U.S. Department of Transportation
Federal Aviation Administration

Advisory Circular

Subject: GUIDANCE FOR INSTALLATION OF MISCELLANEOUS, NONREQUIRED ELECTRICAL EQUIPMENT

Date: 3/6/87 **Initiated by:** ANM-110 **AC No:** 25-10 **Change:**

1. PURPOSE. This advisory circular (AC) sets forth a method of compliance with the requirements of Part 25 of the Federal Aviation Regulations (FAR) pertaining to installations of miscellaneous, nonrequired electrical equipment in transport category airplanes. It is for guidance purposes and provides an example of a method of compliance that has been found acceptable. Because the method of compliance presented in this AC is not mandatory, the terms "shall" and "must" used in this AC apply only to an applicant who chooses to follow this particular method without deviation. The applicant may elect to follow an alternate method provided the alternate method is also found acceptable by the FAA.

2. RELATED FAR SECTIONS. Sections of Part 25 which may apply to installations of miscellaneous nonrequired electrical equipment include:

§ 25.301 Loads.
§ 25.303 Factor of safety.
§ 25.305 Strength and deformation.
§ 25.307 Proof of structure.
§ 25.333 Flight envelope.
§ 25.471 Ground Loads, General.
§ 25.561 Emergency Landing Conditions, General.
§ 25.853 Compartment interiors.
§ 25.1301 Function and installation.
§ 25.1309 Equipment, systems, and installation.
§ 25.1351 Electrical systems and equipment.
§ 25.1353 Electrical equipment and installations.
§ 25.1357 Circuit protective devices.
§ 25.1359 Electrical system fire and smoke protection.
§ 25.1431 Electronic equipment.

3. RELATED READING MATERIAL.

a. Advisory Circulars.

(1) Advisory Circular 25.1309-1, System Design Analysis.

(2) Advisory Circular 43.13-1A, Acceptable Methods, Techniques and Practices, Aircraft Inspection and Repairs.

(3) Advisory Circular 43.13-2A, Acceptable Methods, Techniques and Practices, Aircraft Alterations.

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b. Industry Documents.

(1) Radio Technical Commission for Aeronautics (RTCA) document DO-160B, Environmental Conditions and Test Procedures for Airborne Equipment. This document can be obtained from the RTCA, One McPherson Square, Suite 500, 1425 K Street Northwest, Washington, D.C. 20005.

(2) Underwriter's Laboratories Inc., document UL 1418, Implosion Protected Cathode Ray Tubes for Television Type Appliances. This document can be obtained from the Underwriter's Laboratories Inc., Publications Stock, 333 Pfingsten Road, Northbrook, IL 60062.

c. Government Documents. Code of Federal Regulations, Title 21, Chapter 1, Subchapter J, Part 1020, Section 1020.10 and Part 1030, Section 1030.10. This document can be obtained from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

4. BACKGROUND. Video projection systems, cathode ray tube (CRT) entertainment systems, telephones, stereo systems, galleys, aerial cameras, logo lights, and games are examples of miscellaneous, nonrequired electrical equipment under the related sections of the FAR. Systems or equipment which provide flight information to the flightcrew are not covered by this AC. Appendix I provides more detailed galley certification procedures which are considered necessary due to the heavy electrical loads and higher temperatures that may result from galley installations. This AC provides guidelines in the crashworthiness and structural areas sufficient to substantiate the installation of the components themselves; however, it does not address concerns such as the approval of hydraulic/plumbing systems, fire containment and stowage capacities which may be applicable to the units as a whole. It may be necessary to perform an inflight functional check to determine that the installation and operation of the miscellaneous, nonrequired electrical equipment does not affect the operation of other existing airplane equipment.

5. ACCEPTABLE MEANS OF COMPLIANCE. In the case of an airplane alteration limited to the installation of miscellaneous, nonrequired electrical equipment, an acceptable means of compliance with the applicable airworthiness regulations is as follows:

a. The installation must be able to withstand the flight, ground, and emergency landing conditions of the applicable regulations without failures. This may be demonstrated by tests or analyses.

b. The following flammability requirements should be met for materials used in nonelectrical components, or materials external to a metal enclosure (which will contain a fire) used for electrical components:

(1) The pertinent airworthiness requirements that were in effect for an airplane at the time the application for the type certificate was filed, or

(2) The requirements of § 25.853, Amendment 25-32, effective May 1, 1972, or the same requirements under special conditions for the B-747, DC-10, and L-1011 airplanes.

