DE HAVILLAND AIRCRAFT OF CANADA LIMITED

BOMBARDIER

Toronto Site

PPS 9.06 - ELECTRICAL BONDING AND GROUNDING OF AIRCRAFT STRUCTURES

Issue 43
- This standard supersedes PPS 9.06, Issue 42.
- Deletions have been made at this issue and, therefore, detail changes have not been noted.
- Direct PPS related questions to christie.chung@dehavilland.com or (416) 375-7641.
- This PPS is effective as of the distribution date.

THIS PPS IS CO-OWNED BY DE HAVILLAND AIRCRAFT OF CANADA LIMITED AND BOMBARDIER INC.

- **THIS STANDARD SPECIFIES MANUFACTURING PROCESSES WHICH ARE CRITICAL TO THE LIGHTNING PROTECTION AND TRANSPORT CANADA CERTIFICATION OF THE AIRCRAFT.**
- **IT IS IMPERATIVE THAT THE PROCEDURE SPECIFIED HEREIN BE STRICTLY ADHERED TO.**
- **THE CURRENT ISSUE OF THIS PPS AND ANY SUBSEQUENT REVISIONS TO THE PROCEDURE AND REQUIREMENTS SPECIFIED HEREIN SHALL BE AUTHORIZED BY AN UNDERSIGNED TRANSPORT CANADA DESIGN APPROVAL DESIGNEE (DAD).**

(Peter Bootsma, DAD 212) August 18, 2020

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Issue 43 - Summary of Changes (over the previous issue)

The following summaries are not detailed and are intended only to assist in alerting PPS users to changes which may affect them; refer to the applicable sections of this PPS for detailed procedure and requirements.

- Specified this is a jointly owned PPS by both De Havilland Aircraft of Canada Limited and Bombardier Inc.
- Updated BASF red dye product name, mixed with Humiseal 1B15 sealant, from 335 Neozapon to Orasol Red 335.
- Specified that Paisley Products of Canada Inc. distributes mixed Chase Co. Humiseal 1B15 sealant with BASF Orasol Red 335 dye as Paisley product name “Electrical Connector Coating (Red)”.
- Revised Facilities section.
- Revised Note 3 in Table I.
- Deleted Antenna Installation Data table and specified to torque to the engineering drawing torque value.

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1 SCOPE

1.1 This Production Process Standard (PPS) specifies the procedure and requirements for electrical bonding and grounding of aircraft components and structures (including non-metallic composite components), electrical equipment, static discharge wicks and fuel system components.

1.1.1 This PPS complements the engineering drawings that specify its use as an authorized instruction. The procedure specified in this PPS shall be followed to ensure compliance with all applicable specifications. In general, if this PPS conflicts with the engineering drawing, follow the engineering drawing. The requirements specified in this PPS are necessary to fulfil the engineering design and reliability objectives.

1.1.2 Refer to PPS 13.26 for the subcontractor provisions applicable to this PPS.

2 HAZARDOUS MATERIALS

2.1 Before receipt at De Havilland Canada (DHC) or Bombardier Toronto (BA), all materials shall be approved and assigned Material Safety Data Sheet (MSDS) numbers by the DHC/BA Environment, Health and Safety Department. Refer to the manufacturer's MSDS for specific safety data on any of the materials specified in this PPS. If the MSDS is not available, contact DHC/BA Environment, Health and Safety Department.

3 REFERENCES

3.1 PPS 2.08 - Installation of Voi-Shan, Blind Type, Electrical Bonding and Grounding Terminal Studs.

3.2 PPS 2.11 - Installation of Self-Retaining Nuts and Studs.

3.3 PPS 9.30 - Fabrication of Learjet 45 Electrical Wire Harnesses.

3.4 PPS 9.39 - Installation and Termination of Braided Shields for EMI & HIRF Protection of Wire Harnesses on DASH 8 Series 400 Aircraft.

3.5 PPS 9.41 - Termination of Individual Wire Shields at Glenair 550-003 Backshells.

3.6 PPS 13.26 - General Subcontractor Provisions.

3.7 PPS 13.39 - Bombardier Toronto Engineering Process Manual.

3.8 PPS 14.01 - Torquing - Method and Identification.

3.9 PPS 21.03 - Priming, Sealing & Repair of Integral Fuel Tanks.

3.10 PPS 21.20 - Mixing and Handling Two Part Sealants.

3.11 PPS 21.21 - General Sealing Practices.

3.12 PPS 31.07 - Cleaning and Stripping of Painted Surfaces.

3.13 PPS 31.17 - Solvent Usage.

3.14 PPS 32.02 - Manual Application of C1 Chemical Conversion Coatings.

3.15 PPS 32.07 - Corrosion Protection of Magnesium Alloys.

3.16 PPS 32.35 - Chemical Conversion Coating for Low Electrical Resistance (C10).

3.17 PPS 34.08 - Application of Epoxy-Polyamide (F19 and F45).

4 MATERIALS, EQUIPMENT AND FACILITIES

4.1 Materials

4.1.1 Unless otherwise specified in this section, use only the materials specified. Use of superseding or alternative materials is not allowed.

4.1.2 Abrasive paper, aluminum oxide, 180 - 240 grit size.

4.1.3 Masking tape utilizing rubber based adhesive (e.g., 3M #218 or 3M #8428).

4.1.4 Felt pad impregnated with release agent, HR Smith gasket wipes (product number 10-500-11D).

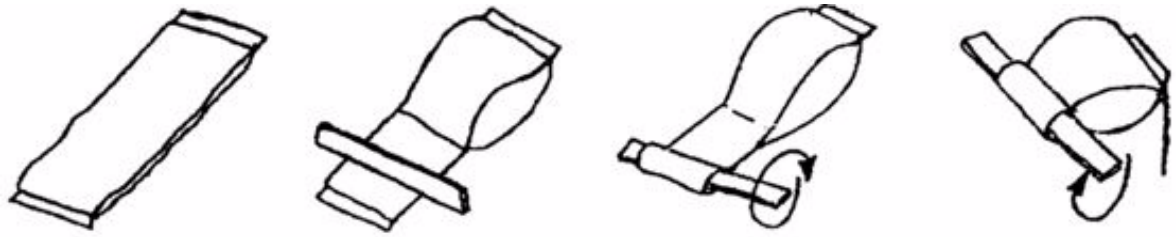
4.1.5 Sealant, extrusion or spatula applications, DHMS S3.01 Type II Class B or BAMS 552-008 Class B sealant as specified in PPS 21.20. Prepare sealant according to PPS 21.20. See section 5.12 for sealant restrictions.

4.1.6 Humiseal sealant, brush application - Humiseal 1B31LOC, Humiseal 1B31EPA or Humiseal 1B15.

4.1.6.1 Humiseal 1B31LOC and Humiseal 1B31EPA contain no MEK, and for this reason are preferred over Humiseal 1B15 sealant for environment, health and safety reasons. Humiseal 1B31LOC and Humiseal 1B31EPA do not need to be dyed red, as they are inspectable using UV lighting tools (see paragraph 4.2.5).

4.1.6.2 Before use, Humiseal 1B15 sealant shall be dyed red by mixing in 4 to 6 grams of BASF Corp. Orasol Red 335 dye per U.S. quart of sealant. It is acceptable to purchase the Humiseal 1B15 sealant and red dye separately and then mix before use, or to purchase the Humiseal 1B15 sealant with the red dye already mixed in (e.g., Paisley Products of Canada Inc., Electrical Connector Coating (Red)). The purpose of dying the Humiseal 1B15 sealant is to make it visible for inspection purposes, so some variation in the shade and intensity of red colour is acceptable.

4.1.7 DHMS S3.02 low adhesion sealing compound, Class A (brush application) or Class B (extrusion gun or spatula application). Prepare sealant according to PPS 21.20. If using sealant which comes in a plastic sachet, after mixing the sealant squeeze it all to one end of the sachet and then cut a small hole in the corner as shown in Figure 1.



STEP 1
Sachet as mixed.

STEP 2
Flatten contents to one end.

STEP 3
Roll flattened.

STEP 4
Cut corner off to leave a small hole for sealant to come out of. Rotate spatula to adjust rate of sealant removal.

FIGURE 1 - PREPARATION OF DHMS S3.02 SEALANT

4.2 Equipment

4.2.1 Any of the following ohmmeters may be used, provided hardware and training is available:

- BCD M1 Milliohm meter.
- Megger digital low resistance ohmmeter (DLRO): DLRO 10 or DLRO 247001.
- SD 8778-1 10 amp constant current ohmmeter test set.
- Ducter Instruments / Megger Instruments BT51 digital low resistance ohmmeter.
- Ducter D203 Micro-Ohmmeter by Megger Instruments.
- HP 4328A milli-ohmmeter.
- HIOKI 3220 or 3540 milliohmmeter.
- Eaton Corp. model 584 resistance tester.
- Eutron S.A.S. micro-ohmmeter BVM 3-10.
- AOIP Measures OM 21-1 ohmmeter.
- AEMC Micro-Ohmmeter, Model 5600, Model 6240 or Model 6250.

4.2.2 Multimeter, 1 megohm range.

4.2.3 500 volt Insulation Resistance Tester (e.g., Biddle Instruments P/N 210801-2).

4.2.4 Spot facing tool (e.g., SD 8383).

4.2.5 UV lighting tools (flashlights) with a wavelength of 300 to 500 nm, for inspecting Humiseal 1B31LOC or Humiseal 1B31EPA sealant application (e.g., Streamlight 51046 Night Com UV or 51045 Twin-Task 3C-UV LED lighting tools). These devices produce potentially harmful UV light (see paragraph 7.4 for safety precautions).

4.3 Facilities

4.3.1 This PPS has been categorized as a Controlled Special Process according to PPS 13.39 and as such only facilities specifically approved according to PPS 13.39 are authorized to perform activities relating to electrical bonding and grounding of aircraft components and structures (including non-metallic composite components), electrical equipment, static discharge wicks and fuel system components according to this PPS.

4.3.2 Subcontractors shall direct requests for approval to DHC Quality.

4.3.3 Facility approval shall be based on a facility report, a facility survey and completion of a qualification test program, if required. The facility report shall detail the materials and equipment to be used, the process sequence to be followed and the laboratory facilities used to show compliance with the requirements of this PPS. Any deviation from the procedure or requirements of this PPS shall be detailed in the facility report. Based upon the facility report, DHC or BA Engineering may identify additional qualification and/or process control test requirements. During the facility survey, the facility requesting qualification shall be prepared to demonstrate their capability. Once approved, no changes to subcontractor facilities may be made without prior written approval from DHC Quality.

4.3.3.1 Unless otherwise specified by DHC or BA Engineering, approval of subcontractor facilities to perform activities relating to electrical bonding and grounding according to this PPS does not require completion of a test program or submission of test samples.

5 PROCEDURE

5.1 General

5.1.1 Aircraft electrical bonding is the process by which electrical conductivity is achieved between the component metallic and non-metallic (composite) parts of an aircraft, to assure electrical continuity of the structure.

5.1.2 Grounding is the electrical connection of a conducting object to the primary structure to provide a return path for current. The primary structure consists of the main framework, fuselage, tail, wings, etc.

5.1.3 Bonding and grounding connections as specified herein are made in order to ensure the proper operation of electrical and electronic equipment, to suppress electromagnetic interference resulting from static discharge, electrical shock and lightning strikes, and to ensure that the aircraft is electrically stable.

