

SECTION 8. WIRING INSTALLATION INSPECTION REQUIREMENTS

11-96. GENERAL. Wires and cables should be inspected for adequacy of support, protection, and general condition throughout. The desirable and undesirable features in aircraft wiring installations are listed below and indicate conditions that may or may not exist. Accordingly, aircraft wiring must be visually inspected for the following requirements:

CAUTION: For personal safety, and to avoid the possibility of fire, turn off all electrical power prior to starting an inspection of the aircraft electrical system or performing maintenance.

- a. **Wires and cables** are supported by suitable clamps, grommets, or other devices at intervals of not more than 24 inches, except when contained in troughs, ducts, or conduits. The supporting devices should be of a suitable size and type, with the wires and cables held securely in place without damage to the insulation.
- b. **Metal stand-offs** must be used to maintain clearance between wires and structure. Employing tape or tubing is not acceptable as an alternative to stand-offs for maintaining clearance.
- c. **Phenolic blocks, plastic liners, or rubber grommets** are installed in holes, bulkheads, floors, or structural members where it is impossible to install off-angle clamps to maintain wiring separation. In such cases, additional protection in the form of plastic or insulating tape may be used.
- d. **Wires and cables** in junction boxes, panels, and bundles are properly supported and laced to provide proper grouping and routing.
- e. **Clamp retaining screws** are properly secured so that the movement of wires and cables is restricted to the span between the points of support and not on soldered or mechanical connections at terminal posts or connectors.
- f. **Wire and cables** are properly supported and bound so that there is no interference with other wires, cables, and equipment.
- g. **Wires and cables** are adequately supported to prevent excessive movement in areas of high vibration.
- h. **Insulating tubing** is secured by tying, tie straps or with clamps.
- i. **Continuous lacing** (spaced 6 inches apart) is not used, except in panels and junction boxes where this practice is optional. When lacing is installed in this manner, outside junction boxes should be removed and replaced with individual loops.
- j. **Do not use tapes** (such as friction or plastic tape) which will dry out in service, produce chemical reactions with wire or cable insulation, or absorb moisture.
- k. **Insulating tubing** must be kept at a minimum and must be used to protect wire and cable from abrasion, chafing, exposure to fluid, and other conditions which could affect the cable insulation. However; the use of insulating tubing for support of wires and cable in lieu of stand-offs is prohibited.
- l. **Do not use** moisture-absorbent material as "fill" for clamps or adapters.
- m. **Ensure that wires and cables** are not tied or fastened together in conduit or insulating tubing.

n. Ensure cable supports do not restrict the wires or cables in such a manner as to interfere with operation of equipment shock mounts.

o. Do not use tape, tie straps, or cord for primary support.

p. Make sure that drain holes are present in drip loops or in the lowest portion of tubing placed over the wiring.

q. Ensure that wires and cables are routed in such a manner that chafing will not occur against the airframe or other components.

r. Ensure that wires and cables are positioned in such a manner that they are not likely to be used as handholds or as support for personal belongings and equipment.

s. Ensure that wires and cables are routed, insofar as practicable, so that they are not exposed to damage by personnel moving within the aircraft.

t. Ensure that wires and cables are located so as not to be susceptible to damage by the storage or shifting of cargo.

u. Ensure that wires and cables are routed so that there is not a possibility of damage from battery electrolytes or other corrosive fluids.

v. Ensure that wires and cables are adequately protected in wheel wells and other areas where they may be exposed to damage from impact of rocks, ice, mud, etc. (If re-routing of wires or cables is not practical, protective jacketing may be installed). This type of installation must be held to a minimum.

w. Where practical, route electrical wires and cables above fluid lines and provide a 6 inch separation from any flammable liquid,

fuel, or oxygen line, fuel tank wall, or other low voltage wiring that enters a fuel tank and requires electrical isolation to prevent an ignition hazard. Where 6 inch spacing cannot practically be provided, a minimum of 2 inches must be maintained between wiring and such lines, related equipment, fuel tank walls and low voltage wiring that enters a fuel tank. Such wiring should be closely clamped and rigidly supported and tied at intervals such that contact between such lines, related equipment, fuel tank walls or other wires, would not occur, assuming a broken wire and a missing wire tie or clamp.

x. Ensure that 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.

y. Wires and cables installed in bilges and other locations where fluids may be trapped are routed as far from the lowest point as possible or otherwise provided with a moisture-proof covering.

