



STANDARD OVERHAUL PRACTICES MANUAL

REPAIR OF WRAPPED WIRE ELECTRICAL CONNECTIONS

**PART NUMBER
NONE**

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PUBLISHED BY BOEING COMMERCIAL AIRPLANES GROUP, SEATTLE, WASHINGTON, USA
A DIVISION OF THE BOEING COMPANY
PAGE DATE: Jul 01/2009

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STANDARD OVERHAUL PRACTICES MANUAL

Revision No. 9
Jul 01/2009

To: All holders of REPAIR OF WRAPPED WIRE ELECTRICAL CONNECTIONS 20-11-06.

Attached is the current revision to this STANDARD OVERHAUL PRACTICES MANUAL

The STANDARD OVERHAUL PRACTICES MANUAL is furnished either as a printed manual, on microfilm, or digital products, or any combination of the three. This revision replaces all previous microfilm cartridges or digital products. All microfilm and digital products are reissued with all obsolete data deleted and all updated pages added.

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Location of Change

Description of Change

NO HIGHLIGHTS

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HIGHLIGHTS

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INTRODUCTION

1. General

- A. The instructions in this manual tell how to do standard shop procedures during maintenance functions from simple checks and replacement to complete shop-type repair.
- B. This manual is divided into separate sections:
 - (1) Title Page
 - (2) Transmittal Letter
 - (3) Highlights
 - (4) Effective Pages
 - (5) Contents
 - (6) Revision Record
 - (7) Record of Temporary Revisions
 - (8) Introduction
 - (9) Procedures
- C. Refer to SOPM 20-00-00 for a definition of standard industry practices, vendor names and addresses, and an explanation of the True Position Dimensioning symbols used.
- D. The data is general. It is not about all situations or specific installations. Use it as a guide to help you write minimum standards.
- E. If the component overhaul instructions are different from the data in this subject, use the component overhaul instructions.

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INTRODUCTION

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REPAIR OF WRAPPED WIRE ELECTRICAL CONNECTIONS

1. INTRODUCTION

- A. A wrapped wire connection consists of a helix of continuous, solid, uninsulated wire tightly wrapped around a terminal post to produce a mechanically and electrically stable connection. The number of turns required depends on the wire size used. In addition to the uninsulated wire wrap turns, an additional turn of insulated wire is wrapped around the terminal to absorb vibration. The insulated turn is at the bottom of the wrapped section. The wrap proceeds upward on the terminal post to the end of the wire.
- B. Definitions
- (1) End Tail - The end of the last turn of uninsulated wire.
 - (2) End Turn - The last or top turn of a wrapped wire connection.
 - (3) Gas-Tight Area - The contact area between the terminal post and wire which will exclude gas fumes when properly wrapped.
 - (4) Lead Turn - The first (lowest) turn of a wrapped wire connection
 - (5) Terminal Post (or Terminal) - A rigid metallic post of rectangular or square cross section on which a solid round wire is wrapped to provide a mechanical and electrical connection.
 - (6) Unwrapping Tool - A tool used to unwrap the wire turns to remove a wrapped wire connection.
 - (7) Wire Dress - The direction or positioning of wiring between connections within the mechanical assembly to obtain optimum routing and spacing.
 - (8) Wire Routing - The physical placement or orientation of wire.
 - (9) Wire Stripping - The removal of insulation from wire.
 - (10) Wire Turn (or Turn) - One complete turn of wire around the terminal post that touches all corners. To count turns, find the first corner touched by the wire. Count the number of turns crossing this corner above this point.
 - (11) Wrapping Level - The section of terminal occupied by a wrapped wire connection. The first level is at the base of the terminal post. The second level is the middle wrapping area. The third level is nearest the free end of the terminal post.
 - (12) Wrapping Tool - A tool consisting of a bit and sleeve assembly used to wrap a solid conductor wire around a terminal post.
 - (13) Manual Wire-wrapping - Application of the wire wrap connection with a hand-held and manually-positioned tool.
 - (14) High Turn - A turn of wire raised off the post by interference with an adjacent turn of wire. This condition may be caused by excessive pressure applied to the tool.
 - (15) Overwrap - A wire turn piled up on a previously made turn within the same wrapped wire connection.
- C. General Process
- (1) Wires to be removed may be unwrapped, or may be clipped close to the terminal post. If the wire to be removed is on a lower level, clipping may be preferable to unwrapping wires on levels above.
 - (2) Wires to be attached must be stripped of insulation for a specified length at the end, inserted in the wrapping tool, and the wrap applied to the terminal post.

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- (3) The section of unwrapped wire may not be re-used. A fresh section of the same wire may be stripped and wrapped. However, sufficient slack must be available to avoid any strain on the connection. This extra length is not normally available on original wiring.

D. Refer to SOPM 20-00-00 for a list of all the vendor names and addresses.

2. MATERIALS

NOTE: Equivalent substitutes may be used.