5.2 Surface Preparation

5.2.1 General

5.2.1.1 If the engineering drawing makes reference to a type of electrical bonding (i.e., “Bonding through Direct Contact”, “Bonding through Attachment Hardware”, etc.), refer to Table I for the surfaces to be prepared. If, instead of specifying a type of electrical bonding, the engineering drawing specifically indicates a particular surface which shall be prepared, then prepare that surface for electrical bonding as specified herein.

5.2.1.2 The following finishes and surface conditions are satisfactory for bonding connections and do not need to be removed. Solvent clean these finishes according to PPS 31.17 immediately before installation:

- plated surfaces
- graphite (powder, flake or sticky)
- chrome pickle or selenious acid treatment on magnesium alloys
- conductive (anti-static) paint finishes
- C1 or C10 chemical conversion coating

5.2.1.3 Remove non-conductive coatings, such as anodic films, primer, paint, etc., from the electrical bond contact area according to section 5.2.2. After stripping any non-conductive coatings, test the electrical bond contact area for consistent electrical conductivity according to section 5.2.3 and then chemical conversion coat (C1 or C10, as specified by the engineering drawing) within 8 hours of stripping. Manually apply C1 chemical conversion coating according to PPS 32.02. Apply C10 chemical conversion coating for low electrical resistance according to PPS 32.35.

5.2.1.3.1 If the electrical bond contact area was masked after the application of C1 or C10 chemical conversion coating and before the application of a non-conductive coating, after removing the masking tape, solvent clean the bond contact area according to PPS 31.17 and visually ensure that the non-conductive coating has not migrated into the bond contact area.
When masking before the application of non-conductive coatings, use masking tape as specified in paragraph 4.1.3.

5.2.1.4 If the engineering drawing specifies coating the shank of a conductive bolt with F13, ensure that no F13 gets under the bolt head.

5.2.1.5 Strip non-conductive coatings on the grounding lug side to provide an acceptable electrical bond contact area.

5.2.1.6 Except for Voi-Shan E-M grounding studs, the electrical bond contact area refers to an area approximately 1/16" larger all around than the area of the component being bonded or, in the case of loop type clamps on tubing, approximately 50% greater than the clamp contact area. Voi-Shan E-M grounding studs utilized the fastener hole to establish the electrical conductivity. Therefore, for Voi-Shan E-M grounding studs the electrical bond contact area is limited to the fastener hole.

TABLE I - SURFACES TO BE PREPARED FOR ELECTRICAL CONTACT BONDING

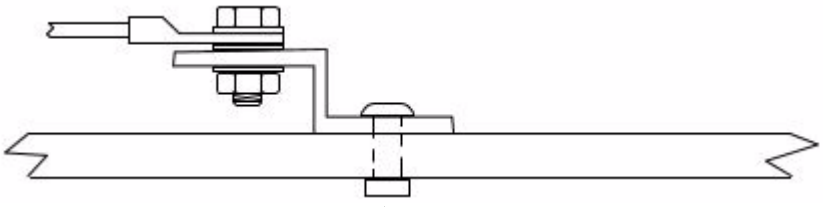
TYPE OF BONDING (As specified on the engineering drawing)	SURFACE TO BE PREPARED (Electrical Bond Contact Area)
Bonding of Connectors	See Figure 2
Bonding through Direct Contact	See Figure 3
Bonding through Attachment Hardware	Nuts/Bolts - See Figure 4 Screws - See Figure 5 Rivets - Inner surface of rivet hole
Bonding through Bonding Jumpers (e.g., ground studs)	See Figure 6
Bonding of Conductive Plumbing Line Fittings which Pass through the Structure	See Figure 7
Bonding of Composite Structure with an External Layer of Aluminum Mesh or Foil	See Figure 8
Bonding of Composite Structures with an External Layer of Conductive Anti-Static Paint	See Figure 9

Note 1. Electrically bond externally mounted equipment (i.e., antennas, light housings, data sensors, static wicks, etc.) through direct contact.

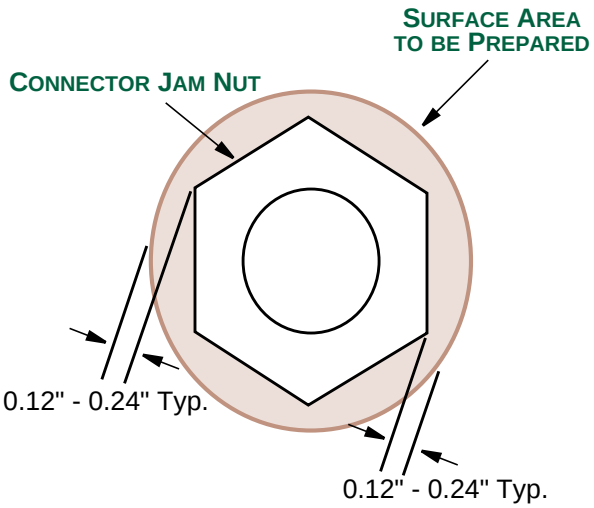
Note 2. After bonding, touch-up the bond points according to section 5.11 and seal the bonding and grounding hardware according to section 5.12 and the engineering drawing.

Note 3. Ordinarily, engineering will specify “Bonding through Attachment Hardware” for riveted joints with a minimum of three rivets if the rivet holes are bare of all insulating finishes, possess a chemical conversion coating finish and have been driven (i.e., are not pull type). However, there are high current applications in which more than three rivets are required or where rivets are not acceptable and the engineering drawing will specify “Bonding through Direct Contact” as advised by the DHC EMC Engineering group.

Note 4. In some applications, a combination of bonding types is required and will be specified. For example, if a bonding jumper is terminated at a “Z” bracket, as shown below, the drawing note for the jumper would be “Bonding through Bonding Jumper” while the drawing note for the bracket would be “Bonding through Attachment Hardware” or “Bonding through Direct Contact”.

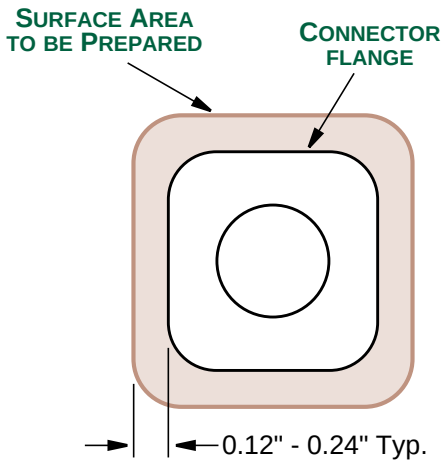


TYP. MIN. 3 RIVETS FOR “BONDING THROUGH ATTACHMENT HARDWARE”



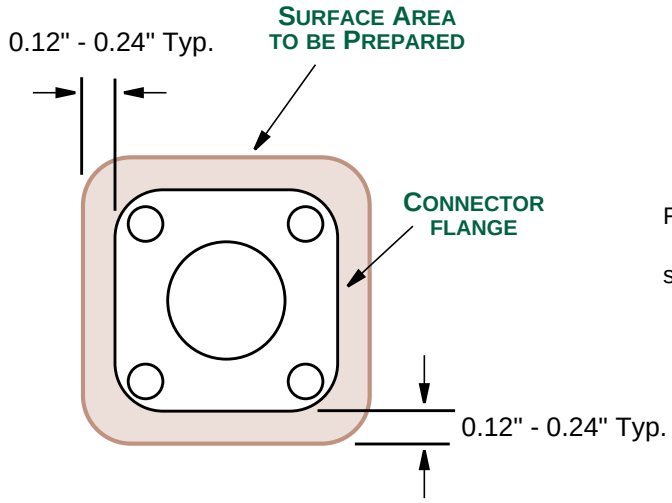
CONNECTOR SECURED BY JAM NUT
- JAM NUT SIDE -

Except for MIL-DTL-38999 Series III and Series IV J Class connectors, for **all** connectors secured with a jam nut (including on the forward pressure bulkhead, aft pressure bulkhead, wing to fuselage interface and the nacelle firewall) prepare a circular area beneath the jam nut with a radius 0.12" - 0.24" wider than the widest points of the jam nut, as shown above.



CONNECTOR SECURED BY JAM NUT
- FLANGE SIDE -

For MIL-DTL-38999 Series III and Series IV Class J connectors, and also for connectors secured with a jam nut on the forward pressure bulkhead, aft pressure bulkhead, wing to fuselage interface and the nacelle firewall, prepare an area on the **flange** side of the structure equal to the flange area plus 0.12" - 0.24" all around, as shown above.



CONNECTOR SECURED BY BOLTED FLANGE

For connectors secured by means of the connector flange, prepare the structure beneath and surrounding the flange an area equal to the flange area plus 0.12" - 0.24" all around, as shown.

