Part 37—Technical Standard Order Authorizations

Subpart A—General

§ 37.1 Applicability.

(a) This part prescribes—

(1) Requirements for the issue of Technical Standard Order Authorizations; and

(2) Technical Standard Orders (hereafter referred to in this part as "TSO's") containing minimum performance and quality control standards for specified materials, parts, or appliances (hereafter referred to in this part as "articles") used on civil aircraft.

(b) The performance standards in each TSO are those that the Administrator finds necessary to ensure that the article concerned will operate satisfactorily or will accomplish satisfactorily its intended purpose under specified conditions.

(c) An article manufactured under a TSO authorization or an FAA letter of acceptance as described in § 37.3(b), is an approved article for the purpose of meeting the regulations of this chapter that require the article to be approved.

(d) For the purposes of this part, a manufacturer is a person who controls the design and quality of an article produced under the TSO system (or to be produced, in the case of an application) including the parts thereof and any processes or services related thereto that are procured from an outside source.

§ 37.3 [TSO marking and privileges.]

(a) Except as provided in paragraph (b) of this section, no person may identify an article with a TSO marking unless he holds a TSO authorization and the article meets applicable TSO standards.

(b) The holder of an FAA letter of acceptance of a statement of conformance issued for an article before July 1, 1962, may continue to manufacture that article without obtaining a TSO authorization, but shall comply with the requirements of § § 37.7 through 37.21.

[(c) Notwithstanding paragraphs (a) and (b) of this section, after August 6, 1976, no person may identify or mark an article with any of the following TSO numbers:

[(1) TSO–C18, –C18a, –C18b, or C18c.

[(2) TSO–C24.

[(3) TSO–C33.

[(4) TSO–C61 or –C61a.]

§ 37.5 Application and issue.

(a) The manufacturer (or his authorized agent) must submit an application for a TSO authorization, together with the following documents, to the Chief, Engineering and Manufacturing Branch, Flight Standards Division, of the region in which the manufacturer is located (or, in the case of the Western Region, the Chief, Aircraft Engineering Division):

(1) A statement of conformance certifying that the applicant has met the requirements of this subpart and that the article concerned meets the applicable performance standards of Subpart B of this part.

(2) Copies of the technical data required in the applicable performance standards of subpart B of this Part, unless a lesser number of copies is authorized by Chief, Engineering and Manufacturing Branch in the region in which the manufacturer is located or in the case of the Western Region, the Chief, Aircraft Engineering Division.

(3) A description of his quality control system in the detail specified in § 21.143 of this chapter.

In complying with this paragraph, the manufacturer may refer to current quality control data filed with the FAA as a part of a previous application. When a series of minor changes in accordance with § 37.11 is anticipated, the manufacturer may set forth in his application the basic model number of the article with open brackets after it to denote

that suffix change letters will be added from time to time.

(b) After receiving the application and other documents required by paragraph (a) of this section to substantiate the manufacturer's compliance with this part and his ability to produce duplicate articles under this part, the Administrator issues a TSO authorization to the manufacturer to identify the article with the applicable TSO marking.

(c) If the application is deficient, the applicant must, when requested by the Administrator, submit any additional information necessary to show compliance with this part. If the applicant fails to submit the additional information within 30 days after the Administrator's request, his application is denied and the applicant is so notified.

(d) The Administrator issues or denies the application within 30 days after its receipt or, if additional information has been requested, within 30 days after receiving that information.

§ 37.7 General rules governing holders of TSO authorizations.

Each manufacturer of an article for which a TSO authorization has been issued under this part must—

(a) Manufacture the article in accordance with Subpart A of this part and the applicable requirements of Subpart B of this part;

(b) Conduct all required tests and inspections, and establish and maintain a quality control system adequate to ensure that the article meets the requirements of paragraph (a) of this section and is in condition for safe operation;

(c) Prepare and maintain, for each model of each article for which a TSO authorization has been issued, a current file of complete technical data and records in accordance with § 37.13; and

(d) Permanently and legibly mark each article to which this section applies with the following information:

(1) The name and address of the manufacturer.

(2) The name, type, or model designation of the article.

(3) The nominal weight of the article, which must be within ±0.2 pounds of the actual weight or ±3% of the actual weight, whichever is greater, except that the difference between the weight marked on the article and the actual weight of the article may not exceed ±10 pounds.

(4) The serial number or the date of manufacture of the article, or both.

(5) The applicable TSO number.

§ 37.9 Approval for deviation.

(a) Each manufacturer who requests approval to deviate from any performance standard of Subpart B of this part must show that the standards from which a deviation is requested are compensated for by factors or design features providing an equivalent level of safety.

(b) The request for approval to deviate, together with all pertinent data, must be submitted to the Chief, Engineering and Manufacturing Branch, Flight Standards Division, of the region in which the manufacturer is located (or, in the case of the Western Region, the Chief, Aircraft Engineering Division).

§ 37.11 Design changes.

(a) *Minor changes by the manufacturer holding the authorization.* The manufacturer of an article under an authorization issued under this part may make minor design changes (any change other than a major change) without further approval by the Administrator. In this case, the changed article keeps the original model number and the manufacturer shall forward to the appropriate Chief, Engineering and Manufacturing Branch (in the case of the Western Region, the Chief, Aircraft Engineering Division), any revised data that is necessary for compliance with § 37.5(a).

(b) *Major changes by manufacturer holding the authorization.* Any design change by the manufacturer that is extensive enough to require a substantially complete investigation to determine compliance with Subpart B of this part is a major change. Before making such a change, the manufacturer must assign a new type or model designation to the article and apply for an authorization under § 37.5.

(c) *Changes by person other than manufacturer.* No design change by any person (other than the manfacturer who submitted

the statement of conformance for the article) is eligible for approval under this part, unless the person seeking the approval is a manufacturer and applies under § 37.5(a). Persons other than a manufacturer may obtain approval for design changes under Part 43 or under the applicable airworthiness regulations.

§ 37.13 Recordkeeping requirements.

(a) *Keeping of records.* Each manufacturer holding a TSO authorization under this Part shall, for each article manufactured under that authorization, keep the following records at his factory:

(1) A complete and current technical data file for each type or model article, including design drawings and specifications.

(2) Complete and current inspection records showing that all inspections and tests required to assure compliance with this Part have been properly done and documented.

(b) *Retention of records.* The manufacturer shall retain the records described in paragraph (a)(1) of this section until he no longer manufactures the article concerned under this Part. At that time, he shall send copies of these records to the Administrator. The manufacturer shall retain the records described in paragraph (a)(2) of this section for a period of at least two years.

§ 37.15 FAA inspection.

Upon the request of the Administrator, each manufacturer of an article under a TSO authorization shall allow the Administrator to inspect—

(a) Any article manufactured under that authorization;

(b) The manufacturer's quality control inspections and tests;

(c) The manufacturing facilities; and

(d) The technical data files on that article.

§ 37.17 Reporting of failures, malfunctions, and defects.

(a) After January 3, 1971, except as provided in paragraph (d) of this section, each manufacturer holding a TSO authorization under this Part, shall report any failure, malfunction, or defect in any article manufactured by it that it determines has resulted in any of the occurrences listed in paragraph (c) of this section.

(b) After January 3, 1971, each manufacturer holding a TSO authorization under this Part shall report any defect in any article manufactured by it that has left its quality control system and that it determines could result in any of the occurrences listed in paragraph (c) of this section.

(c) The following occurrences must be reported as provided in paragraphs (a) and (b) of this section:

(1) Fires caused by a system or equipment failure, malfunction, or defect.

(2) An engine exhaust system failure, malfunction, or defect which causes damage to the engine, adjacent aircraft structure, equipment, or components.

(3) The accumulation or circulation of toxic or noxious gases in the crew compartment or passenger cabin.

(4) A malfunction, failure, or defect of a propeller control system.

(5) A propeller or rotorcraft hub or blade structural failure.

(6) Flammable fluid leakage where an ignition source normally exists.

(7) A brake system failure caused by structural or material failure during operation.

(8) A significant aircraft primary structural defect or failure caused by any autogenous condition (fatigue, understrength, corrosion, etc.).

(9) Any abnormal vibration or buffeting caused by a structural or system malfunction, defect or failure.

(10) An engine failure.

(11) Any structural or flight control system malfunction, defect, or failure, which causes interference with normal control of the aircraft or which derogates the flying qualities.

(12) A complete loss of more than one electrical power generating system or hy-

draulic power system during a given operation of the aircraft.

(13) A failure or malfunction of more than one attitude, airspeed, or altitude instrument during a given operation of the aircraft.

(d) The requirements of paragraph (a) of this section do not apply to—

(1) Failures, malfunctions, and defects that the holder of a TSO authorization—

(i) determines were caused by improper maintenance or improper usage;

(ii) knows were reported to the FAA by another person under the Federal Aviation Regulations; or

(iii) has already reported under the accident reporting provisions of Part 430 of the regulations of the National Transportation Safety Board.

(2) Failures, malfunctions, or defects in articles manufactured by a foreign manufacturer and exported to the United States under § 21.502 of this chapter.

(e) Each report required by this section—

(1) Shall be made to the FAA Regional Office in which the holder is located within 24 hours after the holder has determined that the failure, malfunction, or defect required to be reported has occurred, except that a report due on a Saturday or a Sunday may be delivered on the following Monday and one that is due on a holiday may be delivered on the next workday;

(2) Shall be transmitted in a manner and form acceptable to the Administrator by the most expeditious method available; and

(3) Shall include as much of the following information on the article as is available and applicable:

(i) Aircraft serial number.

(ii) Article serial number.

(iii) Article model designation.

(iv) Identification of the part, component, or system involved. The identification must include the part number.

(v) Nature of the failure, malfunction, or defect.

(f) Whenever the investigation of an accident or service difficulty report shows that an article manufactured under a TSO authorization is unsafe because of a manufacturing or design defect, the manufacturer shall, upon the request of the Administrator, report to the Administrator the results of his investigation and any action, taken or proposed by the manufacturer to correct that defect. If action is required to correct the defect in existing articles, the manufacturer shall submit to the Chief, Engineering and Manufacturing Branch (in the case of the Western Region, the Chief, Aircraft Engineering Division), FAA Regional Office in the region in which he is located, the data necessary for the issue of an appropriate airworthiness directive.

§ 37.19 Noncompliance.

The Administrator may, upon notice, withdraw the TSO authorization of any manufacturer who identifies with a TSO marking an article not meeting the applicable performance standards of this Part.

§ 37.21 Transferability and duration.

An authorization issued under this Part is not transferable and is effective until surrendered, or withdrawn or otherwise terminated by the Administrator.

§ 37.23 Incorporation by reference.

In accordance with 5 U.S.C. 552(a)(1), the technical publications to which reference is made in TSOs in Subpart B, and which have been prepared by organizations other than the FAA, are incorporated and made a part of such TSOs. The incorporated technical publications are available for inspection at Federal Aviation Administration, 800 Independence Avenue, S.W., Washington, D.C. 20590. Additional availability will be indicated as appropriate in particular TSOs.

Subpart B—Technical Standard Orders

§ 37.111 Cargo and baggage compartment smoke detection instruments—TSO–C1b.

(a) *Applicability.* This technical standard order prescribes the minimum performance standards that cargo and baggage compartment

smoke detection instruments must meet in order to be identified with the applicable TSO marking. New models of equipment that are to be so identified, and that are manufactured on or after March 24, 1967, must meet the requirements of the "Federal Aviation Standard, Cargo and Baggage Compartment Smoke Detection Instruments" set forth at the end of this section.

(b) *Marking.* In addition to the markings specified in § 37.7, the equipment must be marked to indicate the following:

(1) Eligibility for installation in either piston or turbine-powered aircraft, or both.

(2) Operational ratings (electrical, vacuum, etc.).

(c) *Data requirements.* The technical data to be submitted in accordance with § 37.5(a)(2) is as follows:

(1) Seven copies of the manufacturer's operating instructions, equipment limitations, and installation procedures; and

(2) One copy of the manufacturer's test report.

(d) *Previously approved equipment.* Smoke detector models approved prior to March 24, 1967, may continue to be manufactured under the provisions of their original approval.

FEDERAL AVIATION ADMINISTRATION STANDARD

Cargo and Baggage Compartment Smoke Detection Instruments

1. Purpose.

This document provides minimum performance standards and test procedures for cargo and baggage compartment smoke detection instruments which are to be approved under this TSO.

2. Classification.

Smoke detection instruments are classified by method of detection as follows:

Type I –Measurement of carbon monoxide gas (CO detectors).

Type II –Measurement of light transmissibility in air (photoelectric devices).

Type III–Visual detection of the presence of smoke by directly viewing air samples (visual devices).

3. Minimum Performance Standards.

Except where otherwise indicated, the minimum performance standards of this section are applicable to Types I, II and III instruments. The term "instrument", wherever referred to in this TSO, does not include any lengths of tubing used to conduct air samples from sampling stations to testing stations.

3.1 *Type Characteristics.* The instruments must perform as follows:

Type I—By testing air for carbon monoxide content, the instrument must be capable of actuating an alarm (or control) circuit at all concentrations of CO that are 0.025 percent and greater by volume. At concentrations over 0.015 but less than 0.025 percent the instrument may actuate the circuit but at concentrations 0.015 percent and less, it must not actuate the circuit.

Type II—By testing air for smoke content of all colors or particle sizes, the instrument must be capable of actuating an alarm (or control) circuit to indicate the presence of smoke particles at all concentrations at which the light transmission percentage is 60 percent or less. At light transmission percentages over 60 but less than 96, the instrument may actuate the circuit but at percentages 96 and over, it must not actuate the circuit. Light transmission percentage is defined as the light falling on a photoelectric cell through a one-foot distance occupied by smoke particles in air, expressed as a percentage of the light transmitted through one foot of clear air.

Type III—By testing air for the presence of smoke of all colors or particle sizes, the instrument must provide a visual display to indicate clearly all smoke concentrations in which the light transmission percentage is 60 percent or less. The instrument may, but is not required to, indicate smoke concentrations for which the light transmission percentage is over 60. Light transmission percentage is as defined for Type II instruments.

3.2 *Materials.* Smoke detection instruments must be constructed of materials of a quality that experience or tests or both have demonstrated to be suitable and dependable for use in aircraft application.

3.3 *False Alarm Signals.* Type I and Type II instruments conforming to the requirements of this standard must not actuate the alarm (or control) circuit as a result of dust and haze normally present in the cargo compartment, nor of the dust that normally accumulates within the instrument. The design must be such that the instrument will not produce a false alarm (or control) signal as a result of abnormal attitudes, ambient light conditions, variations in voltage between 0 and 125 percent of the rated value, nor of accelerations encountered during takeoff, flight, and landing.

3.4 *Functional Test Provisions.* Type I and Type II instrument design must incorporate a means for testing the functioning of the system in flight.

3.5 *Response Time.* Type I and Type II instruments must be designed to actuate an alarm (or control) circuit, and Type III instruments to show visually the presence of smoke, within a maximum time period of 30 seconds after an air sample, ap-

plicable to the type of instrument, is introduced into the instrument. Air samples used to demonstrate compliance with this paragraph must contain the concentrations of carbon monoxide or possess the light transmission characteristics, as applicable, specified in paragraph 3.1.

3.6 *Air Sampling Cycle.* An instrument designed to sample the air from more than one sampling station on a cycling basis must cycle at a rate sufficient to sample all stations within a total time of one minute. When an alarm signal is given, the signal must indicate the location in which the smoke or gas is being detected and must continue to do so until the condition is eliminated. The instrument must begin cycling in a normal manner within 30 seconds after the alarm signal is cleared.

3.7 *Environmental Ranges.* The design of any instrument conforming to this standard must ensure that it is capable of functioning without being adversely affected following prolonged exposure to the ranges of environmental conditions as stated under section 4.

3.8 *Power Variation.* Each instrument type must be designed to ensure proper functioning with the following variations of power parameters (where applicable) from rated values: d.c. voltage, ±15 percent; a.c. voltage, ±10 percent; frequency ±5 percent.

3.9 *Explosion Protection.* Where the instrument is intended to be installed in areas of the airplane where flammable fluids or vapors might be liberated by leakage or failure in fluid systems, design precautions must be made to safeguard against the ignition of such fluids or vapors due to operation of the instrument.

3.10 *Humidity.* Each instrument type must be designed to function properly and not be adversely affected following exposure to any relative humidity in the range from 0 to 95 percent at a temperature of approximately 70 degrees Centigrade.

3.11 *Hazards Due to Malfunction or Failure.* Each instrument type must be designed to safeguard against hazards to the aircraft in the event of malfunction or failure. The maximum operating temperature of any instrument-component surface that comes in contact with air samples must not exceed 200° C.

4. Environmental Conditions.

4.1 *Temperature.* Each instrument type must be designed to function properly over the range of ambient temperatures shown in Column A below and not be adversely affected by exposure to the range of temperature shown in Column B below:

Instrument Location	A	B
Heated Areas (temperature controlled)	−30° to 50°C.	−65° to 70°C.
Unheated Areas (temperature uncontrolled)	−55° to 70°C.	−65° to 70°C.

4.2 *Altitude.* Each instrument type must be designed to function properly from sea level up to the altitudes listed below. The instrument must not be adversely affected when subjected to an ambient pressure of 50 inches of mercury absolute.

Instrument Location	Altitude (Feet)
Pressurized Areas	15,000
Nonpressurized Areas	45,000

4.3 *Vibration.* Each instrument type must be designed to function properly and not be adversely affected when subjected to vibrations of the following characteristics:

	Frequency Cycles per second	*Max. Double Amplitude In Inches*	*Maximum Acceleration*
Piston Engine Powered			
Wings or Empennage	5–500	0.036	10g
Fuselage	5–500	0.036	5g
Panel or Rack (Vibration Isolated)	5–50	0.020	1.5g
Turbine Engine Powered			
Fuselage			
Forward of Spar Area	5–500	0.036	2g
Center of Spar Area	5–1000	0.036	4g
Aft of Spar Area	5–500	0.036	7g
	500–1000	-----	5g
Vibration Isolated Rack	5–1000	0.030	1g
Instrument Panel	5–30	0.020	--
	30–1000	-----	0.25g

5. Qualification Tests.

As evidence of compliance with this standard, the applicant must perform evaluation tests on prototype instruments to demonstrate proper design, reliability in performance of its intended functions, and conformity with the performance standards of section 3. Tests and test procedures employed for this purpose must reasonably demonstrate the absence of any adverse effect on the instrument's performance due to the following factors: power variations, pressure and altitude changes, humidity changes, high and low temperature conditions, airplane vibrations and prolonged operational usage.

6. Individual Performance.

Each instrument manufactured in accordance with this standard must be capable of meeting all the performance standards under section 3. Each in-

strument must be tested so that when an air sample applicable to the type of instrument per section 3.1 is introduced into the instrument under standard atmospheric conditions, the alarm (or control) circuit is actuated (for Type I and II instruments), or the visual display occurs (for Type III instruments), in 30 seconds or less.

§ 37.112 Airspeed indicator (pitot static)—TSO–C2b.

(a) *Applicability*—(1) *Minimum performance standards.* Minimum performance standards are hereby established for airspeed indicators which specifically are required to be approved for use in the civil aircraft of the United States. New models of airspeed indicators (pitot static) manufactured for installation on civil aircraft on or after November 1, 1957, shall meet the standards set forth in SAE Aeronautical Standard AS–391B, "Airspeed Indicator (Pitot Static)," dated December 15, 1954.* Airspeed indicators (pitot static) approved by the Civil Aeronautics Administration prior to November 1, 1957, may continue to be manufactured under the provisions of their original approval.

(b) *Marking.* In lieu of the marking requirement of § 37.7(c) the range shall be shown.

(c) *Data requirements.* With the statement of conformance, one copy of manufacturer's operating instructions, schematic diagrams, and installation procedures shall be furnished the Chief, Engineering and Manufacturing Branch, Flight Standards Division, Federal Aviation Administration, in the region in which the manufacturer is located.

§ 37.113 Turn-and-slip indicator—TSO–C3b.

(a) *Applicability.* This TSO prescribes the minimum performance standards that instruments measuring rate-of-turn and slip (formerly turn-and-bank indicators) must meet in order to be identified with the applicable TSO marking. New models of equipment that are to be so identified and that are manufactured on or after the effective date of this section, must meet the minimum performance standards set forth at the end of this section.

* Copies may be obtained from the Society of Automotive Engineers.

(b) *Marking.* In addition to the markings required by § 37.7, the equipment must also be marked with the instrument's operational power rating (electrical voltage and frequency, air pressure).

(c) *Data requirements.* In accordance with § 37.5, the manufacturer must furnish the Chief, Engineering and Manufacturing Branch, Flight Standards Division, Federal Aviation Administration, in the region in which the manufacturer is located the following technical data:

(1) Seven copies of the manufacturer's operating instructions, equipment limitations, installation procedures (including applicable instrument mounting angle restrictions).

(2) Information regarding specialized procedures employed in the calibration of the instrument, such as the instrument slip angle.

(3) One copy of the manufacturer's test report.

(d) *Previously approved equipment.* Turn-and-slip indicators (formerly identified as turn-and-bank indicators), approved prior to the effective date of this section may continue to be manufactured under the provisions of the original approval.

FEDERAL AVIATION ADMINISTRATION STANDARD

Turn-and-Slip Indicator

1. Purpose.

This document provides minimum performance standards and test procedures for turn-and-slip indicators which are to be approved under this TSO.

2. Scope.

This standard covers instruments incorporating or utilizing components that can sense aircraft angular motions and lateral accelerations to indicate aircraft flight path information in regard to rate-of-turn and slip motions. It provides for three basic types of turn-and-slip indicators as follows:

Type I—Driven by air pressure;

Type II—Driven electrically by Direct Current; and

Type III—Driven electrically by Alternating Current.

3. Performance Requirements.

3.1 *General.*

(a) *Materials.* Materials must be of a quality demonstrated to be suitable and dependable for use in aircraft instruments.

(b) *Environmental conditions.* The instrument must be capable of performing its intended function and not be adversely affected during or following prolonged exposure to the environmental conditions

as stated under § 4. Where optional environmental conditions are set forth in § 4, the condition selected must be declared as an equipment limitation.

3.2 *Detail Requirements.*

(a) *Indicating means.* Rate-of-turn may be indicated by means of a pointer, deflecting in the direction of turn, or by any other means conforming to the standards of this TSO. Slip may be indicated by means of a ball, free to move in a curved transparent tube, or any other means conforming to the standards of this TSO.

(b) *Power variation.* The instrument must provide reasonably reliable and useful indications of aircraft turning and slip motions when operating under rated power conditions with variations of—

(1) Plus or minus 30 percent of rated differential air pressure;

(2) Plus or minus 15 percent of rated DC voltage; or

(3) Plus or minus 10 percent of rated AC voltage and ±5 percent of rated frequency.

(c) *Power malfunction indication.* For Types II and III indicators, means must be incorporated in the instrument to indicate when the electrical power being supplied is outside the lower limit of power variations specified in paragraph (b) of this section. Power malfunction must be indicated in a positive manner.

3.3 *Design Requirements.*

(a) *Fire hazard.* The instrument must be designed to safeguard against fire hazards to the aircraft in the event of malfunction or failure. Under normal conditions, the maximum operating temperature of external surfaces of the instrument must not exceed 200° C. due to self-heating.

(b) *Magnetic effect.* The instrument must not generate an electromagnetic field which will introduce a magnetic course error corresponding to a maximum of 5 degrees deflection of a free magnet approximately 1½ inches long, in a magnetic field with a horizontal intensity of 0.18±0.01 gauss when the instrument is held in various positions on an east-west line with its nearest part 12 inches from the center of the magnet.

(c) *Visibility.* Turn-and-slip indications must be visible from any point within the frustum of a cone, the side of which makes an angle of at least 30 degrees with the perpendicular to the dial and the small diameter of which is the aperture of the instrument case. The distance between the dial and the cover glass must be a practical minimum. At the extreme positions of the slip indicator, at least ½ of the indicator must be visible from a point 12 inches directly in front of the zero position.

(d) *Slip indicator characteristics.* The slip indicator must operate freely when the instrument is rotated about its longitudinal axis with the dial vertical. The range of slip angle indications must be at least 8 degrees either side of vertical. With the instrument in its normal position for mounting, the position of the indicator must be zero±1/32 inch.

(1) *Damping.* While operating at room temperature, the time for the slip indicator to move from the zero position of the slip indication to the rest position must not be less than 0.2 seconds following a sudden rotation of the instrument from a position of 12 degrees bank through the vertical to 12 degrees opposite bank. With the temperature of the instrument stabilized at −30° C. this time must not exceed 4 seconds.

(2) *Slip indicator filling.* Instruments using a liquid as a damping medium for the slip indicator must be so designed and filled that no part of an air bubble will be visible from a point 12 inches directly in front of the instrument when the instrument is rotated to an angle of roll of 45°.

(e) *Turn indicator characteristics.*

(1) *Sensitivity.*

(i) When the instrument is operating at room temperature under rated power and subjected to the turning rates specified in Column A, the turn indicator deflection, in inches, must be within the limits of either Column B or C. The indicator movement must be smooth.

Column A	Column B	Column C
Rate of turn (degrees per minute)	Deflection of indicator (inches)	
0	0±0.015	0±0.015
36	1/32±1/64	1/16±1/64
90	5/64±1/32	5/32±1/32
180	5/32±1/32	5/16±1/16
360	5/16±1/16	9/16±1/8

NOTE.—Column B values pertain to instruments set to indicate a standard rate of turn (180° per minute) with one indicator unit deflection. Column C provides double this displacement for instruments providing increased sensitivity.

(ii) For instruments possessing display features such that the dimensional characteristics prescribed by Columns B and C of subparagraph (i) do not apply, the applicant may demonstrate that the instrument can reliably indicate the prescribed rates of turn (Column A) with clarity and accuracy equivalent to that specified in Column B or C.

(2) *Damping.* The time for the turn indicator or index to return to the zero mark without crossing the zero mark must be at least 2, but not more than 4 seconds, when the instrument is—

(i) Suddenly stopped after being rotated about its vertical axis at a rate that causes full-scale pointer or index deflection; and

(ii) Operated at room temperature under rated power in a normal attitude position.

(3) *Turn indicator starting.* When started by the application of the instrument's rated power, rated performance must be reached in 3 minutes or less. When started under reduced power—

(i) For Type I indicators, the gyro must start to rotate and continue to run on a pressure differential not to exceed 50 percent of rated value. After no more than 5 minutes operation at this reduced power, the instrument must be able to provide an adequate indication of aircraft turning motions.

(ii) For Types II and III indicators, the gyro must start to rotate and continue to run on an applied power not to exceed 80 percent of the rated voltage and at rated frequency. After no more than 5 minutes' operation at this reduced power, the instrument must be able to provide an adequate indication of aircraft turning motions.

NOTE.—When the instrument is operated under the reduced power conditions of § 3.3(e)(3), the sensitivity and damping requirements of § 3.3(e) (1) and (2) do not apply.

4. Environmental Conditions.

The following ranges of environmental conditions are appropriate:

(a) *Temperature.* The instrument must provide reasonably reliable and useful indications of aircraft turn-and-slip motions over the range of ambient temperature of −30° C. to 50° C. and must not be adversely affected by exposure to temperatures of −65° C. to 70° C.

(b) *Altitude.* The instrument must provide reasonably reliable and useful indications of aircraft turn-and-slip motions from −1,000 feet standard altitude up to the maximum declared operating altitude. It must not be adversely affected following exposure to extremes in ambient pressure of 50 and 3 inches of mercury absolute.

(c) *Vibration.* The instrument must provide reasonably reliable and useful indications of aircraft turn-and-slip motions and must not be adversely affected when subjected to vibrations as follows:

Instrument panel mounted (vibration isolated)	Frequency cycles per second	Maximum double amplitude (inches)	Maximum acceleration
Reciprocating engine-powered aircraft.	5-50	0.020	1.5g
Turbine engine-powered aircraft.	5-55	0.020	
	55-1,000		0.25g

(d) *Humidity.* The instrument must provide reasonably reliable and useful indications of aircraft turn-and-slip motions and must not be adversely affected following exposure to any relative humidity in the range of 0 to 95 percent at a temperature of approximately 70° C.

5. Compliance Testing.

As evidence of compliance with this standard, the manufacturer must perform evaluation tests on prototype instruments to demonstrate proper design, reliability in performance of its intended functions, and conformity with all of the performance standards of section 3. Tests must be performed to demonstrate compliance with the environmental conditions specified in § 4.

6. Individual Performance Tests.

The manufacturer must conduct tests or checks of each instrument as may be necessary to assure that it will function properly and will individually meet the minimum performance requirements of section 3.3(c), 3.3(d) and 3.3(e) (1) and (2) of this TSO.

§ 37.114 Bank and pitch instruments (indicating gyro-stabilized type) (gyroscopic horizon, attitude gyro)—TSO-C4c.

(a) *Applicability*—(1) *Minimum performance standards.* Minimum performance standards are hereby established for bank and pitch instruments (indicating gyro-stabilized type) (gyroscopic horizon, attitude gyro) which specifically are required to be approved for use on civil aircraft of the United States. New models of bank and pitch instruments (indicating gyro-stabilized type) (gyroscopic horizon, attitude gyro) manufactured for installation on civil aircraft on or after April 1, 1959, shall meet the standards set forth in SAE Aeronautical Standard AS-396B, "Bank and Pitch Instruments (Indicating Stabilized Type) (Gyroscopic Horizon, Attitude Gyro)," dated July 15, 1958* with the exceptions listed in subparagraph (2) of this paragraph. Bank and pitch instruments (indicating gyro-stabilized type) (gyroscopic horizon, attitude gyro) approved prior to April 1, 1959, may continue to be manufactured under the provisions of their original approval.

(2) *Exceptions.* (i) Conformance with the following sections is not required: 3.1; 3.1.1; 3.1.2; 3.2; 4.3.5.

(ii) Substitute the following for section 7: "Performance tests: The following tests, in addition to any others deemed necessary by the manufacturer, shall be the basis for determining compliance with the performance requirements of this standard."

* Copies may be obtained from the Society of Automotive Engineers, Inc.

(b) *Marking.* In lieu of the weight specified in paragraph (c) of § 37.7, the rating if applicable, i.e., electrical, vacuum, etc., shall be shown.

(c) *Data requirements.* With the statement of conformance, one copy each of the manufacturer's operating instructions, schematic diagrams, and installation procedures shall be furnished the Chief, Engineering and Manufacturing Branch, Flight Standards Division, Federal Aviation Administration, in the region in which the manufacturer is located.

§ 37.115 Direction instrument, nonmagnetic, gyro-stabilized type (directional gyro)—TSO-C5c.

(a) *Applicability*—(1) *Minimum performance standards.* Minimum performance standards are hereby established for direction instruments, non-magnetic, gyro-stabilized type (directional gyro) which specifically are required to be approved for use on civil aircraft of the United States. New models of direction instruments, non-magnetic, gyro-stabilized type (directional gyro) manufactured for installation on civil aircraft on or after April 1, 1959, shall meet the standards set forth in SAE Aeronautical Standard AS-397A, "Direction Instrument, Non-Magnetic, Stabilized Type (Directional Gyro)," dated July 15, 1958,* with the exceptions listed in subparagraph (2) of this paragraph. Direction instruments, non-magnetic gyro-stabilized type (directional gyro) approved prior to April 1, 1959, may continue to be manufactured under the provisions of their original approval.

(2) *Exceptions.* (i) Conformance with the following sections is not required: 3:1; 3.1.1; 3.1.2; 3.2; 4.3.3.

(ii) Substitute the following for section 7.: "Performance tests: The following tests, in addition to any others deemed necessary by the manufacturer, shall be the basis for determining compliance with the performance requirements of this standard."

(b) *Marking.* In lieu of the weight specified in paragraph (c) of § 37.7, the following shall be shown:

(1) Instrument type (I or II).

(2) Rating if applicable, i.e., electrical, vacuum, etc.

(c) *Data requirements.* With the statement of conformance, one copy each of the manufacturer's operating instructions, schematic diagrams and installation procedures shall be furnished the Chief, Engineering and Manufacturing Branch, Flight Standards Division, Federal Aviation Administration, in the region in which the manufacturer is located.

§ 37.116 Direction instrument, magnetic (gyro-stabilized type)—TSO-C6c.

(a) *Applicability*—(1) *Minimum performance standards.* Minimum performance standards are hereby established for direction instruments, magnetic (gyro-stabilized type) which specifically are required to be approved for use on civil aircraft of the United States. New models of direction instruments, magnetic (gyro-stabilized type) manufactured for installation on civil aircraft on or after April 1, 1959, shall meet the standards set forth in SAE Aeronautical Standard AS-399A, "Direction Instrument, Magnetic (Stabilized Type)," dated July 15, 1958,* with the exceptions listed in subparagraph (2) of this paragraph. Direction instruments, magnetic (gyro-stabilized type) approved prior to April 1, 1959, may continue to be manufactured under the provisions of their original approval.

(2) *Exceptions.* (i) Conformance with the following sections is not required: 3.1; 3.1.1; 3.1.2; 3.2; 4.3.3.

(ii) Substitute the following for section 7.: "Performance tests: The following tests in addition to any others deemed necessary by the manufacturer, shall be the basis for determining compliance with the performance requirements of this standard."

(b) *Marking.* In lieu of the weight specified in paragraph (c) of § 37.7, the rating if applicable, i.e., electrical, vacuum, etc., shall be shown.

(c) *Data requirements.* With the statement of conformance, one copy each of the manufacturer's operating instructions, schematic diagrams, and installation procedures shall be furnished the Chief, Engineering and Manu-

* Copies may be obtained from the Society of Automotive Engineers, Inc.

facturing Branch, Flight Standards Division, Federal Aviation Administration, in the region in which the manufacturer is located.

§ 37.117 Direction instrument, magnetic, non-stabilized type (magnetic compass)—TSO-C7c.

(a) *Applicability*—(1) *Minimum performance standards.* Minimum performance standards are hereby established for direction instruments, magnetic, non-stabilized type (magnetic compass) which specifically are required to be approved for use on civil aircraft of the United States. New models of direction instruments, magnetic, non-stabilized type (magnetic compass) manufactured for installation on civil aircraft on or after April 1, 1959, shall meet the standards set forth in SAE Aeronautical Standard AS-398A, "Direction Instrument, Magnetic, Non-Stabilized Type (Magnetic Compass)," dated July 15, 1958,* with the exceptions listed in subparagraph (2) of this paragraph. Direction instruments, magnetic, non-stabilized type (magnetic compass) approved prior to April 1, 1959, may continue to be manufactured under the provisions of their original approval.

(2) *Exceptions.* (i) Conformance with the following sections is not required: 3.1; 3.1.1; 3.1.2; 3.2; 4.3.3.

(ii) Substitute the following for section 7.: "Performance tests: The following tests in addition to any others deemed necessary by the manufacturer, shall be the basis for determining compliance with the performance requirements of this standard."

(b) *Marking.* In lieu of the weight specified in paragraph (c) of § 37.7, the following shall be shown:

(1) Instrument type (I or II).

(2) Rating if applicable, i.e., electrical, vacuum, etc.

(c) *Data requirements.* With the statement of conformance, one copy each of the manufacturer's operating instructions, schematic diagrams, and installation procedures shall be furnished the Chief, Engineering and Manufacturing Branch, Flight Standards Division, Federal Aviation Administration, in the region in which the manufacturer is located.

§ 37.118 Rate of climb indicator, pressure actuated (vertical speed indicator)—TSO-C8b.

(a) *Applicability*—(1) *Minimum performance standards.* Minimum performance standards are hereby established for rate of climb indicators, pressure actuated (vertical speed indicator) which specifically are required to be approved for use on civil aircraft of the United States. New models of rate of climb indicators, pressure actuated (vertical speed indicator) manufactured for installation on civil aircraft on or after April 1, 1959, shall meet the standards set forth in SAE Aeronautical Standard AS-394A, "Rate of Climb Indicator, Pressure Actuated (Vertical Speed Indicator)," dated July 15, 1958,* with the exceptions listed in subparagraph (2) of this paragraph. Rate of climb indicators, pressure actuated (vertical speed indicator) approved prior to April 1, 1959, may continue to be manufactured under the provisions of their original approval.

(2) *Exceptions.* (i) Conformance with the following sections is not required: 3.1; 3.1.1; 3.1.2; 3.2; 4.2.1.

(ii) Substitute the following for section 7.: "Performance tests: The following tests in addition to any others deemed necessary by the manufacturer, shall be the basis for determining compliance with the performance requirements of this standard."

(b) *Marking.* In lieu of the weight specified in paragraph (c) of § 37.7, the following shall be shown:

(1) Instrument type (I, II, III or IV).

(2) Range (feet per minute climb and descent).

(c) *Data requirements.* With the statement of conformance, one copy each of the manufacturer's operating instructions, schematic diagrams, and installation procedures shall be furnished the Chief, Engineering and Manufacturing Branch, Flight Standards Division, Federal Aviation Administration, in the region in which the manufacturer is located.

§ 37.119 Automatic pilots—TSO-C9c.

(a) *Applicability*—(1) *Minimum performance standards.* Minimum performance standards are hereby established for automatic

pilots to maintain flight and/or to provide maneuvering about the three axes through servo control which specifically are required to be approved for use in civil aircraft of the United States. New models of autopilots manufactured for such use on or after September 15, 1960, shall meet the standards set forth in SAE Aeronautical Standard AS-402A, "Automatic Pilots," dated February 1, 1959,* with the exceptions listed in subparagraph (2) of this paragraph and the additions listed in subparagraph (3) of this paragraph. Automatic pilots approved prior to September 15, 1960, may continue to be manufactured under the provisions of their original approval.

(2) *Exceptions.* (i) Conformance with the following sections is not required: 3.1, 3.1.1, 3.1.2, 3.2.

(ii) Substitute the following for section 7.: "Performance tests: The following tests, in addition to any others deemed necessary by the manufacturer, shall be the basis for determining compliance with the performance requirements of this standard."

(3) *Additions.* In addition to the means of indication specified in section 4.3 of AS-402A, the following shall be included:

(i) *Power malfunction indication.* Means shall be provided to indicate readily to the pilot in a positive manner when each phase of the primary power (voltage and/or current) to the automatic pilot is not adequate for safe operation.

(ii) *Airborne navigation reference indication.* A visual means shall be provided to indicate readily to the pilot in a positive manner when the automatic pilot is not engaged to the airborne navigation reference.

(b) *Marking.* In addition to the markings required in § 37.7, range and/or rating if definable shall be shown on each component of the system.

(c) *Data requirements.* With the statement of conformance, one copy each of the following shall be furnished to the Chief, Engineering and Manufacturing Branch, Flight Standards Division, Federal Aviation Administration in the region in which the manufacturer is located:

(1) Manufacturer's operating instructions

(2) Manufacturer's typical installation instructions

(3) Exploded views for each major component of the system

(4) Schematic diagrams for each major component and the system

(5) The manufacturer's compliance test report.

* Copies may be obtained from the Society of Automotive Engineers, Inc.

§ 37.120 Aircraft altimeter, pressure actuated, sensitive type—TSO-C10b.

(a) *Applicability*—(1) *Minimum performance standards.* Minimum performance standards are hereby established for aircraft altimeters which specifically are required to be approved for use on civil aircraft of the United States. New models of altimeters manufactured for such use on or after September 1, 1959, shall meet the standards set forth in SAE Aeronautical Standard AS-392C,* "Altimeter, Pressure Actuated Sensitive Type," revision date February 1, 1959,** with the exceptions listed in subparagraph (2) of this paragraph. Altimeters approved under prior issuances of this section may continue to be manufactured under the earlier provisions.

(2) *Exceptions.* (i) The following specifically numbered paragraphs in AS-392C do not concern minimum performance and therefore are not essential to compliance with this section: 3.1, 3.1.1, 3.1.2, 3.2, 3.2(a) (b) (c) (d) (e) (f).

(ii) In lieu of section 7. in AS-392C, it is a requirement that the altimeters covered by this section be capable of successfully passing the tests in paragraphs 7.1 through 7.5 and an External Case Pressure Test which is as follows:

External Case Pressure Test. The static pressure source of the instrument shall be sealed when an ambient temperature of 25° C and an ambient pressure of 29.92 inches (absolute) of mercury have been achieved. The ambient pressure shall then be in-

* Copies may be obtained from the Society of Automotive Engineers, Inc.

** In addition to the performance standards herein, altimeters when installed in aircraft must meet installation requirements as well as functional and reliability flight tests of the pertinent airworthiness sections of the Federal Aviation Regulations.

creased at a rate of 20 inches of mercury in two seconds to 50 inches (absolute) of mercury and held at that pressure for three minutes. There shall be no adverse effect on the instrument or its accuracy.

(iii) The "Reference Section" under Table II of AS-392C is not applicable.

(b) *Marking.* In lieu of the weight specified in § 37.7(c) the range shall be shown.

(c) *Data requirements.* With the statement of conformance, one copy each of the following shall be furnished to the Chief, Engineering and Manufacturing Branch, Flight Standards Division, Federal Aviation Administration, in the region in which the manufacturer is located:

(1) Manufacturer's operating instructions.

(2) Complete set of instrument's drawings of major components and a test report.

(3) Installation procedures with applicable schematic drawings.

§ 37.121 Fire detectors (thermal sensing and ionization sensing types)—TSO-C11d.

(a) *Applicability*—(1) *Minimum performance standards.* Minimum performance standards are hereby established for fire detectors of the subject types which are required to be approved for use on piston and/or turbine engine-powered civil aircraft of the United States. New models of these types of fire detectors manufactured for use on civil aircraft of the United States on or after the effective date of this section, shall meet the standards specified in Federal Aviation Administration Standards "Fire Detectors (Thermal Sensing and Ionization Sensing Types)," dated August 1, 1961.* Fire detectors approved prior to the effective date of this section, may continue to be manufactured under the provisions of their original approval.

(b) *Marking.* In lieu of information required in § 37.7(c), the alarm temperature shall be shown. Compliance of the detector with the piston or turbine engine requirements, or both, shall be designated by -P, -T, or -PT, respectively, as a suffix following the TSO designation, as TSO-C11d-P.

*Copies may be obtained from the Federal Aviation Administration.

(c) *Data requirements.* (1) The manufacturer shall maintain a current file of complete design data.

(2) The manufacturer shall maintain a current file of complete data describing the inspection and test procedures applicable to his equipment. (See paragraph (d) of this section.)

(3) Six copies each, except where noted, of the following, shall be furnished with the statement of conformance certifying that the instrument conforms to this section, to the Chief, Engineering and Manufacturing Branch, Flight Standards Division, Federal Aviation Administration, in the region in which the manufacturer is located.

(i) Manufacturer's operating instructions and equipment limitations.

(ii) Installation procedures with applicable schematic drawings, wiring diagrams, and specifications. Indicate any limitations, restrictions, or other conditions pertinent to the installation. This data shall include the following:

(*a*) Starting ambient temperature used in determining the response time (see § 7.1.1);

(*b*) Maximum allowable normal ambient temperature at the point of sensor location;

(*c*) Maximum allowable rate of temperature rise at point of sensor location as a result of normal operation;

(*d*) Operating voltage;

(*e*) Mounting or support method; and

(*f*) Maximum or minimum number of units or detector length which can be used in one circuit or one fire zone without adversely affecting sensitivity or causing false indications due to temperature associated with normal operation.

(iii) One copy of the manufacturer's test report.

(d) *Quality control.* Fire detectors shall be produced under a quality control system, established by the manufacturer, which will assure that each detector is in conformity with the requirements of this section and is in a condition for safe operation. This system shall be described in the data required under paragraph (c)(2) of this section. The Administrator shall be permitted to make such

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inspections and tests at the manufacturer's facility as may be necessary to determine compliance with the requirements of this section.

§ 37.122 Life rafts (twin tube)—TSO–C12c.

(a) *Applicability*—(1) *Minimum performance standards.* Minimum performance standards are hereby established for life rafts (twin tube) which specifically are required to be approved for use on civil aircraft of the United States. New models of life rafts manufactured on or after October 15, 1959, shall meet the standards set forth in the ATA Specification No. 800, "Airline Life Rafts," dated May 1, 1958,* with the additional requirements shown in subparagraph (2) of this paragraph, and the exceptions listed in subparagraph (3) of this paragraph. Life raft models approved prior to the effective date of this section may continue to be used under the provisions of their original approval until they are no longer seaworthy.

(2) *Additional requirements.* The degree of inflation shall be such that the raft will be "rounded-out" (i.e., attain its design shape and approximate dimensions) to be able to receive the first occupant within one minute after the start of inflation. Thereafter, inflation during boarding by the remainder of occupants shall be sufficient to ensure a serviceable and rigid raft.

(3) *Exceptions.* For the purpose of this section conformance is not required with the provision of section 4.2.8 of ATA Specification No. 800 that the length of the installed gas release cables be identical and not exceed 30 inches.

(b) *Marking.* In lieu of the marking requirements specified by § 37.7, the marking instructions contained in ATA Specification No. 800 shall be acceptable and, in addition, each life raft shall be permanently marked with the Technical Standard Order designation, FAA–TSO–C12c, to identify the life raft as meeting the requirements of this section.

(c) *Data requirements.* (1) With the statement of conformance, one copy each of the manufacturer's operation and inflation instructions, schematic diagrams, and installation procedures shall be furnished the Chief, Engineering and Manufacturing Branch, Flight Standards Division, Federal Aviation Administration, in the region in which the manufacturer is located.

(2) The raft manufacturer must also provide the purchaser with applicable limitations pertaining to installation of rafts on aircraft. These limitations shall include the minimum and maximum stowage area temperatures and any other limitations which will prevent the raft from performing its intended function and complying with the minimum performance standards under all reasonably foreseeable emergency conditions.

§ 37.123 Life preservers—TSO–C13c.

(a) *Applicability*—(1) *Minimum performance standards.* Minimum performance standards are hereby established for life preservers which specifically are required to be approved for use on civil aircraft of the United States. New models of life preservers manufactured on or after October 15, 1960, shall meet the standards set forth in ATA Specification No. 801, "Airline Life Jackets," dated July 1, 1958,* with the exceptions listed in subparagraph (2) of this paragraph. Life preservers approved prior to October 15, 1960, may continue to be manufactured under the provisions of their original approval.

(2) *Exceptions.* (i) Compliance with section 4.1.1. of ATA Specification No. 801 is optional. Life preservers may be non-reversible provided the design of the preservers is such so as to preclude the probability of improper donning.

(ii) In addition to the placarding instructions contained in section 4.2.2 of ATA Specification No. 801, the preserver shall also be marked with instructions which will describe the proper donning procedure.

(b) *Marking.* Each life preserver shall be marked in accordance with § 37.7 except that the weight specified in § 37.7(c) may be omitted, and the following additional information shall be shown:

(1) Date of manufacture of fabric (month and year);

* Copies may be obtained from the Air Transport Association.

* Copies may be obtained from the Air Transport Association.

(2) "Adult" or "child", as the case may be.

(c) *Data requirements.* With the statement of conformance, one copy each of the manufacturer's operation and inflation instructions shall be furnished the Chief, Engineering and Manufacturing Branch, Flight Standards Division, Federal Aviation Administration, in the region in which the manufacturer is located.

(d) *Quality control.* Each life preserver shall be produced under a quality control system, established by the manufacturer, which will assure that each life preserver is in conformity with the requirements of this standard and is in condition for use. This system shall be described in the records required by section 4.3.1 of ATA Specification No. 801. The Administrator shall be permitted to make such inspections and tests at the manufacturer's facility as may be necessary to determine compliance with the requirements of this standard.

§ 37.124 Aircraft fabric, intermediate grade; external covering material—TSO–C14a.

(a) *Applicability*—(1) *Minimum performance standards.* Minimum performance standards are hereby established for aircraft fabric, intermediate grade, for use as an external covering on civil aircraft of the United States with wing loadings of less than 9 p.s.f. and never exceed speeds of less than 160 m.p.h. Fabric manufactured on or after July 31, 1959, shall meet the requirements set forth in section 3 of SAE Aeronautical Material Specification 3804A, "Cloth, Airplane, Cotton, Mercerized; 65 lb Breaking Strength," revised May 1, 1954.* Fabric approved prior to July 31, 1959, may continue to be manufactured under the provisions of its original approval.

(b) *Marking.* The weight required in § 37.7 need not be included. The TSO number shall be marked continuously along the selvage edge of the fabric.

§ 37.125 Aircraft fabric, grade A; external covering material—TSO–C15c.

(a) *Applicability*—(1) *Minimum performance standards.* Minimum performance standards are hereby established for aircraft fabric, grade A, for use as an external covering on civil aircraft of the United States. Fabric manufactured on or after September 23, 1959, shall meet the requirements set forth in section 3 of SAE Aeronautical Material Specification 3806A, "Cloth, Airplane, Cotton, Mercerized: 80 lb Breaking Strength," revised June 15, 1952,* with the exception listed in subparagraph (2) of this paragraph. Fabric approved prior to September 23, 1959, may continue to be manufactured under the provisions of its original approval.

(2) *Exception.* The elongation limits specified in AMS 3806A 3.2.4. are amended as follows for the purpose of this section.

Nominal width (inches):	*Maximum elongation (percent)*
36	13
42	13
60	14
69	15
90	16

(b) *Marking.* The weight required in § 37.7 need not be included. The TSO number shall be marked continuously along the selvage edge of the fabric.

§ 37.126 Air-speed tubes (electrically heated) —TSO–C16.

(a) *Introduction.* (1) This Technical Standard Order is intended to serve as a criterion by which the product manufacturer can obtain approval of his electrically heated air-speed tube.

(2) In the establishment of this Technical Standard Order, consideration has been given to existing Government and industry standards for air-speed tubes for the purpose of adopting the performance requirements of one of the recognized aeronautical standards as the minimum safety requirements for air-speed tubes which are intended for use in civil aircraft. The specification of the Society of Automotive Engineers for electrically heated air-speed tubes contains such requirements.

(b) *Directive*—(1) *Provision.* The performance requirement for air-speed tubes as

* Copies may be obtained from the Society of Automotive Engineers, Inc.

set forth in sections 5 and 6 of SAE Specification AS–393, Air-Speed Tubes, Electrically Heated, dated December 1, 1947,* stated below, are hereby established as minimum safety requirements for electrically heated air-speed tubes which are intended for use in civil aircraft.

1. *Purpose.* To specify minimum requirements for Electrically Heated Air-Speed Tubes for use on aircraft the operation of which may subject the instrument to environmental conditions specified in section 3.4.

2. *Scope.* This specification covers the following basic types:

Type I. Pitot Pressure, Straight and L-shaped, 12 and 24 volt nominal, 2 wire circuit.

Type II. Pitot and Static Pressures, Straight and L-shaped 12 and 24 volt nominal, 2 wire circuit.

3. *General requirements.*

3.1 *Materials and workmanship.*

3.1.1 *Materials.* Materials shall be of a quality which experience and/or tests have demonstrated to be suitable and dependable for the purpose intended.

3.1.2 *Workmanship.* Workmanship shall be consistent with high grade instrument manufacturing practice.

3.2 *Radio interference.* The instrument shall not be the source of objectionable interference under operating conditions at any frequencies used on aircraft, either by radiation or feedback, in radio sets installed in the same aircraft as the instrument.

3.3 *Identification.* The following information shall be legibly and permanently marked on the units or attached thereto:

a. Name of instrument.

b. SAE Spec. AS 393.

c. Rating (Nominal Voltage).

d. Manufacturer's Part No.

e. Manufacturer's Serial No. or date of manufacture.

f. Manufacturer's name and/or trademark.

3.4 *Environmental conditions.* The following conditions have been established as design criteria only. Tests shall be conducted as specified in sections 5, 6, 7.

3.4.1. *Temperature.* When the instruments are mounted in accordance with manufacturer's instructions, they shall function over the range of ambient temperatures of −65° C to +70° C and shall not be adversely affected by exposure to temperatures of −65° C to +70° C.

3.4.2 *Vibration.* When the instruments are mounted in accordance with the manufacturer's instructions, they shall function and shall not be adversely affected when subjected to the following vibration:

Frequency: 500–3,000 cycles per minute.

Amplitude: 0.250 inch.

Maximum Acceleration: 32.5 g.

NOTE: It is understood that the unit shall withstand vibration at higher frequencies but the acceleration value need not exceed that shown above.

When specified by the purchaser for use in rotary wing aircraft, the frequency range shall be 150–3,000 cycles per minute.

4. *Detail requirements.*

4.1 *Drainage.* The tube shall be designed to provide maximum drainage of water, resulting from rain or melting ice, consistent with maintaining the calibration specified in sections 6.3, 6.4 and 6.5.

4.2 *Marking.* Pitot pressure and static pressure lines shall be identified by the letters P and S, respectively, stamped, etched, engraved or otherwise permanently marked on the lines or fittings. The top of the tube shall be identified.

5. *Individual performance tests.* All instruments shall be subjected to whatever tests the manufacturer deems necessary to demonstrate specific compliance with the specification including the following requirements, where applicable.

5.1 *Leakage.* With a pressure of 10 inches of mercury applied separately to the pitot pressure and/or the static pressure lines, there shall be no evidence of leakage when the corresponding pitot or static pressure openings and drain holes are sealed.

5.2 *Dielectric.* The insulation shall withstand without evidence of damage the application of a sinusoidal voltage at a commercial frequency between the terminals of the heater circuit and the shell (case) for a period of 5 seconds. The R.M.S. value of the sinusoidal voltage applied shall be 500 volts.

5.3 *Heater operation.* When mounted in its normal position, the tube shall be tested for heater operation by applying the minimum rated voltage (12 or 24 volts) for a period of 2 minutes. The power consumption at that time shall be within ±30 percent of the power consumption at rated voltage.

6. *Qualification tests.* As many instruments as deemed necessary to demonstrate that all instruments will comply with the requirements of this section shall be tested in accordance with the manufacturer's recommendations, where applicable.

6.1 *Vibration.* The tubes shall be subjected to vibration for three hour periods in each of the three perpendicular reference planes such that a point on the tip of the tubes will oscillate ¼ inch. The test shall be conducted such that each period of three hours shall consist of one hour at 1,000, 2,000 and 3,000 cycles per minute. Rated voltage shall be applied to the terminals continuously during this test. Ambient temperature shall be 20° to 30° C. There shall be no failure of any kind.

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6.2 *Endurance.* The tubes shall be made to operate continuously in still air at 15 or 30 volts (as applicable) for, at least, five hours. Ambient temperature shall be 70° C. There shall be no damage of any kind except discoloration, which will not affect corrosion resistance.

6.3 *Calibration at zero angle of attack.* The tube shall be mounted in a wind tunnel in line with the airflow and tested separately for pitot pressure and for static pressure at the values for air speeds specified in table I. The test shall be made by comparison with the results obtained under similar conditions with a calibrated tube. The error of the tube expressed in terms of indicated air speed shall not exceed 1 percent of the indication or 1 MPH, whichever is greater, and the static pressure shall be within the tolerances specified in table I.

TABLE I—PERMISSIBLE ERRORS IN STATIC PRESSURE

Indicated air speed m.p.h.:	*Tolerance inches of water*
50	0.10
75	.15
100	.20
125	.25
150	.30
175	.35
200	.40
225	.45
250	.50

6.4 *Calibration at various angles of attack.* The tube shall be tested as specified for "Error at Zero Angle of Attack" at approximately 125 MPH except that the angle of attack shall be varied by 2-degree intervals from +16 to −10 degrees inclusive. The indicated error expressed in terms of indicated air speed shall not differ from the indicated error at zero angle of attack by more than 3 miles per hour, and the error in static pressure shall not differ from the static pressure at zero angle of attack by more than 0.20 inch of water.

6.5 *Calibration at various angles of yaw.* The tube shall be tested as specified in section 6.3 at approximately 125 MPH except that the angle of yaw shall be varied between plus and minus five degrees. The indicated error expressed in terms of indicated air speed shall not differ from the error at zero angle of yaw by more than 3 miles per hour and the error in static pressure shall not differ from the static pressure at zero angle of yaw by more than 0.20 inch of water.

6.6 *Magnetic effect.* The magnetic effect of the tube shall be determined in terms of the deflection of a free magnet approximately 1½ inches long in a magnetic field with a horizontal intensity of 0.18± 0.01 gauss, when the tube is held in various positions and with rated voltage applied on an east-west line with its nearest part five inches from the center of the magnet. (An aircraft Compass with the compensating magnets removed therefrom may be used as the free magnet for this test.) The maximum deflection of the magnet shall not exceed 5 degrees for any pointer deflection.

6.7 *De-icing.* The tube shall be tested in an icing wind tunnel at a temperature of −10° to −20° C. and at an indicated tunnel air speed of 200 miles per hour. When the tube is coated with ¼ inch of ice at the nose, the minimum rated voltage shall be applied to the terminals. The time required to clear the ice cap shall not be more than 2 minutes after the potential is applied. No re-icing shall occur.

6.8 *Cold resistance.* The tube shall be subjected to a temperature of −65° C. or colder for a minimum period of 48 hours. There shall be no evidence of damage. After this test, the tube shall be capable of successfully passing all tests described heretofore.

(2) *Application.* (i) Air-speed tubes complying with the specifications appearing in this Technical Standard Order are hereby approved for all aircraft. Air-speed tubes already approved may continue to be installed in aircraft:

(*a*) For which an application for original type certificate is made prior to the effective date of this order,

(*b*) The prototype of which is flown within 1 year after the effective date of this order, and

(*c*) The prototype of which is not flown within 1 year after the effective date of this order if due to causes beyond the applicant's control.

(ii) If a major change is made in the installation within 9 months after the effective date of this order involving a change in type or model of air-speed tube, previously approved types of air-speed tubes may be installed. However, in any such change made after the 9-month period, new types of air-speed tubes installed in aircraft used in instrument flight shall meet the specifications contained in this section.

(c) *Specific instructions*—(1) *Marking.* In addition to the identification information required in the referenced specification, each air-speed tube shall be permanently marked with the Technical Standard Order designation "FAA-TSO-C16" to identify the air-speed tube as meeting the requirements of this order in accordance with the manufacturer's statement of conformance outlined below. This

identification will be accepted by the Administrator as evidence that the established minimum safety requirements for air-speed tubes have been met.

(2) *Data requirements.* None.

(3) *Effective date.* After September 1, 1948, specifications contained in this Technical Standard Order will constitute the basis for approval of air-speed tubes for use in certificated aircraft used in instrument flight.

(4) *Deviations.* Requests for deviation from, or waiver of, the requirements of this order, which affect the basic airworthiness of the component, should be submitted for approval by the Chief, Engineering and Manufacturing Branch, Flight Standards Division, Federal Aviation Administration, in the region in which the manufacturer is located.

(5) *Conformance.* (i) The manufacturer shall furnish to the Chief, Engineering and Manufacturing Branch, Flight Standards Division, Federal Aviation Administration, in the region in which the manufacturer is located, a written statement of conformance signed by a responsible official of his company, setting forth that the air-speed tube to be produced by him meets the minimum safety requirements established in this order. Immediately thereafter distribution of the air-speed tube conforming with the terms of this order may be started and continued.

(ii) The prescribed identification on the air-speed tubes does not relieve the aircraft manufacturer or owner of responsibility for the proper application of the air-speed tube in his aircraft, nor waive any of the requirements concerning type certification of the aircraft in accordance with existing Federal Aviation Regulations.

(iii) If complaints of nonconformance with the requirements of this order are brought to the attention of the Administrator and investigation indicates that such compliants are justified, the Administrator takes appropriate action to restrict the use of the product involved.

(iv) Copies of this Technical Standard Order may be obtained from the Department of Transportation, Federal Aviation Administration, Distribution Unit, TAD-484.3, Washington, D.C. 20590.

§ 37.127 Fire resistant aircraft sheet and structural material—TSO-C17a.

(a) *Introduction.* This Technical Standard Order is intended to serve as a criterion by which the product manufacturer may obtain Federal Aviation Administration approval of fire resistant aircraft material when required for sheet or structural members. Aircraft manufacturers may also obtain approval of fire resistant materials as part of their aircraft design, and should include them on the aircraft drawings. Such materials shall comply with minimum requirements stated herein, and approval thereof will be recognized by all Federal Aviation Administration representatives.

(b) *Directive.*

(1) *Provision.* The requirements for fire resistant aircraft material as set forth in Section 3 of SAE Specification AMS-3851A, Fire Resistant Properties for Aircraft Materials, dated November 1, 1954,* are hereby established as minimum safety requirements for fire resistant material which is intended for use in civil aircraft.

(2) *Application.* Fire resistant materials complying with the specifications appearing in this Technical Standard Order are hereby approved for all aircraft.

(c) *Specific instructions.*

(1) *Marking.* The material shall be permanently marked with the Technical Standard Order designation, FAA-TSO-C17a, to identify the material as meeting the requirements of this Order in accordance with the manufacturers' statement of conformance outlined below. This identification will be accepted by the Federal Aviation Administration as evidence that the established minimum safety requirements for fire resistant material have been met.

(2) *Data requirements.* None.

(3) *Effective date.* After February 1, 1955, specifications contained in this Order will constitute the basis for approval of fire resistant material for use in civil aircraft.

(4) *Deviations.* Requests for deviation from, or waiver of, the requirements of this

Order, which affect the basic airworthiness of the component, should be submitted for the approval of the Chief, Engineering and Manufacturing Branch, Flight Standards Division, Federal Aviation Administration, in the region in which the manufacturer is located.

(5) *Conformance.*

(i) The manufacturer shall furnish to the FAA (address as noted under "Deviations" above), a written statement of conformance signed by a responsible official of his company, setting forth that the fire resistant material to be produced by him meets the minimum safety standards established in this Order. Immediately thereafter, distribution of the material conforming with the terms of this Order may be started and continued.

(ii) The prescribed identification on the material does not relieve the aircraft manufacturer or owner of responsibility for the proper installation in his aircraft, nor waive any of the requirements concerning type certification of the aircraft in accordance with existing Federal Aviation Regulations.

(iii) If complaints of nonconformance with the requirements of this Order are brought to the attention of the Federal Aviation Administration and investigation indicates that such complaints are justified, the Administrator will take appropriate action to restrict the use of the product involved.

(iv) Copies of this Technical Standard Order and other Technical Standard Orders may be obtained from the Department of Transportation, Federal Aviation Administration, Distribution Unit, TAD-484.3, Washington, D.C. 20590.

§ 37.128 [[Reserved]]

§ 37.129 Portable water-solution type fire extinguishers—TSO–C19b.

(a) *Applicability*—(1) *Minimum performance standards.* Minimum performance standards are hereby established for portable water-solution type fire extinguishers which are to be used in civil aircraft of the United States. New models of portable water-solution type fire extinguishers manufactured for installation in civil aircraft on or after the effective date of this order shall meet the standards of sections 5 and 6 and subsections 4.1.1, 4.1.4, 4.1.5, 4.2.3, 4.3.1 and 4.3.2 of SAE Specification AS–245A, dated December 15, 1956,* with the exceptions listed in subparagraph (2) of this paragraph. Portable water-solution type fire extinguishers approved by the Civil Aeronautics Administration prior to the effective date of this order may continue to be manufactured under the provisions of their original approval.

(2) *Exceptions.* For the purpose of this order, the dischargeable capacity specified in 4.1.1 of AS–245A may be at least one quart.

(b) *Marking.* In addition to the information required in § 37.7, the following also must be legibly and permanently marked on the extinguisher: 1–capacity, 2–test pressure of container and 3–operating and maintenance instructions.

§ 37.130 Combustion heaters—TSO–C20.

(a) *Introduction.* This Technical Standard Order is intended to serve as a criterion by which the product manufacturer may obtain approval of his combustion heaters.

(b) *Directive*—(1) *Provision.* The requirements for combustion heaters, as set forth in SAE Aeronautical Standard AS143B; Heaters, Airplane, Internal Combustion Heat Exchanger Type, dated February 1, 1949,* stated below, are hereby established as minimum safety standards for combustion heaters intended for use in civil aircraft:

1. *Purpose.* To specify standards covering minimum safety and performance requirements for internal combustion heaters and certain auxiliary devices which are considered necessary to the safety and performance of the heaters as used in aircraft. These standards are to be considered currently applicable and necessarily subject to revision from time to time due to rapid development of the aeronautical industry. The following standards are based on practical engineering requirements for such internal combustion heat exchanger type heaters as are now used on airplanes and for such as may be developed to meet later requirements.

2. *Scope.* These standards are written to cover internal combustion heat exchanger type heaters used in the following applications:

2.1 Cabin heating. (All occupied regions and windshield heating.)

2.2 Wing and empennage heating.

2.3 Engine and accessory heating. (When heater is installed as part of the aircraft.)

3. *Definition.* An internal combustion heat exchanger type heater as used for airplane heating is one that utilizes through a heat exchanger the heat produced by combustion of a fuel within the heater for the purpose of heating the air being supplied to the airplane.

4. *General requirements.*

4.1 *Heater components.* An internal combustion type heater shall include all of the following:

4.1.1 Combustion chamber and heat exchanger assembly.

4.1.2 Casing or shroud for combustion chamber and heat exchanger assembly.

4.1.3 Igniter.

4.1.4 Burner.

4.1.5 Ventilating air inlet.

4.1.6 Ventilating air outlet.

4.1.7 Combustion air inlet.

4.1.8 Exhaust outlet.

4.1.9 Fuel inlet.

4.2 *Additional devices.* In addition to the heater, the following additional devices are considered necessary to the safety and performance of the heater and will be covered in that respect by these standards. These devices may be furnished separately or as part of the heater. These standards do not cover all tests necessary on these devices, but only those required in their relationship to the heater.