- A. Topical antistatic solution (V85670)
- (1) Rescue Solution
 - (2) Rescue-2 Chloride-Free
 - (3) No. 70504 (spray bottle)
 - (4) No. 70508 (gallon)
- B. Aqua regia solution (1 to 1 concentrated hydrochloric and nitric acids).
- C. Concentrated ammonium sulfide solution
- D. Adhesive – Type 70 or 82 (Ref SOPM 20-50-12)

3. TOOLS

- A. General
- (1) When wire wrapping or unwrapping is performed on wire bundles with electrostatic discharge sensitive devices attached, one of the following conditions must be met:
 - (a) The tool must be air-powered.
 - (b) The tool may be electrically powered and used in conjunction with an ionized air blower blowing air over the work surface.
 - (c) The tool may be electrically powered with the tip of the tool grounded and the plastic case of the tool treated with topical antistatic solution.
 - (2) Equivalent tools may be substituted for those listed.
- B. Unwrapping Tools – See Table 1

Table 1: Unwrapping Tools

Wire Size AWG	Terminal Post Size (Inches)	Cooper (V96508) Tool Number
28–30	0.025 x 0.025	505241 ^{*[1]}
26–30	0.025 x 0.025	518921 ^{*[1]}

^{*[1]} Bit for air or electric powered unwrapping motor.

- C. Wrapping Tools – See Figure 1
- D. Insulation Stripping Tools
- (1) Use Ideal Industries Stripmaster hand tool with appropriate blades per Table 2.

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**STANDARD OVERHAUL PRACTICES MANUAL****Table 2: Wire Stripping Blades**

Wire Specification	Wire Size (AWG)	Ideal (V30119) Stripmaster Blade Number
BMS-13-46-2 BMS-13-46-3 BMS-13-46-4	30-26	45-1753-1
Same as above	28-26	L-9300

E. Wrapped Connection Test Tools (for quality control sample testing)

- (1) DC Power Supply, variable
- (2) Millivoltmeter
- (3) DC Ammeter (0 to 10 amperes)
- (4) Terminal Stripping Tool (for Terminal Stripping Force Test). Boeing tool A20007-1 may be used.
- (5) Device such as a spring scale to apply and measure 2 to 10 pounds force.

F. Wire Wrap Post Connector Cover Installation/Removal Tools

- (1) Hot air gun – Mamco model HG-S-751-10 (V12642)
- (2) Heat nozzle gun – Ideal Model 46-013 (V30119)

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TERMINAL POST SIZE (INCHES)	WIRE			COOPER (V96508) TOOL NO.	
	AWG	PART NUMBER	SPECIFICATION NUMBER	WRAPPING BIT	WRAPPING SLEEVE
0.025 X 0.025	30	W46-2-30() M81822/5-B30-()	BMS-13-46-2 MIL-W-81822/5	990033	507100 517101
		W46-3-30() M81822/1A-B30-()	BMS-13-46-3 MIL-W-81822/1A		
		W46-4-30()	BMS-13-46-4		
0.025 X 0.025	28	W46-2-28() M81822/5-B28-()	BMS-13-46-2 MIL-W-81822/5	990034	507100 517101
		W46-3-28() M81822/1A-B28-()	BMS-13-46-3 MIL-W-81822/1A		
		W46-4-28()	BMS-13-46-4		
0.025 X 0.025	26	W46-2-26() M81822/5-B26-()	BMS-13-46-2 MIL-W-81822/5	990035	507100 517101
		W46-3-26() M81822/1A-B26-()	BMS-13-46-3 MIL-W-81822/1A		
		W46-4-26()	BMS-13-46-4		
0.025 X 0.025	24	W46-2-24() M81822/5-B24-()	BMS-13-46-2 MIL-W-81822/5	505415	509265
		W46-3-24() M81822/1A-B24-()	BMS-13-46-3 MIL-W-81822/1A		
		W46-4-24()	BMS-13-46-4		

Wire Wrapping Bits and Sleeves
Figure 1

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4. PROCEDURES

A. Preparation

- (1) The terminal posts in ARINC 600 boxes may or may not be accessible for application of wire wrap tools. If not accessible, some disassembly will be required.
- (2) The wire wrap connections are originally applied with the printed circuit assembly connectors and all other components laid out in a horizontal plane. The entire wire bundle may be removed and returned to this condition for rework. The printed circuits assembly connectors need not be removed from the mounting bracket.
- (3) Remove all printed circuit assemblies and other chassis-mounted subassemblies as required. This will normally remove all electrostatic sensitive devices. If it does not, see paragraph on tool precautions when electrostatic sensitive devices are connected to the wire bundle. Use electrostatic sensitive packaging as required for removed assemblies.
- (4) Remove screws at chassis sides holding printed circuit assembly guide brackets.
- (5) Remove rear connector mounting screws.
- (6) Remove all other component mounting hardware as required to free wire bundle from chassis including ground studs. Front panel may be removed, or individual components on front panel may be removed as necessary.
- (7) Carefully remove wire bundle with attached components and lay out as required for access to terminal posts.

B. Removal of Wrapped Wire Connections

- (1) Select the proper unwrapping tool per Table 1. Place tool over terminal post and engage leading edge between the wrap end and next wrap turn. Rotate counterclockwise until all wire has been transferred to tool, or the wrap is sufficiently loose to slide free of post.
- (2) Upper level wraps must be removed to gain access to lower level wraps.
- (3) Do not attempt to remove lower level wraps, and then slide the upper level wraps down the post. Once wrapped, the turns may not be moved on the post.