FIGURE 2 - SURFACES TO BE PREPARED FOR BONDING OF ELECTRICAL CONNECTORS

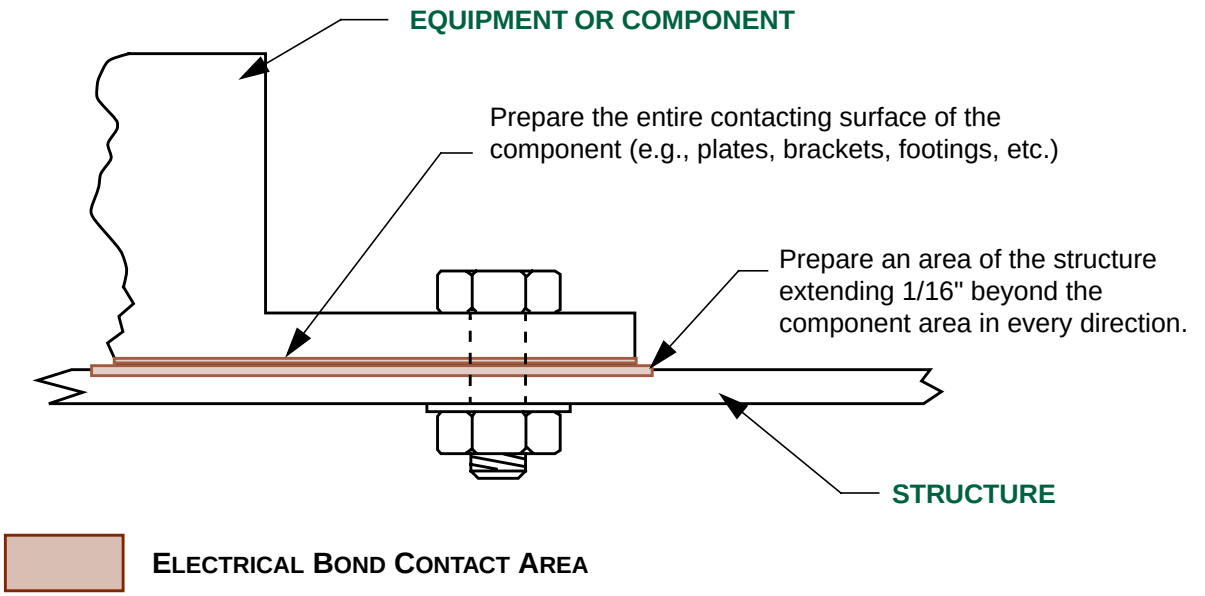


FIGURE 3 - SURFACES TO BE PREPARED FOR DIRECT CONTACT BONDING

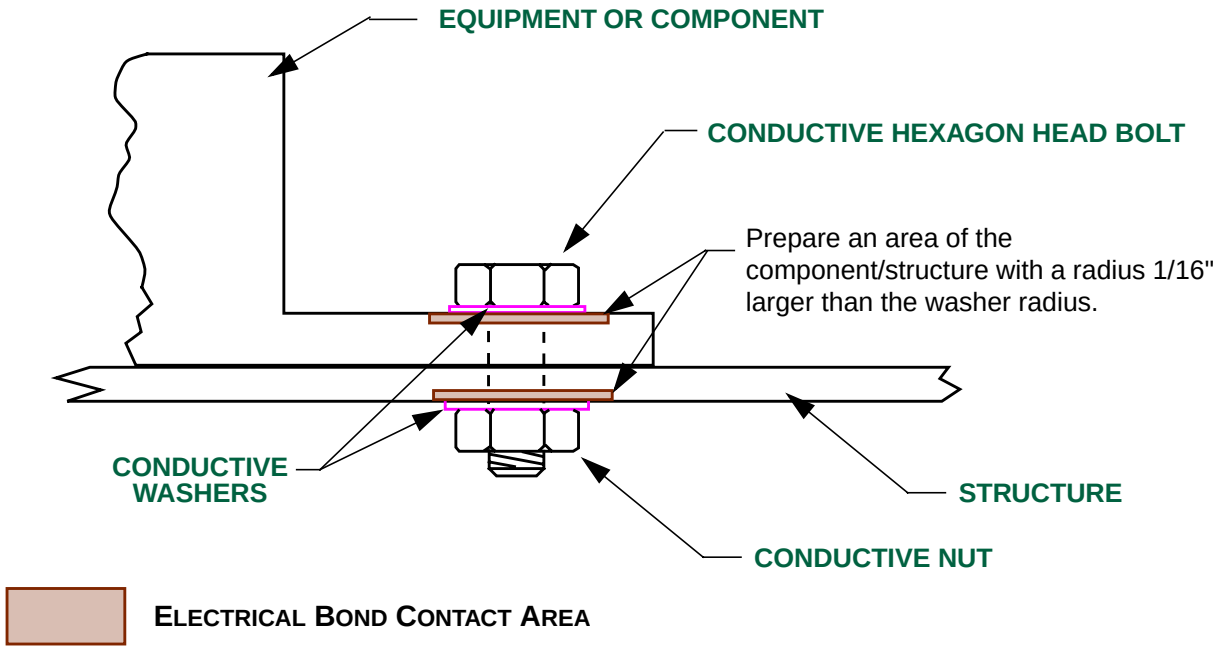


FIGURE 4 - SURFACES TO BE PREPARED FOR BONDING WITH CONDUCTIVE NUTS AND BOLTS

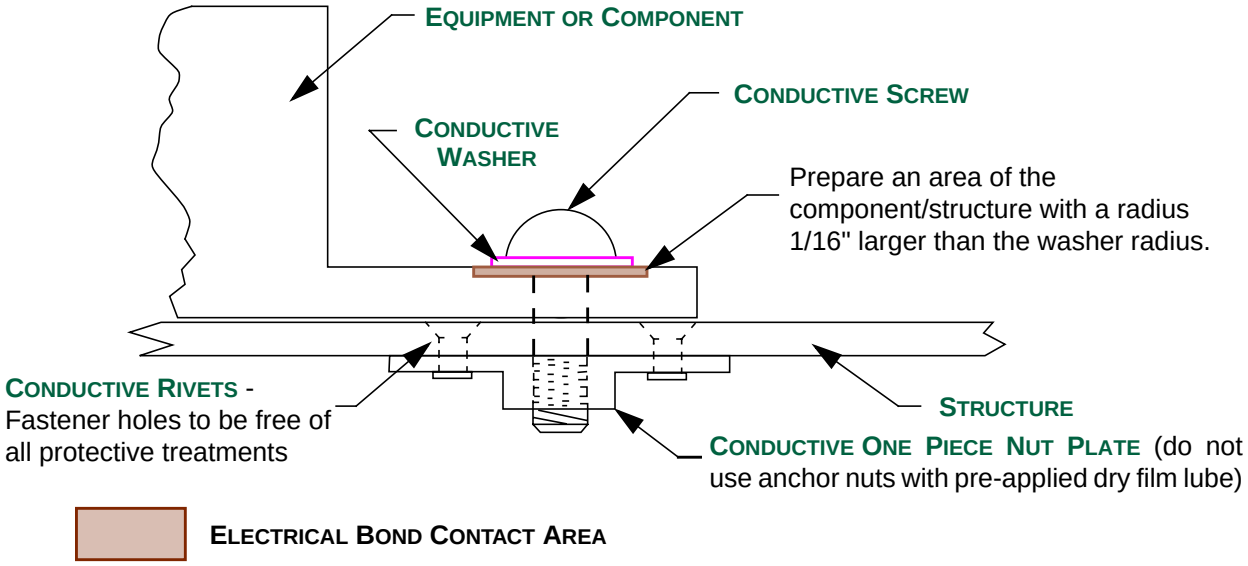


FIGURE 5 - SURFACES TO BE PREPARED FOR BONDING WITH CONDUCTIVE SCREWS AND ANCHOR NUTS

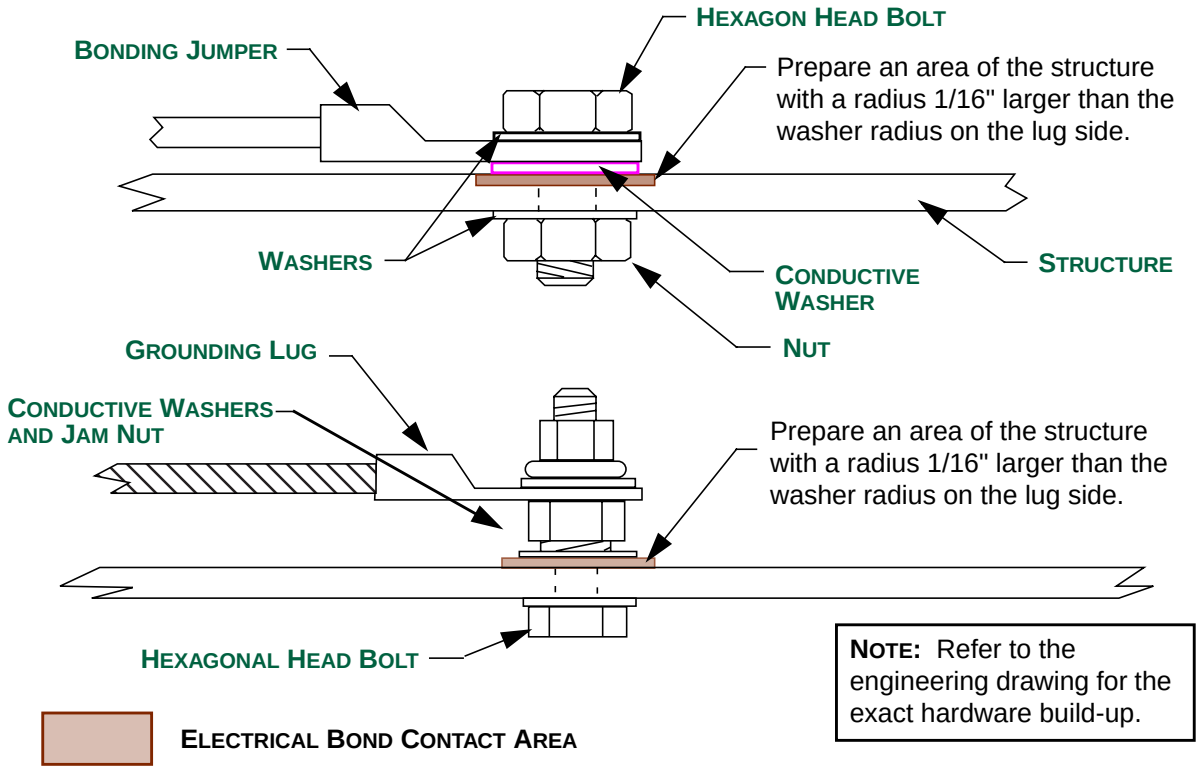
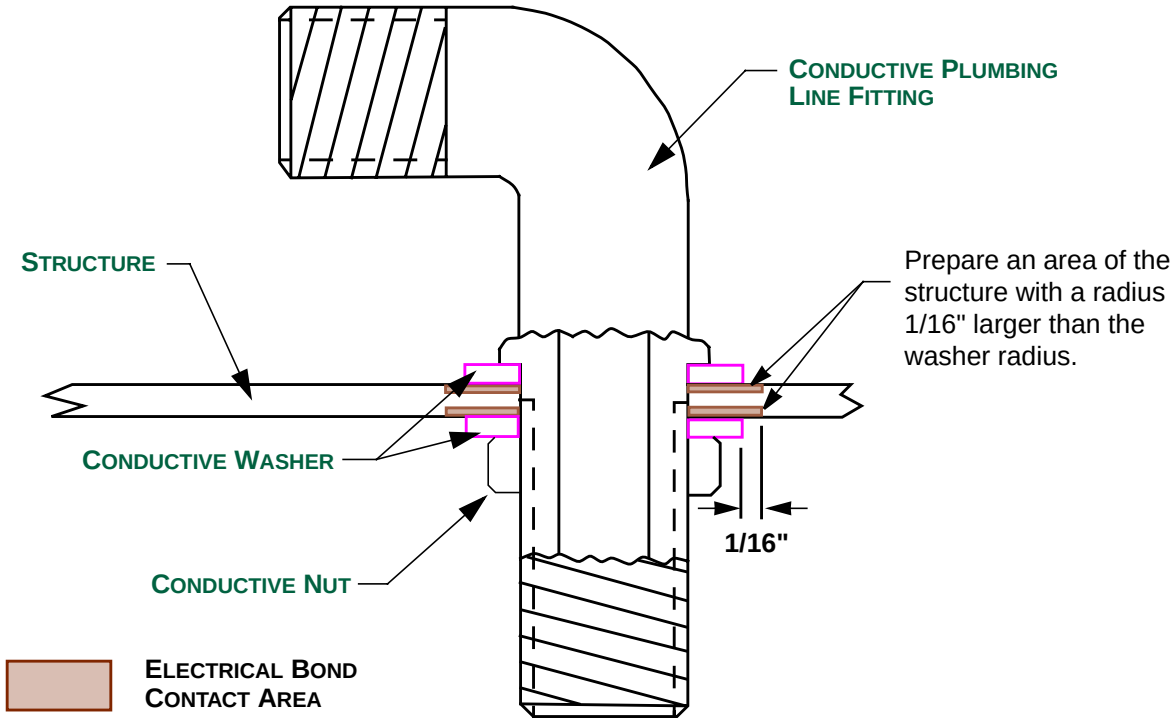


FIGURE 6 - SURFACES TO BE PREPARED FOR BONDING THROUGH BONDING JUMPERS (TYP.)



NOTE: This bonding method applies only when the plumbing line fitting is conductive and passes through the structure; otherwise, bonding jumpers shall be used.