4.2.1 Fuel system.

4.2.1.1 Fuel nozzle, restrictor, orifice, or equivalent.

4.2.1.2 Fuel shutoff valve.

4.2.1.3 Fuel filter.

4.2.2 Safety controls.

4.2.2.1 A device to prevent the heater from becoming overheated.

4.2.2.2 A device to prevent fuel flow to the heater when combustion air is insufficient for safe operation.

4.2.3 Ignition system. (Required for spark ignition only.)

4.2.3.1 Device to provide high voltage power.

4.2.3.2 High voltage ignition lead assembly or equivalent electrical linkage between high voltage device and spark plug.

* Copies may be obtained from the Society of Automotive Engineers, Inc.

4.3 *Materials and workmanship.*

4.3.1 The heater and auxiliary equipment shall be constructed throughout of materials which are considered acceptable for the particular use intended and shall be made and furnished with a degree, uniformity, and grade of workmanship generally accepted in the aircraft industry.

4.3.2 The heater casing or shroud shall be constructed of fireproof material.

4.4 *Design features.*

4.4.1 The design shall be such as to preclude the possibility of discharging harmful concentrations of carbon monoxide into the ventilating air stream. See test, paragraph 6.5.4.1.

4.4.2 Where specified, the design shall be such as to preclude excessive loss of pressurized fuselage air. See test, paragraphs 6.5.4.2 and 6.5.4.3.

4.4.3 The design shall include protection against excessive radio interference. See test, section 6.4.

4.4.4 The design shall be such as to preclude harmful effects on construction or performance due to vibration. See test, section 6.3.

4.4.5 The design shall be such that the life of the heater and accompanying devices shall be comparable to other similar airframe components and accessories. See test, section 6.5.

4.4.6 Unless otherwise specified, the design shall be such that the heater and accompanying devices shall operate satisfactorily within normal ranges of power, fuel, and air supplies available in aircraft.

4.5 *Heater identification.* The following minimum information shall be legibly and permanently marked on the heater or on a nameplate attached thereto:

(a) Manufacturer's name and/or trademark.

(b) Manufacturer's part number.

(c) Manufacturer's serial number.

(d) SAE rated output, _____ B. t. u. hr. (See section 5.1)

(e) Rated fuel pressure _____ psig.

(f) Electrical characteristics.

(g) SAE Spec. AS-143B. For use: Unpr. cabin _____, Press. cabin _____. Wing _____. (Stamp "X" in one or more blanks as applicable.)

5. *Detail requirements.*

5.1 *SAE rating conditions.* Heater shall deliver at least SAE rated output at following conditions:

5.1.1 Sea level ambient pressure.

5.1.2 Rated fuel pressure, as specified by manufacturer.

5.1.3 Rated sea level combustion air rate, as specified by manufacturer.

5.1.4 Ventilating air temperature rise of 250° F.

5.1.5 Inlet temperature of fuel and air between 50° F. and 125° F.

5.2 *Air supply.*

5.2.1 When sufficient combustion or ventilating air for safe operation is not available the heater shall be made automatically inoperative. See tests, paragraphs 6.5.7.1 and 6.5.7.2.

5.2.2 The combustion air and ventilating air inlets on the heater shall be separated from each other.

5.3 *Fuel supply.*

5.3.1 The fuel lines and fittings under pressure in the heater shall be enclosed in such manner as to prevent any fuel leakage from entering the ventilating air stream, and the enclosure shall have adequate provision for draining to the combustion chamber or to a fuel drain fitting.

5.3.2 A fuel drain outlet or equivalent safety device shall be provided to prevent accumulation of fuel in the combustion chamber and heat exchanger assembly in case the fuel flows without igniting.

5.3.3 All fuel lines in the heater shall be constructed of steel or other fire resistant material. Where flexibility is required in these lines, flexible fire resistant coupled hose assemblies shall be used to eliminate the possibility of using hose clamp connections. Connections in metal fuel lines shall not employ solder nor other relatively low melting point materials which cannot withstand a 2000° F. flame for five minutes.

5.3.4 All gaskets, synthetic rubber seals, etc. shall be suitable for use with aromatic fuels and shall be satisfactory for use at the temperatures encountered within the overheating limits of the heater.

5.3.5 The fuel system lines, fittings and controls shall be sufficiently isolated from the combustion side of the heater to prevent their being damaged by flame, radiant heat or backfire.

5.4 *Combustion chamber and heat exchanger assembly.*

5.4.1 The combustion chamber and heat exchanger assembly shall be constructed from a corrosion and heat resistant material in accordance with SAE Aeronautical Material Specification AMS 5540, or equivalent.

5.4.2 Means shall be provided to minimize malfunctioning due to lead deposits and to permit disassembly and cleaning of all parts affected by products of combustion.

5.4.3 The accumulation of lead scale or products of combustion deposits shall not cause functional failure before 500 hours of heater operation.

5.4.4 The heater combustion chamber and heat exchanger assembly shall be so designed that it will not rupture under the most severe explosion conditions that can occur with any possible fuel air mixture as demonstrated by test procedure outlined in section 6.1.6.

5.5 *Exhaust.*

5.5.1 The temperature of the exhaust gases at the point of discharge from the heater shall not exceed 1200° F. at rating. (See section 5.1)

5.6 *Ignition.*

5.6.1 Ignition may be accomplished by:

5.6.1.1 Electrically heated resistance hot wire.

5.6.1.2 Electric high-voltage spark plug.

5.6.2 Ignition may be sustained during operation of the heater or discontinued if satisfactory combustion is assured.

5.6.3 The igniter shall be capable of functioning over a period of 200 hours without service. See test, section 6.5.5.

5.6.4 In event of ignition delay for an indefinite period, either with or without fuel supply, no hazardous condition shall result.

5.6.5 Heaters which are intended for wing-empennage heating shall ignite within 15 seconds under conditions of paragraph 6.1.2.3 except that the temperature shall not be higher than −20° F.

5.7 *Safety controls.* The following automatic safety controls shall be furnished separately or as part of the heater. These controls shall be independent of and in addition to the normal operating controls.

5.7.1 A control to shut off the heater fuel flow in case combustion air supply is insufficient for safe operation.

5.7.2 A control to prevent the heater from becomming overheated under any condition of ventilating air flow.

5.8 *Lines and fittings.*

5.8.1 All pipe and tubing fittings used shall comply with applicable AN standards.

5.8.2 Other fittings not covered above shall conform to accepted aircraft practice.

5.9 *Electrical equipment.*

5.9.1 All electrical equipment, including wiring, instruments, motors, insulation, shielding, relays, etc., shall conform to acceptable aircraft practice.

6. *Test requirements and methods.*

6.1 *Performance tests.* Tests shall be conducted to establish the following:

6.1.1 Ignition characteristic curve, plotting altitude as the ordinate and combustion air pressure differential as the abscissa such that the area under the curve represents the region of reliable starting and burning at −65° F. Include information on temperature of fuel and combustion air supplied to heater. The service ceiling of the heater and its accompanying ignition devices shall be defined as the peak of the ignition characteristic curve. A time record shall be kept on each test start.

6.1.2 Heat output, ventilating air pressure drop, combusion air pressure drop, exhaust temperature, ventilating air temperature rise, fuel rate at—

6.1.2.1 Sea level rating. (See section 5.1.)

6.1.2.2 Sea level rating, except with −65° F. inlet ventilating air, combustion air, and fuel temperatures.

6.1.2.3 20,000 feet pressure altitude with:

(a) Sea level rated weight of ventilating air at −65° F., inlet temperature.

(b) Combustion air at −65° F., inlet temperature, and combustion air pressure differential midway between 20,000 feet altitude ignition limits determined in 6.1.1.

(c) Sea level rated values of voltage and fuel pressure.

(d) Fuel at −65° F., inlet temperature.

NOTE: Temperature measurements for output shall be made in a manner which will provide a representative average temperature of the discharge air. Temperature sensing elements used in test shall be protected against effects of radiation from the heater.

6.1.3 Maximum starting and maximum running amperages required with normal voltage for operation of the heater and accompanying devices at sea level.

6.1.4 Voltage range within which the heater and accompanying devices will operate at sea level and service ceiling.

6.1.5 Collapsing pressure of the combustion chamber and heat exchanger assembly.

6.1.5.1 The heater shall be set up with an adjustable restriction on the combustion air inlet, and a source of vacuum connected to the exhaust outlet. The ventilating air shall discharge freely to atmosphere (sea level). A static pressure tap shall be provided in the exhaust pipe within 12″ of the connection to the heater.

6.1.5.2 For a non-pressurized cabin heater or a wing-empennage heater, the heater shall be operated at sea level rating, except that the exhaust outlet pressure is to be maintained at a value which is at least 4 psi below the ventilating air outlet pressure. After operating the heater for at least one hour at these conditions there must be no permanent distortion of any part of the heater, unless it can be demonstrated that such distortion does not affect the performance or life of the heater.

6.1.5.3 For pressurized cabin heaters, the test shall be the same as 6.1.5.2 except that the exhaust outlet pressure shall be maintained at a value which is at least 10 psi below the ventilating air outlet pressure.

6.1.6 *Combustion chamber burst pressure.* The following design test shall demonstrate compliance with section 5.4.4.

6.1.6.1 With the combustion chamber and heat exchanger assembly at room temperature, introduce a gaseous fuel air mixture in a ratio of from .085 to .095. Purge the combustion chamber and heat exchanger assembly with this mixture to the extent of at least ten times the volume of the combustion chamber and heat exchanger assembly. Ignite the mixture with the heater igniter. Repeat procedure to complete 50 explosions. The heater shall then meet the leakage requirements of section 6.5.4.2.

6.1.7 Radio interference noise levels. See test, section 6.4.

6.1.8 Effect of vibration of heater and accompanying devices. See test, section 6.3.

6.1.9 Minimum life and service requirements of heater and accompanying devices. See test, section 6.5.

6.2 *Test report.* The manufacturer shall furnish a report, on request, covering tests. This report shall include an introduction, a summary, a description

of apparatus, instrumentation, and tests, the results, a discussion, and conclusions.

6.3 *Vibration test.* The heater and auxiliary equipment shall be capable of withstanding and satisfactorily operating when subjected to a steady vibration over a range of frequencies from 600 to 2,700 cycles per minute with a total excursion of 1/16", and from 2,700 to 3,200 cycles per minute with an acceleration not exceeding 6 G's. Unless otherwise specified in detail specifications, the equipment shall be mounted on the vibrating apparatus with the longitudinal axis of the heater in a plane parallel to the vibrating surface of the apparatus and normal to the direction of vibration.

6.3.1 The heater shall be vibrated over a range of from 600 to 2,700 cycles per minute with a total excursion of 1/16". The frequencies at which resonance occurs, if any, shall be observed and noted.

6.3.2 The heater will be vibrated over a range of from 2,700 to 3,200 cycles per minute with an acceleration of not less than 5 G's and not more than 6 G's. The frequencies at which resonance occurs, if any, shall be observed and noted.

6.3.3 If resonance is observed under the test of either 6.3.1 or 6.3.2, a vibration test shall be conducted for fifteen hours at the frequency showing the maximum resonance.

6.3.4 If no resonance is observed under the tests of 6.3.1 or 6.3.2, a vibration test shall be conducted for 15 hours at 2,700 cycles per minute with 1/16" total excursion.

6.3.5 At the conclusion of the vibration test there shall be no evidence of structural failure and the heater and accompanying devices shall operate satisfactorily.

6.4 *Radio interference test.*

6.4.1 The heater shall be set up with a sleeve of bare metal ductwork having the same diameter as the heater casing connected at each end of the casing. The length of each piece of ductwork shall be not less than five diameters and shall be connected to the heater with a clamp of the type normally used in an installation.

6.4.2 In the same manner as 6.4.1, connect ductwork or tubing to the combustion air inlet and to the exhaust outlet with respective dimensions determined by diameters of the combustion air inlet and exhaust outlet fittings.

6.4.3 If the ignition voltage transformer is not part of the heater, mount in external to the heater and connect the high voltage terminal to the spark plug by means of the high voltage ignition lead assembly.

6.4.4 With the ignition system operating, check the complete assembly including heater, high voltage device, and high voltage ignition lead assembly using the recommended procedure of specification JAN-I-225 dated June 14, 1945, and Radio Interference Noise Limit Specification AAF-32466-A dated October 17, 1945.

6.5 *Life tests.* Life tests may be conducted in such manner as to qualify the heater and accompanying devices for cabin heating, wing-empennage anti-icing, or both. For cabin heating only, the duration of the test shall be at least 850 hours "on" time. For wing-empennage anti-icing only, the duration of the test shall be at least 500 hours "on" time. For qualification of the heater and accompanying devices under both cabin heating and wing-empennage classifications, the duration of the test may be 850 hours heater "on" time providing at least 500 hours "on" time is performed at wing-empennage conditions.

6.5.1 *General conditions.* The general conditions applying to both cabin and wing-empennage heater life tests shall be as follows:

6.5.1.1 Tests shall be performed at sea level rated fuel pressure and sea level rated combustion air rate.

6.5.1.2 Inlet air temperature shall not exceed 125° F.

6.5.1.3 Approximately 50% of the life test shall be with "continuous" operation, and the remainder of the test with "rapid cycling" operation.

6.5.1.3.1 During "continuous" operation, the ventilating air rate shall be adjusted as required to give the specified temperature rise under steady conditions. At least once, and not more than twice, during each two hours of operating time, the fuel and ignition system shall be shut off and the heater permitted to cool for at least 10 minutes with continuous ventilating air and combustion air flow. In calculating total "on" time for the heater, the 10-minute cooling periods shall not be included.

6.5.1.3.2 During "rapid cycling" operation, a thermostatic switch in the ventilating air outlet stream shall cycle the fuel on and off and maintain a specified outlet air temperature. The ventilating air rate shall be adjusted so that the average heat output (assuming that the setting of the cycling switch represents the average outlet air temperature) is between 60 and 75% of the rated output. At least once, and not more than twice during each 2 hours of operating time, the fuel and ignition system shall be shut off and the heater permitted to cool for at least 10 minutes with continuous ventilating air and combustion air flow. For cycling operation "on" time is defined as the total elapsed time during which the rapid cycling switch controls the heater operation; it does not include the 10-minute cooling periods.

6.5.2 *Cabin heater life test.* The cabin heater life tests shall be divided into four periods, as follows:

6.5.2.1 *First period—250 hours.* Continuous operation, with the ventilating air rate adjusted to maintain a temperature rise of at least 200° F. and an outlet air temperature of at least 250° F.

6.5.2.2 *Second period—250 hours.* Rapid cycling operation, with the cycling switch set to control at 250±10° F. outlet air temperature.

6.5.2.3 *Third period—175 hours.* Same conditions as first period.

6.5.2.4 *Fourth period—175 hours.* Same conditions as second period.

6.5.3 *Wing-empennage anti-icing heater life tests.* Wing-empennage anti-icing heater life tests shall be divided into two periods, as follows:

6.5.3.1 *First period—250 hours.* Continuous operation, with the ventilating air rate adjusted to maintain a temperature rise of at least 300° F. and an outlet air temperature of at least 350° F.

6.5.3.2 *Second period—250 hours.* Rapid cycling operation, with the cycling switch set to control at 350±10° F. outlet air temperature.

6.5.4 *Performance after tests.* At the end of the life and vibration tests the heater shall meet the following requirements:

6.5.4.1 *Carbon monoxide contamination.* At rating conditions, and with the burner operating, carbon monoxide concentration in the heated ventilating air stream shall not exceed one part in 20,000 or 0.005 of 1%. This test shall be run with the heater exhaust discharging to atmosphere. Then ventilating air samples shall be taken from an unrestricted duct fastened to the heater ventilating air outlet. The duct shall be the same diameter as the heater casing and at least 5 diameters in length. Use carbon monoxide detector assembly AAF No. 46B1790 or Navy Stock No. R-83-BUA-9258, or equivalent.

6.5.4.2 *Leakage.* With an air pressure of 8 psig inside the combustion chamber and heat exchanger assembly, leakage shall not exceed 9 lbs/hr. (sea level and 59° F.). There shall be no leaks which could allow liquid fuel to enter the ventilating air stream in event of ignition failure, when the heater is mounted in any normal position, with drains open.

6.5.4.3 For pressurized cabin heaters, with pressurized jacket, air leakage through the ventilating air shroud or casing shall not exceed 10 lbs/hr. at sea level and room temperature when air pressure of 16 psig is applied to the ventilating air passages.

6.5.4.4 When heater is to be used for wing-empennage anti-icing, the output shall be not less than 90% of the original rating after the life test. If the heater is to be used for cabin heating, the manufacturer shall record in the test report the heater output at the end of the life test.

6.5.5 *Igniter.* Whenever it becomes necessary due to ignition failure during the life test, the igniter may be cleaned, adjusted, or replaced. However, the igniter shall not require servicing or replacement more than twice during the life test of a wing-empennage heater or more than four times during the life test of a cabin heater.

6.5.6 *Fuel system.*

6.5.6.1 Whenever necessary due to stoppage or failure, the fuel orifice or nozzle may be cleaned or replaced. Such servicing shall not be required more than once during a wing-empannage heater life test or twice during a cabin heater life test.

6.5.6.2 The fuel shut off valve may be cleaned once during a wing-empennage heater life test and twice during a cabin heater life test. It shall not be cleaned, serviced, or replaced due to failure to close during the life test. At the end of the life test the valve leakage in the closed position with rated fuel pressure shall not exceed two cubic centimeters of fuel in ten minutes.

6.5.6.3 The fuel filter may be cleaned or the filter element replaced but the filter body shall not be replaced during the life test. At the end of the life test there shall be no leakage through the case or body.

6.5.7 *Safety controls.*

6.5.7.1 The device used to prevent the heater from becoming overheated shall not be serviced or replaced during the life test due to failure to shut off the heater. At the beginning of the life test and at the end of each test period (section 6.5.2 or 6.5.3), any cycling or intermediate control shall be by-passed and the ventilating air rate gradually reduced over a period of 15 minutes to permit operation of this device. Operation shall be within ±25° F. of the value obtained at the beginning of the life test.

6.5.7.2 The device to prevent fuel flow when combustion air is insufficient for safe operation shall be sensitive to heater combustion air pressure differential or to combustion air pressure. The device may be an air actuated electrical switch designed for use with an electrical fuel shut off valve, or an air actuated mechanical valve designed to control the flow of fuel.

6.5.7.2.1 If an air actuated electrical switch is used, it shall be checked as follows at the end of each test period (section 6.5.2 or 6.5.3) with the heater in operation:

6.5.7.2.1.1 Reduce the combustion air differential pressure or combustion air pressure gradually (approximately 30 seconds) from normal rating to a point where the switch closes the electrical fuel shut off valve. The combustion air differential pressure or combustion air pressure at which the fuel shut off valve closes shall not be less than the minimum value required for safe heater operation. At the end of 15 minutes "fuel off" time, the combustion air differential pressure or combustion air pressure, as applicable, shall be gradually increased at the same rate and the switch shall open the electrical fuel shut off valve at or above the rated combustion air pressure differential.

6.5.7.2.2 If an air actuated mechanical fuel valve is used it shall be checked as follows at the end of each test period (sections 6.5.2 or 6.5.3):

6.5.7.2.2.1 With the heater operating and with the fuel shut off valve "open," the combustion air differential pressure shall be reduced gradually (approximately 30 seconds) for normal rating to value required for safe heater operation. Leakage through the air actuated mechanical fuel valve shall then

be measured and shall not exceed two cubic centimeters in ten minutes. At the end of 15 minutes "fuel off" time, the combustion air differential pressure shall be gradually increased at the same rate and the valve shall permit rated fuel flow when the rated combustion air pressure differential is reached.

6.5.7.3 *Ignition system.*

6.5.7.3.1 If necessary, the high voltage device may be serviced or parts replaced once during the life test.

6.5.7.3.2 If necessary the high voltage ignition lead assembly or equivalent may be serviced or replaced once during the life test.

6.5.7.4 Unless otherwise specified, items 6.5.7.1, 6.5.7.2, 6.5.7.2.1, 6.5.7.2.2, 6.5.7.3, and 6.5.7.3.2, if furnished separately, not as part of the heater, need not be tested more than once providing no changes are made in their design, construction, or adjustment.

6.5.7.5 In case of life test failure of one or more of the devices in items 6.5.7.1, 6.5.7.2, 6.5.7.2.1, 6.5.7.2.2, 6.5.7.3, and 6.5.7.3.2, the test may be continued to qualify the heater or devices that have not failed. A separate life test shall apply only to the failed device if necessary to establish reliability.

7. *Desirable features* (Not Mandatory).

7.1 *Operation.*

7.1.1 The operation of the heater and accompanying devices should require a minimum of moving parts.

7.1.2 The heater should start operation within five seconds at −65° F. at sea level and at its service ceiling, and should reach its maximum output within three minutes after being started.

7.1.3 The heater should be designed in such a manner as to preclude violent explosions on being started.

7.1.4 The heater should be designed in such a manner and made from such materials as to withstand deteriorating effects of high humidity, condensation, fungus, and abrasive particles in the air.

7.1.5 The heater and its accompanying devices should not be adversely affected if subjected to ambient temperatures up to 160° F. for indefinite periods.

7.1.6 The heater should be designed to give low air pressure drop at high altitudes.

7.1.7 Where necessary, additional devices such as the following, may be provided to improve heater operation.

7.1.7.1 Air pressure regulator.

7.1.7.2 Fuel pressure regulator.

7.1.7.3 Combustion air blower.

7.1.7.4 Ventilating air blower.

7.1.7.5 Fuel air ratio control.

7.1.7.6 Thermal cycling switch.

7.1.7.7 Cabin heat controls.

7.2 *Igniter.* The igniter should be accessible for quick replacement or servicing.

7.3 *Fuel nozzle.* The fuel nozzle should be accessible for quick replacement or servicing.

(2) *Application.* (i) Combustion heaters complying with the specifications appearing in this order are hereby approved for all aircraft. Heaters already approved may continue to be installed in aircraft:

(*a*) For which an application for original type certificate is made prior to the effective date of this order.

(*b*) The prototype of which is flown within one year after the effective date of this order, and

(*c*) The prototype of which is not flown within one year after the effective date of this order if due to causes beyond the applicant's control.

(ii) If an alteration involving a change in type or model of heater is made within nine months after the effective date of this order, previously approved types of heaters may be installed. However, in any such change made after the nine-month period, new types of heaters installed shall meet the specifications contained in this section.

(c) *Specific instructions*—(1) *Marking.* In addition to the identification information required in the referenced specification, each heater shall be permanently marked with the Technical Standard Order designation, FAA-TSO-C20, to identify the heater as meeting the requirements of this order in accordance with the manufacturers' statement of conformance outlined in subparagraph (5) of this paragraph. This identification will be accepted by the Administrator as evidence that the established minimum safety requirements for combustion heaters have been met.

(2) *Data requirements.* Ten copies of the following technical information shall be submitted by the manufacturer of the heater with his Statement of Conformance to the Chief, Engineering and Manufacturing Branch, Flight Standards Division, Federal Aviation Administration, in the region in which the manufacturer is located:

(i) Rated combustion air flow rates (or pressure drop) including minimum safe rate and variation with altitude.

(ii) Rated ventilating air flow rates (or pressure drop) including minimum safe rate and variation with altitude.

(iii) Ignition characteristics curve established in accordance with section 6.1.1 of Specification AS143B.

(iv) Minimum operating voltage used for subdivision (iii) of this subparagraph.

(v) Maximum operating altitude.

(vi) Operating fuel pressure.

(vii) Installation diagram showing installation of safety devices necessary to achieve compliance with sections 4.2, 5.7 and 6.5.7 through 6.5.7.2.2.1 of Specification AS143B.

(viii) Recommended electrical arrangement and any necessary limitations and pressure or temperature settings which are considered essential to proper and safe installation and operation.

(3) *Effective date.* After June 15, 1949, specifications contained in this order will constitute the basis for approval of combustion heaters for use in certificated aircraft.

(4) *Deviations.* Requests for deviation from, or waiver of, the requirements of this order, which affect the basic airworthiness of the component, shall be submitted for approval by the Chief, Engineering and Manufacturing Branch, Flight Standards Division, Federal Aviation Administration, in the region in which the manufacturer is located.

(5) *Conformance.* (i) The manufacturer shall furnish to the Chief, Engineering and Manufacturing Branch, Flight Standards Division, Federal Aviation Administration, in the region in which the manufacturer is located, a written statement of conformance signed by a responsible official of his company, setting forth that the heater to be produced by him meets the minimum safety requirements established in this order. This statement shall indicate whether the heater meets the standards for cabin or wing-empennage heaters as prescribed in SAE Aeronautical Standard AS-143B and whether it has met the standards of this specification pertinent to pressurized systems. Immediately thereafter distribution of the heaters conforming with the terms of this order may be started and continued.

(ii) The prescribed identification on the heater does not relieve the aircraft manufacturer or owner of responsibility for the proper application of the heater in his aircraft, nor waive any of the requirements concerning type certification of the aircraft in accordance with existing Federal Aviation Regulations.

(iii) If complaints of nonconformance with the requirements of this order are brought to the attention of the Administrator and investigation indicates that such complaints are justified, the Administrator takes appropriate action to restrict the use of the product involved.

(iv) Copies of this Technical Standard Order may be obtained from Department of Transportation, Federal Aviation Administration, Distribution Unit, TAD-484.3, Washington, D.C. 20590.

§ 37.131 Special aircraft turnbuckle assemblies and/or turnbuckle safetying devices—TSO-C21a.

(a) *Applicability.* (1) Minimum performance standards: Minimum performance standards are hereby established for special turnbuckle assemblies and/or safetying devices which are to be used on civil aircraft of the United States.

(2) New models of special turnbuckle assemblies and/or safetying devices manufactured on or after July 1, 1958, shall meet the performance requirements as set forth in sections 3 and 4 of Military Specification MIL-T-5685A dated April 6, 1950,* with the additional tests, when applicable, listed below. Special turnbuckle assemblies and/or safetying devices already approved may continue to be used for the purposes for which approved.

(3) Tests: The following tests, when applicable, are required in addition to those set forth in MIL-T-5685A, and shall be conducted to substantiate the strength and reliability of special turnbuckle assemblies and/or safetying devices. A minimum of six samples each shall be used in conducting the tests for tor-

* Copies may be obtained from the Commander, Air Materiel Command, Attn: MCSIFF-2, Wright-Patterson Air Force Base, Ohio, or from the Commanding Officer, Naval Aviation Supply Depot, 700 Robbins Ave., Philadelphia 11, Pa., Code AD.

sion, tension, fatigue (tensile), and fatigue (torsion).

(i) *Torsion.* At least one sample of each size turnbuckle assembly and safetying device shall be tested in torsion to determine that the torque necessary to overcome the turnbuckle thread friction and break the safetying device is equal to or greater than that required when the conventional safety wire is used in accordance with the safetying procedure recommended in Civil Aeronautics Manual 4b.329–2 effective April 30, 1955 [20 F.R. 2278].

(ii) *Tension.* At least one sample of each size turnbuckle and safetying device assembly shall be tested to determine that the turnbuckle assembly (including safetying device) will not fail at any tensile load under the maximum (ultimate) tensile strength for which the comparable standard MIL or NAS turnbuckle is rated. For this test, the sample shall consist of the turnbuckle assembly (including safetying device) with a two (2) foot length of cable appropriately attached to each terminal (end) of the turnbuckle. In making the determination, the sample shall be tested for tensile strength in accordance with Federal Test Method Std. No. 151.* If the sample does not fail under the specified maximum load, it need not be tested further to destruction.

(iii) *Vibration.* At least one sample of each of 3 representative sizes of turnbuckle assemblies, i.e., the smallest, the largest, and an intermediate size, shall be vibrated to determine that the lock wire, or other safetying device which relies upon spring action or clamping to safety the turnbuckle, can be depended upon not to jump out of place or otherwise lose its safetying properties, under vibratory conditions apt to be encountered in aircraft service. It is suggested that a cable tension load equal to 25 percent of rated ultimate cable strength and a frequency of 3600 cpm with an overall amplitude of 1/8 inch (parallel to the axis of the hole through the barrel) for 25 hours, be used for this determination.

* Copies may be obtained from the General Services Administration.

(iv) *Fatigue (tensile).* At least one sample of each size turnbuckle assembly shall be given a repeated load test, in which a load equal to two-thirds the ultimate tensile strength requirement is applied repeatedly in tension for 300 applications of the load without failure of any component part. For this test, the sample shall consist of the turnbuckle assembly (including safetying device) with a two (2) foot length of cable appropriately attached to each terminal (end) of the turnbuckle.

(v) *Fatigue (bending).* The safety wire used in the conventional lock wire safetying procedure recommended in CAM 4b.329–2 is not considered to be reusable. If the safety device used with the special aircraft turnbuckle assembly is to be considered reusable, at least three (3) samples of the shortest formed non-standard safety wire (or other finished safetying device) shall be tested by alternate fastening and unfastening of the wire (or other safetying device), to determine that the device will not break after repeated applications of the bending loads involved. 200 on and off cycles, simulating rough treatment apt to be experienced during maintenance should substantiate a reasonable service life. It is felt that the shortest safety wire (or other safetying device) will be subjected to the greatest bending stresses. However, if the stresses may be greater in a longer wire (or other safetying device) intended for a larger size turnbuckle, the larger size turnbuckle and the longer wire (or other safetying device) shall be used for this test.

(vi) *Fatigue (torsion).* At least one sample of each size turnbuckle assembly and/or safetying device shall be given a repeated load test in which a load equal to two-thirds the torque (determined in test No. 1 above) required to overcome the turnbuckle thread friction and break the conventional safety wire (CAM 4b.329–2) is applied in torsion first in one direction and then reversed for 3000 complete cycles of reversal without failure of any component part.

§ 37.132 Safety Belts—TSO–C22f.

(a) *Applicability*—(1) *Minimum performance standards.* This technical standard order

prescribes the minimum performance standards that safety belts must meet in order to be identified with the applicable TSO marking. New models of safety belts that are to be so identified and that are manufactured on or after May 1, 1972, must meet the standards set forth in National Aircraft Standards (NAS) Spectification 802 revised May 15, 1950, with the exceptions covered in subparagraph (2) of this paragraph. NAS 801 is incorporated by reference herein in accordance with 5 U.S.C. 552(a)(1) and § 37.23 and is available as indicated in § 37.23. Additionally, NAS 802 may be examined at any FAA regional office of the Chief, Engineering and Manufacturing Branch, (or in the case of the Western Region, the Chief, Aircraft Engineering Division) and may be obtained from the National Standards Association, 1321 14th Street, N.W., Washington, D.C. 20005, at a cost of three (3) dollars. Belts approved under prior issuances of this section may continue to be manufactured under the earlier provisions.

(2) *Exceptions.* (i) For the purpose of this section the strengths specified in section 4.1.1 of NAS 802 shall be 1,500 pounds and 3,000 pounds instead of 3,000 pounds and 6,000 pounds.

(ii) In complying with section 4.3.2.2 of NAS 802, the curved portion of the test form may be padded with no more than one inch of medium density sponge rubber, or equivalent, and covered with suitable fabric to simulate a person's body and clothing.

(iii) Synthetic material webbing which is not subject to loss of strength due to the influence of humidity, temperature variations, etc., need not be subjected to the first six-month retesting period specified in section 3.1.2 of NAS 802. Retesting at succeeding six-month periods will be necessary if the belt manufacturer is unable to ascertain by means of textile data available to him that the webbing is unaffected by ambient storage conditions for the period of time involved.

(iv) In complying with section 4.1.3 of NAS 802, the two-inch webbing width shall be considered a nominal width. Thus, after considering all manufacturing processes as are necessary such as weaving, dyeing, mildew proofing, flame resistance and abrasion treatments, a webbing width of $1\frac{15}{16}$ inches $\pm\frac{1}{16}$ inch shall be acceptable.

(v) The slots or openings in the hardware for attachment of the safety belt webbing shall not be less than two inches.

(vi) In lieu of compliance with paragraphs 1.1.1, 3.1.4, and 4.3.1.1 of NAS 802, the webbing and all other materials used in the belt assembly must comply with the fire protection provisions of § 25.853(b–2) of this chapter.

(b) *Marking.*—(1) Each half of each safety belt shall be marked in accordance with § 37.7 except that the weight required by paragraph (d)(3) of § 37.7 need not be shown and the rated strength of the safety belt assembly shall be shown, and

(2) In lieu of the marking requirement in paragraph (d)(4) of § 37.7 the date of manufacture is required. The serial number may also be marked on the belt but not in lieu of the date of manufacture.

(c) *Data requirements.* (1) The manufacturer shall maintain a current file on complete design data.

(2) The manufacturer shall maintain a current file of complete data describing the inspection and test procedures applicable to his product. (See paragraph (d) of this section.)

(3) One copy of the following shall be furnished to the Chief, Engineering and Manufacturing Branch, Flight Standards Division, Federal Aviation Administration, in the region in which the manufacturer is located: A drawing of the complete belt assembly showing the manufacturer's part numbers together with a notation indicating the minimum webbing strength specified by the belt manufacturer. If the test belts were tested to destruction, the average strength of the belt assembly should also be indicated.

(d) *Quality control.* Each safety belt shall be produced under a quality control system, established by the manufacturer, which will assure that each belt is in conformity with the requirements of this standard. This system shall be described in the data required under paragraph (c)(2) of this section. The Administrator shall be permitted to make such inspec-

tions and tests at the manufacturer's facility as may be necessary to determine compliance with the requirements of this standard.

§ 37.133 Parachutes—TSO–C23b.

(a) *Applicability*—(1) *Minimum performance standards.* Minimum performance standards are hereby established for parachutes which are to be used in civil aircraft of the United States. New models of parachutes manufactured for use in civil aircraft of the United States on or after the effective date of this section shall meet the minimum performance standards of National Aircraft Standards Specification 804 dated August 24, 1949,* with the exceptions covered in subparagraph (2) of this paragraph. Parachutes approved prior to the effective date of this section may continue to be manufactured under the provisions of the original approval.

(2) *Execptions.* (i) The auxiliary parachute used in combination with a standard parachute shall be designed for use in combination with the specific main parachute.

(ii) For the purpose of testing an auxiliary type parachute used in combination with a standard parachute the speed specified in section 4.3.8 of NAS Specification 804 shall be 25 feet per second instead of 21 feet per second.

(b) *Marking.* The auxiliary parachute and its pack shall be marked "Auxiliary Parachute" in addition to the other marking requirements contained in § 37.7.

(c) *Data requirements.* (1) The manufacturer shall maintain a current file of complete design data.

(2) The manufacturer shall maintain a current file of complete data describing the inspection and test procedures applicable to his product. (See paragraph (d) of this section.)

(d) *Quality control.* Each parachute shall be produced under a quality control system, established by the manufacturer, which will assure that each parachute is in conformity with the requirements of this section. This system shall be described in the data required under paragraph (c)(2) of this section. The Administrator shall be permitted to make such inspections and tests at the manufacturer's facility as may be necessary to determine compliance with the requirements of this section.

* Copies may be obtained from the National Standards Association.

§ 37.134 [[Reserved]]

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§ 37.135 Aircraft seats and berths (Type I transport, 6g forward load)—TSO–C25a.

(a) *Applicability*—(1) *Minumum performance standards.* Minimum performance standards are hereby established for aircraft seats and berths (Type I transport, 6g forward load) which are to be used in civil aircraft of the United States. These standards apply to Type I transport seats for use in transport category aircraft for which an application for type certificate was made prior to March 5, 1952.* New models of seats and berths (Type I transport, 6g forward load) manufactured for installation in civil aircraft or after January 15, 1957 shall meet the standards of National Aircraft Standard Specification 806, revised January 1, 1956,** with the changes and exceptions listed in subparagraph (2) of this paragraph. Seats and berths approved by the Civil Aeronautics Administration prior to January 15, 1957, may continue to be manufactured under the provisions of their original approval.

(2) *Exceptions.* (i) The ultimate loads corresponding to the aircraft reduced weight gust load factor or the airplane designer's special requirements may exceed the ultimate down loads for Type I seats specified in subsection 4.1.2 of NAS 806. For the purpose of this section, in order to provide for such loading conditions, the ultimate down loads specified in Table I of 4.1.2 for Type I seats shall be 1,000 pounds (6g) instead of 765 pounds.

(ii) To insure that pilot and copilot seats will provide for the rearward loads resulting from the application of pilot forces to the flight controls, such seats shall withstand a rearward load of 450 pounds. The load shall be applied 8 inches above the intersection of the seat back with the seat bottom.

(iii) The weight of the seat or berth times the appropriate "g" value shall be added to the design ultimate load specified in subdivision (i) of this subparagraph and in subsection 4.1.2 of NAS 806.

(iv) For the purpose of this section, 4.3 (c) of NAS 806 should read: "that the structure is capable of supporting without failure for at least 3 seconds the ultimate loads specified in this order when applied separately."

(b) *Marking.* The weight required in § 37.7 need not be included.

§ 37.136 Aircraft seats and berths—TSO–C39a.

(a) *Applicability*—(1) *Minimum performance standards.* (i) This technical standard order prescribes the minimum performance standards that aircraft seats and berths of the following types must meet in order to be identified with the applicable TSO marking:

TYPE I—Transport (9g forward load).
TYPE II—Normal and utility.
TYPE III—Acrobatic.
TYPE IV—Rotorcraft.

(ii) New models of seats and berths that are to be so identified, and that are manufactured on or after May 1, 1972, must meet the standards set forth in National Aircraft Standard (NAS) Specification 809, dated January 1, 1956, with the exceptions covered in subparagraph (2) of this paragraph. NAS 809 is incorporated by reference herein in accordance with 5 U.S.C. 552(a)(1) and § 37.23 and is available as indicated in § 37.23. Additionally, NAS 809 may be examined at any FAA regional office of the Chief, Engineering and Manufacturing Branch, (or in the case of the Western Region, the Chief, Aircraft Engineering Division) and may be obtained from the National Standards Association, 1321 14th Street, N. W., Washington, D.C., 20005, at a cost of three (3) dollars.

(2) *Exceptions.* (i) The sideward loads as specified in 4.1.2. Table I need not exceed the requirements of the applicable Federal Aviation Regulations.

(ii) In lieu of compliance with paragraphs 2.1, 3.12, and 4.32 of NAS 809, materials in Type I seats and berths must comply with the fire protection provisions of § 25.853(b) of this chapter.

* Standards for Types II, III, IV, and I (for installation in aircraft for which an application for type certificate was made after March 5, 1952), are contained in § 37.136 (TSO–C39).

** Copies may be obtained from the National Standards Association.

(b) *Marking.* The weight required in § 37.7 need not be included.

(c) *Previous approval.* Seats and berths approved prior to May 1, 1972, may continue to be manufactured under the provisions of their original approval.

§ 37.137 Airborne Radio Marker Receiving Equipment—TSO–C35d.

(a) *Applicability.* This technical standard order prescribes the minimum performance standards that airborne radio marker receiving equipment must meet in order to be identified with the applicable TSO marking. New models of equipment that are to be so identified, and that are manufactured on or after May 15, 1971, must meet the requirements of Radio Technical Commission for Aeronautics Document No. DO–143 entitled "Minimum Performance Standards—Airborne Radio Marker Receiving Equipment Operating on 75 Megahertz" dated January 8, 1970, and Radio Technical Commission for Aeronautics Document No. DO–138 entitled "Environmental Conditions and Test Procedures for Airborne Electronic/Electrical Equipment and Instruments" dated June 27, 1968. RTCA Documents Nos. DO–143 and DO–138 are incorporated herein in accordance with 5 U.S.C. 552(a)(1) and § 37.23, and are available as indicated in § 37.23. Additionally, RTCA Documents Nos. DO–143 and DO–138 may be examined at any FAA regional office of the Chief of Engineering and Manufacturing Branch (or in the case of the Western Region, the Chief, Aircraft Engineering Division), and may be obtained from the RTCA Secretariat, Suite 655, 1717 H Street, N.W., Washington, D.C. 20006, at a cost of $6.00 per copy for Document No. DO–143 and $8.00 per copy for Document No. DO–138.

(b) *Marking.* In addition to the markings specified in § 37.7 the equipment must be permanently and legibly marked with the following information:

(1) The environmental categories over which the article has been designed to operate must be marked in accordance with RTCA Document DO–138, Appendix B.

(2) The equipment must be marked to indicate the class declared by the manufacturer as follows:

Class A. Equipment designed for use where marker beacon signals are required for both enroute and approach operations.

Class B. Equipment designed for use where marker beacon signals are required only for approach operations.

Equipment which complies with both Class A and Class B requirements need only be marked as Class A equipment.

(3) Each separate component of equipment (antenna, receiver, indicator, etc.) must be identified with at least the name of the manufacturer, the TSO number, and the environmental categories over which the component is designed to operate. Where an environmental test procedure is not applicable to that component and the test is not conducted, an X should be placed in the space assigned for that category.

(c) *Data requirements.* In accordance with § 37.5, the manufacturer must furnish to the Chief, Engineering and Manufacturing Branch, Flight Standards Division (or in the case of the Western Region, the Chief, Aircraft Engineering Division), Federal Aviation Administration, in the region in which the manufacturer is located, the following technical data:

(1) One copy of the operating instructions and equipment limitations of the manufacturer.

(2) One copy of the installation procedures with applicable schematic drawings, wiring diagrams, and specifications, and a list of components (by part number) or possible combination thereof, which make up a system complying with this TSO. The procedures must show all limitations, restrictions, or other conditions pertinent to the installation.

(3) One copy of the manufacturer's test report.

(d) One copy of the installation procedures with the data identified in paragraph (c)(2) including limitations, restrictions, or other conditions pertinent to the installation must be furnished with each article manufactured under this TSO.

(e) *Previously approved equipment.* Airborne radio marker receiving equipment approved prior to May 15, 1971, may continue to be manufactured under the provisions of its original approval.

§ 37.138 VOR radio receiving equipment operating within the radio-frequency range of 108–118 megacycles (for air carrier aircraft)—TSO–C40a.

(a) *Applicability*—(1) *Minimum performance standards.* Minimum performance standards are hereby established for airborne VOR radio receiving equipment operating within the radio-frequency range of 108–118 megacycles which is to be used on civil aircraft of the United States engaged in air carrier operations. New models of airborne VOR radio receiving equipment manufactured for use on civil air carrier aircraft on or after September 1, 1959, shall meet the minimum performance standards as set forth in Radio Technical Commission for Aeronautics' Paper entitled "Minimum Performance Standards Airborne VOR Receiving Equipment Operating Within the Radio Frequency Range of 108–118 Megacycles," as amended (Paper 225–55/DO–69 dated December 13, 1955, and amendment, Paper 253–58/EC–363 dated November 13, 1958).* Radio Technical Commission for Aeronautics' Paper 100–54/DO–60* which is incorporated by reference in and thus is a part of Paper 225–55/DO–69 has been amended by Paper 256–58/EC–366 dated November 13, 1958. This amendment is also a part of the minimum performance standards. An exception to these standards is covered in subparagraph (2) of this paragraph.

(2) *Exception.* (i) Radio Technical Commission for Aeronautics' Paper 100–54/DO–60, and amendment Paper 256–58/EC–366 dated November 13, 1958, outline environmental test procedures for equipment designed to operate under three environmental test conditions as specified therein under Procedures A, B, and C. Only airborne VOR radio receiving equipment which meets the operating requirements as outlined under Procedure A or Procedure B of Paper 100–54/DO–60, as amended, is eligible under this section.

(ii) The vibration values specified below may be used for equipment designed exclusively for installation on the instrument panel of aircraft in lieu of those specified in Paper 100–54/DO–60 as amended. No shock mounting shall be used during the conduct of this test if the vibration values specified below are used.

Amplitude: 0.01″ (0.02″ total excursion).
Frequency: Variable 5–50 cps.
Maximum Acceleration: 1.5 g.

(iii) Equipment which is designed exclusively for installation on the instrument panel of aircraft need not be subjected to the shock requirements outlined in Paper 100–54/DO–60 as amended.

(iv) Indicating instruments which are a part of the system, but which are not designed exclusively for installation on the instrument panel of aircraft may also be tested to the vibration requirements specified in subdivision (ii) of this subparagraph and need not be subjected to the shock requirements outlined in Paper 100–54/DO–60 as amended.

(b) *Marking.* In addition to the information required in § 37.7, equipment which has been designed to operate over the environmental conditions as outlined in Procedure A of RTCA Paper 100–54/DO–60, as amended, shall be marked as Category A equipment. Equipment which has been designed to operate over the environmental conditions outlined in Procedure B of this same paper shall be marked as Category B equipment. Equipment which has been designed exclusively for installation on the instrument panel of aircraft and which meets only the amended vibration requirements outlined above shall be identified with the letters I.P. following the category of equipment, such as CAT. A—I.P.

(c) *Data requirements.* With the statement of conformance, one copy each of the manufacturer's operating instructions, schematic diagrams, and installation procedures shall be furnished the Chief, Engineering and Manufacturing Branch, Flight Standards Division, Federal Aviation Administration, in the region in which the manufacturer is located.

*Copies of this paper may be obtained from RTCA.

(d) *Previously approved equipment.* Airborne VOR radio receiving equipment approved prior to September 1, 1959, may continue to be manufactured under the provisions of its original approval.

§ 37.139 Airborne radio receiving and direction finding equipment—TSO–C41c.

(a) *Applicability.* This technical standard order prescribes the minimum performance standards that airborne radio receiving and direction finding equipment must meet in order to be identified with the applicable TSO marking. New models of equipment that are to be so identified, and that are manufactured on or after August 14, 1972, must meet the requirements of Radio Technical Commission for Aeronautics Document No. DO–142 entitled "Minimum Performance Standards—Airborne Radio Receiving and Direction Finding Equipment Operating within the Radio Frequency Range of 200–850 Kilohertz" dated January 8, 1970, and Radio Technical Commission for Aeronautics Document No. DO–138 entitled "Environmental Conditions and Test Procedures for Airborne Electronic/Electrical Equipment and Instruments" dated June 27, 1968. RTCA Documents Nos. DO–142 and DO–138 are incorporated herein in accordance with 5 U.S.C. 552(a)(1) and § 37.23. Additionally, RTCA Documents Nos. DO–142 and DO–138 may be examined at any FAA regional office of the Chief of Engineering and Manufacturing Branch (or in the case of the Western Region, the Chief, Aircraft Engineering Division), and may be obtained from the RTCA Secretariat, Suite 655, 1717 H Street, N.W., Washington, D.C. 20006, at a cost of $6 per copy for Document No. DO–142 and $8 per copy for Document No. DO–138.

(b) *Marking.* In addition to the markings specified in § 37.7 the equipment must be permanently and legibly marked with the following:

(1) The equipment must be marked to indicate the environmental categories over which it has been designed to operate in accordance with Appendix B of RTCA Document DO–138.

(2) The equipment must be marked to indicate its class as follows:

Class A. Equipment intended for operation in the European-Mediterranean area (EUM) and in other areas where the frequency separation and geographical separation of ground facilities and their output powers are similar to the EUM area.

Class B. Equipment intended for operation in the United States of America and its possessions, and in other areas where the frequency and geographical separation of ground facilities and their output powers are similar to the USA areas.

Equipment which complies with both Class A and Class B requirements need only be marked as Class A equipment.

(3) Each separate component of the equipment (antenna, receiver, indicator, etc.) must be identified with at least the name of the manufacturer, the TSO number, and the environmental categories over which the component is designed to operate. Where an environmental test procedure described in DO–138 is not applicable to that component and the test is not conducted, an "X" should be placed in the space assigned for that environmental category.

(c) *Data requirements.* In accordance with § 37.5, the manufacturer must furnish to the Chief, Engineering and Manufacturing Branch, Flight Standards Division (or in the case of the Western Region, the Chief, Aircraft Engineering Division), Federal Aviation Administration, in the region in which the manufacturer is located, the following technical data:

(1) One copy of the manufacturer's operating instructions and equipment limitations including a statement specifying the Class of the equipment.

(2) One copy of the installation procedures with applicable schematic drawings, wiring diagrams, and specifications, and a list of components (by part number) or possible combinations thereof, which make up a system complying with this TSO. The procedures must show all limitations, restrictions, or other conditions pertinent to the installation.

(3) One copy of the manufacturer's test report.

(d) One copy of the installation procedures with the data identified in paragraph (c)(2) of this section, including limitations, restrictions, or other conditions pertinent to the installation must be furnished with each equipment manufactured under this TSO.

(e) *Previously approved equipment.* Airborne radio receiving and direction finding equipment approved prior to the effective date of this section may continue to be manufactured under the provisions of its original approval.

§ 37.140 Propeller feathering hose assemblies (rubber and wire braid construction)—TSO–C42.

(a) *Applicability*—(1) *Minimum performance standards.* Minimum performance standards are hereby established for propeller feathering hose assemblies of the following types which are to be used in civil aircraft of the United States;

(i) Type 1 (pressure line) hose assemblies which are intended to be used in the line connecting the feathering pump outlet to the propeller governor.

(ii) Type 2 (supply line "fire-resistant") hose assemblies which are intended to be used in the line connecting the oil supply to the feathering pump where this entire line is located aft of the firewall.

(iii) Type 3 (supply line "fireproof") hose assemblies which are intended to be used in the line connecting the oil supply to the feathering pump where this line is located wholly or in part forward of the firewall.

New models of propeller feathering hose assemblies manufactured for use in civil aircraft on or after March 1, 1957, shall meet the "performance" section of Military Specification MIL–H–8795 (ASG) dated January 6, 1956,* or MIL–H–8790 dated August 22, 1956,* with the following exception and shall also meet the appropriate fire test requirements listed below.

* Copies of these specifications may be obtained by addressing a request to the Commanding General, Air Materiel Command, Wright-Patterson Air Force Base, Dayton, Ohio.

(2) *Exception.* The hydraulic impluse test requirements in MIL–H–8795 (ASG) and MIL–H–8790 need not be met for the purposes of this section.

(3) *Pressure line (type 1) hose assembly fire test*—(i) *Test setup and flame requirements.* (*a*) For the purpose of this test, a length of hose five times the outside diameter or longer shall be subjected to a flame of the size and temperature specified in (*d*) and (*e*) of this subdivision while the hose is in a horizontal position. The entire end fitting shall also be subjected to this flame.

(*b*) The hose assembly shall be installed horizontally in the test setup in such a manner that it includes at least one full 90° bend so that the pressure existing inside the hose will exert an axial force on the end fitting equal to the inside area of the hose multiplied by the internal pressure.

(*c*) During the test the end fitting which is subjected to flame shall be vibrated at the rate of 2,000 cycles per minute through a total amplitude of not less than ⅛ inch, i. e., a displacement of 1/16 inch on each side of the neutral position.

(*d*) The flame temperature shall be 2,000° F., plus or minus 50° F. as measured within ¼ inch of the surface of the hose and end fitting at the point nearest the flame. Suitable shielded thermocouples or equivalent temperature measuring devices shall be used for measuring the flame temperature. A sufficient number of these shall be used to assure that the specified temperature exists at least along the entire end fitting and along the hose for a distance of not less than three times its outside diameter.

(*e*) The flame diameter shall not be less than three times the maximum diameter of the hose or three times the maximum diameter of the end fitting (whichever is greater). The length of the flame shall be such that it extends beyond the end fitting and hose when they are in place during the test, for a distance of not less than three times the maximum diameter of the hose or three times the maximum diameter of the end fitting, whichever is greater.

(*f*) During the test SAE 20 oil or equivalent shall be circulated through the hose assembly, and the oil shall enter the hose assembly at a temperature of not less than 200° F.

NOTE: Items (*d*) and (*e*) of this subdivision, concerning flame size and distribution, will be revised in accordance with agreements reached with the SAE A-3 Flame Test Subcommittee, when its study of this problem is completed.

(ii) *Fire test procedure*—(*a*) *Part I.*

Pressure: 150 psi (minimum).

Oil flow rate: 1.3 quarts/minute (maximum).

Duration: 4 minutes, 30 seconds.

(*b*) *Part II* (*which shall immediately follow Part I*).

Pressure: 1,650 psi (minimum).

Oil flow rate: 14 quarts/minute (maximum: any lower flow rate is acceptable).

Duration: 30 seconds.

(iii) *Criteria for acceptability.* The hose assembly under test shall be considered acceptable if it complies with these test conditions without evidence of leakage.

(4) *Supply line "fire-resistant" (type 2) hose assembly fire test*—(i) *Test set up and flame requirements.* Same as subparagraph (3) (i) of this paragraph.

(ii) *Fire test procedure.*

Pressure: 30 psi (minimum).

Oil flow rate: 1.3 quarts/minute (maximum).

Duration: 5 minutes.

(iii) *Criteria for acceptability.* Same as subparagraph (3) (iii) of this paragraph.

(5) *Supply line "fireproof" (type 3) hose assembly fire test*—(i)—*Test setup and flame requirements.* Same as subparagraph (3) (i) of this paragraph.

(ii) *Fire test procedure.* Test shall be conducted as described in subparagraph (4) (ii) of this paragraph except that upon completion thereof test shall be extended for an additional 10 minutes making the total duration 15 minutes.

(iii) *Criteria for acceptability.* Same as subparagraph (3) (iii) of this paragraph.

(b) *Marking.* The following marking is required in lieu of that specified in § 37.7:

(1) Name or trademark of the manufacturer responsible for compliance with this TSO.

(2) Model designation.

(3) Date of manufacture.

(4) Applicable TSO number, followed immediately by "Type Number" (as "Type 1," etc.). This identification must be legibly stamped on a steel (or other fireproof material) band securely affixed to the hose assembly.

§ 37.141 Aircraft position lights—TSO-C30b.

(a) *Applicability*—(1) *Minimum performance standards.* Minimum performance standards are hereby established for position lights which are to be used in civil aircraft of the United States.* New models of position lights manufactured for installation on civil aircraft on or after March 31, 1957, shall meet the standards set forth in SAE Specification AS271, "Aircraft Position Lights," dated October 15, 1952,** with the exception listed in subparagraph (2) of this paragraph. Position lights approved by the Civil Aeronautics Administration prior to March 31, 1957, may continue to be manufactured under the provisions of their original approval.

(2) *Exceptions.* For the purpose of this section only the standards set forth in subsection 3.3 and section 4 (except subsection 4.3.2.3 and 4.7) need be complied with.

(b) *Marking.* In lieu of the marking requirements of paragraph (d) (3) of § 37.7, the minimum lamp candle power or lamp part number shall be shown.

§ 37.142 Temperature indicators—TSO-C43.

(a) *Applicability*—(1) *Minimum performance standards.* Minimum performance standards are hereby established for temperature indicators which specifically are required to be

* The number and types of position lights for each aircraft category are established in Federal Aviation Regulations Parts 23, 25, 27 and 29 of this title. In general, air-carrier aircraft use all five types listed in AS271, section 2, while other aircraft are equipped with types I, II, and III only.

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approved for use in civil aircraft of the United States. New models of temperature indicators manufactured for installation in civil aircraft on or after October 15, 1957, shall meet the standards set forth in SAE Aeronautical Standard AS-413A, "Temperature Indicator," dated December 15, 1954.* Temperature indicators approved by the Civil Aeronautics Administration prior to October 15, 1957, may continue to be manufactured under the provisions of their original approval.

(b) *Marking.* In lieu of the weight specified in § 37.7(d)(3), the rating shall be shown.

(c) *Data requirements.* With the statement of conformance, one copy each of the manufacturer's operating instructions, schematic diagrams, and installation procedures shall be furnished the Chief, Engineering and Manufacturing Branch, Flight Standards Division, Federal Aviation Administration, in the region in which the manufacturer is located.

§ 37.143 Fuel flowmeters—TSO-C44a.

(a) *Applicability.*—(1) *Minimum performance standards.* Minimum performance standards are hereby established for fuel flowmeters which specifically are required to be approved for use on civil aircraft of the United States. New models of fuel flowmeters manufactured for installation on civil aircraft on or after November 1, 1961, shall meet the standards set forth in SAE Aeronautical Standard AS-407B, "Fuel Flowmeters," revised March 1, 1960,* with exceptions and additions to the standards listed in subparagraph (2) of this paragraph.

(2) *Exceptions and additions.*

(i) Correction to Section 1. of AS-407B: As referenced in this TSO, AS-407B specifies minimum requirements for fuel flowmeters for use on reciprocating engine or turbine-powered civil aircraft. In addition, the following specifically numbered subsections in AS-407B do not concern minimum performance and, therefore, are not essential to compliance with this section: subsections 3.1, 3.2, and 4.2.1.

(ii) Thermal shock: This test shall apply to any hermetically sealed components. The component shall be subjected to four cycles of exposure to water at 85°±2° C. and 5°±2° C. without evidence of moisture pentration or damage to coating or enclosure. Each cycle of the test shall consist of immersing the component in water at 85°±2° C. for a period of 30 minutes, and then within 5 seconds of removal from the bath, the component shall be immersed for a period of 30 minutes in the other bath maintained at 5°±2° C. This cycle shall be repeated continuously, one cycle following the other until four cycles have been completed. Following this test, the component shall be subjected to the Sealing test specified in (iii). No leakage shall occur as a result of this test.

(iii) Sealing: This performance test shall apply to any hermetically sealed components. The component shall be immersed in a suitable liquid, such as water. The absolute pressure of the air above the liquid shall then be reduced to approximately 1 inch of mercury (Hg) and maintained for 1 minute, or until air bubbles cease to be given off by the liquid, whichever is longer. The absolute pressure shall then be increased by 2½ inches Hg. Any bubbles coming from within the indicator case shall be considered as leakage and shall be cause for rejection. Bubbles which are the result of entrapped air in the various exterior parts of the case shall not be considered as leakage. Other test methods which provide evidence equal to the immersion test of the integrity of the instrument's seals may be used. If the component incorporates nonhermetically sealed appurtenances, such as a case extension, these appurtenances may be removed prior to the Sealing test.

(iv) Correction to subsection 3.3.1: Under column *A*, the temperature values for unheated areas (Temperature Uncontrolled) shall be −55° to 70° C.

(b) *Marking.* In addition to the marking requirements of FAR § 37.7, range (transmitters only) and electrical rating shall be shown.

(c) *Data requirements.*

(1) The manufacturer shall maintain a current file of complete design data.

(2) The manufacturer shall maintain a current file of complete data describing the in-

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spection and test procedures applicable to his product (see paragraph (d), Quality control, of this section).

(3) Six copies each, except where noted, of the following shall be furnished to the Chief, Engineering and Manufacturing Division, Flight Standards Service, Federal Aviation Administration, Washington, D.C. 20590.

(i) Manufacturer's operating instructions and instrument limitations.

(ii) Drawings of major components or photographs showing exploded views of instruments.

(iii) Installation procedures with applicable schematic drawings, wiring diagrams and specifications. Indicate any limitations, restrictions, or other conditions pertinent to installation with the statement of conformance certifying that the instrument conform to this section.

(iv) One copy of the manufacturer's test report.

(d) *Quality control.* Each fuel flowmeter shall be produced under a quality control system, established by the manufacturer, which will assure that each fuel flowmeter is in conformity with the requirements of this section and is in condition for safe operation. This system shall be described in the data required under paragraph (c)(2) of this section. A representative of the Administrator shall be permitted to make such inspections and tests at the manufacturer's facility as may be necessary to determine compliance with the requirements of this section.

(e) *Previously approved equipment.* Fuel flowmeters approved by the Administrator prior to November 1, 1961, may continue to be manufactured under the provisions of their original approval.

(f) *Effective date.* November 1, 1961.

§ 37.144 Manifold pressure indicating instruments—TSO–C45.

(a) *Applicability*—(1) *Minimum performance standards.* Minimum performance standards are hereby established for manifold pressure indicating instruments which specifically are required to be approved for use in civil aircraft of the United States. New models of manifold pressure indicating instruments manufactured for installation in civil aircraft on or after October 15, 1957, shall meet the standards set forth in SAE Aeronautical Standard AS–411, "Manifold Pressure Indicating Instruments," dated November 1, 1948.* Manifold pressure indicating instruments approved by the Civil Aeronautics Aministration prior to October 15, 1957, may continue to be manufactured under the provisions of their original approval.

(b) *Marking.* In lieu of the weight specified in § 37.7(d)(3), the range shall be shown.

(c) *Data requirements.* With the statement of conformance, one copy each of the manufacturer's operating instructions, schematic diagrams, and installation procedures shall be furnished the Chief, Engineering and Manufacturing Branch, Flight Standards Division, Federal Aviation Administration, in the region in which the manufacturer is located.

§ 37.145 Maximum allowable airspeed indicator systems—TSO–C46a.

(a) *Applicability.* This technical standard order prescribes the minimum performance standards that maximum allowable airspeed indicator systems must meet in order to be identified with the applicable TSO marking. New models of the instrument that are to be so identified, and that are manufactured on or after the effective date of this TSO, must meet the requirements of the "Federal Aviation Administration Standard, Maximum Allowable Airspeed Indicator Systems", set forth at the end of this section.

(b) *Marking.* In addition to the markings required by § 37.7, the instrument must be marked to indicate its range in knots, and, if applicable, to identify the calibration employed to control the movement of the maximum allowable airspeed pointer in the V_{MO} and M_{MO} ranges, or to identify the particular aircraft type design on which the instrument is intended to be used.

(c) *Data requirements.* In accordance with § 37.5, the manufacturer must furnish the Chief, Engineering and Manufacturing

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Branch, Flight Standards Division, Federal Aviation Administration, in the region in which the manufacturer is located, the following technical data:

(1) Seven copies of the manufacturer's operating instruction, equipment limitations, and installation procedures.

(2) One copy of the test report of the manufacturer.

(d) *Previously approved equipment.* Maximum allowable airspeed indicator models approved prior to the effective date of this section may continue to be manufactured under the provisions of their original approval.

FEDERAL AVIATION ADMINISTRATION STANDARD

Maximum Allowable Airspeed Indicator Systems

1. Purpose.

This document specifies minimum performance standards for pitot-static type, maximum allowable airspeed indicator systems which indicate continuously both indicated airspeed and maximum allowable airspeed.

2. Performance Requirements.

2.1 *General.*

(a) *Materials.* Materials must be of a quality demonstrated to be suitable and dependable for use in aircraft instruments.

(b) *Environmental conditions.* The instrument must be capable of performing its intended function and not be adversely affected during or following prolonged exposure to the environmental conditions stated under section 3. Where optional environmental conditions are set forth, the conditions selected must be declared as equipment limitations.

2.2 *Detail requirements.*

(a) *Indicating means.* Indicated airspeed and maximum allowable airspeed must be displayed in such a manner that the numerical values on the scale increase in a clockwise, left to right, or bottom to top direction.

(b) *Case markings.* The outlets in the case must be marked with "P" for the pitot pressure connection, and with "S" for the static pressure connection.

2.3 *Design requirements.*

(a) *Adjustable settings.*

(1) *Maximum allowable airspeed pointer.* An adjustable stop may be provided in the instrument for limiting the movement of the maximum allowable airspeed pointer. If included, the design of this adjustment must be such that it will not affect the indication of the pointer when the altitude pressure conditions and Mach Number setting are such that the limiting speed will be lower than that set by the adjustable stop.

(2) *Mach Number.* If a readily accessible means is provided for setting the instrument to any desired Mach Number, the value of the setting must be visible from the front of the instrument. When the instrument does not contain an external Mach Number setting adjustment, the value of the permanent Mach Number setting need not be visible from the front of the instrument.

(b) *Visibility.* The indicating means and all markings must be visible from any point within the frustum of a cone, the side of which makes an angle of at least 30° with the perpendicular to the dial and the small diameter of which is the aperture of the instrument case. The distance between the dial and the cover glass must be a practical minimum.

(c) *Calibration.*

(1) *Indicated airspeed pointer.* The indicated airspeed pointer must indicate airspeed in accordance with the values contained in Table I.

(2) *Maximum allowable airspeed pointer.* The maximum allowable airspeed pointer must indicate maximum allowable airspeed values in the V_{MO} and M_{MO} limit ranges which—

(i) Follow the standard fundamental relationships of subsonic compressible flow gas dynamics which are stated in appendix A; or

(ii) Are adjusted to account for design factors that are characteristic of a particular aircraft type design such as, but not limited to, static source pressure error variations and variable speed limitations with altitude.

(d) *Scale error.*

(1) *Instruments with permanent Mach Number setting.* The indicated airspeed scale error and the maximum allowable airspeed scale error must not exceed the tolerances specified in Tables I and II, respectively, with the instrument set at its permanent Mach Number.

(2) *Instruments with means for external Mach Number setting adjustment.*

(i) The indicated airspeed scale error must not exceed the tolerances specified in Table I with the instrument set at the lowest Mach Number.

(ii) The maximum allowable airspeed scale error must not exceed the tolerances specified in Table II with the instrument set at the lowest Mach Number and at increasing Mach Number setting of not more than 0.10 to and including the maximum Mach Number.

(e) *Hysteresis.* The reading of the maximum allowable airspeed pointer first at 30,000 feet altitude and then at 10,000 feet altitude must not differ by more than 2 knots from the corresponding readings obtained for increasing altitudes during tests to assure the instrument complies with the scale error requirements of section 2.3(d)(2)(ii) of this TSO.

(f) *After effect.* To assure the instrument complies with the scale error requirements of section 2.3 (d)(2)(ii) of this TSO, the maximum allowable airspeed pointer must return to its original readings, corrected for any change in atmospheric pressure, within 3 knots, after not less than 1 or more than

5 minutes have elapsed following completion of performance tests.

(g) *Friction.*

(1) *Maximum allowable airspeed pointer.* The friction of the pointer must not produce an error exceeding 4 knots at each point indicated by an asterisk in Table II.