C. Installation of Wrapped Wire Connections

- (1) Examine terminal post for misalignment. Realign, if required, with any tool that will fit over the terminal to the base and not damage terminal (such as an unwrapping tool).
- (2) Select wire size required and cut to length. The wire should be dressed such that the routing of the wire or any applied tension on the wire will not unwrap the connection to less than the minimum requirements of Table 4. Wire shall have sufficient slack to prevent tension on wire or post.
- (3) Silver coated conductors tarnished black may not be used.
- (4) Strip insulation from ends of wire per Table 3. Use stripping tool per Table 2.

Table 3: Insulation Stripping Length

Wire Specification	Wire Size	Post Size	Terminal Strip Length
BMS-13-46-2	26, 24	0.025 x 0.025	0.9 - 1.1 inch
BMS-13-46-3			
BMS-13-46-4			

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- (5) Wrap on the lowest vacant level. When wrapping on level 1, be certain to bottom out the wrapping tool.
- (6) Apply wrapping turns of insulated and uninsulated wire as listed in Table 4.

Table 4: Wrapped Wire Connection Requirements

Wire Size	Terminal Post Size (Inch)	Turns of Stripped Conductor	Number of Post Corners for Insulated Wire		Terminal Post Stripping Force (Lbs. Minimum) ^{*[1]}
			Min.	Max.	
30	0.025 x 0.025	7-8	5	9	3
28	Same as above	7-8	5	9	4
26	Same as above	6-7	4	9	6
24	Same as above	5-6	4	9	7

^{*[1]} Stripping force for test samples (Ref Paragraph 6., PROCESS CONTROL)

- (7) Insulation between posts shall not be cut, torn, crushed, or charred. Indentations such as tool marks are acceptable.
 - (8) Dress wire so that it does not extend above the plane of the terminal post tips.
 - (9) Do not route wire outside of, or along, the outer periphery of the terminal post assembly.
 - (10) Wires that lie between the terminal posts of any terminal post array shall not be tied together.
 - (11) Do not slide a completed wrap along the axis of the terminal post.
 - (12) Unwrap and replace defective wraps. Unwrapped portion of wire may not be re-used.
 - (13) Straighten misaligned wrapped terminal posts:
 - (a) When posts are bent 30° or less, realign sufficiently to establish one post thickness spacing between conducting surfaces.
 - (b) When posts are bent more than 30°, unwrap connection and straighten post. After alignment, examine with 5X magnification. If cracks are found on terminal post, post is not acceptable for wire wrapping.
 - (14) Shield Terminations
 - (a) Use solder sleeve method for installation of shield termination pigtail. It is not necessary to fold shield braid back over wire jacket.
 - (b) Use BMS 13-46-2 wire for pigtail jumper, minimum length of 2 inches.
 - (c) Pigtail jumper shall extend from forward end.
 - (15) Do not route unshielded and unjacketed multiple conductor cable or shielded and jacketed multiconductor cable between wire wrap contacts.
- D. Installation and Removal of Wire Wrap Post Connector Covers**
- (1) Installation
 - (a) Install wire wrap post connector covers by properly orienting the indicated cover over the connector and pushing it on until it is fully seated on the cap pins. Cover shall be fully seated before the application of adhesive.
 - (b) Apply adhesive per SOPM 20-50-12 in the upper half of the groove as shown in Figure 2 to provide maximum coverage of the pin.

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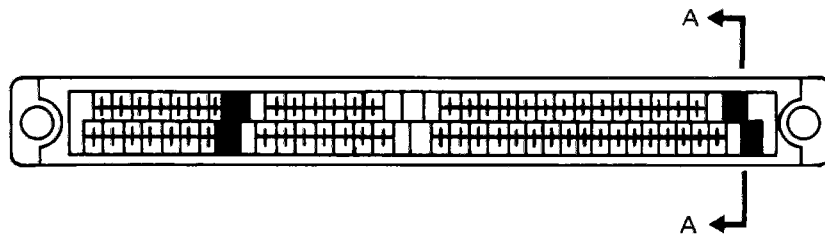
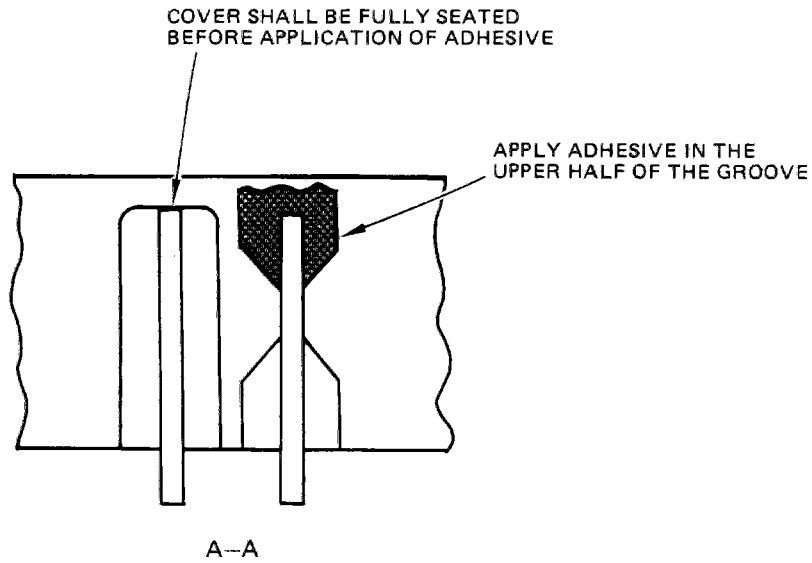
(2) Removal

- (a) Remove the printed circuit board assembly mated to the contact assembly having the pin cover to be replaced and any other assemblies required to gain access to the connector.
- (b) Use a heat gun to remove the cover. Hold the heat gun at least one inch from the cover and point it at the adhesive. Apply heat to cover until the adhesive softens, but do not exceed 20 seconds in any one area to prevent overheating of wiring.
- (c) After adhesive is softened, remove cover by applying an evenly distributed amount of upward force on the connector cover.