FIGURE 7 - ELECTRICAL BONDING OF PLUMBING LINE FITTINGS TO THE STRUCTURE

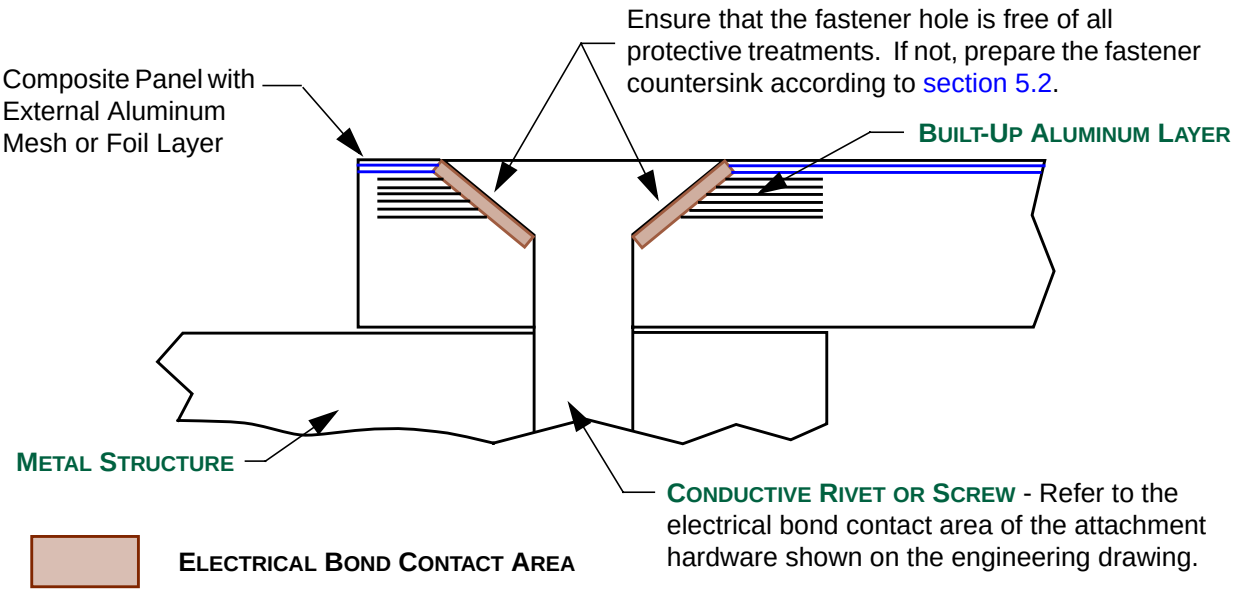


FIGURE 8 - ELECTRICAL BONDING OF COMPOSITE STRUCTURES WITH AN EXTERNAL LAYER OF ALUMINUM MESH OR FOIL

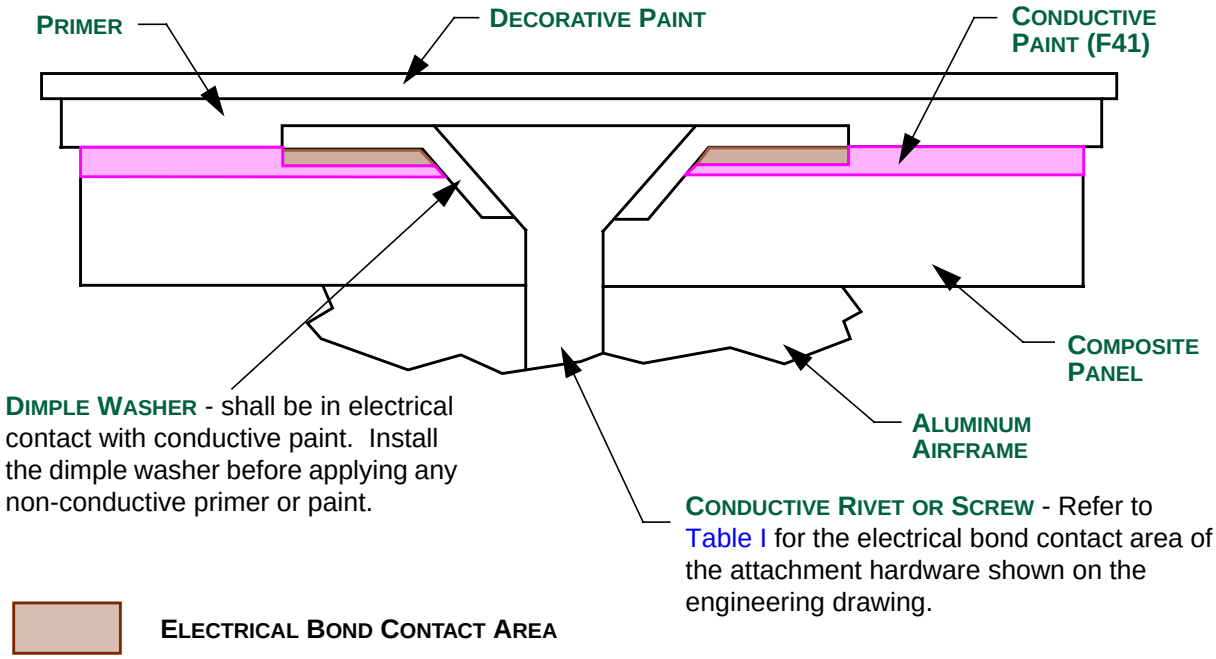


FIGURE 9 - ELECTRICAL BONDING OF COMPOSITE STRUCTURES WITH AN EXTERNAL LAYER OF CONDUCTIVE ANTI-STATIC PAINT

5.2.2 Removal of Non-Conductive Coatings

5.2.2.1 Except as noted in paragraph 5.2.2.1.1, paragraph 5.2.2.1.2 and paragraph 5.2.2.1.3, mechanically remove non-conductive coatings (such as oxides and anodic films, dichromate treatment, paint, primer, etc.) by hand abrading with abrasive paper (ref. paragraph 4.1.2). It is acceptable to use a spot facing tool (ref. paragraph 4.2.4) to remove the bulk of the non-conductive coating provided that final removal is performed by hand abrading. Take care at all times when using a spot facing tool or abrasive paper to remove only the non-conductive coating and avoid damaging the substrate.

5.2.2.1.1 On structure other than aluminum alloy, it is also acceptable to use a stainless steel wire brush to mechanically remove oxides and anodic films, dichromate treatment, paint, primer, etc. Do not use stainless steel wire brushes on aluminum alloys.

5.2.2.1.2 On aircraft fluid lines which have been F19 primed (without bond point masking), locally strip the primer from the bond contact area using chemical paint stripper according PPS 31.07. Use masking tape (ref. paragraph 4.1.3) to limit the extent of stripping.

5.2.2.1.3 If mechanical stripping is impractical, strip paints, dyes or stains from bond contact areas chemically according PPS 31.07. Use masking tape (ref. paragraph 4.1.3) to limit the extent of stripping.

5.2.2.2 When removing non-conductive coatings, do not use the same abrasive tool on different kinds of metal (i.e., don't use a tool on aluminum parts that has been used on steel parts).

5.2.2.3 After mechanically abrading the surface, use a tack rag to remove any dust or adhering particles.

5.2.2.4 Treat the bond contact areas of magnesium alloy parts which have been mechanically cleaned with 10% selenious acid solution according to PPS 32.07.

5.2.2.5 Thoroughly clean all bond contact surfaces (including terminal lugs of bonding jumpers) by solvent wiping them according to PPS 31.17 immediately before installation.

5.2.2.6 Thoroughly clean the housing bore on static discharge wick mounting plates using abrasive paper (ref. paragraph 4.1.2) to remove all paint and primer before installing the static wick.

5.2.3 Testing of Stripped or Masked Electrical Bond Contact Areas

5.2.3.1 Verify that the electrical conductivity is consistent over the electrical bond contact area by placing both probes of an approved ohmmeter (ref. paragraph 4.2.1) on the stripped/masked surface and measuring the resistance. The resistance between the two points shall be no more than 2.5 milliohms.

5.2.3.2 Check the electrical conductivity between several random pair of points within the electrical bond contact area to ensure consistency.

5.2.3.3 If the electrical conductivity is not consistent over the electrical bond contact area, remove the non-conductive coating as specified in section 5.2.2 and re-test the area.

5.3 Installation of Ground Studs

5.3.1 Install all blind type bonding and grounding terminal studs according to PPS 2.08.

5.3.2 Install all PEM studs for use as bonding and grounding terminal studs according to PPS 2.11.

5.3.3 Torque all ground stud jam nuts and securing nuts to the values shown in Table II, according to PPS 14.01.

TABLE II - BONDING HARDWARE TORQUE VALUES

SCREW SIZE	CONVENTIONAL AND BLIND TYPE STUDS	PEM STUDS
#6	N/A	5 - 9 in lbs
#8	15 - 20 in lbs	15 - 18 in lbs
#10	25 - 30 in lbs	25 - 30 in lbs
1/4	40 - 45 in lbs	N/A
5/16	80 - 85 in lbs	N/A
3/8	110 - 125 in lbs	N/A
1/2	140 - 155 in lbs	N/A

5.4 Installation of Static Discharge Wicks

5.4.1 Install all static discharge wick hardware as specified on the engineering drawing.

5.4.2 Torque all static wick attachment screws to the values shown in Table II, according to PPS 14.01.

5.5 Application of Bonding Jumpers

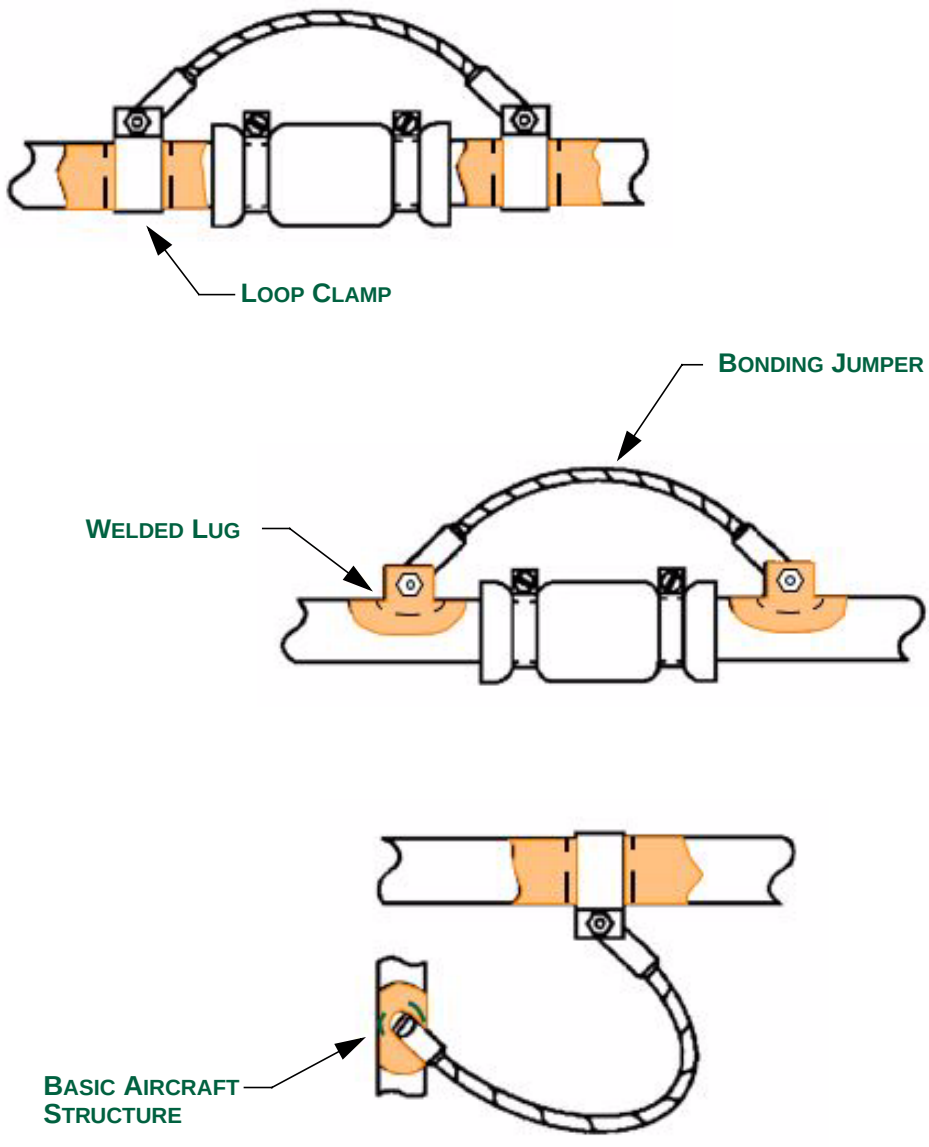
5.5.1 Install bonding hardware and connections according to the engineering drawing. If the engineering drawing does not specify the type of bonding installation required, contact Liaison Engineering.

