STANDARD OVERHAUL PRACTICES MANUAL

REPAIR OF ELECTRICAL TERMINATIONS AND ELECTRICAL BONDING AREAS

PART NUMBER
NONE

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

STANDARD OVERHAUL PRACTICES MANUAL

Revision No. 18
Jul 01/2009

To: All holders of REPAIR OF ELECTRICAL TERMINATIONS AND ELECTRICAL BONDING AREAS 20-11-03.

Attached is the current revision to this STANDARD OVERHAUL PRACTICES MANUAL

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Subject/Page	Date
TITLE PAGE	
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O 1	Jul 01/2009
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20-11-03 HIGHLIGHTS	
O 1	Jul 01/2009
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20-11-03 EFFECTIVE PAGES	
1	Jul 01/2009
2	BLANK
20-11-03 CONTENTS	
1	Mar 01/2007
2	BLANK
20-11-03 REVISION RECORD	
1	Jul 01/2005
2	Jul 01/2005
20-11-03 RECORD OF TEMPORARY REVISIONS	
1	Jul 01/2005
2	Jul 01/2005
20-11-03 INTRODUCTION	
1	Jul 01/2005
2	BLANK
20-11-03 SUBJECT	
1	Jul 01/2005
2	Mar 01/2007
3	Mar 01/2007
4	Mar 01/2007
5	Nov 01/2006
6	Mar 01/2007
7	Mar 01/2007
8	Mar 01/2007
9	Mar 01/2007
10	Mar 01/2007
11	Mar 01/2007
12	Mar 01/2007
13	Mar 01/2007
14	Mar 01/2007
20-11-03 SUBJECT (CONT)	
15	Jul 01/2007
16	BLANK

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

TABLE OF CONTENTS

Paragraph Title	Page
REPAIR OF ELECTRICAL TERMINATIONS AND ELECTRICAL BONDING AREAS	1
INTRODUCTION	1
MATERIALS AND EQUIPMENT	1
SURFACE PREPARATION	2
REPAIR OF TERMINAL LUG CONNECTIONS	5
REPLACEMENT OF DEFECTIVE HEAT SHRINKABLE SLEEVING	11
INSULATING UNATTACHED WIRE ENDS	11
MULTIPLE WIRE AND UNDERSIZED WIRE COMBINATIONS	12
LOW RESISTANCE BONDS	12
ELECTRICAL FAYING SURFACE BONDS	15

STANDARD OVERHAUL PRACTICES MANUAL

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Revision		Filed		Revision		Filed	
Number	Date	Date	Initials	Number	Date	Date	Initials

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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.

REPAIR OF ELECTRICAL TERMINATIONS AND ELECTRICAL BONDING AREAS

1. INTRODUCTION

A. The data in this subject comes from Boeing Process Specifications BAC5117 (Electrical Bonding and Grounding), BAC5153 (Assembly of Electrical Terminations), BAC5155 (Heat-Shrinkable Materials on Electric Wiring) and BAC5120, BAC5120-1, and BAC5120-2 (Crimping). The airline has a copy of the Boeing Process Specification Manual.

B. This data is general. It is not about all situations or specific installations. Use this data as a guide to help you write minimum standards.

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

2. MATERIALS AND EQUIPMENT

NOTE: Equivalent substitutes can be used.

A. Materials

CAUTION: SOME OF THESE MATERIALS ARE FLAMMABLE, CORROSIVE OR TOXIC.

(1) Cleaning Materials (SOPM 20-60-01)

(a) Acetone

(b) Aliphatic Naphtha – TT-N-95 (Supersedes BMS 3-2)

(c) Ethyl Alcohol, denatured

(d) Cleaning Solvent – BMS 11-7

(e) Isopropyl Alcohol – TT-I-735, Grade A

(f) Lacquer Thinner – TT-T-266

(g) Methyl Ethyl Ketone – TT-M-261

(h) Methyl Propyl Ketone (MPK) – BMS 11-9

(i) Sec-Butyl Alcohol

(j) Solvents per BAC5750 with code FB, for metals or organic coatings

(2) Varnish – Nycote 7-11 or 88 (V05803) or Vyna-Kote No. 6 (V55611)

(3) Shrink Fit Sleeving – Thermofit RNF, RT-876, CRN, or TFE (SOPM 20-60-04)