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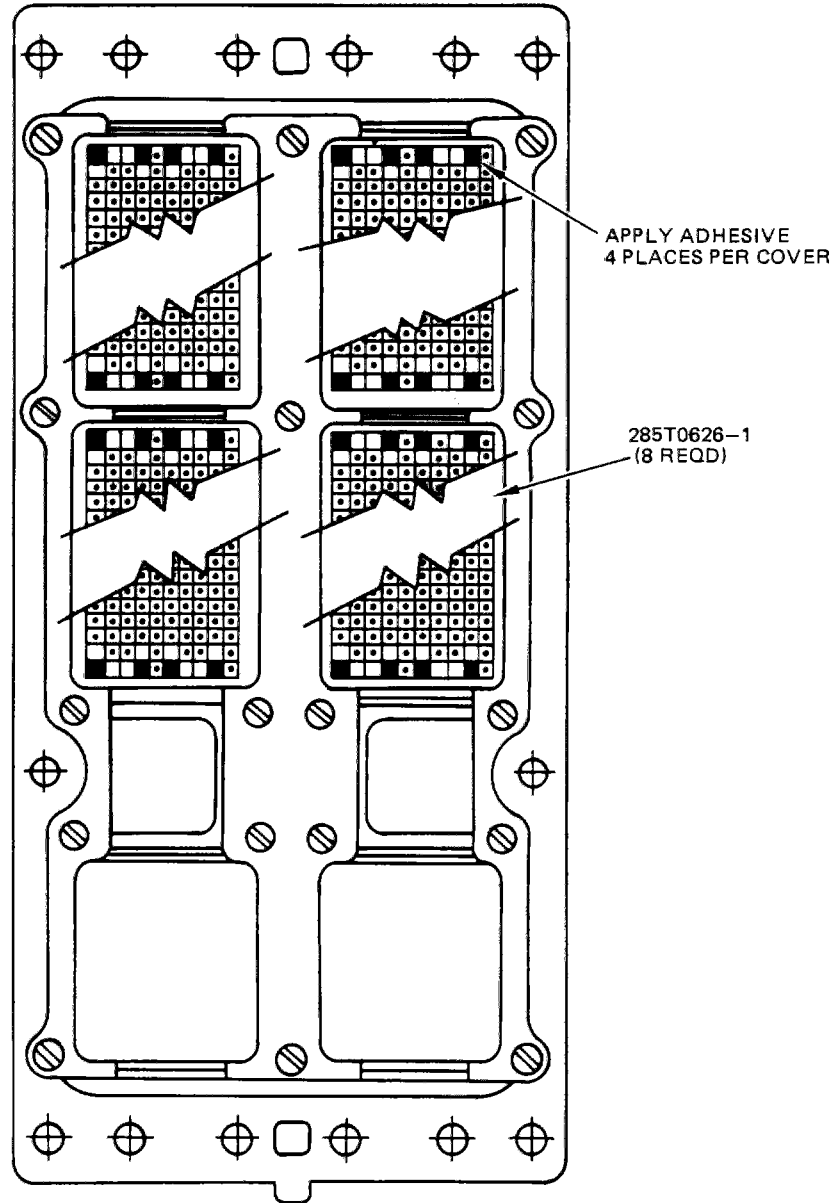
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Replacement of Wire Wrap Connector Cover
Figure 2 (Sheet 1 of 5)