5.5.2 Install bonding connections as directly as possible without applying any strain to the bonding jumpers or welded lugs (see Figure 10).

5.5.3 Install bonding jumpers so that the wire does not come in contact with surrounding structure, equipment, fuel pipes, or other bonding jumpers (see Figure 11). If contact is unavoidable, a CSP 476 bonding jumper (complete with insulating sleeve) shall be used. If the engineering drawing specifies a jumper other than the CSP 476 in these case, contact Liaison Engineering.

5.5.4 If possible, locate bonding connections in protected areas in order to avoid contact with electrical wiring and control boxes or interference with movable components of the aircraft.

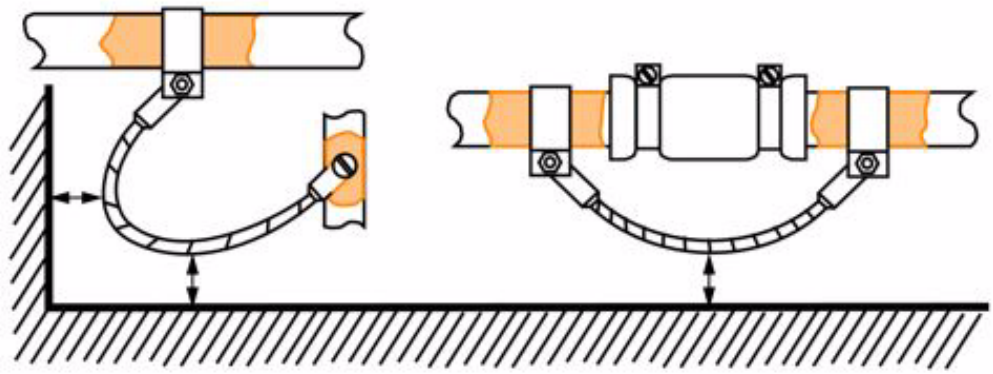
5.5.5 When installing a loop type clamp on a tubular member, take care not to crimp or indent the tube.



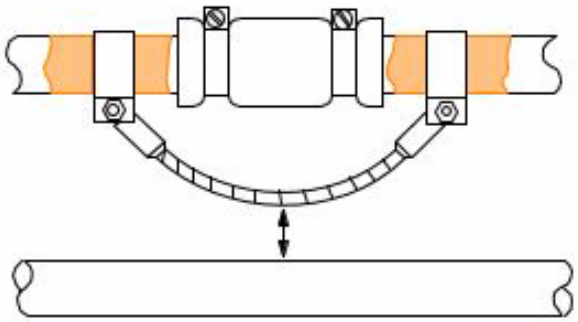
NOTES:

1. Broken lines indicate extent of area to be cleaned for bonding (typical).
2. Shaded areas indicate the extent to which bond points shall be touched up (typical).

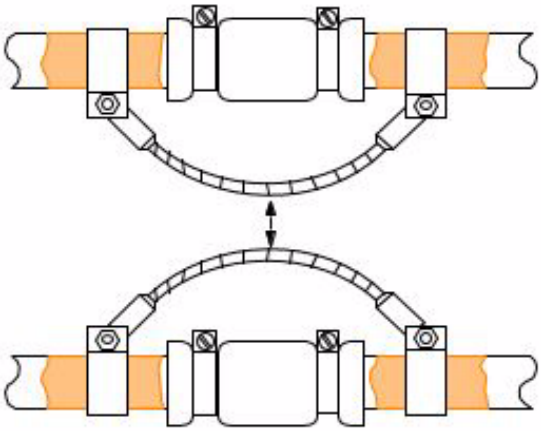
FIGURE 10 - TYPICAL APPLICATION OF BONDING JUMPERS



ENSURE WIRES DOES NOT CONTACT
ADJACENT STRUCTURE OR EQUIPMENT



ENSURE WIRES DOES NOT
CONTACT FUEL PIPES



ENSURE WIRES DOES NOT CONTACT
OTHER BONDING JUMPERS

FIGURE 11 - BONDING JUMPER CLEARANCE REQUIREMENTS

5.6 Electrical Bonding of Plumbing Lines

5.6.1 Unless otherwise specified on the engineering drawing, bond metal plumbing lines to the structure with a mechanically secure connection.

5.6.2 If a plumbing line has intervening non-conductive joints (e.g., T-joints with anodized threads), bond each individual section of more than 3" either to the structure or to the adjacent plumbing line section.

5.6.3 If two or more components are bonded in series, bond both ends of the circuit to the structure to ensure that the loss of an intermediate bond connection will not leave any component isolated from ground.

5.6.4 Regard tube connectors which include an electrical bonding feature (e.g., Wiggins W700 series) as inherently bonded and therefore an integral (conductive) part of the plumbing line.

5.6.5 Bond plumbing line sections to the structure at intervals not exceeding 144".

5.7 Installation of MS90298 Fuel Nozzle Grounding Receptacles

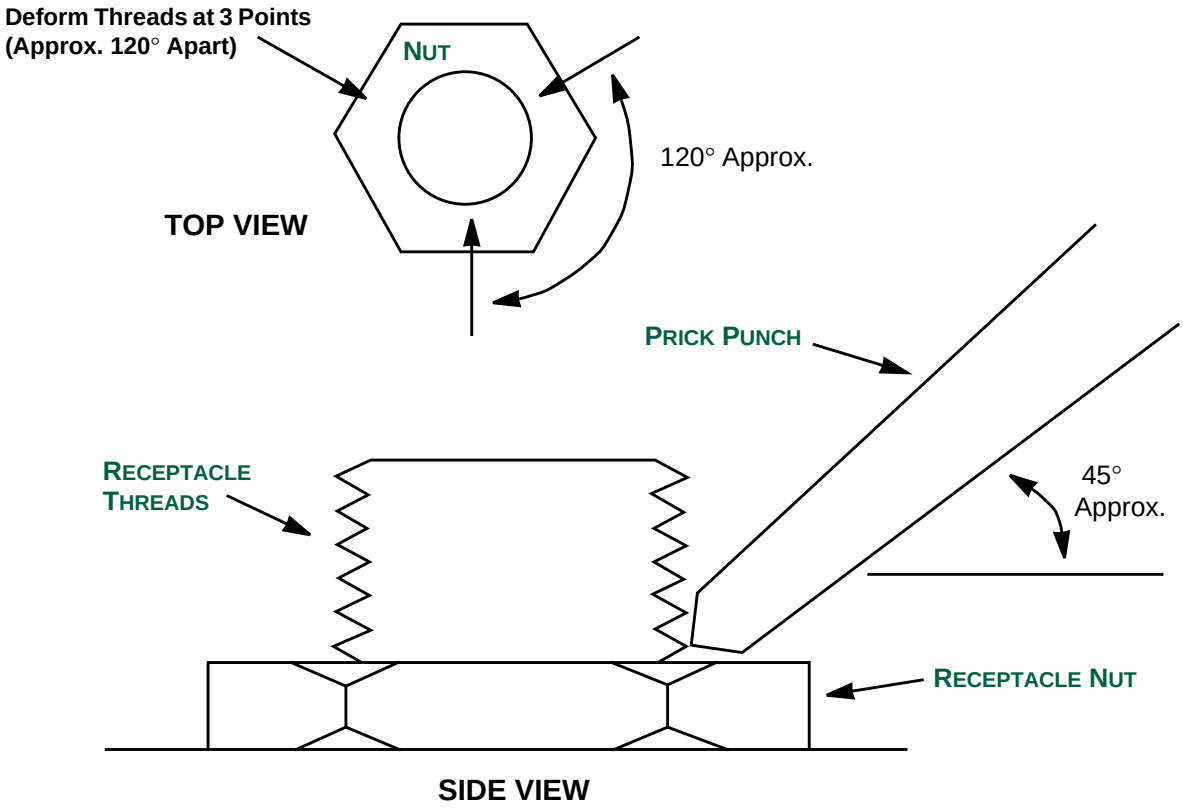
5.7.1 Install MS90298 fuel nozzle grounding receptacles as follows:

Step 1. Prepare the inner surface of the skin around the drilled hole according to section 5.2. Do not remove the protective treatment from the outer surface of the skin.

Step 2. Install the receptacle, including the inner and outer washers, and tighten the nut securely so that the receptacle does not rotate and the inner washer is firmly in contact with the skin.

Step 3. Carry out the bonding resistance test according to section 5.9.2.

Step 4. Secure the receptacle nut at 3 points, approximately 120° apart, around the edge of the thread/nut interface by deforming the threads of the bolt using a suitable prick punch as shown below. Apply only enough force to deform the threads without damaging the aircraft structure.



Step 5. Seal the interior and exterior hardware periphery as specified in section 5.12

5.8 Installation of AMP Grounding Blocks

5.8.1 Install AMP Grounding blocks as follows:

Step 1. Prepare the surface on which the grounding block is to be installed according to section 5.2.

Step 2. Rivet the grounding block to the structure using the rivets specified on the engineering drawing.

Step 3. Solvent clean the immediate area surrounding the grounding block according to PPS 31.17.

Step 4. Seal the grounding block surface contact area with DHMS S3.01 sealant as shown in Figure 12. Prepare DHMS S3.01 sealant according to PPS 21.20.

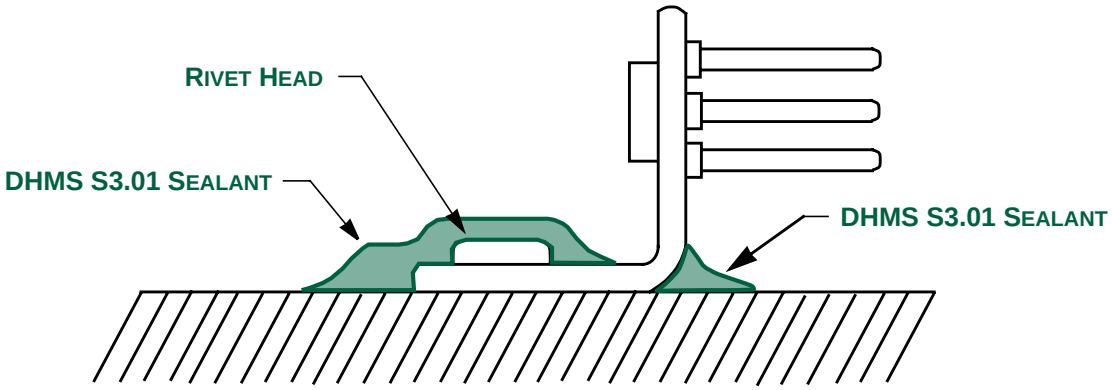


FIGURE 12 - SEALING OF AMP GROUNDING BLOCKS

5.9 Resistance Measurement

5.9.1 General

5.9.1.1 If possible, take resistance measurements or mask (ref. paragraph 4.1.3) areas where resistance measurements are to be taken before applying non-conductive coatings.

5.9.1.2 If non-conductive coatings have been applied to the area where the resistance measurement is to be taken, remove an area of coating sufficient to accommodate the ohmmeter probe according to section 5.2.2 before taking the measurement.

5.9.1.3 If the protective coating has been removed from a part, touch up the area as follows immediately after taking the measurement:

Step 1. Chemically conversion coat (C1 or C10, as specified by the engineering drawing). Manually apply C1 chemically conversion coating according to PPS 32.02. Apply C10 chemical conversion coating for low electrical resistance according to PPS 32.35.