(4) Wipers – BMS 15-5, Class A or B (SOPM 20-60-04)

(5) End Caps – 324484, 324485, 324486, 324487 (V00779)

(6) Abrasives

(a) Abrasive Paper – P-P-121, Garnet

(b) Abrasive Cloth – P-C-451, Aluminum Oxide

(c) Abrasive Blast Grit – Aluminum Oxide, 100-325 grit

(d) Abrasive Pad – Scotch-Brite, Type A, cleaning and finishing, very fine (SOPM 20-60-04)

(7) Masking Tape – Protex 1321 D-3 (SOPM 20-60-04)

(8) Masking Film, Mylar – Protex 223-5 (SOPM 20-60-04)

B. Equipment

(1) Brush, Rotary Wire – AISI 302 Stainless Steel, hard-drawn

(2) Brush, Nonmetallic – Soft natural bristle

(3) Abrasive Disk, Rotary

(4) Wire Stripping Tool – ST2346

(5) Hot-Air Gun – Raychem 500 (V06090)

(6) End Cap Crimping Tool – Amp 46063 (V00779)

(7) Power Supply – Hewlett-Packard 6269A (V28480)

(8) Bonding Meter

(a) Avtron Model T477W (V01014)

(b) BCD Electronics Ltd. Model M1, serial number A0000112 and on (VL1002)

(9) Multimeter (with milliohm scale) – Any certified and calibrated meter and probe can be used in areas without an explosion hazard. Examples: Hewlett-Packard 3466A or 34401A (V28480)

(10) Micro-Ohm Meter – Keithley Model 580 (V80164)

3. SURFACE PREPARATION

A. General

(1) All surfaces for electrical bonding must be clean and have no contamination such as oil, grease, decorative or protective finishes, abrasive particles or metal oxides. These surfaces must be smooth and flat. If metal must be removed for preparation, removal must be kept to a minimum. Before you bond hardware to the surface, remove all temporary protective coatings and clean the bonding surfaces. Then wipe the cleaned area with lint-free cloth or gauze wipers.

(2) Make your selection of the cleaning method from Table 1. Refer to Paragraph 3.B. thru Paragraph 3.G. for procedure details.

Table 1: Surface Cleaning Method Selections

MATERIAL SURFACE	SURFACE FINISH OR CONTAMINATION	CLEANING METHOD	CLEANING AGENT	FORMER TYPE
Aluminum or Composite	Anodize BAC5019 BAC5632 Chemical treatment BAC5626 Class A BAC5719 Class A, B, C Oxide films Primer Enamel Lacquer	CM1	Abrasives, Stainless steel brush	I,II,III, IV,CM2
Aluminum Alloy	Bare Clad Chemical treatment BAC5719 Class D BAC5626 Class B	CM3	Naphtha	V
Magnesium Nickel alloy 625 Stainless steel Titanium	Bare	CM3	Naphtha	VII
Stainless Steel	Cadmium plating	CM3		V, VII

Table 1: Surface Cleaning Method Selections (Continued)

MATERIAL SURFACE	SURFACE FINISH OR CONTAMINATION	CLEANING METHOD	CLEANING AGENT	FORMER TYPE
Magnesium Nickel alloy 625 Stainless steel Titanium	Paint Primer Enamel	CM1		I, II, III, IV, CM2
Iron Steel	Bare	CM4	Spotface	VI
Thermal spray	Bare	CM1		I, II, III, IV, CM2
Thermal spray	Paint, primer, or enamel	CM3		V, VII
Thorstrand aluminum glass fiber cloth	Conductive coatings, painted	CM5	Scotch-Brite pads	None
Printed Wiring Assemblies	Conformal Coating (Encapsulant)	CM6	Isopropyl Alcohol	None
BMS 8-336 metal foil	Paint, primer, enamel, epoxy resin	CM5		None
BMS 10-21 coating	Bare	CM1		I, II, III, IV, CM2
BMS 10-21 coating	Paint, primer or enamel	CM3		V, VII

B. Cleaning Method CM1

CAUTION: DO NOT USE THE ABRASIVE MATERIAL ON MATERIAL DIFFERENT FROM THE TYPE ON WHICH IT WAS FIRST USED.

(1) Hand Application of Abrasives

(a) Clean the surface by hand with Scotch-Brite pads, garnet paper, or aluminum oxide or silicon carbide sandpaper.