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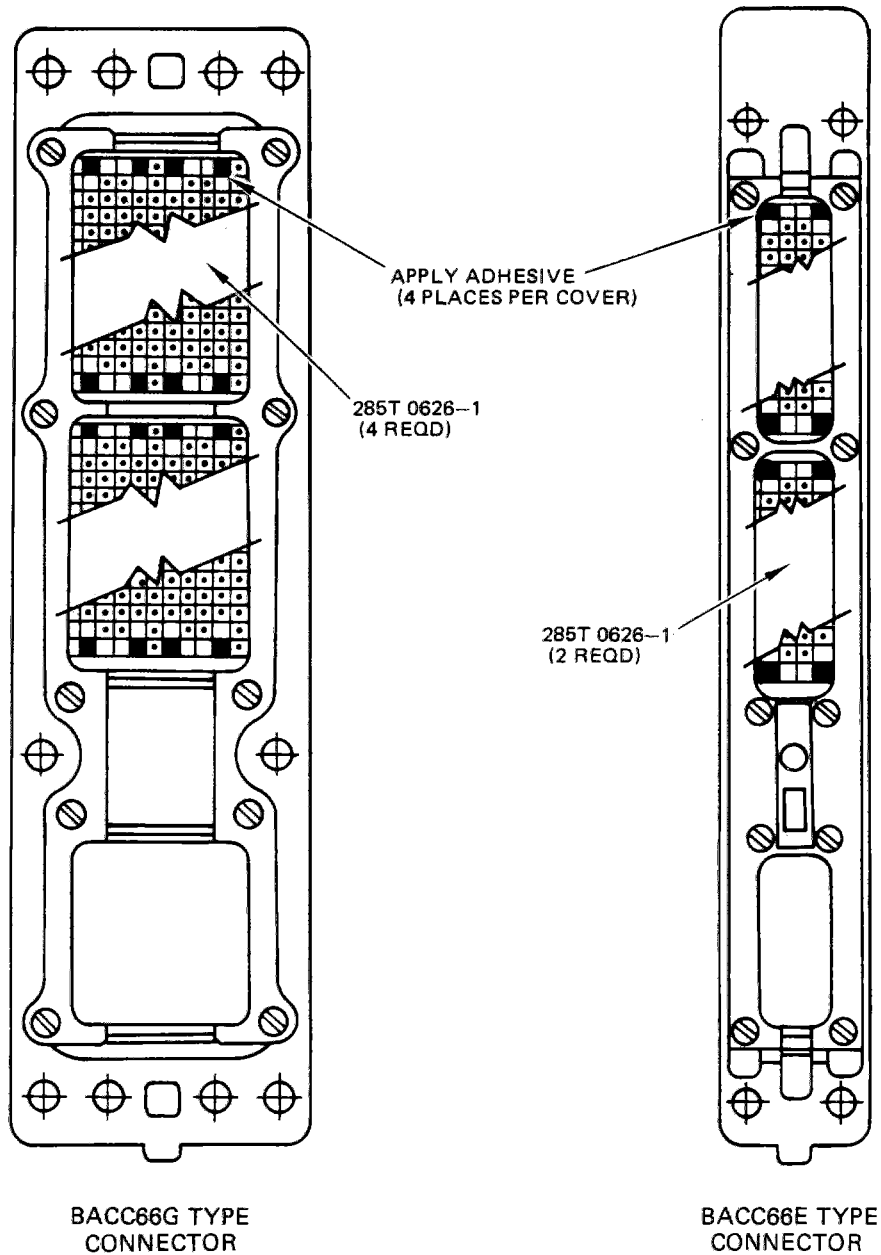


BACC66J TYPE CONNECTOR

Replacement of Wire Wrap Connector Cover
Figure 2 (Sheet 2 of 5)

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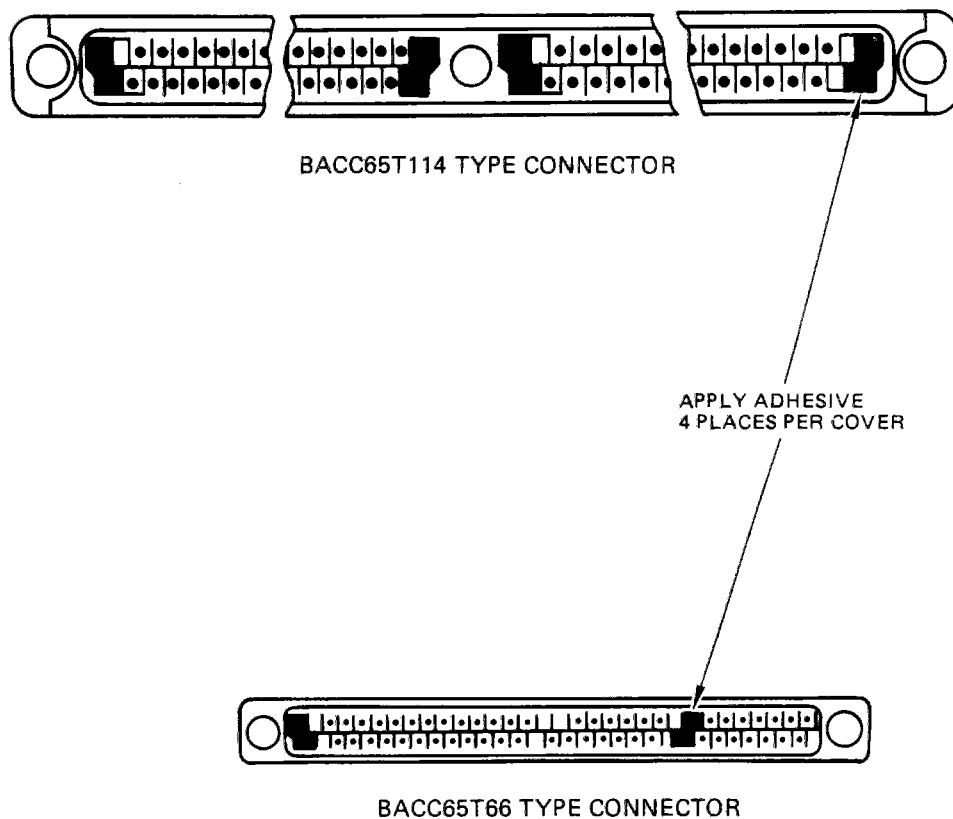
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Replacement of Wire Wrap Connector Cover
Figure 2 (Sheet 3 of 5)