(2) *Indicated airspeed pointer.* The friction of the pointer must not produce an error exceeding 3 knots at each point indicated by an asterisk in Table I.

(h) *Leak.*

(1) *Case leak.* When subjected to a static pressure differtntial of 15 inches of mercury between the inside and outside of the case, the internal pressure must not increase because of case leaks more than 0.05 inches of mercury at the end of 1 minute time following first application of the differential pressure.

(2) *Airspeed diaphragm leak.* There must not be any appparent movement of the indicated airspeed pointer for 1 minute after a sequence of events in which pressure sufficient to produce full scale deflection of the indicated airspeed pointer is applied to the pitot connection (static pressure connection open to atmosphere), the pressure source is stopped, and the connection tubing pinched.

3. Environmental Conditions.

3.1 *Temperature.* The instrument must perform its intended function over the range of ambient temperature from −30° to 50° C. With the instrument temperature stabilized at the limits of the range, the scale error must not exceed by more than 4.5 knots the tolerances specified in Tables I and II at the points marked with an asterisk. The instrument must not be adversely affected by exposure to the range of ambient temperature from −65° to 70° C.

3.2 *Altitude.* The instrument must perform its intended function and must not be adversely affected when operating in the pressure range from −1,000 feet and the maximum altitude of intended operation. The instrument must withstand an external case pressure of 50″ Hg. absolute when installed properly and vented to an atmospheric pressure of approximately 29.92″ Hg. absolute.

3.3 *Vibration.* The instrument must perform its intended function and must not be adversely affected when subjected to vibrations of the following characteristics:

Instrument panel mounted (vibration isolated)	Frequency cycles per second	Maximum double amplitude (inches)	Maximum acceleration
Reciprocating engine powered aircraft	5–50	0.020	1.5g
Turbine engine powered aircraft	5–55	0.020	----------
	55–1000	----------	0.25g

3.4 *Humidity.* The instrument must perform its intended function and must not be adversely affected following exposure to the extreme condition of relative humidity in the range from 0 to 95 percent at a temperature of approximately 70° C. for a period of 10 hours.

4. Compliance Tests.

As evidence of compliance with this standard, the manufacturer must perform evaluation tests on prototype instruments to demonstrate proper design, reliability in performance of its intended functions, and conformity with the performance standards of section 2. Tests must also be performed to demonstrate compliance with the environmental condition requirements specified in section 3.

5. Individual Performance Tests.

The manufacturer must conduct such tests as may be necessary on each instrument to assure that it will meet the minimum performance requirements of sections 2.3(b) through 2.3(h).

TABLE I

Speed knots	Impact pressure (qc) inches Hg at 25° C.	Tolerance knots
50	0.1198	±4.0
*60	.1727	2.0
80	.3075	2.0
*100	.4814	2.0
120	.6950	2.0
*150	1.091	2.5
180	1.580	3.0
*200	1.959	3.0
230	2.610	3.0
*250	3.100	3.0
280	3.924	3.5
*300	4.534	3.5
320	5.195	3.5
*350	6.286	4.0
370	7.082	4.5
*400	8.385	5.0
430	9.826	5.5
*450	10.87	6.0
480	12.56	7.0
*500	13.78	7.0
520	15.07	7.0
*550	17.16	8.5
570	18.66	8.5
*600	21.07	9.0
630	23.71	9.5
*650	25.59	10.0

TABLE II

Altitude feet	Pressure inches mercury	Maximum speed pointer tolerance ±knots
0	29.921	**4
*5,000	24.896	
10,000	20.577	
*15,000	16.886	
20,000	13.750	
*25,000	11.104	
30,000	8.885	
*35,000	7.041	
40,000	5.538	
*45,000	4.355	
50,000	3.425	**4

**From indicated airspeed corresponding to maximum equivalent airspeed or maximum mach whichever is the limiting factor.

APPENDIX A

Relationships For Calibrating Maximum Allowable Airspeed Pointer

(1) For altitudes from sea level to altitude where

$$V_{MO}=C_{so}\sqrt{\frac{2}{k-1}\left\{\left\{1+\frac{P}{Po}\left[\left(\frac{V^2_M}{5\,C^2_{so}}+1\right)^{\frac{k}{k-1}}-1\right]\right\}^{\frac{k-1}{k}}-1\right\}}$$

(2) For altitudes where M_{MO} is limiting factor:

$$V_{MO}=C_{so}\sqrt{\frac{2}{k-1}\left\{\left\{\frac{P}{Po}\left[\left(1+\frac{k-1}{2}\cdot M^2_{MO}\right)^{\frac{k}{k-1}}-1\right]+1\right\}^{\frac{k-1}{k}}-1\right\}}$$

Where:

V_{MO}=Maximum allowable indicated airspeed in knots.

M_{MO}=Maximum allowable mach.

k=Ratio of specific heats=1.40 for air.

Po=Pressure at sea level in inches of Hg.

P=Ambient static pressure in inches of Hg.

C_{SO}=Speed of sound at sea level=661.48 knots.

α=Density ratio at altitude.

V_M=Maximum equivalent airspeed in knots.

§ 37.146 Pressure instruments—fuel, oil, and hydraulic—TSO-C47.

(a) *Applicability*—(1) *Minimum performance standards.* Minimum performance standards are hereby established for pressure instruments—fuel, oil, and hydraulic—which specifically are required to be approved for use in civil aircraft of the United States. New models of pressure indicators—fuel, oil, and hydraulic—manufactured for installation in civil aircraft on or after October 15, 1957, shall meet the standards set forth in SAE Aeronautical Standard AS-408A, "Pressure Instruments—Fuel, Oil, and Hydraulic," dated December 15, 1954.* Pressure instruments—fuel, oil, and hydraulic—approved by the Civil Aeronautics Administration prior to October 15, 1957, may continue to be manufactured under the provisions of their original approval.

(b) *Marking.* In lieu of the weight specified in § 37.7(d)(3), the rating and range shall be shown.

(c) *Data requirements.* With the statement of conformance, one copy each of the manufacturer's operating instructions, schematic diagrams, and installation procedures shall be furnished the Chief, Engineering and Manufacturing Branch, Flight Standards Division, Federal Aviation Administration, in the region in which the manufacturer is located.

§ 37.147 Carbon monoxide detector instruments—TSO-C48.

(a) *Applicability*—(1) *Minimum performance standards.* Minimum performance standards are hereby established for carbon monoxide detector instruments which specifically are required to be approved for use in civil aircraft of the United States. New models of carbon monoxide detector instruments manufactured for installation in civil aircraft on or after October 15, 1957, shall meet the standards set forth in SAE Aeronautical Standard AS-412A, "Carbon Monoxide Detector Instruments," dated December 15, 1956.* Carbon monoxide detector instruments approved by the Civil Aeronautics Administration prior to October 15, 1957, may continue to be manufactured under the provisions of their original approval.

(b) *Marking.* In lieu of the weight specified in § 37.7(d)(3), the rating shall be shown.

(c) *Data requirements.* With the statement of conformance, one copy each of the manufacturer's operating instructions, schematic diagrams, and installation procedures shall be furnished the Chief, Engineering and Manufacturing Branch, Flight Standards Division, Federal Aviation Administration, in the region in which the manufacturer is located.

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§ 37.148 Electric tachometer: magnetic drag (for air carrier aircraft)—TSO–C49a.

(a) *Applicability*—(1) *Minimum performance standards.* Minimum performance standards are hereby established for electric tachometers which specifically are required to be approved for use on civil aircraft of the United States. New models of electric tachometers manufactured for installation on civil aircraft on or after October 15, 1960, shall meet the standards set forth in SAE Aeronautical Standard AS–404B, "Electric Tachometer: Magnetic Drag (Indicator and Generator)," dated February 1, 1959* with exceptions, additions, and substitutions to the standards listed in subparagraph (2) of this paragraph. Electric tachometers approved prior to October 15, 1960),* may continue to be manufactured under the provisions of their original approval.

(2) *Exceptions.* (i) The following specifically numbered parts in AS–404B do not concern minimum performance and therefore are not essential to compliance with this section: Parts 3.1, 3.1.1, 3.1.2, 3.2, 3.2 (a) (b) (c) (d) (e) (f), 4.1.3.1, 4.1.3.2, 4.1.3.3, 4.1.3.4, and 4.1.3.5.

(ii) In lieu of part 7 in AS–404B, it is a requirement that tachometers covered by this section be capable of successfully passing the tests in parts 7.1 through 7.8.

(b) *Marking.* In addition to the markings specified in § 37.7, range and rating shall be shown.

(c) *Data requirements.* (1) The manufacturer shall maintain a current file of complete design data.

(2) The manufacturer shall maintain a current file of complete data describing the inspection and test procedures applicable to his product. (See paragraph (d) of this section.)

(3) Six copies each of the following shall be funished to the Chief, Engineering and Manufacturing Branch, Flight Standards Division, Federal Aviation Administration, in the region in which the manufacturer is located.

(i) Manufacturer's operating instructions and instrument limitations.

(ii) Drawing or photograph showing exploded view of instruments.

(iii) Installation procedures with applicable schematic drawings, wiring diagrams, and specifications. Indicate any limitations, restrictions, or other conditions pertinent to installation.

(d) *Quality control.* Each electric tachometer shall be produced under a quality control system, established by the manufacturer, which will assure that each tachometer is in conformity with the requirements of this section and is in condition or safe operation. This system shall be described in the data required under paragraph (c)(2) of this section. The Administrator shall be permitted to make such inspections and tests at the manufacturer's facility as may be necessary to determine compliance with the requirements of this section.

§ 37.149 Aircraft audio and interphone amplifiers—TSO–C50b.

(a) *Applicability.* This technical standard order prescribes the minimum performance standards that aircraft audio and interphone amplifiers must meet in order to be identified with the applicable TSO marking. New models of the equipment that are to be so identified, and that are manufactured on or after the effective date of this section, must meet the requirements of the "Federal Aviation Administration Standard, Aircraft Audio and Interphone Amplifiers" set forth at the end of this section and the "Federal Aviation Administration Document for Environmental Test Procedures for Airborne Electronic Equipment" set forth in TSO–C87, effective February 1, 1966 (30 F.R. 15553, December 17, 1965).

(b) *Marking*—

(1) In addition to the markings specified in § 37.7, the equipment must be marked to indicate the environmental extremes over which it has been designed to operate. There are six environmental procedures outlined in the FAA Document for Environmental Test Procedures for Airborne Electronic Equipment that have categories established. These must be identified on the nameplate by the words

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* When electric tachometers are installed on civil aircraft, the installation must comply with the functional and installation requirements of Parts 23, 25, 27, or 29 of the Federal Aviation Regulations as applicable.

"Environment Categories" or, as abbreviated "Env. Cat." followed by six letters that identify the categories designated. Reading from left to right, the category designations must appear on the nameplate in the following order so that they may be readily identified—

(i) Temperature-altitude category;

(ii) Vibration category;

(iii) Audio-frequency magnetic field susceptibility category;

(iv) Radio-frequency susceptibility category;

(v) Emission of spurious radio-frequency energy category; and

(vi) Explosion category.

(2) A typical nameplate identification is: Env. Cat. DBAAAX.

(3) If a manufacturer desires to substantiate his equipment under two categories, he must mark the nameplate with both categories in the space designated for that category by placing one letter above the other in the following manner:

Env. Cat. ABAAAX
D

(c) *Data requirements.* In accordance with § 37.5, the manufacturer must furnish to the Chief, Engineering and Manufacturing Branch, Flight Standards Division, Federal Aviation Administration, in the region in which the manufacturer is located, the following technical data:

(1) Manufacturer's operating instruction and equipment limitations.

(2) Installation procedures with applicable schematic drawings, wiring diagrams, and specifications. Indicate any limitations, restrictions, or other conditions pertinent to installation.

(3) Manufacturer's test report.

(d) *Previously approved equipment.* Aircraft audio and interphone amplifier models approved prior to August 18, 1966, may continue to be manufactured under the provisions of their original approval.

FEDERAL AVIATION ADMINISTRATION STANDARD

Aircraft Audio and Interphone Amplifiers

1.0 General Standards.

1.1 *Rating of Components.* The equipment must incorporate in its design components of such rating that, when the equipment is operated throughout the range of the specified environmental tests, the ratings established by the manufacturers of the components are not exceeded. For electron tubes, the continuous commercial service rating of the tube manufacturer is applicable except for the heaters and filaments. The voltage applied to the heaters and filaments of electron tubes must be within 5% of the manufacturer's rating when the equipment is operated under standard test conditions.

1.2 *Operation of Controls.* The design of the equipment must be such that the controls intended for use during flight cannot be operated in any possible position combination or sequence that would result in a condition whose presence or continuation would be detrimental to the continued performance of the equipment.

1.3 *Effect of Tests.* Unless otherwise stated, the design of the equipment must be such that the application of the specified tests produces no discernible condition that would be detrimental to the reliability of equipment manufactured in accordance with such design.

2.0 Minimum Performance Standards Under Standard Test Conditions.

The electrical test procedures applicable to a determination of the performance of the equipment under standard test conditions are set forth in Appendix A of this standard.

2.1 *Audio-Frequency Response.* The audio output must not vary more than 6 db when the level of an audio input signal is held constant and the frequency varied over the frequency range of 350–3,000 c.p.s.

NOTE: The response of the audio amplifier may be changed to effect an overall aircraft receiving system response including the receiver, headphones, etc., such that the audio output does not vary more than 6 db when the level and the percentage modulation is held constant and the audio frequency varied over the range of 350 to 2,500 c.p.s.

2.2 *Distortion.* The combined noise and distortion in the output of the amplifier must not exceed (a) 20% at rated power output, (b) 6% at 0.01 of rated power output. This standard must be met over the frequency range of 350–3,000 c.p.s.

2.3 *Coupling Between Audio Circuits.* The coupling between the audio input circuits of the amplifier must be down at least 40 db at all position combinations of the audio selector switches.

2.4 *Audio Noise Level-Without Signal.* The level of the noise output of the amplifier, in the absence of an audio input signal, must be at least 40 db below the rated output of the amplifier. Equipment designed for an a.c. power source must meet this requirement at all power frequencies within the range for which the equipment is designed.

2.5 *Output Regulation.* The change in the voltage level of the output signal must not exceed 3 db and the distortion in the output signal must not exceed 25%, when the output load impedance is changed

from that for which the amplifier is designed to 50% and to 200% of that for which the amplifier is designed.

2.6 *Emission of Spurious Radio-Frequency Energy.* The levels of conducted and radiated spurious radio-frequency energy emitted by the equipment must not exceed those levels specified in Appendix A to Federal Aviation Administration Document for Environmental Test Procedures for Airborne Electronic Equipment set forth in TSO-C87 (30 F.R. 15553, December 17, 1965), hereafter referred to as FAA Environmental Test Procedures.

3.0 Minimum Peformance Standards Under Environmental Test Conditions.

Unless otherwise specified, the test procedures, applicable to a determination of the performance of this equipment under environmental test conditions are set forth in the FAA Environmental Test Procedures. The applicable electrical test procedures are set forth in Appendix A of this standard.

3.1 *Temperature—Altitude Test.*

a. Low Temperature Test—When subjected to this test, the manufacturer's rated power output must be obtained and the requirements of paragraphs 2.2 and 2.4 must be met.

b. High Temperature Test—

(1) When the equipment is operated at the high short-time operating temperature:

(a) The power output must not be more than 6.0 db below the manufacturer's rated output.

(b) All mechanical devices must operate satisfactorily.

(c) There must be no evidence of materials, such as grease or potting and sealing compounds, exuding or dripping from the equipment components.

(2) When the equipment is operated at the high operating temperature, the manufacturer's rated power output must be obtained and the requirements of paragraphs 2.2 and 2.4 must be met.

c. Decompression Test (Applicable Only to Category D Equipment of Temperature-Altitude Test)—When the equipment is subjected to this test, the power output must not be more than 3.0 db below the manufacturer's rated output.

d. Altitude Test—When the equipment is subjected to this test, the manufacturer's rated power output must be obtained and the standards of paragraph 2.2 must be met.

3.2 *Humidity Test.* After subjection to this test, and:

a. Immediately following the 15-minute warmup period, the power output must not be more than 3.0 db below the manufacturer's rated output.

b. Within four hours from the time primary power is applied, the manufacturer's rated power output must be obtained.

3.3 *Shock Test.*

a. Following the application of the operational shocks, the manufacturer's rated power output must be obtained.

b. Following the application of the crash safety shocks, the equipment must have remained in its mounting, and no part of the equipment or its mounting must have become detached and free of the table or of the equipment.

NOTE: The application of these tests may result in damage to the equipment under test. Therefore, these tests may be conducted after the other tests are completed.

3.4 *Vibration Test.* When subjected to the vibration test, the manufacturer's rated power output must be obtained and the standards of paragraph 2.4 must be met.

3.5 *Temperature Variation Test.* When the equipment is subjected to this test, the manufacturer's rated power output must be obtained.

3.6 *Power Input Test.* When subjected to this test, the manufacturer's rated power output must be obtained and the requirements of paragraphs 2.2 and 2.4 must be met.

3.7 *Low Voltage Test.*

a. When the primary power voltage(s) of d.c. operated equipment is 80% and when that of a.c. operated equipment is 87½% of standard test voltage(s), the standards of paragraph 2.2 must be met.

b. Direct current operated equipment must operate satisfactorily within 2 minutes upon returning the primary voltage(s) to normal after the gradual reduction of the primary power voltage(s) from 80% to 50% of standard test voltage(s).

c. The gradual reduction of the primary power voltage(s) of d.c. operated equipment from 50% to 0% of standard test voltage(s) must produce no evidence of fire or smoke.

NOTE: The application of these tests may result in damage to the equipment under test. Therefore, these tests may be conducted after the other tests are completed.

3.8 *Conducted Voltage Transient Tests.*

a. Following the intermittent transient test, the manufacturer's rated power output must be obtained.

b. During the repetitive transient test, the standards of paragraph 2.4 must be met.

3.9 *Conducted Audio-Frequency Susceptibility Test.* When the equipment is subjected to this test, the standards of paragraph 2.4 must be met.

3.10 *Audio Frequency Magnetic Field Susceptibility Test.* When the equipment is subjected to this test, the standards of paragraph 2.4 must be met.

3.11 *Radio-Frequency Susceptibility Test (Radiated and Conducted).* When subjected to the conducted radio-frequency susceptibility test, the standards of paragraph 2.4 must be met.

NOTE: In the case of amplifiers designed for use with power source filters external to the amplifier,

filters having characteristics for which the equipment is designed may be used to meet this requirement.

3.12 *Explosion Test (When Required).* During the application of this test, the equipment must not cause detonation of the explosive mixture, within the test chambers.

APPENDIX A

1.0 Test Conditions.

The following definitions of terms and conditions of test are applicable to the equipment tests specified herein:

a. *Power Input Voltage—Direct Current.* Unless otherwise specified, when the equipment is designed for operation from a direct current power source, all measurements must be conducted with the power input voltage adjusted to 13.75 V, ± 2% for 12–14 V equipment, or to 27.5 V, ± 2% for 24–28 V equipment. The input voltage must be measured at the equipment power input terminals.

b. *Power Input Voltage—Alternating Current.* Unless otherwise specified, when the equipment is designed for operation from an alternating current power source, all tests must be conducted with the power input voltage adjusted to design voltage ± 2%. In the case of equipment designed for operation from a power source of essentially constant frequency (e.g., 400 c.p.s.), the input frequency must be adjusted to design frequency ± 2%. In the case of equipment designed for operation from a power source of variable frequency (e.g., 350 to 1,000 c.p.s.), tests must be conducted with the input frequency adjusted to within 5% of a selected frequency within the range for which the equipment is designed.

c. *Adjustment of Equipment.* The circuits of the equipment must be properly adjusted in accordance with the manufacturer's recommended practices prior to the application of the specified tests.

d. *Test Instrument Precautions.* Due precautions must be taken to prevent the introduction of errors resulting from the connection of headphones, voltmeters, oscilloscopes, and other test instruments across the input and output impedances of the equipment during the conduct of the tests.

e. *Ambient Conditions.* Unless otherwise specified, all tests must be conducted under conditions of ambient room temperature, pressure, and humidity. However, the room temperature must not be lower than 10° C.

f. *Warmup Period.* Unless otherwise specified, all tests must be conducted after a warmup period of not less than 15 minutes.

g. *Connected Loads.* Unless otherwise specified, all test must be conducted with the equipment outputs connected to loads having the impedance value for which the equipment is designed.

2.0 Test Procedures.

The following test procedures are satisfactory for use in determining the performance of aircraft audio and interphone amplifiers. Test procedures that provide equivalent information may be used.

2.1 *Audio-Frequency Response.*

a. *Equipment Required.* Audio Oscillator (Hewlett-Packard Model 205–A or equivalent), Output Power Meter (General Radio Model 583–A or equivalent).

b. *Measurement Procedure.* If the amplifier has a level control, set it to produce rated amplifier output. Apply a 1,000 c.p.s. signal to the amplifier input. Adjust the input signal level to produce 10% of rated output. Maintain the input signal level constant and vary the frequency of the audio signal through the range of 350 to 3,000 c.p.s. and determine the maximum and minimum amplifier output level.

2.2 *Distortion.*

a. *Equipment Required.* Audio Oscillator (Hewlett-Packard Model 205–A or equivalent), Output Power Meter (General Radio Model 584–A or equivalent), Distortion and Noise Meter (RCA Model 69–B or equivalent).

b. *Measurement Procedure.* If the amplifier has a level control, set it to produce rated amplifier output, then—

(1) Apply a 1,000 c.p.s. signal to the amplifier input. Adjust the input signal level to produce rated output. Maintain the input signal level at the value producing rated output at 1,000 c.p.s. and determine the percentage distortion plus noise in the amplifier output signal at input signal frequencies of 350, 500, 1,800 and 3,000 c.p.s.; and

(2) Repeat procedure in paragraph (1) with an input signal level that produces 0.01 of rated output at 1,000 c.p.s.

2.3 *Coupling Between Audio Circuits.*

a. *Equipment Required.* Audio Oscillator (Hewlett-Packard Model 205–A or equivalent), distortion and Noise Meter (RCA Model 69–B or equivalent).

b. *Measurement Procedure.* If the amplifier has a level control, set it to produce rated amplified output. Apply to one of the amplifier input circuits a 1,000 c.p.s. signal and adjust its level to produce rated output from the amplifier. Determine the output in db above or below the 1,000 c.p.s. input signal level, at the terminals of the other input circuits of the amplifier for all possible ON-OFF combinations of the audio selector switches and level control settings of the amplifier.

2.4 *Audio Noise Level—Without Signal.*

a. *Equipment Required.* Distortion and Noise Meter (RCA Model 69–B or equivalent).

b. *Measurement Procedure.* Apply to the terminals of the amplifier input circuits, resistors having a value equal to the impedance for which the input circuits are designed. If the amplifier has a level control, set it to produce rated amplifier output. Determine the maximum amplifier output for all possible ON-OFF position combinations of the audio selector switches. When the equipment is designed

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for operation from an a.c. power source, determine the maximum amplifier output over the input power source frequency range for which the equipment is designed for all possible ON-OFF position combinations of the audio selector switches.

2.5 *Output Regulation.*

a. *Equipment Required.* Audio Oscillator (Hewlett-Packard Model 205–A or equivalent), Output Power Meter (General Radio Model 583–A or equivalent), Distortion and Noise Meter (RCA Model 69–B or equivalent).

b. *Measurement Procedure.* If the amplifier has a level control, set it to produce rated amplifier output. Apply to the amplifier input a 1,000 c.p.s. signal and adjust its level to produce 10% of rated output from the amplifier. Determine the amplifier output and the distortion plus noise in the output signal with output load impedances of 50%, 100% and 200% of that for which the amplifier is designed. Repeat the above procedure for audio signals of 350, 500, 1,800 and 3,000 c.p.s.

2.6 *Emission of Spurious Radio-Frequency Energy.* Testing need only be done on amplifier equipment that is of such a design that it will generate and emit spurious radio-frequency energy.

a. *Equipment Required.* Comply with paragraph 2.0 a. and b. of Appendix A of FAA Environmental Test Procedures.

b. *Measurement Procedure.* Comply with paragraph 2.0 c. of Appendix A of FAA Environmental Test Procedures.

§ 37.150 Aircraft flight recorder—TSO–C51a.

(a) *Applicability.* This technical standard order prescribes minimum performance standards that aircraft flight recorders must meet in order to be identified with the applicable TSO marking. New models of flight recorders that are to be identified and that are manufactured on or after the effective date of this section must meet the Minimum Performance Standard for Aircraft Flight Recorders set forth at the end of this section.

(b) *Marking.* In addition to the markings required by § 37.7, the rating (nominal voltage and wattage) must also be marked on the recorder.

(c) *Data requirements.* The manufacturer must furnish the Chief, Engineering and Manufacturing Branch (in the case of the Western Region, the Chief, Aircraft Engineering Division), Flight Standards Division, Federal Aviation Administration, in the region where the manufacturer is located, the following technical data:

(1) Six copies of the manufacturer's operating instructions, equipment limitations, and installation procedures.

(2) One copy of the manufacturer's test report.

MINIMUM PERFORMANCE STANDARDS FOR AIRCRAFT FLIGHT RECODER

1. Purpose.

To establish minimum requirements for approved Aircraft Flight Recorders to be used in aircraft primarily for accident analysis, the operation of which may subject the recorder to environmental conditions specified in Section 3.

2. Scope.

This standard covers three basic types of aircraft flight recorders for recording time, air speed, altitude, vertical acceleration, and heading. The intelligence received by the record medium can be from direct and/or remote sensors.

2.1 *Definition of the Types*:

Type I—Non-ejectable,

Type II—Non-ejectable, restricted to any location more than ½ of the wing root chord from the main wing structure through the fuselage and from any fuel tanks,

Type III—Ejectable, unrestricted location.

3. General Requirements.

3.1 *Environmental Conditions*: The following conditions have been established as design requirements only. Tests shall be conducted as specified in Sections 5, 6, and 7.

3.1.1 *Temperature*: When installed in accordance with the instrument manufacturer's instructions, the recorder shall function over the range of ambient temperature shown in Column A below and shall not be adversely affected by exposure to the range of temperature shown in Colunm B below:

Instrument Location	*A*	*B*
Heated Areas (Temperature Controlled)	−30° to 50°C	−65° to 70°C
Unheated Areas (Temperature Uncontrolled)	−55° to 70°C	−65° to 70°C

3.1.2 *Humidity*: The recorder shall function and shall not be adversely affected when exposed to any relative humidity in the range from 0 to 95% at a temperature of approximately 32°C.

3.1.3 *Vibration*: When installed in accordance with the instrument manufacturer's instructions, the recorder shall function properly and shall not be adversely affected when subjected to vibrations of the following characteristics:

Recorder Location in Airframe	*Cycles Per Sec.*	*Max. Double Amplitude (Inches)*	*Max. Acceleration*
Airframe Structure Mounted	5—500	0.036	10g

3.1.4 *Altitude*: The recorder shall function and shall not be adversely affected when subjected to a pressure and temperature range equivalent to —1000

to 50,000 feet standard altitude, per NACA Report No. 1235, except as limited by the application of Paragraph 3.1.1. The recorder shall not be adversely affected following exposure to extremes in ambient pressures of 50 and 3 in. Hg. absolute.

3.1.5 *Radio Interference*: The recorder shall not be the source of objectionable interference, under operating conditions at any frequencies used on aircraft, either by radiation or feed-back, in electronic equipment installed in the same aircraft as the recorder.

3.1.6 *Magnetic Effect*: The magnetic effect of the recorder shall not adversely affect the operation of the other instruments installed in the same aircraft.

4. Detail Requirements.

4.1 *Recording Medium*: The record medium shall conform to the following requirements:

a. The recording medium of recorders employing mechanical inscribed markings shall advance at a rate of not less than 6 inches per hour, and that of recorders employing other means of recording shall advance at a rate sufficient to permit resolution within the accuracy prescribed in section 4.3.

b. The recording medium shall provide a recording of the required data for at least the total elapsed operating time of a flight for which the aircraft might be used.

c. The recording medium shall not be subject to deterioration or distortion of the recorded data within the limits specified herein.

4.2 *Recording Intervals and Ranges*:

a. Time: The time lapse shall be recorded at intervals of not more than one minute.

b. Pressure Altitude: —1000 to 50,000 feet of standard atmosphere pressures, and shall be recorded at intervals of not more than one second.

c. Vertical Acceleration: +6 to —3g, and shall be recorded at intervals of not more than 1/10 of one second, or at intervals of one second in which peak accelerations are recorded.

d. Air Speed: 100 to 450 knots IAS, and shall be recorded at intervals of not more than one second.

e. Heading: 360 degrees azimuth, and shall be recorded at intervals of not more than one second.

4.3 *Record Resolution*: The record resolution shall be such that the data can be analyzed with the accuracy specified in section 6.

4.4 *Record Protection*: The recorder shall be of such design that the recorded data will be protected against damage by fire, impact, and water within the limits specified herein.

4.5 *Pressure Altitude*: The terms of pressure altitude shall conform to Tables I and II.

4.6 *Air Speed*: The terms of air speed shall conform to Table III.

4.7 *Power Variations*: All units shall properly function with ±10% to —20% variation in DC voltage and/or ±10% variation in AC voltage and ±5% in frequency, provided the AC voltage and frequency vary in the same direction. The recorder shall not be damaged when subjected to lower voltages.

4.8 *Power Malfunction Indication*: A means shall be provided for indicating when adequate power is not being received by the recorder for proper operation.

4.9 *Automatic Ejection*: The automatic ejection provision of Type III recorders, including the structure holding the ejectable portion, shall be capable of operating when subjected to inertia loads corresponding to an acceleration of 6g's acting in any direction.

5. Test Conditions.

5.1 *Atmospheric Conditions*: Unless otherwise specified all tests required by this standard shall be conducted at an atmospheric pressure of approximately 29.92 inches of mercury and at an ambient temperature of approximately 25° C. When tests are conducted with the atmospheric pressure or the temperature substantially different from these values, allowance shall be made for the variation from the specified conditions.

5.2 *Vibration (to minimize friction)*: Unless otherwise specified all tests for performance may be made with the recorder subjected to a vibration of 0.002 to 0.005 inch double amplitude at a frequency of 1500 to 2000 cycles per minute. The term double amplitude as used herein indicates total displacement from positive maximum to negative maximum.

5.3 *Vibration Equipment*: Vibration equipment shall be used which will provide frequencies and amplitudes consistent with the requirements of section 3.1.3 with the following characteristics:

5.3.1 *Linear Motion Vibration*: Vibration equipment for testing airframe structure-mounted recorders or portions thereof shall be such as to allow vibration to be applied along each of three mutually perpendicular axes of the test specimen.

5.3.2 *Circular Motion Vibration*: Vibration equipment for testing shock-mounted recorders or portions thereof shall be such that a point on the case will describe, in a plane inclined 45 degrees to the horizontal plane, a circle, the diameter of which is equal to the double amplitude.

5.4 *Position*: All tests shall be conducted with the recorder mounted in its normal operating position.

5.5 *Test Voltage*: All tests for performance shall be conducted at the voltage rating recommended by the manufacturer.

5.6 *Power Conditions*: All tests for performance shall be conducted at the power rating recommended by the manufacturer.

6. Allowable Record Errors.

6.1 *Altitude Record Error*: The recorder shall be tested for allowable error at the test points specified in Table I on decreasing and increasing pressure. The rate of change in pressure during this test shall not be less than 3000 feet per minute. On decreasing pressure, the pressure shall be brought down to, but

shall not exceed, the specified test point. On increasing pressure, the pressure shall be brought up to, but shall not exceed, the specified test point. Within one minute after applying the specified pressure, the error in the record shall not exceed the tolerance values indicated in Table I for each test point.

6.2 *Acceleration Record Error*: The acceleration error shall not exceed plus or minus 0.2G in a stabilized condition, and the total error in following a single, triangular, acceleration pulse of ½ second duration or greater, shall be no more than 10% of the acceleration. (An analytical evaluation is considered acceptable).

6.3 *Time Scale Record Error*: The time lapse error shall not exceed plus or minus 1.0% during an eight hour period.

6.4 *Air Speed Record Error*: The recorder shall be tested for allowable error at the test points specified in Table III on increasing and decreasing speeds. The allowable error shall not exceed the tolerance values specified in Table III.

6.5 *Heading Record Error*: The heading record error shall not exceed plus or minus 2 degrees when measured at 15 degree intervals over 360 degrees in azimuth. This error is the difference between the sensor and the recorder.

7. Performance Tests.

The following tests, in addition to any others deemed necessary by the manufacturer, shall be the basis for determining compliance with the performance requirements of this standard.

7.1 *Room Temperature*: The recorder shall be tested at room temperature to determine compliance with the requirements under section 6.

7.2 *Low Temperature*: The recorder shall be subjected to an ambient temperature of minus 55° C for five hours and while still exposed to this temperature it shall be tested to determine compliance with the requirements under section 6.

7.3 *High Temperature*: The recorder shall be subjected to an ambient temperature of 50° C for five hours and while still exposed to this temperature it shall be tested to determine compliance with the room temperature accuracies under section 6.

7.4 *Extreme Temperature Exposure*: The recorder, after exposure to an ambient temperature of 70° C for 24 hours followed by exposure to —65° C for 24 hours followed immediately by exposure to room temperature for not more than three hours, shall meet the requirements of section 7.1. There shall be no evidence of damage as a result of exposure to the extreme temperatures.

7.5 *Hysteresis*: Not more than 15 minutes after the altitude sensor has been first subjected to the pressure corresponding to standard altitude of 50,000 feet, the pressure shall be increased at a rate corresponding to a decrease in altitude of not less than 3,000 feet per minute until the pressure corresponding to 25,000 feet is reached. Within 10 seconds the error shall not exceed the room temperature error at this test point by more than 100 feet. The altitude sensor shall remain at this pressure for not more than 15 minutes before the test to determine compliance with Table II is made, after which the pressure shall be further increased at the above rate until the pressure corresponding to 20,000 feet is reached. The altitude sensor shall remain at this pressure for not more than ten minutes before the test to determine compliance with Table II is made. The pressure shall be further increased at the above rate until atmospheric pressure is reached.

7.6 *After Effect*: Not more than five minutes after the completion of the hysteresis test, the altitude record shall have returned to its original recording, corrected for any change in atmospheric pressure, within the tolerance shown in Table II.

7.7 *Vibration*:

7.7.1 *Resonance*: The recorder, while operating, shall be subjected to a resonant frequency survey of the appropriate range specified in section 3.1.3 in order to determine if there exists any resonant frequencies of the parts. The amplitude used may be any convenient value that does not exceed the maximum double amplitude and the maximum acceleration specified in section 3.1.3.

The recorder shall then be subjected to a vibration at the appropriate maximum double amplitude or maximum acceleration specified in section 3.1.3 at the resonant frequency for a period of one hour in each axis or with circular motion vibration, whichever is applicable. When more than one resonant frequency is encountered with vibration applied along any one axis, a test period may be accomplished at the most severe resonance, or the period may be divided among the resonant frequencies, whichever shall be considered most likely to produce failure. The test period shall not be less than one-half hour at any resonant mode. When resonant frequencies are not apparent within the specified frequency range, the recorder shall be vibrated for two hours in accordance with the vibration requirements of section 3.1.3 at the maximum double amplitude and the frequency to provide the maximum acceleration.

7.7.2 *Cycling*: The recorder, while operating, shall be tested with the frequency cycled between limits specified in section 3.1.3 in 15 minute cycles for a period of one hour in each axis at an applied double amplitude specified in section 3.1.3, or an acceleration specified in section 3.1.3, whichever is the limiting value. After the completion of this vibration test, no damage shall be evident and the recorder shall meet the requirements of section 6.

7.8 *Humidity, water, impact, penetration resistance, static crush, and fire protection tests*: The humidity, impact, penetration resistance, static crush, and fire protection tests shall be made in the following se-

quence on the same recorder without the need for repairs.

7.8.1 *Humidity*: The recorder shall be mounted in a chamber maintained at a temperature of 70±2° C and a relative humidity of 95±5% for a period of 6 hours. After this period the heat should be shut off and the recorder should be allowed to cool for a period of 18 hours in this atmosphere in which the humidity rises to 100% as the temperature decreases to not more than 38° C. This complete cycle should be conducted fifteen (15) times.

Immediately after cycling, the recorder shall be subjected to the Record Error Tests of Section 6.

7.8.2 *Impact*: The intelligence on the record medium shall be capable of being analyzed after the recorder has been subjected to the following impact shock: Types I and II—Half sine wave impact shocks applied to each of the three main orthogonal axes and having a peak acceleration magnitude of 1,000 g with a time duration of at least five milliseconds. Type III—Acceleration not less than the shocks developed on contact with a horizontal rock surface, considering the direction of ejection and any provisions for alleviation of shock. With regard to the former, the aircraft shall be assumed to be tilted at least 30 degrees from horizontal in the most critical direction.

7.8.3 *Penetration Resistance (Type I and II Recorders Only)*: The intelligence on the record medium shall be capable of being analyzed after the recorder has been subjected to an impact force equal to a 500-pound steel bar which is dropped from a height of 10 feet to strike each side of the enclosure in the most critical plane. The point of contact of the bar shall have an area that is no greater than 0.05 square inches. The longitudinal axis of the bar shall be vertical at the time of impact.

NOTE: The object of this test is to achieve protection of the record medium from possible damage caused by airframe structural members striking the recorder case during crash impact.

7.8.4 *Static crush (Type I and II recorders only)*: The intelligence on the record medium shall be capable of being analyzed after the recorder has been subjected to a static crush force of 5,000 pounds applied continuously, but not simultaneously to each of the three main orthogonal axes for a test period of five minutes.

7.8.5 *Fire Protection*: The record medium shall remain intact so that the intelligence can be analyzed after the recorder is exposed to flames of 1100° C enveloping at least 50 percent of the outside area of the case for the following periods of time:

Type I—30 minutes

Type II—15 minutes

Type III—1.5 minutes

TABLE I—Altitude Record Error Table.

Standard Altitude (Feet)	*Equivalent Pressure Mercury*		*Tolerance, Feet Plus or Minus*	
	MM	*IN. HG*	*Room Temp. (Sec. 6.1)*	*Low Temp. (Sec. 7.1)*
−1,000	787.9	31.02	100	150
−500	773.8	30.47	100	---
0	760.0	29.92	100	150
500	746.4	29.39	100	---
1,000	732.9	28.86	100	---
1,500	719.7	28.33	100	---
2,000	706.6	27.82	100	---
3,000	681.1	26.81	125	---
4,000	656.3	25.84	150	210
6,000	609.0	23.98	150	250
8,000	564.4	22.22	150	---
10,000	522.6	20.58	150	---
12,000	483.3	19.03	180	350
14,000	446.4	17.57	210	---
16,000	411.8	16.21	240	---
18,000	379.4	14.94	270	450
20,000	349.1	13.75	300	---
22,000	320.8	12.63	335	---
25,000	281.9	11.10	375	560
30,000	225.6	8.88	450	600
35,000	178.7	7.04	525	730
40,000	140.7	5.54	600	800
50,000	87.3	3.44	700	---

7.8.6 *Water Protection*: The intelligence on the record medium shall be capable of remaining permanent and reproducible after the record medium has been immersed in seawater for 36 hours.

7.9 *Position Error*: The recorder shall meet the following requirements when turned from its normal operating position through 90° forward and back, and left and right where applicable:

a. Time: Section 6.3

b. Altitude: Section 6.1, except that the tolerance may be increased by 25 feet

c. Acceleration: Section 6.2

d. Airspeed: Section 6.4

e. Heading: Section 6.5

7.10 *Dielectric*: The insulation shall be subjected to a dielectric test with an RMS voltage at a commercial frequency applied for a period of five seconds, equivalent to five times normal circuit operating voltage, except where circuits include components for which such a test would be inappropriate, the test voltage shall be 1.25 times normal circuit operating voltage. The insulation resistance shall not be less than 20 megohms at that voltage.

7.11 *Automatic Ejection Means*: The automatic ejection means for Type III recorders shall be tested to demonstrate that it is capable of ejecting the recorder from its mounting when subjected to forward acting inertia loads of 5g's to 6g's.

8.0 *Recorder Color*: The exterior surface of the recorder must be finished in either a bright orange or a bright yellow color.

TABLE II—Altitude Test Table.

Tests	*Reference Section*	*Tolerance in Feet*
Hysteresis:	7.4	---
First test point 25,000 ---	--	90*
Second test point 20,000 --	--	90*
After effect test ----------	7.5	50

*In excess of the room temperature error.

TABLE III—Airspeed Record Error Table.

Standard Airspeed (Knots)	*Tolerance, Knots Plus or Minus*	
	Room Temp. (Sec. 6.1)	*Low Temp. (Sec. 7.1)*
100	10	12
150	10	12
200	10	12
250	10	12
300	10	12
350	10	12
400	10	12
450	10	12

§ 37.151 Flight directors—TSO–C52a.

(a) *Applicability*—(1) *Minimum performance standards.* Minimum performance standards are hereby established for flight directors which specifically are required to be approved for use on civil aircraft of the United States. New models of flight directors manufactured for installation on civil aircraft on or after the effective date of this section shall meet the standards set forth in SAE Aeronautical Standard AS–420A, "Flight Directors," revised November 15, 1959,* with exceptions and additions to the standards listed in subparagraph (2) of this paragraph.

(2) *Exceptions and additions.* (i) The following specifically numbered parts in AS–420A do not concern minimum performance and therefore are not essential to compliance with this section: parts: 3.1; 3.1.1; 3.1.2; 3.2(a), (b), (c), (d), (e); and 4.1.1.3.

(ii) In lieu of part 7, it is a requirement that flight directors covered by this section be capable of successfully passing the tests in parts 7.1 through 7.6.

(iii) Thermal shock: This test shall apply to any hermetically sealed components. The component shall be subjected to four cycles of exposure to water at 85°±2° C. and 5°±2° C. without evidence of moisture penetration or damage to coating or enclosure. Each cycle of the test shall consist of immersing the component in water at 85° ±2° C. for a period of 30 minutes, and then within 5 seconds of removal from the bath, the component shall be immersed for a period of 30 minutes in the other bath maintained at 5°±2° C. This cycle shall be repeated continuously, one cycle following the other until four cycles have been completed. Following this test, the component shall be subjected to the Sealing test specified in subdivision (iv) of this subparagraph. No leakage shall occur as a result of this test.

(iv) Sealing: This performance test shall apply to each hermetically sealed instrument. The instrument shall be immersed in a suitable liquid, such as water. The absolute pressure of the air above the liquid shall then be re-

* Copies may be obtained from the Society of Automotive Engineers.

duced to approximately one inch of mercury (Hg) and maintained for one minute, or until air bubbles cease to be given off by the liquid, which ever is longer. The absolute pressure shall then be increased by 2½ inches Hg. Any bubbles coming from within the indicator case shall be considered as leakage and shall be cause for rejection. Bubbles which are the result of entrapped air in the various exterior parts of the case shall not be considered as leakage. Other test methods which provide evidence equal to the immersion test of the integrity of the instrument's seals may be used. If the instrument incorporates nonhermetically sealed appurtenances, such as a case extension, these appurtenances may be removed prior to the sealing test.

(v) In addition to paragraph 4.6.2, the indicating means shall be readily discernible under any lighting condition normally encountered in aircraft.

(b) *Marking.* In addition to the markings specified in § 37.7 range and rating shall be shown.

(c) *Data requirements.* (1) The manufacturer shall maintain a current file of complete design data.

(2) The manufacturer shall maintain a current file of complete data describing the inspection and test procedures applicable to his product. (See paragraph (d) *Quality control* in this section.)

(3) Six copies each, except where noted, of the following shall be furnished to the Chief, Engineering and Manufacturing Branch, Flight Standards Division, Federal Aviation Administration, in the region in which the manufacturer is located:

(i) Manufacturer's operating instructions and instrument limitations.

(ii) Drawings of major components or photographs showing exploded views of instruments.

(iii) Installation procedures with applicable schematic drawings, wiring diagrams, and specifications. Indicate any limitations, restrictions, or other conditions pertinent to installation with the statement of conformance certifying that the instrument conforms to this section.

(iv) One copy of the manufacturer's test report.

(d) *Quality control.* Each flight director shall be produced under a quality control system, established by the manufacturer, which will assure that each flight director is in conformity with the requirements of this section and is in condition for safe operation. This system shall be described in the data required under paragrah (c)(2) of this section. The Administrator shall be permitted to make such inspections and tests at the manufacturer's facility as may be necessary to determine compliance with the requirements of this section.

(e) *Previously approved equipment.* Flight directors approved prior to the effective date of this section may continue to be manufactured under the provisions of their original approval.

§ 37.152 Fuel and engine oil system hose assemblies (rubber or tetrafluoroethylene tube and wire braid construction)—TSO–C53a.

(a) *Applicability*—(1) *Minimum performance standards.* Minimum performance standards are hereby established for new models of fuel and engine oil system hose assemblies* of the following types manufactured on or after the effective date of this section, which are to be used on civil aircraft of the United States. Fuel and engine oil system hose assemblies of the following types approved prior to the effective date of this section may continue to be manufactured under the provisions of their original approval.

(i) *Type A.* Non-fire-resistant "normal" temperature hose assemblies which are intended to be used in locations outside fire zones where the fluid and ambient air temperatures do not exceed 250° F.

(ii) *Type B.* Non-fire-resistant "high" temperature hose assemblies which are intended to be used in locations outside fire zones where the fluid and ambient air temperatures do not exceed 450° F.

* Hose assemblies for use in propeller feathering lines are covered in TSO–C42.

(iii) *Type C.* Fire-resistant "normal" temperature hose assemblies which are intended to be used in locations within fire zones where the fluid and ambient air temperatures do not exceed 250° F.

(iv) *Type D.* Fire-resistant "high" temperature hose assemblies which are intended to be used in locations within fire zones where the fluid and ambient air temperatures do not exceed 450° F.

(*a*) New models shall comply with the following minimum requirements. Three samples of each size shall be tested.

(*1*) Type A hose assemblies shall comply with the "3.3 Performance" section requirements of Specification MIL–H–8795A, dated July 25, 1958,* except as noted in subparagraph (2) of this paragraph. The hose incorporated therein shall conform to "3.6 Performance" section of Specification MIL–H–8794A, dated July 25, 1958,* except as noted in subparagraph (2) of this paragraph.

(*2*) Type B hose assemblies shall comply with the "3.6 Performance" section of Specification MIL–H–25579 (USAF) Amendment 2, dated March 19, 1959,** except as noted in subparagraph (2) of this paragraph.

(*3*) Type C hose assemblies shall comply with the above requirements for Type A hose assemblies and in addition shall pass the fire test described in subparagraph (3) of this paragraph.

(*4*) Type D hose assemblies shall comply with the above requirements for Type B hose assemblies and in addition shall pass the fire test described in subparagraph (3) of this paragraph.

(2) *Exceptions.* (i) Type A hose assemblies are not required to comply with sections 3.6.1.2 and 3.6.2.7 of Specification MIL–H–8794A. The operating and proof pressures referred to in Table 1 of that specification shall be those values listed in the "Fuel" column thereof. The burst pressures to be utilized shall be twice the proof pressures listed in the "Fuel" column in Table 1. The foregoing shall likewise apply in showing compliance with Specification MIL–H–8795A.

(ii) Type B hose assemblies are not required to compy with sections 3.6.5, 3.6.7 and 3.6.10 of Specification MIL–H–25579 (USAF). The burst pressures to be utilized shall be twice the proof pressures listed in Table 1 of that specification.

(3) *Fire test procedure and requirements.* A description of the standard fire test apparatus and its use is in FAA "Standard Fire Test Apparatus and Procedure" (Power Plant Engineering Report No. 3).* The use of a protective sleeve over the hose and/or end fittings is permitted to facilitate compliance with the fire test requirements. Sleeves or covers shall be secured to the hose assembly so that fire-resistant properties will be maintained.

(i) Oil pressure during fire test: Type C hose assemblies—the operating pressure specified in the "Fuel" column of Table 1 in Specification MIL–H–8795A. Type D hose assemblies—the operating pressure specified in Table 1 of Specification MIL–H–25579 (USAF).

(ii) Oil flow rate: $5\times$(Hose assembly actual ID in inches)^2. Example: Flow rate for -16 size$=5\times(7/8)^2=3.8$ GPM).

(iii) Duration: 5 minutes.

(iv) Criteria for acceptability: The hose assembly shall be considered acceptable if it complies with these test conditions without evidence of leakage.

(b) *Marking.* The markings required are specified in § 37.7 with the following exceptions:

(1) Trademark may be used in lieu of name, and manufacturer's address is not required.

(2) In lieu of the weight specified in paragraph (d)(3) of § 37.7, the size of the hose assembly shall be shown.

(3) The applicable TSO number shall be followed immediately by the appropriate type designation, as TSO–C53–Type B. Where a protective sleeve is employed, the information should be legibly stamped on a steel (or other

* Copies of these specifications may be obtained by addressing a request to: Commanding Officer, U. S. Naval Supply Depot, 5801 Tabor Ave., Philadelphia, Pa. 19120.

* Copies of Power Plant Engineering Report No. 3 may be obtained by addressing a request to Federal Aviation Administration.

fireproof) band securely affixed to the hose assembly.

(c) *Data requirements.* The following information and data should be submitted with the letter of conformance.

(1) One copy of drawing showing the hose assembly construction, materials, part numbers and the recommended maximum and minimum fluid and ambient temperatures for continuous operation. The following data should be shown for each size: Proof and burst pressure (minimum), Operating pressure (maximum), Bending radius (minimum).

(2) One copy of any installation instructions and/or other pertinent information (may be shown on drawing).

§ 37.153 Stall warning instruments—TSO–C54.

(a) *Applicability*—(1) *Minimum performance standards.* Minimum performance standards are hereby established for stall warning instruments which specifically are required to be approved for use on civil aircraft of the United States. New models of stall warning instruments manufactured for installation on civil aircraft on or after the effective date of this section shall meet the standards set forth in SAE Aeronautical Standard AS 403A, "Stall Warning Instrument," revised July 15, 1958,* with exceptions, and additions to the standards listed in subparagraph (2) of this paragraph.

(2) *Exceptions and additions.* (i) The following specifically numbered parts in AS 403A do not concern minimum performance and therefore are not essential to compliance with this section: Parts 3.1; 3.1.1; 3.1.2; 3.2(a), (b), (c), (d), (e), and (f).

(ii) In lieu of Part 7 of AS 403A, it is a requirement that stall warning instruments covered by this section be capable of successfully passing the tests in Parts 7.1 through 7.7 of AS 403A.

(iii) Thermal shock: This test shall apply to any hermetically sealed component. The component shall be subjected to four cycles of exposure to water at 85°±2° C. and 5°±2° C. without evidence of moisture penetration or damage to coating or enclosure. Each cycle of the test shall consist of immersing the component in water at 85°±2° C. for a period of 30 minutes, and then within 5 seconds of removal from the bath, the component shall be immersed for a period of 30 minutes in the other bath maintained at 5°±2° C. This cycle shall be repeated continuously, one cycle following the other until four cycles have been completed. Following this test, the indicator shall be subjected to the Sealing test specified in subdivision (iv) of this subparagraph. No indicator leakage shall occur as a result of this test.

(iv) Sealing: This performance test shall apply to each hermetically sealed instrument. The instrument shall be immersed in a suitable liquid, such as water. The absolute pressure of the air above the liquid shall then be reduced to approximately 1 inch of mercury (Hg) and maintained for 1 minute, or until air bubbles cease to be given off by the liquid, whichever is longer. The absolute pressure shall then be increased by 2½ inches Hg. Any bubbles coming from within the indicator case shall be considered as leakage and shall be cause for rejection. Bubbles which are the result of entrapped air in the various exterior parts of the case shall not be considered as leakage. Other test methods which provide evidence equal to the immersion test of the integrity of the instrument's seals may be used. If the instrument incorporates nonhermetically sealed appurtenances, such as a case extension, these appurtenances may be removed prior to the sealing test.

(v) Power malfunction indication: Means shall be incorporated in the instrument to indicate when adequate power (voltage and/or current) is not being made available to all phases required for the proper operation of the instrument. The indicating means shall indicate a failure or a malfunction in a positive manner, and be readily discernible under any lighting condition normally encountered in aircraft.

(b) *Marking.* In addition to the markings specified in § 37.7 range or rating (voltage) shall be shown.

* Copies may be obtained from the Society of Automotive Engineers, Inc.

(c) *Data requirements.* (1) The manufacturer shall maintain a current file of complete design data.

(2) The manufacturer shall maintain a current file of complete data describing the inspection and test procedures applicable to his product.

(3) Six copies each, except where noted, of the following shall be furnished to the Chief, Engineering and Manufacturing Branch, Flight Standards Division, Federal Aviation Administration, in the region in which the manufacturer is located.

(i) Manufacturer's operating instructions and instrument limitations.

(ii) Drawings of major components or photographs showing exploded views of instruments.

(iii) Installation procedures with applicable schematic drawings, wiring diagrams, and specifications, including any limitations, restrictions, or other conditions pertinent to installation.

(iv) One copy of the manufacturer's test report.

(d) *Quality control.* Each stall warning instrument shall be produced under a quality control system, established by the manufacturer, which will assure that each stall warning instrument is in conformity with the requirements of this section and is in condition for safe operation. This system shall be described in the data required under paragraph (c)(2) of this section. The Administrator shall be permitted to make such inspections and tests at the manufacturer's facility as may be necessary to determine compliance with the requirements of this standard.

(e) *Previously approved equipment.* Stall warning instruments approved prior to the effective date of this section may continue to be manufactured under the provisions of their original approval.

§ 37.154 Fuel and oil quantity instruments (for reciprocating engine aircraft)—TSO–C55.

(a) *Applicability*—(1) *Minimum performance standards.* Minimum performance standards are hereby established for fuel and oil quantity instruments (for reciprocating engine aircraft) which specificaly are required to be approved for use on civil aircraft of the United States. New models of fuel and oil quantity instruments (for reciprocating engine aircraft) manufactured for installation on civil aircraft on or after April 1, 1959, shall meet the standards set forth in SAE Aeronautical Standard AS–405B, "Fuel and Oil Quantity Instruments," dated July 15, 1958,* with the exceptions listed in subparagraph (2) of this paragraph. Fuel and oil quantity instruments (for reciprocating engine aircraft) approved prior to April 1, 1959, may continue to be manufactured under the provisions of their original approval.

(2) *Exceptions.* (i) Conformance with the following sections is not required: 3.1; 3.1.1; 3.1.2; 3.2; 4.2.1.

(ii) Substitute the following for section 7.: "Performance tests: The following tests, in addition to any others deemed necessary by the manufacturer, shall be the basis for determining compliance with the performance requirements of this standard."

(b) *Marking.* In lieu of the weight specified in § 37.7(d)(3), the following shall be shown:

(1) Instrument type (I or II),

(2) Range,

(3) Rating if applicable, i.e., electrical, vacuum, etc.

(c) *Data requirements.* With the statement of conformance, one copy each of the manufacturer's operating instructions, schematic diagrams, and installation procedures shall be furnished the Chief, Engineering and Manufacturing Branch, Flight Standards Division, Federal Aviation Administration, in the region in which the manufacturer is located.

§ 37.155 Engine-driven direct current generators for aircraft certificated under Part 25—TSO–C56.

(a) *Applicability*—(1) *Minimum performance standards.* Minimum performance standards are hereby established for engine-driven direct current generators which are to be used on civil aircraft of the United States certifi-

* Copies may be obtained from the Society of Automotive Engineers, Inc.

cated under Part 25. New models of engine-driven direct current generators manufactured for use on civil aircraft on or after April 1, 1959, shall meet the minimum performance standards as set forth below.

(i) *Test conditions.* Unless otherwise specified in this section, each test shall be made under the following conditions:

(*a*) *Mounting.* The generator shall be mounted on a suitable drive stand capable of driving the generator continuously within the speed range. The longitudinal axis of the generator shall be horizontal.

(*b*) *Excitation.* The generator shall be self-excited and controlled by a suitable variable resistance in series with the shunt field. The shunt field current shall not be considered as part of the generator load current.

(*c*) *Ambient temperature.* The ambient temperature shall be 95°±9° F.

(*d*) *Altitude.* The tests shall be run at approximately sea level altitude.

(*e*) *Location of load.* The load for the generator shall be so located that it will not appreciably affect the ambient temperature or the blast-cooling air temperature (if blast cooling is used).

(*f*) *Warm-up.* Prior to the test, the generator shall be operated at continuous operating speed delivering rated load at rated voltage for sufficient time to reach a substantially constant temperature.

(ii) *Test methods*—(*a*) *Manufacturer's declaration.* The manufacturer shall declare the following generator ratings and characteristics. (These values are the "rated" and "declared" quantities referred to in subsequent paragraphs describing test methods.)

(*1*) Rated terminal voltage.

(*2*) Rated load current.

(*3*) Minimum blast cooling requirement (if blast cooling is to be used).

(*4*) Rated speed range.

(*5*) Continous operating speed.

(*6*) Minimum speed for regulation.

(*7*) Maximum speed for regulation.

(*8*) Maximum overspeed.

(*9*) Minimum and maximum external field resistance in series with the shunt field.

(*10*) Maximum operating altitude.

(*11*) Allowable brush and commutator wear.

(*12*) Maximum static torque.

(*13*) Equalizing voltage (if provided) at rated load current.

(*14*) Overhang moment, with respect to the drive pad.

(*b*) *Maximum speed for regulation.* The generator shall not be given an operational warm-up prior to this test. The generator shall be operated at the maximum speed for regulation and it shall deliver the rated terminal voltage at no load with no more than the declared maximum external field resistance in series with the shunt field.

(*c*) *Heating, commutation, minimum speed and equalizing voltage.* Provision shall be made for determining speed, terminal voltage, load current, field voltage, field current and the resistance in series with the shunt field. The declared minimum blast cooling requirement shall be supplied to the generator air inlet. The temperature of the cooling air shall be determined by means of a suitable temperature indicating device whose responsive element is located within the cooling air duct. While the generator is cold, the resistance and temperature of the shunt field shall be determined for use in calculating the field temperature rise (average during continuous operation at the declared full load current. The generator shall be considered to have reached a continuous operating condition when the rate of rise of the shunt field temperature, above the then existing ambient temperature, does not exceed 2° F. in five minutes.

(*1*) *Heating.* The ability of the generator to deliver the rated load current at rated terminal voltage at the declared continuous operating speed shall be demonstrated. Immediately following the above run, the ability of the generator to deliver rated load current at rated terminal voltage for both the minimum speed for regulation and the maximum rated speed shall be demonstrated. Following this test, the generator shall demonstrate its ability to deliver rated load current at minimum rated speed, at a terminal voltage not less than 85 percent of the rated terminal voltage.

(*2*) *Commutation.* Immediately following the above heat runs, with the generator hot, the commutation of the generator shall be observed over the rated speed range for no load, half load, and rated load current. There shall be no more than fine, pin-point sparking of the brushes during this test.

(*3*) *Minimum speed.* At no time during the above heat runs shall the required resistance external to the shunt field be less than the declared minimum external field resistance.

(*4*) *Equalizing voltage.* Where an equalizing voltage is provided, it shall be within 5 percent of the declared equalizing voltage when the generator is stabilized in temperature and operating at rated load current at the declared continuous operating speed. The declared minimum blast cooling requirement shall be supplied at the generator air inlet.

(*d*) *Overspeed.* This test shall be made while the generator is hot as a result of testing and shall be made at no load with the field circuit open and at the declared maximum overspeed. The generator shall demonstrate its ability to operate under overspeed conditions for five minutes without mechanical failure, throwing of varnish, or impairing electrical performance.

(*e*) *Dielectric strength.* While the generator is hot as a result of testing, it shall withstand the following test voltage at commercial frequency, applied between windings, and between each winding and frame, for the specified time:

500 volts (rms) for one minute, or

600 volts (rms) for one second.

(*f*) *Ripple voltage.* Ripple voltage shall be determined by means of a peak reading vacuum tube voltmeter in series with a 4.0 microfarad capacitor. The generator shall be operated at 120 percent of minimum rated speed at 50 percent of rated load current, with a manually operated field rheostat, and without a battery in parallel. Peak voltage readings shall be taken with the voltmeter successively connected for each of the two polarities and the higher of the two readings shall not exceed 1.5 volts.

(*g*) *Humidity.* The relative humidity for this test shall be 95±5 percent. Subject equipment to test condition at 160°±4° F. for six hours. The heat source shall be turned off for 16 hours without changing total moisture content in the test space. During the 16-hour period, the temperature shall drop to 100° F. or less. The test shall be repeated ten times, allowing a two-hour period to stabilize to 160° F. Check for corrosion, distortion, and general deterioration. At the end of this test, the generator shall deliver rated load current at the declared continous operating speed for two hours.

(*h*) *Flexible drive.* The flexible drive test shall be conducted on a universal joint torsional vibration machine which has a fly-wheel of at least 20 times the amount of inertia of the generator armature being tested. Testing procedure shall be as follows:

(*1*) 100 hours with ±1 degree torsional amplitude input to drive shaft at critical frequencies. The flexible drive shall limit the armature amplitude within ±5 degrees.

(*2*) 50 hours with ±2 degrees torsional amplitude input to drive shaft at frequencies of 20 to 24 cps. The flexible drive shall limit the armature amplitude within ±7 degrees.

(*3*) 15 minutes with ±2 degrees torsional amplitude input to drive shaft at critical frequencies. The flexible drive shall limit the armature amplitude within ±7 degrees.

(*i*) *Performance of commutator, bearings, and brushes.* The generator shall be operated under the following conditions. New brushes may be installed for this test.

(*1*) 100 hours at the declared continuous operating speed, at rated load current with the test conditions specified in subdivision (i) of this subparagraph.

(*2*) Four continuous cycles consisting of the following: 24 hours at the declared continuous operating speed and rated load current, at altitude conditions approximating 115 percent of the declared maximum operating altitude. The ambient temperature (and cooling air temperature, if blast cooling is used) shall be related to the test altitude by the formula $T=104-(0.005)h$ (where T is the temperature in degrees F. and h is the test altitude in feet), except that the lower temperature limit, regardless of altitude, shall be −67° F. at

least one hour at the declared continuous operating speed and rated load current, with the test conditions specified in subdivision (i) of this subparagraph. The time interval between successive 24-hour runs at altitude shall not exceed two hours. The rate of change of altitude need not be controlled, but the temperature at any transition altitude shall be within 18° F. of that obtained from the temperature-altitude formula above.

(*3*) Two continuos cycles consisting of the following: Nine hours at the declared continuous operating speed and 75 percent rated load current at altitude conditions approximating 115 percent of the declared maximum operating altitude. The ambient temperature (and cooling air temperature, if blast cooling is used) shall be related to the test altitude by the formula $T=160-(0.004)h$ (where T is the temperature in degrees F. and h is the test altitude in feet); at least one hour at the declared continuous operating speed and 75 percent rated load current, with the test conditions specified in subdivision (i) of this subparagraph. The time interval prior to each nine-hour run at altitude shall not exceed two hours. The rate of change of altitude need not be controlled, but the temperature at any transition altitude shall be within 18° F. of that obtained from the temperature-altitude formula above.

(*4*) Evaluation of results of tests (*1*), (*2*), and (*3*) above: Cumulative brush or commutator wear shall not exceed 20 percent of the declared allowable wear after tests (*1*) and (*2*) and shall not exceed 4 percent of the declared allowable wear after test (*3*). No mechanical failure or electrical malfunction shall occur during this test.

(*j*) *Drive shear section.* Sufficient torsional force shall be applied to the drive shear section (or to the armature shaft itself, if no shear section is provided) to result in its failure. The necessary torque indicating instrumentation shall be provided. Failure shall occur at an applied torque of less than the declared maximum static torque.

(*b*) *Marking.* In addition to the marking required in § 37.7, the nameplate shall contain the following information:

(1) Rated terminal voltage.

(2) Rated load current.

(3) Rated speed range.

(*c*) *Data requirements.* The manufacturer shall submit a tabulation of the declared generator ratings and characteristics (called for in paragraph (a)(1)(ii)(*a*) of this section) to the Chief, Engineering and Manufacturing Branch, Flight Standards Division, Federal Aviation Administration, in the region in which the manufacturer is located.

§ 37.156 Aircraft headsets and speakers (for air carrier aircraft)—TSO–C57.

(a) *Applicability*—(1) *Minimum performance standards.* Minimum performance standards are hereby established for aircraft headsets and speakers which are to be used on civil aircraft of the United States engaged in air carrier operations. New models of aircraft headsets and speakers manufactured for use on civil aircraft on or after August 14, 1959, shall meet the minimum performance standards as set forth in Radio Technical Commission for Aeronautics' Paper entitled "Minimum Performance Standards—Aircraft Headsets and Speakers" (Paper 257–58/DO–90 dated November 18, 1958).* Radio Technical Commission for Aeronautics' Paper 100–54/DO–60* which is incorporated by reference in and thus is a part of Paper 257–58/DO–90 has been amended by Paper 256–58/EC–366 dated November 13, 1958. This amendment is also a part of the minimum performance standards. Execptions to these standards are covered in subparagrah (2) of this paragraph.

(2) *Exceptions.* (i) Radio Technical Commission for Aeronautics' Paper 100–54/DO–60, and amendment Paper 256–58/EC–366 dated November 13, 1958, outline environmental test procedures for equipment designed to operate under three environmental test conditions as specified therein under Procedures A, B, and C. Only aircraft headsets and speakers which meet the operating requirements as outlined under Procedure A or Procedure B of Paper 100–54/DO–60, as amended, are eligible under this section.

