum Repair Capability.

C. The serviceability of the Control Surface can be determined by adding all of the Rework Moments (from the Rework Record) to the Static Balance Moment or the Manufacture Limit (if the Static Balance Moment is not known).

D. Serviceability can be regained by removing the paint buildup from Repaints and Repairs that were performed without paint removal, and refinishing the Control Surface.

E. If a Control cannot be Reworked to regain serviceability:

(1) Remove and replace, or

(2) Ask The Boeing Company to analyze the Rework Record to determine its further serviceability.

4. Definition of Terms

A. The definitions 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 put Category I Control Surfaces into fine balance.

In manufacturing, these weights are used to adjust for small variations in Category I Control Surfaces at the initial balance check. In service, Balance Adjust Weights are used to balance a reworked Category I Control Surface as necessary.

(2) Balance Moment (M): The product of the weight or Weight Reaction times the Moment Arm.

(3) Calculated (Static Balance) Limit: The limit for on the airplane calculation of the Balance Moment (of the Control Surface). Once this limit is reached, it is recommended that the Control Surface be removed from the airplane and the Balance Moment found in a balance fixture.

(4) Control Surface: The movable portion of a wing or tail which controls movement about one of the airplane's axes.

(5) Fixed Balance Weights: Specially designed weights installed on a Control Surface forward of the hinge centerline at manufacture.

(6) Manufacture (Static Balance) Limit: The limit that the actual Static 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 Arm (Y): The horizontal 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.

(8) Operational (Static Balance) Limit: The limit that the Static Balance Moment (of the Control Surface) must be less than or equal to for the Control Surface to be used (on the airplane).

(9) Repaint: A procedure that adds exterior primer and/or paint to a Control Surface.

(10) Repair: A procedure that adds a concentrated quantity of repair material (weight) to a Control Surface.

(11) Repair Capability: The total Rework Moment available for Repair operations. This is the difference between the Manufacture Limit of the Control Surface (as given in the Rework Record and on the aluminum foil marker attached to the Control Surface) and the Operational Limit.

(12) Rework: Any procedure that changes the Static Balance Moment or Rework Capability of the Control Surface. This is applicable when you do Repairs, Repaints, or add Balance Adjust Weights.

(13) Rework Capability: The total Rework Moment available for Rework operations. This is the difference between the actual Static Balance Moment of the Control Surface (as given in the Rework Record and on the aluminum foil marker attached to the Control Surface) and the Operational Limit.

(14) Rework Moment (MR): The change in the Static Balance Moment of a Control Surface because of a Rework to the surface. It is the difference between the material removed and the material added, multiplied by the Moment Arm. Also, for a Category I Control Surface, it is the moment change between the Rework to the surface and the moment from adding or subtracting any Balance Adjust Weights.

(15) Rework Record: A record of all the Rework done to a Control Surface. The record must contain (as a minimum):

  (a) The Rework Moment
  (b) The Rework weight and its center of gravity location
  (c) The revised Balance Moment
  (d) The date of Rework
  (e) All Rework procedures done

(16) Static Balance Moment (as used in the SRM): The first moment of the total Control Surface weight about its hinge centerline.

(17) Weight Reaction (WR): The force (in pounds) of a Control Surface acting on a support point at a given distance from its hinge centerline. You determine the Weight Reaction by using a weight scale under the reaction points.

5. Sign Convention

A. Distances

(1) Make the distances aft of the hinge centerline to be positive (+).

(2) Make the distances forward of the hinge centerline to be negative (-).

B. Weight Reactions

(1) Weight Reactions are considered to be positive (+) if the Control Surface makes a downward load on the support.

(2) Weight Reactions are considered to be negative (-) if the Control Surface makes an upward load on the support.

C. Balance Moment

(1) Positive (+) Balance Moments identify Control Surfaces that are underbalanced. This means that the total center of gravity is aft of the hinge centerline which makes the Control Surface tail-heavy.

The elevators and rudder are underbalanced Control Surfaces.

(2) Negative (-) Balance Moments identify Control Surfaces that are overbalanced. This means that the total center of gravity is forward of the hinge centerline which makes the Control Surface nose-heavy. The outboard aileron is the only overbalanced Control Surface.

6. Measuring Accuracy

A. When the Balance Moment is calculated on the airplane from measured quantities, it is important that the distance and the weight measurements be as accurate as possible. To make sure that the Balance Moment tolerances are satisfactory (and keep errors to a minimum), use equipment that is calibrated to make measurements as follows:

(1) Measure the Moment Arm (Y) to an accuracy of ± 0.125 inch.

(2) Measure the angle that the Control Surface is leveled at to an accuracy of ± 0.5 degree.

(3) Measure the weight to ± 0.1 percent of the measured weight.

7. Special Tools and Equipment

A. See Figure 1/GENERAL for details of special tools and equipment for Control Surface balancing.

8. Estimation of Material Weight for Control Surface Repair on the Airplane

A. Repairs to honeycomb structure are described in 51-70-03, GENERAL for a room temperature repair cure, 51-70-04, GENERAL for a 350°F (177°C) repair cure, and 51-70-05, GENERAL for a 250°F (121°C) repair cure.

B. Refer to Figure 2/GENERAL to determine component weights for calculating approximate Repair Moments.

C. For determination of the Control Surface Balance Moments after painting, the areas, centroids, and paint density are shown in Tables II and III of Figure 2/GENERAL. The areas are for both faces of each Control Surface and the centroid is the aft distance normal to the hinge centerline and front spar. The areas and centroids account for components forward and aft of each respective hinge centerline.

SPECIAL TOOLS AND EQUIPMENT

ITEM	PART NUMBER	OPTIONAL PART NUMBER	QUANTITY REQUIRED	DETAIL NO.	SOURCE
BALANCE JIG STAND	2CF65B05528-1	F70330 [B]	1	II AND III	BOEING COMMERICAL AIRPLANE GROUP (BCAG)
TOOL STAND	J51003 [A]	F70330	1	IV	BOEING COMMERICAL AIRPLANE GROUP (BCAG)
WEIGHT REACTION TIP	J51003 [A]	F70330	1	V	BOEING COMMERICAL AIRPLANE GROUP (BCAG)
HINGE SUPPORTS	J51003 [A]	F70330	2	VI	BOEING COMMERICAL AIRPLANE GROUP (BCAG)
PLATFORM SCALE	--	--	1	IV	ANY SOURCE [C]
PROTRACTOR LEVEL	--	--	1	I	ANY SOURCE [D]
24-INCH LEVEL	--	--	1	--	ANY SOURCE
C-CLAMPS	--	--	3	--	ANY SOURCE [F]
SCALE	--	--	1	--	ANY SOURCE [E]

[A] J51003 COMES AS A COMPLETE KIT.

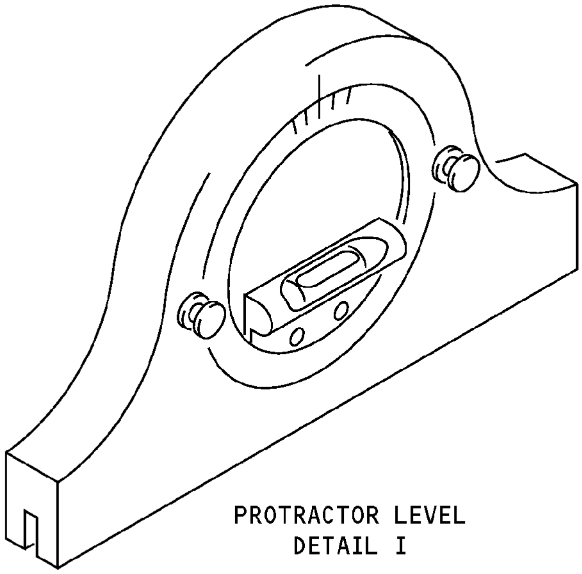
[B] F70330-4, -87 APPLY TO AILERON ONLY.

[C] CERTIFIED SCALE THAT HAS 0.1 POUND GRADUATIONS WITH A 300 POUNDS MINIMUM CAPACITY.

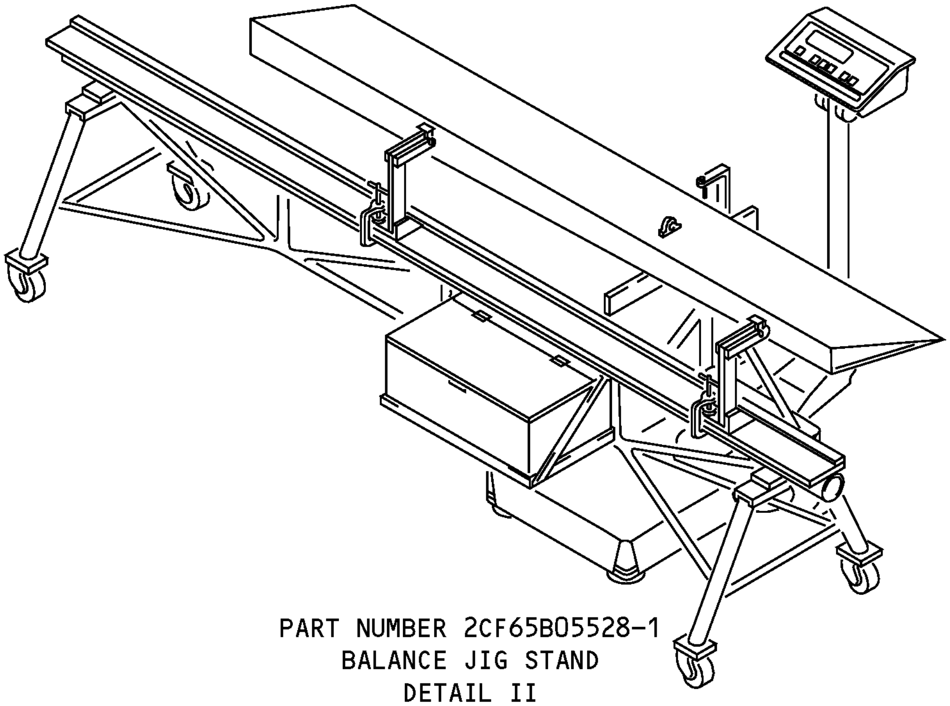
[D] A LEVEL THAT HAS AN ACCURACY OF ± 0.5 DEGREES IS THE NECESSARY MINIMUM.

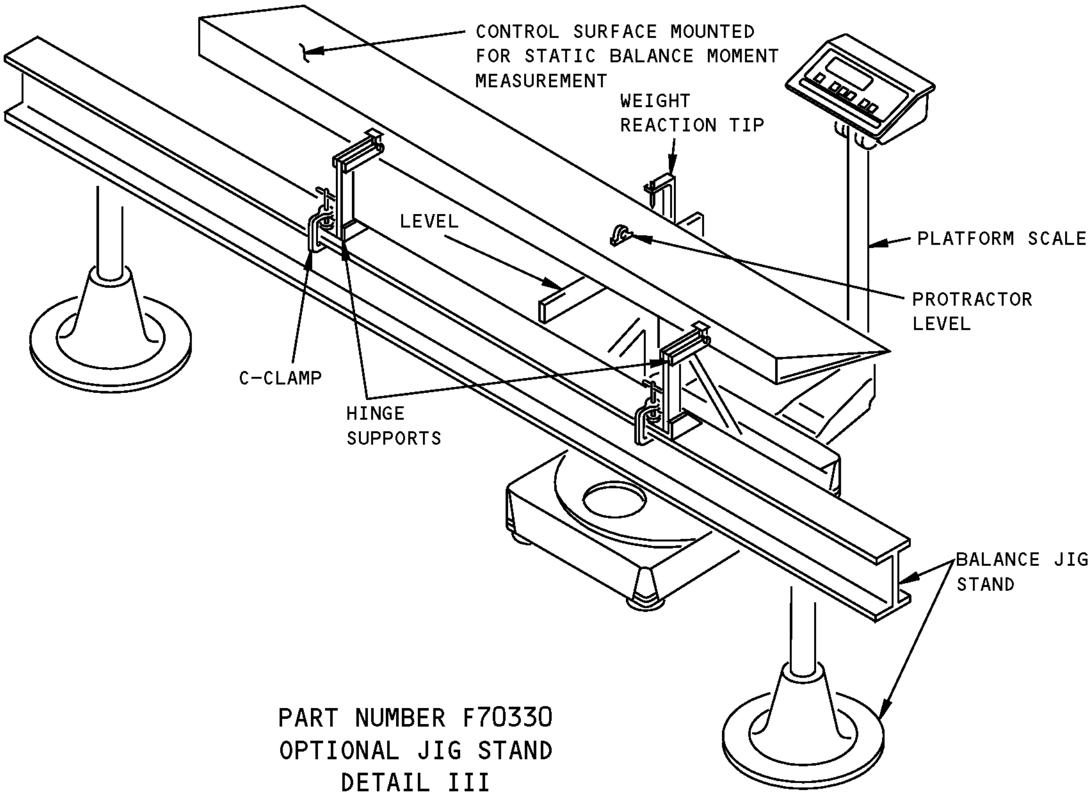
[E] THE SCALE MUST HAVE MINIMUM OF 10 POUNDS CAPACITY IS THE MINIMUM WITH 0.005 GRADUATIONS.

[F] A 4 INCH DROP FORGED STEEL C-CLAMP IS RECOMMENEDED.

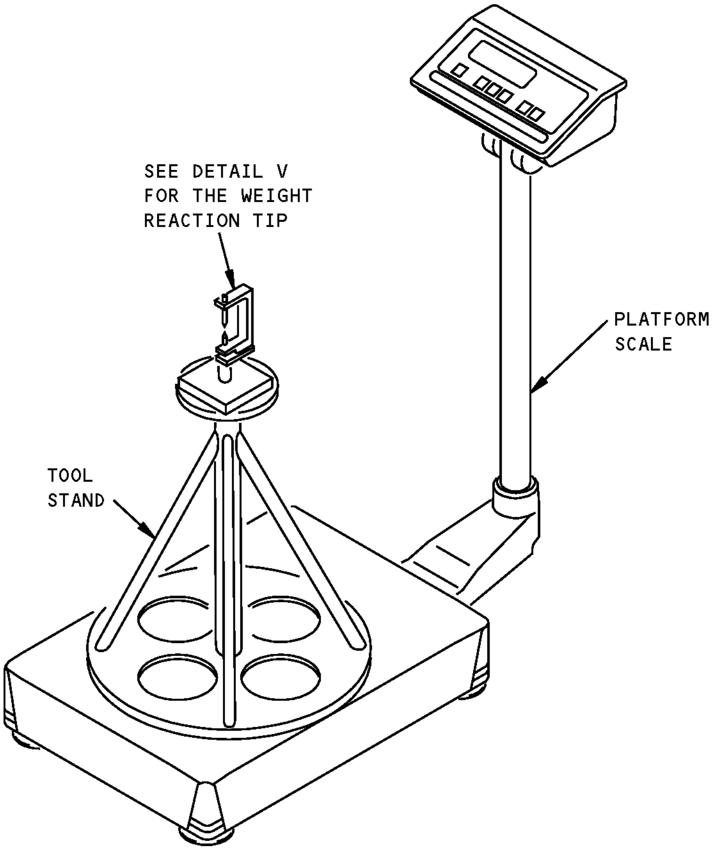


Tools and Equipment
Figure 1 (Sheet 1 of 3)

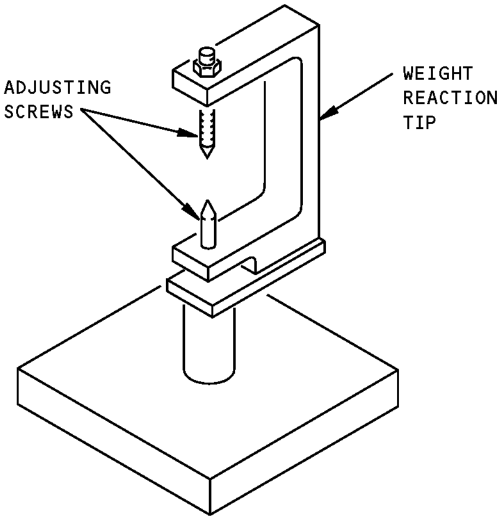




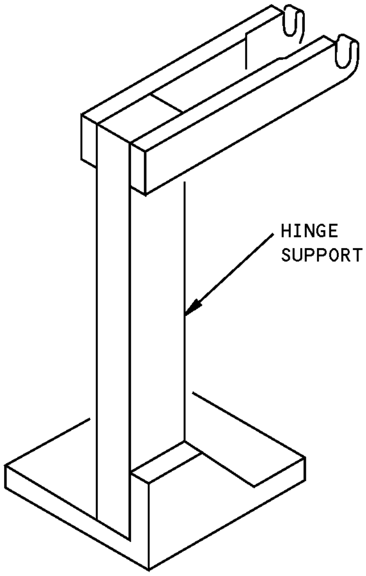
Tools and Equipment
Figure 1 (Sheet 2 of 3)



DETAIL IV



DETAIL V



DETAIL VI

Tools and Equipment
Figure 1 (Sheet 3 of 3)

CONTROL SURFACE MATERIAL	WEIGHT
PREPREG SKIN TYPE	
FIBERGLASS PREPREG	
BMS 8-139, TYPE 120	0.00027 LBS/IN^{2}/PLY
BMS 8-79, TYPE 120	0.00028 LBS/IN^{2}/PLY
BMS 8-79, TYPE 1581	0.00070 LBS/IN^{2}/PLY
BMS 8-79, TYPE 7781	0.00070 LBS/IN^{2}/PLY
GRAPHITE PREPREG (TAPE)	
BMS 8-168, TYPE II, CLASS I, GRADE 145	0.00035 LBS/IN^{2}/PLY
BMS 8-212, TYPE III, CLASS I, GRADE 95	0.00021 LBS/IN^{2}/PLY
BMS 8-212, TYPE III, CLASS I, GRADE 145	0.00033 LBS/IN^{2}/PLY
BMS 8-212, TYPE III, CLASS I, GRADE 190	0.00043 LBS/IN^{2}/PLY
BMS 8-256, TYPE I, CLASS I, GRADE 145	0.00033 LBS/IN^{2}/PLY
GRAPHITE PREPREG (FABRIC)	
BMS 8-168, TYPE II, CLASS II, GRADE 3K-70-PW	0.00047 LBS/IN^{2}/PLY
BMS 8-212, TYPE III, CLASS II, GRADE 3K-135-8H	0.00085 LBS/IN^{2}/PLY
BMS 8-212, TYPE IV, CLASS II, GRADE 3K-70-PW	0.00046 LBS/IN^{2}/PLY
BMS 8-256, TYPE I, CLASS II, GRADE 3K-70-PW	0.00049 LBS/IN^{2}/PLY
BMS 8-258, TYPE I, CLASS II, GRADE 3K-70-PW	0.00049 LBS/IN^{2}/PLY
WET LAYUP SKIN TYPE	
FIBERGLASS WITH RESIN	
BMS 9-3, TYPE D, STYLE 120	0.00030 LBS/IN^{2}/PLY
BMS 9-3 TYPE H-2, STYLE 181-150	0.00083 LBS/IN^{2}/PLY
GRAPHITE FABRIC WITH RESIN	
BMS 9-8 TYPE I, CLASS II, GRADE 3, STYLE 3K-70-P	0.00055 LBS/IN^{2}/PLY
END COVER	
3/64 PHENOLIC SHEET PER MIL-P-15035, TYPE FBE OR FBG	0.00225 LBS/IN^{2}
CORE	
NOMEX	
BMS 8-124, CLASS IV, TYPE V, GRADE 3	0.0017 LBS/IN^{3}
ADHESIVE	
SKIN TO CORE BONDING (350° CURE)	
BMS 8-245, TYPE II, CLASS I, GRADE 05	0.00035 LBS/IN^{2}
SKIN TO CORE BONDING (250°F CURE)	
BMS 5-129, TYPE 2 OR 4, GRADE 10	0.00042 LBS/IN^{2}
CORE SPLICE BONDING (350-250°F CURE)	
BMS 5-90, TYPE III, GRADE 50	0.00274 LBS/IN^{2}
POTTING COMPOUND	
FOR SURFACE DENTS	
BMS 5-28, TYPE 7	0.032 LBS/IN^{3}

Weights of Repair Materials
Figure 2 (Sheet 1 of 2)

CONTROL SURFACE	AREA [A] (SQ. FT.)	CENTROID [B] (IN.)
INBOARD AILERON	66.9	24.8
OUTBOARD AILERON [C]	73.4	8.0
ELEVATOR (INBD AND OUTBD)	204.9	23.4
INBOARD ELEVATOR [C] [D]	71.5	29.6
OUTBOARD ELEVATOR [C] [D]	133.4	20.0
RUDDER	356.0	30.7

SURFACE AREAS AND CENTROIDS
TABLE II

PAINT/DECAL WEIGHT	
	WEIGHT (LB./SQ. FT.)
PAINT (NOMINAL 2.5 MILS)	0.0175
PRIMER (NOMINAL 0.6 MILS)	0.0060
DECAL	0.0200

PAINT WEIGHTS
TABLE III

NOTES

[A] BOTH FACES, INCLUDING PORTIONS FORWARD OF HINGE CENTERLINE

[B] AFT DISTANCE NORMAL TO THE HINGE CENTERLINE AND FRONT SPAR

[C] INCLUDES BALANCE WEIGHT TOWERS

[D] THESE VALUES ARE APPLICABLE FOR THE ELEVATOR WHEN ALL OF THE SURFACE IS PAINTED AGAIN

Weights of Repair Materials
Figure 2 (Sheet 2 of 2)

GENERAL - OUTBOARD AILERON REBALANCE PROCEDURE

1. General

A. This subject gives the balance requirements and rebalancing procedures, after a Rework, for the outboard aileron.

B. The outboard aileron is a Category I Control Surface that can be adjusted to meet the necessary Operational Static Balance Limits. Refer to Table 1/GENERAL for the balance limits.

Table 1: Static Balance Limits

CONTROL SURFACE	CATEGORY	STATIC BALANCE LIMITS (POUND-INCHES)			MAXIMUM REPAIR CAPABILITY (POUND-INCHES)
		MANUFACTURE	CALCULATED	OPERATIONAL	
OUTBOARD AILERON	I	(-) 80	(-) 45	(-) 30	NOT APPLICABLE

C. Refer to 51-60-00, GENERAL for the definitions of the different categories of Control Surfaces and other general data such as:

(1) General balance instructions
(2) Serviceability
(3) Definitions of terms
(4) Sign Conventions
(5) Measuring accuracy
(6) Special tools and equipment
(7) Repair material weights.

D. Refer to 51-60-02, GENERAL for the repair procedures.

2. References

Reference	Title
51-60-00, GENERAL	Control Surface Balance Moment Determination
51-60-02, GENERAL	Elevator Operational Balance Requirements and Procedures
51-70-04, GENERAL	Graphite and/or Aramid Reinforced Epoxy Laminates and Nonmetallic Honeycomb Sandwich Repairs - 350°F (177°C) Cure
51-70-05, GENERAL	Graphite/Aramid/Hybrid Reinforced Epoxy Laminates and Nonmetallic Honeycomb Sandwich Repairs - 250°F (121°C) Cure
SOPM 20-50-12	Application of Adhesives

3. Operational (Static Balance) Limit

A. The design Operational Limit for the outboard aileron is (-) 30 pound-inches.

WARNING: IF THE BALANCE MOMENT OF THE OUTBOARD AILERON IS MORE THAN (-) 30 POUND-INCHES, A CONDITION DANGEROUS TO FLIGHT SAFETY MAY OCCUR.

B. We recommend that the outboard aileron be removed from the airplane when all of the adjust weights have been installed and the Balance Moment is more than its Calculated Limit of (-) 45 pound-inches, or if you are not sure of the Balance Moment. After finding the Balance Moment in a balance fixture, subsequent rework calculations can be used up to the Operational Limit.

NOTE: We recommend that the outboard aileron be removed at (-) 45 pound-inches to protect against possible calculation errors.

C. When the outboard aileron is rebalanced in a balance fixture, Balance Adjust Weights can be added to increase the Rework Capability sufficiently to reduce the need for more weight on the next Rework.

4. Manufacture (Static Balance) Limit

A. The Manufacture Limit for the outboard aileron is (-) 80 pound-inches (finished).

B. The outboard aileron can be delivered with an initial Static Balance Moment less than the Manufacture Limit. This additional moment can be used for more Rework Capability. The example that follows shows how to calculate the total Rework Capability:

Example: Recorded outboard aileron Static Balance Moment is (-) 135 pound-inches

(-)30 pound-inches (Operational Limit)	-	(-)135 pound-inches (Static Balance Moment)	=
(+)105 pound-inches (Total Rework Capability)			

5. Tracking

A. We recommend that you keep a Rework Record of how much weight and Rework Moment is added by each Rework operation and the total Rework Capability that is still available.

B. The Rework Moments, the collected total of all the Rework Moments, Balance Adjust Weights, locations, dates, total surface Repaints, and repaint moments should be recorded in the Rework Record for each outboard aileron. If the outboard aileron is replaced by a spare or installed on a different airplane, the Rework Record must go with that outboard aileron.

C. On most outboard ailerons an aluminum foil moment marker is attached to the inboard end of the front spar. The foil moment marker will contain the Manufacture Limit, Operational Limit, the Static Balance Moment, and any Rework Moments pertaining to that component. It is advisable that a serial number be assigned and included on the marker to facilitate record keeping.

NOTE: The information on the aluminum foil moment marker should be vibro-engraved or rubber-stamped using permanent type ink. Apply a Skydrol-resistant finish to rubber-stamped data as given in SOPM 20-50-12. An example of an aluminum foil moment marker is shown in Figure 5/GENERAL.

6. Rework Moment and Serviceability

A. The aileron is no longer serviceable when it has a Balance Moment more than (-) 30 pound-inches and all of the adjustable weight space on Tower 5 has been used.

B. The serviceability of the aileron can be determined by adding all of the Rework Moments (from the Rework Record) to the Static Balance Moment or the Manufacture Limit of (-) 80 pound-inches (if the Static Balance Moment is not known).

C. Serviceability can be regained by removing the paint buildup from Repaints and Repairs that were performed without paint removal, and refinishing the aileron.

7. Balance Of The Outboard Aileron On The Airplane

A. Calculate the Rework Moment caused by the Repair. Refer to 51-60-00, GENERAL for the material weights.

B. Check to determine that the new Balance Moment is not more than (-) 45 pound-inches, and that the required weight space is available to add more Balance Adjust Weights. See Figure 3/GENERAL for adjustable weight part number and locations. If space is available, an outboard aileron may be rebalanced without removal from the airplane. In addition, the criteria that follows must be met.

(1) The Repair, with good workmanship, can be completed with the required accuracy and tolerances of 51-60-00, GENERAL. The weight tolerances must include equipment tolerances and error of material estimation (both removed damage and the repair material). The distance tolerance must include the possible error in estimating the perpendicular distance from the hinge centerline to the center of gravity of the repair.

C. Adjust the outboard aileron balance as follows:

(1) Check to determine that the required adjustable weight space is available.

(2) Determine the weight of the Repair by subtracting the weight of the removed damaged material from the weight of repair material as determined from 51-60-00, GENERAL.

(3) Locate the hinge centerline as shown in Figure 1/GENERAL.

(4) Measure the perpendicular distance, "Y", from the center of gravity (C.G.) of the repair area to the hinge centerline within ± 0.125 inch. See Figure 1/GENERAL, Detail III.

(5) Calculate the Rework Moment (MR).

MR = Repair Weight (in pounds) multiplied by "Y" (in inches)

(6) Collect the total moments for the outboard aileron by adding this Rework Moment to the Rework Moments as recorded in the Rework Record and the Static Balance Moment.

(7) If the Balance Moment is less than (-) 45 pound-inches, then no balance compensation is required. Record the Rework Moment on the foil moment marker. Record the Repair information in the Rework Record with the location and date of Repair, and that this Rework Moment was determined on the airplane.

(8) If the Balance Moment is more than (-) 45 pound-inches, use Figure 3/GENERAL to determine the number of Balance Adjust Weights to be added. Additional Balance Adjust Weights can be added so sufficient overbalance capability will be available for subsequent Reworks.

(a) Remove the wing trailing edge panels as required to gain access to the adjust weight location on Tower 5 and install the Balance Adjust Weights as required.

(b) Record the Rework Moment (the difference between the Repair moment and the moment from the added adjust weights) on the foil moment marker. Record the Repair information in the Rework Record; note the location and date of Repair, the number and location of Balance Adjust Weights that were added, and that this Rework Moment was determined on the airplane.

8. Sample Calculations - Repairs Which May Be Balanced On The Airplane

A. The examples that follow demonstrate the type of procedures to use when calculating the Rework Moment to determine the Balance Moment. Two examples are given, one which does not require rebalance and one which requires rebalance with Balance Adjust Weights.

B. Example 1 - No adjust weights will be required. Assume that the outboard aileron had been gouged and dented over a 14-inch diameter area, with damage to a 3-ply graphite skin and core with an average thickness of 2.0 inches. The CG of the Repair has a "Y" distance of 13 inches aft of the hinge centerline as shown in Figure 1/GENERAL. Assume that the outboard aileron has a recorded surface Balance Moment of (-) 60.18 pound-inches from two previous Rework operations (1) a total surface Repaint of (+) 17.62 pound-inches (as determined from 51-60-00, GENERAL) and (2) a previous Repair of (+) 2.2 pound-inches.

Balance Moment = (-) 80 + (17.62 + 2.2) = (-) 60.18 pound-inches

(1) The estimated Rework Moment for this Repair is (+) 5.0 pound-inches. The Balance Moment will not be more than (-) 45 pound-inches, therefore, no Balance Adjust Weights are required.

(2) A determination is made that the Repair can be completed, with good workmanship to the required accuracy and tolerance on the airplane.

(3) The Repair is made in accordance with 51-70-04, GENERAL or 51-70-05, GENERAL. The damaged skin and core was removed to a 14-inch diameter.

   (a) Check to ensure that the linear accuracy of 51-60-00, GENERAL is met.

   (b) A balance scale with an accuracy of ± 0.1% was used which meets the requirements of 51-60-00, GENERAL.

(4) Determine the increased weight from the added repair material. The weight of replacement core would be equivalent to the removed core.

The material weight would be from one extra repair ply and the required repair adhesive. The weight of the added repair finish would be equivalent to the removed original finish (primer and paint). The weight of removed Repaints in the Repair area can be calculated and subtracted from the added Repair weight. Use repair material weights in 51-60-00, GENERAL for calculations.

   (a) The added weight for a 350°F (177°C) repair is calculated.

   NOTE: Pi = 3.1416

weight from outer graphite repair ply (17-inch diameter)	= [Pi $(17)^2$(0.0005)]/4 = 0.1135 pound
1-ply adhesive bonding core to opposite face (BMS 8-245)	= [Pi $(14)^2$(0.00035)]/4 = 0.0539 pound
core splice foam adhesive (BMS 5-90, Type III, Grade 50)	= Pi (14) (2) (0.0027) = 0.2375 pound
TOTAL added weight	= 0.4049 pound

   (b) The weight from subsequent Repaints (if applicable) is calculated:

weight from Repaint (17-inch diameter)	= [Pi$(17)^2$(0.000122)]/ 4	= 0.0277 pound (per Repaint)
TOTAL subtracted weight	= 0.0277 (1 Repaint)	= 0.0277 pound

   (c) TOTAL Repair weight = 0.4049 - 0.0277 = 0.3772 pound

   (d) Measured distance from CG to hinge centerline (Y)

   Y as given = 13.0 inches

(e) The calculated Rework Moment	= (0.3772 pound)(13 inches)	= (+) 4.90 pound-inches

(5) The new surface Balance Moment is calculated.

Balance Moment = (-) 60.18 + (+) 4.90 = (-) 55.28 pound-inches

(6) The outboard aileron's Balance Moment is less than the Operational Limit.

(7) Record the Rework Moment on the foil moment marker. Record the Repair information that follows in the Rework Record; the location and date of Repair, and that this Rework Moment had been determined on the airplane.

C. Example 2 - Balance Adjust Weights will be required. Assume that the Rework Moment is (+) 26.0 pound-inches and the initial Balance Moment is (-) 62.38 pound-inches.

(1) Calculate the Balance Moment after Rework:

Balance Moment = (-) 62.38 + (+) 26.0 = (-) 36.38 pound-inches

(2) The Balance Moment is more than (-) 45 pound-inches indicating insufficient overbalance. Sufficient Balance Adjust Weights must be added to increase the overbalance capability to be less than (-) 45 pound-inches.

(a) From Figure 3/GENERAL, Balance Adjust Weight Numbers 1 and 2 have a moment change of (-) 13.40 pound-inches.

(b) Calculate the Rework Moment after adding adjust weights:

Rework Moment = (+) 26.0 + (-) 13.40 = (+) 12.6 pound-inches

(c) Calculate the Balance Moment:

Balance Moment = (-) 62.38 + (+) 12.60 = (-) 49.78 pound-inches

(d) Install the Balance Adjust Weight Numbers 1 and 2 on Tower 5.

(e) Record the Rework Moment on the foil moment marker. Record the Repair information that follows in the Rework Record; the location and date of Repair, the number and location of Balance Adjust Weights that were added, that this Rework Moment was determined on the airplane, and the new Balance Moment of (-) 49.78 pound-inches.

(f) If all of the adjustable weight space on Tower 5 has been used, and the Balance Moment is more than (-) 45 pound-inches, we recommend that the Control Surface be removed from the airplane and the Balance Moment verified in a balance fixture.

9. Balance Of The Outboard Aileron Off Of The Airplane

A. Static balancing requires the removal of the outboard aileron from the airplane.

(1) The outboard aileron must be complete including exterior and decorative finishes, with 6 trailing static dischargers. Bonding jumpers are not required for static balancing.

(2) Mount the outboard aileron (top surface up) on the balance jig as shown in 51-60-00, GENERAL. Locate the hinge supports at Wing Stations (WS) 975.65 and 1031.65 as shown in Figure 1/GENERAL.

(3) Record the tare weight of the tool stand and weight reaction tip fixture (Figure 2/GENERAL). Locate the reaction tip at point "A" which is 0.5 inch from aileron trailing edge on WS 1001.00. Refer to Figure 2/GENERAL. At this location the moment arm is 20.5 inches from the hinge centerline.

(4) With the outboard aileron free to rotate about the hinge line, position the outboard aileron chord plane in a horizontal position by placing a level on the bottom surface and adjusting the weight reaction adjusting screws.

(5) With the chord plane horizontal remove the level and record the scale reading.

(6) Calculate the surface Balance Moment by multiplying the Weight Reaction (WR) in pounds by the 20.50 inch moment arm.

Surface Moment = WR x 20.50 inch

Where WR = scale reading - tare weight

NOTE: Take care to observe proper sign convention as stated in 51-60-00, GENERAL. If (WR) adds to the tare weight this would be a downward force and is positive (+). If (WR) decreases the tare weight this would be an upward force and is negative (-).

Example: Tare weight of tool stand and reaction tip is 30 pound and scale reading is 32 pounds:

WR = 32 - 30 = (+) 2 pounds

Tare weight of tool stand and reaction tip is 30 pounds and scale reading is 28 pounds:

WR = 28 - 30 (-) 2 pounds

(7) If the moment is less than (-) 30 pound-inches, record the Rework Moment on the foil moment marker. Record in the Rework Record that a static balance has been done with the outboard aileron removed from the airplane, the new Balance Moment, and location and type of Rework with the date.

(8) If the moment is more than (-) 30 pound-inches, add sufficient Balance Adjust Weights to Tower 5 to make the moment less. Recheck the moment by repeating steps (4) through (6). Record the Rework Moment on the foil moment marker. Record in the Rework Record that a static balance has been done with the outboard aileron removed from the airplane, the new Balance Moment, the number of balance weights added, and location and type of Rework with the date.

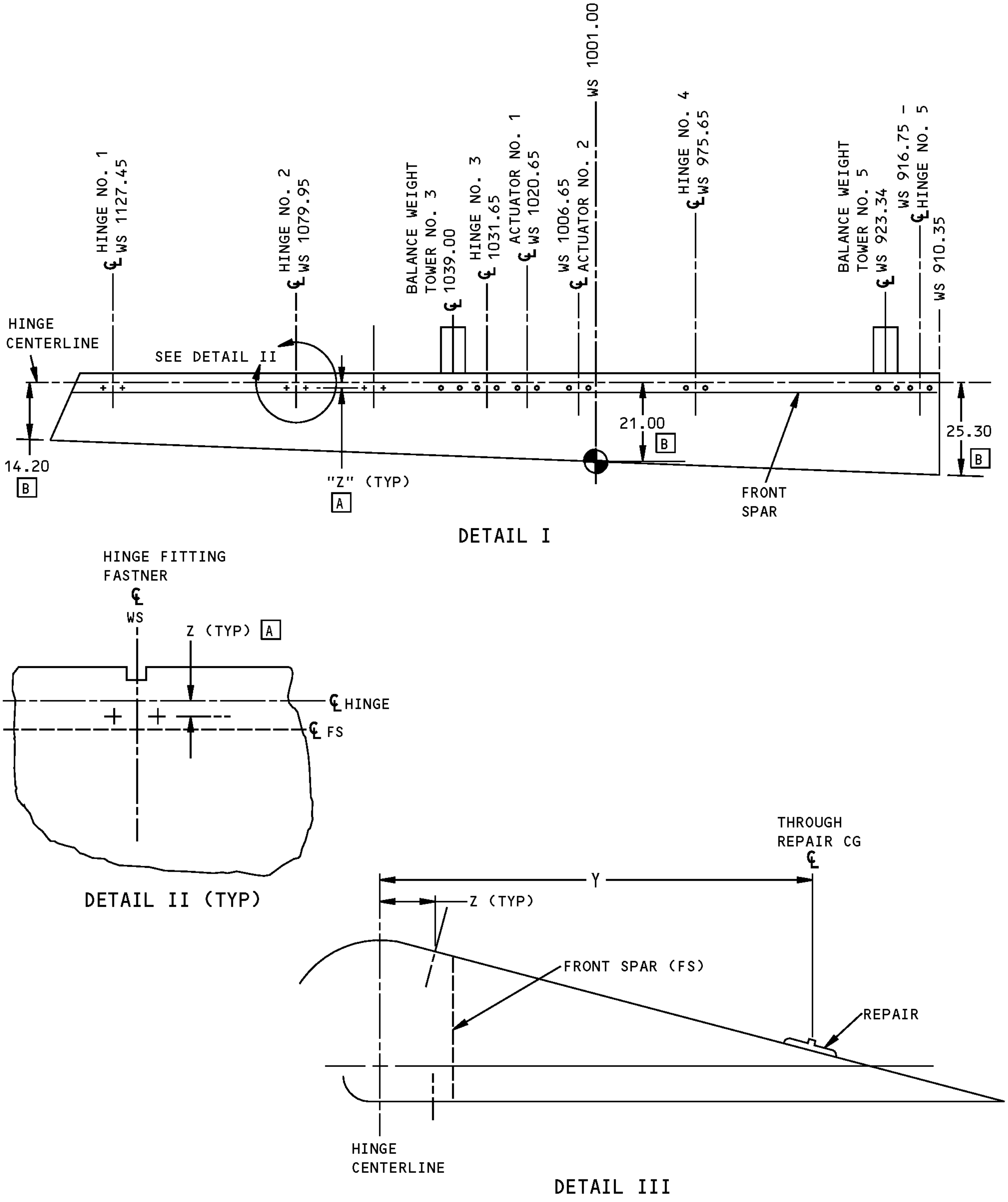
NOTE: Add sufficient Balance Adjust Weights so that the Balance Moment is less than the Calculated Limit for the next Rework.

(9) If the moment is more than (-) 30 pound-inches and all of the adjustable weight space on Tower 5 has been used, the outboard aileron must be:

(a) Refinished and have the paint buildup removed, or

(b) Removed and replaced, or

(c) Ask The Boeing Company to analyze the Rework Record to determine its serviceability.



Locating Hinge Centerline and Moment Arm
Figure 1 (Sheet 1 of 2)

LOCATION	WS	Z A INCHES
HINGE NO. 1	1127.45	1.51
HINGE NO. 2	1079.95	1.46
TOWER NO. 3	1039.00	1.26
HINGE NO. 3	1031.65	1.25
ACT. NO. 1	1020.65	1.34
ACT. NO. 2	1006.65	1.34
HINGE NO. 4	975.65	1.25
TOWER NO. 5	923.34	1.26
HINGE NO. 5	916.75	1.51

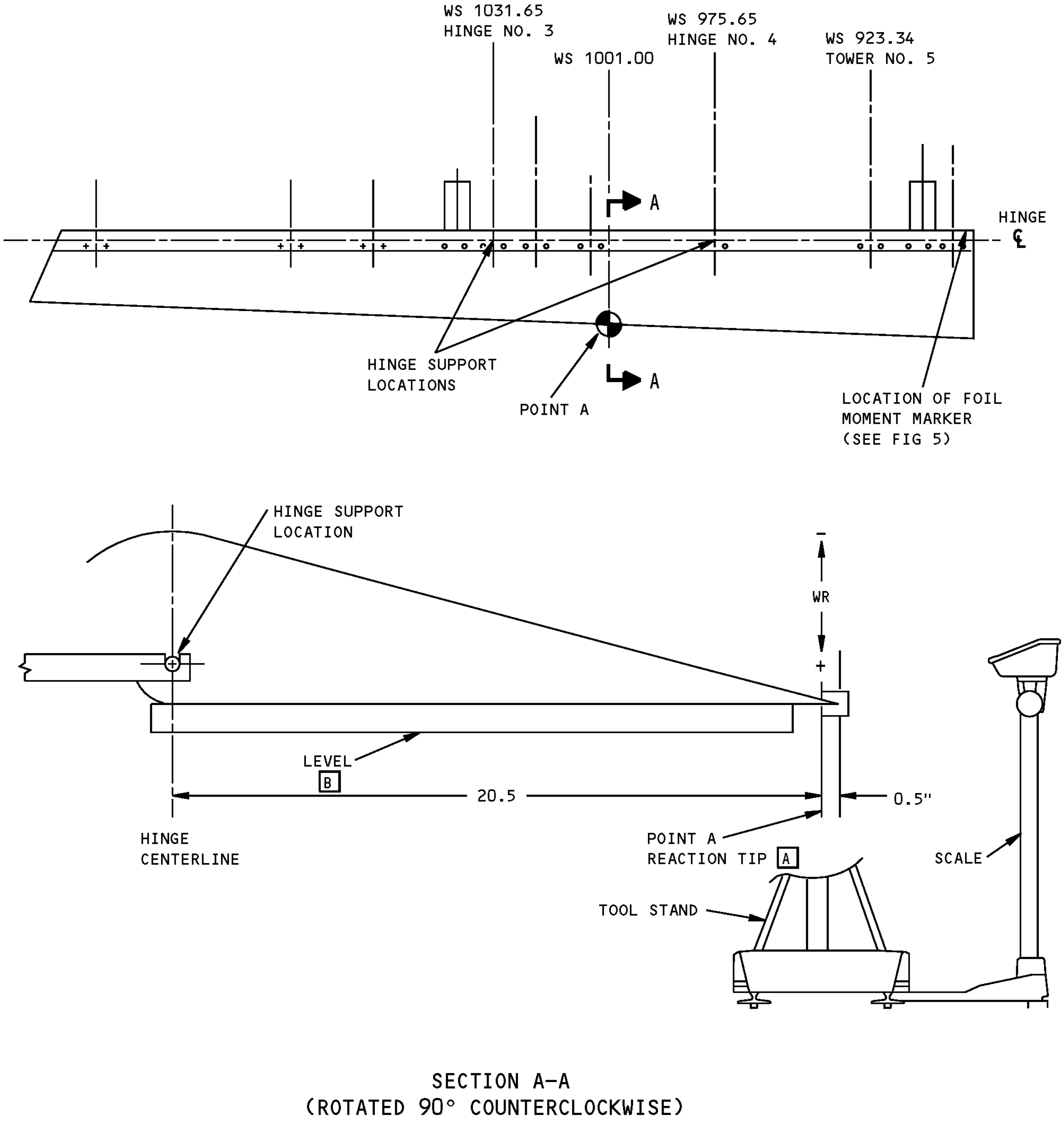
NOTES

- LOCATING HINGE CENTERLINE

A Z IS UPPER AND LOWER SURFACE DISTANCE FROM CENTER OF HINGE FITTING FASTENERS TO HINGE CENTERLINE. LOCATE HINGE CENTERLINE BY MEASURING Z DISTANCES FROM CENTER OF FASTENERS AT GIVEN WS AND SNAP CHALKLINE ACROSS LENGTH OF AILERON. DO NOT USE SHARP PENCIL THAT COULD SCRATCH THROUGH PAINT AND SCORE GRAPHITE FIBERS

B ALTERNATIVE METHOD FOR LOCATING HINGE CENTERLINE. MEASURE DISTANCES FROM EDGE OF AILERON TO HINGE CENTERLINE, SHOWN IN DETAIL I AND SNAP CHALKLINE ACROSS THESE POINTS

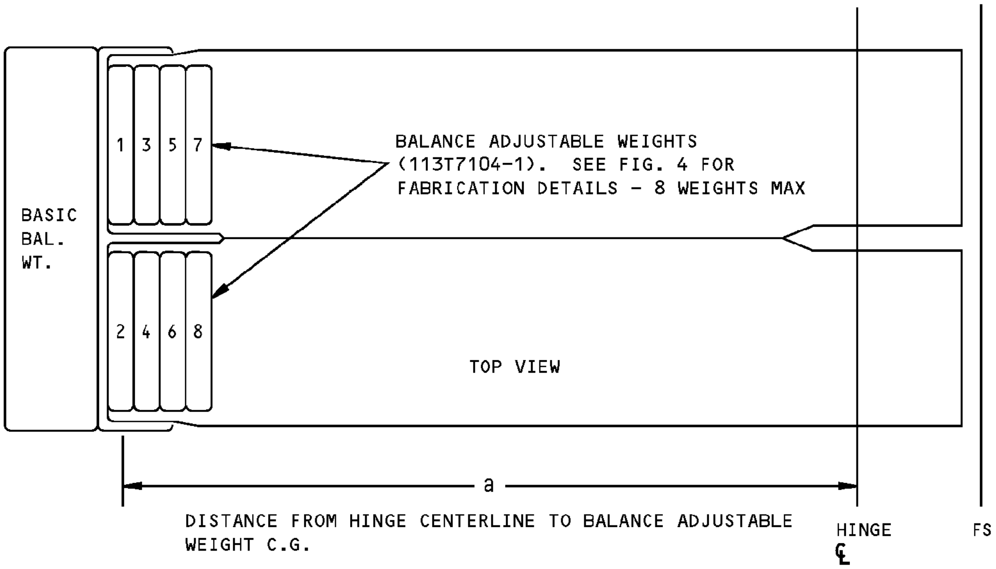
Locating Hinge Centerline and Moment Arm
Figure 1 (Sheet 2 of 2)



NOTES

- A THE REACTION TIP IS PLACED AT WS 1001.00
- B LEVEL THE AILERON WITH A LEVEL ON THE BOTTOM SURFACE

Static Balance Setup
Figure 2



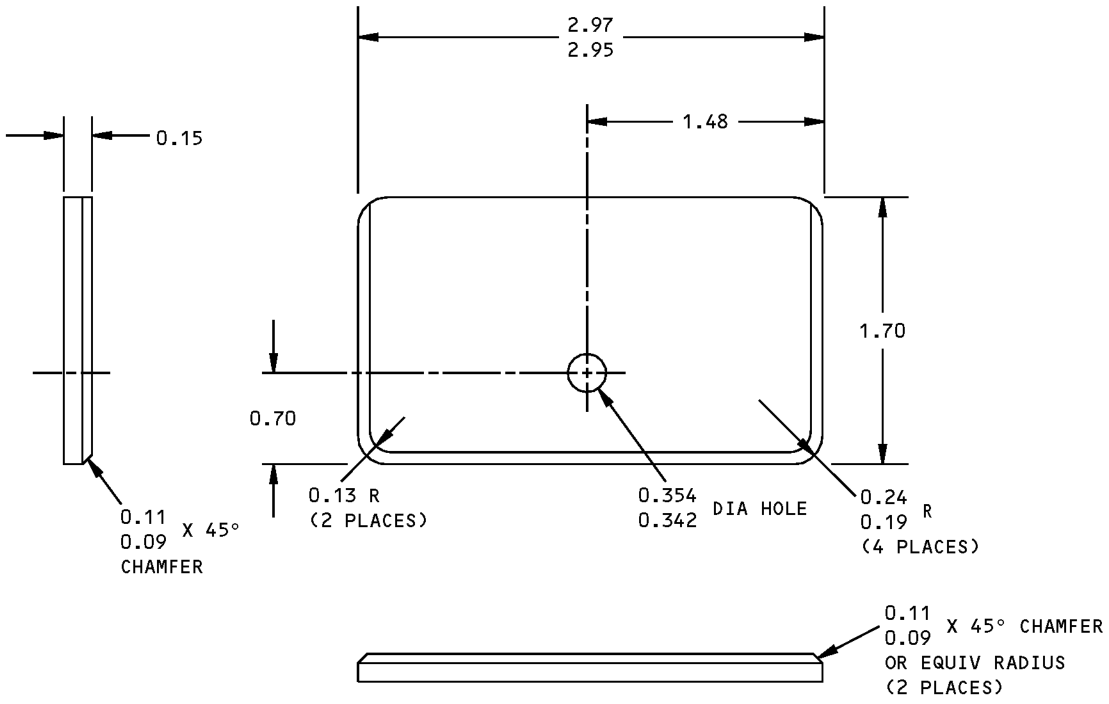
OUTBOARD AILERON BALANCE ADJUSTABLE WEIGHTS AND MOMENTS BALANCE TOWER NO. 5			
BALANCE ADJUSTABLE WEIGHT NUMBER A (113T7104-1)	BALANCE ARM - a (Inches)	INCREMENTAL MOMENT CHANGE B (Pound-Inches)	TOTAL ACCUMULATED MOMENT CHANGE B (Pound-Inches)
1	-13.52	-6.7	-6.7
2	-13.52	-6.7	-13.4
3	-13.37	-6.6	-20.0
4	-13.37	-6.6	-26.6
5	-13.22	-6.5	-33.1
6	-13.22	-6.5	-39.6
7	-13.07	-6.4	-46.0
8	-13.07	-6.4	-52.4

NOTES

A BALANCE ADJUSTABLE WEIGHT IS 0.491 POUNDS PER WEIGHT

B ACCOUNTS FOR MOMENT CHANGE DUE TO LONGER BOLTS

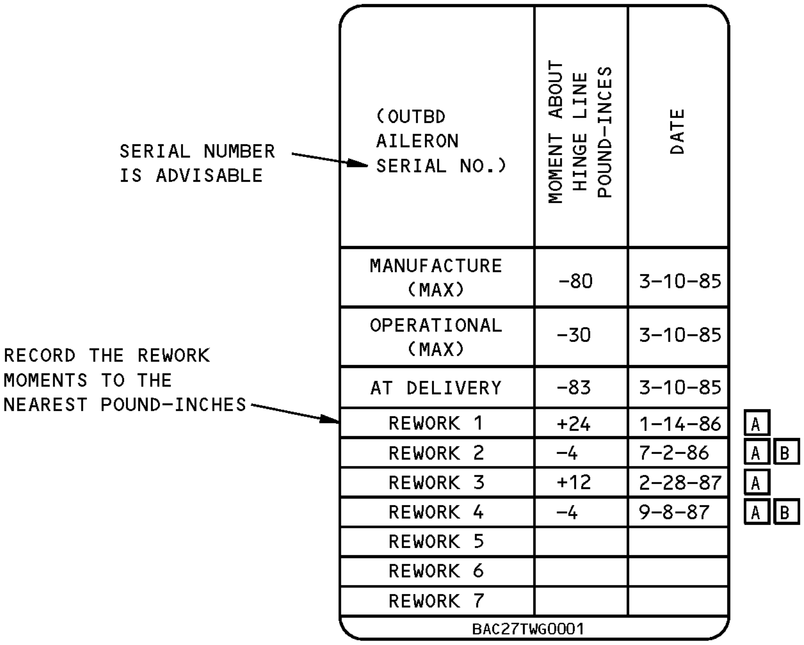
Balance Adjustable Weights and Moments
Figure 3



MATERIAL: SINTERED TUNGSTEN ALLOY PER
MIL-T-21014 CLASS 1, TYPE 2

Outboard Aileron Adjustable Weight
Figure 4

REFERENCE DRAWING
113T7100



SERIAL NUMBER IS ADVISABLE

RECORD THE REWORK MOMENTS TO THE NEAREST POUND-INCHES

(OUTBD AILERON SERIAL NO.)	MOMENT ABOUT HINGE LINE POUND-INCES	DATE	
MANUFACTURE (MAX)	-80	3-10-85	
OPERATIONAL (MAX)	-30	3-10-85	
AT DELIVERY	-83	3-10-85	
REWORK 1	+24	1-14-86	A
REWORK 2	-4	7-2-86	A B
REWORK 3	+12	2-28-87	A
REWORK 4	-4	9-8-87	A B
REWORK 5			
REWORK 6			
REWORK 7			

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NOTES

- ALL RECORDED DATA MUST BE VIBRO-ENGRAVED OR RUBBER STAMPED. SEE PARAGRAPH 5.C.

A RECORD THE CALCULATED REWORK MOMENT (INCLUDE THE CHANGE IN MOMENT FROM ANY ADDED BALANCE ADJUST WEIGHTS)

B THE TOTAL MOMENT WAS MORE THAN -45 POUND-INCHES. BALANCE ADJUST WEIGHTS WERE ADDED

Example Aluminum Foil Moment Marker
Figure 5

GENERAL - ELEVATOR OPERATIONAL BALANCE REQUIREMENTS AND PROCEDURES

1. General

A. This subject gives the balance requirements and procedures for determining and tracking the elevator Rework Capability.

B. The elevator is a Category II Control Surface that cannot be adjusted to meet the necessary Operational Static Balance Limits but has a built-in rework allowance for a moderate amount of Rework. Refer to Table 1/GENERAL for the balance limits.

Table 1: Static Balance Limits

CONTROL SURFACE	CATEGORY	STATIC BALANCE LIMITS (POUND-INCHES)			MAXIMUM REPAIR CAPABILITY (POUND-INCHES)
		MANUFACTURE	CALCULATED	OPERATIONAL	
TOTAL ELEVATOR	II	(+) 5,200	(+) 5,500	(+) 5,600	(+) 400
OUTBOARD ELEVATOR	II	(+) 2,800	(+) 3,000	(+) 3,050	(+) 250
INBOARD ELEVATOR	II	(+) 2,350	(+) 2,450	(+) 2,500	(+) 150

C. Refer to 51-60-00, GENERAL for the definitions of the different categories of Control Surfaces and other general data such as:

(1) General balance instructions
(2) Serviceability
(3) Definition of terms
(4) Sign conventions
(5) Measuring accuracy
(6) Special tools and equipment
(7) Repair material weights

D. Refer to 55-20-01, REPAIR 1 for the repair procedures.

2. References

Reference	Title
51-60-00, GENERAL	Control Surface Balance Moment Determination
55-20-01, REPAIR 1	Elevator Skin
SOPM 20-50-12	Application of Adhesives

3. Operational (Static Balance) Limit

A. The design Operational Limit for total elevator assembly is (+) 5,600 pound-inches.

WARNING: IF THE BALANCE MOMENT FOR THE ELEVATOR IS MORE THAN THE OPERATIONAL LIMIT, A CONDITION DANGEROUS TO FLIGHT SAFETY MAY OCCUR.

B. Outboard elevator: The design Operational Limit for the outboard elevator is (+) 3,050 pound-inches.

C. Inboard elevator: The design Operational Limit for the inboard elevator is (+) 2,500 pound-inches.

D. We recommend an elevator be removed from the airplane when its Balance Moment is more than its Calculated Limit of Table 1/GENERAL, or if you are not sure of the Balance Moment. After finding the Balance Moment in a balance fixture, subsequent rework calculations can be used up to the Operational Limit.

NOTE: We recommend that an elevator be removed at its Calculated Limit to protect against possible calculation errors.

4. Manufacture (Static Balance) Limit

A. The maximum Manufacture Limit for the total elevator assembly is (+) 5,200 pound-inches (finished).

B. Outboard elevator: The maximum Manufacture Limit for the outboard elevator is (+) 2,800 pound-inches (finished).

(1) The outboard elevator can be delivered with an initial Static Balance Moment less than the Manufacture Limit. This additional moment can be used for more Rework Capability. The example that follows shows how to calculate the total Rework Capability:

Example: The recorded outboard elevator Static Balance Moment is (+) 2,710 pound-inches

(+) 3,050 pound-inches (Operational Balance Limit)	-	(+) 2,710 pound-inches (Static Balance Moment)	-
(+) 340 pound-inches (Total Rework Capability)			
(+) 340 pound-inches (Total Rework Capability)	-	(+) 250 pound-inches (Total Repair Capability)	-
(+) 90 pound-inches (Additional Repaint Capability)			

C. Inboard elevator: The maximum Manufacture Limit for the inboard elevator is (+) 2,350 pound-inches (finished).

(1) The inboard elevator can be delivered with an initial Static Balance Moment less than the Manufacture Limit. This additional moment can be used for more Rework Capability. The example that follows shows how to calculate the total Rework Capability:

Example: The recorded inboard elevator Static Balance Moment is (+) 2,131 pound-inches

(+) 2,500 pound-inches (Operational Balance Limit)	-	(+) 2,131 pound-inches (Static Balance Moment)
=	(+) 369 pound-inches (Total Rework Capability)	
(+) 369 pound-inches (Total Rework Capability)	-	(+) 150 pound-inches (Total Repair Capability)
=	(+) 219 pound-inches (Additional Repaint Capability)	

5. Tracking

A. We recommend that you keep a Rework Record of how much weight and Rework Moment is added by each Rework operation and the Rework Capability that is still available.

B. The new Rework Moment, the collected Rework Moments, balance weights, locations, dates, total surface Repaints, and repaint moments should be recorded in the Rework Record for each elevator. If the elevator is replaced by a spare or installed on a different airplane, the Rework Record must go with the elevator.

C. On most elevators an aluminum foil moment marker is attached to the front spar. The foil moment marker will contain the Manufacture Balance Limit, Operational Balance Limit, delivered surface moment, and any Rework Moments pertaining to that component. It is advisable that a serial number be assigned and included on the marker to facilitate record keeping.

NOTE: The information on the aluminum foil moment marker should be vibro-engraved or rubber-stamped using permanent type ink. Apply a Skydrol-resistant finish to rubber-stamped data as given in SOPM 20-50-12. An example of an aluminum foil moment marker is shown in Figure 3/GENERAL.

6. Rework Moment and Serviceability

A. An elevator is no longer serviceable when its Balance Moment is more than its Operational Limit found in Table 1/GENERAL.

B. An elevator is no longer serviceable when the total Repair moments are more than its maximum Repair Capacity found in Table 1/GENERAL:

C. The serviceability of an elevator can be determined by adding all of the Rework Moments (from the Rework Record) to the Static Balance Moment or the Manufacture Limit (if the Static Balance Moment is not known).

D. Serviceability can be regained by removing the paint buildup from Repaints and Repairs that were performed without paint removal, and refinishing the Control Surface.

7. Rework Moment Calculation

A. The Rework Record for the elevator must be examined before a new Rework activity.

  (1) Verify that the Calculated Limits of Table 1/GENERAL will not be exceeded by the addition of the new Rework Moment.

  (2) Verify that the Control Surface Repair Capability of Table 1/GENERAL will not be exceeded.

B. Rework Moment Calculation Procedures for Repairs

  (1) Locate the hinge centerline and trace on the surface of the elevator. Refer to Figure 1/GENERAL.

  (2) Determine the increased weight from the added repair material. The weight of replacement core would be equivalent to the removed core. The material weight would be from one extra repair ply and the required repair adhesive. The weight of the added repair finish would be equivalent to be removed original finish (primer and paint). The weight of removed Repaints in the Repair area can be calculated and subtracted from the added Repair weight. Use repair material weights in 51-60-00, GENERAL for calculations.

  (3) Measure Moment Arm "Y" (in inches) to the centroid of the repair. See Figure 1/GENERAL.

  (4) Calculate the Rework Moment (MR):

  MR = Repair Weight (in pounds) multiplied by "Y" (in inches)

    (a) Determine serviceability of the elevator due to the Repair. Refer to Paragraph 6./GENERAL.

    (b) If the elevator is serviceable, record the necessary Rework information.

C. Rework Moment Calculation Procedures for Repaint

  (1) Locate hinge centerline and trace on the surface of the elevator. See Figure 1/GENERAL.

  (2) Calculate the Rework Moment (MR) from data given in 51-60-00, GENERAL, Figure 2/GENERAL, Tables II and III.

  MR = Surface Area x Paint Density x Centroid Distance

(a) Determine serviceability of the elevator due to the Repaint. Refer to par.Paragraph 6./GENERAL

(b) If the elevator is serviceable, record the necessary Rework Information.

8. Balance of the Total Elevator Assembly on the Airplane

A. Calculate the Rework Moment for the Rework. Refer to Paragraph 7./GENERAL.

B. Add the new Rework Moment to the other Rework Moments (recorded before) and the elevator's Static Balance Moment to find the new Balance Moment for the elevator.

C. If the new Balance Moment of the elevator is calculated to be:

(1) Less than (+) 5,500 pound-inches and less than (+) 400 pound-inches of Repair, the elevator is serviceable.

(2) More than (+) 5,500 pound-inches and less than (+) 400 pound-inches of Repair:

(a) Remove paint accumulated through previous Reworks until the elevator's Calculated Limit is less than (+) 5,500 pound-inches, -or-

(b) Remove and verify that the elevator's Balance Moment is less than (+) 5,600 pound-inches (Operational Limit).

(3) More or less than (+) 5,500 pound-inches and more than (+) 400 pound-inches of Repair:

(a) Remove and replace the elevator, -or-

(b) Ask The Boeing Company to analyze the Rework Record to determine if it is still serviceable.

9. Balance of the Elevator Off of the Airplane

A. Static balancing requires the removal of the elevator from the airplane.

B. The inboard and outboard elevators must be balanced as separate units in order to determine that each unit does not exceed their respective Operational Limits.

(1) One static discharger is to remain on the outboard elevator during balancing.

(2) Bonding jumpers are not required for static balancing.

(3) The Rework must be complete, including the paint finish.

(4) Repainting without removal of existing paint finishes can use up the Rework Capability. Consideration should be given for the removal of the paint buildup and refinishing the elevator as a means of regaining serviceability.

C. To extend the serviceability of components, the intermixing of inboard and outboard elevators with another assembly is allowed. The Rework Record of the individual components should be reviewed to evaluate the advantage of intermixing the elevators. The new intermixed assembly should be static balanced for serviceability determination.

D. Refer to 51-60-00, GENERAL for the necessary tools and equipment to measure the new surface Balance Moment.

(1) Remove the elevator assembly and separate units for individual balancing.

(2) Install the elevator on the balance jig stand connecting the hinge supports. Refer to 51-60-00, GENERAL.

(3) Record the tare weight of the tool stand and weight reaction tip fixture.

(4) Locate the reaction tip at point "A" if balancing the outboard elevator or point "B" if balancing the inboard elevator. See Figure 1/GENERAL and Figure 2/GENERAL. The Moment Arm is 50.82 inches for the outboard elevator and 63.22 inches for the inboard elevator.

(5) With the elevator free to rotate about the hinge line, position the elevator chord plane in a horizontal position (level).

NOTE: The elevator may be horizontally leveled by placing a protractor level on the elevator surface. The surface is positioned at 4 degrees to the chord plane. The adjusting screws in the reaction tip fixture will allow up and down adjustment.

(6) With the chord plane horizontal, remove the protractor level and record the scale reading.

(7) Calculate the surface Balance Moment by multiplying the Weight Reaction (WR) in pounds by the Moment Arm.

Outboard Elevator Balance Moment (pound-inches)	=	WR (pound)	x
50.82 (inches)			
Inboard Elevator Balance Moment (pound-inches)	=	WR (pound)	x
63.22 (inches)			

Where WR = scale reading - tare weight

NOTE: Take care to observe proper sign convention as stated in 51-60-00, GENERAL. If (WR) adds to the tare weight, this would be a downward force and is positive (+). If (WR) decreases the tare weight, this would be an upward force and is negative (-).

Example: Tare weight of tool stand and reaction tip is 30 pounds

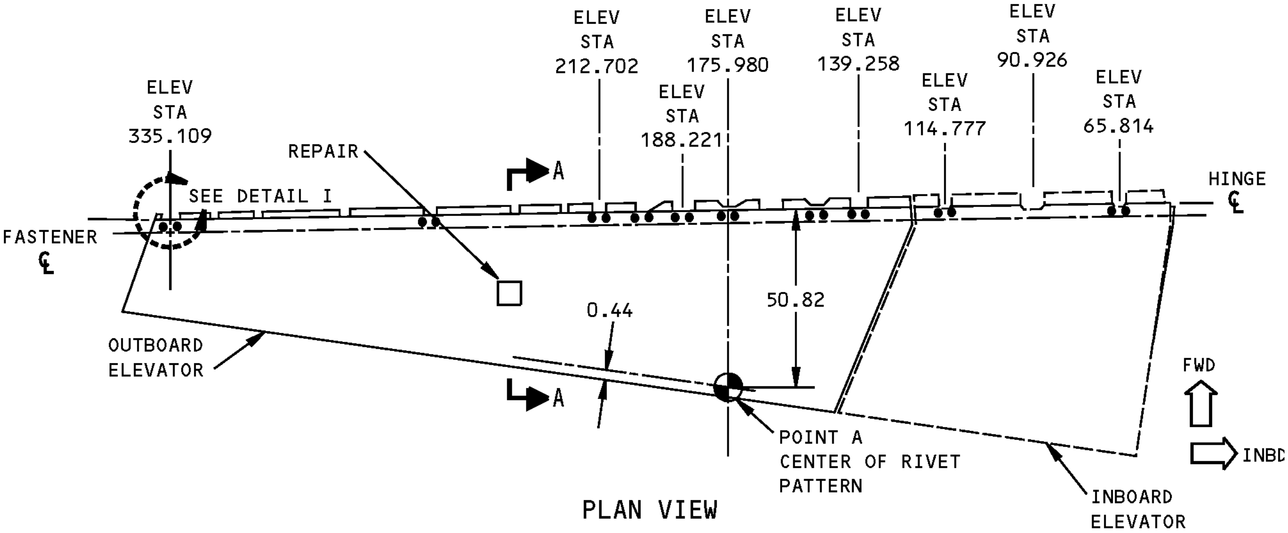
and scale reading is 32 pounds:

WR = 32 - 30 = (+) 2 pounds

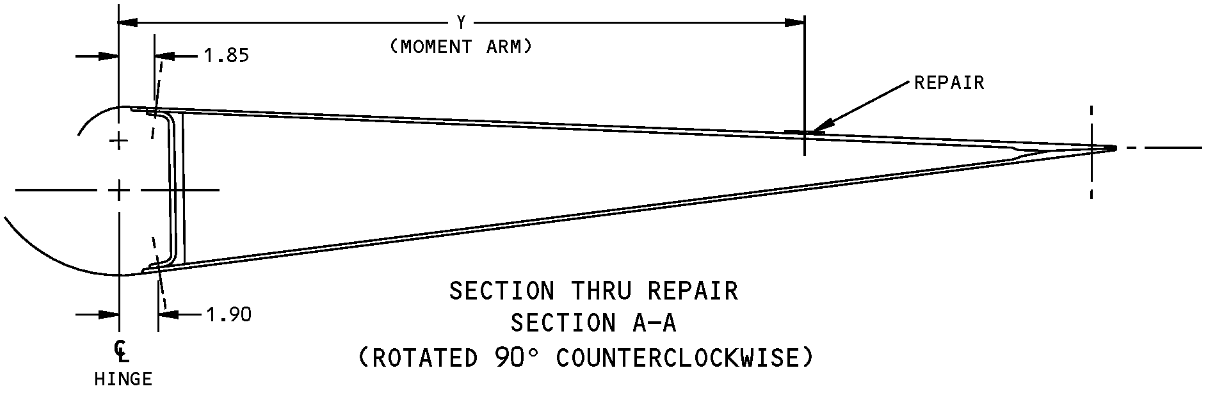
Tare weight of tool stand and reaction tip is 30 pounds and scale reading is 28 pounds:

WR = 28 - 30 = (-) 2 pounds

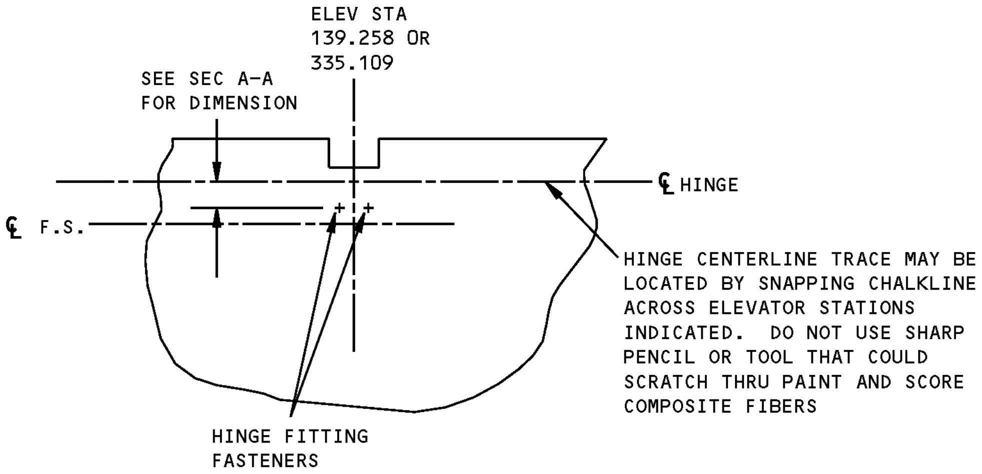
(8) Refer to Paragraph 6./GENERAL for serviceability of the elevator.



PLAN VIEW



SECTION THRU REPAIR
SECTION A-A
(ROTATED 90° COUNTERCLOCKWISE)

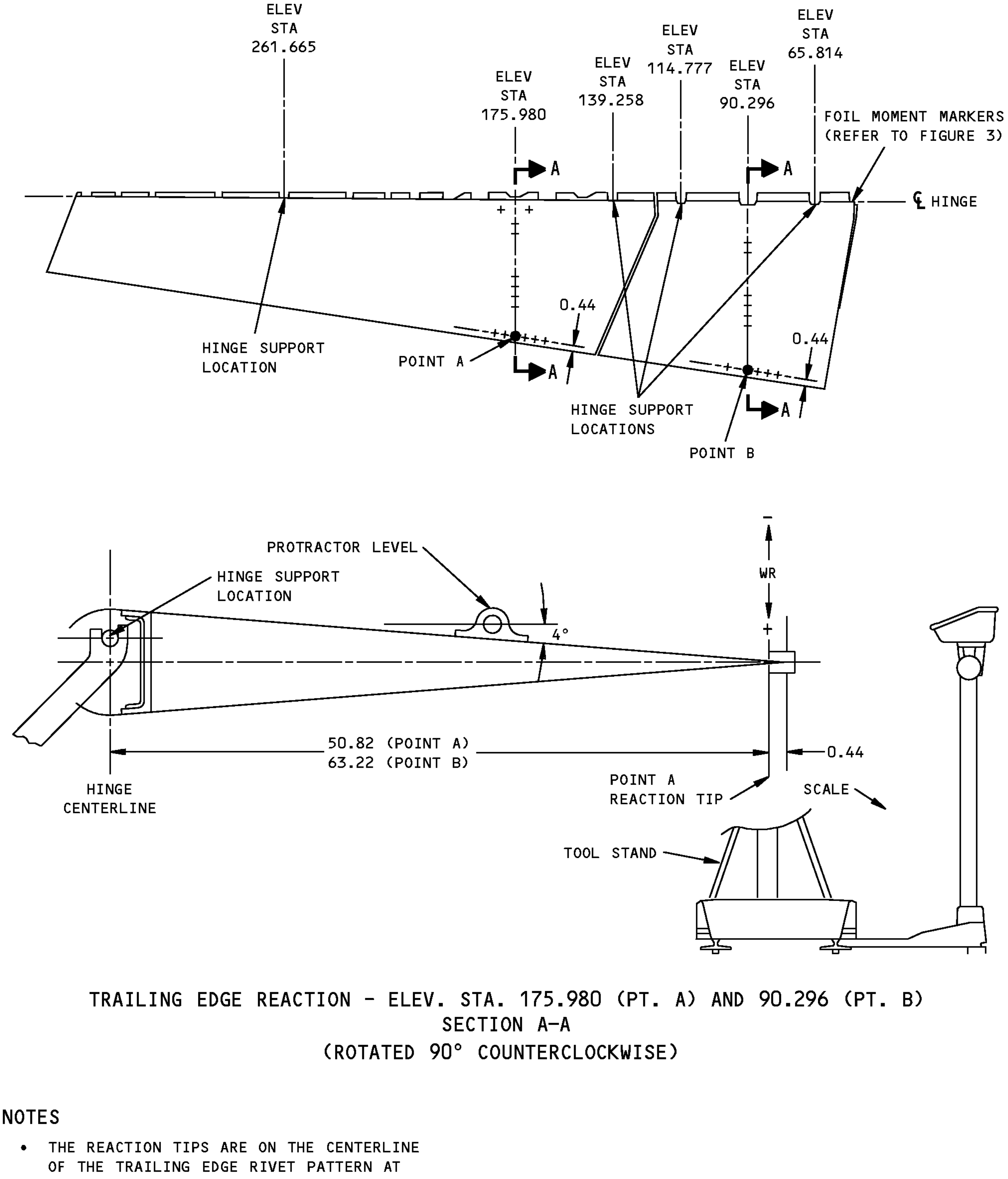


DETAIL I

NOTE

- OUTBOARD ELEVATOR SURFACE MOMENT DETERMINATION SHOWN, INBOARD ELEVATOR SIMILAR

Hinge Centerline and Repair Moment Arm
Figure 1

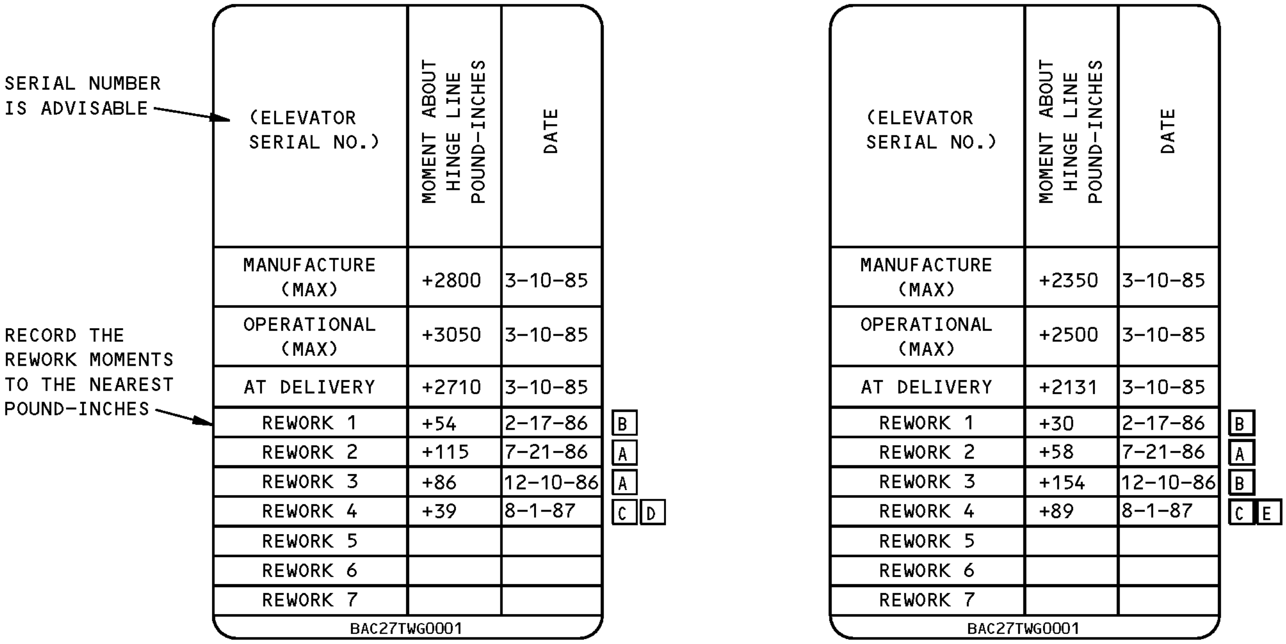


NOTES

- THE REACTION TIPS ARE ON THE CENTERLINE OF THE TRAILING EDGE RIVET PATTERN AT ELEVATOR STATIONS 175.980 AND 90.296

Static Balance Setup
Figure 2

REFERENCE DRAWING
183T2001



SERIAL NUMBER IS ADVISABLE

RECORD THE REWORK MOMENTS TO THE NEAREST POUND-INCHES

(ELEVATOR SERIAL NO.)	MOMENT ABOUT HINGE LINE POUND-INCHES	DATE	
MANUFACTURE (MAX)	+2800	3-10-85	
OPERATIONAL (MAX)	+3050	3-10-85	
AT DELIVERY	+2710	3-10-85	
REWORK 1	+54	2-17-86	B
REWORK 2	+115	7-21-86	A
REWORK 3	+86	12-10-86	A
REWORK 4	+39	8-1-87	C D
REWORK 5			
REWORK 6			
REWORK 7			
BAC27TWG0001			

OUTBOARD ELEVATOR

(ELEVATOR SERIAL NO.)	MOMENT ABOUT HINGE LINE POUND-INCHES	DATE	
MANUFACTURE (MAX)	+2350	3-10-85	
OPERATIONAL (MAX)	+2500	3-10-85	
AT DELIVERY	+2131	3-10-85	
REWORK 1	+30	2-17-86	B
REWORK 2	+58	7-21-86	A
REWORK 3	+154	12-10-86	B
REWORK 4	+89	8-1-87	C E
REWORK 5			
REWORK 6			
REWORK 7			
BAC27TWG0001			

INBOARD ELEVATOR

SAMPLE EVALUATION

NOTES

- ALL RECORDED DATA MUST BE VIBRO-ENGRAVED OR RUBBER STAMPED. SEE PARAGRAPH 5.C.

A RECORD THE CALCULATED REWORK MOMENT FROM A REPAIR

B RECORD THE CALCULATED REWORK MOMENT FROM A REPAINT

C RECORD THE REWORK MOMENT FROM A REPAIR, FOUND BY STATIC BALANCING THE ELEVATOR OFF OF THE AIRPLANE (THE ELEVATOR WAS REMOVED BECAUSE THE BALANCE MOMENT WILL BE MORE THAN THE CALCULATED LIMIT AFTER THE REWORK)

D THE TOTAL MOMENT FOR THE OUTBOARD ELEVATOR AFTER REWORK MUST NOT BE MORE THAN +3,050 POUND-INCHES. THIS ELEVATOR HAS +46 POUND-INCHES OF REWORK MOMENT AVAILABLE (ONLY +10 POUND-INCHES CAN BE FROM A REPAIR)

E THE TOTAL MOMENT FOR THE INBOARD ELEVATOR AFTER REWORK MUST NOT BE MORE THAN +2,500 POUND-INCHES. THIS ELEVATOR HAS +38 POUND-INCHES OF REWORK MOMENT AVAILABLE (ONLY +3 POUND-INCHES CAN BE FROM A REPAIR)

Example Aluminum Foil Moment Marker
Figure 3

GENERAL - RUDDER OPERATIONAL BALANCE REQUIREMENTS AND PROCEDURES

1. General

A. This subject gives the balance requirements and procedures for determining and tracking the rudder Rework Capability.

B. The rudder is a Category II Control Surface that cannot be adjusted to meet the necessary Operational Static Balance Limit but has a built-in rework allowance for a moderate amount of Rework. See Table I for the balance limits.

Table 1: Static Balance Linits

CONTROL SURFACE	CATEGORY	STATIC BALANCE LIMITS (POUND-INCHES)			MAXIMUM REPAIR CAPABILITY (POUND-INCHES)
		MANUFACTURE	CALCULATED	OPERATIONAL	
RUDDER	II	(+) 10,000	(+) 10,400	(+) 10,500	(+) 500

C. Refer to 51-60-00, GENERAL for the definitions of the different categories of Control Surfaces and other general data such as:

(1) General balance instructions

(2) Serviceability

(3) Definition of terms

(4) Sign conventions

(5) Measuring accuracy

(6) Special tools and equipment

(7) Repair material weights

D. Refer to 55-40-01, REPAIR 1 for the repair procedures.

2. References

Reference	Title
51-60-00, GENERAL	Control Surface Balance Moment Determination
55-40-01, REPAIR 1	Rudder Skin
SOPM 20-50-12	Application of Adhesives

3. Operational (Static Balance) Limit

A. The design Operational Limit for the rudder is (+) 10,500 pound-inches.

NOTE: Some rudders will have an aluminum foil marker that give a maximum Operational Balance Limit of (+) 10,300 pound-inches. This procedure permits you to use the (+) 10,500 pound-inches Operational Balance Limit on those rudders.

WARNING: IF THE BALANCE MOMENT OF THE RUDDER IS MORE THAN (+) 10,500 POUND-INCHES, A CONDITION DANGEROUS TO FLIGHT SAFETY MAY OCCUR.

B. We recommend that the rudder be removed from the airplane when the Balance Moment is more than the Calculated Limit of (+) 10,400 pound-inches, or if you are not sure of the Balance Moment. After finding the Balance Moment in a balance fixture, subsequent rework calculations can be used up to the Operational Limit.

NOTE: We recommend that the rudder be removed at (+) 10,400 pound-inches to protect against possible calculation errors.

4. Manufacture (Static Balance) Limit

A. The maximum Manufacture Limit for the rudder is (+) 10,000 pound-inches (finished).

B. The rudder can be delivered with an initial Static Balance Moment less than the Manufacture Limit. This additional moment more than the Repair Capability of (+) 500 pound-inches can be used for Repaint only. The example that follows shows the differences in Rework and Repair Capability: Example: Recorded rudder Static Balance Moment is (+) 9,758 pound-inches

Table 2:

(+) 10,500 pound-inches (Operational Limit)	-	(+) 9,758 pound-inches (Static Balance Moment)	=
(+) 742 pound-inches (Total Rework Capability)			
(+) 742 pound-inches (Total Rework Capability)	-	(+) 500 pound-inches (Total Repair Moment)	=
(+) 242 pound-inches (Additional Repaint Moment)			

5. Tracking

A. We recommend that you keep a Rework Record of how much weight and Rework Moment is added by each Rework operation and the Rework Capability that is still available.

B. The new Rework Moment, the collected total of all the Rework Moments, locations, dates, total surface repaints, and repaint moments must be recorded in the Rework Record. If the rudder is replaced by a spare or installed on a different airplane, the Rework Record must go with the rudder.

C. On most rudders, an aluminum foil moment marker is attached to the front spar near rudder station 115.42. The foil moment marker will contain the Manufacture Limit, Operational Limit, Static Balance Moment (at delivery), and any Rework Moments pertaining to that component. It is advisable that a serial number be assigned and included on the marker to facilitate record keeping.

NOTE: Verify that the aluminum foil moment marker has the new Manufacture Limit and Operational Limit and revise if necessary. All information added to the aluminum foil moment marker should be vibro-engraved or rubber-stamped using permanent type ink. Apply a Skydrol-resistant finish to rubber-stamped data as given in SOPM 20-50-12. An example of an aluminum foil moment marker is shown in Figure 3/GENERAL.

6. Rework Moment and Serviceability

A. The rudder is no longer serviceable when it has a Balance Moment more than (+) 10,500 pound-inches.

B. The rudder is no longer serviceable when the total Repair moments are more than (+) 500 pound-inches.

C. The serviceability of the rudder can be determined by adding all of the Rework Moments (from the Rework Record) to the Static Balance Moment or the Manufacture Limit of (+) 10,000 pound-inches (if the Static Balance Moment is not known).

D. Serviceability can be regained by removing the paint buildup from Repaints and Repairs that were performed without paint removal, and refinishing the rudder.

7. Rework Moment Calculation

A. The Rework Record for the rudder must be examined before a new Rework operation.

(1) Verify that the Calculated Limit of (+) 10,400 pound-inches will not be exceeded by the addition of the Rework Moment.

(2) Verify that the Control Surface Repair Capability of (+) 500 pound-inches will not be exceeded.

B. Rework Moment Calculation Procedures for Repairs

(1) Locate hinge centerline and trace on the surface of the rudder. Refer ro Figure 1/GENERAL.

(2) Determine the increased weight from the added repair material. The weight of replacement core would be equivalent to the removed core.

The material weight would be from one extra repair ply and the required repair adhesive. The weight of the added repair finish would be equivalent to the removed original finish (primer and paint). The weight of removed Repaints in the Repair area can be calculated and subtracted from the added Repair weight. Use repair material weights in 51-60-00, GENERAL for calculations.

(3) Measure Moment Arm "Y" to centroid of Repair. See Figure 1/GENERAL.

(4) Calculate the Repair Moment (MR):

MR = Repair Weight (in pounds) multiplied by "Y" (in inches)

(a) Determine serviceability of the rudder due to the Rework. Refer to Paragraph 6./GENERAL

(b) If the rudder is serviceable, record the necessary Rework information.

C. Rework Moment Calculation Procedures for Repaint

(1) Locate hinge centerline and trace on the surface of the rudder. See Figure 1/GENERAL.

(2) Calculate the Rework Moment from data given in 51-60-00, GENERAL, Figure 2/GENERAL, Tables II and III.

MR = Surface Area x Paint Density x Centroid Distance

(a) Determine serviceability of the rudder due to the Rework. Refer to Paragraph 6./GENERAL.

(b) If the rudder is serviceable, record the necessary Rework information.

8. Balance of the Rudder on the Airplane

A. Calculate the Rework Moment for the Rework. Refer to Paragraph 7./GENERAL.

B. Add the new Rework Moment to the other Rework Moments (recorded before) and the rudder's Static Balance Moment to find the new surface Balance Moment of the rudder.

C. If the Balance Moment of the rudder is calculated to be:

(1) Less than (+) 10,400 pound-inches with less than (+) 500 pound-inches of Repair the rudder is serviceable.

(2) More than (+) 10,400 pound-inches with less than (+) 500 pound-inches of Repair:

(a) Remove paint accumulated through previous Reworks until the rudder's calculated Balance Moment is less than (+) 10,400 pound-inches, or

(b) Remove and balance the rudder off of the airplane. Refer to Paragraph 9./GENERAL

(3) More than or less than the (+) 10,400 pound-inches with more than (+) 500 pound-inches of Repairs, the rudder is not serviceable:

(a) Remove and replace the rudder, or

(b) Ask The Boeing Company to analyze the Rework Record to determine the rudder's further serviceability.

9. Balance of the Rudder Off of the Airplane

A. Static balancing requires the removal of the rudder from the airplane.

(1) The trailing edge static discharger is to remain on the rudder during balancing. Bonding jumpers are not required for static balancing.

(2) The Rework must be complete, including the paint finish.

(3) Repainting without removal of existing paint finishes may use up the Rework Capability. Consideration should be given for the removal of the paint buildup and refinish as a means of regaining serviceability.

B. Refer to 51-60-00, GENERAL for the necessary tools and equipment to measure the new surface Balance Moment.

(1) Install the rudder on the balance jig stand connecting the hinge supports at rudder stations 106.142 and 230.972.

(2) Record the tare weight of the tool stand and weight reaction tip fixture.

(3) Locate the reaction tip at point "A" which is on the trailing edge rivet pattern at rudder station 173.00. See Figure 2/GENERAL.

(4) With the rudder free to rotate about the hinge line, position the rudder chord plane in a horizontal position (level) using a protractor level positioned at 5 degrees and adjusting the weight reaction tip adjusting screws.

(5) With the chord plane horizontal, remove the protractor level and record the scale reading.

(6) Calculate the surface Balance Moment by multiplying the Weight Reaction (WR) in pounds by the 67.65 inch Moment Arm.

Table 3:

Rudder Balance Moment (pound-inches)	=	WR (pound)	x	67.65 (inches)

Where WR = scale reading - tare weight

NOTE: Take care to observe proper sign convention as stated in 51-60-00, GENERAL. If (WR) adds to the tare weight, this would be a downward force and is positive (+). If (WR) decreases the tare weight this would be an upward force and is negative (-).

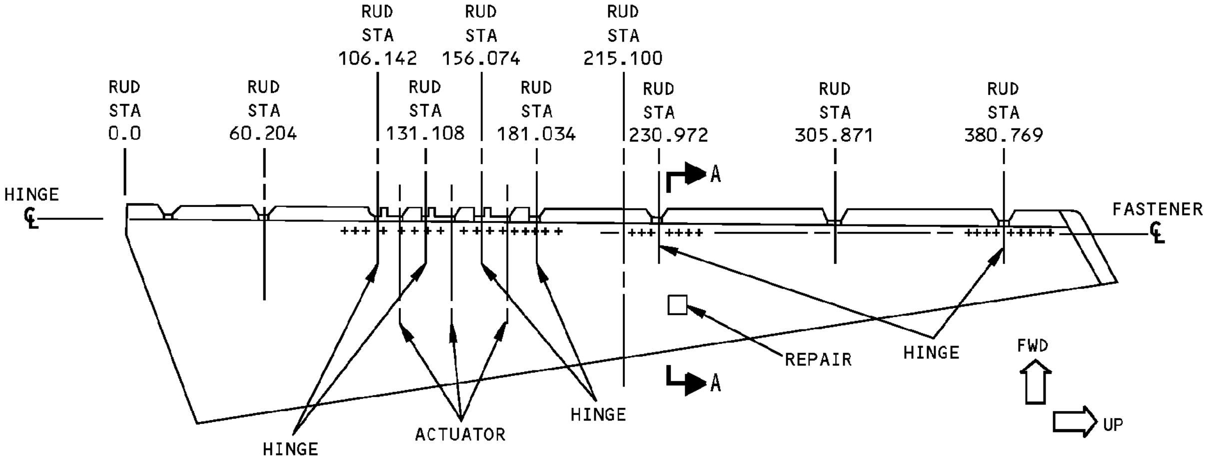
Example: Tare weight of tool stand and reaction tip is 30 pounds and scale reading is 32 pounds:

WR = 32 - 30 = (+) 2 pounds.

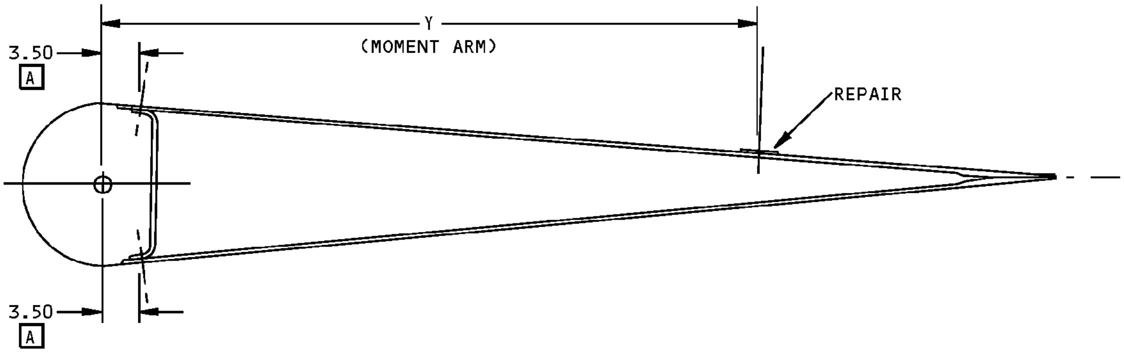
Tare weight of tool stand and reaction tip is 30 pounds and scale reading is 28 pounds:

WR = 28 - 30 = (-) 2 pounds.

(7) Refer to Paragraph 6./GENERAL for serviceability of the rudder.



LEFT SIDE VIEW OF RUDDER

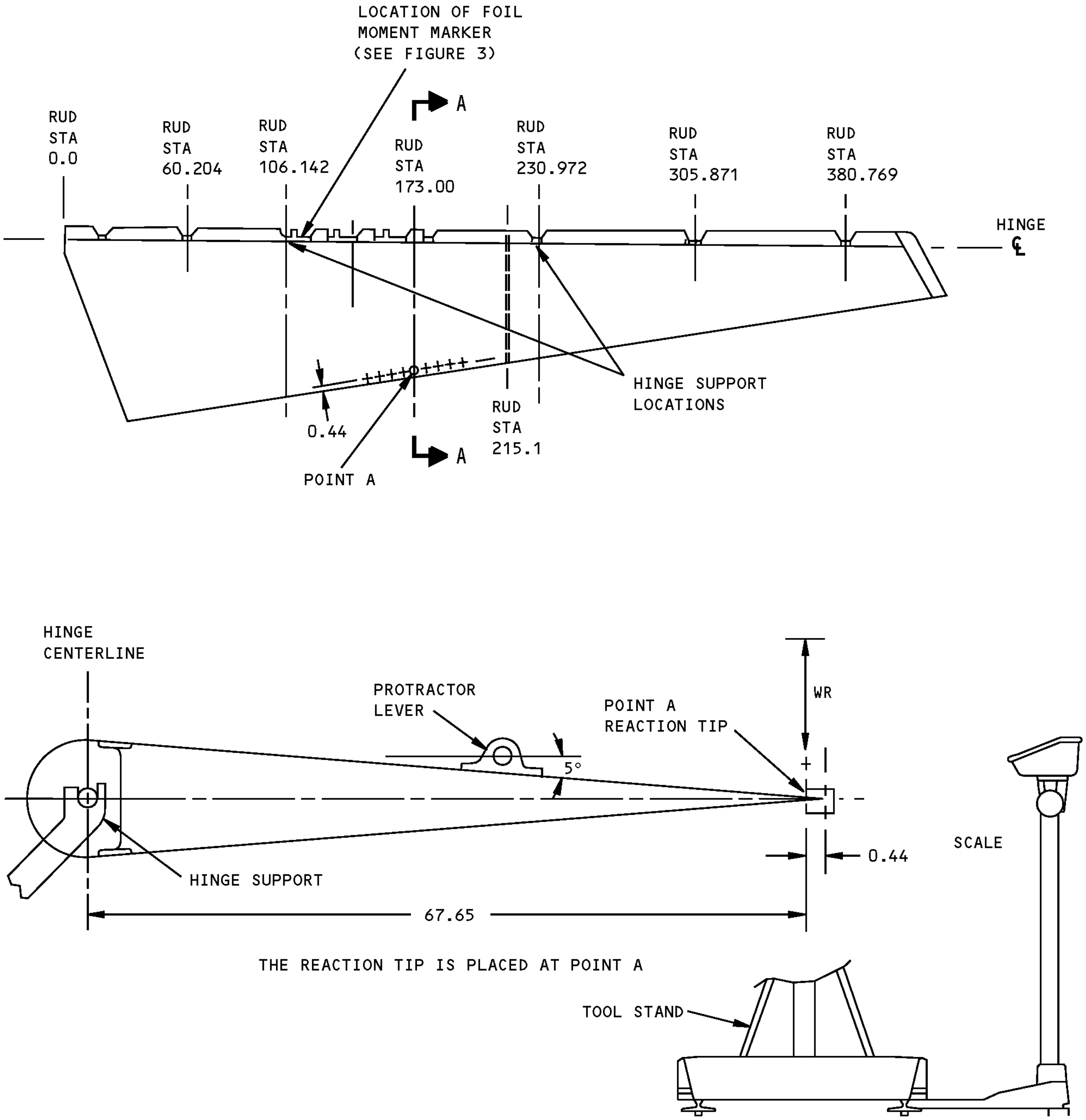


SECTION THRU REPAIR
SECTION A-A
(ROTATED 90° COUNTERCLOCKWISE)

NOTES

A HINGE CENTERLINE TRACE MAY BE LOCATED BY SNAPPING CHALKLINE ACROSS RUDDER STATIONS INDICATED. DO NOT USE SHARP PENCIL OR TOOL THAT COULD SCRATCH THRU PAINT AND SCORE COMPOSITE FIBERS

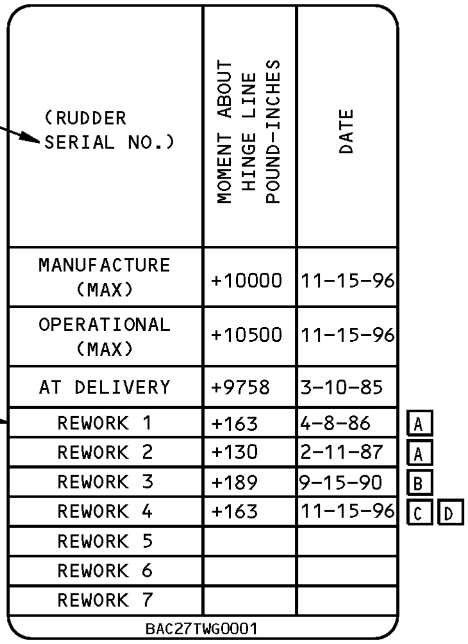
Hinge Centerline Repair Moment Arm
Figure 1



TRAILING EDGE REACTION
RUDDER STA 173.00 (POINT A)
SECTION A-A
(ROTATED 90° COUNTERCLOCKWISE)

Static Balance Setup
Figure 2

REFERENCE DRAWING
173T2001



SERIAL NUMBER IS ADVISABLE

RECORD THE REWORK MOMENTS TO THE NEAREST POUND-INCHES

(RUDDER SERIAL NO.)	MOMENT ABOUT HINGE LINE POUND-INCHES	DATE	
MANUFACTURE (MAX)	+10000	11-15-96	
OPERATIONAL (MAX)	+10500	11-15-96	
AT DELIVERY	+9758	3-10-85	
REWORK 1	+163	4-8-86	A
REWORK 2	+130	2-11-87	A
REWORK 3	+189	9-15-90	B
REWORK 4	+163	11-15-96	C D
REWORK 5			
REWORK 6			
REWORK 7			

BAC27TWG0001

NOTES

- ALL RECORDED DATA MUST BE VIBRO-ENGRAVED OR RUBBER STAMPED. SEE PARAGRAPH 5.C.

A RECORD THE CALCULATED REWORK MOMENT FROM A REPAIR

B RECORD THE CALCULATED REWORK MOMENT FROM A REPAINT

C RECORD THE REWORK MOMENT FROM A REPAIR, FOUND BY STATIC BALANCING THE RUDDER OFF OF THE AIRPLANE (THE RUDDER WAS REMOVED BECAUSE THE BALANCE MOMENT WILL BE MORE THAN THE CALCULATED LIMIT AFTER THE REWORK)

D THE BALANCE MOMENT FOR THE RUDDER AFTER REWORK MUST NOT BE MORE THAN +10,500 POUND-INCHES. THIS RUDDER HAS 97 POUND-INCHES OF REWORK MOMENT AVAILABLE (ONLY 44 POUND-INCHES CAN BE FROM A REPAIR)

Example Aluminum Foil Moment Marker
Figure 3

GENERAL - PROCEDURES TO REWORK AND FILL MINOR DENTS IN METALLIC PARTS ON EXTERNAL AERODYNAMIC SURFACES

1. Applicability

A. The procedure to rework a dent is applicable if the dent agrees with the conditions that follow:
- The dent is on the external aerodynamic surface of the airplane, and
- Is in a 2000 series or 7000 series aluminum (except 7178) sheet or aluminum facesheet/aluminum honeycomb sandwich panel, and
- Is in an area that is a maximum of 0.063 inch thick, and
- Is permitted by the applicable allowable damage limits given in the Chapter-Section-Subject of the damaged part, and
- Does not have other damage (such as creases, nicks, gouges, scratches, and punctures) that is more than what is permitted by the allowable damage limits given in the Chapter-Section-Subject of the damaged part.

B. The procedure to fill a dent is applciable if the dent agrees with the conditions that follow:
- The dent is on the external aerodynamic surface of the airplane, and
- Is in a metallic part, and
- Is permitted by the applicable allowable damage limits given in the Chapter-Section-Subject of the damaged part. The allowable damage data will also tell you if the dent is not permitted to be filled.

C. The instructions in this subject are not applicable to:
- Non-aluminum parts
- Parts that have an aluminum sheet bonded to a non-metallic honeycomb core
- Parts that have non-metallic plies bonded to an aluminum honeycomb core
- A dent in an area where the skin attaches to a frame, stringer, intercostal, or doubler
- A dent across a fastener hole.

Refer to the Chapter-Section-Subject of these parts for the applicable dent data.

D. This subject does not give approval for the final condition of the dent, whether the dent has or has not been reworked. Refer to the applicable allowable damage information in the Chapter-Section-Subject of the damaged part to find the limits that are permitted for the dent.

2. General

A. Dents can cause:
- A reduction in flight performance
- A bad effect on flight characteristics
- A bad effect on stall speed
- Buffeting.

B. For data that is not given in this subject but is needed before you fill a dent, refer to:
- The allowable damage data in the Chapter-Section-Sbuject of the damaged part to find if there are areas where you are not permitted to fill a dent
- SRM 51-30-3 for the sources of the adhesive and fairing compounds.

C. Make sure the aerodynamic smoothness is satisfactory as given in 51-10-01, GENERAL or the performance of the airplane can be reduced.

NOTE: Dents are permitted to the dimensions given in the applicable Chapter-Section-Subject. It is possible that these dimensions are larger than the smoothness limits recommended in SRM 51-70-00.

3. References

Reference	Title
51-10-01, GENERAL	Aerodynamic Smoothness Requirements
51-10-02, GENERAL	Inspection and Removal of Damage
51-30-03, GENERAL	Nonmetallic Materials
51-70-10, GENERAL	Aluminum Honeycomb Structure Repairs
AMM 51-21-01/701	Aircraft Maintenance Manual
AMM 51-21-10/701	Aircraft Maintenance Manual
NDT Part 1, 51-05-01	Tap Test Inspection of Honeycomb Sandwich Structure
NDT Part 4, 51-00-05	Bondline Delamination Inspection in Honeycomb Structure
NDT Part 6, 51-00-01	Aluminum Part Surface Inspection (Meter Display)
SOPM 20-20-02	Penetrant Methods of Inspection
SOPM 20-44-04	Application of Urethane Compatible Primers

4. Instructions to Rework and Fill Dents

A. Inspection Procedures

(1) Do what follows before and after you rework an aluminum sheet, or before you fill it with adhesive or fairing compound.

(a) Do a High Frequency Eddy Current (HFEC) inspection of the damaged area as given in NDT Part 6, 51-00-01 to make sure there are no cracks in the dent or 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.

(b) Do a visual inspection of the damaged area. Make sure that other damage (such as creases, nicks, gouges, scratches, and corrosion) is not more than what is permitted by the allowble damage limits given in the Chapter-Section-Subject of the damaged part.

(2) Do what follows before and after you rework an aluminum facesheet/aluminum honeycomb sandwich panel, or before you fill it with adhesive or fairing compound.

(a) Do a HFEC inspection of the damaged area as given inNDT Part 6, 51-00-01 to make sure there are no cracks in the dent or the adjacent area. If there are cracks, they must be repaired.

(b) Do a visual inspection of the damaged area. Make sure that other damage (such as creases, nicks, gouges, scratches, and corrosion) is not more than what is permitted by the allowable damage limits given in the Chapter-Section-Subject of the damaged part.

(c) Do an inspection of the damaged area to find if there is delamination of the bond as a result of the dent. It is recommended that you use an instrumented Non-Destructive Inspection (NDI) procedure as given in NDT Part 4, 51-00-05. The tap test procedure as given in 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.

B. Rework Procedures

(1) Do an inspection of the dent as given in par. A.

(2) Remove the external finish of the dented area plus a minimum 0.50 inch of the external finish around the dent. Refer to AMM 51-21-01/701.

(3) Apply masking tape around the rework area.

(4) Rework the dent as follows:

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.

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 NOT OBEY, DAMAGE TO THE STRUCTURAL BOND BETWEEN THE FACESHEET AND THE CORE (THAT IS MORE THAN THE ALLOWABLE DAMAGE LIMITS) CAN OCCUR.

(a) For an aluminum facesheet/aluminum honeycomb sandwich panel that has dent conditions that agree with the conditions given in Paragraph 1.A./GENERAL, only use an electromagnetic dent puller to rework the dent.

NOTE: Data on the electromagnetic dent puller is available from:

Electroimpact, Inc.

4606 107th Street

Southwest Mukilteo, WA, 98275, USA

Phone: 425-348-8090

Internet: http://www.electroimpact.comm

(b) For an aluminum sheet that has dent conditions that agree with the conditions given in Paragraph 1.A./GENERAL, use the applicable metal forming procedures (which includes the procedure that uses the electromagnetic dent puler) to rework the dent.

(5) Make sure the reworked dent is satisfactory.

(a) Do an inspection of the dent as given in Paragraph A.

(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.

(6) Apply a chemical conversion coating to all the bare surfaces of the rework area. Refer to 51-10-01, GENERAL.

(7) Apply one layer of BMS 10-79, Type II or III primer to the rework area. Refer to SOPM 20-44-04.

(8) Apply a decorative external finish to the reworked area. Refer to AMM 51-21-10/701.

C. Fill Procedures

(1) Do an inspection of the dent as given in par. A.

(2) Remove the external finish of the dented area plus a minimum 0.50 inch of the external finish around the dent. Refer to AMM 51-21-01/701.

(3) Apply masking tape around the rework area.

(4) Apply a chemical conversion coating to all the bare surfaces of the rework area. Refer to SRM 51-20-01.

(5) Apply one layer of BMS 10-79, Type II or III primer to the rework area. Refer to SOPM 20-44-04.

(6) Fill the dent with BMS 5-92, Type I or Type V adhesive as given in par. D. or EC-3587-1/4 or EC-3587-1 fairing compound as given in par. E.

D. Application of BMS 5-92, Type I or Type V adhesive to fill the dent.

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 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.

(1) Apply BMS 5-92, Type I or Type V adhesive. Refer to 51-30-03 for the material sources of BMS 5-92, Type I and Type V adhesive.

(a) Refer to Table I for the necessary quantity of the Parts A and B components and the related pot life of the BMS 5-92 adhesive. If a lesser or larger quantity of Part A or B is used (or the temperature is outside of the range shown), the pot life will change. Refer to the manufacturer's recommendations when you use different quantities of Parts A and B than those given in Figure 1/GENERAL,Table 1.

NOTE: The pot life is the length of time in which the adhesive can be applied.

(b) Apply the adhesive to the dent until it is just above the necessary contour.

NOTE: If necessary, you can put a plastic sheet (polyethylene or equivalent) over the filled area to help hold the necessary contour. Hold the plastic sheet down with masking tape.

(c) Smooth the adhesive out over the areas around the dent that have a chemical conversion coating.

(2) Cure the BMS 5-92, Type I or Type V adhesive.

(a) Refer to Figure 1/GENERAL for the cure time and cure temperature of the BMS 5-95, Type I adhesive.

(b) Cure BMS 5-92, Type V adhesive under contact pressure at:

1) 70°F (21°C) to 100°F (38°C) for 3 hours minimum or

2) 120°F (49°C) to 130°F (54°C) for 2 hours minimum.

WARNING: MAKE SURE THAT YOU WEAR GLOVES, PROTECTIVE CLOTHING, EYE PROTECTION AND AN APPROVED MASK WHEN YOU SAND THE ADHESIVE. MAKE SURE THAT THERE IS A GOOD FLOW OF CLEAN AIR. WHEN THE STRUCTURAL ADHESIVE IS SANDED, THE FINE DUST THAT IS A RESULT IS HAZARDOUS TO YOUR RESPIRATORY SYSTEM. IF YOU DO NOT OBEY, YOU CAN CAUSE INJURY.

(3) Sand the cured adhesive to the necessary contour of the aerodynamic surface. Use care so that you do not cause damage to the surfaces outside the rework area.

(4) Apply one layer of BMS 10-79, Type II or III primer to the adhesive. Refer to SOPM 20-44-04.

(5) Apply a decorative external finish to the reworked area. Refer to AMM 51-21-10/701.

E. Application of EC-3587-1/4 or EC-3587-1 fairing compound to fill the dent.

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, YOU CAN CAUSE INJURY.

(1) Apply EC-3587-1/4 or EC-3587-1 fairing compound. Refer to 51-30-03, GENERAL for the material sources of EC-3587-1/4 or EC-3587-1 fairing compound.

  (a) Refer to Table 2 for the application time of the fairing compound.

  (b) Apply the fairing compound to the dent until it is just above the necessary contour.

  NOTE: If necessary, you can put a plastic sheet (polyethylene or equivalent) over the filled area to help hold the necessary contour. Hold the plastic sheet down with masking tape.

  (c) Smooth the fairing compound out over the areas around the dent that have a chemical conversion coating.

(2) Cure the fairing compound. Refer to Figure 1/GENERAL, Table 2 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. WHEN THE FAIRING COMPOUND IS SANDED, THE FINE DUST THAT RESULTS IS HAZARDOUS TO YOUR RESPIRATORY SYSTEM. IF YOU DO NOT OBEY, YOU CAN CAUSE INJURY.

(3) Sand the cured fairing compound to the necessary contour of the aerodynamic surface. Use care so that you do not cause damage to the surfaces outside 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 51-21-10/701.

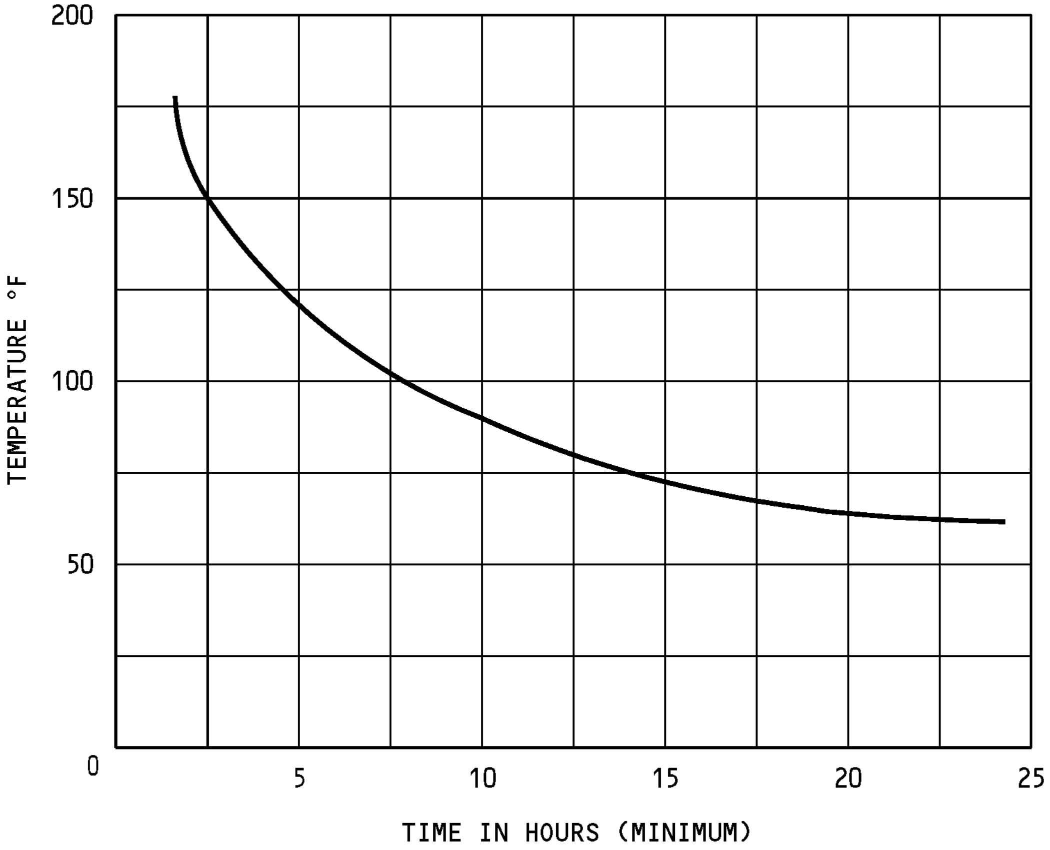
BMS 5-92 ADHESIVE			
TYPE	PART A QUANTITY	PART B QUANTITY	POT LIFE
I	58 GRAMS	42 GRAMS	120 MINUTES AT 65°F (18°C) TO 80°F (27°C) FROM THE TIME PARTS A AND B ARE BLENDED.
V	REFER TO THE MANUFACTURER'S INSTRUCTIONS.	REFER TO THE MANUFACTURER'S INSTRUCTIONS.	20 MINUTES AT 60°F (16°C) TO 80°F (27°C) FROM THE TIME PARTS A AND B ARE BLENDED.

TABLE 1

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)

TABLE 2

BMS 5-92, Adhesive Mix and Cure Data
Figure 1 (Sheet 1 of 2)



BMS 5-92, Adhesive Mix and Cure Data
Figure 1 (Sheet 2 of 2)

GENERAL - LOCATIONS OF THE PRINCIPAL COMPOSITE COMPONENTS

1. General

A. This subject contains information pertaining to the locations of principal fiberglass, graphite, aramid, and graphite/aramid/glass hybrid composite components. Reference is made to the chapter-section-subject for the specific locations in this manual of each component

   (1) Refer to the identification chapter-section-subject for the pictorial representation of a specific component.

   (2) Refer to the specific allowable damage chapter-section-subject for allowable damage data.

   (3) Refer to the specific component repair chapter-section-subject for authorized repairs and repair limits.

B. Refer to Figure 1/GENERAL, Detail I and Table I for principal fiberglass components manufactured at 250°F (121°C) cure temperature.

C. Refer to Figure 1/GENERAL, Detail I and Table II for principal fiberglass components manufactured at 350°F (177°C) cure temperature.

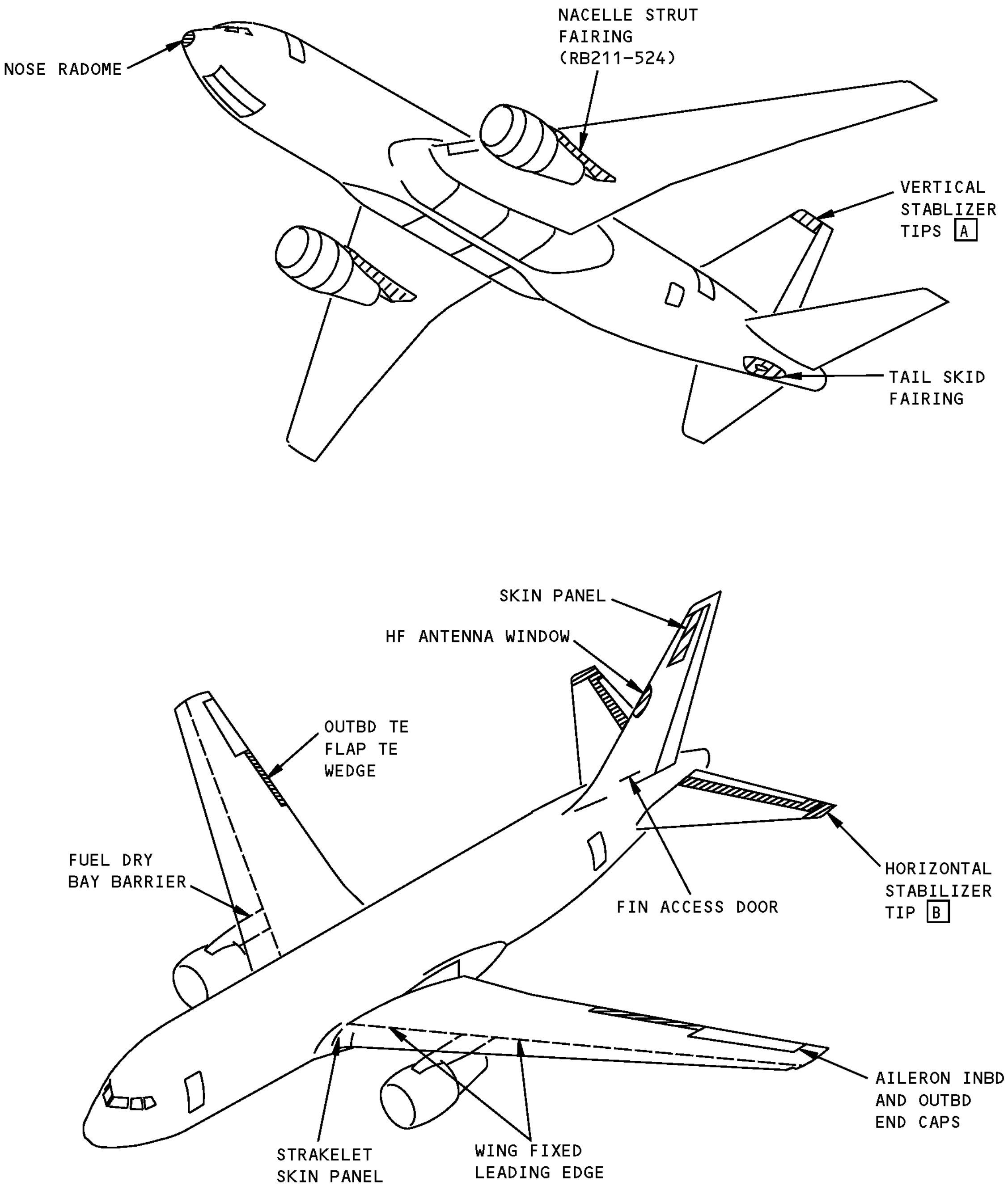
D. Refer to Figure 1/GENERAL, Detail II and Table III for principal graphite fabric components manufactured at 250°F (121°C) cure temperature.

E. Refer to Figure 1/GENERAL, Detail II and Table IV for principal graphite fabric components manufactured at 350°F (177°C) cure temperature.

F. Refer to Figure 1/GENERAL, Detail III and Table V for principal aramid fabric and hybrid fabric components manufactured at 250°F (121°C) cure temperature.

G. Refer to Figure 1/GENERAL, Detail III and Table VI for principal aramid fabric and hybrid fabric components manufactured at 350°F (177°C) cure temperature.

H. Refer to Figure 2/GENERAL for locations of bonded aluminum skin/aluminum honeycomb components.



FIBERGLASS
DETAIL I

Locations of Composite Fabric Components
Figure 1 (Sheet 1 of 9)

COMPONENT DESCRIPTION	REFERENCE DRAWING(S)	SPECIFIC COMPONENT REPAIR, ALLOWABLE DAMAGE, AND IDENTIFICATION SUBJECTS
FIN ACCESS DOOR	148T6702	52-40-02
NOSE RADOME	284T0052	53-10-72
TAIL SKID FAIRING	148T7702	53-80-70
TAIL SKID FAIRING DOOR	148T7703	53-80-70
HORIZONTAL STABILIZER TRAILING EDGE PANELS	183T1110 183T1130 183T1140 183T1280	55-10-01
HORIZONTAL STABILIZER TIP FAIRING	189T0001	55-10-30
HF ANTENNA WINDOW	174T1103	55-30-01
VERTICAL STABILIZER SKIN PANELS	175T2002	55-30-01
VERTICAL STABILIZER RIB WEB	174T1203 175T3008	55-30-09
VERTICAL STABILIZER TIP	179T1000	55-30-30
FUEL DRY BAY BARRIER SKIN	112T8102 112T8103 112T8104	57-20-09
WING LEADING EDGE SLAT SKIN CLOSURE PANEL	114T4151 114T3165	57-43-01
WING FIXED TRAILING EDGE SKIN PANELS	113T1600	57-51-01
WING TRAILING EDGE FLAPS TRAILING EDGE WEDGE ASSEMBLY	113T2320	57-53-02
OUTBOARD AILERON OUTBOARD AND INBOARD END CAPS	113T7110	57-60-02

LOCATION OF PRINCIPAL FIBERGLASS COMPONENTS MANUFACTURED AT
250°F (121°C) CURE TEMPERATURE
TABLE I

NOTES

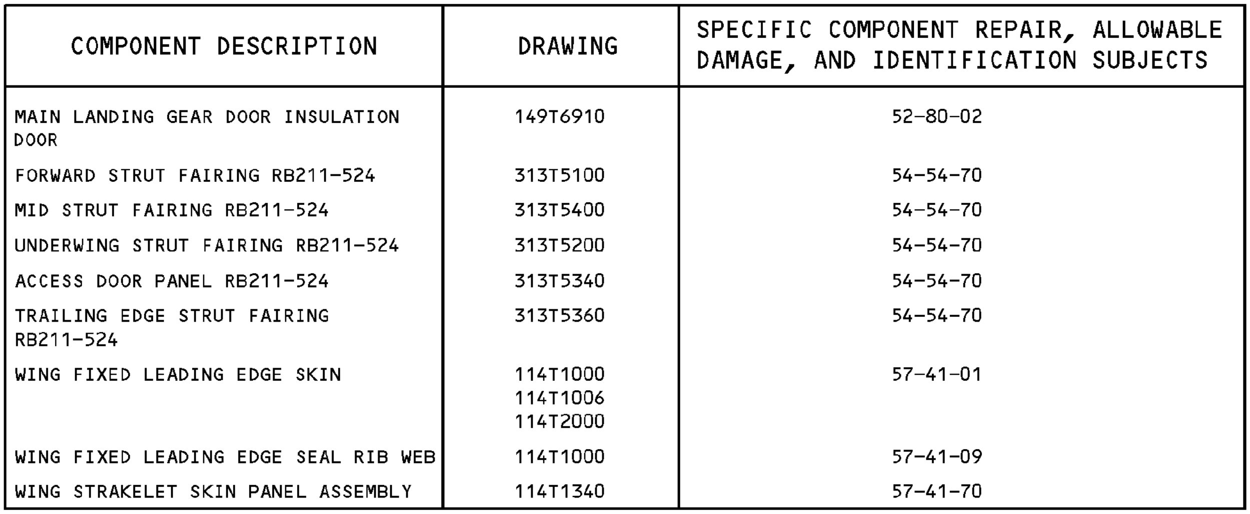
A FOR CUM LINE NUMBERS 136 AND ON

B FOR CUM LINE NUMBERS 148 AND ON

C FOR CUM LINE NUMBER 132

D FOR CUM LINE NUMBERS 132 AND 136

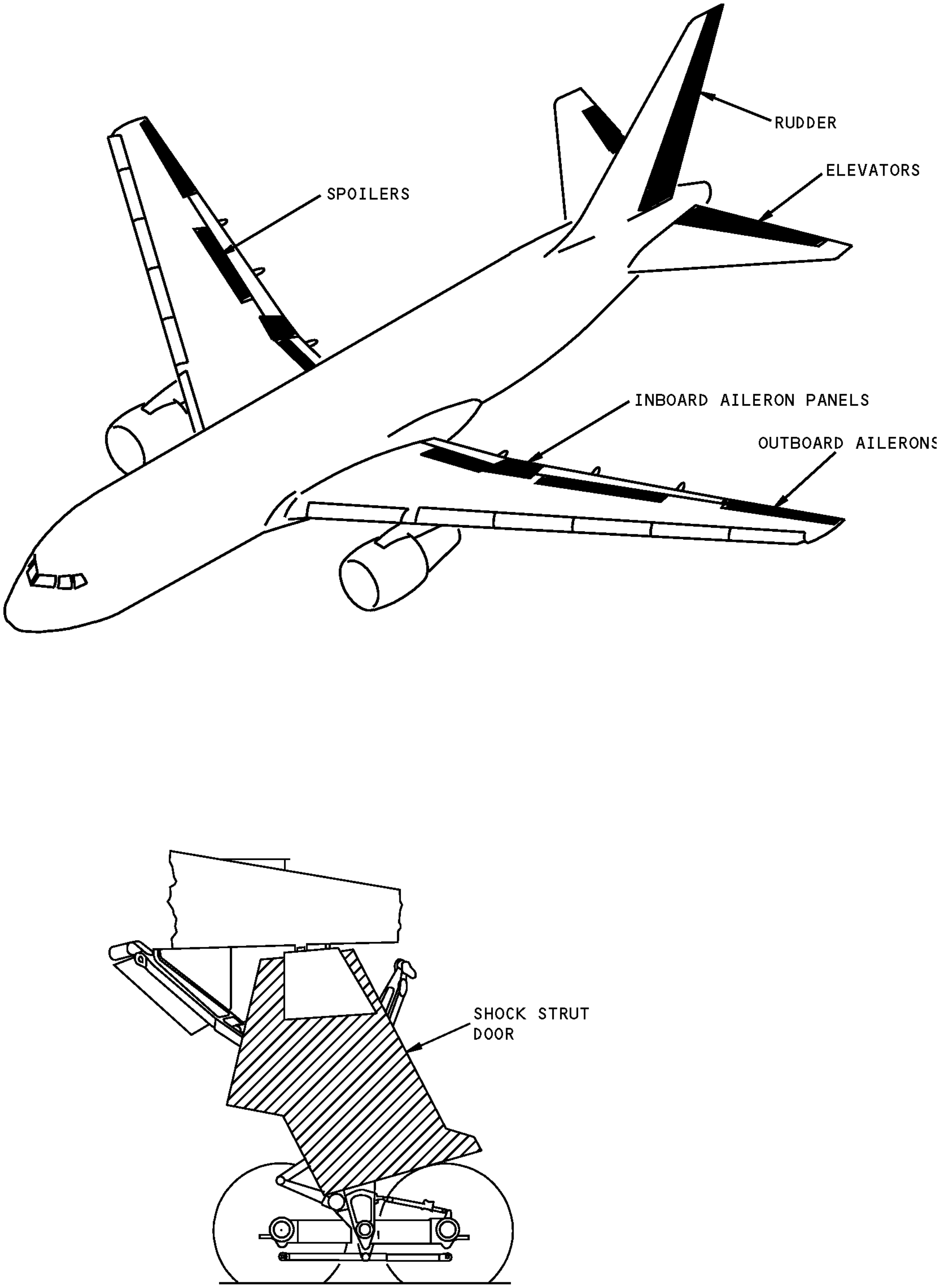
Locations of Composite Fabric Components
Figure 1 (Sheet 2 of 9)



COMPONENT DESCRIPTION	DRAWING	SPECIFIC COMPONENT REPAIR, ALLOWABLE DAMAGE, AND IDENTIFICATION SUBJECTS
MAIN LANDING GEAR DOOR INSULATION DOOR	149T6910	52-80-02
FORWARD STRUT FAIRING RB211-524	313T5100	54-54-70
MID STRUT FAIRING RB211-524	313T5400	54-54-70
UNDERWING STRUT FAIRING RB211-524	313T5200	54-54-70
ACCESS DOOR PANEL RB211-524	313T5340	54-54-70
TRAILING EDGE STRUT FAIRING RB211-524	313T5360	54-54-70
WING FIXED LEADING EDGE SKIN	114T1000 114T1006 114T2000	57-41-01
WING FIXED LEADING EDGE SEAL RIB WEB	114T1000	57-41-09
WING STRAKELET SKIN PANEL ASSEMBLY	114T1340	57-41-70

LOCATION OF PRINCIPAL FIBERGLASS COMPONENTS MANUFACTURED AT
350°F (177°C) CURE TEMPERATURE
TABLE II

Locations of Composite Fabric Components
Figure 1 (Sheet 3 of 9)



GRAPHITE
DETAIL II

Locations of Composite Fabric Components
Figure 1 (Sheet 4 of 9)

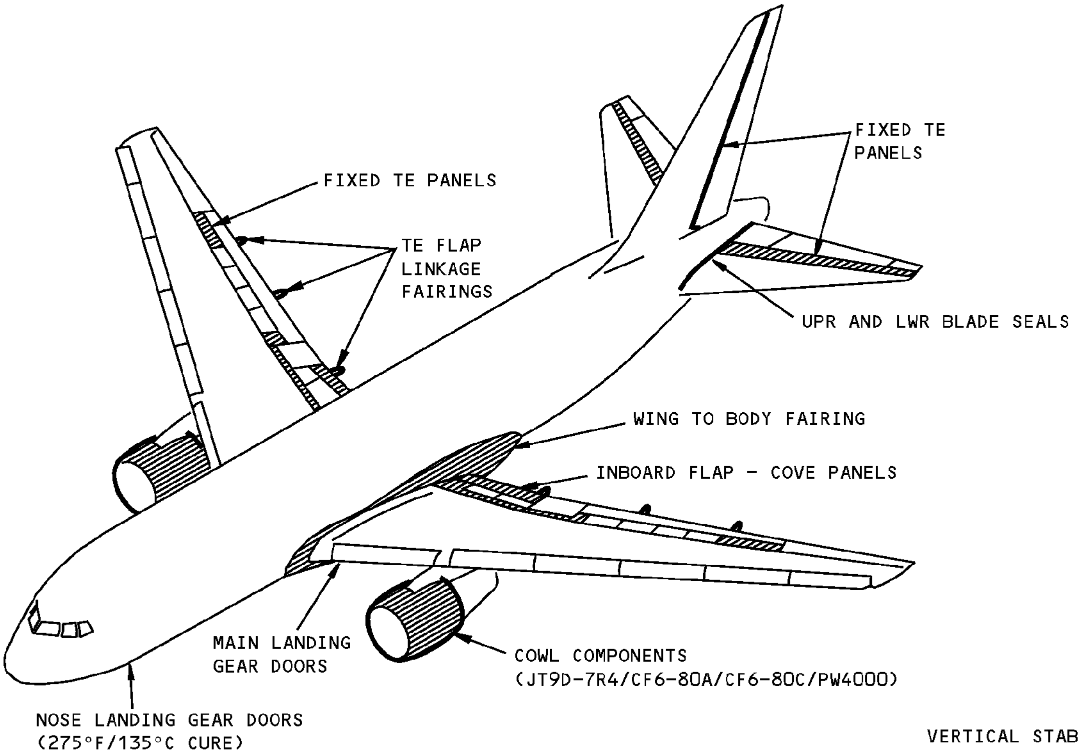
COMPONENT DESCRIPTION	REFERENCE DRAWING(S)	SPECIFIC COMPONENT REPAIR, ALLOWABLE DAMAGE, AND IDENTIFICATION SUBJECTS
WING LANDING GEAR SHOCK STRUT DOOR	113T8201	52-80-02

LOCATION OF PRINCIPAL GRAPHITE FABRIC REINFORCED EPOXY LAMINATES AND NONMETALLIC HONEYCOMB SANDWICH COMPOSITES MANUFACTURED AT 250°F (121°C) CURE TEMPERATURE
TABLE III

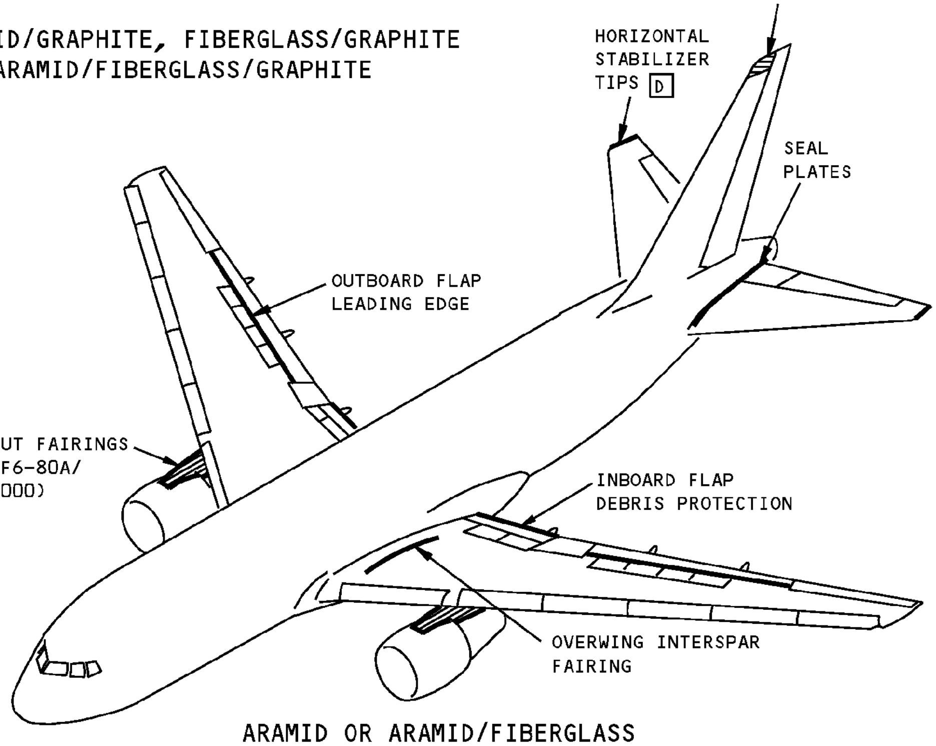
COMPONENT DESCRIPTION	REFERENCE DRAWING(S)	SPECIFIC COMPONENT REPAIR, ALLOWABLE DAMAGE, AND IDENTIFICATION SUBJECTS
ELEVATOR SKIN PANELS	183T2009 183T2001 183T3001	55-20-01
ELEVATOR RIBS AND SPARS	183T3001	55-20-02
RUDDER SKIN PANELS	173T2001 173T2007	55-40-01
RUDDER SPARS	173T2000 173T2002	55-40-02
RUDDER CLOSURE RIB	173T2026 173T2033	55-40-02
RUDDER RIB	173T2008 173T2009 173T2010	55-40-02
INBOARD AILERON UPPER AND LOWER SKIN PANELS	113T6130 113T6131	57-60-01
OUTBOARD AILERON SKIN PANELS	113T7000	57-60-02
OUTBOARD AILERON SPAR	113T7111	57-60-02
OUTBOARD AILERON TRAILING EDGE WEDGE	113T7110	57-60-02
SPOILERS	113T4110 113T5111	57-70-01
SPOILER SPARS	113T5102 113T4100	57-70-02

LOCATION OF PRINCIPAL GRAPHITE FABRIC REINFORCED EPOXY LAMINATES AND NONMETALLIC HONEYCOMB SANDWICH COMPOSITES MANUFACTURED AT 350°F (177°C) CURE TEMPERATURE
TABLE IV

Locations of Composite Fabric Components
Figure 1 (Sheet 5 of 9)



ARAMID/GRAPHITE, FIBERGLASS/GRAPHITE
OR ARAMID/FIBERGLASS/GRAPHITE



ARAMID OR ARAMID/FIBERGLASS
DETAIL III

Locations of Composite Fabric Components
Figure 1 (Sheet 6 of 9)

COMPONENT DESCRIPTION	REFERENCE DRAWING	SPECIFIC COMPONENT REPAIR, ALLOWABLE DAMAGE, AND IDENTIFICATION SUBJECTS
RAM AIR TURBINE ACCESS DOOR	149T7771	52-40-02
MAIN LANDING GEAR DOOR RELEASE ACCESS DOOR	149T7601	52-40-02
ADP ACCESS DOOR	149T0000	52-40-02
HYDRAULIC RESERVOIR FILL ACCESS DOOR	149T0000	52-40-02
PRESSURE BOTTLE ACCESS DOOR	149T0000	52-40-02
OFFWING ESCAPE SLIDE ACCESS DOOR	416T2010 416T2011	52-40-02
INBOARD TRAILING EDGE FLAP MECHANISM ACCESS DOOR	113T1750	52-40-02
ECS DOOR	149T7210	52-40-02
MAIN LANDING GEAR DOOR	149T6910	52-80-02
NOSE LANDING GEAR DOOR FORWARD	141T6910	52-80-02
NOSE LANDING GEAR DOOR AFT	141T6920	52-80-02
FORWARD WING TO BODY FAIRING SKIN PANELS	149T7100	53-30-70
OVERWING FAIRING SKIN PANELS	149T7500	53-50-70
UNDERWING FAIRING SKIN PANELS	149T7200	53-50-70
KEEL BEAM FAIRING	145T8627 145T8629	53-50-70
AFT WING TO BODY FAIRING	149T0001 149T7601	53-60-70
HORIZONTAL STABILIZER TRAILING EDGE PANELS UPPER SURFACE	183T1110	55-10-01
HORIZONTAL STABILIZER TRAILING EDGE PANELS LOWER SURFACE	183T1200 183T1210 183T1220 183T1230 183T1240 183T1250 183T1260 183T1270	55-10-01

LOCATION OF PRINCIPAL ARAMID FABRIC AND HYBRID FABRIC REINFORCED EPOXY LAMINATES AND NONMETALLIC HONEYCOMB SANDWICH COMPOSITES MANUFACTURED AT 250°F (121°C) CURE TEMPERATURE
TABLE V

Locations of Composite Fabric Components
Figure 1 (Sheet 7 of 9)

COMPONENT DESCRIPTION	REFERENCE DRAWING(S)	SPECIFIC COMPONENT REPAIR, ALLOWABLE DAMAGE, AND IDENTIFICATION SUBJECTS
HORIZONTAL STABILIZER TIP FAIRING	189T0001	55-10-30
HORIZONTAL STABILIZER SEAL PLATE	182T7105	55-10-30
HORIZONTAL STABILIZER UPPER AND LOWER BLADE SEAL	182T7100 182T7101 182T7119	55-10-30
VERTICAL STABILIZER SKIN PANELS	173T1101 THRU 173T1109	55-30-01
VERTICAL STABILIZER TIP	179T1000	55-30-30
OVERWING INTERSPAR FAIRING SKIN PANEL	110T3000	57-20-70
WING TIP PANEL	119T0001	57-30-01
WING FIXED TRAILING EDGE SKIN PANELS	113T1600	57-51-01
WING TRAILING EDGE FLAP SKIN PANELS	113T2201 113T2301 113T3100	57-53-01
WING TRAILING EDGE FLAP INBOARD HINGE ASSEMBLY	113T2339	57-53-02
WING TRAILING EDGE FLAP CLOSURE RIB ASSEMBLY	113T2205	57-53-02
FLAP LINKAGE FAIRINGS	113T1700 113T1800	57-53-70
INBOARD AILERON LOWER NOSE SKIN PANEL	113T6115	57-60-01
INBOARD AILERON LOWER NOSE ACCESS PANEL	113T6116 113T6117 113T6118	57-60-01

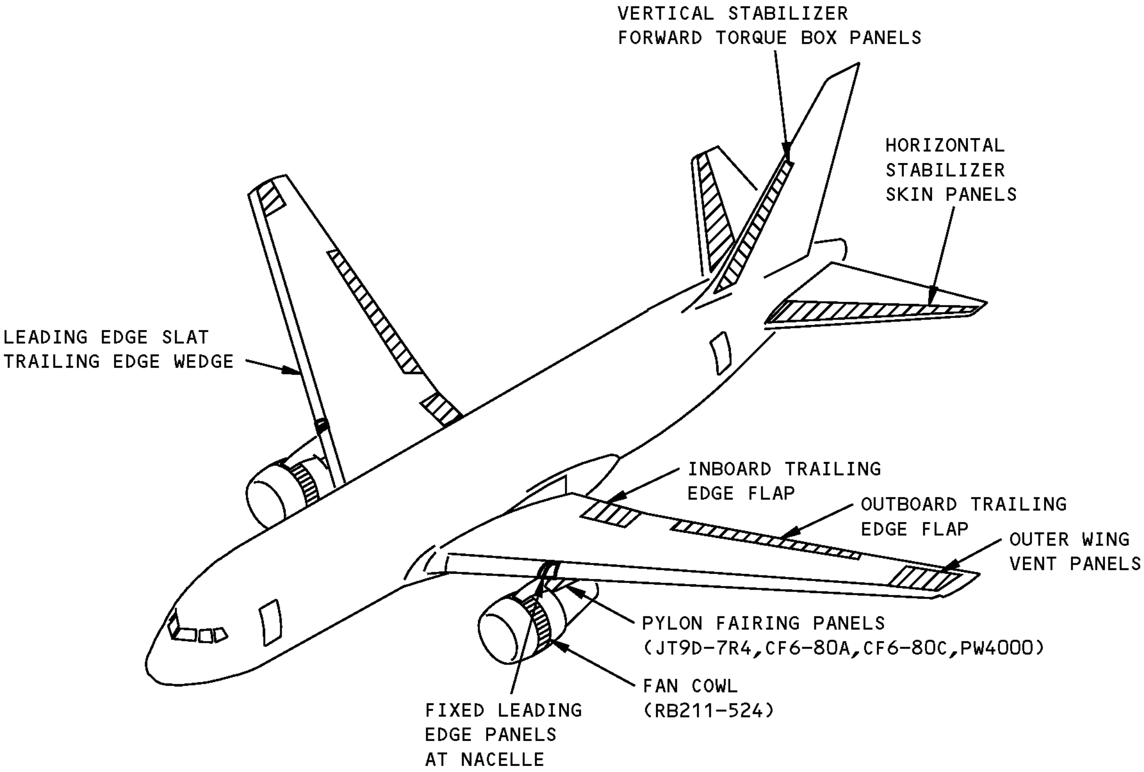
LOCATION OF PRINCIPAL ARAMID FABRIC AND HYBRID FABRIC REINFORCED EPOXY LAMINATES AND NONMETALLIC HONEYCOMB SANDWICH COMPOSITES MANUFACTURED AT 250°F (121°C) CURE TEMPERATURE
TABLE V (CONT)

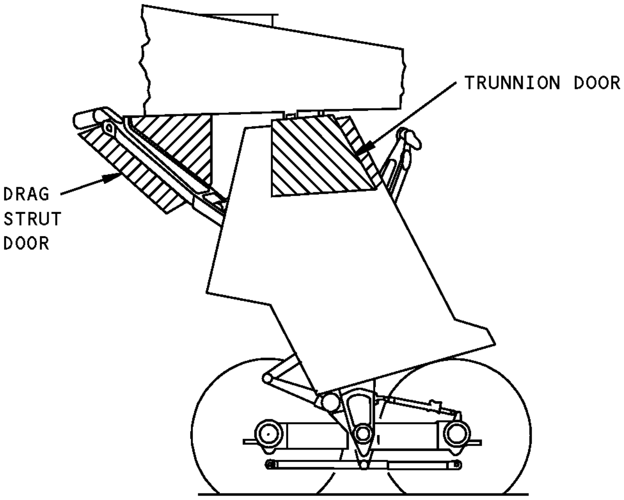
Locations of Composite Fabric Components
Figure 1 (Sheet 8 of 9)

COMPONENT DESCRIPTION	DRAWING	SPECIFIC COMPONENT REPAIR, ALLOWABLE DAMAGE, AND IDENTIFICATION SUBJECTS
INLET COWL SKIN JT9D-7R4	314T3010	54-10-01
INLET COWL SKIN CF6-80A	314T1010	54-11-01
INLET COWL SKIN CF6-80C	224-2130	54-12-01
INLET COWL SKIN PW4000	314T4010	54-13-01
FAN COWL SKIN JT9D-7R4	314T3110	54-20-01
FAN COWL SKIN CF6-80A	314T1110	54-21-01
FAN COWL SKIN CF6-80C	224-2201 224-2202	54-22-01
FAN COWL SKIN PW4000	314T4110	54-23-01
FAN DUCT COWL AND THRUST REVERSER SKIN JT9D-7R4	315T3562	54-30-01
FAN DUCT COWL AND THRUST REVERSER SKIN CF6-80A	315T1564	54-31-01
FAN DUCT COWL AND THRUST REVERSER SKIN PW4000	314T3562	54-33-01
STRUT FAIRING SKIN JT9D-7R4	313T3300 313T3100	54-50-70
STRUT FAIRING SKIN CF6-80A	310T1060 313T1100 313T1300	54-51-70
STRUT FAIRING SKIN CF6-80C	310T1060	54-52-70
STRUT FAIRING SKIN PW4000	313T3300 313T3100	54-53-70
RUDDER TIP	173T2052	55-40-30

LOCATION OF PRINCIPAL ARAMID FABRIC AND HYBRID FABRIC REINFORCED EPOXY LAMINATES AND NONMETALLIC HONEYCOMB SANDWICH COMPOSITES MANUFACTURED AT 350°F (177°C) CURE TEMPERATURE
TABLE VI

Locations of Composite Fabric Components
Figure 1 (Sheet 9 of 9)





Locations of Bonded Aluminum Skin/Aluminum Honeycomb Components
Figure 2 (Sheet 1 of 2)

COMPONENT DESCRIPTION	DRAWING(S)	SPECIFIC COMPONENT REPAIR, ALLOWABLE DAMAGE, AND IDENTIFICATION SUBJECTS
DRAG STRUT DOOR	113T8101	52-80-02
SHOCK STRUT DOOR	113T8201	52-80-02
TRUNNION DOOR	113T8301	52-80-02
STRUT FAIRING PANELS (JT9D-7R4, PW4000)	313T3381	54-50-70 54-53-70
STRUT FAIRING PANELS (CF6-80A)	313T1380 313T1381	54-51-70
STRUT FAIRING PANELS (CF6-80C)	313T1380 313T2381	54-52-70
HORIZONTAL STABILIZER SKIN PANELS	183T1000 183T2000	55-10-01
VERTICAL STABILIZER FORWARD TORQUE BOX PANELS	175T2001	55-30-01
OUTERWING VENT PANELS	112T3600 112T3601 112T4600 112T4601	57-20-01
LEADING EDGE SLAT TRAILING EDGE WEDGE	114T4111 114T4112 114T4113 114T4114 114T4115 114T3110	57-43-02
INBOARD TRAILING EDGE MAIN FLAP	113T2201	57-53-01
INBOARD TRAILING EDGE FLAP, TRAILING EDGE WEDGE	113T2320	57-53-01
OUTBOARD TRAILING EDGE FLAP	113T3100	57-53-01
FIXED LEADING EDGE PANELS AT NACELLE	114T6100 114T6101	57-41-01

TABLE I

Locations of Bonded Aluminum Skin/Aluminum Honeycomb Components
Figure 2 (Sheet 2 of 2)

GENERAL - GRAPHITE AND/OR ARAMID REINFORCED EPOXY LAMINATES AND NONMETALLIC HONEYCOMB SANDWICH REPAIRS - ROOM TEMPERATURE – 150°F (66°C) CURE (WET LAYUP)

1. Scope

WARNING: DO NOT BREATHE CARBON FIBER DUST. MAKE SURE THAT THERE IS A GOOD FLOW OF AIR WHERE YOU DO THE WORK. USE EQUIPMENT TO HELP YOU BREATHE WHEN YOU WORK IN A CONFINED SPACE. USE A VACUUM NEAR THE SOURCE OF THE DUST TO REMOVE THE DUST FROM THE AIR. IF YOU DO NOT OBEY, YOU CAN CAUSE INJURY.

CAUTION: DO NOT LET CARBON FIBER DUST GO INTO ELECTRICAL EQUIPMENT. CARBON FIBER DUST IS ELECTRICALLY CONDUCTIVE AND IT CAN CAUSE SHORT CIRCUITS IF IT GOES INTO ELECTRICAL EQUIPMENT. USE A VACUUM NEAR THE SOURCE OF THE DUST TO REMOVE THE DUST FROM THE AIR. IF YOU DO NOT OBEY, YOU CAN CAUSE DAMAGE TO THE ELECTRICAL EQUIPMENT.

CAUTION: TO GET AN ACCEPTABLE QUALITY REPAIR, DO AS FOLLOWS:

- REFER TO THE APPLICABLE COMPONENT THAT YOU ARE GOING TO REPAIR FOR THE REPAIR LIMITS AND MATERIAL OF THE COMPONENT BEFORE YOU USE THESE REPAIR INSTRUCTIONS.
- USE THE CORRECT MATERIALS FOR THE TYPE OF COMPONENT AND REPAIR THAT IS MADE.
- USE THE MATERIALS THAT AGREE WITH THE SPECIFICATIONS IN THE SRM.
- ACCURATELY FOLLOW THE SRM PROCEDURES AT EACH STEP OF THE REPAIR. IF YOU DO NOT DO THIS, IT CAN CAUSE A REPAIR THAT IS NOT SATISFACTORY AND NOT APPROVED.

ROOM TEMPERATURE/150°F (66°C) CURE REPAIRS WILL NOT RESTORE EITHER THE STRENGTH OR THE DURABILITY OF THE ORIGINAL 250°F (121°C) OR 350°F (177°C) CURE COMPONENTS. FOR SIZE AND LIMITS OF SUCH REPAIRS, SEE APPLICABLE REPAIR SECTION. ROOM TEMPERATURE REPAIRS MUST NOT BE USED IN STRESS CRITICAL AREAS OF PRIMARY STRUCTURE COMPONENTS. FAILURE TO COMPLY WOULD RESULT IN AN INADEQUATE REPAIR.

A. This section contains repairs to components made from epoxy resin reinforced with several layers of graphite tape or fabric aramid fabric or a combination of graphite, aramid or fiberglass. A hybrid is a composite of graphite, arammid and/or fiberglass. The most common contstruction is a sandwich of two laminated skins separated by a honeycomb core. Solid laminate is used for small components, honeycomb panel edgebands and at fitting locations. Fiberglass is also known as glass fabric. This section describes repairs made using room temperature/150°F (66°C) cure materials (wet layup).

NOTE: The repairs called for in this section are wet layup repairs. These repairs require rapid use of catalyzed resin materials. Room temperature wet layup repairs will not return the structure to its original strength or durability. A periodic inspection plan for the repaired area may be required. For size and limits of such repairs, see applicable repair section. The repairs in this section are room temperature repairs, the cure of which may be accelerated by the application of heat as specified herein. To obtain maximum properties, cure repair at 150°F (66°C).

2. **General**

A. Table 1/GENERAL contains an index of subjects in Paragraph 4./GENERAL and Paragraph 5./GENERAL.

Table 1: Index for the Repair Subjects

Paragraph	Subject
Paragraph 4./GENERAL	Repair Procedures Common to Various Repairs
Paragraph 4.A./GENERAL	Determine Damage
Paragraph 4.B./GENERAL	Remove Water from Damaged Area
Paragraph 4.C./GENERAL	Remove and Prepare Damaged Area
Paragraph 4.D./GENERAL	Fabricate, Clean, and Install Honeycomb Replacement Core Plug
Paragraph 4.E./GENERAL	Prepare and Apply Repair Plies
Paragraph 4.F./GENERAL	Layup/Bagging Procedures (Fig. 3)
Paragraph 4.G./GENERAL	Cure the Repair
Paragraph 4.H./GENERAL	Refinish after Repair
Paragraph 4.I./GENERAL	Do the Post-Repair Requirements
Paragraph 5./GENERAL	Typical Repairs
Paragraph 5.A./GENERAL	Repair of Delaminations Between Plies
Paragraph 5.B./GENERAL	Repair of Puncture, 0.50-inch Diameter or Less, in Honeycomb Panel (Figure 15)
Paragraph 5.C./GENERAL	Repair of Damage to One Skin and Honeycomb Core using Replacement Core Plug, Punctures Greater than 0.50-inch Diameter (Fig. 2)
Paragraph 5.D./GENERAL	Repair of Large Puncture through Internal and External Surface of Panel including Core Damage (Fig. 6)
Paragraph 5.E./GENERAL	Replacement of Honeycomb Core on Damaged Edge of Panel (Fig. 7)
Paragraph 5.F./GENERAL	Repairs Where Access is Limited to One Side of Panel (Fig. 8)
Paragraph 5.G./GENERAL	Repair of Damaged Skin Plies in Panel Edgeband (Fig. 9)
Paragraph 5.H./GENERAL	Repair of Punctures and Damage to Multiple Plies in Solid Laminate Panels
Paragraph 5.I./GENERAL	Repair of Punctures, 0.50-inch Diameter or Less, in Solid Laminate Panels
Paragraph 5.J./GENERAL	Repair of Delamination Between Plies in Solid Laminate Panels
Paragraph 5.K./GENERAL	150°F (66°C) Cure Wet Layup Repair of Damaged Panel Attach Holes in Honeycomb Panel Edgebands or Along Edges of Laminated Panels
Paragraph 5.L./GENERAL	Repair of Surface Dents (Fig. 16)
Paragraph 5.M./GENERAL	Repair of Lightning Strike Damage (Fig. 17)
Paragraph 5.N./GENERAL	Repair of Small Damage to One Skin (Fig. 20)
Paragraph 5.O./GENERAL	Repair of Erosion Damage to Panel Edgeband (Fig. 22)

WARNING: HEAT, FIRE, OR SPARKS CAN CAUSE AN EXPLOSION. USE EXPLOSIONPROOF EQUIPMENT WHEN PERFORMING THESE REPAIRS. NONCOMPLIANCE COULD CAUSE PERSONNEL INJURY. BREATHING VAPORS OR ALLOWING SOLVENT TO CONTACT SKIN OR EYES IS HAZARDOUS. WEAR NEOPRENE GLOVES WITH COTTON LINERS, PROTECTIVE CLOTHING, AND EYE GOGGLES. IF CHEMICAL CONTACT OCCURS. WASH THOROUGHLY WITH WATER. IF CHEMICAL SHOULD SPLASH INTO EYES, FLUSH EYES WITH LARGE QUANTITIES OF WATER AND SEEK MEDICAL AID. USE MECHANICAL VENTILATION OR RESPIRATORY PROTECTION WHEN WORKING IN A CONFINED SPACE OR AREA.

CAUTION: WHEN FASTENERS ARE USED IN GRAPHITE COMPOSITE STRUCTURE THEY MUST BE TITANIUM OR CORROSION RESISTANT STEEL. THEY CAN BE BARE, ALUMINUM COATED, OR, -IN THE CASE OF CRES-CADMIUM PLATED. ALUMINUM OR ALLOY STEEL FASTENERS ARE NOT ALLOWED IN GRAPHITE COMPOSITE STRUCTURE. WHEN REINSTALLING ALUMINUM FITTINGS ON GRAPHITE COMPOSITE STRUCTURE, MAKE SURE THAT THE ORIGINAL CORROSION PROTECTIVE TREATMENT, FAYING SURFACE SEAL, IS APPLIED. BMS 5-26 IN FUEL TANK AREAS, AND BMS 5-95 IN ALL OTHER AREAS.

B. Specific allowable damage, repair limitations, and repair data, can be found in the chapter/section/subject associated with each structural component.

C. Use suitable holding fixtures for large repairs to prevent distortion of the structure.

D. Perform the repair procedures specified herein only in areas of reasonable cleanliness. Areas containing oil mist, exhaust fumes, gases, soot, rain, dust, or other particulate matter are specifically prohibited.

E. Protect surfaces from contamination. Do not touch cleaned parts or adhesive with bare hands. Use clean white gloves when handling parts.

F. Refer to 51-30-00 for source of repair materials and equipment.

G. Refer to 51-70-02 for locations of principal composite components.

H. Refer to 51-10-01 for aerodynamic smoothness requirements.

I. Refer to 51-70-16 for hole drilling and machining of composite structures.

J. Repair Tedlar as given in 51-70-14, GENERAL, Paragraph 8.

K. Restore aluminum flame spray as given in 51-70-14, GENERAL.

L. Repair aluminum foil as given in 51-70-14, GENERAL.

M. Refer to Figure 1/GENERAL for resin mixes and potting compound data.

3. References

Reference	Title
51-10-01, GENERAL	Aerodynamic Smoothness Requirements
51-60-00, GENERAL	Control Surface Balance Moment Determination
51-70-14, GENERAL	Allowable Damage and Repair of Flame-Sprayed Aluminum Coatings, Aluminum-Coated Glass Fabric (BMS 8-278), Aluminum Foil (BMS 8-289), and Expanded Aluminum Foil (BMS 8-336)
AMM 51-41-00/201	Aircraft Maintenance Manual
NDT Part 1, 51-01-01	Inspection of Repairs to Composite Structures
SOPM 20-30-99	Solvents For Final Cleaning of Composites Before Structural Bonding (Series 99)

4. Repair Procedures Common to Various Repairs

A. Determine Damage

CAUTION: CHEMICAL PAINT STRIPPERS WILL ATTACK RESIN SYSTEMS, AND SHOULD NOT BE USED TO REMOVE PAINT BEFORE MAKING DAMAGE EVALUATIONS.

(1) Examine visually for extent of damage.

(2) Check panel in vicinity of damage for entry of water, oil, fuel, dirt or other foreign matter. Water can be detected by radiographic methods. Remove contaminants as required.

(3) Check for delamination around the damage.

NOTE: Post repair inspection is recommended. Examples of inspection procedures are given in NDT Part 1, 51-01-01.

B. Remove Water From Damaged Area

(1) Remove water from honeycomb sandwich (Figure 11/GENERAL).

(a) Remove damaged skin plies to open up honeycomb area in the damaged area. Remove standing water using vacuum or oil-free compressed air.

(b) Sand the core to remove the adhesive. Removal of adhesive fillets on core is not required.

(c) Apply a fiberglass or a metal fine mesh screen over the exposed core.

(d) Apply a thermocouple to the center of the screen.

(e) Apply a layer of glass fabric bleeder cloth over the screen and hold in place with masking tape.

(f) Place a vacuum line on the edge of the bleeder cloth and hold in place with masking tape.

(g) If the far side is accessible, apply thermocouple and heating blanket to the far side of the honeycomb sandwich panel.

NOTE: If the far side is accessible, it is acceptable to heat the area using a heating blanket only on the far side. An additional heating blanket may be used on the near side at the location shown in Figure 11/GENERAL to accelerate water removal. If the far side is inaccessible, use of a heating blanket on the near side is required.

(h) When the far side is inaccessible or when using an additional heating blanket, place the heating blanket over the bleeder cloth on the near side.

(i) Place extruded sealing compound around the entire area and seal the area with vacuum bag material.

(j) Evacuate the layup to a minimum 22 inches of mercury vacuum.

(k) Heat the area for 1 hour minimum at 150°F (66°C) to 170°F (77°C). The rate of temperature rise must not exceed 5°F (3°C) per minute.

(l) Remove layup materials and proceed with repair procedure.

(2) Remove water from solid laminate.

(a) Remove damage and/or delamination. Remove standing water using vacuum and oil-free compressed air.

(b) Heat the area for 1 hour minimum at 150°F (66°C) to 170°F (77°C). The rate of temperature rise must not exceed 5°F (3°C) per minute.

C. Remove and Prepare Damaged Area

(1) Damage removal

(a) Trim out the damaged lamination to a smooth shape with rounded corners, or a circular or oval shape. Take care not to damage the undamaged plies, core or surrounding material.

NOTE: Remove only damaged plies, damaged doublers and damaged fillers.

(b) When the core is also damaged, remove the core by trimming to the same outline as the skin. For crush splice repairs leave one to three core cells (0.4 maximum) visible between core cavity and skin (Figure 19/GENERAL). The core area removed should extend at least 0.5 further than the visible core damage limits. Take care to avoid cutting into an undamaged skin on the opposite side. In cores greater than 1.0 thick, partially remove core (at least 0.5 deep) sufficient to cleanup damage.

NOTE: When a potted core repair is to be made, removal of damaged core is not required.

(c) In areas, where contamination cannot be removed by cleaning or drying, remove the contaminated structure along with the other damage.

(d) When opposite inner skin is also damaged, trim out the damage to a smooth rounded shape.

(e) When core is removed from the inner surface of opposite skin, carefully smooth core down to adhesive film.

(f) Inspect cut out area to ensure that all damage has been removed.

CAUTION: SANDING FOR ADHESION OR FINISH REMOVAL MUST NOT EXPOSE OR DAMAGE FILAMENTS IN THE UNTAPERED SURFACE REPAIR AREA. SANDING MUST NOT EXPOSE OR DAMAGE FILAMENTS IN EACH PLY WHEN STEP SANDING OR IN THE PLY BONDED TO THE CORE (FIGURE 9/GENERAL AND FIGURE 14/GENERAL). LOSS OF STRUCTURAL STRENGTH OF THE COMPONENT WILL OCCUR IF THESE CAUTIONS ARE NOT OBSERVED. DO NOT USE PAINT STRIPPERS FOR THE REMOVAL OF FINISH. DAMAGE TO THE ADHESIVE RESIN SYSTEM WILL OCCUR.

(2) Preparation of damaged area (Figure 14/GENERAL)

(a) Determine the number of plies that have been cut. Mask off the area around the cleaned up damage allowing 1.0 overlap for each ply replacement, plus 1.0 extra for each extra ply to ensure that the existing top ply is completely covered by the repair.

NOTE: Where the number of plies is not apparent, refer to the applicable component in the structure identification section or engineering drawing.

WARNING: SANDING GIVES OFF A FINE DUST THAT MAY CAUSE SKIN IRRITATIONS. BREATHING OF AN EXCESSIVE AMOUNT OF THIS DUST MAY BE INJURIOUS. OBSERVE PRECAUTIONS FOR SKIN AND RESPIRATION PROTECTION. EXPLOSIONPROOF EQUIPMENT MUST BE USED WHERE THE POSSIBILITY OF VAPOR IGNITION EXISTS. NONCOMPLIANCE COULD CAUSE PERSONNEL INJURY.

(b) Internal surface of panel (nonaerodynamic surface) and noncritical aerodynamic surfaces.

1) Remove the paint finish or Tedlar film using No. 240 or finer Scotch-Brite abrasive, or No. 150 or finer sandpaper in the masked off area.

2) Taper sand each ply or simply abrade the surface around the cleaned up damage a minimum of 1.0 inch per ply. Refer to Figure 14/GENERAL.

3) An optional procedure for two or three ply laminate face sheets is to fill the cleaned up damage area flush with the original surface using filler plies during the repair layup. The repair plies are then installed directly on the resulting smooth surface of the repair area.

4) Abrade surfaces around repair using No. 240 or finer Scotch-Brite abrasive.

(c) External surface of panel (critical aerodynamic surfaces).

1) Taper sand a uniform taper around the cleaned up damage using No. 80 sandpaper. Refer to Figure 14/GENERAL. The taper or step is to be over an approximate distance of 1.0 for each existing ply of the laminate. Step sanding is optional to taper sanding on sandwich structure except in areas of critical aerodynamic smoothness. Refer to 51-10-01, GENERAL for locations of areas of critical aerodynamic smoothness. Always taper sand on solid laminate structures.

NOTE: For sanding, use a flexible disk sander, a belt sander, a rotating pad sander, or sand by hand.

2) Remove exterior finishes, including enamel finish and conductive coating from the surface of the 1.0 border using No. 150 or finer sandpaper.

(d) Edgeband of panel.

1) Taper sand panel edgeband allowing 1.0 for each existing ply of the laminate.

NOTE: Edgeband is the solid laminate around the outer periphery of the honeycomb panel.

(e) Cleaning of repair area.

1) Remove all sanding dust by applying oil-free compressed air and use a vacuum cleaner.

WARNING: BREATHING VAPORS OR ALLOWING SOLVENT TO CONTACT SKIN OR EYES IS HAZARDOUS. HEAT, FIRE OR SPARKS CAN CAUSE AN EXPLOSION. USE MECHANICAL VENTILATION OR RESPIRATORY PROTECTION WHEN WORKING IN A CONFINED SPACE OR AREA. AVOID CONTACT WITH SKIN EYES AND CLOTHING. WEAR EYE PROTECTION. KEEP AWAY FROM SOURCES OF HEAT, FIRE OR SPARKS.

CAUTION: DO NOT IMMERSE PARTS IN SOLVENT OR ALLOW STANDING SOLVENT ON PART. DAMAGE TO PART WILL OCCUR.

2) Wipe surfaces with a clean cloth moistened with solvent, Series 99 (AMM/ SOPM 20-30-99). Allow solvent to evaporate before proceeding with the repair.

D. Fabricate, Clean, and Install Honeycomb Replacement Core Plug.

(1) Fabricate core plug.

(a) Fabricate core plug. Refer to specific component structural identification section to determine type, class, and grade of the original core.

(b) For butt-splicing, the honeycomb core plug should fit flush with original core and with ribbon direction the same as in original core. The replacement core must overlap to make contact with the cell walls of surrounding core material.

(c) For crush splicing, the honeycomb core plug should be made one to three cells (0.4 maximum) larger than the repair cavity (Figure 19/GENERAL). The replacement core plug must be made from core material which is at least two grades denser than the original core.

(d) Trim core plug to full or partial depth of original core (Paragraph 4.C.(1)/GENERAL(b)) (Figure 2/GENERAL).

NOTE: When applicable, depth of core plug should allow for shrinkage during cure and for thickness of extra plies of fabric cloth between core plug and undamaged core or skin (Figure 3/GENERAL,Figure 2/GENERAL, Figure 8/GENERAL
Figure 8/GENERAL
Figure 14/GENERAL).

(2) Clean core plug.

WARNING: BREATHING VAPORS OR ALLOWING SOLVENT TO CONTACT SKIN OR EYES IS HAZARDOUS. HEAT, FIRE OR SPARKS CAN CAUSE AN EXPLOSION. USE MECHANICAL VENTILATION OR RESPIRATORY PROTECTION WHEN WORKING IN A CONFINED SPACE OR AREA. AVOID CONTACT WITH SKIN, EYES AND CLOTHING. WEAR EYE PROTECTION. KEEP AWAY FROM SOURCES OF HEAT, FIRE OR SPARKS.

CAUTION: DO NOT EXCEED IMMERSION CRITERIA. FAILURE TO COMPLY WILL DAMAGE CORE MATERIAL. DO NOT IMMERSE PARTS IN SOLVENT OR ALLOW STANDING SOLVENT ON PART. DAMAGE TO PART WILL OCCUR.

(a) Clean visually contaminated core by dipping (a maximum of four times) in an acetone or MEK bath for 60 seconds.

(b) Locally contaminated areas can be washed with MIBK, MEK, or acetone.

(c) The core must be completely dry, clean and free of evidence of solvents before installation.

(3) Install core plug (Figure 2/GENERAL, Figure 3/GENERAL, Figure 6/GENERAL,Figure 6/GENERAL, Figure 7/GENERAL).

(a) If one skin is undamaged, cut 2 plies of woven fabric that will fit on the inside surface of the undamaged skin (Figure 2/GENERAL and Figure 14/GENERAL). Saturate the plies with Resin Mix 1, prepared as shown in Figure 1/GENERAL, then position in core cavity.

(b) If both skins are damaged, apply a caul plate against the exterior surface of far side skin and tape in place.

(c) For butt splicing, spread Resin Mix 2, BMS 5-28, Type 7 with micro-balloons on the sides of the replacement core and the undamaged core that will mate when the plug is installed.

Orient ribbon in the direction of original core ribbon.

(d) For crush splicing, prepare and install the core plug per Figure 19/GENERAL. Orient ribbon in the direction of original core ribbon.

(e) Put the layup materials and equipment in place as shown in Figure 3 (Sheet 2).

(f) Evacuate the repair area to a minimum of 22 inches of mercury vacuum.

(g) Cure per Figure 1/GENERAL.

(h) Sand repair core plug approximately flush with surrounding material, making allowance for film adhesive and slight core crush during cure.

(i) Vacuum to remove sanding residue from core cells.

NOTE: The above procedure is based on the core plug installation being cured separately from the repair plies. As an option, core plug installation and repair plies may be cured at the same time.

E. Prepare and Apply Repair Plies

NOTE: Refer to applicable paragraphs for preparation of glass and graphite fabrics. For hybrid components, refer to relevant material paragraphs for each individual ply. Aramid fabric damage will be repaired using glass fabric plies.

CAUTION: USE OF PRECURED PATCHES IS NOT RECOMMENDED. PRECURED PATCHES BONDED TO THE STRUCTURE UNDER VACUUM PRESSURE ONLY AND LARGE PATCHES BONDED TO CONTOURED SURFACES CAN RESULT IN POROUS OR NONCONTINUOUS BONDLINES.

(1) Prepare glass fabric repair plies (BMS 9-3)

(a) Refer to the component structure identification to determine number, style, and orientation of glass fabric used in original structure. Repair existing Type 120 plies with Type D plies.

Repair existing Type 1581 or 181 plies with Type H-2 plies.

Repair existing Type 7781 plies with Type H-3 plies (Figure 13/GENERAL).

Refer to specific structural component repair section for extra repair ply requirements (Figure 18/GENERAL).

(b) From each type of material required, cut a piece that is large enough for cutting the required number of plies for the repair patch. Use one ply of glass fabric in the patch for each damaged ply of the original laminate, plus extra repair plies as required for specific repairs. Refer to specific structural component section.

NOTE: If extra plies are required, use materials listed in Figure 18/GENERAL.

(c) Substitution of repair ply fabrics (Figure 13/GENERAL).

1) Three plies of Type D glass fabric can be used for each ply of Type H-2 or Type H-3 required.
2) One ply of Type H-3 can be used for each ply of Type H-2 required, and vice versa.
3) One ply of Type H-2 or Type H-3 can be used for every two plies of Type D required.
4) One ply of Type D glass fabric can be used for each ply of 120 Aramid.
5) One ply of Type H-2 or H-3 glass fabric can be used for each ply of 285 Aramid.

(d) Impregnate repair plies with resin As given in Paragraph 4.E.(3)/GENERAL.

(2) Prepare graphite fabric repair plies (BMS 9-8)

(a) Refer to the specific structural component identification to determine number, style, and orientation of graphite fabric used in original structure. Refer to the structural component repair section for extra repair ply requirements.

(b) From each type of material required, cut a piece that is large enough for cutting the required number of plies for the repair patch. Use one repair ply for each damaged ply of the original laminate, plus one extra repair ply. Each repair ply must be of equivalent thickness and the same orientation as the original plies. Additional plies may be required for specific repairs. Refer to the specific structural component repair section.

NOTE: If extra plies are required, use the materials listed in Figure 18/GENERAL.

(c) No substitutes are permitted for graphite repair plies. However, 2 plies of graphite fabric may be used as a substitute for graphite tape.

(d) Impregnate repair plies with resin as given in Paragraph 4.E.(3)/GENERAL.

(3) Impregnate repair plies with resin.

(a) Cut two pieces of parting film approximately 3.0 inches larger all around than the fabric. Tape one piece to a smooth surface.

NOTE: Use Teflon film or other parting films.

(b) Lay fabric onto parting film.

(c) Spread Resin Mix 1, prepared as shown in Figure 1/GENERAL, to adequately cover fabric evenly.

(d) Cover the fabric on the parting film with the second piece of parting film.

(e) Press the resin through the fabric by working over the parting film with a squeegee or roller, in order to impregnate the fabric and to remove entrapped air.

(f) Work excess resin to edges of fabric such that fabric weave is barely visible.

NOTE: Resin content of the impregnated fabric shall be 55 ±5 percent by weight.

(g) Cut the impregnated fabric to the required sizes for each individual ply of the patch. The parting film on both sides of the fabric decreases fraying of the edges while cutting the fabric.

NOTE: Refer to Figure 14/GENERAL for required overlap of repair plies. The repair plies must be installed with the same orientation as that of the original plies being repaired. The filler ply over an exposed honeycomb core must be installed with the same orientation as the original surface ply. Other extra repair plies must be installed as specified in individual structural component repair sections.

(4) Apply repair plies (Figure 2/GENERAL and Figure 14/GENERAL).

NOTE: Where the damage has occurred at a lap joint in the original laminates, it is not necessary to make a comparable lap in the repair plies. Where the original core was undamaged and was provided with a recess to match the lap joint, the recess should be filled with filler plies before application of the repair plies.

CAUTION: ENSURE THAT PARTING FILM IS REMOVED FROM REPAIR PLIES PRIOR TO LAYUP AND CURING. NONCOMPLIANCE WILL RESULT IN A RUINED REPAIR.

(a) Apply a coat of Resin Mix 1, prepared as shown in Figure 1/GENERAL, over the repair area.

(b) Remove parting film from one side of the smallest ply of the patch and place the exposed face against the repair area with orientation as in original structure.

(c) Use a squeegee over the parting film that covers the patch to remove wrinkles and entrapped air. Do not apply excessive pressure. Excessive pressure will produce a patch deficient in resin.

(d) After removing parting film from the contact faces, place the next larger size ply of the impregnated patch over the ply on the repair area with proper orientation and with overlap all around per Figure 14/GENERAL.

(e) Place succeeding plies of the patch as described in Paragraph 4.E.(4)(c)/GENERALand Paragraph 4.E.(4)(d)/GENERAL.

(f) Proceed to layup/bagging procedure.

F. Layup/Bagging Procedure (Figure 3/GENERAL)

(1) Place a layer of dry peel ply over the wet layup repair patch. Cut the peel ply so it is large enough to contact the edge bleeder or surface bleeder.

(2) Place a layer of perforated FEP parting film (1 mil thick) over the layup. Cut the FEP so that the edges extend 3 inches beyond the edge of the repair.

(3) Secure three thermocouples (spaced evenly around repair) to the edge of the largest repair ply and connect them to the appropriate recorders.

(4) Place a layer of dry peel ply or Style 120 glass fabric (or equivalent thickness glass fabric) over the repair as a surface bleeder. Cut the surface bleeder so the edges extend 2.0 beyond the edge of the perforated FEP.

(5) Place a layer of solid FEP parting film (1 mil thick) over the surface bleeder. Cut the solid FEP so the edges are even with the edge of the perforated FEP.

(6) Place an optional metal caul plate (such as 0.016-inch thick aluminum) over the fiberglass bleeder. Make the caul plate slightly smaller than the bleeder. Omit this step if layup is for applying pressure for cure of core plug installation only.

(7) Place a heat blanket on the layup if heat blanket is used as heat source. The heat blanket must extend a minimum of 2 inches beyond the repair patch edges.

(8) Place on the layup several plies of glass fabric breather cloth for each ply in the repair. The breather cloth must extend beyond the parting film, and also must extend beyond the heat blanket and caul plate (if they are used). The breather cloth must also make contact with the surface bleeder cloth.

(9) Apply extruded sealing compound around the entire area, approximately 2 to 6 inches outside the heating blanket edge.

(10) Secure the vacuum outlet to the surface breather cloth (outside of the repair ply area).

CAUTION: HOLLOW COMPOSITE COMPONENTS SUCH AS RUDDERS, ELEVATORS, AND AILERONS MUST NOT BE COMPLETELY BAGGED BECAUSE THEY MAY COLLAPSE UNDER 22 INCHES OF MERCURY VACUUM. ATTACH VACUUM BAG TO ONE SIDE OF COMPONENT ONLY OR ATTACH SEPARATE VACUUM BAGS TO EACH SIDE TO ENSURE THAT ATMOSPHERIC PRESSURE IS MAINTAINED INSIDE OF COMPONENT DURING REPAIR. COMPONENTS CONSISTING OF A SINGLE PANEL MADE OF FULL DEPTH HONEYCOMB CORE WITH LAMINATE FACE SHEETS AND EDGEBANDS MAY BE COMPLETELY BAGGED (FIGURE 23/GENERAL).

(11) Lay a piece of vacuum bag material over the entire repair area, sealing the edge with the extruded sealing compound. Pleat the vacuum bag where needed to prevent bridging of bag material and subsequent bag breakage. Pad all sharp objects and corners to prevent bag breakage. In some cases, it is optional to vacuum bag the entire part.

NOTE: The entire repair surface must be vacuum bagged and restrained in place to prevent delamination and distortion when the repair area exceeds 15 percent of panel area. Regardless of the method of heat application, restraining devices that maintain the contour and support the part must be used for large parts sagging and distortion could occur due to the weight of the part.

(12) Evacuate the space under the vacuum bag and maintain a minimum of 22 inches of mercury vacuum.

NOTE: Maintain vacuum of 22 inches of mercury minimum during entire cure cycle.

(13) Check the vacuum bag and ensure that there are no leaks.

G. Cure the Repair

NOTE: Determination of the temperature must be made by using thermocouples placed at edge of patch. The gel and cure times of the potting and laminating resins are based on ambient temperature (70 to 80°F; 21 to 27°C); elevated temperatures will advance the reactions and lower temperatures will retard the reactions. An infrared heat lamp (250 watt), heating blankets or equivalent source may be used to accelerate the cure. The graph shown in Figure 4/GENERAL indicates the temperature obtained on the patch surface when the heat lamp is a certain height. Monitor temperature by thermocouples.

WARNING: USE EXPLOSIONPROOF HEAT LAMP OR HEAT BLANKETS FOR ACCELERATE CURE. NONCOMPLIANCE COULD CAUSE PERSONNEL INJURY.

CAUTION: SURFACE TEMPERATURE MUST NOT EXCEED 170°F (77°C). DAMAGE OR DISTORTION OF STRUCTURE MAY OCCUR IF TEMPERATURE EXCEEDS 170°F (77°C).

(1) Cure of wet layup

(a) Cure of the repair may be accomplished at room temperature (70 to 80°F; 21 to 27°C) or can be accelerated by the use of heat.

See Figure 1/GENERAL and graph in Figure 4/GENERAL for time at temperature requirements.

NOTE: Cure time does not include the time required for the mold and part to heat up to temeprature. Cure time is the period after the part has reached that temperature.

(b) Maintain vacuum of 22 inches of mercury minimum during entire cure cycle.

(c) Remove bagging and parting film after curing.

(d) The patch should be free from pits, blisters, starved areas, and excess resin deposits.

H. Refinish After Repair

CAUTION: DO NOT SAND INTO ORIGINAL STRUCTURE. FAILURE TO COMPLY WILL REDUCE THE STRENGTH OF THE COMPONENT.

(1) Lightly sand edge of topmost repair ply as necessary to fair the edge. Sand surface of repair to produce a smooth finish without damaging fibers.

(2) Refinish repair area as given in 51-70-14, GENERAL, Paragraph 16.

NOTE: The procedures for restoring finishes in 51-70-14, GENERAL include repairs of Tedlar films, conductive finishes, Teflon finishes, paint systems, and aluminum foil tape applications. Sealant applications using BMS 5-95 are restored.

I. Do the Post-Repair Procedures

(1) Do an inspection of the repair to make sure that it is satisfactory. Make sure that there are no empty spaces between plies or defective bonds. The inspection must include the area that was hot plus 2 inches minimum all around.

(2) If you find the repair to be unsatisfactory, you must remove it and install the repair again.

NOTE: The post-repair inspection is recommended. Examples of the inspection procedures are given in NDT Part 1, 51-01-01. Other inspection procedures that have been examined and found to be satisfactory by the airline can be used.

WARNING: MAKE SURE THAT THE OUTBOARD AILERON, ELEVATOR, AND RUDDER (CONTROL SURFACES) ARE BALANCED CORRECTLY AT ALL TIMES. IF YOU DO NOT, FLIGHT SAFETY CAN BE AFFECTED.

(3) After you repair a control surface, you must do a check of the balance to find if a rebalance is necessary. Refer to 51-60-00, GENERAL as necessary.

CAUTION: MAKE SURE THAT REPAIRS MADE TO CONTROL SURFACES AND/OR ADJACENT STRUCTURE DO NOT INTERFERE WITH THE DESIGNED OPERATION OF THE CONTROL SURFACES. DAMAGE TO THE AIRPLANES STRUCTURE CAN BE THE RESULT.

(4) Do a check of all repairs to make sure of clearance and non-interference with the operation of control surfaces.

(5) If a repair creates a blockage of a drain hole in the airplane structure, drill through the repair at the initial drain hole location with the appropriate drill bit. Refer to AMM 51-41-00/201.

5. Typical Repairs

NOTE: These repairs apply to all graphite/aramid/glass fabric reinforced honeycomb and laminate components except radomes and floor panels.

CAUTION: REFER TO THE SPECIFIC STRUCTURAL COMPONENT REPAIR SECTION FOR THE REPAIR LIMITS AND MATERIAL FOR THE COMPONENT BEFORE USING THESE REPAIR INSTRUCTIONS. FAILURE TO COMPLY COULD RESULT IN AN UNACCEPTABLE AND UNAUTHORIZED REPAIR.

A. Repair of Delaminations Between Plies

(1) Delamination of plies over core area of panel (Figure 5/GENERAL)

(a) Determine extent of damage. Ensure that water and other contaminations are removed.

(b) Cut away delaminated plies and prepare damaged area As given in Paragraph 4.C./GENERAL.

(c) Complete repair per Paragraph 4.E./GENERAL thru Paragraph 4.I./GENERAL.

(2) Repair of delaminations between plies of panel edgeband (Figure 12/GENERAL)

CAUTION: DELAMINATION MUST NOT REACH DEEPER THAN 0.5 INTO PANEL EDGEBAND OR EXTEND TO WITHIN 0.5 OF HONEYCOMB CORE (FIGURE 12/GENERAL). IF SO, REPAIR PER DAMAGED PLY METHOD.

(a) Determine extent of damage.

(b) Remove all contaminants and water from damaged area. Area must be completely dried out.

(c) Force Resin Mix 1 (Figure 1/GENERAL) into delaminated area.

(d) Clamp plies together and remove excess resin.

(e) Cure according to Paragraph 4.G./GENERAL, maintaining pressure until cured. Vacuum pressure is not required for this repair.

(f) Refinish surface as required.

(g) Perform applicable post-repair requirements As given in Paragraph 4.I./GENERAL before returning the repaired component to flight service.

B. Repair of Puncture, 0.50-inch Diameter or Less, in Honeycomb Panel (Figure 15/GENERAL)

(1) Remove clear or colored Tedlar film surface using No. 240 or finer Scotch-Brite abrasive, or No. 150 or finer sandpaper in the masked off area.

(2) Remove exterior finishes as applicable, including enamel finish and conductive coating, from the repair surface around the puncture using No. 150 or finer sandpaper.

(3) Dry out structure around puncture per Paragraph 4.B./GENERAL

(4) Remove loose fragments and other contamination from the hole. Clean up damaged area to a smooth and rounded shape per Paragraph 4.C./GENERAL

(5) Clean repair area per Paragraph 4.C.(2)(e)/GENERAL.

(6) Prepare Resin Mix 4, or Resin Mix 5, according to Figure 1/GENERAL.

(7) Work resin into the hole filling as much as possible.

(8) Cure according to Paragraph 4.G./GENERAL.

(9) Carefully sand any projecting material to fair with surrounding surface within ±0.010 inch.

NOTE: A 0.010-inch thick aluminum template may be used to protect surrounding surface while sanding.

(10) Abrade surfaces around repair using No. 240, or finer, Scotch-Brite abrasive.

(11) Clean repair area per Paragraph 4.C.(2)(e)/GENERAL.

(12) Prepare and apply two fabric cover plies and complete repair per Paragraph 4.E./GENERAL thru Paragraph 4.I./GENERAL.

C. Repair of Damage to One Skin and Honeycomb Core Using Replacement Core Plug, Punctures Greater than 0.50-inch Diameter (Figure 2/GENERAL)

(1) Determine extent of damage per Paragraph 4.A./GENERAL

(2) Remove all contamination and water from damaged area as given in Paragraph 4.B./GENERAL. Area must be completely dried out.

(3) Remove damage and prepare area according to Paragraph 4.C./GENERAL.

(4) Fabricate, clean, and install honeycomb replacement core plug as given in Paragraph 4.D./GENERAL

(5) Clean surface according to Paragraph 4.C.(2)(e)/GENERAL

(6) Complete repair as given in Paragraph 4.E./GENERAL thru Paragraph 4.I./GENERAL.

D. Repair of Large Puncture Through Internal and External Surface of Panel Including Core Damage (Figure 6/GENERAL).

(1) Determine extent of damage as given in Paragraph 4.A./GENERAL.

(2) Remove all contamination and water from damaged area as given in Paragraph 4.B./GENERAL Area must be completely dried out.

(3) Remove damage and prepare area according to Paragraph 4.C./GENERAL.

(4) Cut, clean, and install honeycomb replacement core plug as given in Paragraph 4.D./GENERAL, except it is not necessary to vacuum bag the core plug installation at this time.

(5) Prepare and apply repair plies to one surface of the panel according to Paragraph 4.E./GENERAL A caul plate may be used to restrain the core plug in place.

(6) Bag and apply vacuum and cure according to Paragraph 4.F./GENERAL and Paragraph 4.G./GENERAL. Ensure that temperature is approximately equal on both sides of panel.

(7) Sand core plug flush with surrounding material.

(8) Prepare and apply repair plies to the other surface of the panel and complete repair as given in Paragraph 4.E./GENERAL thru Paragraph 4.I./GENERAL.

NOTE: The above two-stage cure procedure is recommended. As an option, a three-stage cure procedure may be used wherein the core plug installation and the repair plies on each side may be cured separately.

E. Replacement of Honeycomb Core on Damaged Edge of Panel (Figure 7/GENERAL).

(1) Determine extent of damage as given in Paragraph 4.A./GENERAL.

(2) Remove all contamination and water from damaged area as given in Paragraph 4.B./GENERAL. Area must be completely dried out.

(3) Remove damage and prepare area according to Paragraph 4.C./GENERAL.

(4) Fabricate, clean, and install honeycomb replacement core plug As given in Paragraph 4.D./GENERAL

(5) Clean surfaces according to Paragraph 4.C.(2)(e)/GENERAL.

(6) Complete repair as given in Paragraph 4.E./GENERAL thru Paragraph 4.I./GENERAL.

F. Repairs Where Access is Limited to One Side of Panel (Figure 8/GENERAL).

NOTE: This repair applies to flat panels (or nearly flat panels) where damage extends completely through a panel, but access is not readily available to repair the unexposed side.

(1) Determine extent of damage as given in Paragraph 4.A./GENERAL.

(2) Remove all contamination and water from damaged area as given in Paragraph 4.B./GENERAL. Area must be completely dried out.

(3) Remove damage and prepare area according to Paragraph 4.C./GENERAL and the following:

(a) Enlarge the hole in the outer skin and core (D diameter) to permit a repair to be made to the inner skin with the required overlap.

NOTE: D diameter = (d + N + 1) inches d = diameter of cleaned up damage (1.5 maximum) N = number of plies in the inner skin. Stepping of the plies in the inner skin is not necessary for this repair.

(b) Clean out damaged area in inner skin leaving an oval shaped hole.

(c) Taper sand the outer skin plies as given in Paragraph 4.C.(2)/GENERAL.

(4) Fabricate an airtight patch, (Figure 8/GENERAL, Details II thru V) to cover the oval hole from the inaccessible side as follows:

(a) Make a suitable mold on which to lay up the patch. A thin gage aluminum sheet or any smooth surface can be used as a mold.

(b) Cover the mold with parting film or release agent.

(c) Lay up five plies of the same prepreg material used in the repair on the mold, using the procedures of Paragraph 4.E./GENERAL, except that all repair plies will have the same diameter and adhesive film will not be used. Make diameter of the repair plies at least equal to D diameter.

(d) Bag and cure the patch as given in Paragraph 4.F./GENERAL and Paragraph 4.G./GENERAL. Place thermocouples at the edge of the patch before cure.

(e) Remove the patch from the mold.

(f) Trim patch into an oval shape with a minor diameter slightly smaller than the major diameter of the cutout.

(g) Drill a 1/8 diameter hole in the center of the patch for a cleco fastener.

(h) Abrade the surface of the patch using No. 240 or finer Scotch-Brite abrasive. Remove all sanding dust by applying oil-free compressed air and using a vacuum cleaner.

(i) Fabricate a strip of spring steel 1.0 X 10.0 inches and drill a 1/8 diameter hole in the center for the cleco fastener.

NOTE: This repair illustrates the use of a spring steel clamp. However, any suitable retaining method may be used.

(j) Assemble the patch and spring steel together with a 1/8 diameter cleco fastener.

(5) Remove Tedlar, if required and abrade the underside of the inner skin to a distance of 0.4 from the edge of the elliptical cutout using No. 180 or finer sandpaper. Avoid abrasion of the existing ply filaments.

CAUTION: DO NOT IMMERSE PARTS IN TRICHLOROETHANE SOLVENT OR ALLOW STANDING SOLVENT TO REMAIN ON PART. DAMAGE TO PART WILL OCCUR.

(6) Clean repair area per 3.C.(2)(e).

(7) Bend up both ends of the spring steel and apply adhesive BMS 5-25 or BMS 5-92 to the precured patch.

(8) Holding the spring steel up, insert the patch into the oval hole, and orientate so that the hole is covered. Release the spring steel so that it holds the patch tightly up against the inner skin.

(9) Cure the adhesive per Figure 4/GENERAL. When cure is complete, remove the cleco fastener and spring. Fill hole for cleco fastener with sealant BMS 5-95, or adhesive BMS 5-25 or BMS 5-92. Allow this to cure.

(10) Clean out the repair area as given in Paragraph 4./GENERAL.

(11) Apply Resin Mix 1 to the surface of the inner skin which fays with the inner skin repair plies.

(12) Cut the required number of repair plies to diameter D and apply repair plies to the inner skin.

(13) Fabricate, clean, and install core plug as given in Paragraph 4.D./GENERAL

(14) Prepare and apply repair plies to the outer skin surface of the panel and complete repair as given in Paragraph 4.E./GENERAL thru Paragraph 4.I./GENERAL.

G. Repair of Damaged Skin Plies in Panel Edgeband (Figure 9/GENERAL).

(1) Determine extent of damage as given in Paragraph 4.A./GENERAL.

(2) Remove all contamination and water from damaged area as given in Paragraph 4.B./GENERAL. Area must be completely dried out.

CAUTION: DO NOT SAND INTO BOND PLY OR CORE (FIGURE 9/GENERAL). LOSS OF STRUCTURAL STRENGTH OF THE COMPONENT WILL OCCUR IF THIS CAUTION IS NOT OBSERVED. BOND PLY IS PLY ADJACENT TO CORE.

(3) Remove damage and prepare area according to Paragraph 4.C./GENERAL.

CAUTION: ON HYBRID PANELS, ENSURE THAT GRAPHITE REPAIR PLIES DO NOT EXTEND INTO AREAS OF FASTENER HOLES. ELECTROLYSIS BETWEEN THE METAL FASTENERS, SUPPORT STRUCTURE AND GRAPHITE MAY CAUSE CORROSION IN THE ALUMINUM STRUCTURE.

(4) Complete repair as given in Paragraph 4.E./GENERAL thru Paragraph 4.I./GENERAL.

H. Repair of Punctures and Damage to Multiple Plies in Solid Laminate Panels (Figure 21/GENERAL)

NOTE: This repair applies to components made from laminated fabric plies and epoxy resin without a honeycomb core.

(1) Determine extent of damage as given in Paragraph 4.A./GENERAL.

(2) Remove all contamination and water from damaged area. Area must be completely dried out. Any structure in the repair area that cannot be dried out must be removed along with the other damage.

CAUTION: DO NOT PENETRATE THE UNDAMAGED PLIES. LOSS OF STRUCTURAL STRENGTH OF THE COMPONENT WILL OCCUR.

(3) Remove damage and prepare area according to Paragraph 4.C./GENERAL

NOTE: Taper sand edges of plies around repair on damaged side of panel.

(4) Complete repair per Paragraph 4.E./GENERAL thru Paragraph 4.I./GENERAL.

I. Repair of Punctures, 0.50-Inch Diameter or Less, in Solid Laminate Panels (Figure 10/GENERAL, Detail II).

(1) Remove exterior finishes as applicable, including enamel finish and conductive coating, from the repair surface around the puncture using No. 150 or finer sandpaper.

(2) Remove all contamination and water from damaged area. Area must be completely dried out.

(3) Remove loose fragments and other contamination from the hole. Clean up damaged area to a smooth and rounded shape.

(4) Clean repair area as given in Paragraph 4.C.(2)(e)/GENERAL.

(5) Prepare Resin Mix 1, including 42% ±3% milled glass fiber, according to Figure 1/GENERAL.

(6) Work resin into the hole filling as much as possible.

(7) Cure according to Paragraph 4.G./GENERAL.

(8) Carefully sand any projecting material to fair with surrounding surface within ±0.010 inch.

NOTE: A 0.010-inch thick aluminum template may be used to protect surrounding surface while sanding.

(9) Abrade surfaces around repair using No. 240, or finer, Scotch-Brite abrasive.

(10) Clean repair area as given in Paragraph 4.C.(2)(e)/GENERAL

(11) Prepare and apply two fabric cover plies according to Paragraph 4.E./GENERAL

NOTE: Refer to specific component structure identification for laminate material and orientation.

For graphite laminates, use graphite repair plies of the same material and orientation as the original surface plies.

For aramid, fiberglass or hybrid laminates, use fiberglass repair plies with the same orientation as the original surface plies.

See Figure 13/GENERAL for repair ply substitutions.

(12) Complete repair as given in Paragraph 4.F./GENERAL thru Paragraph 4.I./GENERAL.

J. Repair of Delaminations Between Plies in Solid Laminate Panels

NOTE: This repair applies to components made from laminated tape or fabric plies and epoxy resin without a honeycomb core.

(1) Repair delaminations using methods described in Paragraph 5.H./GENERAL.

K. 150°F (66°C) Cure Wet Layup Repair of Damaged Panel Attach Holes in Honeycomb Panel Edgebands or Along Edges of Laminated Panels (Figure 10/GENERAL)

(1) Determine the extent of damage as given in Paragraph 4.A./GENERAL.

(2) Remove all contamination and water from damaged area as given in Paragraph 4.B./GENERAL Area must be completely dried out. Any structure in the repair area that cannot be dried out must be removed along with the other damage.

(3) Taper sand around the hole to remove damage according to Figure 10/GENERAL.

(4) Clean area according to Paragraph 4.C.(2)(e)/GENERAL

CAUTION: ON HYBRID PANELS, ENSURE THAT GRAPHITE REPAIR PLIES DO NOT EXTEND INTO AREAS OF FASTENER HOLES. ELECTROLYSIS BETWEEN METAL FASTENERS, SUPPORT STRUCTURE AND GRAPHITE MAY OCCUR CAUSING CORROSION TO ALUMINUM STRUCTURE.

(5) Complete the repair as given in Figure 10/GENERAL and as given in Paragraph 4.E./GENERAL thru Paragraph 4.H./GENERAL thru 3.H., but cure only at 150°F (66°C).

(6) Drill and countersink fastener holes. Refer to 51-70-16 for drilling in composites.

(7) Perform applicable post-repair requirements as given in Paragraph 4.I./GENERAL before returning the repaired component to flight service.

L. Repair of Surface Dents (Figure 16/GENERAL).

(1) Check for delamination and broken fibers as given in Paragraph 4.A./GENERAL.

(2) If delamination is found, repair as given in Paragraph 5.A./GENERAL.

(3) If broken fibers are found, repair as given in Paragraph 5.B./GENERAL or Paragraph 5.C./GENERAL.

(4) If no delamination or broken fibers are found, mark off damaged area allowing 1.0 inch of overlap for the repair ply.

(5) Clean damaged area according to Paragraph 4.C.(2)(e)/GENERAL.

(6) Mask area for repair with masking tape.

(7) Remove Tedlar or decorative finish using No. 240 or finer Scotch-Brite abrasive, or No. 150 or finer sandpaper in the masked off area.

(8) Pot dent flush or slightly higher than surrounding surface with Resin Mix 2 potting compound.

(9) Cure as given in Paragraph 4.G./GENERAL.

CAUTION: DO NOT SAND INTO FIBERS IN THE AREA SURROUNDING DENT.

(10) Sand flush using 150 grit or finer sandpaper.

(11) Clean area according to Paragraph 4.C.(2)(e)/GENERAL.

(12) Prepare and apply one ply layer of Type H-2 or H-3 glass fabric according to Paragraph 4.E./GENERAL The ply layer is to be 2.0 inches larger than the potted area (Figure 16/GENERAL).

(13) Complete repair as given in Paragraph 4.F./GENERAL thru Paragraph 4.H./GENERAL.

M. Repair of Lightning Strike Damage (Figure 17/GENERAL).

(1) Check for delamination as given in Paragraph 4.A./GENERAL.

NOTE: This repair is limited to lightning damage that does not pennetrate the fibers. IF the fibers or core have been damaged, remove and replace as given in Paragraph 4.A./GENERAL thru Paragraph 4.I./GENERAL

(2) If delamination is found, repair as given in Paragraph 5.A./GENERAL or Paragraph 5.H./GENERAL.

(3) If delamination is not found, mark off damaged area allowing 1.0 inch of overlap for the repair ply.

(4) Clean damaged area according to Paragraph 4.C.(2)(e)/GENERAL

(5) Mask area for repair with masking tape.

(6) Remove Tedlar or decorative finish using No. 240 or finer Scotch-Brite abrasive, or No. 150 or finer sandpaper in the masked off area.

(7) Seal surface with Resin Mix 6, prepared as shown in Figure 1/GENERAL. Excess resin must be scraped off before it gels.

(8) Cure as given in Paragraph 4.G./GENERAL.

(9) Prepare and apply one ply layer of Type H-2 or H-3 glass fabric according to Paragraph 4.E.(1)/GENERAL The ply layer is to overlap the lightning damage by 1.0 inch all around (Figure 17/GENERAL).

(10) Complete repair as given in Paragraph 4.F./GENERAL thru Paragraph 4.H./GENERAL.

N. Repair of Small Damage to One Skin (Figure 20/GENERAL)

NOTE: This repair has Inspection Requiremnts and time limits. Refer to the specific structural component repair section for the repair limitations.

(1) Determine the extent of damage as given in Paragraph 4.A./GENERAL

(2) Mask area for repair with masking tape.

(3) Remove Tedlar or decorative finish using No. 240 or finer Scotch-Brite abrasive, or No. 150 or finer sandpaper in the masked off area.

(4) Remove any moisture and contamination using vacuum or oil-free compressed air.

(5) Heat the area for one hour minimum at 150°F (66°C) to 170°F (77°C). The rate of temperature rise must not exceed 5°F (3°C) per minute.

(6) Lightly abrade masked area with 150-grit or finer sandpaper.

(7) Clean area according to Paragraph 4.C.(2)(e)/GENERAL.

(8) Make a wet layup of two plies of Type 1581 glass fabric for each damaged ply of graphite or aramid fabric. The plies are to overlap the damage and each other as shown in Figure 20/GENERAL.

(9) Apply vacuum and cure as given in Paragraph 4.F./GENERAL thru Paragraph 4.H./GENERAL.

O. Repair of Erosion Damage to Panel Edges (Figure 22/GENERAL)

(1) Determine the damaged area as given in Paragraph 4.A./GENERAL If damage exceeds the limits specified in Figure 22/GENERAL, repair as given in Paragraph 5.G./GENERAL If delamination is present, repair as given in Paragraph 5.A.(2)/GENERAL.

(2) Mask the damaged area with masking tape. Use care to keep the rework area within the limits specified in Figure 22/GENERAL.

(3) Remove the moisture and contamination from the rework area with a vacuum or oil free compressed air and by heating the area to between 150°F (66°C) and 170°F (77°C). The rate of heating must not exceed 5°F (3°C) per minute. Refer to Paragraph 4.B./GENERAL.

(4) Taper sand the damaged area using 180 grit or finer sandpaper. Maintain the limits specified in Figure 22/GENERAL.

(5) Clean the area. Refer to Paragraph 4.C.(2)(e)/GENERAL.

(6) Seal the area with Resin Mix 1 (BMS 8-301, Class 2). See Figure 1/GENERAL for resin specifications, mixing, and curing procedures.

RESIN, PREPREG, OR ADHESIVE TYPE	COMPONENTS	PARTS BY WEIGHT	OPEN TIME BEFORE USE, OR POT LIFE OF MIXTURE	CURE TIME [A]
RESIN MIX 1 (LAMINATING RESIN) (BMS 8-301, CLASS 2)	FR 7020 RESIN - PART A HARDENER - PART B EY 3804 RESIN - PART A HARDENER - PART B	100 ±2 58 ±0.5 100 66	APPROX 30 MINUTES AT 75°F (24°C)	30 MINUTES AT 150°F ±10°F (66°C ±6°C) 6 HOURS MIN AT ROOM TEMPERATURE 65°F MIN (19°C) CURE FOR 180 MINUTES AT 150°F (66°C)
RESIN MIX 2 (POTTING RESIN) (BMS 5-28, TYPE 7)	CG-1305 RESIN CG-1305 HARDENER	100 22	60 MINUTES AT 70°F (21°C)	12 HRS AT 65°F MIN (19°C) 2 HRS AT 125°F (52°C) [B]
	FR 7162 RESIN FR 7162 HARDENER	100 ±5 40 ±2		
RESIN MIX 3 (POTTING RESIN)	RESIN MIX 2 MICROBALLOONS	100 5	SAME AS RESIN MIX 2	SAME AS RESIN MIX 2
RESIN MIX 4	RESIN MIX 1 MILLED GLASS FIBER, 1/32-IN	80 20	SAME AS RESIN MIX 1	SAME AS RESIN MIX 1
RESIN MIX 5	RESIN MIX 2 MILLED GLASS FIBER, 1/32-IN	80 20	SAME AS RESIN MIX 2	SAME AS RESIN MIX 2
RESIN MIX 6 (SEALER RESIN) (BMS 8-207, TYPE 1, CLASS I)	EC1838A RESIN EC1838B HARDENER	50 50	20 MINUTES AT 77°F (25°C)	2 HRS AT 105° (41°C) TO 125°F (52°C)
RESIN MIX 6 (SEALER RESIN) ALTERNATE (BMS 8-207 TYPE 1, CLASS II)	FR-40 RESIN 5413C HARDENER	100 ±1 15 ±0.5	20 MINUTES AT 75° TO 79°F (24° TO 26°C)	12 HRS MIN AT ROOM TEMP (65°F MIN) (19°C MIN) 1 HR MIN AT 150°F (66°C) TO 170°F (77°C)
RESIN MIX 6 (SEALER RESIN) ALTERNATE	EPIBOND 156A RESIN EPIBOND 941 HARDENER	100 ±2 10 ±0.5	45 TO 60 MINUTES AT 70°F (21°C)	SEE FIG. 4
RESIN MIX 6 (SEALER RESIN) ALTERNATE	EPIBOND 156A RESIN EPIBOND 156B HARDENER	100 ±2 6 ±0.3	15 TO 25 MINUTES AT 77°F (25°C)	12 HRS AT 65°F MIN (19°C) OR 1 TO 3 HRS AT 150°F (66°C)
RESIN MIX 6 (SEALER RESIN) ALTERNATE	FR-5318S RESIN FR-5318C HARDENER	100 ±2 50 ±1	45 TO 60 MINUTES AT 70°F (21°C)	SEE FIG. 4
RESIN MIX 7 (POTTING RESIN) (BMS 5-28, TYPE 6)	EPOCAST 1636B WITH 1636B HARDENER	100 6.5	60 MINUTES AT 70° TO 80°F (21° TO 27°C)	12 HRS AT 65°F MIN (19°C) 2 HRS AT 125°F (52°C) [B]

Resin Specifications and Mixing Procedure
Figure 1 (Sheet 1 of 2)

WARNING: THESE CHEMICALS CONTAIN TOXIC INGREDIENTS. PROVIDE ADEQUATE VENTILATION AND PROTECT THE SKIN AND EYES FROM CONTACT WITH UNCURED RESINS OR CURING AGENT. WEAR RUBBER GLOVES OVER COTTON GLOVES FOR PROTECTION OF HANDS. IF SKIN IS EXPOSED TO DIRECT CONTACT WITH UNCURED RESINS OR CURING AGENT, WASH WITH WARM WATER OR SOAP. AVOID THE USE OF SOLVENTS FOR CLEANING THE SKIN.

CAUTION: TO PREVENT CONTAMINATION OF THE RESIN, DO NOT USE WAXED CONTAINERS FOR MIXING.

	MIXING PROCEDURE
RESIN MIX 1 RESIN MIX 2 RESIN MIX 6 RESIN MIX 7	ADD HARDENER TO RESIN AND MIX THOROUGHLY.
RESIN MIX 3	1. ADD PHENOLIC MICROBALLOONS TO RESIN AND MIX THOROUGHLY. 2. ADD HARDENER AND MIX THOROUGHLY.
RESIN MIX 4 RESIN MIX 5	ADD MILLED GLASS FIBERS TO RESIN MIX TO PROVIDE A CONSISTENCY SIMILAR TO A THIN PUTTY.

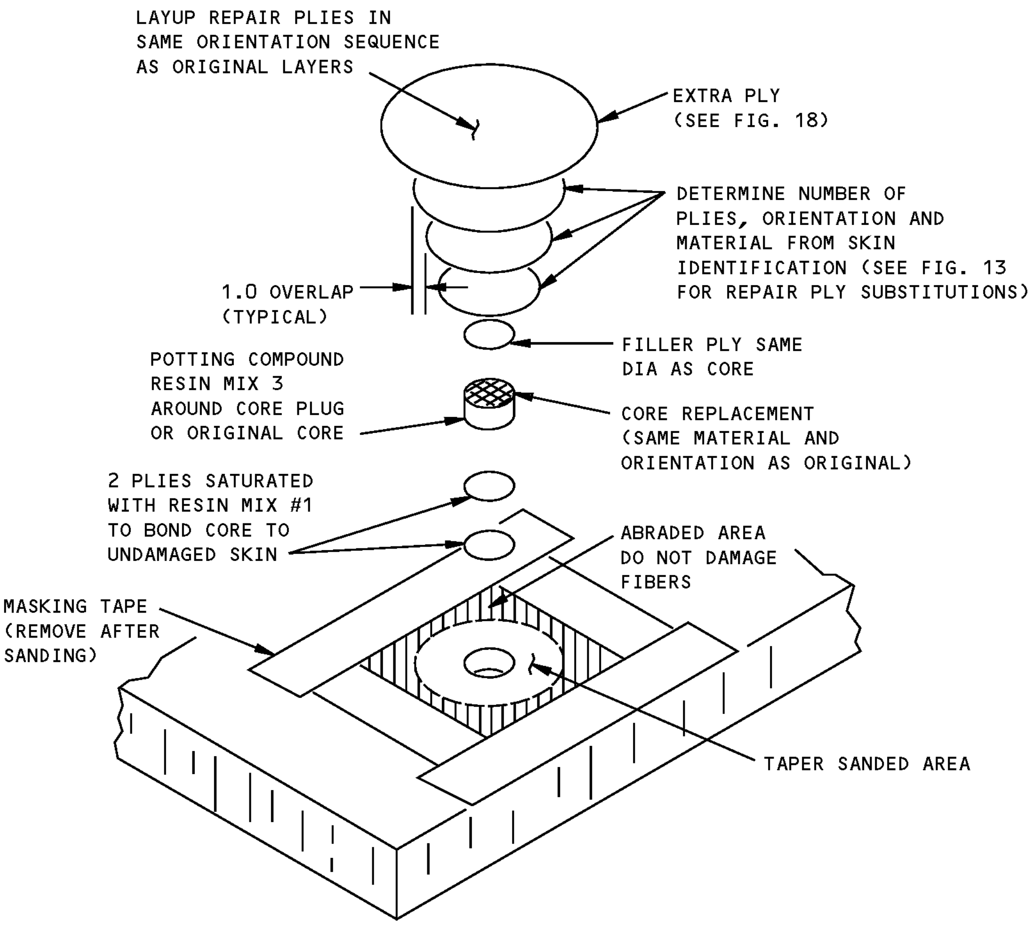
NOTES

- MATERIALS MUST GEL AT ROOM TEMPERATURE PRIOR TO HEATING. RATE OF HEAT RISE MUST BE NO GREATER THAN 7°F (4°C) PER MINUTE.
- REFER TO SRM 51-30-03 FOR SOURCES OF MATERIALS.

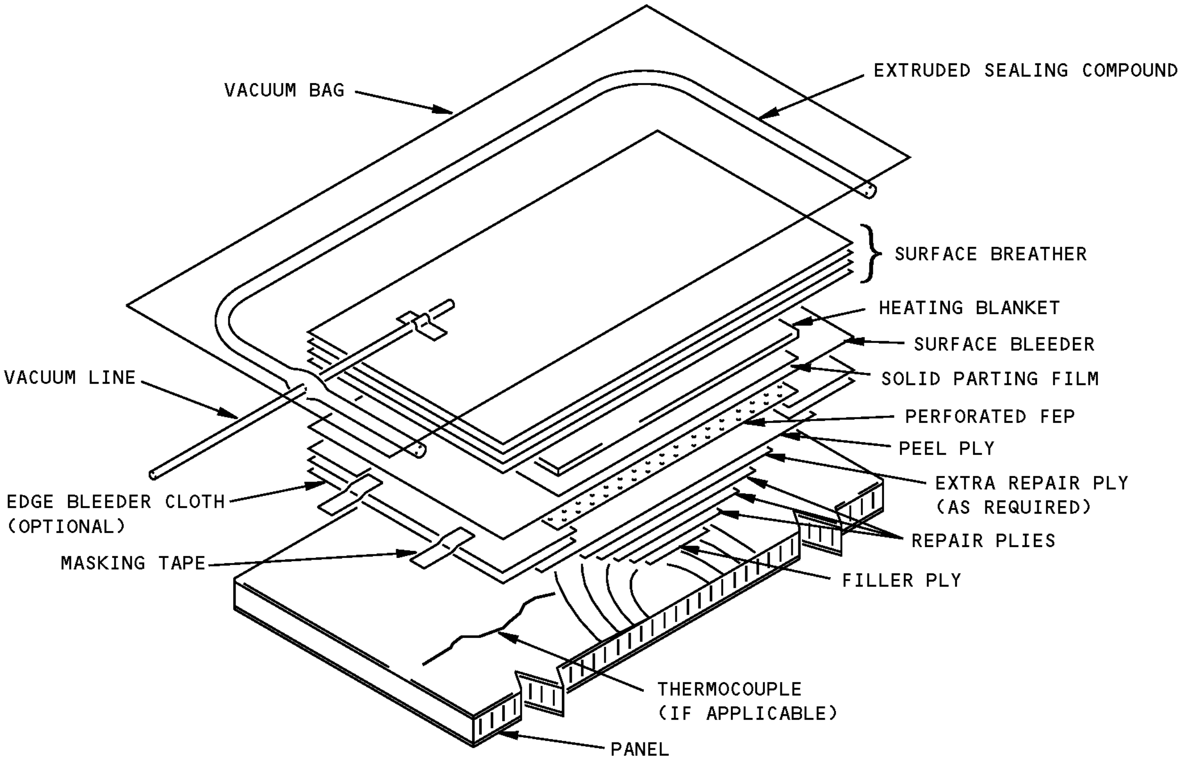
A UNLESS SPECIFIED DIFFERENTLY, CURE TIME IS THE MINIMUM TIME NECESSARY TO CURE PRIOR TO HANDLING, DRILLING, OR SANDING.

B FOR OPTIMUM PROPERTIES, CURE 7 DAYS AT 65°F (19°C) OR 5 HOURS AT 125°F (52°C).