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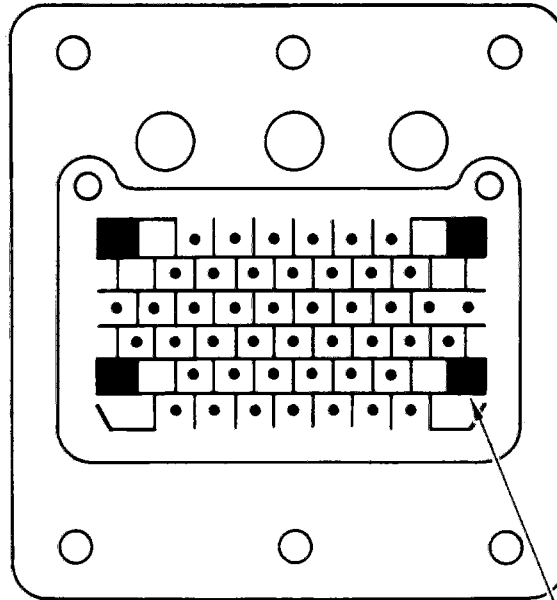


Replacement of Wire Wrap Connector Cover
Figure 2 (Sheet 4 of 5)

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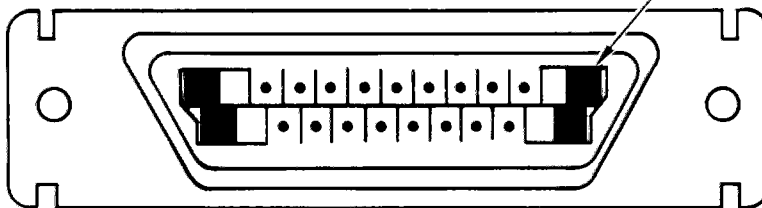


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AMIR57P6031 CONNECTOR

APPLY ADHESIVE
4 PLACES PER COVER



DB-25P-F179A CONNECTOR

Replacement of Wire Wrap Connector Cover
Figure 2 (Sheet 5 of 5)

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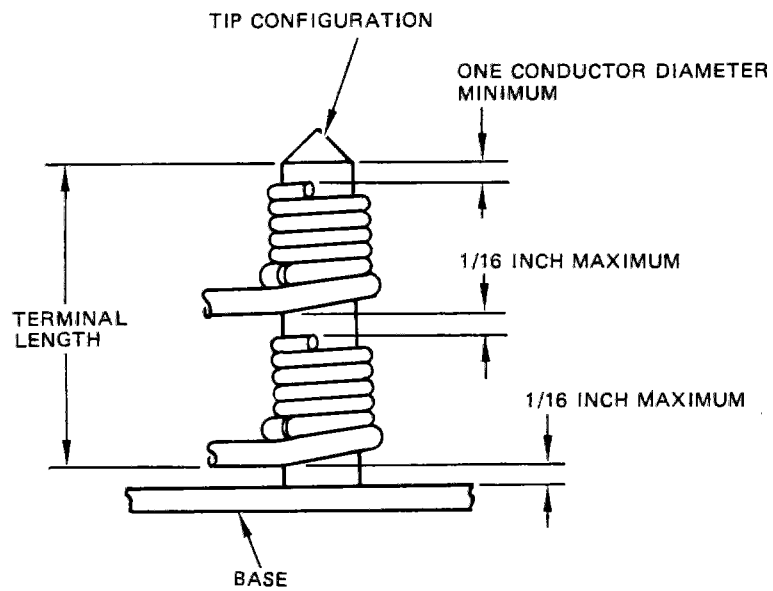
5. CONFIGURATION OF COMPLETED CONNECTIONS

- A. Wrapped connections shall meet the turns requirements of Table 4 for both stripped and insulated portions of wire.
- B. There shall be no damage which exposes base metal that is visible under 5X magnification.
- C. Cuts, tears, or crushing of insulation on the insulated turns are acceptable except that no conductor shall be visible (unaided eye) on the last half turn before the wire leaves the terminal.
- D. Space between adjacent turns of the wrap shall not exceed one half the diameter of the bare conductor except on the first and last turns where the space shall not exceed one diameter of the bare conductor. The sum of all gaps shall not exceed one diameter excluding the first and last turn (Figure 3).
- E. High turns, open turns, and overwrap (Figure 4, Views A, B, C) are not acceptable.
- F. The last turn (end tail) shall not extend more than one conductor diameter beyond the outer diameter of the stripped wire (Figure 4, View D). A blunt tool may be used to bend the excess end tail around the post; however, care must be used to avoid damage to the terminal, wire, or wrap.
- G. Wraps must not extend over the rounded, tapered, or bevelled end of the terminal post (Figure 4, View E). There shall be one conductor diameter minimum between the completion of the wrap and the beginning of the post tip configuration.
- H. The first turn of insulated wire may overlap the turns of uninsulated wire in a connection below it on the same terminal post. On the first wrapping level, the first turn of insulated wire may overlap the terminal post bushing below. The requirements for insulated wire covering corners (Table 4) still apply.
- I. Maximum distance between the start of insulated wire turn and the bushing or base of the terminal post shall be one-sixteenth inch. Maximum distance between wraps shall be one-sixteenth inch (Figure 3).