NOTE: Later requirements may be applied at the applicant's option.

c. For all the flammability tests, there must be an FAA-approved test plan,conformity of test specimens by an FAA or FAA-designee inspector, and witnessing of the test by an FAA or FAA-designee witness. An FAA or FAA-designee inspector must verify that the article or product being tested conforms to approved data or processes or material specifications.

d. Wire added to the airplane must have self-extinguishing insulation equal to or better than that originally approved under the airplane type certificate, unless it is inside an enclosure which is sufficiently airtight that internal combustion cannot be sustained.

e. Electrical equipment and wiring installations must meet the applicable requirements listed in paragraph 2 of this AC. An adequate electrical load analysis should be performed for the electrical equipment, taking into account load shedding, if provided. Except where obviously impractical for such items as TV receivers, cassette players, etc., components should be housed in metal enclosures which either will contain an internal fire, or are sufficiently airtight that internal combustion cannot be sustained. Equipment safety grounds should be separate from electrical circuit grounds. Circuit protective devices should be provided such that a fault in the nonrequired system does not cause a failure of a required system.

f. Electromagnetic Interference (EMI) tests, if required, must have been performed on the subject equipment in accordance with RTCA DO-160B, Environmental Conditions and Test Procedures for Airborne Equipment, dated July 1984, or equivalent requirements approved by the FAA. Tests performed in accordance with RTCA DO-160B, paragraph 21.0, are Conducted Radio Frequency (RF) Interference and Radiated RF Interference tests, both are done to the category "Z" level, unless it can be shown that the equipment location can justify a lower level. In addition, the evaluation should include a cockpit EMI survey with the subject equipment in operation, as in paragraph 5(m)(4) of this AC.

g. Wires and wire bundles should be identified in accordance with AC 43.13-1A, Acceptable Methods, Techniques and Practices, Aircraft Inspection and Repairs, or ATA-100 code.

h. Equipment incorporating CRT's should meet minimum X-ray radiation requirements of the U.S. Department of Health and Human Services, Food and Drug Administration and Bureau of Radiological Health document HEW Publication (FDA) 79-8035 (see Code of Federal Regulations Title 21, Chapter 1, Subchapter J, Part 1020, Section 1020.10), or later approved Health, Education, and Welfare (HEW) publications or FAA-approved equivalent requirements. Commercially purchased units should have a label attached that certifies compliance with the requirements above. Installations that have been modified by removing shielding material from or around the CRT should be retested to the above requirements.

i. Because of the possibility of airplane decompression, a means must be provided for either the automatic removal of power from all components containing CRT's or the installation of a barometric switch for each component using a CRT, unless the high voltage circuits and components have been shown to be free of arcing under appropriate environmental tests specified in RTCA DO-160B dated July 1984, or equivalent tests receiving prior approval by the FAA.

j. Impact and implosion protection for CRT's should be verified in accordance with Underwriter's Laboratories document UL 1418 dated May 5, 1976 (formerly 492.8), paragraphs 13.2 and 14.5, or later Underwriter's Laboratories' revisions or FAA-approved equivalent requirements. Underwriter's Laboratories' labels that certify compliance with the above are attached to most U.S. and foreign manufactured CRT based appliances.

k. Microwave ovens should meet the minimum radiation requirements of the U.S. Department of Health and Human Services, Food and Drug Administration and Bureau of Radiological Health Document HEW Publication (FDA) 80-8035 (see Code of Federal Regulations Title 21, Chapter 1, Subchapter J, Part 1030, Section 1030.10), or later approved Health, Education and Welfare (HEW) publications or FAA-approved equivalent requirements. Commercially purchased units should have a label attached that certifies compliance with the above standards. The installed microwave ovens should have the warning labels attached in such a location that compliance with the above requirements can be determined.

l. Verification by test, if required, must be accomplished in accordance with an FAA-approved test plan on the parts conformed by an FAA or FAA-designee inspector. The test must be witnessed by the FAA or FAA-designee.

m. The interference tests for installed equipment should be performed in accordance with the following:

(1) Equipment Installation. The equipment should 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.