* Copies of this paper may be obtained from RTCA.

(ii) Radio Technical Commission for Aeronautics' Paper 257–58/DO–90 dated November 18, 1958, paragraph 2.3, Pilot Operated Gain Control. The provisions of this paragraph are applicable only to attenuators which are a part of the headset assembly.

(b) *Marking.* In addition to the information required in § 37.7, equipment which has been designed to operate over the environmental conditions as outlined in Procedure A of RTCA Paper 100–54/DO–60, as amended, shall be marked as Category A equipment. Equipment which has been designed to operate over the environmental conditions as outlined in Procedure B of this same paper, as amended, shall be marked as Category B equipment.

(c) *Data requirements.* With the statement of conformance, one copy each of the manufacturer's operating instructions, schematic diagrams, and installation procedures shall be furnished the Chief, Engineering and Manufacturing Branch, Flight Standards Division, Federal Aviation Administration, in the region in which the manufacturer is located.

(d) *Previously approved equipment.* Aircraft headsets and speakers approved prior to August 14, 1959, may continue to be manufactured under the provisions of their original approval.

§ 37.157 Aircraft microphones (for air carrier aircraft)—TSO–C58.

(a) *Applicability*—(1) *Minimum performance standards.* Minimum performance standards are hereby established for aircraft microphones which are to be used on civil aircraft of the United States engaged in air carrier operations. New models of aircraft microphones manufactured for use on civil aircraft on or after August 14, 1959, shall meet the minimum performance standards as set forth in Radio Technical Commission for Aeronautics' Paper entitled "Minimum Performance Standards—Aircraft Microphones" (Paper 258–58/DO–91 dated November 18, 1958).* Radio Technical Commission for Aeronautics' Paper 100–54/DO–60* which is incorporated by reference in and thus is a part of Paper 258–58/DO–91 has been amended by Paper 256–58/EC–366 dated November 13, 1958. This amendment is also a part of the minimum performance standards. An exception to these standards is covered in subparagraph (2) of this paragraph.

(2) *Exception.* Radio Technical Commission for Aeronautics' Paper 100–54/DO–60, and amendment Paper 256–58/EC–366 dated November 13, 1958, outline environmental test procedures for equipment designed to operate under three environmental test conditions as specified therein under Procedure A, B, and C. Only aircraft microphones which meet the operating requirements as outlined under Procedure A or Procedure B of Paper 100–54/DO–60, as amended, are eligible under this section.

(b) *Marking.* In addition to the information required in § 37.7, equipment which has been designed to operate over the environmental conditions as outlined in Procedure A of RTCA Paper 100–54/DO–60, as amended, shall be marked as Category A equipment. Equipment which has been designed to operate over the environmental conditions as outlined in Procedure B of this same paper, as amended, shall be marked as Category B equipment.

(c) *Data requirements.* With the statement of conformance, one copy each of the manufacturer's operating instructions, schematic diagrams, and installation procedures shall be furnished the Chief, Engineering and Manufacturing Branch, Flight Standards Division, Federal Aviation Administration, in the region in which the manufacturer is located.

(d) *Previously approved equipment.* Aircraft microphones approved prior to August 14, 1959, may continue to be manufactured under the provisions of their original approval.

§ 37.158 High frequency (HF) radio communication transmitting equipment operating within the radio frequency range of 1.5 to 30 megacycles—TSO–C31c.

(a) *Applicability.* This technical standard order prescribes the minimum performance

* Copies of these papers may be obtained from RTCA.

standards that airborne high frequency radio communication transmitting equipment must meet in order to be identified with the applicable TSO marking. New models of equipment, that are to be so identified and that are manufactured on or after November 24, 1967, must meet the requirements of the "Federal Aviation Administration Standard, Airborne High Frequency Radio Communication Transmitting Equipment Operating Within the Radio Frequency Range of 1.5 to 30 Megacycles" set forth at the end of this section, and the FAA Document for Environmental Test Procedures for Airborne Electronic Equipment, set forth in TSO-C87, effective February 1, 1966 (30 F.R. 15553, Dec. 17, 1965).

(b) *Marking.* (1) In addition to the markings specified in section 37.7, the equipment must be marked to indicate the environmental extremes over which it has been designed to operate. There are six environmental procedures outlined in the FAA document for Environmental Test Procedures for Airborne Electronic Equipment that have categories established. These must be identified on the nameplate by the words "Environmental Categories" or, as abbreviated, "Env. Cat." followed by six letters which identify the categories designated. Reading from left to right, the category designations must appear on the nameplate in the following order, so that they may be readily identified:

(i) Temperature-altitude category.

(ii) Vibration category.

(iii) Audio frequency magnetic field susceptibility category.

(iv) Radio frequency susceptibility category.

(v) Emission of spurious radio frequency energy, and

(vi) Explosion category.

A typical nameplate identification follows: "Env. Cat. DBAAAX."

(2) Where a manufacturer desires to substantiate his equipment in dual categories for one environment, the nameplate must be marked with both categories in the space designated for that category by placing one letter above the other in the following manner:

A
"Env. Cat. DBAAAX."

(3) Each separate component of equipment (antenna, power supply, etc.) must be identified with at least the name of the manufacturer, the TSO number, and the environmental categories over which the equipment component is designed to operate.

(c) *Data requirements.* In accordance with section 37.5, the manufacturer must furnish to the Chief, Engineering and Manufacturing Branch, Flight Standards Division, Federal Aviation Administration in the region in which the manufacturer is located, the following technical data:

(1) Six copies of the operating instructions and equipment limitations of the manufacturer.

(2) Six copies of the installation procedures with applicable schematic drawings, wiring diagrams, and specifications, and a listing of components (by part number) or possible combinations thereof, which make up a system complying with this TSO. Indicate any limitations, restrictions, or other conditions pertinent to the installation, and

(3) One copy of the manufacturer's test report.

(d) *Previously approved equipment.* Airborne high frequency radio communication transmitting equipment approved prior to November 24, 1967, may continue to be manufactured under the provisions of its original approval.

MINIMUM PERFORMANCE STANDARDS FOR AIRBORNE RADIO COMMUNICATIONS TRANSMITTING EQUIPMENT OPERATING WITHIN THE RADIOFREQUENCY RANGE OF 1.5–30 MEGACYCLES

1.0 General Standards.

1.1 *Operation of controls.* The operation of controls intended for use during flight, in all possible position combinations and sequences, must not result in a condition that would be detrimental to the continued performance of the equipment. Controls that are not normally adjusted in flight must not be readily accessible to flight personnel.

1.2 *Effects of test.* Unless otherwise provided, the design of the equipment must be such that, subsequent to the application of the specified tests, no discernible condition exists that would be detrimental to the continued performance of the equipment.

2.0 Minimum Performance Standards Under Standard Conditions.

The test procedures applicable to a determination of the performance of transmitting equipment including coupling units and definitions of terms, are set forth in Appendix A of this standard.

2.1 *Rated power output.* a. For the amplitude modulation (AM) mode of operation, the transmitter must be capable of delivering an unmodulated radiofrequency power output equal to or greater than the manufacturer's rating.

b. If single sideband (SSB) mode of operation is provided, one sideband and suppressed carrier, the transmitter must be capable of delivering a peak envelope power (PEP) equal to or greater than the manufacturer's rating.

2.2 *Residual radiation.* When all sources of primary power are connected to the transmitter but the microphone switch or the carrier control key is in the "OPEN" position, the rf power output of the transmitter at the carrier frequency must not exceed the following values:

CW Telegraph Break-in Operation SSB and AM Telephone	0.02×10^{12} watts.
CW Telegraph No Break-in Operation	At least 40 db less than the rf power output with the key in the "DOWN" position.

2.3 *Modulation capability.* The transmitter's output carrier must be capable of being amplitude modulated at least 85 percent by an audiofrequency input signal of 1,000 cps over the audio input voltage range for which the transmitter is designed.

2.4 *Audiofrequency distortion.* All noise and distortion components in the output must be at least 25 db below the carrier at modulation frequencies of 400, 1,000 and 2,500 cps when the audio input is held constant at that value producing at least 85 percent modulation at 1,000 cps.

2.5 *Audiofrequency response.* a. If the AM mode of operation is provided, the percentage of modulation of the output carrier must not vary more than 6 db when the frequency of the audio input signal is varied over the range of 350 to 2,500 cps and the level of the audio input signal is held constant at that value which produces—

(1) 85 percent modulation at the frequency of maximum response; or

(2) More than 85 percent modulation at the frequency of maximum response when this value is immediately below that at which clipping or limiting action occurs.

b. If SSB mode of operation is provided, the output power of the transmitter must not vary more than 6 db when the audio input level is held constant at a level producing an output 6 db below rated PEP at the frequency of maximum response and the audio input frequency is varied from 350 to 2,500 cps.

c. If sidetone output is provided, the audiofrequency response must not vary more than 10 db over the range of 350 to 2,500 cps when the level of the audio input to the transmitter is held constant at that value producing—

(1) 85 percent modulation at the frequency of maximum response; or

(2) More than 85 percent modulation at the frequency of maximum response, when this value is immediately below that at which clipping or limiting action occurs.

2.6 *Carrier noise level.* a. If the AM mode of operation is provided, the demodulated noise on the transmitter output must be at least 30 db below the demodulated output obtained when the output signal is modulated 85 percent at 1,000 cps.

b. If CW telegraphy mode of operation is provided, the peak amplitude of the noise on the transmitter output must not exceed 5 percent of the carrier amplitude.

c. If SSB mode of operation is provided, the peak amplitude of the noise on the transmitter output must not exceed 5 percent of the rf amplitude of the output signal, when an audio input signal of a frequency of 2,000 cps and at a level producing an rf output 6 db below rated PEP is applied.

2.7 *Keying (CW telegraphy).* When the transmitter is designed to transmit cw signals, the output amplitude (rf voltage) must change by at least 80 percent of its steady-state value within 1 to 10 milliseconds from the beginning of the rise and decay portions of each keying impulse. Any peaks and troughs in each impulse must not differ in amplitude by more than 30 percent of the steady-state amplitude. This standard must be met over the keying speed range of 200 to 500 dots per minute.

2.8 *Channel selection time.* The time required to change from one channel to another must not exceed 30 seconds. In the case of a transmitter designed to operate with an antenna coupler, the time required for change from one channel to another is the overall transmitter/coupler time.

2.9 *Antenna coupling circuits and units*—a. *Efficiency.* The rf efficiency of antenna coupling circuits and units must be equal to or greater than the manufacturer's rated efficiency.

b. *Power rating.* The rf power capability of antenna coupling circuits and units must be equal to or greater than the manufacturer's power rating.

c. *Keying.* When the circuits of antenna couplers are designed to be keyed for cw operation, they must be capable of being keyed at keying speeds over the range of 200 to 500 dots per minute.

3.0 Minimum Performance Standards Under Environmental Conditions.

Unless otherwise specified, the test procedures applicable to a determination of the performance of this equipment under environmental conditions are set forth in the Federal Aviation Administration Document, Environmental Test Procedures for Airborne Electronic Equipment, set forth in TSO–C87.

3.1 *Temperature-altitude.* These tests are set forth in paragraph 4 of the FAA Environmental Test Procedures.

a. *Low temperature.* When the equi ment is subjected to this test as set forth in paragraph 4.1 of the FAA Environmental Test Procedures—

(1) The rated power output must not decrease by more than 1.5 db below that required by paragraph 2.1 (rated power);

(2) The requirements of paragraphs 2.4 (distortion), 2.6 (carrier noise), 2.7 (keying) and 2.9c (coupler keying) must be met; and

(3) All mechanical devices must operate satisfactorily. The maximum time required to effect a change in operating frequency must not exceed 30 seconds. In the case of a transmitter designed to operate with an antenna coupler, the time required to change from one channel to another is the overall transmitter/coupler change time.

b. *High temperature.* (1) When the equipment is operated at the high short-time operating temperature as set forth in paragraph 4.2 of the FAA Environmental Test Procedures—

(i) All mechanical devices must operate satisfactorily; and

(ii) There must be no evidence of materials, such as grease or potting and sealing compounds, exuding or dripping from the equipment components.

(2) When the equipment is operated at the high operating temperature as set forth in paragraph 4.2 of the FAA Environmental Tests—

(i) The requirements of paragraphs 2.1 (rated power output), 2.4 (distortion), 2.6 (carrier noise), 2.7 (keying) and 2.9c (coupler keying) must be met; and

(ii) All mechanical devices must operate satisfactorily. The maximum time required to effect a change in operating frequency must not exceed 30 seconds. In the case of a transmitter designed to operate with an antenna coupler, the time required for a change from one channel to another is the overall transmitter/coupler change time.

c. *Decompression (when required).* When the equipment is subjected to this test as set forth in paragraph 4.3 of the FAA Environmental Test Procedures—

(1) The rated power output must not decrease by more than 1.5 db below that required by paragraph 2.1 (rated power output);

(2) The requirements of paragraph 2.4 (distortion) must be met; and

(3) All mechanical devices must operate satisfactorily.

d. *Altitude.* When the equipment is subjected to this test as set forth in paragraph 4.3 of the FAA Environmental Test Procedures—

(1) The requirements of paragraph 2.1 (rated power output) must be met;

(2) There must be no evidence of corona or arcing when operated under the following conditions:

(i) *Amplitude modulation.* Without modulation and with the maximum level of modulation for which the equipment is designed.

(ii) *Single sideband.* With full rated Peak Envelope Power.

(3) Following the altitude test, the requirements of paragraph 2.7 (keying) must be met.

3.2 *Humidity.* After subjection to this test as set forth in paragraph 5.0 of the FAA Environmental Test Procedures, and immediately following the 15-minute warm-up period, the rf power output must not have decreased by more than 3 db below that specified in paragraph 2.1 (rated power output). The transmitter must be capable of being modulated at least 50 percent by a 1,000 cps audio signal. The requirements of paragraph 2.7 (keying) must be met, and all mechanical devices must perform their intended functions. Within 4 hours from the time primary power is applied, the requirements of paragraph 2.1 (rated power output) and paragraph 2.3 (modulation capability) must be met. All mechanical devices must perform their intended functions.

3.3 *Shock.* a. Following the application of the operational shocks as set forth in paragraph 6 of the FAA Environmental Test Procedures, the requirements of paragraph 2.1 (rated power output) and 2.3 (modulation capability) must be met.

b. Following the application of the crash safety shocks, the equipment must have remained in its mounting, and no part of the equipment or its mounting must have become detached and free of the shock test equipment. Paragraph 1.2 (effects of test) does not apply.

3.4 *Vibration.* When the equipment is subjected to this test as set forth in paragraph 7 of the FAA Environmental Test Procedures—

a. The frequency of the rf output must not vary by more than 100 cps for amplitude modulation and cw operation, and by more than 10 cps for single sideband operation; and

b. The performance requirements of paragraph 2.4 (distortion), 2.6 (carrier noise), 2.7 (keying) and 2.9c must be met.

3.5 *Temperature variation.* When subjected to

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this test, as set forth in paragraph 8 of the FAA Environmental Test Procedures, the frequency of the rf carrier must be within 0.01 percent of the assigned frequency for AM, and within 20 cps of the specified carrier frequency for SSB.

3.6 *Power input test*—a. *Power input variation.* When subjected to this test as set forth in paragraph 9.1 of the FAA Environmental Test Procedures—

(1) The requirements of paragraph 2.4 (distortion), and paragraph 2.6 (carrier noise), must be met; and

(2) The carrier power output must not be more than 1.5 db below that required by paragraph 2.1 (rated carrier power output).

b. *Low voltage.* (1) When the primary power voltage(s) of DC operated equipment is 80 percent and when that of AC operated equipment is 87½ percent of standard test voltage(s) the equipment must start and continue to operate electrically and mechanically. Degradation of performance is permitted.

(2) The equipment must operate satisfactorily within two (2) minutes upon returning the primary voltage(s) to normal after the gradual reduction of the primary power voltage(s) from 80 percent to 50 percent of the standard test voltage(s); and

(3) The gradual reduction of the primary voltage(s) of DC operated equipment from 50 percent to 0 percent of the standard test voltage(s) must produce no evidence of the presence of fire or smoke. Paragraph 1.2 does not apply.

3.7 *Conducted voltage transients.* a. Following the Intermittent Transient Test, as set forth in paragraph 10.0 of the FAA Environmental Test Procedures, the performance requirements of paragraph 2.1 (rated carrier power output), 2.3 (modulation capability), 2.4 (distortion), and 2.6 (carrier noise level) must be met. Tests with negative transients are not required.

b. During the Repetitive Transients Test, the performance requirements of paragraph 2.6 (carrier noise level) must not be degraded more than 6.0 db.

3.8 *Conducted audiofrequency susceptibility.* When the equipment is subjected to this test, as set forth in paragraph 11 of the FAA Environmental Test Procedures, the performance requirements of paragraph 2.6 (carrier noise level) must be met.

3.9 *Audiofrequency magnetic field susceptibility.* When the equipment is subjected to this test, as set forth in paragraph 12 of the FAA Environmental Test Procedures, the performance requirements of paragraph 2.6 (carrier noise level) must be met.

3.10 *Radiofrequency susceptibility (radiated and conducted).* a. When the equipment is subjected to the radiated radiofrequency susceptibility test, as set forth in paragraph 13 of the FAA Environmental Test Procedures, the performance requirements of paragraph 2.6 (carrier noise level) must not be degraded by more than 5 db.

b. When the equipment is subjected to the conducted radiofrequency susceptibility test, the performance requirements of paragraph 2.6 (carrier noise level) must not be degraded by more than 5 db.

3.11 *Explosion (when required).* During the application of this test, as set forth in paragraph 14 of the FAA Environmental Test Procedures, the equipment must not cause detonation of the explosive mixture within the test chamber.

3.12 *Emission of radiofrequency energy.* The levels of conducted and radiated spurious radiofrequency energy emitted by the equipment must not exceed those levels specified in Appendix A of the FAA Environmental Test Procedures. Radiations may be excluded from these requirements if they are harmonically related to the selected channel frequency or are within the band of frequencies ±50 percent of the band of frequencies between adjacent channels.

APPENDIX A

1.0 Test Conditions.

The following definitions of terms and conditions of tests are applicable to the equipment tests specified herein:

1.1 *Power input voltage.* Unless otherwise specified, all tests must be conducted with the power input voltage adjusted to design voltage ±2 percent. The input voltage must be measured at the equipment power input terminals.

1.2 *Power input frequency.* In the case of equipment designed for operation from an AC power source of essentially constant frequency (e.g., 400 cps), the input frequency must be adjusted to design frequency ±2 percent. In the case of equipment designed for operation from an AC power source of variable frequency (e.g., 300 to 1,000 cps), unless otherwise specified, test must be conducted with the input frequency adjusted to within 5 percent of a selected frequency and within the range for which the equipment is designed.

1.3 *Adjustment of equipment.* The circuits of the equipment must be properly aligned and otherwise adjusted for operation on the specified frequency in accordance with the manufacturer's recommended practices prior to the application of the specified tests.

1.4 *Antenna accessories.* Antenna impedance matching and coupling components supplied or recommended for use with the equipment must be used in all tests requiring such components.

1.5 *Ambient conditions.* Unless otherwise specified, all measurements must be conducted under conditions of ambient room temperature, pressure, and humidity. However, the ambient room temperature must not be less than 10° C.

1.6 *Warm-up period.* Unless otherwise specified, all tests must be conducted after a period of operation at maximum duty cycle of not less than fifteen

(15) minutes. The "ON" and the "OFF" periods of the maximum duty cycle must be five (5) minutes each.

1.7 *Standard test antennas.* Unless otherwise specified, the transmitter must be loaded into a standard test antenna. The constants of the standard test antenna must be as follows—

a. For output circuits designed for a load impedance which varies with frequency; and

1. For frequencies of 3 mc and below, use two test antennas, one having an rf resistance of 3 ohms in series with a capacitance of 265 $\mu\mu$f and the other having an rf resistance of 3 ohms in series with an inductance of 24 μh;

2. For frequencies from 3 mc to and including 5 mc, use two test antennas, one having an rf resistance of 300 ohms in series with a capacitance of 13 $\mu\mu$f and the other having an rf resistance of 300 ohms in series with an inductance of 120 μh; and

3. For frequencies of 5 mc and above, use a test antenna having an rf resistance of 3,000 ohms.

b. For output circuits designed for use with an external coupler or an essentially constant load, the test antenna must be an impedance having a resistance within 10 percent and a reactance of not more than 10 percent of the load impedance for which the equipment is designed.

The resistance, capacitance, and inductance specified for each test antenna are the values presented to the transmitter antenna terminals.

If the above test antennas do not correspond to a typical antenna for which the transmitter is designed, suitable test antennas must be substituted and a description of the test antenna included with the pertinent data.

1.8 *Phantom microphone.* In the conduct of tests which require that an audiofrequency signal be applied to the transmitter audiofrequency input circuit, the signal must be applied through a phantom microphone circuit having the impedance and direct current flow characteristic of the type of microphone for which the transmitter is designed.

1.9 *Single sideband.* The general term single sideband as used in this standard, unless otherwise specified, applies to transmissions with the carrier suppressed at least 26 db below peak envelope power.

1.10 *Amplitude modulation.* The general term amplitude modulation as used in this standard, unless otherwise specified, applies to transmissions with the carrier transmitted at a level between 3 to 6 db below peak envelope power.

1.11 *Standard two-tone test signal.* The term standard two-tone test signal as used in this standard applies to two equal amplitude test tones so selected in frequency that their difference frequency, and 3rd order distortion products are within the audio passband.

2.0 Test Procedures.

The test procedures set forth below are satisfactory for use in determining the performance of airborne radio communication transmitting equipment operating within the radiofrequency range of 1.5 to 30 mc. Test procedures which provide equivalent information may be used.

2.1 *Rated power output*—a. *Amplitude modulation (AM).* With the transmitter operating, adjust the loading of the final rf amplifier stage so that the normal input recommended by the manufacturer for this stage is obtained. The carrier must be unmodulated throughout this test. Observe the reading of the standard test antenna ammeter and compute the power output. The power output must be determined at each of the following frequencies within the range for which the transmitter is designed: 1.5, 3, 5, 7, 10, 15, 20, 25, and 30 megacycles.

b. *Single sideband (SSB).* With the transmitter operating, apply a standard two-tone test signal at a level as recommended by the manufacturer. Adjust the transmitter controls as recommended by the manufacturer. Observe the reading of the standard test antenna ammeter and compute the PEP output. The power output must be determined at each of the following frequencies within the range for which the transmitter is designed: 1.5, 3, 5, 7, 10, 15, 20, 25, and 30 megacycles.

2.2 *Residual radiation.* With all sources of primary power applied to the equipment but with the microphone switch or the carrier control key in the "OFF" position, measure the rf voltage across the transmitter output and compute the power output.

2.3 *Modulation capability.* Apply to the transmitter audio input, through a phantom microphone circuit, an audio signal having a level at the transmitter input equal to the minimum input rating of the transmitter. Couple the vertical plates of an oscilloscope to a standard test antenna and adjust the oscilloscope so that the percentage modulation may be measured on the indicated envelope of the rf output.

If the transmitter has a modulation gain control it should be adjusted to produce at least 85 percent modulation with an audio input signal having a frequency of 1,000 cps and a level, at the transmitter audio input, equal to the minimum input level rating of the transmitter. Measure the percentage modulation. Repeat the entire procedure in this paragraph using an audio input signal level equal to the maximum input rating. When provision is made for the use of alternate types of microphones (i.e., carbon, single and double button, moving coil, crystal, etc.), having different values of internal impedance and output level, conduct this test with the proper phantom microphone circuits for each type.

2.4 *Audiofrequency distortion.* If the transmitter has a modulation gain control, it should be adjusted to produce at least 85 percent modulation with an audio input signal having a frequency of 1,000 cps

and a level, at the transmitter audio input, equal to the maximum input rating of the transmitter.

Apply to the input of the phantom microphone circuit a 1,000 cps signal of sufficient amplitude to produce 85 percent modulation and with a spectrum analyzer, determine the amplitudes of distortion and noise components in the transmitter output. Repeat with other audiofrequencies as required, maintaining the audiofrequency input voltage constant at that value established for 1,000 cps.

2.5 *Audiofrequency response*—a. *Amplitude modulation.* Couple the vertical plates of an oscilloscope to a standard test antenna and adjust the oscilloscope so that the percentage of modulation may be measured on the indicated envelope of the rf output. Also, couple a diode detector with its output connected to a vacuum tube voltmeter to the test antenna. Connect an audio output meter to the sidetone output, and the phantom microphone circuit to the microphone input circuit.

If the transmitter has a modulation gain control, it should be adjusted to produce, in the output signal, at least 85 percent modulation immediately below that at which clipping or limiting takes place with an audio input signal having a frequency of 1,000 cps and a level, at the transmitter audio input, equal to the minimum level rating of the transmitter.

Apply to the microphone input circuit of the transmitter, through a phantom microphone circuit, an audio signal having a level at the transmitter input equal to the minimum input rating of the transmitter. Maintain the audio input level constant throughout the test. Determine compliance with paragraph 2.5a at the following frequencies: 350, 700, 1,000, 1,500, 2,000, and 2,500 cps. Also, read the sidetone output on the audio power meter.

Repeat this test using an audio level at the transmitter audio input equal to the maximum input rating of the transmitter. When provision is made for the use of alternate types of microphones (i.e., carbon, single and double button, crystal, etc.), having different values of internal impedance and output level, repeat this test for each type of microphone, using equivalent phantom microphone circuits.

b. *Single sideband.* Couple to the test antenna a vacuum tube voltmeter. Connect a phantom microphone circuit to the microphone input circuit. Apply to the phantom microphone circuit input a 1,000 cps audio signal having a level at the microphone input equal to the minimum input rating of the transmitter. Adjust the transmitter to produce an output equal to 6 db below rated PEP. Maintain the audio input level constant throughout the test. Determine the peak envelope power at the following frequencies: 350, 700, 1,000, 1,500, 2,000, and 2,500 cps. Also, determine the sidetone output from the output meter.

Repeat this test using an audio level at the transmitter audio input equal to the maximum input rating of the transmitter. When provisions are made for the use of alternate types of microphones (i.e., carbon, single and double button, dynamic, crystal, etc.), having different values of internal impedance and output level, repeat this test for each type of microphone, using equivalent phantom microphone circuits.

2.6 *Carrier noise level*—a. *Amplitude modulation.* Couple the vertical plates of an oscilloscope to a standard test antenna and adjust the oscilloscope so that the percentage of modulation may be measured on the envelope of the rf output. Also, couple to the test antenna a diode detector with its output connected to a distortion meter.

If the transmitter has a modulation gain control, it should be adjusted to produce at least 85 percent modulation with an audio input signal having a frequency of 1,000 cps and a level, at the transmitter input, equal to the minimum input rating of the transmitter.

Apply to the input of a phantom microphone circuit a 1,000 cps signal of sufficient amplitude to produce 85 percent modulation. Remove the audio signal and short circuit the input of the phantom microphone circuit. Determine from readings of the distortion meter, compliance with paragraph 2.6a.

b. *CW telegraphy.* Couple a diode detector to the transmitter output. Connect an AC voltmeter and a DC voltmeter in parallel across the detector load resistor. With the transmitter operating, read the AC and the DC voltmeters. The carrier noise level in percent of carrier amplitude is:

$$\frac{\text{Peak AC volts}}{\text{DC volts}} \times 100$$

c. *Single sideband.* Apply to the input of a phantom microphone circuit a single tone at 2,000 cps of sufficient amplitude to create a peak envelope power of 6 db below rated output. Couple a diode detector to the transmitter output. Connect the AC voltmeter and the DC voltmeter in parallel across the detector load resistor. With the transmitter operating, read the AC and the DC voltmeters. Compute the noise level percentage as in 2.6 db above.

2.7 *Keying (CW telegraph).* Couple the vertical plates of the oscilloscope to a standard test antenna and adjust the oscilloscope so that the envelope of the rf output is indicated.

Over the keying speed range of 200 to 500 dots per minute, observe the wave shape of the dots on the oscilloscope, measuring their rise and fall characteristics and amplitudes of any peaks and troughs that may be present. Also, determine whether any spurious output is present during the spacing portion of the keying cycle.

§ 37.159 High frequency (HF) radio communication receiving equipment operating within the radio frequency range of 1.5 to 30 megacycles—TSO–C32c.

(a) *Applicability.* This technical standard

order prescribes the minimum performance standards that airborne high frequency radio communication receiving equipment must meet in order to be identified with the applicable TSO marking. New models of equipment, which are to be so identified and that are manufactured on or after November 24, 1967, must meet the requirements of the "Federal Aviation Administration Standard, Airborne High Frequency Radio Communication Receiving Equipment Operating Within the Radio Frequency Range of 1.5 to 30 Megacycles" set forth at the end of this section, and the FAA Document for Environmental Test Procedures for Airborne Electronic Equipment, set forth in TSO-C87, effective February 1, 1966 (30 F.R. 15553, Dec. 17, 1965).

(b) *Marking.* (1) In addition to the markings specified in § 37.7, the equipment must be marked to indicate the environmental extremes over which it has been designed to operate. There are six environmental procedures outlined in the FAA document for environmental test procedures for airborne electronic equipment that have categories established. These must be identified on the nameplate by the words "Environmental Categories" or, as abbreviated, "Env. Cat." followed by six letters which identify the categories designated. Reading from left to right, the category designations must appear on the nameplate in the following order, so that they may be readily identified:

(i) Temperature—altitude category.

(ii) Vibration category.

(iii) Audio frequency magnetic field susceptibility category.

(iv) Radio frequency susceptibility category.

(v) Emission of spurious radio frequency energy category.

(vi) Explosion category.

A typical nameplate identification follows: "Env. Cat. DBAAAX."

(2) Where a manufacturer desires to substantiate his equipment in dual categories for one environment, the nameplate must be marked with both categories in the space designated for that category by placing one letter above the other in the following manner:

A
"Env. Cat. DBAAAX"

(3) Each separate component of equipment (antenna, power supply, etc.), must be identified with at least the name of the manufacturer, the TSO number, and the environmental categories over which the equipment component is designed to operate.

(c) *Data requirements.* In accordance with § 37.5, the manufacturer must furnish to the Chief, Engineering and Manufacturing Branch, Flight Standards Division, Federal Aviation Administration, in the region in which the manufacturer is located, the following technical data:

(1) Six copies of the operating instructions and equipment limitations of the manufacturer;

(2) Six copies of the installation procedures with applicable schematic drawings, wiring diagrams, and specifications, and a listing of components (by part number) or possible combinations thereof which make up a system complying with this TSO. Indicate any limitations, restrictions, or other conditions pertinent to the installation; and

(3) One copy of the test report of the manufacturer.

(d) *Previously approved equipment.* Airborne high frequency radio communications receiving equipment approved prior to November 24, 1967, may continue to be manufactured under the provisions of its original approval.

MINIMUM PERFORMANCE STANDARDS FOR AIRBORNE HIGH FREQUENCY RADIO COMMUNICATIONS RECEIVING EQUIPMENT OPERATING WITHIN THE RADIO FREQUENCY RANGE OF 1.5–30 MEGACYCLES

1.0 General Standards.

1.1 *Operation of controls.* The operation of controls intended for use during flight, in all possible combinations and sequences, must not result in a condition whose presence or continuation would be detrimental to the performance of the equipment. Controls which are not normally adjusted in flight must not be readily accessible to flight personnel.

1.2 *Effects of test.* Unless otherwise stated, the application of the specified tests must produce no subsequently discernible condition which would be

detrimental to the continued performance of the equipment.

2.0 Minimum Performance Standards Under Standard Conditions.

The test procedures applicable to a determination of the performance of receiving equipment, including coupling units and definition of terms, are set forth in Appendix A of this standard.

2.1 *Audiofrequency response.* The receiver audio output must not vary more than 8 db when the level of a standard AM signal is held constant at 50 μv and the modulation frequency varied over the range of 350 to 2,500 cps.

2.2 *AGC characteristics.* Between the limits of 10 μv and 500,000 μv input, the audio output must not vary more than 10 db.

2.3 *Gain.* A standard input signal (AM and SSB) of not more than 50 μv must produce a receiver output which is not less than the manufacturer's published rated output.

2.4 *Manual gain control.* The output of the receiver must be adjustable from rated output to at least 20 db below rated output over the rf input signal level range of 50 to 500,000 μv, modulated 85 percent at 1,000 cps.

2.5 *Distortion*—a. *Harmonic.* (1) If amplitude modulation (AM) mode of operation is provided, the combined noise and distortion in the receiver output signal must not exceed 20 percent at rated output when the receiver input signal is modulated 85 percent and its level varied over the range from 50 μv to 500,000 μv. This requirement must be met over the frequency range of 350 to 2,500 cps.

(2) If single sideband (SSB) mode of operation is provided, the combined noise and distortion in the receiver output must not exceed 20 percent at rated output when the receiver input signal level is varied over the range from 50 μv to 500,000 μv. This requirement must be met over the audiofrequency range from 350 to 2,500 cps.

b. *Intermodulation (SSB mode only).* With a standard two-tone test signal applied at levels from 50 μv to 500,000 μv, the 3d order products must be at least 25 db below either of the two test tones in the output.

2.6 *Noise level.* With the receiver gain adjusted to produce rated output when the input signal level is a 100 μv standard AM signal, the receiver output, without modulation of the input signal, must be at least 20 db below rated output. When the equipment is designed for operation from an alternating current power source, this standard must be met over the range of power source frequencies for which the equipment is designed.

2.7 *Sensitivity.* The level of an input signal required to produce a given signal-plus-noise to noise ratio must not exceed the following:

Operation mode (as applicable)	*Input signal voltages*		(S+N)/N (db)
	1.5 MC—3 MC	3 MC—30 MC	
CW telegraphy	10 μv	5 μv	10
Amplitude modulation	10 μv	5 μv	6
Single sideband	5 μv	3 μv	10

2.8 *Selectivity.* a. If amplitude modulation (AM) mode of operation is provided—

(1) The level of an input signal required to produce rated output must not vary more than 6 db over the frequency range from center response frequency −2.5 kc to center response frequency +2.5 kc (center response frequency is defined in Appendix A); and

(2) At frequencies ±10 kc from the center response frequency, the level of an input signal required to produce rated output must be at least 60 db greater than the level required at the frequency of maximum response.

b. If single sideband (SSB) mode of operation is provided—

(1) The level of an input signal required to produce rated output must not vary more than 6 db over the frequency range from f_c+350 cps to f_c+2,500 cps[1]; and

(2) At frequencies f_c−2,150 cps and f_c+5,000 cps, the level of an input signal required to produce rated output must be at least 60 db greater than the level required at the frequency of maximum response.

2.9 *Spurious responses.* a. If amplitude modulation (AM) mode of operation is provided, the level of a standard AM signal input required to produce an output signal-plus-noise to noise ratio of 6 db must be at least 60 db greater than that required at the frequency of maximum response when the frequency of the input signal is varied over the range of 0.190 to 150 mc excluding the range within ±10 kc of the center response frequency.

b. If single sideband (SSB) mode of operation is provided, the level of an input signal required to produce an output signal-plus-noise to noise ratio of 10 db must be at least 60 db greater than that required with a standard SSB signal when the frequency of the input signal is varied over the range of 0.190 to 150 mc, excluding the range from f_c−2,150 cps to f_c+5,000 cps.

2.10 *Cross modulation (AM only).* With the simultaneous application of an unmodulated carrier at the center response frequency (desired signal) and a standard AM signal ±10 kc from the center response frequency (undesired signal), the receiver

[1] f_c = Specified Carrier Frequency.

output must be at least 10 db less than rated output under the following conditions:

Level of desired signal	*Level of undesired signal*
20 μv	1,000 μv
2,000 μv	100,000 μv

2.11 *Desensitization (AM only).* With a 10 μv standard AM signal input, the output of the receiver must not decrease more than 8 db in the presence of an unmodulated carrier having a level of 10,000 μv and a frequency varied between 1.5 mc and 30 mc, but not including the frequencies within 10 kc of the carrier frequency.

2.12 *Channel selection time.* The maximum time required to change from one channel to another, including the time required by an antenna coupler, must not exceed 30 seconds.

3.0 Minimum Performance Standards Under Environmental Conditions.

Unless otherwise specified, the test procedures applicable to a determination of the performance of the equipment under environmental conditions are set forth in the Federal Aviation Administration Document for Environmental Test Procedures for Airborne Electronic Equipment set forth in TSO–C87.

3.1 *Temperature altitude*—a. *Low temperature.* When the equipment is subjected to this test as set forth in paragraph 4.1 of the FAA Environmental Test Procedures—

(1) The output power, with an rf input signal level of 50 μv, must not decrease by more than 2.2 db from that specified in paragraph 2.3 (gain);

(2) The receiver sensitivity must not decrease by more than 6 db below that specified in paragraph 2.7 (sensitivity); and

(3) All mechanical devices must perform their intended functions. The maximum time required to effect a change in operating frequency must not exceed 30 seconds. In the case of equipment designed to operate with an antenna coupler, the time required to change from one channel to another is the overall receiver coupler time.

b. *High temperature.* (1) Short-time Operating Temperature.

When the equipment is subjected to this test as set forth in paragraph 4.2 of FAA Environmental Test Procedures—

(i) All mechanical devices must operate satisfactorily; and

(ii) There must be no evidence of materials, such as grease or potting and sealing compounds, exuding or dripping from the equipment components.

(2) High Operating Temperature.

When the equipment is subjected to this test as set forth in paragraph 4.2 of the FAA Environmental Test Procedures, the requirements of paragraphs 2.3 (gain) and 2.7 (sensitivity) must be met.

c. *Altitude.* When the equipment is subjected to this test as set forth in paragraph 4.3 of the FAA Environmental Test Procedures, the requirements of paragraphs 2.3 (gain) and 2.6 (noise) must be met.

d. *Decompression (when required).* When the equipment is subjected to this test as set forth in paragraph 4.3 of the FAA Environmental Test Procedures—

(1) The receiver output must not decrease by more than 3 db from that specified in paragraph 2.3 (gain); and

(2) The receiver sensitivity must not be more than 6 db below that specified in paragraph 2.7 (sensitivity).

3.2 *Humidity.* a. After being subjected to this test as set forth in paragraph 5 of the FAA Environmental Test Procedures, and within 15 minutes after primary power is applied—

(1) The receiver output and sensitivity must be no more than 10 db below that specified in paragraphs 2.3 (gain) and 2.7 (sensitivity) respectively; and

(2) All mechanical devices must perform their intended functions.

b. Within 4 hours after primary power is applied, the requirements of paragraphs 2.3 (gain) and 2.6 (noise) must be met.

3.3 *Shock.* a. Following the application of the Operational Shocks, as indicated in paragraph 6 of the FAA Environmental Test Procedures, the requirements of paragraphs 2.3 (gain) and 2.6 (noise) must be met.

b. Following the application of the Crash Safety Shocks, the equipment under test must have remained in its mounting and no parts of the equipment or its mounting must have become detached and free of the shock test equipment. Paragraph 1.2 does not apply.

3.4 *Vibration.* When the equipment is subjected to this test as set forth in paragraph 7 of the FAA Environmental Test Procedures, the requirements of paragraph 2.5 (distortion) must be met.

3.5 *Temperature variation.* When the equipment is subjected to this test as set forth in paragraph 8 of the FAA Environmental Test Procedures, the following apply:

(a) If amplitude modulation (AM) mode of operation is provided, the center response frequency of the receiver must not deviate from the channel frequency by more than 500 cps plus 0.01 percent of the channel frequency.

(b) If single sideband (SSB) mode of operation is provided, the frequency in the audio output from a standard SSB signal must not change by more than 25 cps.

3.6 *Power input test*—a. *Power input variation.* When subjected to this test as found in paragraph 9.1 of the FAA Environmental Test Procedures, the requirements of paragraphs 2.3 (gain) and 2.7 (sensitivity) must be met.

b. *Low voltage.* (1) When the primary power voltage(s) of DC operated equipment is 80 percent and when that of AC operated equipment is 87½ percent of standard test voltage(s), the equipment must continue to operate electrically and mechanically. Degradation of performance is tolerable.

(2) DC operated equipment must operate satisfactorily within two (2) minutes upon returning the primary power voltage(s) to normal after the gradual reduction of the primary power voltage(s) from 80 percent to 50 percent of standard test voltage(s).

(3) The gradual reduction of the primary power voltage(s) of DC operated equipment from 50 percent to 0 percent of standard test voltage(s) must produce no evidence of the presence of fire or smoke. Paragraph 1.2, "Effects of Tests," does not apply.

3.7 *Conducted voltage transient susceptibility.* a. Following the Intermittent Transient Test as set forth in paragraph 10 of the FAA Environmental Test Procedures, the requirements of paragraph 2.3 (gain) must be met.

b. During the repetitive Transients Test the output of the receiver must not be more than 1.5 db below that specified in paragraph 2.3 (gain). The requirements of paragraph 2.6 (noise level) must be met within 6 db.

3.8 *Conducted audiofrequency susceptibility.* When the equipment is subjected to this test as set forth in paragraph 11 of the FAA Environmental Test Procedures, the requirements of paragraph 2.5 (distortion) and 2.6 (noise level) must be met.

3.9 *Audiofrequency magnetic field susceptibility.* When the equipment is subjected to this test as set forth in paragraph 12 of the FAA Environmental Test Procedures the requirements of paragraph 2.5 (distortion) must be met.

3.10 *Radiofrequency susceptibility (radiated and conducted).* Adjust the receiver gain to produce rated output with a standard AM input signal of 100 μv. Remove the modulation. Under these conditions, the audioutput must be at least 14 db below rated output when—

a. The radiated radiofrequency susceptibility test is applied, as set forth in paragraph 13 of the FAA Environmental Test Procedures; and

b. The conducted radiofrequency susceptibility test is applied.

3.11 *Explosion test (when required).* When the equipment is subjected to this test, as set forth in paragraph 14 of the FAA Environmental Test Procedures, the equipment must not cause detonation of the explosive mixture within the test chamber.

3.12 *Emission of spurious radiofrequency energy.* The levels of conducted and radiated spurious radiofrequency energy emitted by the equipment must not exceed those levels specified in Appendix A of the FAA Environmental Test Procedures.

APPENDIX A

1.0 Test Conditions.

The following definitionss of terms and conditions of tests are applicable to the equipment tests specified herein:

1.1 *Power input voltage.* Unless otherwise specified, all tests must be conducted with the power input voltage adjusted to design voltage ±2 percent. The input voltage must be measured at the receiver input terminals.

1.2 *Power input frequency.* In the case of receivers designed for operation from an AC power source of essentially constant frequency (e.g., 400 cps), the input frequency must be adjusted to design frequency ±2 percent. In the case of equipment designed for operation from an AC power source of variable frequency (e.g., 300 to 1,000 cps), unless otherwise specified, tests must be conducted with the input frequency adjusted to within 5 percent of a selected frequency and within the range for which the equipment is designed.

1.3 *Adjustment of equipment.* The circuits of the equipment must be properly aligned and otherwise adjusted in accordance with the manufacturer's recommended practices prior to the conduct of the specified tests.

1.4 *Ambient conditions.* Unless otherwise specified, all tests must be conducted under conditions of ambient room temperature, pressure, and humidity. However, the ambient room temperature must not be less than 10° C.

1.5 *Warm-up period.* Unless otherwise specified, all tests must be conducted after a warm-up period of not less than fifteen (15) minutes.

1.6 *Connected load.* Unless otherwise specified, all tests must be performed with the equipment output connected to a load having the impedance value for which the equipment is designed.

1.7 *Signal source*—a. *Variable source impedance.* When the receiver input circuit is designed for a variable source impedance, the test antenna must consist of a capacitance of 250 $\mu\mu$f±10 percent in series with a noninductive resistance of 50 ohms±10 percent. The output resistance of the signal generator must be included in the resistance specified. The receiver input voltage levels specified herein are those equivalent to a voltage in series with the capacitance and resistance.

b. *Fixed source impedance.* When the receiver input circuit is designed for a specific source impedance, such as that provided by a transmission line, the circuit connected to the receiver input must be the equivalent of an rf input voltage in series with an impedance having a resistance within 10 percent and a reactance of not more than 10 percent of the characteristic impedance of the transmission line for which the receiver is designed.

c. *Input voltages.* In the case of a receiver designed for a transmission line having a nominal

characteristic impedance of other than 52 ohms, the rf input voltage values must be computed according to the following equation:

$$E_2 = \sqrt{\frac{E_1^2 \times R_2}{52}}$$

Where E_2 is the rf input voltage to be used in the case of a receiver designed for a tranmission line having a nominal characteristic impedance other than 52 ohms—

E_1 is the rf input voltage specified herein.

R_2 is the nominal characteristic impedance of the transmission line for which the receiver is designed.

The rf input voltage is defined as the open circuit voltage of the circuit connected to the receiver input. For two-tone inputs, the voltage given is for each tone.

1.8 *Standard Test Signals*—a. *Standard AM signal.* A standard AM signal is defined as an rf input signal modulated 30 percent at 1,000 cps.

b. *Standard SSB signal.* A standard SSB signal is defined as an rf input signal 1,000 cps displaced from the carrier frequencies and within the bandpass of the receiver.

c. *Standard two-tone test signal.* A standard two-tone test signal as used in this standard consists of two rf signals, within the receiver passband, of equal amplitude, and so selected in frequency that the 3d order intermodulation products are within the audio passband, and can be resolved.

1.9 *Amplitude modulation.* The general term amplitude modulation as used in this standard, unless otherwise specified, applies to transmissions with the carrier transmitted at a level between 3 to 6 db below peak envelope power.

1.10 *Single sideband.* The general term single sideband as used in this standard, unless otherwise specified, applies to transmissions with the carrier suppressed at least 26 db below peak envelope power.

1.11 *Center response frequency.* Center response frequency as used in this standard is defined as that frequency midway between the two frequencies at which the response is down 6 db from maximum response.

2.0 Test Procedures.

The test procedures set forth below are satisfactory for use in determining the performance of airborne radio communications receiving equipment operating within the radiofrequency range of 1.5–30 mc. Test procedures which provide equivalent information may be used.

2.1 *Audiofrequency response.* With a radiofrequency input signal of sufficient amplitude to produce an output signal-plus-noise to noise ratio of at least 25 db, adjust the receiver gain for one-half of rated output at 1,000 cps. Then, holding the signal level and the modulation percentage constant, vary the audiomodulation frequency through the range of 200-3,000 cps and record the output in db above and below one-half rated output at the following frequencies: 200, 350, 500, 700, 1,000, 1,500, 2,000, and 3,000 cps and the frequencies of maximum and minimum response between 200 and 3,000 cps. This test must be made at an rf frequency within 15 percent of the lowest carrier frequency for which the equipment is designed.

2.2 *AGC characteristic.* Adjust the manual gain control to obtain that condition wherein varying the rf input signal level over the range from 10 μv to 500,000 μv produces a maximum output equal to rated output. Vary the rf input signal level over the range from 10 μv to 500,000 μv observing the output power at input signal levels of 10, 30, 100, 300, 1,000, 3,000, 10,000, 30,000, 100,000, 300,000, and 500,000 μv.

2.3 *Gain*—(a) *Amplitude modulation.* Apply a standard AM signal to the input, and with the receiver gain control at maximum, increase the rf level of the input to the point where rated power output is obtained.

(b) *Single sideband.* Apply a standard SSB signal to the input and, with the receiver gain control at maximum, increase the rf level of the input to the point where rated power output is obtained.

2.4 *Manual gain control.* Apply to the receiver input a 50 μv rf signal modulated 85 percent at 1,000 cps. Adjust the manual gain control to produce rated output. Then readjust the control to its "minimum" gain position, increase the input to 500,000 μv and record the output in db below rated output.

2.5 *Distortion*—a. *Harmonic*—(1) *Amplitude modulation.* Apply to the receiver input a 50 μv rf signal modulated 85 percent at 1,000 cps. Adjust the manual gain control to produce rated output. With the receiver gain control fixed, maintain the rf signal input level at 50 μv, the percentage modulation at 85 percent, and determine the percentage of distortion present in the receiver output at modulation frequencies of 350, 1,000, and 2,500 cps.

Increase the rf input signal level successively to 100, 1,000, 10,000, 100,000, and 500,000 μv. At each rf input signal level, adjust the receiver manual gain control to produce rated output with the input signal modulated 85 percent at 1,000 cps. With the receiver gain control fixed, maintain the rf signal input level constant, the percentage modulation at 85 percent, and determine the percentage of distortion present in the receiver output at modulation frequencies of 350, 1,000, and 2,500 cps.

(2) *Single Sideband.* Apply to the receiver input a 50 μv rf standard single sideband signal. Adjust the gain control to produce rated output. Maintain the rf level control constant at 50 μv, and adjust the input signal frequency to produce successively in the output 350, 1,000, and 2,500 cps. Determine the percentage of distortion for each frequency.

b. *Intermodulation (SSB mode).* Connect two signal generators to the receiver input by means of a combining unit. Apply a standard two-tone test signal successively at 20 μv, 1,000 μv, and 100,000 μv. In each case determine the relative amplitude of the 3d order distortion products.

2.6 *Noise level.* Apply to the receiver input a 100 μv standard AM signal and adjust the receiver gain for rated power output. Remove the modulation from the input signal and measure the receiver output in db below the rated power output level.

2.7 *Sensitivity*—a. *CW telegraphy.* Determine the level of the input signal required to produce a signal-plus-noise to noise ratio of 10 db. Adjust the beat-frequency oscillator so that the audio output frequency is approximately 1,000 cps (800–1,200 cps).

b. *Amplitude modulation.* Determine the level of the rf input signal required to produce a signal-plus-noise to noise ratio of 6 db.

c. *Single sideband.* Determine the level of a standard SSB input signal required to produce a signal-plus-noise to noise ratio of 10 db.

2.8 *Selectivity*—a. *Amplitude modulation.* Apply a standard AM signal to the receiver input of such a level that the receiver operates below the knee of the AVC characteristic and note the output at the frequency of maximum response. Observe the frequencies on both sides of this frequency where the signal generator level must be increased 6 db and 60 db to produce the same output.

b. *Single sideband.* Apply a standard SSB signal to the receiver input of such a level that the receiver operates below the knee of the AVC characteristic and note the output at the frequency of maximum response. Observe the frequencies on both sides of this frequency where the signal generator level must be increased 6 db and 60 db to produce the same output.

2.9 *Spurious responses*—a. *Amplitude modulation.* Apply a standard AM signal to the input, adjust the level of the input to produce a signal-plus-noise to noise ratio of 6 db, and note the receiver output. Increase the level of the input signal by 60 db, vary the frequency of the input signal over the range of 0.190 to 150 mc, excluding the frequency band within ±10 kc of the center response frequency, and determine those frequencies at which the same receiver output is obtained. Conduct this test with the receiver tuned to within 10 percent of at least the following frequencies within the range or ranges for which the receiver is designed: 1.5, 3, 5, 10, 20, and 30 mc.

b. *Single sideband.* Apply a standard SSB signal to the input and adjust the level of the input to produce a signal-plus-noise to noise ratio of 10 db and note the receiver output. Increase the level of the input signal by 60 db and vary the frequency of the input over the range of 0.190 to 150 mc excluding the frequency band from carrier frequency—2,150 cps to carrier frequency +5,000 cps and determine those frequencies at which the same or greater receiver output is obtained. Adjust the signal generator to obtain 1,000 cps on each spurious response. Check specifically on the image and IF frequencies.

2.10 *Cross modulation.* Connect the two signal generators and the receiver together by means of a combining unit.

Set the rf signal level of a standard AM signal to produce an open-circuit voltage at the output of the combining unit of 20 μv. Tune the receiver to the desired signal. Adjust the receiver gain to produce rated output or to produce maximum output if rated output cannot be obtained. Remove the modulation from the desired signal.

Apply an undesired standard AM signal. Set the rf signal level of the undesired signal to produce an open-circuit voltage at the output of the combining unit of 1,000 μv. Set the rf frequency successively 10 kc above and 10 kc below that of the desired signal and note the output of the receiver. Repeat the above procedure using a level of 2,000 μv for the desired signal and 100,000 μv for the undesired signal.

2.11 *Desensitization.* Connect the two signal generators and the receiver by means of a combining unit. Set the level of a standard AM desired signal to produce an open-circuit voltage of 20 μv at the output of the combining unit. Tune the receiver to the desired signal. Adjust the gain of the receiver to produce rated output or to produce maximum output if rated output cannot be obtained. Set the rf signal level of the undesired signal to produce an open-circuit voltage at the output of the combining unit of 10,000 μv. Remove the modulation from the undesired signal.

Vary the frequency of the undesired signal over the range of 1.5 to 30 mc, excluding the frequencies within 10 kc of the desired signal. Observe the level of the output.

§ 37.160 Airborne ILS glide slope receiving equipment, TSO–C34c.

(a) *Applicability.*—(1) This technical standard order prescribes the minimum performance standards that airborne ILS glide slope receiving equipment must meet in order to be identified with the applicable TSO marking. New models of equipment that are to be so identified, and that are manufactured on or after October 15, 1970, must meet the requirements of Radio Technical Commission for Aeronautics Document No. DO–132 entitled "Minimum Performance Standards—Airborne

ILS Glide Slope Receiving Equipment" dated March 15, 1966, and Radio Technical Commission for Aeronautics Document No. DO–138 entitled "Environmental Conditions and Test Procedures for Airborne Electronic/Electrical Equipment and Instruments" dated June 27, 1968, except as provided in subparagraph (2) of this paragraph. RTCA Documents Nos. DO–132 and DO–138 are incorporated herein in accordance with 5 U.S.C. 552(a)(1) and § 37.23, and are available as indicated in § 37.23. Additionally, RTCA Documents Nos. DO–132 and DO–138 may be examined at any FAA regional office of the Chief of Engineering and Manufacturing Branch (or in the case of the Western Region, the Chief, Aircraft Engineering Division), and may be obtained from the RTCA Secretariate, Suite 655, 1717 H Street, N.W., Washington, D.C. 20006, at a cost of $2.50 per copy for Document No. DO–132 and $4.00 per copy for Document No. DO–138.

(2) *Exceptions:*

(i) RTCA Paper DO–108 referenced in RTCA Document DO–132 has been superseded by RTCA Document DO–138. Therefore, the environmental test conditions of RTCA Document DO–138 are applicable to equipment under this TSO.

(ii) RTCA Document DO–138 lists environmental test conditions covering equipment subjected to water, hydraulic fluid, sand and dust, fungus and salt spray, for which there are no corresponding equipment performance requirements in RTCA Document DO–132. Therefore, if the applicant elects to certify compliance with any of the aforementioned environmental test conditions, the equipment performance requirements of paragraphs 2.1a, 2.7, and 2.16 of RTCA Document DO–132 must be met after the equipment has been exposed to those test conditions.

(b) *Marking.* In addition to the markings specified in § 37.7, the article must be permanently and legibly marked with the following information:

(1) The environmental extremes over which the article has been designed to operate. There are 12 environmental test procedures outlined in RTCA Document DO–138 which have categories established. These must be identified on the nameplate by the words, "Environmental Categories" or, as abbreviated, "Env. Cat.", followed by 12 letters which identify the categories designated. Reading from left to right, the category designations must appear on the nameplate in the following order, so that they may be readily identified:

(i) Temperature—altitude category;

(ii) Humidity category;

(iii) Vibration category;

(iv) Audiofrequency magnetic field susceptibility category;

(v) Radiofrequency susceptibility category;

(vi) Emission of spurious radiofrequency energy category;

(vii) Explosion category;

(viii) Waterproofness category;

(ix) Hydraulic fluid category;

(x) Sand and dust category;

(xi) Fungus resistance category; and

(xii) Salt spray category.

(2) The article must be marked to indicate the class of centering accuracy (Class A, B, C, or D) for which it has been designed to operate.

(3) Each separate component of the article (antenna, receiver, indicator, etc.) must be identified with at least the name of the manufacturer, the TSO number, and the environmental categories over which the article component is designed to operate. Where an environmental test procedure is not applicable to that component and the test is not conducted, an X should be placed in the space designed for that category.

(4) Where a manufacturer desires to substantiate his article in dual categories for a specific environmental test procedure, the nameplate must be marked with both categories in the space designated for that category, by placing one letter above the other. A typical nameplate identification would be as follows:

Env. Cat. $\frac{A}{D}$ AJAAAXWHDFS Class A

(c) *Data requirements.* In accordance with § 37.5, the manufacturer must furnish to the Chief, Engineering and Manufacturing Branch, Flight Standards Division (or in the case of the Western Region, the Chief, Aircraft Engineering Division), Federal Aviation Administration, in the region in which the manufacturer is located, the following technical data:

(1) One copy of the operating instructions and equipment limitations of the manufacturer.

(2) One copy of the installation procedures with applicable schematic drawings, wiring diagrams, and specifications, and a listing of components (by part number) or possible combinations thereof, which make up a system complying with this TSO. The procedures must show all limitations, restrictions, or other conditions pertinent to the installation.

(3) One copy of the manufacturer's test report.

(d) Previously approved equipment. Airborne ILS glide slope receiving equipment approved prior to October 15, 1970, may continue to be manufactured under the provisions of its original approval.

§ 37.161 Airborne ILS localizer receiving equipment, TSO–C36c.

(a) *Applicability.* (1) This technical standard order prescribes the minimum performance standards that airborne ILS localizer receiving equipment must meet in order to be identified with the applicable TSO marking. New models of equipment that are to be so identified, and that are manufactured on or after October 15, 1970, must meet the requirements of Radio Technical Commission for Aeronautics Document No. DO–131 entitled "Minimum Performance Standards—Airborne ILS Localizer Receiving Equipment" dated December 15, 1965, and Radio Technical Commission for Aeronautics Document No. DO–138 entitled "Environmental Conditions and Test Procedures for Airborne Electronic/Electrical Equipment and Instruments" dated June 27, 1968, except as provided in subparagraph (2) of this paragraph. RTCA Documents Nos. DO–131 and DO–138 are incorporated herein in accordance with 5 U.S.C. 552(a)(1) and § 37.23, and are available as indicated in § 37.23. Additionally, RTCA Documents Nos. DO–131 and DO–138 may be examined at any FAA regional office of the Chief of Engineering and Manufacturing Branch (or in the case of the Western Region, the Chief, Aircraft Engineering Division) and may be obtained from the RTCA Secretariat, Suite 655, 1717 H Street, N.W., Washington, D.C. 20006, at a cost of $2.50 per copy for Document No. DO–131 and $4.00 per copy for Document No. DO–138.

(2) *Exceptions:*

(i) RTCA Paper DO–138, referenced in RTCA Document DO–131 has been superseded by RTCA Document DO–138. Therefore, the environmental test conditions of RTCA Document DO–138 are applicable to equipment under this Technical Standard Order.

(ii) RTCA Document No. DO–138 lists environmental test conditions covering equipment subjected to water, hydraulic fluid, sand and dust, fungus and salt spray, for which there are no corresponding equipment performance requirements in RTCA Document DO–131. Therefore, if the applicant elects to certify compliance with any of the aforementioned environmental test conditions, the equipment performance requirements of paragraphs 2.1a, 2.7, and 2.20 of RTCA DO–131 must be met after the equipment has been exposed to these test conditions.

(b) *Marking.* In addition to the markings specified in § 37.7, the article must be permanently and legibly marked with the following information:

(1) The environmental extremes over which the article has been designed to operate. There are 12 environmental test procedures outlined in RTCA Document DO–138 which have categories established. These must be identified on the nameplate by the words, "Environmental Categories" or, as abbreviated, "Env. Cat.", followed by 12 letters which identify the categories designated. Reading from left to right the category designations

must appear on the nameplate in the following order, so that they may be readily identified:

(i) Temperature-altitude category;

(ii) Humidity category;

(iii) Vibration category;

(iv) Audiofrequency magnetic field susceptibility category;

(v) Radiofrequency susceptibility category;

(vi) Emission of spurious radiofrequency energy category;

(vii) Explosion category;

(viii) Waterproofness category;

(ix) Hydraulic fluid category;

(x) Sand and dust category;

(xi) Fungus resistance category;

(xii) Salt spray category.

(2) The article must be marked to indicate the class of centering accuracy (Class A, B, C, or D) for which it has been designed to operate.

(3) Each separate component of the article (antenna, receiver, indicator, etc.) must be identified with at least the name of the manufacturer, the TSO number, and the environmental categories over which the article component is designed to operate. Where an environmental test procedure is not applicable to that component and the test is not conducted, an X should be placed in the space designed for that category.

(4) Where a manufacturer desires to substantiate his article in dual categories for a specific environmental test procedure, the nameplate must be marked with both categories in the space designated for that category, by placing one letter above the other. A typical nameplate identification would be as follows:

Env. Cat. $\frac{A}{D}$ AJAAAXWHDFS Class A

(c) *Data requirements.* In accordance with § 37.5, the manufacturer must furnish to the Chief, Engineering and Manufacturing Branch, Flight Standards Division (or in the case of the Western Region, the Chief, Aircraft Engineering Division), Federal Aviation Administration, in the region in which the manufacturer is located, the following technical data:

(1) One copy of the operating instructions and equipment limitations of the manufacturer.

(2) One copy of the installation procedures with applicable schematic drawings, wiring diagrams, and specifications, and a listing of components (by part number) or possible combinations thereof, which make up a system complying with this TSO. The procedures must show all limitations, restrictions, or other conditions pertinent to the installation.

(3) One copy of the manufacturer's test report.

(d) Previously approved equipment. Airborne ILS localizer receiving equipment approved prior to October 15, 1970, may continue to be manufactured under the provisions of its original approval.

§ 37.162 VHF radio communications transmitting equipment operating within the radio-frequency range of 118–136 megacycles—TSO–C37b.

(a) *Applicability*—(1) *Minimum performance standards.* Minimum performance standards are hereby established for airborne VHF radio communications transmitting equipment operating within the radio-frequency range of 118–136 megacycles which is to be used on civil aircraft of the United States engaged in air carrier operations. New models of airborne VHF radio communications transmitting equipment manufactured for use on air carrier aircraft on or after the effective date of this section shall meet the standards as set forth in Radio Technical Commission for Aeronautics Papers 134–61/DO–110* dated July 13, 1961, and 120–61/DO–108* dated July 13, 1961, with the exceptions to these standards listed in subparagraph (2) of this paragraph.

(2) *Exceptions.* (i) Only VHF transmitters which are designed for selection of frequency channels on discrete frequencies spaced 50 kc. apart or closer are eligible under this section.

* Copies of these papers may be obtained from RTCA.

(ii) Radio Technical Commission for Aeronautics Paper 120-61/DO-108 outlines various test procedures which define the environmental extremes over which the equipment shall be designed to operate. Some test procedures have categories established and some do not. Where categories are established, only equipment which qualifies under the following categories, as specified in RTCA Paper 120-61/DO-108, is eligible under this section:

(*a*) Temperature-Altitude Test—Categories A, B, C, or D;

(*b*) Humidity Test—Categories A or B;

(*c*) Vibration Test—Categories A, B, C, D, E, or F;

(*d*) Audio-Frequency Magnetic Field Susceptibility Test—Categories A or B;

(*e*) Radio-Frequency Susceptibility Test—Category A; and

(*f*) Emission of Spurious Radio-Frequency Energy Test—Category A.

(b) *Marking.* (1) In addition to the markings specified in § 37.7 the equipment shall be marked to indicate the environmental extremes over which it has been designed to operate. There are seven environmental test procedures outlined in RTCA Paper 120-61/DO-108 which have categories established. These shall be identified on the nameplate by the words "environmental categories" or, as abbreviated, "Env. Cat." followed by seven letters which identify the categories designated in RTCA Paper 120-61/DO-108. Reading from left to right, the category designations shall appear on the nameplate in the following order, so that they may be readily identified:

(i) Temperature-Altitude Test Category;

(ii) Humidity Test Category;

(iii) Vibration Test Category;

(iv) Audio-Frequency Magnetic Field Susceptibility Test Category;

(v) Radio-Frequency Susceptibility Test Category;

(vi) Emission of Spurious Radio-Frequency Energy Test Category; and

(vii) Explosion Test.

Equipment which meets the explosion test requirement shall be identified by the letter "E". Equipment which does not meet the explosion test requirements shall be identified by the letter "X".

(2) Each major component of equipment (antenna, power supply, etc.) shall be identified with at least the manufacturer's name, TSO number, and the environmental categories over which the equipment component is designed to operate.

(3) The equipment shall be marked to indicate the distance range over which it is designed to operate. Three classes of equipment have been established in RTCA Paper 134-61/DO-110 based upon maximum radio line-of-sight distances as follows:

Class I: 200 nautical miles—Not less than 16 watts output.

Class II: 100 nautical miles—Not less than 4 watts output.

Class III: 50 nautical miles—Not less than 1 watt output.

NOTE: A typical nameplate identification would be as follows: Env. Cat. DABAAAX Class I.

(4) In some cases such as under the Temperature-Altitude Test Category, a manufacturer may wish to substantiate his equipment under two categories. In this case, the nameplate shall be marked with both categories in the space designated for that category by placing one letter above the other in the following manner: Env. Cat. $\frac{A}{D}$ ABAAAX Class I.

(c) *Data requirements.* Six copies each of the following, except where noted, shall be furnished to the Chief, Engineering and Manufacturing Branch, Flight Standards Division, Federal Aviation Administration, in the region in which the manufacturer is located:

(1) Manufacturer's operating instructions and equipment limitations.

(2) Installation procedures with applicable schematic drawings, wiring diagrams, and specifications. Indicate any limitations, restrictions, or other conditions pertinent to installation.