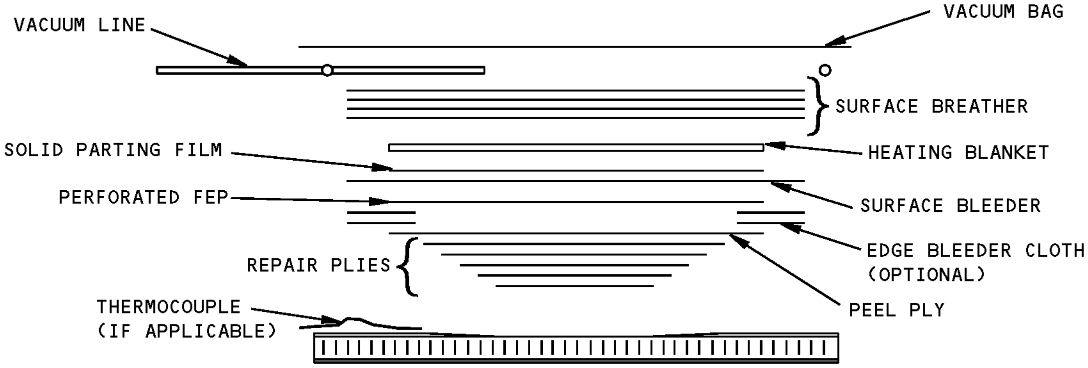
Resin Specifications and Mixing Procedure
Figure 1 (Sheet 2 of 2)



Repair of Large Punctures Thru One Skin of a Sandwich Structure Including Core Damage - Wet Layup
Figure 2

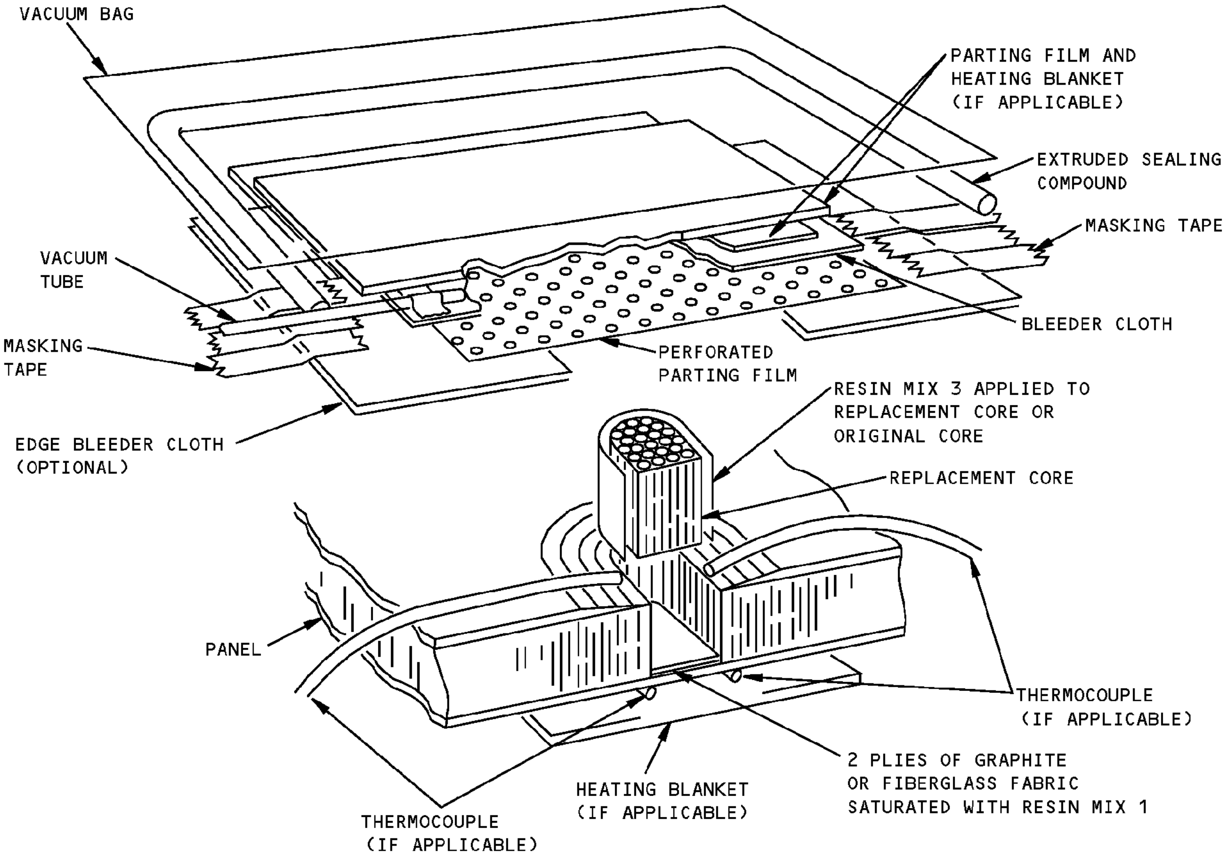


CUTAWAY VIEW OF
BAGGING SEQUENCE FOR SKIN PLY REPAIR
(WET LAYUP)

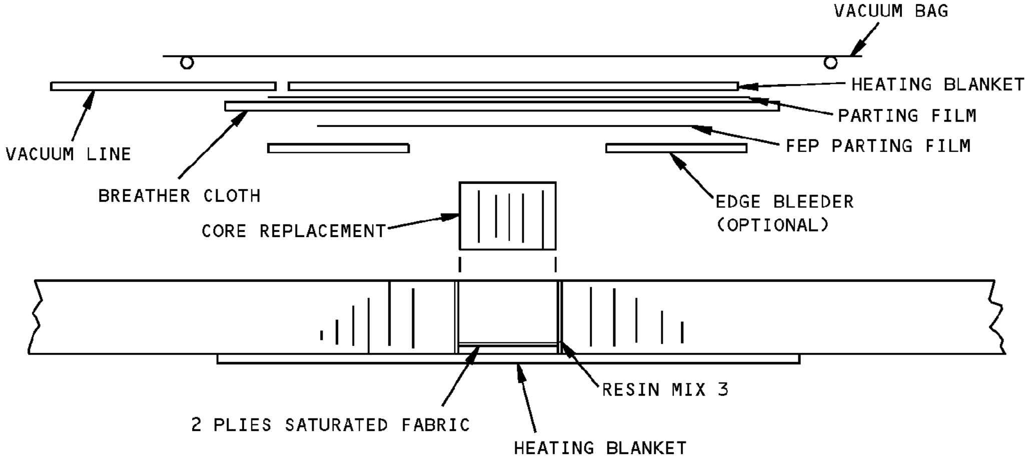


SECTION THRU LAYUP FOR SKIN PLY REPAIR
(WET LAYUP)

Application of Pressure During Cure - Wet Layup
Figure 3 (Sheet 1 of 2)

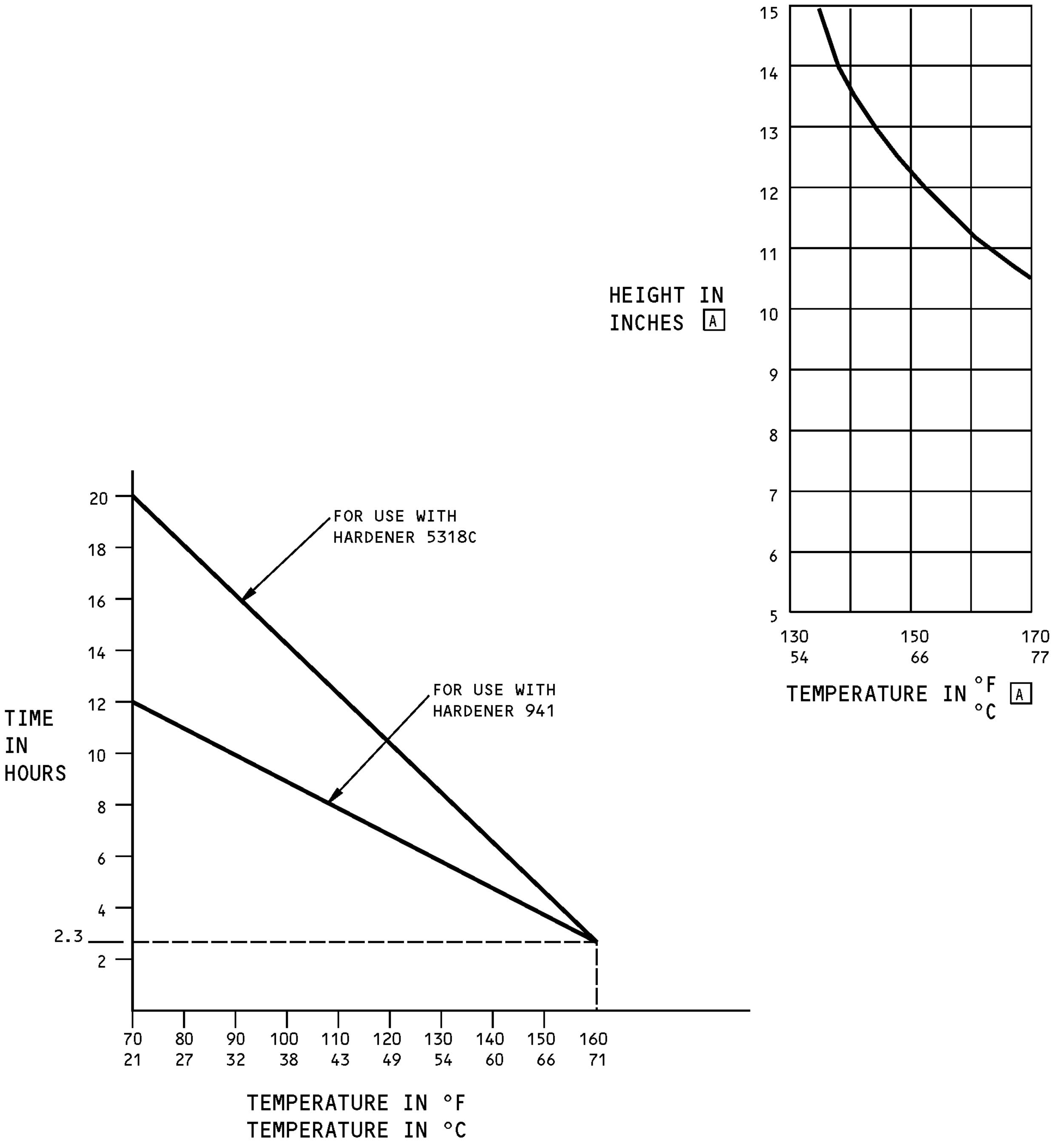


BAGGING SEQUENCE FOR CORE REPLACEMENT
(WET LAYUP ONLY)



SECTION THRU LAYUP FOR CORE REPLACEMENT
(WET LAYUP ONLY)

Application of Pressure During Cure - Wet Layup
Figure 3 (Sheet 2 of 2)

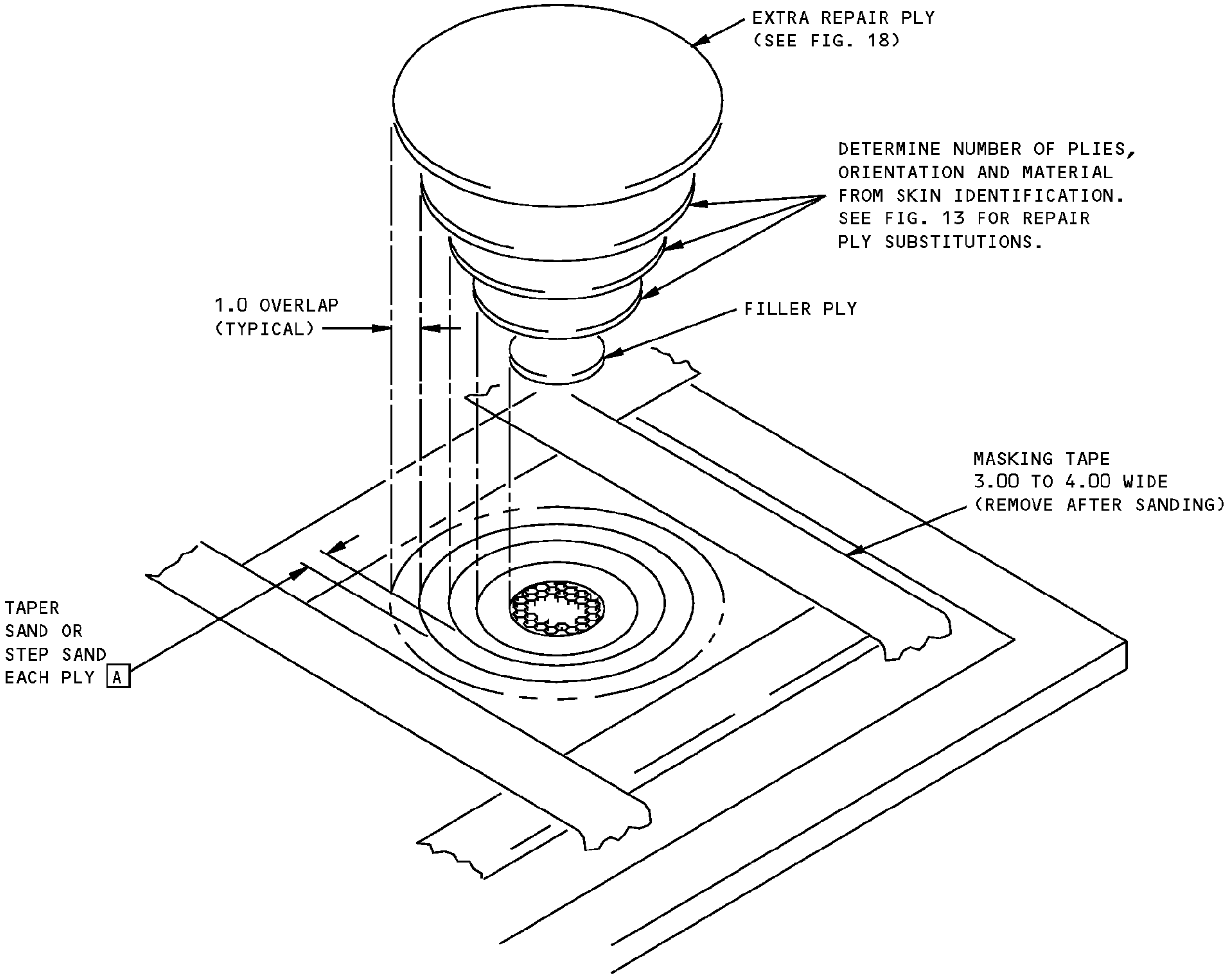


NOTES

- USE THERMOCOUPLES TO MONITOR TEMPERATURE

A THE HEIGHT IN INCHES OF 250 WATT HEAT LAMP FROM THE SURFACES OF THE PATCH VS TEMPERATURE AT SURFACE OF PART

Potting and Laminating Resin Cure Temperature
Figure 4



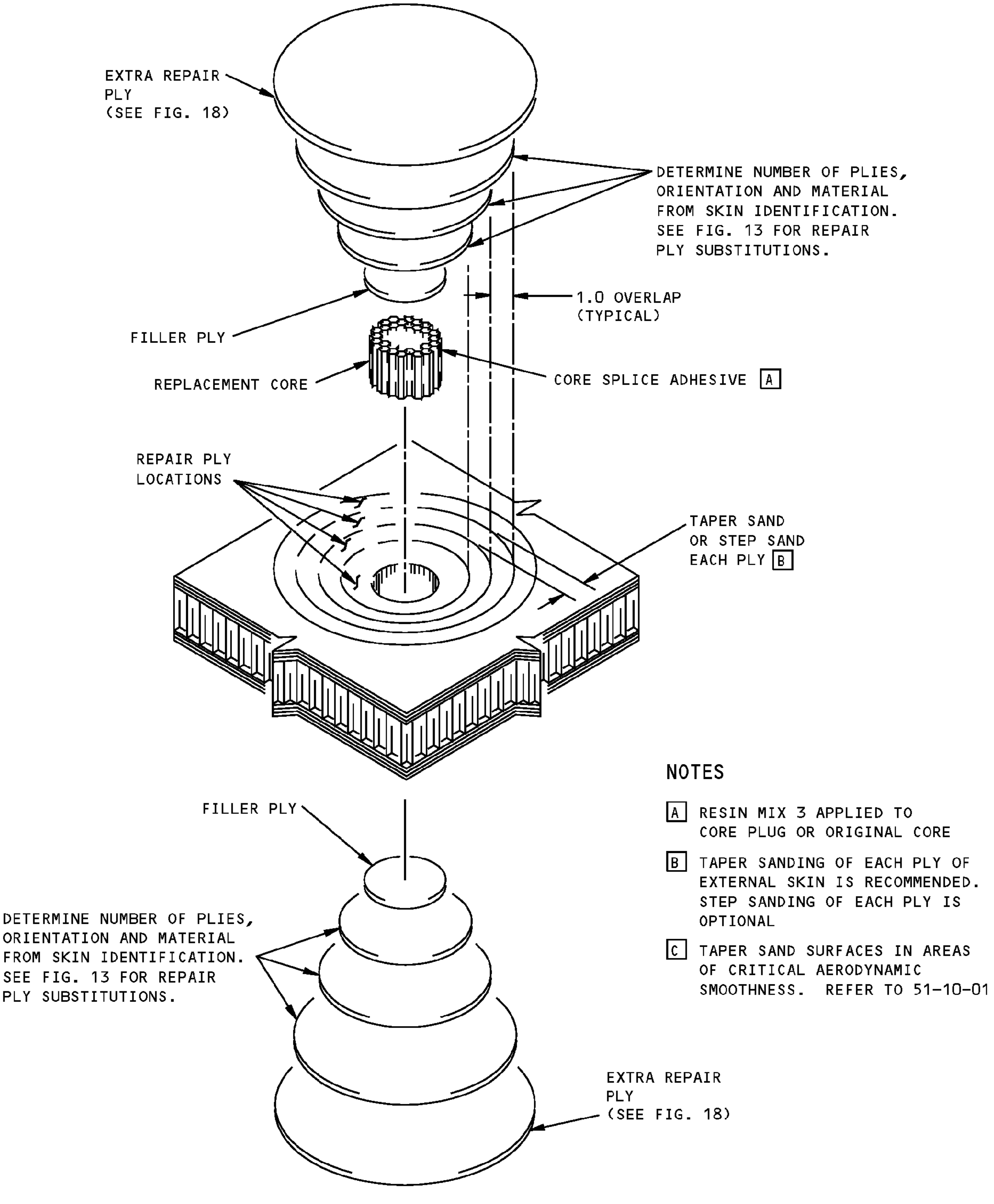
WET LAYUP ONLY

NOTES

A TAPER SANDING OF EACH PLY OF EXTERNAL SKIN IS RECOMMENDED.
STEP SANDING OF EACH PLY OF INTERNAL SKIN IS OPTIONAL B

B TAPER SAND SURFACES IN AREAS OF CRITICAL AERODYNAMIC SMOTHNESS.
SEE 51-10-01

Repair of Damaged External or Internal Skins of a Sandwich Panel - Wet Layup
Figure 5



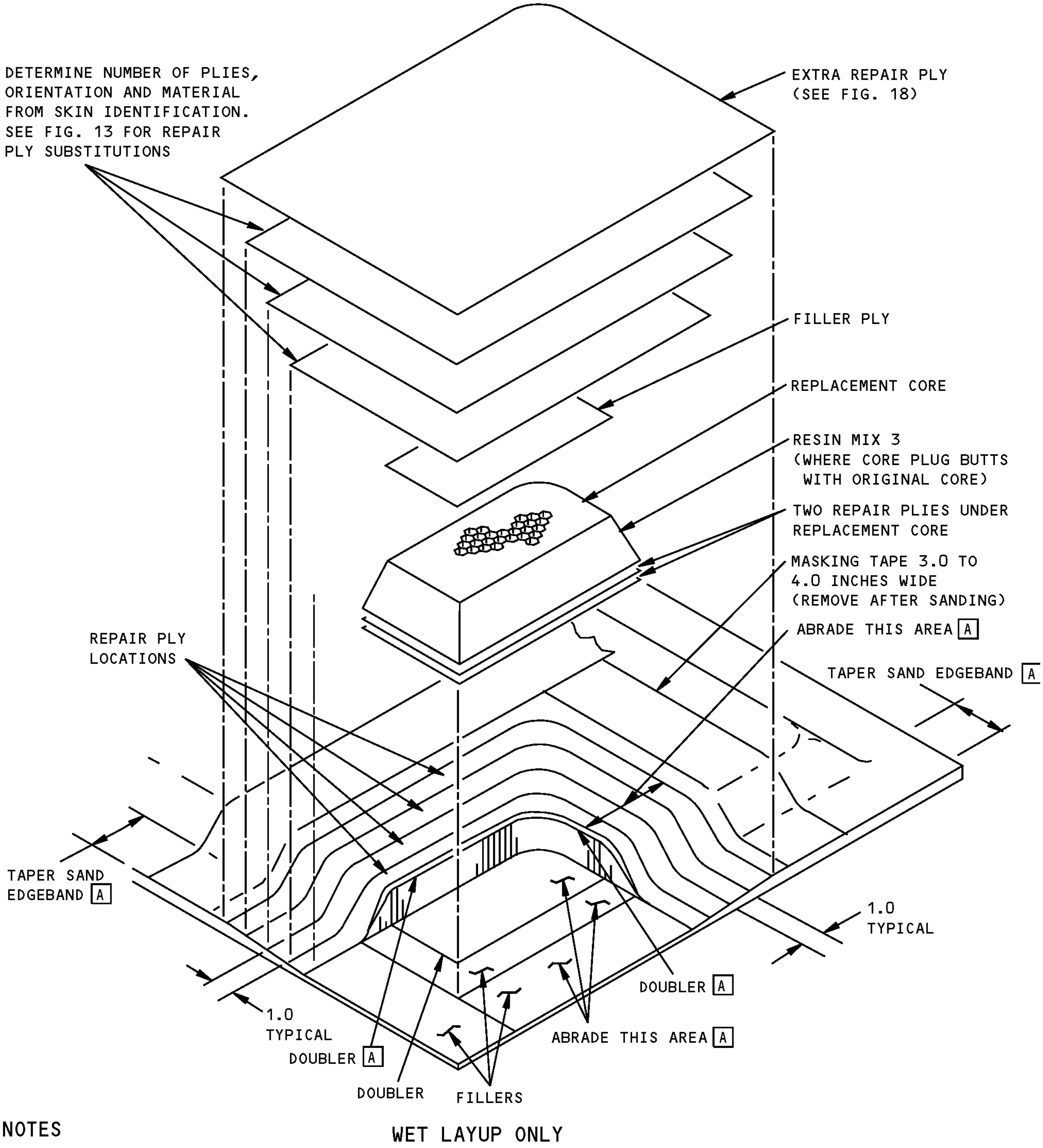
NOTES

A RESIN MIX 3 APPLIED TO CORE PLUG OR ORIGINAL CORE

B TAPER SANDING OF EACH PLY OF EXTERNAL SKIN IS RECOMMENDED. STEP SANDING OF EACH PLY IS OPTIONAL

C TAPER SAND SURFACES IN AREAS OF CRITICAL AERODYNAMIC SMOOTHNESS. REFER TO 51-10-01

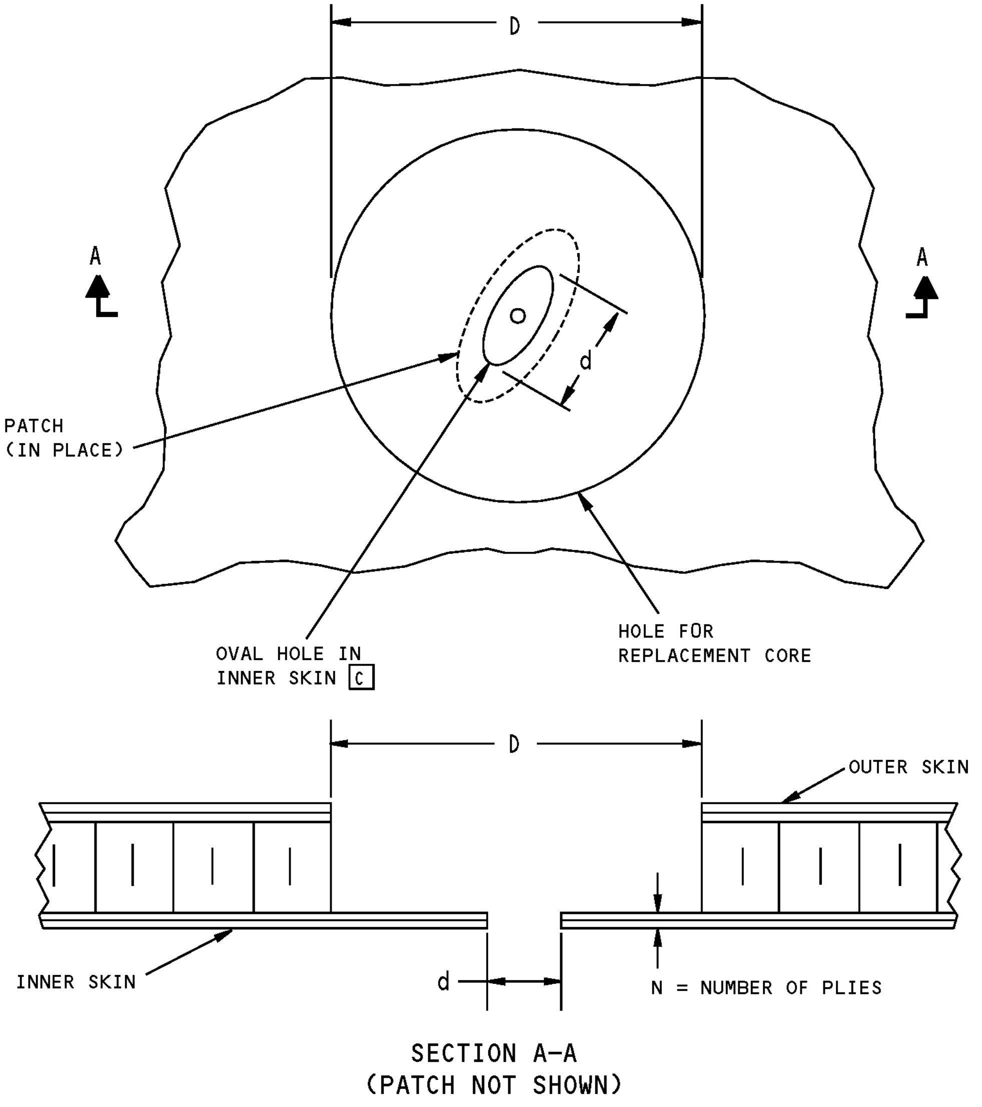
Repair of Large Punctures Through Both Skins of a Sandwich Panel Including Core Damage - Wet Layup
Figure 6



NOTES

A TAPER SANDING IS OPTIONAL TO JUST ABRADING THE SURFACE OF THE SKIN AND DOUBLER PLIES ABOVE AND BELOW THE HONEYCOMB CORE. HOWEVER, TAPER SANDING IS REQUIRED ON THE EDGEBAND

Replacement of Honeycomb Core on Damaged Edge of Sandwich Panel - Wet Layup
Figure 7



DETAIL I

NOTES

- THIS REPAIR ILLUSTRATES THE USE OF A SPRING STEEL CLAMP. HOWEVER, ANY SUITABLE RETAINING DEVICE MAY BE USED
- D = d + N + 1
  d = MAJOR DIAMETER OF OVAL HOLE IN INNER SKIN
  N = NUMBER OF PLIES

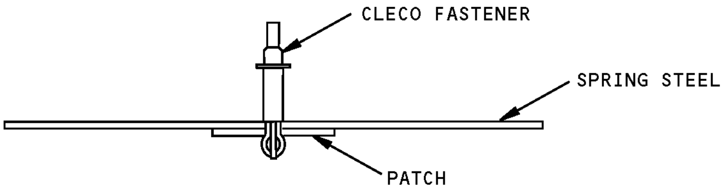
  FOR EXAMPLE:
    IF d = 0.50 INCH
    THEN, D = 0.50 + 2 (PLIES) + 1
          D = 3.50 INCH DIAMETER

A RESIN MIX 3 APPLIED TO CORE PLUG OR ORIGINAL CORE

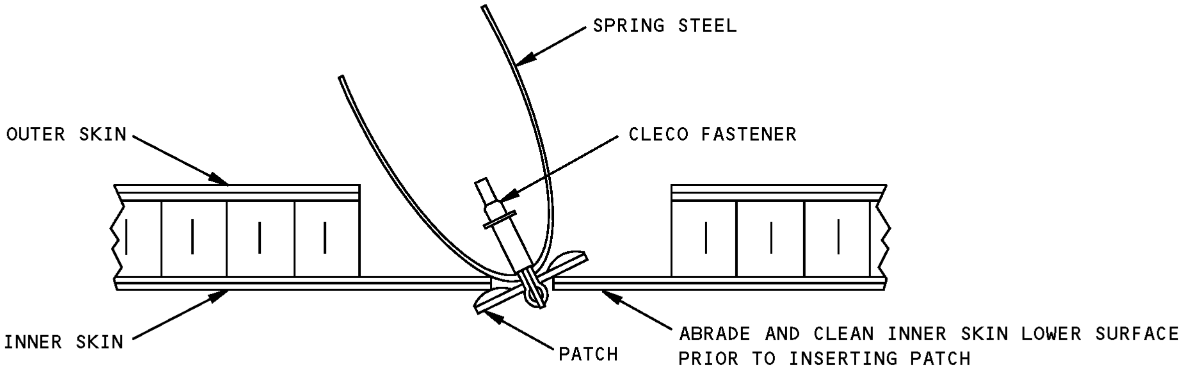
B MAKE TAPER AND OVERLAP PER FIGURE 14

C MAJOR DIAMETER d OF OVAL HOLE IN INNER SKIN IS LIMITED TO 1.5 INCH FOR THIS REPAIR

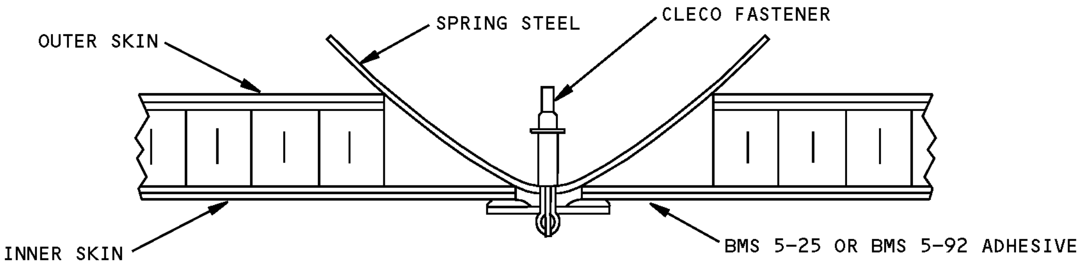
Repair of Damage to External and Internal Skins with Access Limited to One Side - Wet Layup
Figure 8 (Sheet 1 of 3)



ASSEMBLE PATCH AND SPRING STEEL
DETAIL II

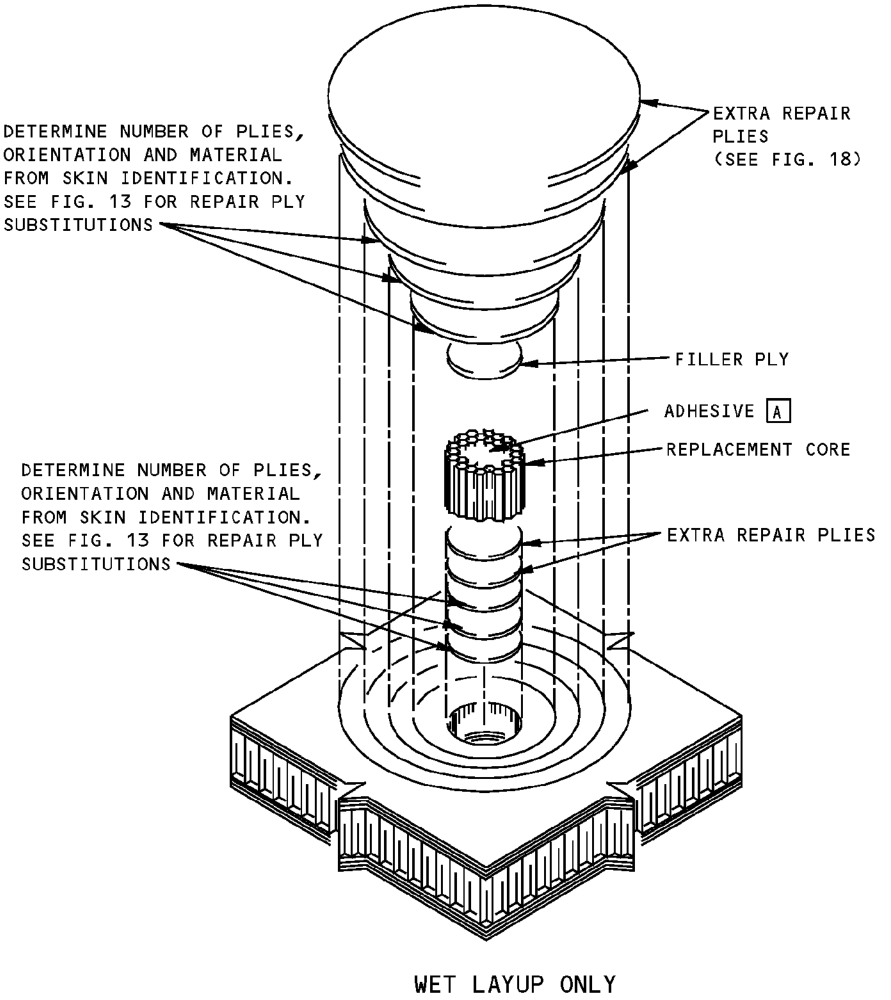


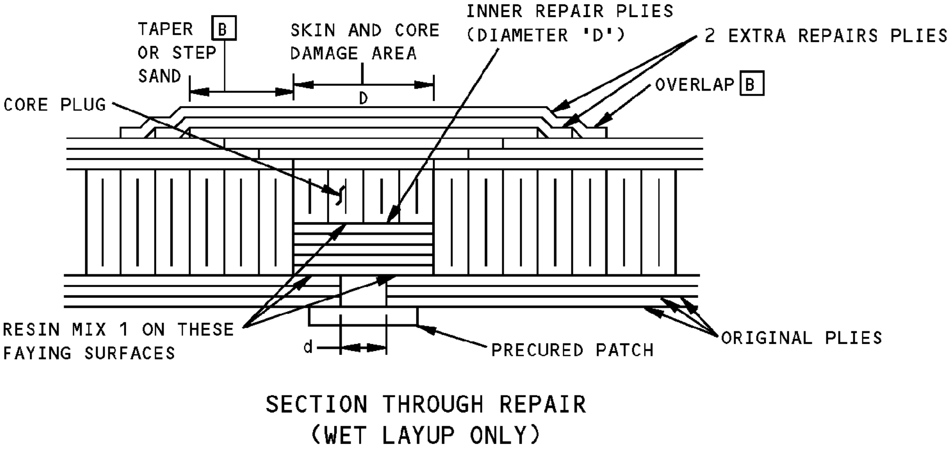
INSERT PATCH INTO OVAL HOLE
DETAIL III



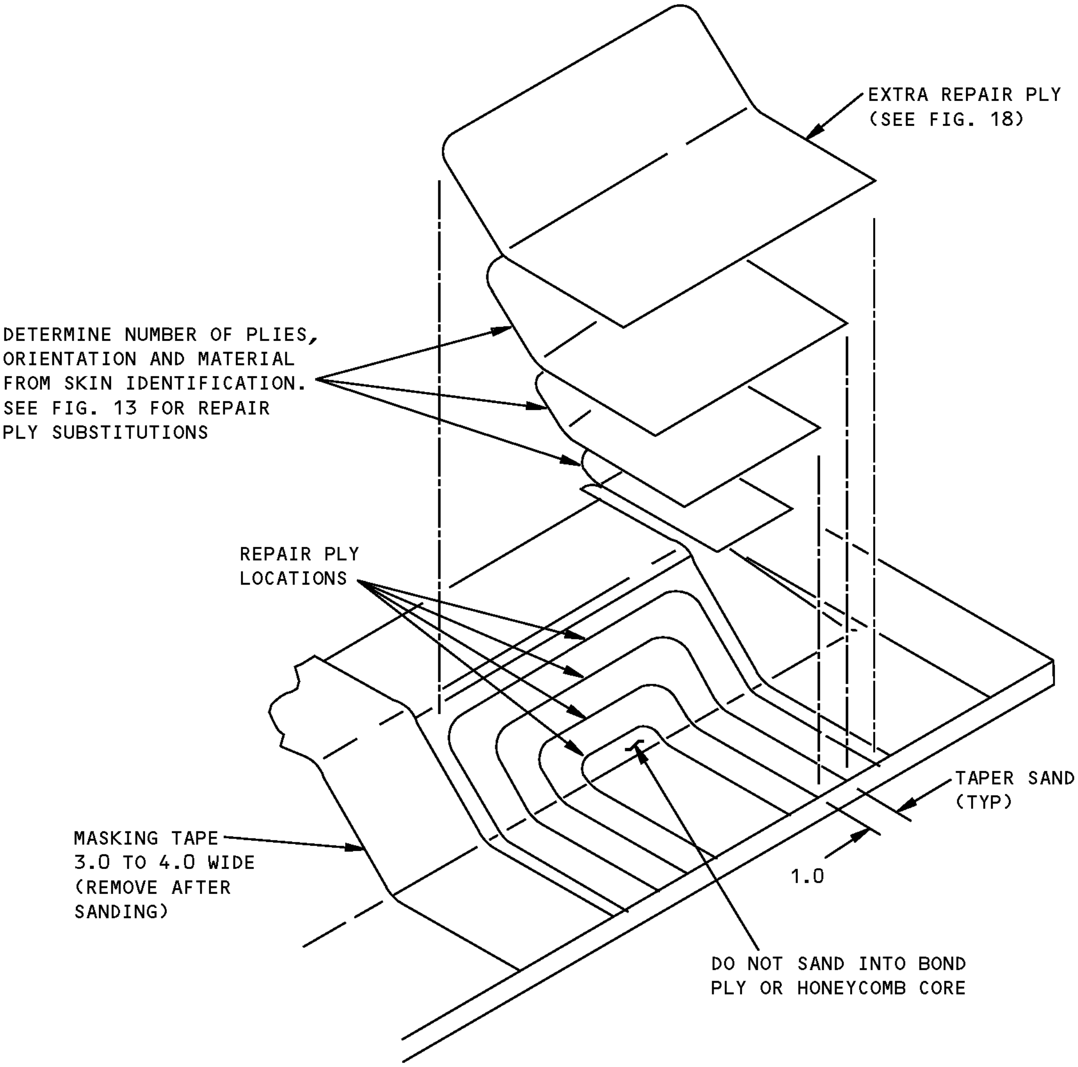
HOLD PATCH IN PLACE WHILE CURING
DETAIL IV

Repair of Damage to External and Internal Skins with Access Limited to One Side - Wet Layup
Figure 8 (Sheet 2 of 3)



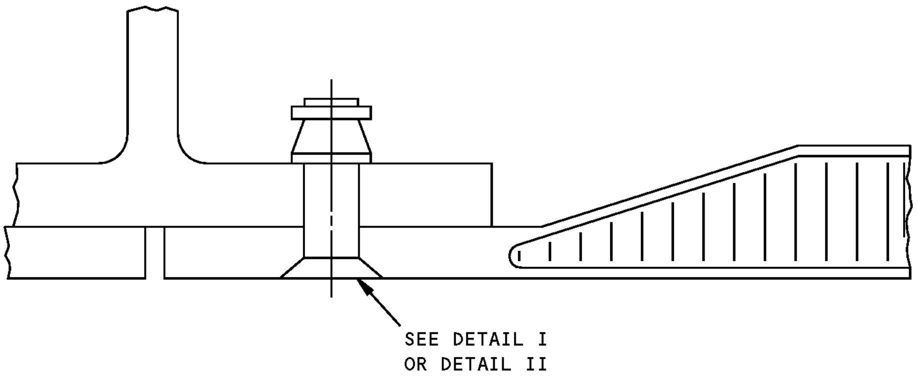


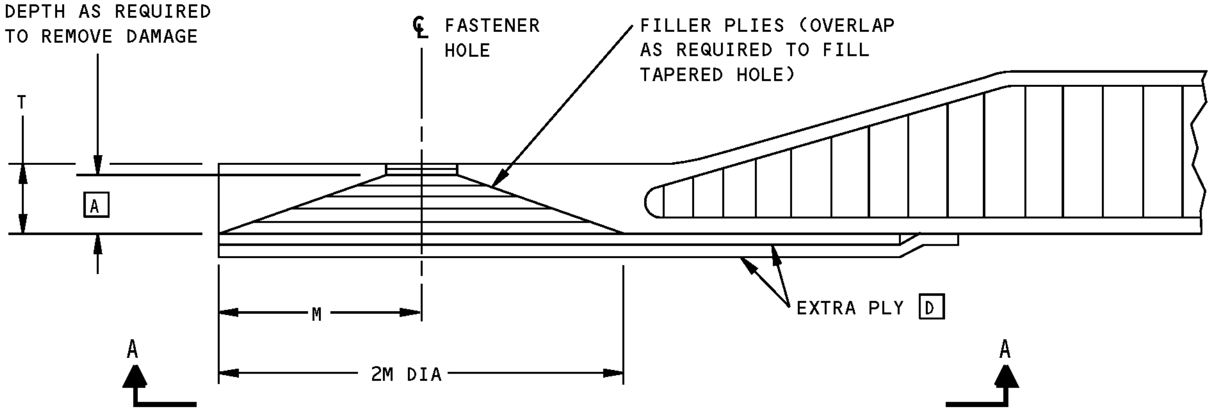
Repair of Damage to External and Internal Skins with Access Limited to One Side - Wet Layup
Figure 8 (Sheet 3 of 3)



WET LAYUP ONLY

Repair of Damaged Skin Plies On A Panel Edge - Wet Layup
Figure 9





SEE DETAIL II FOR ALTERNATIVE METHOD

DETAIL I

NOTES

- M = 5T MAXIMUM AS SHOWN, WHERE T IS THE THICKNESS OF THE EDGEBAND. DO NOT CUT INTO CORE
- THIS REPAIR IS APPLICABLE ONLY WHERE NO MORE THAN TWO ATTACH HOLES ARE DAMAGED IN A SEQUENCE OF TEN. IF MORE THAN TWO ATTACH HOLES IN A SEQUENCE OF TEN ARE DAMAGED, REPAIR THE EDGEBAND AS GIVEN IN PARAGRAPH 5.G. (FIGURE 9).
- D EQUALS FASTENER DIAMETER

A APPLY FILLER PLIES AS REQUIRED TO FILL THE DAMAGED AREA

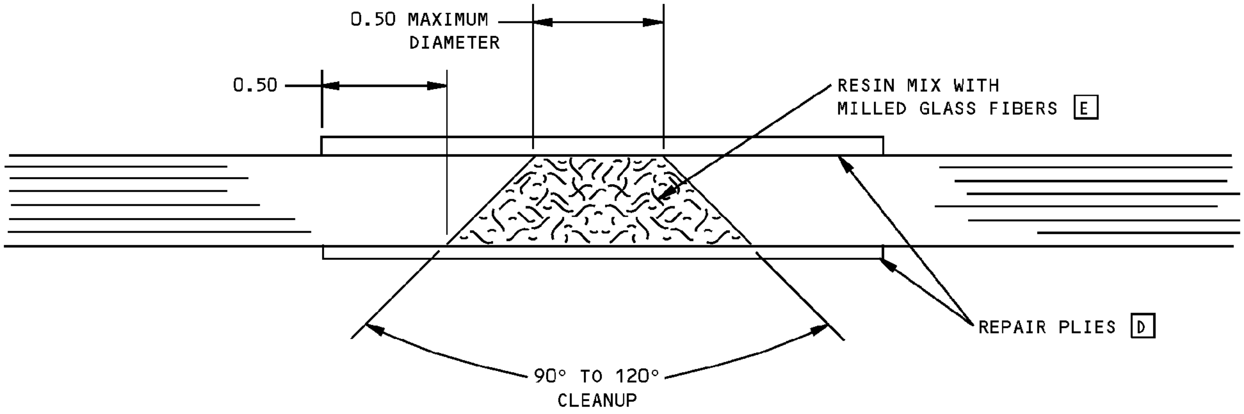
B EXTEND EXTRA PLY FAR ENOUGH SO THAT IT EXTENDS AT LEAST 1.00 INCH PAST EDGE OF DAMAGED AREA

C EXTEND EXTRA REPAIR PLY FAR ENOUGH TO PROVIDE AT LEAST 2D EDGE MARGIN

D ORIENT EXTRA REPAIR PLIES IN THE SAME DIRECTION AS THE ORIGINAL OUTER LAYER

E USE RESIN MIX 1 MIXED WITH 42% MILLED GLASS FIBERS OR BMS 5-28 TYPE 6

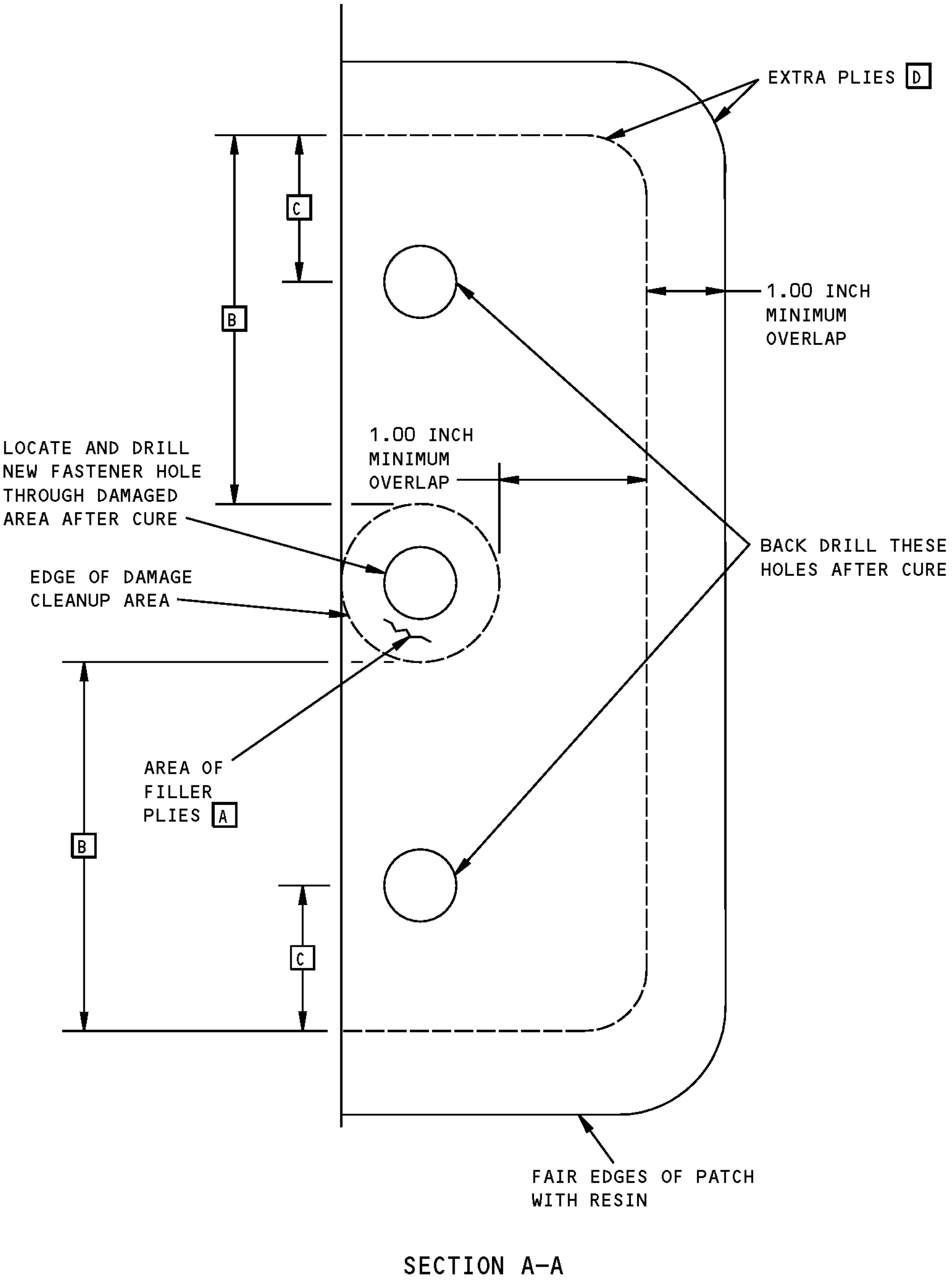
Repair of Damaged Panel Attach Hole - 150 Degrees F (66 Degrees C) Cure Wet Layup
Figure 10 (Sheet 1 of 3)



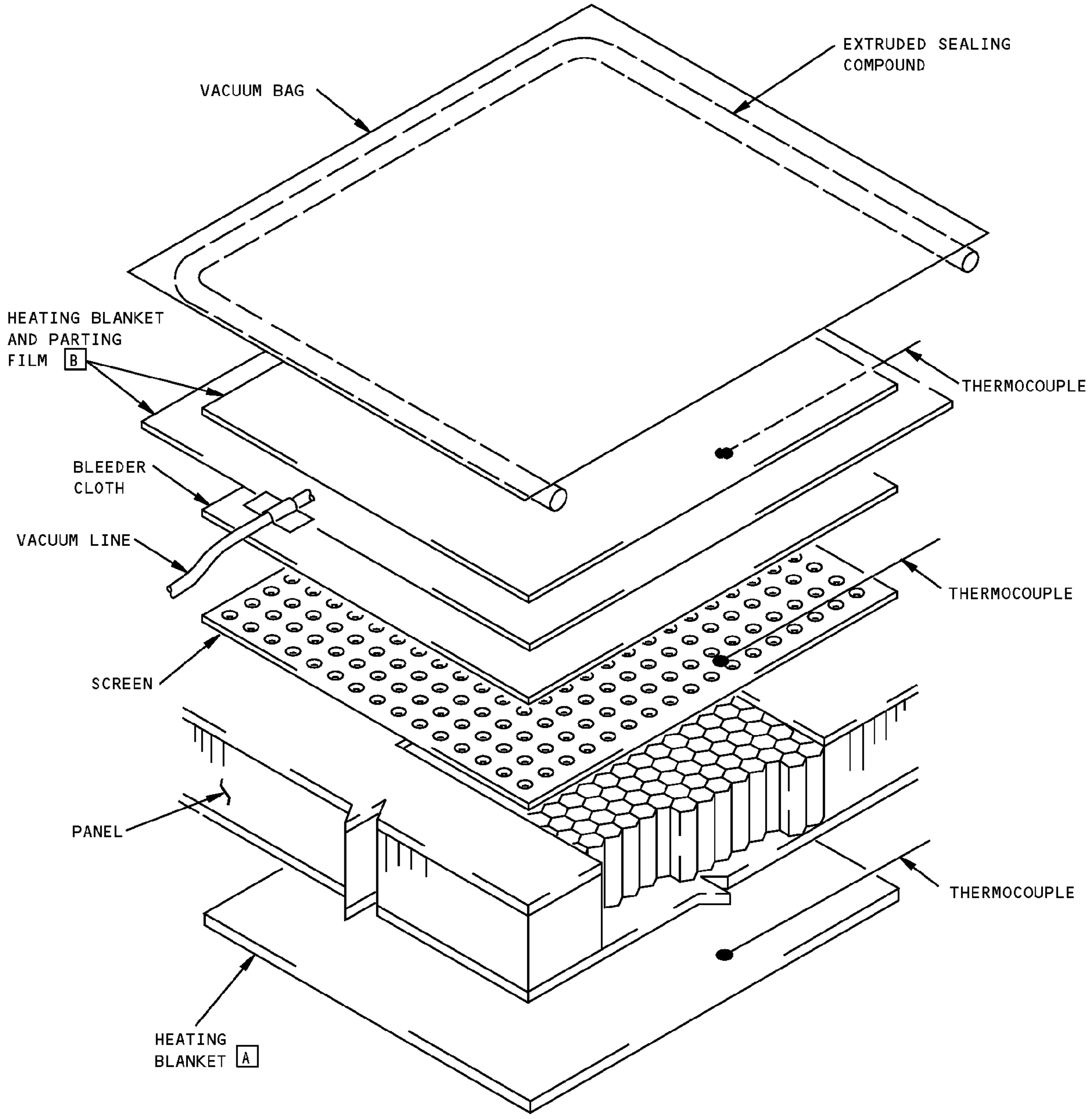
USE AS AN ALTERNATIVE TO DETAIL I

DETAIL II

Repair of Damaged Panel Attach Hole - 150 Degrees F (66 Degrees C) Cure Wet Layup
Figure 10 (Sheet 2 of 3)



Repair of Damaged Panel Attach Hole - 150 Degrees F (66 Degrees C) Cure Wet Layup
Figure 10 (Sheet 3 of 3)

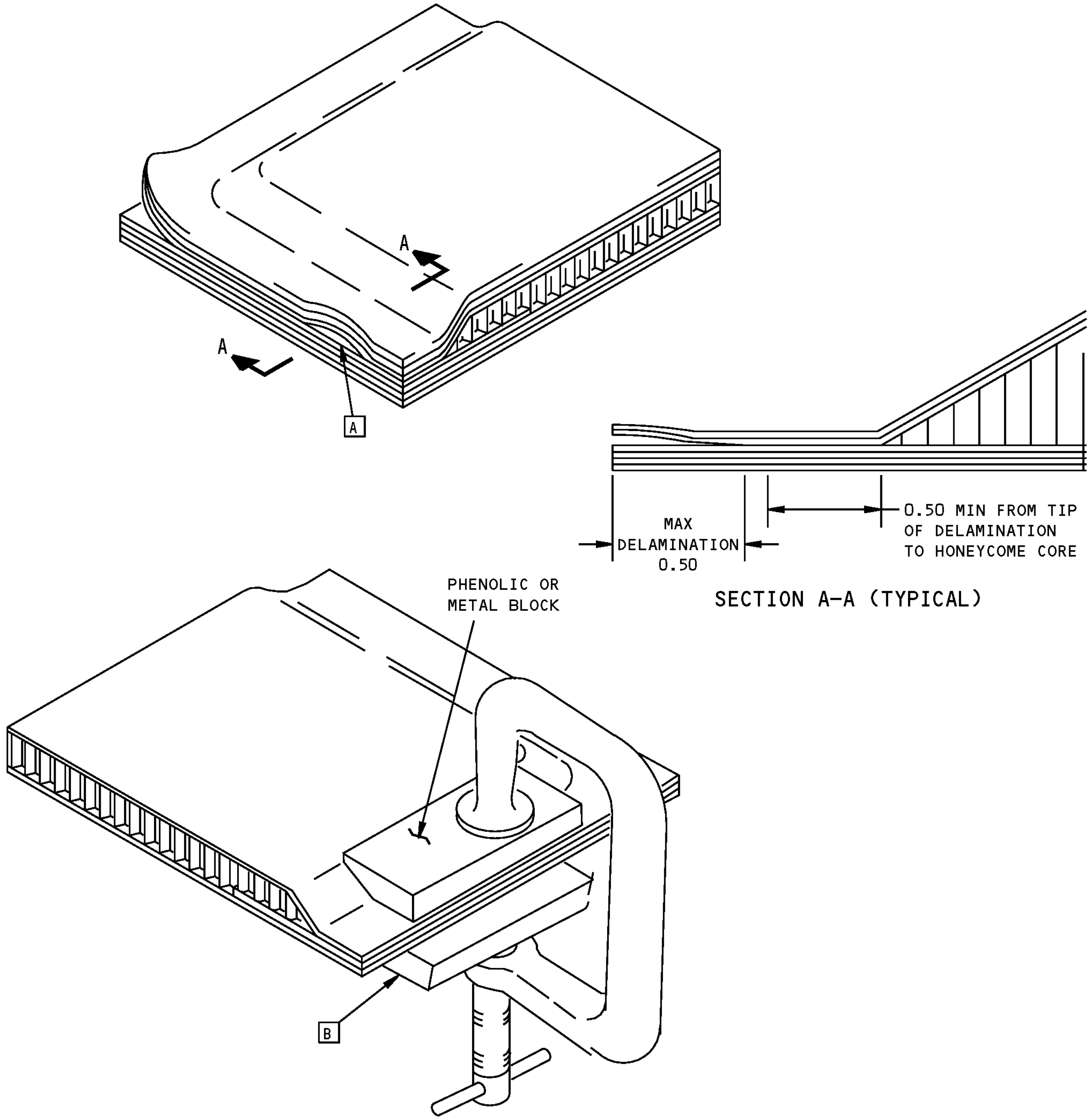


NOTES

A PREFERRED LOCATION OF HEATING BLANKET WHEN OPPOSITE FACE IS ACCESSIBLE

B ALTERNATE LOCATION OF PARTING FILM AND HEATING BLANKET WHEN OPPOSITE SIDE IS INACCESSIBLE. THIS LOCATION MAY BE USED FOR AN ADDITIONAL HEATING BLANKET TO ACCELERATE WATER REMOVAL

Water Removal From Honeycomb Sandwich
Figure 11



NOTES

- REFER TO PARAGRAPH 5.A.(2) FOR COMPLETE REPAIR INSTRUCTIONS

A FORCE RESIN MIX 1 INTO DELAMINATED AREA

B CLAMP PLIES TOGETHER AND CURE

Repair of Delaminations Between Plies of Panel Edgeband
Figure 12

ORIGINAL PLY MATERIAL		REPAIR PLY MATERIAL	REPAIR PLY SUBSTITUTE MATERIAL
GLASS FABRIC	BMS 8-79, TYPE 120	BMS 9-3, TYPE D [A]	BMS 9-3, TYPE H-2 OR H-3 [B]
	BMS 8-139, TYPE 120		
	BMS 8-169, TYPE 120		
	BMS 8-79, TYPE 1581	BMS 9-3, TYPE H-2 [A]	BMS 9-3, TYPE D OR H-3 [C] [D]
	BMS 8-139, TYPE 1581 [E]		
ARAMID FABRIC	BMS 8-218, STYLE 120	BMS 9-3, TYPE D [A] (GLASS FABRIC)	BMS 9-3, TYPE H-2 OR H-3 [B]
	BMS 8-219, STYLE 120		
	BMS 8-218, STYLE 285	BMS 9-3, TYPE H-2 OR H-3 [A] (GLASS FABRIC)	BMS 9-3, TYPE D [C]
	BMS 8-219, STYLE 285		
GRAPHITE TAPE	BMS 8-168, TYPE II, CLASS 1, ALL GRADES	BMS 9-8, TYPE I, CLASS 2. STYLE 3K-70-P [F] (GRAPHITE FABRIC)	NONE
	BMS 8-212, TYPE III, CLASS 1, ALL GRADES		
GRAPHITE FABRIC	BMS 8-168, TYPE II, CLASS 2, STYLE 3K-70-PW	BMS 9-8, TYPE I, CLASS 2, STYLE 3K-70-P	2 PLIES BMS 9-3, TYPE H-2 OR H-3
	BMS 8-212, TYPE IV, CLASS 2, STYLE 3K-70-PW		NONE
	BMS 8-258, CLASS 2, STYLE 3K-70-PW		
	BMS 8-212, TYPE III, CLASS 2, STYLE 3K-135-8H	BMS 9-8, TYPE I, CLASS 2, STYLE 3K-135-8H	2 PLIES BMS 9-8, TYPE I, CLASS 2, STYLE 3K-70-PW
ALUMINUM COATED GLASS FABRIC	BMS 8-278, TYPE I, ALL CLASSES	BMS 9-3, TYPE H-2 OR H-3 [A]	NONE
	BMS 8-278, TYPE II, ALL CLASSES	BMS 9-3, TYPE D [A]	NONE

NOTES

[A] BMS 9-3, CLASSES 2, 5 THRU 13, 16 THRU 19 CAN BE USED. CLASS 7 IS RECOMMENDED BECAUSE IT IS KNOWN TO HAVE GOOD STORAGE LIFE.

[B] USE ONE PLY OF TYPE H-2 OR H-3 IN PLACE OF TWO PLIES OF TYPE D.

[C] USE THREE PLIES OF TYPE D IN PLACE OF ONE PLY OF TYPE H-2 OR H-3.

[D] USE ONE PLY OF TYPE H-3 IN PLACE OF ONE PLY OF TYPE H-2.

[E] BMS 8-139 TYPE 1581 WAS FORMERLY TYPE 181.

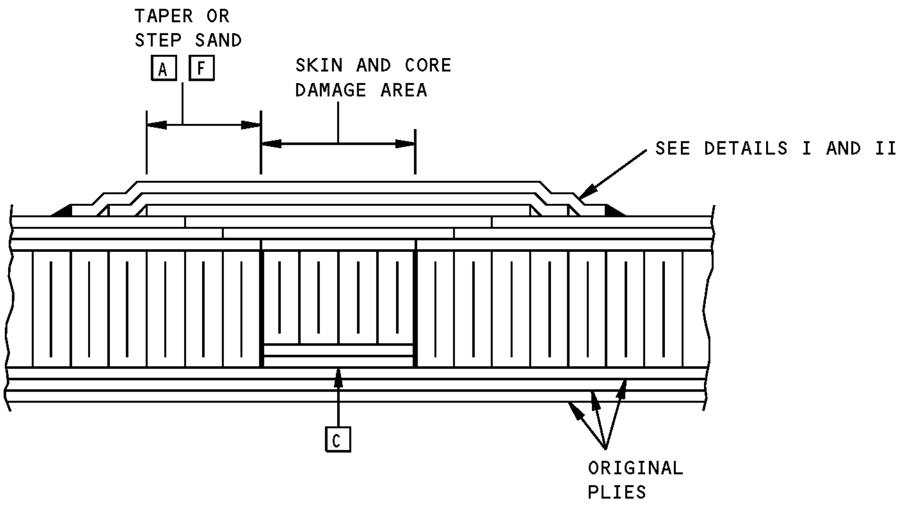
[F] FOR NUMBER OF GRAPHITE FABRIC PLIES REQUIRED, SEE TABLE II.

Repair Ply Materials
Figure 13 (Sheet 1 of 2)

NUMBER OF PLIES					
ORIGINAL PLIES (GRAPHITE TAPE)				REPAIR PLIES (GRAPHITE FABRIC)	
TAPE GRADE	ORIGINAL PLY ORIENTATION			REPAIR PLY ORIENTATION	
	0° OR 90°	+45°	-45°	0° OR 90°	±45°
95	1	---	---	1	---
	---	1	---	---	1
	---	---	1	---	1
	---	1	1	---	1
145	1	---	---	1	1
	---	1	---	---	1
	---	---	1	---	1
190	1	---	---	2	---
	---	1	---	---	2
	---	---	1	---	2

SUBSTITUTION OF GRAPHITE FABRIC FOR GRAPHITE TAPE
TABLE II

Repair Ply Materials
Figure 13 (Sheet 2 of 2)



SECTION THROUGH TYPICAL REPAIR
(WET LAYUP ONLY)

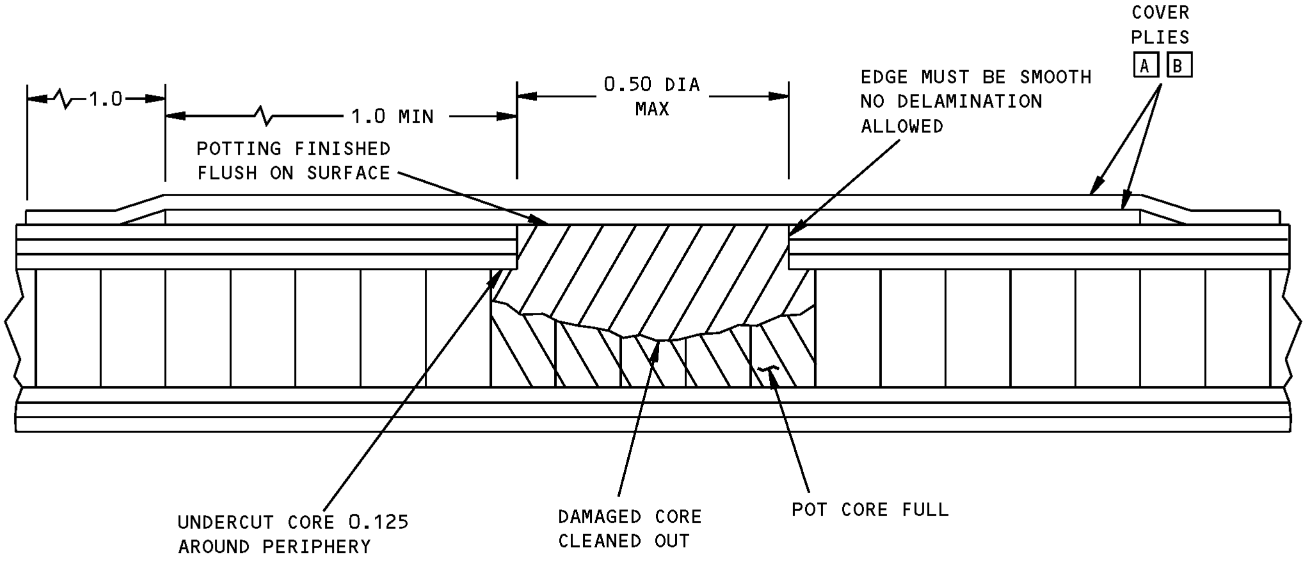
TAPER SANDED SKIN
DETAIL I

STEP SANDED SKIN
DETAIL II

NOTES

- A TAPER SAND OR STEP SAND EXISTING PLIES AROUND REPAIR AREA A MINIMUM OF 1.00 INCH FOR EACH EXISTING PLY
- B DO NOT EXPOSE OR DAMAGE FILAMENTS IN UNTAPERED AREA WHEN SANDING
- C SANDING MUST NOT EXPOSE OR DAMAGE THE FILAMENTS IN BOND PLY (PLY BONDED TO CORE)
- D EACH PLY MUST OVERLAP AT LEAST 1.00 INCH PAST EDGE OF PRECEDING PLY
- E REMOVE DAMAGED PLIES IN STEPS
- F TAPER SAND SURFACES IN AREAS OF CRITICAL AERODYNAMIC SMOOTHNESS. REFER TO 51-10-01

Sanding and Overlap Requirements
Figure 14



TYPICAL SECTION

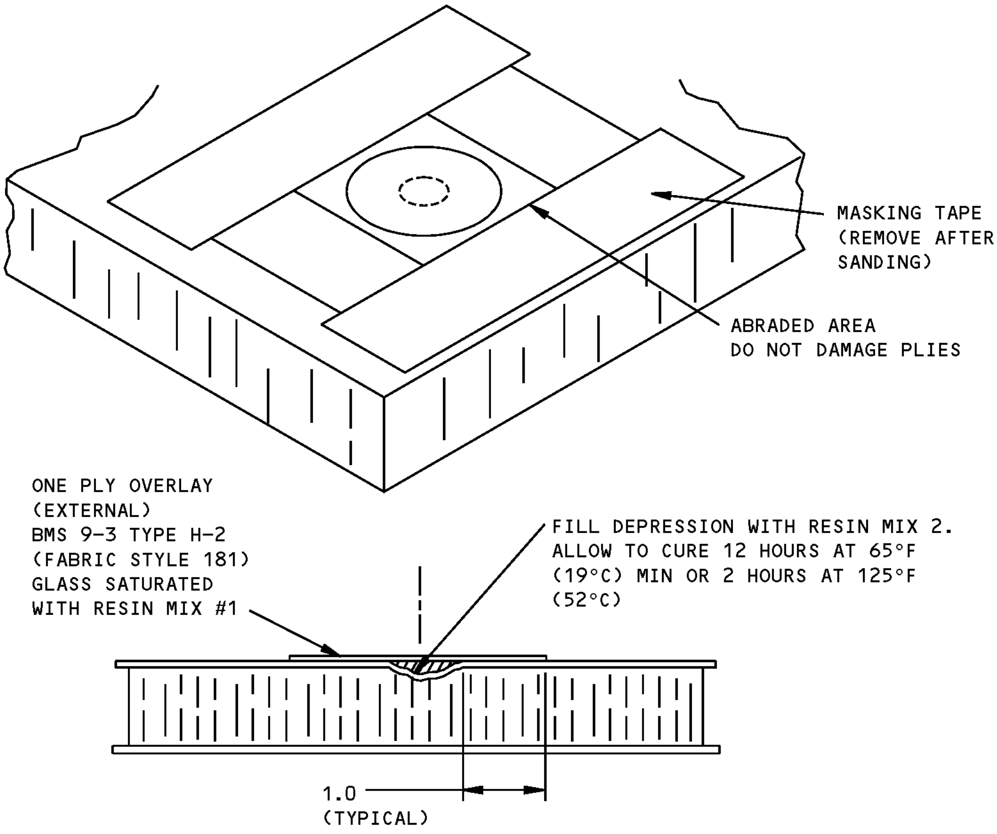
NOTES

- OVERLAP COVER PLIES AS GIVEN IN FIG. 14. DO NOT TAPER SAND OR STEP SAND ANY PLIES

$\boxed{A}$ ORIENT COVER PLIES IN THE SAME DIRECTION AS THE ORIGINAL OUTER LAYER

$\boxed{B}$ PREPARE AND APPLY TWO GLASS FABRIC COVER PLIES AS GIVEN IN PARAGRAPH 4.E, EXCEPT USE TYPE H-2 OR H-3 PLIES ONLY

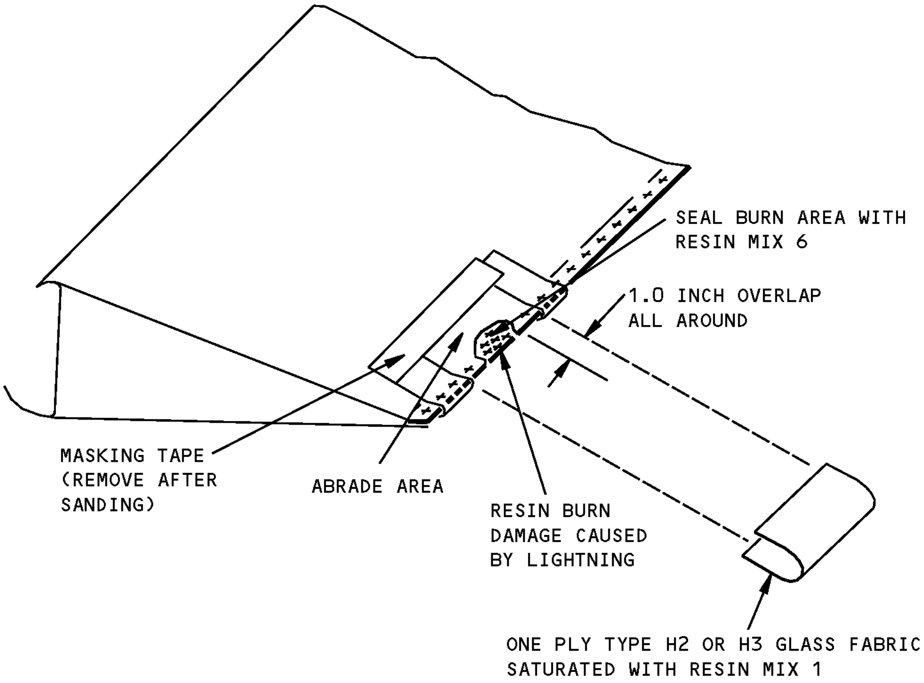
Typical Puncture Repair, 0.50 - Inch Diameter or Less - Wet Layup
Figure 15



NOTE

- REFINISH REWORKED AREAS AS GIVEN IN AMM 51-20.

Typical Repair for Dents - Wet Layup
Figure 16



Typical Repair for Lightning Damage at Trailing Edge - Wet Layup
Figure 17

COMPONENT MATERIAL	EXTRA PLY MATERIAL [B]
GRAPHITE FABRIC	GRAPHITE FABRIC, STYLE 3K-70-P
GRAPHITE/ARAMID/GLASS	GRAPHITE FABRIC, STYLE 3K-70-P [A]
ARAMID	GLASS FABRIC, TYPE H-2 OR H-3
GLASS FABRIC	GLASS FABRIC, TYPE H-2 OR H-3

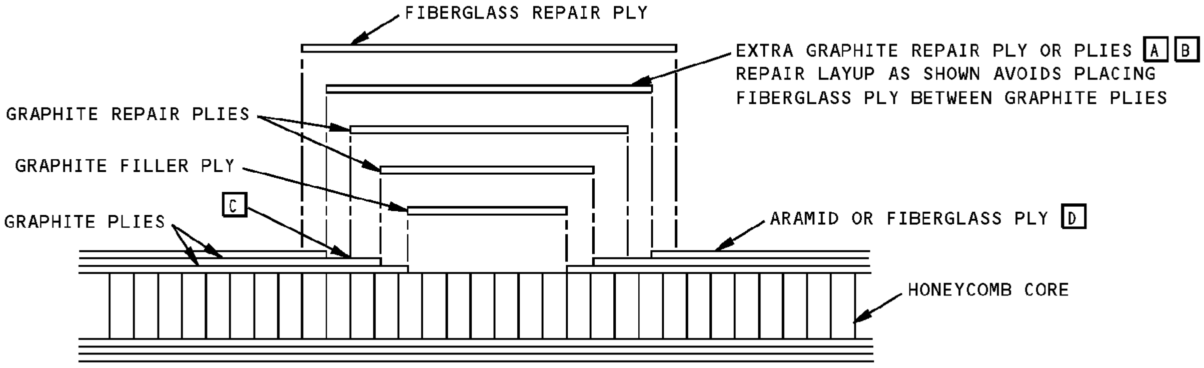
NOTES

[A] ON HYBRID PANELS, GRAPHITE EXTRA PLIES MUST BE BONDED TO GRAPHITE PLY. SEE DETAIL I

[B] THE ORIENTATIONS OF THE EXTRA REPAIR PLIES MUST REPEAT THE ORIENTATIONS OF THE EXISTING PLIES IN THE ORIGINAL LAMINATE STARTING WITH THE OUTERMOST PLY

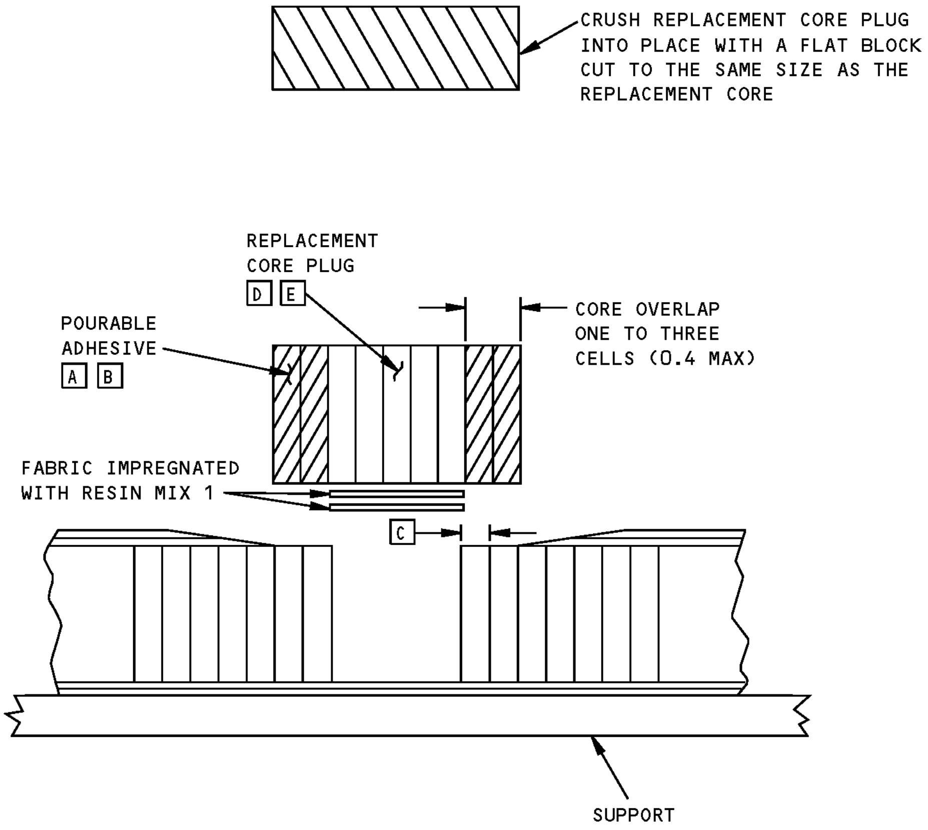
[C] WHEN EXTRA GRAPHITE REPAIR PLY OR PLIES ARE REQUIRED, THE EXISTING OUTER PLY OF ARAMID, BMS 8-278 ALUMINIZED GLASS FABRIC OR FIBERGLASS MUST BE SANDED TO ALLOW AN OVERLAP OF 1.00 FOR EACH EXTRA REPAIR PLY

[D] IF OUTER PLY CONSISTS OF BMS 8-278 ALUMINIZED GLASS FABRIC PLY OR OTHER CONDUCTIVE COATING, REFER TO SRM 51-70-04, SRM 51-70-05, OR SRM 51-70-14 AS APPLICABLE FOR REPAIR OF THE CONDUCTIVE COATING



SECTION THRU HYBRID HONEYCOMB SANDWICH
DETAIL I

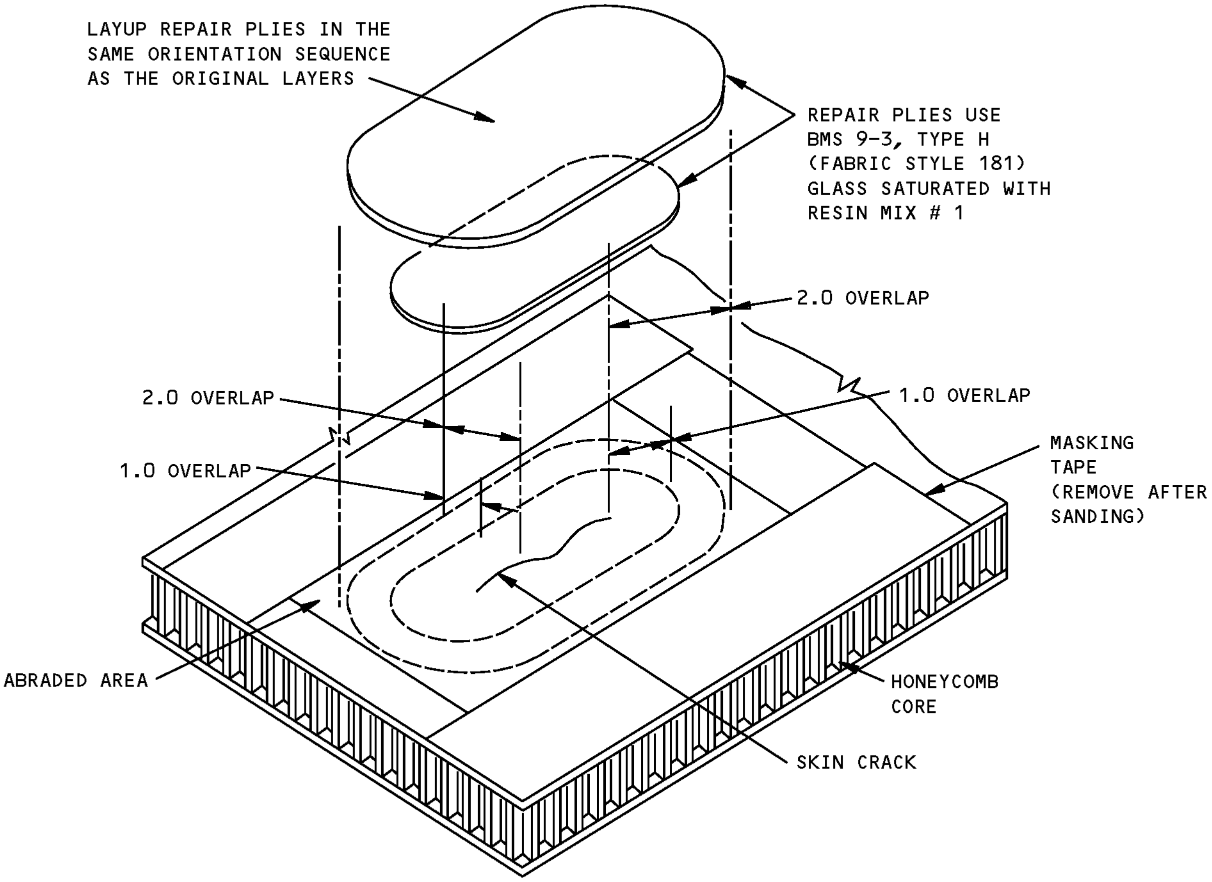
Extra Repair Ply Materials
Figure 18

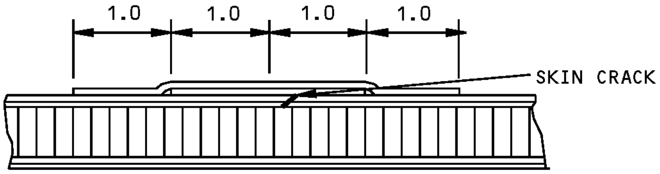


NOTES

- A BEFORE SPLICING, DIP PERIPHERY OF CORE PLUG INTO RESIN MIX 3 TO A DEPTH OF ONE TO THREE CELLS (0.4 INCH MAX)
- B AFTER SPLICING, POUR ADDITIONAL ADHESIVE INTO SPLICED CELLS
- C WHEN PREPARING REPAIR AREA LEAVE ONE TO THREE CELLS (0.4 INCH MAX) VISIBLE BETWEEN CORE REPAIR CAVITY AND SKIN TO MATCH CORE OVERLAP
- D ALIGN HONECOMB CELLS OF REPAIR PLUG WITH ORIGINAL CORE
- E REPLACEMENT CORE PLUG MUST BE MADE FROM CORE MATERIAL AT LEAST TWO GRADES DENSER THAN THE ORIGINAL CORE

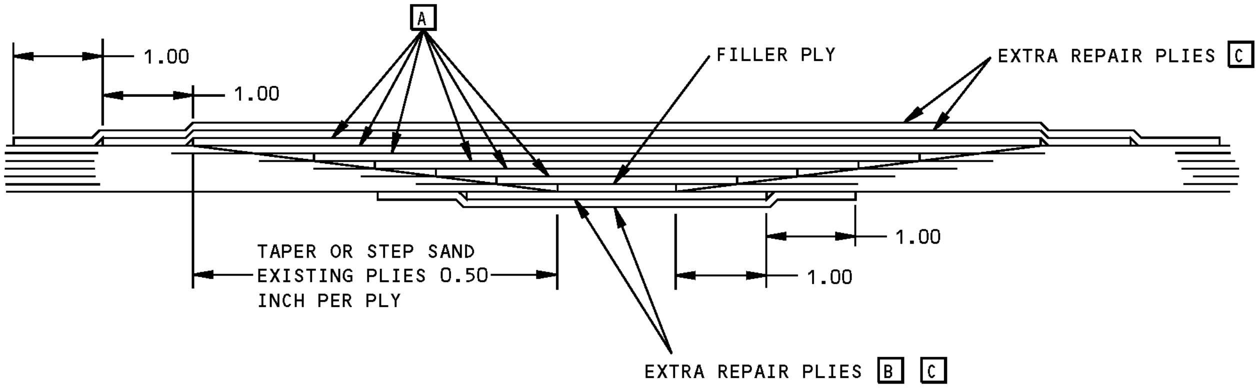
Core Crush Splicing Requirements - Wet Layup
Figure 19





SECTION VIEW

Repair of Small Damage to One Skin
Figure 20



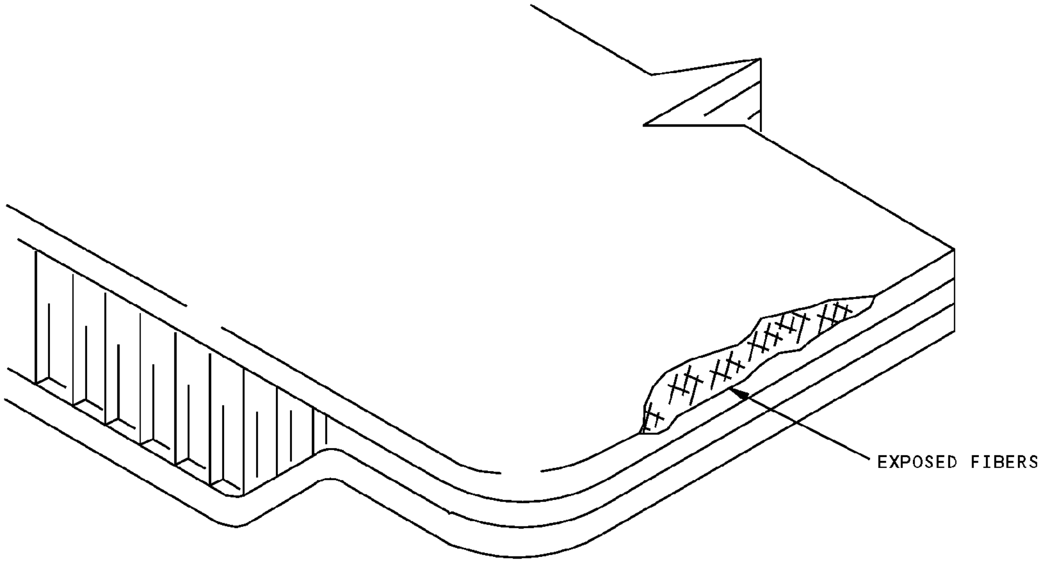
NOTES

A DETERMINE NUMBER OF PLIES, ORIENTATION, AND MATERIAL FROM SPECIFIC COMPONENT STRUCTURE IDENTIFICATION

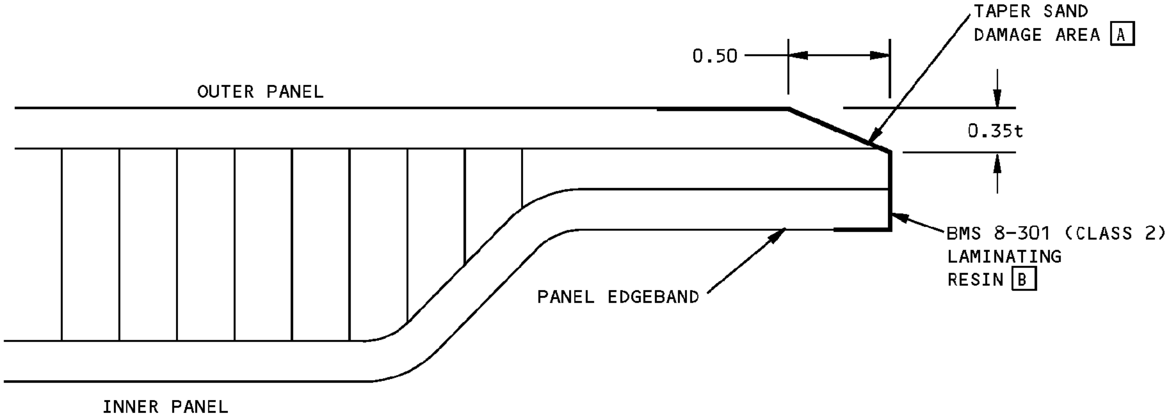
B EXTRA REPAIR PLIES AT THIS LOCATION ARE REQUIRED ONLY IF THE DAMAGE PENETRATES THIS SURFACE

C THE ORIENTATION OF THE OUTERMOST EXTRA REPAIR PLY IS TO BE THE SAME AS THE OUTERMOST PLY OF THE ORIGINAL LAMINATE. ANY OTHER EXTRA REPAIR PLY IS TO BE ORIENTED +45° TO THE EXTRA REPAIR PLY IMMEDIATELY ABOVE IT

Solid Laminate Repair
Figure 21



PANEL EDGE WITH EROSION DAMAGE



SECTION THRU PANEL

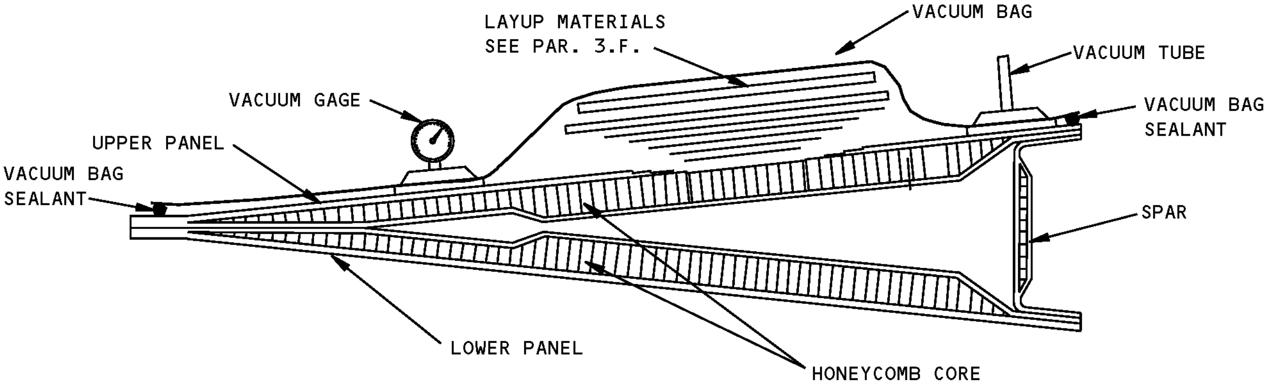
NOTES

- REFER TO 51-10-01 FOR AERODYNAMIC SMOOTHNESS REQUIREMENTS
- REPAIR IS APPLICABLE TO BOTH HONEYCOMB PANEL EDGEBANDS AND SOLID LAMINATE PANEL EDGES

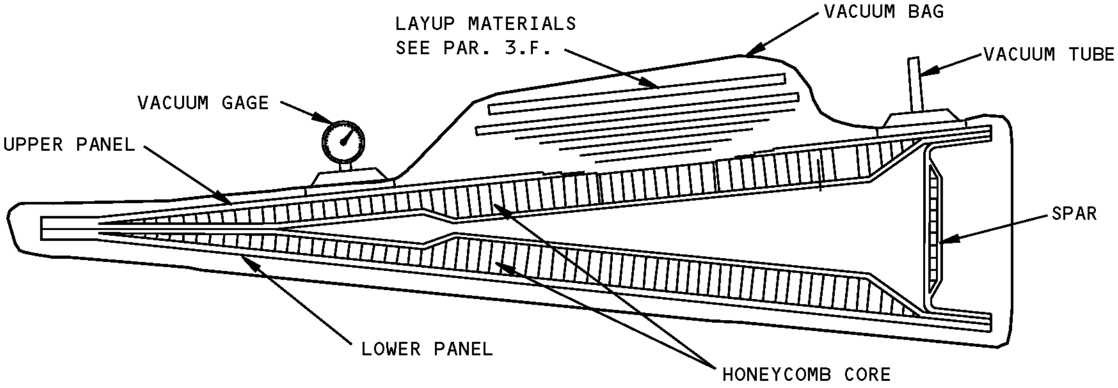
A TAPER SAND EROSION DAMAGE AREA TO 0.50 INCH MAX DISTANCE FROM PANEL EDGE AND 0.35t MAX DEPTH. t = PANEL EDGEBAND THICKNESS

B REFER TO FIGURE 1 FOR RESIN SPECIFICATIONS AND MIXING PROCEDURES

Repair of Erosion Damage to Panel Edges
Figure 22



ACCEPTABLE - VACUUM BAG SEALED TO ONE SIDE ONLY



NOT ACCEPTABLE - VACUUM BAG SEALED AROUND ENTIRE PART
MAY CAUSE ASSEMBLY DISTORTION DURING CURE CYCLE

PARTS CONSISTING OF UPPER AND LOWER PANELS [A]

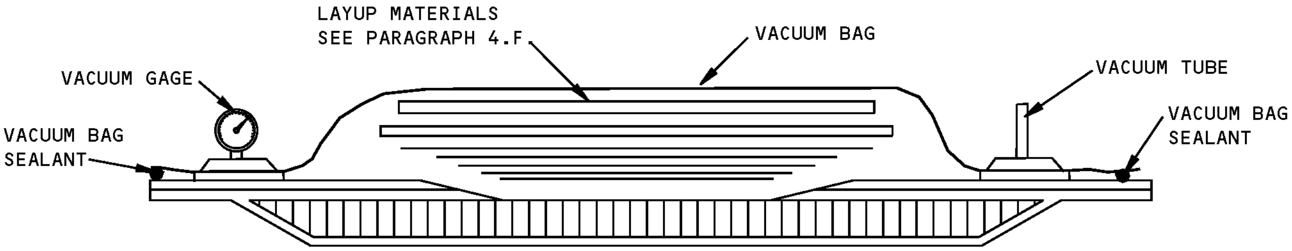
NOTES

- REFER TO PARAGRAPH 4.F. FOR LAYUP AND BAGGING PROCEDURES

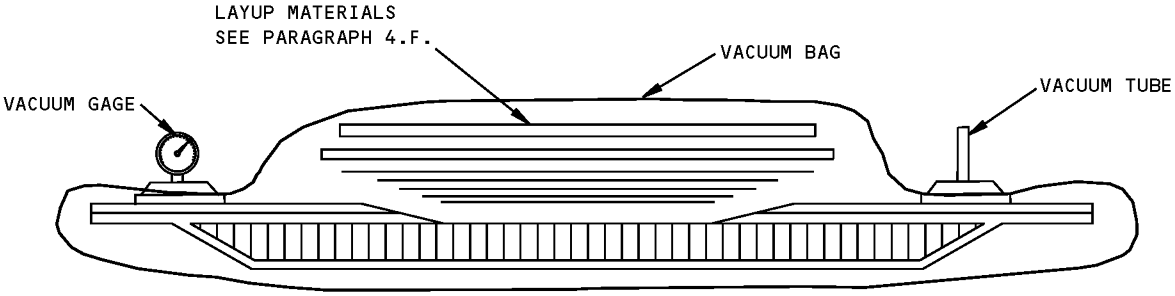
[A] THIS TYPE OF COMPONENT MUST NOT BE COMPLETELY SEALED IN A VACUUM BAG. DAMAGE TO PART WILL OCCUR. VACUUM BAG ONE SIDE OF COMPONENT ONLY

[B] THIS TYPE OF COMPONENT MAY BE COMPLETELY SEALED IN A VACUUM BAG OR MAY BE SEALED ON ONE SIDE ONLY

Vacuum Bagging Restrictions
Figure 23 (Sheet 1 of 2)



ACCEPTABLE - VACUUM BAG SEALED TO ONE SIDE ONLY



ACCEPTABLE - VACUUM BAG SEALED AROUND ENTIRE PART

PARTS CONSISTING OF ONE PANEL B

Vacuum Bagging Restrictions
Figure 23 (Sheet 2 of 2)

GENERAL - GRAPHITE AND/OR ARAMID REINFORCED EPOXY LAMINATES AND NONMETALLIC HONEYCOMB SANDWICH REPAIRS - 350°F (177°C) CURE

1. Scope

WARNING: DO NOT BREATHE CARBON FIBER DUST. MAKE SURE THAT THERE IS A GOOD FLOW OF AIR WHERE YOU DO THE WORK. USE EQUIPMENT TO HELP YOU BREATHE WHEN YOU WORK IN A CONFINED SPACE. USE A VACUUM NEAR THE SOURCE OF THE DUST TO REMOVE THE DUST FROM THE AIR. IF YOU DO NOT OBEY, YOU CAN CAUSE INJURY.

CAUTION: DO NOT LET CARBON FIBER DUST GO INTO ELECTRICAL EQUIPMENT. CARBON FIBER DUST IS ELECTRICALLY CONDUCTIVE AND IT CAN CAUSE SHORT CIRCUITS. USE A VACUUM NEAR THE SOURCE OF THE DUST TO REMOVE THE DUST FROM THE AIR. IF YOU DO NOT OBEY, YOU CAN CAUSE DAMAGE TO THE ELECTRICAL EQUIPMENT.

TO GET AN ACCEPTABLE QUALITY REPAIR, DO AS FOLLOWS:

- REFER TO THE APPLICABLE COMPONENT THAT YOU ARE GOING TO REPAIR FOR THE REPAIR LIMITS AND MATERIAL OF THE COMPONENT BEFORE YOU USE THESE REPAIR INSTRUCTIONS.
- USE THE CORRECT MATERIALS FOR THE TYPE OF COMPONENT AND REPAIR THAT IS MADE.
- USE THE MATERIALS THAT AGREE WITH THE SPECIFICATIONS IN THE SRM.
- ACCURATELY FOLLOW THE SRM PROCEDURES AT EACH STEP OF THE REPAIR. IF YOU DO NOT DO THIS, IT CAN CAUSE A REPAIR THAT IS NOT SATISFACTORY AND NOT APPROVED.

350°F (177°C) CURE REPAIRS ARE RESTRICTED TO REPAIRS IN SPECIFIC AREAS OF COMPONENTS.

350°F (177°C) TEMPERATURE MUST NOT BE APPLIED TO AREAS SEALED WITH BMS 5-95 SEALANT, UNLESS SEALANT CAN BE REPLACED FOLLOWING REPAIR.

A. This section contains repairs to components made from epoxy resin reinforced with several layers of graphite tape or fabric, aramid fabric or a combination of graphite, aramid and fiberglass (hybrids). The most common construction is a sandwich of two laminated skins separated by a nonmetallic honeycomb core. Solid laminate is used for small components, honeycomb panel edgebands and at fitting locations. This section describes repairs made using 350°F (177°C) cure materials (prepreg layup).

B. Table 1/GENERAL contains an index of subjects in Paragraphs 2 and 4.

Table 1: Index of Repair Subjects

Paragraph	Subject
Paragraph 4./GENERAL	Repair Procedures Common to Various Repairs
Paragraph 4.A./GENERAL	Determine Damage
Paragraph 4.B./GENERAL	Remove Water from Damaged Area
Paragraph 4.C./GENERAL	Remove Damage and Prepare Damaged Area
Paragraph 4.D./GENERAL	Fabricate, Clean, and Install Honeycomb Replacement Core Plug

Table 1: Index of Repair Subjects (Continued)

Paragraph	Subject
Paragraph 4.E./GENERAL	Prepare and Apply Preimpregnated (Prepreg) Repair Plies
Paragraph 4.F./GENERAL	Layup and Bagging Procedures
Paragraph 4.G./GENERAL	Cure the Repair
Paragraph 4.H./GENERAL	Refinish After Repair
Paragraph 4.I./GENERAL	Perform Post-Repair Requirements
Paragraph 5./GENERAL	Typical Repairs
Paragraph 5.A./GENERAL	Repair of Delaminations Between Plies
Paragraph 5.B./GENERAL	Repair of Puncture, 0.50-inch Diameter or Less, in Honeycomb Panel
Paragraph 5.C./GENERAL	Repair of Damage to One Skin and Honeycomb Core Using Replacement Core Plug, Punctures Greater than 0.50-inch Diameter
Paragraph 5.D./GENERAL	Repair of Large Puncture Through Internal and External Surface of Panel Including Core Damage
Paragraph 5.E./GENERAL	Replacement of Honeycomb Core on Damaged Edge of Panel
Paragraph 5.F./GENERAL	Repair of Hole through Both Skins of a Honeycomb Panel with Access Available From One Side Only
Paragraph 5.G./GENERAL	Repair of Damaged Skin Plies in Panel Edgeband
Paragraph 5.H./GENERAL	Repair of Damage and Punctures to Multiple Plies in Solid Laminate Panels
Paragraph 5.I./GENERAL	Repair of Punctures, 0.25-inch Diameter or Less, in Solid Laminate Panels
Paragraph 5.J./GENERAL	Repair of Delaminations Between Plies in Solid Laminate Panels
Paragraph 5.K./GENERAL	Repair of Damaged Panel Attach Holes in Honeycomb Panel Edgebands or Along Edges of Solid Laminate Panels
Paragraph 5.L./GENERAL	Repair of Surface Dents
Paragraph 5.M./GENERAL	Repairs to Aluminum Foil

2. General

A. This subject contains repairs to components made from 350°F (177°C) cure graphite/aramid/epoxy materials. The repairs are made using a heating blanket and preimpregnated woven fabric or tape which are cured in a vacuum bag using heat up to 350°F (177°C).

B. These repairs are permanent in nature. Once completed, and the final finish applied as given in the Maintenance Manual, the original strength will be restored.

WARNING: HEAT, FIRE, OR SPARKS CAN CAUSE AN EXPLOSION. USE EXPLOSIONPROOF EQUIPMENT WHEN PERFORMING THESE REPAIRS. NONCOMPLIANCE COULD CAUSE PERSONNEL INJURY. BREATHING VAPORS OR ALLOWING SOLVENT TO CONTACT SKIN OR EYES IS HAZARDOUS. WEAR RUBBER GLOVES, PROTECTIVE CLOTHING, AND EYE GOGGLES. IF CHEMICAL CONTACT OCCURS, WASH THOROUGHLY WITH WATER. IF CHEMICAL SHOULD SPLASH INTO EYES, FLUSH EYES WITH LARGE QUANTITIES OF WATER AND SEEK MEDICAL AID. USE MECHANICAL VENTILATION OR RESPIRATORY PROTECTION WHEN WORKING IN A CONFINED SPACE OR AREA.

(WARNING PRECEDES)

CAUTION: REPAIR MATERIALS MUST BE COMPATIBLE WITH CURE TEMPERATURE. DO NOT USE 250°F (121°C) CURE MATERIALS FOR 350°F (177°C) CURE REPAIRS. FASTENERS INSTALLED IN GRAPHITE COMPOSITE STRUCTURE MAY BE BARE OR ALUMINUM COATED TITANIUM OR CORROSION RESISTANT STEEL. CADMIUM PLATED CORROSION RESISTANT STEEL MAY ALSO BE USED. ALUMINUM OR ALLOY STEEL FASTENERS ARE NOT ALLOWED IN GRAPHITE COMPOSITE STRUCTURES. WHEN REINSTALLING ALUMINUM FITTINGS ON GRAPHITE COMPOSITE STRUCTURE, ENSURE THAT THE ORIGINAL CORROSION PROTECTIVE TREATMENT IS MAINTAINED. INSTALL FITTINGS WITH FAYING SURFACE SEAL USING BMS 5-26 IN FUEL TANK AREAS OR BMS 5-95 IN ALL OTHER AREAS. SOME REPAIRS MAY REQUIRE CURE TEMPERATURES THAT ARE THE SAME AS THAT USED AT COMPONENT MANUFACTURE. CARE MUST BE TAKEN TO PROPERLY SUPPORT THE AREA ADJACENT TO A REPAIR TO PREVENT DELAMINATION OF UNDAMAGED AREAS. EXTENDING VACUUM BAGGING A MINIMUM OF 6.0 INCHES BEYOND THE REPAIR AND THE USE OF SUPPORT STRUCTURE, WHERE REQUIRED ARE RECOMMENDED.

C. Specific allowable damage, repair limitations, and repair data can be found in the chapter/section/subject associated with each structural component.

D. See Figure 1/GENERAL for resin mixes and potting compound data.

E. Refer to 51-30-03, GENERAL for source of repair materials.

F. Refer to 51-10-01, GENERAL for aerodynamic smoothness requirements.

G. Repair Tedlar as given in Paragraph 4.H.(2)/GENERAL

H. Restore aluminum flame spray as given in 51-70-14, GENERAL.

I. Repair aluminum foil where damage to the foil does not extend into the underlying plies as given in 51-70-14, GENERAL.

J. Refer to Paragraph 5.M./GENERAL for repair of parts having an outer layer of aluminum foil.

K. Refer to 51-70-02, GENERAL for locations of principal composite components.

CAUTION: REPAIRS MUST NOT COVER EXISTING DRAIN HOLES IN PANELS.

L. If the repair covers a drain hole, drill through the repair at existing location.

NOTE: Drain holes are usually 0.375 diameter. Drilling holes through graphite/aramid structure require special technique and equipment. Refer to 51-70-16, GENERAL.

M. Material used to repair a component shall be of the same type, class and grade and must be oriented in the same manner as original.

N. Store rolls or precut kits of prepreg and adhesive material below 10°F (-12°C) in sealed moisture proof bags. An identification label must accompany the material inside the bag, with the following information: BMS Type, Class, Grade, Supplier name, batch number, roll number, prepreg lot number and date of kit preparation. Record storage time in and out of refrigeration.

O. Repair Precautions

(1) Keep the repair area well ventilated. Protect prepreg and adhesives from excessive exposure to moisture, dust, oil mist and other particulate matter detrimental to adhesion.

(2) Avoid excessive breathing of fumes from prepreg, fabric or tape, adhesive resin mix and cleaning fluids.

(3) Avoid resin contact with eyes, skin or clothing. Wear protective gloves and clothing when handling prepreg material, adhesive resin mix and cleaning fluids.

(4) Wear approved dust mask and safety glasses when cutting, sanding and abrasive blasting graphite/aramid/epoxy structure. Whenever possible use vacuum pickup when performing these operations.

(5) The solvents and finishes are flammable. Keep away from heat and flame.

WARNING: HEAT, FIRE OR SPARKS CAN CAUSE AN EXPLOSION. USE EXPLOSIONPROOF EQUIPMENT WHEN PERFORMING THESE REPAIRS. NONCOMPLIANCE COULD CAUSE INJURY TO PERSONNEL.

P. Equipment

(1) Vacuum systems shall be capable of maintaining a minimum of 22 inches of mercury.

(2) Refrigerated storage below 10°F (-22°C) shall be provided for storing prepreg, adhesive and peel ply materials.

Q. Repair Preparation

(1) From the material identification section and/or Boeing drawings, identify the part material and the configuration of the damage area such as:

(a) Prepreg type, class, style or grade and cure system.

(b) Number of plies, orientation and stacking sequence.

(c) Adhesive system.

(d) Type of core, core splicing adhesive and potting compound applicable for the sandwich structure.

3. References

Reference	Title
51-10-01, GENERAL	Aerodynamic Smoothness Requirements
51-30-03, GENERAL	Nonmetallic Materials
51-60-00, GENERAL	Control Surface Balance Moment Determination
51-70-02, GENERAL	Locations of the Principal Composite Components
51-70-03, GENERAL	Graphite and/or Aramid Reinforced Epoxy Laminates and Nonmetallic Honeycomb Sandwich Repairs - Room Temperature – 150°F (66°C) Cure (Wet Layup)
51-70-14, GENERAL	Allowable Damage and Repair of Flame-Sprayed Aluminum Coatings, Aluminum-Coated Glass Fabric (BMS 8-278), Aluminum Foil (BMS 8-289), and Expanded Aluminum Foil (BMS 8-336)
51-70-16, GENERAL	Hole Drilling and Machining of Composite Structures
51-70-17, GENERAL	Repairs to 250°F (121°C) and 350°F (177°C) Cured Graphite/Aramid/Fiberglass Reinforced Epoxy Laminates and Nonmetallic Honeycomb Sandwich Structure - 200°F (93°C) to 230°F (110°C) Wet Layup Repair Method
AMM 51-41-00/201	Aircraft Maintenance Manual
DOCUMENT D6-49327	Certification of Autoclaves for Metal Bonding and Curing of Composite Structure
DOCUMENT D6-56273	Qualification of Heat Blankets for Hot Bonding
NDT Part 1, 51-01-01	Inspection of Repairs to Composite Structures
SOPM 20-30-99	Solvents For Final Cleaning of Composites Before Structural Bonding (Series 99)

4. Repair Procedures Common to Various Repairs

A. Determine Damage

CAUTION: CHEMICAL PAINT STRIPPERS WILL ATTACK RESIN SYSTEMS, AND SHOULD NOT BE USED TO REMOVE PAINT BEFORE MAKING DAMAGE EVALUATIONS.

(1) Examine visually for extent of damage.

(2) Check panel in vicinity of damage for entry of water, oil, fuel, dirt or other contamination. Water can be detected by radiographic methods.

(3) Check for delamination around the damage.

NOTE: Post repair inspection is recommended. Examples of inspection procedures are given in NDT Part 1, 51-01-01.

CAUTION: YOU MUST REMOVE ALL LIQUIDS FROM THE AREA OF THE COMPONENT WHICH WILL BE HEATED. IF YOU DO NOT OBEY, DAMAGE TO THE COMPONENT CAN OCCUR.

B. Remove Water From Damaged Area

NOTE: If the damage is less than the thickness of the skin plies and there is no water in the honeycomb core, use the procedure given in Paragraph 4.B.(2)/GENERAL to remove the water from the skin plies.

(1) Remove water from honeycomb sandwich (Figure 11/GENERAL).

(a) Remove damaged skin plies to open up honeycomb area in the damaged area. Remove standing water using vacuum and oil-free compressed air.

(b) Sand the core to remove the adhesive. Removal of adhesive fillets on core is not required.

(c) Apply a fiberglass or metal fine mesh screen over the exposed core.

(d) Apply a thermocouple to the center of the screen.

(e) Apply a layer of glass fabric bleeder cloth over the screen and hold in place with masking tape.

(f) Place a vacuum line on the edge of the bleeder cloth and hold in place with masking tape.

(g) If the far side is accessible, apply thermocouple and heating blanket to the far side of the honeycomb sandwich panel.

NOTE: If the far side is accessible, it is acceptable to heat the area using a heating blanket only on the far side. An additional heating blanket and vacuum application may be used on the near side at the location shown in Figure 11/GENERAL to accelerate water removal. If the far side is inaccessible, use of a heating blanket on the near side is required.

(h) When the far side is inaccessible or when using an additional heating blanket, place the heating blanket over the bleeder cloth on the near side.

(i) Place extruded sealing compound around the entire area and seal the area with vacuum bag material.

(j) Evacuate the layup to a vacuum of 22 inches of mercury minimum.

(k) Heat the area for 1 hour minimum at 150°F (66°C) to 170°F (77°C). The rate of temperature rise must not exceed 5°F (3°C) per minute.

(l) Remove layup materials and proceed with repair procedure.

(2) Remove water from solid laminate.

(a) Remove damage and/or delamination. Remove standing water using vacuum and oil-free compressed air.

(b) Heat the area for 1 hour minimum at 150°F (66°C) to 170°F (77°C). The rate of temperature rise must not exceed 5°F (3°C) per minute.

CAUTION: REMOVE (FOR ALL TYPES OF CURE) OR ISOLATE (HEAT BLANKET ONLY) ALUMINUM STRUCTURE TO PREVENT LOSS OF STRENGTH IN THE ALUMINUM PARTS. ALL ALUMINUM ALLOYS, EXCEPT 2219, MUST BE KEPT BELOW 200°F (93°C). ALUMINUM 2219 CAN BE KEPT UP TO 400°F (204°C). REMOVE SEALANTS, PAINTS AND PRIMERS IN THOSE AREAS WHERE THE TEMPERATUE COULD REACH ABOVE THE MAXIMUM ALLOWABLE TEMPERATURE. REFER TO SRM 51 20-01 FOR THE MAXIMUM ALLOWABLE TEMPERATURES.

C. Remove Damage and Prepare Damaged Area

(1) Damage removal.

(a) Trim out the damaged lamination to a smooth shape with rounded corners, or a circular or oval shape. Take care not to damage the undamaged plies, core or surrounding material.

NOTE: Remove only damaged plies, damaged doublers and damaged fillers.

(b) When the core is also damaged, remove the core by trimming to the same outline as the skin. For crush splice repairs (Paragraph 4.D./GENERAL) leave one to three core cells (0.4 maximum) visible between core cavity and skin (Figure 16/GENERAL). The core area removed should extend at least 0.5 further than visible core damage limits. Take care to avoid cutting into an undamaged skin on the opposite side. In cores greater than 1.0 thick, partially remove core (at least 0.5 deep) sufficient to clean up damage.

(c) In areas where contamination cannot be removed by cleaning or drying as given in Paragraph 4.B./GENERAL, remove the contaminated structure along with the other damage.

(d) When opposite inner skin is also damaged, trim out the damage to a smooth shape as described in Paragraph 4.C.(1)(a)/GENERAL.

(e) When core is removed from inner surface of opposite skin, carefully smooth core down to adhesive film.

(f) Inspect cut out area to ensure that all damage has been removed.

CAUTION: SANDING FOR ADHESION OR FINISH REMOVAL MUST NOT EXPOSE OR DAMAGE FILAMENTS IN THE UNTAPERED SURFACE REPAIR AREA. SANDING MUST NOT EXPOSE OR DAMAGE FILAMENTS IN EACH PLY WHEN STEP SANDING OR IN THE PLY BONDED TO THE CORE (FIGURE 9/GENERAL, FIGURE 13/GENERAL,). LOSS OF STRUCTURAL STRENGTH OF THE COMPONENT WILL OCCUR IF THESE CAUTIONS ARE NOT OBSERVED. DO NOT USE PAINT STRIPPERS OR MECHANICAL BLASTING FOR THE REMOVAL OF FINISH. DAMAGE TO THE ADHESIVE RESIN SYSTEM WILL OCCUR.

(2) Preparation of damaged area (Figure 13/GENERAL).

(a) Determine the number of plies that have been cut. Mask off the area around the cutout allowing 0.5 minimum overlap for each ply replacement, plus 0.5 extra for each extra repair ply to ensure that the existing top ply is completely covered by the repair.

NOTE: Where the number of plies is not apparent, refer to the applicable component structure identification or engineering drawing. If the damaged area has a layer of aluminum foil, cut back the foil enough to allow a new foil layer to have a 1.0 minimum overlap beyond the outermost repair ply (Figure 17/GENERAL).

WARNING: SANDING GIVES OFF A FINE DUST THAT MAY CAUSE SKIN IRRITATIONS. BREATHING OF AN EXCESSIVE AMOUNT OF THIS DUST MAY BE INJURIOUS. OBSERVE PRECAUTIONS FOR SKIN AND RESPIRATION PROTECTION. EXPLOSIONPROOF EQUIPMENT MUST BE USED WHERE THE POSSIBILITY OF VAPOR IGNITION EXISTS. NONCOMPLIANCE COULD CAUSE PERSONNEL INJURY.

(b) Internal surface of panel (nonaerodynamic surface) and noncritical aerodynamic surfaces.

1) Remove the paint finish or Tedlar film in the masked off area using No. 240 or finer Scotch-Brite abrasive, or No. 150 or finer sandpaper.

2) If the damage area has a layer of aluminum foil, cut back the foil enough to allow a new foil layer to be at least 1.25 larger all around than the largest repair ply (Figure 17/GENERAL).

a) Strip the aluminum foil by peeling or abrading. Do not damage underlying composite fibers.

b) Carefully abrade to remove the primer on the aluminum foil to a border at least 1.25 larger all around than the repair area that was just stripped of foil. Spotty traces of primer covering up to 10 percent of border area are acceptable.

c) Taper sand or step sand each ply as given in Item 3) below.

d) Lightly abrade and solvent wipe the primer on the aluminum foil to a border 1.0 larger all around than the 1.25 band of foil that was exposed by primer removal.

e) Alodine treat the foil that was exposed by primer removal in the 1.25 border area.

3) Taper sand each ply or simply abrade the surface around the cleaned up damage a minimum of 0.5 per ply. Refer to Figure 13/GENERAL.

4) An optional procedure for two or three ply laminate face sheets is to fill the cleaned up damage area flush with the original surface using filler plies during the repair layup. The repair plies are then installed directly on the resulting smooth surface of the repair area.

5) Abrade surfaces around repair using No. 150 or finer Scotch-Brite abrasive.

(c) External surface of panel (critical aerodynamic surfaces).

1) Taper sand a uniform taper around the cleaned up damage using No. 180 sandpaper. The taper is to be over a minimum distance of 0.5 for each existing ply of the laminate.

Step sanding is optional to taper sanding on sandwich structure except in areas of critical aerodynamic smoothness. See 51-10-01 for locations of areas of critical aerodynamic smoothness. Always taper sand on solid laminate structures.

NOTE: For sanding, use a flexible disk sander, a belt sander, a rotating pad sander, or sand by hand.

2) Remove exterior finishes, including enamel finish and conductive coating from the surface of the 0.5 border using No. 150 or finer sandpaper.

(d) Edgeband of panel.

1) Taper sand panel edgeband according to Paragraph 4.C.(2)(c)/GENERAL

NOTE: Edgeband is the solid laminate around the outer periphery of the honeycomb panel.

(e) Cleaning of repair area.

1) Remove all sanding dust by applying oil-free compressed air and use a vacuum cleaner.

WARNING: BREATHING VAPORS OR ALLOWING SOLVENT TO CONTACT SKIN OR EYES IS HAZARDOUS. HEAT, FIRE OR SPARKS CAN CAUSE AN EXPLOSION. USE MECHANICAL VENTILATION OR RESPIRATORY PROTECTION WHEN WORKING IN A CONFINED SPACE OR AREA. AVOID CONTACT WITH SKIN, EYES AND CLOTHING. WEAR EYE PROTECTION. KEEP AWAY FROM SOURCES OF HEAT, FIRE OR SPARKS.

CAUTION: DO NOT IMMERSE PARTS IN SOLVENT OR ALLOW STANDING SOLVENT ON PART. DAMAGE TO PART WILL OCCUR.

2) Wipe surfaces with a clean cloth moistened with solvent, Series 99 (AMM/ SOPM 20-30-99). Allow solvent to evaporate before proceeding with the repair.

D. Fabricate, Clean, and Install Honeycomb Replacement Core Plug.

(1) Fabricate core plug.

(a) Fabricate core plug from core called out on engineering drawing. Refer to specific component structural identification section to determine type of core called out on engineering drawing.

(b) For butt splicing, the honeycomb core plug should fit flush with original core and with ribbon direction the same as in original core. Trim the replacement core up to 0.05 of an inch smaller then the cutout. The replacement core is to fit snugly in the cutout after it is wrapped with the foaming adhesive.

(c) For crush splicing, the honeycomb core plug should be made one to three cells (0.4 maximum) larger than the repair cavity (Figure 16/GENERAL). The core plug must be made from core material at least two grades denser than the original core.

(d) Trim core plug to full or partial depth of original core (Paragraph 4.C.(1)/GENERAL(b)) (Figure 2/GENERAL).

NOTE: When applicable, depth of core plug should allow for shrinkage during cure and for thickness of extra plies of fabric cloth and adhesive film between core plug and undamaged core or skin (Figure 2/GENERAL, Figure 8/GENERAL
Figure 8/GENERAL
Figure 13/GENERAL).

(2) Clean core plug.

WARNING: BREATHING VAPORS OR ALLOWING SOLVENT TO CONTACT SKIN OR EYES IS HAZARDOUS. HEAT, FIRE OR SPARKS CAN CAUSE AN EXPLOSION. USE MECHANICAL VENTILATION OR RESPIRATORY PROTECTION WHEN WORKING IN A CONFINED SPACE OR AREA. AVOID CONTACT WITH SKIN, EYES AND CLOTHING. WEAR EYE PROTECTION. KEEP AWAY FROM SOURCES OF HEAT, FIRE OR SPARKS.

CAUTION: DO NOT EXCEED IMMERSION CRITERIA GIVEN IN PARAGRAPH 4.D.(2)(A)/GENERAL DAMAGE TO CORE MATERIAL WILL OCCUR.

DO NOT IMMERSE PARTS IN SOLVENT OR ALLOW STANDING SOLVENT ON PART. DAMAGE TO PART WILL OCCUR.

(a) Clean visually contaminated core by dipping (a maximum of four times) in an MEK or acetone bath for 60 seconds.

(b) Locally contaminated areas can be washed with MIBK, MEK, or Acetone.

(c) The core must be completely dry, clean, and free of evidence of solvents before installation.

CAUTION: WHEN HANDLING ADHESIVE FILM WEAR CLEAN WHITE GLOVES TO PREVENT CONTAMINATION. DO NOT TOUCH THE ADHESIVE FILM WITH BARE HANDS OR OTHER PARTS OF THE BODY. DO NOT FOLD, STRETCH OR OTHERWISE THIN THE ADHESIVE FILM. BONDING OF THE REPAIRED ASSEMBLY MUST BE COMPLETED WITHIN 48 HOURS AFTER THE ADHESIVE HAS BEEN REMOVED FROM REFRIGERATED STORAGE. QUALITY OF THE ADHESIVE WILL BE REDUCED AFTER THIS TIME LIMIT.

(3) Install core plug (Figure 2/GENERAL, Figure 3/GENERAL, Figure 6/GENERAL, Figure 7/GENERAL, Figure 8/GENERAL, Figure 13/GENERAL, typical).

NOTE: Most of the materials used in this procedure have limited life and require controlled storage conditions. Refer to the applicable material specifications for the maximum time out of the controlled storage and for the uncontrolled storage conditions. Before opening the adhesive film wrapper, condition refrigerated adhesives to room temperature until moisture no longer condenses on the wrapper. During use, suspend the film roll of adhesive horizontally through its axis free from other rolls or objects.

(a) For partial core replacement, cut two pieces of BMS 5-154 grade 03 or 05 adhesive film and one piece of 120 fiberglass prepreg fabric to fit the repair hole. Place in position as shown in Figure 2/GENERAL, Section A-A.

(b) For full depth core replacement, where damage does not extend through both skins, trim a piece of BMS 5-154, grade 05 adhesive film to fit repair hole. Place on the inside surface of the undamaged skin (Figure 2/GENERAL, Figure 3/GENERAL, Figure 7/GENERAL, and Figure 13/GENERAL).

(c) If both skins are damaged, tape a metal caul plate (such as 0.032 thick aluminum) against the exterior surface of the far side skin and repair as for damage to one skin only. Repair the far side skin in a subsequent repair cycle.

(d) For butt splicing, wrap the edges of the core plug with BMS 5-90, Type III, Class 1, Grade 50 or BMS 5-90, Type IV foaming adhesive and install in the repair cavity. Align the honeycomb ribbon with the original core ribbon direction.

(e) For crush splicing, prepare and install the core plug as given in Figure 16/GENERAL. Align the honeycomb core ribbon with the original core ribbon direction.

(f) Put the layup materials and equipment in place as given in Figure 3 (Sheet 2).

1) If the damage extends through both face skins, vacuum bag both sides of the panel (or the entire part) using the layup shown in Figure 3 (Sheet 2).

2) If the replacement core plug is less than or equal to 0.5 thick, use the heating blanket on the near side and locate at least two separate thermocouples on the panel surface at the bondline.

3) If the replacement core plug is greater than 0.5 thick and both sides are accessible, use heating blankets on both sides. Locate at least two separate thermocouples on the near side at the bondline and one on the far side corresponding to the center of the repair.

4) If the replacement core plug is greater than 0.5 thick and only one side is accessible, use the heating blanket on the near side and put at least two separate thermocouples into the repair hole so the thermocouples touch the repair materials at the bottom of the repair hole.

NOTE: The ends of these thermocouples will be cured into the adhesive. Cut the thermocouples leaving the embedded ends behind before applying the repair plies. Only the portion of the thermocouple embedded in the core can be left in the repair. The thermocouples cannot come between the repair plies and the sanded surfaces of the original plies.

(g) Evacuate the repair area to a vacuum of 22 inches of mercury minimum.

(h) Cure a minimum of 120 minutes at 345 to 365°F (174 to 185°C) (Figure 14/GENERAL).

(i) Allow the repair area to cool under vacuum until the temperature of the repair area is 125°F (52°C) or less. Then release restraints (if applicable) and remove layup materials and equipment.

(j) Sand core plug approximately flush with surrounding material, making allowance for film adhesive and slight core crush during cure.

(k) Vacuum to remove sanding residue from core cells.

NOTE: The core plug and the repair plies can be cured at the same time if the temperature can be adequately monitored by thermocouples placed on the outside surfaces of the panel (refer to Paragraph 3.D.(3)f)2) thru 4)). If the thermocouples must be embedded in the repair core adhesive, then the core plug must be cured separately to avoid curing the thermocouple between the repair plies and the sanded surface of the original plies.

CAUTION: DO NOT CURE MORE THAN TEN (10) PLIES DURING ONE CURE CYCLE FOR HEAT BLANKET AND OVEN CURES. IF THE REPAIR HAS MORE THAN 10 PLIES, DIVIDE THE REPAIR PLIES EVENLY INTO MULTIPLE CURE CYCLES. IF YOU DO NOT OBEY, POROSITY AND BULGES CAN OCCUR AND THE SUBSEQUENT REPAIR WILL BE UNSATISFACTORY. USE OF PRECURED PATCHES IS NOT RECOMMENDED. PRECURED PATCHES BONDED TO THE STRUCTURE UNDER VACUUM PRESSURE ONLY AND LARGE PATCHES BONDED TO CONTOURED SURFACES CAN RESULT IN POROUS OR NONCONTINUOUS BONDLINES. THE PREIMPREGNATED MATERIAL AND ADHESIVE MUST REMAIN FREE OF CONTAMINATION DURING CUTTING AND HANDLING. WEAR CLEAN WHITE GLOVES WHEN HANDLING.

E. Prepare and Apply Preimpregnated (Prepreg) Repair Plies.

NOTE: Refer to applicable paragraphs for preparation of prepreg glass, aramid and graphite fabrics. For hybrid components refer to applicable material paragraphs for each individual ply. Before opening the prepreg material or adhesive film wrapper, condition refrigerated materials to room temperature until moisture no longer condenses on the wrapper. During use, suspend the film roll of material horizontally through its axis free from other rolls or objects.

(1) Prepare prepreg glass fabric repair plies (BMS 8-139).

(a) Refer to the specific component structural identification to determine type and orientation of glass fabric used in original structure. Repair existing plies of original structure with BMS 8-139, Type 1581 or 7781 (Figure 12/GENERAL).

(b) From BMS 8-139, Type 1581 or 7781 preimpregnated material, cut the required number of plies.

NOTE: Refer to Paragraph 3.E.(1)(c) for substitution of prepreg glass fabric plies. In the patch, use one repair ply for each damaged ply of the original laminate, plus extra repair plies as indicated by specific structural component repair. If extra repair plies are not required by individual repair, one extra ply is required and is to have the same orientation as the original surface ply. Refer to Figure 15/GENERAL for extra repair ply material and orientation. See Figure 13/GENERAL for required overlap of repair plies. The repair plies must be installed with the same orientation as that of the original plies being repaired.

(c) Substitution of prepreg glass fabric plies (Figure 12/GENERAL).

1) If BMS 8-139, Type 1581 or 7781 prepreg material is not available, three plies of BMS 8-139, Type 120 prepreg material may be substituted for each ply of Type 1581 or 7781 prepreg material required.

CAUTION: THE PREIMPREGNATED MATERIAL AND ADHESIVE MUST REMAIN FREE OF CONTAMINATION DURING CUTTING AND HANDLING. WEAR CLEAN WHITE GLOVES WHEN HANDLING.

(2) Prepare prepreg aramid fabric repair plies (BMS 8-218).

NOTE: Before opening the prepreg material or adhesive film wrapper, condition refrigerated materials to room temperature until moisture no longer condenses on the wrapper. During use, suspend the film roll of material horizontally through its axis free from other rolls or objects.

(a) Refer to the specific component structural identification to determine number, style and orientation of aramid fabric used in original structure (Figure 2/GENERAL).

(b) From each type of material required, cut the required number of plies.

NOTE: Refer to Paragraph 3.E.(2)(c) for the substitution for prepreg aramid fabric plies. In the patch, use one repair ply for each damaged ply of the original laminate, plus extra repair plies as indicated by specific structural component repair. If extra repair plies are not required by individual repair, one extra ply is required and is to have the same orientation as the original surface ply. Refer to Figure 15/GENERAL for extra repair ply material and orientation. See Figure 13/GENERAL for required overlap of repair pies. The repair plies must be installed with the same orientation as that of the original plies being repaired.

(c) Substitution of prepreg glass fabric plies (Figure 12/GENERAL) for aramid plies.

1) If BMS 8-139, Type 1581 or 7781 prepreg material is not available, three plies of BMS 8-139, Type 120 prepreg material may be substituted for each ply of Type 1581 or 7781 prepreg material required.

2) One ply of BMS 8-139, Type 120 prepreg material can be used for each ply of BMS 8-218, Style 120 aramid prepreg material.

3) One ply of BMS 8-139, Type 1581 or 7781 prepreg material can be used for each ply of BMS 8-218, Style 285 aramid prepreg material.

CAUTION: TAPE IS A UNIDIRECTIONAL FIBER. WHEN USED IN A LAYUP, THE PREDOMINATE STIFFNESS IS IN THE DIRECTION OF THE FIBER. TAPE HAS LITTLE OR NO STIFFNESS IN THE TRANSVERSE DIRECTION. FABRIC HAS BIDIRECTIONAL PROPERTIES. WHEN SUBSTITUTED FOR TAPE, FABRIC ADDS STIFFNESS IN THE TRANSVERSE DIRECTION. THE EFFECTS OF THIS ADDITIONAL TRANSVERSE STIFFNESS ON THE COMPONENT AND SUBSTRUCTURE MUST BE CONSIDERED PRIOR TO COMMITTING A MAJOR SUBSTITUTION IN A REPAIR. THE PREIMPREGNATED MATERIAL AND ADHESIVE MUST REMAIN FREE OF CONTAMINATION DURING CUTTING AND HANDLING. WEAR CLEAN WHITE GLOVES WHEN HANDLING.

(3) Prepare prepreg graphite repair plies (BMS 8-212 and BMS 8-256).

NOTE: Before opening the prepreg material or adhesive film wrapper, condition refrigerated materials to room temperature until moisture no longer condenses on the wrapper. During use, suspend the film roll of material horizontally through its axis free from other rolls or objects.

(a) Refer to the specific component structural identification section to determine number, style, and orientation of graphite tape or fabric plies used in original structure (Figure 2/GENERAL). Use the same material for the repair plies as was used in the original component except substitute graphite fabric for graphite tape (Figure 12/GENERAL).

(b) From each type of material required, cut the required number of plies.

NOTE: Refer to Paragraph 3.E.(3)(c) for the substitution of prepreg fabric plies.

In the patch, use one repair ply for each damaged ply of the original laminate, plus extra repair plies as indicated by specific structural component repair. If extra repair plies are not required by individual repair, one extra ply is required and is to have the same orientation as the original surface ply. Refer to Figure 15/GENERAL for extra repair ply material and orientation. See Figure 13/GENERAL for required overlap of repair plies. The repair plies must be installed with the same orientation as that of the original plies being repaired.

(c) No substitutes are permitted for graphite fabric repair plies. Graphite fabric however, may be used as a substitute for graphite tape. Refer to Figure 12/GENERAL.

CAUTION: ENSURE THAT PARTING FILM AND POLYETHYLENE SEPARATOR ARE REMOVED FROM REPAIR PLIES PRIOR TO LAYUP AND CURING. NONCOMPLIANCE WILL RESULT IN A RUINED REPAIR.

(4) Apply the repair plies (Figure 2/GENERAL and Figure 13/GENERAL)

NOTE: Where the damage has occurred at a lap joint in the original laminates, it is not necessary to make a comparable lap in the repair plies. Where the original core was undamaged and was provided with a recess to match the lap joint, the recess should be filled with strips of graphite preimpregnated material before application of the repair plies. Use the same graphite material as used in the repair plies.

(a) Make a temporary vacuum bag system.

NOTE: This vacuum bag is used to compact the repair plies and prevent conamination of the repair. Do not use this vacuum bag system for the repair cure.

1) Put one layer of perforated parting film above the repair.

2) Put one layer of glass fabric cloth as a surface breather above the repair.

3) Apply the vacuum sealing compound around the repair area.

4) Put the vacuum bag material over the repair area. Seal the edges with the vacuum sealing compound.

5) Attach a vacuum line above the surface breather.

(b) Cut two plies of BMS 5-154, Type II, Class I, Grade 05 adhesive film, 1/8 inch larger than the largest patch ply which also covers the entire repair area.

NOTE: After curing, the repair will need to be sanded in preparation for refinishing. An additional nonstructural ply covering the entire repair is added which may be sanded as required to obtain a smooth surface for refinishing. Be careful not to sand through this nonstructural sanding ply into the structural plies below it. The second adhesive film ply will be used as a sanding ply. As an option, substitute a ply of BMS 8-139, Type 1581 fiberglass prepreg cut to the same size as the adhesive ply. The fiberglass is less likely to entrap air during the cure. Repairs to aluminum foil will require both plies of adhesive film and one ply of BMS 8-139, Type 120 fiberglass prepreg.

(c) Place one layer of adhesive film over the entire repair area.

(d) Install the repair plies and if necessary the sanding ply also.

NOTE: Add filler plies as necessary to get a smooth repair. Do not use more than four filler plies on one repair area.

1) Install the smallest repair ply first.
2) Make sure that the warp direction of each repair ply that you put in the repair is correct and that the overlap is correct.
3) Install the next ply. Make sure that it is smooth with no wrinkles.
4) Remove the separator sheet.
5) You must do the steps that follow for repairs that have one or more graphite (Carbon Fiber Reinforced Plastic (CFRP) repair plies).

NOTE: Although it is only necessary to compact repairs containing CFRP repair plies, Boeing recommends that you compact all repairs.

a) Compact each ply (or plies) with the temporary vacuum system as follows:
   - 1 minute for each ply (one ply at a time), or
   - 2 minutes for each two plies (two plies at a time), or
   - 6 minutes for each three plies (three plies at a time)

NOTE: Do not compact more than three plies at a time. An adhesive ply counts the same as a repair ply.

b) Do steps 2) through 5) again for all of the repair plies as necessary to complete the layup.

(e) Apply a cover ply of BMS 8-139, Type 1581 fiberglass prepreg or the second ply of adhesive film over the replaced plies. If the repair includes repair to aluminum foil, use the second ply of adhesive film.

(f) If the repair area has a layer of aluminum foil, repair the foil as given in Paragraph 5.M./GENERAL before proceeding with the bagging and cure of the part.

F. Layup and Bagging Procedure

(1) As an optional step, place a layer of dry peel ply larger than the last repair ply over the repair area. When removed after curing, the peel ply leaves a rough surface which may be sanded for refinishing or left as is for any subsequent bonding to the repair area. The peel ply also helps to prevent pits in the cured adhesive surface.

(2) Place one layer of perforated FEP parting film over the replacement plies and extending at least 1 inch beyond the largest patch ply.

(3) Put on the thermocouples.

(a) If you use an autoclave or an oven, then do the step that follows:

1) Put one or more thermocouples at the location where the temperature will increase the fastest and one or more thermocouples where the temperature will increase the slowest.

NOTE: Boeing recommends that you put one or more thermocouples at the thick areas of the part and tool and the thin areas of the part and tool. Use more than two thermocouples when more than 900 square inches of a panel surface is repaired. Insulation is not necessary in the repair area for autoclave or oven cures.

(b) If you use a heat blanket, then do the step that follows:

1) Secure three thermocouples (spaced evenly around the repair) to the panel at the edge of the repair and secure them to the temperature recording device.

(4) Place a layer of dry peel ply over the perforated FEP as a surface bleeder.

NOTE: The peel ply must be cut large enough to make contact with the surface breather.

(5) Place one layer of solid FEP parting film over the layup extending to 1/2 inch short of the edge of the dry peel ply.

(6) Place a heat blanket over the repair (if used).

NOTE: The heat blanket must extend a minimum of 2 inches beyond the edge of the patch. When using a heat blanket that is longer than 12 inches on a side, an aluminum plate (0.040 max) should be used to minimize localized heating. When two or more pads are used, the aluminum plate must be used.

(a) If the area to be repaired is near or attached to aluminum structure that was not removed in step 3.C., do the steps that follow:

1) Isolate the aluminum structure from the areas that will get hot.

2) Add one or more thermocouples to put on the aluminum structure. Make sure that the temperature does not go above 200°F (93°C).

3) You can put insulation around all other metals to prevent cold locations in the repair.

(7) Place a layer of Airweave SS or Style 120 glass fabric over the solid FEP as a surface breather, or, if heat blanket is used, place four to six layers of breather material over the heat blanket to act as an insulator and a surface breather.

NOTE: The surface breather material and the dry peel ply must make contact.

(8) Lay the vacuum line over the edge of the breather material.

(9) Apply extruded sealing compound around the entire repair area, 2 to 6 inches outside the edge of the heat blanket.

CAUTION: HOLLOW COMPOSITE COMPONENTS SUCH AS RUDDERS, ELEVATORS, AND AILERONS MUST NOT BE COMPLETELY BAGGED BECAUSE THEY MAY COLLAPSE UNDER 22 INCHES OF MERCURY VACUUM. ATTACH VACUUM BAG TO ONE SIDE OF COMPONENT ONLY OR ATTACH SEPARATE VACUUM BAGS TO EACH SIDE TO ENSURE THAT ATMOSPHERIC PRESSURE IS MAINTAINED INSIDE OF COMPONENT DURING REPAIR. COMPONENTS CONSISTING OF A SINGLE PANEL MADE OF FULL DEPTH HONEYCOMB CORE WITH LAMINATE FACE SHEETS AND EDGEBANDS MAY BE COMPLETELY BAGGED (FIGURE 18/GENERAL).

(10) Lay a piece of vacuum bag material over the entire repair area, sealing the edge with the extruded sealing compound. Pleat the vacuum bag where needed to prevent bridging of bag material and subsequent bag breakage. Pad all sharp objects and corners to prevent bag breakage. In some cases, it is optional to vacuum bag the entire part.

NOTE: The entire repair surface must be vacuum bagged and restrained in place to prevent delamination and distortion when the repair area exceeds 15 percent of panel area. Regardless of the method of heat application, restraining devices that maintain the contour and support the part must be used for large parts sagging and distortion could occur due to the weight of the part.

(11) Evacuate the space under the vacuum bag and maintain a vacuum of 22 inches of mercury minimum during entire cure cycle.

(12) Check the vacuum bag for leak paths.

G. Cure the repair. Do step (1) for the autoclave procedure, step (2) for the oven cure procedure, or do step (3) for the heat blanket cure procedure.

(1) For autoclave cure, see Figure 14/GENERAL, Detail I and do the steps that follow:

NOTE: Boeing recommends that you use a certified autoclave when you do the procedure that follows. DOCUMENT D6-49327 contains a procedure that Boeing uses, and you can use this as a guide to certify your autoclave.

(a) During all of the repair procedure, make sure that the part to be repaired is held in the specified part tool. The specified part tool must have the same dimensions (or dimensions that are a small amount 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 in the part. A tool with the same thermal expansion properties will help keep the part at the correct contour and shape.

(b) 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 when you cure a repair above 250°F (121°C).

(c) Increase the temperature of the autoclave until it is at 130°F (54°C). When the temperature is at 130°F (54°C), increase the temperature at a rate of 1°F to 5°F (0.5°C to 3°C) for each minute until all thermocouples are in the 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 are more than 0.25 inch (6 mm) thick.

(d) Hold the cure temperature for the specified time as given in Figure 14/GENERAL, Detail I.

NOTE: Cure time does not include the time necessary for the layup and the part to get to the cure temperature. Cure time starts after all of the thermocouple indications are in the cure temperature range. If a thermocouple indication falls below the cure temperature range during the cure, extend the cure cycle time by the time necessary to get the thermocouple to the cure temperature.

(e) Keep the vacuum bag connection to the atmosphere open and the autoclave pressurized until after the cure is complete and the temperature of the part has decreased to 125°F (52°C).

(f) Decrease the autoclave temperature at a maximum rate of 5°F (3°C) for each minute.

(g) When the temperature is less than 125°F (52°C), release the autoclave pressure.

(h) Remove the vacuum bag equipment from the part and tool.

WARNING: USE HEAT CURE EQUIPMENT THAT IS PERMITTED BY THE LOCAL FIRE PROTECTION AUTHORITIES. IF YOU DO NOT OBEY, YOU CAN CAUSE INJURY TO PERSONNEL.

(2) If you use an oven to cure the repair, see Figure 14/GENERAL, Detail I and do the steps that follow:

NOTE: Use a circulating oven that has equipment that can supply a vacuum and can control the temperatures as given in this procedure.

(a) During all of the repair procedure, make sure that the part to be repaired is held in the specified part tool. The specified part tool must have the same dimensions (or dimensions that are a small amount 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 in the part. A tool with the same thermal expansion properties will help keep the part at the correct contour and shape.

(b) Apply a vacuum to the vacuum bag until you have a minimum of 22 inches (0.56M) of Hg (Mercury). Start the heatup process.

Keep a minimum of 22 inches (0.56M) of Hg (Mercury) during the full cure cycle.

(c) Increase the temperature of the oven until it is at 130°F (54°C). When the temperature is at 150°F (54°C), increase the temperatures at a rate of 1 to 5°F (0.5 to 3°C) for each minute until all thermocouples are in the cure temperature range.

(d) Hold the cure temperature for the specified time as given in Figure 14/GENERAL, Detail I.

NOTE: Cure time does not include the time necessary for the layup and the part to get to the cure temperature. Cure time starts after all of the thermocouple indications are in the cure temperature range. If a thermocouple indication falls below the cure temperature during the cure, extend the cure cycle time by the time necessary to get the thermocouple to the cure temperature.

(e) Decrease the 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), remove the vacuum pressure.

(g) Remove the vacuum bag equipment from the part and tool.

WARNING: USE HEAT CURE EQUIPMENT THAT IS PERMITTED BY THE LOCAL FIRE PROTECTION AUTHORITIES. IF YOU DO NOT OBEY, YOU CAN CAUSE INJURY TO PERSONNEL.

(3) For heat blanket cure, see Figure 14/GENERAL, Detail II and do the steps that follow:

NOTE: Boeing recommends that you use a qualified heat blanket when you do the procedure that follows. DOCUMENT D6-56273, is a procedure that Boeing uses, and you can use this as a guide to qualify your heat blanket.

(a) Make sure there is a minimum of three thermocouples for each heat blanket used. Refer to Paragraph 4.F./GENERAL.

(b) Apply a vacuum to the vacuum bag until you have a minimum of 22 inches (0.56M) of Hg (Mercury). Start the heatup process. Keep a minimum vacuum of 22 inches (0.56M) of Hg (Mercury) during the full cure cycle.

(c) Increase the temperature of the heat source until the temperature of the repair is at 130°F (54°C). When the temperature is at 130°F (54°C), increase the temperature at a rate of 1 to 5°F (0.5 to 3°C) for each minute until all thermocouples are at the cure temperature.

NOTE: When you use a hot bond console, obey the manufacturer's operation instructions.

(d) If necessary, put insulation on the cooler areas of the repair area, opposite of the heat source.

(e) Hold the cure temperature for the specified time as given in Figure 14/GENERAL, Detail II.

NOTE: Cure time does not include the time necessary for the layup and the part to get to the cure temperature. Cure time starts after all of the thermocouple indications are in the cure temperature range. If a thermocouple indication falls below the cure temperature during the cure, extend the cure cycle time by the time necessary to get the thermocouple to the cure temperature.

(f) Decrease the temperature at a rate maximum of 5°F (3°C) for each minute.

(g) When the temperature decreases to less than 125°F (52°C), release the vacuum pressure.

(h) Remove the vacuum bag equipment from the part and tool.

H. After Completion of the Cure Cycle.

CAUTION: DO NOT SAND INTO ORIGINAL STRUCTURE. FAILURE TO COMPLY WILL REDUCE THE STRENGTH OF THE COMPONENT.

(1) If multiple cure cycles are to be used to cure groups of repair plies, you must prepare the surfaces of the repair between cure cycles.

NOTE: You can do an inspection between cure cycles to make sure that there are no defective bonds or empty spaces between the repair plies. Refer to Paragraph 4.I./GENERAL if you do an inspection, prepare the surface of the repair after the inspection.

(a) Abrade the largest cured repair ply. Extend the abraded area to 0.25 inches (6 mm) around the edge of the ply. Use 150-grit abrasive paper.

(b) Remove all sanding dust by applying oil free compressed air and using a vacuum cleaner.

WARNING: BREATHING VAPORS OR ALLOWING SOLVENT TO CONTACT SKIN OR EYES IS HAZARDOUS. HEAT, FIRE OR SPARKS CAN CAUSE AN EXPLOSION. USE MECHANICAL VENTILATION OR RESPIRATIORY PROTECTION WHEN WORKING IN A CONFINED SPACE OR AREA. AVOID CONTACT WITH SKIN, EYES AND CLOTHING. WEAR EYE PROTECTION. KEEP AWAY FROM SOURCES OF HEAT, FIRE OR SPARKS.

CAUTION: DO NOT IMMERSE PARTS IN SOLVENT OR ALLOW STANDING SOLVENT ON THE PART. DAMAGE TO THE PART WILL OCCUR.

(c) Wipe the surfaces to be repaired with a clean cloth, moistened with solvent Series 99. Refer to 51-30-03, GENERAL for a source of the solvents.

(d) Clean the surfaces again until a new moist cloth is clean after it is used.

(e) Remove the solvent from the surface before it can dry.

(f) Remove the remaining solvent film before you continue the repair.

(2) Refinish after Repair

(a) Lightly sand edge of top most repair ply as necessary to fair the edge. Do not sand through the nonstructural sanding ply into the structural repair plies below it.

(b) Apply finish to the repaired surface using the following applicable methods.

1) Where clear Tedlar film surfaces have been removed, seal with a brush coat of Resin Mix 3 (Figure 1/GENERAL). Cure for 6 to 8 hours at room temperature or at elevated temperature as given in Figure 4/GENERAL.

2) Where gray or white Tedlar film surfaces have been removed, seal with Resin Mix 3 (Figure 1/GENERAL). Cure 6 to 8 hours at room temperature (or as given in Figure 4/GENERAL) and apply one coat of BMS 10-11 primer and one coat of BMS 10-60, Type II enamel (gray, BAC705; white, BAC7106).

3) Where the conductive coating BMS 10-21 has been removed, reapply as given in 51-24-02 of the 767 Maintenance Manual.

4) Where the abrasion resistant Teflon finish has been removed from the internal surface of the panel edgeband, reapply the finish according to AMM 51-24-13.

5) Where the original painted surfaces have been removed, restore original finish according to 51-21 of the 767 Maintenance Manual.

6) Where sealant has been removed from around fittings or fay surfaces to facilitate repairs, reapply BMS 5-95 sealant as given in AMM 51-20-05.

7) Where bolts have been removed from aluminum fittings common to graphite, reinstall bolts wet with BMS 5-95 sealant and fillet seal around bolt heads and nuts.

8) Where aluminum flame sprayed areas have been damaged, repair as given in 51-70-14, GENERAL.

I. Do the Post-Repair Procedures

(1) Do an inspection of the repair to make sure that it is satisfactory. Make sure that there are no empty spaces between plies or defective bonds. The inspection must include the area that was hot plus 2 inches minimum all around.

(2) If you find the repair to be unsatisfactory, you must remove it and install the repair again.

NOTE: The post-repair inspection is recommended. Examples of the inspection procedures are given in NDT Part 1, 51-01-01. Other inspection procedures that have been examined and found to be satisfactory by the airline can be used.

WARNING: MAKE SURE THAT THE OUTBOARD AILERON, ELEVATOR, AND RUDDER (CONTROL SURFACES) ARE BALANCED CORRECTLY AT ALL TIMES. IF YOU DO NOT, FLIGHT SAFETY CAN BE AFFECTED.

(3) After you repair a control surface, you must do a check of the balance to find if a rebalance is necessary. Refer to 51-60-00, GENERAL as necessary.

CAUTION: MAKE SURE THAT REPAIRS MADE TO CONTROL SURFACES AND/OR ADJACENT STRUCTURE DO NOT INTERFERE WITH THE DESIGNED OPERATION OF THE CONTROL SURFACES. DAMAGE TO THE AIRPLANES STRUCTURE CAN BE THE RESULT.

(4) Do a check of all repairs to make sure of clearance and non-interference with the operation of control surfaces.

(5) If a repair creates a blockage of a drain hole in the airplane structure, drill through the repair at the initial drain hole location with the appropriate drill bit. Refer to AMM 51-41-00/201.

5. Typical Repairs

CAUTION: ESTABLISH COMPONENT MATERIAL AND REPAIR LIMITS PRIOR TO PROCEEDING WITH ANY REPAIRS.

NOTE: These repairs apply to all 350°F (177°C) graphite and/or aramid fabric reinforced honeycomb components, except radomes, when called out in applicable repair index of specific structure.

A. Repair of Delaminations Between Plies

(1) Delamination of plies over core area of panel (Figure 5/GENERAL).

(a) Determine damage as given in Paragraph 4.A./GENERAL Ensure that water and other contamination are removed as given in Paragraph 4.B./GENERAL

(b) Cut away delaminated plies as given in Paragraph 4.C.(1)/GENERAL Do not remove any core.

(c) Prepare damaged area as given in Paragraph 4.C.(2)/GENERAL.

(d) Prepare and apply fabric repair plies and complete repair as given in Paragraph 4.E./GENERAL thru Paragraph 4.I./GENERAL.

(2) Repair of delaminations between plies of panel edgeband.

(a) Repair this type of damage as given in 51-70-17, GENERAL, Paragraph 4.A.(2).

B. Repair of Puncture, 0.50-inch Diameter or Less, in Honeycomb Panel

(1) Repair this type of damage as given in 51-70-17, GENERAL, Paragraph 4.B.

C. Repair of Damage to One Skin and Honeycomb Core Using Replacement Core Plug, Punctures Greater than 0.50-inch Diameter (Figure 2/GENERAL)

(1) Determine extent of damage according to Paragraph 4.A./GENERAL

(2) Ensure that all contamination and water are removed from damaged area (Ref Paragraph 4.B./GENERAL).

(3) Remove damage and prepare area according to Paragraph 4.C./GENERAL

(4) Fabricate, clean, and install honeycomb replacement core plug as given in Paragraph 4.D./GENERAL.

(5) Sand core plug flush with surrounding surface, leaving allowance for film adhesive and slight core crush during cure.

(6) Prepare and apply repair plies and complete repair as given in Paragraph 4.E./GENERAL thru Paragraph 4.I./GENERAL.

D. Repair of Large Puncture Through Internal and External Surface of Panel Including Core Damage (Figure 6/GENERAL).

NOTE: For repair where access to inner surface is limited, refer to Paragraph F.

(1) Determine extent of damage according to Paragraph 4.A./GENERAL.

(2) Remove all contamination and water from damaged area. Refer to Paragraph 4.B./GENERAL.

(3) Remove damage and prepare area according to Paragraph 4.C./GENERAL

(4) Fabricate, clean, and install honeycomb replacement core plug as given in Paragraph 4.D./GENERAL, except do not perform steps 4.D.(3)(e) through 4.D.(3)(j).

(5) Prepare and apply repair plies to one surface of the panel according to Paragraph 4.E./GENERAL. A caul plate may be used on the opposite face of the panel to restrain the core plug in place.

(6) Apply vacuum and cure according to Paragraph 4.F./GENERAL and Paragraph 4.G./GENERAL. Ensure that temperature is approximately equal on both sides of panel.

(7) Sand core plug approximately flush with surrounding material, making allowance for film adhesive and slight core crush during cure.

(8) Prepare and apply repair plies to the other surface of the panel according to Paragraph 4.E./GENERAL.

(9) Complete repair as given in Paragraph 4.F./GENERAL thru Paragraph 4.I./GENERAL.

NOTE: The above two-stage cure procedure is recommended. As an option, a three-stage cure procedure may be used wherein the core plug installation and the repair plies on each side may be cured separately.

E. Replacement of Honeycomb Core on Damaged Edge of Panel (Figure 7/GENERAL).

(1) Determine extent of damage according to Paragraph 4.A./GENERAL.

(2) Remove all contamination and water from damaged area (Paragraph 4.B./GENERAL).

(3) Remove damage and prepare area according to Paragraph 4.C./GENERAL

(4) Fabricate, clean, and install honeycomb replacement core plug as given in Paragraph 4.D./GENERAL.

(5) Sand core plug approximately flush with surrounding core material, leaving allowance for film adhesive and slight core crush during cure.

(6) Clean surfaces according to Paragraph 4.C.(2)(e)/GENERAL.

(7) Prepare and apply repair plies and complete repair as given in Paragraph 4.E./GENERAL thru Paragraph 4.I./GENERAL.

F. Repair of Hole Through Both Skins of a Honeycomb Panel with Access Available from One Side Only (Figure 8/GENERAL).

NOTE: This repair applies to flat panels (or nearly flat panels) where the damage extends completely through the panel, but access is not readily available to repair the unexposed side. See Figure 8/GENERAL when making this repair.

(1) Determine extent of damage (.Paragraph 4.A./GENERAL).

(2) Ensure that all contamination and water is removed from damaged area.

(3) Remove damage and prepare area as given in Paragraph 4.C./GENERAL and the following:

(a) Cut a hole in the outer skin and core (D diameter) to permit a repair to be made to the inner skin with the required overlap.

NOTE: D diameter = d + N + 1 d = major diameter of oval hole in inner skin and is limited to 1.5 inch max. for this repair. (N = number of plies in the inner skin) Stepping of the plies in the inner skin is not necessary for this repair.

(b) Clean out damaged area in inner skin leaving an oval shaped hole, see Detail I, Figure 6/GENERAL.

(c) Taper sand the outer skin plies as given in Paragraph 4.C.(2)/GENERAL.

(4) Fabricate an airtight patch, Figure 8/GENERAL, Details II thru V to cover the oval hole from the inaccessible side as follows:

(a) Make a suitable mold on which to lay up the patch. A thin gage aluminum sheet or any smooth surface can be used as a mold.

(b) Cover the mold with parting film or release agent.

(c) Lay up five plies of the same prepreg material used in the repair on the mold, using the procedures of Paragraph 4.E./GENERAL, except that all repair plies will have the same diameter and adhesive film will not be used. Make diameter of the repair plies at least equal to D diameter.

(d) Bag and cure the patch as given in Paragraph 4.F./GENERAL and Paragraph 4.G./GENERAL. Place thermocouples at the edge of the patch before cure.

(e) Remove the patch from the mold.

(f) Trim patch into an oval shape with a minor diameter slightly smaller than the major diameter of the cutout.

(g) Drill a 1/8 diameter hole in the center of the patch for a cleco fastener.

(h) Abrade the surface of the patch using No. 240 or finer Scotch-Brite abrasive. Remove all sanding dust by applying oil-free compressed air and using a vacuum cleaner.

(i) Fabricate a strip of spring steel 1.0 X 10.0 inches and drill a 1/8 diameter hole in the center for the cleco fastener.

NOTE: This repair illustrates the use of a spring steel clamp. However, any suitable retaining device may be used.

(j) Assemble the patch and spring steel together with a 1/8 diameter cleco fastener, see Figure 6/GENERAL, Detail II.

(5) Remove Tedlar, if required and abrade the underside of the inner skin to a distance of 0.4 from the edge of the elliptical cutout using No. 180 or finer sandpaper. Avoid abrasion of the existing ply filaments.

CAUTION: DO NOT IMMERSE PARTS IN SOLVENT OR ALLOW STANDING SOLVENT TO REMAIN ON PART. DAMAGE TO PART WILL OCCUR.

(6) Clean out the repair area with oil-free compressed air. Wipe the surface with a clean cloth moistened with solvent, Series 99 (AMM/ SOPM 20-30-99).

(7) Bend up both ends of the spring steel and apply adhesive BMS 5-25 or BMS 5-92.

(8) Holding the spring steel up - insert the patch into the oval hole, and orientate so that the hole is covered. Release the spring steel so that it holds the patch tightly up against the inner skin.

(9) Cure the adhesive as given in Figure 4/GENERAL. When cure is complete, remove the cleco fastener and spring. Fill hole for cleco fastener with adhesive BMS 5-25 or BMS 5-92. Allow this to cure.

(10) Clean out the repair area as given in Paragraph 5.F.(6)/GENERAL.

(11) Apply adhesive film BMS 5-154, Grade 03 or 05, 0.10 bigger than diameter D to the surface of the inner skin which fays with the inner skin repair plies.

(12) Cut the required number of repair plies to diameter D and apply repair plies to the inner skin.

(13) Fabricate, clean, and install core plug as given in Paragraph 4.D./GENERAL.

(14) Prepare and apply repair plies to the outer skin surface of the panel and complete repair as given in Paragraph 4.E./GENERAL thru Paragraph 4.I./GENERAL.

G. Repair of Damaged Skin Plies in Panel Edgeband (Figure 9/GENERAL)

(1) Determine extent of damage according to Paragraph 4.A./GENERAL.

(2) Remove all contamination and water from damaged area. Area must be completely dried out. Refer to Paragraph 4.B./GENERAL.

CAUTION: DO NOT SAND INTO BOND PLY OR CORE (FIGURE 9/GENERAL). LOSS OF STRUCTURAL STRENGTH OF THE COMPONENT WILL OCCUR. BOND PLY IS ADJACENT TO CORE.

(3) Remove damage and prepare area according to Paragraph 4.C./GENERAL

CAUTION: ON HYBRID PANELS, ENSURE THAT GRAPHITE REPAIR PLIES DO NOT EXTEND INTO AREAS OF FASTENER HOLES. ELECTROLYSIS BETWEEN METAL FASTENERS, SUPPORT STRUCTURE AND GRAPHITE MAY OCCUR CAUSING CORROSION TO ALUMINUM STRUCTURES.

(4) Prepare and apply repair plies and complete the repair as given in Paragraph 4.E./GENERAL thru Paragraph 4.I./GENERAL.

H. Repair of Damage and Punctures in Solid Laminate Panels

NOTE: This repair applies to components made from laminated fabric and/or tape plies and epoxy resin without a honeycomb core.

(1) Determine extent of damage according to Paragraph 4.A./GENERAL

(2) Remove all contamination and water from damaged area as given in Paragraph 4.B./GENERAL. Area must be completely dried out. Any structure in the repair area that cannot be dried out must be removed along with the other damage.

(3) Remove damage and prepare area according to Paragraph 4.C./GENERAL.

NOTE: Taper sand edges of plies around repair on damaged side of panel.

(4) Prepare and apply repair plies and complete the repair as given in Paragraph 4.E./GENERAL thru Paragraph 4.I./GENERAL.

NOTE: If cleaned up damage penetrates solid laminate, secure a metal caul plate (such as 0.016 thick aluminum) to far side of panel to support repair plies.

I. Repair of Punctures, 0.25-Inch Diameter or Less, in Solid Laminate Panels

NOTE: This repair applies to components made from laminated graphite and/or aramid fabric or tape plies and epoxy resin without a honeycomb core.

(1) Check for delamination as given in Paragraph 4.A./GENERAL

(2) If no delamination is found, clean up damage to a smooth, rounded shape. Repair as given in Paragraph 5.B./GENERAL

(3) If delamination is found, repair as given in Paragraph 5.H./GENERAL

J. Repair of Delaminations Between Plies in Solid Laminate Panels

NOTE: This repair applies to components made from laminated graphite and/or aramid fabric or tape plies and epoxy resin without a honeycomb core.

(1) Repair delaminations using methods described in Paragraph 5.H./GENERAL.

K. Repair of Damaged Panel Attach Holes in Honeycomb Panel Edgebands or Along Edges of Solid Laminate Panels (Figure 10/GENERAL)

(1) Determine the extent of damage according to Paragraph 4.A./GENERAL.

(2) Remove all contamination and water from damaged area as given in Paragraph 4.B./GENERAL. Area must be completely dried out. Any structure in the repair area that cannot be dried out must be removed along with the other damage.

(3) Taper sand around the hole to remove damage according to Figure 10/GENERAL and Paragraph 4.C.(2)(d)/GENERAL.

(4) Clean area according to Paragraph 4.C.(2)(e)/GENERAL.

CAUTION: ON HYBRID PANELS, ENSURE THAT GRAPHITE REPAIR PLIES DO NOT EXTEND INTO AREAS OF FASTENER HOLES. ELECTROLYSIS BETWEEN METAL FASTENERS, SUPPORT STRUCTURE AND GRAPHITE MAY OCCUR CAUSING CORROSION TO ALUMINUM STRUCTURES.

(5) Prepare and apply repair plies according to Paragraph 4.E./GENERAL and Figure 10/GENERAL.

(6) Apply vacuum and cure according to Paragraph 4.F./GENERAL and Paragraph 4.G./GENERAL.

(7) Refinish the repair according to Paragraph 4.H./GENERAL.

(8) Drill and countersink fastener holes.

(9) Perform applicable post-repair requirements as given in Paragraph 4.I./GENERAL before returning the repaired component to flight service.

L. Repair of Surface Dents

(1) Check for delamination and broken fibers as given in Paragraph 4.A./GENERAL.

(2) If delamination is found, repair as given in Paragraph 5.A./GENERAL.

(3) If broken fibers are found, repair as given in Paragraph 5.B./GENERAL or Paragraph 5.C./GENERAL.

(4) If no delamination or broken fibers are found, repair as given in 51-70-03, GENERAL, Paragraph 4.I.

M. Repairs to Aluminum Foil (Figure 17/GENERAL and 2.C.(2)(b)2))

NOTE: This repair is done in addition to the applicable repair of the underlying plies.

(1) Determine the extent of and remove damage. Apply repair materials to the underlying composite structure as given in Paragraph 4.A. through 4.F., up to and including the step for applying the repair plies to the surface that had aluminum foil.

(2) Alodine treat the nonadhesive side of the splice strip, cover ply, and aluminum surfaces that will contact the splice strip and cover ply.

(3) Butt-splice a ply of BMS 8-289, Type 0/350 over the repair area, adhesive side down with a 0.25 maximum gap and no overlap allowance.

(4) Layup splice strips of BMS 8-289 Type 0/350 Form II, adhesive side up, such that they overlap each side of the splice line by approximately 1.25. Form I foil is optional, but requires alodine treatment on nonadhesive side and 0.5 diameter holes on 2.0 centers.

NOTE: Do not allow the cover ply or splice strip to extend into the edgeband area of the panel. Electrical splicing is not allowed on the laminated edgeband faying surface.

(5) Apply BMS 5-154, Type II, Class I, Grade 03 or 05 adhesive and a cover ply of BMS 8-139 Type 120 prepreg over the repair such that they overlap the outer edge of the splice strip by 1.0.

(6) Vacuum bag and cure the repair as given in Paragraph 4.F./GENERAL and Paragraph 4.G./GENERAL.

RESIN, PREPREG, OR ADHESIVE TYPE	COMPONENTS	PARTS BY WEIGHT	OPEN TIME BEFORE USE, OR POT LIFE OF MIXTURE	CURING TIME
RESIN MIX 3 (SEALER RESIN)	EPIBOND 156A RESIN EPIBOND 156B HARDENER	100 ±2 6 ±0.3	15 TO 25 MINUTES AT 77°F (25°C)	12 HOURS AT 70°F (21°C) OR 1 TO 3 HRS AT 150°F (66°C)
RESIN MIX 3 (SEALER RESIN) ALTERNATE	FIBER-RESIN 5318S FIBER-RESIN 5318C	100 ±2 50 ±1	45 TO 60 MINUTES AT 70°F (21°C)	SEE FIG. 4 OR 24 HOURS MIN. AT 70°F (21°C)
RESIN MIX 3 EPOX-O WELD (SEALER RESIN) ALTERNATE	TWO COMPONENT KIT	FOLLOW MANUFACTURERS INSTRUCTIONS FURNISHED WITH EACH KIT		
			45 TO 60 MINUTES AT 70°F (21°C)	SEE FIG. 4 OR 24 HOURS MIN. AT 70°F (21°C)
RESIN MIX 3 (SEALER RESIN) ALTERNATE	EPIBOND 156A RESIN EPIBOND 941 HARDENER	100 ±2 10 ±0.5	45 TO 60 MINUTES AT 70°F (21°C)	SEE FIG. 4 OR 15 HOURS MIN. AT 70°F (21°C)
RESIN MIX 3 (SEALER RESIN) ALTERNATE BMS 8-207, TYPE 1, CLASS II 350°F (177°C)	FR-40 RESIN 5413C HARDENER	100 ±1 15 ±0.5	20 MINUTES AT 75°F (24°C) TO 79°F (26°C)	12 HOURS MIN AT ROOM TEMP. (65°F [18°C] MIN) 1 HOUR MIN AT 150°F (66°C) TO 170°F (77°C)
RESIN MIX 9 BMS 8-214, TYPE 1,	EPOCAST 35A RESIN EPOCAST 927 HARDENER	100 ±1 25 ±0.5	4 HOURS AT 77°F (21°C)	90 MINUTES AT 340°F (171°C) TO 360°F (182°C)
BMS 5-90 TYPE III, CLASS 350-10-10, GRADE 50 (FOAMING ADHESIVE FILM)	FM-490A MA-562 PL-685		$\boxed{B}$ $\boxed{C}$	SEE TEXT
BMS 5-90 TYPE IV, CLASS 350-10-10, (FOAMING EXTRUDABLE ADHESIVE)	PL-460		$\boxed{B}$ $\boxed{C}$	SEE TEXT
BMS 5-154 TYPE II, CLASS 1, GRADE 05	METLBOND 1515-3M 05 PSF ADHESIVE FILM METLBOND 1515-3M-HT 05 PSF ADHESIVE FILM PL-795 05 PSF ADHESIVE FILM		10 DAYS AT 95°F (35°C)	SEE TEXT

Resin, Prepreg, and Adhesive Specifications and Mixing Procedures
Figure 1 (Sheet 1 of 5)

RESIN, PREPREG, OR ADHESIVE TYPE	COMPONENTS	PARTS BY WEIGHT	OPEN TIME BEFORE USE, OR POT LIFE OF MIXTURE	CURING TIME
BMS 8-212 CLASS 1 (TAPE) (350°F/177°C GRAPHITE PREPREG) TYPE II GRADE 190	RIGIDITE 5208T-300-190-35 PERCENT RIGIDITE 5208-C3000-190-35 PERCENT RIGIDITE 5208FT-300-190-35 PERCENT HYE-1034C(190)-II T3T190-12-F263-2 T5T190-12-F263-2 T6C190-12-F263-2 T2C190-12-F263-2 AS4/3501-5A		$\boxed{\text{A}}$	SEE TEXT
TYPE III GRADE 95	RIGIDITE 5208-C3000-95-37 PERCENT RIGIDITE 5208-C6000-95-37 PERCENT HYE-1034C(95)-III HYE-3034C(95)-III T3T95-12-F263-7 T3G95-12-F263-7 T6C95-12-F263-7 T2C95-12-F263-7 AS4/3501-5A CYCOM 985GT3095 FIBREDUX 922C-TS-3.6-37% R 922-C3K-95-37			

Resin, Prepreg, and Adhesive Specifications and Mixing Procedures
Figure 1 (Sheet 2 of 5)

RESIN, PREPREG, OR ADHESIVE TYPE	COMPONENTS	PARTS BY WEIGHT	OPEN TIME BEFORE USE, OR POT LIFE OF MIXTURE	CURING TIME
BMS 8-212 (CONT) (350°F/177°C GRAPHITE PREPREG) CLASS 2 (FABRIC) TYPE III GRADE 145	RIGIDITE 5208-C3000-145-37 PERCENT		$\boxed{A}$	SEE TEXT
	RIGIDITE 5208-C6000-145-37 PERCENT			
	HYG-1034C (145)-III			
	HYE-3034C (145)-III			
	HYE-3034K (145)-III			
	T6C145-12-F263-7			
	T2C145-12-F263-7			
	T3C145-12-F263-7			
	T3G145-12-F263-7			
	AS4/3501-5A			
	CYCOM 985GT3145			
	FIBREDUX 922C-TS-5.5-37%			
	R922-C12K-145-37			
TYPE III STYLE 3K-135-8H	RIGIDITE 5208 WOVEN T-300 STYLE 3K-135-8H-37 PERCENT			
	RIGIDITE 5208 WOVEN C3000 STYLE 3K-135-8H-37 PERCENT			
	RIGIDITE 5208F WOVEN T-300 STYLE 3K-135-8H-37 PERCENT			
	HMF-133/34-III			
	F3T-584-42-F263-7			
	F3C-584-42-F263-7			
	A370-8H/3501-5AD			
	CYCOM 985GF3135H8			
	FIBREDUX 922C-815-37%			
	R922-C3K1358H-37			

Resin, Prepreg, and Adhesive Specifications and Mixing Procedures
Figure 1 (Sheet 3 of 5)

RESIN, PREPREG, OR ADHESIVE TYPE	COMPONENTS	PARTS BY WEIGHT	OPEN TIME BEFORE USE, OR POT LIFE OF MIXTURE	CURING TIME
BMS 8-212 (CONT) (350°F/177°C GRAPHITE PREPREG) CLASS 2 (FABRIC) TYPE IV			$\boxed{A}$	SEE TEXT
STYLE 3K-70-PW	RIGIDITE 5208 WOVEN T-300 STYLE 3K-70-PW-40 PERCENT			
	RIGIDITE 5208 WOVEN C3000 STYLE 3K-70-PW-40 PERCENT			
	RIGIDITE 5208F WOVEN T-300 STYLE 3K-70-PW-40 PERCENT			
	HMF-322/34C-IV			
	HMF-1322/34C-IV			
	W3C-282-42-F263-8			
	W3T-282-42-F263-8			
	A193-P/3501-5AD			
	CYCOM 985GF3070PW			
	FIBREDUX 922C-814NT-40%			
	R922-C3K70PW-40			
BMS 8-139 (350°F/177°C GLASS PREPREG) CLASS 1			$\boxed{A}$	SEE TEXT
TYPE 120	120-F161-108 F50			
	NARMCO 588-120 VOLAN A			
TYPE 1581	1581-F161-108 F50			
	NARMCO 588-181-VOLAN A			
BMS 8-218 (ARAMID PREPREG)			$\boxed{A}$	SEE TEXT
STYLE 120	KEVLAR 49-120 F161-188 CYCOM 985-K120 MXM-7880/KEVLAR 49-120 R 9369-120K			
TYPE 285	KEVLAR 49-285 F161-188 CYCOM 985-K285 MXM-7880/KEVLAR A9-285 R 9369-285K			

Resin, Prepreg, and Adhesive Specifications and Mixing Procedures
Figure 1 (Sheet 4 of 5)

RESIN, PREPREG, OR ADHESIVE TYPE	COMPONENTS	PARTS BY WEIGHT	OPEN TIME BEFORE USE, OR POT LIFE OF MIXTURE	CURING TIME
BMS 8-289 (ALUMINUM FOIL) TYPE 0/350	CYCOM AEL-100-1/1100 ADH WT 0.025 ±0.01 LB/FT^2 C-CLAD H OR J-250/ 350-002 ADH WT 0.002 ±0.0015 LB/FT^2		240 DAYS AT 10°F (-12°C) TO 95°F (35°C)	SEE TEXT

WARNING: THESE CHEMICALS CONTAIN TOXIC INGREDIENTS. PROVIDE ADEQUATE VENTILATION AND PROTECT THE SKIN AND EYES FROM CONTACT WITH UNCURED RESINS OR CURING AGENT. WEAR RUBBER GLOVES OVER COTTON GLOVES FOR PROTECTION OF HANDS. IF SKIN IS EXPOSED TO DIRECT CONTACT WITH UNCURED RESINS OR CURING AGENT, WASH WITH WARM WATER OR SOAP. AVOID THE USE OF SOLVENTS FOR CLEANING THE SKIN.

CAUTION: TO PREVENT CONTAMINATION OF THE RESIN, DO NOT USE WAXED CONTAINERS FOR MIXING.

	RESIN MIXING AND ADHESIVE PREPARATION PROCEDURES
RESIN MIX 3	ADD HARDENER TO RESIN AND MIX THOROUGHLY
BMS 5-90, BMS 5-154	REMOVE WRAPPER BEFORE USE

NOTES

- REFER TO SRM 51-30-03 FOR SOURCES OF MATERIALS.

A ALLOWABLE OUT-TIME OF THIS MATERIAL IS GIVEN IN TERMS OF EXPOSURE UNITS. SEE TABLE I TO DETERMINE HOW MANY EXPOSURE UNITS ARE ACCUMULATED AND FOR THE TOTAL NUMBER OF EXPOSURE UNITS PERMITTED BEFORE USE. MATERIALS EXPOSED TO TEMPERATURES ABOVE 110°F (43°C) ARE TO BE REJECTED.

B REMOVE THE ADHESIVE MATERIAL FROM THE COLD STORAGE AREA. KEEP THE MATERIAL IN AN AREA WHERE THE TEMPERATURE IS 65°F (18°C) TO 90°F (32°C) FOR A MINIMUM OF 30 MINUTES FOR EACH POUND OF WEIGHT.

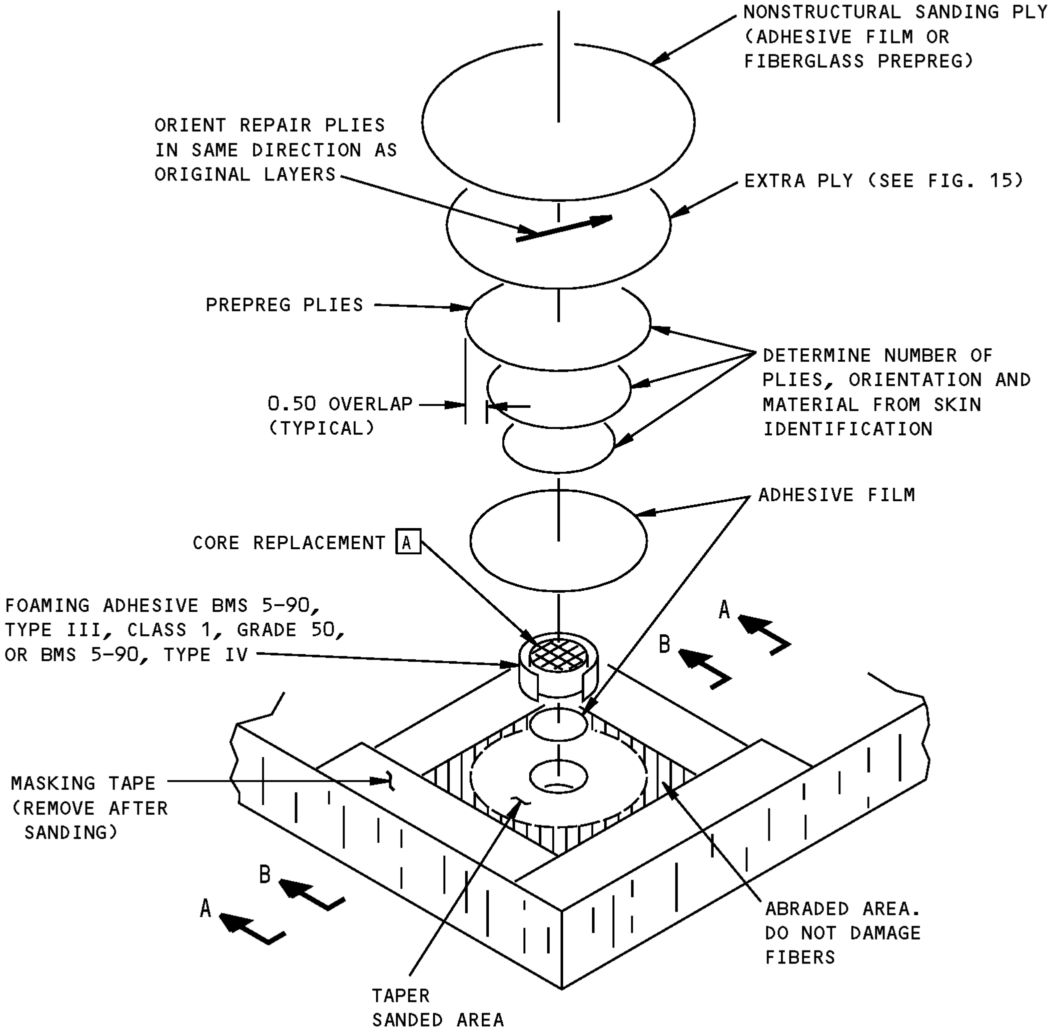
CONDENSATION ON THE EXTERIOR OF THE ROLL IS NOT AN ACCURATE INDICATOR THAT THE MATERIAL IS READY TO BE USED. MAKE SURE THE MATERIAL TEMPERATURE IS EQUAL TO ROOM TEMPERATURE BEFORE YOU USE IT.

C IF THE TOTAL OUTSIDE TIME IS NOT MORE THAN 10 DAYS, THE MATERIAL CAN BE PUT BACK INTO COLD STORAGE ONE OR MORE TIMES.

MATERIAL	EXPOSURE UNITS ACCUMULATED EACH HOUR THE MATERIAL IS EXPOSED TO THE TEMPERATURE RANGES GIVEN BELOW					TOTAL EXPOSURE UNITS PERMITTED BEFORE USE
	10°F TO 40°F (-12°C TO 4°C)	41°F TO 80°F (5°C TO 27°C)	81°F TO 90°F (27°C TO 32°C)	91°F TO 100°F (33°C TO 38°C)	101°F TO 110°F (38°C TO 43°C)	
BMS 8-139	--	1	15	15	15	360
BMS 8-212	1	1	1.4	2.4	8.5	408
BMS 8-218	--	1	7	7	7	168

TABLE I

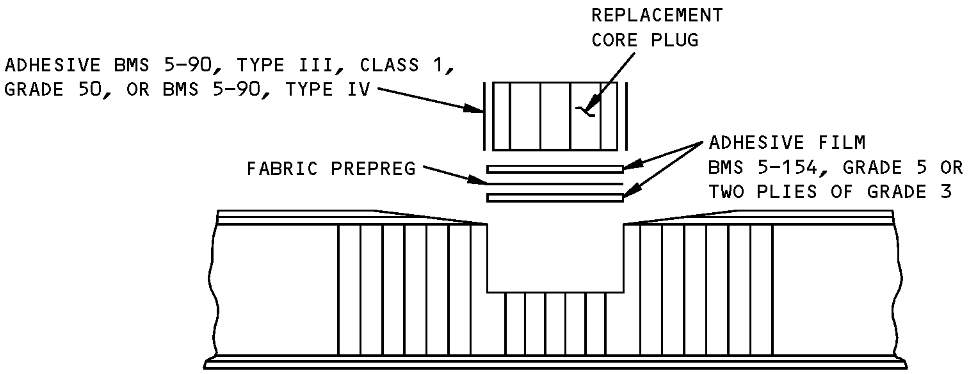
Resin, Prepreg, and Adhesive Specifications and Mixing Procedures
Figure 1 (Sheet 5 of 5)



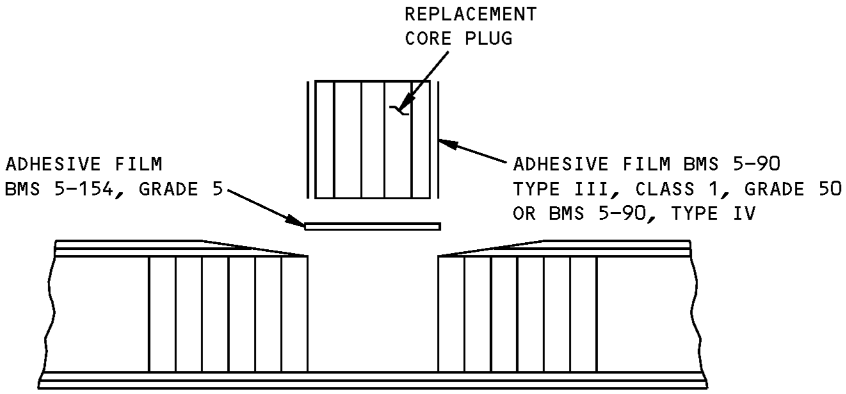
NOTES

A BUTT SPLICING SHOWN. FOR CRUSH SPLICING (SEE FIG. 16).

Repair of Large Punctures Thru One Skin of a Sandwich Structure Including Core Damage - 350 Degrees F (177 Degrees C) Cure
Figure 2 (Sheet 1 of 2)

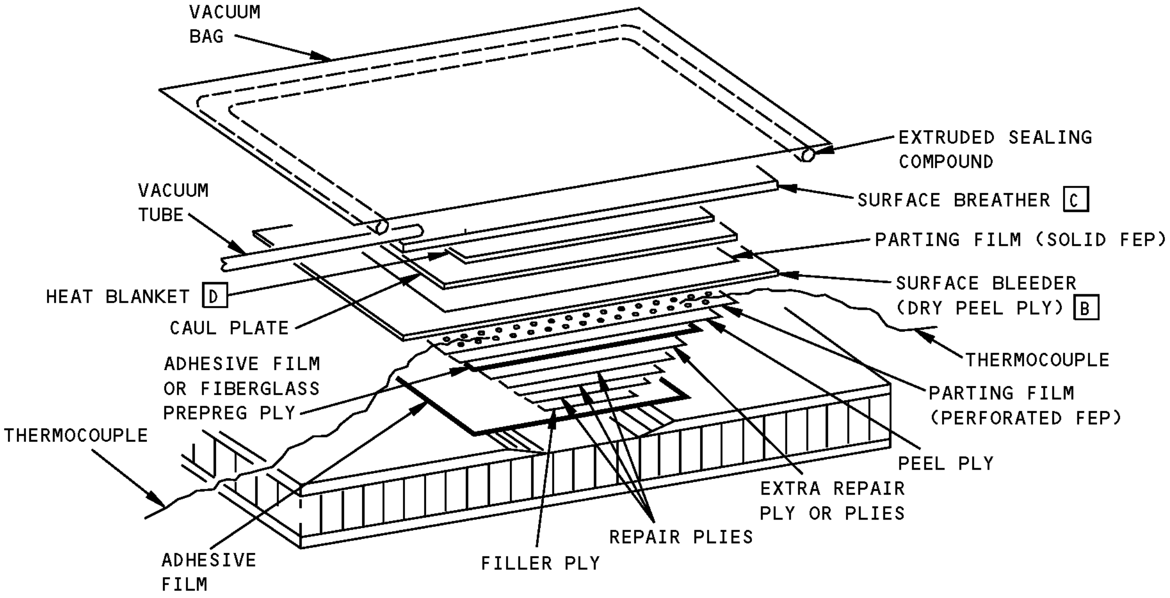


SECTION THRU REPAIR AREA -
PARTIAL DEPTH CORE REPLACEMENT
SECTION A-A



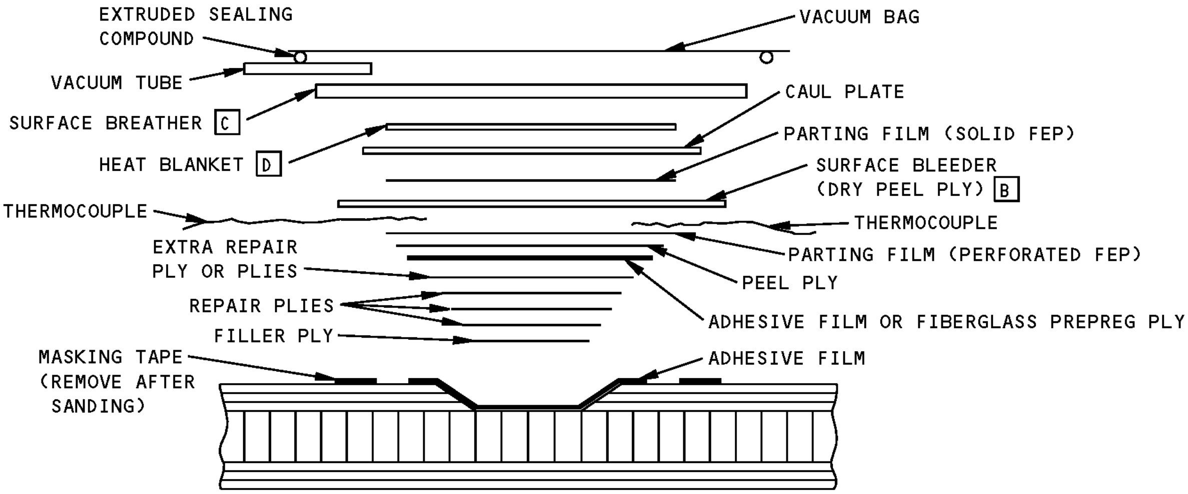
SECTION THRU REPAIR AREA -
FULL DEPTH CORE REPLACEMENT
SECTION B-B

Repair of Large Punctures Thru One Skin of a Sandwich Structure Including Core Damage - 350 Degrees F (177 Degrees C) Cure
Figure 2 (Sheet 2 of 2)



HONEYCOMB PANEL SHOWN
SOLID LAMINATE SIMILAR

BAGGING SEQUENCE FOR SKIN PLY REPAIR



SECTION THRU SKIN PLY REPAIR

NOTES

A ONE PLY OF ADHESIVE FILM (FOR FULL DEPTH CORE REPLACEMENT, WHERE DAMAGE DOES NOT EXTEND THROUGH BOTH SKINS). FOR PARTIAL CORE REPLACEMENT USE TWO PLIES OF ADHESIVE FILM WITH ONE PLY OF BMS 8-212, TYPE IV, CLASS 2 OR BMS 8-256 CLASS 2 GRAPHITE BETWEEN THEM.

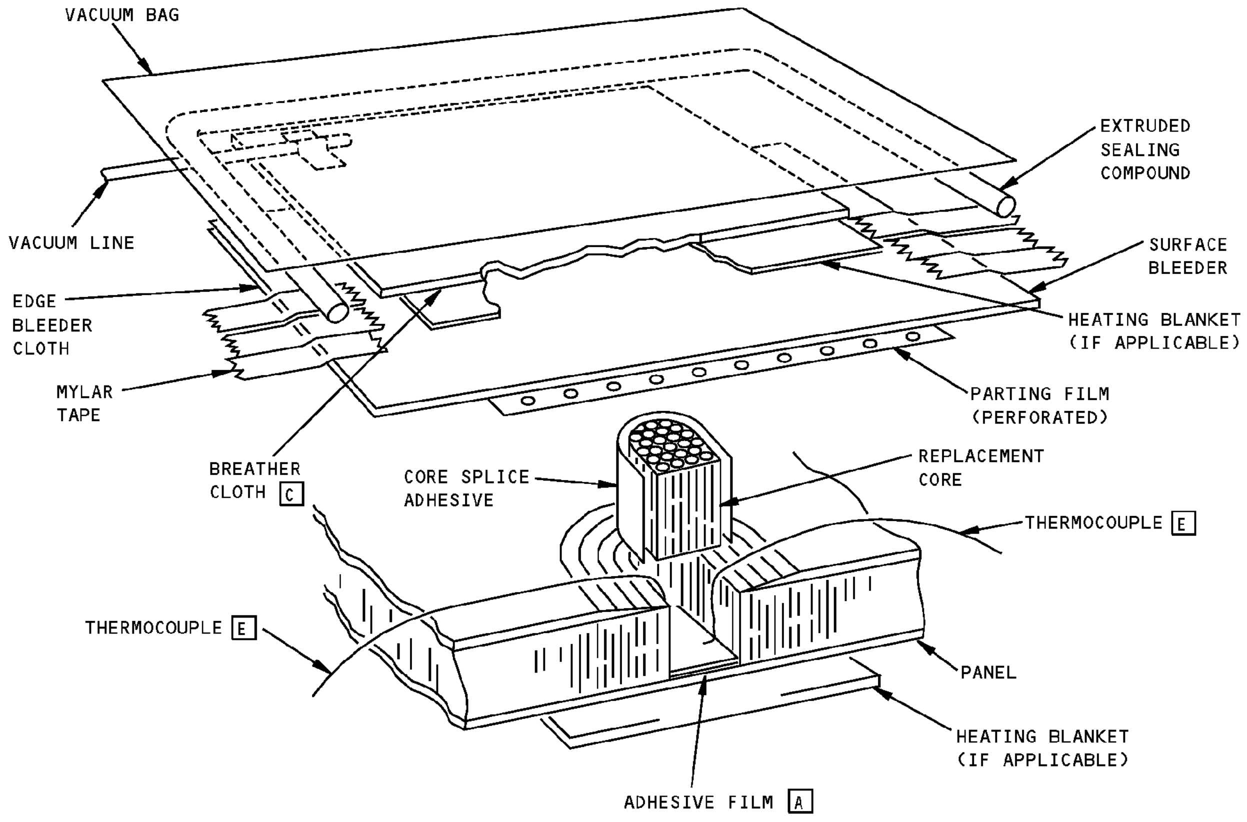
B SURFACE BLEEDER MUST MAKE CONTACT WITH THE SURFACE BREATHER MATERIAL.

C WHEN USING A HEATING BLANKET, USE 4 TO 6 LAYERS OF BREATHER MATERIAL TO PREVENT DAMAGE TO VACUUM BAG.

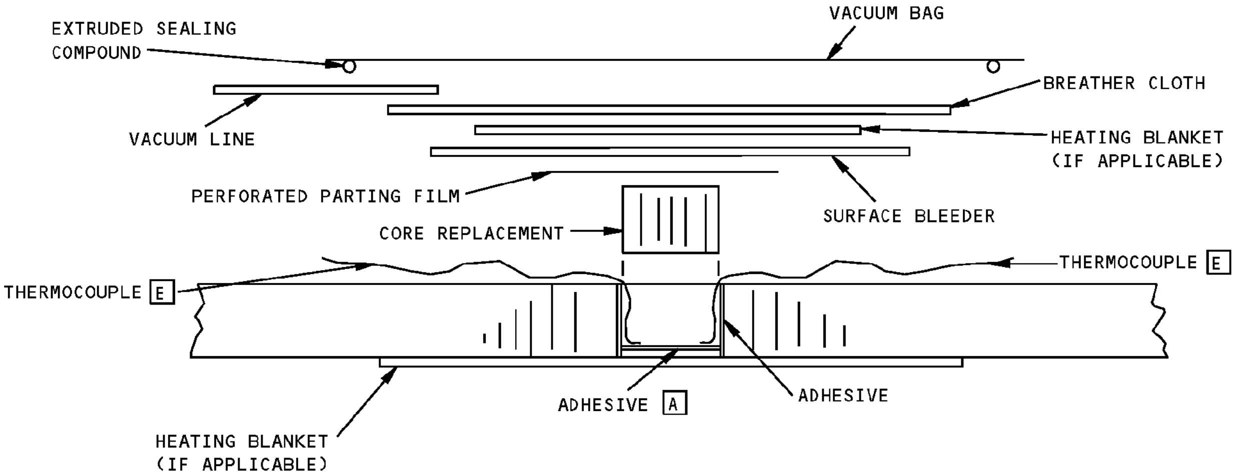
D HEATING BLANKET MUST EXTEND A MINIMUM OF 2 INCHES BEYOND EDGE OF REPAIR PATCH.

E FOR THERMOCOUPLE PLACEMENT REFER TO PAR. 4.D.(3)(f).

Application of Pressure During Cure - 350 Degrees F (177 Degrees C) Cure
Figure 3 (Sheet 1 of 2)

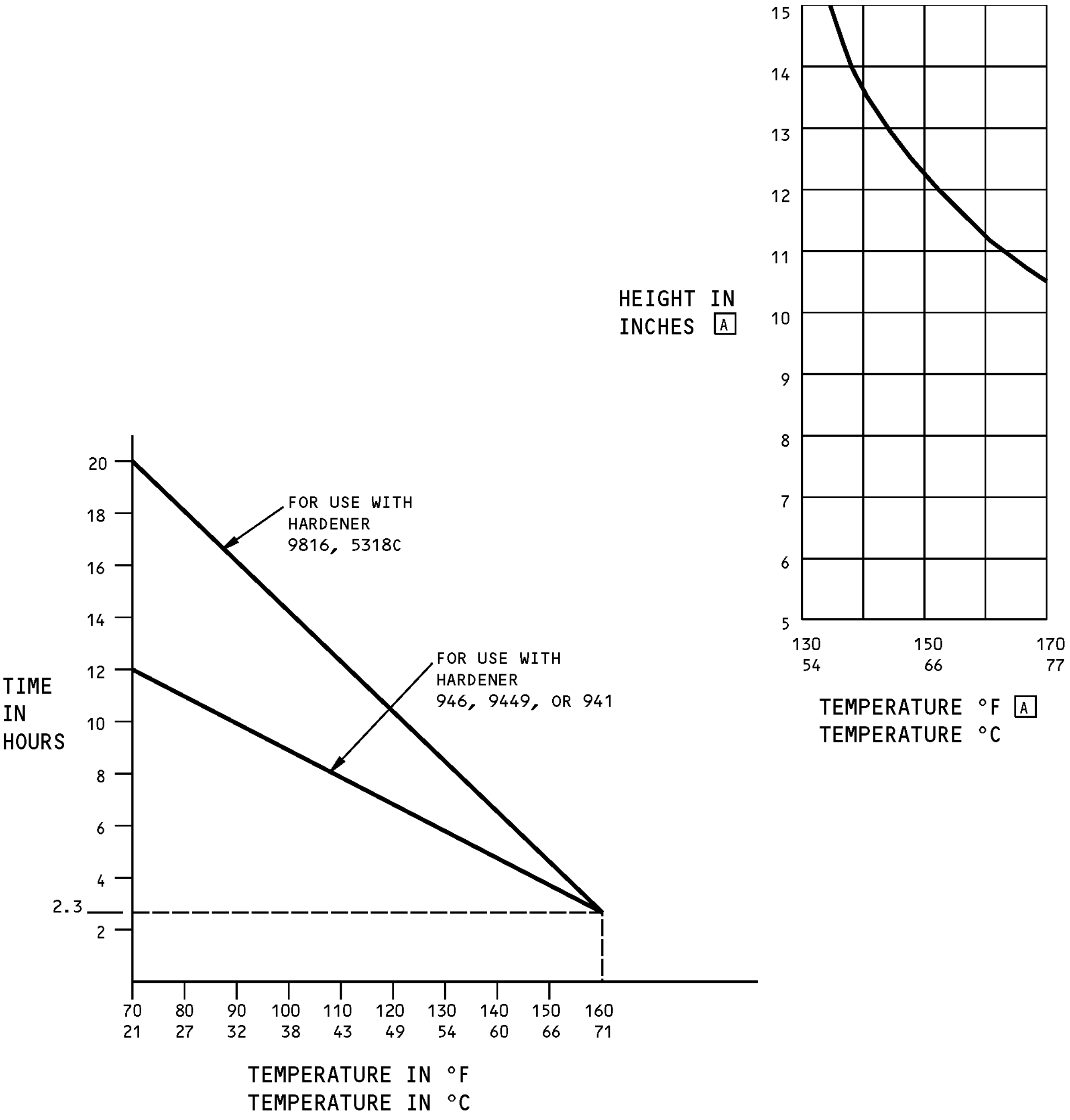


BAGGING SEQUENCE FOR CORE REPLACEMENT - 350°F (177°C) CURE



SECTION THRU LAYUP FOR CORE REPLACEMENT - 350°F (177°C) LAYUP ONLY

Application of Pressure During Cure - 350 Degrees F (177 Degrees C) Cure
Figure 3 (Sheet 2 of 2)

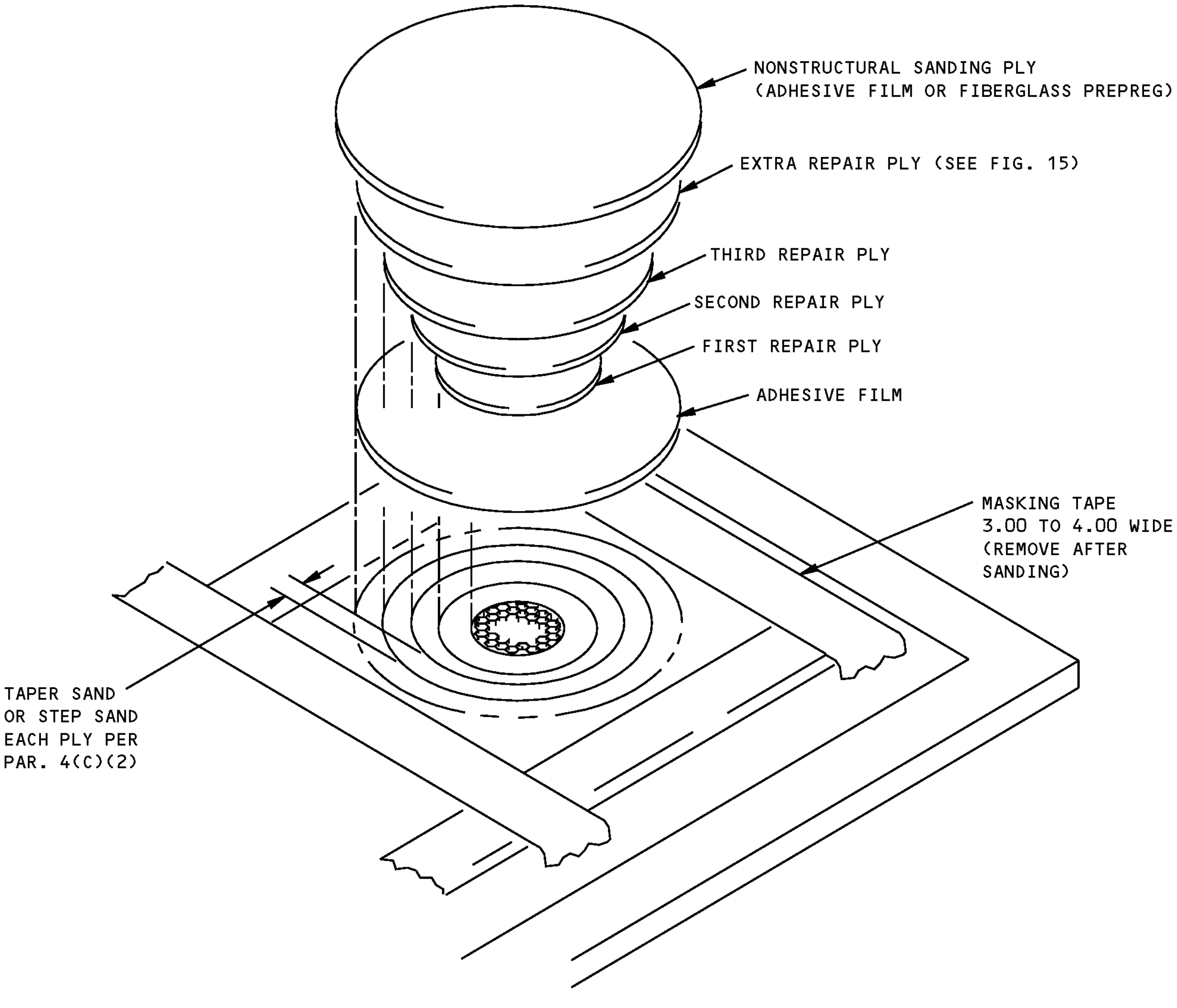


NOTES

- USE THERMOCOUPLES TO MONITOR TEMPERATURE

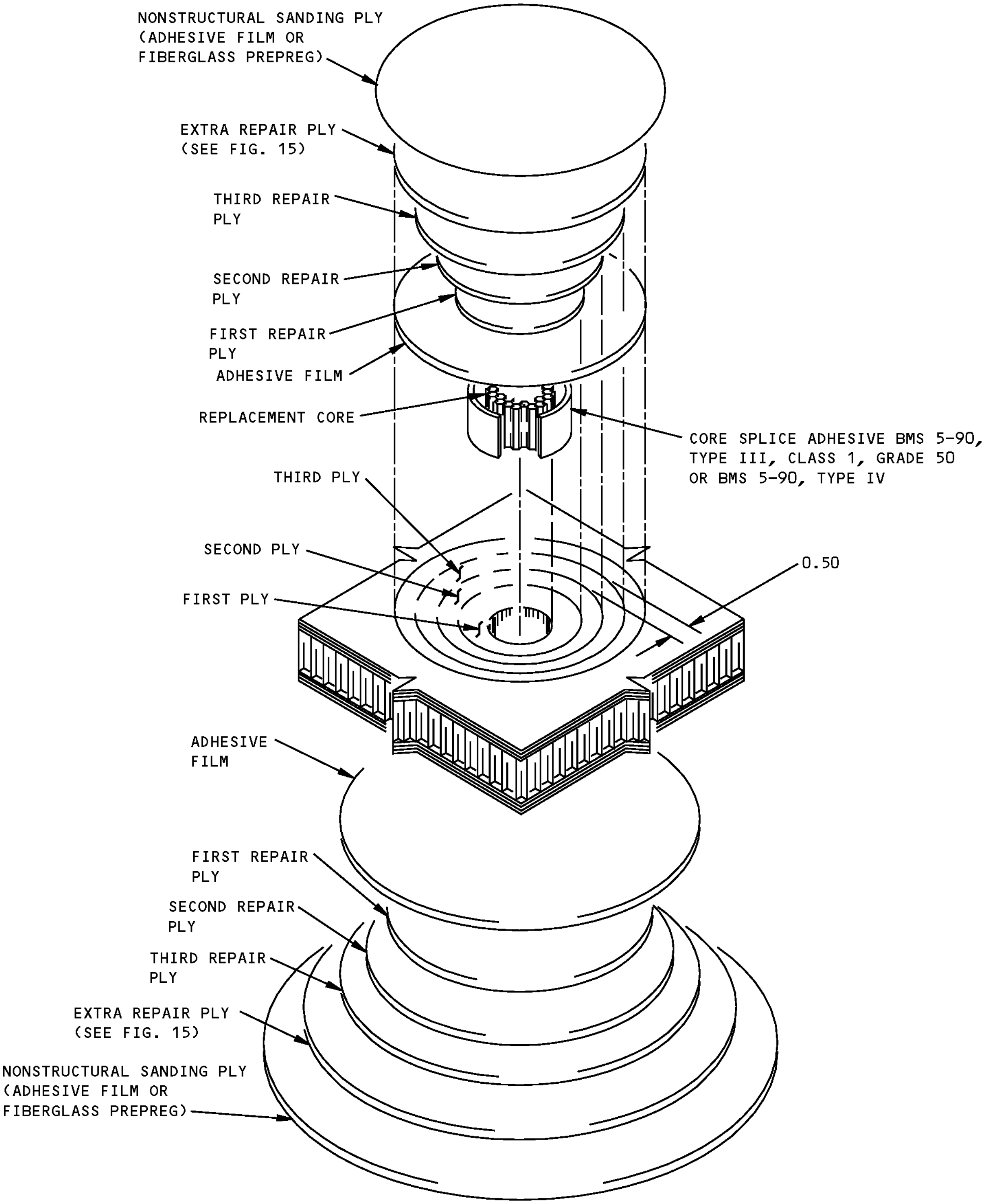
A THE HEIGHT IN INCHES OF 250 WATT HEAT LAMP FROM THE SURFACES OF THE PATCH VS TEMPERATURE AT SURFACE OF PART

Potting and Laminating Resin Cure Temperature
Figure 4

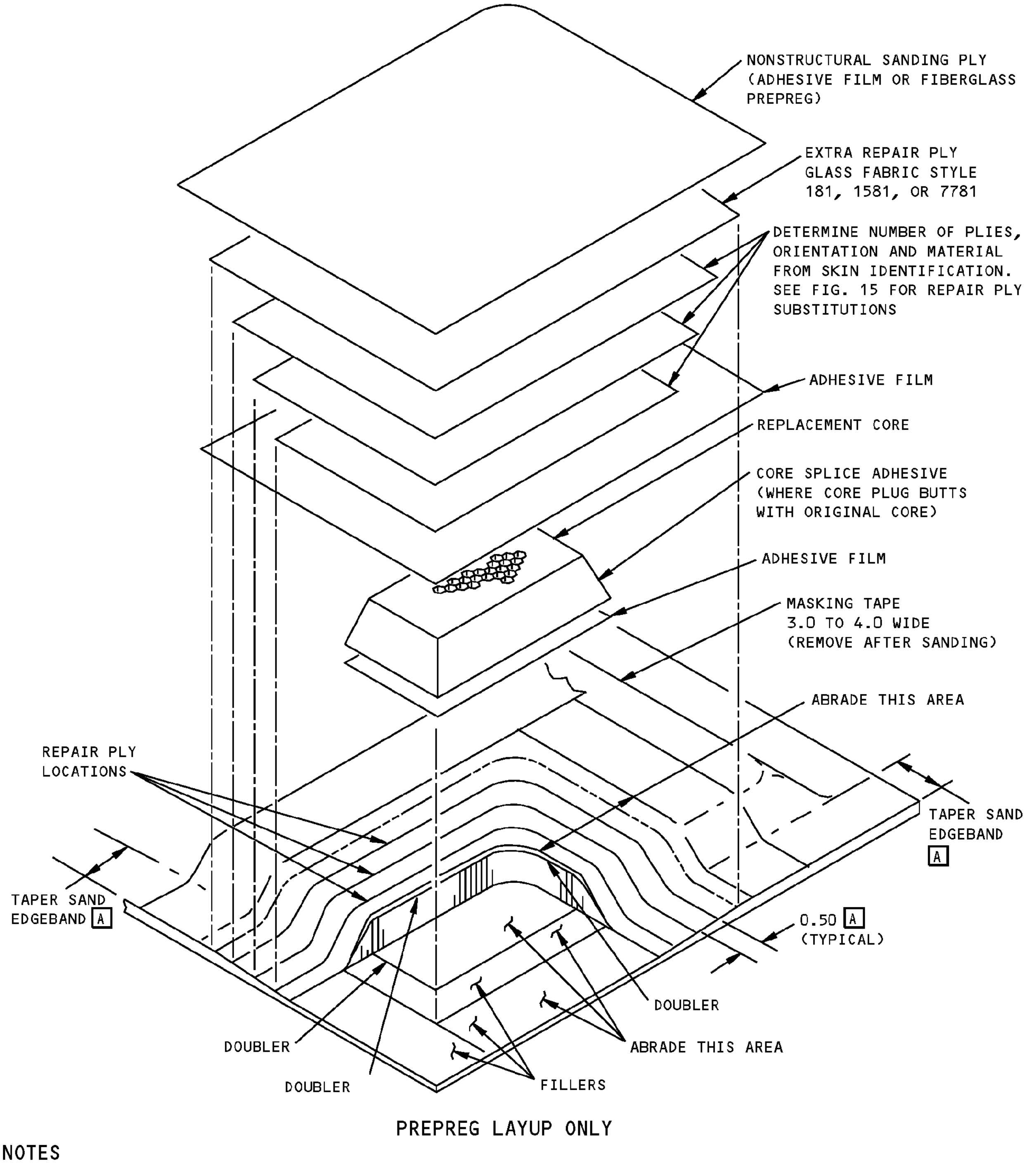


REPAIR PLY LAYUP ONLY

Repair of Damaged External or Internal Skins of a Sandwich Panel - 350 Degrees F (177 Degrees C) Cure
Figure 5



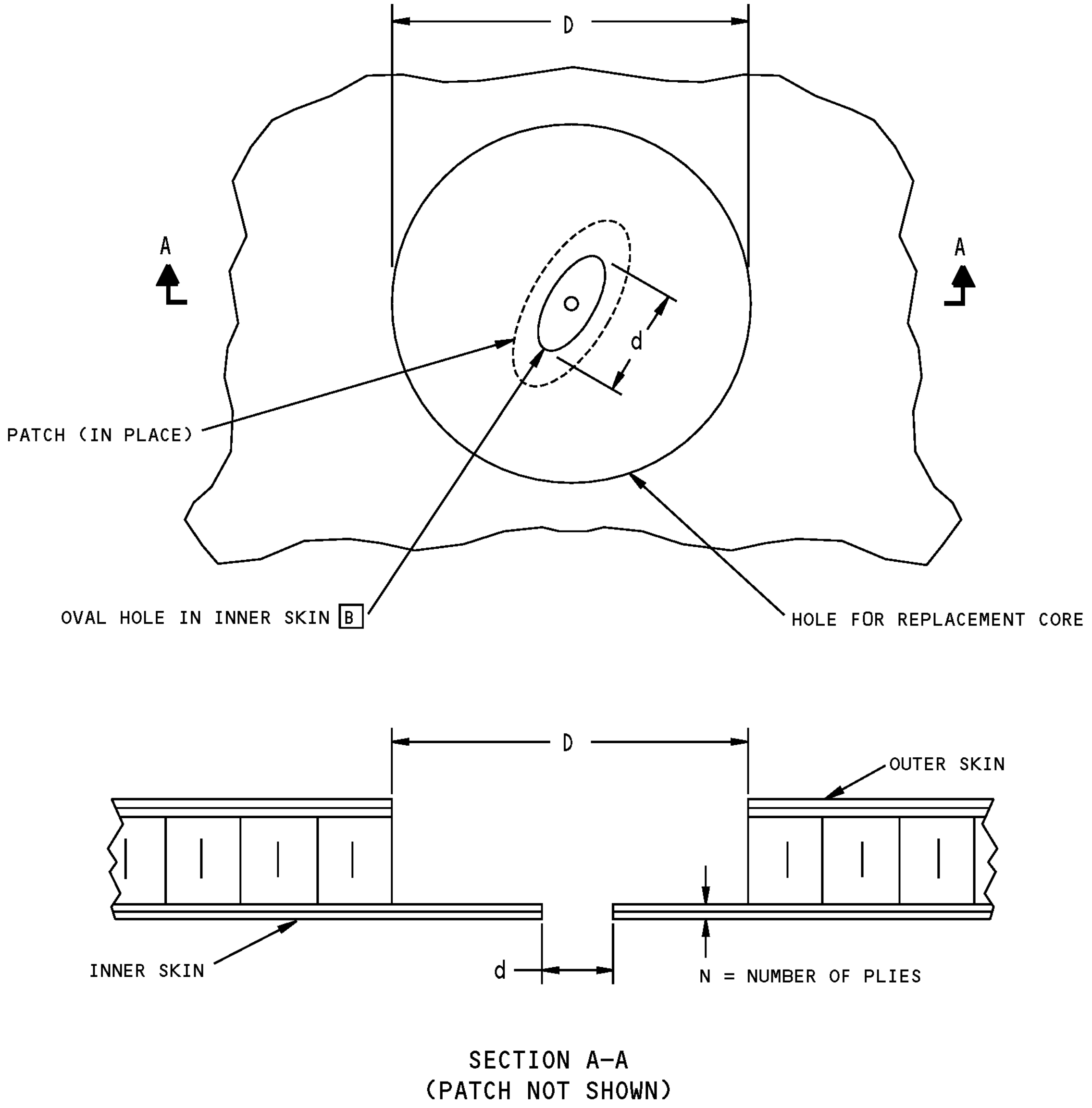
Repair of Large Punctures Thru Both Skins of a Sandwich Panel Including Core Damage - 350 Degrees F (177 Degrees C) Cure
Figure 6



NOTES

A REFER TO FIGURE 13 FOR THE SANDING AND OVERLAP REQUIREMENTS.

Replacement of Honeycomb Core on Damaged Edge of Sandwich Panel - 350 Degrees F (177 Degrees C) Cure
Figure 7



DETAIL I

NOTES

- THIS REPAIR ILLUSTRATES THE USE OF A SPRING STEEL CLAMP. HOWEVER, ANY SUITABLE RETAINING DEVICE MAY BE USED.
- D = d + N + 1
  d = MAJOR DIAMETER OF OVAL HOLE IN INNER SKIN. SIZE LIMITED TO 1.5 INCH FOR THIS REPAIR.
  N = NUMBER OF PLIES
  D = DIAMETER OF HOLE FOR REPLACEMENT CORE

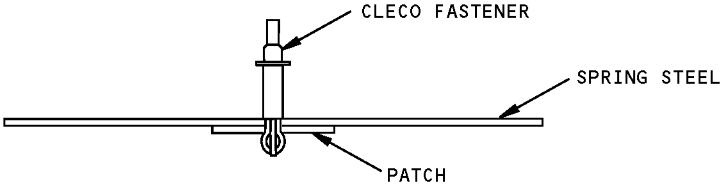
EXAMPLE:

IF d = 0.50 INCH
THEN, D = 0.50 + 2 (PLIES) + 1
D = 3.50 INCH DIAMETER

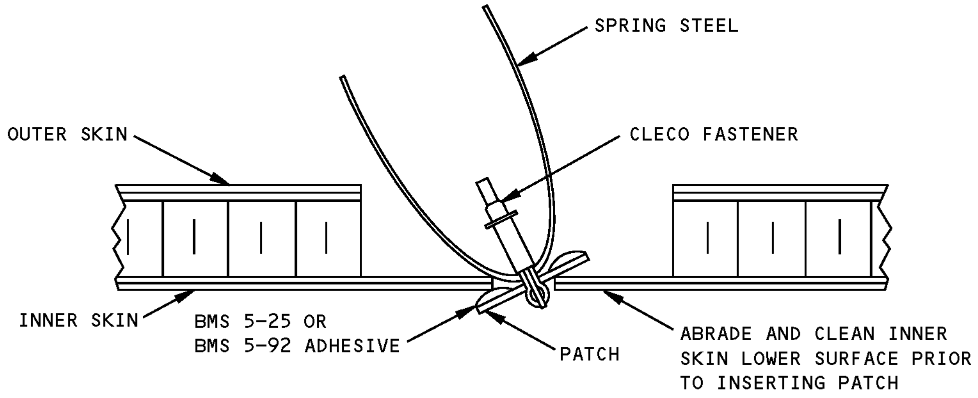
A MAKE TAPER AND OVERLAP AS GIVEN IN FIG. 13.

B MAJOR DIAMETER d OF OVAL HOLE IN INNER SKIN IS LIMITED TO 1.5 INCH FOR THIS REPAIR.

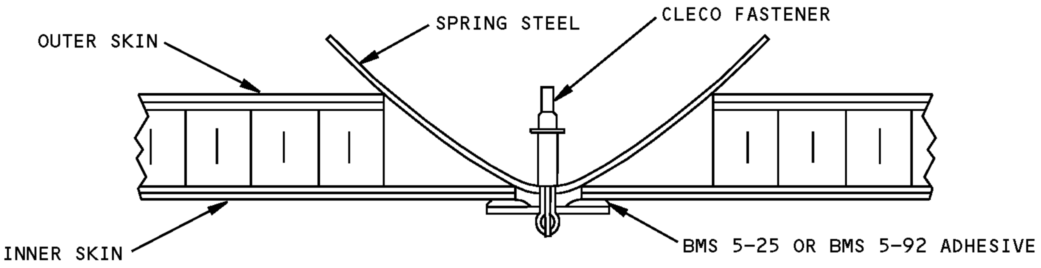
Repair of Damage to External and Internal Skins with Access Limited to One Side - 350 Degrees F (177 Degrees C) Cure
Figure 8 (Sheet 1 of 3)



ASSEMBLE PATCH AND SPRING STEEL
DETAIL II

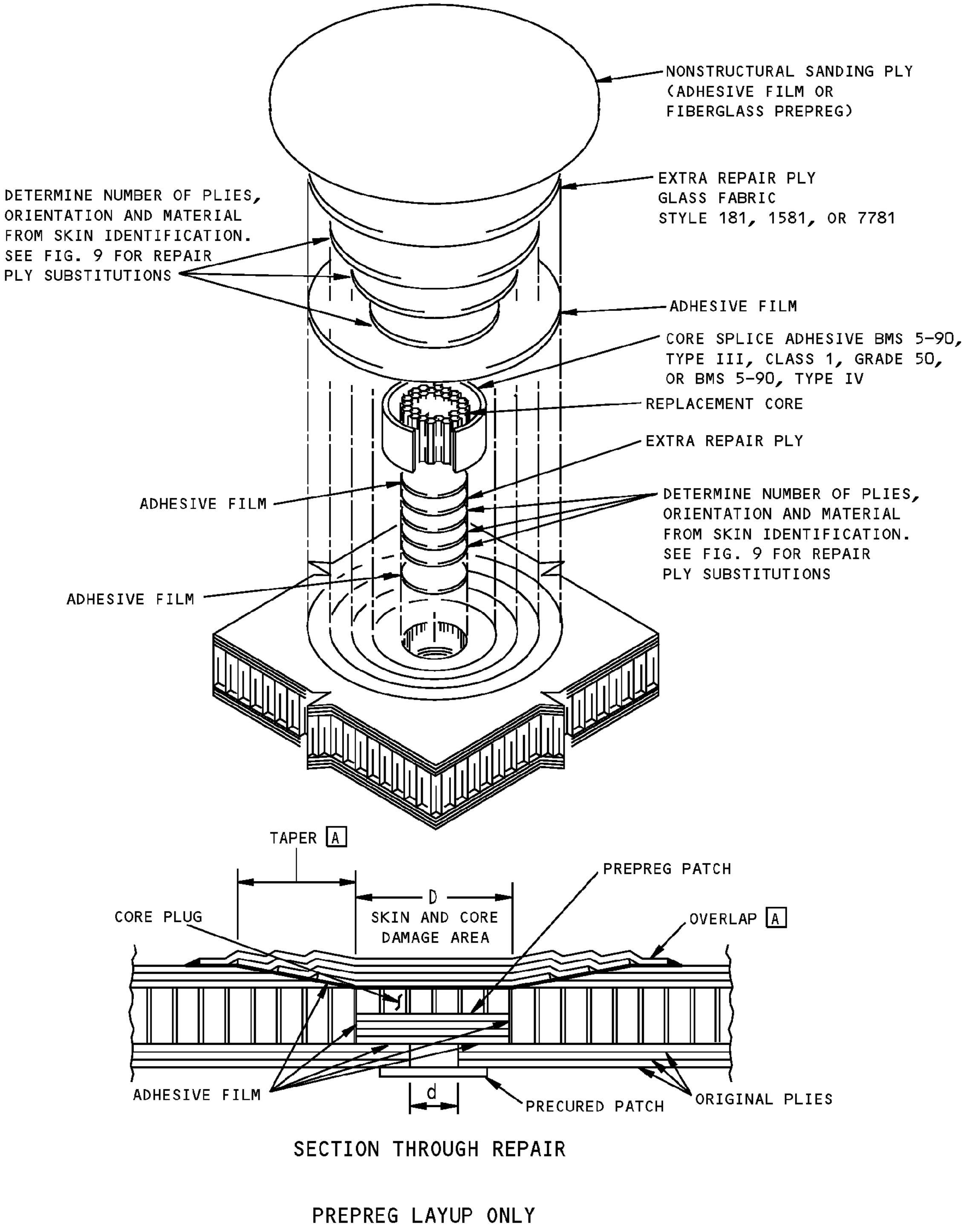


INSERT PATCH INTO OVAL HOLE
DETAIL III



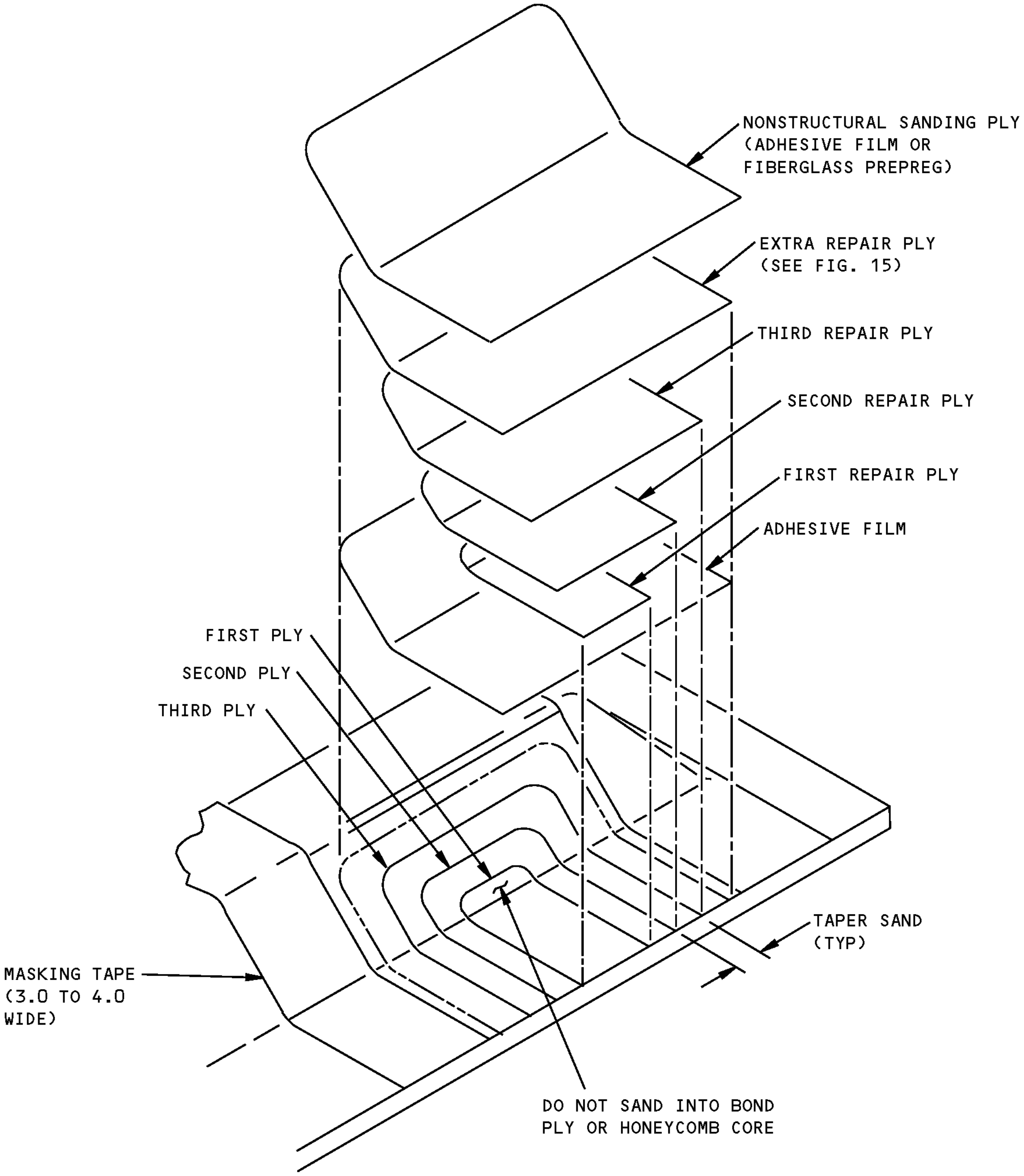
HOLD PATCH IN PLACE WHILE CURING
DETAIL IV

Repair of Damage to External and Internal Skins with Access Limited to One Side - 350 Degrees F (177 Degrees C) Cure
Figure 8 (Sheet 2 of 3)



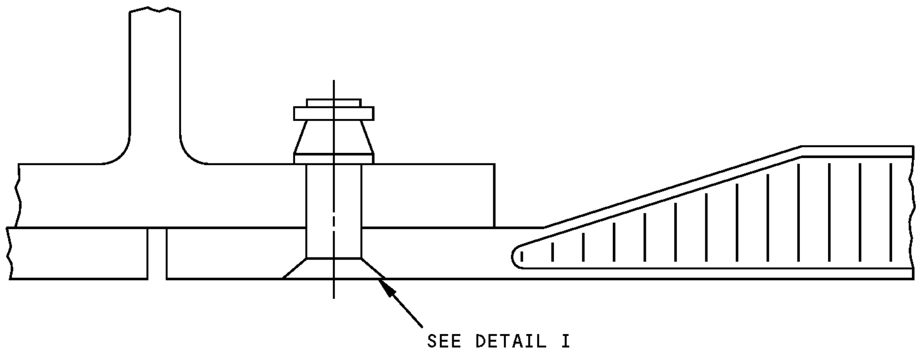
PREPREG LAYUP ONLY
DETAIL V

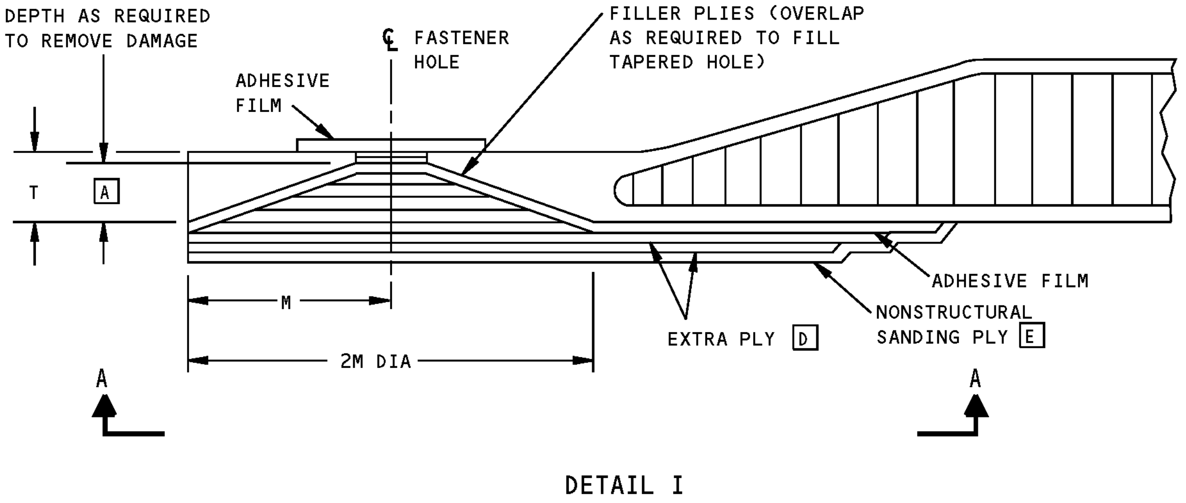
Repair of Damage to External and Internal Skins with Access Limited to One Side - 350 Degrees F (177 Degrees C) Cure
Figure 8 (Sheet 3 of 3)



PREPREG LAYUP ONLY

Repair of Damaged Skin Plies on a Panel Edge - 350 Degrees F (177 Degrees C) Cure
Figure 9





NOTES

- D EQUALS FASTENER DIAMETER
- M = 5T MAXIMUM AS SHOWN WHERE T IS THE THICKNESS OF THE EDGE BAND. DO NOT CUT INTO CORE.
- THIS REPAIR IS APPLICABLE ONLY WHERE NO MORE THAN TWO ATTACH HOLES ARE DAMAGED IN A SEQUENCE OF TEN. IF MORE THAN TWO ATTACH HOLES IN A SEQUENCE OF TEN ARE DAMAGED, REPAIR THE EDGEBAND AS GIVEN IN PARAGRAPH 5.G. (FIGURE 9).

$\boxed{\text{A}}$ APPLY FILLER PLIES AS REQUIRED TO FILL THE DAMAGED AREA.

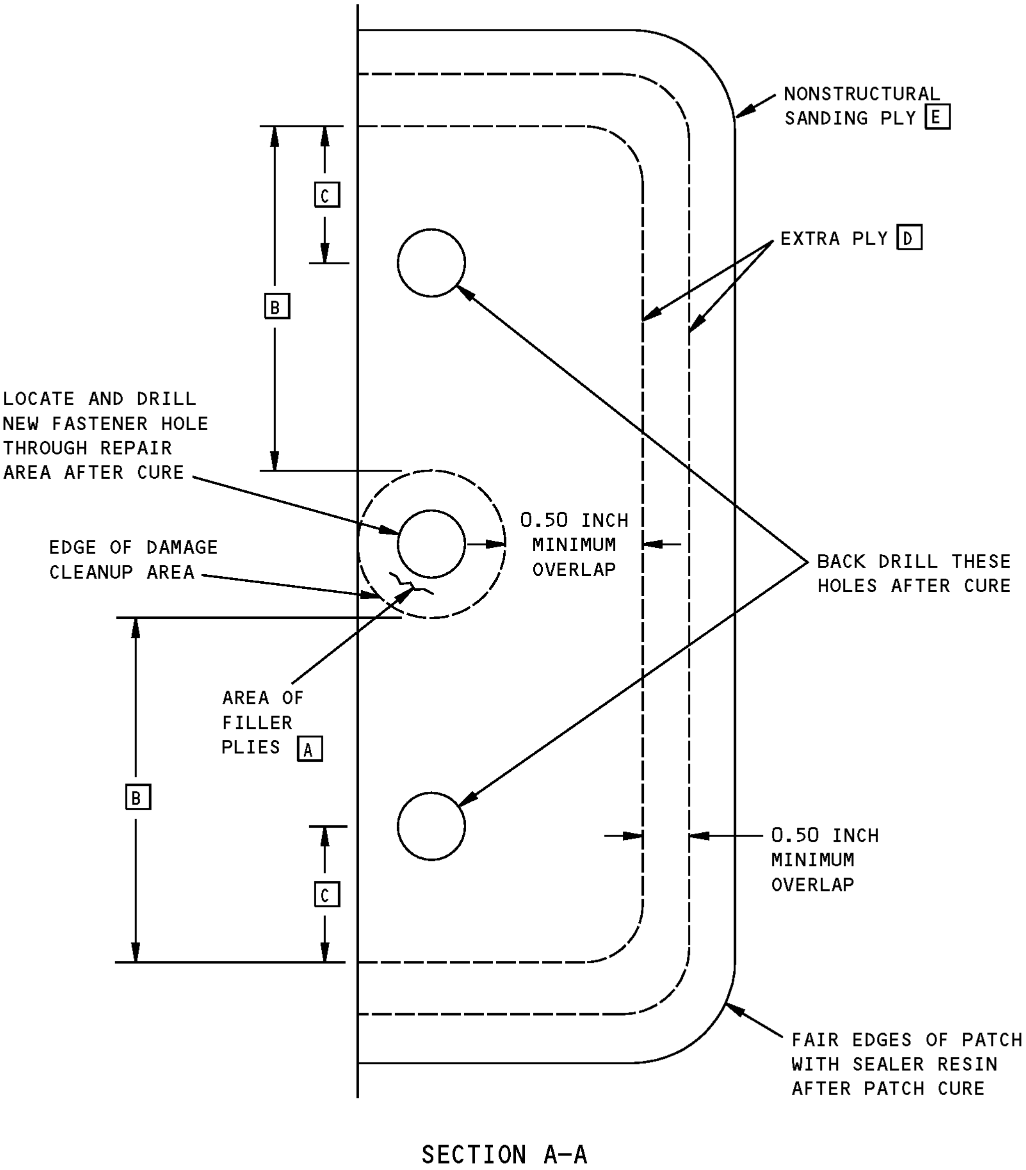
$\boxed{\text{B}}$ EXTEND FIRST EXTRA PLY FAR ENOUGH SO THAT IT EXTENDS AT LEAST 0.50 INCH PAST THE EDGE OF THE DAMAGED AREA.

$\boxed{\text{C}}$ EXTEND FIRST EXTRA PLY FAR ENOUGH TO PROVIDE AT LEAST 2D EDGE MARGIN.

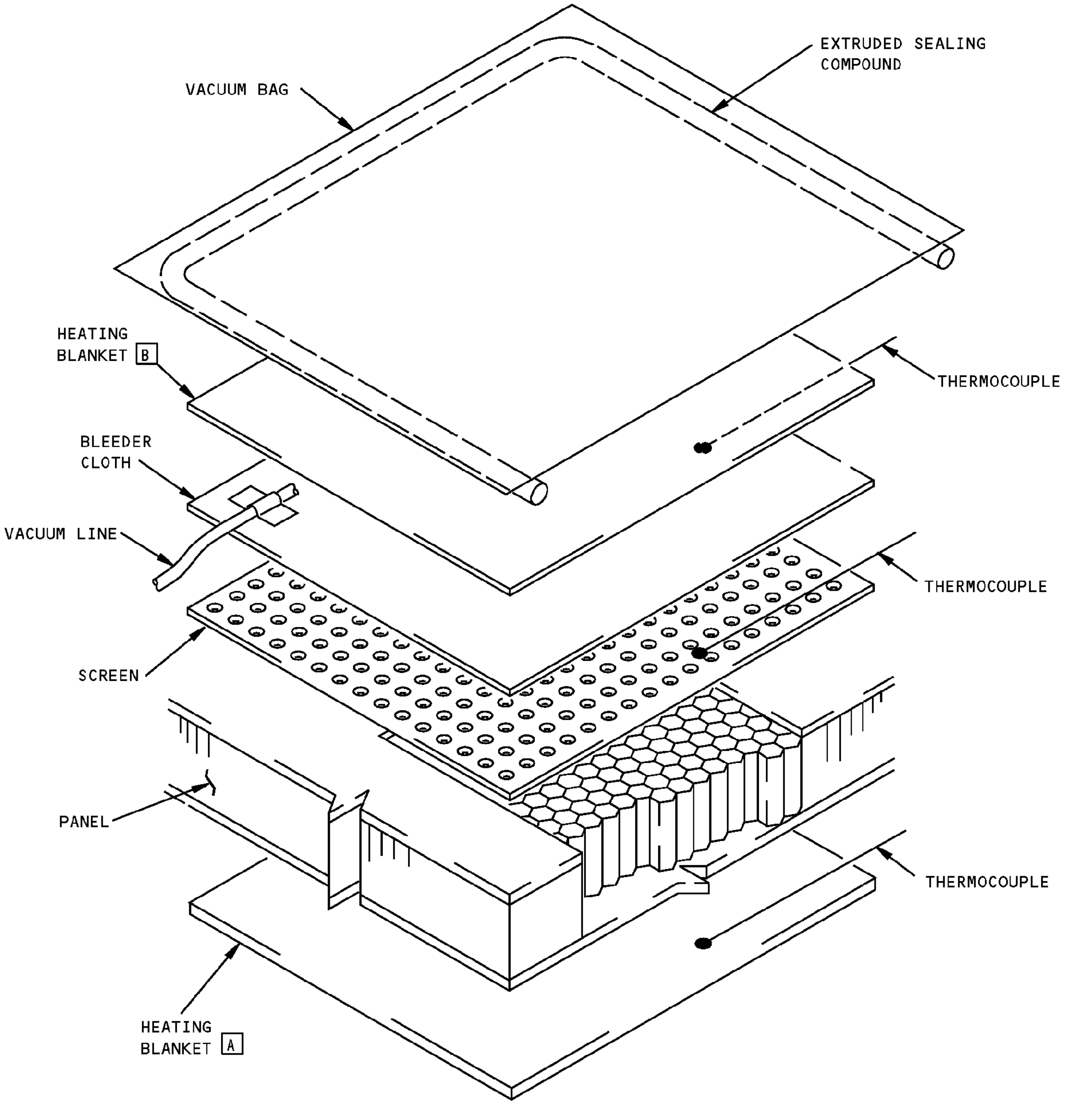
$\boxed{\text{D}}$ ORIENT EXTRA REPAIR PLIES IN THE SAME DIRECTION AS THE ORIGINAL OUTER LAYER (SEE FIG. 15).

$\boxed{\text{E}}$ ADHESIVE FILM BMS 8-145 OR FIBERGLASS PREPREG BMS 8-139, TYPE 1581

Repair of Damaged Panel Attach Hole - 350 Degrees F (177 Degrees C) Cure
Figure 10 (Sheet 1 of 2)



Repair of Damaged Panel Attach Hole - 350 Degrees F (177 Degrees C) Cure
Figure 10 (Sheet 2 of 2)



NOTES

A PREFERRED LOCATION OF HEATING BLANKET WHEN OPPOSITE FACE IS ACCESSIBLE

B ALTERNATE LOCATION OF HEATING BLANKET WHEN OPPOSITE SIDE IS INACCESSIBLE. THIS LOCATION MAY BE USED FOR AN ADDITIONAL HEATING BLANKET TO ACCELERATE WATER REMOVAL

Water Removal From Honeycomb Sandwich
Figure 11

BMS 8-139 STYLE	SEPARATOR FILM COLOR	THICKNESS PER PLY, INCHES	PLY SUBSTITUTIONS
120 $\boxed{A}$	BLUE	0.004-0.006	________
1581, 7781 $\boxed{A}$ $\boxed{C}$	BLUE	0.008-0.012	BMS 8-139, STYLE 120 $\boxed{A}$

BMS 8-139 GLASS FABRIC PREPREG DATA

BMS 8-218 STYLE	SEPARATOR FILM COLOR	THICKNESS PER PLY, INCHES	PLY SUBSTITUTIONS
120 $\boxed{B}$	WHITE	0.0041	BMS 8-139, STYLE 120 $\boxed{B}$
285 $\boxed{B}$	RED	0.010	BMS 8-139, STYLE 1581 $\boxed{B}$

BMS 8-218 ARAMID FABRIC PREPREG DATA

CAUTION: GLASS FABRIC MUST NOT BE SUBSTITUTED FOR GRAPHITE PREPREG REPAIR PLIES.

NOTES

- ORIENT THE SUBSTITUTE MATERIAL THE SAME AS THE ORIGINAL MATERIAL
- 2 PLIES OF BMS 5-154 TYPE II, CLASS 1, GRADE 3 MAY BE SUBSTITUTED FOR EACH PLY OF BMS 5-154 TYPE II, CLASS 1, GRADE 5

$\boxed{A}$ STYLE 1581 IS PREFERRED FOR USE AS REPAIR PLIES. THREE PLIES OF STYLE 120 MAY BE SUBSTITUTED FOR EACH PLY OF STYLE 1581

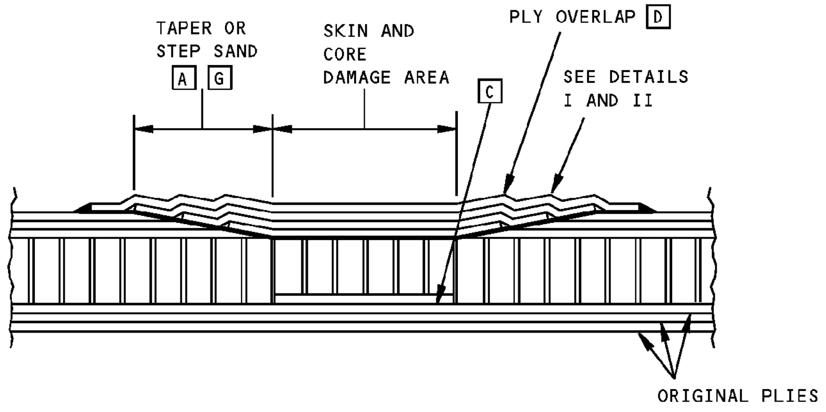
$\boxed{B}$ BMS 8-218, STYLES 120 AND 285 ARE PREFERRED FOR USE AS REPAIR PLIES. ONE PLY OF BMS 8-139 STYLE 120 MAY BE SUBSTITUTED FOR EACH PLY OF BMS 8-218, STYLE 120 AND ONE PLY OF BMS 8-139, STYLE 1581 MAY BE SUBSTITUTED FOR EACH PLY OF BMS 8-218, STYLE 285

$\boxed{C}$ BMS 8-139 STYLE 1581 WAS FORMERLY TYPE 181

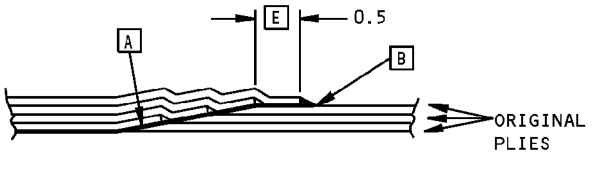
ORIGINAL MATERIAL	SUBSTITUTE MATERIAL
BMS 8-212, CLASS 1, GRADE 95 TAPE	1 PLY BMS 8-212, CLASS 2, STYLE 3K-70-PW FABRIC
BMS 8-212, CLASS 1, GRADE 145 AND GRADE 190 TAPE	2 PLIES GRADE 95 TAPE OR 2 PLIES CLASS 2, TYPE III, STYLE 3K-70-PW FABRIC
BMS 8-212, CLASS 2, STYLE 3K-135-8H FABRIC	2 PLIES BMS 8-212, CLASS 2, STYLE 3K-70-PW

BMS 8-212 GRAPHITE TAPE AND FABRIC PREPREG DATA

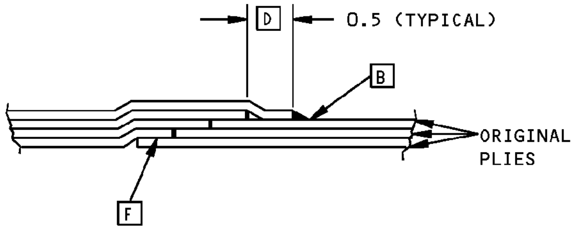
Tape and Fabric Prepreg Ply Substitution Data
Figure 12



SECTION THROUGH TYPICAL REPAIR
(PREPREG LAYUP ONLY)



TAPER SANDED SKIN
DETAIL I

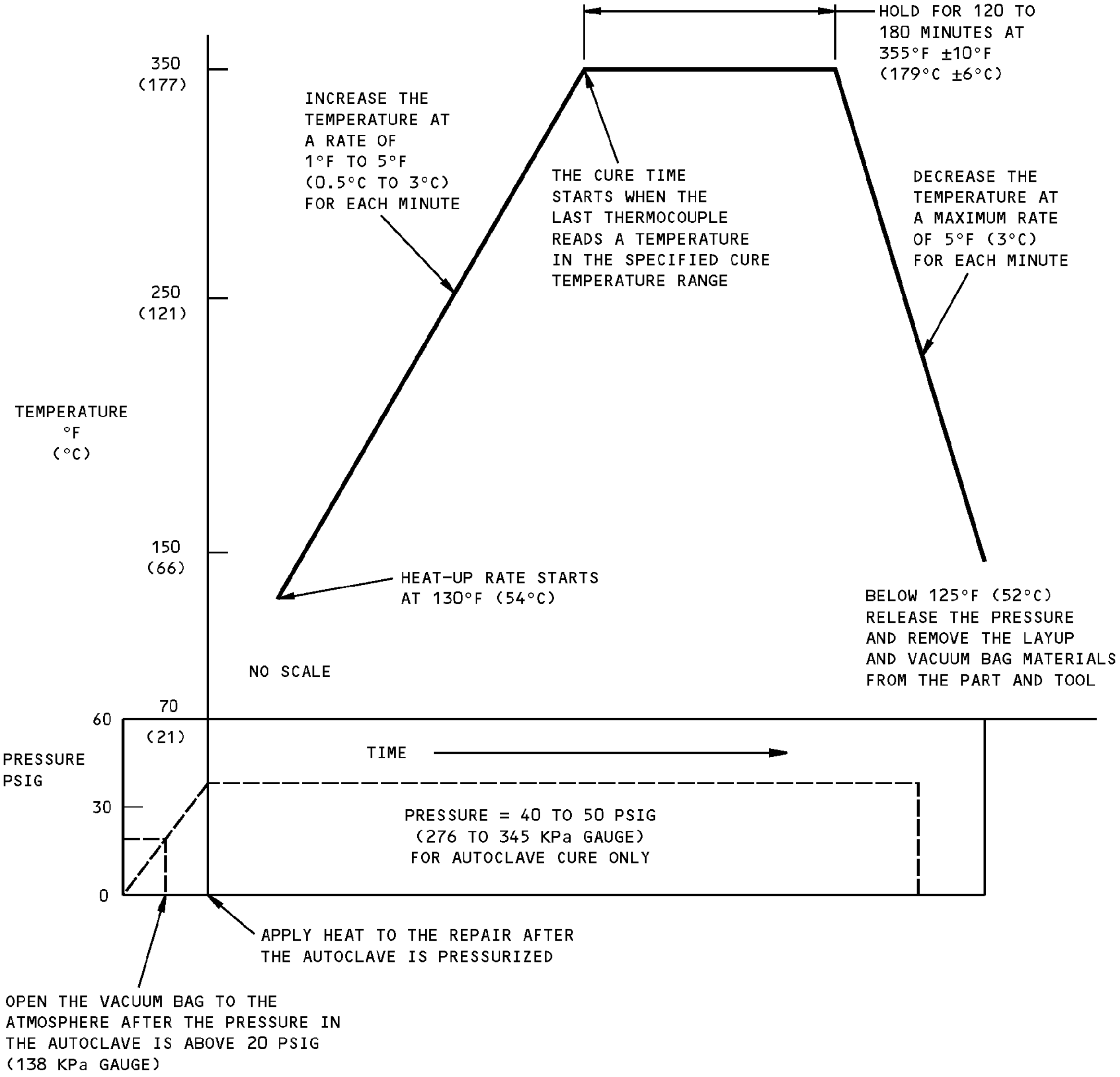


STEP SANDED SKIN
DETAIL II

NOTES

- A TAPER SAND AROUND REPAIR AREA OVER DISTANCE OF 0.5 INCH FOR EACH EXISTING PLY
- B DO NOT EXPOSE OR DAMAGE FILAMENTS IN UNTAPERED AREA WHEN SANDING.
- C SANDING MUST NOT EXPOSE OR DAMAGE THE FILAMENTS IN BOND PLY (PLY BONDED TO CORE).
- D EXTRA PLY MUST OVERLAP AT LEAST 0.5 INCH. EACH SUCCEEDING PLY MUST OVERLAP AT LEAST 0.5 INCH PAST EDGE OF PRECEEDING PLY
- E SURFACE PLY FAYING SURFACE MUST BE AT LEAST 0.5 INCH PAST EDGE OF TAPER.
- F REMOVE DAMAGED PLIES IN STEPS OF 0.5 INCH FOR EACH EXISTING PLY
- G TAPER SAND SURFACES IN AREAS OF CRITICAL AERODYNAMIC SMOOTHNESS. REFER TO 51-10-01

Sanding and Overlap Requirements
Figure 13



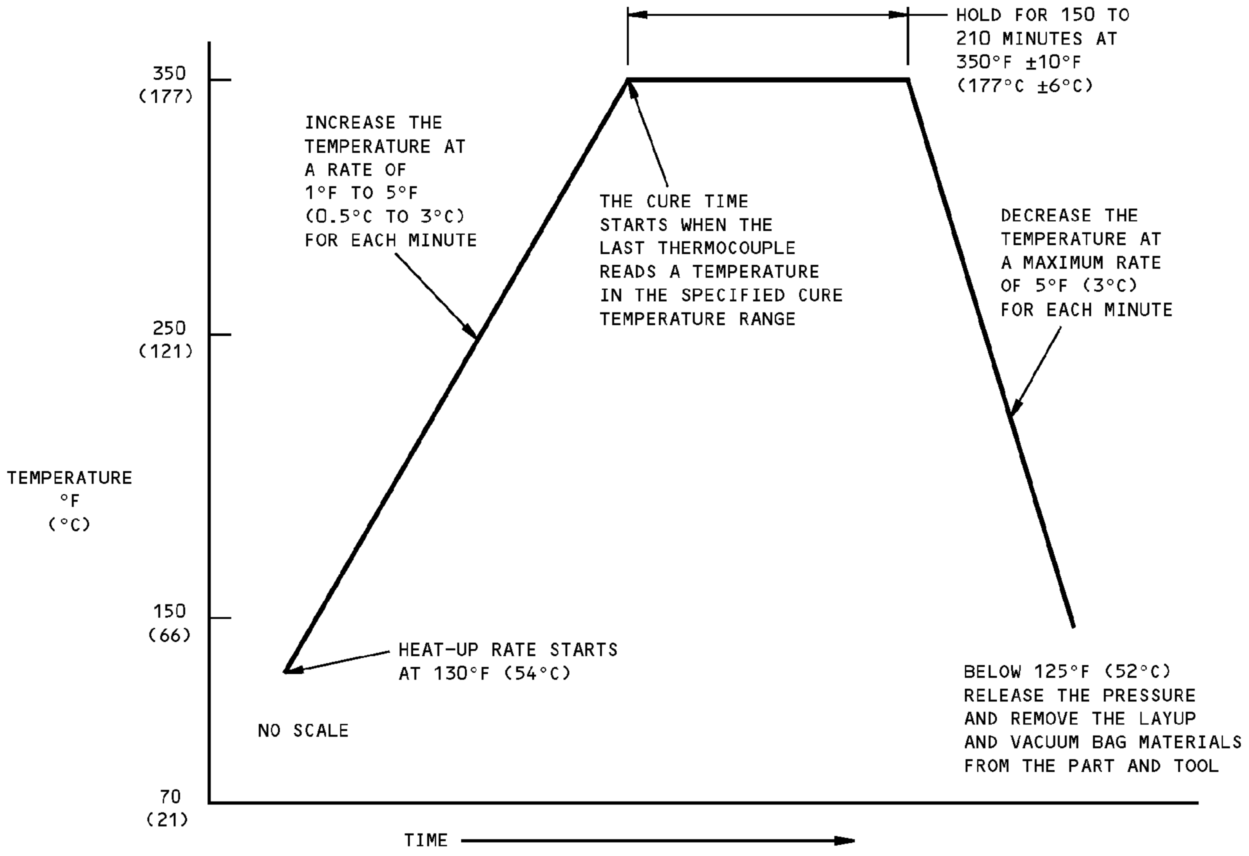
NOTES

- 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

DETAIL I

Repair Cure Cycles
Figure 14 (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

DETAIL II

Repair Cure Cycles
Figure 14 (Sheet 2 of 2)

COMPONENT MATERIAL	EXTRA PLY MATERIAL
GRAPHITE	GRAPHITE FABRIC, STYLE 3K-70-PW [B]
GRAPHITE/ARAMID/GLASS	GRAPHITE FABRIC, STYLE 3K-70-PW [A] [B]
ARAMID	GLASS FABRIC, TYPE 1581 OR 7781

NOTES

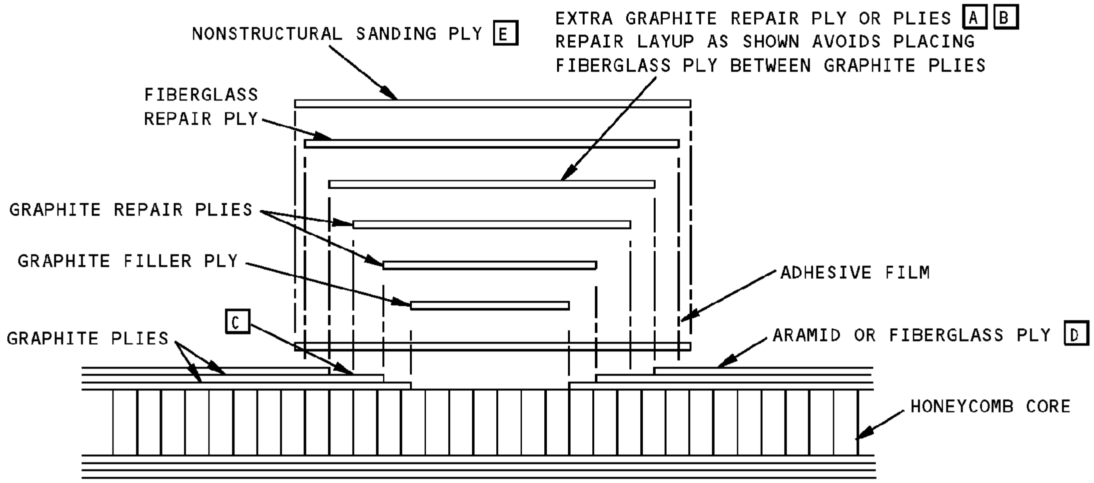
[A] ON HYBRID PANELS, GRAPHITE EXTRA PLIES MUST BE BONDED TO GRAPHITE PLY. SEE DETAIL I

[B] REFER TO THE SPECIFIC COMPONENT REPAIR SECTION FOR THE ORIENTATION OF THE EXTRA REPAIR PLIES. IF IT IS NOT GIVEN AND WHEN MORE THAN ONE EXTRA REPAIR PLY IS REQUIRED, THE ORIENTATIONS OF THE EXTRA REPAIR PLIES MUST REPEAT THE ORIENTATIONS OF THE EXISTING PLIES IN THE ORIGINAL LAMINATE STARTING WITH THE OUTERMOST PLY

[C] WHEN EXTRA GRAPHITE REPAIR PLY OR PLIES ARE REQUIRED, THE EXISTING OUTER PLY OF ARAMID, ALUMINUM COATED GLASS FABIC OR FIBERGLASS MUST BE SANDED TO ALLOW AN ADDITIONAL OVERLAP OF 0.50 INCH EACH EXTRA REPAIR PLY

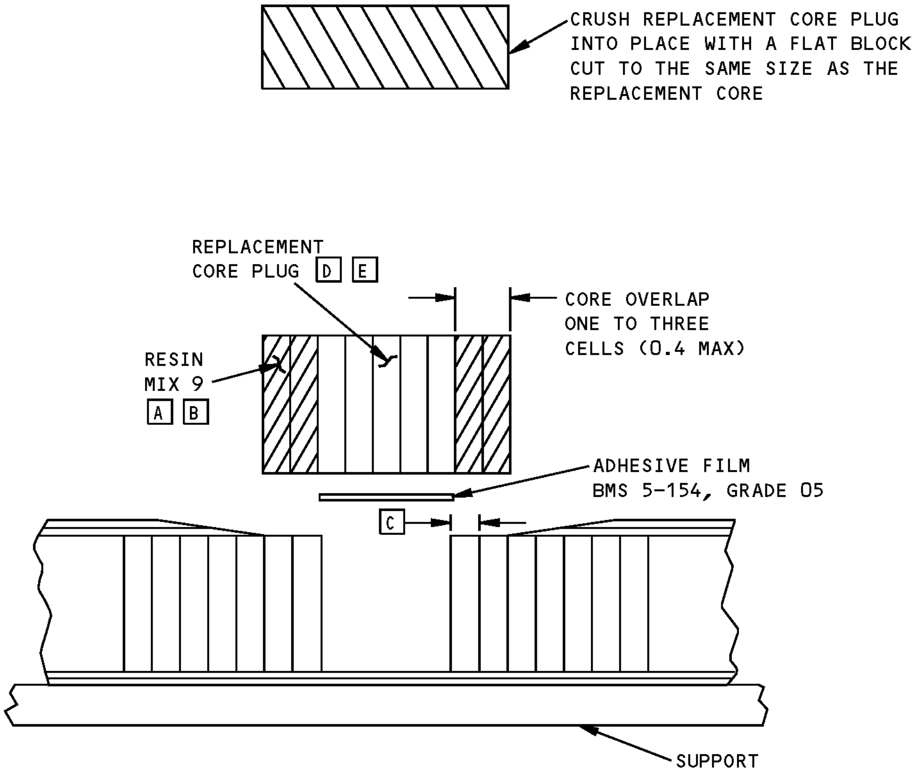
[D] IF OUTER PLY CONSISTS OF ALUMINUM COATED GLASS FABIC CONDUCTIVE COATING, REFER TO 51-70-14,51-70-05 OR FIG. 17 AS APPLICABLE FOR REPAIR OF THE CONDUCTIVE COATING

[E] BMS 5-154 ADHESIVE FILM OR BMS 8-139 FIBERGLASS PREPREG. SEE TEXT PAR 3.E.(4)(a)



SECTION THRU HYBRID HONEYCOMB SANDWICH
DETAIL I

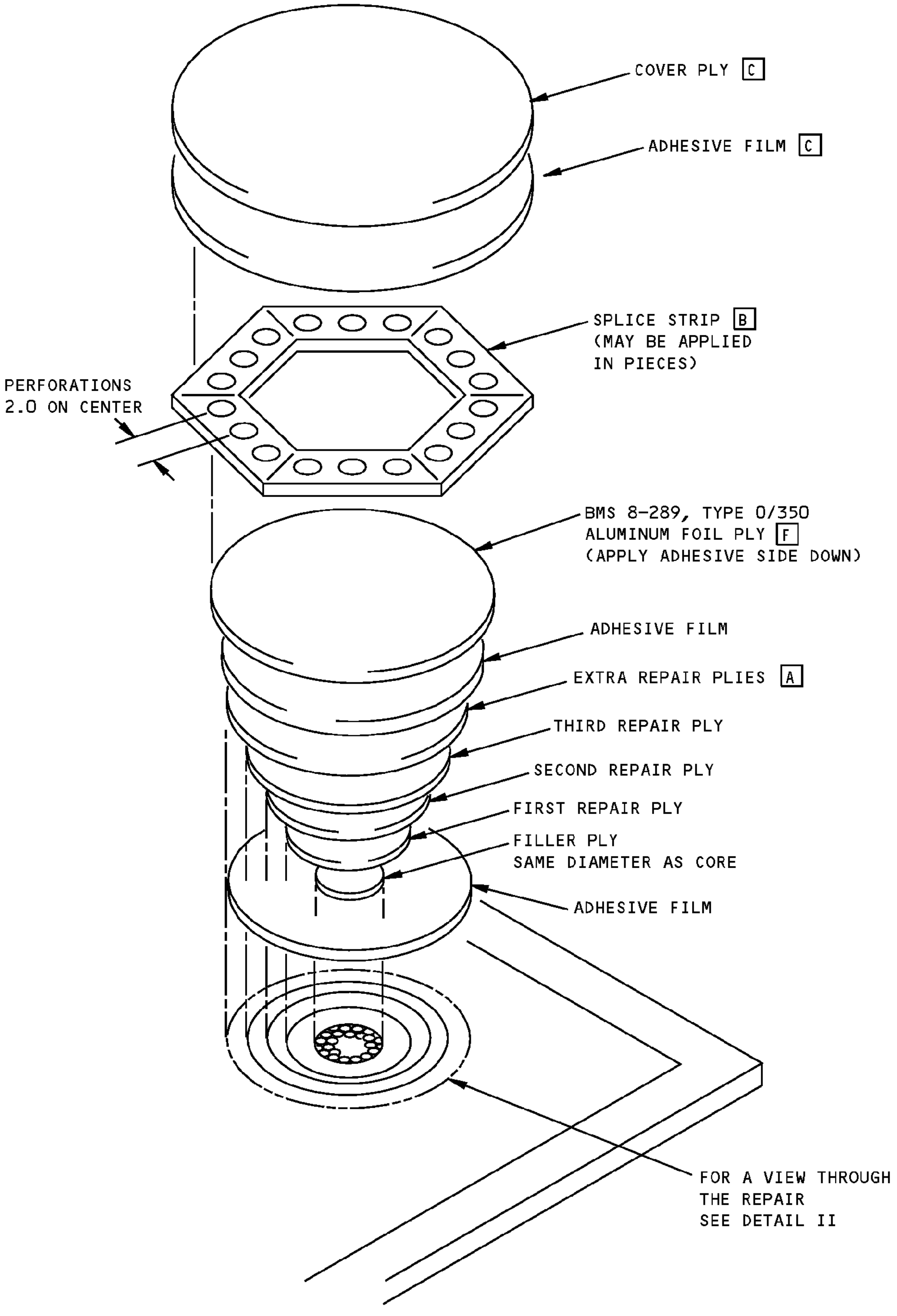
Extra Repair Ply Materials
Figure 15



NOTES

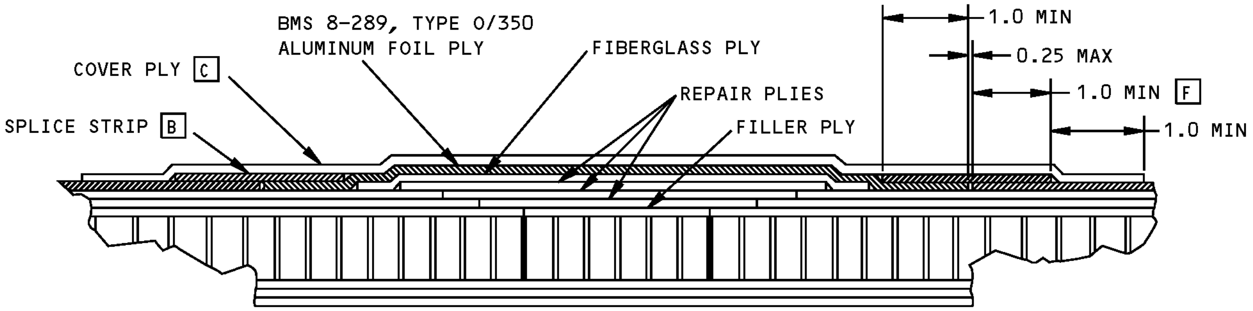
- A DIP PERIPHERY OF CORE PLUG IN RESIN MIX 9 TO A DEPTH OF ONE TO THREE CELLS (0.4 INCH MAX)
- B AFTER SPLICING, POUR RESIN MIX 9 INTO SPLICED CELLS
- C WHEN PREPARING REPAIR AREA LEAVE ONE TO THREE CELLS (0.4 INCH MAX) VISIBLE BETWEEN CORE REPAIR CAVITY AND SKIN TO MATCH CORE OVERLAP
- D ALIGN HONEYCOMB CELLS OF REPAIR PLUG WITH ORIGINAL CORE
- E REPLACEMENT CORE PLUG MUST BE MADE FROM CORE MATERIAL AT LEAST TWO GRADES DENSER THAN THE ORIGINAL CORE

Core Crush Splicing Requirements
Figure 16



REPAIR PLY LAYUP
DETAIL I

Repairs to Aluminum Foil
Figure 17 (Sheet 1 of 2)



VIEW THRU REPAIR
DETAIL II

MATERIAL	SHIPPING AND STORAGE LIFE		SHELF LIFE D	
	MAXIMUM TEMPERATURE E	DURATION (DAYS)	MAXIMUM TEMPERATURE	DURATION (HOURS)
BMS 8-289 CLASS O/350	10°F (-12°C)	180	95°F (35°C)	240

STORAGE AND SHELF LIFE OF BMS 8-289
TABLE I

NOTES

A SEE INDIVIDUAL COMPONENT REPAIR SECTION FOR EXTRA REPAIR PLY REQUIREMENTS. ALL STRUCTURE HAVING AN ALUMINUM FOIL LAYER MUST HAVE A FIBERGLASS PLY TO WHICH THE FOIL IS BONDED. IF A FIBERGLASS EXTRA REPAIR PLY IS NOT REQUIRED BY THE INDIVIDUAL COMPONENT REPAIR SECTION, ONE MUST BE INSTALLED AS THE OUTERMOST PLY.