z. Separate wires from high-temperature equipment, such as resistors, exhaust stacks, heating ducts, etc., to prevent insulation breakdown. Insulate wires that must run through hot areas with a high-temperature insulation material such as fiberglass or PTFE. Avoid high-temperature areas when using cables having soft plastic insulation such as polyethylene, because these materials are subject to deterioration and deformation at elevated temperatures. Many coaxial cables have this type of insulation.

aa. The minimum radius of bends in wire groups or bundles must not be less than 10 times the outside diameter of the largest wire or cable, except that at the terminal strips where wires break out at terminations or re-

verse direction in a bundle. Where the wire is suitably supported, the radius may be 3 times the diameter of the wire or cable. Where it is not practical to install wiring or cables within the radius requirements, the bend should be enclosed in insulating tubing. The radius for thermocouple wire should be done in accordance with the manufacturer's recommendation and shall be sufficient to avoid excess losses or damage to the cable.

bb. Ensure that RF cables, e.g., coaxial and triaxial are bent at a radius of no less than 6 times the outside diameter of the cable.

cc. Ensure that wires and cables, that are attached to assemblies where relative movement occurs (such as at hinges and rotating pieces; particularly doors, control sticks, control wheels, columns, and flight control surfaces), are installed or protected in such a manner as to prevent deterioration of the wires and cables caused by the relative movement of the assembled parts.

dd. Ensure that wires and electrical cables are separated from mechanical control cables. In no instance should wire be able to come closer than 1/2 inch to such controls when light hand pressure is applied to wires or controls. In cases where clearance is less than this, adequate support must be provided to prevent chafing.

ee. Ensure that 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) Allow shifting of equipment, as necessary, to perform alignment, servicing, tuning, removal of dust covers, and changing of internal components while installed in aircraft.

ff. Ensure that unused wires are individually dead-ended, tied into a bundle, and secured to a permanent structure. Each wire should have strands cut even with the insulation and a pre-insulated closed end connector or a 1-inch piece of insulating tubing placed over the wire with its end folded back and tied.

gg. Ensure that all wires and cables are identified properly at intervals of not more than 15 inches. Coaxial cables are identified at both equipment ends.

11-97. WIRING REPLACEMENT. Wiring must be replaced with equivalent wire (see paragraph 11-78) when found to have any of the following defects:

a. Wiring that has been subjected to chafing or fraying, that has been severely damaged, or that primary insulation is suspected of being penetrated.

b. Wiring on which the outer insulation is brittle to the point that slight flexing causes it to crack.

c. Wiring having weather-cracked outer insulation.

d. Wiring that is known to have been exposed to electrolyte or on which the insulation appears to be, or is suspected of being, in an initial stage of deterioration due to the effects of electrolyte.

e. Check wiring that shows evidence of overheating (even if only to a minor degree) for the cause of the overheating.

f. Wiring on which the insulation has become saturated with engine oil, hydraulic fluid, or another lubricant.

g. Wiring that bears evidence of having been crushed or severely kinked.

h. Shielded wiring on which the metallic shield is frayed and/or corroded. Cleaning agents or preservatives should not be used to minimize the effects of corrosion or deterioration of wire shields.

i. Wiring showing evidence of breaks, cracks, dirt, or moisture in the plastic sleeves placed over wire splices or terminal lugs.

j. Sections of wire in which splices occur at less than 10-foot intervals, unless specifically authorized, due to parallel connections, locations, or inaccessibility.

k. When replacing wiring or coaxial cables, identify them properly at both equipment and power source ends.

l. Wire substitution-In the repair and modification of existing aircraft, when a replacement wire is required, the maintenance manual for that aircraft should first be reviewed to determine if the original aircraft manufacturer (OAM) has approved any substitution. If not, then the OAM should be contacted for an acceptable replacement.

m. Testing of the electrical and chemical integrity of the insulation of sample wires taken from areas of the aircraft that have experienced wiring problems in the past, can be used to supplement visual examination of the wire. The test for chemical integrity should be

specific for the degradation mode of the insulation. If the samples fail either the electrical or chemical integrity tests, then the wiring in the area surrounding the sampling area is a candidate for replacement.

11-98. TERMINALS AND TERMINAL BLOCKS. Inspect to ensure that the following installation requirements are met:

a. 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.

b. Terminal module blocks are securely mounted and provided with adequate electrical clearances or insulation strips between mounting hardware and conductive parts, except when the terminal block is used for grounding purposes.

c. Terminal connections to terminal module block studs and nuts on unused studs are tight.

d. Evidence of overheating and corrosion is not present on connections to terminal module block studs.

e. Physical damage to studs, stud threads, and terminal module blocks is not evident. Replace cracked terminal strips and those studs with stripped threads.

f. The number of terminal connections to a terminal block stud does not exceed four, unless specifically authorized.

g. Shielding should be dead-ended with suitable insulated terminals.

h. All wires, terminal blocks, and individual studs are clearly identified to correspond to aircraft wiring manuals.

i. Terminations should be made using terminals of the proper size and the appropriate terminal crimping tools.

