SECTION 2
CHAPTER 15

INSTALLATION OF BUSBARS, JUNCTION BOXES, PROTECTIVE DEVICES, AND TERMINAL BOARDS

INTRODUCTION

1. Procedures for installing equipment in aircraft are recommended in order to make installation easier, to standardize the methods used, and to provide the best possible protection for personnel and equipment.

2. This chapter describes procedures for installing busbars (including preparation), junction boxes, protective devices, and terminal boards in aircraft. It also describes methods of identification and protection and the correct use of hardware.

REFERENCE SPECIFICATIONS

3. The following specifications are applicable to busbars, conduit, junction boxes, protective devices, and terminal boards:

<table>
<thead>
<tr>
<th>Reference</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AN3064</td>
<td>Box Connector, Electrical</td>
</tr>
<tr>
<td>AN960</td>
<td>Washer, Flat</td>
</tr>
<tr>
<td>MIL-C-85049</td>
<td>Connector Accessories, Electrical</td>
</tr>
<tr>
<td>MS18029</td>
<td>Cover Assembly, Electrical, for MS27212 Terminal Board Assembly</td>
</tr>
<tr>
<td>MS21919</td>
<td>Clamp, Loop-Type, Cushioned Support</td>
</tr>
<tr>
<td>MS25082</td>
<td>Nut, Plain, Hexagon, Electrical-Thin</td>
</tr>
<tr>
<td>MS3373</td>
<td>Strip, Mounting, Nut Insulating, for MS27212 Terminal Board</td>
</tr>
<tr>
<td>MS35335</td>
<td>Washer, Lock, Flat - External Tooth</td>
</tr>
<tr>
<td>MS51957</td>
<td>Screw, Machine Pan Head, Cross-recessed, Corrosion Resistant Steel, UNC-2A</td>
</tr>
<tr>
<td>NASM21044</td>
<td>Nut, Self-Locking, Hexagon-Regular Height, 250°F, 125 KSI FTU</td>
</tr>
<tr>
<td>NASM21047</td>
<td>Nut, Self-Locking Plate, Two Lug, Low Height, Steel, 125 KSI FTU, 450°F</td>
</tr>
<tr>
<td>NASM35338</td>
<td>Washer, Lock-Spring, Helical, Regular (medium) Series</td>
</tr>
<tr>
<td>NASM35649</td>
<td>Nut, Plain Hexagon, Machine Screw, UNC-2B</td>
</tr>
<tr>
<td>NASM35650</td>
<td>Nut, Plain-Hexagon, Machine Screw, UNF-2B</td>
</tr>
<tr>
<td>SAE AS 27212</td>
<td>Terminal Board Assembly, Molded-In Stud, Electric</td>
</tr>
<tr>
<td>SAE AS 7351</td>
<td>Clamp, Loop Type Bonding</td>
</tr>
</tbody>
</table>

PREPARATION AND INSTALLATION OF BUSBARS

General

4. Busbars are used in aircraft for power distribution. The most commonly used materials for busbars are bare aluminium, plated aluminium, or plated copper. Aluminium used for busbars is EC (electrical) grade.

Preparation of Busbars

5. Busbars for an aircraft electrical system must be clean and free from grease, dirt, and oxide. Any of these at the electrical junction will cause the connection to heat up and fail. Busbars are cleaned prior to installation in the aircraft and are also treated to prevent or minimize oxidation after installation.

WARNING

Use only approved cleaning compounds and approved procedures to clean aircraft electric components. The use of inappropriate cleaning compounds or failure to follow proper procedures may cause fires or explosions.
**WARNING**
Appropriate personal protective equipment should be worn when handling and using cleaning solutions.

### Preparation of Unplated Aluminium Alloy Busbars

6. Clean unplated aluminium busbars by immersing in MIL-PRF-680 (Stoddard’s solvent) or by wiping with a clean, soft cloth saturated with the solvent. Wipe dry with a clean, soft cloth.

7. After cleaning, treat all electrical contact surfaces as follows:
   - Cover contact surfaces completely with an even coating of petrolatum-zinc dust compound (50% petrolatum, 50% fine zinc dust, by weight).
   - Scratch brush the coated areas, using a rotary steel wire brush with a pilot as shown in Figure 15–1. Brush through the compound.
   - Remove most of the compound from busbar by wiping lightly with a clean, soft cloth.
   - Examine busbar to make sure that there are no steel brush bristles lodged in the aluminium.
   - Apply a thin coating of clean petrolatum-zinc compound to contact surfaces. This compound is the same as that supplied in MS aluminium terminal lugs.