B BMS 8-289, TYPE O/350, FORM II, WITH THE ADHESIVE SIDE UP OR FORM I, ALODINE TREATED ON NONADHESIVE SIDE. PERFORATE FORM I WITH 0.5 DIAMETER HOLES ON 2.0 CENTERS.

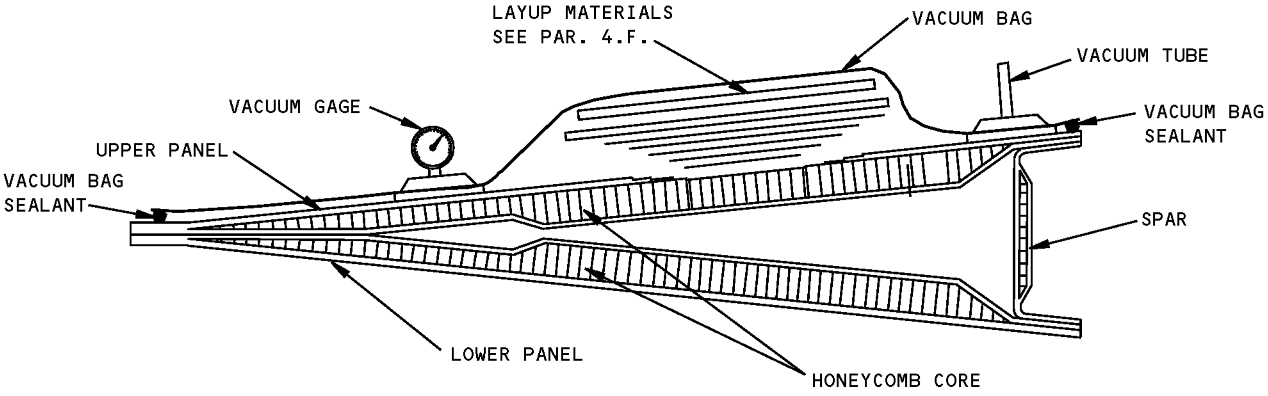
C BMS 8-139, TYPE 120, 1581 OR 7781 GLASS FABRIC WITH BMS 5-154, TYPE II, CLASS 1 GRADE 03 OR 05 ADHESIVE FILM UNDERNEATH

D SHELF LIFE HOURS ACCUMULATE FROM THE DATE OF REMOVAL FROM REFRIGERATION UNTIL START OF THE REPAIR CURE CYCLE.

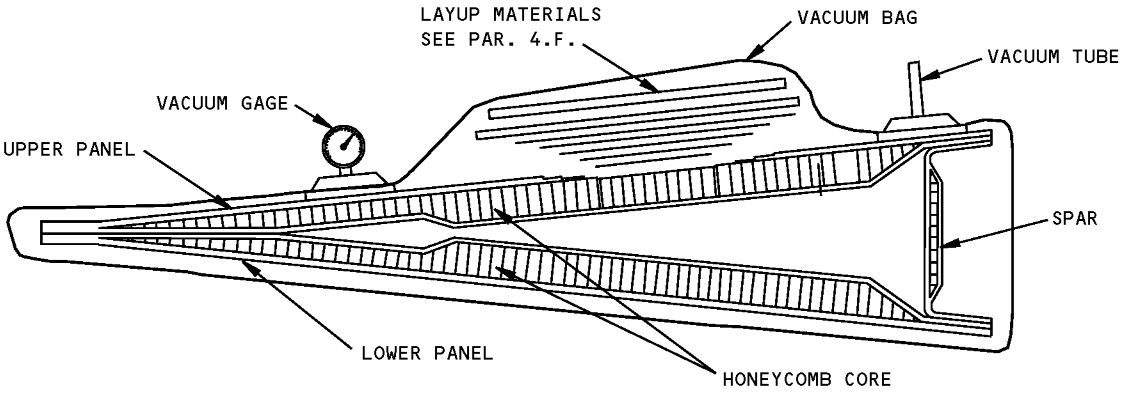
E STORAGE LIFE SHALL BE AS SHOWN IN TABLE I UNLESS PRODUCT IS GUARANTEED BY THE SUPPLIER FOR 360 DAYS STORAGE AT 95°F (35°C).

F TREAT THE INITIAL ALUMINUM FOIL WITH A CHEMICAL CONVERSION COATING.

Repairs to Aluminum Foil
Figure 17 (Sheet 2 of 2)



ACCEPTABLE - VACUUM BAG SEALED TO ONE SIDE ONLY



NOT ACCEPTABLE - VACUUM BAG SEALED AROUND ENTIRE PART
MAY CAUSE ASSEMBLY DISTORTION DURING CURE CYCLE

PARTS CONSISTING OF UPPER AND LOWER PANELS [A]

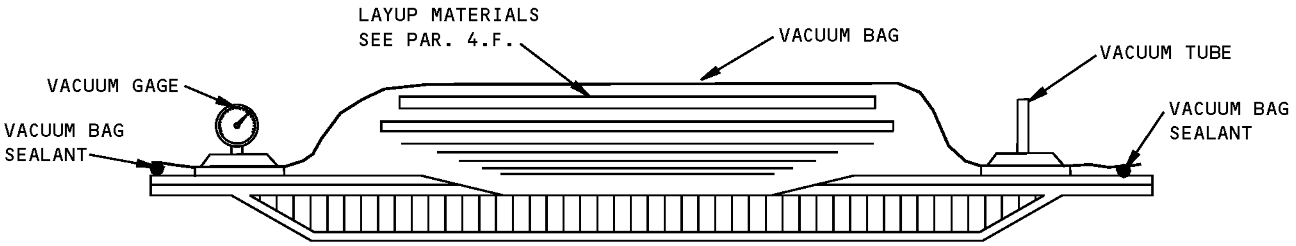
NOTES

- REFER TO PAR. 4.F. FOR LAYUP AND BAGGING PROCEDURES

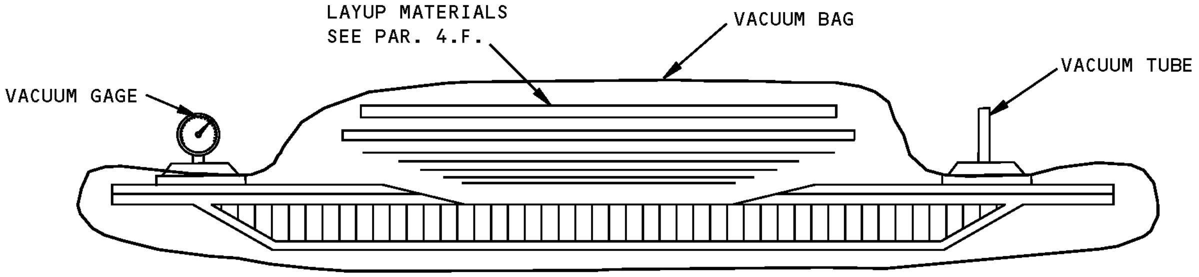
[A] THIS TYPE OF COMPONENT MUST NOT BE COMPLETELY SEALED IN A VACUUM BAG. DAMAGE TO PART WILL OCCUR. VACUUM BAG ONE SIDE OF COMPONENT ONLY

[B] THIS TYPE OF COMPONENT MAY BE COMPLETELY SEALED IN A VACUUM BAG OR MAY BE SEALED ON ONE SIDE ONLY

Vacuum Bagging Restrictions
Figure 18 (Sheet 1 of 2)



ACCEPTABLE - VACUUM BAG SEALED TO ONE SIDE ONLY



ACCEPTABLE - VACUUM BAG SEALED AROUND ENTIRE PART

PARTS CONSISTING OF ONE PANEL B

Vacuum Bagging Restrictions
Figure 18 (Sheet 2 of 2)

GENERAL - GRAPHITE/ARAMID/HYBRID REINFORCED EPOXY LAMINATES AND NONMETALLIC HONEYCOMB SANDWICH REPAIRS - 250°F (121°C) CURE

1. Scope

WARNING: DO NOT BREATHE CARBON FIBER DUST. MAKE SURE THAT THERE IS A GOOD FLOW OF AIR WHERE YOU DO THE WORK. USE EQUIPMENT TO HELP YOU BREATHE WHEN YOU WORK IN A CONFINED SPACE. USE A VACUUM NEAR THE SOURCE OF THE DUST TO REMOVE THE DUST FROM THE AIR. IF YOU DO NOT OBEY, YOU CAN CAUSE INJURY.

CAUTION: DO NOT LET CARBON FIBER DUST GO INTO ELECTRICAL EQUIPMENT. CARBON FIBER DUST IS ELECTRICALLY CONDUCTIVE AND IT CAN CAUSE SHORT CIRCUITS. USE A VACUUM NEAR THE SOURCE OF THE DUST TO REMOVE THE DUST FROM THE AIR. IF YOU DO NOT OBEY, YOU CAN CAUSE DAMAGE TO THE ELECTRICAL EQUIPMENT.

TO GET AN ACCEPTABLE QUALITY REPAIR, DO AS FOLLOWS:

- REFER TO THE APPLICABLE COMPONENT THAT YOU ARE GOING TO REPAIR FOR THE REPAIR LIMITS AND MATERIAL OF THE COMPONENT BEFORE YOU USE THESE REPAIR INSTRUCTIONS.
- USE THE CORRECT MATERIALS FOR THE TYPE OF COMPONENT AND REPAIR THAT IS MADE.
- USE THE MATERIALS THAT AGREE WITH THE SPECIFICATIONS IN THE SRM.
- ACCURATELY FOLLOW THE SRM PROCEDURES AT EACH STEP OF THE REPAIR. IF YOU DO NOT DO THIS, IT CAN CAUSE A REPAIR THAT IS NOT SATISFACTORY AND NOT APPROVED.

250°F (121°C) CURE REPAIRS ARE RESTRICTED TO SPECIFIC AREAS AND COMPONENTS AS SHOWN IN THE INDIVIDUAL COMPONENT REPAIR SECTION IN THE MANUAL. THESE REPAIRS ARE PERMANENT WHEN APPLIED USING THE REPAIR MANUAL PROCEDURES TO COMPONENTS ORIGINALLY MADE FROM 250°F (121°C) CURE MATERIALS.

250°F (121°C) CURE REPAIRS MAY NOT RESTORE THE STRENGTH OR DURABILITY OF COMPONENTS ORIGINALLY MADE USING 350°F (177°C) CURE MATERIALS. THEIR USE IS RESTRICTED TO SPECIFIC AREAS OF COMPONENTS AS SHOWN IN THE INDIVIDUAL COMPONENT REPAIR SECTION OF THE MANUAL.

REPAIRS TO DAMAGE CONTAINED HEREIN, SPECIFY MATERIALS QUALIFIED FOR 250°F (121°C) CURE. 350°F (177°C) CURE MATERIALS WILL NOT CURE AT 250°F (121°C) TEMPERATURES AND MUST NOT BE USED TO ATTEMPT REPAIR OF 250°F (121°C) COMPONENTS.

A. This section contains repairs to components made from epoxy resin reinforced with several layers of graphite tape or fabric, aramid fabric or a combination of graphite, aramid or fiberglass. A hybrid can contain layers of graphite, aramid or fiberglass. The most common construction is a sandwich of two laminated skins separated by a nonmetallic honeycomb core. Fiberglass is also known as glass fabric. Solid laminate is used for small components, honeycomb panel edgebands, and at fitting locations. This section describes repair modes using 250°F (121°C) cure materials (prepreg layup).

B. Table I contains an index of subjects in Paragraph 4./GENERAL and Paragraph 5./GENERAL.

Table 1:

Paragraph	Subject
Paragraph 4./GENERAL	Repair Procedures Common to Various Repairs
Paragraph 4.A./GENERAL	Determine Damage
Paragraph 4.B./GENERAL	Remove Water from Damaged Area
Paragraph 4.C./GENERAL	Remove Damage and Prepare Damaged Area
Paragraph 4.D./GENERAL	Fabricate, Clean, and Install Honeycomb Replacement Core Plug
Paragraph 4.E./GENERAL	Prepare and Apply Preimpregnated (Prepreg) Repair Plies
Paragraph 4.F./GENERAL	Layup/Bagging Procedures
Paragraph 4.G./GENERAL	Cure the Repair
Paragraph 4.H./GENERAL	Refinish After Repair
Paragraph 4.I./GENERAL	Perform Post-Repair Requirements
Paragraph 5./GENERAL	Typical Repairs
Paragraph 5.A./GENERAL	Repair of Delaminations Between Plies
Paragraph 5.B./GENERAL	Repair of Puncture, 0.50-inch Diameter or Less, in Honeycomb Panel
Paragraph 5.C./GENERAL	Repair of Damage to One Skin and Honeycomb Core Using Replacement Core Plug, Punctures Greater Than 0.50-inch Diameter
Paragraph 5.D./GENERAL	Repair of Large Puncture Through Internal and External Surface of Panel Including Core Damage
Paragraph 5.E./GENERAL	Replacement of Honeycomb Core on Damaged Edge of Panel
Paragraph 5.F./GENERAL	Repair of Hole through Both Skins of a Honeycomb Panel With Access Available from One Side Only
Paragraph 5.G./GENERAL	Repair of Damaged Skin Plies in Panel Edgeband
Paragraph 5.H./GENERAL	Repair of Damage and Punctures in Solid Laminate Panels
Paragraph 5.I./GENERAL	Repair of Punctures, 0.25-inch Diameter or Less, in Solid Laminate Panels
Paragraph 5.J./GENERAL	Repair of Delaminations Between Plies in Solid Laminate Panels
Paragraph 5.K./GENERAL	Repair of Damaged Panel Attach Holes in Honeycomb Panel Edgebands or Along Edges of Solid Laminate Panels
Paragraph 5.L./GENERAL	Repair of Surface Dents
Paragraph 5.M./GENERAL	Repairs to Aluminum Foil

2. General

WARNING: HEAT, FIRE, OR SPARKS CAN CAUSE AN EXPLOSION. USE EXPLOSIONPROOF EQUIPMENT WHEN PERFORMING THESE REPAIRS. NONCOMPLIANCE COULD CAUSE PERSONNEL INJURY. BREATHING VAPORS OR ALLOWING SOLVENT TO CONTACT SKIN OR EYES IS HAZARDOUS. WEAR RUBBER GLOVES, PROTECTIVE CLOTHING, AND EYE GOGGLES. IF CHEMICAL CONTACT OCCURS, WASH THOROUGHLY WITH WATER. IF CHEMICAL SHOULD SPLASH INTO EYES, FLUSH EYES WITH LARGE QUANTITIES OF WATER AND SEEK MEDICAL AID. USE MECHANICAL VENTILATION OR RESPIRATORY PROTECTION WHEN WORKING IN A CONFINED SPACE OR AREA.

(WARNING PRECEDES)

CAUTION: FASTENERS INSTALLED IN GRAPHITE COMPOSITE STRUCTURE MUST BE BARE OR ALUMINUM COATED TITANIUM OR CORROSION RESISTANT STEEL. CADMIUM PLATED CORROSION RESISTANT STEEL MAY ALSO BE USED. ALUMINUM OR ALLOY STEEL FASTENERS ARE NOT ALLOWED IN GRAPHITE COMPOSITE STRUCTURES. WHEN REINSTALLING ALUMINUM FITTINGS ON GRAPHITE COMPOSITE STRUCTURE, ENSURE THAT THE ORIGINAL CORROSION PROTECTIVE TREATMENT IS MAINTAINED. INSTALL FITTINGS WITH FAYING SURFACE SEAL USING BMS 5-26 IN FUEL TANK AREAS OR BMS 5-95 IN ALL OTHER AREAS.

A. Use suitable holding fixtures as given in Paragraph 4.G./GENERAL to prevent distortion and delamination of the structure.

B. Perform the repair procedures specified herein only in areas of reasonable cleanliness. Areas containing oil mist, exhaust fumes, gases, soot, rain, dust or other particulate matter are specifically prohibited.

C. Protect surfaces from contamination. Do not touch cleaned parts or adhesive with bare hands. Use clean white gloves when handling parts.

D. Store rolls or precut kits of prepreg and adhesive material below 10°F (-12°C) in sealed moisture proof bags. An identification label must accompany the material inside the bag, with the following information:

BMS Type, Class, Grade, Style, supplier name, batch number, roll number, prepreg lot number and date of kit preparation. Record storage time in and out of refrigeration.

E. Refer to 51-30-00 for source of repair materials and equipment.

F. Refer to 51-10-01 for aerodynamic smoothness requirements.

G. See Figure 1/GENERAL for resin mixes and potting compound data.

H. For repair of Tedlar film, refer to Paragraph 4.H.(2)/GENERAL

I. Restore aluminum flame spray as given in 51-70-14, GENERAL.

J. Refer to 51-70-14, GENERAL for repair of aluminum foil where damage to the aluminum foil does not extend into the underlying plies.

K. Refer to Paragraph 5.M./GENERAL for repair of damage to the underlying plies on parts having an outer layer of aluminum foil.

L. Refer to 51-70-16, GENERAL for drilling and machining of composite structures.

M. Refer to 51-70-02, GENERAL for locations of principal composite components.

3. References

Reference	Title
51-10-01, GENERAL	Aerodynamic Smoothness Requirements
51-20-05, GENERAL	Repair Sealing
51-30-03, GENERAL	Nonmetallic Materials
51-60-00, GENERAL	Control Surface Balance Moment Determination
51-70-02, GENERAL	Locations of the Principal Composite Components
51-70-03, GENERAL	Graphite and/or Aramid Reinforced Epoxy Laminates and Nonmetallic Honeycomb Sandwich Repairs - Room Temperature – 150°F (66°C) Cure (Wet Layup)

(Continued)

Reference	Title
51-70-14, GENERAL	Allowable Damage and Repair of Flame-Sprayed Aluminum Coatings, Aluminum-Coated Glass Fabric (BMS 8-278), Aluminum Foil (BMS 8-289), and Expanded Aluminum Foil (BMS 8-336)
51-70-16, GENERAL	Hole Drilling and Machining of Composite Structures
51-70-17, GENERAL	Repairs to 250°F (121°C) and 350°F (177°C) Cured Graphite/Aramid/Fiberglass Reinforced Epoxy Laminates and Nonmetallic Honeycomb Sandwich Structure - 200°F (93°C) to 230°F (110°C) Wet Layup Repair Method
AMM 51-21	Aircraft Maintenance Manual
AMM 51-24-02	Aircraft Maintenance Manual
AMM 51-24-13	Aircraft Maintenance Manual
AMM 51-41-00/201	Aircraft Maintenance Manual
DOCUMENT D6-49327	Certification of Autoclaves for Metal Bonding and Curing of Composite Structure
DOCUMENT D6-56273	Qualification of Heat Blankets for Hot Bonding
NDT Part 1, 51-01-01	Inspection of Repairs to Composite Structures
SOPM 20-30-99	Solvents For Final Cleaning of Composites Before Structural Bonding (Series 99)

4. Repair Procedures Common to Various Repairs

CAUTION: CHEMICAL PAINT STRIPPERS WILL ATTACK RESIN SYSTEMS, AND SHOULD NOT BE USED TO REMOVE PAINT BEFORE MAKING DAMAGE EVALUATIONS.

A. Determine damage.

(1) Examine visually for extent of damage.

(2) Check panel in vicinity of damage for entry of water, oil, fuel, dirt or other foreign matter. Water can be detected by radiographic methods. Remove contaminants. Refer to Paragraph 4.B./GENERAL for water removal instructions.

(3) Check for delamination around the damage.

NOTE: Post repair inspection is recommended. Examples of inspection procedures are given in NDT Part 1, 51-01-01.

B. Remove water from damaged area.

(1) Remove water from the honeycomb core.

NOTE: If the damage is less than the thickness of the skin plies and there is no water in the honeycomb core, use the procedure given in Paragraph 4.B.(2)/GENERAL to remove the water from the skin plies.

(a) Remove damaged skin plies to open up honeycomb area in the damaged area. Remove standing water using vacuum and oil-free compressed air.

(b) Sand the core to remove the adhesive. Removal of adhesive fillets on core is not required.

(c) Apply a fiberglass or metal fine mesh screen over the exposed core.

(d) Apply a thermocouple to the center of the screen.

(e) Apply a layer of glass fabric bleeder cloth over the screen and hold in place with masking tape.

(f) Place a vacuum line on the edge of the bleeder cloth and hold in place with masking tape.

(g) If the far side is accessible, apply thermocouple and heating blanket to the far side of the honeycomb sandwich panel.

NOTE: If the far side is accessible, it is acceptable to heat the area using a heating blanket only on the far side. An additional heating blanket and vacuum application may be used on the near side at the location shown in Figure 11/GENERAL to accelerate water removal. If the far side is inaccessible, use of a heating blanket on the near side is required.

(h) When the far side is inaccessible or when using additional heating blanket, place the heating blanket over the bleeder cloth on the near side.

(i) Place extruded sealing compound around the entire area and seal the area with vacuum bag material.

(j) Evacuate the layup to a minimum of 22 inches of mercury vacuum.

(k) Heat the area for 1 hour minimum at 150 to 170°F (66 to 77°C). The rate of temperature rise must not exceed 5°F (3°C) per minute.

(l) Remove layup materials and proceed with repair procedure.

(2) Remove water from solid laminate.

(a) Remove damage and/or delamination. Remove standing water using vacuum and oil-free compressed air.

(b) Heat the area for 1 hour minimum at 150 to 170°F (66 to 77°C). The rate of temperature rise must not exceed 5°F (3°C) per minute.

CAUTION: REMOVE (FOR ALL TYPES OF CURE) OR ISOLATE (HEAT BLANKET ONLY) ALUMINUM STRUCTURE TO PREVENT LOSS OF STRENGTH IN THE ALUMINUM PARTS. ALL ALUMINUM ALLOYS, EXCEPT 2219, MUST BE KEPT BELOW 200°F (93°C). ALUMINUM 2219 CAN BE KEPT UP TO 400°F (204°C). REMOVE SEALANTS, PAINTS AND PRIMERS IN THOSE AREAS WHERE THE TEMPERATURE COULD REACH ABOVE THE MAXIMUM ALLOWABLE TEMPERATURE. REFER TO SRM 51-20-01 FOR THE MAXIMUM ALLOWABLE TEMPERATURES.

C. Remove Damage and Prepare Damaged Area

(1) Damage Removal

(a) Trim out the damaged lamination to a smooth shape with rounded corners, or a circular or oval shape. Take care not to damage the undamaged plies, core or surrounding material.

NOTE: Remove only damaged plies, damaged doublers and damaged fillers.

(b) When the core is also damaged, remove the core by trimming to the same outline as the skin. The core area removed should extend at least 0.5 further than the visible core damage limits. Take care to avoid cutting into an undamaged skin on the opposite side. In cores greater than 1.0 thick, partially remove core (at least 0.5 deep) sufficient to clean up damage.

NOTE: When a potted core repair is to be made, removal of damaged core is not required.

(c) In areas where contamination cannot be removed by cleaning or drying as given in Paragraph 4.B./GENERAL, remove the contaminated structure along with the other damage.

(d) When opposite inner skin is also damaged, trim out the damage to a smooth shape as described in Paragraph 4.C.(1)(a)/GENERAL

(e) When core is removed from the inner surface of opposite skin, carefully smooth core down to adhesive film.

(f) Inspect cutout area to ensure that all damage has been removed.

CAUTION: SANDING FOR ADHESION OR FINISH REMOVAL MUST NOT EXPOSE OR DAMAGE FILAMENTS IN THE UNTAPERED SURFACE REPAIR AREA.

SANDING MUST NOT EXPOSE OR DAMAGE FILAMENTS IN EACH PLY WHEN STEP SANDING OR IN THE PLY BONDED TO THE CORE (FIGURE 9/GENERAL AND FIGURE 13/GENERAL).

LOSS OF STRUCTURAL STRENGTH OF THE COMPONENT WILL OCCUR IF THESE CAUTIONS ARE NOT OBSERVED.

DO NOT USE PAINT STRIPPERS FOR THE REMOVAL OF FINISH. DAMAGE TO THE ADHESIVE RESIN SYSTEM WILL OCCUR.

(2) Preparation of damaged area (Figure 13/GENERAL)

(a) Determine the number of plies that have been cut. Mask off the area around the cleaned up damage allowing 0.5 overlap for each ply replacement, plus 0.5 extra for the extra ply to ensure that the existing top ply is completely covered by the repair.

NOTE: Where the number of plies is not apparent, refer to the applicable component section or engineering drawing.

If the damaged area has a layer of aluminum foil, cut back the foil enough to allow a new foil layer to have a 1.0 minimum overlap beyond the outermost repair ply (Figure 17/GENERAL).

WARNING: SANDING GIVES OFF A FINE DUST THAT MAY CAUSE SKIN IRRITATIONS. BREATHING OF AN EXCESSIVE AMOUNT OF THIS DUST MAY BE INJURIOUS. OBSERVE PRECAUTIONS FOR SKIN AND RESPIRATION PROTECTION.

EXPLOSIONPROOF EQUIPMENT MUST BE USED WHERE THE POSSIBILITY OF VAPOR IGNITION EXISTS. NONCOMPLIANCE COULD CAUSE PERSONNEL INJURY.

(b) Internal surface of panel (nonaerodynamic surface) and noncritical aerodynamic surfaces.

1) Remove the paint finish or Tedlar film using No. 240 or finer Scotch-Brite Abrasive, or No. 150 or finer sandpaper in the masked off area

2) If the damage area has a layer of aluminum foil, cut back the foil enough to allow a new foil layer to be at least 1.25 larger all around than the largest repair ply (Figure 17/GENERAL).

a) Strip the aluminum foil by peeling or abrading. Do not damage the underlying composite fibers.

b) Carefully abrade to remove the primer on the aluminum foil to a border 1.25 larger all around than the repair area that was just stripped of foil. Spotty traces of primer covering up to 10 percent of the border area are acceptable.

c) Taper sand or step sand each ply as given in Item 3) below.

d) Lightly abrade and solvent wipe the primer on the aluminum foil to a border 1.0 larger all around than the 1.25 wide band of foil that was exposed by primer removal.

e) Alodine treat the foil that was exposed by primer removal in the 1.25 border area.

3) Taper sand each ply or simply abrade the surface around the cleaned up damage a minimum of 0.5 per ply. Refer to Figure 13/GENERAL.

4) An optional procedure for two or three ply laminate face sheets is to fill the cleaned up damage area flush with the original surface using filler plies during the repair layup. The repair plies are then installed directly on the resulting smooth surface of the repair area.

5) Abrade surfaces around repair using No. 150 or finer Scotch-Brite abrasive.

(c) External surface of panel (critical aerodynamic surfaces).

1) Taper sand a uniform taper around the cleaned up damage using No. 180 sandpaper. The taper is to be over a minimum distance of 0.5 for each existing ply of the laminate. Step sanding is optional to taper sanding on sandwich structure except in areas of critical aerodynamic smoothness. Refer to 51-10-01, GENERAL for locations of areas of critical aerodynamic smoothness. Always taper sand on solid laminate structures.

NOTE: For sanding, use a flexible disk sander, a belt sander, a rotating pad sander, or sand by hand.

2) Remove exterior finishes, including enamel finish and conductive coating from the surface of the 0.5 border using No. 150 or finer sandpaper.

(d) Edgeband of panel.

1) Taper sand panel edgeband according to Paragraph 4.C.(2)/GENERAL(c)(1).

NOTE: Edgeband is the solid laminate around the outer periphery of the honeycomb panel.

(e) Cleaning of repair area.

1) Remove all sanding dust by applying oil-free compressed air and use a vacuum cleaner.

WARNING: BREATHING VAPORS OR ALLOWING SOLVENT TO CONTACT SKIN OR EYES IS HAZARDOUS. HEAT, FIRE OR SPARKS CAN CAUSE AN EXPLOSION. USE MECHANICAL VENTILATION OR RESPIRATORY PROTECTION WHEN WORKING IN A CONFINED SPACE OR AREA. AVOID CONTACT WITH SKIN, EYES AND CLOTHING. WEAR EYE PROTECTION. KEEP AWAY FROM SOURCES OF HEAT, FIRE OR SPARKS.

CAUTION: DO NOT IMMERSE PARTS IN SOLVENT OR ALLOW STANDING SOLVENT ON PART. DAMAGE TO PART WILL OCCUR.

2) Wipe surfaces with a clean cloth moistened with solvent, Series 99 (AMM/ SOPM 20-30-99). Allow solvent to evaporate before proceeding with the repair.

D. Fabricate, Clean, and Install Honeycomb Replacement Core Plug

(1) Fabricate core plug.

(a) Fabricate core plug from core called out on engineering drawing. Refer to specific component structural identification section to determine type of core called out on engineering drawing.

(b) The honeycomb core plug should fit flush with original core and with ribbon direction the same as in original core. Trim the replacement core up to 0.05 of an inch smaller then the cutout.

The replacement core is to fit snugly in the cutout after the core is wrapped with the foaming adhesive.

(c) Trim core plug to full or partial depth of original core (Paragraph 4.C.(1)/GENERAL(b)) (Figure 2/GENERAL).

NOTE: When applicable, depth of core plug should allow for shrinkage during cure and for thickness of extra plies of fabric cloth and adhesive film between core plug and undamaged core or skin (Figure 2/GENERAL, Figure 8/GENERAL, Figure 13/GENERAL).

(2) Clean core plug.

WARNING: BREATHING VAPORS OR ALLOWING SOLVENT TO CONTACT SKIN OR EYES IS HAZARDOUS. HEAT, FIRE OR SPARKS CAN CAUSE AN EXPLOSION. USE MECHANICAL VENTILATION OR RESPIRATORY PROTECTION WHEN WORKING IN A CONFINED SPACE OR AREA. AVOID CONTACT WITH SKIN, EYES AND CLOTHING. WEAR EYE PROTECTION. KEEP AWAY FROM SOURCES OF HEAT, FIRE OR SPARKS.

CAUTION: DO NOT EXCEED IMMERSION CRITERIA GIVEN IN 3.D.(2)(A). DAMAGE TO CORE MATERIAL WILL OCCUR.

DO NOT IMMERSE PARTS IN SOLVENT OR ALLOW STANDING SOLVENT ON PART. DAMAGE TO PART WILL OCCUR.

(a) Clean visually contaminated core by dipping (a maximum of four times) in an acetone or MEK bath for 60 seconds.

(b) Locally contaminated areas can be washed with MIBK, MEK, or Acetone.

(c) The core must be completely dry, clean and free of evidence of solvents before installation.

CAUTION: WHEN HANDLING ADHESIVE FILM WEAR CLEAN WHITE GLOVES TO PREVENT CONTAMINATION.

(CAUTION PRECEDES)

DO NOT TOUCH THE ADHESIVE FILM WITH BARE HANDS OR OTHER PARTS OF THE BODY.

DO NOT FOLD, STRETCH OR OTHERWISE THIN THE ADHESIVE FILM.

BONDING OF THE REPAIRED ASSEMBLY MUST BE COMPLETED WITHIN 48 HOURS AFTER THE ADHESIVE HAS BEEN REMOVED FROM REFRIGERATED STORAGE. QUALITY OF THE ADHESIVE WILL BE REDUCED AFTER THIS TIME LIMIT.

(3) Install core plug (Figure 2/GENERAL, Figure 5/GENERAL, Figure 6/GENERAL, Figure 7/GENERAL, Figure 8/GENERAL, Figure 13/GENERAL, , typical).

NOTE: Most of the materials used in this procedure have limited life and require controlled storage conditions. Refer to the applicable material specifications for the maximum time out of the controlled storage and for the uncontrolled storage conditions.

Before opening the adhesive film wrapper, condition refrigerated adhesives to room temperature until moisture no longer condenses on the wrapper.

During use, suspend the film roll of adhesive horizontally through its axis free from other rolls or objects.

(a) For partial core replacement, cut two pieces of BMS 5-129, Type 2 or 4, Grade 10 adhesive film and one piece of fiberglass prepreg fabric, BMS 8-79, Style 120 to fit the repair hole.

Place in position as shown in Figure 2/GENERAL, Section A-A.

(b) For full depth core replacement, where damage does not extend through both skins, trim a piece of BMS 5-129, Type 2 or 4, Grade 10 adhesive film to fit repair hole and place on the inside surface of the undamaged skin (Figure 2/GENERAL, Figure 3/GENERAL, Figure 7/GENERAL, and Figure 13/GENERAL).

(c) If both skins are damaged, tape a metal caulplate (such as 0.040-inch thick aluminum) against the exterior surface of the far side skin and repair as for damage to one skin only.

Repair the far side skin in a subsequent cure cycle.

(d) Wrap the edges of the core plug with BMS 5-90, Type III, Class 1, Grade 100, or two layers of Grade 50, or BMS 5-90, Type IV, foaming adhesive and install in the repair cavity.

Align the honeycomb ribbon with the original core, ribbon direction.

(e) Put the layup materials and equipment in place as given in Figure 3 (Sheet 2).

1) If the damage extends through both face skins, vacuum bag both sides of the panel (or the entire part) using the layup shown in Figure 3 (Sheet 2).

2) If the replacement core plug is less than or equal to 0.5 thick, use the heating blanket on the near side and locate at least two separate thermocouples on the panel surface at the bondline.

3) If the replacement core plug is greater than 0.5 thick and both sides are accessible, use heating blankets on both sides. Locate at least two separate thermocouples on the near side at the bondline and one on the far side corresponding to the center of the repair.

4) If the replacement core plug is greater than 0.5 thick and only one side is accessible, use the heating blanket on the near side and put at least two separate thermocouples into the repair hole so the thermocouples touch the repair materials at the bottom of the repair hole.

NOTE: The ends of these thermocouples will be cured into the adhesive. Cut the thermocouples leaving the embedded ends behind before applying the repair plies. Only the portion of the thermocouple embedded in the core can be left in the repair. The thermocouples cannot come between the repair plies and the sanded surfaces of the original plies.

(f) Evacuate the repair to a minimum of 22 inches of mercury.

(g) Cure a minimum of 90 minutes at 250 to 270°F (121 to 132°C). See Figure 14/GENERAL.

(h) Allow the repair area to cool under vacuum pressure until the temperature of the repair is 160°F (71°C) or less. Then, release restraints (if applicable) and remove layup materials and equipment.

(i) Sand core plug approximately flush with surrounding material, making allowance for film adhesive and slight core crush during cure.

(j) Vacuum clean to remove sanding residue from core cells.

NOTE: The core plug and the repair plies can be cured at the same time if the temperature can be adequately monitored by thermocouples placed on the outside surfaces of the panel (refer to Paragraph 4.D.(3)/GENERAL(e)2) thru 4)). If the thermocouples must be embedded in the repair core adhesive, then the core plug must be cured separately to avoid curing the thermocouples between the repair plies and the sanded surface of the original plies.

CAUTION: DO NOT CURE MORE THAN TEN (10) PLIES DURING ONE CURE CYCLE FOR HEAT BLANKET AND OVEN CURES. IF THE REPAIR HAS MORE THAN 10 PLIES, DIVIDE THE REPAIR PLIES EVENLY INTO MULTIPLE CURE CYCLES. IF YOU DO NOT OBEY, POROSITY AND BULGES CAN OCCUR AND THE SUBSEQUENT REPAIR WILL BE UNSATISFACTORY.

USE OF PRECURED PATCHES IS NOT RECOMMENDED. PRECURED PATCHES BONDED TO THE STRUCTURE UNDER VACUUM PRESSURE ONLY AND LARGE PATCHES BONDED TO CONTOURED SURFACES CAN RESULT IN POROUS OR NONCONTINUOUS BONDLINES.

E. Prepare and Apply Preimpregnated (Prepreg) Repair Plies

NOTE: Refer to applicable paragraphs for preparation of prepreg glass, aramid and graphite fabrics. For hybrid components, refer to relevent material paragraphs for each individual ply.

(1) Prepare prepreg glass fabric repair plies (BMS 8-79).

CAUTION: THE PREIMPREGNATED MATERIAL AND ADHESIVE MUST REMAIN FREE OF CONTAMINATION BURING CUTTING AND HANDLING. WEAR CLEAN WHITE GLOVES WHEN HANDLING.

(a) Refer to the specific component structural identification to determine type and orientation of glass fabric used in original structure. Repair existing plies of original structure with BMS 8-79, Class III, Style 1581 or 7781 (Figure 12/GENERAL).

(b) From BMS 8-79, Class III, Style 1581 or 7781 preimpregnated material, cut the required number of plies.

NOTE: Refer to Paragraph 4.E.(1)/GENERAL(c), for substitution of prepreg glass fabric plies.

In the patch, use one repair ply for each damaged ply of the original laminate, plus extra repair plies as indicated by specific structural component repair. If extra repair plies are not required by individual repair, one extra ply is required and is to have the same orientation as the original surface ply. Refer to Figure 15/GENERAL for extra repair ply material and orientation.

See Figure 13/GENERAL for required overlap of repair plies. The repair plies must be installed with the same orientation as that of the original plies being repaired.

(c) Substitution of prepreg glass fabric plies (Figure 12/GENERAL).

1) If BMS 8-79, Class III, Style 1581 or 7781 prepreg material is not available, three plies of BMS 8-79, Style 120 prepreg material may be substituted for each ply of Style 1581 or 7781 prepreg material required (Figure 12/GENERAL).

(2) Prepare prepreg aramid fabric repair plies (BMS 8-219).

CAUTION: THE PREIMPREGNATED MATERIAL AND ADHESIVE MUST REMAIN FREE OF CONTAMINATION DURING CUTTING AND HANDLING. WEAR CLEAN WHITE GLOVES WHEN HANDLING.

(a) Refer to the specific component structural identification to determine number, style, and orientation of aramid fabric used in original structure (Figure 12/GENERAL).

(b) From each type of material required, cut the required number of plies.

NOTE: Refer to Paragraph 4.E.(2)/GENERAL(c) for the substitution for prepreg aramid fabric plies.

In the patch, use one repair ply for each damaged ply of the original laminate, plus extra repair plies as indicated by specific structural component repair. If extra repair plies are not required by individual repair, one extra ply is required and is to have the same orientation as the original surface ply. Refer to Figure 15/GENERAL for extra repair ply material and orientation.

See Figure 13/GENERAL for required overlap of repair plies. The repair plies must be installed with the same orientation as that of the original plies being repaired.

(c) Substitution for prepreg aramid fabric plies (Figure 12/GENERAL).

1) Prepreg glass fabric material, BMS 8-79, may be used to substitute for prepreg aramid fabric as given in table shown in Figure 12/GENERAL.

(3) Prepare prepreg graphite fabric or tape repair plies (BMS 8-168).

CAUTION: TAPE IS A UNIDIRECTIONAL FIBER. WHEN USED IN A LAYUP, THE PREDOMINATE STIFFNESS IS IN THE DIRECTION OF THE FIBER. TAPE HAS LITTLE OR NO STIFFNESS IN THE TRANSVERSE DIRECTION.

(CAUTION PRECEDES)

FABRIC HAS BIDIRECTIONAL PROPERTIES. WHEN SUBSTITUTED FOR TAPE, FABRIC ADDS STIFFNESS IN THE TRANSVERSE DIRECTION. THE EFFECTS OF THIS ADDITIONAL TRANSVERSE STIFFNESS ON THE COMPONENT AND SUBSTRUCTURE MUST BE CONSIDERED PRIOR TO COMMITTING A MAJOR SUBSTITUTION IN A REPAIR.

THE PREIMPREGNATED MATERIAL AND ADHESIVE MUST REMAIN FREE OF CONTAMINATION DURING CUTTING AND HANDLING. WEAR CLEAN WHITE GLOVES WHEN HANDLING.

(a) Refer to the specific component structural identification to determine number, style, and orientation of graphite tape or fabric used in original structure (Figure 12/GENERAL).

(b) From each type of material required, cut the required number of plies.

NOTE: Refer to Paragraph 4.E.(3)/GENERAL(c) for the substitution of prepreg tape plies.

In the patch, use one repair ply for each damaged ply of the original laminate, plus extra repair plies as indicated by specific structural component repair. If extra repair plies are not required by individual repair, one extra ply is required and is to have the same orientation as the original surface ply. Refer to Figure 15/GENERAL for extra repair ply material and orientation.

See Figure 13/GENERAL for required overlap of repair plies. The repair plies must be installed with the same orientation as that of the original plies being repaired.

(c) If the type of material required is not available, substitue materials can be used as given in Figure 12/GENERAL. Graphite fabric may be used as a substitue for graphite tape as given in Figure 12/GENERAL.

CAUTION: ENSURE THAT PARTING FILM AND POLYETHYLENE SEPARATOR ARE REMOVED FROM REPAIR PLIES PRIOR TO LAYUP AND CURING. NONCOMPLIANCE WILL RESULT IN A RUINED REPAIR.

(4) Apply the repair plies (Figure 2/GENERAL, Typical Repair, and Figure 13/GENERAL).

NOTE: Where the damage has occurred at a lap joint in the original laminates, it is not necessary to make a comparable lap in the repair plies. Where the original core was undamaged and was provided with a recess to match the lap joint, the recess should be filled with strips of preimpregnated material before application of the repair plies. Use the same material as used in the repair plies.

(a) Make a temporary vacuum bag system.

NOTE: This vacuum bag is used to compact the repair plies and prevent contamination of the repair. Do not use this vacuum bag system for the repair cure.

1) Put one layer of perforated parting film above the repair.
2) Put one layer of glass fabric cloth as a surface breather above the repair.
3) Apply the vacuum sealing compound around the repair area.

4) Put the vacuum bag material over the repair area. Seal the edges with the vacuum sealing compound.

5) Attach a vacuum line above the surface breather.

(b) Cut two plies of BMS 5-129, Type 2 or 4, Grade 10, adhesive film, 1/8 inch larger than the largest patch ply which also covers the entire repair area.

NOTE: After curing, the repair will need to be sanded in preparation for refinishing. An additional nonstructural ply covering the entire repair is added which may be sanded as required to obtain a smooth surface for refinishing. Be careful not to sand through this nonstructural sanding ply into the structural plies below it.

The second adhesive film ply will be used as a sanding ply. As an option, substitute a ply of BMS 8-79, Style 1581 fiberglass prepreg cut to the same size as the adhesive ply. The fiberglass is less likely to entrap air during the cure.

Repairs to aluminum foil will require one ply of adhesive film and one ply of BMS 8-79, Style 120 fiberglass prepreg.

(c) Place one layer of adhesive film over the entire repair area.

(d) Install the repair plies and if necessary the sanding ply also.

NOTE: Add filler plies as necessary to get a smooth repair. Do not use more than four filler plies on one repair area.

1) Install the smallest repair ply first.

2) Make sure that the warp direction of each repair ply that you put in the repair is correct and that the overlap is correct.

3) Install the next ply. Make sure that it is smooth with no wrinkles.

4) Remove the separator sheet.

5) You must do the steps that follow for repairs that have one or more graphite (Carbon Fiber Reinforced Plastic (CFRP)) repair plies.

NOTE: Although it is only necessary to compact repairs containing CFRP repair plies, Boeing recommends that you compact all repairs.

a) Compact each ply (or plies) with the temporary vacuum system as follows:
   - 1 minute for each ply (one ply at a time), or
   - 2 minutes for each two plies (two plies at a time), or
   - 6 minutes for each three plies (three plies at a time)

NOTE: Do not compact more than three plies at a time. An adhesive ply counts the same as a repair ply.

b) Do steps 2) thru 5) again for all of the repair plies as necessary to complete the layup.

(e) Apply a cover ply of BMS 8-79, Style 1581 fiberglass prepreg or the second ply of adhesive film over the replaced plies. If the repair includes repair of aluminum foil, skip this step.

(f) If the repair area has a layer of aluminum foil, repair the foil as given in Paragraph 5.M./GENERAL before proceeding with the next step.

F. Layup/Bagging Procedure

(1) As an optional step, place a layer of dry peel ply over the last layer of repair material. Cut the peel ply so it is large enough to contact the surface bleeder. When removed after curing, the peel ply leaves a rough surface which may be sanded for refinishing or left as is for any subsequent bonding to the repair area. The peel ply also helps to prevent pits in the cured adhesive surface.

(2) Place one layer of perforated FEP parting film over the replacement plies and extending at least 1 inch beyond the largest patch ply.

(3) Put on the thermocouples.

  (a) If you use an autoclave or an oven, then do the step that follows:

    1) Put one or more thermocouples at the location where the temperature will increase the fastest and one or more thermocouples where the temperature will increase the slowest.

    NOTE: Boeing recommends that you put one or more thermocouples at the thick areas of the part and tool and the thin area of the part and tool. Use more than two thermocouples when more than 900 square inches of a panel surface is repaired. Insulation is not necessary in the repair area for autoclave or oven cures.

  (b) If you use a heat blanket, then do the step that follows:

    1) Secure three thermocouples (spaced evenly around the repair) to the panel at the edge of the repair and secure them to the temperature recording device.

(4) Place a layer of dry peel ply over the perforated FEP.

NOTE: The peel ply must be cut large enough to make contact with the surface breather.

(5) Place one layer of solid FEP parting film over the layup extending to 1/2 inch short of the edge of the dry peel ply.

(6) Place a heat blanket over the repair (if used).

NOTE: The heat blanket must extend a minimum of 2 inches beyond the edge of the patch.

When using a heat blanket that is longer than 12 inches on a side, an aluminum pressure plate (0.040 max) should be used to minimize localized heating.

When two or more pads are used, a pressure plate must be used.

  (a) If the area to be repaired is near or attached to aluminum structure that was not removed in step 3.C., do the steps that follow:

    1) Isolate the aluminum structure from the area that will get hot.

    2) Add one or more thermocouples to put on the aluminum structure. Make sure that the temperature does not go above 200°F (93°C).

    3) You can put insulation around all other metals to prevent cold locations in the repair.

(7) Place a layer of Airweave SS or BMS 8-79, Style 120 glass fabric over the solid FEP as a surface breather or, if heat blanket is used, place four to six layers of breather material over the heat blanket to act as an insulator and a surface breather.

NOTE: The surface breather material and the dry peel ply must make contact.

(8) Lay the vacuum line over the edge of the breather material.

(9) Apply extruded sealing compound around the entire repair area, 2 to 6 inches outside the edge of the heat blanket.

CAUTION: HOLLOW COMPOSITE COMPONENTS SUCH AS RUDDERS, ELEVATORS, AND AILERONS MUST NOT BE COMPLETELY BAGGED BECAUSE THEY MAY COLLAPSE UNDER 22 INCHES OF MERCURY VACUUM. ATTACH VACUUM BAG TO ONE SIDE OF COMPONENT ONLY OR ATTACH SEPARATE VACUUM BAGS TO EACH SIDE TO ENSURE THAT ATMOSPHERIC PRESSURE IS MAINTAINED INSIDE OF COMPONENT DURING REPAIR. COMPONENTS CONSISTING OF A SINGLE PANEL MADE OF FULL DEPTH HONEYCOMB CORE WITH LAMINATE FACE SHEETS AND EDGEBANDS MAY BE COMPLETELY BAGGED (FIGURE 16/GENERAL).

(10) Lay a piece of vacuum bag material over the entire repair area, sealing the edge with the extruded sealing compound. Pleat the vacuum bag where needed to prevent bridging of bag material and subsequent bag breakage. Pad all sharp objects and corners to prevent bag breakage. In some cases it is optional to vacuum bag the entire part.

NOTE: The entire repair surface must be vacuum bagged and restrained in place to prevent delamination and distortion when the repair area exceeds 15 percent of panel area. Regardless of the method of heat application, restraining devices that maintain the contour and support the part must be used for large parts where sagging and distortion could occur due to the weight of the part.

(11) Evacuate the space under the vacuum bag and maintain a vacuum of 22 inches of mercury minimum during entire cure cycle.

(12) Check the vacuum bag for leak paths.

G. Cure the repair. Do step (1) for the autoclave procedure, step (2) for the oven cure procedure, or do step (3) for the heat blanket cure procedure.

(1) For an autoclave cure, see Figure 14/GENERAL, Detail I and do the steps that follow:

NOTE: Boeing recommends that you use a certified autoclave when you do the procedure that follows. DOCUMENT D6-49327, is a procedure that Boeing uses, and you can use this as a guide to certify your autoclave.

(a) During all of the repair procedure, make sure that the part to be repaired is held in the specified part tool. This must be done for all parts that were initially made at a cure temperature of 250°F (121°C). Boeing also recommends that you hold the part in the specified part tool, if the part was initially made at a cure temperature of 350°F (177°C). The specified part tool must have the same dimensions (or dimensions that are a small amount 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 in the part. A tool with the same thermal expansion properties will help keep the part at the correct contour and shape.

(b) Pressurize the autoclave to 40 to 50 psig (276 to 345 kPa gauge). Open the vacuum bag to the autosphere when the autoclave pressure is above 20 psig (138 kPa gauge).

(c) Increase the temperature of the autoclave until it is at 130°G (54°C). When the temperature is at 130°F (54°C), increase the temperature at a rate of 2 to 8°F (1 to 5°C) for each minute until all thermocouples are in the cure temperature range.

(d) Hold the cure temperature for the specified time as given in Figure 14/GENERAL, Detail I.

NOTE: Cure time does not include the time necessary for the layup and the part to get to the cure temperature. Cure time starts after all of the theromcouple indications are in the cure temperature range. If a thermocouple indication falls below the cure temperature range during the cure, extend the cure cycle time by the time necessary to get the thermocouple to the cure temperature.

(e) Keep the vacuum bag connection to the atmosphere open and the autoclave pressuirzed until after the cure is complete and the temperature of the part has decreased to 125°F (52°C).

(f) Decrease the autoclave temperature at a maximum rate of 5°F (3°C) for each minute.

(g) When the temperature is less than 125°F (52°C), release the autoclave pressure.

(h) Remove the vacuum bag equipment from the part and tool.

WARNING: USE HEAT CURE EQUIPMENT THAT IS PERMITTED BY THE LOCAL FIRE PROTECITON AUTHORITIES. IF YOU DO NOT OBEY, YOU CAN CAUSE INJURY TO PERSONS.

(2) For an oven cure, see Figure 14/GENERAL, Detail I and do the steps that follow:

(a) During all of the repair procedure, make sure that the part to be repaired is held in the specified part tool. Thismust be done for all parts that were initially made at a cure temperature of 250°F (121°C). Boeing also recommends that you hold the part in the specified part tool, if the part was initially made at a cure temperature of 350°F (177°C). The specified part tool must have the same dimensions (or dimensions tht are a small amount 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 recommendations that the tool have the same thermal expansion properties as the materials in the part. A tool with the same thermal expansion properties will help keep the part at the correct contour and shape.

(b) Apply a vacuum to the vacuum bag until you have a minimum of 22 inches (0.56M) of Hg (Mercury). Start the heatup process.

Keep a minimum vacuum of 22 inches (0.56M) of the Hg (Mercury) during the full cure cycle.

(c) Increase the temperature of the oven until it is at 130°F (54°C). When the temperature is at 150°F (54°C), increase the temperatures at a rate of 2 to 8°F (1 to 5°C) for each minute until all thermocouples are in the cure temperature range.

(d) Hold the cure temperature for the specified time as given in Figure 14/GENERAL, Detail I.

NOTE: Cure time does not include the time necessary for the layup and the part to get to the cure temperature. Cure time starts after all of the thermocouple indications are in the cure temperature range. If a thermocouple indication falls below the cure temperature during the cure, extend the cure cycle time by the time necessary to get the thermocouple to the cure temperature.

(e) Decrease the 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), remove the vacuum pressure.

(g) Remove the vacuum bag equipment from the part and tool.

WARNING: USE HEAT CURE EQUIPMENT THAT IS PERMITTED BY THE LOCAL FIRE PROTECTION AUTHORITIES. IF YOU DO NOT OBEY, YOU CAN CAUSE INJURY TO PERSONNEL.

(3) For heat blanket cure, see Figure 14/GENERAL, Detail II and do the steps that follow:

NOTE: Boeing recommends that you use a qualified heat blanket when you do the procedure that follows. DOCUMENT D6-56273, is a procedure that Boeing uses, and can be used as a guide to qualify your heat blanket.

(a) Make sure there is a minimum of three thermocouples for each heat blanket used. Refer to Paragraph 4.F./GENERAL

(b) Apply a vacuum to the vacuum bag until you have a minimum of 22 inches (0.56M) of Hg (Mercury). Start the heatup process. Keep a minimum vacuum of 22 inches (0.56M) of Hg (Mercury) during the full cure cycle.

(c) Increase the temperature of the heat source until the temperature of the repair is at 130°F (54°C). When the temperature is at 130°F (54°C), increase the temperature at a rate of 2 to 8°F (1 to 5°C) for each minute until all thermocouples are at the cure temperature.

NOTE: When you use a hot bond console, obey the manufacturer's operation instructions.

(d) If necessary, put insulation on the cooler areas of the repair area, opposite of the heat source.

(e) Hold the cure temperature for the specified time as given in Figure 14/GENERAL, Detail II.

NOTE: Cure time does not include the time necessary for the layup and the part to get to the cure temperature. Cure time starts after all of the thermocouple indications are in the cure temperature range. If a thermocouple indication falls below the cure temperature during the cure, extend the cure cycle time by the time necessary to get the thermocouple to the cure temperature.

(f) Decrese the temperature at a rage maximum of 5°F (3°C) for each minute.

(g) When the temperature decreases to less than 120°F (52°C), release the vacuum pressure.

(h) Remove the vacuum bag equipment from the part and tool.

H. After Completion of the Repair Cycle.

CAUTION: DO NOT SAND INTO ORIGINAL STRUCTURE. FAILURE TO COMPLY WILL REDUCE THE STRENGTH OF THE COMPONENT.

(1) If multiple cure cycles are to be used to cure groups of repair plies, you must prepare the surfaces of the repair between cure cycles.

NOTE: You can do an inspection between cure cycles to make sure that there are no defective bonds or empty spaces between the repair plies. Refer to Paragraph 4.I./GENERAL if you do an inspection, prepare the surface of the repair after the inspection.

(a) Abrade the largest cured repair ply. Extend the abraded area to 0.25 inches (6 mm) around the edge of the ply. Use 150-grit abrasive paper.

(b) Remove all sanding dust by applying oil free compressed air and using a vacuum cleaner.

WARNING: BREATHING VAPORS OR ALLOWING SOLVENT TO CONTACT SKIN OR EYES IS HAZARDOUS. HEAT, FIRE OR SPARKS CAN CAUSE AN EXPLOSION. USE MECHANICAL VENTILATION OR RESPIRATIORY PROTECTION WHEN WORKING IN A CONFINED SPACE OR AREA. AVOID CONTACT WITH SKIN, EYES AND CLOTHING. WEAR EYE PROTECTION. KEEP AWAY FROM SOURCES OF HEAT, FIRE OR SPARKS.

CAUTION: DO NOT IMMERSE PARTS IN SOLVENT OR ALLOW STANDING SOLVENT ON THE PART. DAMAGE TO THE PART WILL OCCUR.

(c) Wipe the surfaces to be repaired with a clean cloth, moistened with solvent Series 99. Refer to 51-30-03, GENERAL for a source of the solvents.

(d) Clean the surfaces again until a new moist cloth is clean after it is used.

(e) Remove the solvent from the surface before it can dry.

(f) Remove the remaining solvent film before you continue the repair.

(2) Refinish after Repair

(a) Lightly sand edge of top most repair ply as necessary to fair the edge. Do not sand through the nonstructural sanding ply into the structural repair plies below it.

(b) Apply finish to the repaired surface using the following applicable methods:

1) Where clear Poly Vinyl Flouride (PVF) film surfaces have been removed, seal with a brush coat of Resin Mix 3 (Figure 1/GENERAL). Cure for 6 to 8 hours at room temperature or at elevated temperatures as given in Figure 4/GENERAL.

2) Where gray or white Poly Vinyl Flouride (PVF) film surfaces have been removed, seal with Resin Mix 3 (Figure 1/GENERAL). Cure 6 to 8 hours at room temperature (or as given in Figure 4/GENERAL) and apply one coat of BMS 10-11 primer and one coat of BMS 10-60, Type II enamel (gray, BAC 705; white, BAC 7106).

3) Where BMS 10-21 conductive coating has been removed, reapply as given in AMM 51-24-02.

4) Where the abrasion resistant Teflon finish has been removed from the internal surface of the panel edgeband, reapply the finish according to AMM 51-24-13.

5) Where the original painted surfaces have been removed, restore original finish according to AMM 51-21.

6) Where sealant has been removed from around fittings or fay surfaces to facilitate repairs, reapply BMS 5-95 sealant as given in 51-20-05, GENERAL.

7) Where permanent fasteners have been removed from aluminum fittings common to graphite, reinstall bolts wet with BMS 5-95 sealant and fillet seal around bolt heads and nuts.

8) Where aluminum flame-sprayed areas have been damaged, repair as given in 51-70-14, GENERAL.

I. Do the Post-Repair Procedures

(1) Do an inspection of the repair to make sure that it is satisfactory. Make sure that there are no empty spaces between plies or defective bonds. The inspection must include the area that was hot plus 2 inches minimum all around.

(2) If you find the repair to be unsatisfactory, you must remove it and install the repair again.

NOTE: The post-repair inspection is recommended. Examples of the inspection procedures are given in NDT Part 1, 51-01-01. Other inspection procedures that have been examined and found to be satisfactory by the airline can be used.

WARNING: MAKE SURE THAT THE OUTBOARD AILERON, ELEVATOR, AND RUDDER (CONTROL SURFACES) ARE BALANCED CORRECTLY AT ALL TIMES. IF YOU DO NOT, FLIGHT SAFETY CAN BE AFFECTED.

(3) After you repair a control surface, you must do a check of the balance to find if a rebalance is necessary. Refer to 51-60-00, GENERAL as necessary.

CAUTION: MAKE SURE THAT REPAIRS MADE TO CONTROL SURFACES AND/OR ADJACENT STRUCTURE DO NOT INTERFERE WITH THE DESIGNED OPERATION OF THE CONTROL SURFACES. DAMAGE TO THE AIRPLANES STRUCTURE CAN BE THE RESULT.

(4) Do a check of all repairs to make sure of clearance and non-interference with the operation of control surfaces.

(5) If a repair creates a blockage of a drain hole in the airplane structure, drill through the repair at the initial drain hole location with the appropriate drill bit. Refer to AMM 51-41-00/201.

5. Typical Repairs

CAUTION: TO GET AN ACCEPTABLE QUALITY REPAIR, DO AS FOLLOWS:

- REFER TO THE APPLICABLE COMPONENT THAT YOU ARE GOING TO REPAIR FOR THE REPAIR LIMITS AND MATERIAL OF THE COMPONENT BEFORE YOU USE THESE REPAIR INSTRUCTIONS.
- USE THE CORRECT MATERIALS FOR THE TYPE OF COMPONENT AND REPAIR THAT IS MADE.
- USE THE MATERIALS THAT AGREE WITH THE SPECIFICATIONS IN THE SRM.
- ACCURATELY FOLLOW THE SRM PROCEDURES AT EACH STEP OF THE REPAIR. IF YOU DO NOT DO THIS, IT CAN CAUSE A REPAIR THAT IS NOT SATISFACTORY AND NOT APPROVED.

NOTE: These repairs apply to all graphite/aramid/fiberglass fabric reinforced honeycomb and laminate components, except radomes, when called out in applicable repair index of specific structure.

A. Repair of Delaminations Between Plies

(1) Delamination of plies over core area of panel (Figure 5/GENERAL).

(a) Determine damage as given in Paragraph 4.A./GENERAL Ensure that water and other contamination are removed.

(b) Cut away delaminated plies as given in Paragraph 4.C.(1)/GENERAL Do not remove any core.

(c) Prepare damaged area as given in Paragraph 4.C.(2)/GENERAL.

(d) Prepare and apply fabric repair plies and complete repair as given in Paragraph 4.E./GENERAL thru Paragraph 4.I./GENERAL.

(2) Repair of delaminations between plies of panel edgeband.

(a) Repair this type of damage as given in 51-70-17, GENERAL, Paragraph 3.A.(2).

B. Repair of Puncture, 0.50-inch Diameter or Less, in Honeycomb Panel

(1) Repair this type of damage as given in 51-70-03, GENERAL, Paragraph 4.B..

C. Repair of Damage to One Skin and Honeycomb Core using Replacement Core Plug, Punctures Greater than 0.50-inch Diameter (Figure 2/GENERAL)

(1) Determine extent of damage according to Paragraph 4.A./GENERAL.

(2) Ensure that all contamination and water are removed from damaged area (Ref Paragraph 4.B./GENERAL).

(3) Remove damage and prepare area according to Paragraph 4.C./GENERAL

(4) Fabricate, clean, and install honeycomb replacement core plug as given in Paragraph 4.D./GENERAL.

(5) Sand core plug approximately flush with surrounding material making allowance for film adhesive and slight core crush during cure.

(6) Prepare and apply repair plies and complete repair as given in Paragraph 4.E./GENERAL thru Paragraph 4.I./GENERAL.

D. Repair of Large Puncture Through Internal and External Surface of Panel Including Core Damage (Figure 6/GENERAL).

NOTE: For repair where access to inner surface is limited, refer to Paragraph F.

(1) Determine extent of damage according to Paragraph 4.A./GENERAL.

(2) Ensure that all contamination and water are removed from damaged area. Refer to Paragraph 4.B./GENERAL.

(3) Remove damage and prepare area according to Paragraph 4.C./GENERAL.

(4) Fabricate, clean, and install honeycomb replacement core plug as given in Paragraph 4.D./GENERAL, except do not perform steps 3.D.(3)(e) through 3.D.(3)(k).

(5) Prepare and apply repair plies to one surface of the panel according to Paragraph 4.E./GENERAL A caul plate may be used on the opposite face of the panel to restrain the core plug in place.

(6) Apply vacuum pressure and cure according to Paragraph 4.F./GENERAL and Paragraph 4.G./GENERAL Ensure that temperature is approximately equal on both sides of panel.

(7) Sand core plug approximately flush with surrounding material, making allowance for film adhesive and slight core crush during cure.

(8) Prepare and apply repair plies to the other surface of the panel according to Paragraph 4.E./GENERAL.

(9) Apply vacuum and cure as given in Paragraph 4.F./GENERAL and Paragraph 4.G./GENERAL.

(10) Refinish the repair according to Paragraph 4.H./GENERAL.

(11) Perform applicable post-repair requirements as given in Paragraph 4.I./GENERAL before returning the repaired component to flight service.

NOTE: The above two-stage cure procedure is recommended. As an option, a three-stage cure procedure may be used wherein the core plug installation and the repair plies on each side may be cured separately.

E. Replacement of Honeycomb Core on Damaged Edge of Panel (Figure 7/GENERAL).

(1) Determine extent of damage according to Paragraph 4.A./GENERAL.

(2) Ensure that all contamination and water are removed from damaged area (Ref Paragraph 4.B./GENERAL).

(3) Remove damage and prepare area according to Paragraph 4.C./GENERAL.

(4) Fabricate, clean, and install honeycomb replacement core plug as given in Paragraph 4.D./GENERAL.

(5) Sand core plug approximately flush with surrounding core material, making allowance for film adhesive and slight core crush during cure.

(6) Clean surfaces according to Paragraph 4.C.(2)(e)/GENERAL.

(7) Prepare and apply repair plies and complete repair as given in Paragraph 4.E./GENERAL thru Paragraph 4.I./GENERAL.

F. Repair of Hole Through Both Skins of a Honeycomb Panel with Access Available from One Side Only (Figure 8/GENERAL).

NOTE: This repair applies to flat panels (or nearly flat panels) where the damage extends completely through the panel, but access is not readily available to repair the unexposed side, and the repair is accomplished in one operation, i.e. core repair and patch overlay repair cured together.

See Figure 8/GENERAL when making this repair. Refer to Paragraph 4.C./GENERAL, Typical Repairs when making this repair.

(1) Determine extent of damage.

(2) Ensure that all contamination and water is removed from damaged area.

(3) Remove damage and prepare area as given in Paragraph 4.C./GENERAL and the following:

(a) Cut a hole in the outer skin and core (D diameter) to permit a repair to be made to the inner skin with the required overlap.

NOTE: D diameter = d + N + 1 d = major diameter of oval hole in inner skin and is limited to 1.5 inch max for this repair. N = number of plies in the inner skin

Stepping of the plies in the inner skin is not necessary for this repair.

(b) Clean out damaged area in inner skin leaving an oval-shaped hole. Taper sand the outer skin plies as given in Paragraph 4.C.(2)/GENERAL.

(4) Fabricate an airtight patch, Figure 8/GENERAL (Details II thru V) to cover the oval hole from the inaccessible side as follows:

(a) Make a suitable mold on which to lay up the patch. A thin gage aluminum sheet or any smooth surface can be used as a mold.

(b) Cover the mold with parting film or release agent.

(c) Lay up five plies of the same prepreg material used in the repair on the mold, using the procedures of Paragraph 4.E./GENERAL, except that all repair plies will have the same diameter and adhesive film will not be used. Make diameter of the repair plies at least equal to D diameter.

(d) Bag and cure the patch as given in Paragraph 4.F./GENERAL and Paragraph 4.G./GENERAL. Place thermocouples at the edge of the patch before cure.

(e) Remove the patch from the mold.

(f) Trim patch into an oval shape with a minor diameter slightly smaller than the major diameter of the cutout.

(g) Drill a 1/8 diameter hole in the center of the patch for a cleco fastener.

(h) Abrade the surface of the patch using No. 240 or finer Scotch-Brite abrasive. Remove all sanding dust by applying oil-free compressed air and using a vacuum cleaner.

(i) Fabricate a strip of spring steel 1.0 X 10.0 inches and drill a 1/8 diameter hole in the center for the cleco fastener.

NOTE: This repair illustrates the use of a spring steel clamp. However, any suitable retaining device may be used.

(j) Assemble the patch and spring steel together with a 1/8 diameter cleco fastener. See Figure 8/GENERAL, Detail II.

(5) Remove Tedlar, if required and abrade the underside of the inner skin to a distance of 0.4 from the edge of the elliptical cutout using No. 180 or finer sandpaper. Avoid abrasion of the existing ply filaments.

CAUTION: DO NOT IMMERSE PARTS IN SOLVENT OR ALLOW STANDING SOLVENT TO REMAIN ON PART. DAMAGE TO PART WILL OCCUR.

(6) Clean out the repair area with oil-free compressed air. Wipe the surface with a clean cloth moistened with Solvent, Series 99 (AMM/ SOPM 20-30-99).

(7) Bend up both ends of the spring steel and apply adhesive BMS 5-25 or BMS 5-92 to the precured patch.

(8) Holding the spring steel up - insert the patch into the oval hole, and orientate so that the hole is covered. Release the spring steel so that it holds the patch tightly up against the inner skin.

(9) Cure the adhesive as given in Figure 14/GENERAL. When cure is complete, remove the cleco fastener and spring. Fill hole for cleco fastener with adhesive BMS 5-25 or BMS 5-92. Allow this to cure.

(10) Clean out the repair area as given in Paragraph 5.F.(6)/GENERAL.

(11) Apply adhesive film BMS 5-129, Type 2 or 4, Grade 10, 0.10 bigger than diameter D to the surface of the inner skin which fays with the inner skin repair plies.

(12) Cut the required number of repair plies to diameter D and apply repair plies to the inner skin.

(13) Fabricate and clean core plug as given in Paragraph 4.D.(1)/GENERAL and Paragraph 4.D.(2)/GENERAL

(14) Complete the installation of the core plug as given in Paragraph 4.D.(3)/GENERAL(b) thru 3.D.(3)(j).

(15) Prepare and apply repair plies to the outer skin surface of the panel and complete repair as given in Paragraph 4.E./GENERAL thru Paragraph 4.I./GENERAL.

G. Repair of Damaged Skin Plies in Panel Edgeband (Figure 9/GENERAL)

(1) Determine extent of damage according to Paragraph 4.A./GENERAL

(2) Ensure that all contamination and water are removed from damaged area. Area must be completely dried out.

CAUTION: DO NOT SAND INTO BOND PLY OR CORE (FIGURE 9/GENERAL). LOSS OF STRUCTURAL STRENGTH OF THE COMPONENT WILL OCCUR IF THIS CAUTION IS NOT OBSERVED. BOND PLY IS PLY ADJACENT TO CORE.

(3) Remove damage and prepare area according to Paragraph 4.C./GENERAL

CAUTION: ON HYBRID PANELS, ENSURE THAT GRAPHITE REPAIR PLIES DO NOT EXTEND INTO AREAS OF FASTENER HOLES. ELECTROLYSIS BETWEEN METAL FASTENERS, SUPPORT STRUCTURE AND GRAPHITE MAY OCCUR CAUSING CORROSION TO ALUMINUM STRUCTURES.

(4) Prepare and apply repair plies and complete the repair as given in Paragraph 4.E./GENERAL thru Paragraph 4.I./GENERAL.

H. Repair of Damage and Punctures in Solid Laminate Panels

NOTE: This repair applies to components made from laminated fabric and/or tape plies and epoxy resin without a honeycomb core.

(1) Determine extent of damage according to Paragraph 4.A./GENERAL.

(2) Remove all contamination and water from damaged area as given in Paragraph 4.B./GENERAL. Area must be completely dried out. Any structure in the repair area that cannot be dried out must be removed along with other damage.

(3) Remove all damage and prepare area as given in Paragraph 4.C./GENERAL.

NOTE: Taper sand edges of plies around repair on damaged side of panel.

(4) Prepare and apply repair plies and complete the repair as given in Paragraph 4.E./GENERAL thru Paragraph 4.I./GENERAL.

NOTE: If cleaned up damage penetrates solid laminate, secure a metal caul plate (such as 0.016 thick aluminum) to far side of panel to support repair plies.

I. Repair of Punctures, 0.25-inch Diameter or Less, in Solid Laminate Panels

NOTE: This repair applies to components made from laminated graphite/aramid/fiberglass fabric or tape plies and epoxy resin without a honeycomb core.

(1) Check for delamination as given in Paragraph 4.A./GENERAL.

(2) If no delamination is found, clean up damage to a smooth, rounded shape. Then repair as given in Paragraph 5.B./GENERAL.

(3) If delamination is found, repair as given in Paragraph 5.H./GENERAL.

J. Repair of Delaminations Between Plies in Solid Laminate Panels

NOTE: This repair applies to components made from laminated graphite/aramid/fiberglass fabric or tape plies and epoxy resin without a honeycomb core.

(1) Repair delaminations using methods described in Paragraph 5.H./GENERAL.

K. Repair of Damaged Panel Attach Holes in Honeycomb Panel Edgebands or Along Edges of Solid Laminate Panels (Figure 10/GENERAL).

(1) Determine the extent of damage according to Paragraph 4.A./GENERAL

(2) Ensure that all contamination and water are removed from damaged area as given in Paragraph 4.B./GENERAL. Area must be completely dried out. Any in the repair area that cannot be dried out must removed along with the other damage.

(3) Taper sand around the hole to remove damage according to Figure 10/GENERAL 3.C.(2)(d).

(4) Clean area according to Paragraph 4.C.(2)(e)/GENERAL.

CAUTION: ON HYBRID PANELS, ENSURE THAT GRAPHITE REPAIR PLIES DO NOT EXTEND INTO AREAS OF FASTENER HOLES. ELECTROLYSIS BETWEEN METAL FASTENERS, SUPPORT STRUCTURE AND GRAPHITE MAY OCCUR CAUSING CORROSION TO ALUMINUM STRUCTURE.

(5) Prepare and apply repair plies according to Paragraph 4.E./GENERAL and Figure 10/GENERAL.

(6) Apply vacuum and cure according to Paragraph 4.F./GENERAL and Paragraph 4.G./GENERAL.

(7) Refinish the repair according to Paragraph 4.H./GENERAL.

(8) Drill and countersink fastener holes.

(9) Perform applicable post-repair requirements as given in Paragraph 4.I./GENERAL before returning the repaired component to flight service.

L. Repair of Surface Dents

(1) Check for delamination and broken fibers as given in Paragraph 4.A./GENERAL.

(2) If delamination is found, repair as given in Paragraph 5.A./GENERAL.

(3) If broken fibers are found, repair as given in Paragraph 5.B./GENERAL or Paragraph 5.C./GENERAL.

(4) If no delamination or broken fibers are found, repair as given in 51-70-03, GENERAL, Paragraph 4.M.

M. Repair to Aluminum Foil (Figure 17/GENERAL)

NOTE: This repair is done in addition to the applicable repair of the underlying plies.

(1) Determine the extent of and remove damage. Apply repair materials to the underlying composite structure as given in Paragraph 5.A./GENERAL thru Paragraph 5.F./GENERAL up to and including the step for applying the repair plies to the surface that had aluminum foil.

(2) Alodine treat the nonadhesive side of the splice strip, cover ply, and aluminum surfaces that will contact the splice strip and cover ply.

(3) Butt-splice a ply of BMS 8-289, Type 0/250/x/x/x over the repair area, adhesive side down, with a 0.25 maximum gap and no overlap allowance.

(4) Lay up splice strips of BMS 8-289, Type 0/250/x/x/x Form II adhesive side up, so that they overlap each side of the splice line by about 1.25. Form I is optional but requires alodine treatment on nonadhesive side and 0.5 diameter holes on 2.0 centers.

NOTE: Do not allow the cover ply or splice strip to extend into the edgeband area of the panel. Electrical splicing is not allowed on the laminated edgeband faying surface.

(5) Apply a cover ply of BMS 8-79, Style 120 prepreg over the repair so that they overlap the outer edge of the splice strip by 1.0.

(6) Vacuum bag and cure the repair as given in Paragraph 4.F./GENERAL and Paragraph 4.G./GENERAL

RESIN TYPE	COMPONENTS	PARTS BY WEIGHT	POT LIFE OF MIXTURE	CURING TIME
RESIN MIX 3 (SEALER RESIN)	EPIBOND 156A EPIBOND 156B HARDENER	98 TO 102 5.7 TO 6.3	12 TO 25 MINUTES AT 77°F (25°C)	12 HRS AT 70°F OR 1 TO 3 HRS AT 150°F (66°C)
RESIN MIX 3 (SEALER RESIN) ALTERNATE	FIBER-RESIN 5318S FIBER-RESIN 5318C	98 TO 102 49 TO 51	45 TO 60 MINUTES AT 70°F (21°C)	REFER TO FIG. 4 OR 24 HRS MIN. AT 70°F (21°C)
RESIN MIX 3 EPOX-O WELD (SEALER RESIN) ALTERNATE	TWO COMPONENT KIT	FOLLOW MANUFACTURERS INSTRUCTIONS FURNISHED WITH EACH KIT		
			45 TO 60 MINUTES AT 70°F (21°C)	REFER TO FIG. 4 OR 24 HRS MIN. AT 70°F (21°C)
RESIN MIX 3 (SEALER RESIN) ALTERNATE	EPIBOND 156A EPIBOND 941 HARDENER	98 TO 102 9.5 TO 10.5	45 TO 60 MINUTES AT 70°F (21°C)	REFER TO FIG. 4 OR 16 HRS MIN. AT 70°F (21°C)
RESIN MIX 3 (SEALER RESIN) ALTERNATE BMS 8-207 TYPE 1, CLASS I (250°F)	EC1838A EC1838B HARDENER	50 50	20 MINUTES	12 HOURS MIN. AT 105°F (41°C) TO 125°F (52°C)
RESIN MIX 3 (SEALER RESIN) ALTERNATE BMS 8-207 TYPE 1, CLASS II (350°F)	FR-40 5413C HARDENER	99 TO 101 14.5 TO 15.5	20 MINUTES AT 75°F (24°C) TO 79°F (26°C)	12 HOURS MIN. AT ROOM TEMP. (65°F MIN.) (18°C) 1 HR MIN. AT 150°F (66°C) TO 170°F (77°C)
RESIN MIX 4 (A LOW VISCOSITY INJECTION RESIN)	USE RESIN MIX 1		SEE RESIN MIX 1	

Resin, Prepreg, and Adhesive Specifications and Mixing Procedures
Figure 1 (Sheet 1 of 4)

RESIN, PREPREG, OR ADHESIVE TYPE	COMPONENTS	PARTS BY WEIGHT	OPEN TIME BEFORE USE, OR POT LIFE OF MIXTURE	CURING TIME
BMS 5-90, TYPE III CLASS 250/350-10-10, GRADE 50 OR 100	FM-490A MA-562 PL-685	--	$\boxed{B}$ $\boxed{C}$	SEE TEXT
BMS 5-90, TYPE IV CLASS 250/350-10-10	PL-460			
BMS 5-129, TYPE 2, CLASS IA, GRADE 5 OR 10	AF-126	--	$\boxed{B}$ $\boxed{D}$	SEE TEXT
BMS 5-129, TYPE 2, CLASS IIA, GRADE 5 OR 10	AF-126-2			
BMS 5-129, TYPE 2, CLASS IIB, GRADE 5 OR 10	FM-123-2			
BMS 5-129, TYPE 4, GRADE 10	AF-163-2OST EA-9628NW		$\boxed{B}$ $\boxed{C}$	SEE TEXT
BMS 8-79 (250°F/121°C GLASS PREPREG) CLASS III, GRADE 1			$\boxed{A}$	SEE TEXT
TYPE 120	120-F155-5-F69 120-F255-1-F69 MXB7701-120-Z-6040 RIGIDITE-3203-120,VOLAN A RIGIDITE-3203-120,Z6040 120-F155-5-CS272 G120/F6986S03-S920NM MXB7701-120-B3 MXB7701-120-C3 HG120/RS1212-Z6040			
TYPE 1581	1581-F155-5-F69 1581-F255-1-F69 MXB7701-1581-Z-6040 RIGIDITE-3203-1581,VOLAN A RIGIDITE-3203-1581,Z6040 1581-F155-5-CS272 G1581-F6986S03-S920NM MXB7701-1581-B3 MXB7701-1581-C3 HG120/RS1212-Z6040			
TYPE 7781	7781-F155-5-F69 7781-F255-5-F69 MXB7701-7781-Z-6040 RIGIDITE-3203-7781,VOLAN A RIGIDITE-3203-7781,Z6040 7781-F155-5-CS272 G7781-F6986S03-S920NM MXB7701-7781-B3 MXB7701-1781-C3			

Resin, Prepreg, and Adhesive Specifications and Mixing Procedures
Figure 1 (Sheet 2 of 4)

RESIN, PREPREG, OR ADHESIVE TYPE	COMPONENTS	PARTS BY WEIGHT	OPEN TIME BEFORE USE, OR POT LIFE OF MIXTURE	CURING TIME
BMS 8-168 (250°F/121°C GRAPHITE PREPREG) CLASS 1 (TAPE) TYPE II			A	SEE TEXT
GRADE 95	T3T-95-XX-F155-76 T6C-95-XX-F155-76 T2C-95-XX-F155-76 T6T-95-XX-F155-76 T2T-95-XX-F155-76 CYCOM 919GT-3095			
GRADE 145	T3T-145-XX-F155-76 T6C-145-XX-F155-76 T2C-145-XX-F155-76 T6T-145-XX-F155-76 T2T-145-XX-F155-76 HYE-10714AC(145) HYE-16714AD(145) CYCOM 919GT-3145			
GRADE 190	T3T-190-XX-F155-76 T6C-190-XX-F155-76 T2C-190-XX-F155-76 T6T-190-XX-F155-76 T2T-190-XX-F155-76 HYE-10714AC(190) HYE-16714AD(190) C3U190/F6986S03 CYCOM 919GT-3190			
CLASS 2 (FABRIC) TYPE II STYLE 3K-70-PW	W3T-282-XX-F155-76 W3C-282-XX-F155-76 HMF5-322/97714AC HMF5-1322/97714AC C3WPW/F6986S03 C3BWPW/F6986S03 CYCOM 919GF-3070PW			
BMS 8-219 (250°F/121°C ARAMID PREPREG)			A	SEE TEXT
STYLE 120	KEVLAR 49-120 F155-71 MXM 7714/KEVLAR 49-120 K120/F6986S03-KE-420 CYCOM 919 K120 R-9269-120K			
STYLE 285	KEVLAR 49-285 F155-71 MXM 7714/KEVLAR 49-285 K285/F6986S03-KE-420 CYCOM 919 K285 R-9269-285K			

Resin, Prepreg, and Adhesive Specifications and Mixing Procedures
Figure 1 (Sheet 3 of 4)

WARNING: THESE CHEMICALS CONTAIN TOXIC INGREDIENTS. PROVIDE ADEQUATE VENTILATION AND PROTECT THE SKIN AND EYES FROM CONTACT WITH UNCURED RESINS OR CURING AGENT. WEAR RUBBER GLOVES OVER COTTON GLOVES FOR PROTECTION OF HANDS. IF SKIN IS EXPOSED TO DIRECT CONTACT WITH UNCURED RESINS OR CURING AGENT, WASH WITH WARM WATER OR SOAP. AVOID THE USE OF SOLVENTS FOR CLEANING THE SKIN.

CAUTION: TO PREVENT CONTAMINATION OF THE RESIN, DO NOT USE WAXED CONTAINERS FOR MIXING.

	RESIN MIXING AND ADHESIVE PREPARATION PROCEDURES
RESIN MIX 1 RESIN MIX 3	ADD HARDENER TO RESIN AND MIX THOROUGHLY
BMS 5-90 BMS 5-129	REMOVE WRAPPER FILM BEFORE USE

NOTES

- REFER TO SRM 51-30-00 FOR SOURCES OF MATERIALS.

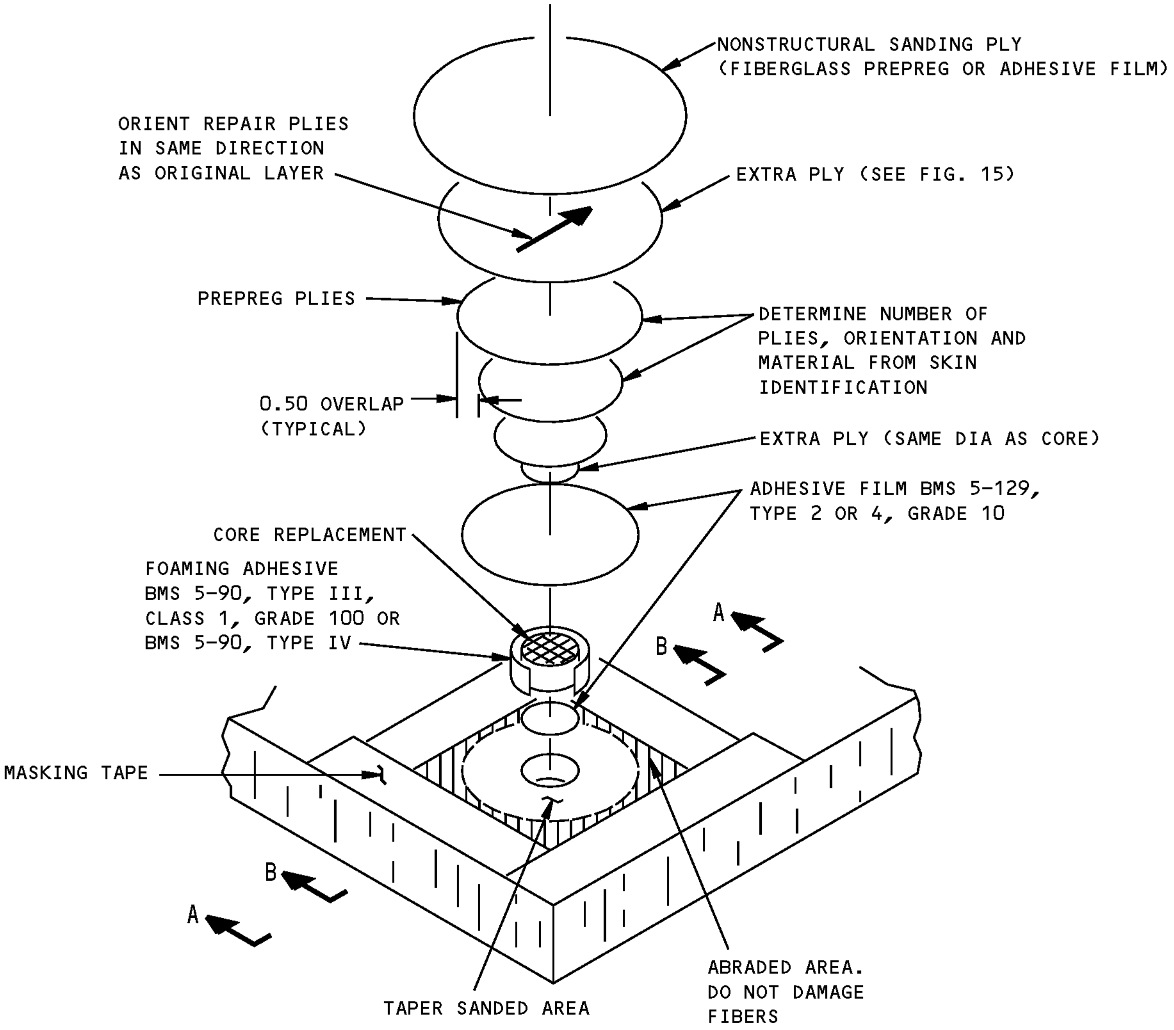
A OUT-TIME OF THIS MATERIAL IS 200 EXPOSURE UNITS. ONE EXPOSURE UNIT IS ACCUMULATED EACH HOUR THE MATERIAL IS EXPOSED TO TEMPERATURES BETWEEN 10°F (-12°C) AND 80°F (27°C). THREE EXPOSURE UNITS ARE ACCUMULATED EACH HOUR THE MATERIAL IS EXPOSED TO TEMPERATURES BETWEEN 81°F (27°C) AND 100°F (38°C). MATERIALS EXPOSED TO TEMPERATURES ABOVE 100°F (38°C) ARE TO BE REJECTED.

B REMOVE THE MATERIAL FROM REFRIGERATION AND KEEP IT SEALED AT 65°F (18°C) TO 90°F (32°C) FOR A MINIMUM OF 8 HOURS FOR A FULL ROLL BEFORE IT IS USED.

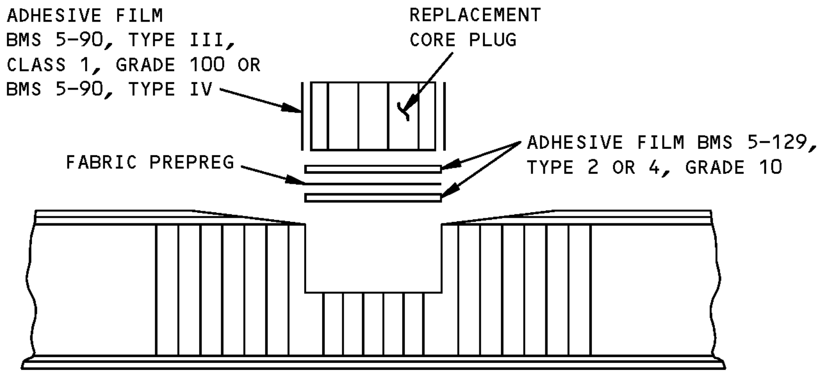
C THE MATERIAL MAY BE PUT BACK INTO REFRIGERATION ONE OR MORE TIMES WHEN THE CUMULATIVE OUT-TIME IS NOT MORE THAN 10 DAYS.

D THE MATERIAL MAY BE PUT BACK INTO REFRIGERATION ONE OR MORE TIMES WHEN THE CUMULATIVE OUT-TIME IS NOT MORE THAN 5 DAYS.

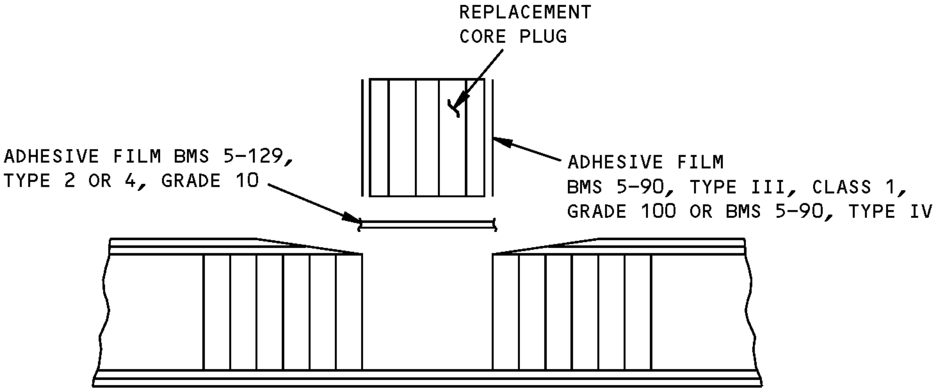
Resin, Prepreg, and Adhesive Specifications and Mixing Procedures
Figure 1 (Sheet 4 of 4)



Repair of Large Punctures Thru One Skin of a Sandwich Structure Including Core Damage - 250 Degrees F (121 Degrees C) Cure
Figure 2 (Sheet 1 of 2)

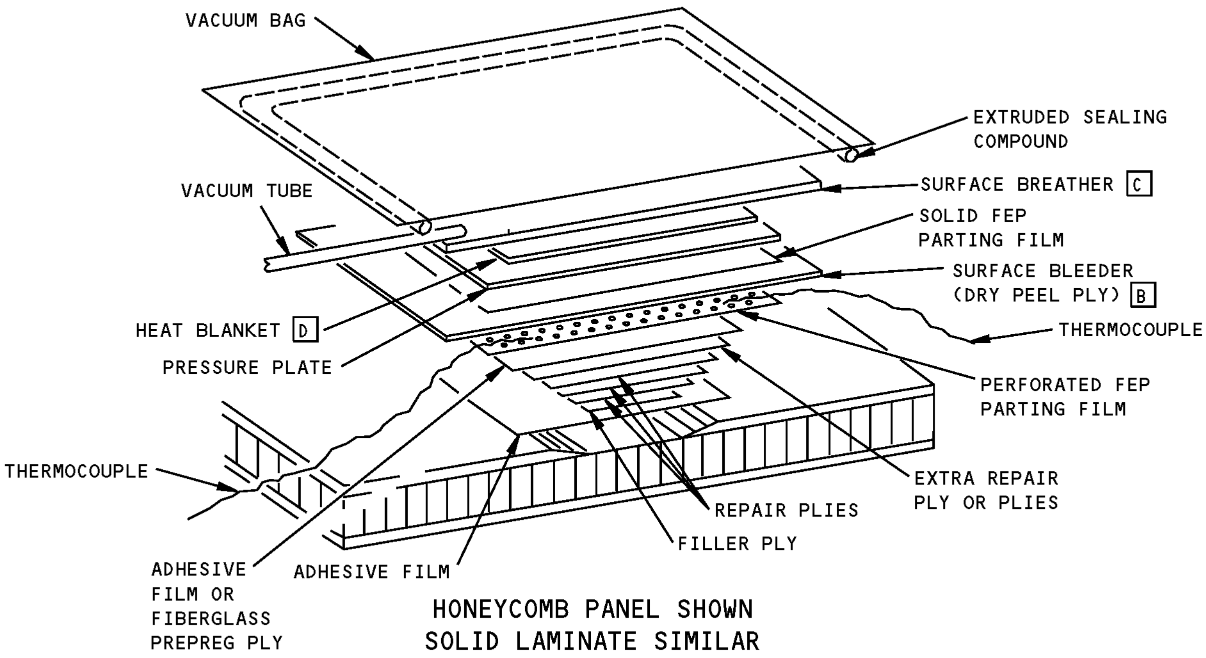


SECTION THRU REPAIR AREA -
PARTIAL DEPTH CORE REPLACEMENT
SECTION A-A



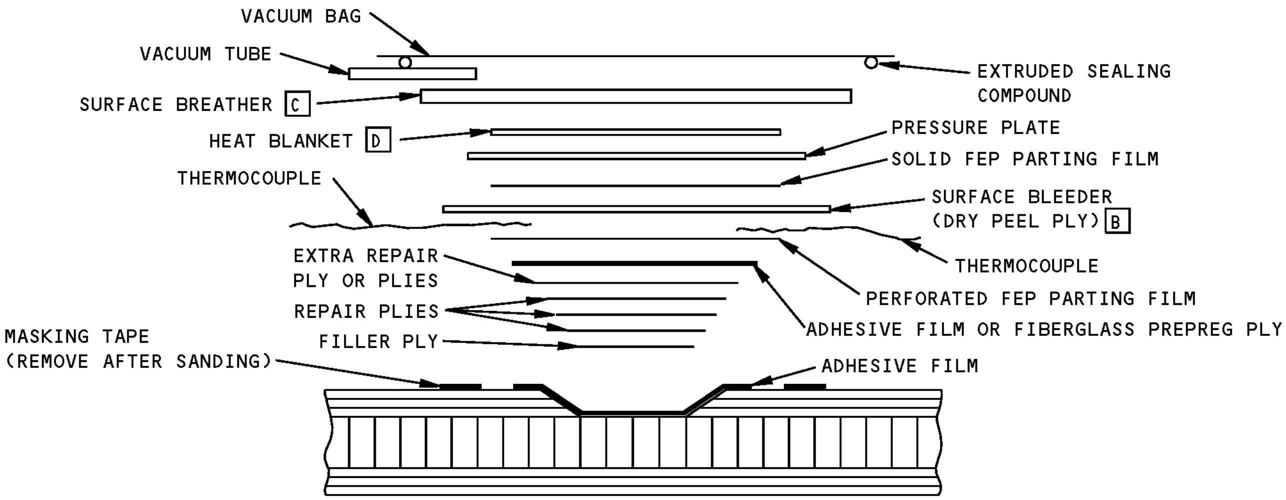
SECTION THRU REPAIR AREA -
FULL DEPTH CORE REPLACEMENT
SECTION B-B

Repair of Large Punctures Thru One Skin of a Sandwich Structure Including Core Damage - 250 Degrees F (121 Degrees C) Cure
Figure 2 (Sheet 2 of 2)



HONEYCOMB PANEL SHOWN
SOLID LAMINATE SIMILAR

BAGGING SEQUENCE FOR SKIN PLY REPAIR



SECTION THRU SKIN PLY REPAIR

NOTES

A ONE PLY OF ADHESIVE FILM (FOR FULL DEPTH CORE REPLACEMENT, WHERE DAMAGE DOES NOT EXTEND THROUGH BOTH SKINS). FOR PARTIAL CORE REPLACEMENT USE TWO PLIES OF ADHESIVE FILM WITH ONE PLY OF BMS 8-168, CLASS 2 GRAPHITE BETWEEN THEM.

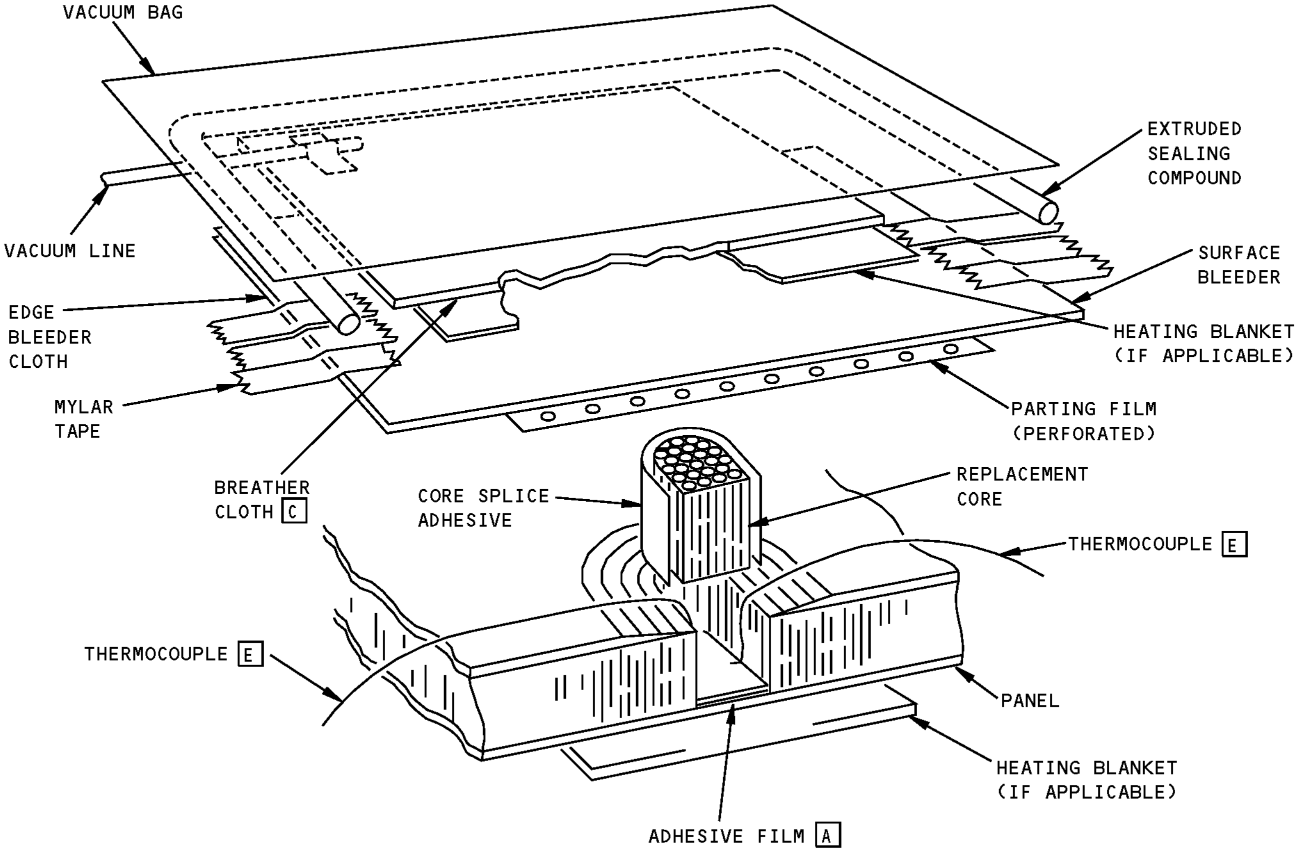
B DRY PEEL PLY MUST MAKE CONTACT WITH THE SURFACE BREATHER MATERIAL.

C WHEN USING A HEATING BLANKET, USE 4 TO 6 LAYERS OF BREATHER MATERIAL TO PREVENT DAMAGE TO VACUUM BAG.

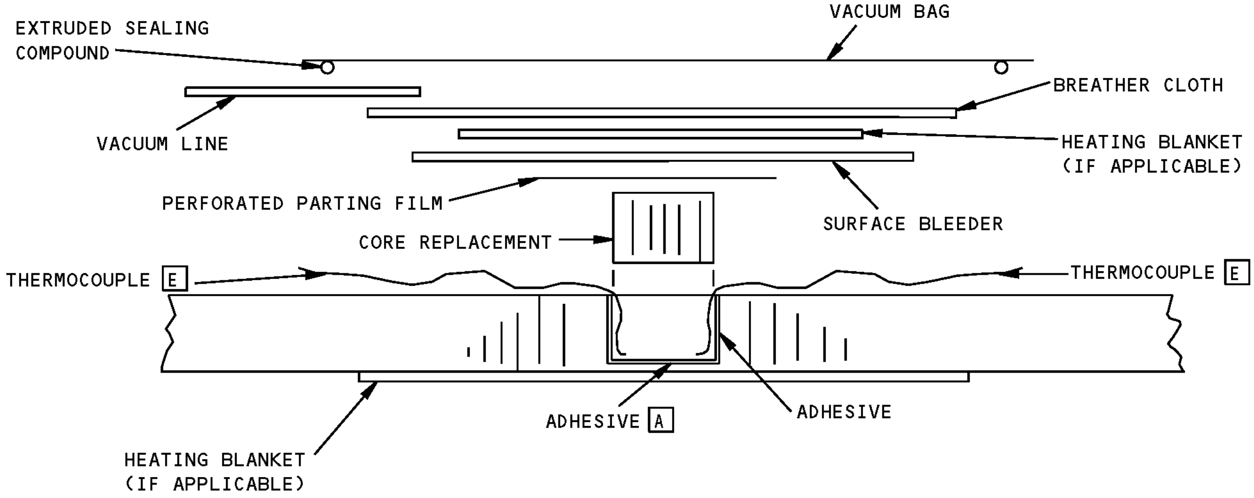
D HEATING BLANKET MUST EXTEND A MINIMUM OF 2 INCHES BEYOND EDGE OF REPAIR PATCH.

E FOR THERMOCOUPLE PLACEMENT REFER TO PAR 4.D.(3)(f).

Application of Pressure During Cure - 250 Degrees F (121 Degrees C) Cure
Figure 3 (Sheet 1 of 2)

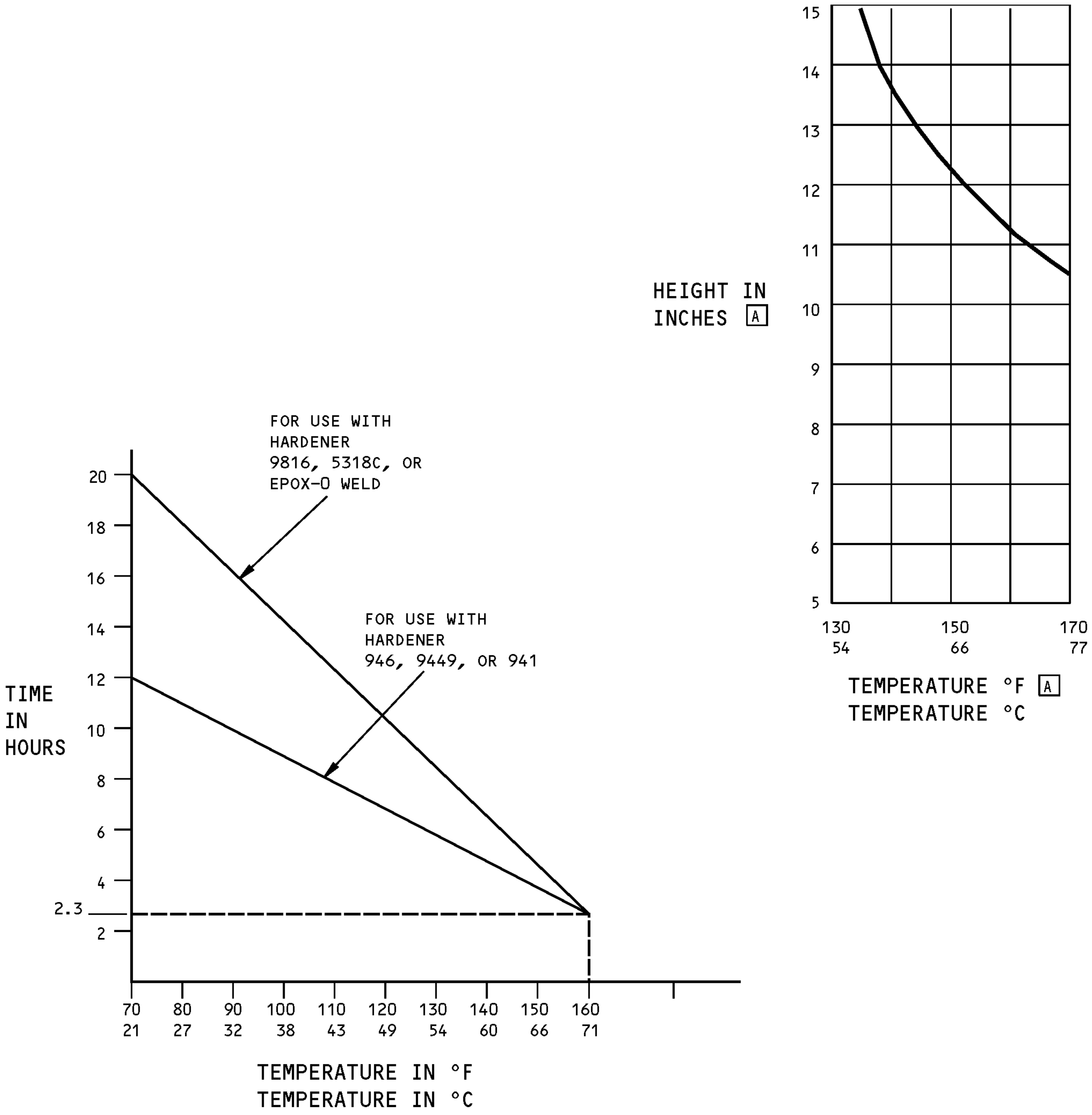


BAGGING SEQUENCE FOR CORE REPLACEMENT



SECTION THRU LAYUP FOR CORE REPLACEMENT

Application of Pressure During Cure - 250 Degrees F (121 Degrees C) Cure
Figure 3 (Sheet 2 of 2)

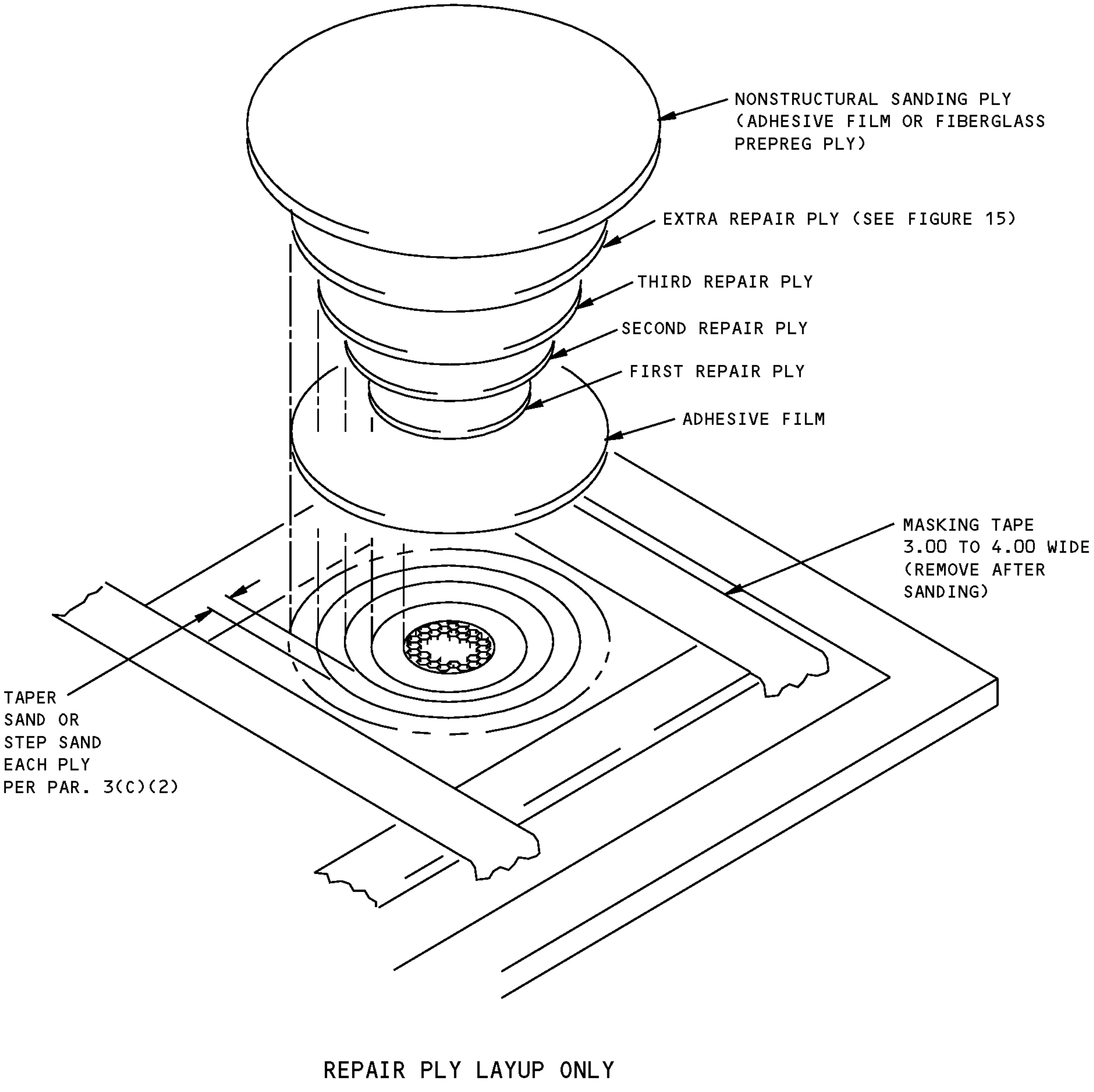


NOTES

- USE THERMOCOUPLES TO MONITOR TEMPERATURE

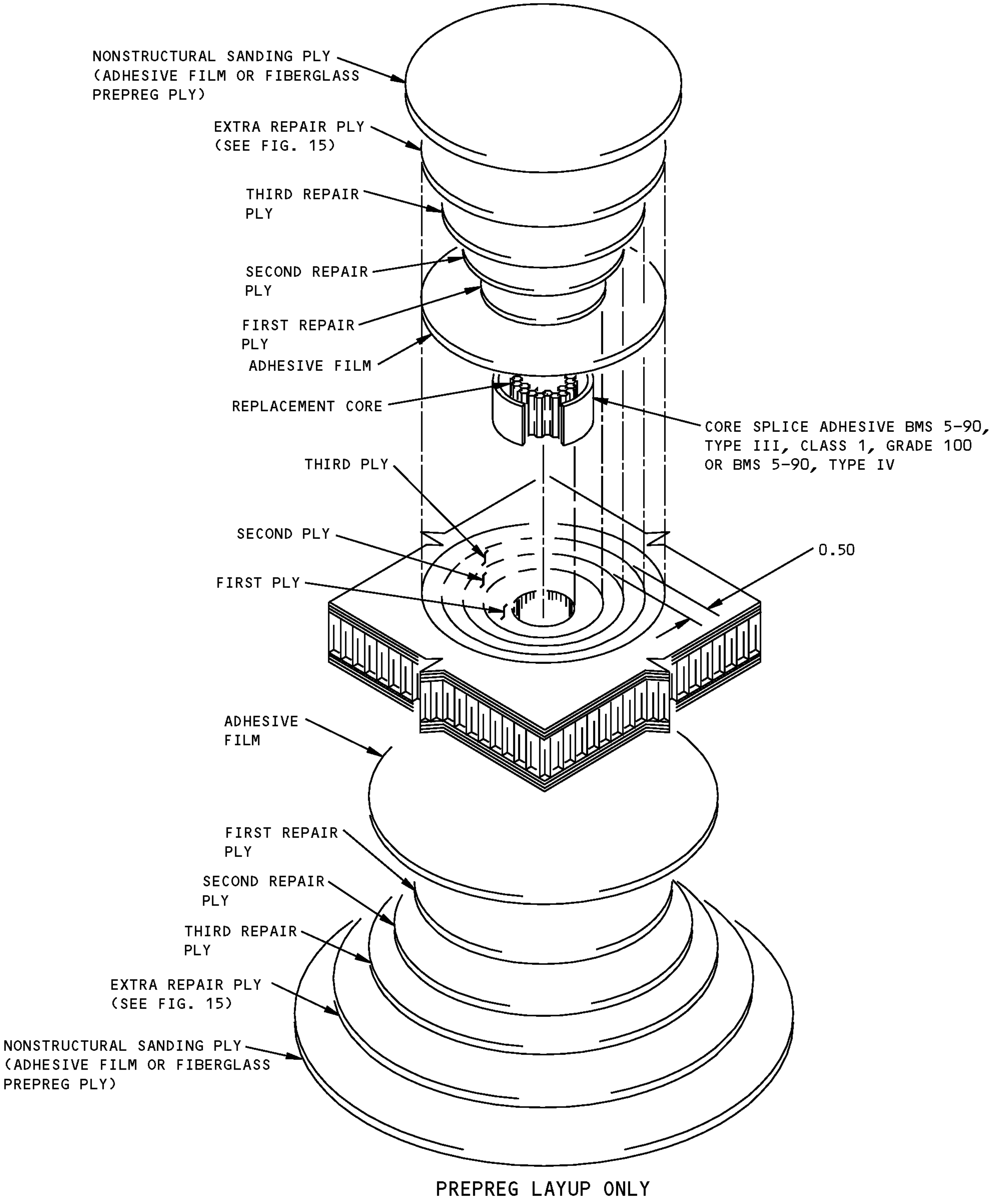
A THE HEIGHT IN INCHES OF 250 WATT HEAT LAMP FROM THE SURFACES OF THE PATCH VS TEMPERATURE AT SURFACE OF PART

Potting and Laminating Resin Cure Temperature
Figure 4

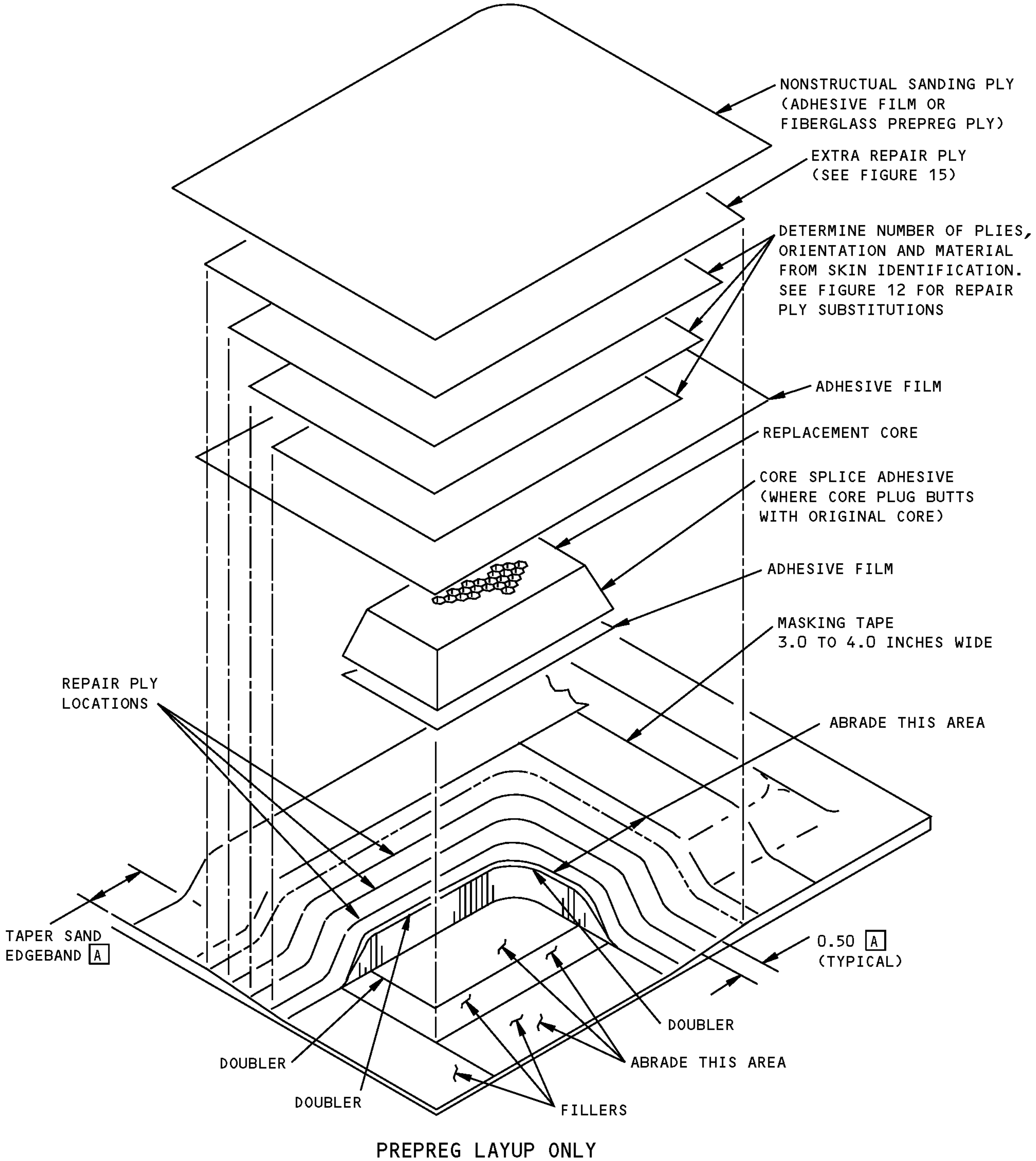


REPAIR PLY LAYUP ONLY

Repair of Damaged External or Internal Skins of a Sandwich Panel - 250 Degrees F (121 Degrees C) Cure
Figure 5



Repair of Large Punctures Thru Both Skins of a Sandwich Panel Including Core Damage - 250 Degrees F (121 Degrees C) Cure
Figure 6

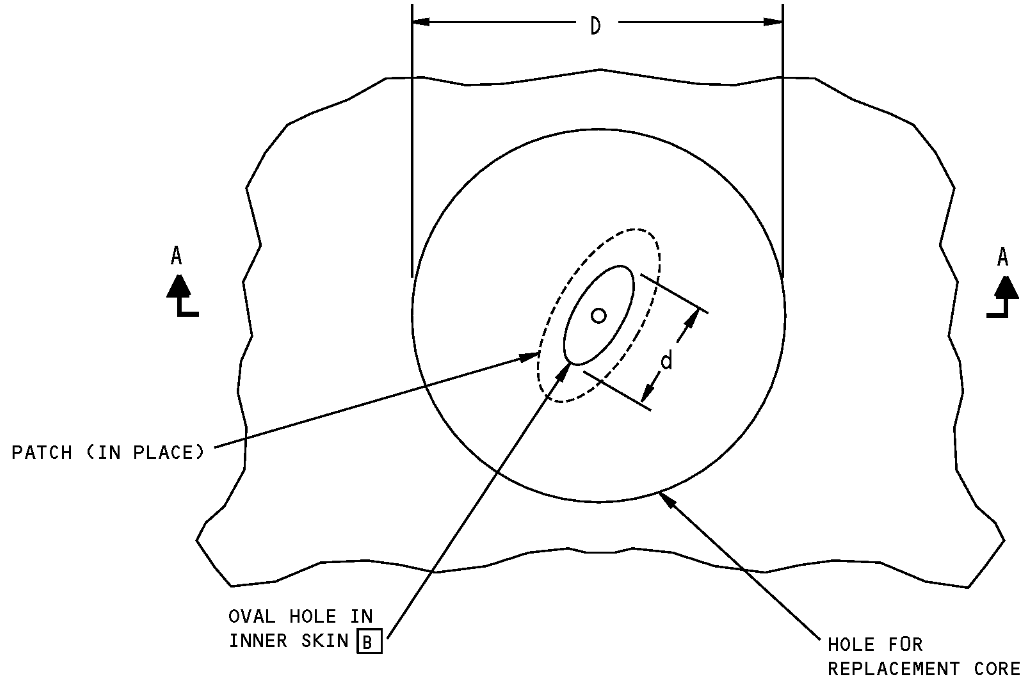


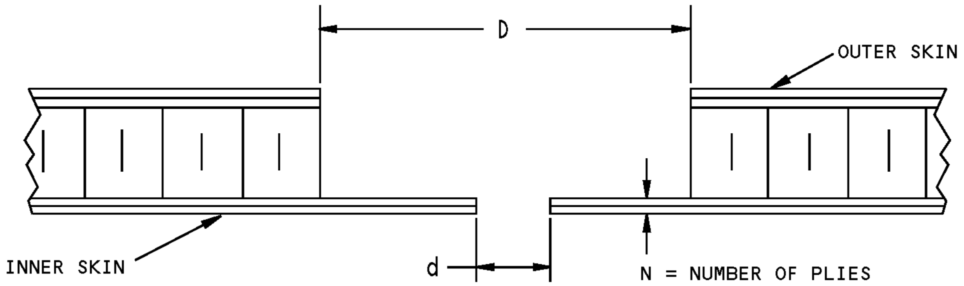
PREPREG LAYUP ONLY

NOTES

A REFER TO FIGURE 13 FOR THE SANDING AND OVERLAP REQUIREMENTS.

Replacement of Honeycomb Core on Damaged Edge of Sandwich Panel - 250 Degrees F (121 Degrees C) Cure
Figure 7





SECTION A-A
(PATCH NOT SHOWN)

DETAIL I

NOTES

- THIS REPAIR ILLUSTRATES THE USE OF A SPRING STEEL CLAMP. HOWEVER, ANY SUITABLE RETAINING DEVICE MAY BE USED.
- D = d + N + 1
  d = MAJOR DIAMETER OF OVAL HOLE IN INNER SKIN. SIZE LIMITED TO 1.5 INCH FOR THIS REPAIR.
  N = NUMBER OF PLIES
  D = DIAMETER OF HOLE FOR REPLACEMENT CORE

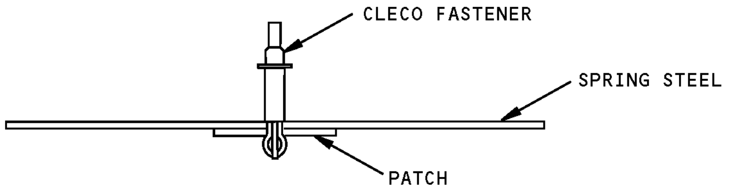
EXAMPLE:

IF d = 0.50 INCH
THEN, D = 0.50 + 2 (PLIES) + 1
D = 3.50 INCH DIAMETER

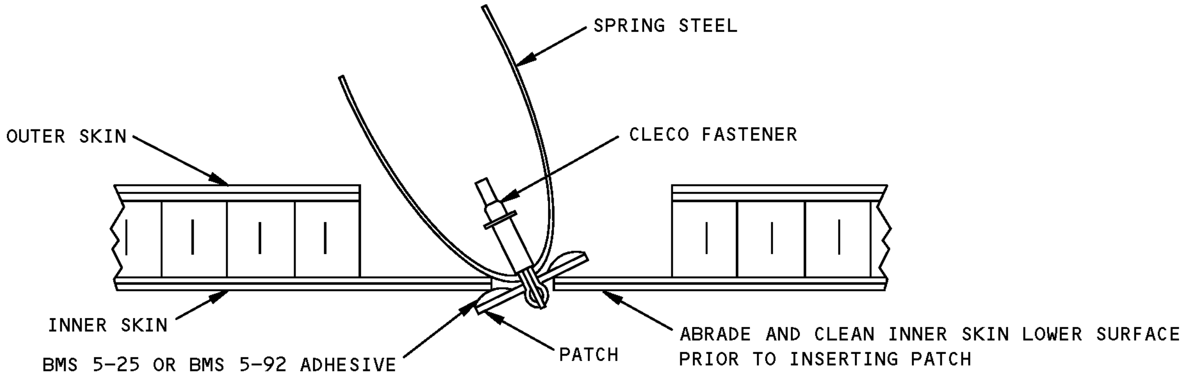
[A] MAKE TAPER AND OVERLAP AS GIVEN IN FIG. 13.

[B] MAJOR DIAMETER d OF OVAL HOLE IN INNER SKIN IS LIMITED TO 1.5 INCH FOR THIS REPAIR.

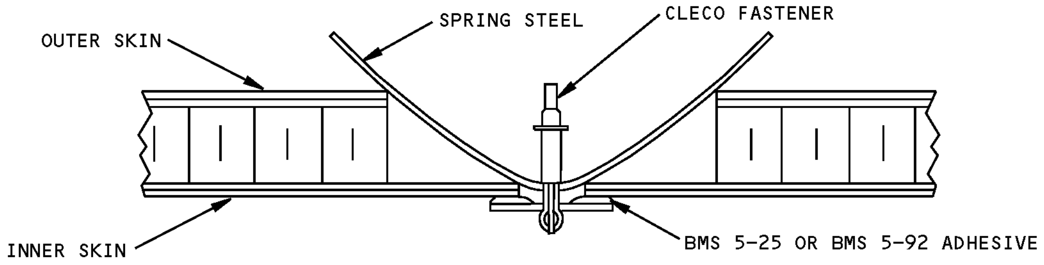
Repair of Damage to External and Internal Skins with Access Limited to One Side - 250 Degrees F (121 Degrees C) Cure
Figure 8 (Sheet 1 of 3)



ASSEMBLE PATCH AND SPRING STEEL
DETAIL II

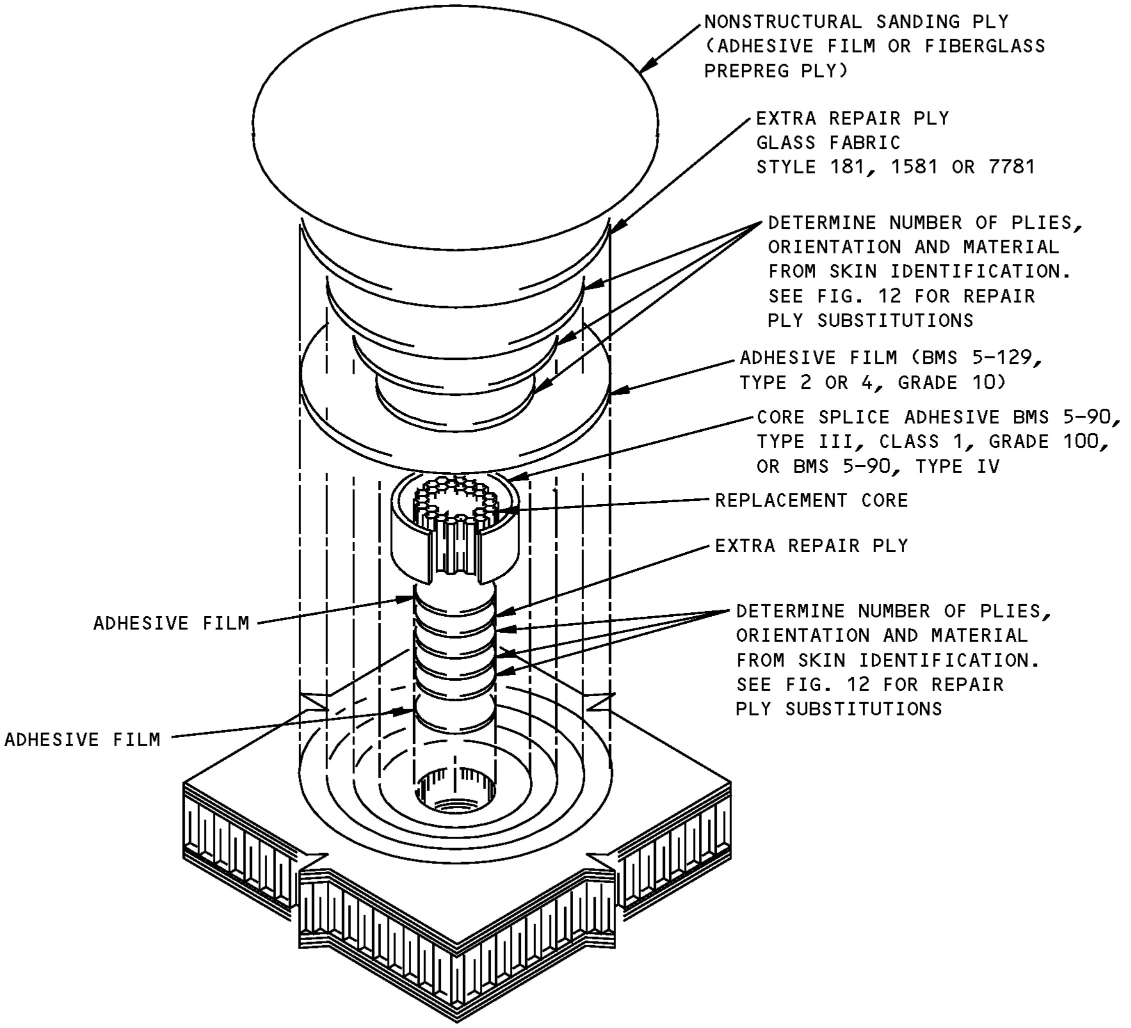


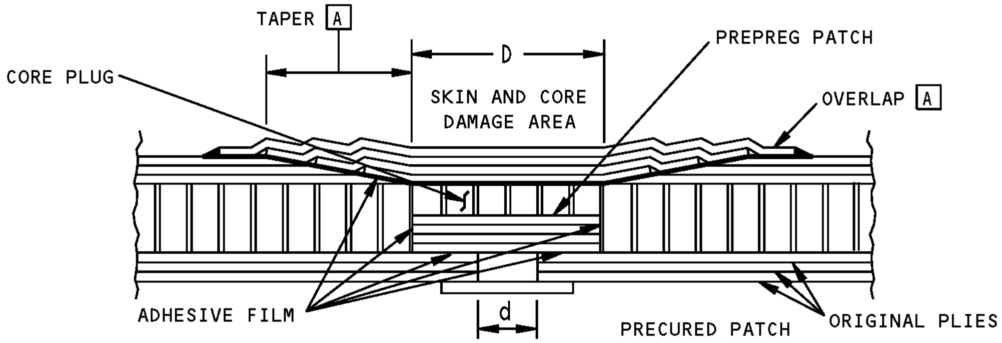
INSERT PATCH INTO OVAL HOLE
DETAIL III



HOLD PATCH IN PLACE WHILE CURING
DETAIL IV

Repair of Damage to External and Internal Skins with Access Limited to One Side - 250 Degrees F (121 Degrees C) Cure
Figure 8 (Sheet 2 of 3)

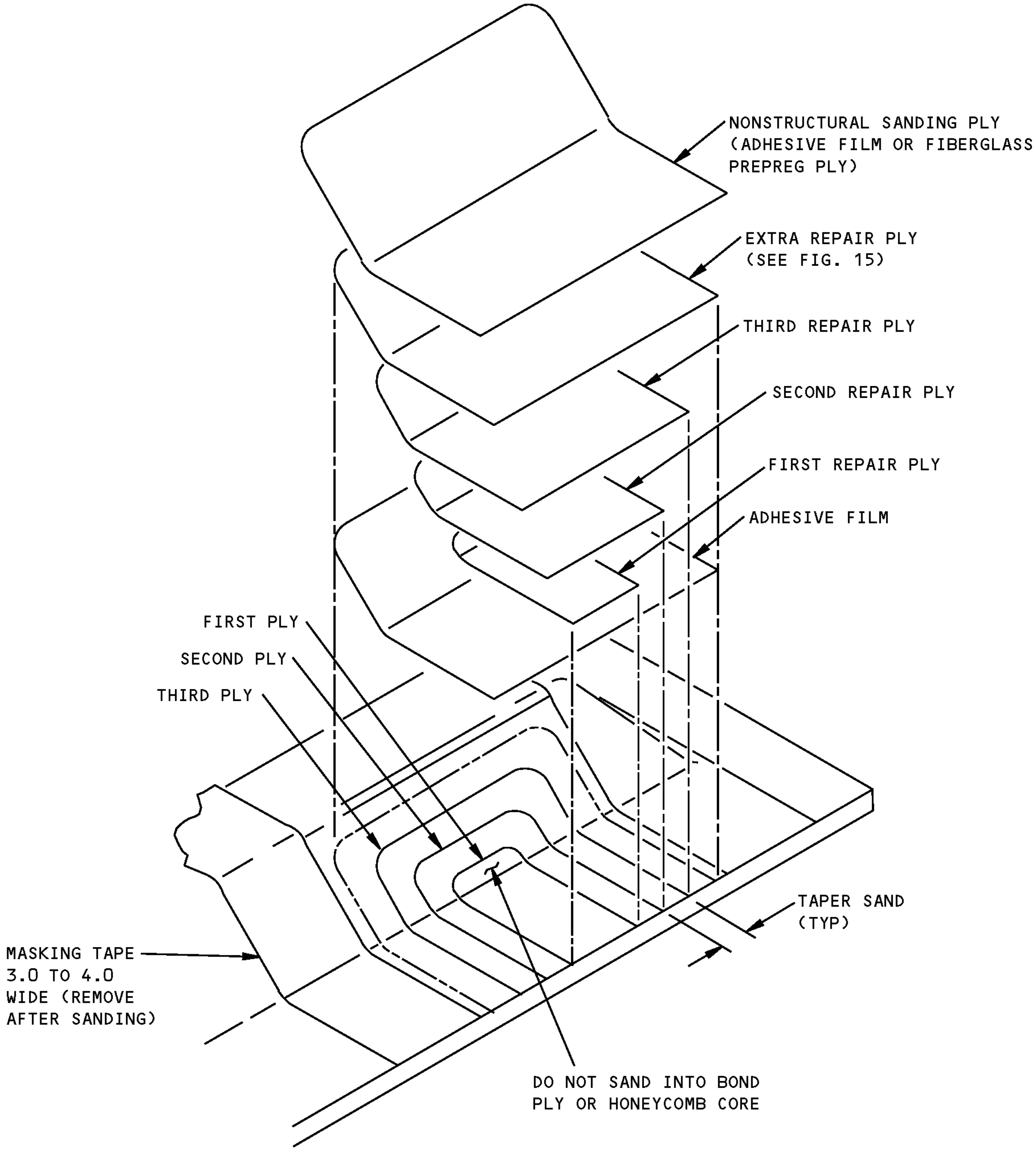




SECTION THROUGH REPAIR

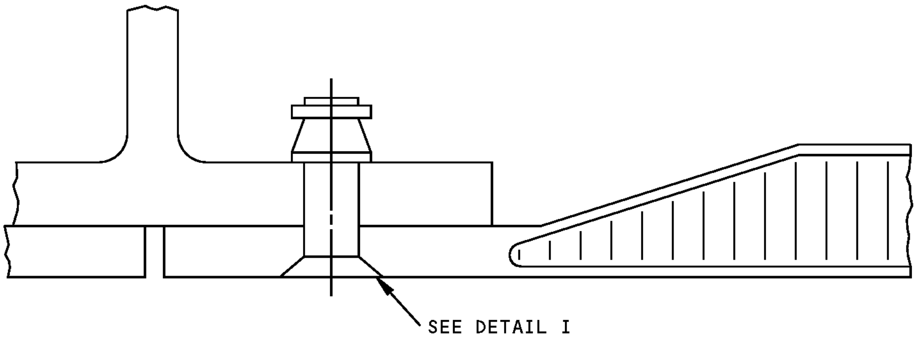
PREPREG LAYUP ONLY
DETAIL V

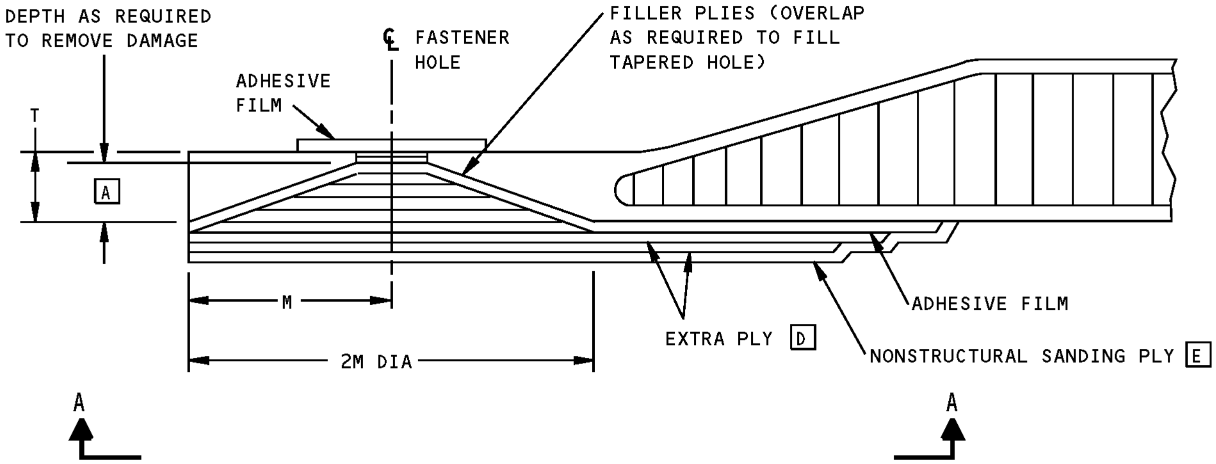
Repair of Damage to External and Internal Skins with Access Limited to One Side - 250 Degrees F (121 Degrees C) Cure
Figure 8 (Sheet 3 of 3)



PREPREG LAYUP ONLY

Repair of Damaged Skin Plies On A Panel Edge - 250 Degrees F (121 Degrees C) Cure
Figure 9





DETAIL I

NOTES

- D EQUALS FASTENER DIAMETER
- M = 5T MAXIMUM AS SHOWN WHERE T IS THE THICKNESS OF THE EDGE BAND. DO NOT CUT INTO CORE.
- THIS REPAIR IS APPLICABLE ONLY WHERE NO MORE THAN TWO ATTACH HOLES ARE DAMAGED IN A SEQUENCE OF TEN. IF MORE THAN TWO ATTACH HOLES IN A SEQUENCE OF TEN ARE DAMAGED, REPAIR THE EDGEBAND AS GIVEN IN PARAGRAPH 4.G. (FIGURE 9).

A APPLY FILLER PLIES AS REQUIRED TO FILL THE DAMAGED AREA.

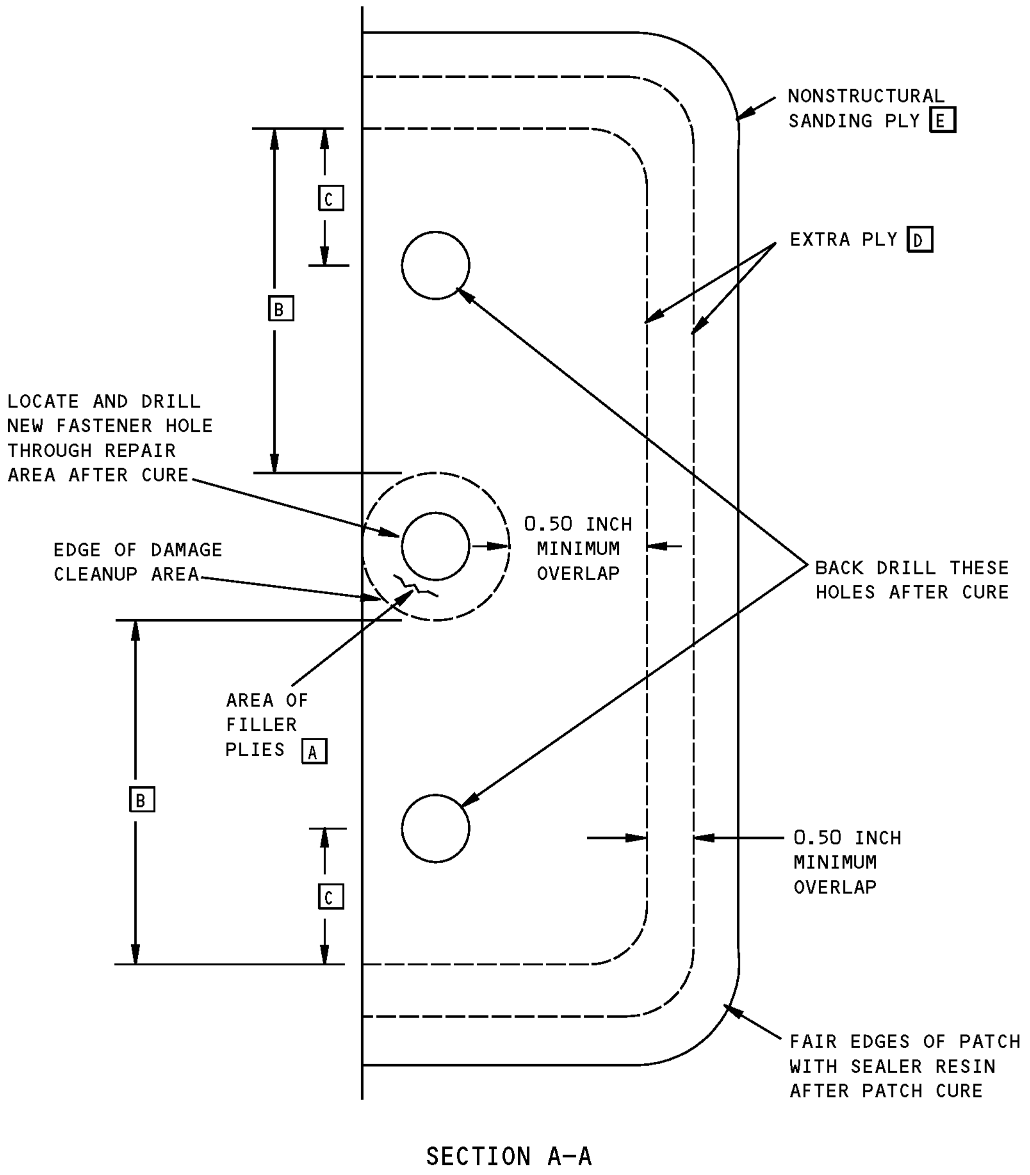
B EXTEND FIRST EXTRA PLY FAR ENOUGH SO THAT IT EXTENDS AT LEAST 0.50 INCH PAST EDGE OF DAMAGED AREA.

C EXTEND FIRST EXTRA PLY FAR ENOUGH TO PROVIDE AT LEAST 2D EDGE MARGIN.

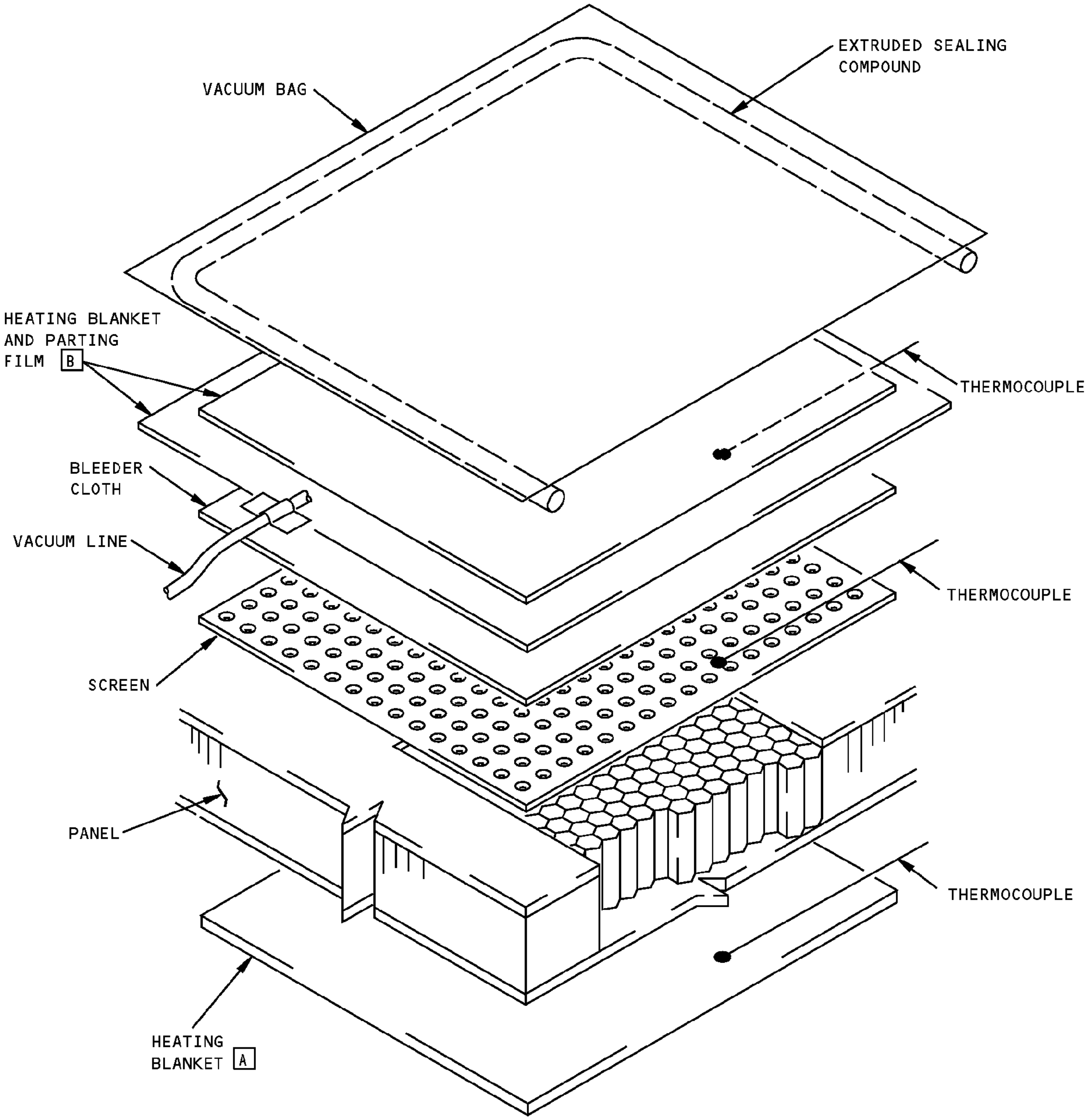
D ORIENT EXTRA REPAIR PLIES IN THE SAME DIRECTION AS THE ORIGINAL OUTER LAYER (SEE FIG. 15).

E FIBERGLASS PREPREG BMS 8-79, TYPE 1581 OR ADHESIVE FILM BMS 5-129, TYPE 2 OR 4, GRADE 10.

Repair of Damaged Panel Attach Hole - 250 Degrees F (121 Degrees C) Cure
Figure 10 (Sheet 1 of 2)



Repair of Damaged Panel Attach Hole - 250 Degrees F (121 Degrees C) Cure
Figure 10 (Sheet 2 of 2)



NOTES

A PREFERRED LOCATION OF HEATING BLANKET WHEN OPPOSITE FACE IS ACCESSIBLE

B ALTERNATE LOCATION OF PARTING FILM AND HEATING BLANKET WHEN OPPOSITE SIDE IS INACCESSIBLE. THIS LOCATION MAY BE USED FOR AN ADDITIONAAL HEATING BLANKET TO ACCELERATE WATER REMOVAL

Water Removal From Honeycomb Sandwich
Figure 11

BMS 8-79 STYLE	SEPARATOR FILM COLOR	THICKNESS PER PLY, INCHES	PLY SUBSTITUTIONS
120 [A]	RED	0.004-0.006	________
1581 [A]	RED	0.008-0.012	BMS 8-79, STYLE 120 [A]
7781 [A]	RED	0.008-0.011	BMS 8-79, STYLE 120 [A]

BMS 8-79 GLASS FABRIC PREPREG DATA

BMS 8-219 STYLE	SEPARATOR FILM COLOR	THICKNESS PER PLY, INCHES	PLY SUBSTITUTIONS
120 [B]	LT BLUE	0.0041	BMS 8-79, STYLE 120 [B]
285 [B]	GREEN	0.010	BMS 8-79, STYLE 1581 OR BMS 8-79, STYLE 7781 [B]

BMS 8-219 ARAMID FABRIC PREPREG DATA

ORIGINAL MATERIAL	SUBSTITUTE MATERIAL
CLASS 1, GRADE 95 TAPE	1 PLY CLASS 2, STYLE 3K-70-PW FABRIC
CLASS 1, GRADE 145 AND GRADE 190 TAPE	2 PLIES GRADE 95 TAPE OR 2 PLIES CLASS 2, STYLE 3K-70-PW FABRIC
CLASS 2, STYLE 3K-135-8H FABRIC	2 PLIES 3K-70-PW FABRIC

BMS 8-168 GRAPHITE SUBSTITUTION DATA

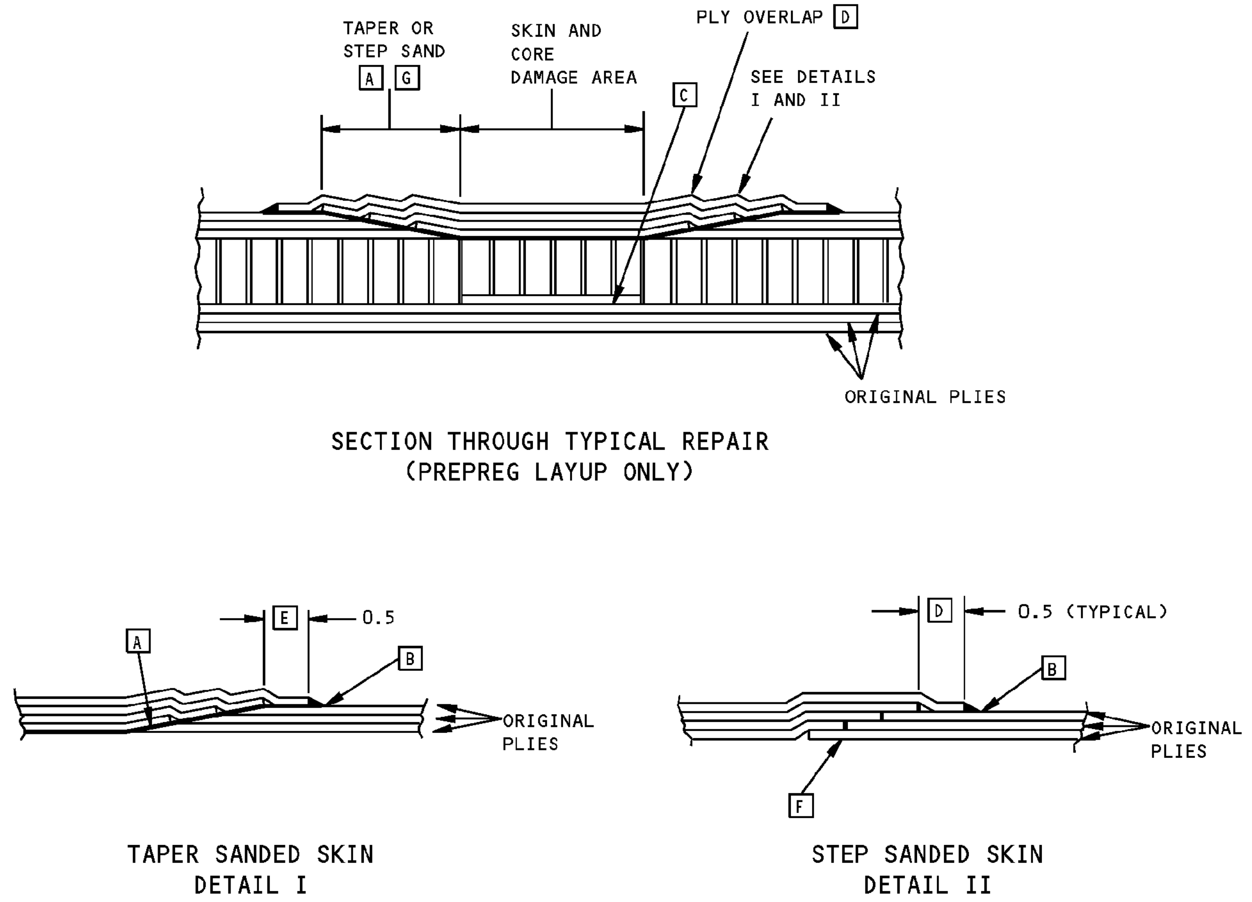
NOTES:

- ORIENT THE SUBSTITUTE MATERIAL THE SAME AS THE ORIGINAL MATERIAL

[A] STYLE 1581 AND 7781 ARE PREFERRED FOR USE AS REPAIR PLIES. THREE PLIES OF STYLE 120 MAY BE SUBSTITUTED FOR EACH PLY OF STYLE 1581 OR 7781

[B] BMS 8-219, STYLES 120 AND 285 ARE PREFERRED FOR USE AS REPAIR PLIES. ONE PLY OF BMS 8-79, STYLE 120 MAY BE SUBSTITUTED FOR EACH PLY OF BMS 8-219, STYLE 120 AND ONE PLY OF BMS 8-79, STYLE 1581 OR 7781 MAY BE SUBSTITUTED FOR EACH PLY OF BMS 8-219, STYLE 285

Tape and Fabric Prepreg Ply Substitution Data
Figure 12



SECTION THROUGH TYPICAL REPAIR
(PREPREG LAYUP ONLY)

TAPER SANDED SKIN
DETAIL I

STEP SANDED SKIN
DETAIL II

NOTES

A TAPER SAND AROUND REPAIR AREA OVER DISTANCE OF 0.5 INCH FOR EACH EXISTING PLY

B DO NOT EXPOSE OR DAMAGE FILAMENTS IN UNTAPERED AREA WHEN SANDING.

C SANDING MUST NOT EXPOSE OR DAMAGE THE FILAMENTS IN BOND PLY (PLY BONDED TO CORE).

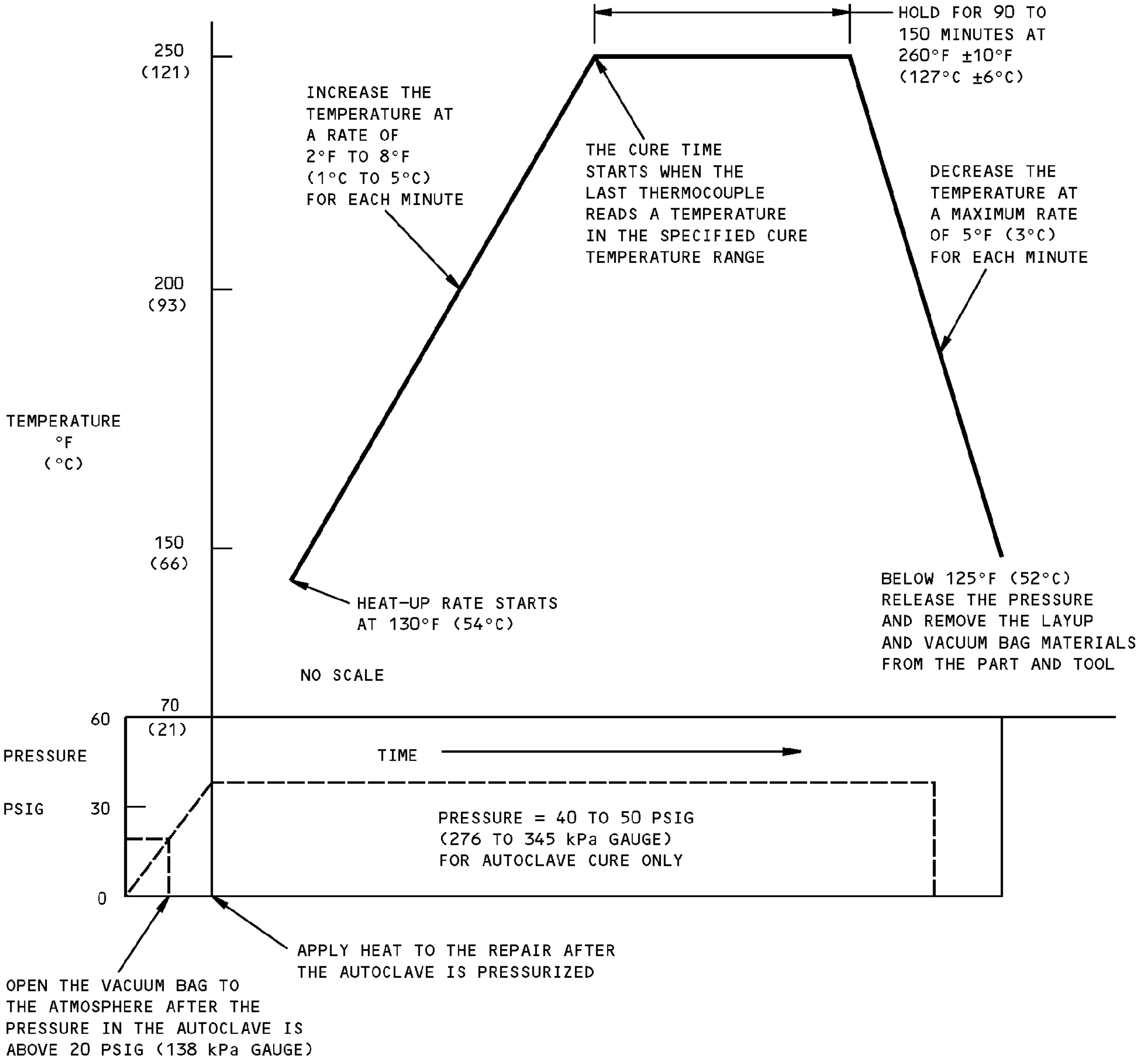
D EXTRA PLY MUST OVERLAP AT LEAST 0.5 INCH. EACH SUCCEEDING PLY MUST OVERLAP AT LEAST 0.5 INCH PAST EDGE OF PRECEEDING PLY

E SURFACE PLY FAYING SURFACE MUST BE AT LEAST 0.5 INCH PAST EDGE OF TAPER.

F REMOVE DAMAGED PLIES IN STEPS OF 0.5 INCH FOR EACH EXISTING PLY

G TAPER SAND SURFACES IN AREAS OF CRITICAL AERODYNAMIC SMOOTHNESS. REFER TO 51-10-01

Sanding and Overlap Requirements
Figure 13



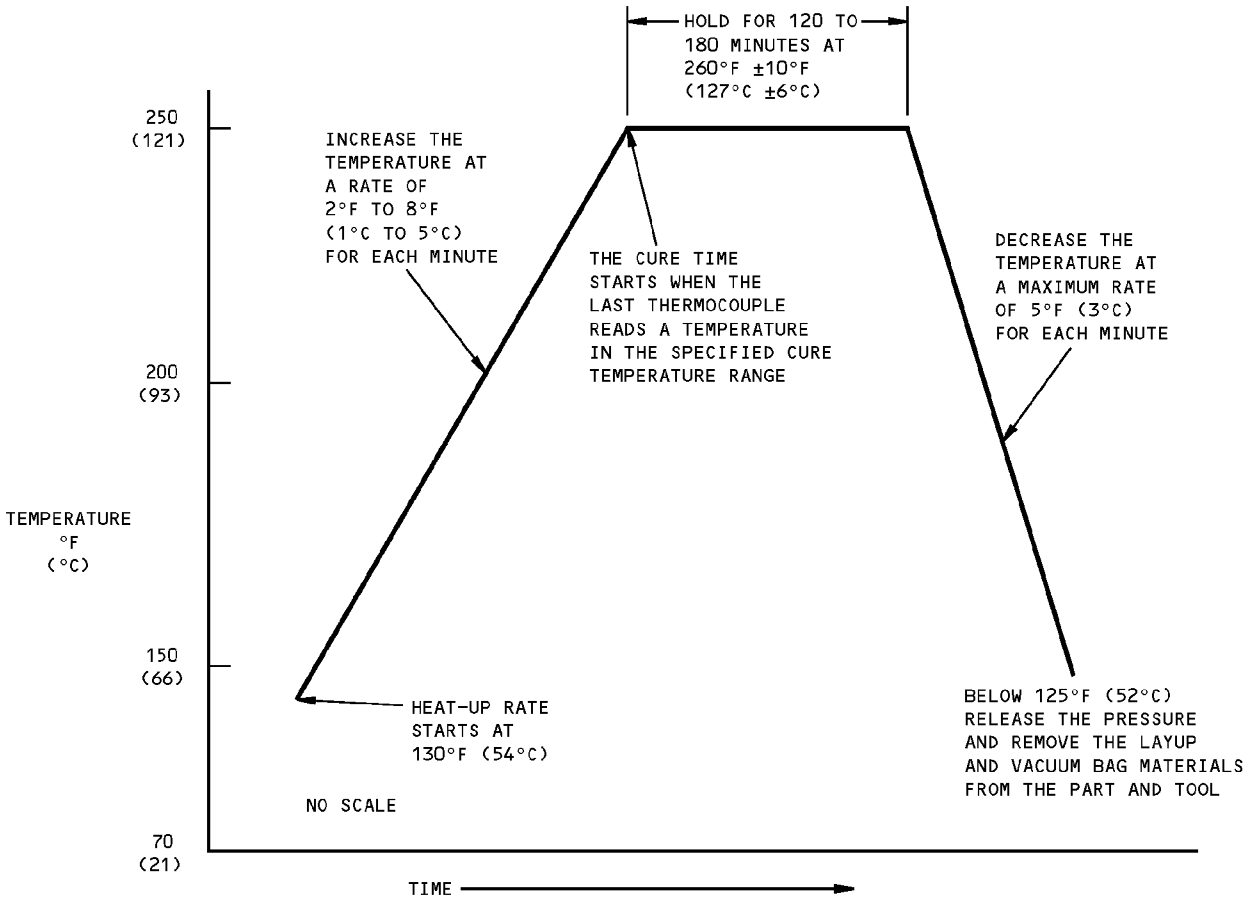
NOTES

- 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

DETAIL I

Repair Cure Cycles
Figure 14 (Sheet 1 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

DETAIL II

Repair Cure Cycles
Figure 14 (Sheet 2 of 2)

COMPONENT MATERIAL	EXTRA PLY MATERIAL [B]
GRAPHITE	GRAPHITE FABRIC, GRADE 95
GRAPHITE/ARAMID/GLASS	GRAPHITE FABRIC, GRADE 95 [A]
ARAMID	GLASS FABRIC, TYPE H-2 OR H-3
FIBERGLASS	GLASS FABRIC, TYPE H-2 OR H-3

NOTES

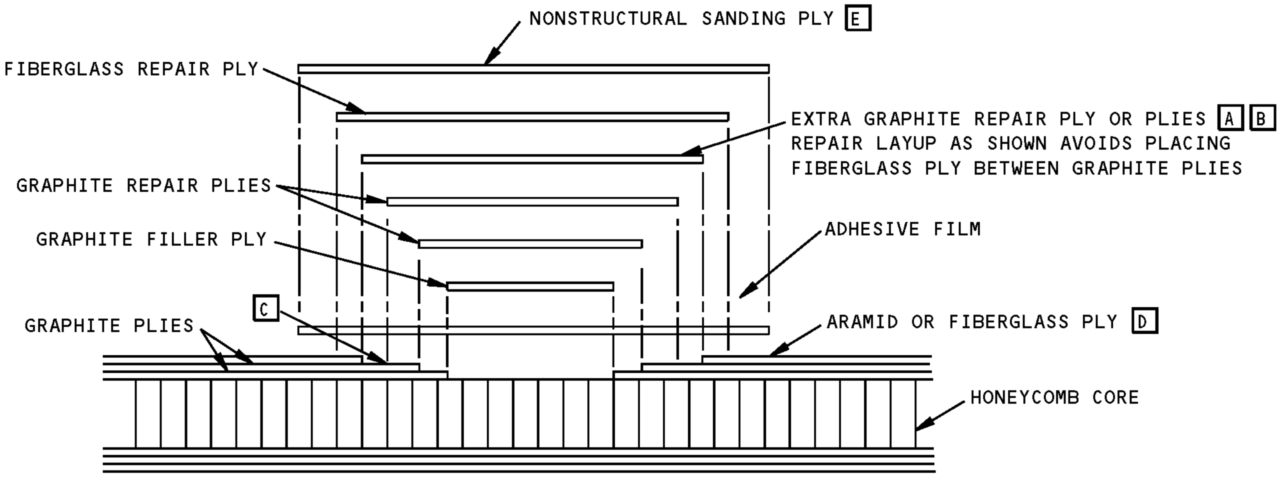
[A] ON HYBRID PANELS, GRAPHITE EXTRA PLIES MUST BE BONDED TO GRAPHITE PLY. SEE DETAIL I.

[B] REFER TO THE COMPONENT REPAIR SPECIFIC SECTION FOR THE ORIENTATIONS OF THE EXTRA REPAIR PLIES. IF THEY ARE NOT GIVEN, THE ORIENTATIONS OF THE EXTRA REPAIR PLIES MUST REPEAT THE ORIENTATIONS OF THE EXISTING PLIES IN THE ORIGINAL LAMINATE, STARTING WITH THE OUTERMOST PLY.

[C] WHEN EXTRA GRAPHITE REPAIR PLY OR PLIES ARE REQUIRED, THE EXISTING OUTER PLY OF ARAMID, ALUMINUM COATED GLASS FABIC OR FIBERGLASS MUST BE SANDED TO ALLOW AN ADDITIONAL OVERLAP OF 0.5 INCH EACH EXTRA REPAIR PLY.

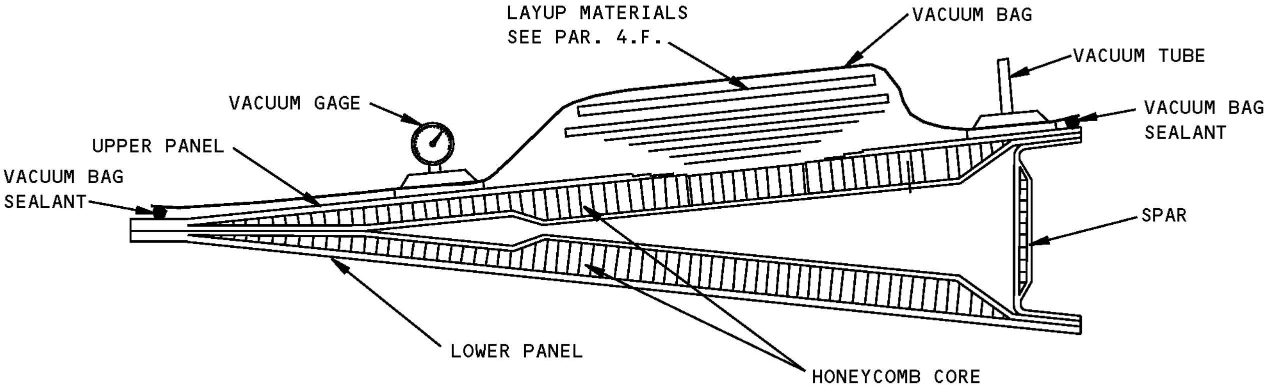
[D] IF OUTER PLY CONSISTS OF ALUMINUM COATED GLASS FABIC OR OTHER CONDUCTIVE COATING, REFER TO SRM 51-70-14,51-70-04 OR FIG. 17 AS APPLICABLE FOR REPAIR OF THE CONDUCTIVE COATING.

[E] FIBERGLASS PREPREG BMS 8-79 OR ADHESIVE FILM BMS 5-129, TYPE 2 OR 4, GRADE 10. SEE TEXT PAR 4.E.(4)(a).

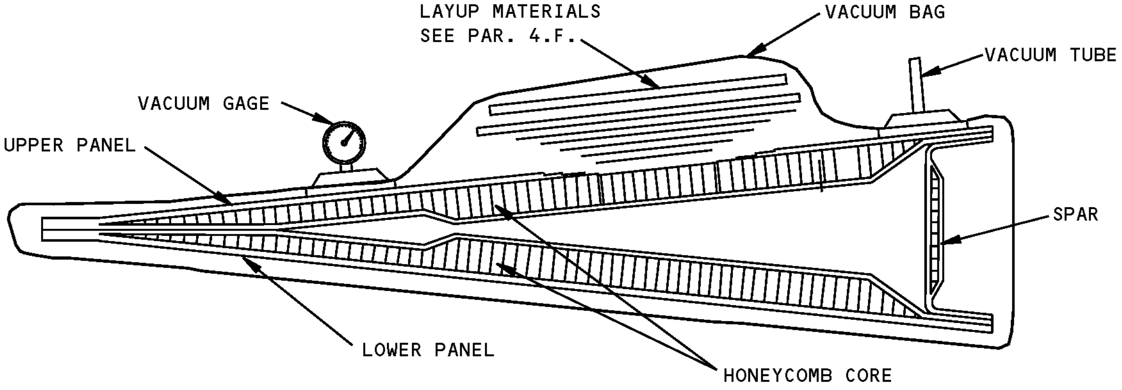


SECTION THRU HYBRID HONEYCOMB SANDWICH
DETAIL I

Extra Repair Ply Material
Figure 15



ACCEPTABLE - VACUUM BAG SEALED TO ONE SIDE ONLY



NOT ACCEPTABLE - VACUUM BAG SEALED AROUND ENTIRE PART
MAY CAUSE ASSEMBLY DISTORTION DURING CURE CYCLE

PARTS CONSISTING OF UPPER AND LOWER PANELS A

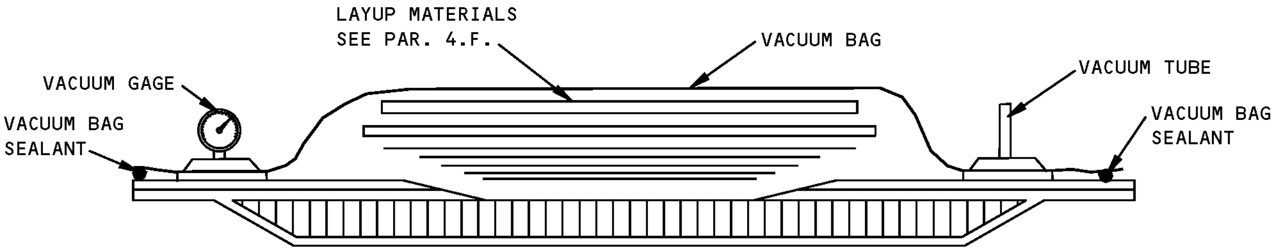
NOTES

- REFER TO PAR. 4.F. FOR LAYUP AND BAGGING PROCEDURES

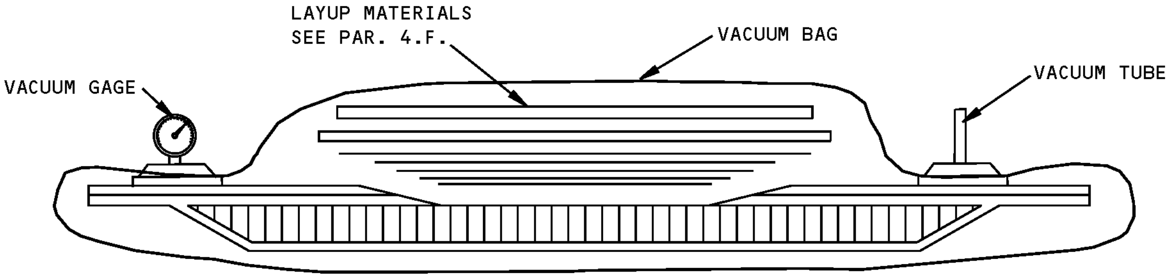
A THIS TYPE OF COMPONENT MUST NOT BE COMPLETELY SEALED IN A VACUUM BAG. DAMAGE TO PART WILL OCCUR. VACUUM BAG ONE SIDE OF COMPONENT ONLY

B THIS TYPE OF COMPONENT MAY BE COMPLETELY SEALED IN A VACUUM BAG OR MAY BE SEALED ON ONE SIDE ONLY

Vacuum Bagging Restrictions
Figure 16 (Sheet 1 of 2)



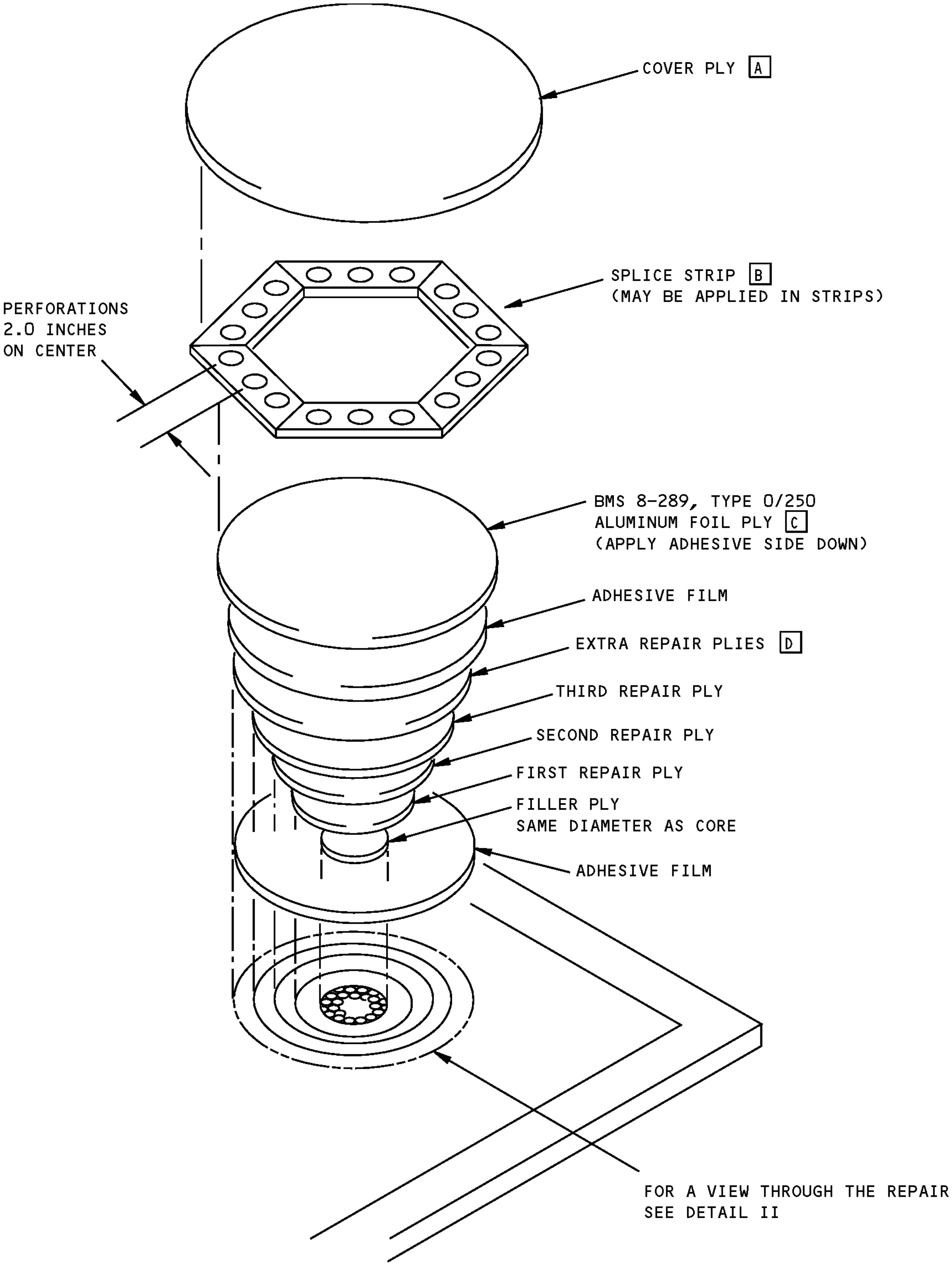
ACCEPTABLE - VACUUM BAG SEALED TO ONE SIDE ONLY



ACCEPTABLE - VACUUM BAG SEALED AROUND ENTIRE PART

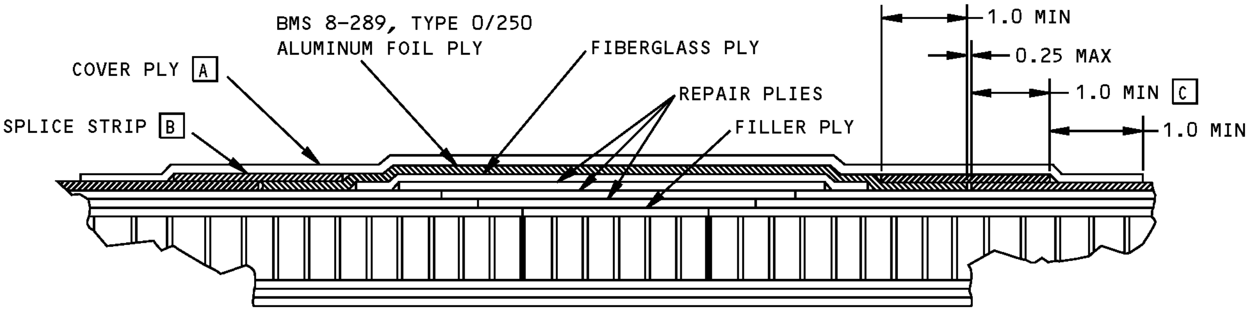
PARTS CONSISTING OF ONE PANEL B

Vacuum Bagging Restrictions
Figure 16 (Sheet 2 of 2)



REPAIR PLY LAYUP
DETAIL I

Repairs to Aluminum Foil
Figure 17 (Sheet 1 of 2)



VIEW THRU REPAIR
DETAIL II

MATERIAL	SHIPPING AND STORAGE LIFE		SHELF LIFE E	
	MAXIMUM TEMPERATURE F	DURATION (DAYS)	MAXIMUM TEMPERATURE	DURATION (HOURS)
BMS 8-289 CLASS O/250	10°F -12°C	180	95°F 35°C	240

STORAGE AND SHELF LIFE OF BMS 8-289
TABLE I

NOTES

A BMS 8-79, TYPE 120, 1581, OR 7781 GLASS FABRIC

B BMS 8-289, TYPE O/250. FORM II WITH THE ADHESIVE SIDE UP OR FORM I, ALODINE TREATED ON NONADHESIVE SIDE. PERFORATE FORM I WITH 0.50 DIAMETER HOLES ON 2.0 CENTERS

C CHEMICAL CONVERSION COAT THE EXISTING ALUMINUM FOIL

D SEE INDIVIDUAL COMPONENT REPAIR SECTION FOR EXTRA REPAIR PLY REQUIREMENTS. ALL STRUCTURE HAVING AN ALUMINUM FOIL LAYER MUST HAVE A FIBERGLASS PLY TO WHICH THE FOIL IS BONDED. IF A FIBERGLASS EXTRA REPAIR PLY IS NOT REQUIRED BY THE INDIVIDUAL COMPONENT REPAIR SECTION, ONE MUST BE INSTALLED AS THE OUTERMOST PLY

E SHELF LIFE HOURS ACCUMULATE FROM THE DATE OF REMOVAL FROM REFRIGERATION UNTIL START OF THE REPAIR CURE CYCLE

F STORAGE LIFE AND OUT TIME SHALL BE AS SHOWN IN TABLE I EXCEPT ON PRODUCTS GUARANTEED BY THE SUPPLIER FOR 360 DAYS STORAGE AT 95°F (35°C)

Repairs to Aluminum Foil
Figure 17 (Sheet 2 of 2)

GENERAL - GLASS FABRIC REINFORCED EPOXY LAMINATES AND NONMETALLIC HONEYCOMB SANDWICH REPAIRS - ROOM TEMPERATURE – 150°F (66°C) CURE (WET LAYUP)

1. General

A. This subject contains repairs to components made from epoxy resin impregnated glass fabric. The most common construction is a sandwich of two laminated skins separated by a nonmetallic honeycomb core. Glass fabric is also known as fiberglass cloth. This subject describes repairs made using room temperature cure materials (wet layup).

NOTE: The repairs called for in this chapter are wet layup repairs. Wet layup repairs require rapid use of catalyzed resin materials. Wet layup will not return the structure to its original strength or durability. A periodic inspection plan for the required area may be required. For size and limits of such repairs see applicable repair. The repairs in this subject are room temperature – 150°F (66°C) repairs, of which the cure may be accelerated by the application of heat as specified. To obtain maximum properties, cure the repair at 150°F (66°C).

CAUTION: TO GET AN ACCEPTABLE QUALITY REPAIR, DO AS FOLLOWS:

- REFER TO THE APPLICABLE COMPONENT THAT YOU ARE GOING TO REPAIR FOR THE REPAIR LIMITS AND MATERIAL OF THE COMPONENT BEFORE YOU USE THESE REPAIR INSTRUCTIONS.
- USE THE CORRECT MATERIALS FOR THE TYPE OF COMPONENT AND REPAIR THAT IS MADE.
- USE THE MATERIALS THAT AGREE WITH THE SPECIFICATIONS IN THE SRM.
- ACCURATELY FOLLOW THE SRM PROCEDURES AT EACH STEP OF THE REPAIR. IF YOU DO NOT DO THIS, IT CAN CAUSE A REPAIR THAT IS NOT SATISFACTORY AND NOT APPROVED.

ROOM TEMPERATURE REPAIRS WILL NOT RESTORE EITHER THE STRENGTH OR DURABILITY OF THE ORIGINAL 250°F (121°C) OR 350°F (177°C) CURED FIBERGLASS COMPONENTS.

ROOM TEMPERATURE/150°F (66°C) REPAIRS MUST NOT BE USED IN STRESS CRITICAL AREAS OF STRUCTURE COMPONENTS. FAILURE TO COMPLY WOULD RESULT IN AN INADEQUATE REPAIR.

B. Specific allowable damage, repair limitations, and repair data, can be found in the chapter/section/subject associated with each structural component.

C. Use suitable holding fixtures for large repairs to prevent distortion of the structure.

D. Perform the repair procedures specified herein only in areas of reasonable cleanliness. Areas containing oil mist, exhaust fumes, gases, soot, rain, dust, or other particulate matter are specifically prohibited.

E. Protect surfaces from contamination. Do not touch cleaned parts or adhesive with bare hands. Use clean white gloves when handling parts.

F. Store resin and/or adhesive material at 40° to 80°F (4° to 27°C) in sealed containers. An identification label must accompany the material inside the bag, with the following information: BMS Type, Class, Grade, supplier name, batch number, and date of preparation.

G. Typical repairs are given in Paragraph 5./GENERAL

H. Refer to REPAIR MATERIALS, SECTION/51-30 for source of repair materials and equipment.

I. Refer to 51-10-01 for aerodynamic smoothness requirements.

J. Refer to Figure 13/GENERAL for resin mixes and potting compound data.

K. Refer to 51-70-16, GENERAL for hole drilling and machining of composite structures.

CAUTION: REPAIRS MUST NOT COVER EXISTING DRAIN HOLES IN PANELS.

L. If the repair covers a drain hole, drill through the repair at existing location.

NOTE: Drain holes are usually 0.375 diameter.

M. For Tedlar repair, refer to Paragraph 4.H.(2)/GENERAL

N. Refer to 51-70-14, GENERAL for repair of aluminum flame spray or aluminum foil where damage to the aluminum foil does not extend into the underlying plies.

O. Refer to 51-70-02, GENERAL for locations of principal composite components.

P. Table 1/GENERAL contains an index of subjects in Paragraph 4./GENERAL and Paragraph 5./GENERAL.

Table 1: Index of the Repair Subjects

Paragraph	Subject
Paragraph 4./GENERAL	Repair Procedures Common to Various Repairs
Paragraph 4.A./GENERAL	Determine Damage
Paragraph 4.B./GENERAL	Remove Water from Honeycomb Sandwich (Figure 1/GENERAL)
Paragraph 4.C./GENERAL	Remove and Prepare Damaged Area
Paragraph 4.D./GENERAL	Fabricate, Clean, and Install Honeycomb Replacement Core Plug
Paragraph 4.E./GENERAL	Prepare and Apply Glass Fabric Repair Plies
Paragraph 4.F./GENERAL	Layup/bagging Procedures (Figure 6/GENERAL)
Paragraph 4.G./GENERAL	Cure the Repair
Paragraph 4.H./GENERAL	Refinish after Repair
Paragraph 4.I./GENERAL	Perform Post-repair Requirements
Paragraph 5./GENERAL	Typical Repairs
Paragraph 5.A./GENERAL	Repair of Delaminations Between Plies
Paragraph 5.B./GENERAL	Repair of Puncture, 0.50-inch Diameter or Less, in Honeycomb Panel (Figure 15/GENERAL)
Paragraph 5.C./GENERAL	Repair of Damage to One Skin and Honeycomb Core using Replacement Core Plug, Punctures Greater than 0.50-inch Diameter (Figure 4/GENERAL)
Paragraph 5.D./GENERAL	Repair of Large Puncture through Internal and External Surface of Panel including Core Damage (Figure 7/GENERAL)
Paragraph 5.E./GENERAL	Replacement of Honeycomb Core on Damaged Edge of Panel (Figure 8/GENERAL)
Paragraph 5.F./GENERAL	Repairs Where Access is Limited to One Side of Panel (Figure 5/GENERAL)
Paragraph 5.G./GENERAL	Repair of Damaged Skin Plies in Panel Edgeband (Figure 3/GENERAL)
Paragraph 5.H./GENERAL	Repair of Damage to Multiple Plies (One Surface Only) in Solid Laminate Panels (Figure 23/GENERAL)
Paragraph 5.I./GENERAL	Repair of Punctures, 0.50-inch Diameter or Less, in Solid Laminate Panels (Figure 22/GENERAL)
Paragraph 5.J./GENERAL	Repair of Delamination Between Plies in Solid Laminate Panels (Figure 11/GENERAL)
Paragraph 5.K./GENERAL	Repair of Damaged Panel Attach Holes in Honeycomb Panel Edgebands or along Edges of Laminated Panels (Figure 10/GENERAL)

Table 1: Index of the Repair Subjects (Continued)

Paragraph	Subject
Paragraph 5.L./GENERAL	Repair of Surface Dents (Figure 16/GENERAL)
Paragraph 5.M./GENERAL	Repair of Lightning Strike Damage (Figure 17/GENERAL)
Paragraph 5.N./GENERAL	Repair of Small Damage to One Skin (Figure 19/GENERAL)
Paragraph 5.O./GENERAL	Repair of Erosion Damage to Panel Edges (Figure 21/GENERAL)
Paragraph 5.P./GENERAL	Boeing Approved Repair Facilities (Figure 20/GENERAL)

2. References

Reference	Title
51-20-05, GENERAL	Repair Sealing
51-30	REPAIR MATERIALS
51-60-00, GENERAL	Control Surface Balance Moment Determination
51-70-02, GENERAL	Locations of the Principal Composite Components
51-70-14, GENERAL	Allowable Damage and Repair of Flame-Sprayed Aluminum Coatings, Aluminum-Coated Glass Fabric (BMS 8-278), Aluminum Foil (BMS 8-289), and Expanded Aluminum Foil (BMS 8-336)
51-70-16, GENERAL	Hole Drilling and Machining of Composite Structures
AMM 51-41-00/201	Aircraft Maintenance Manual
NDT Part 1, 51-01-01	Inspection of Repairs to Composite Structures
NDT Part 6, 51-00-01	Aluminum Part Surface Inspection (Meter Display)
SOPM 20-30-99	Solvents For Final Cleaning of Composites Before Structural Bonding (Series 99)

3. Preparation for Repair

WARNING: HEAT, FIRE, OR SPARKS CAN CAUSE AN EXPLOSION. USE EXPLOSIONPROOF EQUIPMENT WHEN PERFORMING THESE REPAIRS. NONCOMPLIANCE COULD CAUSE PERSONNEL INJURY. BREATHING VAPORS OR ALLOWING SOLVENT TO CONTACT SKIN OR EYES IS HAZARDOUS. WEAR RUBBER GLOVES, PROTECTIVE CLOTHING, AND EYE GOGGLES. IF CHEMICAL CONTACT OCCURS, WASH THOROUGHLY WITH WATER. IF CHEMICAL SHOULD SPLASH INTO EYES, FLUSH EYES WITH LARGE QUANTITIES OF WATER AND SEEK MEDICAL AID. USE MECHANICAL VENTILATION OR RESPIRATORY PROTECTION WHEN WORKING IN A CONFINED SPACE OR AREA.

A. Observe the following precautions during the repair of fiberglass structure.

B. Keep the repair area well ventilated.

C. Avoid excessive breathing of fumes from resin mixes and cleaning fluids.

D. Avoid resin contact with eyes, skin or clothing. Wear protective gloves and clothing when handling resin mixes and cleaning fluids.

E. Wear approved dust mask and safety glasses when cutting, sanding and blasting fiberglass structure. Whenever possible use vacuum pickup when performing these operations.

F. The solvents and finishes are flammable. Keep away from heat and flame.

G. Vacuum systems shall be capable of maintaining a minimum of 22 inches of mercury (22HG).

4. Repair Procedures Common to Various Repairs

A. Determine damage

CAUTION: CHEMICAL PAINT STRIPPERS WILL ATTACK RESIN SYSTEMS, AND SHOULD NOT BE USED TO REMOVE PAINT FOR MAKING DAMAGE EVALUATIONS.

(1) Examine visually for extent of damage.

(2) Check panel in vicinity of damage for entry of water, oil, fuel, dirt or other foreign matter. Water can be detected by radiographic methods. Remove contaminants as required.

(3) Check for delamination around the damage.

NOTE: Post repair inspection is recommended. Examples of inspection procedures are given in NDT Part 6, 51-00-01NDT part 1, 51-01-01.

B. Remove Water from Damaged Area

(1) Remove water from honeycomb sandwich (Figure 1/GENERAL).

(a) Remove damaged skin plies to open up honeycomb area in the damaged area. Remove standing water using vacuum or oil-free compressed air.

(b) Sand the core to remove the adhesive. Removal of adhesive fillets on core is not required.

(c) Apply a fiberglass or metal fine mesh screen over exposed core.

(d) Apply a thermocouple to the center of the screen.

(e) Apply a layer of glass fabric bleeder cloth over the screen and hold in place with masking tape.

(f) Place a vacuum line on the edge of the bleeder cloth and hold in place with masking tape.

(g) If the far side is accessible, apply thermocouple and heating blanket to the far side of the honeycomb sandwich panel.

NOTE: If the far side is accessible, it is acceptable to heat the area using a heating blanket only on the far side. An additional heating blanket may be used on the near side at the location shown in Figure 1/GENERAL to accelerate water removal. If the far side is inaccessible, use of a heating blanket on the near side is required.

(h) When the far side is inaccessible or when using an additional heating blanket, place the heating blanket over the bleeder cloth on the near side.

(i) Place extruded sealing compound around the entire area and seal the area with vacuum bag material.

(j) Evacuate the layup to a minimum of 22 inches of mercury.

(k) Heat the area for 1 hour minimum at 150°F (65°C) to 170°F (76°C). The rate of temperature rise must not exceed 5°F (3°C) per minute. Area must be completely dried out. Any structure in the repair area that cannot be dried out must be removed along with the damage.

(l) Remove layup materials and proceed with the repair procedure.

(2) Remove water from solid laminate.

(a) Remove damage and/or delamination. Remove standing water using vacuum and oil-free compressed air.

(b) Heat the area for 1 hour minimum at 150°F (66°C) to 170°F (77°C). The rate of temperature rise must not exceed 5°F (3°C) per minute.

C. Remove and Prepare Damaged Area

(1) Damage removal.

(a) Trim out the damaged lamination to a smooth rounded shape, such as a circular or oval shape. Take care not to damage the undamaged plies, core or surrounding material.

NOTE: Remove only damaged plies, damaged doublers and damaged fillers.

(b) When the core is also damaged, remove the core by trimming to the same outline as the skin. The core area removed should extend at least 0.5 further than visible core damage limits.

Take care to avoid cutting into an undamaged skin on the opposite side.

NOTE: When a potted core repair is to be made, removal of damaged core is not required.

(c) In areas, where contamination cannot be removed by cleaning or drying as given in Paragraph 4.B./GENERAL, remove the contaminated structure along with the other damage.

(d) When opposite skin is also damaged, trim out the damage to a smooth rounded shape.

(e) When core is removed from the inner surface of opposite skin, carefully smooth down core to adhesive.

(f) Inspect cutout area to ensure that all damage has been removed.

CAUTION: SANDING FOR ADHESION OR FINISH REMOVAL MUST NOT EXPOSE OR DAMAGE FILAMENTS IN THE UNTAPERED SURFACE REPAIR AREA.

SANDING MUST NOT EXPOSE OR DAMAGE FILAMENTS IN EACH PLY WHEN STEP SANDING OR IN THE PLY BONDED TO THE CORE (FIGURE 9/GENERAL AND FIGURE 14/GENERAL).

LOSS OF STRUCTURAL STRENGTH OF THE COMPONENT WILL OCCUR IF THESE CAUTIONS ARE NOT OBSERVED.

DO NOT USE PAINT STRIPPERS FOR THE REMOVAL OF FINISH. DAMAGE TO THE ADHESIVE RESIN SYSTEM WILL OCCUR.

(2) Preparation of Damaged Area (Figure 2/GENERAL)

(a) Determine the number of plies that have been cut. Mask off the area around the cutout allowing 1.0 overlap for each ply replacement, plus 1.0 extra for the extra ply to ensure that the taper on existing top ply is completely covered by the repair.

NOTE: Where the number of plies is not apparent, refer to the applicable component in the structure identification section or engineering drawing.

WARNING: SANDING GIVES OFF A FINE DUST THAT MAY CAUSE SKIN IRRITAIONS. BREATHING OF AN EXCESSIVE AMOUNT OF THIS DUST MAY BE INJURIOUS. OBSERVE PRECAUTIONS FOR SKIN AND RESPIRATION PROTECTION.

(WARNING PRECEDES)

EXPLOSIONPROOF EQUIPMENT MUST BE USED WHERE THE POSSIBILITY OF VAPOR IGNITION EXISTS. NONCOMPLIANCE COULD CAUSE PERSONNEL INJURY.

(b) Internal surface of panel (nonaerodynamic surface).

1) Remove the paint finish or Tedlar film using No. 240 or finer Scotch-Brite Abrasive, or No. 150 or finer sandpaper in the masked off area.

2) Taper sand each ply or simply abrade the surface around the cleaned up damage a minimum of 1.0 per ply. Refer to Figure 2/GENERAL.

3) An optional procedure for two or three ply laminate face sheets is to fill the cleaned up damage area flush with the original surface using filler plies during the repair layup. The repair plies are then installed directly on the resulting smooth surface of the repair area.

4) Abrade surfaces around repair using No. 240, or finer, Scotch-Brite abrasive.

(c) External surface of panel (aerodynamic surface).

1) Taper sand a uniform taper around the repair using No. 180 sandpaper. The taper is to be over an approximate distance of 1.0 for each existing ply of the laminate. Step sanding is optional to taper sanding on sandwich structure except in areas of critical aerodynamic smoothness. Refer to 51-10-01 for locations of areas of critical aerodynamic smoothness. Always taper sand on solid laminate structures.

NOTE: For sanding, use a flexible disk sander, a belt sander, a rotating pad sander, or sand by hand.

CAUTION: SANDING MUST NOT EXPOSE OR DAMAGE FIBERGLASS FILAMENTS IN THE UNTAPERED AREA (FIGURE 2/GENERAL). LOSS OF STRUCTURAL STRENGTH OF THE COMPONENT WILL OCCUR.

DO NOT USE PAINT STRIPPERS FOR THE REMOVAL OF FINISH. DAMAGE TO THE ADHESIVE RESIN SYSTEM WILL OCCUR.

2) Remove exterior finishes, including enamel finish and conductive coating from the surface of the 1.0 border using No. 150 or finer sandpaper.

(d) Edgeband of panel.

CAUTION: DO NOT SAND INTO BOND PLY OR HONEYCOMB CORE (FIGURE 3/GENERAL). BOND PLY IS THE PLY BONDED TO THE HONEYCOMB CORE.

1) Taper sand panel edgeband according to Paragraph 4.C.(2)(c)/GENERAL.

NOTE: Edgeband is the solid laminate around the outer periphery of the honeycomb panel.

(e) Cleaning of repair area.

1) Remove all sanding dust by applying oil-free compressed air or use a vacuum cleaner.

WARNING: WHEN USING SOLVENTS AVOID BREATHING VAPORS. USE MECHANICAL VENTILATION OR RESPIRATORY PROTECTION WHEN WORKING IN A CONFINED SPACE OR AREA. AVOID CONTACT WITH SKIN, EYES AND CLOTHING. WEAR APPROVED GLOVES AND PROTECTIVE CLOTHING. WEAR EYE PROTECTION. KEEP AWAY FROM SOURCES OF HEAT, FIRE OR SPARKS. BREATHING VAPORS OR ALLOWING SOLVENT TO CONTACT SKIN OR EYES IS HAZARDOUS. HEAT, FIRE OR SPARKS CAN CAUSE AN EXPLOSION.

CAUTION: DO NOT IMMERSE PARTS IN SOLVENT OR ALLOW STANDING SOLVENT ON PART. DAMAGE TO PART WILL OCCUR.

2) Wipe surfaces with a clean cloth moistened with solvent, Series 99 (AMM/ SOPM 20-30-99). Allow solvent to evaporate before proceeding with the repair.

D. Fabricate, Clean, and Install Honeycomb Replacement Core Plug

(1) Fabricate core plug.

(a) Fabricate core plug. Refer to the applicable component in the structure identification section to determine core type and material.

(b) The honeycomb core plug should fit flush with original core and with ribbon direction the same as in original core. The replacement core must overlap enough to make contact with the cell walls of surrounding core material.

NOTE: When applicable, depth of core should allow for shrinkage during cure and thickness of extra plies of glass fabric cloth between core and undamaged skin (Figure 2, 4, 5, 6, 7, 8).

(c) As an option the core may be cut larger than the hole and forced into place, crushing together the overlap of the replacement core and the original core. Refer to Figure 18/GENERAL.

(2) Clean core plug.

WARNING: WHEN USING SOLVENTS AVOID BREATHING VAPORS. USE MECHANICAL VENTILATION OR RESPIRATORY PROTECTION WHEN WORKING IN A CONFINED SPACE OR AREA. AVOID CONTACT WITH SKIN, EYES AND CLOTHING. WEAR APPROVED GLOVES AND PROTECTIVE CLOTHING. WEAR EYE PROTECTION. KEEP AWAY FROM SOURCES OF HEAT, FIRE OR SPARKS. BREATHING VAPORS OR ALLOWING SOLVENT TO CONTACT SKIN OR EYES IS HAZARDOUS. HEAT, FIRE OR SPARKS CAN CAUSE AN EXPLOSLION.

CAUTION: DO NOT IMMERSE PARTS IN CHLORINATED SOLVENTS OR ALLOW STANDING SOLVENT ON PART. DAMAGE TO PART WILL OCCUR.

(a) Clean visually contaminated core by dipping (a maximum of four times) in an MEK or acetone bath for 60 seconds.

(b) Locally contaminated areas can be washed with MIBK, MEK, or Acetone..

(c) The core must be completely free of evidence of solvents before installation.

(3) Install core plug (Figure 4/GENERAL, Figure 5/GENERAL, Figure 7/GENERAL, Figure 8/GENERAL, typical).

(a) If one skin is undamaged, cut 2 plies of Type 181 or four plies of Type 120 glass cloth that will fit on the inside surface of the undamaged skin (Figure 4/GENERAL and Figure 5/GENERAL). Saturate the plies with Resin Mix 1, then position in core cavity.

(b) If both skins are damaged, tape a caul plate against the exterior surface of farside skin and repair as for damage to one skin only. Repair the other surface in a subsequent repair cycle.

(c) Spread BMS 5-92 with microballoons, Resin Mix 7 or BMS 5-25 adhesive on the edges of the replacement core and the undamaged core that will mate when the plug is installed. Orient ribbon in the direction of original core ribbon.

(d) Put the layup materials and equipment in place as given in Figure 6/GENERAL.

(e) Evacuate the repair area to a minimum of 22 inches of mercury.

(f) Cure as given in Figure 13/GENERAL.

(g) Sand core plug flush with surrounding surface. Clean surface as given in Paragraph 4.C.(2)/GENERAL.

NOTE: The above procedure is based on the core plug installation being cured separately from the repair plies. As an option, core plug installation and repair plies may be cured at the same time. When this option is used, ensure that temperature on both sides of panel is equal.

E. Prepare and Apply Glass Fabric Repair Plies

CAUTION: USE OF PRECURED PATCHES IS NOT RECOMMENDED. PRECURED PATCHES BONDED TO THE STRUCTURE UNDER VACUUM PRESSURE ONLY AND LARGE PATCHES BONDED TO CONTOURED SURFACES CAN RESULT IN POROUS OR NONCONTINUOUS BONDLINES.

(1) Prepare the overlay patch.

(a) Refer to the applicable component in the identification section to determine number, type, and orientation of glass fabric used in original structure. Repair existing Type 120 plies with Type D plies. Repair existing Type 1581 or 181 plies with Type H-2 plies. Repair existing Type 7781 plies with Type H-3 plies (Figure 14/GENERAL).

(b) From BMS 9-3, Type D (Type 120) or Type H-2 (Type 181-150) or Type H-3 (Type 181-77), cut a piece that is large enough for the required number of plies for the patch to be cut from it.

NOTE: Refer to Paragraph (c) for substitution of glass fabrics. Use one ply of glass fabric in the patch for each damaged ply of the original laminate, plus extra repair plies as required for specific repairs. Refer to the specific structural component repair. If extra repair plies are not indicated by individual repair, one extra ply is required and is to have the same orientation as the original surface ply.

(c) Substitution of glass fabrics (Figure 14/GENERAL).

1) Three plies of Type D glass fabric can be used for each ply of Type H-2 or Type H-3 required.

2) One ply of Type H-3 can be used for each ply of Type H-2 required, and vice versa.

3) One ply of Type H-2 or Type H-3 can be used for every two plies of Type D required.

(d) Cut two pieces of parting film approximately 3.0 inches larger all around than the glass fabric and tape down one piece to a smooth surface.

NOTE: Use Teflon film or other parting films.

(e) Spread Resin Mix 1, prepared as shown in Figure 13/GENERAL over parting film and place the glass fabric over the resin mix.

NOTE: Weight of resin approximately equal to the weight of the dry glass fabric is required to impregnate the cloth.

(f) Cover the fabric on the parting film with the second piece of parting film.

(g) Press the resin through the fabric by working over the parting film with a squeegee or roller, in order to impregnate the fabric and to remove entrapped air.

(h) Cut the impregnated fabric to the required sizes for each individual ply of the patch. The parting film on both sides of the fabric decreases fraying of the edges while cutting the fabric.

NOTE: See Figure 2/GENERAL for required overlap of repair plies. The repair plies must be installed with the same orientation as that of the original plies being repaired. The extra repair ply must be installed with the same orientation as the original surface ply. Other extra repair plies must be installed as specified in individual structural component repair sections.

(2) Apply overlay plies (Figure 2/GENERAL and Figure 4/GENERAL).

NOTE: Where the damage has occurred at a lap joint in the original laminates, it is not necessary to make a comparable lap in the repair plies. Where the original core was undamaged and was provided with a recess to match the lap joint, the recess should be filled with filler plies before application of the repair plies.

CAUTION: ENSURE THAT PARTING FILM IS REMOVED FROM REPAIR PLIES PRIOR TO LAYUP AND CURING. NONCOMPLIANCE WILL RESULT IN A RUINED REPAIR.

(a) Apply a coat of Resin Mix 1, prepared as shown in Figure 13/GENERAL, over the repair area.

(b) Remove parting film from one side of the smallest ply of the patch and place the exposed face against the repair area with orientation as in original structure.

(c) Use a squeegee over the parting film that covers the patch to remove wrinkles and entrapped air. Do not apply excessive pressure. Excessive pressure will produce a patch deficient in resin.

(d) After removing parting film from the contact faces, place the next larger size ply of the impregnated patch over the ply on the repair area with proper orientation and with overlap all around as given in Figure 2/GENERAL.

(e) Place succeeding plies of the patch as described in Paragraph (c) and (d).

(f) After placing the last ply, cover the entire layup with a piece of solid parting film extending about 0.5 over the edges of the patch.

(g) Sweep excess resin to edges of parting film thereby fairing the edges of the patch to the contour of the repair surface. All loose threads must be embedded in the resin.

(h) Wipe off any excess resin that has been squeezed out at the edges of the parting film.

(i) Remove parting film.

F. Layup/Bagging Procedure (Figure 6/GENERAL)

(1) Lay a 6.0 wide border of glass fabric bleeder cloth and hold in position with masking tape. This step is optional.

(2) Place a layer of dry peel ply over the last layer of repair material. Cut the peel ply so it is large enough to contact the edge bleeder or surface bleeder. When removed after curing, the peel ply leaves a rough surface which may be sanded for refinish or left as is for any subsequent bonding to the repair area. The peel ply also helps to prevent pits in the cured repair surface.

(3) Place a layer of perforated FEP parting film (1 mil thick) over the layup. Cut the FEP so the edges extend 3 inches past edge of repair.

(4) Space three thermocouples evenly around the repair in contact with the edge of the outermost patch and connect them to the recorder.

(5) Place a layer of Type 1581 glass fabric or equivalent thickness glass fabric over the repair as a surface bleeder.

NOTE: The bleeder must be cut large enough to make contact with the surface breather.

(6) Place one layer of solid FEP parting film over the layup extending to 0.5 short of the edge of the surface bleeder.

(7) Place a heating blanket on the layup if it will be used as a heat source. The blanket must extend a minimum of 2.0 beyond the edge of the parting film.

NOTE: When using two or more heating blankets or a heating blanket longer than 12 inches on a side, an aluminum caul plate (0.04 max) should be used to minimize localized heating. Make the plates slightly smaller than the surface bleeder and place between the bleeder and the heating blanket.

(8) Place four to six plies of glass fabric breather cloth on the layup. The breather must extend beyond the parting film and make contact with the surface bleeder. The breather must also extend beyond the heating blanket and caul plate if they are used.

(9) Apply extruded sealing compound around the entire area.

(10) Tie in the vacuum outlet to the breather cloth outside of the repair area.

(11) Lay a piece of vacuum bag material over the entire repair area, sealing the edge with the extruded sealing compound. Pleat the vacuum bag where needed to prevent bridging of bag material and subsequent bag breakage. Pad all sharp objects and corners to prevent bag breakage. It is optional to vacuum bag the entire part. See Figure 24/GENERAL.

NOTE: The entire part must be vacuum bagged and restrained in place to prevent delamination and distortion when the repair area exceeds 15% of panel area. Regardless of the method of heat application, restraining devices that maintain the contour and support the part must be used for large parts where sagging and distortion could occur due to the weight of the part.

(12) Evacuate the space under the vacuum bag and maintain a minimum of 22 inches of mercury during the entire cure cycle.

(13) Check the vacuum bag for leak paths.

(14) Cure the repair as given in Paragraph 4.G./GENERAL

G. Cure the Repair

NOTE: Determination of the temperature must be made by using thermocouples placed at edge of patch.

The gel and cure times of the potting and laminating resins are based on an ambient temperature of 70 to 80°F (21 to 27°C); elevated temperatures will reduce reaction time and lower temperatures will increase the reaction time.

An infrared heat lamp (250-watt), heating blankets or equivalent source may be used to accelerate the cure. The graph shown in Figure 12/GENERAL indicates the temperature obtained on the patch surface when the heat lamp is a certain height. Monitor temperature by thermocouples.

WARNING: USE EXPLOSIONPROOF HEAT LAMP, HEAT BLANKETS OR OVEN FOR ACCELERATED CURE. NONCOMPLIANCE COULD CAUSE PERSONNEL INJURY.

CAUTION: SURFACE TEMPERATURE MUST NOT EXCEED 170°F (76°C). DAMAGE OR DISTORTION OF STRUCTURE MAY OCCUR IF TEMPERATURE EXCEEDS 170°F (76°C).

(1) Cure of wet layup.

(a) Cure of the repair may be accomplished at room temperature (70 to 80°F, 21 to 27°C) or can be accelerated by the use of heat. See Figure 13/GENERAL and graph in Figure 12/GENERAL for time at temperature requirement.

(b) Maintain vacuum of 22 inches of mercury minimum during entire cure cycle.

(c) Remove bagging and parting film after curing.

(d) The patch should be free from pits, blisters, starved areas, and excess resin deposits.

H. Refinish after Repair

CAUTION: DO NOT SAND INTO ORIGINAL STRUCTURE. FAILURE TO COMPLY WILL REDUCE THE STRENGTH OF THE COMPONENT.

(1) Lightly sand edge of topmost repair ply as necessary to fair the edge. Sand surface of repair to produce a smooth finish without damaging fibers.

(2) Apply finish to the repaired surface using the following applicable methods.

(a) Where clear Tedlar film surfaces have been removed, seal with a brush coat of Resin Mix 3 (Figure 13/GENERAL). Cure as given in Figure 13/GENERAL.

(b) Where gray or white Tedlar film surfaces have been removed, seal with Resin Mix 3 (Figure 13/GENERAL). Cure as given in Figure 13/GENERAL and apply one coat of BMS 10-11 primer and one coat of BMS 10-60 enamel.

(c) Where BMS 10-21 conductive coating has been removed, reapply as given in AMM 51-24-02.

(d) Where the abrasion resistant Teflon finish has been removed from the internal surface of the panel edgeband, reapply the finish according to AMM 51-24-13.

(e) Where the original painted surfaces have been removed, restore original finish according to AMM 51-21.

(f) Where sealant has been removed from around fittings or fay surfaces to facilitate repairs, reapply BMS 5-95 sealant according to the drawing requirements or 51-20-05, GENERAL51-20-05.

(g) Where aluminum flame-sprayed areas have been damaged, repair as given in 51-70-14, GENERAL.

(h) Restore aluminum foil according to the time limited repair 51-70-14, GENERAL, Paragraph 8.

I. Do the Post-Repair Procedures

(1) Do an inspection of the repair to make sure that it is satisfactory. Make sure that there are no empty spaces between plies or defective bonds. The inspection must include the area that was hot plus 2 inches minimum all around.

(2) If you find the repair to be unsatisfactory, you must remove it and install the repair again.

NOTE: The post-repair inspection is recommended. Examples of the inspection procedures are given in NDT Part 1, 51-01-01. Other inspection procedures that have been examined and found to be satisfactory by the airline can be used.

WARNING: MAKE SURE THAT THE OUTBOARD AILERON, ELEVATOR, AND RUDDER (CONTROL SURFACES) ARE BALANCED CORRECTLY AT ALL TIMES. IF YOU DO NOT, FLIGHT SAFETY CAN BE AFFECTED.

(3) After you repair a control surface, you must do a check of the balance to find if a rebalance is necessary. Refer to 51-60-00, GENERAL as necessary.

CAUTION: MAKE SURE THAT REPAIRS MADE TO CONTROL SURFACES AND/OR ADJACENT STRUCTURE DO NOT INTERFERE WITH THE DESIGNED OPERATION OF THE CONTROL SURFACES. DAMAGE TO THE AIRPLANES STRUCTURE CAN BE THE RESULT.

(4) Do a check of all repairs to make sure of clearance and non-interference with the operation of control surfaces.

(5) If a repair creates a blockage of a drain hole in the airplane structure, drill through the repair at the initial drain hole location with the appropriate drill bit. Refer to AMM 51-41-00/201.

5. Typical Repairs

NOTE: These repairs apply to all glass fabric reinforced honeycomb and laminate components except radomes and floor panels.

CAUTION: TO GET AN ACCEPTABLE QUALITY REPAIR, DO AS FOLLOWS:

- REFER TO THE APPLICABLE COMPONENT THAT YOU ARE GOING TO REPAIR FOR THE REPAIR LIMITS AND MATERIAL OF THE COMPONENT BEFORE YOU USE THESE REPAIR INSTRUCTIONS.
- USE THE CORRECT MATERIALS FOR THE TYPE OF COMPONENT AND REPAIR THAT IS MADE.
- USE THE MATERIALS THAT AGREE WITH THE SPECIFICATIONS IN THE SRM.
- ACCURATELY FOLLOW THE SRM PROCEDURES AT EACH STEP OF THE REPAIR. IF YOU DO NOT DO THIS, IT CAN CAUSE A REPAIR THAT IS NOT SATISFACTORY AND NOT APPROVED.

A. Repair of Delaminations Between Plies

(1) Delamination of plies over core area of panel (Figure 9/GENERAL).

(a) Determine damage.

(b) Remove all water.

(c) Cut away delaminated plies and prepare damaged area as given in Paragraph 4.C./GENERAL Do not remove any core.

(d) Complete repair as given in Paragraph 4.E./GENERAL thru Paragraph 4.I./GENERAL.

(2) Repair of delaminations between plies of panel edgeband (Figure 11/GENERAL).

CAUTION: DELAMINATION MUST NOT REACH DEEPER THAN 0.50 INTO PANEL EDGEBAND OR EXTEND TO WITHIN 0.50 OF HONEYCOMB CORE (FIGURE 11/GENERAL). IF SO, REPAIR AS A DAMAGE SKIN PLY IN PANEL EDGEBAND, PARAGRAPH 5.G./GENERAL

(a) Determine damage.

(b) Ensure that contaminants and water are removed from damaged area.

(c) Force BMS 5-25, grade 1, or Resin Mix 1 (Figure 13/GENERAL), into delaminated area.

(d) Clamp plies together and remove excess resin.

(e) Cure according to Paragraph 4.G./GENERAL, maintaining pressure until cured. Vacuum pressure is not required for this repair.

(f) Refinish of surface is not required.

(g) Perform applicable post-repair requirements as given in Paragraph 4.I./GENERAL before returning the repaired component to flight service.

B. Repair of Puncture, 0.50-inch Diameter or Less, in Honeycomb Panel (Figure 15/GENERAL)

(1) Remove clear or colored Tedlar film surface, as applicable, from repair area as given in Paragraph 4.C.(2)/GENERAL(b)1).

(2) Remove exterior finishes as applicable, including enamel finish and conductive coating, from the repair surface around the puncture using No. 150 or finer sandpaper.

(3) Remove loose fragments and other contamination from the hole. Clean up damaged area smooth and round.

(4) Dry out structure around puncture.

(5) Clean repair area as given in Paragraph 4.C.(2)/GENERAL

(6) Prepare Resin Mix 1, 2, 6, 7, 8, 9, or 11 according to Figure 13/GENERAL.

(7) Work resin into the hole filling as much as possible.

(8) Cure according to Paragraph 4.G./GENERAL

(9) Carefully sand any projecting material to fair with surrounding surface within ±0.010 inch.

NOTE: A 0.010-inch thick aluminum template may be used to protect surrounding surface while sanding.

(10) Abrade surfaces around repair using No. 240, or finer, Scotch-Brite abrasive.

(11) Clean repair area as given in Paragraph 4.C.(2)/GENERAL

(12) Prepare and apply two glass fabric cover plies according to para 3.E. Use type H-2 or H-3 plies.

(13) Complete repair as given in Paragraph 4.F./GENERAL thru Paragraph 4.I./GENERAL.

C. Repair of Damage to One Skin and Honeycomb Core using Replacement Core Plug, Punctures greater than 0.50-inch Diameter (Figure 4/GENERAL).

(1) Determine extent of damage.

(2) Remove all water.

(3) Remove damage and prepare area according to Paragraph 4.C./GENERAL.

(4) Fabricate, clean, and install honeycomb replacement core plug as given in Paragraph 4.D./GENERAL.

(5) Sand core plug flush with surrounding surface.

(6) Clean surface according to Paragraph 4.C.(2)/GENERAL.

(7) Complete repair as given in Paragraph 4.E./GENERAL thru Paragraph 4.I./GENERAL.

D. Repair of Large Puncture through Internal and External Surface of Panel including Core Damage (Figure 7/GENERAL).

(1) Determine extent of damage.

(2) Remove all water.

(3) Remove damage and prepare area according to Paragraph 4.C./GENERAL

(4) Fabricate, clean, and install honeycomb replacement core plug as given in Paragraph 4.D./GENERAL, except it is not necessary to vacuum bag the core plug installation at this time.

(5) Prepare and apply glass fabric repair plies to one surface of the panel according to Paragraph 4.E./GENERAL A caul plate may be used on the opposite face of the panel to restrain the core plug in place.

(6) Apply pressure, by bagging on both sides and cure as given in Paragraph 4.F./GENERAL and Paragraph 4.G./GENERAL Ensure that the temperature is approximately equal on both sides of the panel.

(7) Prepare and apply glass fabric repair plies to the other surface of the panel and complete repair as given in Paragraph 4.E./GENERAL thru Paragraph 4.I./GENERAL.

NOTE: The above two-stage cure procedure is recommended. As an option, a three-stage cure procedure may be used wherein the core plug installation and the repair plies on each side may be cured separately.

E. Replacement of Honeycomb Core on Damaged Edge of Panel (Figure 8/GENERAL)

(1) Determine extent of damage.

(2) Remove all water.

(3) Remove damage and prepare area according to Paragraph 4.C./GENERAL

(4) Fabricate, clean, and install honeycomb replacement core plug as given in Paragraph 4.D./GENERAL.

(5) Sand core plug flush with surrounding core material.

(6) Clean surfaces according to Paragraph 4.C.(2)/GENERAL

(7) Complete repair as given in Paragraph 4.E./GENERAL thru Paragraph 4.I./GENERAL.

F. Repairs Where Access is Limited to One Side of Panel (Figure 5/GENERAL).

NOTE: This repair applies to flat panels (or nearly flat panels) where damage extends completely through a panel, but access is not readily available to repair the unexposed side.

(1) Determine extent of damage as given in Paragraph 4.A./GENERAL.

(2) Remove all contamination and water from the damaged area as given in Paragraph 4.B./GENERAL. Area must be completely dried out.

(3) Remove damage and prepare area according to Paragraph 4.C./GENERAL and the following:

(a) Enlarge the hole in the outer skin and core (D diameter) to permit a repair to be made to the inner skin with the required overlap.

NOTE: D diameter = d + N + 1 d = major diameter of oval hole in inner skin and is limited to 1.5 max for this repair. N = number of plies in the inner skin.

Stepping of the plies in the inner skin is not necessary for this repair.

(b) Clean out damaged area in inner skin leaving an oval shaped hole.

(c) Taper sand the outer skin plies as given in Paragraph 4.C.(2)/GENERAL.

(4) Fabricate an airtight patch, (Figure 5/GENERAL, Details II thru V) to cover the oval hole from the inaccessible side as follows:

(a) Make a suitable mold on which to lay up the patch. A thin gage aluminum sheet or any smooth surface can be used as a mold.

(b) Cover the mold with parting film or release agent.

(c) Lay up five plies of the same material used in the repair on the mold, using the procedures of Paragraph 4.E./GENERAL, except that all repair plies will have the same diameter. Make diameter of the repair plies at least equal to D diameter.

(d) Bag and cure the patch as given in Paragraph 4.F./GENERAL and Paragraph 4.G./GENERAL. Place thermocouples at the edge of the patch before cure.

(e) Remove the patch from the mold.

(f) Trim patch into an oval shape with a minor diameter slightly smaller than the major diameter of the cutout.

(g) Drill a 1/8 diameter hole in the center of the patch for cleco fastener.

(h) Abrade the surface of the patch using No. 240 or finer Scotch-Brite abrasive. Remove all sanding dust by applying oil-free compressed air and using a vacuum cleaner.

(i) Fabricate a strip of spring steel 1.0 X 10.0 inches and drill a 1/8 diameter hole in the center for the cleco fastener.

NOTE: This repair illustrates the use of a spring steel clamp. However, any suitable retaining method may be used.

(j) Assemble the patch and spring steel together with a 1/8 diameter cleco fastener.

(5) Remove Tedlar, if required and abrade the underside of the inner skin to a distance of 0.38 inch from the edge of the elliptical cutout using No. 180 or finer sandpaper. Avoid abrasion of the existing ply filaments.

CAUTION: DO NOT IMMERSE PARTS IN TRICHLOROETHANE SOLVENT OR ALLOW STANDING SOLVENT TO REMAIN ON PART. DAMAGE TO PART WILL OCCUR.

(6) Clean repair area as given in 3.C.(2)(e).

(7) Bend up both ends of the spring steel and apply adhesive BMS 5-25 or BMS 5-92 to the precured patch.

(8) Holding the spring steel up - insert the patch into the oval hole, and orientate so that the hole is covered. Release the spring steel so that it holds the patch tightly up against the inner skin.

(9) Cure the adhesive as given in Figure 12/GENERAL. When cure is complete, remove the cleco fastener and spring. Fill hole for cleco fastener with sealant BMS 5-95, or adhesive BMS 5-25 or BMS 5-92. Allow this to cure.

(10) Clean out the repair area as given in Paragraph 4.C.(2)(e)/GENERAL.

(11) Apply Resin Mix 1 to the surface of the inner skin which fays with the inner skin repair plies.

(12) Cut the required number of repair plies to diameter D and apply repair plies to the inner skin.

(13) Fabricate, clean, and install core plug as given in Paragraph 4.D./GENERAL.

(14) Prepare and apply repair plies to the outer skin surface of the panel and complete repair as given in Paragraph 4.E./GENERAL thru Paragraph 4.I./GENERAL.

G. Repair of Damaged Skin Plies in Panel Edgeband (Figure 3/GENERAL).

(1) Determine extent of damage.

(2) Remove all water.

CAUTION: DO NOT SAND INTO BOND PLY OR CORE (FIGURE 3/GENERAL). LOSS OF STRUCTURAL STRENGTH OF THE COMPONENT WILL OCCUR IF THIS CAUTION IS NOT OBSERVED. BOND PLY IS PLY ADJACENT TO CORE.

(3) Remove damage and prepare area according to Paragraph 4.C./GENERAL

(4) Complete repair as given in Paragraph 4.E./GENERAL thru Paragraph 4.I./GENERAL.

H. Repair of Damage to Multiple Plies (One Surface Only) in Solid Laminate Panels (Figure 23/GENERAL).

NOTE: This repair applies to components made from laminated glass fabric plies and epoxy resin without a honeycomb core.

(1) Determine extent of damage.

(2) Remove all water.

CAUTION: DO NOT PENETRATE THE UNDAMAGED PLIES. LOSS OF STRUCTURAL STRENGTH OF THE COMPONENT WILL OCCUR.

(3) Remove damage and prepare area according to Paragraph 4.C./GENERAL except taper or step sand minimum of 0.50 inch as given in repair ply instead of 1.0 when cleaning up damage.

NOTE: Taper sand edges of plies around repair on damaged side of panel.

(4) Complete repair as given in Paragraph 4.E./GENERAL thru Paragraph 4.I./GENERAL.

I. Repair of Punctures, 0.50-inch Diameter or Less, in Solid Laminate Panels (Figure 22/GENERAL).

NOTE: This repair applies to components made from laminated glass fabric plies and epoxy resin without a honeycomb core.

(1) Check for delamination as given in Paragraph 4.A./GENERAL.

(2) If no delamination is found, clean up damage to a smooth, rounded surface. Then repair as given in Paragraph 5.B./GENERAL except add 42 ±3% milled glass fiber to resin.

(3) If delamination is found, repair as given in Paragraph 5.A./GENERAL.

J. Repair of Delaminations Between Plies in Solid Laminate Panels (Figure 11/GENERAL)

NOTE: This repair applies to components made from laminated glass fabric plies and epoxy resin without a honeycomb core.

(1) Repair delaminations using methods described in Paragraph 5.A./GENERAL.

K. 150°F (66°C) Cure Wet Layup Repair of Damaged Panel Attach Holes in Honeycomb Panel Edgebands or along Edges of Laminated Panels (Figure 10/GENERAL)

(1) Determine the extent of damage.

(2) Remove all water.

(3) Taper sand around the hole to remove damage according to Figure 10/GENERAL.

(4) Clean area according to Paragraph 4.C.(2)/GENERAL

(5) Complete the repair as given in Figure 10/GENERAL and Paragraph 4.E./GENERAL thru Paragraph 4.H./GENERAL. But cure only at 150°F (66°C).

