

SECTION 2

CHAPTER 18

AIRCRAFT ELECTRICAL SYSTEM - INSPECTION

INTRODUCTION

1. The purpose of this chapter is to provide instructions for inspecting aircraft electrical system wiring and interconnecting components and to detail requirements to be met. Compliance with these instructions will be effective in minimising electrical system malfunctions. These instructions should be complied with, except where any procedure conflicts with the aircraft maintenance manual, in which case the aircraft manual shall take precedence.

WARNING

TO AVOID THE POSSIBILITY OF PERSONAL INJURY OR EQUIPMENT DAMAGE, IT IS MANDATORY THAT ALL ELECTRICAL POWER BE REMOVED FROM THE AIRCRAFT PRIOR TO COMMENCING AN INSPECTION OR MAINTENANCE.

INSPECTION

Wiring Installation

2. Wires and cables should be inspected for adequacy of support, protection and general condition throughout. The desirable and undesirable features in aircraft wiring are outlined below and indicated as conditions that should or should not exist. Accordingly, aircraft wiring should be inspected to ascertain that:

- a. Wiring installation conforms to the following precedence:
 - (1) Safety of flight.
 - (2) Ease of maintenance, removal and replacement of the wiring.
 - (3) Cost effective aircraft production or modification.
- b. Wiring has been fabricated and installed so as to achieve the following:
 - (1) Maximum reliability.
 - (2) Minimum interference and coupling between systems.
 - (3) Accessibility for inspection and maintenance.

(4) Prevention of damage.

c. Wiring has been routed to ensure reliability and to offer protection from the following hazards:

- (1) Chafing.
- (2) Use as handholds, or as support for personal equipment.
- (3) Damage by personnel moving within the vehicle.
- (4) Damage by stowage or shifting of cargo.
- (5) Damage by battery or acid fumes and fluids.
- (6) Damage in wheel wells exposed to rocks, ice, mud, etc.
- (7) Damage by moving parts.
- (8) Harsh environments such as SWAMP areas, high temperatures, or areas susceptible to significant fluid or fume concentration.

d. Wires and cables are provided with enough slack to meet the following requirements:

- (1) Permit ease of maintenance.
- (2) Prevent mechanical strain on the wires, cables, junctions and supports.
- (3) Permit free movement of shock and vibration mounted equipment.
- (4) Permit removal and installation of equipment for maintenance or repair.
- (5) When wiring is terminated at a connector (excluding RF connectors) a minimum of 25mm of slack has been provided to

- facilitate complete connector replacement.
- (6) At each end of a wire terminated by a lug, a minimum length of slack equal to twice the barrel length of the lug has been provided. For copper wire AWG 2 and larger, and aluminum wire, AWG 4 and larger, the minimum length of slack shall be equal to one barrel length of the lug.
- e. Wiring is adequately separated from high temperature equipment such as resistors, exhaust stacks, heating ducts and deicers to prevent insulation damage or deterioration.
- f. Conduit, flexible tubing or braided outer jackets, properly supported, covers all wiring in wheel wells. When tubing is used, drainage holes shall be provided at all trap points and at the lowest points between each set of support clamps.
- g. Wiring has been supported to meet the following requirements:
- (1) Prevent chafing.
 - (2) Secure wiring where routed through bulkheads and structural members.
 - (3) Properly support and route wiring in junction boxes, panels and bundles.
 - (4) Prevent mechanical strain or workhardening that would tend to break the conductors and connections.
 - (5) Prevent arcing or overheated wiring from causing damage to mechanical control cables and associated moving equipment.
 - (6) Facilitate reassembly to equipment terminal boards.
 - (7) Prevent interference between wiring and other equipment.
 - (8) Prevent excessive movement in areas of high vibration.
 - (9) Provide rigid support to wiring routed within 15cm of any flammable liquid, fuel or oxygen lines.
- h. Primary support of wiring has been provided by cushion clamps at intervals of not more than 60cm, except when contained in troughs, ducts or conduits. The clamps must be of a suitable size and type to retain the wiring in place securely and without damage to the insulation. Clamps must be compatible with their installation environment. Cushion compounds are formulated to meet specific requirements and are not suitable for all applications.
- i. Secondary support of wiring (support between primary supports) has been provided by the following devices, as detailed in Chapter 8:
- (1) Tying and lacing string.
 - (2) Plastic cable straps.
 - (3) Insulation tape.
- j. Limitations on support:
- (1) Continuous lacing has not been used except in panels and junction boxes where this practice is optional.
 - (2) The use of insulation tape and sleeving for the protection of wiring has been kept to a minimum. Sleeving is preferred when such protection is necessary.
 - (3) Wires have not been tied or fastened together in conduit, covered raceways, or insulation sleeving. This will facilitate ease of replacement.
 - (4) Support does not restrict the wiring in such a manner as to interfere with the movement of shock mounted equipment.
 - (5) Tape or tying and lacing string has not been used as primary support.
 - (6) Plastic cable straps have not been used in the following areas:
 - (a) Where the total temperature (ambient plus rise) exceeds 85°C (185°F).