**NOTE**
Allow final coat of compound to remain on busbar when installed. Excess will be squeezed out of connections and removed later.

**WARNING**
Use only approved cleaning compounds and approved procedures to clean aircraft electric components. The use of inappropriate cleaning compounds or failure to follow proper procedures may cause fires or explosions.

### Preparation of Plated Aluminium and Copper Busbars

8. Clean plated aluminium and copper busbars thoroughly by immersing in MIL-PRF-680 (Stoddard’s solvent) or by wiping with a clean, soft cloth saturated with the solvent. Wipe dry with a clean, soft cloth.

### Repairing Damaged Plating

9. Examine contact surfaces of plated aluminium or copper busbars for damage to plating. Reject damaged aluminium busbars and return for rework. Repair slight damage to plated busbars by tinning with a soldering iron. Thoroughly wash and dry repaired areas. Do not attempt to repair plating on aluminium.

### Mounting Hardware

10. When installing a copper busbar, always place cadmium plated steel plain washer between the busbar and the lockwasher or self-locking nut. (See Figure 15–2.) When installing an aluminium alloy busbar, place an aluminium alloy plain washer between the busbar and the lockwasher or self-locking nut.

### Insulation

11. Insulate the busbar from structure, junction box, or support with a fibreglass, phenolic, or other rigid insulating stand-off as shown in Figure 15–2. Do not use any moisture-absorbing material.

### Protection

12. Install busbars inside panels, junction boxes, or in protected areas when possible. If this cannot be done, protect the busbar with insulating tubing or other means of insulation. See Section 2, Chapter 4 for details.

### INSTALLATION OF JUNCTION BOXES

**General**

13. Junction boxes are containers with hinged or removable covers used in aircraft to provide a protected area for electrical power distribution equipment such as busbars and terminal boards. The material of junction boxes is either metal or hard fibreglass.
Mounting Hardware

14. Use standard AN bolts or screws of the appropriate size to attach junction boxes to aircraft structure. (See Figure 15–3.) Insert screws or bolts so that the head of the screw or bolt is inside the junction box. Do not install attaching hardware so that threaded part of the screw or bolt protrudes inside the junction box, as the sharp thread edges will damage wire insulation.

Insulation

15. The inside of metallic junction boxes is coated with white glyptal or similar material to insulate wiring from the metal, to improve visibility and to make inspection easier. Non-metallic junction boxes need not be so insulated. If this coating is damaged during the installation procedure, repair the damaged parts with the same material as used in the original installation. When a new metallic box is installed, make sure the insulating coating is present and undamaged.

Junction Box Covers

16. Junction box covers may be hinged or attached by means of screws. Screw threads must not extend into the box in the vicinity of wiring. The sharp threads may cut wire insulation. If covers are not hinged, secure the cover to the box with an insulated bead chain, or No. 14 wire, as shown in Figure 15–4. Make this attachment outside the box so that when the box is closed the chain or wire will not interfere with the wiring.

NOTE
If covers are bent during installation or repair, straighten them before final attachment.

Preparation of Wire Entry Holes

17. Determine the outside diameter of the wire, or wire bundle, and make sure that the opening is at least 3mm larger in diameter to allow for later enlargement of the bundle. Use a box connector and cable clamp to protect wiring if this is indicated on the engineering drawing.

CAUTION
Deburr the inner surface of box connectors.

NOTE
When a box connector is not used, protect the edges of the entry hole with plastic or fibre grommets. (See Figure 15–5.)

Drainage of Junction Boxes

18. Provide one or more drainage holes (4.7mm diameter minimum) at the lowest point of the junction box when the aircraft is on the ground. After drilling drainage holes in metal junction boxes, deburr the edges of the hole with a deburring tool or a file.

CAUTION
Do not drill holes in vapour-tight junction boxes.

Vapour Tight Boxes

19. Vapour-tight junction boxes in aircraft are identified as such on the covers. When doing work of any kind on vapour-tight boxes, carefully follow the instructions given in the aircraft manufacturer’s handbook of maintenance instructions for the specific aircraft model.
Identification

20. If junction boxes, as originally installed, are not identified, it is not necessary to do so. If the junction box does have identification marking, make sure marking is replaced as in original.

Bonding or Grounding Junction Boxes

21. Bond or ground junction boxes to structure by direct metal-to-metal contact or by means of a bonding jumper. Test bond or ground as described in Section 2.

Chapter 13. Grounding of equipment in non-metallic boxes shall be on an individual basis, not in series.