11-99. FUSES AND FUSE HOLDERS.

Inspect as follows:

a. Check security of connections to fuse holders.

b. Inspect 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.

c. Check mounting security of fuse holder.

d. Inspect for replenishment of spare fuses used in flight. Replace with fuses of appropriate current rating only.

e. Inspect for exposed fuses susceptible to shorting. Install cover of nonconducting material if required.

11-100. CONNECTORS. Ensure reliability of connectors by verifying that the following conditions are met or that repairs are effected as required.

a. Inspect connectors for security and evidence of overheating (cause of overheating must be corrected), and exteriors for corrosion and cracks. Also, wires leading to connectors must be inspected for deterioration due to overheating. Replace corroded connections and overheated connectors.

b. Ensure installation of cable clamp (reference MIL-C-85049) adapters on applicable MS connectors, except those that are moisture-proof.

c. See that silicone tape is wrapped around wires in MS3057 cable clamp adapters

so that tightening of the cable clamp adapter cap provides sufficient grip on the wires to keep tension from being applied to the connector pins.

d. Make sure unused plugs and receptacles are covered to prevent inclusion of dust and moisture. Receptacles should have metal or composite dust caps attached by their normal mating method. Plugs may have a dust cap similar to above or have a piece of polyolefin shrink sleeving shrunk over the connector, starting from the backshell threads, with a tail sufficiently long enough to double-back over the connector and be tied with polyester lacing tape behind the coupling nut. The cable identification label should be visible behind the connector or a tag should be attached identifying the associated circuit or attaching equipment. The connector should be attached to structure by its normal mounting means or by the use of appropriate clamps.

e. Ensure that connectors are fully mated by checking position and tightness of coupling ring or its alignment with fully mated indicator line on receptacle, if applicable.

f. Ensure that the coupling nut of MS connectors is safetied, by wire or other mechanical locking means, as required by applicable aircraft instructional manuals.

g. Ensure that moisture-absorbent material is not used as "fill" for MS3057 clamps or adapters.

h. Ensure that there is no evidence of deterioration such as cracking, missing, or disintegration of the potting material.

i. Identical connectors in adjacent locations can lead to incorrect connections. When such installations are unavoidable, the attached

wiring must be clearly identified and must be routed and clamped so that it cannot be mismatched.

j. Connectors in unpressurized areas should be positioned so that moisture will drain out of them when unmated. Wires exiting connectors must be routed so that moisture drains away from them.

11-101. JUNCTION BOXES, PANELS, SHIELDS, AND MICROSWITCH HOUSINGS. Examine housing assemblies to ascertain the following:

a. Verify that one or more suitable holes, about 3/8-inch diameter, but not less than 1/8-inch diameter, are provided at the lowest point of the box, except vapor-tight boxes, to allow for drainage with the aircraft on the ground or in level flight.

b. Verify that vapor tight or explosion proof boxes are externally labeled **VAPOR-TIGHT** or **EXPLOSION PROOF**.

c. Verify that boxes are securely mounted.

d. Verify that boxes are clean internally and free of foreign objects.

e. Verify that safety wiring is installed on all lid fasteners on J-boxes, panels, shields, or microswitch housings which are installed in areas not accessible for inspection in flight, unless the fasteners incorporate self-locking devices.

f. Verify that box wiring is properly aligned.

g. Verify that there are no unplugged, unused holes (except drainage holes) in boxes.

11-102. CONDUIT - RIGID METALLIC,

FLEXIBLE METALLIC AND RIGID NONMETALLIC. Inspection of conduit assemblies should ascertain that:

a. Conduit is relieved of strain and flexing of ferrules.

b. Conduit is not collapsed or flattened from excessive bending.

c. Conduits will not trap fluids or condensed moisture. Suitable drain holes should be provided at the low points.

d. Bonding clamps do not cause damage to the conduit.

e. Weatherproof shields on flexible conduits of the nose and main landing gear and in wheel wells are not broken; that metallic braid of weatherproof conduit is not exposed; and that conduit nuts, ferrules, and conduit fittings are installed securely.

f. Ends of open conduits are flared or routed to avoid sharp edges that could chafe wires exiting from the conduit.