(2) Power Input. Unless otherwise specified, tests should be conducted with the equipment powered by the airplane's electrical power generating system.

(3) Associated Equipment or Systems. Unless otherwise specified, all electrically operated equipment and systems on the airplane must be on and operating before conducting interference tests.

(4) Interference Effects. The effects on interference should be evaluated as follows:

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

(ii) 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 communications 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.

(iii) 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.

n. 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. Special attention should be given to those airplanes whose certification basis is Part 25, Amendment 25-23 or later amendments, to assure that the added systems do not affect reliability of an essential or critical system.

NOTE: Ground EMI tests 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, should also be tested with respect to their transmission frequencies and harmonics.

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APPENDIX I
GALLEY CERTIFICATION - PROCEDURES

1. ELECTRICAL LOAD ANALYSIS.

a. Determine that required electrical power is available to power galley equipment.

b. Considering the additional galley loads, the electrical power sources must be able to supply power to the essential loads after failure of:

(1) Any one engine on two-engine airplanes; and

(2) Any two engine on three-or-more-engine airplanes.

c. To comply with the applicable requirements for the essential power source, heavy galley loads must be either automatically or manually reduced under a monitoring procedure to prevent or suppress overloading.

2. WIRING INSTALLATIONS.

a. Review Circuit Analysis to determine:

(1) The wire size and circuit breaker rating is compatible with the electrical load.

(2) On 3-phase AC power systems, the load distribution is divided evenly among the phases.

(3) The electrical connections are in accordance with the manufacturer's instructions.

b. Determine that the wire used has:

(1) Self-extinguishing insulation.

(2) Insulation types, suitable for expected environmental temperature conditions.

(3) Proper identification.

c. Determine that components used have:

(1) Proper identification.

(2) Proper electrical rating for application.

(3) Proper environmental rating (heat, moisture, vibration, mechanical shock, etc.).

(4) Quality of hardware suitable for the application.

3. INSTALLATION REQUIREMENTS.

a. Wire Mechanical Protection.

(1) Ensure that wire support clamps are of the proper quantity and in the proper location.

(2) Provide grommets for wire feed-through holes (except metal parts also require support clamps).

(3) Ensure that power feeder cables comply with § 25.1359(c).

b. Protection from Fluids and Condensation.

(1) Ensure that electrical equipment and terminals are protected from lint, dripping fluids and condensation.

(2) Ensure that connectors are provided with wire drip loops to prevent fluid drainage into connector or equipment.

(3) Ensure that conduits and sleeving upper ends are sealed to prevent fluid from entering. Also insure that drain holes are provided to prevent moisture entrapment.

c. Grounding and Bonding.

(1) Ensure that safety grounding paths of metal portions of galley are direct to airframe.

(2) Ensure that electrical circuit return is electrically bonded to airplane structure separately from safety ground.

(3) Ensure that metallic water lines and faucets should be safety grounded to airplane structure.

(4) Ensure that ground studs are built-up using proper methods.

(5) Ensure that separate ground studs are used for AC and DC circuits.

d. Hazard Protection Considerations.

(1) Hot water heaters and coffee makers should have over-temperature protection and pressure safety valves with overflow provisions.

(2) Waste material storage compartments should pass the fire containment test per § 25.853(e).

(3) Storage compartments should not be subject to excessive temperatures.

(4) Lighting system ballast failures must not provide hazardous quantities of smoke. High temperature ballast failures can be prevented by internal fusible links.

(5) Nonheating surfaces shall not result in a burn on touch by personnel.

(6) Ovens must have sufficient overheat thermostat protective devices to limit exterior oven surface temperature to a safe level.

e. Electromagnetic Interference Considerations. Interference tests should include the activation of relays, rectifiers and inverters as applicable.

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