INSTALLATION OF PROTECTIVE DEVICES

General

22. Protective devices are items of electrical equipment such as circuit breakers, fuses, etc., installed in aircraft to protect the electrical system against overloads caused by short circuits or other faults.

Circuit Breakers

23. A circuit breaker is a device designed to open and close an electric circuit and to open the circuit automatically at a predetermined overload current, without damage to itself. The primary purpose of circuit breakers in aircraft is to provide overcurrent protection for wire and cable and to minimise the danger of smoke and fire.

24. Correct circuit breaker selection should result in a protective device with the lowest standard rating that will not trip inadvertently. It must interrupt the fault or overload current by disconnecting the faulted line from the power distribution point before any wire or insulation damage occurs.

25. The nameplate current rating of circuit breakers is a nominal rating for identification and the actual useable rating for a particular application may be considerably different. Most circuit breakers must carry approximately 115% of their rated current indefinitely. This excess is to provide a tolerance for the effects of wear, vibration etc. The instantaneous trip current is usually in the order of ten times the current rating of the circuit breaker. The applicable Military Standard (MS) should be reviewed when determining the actual trip current for a circuit breaker.
26. When selecting a circuit breaker for a particular application all the variables should be considered. These variables include time-current characteristics of the circuit breaker, start-up surges of equipment, wire type, size and location (ambient temperature) and the maximum altitude at which the equipment is likely to operate. The current carrying capacity of a wire varies considerably depending on the application and should be determined using the graphs contained in SAE AS50881.

27. Both magnetic and thermal type circuit breakers are available however circuit protection in aircraft is primarily provided by thermal circuit breakers which are dependent on temperature rise in the sensing element for actuation. Operation is achieved by deflection of a bimetal strip that will open the circuit at a pre-determined temperature. Temperature rise in the sensing element is caused principally by the load current however this is affected by ambient temperature which can raise or lower the actual current at which the circuit breaker will trip.

28. Trip-free circuit breakers are normally used for all aircraft applications. Manual resetting of this type of circuit breaker cannot be effected while an over current circuit fault remains. Non trip-free circuit breakers are used when the application requires over-riding of the tripping mechanism, in an emergency, when the fault still exists. Both types of circuit breaker can be manually operated to both ON and OFF positions with power applied, without damage to the electrical contacts however circuit breakers should not be used as switches unless specifically designed for this purpose.

29. The trip characteristics of a circuit breaker can change when the trip mechanism has been dormant for long periods. This phenomenon is due to the high internal spring forces which are inherent in most circuit breakers and which can cause a static type of wear to the trip mechanism when in the closed position. Test data suggest that this condition can be prevented by periodically operating the circuit breaker manually with no electrical load, however manual operation should be limited to two or three times a year to avoid excessive dynamic wear of the tripping mechanism.

30. Where practicable, ‘power in’ and ‘power out’ wires should be physically separated to avoid the possibility of a short circuit negating the effect of the circuit breaker.

Mounting Hardware

31. If attaching hardware is furnished with the protective device, use it. If no attaching hardware is furnished, mount the protective device with standard AN cadmium plated steel screws or bolts of the appropriate size. When replacing a protective device, use hardware exactly the same as in the original installation except that a longer screw may be used if necessary.
When a protective device must be attached with a screw into a blind tapped hole, make sure that the screw will give maximum thread engagement without bottoming in the hole. The length is determined as follows (see Figure 15–8):

a. Select a screw of approximately the correct length and install a plain washer and lockwasher on it.

b. Insert the screw into the blind tapped hole and thread it in until it bottoms in the hole. Plain and lock washers should remain free.

c. Back out the screw two turns and measure the length of screw between the under surface of the head and the top washer.

d. Measure the thickness of the mounting part of the protective device and subtract it from the measurement obtained in step c. If the device to be mounted is thicker than the dimension obtained in step c, repeat steps a, b, and c, using a longer screw.

e. Subtract dimension obtained in step d from the overall length of the screw; this will give the maximum length that can be used without bottoming in the tapped hole. If the final length is not a standard length, use the next shorter standard screw.

Mounting Circuit Breakers

35. Mount switch circuit breakers so that when the switch breaker is in the off or open position, the handle will be down or to the rear.

Mounting Toggle Switches and Switch Guards

36. Mount switches and switch guards as follows:

a. Insert toggle switch through the mounting surface.

b. Adjust lower jam nut to obtain approximately 5 threads above the mounting surface.

c. Place switch guard over the switch and install upper jam nut.
d. Adjust the switch up or down as required with upper and lower jam nuts to obtain proper height of the switch lever.

e. When switch is adjusted to the proper height, it can be closed with switch guard and the guard will not interfere with switch operation (see Section 2, Chapter 9, Figure 9–10).