(6) Drill and countersink fastener holes.

(7) Perform applicable post-repair requirements as given in Paragraph 4.I./GENERAL before returning the repaired component to flight service.

L. Repair of Surface Dents (Figure 16/GENERAL).

(1) Check for delamination and broken fibers as given in Paragraph 4.A./GENERAL

(2) If delamination is found, repair as given in Paragraph 5.A./GENERAL.

(3) If broken fibers are found, repair as given in Paragraph 5.B./GENERAL or Paragraph 5.C./GENERAL.

(4) If no delamination or broken fibers are found, mark off damaged area allowing 1.0 inch of overlap for the repair ply.

(5) Clean damaged area according to Paragraph 4.C.(2)/GENERAL

(6) Mask area for repair with masking tape.

(7) Remove Tedlar or decorative finish using No. 240 or finer Scotch-Brite Abrasive, or No. 150 or finer sandpaper in the masked off area.

(8) Pot dent flush or slightly higher than surrounding surface with Resin Mix 11 potting compound.

(9) Cure as given in Paragraph 4.G./GENERAL.

CAUTION: DO NOT SAND INTO FIBERS IN THE AREA SURROUNDING DENT.

(10) Sand flush using 150-grit or finer sandpaper.

(11) Clean area according to Paragraph 4.C.(2)/GENERAL.

(12) Prepare and apply one ply layer of Type H-2 or H-3 glass fabric according to Paragraph 4.E./GENERAL. The ply layer is to be 2.0 inches larger than the potted area.

(13) Apply vacuum and cure as given in Paragraph 4.F./GENERAL and Paragraph 4.G./GENERAL.

(14) Refinish as given in Paragraph 4.H./GENERAL.

M. Repair of Lightning Strike Damage (Figure 17/GENERAL).

CAUTION: THIS REPAIR IS LIMITED TO LIGHTNING DAMAGE NOT PENETRATING FIBERS. IF FIBERS OR CORE HAVE BEEN DAMAGED, REMOVE AND REPLACE AS GIVEN IN PARAGRAPH 4.A./GENERAL THRU PARAGRAPH 4.I./GENERAL.

(1) Check for delamination as given in Paragraph 4.A./GENERAL.

(2) If delamination is found, repair as given in Paragraph 5.A./GENERAL or Paragraph 5.G./GENERAL.

(3) If delamination is not found, mark off damaged area allowing 1.0 inch of overlap for the repair ply.

(4) Clean damaged area according to Paragraph 4.C.(2)/GENERAL

(5) Mask area for repair with masking tape.

(6) Remove tedlar or decorative finish using No. 240 or finer Scotch-Brite Abrasive, or No. 150 or finer sandpaper in the masked off area.

(7) Seal surface with Resin Mix 3, prepared as shown in Figure 13/GENERAL. Excess resin must be scraped off before it gels.

(8) Cure as given in Paragraph 4.G./GENERAL.

(9) Prepare and apply one ply layer of Type H-2 or H-3 glass fabric according to Paragraph 4.E./GENERAL The ply layer is to overlap the lightning damage by 1.0 inch all around (Figure 17/GENERAL).

(10) Apply vacuum and cure as given in Paragraph 4.F./GENERAL and Paragraph 4.G./GENERAL

(11) Refinish as given in Paragraph 4.H./GENERAL.

N. Repair of Small Damage to One Skin (Figure 19/GENERAL).

CAUTION: THIS REPAIR HAS INSPECTION REQUIREMENTS AND TIME LIMITS. SEE SPECIFIC STRUCTURAL COMPONENT REPAIR SECTION FOR REPAIR LIMITATIONS.

(1) Determine extent of damage.

(2) Mask area for repair with masking tape.

(3) Remove Tedlar or decorative finish using No. 240 or finer Scotch-Brite Abrasive, or No. 150 or finer sandpaper in the masked off area.

(4) Remove any moisture and contamination using vacuum or oil-free compressed air.

(5) Heat the area for 1 hour minimum at 150°F (66°C) to 170°F (77°C). The rate of temperature rise must not exceed 5°F (3°C) per minute.

(6) Lightly abrade masked area with 150-grit or finer sandpaper.

(7) Clean area according to Paragraph 4.C.(2)/GENERAL.

(8) Make a wet layup of one ply of Type 181 glass fabric for each damaged ply. The plies are to overlap the damage and each other as shown in Figure 19/GENERAL.

(9) Apply vacuum and cure as given in Paragraph 4.F./GENERAL and Paragraph 4.G./GENERAL.

O. Repair of Erosion Damage to Panel Edges (Figure 21/GENERAL).

(1) Determine the damaged area as given in Paragraph 4.A./GENERAL If damage exceeds the limits specified in Figure 21/GENERAL, repair as given in Paragraph 5.G./GENERAL If delamination is present, repair as given in Paragraph 5.A./GENERAL (2).

(2) Mask the damaged area with maksing tape. Use care to keep the rework area within the limits specified in Figure 21/GENERAL.

(3) Remove the moisture and contamination from the rework area with a vacuum or oil-free compressed air and by heating the area to between 150°F (66°C) and 170°F (77°C). The rate of heating must not exceed 5°F (3°C) per minute. Refer to Paragraph 4.B./GENERAL.

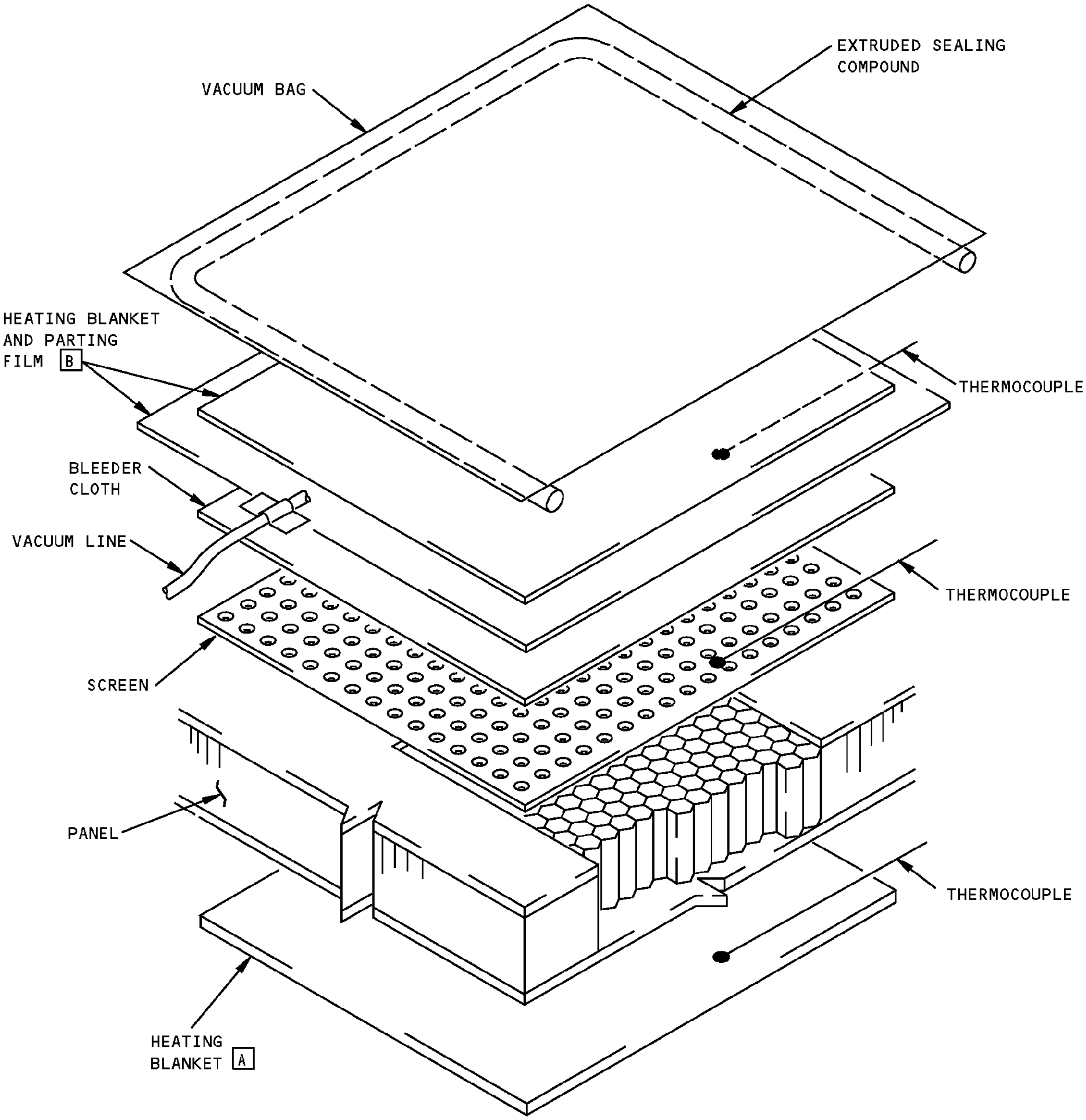
(4) Taper sand the damaged area using 180 grit or finer sandpaper. Maintain the limits specified in Figure 21/GENERAL.

(5) Clean the area. Refer to Paragraph 4.C.(2)(e)/GENERAL.

(6) Seal the area with Resin Mix 1 (BMS 8-301 Class 2). See Figure 13/GENERAL for resin specifications, mixing, and curing procedures.

P. Boeing Approved Repair Facilities

(1) For Boeing approved repair facilities for glass fabric reinforced epoxy resin components see Figure 20/GENERAL.

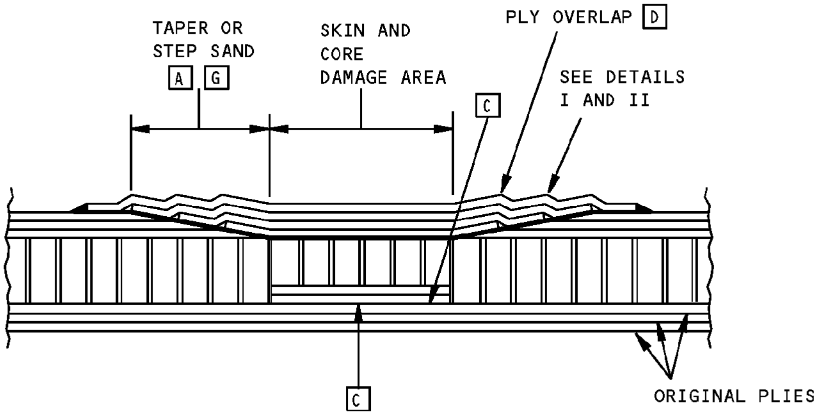


NOTES

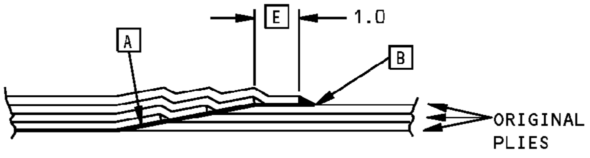
A PREFERRED LOCATION OF HEATING BLANKET WHEN OPPOSITE FACE IS ACCESSIBLE

B ALTERNATE LOCATION OF PARTING FILM AND HEATING BLANKET WHEN OPPOSITE SIDE IS INACCESSIBLE. THIS LOCATION MAY BE USED FOR AN ADDITIONAAL HEATING BLANKET TO ACCELERATE WATER REMOVAL

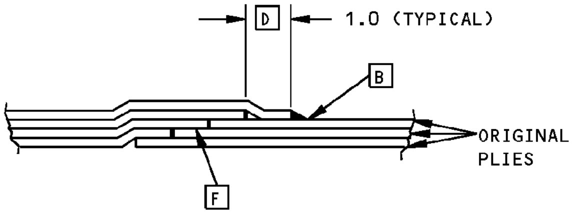
Water Removal From Honeycomb Sandwich
Figure 1



SECTION THROUGH TYPICAL REPAIR
(WET LAYUP ONLY)



TAPER SANDED SKIN
DETAIL I



STEP SANDED SKIN
DETAIL II

NOTES

A TAPER SAND OR STEP SAND EXISTING PLIES AROUND REPAIR AREA A MINIMUM OF 1.0 INCH FOR EACH EXISTING PLY.

B DO NOT EXPOSE OR DAMAGE FILAMENTS IN UNTAPERED AREA WHEN SANDING.

C SANDING MUST NOT EXPOSE OR DAMAGE THE FILAMENTS IN BOND PLY (PLY BONDED TO CORE).

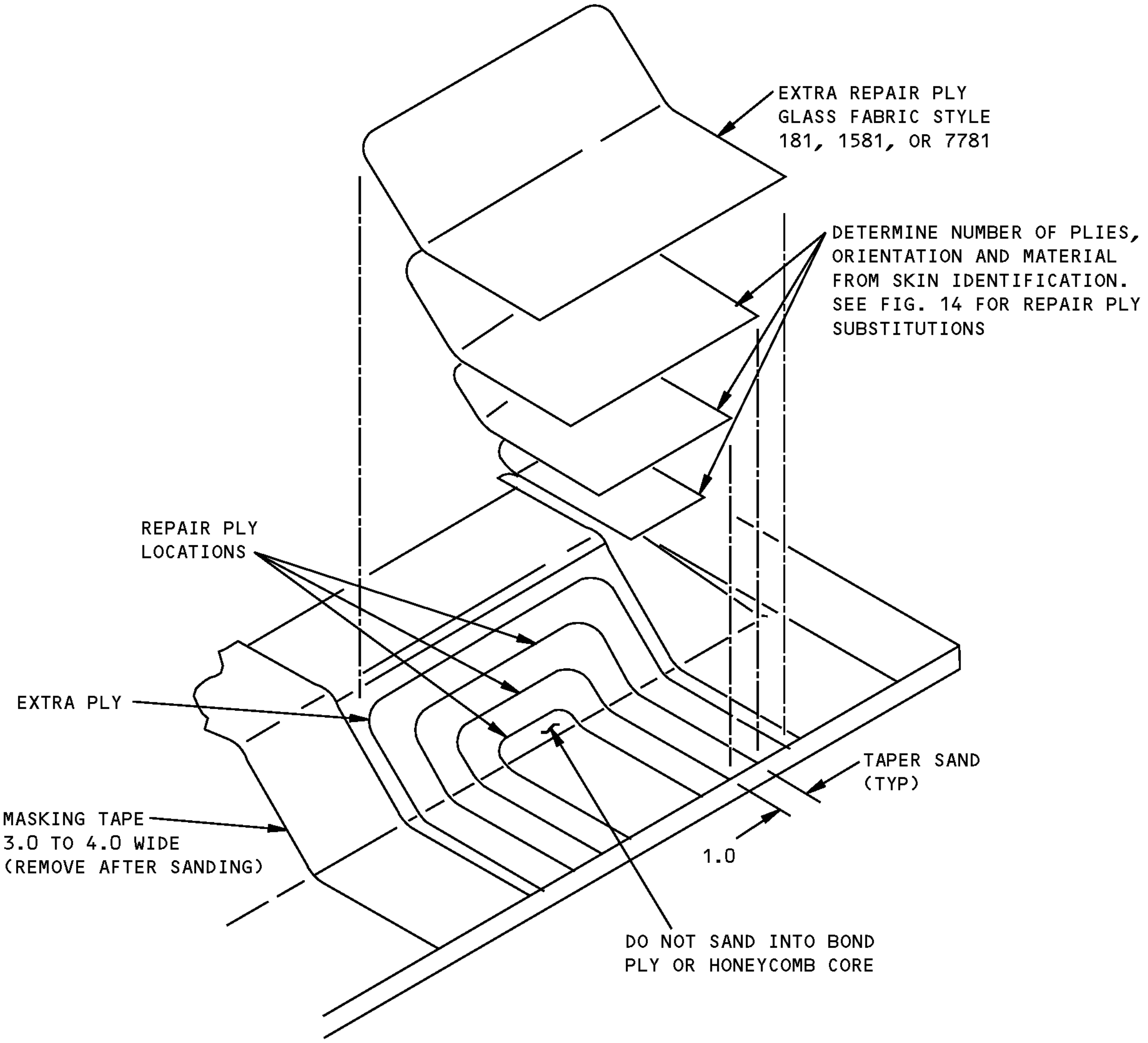
D EXTRA PLY MUST OVERLAP AT LEAST 1.0 INCH PAST EDGE OF DAMAGE. EACH SUCCEEDING PLY MUST OVERLAP AT LEAST 1.0 INCH PAST EDGE OF PRECEDING PLY.

E SURFACE PLY FAYING SURFACE MUST BE AT LEAST 1.0 INCH PAST EDGE OF TAPER.

F REMOVE DAMAGED PLIES IN STEPS.

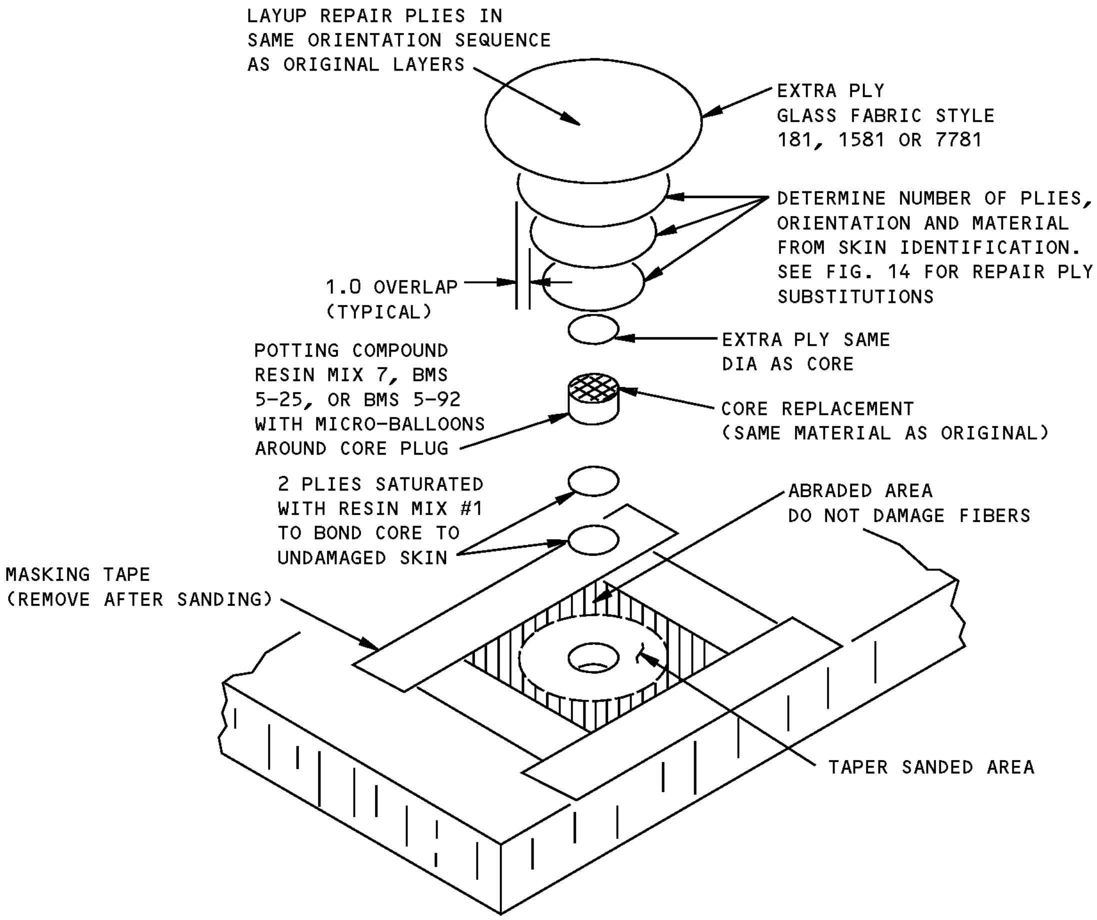
G TAPER SAND SURFACES IN AREAS OF CRITICAL AERODYNAMIC SMOOTHNESS. REFER TO 51-10-01

Sanding and Overlap Requirements
Figure 2

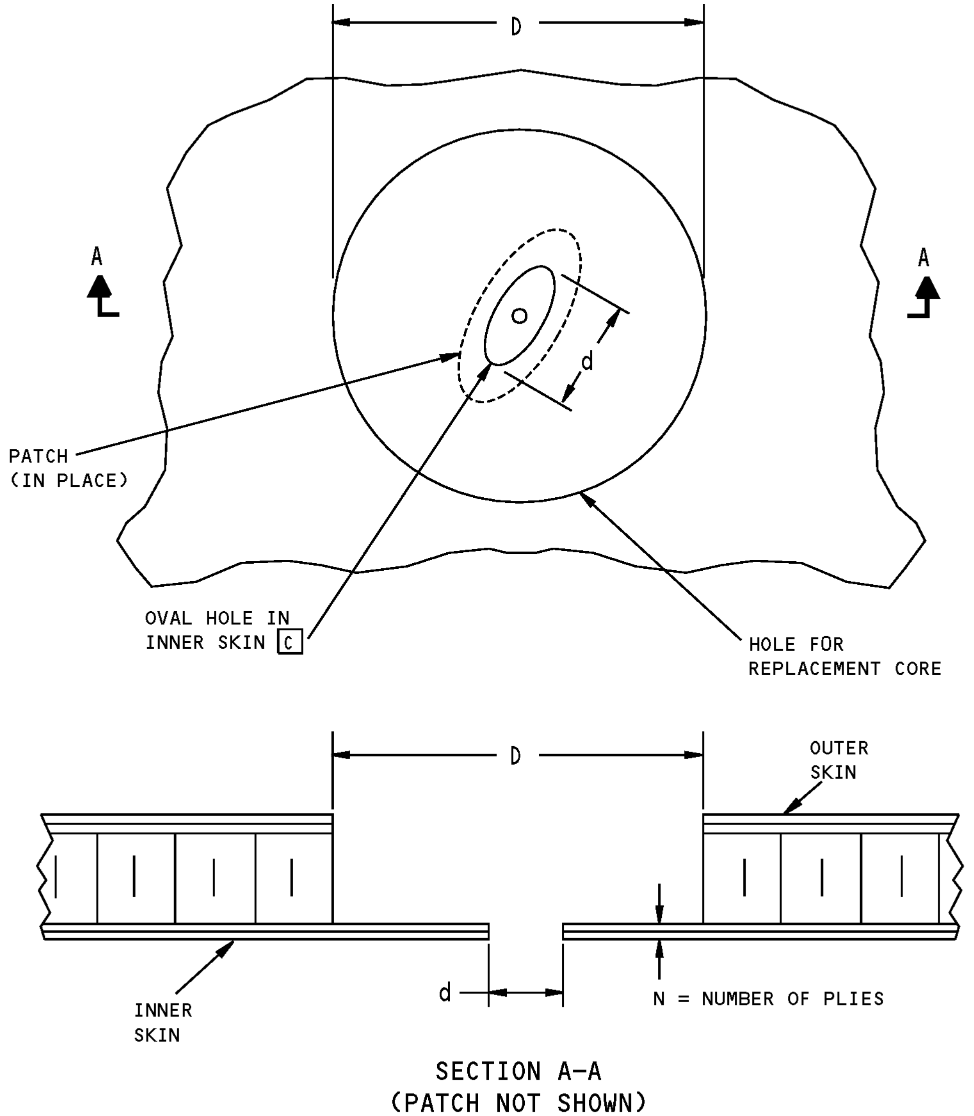


WET LAYUP ONLY

Repair of Damaged Skin Plies On A Panel Edge - Wet Layup
Figure 3



Repair of Large Punctures Thru One Skin of a Sandwich Structure Including Core Damage - Wet Layup
Figure 4



DETAIL I

NOTES

- THIS REPAIR ILLUSTRATES THE USE OF A SPRING STEEL CLAMP. HOWEVER, ANY SUITABLE RETAINING DEVICE MAY BE USED
- D = d + N + 1
  d = MAJOR DIAMETER OF OVAL HOLE IN INNER SKIN
  N = NUMBER OF PLIES

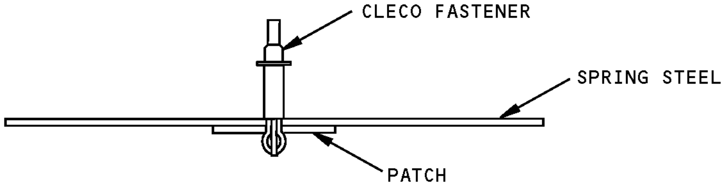
  FOR EXAMPLE:
  IF d = 0.50 INCH
  THEN, D = 0.50 + 2 (PLIES) + 1
  D = 3.50 INCH DIAMETER

A RESIN MIX 7, BMS 5-25 OR 5-92 WITH MICRO-BALLOONS APPLIED TO BOTH CORE PLUG AND ORIGINAL CORE

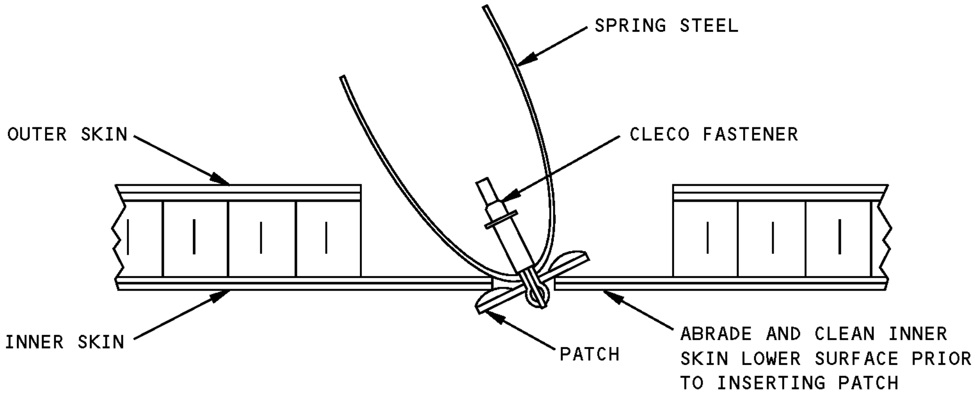
B MAKE TAPER AND OVERLAP PER FIGURE 14

C MAJOR DIAMETER d OF OVAL HOLE IN INNER SKIN IS LIMITED TO 1.5 INCH FOR THIS REPAIR

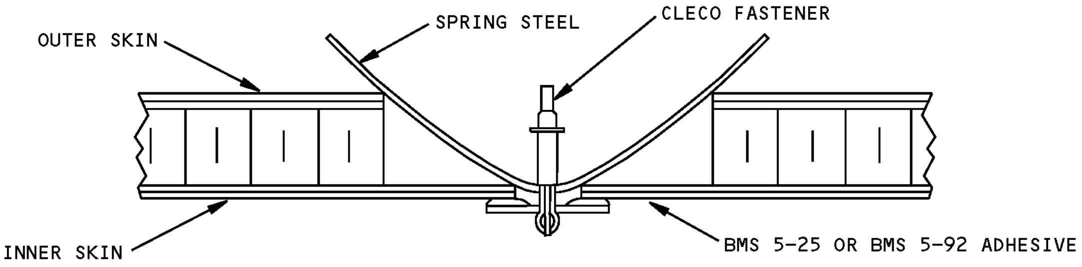
Repair of Damage to External and Internal Skins with Access Limited to One Side - Wet Layup
Figure 5 (Sheet 1 of 3)



ASSEMBLE PATCH AND SPRING STEEL
DETAIL II

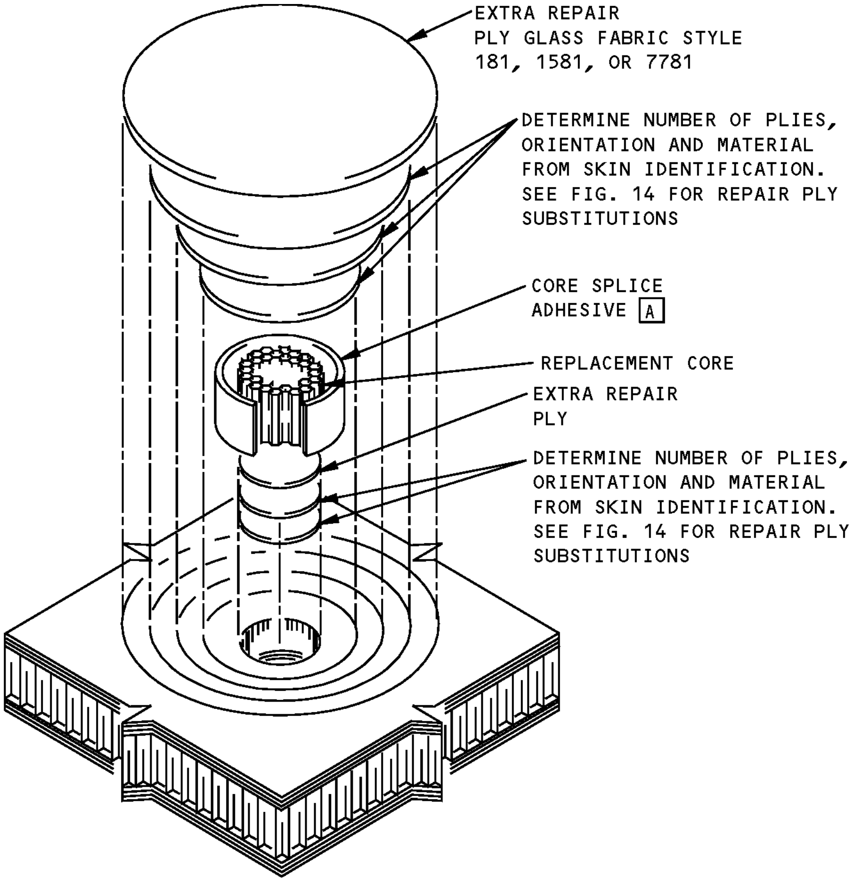


INSERT PATCH INTO OVAL HOLE
DETAIL III

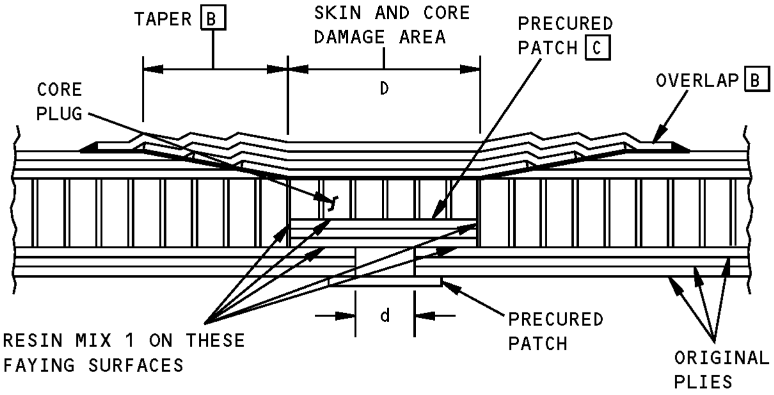


HOLD PATCH IN PLACE WHILE CURING
DETAIL IV

Repair of Damage to External and Internal Skins with Access Limited to One Side - Wet Layup
Figure 5 (Sheet 2 of 3)

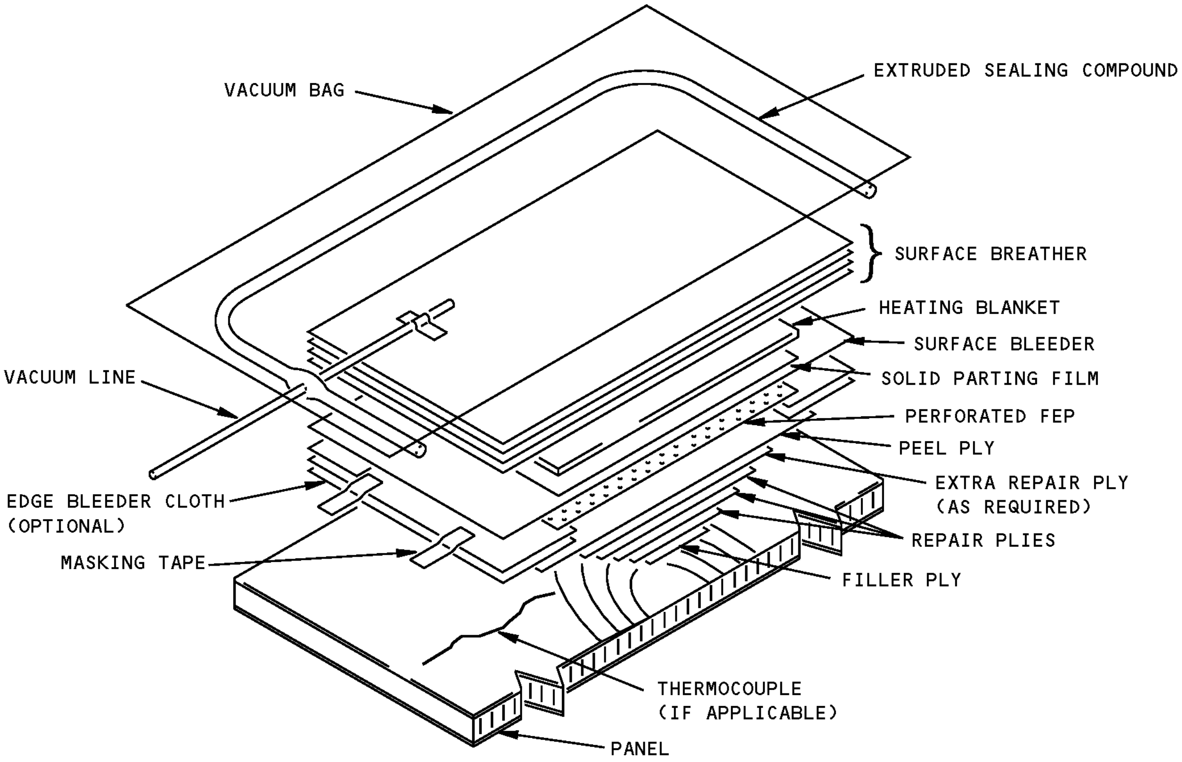


WET LAYUP ONLY

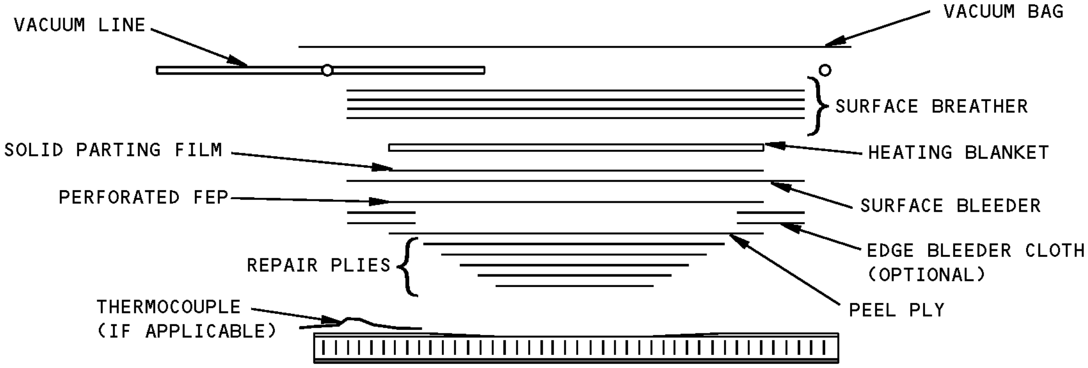


SECTION THROUGH REPAIR
(WET LAYUP ONLY)

Repair of Damage to External and Internal Skins with Access Limited to One Side - Wet Layup
Figure 5 (Sheet 3 of 3)

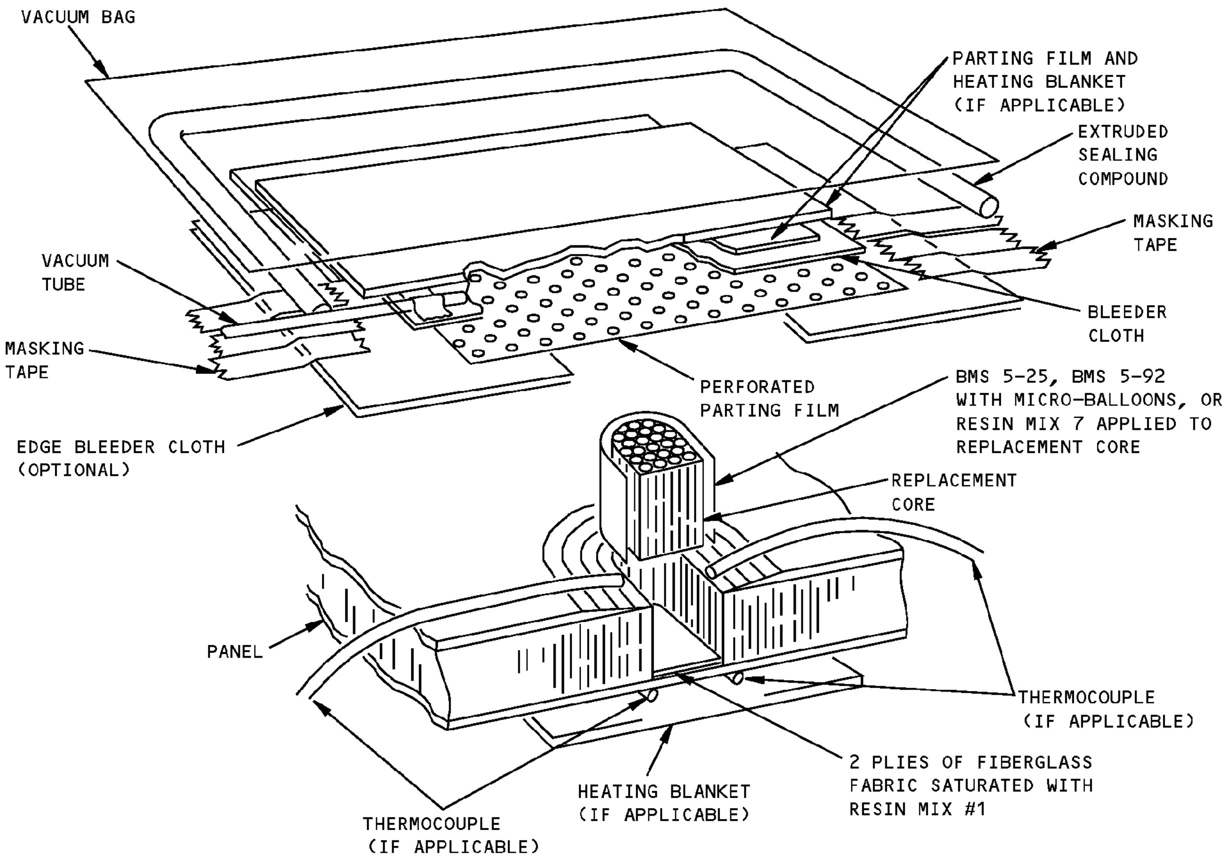


CUTAWAY VIEW OF
BAGGING SEQUENCE FOR SKIN PLY REPAIR
(WET LAYUP)

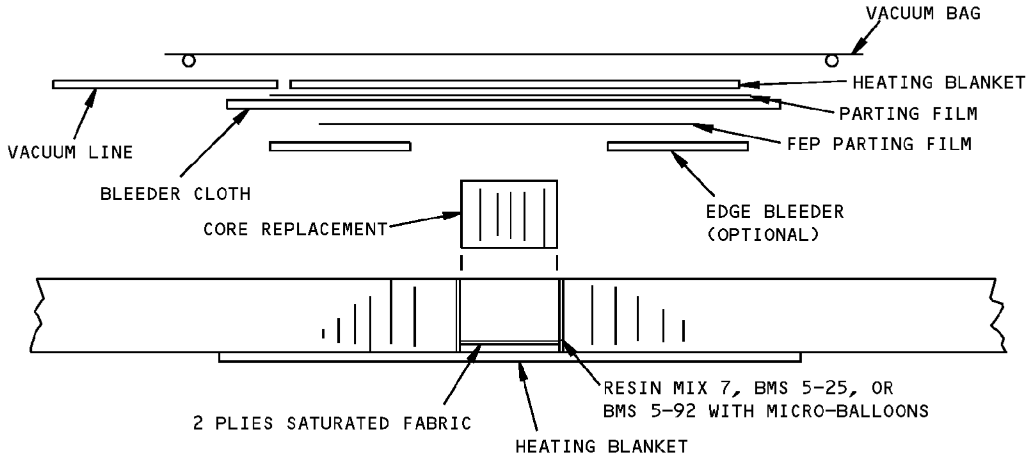


SECTION THRU LAYUP FOR SKIN PLY REPAIR
(WET LAYUP)

Application of Pressure During Cure - Wet Layup
Figure 6 (Sheet 1 of 2)

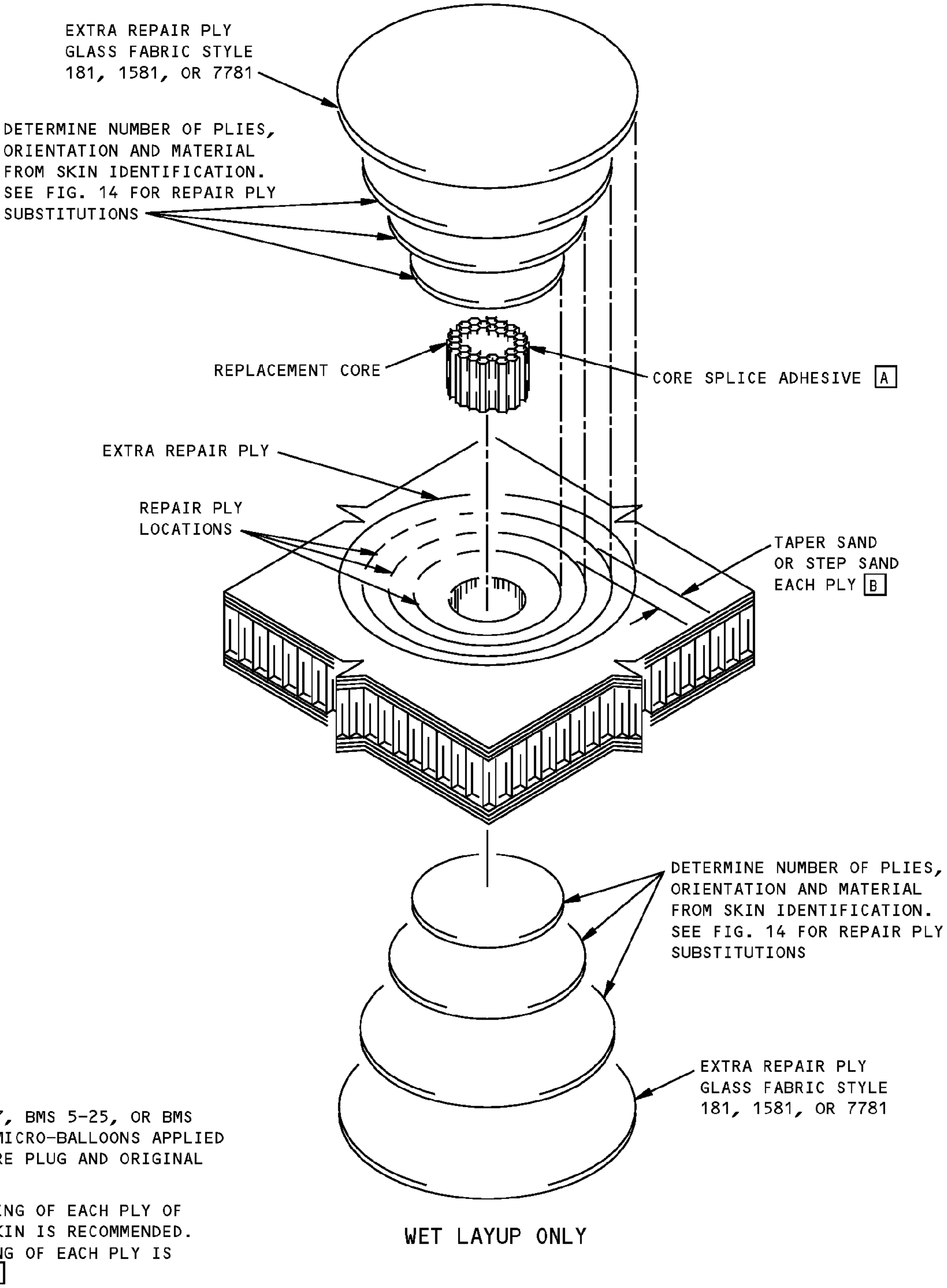


BAGGING SEQUENCE FOR CORE REPLACEMENT
(WET LAYUP ONLY)



SECTION THRU LAYUP FOR CORE REPLACEMENT
(WET LAYUP ONLY)

Application of Pressure During Cure - Wet Layup
Figure 6 (Sheet 2 of 2)



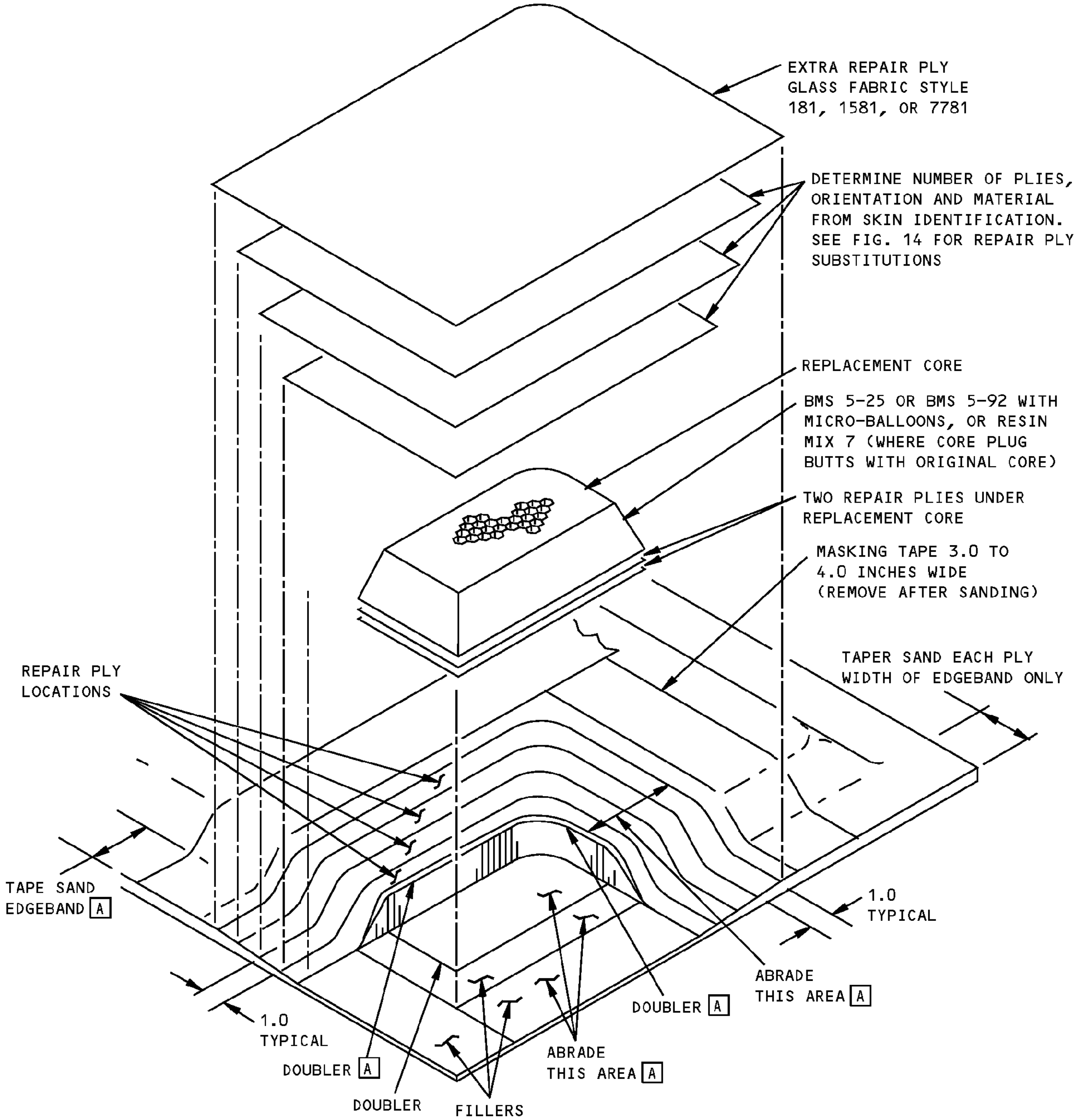
NOTES

A RESIN MIX 7, BMS 5-25, OR BMS 5-92 WITH MICRO-BALLOONS APPLIED TO BOTH CORE PLUG AND ORIGINAL CORE

B TAPER SANDING OF EACH PLY OF EXTERNAL SKIN IS RECOMMENDED. STEP SANDING OF EACH PLY IS OPTIONAL C

C TAPER SAND SURFACES IN AREAS OF CRITICAL AERODYNAMIC SMOOTHNESS. REFER TO 51-10-01

Repair of Large Punctures Through Both Skins of a Sandwich Panel Including Core Damage - Wet Layup
Figure 7

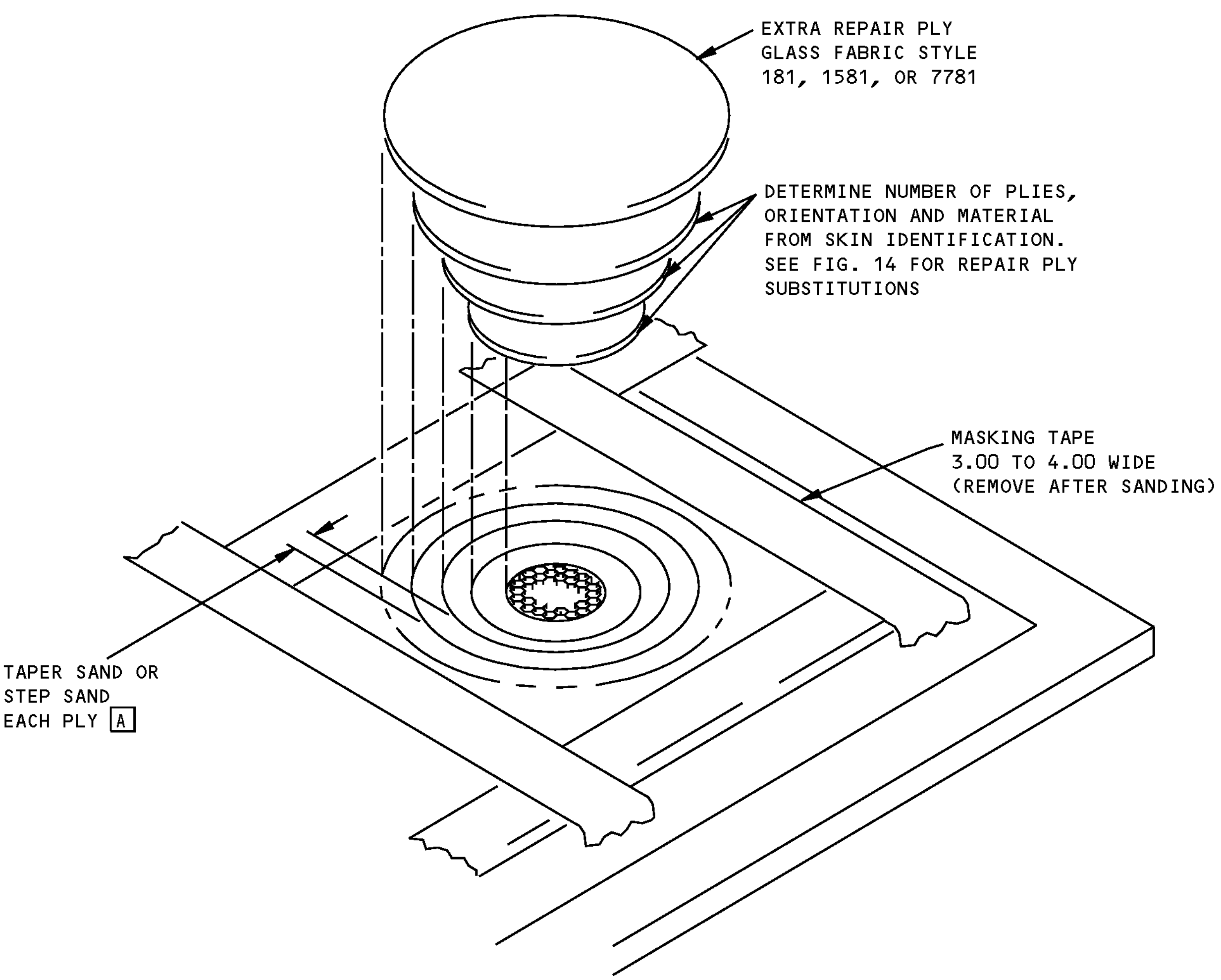


WET LAYUP ONLY

NOTE

A TAPER SANDING IS OPTIONAL TO JUST ABRADING THE SURFACE OF THE SKIN AND DOUBLER PLIES ABOVE AND BELOW THE HONEYCOMB CORE. HOWEVER, TAPER SANDING IS REQUIRED ON THE EDGEBAND

Replacement of Honeycomb Core on Damaged Edge of Sandwich Panel - Wet Layup
Figure 8



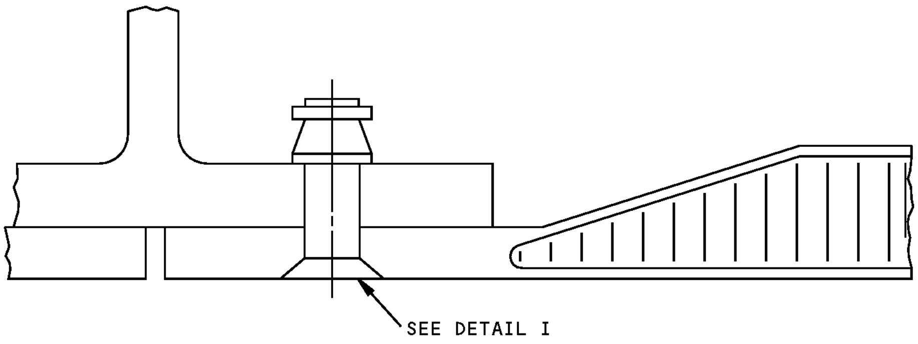
WET LAYUP ONLY

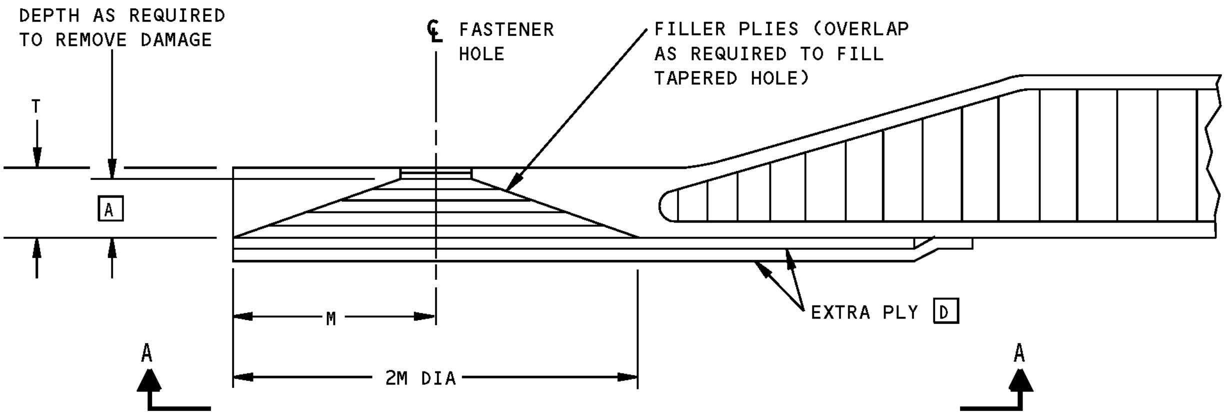
NOTES

A TAPER SANDING OF EACH PLY OF EXTERNAL SKIN IS RECOMMENDED. STEP SANDING OF EACH PLY OF INTERNAL SKIN IS OPTIONAL B

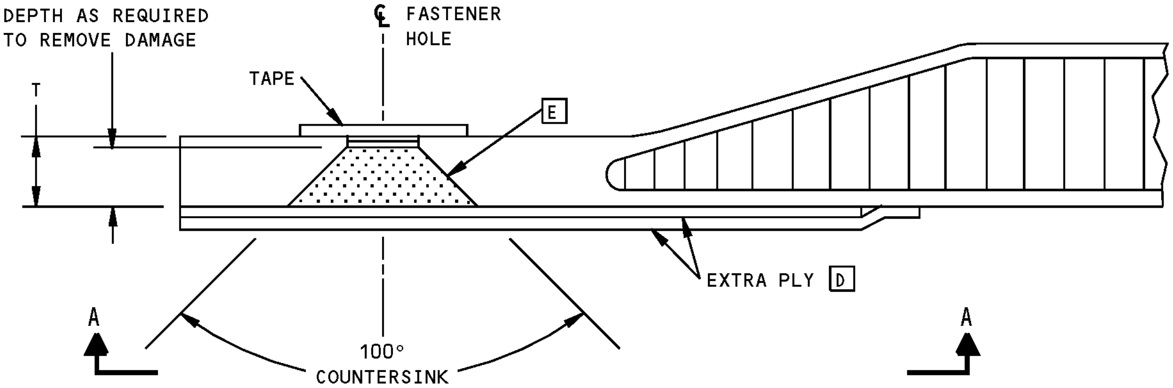
B TAPER SAND SURFACES IN AREAS OF CRITICAL AERODYNAMIC SMOTHNESS. SEE 51-10-01

Repair of Damaged External or Internal Skins of a Sandwich Panel - Wet Layup
Figure 9





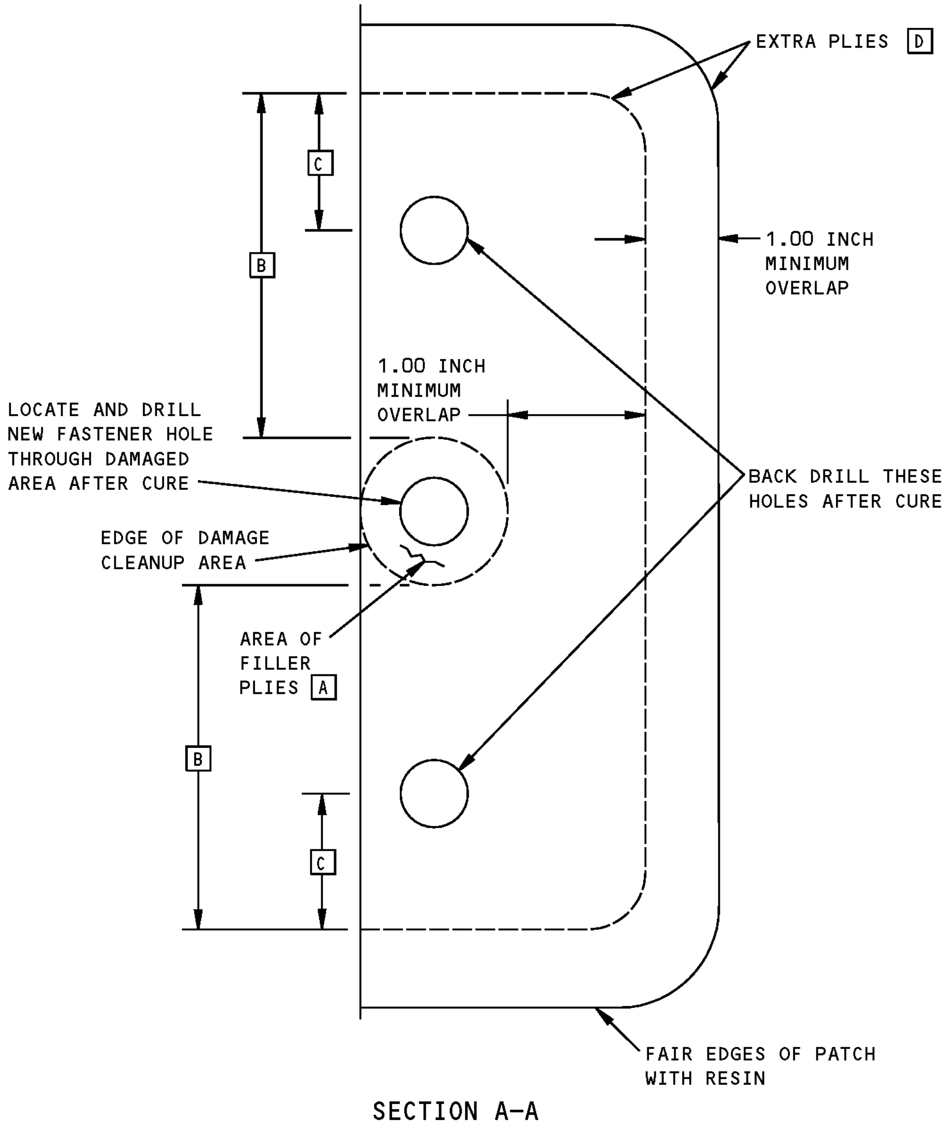
DETAIL I



ALTERNATIVE METHOD OF REPAIR

DETAIL II

Repair of Damaged Panel Attach Hole - 150 Degrees F (66 Degrees C) Cure Wet Layup
Figure 10 (Sheet 1 of 2)



NOTES

- M = 5T MAXIMUM AS SHOWN, WHERE T IS THE THICKNESS OF THE EDGEBAND. DO NOT CUT INTO CORE
- THIS REPAIR IS APPLICABLE ONLY WHERE NO MORE THAN TWO ATTACH HOLES ARE DAMAGED IN A SEQUENCE OF TEN. IF MORE THAN TWO ATTACH HOLES IN A SEQUENCE OF TEN ARE DAMAGED, REPAIR THE EDGEBAND AS GIVEN IN PARAGRAPH 5.G. (FIGURE 3).
- D EQUALS FASTENER DIAMETER

A APPLY FILLER PLIES AS REQUIRED TO FILL THE DAMAGED AREA

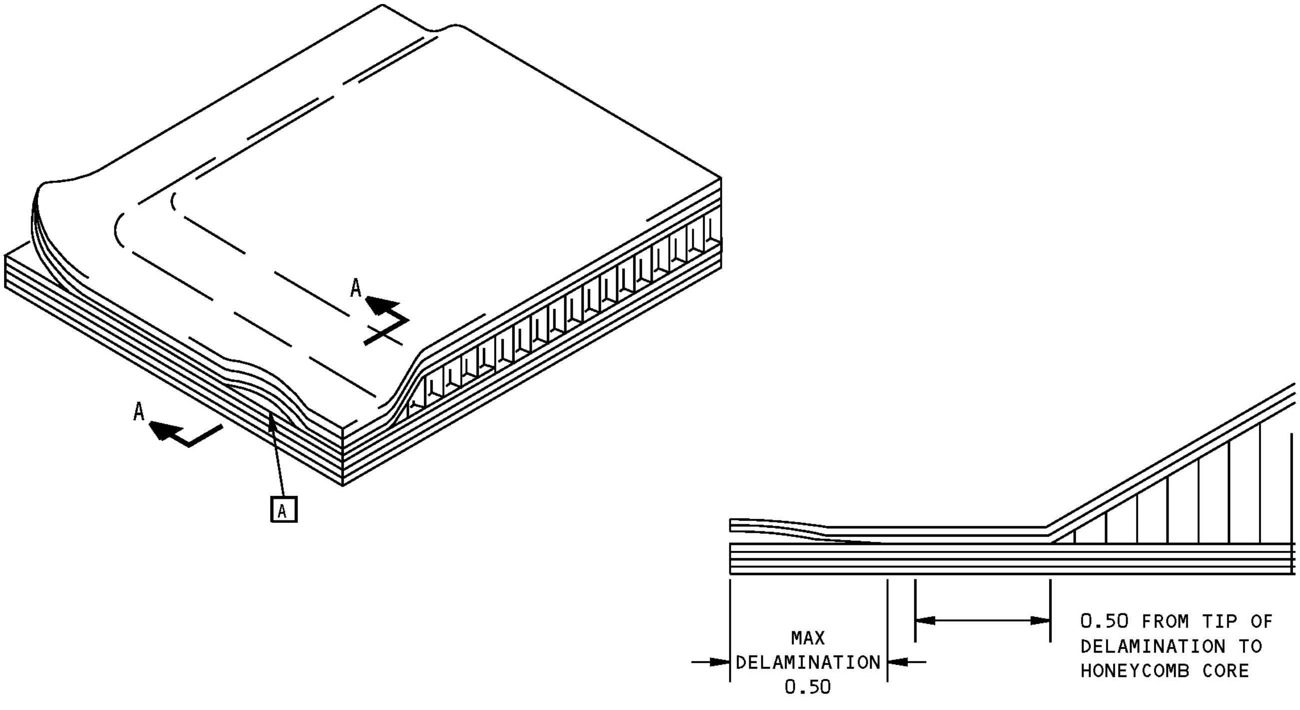
B EXTEND EXTRA PLY FAR ENOUGH SO THAT IT EXTENDS AT LEAST 1.00 INCH PAST EDGE OF DAMAGED AREA

C EXTEND EXTRA REPAIR PLY FAR ENOUGH TO PROVIDE AT LEAST 2D EDGE MARGIN

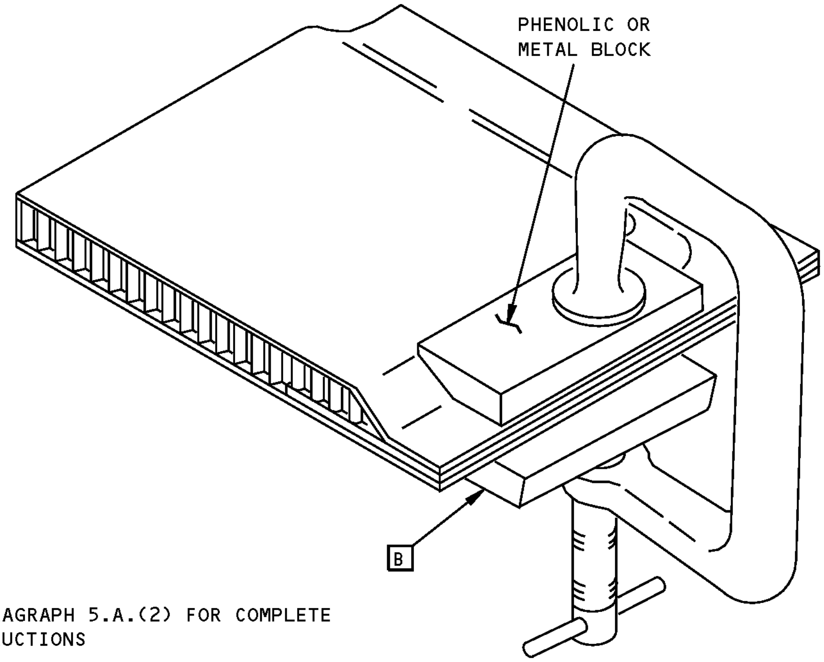
D ORIENT EXTRA REPAIR PLIES IN THE SAME DIRECTION AS THE ORIGINAL OUTER LAYER

E FILL COUNTERSINK WITH RESIN MIX #1 (FAST CURE) AND 42% ±3% MILLED GLASS FIBERS, OR BMS 5-28 TYPE 6 SCRAPE RESIN FLUSH CURE PER FIG 13. CURE BMS 5-28 TYPE 6 24 HOURS AT 75°F ±5°F THEN POST CURE AT 160°F ±10°F FOR A MINIMUM OF 4 HOURS. AFTER CURE SAND SURFACES FLUSH

Repair of Damaged Panel Attach Hole - 150 Degrees F (66 Degrees C) Cure Wet Layup
Figure 10 (Sheet 2 of 2)



SECTION A-A (TYPICAL)



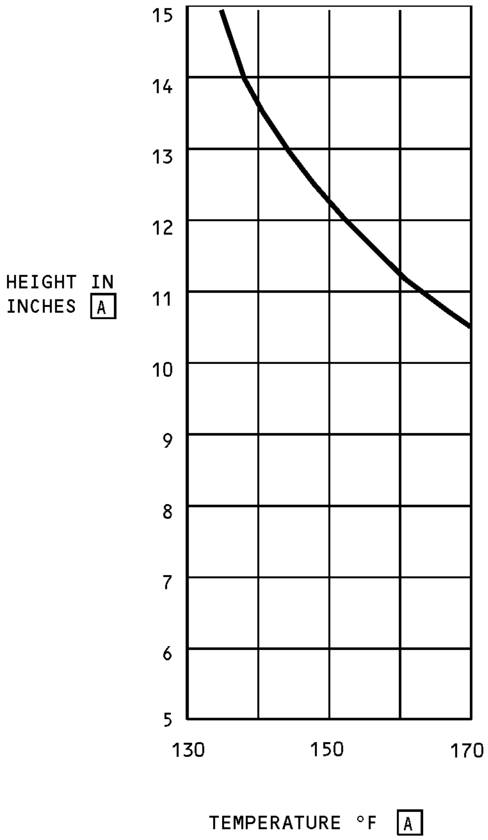
NOTES

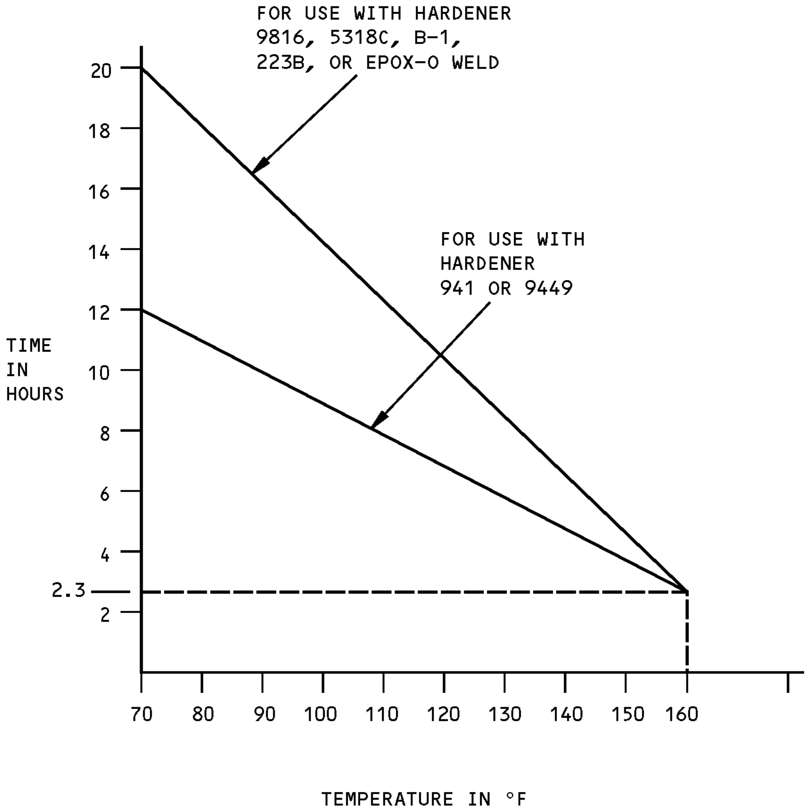
- REFER TO PARAGRAPH 5.A.(2) FOR COMPLETE REPAIR INSTRUCTIONS

A FORCE RESIN MIX 1 INTO DELAMINATED AREA

B CLAMP PLIES TOGETHER AND CURE

Repair of Delaminations Between Plies of Panel Edgeband
Figure 11





NOTES

- USE THERMOCOUPLES TO MONITOR TEMPERATURE

A THE HEIGHT IN INCHES OF 250 WATT HEAT LAMP FROM THE SURFACES OF THE PATCH VS TEMPERATURE AT SURFACE OF PART

Potting and Laminating Resin Cure Temperature
Figure 12

RESIN TYPE	COMPONENTS	PARTS BY WEIGHT	POT LIFE OF MIXTURE	CURE TIME $\boxed{B}$
RESIN MIX 1 (LAMINATING RESIN) BMS 8-301, CLASS 2	FR 7020 PART A RESIN PART B HARDENER	 100 ±2 58 ±0.5	APPROX 30 MINUTES AT 75°F	30 MINUTES AT 150°F ±10°F (66°C ±6°C) OR 6 HRS AT ROOM TEMPERATURE 68°F (20°C) $\boxed{C}$
	EY 3804 PART A RESIN PART B HARDENER	 100 66		CURE FOR 180 MINUTES
RESIN MIX 2 (POTTING RESIN) (BMS 5-28, TYPES 15, 17, 19)	TWO COMPONENT KIT	FOLLOW MANUFACTURERS INSTRUCTIONS FURNISHED WITH EACH KIT		5 HRS AT 120-130°F (49-54°C)
RESIN MIX 3 (SEALER RESIN)	EPIBOND 156A EPIBOND 156B HARDENER	98 TO 102 5.7 TO 6.3	15 TO 25 MINUTES AT 77°F (25°C)	12 HRS AT 70°F (21°C) OR 1 TO 3 AT 150°F (66°C)
RESIN MIX 3 (SEALER RESIN) ALTERNATE	FIBER-RESIN 5318S FIBER-RESIN 5318C	98 TO 102 49 TO 51	45 TO 60 MINUTES AT 70°F (21°C)	SEE FIG. 12 OR 24 HRS MIN. AT 70°F (21°C)
RESIN MIX 3 EPOX-O WELD (SEALER RESIN) ALTERNATE	TWO COMPONENT KIT	FOLLOW MANUFACTURERS INSTRUCTIONS FURNISHED WITH EACH KIT		
			45 TO 60 MINUTES AT 70°F (21°C)	SEE FIG. 12 OR 24 HRS MIN. AT 70°F (21°C)
RESIN MIX 3 (SEALER RESIN) ALTERNATE	EPIBOND 156A EPIBOND 941 HARDENER	98 TO 102 9.5 TO 10.5	45 TO 60 MINUTES AT 70°F (21°C)	SEE FIG. 12 OR 16 HRS MIN. AT 70°F (21°C)
RESIN MIX 4 (LOW VISCOSITY INJECTION RESIN)	USE RESIN MIX 1		SEE RESIN MIX 1	

Resin Type Specifications and Mixing Procedures
Figure 13 (Sheet 1 of 4)

RESIN TYPE	COMPONENTS	PARTS BY WEIGHT	POT LIFE OF MIXTURE	$\boxed{B}$ CURING TIME
RESIN MIX 6 (POTTING RESIN) READY-TO-USE PACKAGE NO. 80055-44 OR NO. 80055-45	FOLLOW MANUFACTURERS INSTRUCTIONS FURNISHED WITH EACH KIT			
RESIN MIX 7 (POTTING RESIN)	QUICKSET EPOXI-PATCH KIT 615 PHENOLIC MICROBALLONS	100 15 TO 20	APPROX 4 MINUTES AT 70°F (21°C)	1 HR AT 70°F (21°C)
RESIN MIX 8 (POTTING RESIN)	RESIN MIX 1 MILLED GLASS FIBERS 1/32-INCH LONG	100 30 TO 40	SAME AS FOR RESIN MIX 1 USED IN MIXTURE	SEE FIG. 12
RESIN MIX 9 (POTTING RESIN)	RESIN MIX 1 PHENOLIC MICROBALLONS	100 15 TO 30	SAME AS RESIN MIX 1	SEE FIG. 12
RESIN MIX 11 (POTTING RESIN) (BMS 5-28, TYPE 6)	EPOCAST 1636A WITH EPOCAST 1636B HARDENER	100	60 MINUTES AT 70° TO 80°F (21° TO 27°C)	1.5 HRS AT 260 ±10°F (127 ±6°C) OR 1.0 HR AT 350 ±10°F (177 ±6°C)
RESIN MIX 11 (POTTING RESIN) (BMS 5-28, TYPE 15)	EPOCAST 1615A WITH 1615B HARDENER	100 14	10 TO 30 MINUTES AT 70° TO 80°F (21° TO 27°C)	7 DAYS AT 77°F (25°C) OR 5 HRS AT 120° TO 130°F (49° TO 54°C)
RESIN MIX 11 (POTTING RESIN) (ALTERNATE) (BMS 5-28, TYPE 17)	EPOCAST 1617A WITH 1617B HARDENER	100 20	60 TO 90 MINUTES AT 70° TO 80°F (21° TO 27°C)	7 DAYS AT 77°F (25°C) OR 5 HRS AT 120° TO 130°F (49° TO 54°C)
RESIN MIX 11 (POTTING RESIN) (ALTERNATE)	FR 7176A WITH 7176B HARDENER	100 15	12 TO 17 MINUTES AT 70° TO 80°F (21° TO 27°C)	7 DAYS AT 77°F (25°C) OR 5 HRS AT 120° TO 130°F (49° TO 54°C)
RESIN MIX 11 (POTTING RESIN) (ALTERNATE) (BMS 5-28, TYPE 19)	EPOCAST 1619A WITH 1619B HARDENER	100 25	20 TO 40 MINUTES AT 70° TO 80°F (21° TO 27°C)	7 DAYS AT 77°F (25°C) OR 5 HRS AT 120° TO 130°F (49° TO 54°C)

Resin Type Specifications and Mixing Procedures
Figure 13 (Sheet 2 of 4)

RESIN TYPE	COMPONENTS	PARTS BY WEIGHT	POT LIFE OF MIXTURE	B CURING TIME
RESIN MIX 11 (POTTING RESIN) (ALTERNATE)	TS 4038A WITH TS 4038B HARDENER	100 20	20 TO 70 MINUTES AT 70° TO 80°F (21° TO 27°C)	7 DAYS AT 77°F (25°C) OR 5 HRS AT 120° TO 130°F (49° TO 54 °C)
RESIN MIX 11 (POTTING RESIN) (ALTERNATE)	FR 7174A WITH 7174B HARDENER	100 24	20 TO 70 MINUTES AT 70° TO 80°F (21° TO 27°C)	7 DAYS AT 77°F (25°C) OR 5 HRS AT 120° TO 130°F (49° TO 54 °C)
RESIN MIX 11 (POTTING RESIN) (ALTERNATE)	EPOCAST 1511A WITH 1511B HARDENER	100 15	20 MINUTES AT 70° TO 80°F (21° TO 27°C)	7 DAYS AT 77°F (25°C) OR 5 HRS AT 120° TO 130°F (49° TO 54 °C)
BMS 5-25 GRADE 1 ADHESIVE	ADHESIVE PASTE EA 901 CURING AGENT B-1	100 16 TO 17	1 HR AT 70° TO 80°F (21° TO 27°C)	24 HRS AT 65° TO 80°F (19° TO 27°C) OR PER FIG. 12
BMS 5-25 GRADE 1 ADHESIVE (ALTERNATE)	ADHESIVE PASTE AEROBOND 223BA WITH 223B HARDENER	100 16 TO 18	1 HR AT 70° TO 80°F (21° TO 27°C)	24 HRS AT 70° TO 80°F (21° TO 27°C) OR PER FIG. 12
BMS 5-92, TYPE I, II, OR IV LIQUID ADHESIVE	EC2216A WITH EC2216B, COLORS OPTIONAL	TYPE I 58 42 TYPES II AND IV 50 50	80 TO 100 MINUTES AT 70° TO 80°F (21° TO 27°C)	7 DAYS AT 70° TO 80°F (21° TO 27°C)

Resin Type Specifications and Mixing Procedures
Figure 13 (Sheet 3 of 4)

WARNING: THESE CHEMICALS CONTAIN TOXIC INGREDIENTS. PROVIDE ADEQUATE VENTILATION AND PROTECT THE SKIN AND EYES FROM CONTACT WITH UNCURED RESINS OR CURING AGENT. WEAR RUBBER GLOVES OVER COTTON GLOVES FOR PROTECTION OF HANDS. IF SKIN IS EXPOSED TO DIRECT CONTACT WITH UNCURED RESINS OR CURING AGENT, WASH WITH WARM WATER OR SOAP. AVOID THE USE OF SOLVENTS FOR CLEANING THE SKIN.

CAUTION: TO PREVENT CONTAMINATION OF THE RESIN, DO NOT USE WAXED CONTAINERS FOR MIXING.

MIXING PROCEDURE	
RESIN MIX 1 RESIN MIX 2 RESIN MIX 3 RESIN MIX 4 RESIN MIX 11	ADD HARDENER TO RESIN AND MIX THOROUGHLY.
RESIN MIX 6	FOLLOW MANUFACTURERS INSTRUCTIONS FURNISHED WITH EACH KIT
RESIN MIX 7	1. MIX COMPONENTS OF KIT ACCORDING TO MANUFACTURERS INSTRUCTIONS. 2. ADD PHENOLIC MICROBALLOONS TO MIXTURE IN 1. ABOVE AND MIX THOROUGHLY.
RESIN MIX 8	ADD MILLED GLASS FIBERS TO RESIN MIX 1 TO PROVIDE A CONSISTENCY SIMILAR TO A THIN PUTTY.
RESIN MIX 9	1. ADD PHENOLIC MICROBALLOONS TO RESIN AND MIX THOROUGHLY. 2. ADD HARDENER AND MIX THOROUGHLY.
BMS 5-25 GRADE 1	MIX COMPONENTS THOROUGHLY UNTIL A UNIFORM PURPLE-RED COLOR DEVELOPS.
BMS 5-92	MIX COMPONENTS THOROUGHLY TO OBTAIN A UNIFORM COLOR.

NOTES

- MATERIALS MUST GEL AT ROOM TEMPERATURE PRIOR TO HEATING. RATE OF HEAT RISE MUST BE NO GREATER THAN 7°F (4°C) PER MINUTE.
- REFER TO SRM 51-30-03 FOR SOURCES OF MATERIALS.

A FORMERLY EPOCAST H-1835

B UNLESS SPECIFIED DIFFERENTLY, CURE TIME IS THE MINIMUM TIME NECESSARY TO CURE PRIOR TO HANDLING OR SANDING.

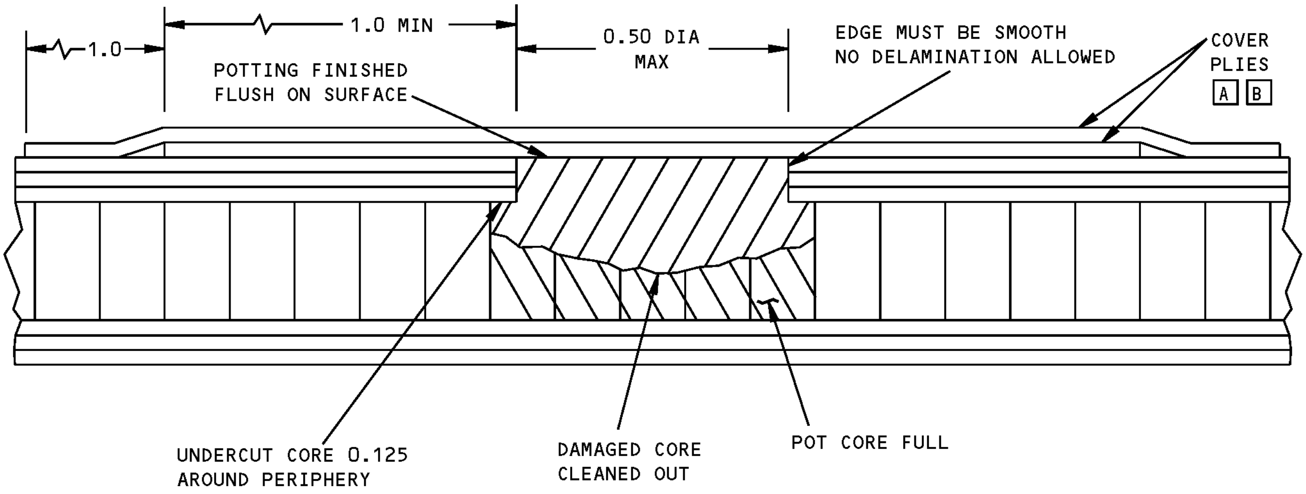
Resin Type Specifications and Mixing Procedures
Figure 13 (Sheet 4 of 4)

BMS 9-3 TYPE	FABRIC STYLE	THICKNESS PER PLY INCHES	BMS 8-79 EQUIVALENT TYPE	BMS 8-139 EQUIVALENT TYPE	PLY SUBSTITUTIONS
D	120	0.004-0.006	120	120	USE THREE PLIES OF TYPE D IN PLACE OF ONE PLY OF TYPE H-2 OR H-3
H-2	181-150	0.008-0.012	1581	181	USE ONE PLY OF TYPE H-2 OR H-3 IN PLACE OF TWO PLIES OF TYPE D
H-3	181-77	0.008-0.011	7781		USE ONE PLY OF TYPE H-3 IN PLACE OF ONE PLY OF TYPE H-2, AND VICE VERSA

NOTE

- BMS 9-3, CLASSES 2, 5 THRU 13, 16 THRU 19 CAN BE USED. CLASS 7 IS RECOMMENDED BECAUSE IT IS KNOWN TO HAVE GOOD STORAGE LIFE.

BMS 9-3 Glass Fabric Substitution
Figure 14



TYPICAL SECTION

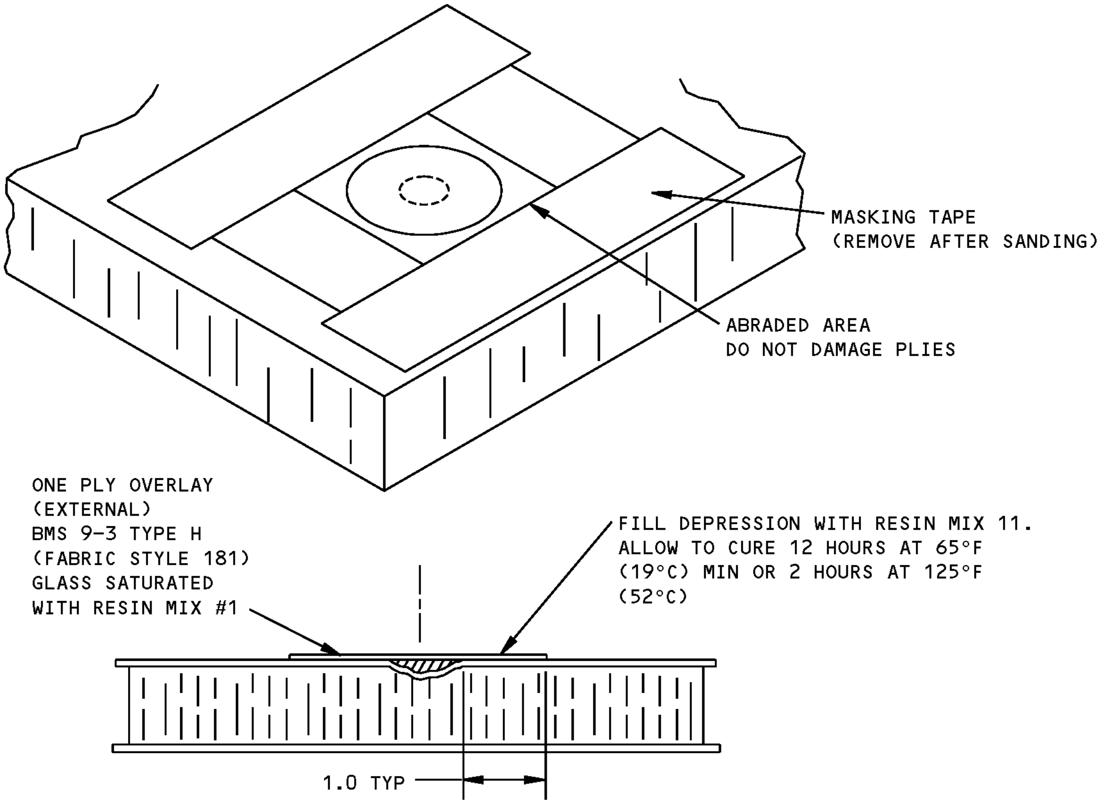
NOTES

- OVERLAP COVER PLIES PER FIG. 2. DO NOT TAPER SAND OR STEP SAND ANY PLIES

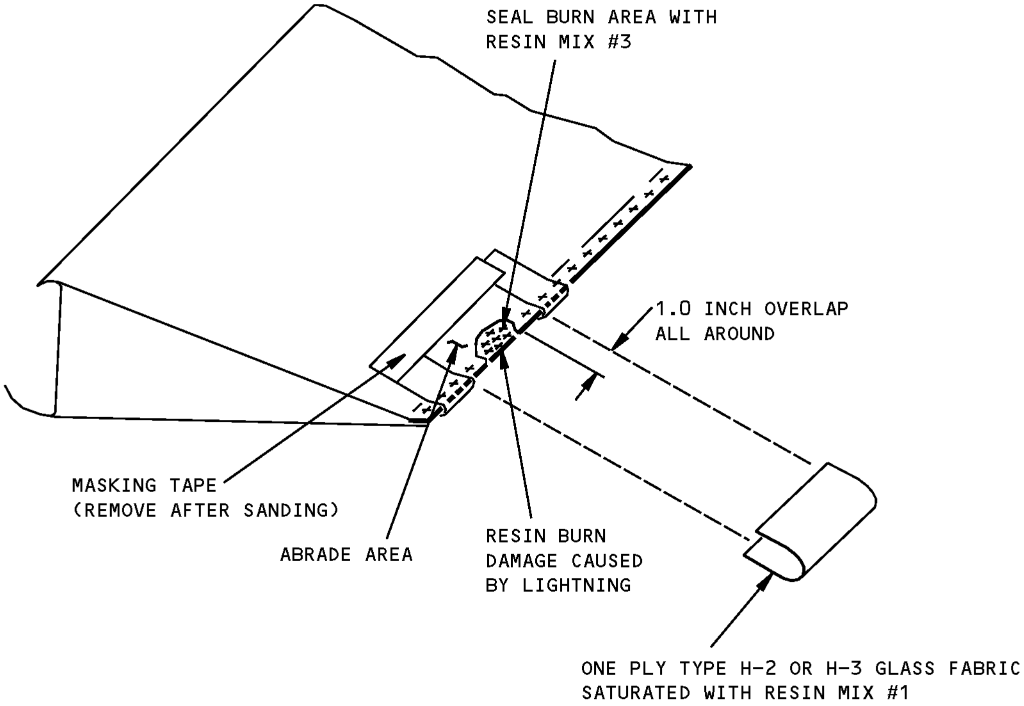
A ORIENT COVER PLIES IN THE SAME DIRECTION AS THE ORIGINAL OUTER LAYER

B PREPARE AND APPLY TWO GLASS FABRIC COVER PLIES PER PAR. 5.E, EXCEPT USE TYPE H-2 OR H-3 PLIES ONLY

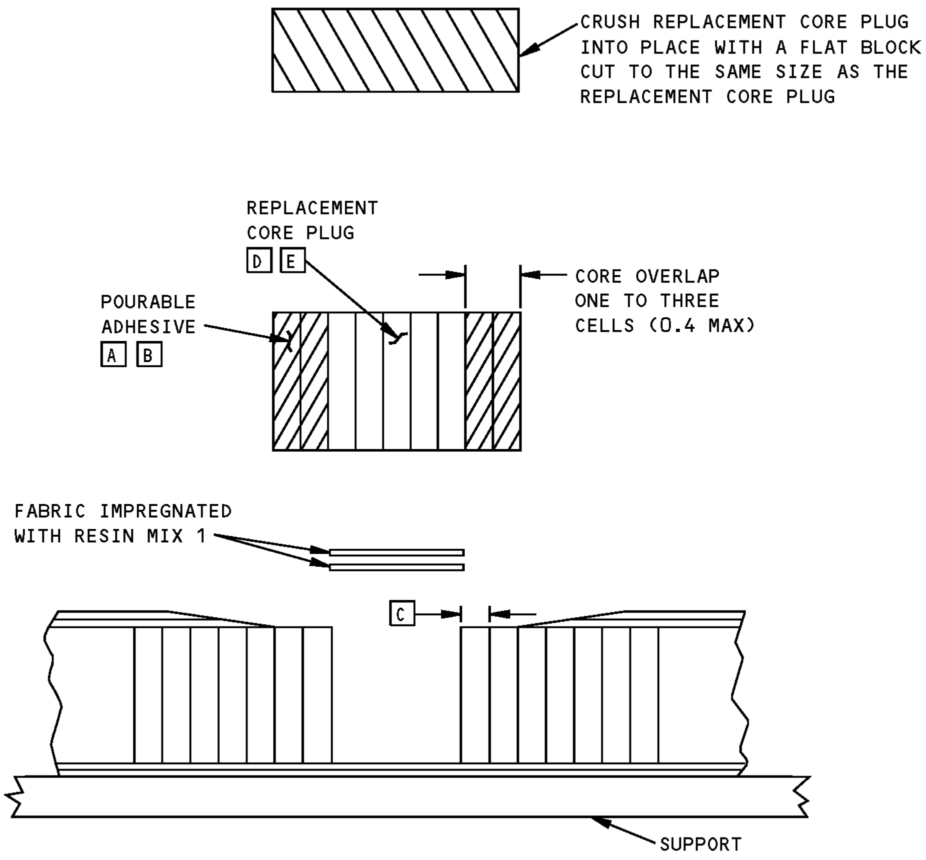
Typical Puncture Repair, 0.50 - Inch Diameter or Less - Room Temperature Cure
Figure 15



Typical Repair for Dents - Wet Layup
Figure 16



Typical Repair for Lightning Damage at Trailing Edge - Wet Layup
Figure 17



NOTES

A BEFORE SPLICING, DIP PERIPHERY OF CORE PLUG INTO RESIN MIX 3 TO A DEPTH OF ONE TO THREE CELLS (0.4 INCH MAX)

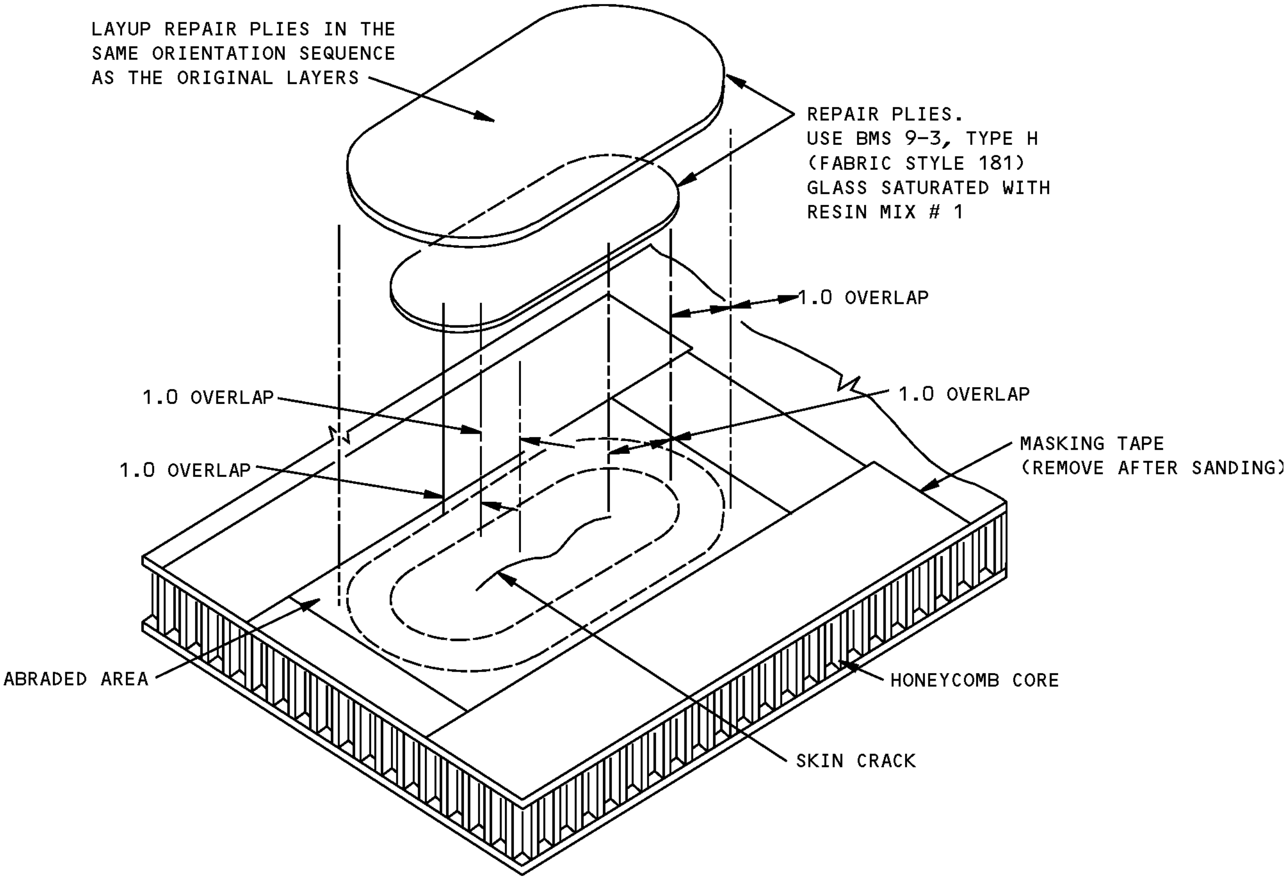
B AFTER SPLICING, POUR ADDITIONAL ADHESIVE INTO SPLICED CELLS

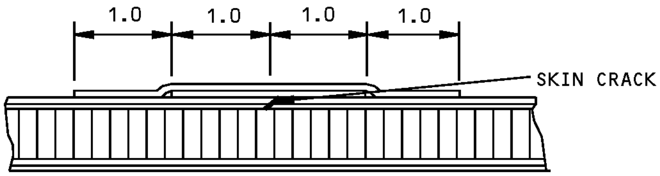
C WHEN PREPARING REPAIR AREA LEAVE ONE TO THREE CELLS (0.4 INCH MAX) VISIBLE BETWEEN CORE REPAIR CAVITY AND SKIN TO MATCH CORE OVERLAP

D ALIGN HONECOMB CELLS OF REPAIR PLUG WITH ORIGINAL CORE

E REPLACEMENT CORE PLUG MUST BE MADE FROM CORE MATERIAL AT LEAST TWO GRADES DENSER THAN THE ORIGINAL CORE

Core Crush Splicing Requirements - Wet Layup
Figure 18





SECTION VIEW

Repair of Small Damage to One Skin
Figure 19

COMPANY	ADDRESS	LT	HT
AERITALIA, PIAZZALE V.	TECCHIO 51, 80125, NAPLES, ITALY	X	
AERONCA INC., AEROSPACE GROUP, MIDDLETOWN PLANT	1712 GERMANTOWN RD, MIDDLETOWN, OHIO, 45042 U.S.A.	X	
BOEING OF CANADA LTD., WINNIPEG DIV.	99 MURRAY PARK RD, WINNIPEG, MANITOBA, CANADA R3J-3M6	X	X
CONSTRUCCIONES AERONAUTICAS S.A.	REY FRANSICO, MADRID 8, SPAIN	X	
FAIRCHILD INDUSTRIES, INC., REPUBLIC DIVISION	SHOWALTER RD, HAGERSTOWN, MARYLAND 21740 U.S.A.	X	
FUJI HEAVY INDUSTRIES, LTD., AIRCRAFT DIVISION	NO. 680 NISHIHARA CHO, UTSUNOMIYA CITY, TOCHIGI PREFECTURE, JAPAN	X	
HEATH TECHNA CORP, PRECISION STRUCTURES DIVISION	19819 84TH AVE. SOUTH, KENT, WASHINGTON 90831 U.S.A.	X	X
HITCO, AUBURN FACILITY	3016 AUBURN WAY NORTH, AUBURN, WASHINGTON 98002 U.S.A.	X	X
HITCO DEFENSE PRODUCTS DIVISION	1600 W. 135TH ST., GARDENA, CALIFORNIA 90249 U.S.A.		
KAWASAKI HEAVY INDUSTRIES LTD	2-16 NAKAMACHI-DORI, IKUDAKU, KOBE, 650 JAPAN	X	
LING-TEMCO-VOUGHT INC.	P.O. BOX 5003, DALLAS, TEXAS 75222 U.S.A.	X	X
MITSUBISHI HEAVY INDUSTRIES LTD	2-5-1 MARUNOUCHI, CHIYODAKU, TOKYO NO. 100 JAPAN	X	
NORTHROP CORP., VENTURA DIVISION	1515 RANCHO CONEJO BLVD, NEWBURY PARK, CALIFORNIA 91320 U.S.A.	X	X
PANEL-AIR CORP.	1571 W. MACARTHUR BLVD, COSTA MESA, CALIFORNIA 92026 U.S.A.	X	
ROCKWELL INTERNATIONAL CORP., TULSA DIVISION	P.O. BOX 51308, TULSA, OKLAHOMA, 74151 U.S.A.	X	X
ROHR INDUSTRIES INC.	P.O. BOX 878, CHULA VISTA, CALIFORNIA 92012 U.S.A.	X	
SHORT BROS. AND HARLAND LTD	P.O. 241, AIRPORT ROAD, BELFAST BT3-9DZ, NORTHERN IRELAND	X	
THE BOEING COMPANY, FABRICATION AND SERVICES DIVISION	P.O. BOX 3707, SEATTLE, WASHINGTON 98124 U.S.A.	X	X

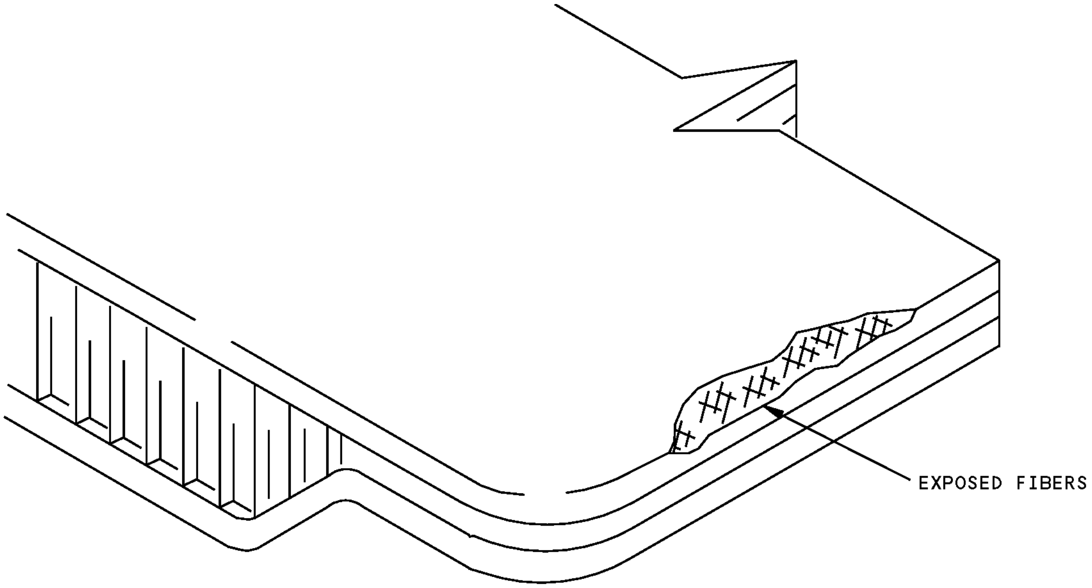
NOTES

- ALL APPROVED FOR ROOM TEMPERATURE 65°-100° CURE REPAIRS
- LT = APPROVED FOR LOW TEMPERATURE (250°F) CURE REPAIRS
- HT = APPROVED FOR HIGH TEMPERATURE (350°F) CURE REPAIRS

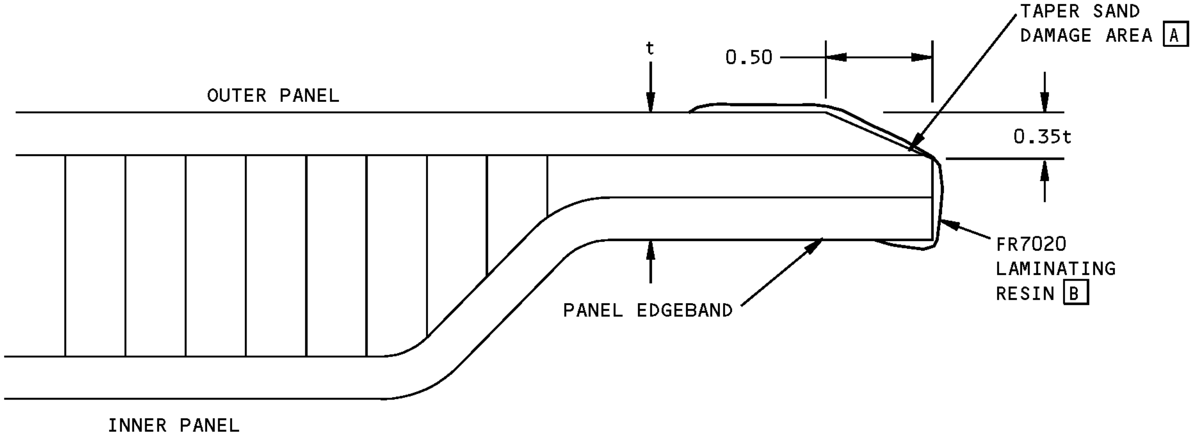
Boeing-Approved Repair Facilities for Glass Fabric Reinforced Epoxy Resin Components
Figure 20 (Sheet 1 of 2)

COMPANY	ADDRESS	L T	H T
TOOL RESEARCH AND ENGINEERING CORP., ADVANCED STRUCTURES DIVISION	801 ROYAL OAK DRIVE, MONROVIA, CALIFORNIA 91016 U.S.A.		
YOKOHAMA RUBBER CO. LTD	2-1 OIWAKE, HIRATSUKA-SHI, KANAGAWA 254 JAPAN	X	
AERITALIA, FOMIGLIANO D'ARCO	NAPLES, ITALY	X	
AERITALIA, FOMIGLIANO D'ARCO	TURIN, ITALY	X	
BOEING MILITARY AIRPLANE CO.	3801 S. OLIVER, WICHITA, KANSAS 67210 U.S.A.		X
BOEING VERTOL CO.	P.O. BOX 16858, PHILADELPHIA, PENNSYLVANIA 19142 U.S.A.	X	
CANADAIR LTD	P.O. BOX 6087, MONTREAL, QUEBEC, CANADA H3C-3G9	X	X
GENERAL DYNAMICS CORP., CONVAIR DIV.	P.O. BOX 80877, SAN DIEGO, CALIFORNIA 92138 U.S.A.		X
GRUMMAN AEROSPACE CORP.	MILLEDGEVILLE, GEORGIA U.S.A.		X
RUSSELL PLASTIC TECHNOLOGY	LINDENHURST, NEW YORK U.S.A.	X	X

Boeing-Approved Repair Facilities for Glass Fabric Reinforced Epoxy Resin Components
Figure 20 (Sheet 2 of 2)



PANEL EDGE WITH EROSION DAMAGE



SECTION THRU PANEL

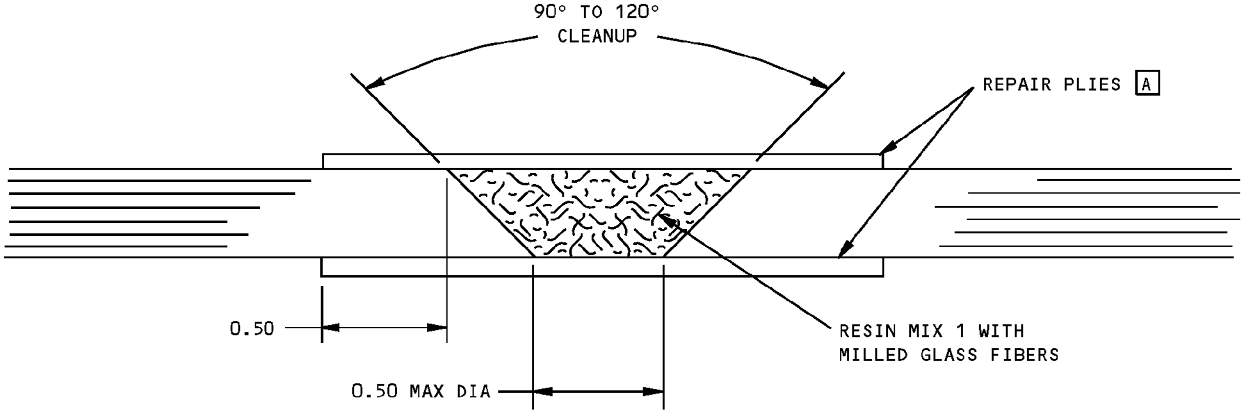
NOTES

- REFER TO 51-10-01 FOR AERODYNAMIC SMOOTHNESS REQUIREMENTS
- REPAIR IS APPLICABLE TO BOTH HONEYCOMB PANEL EDGEBANDS AND SOLID LAMINATE PANEL EDGES

A TAPER SAND EROSION DAMAGE AREA TO 0.50 INCH MAX DISTANCE FROM PANEL EDGE AND 0.35t MAX DEPTH. t = PANEL EDGEBAND THICKNESS

B REFER TO FIGURE 1 FOR RESIN SPECIFICATIONS AND MIXING PROCEDURES

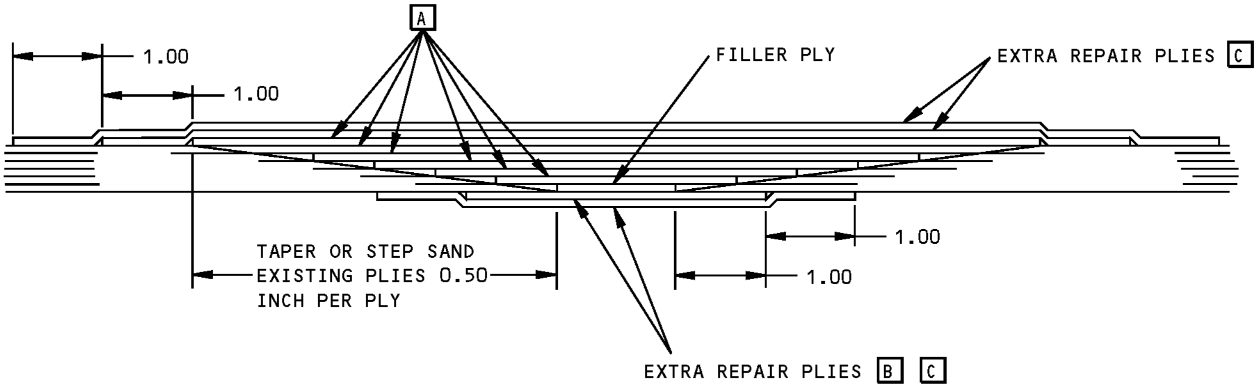
Repair of Erosion Damage to Panel Edges
Figure 21



NOTES

A REPAIR PLIES ARE TO HAVE THE SAME ORIENTATION AS THE ORIGINAL SURFACE PLIES

Repair of Punctures, 0.50 Inch Diameter or Less, in Solid Laminate
Figure 22



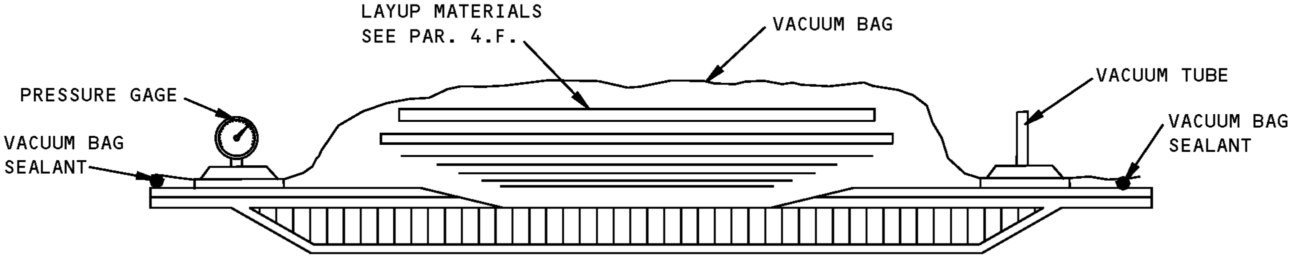
NOTES

A DETERMINE NUMBER OF PLIES, ORIENTATION, AND MATERIAL FROM SPECIFIC COMPONENT STRUCTURE IDENTIFICATION

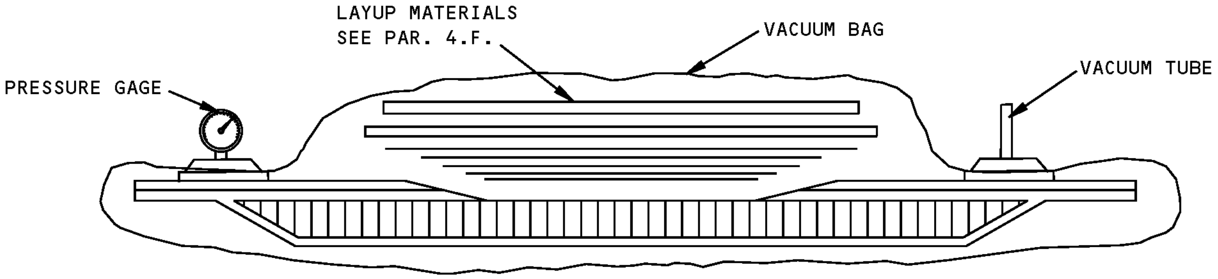
B EXTRA REPAIR PLIES AT THIS LOCATION ARE REQUIRED ONLY IF THE DAMAGE PENETRATES THIS SURFACE

C THE ORIENTATION OF THE OUTERMOST EXTRA REPAIR PLY IS TO BE THE SAME AS THE OUTERMOST PLY OF THE ORIGINAL LAMINATE. ANY OTHER EXTRA REPAIR PLY IS TO BE ORIENTED +45° TO THE EXTRA REPAIR PLY IMMEDIATELY ABOVE IT

Solid Laminate Repair
Figure 23



ACCEPTABLE - VACUUM BAG SEALED TO ONE SIDE ONLY



ACCEPTABLE - VACUUM BAG SEALED AROUND ENTIRE PART

PARTS CONSISTING OF ONE PANEL [A]

NOTES

- REFER TO PAR. 4.F. FOR LAYUP AND BAGGING PROCEDURES

[A] THIS TYPE OF COMPONENT MAY BE COMPLETELY SEALED IN A VACUUM BAG OR MAY BE SEALED ON ONE SIDE ONLY

Vacuum Bagging Restrictions
Figure 24

GENERAL - GLASS FABRIC REINFORCED EPOXY LAMINATES AND NONMETALLIC HONEYCOMB SANDWICH REPAIRS - 250°F (121°C) CURE

1. Scope

CAUTION: TO GET AN ACCEPTABLE QUALITY REPAIR, DO AS FOLLOWS:

- REFER TO THE APPLICABLE COMPONENT THAT YOU ARE GOING TO REPAIR FOR THE REPAIR LIMITS AND MATERIAL OF THE COMPONENT BEFORE YOU USE THESE REPAIR INSTRUCTIONS.
- USE THE CORRECT MATERIALS FOR THE TYPE OF COMPONENT AND REPAIR THAT IS MADE.
- USE THE MATERIALS THAT AGREE WITH THE SPECIFICATIONS IN THE SRM.
- ACCURATELY FOLLOW THE SRM PROCEDURES AT EACH STEP OF THE REPAIR. IF YOU DO NOT DO THIS, IT CAN CAUSE A REPAIR THAT IS NOT SATISFACTORY AND NOT APPROVED.

250°F (121°C) CURE REPAIRS ARE RESTRICTED TO SPECIFIC AREAS AND COMPONENTS AS SHOWN IN THE INDIVIDUAL COMPONENT REPAIR IN THE MANUAL. THESE REPAIRS ARE PERMANENT WHEN APPLIED USING THE REPAIR MANUAL PROCEDURES TO COMPONENTS ORIGINALLY MADE FROM 250°F (121°C) CURE MATERIALS.

A. The following subject includes repairs to components made from epoxy resin reinforced with several layers of fiberglass fabric. The most common construction is a sandwich of two laminated skins separatd by a nonmetallic honeycomb core. Glass fabric is also known as fiberglass cloth. Solid laminate is used for small components, honeycomb panel edgeband and at fitting locations.

B. These repairs use 250°F (121°C) cure fiberglass epoxy preimpregnated (prepreg) materials which are cured in a vacuum bag either in an autoclave or with a heating blanket as a heat source.

C. These repairs are permanent in nature. Once completed and the final finish applied as given in the Maintenance Manual, the original strength will be restored.

D. Table 1/GENERAL contains an index of subjects in this procedure.

Table 1: Index of the Repair Subjects

Paragraph	Subject
Paragraph 2.A./GENERAL	Repair Information Sources
Paragraph 2.B./GENERAL	Precautions
Paragraph 2.C./GENERAL	Repair Material Handling
Paragraph 2.D./GENERAL	Equipment
Paragraph 2.E./GENERAL	Preparation
Paragraph 2.F./GENERAL	Repair Considerations
Paragraph 4./GENERAL	Repair Procedures Common to Various Repairs
Paragraph 4.A./GENERAL	Determine Damage
Paragraph 4.B./GENERAL	Remove Water from Honeycomb Sandwich
Paragraph 4.C./GENERAL	Remove and Prepare Damaged Area
Paragraph 4.D./GENERAL	Fabricate, Clean and Install Honeycomb Replacement Core Plug
Paragraph 4.E./GENERAL	Prepare and Apply Preimpregnated (Prepreg) Glass Fabric Repair Plies

Table 1: Index of the Repair Subjects (Continued)

Paragraph	Subject
Paragraph 4.F./GENERAL	Layup-and-Bagging Procedures
Paragraph 4.G./GENERAL	Cure the Repair
Paragraph 4.H./GENERAL	Refinish after Repair
Paragraph 4.I./GENERAL	Perform Post-Repair Requirements
Paragraph 5./GENERAL	Typical Repairs
Paragraph 5.A./GENERAL	Repair of Delaminations Between Plies
Paragraph 5.B./GENERAL	Repair of Puncture, 0.50-inch Diameter or Less, in Honeycomb Panel
Paragraph 5.C./GENERAL	Repair of Damage to One Skin and Honeycomb Core using Replacement Core Plug, Punctures Greater than 0.5-inch Diameter
Paragraph 5.D./GENERAL	Repair of Large Puncture through Internal and External Surface of Panel including Core Damage
Paragraph 5.E./GENERAL	Replacement of Honeycomb Core on Damaged Edge of Panel
Paragraph 5.F./GENERAL	Repair of Hole through Both Skins of a Honeycomb Panel with Access Available from One Side Only
Paragraph 5.G./GENERAL	Repair of Damaged Skin Plies in Panel Edgeband
Paragraph 5.H./GENERAL	Repair of Damage Greater than 0.5-inch Diameter in Solid Laminate Panels
.Paragraph 5.I./GENERAL	Repair of Punctures, 0.5-inch Diameter or Less, in Solid Laminate Panels
Paragraph 5.J./GENERAL	Repair of Delamination Between Plies in Solid Laminate Panels
Paragraph 5.K./GENERAL	Repair of Damaged Panel Attach Holes in Honeycomb Panel Edgebands or along Edges of Solid Laminate Panels
Paragraph 5.L./GENERAL	Repair of Surface Dents
Paragraph 5.M./GENERAL	Repairs to Aluminum Foil

2. General

A. Repair Information Sources

(1) Specific allowable damage, repair limitations and repair data can be found in the chapter/section/subject associated with each component.

(2) Typical repairs are given in Paragraph 5./GENERAL

(3) Refer to 51-70-02, GENERAL for the locations of principal composite components.

(4) See Figure 1/GENERAL for resin mixes and potting compond data.

(5) Refer to REPAIR MATERIALS, SECTION/51-30 for sources of repair materials and equipment.

(6) Refer to 51-10-01, GENERAL for aerodynamic smoothness requirements.

(7) Refer to Paragraph 5.M./GENERAL for the repair of damage to the underlying plies on parts having an outer layer of aluminum foil.

(8) Repair aluminum foil where damage to the aluminum foil does not extend into the underlying plies as given in 51-70-14, GENERAL.

(9) Restore aluminum flame spray as given in 51-70-14, GENERAL.

(10) Repair Tedlar as given in Paragraph 4.H./GENERAL

(11) Refer to 51-70-16, GENERAL for hole drilling and machining of composite parts.

B. Precautions

WARNING: BREATHING VAPORS OR ALLOWING SOLVENT TO CONTACT SKIN OR EYES IS HAZARDOUS. WEAR RUBBER GLOVES, PROTECTIVE CLOTHING AND EYE GOGGLES. IF CHEMICAL CONTACT OCCURS, WASH THOROUGHLY WITH WATER. IF CHEMICAL SHOULD SPLASH INTO EYES, FLUSH EYES WITH LARGE QUANTITIES OF WATER AND SEEK MEDICAL AID. USE MECHANICAL VENTILATION OR RESPIRATORY PROTECTION WHEN WORKING IN A CONFINED SPACE OR AREA.

(1) Keep the repair area well ventilated.

(2) Avoid excessive breathing of fumes from prepreg materials, adhesive resin mix and cleaning fluids.

(3) Avoid resin contact with eyes, skin or clothing. Wear protective gloves and clothing when handling prepreg material, adhesive resin mix and cleaning fluids.

(4) Wear approved dust mask and safety glasses when cutting, sanding and abrasive blasting composite structure. Whenever possible, use vacuum pickup when performing these operations.

(5) The solvents and finishes are flammable. Keep away from heat and flame.

C. Repair Material Handling

(1) Perform these repair procedures only in areas of reasonable cleanliness. Areas subject to oil mist, exhaust fumes, gases, soot, rain, dust or other particulate matter are specifically prohibited.

(2) Protect surfaces from contamination. Do not touch cleaned parts or adhesive with bare hands. Use clean white gloves when handing parts.

(3) Store rolls or precut kits of prepreg and adhesive material below 10°F (-12°C) in sealed moistureproof bags. An identification label must accompany the material inside the bag with the following information: BMS type, class, grade, supplier name, batch number, roll number, prepreg lot number and date of kit preparation. Record storage time in and out of refrigeration.

WARNING: HEAT, FIRE OR SPARKS CAN CAUSE AN EXPLOSION. USE EXPLOSIONPROOF EQUIPMENT WHEN PERFORMING THESE REPAIRS. NONCOMPLIANCE COULD INJURY TO PERSONNEL.

D. Equipment

(1) Vacuum systems shall be capable of maintaining a minimum of 22 inches of mercury.

(2) Refrigerated storage below 10°F (-12°C) shall be provided for storing prepreg, adhesive and preimpregnated peel ply materials.

E. Preparation

(1) From the identification section or Boeing drawings, identify the material the part is made of and the configuration of the core and plies in the damaged area.

   (a) Prepreg type, class, grade or style and cure system.

   (b) Number of plies, orientation, and stacking sequence.

   (c) Type, class and grade of core.

F. Repair Considerations

CAUTION: 250°F (121°C) CURE REPAIRS MAY NOT RESTORE THE STRENGTH OR DURABILITY OF COMPONENTS ORIGINALLY MADE USING 350°F (177°C) CURE MATERIALS. THEIR USE IS RESTRICTED TO SPECIFIC AREAS OF COMPONENTS AS SHOWN IN THE INDIVIDUAL COMPONENT REPAIR OF THE MANUAL.

REPAIRS IN THIS SUBJECT SPECIFY MATERIALS QUALIFIED FOR 250°F (121°C) CURE. 350°F (177°C) CURE MATERIALS WILL NOT CURE AT 250°F (121°C) AND MUST NOT BE USED TO REPAIR COMPONENTS ORIGINALLY MADE FROM 250°F (121°C) CURE MATERIALS.

(1) Material used to repair a component shall be of the same type, class and grade and must be orientated in the same direction as the ply it replaces. Refer to Figure 2/GENERAL for allowable substitutes.

CAUTION: SOME REPAIRS MAY REQUIRE CURE TEMPERATURES THAT ARE THE SAME AS THOSE USED WHEN THE COMPONENT WAS ORIGINALLY MANUFACTURED. CARE MUST BE TAKEN TO PROPERLY SUPPORT THE AREA ADJACENT TO THE REPAIR TO PREVENT DELAMINATION OF UNDAMAGED AREAS. EXTENDING VACUUM BAGGING A MINIMUM OF 6.0 INCHES BEYOND THE REPAIR AND THE USE OF SUPPORT STRUCTURE WHERE REQUIRED ARE RECOMMENDED.

(2) Use suitable holding fixtures as given in Paragraph 4.G./GENERAL to prevent distortion and delamination of the undamaged structure.

CAUTION: DO NOT USE BMS 5-95 AS A FAYING SURFACE SEALANT IN FUEL TANK AREAS. USE BMS 5-26 IN FUEL TANK AREAS.

(3) Install fittings with faying surface seal using BMS 5-26 in fuel tank areas and BMS 5-95 in all other areas.

CAUTION: REPAIRS MUST NOT COVER EXISTING DRAIN HOLES.

(4) If the repair covers a drain hole, drill through the repair at the existing location.

NOTE: Drain holes are usually 0.375 inch in diameter. Refer to 51-41 of the Airplane Maintenance Manual.

WARNING: FLIGHT SAFETY DEMANDS THAT CERTAIN CONTROL SURFACES BE PROPERLY BALANCED AT ALL TIMES.

(5) Following the repair of a control surface, balance must be checked to determine whether or not rebalancing is required. Rebalance as necessary as given in 51-60-00, GENERAL.

CAUTION: REPAIRS MADE TO CONTROL SURFACES AND ADJACENT STRUCTURE MUST NOT INTERFERE WITH THE DESIGNED OPERATION OF THE CONTROL SURFACES. DAMAGE TO THE AIRPLANE STRUCTURE MAY OCCUR.

(6) Check all repairs for noninterference with the operation of control surfaces. Ensure adequate clearances for all repaired parts.

3. References

Reference	Title
51-10-01, GENERAL	Aerodynamic Smoothness Requirements
51-20-05, GENERAL	Repair Sealing

(Continued)

Reference	Title
51-30	REPAIR MATERIALS
51-60-00, GENERAL	Control Surface Balance Moment Determination
51-70-02, GENERAL	Locations of the Principal Composite Components
51-70-06, GENERAL	Glass Fabric Reinforced Epoxy Laminates and Nonmetallic Honeycomb Sandwich Repairs - Room Temperature – 150°F (66°C) Cure (Wet Layup)
51-70-14, GENERAL	Allowable Damage and Repair of Flame-Sprayed Aluminum Coatings, Aluminum-Coated Glass Fabric (BMS 8-278), Aluminum Foil (BMS 8-289), and Expanded Aluminum Foil (BMS 8-336)
51-70-16, GENERAL	Hole Drilling and Machining of Composite Structures
51-70-17, GENERAL	Repairs to 250°F (121°C) and 350°F (177°C) Cured Graphite/Aramid/Fiberglass Reinforced Epoxy Laminates and Nonmetallic Honeycomb Sandwich Structure - 200°F (93°C) to 230°F (110°C) Wet Layup Repair Method
AMM 51-21-00	Aircraft Maintenance Manual
AMM 51-24-00	Aircraft Maintenance Manual
AMM 51-24-13	Aircraft Maintenance Manual
AMM 51-41-00/201	Aircraft Maintenance Manual
DOCUMENT D6-49327	Certification of Autoclaves for Metal Bonding and Curing of Composite Structure
DOCUMENT D6-56273	Qualification of Heat Blankets for Hot Bonding
NDT Part 1, 51-01-01	Inspection of Repairs to Composite Structures
SOPM 20-30-99	Solvents For Final Cleaning of Composites Before Structural Bonding (Series 99)

4. Repair Procedures Common to Various Repairs

CAUTION: CHEMICAL PAINT STRIPPERS WILL ATTACK RESIN SYSTEMS, AND SHOULD NOT BE USED TO REMOVE PAINT FOR MAKING DAMAGE EVALUATIONS.

A. Determine Damage

(1) Examine visually for extent of damage.

(2) Check panel in the vicinity of damage for entry of water, oil, fuel, dirt or other foreign matter. Water can be detected by radiographic methods. Remove contaminants as required.

(3) Check for delamination around the damage.

NOTE: Post repair inspection is recommended. Examples of inspection procedures are given in NDT Part 1, 51-01-01.

B. Remove Water from Honeycomb Sandwich (Figure 6/GENERAL)

(1) Remove damaged skin plies to open up honeycomb area in the damaged area. Remove standing water using vacuum and oil-free compressed air.

(2) Sand the core to remove the adhesive. Removal of adhesive fillets on core is not required.

(3) Apply a fiberglass or metal fine mesh screen over the exposed core.

(4) Apply a thermocouple to the center of the screen.

(5) Apply a layer of glass fabric bleeder cloth over the screen and hold in place with masking tape.

(6) Place a vacuum line on the edge of the bleeder cloth and hold in place with masking tape.

(7) If the far side is accessible, apply thermocouple and heating blanket to the far side of the honeycomb sandwich panel.

NOTE: If the far side is accessible, it is acceptable to heat the area using a heating blanket only on the far side. An additional heating blanket and vacuum application may be used on the near side at the location shown in Figure 6/GENERAL to accelerate water removal. If the far side is inaccessible, use of a heating blanket on the near side is required.

(8) When the far side is inaccessible or when using additional heating blanket, place the heating blanket over the bleeder cloth on the near side.

(9) Place extruded sealing compound around the entire area and seal the area with vacuum bag material.

(10) Evacuate the layup to a minimum 22 inches of mercury.

(11) Heat the area for 1 hour minimum at 150°F (66°C) to 170°F (77°C). The rate of temperature rise must not exceed 5°F (3°C) per minute. Area must be completely dried out. Any structure in the repair area that cannot be dried out must be removed along with the other damage.

(12) Remove layup materials and proceed with repair procedure.

CAUTION: REMOVE (FOR ALL TYPES OF CURE) OR ISOLATE (HEAT BLANKET ONLY) ALUMINUM STRUCTURE TO PREVENT LOSS OF STRENGTH IN THE ALUMINUM PARTS. ALL ALUMINUM ALLOYS, EXCEPT 2219, MUST BE KEPT BELOW 200°F (93°C). ALUMINUM 2219 CAN BE KEPT UP TO 400°F (204°C).

REMOVE SEALANTS, PAINTS AND PRIMERS IN THOSE AREAS WHERE THE TEMPERATUE COULD REACH ABOVE THE MAXIMUM ALLOWABLE TEMPERATURE. REFER TO SRM 51 20-01 FOR THE MAXIMUM ALLOWABLE TEMPERATURES.

C. Remove Damage and Prepare Damaged Area

(1) Damage Removal

(a) Trim out the damaged lamination to a smooth rounded shape, such as a circular or oval shape. Take care not to damage the undamaged plies, core or surrounding material.

NOTE: Remove only damaged plies, damaged doublers and damaged fillers.

(b) When the core is also damaged, remove the core by trimming to the same outline as the skin. The core area removed should extend at least 0.25 inch further than visible core damage limits. Take care to avoid cutting into an undamaged skin on the opposite side. In cores greater than 1.0 thick, partially remove core (at least 0.5 deep) sufficient to clean up damage.

NOTE: When a potted core repair is to be made, removal of damaged core is not required.

(c) In areas where contamination cannot be removed by cleaning or drying as given in Paragraph 4.B./GENERAL, remove the contaminated structure along with the other damage.

(d) When opposite skin is also damaged, trim out the damage to a smooth rounded shape as described in Paragraph 4.C.(1)(a)/GENERAL.

(e) When core is removed from the inner surface of the opposite skin, carefully smooth core down to adhesive film.

(f) Inspect cutout area to ensure that all damage has been removed.

CAUTION: SANDING FOR ADHESION OR FINISH REMOVAL MUST NOT EXPOSE OR DAMAGE FILAMENTS IN THE UNTAPERED SURFACE REPAIR AREA.

SANDING MUST NOT EXPOSE OR DAMAGE FILAMENTS IN EACH PLY WHEN STEP SANDING OR IN THE PLY BONDED TO THE CORE (FIGURE 7/GENERAL). LOSS OF STRUCTURAL STRENGTH OF THE COMPONENT WILL OCCUR IF THESE CAUTIONS ARE NOT OBSERVED.

DO NOT USE PAINT STRIPPERS FOR THE REMOVAL OF FINISH. DAMAGE TO THE ADHESIVE RESIN SYSTEM WILL OCCUR.

(2) Preparation of Damaged Area (Figure 7/GENERAL).

(a) Determine the number of plies that have been cut. Mask off the area around the cutout allowing 0.5 overlap for each ply replacement, plus 0.5 extra for the extra ply to ensure that the taper on existing top ply is completely covered by the repair.

NOTE: Where the number of plies is not apparent, refer to the applicable component in the structure identification section or engineering drawing.

WARNING: SANDING GIVES OFF A FINE DUST THAT MAY CAUSE SKIN IRRITATIONS. BREATHING OF AN EXCESSIVE AMOUNT OF THIS DUST MAY BE INJURIOUS. OBSERVE PRECAUTIONS FOR SKIN AND RESPIRATION PROTECTION.

EXPLOSIONPROOF EQUIPMENT MUST BE USED WHERE THE POSSIBILITY OF VAPOR IGNITION EXISTS. NONCOMPLIANCE COULD CAUSE PERSONNEL INJURY.

(b) Internal surface of panel (nonaerodynamic surface) and noncritical aerodynamic surfaces

1) Remove the paint finish or Tedlar film using No. 240 or finer Scotch-Brite Abrasive, or No. 150 or finer sandpaper in the masked off area.

2) If the damaged area has a layer of aluminum foil, cut back the foil enough to allow a new foil layer to have 1.25 minimum overlap beyond the outermost repair ply (Figure 17/GENERAL).

a) Strip the aluminum foil by peeling or abrading. Do not damage underlying composite fibers.

b) Carefully abrade to remove the primer on the aluminum foil to a border at least 1.25 larger all around than the repair area that was just stripped of foil. Spotty traces of primer covering up to 10% of border area are acceptable.

c) Taper sand or step sand each ply as given in Item 3) below.

d) Lightly abrade and solvent wipe the primer on the aluminum foil to a border 1.0 larger all around than the 1.25 wide band of foil that was exposed by primer removal.

e) Alodine treat the foil that was exposed by primer removal in the 1.25 border area.

3) Taper sand each ply or simply abrade the surface around the cleaned up damage a minimum of 0.5 per ply. See Figure 2/GENERAL.

4) An optional procedure for two or three ply laminate face sheets is to fill the cleaned up damage area flush with the original surface using filler plies during the repair layup. The repair plies are then installed directly on the resulting smooth surface of the repair area.

5) Abrade surfaces around repair using No. 150 or finer Scotch-Brite abrasive.

(c) External surface of panel (aerodynamic surface)

1) Taper sand a uniform taper around the repair using No. 180 sandpaper. The taper is to be over an approximate distance of 0.5 for each existing ply of the laminate. Step sanding is optional to taper sanding on sandwich structure except in areas of critical aerodynamic smoothness. Refer to 51-10-01, GENERAL for locations of areas of critical aerodynamic smoothness. Always taper sand on solid laminate structures.

NOTE: For sanding, use a flexible disk sander, a belt sander, a rotating pad sander, or sand by hand.

2) Remove exterior finishes, including enamel finish and conductive coating, from the surface of the 0.5-inch border using No. 150 or finer sandpaper.

(d) Edgeband of panel.

1) Taper sand panel edgeband according to Paragraph (c).

NOTE: Edgeband is the solid laminate around the outer periphery of the honeycomb panel.

(e) Cleaning of repair area.

1) Remove all sanding dust by applying oil-free compressed air or use a vacuum cleaner.

WARNING: WHEN USING SOLVENTS AVOID BREATHING VAPORS. USE MECHANICAL VENTILATION OR RESPIRATORY PROTECTION WHEN WORKING IN A CONFINED SPACE OR AREA. AVOID CONTACT WITH SKIN, EYES AND CLOTHING. WEAR APPROVED GLOVES AND PROTECTIVE CLOTHING. WEAR EYE PROTECTION. KEEP AWAY FROM SOURCES OF HEAT, FIRE OR SPARKS. BREATHING VAPORS OR ALLOWING SOLVENT TO CONTACT SKIN OR EYES IS HAZARDOUS. HEAT, FIRE OR SPARKS CAN CAUSE AN EXPLOSION.

CAUTION: DO NOT IMMERSE PARTS IN SOLVENT OR ALLOW STANDING SOLVENT ON PART. DAMAGE TO PART WILL OCCUR.

2) Wipe surfaces with a clean cloth moistened with solvent, Series 99 (AMM/ SOPM 20-30-99). Allow solvent to evaporate before proceeding with the repair.

D. Fabricate, Clean, and Install Honeycomb Replacement Core Plug

NOTE: For small core damage (clean up dimension less than 0.5 inch deep and 3.0-inch diameter) it is permissible to fill cavity with resin instead of installing a core plug. Use resin mix BMS 5-28, Type 6 or 7. After cure, sand resin flush with surrounding surface. A 0.01-inch thick aluminum template may be used to protect the surrounding surface while sanding.

(1) Fabricate core plug.

(a) Fabricate core plug. Refer to the applicable component in the structure identification section to determine core type and material.

(b) The honeycomb core plug should fit flush with original core and with ribbon direction the same as in original core. Trim the replacement core up to 0.05 of an inch smaller then the cutout.

The replacement core is to fit snugly in the cutout after it is wrapped with foam adhesive.

NOTE: When applicable, depth of core should allow for shrinkage during cure and thickness of adhesive film between core and undamaged skin (Figure 10, 11, 12 and 13).

(2) Clean core plug.

WARNING: WHEN USING SOLVENTS AVOID BREATHING VAPORS. USE MECHANICAL VENTILATION OR RESPIRATORY PROTECTION WHEN WORKING IN A CONFINED SPACE OR AREA. AVOID CONTACT WITH SKIN, EYES AND CLOTHING. WEAR APPROVED GLOVES AND PROTECTIVE CLOTHING. WEAR EYE PROTECTION. KEEP AWAY FROM SOURCES OF HEAT, FIRE OR SPARKS. BREATHING VAPORS OR ALLOWING SOLVENT TO CONTACT SKIN OR EYES IS HAZARDOUS. HEAT, FIRE OR SPARKS CAN CAUSE AN EXPLOSION.

CAUTION: DO NOT IMMERSE PARTS IN CHLORINATED SOLVENTS OR ALLOW STANDING SOLVENT TO REMAIN ON PART. DAMAGE TO PART WILL OCCUR.

(a) Clean visually contaminated core by dipping (a maximum of four times) in an MEK or acetone bath for 60 seconds.

(b) Locally contaminated areas can be washed with MIBK, MEK, or Acetone.

(c) The core must be completely free of evidence of solvents before installation.

CAUTION: WHEN HANDLING ADHESIVE FILM WEAR CLEAN WHITE GLOVES TO PREVENT CONTAMINATION.

(CAUTION PRECEDES)

DO NOT TOUCH THE ADHESIVE FILM WITH BARE HANDS OR OTHER PARTS OF THE BODY.

DO NOT FOLD, STRETCH OR OTHERWISE THIN THE ADHESIVE FILM.

BONDING OF THE REPAIRED ASSEMBLY MUST BE COMPLETED WITHIN 48 HOURS AFTER THE ADHESIVE HAS BEEN REMOVED FROM REFRIGERATED STORAGE. QUALITY OF THE ADHESIVE WILL BE REDUCED AFTER THIS TIME LIMIT.

(3) When both sides of the honeycomb panel are accessible, install core plug (Figure 10, 11, 12, 13 typical).

NOTE: Honeycomb core is a good insulator, especially after air has been evacuated from core cells. To ensure that the adhesives and prepreg are completely cured, use of a heat blanket on both sides of the part is recommended. If only one heat blanket is used, or if partial depth core plug is applied, attach a thermocouple to the adhesive on the surface farthest from the heat blanket to verify adequate cure. When using one heat blanket, heat damage to the surface around the core cutout may occur. To prevent the heat damage, insulate skin surface from heat blanket and monitor surface temperature with a thermocouple. It is permissible to replace damaged honeycomb using a room temperature cure as given in 51-70-06, GENERAL, for core to core bond only. Most of the materials used in this procedure have limited life and require controlled storage conditions. Refer to the applicable material specifications for the maximum time out of the controlled storage and for the uncontrolled storage conditions. Before opening the adhesive film wrapper, condition refrigerated adhesive to room temperature until moisture no longer condenses on the wrapper. During use, suspend the film roll of adhesive horizontally through its axis free from other rolls or objects.

(a) For partial core replacement, cut two pieces of BMS 5-129, Type 2 or 4, Grade 10 adhesive film and one piece of fiberglass prepreg fabric, Type 120 to fit the repair hole. Place in position as shown in Figure 10/GENERAL, Section A-A.

(b) Where damage does not extend through both skins trim a piece of BMS 5-129, Type 2 or 4, Grade 10 adhesive film to fit repair hole and place on the inside surface of the undamaged skin (Figure 10/GENERAL typical).

(c) If both skins are damaged, tape a metal caul plate (such as 0.016-inch thick aluminum) against the exterior surface of the far side skin and repair as for damage to one skin only.

Repair the other surface in a subsequent repair cycle.

(d) Wrap the edges of the core plug with BMS 5-90, Type III or IV, Grade 10, foaming adhesive; or three layers of BMS 5-129, Type 2 or 4, Grade 10.

(e) Install the core plug with honeycomb ribbon direction aligned with original core.

(f) Put the layup materials and equipment in place as given in Figure 5 (Sheet 2).

1) If the damage extends through both face skins, vacuum bag both sides of the panel (or the entire part) using the layup shown in Figure 5 (Sheet 2).

2) If the replacement core plug is less than or equal to 0.5 thick, use the heating blanket on the near side and locate at least two separate thermocouples on the panel surface at the bondline.

3) If the replacement core plug is greater than 0.5 thick and both sides are accessible, use heating blankets on both sides. Locate at least two separate thermocouples on the near side at the bondline and one on the far side corresponding to the center of the repair.

4) If the replacement core plug is greater than 0.5 thick and only one side is accessible, use the heating blanket on the near side and put at least two separate thermocouples into the repair hole so the thermocouples touch the repair materials at the bottom of the repair hole.

NOTE: The ends of these thermocouples will be cured into the adhesive. Cut the thermocouples leaving the embedded ends behind before applying the repair plies. Only the portion of the thermocouple embedded in the core can be left in the repair. The thermocouples cannot come between the repair plies and the sanded surfaces of the original plies.

(g) Evacuate the repair area to a minimum of 22 inches of mercury.

(h) Cure a minimum of 90 minutes at 250 to 270°F (121 to 132°C) (Figure 4/GENERAL).

(i) Allow the repair area to cool under vacuum pressure until the temperature of the repair area is 160°F (71°C) or less. Then release restraints (if applicable) and remove layup materials and equipment.

(j) Sand core plug flush with surrounding surface. Clean surface as given in Paragraph 4.C.(2)/GENERAL

NOTE: The core plug and the repair plies can be cured at the same time if the temperature can be adequately monitored by thermocouples placed on the outside surfaces of the panel (refer to Paragraph 4.D.(3)/GENERAL(f)2) thru 4)). If the thermocouples must be embedded in the repair core adhesive, then the core plug must be cured separately to avoid curing the thermocouple between the repair plies and the sanded surface of the original plies.

CAUTION: DO NOT CURE MORE THAN TEN (10) PLIES DURING ONE CURE CYCLE FOR HEAT BLANKET AND OVEN CURES. IF THE REPAIR HAS MORE THAN 10 PLIES, DIVIDE THE REPAIR PLIES EVENLY INTO MULTIPLE CURE CYCLES. IF YOU DO NOT OBEY, POROSITY AND BULGES CAN OCCUR AND THE SUBSEQUENT REPAIR WILL BE UNSATISFACTORY.

E. Prepare and Apply Preimpregnated (Prepreg) Glass Fabric Repair Plies (Figure 9/GENERAL)

CAUTION: THE PREIMPREGNATED MATERIAL AND ADHESIVE MUST REMAIN FREE OF CONTAMINATION DURING CUTTING AND HANDLING. WEAR CLEAN WHITE GLOVES WHEN HANDLING.

(CAUTION PRECEDES)

USE OF PRECURED PATCHES IS NOT RECOMMENDED. PRECURED PATCHES BONDED TO THE STRUCTURE UNDER VACUUM PRESSURE ONLY AND LARGE PATCHES BONDED TO CONTOURED SURFACES CAN RESULT IN POROUS OR NONCONTINUOUS BONDLINES.

(1) Prepare the repair plies.

NOTE: Before opening the prepreg material or adhesive film wrapper condition refrigerated materials to room temperature until moisture no longer condenses on the wrapper.

During use, suspend the film roll of material horizontally through it axis free from other rolls or objects.

(a) Refer to the structure identification section to determine type and orientation of glass fabric used in original structure.

Repair existing plies of original structure with BMS 8-79, Class III, Style 120, 1581, or 7781 (Figure 2/GENERAL).

(b) From BMS 8-79, Class III, Style 120, 1581, or 7781 preimpregnated material, cut the required number of plies.

NOTE: Refer to par. (c) below for substitution of prepreg glass fabric plies.

Use one ply of the same initial prepreg material for each damaged initial ply, plus one extra repair ply of Style 120, 1581, or 7781 unless material substitution rules call for a different number of plies (par. (c)).

Additional plies, to those above, can be necessary for specific repairs. The number of these plies will be given in the specific repair.

See Figure 7/GENERAL for required overlap of repair plies. The repair plies must be installed with the same orientation as that of the original plies being repaired. The extra repair ply must be installed with the same orientation as the original surface ply.

(c) Substitution of prepreg glass fabric plies (Figure 2/GENERAL).

1) For structure that uses BMS 8-79, Class III, Style 120 prepreg material, you can use one of the substitutions that follow if the initial and substituted plies have the same orientation.

a) One ply of Style 1581 or 7781 can be substituted for two initial plies of Style 120 for structure that has a minimum of three plies. If the number of plies that is calculated is not a whole number, use the next larger whole number. In cases where the structure has only two initial plies of Style 120, use two plies of Style 1581 or 7781.

b) One ply of Style 120 can be substituted for each initial ply of Style 120.

2) For structure that uses BMS 8-79, Class III, Style 1581 or 7781 prepreg material, you can use one of the substitutions that follow if the initial and substituted plies have the same orientation.

a) One ply of Style 1581 or 7781 can be substituted for each initial ply of Style 1581 or 7781.

b) Three plies of Style 120 can be substituted for each initial ply of Style 1581 or 7781.

c) Five plies of Style 120 can be substituted for two plies of Style 1581 or 7781.

d) Seven plies of Style 120 can be substituted for three plies of Style 1581 or 7781.

e) Ten plies of Style 120 can be substituted for four plies of Style 1581 or 7781.

f) Twelve plies 120 can be substituted for five plies of Style 1581 or 7781.

g) In all cases where Style 120 is used, the total thickness of the Style 120 plies must be more than the total thickness of the Style 1581 or 7781 plies they replace (one ply of Style 120 is 0.0041 inch thick and one ply of Style 1581 or 7781 is 0.0095 inch thick).

3) For one extra repair ply, use BMS 8-79, Class III, Style 120, 1581, or 7781. If additional repair plies are specified in a chapter-section-subject repair that refers to GENERAL, use the rules given above for initial ply substitutions.

CAUTION: ENSURE THAT PARTING FILM AND POLYETHYLENE SEPARATOR ARE REMOVED FROM REPAIR PLIES PRIOR TO LAYUP AND CURING. NONCOMPLIANCE WILL RESULT IN A RUINED REPAIR.

(2) Apply the repair plies.

NOTE: Where the damage has occurred at a lap joint in the original laminates, it is not necessary to make a comparable lap in the repair plies. Where the original core was undamaged and was provided with a recess to match the lap joint, the recess should be filled with strips of BMS 8-79, Class III, Style 120, 1581, or 7781 preimpregnated material before application of the repair plies.

(a) Make a temporary vacuum bag system.

NOTE: This vacuum bag is used to compact the repair plies and prevent conamination of the repair. Do not use this vacuum bag system for the repair cure.

1) Put one layer of perforated parting film above the repair.

2) Put one layer of glass fabric cloth as a surface breather above the repair.

3) Apply the vacuum sealing compound around the repair area.

4) Put the vacuum bag material over the repair area. Seal the edges with the vacuum sealing compound.

5) Attach a vacuum line above the surface breather.

(b) Cut two plies of BMS 5-129, Type 2 or 4 adhesive film, 1/8-inch larger than the largest patch ply which also covers the repair area.

NOTE: After curing, the repair will need to be sanded in preparation for refinishing. An additional nonstructural ply covering the entire repair is added which may be sanded as required to obtain a smooth surface for refinishing. Be careful not to sand through this nonstructural sanding ply into the structural plies below it.

The second adhesive film ply will be used as a sanding ply. As an option, substitute a ply of BMS 8-79, Style 120, 1581, or 7781 fiberglass prepreg cut to the same size as the adhesive ply. The fiberglass is less likely to entrap air during the cure.

Repairs to aluminum foil will require one ply of adhesive film and one ply of BMS 8-79, Style 120, 1581, or 7781 fiberglass prepreg.

(c) Place a layer of adhesive film over the entire repair area.

(d) 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 area.

1) Install the smallest repair ply first.

2) Make sure that the warp direction of each repair ply that you put in the repair is correct and that the overlap is correct.

3) Install the next ply. Make sure that it is smooth with no wrinkles.

4) Remove the separator sheet.

5) Boeing recommends that you do the steps that follow:

a) Compact the repair plies with a temporary vacuum system as follows for repairs that have five or more repair plies.

- 1 minute for each ply (one ply at a time), or
- 2 minutes for each two plies (two plies at a time), or
- 6 minutes for each three plies (three plies at a time)

b) Do steps 2) through 5) again for all of the repair plies as necessary to complete the layup.

(e) Apply a cover ply of BMS 8-79, Style 120, 1581, or 7781 fiberglass prepreg or the second ply of adhesive film over the replaced plies. If the repair includes repair of aluminum foil, skip this step.

(f) If the repair area has a layer of aluminum foil, repair the foil as given in Paragraph 5.M./GENERAL before proceeding with the bagging and cure of the part.

F. Layup/bagging Procedure (Figure 5/GENERAL)

(1) As an optional step, place a layer of dry peel ply over the last layer of repair material. Cut the peel ply so it is large enough to contact the surface bleeder. When removed after curing, the peel ply leaves a rough surface which may be sanded for refinishing or left as is for any subsequent bonding to the repair area. The peel ply also helps to prevent pits in the cured repair surface.

(2) Place a layer of perforated FEP parting film (1 mil thick) over the layup. Cut the FEP so that edges extend 3 inches past edge of repair.

(3) Put on the thermocouples.

(a) If you use an autoclave or an oven, then do the step that follows:

1) Put one or more thermocouples at the location where the temperature will increase the fastest and one or more thermocouples where the temperature will increase the slowest.

NOTE: Boeing recommends that you put one or more thermocouples at the thick areas of the part and tool and the thin areas of the part and tool. Use more than two thermocouples when more than 900 square inches of a panel surface is repaired. Insulation is not necessary in the repair area for autoclave or oven cures.

(b) If you use a heat blanket, then do the step that follows:

1) Secure three thermocouples (spaced evenly around the repair) to the panel at the edge of the repair and secure them to the temperature recording device.

(4) Place a layer of BMS 9-3, Type D, H-2, or H-3 glass fabric or equivalent thickness glass fabric over the repair as a surface bleeder.

NOTE: The bleeder must be cut large enough to make contact with the surface breather.

(5) Place one layer of solid FEP parting film over the layup extending to 0.5 short of the edge of the surface bleeder.

(6) Place a heat blanket on the layup if it will be used as a heat source. The blanket must extend a minimum of 2.0 beyond the edge of the parting film.

NOTE: When using two or more heat blankets or a heat blanket longer than 12.0 on a side, an aluminum caul plate (0.04 max) should be used to minimize localized heating. Make the plate slightly smaller than the surface bleeder and place between the bleeder and the heat blanket.

(a) If the area to be repaired is near or attached to aluminum structure that was not removed in step 3.C., do the steps that follow:

1) Isolate the aluminum structure from the areas that will get hot.

2) Add one or more thermocouples to put on the aluminum structure. Make sure that the temperature does not go above 200°F (93°C).

3) You can put insulation around all other metals to prevent cold locations in the repair.

(7) Place on the layup four to six plies of glass fabric breather cloth for each ply in the repair. The breather cloth must extend beyond the parting film, and also must extend beyond the heat blanket and caul plate (if they are used). The breather cloth must also make contact with the surface bleeder cloth.

(8) Apply extruded sealing compound around the entire area.

(9) Tie in the vacuum outlet to the breather cloth (outside of the repair ply area).

(10) Lay a piece of vacuum bag material over the entire area. Seal the edge with extruded sealing compound around the entire area.

NOTE: Pleat the vacuum bag where needed to prevent bridging of bag material and subsequent bag breakage. Pad all sharp objects and corners to prevent bag breakage.

The whole part must be vacuum bagged and restrained in place to prevent delamination and distortion when the part is cured in an oven or if repair area exceeds 15% of panel area. Regardless of the method of heat application, restraining devices that maintain the contour and support the part must be used for large parts where sagging and distortion could occur due to the weight of the part.

(11) Evacuate the space under the vacuum bag and maintain a minimum of 22 inches of mercury.

NOTE: Maintain vacuum of 22 inches of mercury minimum during entire cure cycle.

G. Cure the repair. Do step (1) for the autoclave procedure, step (2) for the oven cure procedure, or do step (3) for the heat blanket cure procedure.

(1) For an autoclave cure, see Figure 4/GENERAL, Detail I and do the steps that follow:

NOTE: Boeing recommends that you use a certified autoclave when you do the procedure that follows. DOCUMENT D6-49327, is a procedure that Boeing uses, and you can use this as a guide to certify your autoclave.

(a) During all of the repair procedure, make sure that the part to be repaired is held in the specified part tool. This must be done for all parts that were initially made at a cure temperature of 250°F (121°C). Boeing also recommends that you hold the part in the specified part tool, if the part was initially made at a cure temperature of 350°F (177°C). The specified part tool must have the same dimensions (or dimensions that are a small amount 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 in the part. A tool with the same thermal expansion properties will help keep the part at the correct contour and shape.

(b) 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).

(c) Increase the temperature of the autoclave until it is at 130°F (54°C). When the temperature is at 130°F (54°C), increase the temperature at a rate of 2°F to 8°F (1°C to 5°C) for each minute until all thermocouples are in the cure temperature range.

(d) Hold the cure temperature for the time specified as given in Figure 4/GENERAL, Detail I.

NOTE: Cure time does not include the time necessary for the layup and the part to get to the cure temperature. Cure time starts after all of the thermocouple indications are in the cure temperature range. If a thermocouple indication falls below the cure temperature range during the cure, extend the cure cycle time by the time necessary to get the thermocouple to the cure temperature.

(e) Keep the vacuum bag connection to the atmosphere open and the autoclave pressurized until after the cure is complete and the temperature of the part has decreased to 125°F (52°C).

(f) Decrease the autoclave temperature at a maximum rate of 5°F (3°C) for each minute.

(g) When the temperature is less than 125°F (52°C), release the autoclave pressure.

(h) Remove the vacuum bag equipment from the part and tool.

WARNING: USE HEAT CURE EQUIPMENT THAT IS PERMITTED BY THE LOCAL FIRE PROTECTION AUTHORITIES. IF YOU DO NOT OBEY, YOU CAN CAUSE INJURY TO PERSONNEL.

(2) For oven cure, see Figure 4/GENERAL, Detail I and do the steps that follow:

NOTE: Use a circulating oven that has equipment that can supply a vacuum and can control the temperatures as given in this procedure.

(a) During all of the repair procedure, make sure that the part to be repaired is held in the specified part tool. This must be done for all parts that were initially made at a cure temperature of 250°F (121°C). Boeing also recommends that you hold the part in the specified part tool, if the part was initially made at a cure temperature of 350°F (177°C). The specified part tool must have the same dimensions (or dimensions that are a small amount 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 in the part. A tool with the same thermal expansion properties will help keep the part at the correct contour and shape.

(b) Apply a vacuum to the vacuum bag until you have a minimum of 22 inches (0.56M) of Hg (Mercury). Start the heatup process.

Keep a minimum vacuum of 22 inches (0.56M) of the Hg (Mercury) during the full cure cycle.

(c) Increase the temperature of the oven until it is at 130°F (54°C). When the temperature is at 150°F (54°C), increase the temperatures at a rate of 2 to 8°F (1 to 5°C) for each minute until all thermocouples are in the cure temperature range.

(d) Hold the cure temperature for the specified time as given in Figure 4/GENERAL, Detail I.

NOTE: Cure time does not include the time necessary for the layup and the part to get to the cure temperature. Cure time starts after all of the thermocouple indications are in the cure temperature range. If a thermocouple indication falls below the cure temperature during the cure, extend the cure cycle time by the time necessary to get the thermocouple to the cure temperature.

(e) Decrease the 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), remove the vacuum pressure.

(g) Remove the vacuum bag equipment from the part and tool.

WARNING: USE HEAT CURE EQUIPMENT THAT IS PERMITTED BY THE LOCAL FIRE PROTECTION AUTHORITIES. IF YOU DO NOT OBEY, YOU CAN CAUSE INJURY TO PERSONNEL.

(3) For heat blanket cure, see Figure 4/GENERAL, Detail II and do the steps that follow:

NOTE: Boeing recommends that you use a qualified heat blanket when you do the procedure that follows. DOCUMENT D6-56273, is a procedure that Boeing uses, and uou can use this as a guide to qualify your heat blanket.

(a) Make sure there is a minimum of three thermocouples for each heat blanket used. Refer to Paragraph 4.F./GENERAL

(b) Apply a vacuum to the vacuum bag until you have a minimum of 22 inches (0.56M) of Hg (Mercury). Start the heatup process.

Keep a minimum vacuum of 22 inches (0.56M) of Hg (Mercury) during the full cure cycle.

(c) Increase the temperature of the heat source until the temperature of the repair is at 130°F (54°C). When the temperature is at 130°F (54°C), increase the temperature at a rate of 2 to 8°F (1 to 5°C) for each minute until all thermocouples are at the cure temperature.

NOTE: When you use a hot bond console, obey the manufacturer’s operation instructions.

(d) If necessary, put insulation on the cooler areas of the repair area, opposite of the heat source.

(e) Hold the cure temperature for the specified time, as given in Figure 14/GENERAL, Detail II.

NOTE: Cure time does not include the time necessary for the layup and the part to get to the cure temperature. Cure time starts after all of the thermocouple indications are in the cure temperature range. If a thermocouple indication falls below the cure temperature during the cure, extend the cure cycle time by the time necessary to get the thermocouple to the cure temperature.

(f) Decrease the temperature at a rate maximum of 5°F (3°C) for each minute.

(g) When the temperature decreases to less than 125°F (52°C), release the vacuum pressure.

(h) Remove the vacuum bag equipment from the part and tool.

H. Refinish after Repair

CAUTION: DO NOT SAND INTO ORIGINAL STRUCTURE. FAILURE TO COMPLY WILL REDUCE THE STRENGTH OF THE COMPONENT.

(1) Lightly sand edge of top most repair ply as necessary to fair the edge. Sand surface of repair to produce a smooth finish without damaging fibers.

(2) Apply finish to the repaired surface using the following applicable methods.

(a) Where clear Tedlar film surfaces have been removed, seal with a brush coat of Resin Mix 3 (Figure 1/GENERAL). Cure for 6 to 8 hours at room temperature or as given in Figure 1/GENERAL.

(b) Where gray or white Tedlar film surfaces have been removed, seal with Resin Mix 3 (Figure 1/GENERAL). Cure 6 to 8 hours at room temperature (or as given in Figure 1/GENERAL) and apply one coat of BMS 10-11 primer and one coat of BMS 10-60, Type II enamel.

(c) Where BMS 10-21 conductive coating has been removed, reapply as given in AMM 51-24-00.

(d) Where the abrasion resistant Teflon finish has been removed from the internal surface of the panel edgeband, reapply the finish according to AMM 51-24-13.

(e) Where the original painted surfaces have been removed, restore original finish according to AMM 51-21-00 of the Maintenance Manual.

(f) Where sealant has been removed from around fittings or fay surfaces to facilitate repairs, reapply BMS 5-95 sealant as given in 51-20-05, GENERAL.

(g) Where permanent fasteners have been removed from aluminum fittings common to graphite, reinstall bolts wet with BMS 5-95 sealant and fillet seal around bolt heads and nuts.

(h) Where aluminum flame sprayed areas have been damaged, repair as given in 51-70-14, GENERAL.

(i) Where aluminum coated glass fabric (BMS 8-278) has been repaired, aluminum flame spray as given in 51-70-14, GENERAL.

I. Do the Post-Repair Procedures

(1) Do an inspection of the repair to make sure that it is satisfactory. Make sure that there are no empty spaces between plies or defective bonds. The inspection must include the area that was hot plus 2 inches minimum all around.

(2) If you find the repair to be unsatisfactory, you must remove it and install the repair again.

NOTE: The post-repair inspection is recommended. Examples of the inspection procedures are given in NDT Part 1, 51-01-01. Other inspection procedures that have been examined and found to be satisfactory by the airline can be used.

WARNING: MAKE SURE THAT THE OUTBOARD AILERON, ELEVATOR, AND RUDDER (CONTROL SURFACES) ARE BALANCED CORRECTLY AT ALL TIMES. IF YOU DO NOT, FLIGHT SAFETY CAN BE AFFECTED.

(3) After you repair a control surface, you must do a check of the balance to find if a rebalance is necessary. Refer to 51-60-00, GENERAL as necessary.

CAUTION: MAKE SURE THAT REPAIRS MADE TO CONTROL SURFACES AND/OR ADJACENT STRUCTURE DO NOT INTERFERE WITH THE DESIGNED OPERATION OF THE CONTROL SURFACES. DAMAGE TO THE AIRPLANES STRUCTURE CAN BE THE RESULT.

(4) Do a check of all repairs to make sure of clearance and non-interference with the operation of control surfaces.

(5) If a repair creates a blockage of a drain hole in the airplane structure, drill through the repair at the initial drain hole location with the appropriate drill bit. Refer to AMM 51-41-00/201.

5. Typical Repairs

CAUTION: TO GET AN ACCEPTABLE QUALITY REPAIR, DO AS FOLLOWS:

- REFER TO THE APPLICABLE COMPONENT THAT YOU ARE GOING TO REPAIR FOR THE REPAIR LIMITS AND MATERIAL OF THE COMPONENT BEFORE YOU USE THESE REPAIR INSTRUCTIONS.
- USE THE CORRECT MATERIALS FOR THE TYPE OF COMPONENT AND REPAIR THAT IS MADE.
- USE THE MATERIALS THAT AGREE WITH THE SPECIFICATIONS IN THE SRM.
- ACCURATELY FOLLOW THE SRM PROCEDURES AT EACH STEP OF THE REPAIR. IF YOU DO NOT DO THIS, IT CAN CAUSE A REPAIR THAT IS NOT SATISFACTORY AND NOT APPROVED.

NOTE: These repairs apply to glass fabric reinforced honeycomb components, except radomes.

A. Repair of Delaminations Between Plies

(1) Delamination of plies over core area of panel (Figure 9/GENERAL).

(a) Determine extent of damage as given in Paragraph 4.A./GENERAL Ensure that water and other contamination are removed.

(b) Cut away delaminated plies and prepare damaged area as given in Paragraph 4.C./GENERAL. Do not remove any core.

(c) Complete repair as given in Paragraph 4.E./GENERAL thru Paragraph 4.I./GENERAL.

(2) Repair of delaminations between plies of panel edgeband.

(a) Repair this type of damage as given in 51-70-17, GENERAL, paragraph 3.A. or as given in 51-70-06, GENERAL, Paragraph 4.A.

B. Repair of Puncture, 0.50-inch Diameter or Less, in Honeycomb Panel

(1) Repair this type of damage as given in51-70-17, GENERAL, Paragraph 3.B. or Paragraph 4.B.

C. Repair of Damage to One Skin and Honeycomb Core using Replacement Core Plug, Punctures greater than 0.5-inch Diameter (Figure 10/GENERAL)

(1) Determine extent of damage.

(2) Ensure that all contamination and water are removed from damaged area as given in Paragraph 4.B./GENERAL.

(3) Remove damage and prepare area according to Paragraph 4.C./GENERAL

(4) Fabricate, clean, and install honeycomb replacement core plug as given in Paragraph 4.D./GENERAL.

(5) Sand core plug flush with surrounding surface making allowance for film adhesive and slight core crush during cure.

(6) Clean surface according to Paragraph 4.C.(2)/GENERAL

(7) Complete repair as given in Paragraph 4.E./GENERAL thru Paragraph 4.I./GENERAL.

D. Repair of Large Puncture through Internal and External Surface of Panel including Core Damage (Figure 11/GENERAL).

(1) Determine extent of damage as given in Paragraph 4.A./GENERAL.

(2) Ensure that all contamination and water are removed from damaged area. Refer to Paragraph 4.B./GENERAL.

(3) Remove damage and prepare area according to Paragraph 4.C./GENERAL.

(4) Fabricate, clean, and install honeycomb replacement core plug as given in Paragraph 4.D./GENERAL, except do not cure the core plug installation at this time.

(5) Prepare and apply glass fabric repair plies to one surface of the panel according to Paragraph 4.E./GENERAL. A caul plate may be used on the opposite face of the panel to restrain the core plug in place.

(6) Apply pressure and cure according to Paragraph 4.F./GENERAL and Paragraph 4.G./GENERAL. Ensure that temperature is approximately equal on both sides of panel.

(7) Prepare and apply glass fabric repair plies to the other surface of the panel according to Paragraph 4.E./GENERAL

(8) Complete repair as given in Paragraph 4.F./GENERAL thru Paragraph 4.I./GENERAL.

NOTE: The above two-stage cure procedure is recommended. As an option, a three-stage cure procedure may be used wherein the core plug installation and the repair plies on each side may be cured separately.

E. Replacement of Honeycomb Core on Damaged Edge of Panel (Figure 12/GENERAL).

(1) Determine extent of damage.

(2) Ensure that all contamination and water are removed from damaged area.

(3) Remove damage and prepare area according to Paragraph 4.C./GENERAL.

(4) Fabricate, clean, and install honeycomb replacement core plug as given in Paragraph 4.D./GENERAL.

(5) Sand core plug flush with surrounding core material making allowance for film adhesive and slight core crush during cure.

(6) Clean surfaces according to Paragraph 4.C.(2)/GENERAL.

(7) Complete repair as given in Paragraph 4.E./GENERAL thru Paragraph 4.I./GENERAL.

F. Repair of Hole Through Both Skins of a Honeycomb Panel with Access Available from One Side Only (Figure 13/GENERAL .)

NOTE: This repair applies to flat panels (or nearly flat panels) where the damage extends completely through the panel, but access is not readily available to repair the unexposed side, and the repair is accomplished in one operation, i.e., core repair and patch overlay repair cured together.

See Figure 13/GENERAL when making this repair. Refer to Paragraph 5./GENERAL, Typical Repairs when making this repair.

(1) Determine extent of damage.

(2) Ensure that all contamination and water is removed from damaged area.

(3) Remove damage and prepare area as given in Paragraph 4.C./GENERAL and the following:

(a) Cut a hole in the outer skin and core (D diameter) to permit a repair to be made to the inner skin with the required overlap.

NOTE: D diameter = d + N + 1 d = major diameter of oval hole in inner skin and is limited to 1.5 inch max for this repair. N = number of plies in the inner skin

Stepping of the plies in the inner skin is not necessary for this repair.

(b) Clean out damaged area in inner skin leaving an oval shaped hole. Taper sand the outer skin plies as given in Paragraph 4.C.(2)/GENERAL.

(4) Fabricate an airtight patch, Figure 13/GENERAL (Details II thru V) to cover the oval hole from the inaccessible side as follows:

(a) Make a suitable mold on which to lay up the patch. A thin gage aluminum sheet or any smooth surface can be used as a mold.

(b) Cover the mold with parting film or release agent.

(c) Lay up five plies of the same prepreg material used in the repair on the mold, using the procedures of Paragraph 4.E./GENERAL, except that all repair plies will have the same diameter and adhesive film will not be used. Make diameter of the repair plies at least equal to D diameter.

(d) Bag and cure the patch as given in Paragraph 4.F./GENERAL and Paragraph 4.G./GENERAL. Place thermocouples at the edge of the patch before cure.

(e) Remove the patch from the mold.

(f) Trim patch into an oval shape with a minor diameter slightly smaller than the major diameter of the cutout.

(g) Drill a 1/8 diameter hole in the center of the patch for a cleco fastener.

(h) Abrade the surface of the patch using No. 240 or finer Scotch-Brite abrasive. Remove all sanding dust by applying oil-free compressed air and using a vacuum cleaner.

(i) Fabricate a strip of spring steel 1.0 X 10.0 inches and drill a 1/8 diameter hole in the center for the cleco fastener.

NOTE: This repair illustrates the use of a spring steel clamp. However, any suitable retaining device may be used.

(j) Assemble the patch and spring steel together with a 1/8 diameter cleco fastener. See Figure 13/GENERAL, Detail II.

(5) Remove Tedlar, if required and abrade the underside of the inner skin to a distance of 0.4 from the edge of the elliptical cutout using No. 180 or finer sandpaper. Avoid abrasion of the existing ply filaments.

CAUTION: DO NOT IMMERSE PARTS IN SOLVENT OR ALLOW STANDING SOLVENT TO REMAIN ON PART. DAMAGE TO PART WILL OCCUR.

(6) Clean out the repair area with oil-free compressed air. Wipe the surface with a clean cloth moistened with solvent, Series 99 (AMM/ SOPM 20-30-99).

(7) Bend up both ends of the spring steel and apply adhesive BMS 5-25 or BMS 5-92 to the precured patch.

(8) Holding the spring steel up - insert the patch into the oval hole, and orientate so that the hole is covered. Release the spring steel so that it holds the patch tightly up against the inner skin.

(9) Cure the adhesive as given in Figure 1/GENERAL. When cure is complete, remove the cleco fastener and spring. Fill hole for cleco fastener with adhesive BMS 5-25 or BMS 5-92. Allow this to cure.

(10) Clean out the repair area as given in Paragraph (6).

(11) Apply adhesive film BMS 5-129, 0.10 bigger than diameter D to the surface of the inner skin which fays with the inner skin repair plies.

(12) Cut the required number of repair plies to diameter D and apply repair plies to the inner skin.

(13) Fabricate and clean core plug as given in Paragraph 4.D.(1)/GENERAL and Paragraph 4.D.(2)/GENERAL.

(14) Complete the installation of the core plug as given in Paragraph 4.D.(3)/GENERAL(b) thru 3.D.(3)(j).

(15) Prepare and apply repair plies to the outer skin surface of the panel and complete repair as given in Paragraph 4.E./GENERAL thru Paragraph 4.I./GENERAL.

G. Repair of Damaged Skin Plies in Panel Edgeband (Figure 14/GENERAL).

(1) Determine extent of damage as given in Paragraph 4.A./GENERAL

(2) Ensure that all contamination and water are removed from damaged area. Area must be completely dried out.

CAUTION: DO NOT SAND INTO BOND PLY OR CORE (FIGURE 14/GENERAL). LOSS OF STRUCTURAL STRENGTH OF THE COMPONENT WILL OCCUR IF THIS CAUTION IS NOT OBSERVED. BOND PLY IS PLY ADJACENT TO CORE.

(3) Remove damage and prepare area according to Paragraph 4.C./GENERAL.

(4) Complete repair as given in Paragraph 4.E./GENERAL thru Paragraph 4.I./GENERAL.

H. Repair of Damage Greater than 0.5-inch Diameter in Solid Laminate Panels (Figure 15/GENERAL).

NOTE: This repair applies to components made from laminated glass fabric plies and epoxy resin without a honeycomb core.

(1) Determine extent of damage as given in Paragraph 4.A./GENERAL.

(2) Ensure that all contamination and water are removed from damaged area. Area must be completely dried out. Any structure in the repair area that cannot be dried out must be removed along with the other damage.

CAUTION: DO NOT PENETRATE THE UNDAMAGED PLIES. LOSS OF STRUCTURAL STRENGTH OF THE COMPONENT WILL OCCUR.

(3) Remove damage and prepare area according to Paragraph 4.C./GENERAL.

NOTE: Taper sand edges of plies around repair on damaged side of panel.

(4) Complete repair as given in Paragraph 4.E./GENERAL thru Paragraph 4.I./GENERAL.

NOTE: If cleaned up damage penetrates solid laminate, secure a metal caul plate (such as 0.016 thick aluminum) to far side of panel to support repair plies.

I. Repair of Punctures, 0.5-inch Diameter or Less, in Solid Laminate Panels

NOTE: This repair applies to components made from laminated glass fabric plies and epoxy resin without a honeycomb core.

(1) Check for delamination as given in Paragraph 4.A./GENERAL.

(2) If no delamination is found, clean up damage to a smooth, rounded surface. Then repair as given in Paragraph 5.B./GENERAL.

(3) If delamination is found, repair as given in Paragraph 5.H./GENERAL.

J. Repair of Delamination Between Plies in Solid Laminate Panels

NOTE: This repair applies to components made from laminated glass fabric plies and epoxy resin without a honeycomb core.

(1) Repair delaminations using methods described in Paragraph 5.H./GENERAL.

K. Repair of Damaged Panel Attach Holes in Honeycomb Panel Edgebands or along Edges of Solid Laminate Panels (Figure 16/GENERAL).

(1) Determine the extent of damage according to Paragraph 4.A./GENERAL.

(2) Ensure that all contamination and water are removed from damaged area as given in Paragraph 4.B./GENERAL. Area must be completely dried out. Any structure in the repair area that cannot be dried out must be removed along with the other damage.

(3) Taper sand around the hole to remove damage according to Figure 16/GENERAL and Paragraph 4.C.(2)/GENERAL.

(4) Clean area according to Paragraph 4.C.(2)(e)/GENERAL.

(5) Complete repair as given in Paragraph 4.E./GENERAL thru Paragraph 4.H./GENERAL.

(6) Drill and countersink fastener holes.

(7) Perform applicable post-repair requirements as given in Paragraph 4.I./GENERAL before returning the repaired component to flight service.

L. Repair of Surface Dents

(1) Check for delamination and broken fibers as given in Paragraph 4.A./GENERAL.

(2) If delamination is found, repair as given in Paragraph 5.H./GENERAL.

(3) If broken fibers are found, repair as given in Paragraph 5.B./GENERAL or Paragraph 5.C./GENERAL.

(4) If no delamination or broken fibers are found, repair as given in 51-70-06, GENERAL, Paragraph 4.M.

M. Repairs to Aluminumn Foil (Figure 17/GENERAL and 3.C.(2)(b)2))

NOTE: Do this repair in addition to the applicable repair of the underlying plies.

(1) Determine extent of damage, remove damage and apply repair materials to the underlying composite structure as given in Paragraph 5.A./GENERAL thru Paragraph 5.F./GENERAL, up to and including the step for repairing the repair plies to the surface that has aluminum foil.

(2) Alodine treat nonadhesive side of splice strip, cover ply and aluminum surfaces that will contact splice strip and cover ply.

(3) Butt-splice a ply of BMS 8-289, Type 0/250/X/X/X over the repair area, adhesive side down, with a 0.25 maximum gap and no overlap allowance.

(4) Layup splice strips of BMS 8-289 Type 0/250/X/X/X Form II adhesive side up, such that they overlap each side of the splice line by approximately 1.25. Form I foil is optional, but requires alodine treatment on nonadhesive side and 0.5 diameter holes on 2.0 centers.

NOTE: Do not allow the cover ply or splice strip to extend into the edgeband area of the panel. Electrical splicing is not allowed on the laminated edgeband faying surface.

(5) Apply a cover ply BMS 8-79, Style 120, 1581, or 7781 prepreg over the repair such that it overlaps the outer edge of the splice strip by 1.0. Do not allow the cover ply or splice strip to extend into the edgeband area of the panel.

(6) Vacuum bag and cure the repair as given in Paragraph 4.F./GENERAL and Paragraph 4.G./GENERAL.

RESIN, PREPREG, OR ADHESIVE TYPE	COMPONENTS	PARTS BY WEIGHT	OPEN TIME BEFORE USE, OR POT LIFE OF MIXTURE	CURING TIME
BMS 5-90, TYPE III, CLASS 250-10-10, GRADE 50 OR 100	FM-490A MA-562 PL-685	—	B C	SEE TEXT
BMS 5-90, TYPE IV, CLASS 250/350-10-10	PL-460			
BMS 5-129, TYPE 2, CLASS IA, GRADE 10	AF-126		B D	SEE TEXT
BMS 5-129, TYPE 2, CLASS IIA, GRADE 10	AF-126-2			
BMS 5-129, TYPE 2, CLASS IIB, GRADE 10	FM-123-2			
BMS 5-129, TYPE 4, GRADE 10	AF-163-2OST EA-9628NW		B C	SEE TEXT
BMS 8-79 (PREPREG) CLASS III, GRADE A, STYLES			A	SEE TEXT
120	120-F155-5-F69			
1581	1581-F155-5-F69			
7781	7781-F155-5-F69			
120	120-F255-5-F69			
1581	1581-F255-5-F69			
7781	7781-F255-5-F69			

Resin, Prepreg, and Adhesive Specifications and Mixing Procedures
Figure 1 (Sheet 1 of 4)

RESIN, PREPREG, OR ADHESIVE TYPE	COMPONENTS	PARTS BY WEIGHT	OPEN TIME BEFORE USE, OR POT LIFE OF MIXTURE	CURING TIME
BMS 8-79 (PREPREG) CLASS III, GRADE A, STYLES			200 HOURS AT 75 ±5°F (23.5 ±2.5°C)	SEE TEXT
120	NARMCO-3203-120, Z6040			
1581	NARMCO-3203-1581, Z6040			
7781	NARMCO-3203-7781, Z6040			
120	NARMCO-3203F-120, Z6040			
1581	NARMCO-3203F-1581, Z6040			
7781	NARMCO-3203F-7781, Z6040			
120	MXB7701-120-Z-6040			
1581	MXB7701-1581-Z-6040			
7781	MXB7701-7781-Z-6040			
120	120-F155-5-CS272			
1581	1581-F155-5-CS272			
7781	7781-F155-5-CS272			
120	G120/F6986S03-S920NM			
1581	G1581/F6986S03-S920NM			
7781	G7781/F6986S03-S920NM			
120	MXB7701-120-B3			
1581	MXB7701-1581-B3			
7781	MXB7701-7781-B3			
120	MXB7701-120-C3			
1581	MXB7701-1581-C3			
7781	MXB7701-7781-C3			
120	NARMCO-3203-120, VOLAN A			
1581	NARMCO-3203-1581, VOLAN A			
7781	NARMCO-3203-7781, VOLAN A			
120	HG120/RS1212-Z6040			
1581	HG120/RS1212-Z6040			
BMS 8-289 (ALUMINUM FOIL)			10 DAYS AT 10°F (-12°C) TO 95°F (35°C)	SEE TEXT
TYPE 0/250/2/1100/025 FORM I	CYCOM AEL-200-1/1100 ADH WT 0.025 ±0.01 LB/FT^2			
	C-CLAD H-250-025 ADH WT 0.025 ±0.01 LB/FT^2			
TYPE 0/250/2/1100/002 FORM I	C-CLAD H-250/350-002 ADH WT 0.002 ±0.0015 LB/FT^2			
TYPE 0/250/4/1145/002 SPLICE FORM II	C-CLAD M-250/350-002 SPLICE ADH WT 0.002 ±0.0015 LB/FT^2			

Resin, Prepreg, and Adhesive Specifications and Mixing Procedures
Figure 1 (Sheet 2 of 4)

RESIN, PREPREG, OR ADHESIVE TYPE	COMPONENTS	PARTS BY WEIGHT	OPEN TIME BEFORE USE, OR POT LIFE OF MIXTURE	CURING TIME
RESIN MIX 3 (SEALER RESIN)	EPIBOND 156A RESIN EPIBOND 156B HARDENER	98 TO 102 4.7 TO 5.3	15 TO 25 MINUTES AT 77°F (25°C)	12 HOURS AT 70°F (21°C) OR 1 TO 3 HRS AT 150°F (66°C)
RESIN MIX 3 (SEALER RESIN) ALTERNATE	FR-5318S RESIN FR-5318C HARDENER	98 TO 102 49 TO 51	45 TO 60 MINUTES AT 70°F (21°C)	SEE FIG. 3
RESIN MIX 3 EPOX-O WELD (SEALER RESIN) ALTERNATE	TWO COMPONENT KIT	FOLLOW MANUFACTURERS INSTRUCTIONS FURNISHED WITH EACH KIT		
			45 TO 60 MINUTES AT 70°F (21°C)	SEE FIG. 3
RESIN MIX 3 (SEALER RESIN) ALTERNATE BMS 8-207 TYPE 1, CLASS I 250°F (121°C)	EC1838A RESIN EC1838B HARDENER	50 50	20 MINUTES AT 75° TO 79°F (24° TO 26°C)	2 HOURS MIN. AT 105°F TO 125°F (41°C TO 52°C)
RESIN MIX 3 (SEALER RESIN) ALTERNATE BMS 8-207 TYPE 1, CLASS II 350°F (177°C)	FR-40 RESIN FR-5413C HARDENER	99 TO 101 14.5 TO 15.5	20 MINUTES AT 75°F TO 79°F (24°C TO 26°C)	12 HOURS MIN. AT ROOM TEMP. (65°F MIN.) (19°C MIN.) 1 HR MIN. AT 150°F TO 170°F (66°C TO 77°C)
RESIN MIX 3 (SEALER RESIN) ALTERNATE	EPIBOND 156A RESIN EPIBOND 941 HARDENER	98 TO 102 9.5 TO 10.5	45 TO 60 MINUTES AT 70°F (21°C)	SEE FIG. 3

Resin, Prepreg, and Adhesive Specifications and Mixing Procedures
Figure 1 (Sheet 3 of 4)

WARNING: THESE CHEMICALS CONTAIN TOXIC INGREDIENTS. PROVIDE ADEQUATE VENTILATION AND PROTECT THE SKIN AND EYES FROM CONTACT WITH UNCURED RESINS OR CURING AGENT. WEAR RUBBER GLOVES OVER COTTON GLOVES FOR PROTECTION OF HANDS. IF SKIN IS EXPOSED TO DIRECT CONTACT WITH UNCURED RESINS OR CURING AGENT, WASH WITH WARM WATER OR SOAP. AVOID THE USE OF SOLVENTS FOR CLEANING THE SKIN.

CAUTION: TO PREVENT CONTAMINATION OF THE RESIN, DO NOT USE WAXED CONTAINERS FOR MIXING.

MIXING PROCEDURE	
RESIN MIX 1 RESIN MIX 3	ADD HARDENER TO RESIN AND MIX THOROUGHLY.
BMS 5-90 OR 5-129	REMOVE WRAPPER FILM BEFORE USE.

NOTES

- REFER TO SRM 51-30-00 FOR SOURCES OF MATERIALS.

A OUT-TIME OF THIS MATERIALS IS 200 EXPOSURE UNITS. ONE EXPOSURE UNIT IS ACCUMULATED EACH HOUR THE MATERIAL IS EXPOSED TO TEMPERATURES BETWEEN 10°F (-12°C) AND 80°F (27°C). THREE EXPOSURE UNITS ARE ACCUMULATED EACH HOUR THE MATERIAL IS EXPOSED TO TEMPERATURES BETWEEN 81°F (27°C) AND 100°F (38°C). MATERIALS EXPOSED TO TEMPERATURES ABOVE 100°F (38°C) ARE TO BE REJECTED.

B REMOVE THE MATERIAL FROM REFRIGERATION AND KEEP IT SEALED AT 65°F (18°C) TO 90°F (32°C) FOR A MINIMUM OF 8 HOURS FOR A FULL ROLL BEFORE IT IS USED.

C THE MATERIAL MAY BE PUT BACK INTO REFRIGERATION ONE OR MORE TIMES WHEN THE CUMULATIVE OUT-TIME IS NOT MORE THAN 10 DAYS.

D THE MATERIAL MAY BE PUT BACK INTO REFRIGERATION ONE OR MORE TIMES WHEN THE CUMULATIVE OUT-TIME IS NOT MORE THAN 5 DAYS.

Resin, Prepreg, and Adhesive Specifications and Mixing Procedures
Figure 1 (Sheet 4 of 4)

BMS 8-79 STYLE	THICKNESS PER PLY, INCHES	PLY SUBSTITUTIONS
120	0.0041	A
1581	0.0095	A
7781	0.0095	A

NOTES

A FOR STRUCTURE THAT USES BMS 8-79, CLASS III, STYLE 120 PREPREG MATERIAL, YOU CAN USE ONE OF THE SUBSTITUTIONS THAT FOLLOW IF THE INITIAL AND SUBSTITUTED PLIES HAVE THE SAME ORIENTATION.

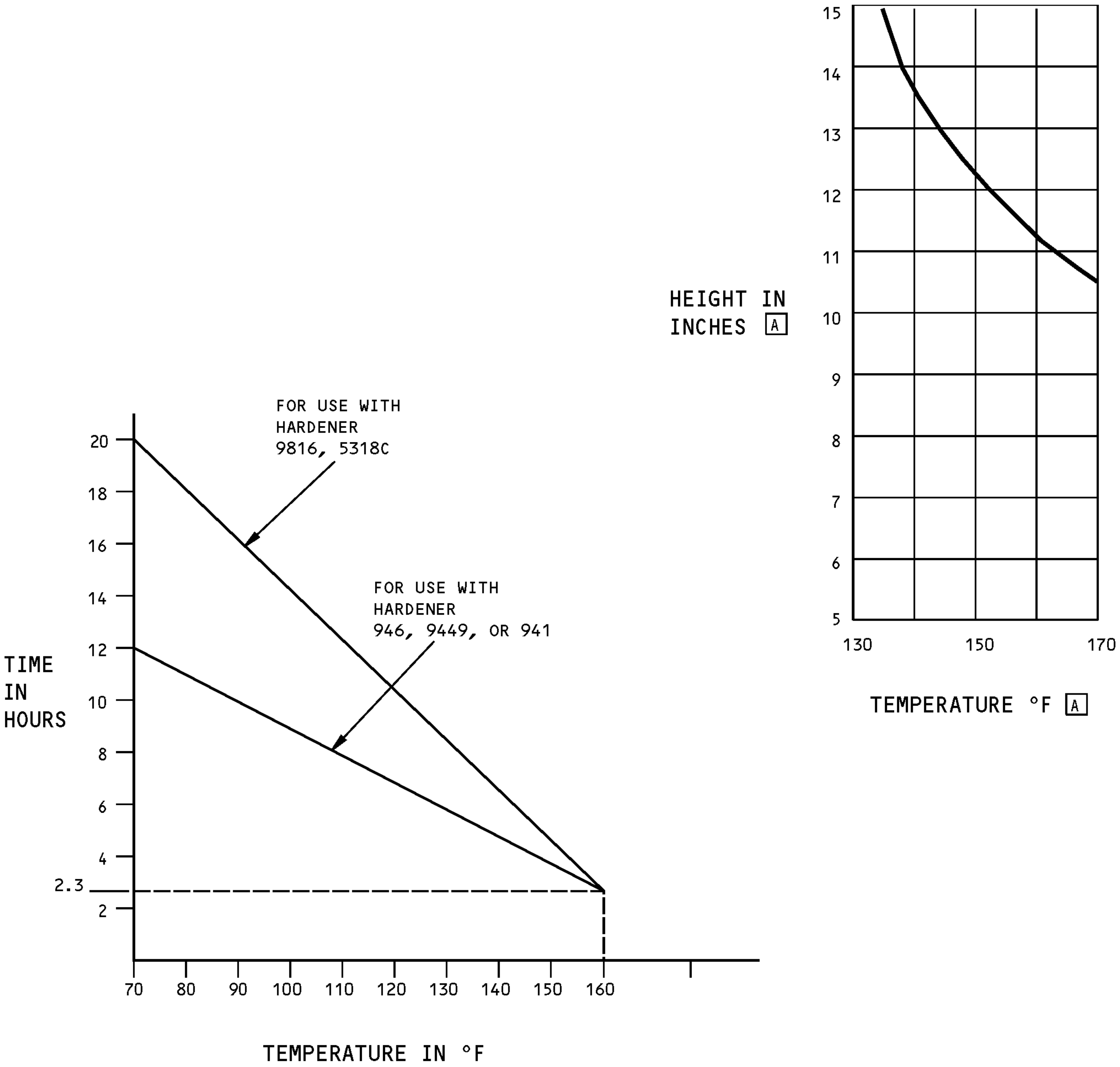
- ONE PLY OF STYLE 1581 OR 7781 CAN BE SUBSTITUTED FOR TWO INITIAL PLIES OF STYLE 120 FOR STRUCTURE THAT HAS A MINIMUM OF THREE PLIES. IF THE NUMBER OF PLIES THAT IS CALCULATED IS NOT A WHOLE NUMBER, USE THE NEXT LARGER WHOLE NUMBR. IN CASES WHERE THE STRUCTURE HAS ONLY TWO INITIAL PLIES OF STYLE 120, USE TWO PLIES OF STYLE 1581 OR 7781
- ONE PLY OF STYLE 120 CAN BE SUBSTITUTED FOR EACH INITIAL PLY OF STYLE 120.

FOR STRUCTURE THAT USES BMS 8-79, CLASS III, STYLE 1581 OR 7781 PREPREG MATERIAL, YOU CAN USE ONE OF THE SUBSTITUTIONS THAT FOLLOW IF THE INITIAL AND SUBSTITUTED PLIES HAVE THE SAME ORIENTATION.

- ONE PLY OF STYLE 1581 OR 7781 CAN BE SUBSTITUTED FOR EACH INITIAL PLY OF STYLE 1581 OR 7781
- THREE PLIES OF STYLE 120 CAN BE SUBSTITUTED FOR EACH INITIAL PLY OF STYLE 1581 OR 7781
- FIVE PLIES OF STYLE 120 CAN BE SUBSTITUTED FOR TWO PLIES OF STYLE 1581 OR 7781
- SEVEN PLIES OF STYLE 120 CAN BE SUBSTITUTED FOR THREE PLIES OF STYLE 1581 OR 7781
- TEN PLIES OF STYLE 120 CAN BE SUBSTITUTED FOR FOUR PLIES OF STYLE 1581 OR 7781
- TWELVE PLIES 120 CAN BE SUBSTITUTED FOR FIVE PLIES OF STYLE 1581 OR 7781
- IN ALL CASES WHERE STYLE 120 IS USED, THE TOTAL THICKNESS OF THE STYLE 120 PLIES MUST BE MORE THAN THE TOTAL THICKNESS OF THE STYLE 1581 OR 7781 PLIES THEY REPLACE (ONE PLY OF STYLE 120 IS 0.0041 INCH THICK AND ONE PLY OF STYLE 1581 OR 7781 IS 0.0095 INCH THICK).

FOR ONE EXTRA REPAIR PLY, USE BMS 8-79, CLASS III, STYLE 120,1581, OR 7781. IF ADDITIONAL REPAIR PLIES ARE SPECIFIED IN A CHAPTER-SECTION-SUBJECT REPAIR THAT REFERS TO SRM 51-70-07, USE THE RULES GIVEN ABOVE FOR INITIAL PLY SUBSTITUTIONS.

BMS 8-79 Glass Fabric Prepreg Data
Figure 2

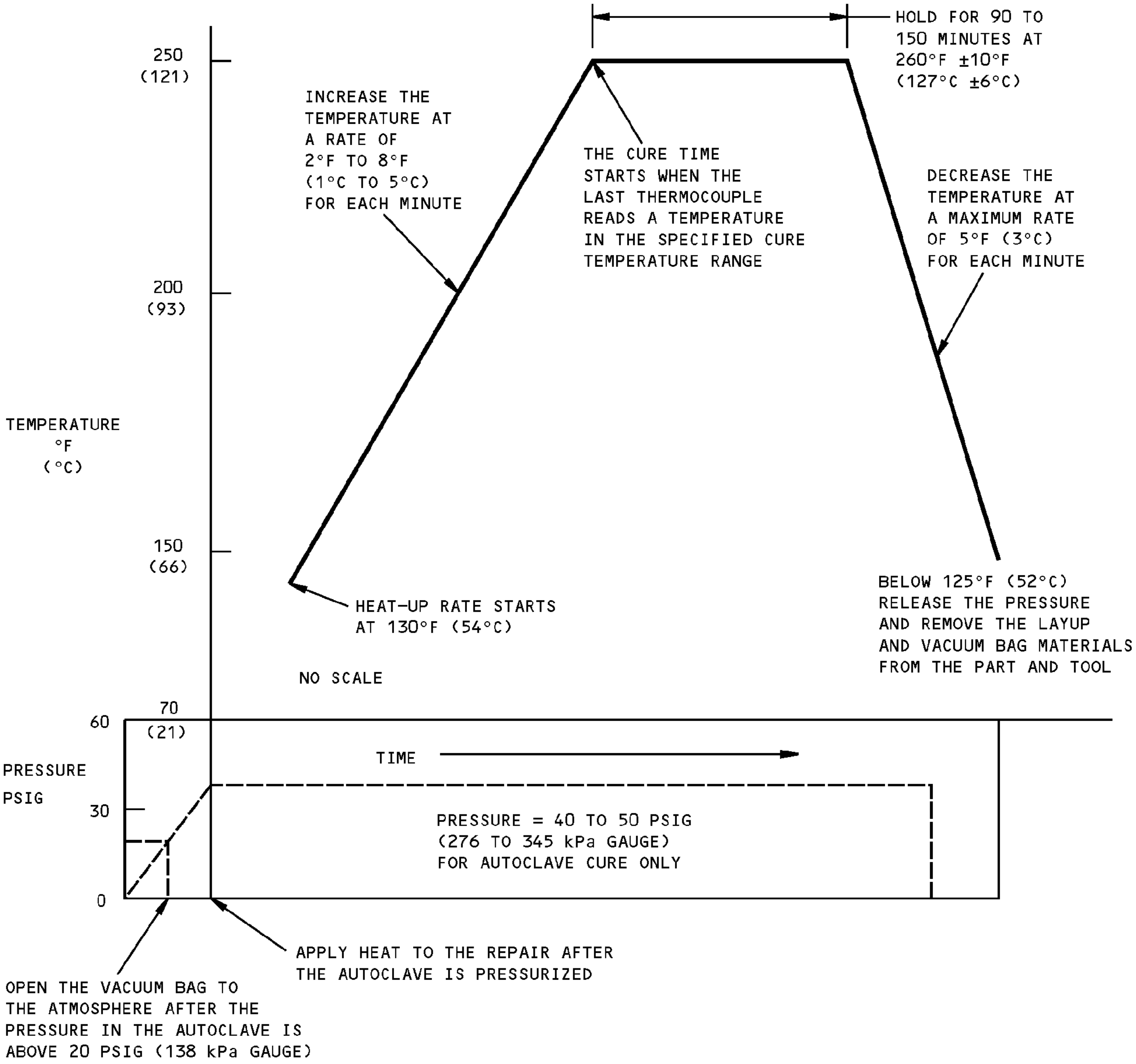


NOTES

- USE THERMOCOUPLES TO MONITOR TEMPERATURE

A THE HEIGHT IN INCHES OF 250 WATT HEAT LAMP FROM THE SURFACES OF THE PATCH VS TEMPERATURE AT SURFACE OF PART

Potting and Laminating Resin Cure Temperature
Figure 3



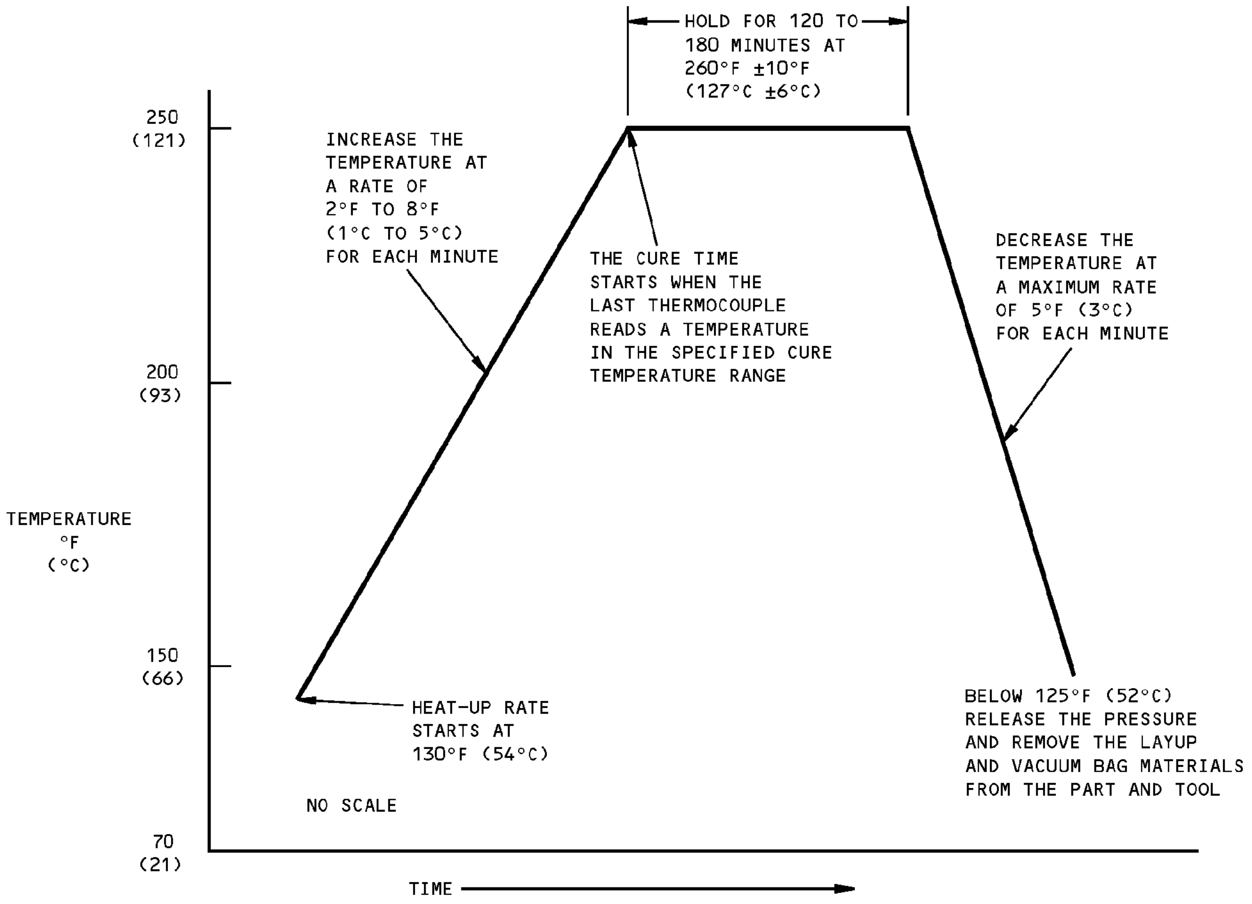
NOTES

- 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

DETAIL I

Repair Cure Cycles
Figure 4 (Sheet 1 of 2)



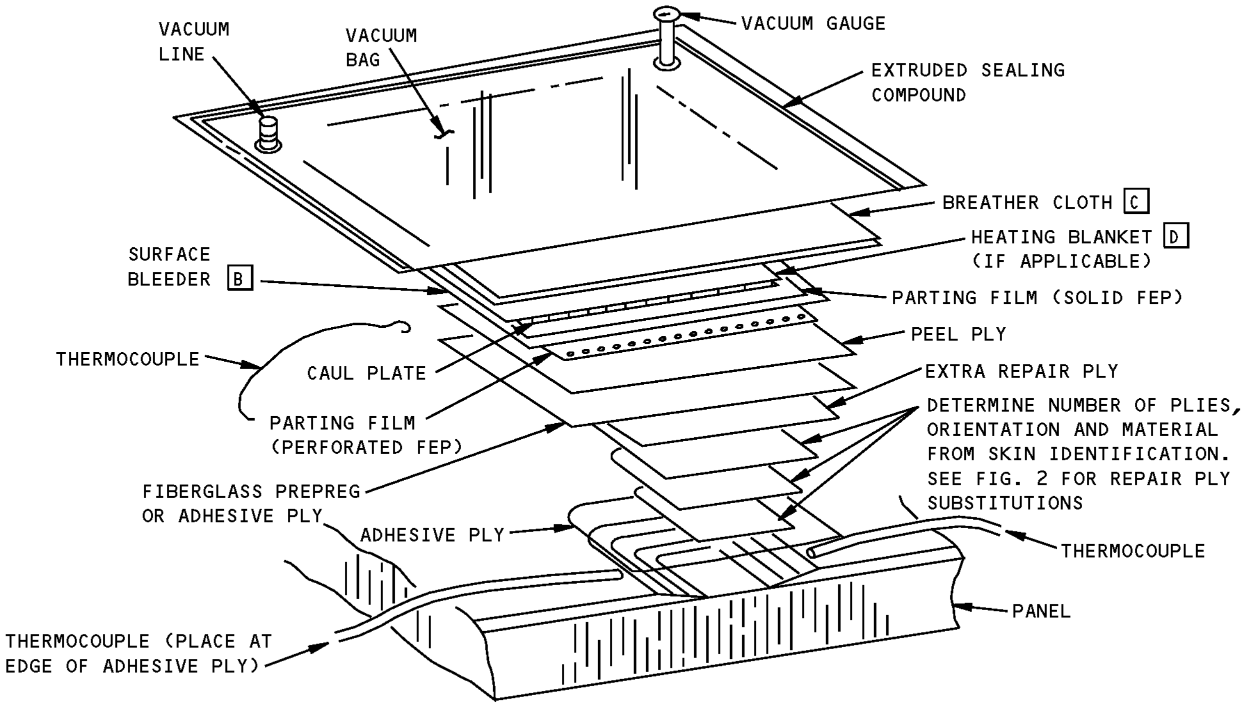
NOTES

- KEEP A MINIMUM VACUUM OF 22 INCHES (0.56 M) OF H_g (MERCURY) DURING THE FULL CURE CYCLE.

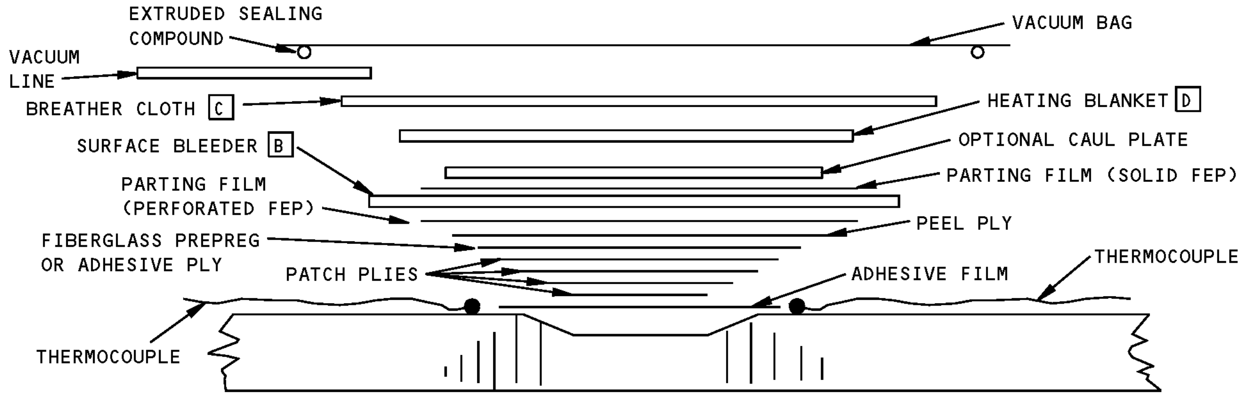
250°F (121°C) HEAT BLANKET CURE CYCLE

DETAIL II

Repair Cure Cycles
Figure 4 (Sheet 2 of 2)



APPLICATION OF PRESSURE FOR SKIN PLY REPAIR
(PREPREG LAYUP)

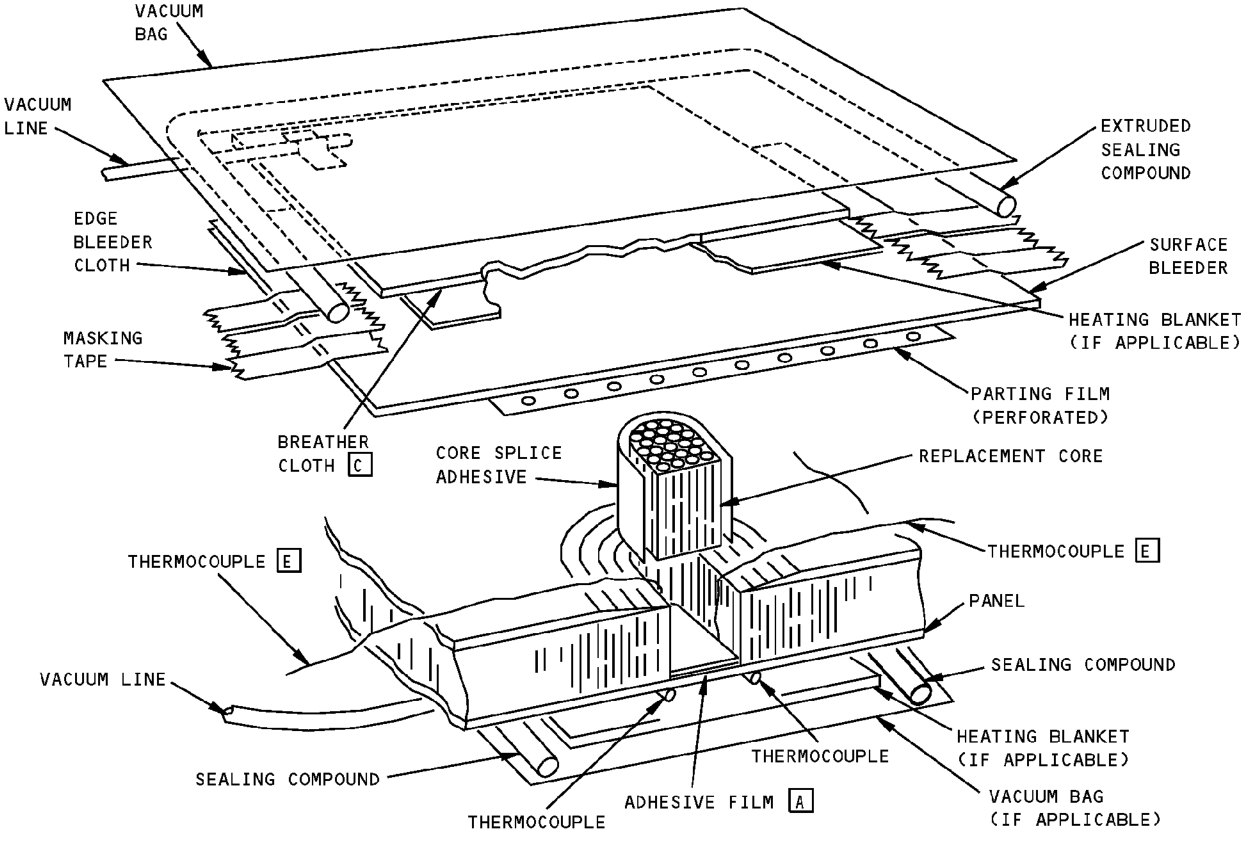


SECTION THRU LAYUP FOR SKIN PLY REPAIR
(PREPREG LAYUP)

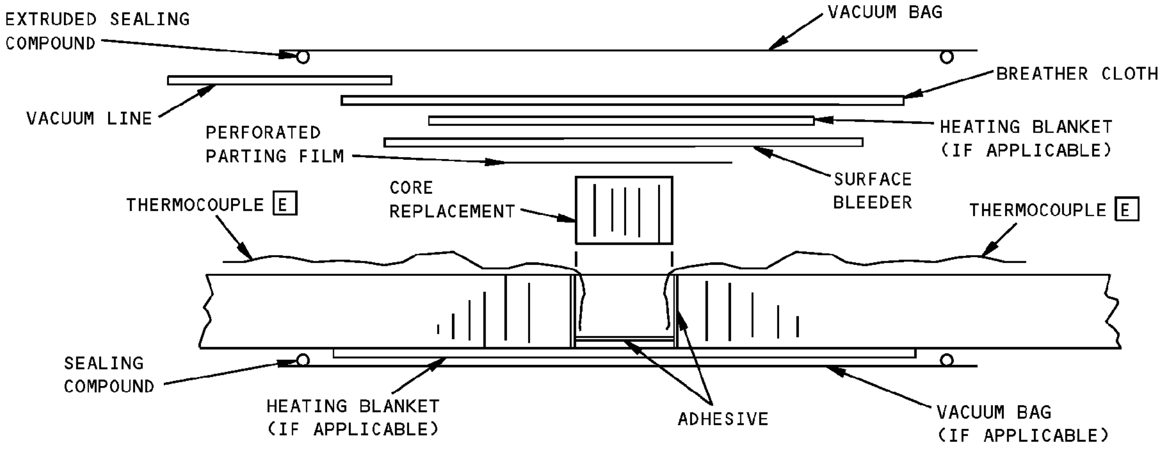
NOTES

- A ONE PLY OF ADHESIVE FILM (FOR FULL DEPTH CORE REPLACEMENT, WHERE DAMAGE DOES NOT EXTEND THROUGH BOTH SKINS). FOR PARTIAL CORE REPLACEMENT USE TWO PLIES OF ADHESIVE FILM WITH ONE PLY OF BMS 8-79 CLASS III, GRADE A, STYLE 120,1581, OR 7781 BETWEEN THEM.
- B SURFACE BLEEDER MUST MAKE CONTACT WITH THE SURFACE BREATHER MATERIAL.
- C WHEN USING A HEATING BLANKET, USE 4 TO 6 LAYERS OF BREATHER MATERIAL TO PREVENT DAMAGE TO VACUUM BAG.
- D HEATING BLANKET MUST EXTEND A MINIMUM OF 2 INCHES BEYOND EDGE OF REPAIR PATCH.
- E FOR THERMOCOUPLE PLACEMENT, REFER TO PAR. 4.D.(3)(F).

Application of Pressure During Cure - 250 Degrees F (121 Degrees C) Cure
Figure 5 (Sheet 1 of 2)

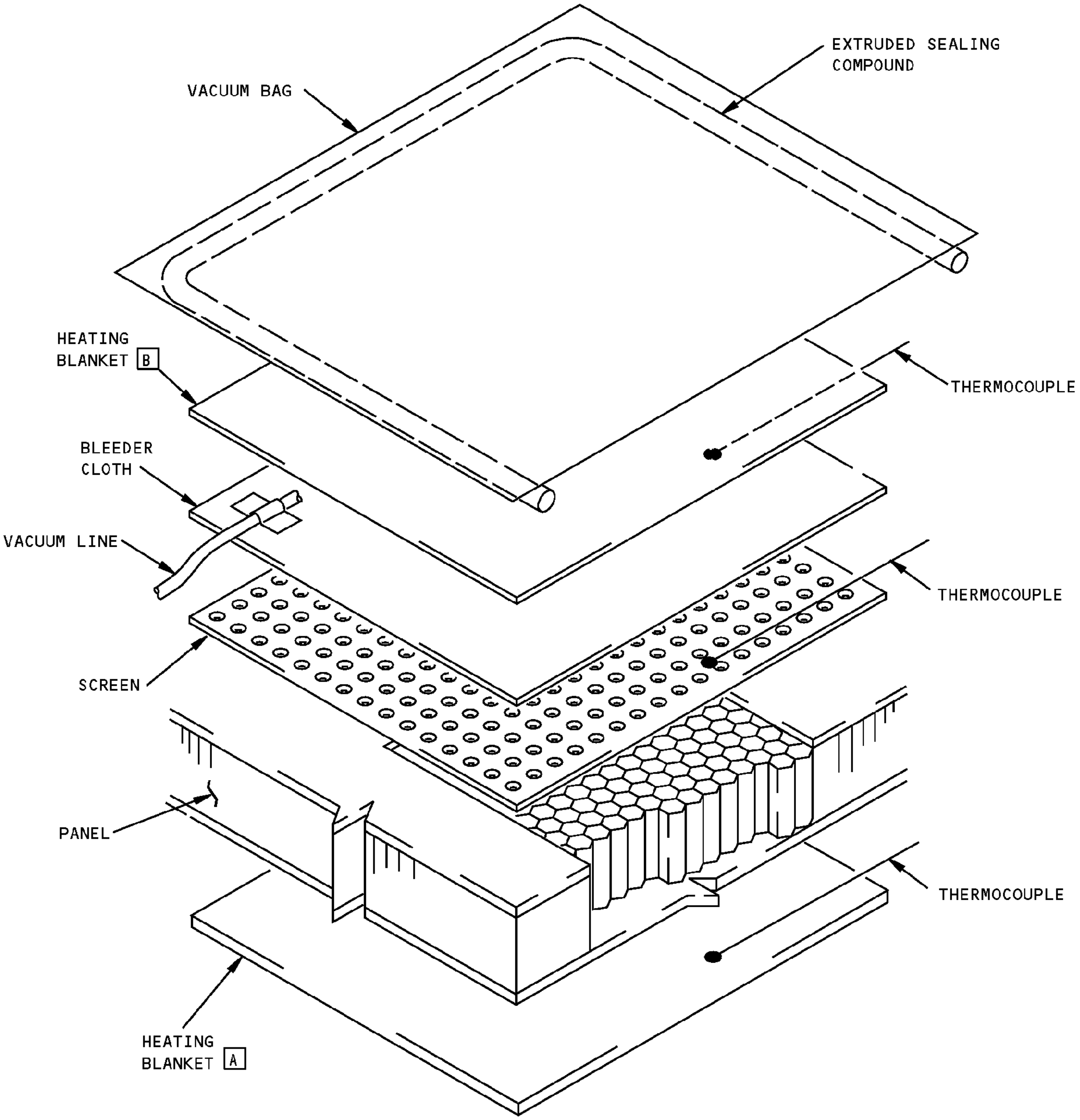


BAGGING SEQUENCE FOR CORE REPLACEMENT



SECTION THRU LAYUP FOR CORE REPLACEMENT

Application of Pressure During Cure - 250 Degrees F (121 Degrees C) Cure
Figure 5 (Sheet 2 of 2)

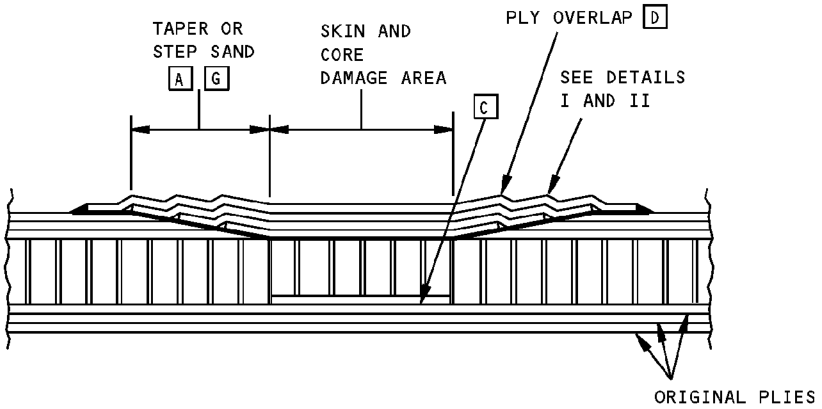


NOTES

A PREFERRED LOCATION OF HEATING BLANKET WHEN OPPOSITE FACE IS ACCESSIBLE

B ALTERNATE LOCATION OF HEATING BLANKET WHEN OPPOSITE SIDE IS INACCESSIBLE. THIS LOCATION MAY BE USED FOR AN ADDITIONAL HEATING BLANKET TO ACCELERATE WATER REMOVAL

Water Removal From Honeycomb Sandwich
Figure 6



SECTION THROUGH TYPICAL REPAIR
(PREPREG LAYUP ONLY)

TAPER SANDED SKIN
DETAIL I

STEP SANDED SKIN
DETAIL II

NOTES

A TAPER SAND AROUND REPAIR AREA OVER DISTANCE OF 0.5 INCH FOR EACH EXISTING PLY

B DO NOT EXPOSE OR DAMAGE FILAMENTS IN UNTAPERED AREA WHEN SANDING

C SANDING MUST NOT EXPOSE OR DAMAGE THE FILAMENTS IN BOND PLY (PLY BONDED TO CORE)

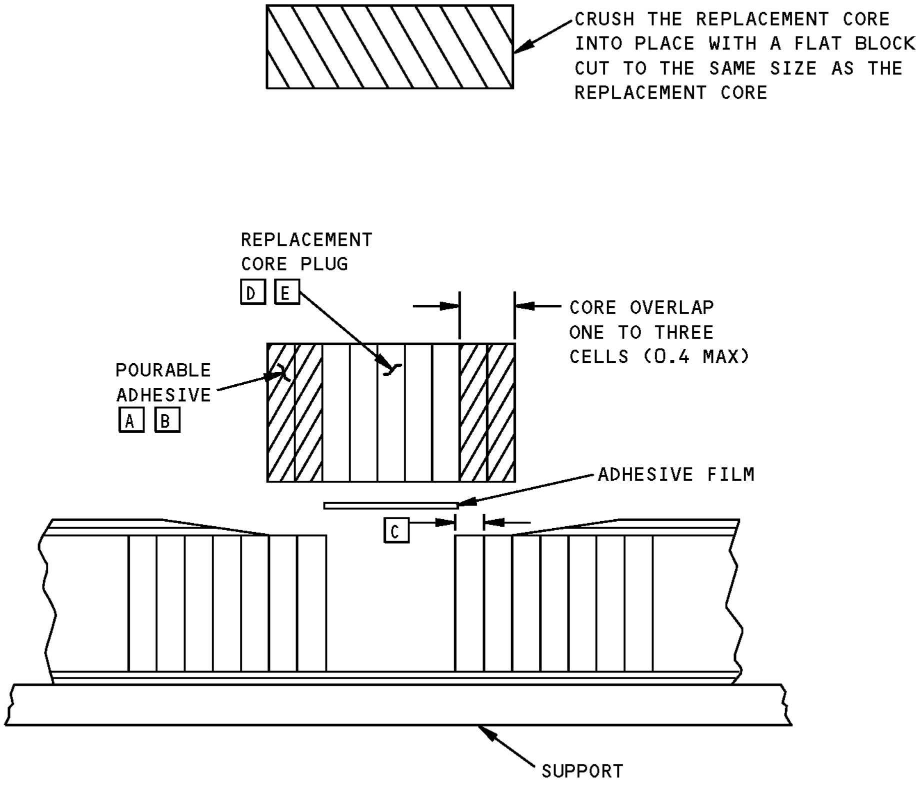
D EXTRA PLY MUST OVERLAP AT LEAST 0.5 INCH. EACH SUCCEEDING PLY MUST OVERLAP AT LEAST 0.5 INCH PAST EDGE OF PRECEEDING PLY

E SURFACE PLY FAYING SURFACE MUST BE AT LEAST 0.5 INCH PAST EDGE OF TAPER

F REMOVE DAMAGED PLIES IN STEPS OF 0.5 INCH FOR EACH EXISTING PLY

G TAPER SAND SURFACES IN AREAS OF CRITICAL AERODYNAMIC SMOOTHNESS. REFER TO 51-10-01

Sanding and Overlap Requirements
Figure 7



NOTES

- CORE CRUSH SPLICING MAY ONLY BE USED WHEN SPLICING BMS 8-124, CLASS I, TYPE I, GRADE 4.0 OR HIGHER DENSITY, FIBERGLASS REINFORCED NON-METALLIC HONEYCOMB CORE

A BEFORE SPLICING, DIP PERIPHERY OF CORE PLUG IN ADHESIVE TO A DEPTH OF ONE TO THREE CELLS (0.4 INCH MAX)

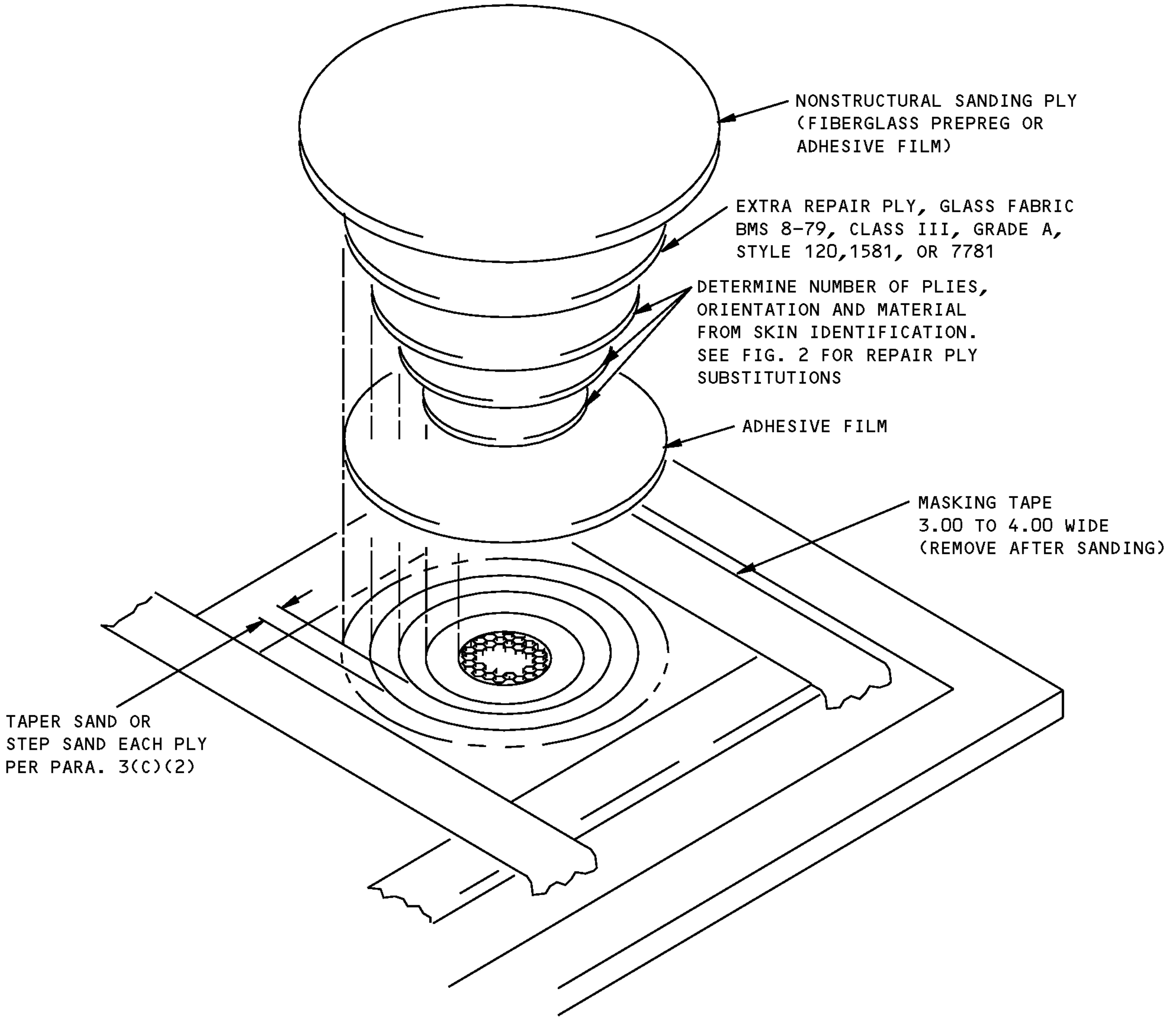
B AFTER SPLICING POUR ADDITIONAL ADHESIVE INTO SPLICED CELLS

C WHEN PREPARING REPAIR AREA LEAVE ONE TO THREE CELLS (0.4 INCH MAX) VISIBLE BETWEEN CORE REPAIR CAVITY AND SKIN TO MATCH CORE OVERLAP

D ALIGN HONEYCOMB CELLS OF REPAIR PLUG WITH ORIGINAL CORE

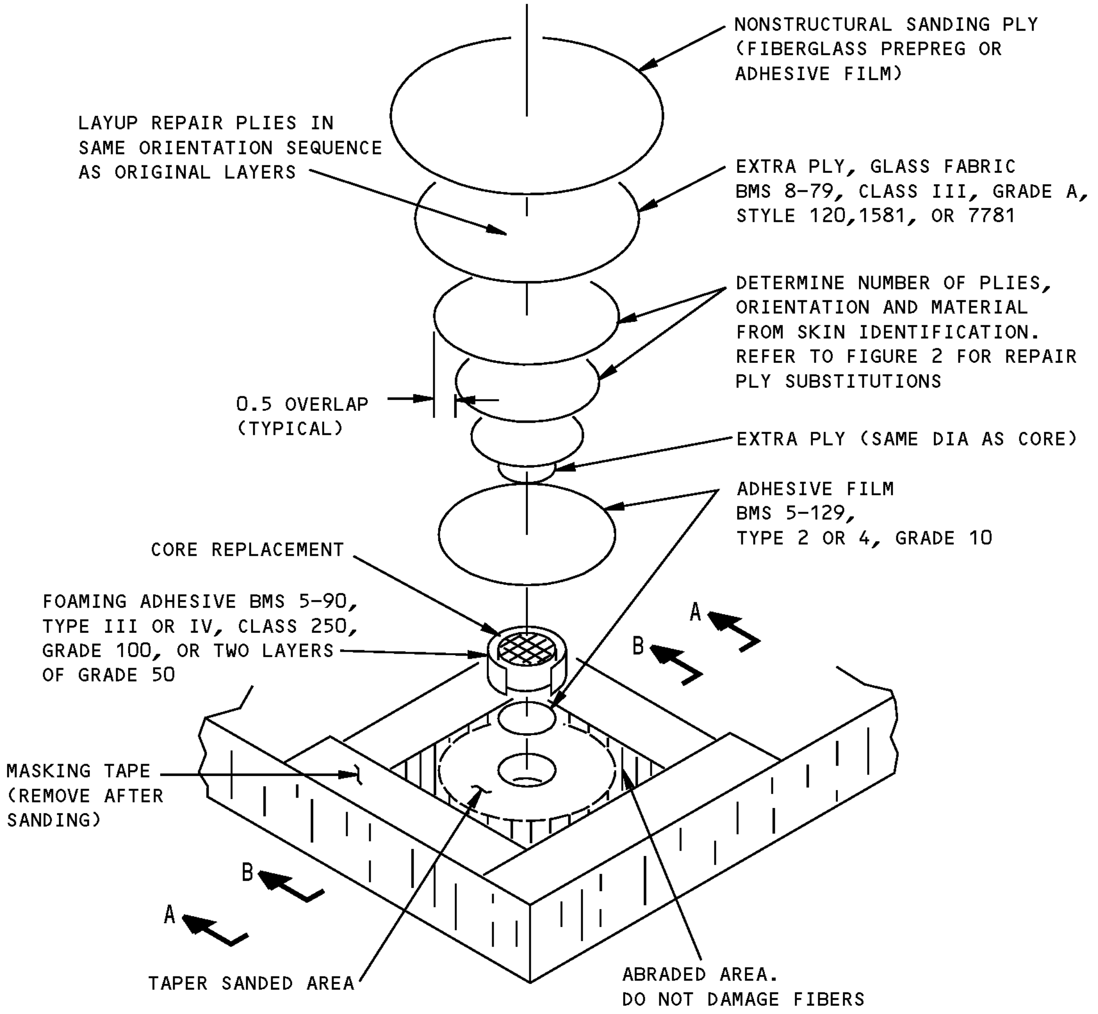
E REPLACEMENT CORE PLIES MUST BE MADE FROM CORE MATERIAL AT LEAST TWO GRADES DENSER THAN THE ORIGINAL CORE

Core Crush Splicing Requirements - 250 Degrees F (121 Degrees C) Cure
Figure 8

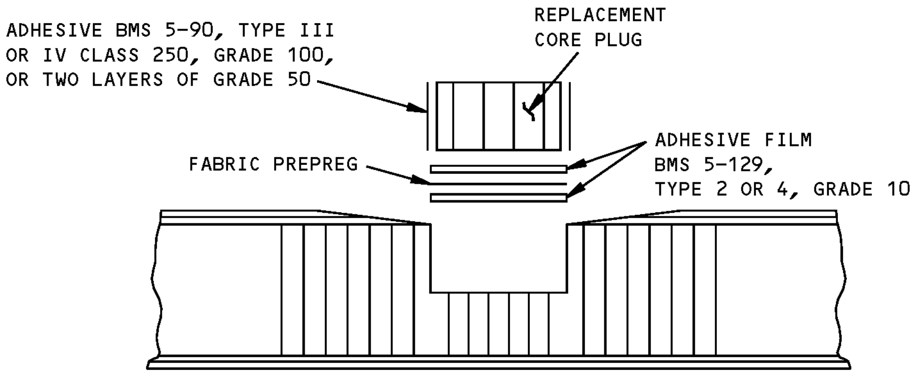


REPAIR PLY LAYUP ONLY

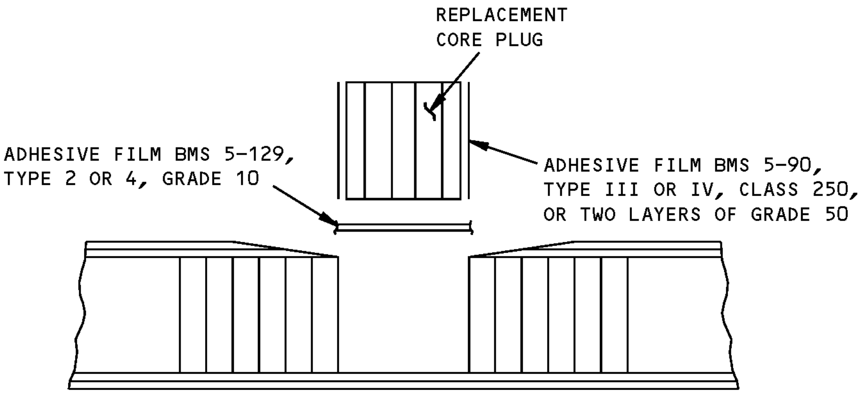
Repair of Damaged External or Internal Skins of a Sandwich Panel - 250 Degrees F (121 Degrees C) Cure
Figure 9



Repair of Large Punctures Thru One Skin of a Sandwich Structure Including Core Damage - 250 Degrees F (121 Degrees C) Cure
Figure 10 (Sheet 1 of 2)

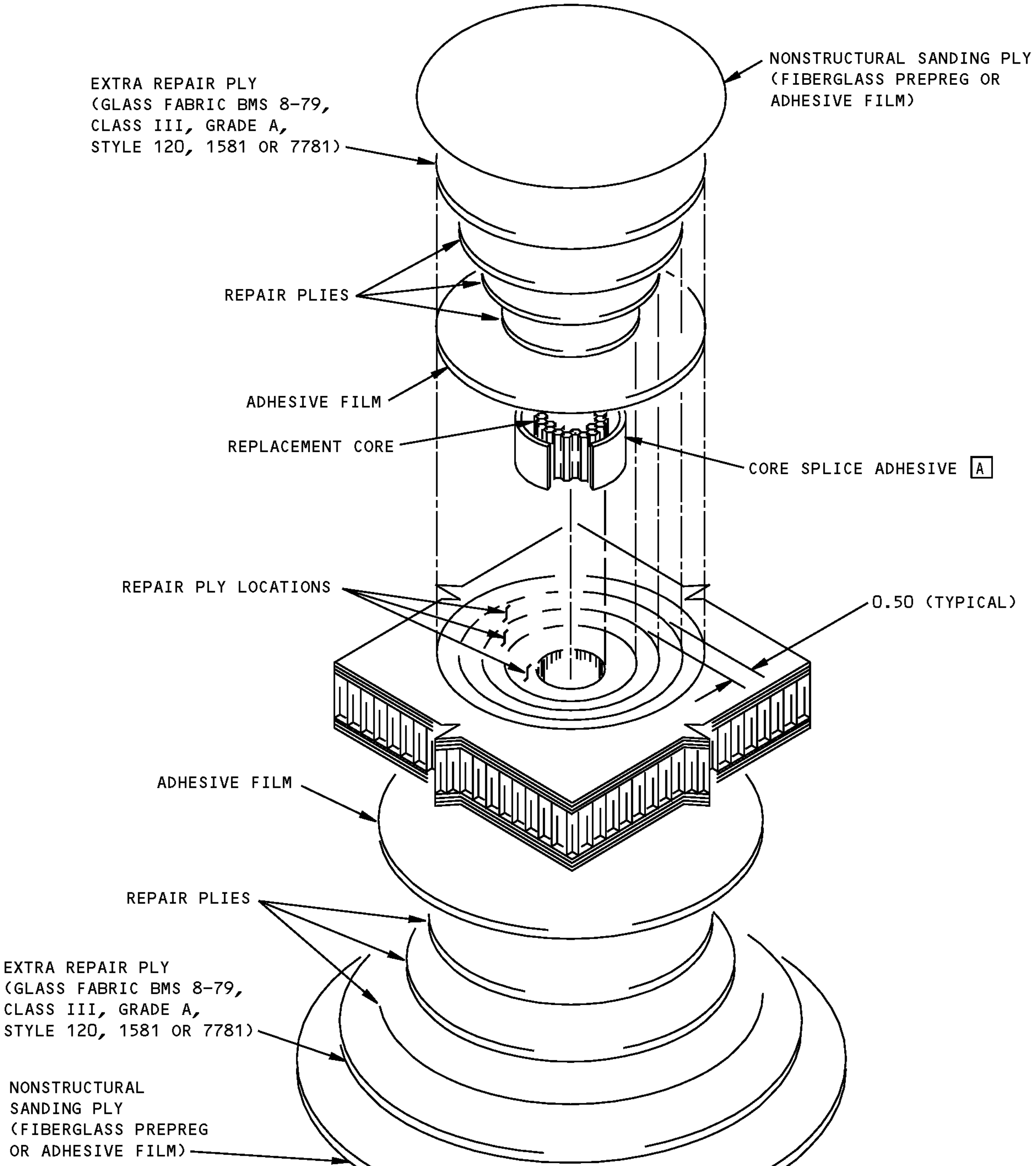


SECTION THRU REPAIR AREA - PARTIAL DEPTH CORE REPLACEMENT
SECTION A-A



SECTION THRU REPAIR AREA - FULL DEPTH CORE REPLACEMENT
SECTION B-B

Repair of Large Punctures Thru One Skin of a Sandwich Structure Including Core Damage - 250 Degrees F (121 Degrees C) Cure
Figure 10 (Sheet 2 of 2)

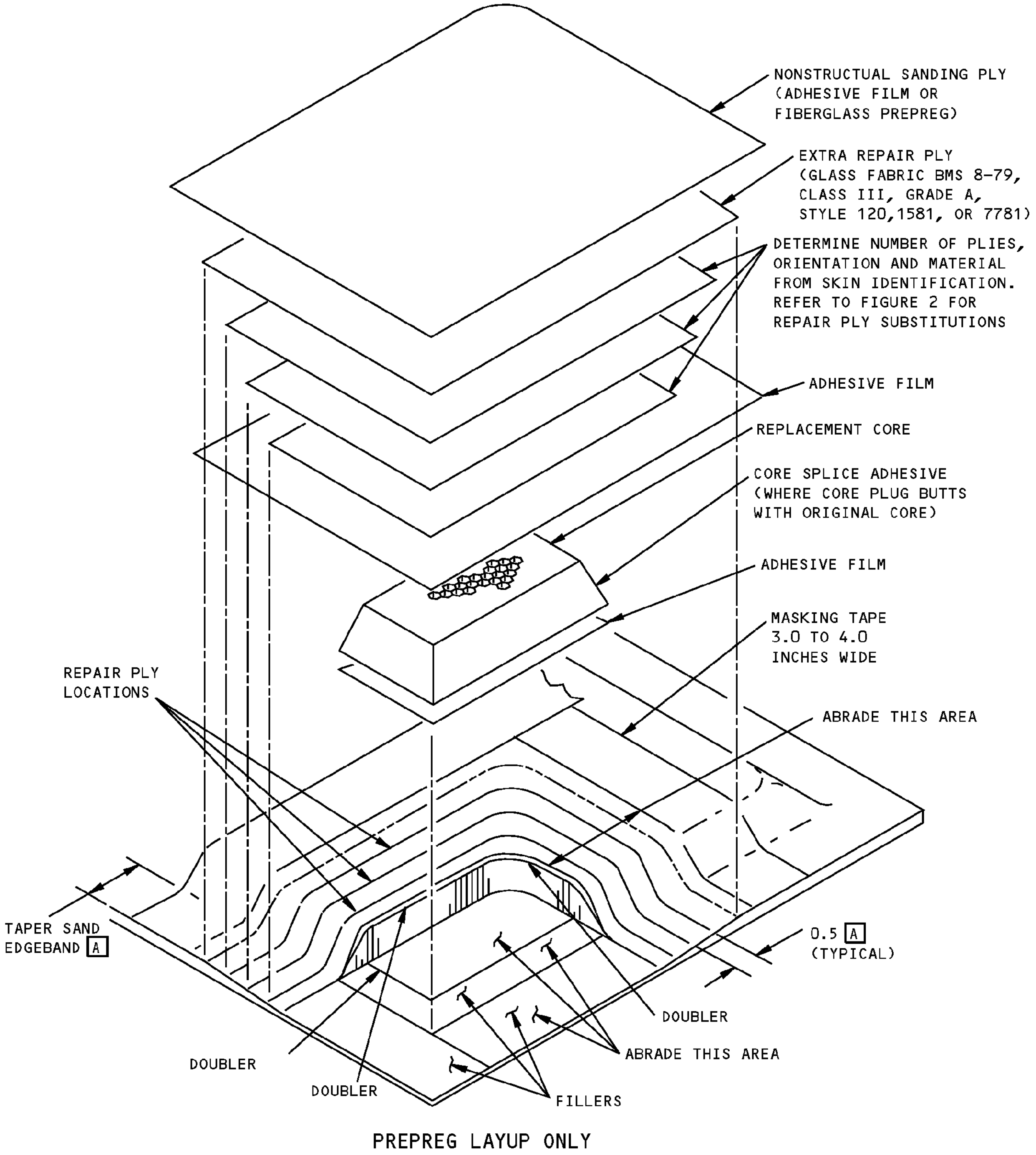


PREPREG LAYUP ONLY

NOTES

- A ADHESIVE APPLIED TO CORE PLUG (SEE PAR. 4.D.(3))

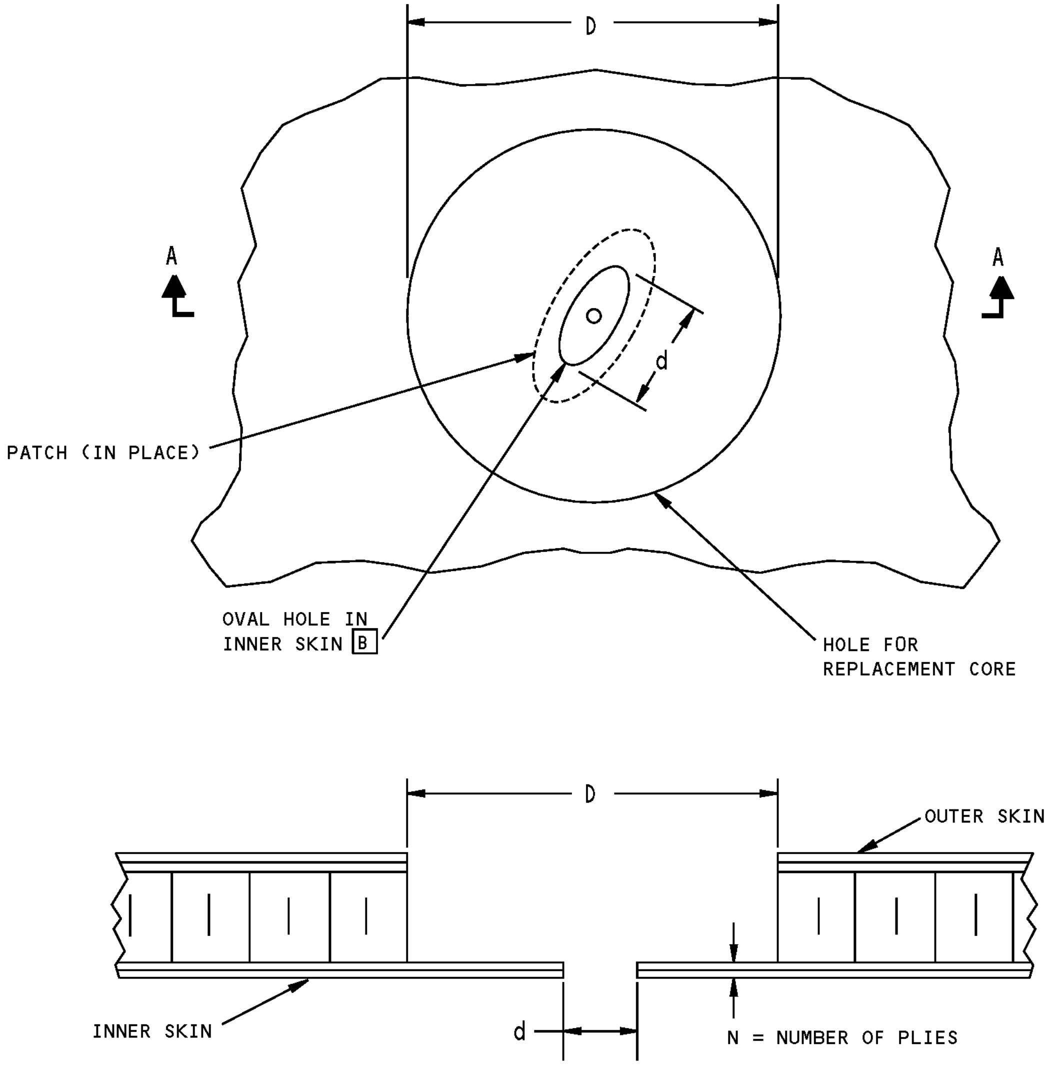
Repair of Large Punctures Thru Both Skins of a Sandwich Panel Including Core Damage - 250 Degrees F (121 Degrees C) Cure
Figure 11



NOTES

A REFER TO FIGURE 7 FOR THE SANDING AND OVERLAP REQUIREMENTS.