(b) Use a circular motion with the abrasive material.

(c) Continue until the coating is removed and the metal surface is bright.

(d) On shot peened surfaces, if you remove an amount of material more than the larger of the nominal Almen A2 intensity or 0.001 inch, shot peen the surface again per SOPM 20-10-03. Then manually clean per BAC5744 or solvent clean per BAC5750 (SOPM 20-30-03).

(e) Solvent clean the surface by the Final Cleaning procedure of BAC5750 (SOPM 20-30-03).

CAUTION: DO NOT USE A BRUSH WITH CARBON STEEL BRISTLES, BECAUSE STEEL RUBBED INTO THE METAL SURFACES CAN CAUSE CORROSION. ALSO, DO NOT USE WIRE BRUSHES ON MAGNESIUM.

(2) Stainless Steel Rotary Brushes

(a) Clean the surface with a rotary stainless steel wire brush in a manual or power drill motor.

(b) Use light, intermittent pressure. Keep the cutting face parallel with the surface.

(c) Examine the surface after each intermittent operation of the brush. Remove a minimum amount of the metal or conductive finish. Continue only until the metal surfaces is bright.

NOTE: Anodic layers can have different thicknesses, and are not always easy to remove with a wire brush. Then you can use an abrasive disk per step (3) below.

(d) On shot peened surfaces, if you remove an amount of material more than the larger of the nominal Almen A2 intensity or 0.001 inch, shot peen the surface again per SOPM 20-10-03. Then manually clean per BAC5744 or solvent clean per BAC5750 (SOPM 20-30-03).

(e) Solvent clean the surface by the Final Cleaning procedure of BAC5750 (SOPM 20-30-03).

CAUTION: DO NOT USE THE ABRASIVE DISK ON MATERIAL DIFFERENT FROM THE TYPE ON WHICH IT WAS FIRST USED.

(3) Rotary Abrasive Disk

(a) Clean the surface with an abrasive sheet or disk in a rotary mandrel in a manual or power drill motor.

(b) Use light, intermittent pressure. Keep the cutting edge parallel with the surface. If you use an abrasive disk without a pilot, keep the cutting edge at an angle less than 30 degrees to the surface.

(c) Continue until the coating is removed and the metal surface is bright.

(d) On shot peened surfaces, if you remove an amount of material more than the larger of the nominal Almen A2 intensity or 0.001 inch, shot peen the surface again per SOPM 20-10-03. Then manually clean per BAC5744 or solvent clean per BAC5750 (Ref SOPM 20-30-03).

(e) Solvent clean the surface by the Final Cleaning procedure of BAC5750 (SOPM 20-30-03).

C. Cleaning Method CM2 – Superseded by Cleaning Method CM3

D. Cleaning Method CM3

CAUTION: BE SURE TO USE A SOLVENT THAT AGREES WITH THE SURFACE TO BE CLEANED.

(1) Solvent clean the surface by the Final Cleaning procedure of BAC5750 (SOPM 20-30-03). Use a solvent from this list:

(a) Acetone

(b) Ethyl alcohol, denatured

(c) Isopropyl alcohol

(d) Methyl ethyl ketone - sec-butyl alcohol, 1-to-1 mix

(e) Methyl propyl ketone

(f) Solvents with FB code in BAC5750

(2) If unwanted matter stays, it could be because of fast solvent evaporation. Try to clean a smaller area at one time.

E. Cleaning Method CM4 uses a hand spotface tool to prepare steel studs on ground support equipment. Refer to BAC5117 for details.

F. Cleaning Method CM5

CAUTION: BE CAREFUL TO REMOVE ONLY A MINIMUM OF ALUMINUM COATING FROM THE GLASS FIBERS.

(1) Use Scotch Brite cleaning and finishing Type A very fine abrasive pads to clean the paint or primer of conductivity-coated Thorstrand aluminum glass fiber cloth. Clean the surface only until the bright aluminum surface becomes bright.

G. Cleaning Method CM6

NOTE: This method comes from document D6-35610-1, section 9.5.3.4.

(1) Use a wiper or a nonmetallic brush soaked with clean isopropyl alcohol.

(2) Clean the surface with light pressure. Continue to clean, with clean materials each time, until the unwanted matter is gone from the area.