- (b) Where failure of the strap would permit movement of the wiring against parts which could damage the insulation or allow wiring to foul mechanical linkages.
 - (c) Where failure would permit the strap to fall into moving parts.
 - (d) In high vibration areas.
 - (e) In SWAMP areas such as wheel wells, near wing flaps, or wing folds.
 - (f) Where exposed to ultra-violet light (sunlight) unless the straps are resistant to such exposure.
 - (g) To tie wires into groups within a bundle.
- (7) Moisture-absorbent type material is not used as "fill" for clamps or adapters.
- k. Radius of bend.
- (1) For single wires individually routed and supported, the minimum bend radius is ten times the outside diameter of the wire. At the point where an individual wire breaks out from a group, harness or bundle, the minimum bend radius of the wire is ten times the outside diameter of the wire, provided the wire is suitably supported at the breakout point. If wires used as shield terminators or jumpers are required to reverse direction in a harness, the minimum bend radius of the wire is three times the diameter at the point of reversal providing the wire is adequately supported.
 - (2) The minimum bend radius of a group, bundle, or harness is six times the diameter of the group, bundle, or harness. In no case shall the bend radius of the group, bundle or harness be less than ten times the diameter of the largest included single wire.
 - (3) The minimum bend radius of a coaxial cable will not adversely affect the characteristics of the cable. For flexible type coaxial cables, the radius of bend shall not be less than six times the outside diameter. For semi-rigid types, the radius shall not be less than ten times the outside diameter.
- l. Wires and cables routed within 15cm of any flammable liquid or fuel line are closely and rigidly supported.
 - m. A trap or drip loop is provided to prevent fluids or condensed moisture from running into wires and cables dressed downward to a connector, terminal block, panel, or junction box.
 - n. Drain holes are present in drip loops or lowest portion of tubing placed over wiring.
 - o. Wires and cables, installed in bilges and other locations where fluids may be trapped are routed as far removed from the lowest point as possible or protected with vinyl tubing when this is not possible.
 - p. Wires and cables attached to assemblies where relative movement occurs (such as at hinges and rotating pieces; particularly control sticks, control wheels, columns and flight control surfaces) are installed or protected in such manner as to prevent deterioration of the wires and cables caused by the relative movement of the assembly parts.
 - q. Unused wires are individually dead ended, tied into a bundle, and secured to a permanent structure. Each wire is to have strands cut even with insulation and a pre-insulated end cap, or a 25mm piece of insulating tubing placed over wire with its end folded back and tied.

Wiring Replacement

3. Wiring should be replaced when found to have any of the following defects:
- a. Wiring that has been damaged to the extent that the primary insulation has been breached.
 - b. Wiring that is known to have been exposed to battery acid or on which the insulation appears to be, or is suspected of being, in an initial stage of deterioration, due to the effects of battery acid.