(3) One copy of the manufacturer's test report.

§ 37.163 VHF radio communications receiving equipment operating within the radio-frequency range of 118–136 megacycles—TSO–C38b.

(a) *Applicability*—(1) *Minimum performance standards.* Minimum performance standards are hereby established for VHF radio communications receiving equipment operating within the radio-frequency range of 118–136 megacycles which is to be used on civil aircraft of the United States engaged in air carrier operations. New models of airborne VHF radio communications receiving equipment manufactured for use on air carrier aircraft on or after the effective date of this section shall meet the standards as set forth in Radio Technical Commission for Aeronautics Papers 130–61/DO–108* dated July 13, 1961, and 120–61/DO–108* dated July 13, 1961, with the exceptions to these standards listed in subparagraph (2) of this paragraph.

(2) *Exceptions.* (i) Radio Technical Commission for Aeronautics Paper 130–61/DO–109, Paragraph 2.8, Selectivity, outlines selectivity requirements for receivers designed for selection of frequency channels in discrete increments of 50 kc. or 100 kc. Only VHF receivers which are designed for selection of frequency channels on discrete frequencies spaced 50 kc. apart or closer are eligible under this section.

(ii) Radio Technical Commission for Aeronautics Paper 120–61/DO–108 outlines various test procedures which define the environmental extremes over which the equipment shall be designed to operate. Some test procedures have categories established and some do not. Where categories are established, only equipment which qualifies under the following categories, as specified in RTCA Paper 120–61/DO–108, is eligible under this order:

(*a*) Temperature-Altitude Test—Categories A, B, C, or D;

(*b*) Humidity Test—Categories A or B;

(*c*) Vibration Test—Categories A, B, C, D, E, or F;

(*d*) Audio-Frequency Magnetic Field Susceptibility Test—Categories A or B;

(*e*) Radio-Frequency Susceptibility Test—Category A;

(*f*) Emission of Spurious Radio-Frequency Energy Test—Category A.

(b) *Marking.* (1) In addition to the markings specified in § 37.7, the equipment shall be marked to indicate the environmental extremes over which it has been designed to operate. There are seven environmental test procedures outlined in RTCA Paper 120–61/DO–108 which have categories established. These shall be identified on the nameplate by the words "environmental categories" or, as abbreviated, "Env. Cat." followed by seven letters which identify the categories designated in RTCA Paper 120–61/DO–108. Reading from left to right the category designations shall appear on the nameplate in the following order, so that they may be readily identified:

(i) Temperature-Altitude Test Category;

(ii) Humidity Test Category;

(iii) Vibration Test Category;

(iv) Audio-Frequency Magnetic Field Susceptibility Test Category;

(v) Radio-Frequency Susceptibility Test Category;

(vi) Emission of Spurious Radio-Frequency Energy Test Category, and

(vii) Explosion Test.

Equipment which meets the explosion test requirement shall be identified by the letter "E". Equipment which does not meet the explosion test requirement shall be identified by the letter "X".

(2) Each major component of equipment (antenna, power supply, etc.) shall be identified with at least the manufacturer's name, TSO number, and the environmental categories over which the equipment component is designed to operate.

NOTE: A typical nameplate identification would be as follows: Env. Cat. DABAAAX.

(3) In some cases such as under the Temperature-Altitude Test Category, a manufacturer may wish to substantiate his equipment under two categories. In this case, the nameplate shall be marked with both categories in the space designated for that category by placing one letter above the other in the following manner; Env. Cat. $\frac{A}{D}$ABAAAX.

* Copies of these papers may be obtained from RTCA.

(c) *Data requirements.* Six copies each of the following, except where noted, shall be furnished to the Chief, Engineering and Manufacturing Branch, Flight Standards Division, Federal Aviation Administration, in the region in which the manufacturer is located:

(1) Manufacturer's operating instructions and equipment limitations.

(2) Installation procedures with applicable schematic drawings, wiring diagrams, and specifications. Indicate any limitations, restrictions, or other conditions pertinent to installation.

(3) One copy of the manufacturer's test report.

§ 37.164 Airborne selective calling equipment (for air carrier aircraft)—TSO–C59.

(a) *Applicability*—(1) *Minimum performance standards.* Minimum performance standards are hereby established for airborne selective calling equipment which is to be used on civil aircraft of the United States engaged in air carrier operations. New models of airborne selective calling equipment manufactured for use on civil air carrier aircraft on or after July 31, 1959, shall meet the minimum performance standards as set forth in Radio Technical Commission for Aeronautics' Paper entitled "Minimum Peformance Standards—Airborne Selective Calling Equipment," Paper 25–59/DO–93 dated February 10, 1959.* Radio Technical Commission for Aeronautics' Paper 100–54/DO–60* which is incorporated by reference in and thus is a part of Paper 25–59/DO–93 has been amended by Paper 256–58/EC–366 dated November 13, 1958. This amendment is also a part of the minimum performance standards. An exception to these standards is covered in subparagraph (2) of this paragraph.

(2) *Exception.* Radio Technical Commission for Aeronautics' Paper 100–54/DO–60, and amendment Paper 256–58/EC–366 dated November 13, 1958, outline environmental test procedures for equipment designed to operate under three environmental test conditions as specified therein under Procedures A, B, and C. Only airborne selective calling equipment which meets the operating requirements as outlined under Procedure A or Procedure B of Paper 100–54/DO–60, as amended, is eligible under this section.

(b) *Marking.* In addition to the information required in § 37.7, equipment which has been designed to operate over the environmental conditions as outlined in Procedure A of RTCA Paper 100–54/DO–60, as amended, shall be marked as Category A equipment. Equipment which has been designed to operate over the environmental conditions outlined in Procedure B of this same paper shall be marked as Category B equipment.

(c) *Data requirements.* With the statement of conformance, one copy each of the manufacturer's operating instructions, schematic diagrams, and installation procedures shall be furnished the Chief, Engineering and Manufacturing Branch, Flight Standards Division, Federal Aviation Administration, in the region in which the manufacturer is located.

(d) *Previously approved equipment.* Airborne selective calling equipment approved prior to July 31, 1959, may continue to be manufactured under the provisions of its original approval.

§ 37.165 Airborne Loran A receiving equipment operating within the radio-frequency range of 1800–2000 kilocycles (for air carrier aircraft)—TSO–C60.

(a) *Applicability*—(1) *Minimum performance standards.* Minimum performance standards are hereby established for airborne Loran A receiving equipment operating within the radio-frequency range of 1800–2000 kilocycles which is to be used on civil aircraft of the United States engaged in air carrier operations. New models of airborne Loran A receiving equipment manufactured for use on civil air carrier aircraft on or after July 31, 1959, shall meet the minimum performance standards as set forth in Radio Technical Commission for Aeronautics' Paper entitled "Minimum Performance Standards—Airborne Loran A Receiving Equipment Operating Within the Radio-Frequency Range of 1800–2000 Kilocycles" (Paper 226–58/DO–92* dated November 18, 1958). Radio Technical Commission for Aeronautics' Paper 100–54/DO–60* which

* Copies of these papers may be obtained from RTCA.

* Copies of these papers may be obtained from RTCA.

is incorporated by reference in and thus is a part of Paper 226-58/DO-92 has been amended by Paper 256-58/EC-366 dated November 13, 1958. This amendment is also a part of the minimum performance standards. An exception of these standards is contained in subparagraph (2) of this paragraph.

(2) *Exceptions.* (i) Radio Technical Commission for Aeronautics' Paper 100-54/DO-60, and amendment Paper 256-58/EC-366 dated November 13, 1958, outline environmental test procedures for equipment designed to operate under three environmental test conditions as specified therein under Procedures A, B, and C. Only airborne Loran A receiving equipment which meets the operating requirements as outlined under Procedure A or Procedure B of Paper 100-54/DO-60, as amended, is eligible under this section.

(ii) The vibration values specified below may be used for equipment designed exclusively for installation on the instrument panel of aircraft in lieu of those specified in paper 100-54/DO-60 as amended. No shock mounting shall be used during the conduct of this test if the vibration values specified below are used.

Amplitude: 0.01″ (0.02″ total excursion).
Frequency: Variable 5-50 cps.
Maximum acceleration: 1.5 g.

(iii) Equipment which is designed exclusively for installation on the instrument panel of aircraft need not be subjected to the shock requirements outlined in Paper 100-54/DO-60 as amended.

(iv) Indicating instruments which are a part of the system, but which are not designed exclusively for installation on the instrument panel of aircraft, may also be tested to the vibration requirements specified in subdivision (ii) of this subparagraph, and need not be subjected to the shock requirements outlined in Paper 100-54/DO-60 as amended.

(b) *Marking.* In addition to the information required in § 37.7, equipment which has been designed to operate over the environmental conditions as outlined in Procedure A of RTCA Paper 100-54/DO-60, as amended, shall be marked as Category A equipment. Equipment which has been designed to operate over the environmental conditions outlined in Procedure B of this same paper shall be marked as Category B equipment. Equipment which has been designed exclusively for installation on the instrument panel of aircraft and which meets only the amended vibration requirements oulined above shall be identified with the letters I.P. following the category of equipment, such as CAT. A-I.P.

(c) *Data requirements.* With the statement of conformance, one copy each of the manufacturer's operating instructions, schematic diagrams, and installation procedures shall be furnished the Chief, Engineering and Manufacturing Branch, Flight Standards Division, Federal Aviation Administration, in the region in which the manufacturer is located.

(d) *Previously approved equipment.* Airborne Loran A receiving equipment approved prior to July 31, 1959, may continue to be manufactured under the provisions of its original approval.

§ 37.166 [Reserved]

[§ 37.167 Aircraft tires—TSO-C62c.

(a) *Applicability.* This technical standard order (TSO) prescribes the minimum performance standards that tires, excluding tailwheel tires, must meet in order to be identified with the applicable TSO marking. Tires which are to be so identified and which are manufactured on or after December 31, 1979, must meet the requirements of the "Federal Aviation Administration Standard for Aircraft Tires," effective December 31, 1979, set forth at the end of this section.

(b) *Marking.* In lieu of the marking requirements of § 37.7(d), aircraft tires must be legibly and permanently marked at least with the following:

(1) Brand name and the name or registered trademark of the manufacturer responsible for compliance.

(2) Speed rating, load rating, size, skid depth, serial number, and the manufacturer's part number and plant code.

(3) Applicable technical standard order (TSO) number.]

[(c) *Data requirements.*

(1) In addition to the data specified in § 37.5, the manufacturer must also furnish to the Chief, Engineering and Manufacturing Branch, Federal Aviation Administration (or, in the case of the Western Region, the Chief, Aircraft Engineering Division), in the region in which the manufacturer is located, one copy, or copies as otherwise requested by the regional office, of the following technical data: speed rating, load rating, rated inflation pressure, tire size, width, outside diameter, mold skid depth, nominal loaded radius at rated load and inflation pressure, permissible tolerance on the nominal loaded radius, the actual loaded radius of the test tire at rated load and inflation pressure, weight, static unbalance of the test tire, wheel rim designation, manufacturer's part number and, for high-speed tires, a load deflection curve at loads up to 1.5 times load rating, and a summary of the load-speed-time parameters used in the dynamometer tests. As used in this section, the term "high-speed tire" means a tire tested at a speed greater than 120 mph.

(2) The manufacturer must also furnish the applicable maintenance and repair instructions to the regional office identified in paragraph (c)(1) of this section. The maintenance data provided by the manufacturer must include inspection criteria for tires to determine eligibility for used tires to be continued in service. Recapping procedures must be included in the maintenance information along with any special repair methods applicable to the tire and special nondestructive inspection techniques.

(d) *Previously approved equipment.*

(1) Notwithstanding § 37.3(a) and (b) of this Part and the provisions of any specific previous TSO approval, after December 31, 1982, no person may identify or mark a tire having a speed rating above 160 mph with TSO numbers TSO-C62, TSO-C62a, or TSO-C62b.

(2) Aircraft tires, except for those specified in paragraph (d)(1) of this section, approved prior to December 31, 1979, may continue to be manufactured under the provisions of their original approval.

FEDERAL AVIATION ADMINISTRATION STANDARD FOR AIRCRAFT TIRES

1.0 Purpose. This document contains minuimum performance standards for new aircraft tires, excluding tailwheel tires, that are to be identified as meeting the standards of TSO-C62c.

2.0 Scope. These minimum performance standards apply to aircraft tires having speed and load ratings that are established on the basis of the speed and loads to which the tires have been tested.

3.0 Material requirement. Materials must be suitable for the purpose intended. The suitability of the materials must be determined on the basis of satisfactory service experience or substantiating dynamometer tests.

4.0 Design and construction.

4.1 *Unbalance.* The moment (M) of static unbalance in inch ounces may not be greater than the value determined using the formula, moment (M) = $0.025D^2$ rounded off to the next lower whole number. D = maximum outside diameter of the tire in inches.

4.2 *Balance marker.* A balance marker, consisting of a red dot, must be affixed on the sidewall of the tire immediately above the bead to indicate the lightweight point of the tire. The dot must remain for any period of storage plus the original tread life of the tire.

4.3 *Overpressure.* The tire must withstand for at least 3 seconds a pressure of at least 4.0 times the rated inflation pressure (as specified in paragraph 5.2) at ambient temperature.

4.4 *Temperature.*

4.4.1 *Ambient.* It must be substantiated by applicable tests or shown by analysis that the physical properties of the tire materials have not been degraded by exposure of the tire to the temperature extremes of not higher than −40°F and not lower than +160°F for a period of not less than 24 hours at each extreme.

4.4.2 *Wheel rim heat.* It must be substantiated by the applicable tests or shown by analysis that the physical properties of the tire materials have not been degraded by exposure of the tire to a wheel bead seat temperature of not lower than 300°F for at least 1 hour, except that low-speed tires or nose-wheel tires may be tested or analyzed at the highest wheel-bead seat temperatures expected to be encountered during normal operations.

4.5 *Tread design.* Changes in materials that affect performance or changes in number or location of tread ribs and grooves or skid depth increases, made subsequent to the tire qualification, are major changes and must be substantiated by dynamometer tests in accordance with paragraph 6.0

4.6 *Slippage.* Tires tested in accordance with the dynamometer tests provided by paragraph 6.0 may not slip on the wheel rim during the first five dynamometer cycles. Slippage that subsquently occurs may not damage the tube, valve, or the air seal of the tire bead of tubeless tires.]

[4.7 *Leakage.* After an initial 12-hour minimum stabilization period, the tire must be capable of retaining air pressure with a loss of pressure not exceeding 5 percent in 24 hours from the initial pressure equal to the rated inflation pressure.

5.0 Ratings.

5.1 *Load ratings.* The load ratings of aircraft tires must be established in accordance with the provisions under §§ 23.733, 25.733, 27.733, and 29.733 of this chapter, in effect on December 31, 1979, as appropriate.

5.2 *Rated inflation pressure.* The rated inflation pressure must be established at an identified ambient temperature on the basis of the rated load as established under paragraph 5.1.

5.3 *Loaded radius.* The loaded radius is defined as the distance from the axle centerline to a flat surface for a tire initially inflated to the rated inflation pressure and then loaded to its rated load against the flat surface. The nominal loaded radius, the allowable tolerance on the loaded radius, and the actual loaded radius for the test tires must be identified.

6.0 Dynamometer test requirements. The tire may not fail the applicable dynamometer tests specified herein or have visible signs of deterioration other than normal expected tread wear except as provided in paragraph 6.3.3.3.

6.1 *General.* The following conditions apply to both low-speed and high-speed tires when these tires are subjected to the applicable dynamometer tests:

6.1.1 *Tire test load.* Unless otherwise specified herein for a particular test, the tire must be forced against the dynamometer flywheel at not less than the rated load of the tire during the entire roll distance of the test.

6.1.2 *Test inflation pressure.* The test inflation pressure must be the pressure required at an identified ambient temperature to obtain the same loaded radius against the flywheel of the dynamometer as the loaded radius for a flat surface as defined in paragraph 5.3 of this standard. Adjustments to the test inflation pressure may not be made to compensate for increases due to temperature rise occurring during the tests.

6.1.3 *Test specimen.* A single tire specimen must be used in the applicable dynamometer tests specified herein.

6.2 *Low speed tires.* Tires operating at ground speeds of 120 mph or less must withstand 200 landing cycles on a dynamometer at the following test temperature and kinetic energy and using either test method A or test method B.

6.2.1 *Test temperature.* The temperature of the air contained in the tire or of the carcass measured at the hottest point of the tire must be not lower than 105°F at the start of at least 90 percent of the test cycles. For the remaining 10 percent of the test cycles, the contained air or carcass temperature must be not lower than 80°F at the start of each cycle. Rolling the tire on the flywheel is acceptable for obtaining the minimum starting temperature.

6.2.2 *Kinetic energy.* The kinetic energy of the flywheel to be absorbed by the tire must be calculated as follows:

K.E. = CWV^2 = 162.7W = Kinetic energy in foot pounds.

where

C = 0.0113
W = Load rating of the tire in pounds
V = 120 mph

6.2.3 *Test method A—variable mass flywheel.* The total number of dynamometer landings must be divided into two equal parts having speed ranges shown below. If the exact number of flywheel plates cannot be used to obtain the calculated kinetic energy value or proper flywheel width, a greater number of plates must be selected and the dynamometer speed adjusted to obtain the required kinetic energy.

6.2.3.1 *Low-speed landings.* In the first series of 100 landings, the maximum landing speed is 90 mph and the minimum unlanding speed is 0 mph. The landing speed must be adjusted so that 56 percent of the kinetic energy calculated under paragraph 6.2.2 will be absorbed by the tire. If the adjusted landing speed is calculated to be less than 80 mph, the following must be done: The landing speed must be determined by adding 28 percent of the kinetic energy calculated under paragraph 6.2.2 to the flywheel kinetic energy at 64 mph, and the unlanding speed determined by subtracting 28 percent of the kinetic energy calculated under paragraph 6.2.2 from the flywheel kinetic energy at 64 mph.

6.2.3.2 *High-speed landings.* In the second series of 100 landings, the minimum landing speed is 120 mph and the nominal unlanding speed is 90 mph. The unlanding speed must be adjusted as necessary so that 44 percent of the kinetic energy calculated under paragraph 6.2.2 will be absorbed by the tire.

6.2.4 *Test method B—fixed mass flywheel.* The total number of dynamometer landings must be divided into two equal parts having speed ranges indicated below. Each landing must be made in a time period, T, calculated so that the tire will absorb the kinetic energy determined under paragraph 6.2.2. The time period must be calculated using the equation:

$$T_C = \frac{KE_C}{\left(\frac{KE_{W\,(UL)} - KE_{W\,(LL)}}{T_{L\,(UL)} - T_{L\,(LL)}}\right) - \left(\frac{KE_{W\,(UL)} - KE_{W\,(LL)}}{T_{W\,(UL)} - T_{W\,(LL)}}\right)}$$

For the 90 mph to 0 mph test, the equation reduces to:]

$$T_C = \frac{KE_C}{\left(\frac{KE_W\ (UL)}{T_L\ (UL)}\right) - \left(\frac{KE_W\ (UL)}{T_W\ (UL)}\right)}$$

where:

T_C = Calculated time, in seconds, for the tire to absorb the required kinetic energy.

KE_C = Kinetic energy, in foot pounds, the tire is required to absorb during each landing cycle.

KE_W = Kinetic energy, in foot pounds, of the flywheel at given speed.

T_L = Coast down time, in seconds, with rated tire load on flywheel.

T_W = Coast down time, in seconds, with no tire load on flywheel.

(UL) = Subscript for upper speed limit.

(LL) = Subscript for lower speed limit.

6.2.4.1 *Low-speed landings.* In the first series of 100 landings, the tire must be landed against the flywheel with the flywheel having a peripheral speed of not less than 90 mph. The flywheel deceleration must be constant from 90 mph to 0 mph in the time T_C.

6.2.4.2 *High-speed landings.* In the second series of 100 landings, the tire must be landed against the flywheel with the flywheel having a peripheral speed of not less than 120 mph. The flywheel deceleration must be constant from 120 mph to 90 mph in the time T_C.

6.3 *High-speed tires.* Except as provided in the alternate test, tires operating at ground speeds greater than 120 mph must be tested on a dynamometer in accordance with paragraph 6.3.3. The curves to be used as a basis for tests under paragraph 6.3.3 must be established in accordance with the provisions of §§23.733 or 25.733, as appropriate. The load at the start of the test must be equal to the rated load of the tire. The load at any time during the test must be equal to the load shown on the established curve at that speed times the rated load of the tire divided by the initial load-speed-time curve load of the tire. Alternate tests involving a landing sequence for tires operating at ground speeds greater than 120 mph and not over 160 mph are set forth in paragraph 6.3.4.

6.3.1 *Test temperature.* The temperature of the air contained in the tire or of the carcass measured at the hottest point of the tire must be not lower than 120°F at the start of at least 90 percent of the test cycles specified in paragraphs 6.3.3.4 and at least 105°F at the start of the overload test (6.3.3.3) and of at least 90 percent of the test cycles specified in paragraphs 6.3.3.2 and 6.3.4. For the remaining 10 percent of each group of cycles, the contained air or carcass temperature must be not lower than 80°F at the start of each cycles. Rolling the tire on the dynamometer is acceptable for obtaining the minimum starting temperature.

6.3.2 *Dynamometer test speeds.* Applicable dynamometer test speeds for corresponding maximum ground speeds are as follows:

Maximum ground speed of aircraft, mph		*Speed rating of tire mph*	*Minimum dynamometer speed at S_2, mph*
Over —	*Not Over*		
120	160	160	160
160	190	190	190
190	210	210	210
210	225	225	225
225	235	235	235
235	245	245	245

For ground speeds over 245 mph, the tire must be tested to the maximum applicable load-speed-time requirements and appropriately identified with the proper speed rating.

6.3.3 *Dynamometer cycles.* The test tire must withstand 50 takeoff cycles, 1 overload takeoff cycle, and 10 taxi cycles described below. The sequence of the cycles is optional.

6.3.3.1 *Symbol definitions.* The numerical values which are used for the following symbols must be determined from the applicable airplane load-speed-time data:

L_0 = Tire load at start of takeoff, pounds, (not less than rated load).

L_1 = Tire load at rotation, pounds.

L_2 = Zero tire load (liftoff).

RD = Roll distance, feet.

S_0 = Zero tire speed.

S_1 = Tire speed at rotation, mph.

S_2 = Tire speed at liftoff, mph (not less than speed rating).

T_0 = Start of takeoff.

T_1 = Time to rotation, seconds.

T_2 = Time to liftoff, secondb.

6.3.3.2 *Takeoff cycles.* For these cycles the loads, speeds, and distance must conform to either Figure 1 or Figure 2. Figure 1 defines a test cycle that is generally applicable to any aircraft. If Figure 2 is used to define the test cycle, the loads, speeds, and distance must be selected based on the most critical takeoff conditions established by the applicant.

6.3.3.3 *Overload takeoff cycle.* The cycle must duplicate the takeoff cycles specified under paragraph 6.3.3.2 except that the tire load through the cycle must be increased by a factor of at least 1.5. Upon completion of the overload takeoff cycle, the tire must be capable of retaining air pressure with the

[loss of pressure not exceeding 10 percent in 24 hours from the initial test pressure. Good condition of the tire tread is not required.

6.3.3.4 *Taxi cycles.* The tire must withstand at least 10 taxi cycles on a dynamometer under the following test conditions:

Number of test cycles	*Minimum tire load, lbs.*	*Minimum speed mph*	*Minimum roll distance, ft.*
8	rated load	40	35,000
2	1.2 times rated load	40	35,000

6.3.4 *Alternate dynamometer tests.* For tires with a speed rating of 160 mph, test cycles which simulate landing may be used in lieu of the takeoff cycles specified in paragraphs 6.3.3.2 and 6.3.3.3. The tire must withstand 100 test cycles at rated load in accordance with paragraph 6.3.4.1 followed by 100 test cycles at rated load in accordance with paragraph 6.3.4.2.

6.3.4.1 *Low-speed landings.* In the first series of 100 landings, the test procedure for low-speed landings established under paragraphs 6.2.3 or 6.2.4, as appropriate, must be followed.

6.3.4.2 *High-speed landings.* In the second series of 100 landings, the test procedure for low-speed landings established under paragraphs 6.2.3 or 6.2.4, as appropriate, must be followed, except that the tire must be landed against the flywheel rotating at a speed of 160 mph with the rated load applied for the duration of the test. The unlanding speed must be adjusted as necessary in order that 44 percent of the kinetic energy, as calculated in paragraph 6.2.2, is absorbed by the tire during the series of tests.

FIGURE 1

GRAPHIC REPRESENTATION OF A UNIVERSAL LOAD-SPEED-TIME TEST CYCLE

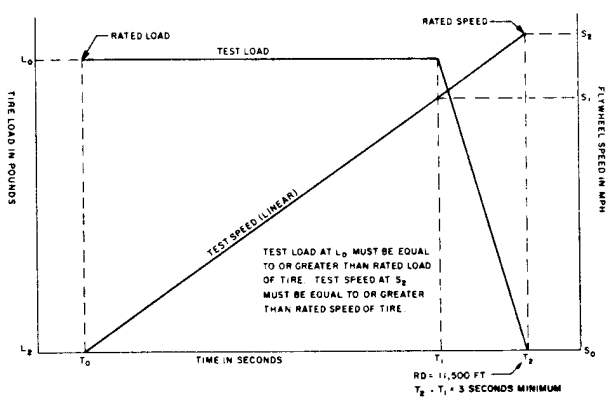

Figure 1

FIGURE 2

GRAPHIC REPRESENTATION OF A RATIONAL LOAD-SPEED-TIME TEST CYCLE

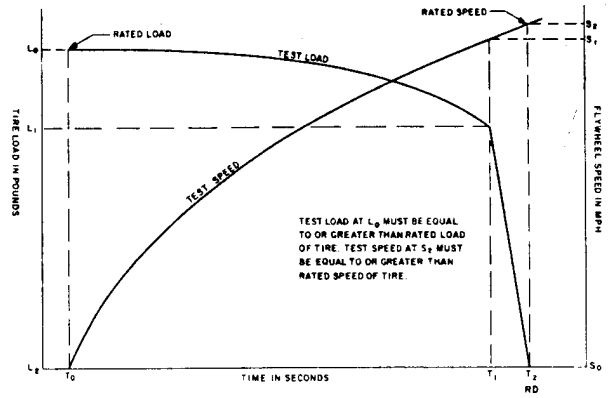

Figure 2

7.0 Requalification tests. Requalification in accordance with paragraph 6.0 of a given load rated tire required as a result of a tread design or material change will automatically qualify the same changes in a lesser load rated tire of the same size, speed rating, and skid depth provided—

7.1 The lesser load rated tire has been qualified to the applicable requirements specified in this standard; and

7.2 The ratio of qualification testing load to rated load for the lesser load rated tire does not exceed the same ratio for the higher load rated tire at any given test condition.]

§ 37.168 Airborne weather radar equipment—TTSO-C63b.

(a) *Applicability*—(1) This technical standard order prescribes the minimum performance standards that airborne weather radar equipment must meet in order to be identified with the applicable TSO marking. New models of equipment that are to be so identified, and that are manufactured on or after August 18, 1972, must meet the requirements of Radio Technical Commission for Aeronautics Document No. DO-134 entitled "Minimum Performance Standards—Airborne Weather and Ground Mapping Pulsed Radars," dated February 16, 1967, and Radio Technical Commission for Aeronautics Document No. DO-138 entitled "Environmental Conditions and Test Procedures for Airborne Electronic/Electrical Equipment and Instruments" dated June 27, 1968, except as provided in subparagraph (2) of this paragraph. RTCA Documents Nos. DO-134]

and DO-138 are incorporated herein in accordance with 5 U.S.C. 552(a) (1) and § 37.23 of the Federal Aviation Regulations, and are available as indicated in § 37.23. Additionally, RTCA Documents Nos. DO-134 and DO-138 may be examined at any FAA regional office of the Chief of Engineering and Manufacturing Branch (or in the case of the Western Region, the Chief, Aircraft Engineering Division), and may be obtained from the RTCA Secretariat, Suite 655, 1717 H Street, N.W., Washington, D.C., 20006, at a cost of $6 per copy for Document No. DO-134 and $8 per copy for Document No. DO-138.

(2) *Exceptions.* (i) RTCA Paper DO-108, referenced in RTCA Document No. DO-134, has been superseded by RTCA Document No. DO-138, and the requirements of RTCA Document No. DO-134 must be met using the environmental test condition of RTCA Document No. DO-138. The exception provided in paragraph 2.14.1 of RTCA Document No. DO-134 is applicable after substituting the words "Figure 2 on page 13 of DO-138 Appendix A" in place of the words "Figure 4-A on page 9 of DO-108 Appendix A."

(ii) RTCA Document No. DO-138 lists environmental test conditions covering equipment subjected to water, hydraulic fluid, sand and dust, fungus and salt spray, for which there are no corresponding equipment performance requirements in RTCA Document No. DO-134, and compliance with these environmental test conditions is not required. If the applicant elects to certify compliance with any of those environmental test conditions, the equipment performance requirements of paragraph 2.7 of RTCA Document No. DO-134 must be met after the equipment has been exposed to those test conditions.

(b) *Marking.* In addition to the markings specified in § 37.7, the article must be permanently and legibly marked with the following information:

(1) The environmental categories over which the article has been designed to operate must be marked in accordance with RTCA Document DO-138, Appendix B.

(2) The maximum system range in nautical miles, declared by the article manufacturer. This must be identified on the name plate, following the environmental category designations, by the word "class" and the following class number which identifies the maximum system range:

Class	*Maximum system range in nautical miles*
1	25
2	50
3	75
4	100
5	125
6	150
7	over 150

(3) Each separate component of the article (antenna, transmitter-receiver, indicator, etc.) must be identified with at least the name of the manufacturer, the TSO number, and the environmental categories over which the article component is designed to operate. Where an environmental test procedure is not applicable to that component and the test is not conducted, an X should be placed in the space assigned for that category.

(c) *Data requirements.* (1) In accordance with § 37.5, the manufacturer must furnish to the Chief, Engineering and Manufacturing Branch, Flight Standards Division (or in the case of the Western Region, the Chief, Aircraft Engineering Division), Federal Aviation Administration, in the region in which the manufacturer is located, the following technical data:

(i) One copy of the operating instructions and equipment limitations of the manufacturer.

(ii) One copy of the installation procedures with applicable schematic drawings, wiring diagrams, and specifications, and a list of components (by part number) or possible combinations thereof, which make up a system complying with this TSO. The procedures must set forth all limitations, restrictions, or other conditions pertinent to the installation.

(iii) One copy of the manufacturer's test report.

(2) One copy of the technical data specified in subparagraph (1) (ii) of this paragraph must be furnished with each article manufactured.

(d) *Previously approved equipment.* Airborne weather radar equipment approved prior

to the effective date of this section may continue to be manufactured under the provisions of its original approval.

§ 37.169 Oxygen mask assembly, continuous flow, passenger (for air carrier aircraft)—TSO-C64.

(a) *Applicability*—(1) *Minimum performance standards.* Minimum performance standards are hereby established for passenger oxygen mask assemblies which are to be approved for use on civil aircraft of the United States. New models of passenger oxygen mask assemblies manufactured for installation on civil aircraft on or after the effective date of this section shall meet the standards set forth in National Aircraft Standards, NAS 1179, "Oxygen Mask Assembly, Passengers", Revision 2, dated March 31, 1961,* with exceptions to the standard listed in subparagraph (2) of this paragraph.

(2) *Exceptions.* (i) The following specifically numbered subparagraphs in NAS 1179 are not concerned with minimum performance and, therefore, are not essential to compliance with this section: 2.0 in its entirety, 3.1.1, 3.1.2, 3.1.3.7, 3.1.12, 3.3.11 in its entirety, 4.2, 4.3.5, 5.3, 5.6, 5.7, and 5.8.

*Copies of this standard may be obtained from the National Standards Association, Inc.

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(ii) Conformance to "NAS Standard Part Number" and "NAS Standard Drawing" referred to throughout NAS 1179 is not required.

(iii) Paragraph 1.4 of NAS 1179 shall be revised and made a part of this standard, as follows:

1.4 *Coding of performance classification.* An eight digit performance classification number shall be assigned to each class of masks. This number shall correspond to the number assigned to the minimum performance curve established in paragraph 4.1.7.2.2 and shall appear in the part callout as the first dash number following specification No. NAS 1179. Each pair of digits, starting with the first pair to the left, shall represent the required minimum oxygen flow rates (NTPD) to the mask shown on curve "C" of Figure 2 at cabin pressure altitudes of 15,000, 25,000, 30,000 feet and the maximum approved altitude, respectively. Flow rates shall be to one decimal.

Typical example. NAS 1179-08233248-XX*

0.8—required minimum oxygen flow, LPM, NTPD, at 15,000 ft.

2.3—required minimum oxygen flow, LPM, NTPD, at 25,000 ft.

3.2—required minimum oxygen flow, LPM, NTPD, at 30,000 ft.

4.8—required minimum oxygen flow, LPM, NTPD, at maximum approved altitude.

(b) *Marking.* Each oxygen mask assembly shall be marked in accordance with § 37.7 except that the weight specified in § 37.7 may be omitted, and the following additional information shall be shown:

(1) The performance classification number.

(c) *Data requirements.* (1) The manufacturer shall maintain a current file of complete design data.

(2) The manufacturer shall maintain a current file of complete data describing the inspection and test procedures applicable to his products. (See paragraph (d) of this section.)

(3) Six copies each, except where noted, of the following, shall be furnished the Chief, Engineering and Manufacturing Branch, Flight Standards Division, Federal Aviation Administration, in the region in which the manufacturer is located.

(i) Manufacturer's operating instructions and equipment limitations.

(ii) Installation procedures with applicable drawings and specifications, limitations, restrictions, or other conditions pertinent to installation. These limitations shall include the regulators which are capable of providing an oxygen partial pressure specified in the applicable Federal Aviation Regulations.

(iii) One copy of the manufacturer's test report.

(iv) Manufacturer's cleaning and sterilizing procedures.

(d) *Quality control.* Passenger oxygen masks shall be produced under a quality control system, established by the manufacturer, which will assure that each mask assembly is in conformity with the requirements of this section and is in a condition for safe operation. This system shall be described in the data required under paragraph (c) (2) of this section. The Administrator shall be permitted to make such inspections and production tests at the manufacturer's facility as may be necessary to determine compliance with the requirements of this section.

(e) *Previously approved equipment.* Passenger oxygen masks approved prior to the effective date of this section may continue to be manufactured under the provisions of its original approval.

§ 37.170 Airborne doppler radar groundspeed and/or drift angle measuring equipment (for air carrier aircraft)—TSO–C65.

(a) *Applicability*—(1) *Minimum performance standards.* Minimum performance standards are hereby established for airborne doppler radar groundspeed and/or drift angle measuring equipment which is to be used on civil aircraft of the United States engaged in air carrier operations. New models of airborne doppler radar groundspeed and/or drift angle measuring equipment manufactured for use on civil air carrier aircraft on or after April 20, 1960, shall meet the minimum performance standards as set forth in Radio Technical Commission for Aeronautics' Paper entitled "Minimum Performance Standards—Airborne Doppler Radar Ground Speed and/or Drift Angle Measuring Equipment" (Paper

* XX—Additional coding which the mask manufacturer may desire to add.

166–59/DO–98* dated September 8, 1959). Radio Technical Commission for Aeronautics' Paper 100–54/DO–60* which is incorporated by reference in and thus is a part of Paper 166–59/DO–98 has been amended by Paper 256–58/EC–366 dated November 13, 1958. This amendment is also a part of the minimum performance standards. An exception to these standards is covered in subparagraph (2) of this paragraph.**

(2) *Exceptions.* (i) Radio Technical Commission for Aeronautics' Paper 100–54/DO–60, and amendment Paper 256–58/EC–366 dated November 13, 1958, outline environmental test procedures for equipment designed to operate under three environmental test conditions as specified therein under Procedures A, B, and C. Only airborne doppler radar groundspeed and/or drift angle measuring equipment which meets the operating requirements as outlined under Procedure A or Procedure B of Paper 100–54/DO–60, as amended, is eligible under this section.

(ii) The vibration values specified below may be used for equipment designed exclusively for installation on the instrument panel of aircraft in lieu of those specified in Paper 100–54/DO–60 as amended. No shock mounting shall be used during the conduct of this test if the vibration values specified below are used.

Amplitude: 0.01″ (0.02″ total excursion).

Frequency: Variable 10–55 cps.

Maximum Acceleration: 1.5 g.

(iii) Equipment which is designed exclusively for installation on the instrument panel of aircraft need not be subjected to the shock requirements outlined in Paper 100–54/DO–60 as amended.

(iv) Indicating instruments which are a part of the system, but which are not designed exclusively for installation on the instrument panel of aircraft, may also be tested to the vibration requirements specified in subdivision (ii) of this subparagraph, and need not be subjected to the shock requirements outlined in Paper 100–54/DO–60 as amended.

(b) *Marking.* In addition to the information required in § 37.7, equipment which has been designed to operate over the environmental conditions as outlined in Procedure A of RTCA Paper 100–54/DO–60, as amended, shall be marked as Category A equipment. Equipment which has been designed to operate over the environmental conditions outlined in Procedure B of this same paper shall be marked as Category B equipment. Equipment which has been designed exclusively for installation on the instrument panel of aircraft and which meets only the amended vibration requirement outlined above shall be identified with the letters I.P. following the category of equipment, such as CAT. A—IP.

(c) *Data requirements.* With the statement of conformance, one copy each of the manufacturer's operating instructions, schematic diagrams, and installation procedures shall be furnished the Chief, Engineering and Manufacturing Branch, Flight Standards Division, Federal Aviation Administration, in the region in which the manufacturer is located.

(d) *Previously approved equipment.* Airborne doppler radar groundspeed and/or drift angle measuring equipment approved prior to April 20, 1960, may continue to be manufactured under the provisions of its original approval.

§ 37.171 Airborne distance measuring equipment (air carrier aircraft)—TSO–C66a.

(a) *Applicability.* This Technical Standard Order prescribes the minimum performance standards which airborne distance measuring equipment, to be used on U.S. civil aircraft engaged in air carrier operations, must meet in order to be identified with the applicable TSO marking. New models of such equipment which are to be so identified and which are manufactured on or after the effective date of this section shall meet the requirements set forth in the Federal Aviation Administration standard entitled "Minimum Performance Standards for Airborne Distance Measuring Equipment Operating Within the Radio Fre-

* Copies of these papers may be obtained from RTCA.

** In addition to the performance standards herein, airborne doppler radar groundspeed and/or drift angle measuring equipment when installed in aircraft must meet installation requirements as well as functional and reliability flight tests of the pertinent airworthiness sections of the Federal Aviation Regulations.

quency Range 960–1215 Megacycles"* dated February 15, 1965, and Federal Aviation Administration document "Environmental Test Procedures for Airborne Electronic Equipment" dated August 31, 1962.*

(b) *Marking.*

(1) In addition to the marking specified in § 37.7, the equipment must be marked to indicate the environmental extremes over which it has been designed to operate. There are six environmental procedures outlined in the FAA document "Environmental Test Procedures for Airborne Electronic Equipment" which have categories established. These shall be identified on the nameplate by the words "Environmental Categories" or, as abbreviated, "Env. Cat.," followed by six letters which identify the categories designated in the FAA document. Reading from left to right, the category designations shall appear on the nameplate in the following order so that they may be readily identified—

(i) Temperature-Altitude Test Category;

(ii) Vibration Test Category;

(iii) Audio-Frequency Magnetic Field susceptibility Category;

(iv) Radio-Frequency Susceptibility Category;

(v) Emission of Spurious Radio-Frequency Energy Test Category; and

(vi) Explosion Test Category.

(2) In some cases, such as under the temperature-altitude test category, a manufacturer may wish to substantiate his equipment under two categories. In this case, the nameplate must be marked with both categories in the space designated for that category by placing one letter above the other in the following manner: Env. Cat. $\frac{A}{D}$ BAAAX

(3) Each separate component of equipment (antenna, indicator, etc.) shall be identified with at least the manufacturer's name, TSO number, and the environmental categories over which the equipment component is designed to operate.

(c) *Data Requirements.*

In accordance with § 37.5, the manufacturer must furnish to the Chief, Engineering and Manufacturing Branch, Flight Standards Division, Federal Aviation Administration, in the region in which the manufacturer is located, the following technical data:

(1) Manufacturer's operating instructions and equipment limitations.

(2) Installation procedures with applicable schematic drawings, wiring diagrams, and specifications. Indicate any limitations, restrictions, or other conditions pertinent to installation.

(3) One copy of the manufacturer's test report.

(d) *Previously approved equipment.*

Airborne distance measuring equipment approved prior to the effective date of this section may continue to be manufactured and identified with the applicable TSO marking under the provisions of its original approval.

(e) *Effective date.* September 10, 1965.

*Copies may be obtained upon request addressed to Federal Aviation Administration.

[§ 37.172 Aircraft wheels and wheel-brake assemblies—TSO-C26c.

(a) *Applicability.* This Technical Standard Order prescribes the minimum performance standards that aircraft landing wheels and wheel-brake assemblies must meet in order to be identified with the applicable TSO marking. New models of such equipment which are to be so identified and which are manufactured on or after December 31, 1979, must meet the requirements of the Federal Aviation Administration Standard for Aircraft Wheels and Wheel-Brake Assemblies set forth at the end of this section.

(b) *Marking.* In lieu of the marking requirements of § 37.7, aircraft wheels and wheel-brake assemblies must be legibly and permanently marked with the following information:

(1) Name of the manufacturer responsible for compliance.

(2) Serial number, or date of manufacture, or both.

(3) Part number.

(4) Applicable technical standard order (TSO) number.

(5) Size (this marking applies to wheels only).

All stamped, etched, or embossed markings must be located in noncritical areas.

(c) *Data requirements.* (1) In addition to the data specified in § 37.5, the manufacturer must]

[furnish to the Chief, Engineering and Manufacturing Branch, Federal Aviation Administration, in the region in which the manufacturer is located (or, in the case of the Western Region, the Chief, Aircraft Engineering Division), the following technical data:

(i) One copy of the applicable limitations pertaining to installation of wheels and brakes on aircraft, including the weight of the brake assembly, maximum static load rating, maximum limit load rating, maximum accelerate-stop kinetic energy in foot-pounds (KE_{RT}), design landing kinetic energy in foot-pounds (KE_{DL}), accelerate-stop deceleration in feet/second^2, design landing stop deceleration in feet/second^2, applicable speed as specified in paragraph 4.2(a)(1) of the FAA Standard for Aircraft Wheels and Wheel-Brake Assemblies, type of hydraulic fluid used, and the weight of the wheel.

(ii) One copy of the manufacturer's test report.

(2) Upon request of the regional office specified in paragraph (c)(1) of this section, the manufacturer must furnish the applicable maintenance instructions.

(d) *Previously approved equipment.* Wheels and wheel-brake assemblies approved prior to December 31, 1979, may continue to be manufactured under the provisions of their original approval.

FEDERAL AVIATION ADMINISTRATION STANDARD FOR AIRCRAFT WHEELS AND WHEEL-BRAKE ASSEMBLIES

1. Purpose.

This document contains minimum performance standards for aircraft landing wheels and wheel-brake assemblies.

2. Design and Construction.

(a) *Design.*

(1) *Lubricant retainers.* Lubricant retainers must retain the lubricant under all operating conditions, prevent the lubricant from reaching braking surfaces, and prevent foreign matter from entering the bearings.

(2) *Removable flanges.* All removable flanges must be assembled onto the wheel in a manner that will prevent the removable flange and retaining device from leaving the wheel if a tire should deflate while the wheel is rolling.

(3) *Adjustment.* When necessary to assure safe performance, the brake mechanism must be equipped with suitable adjustment devices.

(4) *Water seal.* Wheels intended for use on amphibious aircraft must be sealed to prevent entrance of water into the wheel bearings or other portions of the wheel or brake, unless the design is such that brake action and service life will not be impaired by the presence of sea water or fresh water.

(5) *Explosion prevention.* Unless determined to be unnecessary, means must be provided to minimize the probability of wheel and tire explosions which result from elevated brake temperatures.

(b) *Construction.*

(1) *Castings.* Castings must be of high quality, clean, sound, and free from blowholes, porosity, or surface defects caused by inclusions, except that loose sand or entrapped gases may be allowed when the serviceability of the casting has not been impaired.

(2) *Forgings.* Forgings must be of uniform condition, free from blisters, fins, folds, seams, laps, cracks, segregation, and other defects. If strength and serviceability are not impaired, imperfections may be removed.

(3) *Rim surfaces.* For wheels designed for use with a tire and inner tube combination, the surface of the rim between bead seats must be free from defects which would be injurious to the inner tube while mounting the tire or while in service.

(4) *Rim joints.* For wheels designed for use with a tire and inner tube combination, joints in the rim surface and joints between rim surfaces and demountable flanges must be smooth, close fitting, and noninjurious to the inner tube while mounting the tire or while in service.

(5) *Rivets and bolts.* When rivets are used, they must be well headed over, and rivets and bolts coming in contact with the casing or tube must be smooth enough not to damage the tube or casing during normal operation.

(6) *Bolts and studs.* When bolts and studs are used for fastening together sections of a wheel, the length of the threads for the nut extending into and bearing against the sections must be held to a minimum and there must be sufficient unthreaded bearing area to carry the required load.

(7) *Steel parts.* All steel parts, except braking surfaces and those parts fabricated from corrosion-resistant steel must be cadmium plated or zinc plated or have equivalent protection from corrosion.

(8) *Aluminum parts.* All aluminum alloy parts must be anodized or have equivalent protection from corrosion. This protection must include protection for fuse plug holes, valve stem holes, and other passages.

(9) *Magnesium parts.* All magnesium alloy parts must receive a suitable dichromate treatment or have equivalent protection from corrosion. This protection must include protection for fuse plug holes, valve stem holes, and other passages.

(10) *Bearing and braking surfaces.* The bearings and braking surfaces must be protected during the application of finish to the wheels and brakes.

(11) *Fatigue.* The construction of the wheel must take into account techniques used to improve fatigue resistance of critical areas of the wheel.]

[3. Rating.

(a) Each wheel design must be rated for the following:

(1) S = Maximum static load in pounds (ref. §§ 23.731(b), 25.731(b), 27.731(b), and 29.731(b) of this chapter).

(2) L = Maximum limit load in pounds (ref. §§ 23.731(c), 25.731(c), 27.731(c), and 29.731(c) of this chapter).

(b) Each wheel-brake assembly design must be rated for the following:

(1) KE_{DL} = Kinetic energy capacity in foot-pounds per wheel-brake assembly at the design landing rate of absorption.

(2) KE_{RT} = Kinetic energy capacity in foot-pounds per wheel-brake assembly at the maximum accelerate-stop rate of absorption for wheel-brake assemblies of airplanes certificated under Part 25 of this chapter only.

4. Qualification Tests. The aircraft wheels and wheel-brake assemblies must be tested as follows and the test data included in the applicant's test report required by § 37.172(c) (1) (ii) of this Part.

4.1 *Wheel Tests.* To establish the S and L ratings for a wheel, test a standard sample in accordance with the following radial, combined, and static load tests:

(a) *Maximum radial load test.* Test the wheel for yield and ultimate loads as follows:

(1) *Test method.* Mount the wheel with a suitable tire of proper fit installed, on its axle, and position it against a flat nondeflecting surface. The wheel axle must have the same angular orientation to the nondeflecting surface that it will have to the runway when it is mounted on the aircraft and is under the maximum limit load. Inflate the tire to the pressure recommended for the S load with air or water. If water inflation is used, the water must be bled off to obtain the same tire deflection that would result if air inflation were used. Water pressure may not exceed the pressure which would develop if air inflation were used and the tire deflected to its maximum extent. Load the wheel through its axle perpendicular to the flat nondeflecting surface. Deflection readings must be taken at suitable points to indicate deflection and permanent set of the wheel rim at the bead seat.

(2) *Yield load.* Apply to the wheel a load not less than 1.15 times the maximum radial limit load, determined under §§ 23.471 through 23.511, or §§ 25.471 through 25.511, or §§ 27.471 through 27.505, or §§ 29.471 through 29.511 of this chapter, as appropriate. Apply the load with the wheel positioned against the nondeflecting surface, and the valve hole positioned at 90° with respect to the line between the center of the wheel and the point of contact, then with the valve hole positions 180°, 270°, and 0° from the nondeflecting surface. The 90° increments must be altered to other positions if the other positions are more critical. Three successive loadings at the 0° position may not cause permanent set increments of increasing magnitude. The permanent set increment caused by the last loading at the 0° position may not exceed 5 percent of the deflection caused by that loading or 0.005 inches, whichever is greater. The bearing cups, cones, and rollers used in operation must be used for these loadings. There must be no yielding of the wheel such as would result in loose bearing cups, air, or water leakage through the wheel or past the wheel seal, or interference in any critical areas.

(3) *Ultimate load.* Apply to the wheel a load, not less than 2 times the maximum radial limit load for castings and 1.5 times the maximum radial limit load for forgings, determined under §§ 23.471 through 23.511, or §§ 25.471 through 25.511 or §§ 27.471 through 27.505, or §§ 29.471 through 29.511 of this chapter, as appropriate. Apply the load with the same wheel positioned against the nondeflecting surface and the valve hole positioned at 0° with respect to the line between the center of the wheel and the point of contact. The wheel must be able to support the load without failure for at least 3 seconds. The bearing cones may be replaced with conical bushings, but the cups used in operation must be used for this loading. If, at a point of loading during the test, it is shown that the tire will not successfully maintain pressure or if bottoming of the tire on the nondeflecting surface occurs, the tire pressure may be increased to no more than 2 times the rated inflation pressure. If bottoming of the tire continues to occur with this increased pressure, a loading block which fits between the rim flanges and simulates the load transfer of the inflated tire may be used.The arc of wheel supported by the loading block must be no greater than 60°.

(4) If the radial limit load in paragraph 4.1(b) is equal to or greater than the maximum radial limit in paragraphs 4.1(a) (2) and (3), the tests specified in paragraphs 4.1(a) (2) and (3) may be omitted.

(b) *Combined radial and side load test.* Test the wheel for the yield and ultimate loads as follows:

(1) *Test method.* Mount the wheel, with a suitable tire or proper fit installed, on its axle, and position it against a flat nondeflecting surface. The wheel axle must have the same angular orientation to the nondeflecting surface that it will have to the runway when it is mounted on the aircraft and is under the combined radial and side load. Inflate the tire to the pressure recommended for the maximum static load with air or water. If water inflation is used, the water must be bled off to obtain the same tire deflection that would result if air inflation were used. Water pressure may not exceed the pressure which would develop if air inflation were used and the tire deflected to its maximum extent. For the radial load component, load the wheel through its axle perpendicular to the flat nondeflecting surface. For the side load component, load the wheel through its axle parallel to the flat nondeflecting surface. The side load reaction must arise from the friction of the tire or the loading block on the nondeflecting surface. Apply the two loads simultaneously, increasing them either continuously or in increments no larger than 10 percent of the loads]

[to be applied. Alternatively, a resultant load equivalent to the radial and side loads may be applied to the axle. Deflection readings must be taken at suitable points to indicate deflection and permanent set of the wheel rim at the bead seat.

(2) *Yield load.* Apply to the wheel radial and side loads not less than 1.15 times the respective ground loads determined under §§ 23.485, or 23.497, and 23.499, or §§ 25.485, 25.495, 25.497, and 25.499, or §§ 27.485 and 27.497, or §§ 29.485 and 29.497 of this chapter, as appropriate. Apply these loads with the wheel positioned against the nondeflecting surface and the valve hole positioned at 90° with respect to the line between the center of the wheel and the point of contact, then with the valve hole positioned 180°, 270°, and 0° from the nondeflecting surface. The 90° increments must be altered to other positions if the other positions are more critical. Three successive loadings at the 0° position may not cause permanent set increments of increasing magnitude. The permanent set increment caused by the last loading at the 0° position may not exceed 5 percent of the deflection caused by that loading, or 0.005 inch, whichever is greater. The bearing cups, cones, and rollers used in operation must be used in this test. There must be no yielding of the wheel such as would result in loose bearing cups, air or water leakage through the wheel or past the wheel seal, or interference in any critical areas. A tire and tube may be used when testing a tubeless wheel only when it has been demonstrated that pressure will be lost due to the inability of a tire bead to remain properly positioned under the load. The wheel must be tested for the most critical inboard and outboard side loads.

(3) *Ultimate load.* Apply to the wheel radial and side loads not less than 2 times for castings and 1.5 times for forgings the respective ground loads determined under §§ 23.485, 23.497, and 23.499, or §§ 25.485, 25.495, 25.497, and 25.499, or §§ 27.485 and 27.497, or §§ 29.485 and 29.497 of this chapter, as appropriate. Apply these loads with the same wheel positioned against the nondeflecting surface and the valve hole positioned at 0° with respect to the center of the wheel and the point of contact. The wheel must be able to support the load without failure for at least 3 seconds. The bearing cones may be replaced with conical bushings, but the cups used in operation must be used for this loading. If, at a point of loading during the test, it is shown that the tire will not successfully maintain pressure of if bottoming of the tire on the nondeflecting surface occurs, the tire pressure may be increased to no more than 2 times the rated inflated pressure. If bottoming of the tire continues to occur with this increased pressure, a loading block which fits between the rim flanges and simulates the load transfer of the inflated tire may be used. The arc of wheel supported by the loading block must be no greater than 60°.

(c) *Maximum static load test.* Test the wheel for the maximum static load test as follows:

(1) *Test method.* Mount the wheel, with a suitable tire of proper fit installed, on its axle, and position it against a flat nondeflecting surface or a flywheel. The wheel axle must have the same angular orientation to the load surface that it will have to the runway when it is mounted on the aircraft and is under the maximum static load. Inflate the tire to the pressure recommended for the maximum static load "S". The radial load must be applied to the wheel through the axle and perpendicular to the load surface. The side load, when required, must be applied through the wheel axle and parallel to the load surface. For the side load, the wheel axle must be rotated or yawed to the angle which will produce a side load component equal to 0.15 "S" while the wheel is being roll tested.

(2) *Roll test.* The wheel must be tested under the loads and for the distance shown in Table I. At the end of the test there must be no cracks on the wheel and no leakage through the wheel or past the wheel seal, and the bearing cups may not be loosened in the hub.

Table I

Category of Aircraft	*Load Conditions*	*Roll Distance (Miles)*
Part 25	Maximum static load, "S"	2000
	Maximum static load, "S" plus 0.15 "S" side load applied in outboard direction.	100
	Maximum static load, "S" plus 0.15 "S" side load applied in inboard direction.	100
Part 23	Maximum static load, "S"	1000
Parts 27 and 29	Maximum static load, "S"	250

(3) *Roll on rim test.* The wheel without a tire must be tested at a speed not less than 10 mph under the loads and distance shown in Table II. The test axle angular orientation with the load surface must approximate that of the airplane axle to the runway under maximum static load. At the end of the test there may be cracks but no fragmentation of the wheel. (V_R = takeoff speed in knots.)

Table II

Category of Aircraft	*Load Conditions*	*Roll Distance (feet)*
Part 25	Maximum static load "S"	$V_R2 \times 0.5$

(d) *Pressure test.* Pressure test the wheel in accordance with the following:

(1) *Overpressure test.* The wheel must be hydrostatically tested to withstand without failure for at least 3 seconds application of an overpressure factor not less than 4.0 for Part 25 airplanes, 3.5 for Part 23 airplanes, and 3.0 for rotorcraft, times the rated inflation pressure determined by the applicant.]

[(2) *Diffusion test.* The tubeless tire and wheel assembly must hold the rated inflation pressure for 24 hours with no greater pressure drop than 5 percent. This test must be performed after the tire growth has stablized.

4.2 *Wheel brake assembly test.* A sample of a wheel-brake assembly design, with a suitable tire of proper fit installed, must meet the following tests to qualify the design for its kinetic energy ratings. The wheel of a wheel-brake assembly must be separately tested under paragraph 4.1. The wheel-brake assembly must be tested with the operating medium specified by the manufacturer.

(a) *Dynamic torque tests.* Test the wheel-brake assembly on a suitable inertial brake testing machine in accordance with the following:

(1) *Speed and weight values.* For airplanes, select either Method I or Method II below to calculate the kinetic energy level which a single wheel and wheel-brake assembly will be required to absorb. For rotorcraft, use Method I.

(i) *Method I.* Calculate the kinetic energy level to be used in the brake testing machine by using the equation:

$$KE = \frac{0.0443WV^2}{N}$$

Where—

KE = Kinetic energy per wheel-brake assembly (ft.-lbs.);

W = Design landing weight (lbs.);

V = Aircraft speed in knots. V must be not less than V_{SO}, the poweroff stalling speed of the aircraft at sea level, at the design landing weight, and the landing configuration. For the accelerate-stop tests applicable only to wheel-brake assemblies for airplanes certificated under Part 25 of this chapter, the manufacturer must determine the most critical combination of takeoff weight and speed;

N = Number of wheels with brakes.

For rotorcraft, the manufacturer must calculate the most critical combination of takeoff weight and brake application speed to be used in the above equation.

(ii) *Method II.* The speed and weight values may be determined by other equations based on rational analysis of the sequence of events expected to occur during an accelerate-stop condition or an operational landing at maximum landing weight. The analysis must include rational or conservative values for braking coefficients of friction between the tire and runway, aerodynamic drag, propeller drag, powerplant forward thrust, and, if critical, loss of drag credit for the most adverse single-engine or propeller due to malfunction. Do not consider the decelerating effects of propeller reverse pitch, drag parachutes, and powerplant thrust reversers.

(2) *Test requirements.* The wheel-brake assembly must bring the inertial testing machine to a stop at the average deceleration, and for the number of repetitions specified in Table III without failure, impairment of operation, or replacement of parts except as permitted in paragraph 4.2(a) (3).

Table III

Category of Aircraft	*Tests*
Parts 23 and 25	KE_{DL}: 100 design landing stops at a deceleration selected by manufacturer but not less than 10 ft./sec.^{2}
Part 25	KE_{RT}: 1 accelerate-stop at a deceleration selected by manufacturer but not less than 6 ft./sec.^{2}
Parts 27 and 29	KE_{DL}: 20 design landing stops at a deceleration selected by manufacturer but not less than 6 ft./sec.^{2}

(3) *General conditions.*

(i) During landing stop tests (KE_{DL}), one change of brake lining is permissible. The remainder of the brake assembly parts must withstand the 100 KE_{DL} stops without failure or impairment of operation.

(ii) During the accelerate-stop tests (KE_{RT}), brake lining and bare discs may be new or used. No less than two landing stop tests must have been completed on the brake prior to this test. The brakes must be usable for taxi after the accelerate-stop test to KE_{RT}.

(iii) As used in this paragraph, "brake lining" is either individual blocks of wearing material or discs which have wearing material integrally bonded to them. "Bare discs" are plates or drums which do not have wearing material integrally bonded to them.

(b) *Brake structural torque test.* Apply load S and a torque load specified in paragraph 4.2(b) (1) or (2), as applicable, for at least 3 seconds. Rotation of the wheel must be resisted by a reaction force transmitted through the brake or brakes by an application of at least maximum brake line pressure or brake cable tension in the case of a nonhydraulic brake. If such pressure or tension is insufficient to prevent rotation, the friction surface may be clamped, bolted, or otherwise restrained while applying the pressure or tension.

(1) For landing gears with only one wheel per landing gear strut, the torque load is 1.2 SR where R is the normal loaded radius of the tire at rated inflation pressure under load S.

(2) For landing gears with multiple wheels per landing gear strut, the torque load is 1.44 SR where R is the normal loaded radius of the tire at rated inflation pressure under load S.

(c) *Overpressure-hydraulic brakes.* The brake with actuator piston extended to simulate a maximum worn condition must withstand hydraulic pressure for at least 3 seconds, equal to the following:]

[(1) For airplanes, 2 times the maximum brake line pressure available to the brakes.

(2) For rotorcraft, 2 times the pressure required to hold the rotorcraft on a 20 degree slope at design takeoff weight.

(d) *Endurance tests—hydraulic brakes.* The hydraulic brake assembly must be subjected to an endurance test during which the total leakage may not exceed 5cc and no malfunction may occur during or upon completion of the test. Minimum piston travel during the test may not be less than the maximum allowable piston travel in operation. The tests must be conducted by subjecting the hydraulic brake assembly to—

(1) 100,000 cycles for airplanes, and 50,000 cycles for rotorcraft, of application and release of the average hydraulic pressure needed in the KE_{DL} tests specified in paragraph 4.2(a) (2) except that manufacturers using Method II in conducting the tested specified in paragraph 4.2(a) (2) must subject the wheel-brake assembly to the average of the maximum pressures needed in those tests. The piston must be adjusted so that 25,000 cycles for airplanes, and 12,500 cycles for rotorcraft, are performed at each of the four positions where the piston would be at rest when adjusted for 25, 50, 75, and 100 percent of the wear limit; and

(2) 5,000 cycles for airplanes, and 2,500 cycles for rotorcraft, at the maximum system pressure available to the brakes.]

§ 37.173 Airborne radar altimeter equipment (for air carrier aircraft)—TSO-C67.

(a) *Applicability*—(1) *Minimum performance standards.* Minimum performance standards are hereby established for airborne radar altimeter equipment which is to be used on civil aircraft of the United States engaged in air carrier operations. New models of airborne radar altimeter equipment manufactured for use on civil air carrier aircraft on or after November 15, 1960, shall meet the minimum performance standards as set forth in Radio Technical Commission for Aeronautics' Paper entitled "Minimum Performance Standards for Airborne Radar Altimeter Equipment Intended for Determining Pressure Gradients and Operating Within the Radio Frequency Band of 420–460 Megacycles," (Paper 73-60/DO-103)* dated April 12, 1960. Radio Technical Commission for Aeronautics' Paper 100-54/DO-60* which is incorporated by reference in and thus is a part of Paper 73-60/DO-103 has been amended by Paper 256-58/EC-366. This amendment is also a part of the minimum performance standards. Exceptions, additions, and substitutions to these standards are covered in subparagraph (2) of this paragraph.**

(2) *Exceptions.* (i) Radio Technical Commission for Aeronautics' Paper 100-54/DO-60, and amendment Paper 256-58/EC-366 dated November 13, 1958, outline environmental test procedures for equipment designed to operate under three environmental test conditions as specified therein under Procedures A, B, and C. Only airborne radar altimeter equipment which meets the operating requirements as outlined under Procedure A or Procedure B of Paper 100-54/DO-60, as amended, is eligible under this section.

(ii) The vibration values specified below may be used for equipment designed exclusively for installation on the instrument panel of aircraft in lieu of those specified in Paper 100-54/DO-60 as amended. No shock mounting shall be used during the conduct of this test if the vibration values specified below are used,

Amplitude: 0.01″ (0.02″ total excursion).
Frequency: Variable 10–55 c.p.s.
Maximum Acceleration: 1.5 g.

(iii) Equipment which is designed exclusively for installation on the instrument panel of aircraft need not be subjected to the shock requirements outlined in Paper 100-54/DO-60 as amended.

(iv) Indicating instruments which are a part of the system, but which are not designed exclusively for installation on the instrument panel of aircraft, may also be tested to the vibration requirements specified in subdivision (ii) of this subparagraph, and need not be subjected to the shock requirements outlined in Paper 100-54/DO-60 as amended.

(*b*) *Marking.* (1) In addition to the markings specified in § 37.7 equipment which has been designed to operate over the environmental conditions outlined in Procedure A of RTCA Paper 100-54/DO-60 as amended, shall be marked as Category A equipment. Equipment which has been designed to operate over the environmental conditions outlined in Procedure B of this same paper shall be marked as Category B equipment. Equipment which has been designed exclusively for installation on the instrument panel of aircraft and which meets only the amended vibration requirements outlined above shall be identified with the letters I.P. following the category of equipment, such as CAT.A-I.P.

(2) Each major component of airborne radar altimeter equipment (antenna, power supply, etc.) shall be identified with at least the manufacturer's name and TSO number.

(c) *Data requirements.* (1) The manufacturer shall maintain a current file of complete design data.

(2) The manufacturer shall maintain a current file of complete data describing the inspection and test procedures applicable to his product. (See paragraph (d) of this section.)

(3) Six copies each, except where noted, of the following, shall be furnished to the Chief Engineering and Manufacturing Branch, Flight Standards Division, Federal Aviation

*Copies of these papers may be obtained from RTCA.

**When airborne radar altimeter equipment is installed on civil aircraft, the installation must comply with the functional and installation requirements of Parts 23, 25, 27 or 29 of the Federal Aviation Regulations as applicable.

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Administration, in the region in which the manufacturer is located.

(i) Manufacturer's operating instructions and equipment limitations.

(ii) Installation procedures with applicable schematic drawings, wiring diagrams, and specifications. Indicate any limitations, restrictions, or other conditions pertinent to installation.

(iii) One copy of the manufacturer's test report.

(d) *Quality control.* Airborne radar altimeter equipment shall be produced under a quality control system, established by the manufacturer, which will assure that each equipment is in conformity with the requirements of this section and is in a condition for safe operation. This system shall be described in the data required under paragraph (c)(2) of this section. The Administrator shall be permitted to make such inspections and tests at the manufacturer's facility as may be necessary to determine compliance with the requirements of this section.

(e) *Previously approved equipment.* Airborne radar altimeter equipment approved prior to November 15, 1960, may continue to be manufactured under the provisions of its original approval.