4. REPAIR OF TERMINAL LUG CONNECTIONS

A. If there is contamination, disconnect the terminal lugs and fully clean the terminal lug and bonding area of the mating surface, as of the chassis (Figure 1). Solvent clean the surfaces with a cloth and naphtha per SOPM 20-30-03. Immediately wipe dry with a clean lint-free wiper.

B. To replace a defective terminal lug, cut the defective terminal lug from the wire with a wire cutting tool. Make the cut as near to the terminal lug edge as possible.

(1) On uninsulated terminals or splices, cut the wire at the end of wire insulation.

(2) On preinsulated terminals or splices, cut the wire at the end of terminal insulation.

C. Remove the insulation from the end of the wire with a wire stripping tool such as ST2346.

(1) Remove sufficient insulation to let the bare wire get to the bottom of the solder or crimp barrel of the terminal lug. Do not cut or nick the conductor strands. Conductor strands with rough surfaces, flat areas, or scrapes are acceptable, if the base metal of copper wire is not exposed.

(2) Frayed insulation at the stripped wire ends is not acceptable. But fiberglass strands are permitted if they are no more than 10% of the total fiberglass stranding. A small amount of varnish grade A can be applied, if necessary to the frayed insulation. Do not get varnish on the bare conductor. Do not bend over the conductor ends to help in the removal of frayed insulation strands.

D. Put the wire(s) into the terminal lug. Make sure that all conductor strands go in and go through the full length of the terminal lug barrel. Also, make sure the insulation of small diameter wires does not go into the terminal lug barrel and that you can see the conductor strands at the other end of the crimp barrel.

(1) The conductors must not touch the adjacent installation screws, nuts or washers.

(2) For preinsulated terminal lugs such as BACT12AC and BACT12S, push the end of the wire insulation against the end of the metallic conductor crimp barrel under the preinsulation sleeve.

(3) Refer to Table 2 for data about the distance between the end of the wire insulation and the end of the crimp barrel or preinsulated sleeve on the lug.

Table 2: Permitted Gaps Between Wire Insulation and Lugs

				Wire Size	
				AWG 10 and thinner	AWG 8 and thicker
Without Insulation Grip Support	Un-insulated	Single Conductor	Preferred Gap	0	0
			Maximum Gap	0.125	0.250
		Multiple Conductor	Preferred Gap	0.134	0.250
			Maximum Gap	0.250	0.380
	Pre-insulated	Single Conductor	Preferred Gap	0	0
			Maximum Gap	0.125	0.187
		Multiple Conductor	Preferred Gap	0.125	0.250
			Maximum Gap	0.250	0.370
With Insulation Grip Support	Un-insulated	Single Conductor	Preferred Gap	0	0
			Maximum Gap	0	0
		Multiple Conductor	Preferred Gap	-	-
			Maximum Gap	-	-
	Pre-insulated	Single Conductor	Preferred Gap	0	0
			Maximum Gap	0	0
		Multiple Conductor	Preferred Gap	0–0.125	0–0.250
			Maximum Gap	0–0.250	0.375

E. Crimp the terminal lug on the wire with the correct crimping tool. Refer to BAC5153 for tables of applicable tools and adjustments.

(1) The crimp dents must be as symmetrical as possible (Figure 2).

(2) The crimp dents must be confined to the conductor and/or insulation grip barrels.

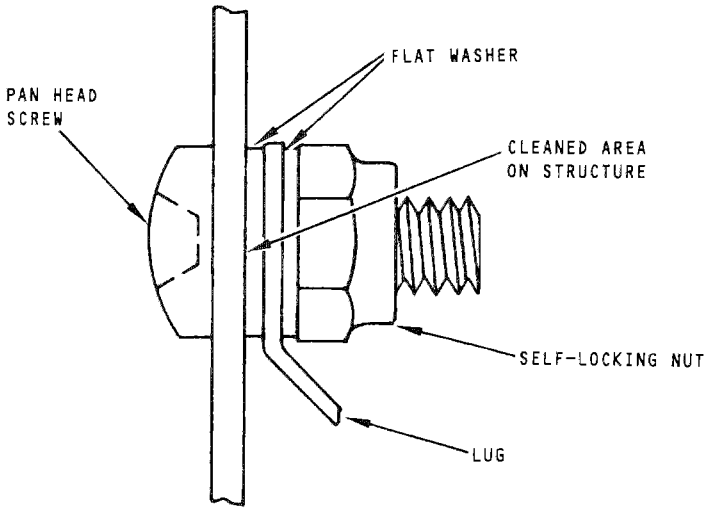
(3) The insulation grip barrels must be sufficiently closed by the crimping tool to prevent movement of the wire within the insulation grip barrel.