- c. Wiring that shows evidence of overheating. Replace cracked terminal strips and those studs with stripped threads.
- d. Wiring on which the insulation has become saturated with engine oil, landing gear lubricant, hydraulic fluid, etc. Saturated wire will be determined by a visual inspection taking into consideration wire and circuit intent. If the wire is saturated, the wire should be replaced. If spillage has occurred, but the wire does not appear to be saturated, clean with solvent that will not deteriorate the insulation.
- e. Wiring that bears evidence of having been crushed or kinked.
- f. Shielded wiring on which the metallic shield is frayed and/or corroded. Cleaning agents or preservatives shall not be used to minimize the effects of corrosion or deterioration of wire shields.
- g. Wiring that bears evidence of breaks, cracks, dirt, or moisture in the plastic sleeves placed over wire splices or terminal lugs.
- h. Sections of wire on which in-line splices do not comply with Chapter 6, Paragraph 27, should be replaced.
- g. When the terminal lugs attached to a stud vary in diameter, ensure the largest diameter lug is placed on the bottom and the smallest diameter on top.
- h. Terminal lugs have been selected with a stud hole diameter which matches the diameter of the stud.
- i. Terminal lugs have been positioned so that bending of the terminal lug is not required to remove the fastening screw or nut, and movement of the terminal lugs will tend to tighten the connection.
- j. The following discrepancies are cause for replacement of terminal boards:
 - (1) Crack(s) extending from a terminal to any threaded insert.
 - (2) Crack(s) extending from a terminal to any other terminal.
 - (3) Crack(s) extending over 6.35mm in length from any terminal in any direction.

Terminals and Terminal Blocks

4. Inspect to ensure compliance with the following installation requirements:
 - a. Terminal blocks are securely mounted.
 - b. Terminal connections are securely attached to terminal block studs.
 - c. Insulating tubing is placed over terminals (except pre-insulated types) to provide electrical protection and mechanical support; and is secured to prevent slippage of the tubing from the terminal.
 - d. Evidence of overheating and corrosion is not present on connections to terminal block studs.
 - e. A maximum of four terminal lugs or three terminal lugs and a bus bar have been connected to any one stud.
 - f. Physical damage to studs, stud threads, and terminal blocks is not evident.

Fuses and Fuse Holders

5. Inspect as follows:
 - a. For security of mounting of fuse holder.
 - b. For security of connections to fuse holders.
 - c. For the presence of corrosion and evidence of overheating on fuses and fuse holders. Replace corroded fuses and clean fuse holders. If evidence of overheating is found, check for correct rating of fuse.
 - d. For replenishment of spare fuses used in flight, ensure fuses possess the same electrical features including blowtime, current and voltage rating.
 - e. Inspect fuse holder cap to ensure the rubber grommet is properly installed.
 - f. Ensure the fuse holder cap retains the fuse when either inserting or removing a fuse. Fuseholder caps which do not securely retain fuses must be replaced.

MS Connectors.

6. Ensure the following criteria for connectors are met or that repairs are effected as required:

- a. Inspect connectors for security, evidence of overheating and for corrosion or cracks. Replace where necessary.
- b. Ensure installation of cable clamp adapters on all MS connectors except those that are moisture proof, on which they are optional.
- c. Ensure that approved tape is wrapped around wires in cable clamp adapters so that tightening of the cable clamp provides sufficient grip on the wires to keep tension from being applied to the connector pins.
- d. Ensure that unused plugs and receptacles are appropriately sealed to avoid contamination. The connectors should then be secured to the aircraft structure or to other wiring that is properly anchored.
- e. Ensure that the coupling nut of MS connectors is secured, by lock wire or other mechanical locking means, as required by the applicable aircraft maintenance manual.
- f. Ensure that moisture-absorbent type material is not used as 'fill' under clamps or adapters.
- g. Ensure that there is no evidence of deterioration of potting compound in potted connectors.
- h. When crimp contact connectors are used, the unused contacts shall be installed. Sealing plugs should be inserted in unused grommet holes of environment resistant connectors.
- i. Spare contacts in potted connectors shall have a pigtail attached, consisting of a wire of the largest size that can be accommodated by the contact and which extends 12.7 to 17.8cm beyond the potting material. The pigtails shall be identified and dead ended.