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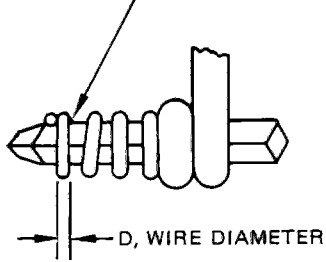


Wrapping Dimensions
Figure 3

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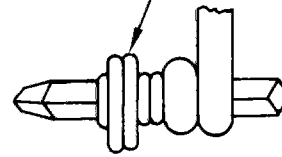
MAXIMUM GAP EXCEEDS 1/2 OF "D"



OPEN TURNS

(A)

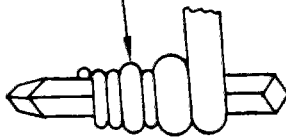
OVERWRAP



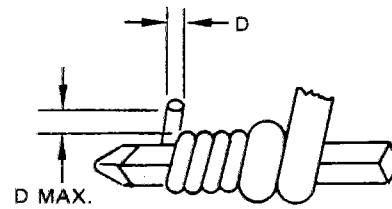
OVERWRAPPED TURNS

(B)

HIGH TURN



HIGH TURN

(C)EXCESSIVE END TAIL
EXTENSION**(D)**EXTENSION OF WRAP ONTO
TERMINAL POST TIP**(E)**OVERLAP NOT MEETING
REQUIREMENTS**(F)**Unacceptable Connections
Figure 4**20-11-06**



STANDARD OVERHAUL PRACTICES MANUAL

6. PROCESS CONTROL

A. General

- (1) Certain checks on the quality of the wire wrap process can, and should, be made on each wire wrap connection. These checks are listed in Paragraph 5..
- (2) Certain checks cannot be made or are impractical to make on each wire wrap connection. These checks are listed in this section:
 - (a) Electrical resistance check between terminal post and wrapped conductor.
 - (b) Gas tight integrity check between wrap and terminal post.
 - (c) Stripping force required to slide wiring along terminal post axis.
 - (d) Unwrapping tests
- (3) The checks listed in this section should be made on the conditions listed, at selected time intervals dependent upon extent of usage of the tool, and at any time the potential performance of the tool to be used is in doubt.
- (4) Wrap a set of 24 samples for initial tests. Wrap a set of 6 samples for periodic tests.
 - (a) Apply wrap samples two-to-the-post with some space between wraps. Leave sufficient space between the lower wrap and the terminal base for insertion of a stripping tool (Figure 6).

B. Initial Tests

- (1) Perform initial tests on new tools; on tools that have been repaired, adjusted, or modified; on tools that have not had initial tests for a six month period; or every ten working days on tools in constant use.
- (2) Perform the following tests on twelve sample wraps in the order listed:
 - (a) Resistance test
 - (b) Terminal stripping force test
 - (c) Unwrap test
- (3) Perform gas tight test on twelve sample wraps.

C. Periodic Tests

- (1) Perform periodic tests daily on tools in constant use; after each change of tool bit, sleeve, or wrapper; or when dropping or mishandling causes tool performance to be suspect.
- (2) Perform the following tests on six sample wraps in the order listed:
 - (a) Terminal stripping force test
 - (b) Unwrap test

D. Resistance Tests

- (1) Make connections as shown in Figure 5 with power supply set to zero.
- (2) Slowly increase voltage until series ammeter reads as shown in Table 5. Millivoltmeter shall not indicate more than 4 millivolts.

Table 5: Resistance Tests

AWG Wire Size	DC Current In Series Ammeter ($\pm 2\%$)
30	1.0
28	2.0

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Table 5: Resistance Tests (Continued)

AWG Wire Size	DC Current In Series Ammeter ($\pm 2\%$)
26	2.4

E. Terminal Stripping Force Test

- (1) Use stripping tool as shown in Figure 6.
 - (a) The stripping tool jaw shall engage at 80° - 100° to the axis of the terminal post.
 - (b) Total clearance between the terminal post and stripping tool jaw shall not exceed 0.7 times the diameter of the uninsulated wire. There shall be a minimum clearance such that there is no binding between the tool and terminal post.
 - (c) Both sides of the stripping tool jaw shall be in the same plane creating a flat surface contact with the wire on each side of the post.
- (2) Apply a stripping force along the axis of the terminal post at a uniform rate of one to ten inches per minute until the maximum force as listed in Table 4 is reached or exceeded. The stripping force is defined as the force in pounds required to displace the entire wrap one connection length. If such displacement occurs before the maximum listed in Table 4 is reached, the wrap is not acceptable.

F. Unwrapping Test

- (1) Select the proper unwrap tool per Table 1.
- (2) Place tool over terminal post and engage leading edge between the wrap end and next wrap turn. Rotate tool counterclockwise until all wire has been transferred to tool, or wire wrap is loosened and removed from post. If wire did not transfer to tool, place a round shaft of a size that will fit inside to support the wire wrap spiral during unwrapping and straightening.
- (3) Hold the insulated portion of the wire firmly. Rotate the tool or shaft to unwind the wire into a straight length. The wire need not be perfectly straight. Waves and deformations in the wire are acceptable. Wire shall withstand unwrap and straightening without breaking of the conductor.