§ 37.174 Airborne automatic dead reckoning computer equipment utilizing aircraft heading and doppler-obtained groundspeed and drift angle data (for air carrier aircraft) —TSO–C68.

(a) *Applicability*—(1) *Minimum performance standards.* Minimum performance standards are hereby established for airborne automatic dead reckoning computer equipment utilizing aircraft heading and doppler-obtained groundspeed and drift angle data which is to be used on civil aircraft of the United States engaged in air carrier operations. New models of airborne automatic dead reckoning computer equipment utilizing aircraft heading and doppler-obtained groundspeed and drift angle data manufactured for use on civil air carrier aircraft on or after January 16, 1961, shall meet the standards in Radio Technical Commission for Aeronautics Papers 101–60/DO–104* dated June 8, 1960; 100–54/DO–60* dated April 13, 1954; and 256–58/EC–366* dated November 13, 1958. Exceptions, additions, and substitutions to these standards are listed in subparagraph (2) of this paragraph.

(2) *Exceptions.* (i) Radio Technical Commission for Aeronautics Paper 100–54/DO–60, and amendment Paper 256–58/EC–366 dated November 13, 1958, outline environmental test procedures for equipment designed to operate under three environmental test conditions as specified therein under Procedures A, B, and C. Only airborne automatic dead reckoning computer equipment utilizing aircraft heading and doppler-obtained groundspeed and drift angle data which meets the operating requirements as outlined under Procedure A or Procedure B of Paper 100–54/DO–60, as amended, is eligible under this section.

(ii) The vibration values specified below may be used for equipment designed exclusively for installation on the instrument panel of aircraft in lieu of those specified in Paper 100–54/DO–60 as amended. No shock mounting shall be used during the conduct of this test if the vibration values specified below are used.

Amplitude: 0.01″ (0.02″ total excursion).
Frequency: Variable 10–55 c.p.s.
Maximum Acceleration: 1.5 g.

(iii) Equipment which is designed exclusively for installation on the instrument panel of aircraft need not be subjected to the shock requirements outlined in Paper 100–54/DO–60 as amended.

(iv) Indicating instruments which are a part of the system, but which are not designed exclusively for installation on the instrument panel of aircraft, may also be tested to the vibration requirements specified in subdivision (ii) of this subparagraph, and need not be subjected to the shock requirements outlined in Paper 100–54/DO–60 as amended.

(b) *Marking.* (1) In addition to the markings specified in § 37.7, equipment which has been designed to operate over the environmental conditions outlined in Procedure A of

* Copies of these papers may be obtained from RTCA.

RTCA Paper 100-54/DO-60, as amended, shall be marked as Category A equipment. Equipment which has been designed to operate over the environmental conditions outlined in Procedure B of this same paper shall be marked as Category B equipment. Equipment which has been designed exclusively for installation on the instrument panel of aircraft and which meets only the amended vibration requirements outlined above shall be identified with the letters I.P. following the category of equipment, such as CAT. A-I.P.

(2) Each major component of equipment (antenna, power supply, etc.) shall be identified with at least the manufacturer's name and TSO number.

(c) *Data requirements.* (1) The manufacturer shall maintain a current file of complete design data.

(2) The manufacturer shall maintain a current file of complete data describing the inspection and test procedures applicable to his product. (See paragraph (d) of this section.)

(3) Six copies each, except where noted, of the following shall be furnished to the Chief, Engineering and Manufacturing Branch, Flight Standards Division, Federal Aviation Administration, in the region in which the manufacturer is located.

(i) Manufacturer's operating instructions and equipment limitations.

(ii) Installation procedures with applicable schematic drawings, wiring diagrams, and specifications. Indicate any limitations, restrictions, or other conditions pertinent to installation.

(iii) One copy of the manufacturer's test report.

(d) *Quality control.* Airborne automatic dead reckoning computer equipment utilizing aircraft heading and doppler-obtained groundspeed and drift angle data shall be produced under a quality control system established by the manufacturer, which will assure that each equipment is in conformity with the requirements of this section and is in a condition for safe operation. This system shall be described in the data required under paragraph (c)(2) of this section. The Administrator shall be permitted to make such inspections and tests at the manufacturer's facility as may be necessary to determine compliance with the requirements of this section.

(e) *Previously approved equipment.* Airborne automatic dead reckoning computer equipment utilizing aircraft heading and doppler-obtained groundspeed and drift angle data approved prior to January 16, 1961, may continue to be manufactured under the provisions of its original approval.

§ 37.175 Emergency evacuation slides—TSO-C69.

(a) *Applicability*—(1) *Minimum performance standards.* Minimum performance standards are hereby established for emergency evacuation slides which are required to be of an approved type to be eligible for use on civil aircraft of the United States. New models of emergency evacuation slides manufactured on or after August 15, 1961, shall meet the standards set forth in FAA standard "Emergency Evacuation Slides".* However, new models manufactured on or after October 24, 1967, are required to be designed so as to be fully inflated in not more than 10 seconds after actuation of the inflation means. Emergency evacuation slides approved prior to August 15, 1961, may continue to be manufactured under the provisions of their original approval.

(b) *Marking.* The slide shall be permanently marked in accordance with the marking provisions of § 37.7 except that (1) a part number which shall vary with length or any other change in the slide, (2) serial number, and (3) date of manufacture shall be included.

(c) *Data requirements.* (1) One copy each of the following shall be furnished to the Chief, Engineering and Manufacturing Branch, Flight Standards Division, Federal Aviation Administration, in the region in which the manufacturer is located.

(i) Packing instructions.

(ii) Operation instructions.

(iii) Assembly drawing.

(iv) Applicable limitations pertaining to installation of slides on aircraft. These limitations shall include the minimum and maxi-

* Copies of the FAA Standard may be obtained upon request addressed to Federal Aviation Administration.

mum stowage area temperatures and any other limitations which will prevent the slide from performing its intended function and from complying with the minimum performance standards under all reasonable foreseeable emergency conditions. The slide manufacturer shall also provide the purchaser with such limitations.

(2) The manufacturer shall maintain a current file of complete design data.

(3) The manufacturer shall maintain a current file of complete data describing the inspection and test procedures applicable to his evacuation slide. (See paragraph (d) of this section.)

(d) *Quality control.* Emergency evacuation slides shall be produced under a quality control system, established by the manufacturer, which will assure that each slide is in conformity with the requirements of this section and is in a condition for safe operation. This system shall be described in the data required under paragraph (c)(3) of this section. The Administrator shall be permitted to make such inspections and tests at the manufacturer's facility as may be necessary to determine compliance with the requirements of this section.

§ 37.176 Liferafts (nonreversible)—TSO–C70.

(a) *Applicability*—(1) *Minimum performance standards.* Minimum performance standards are hereby established for liferafts (nonreversible) which are required to be of an approved type to be eligible for use on civil aircraft of the United States. Nonreversible liferaft models manufactured on or after the effective date of this section shall meet the standards set forth in FAA Standard "Nonreversible Liferaft"* dated March 1, 1961.

(b) *Marking.* The raft shall be permanently marked in accordance with the marking provisions of § 37.7 except for the following:

(1) The serial number of the raft need not be included.

(2) Include the rated and the overload capacity of the raft.

(3) Include the type of raft, i.e., Type I or Type II.

(c) *Data requirements.* (1) One copy each of the following shall be furnished to the Chief, Engineering and Manufacturing Branch, Flight Standards Division, Federal Aviation Administration, in the region in which the manufacturer is located.

(i) Packing instructions.

(ii) Operation instructions.

(iii) Assembly drawing.

(iv) Applicable limitations pertaining to installation of rafts on aircraft. These limitations shall include the minimum and maximum stowage area temperatures and any other limitations which will prevent the raft from performing its intended function and from complying with the minimum performance standards under all reasonably foreseeable emergency conditions. The raft manufacturer shall also provide the purchaser with such limitations.

(2) The manufacturer shall maintain a current file of complete design data.

(3) The manufacturer shall maintain a current file of complete data describing the inspection and test procedures applicable to his liferafts. (See paragraph (d) of this section.)

(d) *Quality control.* Liferafts shall be produced under a quality control system, established by the manufacturer, which will assure that each raft is in conformity with the requirements of this section and is in a condition for safe operation. This system shall be described in the data required under paragraph (c)(3) of this section. The Administrator shall be permitted to make such inspections and production tests at the manufacturer's facility as may be necessary to determine compliance with the requirements of this section.

§ 37.177 Airborne static ("DC to DC") electrical power converter (for air carrier aircraft)—TSO–C71.

(a) *Applicability*—(1) *Minimum performance standards.* Minimum performance standards are hereby established for airborne static ("DC to DC") electrical power converter equipment which is to be used on civil aircraft of the United States engaged in air carrier operations. New models of such equipment manufactured for use on civil air carrier air-

* Copies may be obtained upon request addressed to Federal Aviation Administration.

craft on or after the effective date of this section shall meet the standards set forth in FAA Standard, "Airborne Static ('DC to DC') Electrical Power Converter (For Air Carrier Aircraft)" dated April 15, 1961,* and Radio Technical Commission for Aeronautics Paper 100-54/DO-60 as amended by Paper 256-58/EC-366 dated November 13, 1958.** Manufacturers of such equipment shall also comply with the requirements of paragraphs (b), (c), and (d) of this section for acceptance of their equipment under this section.

(b) *Marking.* In addition to the markings specified in § 37.7, equipment which has been designed to operate over the environmental conditions outlined in Procedure A of RTCA Paper 100-54/DO-60, as amended shall be marked as Category A equipment. Equipment which has been designed to operate over the environmental conditions outlined in Procedure B of this same paper shall be marked as Category B equipment.

(c) *Data requirements.* (1) The manufacturer shall maintain a current file of complete design data.

(2) The manufacturer shall maintain a current file of complete data describing the inspection and test procedures applicable to his product. (See paragraph (d) of this section.)

(3) Six copies each, except where noted, of the following shall be furnished to the Chief, Engineering and Manufacturing Branch, Flight Standards Division, Federal Aviation Administration, in the region in which the manufacturer is located.

(i) Manufacturer's operating instructions and equipment limitations.

(ii) Installation procedures with applicable schematic drawings, wiring diagrams, and specifications. Indicate any limitations, restrictions, or other conditions pertinent to installation.

(iii) One copy of the manufacturer's test report.

(d) *Quality control.* Airborne static ("DC to DC") electrical power converter equipment shall be produced under a quality control system, established by the manufacturer, which will assure that each equipment is in conformity with the requirements of this section and is in a condition for safe operation. This system shall be described in the data required under paragraph (c)(2) of this section. The Administrator shall be permitted to make such inspections and tests at the manufacturer's facility as may be necessary to determine compliance with the requirements of this section.

(e) *Previously approved equipment.* Airborne static ("DC to DC") electrical power converter equipment approved prior to the effective date of this section may continue to be manufactured under the provisions of its original approval.

§ 37.178 Individual flotation devices—TSO-C72b.

(a) *Applicability.* This Technical Standard Order (TSO) prescribes the minimum performance standards that individual flotation devices must meet in order to be identified with the applicable TSO marking. New models of the devices that are to be so identified, and that are manufactured on or after May 1, 1972, must meet the requirements of the "Federal Aviation Administration Standard, Individual Flotation Devices", amended effective May 1, 1972, set forth at the end of this section.

(b) *Marking.* The marking specified in § 37.7(d) must be shown except that the weight need not be included.

(c) *Data requirements.* In addition to the data specified in § 37.5, the manufacturer must furnish to the Chief, Engineering and Manufacturing Branch, Flight Standards Division, Federal Aviation Administration, in the region in which the manufacturer is located, the following technical data:

(1) Six copies of the descriptive information on the device.

(2) Six copies of the manufacturers' equipment operating instructions and limitations.

(3) Six copies of the applicable installation instructions indicating any restrictions or other conditions pertinent to installation.

(4) One copy of the manufacturers' test report.

* Copies of the FAA Standard may be obtained upon request addressed to Federal Aviation Administration.

** Copies of RTCA Paper 100-54/DO-60 may be obtained from RTCA.

(5) One copy of the manufacturers' special cleaning and maintenance instructions.

(d) *Previously approved equipment.* Flotation device models approved prior to November 4, 1966, may continue to be manufactured under the provisions of their original approval.

FEDERAL AVIATION ADMINISTRATION STANDARD

Individual Flotation Devices

1.0 Purpose.

To specify minimum performance standards for individual flotation devices other than life preservers defined in the TSO-C13 Series.

2.0 Types and Description of Devices.

This standard provides for the following two categories of individual flotation devices:

a. Inflatable types (compressed gas inflation).

b. Noninflatable types.

2.0.1 *Description of Inflatable Types.* Inflation must be accomplished by release of a compressed gas contained in a cartridge into the inflation chamber. The cartridge must be activated by a means readily accessible and clearly marked for its intended purpose. The flotation chamber must also be capable of oral inflation in the event of failure of the gas cartridge.

2.0.2 *Description of Noninflatable Types.* Seat cushions, head rests, arm rests, pillows or similar aircraft equipment are eligible as flotation devices under this standard provided they fulfill minimum requirements for safety and performance. Compression through extended service use, perspiration and periodic cleaning must not reduce the buoyancy characteristics of these devices below the minimum level prescribed in this standard.

2.1 *Instructions for Use.* Where the design features of the device relative to its purpose and proper use are not obvious to the user, clearly worded instructions must be provided. These instructions must be visible under conditions of emergency lighting.

3.0 Definitions.

The following are definitions of terms used throughout the standard:

a. *Buoyancy.* The amount of weight a device can support in fresh water at 85° F.

b. *Flame Resistant.* Not susceptible to combustion to the point of propagating a flame beyond safe limits after the ignition source is removed.

c. *Corrosion Resistant.* Not subject to deterioration or loss of strength as a result of prolonged exposure to a humid atmosphere.

4.0 General Requirements.

4.0.1 *Materials and Processes.* Materials used in the finished product must be of the quality which experience and tests have demonstrated to be suitable for the use intended throughout the service life of the device. The materials and process must conform to specifications selected or prepared by the manufacturer which will insure that the performance, strength and durability incorporated in the prototype are continued or exceeded in subsequently produced articles

4.0.2 *Fungus Protection.* Materials used in the finished product must contain no nutrient which will support fungus growth unless such materials are suitably treated to prevent such growth.

4.0.3 *Corrosion Protection.* Metallic parts exposed to the atmosphere must be corrosion resistant or protected against corrosion.

4.0.4 *Fire Protection.* If the device is not used as part of a seat or berth, materials used in the device, including any covering, must meet paragraph 6.0.2 of this standard. If the device is to be used as part of a seat or berth, all materials used in the device must meet paragraph 7.0.3 of this standard.

4.0.5 *Temperature Range.* Materials used in the construction of the device must be suitable for the intended purpose following extended exposures through a range of operating temperatures from −40° F. to +140° F.

4.1 *Design and Construction.*

4.1.1 *General.* The design of the device, the inflation means if provided, and straps or other accessories provided for the purpose of donning by the user must be simple and obvious thereby making its purpose and actual use immediately evident to the user.

4.1.2 *Miscellaneous Design Features.* The devices must be adaptable for children as well as adults. They must have features which enable the users to retain them when jumping into the water from a height of at least 5 feet. Attachment straps must not pass between the user's legs for retention or restrict breathing or blood circulation.

5.0 Performance Characteristics.

5.0.1 *Buoyancy Standard.* The device must be shown by the tests specified in paragraph 7.0.1 to be capable of providing not less than 14 pounds of buoyancy in fresh water at 85° F. for a period of 8 hours.

5.0.2 *Utilization.* The devices must be capable of being utilized by the intended user with ease.

5.0.3 *Function Under Temperature Limits.* The device must be functional within the temperature limitations of −40° F. to +140° F.

6.0 Standard Test Procedures.

6.0.1 *Salt Spray Test Solution.* The salt used must be sodium chloride or equivalent containing on the dry basis not more than 0.1 percent of sodium iodide and not more than 0.2 percent of impurities. The solution must be prepared by dissolving 20 ±2 parts by weight of salt in 80 parts by weight of distilled or other water containing not more than 200 parts per million of total solids. The solution must be kept free from solids by filtration, decantation, or any other suitable means. The solution must be adjusted to be maintained at a specific gravity of from 1.126 to 1.157 and a PH of between 6.5 and 7.2

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when measured at a temperature in the exposure zone maintained at 95° F.

6.0.2 *Flame Resistance.* Three specimens approximately 4 inches wide and 14 inches long must be tested. Each specimen must be clamped in a metal frame so that the two long edges and one end are held securely. The frame must be such that the exposed area of the specimen is at least 2 inches wide and 13 inches long with the free end at least ½ inch from the end of the frame for ignition purposes. In the case of fabrics, the direction of the weave corresponding to the most critical burn rate must be parallel to the 14-inch dimension. A minimum of 10 inches of the specimen must be used for timing purposes, and approximately 1½ inches must burn before the burning front reaches the timing zone. The specimen must be long enough so that the timing is stopped at least one inch before the burning front reaches the end of the exposed area.

The specimens must be supported horizontally and tested in draft free conditions. The surface that will be exposed when installed in the aircraft must face down for the test. The specimens must be ignited by the Bunsen or Tirrell burner. To be acceptable, the average burn rate of the three specimens must not exceed four inches per minute. Alternatively, if the specimens must not support combustion after the ignition flame is applied for 15 seconds or if the flame extinguishes itself and subsequent burning without a flame does not extend into the undamaged areas, the material is also acceptable.

7.0 Test Requirements.

7.0.1 *Buoyancy Testing.* The flotation device, including all dress covers, and straps that would normally be used by a survivor in an emergency, must be tested in accordance with either subparagraph (a) or (b) of this paragraph, as applicable, or an equivatest procedure. The test may be conducted using non-fresh water, or at a temperature other than 85° F., or both, provided the result can be converted to the standard water condition specified in paragraph 5.0.1. The test may be conducted in open (ocean or lake) or restricted (swimming pool) water The test specimen of noninflatable devices, such as pillows or seat cushions, must either be preconditioned to simulate any detrimental effects on buoyancy resulting from extended service or an increment must be added to the buoyancy standard in paragraph 5.0.1 sufficient to offset any reduction in buoyancy which would result from extended service use.

a. *Test procedures applicable to inflatable devices and to noninflatable devices made from closed cell material.* The device must be tested by submerging it in water so that no part of it is less than 24 inches below the surface. It must be shown that the buoyancy of the device is at least equal to the value specified in paragraph 5.0.1 after submersion for at least 8 hours, except that the test may be discontinued in less than 8 hours if buoyancy measurements taken at 4 successive 30-minute intervals show that the buoyancy of the device has stabilized at a value at least equal to the value specified in paragraph 5.0.1.

b. *Test procedures applicable to noninflatable devices made from open cell material.* The device must be completely submerged and either supporting a human subject or attached to a mechanical apparatus that simulates the movements characteristic of a non-swimmer. During the test, the device must be subjected to a squeezing action comparable to that caused by the movements characteristic of a nonswimmer. It must be shown that the buoyancy of the device is at least equal to the value specified in paragraph 5.0.1 after testing for at least 8 hours, except that the test may be discontinued in less than 8 hours if the buoyancy measurements taken at 4 successive 30-minute intervals show that the buoyancy of the device has stabilized at a value at least equal to the value specified in paragraph 5.0.1.

7.0.2 *Salt Spray Testing.* All metallic operating parts must be placed in an enclosed chamber and sprayed with an atomized salt solution for a period of 24 hours. The solution must be atomized in the chamber at a rate of three quarts per 10 cubic feet of chamber volume per 24-hour period. At the end of the test period, it must be demonstrated that the parts operate properly.

7.0.3 *Test for Fire Protection of Materials.* Materials used in flotation devices that are to be used as part of an aircraft seat or berth must comply with the self-extinguishing fire protection provisions of § 25.853(b) of Part 25 of this chapter. In all other applications, the materials in the flotation devices must be tested in acordance with paragraph 6.0.2 of this standard to substantiate adequate flame resistant properties.

7.0.4 *Extreme Temperature Testing.* Tests must be performed to demonstrate that the device is operable throughout the temperature range specified in paragraph 5.0.3. In performing these tests, preconditioning of test specimens must be accomplished to simulate conditions of immediate use of the device following an aircraft takeoff.

NOTE: An acceptable procedure for preconditioning may involve storage of the device for 8 hours at the extreme temperatures specified, followed by exposure to room temperature conditions for a period of time not to exceed 10 minutes.

§ 37.179 Static electrical power inverter—TSO-C73.

(a) *Applicability.* Minimum performance standards are hereby established for airborne static electrical power inverter equipment which is to be used on United States civil aircraft engaged in air carrier operations. New models of airborne static electric power in-

verter equipment manufactured on or after the effective date of this section shall meet the standards specified in Federal Aviation Administration Standard, "Airborne Static Electrical Power Inverter", dated July 25, 1963.*

(b) *Marking.* In addition to the marking requirements of § 37.7(d), each static inverter shall be marked with the following:

(1) Rated terminal voltage, frequency, and the number of phases;

(2) Rated power in volt amperes;

(3) Output load power factor; and

(4) Maximum operating altitude.

(c) *Data requirements.* In addition to the data required by § 37.5, the manufacturer shall furnish to the Chief, Engineering and Manufacturing Branch, Flight Standards Division, Federal Aviation Administration, in the region in which the manufacturer is located, the following technical data:

(1) Six copies of the manufacturer's operating instruction and the equipment limitations. Installation procedures with applicable schematic drawings, wiring diagrams, and specifications. Indicate any restrictions or condition pertinent to installation, and

(2) One copy of the manufacturer's test report.

§ 37.180 Airborne ATC Transponder Equipment—TSO–C74c.

(a) *Applicability.* This technical standard order prescribes the minimum performance standards which airborne ATC transponder equipment must meet in order to be identified with the applicable TSO marking. New models of such equipment that are to be so identified and that are manufactured on or after January 26, 1973, must meet the following performance and environmental standards:

(1) *Performance standards.* (i) Equipment marked as Class 1A must be equipment intended for installation in aircraft that operate at altitudes above 15,000 feet and must meet the minimum performance standards of "Federal Aviation Standard, Airborne ATC Transponder Equipment," set forth at the end of this section, as applicable.

(ii) Equipment marked as Class 1B must be equipment intended for installation in aircraft that operate at altitudes not exceeding 15,000 feet and must meet the minimum performance standards of "Federal Aviation Standard, Airborne ATC Transponder Equipment," set forth at the end of this section, as applicable.

(iii) Equipment marked as Class 2A must be equipment intended for installation in aircraft that operate at altitudes above 15,000 feet and must meet the minimum performance standards set forth in Section II of Part Two in Radio Technical Commission for Aeronautics Document No. DO–144 entitled "Minimum Operational Characteristics—Airborne ATC Transponder Systems," dated March 12, 1970, and Change No. 1 to DO–144, Paper 232–70/EC–643, dated November 5, 1970, as applicable, except as provided in subparagraph (2) of this paragraph.

(iv) Equipment marked as Class 2B must be equipment intended for installation in aircraft that operate at altitudes not exceeding 15,000 feet and must meet the minimum performance standards set forth in Section II of Part Two in Radio Technical Commission for Aeronautics Document No. DO–144 entitled, "Minimum Operational Characteristics—Airborne ATC Transponder Systems," dated March 12, 1970, and Change No. 1 to DO–144, Paper 232–70/EC–643, dated November 5, 1970, as applicable, except as provided in subparagraph (2) of this paragraph.

(2) *Exceptions.* (i) In lieu of the requirements in subparagraph II A.8.c. of Part Two in RTCA Document DO–144, the reply characteristics apply over a received signal amplitude range between minimum triggering level and a level of −21 dbm.

(ii) The requirement specified in subparagraph II A.9.a. of Part Two in RTCA Document DO–144 need not be complied with.

(iii) The requirements of subparagraph II A.16.b. (2) and (3) of Part Two of RTCA Document DO–144, in so far as, they pertain to pressure altitude information pulses, must

* Copies may be obtained upon request addressed to Federal Aviation Administration.

be complied with only if complete altitude reporting capability is provided.

(iv) The requirements of subparagraph II A.16.b.(4), (5), and (6) of Part Two of RTCA Document DO-144 must be complied with only if complete altitude reporting capability is provided.

(3) *Environmental standards.* RTCA Document No. DO-138 entitled "Environmental Conditions and Test Procedures for Airborne Electronic/Electrical Equipment and Instruments," dated June 27, 1968, must be used in determining the environmental conditions over which the equipment has been designed to operate. Classes 2A and 2B equipment need only be tested for the environmental conditions of temperature and altitude, humidity, shock, vibration, and power input voltage set forth in paragraphs 4.0, 5.0, 6.0, 7.0, and 9.0 of DO-138.

(b) *Availability of documents.* RTCA Document Nos. DO-138, dated June 27, 1968, and DO-144, dated March 12, 1970, as amended by Change No. 1 (Paper 232-70/EC-643), dated November 5, 1970, are incorporated herein in accordance with 5 U.S.C. 552(a)(1) and § 37.23 of the Federal Aviation Regulations and are available as indicated in § 37.23. Additionally, RTCA Document Nos. DO-138 and DO-144, as amended, may be examined at any FAA regional office of the Chief of Engineering and Manufacturing Branch (or in the case of the Western Region, the Chief, Aircraft Engineering Division) and may be obtained from the RTCA Secretariat, Suite 655, 1717 H Street, N.W., Washington, D.C. 20006, at a cost of $8 per copy for Document No. DO-138 and $6 per copy for Document No. DO-144.

(c) *Marking.* In addition to the markings specified in § 37.7, the equipment must meet the following requirements:

(1) The environmental categories over which it has been designed to operate as set forth in Appendix B of RTCA Document No. DO-138 must be permanently and legibly marked on the equipment. Where an environmental test procedure is not applicable and the test is not conducted, an "X" should be placed in the space assigned for that category.

(2) The class which the equipment meets must be permanently and legibly marked on the equipment. Equipment which meets the requirements of more than one class need only be marked with the class which contains the more severe requirements. When listed in order of severity of requirements, highest first, the classes are: 1A, 1B, 2A, and 2B.

(3) Each separate component of equipment (antenna, receiver-transmitter, etc.) must be permanently and legibly marked with at least the name of the manufacturer, the TSO number, and the environmental categories over which it is designed to operate.

(d) *Data requirements.* (1) In accordance with § 37.5, the manufacturer must furnish to the Chief, Engineering and Manufacturing Branch, Flight Standards Division (or in case of the Western Region, the Chief, Aircraft Engineering Division), Federal Aviation Administration, in the region in which the manufacturer is located, one copy of the following technical data:

(i) Manufacturer's operating instructions and equipment limitations.

(ii) Installation procedures with applicable schematic diagrams, wiring diagrams, and specifications. Indicate any limitations, restrictions, or other conditions pertinent to the installation.

(iii) Manufacturer's test report(s).

(iv) Equipment data sheets specifying, within the prescribed range of environmental conditions, the actual performance of equipment of that type with respect to each performance factor prescribed in the applicable standard. Performance data for abnormal environmental conditions may also be included.

(2) One copy of the technical data specified in subdivisions (i), (ii), and (iv) of subparagraph (d)(1) must be furnished with each article.

(e) *Previously approved equipment.* Airborne ATC Transponder Equipment approved prior to the effective date of this section may continue to be manufactured under the provisions of its original approval.

FEDERAL AVIATION ADMINISTRATION STANDARD

Airborne ATC Transponder Equipment

1.0 General Standards.

1.1 *Operation of Controls.* The design of the equipment must be such that the controls intended for use during flight cannot be operated in any possible position combination, or sequence that would result in a condition detrimental to the continued performance of the equipment. Controls that are not normally adjusted in flight must not be readily accessible in flight.

1.2 *Operating Controls.* In addition to such other operating controls as are necessary, controls must be provided to accomplish the following functions:

a. Selection of reply codes.

b. Selection of "standby" condition.

c. Selection of Modes 3/A and C combined.

d. Activation of identification feature.

e. Removal of all information pulses on the Mode C reply.

1.3 *Effects of Test.* Unless otherwise stated, the design of the equipment must be such that the application of the specified tests produces no discernible condition that would be detrimental to the continued performance of equipment manufactured in accordance with such design.

2.0 Minimum Performance Standards Under Standard Conditions.

The test conditions and definitions of terms applicable to a determination of the performance of airborne ATC transponder equipment are set forth in Appendix A.

2.1 *Receiver Operating Frequency and Bandwidth.*

a. The receiver nominal center frequency must be 1030 MHz.

b. With an input signal level 3 db above the minimum triggering level, the receiver bandwidth must be such that the receiver accepts pulses as outlined in Appendix A with an interrogation center frequency drift of ±0.2 MHz.

c. The skirt bandwidth must be such that the sensitivity of the receiver is at least 60 db down at ±25 MHz and beyond.

2.2 *Receiver Sensitivity and Dynamic Range.*

a. The minimum triggering level (MTL) of the transponder must be such that replies are generated to 90 percent of the interrogation signals when—

1. The two pulses P_1 and P_3 constituting an interrogation are of equal amplitude and P_2 is not detected; and

2. The implitude of these signals received at the antenna end of the transmission line of the transponder is nominally 71 db below 1 milliwatt with limits between 69 and 77 db below 1 milliwatt.

b. With the transponder adjusted to comply with paragraph a, the random triggering rate (squitter) must not be greater than five reply pulse groups or suppressions per second averaged over a period of at least 30 seconds.

c. The variation of the minimum triggering level between modes must not exceed 1 db for nominal pulse spacings and pulse widths.

d. The reply characteristics apply over a received signal amplitude range between minimum triggering level and 50 db above that level.

e. The standards of this section assume a transmission line loss of 3 db and an antenna performance equivalent to that of a simple quarter wave antenna. In the event that these assumed conditions do not apply, the equipment must be adjusted as necessary to provide a sensitivity equivalent to that specified.

2.3 *Spurious Responses.* All spurious responses, including response to image frequencies, must be such that the response to such signals is at least 60 db down from the normal sensitivity of the receiver.

2.4 *Interrogation.* The equipment must accept and reply to interrogations on at least Modes 3/A and C.

NOTE.—Interrogation Modes B and D as defined in Figure 1 have been agreed upon internationally and their use may be specified for certain flight operations. These modes may be provided as optional features on transponder equipment.

2.5 *Side-lobe Suppression.* The equipment must provide side-lobe suppression.

2.6 *Decoding Performance.*

a. Conditions Under Which Transponder Must Reply. When selected to reply to a particular interrogation mode, and with a signal amplitude range from the minimum triggering level to 50 db above that level, the transponder must reply to at least 90 percent of the interrogations when all of the following conditions are met:

(1) Either the received amplitude of P_1 is in excess of a level of 9 db above the received amplitude of P_2, or no pulse is received 2 ±0.7 microsecond following P_1.

(2) The received amplitude of P_3 is in excess of a level 1 db below the received amplitude of P_1 but no greater than 3 db above the received amplitude of P_1.

(3) The received amplitude of a proper interrogation is more than 10 db above the received amplitude of random pulses where the latter are not recognized by the transponder as P_1, P_2, or P_3.

b. Conditions Under Which Transponder Must Not Reply. Over the signal amplitude from the minimum triggering level to 50 db above this level, the transponder must not reply to more than 10 percent of the interrogations under either of the following conditions:

(1) The interval between interrogation pulse P_1 and P_3 differ from the specified spacing for the particular mode setting by more than ±1.0 microsecond.

(2) The interrogations consist of single pulses. However, this does not apply to those combinations of single pulses that occur at the selected interrogation spacing or to single pulses that have amplitude variations approximating a normal interrogation condition.

c. *Side-lobe Suppression.* The transponder must be suppressed for a period of 35 ±10 microseconds following receipt of a pulse pair of proper spacing and amplitude indicative of side-lobe interrogation. This suppression action must be capable of being reinitiated for the full duration within 2 microseconds after the end of any suppression period. The transponder must be suppressed with a 99 percent efficiency over a received signal amplitude range between 3 db above minimum triggering level and 50 db above that level and upon receipt of properly spaced interrogations when the received amplitude of P_2 is equal to or in excess of the received amplitude of P_1 and spaced 2.0 ±0.15 microsecond from P_1.

2.7 *Transponder Discrimination and Desensitization.*

a. Pulse Width Discrimination. Received signals of amplitude between minimum triggering level and at least 6 db above this level, and of a duration less than 0.3 microsecond, must not cause the transponder to initiate more than 10 percent reply or suppression action. With the exception of pulses having amplitude variations approximating a normal interrogation or suppression pulse pair condition, any pulse of a duration more than 1.5 microseconds must not cause the transponder to initiate reply or suppression action over the signal amplitude range from the minimum triggering level to 50 db above that level.

b. Echo Suppression and Recovery.

(1) *Echo suppression desensitization.* Upon receipt of any pulse more than 0.7 microsecond in duration (desensitization pulse), the receiver must be desensitized by an amount that is within at least 9 db of the amplitude of the desensitizing pulse but must at no time exceed the amplitude of the desensitizing pulse except for overshoot during the first microsecond following the desensitizing pulse.

(2) *Recovery.* Following desensitization, the receiver must recover sensitivity (within 3 db of minimum triggering level) within 15 microseconds after reception of a desensitizing pulse having a signal strength up to 50 db above minimum triggering level. Recovery must be nominally linear at an average rate not exceeding 3.5 db per microsecond.

(3) *Narrow pulses.* Single pulses of duration less than 0.7 microsecond must not cause desensitization of duration or amount greater than that permitted in subparagraphs (1) or (2).

c. *Dead Time.* (1) After reception of a proper interrogation, the transponder must reply to no other interrogation for the duration of the reply pulse train. This dead time must end no later than 125 microseconds after the transmission of the last reply pulse of the group.

(2) The dead time of the transponder created by means other than normal interrogations shall not exceed a period or more than 2,500 microseconds duration at a maximum duty cycle of 4.5 percent.

d. *Reply Rate Control.* A sensitivity-reduction type reply rate control must be provided. The range of this control must permit adjustment of the reply rate to any value between 500 replies per second and the maximum rate of which the transponder is capable, or 2,000 replies per second, whichever is the lesser, without regard to the number of pulses in each reply. Sensitivity reduction in excess of 3 db must not take effect until 90 percent of the selected reply reply rate is exceeded. The sensitivity must be reduced by at least 30 db when the rate exceeds the selected value by 50 percent. The reply rate limit must be set at 1,200 replies per second, or the maximum value below 1,200 replies per second of which the transponder is capable.

2.8 *Transponder Reply Rate Capability.*

a. For equipment intended for installation in aircraft that operate at altitudes above 15,000 feet, the reply rate capability must be at least 1,200 reply groups per second for a 15 pulse coded reply.

b. For equipment intended for installation in aircraft that operate at altitudes not exceeding 15,000 feet, the reply rate capability must be at least 1,000 reply groups per second for a 15 pulse coded reply.

2.9 *Transponder Reply Code Capability.* Transponders must provide the following code capability:

a. Framing pulses (see par. 2.13a.).

b. Information pulses in all combinations of the A, B, C, and D subscript groups, to create 4096 codes (see par. 2.13b.).

c. Special position identification pulse (SPI) (see par. 2.13c.).

2.10 *Reply Transmission Frequency.* The center frequency of the reply transmission must be 1090 ±3 MHz.

2.11 *Transmitter Power Output.*

a. For equipment intended for installation in aircraft which operate at altitudes above 15,000 feet, the peak pulse power available at the antenna end of the transmission line of the transponder must be at least 21 db and not more than 27 db above 1 watt at any reply rate up to 1,200 per second for a 15-pulse coded reply.

b. For equipment intended for installation in aircraft which operate at altitudes not exceeding 15,000 feet, the peak pulse power available at the antenna

end of the transmission line of the transponder must be at least 18.5 db and not more than 27 db above 1 watt at any reply rate up to 1,200 per second for a 15-pulse coded reply.

c. The standards of this section assume a transmission line loss of 3 db and an antenna performance equivalent to that of a simple quarter wave antenna. In the event that these assumed conditions do not apply, the equipment must be adjusted as necessary to provide a transmitter power output equivalent to that specified.

2.12 *Reply Delay and Jitter.*

a. The time delay between the arrival, at the transponder input, of the leading edge of P_3, and the transmission of the leading edge of the first pulse of the reply must be 3 ±0.5 microseconds.

b. The jitter of the reply pulse code group with respect to P_3 must not exceed ±0.1 microsecond for receiver input levels between 3 and 50 db above the minimum triggering level.

c. Delay variations between modes on which the transponder is capable of replying must not exceed 0.2 microseconds.

2.13 *Reply Transmission Pulse Characteristics.*

a. Framing Pulses. The reply function must employ a signal comprising two framing pulses spaced 20.3 microseconds measured leading-edge to leading-edge at half-voltage points, as the most elementary code.

b. Information Pulses. Information pulses spaced at intervals of 1.45 microseconds measured leading-edge to leading-edge at the half-voltage points with the first pulse positioned 1.45 microseconds after the first framing pulse must be provided. The designation of these pulses and their position with respect to the first framing pulse is as follows:

Pulse	Position (Microseconds)
C_1	1.45
A_1	2.90
C_2	4.35
Pulse	**Position (Microseconds)**
A_2	5.80
C_4	7.25
A_4	8.70
X*	10.15
B_1	11.60
D_1	13.05
B_2	14.50
D_2	15.95
B_4	17.40
D_4	18.85

* The X pulse is referenced here for possible future use.

NOTE.—Details and nomenclature of the transponder reply pulse codes are set forth in Appendix A.

c. Special Position Identification Pulse (SPI). In addition to the information pulses provided, a special position identification pulse, which may be used with any of the other information pulses upon request, must be provided at a spacing 4.35 microseconds following the last framing pulse. When replying to any mode of interrogation to which the transponder is capable, except Mode C, the selection of the SPI pulse must be initiated by an IDENT switch. Upon activation of the IDENT switch, the SPI pulse must be transmitted for a period between 15 and 30 seconds and must be repeatable at any time.

d. Reply Pulse Shape. All reply pulses and SPI pulses must be 0.45 ±0.10 microsecond in duration and have rise times of from 0.05 to 0.1 microsecond and decay times of from 0.05 to 0.2 microsecond. The pulse amplitude variation of one pulse with respect to any other pulse in a reply train must not exceed 1 db. The rise and decay time may be less providing the sideband radiation is no greater than that which would be produced theoretically by a trapezoidal wave having the stated rise and decay time.

e. Reply Pulse Spacing Tolerances. The pulse spacing tolerances for each pulse (including the last framing pulse) with respect to the first framing pulse of the reply group must be ±0.10 microsecond. The pulse spacing tolerance of the special position identification pulse with respect to the last framing pulse of the reply group must be ±0.10 microsecond. The pulse spacing tolerance of any pulse in the reply group with respect to any other pulse (except the first framing pulse) must be no more than ±0.15 microsecond.

2.14 *Pressure-Altitude Transmission.* The equipment must have the capability for automatic pressure-altitude transmission in 100-foot increments on Mode C when operated in conjunction with a pressure-altitude encoder (digitizer). The equipment must be capable of automatic reply to Mode C interrogations with combinations of information pulses coded in binary form in 100-foot increments necessary for the equipment to operate up to design maximum altitude. The transponder must be provided with a means to remove the information pulses from the Mode C reply when requested by Air Traffic Control. The transponder must continue transmitting the framing pulses on Mode C when the information pulses have been removed or are not provided. Automatic pressure altitude transmission codes pulse position assignment are set forth in figure 2.

2.15 *Self Test and Monitor.* If a self test feature or monitor is provided, the devices that radiate test interrogation signals, or prevent transponder reply to proper interrogation during the test period, must be limited to intermittent use which is no longer than that required to determine the transponder status. The test interrogation rate must not exceed 450 per second and the interrogation signal level at the antenna end of the transmission line must not exceed a level of −40 dbm.

2.16 *Antenna.* The equipment antenna radiation pattern must be predominantly vertically polarized and be essentially omnidirectional in the horizontal plane with a nominal vertical beamwidth of at least ±30 degrees from the horizontal plane. The voltage standing wave ratio (VSWR) produced on the antenna transmission line by the antenna must not exceed 1.5:1 when operating on the radio frequencies of 1030 and 1090 MHz.

2.17 *Interference Suppression Pulse Response.* If the equipment is designed to accept and respond to suppression pulses from other electronic equipment in the aircraft (to disable it while the other equipment is transmitting), the equipment must regain normal sensitivity, within 3 db, not later than 15 microseconds after the end of the applied suppression pulse.

2.18 *Emission of Spurious Radiofrequency Energy.* The levels of conducted and radiated spurious radiofrequency energy emitted by the equipment must not exceed those levels specified in Appendix A of RTCA Document No. DO–138 entitled "Environmental Conditions and Test Procedures for Airborne Electronic/Electrical Equipment and Instruments," dated June 27, 1968.

3.0 Minimum Performance Standards Under Environmental Conditions.

Unless otherwise specified, the test procedures applicable to a determination of the performance of airborne ATC transponder equipment under environmental conditions are set forth in RTCA Document No. DO–138 entitled "Environmental Conditions and Test Procedures for Airborne Electronic/Electrical Equipment and Instruments," dated June 27, 1968.

3.1 *Temperature-Altitude.*

a. *Low Temperature.*

(1) When the equipment is subjected to this test, the standards of the following paragraphs must be met: 2.1a; 2.2, except that at temperatures below −15°C., the sensitivity must not be less than −69 dbm and the variation of sensitivity of the receiver between any mode on which it is capable of operating must be less than 2 db; 2.6a(1); 2.6b(1); 2.6c; 2.7b; 2.7c; 2.10; 2.11; 2.12. except that at temperatures below −15°C., the delay variation between modes on which the transponder is capable of replying must be less than 0.4 microsecond; 2.13c; 2.13d; and 2.13e.

(2) Following the low temperature test, the requirements of paragraph 2.16 must be met.

b. *High Temperature.*

(1) When the equipment is subjected to the high short-time operating temperature test, the equipment must operate electrically and mechanically.

(2) When the equipment is subjected to the high operating temperature test, the standards of the following paragraphs must be met: 2.1a; 2.2. except that at temperatures above +40°C., the sensitivity must not be less than −69 dbm and the variation of sensitivity of the receiver between any mode on which it is capable of operating must be less than 2 db; 2.6a(1); 2.6b(1); 2.6c; 2.7b; 2.7c; 2.10; 2.11; 2.12, except that at temperatures above +40°C., the delay variation between modes on which the transponder is capable of replying must be less than 0.4 microsecond; 2.13c; 2.13d; and 2.13e.

(3) Following the high temperature test, the requirements of paragraph 2.16 must be met.

c. *Altitude.*

(1) When the equipment is subjected to this test, the standards of the following paragraphs must be met: 2.1a and b; 2.10; 2.11; and 2.13d.

(2) Following the altitude test, the requirements of paragraph 2.16 must be met.

d. *Decompression (when required).* When the equipment is subjected to this test, the standards of paragraphs 2.1a and b; 2.10; 2.11; and 2.13a must be met.

e. *Overpressure (when required).* When the equipment is subject to this test, the standards of paragraphs 2.1a and b; 2.10; 2.11; and 2.13a must be met.

3.2 *Humidity.* After being subjected to this test, the equipment must meet the following:

a. Within 15 minutes from the time primary power is applied, the receiver sensitivity must be within 3 db of that specified in paragraph 2.2, transmitter power output must be within 3 db of that specified in paragraph 2.11, and the requirements of 2.1a; 2.1b; and 2.10 must be met.

b. Within 4 hours from the time primary power is applied, the standards of paragraphs 2.1a and b; 2.2; 2.10; 2.11; and 2.16 must be met.

3.3 *Shock.*

a. Following the application of the 6G shocks, the standards of the following paragraphs must be met: 2.1a; 2.2; 2.6a(1); 2.6c; 2.7b; 2.7c; 2.10; 2.11; 2.12; 2.13c; 2.13d; 2.13e; and 2.16.

b. Following the application of the 15G shocks, the equipment must have remained in its mounting and no parts of the equipment or its mounting become detached and free of the shock test equipment. The application of the 15G shock test may result in damage to the equipment. Therefore, this test may be conducted after the other tests are completed.

3.4 *Vibration.*

a. When the equipment is subjected to this test, the standards of the following paragraphs must be met: 2.1a; 2.2; 2.6a(1); 2.6b(1); 2.6c; 2.7b; 2.7c; 2.10; 2.11; 2.13c; 2.13d; and 2.13e.

b. Following the vibration test, the requirements of paragraph 2.16 must be met.

3.5 *Temperature Variation.*

a. When the equipment is subjected to this test, the standards of the following paragraphs must be met: 2.1a; 2.2, except that at temperatures below −15° C. and above +40° C., the sensitivity must be not less than −69 dbm and the variation of sensitivity of the receiver between any mode on which it is

capable of operating must be less than 2 db; 2.6a(1); 2.6b(1); 2.6c; 2.7b; 2.7c; 2.10; 2.11; 2.12, except that at temperatures below −15° C. and above +40° C., the delay variation between modes on which the transponder is capable of replying must be less than 0.4 microsecond; 2.13c; 2.13d; and 2.13e.

b. Following the temperature variation test, the requirement of paragraph 2.16 must be met.

3.6 *Power Input Variation.* When the equipment is subjected to this test, the standards of the following paragraphs must be met: 2.1a; 2.2; 2.6a(1); 2.6b(1); 2.6c; 2.7b; 2.7c; 2.10; 2.11; 2.12; 2.13c; 2.13d; and 2.13e.

3.7 *Low Voltage.*

a. When the primary power voltage(s) of d.c. operated equipment is 80 percent and when that of a.c. operated equipment is 87½ percent of design voltage(s), the equipment must operate electrically and mechanically.

b. D.c. operated equipment must meet the standards of paragraphs 2.1a and b; 2.2; 2.10; and 2.11 within two (2) minutes upon returning the primary power voltage(s) to design voltage, after the gradual reduction of the primary voltage(s) from 80 percent to 50 percent of design voltage(s).

c. The gradual reduction of the primary power voltage(s) of d.c. operated equipment from 50 percent to 0 percent of design voltage(s) must produce no evidence of the presence of fire or smoke. Paragraph 1.2 does not apply.

3.8 *Conducted Voltage Transient.* When the equipment is subjected to this test, the standards of paragraphs 2.1a and b; 2.2; 2.10; and 2.11 must be met.

3.9 *Conducted Audiofrequency Susceptibility.* When the equipment is subjected to this test, the standards of paragraphs 2.1a and b; 2.2; 2.10; and 2.11 must be met.

3.10 *Audiofrequency Magnetic Field Susceptibility.* When the equipment is subjected to this test, the standards of paragraphs 2.1a and b; 2.2; 2.10; and 2.11 must be met.

3.11 *Radiofrequency Susceptibility (radiated and conducted).* When the equipment is subjected to this test, the standards of paragraphs 2.1a and b; 2.2b; 2.10; and 2.11 must be met.

3.12 *Explosion (when required).* When the equipment is subjected to this test, the equipment must cause no detonation of the explosive mixture within the test chamber.

3.13 *Waterproofness (drip proof) Test (when required).* After subjection to this test, the standards of paragraphs 2.1; 2.2; 2.10; 2.11; and 2.13a must be met.

3.14 *Hydraulic Fluid Test (when required).* After subjection to this test, the standards of paragraphs 2.1; 2.2; 2.10; 2.11; and 2.13a must be met.

3.15 *Sand and Dust Test (when required).* After subjection to this test, the standards of paragraphs 2.1; 2.2; 2.10; 2.11; and 2.13a must be met.

3.16 *Fungus Resistance Test (when required).* After subjection to this test, the standards of paragraphs 2.1; 2.2; 2.10; 2.11; and 2.13a must be met.

3.17 *Salt Spray Test (when required).* After subjection to this test, the standards of paragraphs 2.1; 2.2; 2.10; 2.11; and 2.13a must be met.

APPENDIX A

1.0 Test Conditions.

The following definitions of terms and conditions of test are applicable to the ATC transponder equipment.

a. Power Input Voltage–Direct Current. Unless otherwise specified, when the equipment is designed for operation from a direct current power source, all measurements must be conducted with the power input voltage adjusted to 13.75 volts, ±2 percent for 12–14 volt equipment, or to 27.5 volts, ±2 percent for 24–28 volt equipment. The input voltage must be measured at the equipment power input terminals.

b. Power Input Voltage–Alternating Current. Unless otherwise specified, when the equipment is designed for operation from an alternating current power source, all tests must be conducted with the power input voltage adjusted to design voltage ±2 percent. In the case of equipment designed for operation from a power source of essentially constant frequenly (e.g., 400 Hz, the input frequency must be adjusted to design ±2 percent. In the case of equipment designed for operation from a power source of variable frequency (e.g., 350 to 1000 Hz, tests must be conducted with the input frequency adjusted to within 5 percent of a selected frequency within the range for which the equipment is designed.

c. Adjustment of Equipment. The circuits of the equipment under test must be properly aligned and otherwise adjusted in accordance with the manufacturer's recommended practices prior to the application of the specified tests.

d. Test Instrument Precautions. Due precautions must be taken during the conduct of the tests to prevent the introduction of errors resulting from the improper connection of headphones, voltmeters, oscilloscopes, and other test instruments across the input and output impedances of the equipment under test.

e. Ambient Conditions. Unless otherwise specified, all tests must be conducted under conditions of ambient room temperature, pressure and humidity. However, the room temperature must not be lower than 10° C.

f. Warm-up Period. Unless otherwise specified, all tests must be conducted after a warm-up period of not less than fifteen (15) minutes.

g. Connected Load. Unless otherwise specified, all tests must be performed with the equipment con-

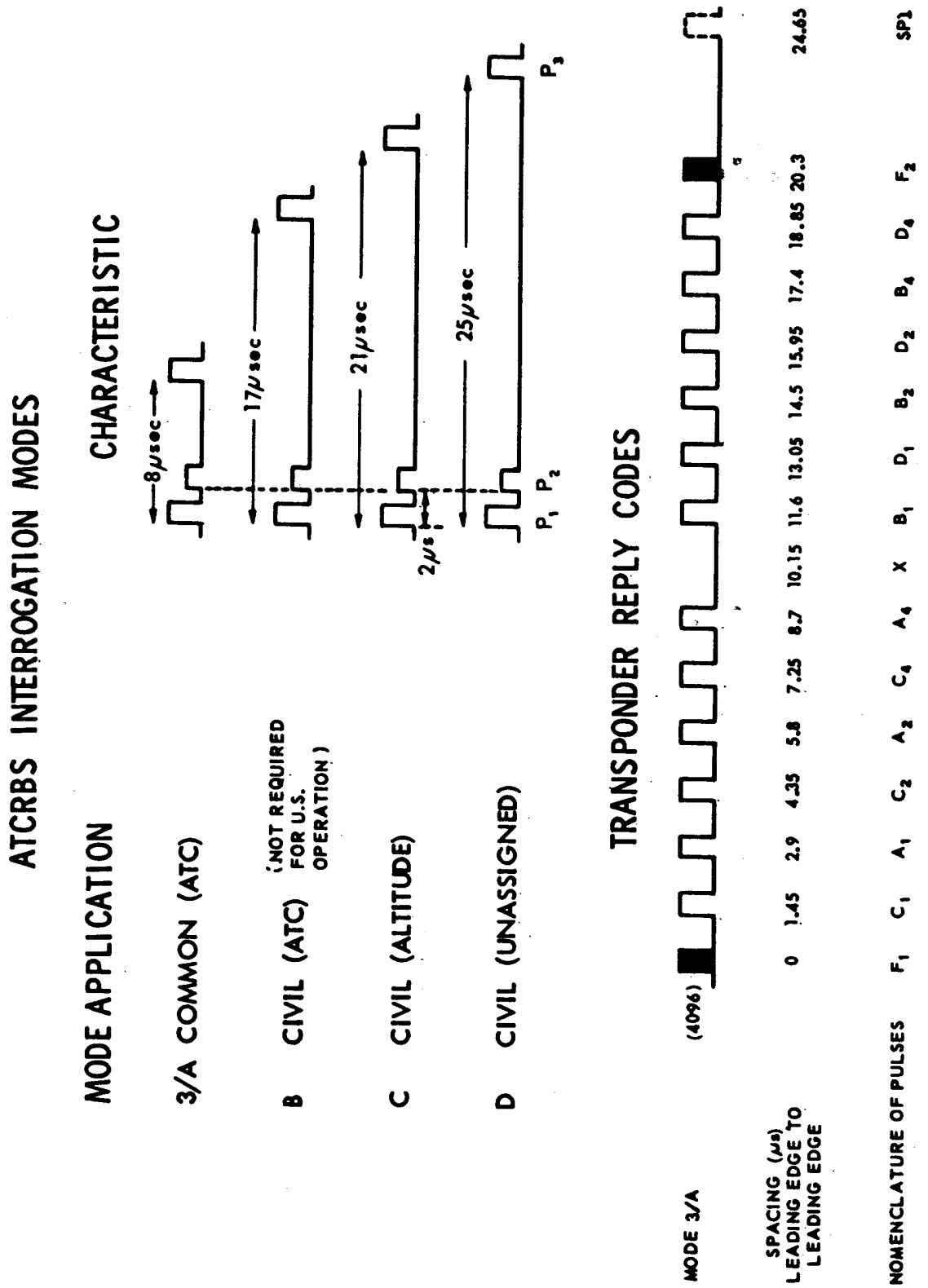

FIGURE 1—ATCRBS, Interrogation modes and reply codes.

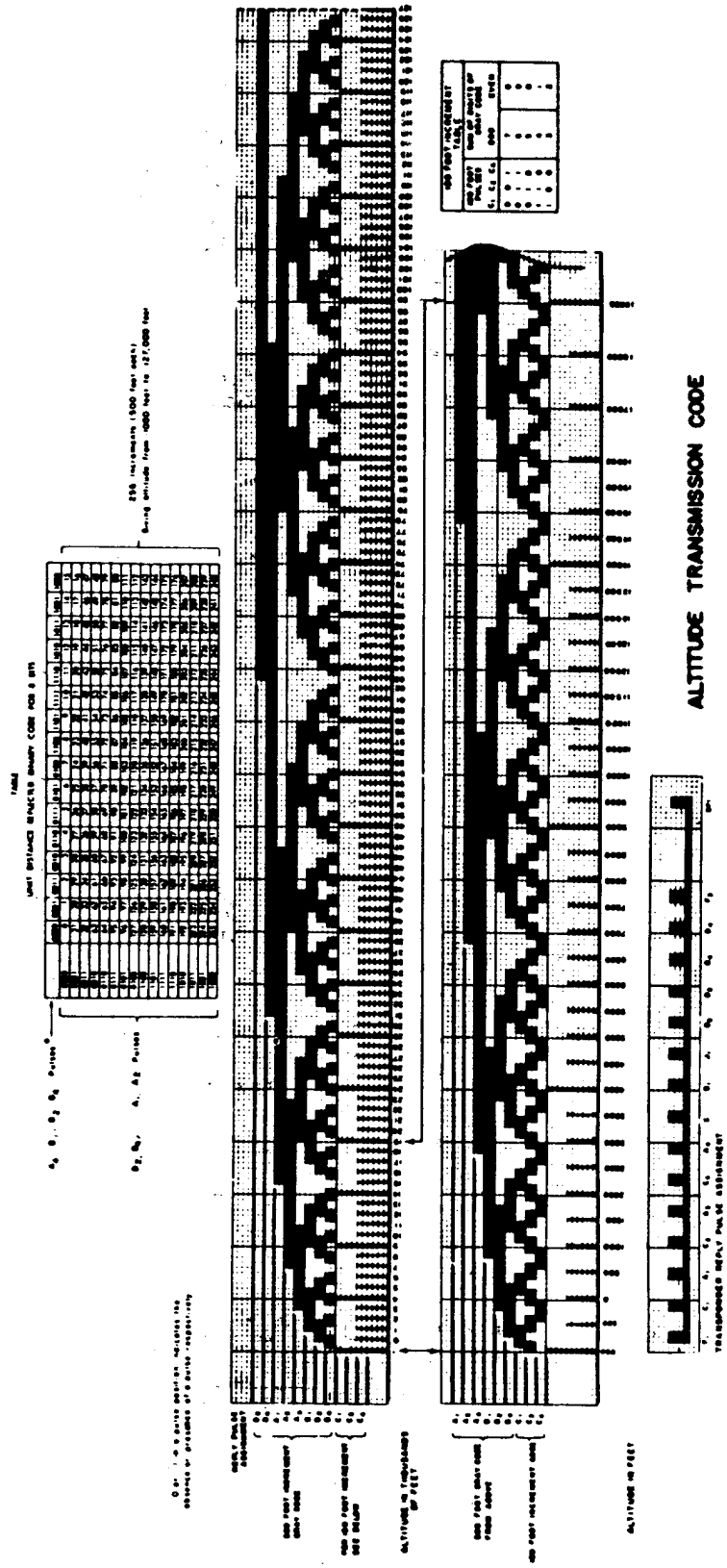

FIGURE 2.—Altitude transmission code.

nected to loads having the impedance value for which it is designed.

h. Interrogation Test Signal. The characteristics of the interrogation test signal are:

Radio frequency: The frequency of the signal generator oscillator must be 1030 MHz±0.01 percent.

CW output: CW output between pulses must be at least 60 db below the peak level of the pulses.

Interrogation: The interrogation must consist of two transmitted pulses designated P_1 and P_3. When providing side-lobe suppression the basic interrogation is supplemented by pulse P_2 transmitted after P_1. The amplitude of P_3 must not be more than 1 db below the radiated amplitude of P_1.

Pulse coding: The interval, measured leading-edge to leading-edge at half voltage points, between P_1 and P_3, is as follows:

Mode 3/A	8 ±0.2 microseconds.
Mode B	17 ±0.2 microseconds.
Mode C	21 ±0.2 microseconds.
Mode D	25 ±0.2 microseconds.

The interval between P_1 and P_2 when P_2 is used, must be 2.0 ±0.15 microseconds.

Pulse shape: The pulse envelope as detected by a linear detector must have a shape falling within the following limits:

(1) *Pulse rise time:* The time required for the leading edge of pulses P_1, P_2, and P_3 to rise from 10 to 90 percent of its maximum voltage amplitude must be between 0.05 and 0.1 microsecond.

(2) *Pulse fall time:* The time required for the trailing edge of pulses P_1, P_2, and P_3 to fall from 90 to 10 percent of its maximum voltage amplitude must be between 0.05 and 0.2 microsecond.

(3) *Pulse duration:* The duration of pulses P_1, P_2, and P_3 must be 0.8 ±0.1 microsecond measured at the half voltage points.

i. Code Nomenclature. The code designations consist of four digits each of which lies between 0 and 7, inclusive, and consist of the sum of the numerical subscripts of the pulse employed as follows:

Digit	*Pulse group*
First	A
Second	B
Third	C
Fourth	D

Examples:

1. Code 3600 consists of information pulses A_1, A_2, B_2, B_4.

2. Code 2057 consists of A_2, C_1, C_4, D_1, D_2, D_4.

j. Minimum Triggering Level (MTL). Means the lowest level of signal to which the transponder will reply to 90 percent of the received interrogations.

§ 37.181 Hydraulic hose assemblies—TSO-C75.

(a) *Applicability.* Minimum performance standards are hereby established for hydraulic hose assemblies which are to be used on U.S. civil transport category aircraft. New models of hydraulic hose assemblies, manufactured on or after the effective date of this section, which are to be used on U.S. civil transport category aircraft shall meet the standards specified in Federal Aviation Administration Standard, "Hydraulic Hose Assemblies", dated December 15, 1962.* Hydraulic hose assemblies approved prior to the effective date of this section may continue to be manufactured under the provisions of their prior approval.

(b) *Marking.* Articles shall be marked in accordance with the requirements of § 37.7(d) with the following exceptions:

(1) Trademark may be used in lieu of name, and manufacturer's address is not required;

(2) Size, type, and maximum operating pressure of the hose assembly shall be shown in lieu of the weight in paragraph (d)(3) of § 37.7;

(3) Part number shall be shown;

(4) Date of manufacture in terms of month and year is to be shown and serial number omitted;

(5) In lieu of paragraph (d)(2) of § 37.7 hose assemblies suitable for use with synthetic base fluilds shall be marked with the letter "S" immediately following the type designation. Assemblies suitable for use with petroleum base fluids shall be marked with the letter "P". Assemblies suitable for use with both synthetic and petroleum base fluids shall be marked with "S/P", i.e., Type II-B-S, Type II-B-P, or Type II-B-S/P; and

(6) Hose assemblies complying with the fire resistant requirements shall be identified by the letter "F" immediately following the type and fluid designation, i.e., Type II-B-S/P-F.

(c) *Data requirements.* In accordance with the provisions of § 37.5, the manufacturer shall furnish to the Chief, Engineering and Manufacturing Branch, Flight Standards Division, Federal Aviation Administration, in the re-

* Copies may be obtained upon request addressed to the Federal Aviation Administration.

gion in which the manufacturer is located, six copies of the following technical data:

(1) Type;

(2) Size;

(3) Maximum operating pressure;

(4) Part number; and

(5) Installation instructions and limitations, if any.

(d) Effective date. September 4, 1963.

§ 37.182 Fuel drain valves—TSO–C76.

(a) *Applicability.* Minimum performance standards are hereby established for fuel drain valves to be used in civil aircraft of the United States. New models of fuel drain valves manufactured on or after the effective date of this section shall meet the standards specified in the Federal Aviation Administration Standards, "Fuel Drain Valves", dated October 1, 1962.*

(b) *Marking.* Articles shall be marked in accordance with the requirements of § 37.7(d) except that:

(1) The size shall be shown in lieu of the weight required by § 37.7(d)(3); and

(2) Parts too small to contain all the required information shall be marked with the TSO number and the manufacturer's name or identifying mark. For such parts, the other marking data required by § 37.7(d) shall be placed on the shipping container of the part.

(c) *Data requirements.* In addition to the data specified in § 37.5 the manufacturer shall furnish to the Chief, Engineering and Manufacturing Branch, Flight Standards Division, Federal Aviation Administration, in the region in which the manufacturer is located, the following technical data:

(1) Six copies of an instruction manual describing the product and supplying information on maintenance, overhaul, and installation.

(2) One copy of the manufacturer's test report.

§ 37.183 Gas turbine auxiliary power units—TSO–C77.

(a) *Applicability.* Minimum performance standards are hereby established for gas turbine auxiliary power units for use on civil aircraft of the United States. New models of gas turbine auxiliary power units manufactured for use on civil aircraft on or after the effective date of this section shall meet the standards specified in the Federal Aviation Administration Standard, "Gas Turbine Auxiliary Power Units", dated January 3, 1963.*

(b) *Marking.* Articles shall be marked in accordance with the requirements of § 37.7(d) except that the weight need only be shown to the nearest pound. In addition, the following shall also be shown:

(1) Maximum rated speeds and temperature;

(2) Maximum allowable speeds and temperature;

(3) Maximum rated output;

(4) Category and class of service;

(5) Fuel grade and specification; and

(6) Lubricating oil grade and specification.

(c) *Data requirements.* In accordance with the provisions of § 37.5, the manufacturer shall furnish to the Chief, Engineering and Manufacturing Branch, Flight Standards Division, Federal Aviation Administration, in the region in which the manufacturer is located, the following technical data:

(1) Instruction manual containing instructions for the installation, operation, servicing maintenance, repair, and overhaul of the unit.

(2) Model specification.

§ 37.184 Crewmember demand oxygen masks—TSO–C78.

(a) *Applicability.* This TSO prescribes the minimum performance standards that aircraft crewmember demand oxygen masks must meet in order to be identified with the applicable TSO marking. New models of demand oxygen masks that are to be so identified and that are manufactured on or after February 10, 1967, must meet the requirements of the following "Federal Aviation Administration Standard, Crewmember Demand Oxygen Masks."

(b) *Marking.* Each oxygen mask manufactured in accordance with the provisions of this section must be marked—

* Copies may be obtained from the Federal Aviation Administration.

* Copies may be obtained from the Federal Aviation Administration.

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(1) To indicate whether it is a "non-pressure demand" or a "pressure demand" mask;

(2) To indicate the maximum environmental (cabin) altitude for which it is qualified; and

(3) As specified in § 37.7, except that the markings need not include the serial number, the weight, or the date of manufacture.

(c) *Data requirements.* In accordance with § 37.5, the manufacturer must furnish to the Chief, Engineering and Manufacturing Branch, Flight Standards Division, Federal Aviation Administration, in the region in which the manufacturer is located, the following technical data:

(1) Seven sets of manufacturer's operating instructions and equipment limitations.

(2) Seven sets of installation procedures with applicable drawings and specifications, limitations, restrictions, and other conditions pertinent to installation.

(3) One copy of the manufacturer's test report.

(4) One copy of the manufacturer's maintenance instructions, including cleaning and sterilizing procedures.

(d) *Previously approved equipment.* Crewmember demand oxygen masks approved prior to February 10, 1967, may continue to be manufactured under the provisions of the original approval.

FEDERAL AVIATION ADMINISTRATION STANDARD

Crewmember Demand Oxygen Masks

1.0 Purpose.

This Standard contains minimum performance standards for the manufacture of demand type oxygen masks for use with non-pressure demand (straight-demand and diluter-demand) and pressure-demand oxygen systems.

2.0 Design and Construction of Mask.

To be eligible for approval under a Technical Standard Order authorization, the oxygen mask must possess the following design and construction characteristics.

2.1 Masks designed for use with a remotely located oxygen flow regulator must include a flexible oxygen supply tube fixed or detachable at the mask or at the regulator or at both. Oxygen supply tubes used in conjunction with mask-mounted oxygen flow regulators are not subject to this paragraph.