Replacement of Honeycomb Core on Damaged Edge of Sandwich Panel - 250 Degrees F (121 Degrees C) Cure
Figure 12



SECTION A-A
(PATCH NOT SHOWN)

DETAIL I

NOTES

- THIS REPAIR ILLUSTRATES THE USE OF A SPRING STEEL CLAMP. HOWEVER, ANY SUITABLE RETAINING DEVICE MAY BE USED.
- D = d + N + 1
  d = MAJOR DIAMETER OF OVAL HOLE IN INNER SKIN. SIZE LIMITED TO 1.5 INCH FOR THIS REPAIR
  N = NUMBER OF PLIES
  D = DIAMETER OF HOLE FOR REPLACEMENT CORE

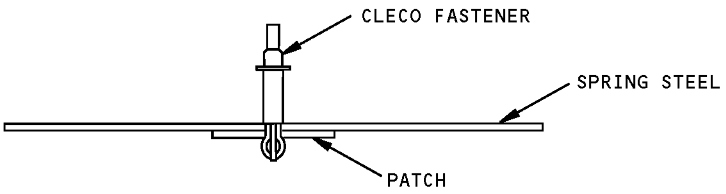
EXAMPLE:

IF d = 0.50 INCH
THEN, D = 0.50 + 2 (PLIES) + 1
D = 3.50 INCH DIAMETER

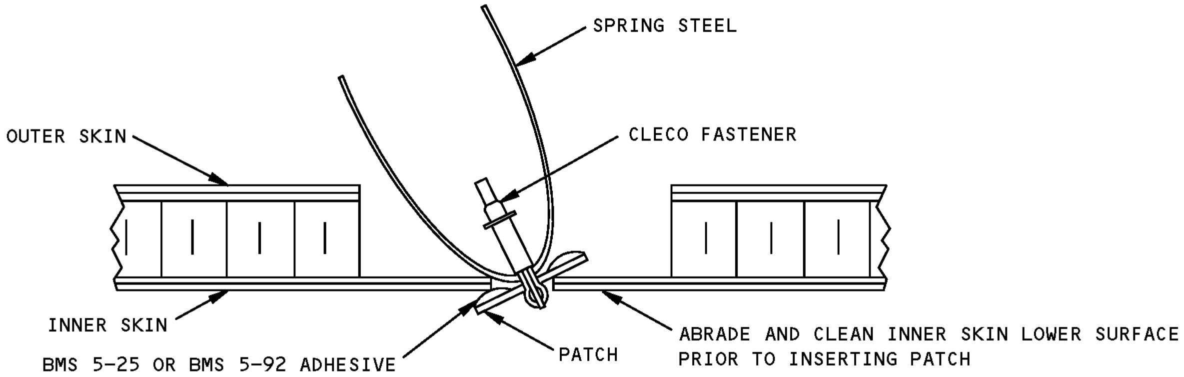
A MAKE TAPER AND OVERLAP PER FIG. 2.

B MAJOR DIAMETER d OF OVAL HOLE IN INNER SKIN IS LIMITED TO 1.5 INCH FOR THIS REPAIR.

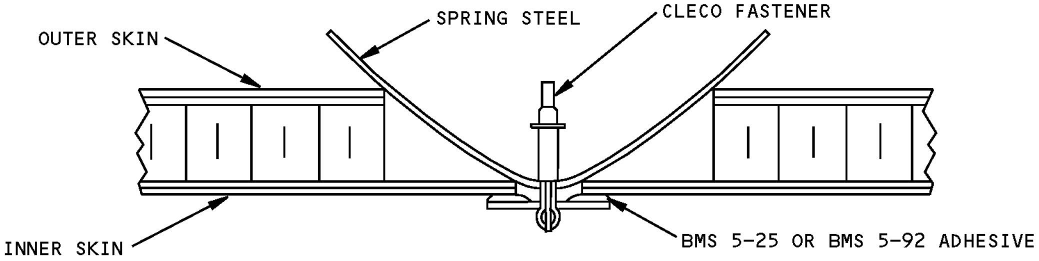
Repair of Damage to External and Internal Skins with Access Limited to One Side - 250 Degrees F (121 Degrees C) Cure
Figure 13 (Sheet 1 of 3)



ASSEMBLE PATCH AND SPRING STEEL
DETAIL II

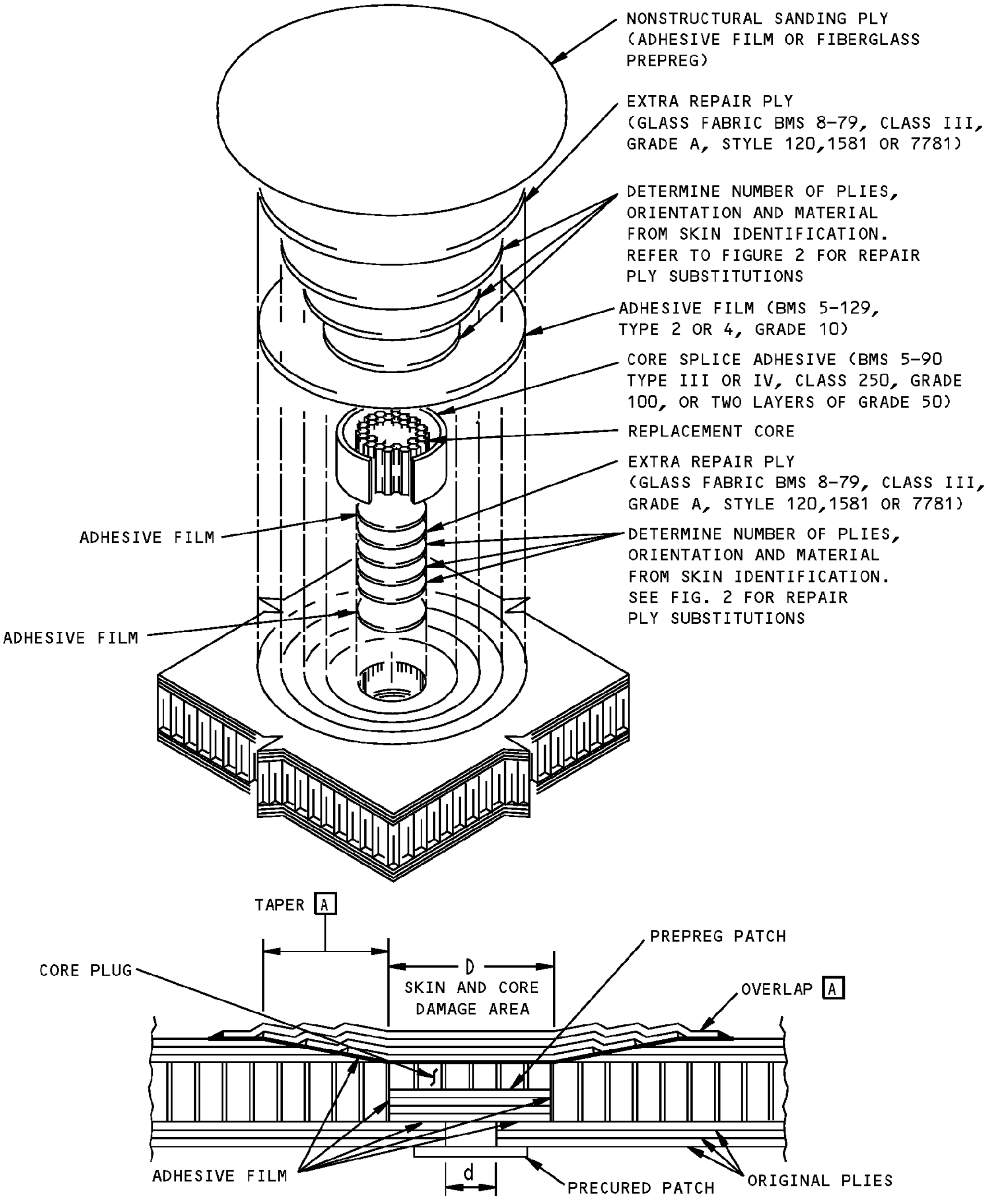


INSERT PATCH INTO OVAL HOLE
DETAIL III



HOLD PATCH IN PLACE WHILE CURING
DETAIL IV

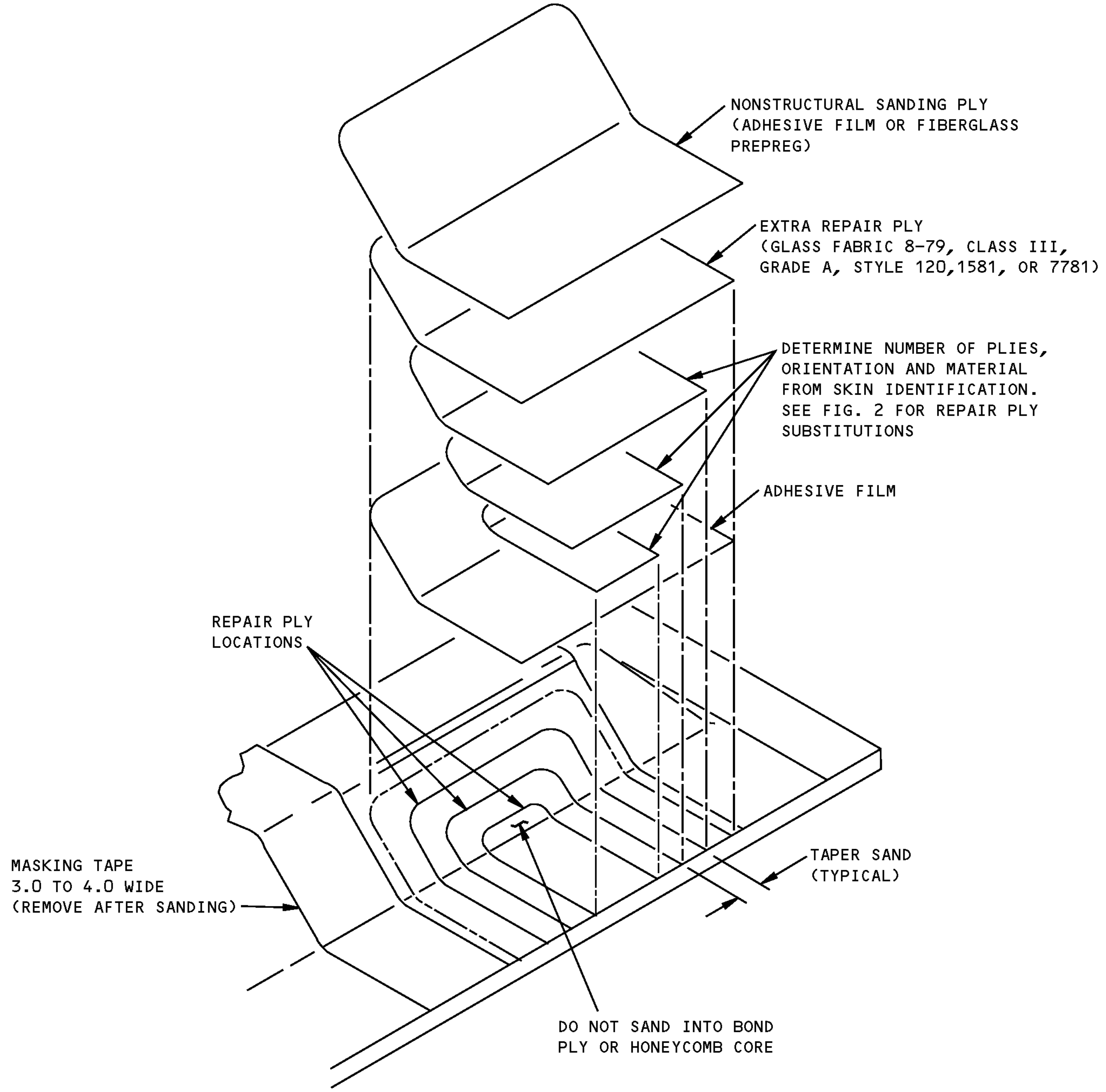
Repair of Damage to External and Internal Skins with Access Limited to One Side - 250 Degrees F (121 Degrees C) Cure
Figure 13 (Sheet 2 of 3)



SECTION THROUGH REPAIR

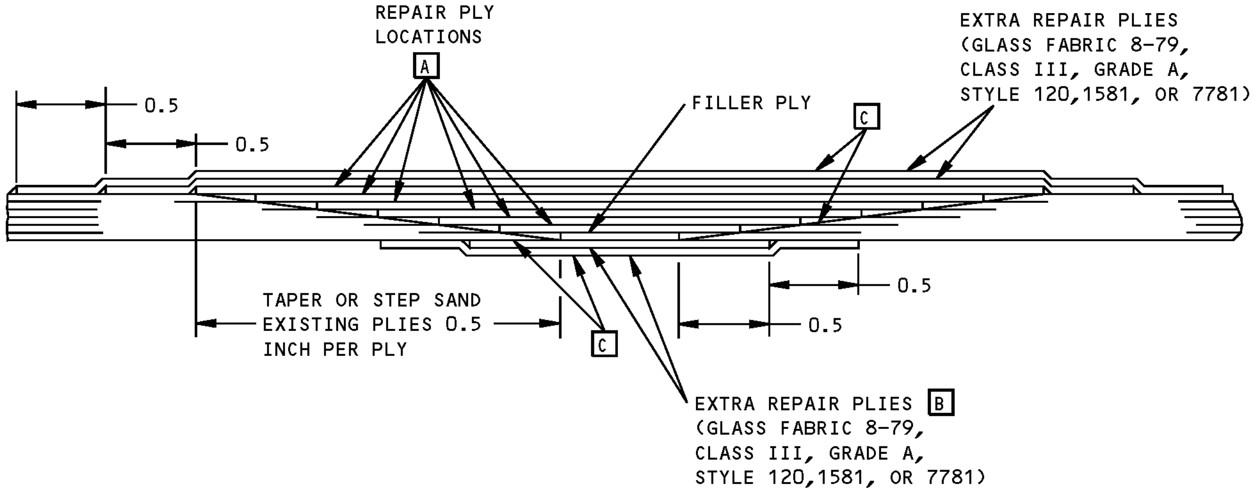
PREPREG LAYUP ONLY
DETAIL V

Repair of Damage to External and Internal Skins with Access Limited to One Side - 250 Degrees F (121 Degrees C) Cure
Figure 13 (Sheet 3 of 3)



PREPREG LAYUP ONLY

Repair of Damaged Skin Plies On A Panel Edge - 250 Degrees F (121 Degrees C) Cure
Figure 14



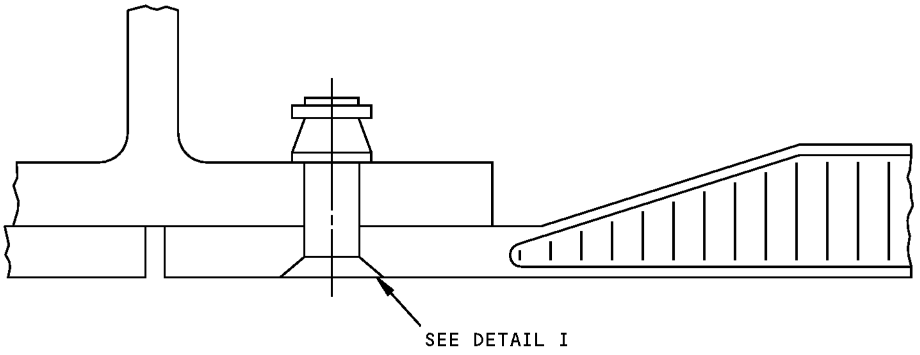
NOTES

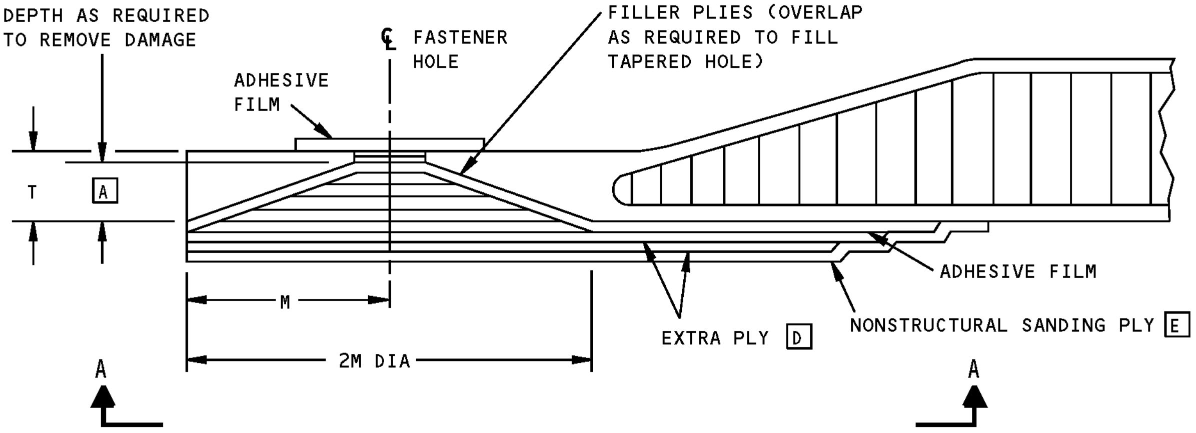
A DETERMINE NUMBER OF PLIES, ORIENTATION, AND ORIGINAL MATERIAL FROM SPECIFIC COMPONENT STRUCTURE IDENTIFICATION. SEE FIG. 2 FOR REPAIR PLY SUBSTITUTIONS.

B EXTRA REPAIR PLIES AT THIS LOCATION ARE REQUIRED ONLY IF THE DAMAGE PENETRATES THIS SURFACE.

C PLACE ONE PLY OF BMS 5-129, TYPE 2 OR 4, GRADE 10 ADHESIVE FILM OVER THE REPAIR AREA BEFORE APPLYING THE REPAIR PLIES AND OVER THE LAST REPAIR PLY IN THE PATCH. THE ADHESIVE FILMS ARE TO BE 1/8 INCH LARGER THAN THE LARGEST REPAIR PLY IN THE PATCH.

Repair of Damage Greater than 0.5-inch Diameter to Solid Laminates
Figure 15





DETAIL I

NOTES

- D EQUALS FASTENER DIAMETER
- M = 5T MAXIMUM AS SHOWN WHERE T IS THE THICKNESS OF THE EDGE BAND. DO NOT CUT INTO CORE
- THIS REPAIR IS APPLICABLE ONLY WHERE NO MORE THAN TWO ATTACH HOLES ARE DAMAGED IN A SEQUENCE OF TEN. IF MORE THAN TWO ATTACH HOLES IN A SEQUENCE OF TEN ARE DAMAGED, REPAIR THE EDGEBAND AS GIVEN IN PARAGRAPH 5.G. (FIGURE 14).

A APPLY FILLER PLIES AS REQUIRED TO FILL THE DAMAGED AREA.

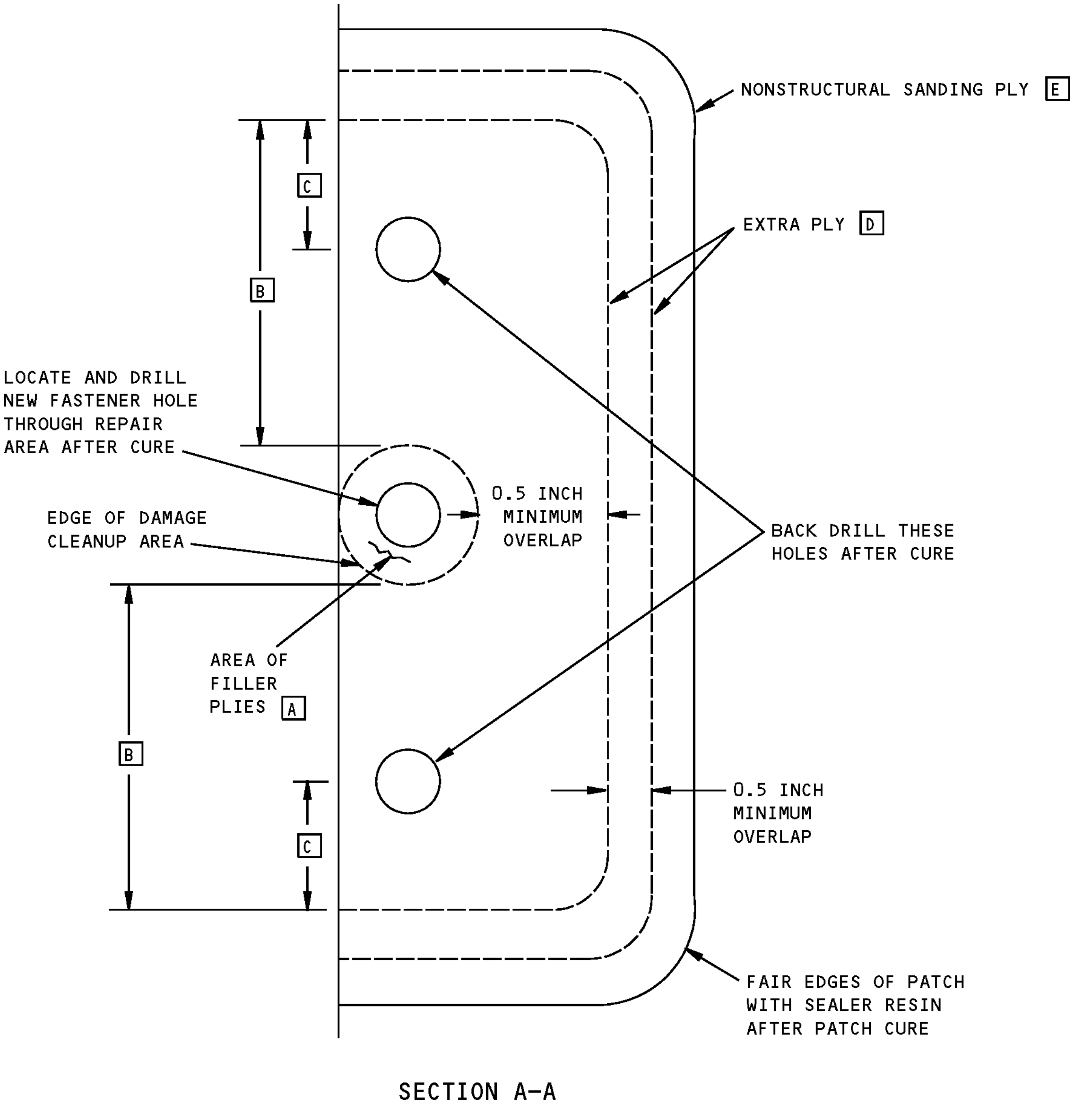
B EXTEND FIRST EXTRA PLY FAR ENOUGH SO THAT IT EXTENDS AT LEAST 0.5 INCH PAST EDGE OF DAMAGED AREA.

C EXTEND FIRST EXTRA PLY FAR ENOUGH TO PROVIDE AT LEAST 2D EDGE MARGIN.

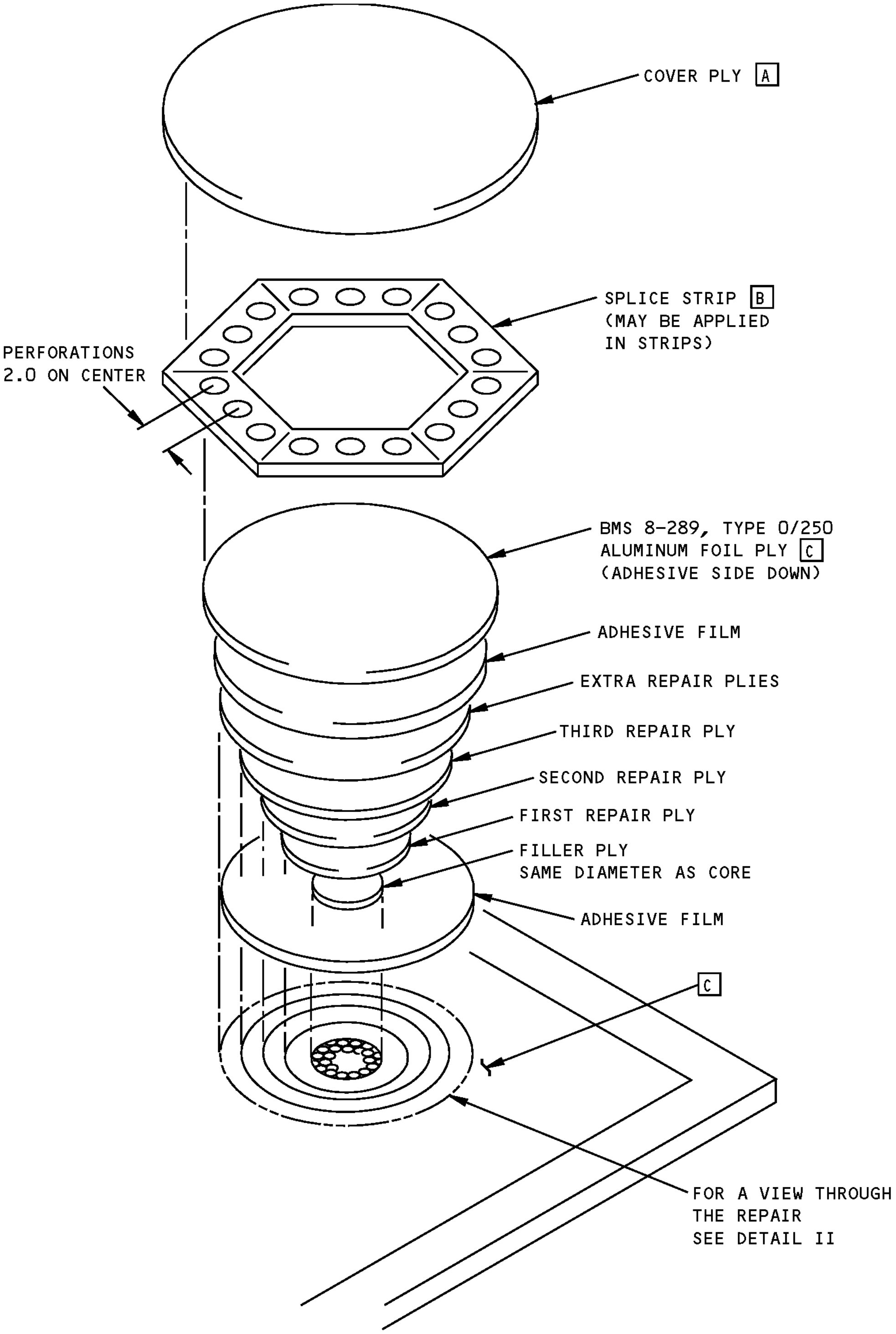
D ORIENT EXTRA REPAIR PLIES IN THE SAME DIRECTION AS THE ORIGINAL OUTER LAYER.

E FIBERGLASS PREPREG BMS 8-79, STYLE 1581 OR ADHESIVE FILM BMS 5-129, TYPE 2 OR 4, GRADE 10.

Repair of Damaged Panel Attach Hole - 250 Degrees F (121 Degrees C) Cure
Figure 16 (Sheet 1 of 2)

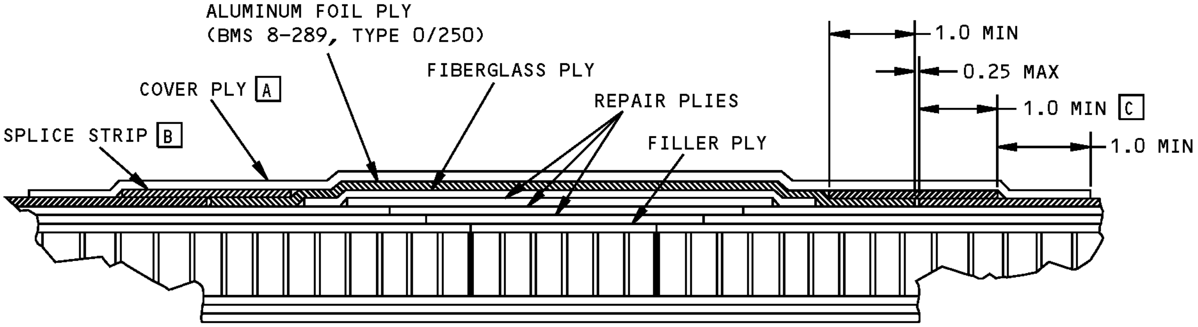


Repair of Damaged Panel Attach Hole - 250 Degrees F (121 Degrees C) Cure
Figure 16 (Sheet 2 of 2)



REPAIR PLY LAYUP
DETAIL I

Repairs to Aluminum Foil
Figure 17 (Sheet 1 of 2)



VIEW THRU REPAIR
DETAIL II

MATERIAL	SHIPPING AND STORAGE LIFE		SHELF LIFE D	
	MAXIMUM TEMPERATURE E	DURATION (DAYS)	MAXIMUM TEMPERATURE	DURATION (HOURS)
BMS 8-289 TYPE O/250	10°F (-12°C)	180	95°F (35°C)	240

STORAGE AND SHELF LIFE OF BMS 8-289
TABLE I

NOTES

A GLASS FABRIC BMS 8-79, CLASS III, GRADE A STYLE 120,1581, OR 7781.

B BMS 8-289, TYPE O/250, FORM II, WITH THE ADHESIVE SIDE UP OR FORM I, ALODINE TREATED ON NONADHESIVE SIDE. PERFORATE THE FOR I WITH 0.50 DIAMETER HOLES ON 2.0 CENTERS.

C APPLY A CHEMICAL CONVERSION COATING TO THE INITIAL ALUMINUM FOIL.

D SHELF LIFE HOURS ACCUMULATE FROM THE DATE OF REMOVAL FROM REFRIGERATION UNTIL START OF THE REPAIR CURE CYCLE.

E STORAGE LIFE SHALL BE AS SHOWN IN TABLE I UNLESS PRODUCT IS GUARANTEED BY THE SUPPLIER FOR 360 DAYS STORAGE AT 95°F (35°C).

Repairs to Aluminum Foil
Figure 17 (Sheet 2 of 2)

GENERAL - GLASS FABRIC REINFORCED EPOXY LAMINATES AND NONMETALLIC HONEYCOMB SANDWICH REPAIRS - 350°F (177°C) CURE

1. General

CAUTION: TO GET AN ACCEPTABLE QUALITY REPAIR, DO AS FOLLOWS:

- REFER TO THE APPLICABLE COMPONENT THAT YOU ARE GOING TO REPAIR FOR THE REPAIR LIMITS AND MATERIAL OF THE COMPONENT BEFORE YOU USE THESE REPAIR INSTRUCTIONS.
- USE THE CORRECT MATERIALS FOR THE TYPE OF COMPONENT AND REPAIR THAT IS MADE.
- USE THE MATERIALS THAT AGREE WITH THE SPECIFICATIONS IN THE SRM.
- ACCURATELY FOLLOW THE SRM PROCEDURES AT EACH STEP OF THE REPAIR. IF YOU DO NOT DO THIS, IT CAN CAUSE A REPAIR THAT IS NOT SATISFACTORY AND NOT APPROVED.

350°F (177°C) CURE REPAIRS ARE RESTRICTED TO REPAIRS IN SPECIFIC AREAS OF COMPONENTS.

THESE REPAIRS ARE PERMANENT WHEN APPLIED USING THE REPAIR MANUAL PROCEDURES TO COMPONENTS ORIGINALLY MADE FROM 350°F (177°C) CURE MATERIALS.

350°F (177°C) TEMPERATURE MUST NOT BE APPLIED TO AREAS SEALED WITH BMS 5-95 SEALANT, UNLESS SEALANT CAN BE REPLACED FOLLOWING REPAIR. SOME REPAIRS MAY REQUIRE CURE TEMPERATURES THAT ARE THE SAME AS THAT USED DURING COMPONENT MANUFACTURE. CARE MUST BE TAKEN TO PROPERLY SUPPORT THE AREA ADJACENT TO A REPAIR TO PREVENT DELAMINATION OF UNDAMAGED AREAS. EXTENDING VACUUM BAGGING A MINIMUM OF 6.0 INCHES BEYOND THE HEAT BLANKET AND THE USE OF SUPPORT STRUCTURE, WHERE REQUIRED ARE RECOMMENDED.

REPAIR MATERIALS MUST BE COMPATIBLE WITH CURE TEMPERATURE. DO NOT USE 250°F (121°C) CURE MATERIALS FOR 350°F (177°C) CURE REPAIRS.

A. Repairs contained herein are to components made from epoxy resin reinforced with several layers of fiberglass fabric. The most common construction is a sandwich of two laminated skins separated by a nonmetallic honeycomb core. Solid laminate is used for small components, honeycomb panel edgebands and at fitting locations. Repairs described use 350°F cure materials (prepreg layup).

B. Table 1/GENERAL contains an index of subjects in this procedure.

Table 1: Index of the Subjects

Paragraph	Subject
Paragraph 4./GENERAL	Repair Procedures Common to Various Repairs
Paragraph 4.A./GENERAL	Determine Damage
Paragraph 4.B./GENERAL	Remove Water from Damaged Area
Paragraph 4.C./GENERAL	Remove and Prepare Damaged Area
Paragraph 4.D./GENERAL	Fabricate, Clean, and Install Honeycomb Replacement Core Plug
Paragraph 4.E./GENERAL	Prepare and Apply Preimpregnated (Prepreg) Repair Plies

Table 1: Index of the Subjects (Continued)

Paragraph	Subject
Paragraph 4.F./GENERAL	Layup/Bagging Procedures
Paragraph 4.G./GENERAL	Cure the Repair
Paragraph 4.H./GENERAL	Refinish after Repair
Paragraph 4.I./GENERAL	Perform Post-Repair Requirements
Paragraph 5./GENERAL	Typical Repairs
Paragraph 5.A./GENERAL	Repair of Delaminations Between Plies
Paragraph 5.B./GENERAL	Repair of Puncture, 0.50-inch Diameter or Less, in Honeycomb Panel
Paragraph 5.C./GENERAL	Repair of Damage to One Skin and Honeycomb Core using Replacement Core Plug, Punctures Greater than 0.50-inch Diameter
Paragraph 5.D./GENERAL	Repair of Large Puncture through Internal and External Surface of Panel Including Core Damage
Paragraph 5.E./GENERAL	Replacement of Honeycomb Core on Damaged Edge of Panel
Paragraph 5.F./GENERAL	Repair of Hole Through Both Skins of a Honeycomb Panel with Access Available from One Side Only
Paragraph 5.G./GENERAL	Repair of Damaged Skin Plies in Panel Edgeband
Paragraph 5.H./GENERAL	Repair of Damage and Punctures in Solid Laminate Panels
Paragraph 5.I./GENERAL	Repair of Punctures, 0.25-inch Diameter or Less, in Solid Laminate Panels
Paragraph 5.J./GENERAL	Repair of Delamination Between Plies in Solid Laminate Panels
Paragraph 5.K./GENERAL	Repair of Damaged Panel Attach Holes in Honeycomb Panel Edgebands or along Edges of Solid Laminate Panels
Paragraph 5.L./GENERAL	Repair of Surface Dents
Paragraph 5.M./GENERAL	Repairs to Aluminum Foil

2. References

Reference	Title
51-10-01, GENERAL	Aerodynamic Smoothness Requirements
51-20-05, GENERAL	Repair Sealing
51-30	REPAIR MATERIALS
51-60-00, GENERAL	Control Surface Balance Moment Determination
51-70-02, GENERAL	Locations of the Principal Composite Components
51-70-06, GENERAL	Glass Fabric Reinforced Epoxy Laminates and Nonmetallic Honeycomb Sandwich Repairs - Room Temperature – 150°F (66°C) Cure (Wet Layup)
51-70-14, GENERAL	Allowable Damage and Repair of Flame-Sprayed Aluminum Coatings, Aluminum-Coated Glass Fabric (BMS 8-278), Aluminum Foil (BMS 8-289), and Expanded Aluminum Foil (BMS 8-336)
51-70-16, GENERAL	Hole Drilling and Machining of Composite Structures
51-70-17, GENERAL	Repairs to 250°F (121°C) and 350°F (177°C) Cured Graphite/Aramid/Fiberglass Reinforced Epoxy Laminates and Nonmetallic Honeycomb Sandwich Structure - 200°F (93°C) to 230°F (110°C) Wet Layup Repair Method
AMM 51-21	Aircraft Maintenance Manual
AMM 51-24-02	Aircraft Maintenance Manual
AMM 51-24-13	Aircraft Maintenance Manual

(Continued)

Reference	Title
AMM 51-41-00/201	Aircraft Maintenance Manual
DOCUMENT D6-49327	Certification of Autoclaves for Metal Bonding and Curing of Composite Structure
DOCUMENT D6-56273	Qualification of Heat Blankets for Hot Bonding
NDT Part 1, 51-01-01	Inspection of Repairs to Composite Structures
SOPM 20-30-99	Solvents For Final Cleaning of Composites Before Structural Bonding (Series 99)

3. Preparation for Repair

WARNING: HEAT, FIRE, OR SPARKS CAN CAUSE AN EXPLOSION. USE EXPLOSIONPROOF EQUIPMENT WHEN PERFORMING THESE REPAIRS. NONCOMPLIANCE COULD CAUSE PERSONNEL INJURY.

BREATHING VAPORS OR ALLOWING SOLVENT TO CONTACT SKIN OR EYES IS HAZARDOUS. WEAR NEOPRENE GLOVES, PROTECTIVE CLOTHING, AND EYE GOGGLES. IF CHEMICAL CONTACT OCCURS, WASH THOROUGHLY WITH WATER. IF CHEMICAL SHOULD SPLASH INTO EYES, FLUSH EYES WITH LARGE QUANTITIES OF WATER AND SEEK MEDICAL AID. USE MECHANICAL VENTILATION OR RESPIRATORY PROTECTION WHEN WORKING IN A CONFINED SPACE OR AREA.

A. Use suitable holding fixtures as given in Paragraph 4.G./GENERAL to prevent distortion and delamination of the structure.

B. Perform the repair procedures specified herein only in areas of reasonable cleanliness. Areas containing oil mist, exhaust fumes, gases, soot, rain, dust, or other particulate matter are specifically prohibited.

C. Protect surfaces from contamination. Do not touch cleaned parts or adhesive with bare hands. Use clean white gloves when handling parts.

D. Store rolls or precut kits of prepreg and adhesive material below 10°F in sealed moisture proof bags. An identification label must accompany the material inside the bag, with the following information: BMS Type, Class, grade, supplier name, batch number, roll number, prepreg lot number and date of kit preparation. Record storage time in and out of refrigeration.

E. Refer to REPAIR MATERIALS, SECTION/51-30 for source of repair materials and equipment.

F. Refer to 51-10-01, GENERAL for aerodynamic smoothness requirements.

G. Refer to 51-70-16, GENERAL for hole drilling and machining of composite structures.

H. See Figure 1/GENERAL for resin mixes and potting compound data.

I. Restore aluminum flame spray as given in 51-70-14, GENERAL.

J. Refer to 51-70-14, GENERAL for repair of aluminum foil where damage to the aluminum foil does not extend into the underlying plies.

K. Refer to Paragraph 5.M./GENERAL for repair of damage to underlying structure on parts having an outer layer of aluminum foil.

L. Refer to 51-70-02, GENERAL for locations of principal composite components.

M. Repair Tedlar according to Paragraph 4.H./GENERAL.

4. Repair Procedures Common to Various Repairs

A. Determine Damage

CAUTION: CHEMICAL PAINT STRIPPERS WILL ATTACK RESIN SYSTEMS, AND SHOULD NOT BE USED TO REMOVE PAINT BEFORE MAKING DAMAGE EVALUATIONS.

(1) Examine visually for extent of damage.

(2) Check part in vicinity of damage for entry of water, oil, fuel, dirt or other foreign matter. Water can be detected by radiographic methods. Remove contaminants as required.

(3) Check for delamination around the damage.

NOTE: Post repair inspection is recommended. Examples of inspection procedures are given in NDT Part 1, 51-01-01.

B. Remove Water From Damaged Area

(1) Remove water from honeycomb sandwich (Figure 2/GENERAL).

(a) Remove damaged skin plies to open up honeycomb area in the damaged area. Remove standing water using vacuum and oil-free compressed air.

(b) Sand the core to remove the adhesive. Removal of adhesive fillets on core is not required.

(c) Apply a fiberglass or metal fine mesh screen over the exposed core.

(d) Apply a thermocouple to the center of the screen.

(e) Apply a layer of glass fabric bleeder cloth over the screen and hold in place with masking tape.

(f) Place a vacuum line on the edge of the bleeder cloth and hold in place with masking tape.

(g) If the far side is accessible, apply thermocouple and heating blanket to the far side of the honeycomb sandwich manual.

NOTE: If the far side is accessible, it is acceptable to heat the area using a heating blanket only on the far side. An additional heating blanket and vacuum application may be used on the near side at the location shown in Figure 2/GENERAL to accelerate water removal. If the far side is inaccessible, use of a heating blanket on the near side is required.

(h) When the far side is inaccessible or when using an additional heating blanket, place the heating blanket over the bleeder cloth on the near side.

(i) Place extruded sealing compound around the entire area and seal the area with vacuum bag material.

(j) Evacuate the layup to a vacuum of 22 inches of mercury minimum.

(k) Heat the area for 1 hour minimum at 150°F (65°C) to 170°F (76°C). The rate of temperature rise must not exceed 5°F (3°C) per minute.

(l) Remove layup materials and proceed with repair procedure.

(2) Remove water from solid laminate.

(a) Remove damage and/or delamination. Remove standing water using vacuum and oil-free compressed air.

(b) Heat the area for 1 hour minimum at 150°F (65°C) to 170°F (76°C). The rate of temperature rise must not exceed 5°F (3°C) per minute.

CAUTION: REMOVE (FOR ALL TYPES OF CURE) OR ISOLATE (HEAT BLANKET ONLY) ALUMINUM STRUCTURE TO PREVENT LOSS OF STRENGTH IN THE ALUMINUM PARTS. ALL ALUMINUM ALLOYS, EXCEPT 2219, MUST BE KEPT BELOW 200°F (93°C). ALUMINUM 2219 CAN BE KEPT UP TO 400°F (204°C).

(CAUTION PRECEDES)

REMOVE SEALANTS, PAINTS AND PRIMERS IN THOSE AREAS WHERE THE TEMPERATUE COULD REACH ABOVE THE MAXIMUM ALLOWABLE TEMPERATURE. REFER TO SRM 51 20-01 FOR THE MAXIMUM ALLOWABLE TEMPERATURES.

C. Remove Damage and Prepare Damaged Area

(1) Damage Removal

(a) Trim out the damaged lamination to a smooth shape with rounded corners, or a circular or oval shape. Take care not to damage the undamaged plies, core or surrounding material.

NOTE: Remove only damaged plies, damaged doublers and damaged fillers.

(b) When the core is also damaged, remove the core by trimming to the same outline as the skin. For crush splice repairs (Paragraph 4.D./GENERAL) leave one to three core cells (0.4 maximum) visible between core cavity and skin (Figure 3/GENERAL). The core area removed should extend at least 0.5 further than visible core damage limits. Take care to avoid cutting into an undamaged skin on the opposite side. In cores greater than 1.0 thick, partially remove core (at least 0.5 deep) sufficient to clean up damage.

(c) In areas where contamination cannot be removed by cleaning or drying, remove the contaminated structure along with the other damage.

(d) When opposite inner skin is also damaged, trim out the damage to a smooth shape as described in Paragraph (a).

(e) When core is removed from inner surface of opposite skin, carefully smooth core down to adhesive film.

(f) Inspect cut out area to ensure that all damage has been removed.

CAUTION: SANDING FOR ADHESION OR FINISH REMOVAL MUST NOT EXPOSE OR DAMAGE FILAMENTS IN THE UNTAPERED SURFACE REPAIR AREA.

SANDING MUST NOT EXPOSE OR DAMAGE FILAMENTS IN EACH PLY WHEN STEP SANDING OR IN THE PLY BONDED TO THE CORE (FIGURE 4/GENERAL AND FIGURE 14/GENERAL).

LOSS OF STRUCTURAL STRENGTH OF THE COMPONENT WILL OCCUR IF THESE CAUTIONS ARE NOT OBSERVED.

DO NOT USE PAINT STRIPPERS FOR THE REMOVAL OF FINISH. DAMAGE TO THE ADHESIVE RESIN SYSTEM WILL OCCUR.

(2) Preparation of damaged area (Figure 4/GENERAL).

(a) Determine the number of plies that have been cut. Mask off the area around the cutout allowing 0.5 minimum overlap for each ply replacement, plus 0.5 extra for each repair ply to ensure that the existing top ply is completely covered by the repair.

NOTE: Where the number of plies is not apparent, refer to the applicable component structure identification or engineering drawing.

WARNING: SANDING GIVES OFF A FINE DUST THAT MAY CAUSE SKIN IRRITATIONS. BREATHING OF AN EXCESSIVE AMOUNT OF THIS DUST MAY BE INJURIOUS. OBSERVE PRECAUTIONS FOR SKIN AND RESPIRATION PROTECTION.

(WARNING PRECEDES)

EXPLOSIONPROOF EQUIPMENT MUST BE USED WHERE THE POSSIBILITY OF VAPOR IGNITION EXISTS. NONCOMPLIANCE COULD CAUSE PERSONNEL INJURY.

(b) Internal surface of panel (nonaerodynamic surface) and noncritical aerodynamic surfaces.

1) Remove the paint finish or Tedlar film in the masked off area using No. 240 or finer Scotch-Brite abrasive, or No. 150 or finer sandpaper.

2) If the damage area has a layer of aluminum foil, cut back the foil enough to allow a new foil layer to be at least 1.25 larger all around than the largest repair ply (Figure 16/GENERAL).

a) Strip the aluminum foil by peeling or abrading. Do not damage underlying composite fibers.

b) Carefully abrade to remove the primer on the aluminum foil to a border 1.25 larger all around than the repair area that was just stripped of aluminum foil. Spotty traces of primer covering up to 10 percent of the border area are acceptable.

c) Taper sand or step sand each ply as given in Item 3) below.

d) Lightly abrade and solent wipe the primer on the aluminum foil to a border 1.0 larger all around than the 1.25 wide band of foil that was exposed by primer removal.

e) Apply a chemical conversion coating to the exposed foil in the 1.25 border area.

3) Taper sand each ply or simply abrade the surface around the cleaned up damage a minimum of 0.5 per ply. See Figure 4/GENERAL.

4) An optional procedure for two or three ply laminate face sheets is to fill the cleaned up damage area flush with the 5 original surface using filler plies during the repair layup. The repair plies are then installed directly on the resulting smooth surface of the repair area.

5) Abrade surfaces around repair using No. 240 or finer Scotch-Brite abrasive.

(c) External surface of panel (critical aerodynamic surfaces).

1) Taper sand a uniform taper around the cleaned up damage using No. 80 sandpaper. Taper a minimum distance of 0.3 for each existing ply of the laminate. Step sanding is optional to taper sanding on sandwich structure except in areas of critical aerodynamatic smoothness. See 51-10-01 for location of areas of critical aerodynamic smoothness.

Always taper sand on solid laminate structures.

NOTE: For sanding, use a flexible disk sander, a belt sander, a rotating pad sander, or sand by hand.

2) Remove exterior finishes, including enamel finish and conductive coating from the surface of the 0.5 border using No. 150 or finer sandpaper.

(d) Edgeband of panel.

1) Taper sand panel edgeband according to Paragraph 4.C.(2)/GENERAL

NOTE: Edgeband is the solid laminate around the outer periphery of the honeycomb panel.

(e) Cleaning of repair area.

1) Remove all sanding dust by applying oil-free compressed air and use a vacuum cleaner.

WARNING: BREATHING VAPORS OR ALLOWING SOLVENT TO CONTACT SKIN OR EYES IS HAZARDOUS. HEAT, FIRE OR SPARKS CAN CAUSE AN EXPLOSION. USE MECHANICAL VENTILATION OR RESPIRATORY PROTECTION WHEN WORKING IN A CONFINED SPACE OR AREA. AVOID CONTACT WITH SKIN, EYES AND CLOTHING. WEAR EYE PROTECTION. KEEP AWAY FROM SOURCES OF HEAT, FIRE OR SPARKS.

CAUTION: DO NOT IMMERSE PARTS IN SOLVENT, OR ALLOW STANDING SOLVENT TO REMAIN ON PART. DAMAGE TO PART WILL OCCUR.

2) Wipe surfaces with a clean cloth moistened with solvent, Series 99 (AMM/ SOPM 20-30-99). Allow solvent to evaporate before proceeding with the repair.

D. Fabricate, Clean, and Install Honeycomb Replacement Core Plug

(1) Fabricate core plug.

(a) Fabricate core plug. Refer to the applicable component in the structure identification section to determine core type and material.

(b) For butt splicing, the honeycomb core plug should fit flush with original core and with ribbon direction the same as in original core. Trim replacement upto 0.05 of an inch smaller then the coutout. The replacement core is to fit snugly in the cutout after it is wrapped with foaming adhesive.

(c) For crush splicing, the honeycomb core plug should be made one to three cells (0.4 maximum) larger than the repair cavity (Figure 3/GENERAL). The core plug must be made from core material at least two grades denser than the original core.

(d) Trim core plug to full or partial depth of original core (Paragraph 4.C.(1)/GENERAL(b)) (Figure 5/GENERAL).

NOTE: When applicable, depth of core plug should allow for shrinkage during cure and for thickness of extra plies of fabric cloth and adhesive film between core plug and undamaged core or skin (Figure 4, 5, and 6).

(2) Clean core plug.

WARNING: BREATHING VAPORS OR ALLOWING SOLVENT TO CONTACT SKIN OR EYES IS HAZARDOUS. HEAT, FIRE OR SPARKS CAN CAUSE AN EXPLOSION. USE MECHANICAL VENTILATION OR RESPIRATORY PROTECTION WHEN WORKING IN A CONFINED SPACE OR AREA. AVOID CONTACT WITH SKIN, EYES AND CLOTHING. WEAR EYE PROTECTION. KEEP AWAY FROM SOURCES OF HEAT, FIRE OR SPARKS.

CAUTION: DO NOT EXCEED IMMERSION CRITERIA. DO NOT IMMERSE PARTS IN IN CHLORINATED SOLVENT OR ALLOW SOLVENT TO REMAIN ON PART. DAMAGE TO PART WILL OCCUR.

(a) Clean visually contaminated core by dipping (a maximum of four times) in an acetone or MEK bath for 60 seconds.

(b) Locally contaminated areas can be washed with MIBK, MEK, or Acetone.

(c) The core must be completely dry, clean, and free of evidence of solvents before installation.

(3) Install core plug (Figure 4, 5, 6, 7, 8, and 15).

NOTE: Most of the materials used in this procedure have limited life and require controlled storage conditions. Refer to the applicable material specifications for the maximum time out of the controlled storage and for the uncontrolled storage conditions.

Before opening the adhesive film wrapper, condition refrigerated adhesives to room temperature until moisture no longer condenses on the wrapper.

During use, suspend the film roll of adhesive horizontally

CAUTION: WHEN HANDLING ADHESIVE FILM WEAR CLEAN WHITE GLOVES TO PREVENT CONTAMINATION.

DO NOT TOUCH THE ADHESIVE FILM WITH BARE HANDS OR OTHER PARTS OF THE BODY.

DO NOT FOLD, STRETCH OR OTHERWISE THIN THE ADHESIVE FILM.

BONDING OF THE REPAIRED ASESMBLY MUST BE COMPLETED WITHIN 48 HOURS AFTER THE ADHESIVE HAS BEEN REMOVED FROM REFRIGERATED STORAGE. QUALITY OF THE ADHESIVE WILL BE REDUCED AFTER THIS TIME LIMIT.

(a) For partial core replacement, cut two pieces of BMS 8-145 Type I adhesive film and one piece of 120 fiberglass prepreg fabric to fit the repair hole. Place in position as shown in Figure 5/GENERAL.

(b) For full depth core replacement, where damage does not extend through both skins, trim a piece of BMS 8-145 Type I adhesive film to fit repair hole. Place on the inside surface of the undamaged skin (Figure 4, 5, 7 and 13).

(c) If both skins are damaged, tape a metal caul plate (such as 0.032 inch thick aluminum) against the exterior surface of the far side skin and repair as for damage to one skin only.

Repair the far side skin in a subsequent repair cycle.

(d) For butt splicing, wrap the edges of the core plug with BMS 5-90, Type III or IV, Class 350, grade 50 foaming adhesive and install in the repair cavity. Align the honeycomb ribbon with the original core ribbon direction.

(e) For crush splicing, prepare and install the core plug as given in Figure 3/GENERAL. Align the honeycomb core ribbon with the original core ribbon direction.

(f) Put the layup materials and equipment in place as given in Figure 7 (Sheet 2).

1) If the damage extends through both face skins, vacuum bag both sides of the panel (or the entire part) using the layup shown in Figure 7 (Sheet 2).

2) If the replacement core plug is less than or equal to 0.5 thick, use the heating blanket on the near side and locate at least two separate thermocouples on the panel surface at the bondline.

3) If the replacement core plug is greater than 0.5 thick and both sides are accessible, use heating blankets on both sides. Locate at least two separate thermocouples on the near side at the bondline and one on the far side corresponding to the center of the repair.

4) If the replacement core plug is greater than 0.5 thick and only one side is accessible, use the heating blanket on the near side and put at least two separate thermocouples into the repair hole so the thermocouples touch the repair materials at the bottom of the repair hole.

NOTE: The ends of these thermocouples will be cured into the adhesive. Cut the thermocouples leaving the embedded ends behind before applying the repair plies. Only the portion of the thermocouple embedded in the core can be left in the repair. The thermocouples cannot come between the repair plies and the sanded surfaces of the original plies.

(g) Evacuate the repair area to a vacuum of 22 inches of mercury minimum.

(h) Cure a minimum of 120 minutes at 345 to 365°F (174 to 185°C) (Figure 8/GENERAL).

(i) Allow the repair area to cool under vacuum until the temperature of the repair area is 125°F (52°C) or less. Then release restraints (if applicable) and remove layup materials and equipment.

(j) Sand core plug approximately flush with surrounding material, making allowance for film adhesive and slight core crush during cure.

(k) Vacuum to remove sanding residue from core cells.

NOTE: The core plug and the repair plies can be cured at the same time if the temperature can be adequately monitored by thermocouples placed on the outside surfaces of the panel (refer to Paragraph 3.D,(3)(e)2) thru 4)). If the thermocouples must be embedded in the repair core adhesive, then the core plug must be cured separately to avoid curing the thermocouple between the repair plies and the sanded surface of the original plies.

CAUTION: DO NOT CURE MORE THAN TEN (10) PLIES DURING ONE CURE CYCLE FOR HEAT BLANKET AND OVEN CURES. IF THE REPAIR HAS MORE THAN 10 PLIES, DIVIDE THE REPAIR PLIES EVENLY INTO MULTIPLE CURE CYCLES. IF YOU DO NOT OBEY, POROSITY AND BULGES CAN OCCUR AND THE SUBSEQUENT REPAIR WILL BE UNSATISFACTORY.

USE OF PRECURED PATCHES IS NOT RECOMMENDED. PRECURED PATCHES BONDED TO THE STRUCTURE UNDER VACUUM PRESSURE ONLY AND LARGE PATCHES BONDED TO CONTOURED SURFACES CAN RESULT IN POROUS OR NONCONTINUOUS BONDLINES.

THE PREIMPREGNATED MATERIAL AND ADHESIVE MUST REMAIN FREE OF CONTAMINATION DURING CUTTING AND HANDLING. WEAR CLEAN WHITE GLOVES WHEN HANDLING.

E. Prepare and Apply Preimpregnated (Prepreg) Repair Plies

NOTE: Before opening the prepreg material or adhesive film wrapper, condition refrigerated materials to room temperature until moisture no longer condenses on the wrapper.

During use, suspend the film roll of material horizontally through its axis free from other rolls or objects.

(1) Prepare prepreg glass fabric repair plies (BMS 8-139).

(a) Refer to the specific component structural identification section to determine type and orientation of glass fabric used in original structure. Repair existing plies of original structure with BMS 8-139, Type 1581 (Figure 9/GENERAL).

(b) From BMS 8-139, Type 1581 preimpregnated material, cut the required number of plies.

NOTE: Refer to par. (c) below for substitution of prepreg glass fabric plies.

Use one ply of prepreg in the patch for each damaged fiberglass ply of the original laminate, plus one extra repair ply, unless material substitution rules call for a different number of plies (Paragraph (c)).

See Figure 4/GENERAL for required overlap of repair plies. The repair plies must be installed with the same orientation as that of the original plies being repaired. The extra repair plies must be installed with the same orientation as the original surface ply.

Additional plies, to those above, may be required for specific repairs. Refer to the specific component repair section. If additional plies are required, use the glass fabric materials shown in Figure 9/GENERAL.

(c) Substitution of prepreg glass fabric plies (Figure 9/GENERAL).

1) If BMS 8-139, Type 1581 prepreg material is not available, three plies of BMS 8-139, Type 120 prepreg material may be substituted for each ply of Type 1581 prepreg material required.

CAUTION: ENSURE THAT PARTING FILM AND POLYETHYLENE SEPARATOR ARE REMOVED FROM REPAIR PLIES PRIOR TO LAYUP AND CURING. NONCOMPLIANCE WILL RESULT IN A RUINED REPAIR.

(2) Apply the repair plies (Figure 4/GENERAL and Figure 5/GENERAL).

NOTE: Where the damage has occurred at a lap joint in the original laminates, it is not necessary to make a comparable lap in the repair plies.

(a) Make a temporary vacuum bag system.

NOTE: This vacuum bag is used to compact the repair plies and prevent conamination of the repair. Do not use this vacuum bag system for the repair cure.

1) Put one layer of perforated parting film above the repair.

2) Put one layer of glass fabric cloth as a surface breather above the repair.

3) Apply the vacuum sealing compound around the repair area.

4) Put the vacuum bag material over the repair area. Seal the edges with the vacuum sealing compound.

5) Attach a vacuum line above the surface breather.

(b) Cut two plies of BMS 8-145, Type I adhesive film, 1/8 inch larger than the largest patch ply which also covers the entire repair area.

NOTE: After curing, the repair will need to be sanded in preparation for refinishing. An additional nonstructural ply covering the entire repair is added which may be sanded as required to obtain a smooth surface for refinishing. Be careful not to sand through this nonstructural sanding ply into the structural plies below it.

The second adhesive film ply will be used as a sanding ply. As an option, substitute a ply of BMS 8-139, Type 1581 fiberglass prepreg cut to the same size as the adhesive ply. The fiberglass is less likely to entrap air during the cure.

Repairs to aluminum foil will require both plies of adhesive film and one ply of BMS 8-139, Type 120 fiberglass prepreg.

(c) Place one layer of adhesive film over the entire repair area.

(d) Install the repair plies and, if necessary, the sanding ply also.

NOTE: Add filler plies as necessary to get a smooth repair. Do not use more than four filler plies on one repair area.

1) Install the smallest repair ply first.
2) Make sure that the warp direction of each repair ply that you put in the repair is correct and that the overlap is correct.
3) Install the next ply. Make sure that it is smooth with no wrinkles.
4) Remove the separator sheet.
5) Boeing recommends that you do the steps that follow:
    a) Compact the repair plies with a temporary vacuum system as follows for repairs that have five or more repair plies.
        - 1 minute for each ply (one ply at a time), or
        - 2 minutes for each two plies (two plies at a time), or
        - 6 minutes for each three plies (three plies at a time)
    b) Do steps 2) through 5) again for all of the repair plies as necessary to complete the layup.

(e) Apply a cover ply of BMS 8-139, Type 1581 fiberglass prepreg or the second ply of adhesive film over the replaced plies. If the repair includes repair to aluminum foil, use the second ply of adhesive film.

(f) If the repair has a layer of aluminum foil, repair the foil as given in Paragraph 5.M./GENERAL before proceeding with the bagging and cure of the part.

F. Layup/Bagging Procedure (Figure 7/GENERAL).

(1) As an optional step, place a layer of dry peel ply over the last layer of repair material. Cut the peel ply so it is large enough to contact the surface bleeder. When removed after curing, the peel ply leaves a rough surface which may be sanded for refinishing or left as is for any subsequent bonding to the repair area. The peel ply also helps to prevent pits in the cured repair surface.

(2) Place one layer of perforated FEP parting film over the replacement plies and extending at least 1 inch beyond the largest patch ply.

(3) Put on the thermocouples.

  (a) If you use an autoclave or an oven, then do the step that follows:

    1) Put one or more thermocouples at the location where the temperature will increase the fastest and one or more thermocouples where the temperature will increase the slowest.

    NOTE: Boeing recommends that you put one or more thermocouples at the thick areas of the part and tool and the thin areas of the part and tool. Use more than two thermocouples when more than 900 square inches of a panel surface is repaired. Insulation is not necessary in the repair area for autoclave or oven cures.

  (b) If you use a heat blanket, then do the step that follows:

    1) Secure three thermocouples (spaced evenly around the repair) to the panel at the edge of the repair and secure them to the temperature recording device.

(4) Place a layer of dry peel ply over the perforated FEP.

NOTE: The peel ply must be cut large enough to make contact with the surface breather.

(5) Place one layer of solid FEP parting film over the layup extending to 1/2 inch short of the edge of the dry peel ply.

(6) Place a heat blanket over the repair (if used).

NOTE: The heat blanket must extend a minimum of 2 inches beyond the edge of the patch.

When using a heat blanket that is longer than 12 inches on a side, an aluminum plate (0.040 max) should be used to minimize localized heating.

When two or more pads are used, the aluminum plate must be used.

  (a) If the area to be repaired is near or attached to aluminum structure that was not removed in Paragraph 4.C./GENERAL, do the steps that follow:

    1) Isolate the aluminum structure from the areas that will get hot.

    2) Add one or more thermocouples to put on the aluminum structure. Make sure that the temperature does not go above 200°F (93°C).

    3) You can put insulation around all other metals to prevent cold locations in the repair.

(7) Place a layer of Airweave SS or Style 120 glass fabric over the solid FEP as a surface breather, or, if heat blanket is used, place four to six layers of breather material over the heat blanket to act as an insulator and a surface breather.

NOTE: The surface breather material and the dry peel ply must make contact.

(8) Lay the vacuum line over the edge of the breather material.

(9) Apply extruded sealing compound around the entire repair area 2 to 6 inches outside the edge of the heat blanket.

(10) Secure the vacuum outlet to the surface breather cloth (outside of the repair ply area).

(11) Lay a piece of vacuum bag material over the entire repair area. Seal the edge with extruded sealing compound around the entire repair area. It is optional to envelope bag the entire part.

NOTE: Pleat the vacuum bag where needed to prevent bridging of bag material and subsequent bag breakage. Pad all sharp objects and corners to prevent bag breakage.

The whole part must be vacuum bagged and restrained in place to prevent delamination and distortion when the repair area exceeds 15% of panel area. Regardless of the method of heat application, restraining devices that maintain the contour and support the part must be used for large parts where sagging and distortion could occur due to the weight of the part.

(12) Check the vacuum bag and ensure that there are no leaks.

(13) Evacuate the space under the vacuum, bag and maintain a vacuum of 22 inches of mercury minimum.

NOTE: Maintain vacuum of 22 inches of mercury minimum during entire cure cycle.

G. Cure the repair. Do step (1) for the autoclave procedure, step (2) for the oven cure procedure, or do step (3) for the heat blanket cure procedure.

(1) For the autoclave cure procedure, see Figure 8/GENERAL, Detail I and do the steps that follow:

NOTE: Boeing recommends that you use a certified autoclave when you do the procedure that follows. DOCUMENT D6-49327, is a procedure that Boeing uses, and you can use this as a guide to certify your autoclave.

(a) During all of the repair procedure, make sure that the part to be repaired is held in the specified part tool. The specified part tool must have the same dimensions (or dimensions that are a small amount 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 in the part. A tool with the same thermal expansion properties will help keep the part at the correct contour and shape.

(b) 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 when you cure a repair above 250°F (121°C).

(c) Increase the temperature of the autoclave until it is at 130°F (54°C). When the temperature is at 130°F (54°C), increase the temperature at a rate of 1°F to 5°F (0.5°C to 3°C) for each minute until all thermocouples are in the 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 are more than 0.25 inch (6 mm) thick.

(d) Hold the cure temperature for the specified time as given in Figure 8/GENERAL, Detail I.

NOTE: Cure time does not include the time necessary for the layup and the part to get to the cure temperature. Cure time starts after all of the thermocouple indications are in the cure temperature range. If a thermocouple indication falls below the cure temperature range during the cure, extend the cure cycle time by the time necessary to get the thermocouple to the cure temperature.

(e) Keep the vacuum bag connection to the atmosphere open and the autoclave pressurized until after the cure is complete and the temperature of the part has decreased to 125°F (52°C).

(f) Decrease the autoclave temperature at a maximum rate of 5°F (3°C) for each minute.

(g) When the temperature is less than 125°F (52°C), release the autoclave pressure.

(h) Remove the vacuum bag equipment from the part and tool.

WARNING: USE HEAT CURE EQUIPMENT THAT IS PERMITTED BY THE LOCAL FIRE PROTECTION AUTHORITIES. IF YOU DO NOT OBEY, YOU CAN CAUSE INJURY TO PERSONNEL.

(2) If you use an oven to cure the repair, see Figure 8/GENERAL, Detail I and do the steps that follow:

NOTE: Use a circulating oven that has equipment that can supply a vacuum and can control the temperatures as given in this procedure.

(a) During all of the repair procedure, make sure that the part to be repaired is held in the specified part tool. The specified part tool must have the same dimensions (or dimensions that are a small amount 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 in the part. A tool with the same thermal expansion properties will help keep the part at the correct contour and shape.

(b) Apply a vacuum to the vacuum bag until you have a minimum of 22 inches (0.56M) of Hg (Mercury). Start the heatup process.

Keep a minimum of 22 inches (0.56M) of Hg (Mercury) during the full cure cycle.

(c) Increase the temperature of the oven until it is at 130°F (54°C). When the temperature is at 150°F (54°C), increase the temperatures at a rate of 1°F to 5°F (0.5°C to 3°C) for each minute until all thermocouples are in the cure temperature range.

(d) Hold the cure temperature for the specified time as given in Figure 8/GENERAL, Detail I.

NOTE: Cure time does not include the time necessary for the layup and the part to get to the cure temperature. Cure time starts after all of the thermocouple indications are in the cure temperature range. If a thermocouple indication falls below the cure temperature during the cure, extend the cure cycle time by the time necessary to get the thermocouple to the cure temperature.

(e) Decrease the 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), remove the vacuum pressure.

(g) Remove the vacuum bag equipment from the part and tool.

WARNING: USE HEAT CURE EQUIPMENT THAT IS PERMITTED BY THE LOCAL FIRE PROTECTION AUTHORITIES. IF YOU DO NOT OBEY, YOU CAN CAUSE INJURY TO PERSONNEL.

(3) For heat blanket cure, see Figure 8/GENERAL, Detail II and do the steps that follow:

NOTE: Boeing recommends that you use a qualified heat blanket when you do the procedure that follows. DOCUMENT D6-56273, is a procedure that Boeing uses, and you can use this as a guide to qualify your heat blanket.

(a) Make sure there is a minimum of three thermocouples for each heat blanket used. Refer to Paragraph 4.F./GENERAL

(b) Apply a vacuum to the vacuum bag until you have a minimum of 22 inches (0.56M) of Hg (Mercury). Start the heatup process. Keep a minimum vacuum of 22 inches (0.56M) of Hg (Mercury) during the full cure cycle.

(c) Increase the temperature of the heat source until the temperature of the repair is at 130°F (54°C). When the temperature is at 130°F (54°C), increase the temperature at a rate of 1 to 5°F (0.5 to 3°C) for each minute until all thermocouples are at the cure temperature.

NOTE: When you use a hot bond console, obey the manufacturer’s operation instructions.

(d) If necessary, put insulation on the cooler areas of the repair area, opposite of the heat source.

(e) Hold the cure temperature for the specified time as given in Figure 8/GENERAL, Detail II.

NOTE: Cure time does not include the time necessary for the layup and the part to get to the cure temperature. Cure time starts after all of the thermocouple indications are in the cure temperature range. If a thermocouple indication falls below the cure temperature during the cure, extend the cure cycle time by the time necessary to get the thermocouple to the cure temperature.

(f) Decrease the temperature at a rate maximum of 5°F (3°C) for each minute.

(g) When the temperature decreases to less than 125°F (52°C), release the vacuum pressure.

(h) Remove the vacuum bag equipment from the part and tool.

H. Refinish After Repair

CAUTION: DO NOT SAND INTO ORIGINAL STRUCTURE. FAILURE TO COMPLY WILL REDUCE THE STRENGTH OF THE COMPONENT.

(1) Lightly sand edge of top most repair ply as necessary to fair the edge. Sand surface of repair to produce a smooth finish without damaging fibers.

(2) Apply finish to the repaired surface using the following applicable methods.

(a) Where clear Tedlar film surfaces have been removed, seal with a brush coat of Resin Mix 3 (Figure 1/GENERAL). Cure for 6 to 8 hours at room temperature or at elevated temperature as given inFigure 10/GENERAL.

(b) Where gray or white Tedlar film surfaces have been removed, seal with Resin Mix 3 (Figure 1/GENERAL). Cure 6 to 8 hours at room temperature (or as given inFigure 10/GENERAL) and apply one coat of BMS 10-11 primer and one coat of BMS 10-60, Type II enamel (gray, BAC705; white, BAC7106).

(c) Where BMS 10-21 conductive coating has been removed, reapply as given in AMM 51-24-02.

(d) Where the abrasion resistant Teflon finish has been removed from the internal surface of the panel edgeband, reapply the finish according to AMM 51-24-13.

(e) Where the original painted surfaces have been removed, restore original finish according to AMM 51-21.

(f) Where sealant has been removed from around fittings, fasteners or fay surfaces to facilitate repairs, reapply BMS 5-95 sealant as given in51-20-05, GENERAL.

(g) Where bolts have been removed from aluminum fittings common to graphite, reinstall bolts wet with BMS 5-95 sealant and fillet seal around boltheads and nuts.

(h) Where aluminum flame sprayed areas have been damaged, repair as given in 51-70-14, GENERAL.

(i) Where aluminum coated glass fabric (BMS 8-278) has been repaired, aluminum flame spray as given in 51-70-14, GENERAL.

I. Do the Post-Repair Procedures

(1) Do an inspection of the repair to make sure that it is satisfactory. Make sure that there are no empty spaces between plies or defective bonds. The inspection must include the area that was hot plus 2 inches minimum all around.

(2) If you find the repair to be unsatisfactory, you must remove it and install the repair again.

NOTE: The post-repair inspection is recommended. Examples of the inspection procedures are given in NDT Part 1, 51-01-01. Other inspection procedures that have been examined and found to be satisfactory by the airline can be used.

WARNING: MAKE SURE THAT THE OUTBOARD AILERON, ELEVATOR, AND RUDDER (CONTROL SURFACES) ARE BALANCED CORRECTLY AT ALL TIMES. IF YOU DO NOT, FLIGHT SAFETY CAN BE AFFECTED.

(3) After you repair a control surface, you must do a check of the balance to find if a rebalance is necessary. Refer to 51-60-00, GENERAL as necessary.

CAUTION: MAKE SURE THAT REPAIRS MADE TO CONTROL SURFACES AND/OR ADJACENT STRUCTURE DO NOT INTERFERE WITH THE DESIGNED OPERATION OF THE CONTROL SURFACES. DAMAGE TO THE AIRPLANES STRUCTURE CAN BE THE RESULT.

(4) Do a check of all repairs to make sure of clearance and non-interference with the operation of control surfaces.

(5) If a repair creates a blockage of a drain hole in the airplane structure, drill through the repair at the initial drain hole location with the appropriate drill bit. Refer to AMM 51-41-00/201.

5. Typical Repairs

CAUTION: ESTABLISH COMPONENT MATERIAL AND REPAIR LIMITS PRIOR TO PROCEEDING WITH ANY REPAIRS.

NOTE: These repairs apply to all 350°F (177°C) fiberglass fabric reinforced honeycomb components, except radomes, when called out in applicable repair index of specific structure.

A. Repair of Delaminations Between Plies

(1) Delamination of plies over core area of panel (Figure 11/GENERAL).

(a) Determine extent of damage as given in Paragraph 4.A./GENERAL. Ensure that water and other contamination are removed as given in Paragraph 4.B./GENERAL.

(b) Cut away delaminated plies and prepare damaged area as given in Paragraph 4.C./GENERAL. Do not remove any core.

(c) Complete repair as given in Paragraph 4.E./GENERAL thru Paragraph 4.I./GENERAL.

(2) Repair of delaminations between plies of panel edgeband.

(a) Repair this type of damage as given in 51-70-17, GENERAL, Paragraph 3.A.

B. Repair of Puncture, 0.50-inch Diameter or Less, in Honeycomb Panel

(1) Repair this type of damage as given in 51-70-17, GENERAL, Paragraph 3.B.

C. Repair of Damage to One Skin and Honeycomb Core Using Replacement Core Plug, Punctures Greater than 0.50-inch Diameter (Figure 5/GENERAL)

(1) Determine extent of damage as given in Paragraph 4.A./GENERAL

(2) Ensure that all contamination and water are removed from damaged area as given in Paragraph 4.B./GENERAL.

(3) Remove damage and prepare area according to Paragraph 4.C./GENERAL.

(4) Fabricate, clean, and install honeycomb replacement core plug as given in Paragraph 4.D./GENERAL.

(5) Sand core plug approximately flush with surrounding material, making allowance for adhesive film and slight core crush during cure.

(6) Complete repair as given in Paragraph 4.E./GENERAL thru Paragraph 4.I./GENERAL.

D. Repair of Large Puncture Through Internal and External Surface of Panel Including Core Damage (Figure 12/GENERAL)

NOTE: For repair where access to inner surface is limited, refer to Paragraph 5.F./GENERAL.

(1) Determine extent of damage as given in Paragraph 4.A./GENERAL.

(2) Remove all contamination and water from damaged area as given in Paragraph 4.B./GENERAL.

(3) Remove damage and prepare area according to Paragraph 4.C./GENERAL.

(4) Fabricate, clean, and install honeycomb replacement core plug as given in Paragraph 4.D./GENERAL, except do not perform steps 3.D.(3)(e) through 3.D.(3)(j).

(5) Prepare and apply repair plies to one surface of the panel according to Paragraph 4.E./GENERAL. A caul plate may be used on the opposite face of the panel to restrain the core plug in place.

(6) Apply vacuum and cure according to Paragraph 4.F./GENERAL and Paragraph 4.G./GENERAL.Ensure that temperature is approximately equal on both sides of panel.

(7) Sand core plug approximately flush with surrounding material, making allowance for film adhesive and slight core crush during cure.

(8) Prepare and apply repair plies to the other surface of the panel according to Paragraph 4.E./GENERAL.

(9) Complete repair as given in Paragraph 4.F./GENERAL thru Paragraph 4.I./GENERAL

NOTE: The above two-stage cure procedure is recommended. As an option, a three-stage cure procedure may be used wherein the core plug installation and the repair plies on each side may be cured separately.

E. Replacement of Honeycomb Core on Damaged Edge of Panel (Figure 13/GENERAL).

(1) Determine extent of damage according to Paragraph 4.A./GENERAL.

(2) Remove all contamination and water from damaged area as given in Paragraph 4.B./GENERAL.

(3) Remove damage and prepare area according to Paragraph 4.C./GENERAL.

(4) Fabricate, clean, and install honeycomb replacement core plug as given in Paragraph 4.D./GENERAL.

(5) Sand core plug approximately flush with surrounding core material, making allowance for adhesive film and slight core crush during cure.

(6) Clean surfaces according to Paragraph 4.C.(2)/GENERAL.

(7) Complete repair as given in Paragraph 4.E./GENERAL thru Paragraph 4.I./GENERAL.

F. Repair of Hole Through Both Skins of a Honeycomb Panel with Access Available from One Side Only (Figure 6/GENERAL).

NOTE: This repair applies to flat panels (or nearly flat panels) where the damage extends completely through the panel, but access is not readily available to repair the unexposed side, and the repair is accomplished in one operation, i.e. core repair and patch overlay repair cured together.

(1) Determine extent of damage (.Paragraph 4.A./GENERAL).

(2) Ensure that all contamination and water is removed from damaged area (Paragraph 4.B./GENERAL).

(3) Remove damage and prepare area as given in Paragraph 4.C./GENERAL and the following:

(a) Cut a hole in the outer skin and core (D diameter) to permit a repair to be made to the inner skin with the required overlap.

NOTE: D diameter = d + N + 1 d = major diameter of oval hole in inner skin N = number of plies in the inner skin

Stepping of the plies in the inner skin is not necessary for this repair.

(b) Clean out damaged area in inner skin leaving an oval shaped hole, see detail I, Figure 6/GENERAL.

(4) Fabricate an airtight patch, Figure 6/GENERAL, Details II thru V to cover the oval hole from the inaccessible side as follows:

(a) Make a suitable mold on which to lay up the patch. A thin gauge aluminum sheet or any smooth surface can be used as a mold.

(b) Cover the mold with parting film or release agent.

(c) Lay up five plies of the same prepreg material used in the repair on the mold, using the procedures of Paragraph 4.E./GENERAL, except that all repair plies will have the same diameter and adhesive film will not be used. Make diameter of the repair plies at least equal to D diameter.

(d) Bag and cure the patch as given in Paragraph 4.F./GENERAL and Paragraph 4.G./GENERAL. Place thermocouples at the edge of the patch before cure.

(e) Remove the patch from the mold.

(f) Trim patch into an oval shape with a minor diameter slightly smaller than the major diameter of the cutout see Figure 6/GENERAL, Detail I.

(g) Drill a 1/8 diameter hole in the center of the patch for a cleco fastener.

(h) Abrade the surface of the patch using No. 240 or finer Scotch-Brite abrasive. Remove all sanding dust by applying oil-free compressed air and using a vacuum cleaner.

(i) Fabricate a strip of spring steel 1.0 X 10.0 inches and drill a 1/8 diameter hole in the center for the cleco fastener.

(j) Assemble the patch and spring steel together with a 1/8 diameter cleco fastener, see Figure 6/GENERAL, Detail II.

(5) Remove Tedlar, if required and abrade the underside of the inner skin to a distance of 0.38 inch from the edge of the elliptical cutout using No. 180 or finer sandpaper. Avoid abrasion of the existing ply filiments.

CAUTION: DO NOT IMMERSE PARTS IN TRICHLOROETHANE SOLVENT OR ALLOW STANDING SOLVENT TO REMAIN ON PART. DAMAGE TO PART WILL OCCUR.

(6) Clean out the repair area with oil-free compressed air. Wipe the surface with a clean cloth moistened with MEK, MIBK, or acetone.

(7) Bend up both ends of the spring steel and apply adhesive BMS 5-25 or BMS 5-92, see Figure 6/GENERAL.

(8) Holding the spring steel up - insert the patch into the oval hole, and orientate so that the hole is covered. Release the spring steel so that it holds the patch tightly up against the inner skin.

(9) Cure the adhesive as given in Figure 10/GENERAL. When cure is complete, remove the cleco fastener and spring. Fill hole for cleco fastener with adhesive BMS 5-25 or BMS 5-92. Allow this to cure.

(10) Clean out the repair area as given in Paragraph (6).

(11) Apply adhesive film BMS 8-245, Grade 03 or 05, 0.10 bigger than diameter D to the surface of the inner skin which fays with the inner skin repair plies.

(12) Cut the required number of repair plies to diameter D and apply repair plies to the inner skin.

(13) Fabricate and clean core plug as given inParagraph 4.D.(1)/GENERAL and Paragraph 4.D.(2)/GENERAL.

(14) Complete the installation of the core plug as given in Paragraph 3.D.(3)(b) thru 3.D.(3)(j).

(15) Prepare and apply repair plies to the outer skin surface of the panel and complete repair as given inParagraph 4.E./GENERAL thru Paragraph 4.I./GENERAL3.I.

G. Repair of Damaged Skin Plies in Panel Edgeband (Figure 14/GENERAL).

(1) Determine extent of damage as given in Paragraph 4.A./GENERAL.

(2) Remove all contamination and water from damaged area as given inParagraph 4.B./GENERAL. Area must be completely dried out.

CAUTION: DO NOT SAND INTO BOND PLY OR CORE (FIGURE 14/GENERAL). LOSS OF STRUCTURAL STRENGTH OF THE COMPONENT WILL OCCUR. BOND PLY IS ADJACENT TO CORE.

(3) Remove damage and prepare area according to Paragraph 4.C./GENERAL.

(4) Complete repair as given inParagraph 4.E./GENERAL thru Paragraph 4.I./GENERAL.

H. Repair of Damage and Punctures in Solid Laminate Panels

NOTE: This repair applies to components made from laminated fabric and/or tape plies and epoxy resin without a honeycomb core.

(1) Determine extent of damage as given in Paragraph 4.A./GENERAL.

(2) Remove all contamination and water from damaged area as given inParagraph 4.B./GENERAL. Area must be completely dried out. Any structure in the repair area that cannot be dried out must be removed along with the other damage.

(3) Remove damage and prepare area according to Paragraph 4.C./GENERAL.

NOTE: Taper sand edges of plies around repair on damaged side of panel.

(4) Prepare and apply repair plies according to Paragraph 4.E./GENERAL.

NOTE: If cleaned up damage penetrates solid laminate, secure a metal caul plate (such as 0.016 thick aluminum) to far side of panel to support repair plies.

(5) Complete repair as given in Paragraph 4.F./GENERAL thru Paragraph 4.I./GENERAL.

I. Repair of Punctures, 0.25-Inch Diameter or Less, in Solid Laminate Panels

NOTE: This repair applies to components made from laminated fiberglass fabric plies and epoxy resin without a honeycomb core.

(1) Check for delamination as given in Paragraph 4.A./GENERAL.

(2) If no delamination is found, clean up damage to a smooth, rounded shape. Repair as given inParagraph 5.B./GENERAL.

(3) If delamination is found, repair as given in Paragraph 5.H./GENERAL.

J. Repair of Delamination Between Plies in Solid Laminate Panels

NOTE: This repair applies to components made from laminated fiberglass fabric plies and epoxy resin without a honeycomb core.

(1) Repair delamination using methods described in Paragraph 5.H./GENERAL

K. Repair of Damaged Panel Attach Holes in Honeycomb Panel Edgebands or ALong Edges of Solid Laminate Panels (Figure 15/GENERAL).

(1) Determine the extent of damage as given in Paragraph 4.A./GENERAL.

(2) Remove all contamination and water from damaged area according to Paragraph 4.B./GENERAL Area must be completely dried out. Any structure in the repair area that cannot be dried out must be removed along with the other damage.

(3) Taper sand around the hole to remove damage according to Figure 15/GENERAL and Paragraph 4.C.(2)(d)/GENERAL.

(4) Clean area according to Paragraph 4.C.(2)/GENERAL.

(5) Complete repair as given in Paragraph 4.E./GENERAL thru Paragraph 4.H./GENERAL

(6) Drill and countersink fastener holes.

(7) Perform applicable post-repair requirements as given in Paragraph 4.I./GENERAL before returning the repaired component to flight service.

L. Repair of Surface Dents

(1) Check for delamination and broken fibers as given in Paragraph 4.A./GENERAL

(2) If delamination is found, repair as given in Paragraph 5.A./GENERAL.

(3) If broken fibers are found, repair as given in Paragraph 5.B./GENERAL or Paragraph 5.C./GENERAL.

(4) If no delamination or broken fibers are found, repair as given in 51-70-06, GENERAL, Paragraph 4.M.

M. Repair of BMS 8-289 ALuminum Foil (Figure 16/GENERAL and Paragraph 3.C.(2) (b)2))

NOTE: This repair is done in addition to the applicable repair of the underlying plies.

(1) Determine the extent of and remove damage. Apply repair materials to the underlying composite structure as given in Paragraph 5.A./GENERAL thru Paragraph 5.F./GENERAL, up to and including the step for applying the repair plies to the surface that had aluminum foil

(2) Apply a chemical conversion coating to Alodine treat the nonadhesive side of the splice strip, cover ply, and aluminum surfaces that will contact the splice strip and cover ply.

(3) Butt-splice a ply of BMS 8-289, Type 0/350/x/x/x over the repair area, adhesive side down, with a 0.25 maximum gap and no overlap allowance.

(4) Lay up splice strips of BMS 8-289, Type 0/350/x/x/x, Form II adhesive side up, so that they overlap each side of the splice line by about 1.25 inch. Form I is optional but requires chemical conversion coating treatment on nonadhesive side and 0.5 diameter holes on 2.0 centers.

NOTE: Do not allow the splice strip or cover ply to extend into the edgeband area of the panel. Electrical splicing is not allowed on the laminated edgeband faying surface.

(5) Apply a layer of BMS 8-145, Type I adhesive and a cover ply of BMS 8-139 Type 120 prepreg over the repair so that they overlap the outer edge of the splice strip by 1.0.

(6) Vacuum bag and cure to repair as given in Paragraph 4.F./GENERAL and Paragraph 4.G./GENERAL.

RESIN, PREPREG, OR ADHESIVE TYPE	COMPONENTS	PARTS BY WEIGHT	OPEN TIME BEFORE USE, OR POT LIFE OF MIXTURE	CURING TIME $\boxed{A}$
RESIN MIX 3 (SEALER RESIN)	EPIBOND 156A RESIN EPIBOND 156B HARDENER	98 TO 102 4.7 TO 5.3	15 TO 25 MINUTES AT 77 ±2°F (25 ±1°C)	12 HOURS AT 70°F (21°C) OR 1 TO 3 HRS AT 150°F (66°C)
RESIN MIX 3 (SEALER RESIN) ALTERNATE	FIBER-RESIN 5318S FIBER-RESIN 5318C	99 TO 102 49 TO 51	45 TO 60 MINUTES AT 70°F (21°C)	SEE FIG. 10
RESIN MIX 3 EPOX-O WELD (SEALER RESIN) ALTERNATE	TWO COMPONENT KIT	FOLLOW MANUFACTURERS INSTRUCTIONS FURNISHED WITH EACH KIT		
			45 TO 60 MINUTES AT 70°F (21°C)	SEE FIG. 10
RESIN MIX 3 (SEALER RESIN) ALTERNATE	EPIBOND 156A RESIN EPIBOND 941 HARDENER	98 TO 102 9.5 TO 10.5	45 TO 60 MINUTES AT 70°F (21°C)	SEE FIG. 10
RESIN MIX 3 (SEALER RESIN) ALTERNATE BMS 8-207 TYPE 1, CLASS II	FR-40 RESIN 5413C HARDENER	99 TO 101 14.5 TO 15.5	20 MINUTES AT 77 ±2°F (25 ±1°C)	12 HOURS MIN AT 65°F (18°C) 1 HOUR MIN AT 150°F (66°C) TO 170°F (77°C)
RESIN MIX 9 BMS 8-214 TYPE 1	EPOCAST 35A RESIN EPOCAST 927 HARDENER	99 TO 101 25 ±0.5	4 HOURS AT 70°F (21°C)	90 MINUTES AT 340°F (171°C) TO 360°F (132°C)
BMS 5-90 TYPE III, CLASS 350-10-10, GRADE 50 (FOAMING ADHESIVE FILM)	FM-490A MA-562 PL-685		$\boxed{C}$ $\boxed{D}$	SEE TEXT
BMS 5-90, TYPE IV, CLASS 350-10-10, (FOAMING EXTRUDABLE ADHESIVE)	PL-460		$\boxed{C}$ $\boxed{D}$	SEE TEXT
BMS 8-145 TYPE I				SEE TEXT

NOTES

- REFER TO SRM 51-30-00 FOR SOURCES OF MATERIALS.

$\boxed{A}$ CURE TIME IS THE MINIMUM TIME REQUIRED TO CURE PRIOR TO HANDLING OR SANDING.

$\boxed{B}$ BMS 8-139, TYPE 1581 WAS FORMERLY TYPE 181.

$\boxed{C}$ REMOVE THE MATERIAL FROM REFRIGERATION AND KEEP IT SEALED AT 65°F (18°C) TO 90°F (32°C) FOR A MINIMUM OF 8 HOURS BEFORE IT IS USED.

$\boxed{D}$ THE MATERIAL MAY BE PUT BACK INTO REFRIGERATION ONE OR MORE TIMES WHEN THE CUMULATIVE OUT-TIME IS NOT MORE THAN 10 DAYS.

Resin, Prepreg, and Adhesive Type Specifications and Mixing Procedures
Figure 1 (Sheet 1 of 2)

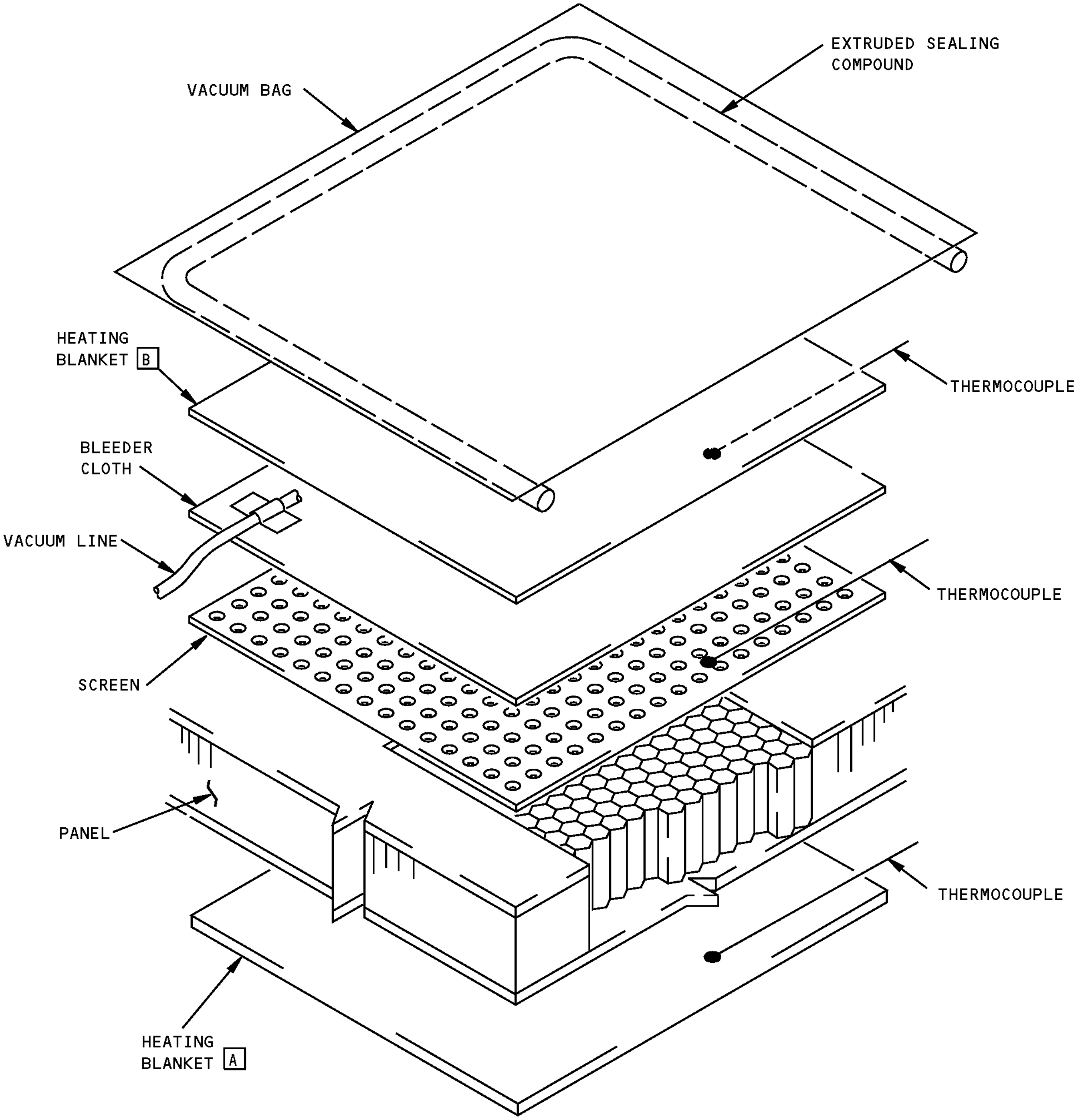
RESIN, PREPREG, OR ADHESIVE TYPE	COMPONENTS	PARTS BY WEIGHT	OPEN TIME BEFORE USE, OR POT LIFE OF MIXTURE	CURING TIME
BMS 8-139 (GLASS PREPREG) CLASS II TYPES: 120 1581 B	 120-F164-6-F50 1581-F164-6-F50		15 DAYS AT 65°F TO 80°F 1 DAY AT 81°F TO 110°F	SEE TEXT

WARNING: THESE CHEMICALS CONTAIN TOXIC INGREDIENTS. PROVIDE ADEQUATE VENTILATION AND PROTECT THE SKIN AND EYES FROM CONTACT WITH UNCURED RESINS OR CURING AGENT. WEAR NEOPRENE GLOVES OVER COTTON GLOVES FOR PROTECTION OF HANDS. IF SKIN IS EXPOSED TO DIRECT CONTACT WITH UNCURED RESINS OR CURING AGENT, WASH WITH WARM WATER OR SOAP. AVOID THE USE OF SOLVENTS FOR CLEANING THE SKIN.

CAUTION: TO PREVENT CONTAMINATION OF THE RESIN, DO NOT USE WAXED CONTAINERS FOR MIXING.

	MIXING PROCEDURE
RESIN MIX 3 RESIN MIX 9	ADD HARDENER TO RESIN AND MIX THOROUGHLY
BMS 5-90 BMS 8-145	REMOVE WRAPPER BEFORE USE

Resin, Prepreg, and Adhesive Type Specifications and Mixing Procedures
Figure 1 (Sheet 2 of 2)

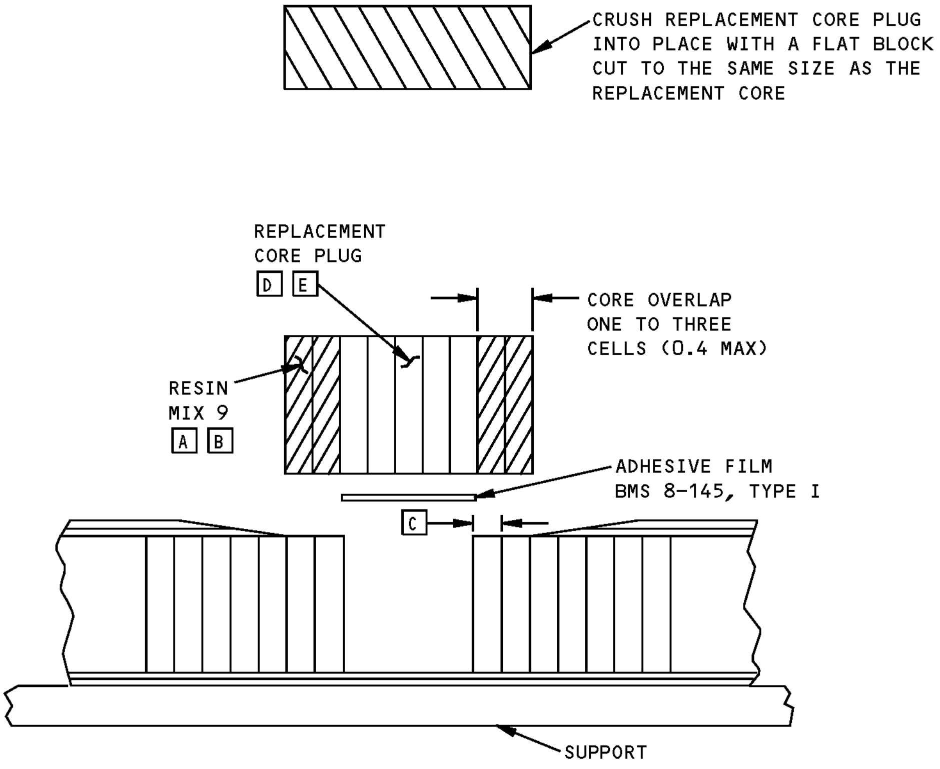


NOTES

A PREFERRED LOCATION OF HEATING BLANKET WHEN OPPOSITE FACE IS ACCESSIBLE

B ALTERNATE LOCATION OF HEATING BLANKET WHEN OPPOSITE SIDE IS INACCESSIBLE. THIS LOCATION MAY BE USED FOR AN ADDITIONAL HEATING BLANKET TO ACCELERATE WATER REMOVAL

Water Removal From Honeycomb Sandwich
Figure 2



NOTES

- CORE CRUSH SPLICING MAY ONLY BE USED WHEN SPLICING BMS 8-124, CLASS I, TYPE I, GRADE 4.0 OR HIGHER DENSITY, FIBERGLASS REINFORCED NON-METALLIC HONEYCOMB CORE

A DIP PERIPHERY OF CORE PLUG IN RESIN MIX 9 TO A DEPTH OF ONE TO THREE CELLS (0.4 MAX)

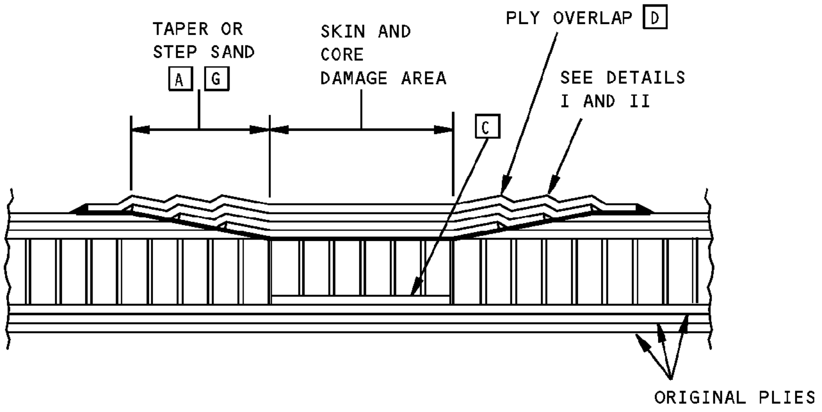
B AFTER SPLICING, POUR RESIN MIX 9 INTO SPLICED CELLS

C WHEN PREPARING REPAIR AREA LEAVE ONE TO THREE CELLS (0.4 MAX) VISIBLE BETWEEN CORE REPAIR CAVITY AND SKIN TO MATCH CORE OVERLAP

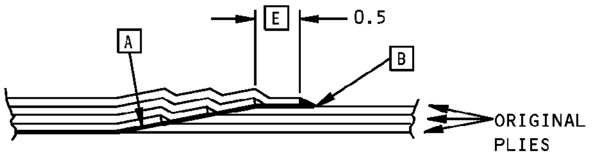
D ALIGN HONEYCOMB RIBBON OF REPAIR PLUG WITH ORIGINAL CORE

E REPLACEMENT CORE PLUG MUST BE MADE FROM CORE MATERIAL AT LEAST TWO GRADES DENSER THAN THE ORIGINAL CORE

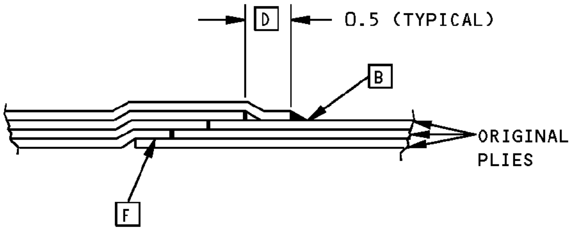
Core Crush Splicing Requirements
Figure 3



SECTION THROUGH TYPICAL REPAIR
(PREPREG LAYUP ONLY)



TAPER SANDED SKIN
DETAIL I



STEP SANDED SKIN
DETAIL II

NOTES

A TAPER SAND AROUND REPAIR AREA OVER DISTANCE OF 0.5 INCH FOR EACH EXISTING PLY

B DO NOT EXPOSE OR DAMAGE FILAMENTS IN UNTAPERED AREA WHEN SANDING.

C SANDING MUST NOT EXPOSE OR DAMAGE THE FILAMENTS IN BOND PLY (PLY BONDED TO CORE).

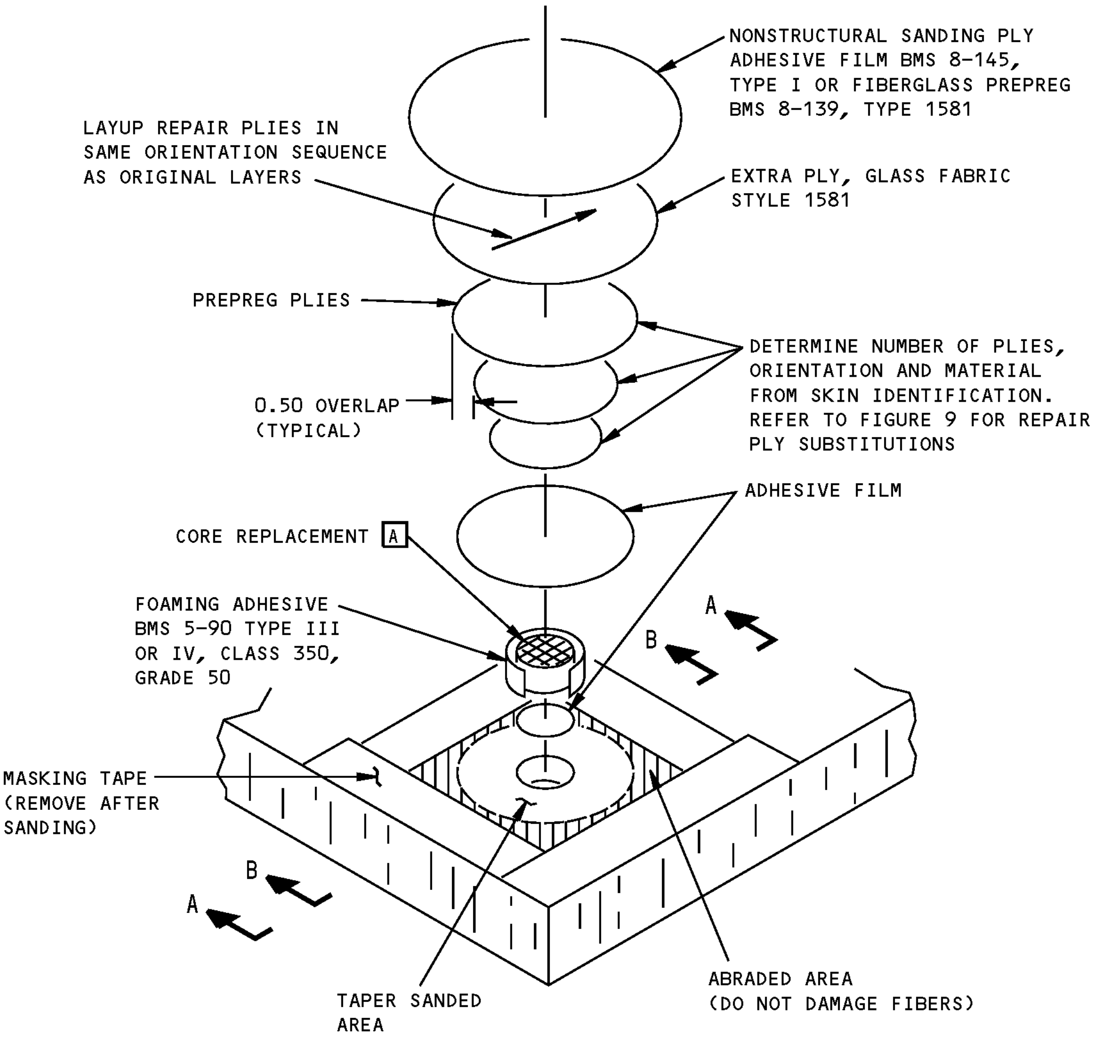
D EXTRA PLY MUST OVERLAP AT LEAST 0.5 INCH. EACH SUCCEEDING PLY MUST OVERLAP AT LEAST 0.5 INCH PAST EDGE OF PRECEEDING PLY

E SURFACE PLY FAYING SURFACE MUST BE AT LEAST 0.5 INCH PAST EDGE OF TAPER.

F REMOVE DAMAGED PLIES IN STEPS OF 0.5 INCH FOR EACH EXISTING PLY

G TAPER SAND SURFACES IN AREAS OF CRITICAL AERODYNAMIC SMOOTHNESS. REFER TO 51-10-01

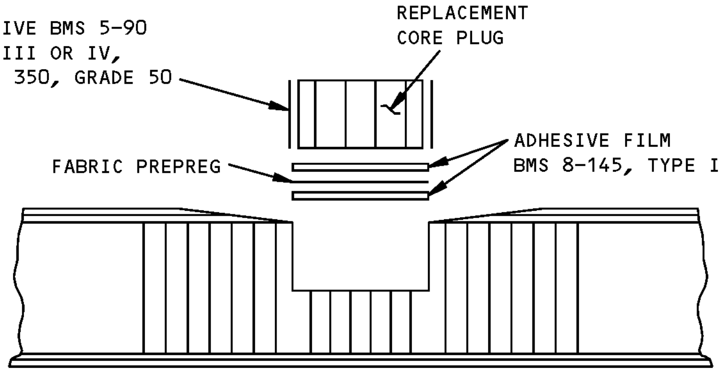
Sanding and Overlap Requirements
Figure 4



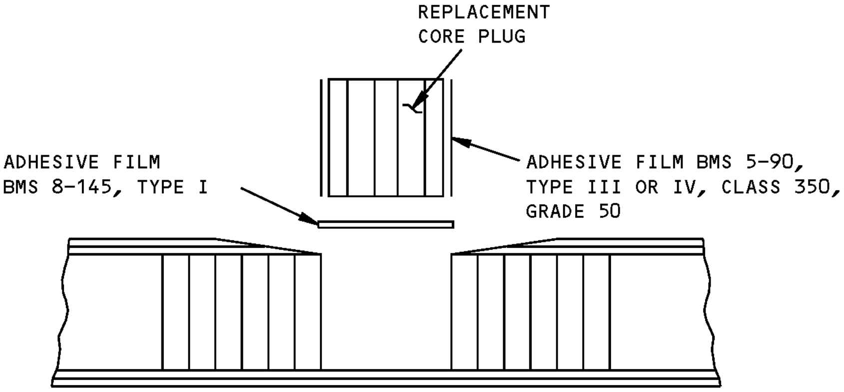
NOTES

A BUTT SPLICING SHOWN. FOR CRUSH SPLICING REFER TO FIGURE 3.

Repair of Large Punctures Thru One Skin of a Sandwich Structure Including Core Damage - 350 Degrees F (177 Degrees C) Cure
Figure 5 (Sheet 1 of 2)

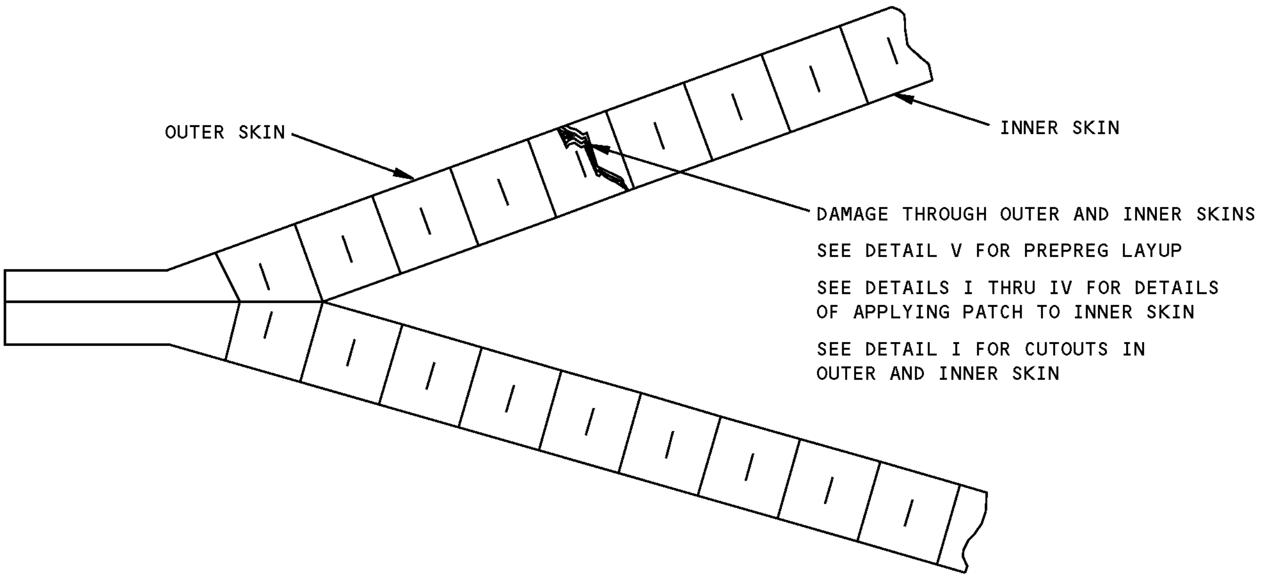


SECTION THRU REPAIR AREA - PARTIAL DEPTH CORE REPLACEMENT
SECTION A-A



SECTION THRU REPAIR AREA - FULL DEPTH CORE REPLACEMENT
SECTION B-B

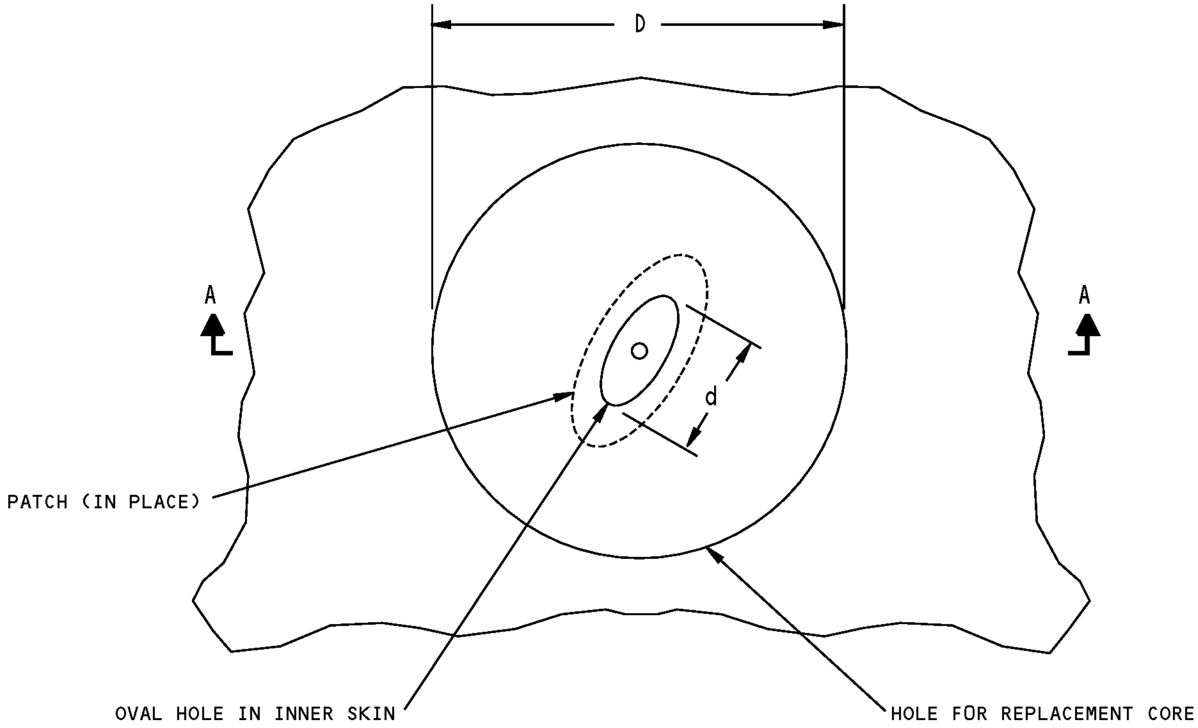
Repair of Large Punctures Thru One Skin of a Sandwich Structure Including Core Damage - 350 Degrees F (177 Degrees C) Cure
Figure 5 (Sheet 2 of 2)

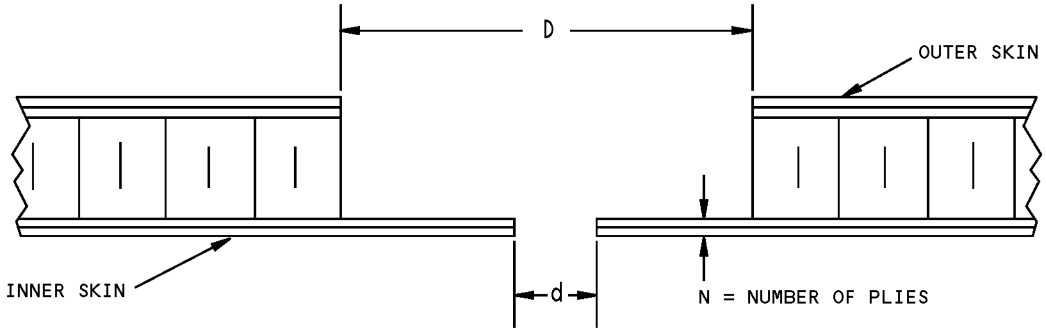


NOTES

- A FILM ADHESIVE APPLIED TO CORE PLUG EDGE (SEE PAR. 4.D.(3)).
- B MAKE TAPER AND OVERLAP PER FIG. 4.

Repair of Damage to External and Internal Skins with Access Limited to One Side - 350 Degrees F (177 Degrees C) Cure
Figure 6 (Sheet 1 of 4)





SECTION A-A
(PATCH NOT SHOWN)

- D = d + N + 1

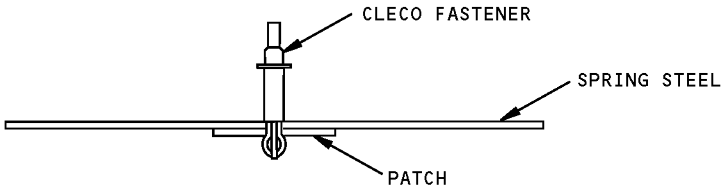
  d = MAJOR DIAMETER OF OVAL HOLE IN INNER SKIN
  N = NUMBER OF PLIES
  D = DIAMETER OF HOLE FOR REPLACEMENT CORE

EXAMPLE

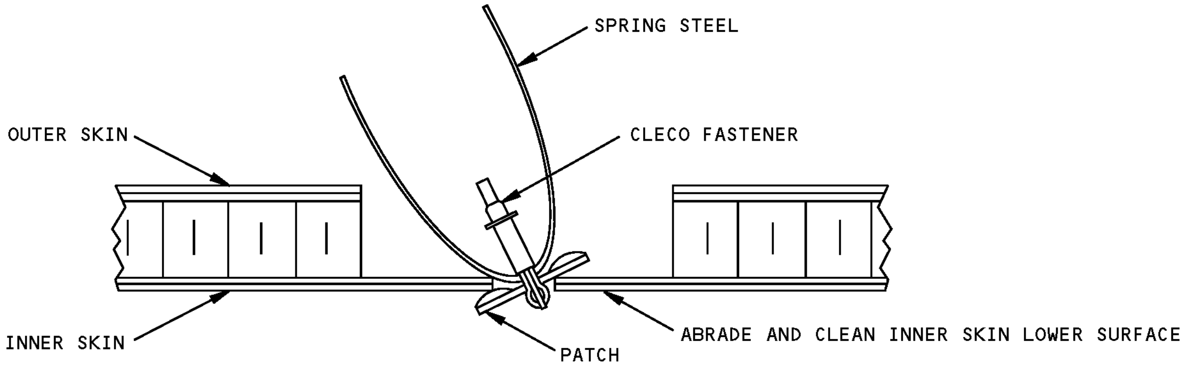
d = 0.50 INCH
D = 0.50 + 2 (PLIES) + 1
D = 3.50 INCH DIAMETER

DETAIL I

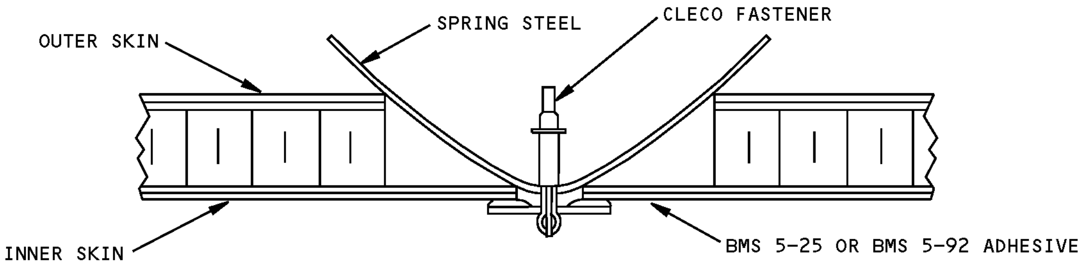
Repair of Damage to External and Internal Skins with Access Limited to One Side - 350 Degrees F (177 Degrees C) Cure
Figure 6 (Sheet 2 of 4)



ASSEMBLE PATCH AND SPRING STEEL
DETAIL II

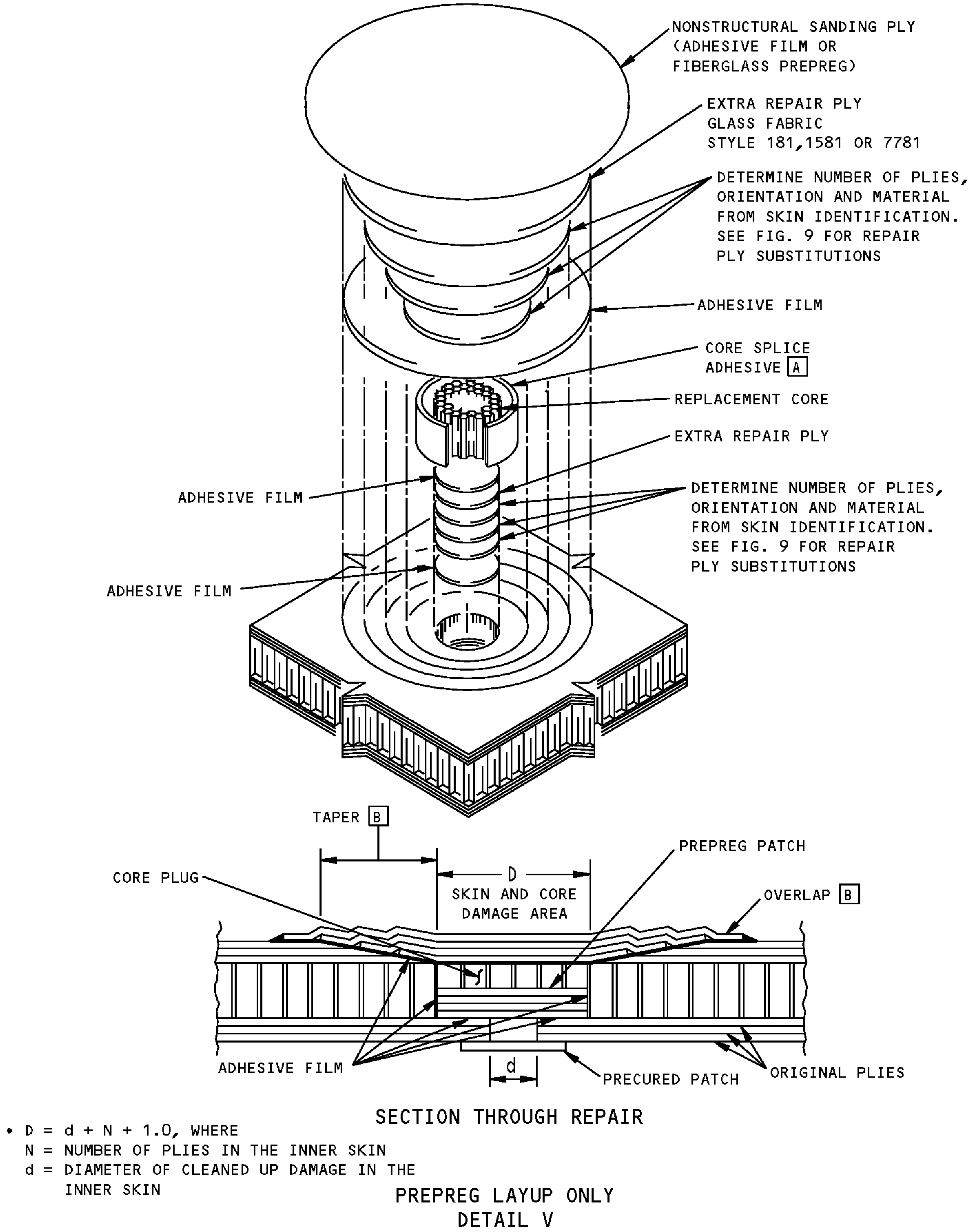


INSERT PATCH INTO OVAL HOLE
DETAIL III



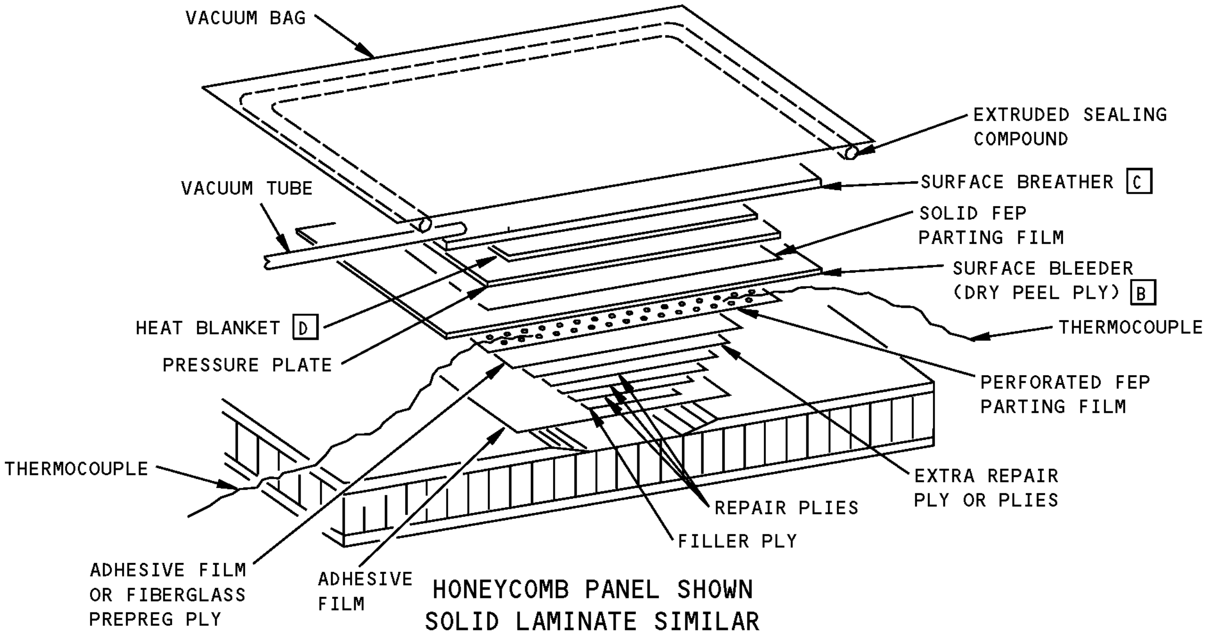
HOLD PATCH IN PLACE WHILE CURING
DETAIL IV

Repair of Damage to External and Internal Skins with Access Limited to One Side - 350 Degrees F (177 Degrees C) Cure
Figure 6 (Sheet 3 of 4)

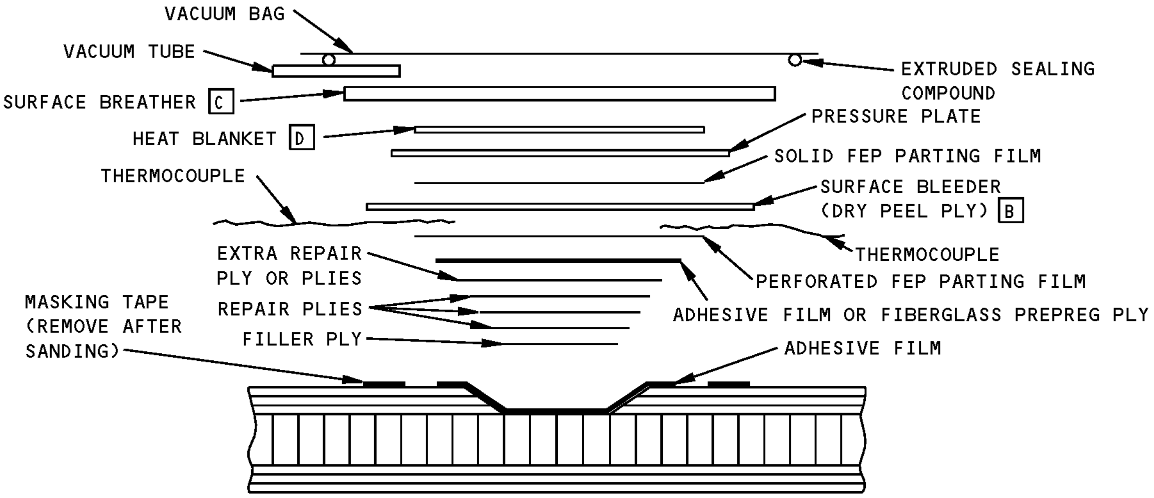


- D = d + N + 1.0, WHERE
  N = NUMBER OF PLIES IN THE INNER SKIN
  d = DIAMETER OF CLEANED UP DAMAGE IN THE INNER SKIN

Repair of Damage to External and Internal Skins with Access Limited to One Side - 350 Degrees F (177 Degrees C) Cure
Figure 6 (Sheet 4 of 4)



BAGGING SEQUENCE FOR SKIN PLY REPAIR



SECTION THRU SKIN PLY REPAIR

NOTES

A ONE PLY OF ADHESIVE FILM (FOR FULL DEPTH CORE REPLACEMENT, WHERE DAMAGE DOES NOT EXTEND THROUGH BOTH SKINS). FOR PARTIAL CORE REPLACEMENT USE TWO PLIES OF ADHESIVE FILM WITH ONE PLY OF BMS 8-139, TYPE 120 FIBERGLASS PREPREG BETWEEN THEM.

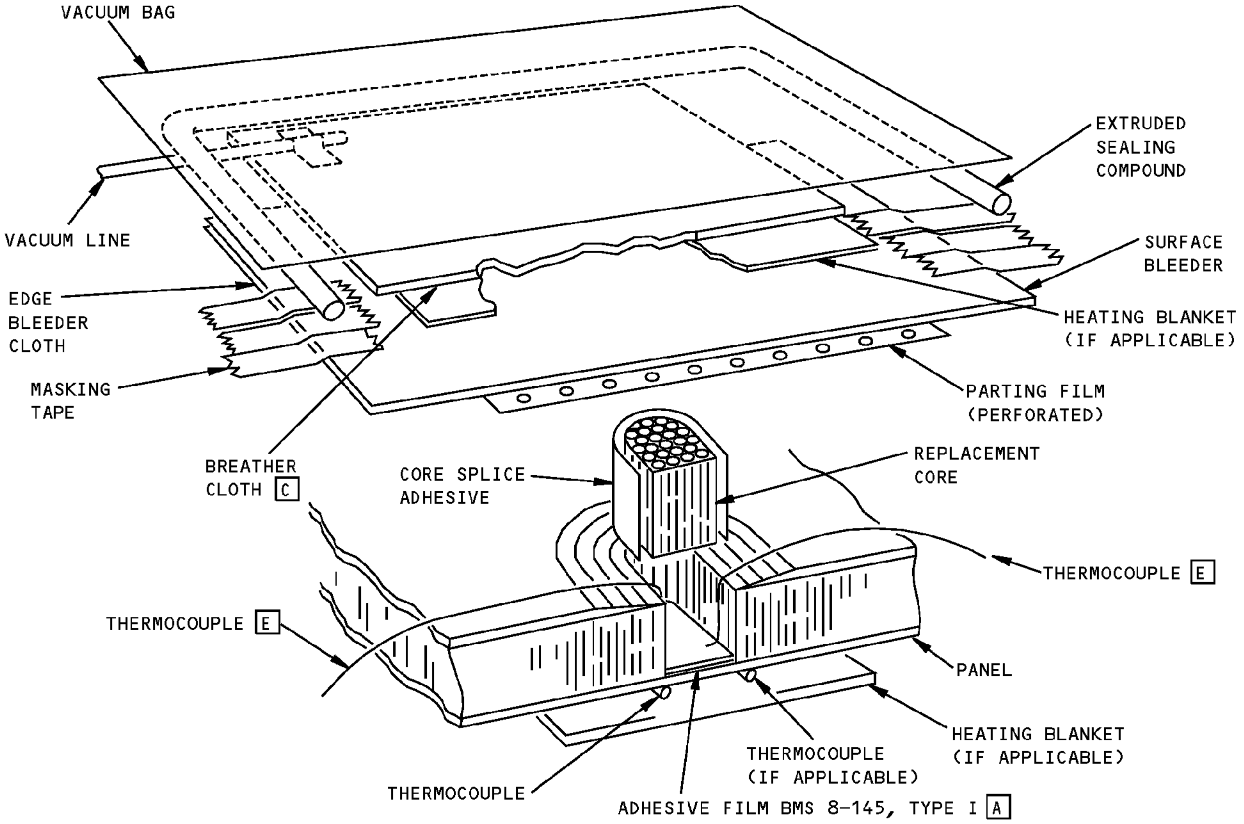
B DRY PEEL PLY MUST MAKE CONTACT WITH THE SURFACE BREATHER MATERIAL.

C WHEN USING A HEATING BLANKET, USE 4 TO 6 LAYERS OF BREATHER MATERIAL TO PREVENT DAMAGE TO VACUUM BAG.

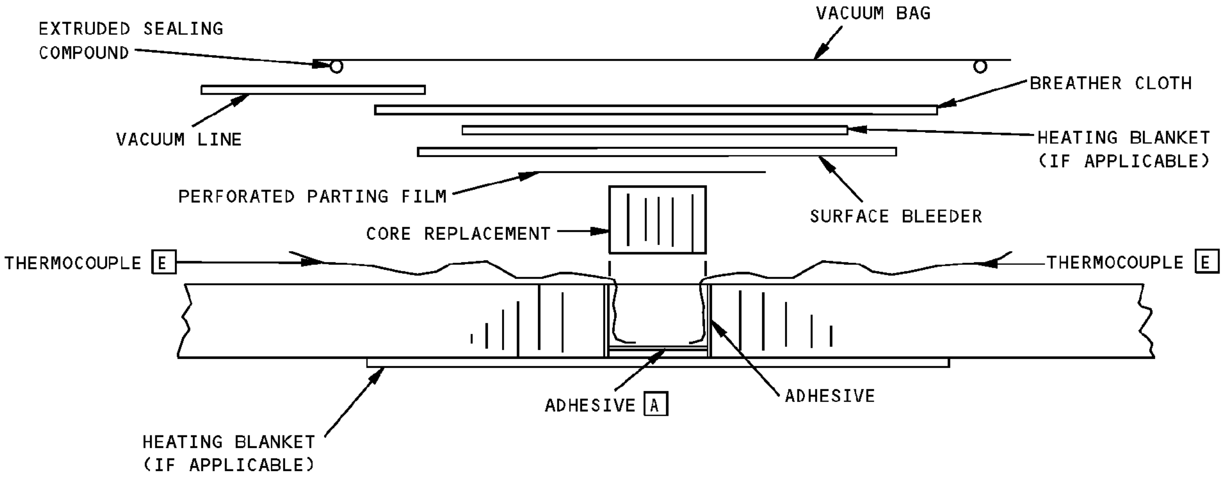
D HEATING BLANKET MUST EXTEND A MINIMUM OF 2 INCHES BEYOND EDGE OF REPAIR PATCH.

E IT IS PERMISSIBLE TO LEAVE A THERMOCOUPLE BONDED TO THE INSIDE OF A HONEYCOMB CORE CELL PROVIDED IT DOES NOT INTERFERE WITH SUBSEQUENT SKIN REPAIR. SEE PAR. 4.D.(3)(f)2) THRU 5)

Application of Pressure During Cure - 350 Degrees F (177 Degrees C) Cure
Figure 7 (Sheet 1 of 2)

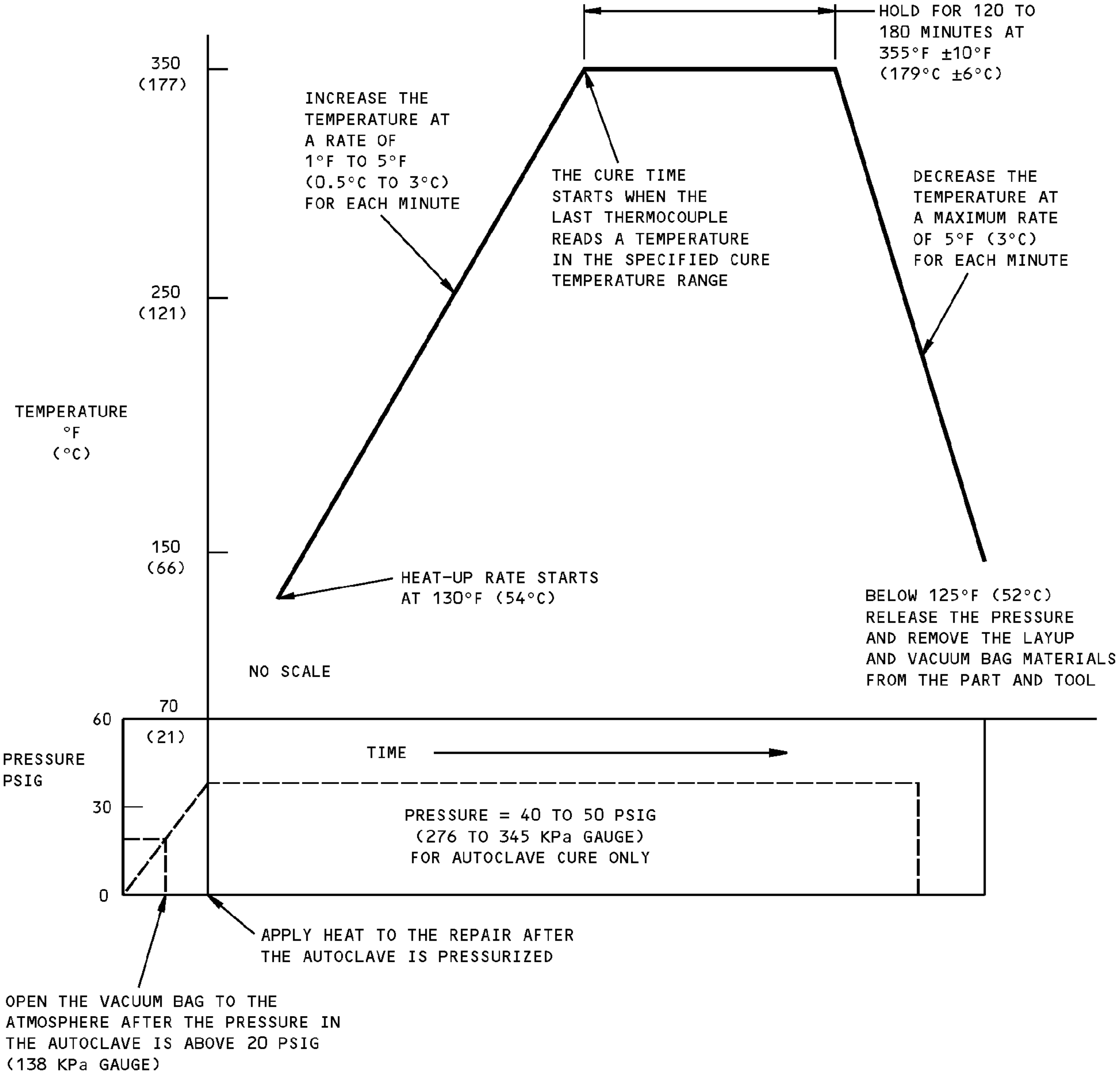


BAGGING SEQUENCE FOR CORE REPLACEMENT



SECTION THRU LAYUP FOR CORE REPLACEMENT

Application of Pressure During Cure - 350 Degrees F (177 Degrees C) Cure
Figure 7 (Sheet 2 of 2)



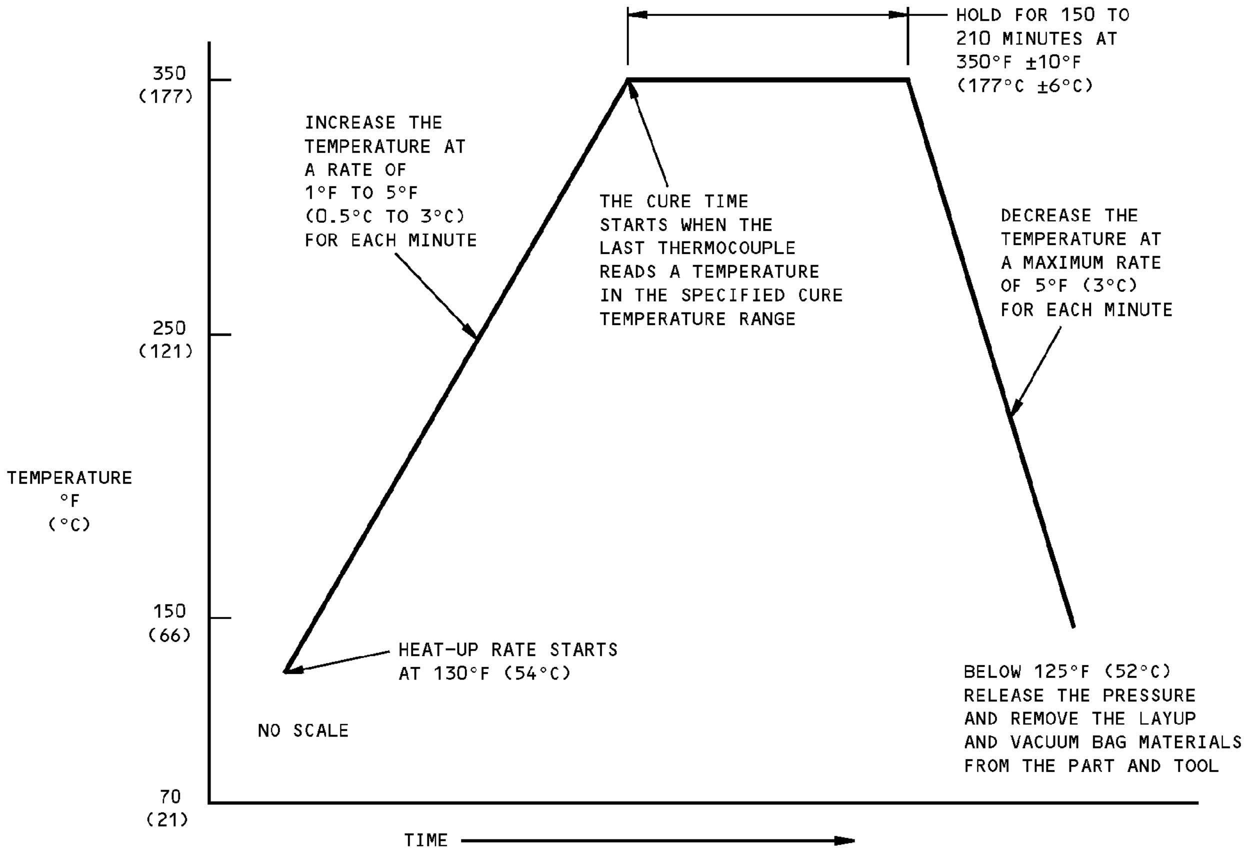
NOTES

- 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

DETAIL I

Repair Cure Cycles
Figure 8 (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

DETAIL II

Repair Cure Cycles
Figure 8 (Sheet 2 of 2)

BMS 8-139 TYPE	SEPARATOR FILM COLOR	THICKNESS PER PLY, INCHES	PLY SUBSTITUTIONS
120 $\boxed{A}$	BLUE	0.004-0.006	NONE
1581 $\boxed{A}$ $\boxed{B}$	BLUE	0.008-0.012	BMS 8-139, TYPE 120 $\boxed{A}$

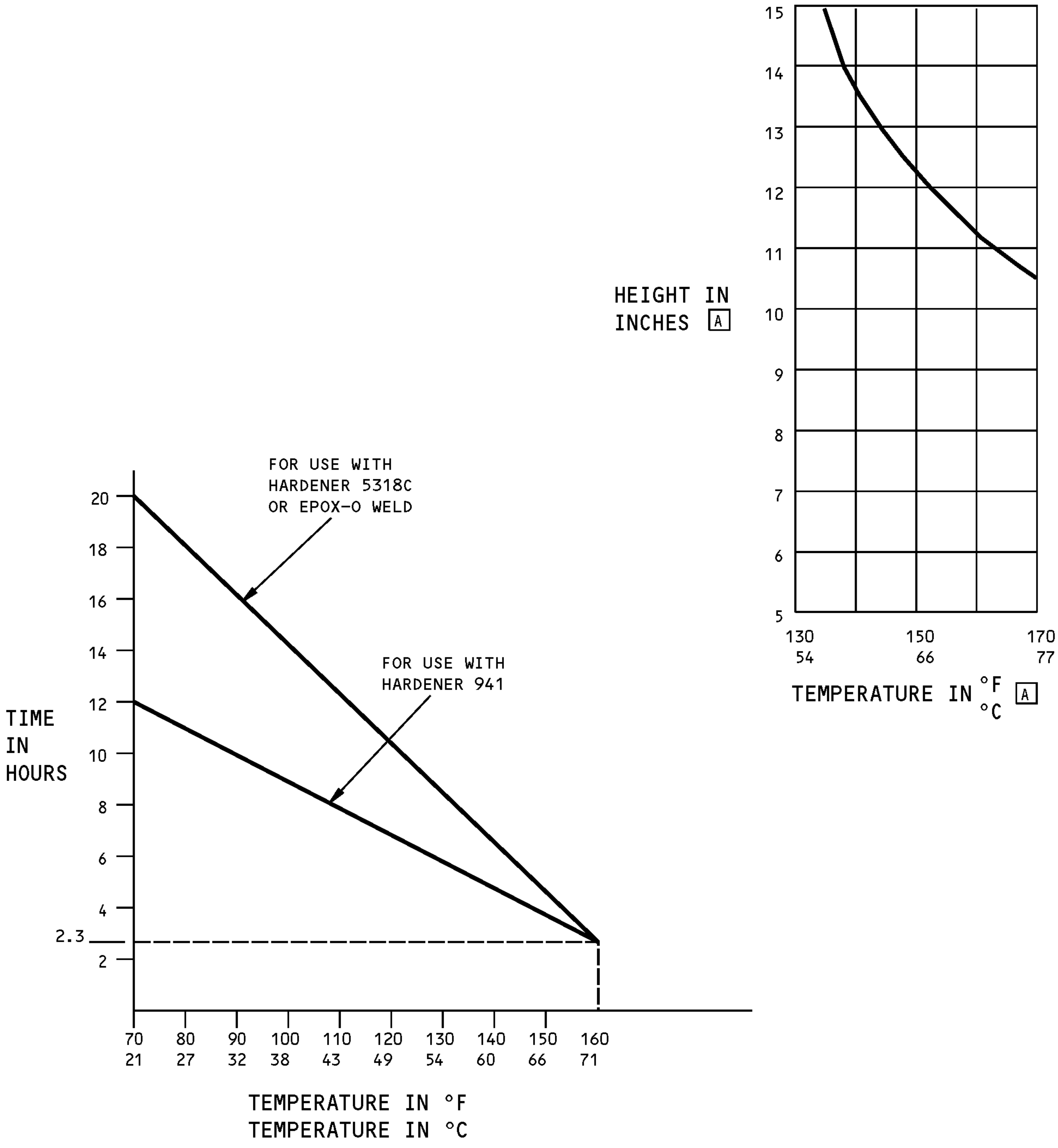
BMS 8-139 GLASS FABRIC PREPREG DATA

NOTES

$\boxed{A}$ TYPE 1581 IS PREFERRED FOR USE AS REPAIR PLIES. THREE PLIES OF TYPE 120 MAY BE SUBSTITUTED FOR EACH PLY OF TYPE 1581

$\boxed{B}$ TYPE 1581 WAS FORMERLY TYPE 181

BMS 8-139 Glass Fabric Prepreg Data
Figure 9

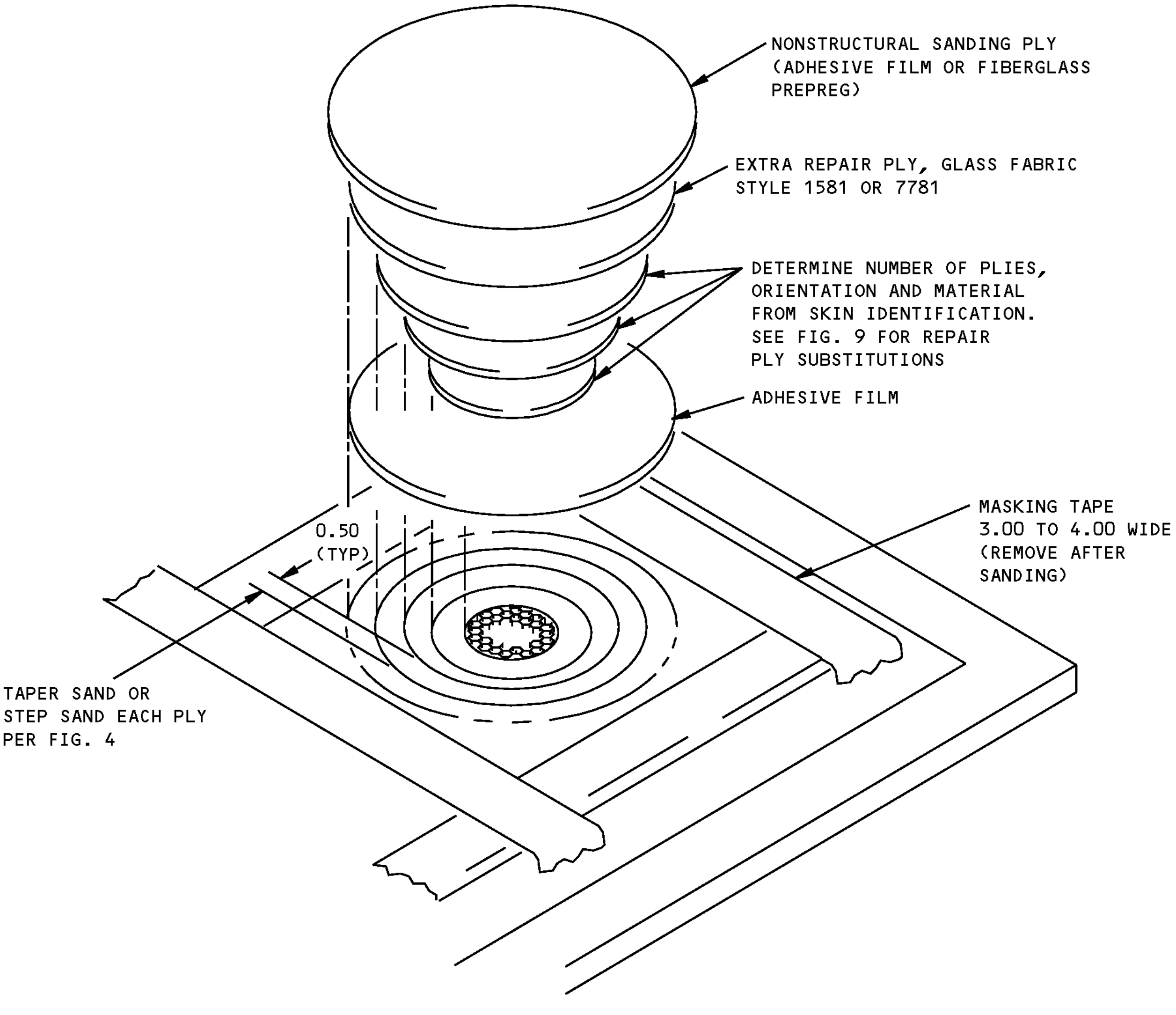


NOTES

- USE THERMOCOUPLES TO MONITOR TEMPERATURE

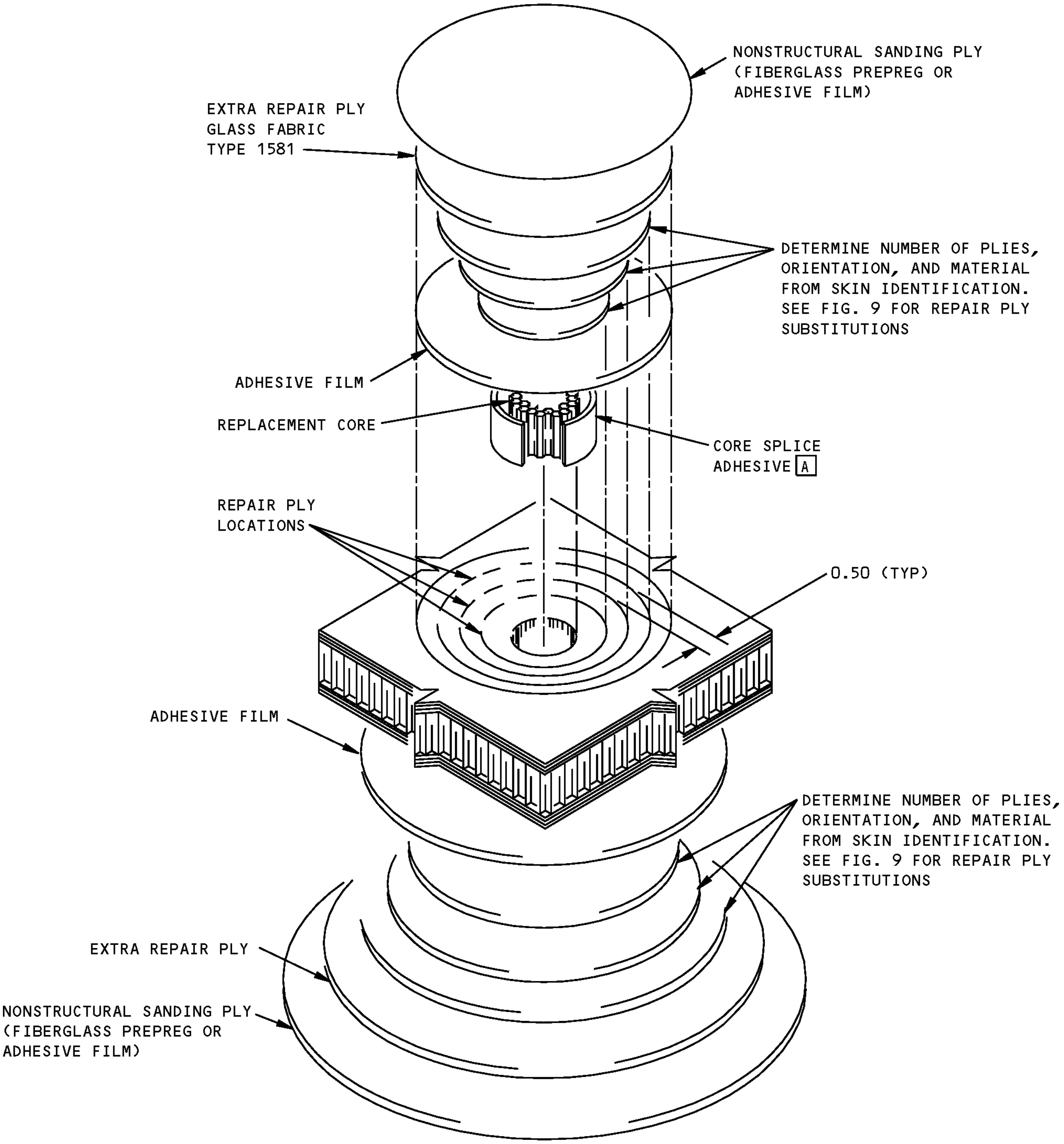
A THE HEIGHT IN INCHES OF 250 WATT HEAT LAMP FROM THE SURFACES OF THE PATCH VS TEMPERATURE AT SURFACE OF PART

Potting and Laminating Resin Cure Temperature
Figure 10



PREPREG PLY LAYUP ONLY

Repair of Damaged External or Internal Skins of a Sandwich Panel - 350 Degrees F (177 Degrees C) Cure
Figure 11



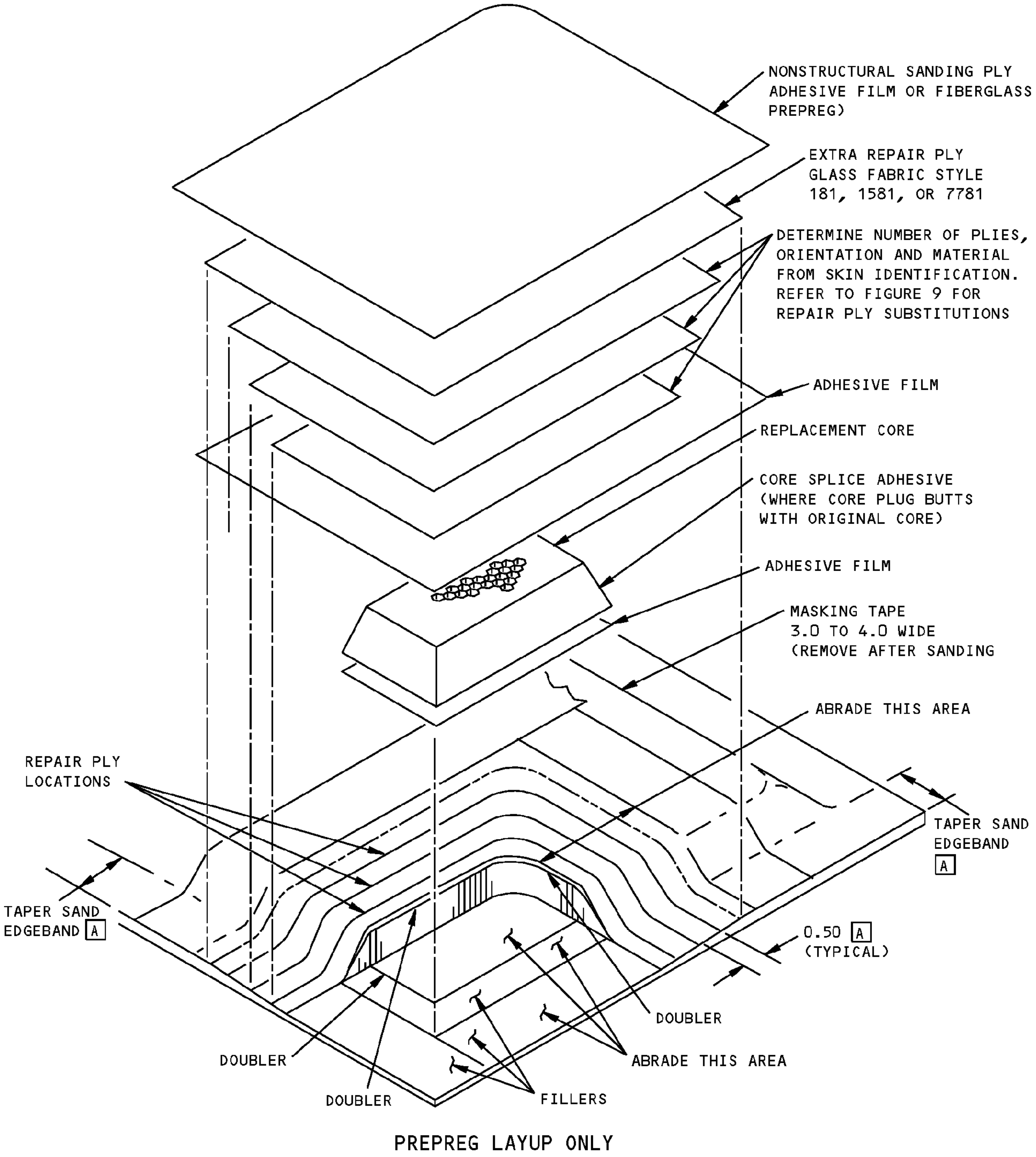
PREPREG LAYUP ONLY

NOTES

- MAKE THE REPAIR TO THE TOP SKIN A DIFFERENT SIZE THAN THE REPAIR TO THE BOTTOM SKIN.

A ADHESIVE APPLIED TO CORE PLUG (SEE PAR. 4D(3)).

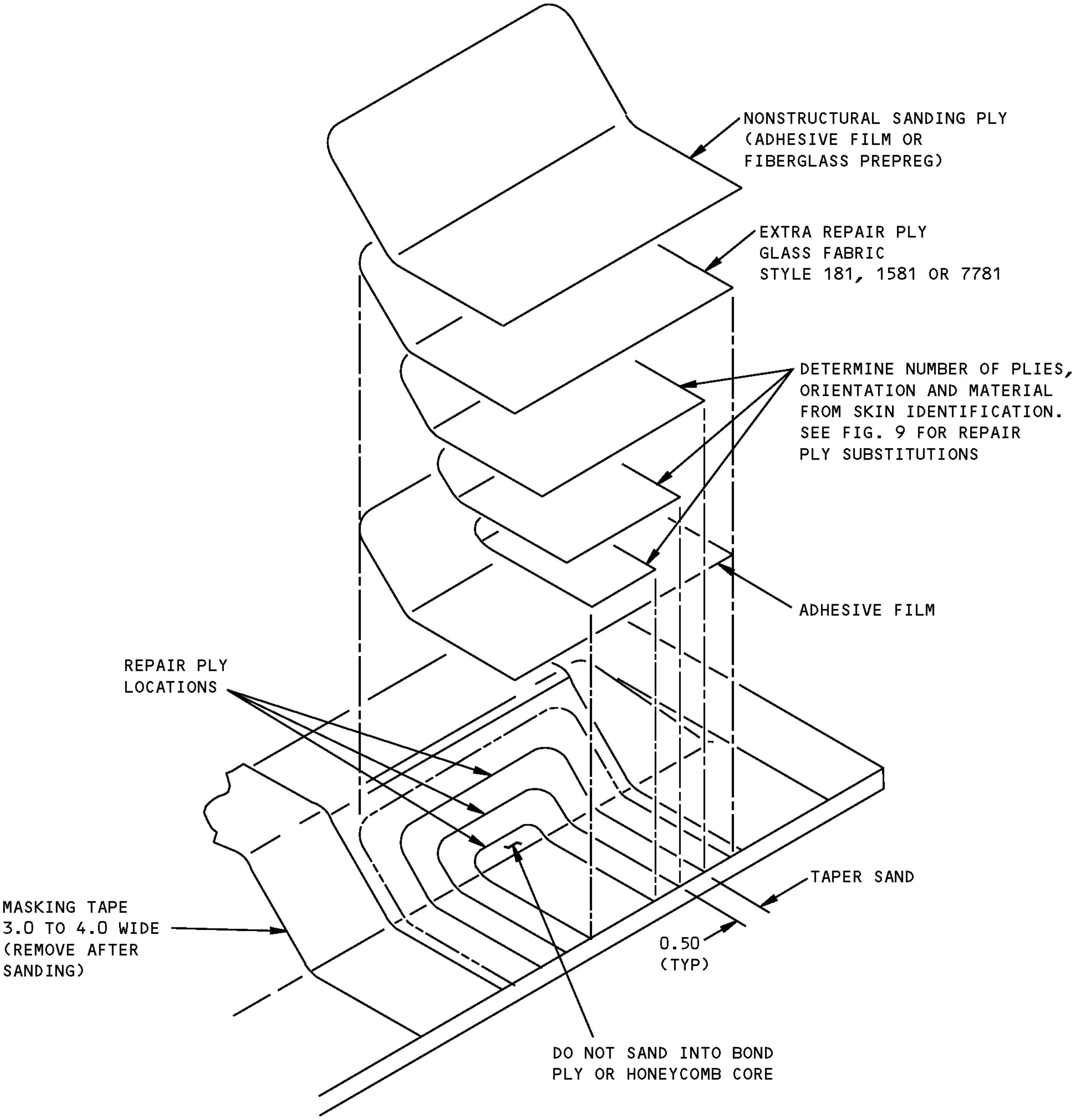
Repair of Large Punctures Thru Both Skins of a Sandwich Panel Including Core Damage - 350 Degrees F (177 Degrees C) Cure
Figure 12



NOTES

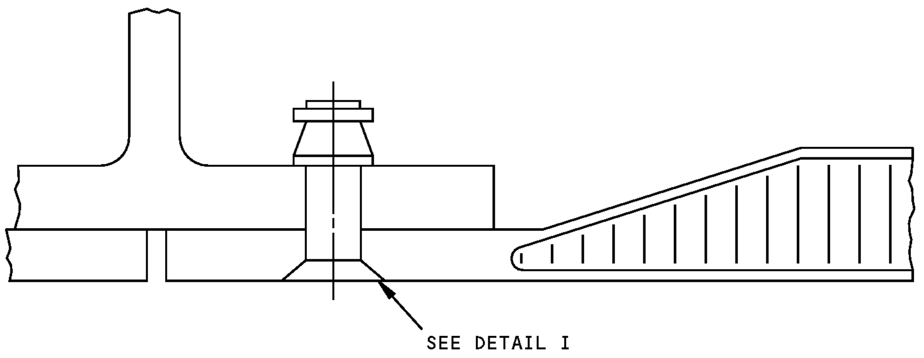
A REFER TO FIG. 4 FOR THE SANDING AND OVERLAP REQUIREMENTS.

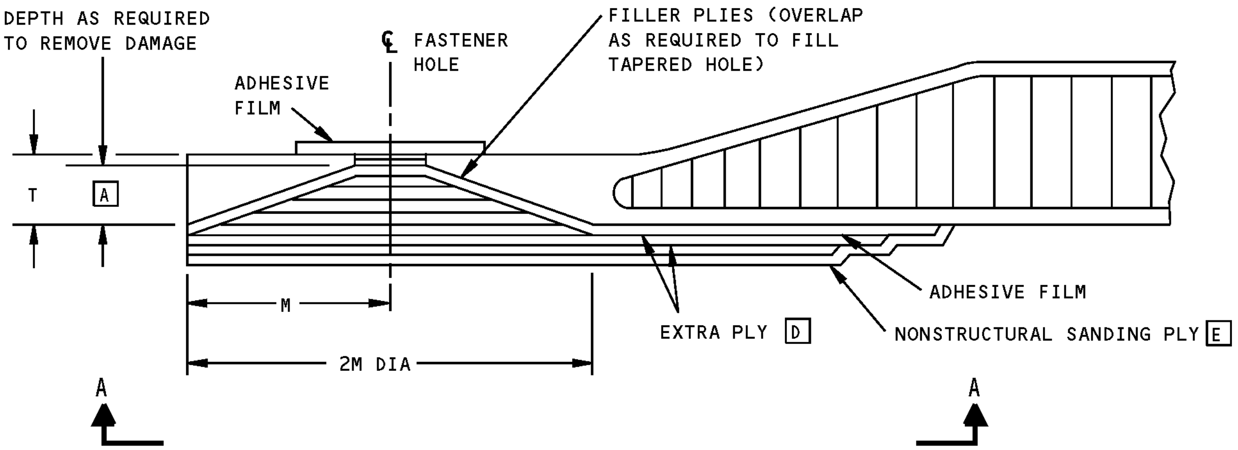
Replacement of Honeycomb Core on Damaged Edge of Sandwich Panel - 350 Degrees F (177 Degrees C) Cure
Figure 13



PREPREG LAYUP ONLY

Repair of Damaged Skin Plies on a Panel Edge - 350 Degrees F (177 Degrees C) Cure
Figure 14





DETAIL I

NOTES

- D EQUALS FASTENER DIAMETER
- M = 5T MAXIMUM AS SHOWN WHERE T IS THE THICKNESS OF THE EDGE BAND. DO NOT CUT INTO CORE.
- THIS REPAIR IS APPLICABLE ONLY WHERE NO MORE THAN TWO ATTACH HOLES ARE DAMAGED IN A SEQUENCE OF TEN. IF MORE THAN TWO ATTACH HOLES IN A SEQUENCE OF TEN ARE DAMAGED, REPAIR THE EDGEBAND AS GIVEN IN PARAGRAPH 5.G. (FIGURE 14).

$\boxed{A}$ APPLY FILLER PLIES AS REQUIRED TO FILL THE DAMAGED AREA.

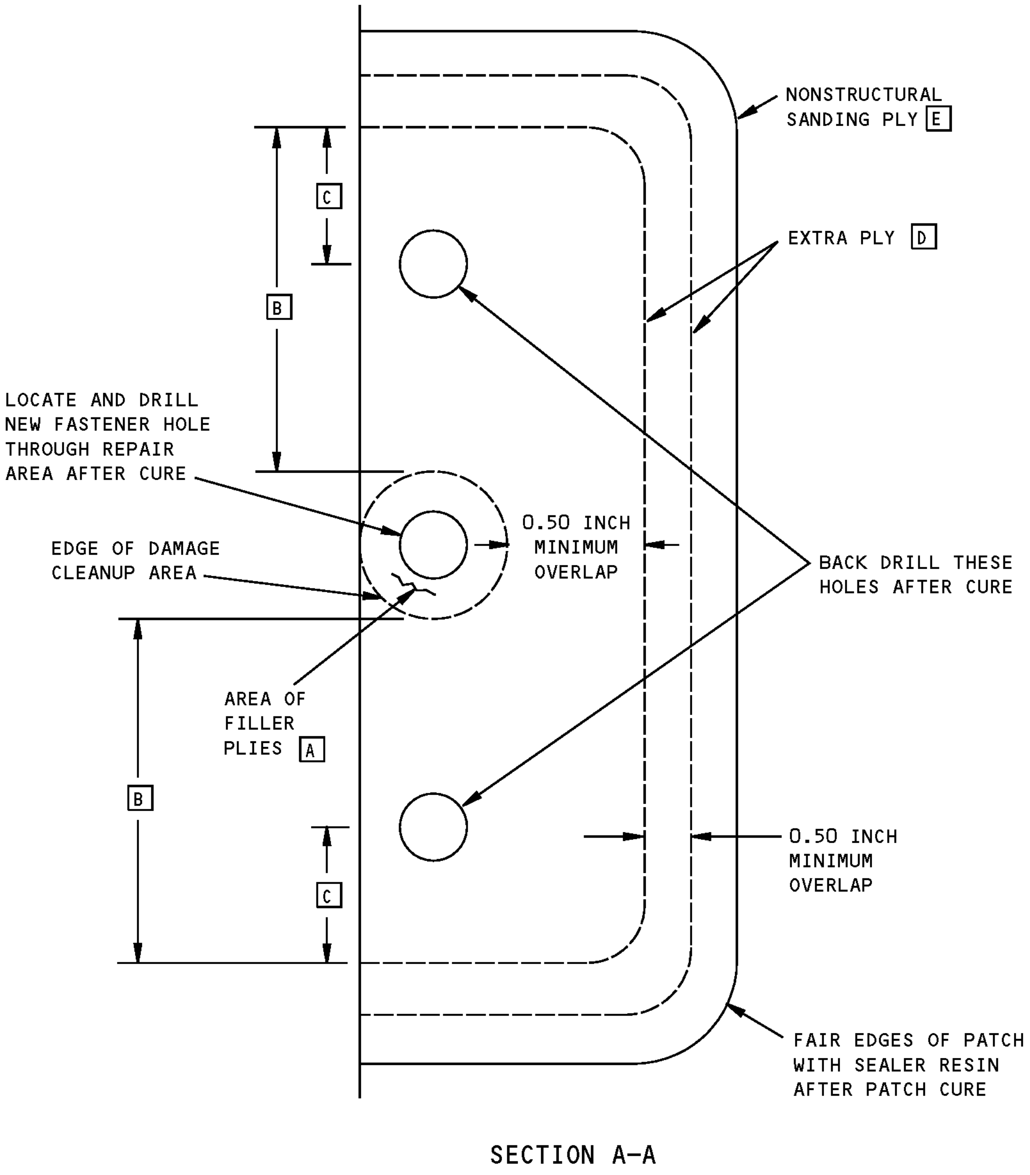
$\boxed{B}$ EXTEND FIRST EXTRA PLY FAR ENOUGH SO THAT IT EXTENDS AT LEAST 0.50 INCH PAST EDGE OF DAMAGED AREA.

$\boxed{C}$ EXTEND FIRST EXTRA PLY FAR ENOUGH TO PROVIDE AT LEAST 2D EDGE MARGIN.

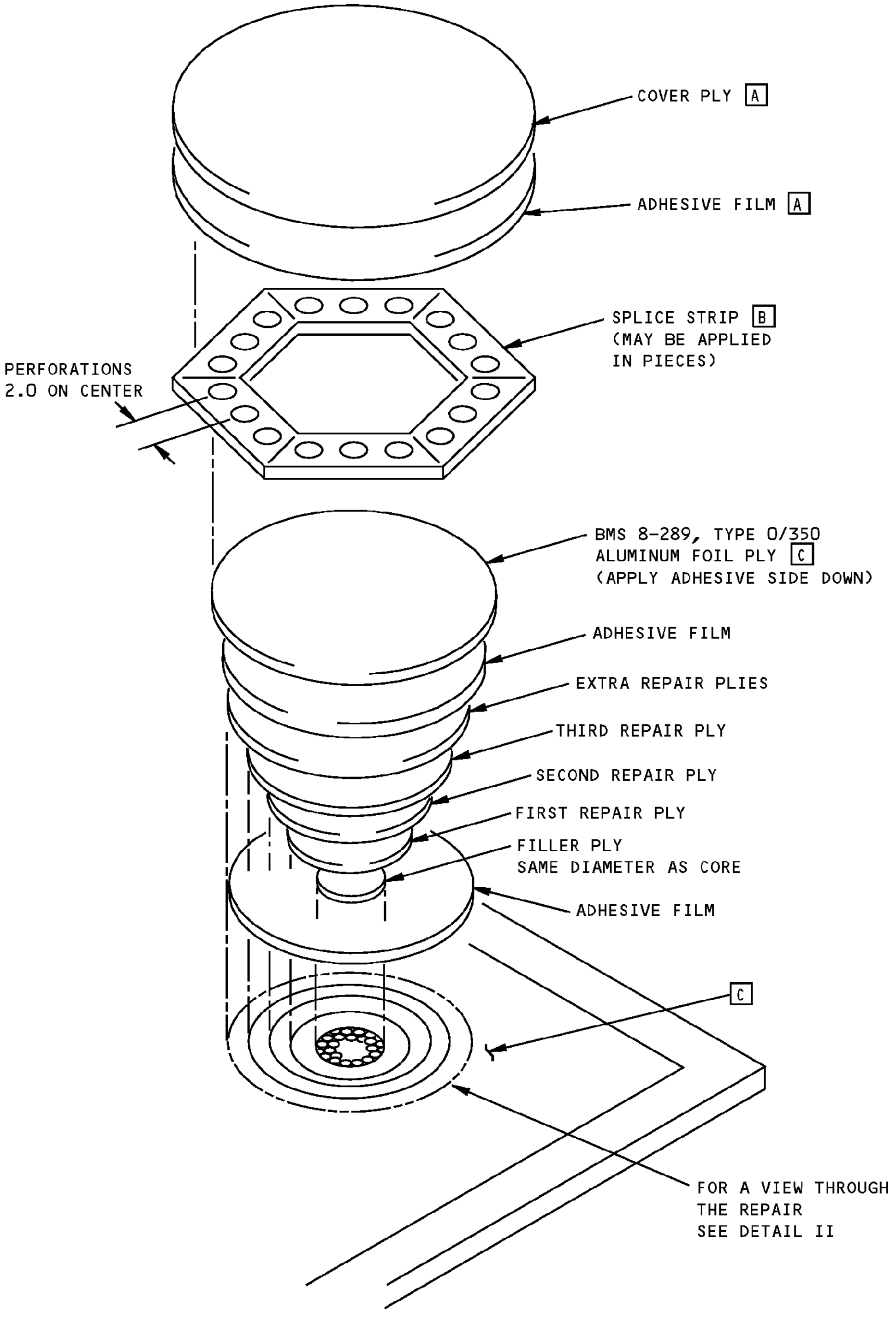
$\boxed{D}$ ORIENT EXTRA REPAIR PLIES IN THE SAME DIRECTION AS THE ORIGINAL OUTER LAYER (SEE FIG. 15).

$\boxed{E}$ ADHESIVE FILM 8-145 OR FIBERGLASS PREPREG BMS 8-139, TYPE 1581

Repair of Damaged Panel Attach Hole - 350 Degrees F (177 Degrees C) Cure
Figure 15 (Sheet 1 of 2)

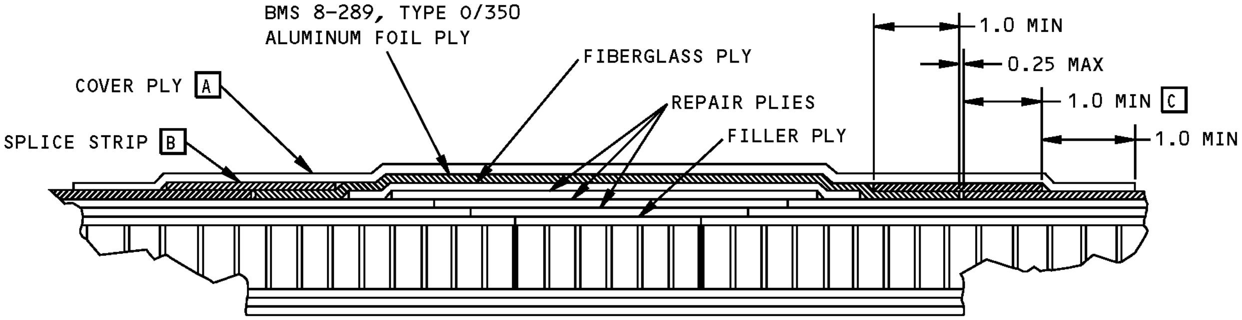


Repair of Damaged Panel Attach Hole - 350 Degrees F (177 Degrees C) Cure
Figure 15 (Sheet 2 of 2)



REPAIR PLY LAYUP
DETAIL I

Repairs to Aluminum Foil
Figure 16 (Sheet 1 of 2)



VIEW THRU REPAIR
DETAIL II

MATERIAL	SHIPPING AND STORAGE LIFE		SHELF LIFE D	
	MAXIMUM TEMPERATURE E	DURATION (DAYS)	MAXIMUM TEMPERATURE	DURATION (HOURS)
BMS 8-289 CLASS 350	10 (-12°C)	180	95 (35°C)	240

STORAGE AND SHELF LIFE OF BMS 8-289
TABLE I

NOTES

A BMS 8-139, TYPE 120 OR 1581 GLASS FABRIC WITH BMS 8-145, TYPE I ADHESIVE FILM UNDERNEATH.

B BMS 8-289, TYPE O/350 FORM II WITH THE ADHESIVE SIDE UP OR FORM I ALODINE TREATED ON NONADHESIVE SIDE. PERFORATE FORM I WITH 0.50 HOLES ON 2.0 CENTERS.

C APPLY A CHEMICAL CONVERSION COATING TO THE INITIAL ALUMINUM FOIL.

D SHELF LIFE HOURS ACCUMULATE FROM THE DATE OF REMOVAL FROM REFRIGERATION UNTIL START OF THE REPAIR CURE CYCLE.

E STORAGE LIFE SHALL BE AS SHOWN IN TABLE I UNLESS THE PRODUCT IS GUARANTEED BY THE SUPPLIER FOR 360 DAYS STORAGE AT 95°F (35°C).

Repairs to Aluminum Foil
Figure 16 (Sheet 2 of 2)

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. These data was revised to show the newest technology and was moved to 51-70-10, REPAIR GENERAL

GENERAL - ALUMINUM HONEYCOMB STRUCTURE REPAIRS

1. References

Reference	Title
51-70-10, REPAIR GENERAL	Aluminum Skin/Aluminum Honeycomb Panel Repairs

2. Obsolete Data

A. These data was revised to show the newest technology and was moved to 51-70-10, REPAIR GENERAL.

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 Nonmetallic Repair Parts
51-20-05, GENERAL	Repair Sealing
51-30-01, GENERAL	Sheet Metal Materials
AMM 51-21-01/701	Aircraft Maintenance Manual
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
DOCUMENT D6-49327	Certification of Autoclaves for Metal Bonding and Curing of Composite Structure

(Continued)

Reference	Title
DOCUMENT D6-56273	Qualification of Heat Blankets for Hot Bonding
NDT Part 1, 51-01-01	Inspection of Repairs to Composite Structures
NDT Part 1, 51-01-04	Installation of Rivets Into Reference Standards
NDT Part 1, 51-04-00	Ultrasonic
NDT Part 1, 51-05-01	Tap Test Inspection of Honeycomb Sandwich Structure
SOPM 20-30-03	Standard Overhaul Practices Manual
SOPM 20-30-97	Solvents For Final Cleaning Before Structural Bonding (Series 97)

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 6./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 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 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.

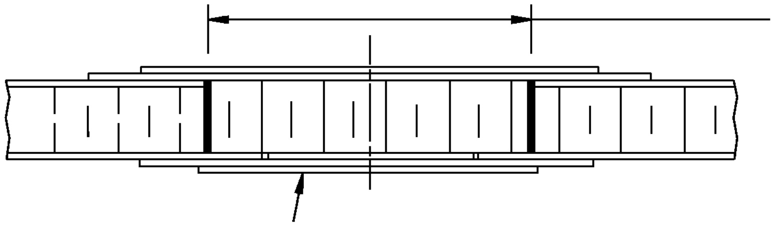
S. Refer to Table 202/REPAIR GENERAL and make a repair selection.

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]	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
	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
	PERMANENT	[5]	64 SQUARE INCHES (400 SQUARE cm) [6]	200 SQUARE INCHES (0.13 SQUARE METERS) OR SEE DETAIL A

TABLE A



THIS SIDE CAN BE REPAIRED ALSO, IF DAMAGE IS 200 SQUARE INCHES (0.13 SQUARE METERS) OR LESS

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.

PERMITTED DAMAGE SIZES THAT CAN BE REPAIRED TO SURFACES PREPARED WITH TANK PAA (BAC5555), PACS OR PANTA AND CURED IN AN AUTOCLAVE [8]

Ⓐ

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.

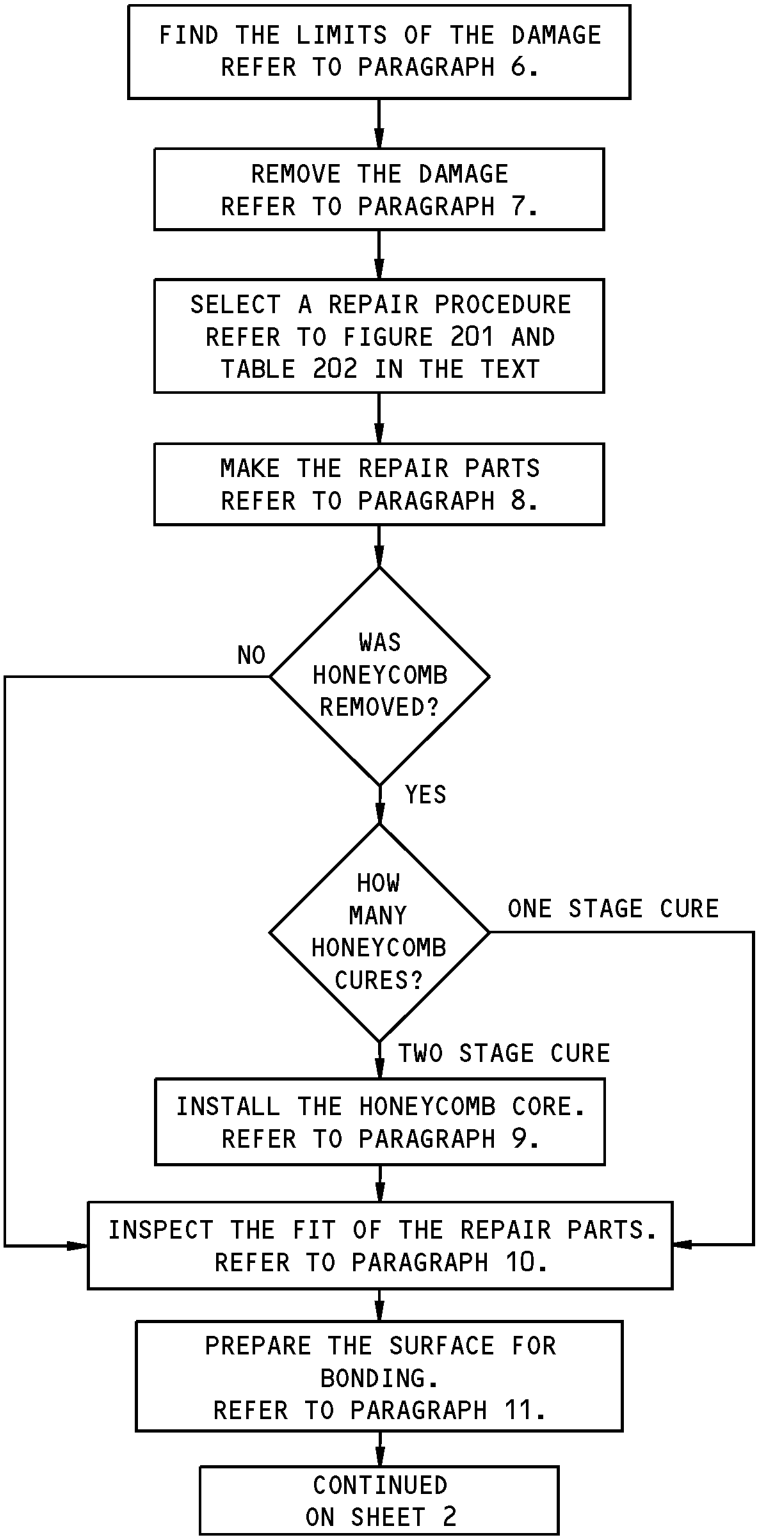
[7] UNLESS SPECIFIED DIFFERENTLY IN THE SPECIFIC COMPONENT REPAIR SECTION.

[8] LARGER DAMAGE CAN BE REPAIRED IF YOU DO ALL OF THE FOLLOWING:

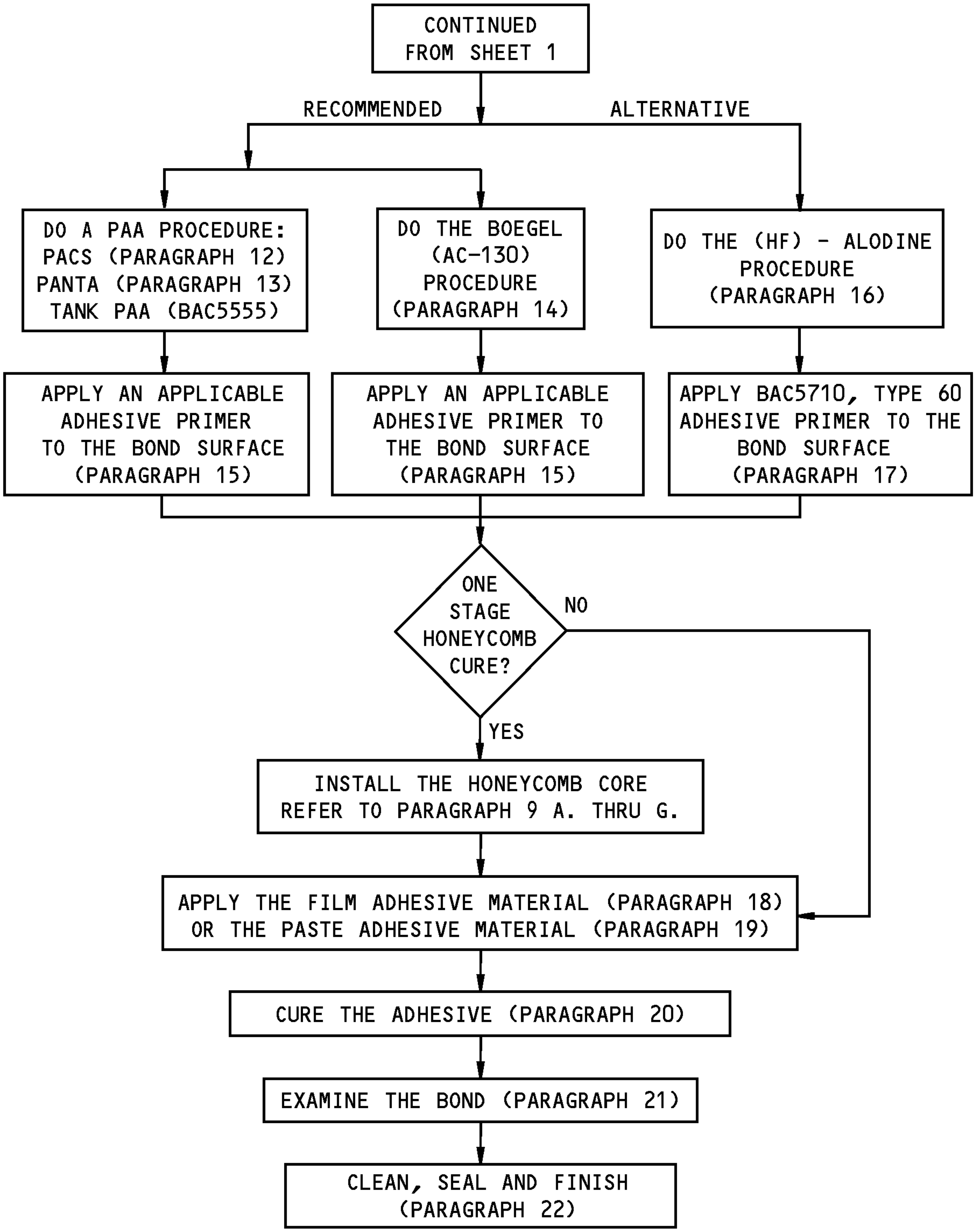
- GET AN ENGINEERING REVIEW
- USE APPROVED ENGINEERING DRAWINGS FOR THE COMPONENT
- USE APPROVED MATERIALS AND MANUFACTURING PROCESSES SPECIFIED IN THE COMPONENT ENGINEERING DRAWINGS.

[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 NDT Part 1, 51-01-04 for instrumented NDI procedures, or 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 Paragraph 15./REPAIR GENERALor 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.

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(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.A./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 the 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	CURE TIME	CURE TEMPERATURE
BMS5-28, Type 6 or 7 (Potting Compound)	60 Minutes	90 Minutes	250° to 260°F (121° to 127°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 250 (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 Type II 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 for the two stage honeycomb repair configuration 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 203/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.F.(18)/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.G.(1)(a)/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 BMS5-89 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.E.(4)/REPAIR GENERAL and Paragraph 16.E.(5)/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.E.(5)/REPAIR GENERAL through Paragraph 16.F.(5)/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.

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.

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. 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./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 203/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 ±5°F (±3°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.

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.

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 210/REPAIR GENERAL and Figure 211/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 NDT Part 1, 51-01-01 and 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 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.

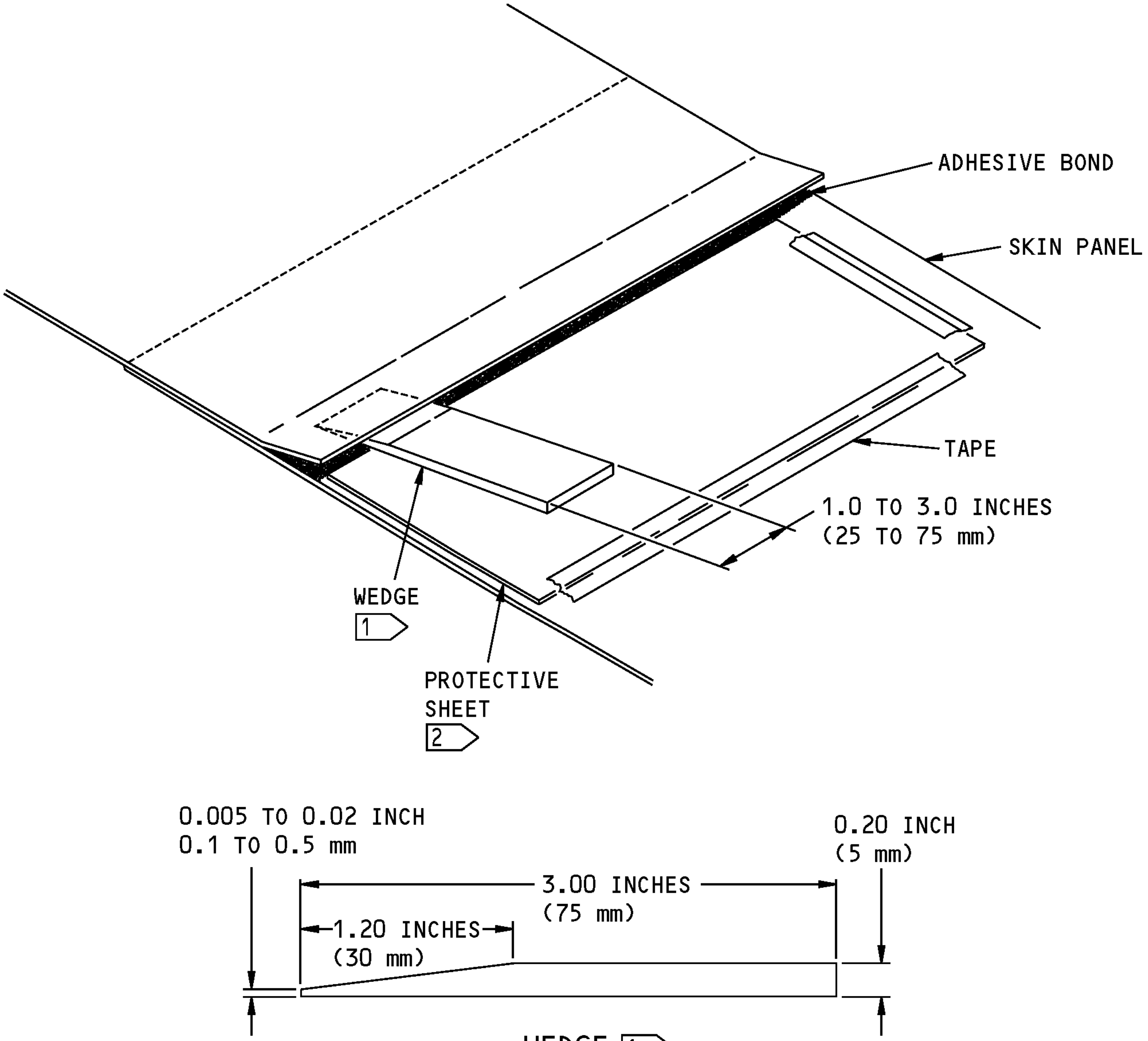
D. Remove all repair parts that have an unsatisfactory bond or cut out and repair the area that is disbonded. Do all of the necessary repair steps to make the repair satisfactory.

22. Clean, seal and finish

A. If the repair is satisfactory, then clean the surfaces that are to be sealed and finished. Refer toAMM 51-21-01/701.

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 51-21-01/701.



WEDGE 1

SEPARATION OF THE BONDED PARTS WITH WEDGES

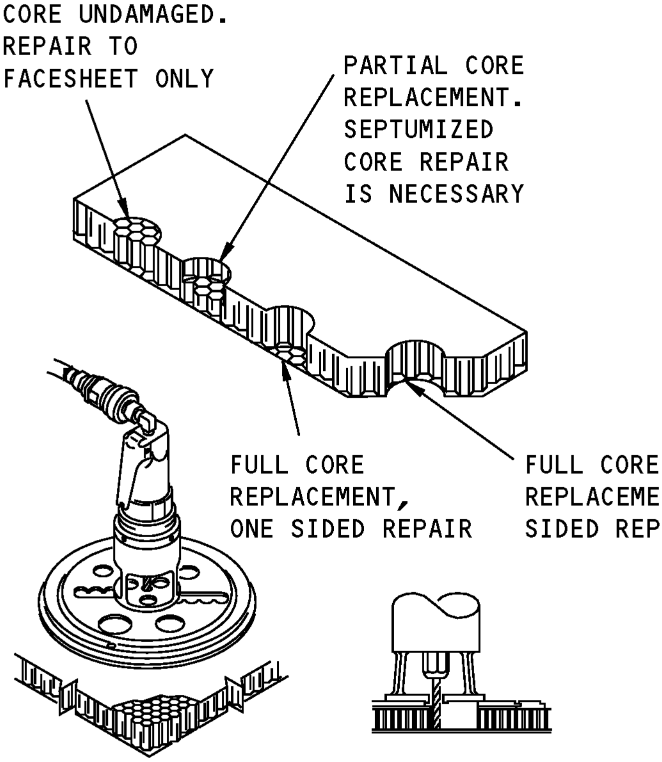
A

NOTES

1 WOOD OR PLASTIC ARE EXAMPLE MATERIALS

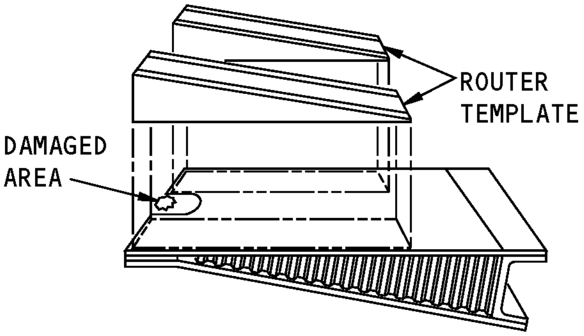
2 METAL OR PLASTIC ARE EXAMPLE MATERIALS

Damage Removal Procedures
Figure 203 (Sheet 1 of 2)



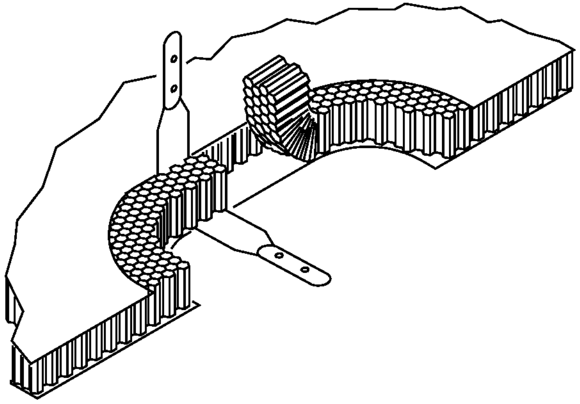
HONEYCOMB CORE REMOVAL

B



REMOVING HONEYCOMB CORE FROM A TAPERED CONTROL SURFACE

C



REMOVAL OF CORE WITH CORE KNIFE

D

INSTRUCTIONS

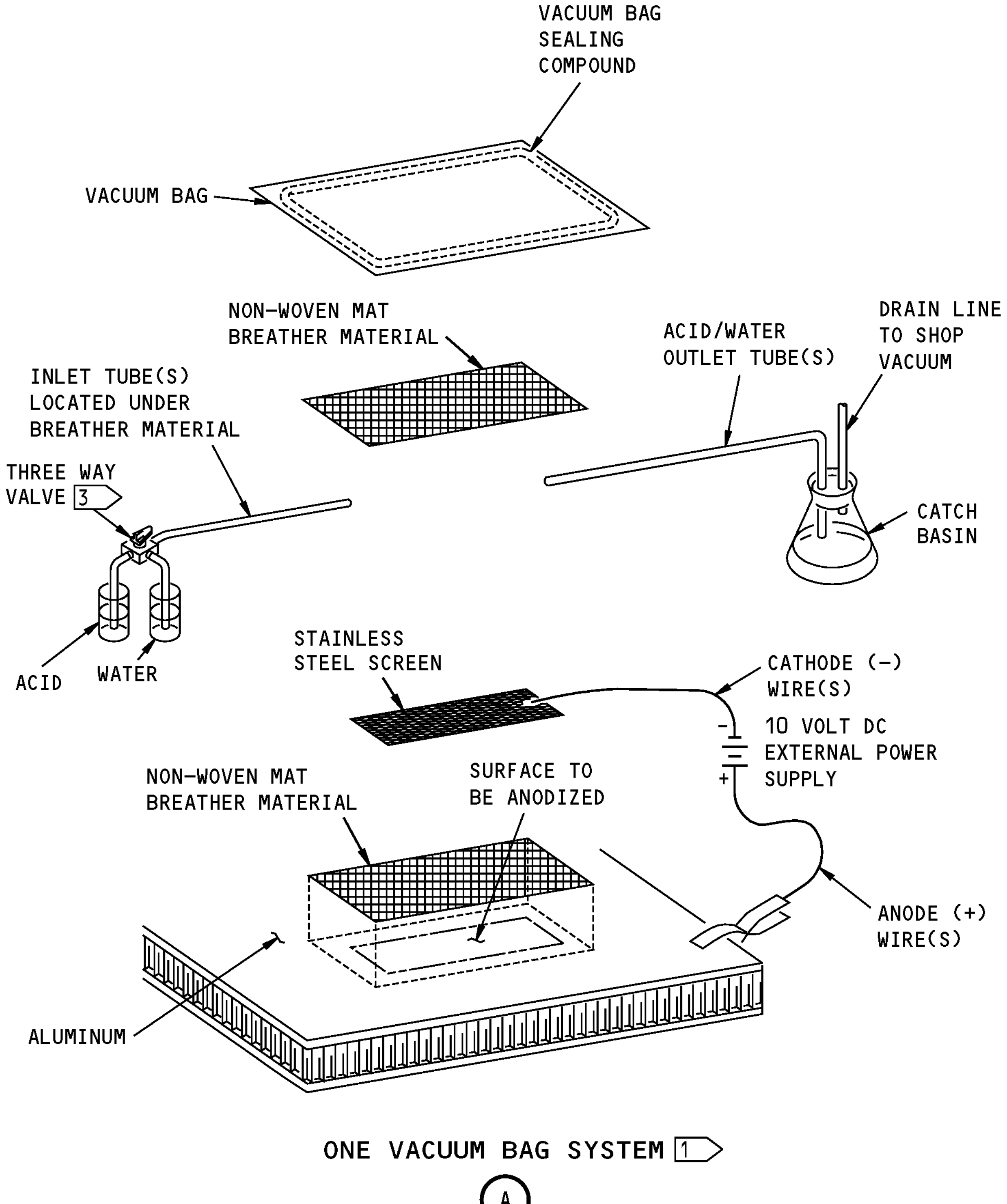
1. Remove the face sheet and/or core with a power router, using a router template to protect the undamaged part of the face sheet. Refer to SRM 51-10-02 for instructions on the use of a router and template.

   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.

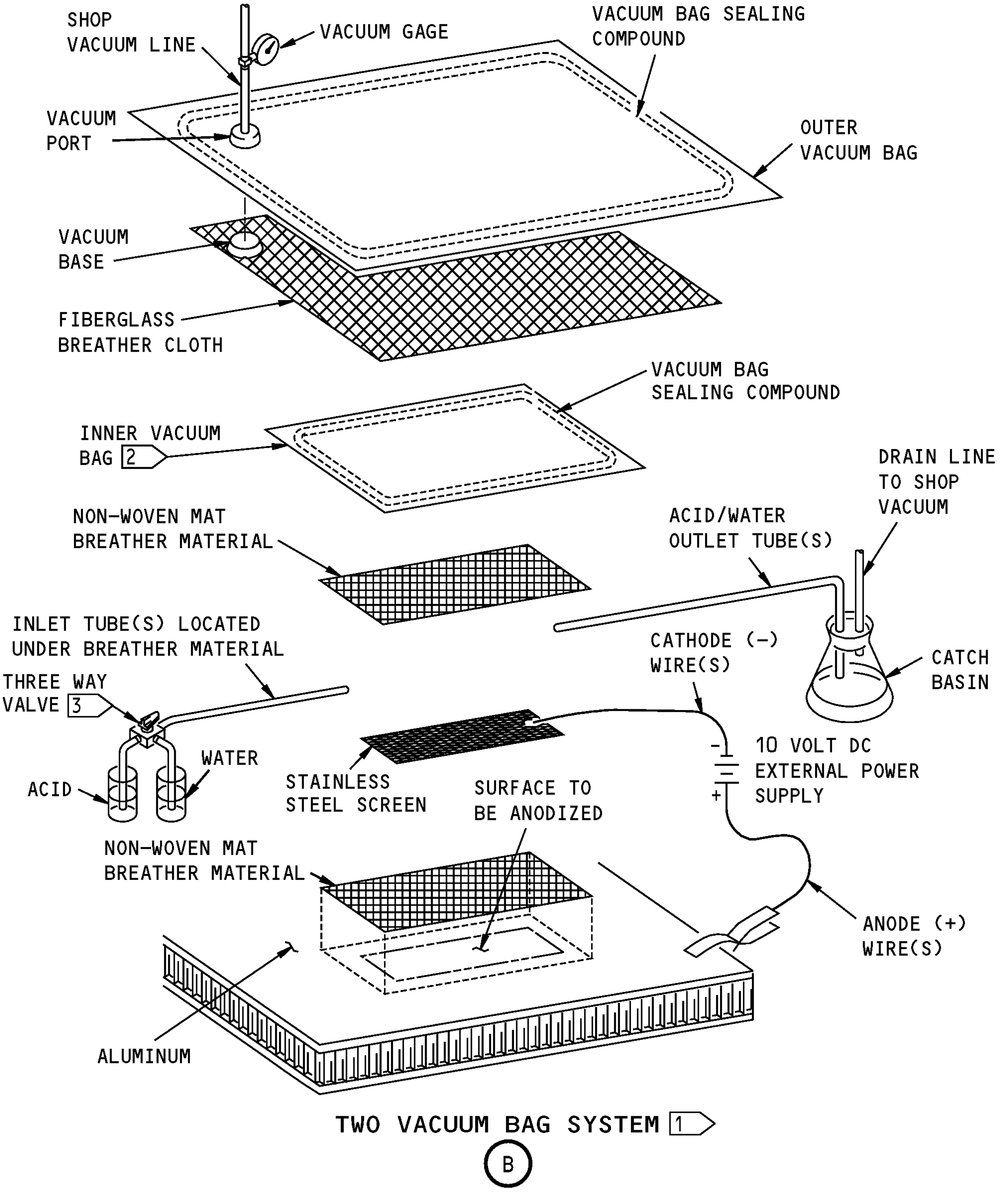
2. If you are routing a tapered part, you can use wedge shaped router templates. This will permit the router to cut the core material parallel with the lower surface. See Detail C.

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

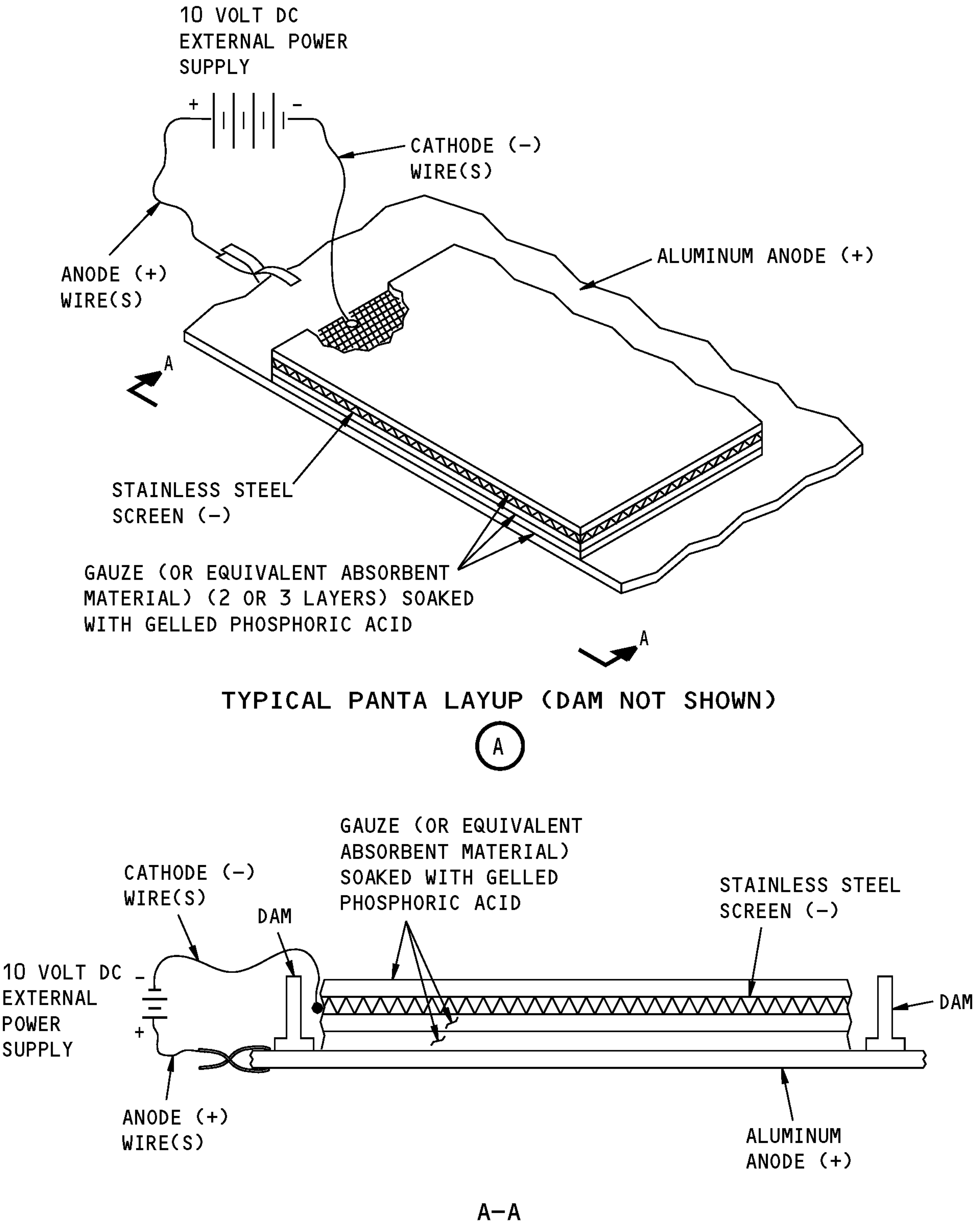
1 WHEN THE SURFACE TO BE ANODIZED IS FACE UP (AS SHOWN IN THIS FIGURE), THE SECOND, OUTER VACUUM BAG IS OPTIONAL. IF THE SURFACE TO BE ANODIZED IS FACE DOWN OR IF THE SURFACE IS VERTICAL, THEN BOEING RECOMMENDEDS THAT YOU USE AN OUTER VACUUM BAG. THE OUTER VACUUM BAG WILL CONTAIN THE ACID IF THERE IS 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.

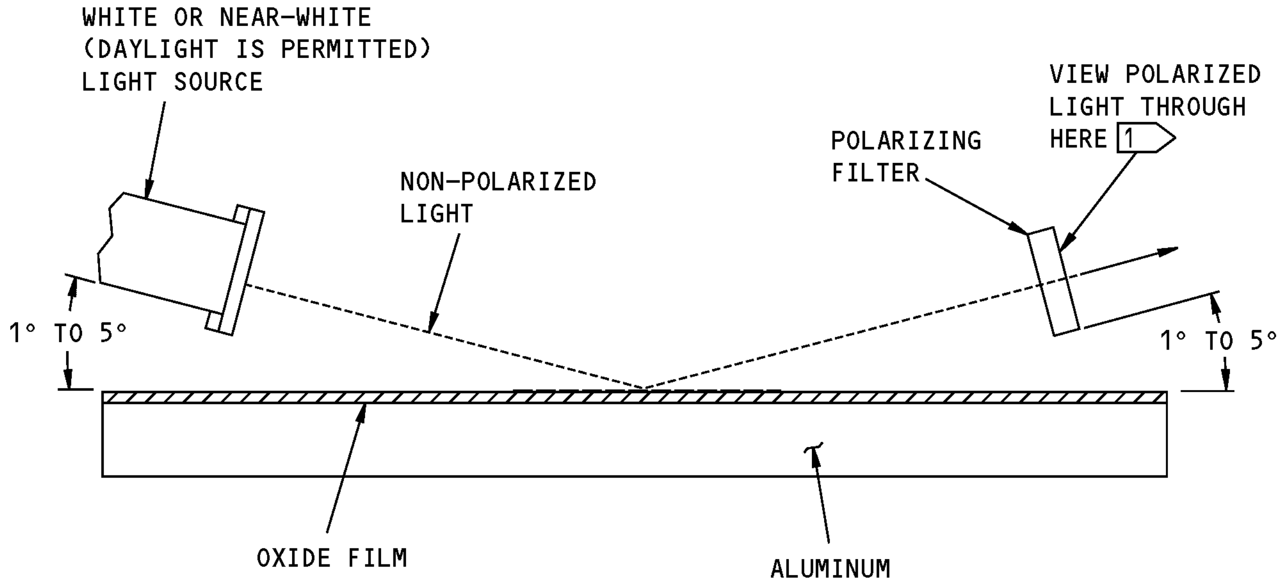
3 THE THREE-WAY VALVE OPERATION MUST PERMIT THE CONDITIONS THAT FOLLOW:

- NO FLOW (OFF)
- FLOW OF ACID ONLY
- FLOW OF RINSE WATER ONLY

Phosphoric Acid Containment System (PACS)
Figure 204 (Sheet 3 of 3)



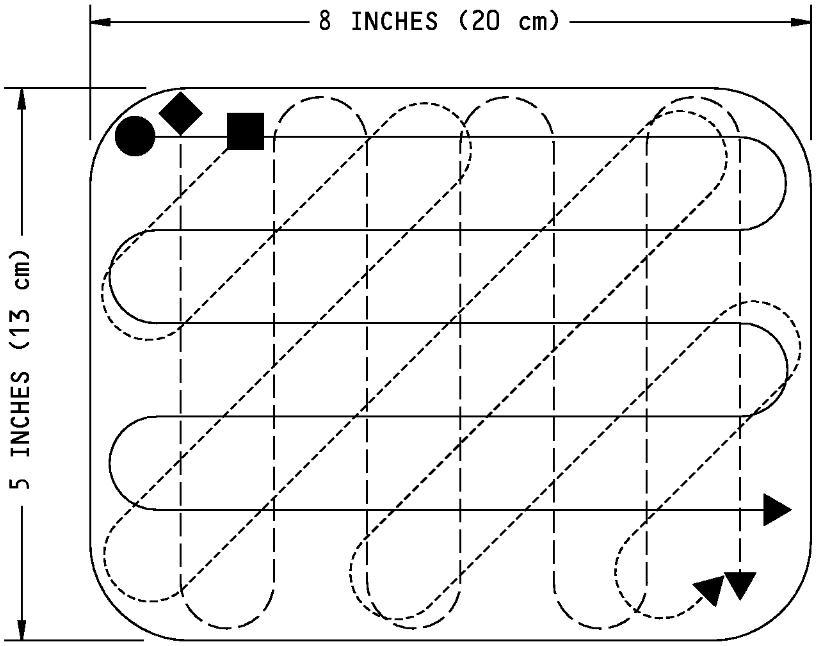
Phosphoric Acid Non-Tank Anodize (PANTA) Layup
Figure 205



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



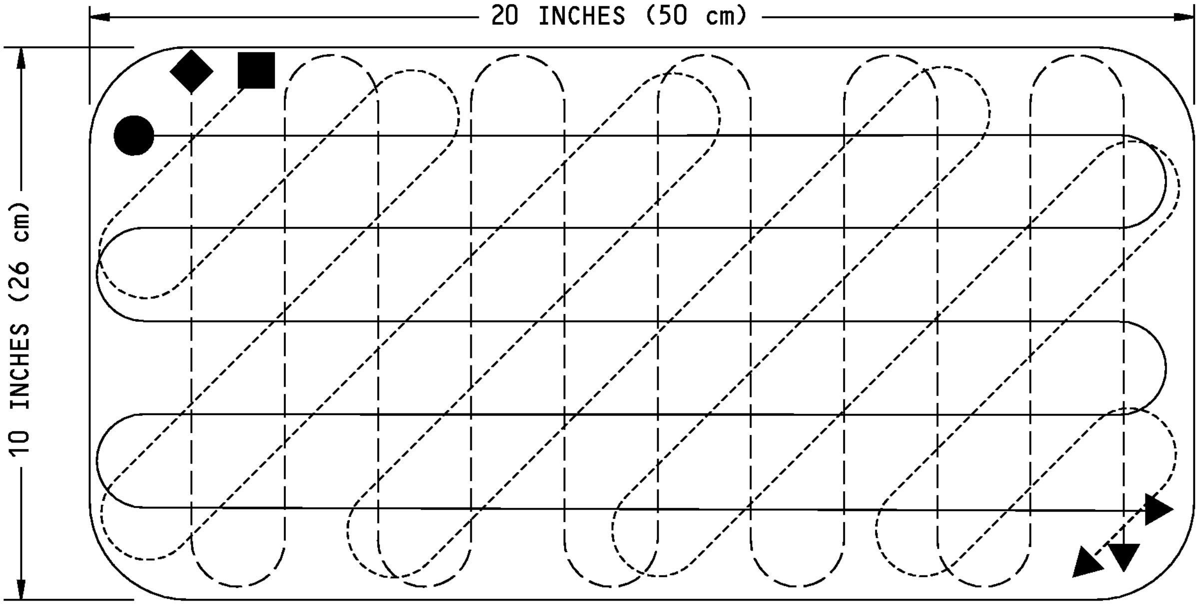
AREA SANDING PATTERN (SMALL SECTION)- THREE DISC EXAMPLE
(2.0 INCHES (50 mm) DIAMETER DISCS) 1

(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)



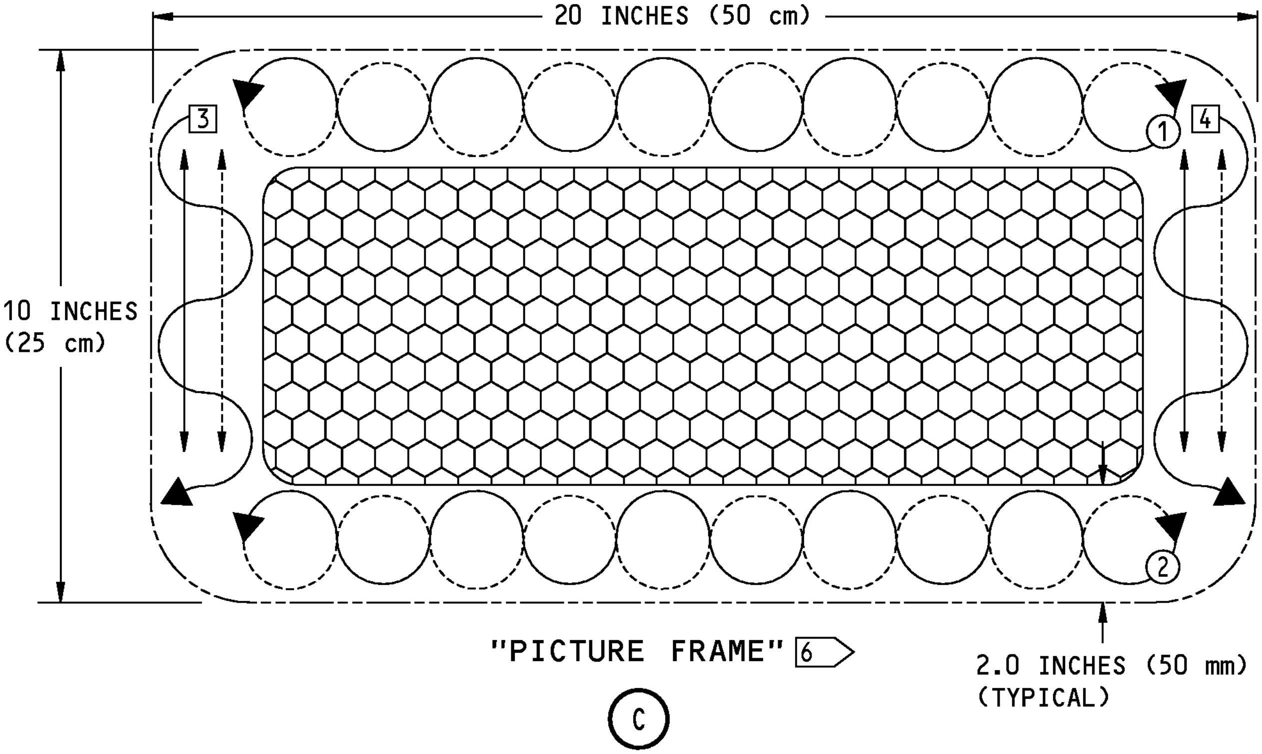
AREA SANDING PATTERN (LARGE SECTION)- 11 DISC EXAMPLE
(2.0 INCHES (50 mm) DIAMETER DISCS) 1

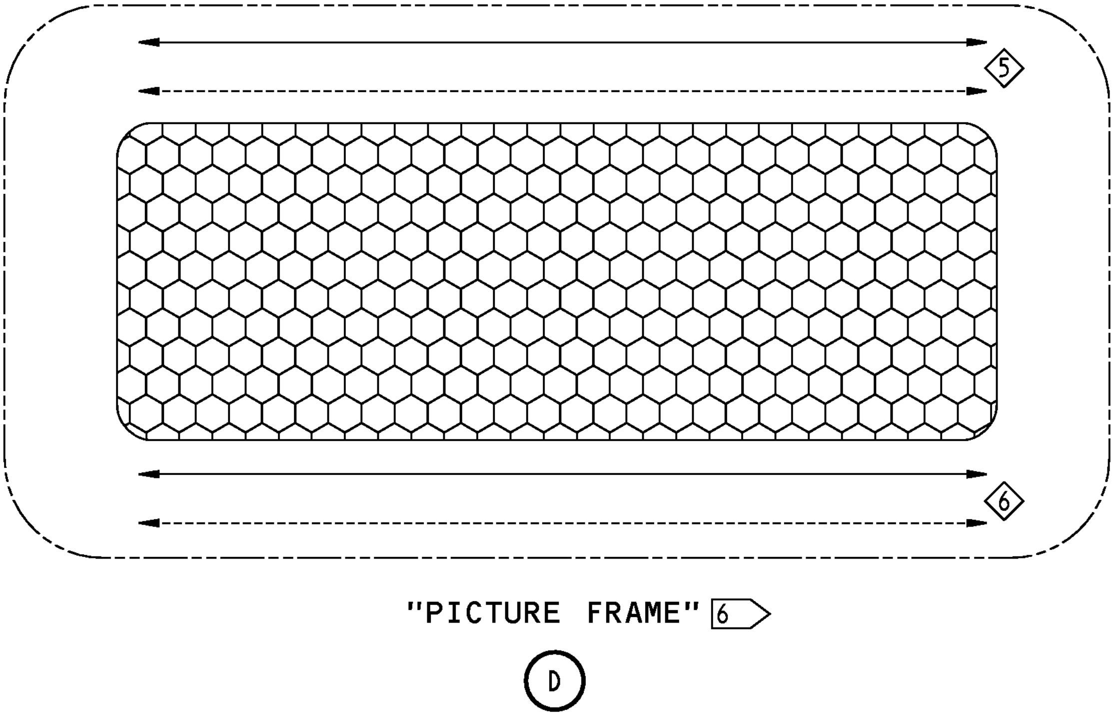
B

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 ■---------▶ (WITH GRINDER OR SANDER)	45 DEGREES	30 SECONDS	GRINDER
	RANDOM	30 SECONDS	SANDER

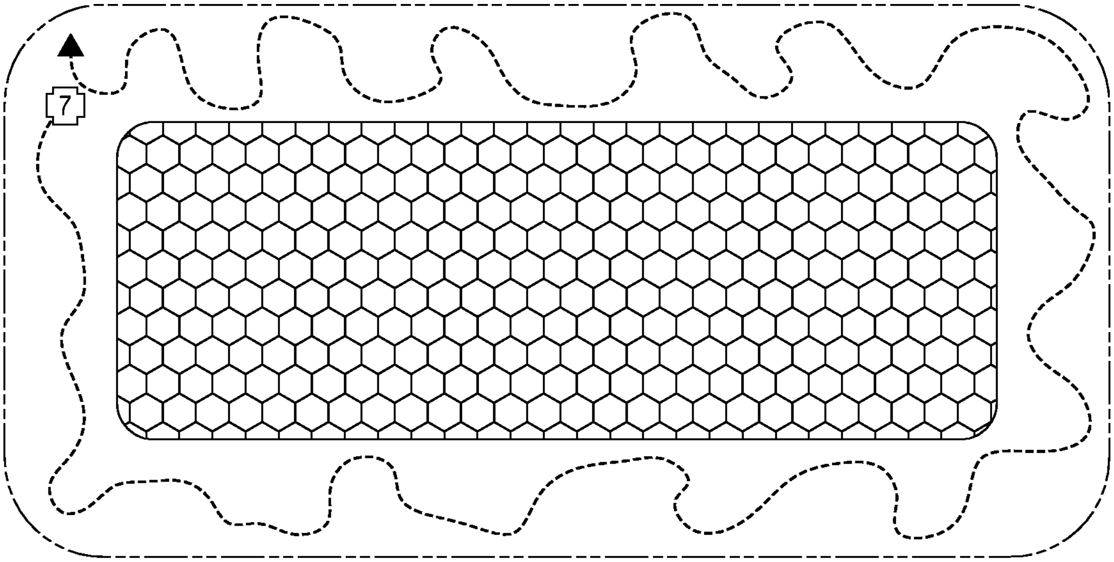
TABLE B

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

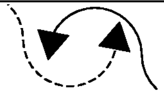
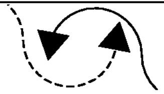
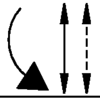
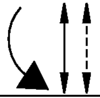
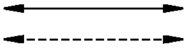
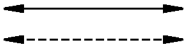
SANDPAPER SEQUENCE	PATTERN	TIME
1ST PIECE ① 	SINE WAVES	30 SECONDS
2ND PIECE ② 	SINE WAVES	30 SECONDS
3RD PIECE 3 	SINE WAVES AND THEN STRAIGHT LINES	30 SECONDS
4TH PIECE 4 	SINE WAVES AND THEN STRAIGHT LINES	30 SECONDS
5TH PIECE 5 	STRAIGHT LINES	30 SECONDS
6TH PIECE 6 	STRAIGHT LINES	30 SECONDS
7TH 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).