Step 2. Touch up the area as specified in section 5.11.

5.9.1.4 Refer parts with unacceptable electrical resistance to DHC MRB or DHC delegated MRB for disposition.

5.9.2 Resistance Measurement of Aluminum Structure and Integral Fuel Tanks

5.9.2.1 Use an ohmmeter (ref. paragraph 4.2.1) to perform resistance measurements of the aluminum structure and integral fuel tanks.

5.9.2.2 Ensure that the resistance values are as specified on the engineering drawing and the functional test procedure (Engineering Order).

5.9.2.3 Perform resistance measurements of the integral fuel tanks after completion of the tank structure and before closing of the tank access panels.

5.9.2.4 Perform resistance measurements of the fuel nozzle grounding receptacles after installation and before sealing as specified in section 5.7.

5.9.2.5 When measuring the resistance of aircraft structures, ensure that the aircraft is properly grounding via the designated structural ground return.

5.9.2.6 Record the aircraft structure resistance readings in the applicable manufacturing documentation (e.g., Process Sheet or Assembly Manual).

5.9.3 Resistance Measurement of Conductive Coatings on Composite Structures

5.9.3.1 Perform the resistance measurement of the component before it is installed in the aircraft.

5.9.3.2 Measure the resistance of conductive coatings on composite structures after the coat has been cured according to PPS 34.15 or PPS 34.19 (as applicable) and before the primer or paint is applied.

5.9.3.3 Use a 1 megohm multimeter (ref. paragraph 4.2.2) to measure the electrical resistance of the conductive coating. Place the multimeter probes firmly in contact with the conductive coating, approximately 12" apart. If the surface is less than 12" wide, place the probes as far apart as possible, near the edges of the surface. The maximum acceptable resistance value for the conductive coating is 300,000 ohms. Take a sufficient number of measurements to give a representative sample of the electrical resistance of the conductive coating.

5.9.3.4 Record the resistance readings on the applicable manufacturing documentation (e.g., Process Sheet or Assembly Manual) for the composite component being tested.

5.9.4 Resistance Measurement between the Conductive Coating on a Composite Structure and the Airframe

5.9.4.1 After installing a composite structure coated with a conductive coating, measure the resistance between the conductive coating and the airframe using a 1 megohm multimeter (ref. paragraph 4.2.2) as specified on the engineering drawing or the functional test procedure (Engineering Order).

5.9.4.2 Measure the resistance between an exposed area of the conductive coating and the airframe. If an exposed area of the conductive coating is not available, carefully pierce the outer coating with the probe to contact the conductive coating. Unless otherwise specified on the engineering drawing or the functional test procedure (engineering order), the maximum acceptable resistance value between the conductive coating and the airframe is 300,000 ohms.

5.9.4.3 Record the resistance reading in the applicable manufacturing documentation (e.g., Process Sheet or Assembly Manual).

5.9.5 Resistance Measurement of the Aluminum Mesh or Foil Layer on Composite Structures

5.9.5.1 Perform the resistance measurement of the aluminum mesh or foil layer on a composite component before installing the component on the aircraft. Use an ohmmeter (ref. paragraph 4.2.1) to perform the measurement.

5.9.5.2 Lightly abrade the exposed aluminum mesh or foil test patch and a small area of the aluminum mesh or foil located along the edge of the component using abrasive paper (ref. paragraph 4.1.2) to remove the resin and just expose the aluminum mesh or foil. Take extreme care to avoid abrading through the aluminum mesh or foil.

5.9.5.3 Measure the resistance between the exposed aluminum test patch and the exposed area on the edge of the component. Record the resistance reading on the applicable manufacturing documentation (e.g., Process Sheet or Assembly Manual) for the composite component being tested. The acceptable resistance values for composite components are specified on the engineering drawing or the functional test procedure (Engineering Order).

5.9.6 Resistance Measurement Between the Aluminum (Mesh or Foil) Layer on a Composite Structure and the Airframe

5.9.6.1 After installing a composite structure with an aluminum mesh or foil layer, measure the resistance between the aluminum mesh or foil layer and the airframe using an ohmmeter (ref. paragraph 4.2.1).

5.9.6.2 Lightly abrade the exposed aluminum mesh or foil test patch using abrasive paper (ref. paragraph 4.1.2) to remove the resin and just expose the aluminum mesh or foil. Take extreme care to avoid abrading through the aluminum mesh or foil.

5.9.6.3 Measure the resistance between the exposed aluminum test patch and the airframe. Record the resistance reading in the applicable manufacturing documentation (e.g., Process Sheet or Assembly Manual). The acceptable resistance values are specified on the engineering drawing or the functional test procedure (Engineering Order).

5.9.7 Resistance Measurement Between De-Icer Boots and the Airframe

5.9.7.1 After installing de-cer boots on the airframe, measure the resistance between the de-icer boot and the airframe using a 500V insulation resistance tester (ref. paragraph 4.2.3) as specified on the engineering drawing or the functional test procedure (Engineering Order). Take extreme care to avoid damaging the de-icer boot. Record the resistance reading in the applicable manufacturing documentation (e.g., Process Sheet or Assembly Manual). The acceptable resistance values are specified on the engineering drawing or the functional test procedure (Engineering Order).

5.9.8 Resistance Measurement Between Connectors and the Airframe

5.9.8.1 After installing a connector, use an ohmmeter (ref. paragraph 4.2.1) to measure the resistance between the connector and the primary structure as shown in Figure 13. The maximum acceptable resistance value between the connector and the airframe is 5 milliohms.

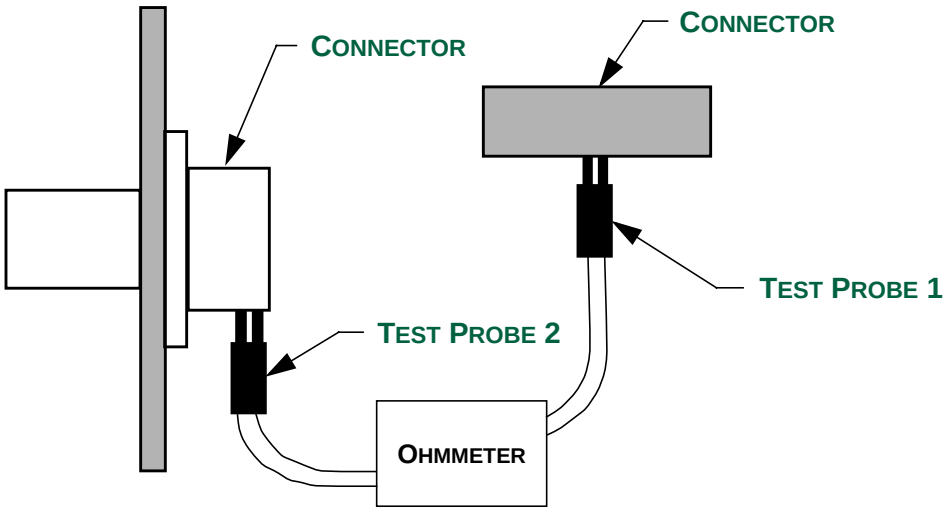


FIGURE 13 - MEASURING RESISTANCE BETWEEN CONNECTOR AND STRUCTURE

5.9.9 Resistance Measurement Between Exposed Overbraid Shields and Connectors

5.9.9.1 If specified by the engineering drawing, after completing the assembly of a cable harness with exposed overbraid shield, use an ohmmeter (ref. paragraph 4.2.1) to measure the resistance between the overbraid shield and the connectors on either end of the shield as shown in Figure 14. When performing the resistance measurement, ensure that the test probes are not more than 6" apart. The maximum acceptable resistance value between the overbraid shield and the connector is 2.5 milliohms.

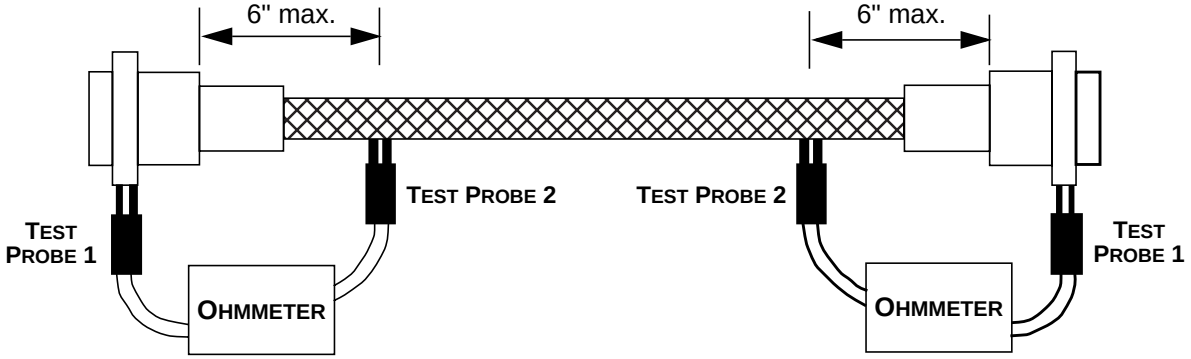


FIGURE 14 - RESISTANCE TESTING OF EXPOSED OVERBRAID

5.9.10 Electrical Bonding Resistance Measurement for Unexposed Overbraid (Connector to Connector)

5.9.10.1 If specified by the engineering drawing, after completing the assembly of a cable harness with unexposed overbraid shield, use an ohmmeter (ref. paragraph 4.2.1) to measure the resistance between the connectors on either end of the harness as shown in Figure 15. The maximum acceptable resistance value between the two connectors is dependent on the length of the cable. Maximum resistance values are given in Table III.

5.9.10.2 If a cable harness contains break-outs or transitions, measure the resistance between each pair of connectors with wires running between them. When referring to Table III, use the length of cable between the two connectors as “L”.

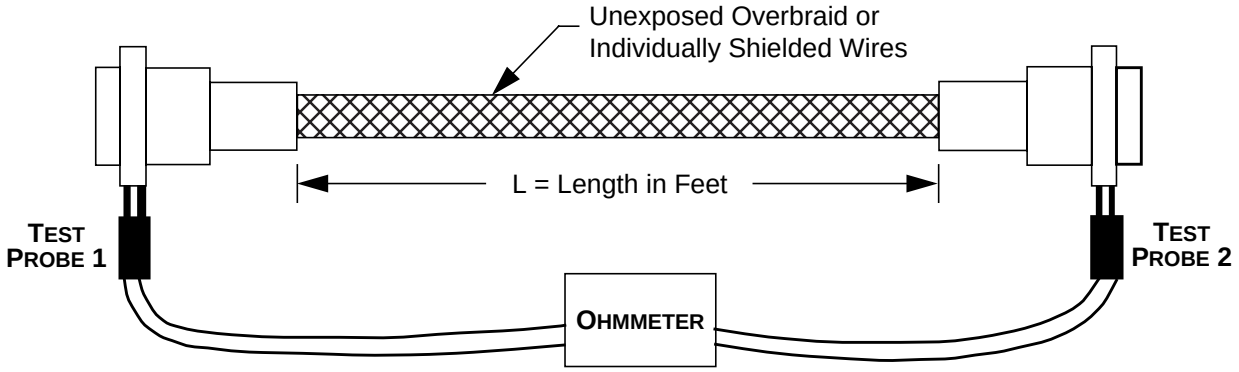


FIGURE 15 - RESISTANCE TESTING OF UNEXPOSED OVERBRAID OR INDIVIDUALLY SHIELDED WIRES

TABLE III - MAXIMUM RESISTANCE VALUES FOR UNEXPOSED OVERBRAID SHIELDS (CONNECTOR TO CONNECTOR)