NOTE

A bayonet coupled electrical connector is correctly fastened if all three bayonet pins on the receptacle are located in the holes on the plug coupling ring. A click will be heard when the pins locate into the receptacle ring holes. A threaded coupled electrical connector is correctly fastened if the plug is fully seated in the receptacle and cannot be moved in or out of the receptacle. A slight lateral movement is permissible due to the difference in size between the locating keys and keyways.

Splices

7. Crimp type splices shall comply with the following:

- a. Only environmentally sealed splices should be used aircraft wiring for new and replacement applications. Where non-environmental splices are currently fitted, replacement with environmental splices is only required when original splices display signs of degradation.
- b. The spacing of splices at staggered intervals to prevent excessive enlargement of the bundle. Groups of non-staggered splices need not be replaced, however it may be necessary to use extra clamps to support the added localized weight.
- c. Quick disconnect splices, designed for disconnection without the use of tools, should not be used.
- d. There should not be more than one splice in any wire segment between any two connectors or other terminating points.
- e. Splices should not be used to salvage scrap lengths of wire.
- f. Splices should not be used within 30cm of a connector or other terminating point.
- g. Splices should not be used on firing or control circuits associated with ordinance or explosive systems.

Junction Boxes, Panels, Shields and Micro-Switch Housings.

8. These housing assemblies should be examined to ascertain the following:

- a. Suitable hole(s) smaller than 9.5mm diameter, but not less than 3.1mm diameter, is (are) provided at the lowest point(s) of the box(es), except vapour-tight boxes, to allow for drainage with the airplane on the ground and in level flight.
- b. Vapour-tight or explosion proof boxes are externally labelled "vapour-tight" or "explosion proof."
- c. Boxes are securely mounted.
- d. Boxes are clean internally and free of foreign objects.
- e. Safety wiring is installed on all lid fasteners on J-boxes, panels, shields, or micro-switch housings which are installed in areas not accessible for inspection in flight, unless the fasteners incorporate self-locking devices.
- f. There are no unplugged unused holes (except drainage holes) in boxes.

Conduit - Rigid Metallic, Flexible Metallic and Rigid Non-Metallic.

9. Inspect conduit assemblies to ensure that:
- a. Conduit is installed so that strain and flexing of ferrules is relieved.
 - b. Conduit is not collapsed or flattened from excessive bending.
 - c. Conduits are installed so that fluids or condensed moisture will not be trapped. Suitable drain holes shall be provided at the low points, except for metallic flexible conduit.
 - d. Bonding clamps are installed in a manner that damage to the conduit cannot result.
 - e. The diameter of wiring bundles installed in conduits shall not exceed 80% of the conduits inner diameter.

Electrical Bonds

10. An electrical bond is defined as any fixed union existing between two metallic objects that results in electrical conductivity between them. Such union results from either physical contact between conductive surfaces of the objects or from the addition of an electrical connection between them. Other desirable features which must be present in order for a good bond to exist are as follows:

- a. Metallic conduit bonded to the aircraft structure at each terminating and break point. The bonding path may be through the equipment at which the conduit terminates.
- b. Bond connections are secure and free from corrosion.
- c. Bonding jumpers do not interfere in any way with the operation of movable components of the aircraft.
- d. Self-tapping screws have not been used for bonding purposes. Only standard threaded screws or bolts of appropriate size should be used.
- e. Exposed conducting frames or parts of electrical or electronic equipment have a low resistance bond of less than 0.1 ohm to structure.
- f. Bonding jumpers have been kept as short, straight and direct as possible.
- g. Bonds have been attached directly to the basic aircraft structure rather than through other bonded parts as far as practical.
- h. Bonds have been installed to ensure that the structures of aircraft are electrically stable and free from the hazards of lightning, static discharge, electrical shock, etc., and to provide for the suppression of radio interference resulting from these hazards.