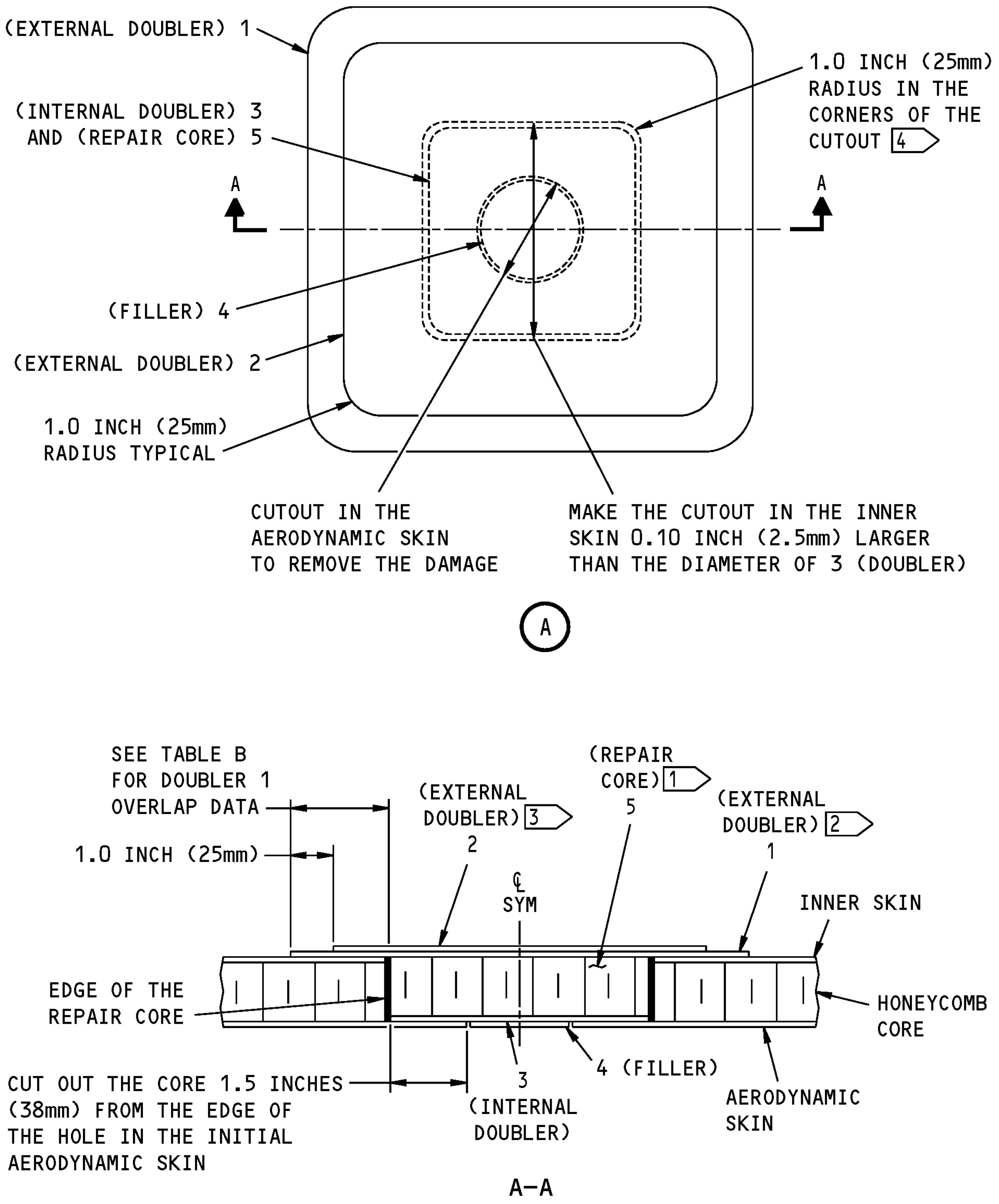
[3] FIRST SHEET:
DO 20 SECONDS IN THE ⇔ DIRECTION AND 10 SECONDS IN THE ⊥ DIRECTION.
SECOND SHEET:
DO 10 SECONDS IN THE ⊥ DIRECTION AND 20 SECONDS IN A DIAGONAL DIRECTION (GRINDER) OR RANDOM DIRECTION (SANDER).

[4] REFER TO DETAIL A.

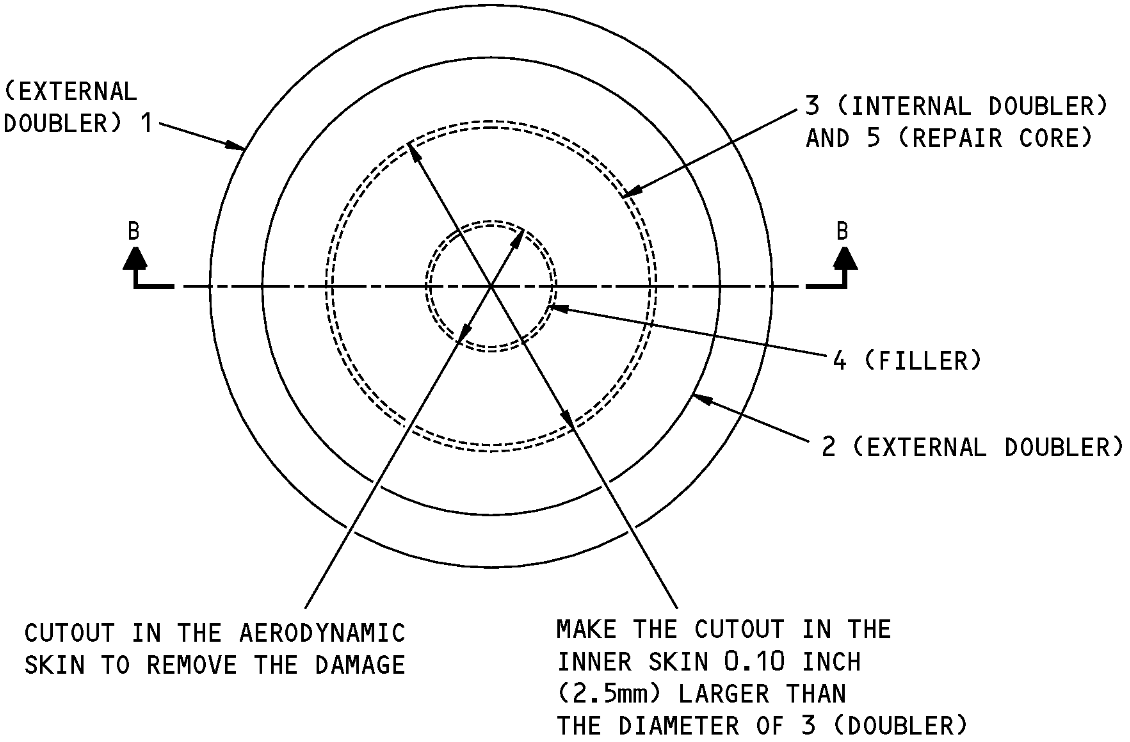
[5] NOT PERMITTED FOR AREAS LESS THAN 40 SQUARE INCHES (260 cm)
USE TWO SHEETS TO SAND AREAS THAT ARE 40 TO 50 SQUARE INCHES (260 TO 320 SQUARE cm).

[6] A "PICTURE FRAME" DESCRIBES THE AREA ALONG THE EDGES OF A CUTOUT. REFER TO TABLE C.

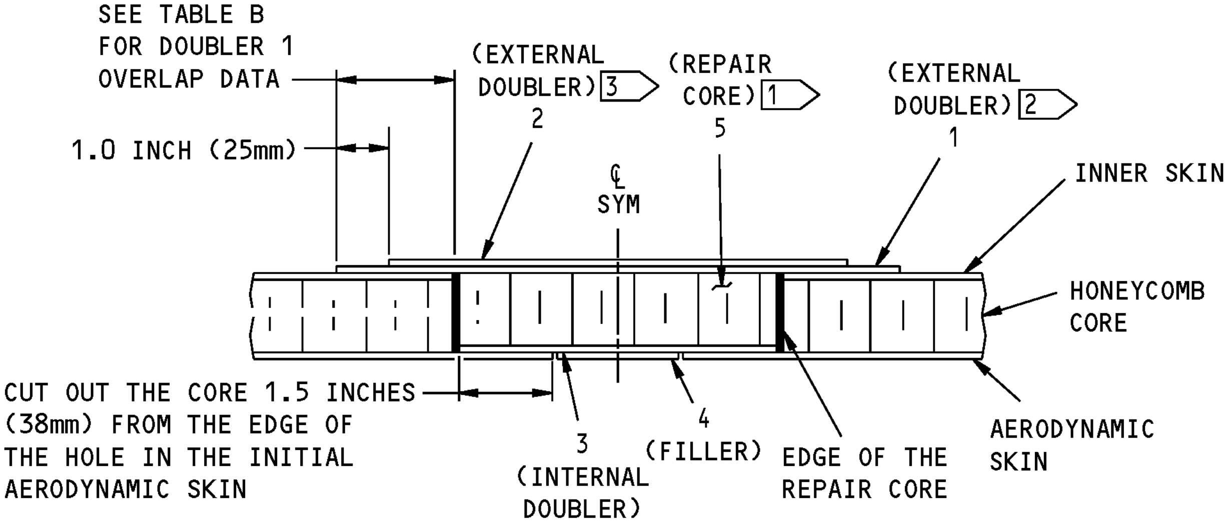
Sanding Procedure Used for Boegel
Figure 207 (Sheet 5 of 5)



Repair Doubler Specifications for Flush Repairs
Figure 208 (Sheet 1 of 4)



B



B-B

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:

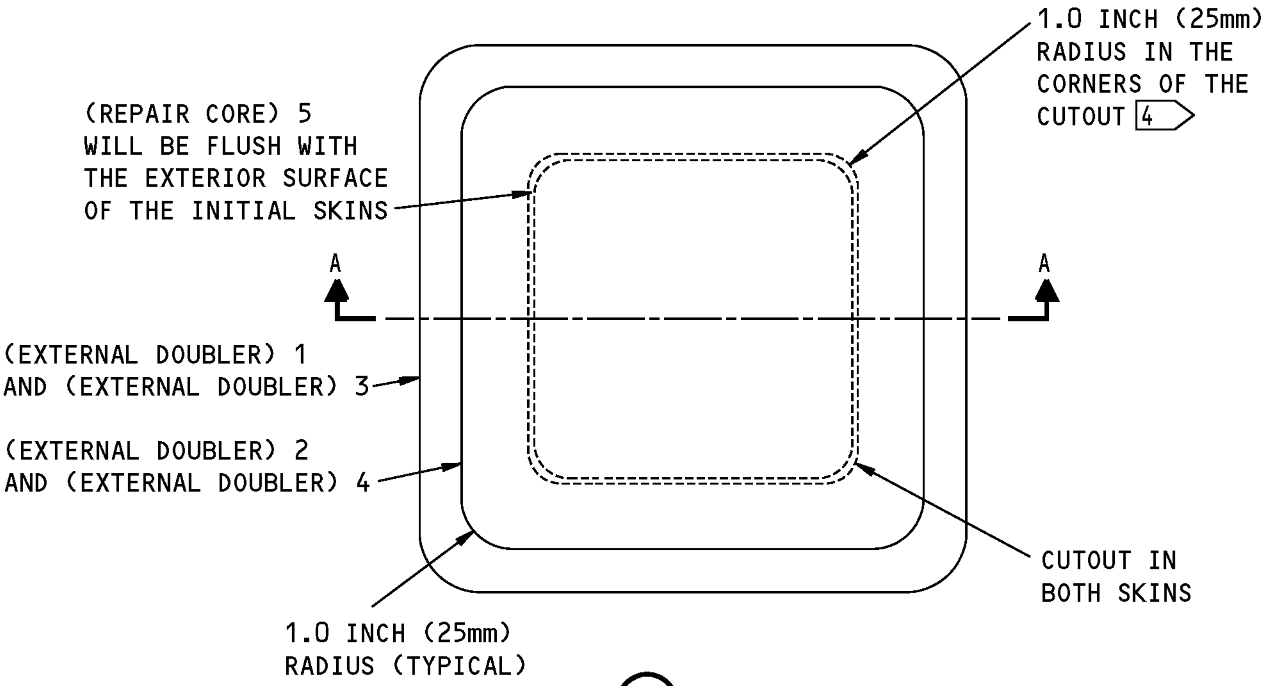
- MAKE THE PART 1 DOUBLER TO THE SAME CURVATURE AS THE SKIN SURFACE, SO THAT LIGHT FINGER PRESSURE MAKES THE DOUBLER TOUCH ALL OF THE SKIN SURFACE, OR
- MAKE THE PART 1 DOUBLER FROM 0.012 GAGE, AND MAKE THE PART 2 DOUBLER FROM THE THICKNESS SPECIFIED IN TABLE C.

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)



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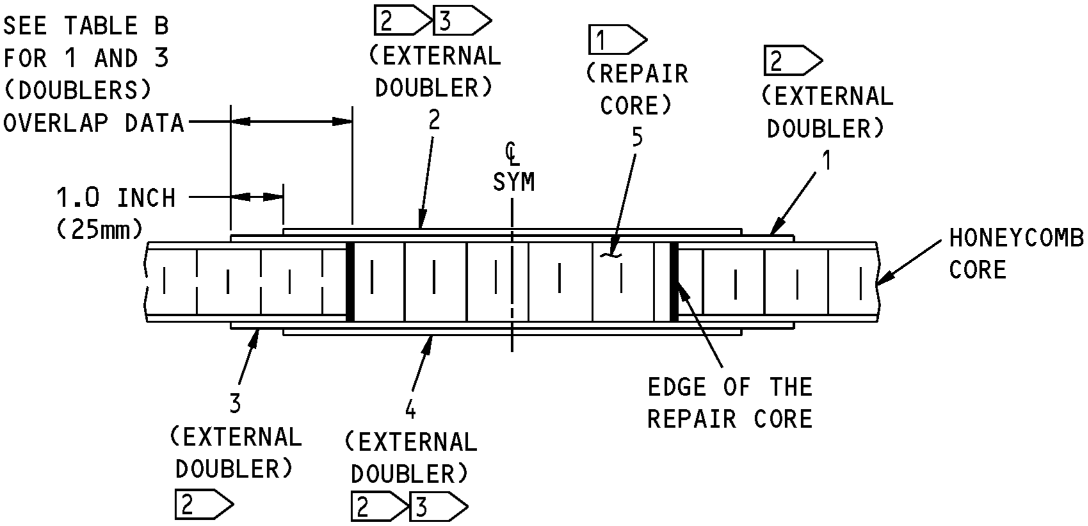
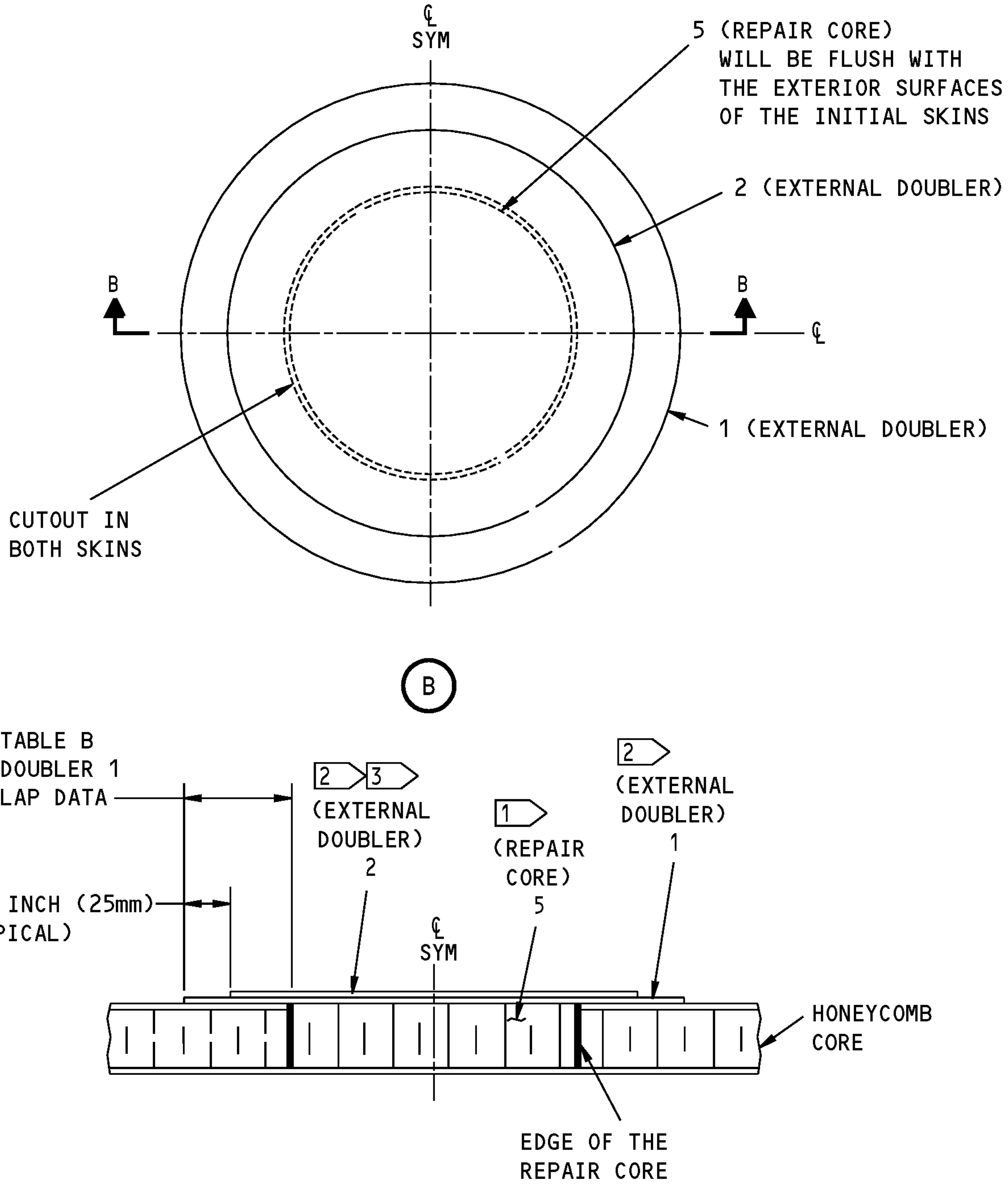


TWO-SIDED REPAIR SHOWN
SEE DETAIL B FOR ONE SIDED REPAIR
A-A

Repair Doubler Specifications for External Patch Repairs
Figure 209 (Sheet 1 of 4)



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.

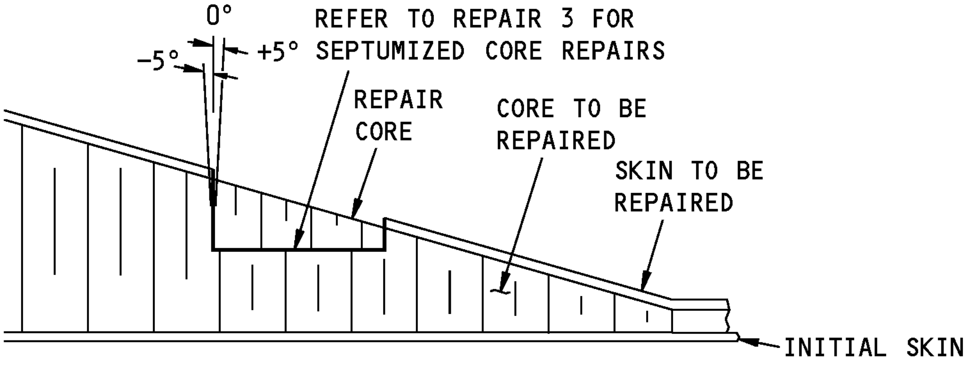
3▷ WHEN YOU USE THE PART 2 AND 4 DOUBLERS, MAKE THE PARTS 2 AND 4 DOUBLERS 1.0 INCH (25 mm) SMALLER ALL AROUND THAN THE PARTS 1 AND 3 DOUBLERS.

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).

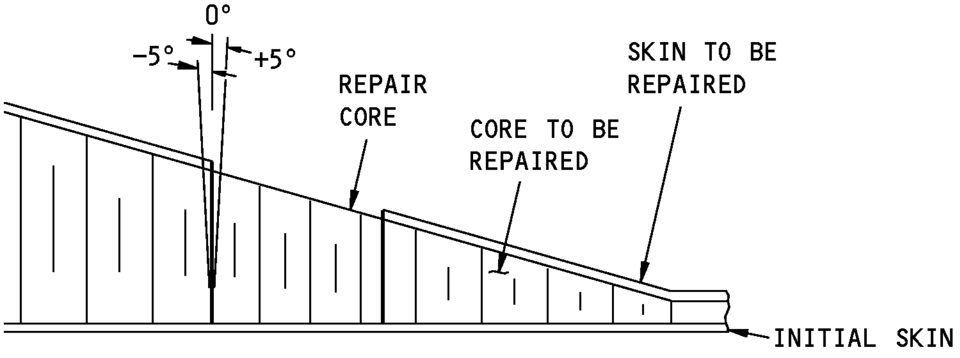
6▷ IF A SKIN TO BE REPAIRED HAS A HIGH CURVATURE AND A GAGE OF 0.033 OR THICKER, THEN MAKE THE REPAIR DOUBLERS TO THE SAME CURVATURE AS THE SKIN SURFACE. MAKE SURE THAT LIGHT FINGER PRESSURE CAN MAKE THE DOUBLERS TOUCH ALL OF THE SKIN SURFACE.

Repair Doubler Specifications for External Patch Repairs
Figure 209 (Sheet 4 of 4)



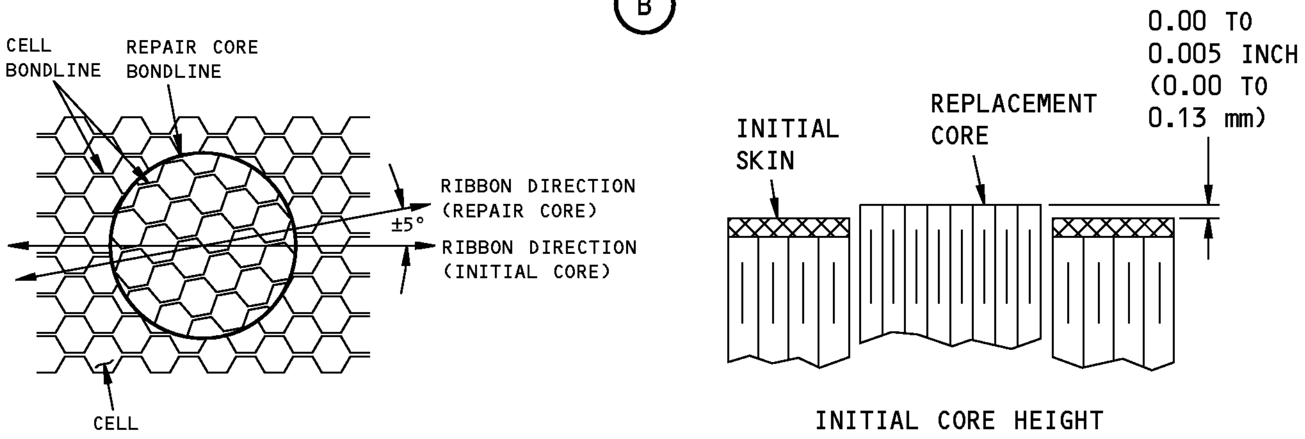
PARTIAL DEPTH CORE REPLACEMENT
(TYPICAL) 1

A



FULL DEPTH CORE REPLACEMENT
(TYPICAL) 1

B



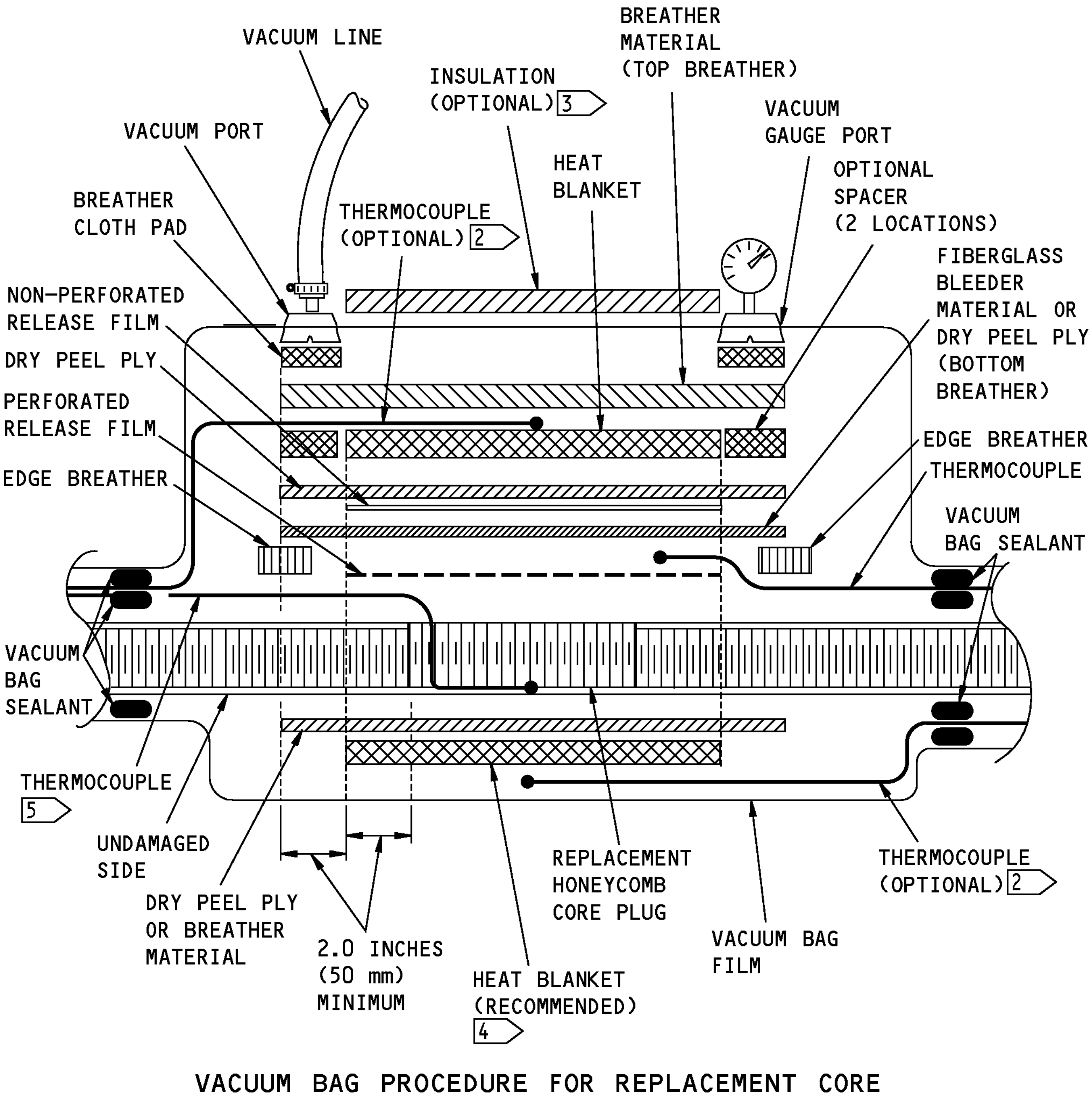
CORE ALIGNMENT

C

INITIAL CORE HEIGHT
(BEFORE CURE)

D

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.

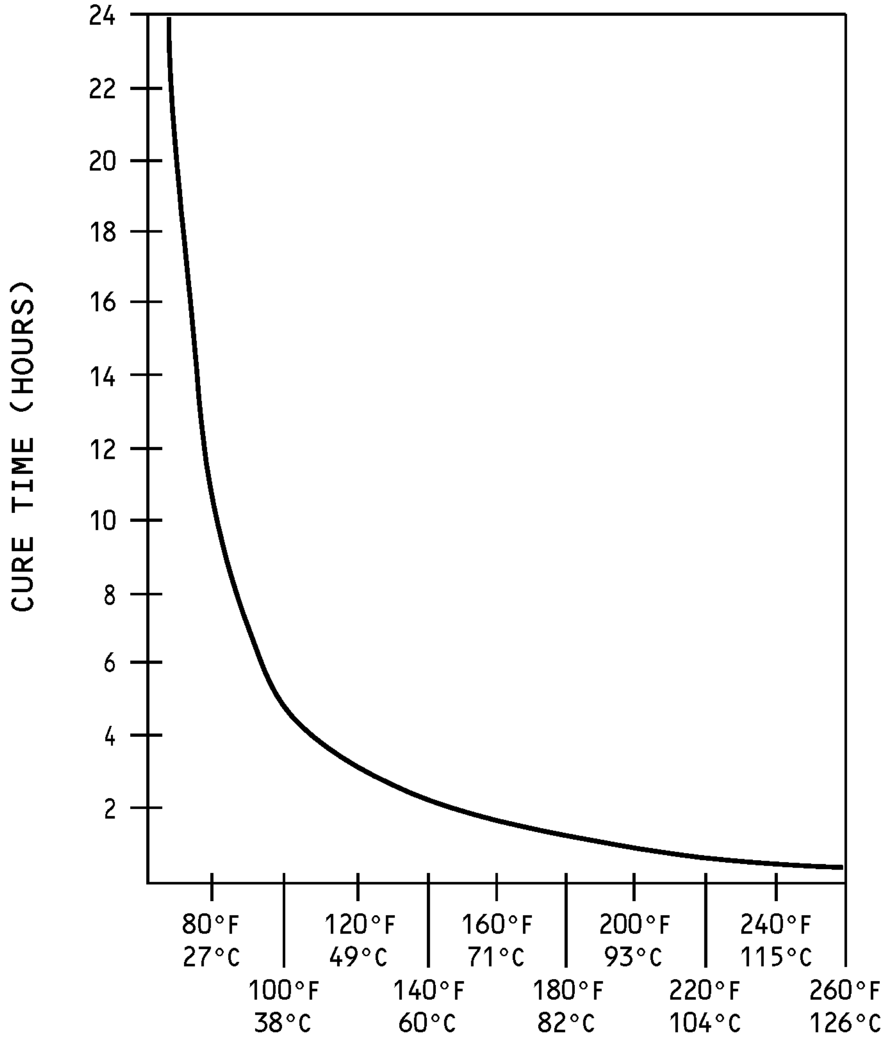
4 IF YOU USE A HEAT BLANKET ON THE UNDAMAGED SIDE, MAKE SURE THAT THE HEAT BLANKET CAN BE HELD AGAINST THE PART. A VACUUM BAG CAN BE USED TO HOLD THE HEAT BLANKET, OR YOU CAN PUT THE PART ON A TOOL SURFACE (WITH INSULATION BETWEEN THE HEAT BLANKET AND THE TOOL SURFACE.

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

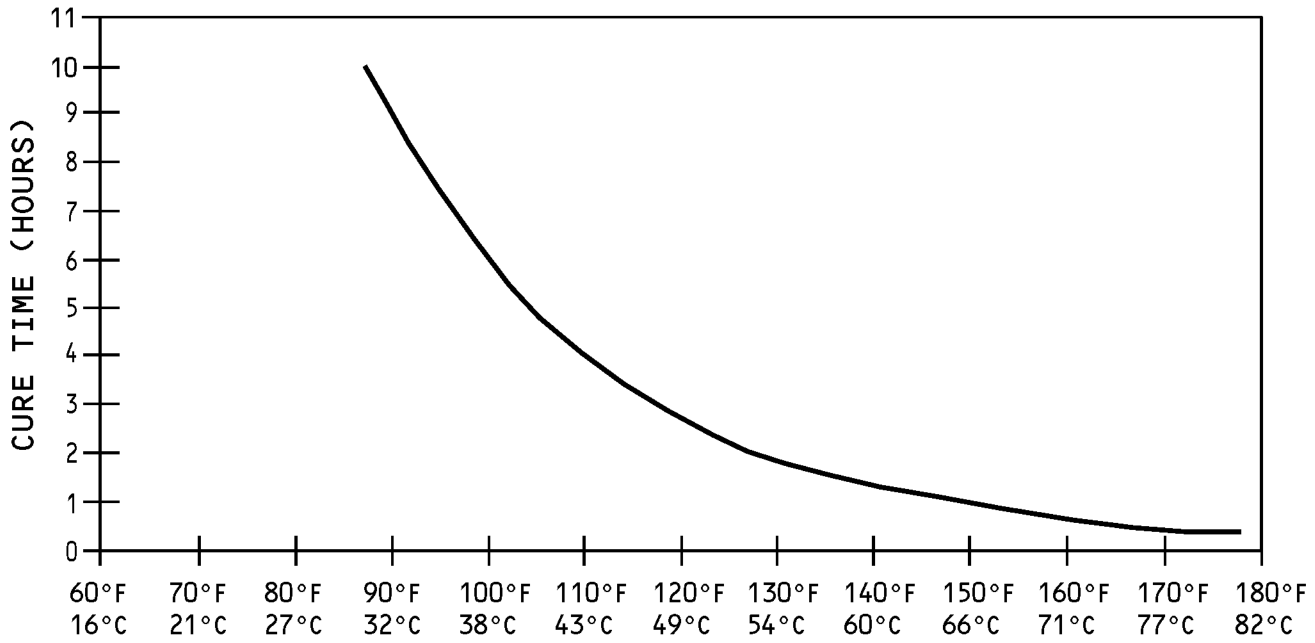
BMS 5-92 TWO-PART PASTE ADHESIVE MIXTURE DATA
TABLE A



BMS 5-92, TYPE I CURE TEMPERATURE

Ⓐ

Cure Time for BMS5-92, Two-part Paste Adhesive
Figure 211 (Sheet 1 of 2)



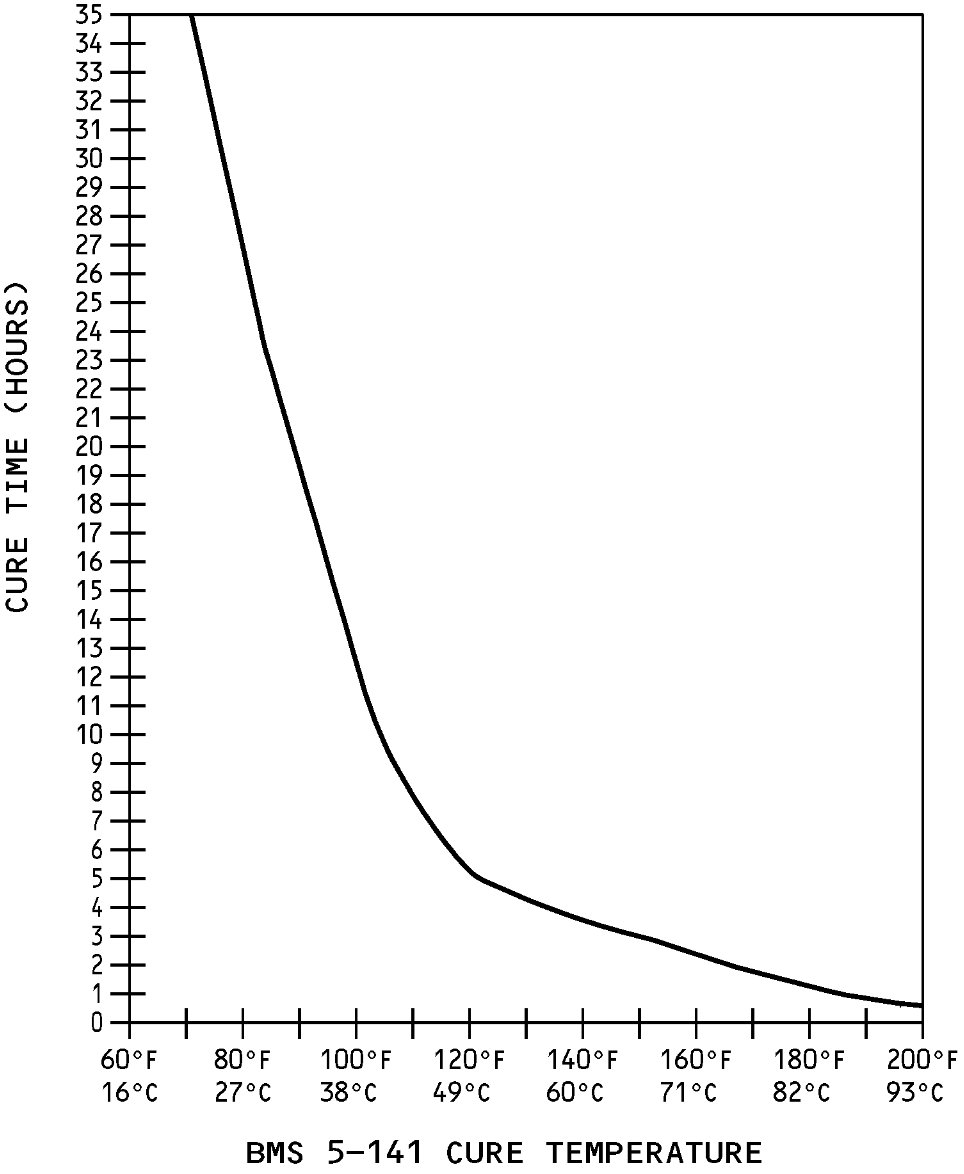
BMS 5-92, TYPE V, CLASS 2 CURE TEMPERATURE

Ⓑ

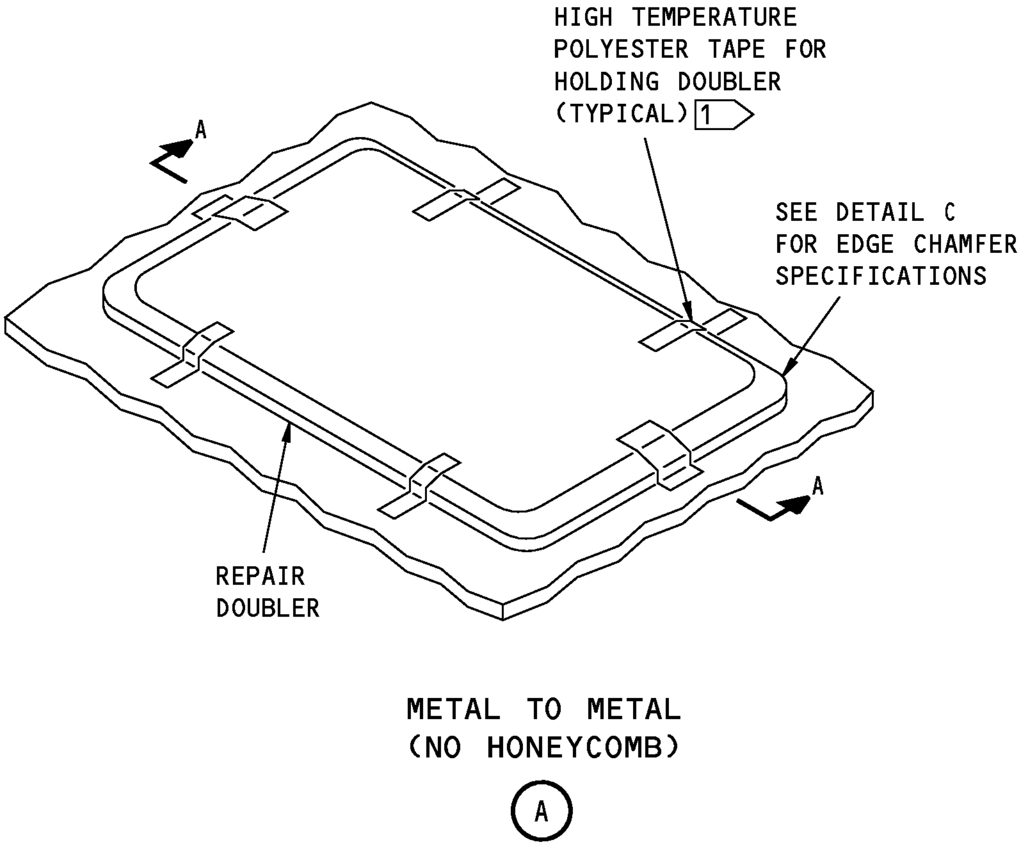
NOTES

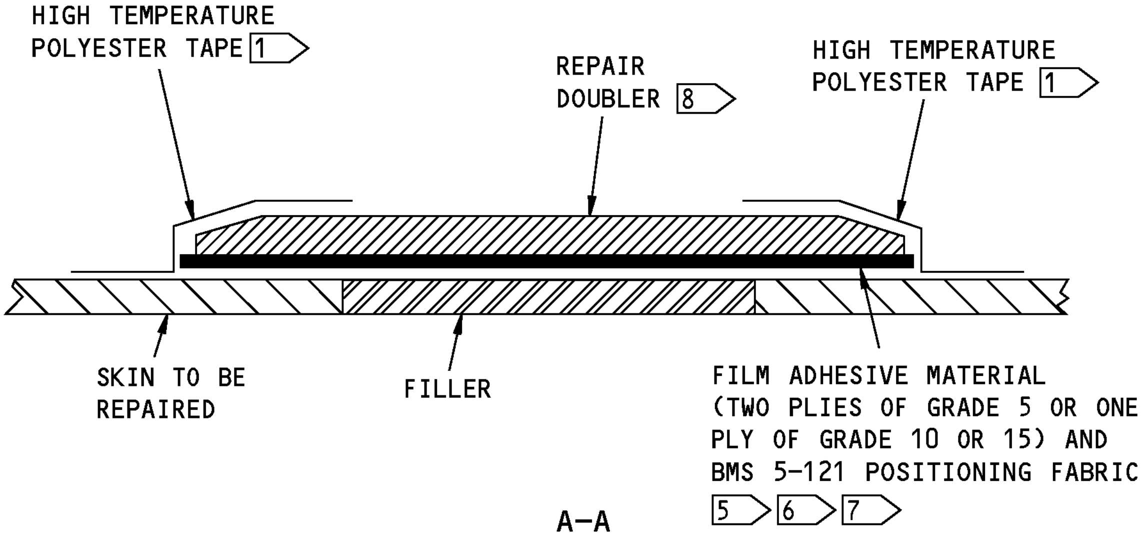
- IF A TYPE IS NOT SPECIFIED IT IS PREFERRED THAT YOU USE TYPE V.
- CURE UNDER PRESSURE AS FOLLOWS:
  (1) BMS5-92, TYPE V, CLASS 1 ADHESIVE:
  3 HOURS MINIMUM AT 70 TO 100°F (21 TO 38°C), OR
  2 HOURS MINIMUM AT 120 TO 130°F (49 TO 54°C).
  (2) BMS5-92, TYPE V, CLASS 2 ADHESIVE:
  7 HOURS MINIMUM AT 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)

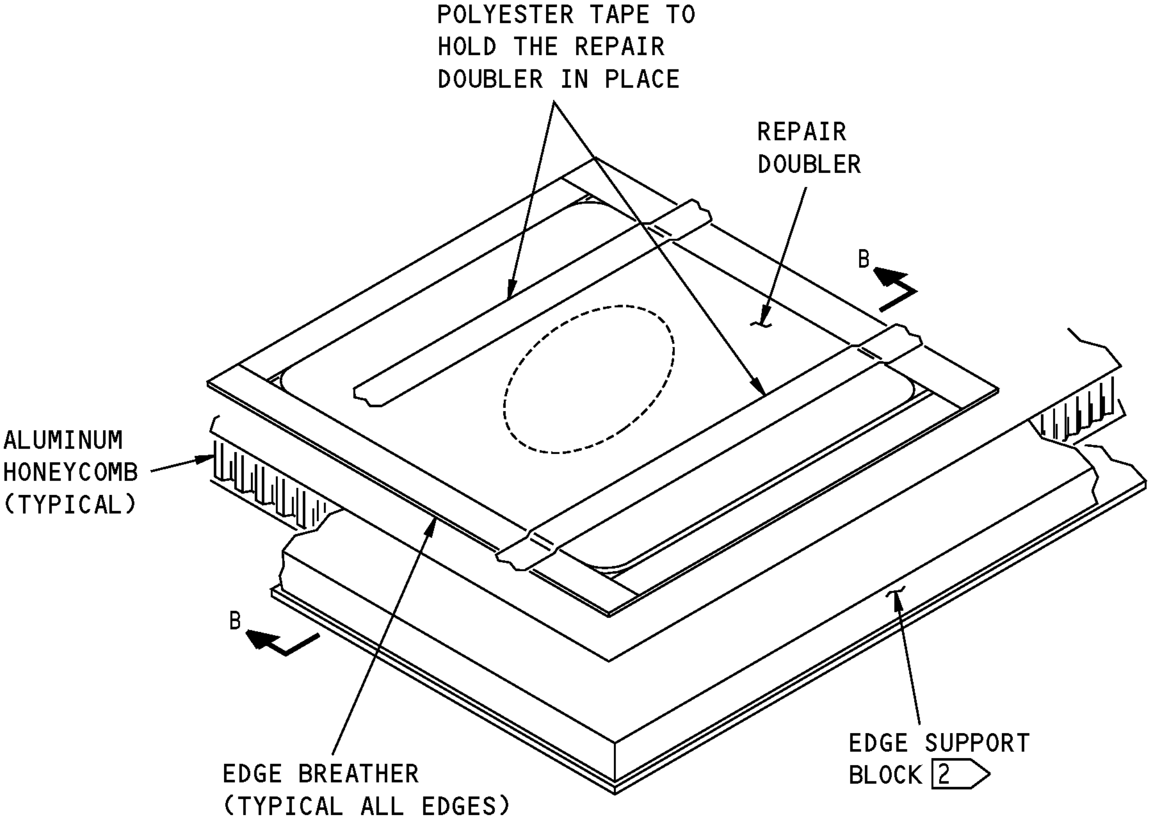


Cure Time for BMS5-141 Paste Adhesive
Figure 212

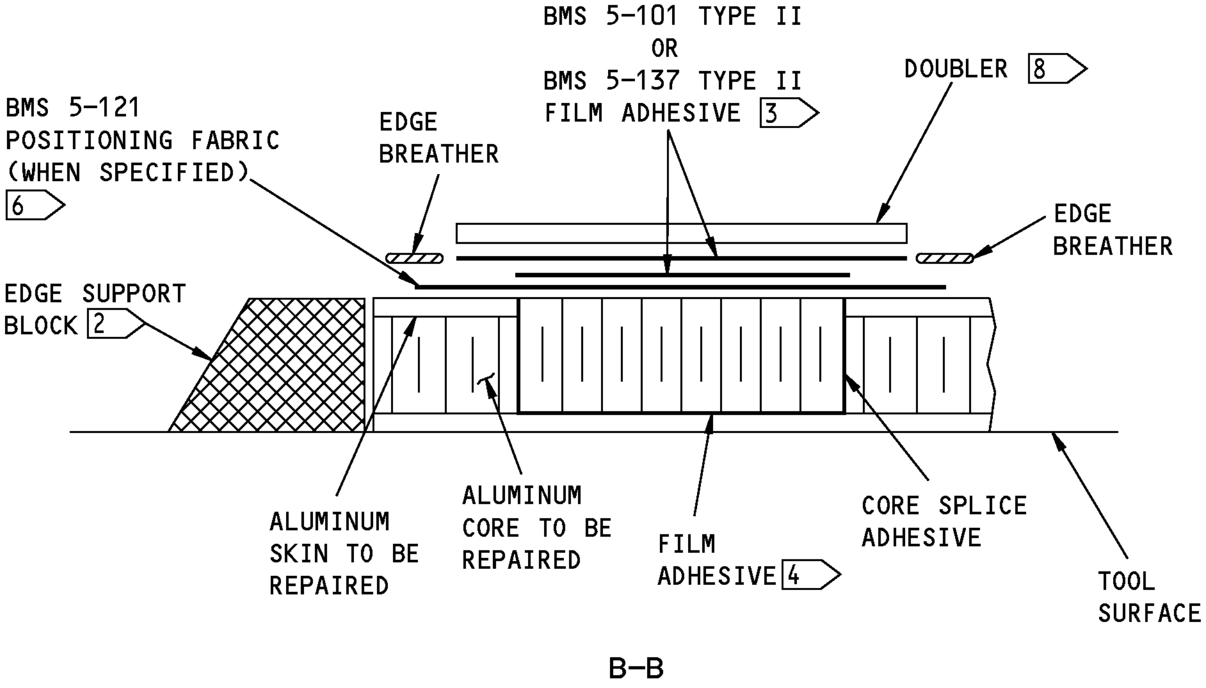


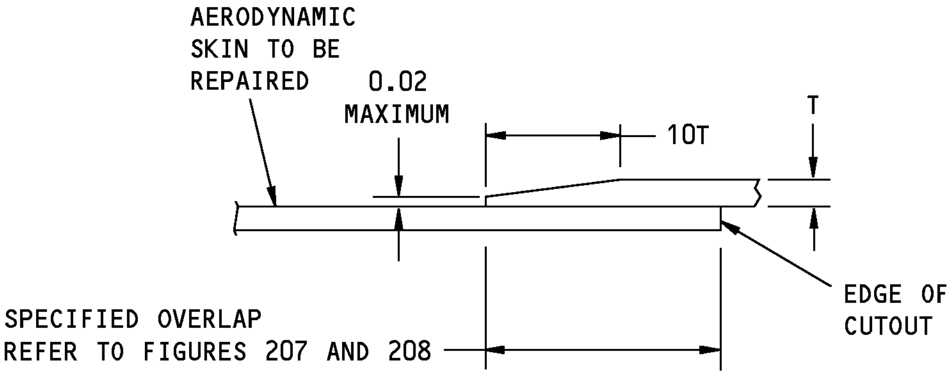


Installation of the Repair Doubler
Figure 213 (Sheet 1 of 6)



Installation of the Repair Doubler
Figure 213 (Sheet 2 of 6)

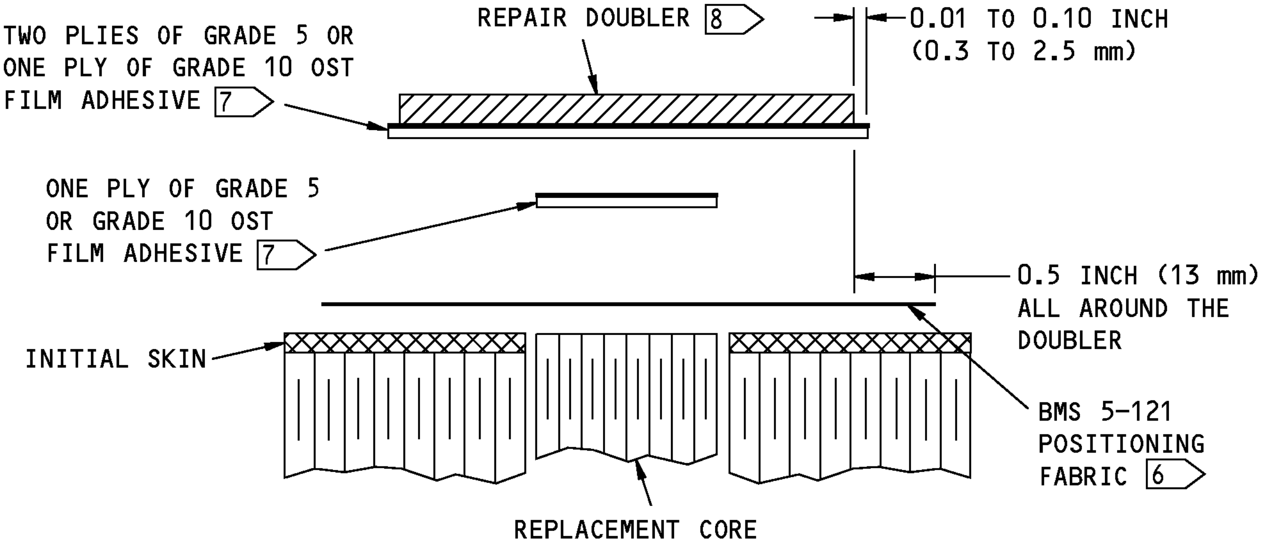




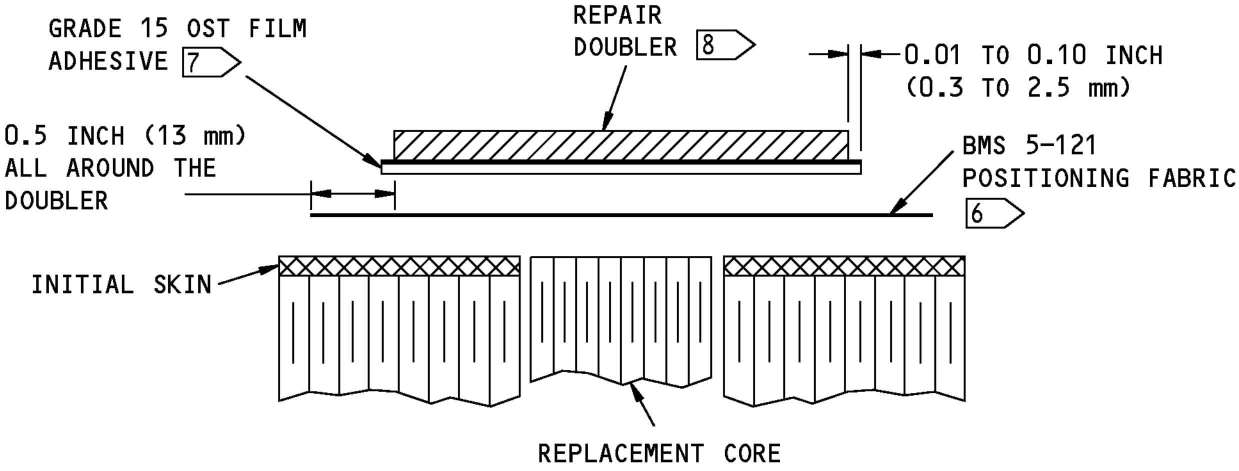
TYPICAL CHAMFERED EXTERNAL PATCH
(GAGE THICKNESS 0.032 AND MORE)

C

Installation of the Repair Doubler
Figure 213 (Sheet 3 of 6)



INSTALLATION OF EXTERNAL DOUBLER AND GRADE 5 OR GRADE 10 OST FILM ADHESIVE

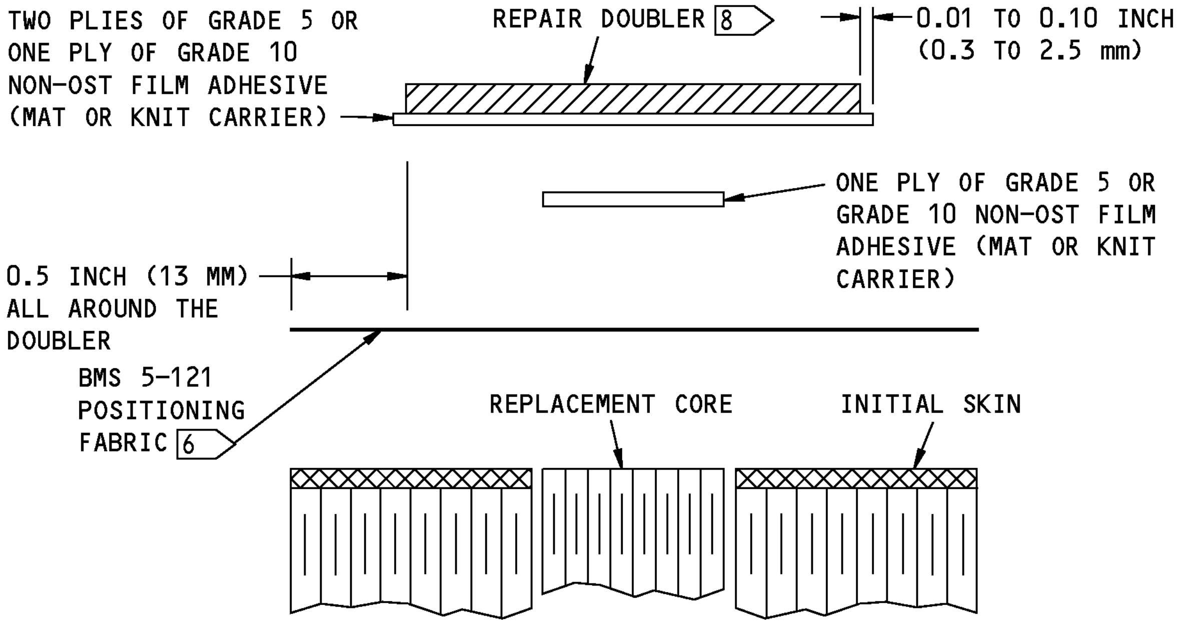


INSTALLATION OF EXTERNAL DOUBLER AND GRADE 15 OST FILM ADHESIVE 5

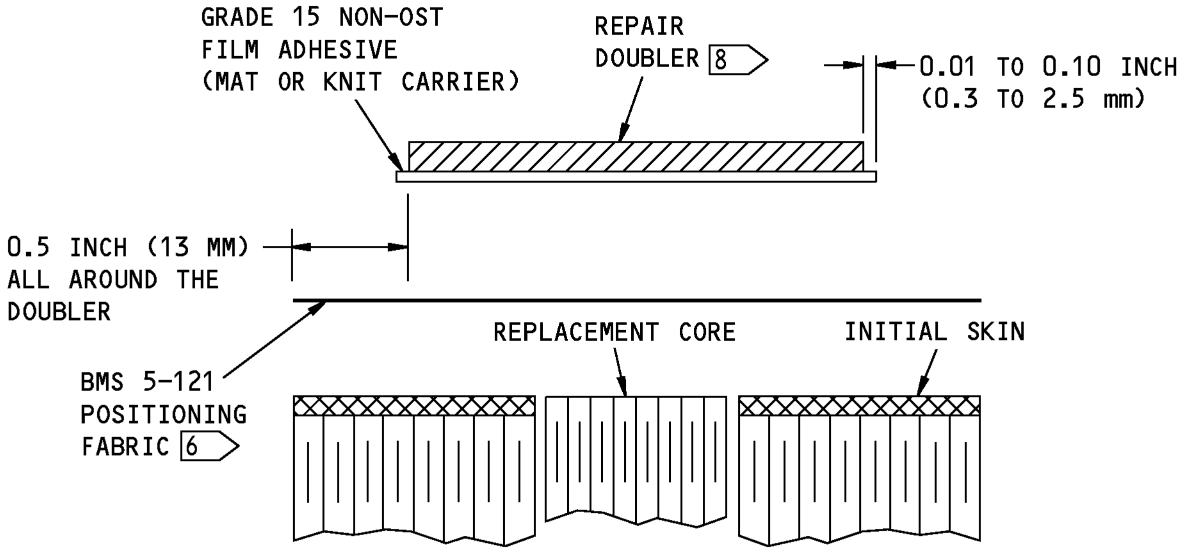
INSTRUCTIONS TO APPLY ONE-SIDE-TACKY (OST) FILM ADHESIVE 7

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.

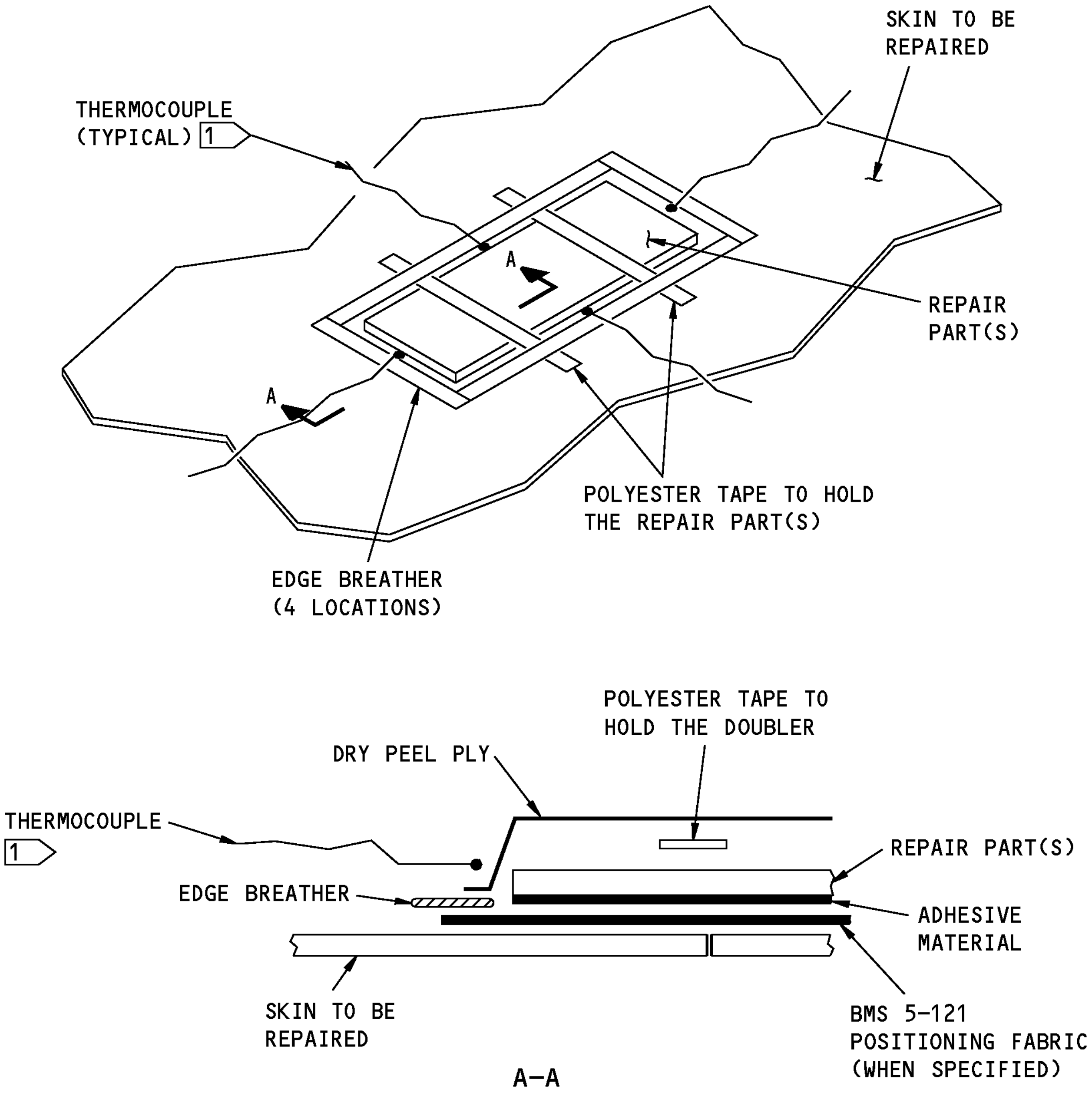
[5] DO NOT USE GRADE 15 FILM ADHESIVE IF THE DOUBLER TO BE BONDED IS ≤ 0.020 GAGE

[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.

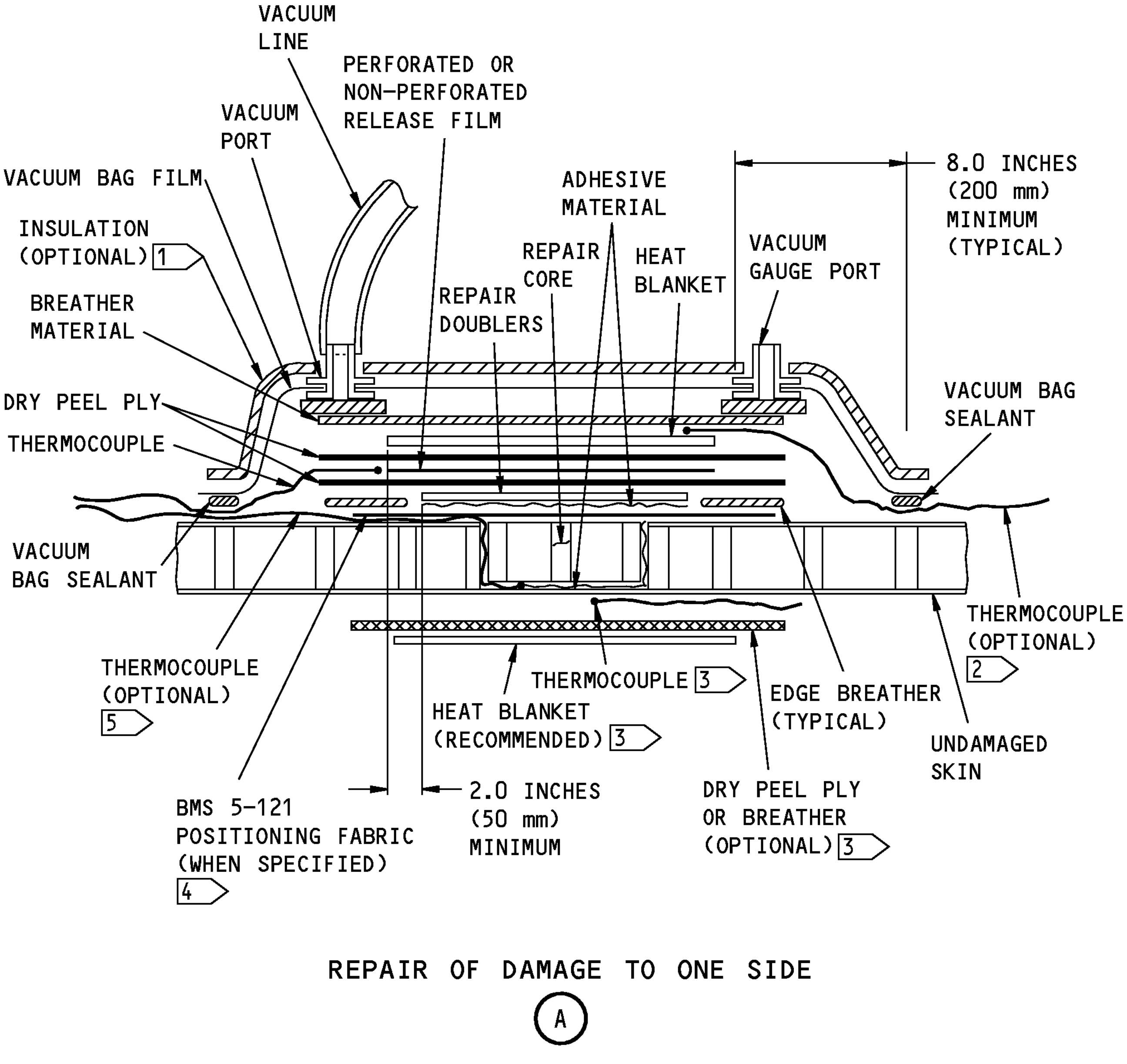
[8] IF MORE THAN ONE DOUBLER IS NECESSARY, THEN PUT FILM ADHESIVE MATERIAL (TWO PLIES OF GRADE 5 OR ONE PLY OF GRADE 10 OR 15) AND BMS 5-121 POSITIONING FABRIC BETWEEN EACH DOUBLER. [6] [7]

Installation of the Repair Doubler
Figure 213 (Sheet 6 of 6)

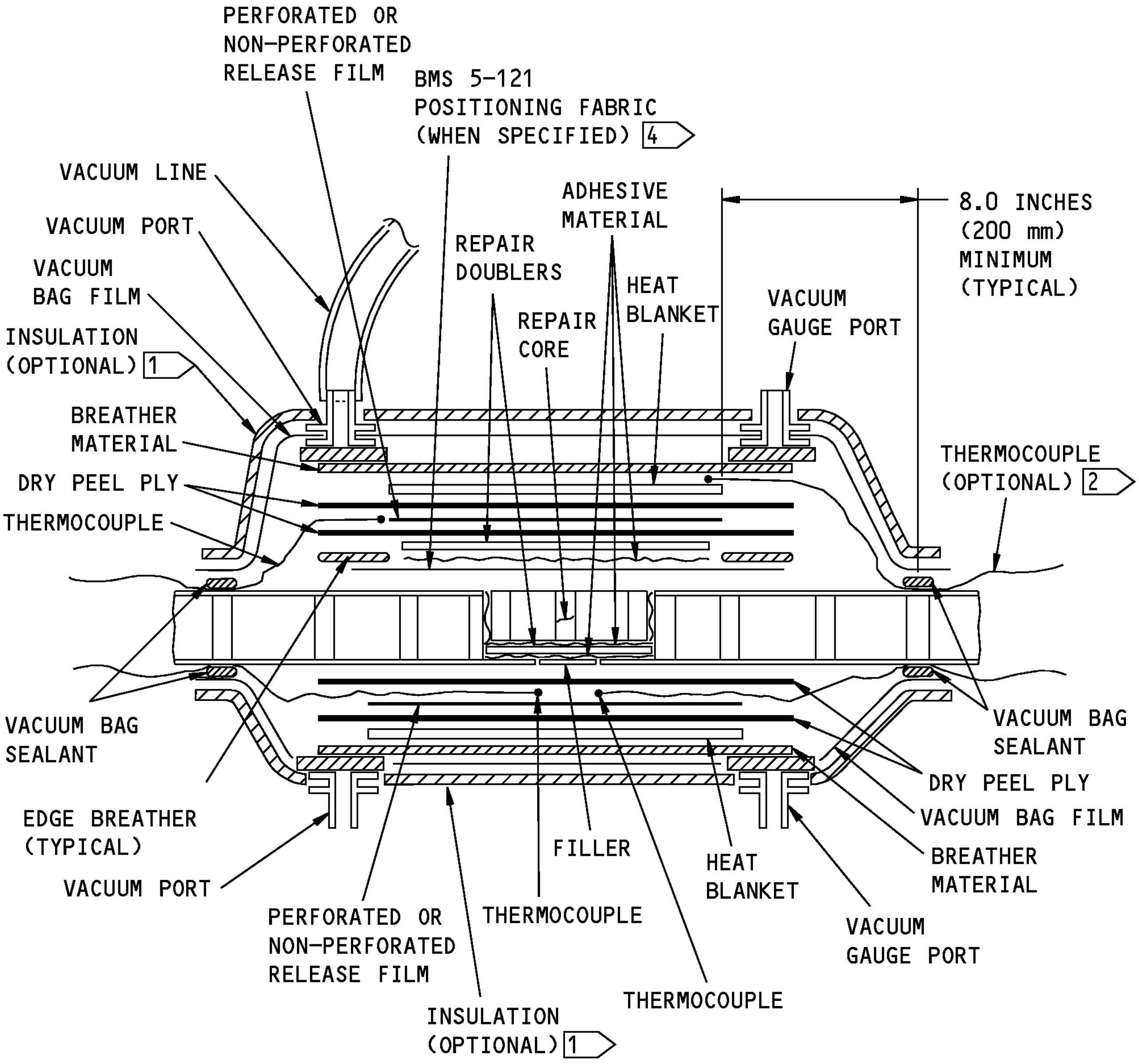


1 REPAIRS MUST HAVE A MINIMUM OF FOUR THERMOCOUPLES AT THE EDGES OF THE LARGEST REPAIR PART. SPACE THE THERMOCOUPLES EQUAL DISTANCES AROUND THE REPAIR PART(S).

Thermocouple Locations
Figure 214



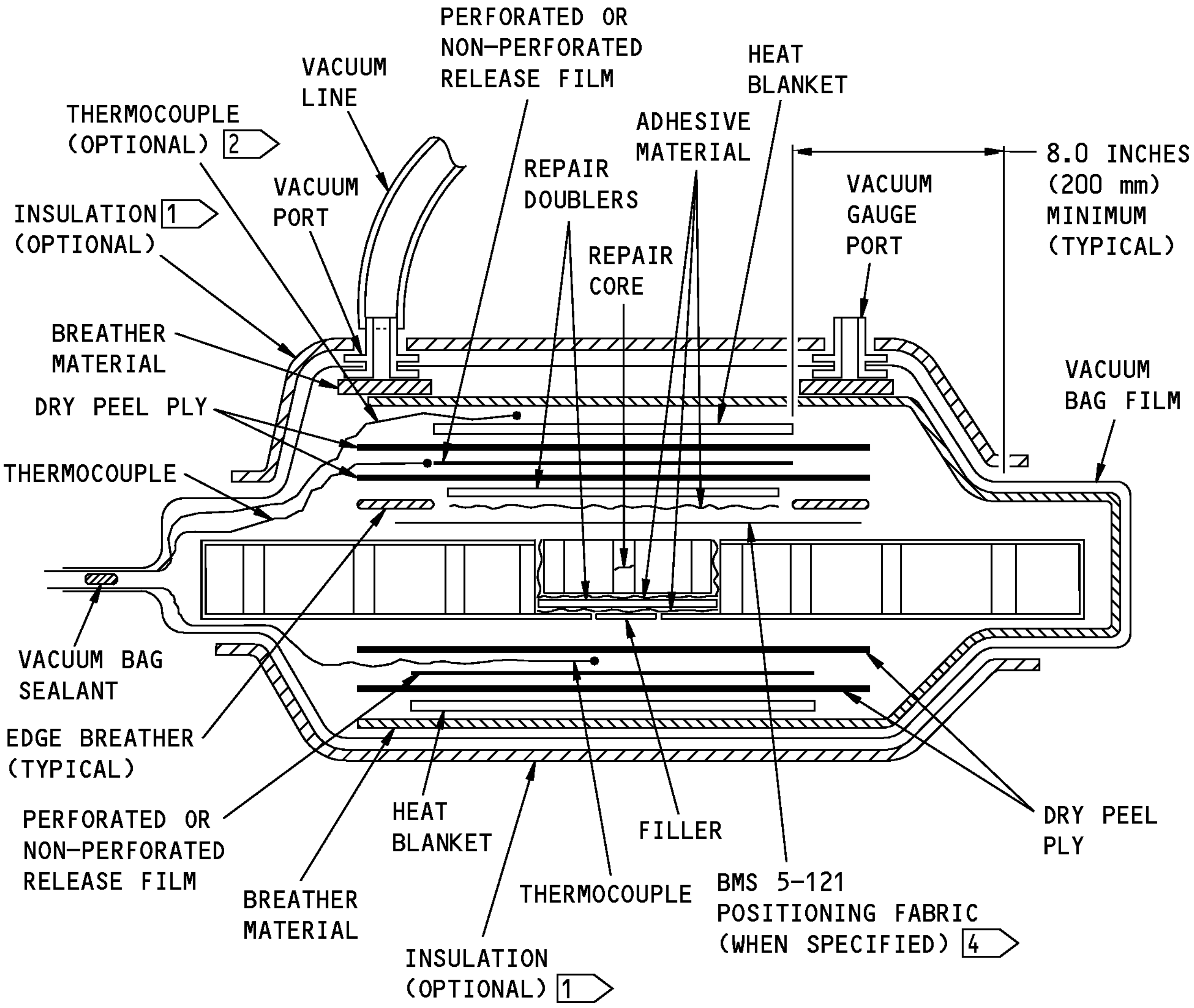
Layup of Vacuum Bagging Materials
Figure 215 (Sheet 1 of 5)



REPAIR OF DAMAGE TO BOTH SIDES
(SEPARATE VACCUM BAGS)

Ⓑ

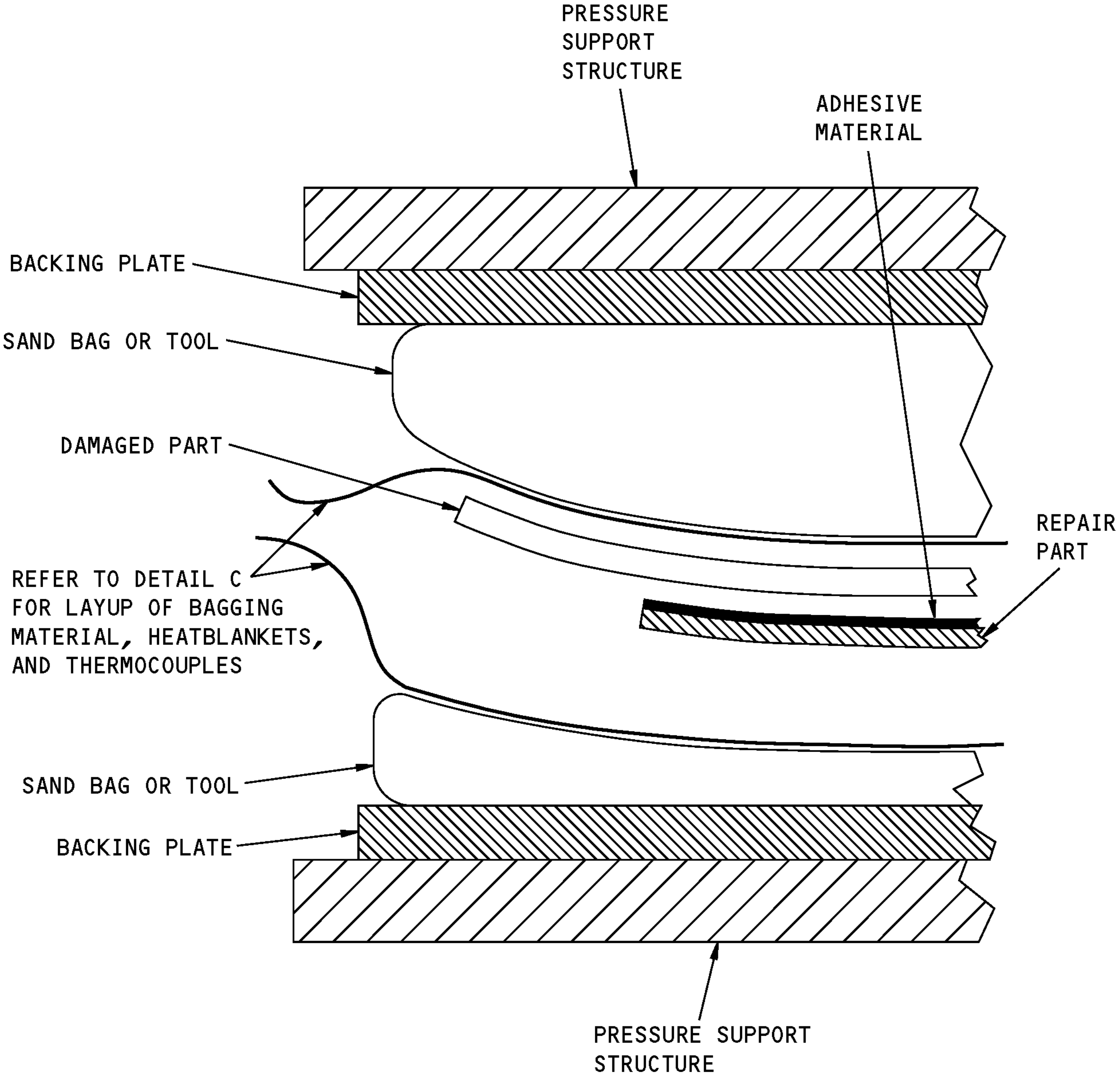
Layup of Vacuum Bagging Materials
Figure 215 (Sheet 2 of 5)



REPAIR OF DAMAGE TO BOTH SIDES
(ENVELOPE BAG)

Ⓒ

Layup of Vacuum Bagging Materials
Figure 215 (Sheet 3 of 5)



APPLICATION OF PRESSURE FOR ROUNDED OR CONTOURED PANELS

Ⓓ

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.

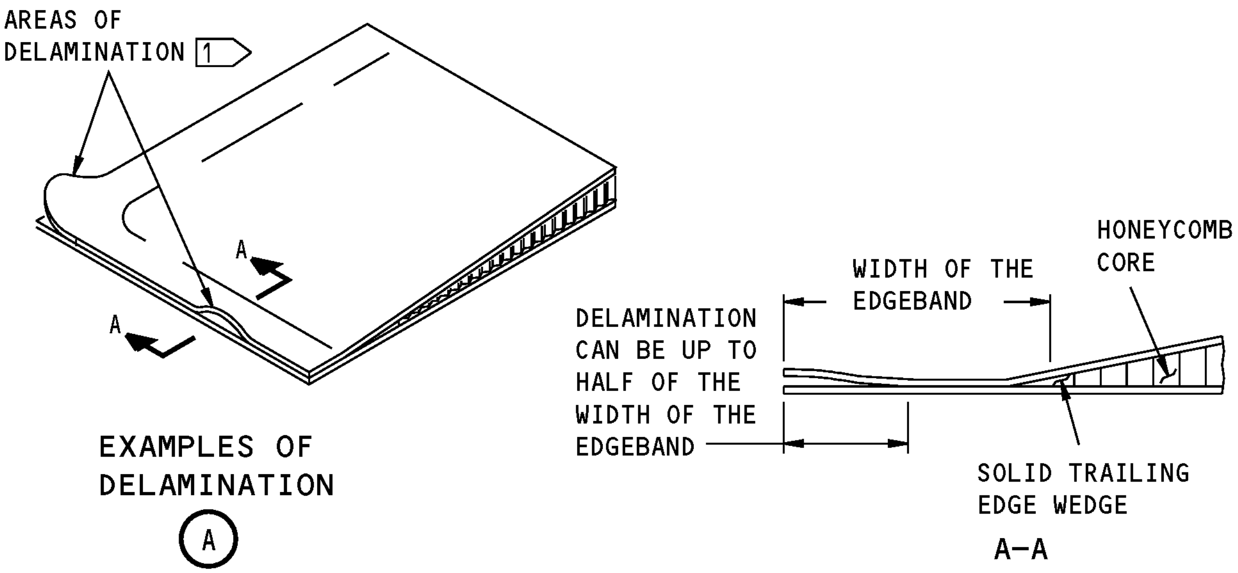
(1) Make sure that there is no air caught in-between the adhesive material and the skins.

(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.

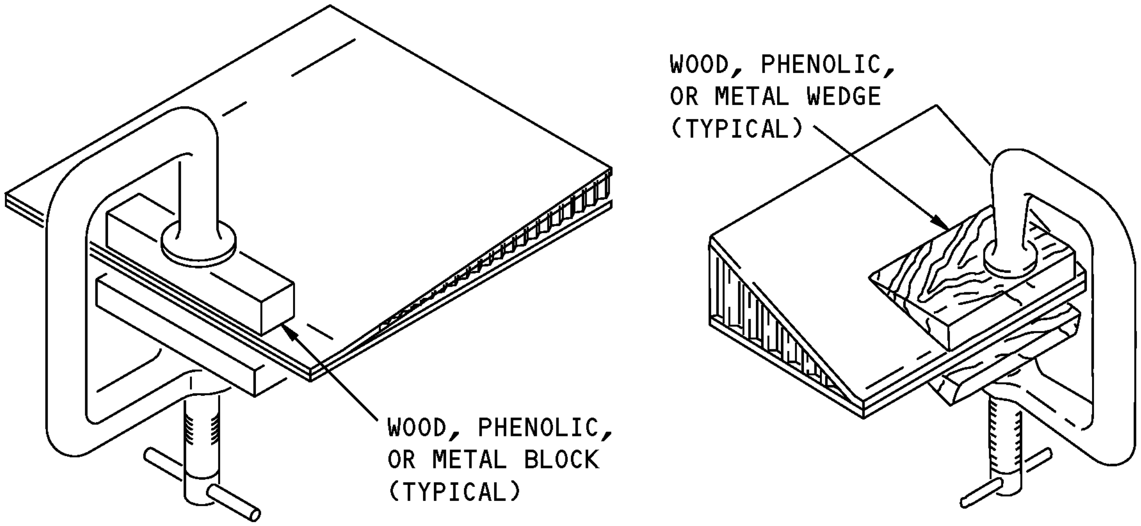
H. Clean, seal and finish as given in Paragraph 22./REPAIR GENERAL.



EXAMPLES OF DELAMINATION

A

A-A



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
NDT Part 1, 51-04-00	Ultrasonic
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 NDT Part 1, 51-05-01 or NDT Part 1, 51-04-00.

B. Remove the surface finish and all contamination as specified in Paragraph 7./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 in Paragraph 8./REPAIR GENERAL and Paragraph 10./REPAIR GENERAL.

(3) If there is an adhesive primer on the surface then do an inspection as specified in Paragraph 11./REPAIR GENERAL. If the primer is in a satisfactory condition, then permit the primer to remain. Clean the primer as specified in Paragraph 11./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 12./REPAIR GENERAL.

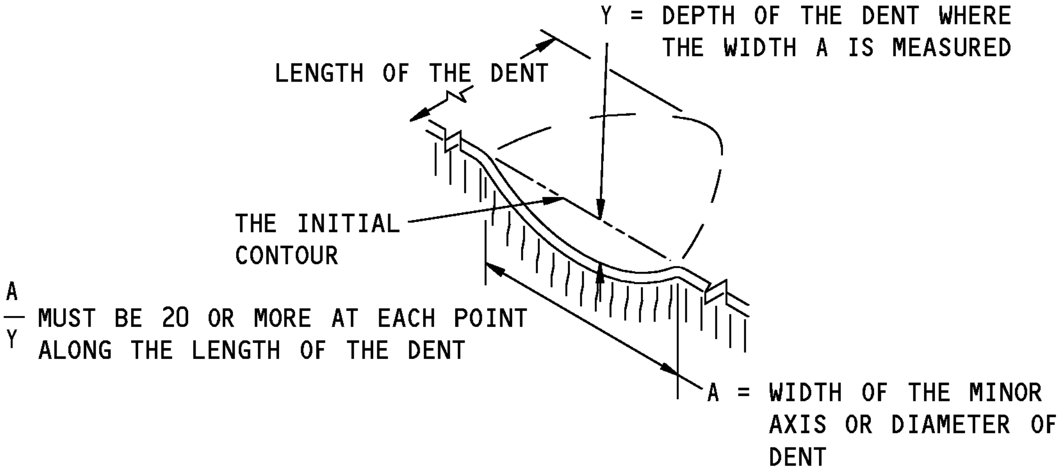
2) Fill the dent with the same paste adhesive that will be used to bond the doubler.

(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 12./REPAIR GENERAL.

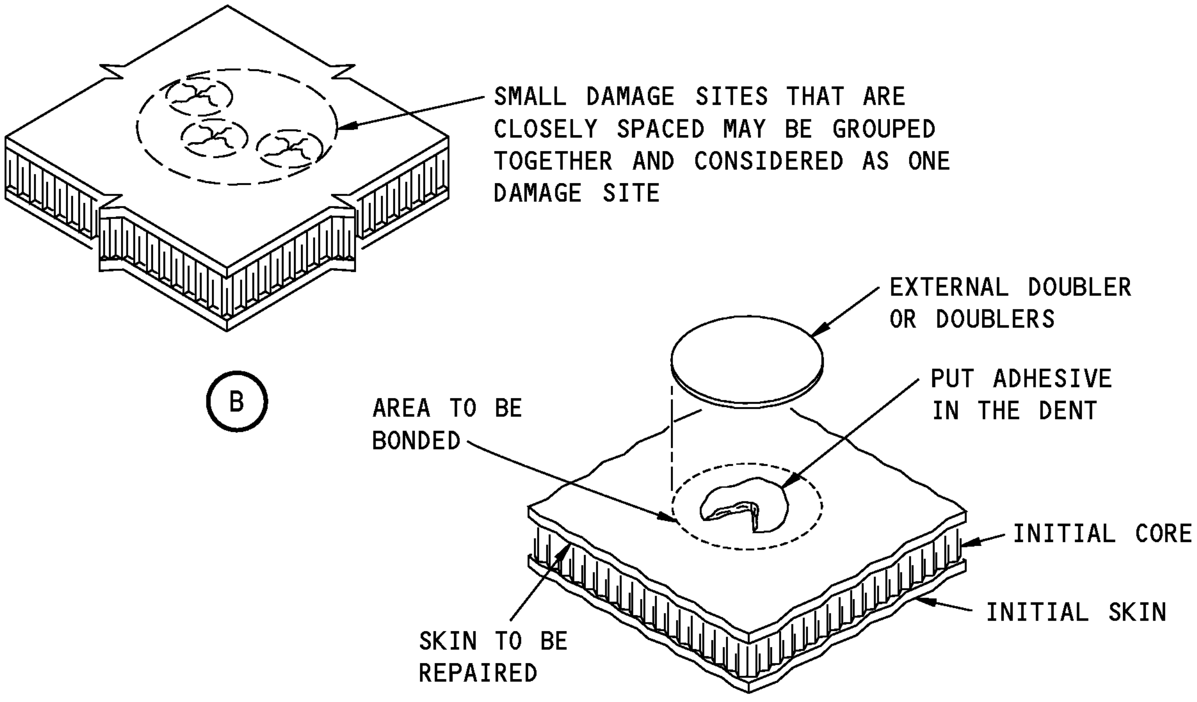
2) Fill the dent with the same film adhesive that will be used to bond the doubler. You can add BMS 5-121 positioning fabric to the adhesive inside the dent, (if necessary).

F. Refer to REPAIR GENERAL for the bonding procedure and other repair steps.



DENT THAT IS PERMITTED IN METAL HONEYCOMB STRUCTURE

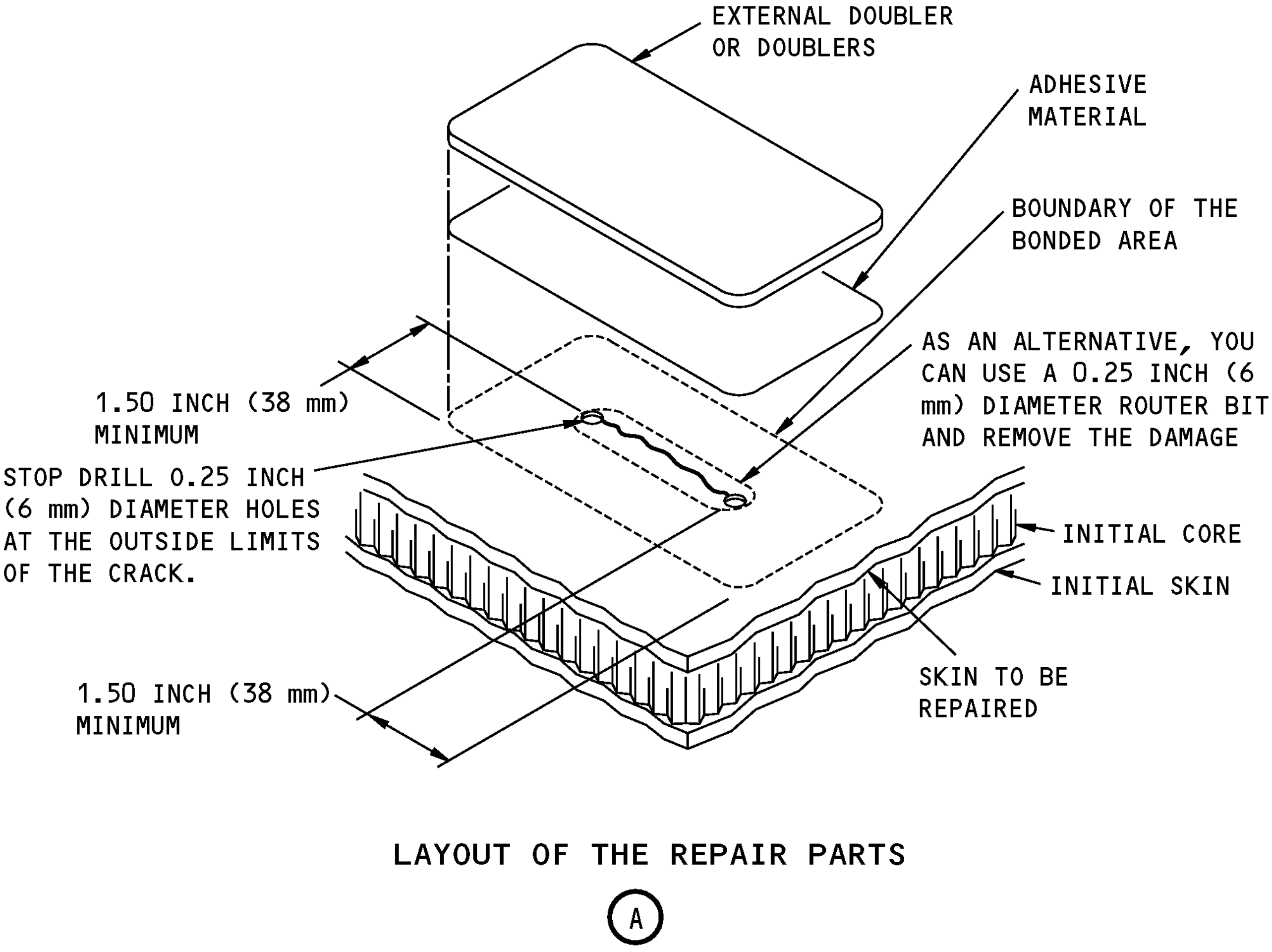
A

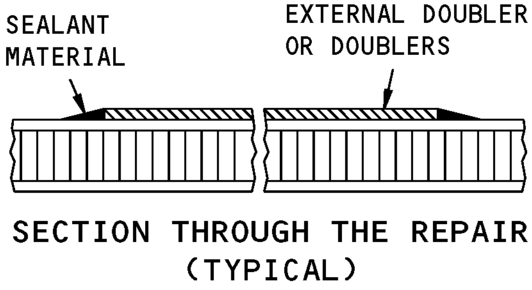


LAYOUT OF THE REPAIR PARTS

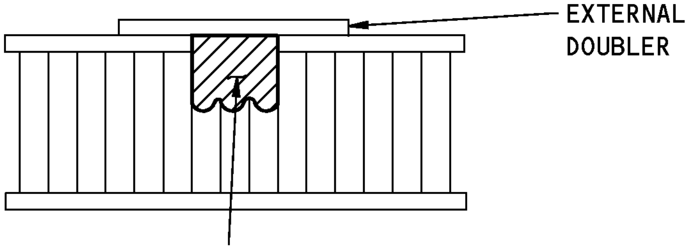
C

External Doubler Repair of a Dent
Figure 201





External Doubler Repair of a Nick, Gouge, or Crack in the Skin
Figure 202

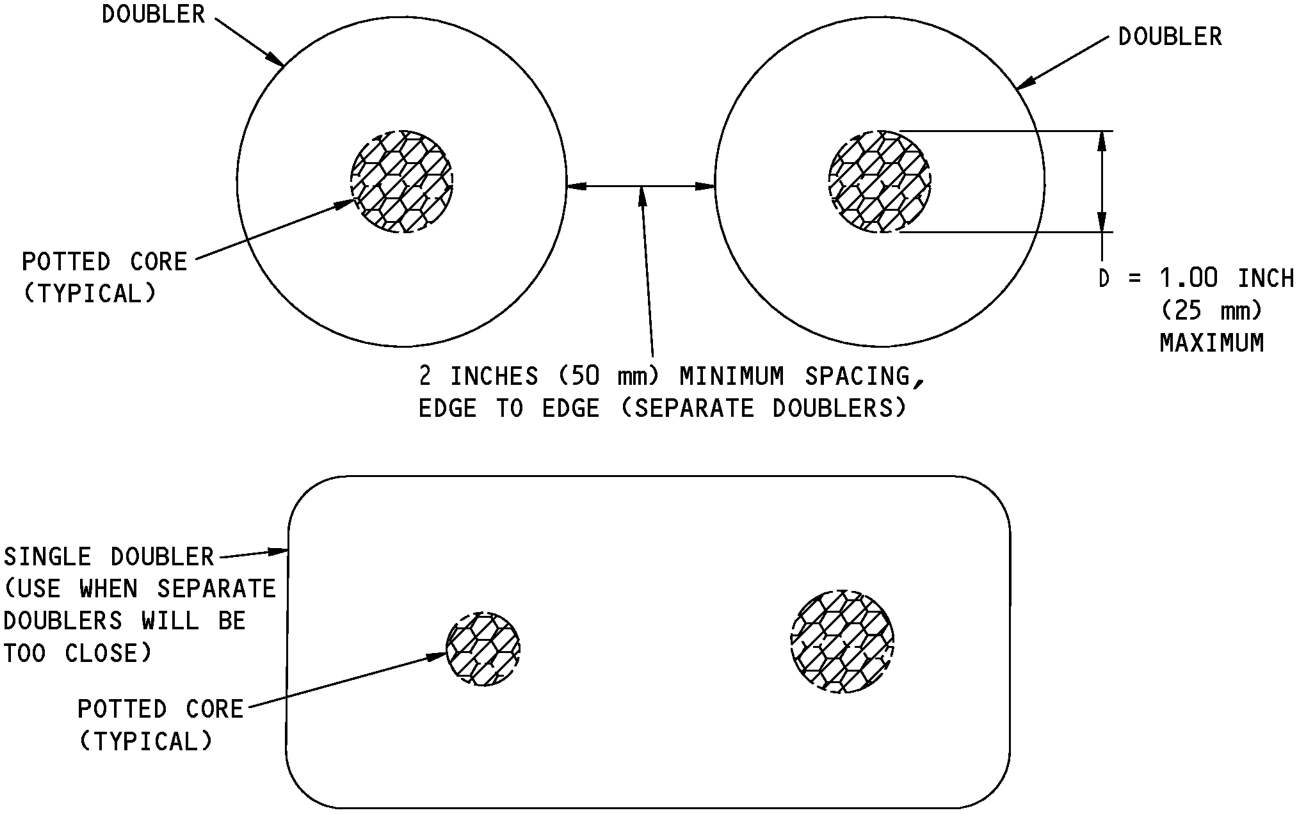


FILL THE CORE CELLS WITH BMS 5-28 TYPE 6 OR 7 POTTING COMPOUND

MAKE THE CELL WALLS STRAIGHT, OR CUT OUT THE CORE IF NECESSARY, TO MAKE IT EASY TO APPLY THE POTTING COMPOUND

PERMITTED DEPTH OF POTTING COMPOUND

Ⓐ



PERMITTED SPACING OF POTTED AREAS

Ⓑ

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
51-70-07, GENERAL	Glass Fabric Reinforced Epoxy Laminates and Nonmetallic Honeycomb Sandwich Repairs - 250°F (121°C) Cure
51-70-08, GENERAL	Glass Fabric Reinforced Epoxy Laminates and Nonmetallic Honeycomb Sandwich Repairs - 350°F (177°C) Cure
51-70-17, GENERAL	Repairs to 250°F (121°C) and 350°F (177°C) Cured Graphite/Aramid/Fiberglass Reinforced Epoxy Laminates and Nonmetallic Honeycomb Sandwich Structure - 200°F (93°C) to 230°F (110°C) Wet Layup Repair Method

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 I 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 51-70-17, 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 51-70-07, 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 51-70-08, 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 51-70-07, GENERAL or 51-70-17, 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,

(b) Then, 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 51-70-17, 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 51-70-07, 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 51-70-08, 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 51-70-07, GENERAL or 51-70-17, GENERAL to make pre-cured GFRP laminate.

(a) Lightly abrade the surface resin of the pe-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,

(b) Then, 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 51-70-07, GENERAL if the GFRP septum is used or 51-70-17, GENERAL if the aluminum septum is used.

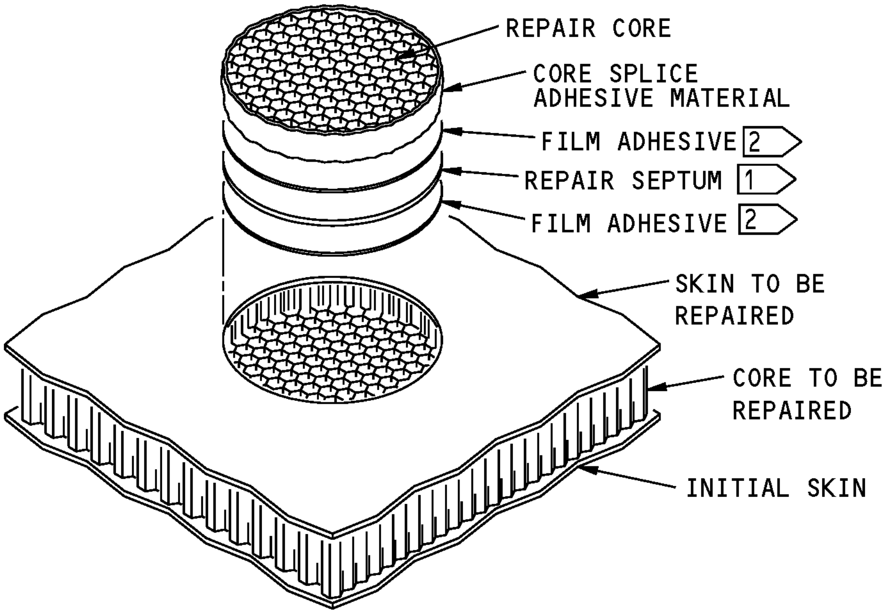
G. Cut the core/septum assembly to the necessary shape. (A core cylinder, for example).

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.

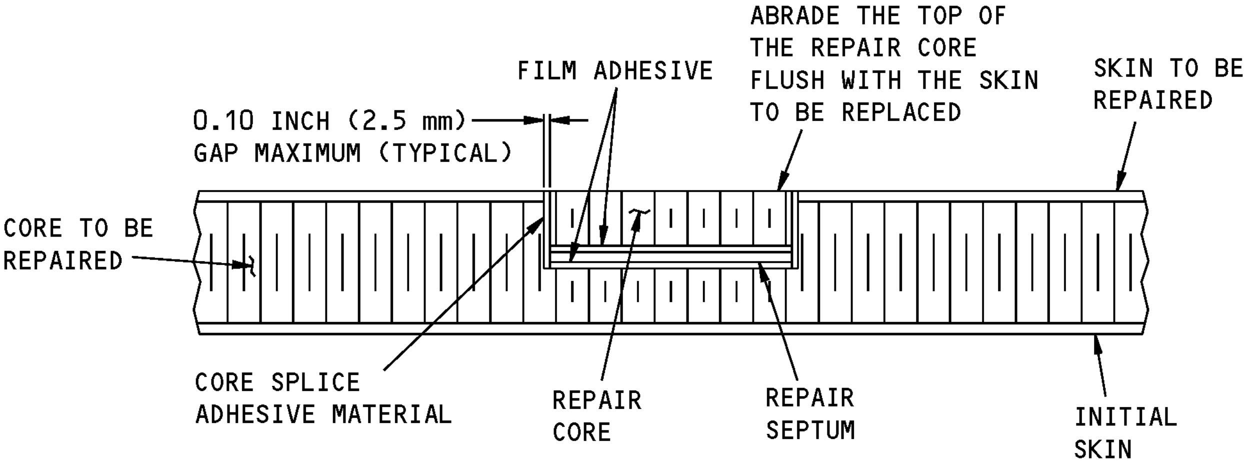
7. Complete the Repair

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 51-70-17, GENERAL. 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 51-70-07, GENERAL. 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 51-70-08. 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 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.

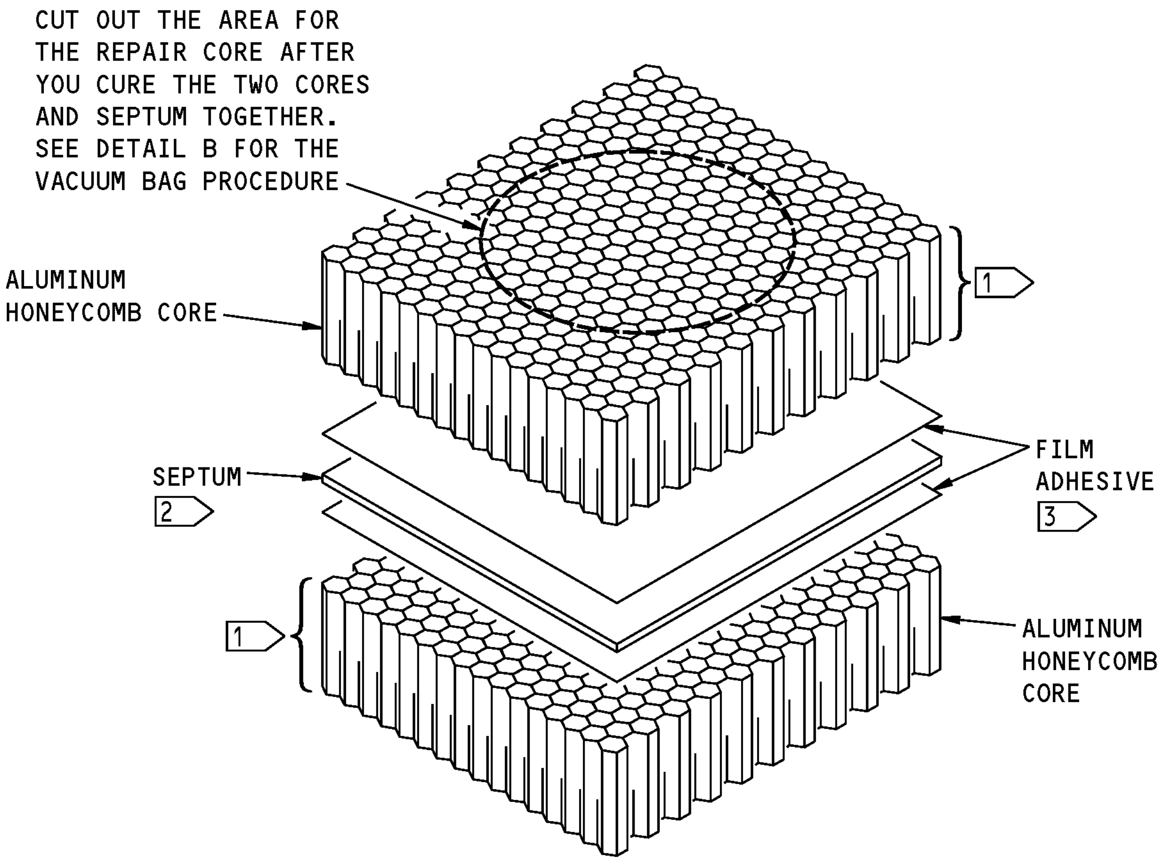
B. FOR THE PRE-CURED 350°F (177°C) GFRP SEPTUM:

- 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).

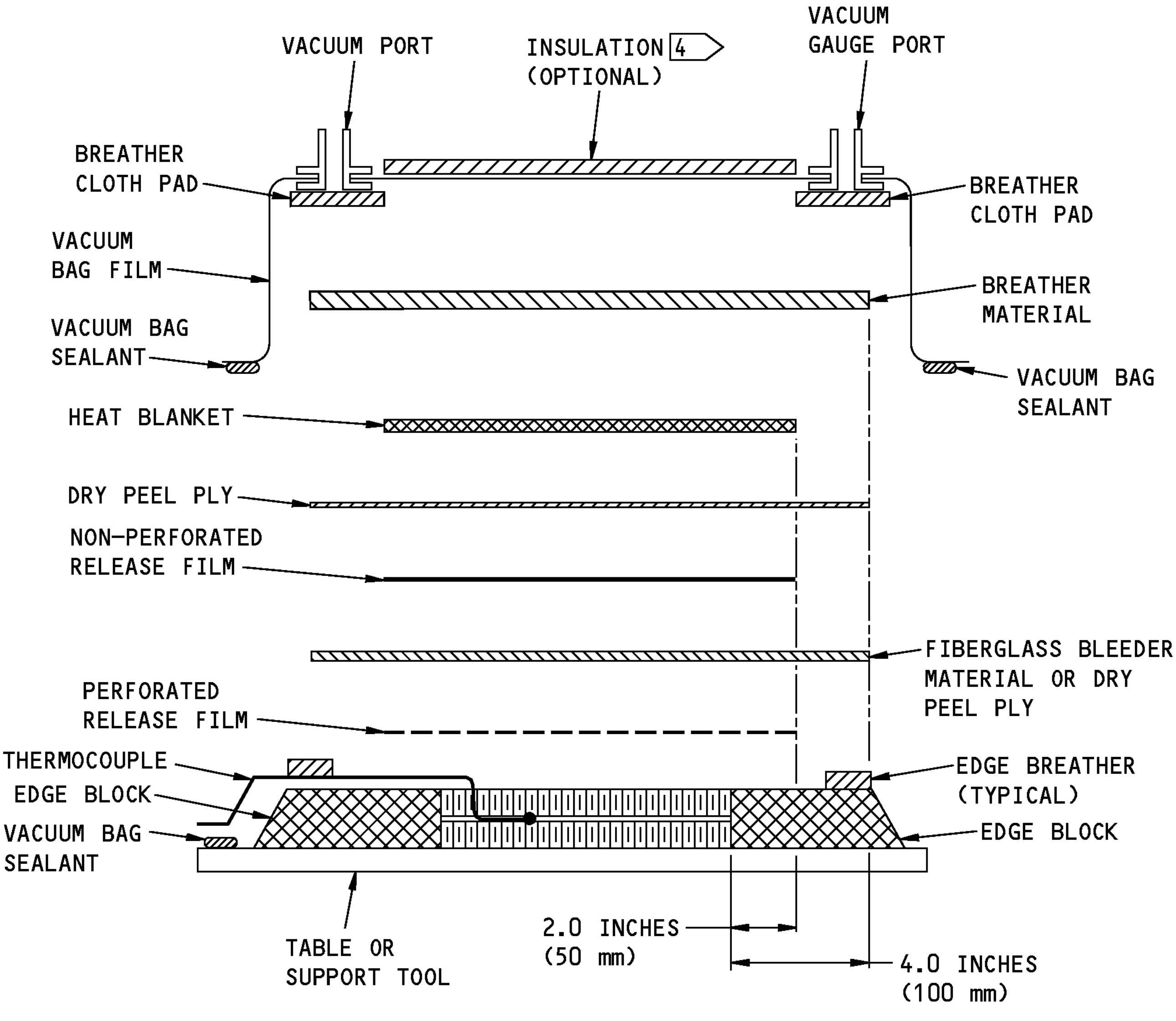
Bonded Doubler Repair That Uses an Internal Septum For a Less Than Full Depth Core Replacement
Figure 201 (Sheet 3 of 3)



LAYOUT OF THE ALUMINUM CORE SEPTUM ASSEMBLY

A

Bonded Doubler Repair That Uses Two Cores and an Internal Septum for Full Core Replacement
Figure 202 (Sheet 1 of 5)



VACUUM BAG PROCEDURE

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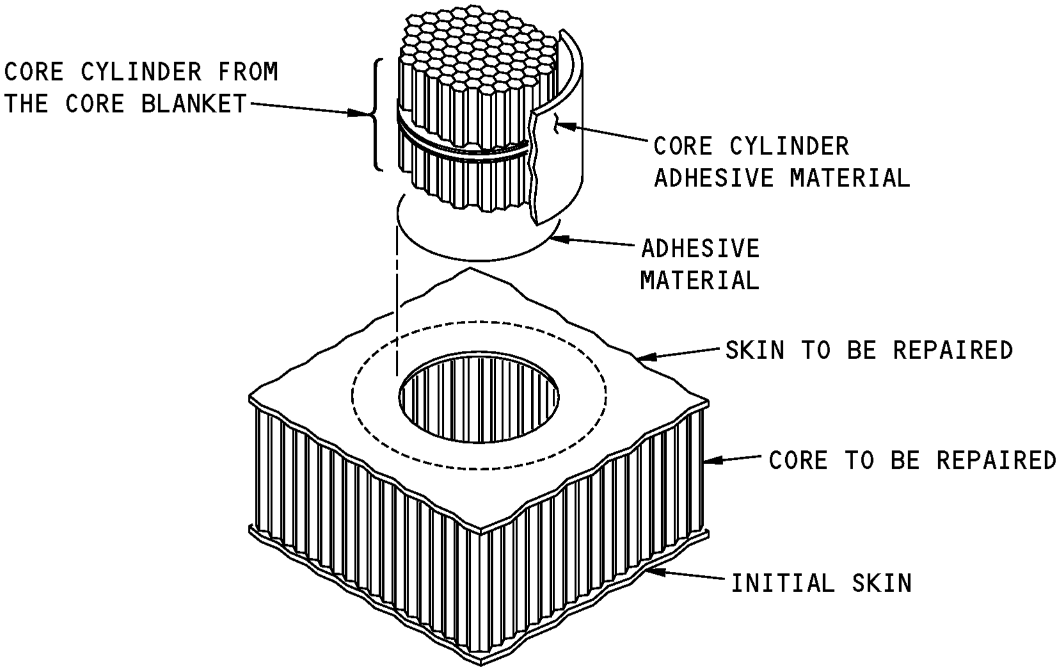
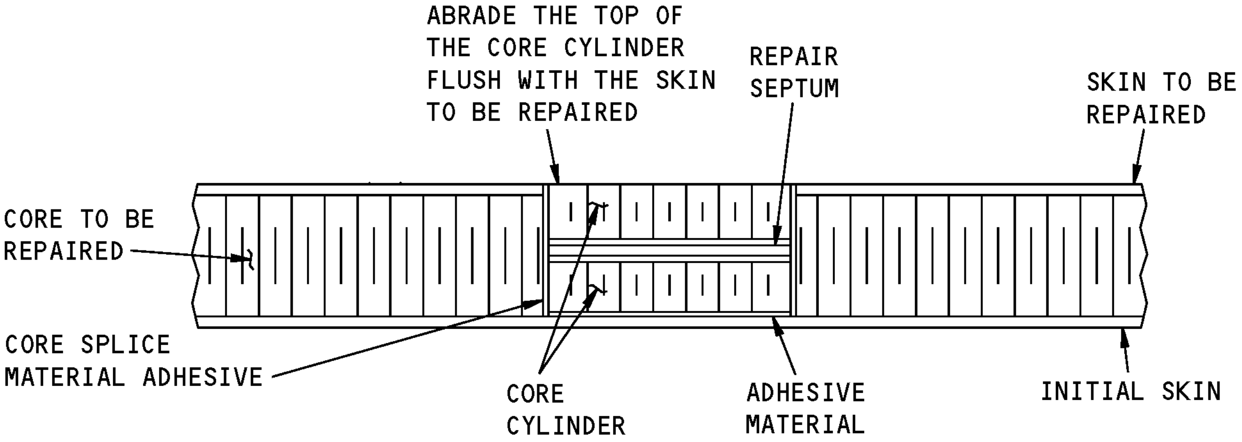
Bonded Doubler Repair That Uses Two Cores and an Internal Septum for Full Core Replacement
Figure 202 (Sheet 2 of 5)



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

- REFER TO REPAIR GENERAL FOR REPAIR CORE INSTALLATION PROCEDURES.

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 51-70-17, GENERAL. 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 51-70-07, GENERAL. 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 51-70-08. 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. This procedure 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.

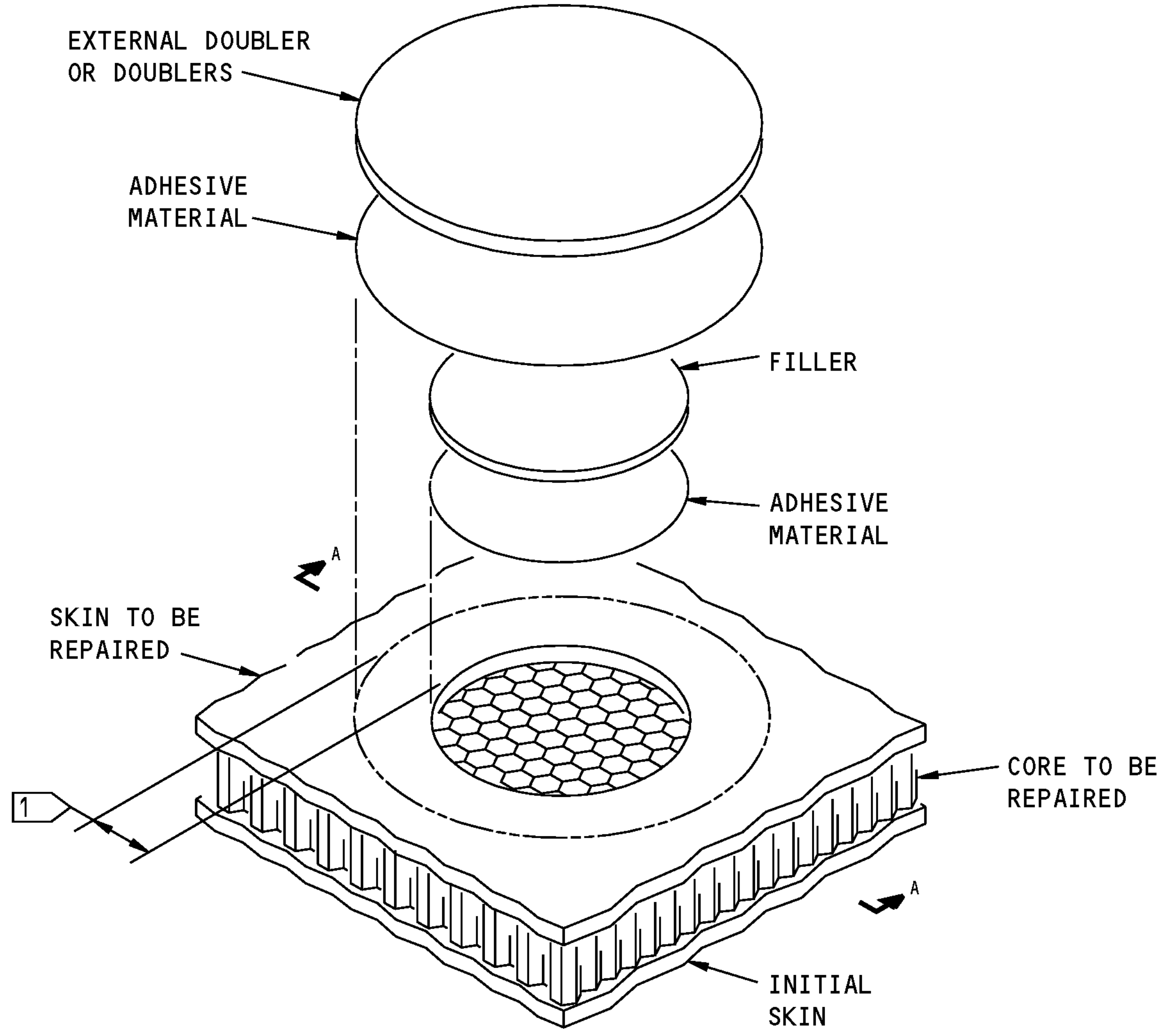
C. If the edge of a cutout is less than 3.0 inches (75mm) from a fitting or attached structure then do one or more of the steps that follow:

   (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.

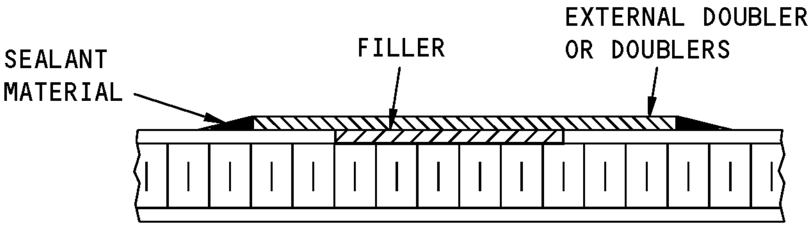
   (3) If you are not sure, or if these instructions will not give a satisfactory repair, then ask Boeing for help.

D. Refer to REPAIR GENERAL for the repair steps.



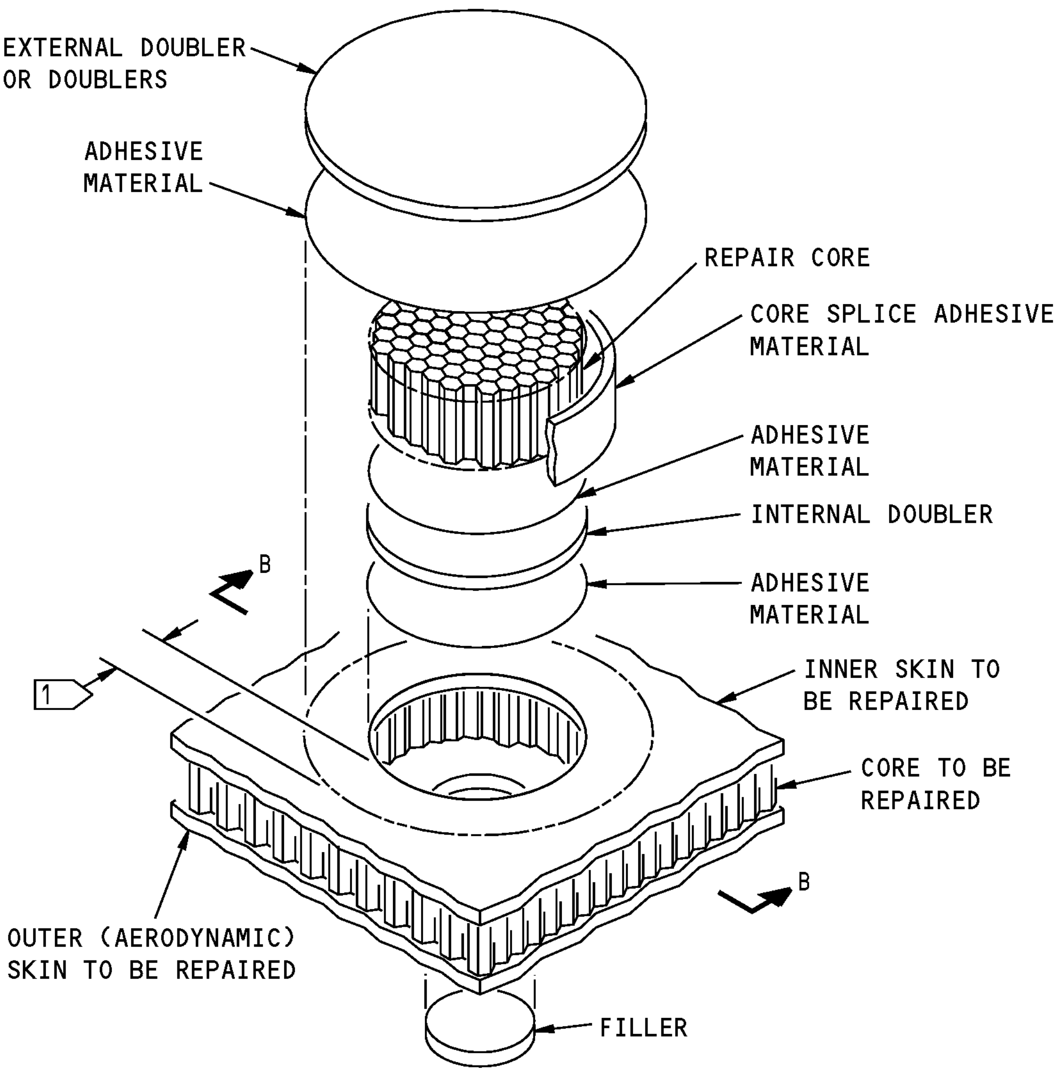
EXTERNAL DOUBLER AND FILLER REPAIR TO ONE SKIN

A



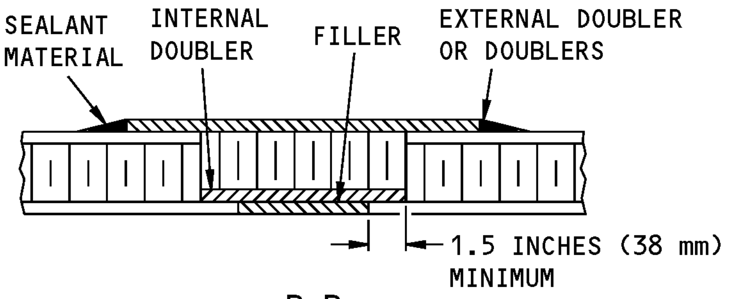
A-A

Repair of Damage Away From the Panel Edges
Figure 201 (Sheet 1 of 5)



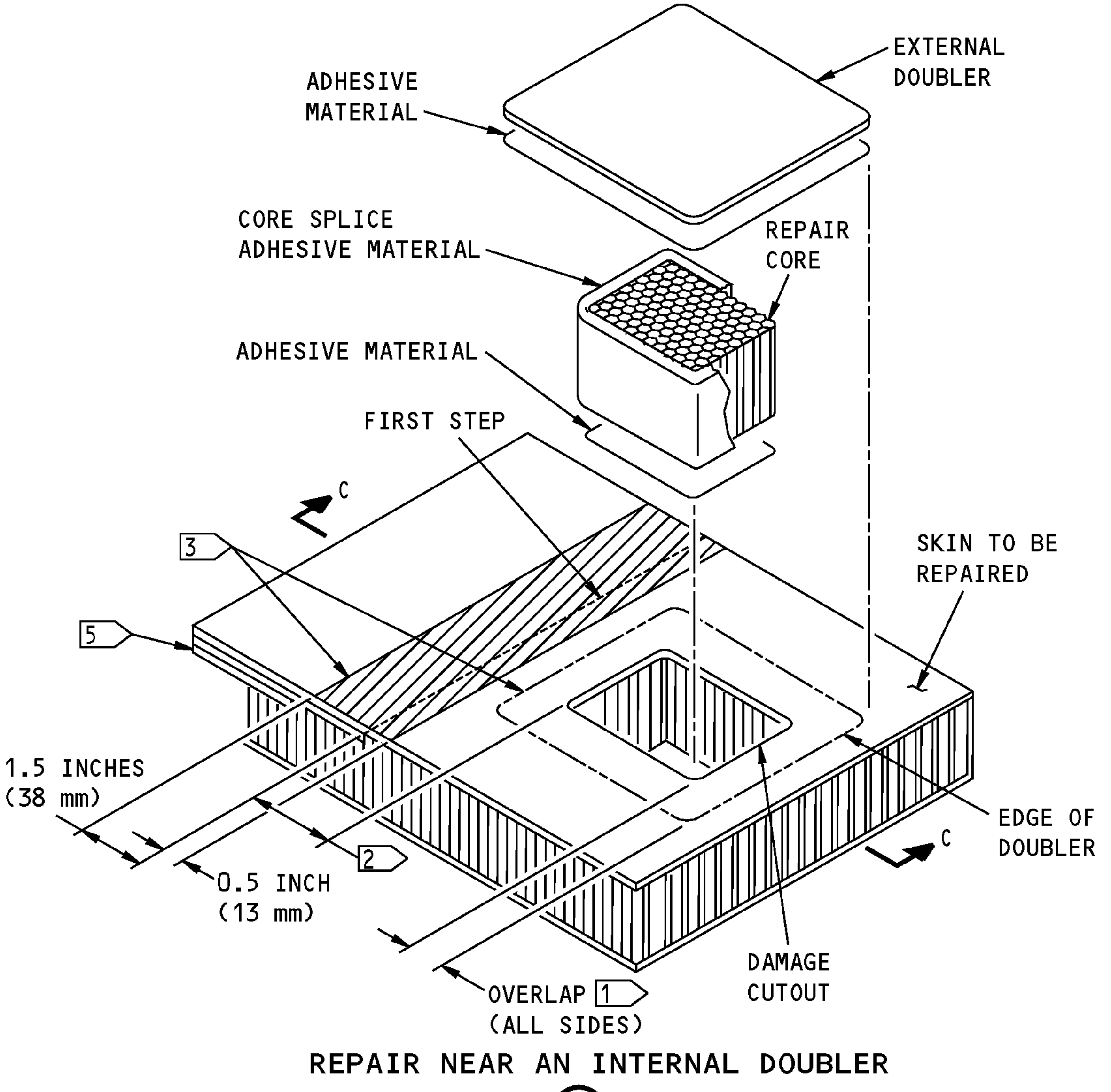
REPAIR TO CORE AND TWO SKINS

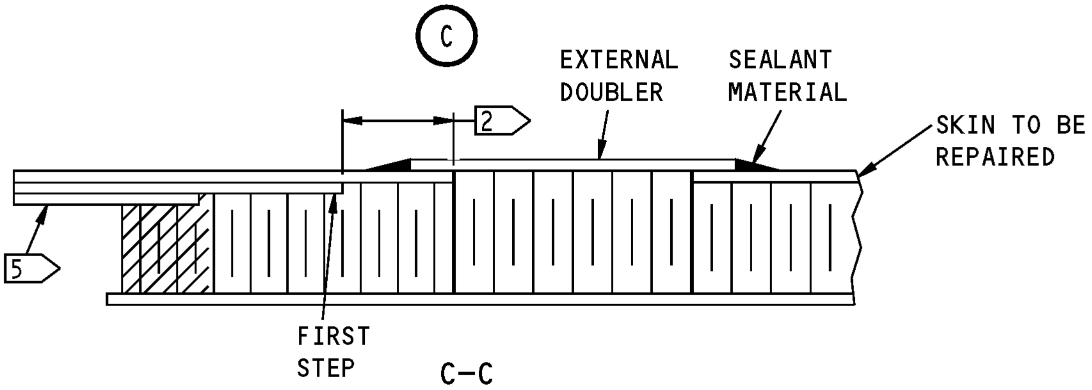
Ⓑ



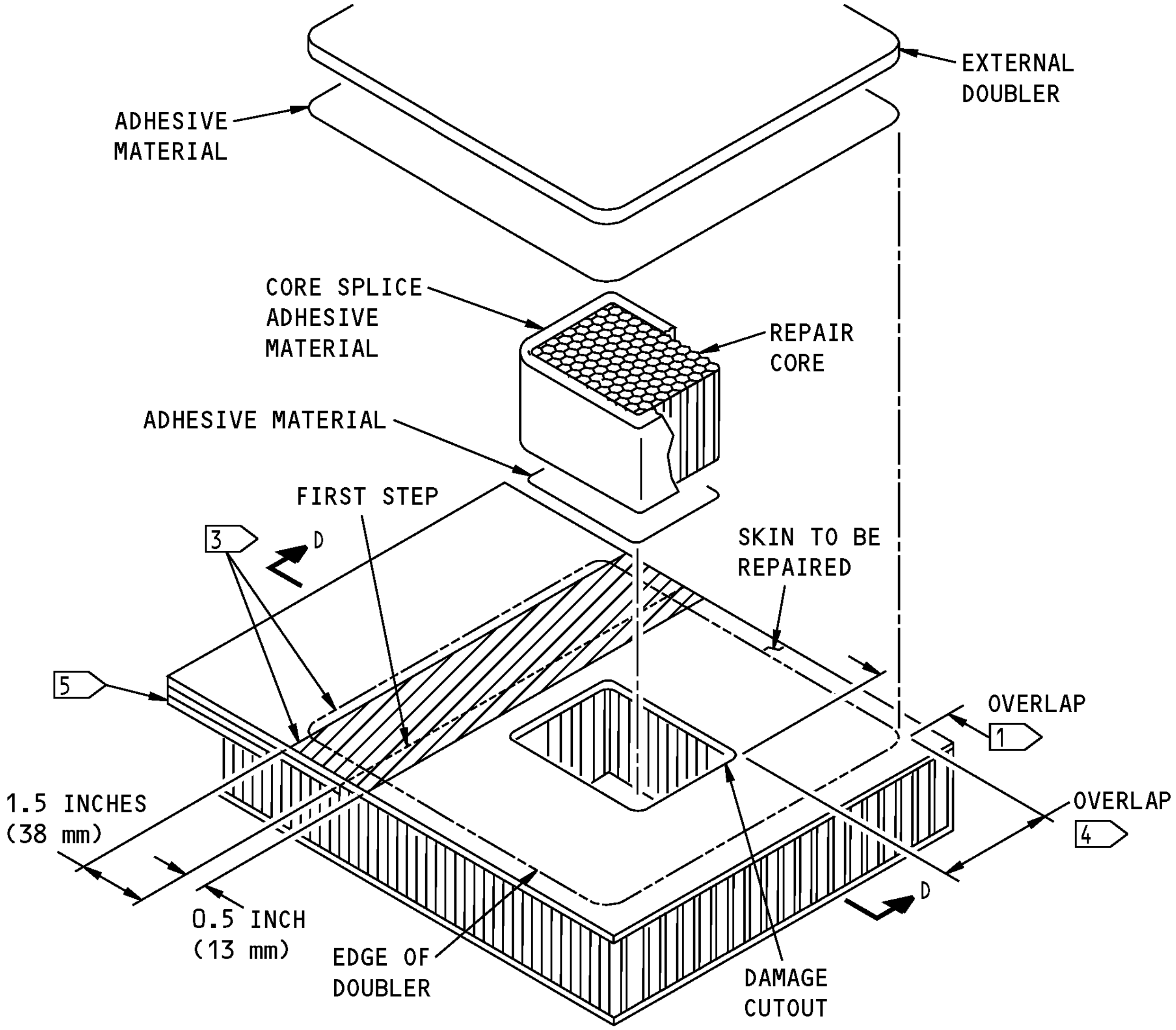
B-B

Repair of Damage Away From the Panel Edges
Figure 201 (Sheet 2 of 5)



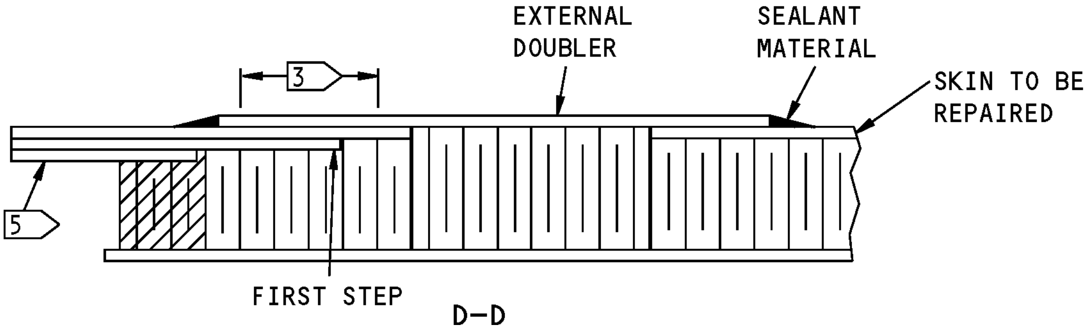


Repair of Damage Away From the Panel Edges
Figure 201 (Sheet 3 of 5)



REPAIR TO PART OF AN INTERNAL DOUBLER

D



D-D

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

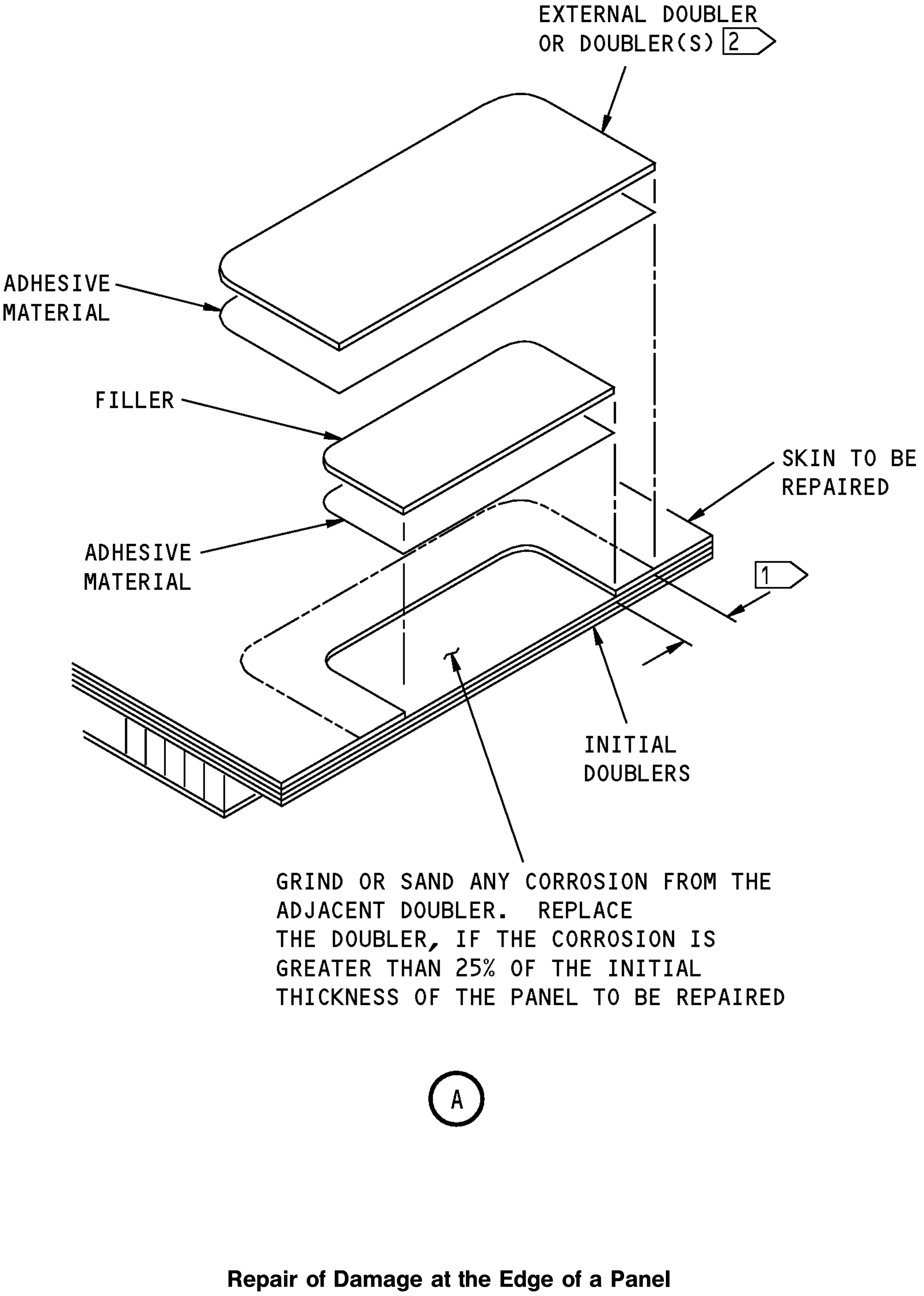
[3] IF THE EDGE OF AN EXTERNAL DOUBLER WILL BE CLOSER THAN 0.5 INCH (13 mm) TO THE FIRST STEP, OR WILL NOT BE FARTHER THAN 1.5 INCHES (38 mm) PAST THE FIRST STEP, THEN SEE DETAIL D AND DO THE STEPS THAT FOLLOW:

- 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.

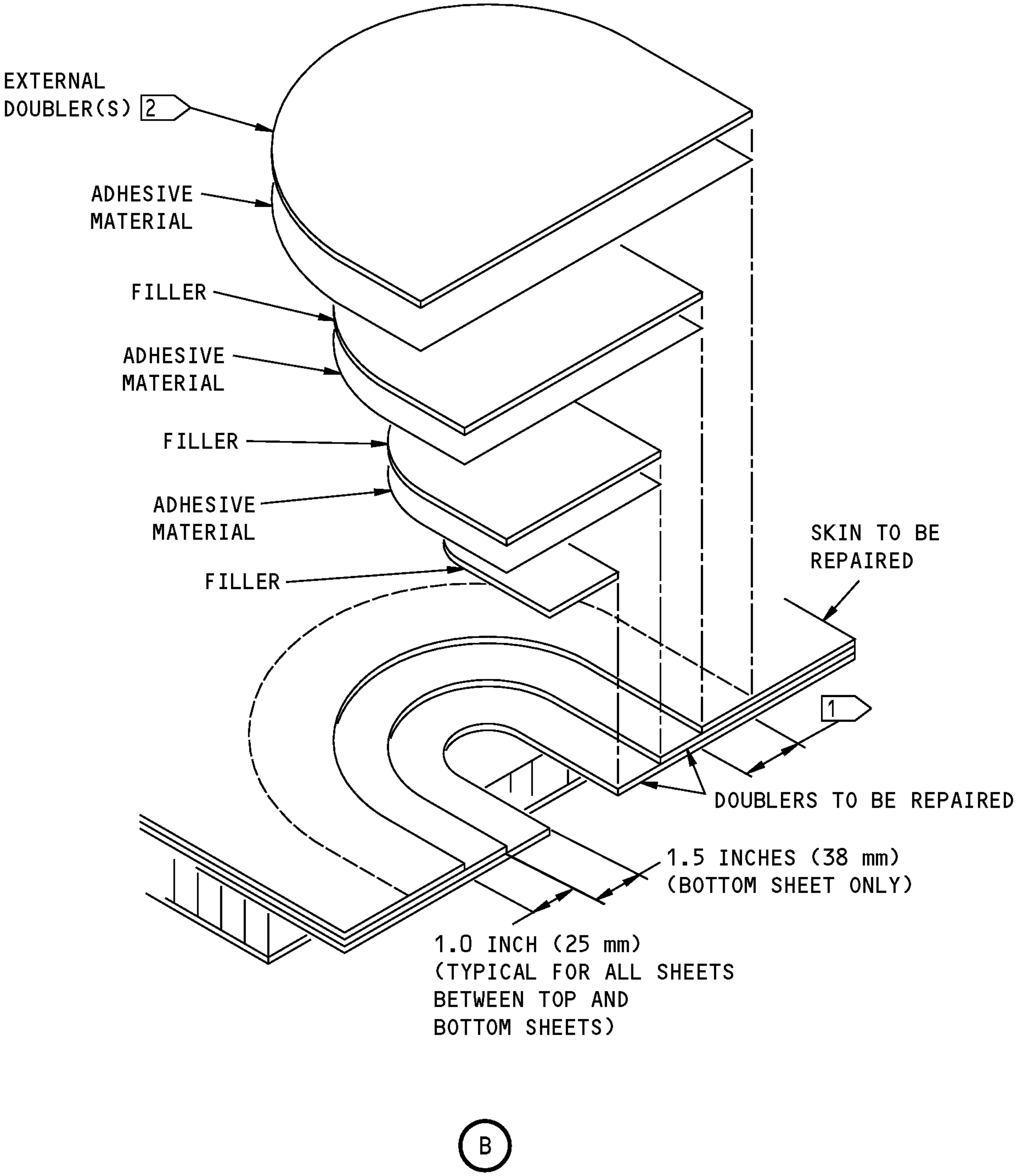
[4] INCREASE THE OVERLAP ON BOTH SIDES OF THE CUTOUT BY 0.5 INCH (13 mm).

[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].

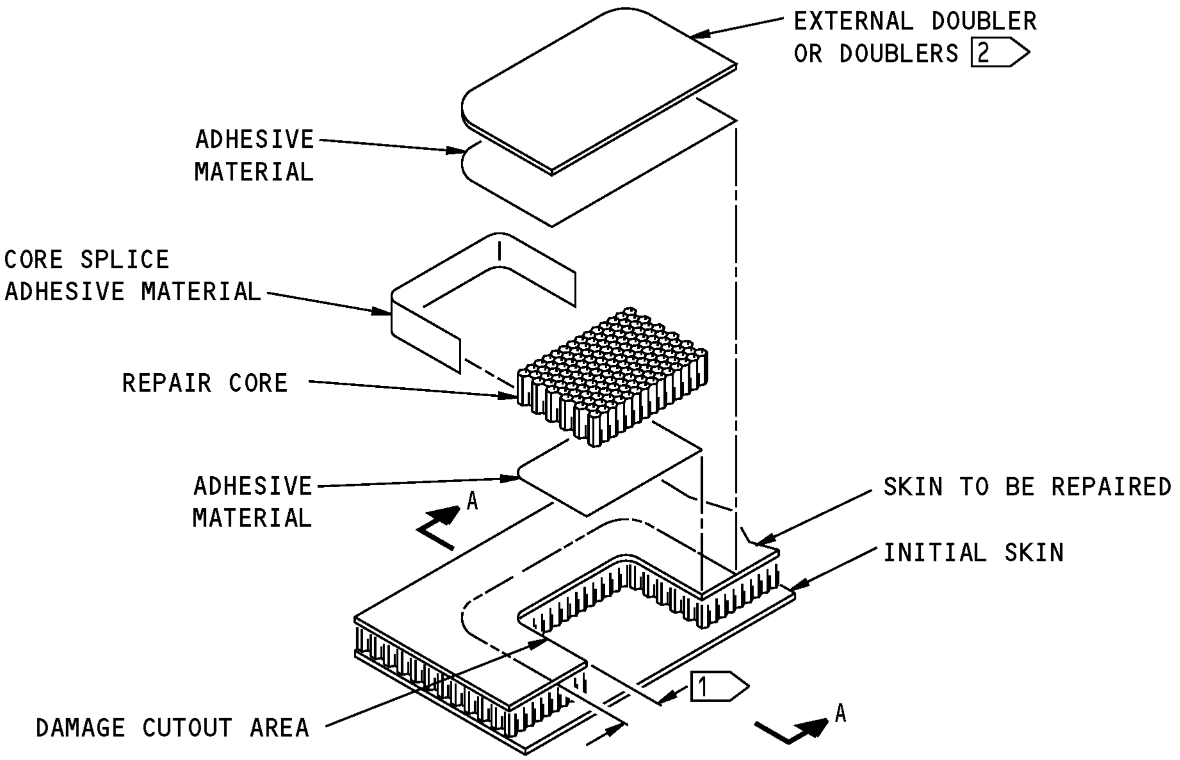
Repair of Damage Away From the Panel Edges
Figure 201 (Sheet 5 of 5)



Repair of Damage at the Edge of a Panel
Figure 202 (Sheet 1 of 9)

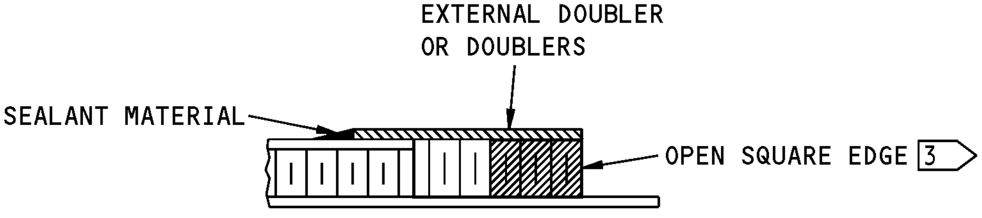


Repair of Damage at the Edge of a Panel
Figure 202 (Sheet 2 of 9)



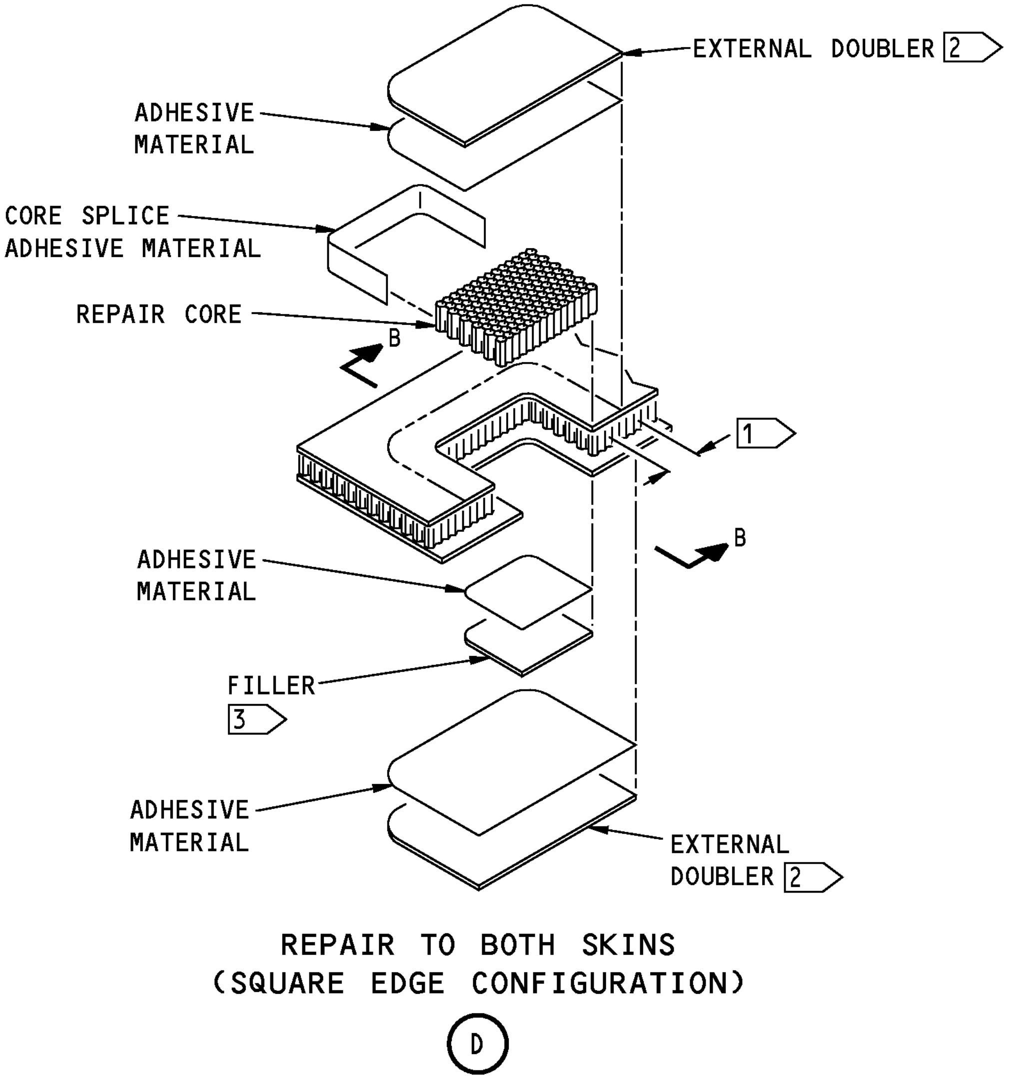
REPAIR TO ONE SKIN ONLY
(SQUARE EDGE CONFIGURATION)

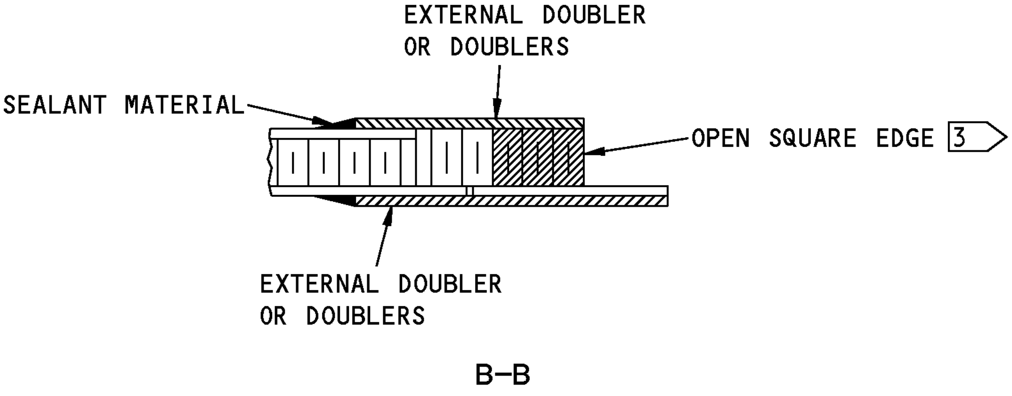
Ⓒ



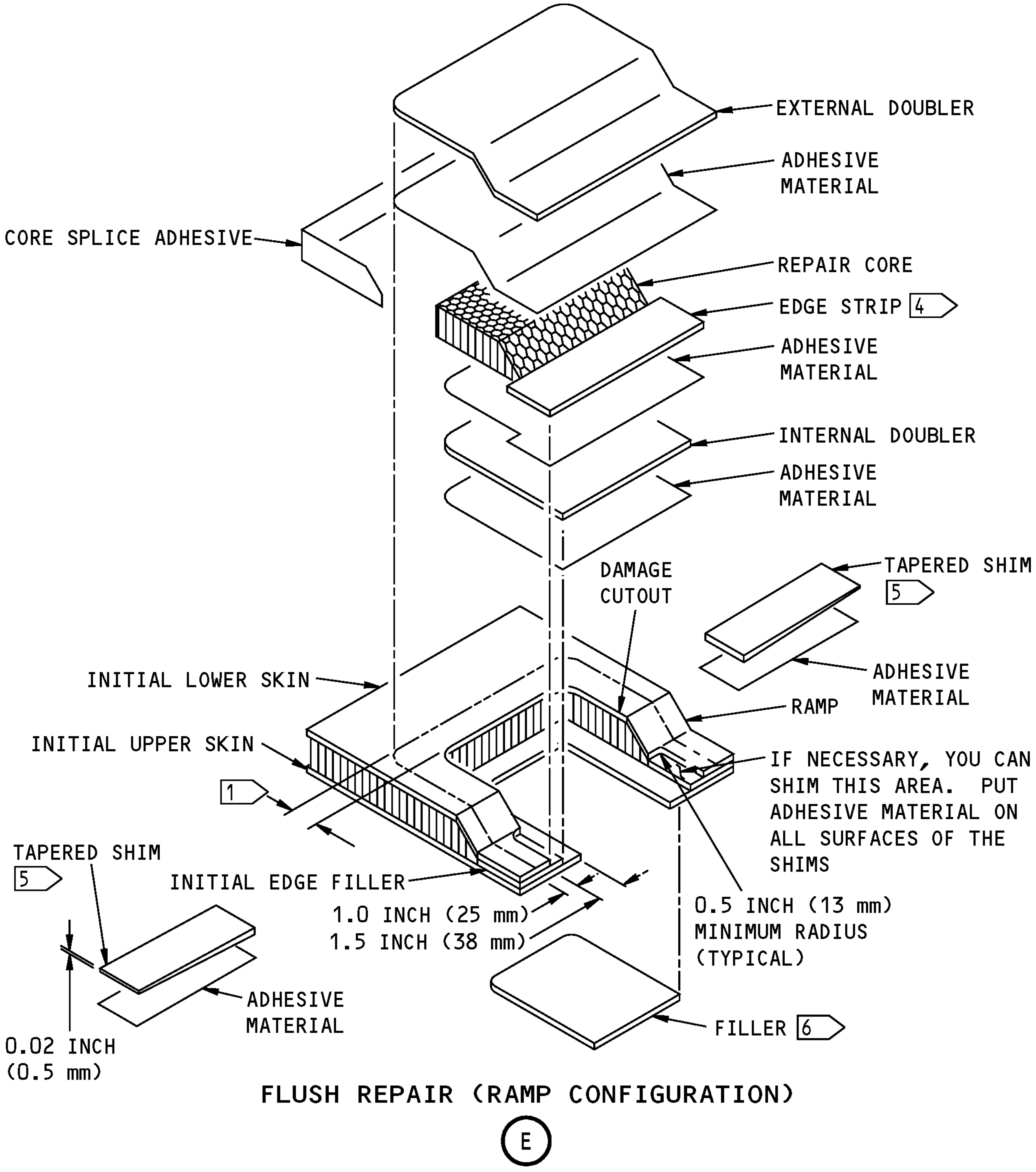
A-A

Repair of Damage at the Edge of a Panel
Figure 202 (Sheet 3 of 9)

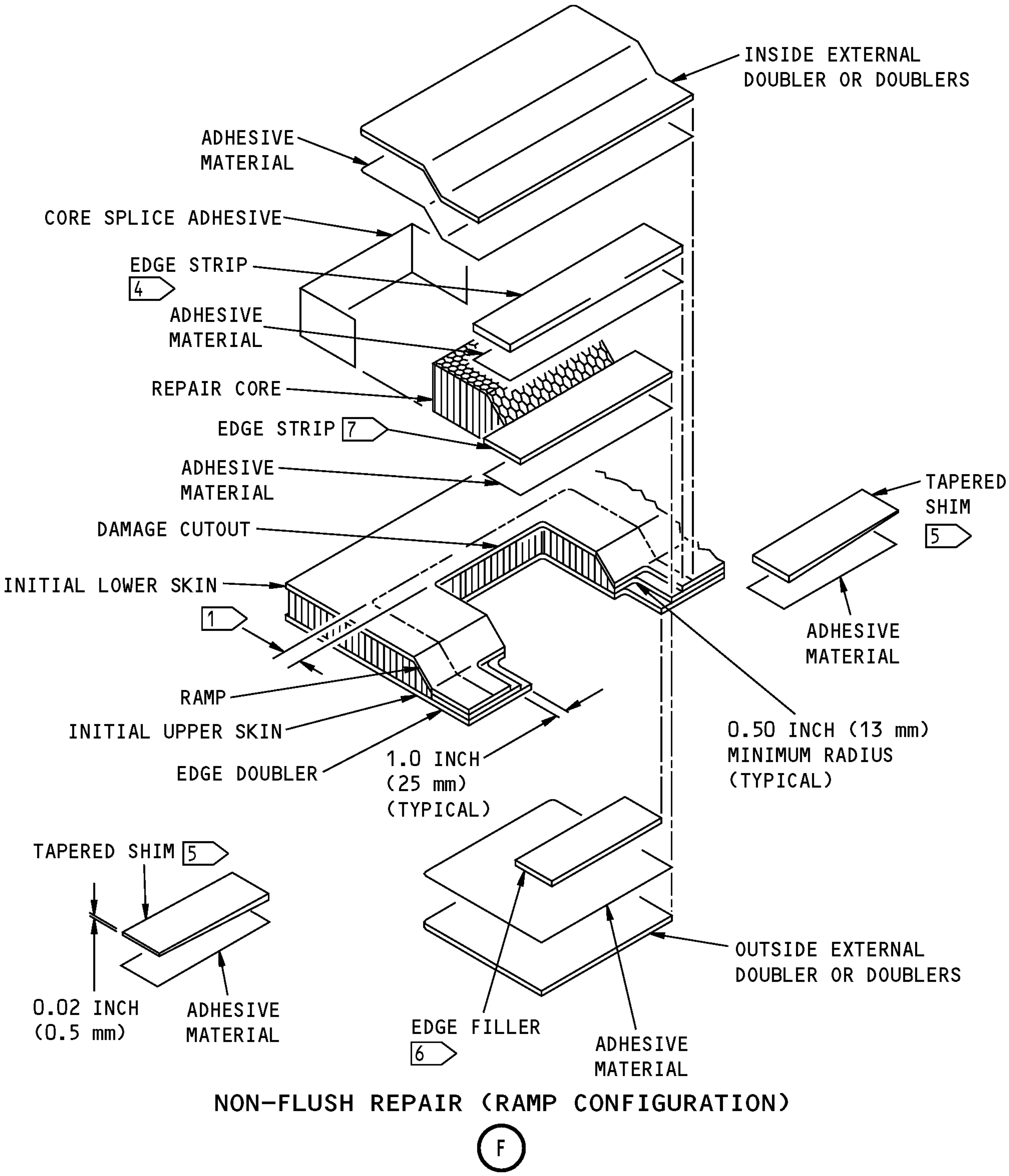




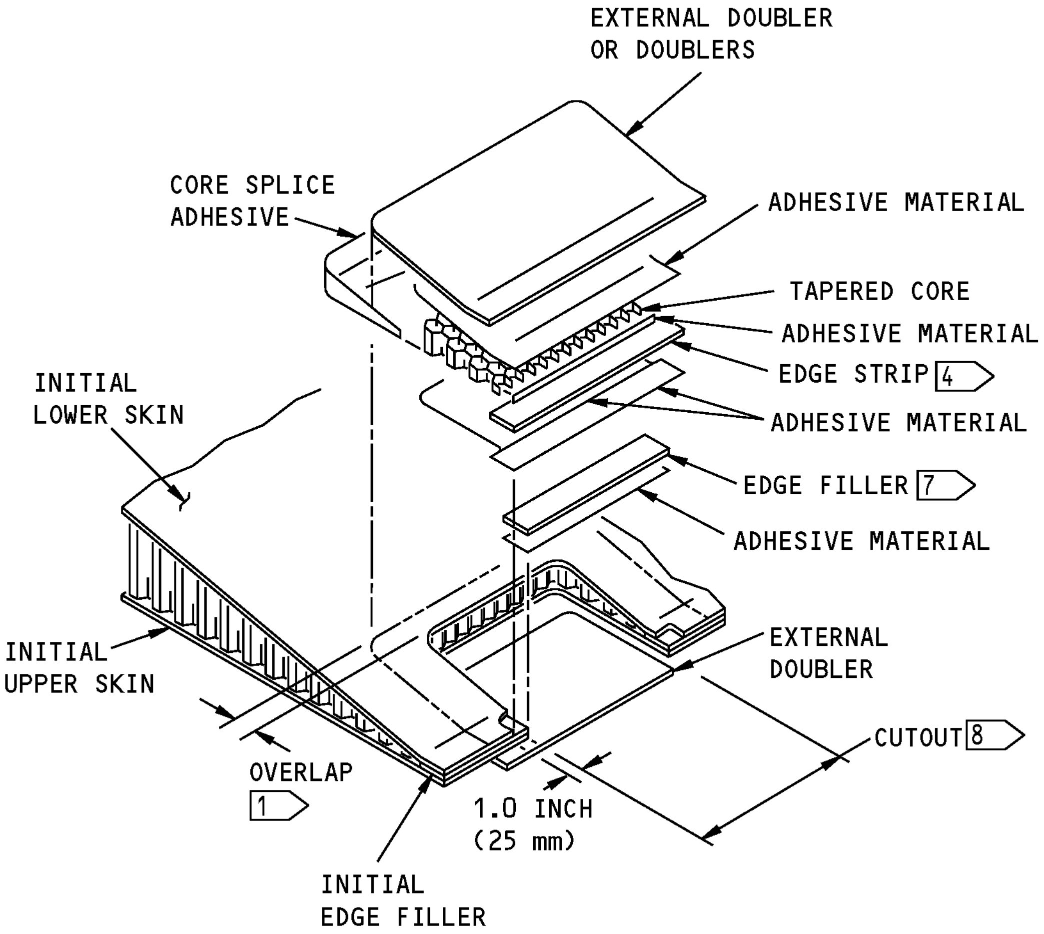
Repair of Damage at the Edge of a Panel
Figure 202 (Sheet 4 of 9)



Repair of Damage at the Edge of a Panel
Figure 202 (Sheet 5 of 9)



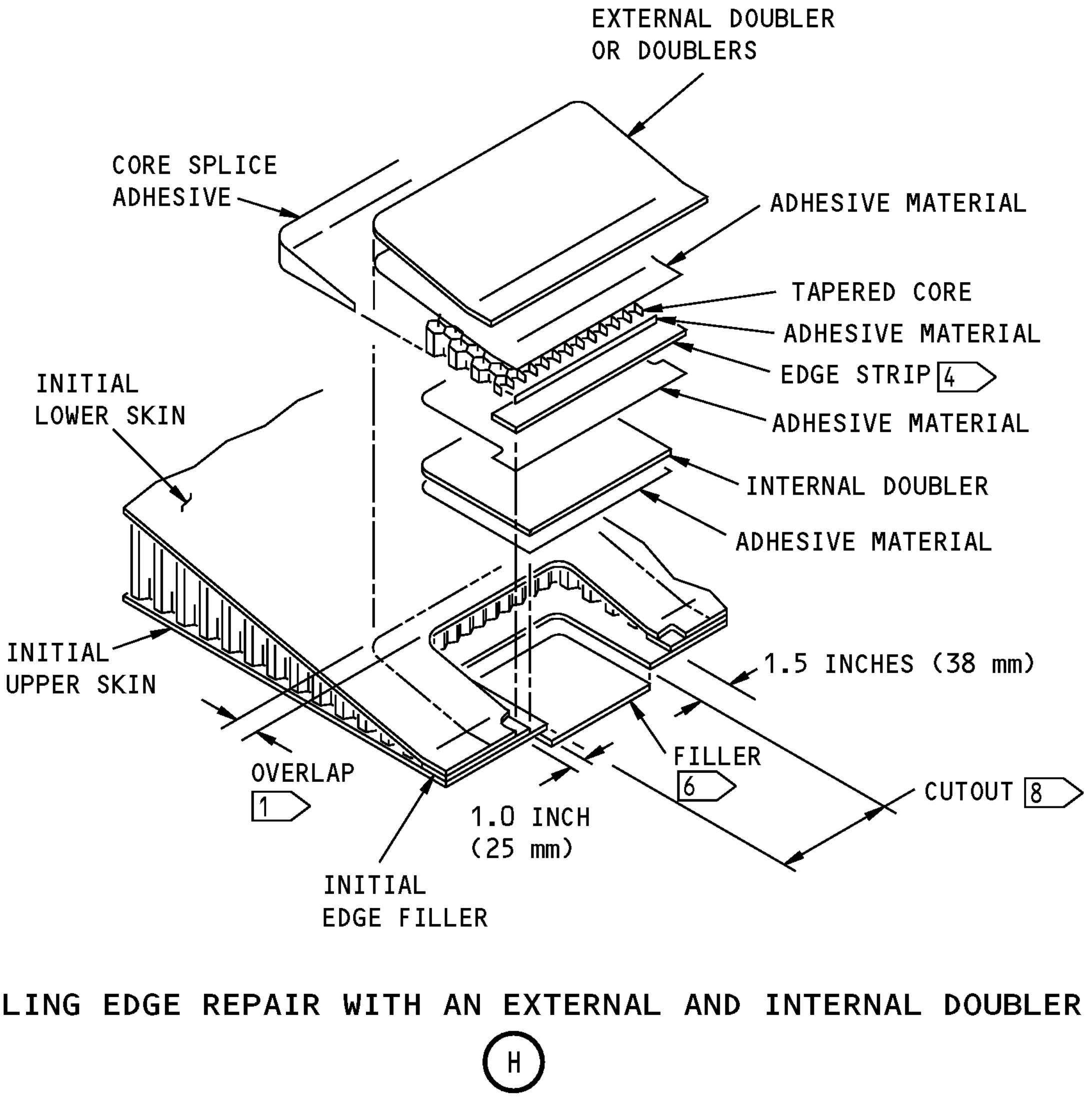
Repair of Damage at the Edge of a Panel
Figure 202 (Sheet 6 of 9)



TRAILING EDGE REPAIR WITH TWO EXTERNAL DOUBLERS

Ⓖ

Repair of Damage at the Edge of a Panel
Figure 202 (Sheet 7 of 9)



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.

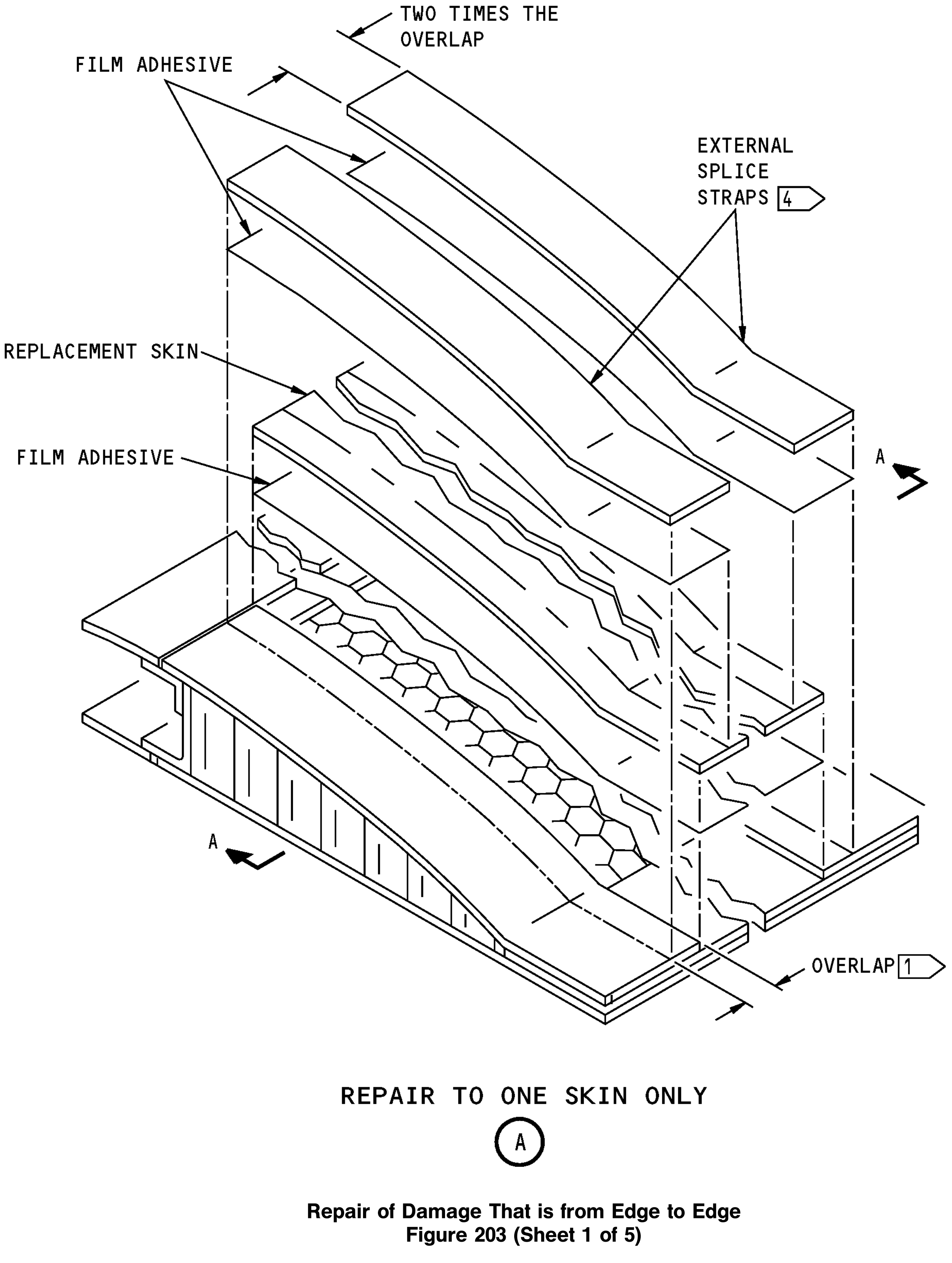
6> MAKE THE FILLER FROM THE SAME BOEING MATERIALS SPECIFICATION (BMS) MATERIAL OR AN EQUIVALENT MATERIAL THAT IS THE SAME THICKNESS AS THE INITIAL UPPER OR LOWER SKIN AS APPLICABLE.

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.

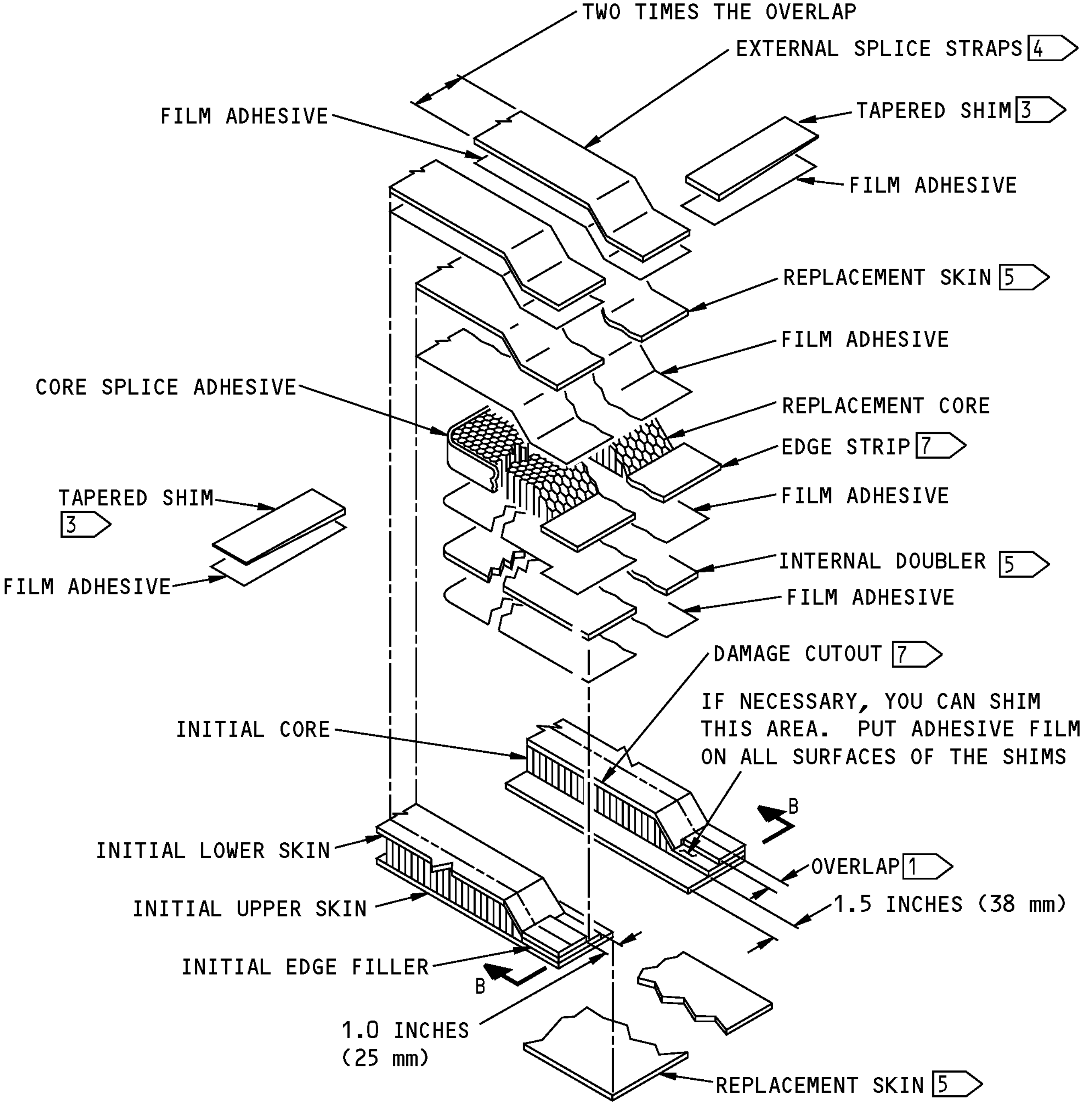
Repair of Damage at the Edge of a Panel
Figure 202 (Sheet 9 of 9)



REPAIR TO ONE SKIN ONLY

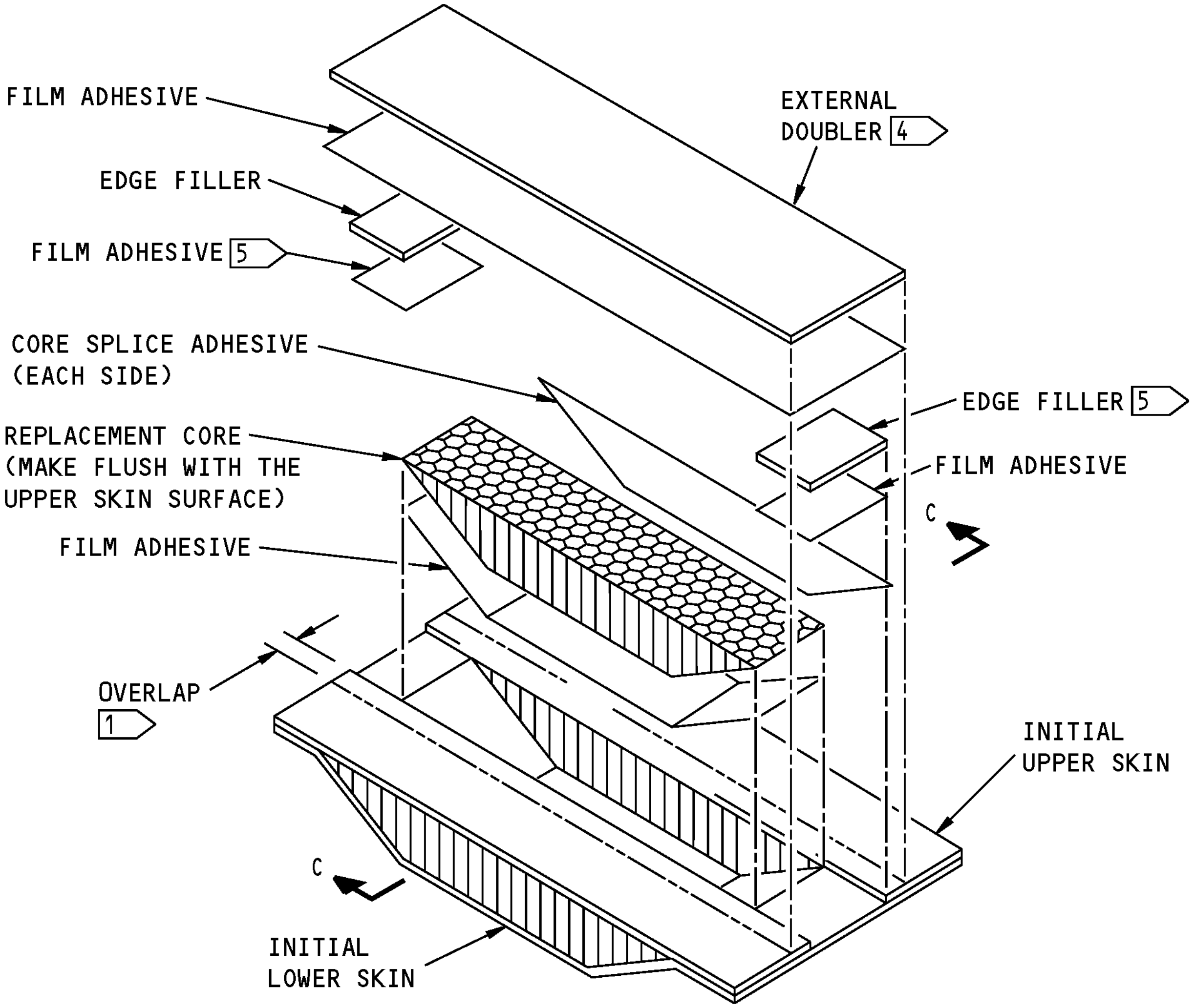
Ⓐ

Repair of Damage That is from Edge to Edge
Figure 203 (Sheet 1 of 5)



REPAIR TO TWO SKINS AND CORE
(REPLACEMENT CORE FLUSH WITH INITIAL CORE)
Ⓑ

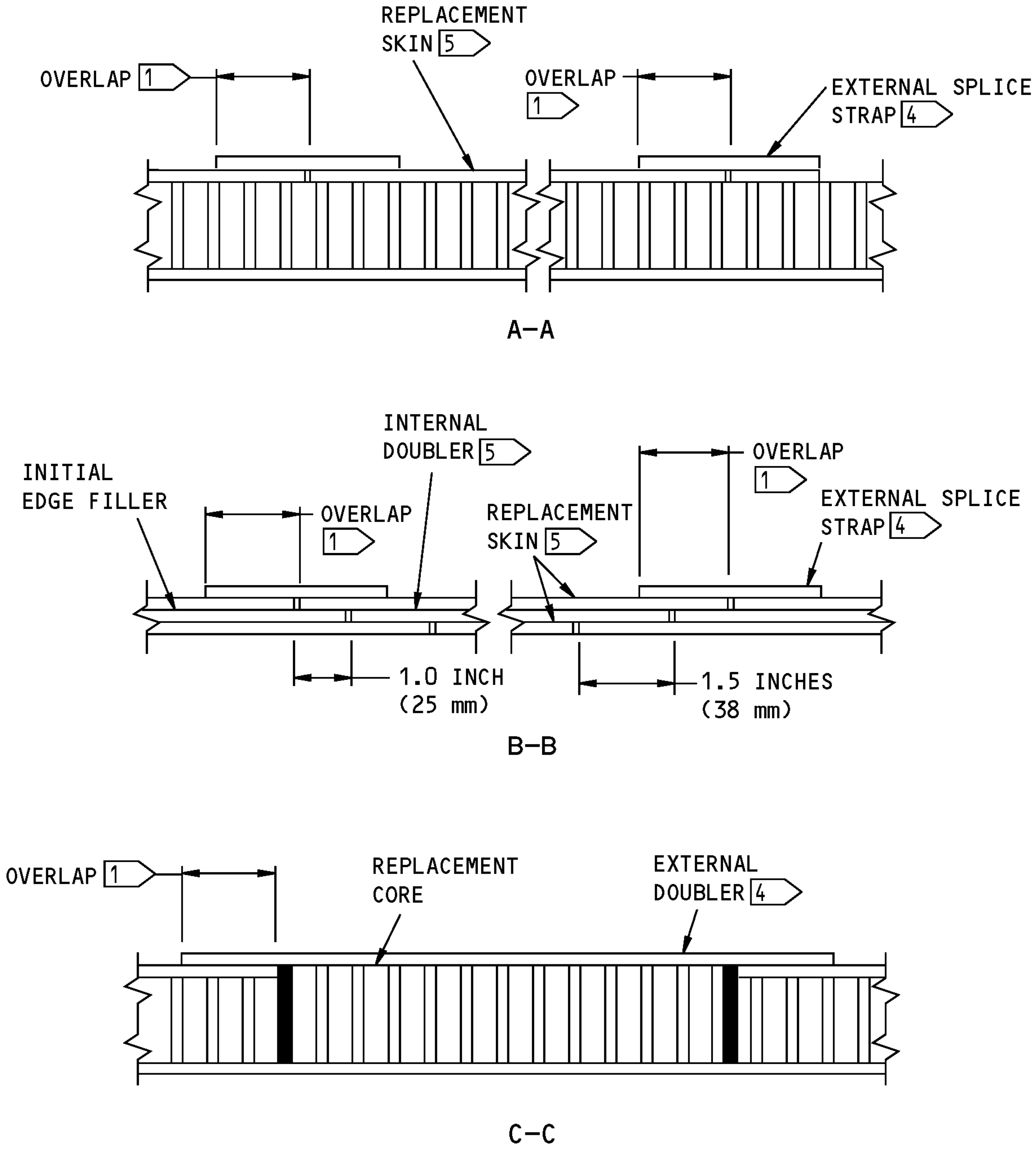
Repair of Damage That is from Edge to Edge
Figure 203 (Sheet 2 of 5)



REPAIR TO ONE SKIN AND CORE
(REPLACEMENT CORE FLUSH WITH AN INITIAL SKIN)

Ⓒ

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.

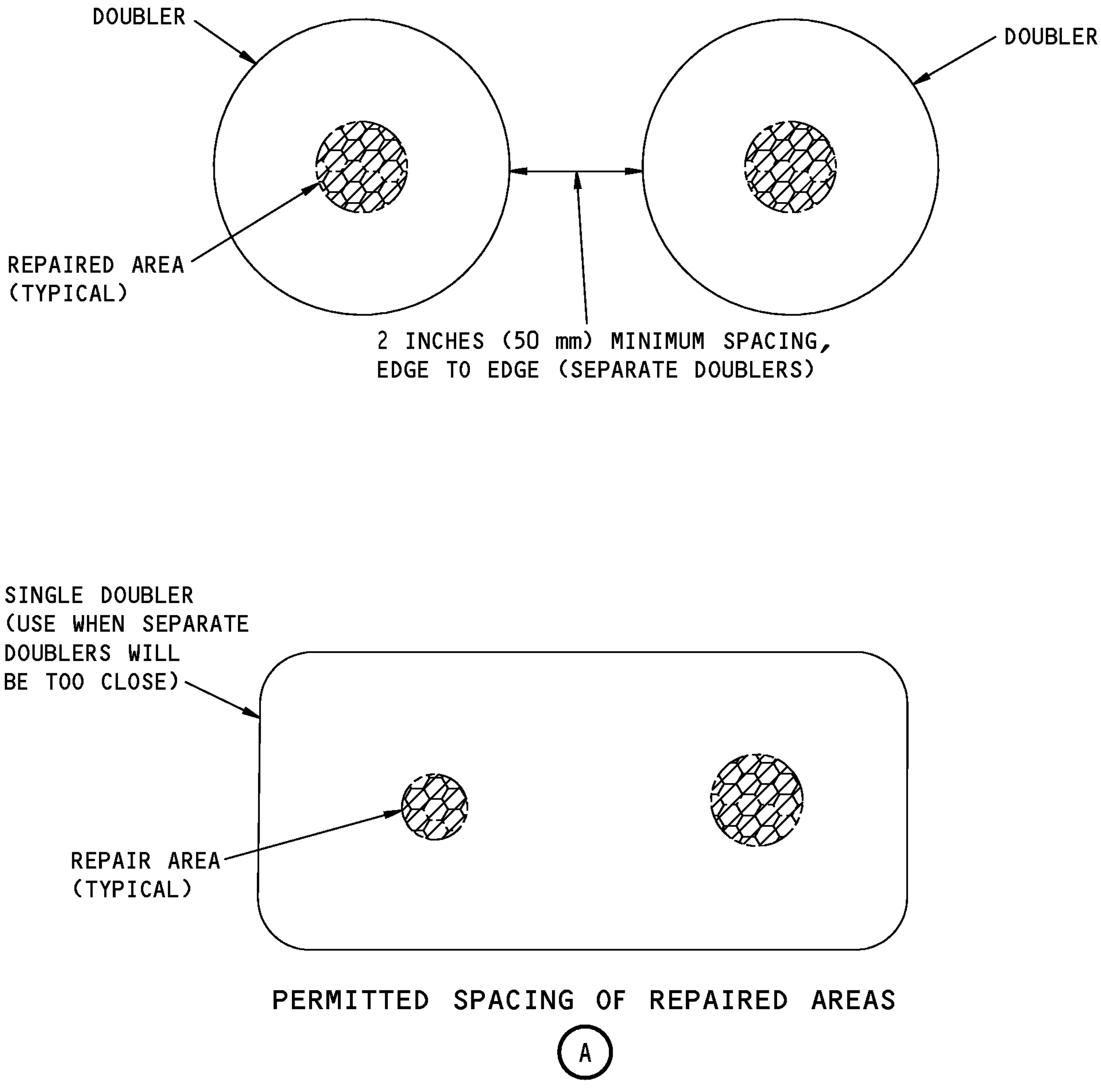
4 > REFER TO REPAIR GENERAL, FIGURE 208 OR 209 FOR DOUBLER THICKNESS.

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

GENERAL - TYPICAL FORMED SECTION REPAIR

REPAIR INSTRUCTIONS

1. Get access to the damaged area.
2. Cut and remove the damaged part of the formed section. See Details I through VI. Be careful to not damage the adjacent structure. It may be necessary to remove additional fasteners to obtain clearance.
3. Find the number of fasteners and fastener rows that are necessary. See Tables II, III, and IV.
4. Make the repair parts. See Table I.
5. Assemble the repair parts and drill the fastener holes.
6. Disassemble the repair parts
7. Remove the nicks, scratches, gouges, burrs, and sharp edges from the repair parts and the cut edges of the formed section.
8. Apply a chemical conversion coating to the repair parts and to the bare surfaces of the formed section. Refer to SRM 51-20-01.
9. Apply one layer of BMS 10-11, Type I primer to the repair parts and to the bare surfaces of the formed section. Refer to SOPM 20-41-02.
10. Install the repair parts with BMS 5-95 sealant between the mating surfaces.
11. Install the fasteners. Fasteners that are not made of aluminum must be installed wet with BMS 5-95 selant.
12. Apply the finish to the repair area. Refer to AMM 51-21.

NOTES

- D = FASTENER DIAMETER
- WHEN YOU USE THIS REPAIR REFER TO:
  - AMM 51-21 FOR INTERIOR AND EXTERIOR FINISHES
  - SOPM 20-41-02 FOR APPLICATION OF CHEMICAL AND SOLVENT RESISTANT FINISHES
  - SRM 51-10-01 FOR AERODYNAMIC SMOOTHNESS REQUIREMENTS
  - SRM 51-10-02 FOR INSPECTION AND REMOVAL OF DAMAGE
  - SRM 51-20-01 FOR PROTECTIVE TREATMENT OF METAL
  - SRM 51-20-05 FOR REPAIR SEALING
  - SRM 51-30-01 FOR MINIMUM BEND RADII
  - SRM 51-40 FOR FASTENER CODE, INSTALLATION AND REMOVAL, HOLE SIZES, AND EDGE MARGINS
  - SRM 51-60 FOR CONTROL SURFACE BALANCING.
- REPAIRS ARE SHOWN WITH THE REPAIR PARTS INSTALLED ON THE INSIDE OF THE FORMED SECTION. IF THERE IS SUFFICIENT CLEARANCE, YOU CAN INSTALL THE REPAIR PARTS ON THE OUTSIDE OF THE FORMED SECTION.

A EACH DAMAGED FLANGE MUST BE REPAIRED. IF THE REPAIR PARTS ARE INSTALLED ON THE OUTER SURFACE OF THE FORMED SECTION, MAKE THE REPAIR PARTS THE SAME THICKNESS AS THE FORMED SECTION. IF THE REPAIR PARTS ARE INSTALLED ON THE INNER SURFACE OF THE FORMED SECTION, MAKE THE REPAIR PARTS A MINIMUM OF 0.012 INCH THICKER THAN THE FORMED SECTION.

B THIS REPAIR IS FOR DAMAGE WHICH REQUIRES THE REMOVAL OF LESS THAN 50 PERCENT OF THE CROSS SECTIONAL AREA. REFER TO DETAILS IV, V, AND VI FOR THE REPAIR OF DAMAGE GREATER THAN 50 PERCENT.

C THE OUTSIDE RADIUS OF THE REPAIR PART MUST BE EQUAL TO OR LARGER THAN THE INSIDE RADIUS OF THE INITIAL FORMED SECTION.

D DO NOT USE LESS THAN THREE FASTENERS IN A ROW.

E INSTALL THE FILLER WHERE THE FLANGES ATTACH TO THE WEB OR SKIN.

FASTENER SYMBOLS

+ INITIAL FASTENER LOCATION. REPLACE INITIAL RIVET WITH 1/32 INCH DIAMETER OVERSIZE RIVET.

● INITIAL OR REPAIR FASTENER LOCATION.

⌖ REPAIR FASTENER LOCATION. THESE FASTENERS ARE REQUIRED FOR THE COMPRESSION STABILITY OF THE REPAIR ANGLE AND SHOULD BE EXTENDED A MINIMUM OF TWO FASTENER LOCATIONS BEYOND THE TRIMMED OUT REGION AS SHOWN IN DETAILS I, II, OR III. DO NOT INCLUDE THESE FASTENERS IN THE NUMBER OF FASTENERS NECESSARY TO MAKE THE REPAIR.

Typical Formed Section Repair
Figure 1 (Sheet 1 of 10)

REPAIR MATERIAL			
PART		QTY	MATERIAL
1	ANGLE	1	SAME MATERIAL AS THE INITIAL FORMED SECTION $\boxed{A}$
2	ANGLE	1	SAME MATERIAL AS THE INITIAL FORMED SECTION $\boxed{A}$
3	ANGLE	1	SAME MATERIAL AS THE INITIAL FORMED SECTION $\boxed{A}$
4	CHANNEL	1	SAME MATERIAL AS THE INITIAL FORMED SECTION $\boxed{A}$
5	CHANNEL	1	SAME MATERIAL AS THE INITIAL FORMED SECTION $\boxed{A}$
6	FILLER $\boxed{E}$	AS REQD	SAME MATERIAL AND THICKNESS AS THE INITIAL FORMED SECTION

TABLE I

FASTENER PITCH AND ROW SPACING												
INITIAL FORMED SECTION THICKNESS	5/32-INCH DIA. FASTENERS			3/16-INCH DIA. FASTENERS			1/4-INCH DIA. FASTENERS			5/16-INCH DIA. FASTENERS		
	FASTENER PITCH		ROW SPACING	FASTENER PITCH		ROW SPACING	FASTENER PITCH		ROW SPACING	FASTENER PITCH		ROW SPACING
	MIN	MAX	MIN	MIN	MAX	MIN	MIN	MAX	MIN	MIN	MAX	MIN
0.032	0.60	0.70	0.93	0.75	0.85	1.12						
0.036	0.60	0.70	0.93	0.75	0.85	1.12						
0.040	0.60	0.70	0.93	0.75	0.85	1.12						
0.045	0.60	0.75	0.93	0.75	0.85	1.12						
0.050	0.60	0.85	0.93	0.75	0.85	1.12	1.00	1.10	1.50			
0.056	0.60	0.95	0.93	0.75	0.95	1.12	1.00	1.10	1.50			
0.063	0.60	1.05	0.93	0.75	1.05	1.12	1.00	1.10	1.50	1.20	1.30	1.87
0.071	0.60	1.20	0.93	0.75	1.20	1.12	1.00	1.20	1.50	1.20	1.30	1.87
0.080	0.60	1.35	0.93	0.75	1.35	1.12	1.00	1.35	1.50	1.20	1.35	1.87
0.090				0.75	1.50	1.12	1.00	1.50	1.50	1.20	1.50	1.87
0.100				0.75	1.70	1.12	1.00	1.70	1.50	1.20	1.70	1.87
0.112				0.75	1.90	1.12	1.00	1.90	1.50	1.20	1.90	1.87
0.125				0.75	2.15	1.12	1.00	2.15	1.50	1.20	2.15	1.87
0.140				0.75	2.37	1.12	1.00	2.37	1.50	1.20	2.37	1.87
0.160				0.75	2.60	1.12	1.00	2.60	1.50	1.20	2.60	1.87
0.180				0.75	2.96	1.12	1.00	2.96	1.50	1.20	2.96	1.87

TABLE II

Typical Formed Section Repair
Figure 1 (Sheet 2 of 10)

FASTENERS PER INCH OF WIDTH, 2024-T3 OR T4 MATERIAL $\boxed{D}$														
SHEET THICKNESS	PROTRUDING HEAD							100° COUNTERSUNK (SHEAR) HEAD						
	BACR15BB()D, OR MS20470D()				BACB30MY()K+ BACC30M()			BACR15CE()D				BACB30NW()K+ BACC30M()		
	5/32	3/16	1/4	5/16	3/16	1/4	5/16	5/32	3/16	1/4	5/16	3/16	1/4	5/16
0.032	4													
0.036	4													
0.040	4	3			3									
0.045	4	3			3									
0.050	4	3	3		3	3								
0.056	4	3	3		3	3								
0.063	5	3	3	2	3	3	2	5				3		
0.071	5	4	3	2	3	3	2	5	5			3		
0.080		4	3	2	3	3	2	6	5			3		
0.090		5	3	2	3	3	2		5			3		
0.100		5	3	2	3	3	2		5	4	3	3	3	2
0.112			3	2	3	3	2			4	3	3	3	2
0.125			4	3	3	3	2			4	3	3	3	2
0.140			4	3	3	3	2			4	3	3	3	2
0.160			5	3	3	3	2			5	3	3	3	3
0.180			5	4	4	3	2			5	4	4	3	3

TABLE III

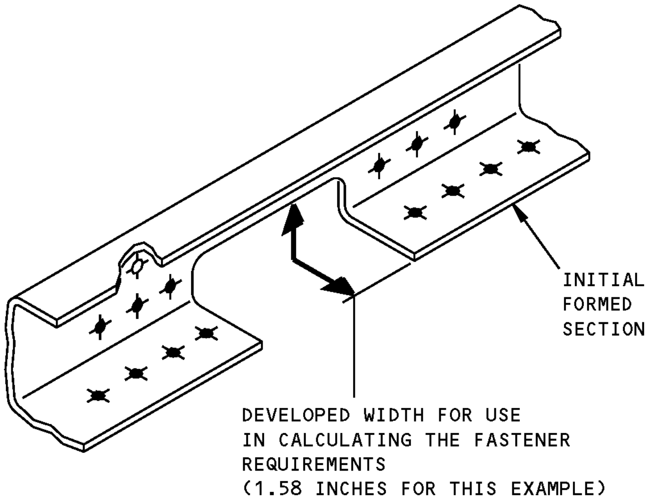
EXAMPLE OF HOW TO FIND THE NUMBER OF FASTENERS NECESSARY TO REPAIR A PARTIALLY SEVERED FORMED SECTION.

SEE DETAILS I, II OR III.

ASSUME THE DAMAGE IS IN A 0.071 INCH THICK 2024-T3 ALUMINUM CHANNEL. MEASURE ALONG THE OUTER SURFACE TO FIND THE WIDTH OF THE DAMAGE. ASSUME THE DEVELOPED WIDTH OF THE DAMAGE IS 1.58 INCHES. NEXT, REFER TO TABLE III FOR THE NUMBER OF FASTENERS THAT ARE NECESSARY PER INCH OF WIDTH. ASSUME THE REPAIR IS TO BE MADE WITH 3/16-INCH DIAMETER BACR15BB6D() RIVETS. THE TABLE SHOWS THAT FOUR 3/16-INCH DIAMETER RIVETS ARE NECESSARY. TO FIND THE TOTAL NUMBER OF FASTENERS THAT ARE NECESSARY ON EACH SIDE OF THE CUTOUT, MULTIPLY THE WIDTH OF THE DAMAGE BY THE NUMBER OF FASTENERS SHOWN IN TABLE III. USE THE NEXT HIGHER WHOLE NUMBER.

1.58 INCHES MULTIPLIED BY FOUR RIVETS = 6.32 RIVETS. USE SEVEN RIVETS ON EACH SIDE OF THE DAMAGE.

FOR AN EXAMPLE OF HOW TO FIND THE NUMBER OF FASTENERS NECESSARY TO REPAIR A COMPLETELY SEVERED FORMED SECTION, SEE THE EXAMPLE BELOW TABLE IV.



EXAMPLE OF PARTIALLY SEVERED MEMBER

Typical Formed Section Repair
Figure 1 (Sheet 3 of 10)

FASTENERS PER INCH OF WIDTH, 7075-T6 MATERIAL [D]													
SHEET THICKNESS	PROTRUDING HEAD							100° COUNTERSUNK (SHEAR) HEAD					
	BACR15BB()D, OR MS20470D()				BACB30MY()K+ BACC30M()			BACR15CE()D			BACB30NW()K+ BACC30M()		
	5/32	3/16	1/4	5/16	3/16	1/4	5/16	3/16	1/4	5/16	3/16	1/4	5/16
0.032 0.036	4 4	3 3											
0.040 0.045	4 4	3 3											
0.050 0.056	5 5	3 4	3 3		3 3	3 3							
0.063 0.071		4 5	3 3	2 2	3 3	3 3	2 2	 5			3 3		
0.080 0.090		5	3 3	2 2	3 3	3 3	2 2				4 4		
0.100 0.112			4 4	3 3	3 3	3 3	2 2		4 4	3 3	4 4	3 3	2 2
0.125 0.140			5 5	3 3	3 4	3 3	2 2		5 5	3 3	4 4	3 3	2 2
0.160 0.180				4 4	4 4	3 3	2 2			3 4	4 4	3 3	2 2

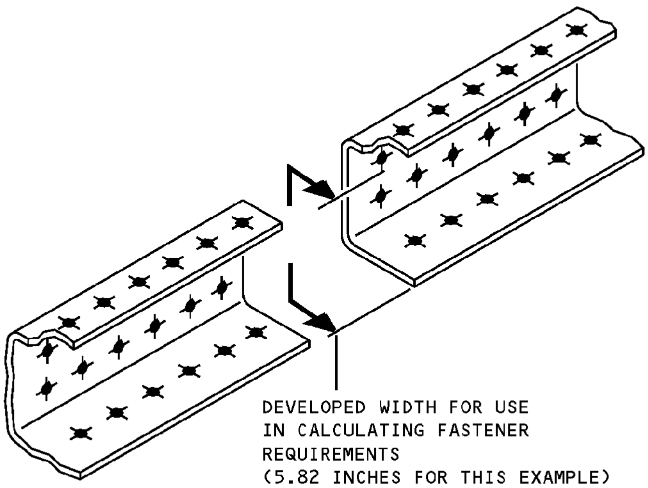
TABLE IV

EXAMPLE OF HOW TO FIND THE NUMBER OF FASTENERS NECESSARY TO REPAIR A COMPLETELY SEVERED FORMED SECTION.

SEE DETAILS IV, V OR VI.

ASSUME THE DAMAGE IS IN A 0.063 INCH THICK 7075-T6 ALUMINUM CHANNEL. MEASURE ALONG THE OUTER SURFACE TO FIND THE WIDTH OF THE DAMAGE. ASSUME THE DEVELOPED WIDTH OF THE DAMAGE IS 5.82 INCHES. NEXT, REFER TO TABLE IV FOR THE NUMBER OF FASTENERS THAT ARE NECESSARY PER INCH OF WIDTH. ASSUME THE REPAIR IS TO BE MADE WITH 3/16-INCH DIAMETER BACR15BB6D() RIVETS. THE TABLE SHOWS THAT FOUR 3/16-INCH DIAMETER RIVETS ARE NECESSARY. TO FIND THE TOTAL NUMBER OF FASTENERS THAT ARE NECESSARY ON EACH SIDE OF THE CUTOUT, MULTIPLY THE WIDTH OF THE DAMAGE BY THE NUMBER OF FASTENERS SHOWN IN TABLE IV. USE THE NEXT HIGHER WHOLE NUMBER.

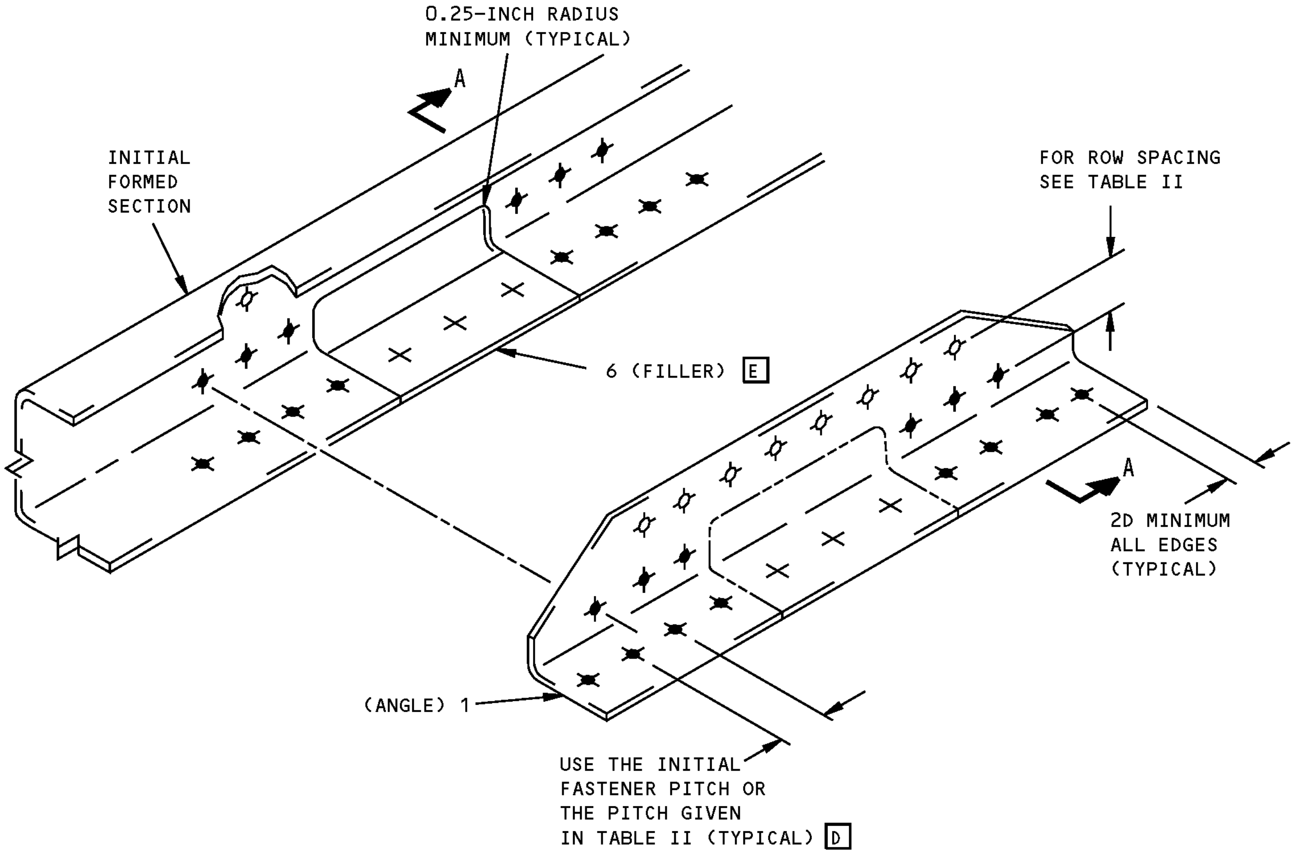
5.82 INCHES MULTIPLIED BY FOUR RIVETS = 23.28 RIVETS. USE TWENTY-FOUR RIVETS ON EACH SIDE OF THE DAMAGE.



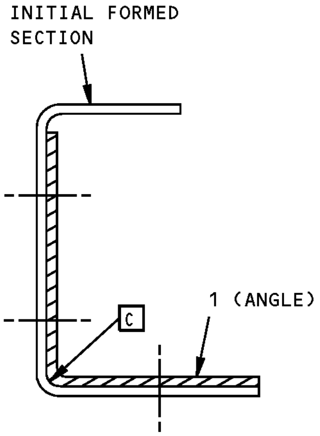
DEVELOPED WIDTH FOR USE IN CALCULATING FASTENER REQUIREMENTS (5.82 INCHES FOR THIS EXAMPLE)

EXAMPLE OF COMPLETELY SEVERED MEMBER

Typical Formed Section Repair
Figure 1 (Sheet 4 of 10)

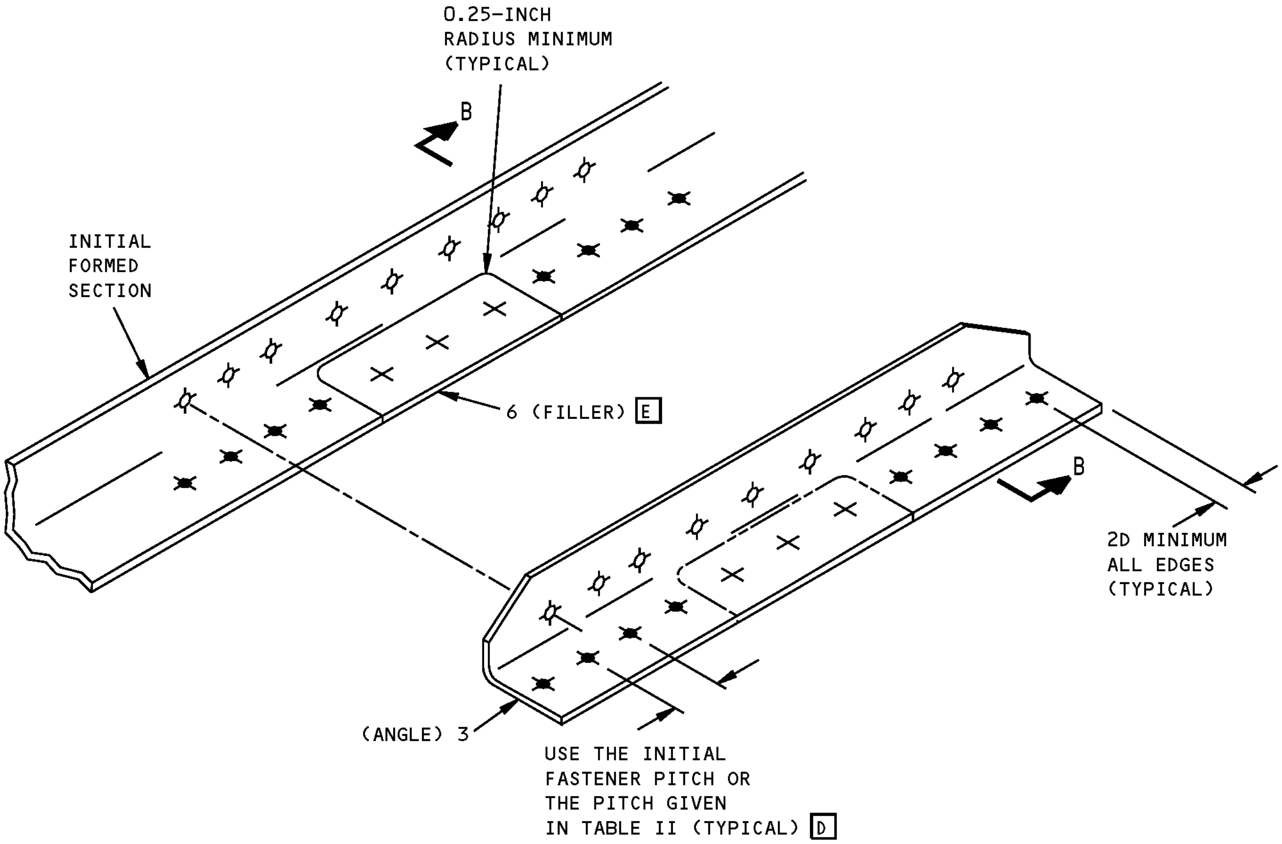


PARTIALLY SEVERED SECTION
TYPICAL FORMED CHANNEL REPAIR
DETAIL I B

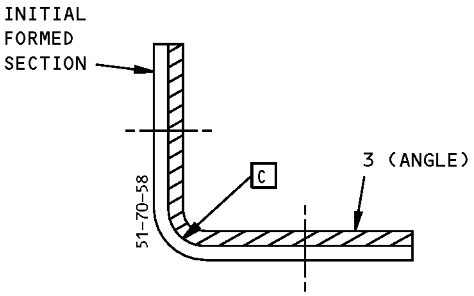


SECTION A-A

Typical Formed Section Repair
Figure 1 (Sheet 5 of 10)

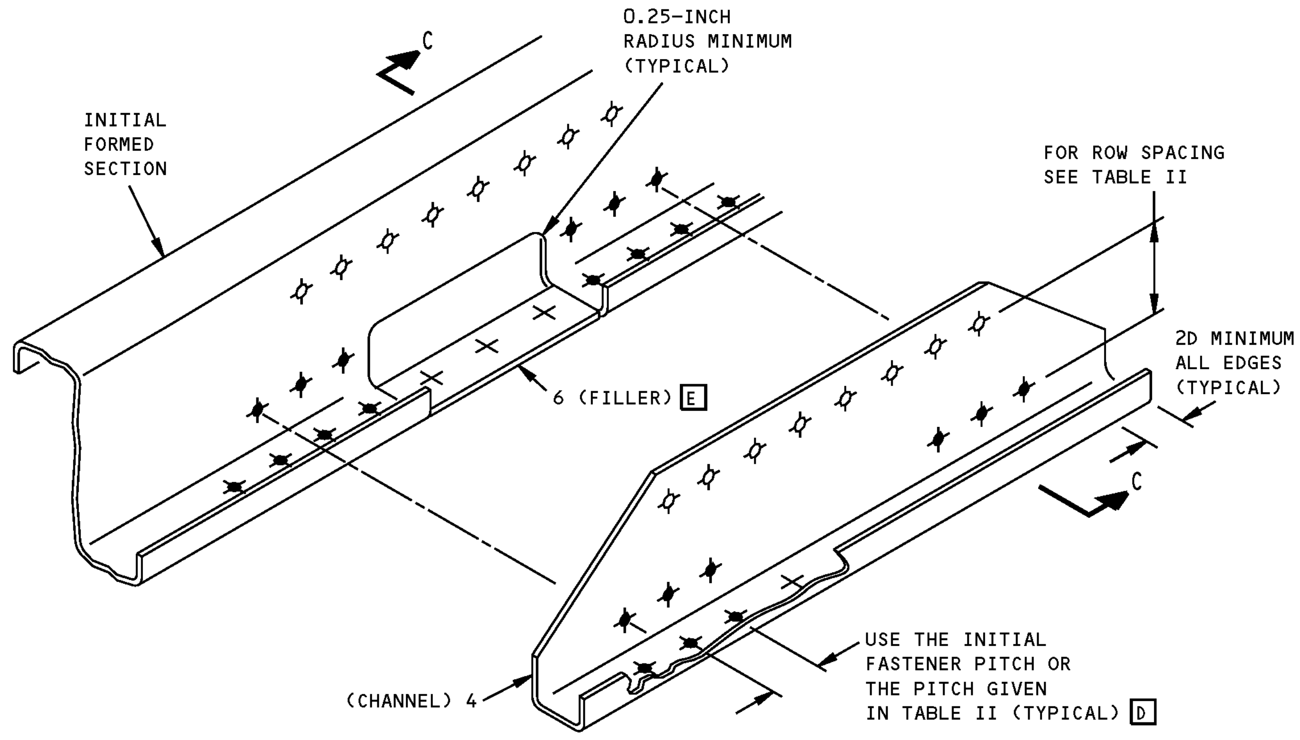


PARTIALLY SEVERED SECTION
TYPICAL FORMED ANGLE REPAIR
DETAIL II B

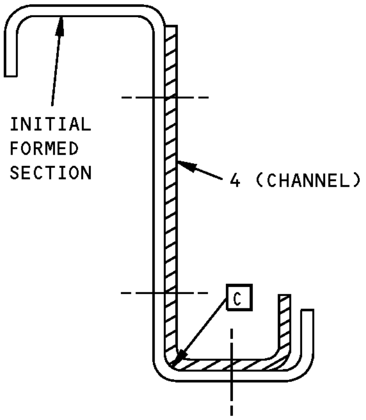


SECTION B-B

Typical Formed Section Repair
Figure 1 (Sheet 6 of 10)

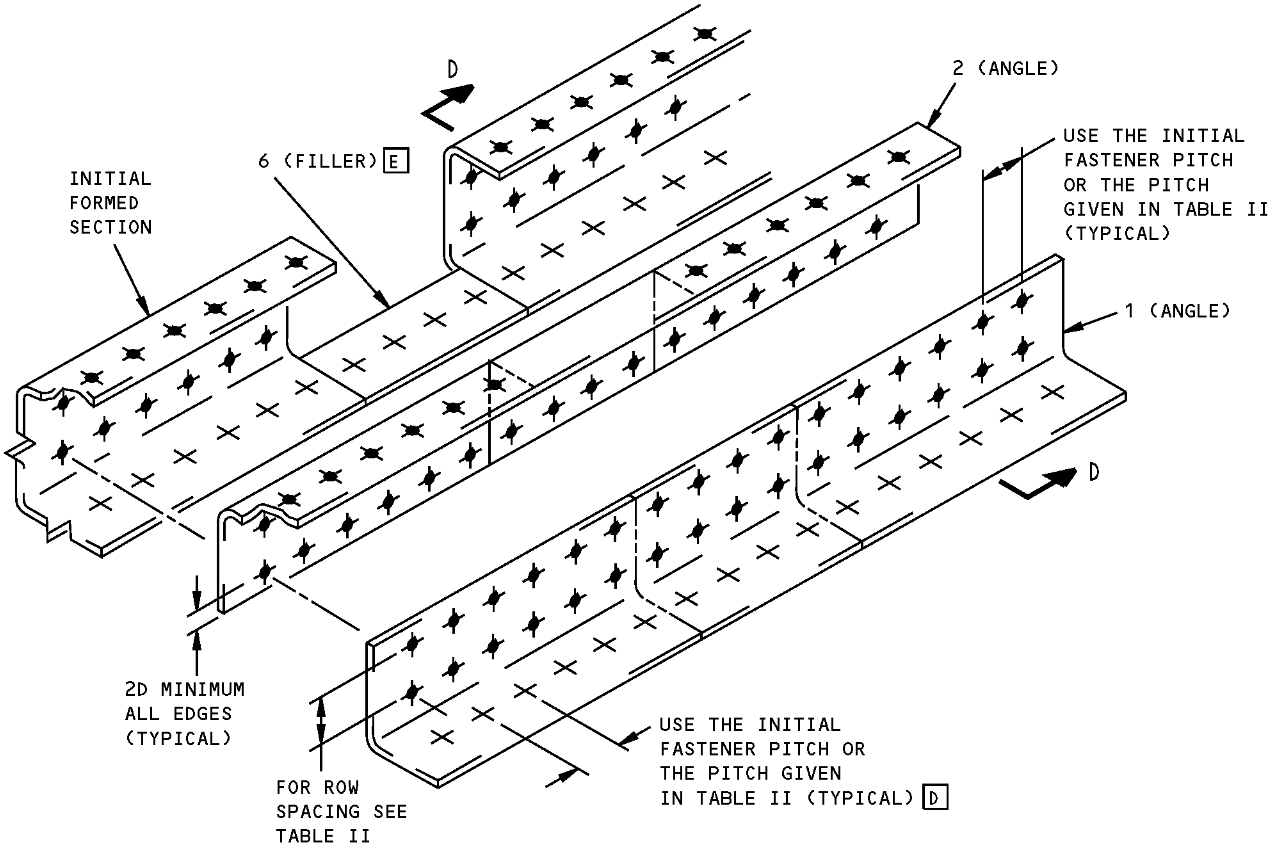


PARTIALLY SEVERED SECTION
TYPICAL FORMED ZEE SECTION REPAIR
DETAIL III B

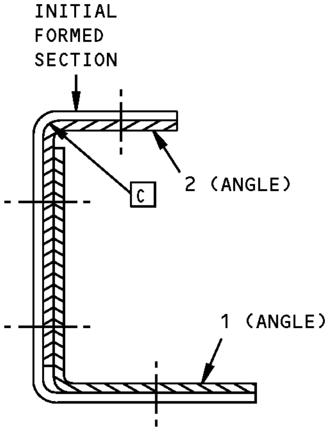


SECTION C-C

Typical Formed Section Repair
Figure 1 (Sheet 7 of 10)

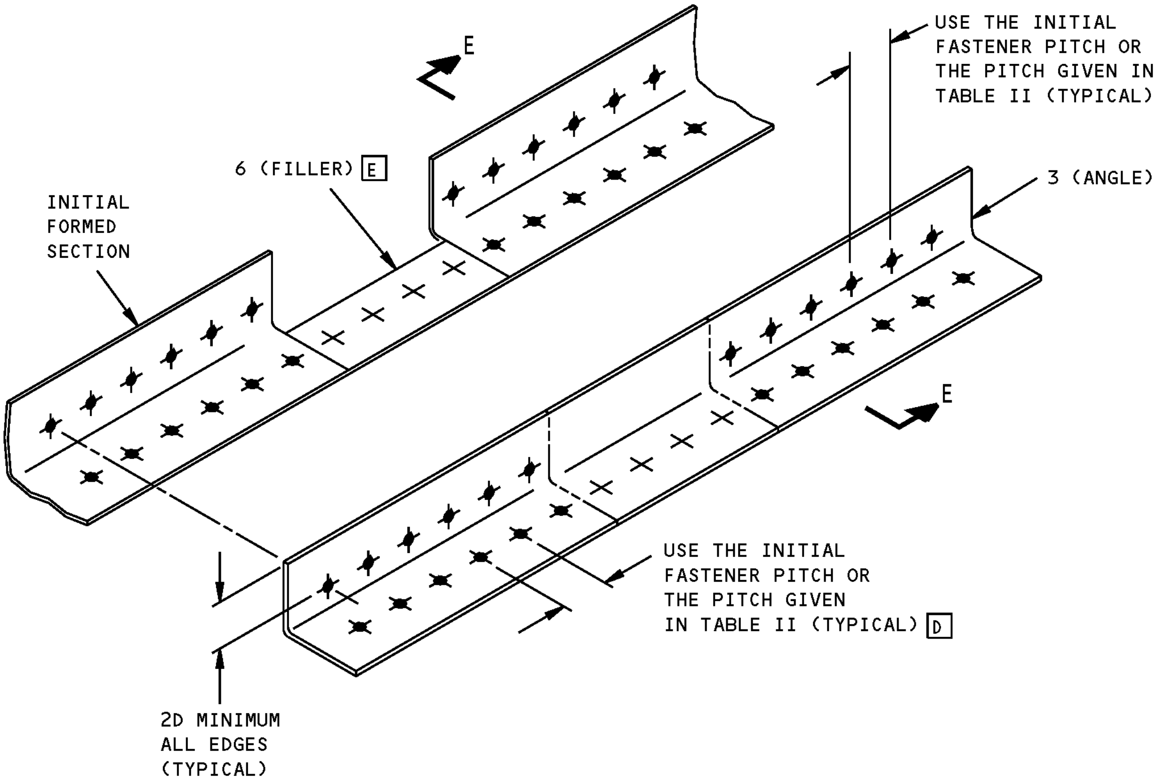


COMPLETELY SEVERED SECTION
TYPICAL FORMED CHANNEL REPAIR
DETAIL IV

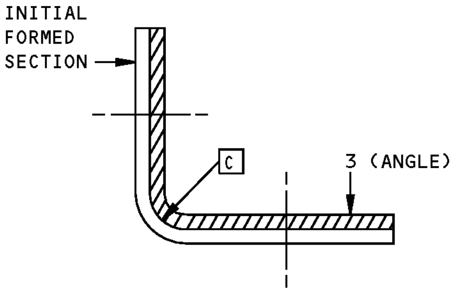


SECTION D-D

Typical Formed Section Repair
Figure 1 (Sheet 8 of 10)

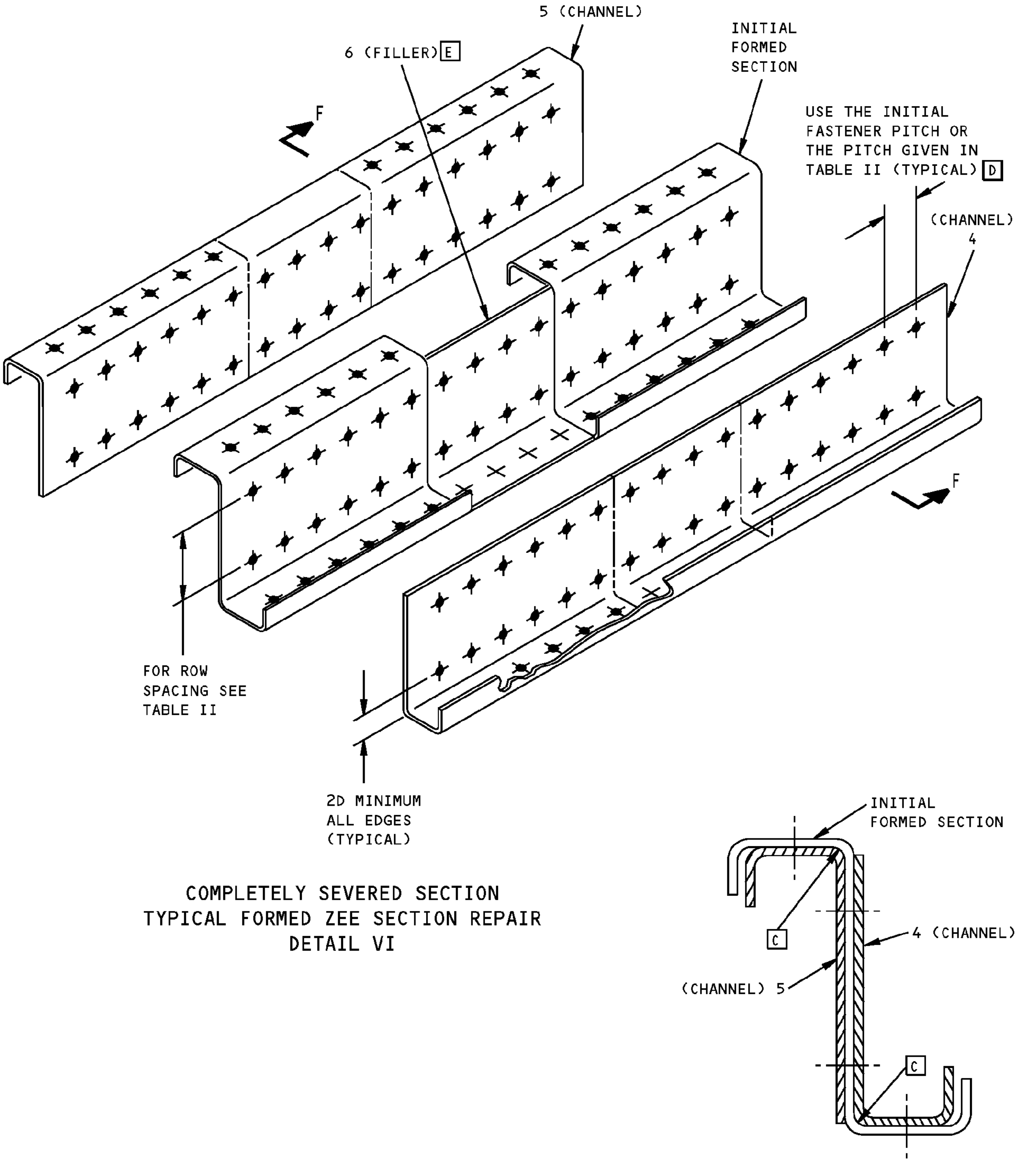


COMPLETELY SEVERED SECTION
TYPICAL FORMED ANGLE REPAIR
DETAIL V



SECTION E-E

Typical Formed Section Repair
Figure 1 (Sheet 9 of 10)



COMPLETELY SEVERED SECTION
TYPICAL FORMED ZEE SECTION REPAIR
DETAIL VI

SECTION F-F

Typical Formed Section Repair
Figure 1 (Sheet 10 of 10)

GENERAL - TYPICAL EXTRUDED SECTION REPAIR

REPAIR INSTRUCTIONS

1. Cut and remove damaged portion of extrusion.
2. Calculate the gages and lengths of the repair parts and fabricate them accordingly. J
3. Assemble the repair parts and drill the fastener holes.
4. Remove the repair parts.
5. Break sharp edges of original and repair parts 0.015 to 0.030.
6. Remove all nicks, scratches, burrs, sharp edges and corners from original and repair parts.
7. Alodize the repair parts and the raw edges of the original parts per 51-20-01.
8. Apply one coat of BMS 10-11, Type 1 primer to all repair parts in accordance with 51-24 of the 767 Maintenance Manual.
9. Install the repair parts with BMS 5-95 faying surface sealant applied to all faying surfaces. Install fasteners wet with BMS 5-95.
10. Restore original finish per AMM 51-21

NOTES

- THIS REPAIR DOES NOT APPLY TO WING STRINGERS, WING SPAR CHORDS, WING CENTER SECTION, WING SPANWISE BEAM CHORDS, STRUCTUREIN FUEL TANKS OR UPPER CHORD OF OVERWING FLOOR BEAMS
- WHEN YOU USE THIS REPAIR, REFER TO:
  - AMM 51-21 OF FOR INTERIOR AND EXTERIOR FINISHES
  - AMM 51-31 OF FOR SEALS AND SEALING
  - SRM 51-20-01 FOR PROTECTIVE TREATMENT OF METALS
  - SRM 51-40 FOR FASTENER CODE, REMOVAL, INSTALLATION, HOLE SIZES AND EDGE MARGINS
  - SRM 51-20-05 FOR SEALING OF REPAIRS

A SELECTION OF GAGE DETERMINED IN CONJUNCTION WITH PART 3 TO GIVE A COMBINED CROSS-SECTIONAL AREA OF ALL PLATES 1.25 TIMES GREATER THAN THE ORIGINAL 2024-T3 EXTRUSION OR 1.35 TIMES GREATER THAN THE ORIGINAL 7075-T6 EXTRUSION. EACH LEG OF THE EXTRUSION MUST BE JOINED BY MATERIAL PROPORTIONATELY GREATER THAT THE ORIGINAL AREA

B SELECTION OF GAGE DETERMINED BY FASTENER SPACING FROM TABLE I AND AREA REQUIREMENTS IN CONJUNCTION WITH OTHER REPAIR PARTS AS SHOWN IN NOTE A. IF NECESSARY FOR AREA REQUIREMENTS, ADDITIONAL PLATES MAY BE FITTED USING TABLE I AS A GUIDE TO MINIMUM GAGE.

C ALL FASTENERS IN REPAIR TO BE OF SAME NOMINAL DIAMETER, WHICH IS TO BE DETERMINED BY AVAILABLE EDGE MARGINS AND SKIN THICKNESS AVAILABLE FOR COUNTERSINKING. EDGE MARGINS MUST NOT BE LESS THAN 2D. RECOMMENDED FASTENER SPACING 4D. (D = DIAMETER OF FASTENER)

D INSTALL IN SUCH A SEQUENCE, OR COMBINATION OF SUITABLE FASTENERS AND NUTS, THAT WILL PREVENT INTERFERENCE OF NUTS. INTERFERENCE MAY BE PREVENTED BY DIMENSIONAL CONTROL, PROVIDED THAT MINIMUM EDGE MARGIN AND SPACING IS MAINTAINED

E SUITABLE PROTRUDING HEAD FASTENERS

BOLT:
BACB30FM HI-LOK
BACB30FP HI-LOK, 1/64 OVERSIZE

NUT:
BACC30M HI-LOK COLLAR

F SUITABLE FLUSH HEAD FASTENERS

BOLT:
BACB30FN HI-LOK
BACB30FQ HI-LOK, 1/64 OVERSIZE
BACB30LU STANDARD AND OVERSIZE

NUTS:
BACC30M HI-LOK COLLAR
BACN10JC LOCKNUT (INSTALL WITH 0.062 THICK STANDARD WASHER)

G SELECTION OF GAGE DETERMINED IN CONJUNCTION WITH PART 6 TO GIVE A COMBINED CROSS-SECTIONAL AREA OF ALL PLATES 1.25 TIMES GREATER THAT THE ORIGINAL 2024-T3 EXTRUSION OR 1.35 TIMES GREATER THAN THE ORIGINAL 7075-T6 EXTRUSION. EACH LEG OF THE EXTRUSION MUST BE JOINED BY MATERIAL PROPORTIONATELY GREATER THAN THE ORIGINAL AREA

H SELECTION OF GAGE DETERMINED BY FASTENER SPACING FROM TABLE II AND AREA REQUIREMENTS IN CONJUNCTION WITH OTHER REPAIR PARTS AS IN NOTE G. IF NECESSARY FOR AREA REQUIREMENTS, ADDITIONAL PLATES MAY BE FITTED USING TABLE II AS A GUIDE TO MINIMUM GAGE.

J THE BEND RADIUS OF REPAIR PART MUST BE MADE SO THAT THE OUTSIDE RADIUS OF THE INNER NESTING PART IS GREATER THAN THE INSIDE RADIUS OF ADJACENT PART.