G. Gas Tight Test

- (1) The test consists of exposing the wrap to aqua regia fumes, then darkening the wrap with ammonium sulfide gas. The wrapped wire connection, except for the first and last turn, shall have a gas tight area on at least 75 percent of the corners in contact with uninsulated wire. The gas tight area should appear in bright, sharp contrast with the darkened post.
- (2) The wrap should not contact the solutions during test.
- (3) Suspend the wrap in a 16 x 15 milliliter test tube containing 1 to 2 milliliters of aqua regia solution (1 to 1 concentrated hydrochloric and nitric acids). Cork tube and expose wrap to fumes for 10 minutes minimum.
- (4) Transfer wrap to another test tube of similar size containing 1 milliliter of concentrated ammonium sulfide solution. Cork tube and expose wrap to fumes until wrap turns dark. Copper and gold sulfide color should develop on exposed areas.
- (5) Remove and dry sample wrap. Unwrap with tool that does not scratch post. Verify bright contrasting areas meet requirements stated above.

H. Retest

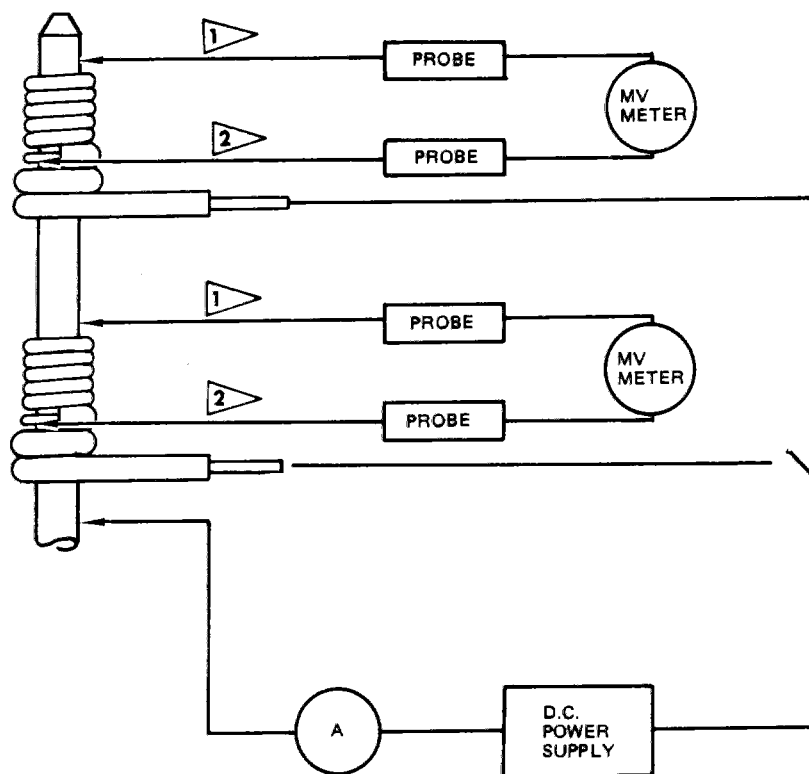
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- (1) If wire wrapped connections fail to meet test requirements repair and adjust the tool, and perform another set of tests.
- (2) If a tool fails to perform properly under routine testing, the quality of previously performed work is suspect and should be inspected.

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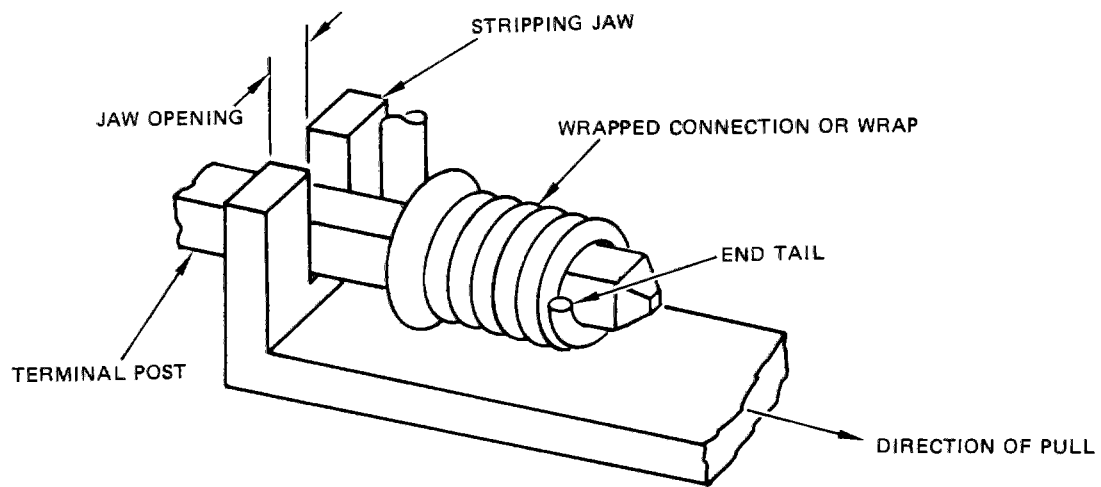
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- 1** THIS PROBE MUST NOT TOUCH THE WIRE
2 PLACE THIS PROBE ON FIRST TURN OF UNINSULATED WIRE

Resistance Tests
Figure 5

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Terminal Stripping Force Test
Figure 6

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