(4) The insulation grip barrels must not break the wire insulation or the outer jacket.

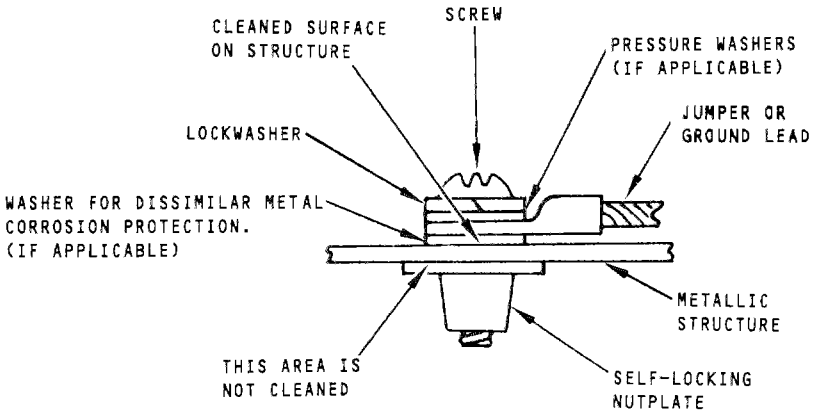
(5) The terminals must not be cracked or show metal when examined under five-power.

F. For easier installation, preinsulated terminals (size 10 thru 22 only) can be bent down 90 degrees (see Figure 3) if there is sufficient clearance between the terminal shank and the mounting stud to permit installation and removal as bent. On terminal blocks, the terminal can be bent up a maximum of 30 degrees. Bend the terminal only once, in the direction shown.

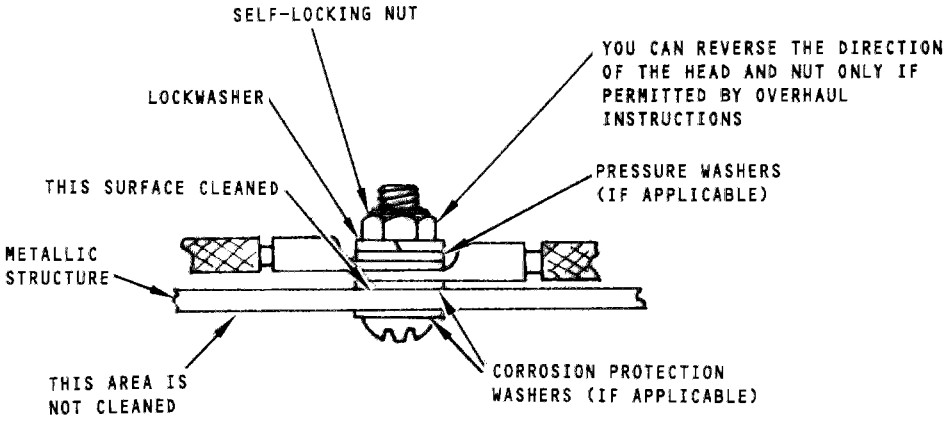
G. Install the terminal lugs by the overhaul instructions.