L	R_{MAX}	L	R_{MAX}	L	R_{MAX}	L	R_{MAX}	L	R_{MAX}
1’	1 mΩ	21’	47 mΩ	41’	87 mΩ	61’	127 mΩ	81’	167 mΩ
2’	9 mΩ	22’	49 mΩ	42’	89 mΩ	62’	129 mΩ	82’	169 mΩ
3’	11 mΩ	23’	51 mΩ	43’	91 mΩ	63’	131 mΩ	83’	171 mΩ
4’	13 mΩ	24’	53 mΩ	44’	93 mΩ	64’	133 mΩ	84’	173 mΩ
5’	15 mΩ	25’	55 mΩ	45’	95 mΩ	65’	135 mΩ	85’	175 mΩ
6’	17 mΩ	26’	57 mΩ	46’	97 mΩ	66’	137 mΩ	86’	177 mΩ
7’	19 mΩ	27’	59 mΩ	47’	99 mΩ	67’	139 mΩ	87’	179 mΩ
8’	21 mΩ	28’	61 mΩ	48’	101 mΩ	68’	141 mΩ	88’	181 mΩ
9’	23 mΩ	29’	63 mΩ	49’	103 mΩ	69’	143 mΩ	89’	183 mΩ
10’	25 mΩ	30’	65 mΩ	50’	105 mΩ	70’	145 mΩ	90’	185 mΩ
11’	27 mΩ	31’	67 mΩ	51’	107 mΩ	71’	147 mΩ	91’	187 mΩ
12’	29 mΩ	32’	69 mΩ	52’	109 mΩ	72’	149 mΩ	92’	189 mΩ
13’	31 mΩ	33’	71 mΩ	53’	111 mΩ	73’	151 mΩ	93’	191 mΩ
14’	33 mΩ	34’	73 mΩ	54’	113 mΩ	74’	153 mΩ	94’	193 mΩ
15’	35 mΩ	35’	75 mΩ	55’	115 mΩ	75’	155 mΩ	95’	195 mΩ
16’	37 mΩ	36’	77 mΩ	56’	117 mΩ	76’	157 mΩ	96’	197 mΩ
17’	39 mΩ	37’	79 mΩ	57’	119 mΩ	77’	159 mΩ	97’	199 mΩ
18’	41 mΩ	38’	81 mΩ	58’	121 mΩ	78’	161 mΩ	98’	201 mΩ
19’	43 mΩ	39’	83 mΩ	59’	123 mΩ	79’	163 mΩ	99’	203 mΩ
20’	45 mΩ	40’	85 mΩ	60’	125 mΩ	80’	165 mΩ	100’	205 mΩ

L = Length of the cable end to end in feet (approximate length to the nearest whole foot).
R_{MAX} = Maximum Resistance measured in milliohms. $R_{max} = (R_{overbraid} \times L) + 5m\Omega = (2m\Omega \times L) + 5m\Omega$

5.10 Verification of Individual Shield Termination at Connector Backshells

5.10.1 For cable harnesses with individually shielded wires but without overbraid shields, verify proper shield termination before the backshell is closed.

5.11 Touch-Up of Bond Points and Resistance Measurement Points

5.11.1 Except as noted below, if the protective coating has been removed from a part or an area of the part that was masked to accomplish electrical bonding or resistance measurement, solvent clean the affected area according to PPS 31.17 and touch up the area with F19 primer (applied by brush according to PPS 34.08) within 24 hours of installing the bonding hardware.

- Touch up integral fuel tanks with F21 Type II primer (applied by brush according to PPS 21.03).
- Bond points which are to be potted with sealant as specified in section 5.12 do not require primer touch-up.

5.11.2 Ensure that primer refinishing provides complete coverage of the affected area and covers an area approximately twice that of the area cleaned for bonding/resistance measurement.

5.11.3 If the affected area requires paint tough-up, brush coat it with the top coat paint system matching the surrounding area according to the applicable PPS.

5.11.4 Touch up any unused bonding points provided at the ends of the primed fluid lines according to paragraph 5.11.1.

5.12 Sealing of Bonding and Grounding Hardware

5.12.1 Pot electrical bonding and grounding attachment points and hardware using the sealant specified on the engineering drawing. If the engineering drawing does not specify the sealant to use, use the sealant specified below depending on the aircraft location to be sealed and application procedure:

- Inside fuel tanks and areas exposed to hydraulic fluid (e.g., Skydrol), seal using DHMS S3.01 Class B sealant (extrusion). **Do not** use any other sealants in these areas (i.e., Do not use BAMS 552-008 or Humiseal sealants).
- For all other areas, seal with one of the following sealants: DHMS S3.01 Class B (extrusion or spatula) or BAMS 552-008 Class B (extrusion or spatula) sealants specified in PPS 21.20, or Humiseal sealant (brush apply only - Humiseal 1B31LOC, Humiseal 1B31EPA or Humiseal 1B15 (ref. paragraph 4.1.6)).

5.12.1.1 Prepare two parts sealants (i.e., DHMS S3.01 and BAMS 552-008) according to PPS 21.20.

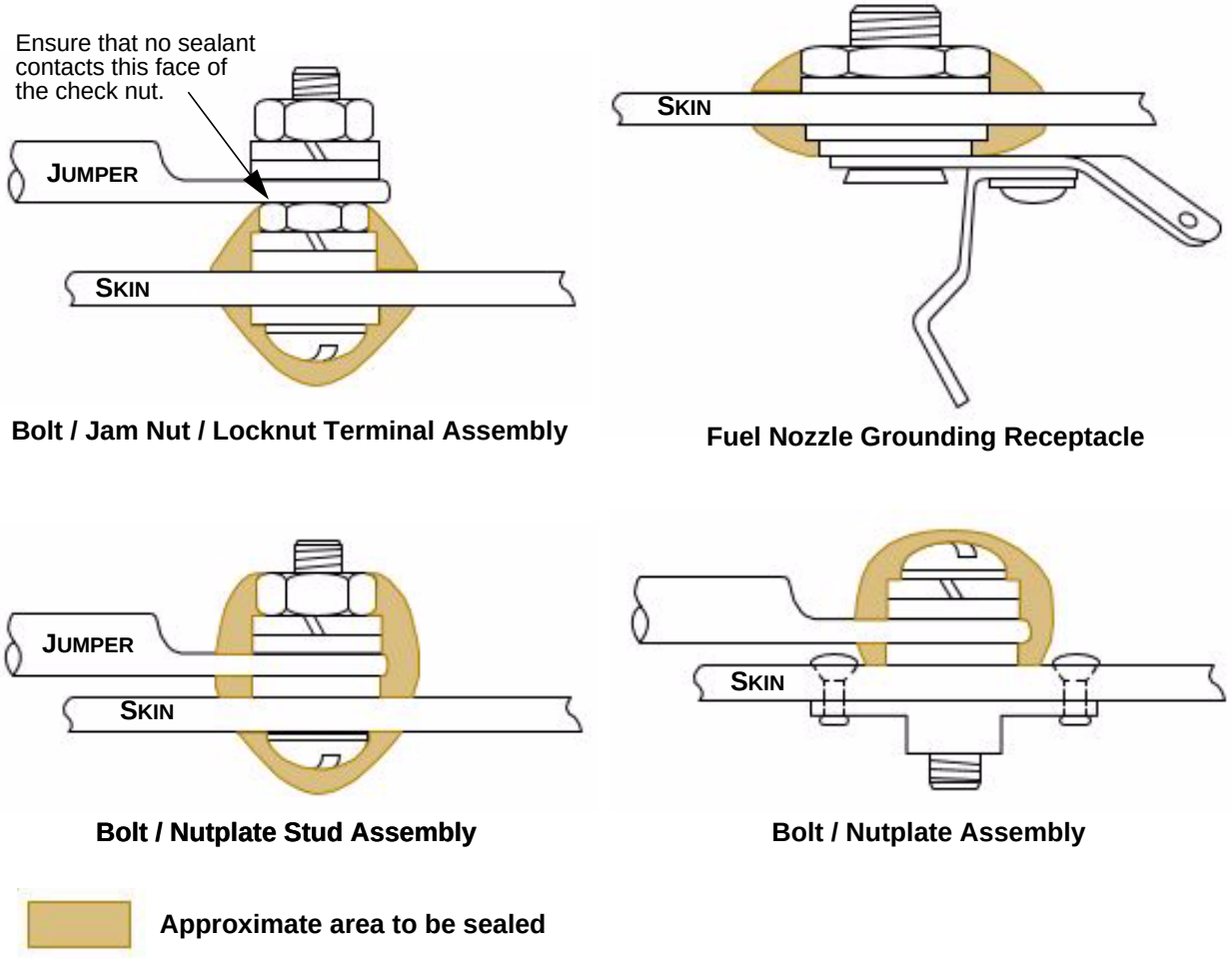
5.12.1.2 Perform sealing according to PPS 21.21. Ensure paragraph 5.12.4 requirements are met following sealing.

5.12.1.3 Refer to Figure 16 or Figure 17 for the typical areas to be sealed on the various types of bonding assemblies. For clamps which secure/support overbraid harness and provide electrical bonding and grounding, pot the clamp attachment point to the structure. However, it is not necessary to pot or seal in the area where the clamp contacts the overbraid harness.

5.12.2 When installing the bonding hardware, including bonding jumpers, check that all of the nuts or attachment screws are fully tightened.

5.12.3 Before applying sealant, solvent clean the structure surrounding the bonding attachment point according to PPS 31.17. Solvent clean an area about 50% greater than the sealant contact area.

5.12.4 Extend the sealant approximately 1/8" beyond the area stripped of protective coating.



Bolt / Jam Nut / Locknut Terminal Assembly

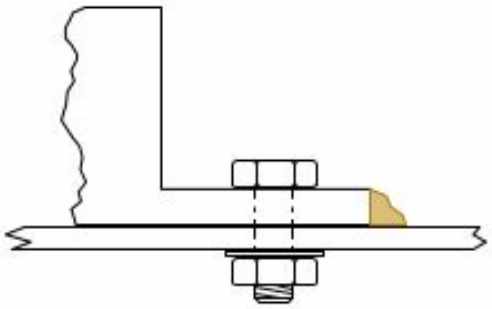
Fuel Nozzle Grounding Receptacle

Bolt / Nutplate Stud Assembly

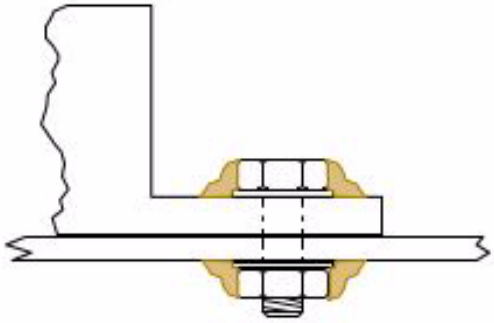
Bolt / Nutplate Assembly

Approximate area to be sealed

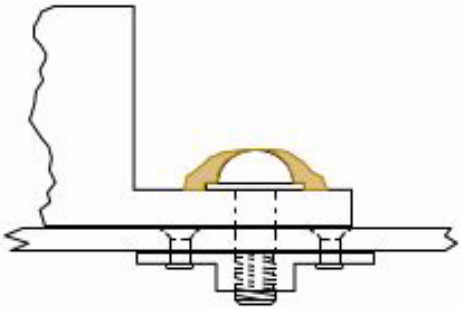
FIGURE 16 - SEALING OF ELECTRICAL BONDING ASSEMBLIES - INDIRECT BONDING



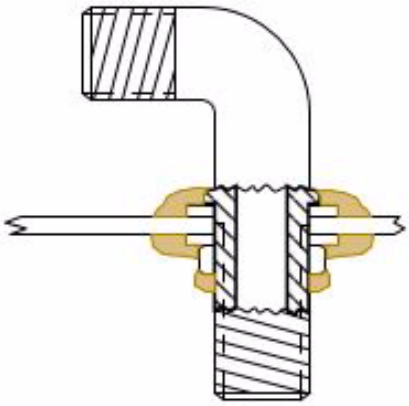
Direct Contact Bonding



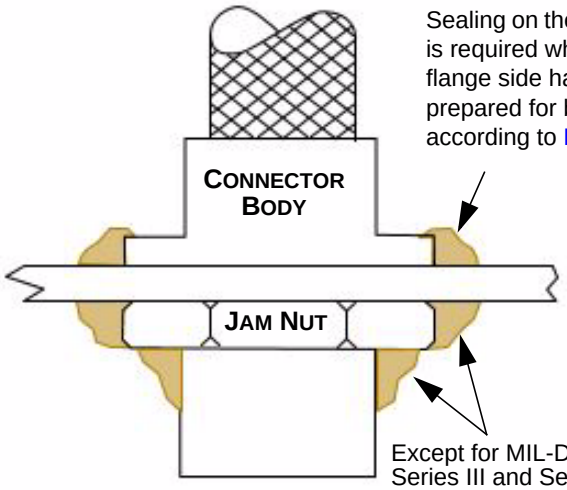
Bonding of Plumbing Line Fittings to the Structure