Mounting Relays

37. Mount relays so that foreign particles cannot fall between the terminals and so that liquid cannot accumulate inside the cover.

Special Precautions for Bonding or Grounding Connections

38. When a bond or ground connection is made through the mating surfaces of structure and mounting pad, prepare the contacting surfaces as described in Section 2, Chapter 13, before attaching the device to structure.

Protection

39. If possible, mount protective devices in junction boxes or protected areas. If this is not possible, and the devices are to be installed in locations where they may be subject to damage or where the terminals may be dangerous to personnel, provide a cover to go over the protective device.

Circuit Breaker Lockout/Deactivation

<table>
<thead>
<tr>
<th>CAUTION</th>
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<tbody>
<tr>
<td>Use only red or white TEFiON devices for deactivating circuit breakers. Do not use black for this purpose.</td>
</tr>
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</table>

40. When positive lockout/deactivation of an electrical circuit breaker is required, install circuit breaker collar PN 12E2081-9, and secure with a self-clinching cable tie-wrap.

Circuit Breaker Blanking Plugs

41. When a circuit breaker is removed a blanking plug should be installed in the mounting hole. The following blanking plugs are suitable for this purpose: Metal Plug, PN NAS451-43 or Rubber Plug, PN G34.

Identification

42. Make sure that each protective device is identified by a plate or decal, permanently attached to adjacent aircraft structure. If the location of a protective device is changed, make sure that the identification marking is also relocated and completely visible. Make sure the new identification marking is exactly the same as the original.

INSTALLATION OF TERMINAL BOARDS

General

43. Terminal boards are used in aircraft to provide junction points of good electrical conductivity for circuits that are not frequently disconnected.

Mounting Hardware

44. Use standard AN cadmium plated steel hardware of the appropriate size.

Method of Attachment

45. Install mounting screws so that the screw protrudes through the bottom of the terminal board, as shown in Figure 15–10. The length of the screw should allow for some protrusion beyond the nut. Pass a steel scale or other flat piece of metal over the top of the nut. If it passes over freely, the screw is too short and is to be replaced with the next longer length. Protrusion of screw should not exceed two threads.

Alternative Method of Attachment

46. If it is not possible to install the mounting screw from the top of the terminal board, install it from the back, as shown in Figure 15–11. In this case, the end of the screw should project just beyond the top of the nut, but do not use a screw that will extend beyond the level of the terminal board mounting surface.

Insulation

47. Place an insulating strip over each mounting screw, long enough so it will go over the two adjacent terminal studs. If there is no terminal mounted to the stud the insulating strip should be secured to the board under a nut and washers as shown in Figure 15–12. The MS14151 washer is not required if a busbar is installed on the terminal stud.
Attaching Busbar to Terminal Board

48. When a MS25226 busbar is to be attached to a MS25123 terminal board, mount the busbar directly on top of the nut that holds the terminal stud in place. When MS25226 busbar is to be attached to a MS27212 terminal board, mount the busbar directly on the base of the moulded-in stud, and above the insulating strip (MS3373) if used. (See Figure 15–12 and Section 2, Chapter 4, Figure 4–18).

NOTE

If aluminium busbars are removed and are to be reinstalled, examine the busbar for deformation before reinstalling it. If there is any deformation, discard it and install a new busbar.

Protection of Terminal Boards

49. Where possible, mount terminal boards inside junction boxes or other enclosures. If this is not possible, and the terminal board is located where it may be damaged, or may be dangerous to personnel, provide a cover. Use terminal board cover MS18029 on the MS27212 terminal board. Attach no more than two terminal lugs on the stud that is to be used for mounting the cover to the terminal board. If no cover is available the terminal board may be protected by a wrapping of insulating sheeting. Use a piece of insulating sheet large enough to make a generous lap over the studs. Punch holes in the insulating sheet, install it over the grounded studs, and fasten with nuts and washers.

Identification

50. Each terminal board in the aircraft electrical system is identified by the letters TB, followed by a number which is the number of the individual board. Each stud on the terminal board is identified by a number located adjacent to it, with the lowest number in the series at the end nearest the terminal board identification number. (See Figure 15–13.) The identification may be marked on the aircraft structure to which the terminal board is attached or may be on an identification strip cemented to the structure under the terminal board. When a terminal board is replaced, do not remove the identification marking unless it has been damaged. In that case replace the identification marking exactly as in the original, in accordance with the applicable wiring diagram.
Figure 15–13 Identification of Terminal Board
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