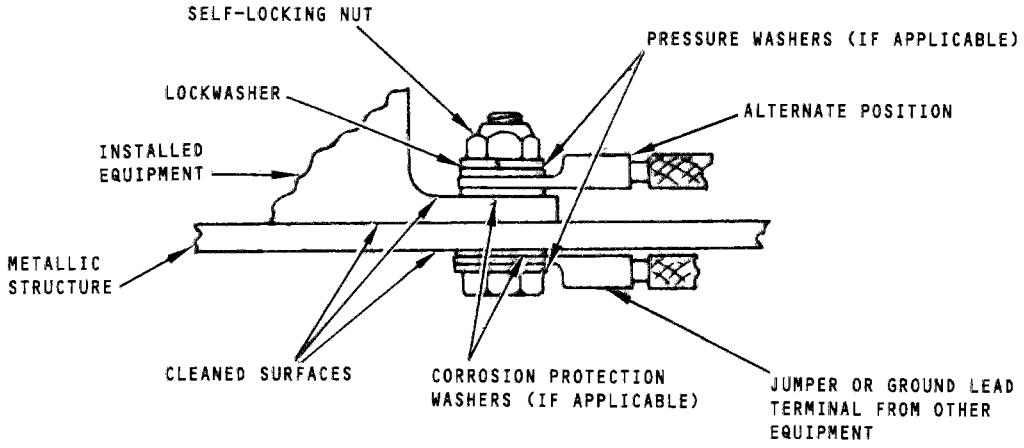


TYPICAL GROUND BUILDUP
FOR ELECTRONIC BOXES

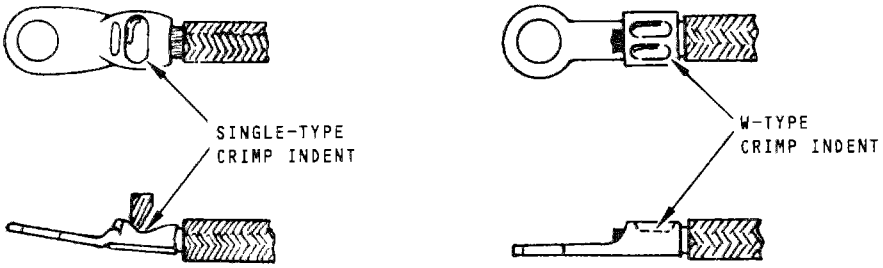


Typical Cleaning Procedure
Figure 1 (Sheet 1 of 2)

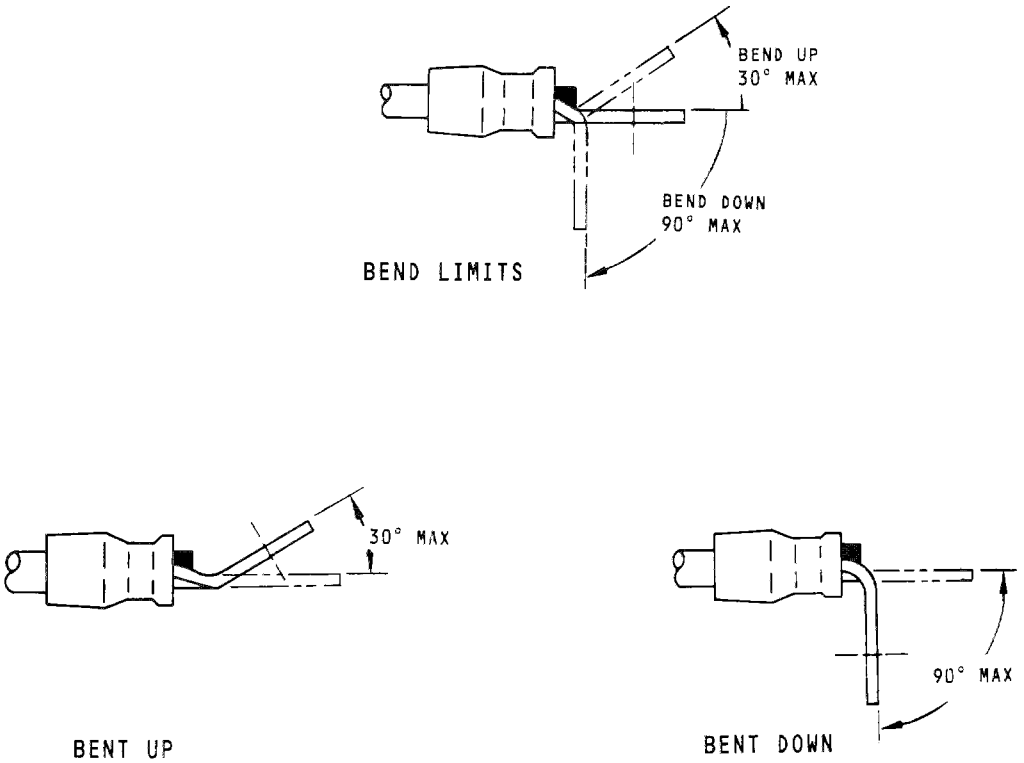




Typical Cleaning Procedure
Figure 1 (Sheet 2 of 2)



Typical Crimped Terminations
Figure 2



Bent Lug Limits
Figure 3

5. REPLACEMENT OF DEFECTIVE HEAT SHRINKABLE SLEEVING

A. Carefully remove the defective sleeving from the component. Do not cut into or damage the component.

B. For the replacement sleeving, refer to the overhaul instructions for the correct sleeving type. If the type is not specified, use Raychem thermofit sleeving or equivalent.