FASTENER SYMBOLS

⊕ REPAIR FASTENER LOCATION

Typical Extruded Section Repair
Figure 1 (Sheet 1 of 6)

REPAIR MATERIAL					
		2024 EXTRUSIONS		7075 EXTRUSIONS	
PART		QTY	MATERIAL	QTY	MATERIAL
1	PLATE	AS REQ	0.040 CLAD 2024-T3	AS REQ	0.040 CLAD 7075-T6
2	PLATE	AS REQ	0.040 TO 0.063 CLAD 2024-T3 $\boxed{A}$	AS REQ	0.040 TO 0.063 CLAD 7075-T6 $\boxed{A}$
3	PLATE	AS REQ	0.050 TO 0.125 CLAD 2024-T3 $\boxed{B}$	AS REQ	0.050 TO 0.125 CLAD 7075-T6 $\boxed{B}$
4	FILLER	AS REQ	SAME AS ORIGINAL EXTRUSION	AS REQ	SAME AS ORIGINAL EXTRUSION
5	PLATE	AS REQ	0.040 TO 0.063 CLAD 2024-T3 $\boxed{G}$	AS REQ	0.040 TO 0.063 CLAD 7075-T6 $\boxed{G}$
6	PLATE	AS REQ	0.040 TO 0.063 CLAD 2024-T3 $\boxed{H}$	AS REQ	0.040 TO 0.063 CLAD 7075-T6 $\boxed{H}$

MINIMUM THICKNESS OF REPAIR PART 3	
FASTENER SPACING	REPAIR PLATE GAGE
UP TO 0.75	0.050
OVER 0.75 TO 0.84	0.056
OVER 0.84 TO 0.94	0.063
OVER 0.94 TO 1.06	0.071
OVER 1.06 TO 1.20	0.080
OVER 1.20 TO 1.35	0.090
OVER 1.35 TO 1.50	0.100
OVER 1.50 TO 1.68	0.112
OVER 1.68 TO 1.77	0.125

TABLE I

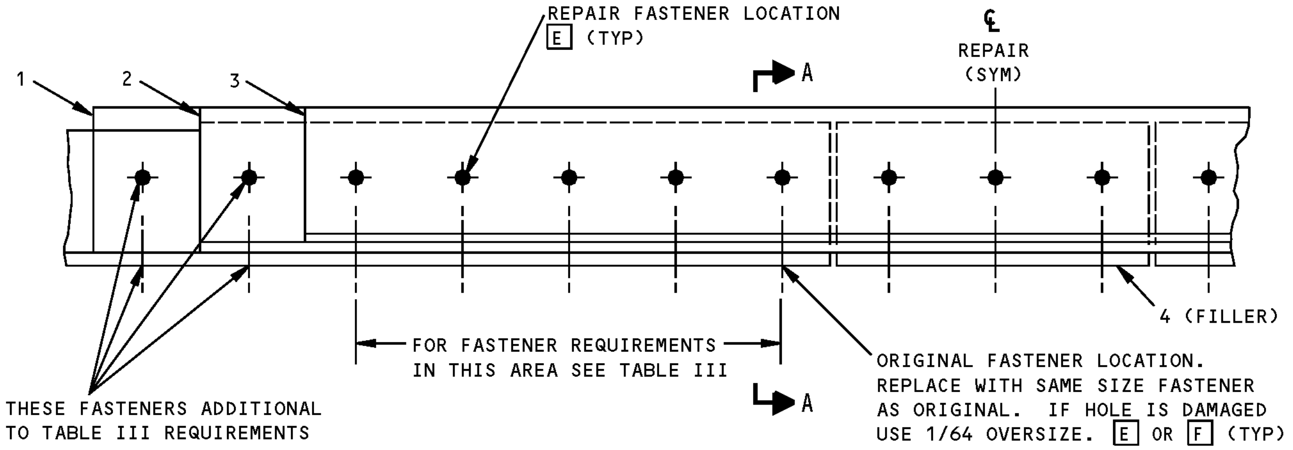
MINIMUM THICKNESS OF REPAIR PART 6	
FASTENER SPACING	REPAIR PLATE GAGE
UP TO 0.75	0.040
OVER 0.75 TO 0.84	0.056
OVER 0.84 TO 1.75	0.063

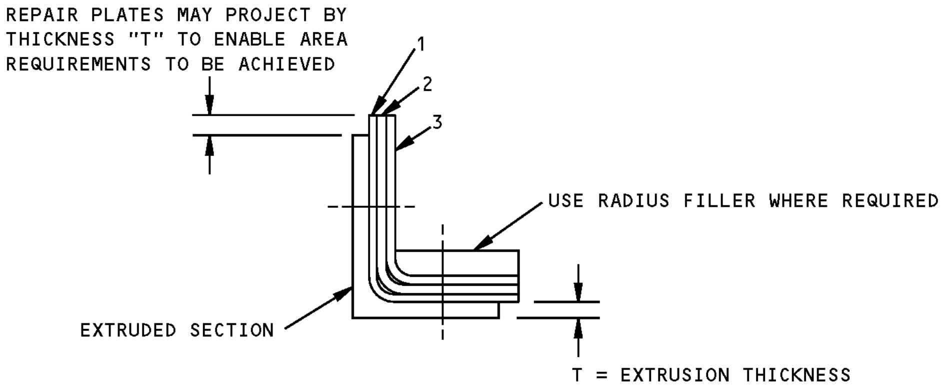
TABLE II

FASTENER DIAMETER	FASTENERS PER INCH WIDTH OF FLANGE OR WEB OF ORIGINAL EXTRUSION $\boxed{C}$	
	2024 EXTRUSION	7075 EXTRUSION
5/32	5.0	5.3
3/16	4.2	4.4
1/4	3.1	3.3

TABLE III

Typical Extruded Section Repair
Figure 1 (Sheet 2 of 6)



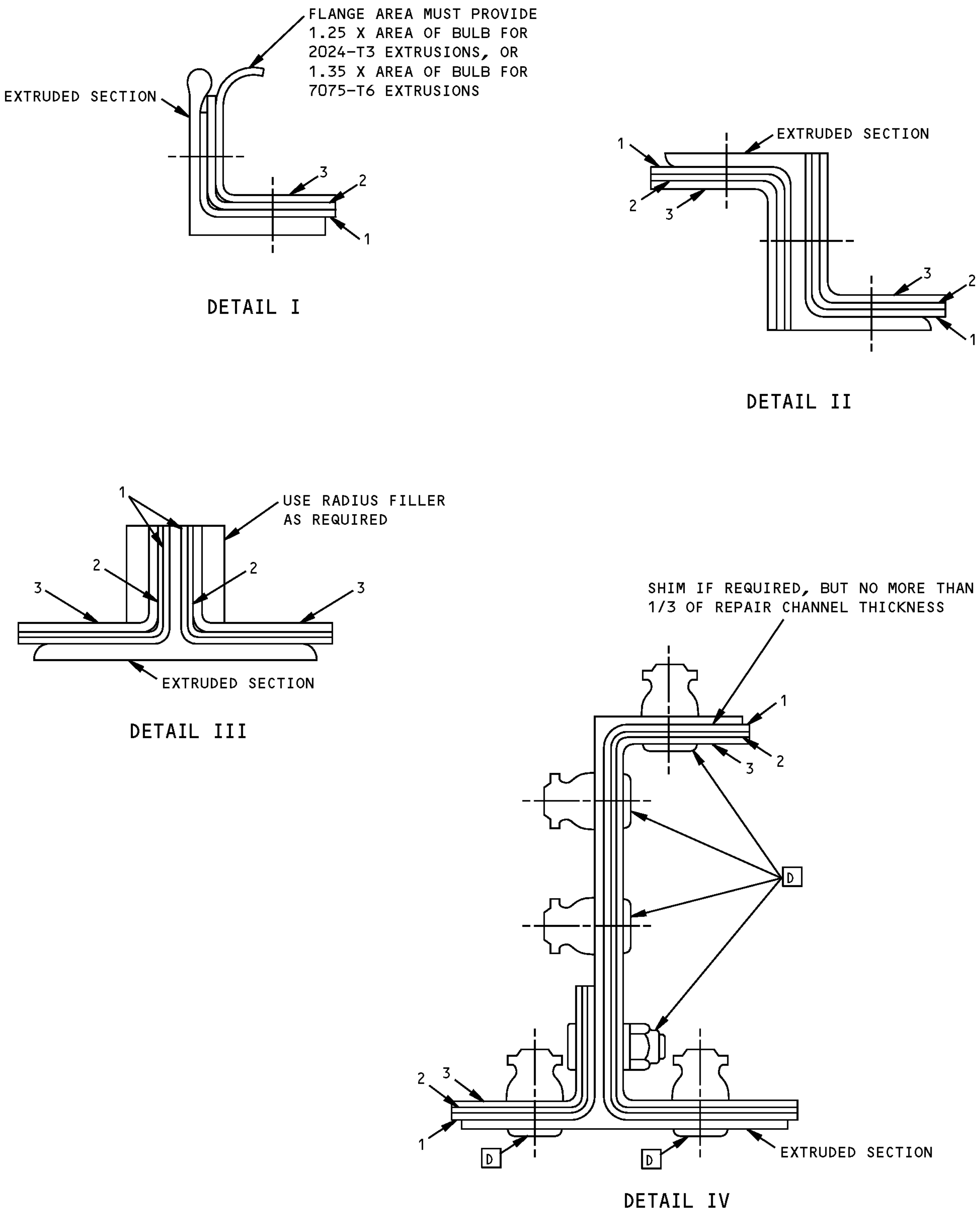


SEE DETAILS I, II, III AND IV
FOR TYPICAL REPAIRS OF OTHER SECTIONS

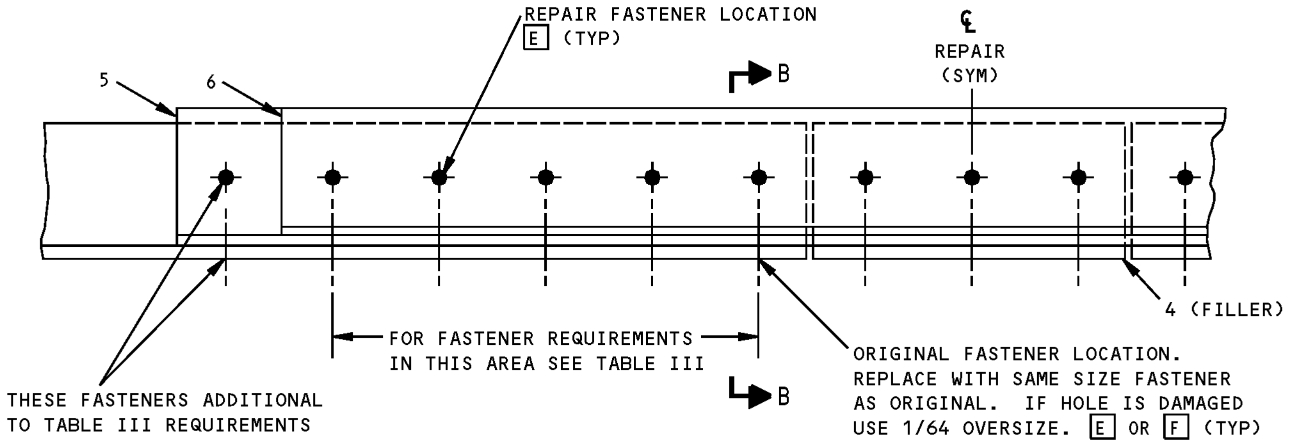
SECTION A-A

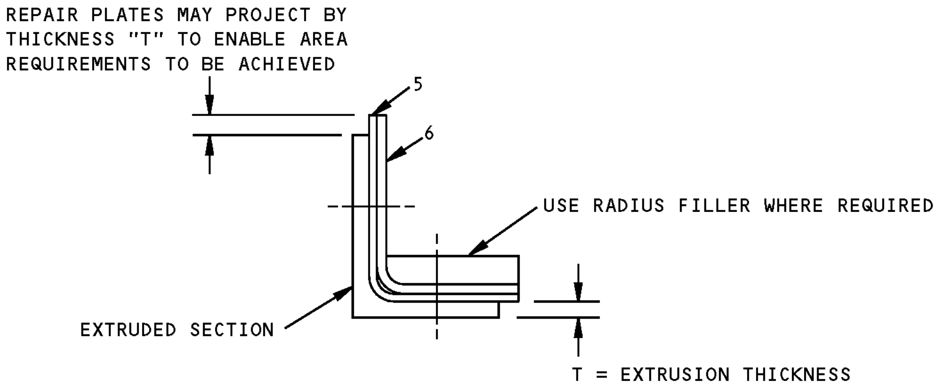
TYPICAL REPAIR OF EXTRUSIONS GREATER THAN 0.080 GAGE

Typical Extruded Section Repair
Figure 1 (Sheet 3 of 6)



Typical Extruded Section Repair
Figure 1 (Sheet 4 of 6)



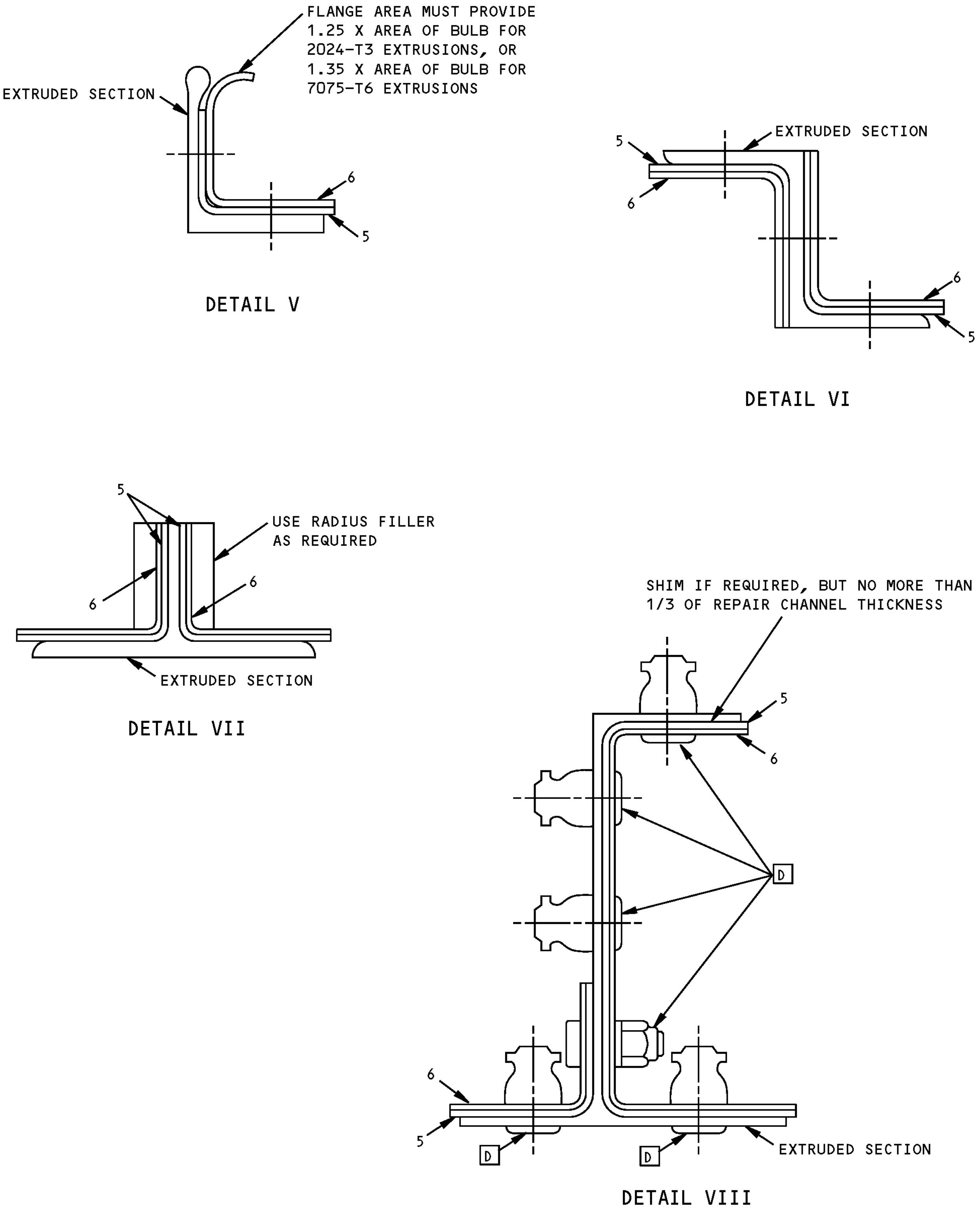


SEE DETAILS V, VI, VII AND VIII
FOR TYPICAL REPAIRS OF OTHER SECTIONS

SECTION B-B

TYPICAL REPAIR OF EXTRUSIONS 0.080 GAGE AND LESS

Typical Extruded Section Repair
Figure 1 (Sheet 5 of 6)



Typical Extruded Section Repair
Figure 1 (Sheet 6 of 6)

REPAIR INSTRUCTIONS

1. Remove fasteners and sealant over the area to be repaired.
2. Cut out the damaged portion of the extrusion in such a manner that fastener edge margins are maintained.
3. Calculate the gages of repair parts. Thickness of repair part flanges (at constant section) shall be at least 1.25 times thickness of original extrusion and area shall be at least 1.25 times area of original. Refer to sample calculation.
4. Calculate the number of fasteners to develop the strength of the repair parts. Refer to sample calculation.
5. Make the repair parts. Do not machine repair parts from large sections with strength properties reduced from those of the part repaired.
6. Assemble the repair parts and drill and ream the fastener holes in existing and new locations.
7. Remove the repair parts and remove all burrs, nicks, sharp edges, and corners from the cut original parts and the repair parts. Chamfer or radius 0.015 to 0.030 on all cut edges.
8. Alodize the repair parts and the raw edges of existing parts per SRM 51-20-01.
9. Apply one coat of BMS 10-11, Type 1 primer to all repair parts in accordance with AMM 51-24
10. Install prepack seals between the original extrusions and the repair parts, making BMS 5-95 faying surface seals between mating faces. Fasteners must be installed wet with BMS 5-95 injection sealant in gap between original and filler extrusion.
11. Restore finish after completion of repair per AMM 51-21.

NOTES

- THIS REPAIR DOES NOT APPLY TO WING STIFFENERS, SPAR CHORDS, WING CENTER SECTION, SPANWISE BEAM CHORDS, OR STRUCTURE IN FUEL TANK AREAS
- THIS REPAIR MAY BE USED TO PARTIALLY REPLACE AN EXTRUSION OR TO SPLICE AN EXTRUSION WITH A CROSS SECTION CRACK INCLUDING A COMPLETE BREAK
- REPAIR IS SYMMETRICAL ON EACH SIDE OF JOINT
- EXTRUSION REPAIRS MADE WITH "AND" EXTRUDED SECTIONS ARE PREFERRED
- REPAIRS SHOWN ARE CONSTANT SECTION EXTRUSIONS
- THIS REPAIR PROCEDURE IS A SUPPLEMENT TO THE EXISTING REPAIR PROCEDURE(S) IN SRM 51-70-12
- EXISTING REPAIRS MADE ACCORDING TO OTHER FIGURE(S) IN SRM 51-70-12 ARE SATISFACTORY AND ARE NOT AFFECTED BY THIS PROCEDURE
- THIS REPAIR IS LIMITED TO THOSE LOCATIONS WHERE SPACE AND ADJACENT STRUCTURE PERMIT THE DEVELOPMENT OF THE REPAIR
- REFER TO THE FOLLOWING WHEN USING THIS REPAIR:
  - AMM 51-21 FOR INTERIOR AND EXTERIOR FINISHES
  - AMM 51-24 FOR SEALS AND SEALING
  - SRM 51-10-02 FOR INSPECTION AND REMOVAL OF DAMAGE
  - SRM 51-20-01 FOR PROTECTIVE TREATMENT OF METALS
  - SRM 51-20-05 FOR SEALING OF REPAIRS
  - SRM 51-40 FOR FASTENER CODE, REMOVAL, INSTALLATION, HOLE SIZES AND EDGE MARGINS.

[A] FASTENERS IN ROW X AND Y MAY BE STAGGERED TO SUIT DEPTH OF EXTRUSION AND TO SUIT 4D DIMENSION. THE TOTAL NUMBER OF FASTENERS THRU WEB INCLUDES ROWS X AND Y

[B] MACHINE TAPER AT 20 TO 1 SLOPE AND TO 0.040 MINIMUM THICKNESSOR TO MAXIMUM THICKNESS EQUAL TO 1/3 THE THICKNESS OF THE FLANGE BEING SPLICED

[C] RADIUS OR CHAMFER TO SUIT RADIUS OF ORIGINAL EXTRUSION AND INSTALL PREPACK SEAL - TYPICAL

[D] DETERMINE DIAMETER FROM TABLE I AND THE FOLLOWING CRITERIA:

(a) WHERE FLUSH HEAD FASTENERS ARE REQUIRED, INSTALL ALL BACB30FN HI-LOKS AND WHERE PROTRUDING HEAD FASTENERS ARE REQUIRED, INSTALL BACB30FM HI-LOKS

(b) FASTENER DIAMETER SHOULD NOT EXCEED 1/16 INCH GREATER THAN THE ORIGINAL FASTENER UNLESS ADEQUATE EDGE MARGINS CAN BE MAINTAINED AND KNIFE EDGES AVOIDED

[E] INSTALL SHIMS TO MAXIMUM GAP EQUAL TO 0.005 INCH

Typical Extruded Section Repair - Machine Tapered
Figure 2 (Sheet 1 of 10)

SYMBOLS

G = ORIGINAL THICKNESS OF UPPER FLANGE

G_1 = THICKNESS OF UPPER FLANGE OF REPAIR MEMBER

H = ORIGINAL THICKNESS OF LOWER FLANGE

H_1 = THICKNESS OF LOWER FLANGE OF REPAIR MEMBER

T = ORIGINAL THICKNESS OF VERTICAL LEG

T_1 = THICKNESS OF VERTICAL LEG OF REPAIR MEMBER WHERE ONE REPAIR MEMBER IS USED

T_2 = THICKNESS OF VERTICAL LEG OF REPAIR MEMBER WHERE TWO REPAIR MEMBERS ARE USED

A_{FG} = UPPER REPAIR FLANGE AREA IF REPAIR FLANGE DOES NOT PROJECT PAST END OF FLANGE OF ORIGINAL MEMBER

A_{FH} = LOWER REPAIR FLANGE AREA IF REPAIR FLANGE DOES NOT PROJECT PAST END OF FLANGE OF ORIGINAL MEMBER

A_W = REPAIR MEMBER WEB AREA

D = ONE FASTENER DIAMETER

F_{TU} = ULTIMATE TENSILE STRENGTH

F_{BRU} = ULTIMATE BEARING STRENGTH

PSI = POUNDS PER SQUARE INCH

+ ORIGINAL FASTENER LOCATIONS $\boxed{D}$

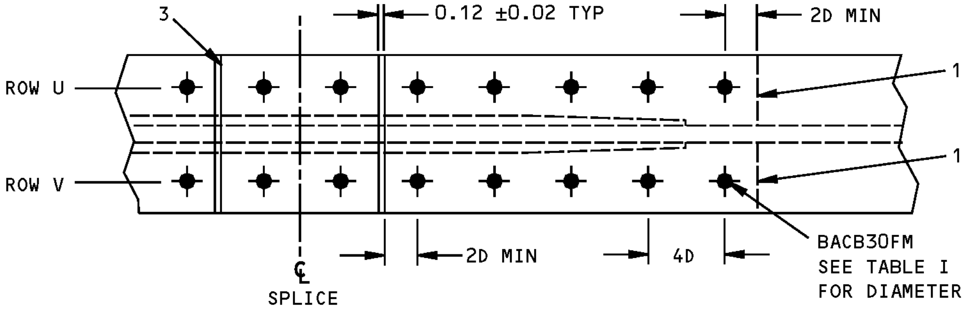
⌖ REPAIR FASTENER LOCATION.
INSTALL BACB30FM HI-LOKS.
SEE TABLE I FOR DIAMETER

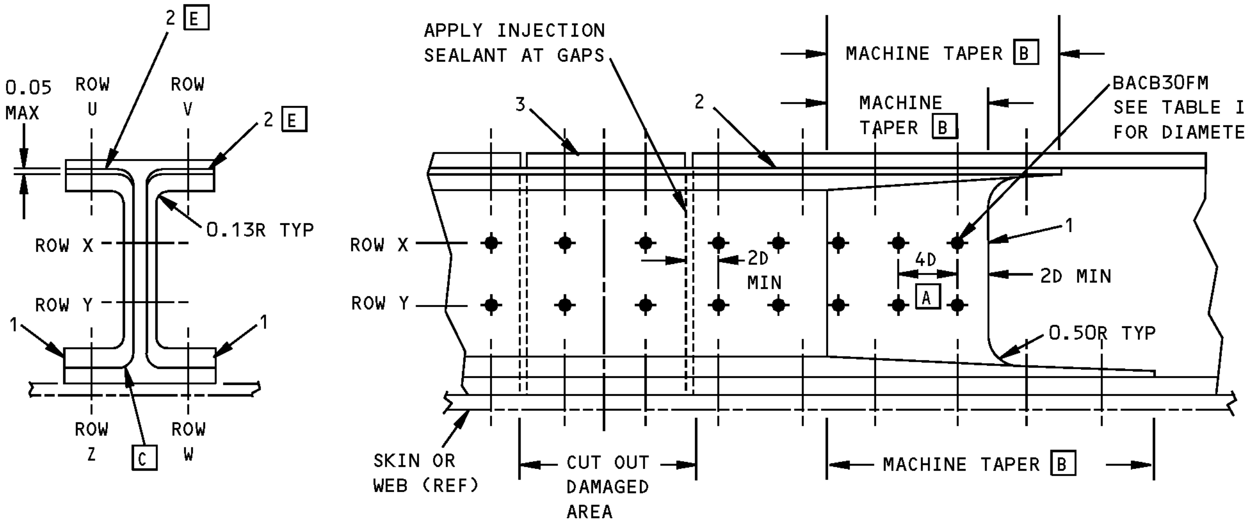
REPAIR MATERIAL			
PART		QTY	MATERIAL
1	REPAIR SECTION	1 OR 2	SAME AS MEMBER BEING REPAIRED OR EQUIVALENT. SEE REPAIR INSTRUCTIONS, STEP 5
2	SHIM	1 OR 2	
3	FILLER	1	
4	REPAIR SECTION	1	

TOTAL MATERIAL THICKNESS (INCHES)	FASTENER DIAMETER (INCHES)
UNDER 0.50	3/16 OR 1/4
0.50 TO 0.65	1/4 OR 5/16
0.66 TO 0.80	5/16 OR 3/8
0.81 AND OVER	3/8

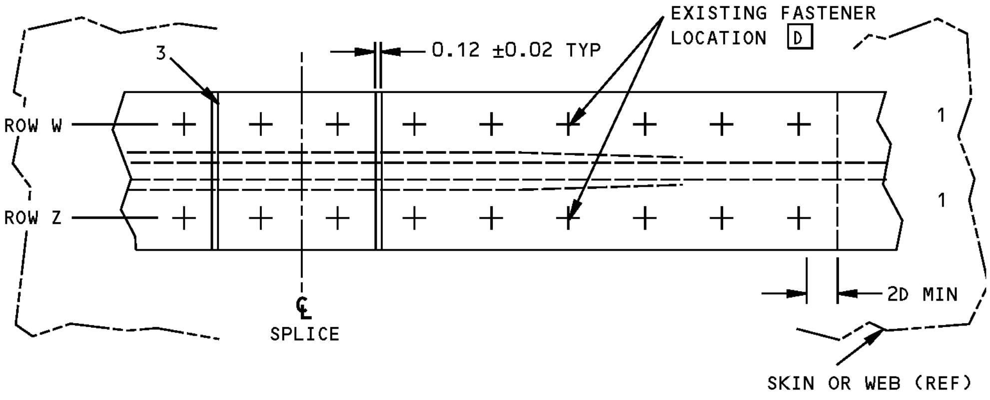
TABLE I

Typical Extruded Section Repair - Machine Tapered
Figure 2 (Sheet 2 of 10)





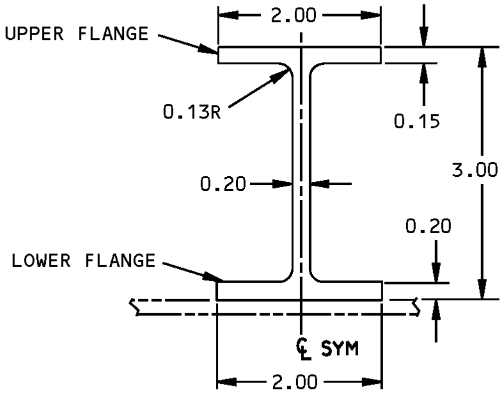
SIDE VIEW OF REPAIR



Typical Extruded Section Repair - Machine Tapered
Figure 2 (Sheet 3 of 10)

SAMPLE CALCULATION FOR AREA AND GAGE

THE FOLLOWING EXAMPLE SHOWS THE CALCULATION REQUIRED TO REPAIR AN EXTRUSION OF THE FOLLOWING DIMENSIONS:



MATERIAL: 2024-T4 EXTRUSION

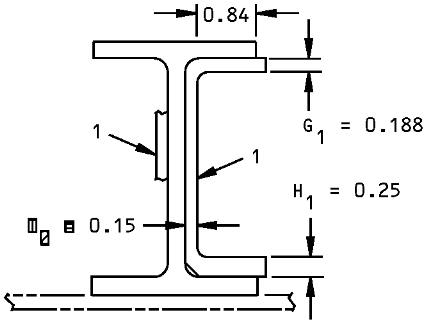
THICKNESS OF REPAIR PART (AT CONSTANT SECTION) FLANGES SHALL BE AT LEAST 1.25 x THICKNESS OF ORIGINAL EXTRUSION AND AREA SHALL BE AT LEASE 1.25 x AREA OF ORIGINAL (SEE SYMBOLS IN NOTES).

REPAIR PART 1

UPPER FLANGE THICKNESS – G_1

$$1.25 \times \text{FLANGE GAGE} = 1.25 \times 0.15 = 0.188$$

$$1.25 \times \text{ORIGINAL AREA} = 1.25 \times 2.00/_2 \times 0.15 = 0.188$$



NOTE: RADIUS AREA OF ORIGINAL SECTION IGNORED.

A_{FG} = REPAIR FLANGE AREA IF GAGE = 0.188 AND IF REPAIR FLANGE DOES NOT PROJECT PAST END OF FLANGE OF ORIGINAL MEMBER

$$A_{FG} = \left[1 - T/2 - \frac{1.25T}{4}\right] \times 0.188$$

$$A_{FG} = \left[1 - \frac{0.20}{2} - \frac{1.25(0.20)}{4}\right] \times 0.188$$

$A_{FG} = 0.84 \times 0.188 = 0.158$, WHICH IS LESS THAN THE AREA REQUIREMENT

SO PROJECT END OF REPAIR FLANGE TO MAKE AREA EQUAL TO 0.188. FLANGE MAY PROJECT BY THICKNESS OF REPAIR FLANGE.

0.188(0.188) = ADDITIONAL AREA = 0.035

$A_{FG} + 0.035 = 0.158 + 0.035 = 0.193$, WHICH IS GREATER THAN 0.188 AND THEREFORE MEETS THE AREA REQUIREMENT.

Typical Extruded Section Repair - Machine Tapered
Figure 2 (Sheet 4 of 10)

LOWER FLANGE THICKNESS - H_1

1.25 x FLANGE GAGE = 1.25 x 0.20 = 0.25

1.25 x ORIGINAL AREA = 1.25 x $2.00/_2$ x 0.20 = 0.25

A_{FH} = REPAIR FLANGE AREA IF GAGE = 0.25 AND IF REPAIR FLANGE DOES NOT PROJECT PAST END OF FLANGE OF ORIGINAL MEMBER.

A_{FH} = 0.84 x 0.25 = 0.21, WHICH IS LESS THAN THE AREA REQUIREMENT.

SO PROJECT END OF REPAIR FLANGE TO MAKE AREA EQUAL TO 0.188. FLANGE MAY PROJECT BY THICKNESS OF REPAIR FLANGE.

0.25(0.25) = ADDITIONAL AREA = 0.0625

A_{FH} + 0.0625 = 0.21 + 0.0625 = 0.272, WHICH IS GREATER THAN 0.25 AND THEREFORE MEETS THE AREA REQUIREMENT.

WEB THICKNESS - T_2

1.25 x WEB GAGE x 1/2 = 1.25 x 0.20 = 0.125

1.25 x ORIGINAL AREA = 1.25 x 0.20 (3.00-0.15-0.20) = 0.663

A_W = REPAIR WEB AREA

IF REPAIR GAGE = 0.125,

THEN A_W = 0.125 (3.00-0.15-0.188-0.25-0.20)
A_W = 0.2765
$2A_W$ = 0.553, WHICH IS LESS THAN THE AREA REQUIREMENT.

SO SET $2A_W$ = 0.663 TO DETERMINE LARGER REPAIR GAGE
0.663 - T_2 (3.00-0.15-0.188-0.25-0.20) x 2
T_2 = 0.15

Typical Extruded Section Repair - Machine Tapered
Figure 2 (Sheet 5 of 10)

SAMPLE CALCULATION – FASTENER REQUIREMENTS

NOTE: FASTENER REQUIREMENTS ARE CALCULATED TO DEVELOP THE STRENGTH OF REPAIR PARTS. THIS SAMPLE CALCULATION IS TO DETERMINE THE NUMBER OF FASTENERS REQUIRED FOR THE REPAIR SECTION IDENTIFIED IN THE PREVIOUS CALCULATION. STRENGTHS OF FASTENERS ARE OBTAINED FROM 51-40-07.

THE FOLLOWING CONDITIONS SHALL BE USED TO DETERMINE THE MINIMUM FASTENER REQUIREMENTS:

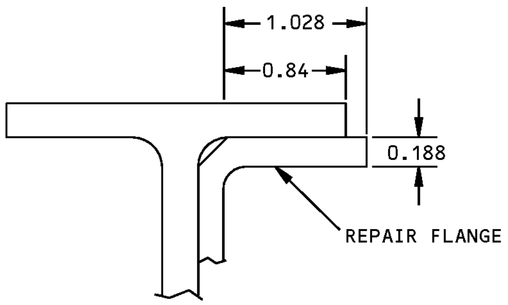
1. CONSERVATIVELY INSTALL SUFFICIENT FASTENERS IN THE CONSTANT SECTION TO DEVELOP THE REPAIR, USING A MINIMUM OF TWO FASTENERS.
2. FASTENER REQUIREMENTS IN TAPERED SECTION SHALL BE BASED ON LENGTH OF TAPERED SECTION, WITH 2D EDGE MARGIN AT END OF PART AND ABOUT 4D SPACING (3D TO 5D VARIATION).

   NOTE: THE THICKNESS OF TABERED SECTION IS TO BE PER NOTE $\boxed{B}$.
3. LENGTH OF REPAIR PART IS TO BE DETERMINED BY LENGTH OF LONGEST SECTION (FLANGE OR WEB) OF REPAIR PART.

UPPER FLANGE

REQUIRED CAPABILITY (USING 3/16 DIAMETER HI-LOKS) $= [(0.84 + 0.188) \times 0.188 - 0.19(0.188)]F_{TU}$

$$= \underbrace{[(1.028) \times 0.188}_{\text{AREA CALCULATION OF REPAIR FLANGE}} - \underset{\text{HOLE SIZE}}{0.19}(\underset{\text{REPAIR FLANGE THICKNESS}}{0.188})] \times \underset{\text{ULTIMATE TENSILE STRENGTH OF 2024-T4 EXTRUSION}}{61{,}000}$$



REQUIRED CAPABILITY = 9,610 LBS.

CONSTANT SECTION:

FOR 3/16 DIAMETER HI-LOKS, THE FASTENERS ARE BEARING CRITICAL FOR THE 0.150 ORIGINAL FLANGE. THE BEARING ALLOWABLE IS 2,150 POUNDS PER FASTENER. THE NUMBER OF FASTENERS REQUIRED IN CONSTANT SECTION IS 9,610/2,150 = 4.47. USE 5 FASTENERS AND SPACE AT ABOUT 4D.

TAPERED SECTION:

THICKNESS AT END OF PART = 1/3(0.15) = 0.05 PER NOTE $\boxed{B}$. THEN LENGTH OF TAPERED SECTION FOR 20 TO 1 TAPER RATIO = (0.188 – 0.05)20 = 2.76 INCHES. USING 2D EDGE MARGIN FOR END FASTENER AND 2D FROM START OF TAPER TO FIRST FASTENER IN TAPERED SECTION, DISTANCE REMAINING IS 2.76 – 4D = 2.76 – 4 (0.188) = 2.01 INCHES. INSTALL ADDITIONAL FASTENERS IN TAPERED SECTION AT 3 TO 5 DIAMETER SPACING.

TWO ADDITIONAL WOULD GIVE $\frac{2.01}{3(0.188)} = 3.6\text{D}$ SPACING.

Typical Extruded Section Repair - Machine Tapered
Figure 2 (Sheet 6 of 10)

WEB

REQUIRED CAPABILITY (USING 3/16 DIAMETER HI-LOKS) $= [0.15(3.00-0.15-0.188-0.25-0.20) - 0.19(0.15)2]\ F_{TU}$

$$= [\underbrace{0.15(2.212)}_{\text{AREA CALCULATION OF REPAIR WEB}} - \underset{\text{HOLE SIZE}}{0.19}(\underset{\text{REPAIR WEB THICKNESS}}{0.15})2] \times \underset{\text{ULTIMATE TENSILE STRENGTH OF 2024-T4 EXTRUSION}}{61{,}000}$$

REQUIRED CAPABILITY = 16,763 LBS. FOR EACH REPAIR WEB
= 2(16,763)
= 33,526 LBS. FOR BOTH REPAIR WEBS.

CONSTANT SECTION:

FROM PREVIOUS CALCULATIONS, 3/16 DIAMETER HI-LOKS ARE BEARING CRITICAL IN 0.150 THICK MATERIAL. SO 2,150 POUNDS OF LOAD PER FASTENER COULD BE TRANSFERRED INTO EACH REPAIR WEB IF THE REPAIR WEB WERE MORE CRITICAL THAN THE ORIGINAL WEB. THE FASTENERS REACT IN DOUBLE SHEAR WITH RESPECT TO THE ORIGINAL WEB. SO 2 x 2,150 = 4,300 POUNDS PER FASTENER COULD BE TRANSFERRED FROM THE ORIGINAL WEB IF THE ORIGINAL WEB WERE NOT BEARING CRITICAL. BEARING ALLOWABLE FOR 0.20 THICK ORIGINAL WEB IS 2,330 POUNDS, WHICH IS LESS THAN 4,300 POUNDS. THUS, FASTENERS ARE BEARING CRITICAL IN ORIGINAL WEB (0.20 THICK). THE NUMBER OF FASTENERS REQUIRED IN CONSTANT SECTION IS 33,526/2,330 = 14.39. SINCE THE REPAIR CONSERVATIVELY TRANSFERS THE ENTIRE LOAD IN THE CONSTANT SECTION, USE 14 FASTENERS AND SPACE AT ABOUT 4D.

TAPERED SECTION:

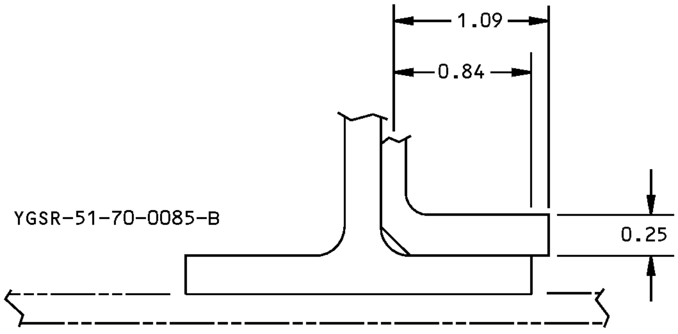
THICKNESS AT END OF PART = 1/3(0.20) = 0.067 PER NOTE $\boxed{B}$. THEN LENGTH OF TAPERED SECTION FOR 20 TO 1 TAPER RATIO = (0.15 − 0.067)20 = 1.66 INCHES. USING 2D EDGE MARGIN FOR END FASTENER AND 2D FROM START OF TAPER TO FIRST FASTENER IN TAPERED SECTION, DISTANCE REMAINING IS 1.66 − 4D = 1.66 − 4(0.1888) = 0.91 INCH. ONE ADDITIONAL FASTENER WOULD GIVE $\frac{0.91}{2(0.188)} = 2.43D$ SPACING (TOO CLOSE).
SO DO NOT INSTALL THE ADDITIONAL FASTENER. THEN SPACING = $\frac{0.91}{2(0.188)} = 4.85D$, WHICH MEETS THE 3 TO 5 DIAMETER SPACING REQUIREMENT.

Typical Extruded Section Repair - Machine Tapered
Figure 2 (Sheet 7 of 10)

LOWER FLANGE

REQUIRED CAPABILITY (USING 1/4 DIAMETER HI-LOKS) $= [(0.84+0.25) \times 0.25 - 0.25(0.25)]\ F_{TU}$

$$= [\underbrace{(1.09) \times 0.25}_{\text{AREA CALCULATION OF REPAIR FLANGE}} - \underbrace{0.25}_{\text{HOLE SIZE}}\underbrace{(0.25)}_{\text{REPAIR FLANGE THICKNESS}}] \times \underbrace{61{,}000}_{\text{ULTIMATE TENSILE STRENGTH OF 2024-T4 EXTRUSION}}$$



REQUIRED CAPABILITY = 12,810 LBS.

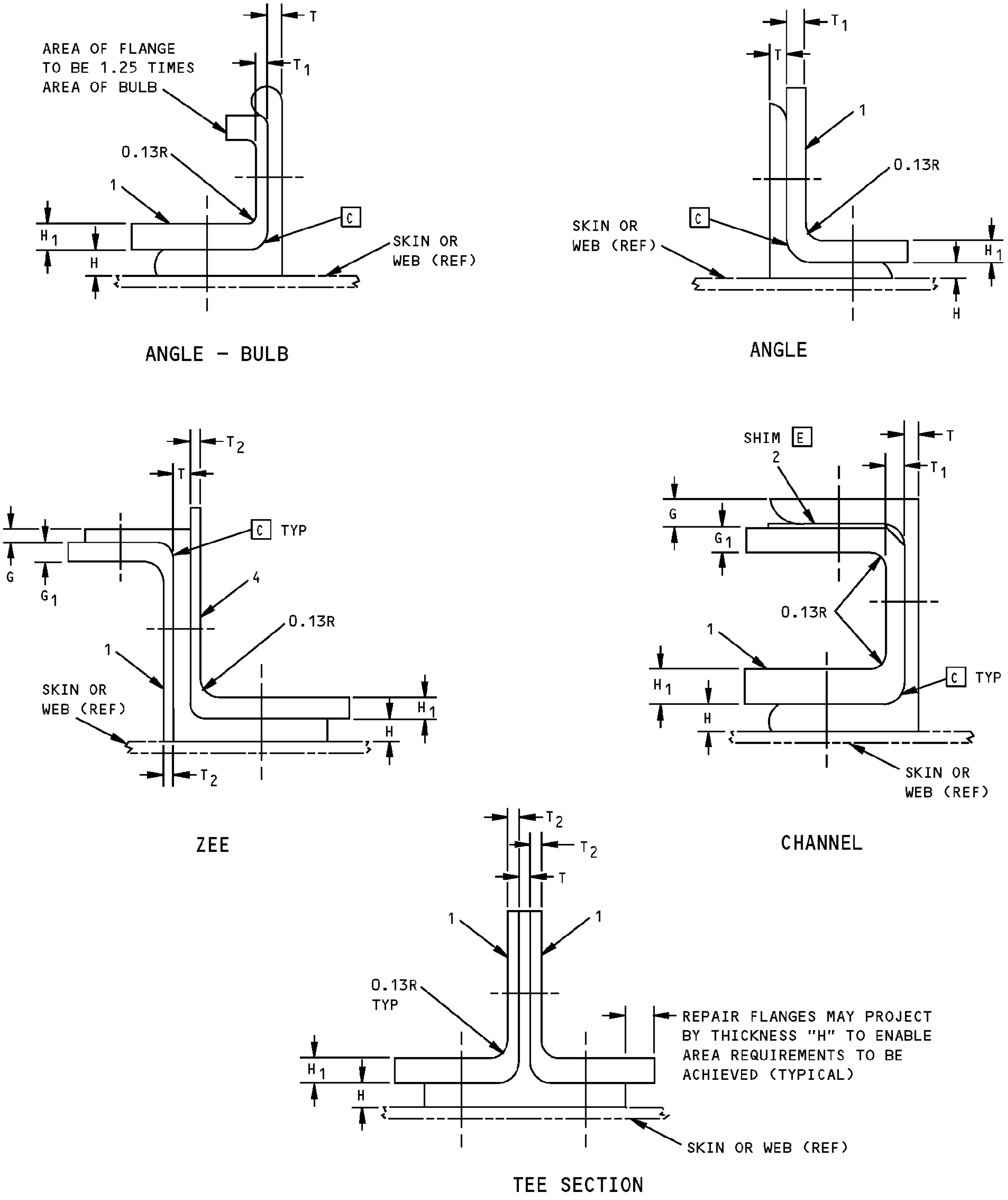
CONSTANT SECTION:

FOR 1/4 DIAMETER HI-LOKS,THE FASTENERS ARE BEARING CRITICAL IN THE 0.20 ORIGINAL FLANGE. THE BEARING ALLOWABLE IS 3.790 POUNDS PER FASTENER. THE NUMBER OF FASTENERS REQUIRED IN CONSTANT SECTION IS 12,810/3,790 = 3.38. USE 4 FASTENERS AND SPACE AT ABOUT 4D. IF THERE ARE EXISTING 1/4 DIAMETER FASTENERS, PICK UP 4. IF FASTENER DIAMETER DIFFERS, RECALCULATE REQUIREMENT.

TAPERED SECTION:

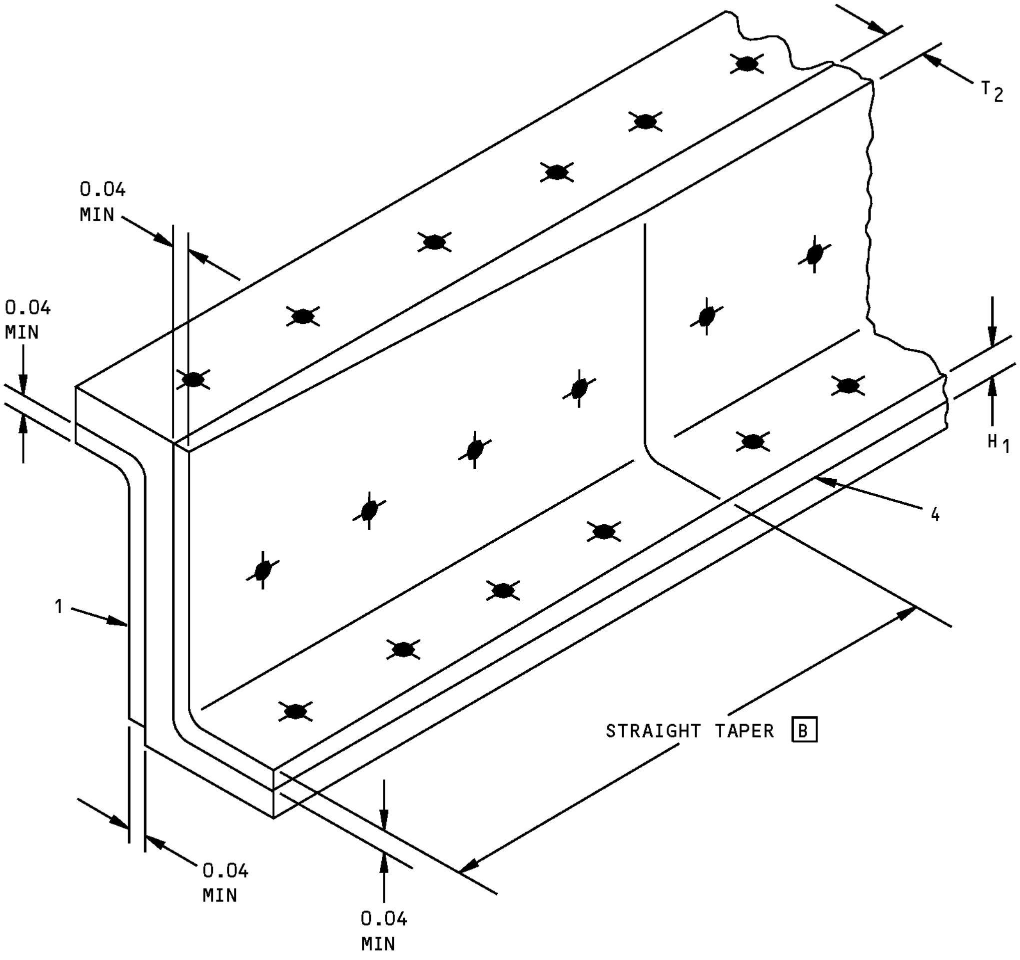
THICKNESS AT END OF PART = 1/3(0.20) = 0.067 PER NOTE $\boxed{B}$. THEN LENGTH OF TAPERED SECTION FOR 20 TO 1 TAPER RATIO = (0.25 - 0.067)20 = 3.66 INCHES. USING 2D EDGE MARGIN FOR END FASTENER AND 2D FROM START OF TAPER TO FIRST FASTENER IN TAPERED SECTION, DISTANCE REMAINING IS 3.66 - 4D = 3.66 - 4(0.25) = 2.66 INCHES. INSTALL ADDITIONAL FASTENERS IN TAPERED SECTION AT 3 TO 5 DIAMETER SPACING. TWO ADDITIONAL WOULD GIVE $\frac{2.66}{3(0.25)}$ = 3.55D SPACING. IF THERE ARE EXISTING FASTENERS, MAKE ADJUSTMENTS TO END UP WITH APPROXIMATELY SAME END THICKNESS AND TAPER RATIO.

Typical Extruded Section Repair - Machine Tapered
Figure 2 (Sheet 8 of 10)



TYPICAL EXTRUDED SECTIONS

Typical Extruded Section Repair - Machine Tapered
Figure 2 (Sheet 9 of 10)



ISOMETRIC VIEW OF REPAIR ANGLES
(TYPICAL FOR ALL SECTIONS)

Typical Extruded Section Repair - Machine Tapered
Figure 2 (Sheet 10 of 10)

GENERAL - TYPICAL WEB REPAIR

APPLICABILITY

THIS REPAIR DOES NOT APPLY TO THE AREAS THAT FOLLOW:

- MAIN WHEEL WELL PRESSURE DECK WEBS
- NOSE WHEEL WELL PRESSURE DECK WEBS
- FLOOR BEAM WEBS
- FRAMES
- SECTION 45 KEEL BEAM WEBS
- SECTION 48 UPPER AND LOWER LONGERONS
- BULKHEADS AT STA 132.5, 169.8, 287, 1582, 1702, 1725.5, 1809.5, AND CANT STA 182.5
- APU FIREWALL BULKHEAD AT STA 1832 AND 1843
- HORIZONTAL AND VERTICAL STABILIZERS
- CENTER WING FRONT AND REAR SPAR WEBS
- OUTER WING FRONT AND REAR SPAR WEBS
- OUTER WING INTERSPAR RIB WEBS

REPAIR INSTRUCTIONS

1. Get access to the damage area.
2. Cut and remove the damaged part of the web.
3. Make the repair part. See Table I, Detail I.
4. Assemble the repair parts and drill the fastener holes. See Table II to find the necessary rows of rivets and rivet spacing.
5. Disassemble the repair parts.
6. Remove the nicks, scratches, gouges, burrs, and sharp edges from the repair parts and the initial parts.
7. Apply a chemical conversion coating to the repair parts and to the bare aluminum surfaces of the initial parts. Refer to 51-20-01.
8. Apply one layer of BMS 10-11, Type I primer to the repair parts and to the bare aluminum surfaces of the initial parts. Refer to AMM 51-21.
9. Install the repair parts with BMS 5-95 sealant between the faying surfaces. Install the non-aluminum fasteners wet with BMS 5-95 sealant.
10. Apply the finish to the repair area. Refer to AMM 51-21.

NOTES

- FOR CHEM-MILLED WEBS INSTALL THE REPAIR PART ON SIDE OF THE WEB WHICH IS NOT CHEM-MILLED IF POSSIBLE. WHERE NOT POSSIBLE, SHIMS MAY BE USED TO MAKE UP FOR VARIATIONS IN THICKNESS.
- WHEN YOU USE THIS REPAIR REFER TO:
  - AMM 51-21 FOR INTERIOR AND EXTERIOR FINISHES
  - AMM 51-31 FOR SEALS AND SEALING
  - SRM 51-20-01 FOR PROTECTIVE TREATMENT OF METAL
  - SRM 51-10-02 FOR INSPECTION AND REMOVAL OF DAMAGE
  - SRM 51-20-05 FOR REPAIR SEALING
  - SRM 51-40 FOR FASTENER CODE, REMOVAL, INSTALLATION, HOLE SIZES AND EDGE MARGINS

$\boxed{A}$ IF THE INITIAL WEB IS 7075-T6, USE CLAD 7075-T6 ONE GAGE THICKER.

IF THE INITIAL WEB IS 2024-T3, USE CLAD 2024-T3 ONE GAGE THICKER.

$\boxed{B}$ IF THE REPAIR OCCURS AT THE EDGE OF A WEB WITH AN INITIAL ONE ROW ATTACHMENT TO A CHORD, ONE ROW OF FASTENERS IS ADEQUATE AT THE CHORD.

FASTENER SYMBOLS

+ INITIAL FASTENER LOCATION

⌖ REPAIR FASTENER LOCATION. SEE TABLE II FOR THE FASTENER.

REPAIR MATERIAL			
PART		QTY	MATERIAL
1	DOUBLER	1	$\boxed{A}$

TABLE I

Typical Web Repair
Figure 1 (Sheet 1 of 5)

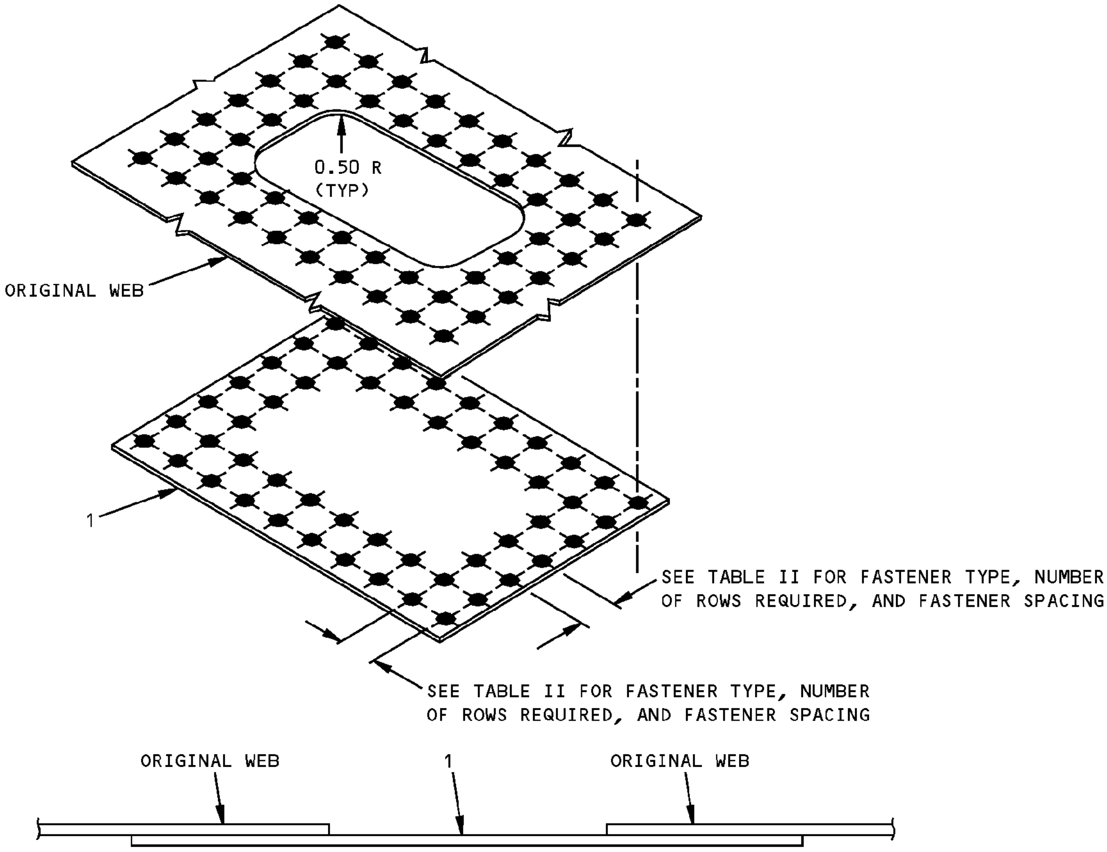
GAGE OF ORIGINAL WEB		MATERIAL															
		2024-T3 CLAD SHEET								7075-T6 CLAD SHEET							
		TYPE OF FASTENERS								TYPE OF FASTENERS							
		MS20470D()-(), BACR15BB()D() OR BACR15FT()D()					BACB30MY()K() OR BACB30FM WITH BACC30M() COLLAR			MS20470D()-(), BACR15BB()D() OR BACR15FT()D()					BACB30MY()K() OR BACB30FM WITH BACC30M() COLLAR		
		1/8	5/32	3/16	1/4	5/16	3/16	1/4	5/16	1/8	5/32	3/16	1/4	5/16	3/16	1/4	5/16
0.016	REQ'D ROWS B SPACING MINIMUM SPACING MAXIMUM	2 0.44 0.65	2 0.55 0.82							2 0.44 0.59	2 0.55 0.74						
0.020	REQ'D ROWS B SPACING MINIMUM SPACING MAXIMUM	2 0.44 0.65	2 0.55 0.82							2 0.44 0.59	2 0.55 0.74						
0.025	REQ'D ROWS B SPACING MINIMUM SPACING MAXIMUM		2 0.55 0.82								2 0.55 0.74						
0.028	REQ'D ROWS B SPACING MINIMUM SPACING MAXIMUM		2 0.55 0.82								2 0.55 0.74						
0.032	REQ'D ROWS B SPACING MINIMUM SPACING MAXIMUM		2 0.55 0.82	2 0.66 0.98							2 0.55 0.74	2 0.66 0.89					
0.036	REQ'D ROWS B SPACING MINIMUM SPACING MAXIMUM		2 0.55 0.82	2 0.66 0.98							2 0.55 0.73	2 0.66 0.89					
0.040	REQ'D ROWS B SPACING MINIMUM SPACING MAXIMUM		2 0.55 0.81	2 0.66 0.98							2 0.55 0.73	2 0.66 0.90					
0.045	REQ'D ROWS B SPACING MINIMUM SPACING MAXIMUM		2 0.55 0.81	2 0.66 0.98							2 0.55 0.66	2 0.66 0.90					
0.050	REQ'D ROWS B SPACING MINIMUM SPACING MAXIMUM		2 0.55 0.74	2 0.66 0.98	2 0.88 1.30		2 0.67 0.88	2 0.88 1.06			2 0.55 0.60	2 0.66 0.85	2 0.88 1.20		2 0.67 0.84	2 0.88 1.04	
0.056	REQ'D ROWS B SPACING MINIMUM SPACING MAXIMUM			2 0.66 0.94	2 0.88 1.31		2 0.67 0.88	2 0.88 1.12				2 0.66 0.77	2 0.88 1.20		2 0.67 0.84	2 0.88 1.12	
0.063	REQ'D ROWS B SPACING MINIMUM SPACING MAXIMUM			2 0.66 0.85	2 0.88 1.34	2 1.10 1.68	2 0.67 0.88	2 0.88 1.17	2 1.10 1.33			2 0.66 0.69	2 0.88 1.19	2 1.10 1.51	2 0.67 0.84	2 0.88 1.12	2 1.10 1.31
0.071	REQ'D ROWS B SPACING MINIMUM SPACING MAXIMUM				2 0.88 1.32	2 1.10 1.68	2 0.67 0.88	2 0.88 1.18	2 1.10 1.42				2 0.88 1.07	2 1.10 1.51	2 0.67 0.84	2 0.88 1.12	2 1.10 1.40
0.080	REQ'D ROWS B SPACING MINIMUM SPACING MAXIMUM				2 0.88 1.19	2 1.10 1.68	2 0.67 0.88	2 0.88 1.18	2 1.10 1.47				2 0.88 0.97	2 1.10 1.46	2 0.67 0.84	2 0.88 1.12	2 1.10 1.41
0.090	REQ'D ROWS B SPACING MINIMUM SPACING MAXIMUM				2 0.88 1.07	2 1.10 1.62	2 0.67 0.88	2 0.88 1.18	2 1.10 1.47					2 1.10 1.32	2 0.67 0.84	2 0.88 1.13	2 1.10 1.40
0.100	REQ'D ROWS B SPACING MINIMUM SPACING MAXIMUM					2 1.10 1.48	2 0.67 0.88	2 0.88 1.18	2 1.10 1.47					2 1.10 1.20	2 0.67 0.84	2 0.88 1.13	2 1.10 1.40

TABLE II

Typical Web Repair
Figure 1 (Sheet 2 of 5)

GAGE OF ORIGINAL WEB		MATERIAL															
		2024-T3 CLAD SHEET								7075-T6 CLAD SHEET							
		TYPE OF FASTENERS								TYPE OF FASTENERS							
		MS20470D()-(), BACR15BB()D() OR BACR15FT()D()					BACB30MY()K() OR BACB30FM WITH BACC30M() COLLAR			MS20470D()-(), BACR15BB()D() OR BACR15FT()D()					BACB30MY()K() OR BACB30FM WITH BACC30M() COLLAR		
		1/8	5/32	3/16	1/4	5/16	3/16	1/4	5/16	1/8	5/32	3/16	1/4	5/16	3/16	1/4	5/16
0.112	REQ'D ROWS $\boxed{B}$ SPACING MINIMUM SPACING MAXIMUM					2 1.10 1.33	2 0.67 0.86	2 0.88 1.18	2 1.10 1.48						2 0.67 0.85	2 0.88 1.13	2 1.10 1.41
0.125	REQ'D ROWS $\boxed{B}$ SPACING MINIMUM SPACING MAXIMUM						2 0.67 0.83	2 0.88 1.18	2 1.10 1.47						2 0.67 0.84	2 0.88 1.12	2 1.41

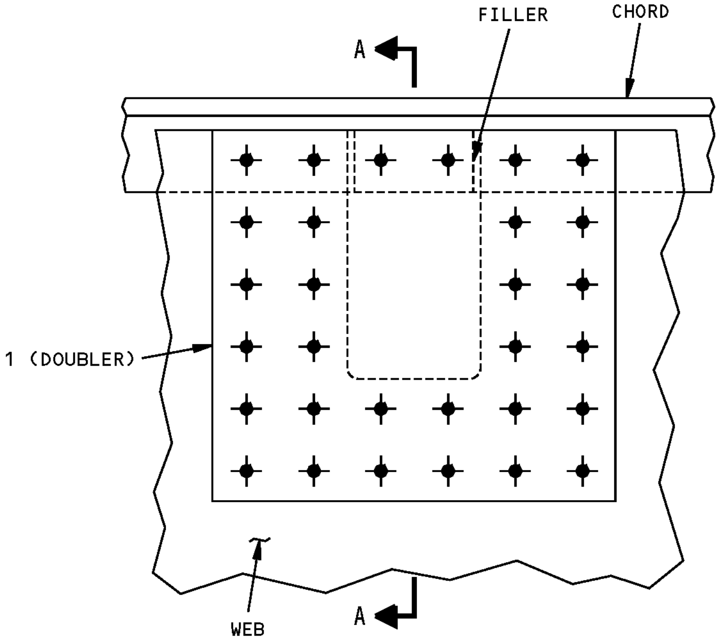
TABLE II (CONT)



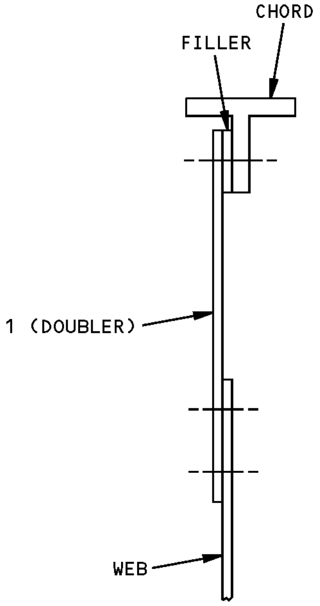
SECTION THROUGH REPAIR

DETAIL I

Typical Web Repair
Figure 1 (Sheet 3 of 5)

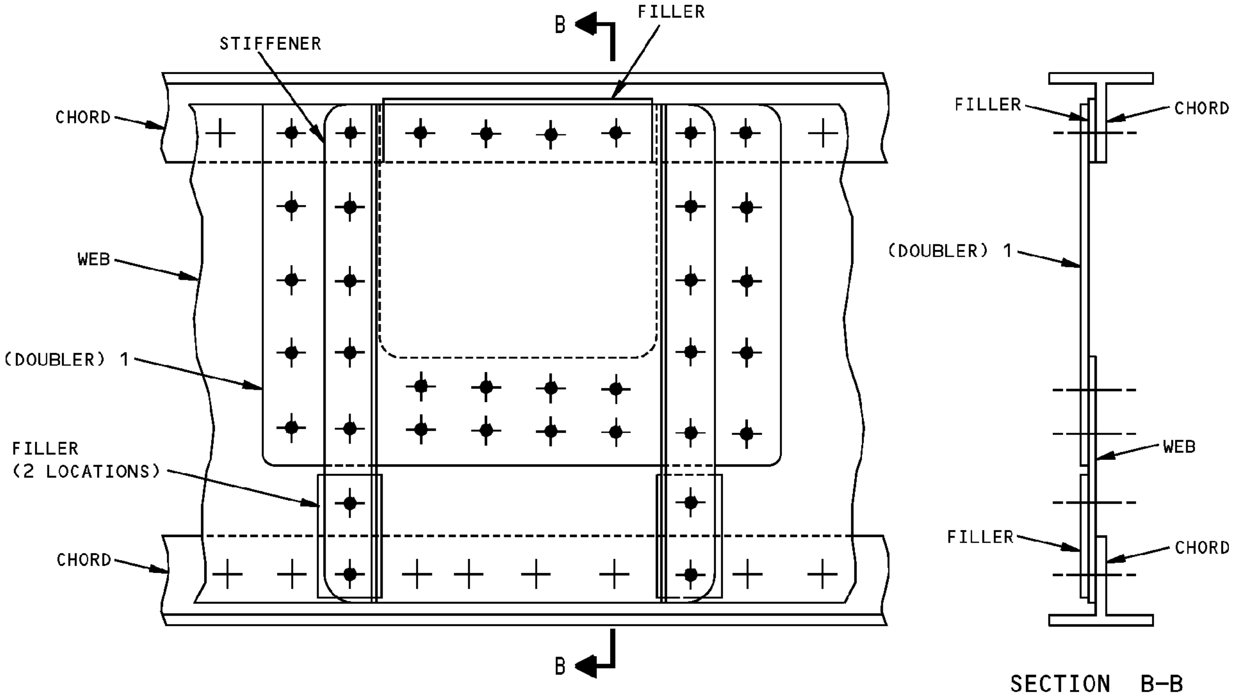


DETAIL II



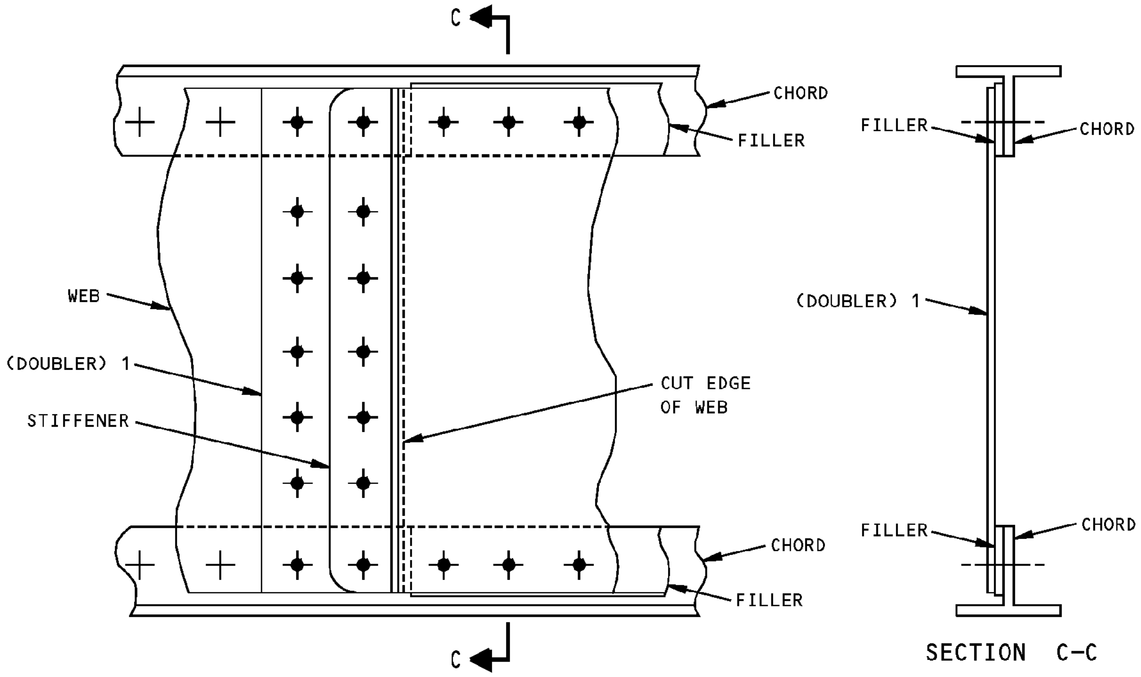
SECTION A-A

Typical Web Repair
Figure 1 (Sheet 4 of 5)



SECTION B-B

PARTIAL-DEPTH REPAIR



SECTION C-C

FULL-DEPTH REPAIR

DETAIL III

Typical Web Repair
Figure 1 (Sheet 5 of 5)

GENERAL - ALLOWABLE DAMAGE AND REPAIR OF FLAME-SPRAYED ALUMINUM COATINGS, ALUMINUM-COATED GLASS FABRIC (BMS 8-278), ALUMINUM FOIL (BMS 8-289), AND EXPANDED ALUMINUM FOIL (BMS 8-336)

1. General

A. This subject contains allowable damage and repair data for flame-sprayed aluminum coatings, aluminum coated glass fabric (BMS 8-278), and aluminum foil (BMS 8-289).

B. Refer to Figure 1/GENERAL for location of flame-sprayed aluminum coatings, aluminum coated glass fabric, and aluminum foil on the airplane. Table I lists the Boeing drawings for the callouts in the locator diagram.

C. The allowable damage and repairs contained in this subject apply only to the flame-sprayed aluminum coating, aluminum coated glass fabric ply, or aluminum foil ply on glass fabric and composite panels. For allowable damage or repairs to underlying plies, see the specific component allowable damage or repair subject.

D. Repairs by flame-spraying glass fabric reinforced epoxy resin components may be carried out by any approved facilities. Where a metal-spraying capability exists, damaged flame-sprayed aluminum coatings may be repaired as outlined in Paragraph 10.A./GENERAL. Alternate repairs for replacing entire aluminum flame sprayed areas are in Paragraph 10.B./GENERAL and Paragraph 10.C./GENERAL.

E. Refer to Figure 2/GENERAL, TABLE III for list of repair resins. Store Resins at 40°F (5°C) to 80°F (27°C) in sealed containers. Store BMS 10-21 Conductive Coating at 40°F (5°C) to 90°F (32°C) in sealed containers. An identification label must accompany the material inside the bag with the following information: BMS number, type, class, grade, supplier name and product designation, batch number, and date of manufacture.

F. Refer to 51-30-03, GENERAL for sources of materials.

G. Table 1/GENERALcontains an index of subjects in subsequent paragraphs.

H. For Tedlar repair, refer to Paragraph 15.

I. A composite panel is "electrically critical" if its aluminum layer is used to prevent lightning strike damage to wires, electrical components, fuel vapor zones, or antennae. Electrically critical panels that have been damaged must be repaired by the applicable time-limited or permanent repair. Refer to Figure 1/GENERAL, TABLE II. Failure to repair an electrically critical panel could cause the loss of necessary airplane systems if that panel has subsequent lightning strike damage.

Table 1: Index of Subjects

PARAGRAPH	SUBJECT
Paragraph 3./GENERAL	Allowable Damage for Flame-Sprayed Coatings
Paragraph 4./GENERAL	Allowable Damage for Aluminum Coated Glass Fabric (BMS 8-278)
Paragraph 5./GENERAL	Allowable Damage for Aluminum Foil (BMS 8-289)
Paragraph 6./GENERAL	Sealing of Allowable Damage to Flame-Sprayed Aluminum coatings and Aluminum Coated Glass Fabric with Resin
Paragraph 7./GENERAL	Time Limited Repair for Flame-Sprayed Coatings
Paragraph 8./GENERAL	Time Limited Repair for Aluminum Coated Glass Fabric (BMS 8-278)
Paragraph 9./GENERAL	Time Limited Repair for Aluminum Foil (BMS 8-289)
Paragraph 10./GENERAL	Repair of Flame-Sprayed Aluminum Coating - Full Conductivity
Paragraph 11./GENERAL	Repair of Flame-Sprayed Coatings by Potting

Table 1: Index of Subjects (Continued)

PARAGRAPH	SUBJECT
Paragraph 12./GENERAL	Restoration of Conductivity for Fasteners in Aluminum Flame-Sprayed Panels
Paragraph 13./GENERAL	Repair of Fastener Holes in Aluminum Flame-Sprayed Panels
Paragraph 14./GENERAL	Permanent Repair for Aluminum Coated Glass Fabric (BMS 8-278)
Paragraph 15./GENERAL	Permanent Repair for Aluminum Foil (BMS 8-289)
Paragraph 16./GENERAL	Repair of Expanded Aluminum Foil (BMS 8-336)
Paragraph 17./GENERAL	Repair of Surface Coatings or Finishes after Repair

2. References

Reference	Title
51-20-01, GENERAL	Protective Treatment of Metallic and Nonmetallic Repair Parts
51-30-03, GENERAL	Nonmetallic Materials
51-70-01, GENERAL	Procedures to Rework and Fill Minor Dents in Metallic Parts on External Aerodynamic Surfaces
51-70-09, GENERAL	Metal-to-Metal Structural Repair Adhesive Bond Procedures
51-70-10, GENERAL	Aluminum Honeycomb Structure Repairs
AMM 23-61-01	Aircraft Maintenance Manual
AMM 51-21-00	Aircraft Maintenance Manual
AMM 51-24-02	Aircraft Maintenance Manual
AMM 51-24-13	Aircraft Maintenance Manual
SOPM 20-30-97	Solvents For Final Cleaning Before Structural Bonding (Series 97)

3. Allowable Damage for Flame-Sprayed Aluminum Coatings

A. Cracks and slits up to 6.0-inch maximum length are allowed provided they do not extend from one edge to another edge.

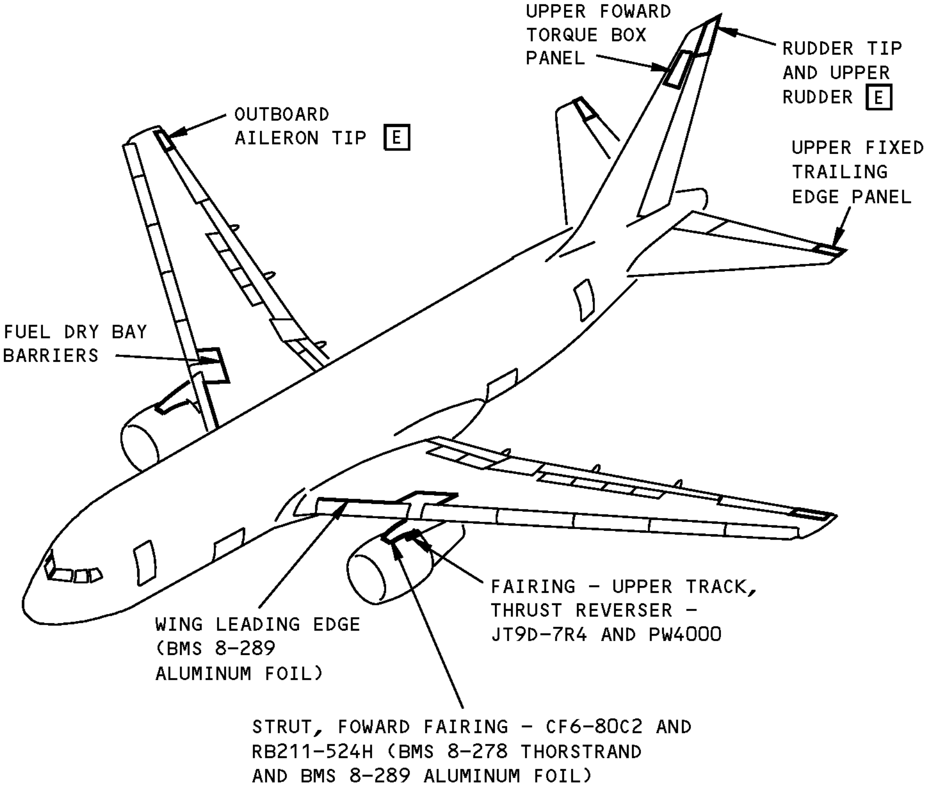
B. Nicks, gouges and scratches are allowed provided the underlying plies are not damaged.

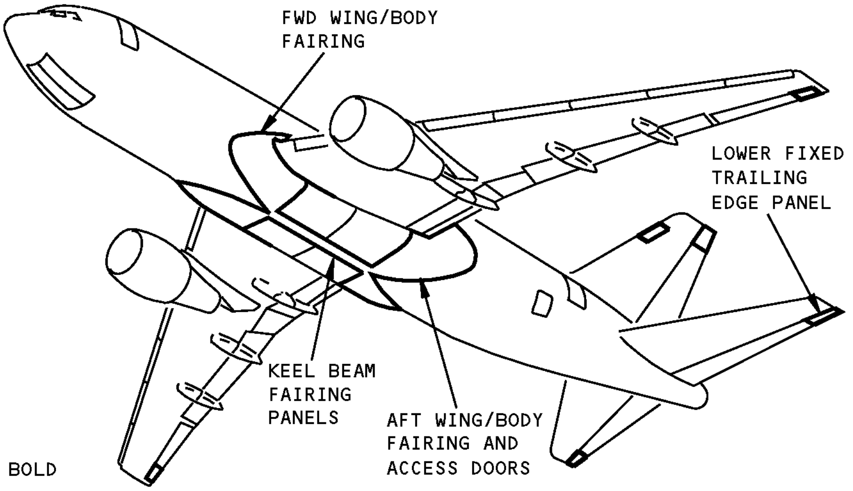
C. Total damage to the flame-sprayed aluminum surface must not exceed 4.0 square inches.

D. Seal damage with resin as given in Paragraph 7./GENERAL or protect damage with aluminum foil tape (speed tape) 3M-Y436 or equivalent.

E. If aluminum foil tape is used, record location of damage and inspect at every airplane "A" check. Replace aluminum foil tape if any peeling or deterioration of tape is evident.

F. Damage that exceeds the allowable damage limits must be repaired.





NOTES

- FLAME SPRAYED AREAS ARE SHOWN IN BOLD
- REFER TO 51-24-02 OF THE 767 MAINTENANCE MANUAL FOR LOCATION AND REPAIR OF BMS 10-21 CONDUCTIVE COATING (ELECTRICALLY NON-CRITICAL AREAS)

A BMS 8-278 ALUMINUM COATED GLASS FABRIC
B BMS 8-289 ALUMINUM FOIL
C ELECTRICALLY CRITICAL
D ELECTRICALLY NON-CRITICAL
E CUM LINE NUMBERS 132-249 (WITHOUT SB 767-51-0010 OR 0012 INCORPORATED)

Location of Flame-Sprayed Aluminum Coatings, Aluminum Coated Glass Fabric (BMS 8-278), and Aluminum Foil (BMS 8-289)
Figure 1 (Sheet 1 of 2)

DRAWING NUMBER	DESCRIPTION
112T5055	DOOR ASSY - BAFFLE, INSPAR RIB NO. 5 - WING $\boxed{C}$
112T8102	BARRIER - DRY BAY, RIB NO. 6 TO RIB NO. 7 $\boxed{C}$
112T8103	BARRIER - DRY BAY, RIB NO. 7 TO RIB NO. 8 $\boxed{C}$
112T8104	BARRIER - DRY BAY, RIB NO. 8 TO RIB NO. 9 $\boxed{C}$
113T1740	FAIRING PANEL - INBD TE FLAP $\boxed{D}$
113T1751	PANEL - FAIRING DOOR INBD TE FLAPS $\boxed{D}$
113T7110	BOND ASSY - OUTBD AILERON $\boxed{E}$
114T1810	SKIN PANEL - WING LE $\boxed{B}\boxed{C}$
145T8616	KEEL BEAM FAIRING PANELS $\boxed{C}$
149T7122	PANEL - STA 644 TO 698 FWD OF FRONT SPAR FAIRING $\boxed{C}$
149T7123	UPR PANEL - STA 698 TO FRONT SPAR $\boxed{C}$
149T7124	LWR PANEL - STA 698 TO FRONT SPAR $\boxed{C}$
149T7250	PANEL - FWD, INBD, LS, UNDERWING FAIRING $\boxed{C}$
149T7251	PANEL - FWD, INBD, RS, UNDERWING FAIRING $\boxed{C}$
149T7252	PANEL - FWD, OUTBD, LS, UNDERWING FAIRING $\boxed{C}$
149T7253	PANEL - FWD, OUTBD, RS, UNDERWING FAIRING $\boxed{C}$
149T7256	PANEL - JACKING UNDERWING FAIRING $\boxed{D}$
149T7257	PANEL - PRESSURE RELIEF, UNDERWING FAIRING $\boxed{C}$
149T7261	PANEL - GROUND AIR SUPPLY, UNDERWING FAIRING $\boxed{C}$
149T7608	ACCESS DOOR - ADP, AFT FAIRING $\boxed{C}$
149T7609	PANEL - ADP FWD, AFT FAIRING $\boxed{C}$
149T7610	ACCESS DOOR - ADP, AFT FAIRING $\boxed{C}$
149T7611	ACCESS DOOR - HYDRAULIC RESERVOIR FILL, AFT FAIRING $\boxed{C}$
149T7612	ACCESS DOOR - PRESSURE BOTTLE, AFT FAIRING $\boxed{C}$
149T7613	ACCESS DOOR - MLG DOOR GROUND CONTROL, AFT FAIRING $\boxed{C}$
149T7614	PANEL - PRESSURE RELIEF, AFT FAIRING $\boxed{C}$
149T7615	PANEL - STA 1219 TO STA 1249.7, AFT FAIRING $\boxed{C}$
149T7619	PANEL - STA 1175 TO STA 1219, LS, LWR, AFT FAIRING $\boxed{C}$
149T7620	PANEL - STA 1175 TO STA 1219, RS, LWR, AFT FAIRING $\boxed{C}$
149T7622	PANEL - STA 1137 TO STA 1175, LS, LWR, AFT FAIRING $\boxed{C}$
149T7624	PANEL - AFT WHEEL WELL BHD TO STA 1137, LS, MID, AFT FAIRING $\boxed{C}$
149T7625	PANEL - STA 1137 TO STA 1189.6, RS, AFT FAIRING $\boxed{C}$
149T7626	PANEL - STA 1137 TO STA 1175, RS, LWR, AFT FAIRING $\boxed{C}$
149T7629	PANEL - AFT WHEEL WELL BHD TO STA 1137, LWR, AFT FAIRING $\boxed{C}$
149T7630	PANEL - STA 1175 TO STA 1196, LS, MID, AFT FAIRING $\boxed{C}$
149T7771	DOOR - RAT, AFT FAIRING $\boxed{C}$
173T2004	UPR PANEL - RUDDER $\boxed{D}\boxed{E}$
173T2052	TIP - RUDDER $\boxed{D}$
173T2092	TIP - RUDDER, REWORK $\boxed{D}$
175T1300	ACCESS COVER - AUX SPAR, VERTICAL STABILIZER $\boxed{C}$
175T2002	UPR PANEL - FWD TORQUE BOX, FSS 295.9 TO UPR CLOSURE RIB $\boxed{D}$
183T1130	UPR PANEL - FIXED TE, ELEV STA 335.1 TO HS BL 357.4 $\boxed{D}$
183T1280	PANEL - LWR, FIXED TE, ELEV STA 335.1 TO HS BL 357.4 $\boxed{D}$
189T0001	FAIRING - HORIZONTAL STABILIZER TIP $\boxed{D}$
284T0781	PANEL, SEPTUM - VERTICAL STABILIZER $\boxed{D}$
313T1200	FAIRING INSTL - UNDERWING, STRUT $\boxed{B}\boxed{C}$
313T2101	PANEL ASSY - FWD FAIRING STRUT - CF6-80C $\boxed{A}\boxed{B}\boxed{C}$
313T3101	PANEL ASSY - FWD STRUT FAIRING $\boxed{B}\boxed{D}$
313T3200	FAIRING INSTL - UNDERWING, STRUT $\boxed{B}\boxed{C}$
313T5103	BONDED PANEL ASSY - FWD FAIRING, AFT SEGMENT, RB211-524H $\boxed{A}\boxed{B}\boxed{C}$
313T5104	BONDED PANEL ASSY - FWD FAIRING, FWD SEGMENT, RB211-524H $\boxed{A}\boxed{B}\boxed{C}$
313T5201	BONDED PANEL ASSY - UNDERWING FAIRING RB211-524H $\boxed{A}\boxed{B}\boxed{D}$
313T5361	PANEL ASSY - TRAILING EDGE FAIRING $\boxed{B}\boxed{C}$
313T5381	BONDED PANEL ASSY - AFT FAIRING STRUT, RB211-524H $\boxed{B}\boxed{C}$
313T5401	BONDED PANEL ASSY - MID FAIRING, RB211-524H $\boxed{A}\boxed{B}\boxed{C}$
315T3530	FAIRING - UPPER TRACK, THRUST REVERSER - JT9D-7R4 AND PW4000 $\boxed{C}$

TABLE I

Location of Flame-Sprayed Aluminum Coatings, Aluminum Coated Glass Fabric (BMS 8-278), and Aluminum Foil (BMS 8-289)
Figure 1 (Sheet 2 of 2)

4. Allowable Damage for Aluminum Coated Glass Fabric (BMS 8-278 Thorstrand)

A. Cracks up to 6.0 maximum length are allowed providing that cracks do not extend from one edge to another edge (including corners).

B. Holes and punctures up to 2.0 maximum diameter are allowed.

C. Delamination is allowed provided there are no cracks or holes.

D. Nicks, gouges, scratches, and dents are allowed provided the underlying plies are not damaged.

E. Total damage to the aluminum coated glass fabric ply must not exceed 4 sq. in.

F. Seal damage with resin as given in Paragraph 5 or protect damage with aluminum foil tape (speed tape) 3M-Y436 or equivalent.

G. If aluminum foil tape is used, record location of damage and inspect at every airplane "A" check. Replace aluminum foil tape if any peeling or deterioration of tape is evident.

H. Damage that exceeds the allowable limits must be repaired.

5. Allowable Damage for Aluminum Foil (BMS 8-289)

A. Cracks or slits up to 4.0 inch maximum length are allowed provided they are not over 50% of the panel dimension.

B. Holes and punctures up to 3.0 inches maximum diameter are allowed provided they are 6.0 inches from any other damage. The maximum cumulative allowable damage per 4.0 square foot area is 29.0 square inches (5%).

C. Dents and delamination are allowed provided there are not cracks, slits, or holes.

D. Protect damage that penetrates the aluminum foil with aluminum foil tape (speed tape) 3M-Y436 or equivalent and inspect as given in Paragraph 5.E./GENERAL or permanent repair as given in this section of this manual.

E. Record location of damage and inspect at every airplane "A" check. Replace alumimum foil tape if any peeling or deterioration is evident.

F. Damage that exceeds the allowable limits must be repaired.

6. Sealing of Allowable Damage to Flame-Sprayed Aluminum Coatings and Aluminum Coated Glass Fabric with Resin

A. Lightly sand the damaged area with 240 grit or finer abrasive paper.

WARNING: KEEP SOLVENTS AWAY FROM SOURCES OF HEAT, FIRE, OR SPARKS. HEAT, FIRE, OR SPARKS CAN CAUSE AN EXPLOSION.

AVOID CONTACT OF SOLVENT WITH SKIN, EYES, AND CLOTHING. WEAR EYE PROTECTION AND USE MECHANICAL VENTILATION OR RESPIRATORY PROTECTION WHEN WORKING IN A CONFINED SPACE OR AREA. BREATHING VAPORS OR ALLOWING SOLVENT TO CONTACT SKIN OR EYES IS HAZARDOUS.

B. Wipe damaged area with a clean cloth moistened with BMS 11-7, MPK High Purity, MEK, MIBK, or acetone to remove any sanding dust or other contamination.

C. Mix Resin Mix 1 as given in Figure 2/GENERAL.

D. Apply Resin Mix 1 to damaged area. Apply an excess to allow for shrinkage during cure.

WARNING: FOR ACCELERATED CURE, USE HEAT CURING EQUIPMENT THAT IS ACCEPTABLE TO LOCAL FIRE PROTECTION AUTHORITIES. FAILURE TO COMPLY COULD CAUSE PERSONNEL INJURY.

E. Cure as given in Figure 2/GENERAL. If a heat lamp is used as a heat source, see Figure 3/GENERAL for heat lamp temperature curve.

F. Sand repair area with 240 grit or finer abrasive paper to a smooth surface that is flush with the surrounding area.

G. Apply a chemical conversion coating as given in 51-20-01, GENERALSRM 51-20-01 to any exposed flame-sprayed aluminum surface.

H. Refinish repair area as given in Paragraph 16.

7. Time Limited Repair for Flame-Sprayed Aluminum Coatings

A. This repair is allowed on damaged flame-sprayed aluminum coatings, provided cracks are less than 0.25 wide and damage in one area is less than 4.0 sq. in. The total damage per panel that is allowed by this procedure must not exceed 10% of the flame-sprayed aluminum surface. Damage that exceeds these limits must be repaired as given in Paragraph 10./GENERAL

CAUTION: DO NOT SAND INTO FIBERS OF UNDERLYING PLIES. DAMAGE TO STRUCTURE WILL OCCUR.

B. Lightly sand the damaged area with 180 grit or finer abrasive paper to remove any loose flame-sprayed aluminum.

C. Remove finish 1.00 minimum around the edge of the damage using 240 grit or finer abrasive paper. Do not sand through the flame-sprayed aluminum coating.

WARNING: KEEP SOLVENTS AWAY FROM SOURCES OF HEAT, FIRE, OR SPARKS. HEAT, FIRE, OR SPARKS CAN CAUSE AN EXPLOSION.

AVOID CONTACT OF SOLVENT WITH SKIN, EYES, AND CLOTHING. WEAR EYE PROTECTION AND USE MECHANICAL VENTILATION OR RESPIRATORY PROTECTION WHEN WORKING IN A CONFINED SPACE OR AREA. BREATHING VAPORS OR ALLOWING SOLVENT TO CONTACT SKIN OR EYES IS HAZARDOUS.

D. Wipe areas to be coated with conductive coating with a clean cloth moistened with BMS 11-7, MPK High Purity, MEK, MIBK, or acetone to remove any sanding dust or other contamination.

E. Apply a chemical conversion coating as given in 51-20-01, GENERAL to all exposed flame-sprayed aluminum.

F. Apply BMS 10-21 Type III conductive coating as given in AMM 51-24-02.

G. Refinish repair area as given in Paragraph 16.

H. Time Limited repair has FAA approval providing it is replaced with a permanent repair no later than the next "A" check.

8. Time Limited Repair for Aluminum-Coated Glass Fabric (BMS 8-278 Thorstrand)

WARNING: KEEP SOLVENTS AWAY FROM SOURCES OF HEAT, FIRE, OR SPARKS. HEAT, FIRE, OR SPARKS CAN CAUSE AN EXPLOSION.

(WARNING PRECEDES)

AVOID CONTACT OF SOLVENT WITH SKIN, EYES, AND CLOTHING. WEAR EYE PROTECTION AND USE MECHANICAL VENTILATION OR RESPIRATORY PROTECTION WHEN WORKING IN A CONFINED SPACE OR AREA. BREATHING VAPORS OR ALLOWING SOLVENT TO CONTACT SKIN OR EYES IS HAZARDOUS.

A. Wipe damaged area with a clean cloth moistened with BMS 11-7, MPK High Purity, MEK, MIBK, or acetone to remove any contamination.

B. Apply aluminum foil tape (speed tape) 3M Y-436 to damaged area.

C. Apply conductive coating as given in AMM 51-24-02 and Figure 6/GENERAL to aluminum foil tape and out to fasteners with dimpled washers.

Conductive coating must extend from aluminum foil tape to fasteners with dimpled washers to ensure proper grounding to airplane structure.

D. Refinish repair area as given inParagraph 17./GENERAL.

E. Time limited repair has FAA approval providing it is replaced with a permanent repaiParagraph 14./GENERAL no later than the next airplane "C" check.

9. Time Limited Repair for Aluminum Foil (BMS 8-289)

WARNING: KEEP SOLVENTS AWAY FROM SOURCES OF HEAT, FIRE, OR SPARKS. HEAT, FIRE, OR SPARKS CAN CAUSE AN EXPLOSION.

AVOID CONTACT OF SOLVENT WITH SKIN, EYES, AND CLOTHING. WEAR EYE PROTECTION AND USE MECHANICAL VENTILATION OR RESPIRATORY PROTECTION WHEN WORKING IN A CONFINED SPACE OR AREA. BREATHING VAPORS OR ALLOWING SOLVENT TO CONTACT SKIN OR EYES IS HAZARDOUS.

A. Wipe damaged area with a clean cloth moistened with solvent, Series 97 (AMM/ SOPM 20-30-97) to remove any contamination.

B. Cut a sheet of bare aluminum foil such that it will overlap the edge of the damage by 1.0 minimum.

C. Place aluminum foil sheet over the damaged area such that it overlaps the edge of the damage by 1.0 minimum.

D. Apply aluminum foil tape (speed tape) 3M Y-436 or equivalent around the edges of the aluminum foil sheet.

E. Time limited repair has FAA approval providing it is replaced with a permanent repair no later than the next airplane "C" check.

10. Repair of Flame-Sprayed Aluminum Coating - Full Conductivity

CAUTION: DO NOT USE PAINT STRIPPERS ON COMPOSITE STRUCTURES. CHEMICAL PAINT STRIPPERS MAY ATTACK RESIN SYSTEMS:

A. Repair of Damaged Flame-Sprayed Area

(1) Mask off the area surrounding the damage.

CAUTION: DO NOT SAND INTO FIBERS OF UNDERLYING PLIES. DAMAGE TO STRUCTURE WILL OCCUR.

(2) Lightly sand the damaged area with 180 grit or finer abrasive paper to remove any loose flame-sprayed aluminum.

(3) Sand the undamaged aluminum flame-sprayed coating a minumum of 1.0 around the edge of the damage.

WARNING: KEEP SOLVENTS AWAY FROM SOURCES OF HEAT, FIRE, OR SPARKS. HEAT, FIRE, OR SPARKS CAN CAUSE AN EXPLOSION.

AVOID CONTACT OF SOLVENT WITH SKIN, EYES, AND CLOTHING. WEAR EYE PROTECTION AND USE MECHANICAL VENTILATION OR RESPIRATORY PROTECTION WHEN WORKING IN A CONFINED SPACE OR AREA. BREATHING VAPORS OR ALLOWING SOLVENT TO CONTACT SKIN OR EYES IS HAZARDOUS.

(4) Wipe damaged area with a clean cloth moistened with BMS 11-7, MPK High Purity, MEK, MIBK, or acetone to remove any sanding dust or other contamination.

(5) Overspray the damaged area with flame-sprayed aluminum coating to a thickness of 0.010 to 0.012.

  (a) Flame-sprayed coatings are applied using 1/8 diameter pure aluminum wire as given in AMS 4180, and a Metco 8E or 11E gun (Metco, Inc., 1105 Prospect Ave., Westbury, NY 11590) or equivalent.

  See the manufacturer's operating instructions for use of this equipment.

  (b) Spray at a gun-to-work distance of 4.0 minimum to 8.0 maximum. When spraying with MAPP gas, a gun-to-work distance of 10.0 maximum is allowed.

  CAUTION: DO NOT ALLOW THE PART SURFACE TEMPERATURE TO EXCEED 120°F (49°C). BUCKLING, CRACKING, OR LIFTING OF THE FLAME-SPRAYED ALUMINUM COATING MAY OCCUR.

  (c) Use a surface pyrometer to monitor the part surface temperature.

  (d) Apply flame-sprayed aluminum coating evenly with a progressive build-up over the repair area using a traverse rate of 10 to 22 inches per second. Overlap each previous pass by one-third of the spray width.

  (e) Determine the thickness of the flame-sprayed aluminum coating by one or both of the following methods:

    1) Peel oversprayed material from masking tape (outside the designated area). Measure one sample for every 6 inches of flame spray edge or a minimum of two samples.

    2) Measure and record (on the side opposite the surface to be flame sprayed) the thickness of the laminate. After flame spray, re-measure the previous locations and calculate the flame-sprayed coating thickness. Sample the thickness every 6 inches or a minimum of two measurements per part.

(6) Remove masking tape.

(7) Thoroughly mix together equal quantities of EC 1838 Parts A and B. Refer to Figure 2/GENERAL for BMS 8-207 type I class 1 resin type.

NOTE: EC 1838 may be thinned with up to 10 parts lacquer thinner (TT-T-266) per 100 parts catalyzed resin to facilitate coat application.

(8) Carefully apply the resin mix evenly over the the entire oversprayed area.

WARNING: FOR ACCELERATED CURE, USE HEAT CURING EQUIPMENT THAT IS ACCEPTABLE TO LOCAL FIRE AUTHORITIES. FAILURE TO COMPLY COULD CAUSE PERSONNEL INJURY.

(9) Cure the resin sealed surface as given in Figure 2/GENERAL. If a heat lamp is used as a heat source, see Figure 3/GENERAL for heat lamp temperature curve.

(10) Sand the oversprayed area to produce a smooth surface that is flush with the surrounding area. Use 240-grit wet or dry abrasive paper.

(11) Wipe area clean with a clean cheesecloth moistened with BMS 11-7, MPK High Purity, MIBK, MEK, or acetone.

(12) Apply a chemical conversion coating to all exposed flame sprayed surface in the repaired area as detailed in 51-20-01, GENERAL.

(13) Refinish the repaired area as given in Paragraph 16.

B. Replacement of Entire Flame-Sprayed Area on a flat or single contour surface (Alternate Repair).

CAUTION: THE FOLLOWING REPAIR IS ONLY TO BE USED WHEN REPLACING THE ENTIRE FLAME-SPRAYED AREA. NO PATCHING IS ALLOWED USING THIS REPAIR. FAILURE TO COMPLY WILL RESULT IN AN UNACCEPTABLE AND UNAUTHORIZED REPAIR.

(1) Remove all removable fasteners, electrical bonding (dimpled) washers, and static discharger bases, as applicable. Remove static discharger bases as given in AMM 23-61-01. On some panels electrical bonding washers may not be used. In this case, permanent fasteners that provide the electrical bond to the airplane structure (Ref engineering drawing) must be removed.

NOTE: Removal of all other permanent fasteners is optional. However, subsequent removal of these fasteners will require removal and possible repair of flame-sprayed aluminum coating on fastener head if they are not removed prior to this repair.

CAUTION: DO NOT SAND INTO FIBERS OF UNDERLYING PLIES. DAMAGE TO STRUCTURE WILL OCCUR.

(2) Remove all of the existing flame-sprayed aluminum (both damaged and undamaged) from the panel by sanding with 180 grit or finer abrasive paper.

WARNING: KEEP SOLVENTS AWAY FROM SOURCES OF HEAT, FIRE, OR SPARKS. HEAT, FIRE OR SPARKS CAN CAUSE AN EXPLOSION.

AVOID CONTACT OF SOLVENT WITH SKIN, EYES, AND CLOTHING. WEAR EYE PROTECTION AND USE MECHANICAL VENTILATION OR RESPIRATORY PROTECTION WHEN WORKING IN A CONFINED SPACE OR AREA. BREATHING VAPORS OR ALLOWING SOLVENT TO CONTACT SKIN OR EYES IS HAZARDOUS.

(3) Wipe panel surface with a clean cloth moistened with BMS 11-7, MPK High Purity, MEK, MIBK, or acetone to remove any sanding dust or other contamination.

(4) Cut a piece of PVA film larger than the repair area and secure to a smooth, flat surface.

(5) Apply flame-sprayed aluminum coating to PVA film and apply sealer resin. (See Paragraph 9.A.(5) thru (9))

(6) Cut the flame-sprayed PVA film to match the flame-sprayed area on the panel.

(7) Cut a 0.020 aluminum caul plate the same size and shape as the flame-sprayed PVA film.

(8) Apply a coat of BMS 5-92 adhesive to the repair area on the panel.

(9) On graphite panels, apply a glass fabric ply to the repair area as follows:

  (a) Cut a piece of BMS 9-3, Type H-2 or Type H-3 glass fabric larger than the original glass fabric isolation ply.

  (b) Cut two pieces of parting film 3.0 larger all around than the glass fabric.

  (c) Tape down one piece of parting film to a smooth surface.

  (d) Lay glass fabric onto parting film.

  (e) Prepare BMS 5-92 Type I adhesive.

  (f) Spread adhesive evenly over glass fabric.

  (g) Lay second piece of parting film over glass fabric.

  (h) Work adhesive thoroughly and evenly into fabric with a squeegee or roller to impregnate the fabric and to remove entrapped air.

  (i) Work excess adhesive to edges of fabric.

  (j) Cut the impregnated glass fabric to the same size as the original glass fabric isolation ply. The parting film on both sides of the fabric decreases fraying of the edges while cutting the fabric.

CAUTION: ENSURE THAT PARTING FILM IS REMOVED FROM GLASS FABRIC PRIOR TO LAYUP AND CURING. NONCOMPLIANCE WILL RESULT IN A RUINED REPAIR.

  (k) Remove parting film from one side of glass fabric and place exposed face against the repair area.

  (l) Remove wrinkles and entrapped air with a squeegee. Do not apply excessive pressure or repair will be deficient in adhesive.

  (m) Remove second piece of parting film from glass fabric.

(10) Apply a coat of BMS 5-92 Type I adhesive to the exposed aluminum surface of the flame-sprayed PVA film.

(11) Place flame-sprayed PVA film (with PVA film facing out) against the repair area (or on top of glass fabric, as applicable).

(12) Remove wrinkles and entrapped air with a squeegee.

(13) Refer to Figure 4/GENERAL, Detail I for the following layup procedure.

  (a) Place a layer of perforated FEP parting film (1 mil thick) over the repair. Cut the FEP so that the edges extend 3.0 beyond the edge of the repair.

  (b) If using an accelerated cure, secure three thermocouples (spaced evenly around repair) to the panel at the edge of the repair and connect them to the appropriate recorders.

  (c) Place a layer of glass fabric over the perforated FEP as a surface breather. Cut the surface breather so that the edges extend 2.0 beyond the edge of the perforated FEP.

  (d) Secure a vacuum line on the edge of the surface breather.

  (e) Place a layer of solid FEP parting film (2 mil thick) over the surface breather. Cut the solid FEP so that the edges are even with the perforated FEP.

  (f) Place the aluminum caul plate over the solid FEP, (where contour of part permits).

WARNING: FOR ACCELERATED CURE, USE HEAT CURING EQUIPMENT THAT IS ACCEPTABLE TO LOCAL FIRE PROTECTION AUTHORITIES. FAILURE TO COMPLY COULD CAUSE PERSONNEL INJURY.

(g) If a heat blanket is used as a heat source, perform the following steps:

NOTE: A heat blanket, infrared heat lamp, or equivalent heat source may be used to accelerate the cure.

If the repair is made on structure too small to allow the heat blanket to be vacuum bagged, proceed to Paragraph 10./GENERAL B.(13)(h) and place heat blanket over the vacuum bag.

1) Place a heat blanket over the caul plate. The heat blanket must extend 2.0 inches beyond the edge of the repair.

2) Place controlling thermocouple over the center of the heat blanket.

3) Place four to six layers of glass fabric over the heat blanket. The glass fabric will insulate the heat blanket and prevent damage to the bagging film.

(h) Apply extruded sealing compound around the entire repair area, approximately 6.0 outside the edge of the heat blanket.

(i) Lay a piece of vacuum bag material over the entire repair area, sealing the edge with the extruded sealing compound. Pleat the vacuum bag where needed to prevent bridging of bag material and subsequent breakage. Pad all sharp objects and corners to prevent bag breakage. It is optional to vacuum bag the entire part.

NOTE: The entire part must be vacuum bagged and restrained in place to prevent delamination and distortion when the repair area exceeds 15% of panel area. Regardless of the method of heat application, restraining devices that maintain the contour and support the part must be used for large parts where sagging and distortion could occur due to the weight of the part.

(j) Evacuate the space under the vacuum bag and maintain a vacuum of 22 inches of mercury minimum.

(k) Check the vacuum bag for leaks.

(14) Cure repair as given in Figure 2/GENERAL and Figure 5/GENERAL. A heat blanket, infrared heat lamp, or equivalent heat source may be used to accelerate the cure. If a heat lamp is used as a heat source, refer to Figure 3/GENERAL for heat lamp temperature curve. Heat at a maximum of 8°F (5°C) per minute. Determination of the temperature must be made using the thermocouple placed at the edge of the repair. Use the thermocouple with the lowest reading to determine the cure temperature.

NOTE: Cure time does not include the time required for the part to heat up to temperature. Cure time is the period after the part has reached that temperature.

(15) Maintain vacuum of 22 inches of mercury minimum during entire cure cycle.

(16) Remove bagging material.

(17) Remove PVA film from flame-sprayed area.

(18) Reinstall fasteners, electrical bonding (dimpled) washers, and static discharger bases, as applicable. Reinstall static discharger bases as given in AMM 23-61-01.

(19) Check conductivity from base of static discharger to the adjacent surface of the aluminum flame spray. Resistance shall not exceed 0.10 ohms.

(20) Ensure conductivity between washer and adjacent surface. Resistance shall not exceed 0.10 ohms.

(21) Apply a chemical conversion coating as given in 51-20-01, GENERAL to the flame-sprayed aluminum surface.

(22) Refinish the repair area as given in Paragraph 16.

C. Replacement of Entire Flame-Sprayed Area (Second Alternate Repair).

CAUTION: THE FOLLOWING REPAIR IS ONLY TO BE USED WHEN REPLACING THE ENTIRE FLAME-SPRAYED AREA. NO PATCHING IS ALLOWED USING THIS REPAIR. FAILURE TO COMPLY WILL RESULT IN AN UNACCEPTABLE AND UNAUTHORIZED REPAIR.

(1) Perform steps 9.B.(1) thru (3).

(2) Cut a piece of 0.010-0.012 aluminum foil sheet the size of the original flame-sprayed area.

(3) Clean, anodize, and prime all surfaces of aluminum foil sheet as given in 51-70-09.

(4) Apply a coat of BMS 5-92 Type I adhesive to the repair area on the panel.

(5) On graphite panels, apply a glass fabric ply to the repair area as given in Paragraph 10.B.(9)/GENERAL.

(6) Apply a coat of BMS 5-92 Type I adhesive to the faying surface of the aluminum repair sheet.

(7) Place the aluminum foil sheet with adhesive coating against the repair area (or on top of glass fabric, as applicable).

(8) Remove wrinkles and entrapped air with a squeegee.

(9) Refer to Figure 4/GENERAL (Detail II) and as given in Paragraph 10.B./GENERAL(13) (a) thru (e) and (g) thru (k) for layup procedure.

(10) Cure, reinstall fasteners, and finish the repaired aluminum surface by performing steps 9.B.(14) thru (16), (18) thru (20) and (22).

11. Repair of Flame-Sprayed Coatings by Potting

NOTE: Repairs made using the potting process will not restore conductivity and therefore are restricted by the limitations of as given in Paragraph 3./GENERAL.

A. Refer to repair limits in Paragraph 2 prior to undertaking potting repair.

B. Lightly sand the repair area with 240-grit or finer abrasive paper.

NOTE: The area to be repaired by this procedure shall not extend into the glass fabric of the laminate or sandwich structure.

C. Wipe area with clean cloth or gauze moistened with BMS 11-7, MPK High Purity, MIBK, MEK, or acetone to remove any sanding dust or other contamination.

D. Thoroughly mix BMS 5-28 type 3 potting resin as given in Figure 2/GENERAL.

E. Apply the potting resin with a spatula to the areas to be repaired. Apply an excess to allow for shrinkage during cure.

F. Cure the potting resin as given in Figure 2/GENERAL.

G. Sand the potted area with 240-grit or finer abrasive to produce a smooth surface that is flush with the surrounding area.

H. Apply a chemical conversion coating to all exposed flame-sprayed surface in repaired area as detailed in 51-20-01, GENERAL.

I. Refinish the repaired area as given in Paragraph 16.

12. Restoration of Conductivity for Fasteners in Aluminum Flame-Sprayed Panels

NOTE: Repairs made using this method are restricted by the limitations of Paragraph 3./GENERAL.

A. Lightly sand the area with 320-grit abrasive paper.

B. Wipe area with clean cloth or gauze moistened with BMS 11-7, MPK High Purity, MIBK, MEK, or acetone to remove sanding dust and any other contamination.

C. Attach an aluminum foil strap (0.004-0.006 inch thick) connecting the fastener to the cleaned area. Use speed tape to hold the aluminum foil in place. The speed tape should overlap the flame-sprayed coating.

D. With resistance meter, ensure that the conductivity has been restored. Resistance should not exceed 1.0 ohm.

13. Repair of Fastener Holes in Aluminum Flame-Sprayed Panels

NOTE: Repairs made using this method restore full electrical conductivity and continuity to damaged fastener holes.

A. Repair fastener hole according to 51-70-01, GENERAL.

B. Apply flame-sprayed coating according to Paragraph 10.A./GENERAL.

C. Drill and countersink fastener locations from mating airplane structure or from hole transfer template.

D. Apply a chemical conversion coating to the exposed flame-sprayed coating according to 51-20-01, GENERAL.

E. Install dimpled washer and fastener.

NOTE: Captive washers should be installed according to BACW10CC.

F. Apply BMS 10-79, type II or III primer over flame-sprayed coating and fastener.

G. Refinish the repaired area as given in Paragraph 16.

14. Permanent Repair for Aluminum Coated Glass Fabric (BMS 8-278)

A. Mask off the area surrounding the damage with masking tape.

CAUTION: DO NOT SAND INTO FIBERS OF UNDERLYING PLIES. DAMAGE TO STRUCTURE WILL OCCUR.

B. Remove exterior finish from damaged area and 1.0 beyond damage by sanding with 240 grit or finer abrasive paper. Remove damage by sanding with 150 grit or finer abrasive paper.

WARNING: KEEP SOLVENTS AWAY FROM SOURCES OF HEAT, FIRE, OR SPARKS. HEAT, FIRE, OR SPARKS CAN CAUSE AN EXPLOSION.

AVOID CONTACT OF SOLVENT WITH EYES, SKIN, AND CLOTHING. WEAR EYE PROTECTION AND USE MECHANICAL VENTILATION OR RESPIRATORY PROTECTION WHEN WORKING IN A CONFINED SPACE OR AREA. BREATHING VAPORS OR ALLOWING SOLVENT TO CONTACT SKIN OR EYES IS HAZARDOUS.

C. Wipe repair area with a clean cloth moistened with BMS 11-7, MPK High Purity, MEK, MIBK, or acetone to remove any sanding dust or other contamination.

D. Apply flame-sprayed aluminum coating as given in Paragraph 10.A./GENERAL to a thickness of 0.010 to 0.012.

E. Remove masking tape.

F. Mix Resin Mix 1 as given in Figure 2/GENERAL.

G. Apply Resin Mix 1 to repair area.

WARNING: FOR ACCELERATED CURE, USE HEAT CURING EQUIPMENT THAT IS ACCEPTABLE TO LOCAL FIRE PROTECTION AUTHORITIES. FAILURE TO COMPLY COULD CAUSE INJURY TO PERSONNEL.

H. Cure as given in Figure 2/GENERAL. If a heat lamp is used as a heat source, see Figure 3/GENERAL for heat lamp temperature curve.

I. Sand repair area with 240 grit or finer abrasive paper to a smooth surface that is flush with the surrounding area.

J. Apply conductive coating as given in AMM 51-24-02 and Figure 6/GENERAL to repair area and out to fasteners with dimpled washers.

Conductive coating must extend from repair area to fasteners with dimpled washers to ensure proper grounding to airplane structure.

K. Refinish repair area as given in Paragraph 16.

15. Permanent Repair for Aluminum Foil (BMS 8-289)

A. Determine extent of damage.

(1) Use this repair only for damage exclusively to the aluminum foil.

(2) For structural damage extending into underlying plies, repair as given in SRM 51-70-04, SRM 51-70-05, SRM 51-70-07, SRM 51-70-08, or SRM 51-70-17 as applicable.

(3) Refer to Figure 7/GENERAL for the following repair procedure.

B. Preparation for Repair

(1) Mask off the area surrounding the damage with masking tape.

(2) Remove damaged foil by peeling or abrading. Do not damage underlying glass fibers.

(3) Abrade and solvent wipe the primer on the aluminum foil on a 3-inch minimum border around the damaged area.

(4) Remove primer on a 1.0-inch minimum border; abrade and solvent wipe foil surface to water-brake-free condition. Spotty traces of primer covering up to 10% of border area are acceptable.

(5) Abrade and solvent wipe exposed composite surface. Do not damage underlying glass fibers.

C. Permanent Repair of Aluminum Foil (BMS 8-289)

NOTE: This repair is applicable for damage to the aluminum foil only. For damage extending into the structural plies under the foil, refer to SRM 51-70-04, SRM 57-70-05, SRM 51-70-07, SRM 51-70-08 or SRM 51-70-17.

(1) Cut a BMS 8-289 aluminum foil patch the size and shape of the area to be repaired. (BMS 8-289 Type 0/250/x/x/x Form I, where x = optional thickness, alloy, and adhesive thickness.)

(2) Apply Resin Mix 3 as given in Figure 2/GENERAL or EA 956 (BMS 5-128) or EA 9396 to the exposed fiberglass area.

(3) Butt-splice the BMS 8-289 patch, adhesive side down, to the existing foil (no overlap, 0.25 inch max gap). Press down and remove excess resin (squeeze-out) with cheesecloth wetted with BMS 11-7, MPK High Purity, MEK, MIBK, or acetone.

(4) Cut splice strip of BMS 8-289 Type 0/250/x/x/x, Form II preferred, Form I optional. Form II splice strip may be pieced and trimmed to fit the repair area. If Form I splice strip is used, alodine treat nonadhesive side of splice strip and perforate splice strip centerline with 0.5 diameter (nominal) holes 2.0 inches (nominal) on center.

(5) Apply a chemical conversion coating to all aluminum surfaces that will contact splice strip and cover ply.

(6) Place the splice strip, adhesive side up, over the aluminum surface so that it has a minimum 1.0 overlap on each side of the splice line. The outer edge of the splice strip is to be at least 1.0 from the edge of part.

NOTE: Local spots of Resin Mix 3, EA 956 or EA 9396, approximately 0.25 diameter 4.0 spacing may be used, if necessary, on the non-adhesive side of the splice strip to hold it in place. Do not use large amounts of resin for this purpose

Splicing is not allowed on the laminate edge-band faying surface.

(7) Place a cover ply of BMS 9-3 Type D fiberglass impregnated with Resin Mix 3, EA 956 or EA 9396, over the repair so that it overlays the repair, including the splice strip, by 1.0 minimum on all sides.

Impregnate the fiberglass using the procedure described in Paragraph 10.B.(9)/GENERAL.

(8) Apply parting film, breather, heat blanket and vacuum bag given in Paragraph 10.B./GENERAL(13). Cure Resin Mix 3 given in Figure 5/GENERAL. EA 956 and EA 9396 will cure to handling strength in 24 hours minimum at 70-100°F.

Full cure is achieved in 5 days at 70-100°F or can be accelerated to 1 hour at 180 ±10°F. The adhesive on the aluminum foil will sufficiently bond with any of the above cure cycles.

(9) Refinish the repaired area according to Paragraph 16.

16. Repair of Expanded Aluminum Foil (BMS 8-336)

CAUTION: DO NOT USE EXPANDED ALUMINUM FOIL (BMS 8-336) TO REPAIR ELECTRICALLY CRITICAL AREAS. TELL THE BOEING COMPANY IF IT IS NECESSARY TO DO A REPAIR IN AN ELECTRICALLY CRITICAL AREA.

A. Use expanded aluminum foil (BMS 8-336, Type I, Class 1, Grade 016, Form A) to repair expanded aluminum foil, flame spray, or aluminum-coated glass fabric (BMS 8-278) only. Repair of aluminum foil (BMS 8-289) parts with expanded aluminum foil is not permitted.

NOTE: Use new cotton gloves to touch the expanded aluminum foil.

CAUTION: DO NOT ABRADE INTO FIBERS. DAMAGE TO THE STRUCTURE WILL OCCUR.

B. Lightly abrade the damaged area with 180-grit or better abrasive paper. Remove any loose layers.

C. Remove the finish at least 2.00 inches around the edge of the damage. Use 240-grit or better abrasive paper. Do not abrade through the layer that gives protection.

WARNING: KEEP SOLVENTS AWAY FROM SOURCES OF HEAT, FIRE, OR SPARKS. HEAT, FIRE, OR SPARKS CAN CAUSE AN EXPLOSION.

(WARNING PRECEDES)

IT IS DANGEROUS TO BREATHE GASES OF SOLVENTS OR TO LET THE SOLVENT TOUCH YOUR SKIN, EYES, OR CLOTHING. WHEN YOU USE SOLVENTS, DO NOT BREATHE THE GASES. USE MECHANICAL VENTILATION OR RESPIRATORY PROTECTION WHEN YOU WORK IN A CONFINED AREA. DO NOT LET THE SOLVENT TOUCH YOUR SKIN, EYES, OR CLOTHING. WEAR APPROVED GLOVES AND CLOTHING TO GIVE PROTECTION.

D. Rub the surface to be cleaned with a clean cloth that is soaked with BMS 11-7, MPK High Purity, or MEK. Immediately use a clean, dry cloth to dry the area. Do not permit the solvent to dry on the suface.

Frequently change the dirty cloths for clean ones. Do this procedure again.

E. If the expanded aluminum foil is bare, use one of the two procedures that follow:

NOTE: It is recommended to use the anodize procedure.

(1) Anodize the expanded aluminum foil with phosphoric acid. Refer to 51-70-09, GENERAL. Apply a primer to the expanded aluminum foil in less than 72 hours:

(a) Apply a layer of BMS 5-89 primer to the 250°F (121°C) cured parts. Apply the primer to a cured film thickness of 0.00015 to 0.0004 inch. Air dry the primer a minimum of 30 minutes or infrared dry until tack-free at 200°F (93°C) maximum. Cure the primer at 250 ±10°F (121 ±6°C) for 30 to 120 minutes.

NOTE: Primer will appear glossy.

(b) Apply a layer of BMS 5-137 primer to 350°F (177°C) cured parts. Apply the primer to a cured film thickness of 0.00020 to 0.00035 inch. Air dry the primer for a minimum of 30 minutes at 65° to 90°F (18° to 32°C) or infrared dry for 5 to 10 minutes at 200°F (93°C) maximum.

(2) Apply a chemical conversion coating. Refer to 51-20-01, GENERAL.

F. Vapor degrease. Refer to 51-70-10, GENERAL.

G. Apply a chemical conversion coating to all the bare surfaces of the metal. Refer to 51-20-01, GENERAL. Continue with the layup, bagging and curing procedures given in Paragraph 16.H./GENERAL for repairs with prepreg material or Paragraph 16.I./GENERAL for wet layup repairs.

H. Do the repair with prepreg material.

NOTE: You must keep wrinkles, folds, cuts, tears or broken strands in the repair plies to a minimum. Refer to Table 4/GENERALfor the limits and rework instructions before you do this repair.

(1) There are four procedures to apply the expanded aluminum foil as shown in Table 2/GENERALand Figure 8/GENERAL.

Table 2: Ply Data

PROCEDURE	SUBSTRATE	TOOLSIDE PLY	EXPANDED FOIL PLY	ISOLATION PLY
1 (SEE FIG. 9, DETAILS I,II,V AND VI)	250°F (121°C) FIBERGLASS	1 PLY BMS 8-79, STYLE 120 GLASS FIBER (OPTIONAL: STYLE 220) 1 PLY BMS 5-129, GRADE 10 ADHESIVE	1 PLY BMS 8-336, TYPE I, CLASS 1, FORM A, ANODIZED AND PRIMED AS GIVEN IN PAR. 16.E.	NONE REQUIRED
2 (SEE FIG. 9, DETAILS III,IV, VII AND VIII)	250°F (121°C) FIBERGLASS/ CARBON FIBER REINFORCED PLASTIC	1 PLY BMS 8-245, GRADE 5 ADHESIVE	1 PLY BMS 8-336, TYPE I, CLASS 1, FORM A, ANODIZED AND PRIMED AS GIVEN IN PAR. 16.E.	BMS 8-79, STYLE 120 GLASS FIBER
3 (SEE FIG. 9, DETAILS I,II,V AND VI)	350°F (177°C) FIBERGLASS	1 PLY BMS 8-139, STYLE 120 GLASS FIBER (OPTIONAL: STYLE 220) 1 PLY BMS 8-245, GRADE 5 ADHESIVE	1 PLY BMS 8-336, TYPE I, CLASS 1, FORM A, ANODIZED AND PRIMED AS GIVEN IN PAR. 16.E.	NONE REQUIRED
4 (SEE FIG. 9, DETAILS II,IV, VII AND VIII)	350°F (177°C) CARBON FIBER REINFORCED PLASTIC	1 PLY BMS 8-245, GRADE 5 ADHESIVE	1 PLY BMS 8-336, TYPE I, CLASS 1, FORM A, ANODIZED AND PRIMED AS GIVEN IN PAR. 16.E.	BMS 8-139, STYLE 120 GLASS FIBER

(2) Apply the expanded aluminum foil and the necessary overlay and isolation plies with adhesive to the repair area on the panel.

(3) A second ply of expanded aluminum foil can be necessary in the edgeband to make the electrical continuity better. Use one ply of film adhesive, BMS 8-245, Type II, Class 1, Grade 05. This will make the wetting better for the expanded aluminum foil. You can use BMS 5-129, Class A, Grade 5, film adhesive for 250°F (121°C) cure parts with a 250°F (121°C) cure fiberglass overlay. Refer to Figure 9/GENERAL. Butt splice the edgeband expanded aluminum foil a shown in Figure 9/GENERAL, Detail I.

(4) Vacuum compact for at least 1 minute at a minimum of 22 inches of mercury.

(5) Do the layup procedure as given in Paragraph 10.B./GENERAL(13), except use expanded aluminum foil instead of aluminum flame spray.

(6) Do the cure procedure as given in Paragraph 10.B./GENERAL(14) thru 9.B.(16).

(7) Apply a finish to the repair area. Refer to AMM 51-21-00.

I. Do the wet layup repair.

NOTE: You must keep wrinkles, folds, cuts, tears or broken strands in the repair plies to a minimum. Refer to Table 4/GENERALfor the limits and rework instructions before you do this repair.

(1) Do the repair given in as given in Paragraph 16.H./GENERAL except soak the isolation layer given in Table 2/GENERAL with resin. Use BMS 8-301, Class 1 resin.

NOTE: You can add up to 3.5 percent weight of Cab-O-Sil to make the BMS 8-301, Class 1 thicker. Do not impregnate more fabric than can be used in 8 hours.

NOTE: An isolation ply is not necessary on glass fabric reinforced epoxy laminates.

(2) Use the mixed resin to fabric ratios, by weight, shown in Table 3/GENERAL:

Table 3: Resin to Fabric Ratio

MATERIAL	RATIO
Carbon fabric:	1.3 to 1
All other fabric:	1 to 1

(3) Apply a layer of expanded aluminum foil to the repair area on the panel. Soak the layer with resin.

(4) Vacuum compact for at least 1 minute at a minimum of 22 inches of mercury.

(5) Apply an overlay ply, if one is necessary. Soak the layer with resin.

(6) Vacuum compact for at least 1 minute at a minimum of 22 inches of mercury.

(7) Apply an overlay ply, if one is necessary. Use BMS 8-245.

(8) Do the layup procedure given in Paragraph 10.B./GENERAL(13).

(9) Do the cure procedure given in Paragraph 10.B./GENERAL(14) thru 9.B.(16).

(10) Apply a finish to the repair area. Refer to Paragraph 16.

J. Examine the repair that you did in Paragraph 15.H. or Paragraph 15.I. for wrinkles, folds, cuts, tears and broken strands. See Table 4/GENERAL.

Table 4: Allowable Damage Limits

DAMAGE		**ALLOWABLE LIMITS**	**REWORK LIMITS**	**REWORK PROCEDURES**
	LOCATION			
WRINKLES AND FOLDS	THE CENTER OF PART	THE PERMITTED LIMITS ARE LESS THAN 0.10 INCH IN LENGTH. LESS THAN OR EQUAL TO 1.0 INCH WIDE AND NOT LONGER THAN 6.0 INCHES. IT IS NOT PERMITTED TO DO MORE THAN ONE REPAIR IN A 12.0 BY 12.0 INCH AREA	THE AREA TO DO THE REPAIR AGAIN MUST NOT BE LARGER THAN 4.0 BY 8.0 INCHES. IT IS NOT PER- MITTED TO DO MORE THAN ONE REPAIR IN A 12.0 BY 12.0 INCH AREA	1 CUT OUT THE WRINKLE OR FOLD WITH SCISSORS 2 SPLICE IN NEW BMS 3-336 MATERIAL. REFER TO PAR. 16.H. OR PAR. 16.I.
	THE EDGEBAND	NO WRINKLES ARE PERMITTED LESS THAN 1.5 INCHES FROM THE EDGE OF THE PART		
WRINKLES AND FOLDS	AT THE EXPANDED FOIL SPLICE	NOT PERMITTED	THE AREAS TO DO THE REPAIR AGAIN ARE AS FOLLOWS: 1 THE SAME OR LESS THAN 0.5 INCHES IN WIDTH FOR SPLICE WIDTHS THAT ARE 0.5-0.75 INCH 2 THE SAME OR LESS THAN 0.75 INCHES FOR SPLICE WIDTHS 0.75-1.0 INCH 3 THE REPAIR MUST BE LESS THAN 3.0 INCHES IN LENGTH	1 REMOVE THE FOLD AND MAKE THE WRINKLE FLAT 2 IF YOU CANNOT REMOVE THE WRINKLE OR FOLD, CUT AWAY THE BAD MATERIAL

Table 4: Allowable Damage Limits (Continued)

DAMAGE		ALLOWABLE LIMITS	REWORK LIMITS	REWORK PROCEDURES
	LOCATION			
CUTS, TEARS, AND BROKEN STRANDS		LESS THAN OR EQUAL TO 0.5 INCH IN LENGTH IN A SQUARE FOOT AREA	LENGTH NOT MORE THAN 0.5 INCH IN A SQUARE FOOT AREA	SPLICE IN NEW BMS 8-336 MATERIAL. REFER TO PAR. 16.H. OR 16.I.

NOTE: THE MATERIAL THAT YOU REMOVE MUST NOT BE MORE THAN THE WIDTH OF THE SPLICE.

17. Repair of Surface Coatings or Finishes After Repair

A. Lightly sand, with 180-grit or finer abrasive paper, the surface and edge of topmost ply to produce a feather edge.

B. Apply finish to the repaired surface using the following applicable methods.

(1) Where clear Tedlar film surfaces have been removed, seal with Resin Mix 1 (Figure 2/GENERAL). Scrape excess resin off before its gels. Cure for 6 to 8 hours at room temperaure.

NOTE: For underwing fairing panels with high operating temperatures, seal with Resin Mix 2 (Figure 2/GENERAL). Refer to Figure 1/GENERAL for location of these panels.

(2) Where gray or white Tedlar film surfaces have been removed, seal with Resin Mix 1 (Figure 2/GENERAL). Scrape excess resin off before it gels. Cure 6 to 8 hours at room temperature and apply one coat of BMS 10-11 primer and one coat of BMS 10-60 enamel according to AMM 51-21.

NOTE: For underwing fairing panels with high operating temperatures, seal with Resin Mix 2 (Figure 2/GENERAL). See Figure 1/GENERAL for location of these panels.

(3) Where BMS 10-21 conductive coating has been removed, apply coating according to AMM 51-24-02.

(4) Where the abrasion resistant Teflon finish has been removed from the internal surface of the panel edgeband, apply finish according to AMM 51-24-13.

(5) Where the original painted surfaces have been removed, apply finish according to AMM 51-21.

RESIN TYPE	COMPONENTS	PARTS BY WEIGHT	POT LIFE OF MIXTURE	CURING TIME A B
RESIN MIX 1	EPIBOND 156A EPIBOND 156B HARDENER	100 ±2 5 ±0.3	45 TO 60 MINUTES AT 70°F (21°C)	6 TO 8 HOURS AT 70°F (21°C)
RESIN MIX 1 (ALTERNATIVE)	FIBER-RESIN 5318S FIBER-RESIN 5318C	100 ±2 50 ±1	45 TO 60 MINUTES AT 70°F (21°C)	REFER TO FIG. 3
RESIN MIX 1 EPOX-O WELD (ALTERNATIVE)	TWO COMPONENT KIT	FOLLOW MANUFACTURER'S INSTRUCTIONS FURNISHED WITH EACH KIT		
			45 TO 60 MINUTES AT 70°F (21°C)	REFER TO FIG. 3, CHARTS I AND II
RESIN MIX 1 (ALTERNATIVE)	EPIBOND 156A EPIBOND 941 HARDENER	100 ±2 10 ±0.5	45 TO 60 MINUTES AT 70°F (21°C)	REFER TO FIG. 3, CHARTS I AND II
RESIN MIX 2 BMS 8-214, TYPE I	EPOCAST 35A FURANE 927 HARDENER	100 ±2 25 ±0.5	320 MINUTES MINIMUM AT 77°F (25°C)	A. INCREASE THE TEMPERATURE A RATE OF 6 TO 8°F (3 TO 4°C)/MINUTE TO 180 ±10°F (82 ±5°C). KEEP THE TEMPERATURE AT 180 ±10°F (82 ±5°C) FOR A MINIMUM OF 2.5 HOURS. B. INCREASE THE TEMPERATURE A RATE OF 6 TO 8°F (3 TO 4°C)/MINUTE TO 350 ±10°F (177 ±5°C). KEEP THE TEMPERATURE AT 350 ±10°F (177 ±5°C) FOR A MINIMUM OF 1.5 HOURS. C. COOL AT 6 TO 8°F (3 TO 4°C)/MINUTE. WHEN THE PART IS 150°F (66°C) OR LESS, YOU CAN REMOVE IT FROM THE TOOL.
RESIN MIX 2 BMS 8-207 TYPE I, CLASS 2 (ALTERNATIVE)	FIBER RESIN 40 HARDENER 5413C	100 ±1 15 ±0.5	20 MINUTES AT 77 ±2°F (25 ±1°C)	12 HOURS MINIMUM AT 65°F (18°C) MINIMUM OR 1 HOUR MINIMUM AT 160 ±10°F (71 ±5 C)
BMS 8-207, TYPE I, CLASS 1	EC1838A RESIN EC1838B HARDENER	50 ±2 50 ±2	20 MINUTES AT 77 ±2°F (25 ±1°C)	2 HOURS MINIMUM AT 115 ±10°F (46 ±5°C)
BMS 5-28, TYPE 3	EPOCAST 1511A EPOCAST 1511B	100 15	20 MINUTES AT 75°F (24°C)	5 HOURS AT 125 +5°F (52 +2°C)
BMS 5-92, TYPE I AND TYPE III ADHESIVE	TYPE I: EC2216A (GRAY) EC2216B (WHITE)	100 ±2 140 ±2 TYPE III MIX RATIO IS GIVEN ON THE CONTAINER	2 HRS AT 75°F (24°C)	24 HOURS AT 65 TO 100°F (18 TO 38°C). 180 ±10 MINUTES AT 120 ±10°F (49 ±5°C). 130 ±10 MINUTES AT 160 ±10°F (71 ±5°C). 40 ±20 MINUTES AT 250 ±10°F (121 ±5°C). DO NOT SAND OR DRILL THROUGH THE MATERIAL UNTIL IT IS FULLY CURED.

TABLE V

Resin Mix for Repair of Flame-Sprayed Aluminum Coatings, Aluminum Coated Glass Fabric (BMS 8-278), and Aluminum Foil (BMS 8-289)
Figure 2 (Sheet 1 of 2)

RESIN TYPE	COMPONENTS	PARTS BY WEIGHT	POT LIFE OF MIXTURE	CURING TIME [A] [B]
RESIN MIX 3 (LAMINATING RESIN) (BMS 8-301, CLASS 1)	EA 9390A BASE EA 9390B HARDENER	100 ±2 56 ±1	2 HOURS MAXIMUM AT 75°F (24°C)	220 ±5 MINUTES AT 200 ±10°F (93 ±5°C). 150 ±5 MINUTES AT 250 ±10°F (121 ±5°C). RAISE THE TEMPERATURE NO MORE THAN 7°F (4°C)/ MINUTE. START THE CURE CYCLE LESS THAN 8 HOURS AFTER YOU MIX THE RESIN.

TABLE V

NOTES

[A] WHEN YOU USE A HEAT LAMP AS A HEAT SOURCE, REFER TO FIG. 3, CHART II.

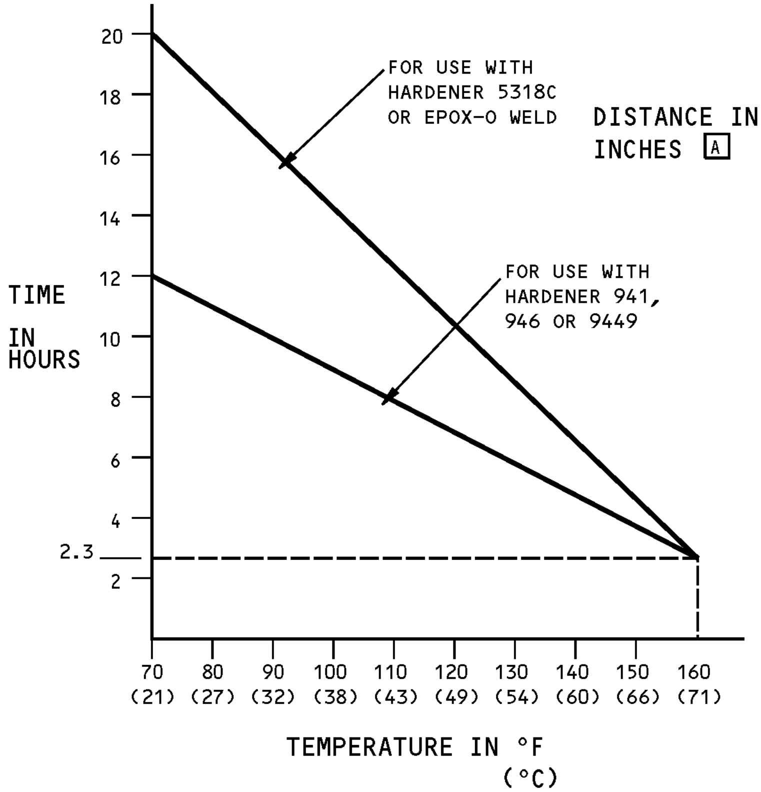
[B] WHEN YOU CURE THE RESIN ABOVE 125°F (57°C), REFER TO FIG. 5.

WARNING: THESE CHEMICALS CONTAIN DANGEROUS MATERIALS. HAVE A GOOD FLOW OF AIR. USE EYE AND SKIN PROTECTION. DO NOT TOUCH THE RESIN THAT HAS NOT CURED OR THE CURING AGENT. PUT RUBBER GLOVES ABOVE COTTON GLOVES FOR PROTECTION OF THE HANDS. IF YOU TOUCH THE RESIN THAT HAS NOT CURED OR THE CURING AGENT, CLEAN THE AREA WITH WARM WATER OR SOAP.

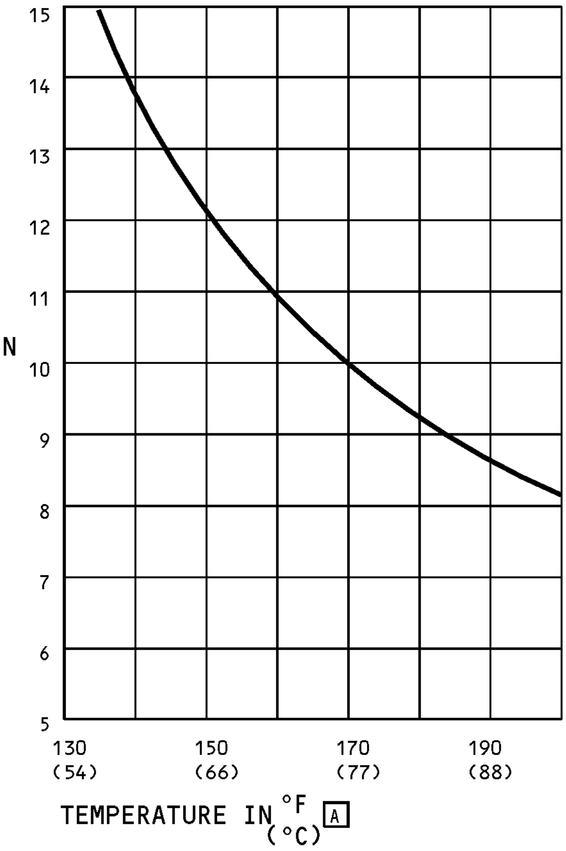
CAUTION: DO NOT USE WAX CONTAINERS TO MIX THE RESIN AND THE CURING AGENT. CONTAMINATION OF THE RESIN WILL OCCUR.

MIXING PROCEDURE	
BMS 8-207 TYPE I, CLASS I RESIN MIX 1 RESIN MIX 3	ADD HARDENER TO RESIN AND MIX FULLY.

Resin Mix for Repair of Flame-Sprayed Aluminum Coatings, Aluminum Coated Glass Fabric (BMS 8-278), and Aluminum Foil (BMS 8-289)
Figure 2 (Sheet 2 of 2)



CURE TIMES FOR ALTERNATIVE
RESIN MIX 1
CHART I



HEAT LAMP CURING
CHART II

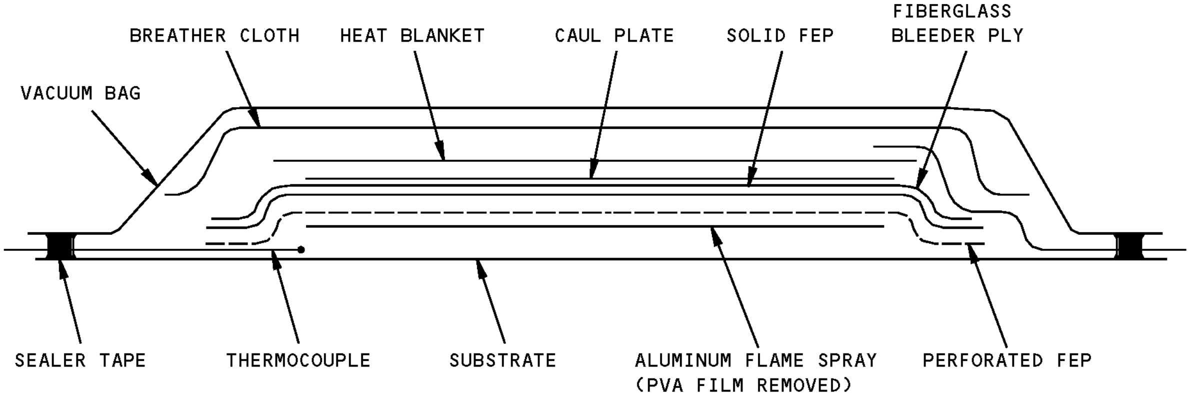
NOTES

- USE THERMOCOUPLES TO MONITOR THE TEMPERATURE.

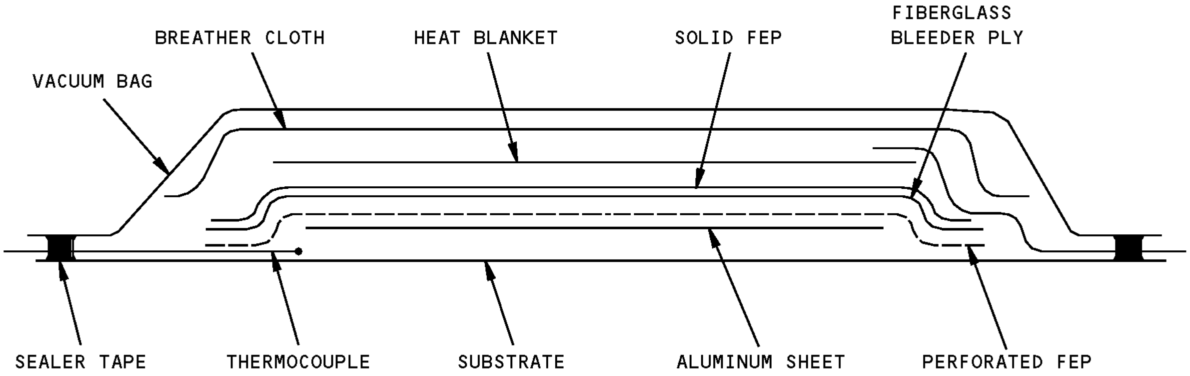
A THIS GRAPH SHOWS THE DISTANCE OF A 250-WATT HEAT LAMP FROM THE SURFACES OF THE PATCH VS. THE TEMPERATURE AT THE SURFACE OF THE PART.

B AFTER THE CURE, ONCE THE PART COOLS TO 100°F (38°C) OR LESS, YOU CAN REMOVE THE TOOL AND BAG MATERIALS. WORK CURE IS THE NECESSARY TIME AND TEMPERATURE TO MAKE THE RESIN SUFFICIENTLY HARD FOR YOU TO SAND OR CUT. AT THIS TIME THE RESIN HAS NOT PERMANENTLY FORMED, BUT IT DOES NOT HAVE FULL PROPERTIES. IF YOU CUT THE MATERIAL BEFORE CURE TIME, YOU WILL DAMAGE YOUR CUTTERS. DO NOT PUT PARTS IN USE UNTIL THEY ARE FULLY CURED.

Potting and Laminating Resin Cure Temperature
Figure 3

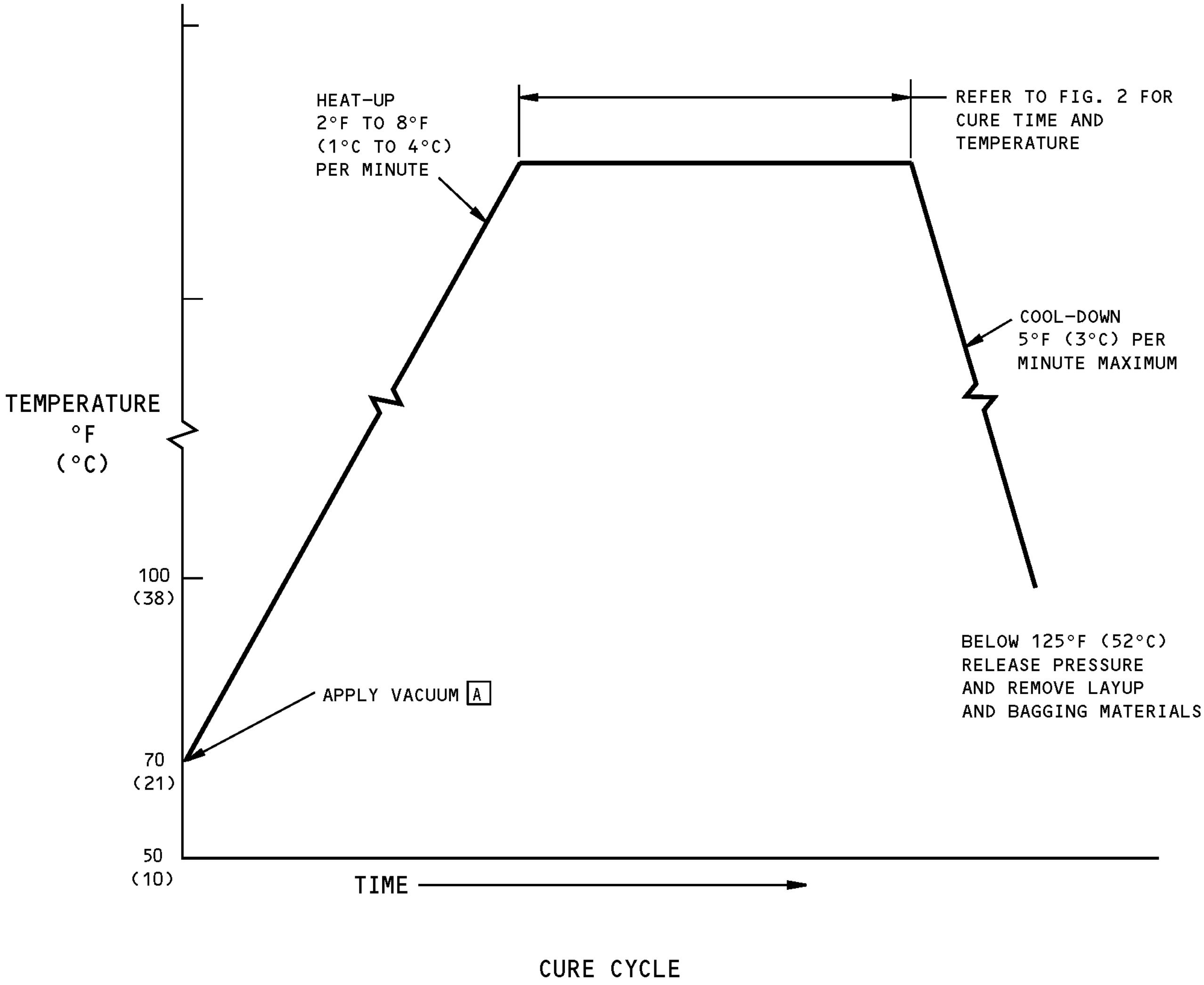


ALTERNATE REPAIR
DETAIL I



SECOND ALTERNATE REPAIR
DETAIL II

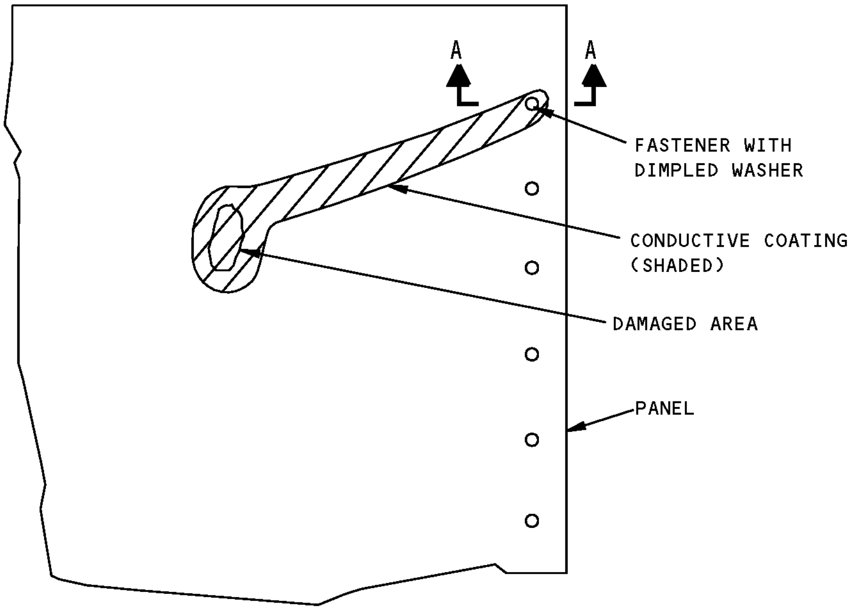
Repair Layup
Figure 4



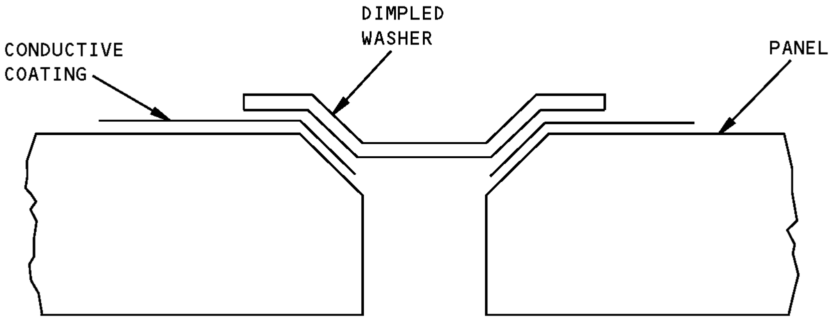
NOTES

A MAINTAIN 22 INCHES MERCURY VACUUM MINIMUM DURING ENTIRE CURE CYCLE

Cure Cycle
Figure 5



VIEW ON PANEL

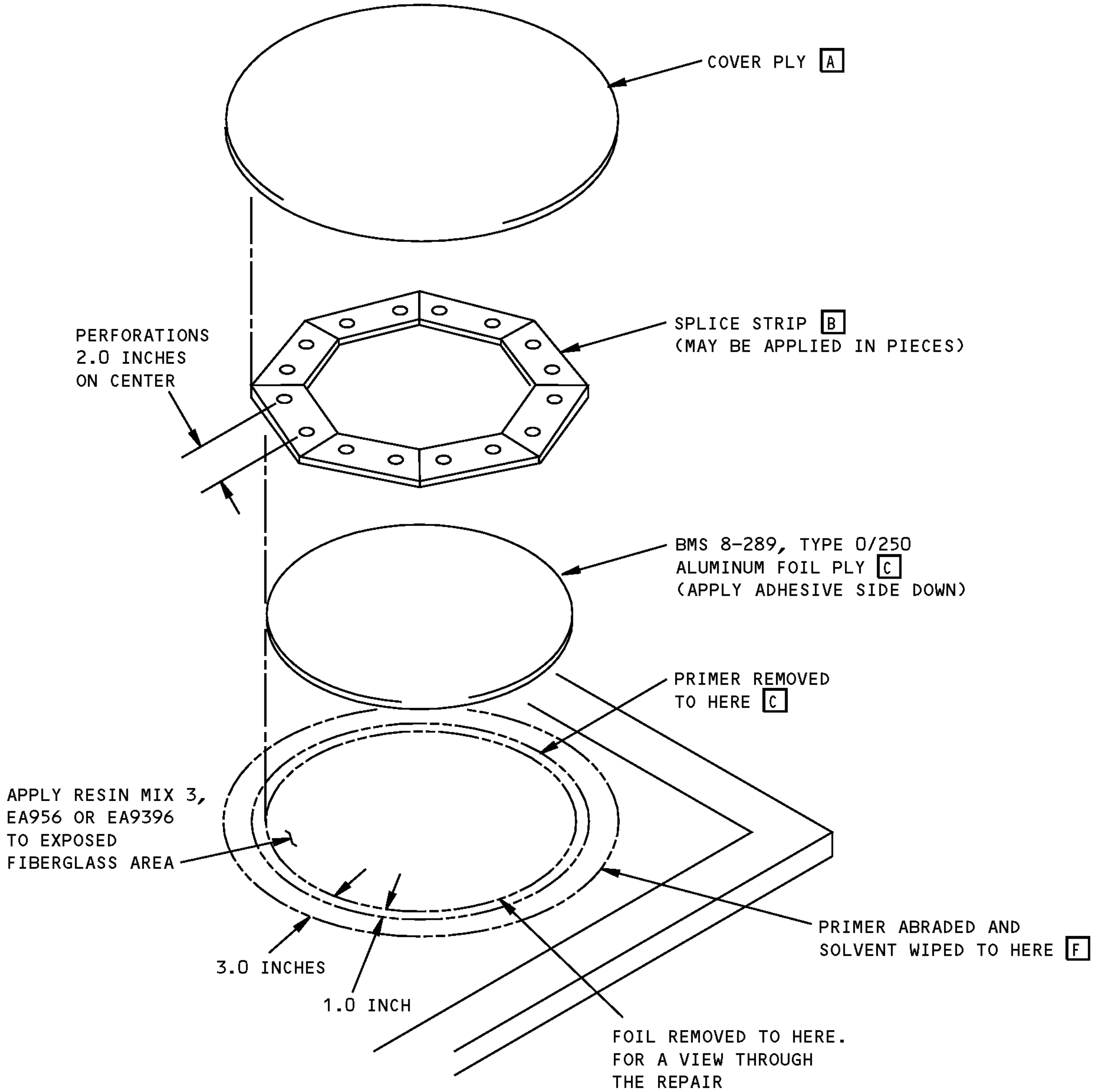


SECTION A-A
(FASTENER NOT SHOWN)

NOTE

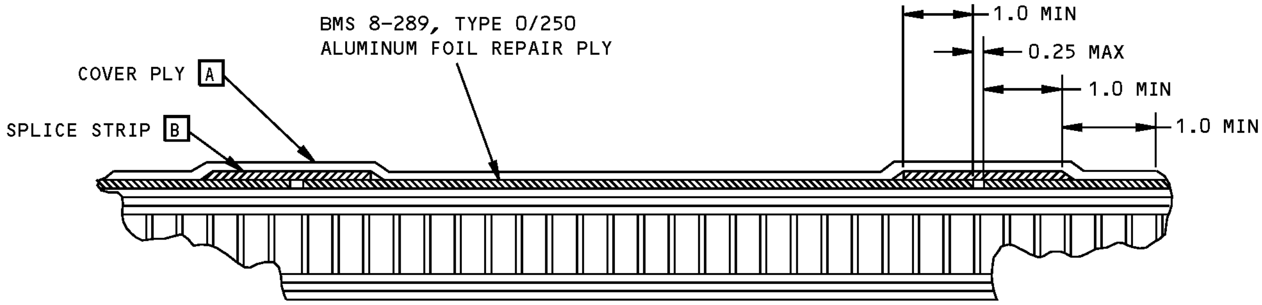
- CONDUCTIVE COATING MUST RUN UNDER DIMPLED WASHER

Application of Conductive Coating to Repairs of Aluminum Coated Glass Fabric (BMS 8-278 Thorstrand)
Figure 6



REPAIR PLY LAYUP
DETAIL I

Aluminum Foil Repair
Figure 7 (Sheet 1 of 2)

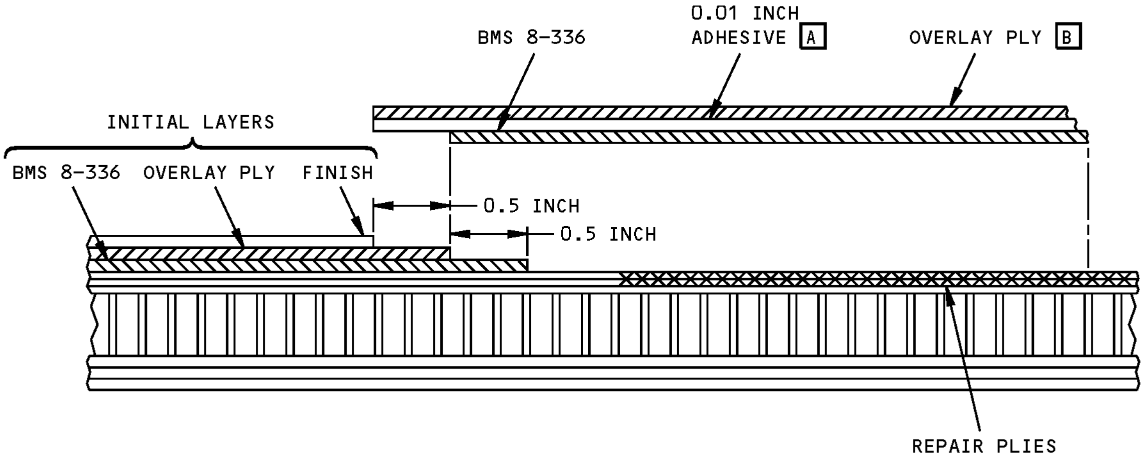


VIEW THRU REPAIR
DETAIL II

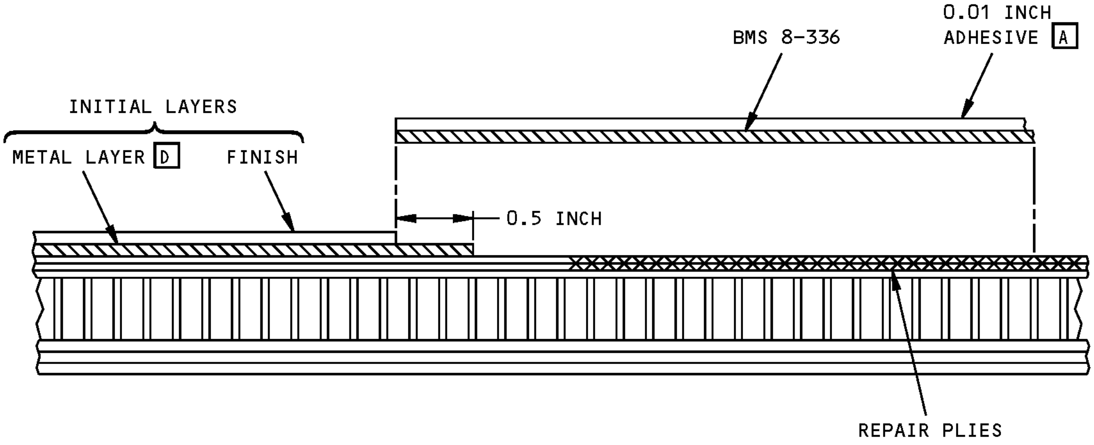
NOTES

- [A] BMS 9-3, TYPE D FIBERGLASS IMPREGNATED WITH RESIN MIX 3, EA956 OR EA9396.
- [B] BMS 8-289, TYPE O/250 WITH THE ADHESIVE SIDE UP. FORM II PREFERRED; FORM I OPTIONAL. IF FORM I IS USED, TREAT NON-ADHESIVE SIDE WITH A CHEMICAL CONVERSION COATING AND PERFORATE CENTERLINE WITH 0.5 INCH DIAMETER HOLES, 2.0 INCHES ON CENTER.
- [C] TREAT THE FOIL SURFACE AREA IN CONTACT WITH THE SPLICE STRIP AND THE COVER PLY WITH A CHEMICAL COATING.

Aluminum Foil Repair
Figure 7 (Sheet 2 of 2)



GLASS FABRIC PARTS, EXPANDED ALUMINUM FOIL,
OVERLAY PLY, PREPREG REPAIR
DETAIL I

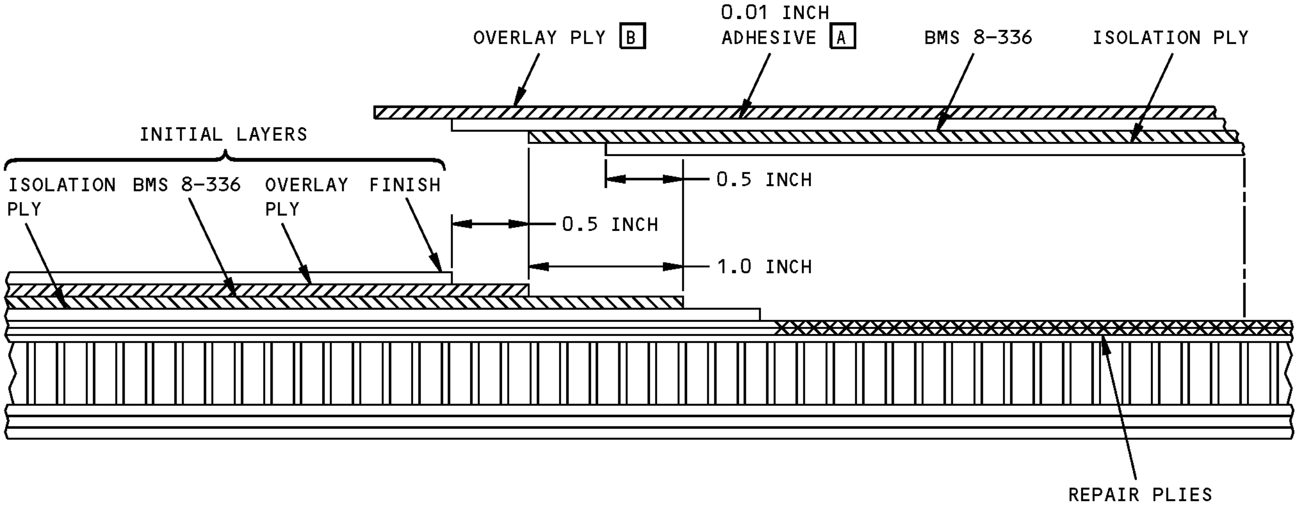


GLASS FABRIC PARTS, METAL LAYER,
NO OVERLAY PLY, PREPREG REPAIR
DETAIL II

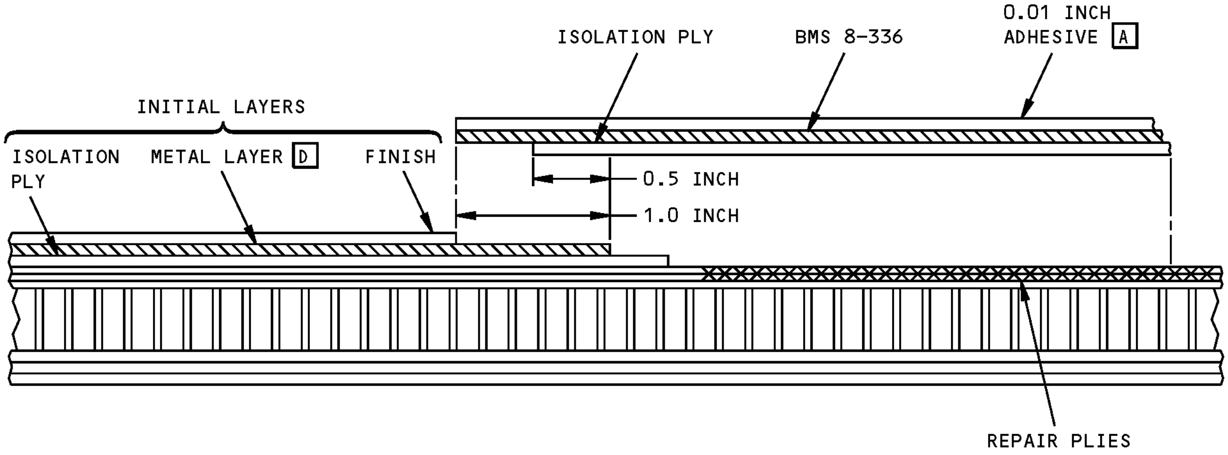
NOTES

- A USE BMS 5-129, GRADE 10 FOR PROCEDURE 1 REPAIRS. USE BMS 8-245, GRADE 5 FOR PROCEDURE 2, 3 AND 4 REPAIRS.
- B USE BMS 8-79, TYPE 120 OR BMS 5-129, GRADE 10 FOR PROCEDURE 1 REPAIRS. USE BMS 8-139, TYPE 120 FOR PROCEDURE 3 REPAIRS. USE BMS 8-245, GRADE 5 FOR PROCEDURE 2 AND 4 REPAIRS. DO NOT EXTEND THE OVERLAY PLY INTO THE EDGEBAND.
- C USE BMS 8-79, STYLE 120 FOR METHOD 2 REPAIRS. USE BMS 8-139, STYLE 120 FOR METHOD 4 REPAIRS.
- D FLAME SPRAY, BMS 8-278, OR BMS 8-336

Apply the Expanded Aluminum Foil
Figure 8 (Sheet 1 of 4)

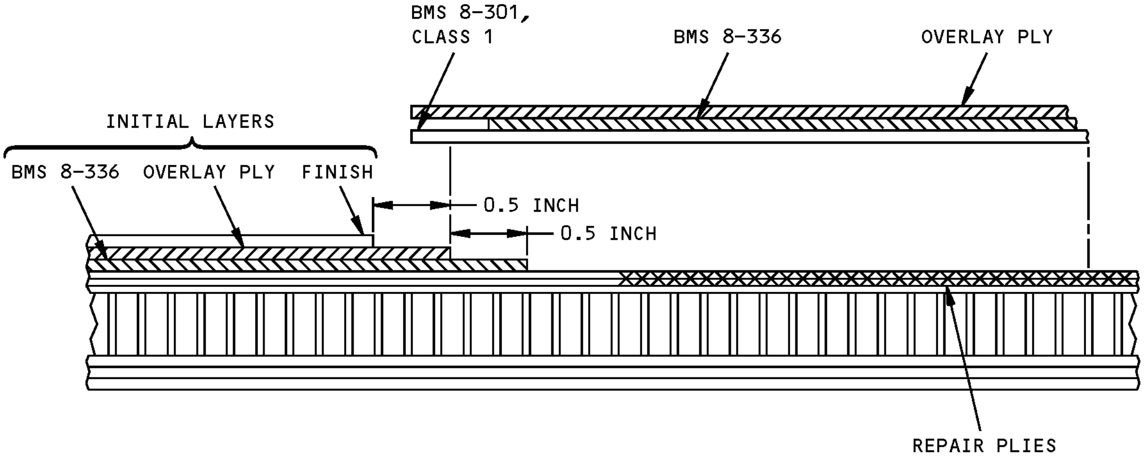


GRAPHITE/ARAMID/HYBRID PARTS, EXPANDED ALUMINUM FOIL, OVERLAY PLY, PREPREG REPAIR
DETAIL III

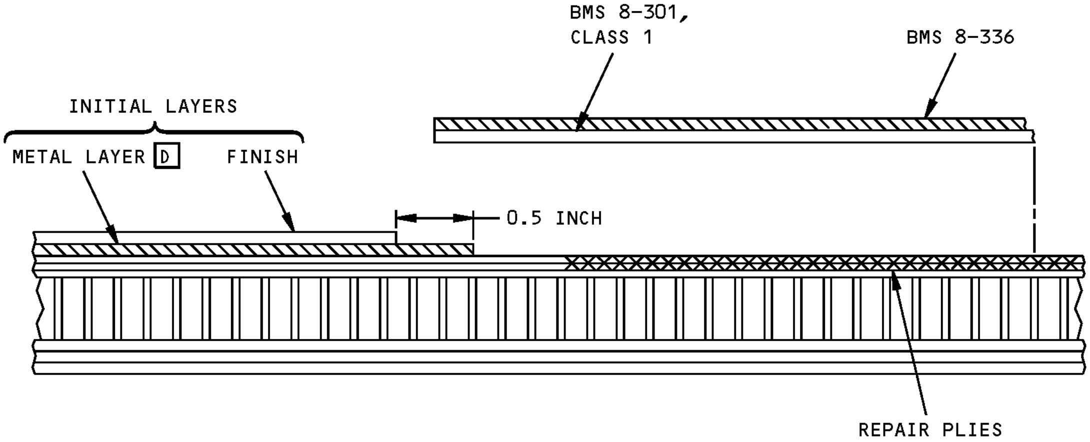


GRAPHITE/ARAMID/HYBRID PARTS, METAL LAYER, NO OVERLAY PLY, PREPREG REPAIR
DETAIL IV

Apply the Expanded Aluminum Foil
Figure 8 (Sheet 2 of 4)

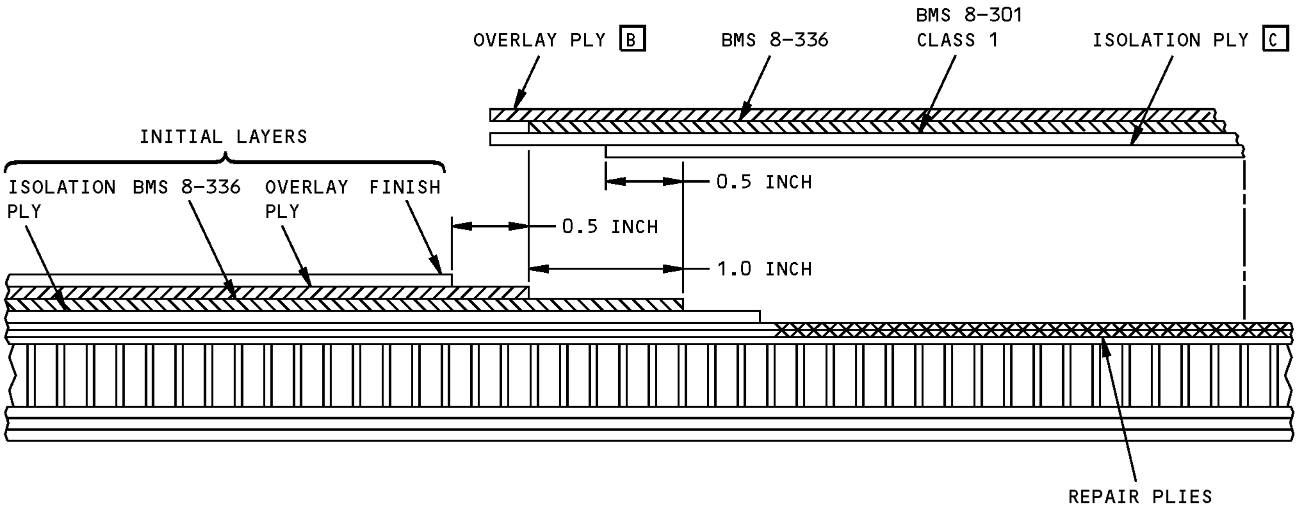


GLASS FABRIC PARTS, EXPANDED ALUMINUM FOIL,
OVERLAY PLY, WET LAY-UP REPAIR
DETAIL V

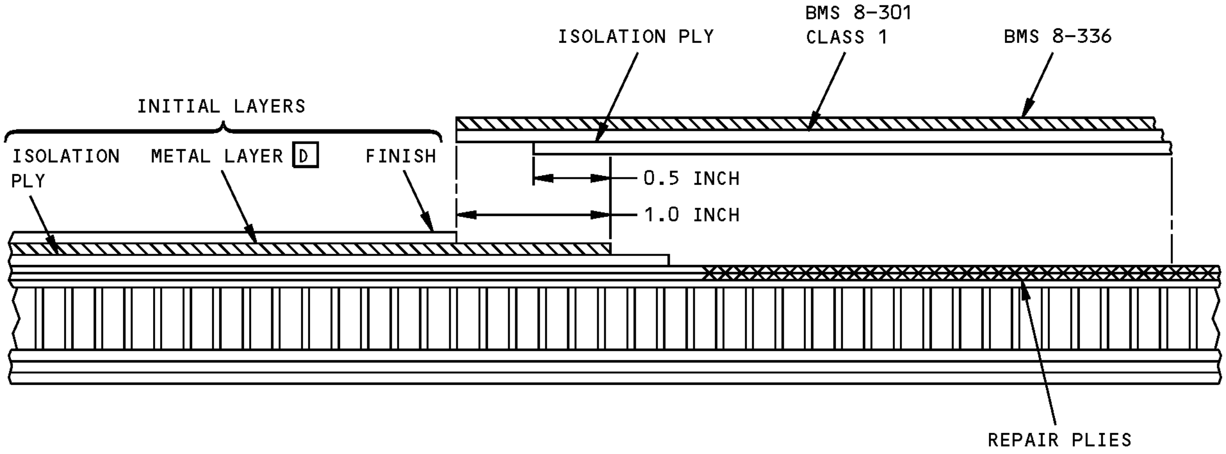


GLASS FABRIC PARTS, METAL LAYER,
NO OVERLAY PLY, WET LAY-UP REPAIR
DETAIL VI

Apply the Expanded Aluminum Foil
Figure 8 (Sheet 3 of 4)

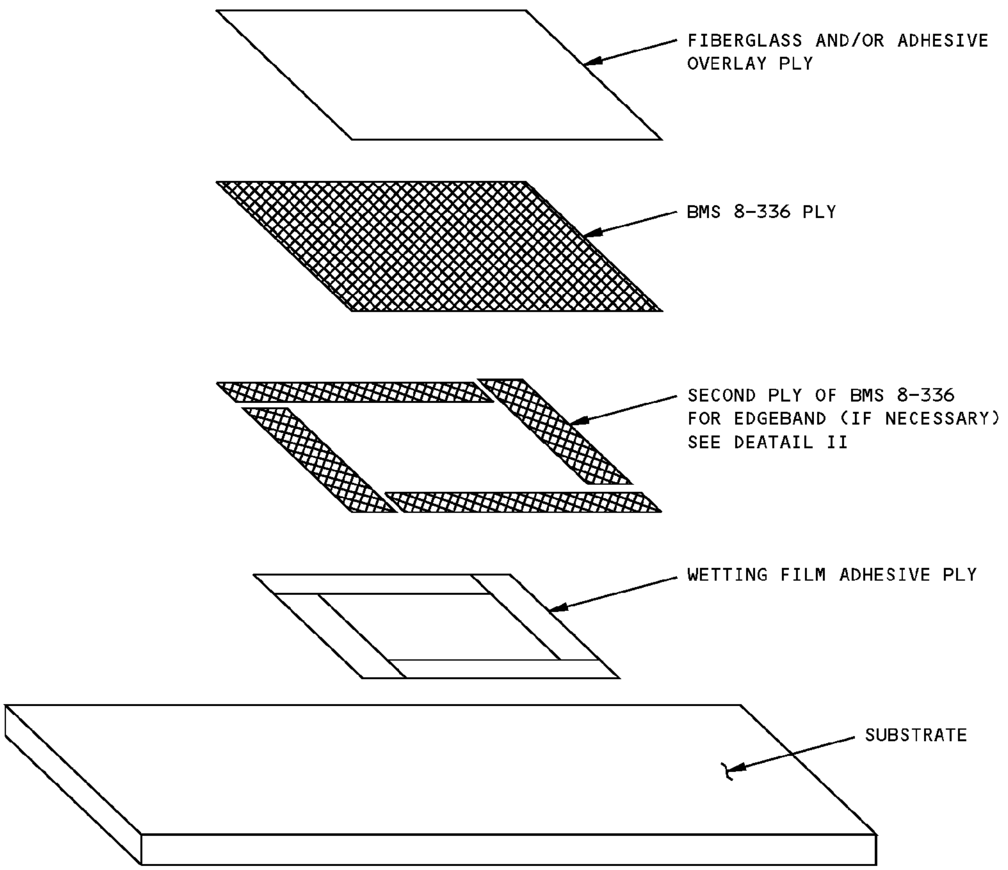


GRAPHITE/ARAMID/HYBRID PARTS, EXPANDED ALUMINUM FOIL,
OVERLAY PLY, WET LAY-UP REPAIR
DETAIL VII

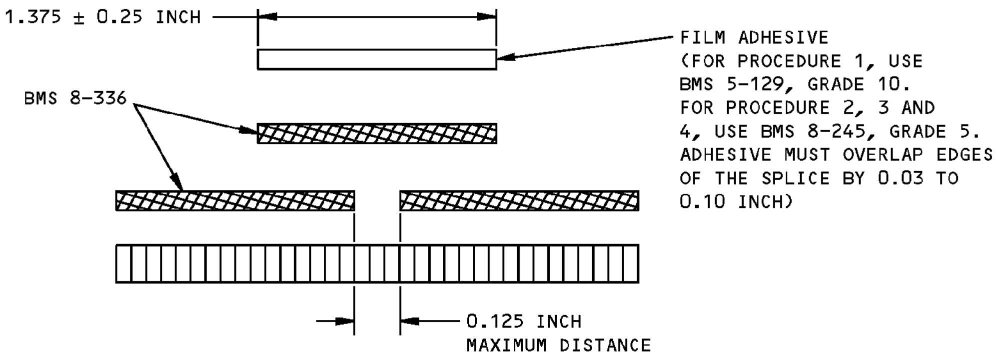


GRAPHITE/ARAMID/HYBRID PARTS, METAL LAYER,
NO OVERLAY PLY, WET LAY-UP REPAIR
DETAIL VIII

Apply the Expanded Aluminum Foil
Figure 8 (Sheet 4 of 4)



BMS 8-36 EDGEBAND APPLICATION
AND OPTIONAL WETTING ADHESIVE PLY
DETAIL I



BUTT SPLICE
DETAIL II

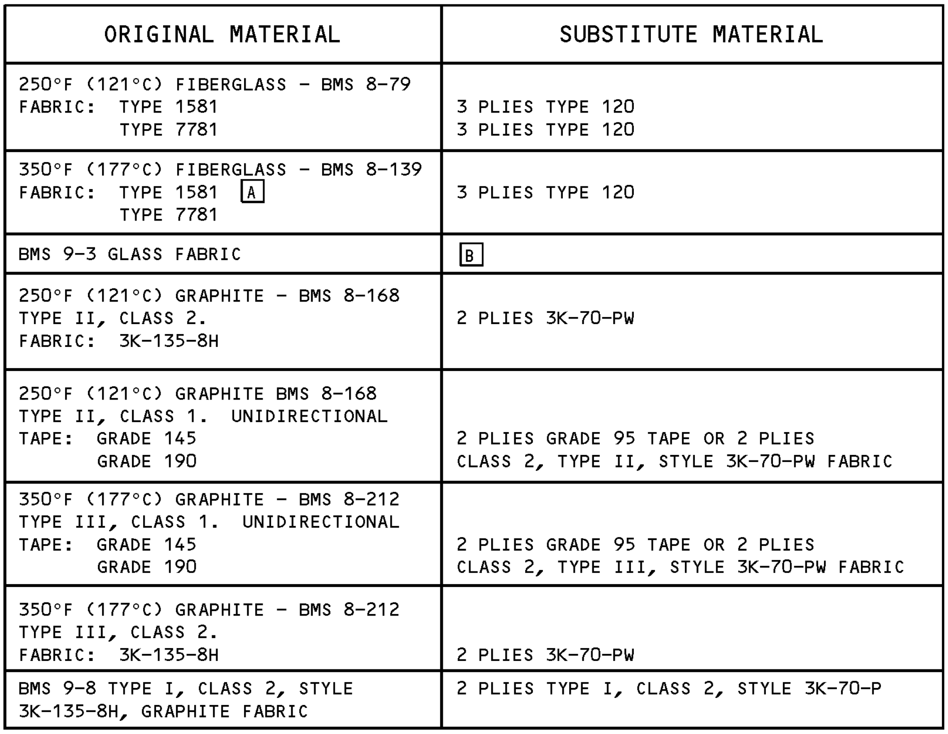
BMS 8-336 Edgeband Application and Optional Wetting Adhesive Ply
Figure 9

GENERAL - COMPOSITE MATERIALS SUBSTITUTION

1. General

A. Fiberglass/Aramid/Graphite Materials The following table shows substitute materials for repairing fiberglass/aramid/graphite materials when the ’as manufactured’ material is not available or not in stock.

B. Nonmetallic Honeycomb Core (BMS 8-124) Substitute nonmetallic honeycomb core with same or higher density nonmetallic core.



ORIGINAL MATERIAL	SUBSTITUTE MATERIAL
250°F (121°C) FIBERGLASS - BMS 8-79 FABRIC: TYPE 1581 TYPE 7781	3 PLIES TYPE 120 3 PLIES TYPE 120
350°F (177°C) FIBERGLASS - BMS 8-139 FABRIC: TYPE 1581 A TYPE 7781	3 PLIES TYPE 120
BMS 9-3 GLASS FABRIC	B
250°F (121°C) GRAPHITE - BMS 8-168 TYPE II, CLASS 2. FABRIC: 3K-135-8H	2 PLIES 3K-70-PW
250°F (121°C) GRAPHITE BMS 8-168 TYPE II, CLASS 1. UNIDIRECTIONAL TAPE: GRADE 145 GRADE 190	2 PLIES GRADE 95 TAPE OR 2 PLIES CLASS 2, TYPE II, STYLE 3K-70-PW FABRIC
350°F (177°C) GRAPHITE - BMS 8-212 TYPE III, CLASS 1. UNIDIRECTIONAL TAPE: GRADE 145 GRADE 190	2 PLIES GRADE 95 TAPE OR 2 PLIES CLASS 2, TYPE III, STYLE 3K-70-PW FABRIC
350°F (177°C) GRAPHITE - BMS 8-212 TYPE III, CLASS 2. FABRIC: 3K-135-8H	2 PLIES 3K-70-PW
BMS 9-8 TYPE I, CLASS 2, STYLE 3K-135-8H, GRAPHITE FABRIC	2 PLIES TYPE I, CLASS 2, STYLE 3K-70-P

COMPOSITE MATERIALS - SUBSTITUTION TABLE

TABLE I

Composite Materials Substitution
Figure 1 (Sheet 1 of 2)

ORIGINAL MATERIAL	SUBSTITUTE MATERIAL
250°F (121°C) ARAMID - BMS 8-219 C FABRIC: STYLE 120 STYLE 285	1 PLY BMS 8-79 TYPE 120 1 PLY BMS 8-79 TYPE 1581 OR 7781 OR 3 PLIES BMS 8-79 TYPE 120
350°F (177°C) ARAMID - BMS 8-218 C FABRIC: STYLE 120 STYLE 285	1 PLY BMS 8-139 TYPE 120 1 PLY BMS 8-139 TYPE 1581 OR 7781 OR 3 PLIES BMS 8-139 TYPE 120
275°F (135°C) FIBERGLASS - BMS 8-169 D FABRIC: TYPE 120	1 PLY BMS 8-79 TYPE 120
275°F (135°C) GRAPHITE - BMS 8-258 D CLASS II FABRIC: 3K-70-PW	1 PLY BMS 8-168 TYPE II, CLASS 2 3K-70-PW

COMPOSITE MATERIALS - SUBSTITUTION TABLE

TABLE I (CONT)

NOTES

A BMS 8-139 TYPE 1581 WAS FORMERLY TYPE 181

B THREE PLIES OF TYPE D GLASS FABRIC CAN BE USED FOR EACH PLY OF TYPE H-2 OR TYPE H-3 REQUIRED

ONE PLY OF TYPE H-3 CAN BE USED FOR EACH PLY OF TYPE H-2 REQUIRED AND VICE VERSA

ONE PLY OF TYPE H-2 OR TYPE H-3 CAN BE USED FOR EVERY TWO PLIES OF TYPE D REQUIRED

C ONE PLY OF BMS 9-3 TYPE D GLASS FABRIC CAN BE USED FOR EACH PLY OF STYLE 120 ARAMID

ONE PLY OF BMS 9-3 TYPE H-2 OR H-3 GLASS FABRIC CAN BE USED FOR EACH PLY OF STYLE 285 ARAMID

D THESE MATERIALS ARE USED ONLY ON NOSE LANDING GEAR DOORS (52-80-02)

Composite Materials Substitution
Figure 1 (Sheet 2 of 2)

GENERAL - HOLE DRILLING AND MACHINING OF COMPOSITE STRUCTURES

1. Applicability

WARNING: DO NOT BREATHE THE CARBON FIBER DUST. MAKE SURE THAT THERE IS A GOOD FLOW OF AIR WHERE YOU DO THE WORK. USE EQUIPMENT TO HELP YOU BREATHE WHEN YOU WORK IN A CONFINED SPACE. USE A VACUUM NEAR THE SOURCE OF THE DUST TO REMOVE THE DUST FROM THE AIR. IF YOU DO NOT OBEY, YOU CAN CAUSE INJURY

CAUTION: DO NOT LET CARBON FIBER DUST TO GO ONTO ELECTRICAL EQUIPMENT. CARBON FIBER DUST IS ELECTRICALLY CONDUCTIVE AND CAN CAUSE SHORT CIRCUITS IF IT GOES INTO ELECTRICAL EQUIPMENT. USE A VACUUM NEAR THE SOURCE OF THE DUST TO REMOVE THE DUST FROM THE AIR. IF YOU DO NOT OBEY, YOU CAN CAUSE DAMAGE TO THE ELECTRICAL EQUIPMENT.

A. This section contains machining information for advanced composite structures. Advanced composites, graphite and especially aramid structures, require special drilling, trimming and countersinking techniques to prevent excessive fiber breakout and/or delamination. Machining information in graphite/aramid-to-aluminum/titanium structures, countersinking in graphite/aramid structures, deburring, and hole quality is also included.

B. Refer to FASTENERS, SECTION/51-40 for general fastener information.

  (1) Refer to Figure 10/GENERAL for fastener hole sizes.

  (2) Refer to 51-40-08, GENERAL for fastener countersink dimensions.

C. The equipment required for drilling and trimming operations are listed in Figure 1/GENERAL.

CAUTION: WEAR APPROVED DUST MASK AND SAFETY GLASSES WHEN DRILLING, REAMING OR COUNTERSINKING COMPOSITE STRUCTURES. USE OF VACUUM PICKUP WHEN DRILLING IS RECOMMENDED.

D. Health and safety precautions should be observed when conducting hole preparation operations contained herein.

2. References

Reference	Title
51-40	FASTENERS
51-40-08, GENERAL	Countersinking

3. Hole Drilling in Graphite or Graphite/Fiberglass Combinations

A. Drill holes using a 4-flute, straight shank, carbide drill (Figure 2/GENERAL, Detail III).

B. The drill operation is best accomplished by placing the drill against the work without rotation, applying a steady, medium force, and then operating the drill motor.

NOTE: Some trial drilling on scrap material is recommended. Slow, cautious feeding will result in chatter of the drill and oversized holes. Excessive feed force may cause ramming of drill into the work.

C. Ensure that the drill is normal to the work surface.

D. Acceptable quality holes can be produced by drilling at the following speeds:

  (1) For material stacks 0.060 and thicker, drill at 18,000-24,000 RPM.

(2) For material stacks less than 0.060 thick drill at 6000 RPM or less.

NOTE: Drills designed for high RPM hole preparation operations in graphite or graphite/ fiberglass structures cannot be effectively and practically used in graphite/metal combination structures at high RPM. However, at 2000-5000 RPM, drills may be used to ream holes through graphite-to-aluminum stacks when the aluminum is 0.100 or less in thickness.

4. Hole Drilling in Graphite-to-Aluminum Structures

A. Use a solid carbide or carbide tipped twist drill with an uncleared pilot. Use a drill speed between 2000 and 5000 RPM.

B. Drill from the graphite side producing a No. 40 pilot hole to reduce fiber breakout.

C. For hole tolerance, drill a 1/32" undersized hole and ream at 600 to 1000 RPM with a piloted carbide straight flute reamer.

D. Use a 4-flute, straight shank, carbide drill, or equivalent, to ream holes in graphite-to-aluminum stacks.

5. Hole Drilling in Graphite-to-Titanium Structures

A. Use drills mentioned for graphite-to-aluminum combinations (Paragraph 4.A./GENERAL).

B. Use a 500 RPM drill motor with no cutting fluid.

C. All holes should be piloted first, drilled and reamed to size.

6. Countersinking in Graphite Structures

A. Use a 3-blade insert cutter or a 2-blade diamond cutter for countersinking (Figure 2/GENERAL, Detail I).

B. Countersink at 500 RPM with carbide cutters and up to 5000 RPM with diamond cutters.

NOTE: Use of a vacuum adapted microstop or the modular suction casing as shown in Figure 3/GENERAL and Figure 4/GENERAL is recommended.

C. For taped surfaces, bond a mask pad onto the vacuum adapted microstop. This pad must be sized as the countersink depth is set (Figure 5/GENERAL).

NOTE: Each fastener size will require a separate microstop and adjustment.

D. Because of wear rate (approximately 50 holes per grind) and fastener head radius, the following techniques must be used:

(1) The countersink depth must be set with a sharp cutter.

(2) The depth should always be set in some scrap material using a fully torqued fastener from the same lot for the definition of countersink depth.

(3) For a large number of flush fasteners, have two sharp countersinks available to begin the work.

(4) After the depth control is established with both cutters, one cutter is used to produce all of the countersinks, and the other is used to follow or clean up any problems caused by the wear of the first tool.

7. Deburring

A. Use a conical abrasive tool (fine grit, closed structure, rubber bond) with a 500 RPM drill unit to remove frayed or delaminated fibers from the entrance and exit of a hole.

8. Hole Quality

A. See Figure 6/GENERAL for hole quality requirements.

9. Hole Drilling in Aramid Structures

A. For full size holes, use a high spiral, 135° split point drill (Figure 2/GENERAL, Detail III) at 5200 RPM in a drill motor mounted with an adapter and drill guide (Figure 1/GENERAL, Table II) to control fiber breakout.

B. The drill operation is best accomplished by placing the drill against the work without rotation, applying a steady, medium force, and then operating the drill motor.

NOTE: Some trial drilling on scrap material is recommended. Improper technique can cause rejectable delamination. Use slow, controlled feed, especially when breaking through the backside of the material.

Pilot holes are not recommended. If pilot holes must be used, drill them at 2000 RPM with a No. 30 HSS high spiral drill. Ream at 500 to 700 RPM with a standard, four straight flute reamer.

C. Ensure that the drill is normal to the work surface.

D. If the adapter and drill guide and high spiral drills are unavailable, use a backup and clamp at hole location to prevent fiber breakout.

10. Rough Trimming Graphite Panels

A. Scribe contour lines on the material to be trimmed with a 0.10 inch excess allowance for final trimming.

B. Rough trimming can be accomplished prior to final trimming by the following methods:

(1) For band sawing, use a diamond abrasive, 40-60 grit cutter or a carbide abrasive, medium grit cutter at 1000-3000 SFM. A backup on the exit side is required to prevent delamination with the unidirectional tape side facing upward. Use of a vacuum pickup is recommended.

(2) For circular sawing, use an 8-10 inch diameter diamond abrasive, 40-60 grit cutter or a carbide abrasive, medium grit cutter at 3000-5000 RPM. Extend the blade height 0.25 inch above the workpiece to control out-of-plane forces from delaminating material plies.

(3) For portable circular sawing, use a 2.0-inch diameter diamond abrasive, 40-60 grit cutter or a carbide abrasive medium grit cutter at 15,000-18,000 RPM. Use of a vacuum is recommended (Figure 7/GENERAL).

(4) For valve stem cutting, see Figure 9/GENERAL.

11. Final Trimming Graphite Panels

A. Limit the radial depth of cut to a quarter of the cutter diameter or 0.06 inch, whichever is less, to eliminate excessive delamination experienced in heavier cuts.

B. Final trimming can be accomplished after rough trimming by the following methods:

(1) For spindle shaping, use a 1 inch diameter x 3/4" cut x 3/4" shank x 4" long diamond abrasive, 40-60 grit cutter at 6000-10,000 RPM or a carbide rotary, single cut cutter at a feed rate of 500-1500 SFM set in a holding fixture. Use of a vacuum pick-up is recommended.

(2) For routing, use a 0.25 inch diamter x 3/4" cut x 2 1/2" long diamond abrasive, 40-60 grit cutter in an 18,000-23,000 RPM air motor, Dotco 10L 2580-01 with rear exhaust or TSI-DFR dualflex router with integral vacuum pick-up, at a speed of 1200-5000 SFM. Optional to use a carbide rotary burr, single cut cutter at a speed of 500-1300 SFM. Use a holding fixture with a 0.06 inch setback. Use of a vacuum pickup is recommended, (see Figure 7/GENERAL).

(3) For trimming graphite panels for fit up, use the air motors mentioned in Paragraph B.(2) and a 1/4 inch x 1 inch cut x 2 inch long carbide rotary file, single cut cutter.

12. Deburring Trimmed Graphite Panels

A. Deburr trimmed graphite panels after final trimming by the following methods:

(1) Deburr with 280/320 (wet or dry) medium grit abrasive cloth or with a Scotchbrite abrasive pad.

NOTE: Fine finishes may require a secondary stroke with a 200 grit garnet cloth.

(2) Use a 2 inch disc sander, 180 grit abrasive in an air motor.

(3) Belt sand with 80 grit bands and file with the direction of the strokes towards the centerline of the material. Use a Dotco 10L1280-32 with a #14-1301 sanding attachment, or equivalent.

13. Hole Drilling in Aramid-to-Aluminum Structures

A. Drill holes in one operation from the aramid side at 6000 RPM. Use a 135° split point, high spiral drill and drill motor mounted with an adapter and drill guide (Figure 1/GENERAL, Table II). Locate holes with a strip template.

NOTE: Hole diameters in aramid laminates are 0.001 to 0.003 less than cutter diameter while the holes in aluminum are 0.001 to 0.003 larger than cutter diameter. Drill to produce the required hole size in aluminum and ream the stack-up, if required, to final size.

B. If required, ream hole at 500 RPM with a standard 4-straight flute reamer to obtain final hole size.

C. Use the following methods for drilling holes in aramid panels previously located by pilot holes in aluminum:

(1) Press the aramid panel firmly against the aluminum substructure and drill hole in one operation from the aluminum side.

(2) Press the aramid panels firmly together so that they remain in contact while drilling. Pilot the aramid panel, then drill to full size from the aramid side.

(3) Ream to full size, if required, at 500 RPM.

14. Hole Drilling in Aramid-to-Titanium Structures

A. Use drills and techniques mentioned for aramid-to-aluminum combinations in Paragraph 9.A./GENERAL except drill and/or ream at 500 RPM or slower with no cutting fluid.

15. Countersinking in Aramid Structures

A. Use 3-blade carbide insert cutters or standard HSS countersink cutters for countersinking in aramid structures.

B. Countersink at 500 to 680 RPM.

C. Use a vacuum adapted microstop or the modular suction casing as shown in Figure 3/GENERAL and Figure 4/GENERAL.

D. For surfaces without fiberglass plies, bond a mask pad onto the vacuum adapter microstop. This pad must be sized as the countersink depth is set (Figure 5/GENERAL).

NOTE: Each fastener size will require a separate microstop and adjustment.

16. Deburring

A. Use carbide wire mesh sandpaper to remove frayed fibers from the entrance and exit of the hole.

NOTE: If outer plies of structure are fiberglass, a conical abrasive tool with a medium grit is recommended to remove fibers and fuzz.

17. Hole Quality

A. See Figure 6/GENERAL for hole quality requirements.

18. Rough Trimming Aramid Panels

A. Scribe contour lines on the material to be trimmed with a 0.10 inch excess allowance for final trimming.

B. Rough trimming aramid panels may be accomplished prior to final trimming by the following methods:

  (1) For band sawing, use a carbon steel cutter with 12-18 teeth per inch at 1500-3000 SFM or a HSS blade, wavy set cutter with 14-18 teeth per inch at 2500-3500 SFM. Use of vacuum pickup is recommended.

  (2) For circular sawing, use a semi-HSS, alternate cutter with 10-14 teeth per inch at 12,000-15,000 RPM and with Boelube 100A lubricant. Use of vacuum pick-up is recommended.

  (3) For saber sawing, use a HSS blade, wavy set cutter (Bosch T-218A or equivalent) with 18-20 teeth per inch at 2500-3500 SPM (strokes per minute) and a Bosch saber saw No. 7598, or equivalent, with Boelube 100A lubricant.

  (4) For valve stem cutting, see Figure 9/GENERAL.

19. Final Trimming Aramid Panels

A. Limit the radial depth of cut to a quarter of the cutter diameter or 0.06 inch, whichever is less, to eliminate excessive delamination experienced in heavier cuts.

B. Final trimming can be accomplished after rough trimming by the following methods:

  (1) For hand (portable) routing, use either a carbide fluted 0° helix cutter, a 70° double helix cutter, or a carbide rotary burr, diamond cut cutter with Boelube 100A lubricant at 15,000-18,000 RPM. Use of vacuum pick-up is recommended.

  (2) For track routing, use a 1/4 inch diameter, 1 inch by 2 1/2 inch long diamond cut cutter in a router, Dotco (rear exhaust) 10L2582-01 or equivalent, at 18,000 RPM and at a feed rate of 16-18 IPM with Boelube 100A lubricant.

  (3) For hand routing with Boeing standard cutter ST1435-D (3/16 inch dia) use a 15,000-18,000 RPM air motor, rear exhaust, DOTCO 10L2582-01, or TS1-DFR dualflex router with integral vacuum system.

  Use Boelube 100A at a feed rate of 10-15 feet per minute. For this cutter use a standard 1/4 inch router guide, provided the routing fixture is set back 3/32 inch (for 3/16 dia cutter).

  (4) For hand routing with Boeing standard cutter ST1435-E (1/4 inch dia) use router, DOTCO 10L4018A-01, with a standard 1/4 router guide (0.062 set back). Use Boelube 100A at a feed rate of 10-15 feet per minute.

  NOTE: Both above cutters leave a burr free edge.

  (5) To final trim aramid panels for fit up, use a 15,000-18,000 RPM hand router with rear exhaust, DOTCO 10L2582-01 - or equivalent, with a 1/4 inch by 1 inch cut by 2 inch long double cut, medium rotary file, or disc sand using any air motor (rear exhaust preferred) use with 2 inch dia 180 grit disc sander.

20. Deburring Trimmed Aramid Panels

A. Deburr trimmed aramid panels after final trimming by the following methods:

  (1) Block sand with 280/320 grit wetted with Boelube 100A lubricant.

  (2) Use a 2 inch diameter 180 grit disc sander with an air motor with rear exhaust.

  (3) Belt sand with a DOTCO 10L1280-32 sander and a DOTCO 14-1301 sanding attachment, or equivalent, with an 80 grit silicon carbide belt. File with the direction of each stroke towards the centerline of the material.

21. Trimming Hybrid Aramid/Graphite Panels

A. For aramid/graphite panels with more than 3 plies of graphite in the panel, use trimming methods mentioned for trimming graphite, except use 20-40 grit and mist spray with Boelube 100A.

B. For aramid/graphite panels with less than 3 plies of graphite in the panel, use trimming methods mentioned for trimming aramid.

22. Treatmrnt Of Fastener Holes in Composite Panels

A. Prime countersinks and holes with BMS 10-11 Type I or BMS 10-79 Type III. BMS 10-79 Type II is optional for graphite panels.

B. For fastener installation procedures and restrictions concerning composite panels, refer to 51-40-02.

DESCRIPTION	SPEED (RPM)	CHUCK SIZE IF APPLICABLE (INCH)	MODEL NUMBER	SUPPLIER
DRILL MOTORS (IN LINE):	330	1/2	41D-108	B
	400	1/2	15DP-4B	O
	500	3/8	6AR3	A
	650	1/4	21D-106	B
	900	1/4	21D-105	B
	900	1/4	15C1490A-38	C
	1000	1/4	3AN1	A
	1000	3/8	31DR-805	B
	2000	3/8	42DR-103	B
	2000	1/4	15C2991-38	C
	3000	1/2	15C2992-53	C
	5000	3/8	15C2993-51	C
	6000	1/4	42DR-101	B
	6000	1/4	7AH1	A
	12000	1/4	15C2982D-38	C
	18000	1/4	41D-100	B
	20000	1/4	7AD1	A
DRILL MOTORS (ANGLE HEAD):	600		15L1281B-32	C
	2100	1/4	21A-624	B
	5000	1/4	31AR-621	B

HOLE PREPARATION EQUIPMENT FOR GRAPHITE AND ARAMID STRUCTURES
TABLE I

Cutting Tools for Composite Panels
Figure 1 (Sheet 1 of 15)

DESCRIPTION	TYPE	SUPPLIER
MISCELLANEOUS:	MICROSTOPS	
	• MAGNAVON NO. 2193 S OR NO. 2140 T	L
	• ZEPHYR NO. ZT330	N
	ADAPTER: NO. 2767 (FITS DOTCO AIR MOTORS), NO. 2852, OR NO. 2072 JACOBS CHUCK QUICK CHANGE CHUCK: NO. 1365A DRILL GUIDE: NO. 2772 (QUICK CHANGE) OR NO. 2044 EXTENSION: NO. 2817 DRILL BUSHING: NO. 2043 DRILL STOP: NO. 2776 DRILL BITS QUICK CHANGE DRILL BITS	
CUTTERS:	DRILLS	
	• ST1257B (SOLID CARBIDE) • ST10-907-H (CARBIDE TIPPED HSS TWIST)	R U V W
	• NO. 30 1-5/16 SCREW MACHINE: NO. EDP04431 • NO. 30 2-3/4 JOBBER: NO. EDP01126 • NO. 40 1-13/16 SCREW MACHINE: NO. EDP04409 • NO. 40 2-3/8 JOBBER: NO. EDP01104 • HSS DRILLS FOR PILOTING	W
	COUNTERSINKS	
	• ST1221C-C • ST10-1223	L M
	• ST1223C-D	X
	REAMERS (WITH 1/32 UNDERSIZE PILOT)	
	• ST1864P (CARBIDE) FOR GRAPHITE OR GRAPHITE WITH ALUMINUM • SINGLE-STEP OR DOUBLE-STEP DESIGN FOR GRAPHITE WITH TITANIUM	R W
	HOLE SAWS	
	• DIAMOND GRIT HOLE SAWS	K M X Y

HOLE PREPARATION EQUIPMENT FOR GRAPHITE STRUCTURES
TABLE II

Cutting Tools for Composite Panels
Figure 1 (Sheet 2 of 15)

DESCRIPTION	TYPE	SUPPLIER
MISCELLANEOUS:	MICROSTOPS • MAGNAVON NO. 2193 S OR NO. 2140 T • ZEPHYR NO. ZT330	L N
	ADAPTER: NO. 2767 (FITS DOTCO AIR MOTORS), NO. 2852, OR NO. 2072 JACOBS CHUCK QUICK CHANGE CHUCK: NO. 1365A DRILL GUIDE: NO. 2772 (QUICK CHANGE) OR NO. 2044 EXTENSION: NO. 2817 DRILL BUSHING: NO. 2043 DRILL STOP: NO. 2776 DRILL BITS QUICK CHANGE DRILL BITS	G
CUTTERS:	DRILLS • HSS TWIST DOUBLE-MARGIN STEP DRILL • BW 840 KLENK DRILL	U V W
	COUNTERSINKS • ST10-1223	L M
	REAMERS • B1-3079 (STRAIGHT, HSS) • B1-3085 (PILOT, HSS) • SINGLE-STEP OR DOUBLE-STEP DESIGN FOR ARAMID WITH TITANIUM	Q W
	HOLE SAWS • HSS OR CARBIDE INSERT HOLE SAWS, WITH 30° POSITIVE FACE AND 30° POSITIVE CLEARANCE CUTTING ANGLES	K M X Y

HOLE PREPARATION EQUIPMENT FOR ARAMID STRUCTURES
TABLE III

**Cutting Tools for Composite Panels
Figure 1 (Sheet 3 of 15)**

DESCRIPTION	TYPE	SUPPLIER
DRILL MOTORS:	6000-10,000 RPM DRILL UNIT	K
	15,000-18,000 RPM DRILL UNIT DOTCO NO. 10L2580C-01 18,000-23,000 RPM DRILL UNIT DOTCO NO. 10L2580C-01	C
ROUTERS:	15,000-25,000 RPM, DUALFLEX TSI-DFR WITH INTEGRAL VACUUM SYSTEM ACCESSORY - OPTIONAL	K
	DOTCO 10L2502C-01 HAND ROUTER 18,000 RPM DOTCO 10L2500C-01 23,000 RPM	C
SAWS:	BAND SAW - 1000-3000 SFM 2500-3500 SFM	K M Y
	CIRCULAR SAW - 3000-5000 RPM	K M Y
	PORTABLE CIRCULAR SAW - 12,000 RPM, DOTCO 10L1280-32 H OR 18,000 RPM, DOTCO 10L1281-32 I	C
	SABER SAW - 2500-3500 SFM BOSCH MODEL NO. 7598	D
CUTTERS:	DIAMOND ABRASIVE CUTTER, 40-60 GRIT 8-10 INCH DIA 2 INCH DIA 1 INCH DIA X 3/4 INCH CUT X 3/4 SHANK X 4 INCHES LONG 1/4 INCH DIA X 3/4 INCH CUT X 2-1/2 INCH LONG DIAMOND CUT, ROTARY BURR CUTTER (NO. SA-1A-8) 1/4 INCH DIA X 1 INCH CUT X 2-1/2 INCH LONG ROTARY FILE, DOUBLE CUT, MEDIUM CUTTER (NO. SA-1A-4) 1/4 INCH DIA X 1 INCH CUT X 2-1/2 INCH LONG CARBIDE ABRASIVE, MEDIUM GRIT CARBIDE, ROTARY FILE, SINGLE CUT (NO. SA-1A-1) 1/4 INCH DIA X 1 INCH CUT X 2 INCH LONG HSS BLADE, WAVY SET 14-18 TPI	M
	HSS BLADE, 18-20 TPI, BOSCH (NO. T-218A)	D
	ST1435-E TWO FLUTE CUTTER	E Y AU
ABRASIVES:	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	K M Y Z
LUBRICANTS:	BOELUBE 100A	F
MISCELLANEOUS:	SANDER WITH SANDER ATTACHMENT DOTCO NO. 10L1280-32 (SANDER) DOTCO NO. 14-1301 (1/2 INCH WIDE SANDER ATTACHMENT)	C

TRIMMING EQUIPMENT FOR COMPOSITE STRUCTURES
TABLE IV

Cutting Tools for Composite Panels
Figure 1 (Sheet 4 of 15)

PROPERTIES	MATERIAL			
	FIBERGLASS	GRAPHITE-EPOXY	ARAMID	HYBRID
CUTTING CHARACTERISTICS	RESIDUE IN POWDER FORM	VERY SIMILAR TO FIBERGLASS	NOT SIMILAR TO FIBERGLASS	VERY DIFFICULT TO DRILL
HOLE GENERATION	NO PROBLEM EXCEPT THAT RESIDUE MAY CAUSE SKIN IRRITATION IN SOME PEOPLE	NO PROBLEM IN CLOTH LAMINATES BREAKOUT IS A SIGNIFICANT PROBLEM IN TAPE	SIGNIFICANT PROBLEM (FUZZING, SHREDDING, BREAKOUT, DELAMINATION ARE MAJOR PROBLEMS)	PROBLEMS OCCUR EXCEPT WITH A KLENK DRY BW840
CUTTER MATERIAL	HSS OR CARBIDE	CARBIDE	HSS OR CARBIDE	HSS OR CARBIDE
CUTTER SPEED	HIGH SPEEDS ARE DESIRABLE	HIGH SPEEDS ARE DESIRABLE	TENDENCY TO HEAT UP AND CHATTER AT HIGH SPEEDS	6200 OPTIMUM SPEED
SELF FEEDING	-----	-----	TENDENCY TO SELF-FEED WITH TWIST DRILLS	-----

COMPARATIVE HOLE PREPARATION PROPERTIES
TABLE V

Cutting Tools for Composite Panels
Figure 1 (Sheet 5 of 15)

MATERIAL	FIBERGLASS LAMINATES			GRAPHITE-EPOXY $\boxed{\text{AC}}$		
DRILL TYPE $\boxed{\text{AF}}$	1. ST 10-907-H $\boxed{\text{AD}}$ 2. ST 1257B $\boxed{\text{AE}}$			1. ST 10-907-H 2. ST 1257B		
CUTTER LIFE (HOLES)	50-100			50-100		
DRILL SIZE (INCH)	MAX RPM (DRY)	MAX RPM (WET)	FEED (IPR)	MAX RPM (DRY) $\boxed{\text{AA}}$	MAX RPM (WET) $\boxed{\text{AA}}$	FEED (IPR) $\boxed{\text{AB}}$
1/16 - NO. 40	6000	6000	0.005	6000	6000	0.002
0.09	6000	6000	0.005	6000	6000	0.002
0.12	6000	6000	0.005	6000	6000	0.002
5/32 - NO. 30	6000	6000	0.005	6000	6000	0.002
0.18	6000	6000	0.005	6000	6000	0.002
7/32	6000	6000	0.005	6000	6000	0.002
1/4	6000	6000	0.005	6000	6000	0.002
0.31	5000	6000	0.005	6000	6000	0.002
3/8	5000	6000	0.005	6000	5000	0.002
1/2	3000	5000	0.005	5000	3000	0.002
5/8	3000	3000	0.005	3000	3000	0.002
3/4	2000	3000	0.005	3000	2000	0.002
1	1000	3000	0.005	3000	1000	0.002

MATERIAL/RPM DRILLING FIBERGLASS AND GRAPHITE
TABLE VI

Cutting Tools for Composite Panels
Figure 1 (Sheet 6 of 15)

MATERIAL	GRAPHITE-EPOXY AND ALUMINUM STACK [AC]		
DRILL TYPE	ST10-907-H [AD]		
CUTTER LIFE (HOLES)	50-100		
DRILL SIZE (INCH)	MAXIMUM RPM (DRY)	MAXIMUM RPM (WET) [AG]	FEED (IPR) [AH]
1/16 - NO. 40	6000		0.002
0.09	6000		0.002
0.12	5000		0.002
5/32 - NO. 30	5000		0.002
0.18	3000		0.002
7/32	3000		0.003
1/4	3000		0.004
0.31	3000		0.004
3/8	2000		0.004
1/2	1500		0.006
5/8	1250		0.006
3/4	1000		0.008
1	750		0.008

MATERIAL/RPM - DRILLING GRAPHITE AND ALUMINUM
TABLE VII

Cutting Tools for Composite Panels
Figure 1 (Sheet 7 of 15)

MATERIAL	GRAPHITE-EPOXY AND TITANIUM STACK AC		
DRILL TYPE	1. ST10-907-H AK 2. ST7096-BG AL AN		
DRILL SIZE	MAXIMUM RPM (DRY)	MAXIMUM RPM (WET)	FEED (IPR) AM
1/16 - NO. 40	850	1275	0.001
0.09		1200	0.001
0.12		800	0.001
5/32 - NO. 30	500	750	0.001
0.18		600	0.002
7/32	375	550	0.002
1/4	300	450	0.002
0.31		300	0.004
3/8	200	300	0.004
1/2	150	225	0.004
5/8	125	190	0.004
3/4	100	150	0.006
1	75	110	0.006

MATERIAL/RPM - DRILLING GRAPHITE AND TITANIUM
TABLE VIII

Cutting Tools for Composite Panels
Figure 1 (Sheet 8 of 15)

APPROXIMATE DRILL DIAMETER (INCH)	MAXIMUM STACK THICKNESS (INCH)	DRILL TYPE AI	MAXIMUM SPEED (RPM)	FEED (IPR) AJ
1/16	0.25	HSS	2000	0.002
0.12 - NO. 31	0.25	HSS TWIST - DOUBLE-MARGIN OR BW 840 KLENK DRILL (PREFERRED)	6000	0.002
0.18 - NO. 15	0.375		6000	0.002
1/4	0.375		6000	0.002
5/16	0.375		6000	0.002
3/8	0.375		6000	0.002

MATERIAL/RPM - DRILLING ARAMID STRUCTURES
TABLE IX

Cutting Tools for Composite Panels
Figure 1 (Sheet 9 of 15)

APPROXIMATE DRILL DIAMETER (INCH)	MAXIMUM STACK THICKNESS (INCH)	DRILL TYPE AI	MAXIMUM SPEED (RPM)	FEED (IPR) AJ
1/16	0.25	HSS - TWIST	4500	0.002
0.12 - NO. 31	0.25	HSS - TWIST - DOUBLE-MARGIN, STEP	3000	0.002
0.18 - NO. 15	0.375		2000	0.002
1/4	0.375		1500	0.003
5/16	0.375		1200	0.004
3/8	0.375		1000	0.004

MATERIAL/RPM - DRILLING ARAMID AND ALUMINUM
TABLE X

Cutting Tools for Composite Panels
Figure 1 (Sheet 10 of 15)

APPROXIMATE DRILL DIAMETER (INCH)	MAXIMUM STACK THICKNESS (INCH)	DRILL TYPE AI	MAXIMUM SPEED (RPM)	FEED (IPR) AJ
1/16	0.25	HSS - TWIST	1200	0.002
0.12 - NO. 31	0.25	HSS - TWIST - DOUBLE-MARGIN, STEP	750	0.002
0.18 - NO. 15	0.375		500	0.002
1/4	0.375		375	0.003
5/16	0.375		300	0.004
3/8	0.375		250	0.004

MATERIAL/RPM - DRILLING ARAMID AND TITANIUM
TABLE XI

Cutting Tools for Composite Panels
Figure 1 (Sheet 11 of 15)

ARAMID	SAW BLADE	
	TYPE	SPEED (SFM)
STRUCTURAL	1. HSS ALTERNATE SET 14-17 TEETH/INCH 2. HARD-BACK 14-17 TEETH/INCH	4000 TO 7000
NON-STRUCTURAL	SANDVIK FLEX-BACK 14-17 TEETH/ INCH 1/2 INCH WIDE	4000 TO 7000

SAW BLADES FOR USE IN ROUGH TRIMMING OF ARAMID STRUCTURES
TABLE XII

Cutting Tools for Composite Panels
Figure 1 (Sheet 12 of 15)

REAMER SIZE (INCH) AT	GRAPHITE OR ARAMID			WITH ALUMINUM			WITH TITANIUM		
	SPEED (RPM) AO	FEED (IPR) AP	REAMER TYPE	SPEED (RPM) AO	FEED (IPR) AP	REAMER TYPE	SPEED (RPM) AO	FEED (IPR) AP	REAMER TYPE
1/8	2000	0.002	AQ AR	800	0.003	AQ AR	500	0.002	AS
3/16	2000	0.002		800	0.003		400	0.002	
1/4	1500	0.002		700	0.004		300	0.004	
3/8	1500	0.002		700	0.006		200	0.006	
1/2	1000	0.002		600	0.006		130	0.006	
5/8	1000	0.002		600	0.008		100	0.008	

REAMING COMPOSITES AND COMPOSITES WITH METAL
TABLE XIII

Cutting Tools for Composite Panels
Figure 1 (Sheet 13 of 15)

NOTES

A INGERSOLL-RAND COMPANY
POWER TOOL DIVISION
P.O. BOX 1776
LIBERTY CORNER, NJ 07938

B DELTA INTERNATIONAL
POWER TOOL DIVISION
4290 RAINES ROAD
MEMPHIS, TENNESEE 38118
OR
ROCKWELL INDUSTRIAL TOOLS
US HWY #1 NORTH
P.O. BOX 1765
COLUMBIA, SC 29202
OR
E.A. SELZER & ASSOCIATES
15086 N.E. 40TH ST.
REDMOND, WA 98052

C DOTCO/COOPER AIR TOOLS
RT 18E
P.O. BOX 182
HICKSVILLE, OH 43526
OR
L, P

D ROBERT BOSCH CORP.
2800 - S. 25TH AVE.
BROADVIEW, IL 60153

E ULTRA-TOOL INTERNATIONAL, INC.
5451 McFADDON AVENUE
HUNTINGTON BEACH, CA 92649

F THE ORELUBE CORPORATION
201 EAST BETHPAGE ROAD
PLAINVIEW, NY 11803

G MAGNAVON INDUSTRIES, INC.
4320 EAST LA PALMA AVENUE
ANAHEIM, CA 92807-1806

H FOR TRIMMING ARAMID

I FOR TRIMMING GRAPHITE

J DELETED

K ANY SOURCE

L PACIFIC DISTRIBUTING, INC.
7118 BEACON AVE. SOUTH
SEATTLE, WA 98108

M ARONSON INDUSTRIAL SUPPLY
P.O. BOX 80987
5300 DENVER AVE. SOUTH
SEATTLE, WA 98108

N ZEPHYR
981 INDUSTRY ROAD
SUITE NO. 31
SEATTLE, WA 98118

O DRESSER INDUSTRIES
INDUSTRIAL TOOL DIVISION
1136 INDUSTRY DR.
SEATTLE, WA 98188

P COOPER INDUSTRIES
7500 212TH S.W., SUITE #205
EDMONDS, WA 98020

Q ALVORD-POLK
P.O. BOX 97
MILLERSBURG, PA 17061

R CLARK & CLARK
P.O. BOX 17449
TUCSON, AZ 85731

S FOR COUNTERSINKING ON STRUCTURE ONLY

T FOR COUNTERSINKING ON EXTERIOR SKINS

U PRECISION TWIST DRILL
ONE PRECISION PLAZA
CRYSTAL LAKE, IL 60014

V MOHAWK TOOLS INCORPORATED
MACHINE TOOL DIVISION
910 EAST MAIN STREET
MONTPELIER, OH 43543-1260

Cutting Tools for Composite Panels
Figure 1 (Sheet 14 of 15)

NOTES (CONT)

W CLEVELAND TWIST DRILL COMPANY
SUBSIDIARY OF ACME-CLEVELAND CORP.
1242 E. 49TH ST.
CLEVELAND, OH 44114

X ATI INDUSTRIES
220 N. TULIP
ESCONDITO, CA 92025

OR

L

Y GENERAL TOOL AND SUPPLY CO.
P.O. BOX 80904
SEATTLE, WA 98108-3317

Z SANDING ABRASIVE
19015 PARTHENIA ST.
NORTHRIDGE, CA 91324

AA FOR DRILL SIZES BETWEEN 0.09 AND 1/4 INCH USED ON A GRAPHITE EPOXY STRUCTURE AND FOR MATERIAL STACKUPS 0.06 INCH AND THICKER, DRILLING CAN BE PERFORMED AT 18,000 RPM IF AND ONLY IF THE DRILLS BEING USED ARE JOBBER LENGTH DRILLS MEASURING 3 INCHES LONG OR LESS

AB FEED RATE SHOWN IS FOR DRILLNG GR/EP UNIDIRECTIONAL TAPE. IT MAY BE INCREASED TO 0.004-0.005 IPR IF STURDY BACKUP IS USED, OR THE GR/EP PART HAS FABRIC CO-CURED ON DRILL EXIT SIDE

AC VACUUM DUST COLLECTION MANDATORY

AD CARBIDE-TIPPED HSS TWIST DRILL

AE 4-FLUTE, STRAIGHT SHANK CARBIDE DRILL; SEE FIG. 2, DETAIL III

AF TO PREVENT DRILL BREAKAGE AND POSSIBLE SERIOUS INJURY, DRILLS LONGER THAN THREE INCHES MUST NOT BE USED AT SPEEDS ABOVE 6000 RPM

AG NOT APPLICABLE

AH FEED RATE SHOWN IS FOR DRILLING GR/EP WITH CO-CURED FABRIC AND ALUMINUM ON DRILL EXIT SIDE. WHEN DRILL EXISTS THROUGH GR/EP UNIDIRECTIONAL TAPE, REDUCE FEED RATE TO 0.002 IPR

AI USE BOELUBE TO PREVENT RESIN BUILDUP ON CUTTER

AJ APPLICABLE TO POWER-FEED DRILLING ONLY

AK MAXIMUM STACKUP OF 0.18 INCH OF WHICH 0.10 INCH MAXIMUM TITANIUM DEPTH IS ALLOWED. THIS IS A CARBIDE-TIPPED HSS TWIST DRILL

AL CARBIDE-TIPPED, OIL-HOLE DRILL WITH THREADED SHANK FOR USE IN DEEP HOLES

AM FEED RATE SHOWN IS FOR DRILLING GR/EP WITH CO-CURED FABRIC OR TITANIUM ON DRILL EXIT SIDE

AN CAN BE OBTAINED FROM:

ARONSON INDUSTRIAL SUPPLY
P.O. BOX 80987
5300 DENVER AVE. SO.
SEATTLE, WA 98108

* RECOMMENDED: GUHRING BRAND

AO MAXIMUM SPEED OF 700 RPM WHEN REAMING ARAMID MATERIALS

AP APPLICABLE TO POWER-FEED EQUIPMENT ONLY

AQ ST1864P (CARBIDE) FOR GRAPHITE OR GRAPHITE WITH ALUMINUM

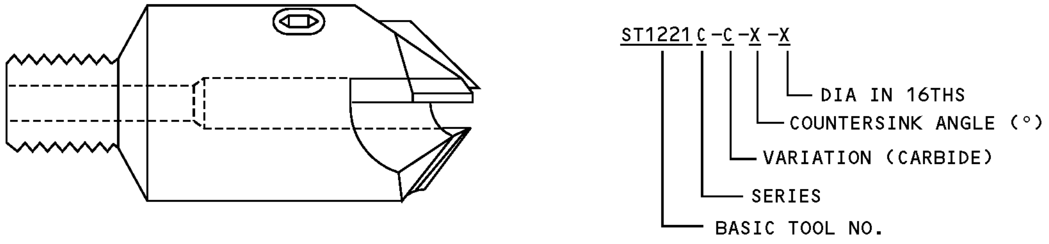
AR B1-3079 (STRAIGHT, HSS) OR B1-3085 (PILOT, HSS); BOTH REAMERS ARE USED ON ARAMID OR ARAMID WITH ALUMINUM STRUCTURES

AS SINGLE-STEP OR DOUBLE-STEP DESIGN FOR GRAPHITE OR ARAMID WITH TITANIUM

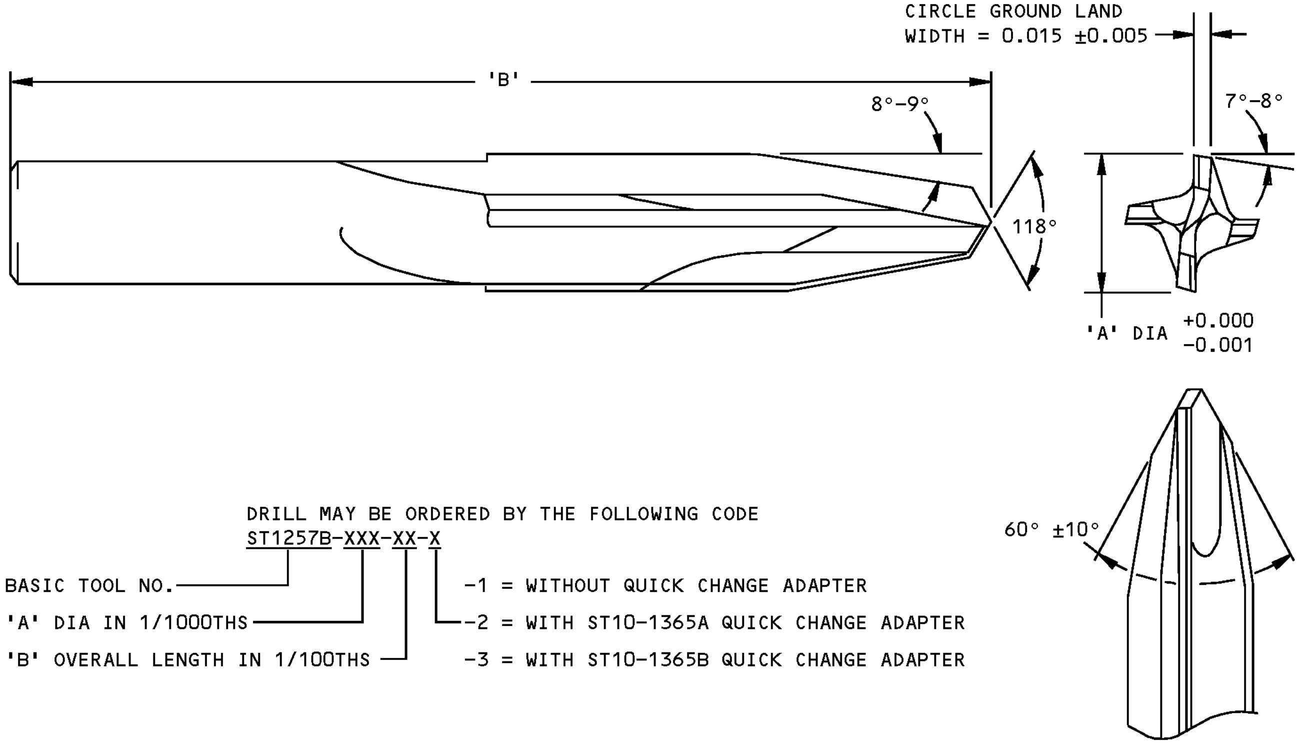
AT A MINIMUM CUT OF 1/64 INCH ON THE DIAMETER IS REQUIRED WHEN REAMING HOLES UP TO 5/16-INCH DIAMETER, FOR LARGER HOLES, A MINIMUM CUT OF 1/32-INCH ON THE DIAMETER IS REQUIRED

AU KIMBERLY INDUSTRIAL SUPPLY
1637 NW 14TH
PORTLAND, OREGON 97232

Cutting Tools for Composite Panels
Figure 1 (Sheet 15 of 15)

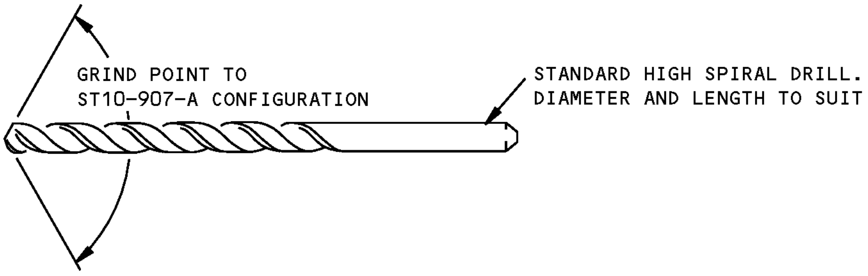


ST1221C-C $\boxed{A}$ CUTTER - MICROSTOP, COUNTERSINK 3-FLUTE-CARBIDE
DETAIL I

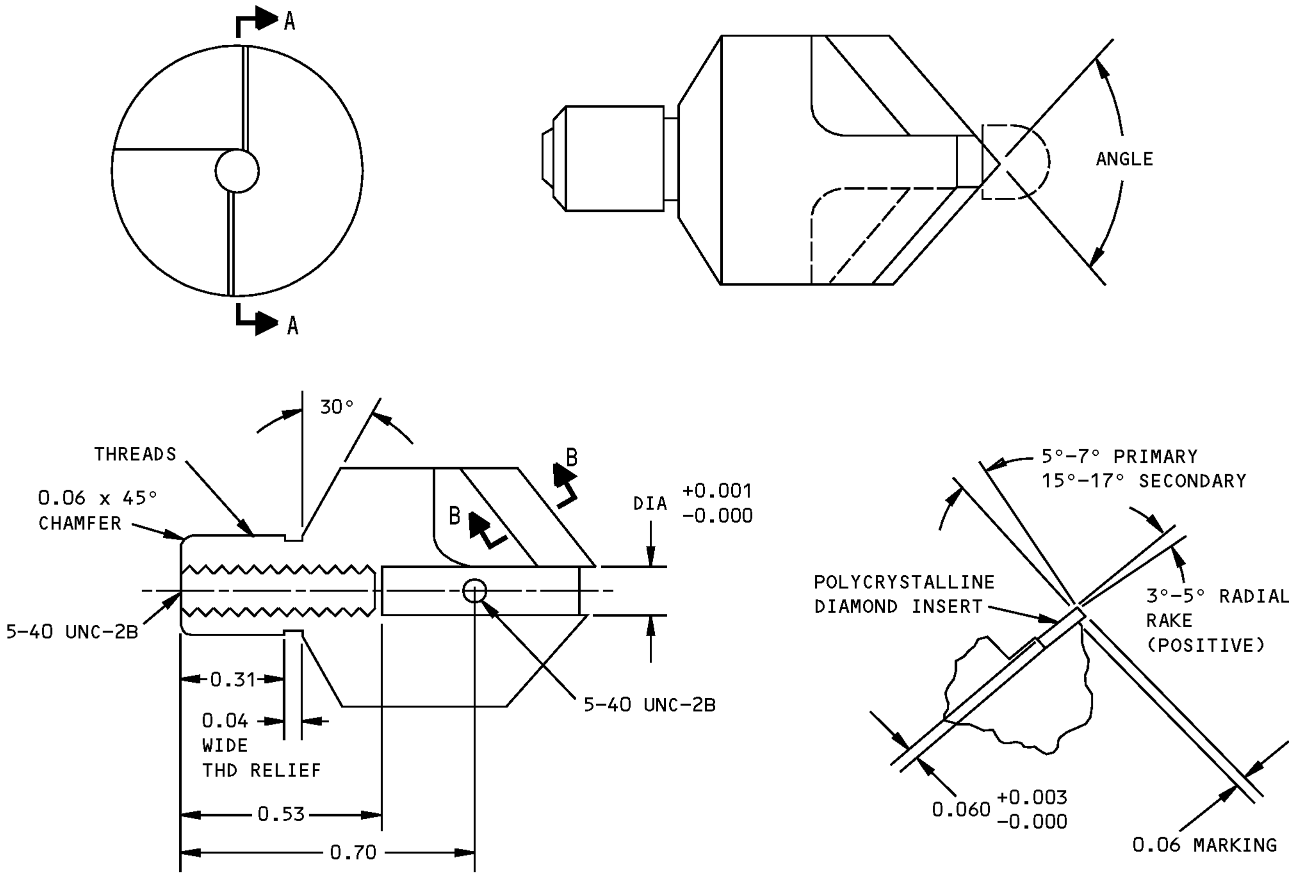


ST1257B $\boxed{A}$ 4-FLUTE, STRAIGHT SHANK, RH DRILL
DETAIL II

Cutters for Hole Drilling in Graphite and Aramid Structures
Figure 2 (Sheet 1 of 2)



ST10-907-H $\boxed{\text{A}}$ HIGH SPIRAL DRILL, 135° SPLIT POINT
DETAIL III



SECTION A-A

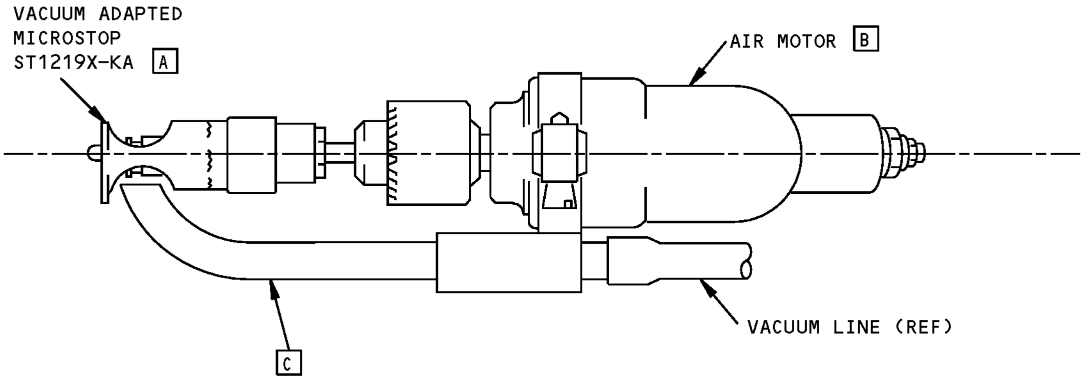
SECTION B-B

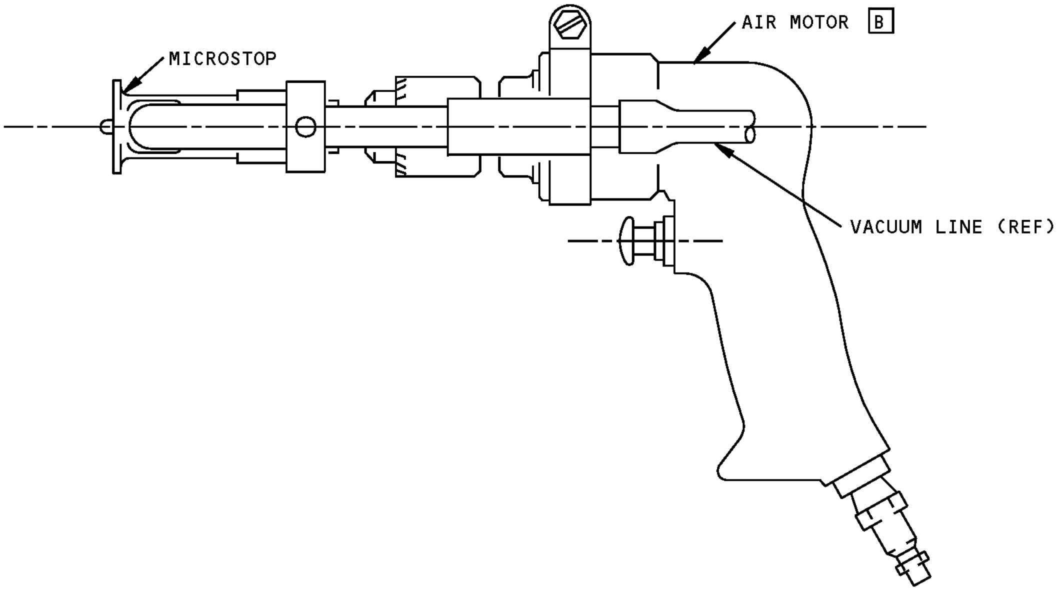
ST1223C-D $\boxed{\text{A}}$ CUTTER - 2-FLUTE, POLYCRYSTALLINE DIAMOND
DETAIL IV

NOTES

$\boxed{\text{A}}$ BOEING STANDARD TOOL NUMBER

Cutters for Hole Drilling in Graphite and Aramid Structures
Figure 2 (Sheet 2 of 2)





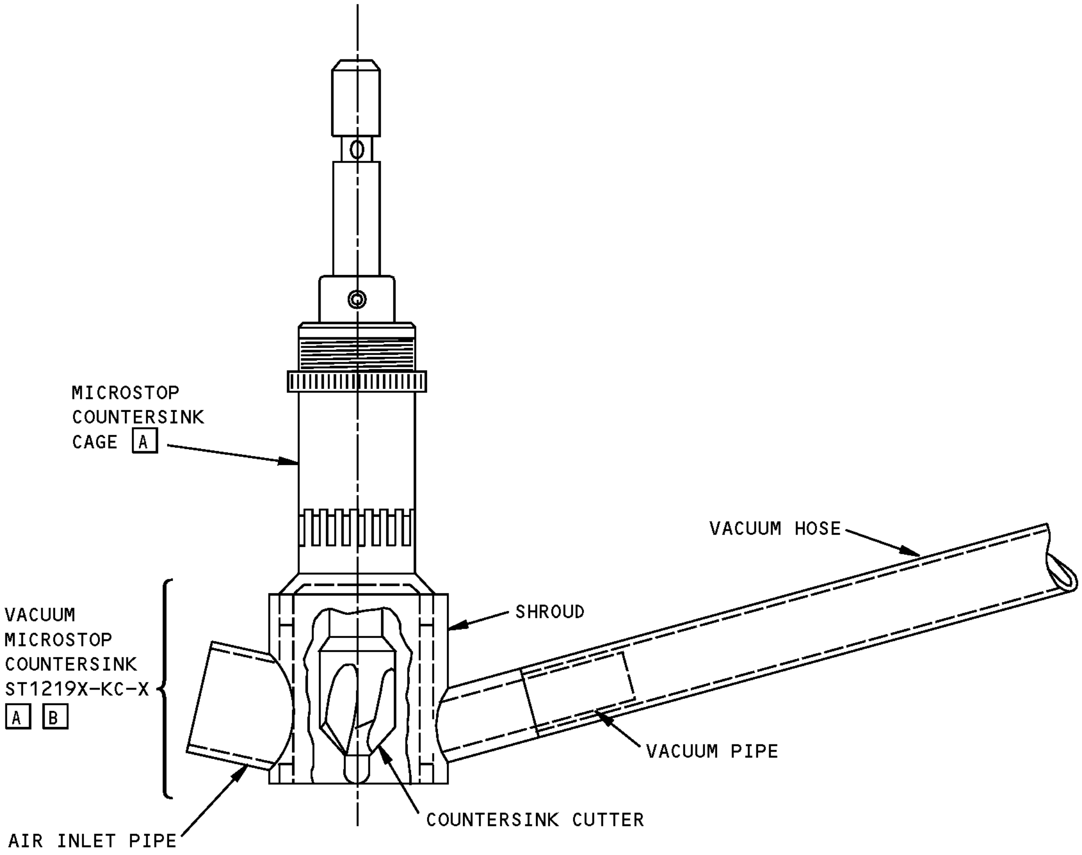
NOTES

A BOEING STANDARD TOOL NUMBER

B 5000 RPM AIR MOTOR

C STAINLESS STEEL TUBING
1/2 O.D. X 0.035 WALL X 7 1/2
SOURCE: KILSBY ROBERTS CO.
22011 76TH AVE SO.
KENT, WA 98032
(800) 562-5311
(206) 872-0100

Microstop/Vacuum Foot Setup for Countersinking Graphite and Aramid Structures
Figure 3 (Sheet 1 of 2)

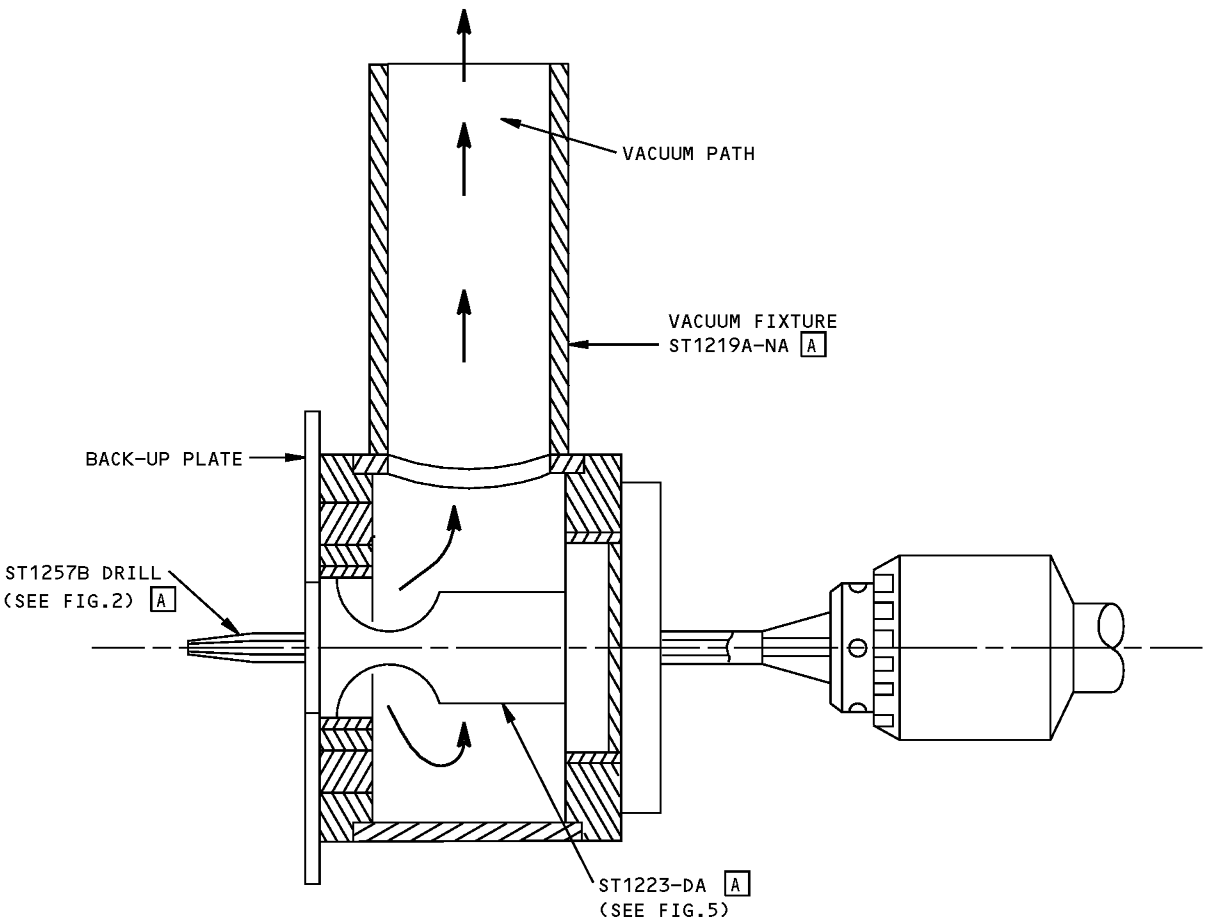


NOTES

A BOEING STANDARD TOOL NUMBER

B USE ST1219X-KC-13 WITH MAGNAVON
NO. 2140 MICROSTOP COUNTERSINK CAGE
OR ST1219X-KC-14 WITH MAGNAVON
NO. 2193 MICROSTOP COUNTERSINK CAGE

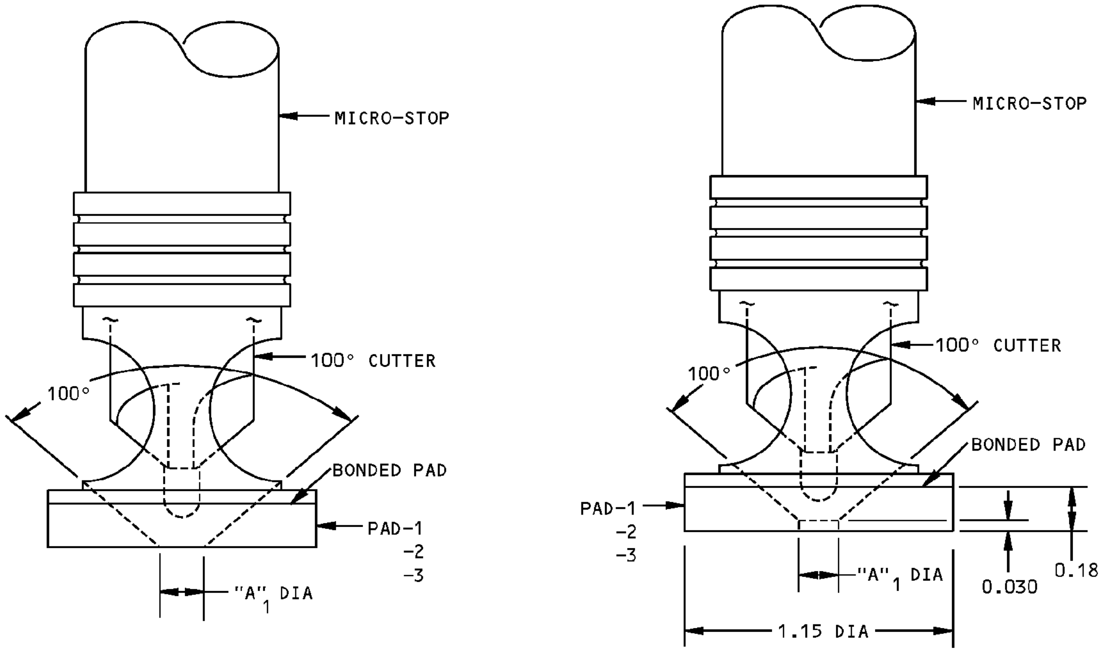
Microstop/Vacuum Foot Setup for Countersinking Graphite and Aramid Structures
Figure 3 (Sheet 2 of 2)



NOTES

A BOEING STANDARD TOOL NO.