Bonding with Contact Screws



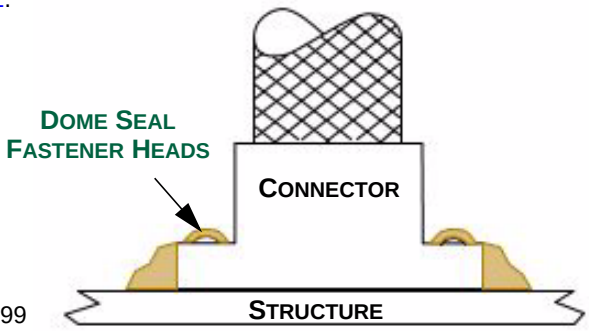
Bonding of Plumbing Line Fittings to the Structure



Sealing on the flange side is required whenever the flange side has been prepared for bonding according to Figure 2.

Except for MIL-DTL-38999 Series III and Series IV Class J connectors, sealing on the jam nut side is required for all connectors secured with a jam nut.

Bonding of Jam Nut Electrical Connectors



Bonding of Electrical Connectors Secured by Means of the Connector Flange

Approximate area to be sealed

FIGURE 17 - SEALING OF ELECTRICAL BONDING ASSEMBLIES - DIRECT BONDING

5.13 Installation of Aircraft Antennas

5.13.1 If the antenna is being mounted on the **upper** surface of the airframe and is fitted with damage holes, ensure that the drainage holes at the base and sides are kept free of sealant to allow drainage from the shell. Plug and fillet seal any drainage holes on top of the antenna using the plugs provided.

5.13.2 If the antenna is being mounted on the **lower** surface of the airframe and is fitted with drainage holes, ensure that the drainage holes at the tip (i.e., lowest point of inverted antenna) are kept free of sealant to allow drainage from the shell. Plug and fillet seal any drainage holes on the base or sides of the antenna using the plugs provided.

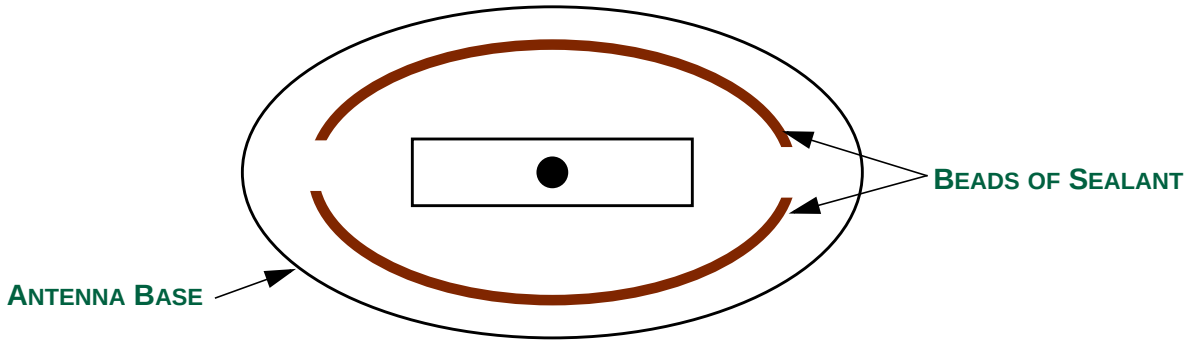
5.13.3 Install the antenna as follows:

Step 1. Ensure that the correct antenna, fixing studs, gasket, etc. are readily available.

Step 2. Prepare the antenna mounting are of the airframe for bonding according to section 5.2.

Step 3. For wet fit and dry fit gaskets, apply release agent to the antenna base and the mounting area of the airframe using a gasket wipe. Ensure that the surfaces are well covered with release agent, but not to excess.

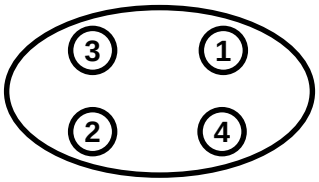
Step 4. If the engineering drawing specifies use of a wet fit gasket, apply DHMS S3.02 sealant to the antenna base and the mounting area of the airframe approximately as shown below and then spread the sealant evenly over the complete surface of the antenna base and the mounting area of the airframe to a thickness of approximately, but not more than 0.010" using a wooden spatula. Do not apply sealant if installing a dry fit gasket.



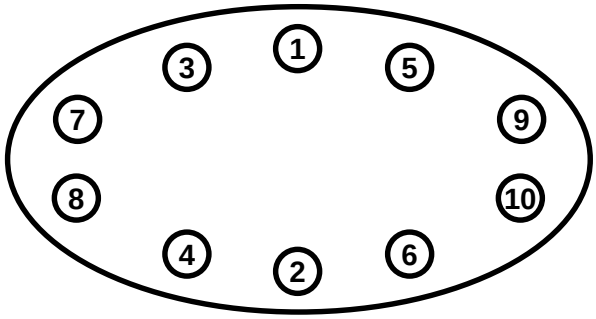
Step 5. Carefully place the gasket on the antenna base, ensuring that the mounting holes in the gasket align with the antenna mounting holes. If the engineering drawing specifies use of a HR Smith conductive dry fit sealing gasket, remove all the release paper from the mating side of the gasket to expose the adhesive surface before applying the gasket.

Step 6. For the antenna/gasket assembly on the aircraft and secure it with the fixing bolts. For HR Smith conductive dry fit sealing gaskets, remove all the release paper from the mating side of the gasket to expose the adhesive surface before applying the antenna/gasket assembly.

Step 7. Tighten the bolts, in the sequence shown below, to the torque value specified on the engineering drawing according to PPS 14.01.



Follow this sequence for antennae with 4 bolts.



Follow this sequence for antennae with 6 or more bolts.

Step 8. Solvent clean the exposed area of the aircraft structure around the antenna according to PPS 31.17.

Step 9. Touch up the exposed area of the aircraft structure around the antenna with F19 primer by brush according to PPS 34.08 within 24 hours of installing the antenna. Ensure that primer re-finishing provides complete coverage of the affected area.

Step 10. If the affected area requires paint touch-up, brush coat it with the top coat paint system matching the surround area according to the applicable PPS.

Step 11. Use DHMS S3.01 Type II sealant (prepared according to PPS 21.20) to both fillet seal around the antenna and dome seal the fixing bolts according to section 5.12. The aircraft is ready to fly approximately 24 hours after sealing.

Step 12. Carry out the antenna electrical bonding check according to the Engineering requirements.

6 REQUIREMENTS

6.1 Check that all bonding point surfaces were thoroughly cleaned before the installation of clamps and bonding jumpers. This ensure a satisfactory bond.

6.2 Check pipe lugs for cracks, bonding terminals for insecure wire braiding, and clamps and connections for looseness.

6.3 Ensure that all bond connections are tightened to the torque value specified in Table II.

6.4 Ensure that the method and materials used for bonding and ground connections are in conformance with this standard and the engineering drawing.

6.5 Ensure that bonding jumpers are installed so that the wire does not come in contact with surrounding structure, equipment, fuel pipes, or other bonding jumpers (see Figure 11). If contact is unavoidable, use a CSP 476 bonding jumper (complete with insulating sleeve). If the engineering drawing specifies a jumper other than the CSP 476, contact Liaison Engineering.

6.6 For cable harnesses with individually shielded wires but without overbraid shields, verify proper shield termination according to PPS 9.30, PPS 9.39 or PPS 9.41, as applicable, before the backshell is closed.

6.7 Ensure that touch up primer and, if applicable, paint top-coat, has been applied to any aircraft structure remaining exposed after installation of all bonding and grounding hardware.

6.8 Ensure that the following resistance measurements are recorded on the applicable manufacturing documentation (e.g., Process Sheet or Assembly Manual):

- resistance measurements of the aluminum structure
- resistance measurements between conductive coatings on composite structures and the airframe
- resistance measurements between aluminum (mesh or foil) layers on composite structures and the airframe
- resistance measurements between de-icing boots and the airframe
- resistance measurements of the aluminum (mesh or foil) layer on composite structures
- resistance measurements of conductive coatings on composite structures

6.8.1 Maintain a record of all resistance measurements.

6.9 Ensure appropriate coverage of sealant over sealed bonding and grounding hardware as shown in Figure 16 and Figure 17 (including full coverage over washers, as applicable). When Humiseal 1B31LOC or Humiseal 1B31EPA sealant has been applied, use UV lighting tools (ref. paragraph 4.2.5) to ensure appropriate coverage of sealant, as these sealants contain a special material which glows blue when exposed to UV light (this enables the operator to see clearly if the coverage and uniformity are acceptable and gives an idea as to the coating thickness since the more sealant is present, the more the deeper blue it appears).

7 DHC SAFETY PRECAUTIONS

7.1 The safety precautions specified herein are specific to DHC/BA to meet Canadian Federal and Provincial government environmental, health and safety regulations. It is strongly recommended that other facilities consider these safety precautions; however, suppliers, subcontractors and partners are responsible for ensuring that their own environmental, health and safety precautions satisfy the appropriate local government regulations.

7.2 Observe standard plant safety precautions when performing the procedure specified herein.

7.3 Refer to PPS 31.17 for the safety precautions for handling and using solvents.

7.4 The longer wave ultraviolet light generated by the UV lights (flashlights) referenced herein do not pose a hazard under normal use. However, extended exposure can be harmful to the eye or skin (i.e., the ultraviolet light should not be directed at the eye and exposure to skin should be avoided).

8 PERSONNEL REQUIREMENTS

8.1 This PPS has been categorized as a Controlled Special Process according to PPS 13.39. Refer to PPS 13.39 for personnel requirements.

9 MAINTENANCE OF EQUIPMENT

9.1 Ensure that ohmmeters, multimeters and insulation resistance testers used for resistance measurement as specified herein are re-calibrated according to the equipment manufacturer's instructions. If the equipment manufacturer does not specify/recommend a re-calibration frequency, re-calibrate every 4 months.

9.2 Keep test equipment clean and dry at all times.

9.3 Take care when handling the test leads and probes to avoid damage to components, aircraft or equipment.