11-103. JUNCTIONS. Ensure that only aircraft manufacturer approved devices, such as solderless type terminals, terminal blocks, connectors, disconnect splices, permanent splices, and feed-through bushings are used for cable junctions. Inspect for the provisions outlined below:

a. Electrical junctions should be protected from short circuits resulting from movement of personnel, cargo, cases, and other loose or stored materials. Protection should be provided by covering the junction, installing them in junction boxes, or by locating them in such a manner that additional protection is not required, etc.

b. Exposed junctions and buses should be protected with insulating materials. Junctions and buses located within enclosed areas containing only electrical and electronic equipment are not considered as exposed.

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

11-104. CIRCUIT BREAKERS. Note those circuit breakers which have a tendency to open circuits frequently, require resetting more than normal, or are subject to nuisance tripping. Before considering their replacement, investigate the reason.

11-105. SYSTEM SEPARATION. Wires of redundant aircraft systems should be routed in separate bundles and through separate connectors to prevent a single fault from disabling multiple systems. Wires not protected by a circuit-protective device, such as a circuit breaker or fuse, should be routed separately from all other wiring. Power feeders from separate sources should be routed in separate bundles from each other and from other aircraft wiring, in order to prevent a single fault from disabling more than one power source. The ground wires from aircraft power sources should be attached to the airframe at separate points so that a single failure will not disable multiple sources. Wiring that is part of electro-explosive subsystems, such as cartridge-actuated fire extinguishers, rescue hoist shear, and emergency jettison devices, should be routed in shielded and jacketed twisted-pair cables, shielded without discontinuities, and kept separate from other wiring at connectors. To facilitate identification of specific separated system bundles, use of colored plastic cable ties or lacing tape is allowed. During aircraft maintenance, colored plastic cable straps or lacing tape should be replaced with the same type and color of tying materials.

11-106. ELECTROMAGNETIC INTERFERENCE (EMI). Wiring of sensitive circuits that may be affected by EMI must be routed away from other wiring interference, or provided with sufficient shielding to avoid system malfunctions under operating conditions. EMI between susceptible wiring and wiring which is a source of EMI increases in proportion to the length of parallel runs and decreases with greater separation. EMI should be limited to negligible levels in wiring related to critical systems, that is, the function of the critical system should not be affected by the EMI generated by the adjacent wire. Use of shielding with 85 percent coverage or greater is recommended. Coaxial, triaxial, twinaxial, or quadraxial cables should be used, wherever appropriate, with their shields connected to ground at a single point or multiple points, depending upon the purpose of the shielding. The airframe grounded structure may also be used as an EMI shield.

11-107. INTERFERENCE TESTS. Perform an interference test for installed equipment and electrical connections as follow:

a. The equipment must be installed in accordance with manufacturer's installation instructions. Visually inspect all the installed equipment to determine that industry standard workmanship and engineering practices were used. Verify that all mechanical and electrical connections have been properly made and that the equipment has been located and installed in accordance with the manufacturer's recommendations. The wire insulation temperature rating should also be considered.

b. Power input tests must be conducted with the equipment powered by the airplane's electrical power generating system, unless otherwise specified.

c. All associated electrically operated equipment and systems on the airplane must be on and operating before conducting interference tests, unless otherwise specified.

d. The effects on interference must be evaluated as follows:

(1) The equipment shall not be the source of harmful conducted or radiated interference or adversely affect other equipment or systems installed in the airplane.

(2) With the equipment energized on the ground, individually operate other electrically operated equipment and systems on the airplane to determine that no significant conducted or radiated interference exists. Evaluate all reasonable combinations of control settings and operating modes. Operate communication and navigation equipment on at least one low, high and mid-band frequency. Make note of systems or modes of operation that should also be evaluated during flight.

(3) For airplane equipment and systems that can be checked only in flight, determine that no operationally significant conducted or radiated interference exists. Evaluate all reasonable combinations of control settings and operating modes. Operate communications and navigation equipment on at least one low, high and mid-band frequency.

NOTE: Electromagnetic compatibility problems which develop after installation of this equipment may result from such factors as design characteristics of previously installed systems or equipment, and the physical installation itself. It is not intended that

the equipment manufacturer should design for all installation environments. The installing facility will be responsible for resolving any incompatibility between this equipment and previously installed equipment in the airplane. The various factors contributing to the incompatibility should be considered.

NOTE: Ground EMI test have consistently been found adequate for follow-on approvals of like or identical equipment types, irrespective of the airplane model used for the initial approval. Radio frequency transmission devices, such as wireless telephones, must also be tested with respect to their transmission frequencies and harmonics.

11-108. IDENTIFICATION STENCILS AND PLACARDS ON ELECTRICAL EQUIPMENT. Replace worn stencils and missing placards.

11-109.—11-114. [RESERVED.]