(1) Get a sleeve which, while not yet shrunk, will be a loose fit over the part to be insulated, and will be permanently held in position after it is shrunk.

(2) Cut sleeve to the necessary length. Because the sleeve becomes approximately 10 percent shorter when it shrinks, cuts the new sleeve approximately 10 percent longer. The shrunk sleeve must overlap the wiring insulation 0.50 inch minimum inch on splices and terminals, 0.38 inch minimum on connector contacts, and 0.19 inch minimum on shield termination points, dead-ends, breakouts, unless specified by the overhaul instructions.

(3) If you must replace defective sleeving on the emitter and base terminals of transistors, refer to the applicable overhaul instructions for special details, because this sleeving is usually not heat shrinkable sleeving.

C. Shrink the sleeving into position with a hot air gun, an oven, an infrared radiant heater, or a shop air heater. If you use a gun:

(1) Adjust the air vent on the gun to the fully open position.

(2) If this is one of those guns that is switched on immediately before you use it, let it heat up for 3-15 seconds before you turn it on the hardware. The time limit for the gun applied to the hardware is applicable with or without the preheat time.

(3) Hold the gun at a minimum of one inch from the shrinkable sleeve and point it at the center of the sleeve.

(4) Apply heat to the sleeving until it shrinks into position, but do not keep the heat in one area for more than 20 seconds, to prevent damage to the wiring inside the sleeving. Usually 5 to 10 seconds is sufficient.

(5) The shrunk sleeve must not be burnt, cracked, split or show other damage, but a small color change is acceptable.

(6) If the shrunk sleeve is not permanently held in position, let it get cool (about 2 minutes or until you can hold it tightly in your bare hand). Then apply heat again per Paragraph 5.C.(3) and Paragraph 5.C.(4) above.

6. INSULATING UNATTACHED WIRE ENDS

A. Before you apply power to the equipment, give protection to all unattached wire ends or terminals.

B. One procedure covers unstripped ends of wire with end caps as shown in Table 3 below. Crimp these end caps with AMP (V0779) tool 46063 or equivalent.

Table 3: Wire End Protectors

AWG Wire Size	AMP (V0779) Part No.
24-20	324484
22-18	324485
16-14	324486
12-10	324487

C. For other procedures, refer to BAC5153.

7. MULTIPLE WIRE AND UNDERSIZED WIRE COMBINATIONS

A. Multiple Wire Combinations

(1) When specified by the overhaul instructions, you can install more than one wire in a termination barrel, and crimp them with the same tool as for one wire.

(a) In a size 18 thru 22 crimp barrel, you can install two size 22 wires, or one size 22 wire and one size 20 wire.

(b) Also, for preinsulated terminal lugs, you can install these combinations in a size 16 thru 22 crimp barrel:

1) One size 20 wire and one size 20 or 22 wire.

2) Two or three size 22 wires.

(2) When you install two or more wires in a one barrel, put the stripped wire ends together and put them into the barrel as a unit. Make sure all conductor strands go into the conductor crimp barrel. Keep the wire insulation out of the barrel. The individual wire strands can be twisted to help keep them together. If loose insulation fibers become a problem, you can install a heat shrinkable sleeve around the wires per Paragraph 3.

(3) Push the insulation of all wires to the bottom of the insulation barrel if possible. If this is not possible because of the size and/or number of wires, let the insulation of one or more wires stay out of the insulation barrel.

B. An adapter can be used as filler to adapt an undersize wire or group of wires to a crimp barrel. Refer to BAC5120-1 and BAC5120-2 for more details.

C. To adapt oversize wires to connectors and solder cups, refer to the procedure for soldering wires to solder type contacts in, SOPM 20-11-02, par. 5.

8. LOW RESISTANCE BONDS

A. Low resistance bonds (approximately 0.0025 ohm) are specified at some electrical terminations and between some assembly part faying surfaces. After you clean and install all the related parts, measure the bonding resistance. Use Method 1 or 2 in areas without an explosive hazard. Use Method 3 in areas with an explosive hazard.