Locator/Vacuum Shroud Set-up for Countersinking Graphite Structures
Figure 4



1ST OPERATION

2ND OPERATION [A]

ST1223DA [B]

TOOL NUMBER [B]	PAD ITEM NO.	$A_1{}^{+0.005}_{-0.000}$ DIA 1ST OPERATION	$A_1{}^{+0.010}_{-0.000}$ DIA ESTABLISHED SURFACE FLUSHNESS 2ND OPERATION
ST1223DA-156	-1	0.156	0.156
ST1223DA-187	-2	0.187	0.187
ST1223DA-250	-3	0.250	0.250

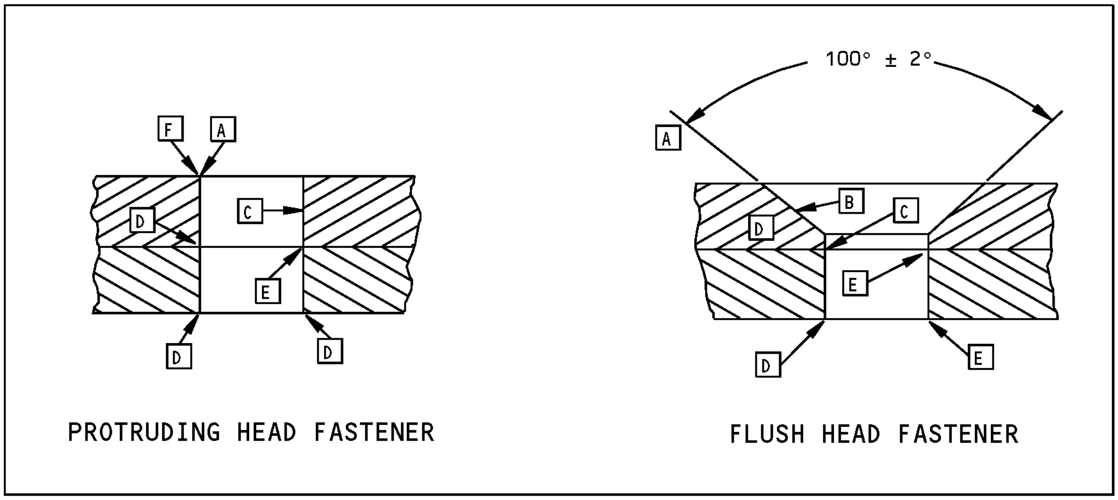
DIAMETERS FOR ST1223DA FOOT - PHENOLIC MICROSTOP COUNTERSINK
TABLE I

NOTES

[A] AFTER PHENOLIC PAD IS BONDED, ADJUST CUTTER TO OBTAIN A_1 DIA AS SHOWN

[B] BOEING STANDARD TOOL NUMBER

Foot - Phenolic Microstop Countersink
Figure 5



HOLE REQUIREMENTS
TABLE I

NOTES

A THERE SHALL BE NO DELAMINATION TO THE EXTERNAL PLY

B COUNTERSINKS SHALL BE CCONCENTRIC TO THE HOLE WITHIN 0.003 INCH. COUNTERSINK AXIS SHALL BE PARALLEL TO THE HOLE WITHIN 1°

C THERE SHALL BE NO EVIDENCE OF DELAMINATION OR MATERIAL SCORCHING ON THE SURFACE OF THE HOLE OR COUNTERSINK EXCEPT AS INDICATED BY F . SURFACE FINISH SHALL BE 125 MICRO-INCHES MAXIMUM

D BURRS, DUST, OR FIBER PARTICLES WHICH PREVENT SEATING OF THE FASTENER OR INTIMATE CONTACT OF STRUCTURE MUST BE REMOVED

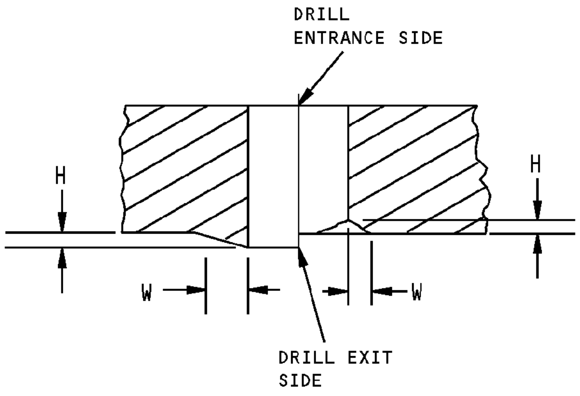
E BREAKOUT DAMAGE SHALL NOT EXCEED LIMITS SHOWN IN TABLE II. BREAKOUT DAMAGE IS DEFINED TO BE CHIPPING, SPLINTERING, OR DELAMINATION

F BREAKOUT OR CHIPPING OF THE EXTERNAL PLY SHALL NOT EXCEED 0.030 INCH FROM THE EDGE OF THE DRILLED HOLES. WHERE THE EXTERNAL PLIES ARE UNIDIRECTIONAL GRAPHITE/EPOXY TAPE, THE BREAKOUT ALLOWANCE IS 0.100 INCH FROM THE EDGE OF THE DRILLED HOLES

G 250°F (121°C) CURE

H 350°F (177°C) CURE

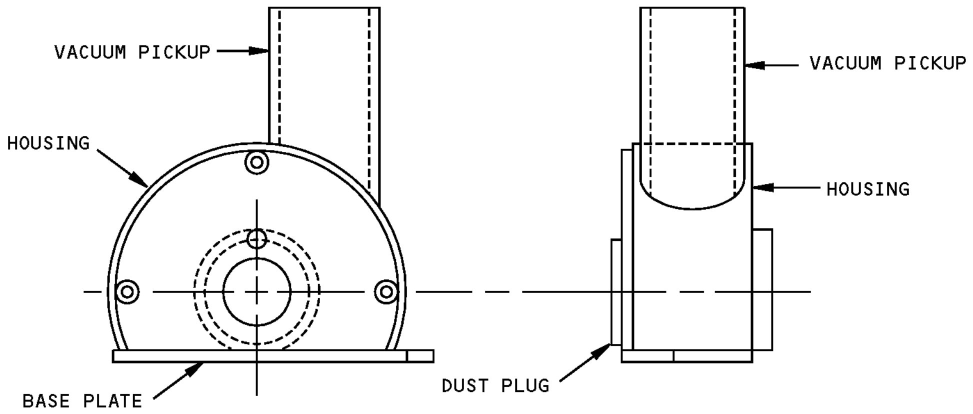
Hole Requirements for Graphite and Aramid Structures
Figure 6 (Sheet 1 of 2)



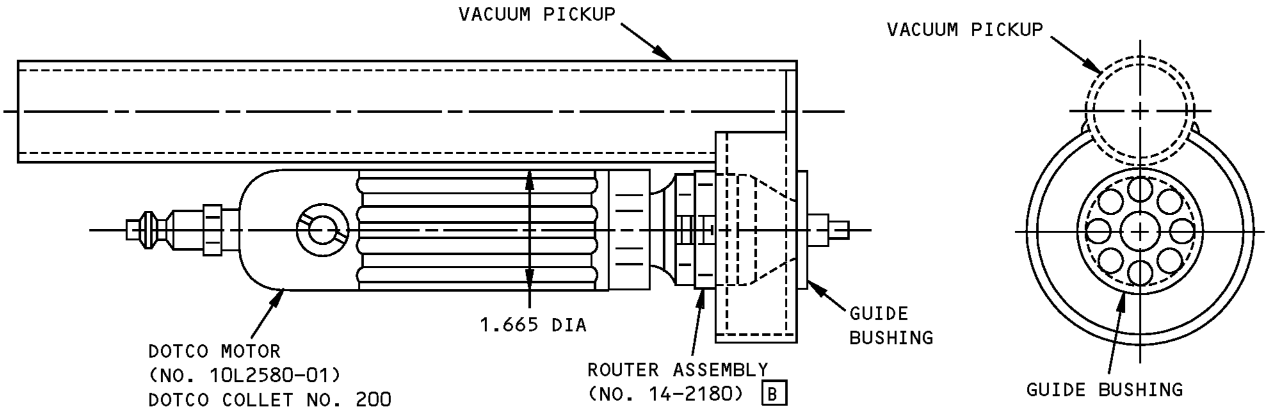
SIZE (inches)	GRAPHITE/EPOXY FABRIC BMS 8-168 G, BMS 8-212 H		GRAPHITE/EPOXY TAPE BMS 8-168 G, BMS 8-212 H		ARAMID/EPOXY FABRIC BMS 8-219 G AND FIBERGLASS/ EPOXY FABRIC BMS 8-79 G, BMS 8-139 H		ARAMID/EPOXY FABRIC BMS 8-218 H	
	H MAX (inches)	W MAX (inches)	H MAX (inches)	W MAX (inches)	H MAX (inches)	W MAX (inches)	H MAX (inches)	W MAX (inches)
3/32	0.007	0.015	0.014	0.050	0.010	0.015	0.014	0.075
1/8	↓	0.020	↓	0.050	↓	0.020	↓	0.075
9/64		0.025		0.075		0.025		0.075
5/32		0.030		0.100		0.030		0.100
3/16		0.030		0.100		0.030		0.100
1/4		0.040		0.100		0.040		0.100
5/16		0.040		0.120		0.040		0.100
3/8		0.040		0.120		0.040		0.100
7/16		0.040		0.150		0.040		0.100
1/2		0.040		0.150		0.040		0.100

LIMITS FOR DRILL BREAKOUT DAMAGE TO FASTENER HOLES
TABLE II

Hole Requirements for Graphite and Aramid Structures
Figure 6 (Sheet 2 of 2)



ST1265H [A] VACUUM GUARD FOR DOTCO CIRCULAR SAW MODEL 10L1280-32
DETAIL I



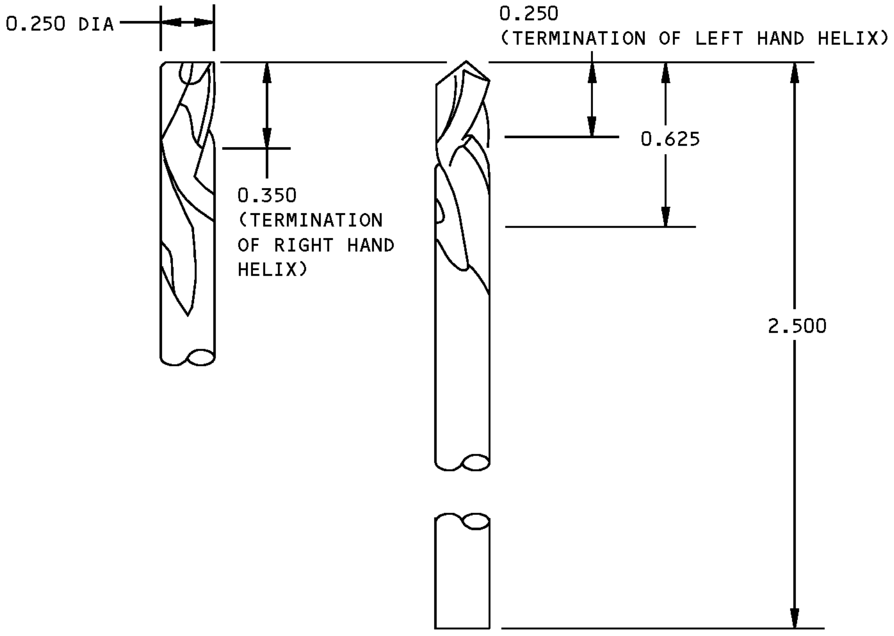
ST-301-J-15 [A] VACUUM PICKUP FOR DOTCO DRILL MOTOR
DETAIL II

NOTES

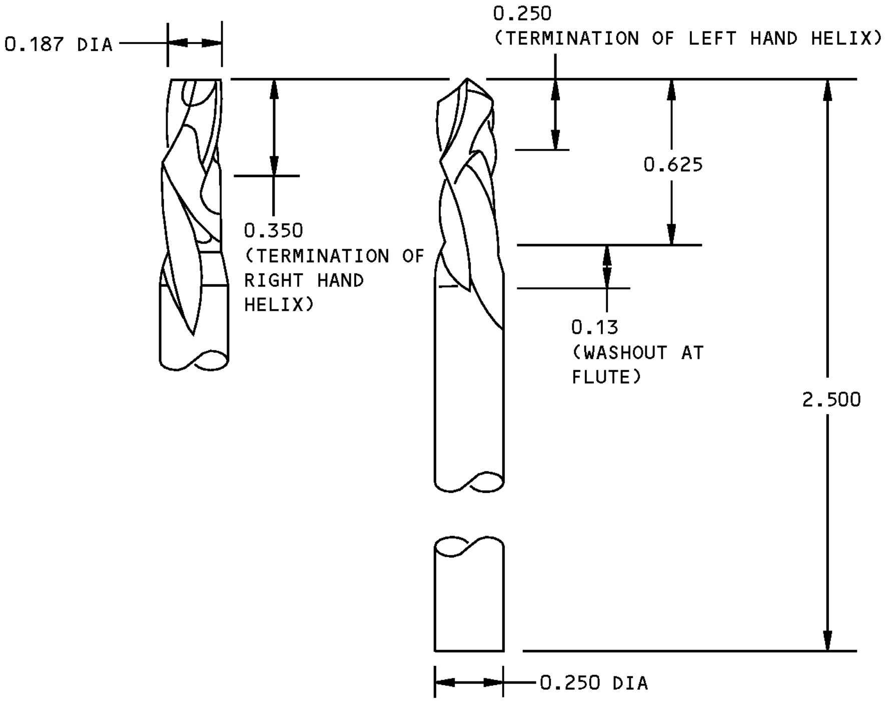
[A] BOEING STANDARD TOOL NO.

[B] PACIFIC DISTRIBUTING INC.
7118 BEACON AVE SO.
SEATTLE, WA 98108

Vacuum Pickup for Trimming Operations
Figure 7



HERRING BONE TWO FLUTE CUTTER - 20° HELIX ANGLE
DETAIL I



HERRING BONE, TWO FLUTE CUTTER - 20° HELIX ANGLE
DETAIL II

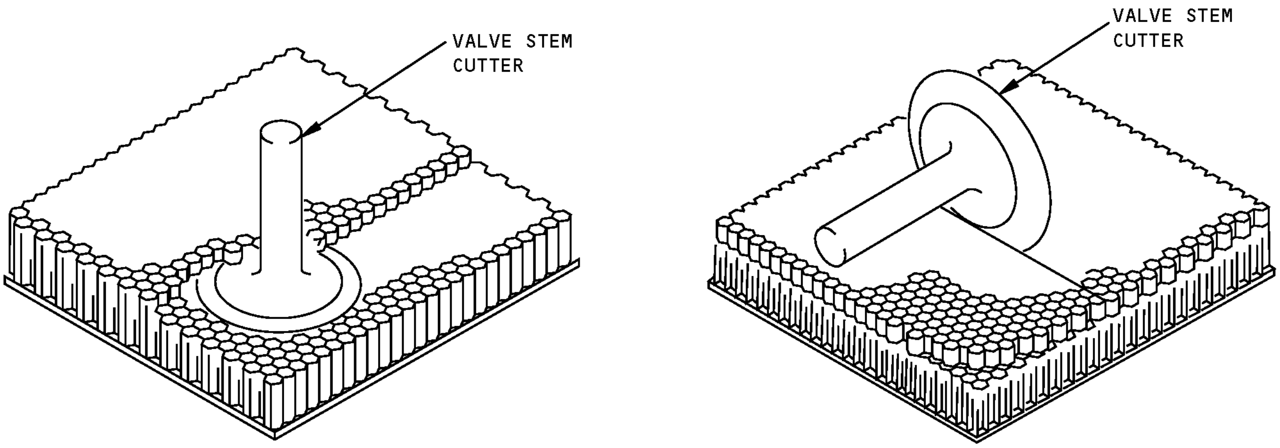
Cutter for Trimming Aramid Panels
Figure 8

TWO-PIECE CUTTER

ONE-PIECE CUTTER

VALVE STEM CUTTERS

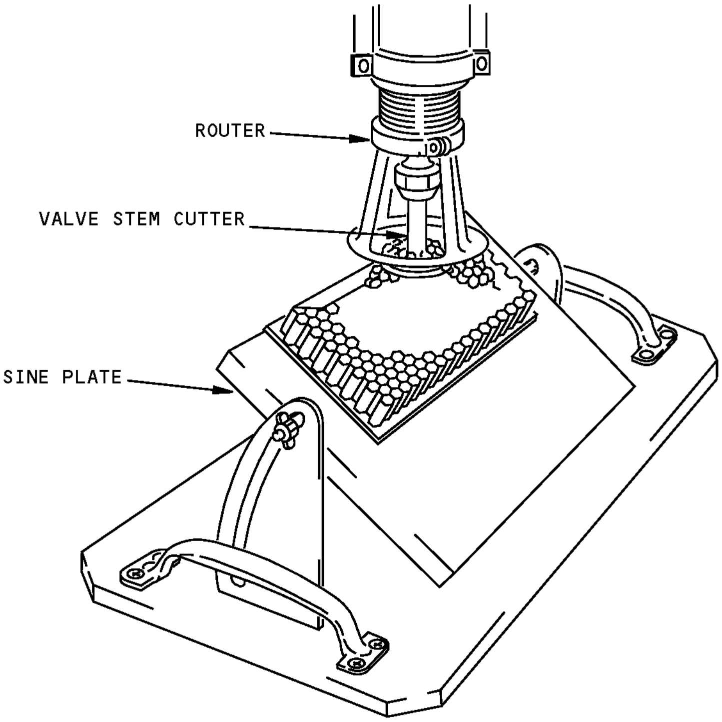
DETAIL I



FLAT CUTTING FOR DOUBLER RECESSES, EDGE STEPS
OR OVERALL THICKNESS REDUCTION

DETAIL II

Machining with Valve Stem Cutter
Figure 9 (Sheet 1 of 2)



DETAIL III

NOTES

- SEE 51-30-05 FOR CUTTER SIZES AND MANUFACTURER
- CUTTERS ATTACH TO POWER ROUTER (SEE DETAIL III)
- MACHINE WITH SINE PLATE FOR MAKING TAPERED CUTS OR WEDGE SHAPED DETAILS
- NONMETALLIC HONEYCOMB MAY BE STABILIZED BY:
  1. USE OF DOUBLE-BACKED TAPE
  2. BONDING A LAYER OF ADHESIVE FILM TO SURFACE OF HONEYCOMB
  3. BONDING A LAYER OF ADHESIVE FILM AND A LAYER OF PREPREGNATED FIBERGLASS CLOTH
- STABILIZED HONEYCOMB DETAILS MAY BE HELD FOR MACHINING BY USE OF VACUUM, MECHANICAL CLAMPING USING LARGE AREA PADS, DOUBLE-BACKED TAPE OR SHOT BAGS

Machining with Valve Stem Cutter
Figure 9 (Sheet 2 of 2)

NOTES

- SEE 51-40-05 FOR HOLE SIZES IN METAL STRUCTURES

$\boxed{A}$ USE OF ALUMINUM FASTENERS IN GRAPHITE AND HYBRID ARAMID/GRAPHITE PANELS IS NOT RECOMMENDED; CORROSION MAY RESULT. CRES OR TITANIUM FASTENERS ARE RECOMMENDED

RIVET TYPE $\boxed{A}$	NOMINAL RIVET DIA (INCH)	HOLE SIZE			
		ARAMID/EPOXY TAPE OR FABRIC		ARAMID/EPOXY WITH ALUMINUM OR FIBERGLASS WITH AND WITHOUT ALUMINUM	
		MIN	MAX	MIN	MAX
BACR15CE	3/32	0.098	0.103	0.098	0.103
	1/8	0.130	0.137	0.128	0.135
	5/32	0.161	0.169	0.159	0.167
	3/16	0.192	0.200	0.190	0.198
	1/4	0.255	0.261	0.255	0.261
BACR15BA,	3/32	0.098	0.103	0.098	0.103
BACR15BB,	1/8	0.130	0.137	0.128	0.135
BACR15FT	5/32	0.161	0.173	0.159	0.171
	3/16	0.193	0.204	0.191	0.202
	1/4	0.254	0.265	0.254	0.265

HOLE SIZES FOR SOLID RIVETS
TABLE I

NOMINAL RIVET DIAMETER (INCH)	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 HOLLOW-ENDED BACR15GA RIVETS (TITANIUM)
TABLE II

Fastener Hole Sizes in Composites
Figure 10 (Sheet 1 of 2)

THREAD SIZE (INCH)	HOLE SIZE (INCH)	
	MINIMUM	MAXIMUM
#4-40	0.114	0.117
#6-32	0.140	0.143
#8-32	0.164	0.167
#10-32	0.190	0.193
1/4-28	0.250	0.253
5/16-24	0.312	0.315
3/8-24	0.375	0.378

HOLE SIZES FOR BOLTS AND NUTS [A]
TABLE III

NOMINAL OVERSIZE	ORIGINAL HOLE SIZE (INCH)			
	(-6) #10	(-8) 1/4	(-10) 5/16	(-12) 3/8
	0.193 0.190	0.253 0.250	0.315 0.312	0.378 0.375
	HOLE SIZES FOR OVERSIZE REPLACEMENT FASTENERS			
1/64	0.206 0.203	0.269 0.266	0.331 0.328	0.395 0.391
1/32	0.222 0.219	0.284 0.281	0.348 0.344	0.410 0.406

HOLE SIZES (INCHES) FOR OVERSIZE HEX DRIVE FASTENERS [A]
TABLE IV

Fastener Hole Sizes in Composites
Figure 10 (Sheet 2 of 2)

GENERAL - REPAIRS TO 250°F (121°C) AND 350°F (177°C) CURED GRAPHITE/ARAMID/FIBERGLASS REINFORCED EPOXY LAMINATES AND NONMETALLIC HONEYCOMB SANDWICH STRUCTURE - 200°F (93°C) TO 230°F (110°C) WET LAYUP REPAIR METHOD

1. Applicability

WARNING: DO NOT BREATHE CARBON FIBER DUST. MAKE SURE THAT THERE IS A GOOD FLOW OF AIR WHERE YOU DO THE WORK. USE EQUIPMENT TO HELP YOU BREATHE WHEN YOU WORK IN A CONFINED SPACE. USE A VACUUM NEAR THE SOURCE OF THE DUST TO REMOVE THE DUST FROM THE AIR. IF YOU DO NOT OBEY, YOU CAN CAUSE INJURY.

CAUTION: DO NOT LET CARBON FIBER DUST GO INTO ELECTRICAL EQUIPMENT. CARBON FIBER DUST IS ELECTRICALLY CONDUCTIVE AND IT CAN CAUSE SHORT CIRCUITS. USE A VACUUM NEAR THE SOURCE OF THE DUST TO REMOVE THE DUST FROM THE AIR. IF YOU DO NOT OBEY, YOU CAN CAUSE DAMAGE TO THE ELECTRICAL EQUIPMENT.

A. This subject contains repairs to components made from epoxy resin reinforced with several layers of graphite tape or fabric, aramid fabric or a combination of graphite, aramid and fiberglass (hybrids). The most common construction is a sandwich of two laminated skins separated by a nonmetallic honeycomb core. Solid laminate is used for small components, honeycomb panel edgebands and at fitting locations. Repairs described herein use hand-impregnated composite material (wet layup).

WARNING: HEAT, FIRE, OR SPARKS CAN CAUSE AN EXPLOSION. USE EXPLOSIONPROOF EQUIPMENT WHEN PERFORMING THESE REPAIRS. NONCOMPLIANCE COULD CAUSE PERSONNEL INJURY.

BREATHING VAPORS OR ALLOWING SOLVENT TO CONTACT SKIN OR EYES IS HAZARDOUS. WEAR NEOPRENE GLOVES, PROTECTIVE CLOTHING, AND EYE GOGGLES. IF CHEMICAL CONTACT OCCURS, WASH THOROUGHLY WITH WATER. IF CHEMICAL SHOULD SPLASH INTO EYES, FLUSH EYES WITH LARGE QUANTITIES OF WATER AND SEEK MEDICAL AID. USE MECHANICAL VENTILATION OR RESPIRATORY PROTECTION WHEN WORKING IN A CONFINED SPACE OR AREA.

CAUTION: REFER TO THE SPECIFIC STRUCTURAL COMPONENT REPAIR SECTION FOR THE REPAIR LIMITS AND MATERIAL OF THE COMPONENT BEFORE USING THESE REPAIR INSTRUCTIONS. FAILURE TO COMPLY COULD RESULT IN AN UNACCEPTABLE AND UNAUTHORIZED REPAIR.

(CAUTION PRECEDES)

THESE REPAIRS ARE PERMANENT WHEN APPLIED USING THE REPAIR MANUAL PROCEDURES TO COMPONENTS ORIGINALLY MADE FROM 350°F (177°C) CURE MATERIALS.

TEMPERATURES ABOVE 260°F (126°C) MUST NOT BE APPLIED TO AREAS SEALED WITH BMS 5-95 SEALANT, UNLESS SEALANT CAN BE REPLACED FOLLOWING REPAIR.

SOME REPAIRS MAY REQUIRE CURE TEMPERATURES THAT ARE THE SAME AS THAT USED DURING COMPONENT MANUFACTURE. CARE MUST BE TAKEN TO PROPERLY SUPPORT THE AREA ADJACENT TO THE REPAIR TO PREVENT DELAMINATION OF UNDAMAGED AREAS. EXTENDING VACUUM BAGGING A MINIMUM OF 6.0 INCHES BEYOND THE HEAT BLANKET AND THE USE OF SUPPORT STRUCTURE, WHERE REQUIRED ARE RECOMMENDED.

CAUTION: FASTENERS INSTALLED IN GRAPHITE COMPOSITE STRUCTURE SHALL BE TITANIUM ALLOY, CRES, OR MONEL. BMS 10-85 COATED FASTENERS (CRES OR TITANIUM ALLOY) ARE REQUIRED WHEN MATING GRAPHITE COMPOSITES WITH ALUMINUM. INSTALL FASTENERS WET WITH SEALANT AS GIVEN IN 51-20-05. IF ALUMINUM OR CADMIUM PLATED CRES WASHERS, NUTS OR COLLARS ARE USED, THEY SHALL BE USED ON THE ALUMINUM SIDE OF THE ASSEMBLY ONLY. ALL COLLARS, NUTS, AND WASHERS SHALL BE CAP SEALED AS GIVEN IN 51-20-05. PHOSPHATE FLUORIDE COATED FASTENERS ARE REQUIRED IN ELECTRICAL CONDUCTIVITY APPLICATIONS (I.E. ALUMINUM FLAME SPRAYED OR BMS 10-21 COATED PANELS). ALUMINUM AND ALLOY STEEL FASTENERS ARE NOT ALLOWED IN GRAPHITE COMPOSITE STRUCTURES.

WHEN REINSTALLING ALUMINUM FITTINGS ON GRAPHITE COMPOSITE STRUCTURE, ENSURE THAT THE ORIGINAL CORROSION PROTECTIVE TREATMENT IS MAINTAINED. INSTALL FITTINGS WITH FAYING SURFACE SEAL USING BMS 5-26 IN FUEL TANK AREAS OR BMS 5-95 IN ALL OTHER AREAS.

B. Use suitable holding fixtures as given in Paragraph 3.F./GENERAL to prevent distortion and delamination of the structure.

C. Perform the repair procedures specified herein only in areas of reasonable cleanliness. Areas containing oil mist, exhaust fumes, gases, soot, rain, dust, or other particulate matter are specifically prohibited.

D. Protect surfaces from contamination. Do not touch cleaned parts or adhesive with bare hands. Use clean white gloves when handling parts. Refer to Paragraph 3.D.(3)/GENERAL for protection when working with resin system.

E. Store resin and/or adhesive material below 10°F (-12°C) in sealed containers. An identification label must accompany the material inside the bag, with the following information: BMS Type, Class, grade, supplier name, batch number, and date of preparation. Record storage time in and out of refrigeration.

F. Refer to 51-10-01, GENERAL for aerodynamic smoothness requirements.

G. Refer to REPAIR MATERIALS, SECTION/51-30 for source of repair materials.

H. Refer to 51-70-16, GENERAL for drilling and machining of composites.

I. Refer to Figure 1/GENERAL for resin mixes and potting compound data.

J. Restore aluminum flame spray as given in 51-70-14, GENERAL.

K. Repair Tedlar according to Paragraph 3.H./GENERAL

L. Table 1/GENERAL contains an index of subjects in this procedure.

Table 1: Index of Subjects

Paragraph	Subject
Paragraph 3./GENERAL	Repair Procedures Common to Various Repairs
Paragraph 3.A./GENERAL	Determine Damage
Paragraph 3.B./GENERAL	Remove Water from Damaged Area
Paragraph 3.C./GENERAL	Remove and Prepare Damaged Area
Paragraph 3.D./GENERAL	Fabricate, Clean, and Install Honeycomb Replacement Core Plug
Paragraph 3.E./GENERAL	Prepare and Apply Repair Plies
Paragraph 3.F./GENERAL	Layup/bagging Procedure (Fig. 4)
Paragraph 3.G./GENERAL	Cure the Repair
Paragraph 3.H./GENERAL	Refinish after Repair
Paragraph 3.I./GENERAL	Perform Post-repair Requirements
Paragraph 4./GENERAL	Typical Repairs
Paragraph 4.A./GENERAL	Repair of Delaminations Between Plies
Paragraph 4.B./GENERAL	Repair of Puncture, 0.50-inch Diameter or Less, in Honeycomb Panel
Paragraph 4.C./GENERAL	Repair of Damage to One Skin and Honeycomb Core using Replacement Core Plug, Punctures Greater than 0.50-inch Diameter (Fig. 11)
Paragraph 4.D./GENERAL	Repair of Large Puncture through Internal and External Surface of Panel Including Core Damage (Fig. 12)
Paragraph 4.E./GENERAL	Replacement of Honeycomb Core on Damaged Edge of Panel (Fig. 13)
Paragraph 4.F./GENERAL	Repairs Where Access is Limited to One Side of Panel. (Fig. 14)
Paragraph 4.G./GENERAL	Repair of Damaged Skin Plies in Panel Edgeband (Fig. 15)
Paragraph 4.H./GENERAL	Repair of Damage and Punctures in Solid Laminate Panels
Paragraph 4.I./GENERAL	Repair of Punctures, 0.50-inch Diameter or Less, in Solid Laminate Panels
Paragraph 4.J./GENERAL	Repair of Delamination Between Plies in Solid Laminate Panels
Paragraph 4.K./GENERAL	Repair of Damaged Panel Attach Holes in Honeycomb Panel Edgebands or along Edges of Solid Laminate Panels (Fig. 16)
Paragraph 4.L./GENERAL	Repair of Surface Dents
Paragraph 4.M./GENERAL	Repair of Damage to Solid Honeycomb Trailing Edge Wedge and Structural Solid Laminate Trailing Edge

2. References

Reference	Title
51-10-01, GENERAL	Aerodynamic Smoothness Requirements
51-20-05, GENERAL	Repair Sealing
51-30	REPAIR MATERIALS
51-30-03, GENERAL	Nonmetallic Materials

(Continued)

Reference	Title
51-60-00, GENERAL	Control Surface Balance Moment Determination
51-70-03, GENERAL	Graphite and/or Aramid Reinforced Epoxy Laminates and Nonmetallic Honeycomb Sandwich Repairs - Room Temperature – 150°F (66°C) Cure (Wet Layup)
51-70-06, GENERAL	Glass Fabric Reinforced Epoxy Laminates and Nonmetallic Honeycomb Sandwich Repairs - Room Temperature – 150°F (66°C) Cure (Wet Layup)
51-70-14, GENERAL	Allowable Damage and Repair of Flame-Sprayed Aluminum Coatings, Aluminum-Coated Glass Fabric (BMS 8-278), Aluminum Foil (BMS 8-289), and Expanded Aluminum Foil (BMS 8-336)
51-70-16, GENERAL	Hole Drilling and Machining of Composite Structures
AMM 51-21-00	Aircraft Maintenance Manual
AMM 51-21-12	Aircraft Maintenance Manual
AMM 51-24-02	Aircraft Maintenance Manual
AMM 51-24-13	Aircraft Maintenance Manual
AMM 51-41-00/201	Aircraft Maintenance Manual
NDT Part 1, 51-01-01	Inspection of Repairs to Composite Structures
SOPM 20-30-03	Standard Overhaul Practices Manual
SOPM 20-30-99	Solvents For Final Cleaning of Composites Before Structural Bonding (Series 99)

3. Repair Procedures Common to Various Repairs

A. Determine Damage

CAUTION: CHEMICAL PAINT STRIPPERS WILL ATTACK RESIN SYSTEMS, AND SHOULD NOT BE USED TO REMOVE PAINT BEFORE MAKING DAMAGE EVALUATIONS.

(1) Examine visually for extent of damage.

(2) Check panel in vicinity of damage for entry of water, oil, fuel, dirt or other foreign matter. Water can be detected by radiographic methods. Remove contaminants as required.

(3) Check for delamination around the damage.

NOTE: Delamination can be detected by instrumental nondestructive inspection (NDI) methods or by tapping the skin with a small metal disk. For tap test use a solid metal disk and tap the repair area lightly but firmly. Void areas will produce a dull sound as opposed to a sharp ring on a solid bonded area. Tap testing is not a reliable method for determining damage. Whenever possible, use NDI methods according to the Nondestructive Test Manual, D634T301.

B. Remove Water from Damaged Area

(1) Remove water from honeycomb sandwich (Figure 6/GENERAL).

NOTE: If the damage is less than the thickness of the skin plies and there is no water in the honeycomb, use the procedure in Paragraph 3.B.(2)/GENERAL to remove the water from the skin plies.

(a) Remove damaged skin plies to open up honeycomb area in the damaged area. Remove standing water using vacuum and oil-free compressed air.

(b) Sand the core to remove the adhesive. Removal of adhesive fillets on core is not required.

(c) Apply a fiberglass or metal fine mesh screen over exposed core.

(d) Apply a thermocouple to the center of the screen.

(e) Apply a layer of glass fabric bleeder cloth over the screen and hold in place with masking tape.

(f) Place a vacuum line on the edge of the bleeder cloth and hold in place with masking tape.

(g) If the far side is accessible, apply thermocouple and heating blanket to the far side of the honeycomb sandwich panel.

NOTE: If the far side is accessible, it is acceptable to heat the area using a heating blanket only on the far side. An additional heating blanket and vacuum application may be used on the near side at the location shown in Figure 6/GENERAL to accelerate water removal. If the far side is inaccessible, use of a heating blanket on the near side is required.

(h) When the far side is inaccessible or when using an additional heating blanket, place the heating blanket over the bleeder cloth on the near side.

(i) Place extruded sealing compound around the entire area and seal the area with vacuum bag material.

(j) Evacuate the layup to vacuum of 22 inches of mercury minimum.

(k) Heat the area for 1 hour minimum at 150°F (66°C) to 170°F (77°C). The rate of temperature rise must not exceed 5°F (3°C) per minute.

(l) Remove layup materials and proceed with repair procedure.

(2) Remove water from solid laminate.

(a) Remove damage and/or delamination. Remove standing water using vacuum and oil-free compressed air.

(b) Heat the area for 1 hour minimum at 150°F (66°C) to 170°F (77°C). The rate of temperature rise must not exceed 5°F (3°C) per minute.

C. Remove and Prepare Damaged Area

(1) Damage removal.

(a) Trim out the damaged lamination to a smooth shape with rounded corners, or a circular or oval shape. Take care not to damage the undamaged plies, core or surrounding material.

NOTE: Remove only damaged plies, damaged doublers and damaged fillers.

(b) When the core is also damaged, remove the core by trimming to the same outline as the skin. For crush splice repairs (Paragraph 3.D./GENERAL) leave one to three core cells (0.4 maximum) visible between core cavity and skin (Figure 7/GENERAL). The core area removed should extend at least 0.5 further than visible core damage limits. Take care to avoid cutting into an undamaged skin on the opposite side. In cores greater than 1.0 thick, partially remove core (at least 0.5 deep) sufficient to clean up damage.

(c) In areas where contamination cannot be removed by cleaning or drying as given in Paragraph 3.B./GENERAL, remove the contaminated structure along with the other damage.

(d) When opposite inner skin is also damaged, trim out the damage to a smooth shape as described in Paragraph (a).

(e) When core is removed from inner surface of opposite skin, carefully smooth core down to adhesive film.

(f) Inspect cut out area to ensure that all damage has been removed.

CAUTION: SANDING FOR ADHESION OR FINISH REMOVAL MUST NOT EXPOSE OR DAMAGE FILAMENTS IN THE UNTAPERED SURFACE REPAIR AREA.

SANDING MUST NOT EXPOSE OR DAMAGE FILAMENTS IN EACH PLY WHEN STEP SANDING OR IN THE PLY BONDED TO THE CORE (FIGURE 2/GENERAL, FIGURE 8/GENERAL, FIGURE 13/GENERAL).

LOSS OF STRUCTURAL STRENGTH OF THE COMPONENT WILL OCCUR IF THESE CAUTIONS ARE NOT OBSERVED.

DO NOT USE PAINT STRIPPERS FOR THE REMOVAL OF FINISH. DAMAGE TO THE ADHESIVE RESIN SYSTEM WILL OCCUR.

(2) Preparation of damaged area (Figure 2/GENERAL, Figure 8/GENERAL
Figure 8/GENERAL
Figure 13/GENERAL
Figure 13/GENERAL and Figure 15/GENERAL).

(a) Determine the number of plies that have been cut. Mask off area around the cutout allowing 0.5 or 1.0 minimum for each ply replacement and each extra ply. Use 1.0 overlap for heat-affected components and 0.5 for all others. Refer to the specific component repair chart to find which value to use.

NOTE: Where the number of plies is not apparent, refer to the applicable component in the structure identification section.

WARNING: SANDING GIVES OFF A FINE DUST THAT MAY CAUSE SKIN IRRITATIONS. BREATHING OF AN EXCESSIVE AMOUNT OF THIS DUST MAY BE INJURIOUS. OBSERVE PRECAUTIONS FOR SKIN AND RESPIRATION PROTECTION.

EXPLOSIONPROOF EQUIPMENT MUST BE USED WHERE THE POSSIBILITY OF VAPOR IGNITION EXISTS. NONCOMPLIANCE COULD CAUSE PERSONNEL INJURY.

(b) Internal surface of panel (nonaerodynamic surface) and noncritical aerodynamic surfaces.

1) Remove the paint finish or Tedlar film in the masked off area using No. 240 or finer Scotch-Brite abrasive, or No. 150 or finer sandpaper.

2) Taper sand each ply or simply abrade the surface around the cleaned up damage a minimum of 0.5 or 1.0 per ply. Refer to Paragraph (a).

3) An optional procedure for two or three ply laminate face sheets is to fill the cleaned up damage area flush with the original surface using filler plies during the repair layup. The repair plies are then installed directly on the resulting smooth surface of the repair area.

(c) External surface of panel (critical aerodynamic surfaces).

1) Taper sand a uniform taper around the cleaned up damage using No. 80 sandpaper. Taper a minimum distance of 0.5 or 1.0 for each existing ply of the laminate. Refer to Paragraph (a) to determine the required distance. Step sanding is optional to taper sanding on sandwich structure except in areas of critical aerodynamic smoothness. Refer to 51-10-01, GENERAL for locations of areas of critical aerodynamic smoothness. Always taper sand on solid laminate structures.

NOTE: For sanding, use a flexible disk sander, a belt sander, a rotating pad sander, or sand by hand.

2) Remove exterior finishes, including enamel finish and conductive coating from the surface of the 0.5 or 1.0 border using No. 150 or finer sandpaper.

(d) Edgeband of panel.

1) Taper sand panel edgeband according to Paragraph 3.C.(2)(c)/GENERAL.

NOTE: Edgeband is the solid laminate around the outer periphery of the honeycomb panel.

(e) Cleaning of repair area.

1) Remove all sanding dust by applying oil-free compressed air and use a vacuum cleaner.

WARNING: BREATHING VAPORS OR ALLOWING SOLVENT TO CONTACT SKIN OR EYES IS HAZARDOUS. HEAT, FIRE OR SPARKS CAN CAUSE AN EXPLOSION. USE MECHANICAL VENTILATION OR RESPIRATORY PROTECTION WHEN WORKING IN A CONFINED SPACE OR AREA. AVOID CONTACT WITH SKIN, EYES AND CLOTHING. WEAR EYE PROTECTION. KEEP AWAY FROM SOURCES OF HEAT, FIRE OR SPARKS.

CAUTION: DO NOT IMMERSE PARTS IN SOLVENT OR ALLOW STANDING SOLVENT TO REMAIN ON PART. DAMAGE TO PART WILL OCCUR.

2) Wipe surfaces with a clean cloth moistened with solvent, Series 99 (AMM/ SOPM 20-30-99). Allow solvent to evaporate before proceeding with the repair.

D. Fabricate, Clean, and Install Honeycomb Replacement Core Plug

(1) Fabricate core plug.

(a) Fabricate core plug. Refer to the applicable component in the structure identification section to determine core type and material.

(b) For butt splicing, the honeycomb core plug should fit flush with original core and with ribbon direction the same as in original core. The replacement core must overlap and make intimate contact with the cell walls of surrounding core material.

(c) For crush splicing, the honeycomb core plug should be at least two grades higher (denser) than the original core and one to three cells (0.4 maximum) larger than the repair cavity (Figure 7/GENERAL).

(d) Trim core plug to full or partial depth of original core (Paragraph 3.C.(1)/GENERAL(b)).

NOTE: When applicable, depth of core plug should allow for shrinkage during cure and for thickness of extra plies of fabric cloth and adhesive between core plug and undamaged core or skin (Figure 7/GENERAL and Figure 8/GENERAL).

(2) Clean core plug.

WARNING: BREATHING VAPORS OR ALLOWING SOLVENT TO CONTACT SKIN OR EYES IS HAZARDOUS. HEAT, FIRE OR SPARKS CAN CAUSE AN EXPLOSION. USE MECHANICAL VENTILATION OR RESPIRATORY PROTECTION WHEN WORKING IN A CONFINED SPACE OR AREA. AVOID CONTACT WITH SKIN, EYES AND CLOTHING. WEAR EYE PROTECTION. KEEP AWAY FROM SOURCES OF HEAT, FIRE OR SPARKS.

CAUTION: DO NOT EXCEED IMMERSION CRITERIA. DO NOT IMMERSE PARTS IN SOLVENT OR ALLOW STANDING SOLVENT ON PART. DAMAGE TO PART WILL OCCUR.

(a) Clean visually contaminated core by dipping (a maximum of four times) in a MIBK, MEK, or acetone bath for 60 seconds, or vapor degrease core (according to SOPM 20-30-03) limiting immersion to 30 seconds per cycle for a maximum of 4 cycles.

(b) Locally contaminated areas can be washed with MIBK, MEK, or Acetone.

(c) The core must be completely dry, clean, and free of evidence of solvents before installation.

(3) Install core plug (Figure 3, 7, 11, 12, 13, 14).

WARNING: BREATHING VAPORS OR ALLOWING RESIN COMPONENTS TO CONTACT SKIN OR EYES IS HAZARDOUS. WEAR PROTECTIVE CLOTHING AND EYE GOGGLES. NEOPRENE GLOVES WITH COTTON LINERS SHOULD BE USED FOR HAND PROTECTION. GLOVES AND LINERS SHOULD BE USED FOR A MAXIMUM OF 2 HOURS AND DISCARDED. HANDS SHOULD BE WASHED WITH SOAP AND WATER IMMEDIATELY AFTER REMOVAL OF GLOVES AND LINERS. IF GLOVES NEED TO BE REMOVED DURING USE OR A PUNCTURE IS SUSPECTED THEY SHOULD BE REPLACED WITH NEW GLOVES AND COTTON LINERS. IF CHEMICAL CONTACT OCCURS WASH THOROUGHLY WITH WATER. IF CHEMICAL SHOULD SPLASH INTO EYES, FLUSH EYES WITH LARGE QUANTITIES OF WATER AND SEEK MEDICAL AID. USE MECHANICAL VENTILATION OR RESPIRATORY PROTECTION WHEN WORKING IN A CONFINED SPACE OR AREA.

(a) If one skin is undamaged and for full core depth replacement apply two plies of BMS 9-3, Type H-2 or H-3 fiberglass fabric or four plies of BMS 9-3, Type D fiberglass fabric saturated with Resin Mix 2 as given in Paragraph 3.E./GENERAL to the undamaged skin in the repair cavity.

(b) If one skin is undamaged and for partial core replacement apply Resin Mix 3 to face of undamaged core in the repair cavity. Then apply 2 plies of BMS 9-3, Type H-2 or H-3 fiberglass fabric or four plies of BMS 9-3, Type D fiberglass fabric saturated with Resin Mix 2 as given in Paragraph 3.E./GENERAL in the repair cavity.

(c) If both skins of the panel are damaged, repair one surface of the panel and replacement core plug. Repair other surface with subsequent repair cycle.

(d) For butt splicing, apply uniform coat of Resin Mix 1 to the sides of the core plug.

NOTE: It is optional to apply the resin to the inside surface of the existing core instead of to the core plug.

(e) For crush splicing, prepare and install the core plug as given in Figure 7/GENERAL.

(f) Apply Resin Mix 3 to lower face of the core plug.

(g) Insert the core plug into the core cavity. Orient the ribbon direction to align with the original core ribbon.

(h) Put the layup materials and equipment in place as given in Figure 4/GENERAL.

1) If the damage extends through both face skins, vacuum bag both sides of the panel (or the entire part) using the layup shown in Figure 4/GENERAL.

2) If the replacement core plug is less than or equal to 0.5 thick, use the heating blanket on the near side and locate at least two separate thermocouples on the panel surface at the bondline.

3) If the replacement core plug is greater than 0.5 thick and both sides are accessible, use heating blankets on both sides. Locate at least two separate thermocouples on the near side at the bondline and one on the far side corresponding to the center of the repair.

4) If the replacement core plug is greater than 0.5 thick and only one side is accessible, use the heating blanket on the near side and put at least two separate thermocouples into the repair hole so the thermocouples touch the repair materials at the bottom of the repair hole.

NOTE: The ends of these thermocouples will be cured into the adhesive. Cut the thermocouples leaving the embedded ends behind before applying the repair plies. Only the portion of the thermocouple embedded in the core can be left in the repair. The thermocouples cannot come between the repair plies and the sanded surfaces of the original plies.

(i) Vacuum bag the repair as given in Paragraph 3.F./GENERAL.

NOTE: A heat lamp may be used instead of a heat blanket to gel the core repair resin. Refer to the heat lamp temperature curve (Figure 9/GENERAL).

(j) Cure the core repair as given in Paragraph G.

NOTE: The core plug and the repair plies can be cured at the same time if the temperature can be adequately monitored by thermocouples placed on the outside surfaces of the panel (refer to 2D.(3)(h) 2) thru 4)). If the thermocouples must be embedded in the repair core adhesive, then the core plug must be cured separately to avoid curing the thermocouple between the repair plies and the sanded surface of the original plies.

If the core plug and repair plies are to be cured separately, the core plug can be partially cured instead of fully cured before the skin repair plies are applied. Allow the resin to gel by curing for 20 minutes at 150°F (66°C) then remove the bagging materials and continue with the repair (Figure 5/GENERAL, Detail I). The gelled core repair resin will reach full cure when the skin repair plies are cured (Figure 5/GENERAL, Detail II).

Monitor bondline temperatures throughout the cure. Failure to reach the necessary cure temperature for the specified cure period is cause for rejection of the repair.

(k) Allow the repair area to cool under vacuum until the temperature of the repair area is 125°F (52°C) or less. Then release restraints (if applicable) and remove layup materials and equipment.

(l) Sand core plug approximately flush with surrounding material, making allowance for adhesive and slight core crush during cure.

(m) Vacuum to remove sanding residue from core cells.

E. Prepare and Apply Repair Plies

NOTE: Refer to applicable paragraphs for preparation of glass and graphite fabrics. For hybrid components, refer to relevant material paragraphs for each individual ply. Aramid fabric damage will be repaired using glass fabric repair plies. Refer to Figure 17/GENERAL for substitution of glass fabric for aramid fabric.

CAUTION: USE OF PRECURED PATCHES IS NOT RECOMMENDED. PRECURED PATCHES BONDED TO THE STRUCTURE UNDER VACUUM PRESSURE ONLY AND LARGE PATCHES BONDED TO CONTOURED SURFACES CAN RESULT IN POROUS OR NONCONTINUOUS BONDLINES.

(1) Prepare glass fabric repair plies (BMS 9-3)

(a) Refer to the component structure identification to determine number, style, and orientation of glass fabric used in original structure. Repair existing Type 120 plies with Type D plies.

Repair existing Type 1581 plies with Type H-2 plies. Repair existing Type 7781 plies with Type H-3 plies. Refer to specific structural component repair section for extra repair ply requirements. Refer to Figure 17/GENERAL for substitution of glass fabric repair plies.

(b) From each type of material required, cut a piece that is large enough for cutting the required number of plies for the repair patch.

NOTE: In the patch, use one repair ply for each damaged ply of the original laminate, plus extra repair plies as indicated by specific structural component repair. Each repair ply must be the same orientation as the original plies. If extra repair plies are not required by individual repair, one extra ply is required and is to have the same orientation as the original surface ply. Refer to Figure 18/GENERAL for extra repair ply material and orientation.

(c) When replacing ply over core, a filler ply the size of the cutout is required to minimize surface depression.

(d) Impregnate repair plies with resin as given in Paragraph (3).

(2) Prepare graphite fabric repair plies (BMS 9-8). See Figure 17/GENERAL.

(a) Refer to the specific structural component identification to determine number, style, and orientation of graphite fabric used in original structure. Refer to the structural component repair section for extra repair ply requirements.

(b) From each type of material required, cut a piece that is large enough for cutting the required number of plies for the repair patch.

NOTE: In the patch, use one repair ply for each damaged ply of the original laminate, plus extra repair plies as indicated by specific structural component repair. Each repair ply must be the same orientation as the original plies. If extra repair plies are not required by individual repair, one extra ply is required and is to have the same orientation as the original surface ply. Refer to Figure 18/GENERAL for extra repair ply material and orientation.

(c) When replacing ply over core a filler ply the size of the cutout is required to minimize surface depression.

(d) Impregnate repair plies with resin as given in Paragraph 3.E.(3)/GENERAL.

(3) Impregnate repair plies with resin.

(a) Cut two pieces of parting film approximately 3.0 larger all around than the fabric and tape down one piece to a smooth surface.

NOTE: Use Teflon film or other parting films.

(b) Weigh the fabric to be impregnated. Multiply the weight by 1.3 for carbon fabric, or 1.0 for fiberglass fabric. The result gives you the quantity of 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 removed.

(c) Mix Resin Mix 2 and weigh it to find the correct amount necessary to impregnate the fabric.

(d) Put half of the resin in the center of the solid parting film.

(e) Lay the fabric onto the parting film and resin.

NOTE: Cut a piece of fabric that is large enough for cutting the required number of plies for the repair patch.

(f) Put the remaining laminating resin over the fabric in the center.

(g) Cover the fabric with parting film. Make sure that the parting film is smooth.

(h) 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.

NOTE: Resin content of the impregnated fabric shall be 55 ±5 percent by weight.

(i) Cut the impregnated fabric to the required sizes for each individual ply of the patch. The parting film on both sides of the fabric decreases fraying of the edges while cutting the fabric. Do not remove the solid parting film at this time.

NOTE: The total number of repair plies is to be in accordance with Paragraph 3.E.(2)/GENERAL Refer to Figure 8/GENERAL for required overlap of repair plies. The repair plies must be installed with the same orientation as that of the original plies being repaired. Where repair plies are to be applied over an exposed honeycomb core a filler ply the same size as the cutout is required to minimize surface depression. Extra repair plies must be installed as specified in individual structural component repair sections.

(4) Apply repair plies (Figure 14/GENERAL).

NOTE: Where the damage has occurred at a lap joint in the original laminates, it is not necessary to make a comparable lap in the repair plies. Where the original core was undamaged and was provided with a recess to match the lap joint, the recess should be filled with filler plies before application of the repair plies.

CAUTION: ENSURE THAT PARTING FILM IS REMOVED FROM REPAIR PLIES PRIOR TO LAYUP AND CURING. NONCOMPLIANCE WILL RESULT IN A RUINED REPAIR.

(a) Thoroughly coat face of exposed honeycomb core with Resin Mix 3 just prior to applying repair plies. Use of roller for resin application is recommended.

(b) Remove parting film from one side of the smallest ply of the patch and place the exposed face against the repair area with orientation as in original structure.

NOTE: The filler ply applied over the honeycomb core is to have the same orientation as the first repair ply.

(c) Use a squeegee over the parting film that covers the patch to remove wrinkles and entrapped air. Do not apply excessive pressure. Excessive pressure will produce a patch deficient in resin.

(d) After removing parting film from the contact faces, place the next larger size ply of the impregnated patch over the ply on the repair area with proper orientation and with overlap all around as given in Figure 8/GENERAL.

(e) Place succeeding plies of the patch as described in Paragraph (c) and (d).

(f) Proceed to layup/bagging procedure.

F. Layup/Bagging Procedure (Figure 4/GENERAL)

(1) Place a layer of dry peel ply over the last layer of repair material. Cut the peel ply so it is large enough to contact the surface bleeder. When removed after curing, the peel ply leaves a rough surface which may be sanded for refinishing or left as is for any subsequent bonding to the repair area. The peel ply also helps to prevent pits in the cured repair surface.

(2) Place a layer of perforated FEP parting film (1 mil thick) over the layup. Cut the FEP so that edges extend 3 inches past edge of repair.

(3) Secure three thermocouples (spaced evenly around repair) to the panel at the edge of the repair and connect them to the appropriate recorders.

(4) Place a layer of dry peel ply or Style 120 glass fabric (or equivalent thickness glass fabric) over the perforated FEP as a surface bleeder. Cut the surface bleeder so that the edges extend 2 inches beyond the edge of the perforated FEP.

(5) Place a layer of solid FEP parting film (2 mil thick) over the surface bleeder. Cut the solid FEP so that the edges are even with the edge of the perforated FEP.

(6) Place a layer of Airweave SS or Style 120 glass fabric over the solid FEP as a surface breather. Cut the surface breather so that the edges extend to the edge of the surface bleeder. Make certain the surface breather makes contact with they surface bleeder along the edges.

(7) Secure a vacuum line on the edge of the surface breather.

WARNING: USE HEAT CURING EQUIPMENT THAT IS ACCEPTABLE TO LOCAL FIRE PROTECTION AUTHORITIES. FAILURE TO COMPLY COULD CAUSE PERSONNEL INJURY.

(8) If a heat blanket is used as a heat source, perform the following steps:

NOTE: A heat blanket or an equivalent heat source may be used to cure the repair. Infrared heat lamps are not recommended for accelerated cures above 180°F (82°C).

If the repair is made on a structure too small to allow the heat blanket to be vacuum bagged, proceed to Paragraph (8) and place heat blanket over the vacuum bag. A second vacuum bag may then be placed over the part to hold the heat blanket in place.

(a) Place a heat blanket over the surface breather. The heat blanket must extend a minimum of 2 inches beyond the repair patch edges.

NOTE: When using a heat blanket larger than 12 inches on one side, an aluminum caul plate (0.016 inch thick) can be used under the heat blanket to minimize localized heating. Make the caul plate slightly smaller than the surface breather.

(b) Place controlling thermocouple over the center of the heat blanket.

(c) Place 4 to 6 layers of glass fabric over the heat blanket. The glass fabric will insulate the heat blanket and prevent damage to the bagging film.

(9) Apply extruded sealing compound around the entire repair area, approximately 6 inches outside the edge of the heat blanket.

CAUTION: THE ENTIRE SURFACE MUST BE VACUUM BAGGED AND THE ENTIRE COMPONENT RESTRAINED IN PLACE TO PREVENT DELAMINATION AND DISTORTION WHEN THE REPAIR AREA EXCEEDS 15 PERCENT OF PANEL AREA. REGARDLESS OF THE METHOD OF HEAT APPLICATION, RESTRAINING DEVICES THAT MAINTAIN THE CONTOUR AND SUPPORT THE PART MUST BE USED FOR LARGE PARTS WHERE SAGGING AND DISTORTION COULD OCCUR DUE TO THE WEIGHT OF THE PART.

(10) Lay a piece of vacuum bag material over the entire repair area, sealing the edge with the extruded sealing compound. Pleat the vacuum bag where needed to prevent bridging of bag material and subsequent bag breakage. Pad all sharp objects and corners to prevent bag breakage. It is optional to vacuum bag the entire part.

CAUTION: HOLLOW COMPOSITE COMPONENTS BUILT UP FROM TWO PANELS SUCH AS RUDDERS, ELEVATORS, AND AILERONS MUST NOT BE COMPLETELY VACUUM BAGGED BECAUSE THEY MAY COLLAPSE UNDER 22 INCHES OF MERCURY VACUUM. ATTACH THE VACUUM BAG TO ONE SIDE OF COMPONENT ONLY OR ATTACH SEPARATE VACUUM BAGS TO EACH PANEL OF THE COMPONENT TO ENSURE THAT ATMOSPHERIC PRESSURE INSIDE OF THE COMPONENT IS MAINTAINED DURING REPAIR. COMPONENTS CONSISTING OF A SINGLE PANEL MADE OF FULL DEPTH HONEYCOMB CORE WITH LAMINATE FACESHEETS AND EDGEBANDS MAY BE COMPLETELY VACUUM BAGGED (FIGURE 22/GENERAL).

(11) Evacuate the space under the vacuum bag and maintain a vacuum of 22 inches of mercury minimum during entire cure cycle.

(12) Check the vacuum bag for leak paths.

(13) Cure the repair as given in Paragraph 3.G./GENERAL.

WARNING: USE HEAT CURING EQUIPMENT THAT IS ACCEPTABLE TO LOCAL FIRE PROTECTION AUTHORITIES. NONCOMPLIANCE COULD CAUSE PERSONNEL INJURY.

CAUTION: SURFACE TEMPERATURE MUST NOT EXCEED CURE TEMPERATURE SPECIFIED IN THE SPECIFIC COMPONENT REPAIR SUBJECT. DAMAGE OR DISTORTION OF STRUCTURE MAY OCCUR IF TEMPERATURE EXCEEDS THAT SPECIFIED.

G. Cure the Repair

NOTE: Determination of the temperature must be made by using thermocouples placed at edge of the outermost ply in the repair patch.

In honeycomb panels, for repairs to both skins or single skin and partial depth core replacement using a septum, thermocouples must be located on both repair surfaces to monitor cure temperatures.

When using a hot bond repair console, consult manufacturer’s operating instructions.

(1) Raise the temperature at a maximum rate of 2° to 7°F (1° to 4°C) per minute to follow the cure cycle temperature-time profile shown in Figure 5/GENERAL. Cure as given in Figure 5/GENERAL at the temperature specified in the specific component structure repair subject. Determine cure temperature from thermocouple at the edge of the repair ply that has the lowest reading.

NOTE: Cure time does not include the time required for the mold and part to heat up to temperature. Cure time is the period after the part has reached that temperature.

(2) Cool down repair after cure period at a rate of 5°F (3°C) per minute maximum while still maintaining vacuum.

(3) When the repaired area has cooled to less than 125°F (52°C), release vacuum pressure and remove vacuum bagging materials and other layup materials.

H. After Completion of the Cure Cycle.

CAUTION: DO NOT SAND INTO THE INITIAL STRUCTURE. FAILURE TO COMPLY WILL REDUCE THE STRENGTH OF THE COMPONENT.

(1) If multiple cure cycles are to be used to cure groups of repair plies, you must prepare the surfaces of the repair between cure cycles.

NOTE: You can do an inspection between cure cycles to make sure that there are no empty spaces between the repair plies or defective bonds. Refer to Paragraph 3.I./GENERAL if you do an inspection, prepare the surface of the repair after the inspection.

(a) Abrade the largest cured repair ply. Extend the abraded area to 0.25 inches (6 mm) around the edge of the ply. Use 150-grit abrasive paper.

(b) Remove all sanding dust by applying oil free compressed air and using a vacuum cleaner.

WARNING: BREATHING VAPORS OR ALLOWING SOLVENT TO CONTACT SKIN OR EYES IS HAZARDOUS. HEAT, FIRE OR SPARKS CAN CAUSE AN EXPLOSION. USE MECHANICAL VENTILATION OR RESPIRATIORY PROTECTION WHEN WORKING IN A CONFINED SPACE OR AREA. AVOID CONTACT WITH SKIN, EYES AND CLOTHING. WEAR EYE PROTECTION. KEEP AWAY FROM SOURCES OF HEAT, FIRE OR SPARKS.

CAUTION: DO NOT IMMERSE PARTS IN SOLVENT OR ALLOW STANDING SOLVENT ON THE PART. DAMAGE TO THE PART WILL OCCUR.

(c) Wipe the surfaces to be repaired with a clean cloth, moistened with solvent Series 99. Refer to 51-30-03, GENERAL for a source of the solvents.

(d) Clean the surfaces again until a new moist cloth is clean after it is used.

(e) Remove the solvent from the surface before it can dry.

(f) Remove the remaining solvent film before you continue the repair.

(2) Refinish after Repair

(a) Lightly sand the edge of the topmost repair ply as necessary to fair the edge. Sand the surface of the repair to produce a smooth finish without damaging the fibers.

(b) Apply a finish to the repaired surface using the applicable methods that follow:

1) Where clear Poly Vinyl Flouride (PVF) film surfaces have been removed, seal with a brush coat of Resin Mix 5 (Figure 1/GENERAL). Cure as given in Figure 1/GENERAL.

2) Where grey or white PVF film surfaces have been removed, seal with Resin Mix 5 (Figure 1/GENERAL). Cure as given in Figure 1/GENERAL and apply one coat of BMS 10-11 primer and one coat of BMS 10-60 enamel (grey, BAC705; white, BAC7106).

3) Where the abrasion resistant Teflon finish has been removed from the internal surface of the panel edgeband, reapply the finish according to AMM 51-24-13.

4) Where the original painted surfaces have been removed, restore original finish according to AMM 51-21-00.

5) Where BMS 10-21 conductive coating has been removed, apply conductive finish according to AMM 51-24-02.

6) Where aluminum foil (BMS 8-289) has been removed, repair as given in 51-70-14, GENERAL.

7) Where aluminum flame sprayed areas have been damaged, repair as given in 51-70-14, GENERAL.

8) Where aluminum coated glass fabric (BMS 8-278) has been repaired, aluminum flame spray pas given in 51-70-14, GENERAL.

9) Where sealant has been removed from around fittings or fay surfaces to facilitate repairs, reapply BMS 5-26 in fuel tank areas or BMS 5-95 in all other areas as given in drawing requirements or 51-20-05, GENERAL.

10) Restore sealant applications of BMS 5-95 on exterior aramid surfaces as given in AMM 51-21-12.

I. Do the Post-Repair Procedures

(1) Do an inspection of the repair to make sure that it is satisfactory. Make sure that there are no empty spaces between plies or defective bonds. The inspection must include the area that was hot plus 2 inches minimum all around.

(2) If you find the repair to be unsatisfactory, you must remove it and install the repair again.

NOTE: The post-repair inspection is recommended. Examples of the inspection procedures are given in NDT Part 1, 51-01-01. Other inspection procedures that have been examined and found to be satisfactory by the airline can be used.

WARNING: MAKE SURE THAT THE OUTBOARD AILERON, ELEVATOR, AND RUDDER (CONTROL SURFACES) ARE BALANCED CORRECTLY AT ALL TIMES. IF YOU DO NOT, FLIGHT SAFETY CAN BE AFFECTED.

(3) After you repair a control surface, you must do a balance check to see if a rebalance is necessary. Refer to 51-60-00, GENERAL.

CAUTION: MAKE SURE THAT REPAIRS MADE TO CONTROL SURFACES AND/OR ADJACENT STRUCTURE DO NOT INTERFERE WITH THE DESIGNED OPERATION OF THE CONTROL SURFACES. DAMAGE TO THE AIRPLANE STRUCTURE CAN BE THE RESULT.

(4) Do a check of all repairs to make sure of clearance and non-interference with the operation of control surfaces.

(5) If a repair creates a blockage of a drain hole in the airplane structure, drill through the repair at the initial drain hole location with the applicable drill bit. Refer to AMM 51-41-00/201.

4. Typical Repairs

NOTE: Refer to the specific component repair section for the initial ply materials and the repair limits before you do these repairs.

A. Repair of Delaminations Between Plies

(1) Delamination of plies over core area of panel (Figure 10/GENERAL).

(a) Determine damage as given in Paragraph 3.A./GENERAL Ensure that water and other contamination are removed as given in Paragraph 3.B./GENERAL.

(b) Cut away delaminated plies and prepare damaged area as given in Paragraph 3.C./GENERAL. Do not remove any core.

(c) Complete repair as given in Paragraph 3.E./GENERAL thru Paragraph 3.I./GENERAL.

(2) Repair of delaminations between plies of panel edgeband (Figure 23/GENERAL).

CAUTION: DELAMINATION MUST NOT REACH DEEPER THAN 0.50 INTO PANEL EDGEBAND OR EXTEND TO WITHIN 0.50 OF HONEYCOMB CORE. SEE FIGURE 23/GENERAL. IF SO, REPAIR AS GIVEN IN THE DAMAGED PLY METHOD.

(a) Determine extent of damage.

(b) Remove all contaminants and water from damaged area. Area must be completely dried out.

(c) Force Resin Mix 2 (Figure 1/GENERAL) into delaminated area.

(d) Clamp plies together and remove excess resin.

(e) Cure at 200°F (93°C) as given in Paragraph 3.G./GENERAL, maintaining pressure until cured. Vacuum pressure is not required for this repair.

(f) Refinish surface as required.

(g) Perform applicable post-repair requirements as given in Paragraph 4.I./GENERAL before returning the repaired component to flight service.

B. Repair of Puncture, 0.50-inch Diameter or Less, in Honeycomb Panel (Figure 24/GENERAL).

(1) Remove clear or colored Tedlar film surface using No. 240 or finer Scotch-Brite abrasive, or No. 150 or finer sandpaper in the masked off area.

(2) Remove exterior finishes as applicable, including enamel finish and conductive coating, from the repair surface around the puncture using No. 150 or finer sandpaper.

(3) Dry out structure around puncture.

(4) Remove loose fragments and other contamination from the hole. Clean up damaged area to a smooth and rounded shape as given in Paragraph 3.C./GENERAL.

(5) Mix Resin Mix 4 according to Figure 1/GENERAL.

(6) Work resin into the hole filling as much as possible.

(7) Gel the potting resin as given in Figure 5/GENERAL.

(8) Carefully sand any projecting material to fair with surrounding surface within ±0.010 inch.

NOTE: A 0.010-inch thick aluminum template may be used to protect surrounding surface while sanding.

(9) Abrade surfaces around repair using No. 240, or finer, Scotch-Brite abrasive.

(10) Clean repair area as given in Paragraph 3.C.(2)/GENERAL.

(11) Prepare and apply two fabric cover plies and complete repair as given in Paragraph 3.E./GENERAL thru Paragraph 3.I./GENERAL.

C. Repair of Damage to One Skin and Honeycomb Core Using Replacement Core Plug, Punctures Greater than 0.50-inch Diameter (Figure 11/GENERAL).

(1) Determine extent of damage according to Paragraph 3.A./GENERAL.

(2) Ensure that all contamination and water are removed from damaged area (Ref Paragraph 3.B./GENERAL).

(3) Remove damage and prepare area according to Paragraph 3.C./GENERAL.

(4) Fabricate, clean, and install honeycomb replacement core plug as given in Paragraph 3.D./GENERAL.

(5) Sand core plug flush with surrounding surface, leaving allowance for slight core depression into filler plies during cure.

(6) Complete repair as given in Paragraph 3.E./GENERAL thru Paragraph 3.I./GENERAL.

D. Repair of Large Puncture Through Internal and External Surface of Panel Including Core Damage (Figure 12/GENERAL).

NOTE: For repair where access to inner surface is limited, refer to Paragraph 3.F./GENERAL.

(1) Determine extent of damage according to Paragraph 3.A./GENERAL.

(2) Remove all contamination and water from damaged area. Refer to Paragraph 3.B./GENERAL.

(3) Remove damage and prepare area according to Paragraph 3.C./GENERAL.

(4) Fabricate, clean, and install honeycomb replacement core plug as given in Paragraph 3.D./GENERAL, except it is not necessary to vacuum bag the core plug installation at this time.

(5) Prepare and apply repair plies to one surface of panel according to Paragraph 3.E./GENERAL. A caul plate may be used to restrain the core plug in place.

(6) Bag repair and cure according to Paragraph 3.F./GENERAL and Paragraph 3.G./GENERAL. Ensure that temperature is approximately equal on both sides of panel.

(7) Sand core plug approximately flush with surrounding material, making allowance for slight core crush during cure.

(8) Prepare and apply repair plies to the other surface of the panel according to Paragraph 3.E./GENERAL.

(9) Complete repair as given in Paragraph 3.F./GENERAL through Paragraph 3.I./GENERAL.

NOTE: The above two-stage cure procedure is recommended. As an option, a three-stage cure procedure may be used wherein the core plug installation and the repair plies on each side may be cured separately.

E. Replacement of Honeycomb Core on Damaged Edge of Panel (Figure 13/GENERAL).

(1) Determine extent of damage according to Paragraph 3.A./GENERAL.

(2) Remove all contamination and water from damaged area (Ref Paragraph 3.B./GENERAL).

(3) Remove damage and prepare area according to Paragraph 3.C./GENERAL.

(4) Fabricate, clean, and install honeycomb replacement core plug as given in Paragraph 3.D./GENERAL.

(5) Sand core plug approximately flush with surrounding core material, leaving allowance for slight core depression into the filler plies during cure.

(6) Clean surfaces according to Paragraph 3.C.(2)/GENERAL.

(7) Complete repair as given in Paragraph 3.E./GENERAL through Paragraph 3.I./GENERAL.

F. Repair of Hole through Both Skins of a Honeycomb Panel with Access Available from One Side (Figure 14/GENERAL).

NOTE: This repair applies to flat panels (or nearly flat panels) where the damage extends completely through a panel, but access is not readily available to repair the unexposed side, and the repair is accomplished in one operation, i.e., core repair and patch overlay repair cured together.

(1) Determine extent of damage.

(2) Make sure that all contamination and water is removed from the damaged area.

(3) Remove damage and prepare area as given in Paragraph 3.C./GENERAL and the following:

(a) Cut a hole in the outer skin and core (D diamter) to permit a repair to be made to the inner skin with the required overlap.

NOTE: D diameter = d + N + 1 d = maximum diameter of oval hole in inner skin N = number of plies in the inner skin

Stepping of the plies in the inner skin is not necessary for this repair.

(b) Clean out damaged area in inner skin leaving a oval shaped hole, refer to Figure 14/GENERAL, Detail II.

(c) Taper sand the outer skin plies as given in Paragraph 3.C.(2)/GENERAL.

(4) Fabricate an airtight patch, Figure 14/GENERAL, details II thru V to cover the oval hole from the inaccessible side as follows:

(a) Make a suitable mold on which to lay up the patch. A thin gage aluminum sheet or any smooth surface can be used as a mold.

(b) Cover the mold with parting film or a release agent.

(c) Lay up 5 plies of the same wet lay up material used in the repair on the mold, using the procedures of Paragraph 3.E.(2)/GENERAL and Paragraph 3.E.(3)/GENERAL, except that all repair plies will have the same diameter. Make diameter of repair plies at least equal to D diameter.

(d) Bag and cure the patch as given in Paragraph 3.F./GENERAL and Paragraph 3.G./GENERAL. Place thermocouples at edge of the patch before cure.

(e) Remove the patch from the mold.

(f) Cut an oval patch, whose small dimension will just fit through the oval hole in the inner skin, see Figure 14/GENERAL, Detail II.

(g) Drill a 1/8 diameter hole in the center of the patch for a cleco fastener.

(h) Abrade the surface of the patch using No. 150 or finer Scotch-Brite abrasive. Remove all sanding dust by applying oil-free compressed air and use a vacuum cleaner.

(i) Fabricate a strip of spring steel 1.0 x 18.0 inch maximum and drill a 1/8 diameter hole in the center for the cleco fastener.

(j) Assemble the patch and spring steel together with a 1/8 diameter cleco fastener, see Figure 14/GENERAL.

(5) Remove Tedlar, if required and abrade the underside of the inner skin to a distance of 0.4 from the edge of the elliptical cutout using No. 180 sandpaper or finer. Avoid abrasion of the existing ply filaments.

CAUTION: DO NOT IMMERSE PARTS IN SOLVENT OR ALLOW STANDING SOLVENT TO REMAIN ON PART. DAMAGE TO PART WILL OCCUR.

(6) Clean out the repair area with oil-free compressed air. Wipe the surface with a clean cloth moistened with solvent, Series 99 (AMM/ SOPM 20-30-99).

(7) Bend up both ends of the spring steel and apply adhesive BMS 5-25 or 5-92 to the patch, see Figure 14/GENERAL.

(8) Holding the spring steep up - insert the patch into the oval hole, and orientate so that the hole is covered. Release the spring steel so that it holds the patch tightly against the inner skin.

(9) Cure the adhesive as given in Figure 1/GENERAL. When cure is complete, remove the cleco fastener and spring. Fill hole for cleco fastener flush with sealant BMS 5-95, or adhesive BMS 5-25 or BMS 5-92. Allow this to cure.

(10) Clean out the repair area as given in Paragraph (6).

(11) Lay up the required number of repair plies for the inner skin patch using the procedures of Paragraph 3.E./GENERAL, except all repair plies will have the same D diameter (Paragraph (3)(a)). Use one ply for each damaged ply of the original laminate, plus two additional plies.

(12) Fabricate, clean and install core plug as given in Paragraph 3.D./GENERAL.

(13) Prepare and apply repair plies to the outer skin surface of the panel as given in Paragraph 3.E./GENERAL.

(14) Complete repair as given in Paragraph 3.F./GENERAL through Paragraph 3.I./GENERAL.

G. Repair of Damaged Skin Plies in Panel Edgeband (Figure 15/GENERAL).

(1) Determine extent of damage according to Paragraph 3.A./GENERAL.

(2) Remove all contamination and water from damaged area. Area must be completely dried out. Refer to Paragraph 3.B./GENERAL.

CAUTION: DO NOT SAND INTO BOND PLY OR CORE (FIGURE 15/GENERAL). LOSS OF STRUCTURAL STRENGTH OF THE COMPONENT WILL OCCUR. BOND PLY IS ADJACENT TO CORE.

(3) Remove damage and prepare area according to Paragraph 3.C./GENERAL.

CAUTION: ON HYBRID PANELS, ENSURE THAT GRAPHITE REPAIR PLIES DO NOT EXTEND INTO AREAS OF FASTENER HOLES. ELECTROLYSIS BETWEEN METAL FASTENERS, SUPPORT STRUCTURE AND GRAPHITE MAY OCCUR CAUSING CORROSION TO ALUMINUM STRUCTURES.

(4) Complete repair as given in Paragraph 3.E./GENERAL through Paragraph 3.I./GENERAL.

H. Repair of Damage and Punctures in Solid Laminate Panels (Figure 19/GENERAL).

NOTE: This repair applies to components made from laminated fabric and/or tape plies and epoxy resin without a honeycomb core.

(1) Determine extent of damage according to Paragraph 3.A./GENERAL.

(2) Remove all contamination and water from damaged area as given in Paragraph 3.B./GENERAL Area must be completely dried out. Any structure in the repair area that cannot be dried out must be removed along with the other damage.

(3) Remove damage and prepare area according to Paragraph 3.C./GENERAL.

NOTE: Taper sand edges of plies around repair on damaged side of panel.

(4) Prepare and apply repair plies according to Paragraph 3.E./GENERAL.

NOTE: If cleaned up damage penetrates solid laminate, secure a metal caul plate (such as 0.016 thick aluminum) to far side of panel to support repair plies.

(5) Complete repair as given in Paragraph 3.F./GENERAL through Paragraph 3.I./GENERAL.

I. Repair of Punctures, 0.50-Inch Diameter or Less, in Solid Laminate Panels (Figure 20/GENERAL).

NOTE: This repair applies to components made from laminated tape or fabric without a honeycomb core.

(1) Remove exterior finishes as applicable, including enamel finish and conductive coating, from the repair surface around the puncture using No. 150 or finer sandpaper.

(2) Remove all contamination and water from damaged area as given in Paragraph 3.B./GENERAL. Area must be completely dried out.

(3) Remove loose fragments and other contamination from the hole. Clean up damaged area to a smooth and rounded shape as given in Paragraph 3.C./GENERAL.

(4) Clean repair area as given in Paragraph 3.C.(2)(e)/GENERAL.

(5) Prepare Resin Mix 2, including 42 ±3 percent milled glass fiber, according to Figure 1/GENERAL.

(6) Work resin into the hole filling as much as possible.

(7) Cure according to Paragraph 3.G./GENERAL.

(8) Carefully sand any projecting material to fair with surrounding surface within ± 0.010 inch.

NOTE: A 0.010-inch thick aluminum template may be used to protect surrounding surface while sanding.

(9) Abrade surfaces around repair using No. 240, or finer, Scotch-Brite abrasive.

(10) Clean repair area as given in Paragraph 3.C.(2)(e)/GENERAL.

(11) Prepare and apply two fabric cover plies and complete repair as given in Paragraph 3.E./GENERAL thru Paragraph 3.I./GENERAL.

NOTE: Refer to specific component structure identification for laminate material and orientation as the original surface plies.

For aramid, fiberglass or hybrid laminates, use fiberglass repair plies with the same orientation as the original surface plies.

Refer to Figure 17/GENERAL for repair ply substitutions.

J. Repair of Delaminations Between Plies in Solid Laminate Panels

NOTE: This repair applies to components made from laminated tape or fabric without a honeycomb core.

(1) Repair delaminations using methods described in Paragraph 4.H./GENERAL.

K. Repair of Damaged Panel Attach Holes in Honeycomb Panel Edgebands or Along Edges of Solid Laminate Panels (Figure 16/GENERAL).

(1) Determine the extent of damage according to Paragraph 3.A./GENERAL.

(2) Remove all contamination and water from damaged area as given in Paragraph 3.B./GENERAL. Area must be completely dried out. Any structure in the repair area that cannot be dried out must be removed along with the other damage.

(3) Taper sand around the hole to remove damage according to Figure 16/GENERAL and Paragraph 3.C.(2)(d)/GENERAL.

(4) Clean area according to Paragraph 3.C.(2)(e)/GENERAL.

CAUTION: ON HYBRID PANELS, ENSURE THAT GRAPHITE REPAIR PLIES DO NOT EXTEND INTO AREAS OF FASTENER HOLES. ELECTROLYSIS BETWEEN METAL FASTENERS, SUPPORT STRUCTURE AND GRAPHITE MAY OCCUR CAUSING CORROSION TO ALUMINUM STRUCTURES.

(5) Complete repair Paragraph 3.E./GENERAL and Figure 16/GENERAL.

(6) Bag repair and cure Paragraph 3.F./GENERAL and Paragraph 3.G./GENERAL.

(7) Refinish the repair as given in Paragraph 3.H./GENERAL.

(8) Drill and countersink fastener holes. Refer to51-70-16, GENERAL for drilling composite structure.

(9) Perform applicable post-repair requirements as given in Paragraph 3.I./GENERAL before returning the repaired component to flight service.

L. Repair of Surface Dents

(1) Check for delamination and broken fibers as given in Paragraph 3.A./GENERAL.

(2) If delamination is found, repair as given in Paragraph A.

(3) If broken fibers are found, repair as given in Paragraph B. or C.

(4) If no delamination or broken fibers are found, repair as given in 51-70-03, GENERAL for graphite, aramid or hybrid components or 51-70-06, GENERAL for fiberglass components.

M. Repair of Damage to Solid Honeycomb Trailing Edge Wedge and Structural Solid Laminate Trailing Edge (Figure 21/GENERAL).

NOTE: This repair applies to components made with solid honeycomb trailing edge wedge and structural solid laminate trailing edge.

This repair is made in two stages: (a) Lower skin and honeycomb core (b) Upper skin and solid laminate wedge

REPAIR

STAGE I:

CAUTION: SOME COMPONENTS HAVE 350°F (177°C) LAMINATED SKINS BONDED TO THE CORE WITH 250°F (121°C) CURE ADHESIVE. REPAIRS MUST BE MADE USING 200°F (94°C) CURE MATERIALS TO PREVENT SKIN-TO-CORE DISBONDING.

(1) Determine extent of damage as given in Paragraph 3.A./GENERAL.

(2) Remove moisture and debris as given in Paragraph 3.B./GENERAL.

NOTE: Do not taper sand upper surface skin plies during stage I of repair.

(3) Remove damage and prepare lower surface for repair as given in Paragraph 3.C./GENERAL.

NOTE: Caul plate must cover an area that extends a minimum of 2 inches beyond damage cutout. Caul plate must extend aft to the original trailing edge location.

(4) Attach caul plate to upper surface.

NOTE: Honeycomb core repair wedge must extend aft beyond the original trailing edge location to maintain lower surface contour. Ribbon direction of core repair wedge must be the same ribbon direction as the original core.

(5) Fabricate a honeycomb core repair wedge as given in Paragraph 3.D./GENERAL. Sand the repair core to a thickness that will accommodate the lower surface skin repair plies and taper the core to conform with the contour of the component.

NOTE: Repair plies must extend aft beyond the existing trailing edge location.

(6) Prepare the lower surface skin repair plies as given in Paragraph 3.E./GENERAL.

(7) Apply potting resin to core splice areas and fit repair core wedge in place as given in Paragraph 3.D./GENERAL.

NOTE: Seal caul plate to lower surface or wrap vacuum bag around the trailing edge and enclose both the repair area and the caul plate in order to maintain vacuum pressure during cure.

(8) Layup the lower surface skin repair plies and vacuum bag repair as given in Paragraph 3.F./GENERAL.

(9) Cure the repair as given in Paragraph 3.G./GENERAL.

(10) Remove all bagging materials and caul plate.

REPAIR STAGE II:

NOTE: Caul plate must cover an area extending a minimum of 1 inch beyond the periphery of the lower surface repair area and aft a minimum of 2 inches beyond the trailing edge location. See Figure 21/GENERAL, Sheet 3.

(11) Attach caul plate to the lower surface.

(12) Taper sand the upper skin plies, the repair core wedge, and the existing laminate wedge plies to accommodate the wedge repair plies and upper surface skin repair plies. Refer to Paragraph 3.D./GENERAL and Figure 21/GENERAL, Detail II.

NOTE: Wedge repair plies must be layed up so the thickness of the original wedge is obtained. Allow for accommodation of the upper skin repair plies and maintain the contour of the upper skin surface.

(13) Prepare the laminate wedge repair plies as given in Paragraph 3.E./GENERAL.

(14) Prepare the upper surface skin repair plies as given in Paragraph 3.E./GENERAL.

(15) Layup the wedge repair plies and upper surface skin repair and vacuum bag the repair as given in Paragraph 3.F./GENERAL.

(16) Cure the repair as given in Paragraph 3.G./GENERAL.

(17) Carefully trim the trailing edge of the repair to conform to the existing trailing edge.

(18) Restore original finish as given in Paragraph 3.H./GENERAL.

(19) Perform post repair requirements as given in Paragraph 3.I./GENERAL.

RESIN TYPE	COMPONENTS	PARTS BY WEIGHT	OPEN TIME BEFORE USE, OR POT LIFE OF MIXTURE	CURING TIME [A] [B] [C]
RESIN MIX 1 (POTTING RESIN) (BMS 5-28, TYPE 7)	CG-1305 RESIN CG-1305 HARDENER MICROBALLOONS	100 ±5 22 ±1 6	60 MINUTES AT 77°F (25°C)	7 DAYS AT 77 ±2°F (25 ±1°C) 90 MINUTES AT 260 ±10°F (127 ±6°C) 60 MINUTES AT 350 ±10°F (177 ±6°C) [D]
	FR 7162A RESIN FR 7162B HARDENER MICROBALLOONS	100 ±5 40 ±2 7		
RESIN MIX 2 (LAMINATING RESIN) (BMS 8-301, CLASS I)	EA 9390A BASE EA 9390B HARDENER	100 ±5 56	2 HOURS AT 77°F (25°C)	220 MINUTES AT 200 ±10°F (93 ±6°C) OR 180 MINUTES AT 230 ±10°F (110 ±6°C)
RESIN MIX 3 (POTTING RESIN)	RESIN MIX 2 CAB-O-SIL (FUMED SILICA)	100 4 ±0.5	SAME AS RESIN MIX 2	SAME AS RESIN MIX 2
RESIN MIX 4 (POTTING RESIN)	RESIN MIX 2 MILLED GLASS FIBER (1/32-INCH LONG)	80 20	SAME AS RESIN MIX 2	SAME AS RESIN MIX 2
RESIN MIX 5 (SEALER RESIN) (BMS 8-207, TYPE 1, CLASS I)	EC1838A RESIN EC1838B HARDENER	50 50	20 MINUTES AT 75° TO 79°F (24° TO 26°C)	2 HRS AT 105° (41°C) TO 125°F (52°C)
RESIN MIX 5 (SEALER RESIN) ALTERNATE (BMS 8-207, TYPE 1, CLASS II)	FR-40 RESIN FR-5413C HARDENER	100 ±1 15 ±0.5	20 MINUTES AT 75° TO 79°F (24° TO 26°C)	12 HRS MIN AT ROOM TEMP (65°F MIN) (19°C MIN) 1 HR MIN AT 150°F (66°C) TO 170°F (77°C)
RESIN MIX 5 (SEALER RESIN) ALTERNATE	EPIBOND 156A RESIN EPIBOND 941 HARDENER	100 ±2 10 ±0.5	45 TO 60 MINUTES AT 70°F (21°C)	SEE FIG. 9
RESIN MIX 5 (SEALER RESIN) ALTERNATE	EPIBOND 156A RESIN EPIBOND 156B HARDENER	100 ±2 6 ±0.3	15 TO 25 MINUTES AT 77°F (25°C)	12 HRS AT 70°F (21°C) OR 1 TO 3 HRS AT 150°F (66°C)
RESIN MIX 5 (SEALER RESIN) ALTERNATE	FR-5318S RESIN FR-5318C HARDENER	100 ±2 50 ±1	45 TO 60 MINUTES AT 70°F (21°C)	SEE FIG. 9
RESIN MIX 5 EPOX-O WELD (SEALER RESIN) ALTERNATE	TWO COMPONENT KIT	FOLLOW MANUFACTURERS INSTRUCTIONS FURNISHED WITH EACH KIT		
			45 TO 60 MINUTES AT 70°F (21°C)	SEE FIG. 9

Resin Specifications and Mixing Procedures
Figure 1 (Sheet 1 of 2)

RESIN TYPE	COMPONENTS	PARTS BY WEIGHT	OPEN TIME BEFORE USE, OR POT LIFE OF MIXTURE	CURING TIME
BMS 5-25 TYPE II, GRADE 1 ADHESIVE	EPIBOND 1539A EPIBOND 1539B-10	113 ±5.6 100 ±5.0	60 MINUTES AT 70°F (21°C) TO 80°F (27°C)	12 HRS MIN AT 65°F (19°C) TO 100°F (38°C). 2 HRS MIN AT 115°F (46°C) TO 135°F (57°C)
BMS 5-92 TYPE I ADHESIVE	EC2216A GRAY EC2216B WHITE	140 100	2 HRS BELOW 100°F (38°C)	24 HRS MIN AT 65°F (19°C) TO 100°F (38°C). 180 ±10 MINUTES AT 110°F (43°C) TO 130°F (54°C)

WARNING: THESE CHEMICALS CONTAIN TOXIC INGREDIENTS. PROVIDE ADEQUATE VENTILATION AND PROTECT THE SKIN AND EYES FROM CONTACT WITH UNCURED RESINS OR CURING AGENT. WEAR NEOPRENE GLOVES OVER COTTON GLOVES FOR PROTECTION OF HANDS. IF SKIN IS EXPOSED TO DIRECT CONTACT WITH UNCURED RESINS OR CURING AGENT, WASH WITH WARM WATER OR SOAP. AVOID THE USE OF SOLVENTS FOR CLEANING THE SKIN.

CAUTION: TO PREVENT CONTAMINATION OF THE RESIN, DO NOT USE WAXED CONTAINERS FOR MIXING.

	MIXING PROCEDURE
RESIN MIX 1	1. ADD PHENOLIC MICROBALLOONS TO RESIN AND MIX THOROUGHLY. 2. ADD HARDENER AND MIX THOROUGHLY.
RESIN MIX 2 RESIN MIX 5 BMS 5-25 BMS 5-92	ADD HARDENER TO RESIN AND MIX THOROUGHLY.
RESIN MIX 3	ADD CAB-O-SIL TO RESIN MIX 2 AND MIX THOROUGHLY.
RESIN MIX 4	ADD MILLED GLASS FIBERS TO RESIN MIX TO PROVIDE A CONSISTENCY SIMILAR TO A THIN PUTTY.

NOTES

- REFER TO SRM 51-30-00 FOR SOURCES OF MATERIALS

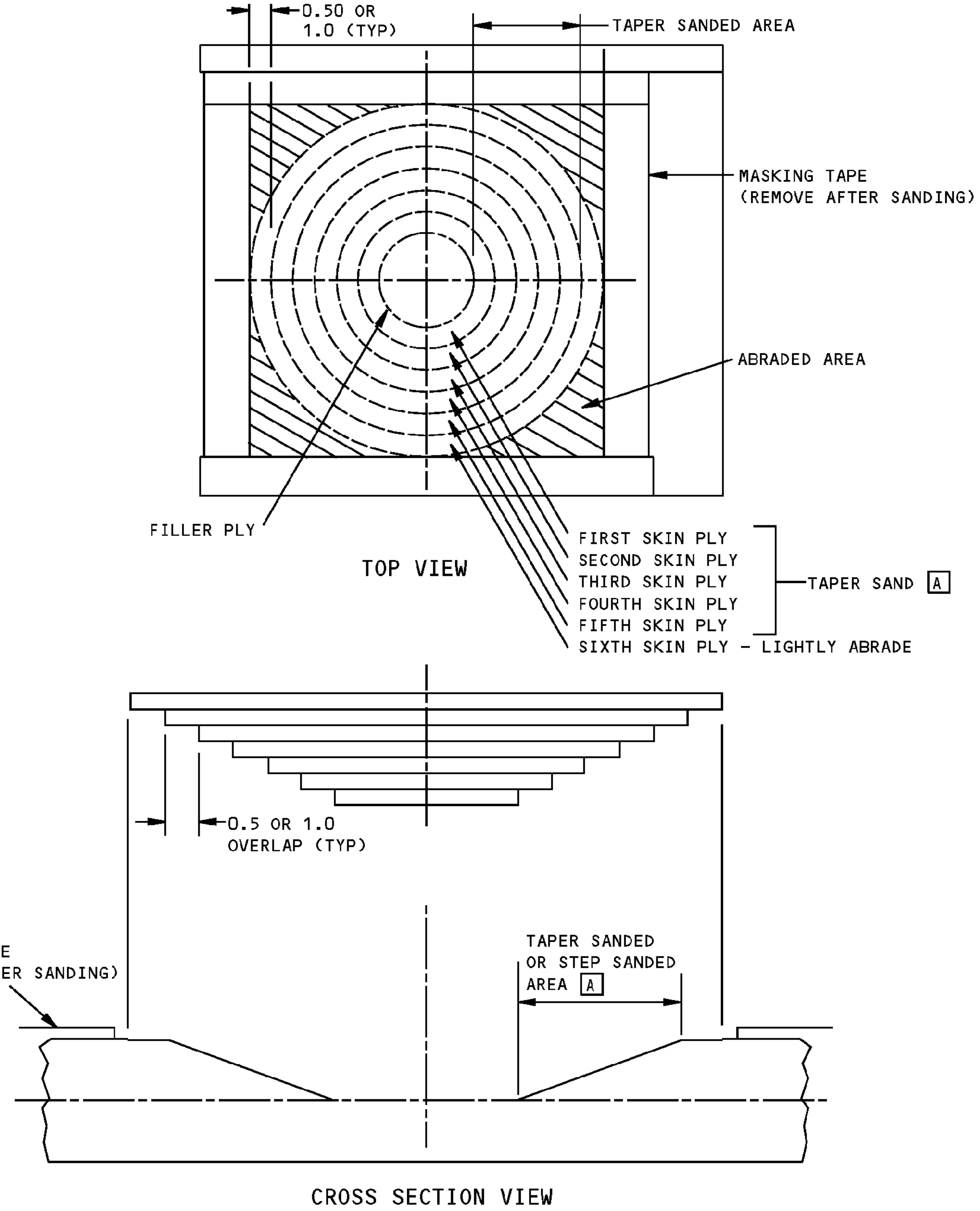
$\boxed{A}$ CURE TIME IS THE MINIMUM TIME REQUIRED TO CURE PRIOR TO HANDLING OR SANDING.

$\boxed{B}$ IF HEAT LAMP IS USED AS A HEAT SOURCE, SEE FIG. 9 FOR HEAT LAMP TEMPERATURE CURVE.

$\boxed{C}$ SEE FIG. 5 WHEN CURING RESINS ABOVE 125°F (57°C).

$\boxed{D}$ BMS 5-28, TYPE 7 MUST GEL PRIOR TO RAISING CURE TEMPERATURE HIGHER THAN 150°F (66°C).

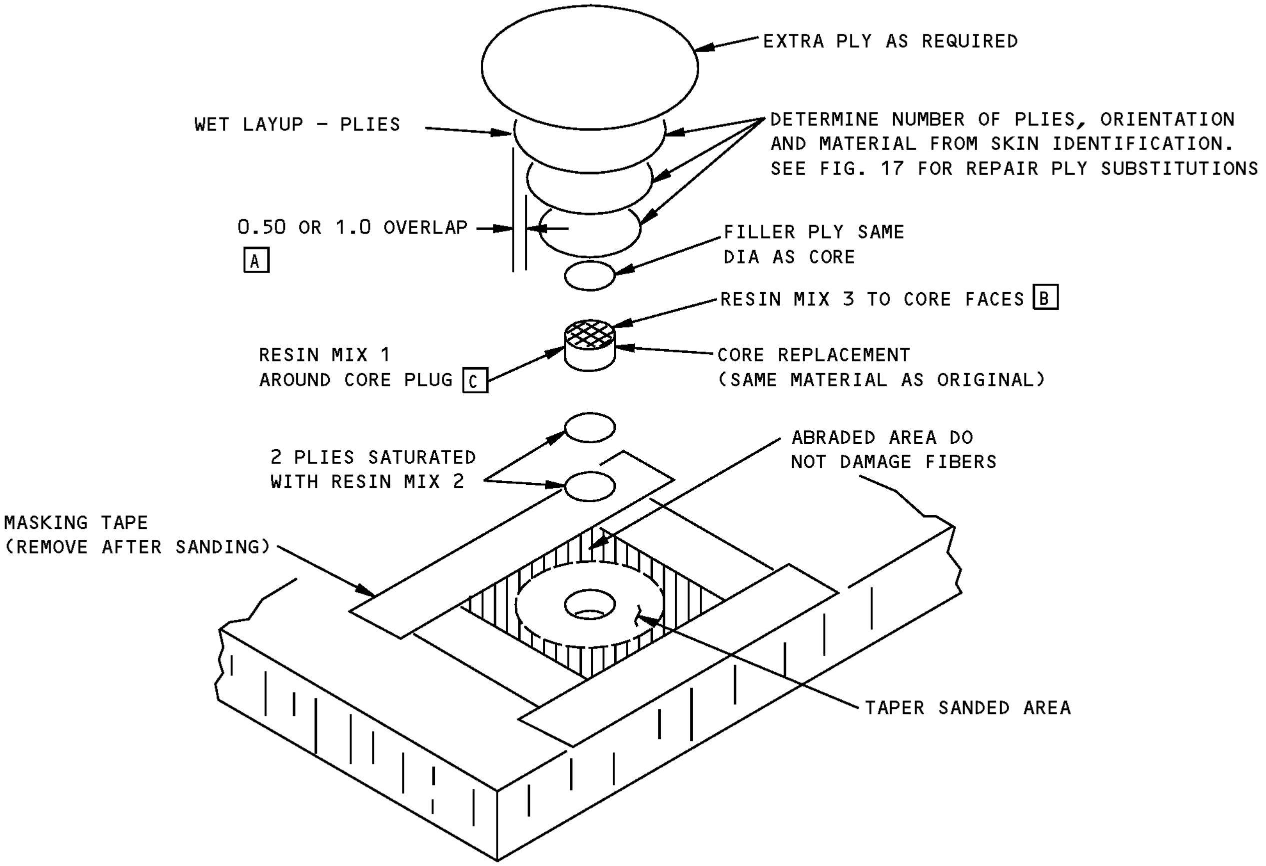
Resin Specifications and Mixing Procedures
Figure 1 (Sheet 2 of 2)



NOTES

A TAPER SANDING FOR SOLID LAMINATES SHOWN. SANDING FOR HONEYCOMB AREAS SIMILAR - OPTIONAL USE STEP TAPER (TAPER SANDING NOT REQUIRED IN NONCRITICAL AERODYNAMIC AREAS OF HONEYCOMB SKIN)

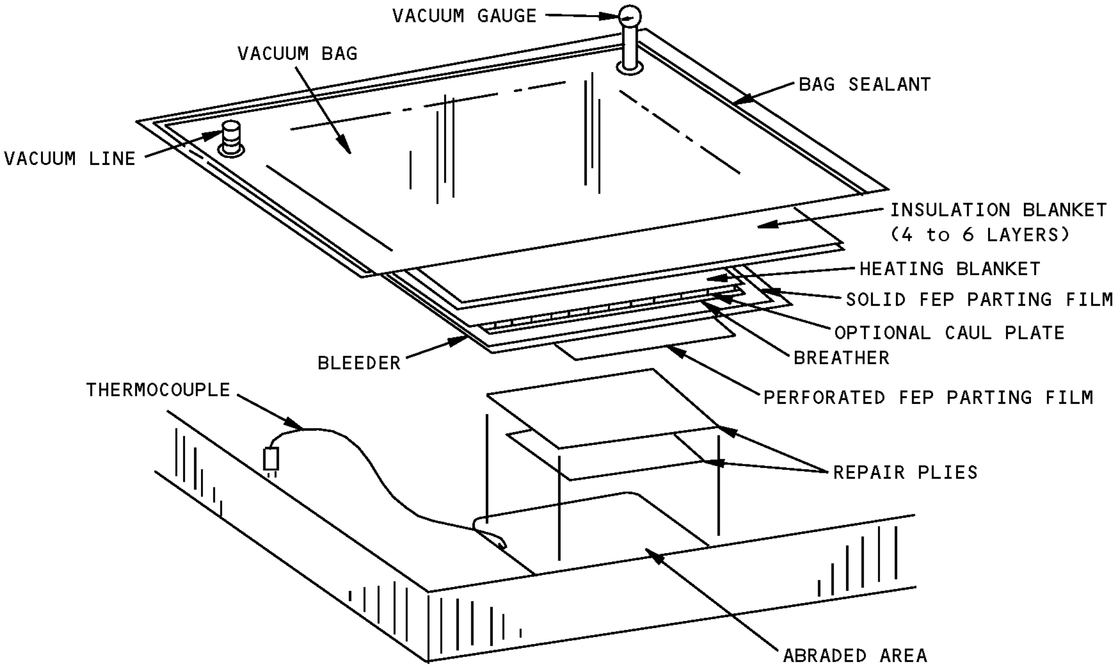
Sanding
Figure 2



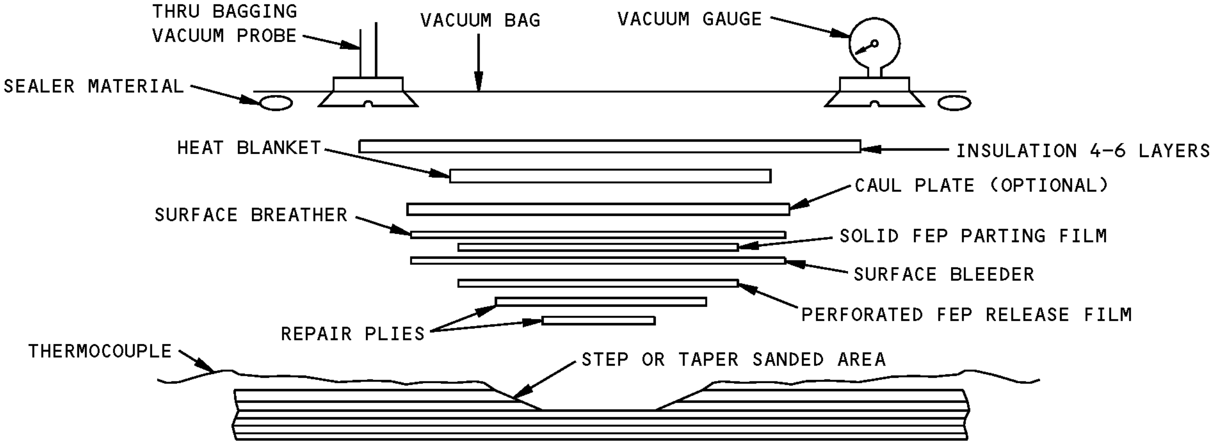
NOTES

- A SOME 350°F (117°C) ORIGINAL CURE TEMPERATURE COMPONENTS IN HEAT-AFFECTED ZONES REQUIRE 1.00 MINIMUM OVERLAP FOR EACH REPAIR PLY AND ARE IDENTIFIED IN THE COMPONENT REPAIR CHARTS. ALL OTHER COMPONENTS 0.50 MINIMUM OVERLAP
- B APPLY RESIN MIX 3 TO LOWER FACE JUST PRIOR TO CORE PLUG INSERTION AND TO UPPER FACE JUST PRIOR TO REPAIR PLY APPLICATION
- C RESIN MIX 1 MAY BE APPLIED TO PERIPHERY OF EXISTING CORE INSTEAD OF ON CORE PLUG

Typical Repair for Hole Damage thru One Skin and Core
Figure 3

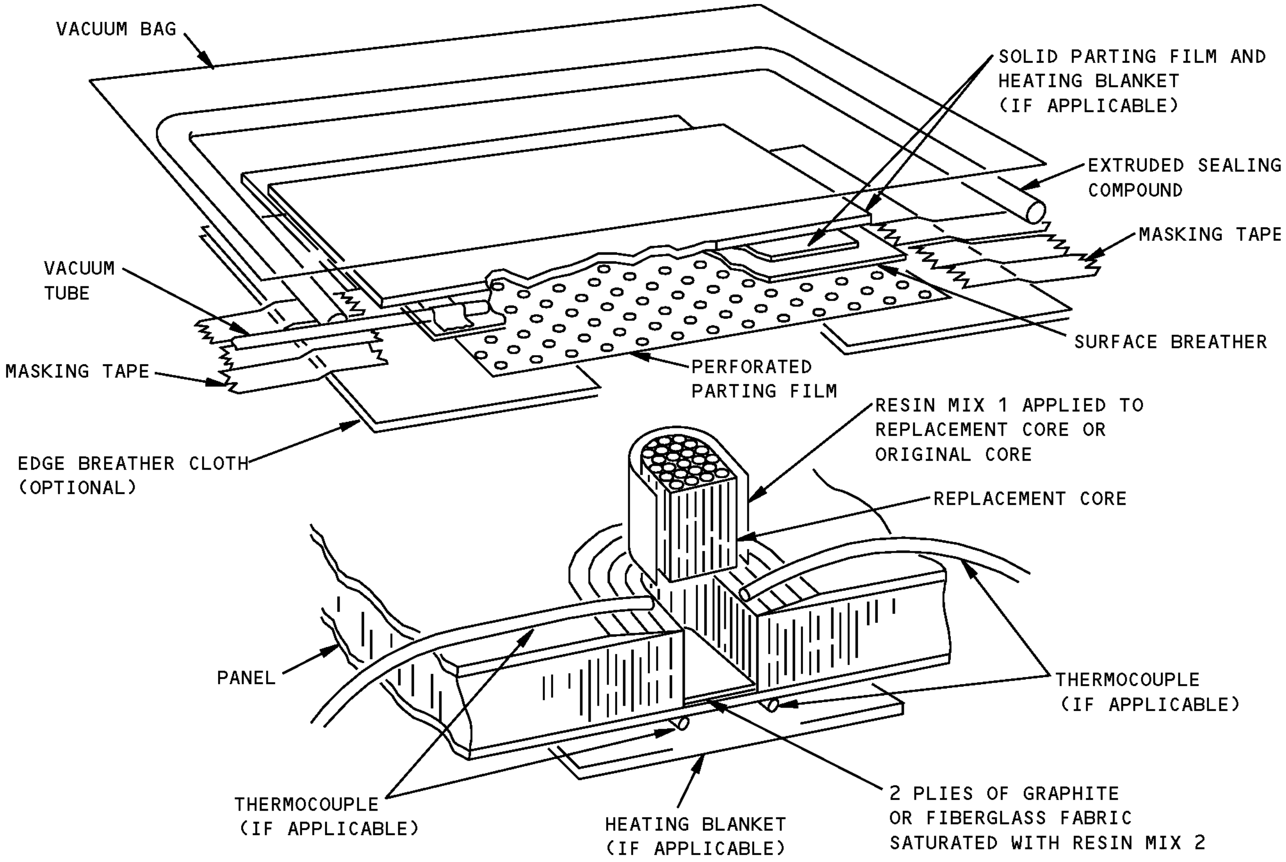


SKIN PLY REPAIR

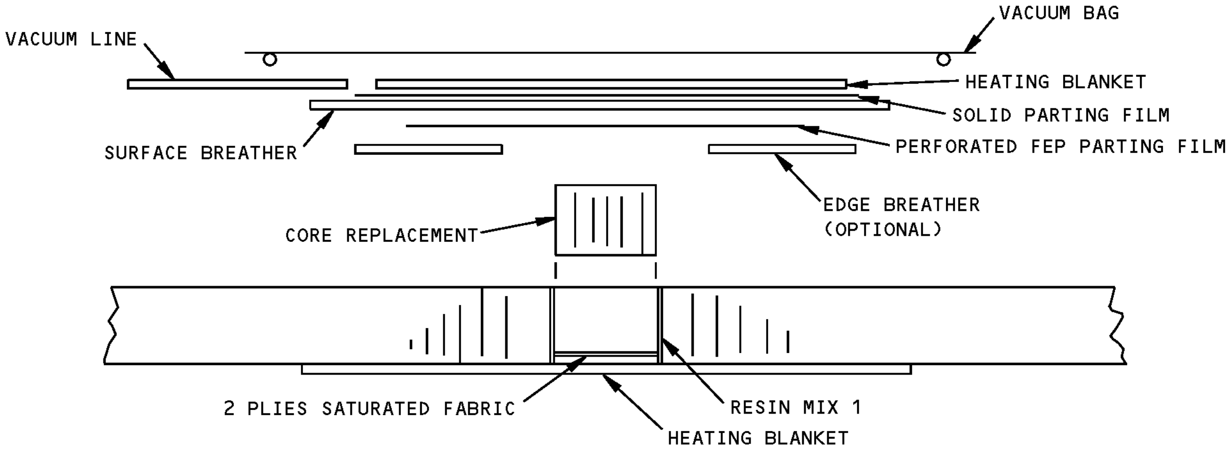


SECTION THRU LAYUP FOR SKIN PLY REPAIR

Skin Repair Layup
Figure 4 (Sheet 1 of 2)

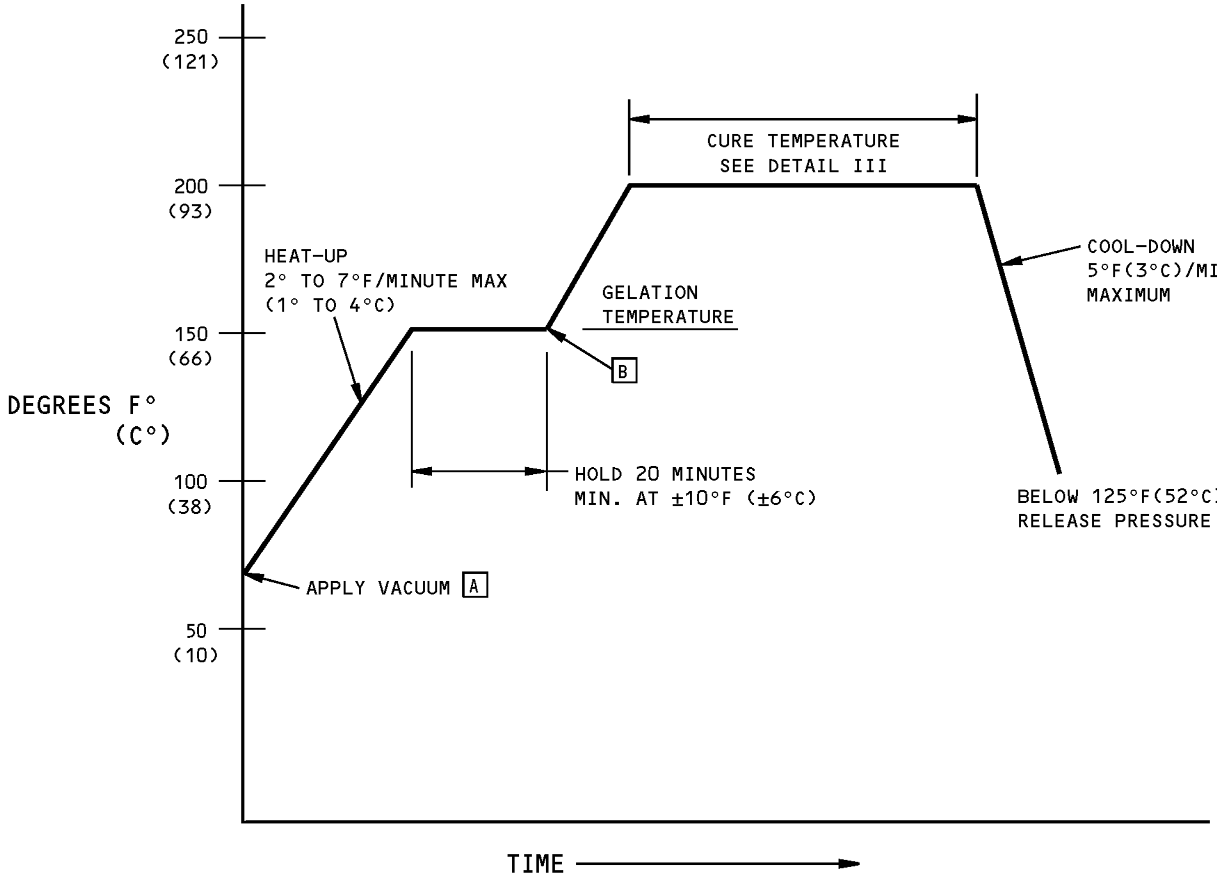


BAGGING SEQUENCE FOR CORE REPLACEMENT



SECTION THRU LAYUP FOR CORE REPLACEMENT

Skin Repair Layup
Figure 4 (Sheet 2 of 2)



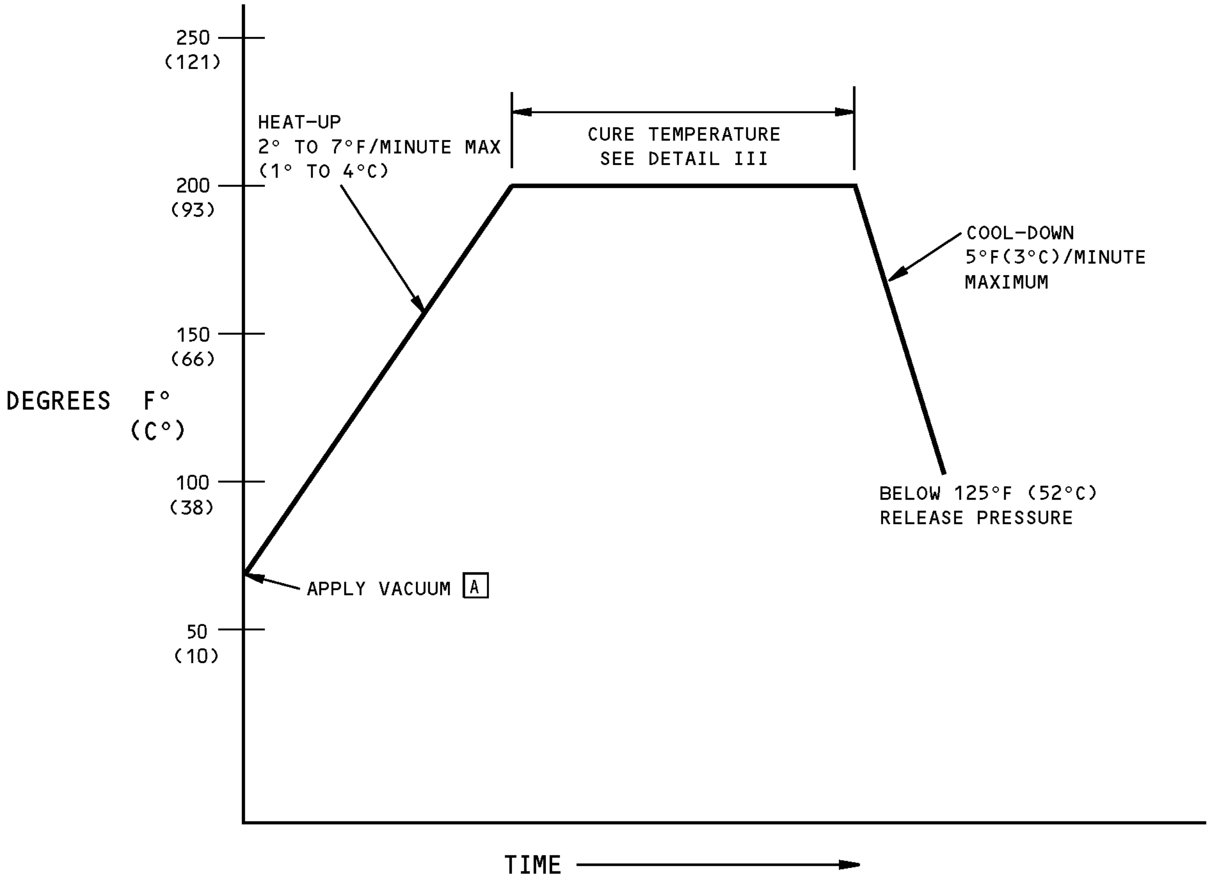
CURE CYCLE FOR HONEYCOMB CORE
DETAIL I

NOTES

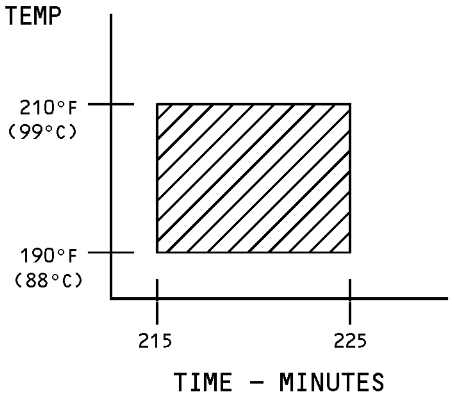
A MAINTAIN 22 INCHES VACUUM MINIMUM DURING ENTIRE CURE CYCLE

B HEAT MAY BE TURNED OFF AT THIS POINT; CORE SANDED AND SKIN REPAIR PLIES APPLIED AND COCURED TO THE REQUIRED CURE TEMPERATURE. SEE DETAIL II FOR CURE CYCLE FOR REPAIR PLIES

Cure Cycle
Figure 5 (Sheet 1 of 2)

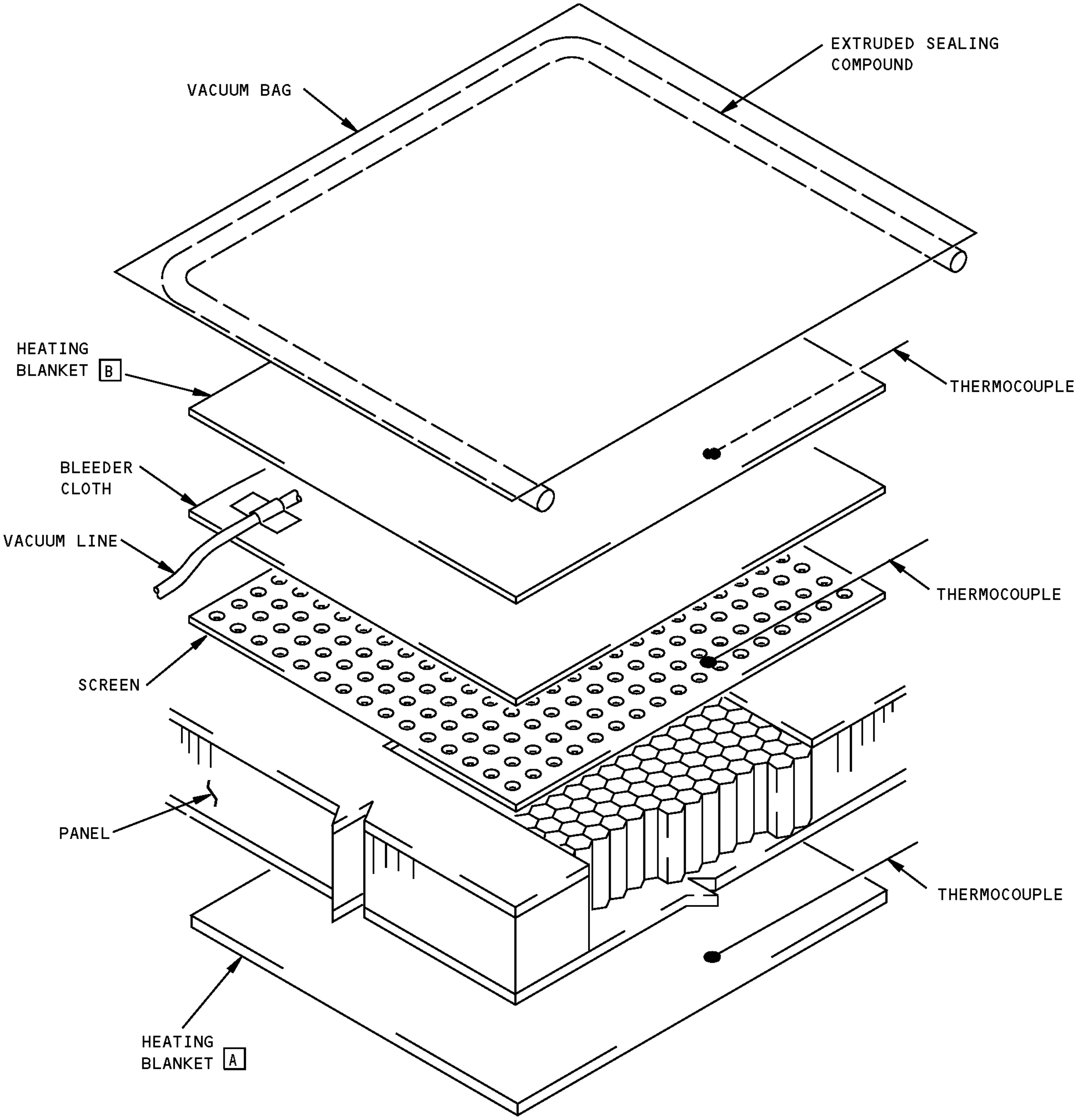


CURE CYCLE FOR REPAIR PLIES
DETAIL II



DETAIL III

Cure Cycle
Figure 5 (Sheet 2 of 2)

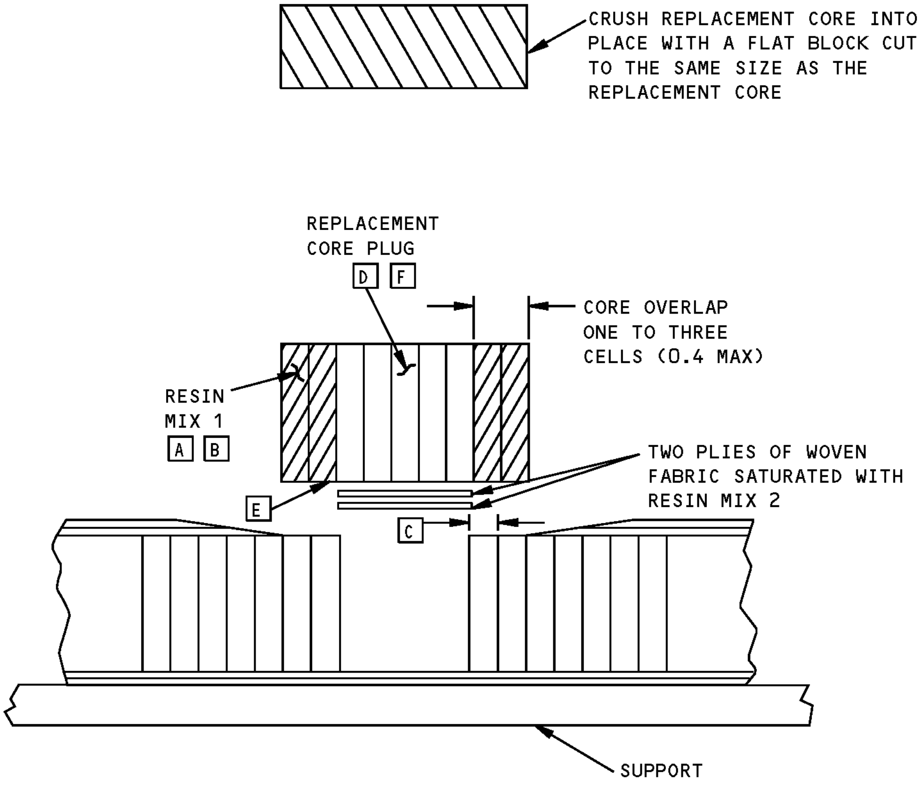


NOTES

A PREFERRED LOCATION OF HEATING BLANKET WHEN OPPOSITE FACE IS ACCESSIBLE

B ALTERNATE LOCATION OF HEATING BLANKET WHEN OPPOSITE SIDE IS INACCESSIBLE. THIS LOCATION MAY BE USED FOR AN ADDITIONAAL HEATING BLANKET TO ACCELERATE WATER REMOVAL

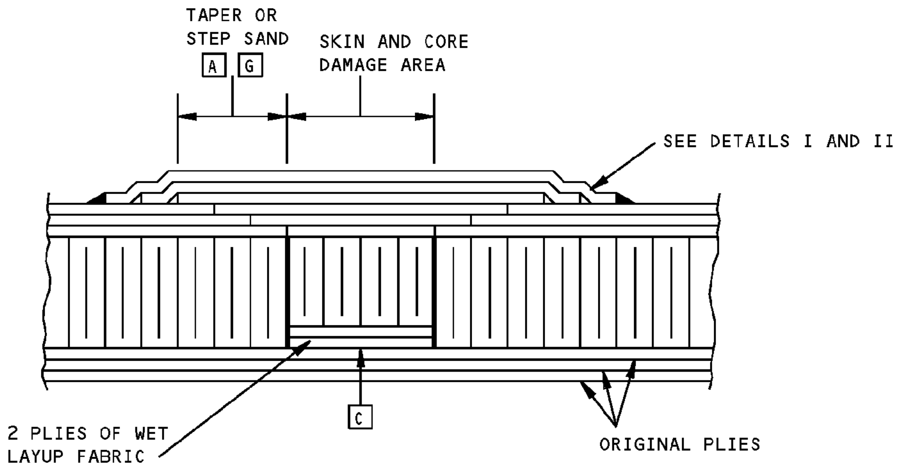
Water Removal From Honeycomb Sandwich
Figure 6



NOTES

- A DIP PERIPHERY OF CORE PLUG IN RESIN MIX 1 TO A DEPTH OF ONE TO THREE CELLS (0.4 MAX)
- B AFTER SPLICING, POUR RESIN MIX 1 INTO SPLICED CELLS
- C WHEN PREPARING REPAIR AREA LEAVE ONE TO THREE CELLS (0.4 MAX) VISIBLE BETWEEN CORE REPAIR CAVITY AND SKIN TO MATCH CORE OVERLAP
- D ALIGN HONEYCOMB CELLS OF REPAIR PLUG WITH ORIGINAL CORE
- E ROLLER APPLY RESIN MIX 3 TO FACE OF CORE
- F REPLACEMENT CORE PLUG MUST BE MADE FROM CORE MATERIAL AT LEAST TWO GRADES DENSER THAN THE ORIGINAL CORE

Core Crush Splicing Requirements
Figure 7



SECTION THROUGH TYPICAL REPAIR
(WET LAYUP ONLY)

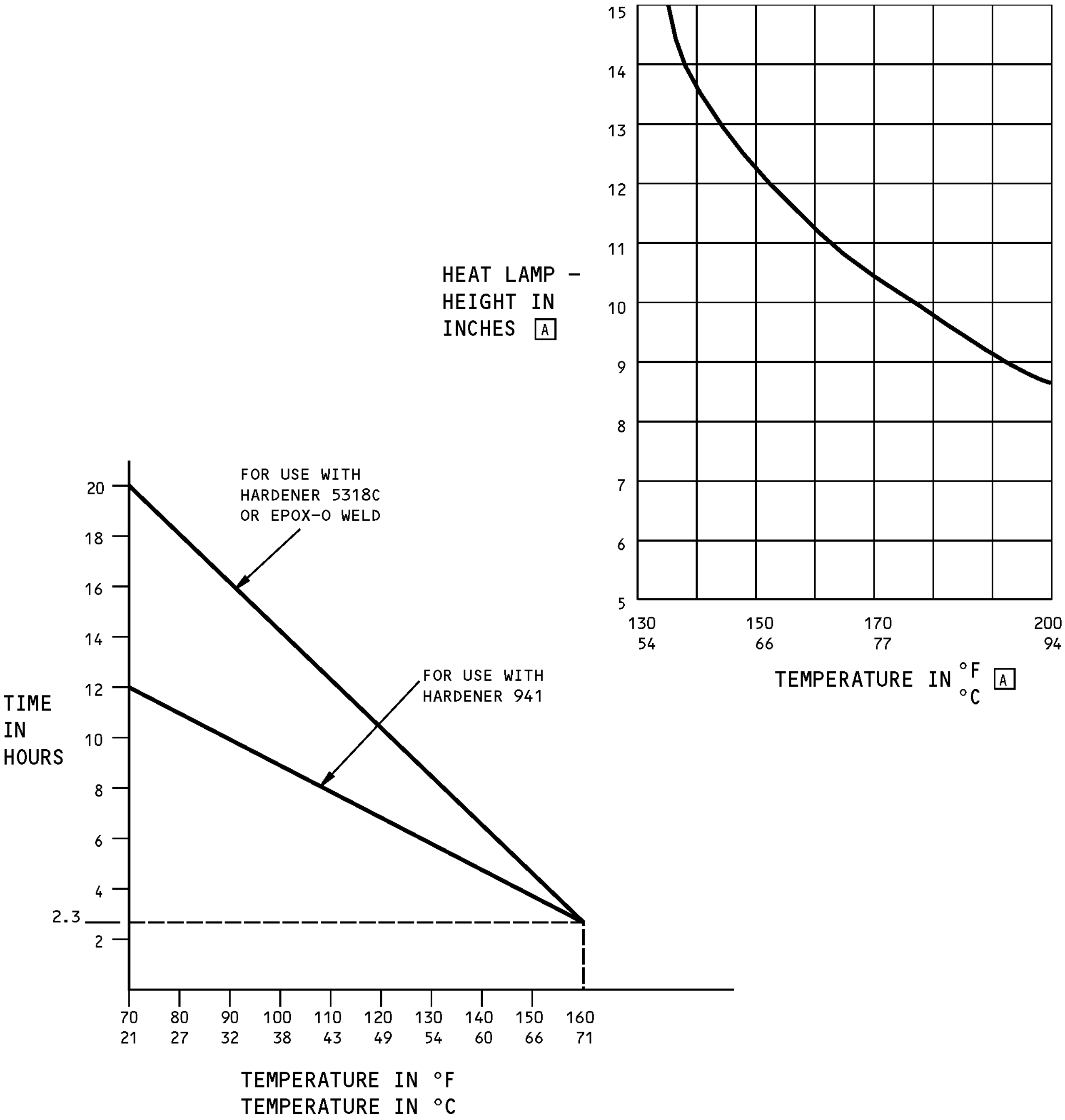
TAPER SANDED SKIN
DETAIL I

STEP SANDED SKIN
DETAIL II

NOTES

- A TAPER SAND AROUND REPAIR AREA OVER DISTANCE OF 0.50 OR 1.00 INCH FOR EACH EXISTING PLY G
- B DO NOT EXPOSE OR DAMAGE FILAMENTS IN UNTAPERED AREA WHEN SANDING
- C SANDING MUST NOT EXPOSE OR DAMAGE THE FILAMENTS IN BOND PLY (PLY BONDED TO CORE)
- D EACH PLY MUST OVERLAP AT LEAST 0.50 OR 1.00 INCH PAST EDGE OF PRECEEDING PLY E
- E THE MINIMUM OVERLAP REQUIREMENT OF 0.50 IS TYPICAL FOR MOST REPAIRS. SOME HEAT-AFFECTED ZONES MADE FROM 350°F (177°C) ORIGINAL CURE TEMPERATURE COMPONENTS REQUIRE 1.00 MINIMUM OVERLAP AND AIR IDENTIFIED IN COMPONENT REPAIR CHARTS
- F REMOVE DAMAGED PLIES IN STEPS OF 0.50 OR 1.00 INCH FOR EACH EXISTING PLY E
- G TAPER SAND SURFACES IN AREAS OF CRITICAL AERODYNAMIC SMOOTHNESS. REFER TO 51-10-01

Sanding and Overlap Requirements
Figure 8

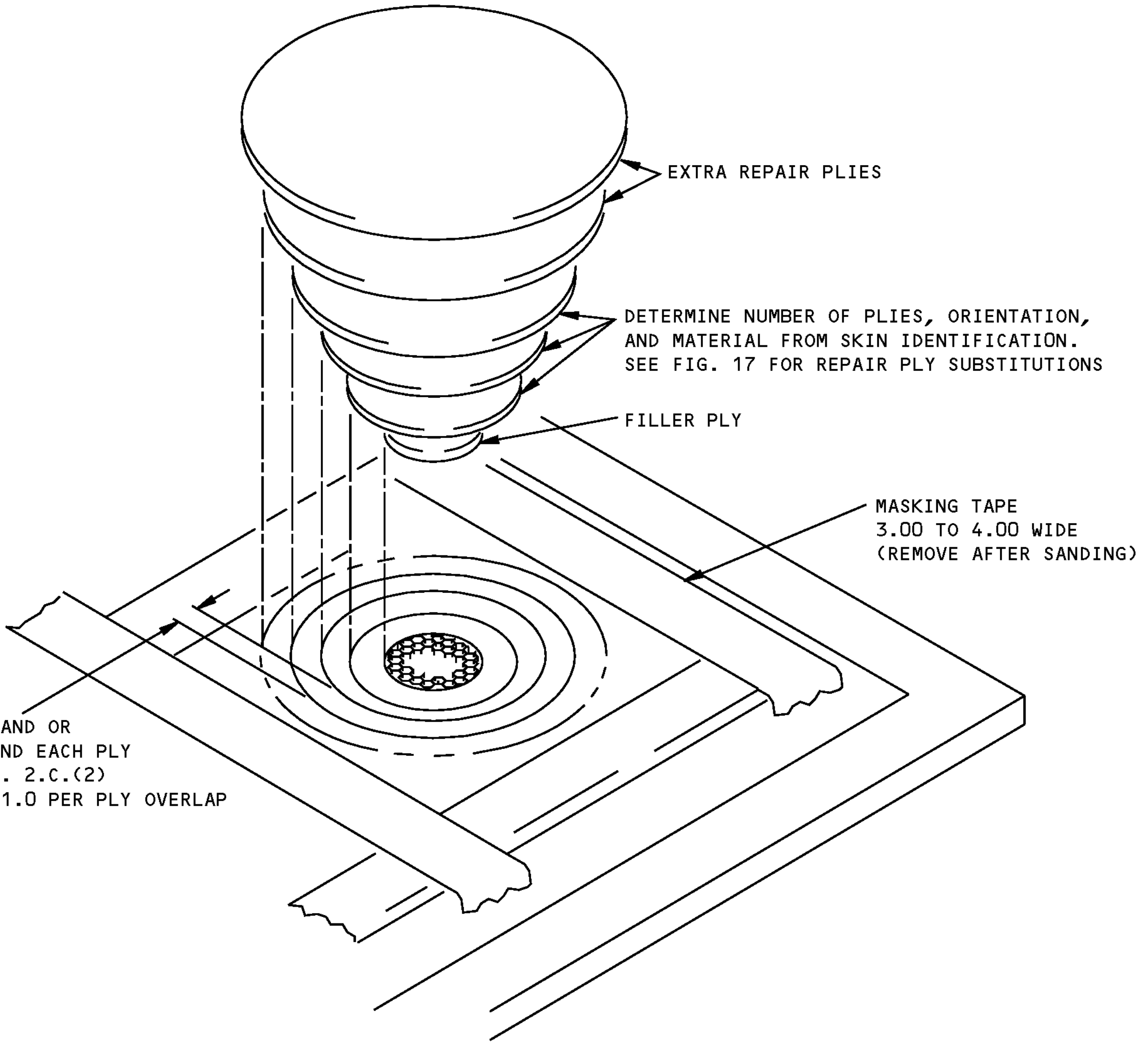


NOTES

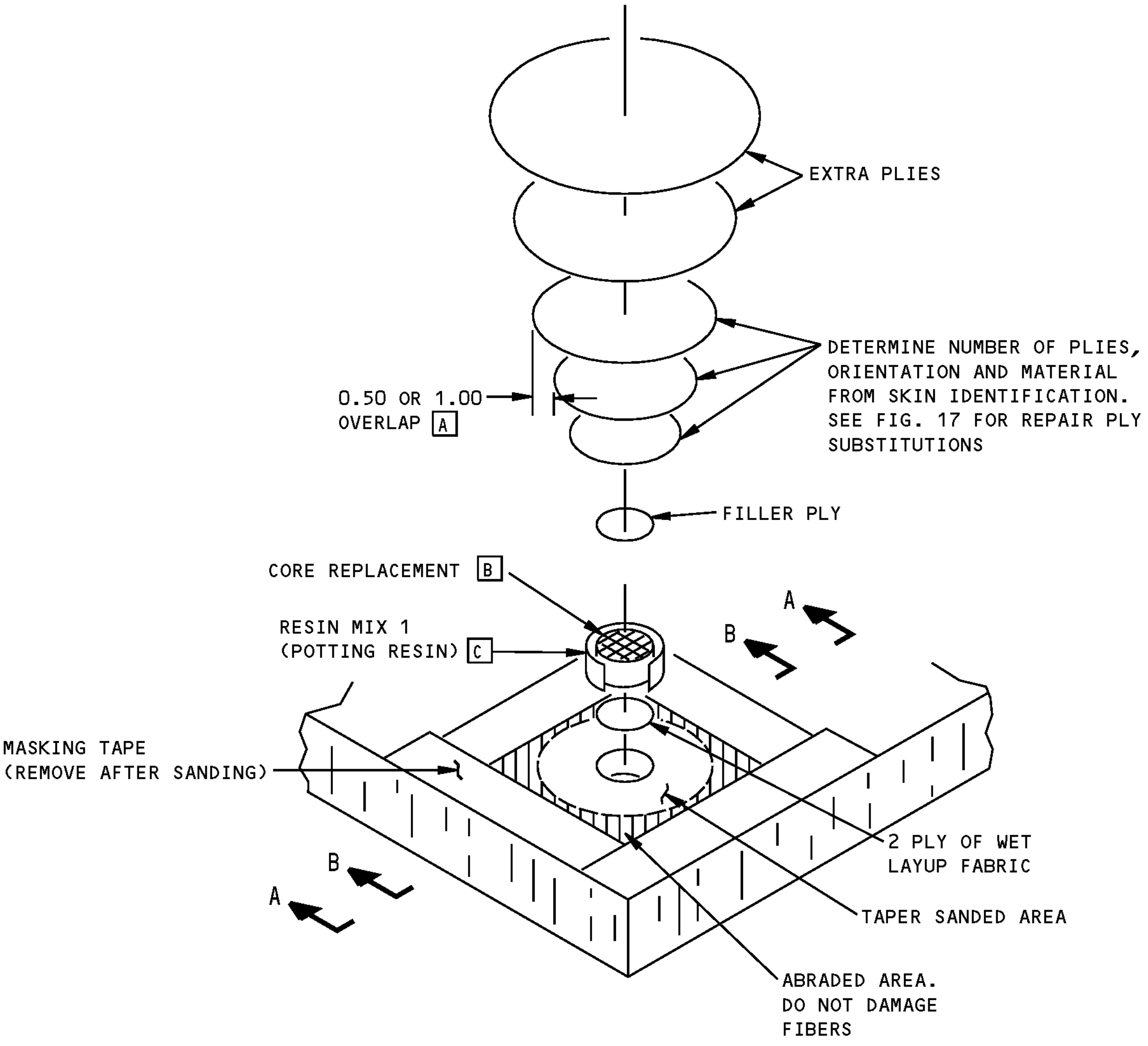
- USE THERMOCOUPLES TO MONITOR TEMPERATURE

A THE HEIGHT IN INCHES OF 250 WATT HEAT LAMP FROM THE SURFACES OF THE PATCH VS TEMPERATURE AT SURFACE OF PART

Potting and Laminating Resin Cure Temperature
Figure 9



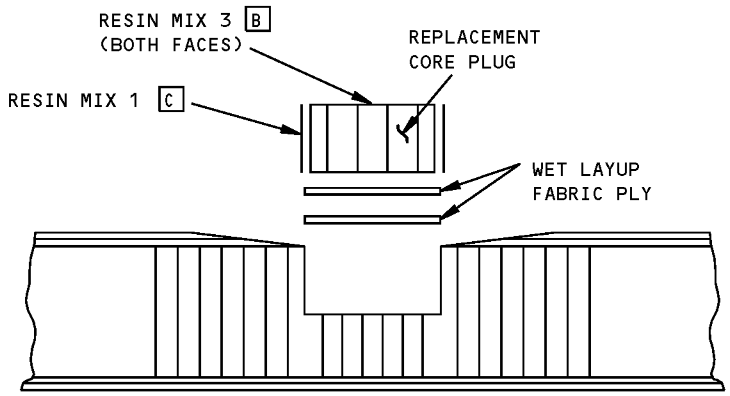
Repair of Damaged External or Internal Skins of a Sandwich Panel
Figure 10



NOTES

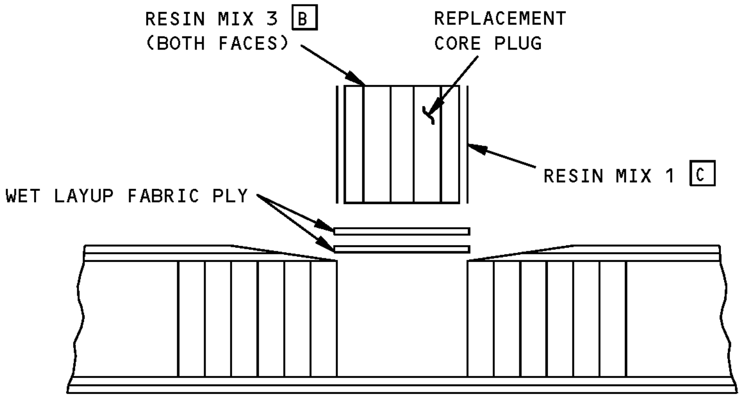
- A SOME 350°F (177°C) ORIGINAL CURE TEMPERATURE COMPONENTS IN HEAT-AFFECTED ZONES REQUIRE 1.00 MINIMUN OVERLAP FOR EACH REPAIRPLY AND ARE IDENTIFIED IN COMPONENT REPAIR CHARTS. ALL OTHER COMPONENTS REQUIRE 0.50 MINIMUM OVERLAP
- B APPLY RESIN MIX 3 TO LOWER FACE JUST PRIOR TO CORE INSERTION AND TO UPPER FACE JUST PRIOR TO REPAIR PLY APPLICATION
- C RESIN MIX 1 MAY BE APPLIED TO PERIPHERY OF EXISTING CORE INSTEAD OF ON CORE PLUG

Repair of Large Punctures Thru One Skin of a Sandwich Structure Including Core Damage
Figure 11 (Sheet 1 of 2)



SECTION THRU REPAIR AREA - PARTIAL DEPTH CORE REPLACEMENT

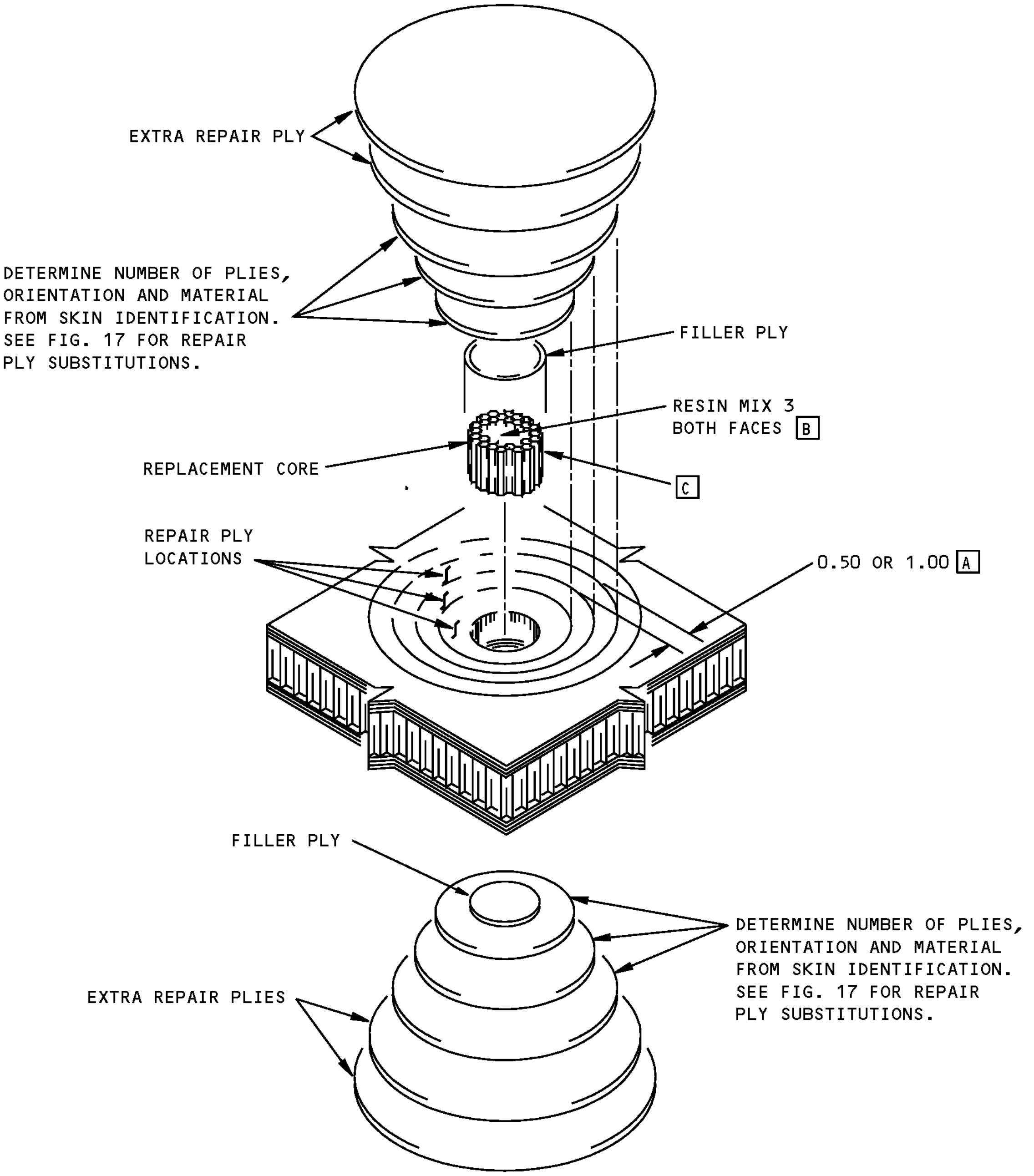
SECTION A-A



SECTION THRU REPAIR AREA - FULL DEPTH CORE REPLACEMENT

SECTION B-B

Repair of Large Punctures Thru One Skin of a Sandwich Structure Including Core Damage
Figure 11 (Sheet 2 of 2)



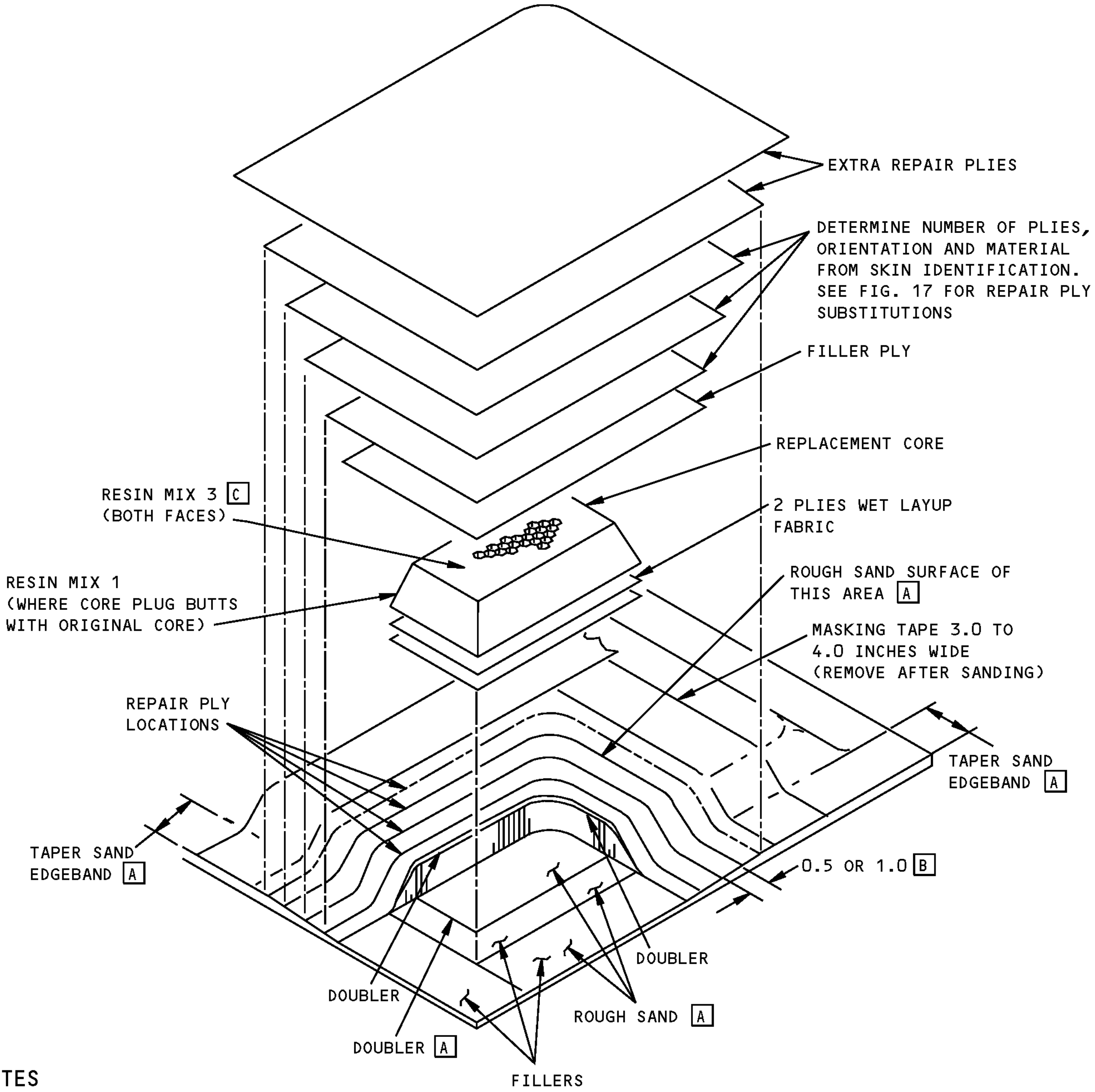
NOTES

A SOME 350°F (177°C) ORIGINAL CURE TEMPERATURE COMPONENTS IN HEAT-AFFECTED ZONES REQUIRE 1.00 MINIMUN OVERLAP FOR EACH REPAIR PLY AND ARE IDENTIFIED IN COMPONENT REPAIR CHARTS. ALL OTHER COMPONENTS REQUIRE 0.50 MINIMUM OVERLAP

B APPLY RESIN MIX 3 TO HONEYCOMB CORE FACES JUST PRIOR TO REPAIR PLY APPLICATION

C RESIN MIX 1 MAY BE APPLIED TO PERIPHERY OF EXISTING CORE INSTEAD OF ON CORE PLUG

Repair of Large Punctures Thru Both Skins of a Sandwich Panel Including Core Damage
Figure 12



NOTES

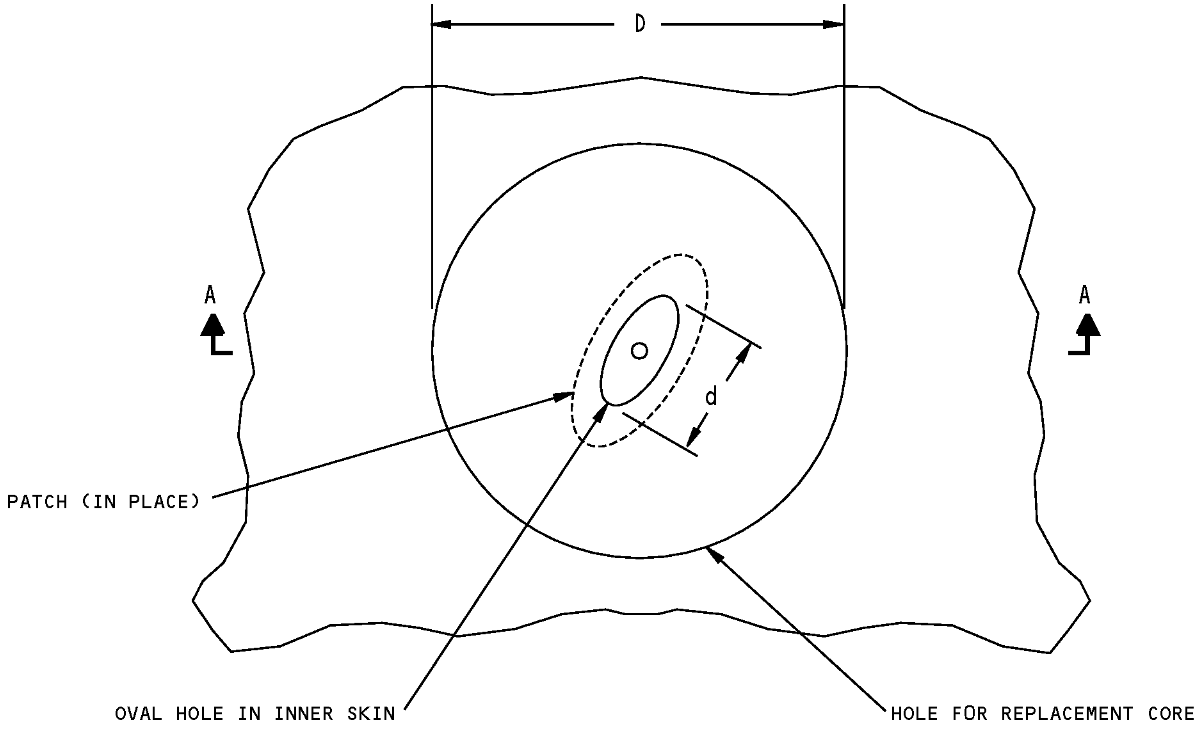
A TAPER SANDING IS OPTIONAL TO JUST ABRADING THE SURFACE OF THE SKIN AND DOUBLER PLIES ABOVE AND BELOW THE HONEYCOMB CORE. HOWEVER, TAPER SANDING IS REQUIRED ON THE EDGEBAND

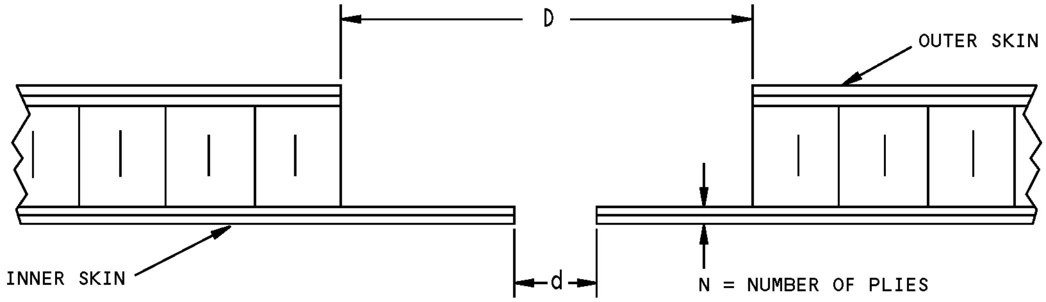
B SOME 350°F (177°C) ORIGINAL CURE TEMPERATURE COMPONENTS IN HEAT-AFFECTED ZONES REQUIRE 1.0 MINIMUN OVERLAP FOR EACH REPAIR PLY AND ARE IDENTIFIED IN THE COM- PONENT REPAIR CHARTS. ALL OTHER COMPONENTS REQUIRE 0.5 MINIMUM OVERLAP

C APPLY RESIN MIX 3 TO LOWER FACE JUST PRIOR TO CORE PLUG INSERTION AND TO UPPER FACE JUST PRIOR TO REPAIR PLY APPLICATION

D RESIN MIX 1 MAY BE APPLIED TO PERIPHERY OF EXISTING CORE INSTEAD OF ON CORE PLUG

Replacement of Honeycomb Core on Damaged Edge of Sandwich Panel
Figure 13





SECTION A-A
(PATCH NOT SHOWN)

- D = d + N + 1

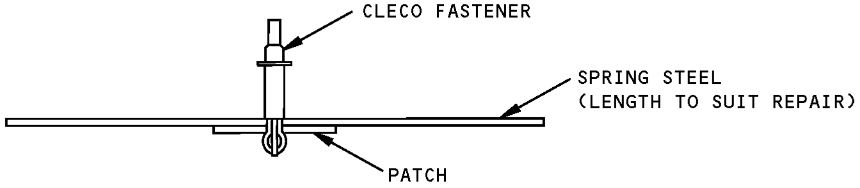
d = MAJOR DIAMETER OF OVAL HOLE IN INNER SKIN
N = NUMBER OF PLIES
D = DIAMETER OF HOLE FOR REPLACEMENT CORE

EXAMPLE

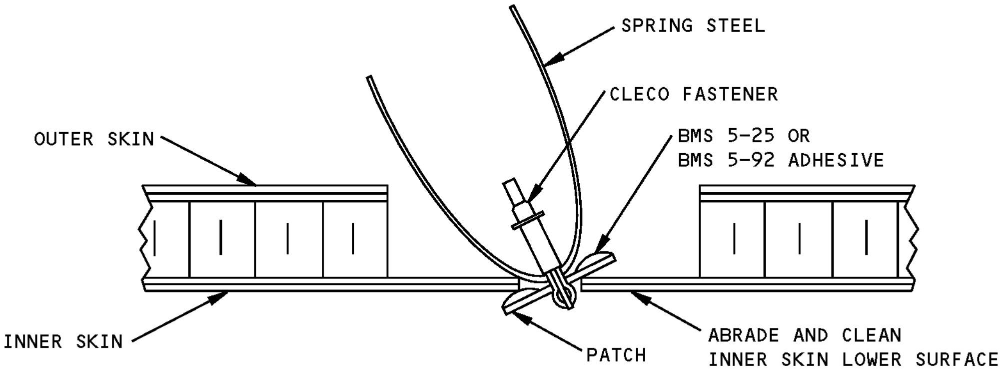
d = 0.50 INCH
D = 0.50 + 2 (PLIES) + 1
D = 3.50 INCH DIAMETER

DETAIL I

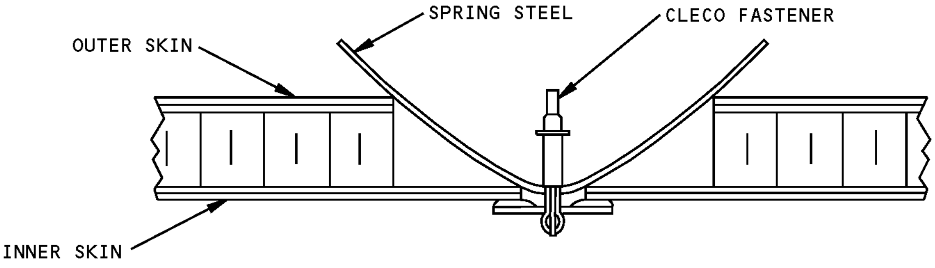
Repair of Damage to External and Internal Skins with Access Limited to One Side
Figure 14 (Sheet 1 of 3)



ASSEMBLE PATCH AND SPRING STEEL
DETAIL II

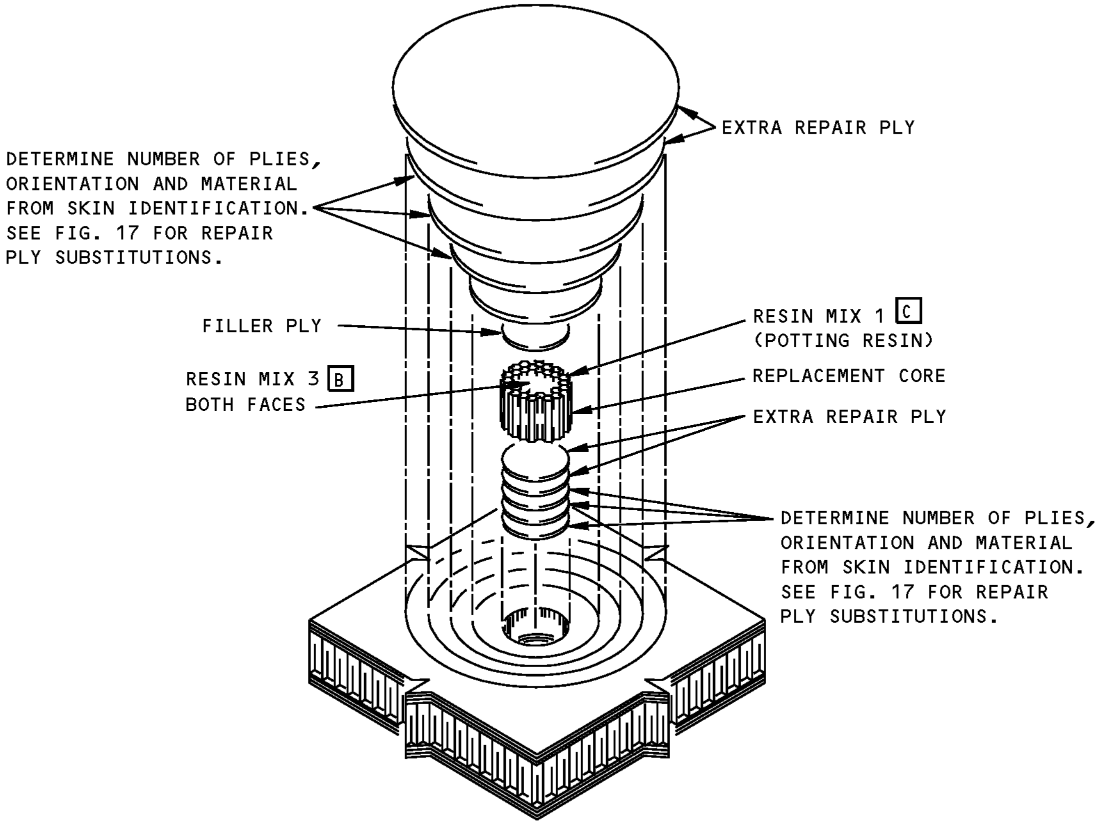


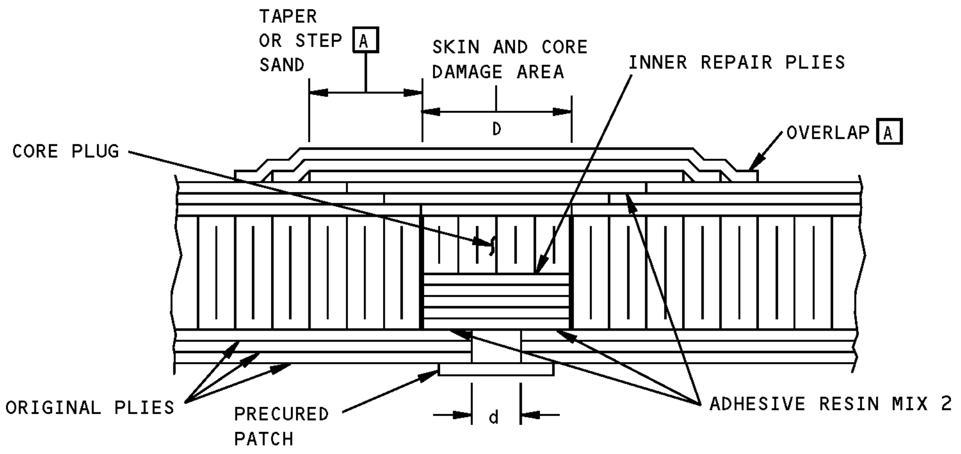
INSERT PATCH INTO OVAL HOLE
DETAIL III



HOLD PATCH IN PLACE WHILE CURING
DETAIL IV

Repair of Damage to External and Internal Skins with Access Limited to One Side
Figure 14 (Sheet 2 of 3)





DETAIL V
SECTION THROUGH REPAIR

NOTES

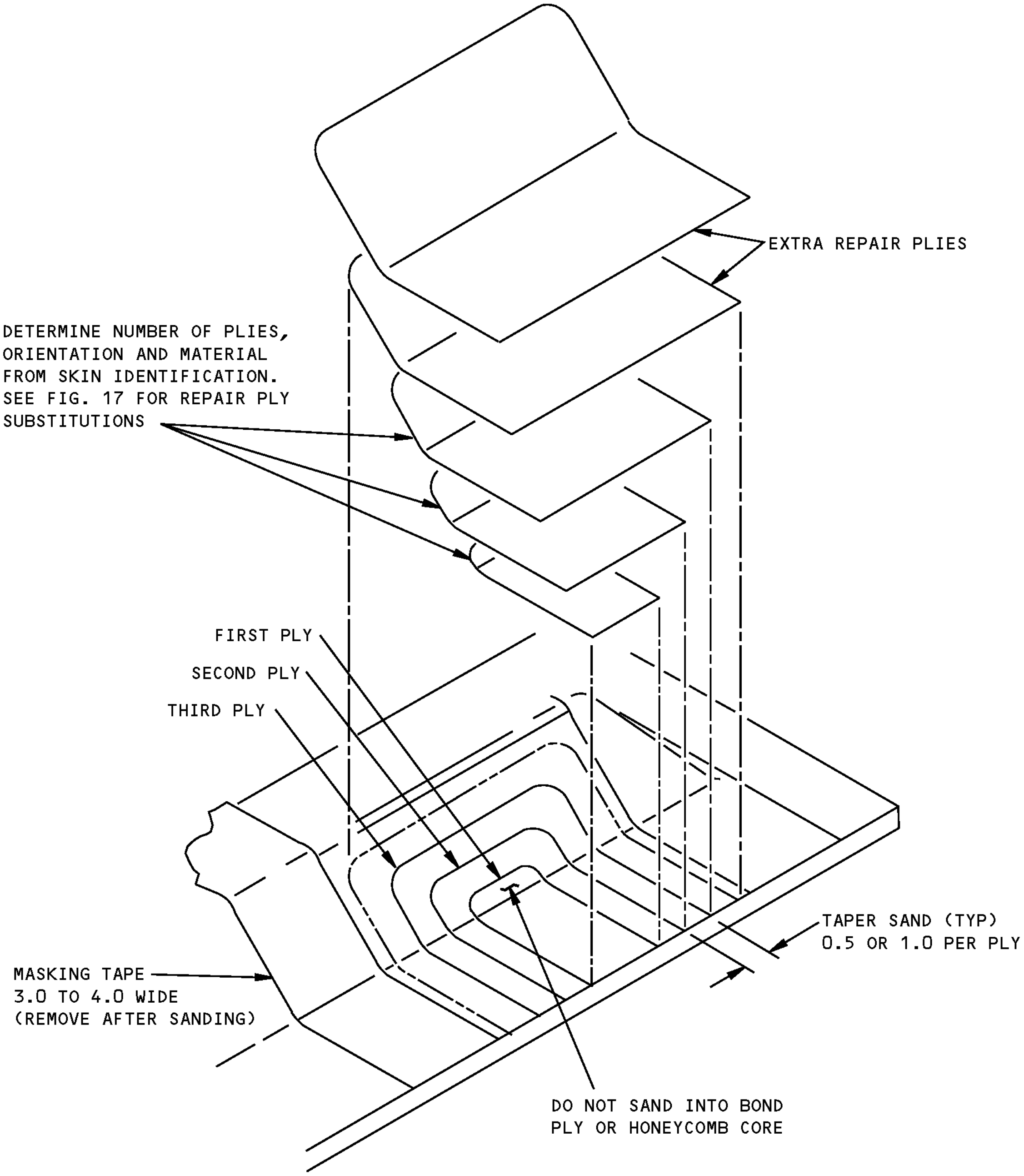
- D = d + N + 1.0, WHERE
  N = NUMBER OF PLIES IN THE INNER SKIN
  d = DIAMETER OF CLEANED UP DAMAGE IN THE INNER SKIN

$\boxed{A}$ MAKE TAPER AND OVERLAP PER FIG. 8

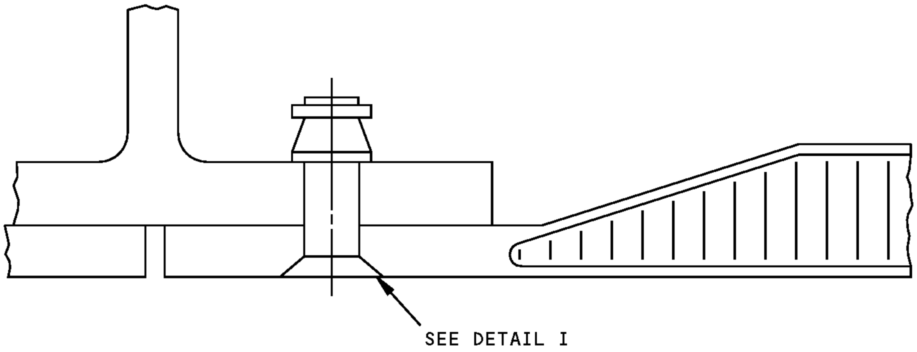
$\boxed{B}$ APPLY RESIN MIX 3 TO LOWER FACE JUST PRIOR TO CORE INSERTION AND TO UPPER FACE JUST PRIOR TO REPAIR PLY APPLICATION

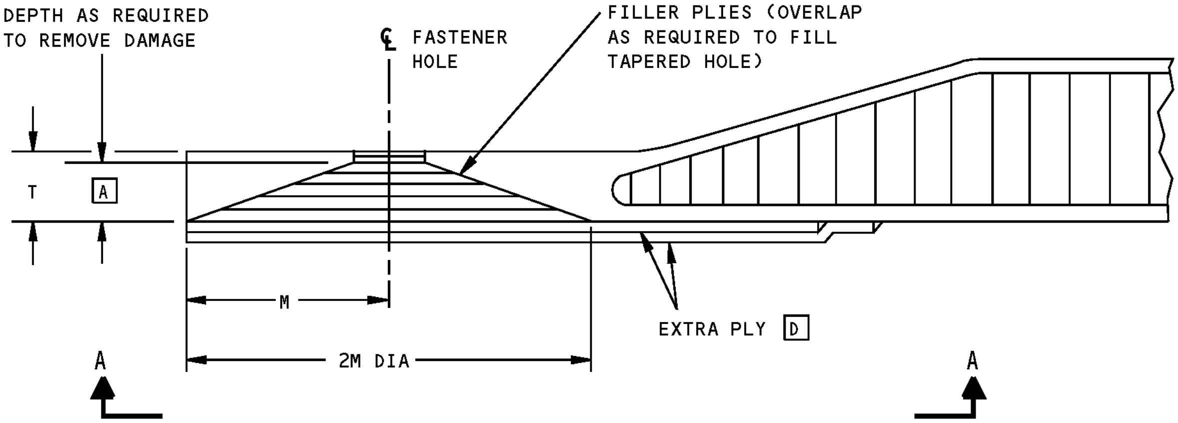
$\boxed{C}$ RESIN MIX 1 MAY BE APPLIED TO PERIPHERY OF EXISTING CORE INSTEAD OF ON CORE PLUG

Repair of Damage to External and Internal Skins with Access Limited to One Side
Figure 14 (Sheet 3 of 3)



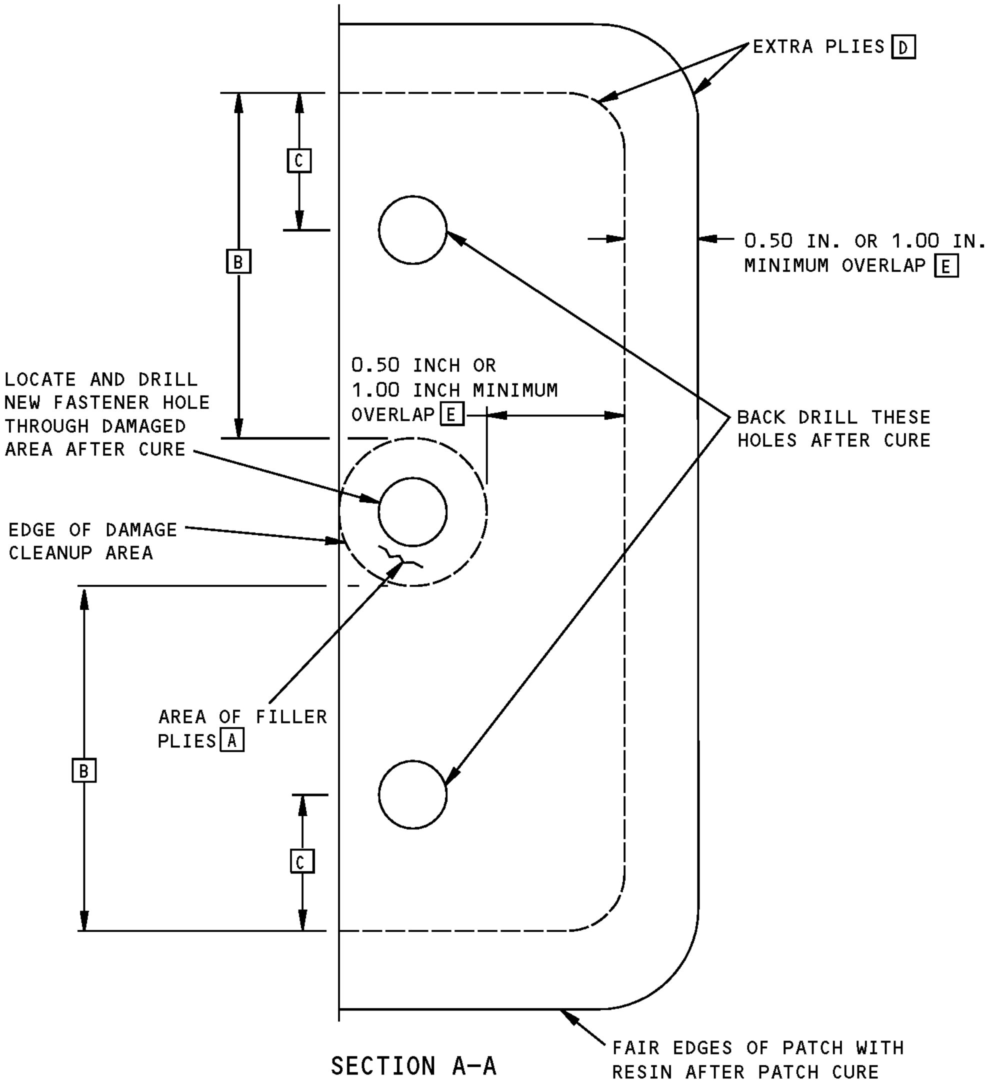
Repair of Damaged Skin Plies On A Panel Edge
Figure 15





DETAIL I

Repair of Damaged Panel Attach Hole
Figure 16 (Sheet 1 of 2)



NOTES

- D EQUALS FASTENER DIAMETER

  M = 5T MAXIMUM AS SHOWN, WHERE T IS THE THICKNESS OF THE EDGE BAND. DO NOT CUT INTO CORE

- THIS REPAIR IS APPLICABLE ONLY WHERE NO MORE THAN TWO ATTACH HOLES ARE DAMAGED IN A SEQUENCE OF TEN. IF MORE THAN TWO ATTACH HOLES IN A SEQUENCE OF TEN ARE DAMAGED, REPAIR THE EDGEBAND AS GIVEN IN PARAGRAPH 3.G. (FIGURE 15).

A APPLY FILLER PLIES AS REQUIRED TO FILL THE DAMAGED AREA.

B EXTEND FIRST EXTRA PLY FAR ENOUGH SO THAT IT EXTENDS AT LEAST 0.50 OR 1.00 INCH PAST EDGE OF DAMAGED AREA E

C EXTEND FIRST EXTRA PLY FAR ENOUGH TO PROVIDE AT LEAST 2D EDGE MARGIN

D ORIENT EXTRA REPAIR PLIES IN THE SAME DIRECTION AS THE INITIAL OUTER LAYER (SEE FIG. 15)

E SOME 350°F (177°C) INITIAL CURE TEMPERATURE COMPONENTS IN HEAT-AFFECTED ZONES REQUIRE 1.00 INCH MINIMUM OVERLAP FOR EACHREPAIR PLY AND ARE IDENTIFIED IN THE COMPONENT REPAIR CHARTS. ALL OTHER COMPONENTS REQUIRE 0.50 MINIMUM OVERLAP

Repair of Damaged Panel Attach Hole
Figure 16 (Sheet 2 of 2)

ORIGINAL PLY MATERIAL		REPAIR PLY MATERIAL	REPAIR PLY SUBSTITUTE MATERIAL
GLASS FABRIC	BMS 8-79, TYPE 120	BMS 9-3, TYPE D [A]	BMS 9-3, TYPE H-2 OR H-3 [B]
	BMS 8-139, TYPE 120		
	BMS 8-169, TYPE 120		
	BMS 8-331, TYPE 42		
	BMS 8-79, TYPE 1581	BMS 9-3, TYPE H-2 [A]	BMS 9-3, TYPE D OR H-3 [C] [D]
	BMS 8-139, TYPE 1581 [F]		
ARAMID FABRIC	BMS 8-218, STYLE 120	BMS 9-3, TYPE D [A] (GLASS FABRIC)	BMS 9-3, TYPE H-2 OR H-3 [B]
	BMS 8-219, STYLE 120		
	BMS 8-218, STYLE 285	BMS 9-3, TYPE H-2 OR H-3 [A] (GLASS FABRIC)	BMS 9-3, TYPE D [C]
	BMS 8-219, STYLE 285		
GRAPHITE TAPE	BMS 8-168, TYPE II, CLASS 1, ALL GRADES	BMS 9-8, TYPE I, CLASS 2, STYLE 3K-70-P [E] (GRAPHITE FABRIC)	NONE
	BMS 8-212, TYPE II, CLASS 1 OR 3, ALL GRADES		
GRAPHITE FABRIC	BMS 8-168, TYPE II, CLASS 2, STYLE 3K-70-PW	BMS 9-8, TYPE I, CLASS 2, STYLE 3K-70-P	NONE
	BMS 8-212, TYPE IV, CLASS 2, STYLE 3K-70-PW		
	BMS 8-256, TYPE IV, CLASS 2, STYLE 3K-70-PW		
	BMS 8-258, CLASS 2, STYLE 3K-70-PW		
	BMS 8-212, TYPE III, CLASS 2, STYLE 3K-135-8H	BMS 9-8, TYPE I, CLASS 2, STYLE 3K-135-8H	NONE

NOTES

[A] BMS 9-3, CLASSES 2, 5 THRU 13, 16 THRU 19 CAN BE USED. CLASS 7 IS RECOMMENDED BECAUSE IT IS KNOWN TO HAVE GOOD STORAGE LIFE.

[B] USE ONE PLY OF TYPE H-2 OR H-3 IN PLACE OF TWO PLIES OF TYPE D.

[C] USE THREE PLIES OF TYPE D IN PLACE OF ONE PLY OF TYPE H-2 OR H-3.

[D] USE ONE PLY OF TYPE H-3 IN PLACE OF ONE PLY OF TYPE H-2.

[E] TWO CONSECUTIVE PLIES OF GRAPHITE FABRIC ARE REQUIRED FOR EACH PLY OF GRAPHITE TAPE. ALIGN THE FABRIC WARP FIBERS IN THE SAME DIRECTION AS THE TAPE FIBERS.

[F] BMS 8-139 TYPE 1581 WAS FORMERLY TYPE 181.

Repair Ply Substitutions
Figure 17

COMPONENT MATERIAL	EXTRA PLY MATERIAL
GRAPHITE FABRIC	GRAPHITE FABRIC, STYLE 3K-70-P [B]
GRAPHITE/ARAMID/GLASS	GRAPHITE FABRIC, STYLE 3K-70-P [A] [B]
ARAMID	GLASS FABRIC, TYPE H-2 OR H-3 [B]
GLASS FABRIC	GLASS FABRIC, TYPE H-2 OR H-3 [B]

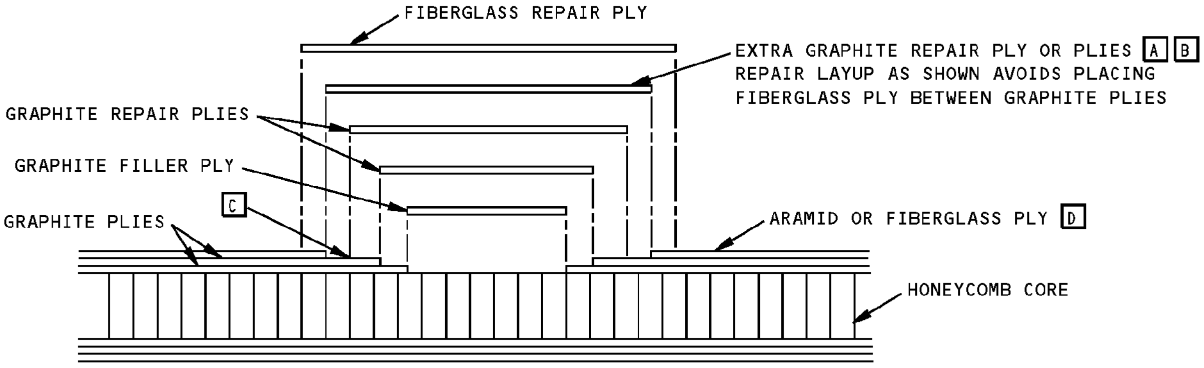
NOTES

[A] ON HYBRID PANELS, GRAPHITE EXTRA PLIES MUST BE BONDED TO GRAPHITE PLY. SEE DETAIL I

[B] REFER TO THE COMPONENT SPECIFIC SECTION FOR THE ORIENTATIONS OF THE EXTRA REPAIR PLIES. IF NOT GIVEN, THE ORIENTATIONS OF THE EXTRA REPAIR PLIES MUST REPEAT THE ORIENTATIONS OF THE EXISTING PLIES IN THE ORIGINAL LAMINATE STARTING WITH THE OUTERMOST PLY

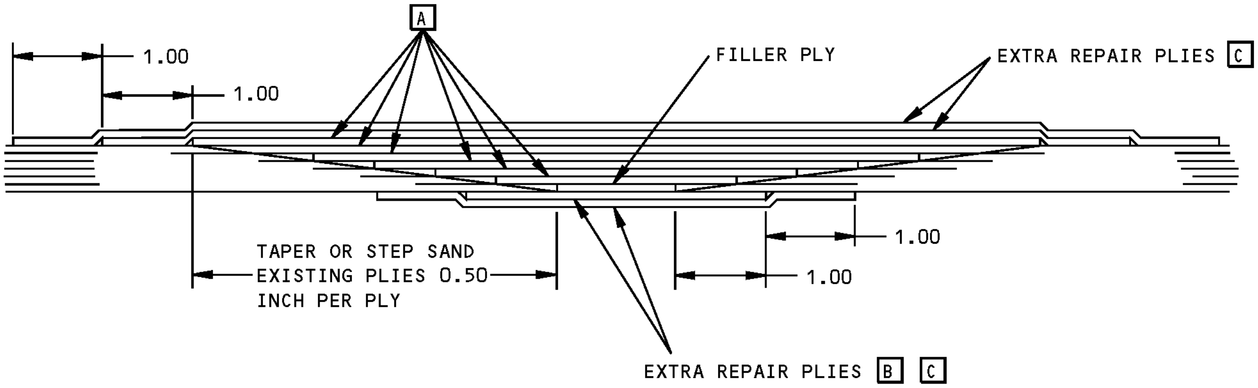
[C] WHEN EXTRA GRAPHITE REPAIR PLY OR PLIES ARE REQUIRED, THE EXISTING OUTER PLY OF ARAMID, ALUMINUM COATED GLASS FABRIC (BMS 8-278) OR FIBERGLASS MUST BE SANDED TO ALLOW AN OVERLAP OF 1.00 FOR EACH EXTRA REPAIR PLY

[D] IF OUTER PLY CONSISTS OF ALUMINUM COATED GLASS FABRIC (BMS 8-278) PLY OR OTHER CONDUCTIVE COATING, REFER TO 51-70-04, 51-70-05 OR 51-70-14 AS APPLICABLE FOR REPAIR OF THE CONDUCTIVE COATING



SECTION THRU HYBRID HONEYCOMB SANDWICH
DETAIL I

Extra Repair Ply Materials
Figure 18



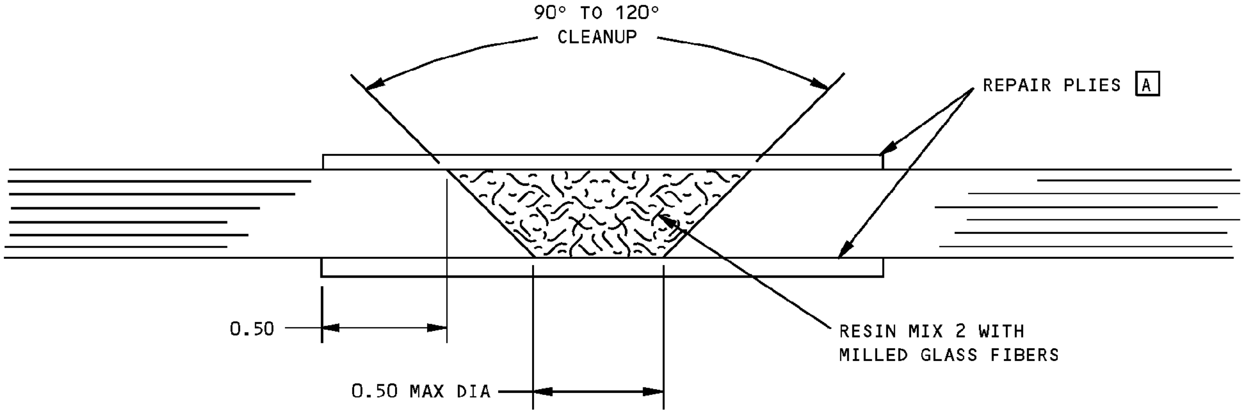
NOTES

A DETERMINE NUMBER OF PLIES, ORIENTATION, AND MATERIAL FROM SPECIFIC COMPONENT STRUCTURE IDENTIFICATION

B EXTRA REPAIR PLIES AT THIS LOCATION ARE REQUIRED ONLY IF THE DAMAGE PENETRATES THIS SURFACE

C THE ORIENTATION OF THE EXTRA REPAIR PLY IS TO BE THE SAME AS THE OUTER PLY OF THE ORIGINAL LAMINATE

Solid Laminate Repair - 200 Degrees F (94 Degrees C) to 230 Degrees F (110 Degrees C)
Figure 19



NOTES

- THIS REPAIR MAY BE USED AS AN ALTERNATIVE TO REPAIR SHOWN IN FIG. 16

A REPAIR PLIES ARE TO HAVE THE SAME ORIENTATION AS THE ORIGINAL SURFACE PLIES

Repair of Punctures, 0.50 Inch Diameter or Less, in Solid Laminate Panels
Figure 20

NOTES

- READ ALL REPAIR INSTRUCTIONS IN PAR. 4.N. BEFORE MAKING THIS REPAIR
- THIS REPAIR IS MADE IN TWO STAGES:
  (A) LOWER SKIN AND HONEYCOMB CORE
  (B) UPPER SKIN AND SOLID LAMINATE WEDGE
- DO NOT TRIM TRAILING EDGE UNTIL AFTER STAGE II OF REPAIR

A TRAILING EDGE OF CORE WEDGE MUST EXTEND BEYOND THE EXISTING TRAILING EDGE TO ALLOW FOR FINAL TRIM. WEDGE MUST BE TAPERED TO CONFORM TO THE CONTOUR OF THE LOWER SKIN SURFACE. REPAIR CORE RIBBON DIRECTION MUST MATCH ORIGINAL CORE RIBBON DIRECTION

B REPAIR PLIES MUST EXTEND BEYOND THE EXISTING TRAILING EDGE LOCATION TO ALLOW FOR FINAL TRIM

C TAPER SAND REPAIR CORE WEDGE TO ACCOMMODATE THE WEDGE REPAIR PLIES. DO NOT SAND INTO LOWER SKIN PLIES

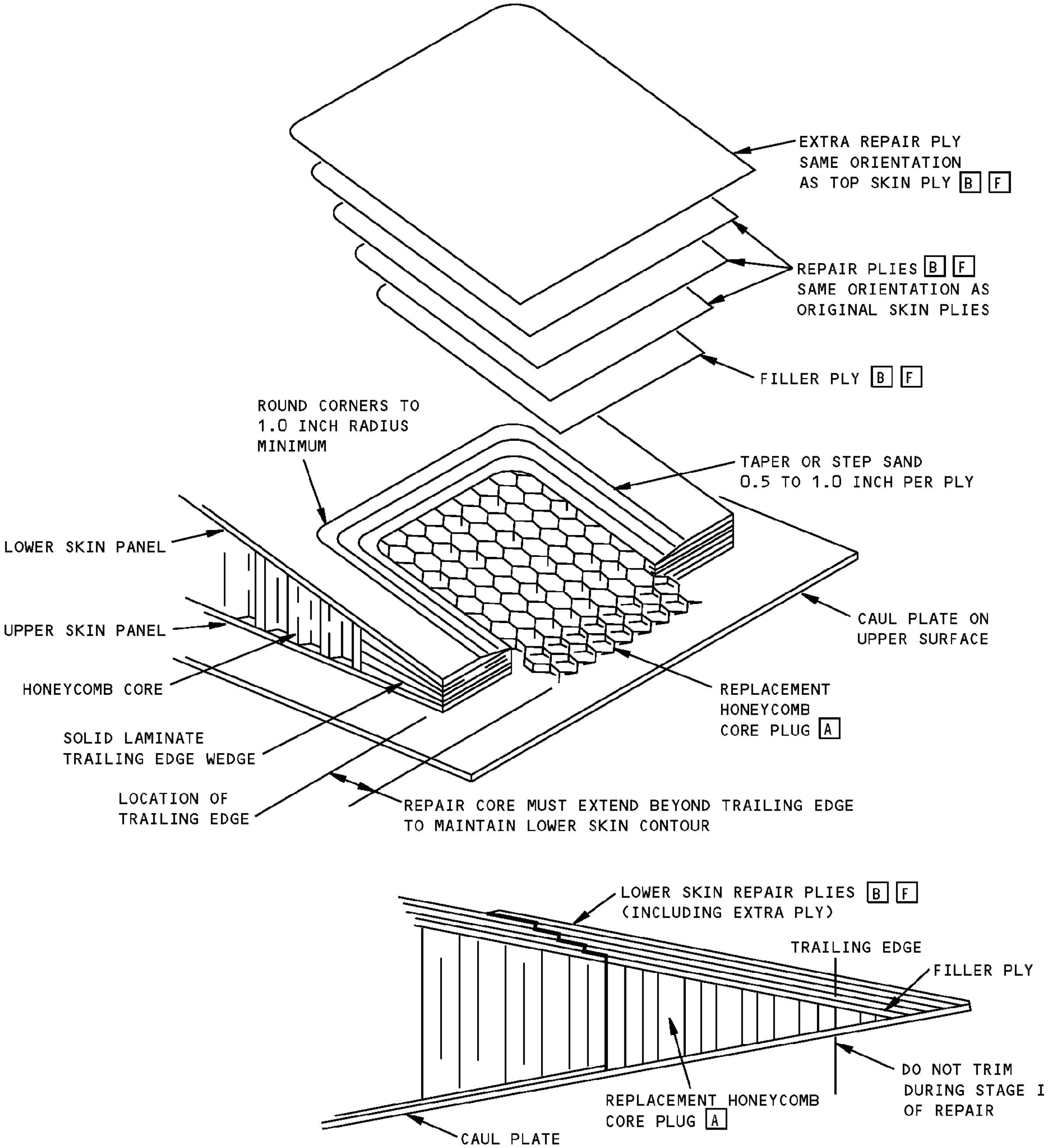
D WEDGE REPAIR PLIES MUST BE LAYERED SO THAT THE THICKNESS OF ORIGINAL WEDGE IS OBTAINED. ALLOW FOR ACCOMMODATION OFUPPER SKIN REPAIR PLIES AND MAINTAIN CONTOUR OF UPPER SKIN SURFACE

E LAY UP WEDGE REPAIRS AS FOLLOWS:

45° FOR THE PLY NEXT TO THE CORE. 0°,0°, 45°,0°,0°,45° FOR ALL OTHER PLIES. REPEAT THIS SEQUENCE AS REQUIRED

F LAY UP REPAIR PLIES WITH SAME ORIENTATION AS ORIGINAL SKIN PLIES. LAY UP EXTRA PLIES WITH SAME ORIENTATION AS ORIGINAL SKIN OUTER PLY

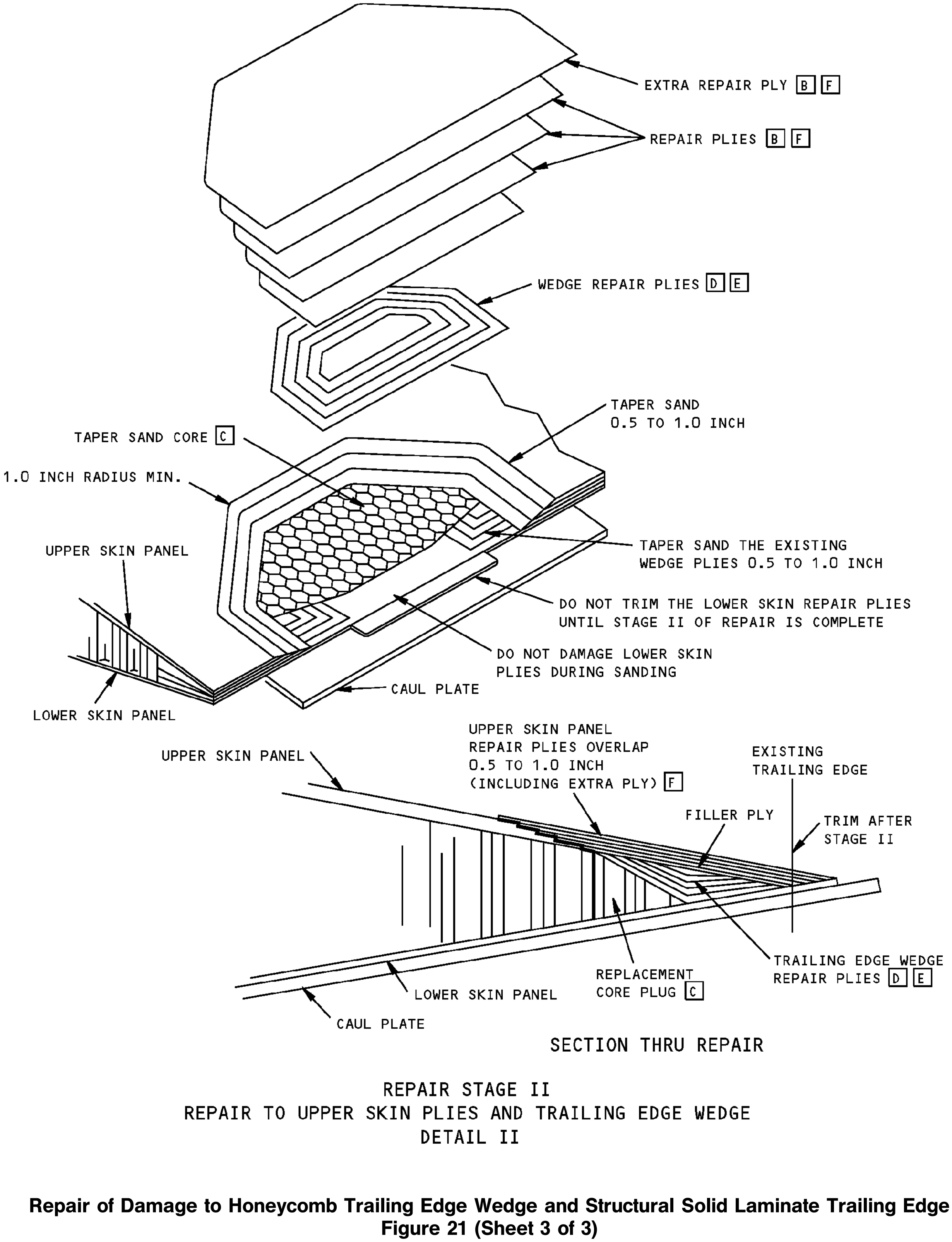
Repair of Damage to Honeycomb Trailing Edge Wedge and Structural Solid Laminate Trailing Edge
Figure 21 (Sheet 1 of 3)



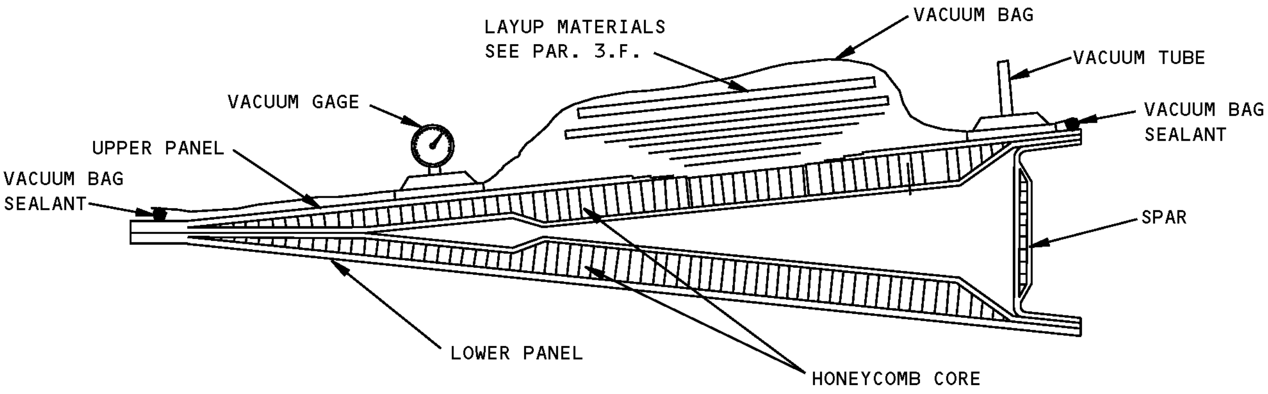
CROSS-SECTIONAL VIEW THRU
CENTER OF REPAIR AFTER LAYUP

REPAIR STAGE I
REPAIR TO LOWER SKIN PLIES AND TRAILING EDGE WEDGE
DETAIL I

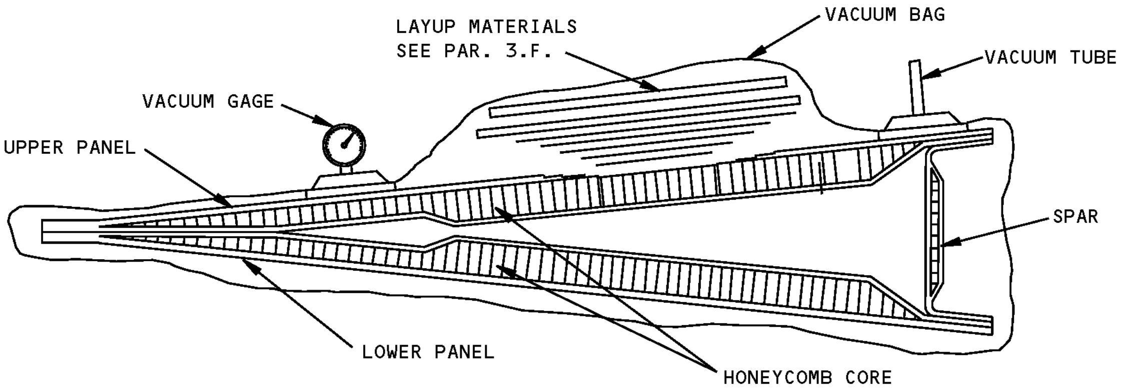
Repair of Damage to Honeycomb Trailing Edge Wedge and Structural Solid Laminate Trailing Edge
Figure 21 (Sheet 2 of 3)



Repair of Damage to Honeycomb Trailing Edge Wedge and Structural Solid Laminate Trailing Edge
Figure 21 (Sheet 3 of 3)



ACCEPTABLE - VACUUM BAG SEALED TO ONE SIDE ONLY



NOT ACCEPTABLE - VACUUM BAG SEALED AROUND ENTIRE PART

PARTS CONSISTING OF UPPER AND LOWER PANELS [A]

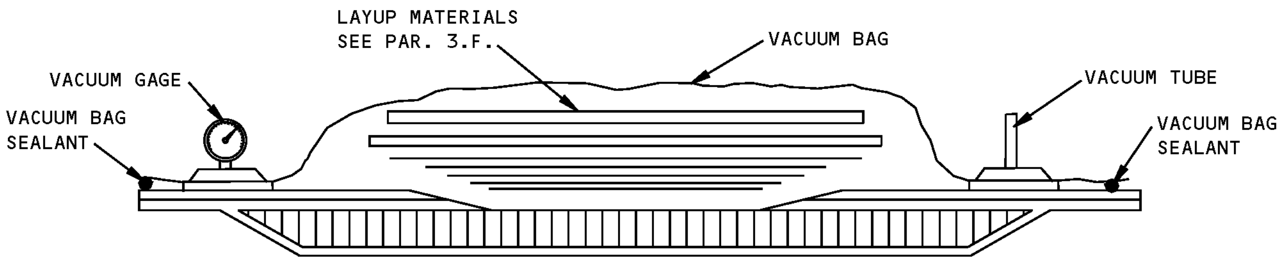
NOTES

- REFER TO PAR. 3.F. FOR LAYUP AND BAGGING PROCEDURES

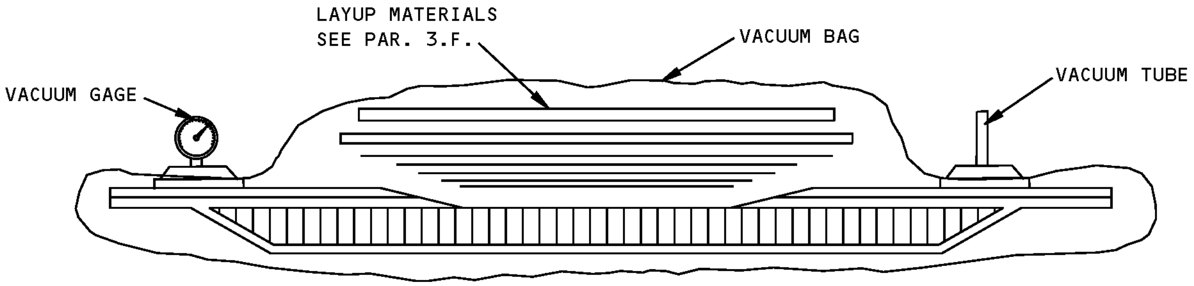
[A] THIS TYPE OF COMPONENT MUST NOT BE COMPLETELY SEALED IN A VACUUM BAG. DAMAGE TO PART WILL OCCUR. VACUUM BAG ONE SIDE OF COMPONENT ONLY

[B] THIS TYPE OF COMPONENT MAY BE COMPLETELY SEALED IN A VACUUM BAG OR MAY BE SEALED ON ONE SIDE ONLY

Vacuum Bagging Restrictions
Figure 22 (Sheet 1 of 2)



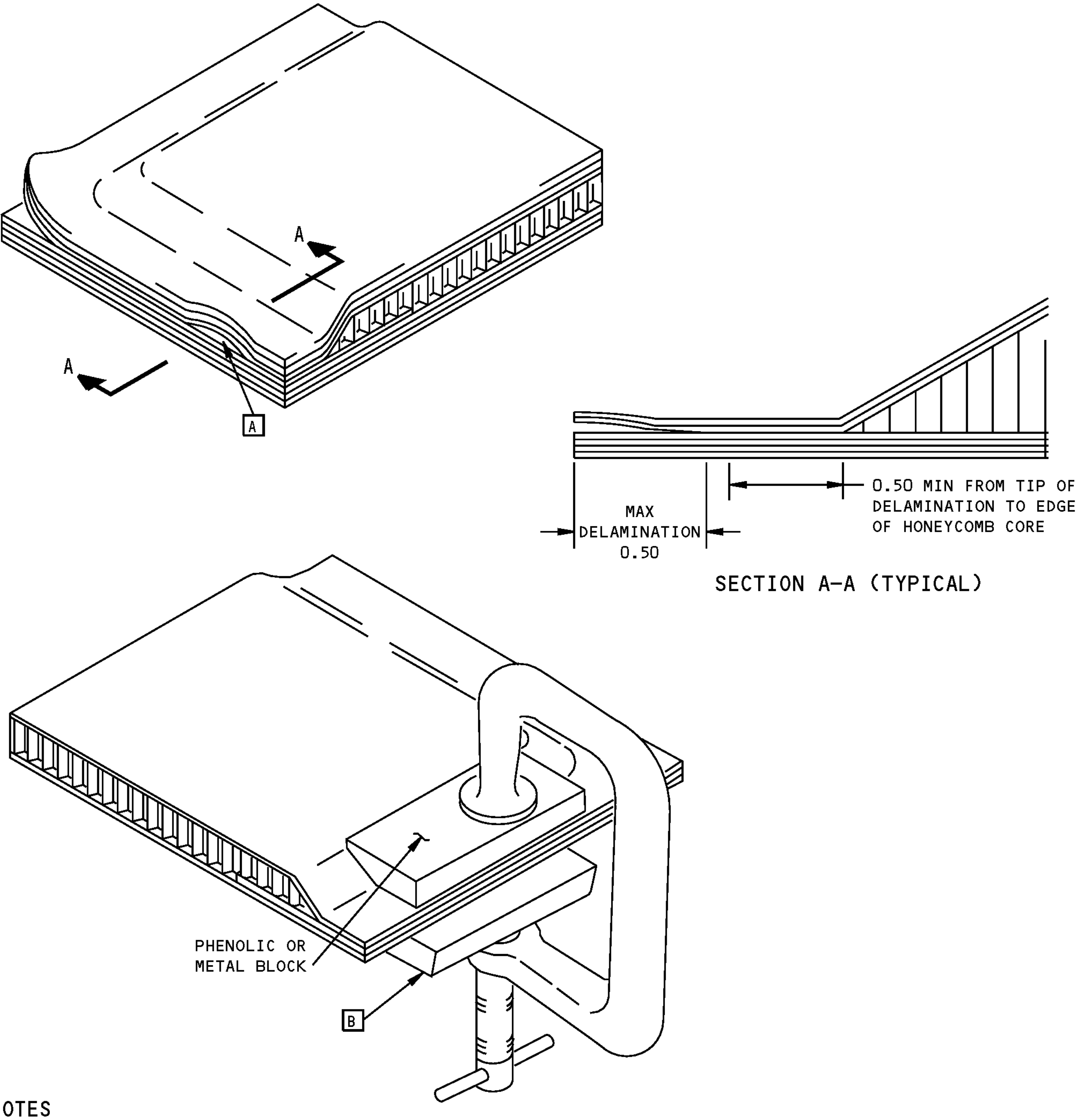
ACCEPTABLE - VACUUM BAG SEALED TO ONE SIDE ONLY



ACCEPTABLE - VACUUM BAG SEALED AROUND ENTIRE PART

PARTS CONSISTING OF ONE PANEL B

Vacuum Bagging Restrictions
Figure 22 (Sheet 2 of 2)



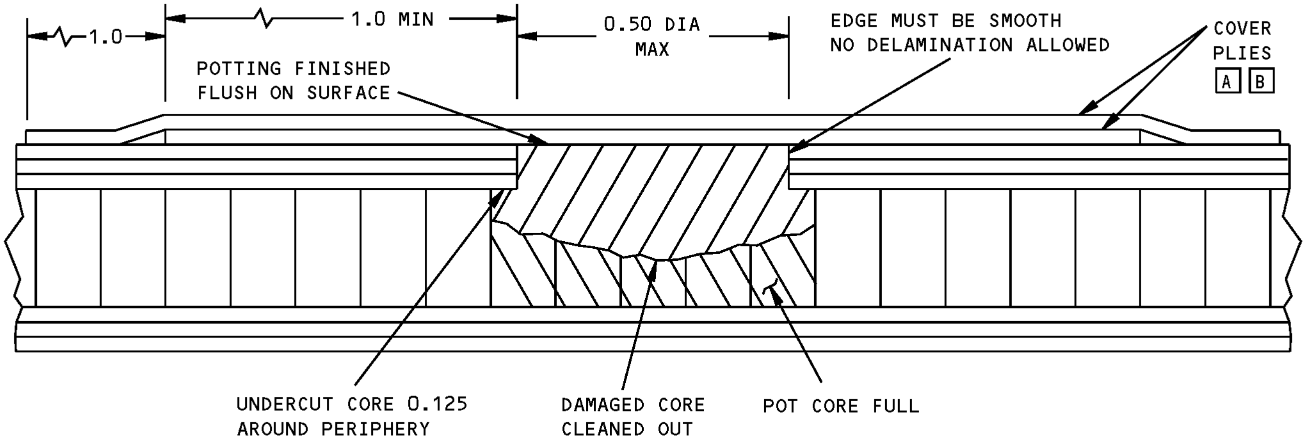
NOTES

- REFER TO PARAGRAPH 4.A.(2) FOR COMPLETE REPAIR INSTRUCTIONS.

A FORCE RESIN MIX 2 INTO DELAMINATED AREA.

B CLAMP PLIES TOGETHER AND CURE.

Repair of Delaminations Between Plies of Panel Edgeband
Figure 23



TYPICAL SECTION

NOTES

- OVERLAP COVER PLIES PER FIG. 14. DO NOT TAPER SAND OR STEP SAND ANY PLIES

A ORIENT COVER PLIES IN THE SAME DIRECTION AS THE ORIGINAL OUTER LAYER

B PREPARE AND APPLY TWO GLASS FABRIC COVER PLIES PER PAR. 4.E, EXCEPT USE TYPE H-2 OR H-3 PLIES ONLY

Typical Puncture Repair, 0.50 Inch Diameter or Less - Wet Layup
Figure 24

GENERAL - TYPICAL METAL OVERLAY REPAIRS TO COMPOSITE PANELS

1. General

A. This subject contains time-limited repairs to composite panels, with accessibility to both sides, using metal overlay plate bonded and bolted over the damaged area (Figure 1/GENERAL).

B. These repairs have FAA approval, providing metal overlay repairs are limited to secondary structure and replaced with a permanent repair within 300 flight hours.

NOTE: Metal overlay repairs are not permitted on nose radome, HF antenna window, wing leading edge, or flight control surfaces. Refer to 51-00-04, GENERAL for structural classification diagram.

2. References

Reference	Title
51-00-04, GENERAL	Structural Classification

3. Repair Preparation

A. Determine extent of damage.

NOTE: Maximum size of damage permitted by this repair is 4.00 inches unless otherwise specified in an individual component repair subject.

B. Check in vicinity of damage for entry of water, dirt or other foreign matter.

C. Remove any water present by means of suction or blowing warm air over the damaged area.

WARNING: BREATHING VAPORS OR ALLOWING SOLVENT TO CONTACT SKIN OR EYES IS HAZARDOUS. HEAT, FIRE OR SPARKS CAN CAUSE AN EXPLOSION. USE MECHANICAL VENTILATION OR RESPIRATORY PROTECTION WHEN WORKING IN A CONFINED SPACE OR AREA. AVOID CONTACT WITH SKIN, EYES AND CLOTHING. WEAR EYE PROTECTION. KEEP AWAY FROM SOURCES OF HEAT, FIRE OR SPARKS.

CAUTION: DO NOT USE PAINT STRIPPERS FOR THE REMOVAL OF FINISH. DAMAGE TO THE ADHESIVE SYSTEM WILL OCCUR. DO NOT IMMERSE PARTS IN SOLVENTS OR ALLOW STANDING SOLVENT TO REMAIN ON PART. DAMAGE TO PART WILL OCCUR.

D. Wipe the area around damage with clean cheesecloth moistened with MEK:sec-butyl alcohol 42:58, MPK, MEK, MIBK, or acetone.

4. Apply the Repair Plate

A. Mark out damaged area and determine size of repair plate (Figure 1/GENERAL).

NOTE: Multiple repairs in large bays shall be no closer, centerline to centerline, than six times the maximum damage diameter.

B. Manufacture repair plate from aluminum, CRES, or titanium. Mark and drill fastener holes as given in Figure 1/GENERAL.

C. Drill fastener holes through panel from repair plate.

D. If an aluminum repair plate is used, apply one coat of BMS 10-79 Type II or Type III primer and one coat of BMS 10-60 Type II enamel to all surfaces of plate.

NOTE: CRES and titanium plates do not require finish.

E. Spread layer of BMS 5-95 B-1/2 sealant over area to be covered by repair plate.

F. Fit repair plate and insert CRES, titanium, or cadmium plated steel removable fasteners with wet BMS 5-95 sealant or with BMS 3-24 grease, taking care not to contaminate area to be painted.

NOTE: Only CRES or titanium fasteners are allowed in graphite or graphite hybrid composites.

G. Use 0.75 dia washers under nuts. Torque nuts carefully to avoid crushing honeycomb core.

H. Cap and fay seal fasteners with BMS 5-95 and refinish reworked area.

NOTES

- THIS REPAIR TO BE USED ON SECONDARY STRUCTURES ONLY. METAL OVERLAY REPAIRS ARE NOT PERMITTED ON NOSE RADOME, HF ANTENNA WINDOW, WING LEADING EDGE, OR FLIGHT CONTROL SURFACES
- MULTIPLE REPAIRS IN LARGE BAYS SHALL BE NO CLOSER, ℄ TO ℄, THAN 6 TIMES THE MAX DAMAGE DIAMETER
- REFER TO THE FOLLOWING WHEN MAKING THIS REPAIR

  51-00-04 FOR STRUCTURAL CLASSIFICATION DIAGRAM

  51-20-05 FOR SEALING OF REPAIRS

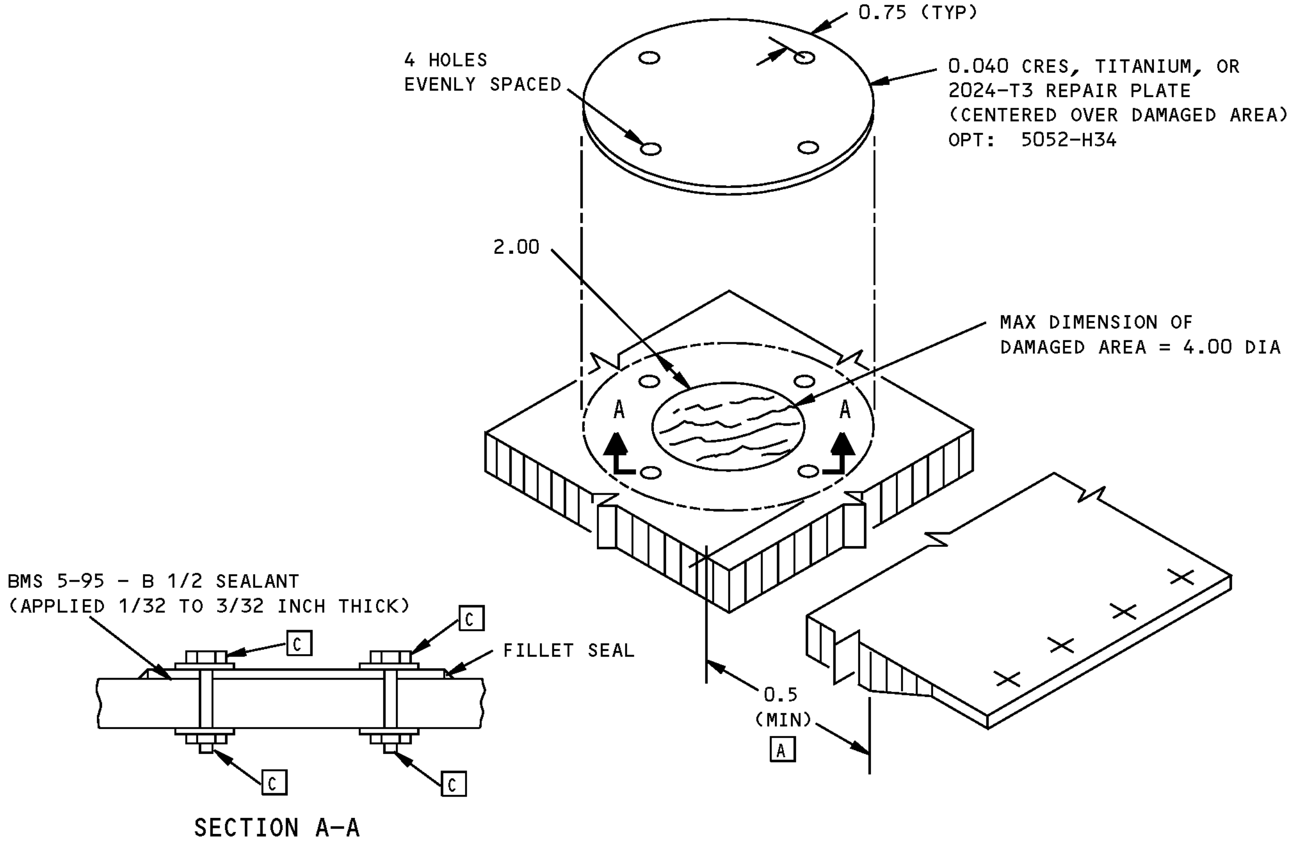
  51-40 FOR FASTENER CODE, REMOVAL, INSTALLATION, HOLE SIZES AND EDGE MARGINS

  51-70-16 FOR MACHINING METHODS, FASTENER HOLE SIZES AND TREATMENT OF FASTENER HOLES IN COMPOSITES

A FOR DAMAGE CLOSE TO PANEL EDGE USE REPAIR SHOWN ON SHEET 2

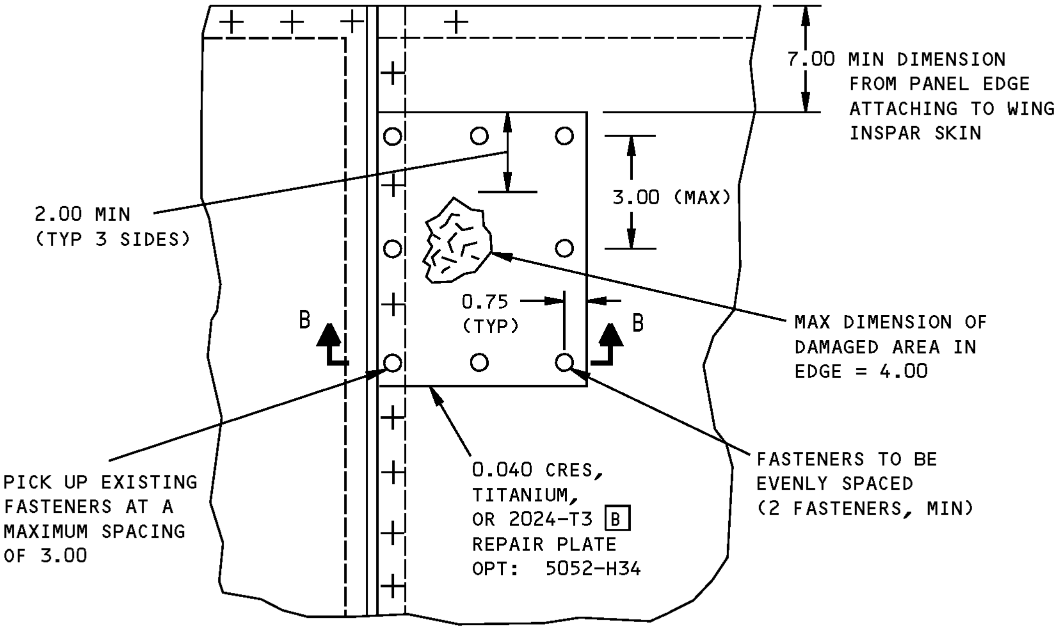
B USE 0.063 SHEET IF DAMAGE IS WITHIN 1.0 INCH OF EDGE BAND OR IN EDGEBAND

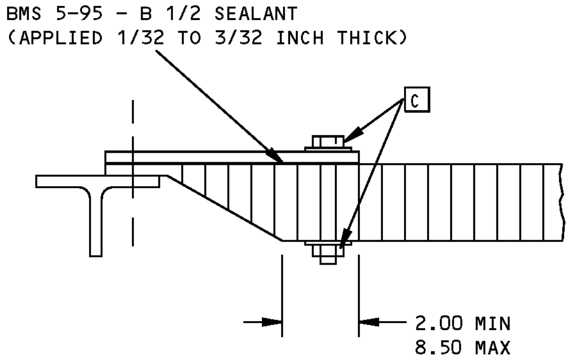
C 3/16 DIAMETER BOLT OR SCREW WITH LOCKNUT. ALUMINUM WASHERS, 0.75 DIA X 0.06 THICK. BOLTS MUST BE INSTALLED WET WITH BMS 5-95 SEALANT OR WITH BMS 3-24 GREASE. CAP AND FAY SEAL PROTRUDING FASTENER HEADS AND NUTS/WASHERS



TYPICAL REPAIR IN FIELD AREA
REPAIR I

Metal Overlay Repair to Composite Panel
Figure 1 (Sheet 1 of 2)





SECTION B-B

TYPICAL REPAIR NEAR EDGEBAND
REPAIR II

Metal Overlay Repair to Composite Panel
Figure 1 (Sheet 2 of 2)