2.2 The mask must be designed for respiration through the nose and mouth (oronasal). The mask may also include integral goggles designed to protect the eyes from smoke and harmful gases (fullface).

2.3 The mask must be constructed of materials that—

(a) do not contaminate air or oxygen;

(b) are not adversely affected by continuous contact with oxygen; and

(c) are at least flame resistant.

2.4 The mask must be designed to prevent the accumulation of hazardous quantities of expiratory gases within the facepiece chamber.

2.5 The mask must be designed to prevent the formation or accumulation of frost which would interfere with the function of the exhalation valve, unless it can be shown that the frost can be removed by external manipulation without removing the mask from the face of the user.

2.6 The fullface mask must be designed to include means for the prevention or the removal of condensation from the inside surfaces of the goggle lenses.

2.7 Masks equipped with oxygen supply tubes designed for quick disconnection at the mask or at the regulator must incorporate means to alert the user when his oxygen supply tube has become disconnected. Such means must not restrict the flow of ambient air through the oxygen supply tube by an amount exceeding 25 percent. This section does not apply if the quick disconnect device incorporates means to prevent inadvertent separation.

3.0 Performance.

Five masks of each kind for which approval is sought must be shown to comply with the minimum performance standards set forth in paragraphs 3.1 through 3.12, except that only one mask of each kind is required to comply with the provisions of paragraphs 3.6, 3.8, 3.9, and 3.11. Tests must be conducted at ambient atmospheric conditions of approximately 30″ hg. and 70° F., except as otherwise specified. Gas flow rates and pressures must be corrected to STPD.

3.1 *Quick-disconnect Coupling.* The force required to separate quick-disconnect couplings not designed to prevent inadvertent separation must not be less than 10 pounds exerted along the axis of symmetry of the oxygen supply tube.

3.2 *Strength.*

(a) The mask must be capable of sustaining a pull force on the suspension device attachment fittings of not less than 35 pounds in any direction for a period of not less than 3 seconds.

(b) The oxygen supply tube assembly must be capable of sustaining a pull force of not less than 30 pounds exerted along the axis of symmetry of the tube for a period of not less than 3 seconds.

(c) The oxygen supply tube assembly must be capable of sustaining an internal pressure of 1.5 p.s.i.g.

3.3 *Leakage.*

(a) The total inward leakage rate, with the complete mask positioned on the face or on a suitable test stand in a manner which simulates normal use, must not exceed 0.10 LPM STPD at any negative differential pressure within the range of from zero to 6.0 inches of water.

(b) Inhalation valves installed in pressure-demand masks must not backleak more than 0.015 LPM, STPD, when subjected to a suction pressure differential of 0.1" H_2O and not more than 0.15 LPM, STPD, when subjected to a suction pressure differential of 12.0" H_2O.

(c) The oxygen supply tube assembly must not leak when subjected to an internal pressure of 1.5 p.s.i.g.

3.4 *Flow Resistance.*

(a) The inspiratory resistance of the mask and oxygen supply tube including the oxygen supply con nector when inserted in an appropriate mating fitting must not exceed the following negative differential pressures at the corresponding oxygen flow rates:

Differential Pressure (inches H_2O)	*Flow Rate (LPM)*
0.6	20
1.5	70
2.5	100

(b) The expiratory resistance of the mask must not exceed the following positive differential pressures at the corresponding oxygen flow rates:

Differential Pressure (inches H_2O)	*Flow Rate (LPM)*
1.0	20
2.0	70
3.0	100

3.5 *Pressure-Demand Exhalation Valve Performance.* The exhalation valve installed in a pressure-demand mask must open when the pressure within the facepiece is 20 mm Hg and the pressure in the supply tube is 15 to 19.9 mm Hg.

3.6 *Vibration.* The flow of gases during the respiratory process must not cause vibration, flutter, or chatter which would interfere with the satisfactory operation of the mask.

3.7 *Acceleration Load.* The exhalation valve must not inadvertently operate under a 3g load applied in any direction.

3.8 *Extreme Temperature.* The mask must comply with paragraphs 3.3 through 3.5 in an ambient temperature of 70° F. within 15 miuntes after being stored at a temperature of 160° F. for 12 hours, and within 15 minutes after being stored at 0° F. for 2 hours. The relative humidity during storage must vary from 5 to 95 percent. The mask facepiece must not be gummy or sticky and must provide a normal seal after the high temperature exposure.

3.9 *Low Temperature Test Delay.*

(a) The mask must function properly, without apparent delay, at a temperature of 70° F. after being stored at a temperature of 20° F. for not less than 2 hours.

(b) The mask must function properly, without apparent delay, and continue for a period of not less than 15 minutes when tested at a temperature of 20° F. after being stored at a temperature of 70° F. for not less than 12 hours.

3.10 *Decompression.*

(a) A mask not equipped with a pressure relief valve must not suffer damage and must comply with paragraphs 3.3 through 3.5 after being subjected to a decrease in ambient pressure from 12 p.s.i.a. to not less than 2.7 p.s.i.a. for a straight or diluter-demand kind, or to not less than 2.1 p.s.i.a. for a pressure-demand kind, within a period of not more than 1 second. This decompression test must simulate the condition that would be imposed on a mask being worn by a crewmember during the specified decompression.

(b) A mask equipped with a pressure relief value must be subjected to the decompression specified in subparagraph (a) of this section during which the pressure relief valve must open at a differential pressure of 17" H_2O and must relieve the differential pressure to a value not exceeding 16" H_2O within 5 seconds. During the 5-second interval, the pressure differential must not exceed a value of 20" H_2O. The pressure relief valve must close at a differential pressure of 14" H_2O.

3.11 *Cycling.* The mask must comply with paragraphs 3.3 through 3.5 after being subjected to the following simulated breathing schedule for a total of 50,000 cycles:

Respiratory Cycles	*Minute Flow Rate LPM, STPD*	*Volume, Tidal Liters*
20,000	20	1.0
25,000	30	1.5
5,000	70	2.0

A constant time interval must be maintained between respiratory cycles.

3.12 *Microphone.* If the mask is designed to include a microphone, the installation of the microphone must not interfere with the operation of the mask.

4.0 Quality Control.

4.1 *Production Tests.* Each mask must be shown to comply with the provisions of paragraph 3.3(a), total leakage.

4.2 *Random Tests.* One mask must be selected at random from each lot and must be shown to comply with paragraph 3.1 through 3.12. The lot size must be selected by the applicant subject to the approval of

the Federal Aviation Administration (see FAR § 37.5), on the basis of evaluation of the applicant's quality control systems (see § 37.5(a)(3)).

5.0 Maximum Environmental (Cabin) Altitude.

The minimum pressure to which the mask has been shown to decompress satisfactorily in accordance with paragraphs 3.10(a) or (b) of this standard determines the maximum environmental altitude of the mask, except that it shall not exceed the value shown in the following table:

Maximum Environmental (Cabin) Altitude	Kind Of Mask
40,000 feet	Straight or Diluter-Demand
45,000 feet	Pressure-Demand

6.0 Abbreviations and Definitions.

LPM	Liters per minute.
STPD	Standard temperature and pressure, dry (0°C. 760 mm. Hg.)
p.s.i.g.	Pounds per square inch, gage.
p.s.i.a.	Pounds per square inch, absolute.
g	Acceleration of gravity, 32.2 feet/second^2.
Tidal Volume	Volume of air inspired per breath.

§ 37.185 Fire detectors (radiation sensing type)—TSO–C79.

(a) *Applicability.* Minimum performance standards are hereby established for radiation sensing type fire detectors which are for use on both piston and turbine engine-powered civil aircraft of the United States. New models of fire detectors (radiation sensing type) manufactured on or after the effective date of this section, which are to be used on civil aircraft of the United States, shall meet the standards specified in Federal Aviation Administration Standard, "Fire Detectors (Radiation Sensing Type)", dated May 15, 1963.*

(b) *Marking.* In lieu of the weight required in § 37.7(d)(3), the operating voltage for the detector shall be shown. Compliance of the detector with the piston or turbine engine requirements, or both, shall be designated by —P, —T, or —PT, respectively, as a suffix following the technical standard order designation as TSO–C79–P.

(c) *Data requirements.* (1) In accordance with the provisions of § 37.5, the manufacturer shall furnish to the Chief, Engineering and Manufacturing Branch, Flight Standards Division, Federal Aviation Administration, in the region in which the manufacturer is located, the following technical data:

(i) Six copies of the manufacturer's operating instructions and equipment limitations;

(ii) Six copies of the installation procedures with applicable schematic drawings, wiring diagrams, and specifications, indicating any limitations, restrictions, or other conditions pertinent to installation; and

(iii) One copy of the manufacturer's test report.

(2) The data required under subparagraph (1) (i) and (ii) of this paragraph shall include the following:

(i) Cone of vision expressed in degrees (apex of the cone is to be at the center of the sensor and the axis of the cone is to be at right angles to the face of the sensor).

(ii) Maximum effective range at field extremities;

(iii) Maximum allowable normal ambient temperature at the point of detector location;

(iv) Maximum and minimum allowable rate of temperature rise at point of detector location as a result of normal operation;

(v) Operating voltage;

(vi) Mounting or support method;

(vii) Maximum or minimum number of units which can be used in one circuit or one fire zone without adversely affecting sensitivity or causing false indications due to temperature;

(viii) Maximum allowable vibration at point of detector location;

(ix) Installation limitations (minimum distance) because of magnetic effect;

(x) Peak RF voltage and corresponding frequency;

(xi) Whether instrument is for pressurized area, nonpressurized area or both;

(xii) Which of the conditions in paragraphs 7.3.3, 7.3.4, 7.3.5 and 7.3.6 adversely affect the detector; and

(xiii) Whether detector meets the fire resistance requirements of paragraph 7.14.

* Copies may be obtained from the Federal Aviation Administration.

§ 37.186 Flexible fuel and oil cell material—TSO–C80.

(a) *Applicability.* Minimum performance standards are hereby established for flexible fuel and oil cell liner material. New types of flexible fuel and oil cell material manufactured after the effective date of this section for use in civil aircraft of the United States shall meet the standards specified in Federal Aviation Administration Standard, "Flexible Fuel and Oil Cell Material", dated August 1, 1963.*

(b) *Marking.* In lieu of the marking requirements of § 37.7(d), flexible fuel and oil cell material shall be legibly and permanently marked with the following information:

(1) Name and address of the manufacturer;

(2) Type of fluid for which approved, i.e. fuel, or MIL–L–6082 oil, or MIL–L–7808 oil;

(3) For oil cell material, the minimum and maximum temperature limit;

(4) For oil cell material, the oil-dilution suitability;

(5) Month and year manufactured; and

(6) Applicable Technical Standard Order (TSO) number.

(c) *Data requirements.* In accordance with the provisions of § 37.5, the manufacturer shall furnish to the Chief, Engineering and Manufacturing Branch, Flight Standards Division, Federal Aviation Administration, in the region in which the manufacturer is located, the following technical data:

(1) Six copies of the manufacturer's end product typical assembly instructions and limitations;

(2) Six copies of the recommended installation procedures, limitations, restrictions, or other conditions pertinent to a satisfactory installation;

(3) Six copies of the instructions for the inspection, repair and storage of material and/or cells including age limits on material, i.e. shelf life and service time;

(4) Six copies of the following descriptive information:

(i) construction number and description (ply by ply) of the construction buildup complete with weight and gage of each ply,

(ii) support means (type of fastener and locations),

(iii) total weight per square foot of cell constructions, and

(iv) total thickness of cell construction; and

(5) One copy of the manufacturer's test report.

(d) *Effective date.* May 26, 1964.

* Copies may be obtained from the Federal Aviation Administration.

§ 37.190 Cockpit voice recorder—TSO–C84.

(a) *Applicability.* (1) Minimum performance standards are hereby established for cockpit voice recorders for use on United States civil aircraft. New models of cockpit voice recorders manufactured for use on civil aircraft on or after September 2, 1964, shall meet the standards specified in Federal Aviation Administration Standard, "Minimum Performance Standards for Cockpit Voice Recorders," dated November 1, 1963,* and Federal Aviation Administration document entitled "Environmental Test Procedures for Airborne Electronic Equipment," August 31, 1962,* except as provided in subparagraph (2) of this paragraph.

(2) Federal Aviation Administration document, "Environmental Test Procedures for Airborne Electronic Equipment," outlines various test procedures which define the environmental extremes over which the equipment shall be designed to operate. Some test procedures have categories established and some do not. Where categories are established, only equipment which qualifies under one or more of the following categories, as specified in the FAA document, is eligible for approval under this order:

(i) Temperature-Altitude Test—Categories A, B, C, or D;

(ii) Vibration Test—Categories A, B, C, D, E, or F;

(iii) Audio-Frequency Magnetic Field Susceptibility Test—Categories A or B;

(iv) Radio-Frequency Susceptibility Test—Category A; and

(v) Emission of Spurious Radio-Frequency Energy Test—Category A.

* Copies may be obtained upon request addressed to the Federal Aviation Administration.

(b) *Marking.* (1) In addition to the markings specified in § 37.7(d), the equipment shall be marked to indicate the environmental extremes over which it has been designed to operate. There are six environmental test procedures outlined in the FAA document, "Environmental Test Procedures for Airborne Electronic Equipment" which have categories established. These shall be identified on the nameplate by the words "environmental categories" or, as abbreviated, "Env. Cat." followed by six letters which identify the categories under which the equipment is qualified. Reading from left to right, the category designations shall appear on the nameplate in the following order so that they may be readily identified:

(i) Temperature-Altitude Category;

(ii) Vibration Test Category;

(iii) Audio-Frequency Magnetic Field Susceptibility Test Category;

(iv) Radio-Frequency Susceptibility Test Category;

(v) Emission of Spurious Radio-Frequency Energy Test Category; and

(vi) Explosion Test.

(2) Equipment which meets the explosion test requirement shall be identified by the letter "E." Equipment which does not meet the explosion test requirement shall be identified by the letter "X." A typical nameplate identification would be as follows: Env. Cat. DBAAAX.

(3) In some cases such as under the Temperature-Altitude Test Category, a manufacturer may wish to substantiate his equipment under two categories. In this case, the nameplate shall be marked with both categories in the space designated for that category by placing one letter above the other in the following manner: Env. Cat. $\begin{matrix}A\\D\end{matrix}$ BAAAX.

(c) *Data requirements.* In accordance with the provisions of § 37.5, the manufacturer shall furnish to the Chief, Engineering and Manufacturing Branch, Flight Standards Division, Federal Aviation Administration, in the region in which the manufacturer is located the following technical data:

(1) Six copies of the manufacturer's operating instructions and equipment limitations;

(2) Six copies of the installation procedures with applicable schematic drawings, wiring diagrams, and specifications, indicating any limitations, restrictions, or other conditions pertinent to installation; and

(3) One copy of the manufacturer's test report.

§ 37.191 Survivor locator lights—TSO–C85.

(a) *Applicability.* Minimum performance standards are hereby established for survivor locator lights intended for installation on life preservers (adult and child) and life rafts for use in civil aircraft of the United States. New models of survivor locator lights manufactured on or after the effective date of this section shall meet the requirements specified in Federal Aviation Administration Standard "Survivor Locator Lights," dated April 22, 1964.*

(b) *Marking.* The survivor locator light shall be permanently marked in accordance with the provisions of § 37.7(d), except that the weight of the light assembly may be omitted.

(c) *Data requirements.* In accordance with the provisions of § 37.5, as applicable, manufacturers of survivor locator lights shall furnish to the Chief, Engineering and Manufacturing Branch, Flight Standards Division, Federal Aviation Administration, in the region in which the manufacturer is located, the following technical data:

Six copies of an instruction manual containing descriptive information of the device, information for its maintenance and overhaul, instruction concerning the proper mounting of the light on the life preservers or life rafts to ensure continued compliance with prescribed minimum performance standards and pertinent operating instructions and limitations for the device.

(d) *Effective date.* July 6, 1964.

§ 37.192 Twin seaplane floats—TSO–C27.

(a) *Introduction.* This Technical Standard Order is intended to serve as a criterion by

* Copies may be obtained upon request addressed to the Federal Aviation Administration.

which the product manufacturer may produce floats which will meet standards acceptable to the Federal Aviation Administration. In lieu of the above procedure, floats may be approved as part of the aircraft design, in which case the aircraft manufacturer should submit the pertinent float drawings and include them on the aircraft drawing list. Such floats shall comply with the strength and performance requirements for floats as stated in this Order, and the approval thereof will be recognized by all Federal Aviation Administration representatives.

(b) *Directive.*

(1) *Provision.* The strength and performance requirements for seaplane floats as set forth in Sections 3 and 4 of National Aircraft Standards Specifications NAS 807 dated June 1, 1951,* with the exceptions hereinafter noted, are hereby established as minimum safety standards for seaplane floats intended for use on all civil aircraft.**

(2) *Exceptions.*

(i) Section 4.3.3.4 Unsymmetrical Landing. Two-Float Landing with Drift. Third sentence—"The side load shall be $\frac{\tan \beta}{4}$ times the step landing load of 4.3.3.1."

(ii) Section 4.3.3 Limit Load Factors for General Structure Design. Definition of symbols following subpart (b). "V_{S_0}=airplane design stalling speed at design landing weight with zero thrust and landing flaps or other high lift devices in position for landing (miles per hour, EAS).

W=one half the airplane design landing weight."

NOTE: For single-engine aircraft, the design landing weight is the design maximum weight for which approval is desired. For multi-engine aircraft which meet the requirements of FAR 23.473 the landing weight may be less than the maximum design weight.

(3) *Application.*

(i) Seaplane floats complying with the specifications appearing in this Order are hereby acceptable for use on civil aircraft. Floats already approved by the Administrator may continue to be installed—

(*a*) by the aircraft manufacturer on production aircraft; or

(*b*) by an individual or agency making—

(*aa*) an alteration or replacement involving a change in type or model of floats; or

(*bb*) an original installation on an individual airplane.

(ii) For amphibious type float design, the provisions of NAS 807 in addition to the current ground loads and landing gear design and construction requirement of Part 23 or Part 25 of the Federal Aviation Regulations, whichever is applicable, shall apply.

(c) *Specific instructions.*

(1) *Marking.*

(i) In addition to the identification information required in Section 3.5 of Specification NAS 807 (except that "NAS Specification No. 807" is not required), each seaplane float shall be permanently marked with the Technical Standard Order designation FAA-TSO-C27 to identify the seaplane float as meeting the requirements of this Order in accordance with the manufacturer's statement of conformance described below. This identification will be accepted by the Federal Aviation Administration as evidence that the established minimum safety requirements for seaplane floats have been met. For floats approved as part of the aircraft design, no identification other than the aircraft manufacturer's part or drawing number is required.

(ii) For amphibious float design, the word "amphibious" shall also be included in the float identification marking.

(2) *Data requirements.* None.

(3) *Effective date.* After March 15, 1952, specifications contained in this Order will constitute the basis for approval of seaplane floats for use on certificated aircraft.

(4) *Deviations.* Requests for deviation from, or waiver of, the requirements of this Order, which affect the basic airworthiness of the component, should be submitted for the approval of the Chief, Engineering and Manu-

* Copies may be obtained from the National Standards Association, Inc.

** The strength requirements contained herein are conservative for rotorcraft twin-float installation.

facturing Branch, Flight Standards Division, Federal Aviation Administration, in the region in which the manufacturer is located.

(5) *Conformance.*

(i) The manufacturer shall furnish to the FAA (address as noted under "Deviations" above), a written statement of conformance signed by a responsible official of his company, setting forth that the designated seaplane float model to be produced by him meets the minimum safety standards established in this Order. Immediately thereafter, distribution of the seaplane floats conforming with the terms of this Order may be started and continued. A statement of conformance is not required for floats approved as part of the aircraft design.

(ii) The prescribed identification on the seaplane floats does not relieve the aircraft manufacturer or owner of responsibility for the proper installation of the seaplane floats on his aircraft, nor waive any of the requirements concerning type certification of the aircraft in accordance with existing Federal Aviation Regulations.

(iii) If complaints of nonconformance with the requirements of this Order are brought to the attention of the Federal Aviation Administration, and investigation indicates that such complaints are justified, the Administrator will take appropriate action to restrict the use of the product involved.

(iv) Copies of this Technical Standard Order and other Technical Standard Orders may be obtained from the Department of Transportation, Federal Aviation Administration, Distribution Unit, TAD-484.3, Washington, D.C. 20590.

§ 37.193 Aircraft skis—TSO-C28.

(a) *Introduction.* This Technical Standard Order is intended to serve as a criterion by which the product manufacturer may produce skis which will meet standards acceptable to the Federal Aviation Administration. In lieu of the above procedure, skis may be approved as part of the aircraft design, in which case the aircraft manufacturer should submit the pertinent ski drawings and include them on the aircraft drawing list. Such skis shall comply with the strength and performance requirements for skis as stated in this Order, and the approval thereof will be recognized by all Federal Aviation Administration representatives.

(b) *Directive.*

(1) *Provision.* The strength and performance requirements for skis as set forth in Sections 4 and 5 of National Aircraft Standards Specification NAS 808 dated December 15, 1951,* are hereby established as minimum safety standards for skis intended for use on civil aircraft.**

(2) *Application.* Skis complying with the specifications appearing in this Order are hereby acceptable for use on civil aircraft.

Aircraft skis already approved by the Administrator may continue to be installed by the aircraft manufacturer on production aircraft—

(i) For which an application for original type certificate is made prior to the effective date of this Order;

(ii) The prototype of which is flown within one year after the effective date of this Order; and

(iii) The prototype of which is not flown within one year after the effective date of this Order if due to causes beyond the applicant's control.

If an alteration or replacement involving a change in type or model of aircraft skis is made, or if an original installation on an individual airplane is made, previously type certificated skis may be installed.

(c) *Specific instructions.*

(1) *Marking.* In addition to the identification information required in Section 3.8 of Specification NAS 808 (except that "NAS Specification No. 808" and "For Installation Geometry, see Ski Installation Drawing No. _____" are not required), each ski shall be permanently marked with the Technical Standard Order designation FAA-TSO-C28 to identify the ski as meeting the requirements

* Copies may be obtained from the National Standards Association, Inc.

** The strength requirements contained herein are conservative for rotorcraft ski installation.

of this Order in accordance with the manufacturer's statement of conformance described below. This identification will be accepted by the Federal Aviation Administration as evidence that the established minimum safety requirements for skis have been met. For skis approved as part of the aircraft design, no identification other than the aircraft manufacturer's part or drawing number is required.

(2) *Data requirements.* None.

(3) *Effective date.* After March 15, 1952, specifications contained in this Order will constitute the basis for approval of skis for use on certificated aircraft.

(4) *Deviations.* Requests for deviation from, or waiver of, the requirements of this Order, which affect the basic airworthiness of the component, should be submitted for the approval of the Chief, Engineering and Manufacturing Branch, Flight Standards Division, Federal Aviation Administration, in the region in which the manufacturer is located.

(5) *Conformance.*

(i) The manufacturer shall furnish to the FAA (address as noted under "Deviations" above), a written statement of conformance signed by a responsible official of his company, setting forth that the designated ski to be produced by him meets the minimum safety standards established in this Order. Immediately thereafter, distribution of the skis conforming with the terms of this Order may be started and continued. A statement of conformance is not required for skis approved as part of the aircraft design.

(ii) The prescribed identification on the skis does not relieve the aircraft manufacturer or owner of responsibility for the proper installation of the skis on his aircraft, nor waive any of the requirements concerning type certification of the aircraft in accordance with existing Federal Aviation Regulations.

(iii) If complaints of nonconformance with the requirements of this Order are brought to the attention of the Federal Aviation Administration, and investigation indicates that such complaints are justified, the Administrator will take appropriate action to restrict the use of the product involved.

(iv) Copies of this Technical Standard Order and other Technical Standard Orders may be obtained from the Department of Transportation, Federal Aviation Administration, Distribution Unit, TAD–484.3, Washington, D.C. 20590.

§ 37.194 [[Reserved]]

§ 37.195 Airborne low-range radio altimeter—TSO–C87.

(a) *Applicability.* This Technical Standard Order prescribes the minimum performance standards which airborne low-range radio altimeter equipment must meet in order to be identified with the applicable TSO marking. New models of the equipment which are to be so identified and which are manufactured on or after the effective date of this sectioin must meet the Minimum Performance Standards for Airborne Low-Range Radio Altimeters set forth at the end of this section.

(b) *Markings.* (1) In addition to the markings required by § 37.7, the equipment must be marked to indicate the environmental extremes over which it has been designed to operate. There are six environmental procedures outlined in the "Environmental Test Procedures for Airborne Electronic Equipment" which have categories established. These must be identified on the nameplate by the words "Env. Cat." followed by six letters which identify the categories designated in the document. Reading from left to right, the category desig-

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nations must appear on the nameplate in the following order so that they may be readily identified—

(i) Temperature-altitude category;

(ii) Vibration category;

(iii) Audio-frequency magnetic field susceptibility category;

(iv) Radio-frequency susceptibility category;

(v) Emission of spurious radio-frequency energy category; and

(vi) Explosion category.

(2) A typical nameplate identification might be as follows: Env. Cat. DBAAAX.

(3) If a manufacturer desires to substantiate his equipment under two categories, he must mark the nameplate with both categories in the space designated for that category by placing one letter above the other in the following manner: Env. Cat. $\frac{A}{D}$ BAAAX

(c) *Data requirement.* In accordance with § 37.5, the manufacturer must furnish to the Chief, Engineering and Manufacturing Branch, Flight Standards Division, Federal Aviation Administration in the region in which the manufacturer is located, the following technical data:

(1) Manufacturer's operating instructions and equipment limitations.

(2) Installation procedures with applicable schematic drawings, wiring diagrams, and specifications. Any limitations, restrictions, or other conditions pertinent to installation must be indicated.

(3) One copy of the manufacturer's test report.

(d) *Previously approved equipment.* Airborne low-range radio altimeter models approved prior to the effective date of this section may continue to be manufactured under the provisions of their original approval.

MINIMUM PERFORMANCE STANDARDS FOR AIRBORNE LOW-RANGE RADIO ALTIMETERS

1.0 General Standards.

1.1 *Rating of Components.* The equipment shall not incorporate any component of such rating that, when the equipment is operated throughout the range of the specified environmental tests, the rating established by the manufacturer of the component is exceeded. For electron tubes and transistors, either the tube or transistor manufacturer's continuous commercial service rating, his established pulse rating, or his approved rating as applied to the particular application, whichever is appropriate, shall apply, except for the heaters and filaments. The voltage applied to the heaters and filaments of electron tubes shall be within 5 percent of the manufacturer's rating, or at a value approved by the tube manufacturer for the particular service, when the equipment is operated under standard operating conditions. When the heaters and filaments are connected in series, the 5 percent tolerance shall apply to the sum of their voltage ratings.

1.2 *Operation of Controls.* The operation of controls intended for use during flight, at all possible position combinations and sequences, shall not result in a condition whose presence or continuation would be detrimental to the continued performance of the equipment.

1.3 *Accessibility of Controls.* Controls which are not normally adjusted in flight shall not be readily accessible to flight personnel.

1.4 *Effects of Tests.* Unless otherwise stated, the application of the specified tests shall produce no subsequently discernible condition which would be detrimental to the continued performance of the equipment.

2.0 Minimum Performance Standards Under Standard Conditions.

The test procedures applicable to the determination of the performance of airborne low-range radio altimeter equipment under standard conditions are set forth in Appendix A of this standard. Test procedures which provide equivalent information may be used. Compliance with the performance requirements may be shown by an appropriate combination of data obtained from the laboratory and/or flight measurements. Calculations and extrapolations employing the basic test data may be used to make a direct determination of equipment performance by means of these basic test procedures.

2.1 *Accuracy of Pilot's Display.* The altitude information displayed for the pilot's use shall not exhibit errors in excess of those set forth in Column 1 of Table I for 95 percent of all observations conducted under any combination of the measurement conditions listed with the table.

NOTE: The above measurement conditions need not be applied simultaneously but may be combined by analytical methods.

TABLE I.—ACCURACY REQUIREMENTS AND MEASUREMENT CONDITIONS

*Altitude** (*ft.*)	*Vertical velocity* (*ft./sec.*)	*Column 1—Pilot's display*	*Column 2—Precision equipment output* (*ft.*)
3 to 100	0 to 15	±5 ft.	±3 ft.
100 to 500	0 to 20	±5%	±3%
500 to that altitude for which the equipment is designed	0 to 20	±7%	±5%

* That "one-way" distance measured from the antenna to the terrain. The altitude may be offset by a distance equal to the vertical distance between the antennas and the terrain at touchdown.

Measurement Conditions:

(1) Lateral velocities from 0 to 50 feet per second.

(2) Longitudinal velocities from 0 to 300 feet per second.

(3) Pitch angle range of 0 to ±15 degrees.

(4) Roll angle range of 0 to ±20 degrees.

(5) Vertical velocity from 0 to 15 feet per second up to 100 feet and 0—20 feet per second above 100 feet.

NOTE: Conditions 1 through 5 above include all associated doppler shift and step errors.

Further, the equipment shall continue to function and provide altitude information which exhibits no errors in excess of ±20 percent of the indicated altitude for 95 percent of all observations at bank angles from 20 to 30 degrees.

2.2 *Accuracy of the Percision Equipment Output.* The equipment need not provide as a condition of compliance with this minimum performance standard a precision equipment output for use in conjunction with autopilots, flight directors, or similar flight control computing devices. However, the altitude data supplied by such outputs, where provided, shall not exhibit errors in excess of those set forth in Column 2 of Table I for 95 percent of all observations conducted under any combination of the measurement conditions listed in 2.1.

2.3 *Precision Equipment Output Noise.* The r.m.s. noise content of the data provided by the precision equipment output shall be less than 0.25 foot at all altitudes up to 100 feet.

2.4 *Time constant.* When the equipment is abruptly subjected to an altitude change of not more than 10 percent of the indicated altitude or 20 feet whichever is smaller the transfer function time constant of the precision equipment output shall not exceed 0.1 second. Further, for transients of 20 feet or less at altitudes of 200 feet or less the system shall not lose lock. If the equipment should lose lock due to loss of signal at altitudes above 200 feet and up to the maximum altitude for which it is designed, it shall recapture the signal in less than one second.

2.5 *Rate Data.* The equipment need not provide a rate data output as a condition of compliance with this minimum performance standard. However, those altimeters which do have rate outputs shall comply with the following requirements regarding range and accuracy for at least 95 percent of all observations for heights from the terrain to the antenna in the range from:

RATE DATA

Altitude (*ft.*)	*Range* (*ft./sec.*)	*Accuracy* (*ft./sec.*)
0–100	0–15	± (1.5 ft.+0.01h+0.1/r/)
100–200	0–20	± (2.0 ft.+0.01h+0.1/r/)

Where:

h=altitude in feet.

/r/=absolute value of rate (feet/sec.).

2.6 *Failure Warning System.*

(a) *Warning conditions.* A failure warning system shall be incorporated in the equipment to indicate to the pilot, and to any systems which may be utilizing the altimeter data, the existence of the following conditions:

(1) Loss of power.

(2) Loss of signal or altitude sensing capability when within the manufacturer's stated operating altitude range.

(b) *Warning indication characteristics.* An indication plainly discernible under all normal flight conditions shall be provided. If a flag is used, it shall be as large as practicable commensurate with the display.

2.7 *Self-Test Feature.* If self-test feature is provided, any probable malfunction of the self-test feature shall not degrade the performance of the radio altimeter.

2.8 *Transmitting Operating Frequency.* The transmitter shall be operated within a frequency band available for the operation of airborne radio altimeters in the Aeronautical Radio Navigation Service and in accordance with applicable Federal Aviation Administration, and Federal Communications Commission Rules and Regulations.

2.9 *Maximum Altitude Range.* To satisfactorily perform its intended function, the maximum range shall be at least 500 feet.

3.0 Minimum Performance Standards Under Environmental Conditions.

Unless otherwise specified, the test procedures applicable to a determination of performance of radio altimeter equipment under environmental conditions are set forth in the FAA Document for "Environmental Test Procedures for Airborne Electronic Equipment", dated August 31, 1962.

3.1 *Temperature-Altitude.*

(a) Low Temperature—When subjected to this test:

(1) The requirements of paragraphs 2.3 and 2.6 shall be met.

(2) The requirements of paragraphs 2.1 and 2.2 shall be met using the procedure set forth in 2.2 of Appendix A.

(3) All mechnical devices shall perform their intended functions.

(b) High Temperature—

(1) When the equipment is operated at the High Short-Time Operating Temperature:

(*a*) The requirements of paragraphs 2.1 and 2.2 shall not be degraded by more than a factor of 2 from the values set forth using the procedures set forth in 2.2 and 2.3 respectively, of Appendix A.

(*b*) The requirements of paragraph 2.6 shall be met.

(*c*) All mechanical devices shall operate satisfactorily.

(2) When the equipment is operated at the High Operating Temperature:

(*a*) The requirements of paragraphs 2.3 and 2.6 shall be met.

(*b*) The requirements of paragraphs 2.1 and 2.2 shall be met using the procedures set forth in 2.2 of Appendix A.

(c) Decompression (Applicable only to Category D equipment of Temperature-Altitude Test)—When the equipment is subject to this test:

(1) The requirements of paragraphs 2.1 and 2.3 shall be met using the procedures set forth in 2.2 and 2.3, respectively, of Appendix A.

(2) All mechanical devices shall perform their intended functions.

(d) Altitude—When the equipment is subjected to this test:

(1) The requirements of paragraphs 2.3 and 2.6 shall be met.

(2) The requirements of paragraphs 2.1 and 2.2 shall be met using the procedures set forth in 2.2 of Appendix A.

3.2 *Humidity.* After subjection to this test and:

(a) Within 15 minutes from the time that primary power is applied:

(1) The requirements of paragraph 2.6 shall be met.

(2) All mechanical devices shall operate satisfactorily.

(b) Within 4 hours from the time that primary power is applied:

(1) The requirements of paragraphs 2.3 and 2.6 shall be met.

(2) The requirements of paragraphs 2.1 and 2.2 shall be met using the procedures set forth in 2.2 of Appendix A.

3.3 *Shock.*

(a) Following the application of the Operational Shocks.

(1) The requirements of paragraphs 2.3 and 2.6 shall be met.

(2) The requirements of paragraphs 2.1 and 2.2 shall be met using the procedures set forth in 2.2 of Appendix A.

(b) Following the application of the Crash Safety Shocks, the equipment shall have remained in its mounting and no part of the equipment or its mounting shall have become detached and free of the shock test table or the equipment under test.*

3.4 *Vibration.* When subjected to this test:

(a) The requirements of paragraphs 2.3 and 2.6 shall be met.

(b) The requirements of paragraphs 2.1 and 2.2 shall be met using the procedures set forth in 2.2 of Appendix A.

3.5 *Temperature Variation.* When subjected to this test:

(a) The requirements of paragraphs 2.3 and 2.6 shall be met.

(b) All mechanical devices shall perform their intended functions.

3.6 *Power Input Variation.* When subjected to this test:

(a) The requirements of paragraphs 2.3 and 2.6 shall be met.

(b) All mechanical devices shall perform their intended functions.

3.7 *Low Voltage.*

(a) When the equipment is subjected to the first part of the low voltage test procedure set forth in 9.2a, of Environmental Test Procedures for Airborne Electronic Equipment document.

(1) The equipment shall operate electrically and mechanically.

(2) The requirements of paragraph 2.6 shall be met.

(b) When the equipment is subjected to the second part of the low voltage test procedure set forth in 9.2b(1), of Environmental Test Procedures for Airborne Electronic Equipment document.

(1) The requirements of paragraphs 2.3 and 2.6 shall be met.

(2) The requirements of paragraphs 2.1 and 2.2 shall be met using the procedures set forth in 2.2 of Appendix A.

(c) When the equipment is subjected to the third part of the low voltage test procedure set forth in 9.2b(2), of Environmental Test Procedures for Airborne Electronic Equipment document, there shall be no evidence external to the equipment of the presence of fire or smoke.*

3.8 *Conducted Voltage Transient.*

(a) Subsequent to the subjection of the intermittent transient test, the requirements of paragraphs 2.1 and 2.3 shall be met using the procedures set forth in 2.2 of Appendix A.

* The application of this test may result in damage to the equipment under test. Therefore, it may be conducted after the other tests are completed.

(b) When being subjected to the repetitive transient test the requirements of paragraphs 2.3 and 2.6 shall be met.

3.9 *Conducted Audio-Frequency Susceptibility.* When subjected to this test:

(a) The requirements of paragraphs 2.3 and 2.6 shall be met.

(b) The requirements of paragraphs 2.1 and 2.2 shall be met using the procedures set forth in 2.2 of Appendix A.

3.10 *Audio-Frequency Magnetic Field Susceptibility.* When subjected to this test:

(a) The requirements of paragraphs 2.3 and 2.6 shall be met.

(b) The requirements of paragraphs 2.1 and 2.2 shall be met using the procedures set forth in 2.2 of Appendix A.

3.11 *Radio-Frequency Susceptibility (Radiated and Conducted).* When subjected to this test:

(a) The requirements of paragraphs 2.3 and 2.6 shall be met.

(b) The requirements of paragraphs 2.1 and 2.2 shall be met using the procedures set forth in 2.2 of Appendix A.

3.12 *Explosion (When Required).* During the application of this test the equipment shall not cause detonation of the explosive mixture within the test chamber.

3.13 *Emission of Radio-Frequency Energy.* The levels of conducted and radiated spurious radio-frequency energy emitted by the equipment shall not exceed those levels specified in Appendix A to the Federal Aviation Administration document, "Environmental Test Procedures for Airborne Electronic Equipment", dated August 31, 1962, for the aircraft category for which the equipment is designed.

APPENDIX A

1.0 Test Conditions.

The following definitions of terms and conditions of test are applicable to the test procedures specified herein.

1.1 *Power Input Voltage-Direct Current.* Unless otherwise specified, when the equipment is designed for operation from a direct current power source, all measurements shall be conducted with the power input voltage adjusted to 13.75 volts, ±2 percent for 12–14 volt equipment, or to 27.5 volts, ±2 percent for 24–28 volt equipment. The input voltage shall be measured at the receiver power input terminals.

1.2 *Power Input Voltage-Alternating Current.* Unless otherwise specified, when the equipment is designed for operation from an alternating current power source all tests shall be conducted with the power input voltage adjusted to design voltage ±2 percent. In the case of equipment designed for operation from a power source of essentially constant frequency (e.g., 400 c.p.s.), the input frequency shall be adjusted to design frequency ±2 percent. In the case of equipment designed for operation from a power source of variable frequency (e.g., 350 to 1,000 c.p.s.), tests shall be conducted with the input frequency adjusted to within 5 percent of a selected frequency within the range for which the equipment is designed.

1.3 *Adjustment of Equipment.* The circuits of the equipment under test shall be properly alined and otherwise adjusted in accordance with the manufacturer's recommended practices prior to the application of the specified tests.

1.4 *Ambient Conditions.* Unless otherwise specified, all tests shall be conducted under conditions of ambient room temperature, pressure, and humidity. However, the room temperature shall be not lower than 10° C.

1.5 *Warmup Period.* Unless otherwise specified, all tests shall be conducted after a warmup period of not less than fifteen (15) minutes.

1.6 *Description of Test Equipment.*

(a) Altitudes Simulator. The altitude simulator consists of variable and fixed RF attenuators, and coaxial cables or other suitable delays to simulate the various altitudes. The simultator must accept the altimeter energy, attenuate and delay this RF energy and present the delayed signal of the altimeter receiver. The test equipment must also include provisions to simulate the cross-coupling which exists between separate transmitter and receiver antennas. The simulator should be calibrated to provide the desired altitude of an accuracy of better than 1 percent and the appropriate attenuation to within ±2.5 db. The variable attenuator shall be calibrated in radar cross-section [$\sigma_0(o)$]* between the values of 0.003 and 1.0.

(b) Digital Voltmeter.

(c) AC VTVM.

(d) Demodulator. The Demodulator consists of a synchronous detector excited by an a.c. reference voltage. The bandwidth of the Demodulator should exceed 5 c.p.s. Ripple rejection should exceed 60 db. Means to set the Demodulator gain to unity should be provided. Means to balance the Demodulator output to zero should be provided.

(e) Filter. See Figure 2 or 3.

(f) Alarm Signal Monitor. The Alarm Signal Monitor consists of a simple indicator such as a pilot lamp.

(g) Remodulator. The Remodulator is an electronic or electromechanical switch excited by an a.c. reference voltage. It converts low frequencies to suppressed carrier modulation where the carrier frequency is the a.c. reference voltage. Means to set the Remodulator gain to unity should be provided.

* Defined in Appendix B.

2.0 Test Procedures.

The test procedures set forth herein are satisfactory for use in determining the performance of airborne low-range radio altimeters. Test procedures which provide equivalent information may be used.

2.1 *Accuracy (In-Flight).*

(a) Altitude Information. With the equipment installed in an aircraft, operate the equipment in flight over a runway or other smooth surface at altitudes and descent rates in accordance with paragraph 2.1. Determine the true altitude of the aircraft by theodolite or other means and compute the accuracy of the altitude information from the altimeter. Extrapolation of the test data by theoretical means, from the results so obtained, is permissible in order to demonstrate compliance with the standards in paragraphs 2.1 and 2.2.

(b) Altitude Rate Information. With the equipment installed in an aircraft, operate the equipment in flight over a runway or other smooth surface at altitudes and descent rates in accordance with paragraph 2.5. Determine the true descent rate of the aircraft and compute the accuracy of the altitude rate information from the altimeter. Extrapolation of test data by theoretical means, from the results sso obtained is permissible in order to demonstrate compliance with the standards in paragraph 2.5.

2.2 *Altitude Accuracy and Loop Gain.*

(a) Equipment Required: Atitude Simulator, Digital Voltmeter or AC VTVM, Flag Monitor.

The choice of voltmeters depends on the voltage output of the altimeter which could be a.c. or d.c.

(b) Measurement Procedures. Connect the equipment as shown in Figure 1. Set the altitude simulator to a specified altitude and a radar cross section [$\sigma_0(o)$] of 0.1. Monitor the altitude output with the voltmeter and vertify altimeter calibration. Monitor pilots indicator and warning signal. Vary radar cross section [$\sigma_0(o)$] over the range of 1.0 to 0.01. Altitude indication should remain within the limits specified. Altimeter can lose track and indicate fail for [$\sigma_0(o)$] below 0.01.

Adjust the altitude simulator to another altitude and repeat the above measurements. Note in Appendix B a different total attenuation is required to permit the radar cross section [$\sigma_0(o)$] dial to remain in calibration.

2.3 *Altitude Noise.*

(a) Equipment Required: Altitude Simulator, Digital Voltmeter, Remodulator, AC VTVM, Filter.

If the altitude output is an a.c. voltage the following additional equipment is required:

Demodulator.

(b) Measurement Procedure. Connect the equipment as shown in FIGURE 2 or 3. Set the altitude simulator to a specified altitude and a scattering radar

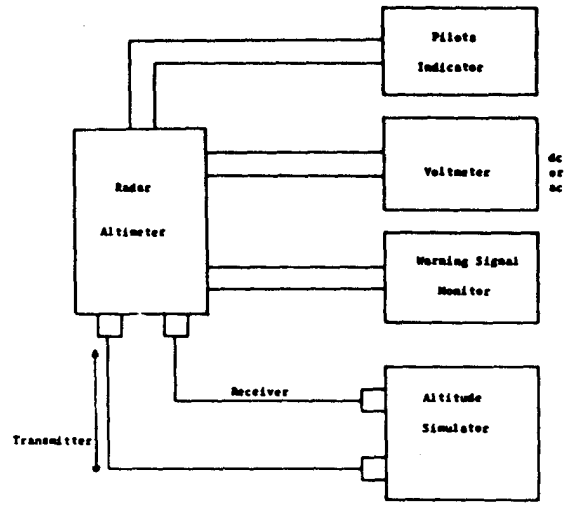

FIGURE 1—Equipment test connections.

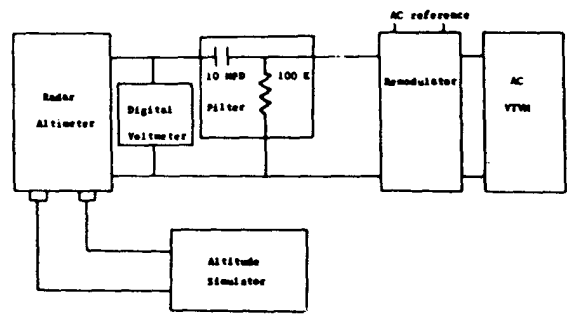

FIGURE 2—DC altitude output.

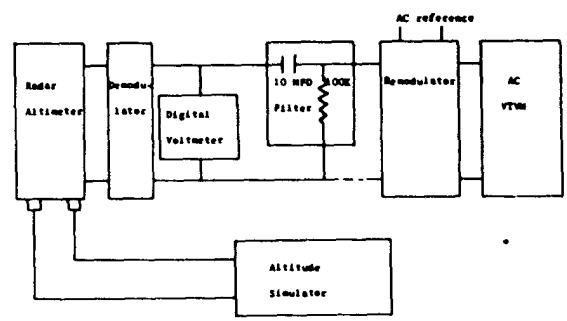

FIGURE 3—AC altitude output.

cross section corresponding to $[\sigma_0(o)]$ of 0.01. Read the r.m.s. voltage indicated by the a.c. VTVM. Convert to altitude noise in feet. The measurement should be repeated at one other simulated altitude.

2.4 *Time Constant.*

(a) Equipment Required: Altitude Simulator.

(b) Test Procedure. Couple the radio altimeter to the altitude simulator. Set the altitude simulator to an equivalent altitude of 100 to 200 feet. Insert a change in the delay equivalent to 10 percent of the indicated altitude. The analog output of the altimeter shall be observed and shall reach 63 percent of the ultimate change in 0.1 second or less with less than 5 percent over-shoot. Consideration must be given to the time required for switching the delay in and/or out in the above measurement.

APPENDIX B

Determination of External Loop Loss (Derivation)

1.0 Definition of External Loop Loss.

In the useful signal path, i.e., transmiting antenna to ground to receiving antenna, the External Loop Loss is defined for average power in c-w systems and peak power in pulse systems.

The external loop loss is the ratio of the available power entering the receiving antenna aperture to the power leaving the transmitter antenna aperture.

2.0 Characteristics of External Loop Loss.

The loss defined above is independent of antenna and transmission line losses, inefficiencies, and mismatches. It deals only with the geometric power gain, (G), the beam patterns of the antennas, and the characteristics of the ground. Further, it is independent of the signal processing characteristics of the altimeter and may be measured, essentially, with an attenuator only.

3.0 External Loop Loss, Beam Limited Case.

The basic formulation for external loop loss depicts a beam limited case in which it is assumed that transmitting and receiving apertures are identical. The analytical expression for this case is:

$$L=\frac{G\lambda^2\sigma_0(O)F}{16\pi^2H^2}=\frac{A\sigma_0(O)F}{4\pi H^2} \qquad 3.1$$

where G is the power gain of either antenna (defined in terms of the actual beam pattern), λ is the wavelength, H is the altitude, $\sigma_0(O)$ is the vertical incidence unit scattering radar cross section of the ground, and F is a normalized function of H. Limitations on roll and pitch under 100 feet of altitude and the effect of finite separation of transmitting and receiving antennas is accounted for by F. A is defined as $\frac{G\lambda^2}{4\pi}$.

4.0 External Loop Loss, Pulse Limited Case.

In the pulsed altimeter, the external loop loss is described by Eq. (3.1) below the critical altitude, i.e., that altitude above which the performance is pulse limited.

Defining the critical altitude, H_c, as

$$H_c=\frac{c\tau G}{4} \qquad 4.1$$

where c is the velocity of light and τ is the pulse length. The external loop loss is defined above H_c by extending the loss.

$$\frac{G\lambda^2\sigma_0(O)F}{16\pi^2H_c^2}$$

according to a $1/H^3$ law.

5.0 Essentials of F or F(H).

$$F(H)=M(H)V^*(H) \qquad 5.1$$

5.1 $\underline{M(H)}$

The function M(H) takes care of the fact that pitch and roll maneuvering becomes progressively limited for altitudes below 100 feet. The choice for $\sigma_0(O)$ includes margin for pitch and roll to the 3 db limits of the beamwidth for altitudes above 100 feet. It is expected that at 3 feet of altitude, however, pitch and roll will be very limited and well within the 3 db beam limits. Accordingly, it is proposed to decrease the required loop loss by 0 db at 100 feet and 6 db at 3 feet, the variation between 3 feet and 100 feet to be linear in db, i.e.,

$$10 \log M(H)=-\frac{6}{97}H+6\frac{18}{97} \qquad 5.2$$

5.2V*(H)

This quantity takes care of the effects of antenna spacing.

$$V^*=\frac{2[\cos^{-1}\alpha-\alpha\sqrt{1-\alpha^2}]}{\pi\ (1+\alpha^2\tan^2\theta_0)\ 5/2}\ 0\leq\alpha\leq1, \qquad 5.3$$

where,

$$\alpha=\frac{D}{2H\tan\theta_0}, \qquad 5.4$$

D is the antenna spacing, and

$2\theta_0$ is the beamwidth.

6.0 Curves of External Loop Loss.

All that remains is to make a choice for $\sigma_0(0)$ such that the resulting external loop loss calculated is just sufficient to insure reliable operation over all terrain even for pitch and roll maneuvers out to the 3 db beamwidths. A considerable amount of data accumulated for both pulse and FM/CW altimeters in the 4200–4400 mc region involving many flight tests over a wide variety of terrain and practical problems of adjustment, maintenance and calibration of radio altimeters indicates a choice of

$$\sigma_0(0)=6\times10^{-3}. \qquad 6.1$$

With respect to making a choice for the 1600–1660 mc range, it cannot be done on the basis of extensive flight data. Accordingly, it will be necessary to extrapolate from the 4200–4400 mc data. The trend of change of $\sigma_0(\theta)$ with frequency is slow; $\sigma_0(O)$ tending to decrease with frequency but $\sigma_0(\theta)$ tending to vary more slowly with β as the frequency decreases. The first effect definitely increases loop loss; the second effect tends to decrease loop loss. In the absence of data to the contrary, the two effects can be assumed to cancel each other and that one may then choose the same value of $\sigma_0(0)$ for both frequency ranges. The curves which follow are based on this assumption.

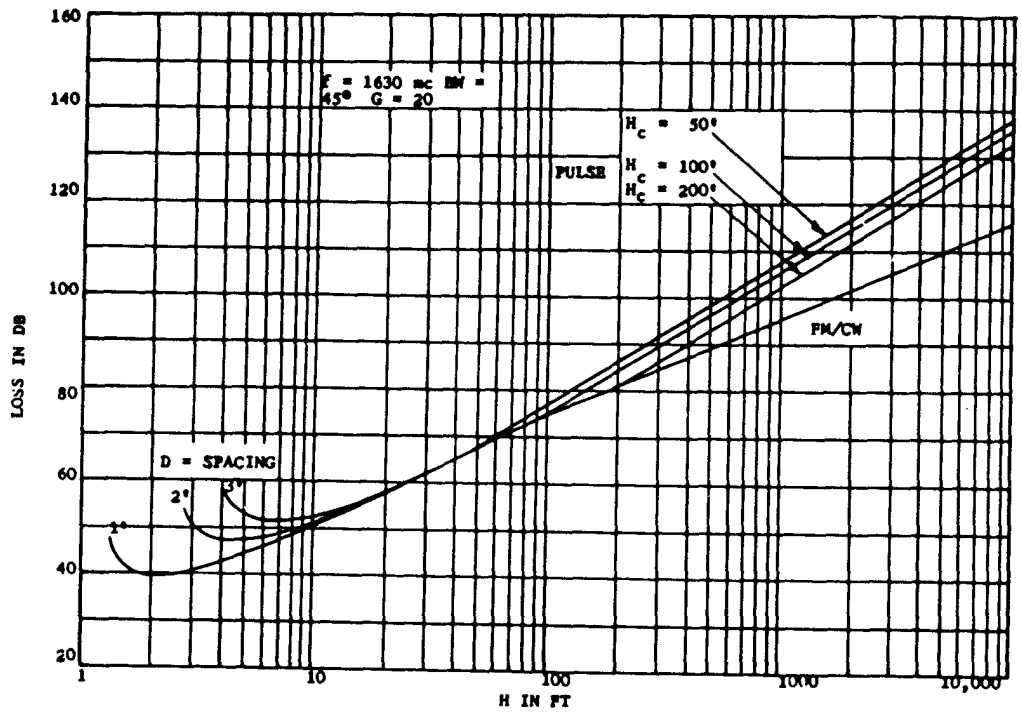

FIGURE 1—External loop loss.

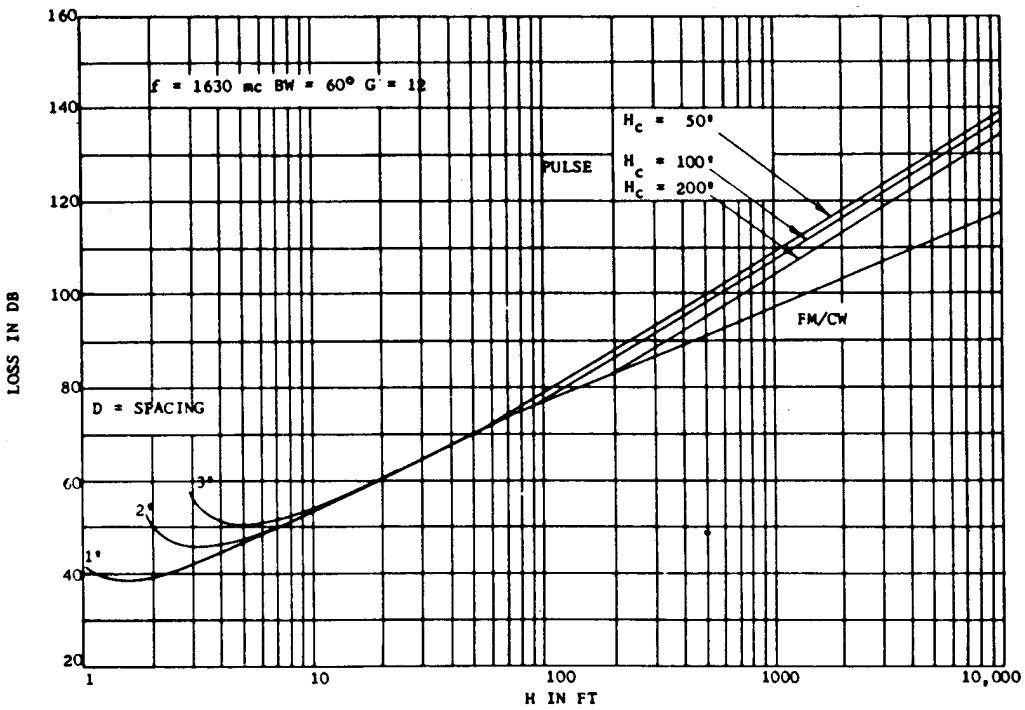

FIGURE 2—External loop loss.

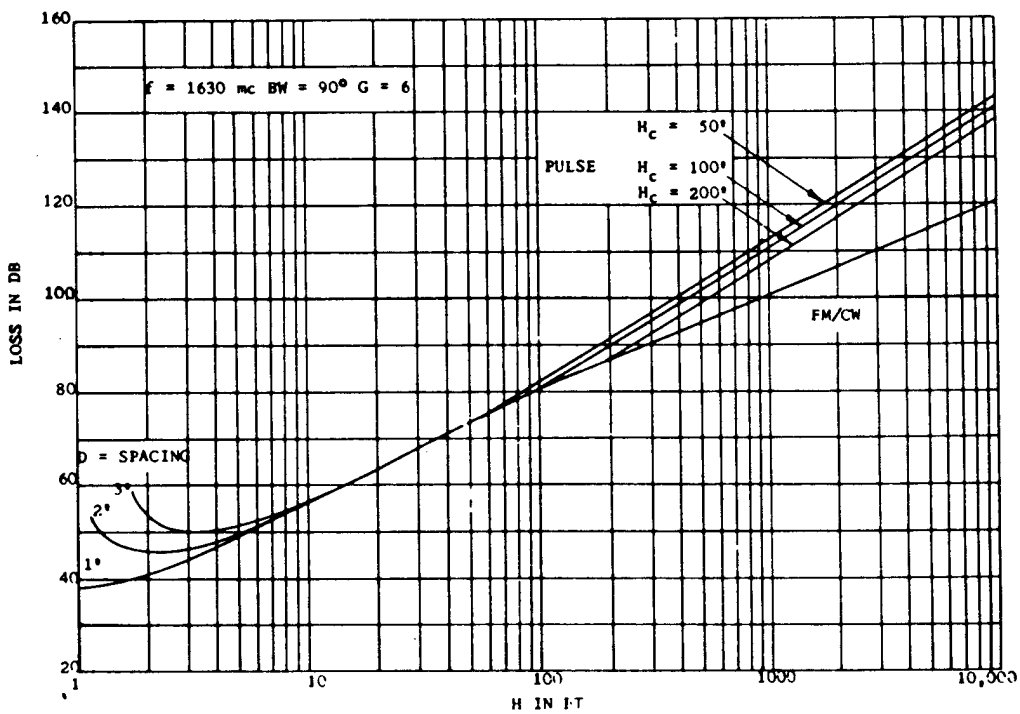

FIGURE 3—External loop loss.

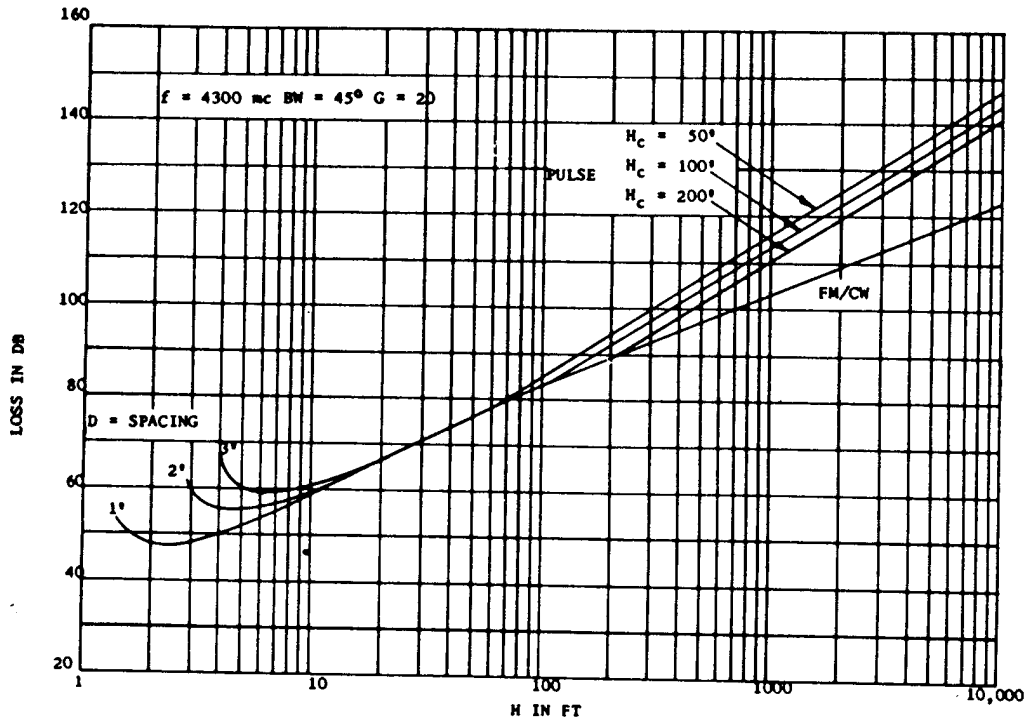

FIGURE 4—External loop loss.

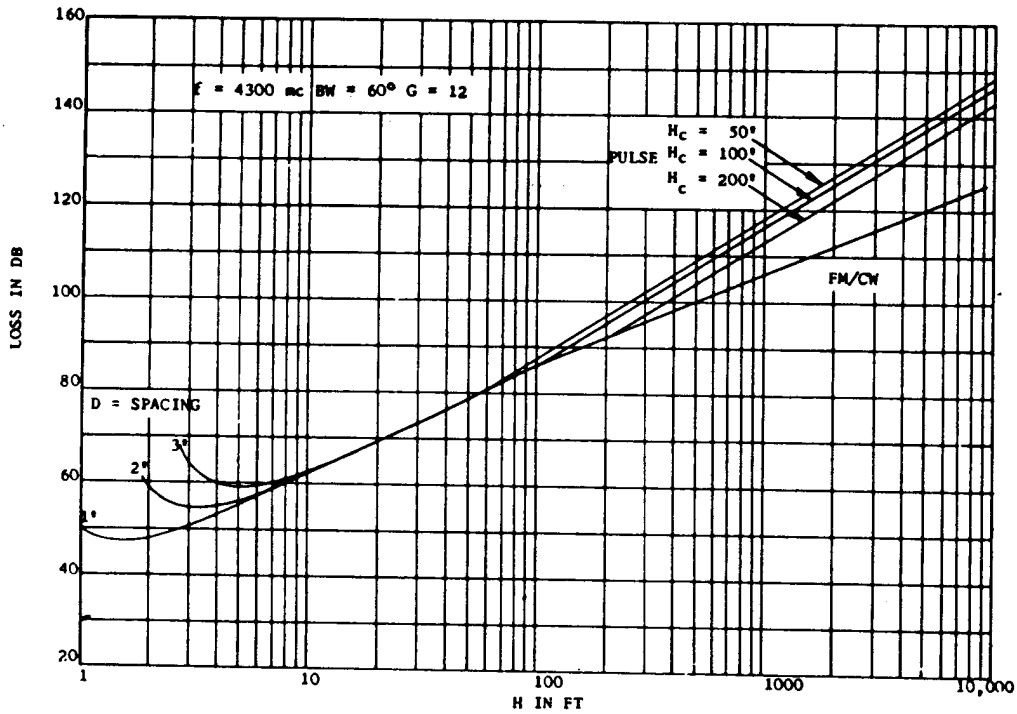

FIGURE 5—External loop loss.

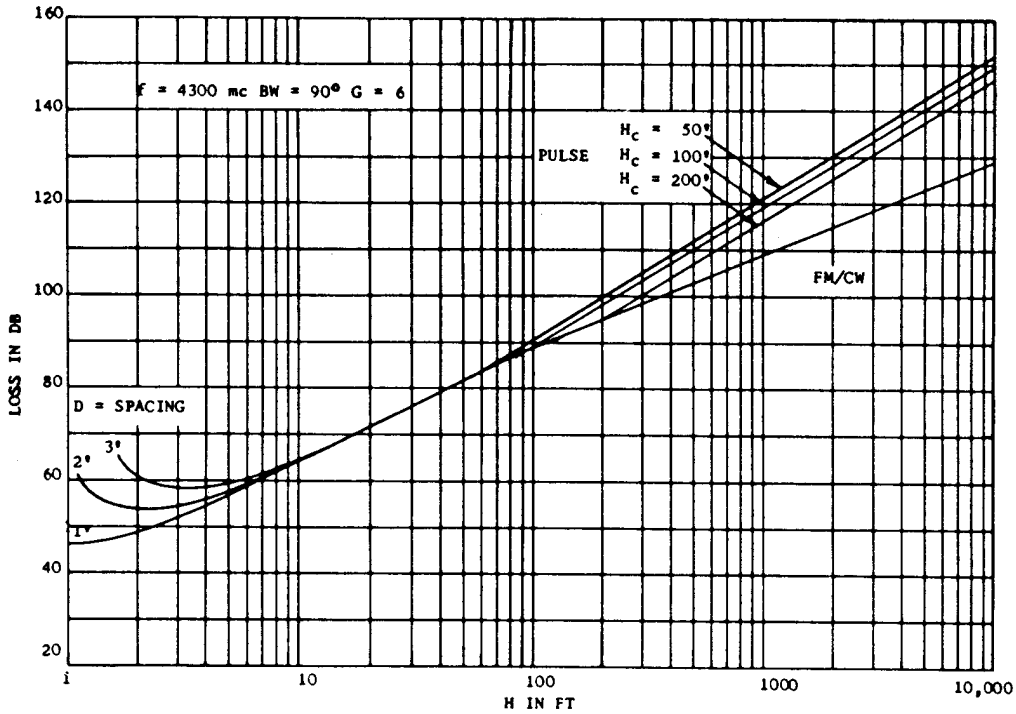

FIGURE 6—External loop loss.

FEDERAL AVIATION ADMINISTRATION DOCUMENT FOR ENVIRONMENTAL TEST PROCEDURES FOR AIRBORNE ELECTRONIC EQUIPMENT

1.0 Purpose.

This report sets forth Environmental Test Procedures applicable to airborne electronic equipment. The purpose of these tests is to provide a laboratory means of determining the performance characteristics of the equipment under conditions representative of those which may be encountered in actual aeronautical operations.

2.0 Definitions of Terms.

2.1 *Equipment Temperature Stabilization.* Equipment temperature stabilization is that condition wherein (1) the temperature of the largest internal mass is within ±3° C. of the specified value when the equipment is not operating, or (2) the crest temperatures of the largest internal mass do not differ by more than 5° C. when the equipment is operating.

2.2 *Maximum Duty Cycle.* Maximum duty cycle is the relationship between the maximum length of time for which an equipment is designed to deliver its rated output power and the length of time during which "standby" power only may be applied when such "ON-OFF" operation is periodic.

2.3 *Not operating.* Not operating is that condition wherein no power is applied to the equipment.