Wire and Cable Junctions

11. Ensure that only approved devices, such as solderless type terminals, terminal blocks, connectors, disconnect splices and permanent splices are used for wire and cable junctions. Inspect for compliance with the provisions listed below:

- a. Electrical junctions are protected from short circuits resulting from movement of personnel, cargo, shell cases, clips, and other loose or stored materials. Protection shall be provided by covering the junctions, installing them in junction boxes, or by locating them in such a manner that additional protection is not required.
- b. Exposed junctions and busses shall be protected with insulating materials. Junctions and busses located within enclosed areas containing only electrical

and electronic equipment are not considered to be exposed.

- c. Electrical junctions shall be mechanically and electrically secure. They shall not be subject to mechanical strain or used as a support for insulating materials, except for insulation on terminals.

Switches, Toggle

12. In the event the following inspections reveal that the switches are unserviceable, replace defective switches with switches of the same type and current rating. Inspect as follows:

- a. Conduct visual examination for physical damage and that switches are securely attached to the mounting panel.
- b. Check for loose or deformed electrical connections or evidence of corrosion of the terminals, terminal lugs or screws.
- c. Check for manual operation by actuating toggle lever several times. This also serves to remove any superficial contamination or foreign deposits on the internal electrical contacts
- d. Test for electrical continuity as measured across the external terminals by means of an ohmmeter. Electrical resistance across any set of closed contacts should not exceed one (1) ohm. Intermittent or excessive resistance normally indicates that the internal contacts are corroded. In the event a few additional actuations of the switch do not clear up this condition, replace the switch with like item. Continuity tests of installed switches require that the switch be electrically isolated from other circuitry to preclude measurement of low resistance parallel systems. This can usually be accomplished by opening the circuit breaker or fuse on the line side of the switches.
- e. Switches that are exposed to direct water spray, rain or heavy dust concentrations require more frequent checks for manual operation, corrosion and continuity.

Circuit Breakers

WARNING

INSTALLED CIRCUIT BREAKERS SHOULD BE SELECTED OFF AND ALL ELECTRICAL POWER INCLUDING BATTERIES SHOULD BE DISCONNECTED PRIOR TO PROCEEDING WITH INSPECTION OR MAINTENANCE.

WARNING

REPLACEMENT CIRCUIT BREAKERS MUST HAVE EQUIVALENT ELECTRICAL CHARACTERISTICS

13. When replacement is necessary use circuit breakers of the same type and current rating. Inspect as follows:

- a. Ensure that the circuit breaker is firmly secured to the mounting panel and there is no evidence of physical damage.
- b. Inspect for loose electrical terminations or evidence of corrosion of the terminals, terminal lugs and screws.
- c. Ensure positive manual operation by actuating the push-pull button or toggle several times. This operation also serves to remove any superficial contaminants or foreign deposits present on the surface of the internal electrical contacts.
- d. Check for evidence of circuit breaker overheating.
- e. Test for electrical continuity, as measured across the external breaker terminals. Use an appropriate ohmmeter to determine that the maximum electrical resistance does not exceed one tenth (0.1) of an ohm. Intermittent or excessive resistance readings normally indicate that the internal breaker contacts are corroded. In the event a few additional actuations of the breaker do not correct this condition, the breaker should be replaced. Continuity tests of installed breakers require that the breaker be electrically isolated from other circuitry to preclude measurement of low resistance parallel systems. This can usually be accomplished by opening the switch or switches on the load side of the breaker.

- f. Circuit breakers that are exposed to direct water spray, rain, snow or heavy dust concentrations require more frequent checks for manual operation, corrosion, continuity, evidence of burning or electrical arcing.

Grounding/Bonding Receptacles

- 14. Inspect grounding/bonding receptacles for servicability in accordance with Section 2, Chapter 14, Para 56. Replace defective items as required.