B. Method 1 (For areas without an explosion hazard)

(1) Test Equipment

(a) Voltmeter

(b) Power Supply

(c) Ammeter

(2) Connect the test equipment as shown in Figure 4 with the power supply set to zero volts.

(3) Slowly increase the power supply voltage output until the ammeter indicates exactly 1 ampere.

(4) At this condition, the voltmeter reading becomes numerically equal to the resistance between the contact surfaces. This value must be no larger than the bonding resistance specified by the overhaul instructions.

(5) As an alternate to Paragraph 8.B.(3) and Paragraph 8.B.(4), calculate the resistance from the voltmeter and ammeter readings, as shown.

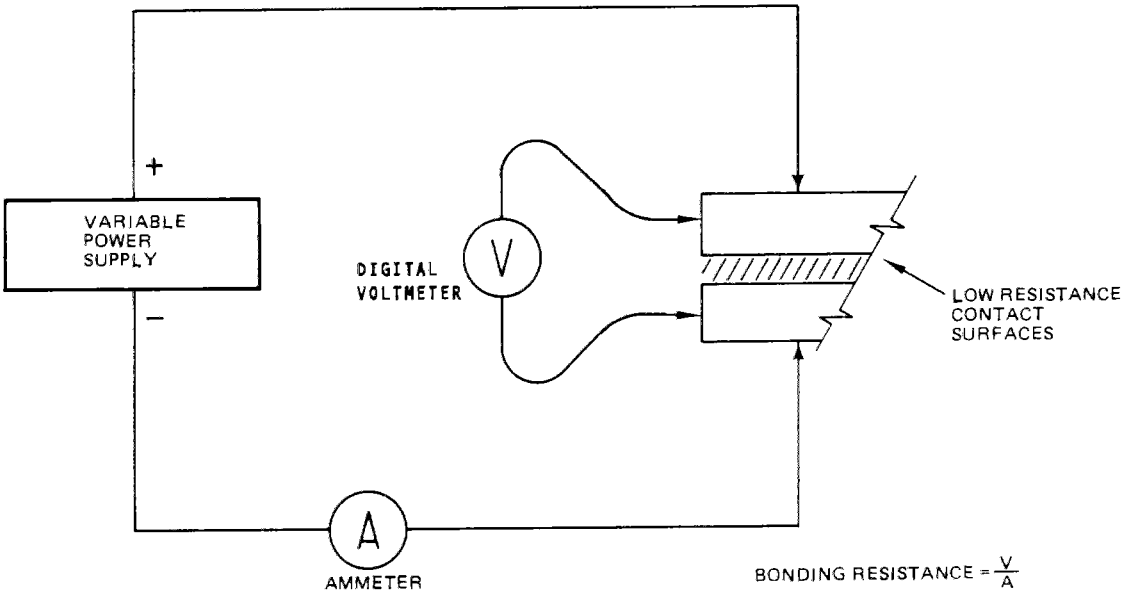
C. Method 2 (For areas without an explosion hazard) – Use a multimeter with milliohm scale and measure the bonding resistance directly. Use standard industry practices and the instructions of the meter vendor.

D. Method 3 – (For areas with an explosion hazard)

(1) Use a bonding meter, such as an Avtron (V01014) Model T477W, to measure the bonding resistance directly. Use standard industry practices and the instructions of the meter vendor.

(2) The bonding meter you use must agree with Underwriters Laboratory Standard 913 for Class I, Group A atmosphere or Factory Mutual Approval Standard 3610.

E. For other surfaces and special situations, such as conductive finishes, refer to BAC5117.



Test Setup to Measure Bonding Resistance
Figure 4

9. ELECTRICAL FAYING SURFACE BONDS

A. BAC5117 has different categories for electrical faying surface bonds (Table 4).

B. This paragraph does not apply to the other bonding procedures in SOPM 20-11-03.

C. If the overhaul instructions do not identify the procedure for the bond, or if they specify an electrical faying surface bond without a category, use a Category One bond.

D. Refer to BAC5117 for procedure details.

Table 4: Categories of Electrical Faying Surface Bonds

Category	Description
One	Unsealed electrical faying surface bond
Two	Fay sealed electrical faying surface bond
Six	Fillet sealed electrical faying surface bond
Seven	Driven rivet bond