2.4 *Controlled Temperature Location.* Controlled temperature location is a space within a aircraft in which the temperature of the air is maintained, either manually or automatically, within the limits specified in the appropriate category of Table 1 of paragraph 4.0, Temperature-Altitude Test.

3.0 Conditions of Test.

3.1 *Connection of Equipment.* Connect the equipment mechanically and electrically as recommended by the manufacturer, including any cooling provisions, to the extent necessary to make such tests and measurements as are required to determine compliance with the applicable standards of paragraph 3.0, "Minimum Performance Standards under Environmental Test Conditions," of the appropriate FAA airborne electronic equipment Minimum Performance Standards.

3.2 *Order of Tests.* The tests may be conducted in any desired order, with the exception that the humidity test shall not be conducted prior to the temperature-altitude and the vibration tests. The purpose of this exception is to determine whether materials used to protect circuit elements from moisture have lost their protective function due to deterioration from exposure to either extreme temperatures or to vibration.

3.3 *Measurement of Temperature of Air in Test Chamber.*

a. The temperature of the air in the test chamber shall be measured at such a location within the test chamber that the temperature of the air so measured is representative of that immediately surrounding the equipment. Measurement of chamber wall temperature is not suitable, due to temperature lag and heat transfer through the chamber wall.

b. Means of circulating the air in the test chamber may be employed to approximate a uniform air temperature condition throughout the chamber. When such means are employed, the air blast shall not be directed upon the equipment under test.

3.4 *Ambient Room Temperature.* When tests are conducted under "ambient room temperature," the ambient room air temperature shall be between +10° C. and +40° C.

3.5 *Power Input Voltage.* Unless specified otherwise, all tests shall be conducted with the power input voltage adjusted to design voltage ±2 percent. The input voltage shall be measured at the equipment power input terminals.

3.6 *Power Input Frequency.*

a. In the case of equipment designed for operation from an a.c. power source of essentially constant frequency (e.g., 400 c.p.s.), the input frequency shall be adjusted to design frequency ±2 percent, unless otherwise specified.

b. In the case of equipment designed for operation from an a.c. power source of variable frequency (e.g., 300 to 1,000 c.p.s.), tests shall be conducted with the input frequency adjusted to within 5 percent of a selected frequency and within the input power frequency range for which the equipment is designed, unless otherwise specified.

4.0 Temperature-Altitude Test.

Several temperature-altitude test procedures are specified,* according to the category for which the equipment is designed to be used, as follows:

Category A—Equipment intended for installation in nonpressurized and noncontrolled temperature locations in aircraft which operate at altitudes up to 45,000 feet m.s.l.

Category B—Equipment intended for installation in nonpressurized and noncontrolled temperature locations in aircraft which operate at altitudes up to 30,000 feet m.s.l.

Category C—Equipment intended for installation in nonpressurized and noncontrolled temperature locations in aircraft which operate at altitudes up to 20,000 feet m.s.l.

Category D—Equipment intended for installation in controlled temperature and pressurized locations in aircraft in which the pressures are no lower than that which is equivalent to an altitude of 15,000 feet m.s.l.

Category E—Equipment intended for installation in nonpressurized but controlled temperature locations in aircraft which operate at altitudes up to 20,000 feet m.s.l.

Category F—Equipment intended for installation in nonpressurized but controlled temperature locations in aircraft which operate at altitudes up to 12,000 feet m.s.l.

4.1 *Test Procedure (Low Temperature).* Stabilize the equipment temperature at the appropriate (depending upon category used) Low Not Operating Temperature specified in Table 1 at ambient room atmospheric pressure, with equipment not operating* Maintain this stablized temperature for 30 minutes: then stablize the equipment temperature at the appropriate Low Operating Temperature specified in Table 1 at ambient room atmospheric pressure, with the equipment not operating. Then operate the equipment at maximum duty cycle for a period of 15 minutes, beginning with the "ON" cycle in the case of equipment designed for intermittent duty service. Maintain the temperature of the air in the test chamber within 3° C. of the Low Operating Temperature of Table 1. Determine the compliance with the applicable standards of paragraph 3.0 "Minimum Performance Standards under Environmental Test Conditions" of the appropriate FAA airborne electronic equipment Minimum Performance Standards.**

4.2 *Test Procedure (High Temperature).*

a. At ambient room pressure, with the equipment not operating, stabilize the equipment temperature to within 3° C. of the appropriate High Not Operating Temperature of Table 1. After 30 minutes, adjust the test chamber air temperature to within 3° C. of the High Short-time Operating Temperature specified in Table 1. Operate the equipment at maximum duty cycle for 30 minutes. Determine compliance with the applicable standards of paragraph 3.0, "Minimum Performance Standards under Environmental Test Conditions," of the appropriate FAA airborne electronic equipment Minimum Performance Standards during this 30-minute period.

NOTE: The purpose of this test is to simulate temperature conditions which may be encountered in aircraft while on the ground in certain geographical areas.

b. With the equipment operating, adjust the test chamber air temperature to within 3° C. of the appropriate High Operating Temperature specified in Table 1 at ambient room pressure. After the equip-

* The temperature-altitude test and the temperature variation test may be combined, if desired. See paragraph 8.1, Alternate Test Procedure.

*This is not intended to be a temperature shock test The rate at which the temperature of the equipment under test is reduced from ambient to the appropriate Low Not Operating Temperature specified in Table 1 is optional.

**Optionally, the tests specified in this paragraph (4.1.) may be commenced with the initial temperature of the equipment at any value between the appropriate Operating and Low Not Operating Temperatures specified in Table 1.

TABLE 1.—Altitude-Temperature Criteria

Condition		Cat. A	Cat. B	Cat. C	Cat. D	Cat. E	Cat. F
Maximum operating altitude		45,000′	30,000′	20,000′	*15,000	20,000′	12,000′
Test altitude		55,000′	35,000′	25,000′	*20,000	25,000′	15,000′
Decompression test altitude		----------	----------	----------	40,000′	----------	----------
Not operating temperature	Low	−62° C.	−50° C.	−50° C.	−50° C.	−40° C.	−40° C.
	High	+71° C.	+71° C.	+71° C.	+71° C.	+71° C.	+71° C.
Short-time operating high temperature.		+71° C.	+71° C.	+71° C.	+60° C.	+50° C.	+45° C.
Operation temperature.	Low	−54° C.	−46° C.	−40° C.	−15° C.	−15° C.	−15° C.
	High	+55° C.	+55° C.	+55° C.	+55° C.	+40° C.	+40° C.

*The maximum operating altitude and test altitude of Cat. D equipment represent atmospheres established by pressurization.

ment temperature has become stabilized, operate the equipment for two (2) hours and determine compliance with the applicable standards of Paragraph 3.0, "Minimum Performance Standards under Environmental Test Conditions," of the appropriate FAA airborne electronic equipment Minimum Performance Standards.

4.3 *Test Procedure (Altitude).*

a. Operate the equipment at maximum duty cycle. Decrease the atmospheric pressure to within 5 percent of the appropriate Test Altitude specified in Table 1. Conduct this test at ambient room temperature. Determine compliance with the applicable standards of Paragraph 3.0, "Minimum Performance Standards under Environmental Test Conditions," of the appropriate FAA airborne electronic equipment Minimum Performance Standards.

b. This test is intended for application only to Category D equipment. With the equipment operating at the Test Altitude specified in Table 1, reduce the atmospheric pressure to that equivalent to the Decompression Test Altitude specified in Table 1. This reduction in pressure shall be effected within a time period not to exceed 15 seconds. Maintain this reduced pressure for at least 10 minutes, then increase the pressure to that equivalent to the Test Altitude specified in Table 1. Conduct this test at ambient room temperature. Determine compliance with the applicable standards of paragraph 3.0, "Minimum Performance Standards under Environmental Test Conditions," of the appropriate FAA airborne electronic equipment Minimum Performance Standards.

5.0 Humidity Test.

Subject the equipment to an atmosphere having a relative humidity of between 95 percent and 100 percent and an ambient temperature of 50° C. ±3° C. for a period of 48 hours. During this 48-hour period, no electrical or mechanical power shall be applied to the equipment. At least once each hour, the relative humidity shall be 100 percent with condensation on the equipment. At the end of the 48-hour exposure period, remove the equipment from the test chamber and drain off (do not wipe) any condensed moisture. Within 5 minutes after removal of the equipment from the test chamber, apply standard primary test voltage(s) to the equipment. Allow 15 minutes following the application of primary power for the equipment to warmup. Immediately following the warmup period, determine compliance with the applicable standards of paragraph 3.0, "Minimum Performance Standards under Environmental Test Conditions" of the appropriate FAA airborne electronic equipment Minimum Performance Standards.

6.0 Shock Test.

6.1 *Operational Shocks.*

a. Secure the equipment to a shock table by the mounting means intended for use in service installations. Apply to the shock table, with the equipment mounted in each of the following six positions, three shocks each having a peak acceleration of at least 6G and a time duration of at least 10 milliseconds.

(1) Normal upright.

(2) Suspended upside down.

(3) At positions such that the longitudinal axis of the equipment sucessively forms angles of plus 90° and minus 90° (two positions) with the plane of the table.

(4) At positions such that the lateral axis of the equipment successively forms angles of plus 90° and minus 90° (two positions) with the plane of the table.

b. After application of the shocks, determine compliance with the applicable standards of paragraph 3.0, "Minimum Performance Standards under Environmental Test Conditions" of the appropriate FAA airborne electronic equipment Minimum Performance Standards.

6.2 *Crash Safety Shocks.* Apply, in each of the six equipment positions listed in paragraph 6.1, one shock having a peak acceleration of at least 15G and a time duration of at least 10 milliseconds. After application of the six shocks, determine compliance with the applicable standards of paragraph 3.0, "Minimum Performance Standards under Environmental Test Conditions" of the appropriate FAA airborne electronic equipment Minimum Performance Standards.

NOTE: During this test, an equivalent weight may be substituted for the electrical and mechanical components normally mounted within or on the equipment case. Such equivalent weight shall approximate the weight of the components which it replaces and shall be so located that the center of gravity of the equipment is essentially unchanged. The equivalent weight shall not contribute to the strength of the equipment case or its mounting fastenings to a greater extent than the components it replaces.

7.0 Vibration Test.

7.1 *Test Procedure.*

a. So secure the equipment under test to a vibration table that sinusoidal vibratory motion is exerted parallel to the longitudinal* axis of the equipment. The equipment shall be affixed to the vibration table by the means specified by the equipment manufacturer for service installations. Connect the equipment for proper operation. Start it operating in its principal mode. (Multipurpose equipments, such as transceivers, shall be tested in all modes.)

b. With the equipment operating, vary the vibration frequency from 10 to 55 to 10 c.p.s. in a time period of from 1 to 3 minutes** at an amplitude appropriate to the category of equipment under test. (Refer to Table 2). Continue vibrating the equipment in this manner for a period of at least ninety (90) minutes.

c. Determine compliance with the applicable standards of paragraph 3.0 "Minimum Performance Standards under Environmental Test Conditions" of the appropriate FAA airborne electronic equipment Minimum Performance Standards.

d. Repeat the procedures specified in paragraphs 7.1 *a.*, *b.*, and *c.*, with the vibratory motion applied in a direction parallel to the lateral axis of the equipment.

e. Repeat the procedures specified in paragraphs 7.1 *a.*, *b.*, and *c.*, with the vibratory motion applied in a direction parallel to the vertical axis of the equipment.

f. If the equipment is to be tested under a vibration category which requires vibration tests in the 55 to 500 cycle frequency range, repeat all of the above test procedures, but starting at 55 cycles and running to 500 cycles, and returning to 55 cycles with the excursion so adjusted for each frequency as to produce the constant acceleration figure specified in Table 2.*

TABLE 2.—CATEGORIZATION OF AIRCRAFT VIBRATION CHARACTERISTICS BY AIRCRAFT TYPES AND LOCATIONS THEREIN

Aircraft description	Fuselage	Instrument panels (vibration protected or otherwise) and isolated racks	Any location not specified
Rotary wing aircraft	A	F	A
Turbo engine fixed wing aircraft	B	C	A
Piston engine fixed wing aircraft, heavy multi-engine type (over 12,500 lbs.)	E	F	D
Piston engine fixed wing aircraft, light multi-engine type (under 12,500 lbs.)	F	F	E
Piston engine fixed wing aircraft, light single engine type (under 12,500 lbs.)	F	F	F

7.2 *Vibration Characteristics of Categories:*

Category A—Constant total excursion of 0.030" from 10 to 55 c.p.s. with a maximum acceleration of 5G; and Constant acceleration of 5G from 55 to 500 c.p.s.

Category B—Constant total excursion of 0.020" from 10 to 55 c.p.s. with a maximum acceleration of 3G; and Constant acceleration of 1.5G from 55 to 500 c.p.s.

Category C—Constant total excursion of 0.010" from 10 to 55 c.p.s. with a maximum acceleration of 1.5G; and Constant acceleration of 0.25G from 55 to 500 c.p.s.

Category D—Constant total excursion of 0.030" from 10 to 55 c.p.s. with a maximum acceleration of 5G.

* Optionally, vibratory motion may be first applied to any axis of the equipment, i.e., lateral, vertical or longitudinal. Any sequence thereafter is permissible.

** Either a linear or logarithmic sweep (scan) may be used.

*Optionally, the tests specified in paragraphs 7.1 *a.*, *b.*, *c.*, *d.*, *e.*, and *f.*, may be combined, if desired, with a total sweep time of from 2 to 6 minutes and a total time of 180 minutes.

Category E—Constant total excursion of 0.020" from 10 to 55 c.p.s. with a maximum acceleration of 3G.

Category F—Constant total excursion of 0.010" from 10 to 55 c.p.s. with a maximum acceleration of 1.5G.

8.0 Temperature Variation Test.

Stabilize the equipment temperature at the appropriate Operating Low Temperature specified in Table 1, at ambient room atmospheric pressure with the equipment not operating.* Operate the equipment at maximum duty cycle for a period of 15 minutes, beginning with "ON" cycle in the case of equipment designed for intermittent duty service, with the voltage and frequency of the primary power source adjusted to standard values. Increase the temperature of the air in the test chamber to the Operating High Temperature specified in Table 1, at a rate** not exceeding 1° C. per minute. In the interval between the time that the equipment temperature stabilizes at the appropriate Operating Low Temperature and the time it stabilizes at the appropriate Operating High Temperature, determine compliance with the applicable standards of paragraph 3.0, "Minimum Performance Standards Under Environmental Test Conditions" of the appropriate FAA Airborne Electronic Equipment Minimum Performance Standards.

8.1 *Alternate Test Procedure.* It is permissible to combine the temperature variation test and the temperature-altitude test. In this case, proceed as follows:

(1) Conduct that portion of the temperature-altitude test specified in paragraph 4.1.

(2) Increase the temperature of the air in the test Chamber to the High Operating Temperature specified in the applicable category of Table 1 at a rate*** not exceeding 1° C. per minute. In the interval between the time that the equipment temperature stabilizes at the appropriate Low Operating Temperature and the time it stabilizes at the appropriate High Extended-time Operation Temperature, determine compliance with the applicable standards of paragraph 3.0, "Minimum Performance Standards under Environmental Test Conditions," of the appropriate FAA Airborne Electronic Equipment Minimum Performance Standards.

(3) Conduct those portions of the Temperature-Altitude Test specified in paragraphs 4.2*a*. through 4.3*b*.

* The purpose of this test is to determine certain performance characteristics of the equipment at various temperatures between the Operating Low Temperature and the Extended-time Operation High Temperature specified in the applicable Category of Table 1.

** If desired, this rate may, if necessary, be reduced to zero to permit measurements to be taken.

*** If desired, this rate may, if necessary, be reduced to zero to permit measurements to be taken.

9.0 Power Input Test.

9.1 *Power Input Variation Test.*

a. Adjust the primary power input as follows:

(1) In the case of equipment designed to operate from a d.c. power source, adjust the primary power voltage to 110 percent of the design voltage.

(2) In the case of equipment designed to operate from a.c. primary power sources of essentially constant frequency, such as 400 c.p.s. adjust the primary power voltage to 110 percent of the design voltage and the frequency to 105 percent of design frequency. The crest factor shall be 1.4, ±10 percent.

(3) In the case of equipment designed to operate from a.c. primary power sources of variable frequency, such as 300 to 1,000 c.p.s, adjust the primary power voltage to 110 percent of design voltage and the frequency to the highest for which the equipment is designed. The crest factor shall be 1.4, ±10 percent.

NOTE: For the purposes of this test, equipment which derives a.c. power from an inverter provided exclusively for the equipment shall be considered as d.c. operated.

b. Operate the equipment at maximum duty cycle for 30 minutes, with the primary power adjusted as specified in paragraph 9.1*a*. Determine compliance with the applicable standards of paragraph 3.0, "Minimum Performance Standards under Environmental Test Conditions," of the appropriate FAA airborne electronic equipment Minimum Performance Standards during this 30-minute period.

c. Adjust the primary power input as follows:

(1) In the case of equipment designed to operate from a d.c. power source, adjust the primary power voltage to 90 percent of the design voltage.

(2) In the case of equipment designed to operate from a.c. primary power sources of essentially constant frequency, such as 400 c.p.s., adjust the primary power voltage to 90 percent of the design voltage and the frequency to no higher than 95 percent of design frequency. The crest factor shall be 1.4 ±10 percent.

(3) In the case of equipment designed to operate from a.c. primary power sources of variable frequency, such as 300 to 1,000 c.p.s., adjust the primary power voltage to 90 percent of design voltage and the frequency to the lowest for which the equipment is designed. The crest factor shall be 1.4 ±10 percent.

NOTE: For the purposes of this test, equipment which derives a.c. power from an inverter provided exclusively for the equipment shall be considered as d.c. operated.

d. Operate the equipment at maximum duty cycle for a period of 30 minutes with the primary power adjusted as specified in paragraph 9.1*c*. Determine compliance with the applicable standards of paragraph 3.0 "Minimum Performance Standards under Environmental Test Conditions" of the appropriate FAA airborne electronic equipment Minimum Performance Standards during this 30-minute period.

9.2 *Low Voltage Test.*

a. A.C. and D.C. Equipments. Operate the equipment at maximum duty cycle for a period of at least 30 minutes at an input power voltage(s) 80 percent of standard test voltage(s) in the case of d.c. equipment, or 87½ percent of standard test voltage(s) in the case of a.c. equipment. During this period, determine compliance with the applicable standards of paragraph 3.0, "Minimum Performance Standards under Environmental Test Conditions," of the appropriate FAA Airborne Electronic Minimum Performance Standards.

b. D.C. Equipments.

(1) With the equipment operating, decrease the input power voltage(s) from 80 percent of standard test voltage(s) to 50 percent of standard test voltage(s) at a rate not greater than 2 percent of the standard test voltage(s) per minute and continue operating the equipment for a period of at least 10 minutes at the 50 percent input power level. With the equipment still operating, adjust the input power voltage(s) to 100 percent of standard test voltage(s) and determine compliance with the applicable standards of paragraph 3.0, "Minimum Performance Standards under Environmental Test Conditions," of the appropriate FAA Airborne Electronic Minimum Performance Standards.*

(2) With the equipment operating, reduce the input power voltage(s) from 100 percent to 50 percent of standard test voltage(s) and continue the reduction of the input power voltage(s) from the 50 percent level to zero input voltage(s) at a rate not greater than 2 percent of the standard test voltage(s) per minute. Determine compliance with the applicable standards of paragraph 3.0, "Minimum Performance Standards under Environmental Test Conditions," of the appropriate FAA Airborne Electronic Minimum Performance Standards.**

NOTE: For the purposes of this test, equipment which derives a.c. power from an inverter provided exclusively for the equipment shall be considered as d.c. operated.

10.0 Conducted Voltage Transient Test.

10.1 *Intermittent Transients.* With the equipment operating at its normal input voltage(s), apply to each of the d.c. primary input power leads a series of positive and negative voltage transients having the characteristics (amplitude and wave form) appropriate to the applicable normal d.c. input voltages specified in Figure 1, for a period of at least ten (10) seconds and at a rate of not less than two (2) transients per second. Immediately after the 10-second period, determine compliance with the applicable standards of paragraph 3.0, "Minimum Performance Standards under Environmental Test Conditions," of the appropriate FAA Airborne Electronic Equipment Minimum Performance Standards. The positive and negative transients should be developed, applied and monitored in a manner similar to that shown in Figures 2 and 3.

10.2 *Repetitive Transients.* With the equipment operating at its normal input voltage(s), apply to each of the d.c. primary input power leads a series of positive voltage transients having the characteristics (amplitude and wave form) appropriate to the applicable normal d.c. input voltages specified in Figure 1 at a rate of not less than two (2) transients per second and, simultaneously, determine compliance with the applicable standards of paragraph 3.0, "Minimum Peformance Standards under Environmental Test Conditions" of the appropriate FAA Airborne Electronic Equipment Minimum Performance Standards. The positive voltage transients should be developed, applied and monitored in a manner similar to that shown in Figure 2.*

11.0 Conducted Audio-Frequency Susceptibility Test.

11.1 *D.C. Input Power Leads.* Apply a sine wave audio frequency signal in series with each ungrounded d.c. input power lead. While varying the audio frequency of the applied signal between 200 and 20,000 cycles per second, maintain the r.m.s. amplitude of this signal at not less than 5 percent of the nominal d.c. input voltage and determine compliance with the applicable standards of paragraph 3.0, "Minimum Performance Standards Under Environmental Test Conditions" of the appropriate FAA Airborne Eelectronic Equipment Minimum Performance Standards. When conducting this test, all equipment interconnecting cables and RF transmission lines shall be in accordance with the manufacturer's installation wiring diagram and shall use shielded or twisted wires only where specified. Where no length of interconnecting cables is specified, the cables shall be at least five (5) feet long. Any inputs or outputs from or to other equipment(s) normally associated with the equipment under test shall be adequately simulated.

11.2 *A.C. Input Power Leads.* Apply a sine wave audio frequency signal in series with each ungrounded a.c. input power lead. With the frequency of this signal successively adjusted to the second harmonic of the a.c. power frequency and to each next higher order harmonic up to 9,000 cycles, maintain the r.m.s. amplitude of this signal at not less than 5 percent of the nominal a.c. input voltage and determine compliance with the applicable standards of paragraph 3.0 "Minimum Performance Stand-

* The purpose of this test is to determine those conditions resulting from decreased voltage(s) (such as relay chatter), the presence or continuation of which would contribute to malfunctioning of the equipment at standard test voltage(s).

** The purpose of this test is to determine whether the reduction of the input power voltage(s) from standard test voltage(s) to zero input voltage(s) produces evidence, external to the equipment, of smoke or fire.

* This test applies to equipment designed to utilize d.c. primary power which is furnished by the aircraft's electrical system. Equipment designed to operate solely on a.c. primary power need not be subjected to this test.

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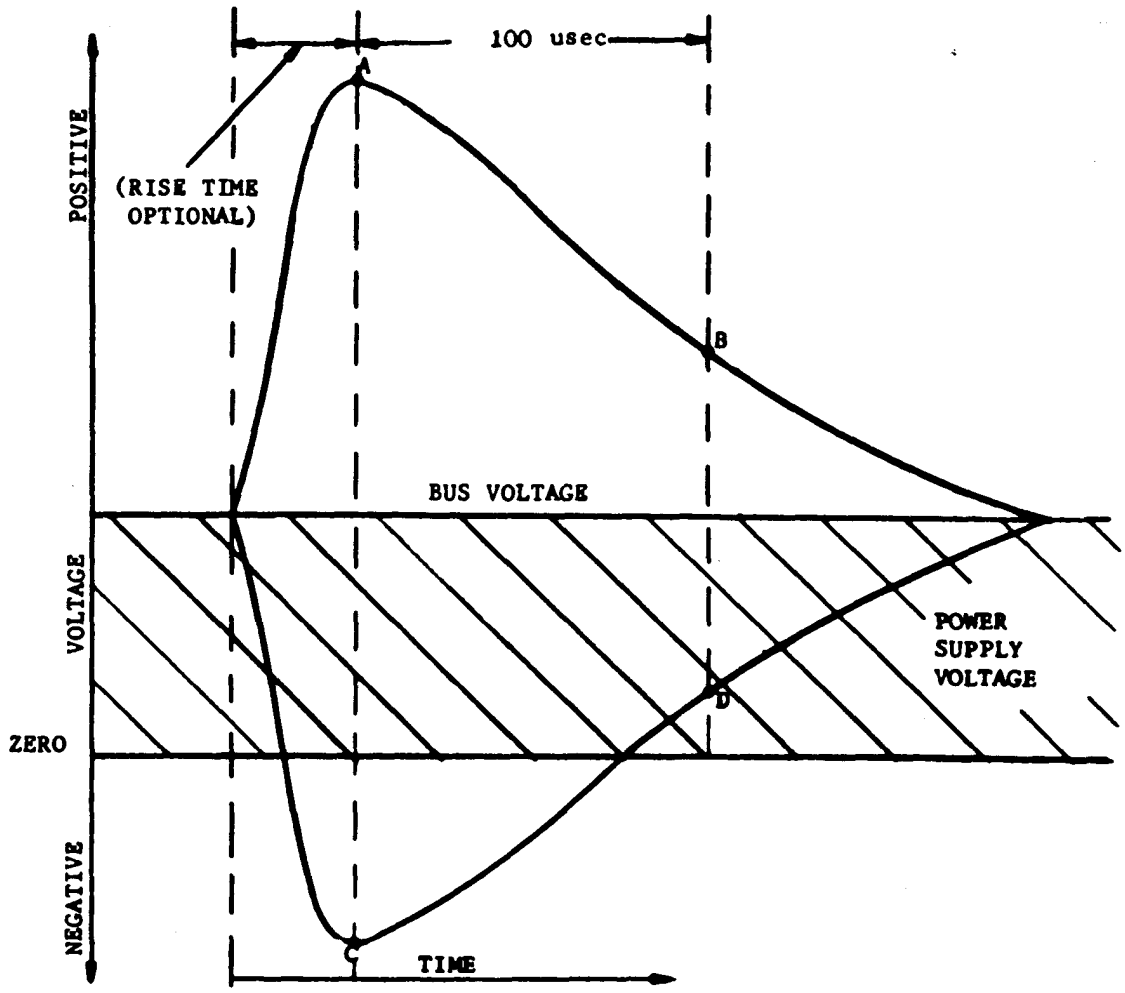


Normal Bus Voltage	Intermittent Transient Test Voltage		Repetitive Transient Test Voltage	
	Point A	Point B	Point A	Point B
28	+78	+46	+48	+35
14	+39	+23	+24	+17
	Point C	Point D		
28	-22	+10		
14	-11	+5		

FIGURE 1—Transient voltage characteristics.

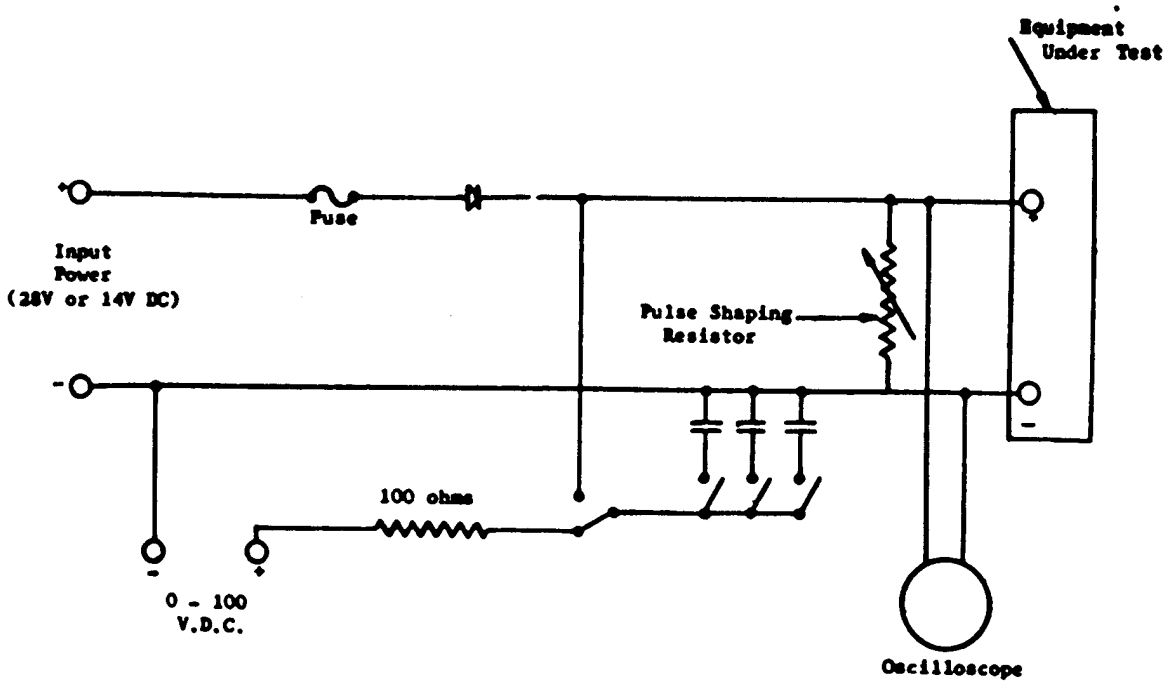


FIGURE 2—Positive pulse generating network.

ards Under Environmental Test Conditions" of the appropriate FAA Airborne Electronic Equipment Minimum Performance Standards. When conducting this test, all equipment interconnecting cables and RF transmission lines shall be in accordance with the manufacturer's installation wiring diagram and shall use shielded or twisted wires only where specified. Where no length of interconnecting cables is specified, the cables shall be at least five (5) feet long. Any inputs or outputs from or to other equipment(s) normally associated with the equipment under test shall be adequately simulated.

12.0 Audio Frequency Magnetic Field Susceptibility Test.

12.1 *Categories of Equipment.* For the purpose of this test, equipment is categorized as follows:

Category A—Equipment which is intended for installation in an aircraft which has an a.c. power source having a rating of 250 VA (volt-amperes) or greater.

Category B—Equipment which is intended for installation in an aircraft which has an a.c. power source having a rating of less than 250 VA, or which has no a.c. power source whatever.

12.2 *Test Procedure.*

Category A—Expose the equipment under test to an audio frequency magnetic field which is generated by a 400 c.p.s. current of at least 20 amperes (r.m.s.) flowing in a straight wire radiator, which is within 12 inches of the periphery of the unit of equipment under test, and determine compliance with the applicable standards of paragraph 3.0 "Minimum Performance Standards Under Environmental Test Conditions" of the appropriate FAA Airborne Electronic Equipment Minimum Performance Standards. During this test, the radiator shall be so oriented with respect to each external surface of each unit as to cause maximum interference. The length of the radiator shall be such that it extends a distance of at least 2 feet (laterally) beyond the exposed surface of the unit under test. The leads supplying current to the radiator shall be routed at least 2 feet away from any part of the unit under test and from the radiator itself. All units of the equipment under test shall be individually tested.

Category B—No test of Category B equipment is required.

13.0 Radio Frequency Susceptibility Test (Radiated and Conducted).

For the purposes of this test,* equipment is categorized as follows:

Category A—Equipment which is intended for installation in aircraft having a Maximum Weight of more than 12,500 pounds.

Category B—Equipment which in intended for installation in aircraft having a Maximum Weight of 12,500 pounds, or less.

* See "Introduction" of Appendix A for information on the relationship between the emission of spurious radio frequency energy from electrical and electronic equipment installed in an aircraft and the levels of radio frequency susceptibility signals used in this test procedure.

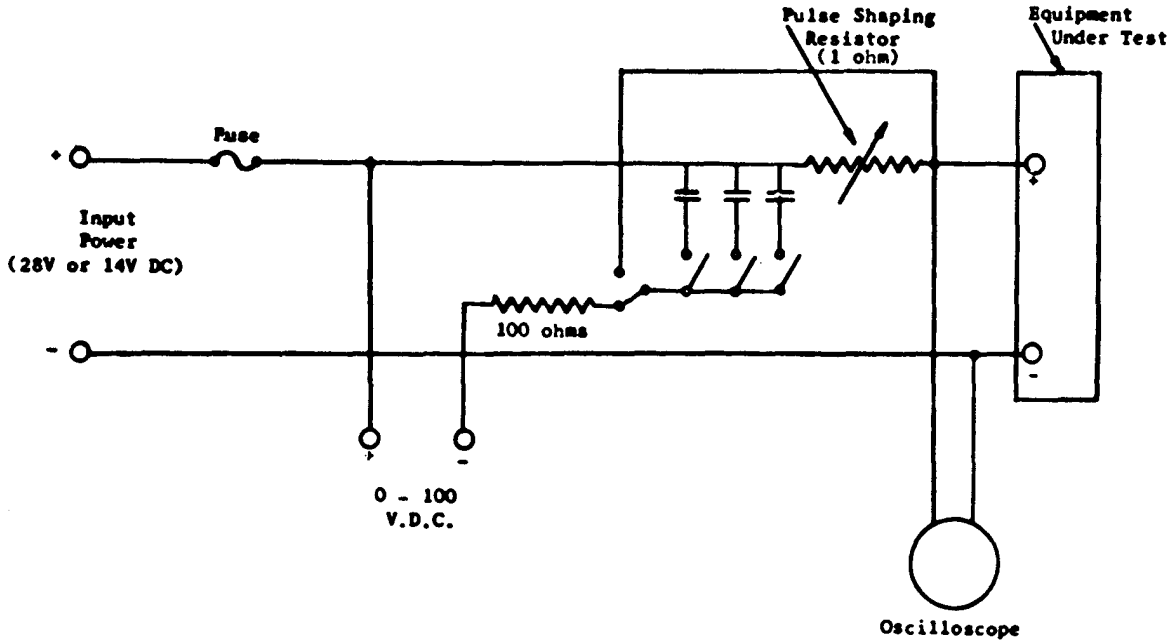


FIGURE 3—Negative pulse generating network.

13.1 *General Requirements.*

(*a*) The equipment under test shall be set up on a ground plane and operated in accordance with the following criteria:

(1) Ground Plane.—A copper or brass ground plane, 0.01 inch thick minimum for copper, 0.025 inch thick minimum for brass, 12-square feet or more in area with a minimum width of 30 inches, shall be used. In all cases where a shielded room is employed, the ground plane shall be bonded to the shielded room at intervals no greater than 3 feet, and at both ends of the ground plane.

(2) Shock and Vibration Isolators.—The equipment under test shall be secured to mounting bases incorporating shock or vibration isolators, if such mounting bases are specified by the equipment manufacturer. The bonding straps furnished with the mounting base shall be connected to the ground plane. Where mounting bases do not incorporate bonding straps, bonding straps shall not be used in the test setup.

(3) Bonding.—Only the provisions included in the design of the equipment and specified in the installation instructions shall be used to bond units, such as equipment case and mount, together or to the ground plane. Where bonding straps are required to complete the test setup they shall have a length not greater than 5 times the width, shall have a minimum thickness of 0.025 inch, and shall be copper or brass metal straps, not braid. Connections made with such bond straps shall have clean metal-to-metal contact.

(4) External Ground Terminal.—When an external terminal is available for a ground connection on the equipment under test, this terminal shall be connected to the ground plane if the terminal is normally grounded in the installation. If the installation conditions are unknown, the terminal shall not be grounded.

(5) Interconnecting Cables.—All equipment interconnecting cables and RF transmission lines shall be in accordance with the manufacturer's installation wiring diagram and shall use shielded or twisted wires only where specified. Where no length of interconnecting cables is specified, the cables shall be at least five (5) feet long. Any inputs or outputs from or to other equipment associated with the equipment under test shall be adequately simulated.

(6) Dummy Antennas.—The dummy antenna shall have electrical characteristics which closely simulate those of the normal antenna, and should be shielded. It shall contain electrical components which are used in the normal antenna (such as filters, crystal diodes, synchros, motors, etc.).

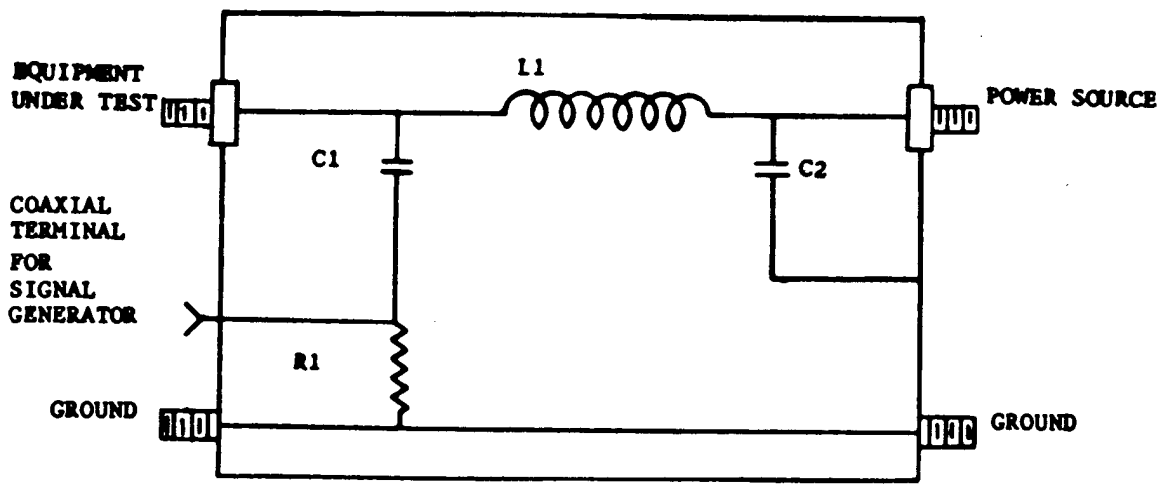
b. Test instruments shall be set up and operated in accordance with the following criteria:

(1) Bonding.—Interference meters used for measurement during the "conducted" test shall not be bonded to the ground plane except through the interconnecting coaxial cable. The counterpoise on rod antennas shall be bonded to the ground plane with a strap of such length that the rod antenna

can be positioned correctly. The strap shall be as wide as the counterpoise.

(2) Powerline Stabilization Network.—One stabilization network shall be inserted in each ungrounded primary input power lead of the equipment under test. The network enclosure shall be bonded to the ground plane. The network shall be constructed in accordance with Figure 4. The input impedance characteristics of the stabilization network are shown in Figure 5.

(3) Antenna Orientation and Positioning in Shielded Enclosures.—The rod or dipole antenna shall be located as shown in Figures 6 or 7. The rod antenna shall be so placed that the antenna is in a vertical position. The rod antenna shall be located at the point where maximum radiation pickup is obtained when it is moved along a line parallel with the edge of the ground plane. Those measurements which use a resonate dipole antenna shall have the dipole positioned parallel with the edge of the ground plane. The dipole antenna shall be centered 12 inches ±1 inch above the level of the ground plane. The rod or the dipole antenna shall be located at the distance from the equipment under test specified in Figures 6 and 7. When the dimensions of the dipole antenna become smaller than the test layout, the antenna shall be moved parallel to the edge of the ground plane to keep its sensitive elements adjacent to the point of maximum radiation. At frequencies from 25 up to and including 35 megacycles, the measurements shall be taken with the dipole antenna adjusted to resonance at 35 megacycles. The dipole antenna shall be adjusted to resonance at all frequencies above 35 mega-



ENCLOSURE DATA: 14 GAGE (B & S) ALUMINUM SUGGESTED SIZE 9¾ IN. BY 4 BY 4 IN.
FORM DATA: 5¼ IN. LENGTH, 3 IN. DIA (OD), .125 IN. WALL DRILL ⅜ IN. HOLE 7/16 IN. FROM EACH END.
COIL DATA: L1=5 MICROHENRIES, 13 TURNS SINGLE LAYER, 4 IN. WINDING LENGTH.
WIRE DATA: AWG 6, 600 VOLT, .310 IN. DIA (OD). (FOR 50 AMPERE NETWORK.)
CAPACITOR: C1 SHALL BE MOUNTED ON 1 IN. INSULATING BLOCK ABOVE GROUND.
CAPACITOR DATA: C1=.1 UF, 600-VOLT DC, BATHTUB.
C2=1 UF, 600-VOLT DC, BATHTUB, SINGLE TERMINAL CASE MOUNTED ON GROUND.
RESISTOR DATA: R1=5,000-OHM, 5-WATT CARBON.

1. The values given for the component parts of the network are nominal. Regardless of the construction or deviation from nominal values, the network must have an impedance within 20 percent of that given in Figure 5.
2. Connecting leads to condensers and resistors should be as nearly as possible to zero length.
3. Networks may also be constructed having a 1-ohm series resistor between the line and capacitor C2. This 1-ohm resistor shall be made up from ten 10-ohm, 1-watt composition resistors.
4. The data given in this figure is suitable for the construction of 50-ampere networks. Other current-carrying networks may be constructed by changing the wire size given for the coil and the size of the over-all enclosure.
5. The 50-ohm transmission line should be extended within the enclosure right up to the location where it connects with capacitor C1.

FIGURE 4—Powerline stabilization network schematic diagram.

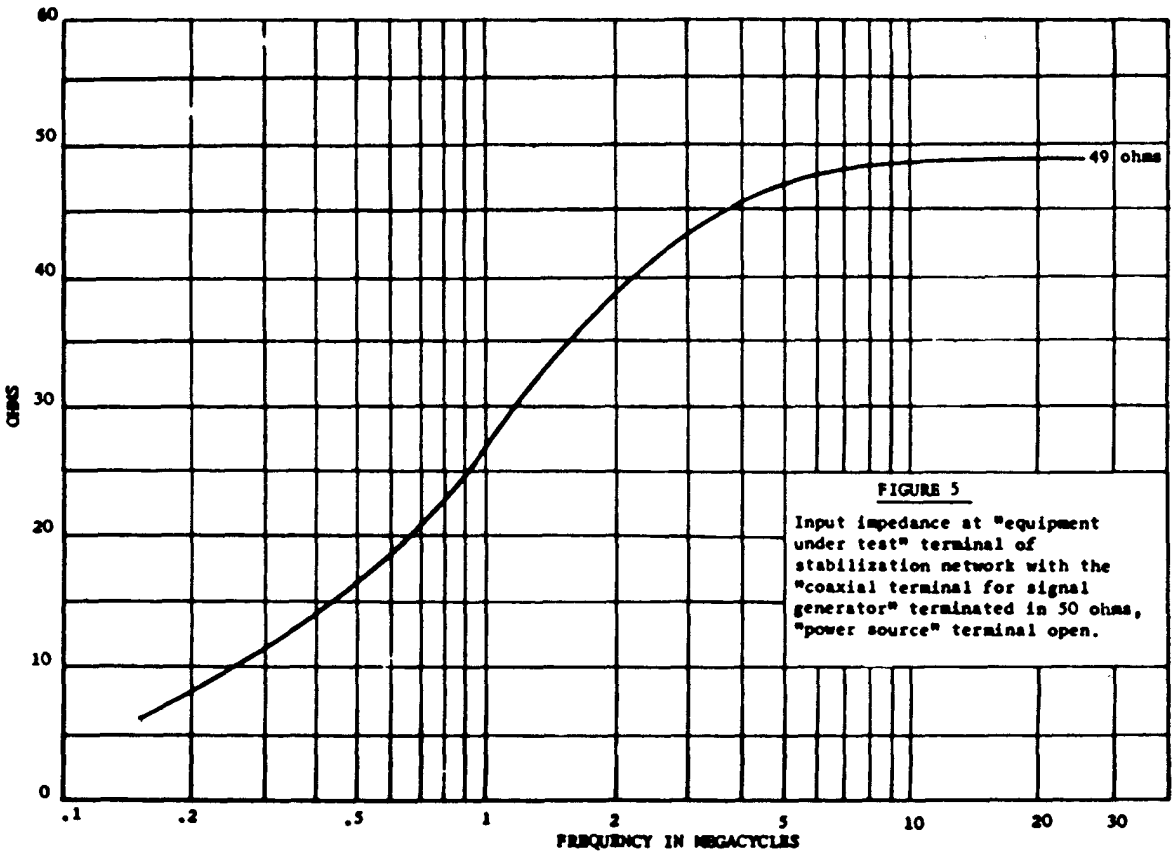


FIGURE 5

Input impedance at "equipment under test" terminal of stabilization network with the "coaxial terminal for signal generator" terminated in 50 ohms, "power source" terminal open.

cycles. In screen room tests, the antennas shall be at least 1 foot away from any wall.

13.2 *Conducted Radio Frequency Susceptibility Test.* With the equipment under test arranged in a manner similar to that shown in Figure 8 apply through the powerline stabilization network an RF signal modulated 30 percent at 1,000 c.p.s. between each ungrounded primary input power lead and ground. Determine compliance with the applicable standards of paragraph 3.0 "Minimum Performance Standards under Environmental Test Conditions" of the appropriate FAA Airborne Electronic Equipment Minimum Performance Standards when the signal level is varied (versus frequency) over the range specified in Figure 9 or Figure 10 for Category A and Category B installations, respectively. The output impedance of the signal generator shall be 50 ohms. The voltages specified shall be those which exist across the 50 ohm signal generator output when no load is connected to the signal generator. All equipment interconnecting cables shall have 4 feet of their length bundled together and supported 2 inches above the ground plane, as shown in Figure 8.

13.3 *Radiated Radio Frequency Susceptibility Test.* Expose the equipment under test to a radio frequency field, the levels of which (versus frequency) are specified in Figures 11 and 12 for Category A and Category B installations, respectively. The voltages specified in Figures 11 and 12 are those existing across the radiating antenna terminals. The test signal shall be modulated 30 percent at 1.000 c.p.s. The type of radiating antenna to be employed is related to the frequency of the test signal as follows:

Frequency	*Type of antenna*
90 kc. to 25 mc	41 inch rod antenna.
25 mc. to 35 mc	Dipole antenna adjusted to resonance at 35 mc.
35 mc. to 1,000 mc	Dipole antenna adjusted to resonance at test frequency.

Care should be taken to use matching networks when required. The equipment under test, the radiating antenna and the line stabilization networks shall be arranged in accordance with Figure 6, when using the rod antenna, and Figure 7, when using the dipole antenna. During this test, determine compliance with the applicable standards of paragraph 3.0 "Minimum Performance Standards under Environ-

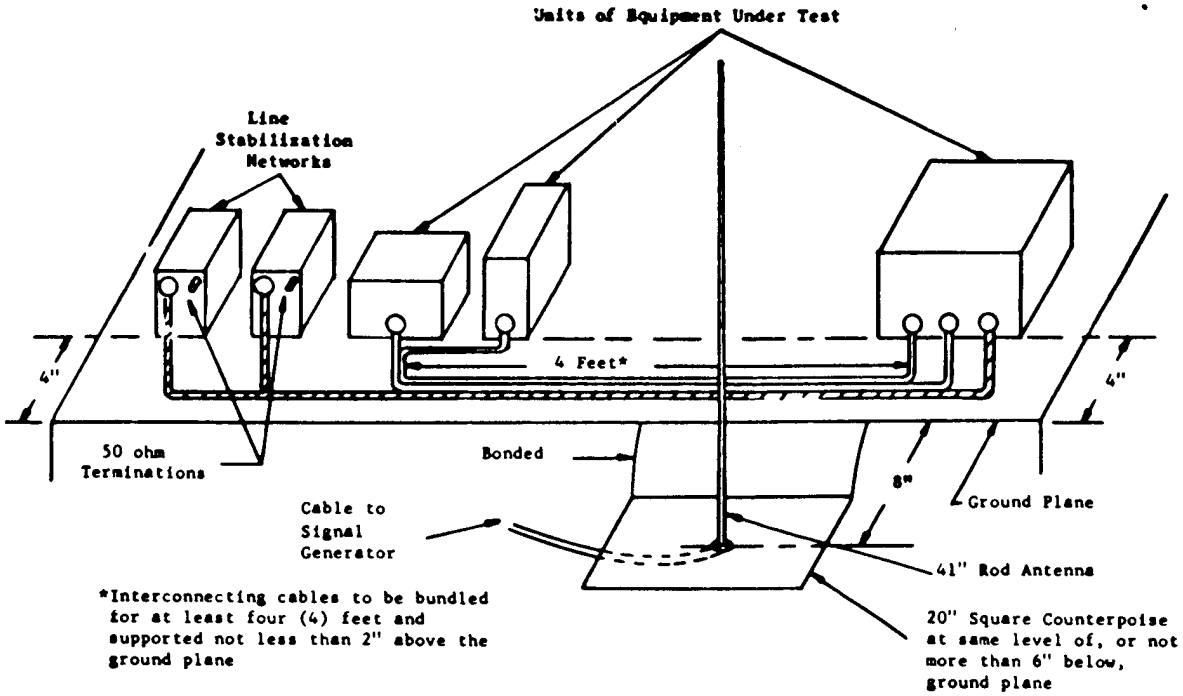


FIGURE 6—Location of rod antenna and arrangement of equipment.

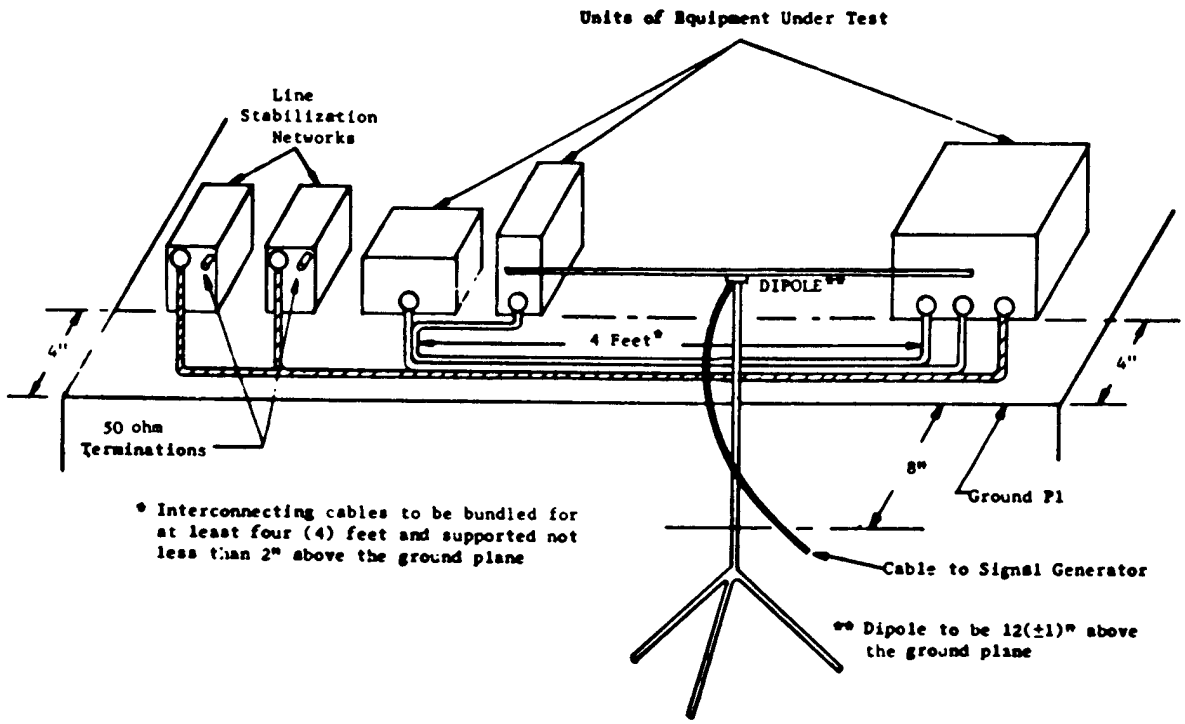


FIGURE 7—Location of dipole antenna and arrangement of equipment.

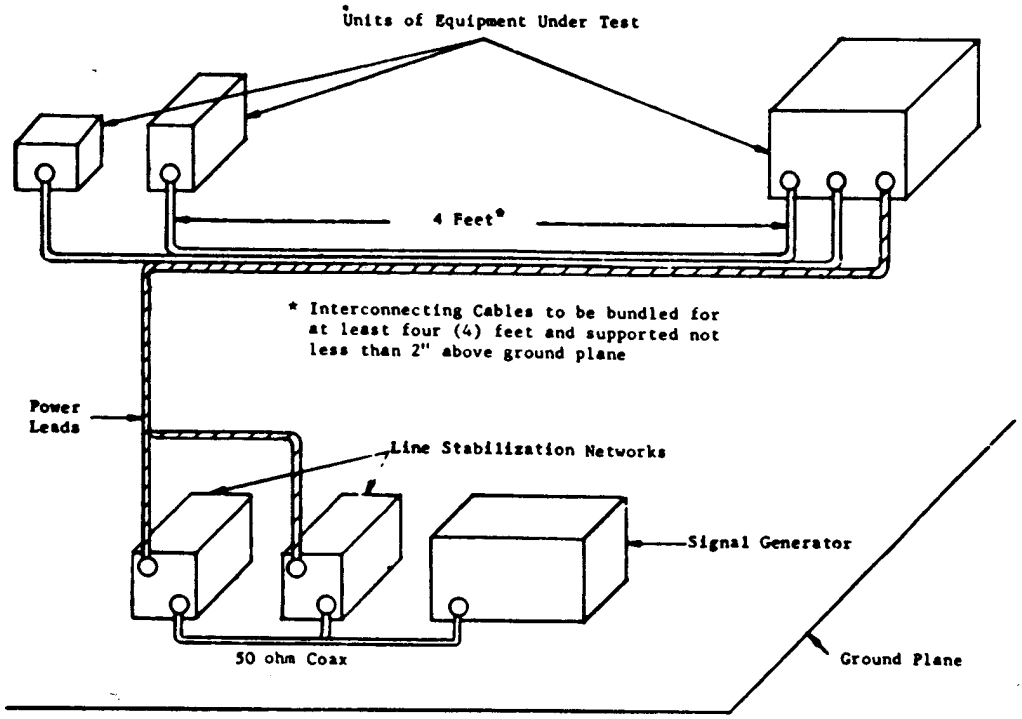
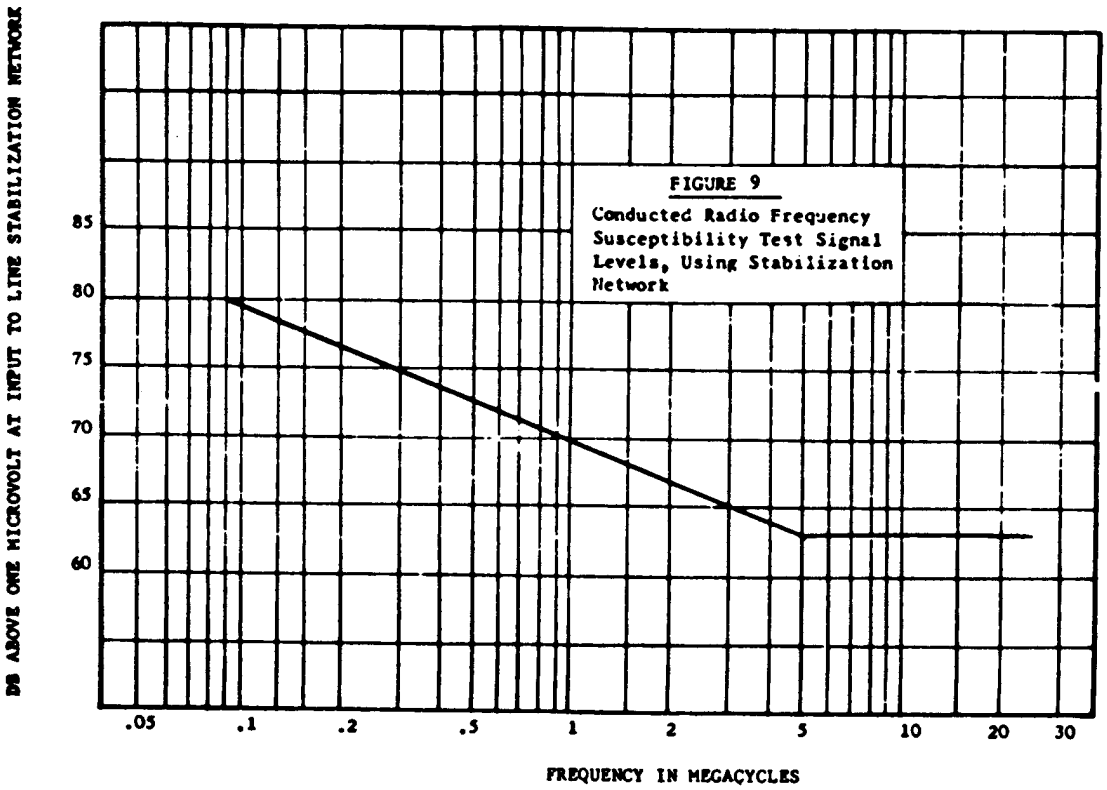


FIGURE 8—Arrangement of equipment for conducted RF susceptibility test.



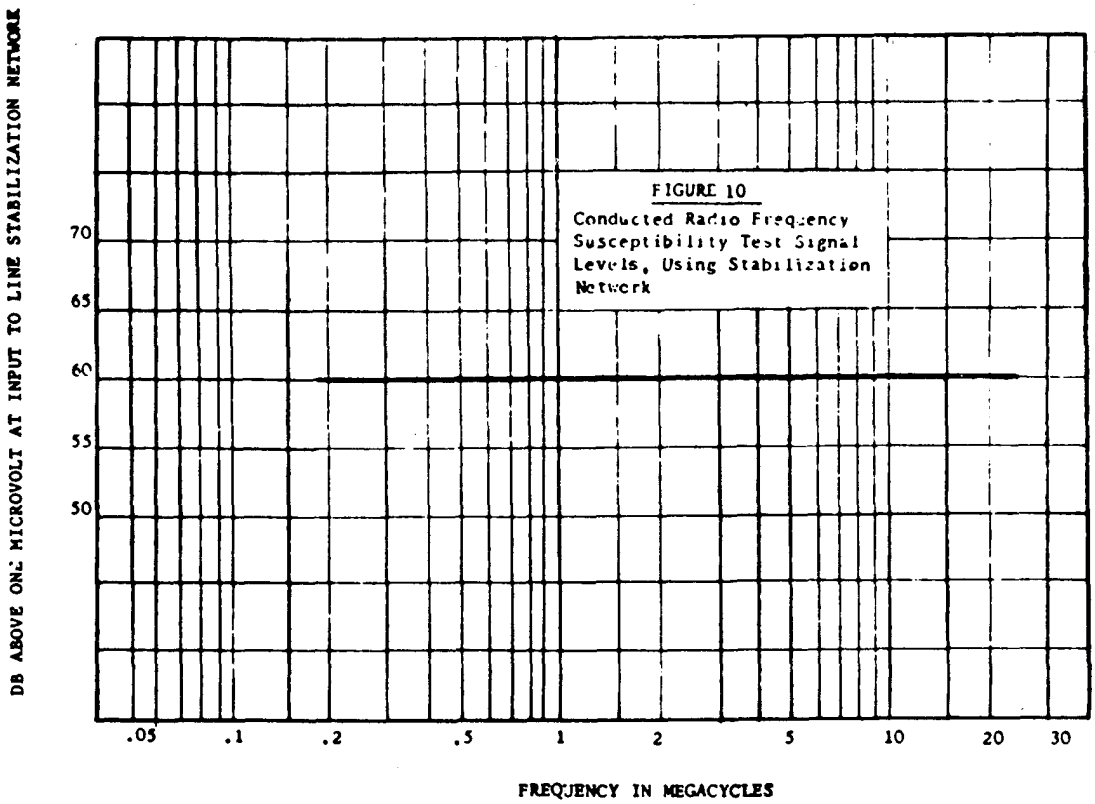


FIGURE 10

Conducted Radio Frequency Susceptibility Test Signal Levels, Using Stabilization Network

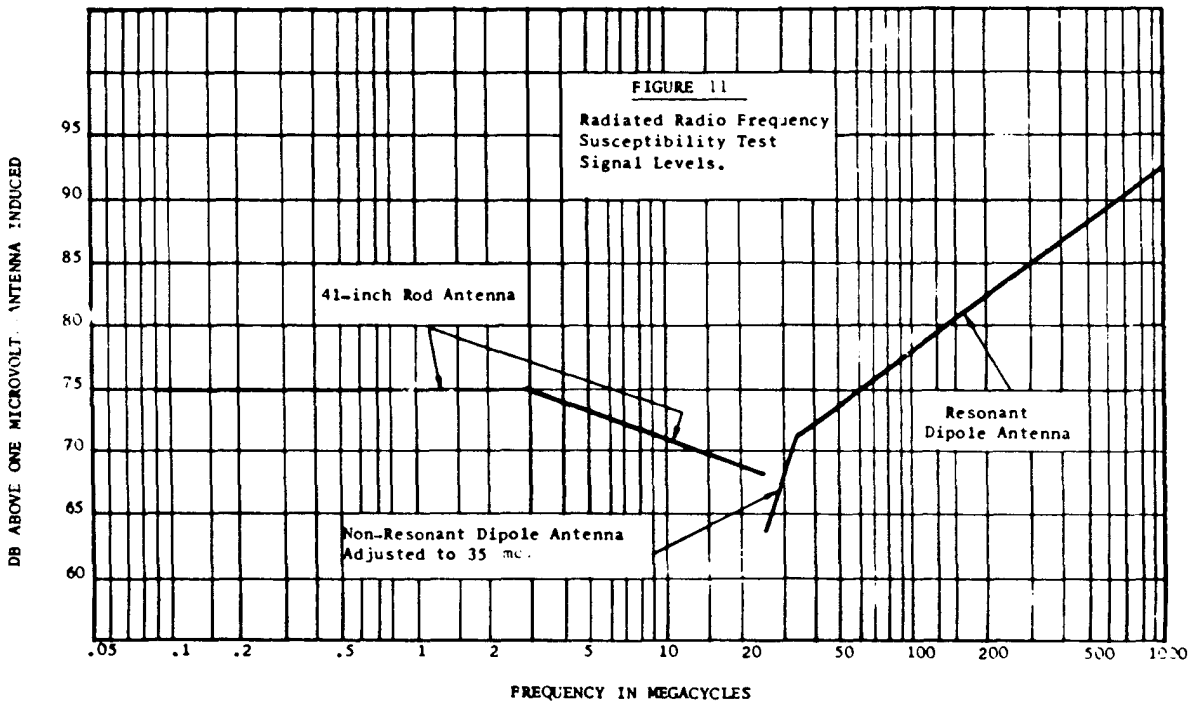
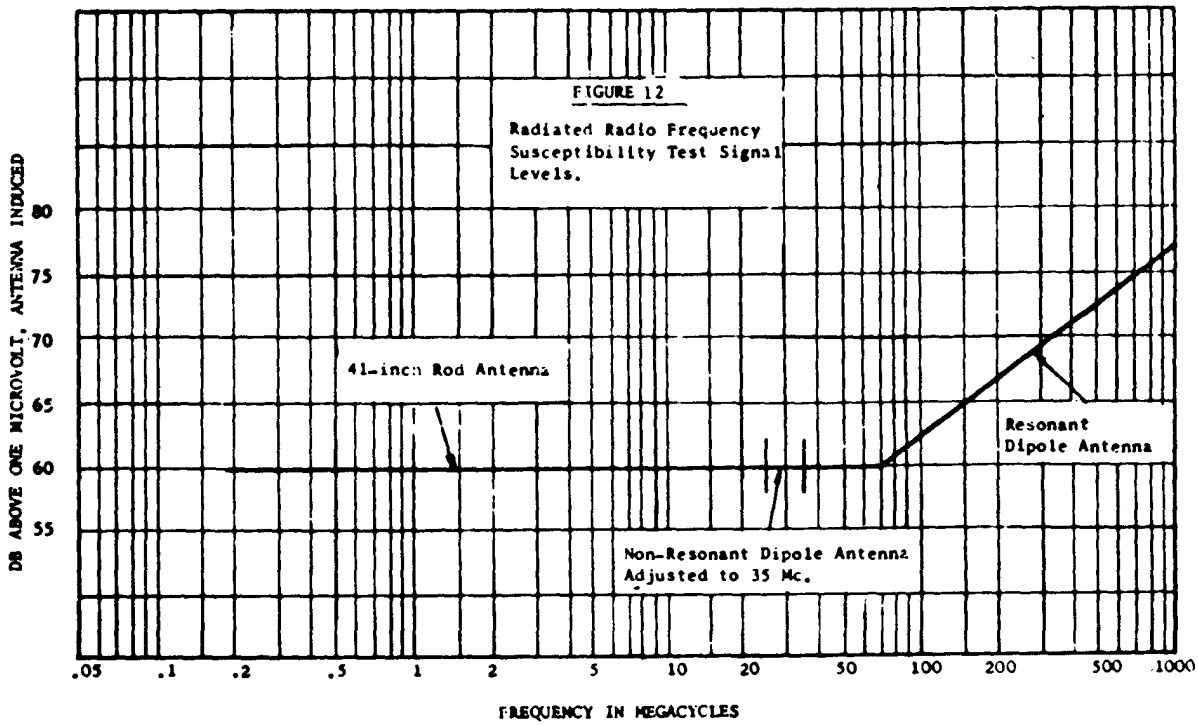


FIGURE 11

Radiated Radio Frequency Susceptibility Test Signal Levels.



mental Test Conditions" of the appropirate FAA Airborne Electronic Equipment Minimum Performance Standards.

14.0 Explosion Test.

14.1 *Application and Conditions of Test.*

a. Application and Categories of Equipment.

(1) It is recognized that installation practices in civil aircraft and in many noncivil transport aircraft normally do not require the installation of equipment in locations where an explosive atmosphere may exist in the course of normal aircraft operations. For such installations, the Explosion Test is not applicable and the equipment is designated as Category "X" equipment.

(2) It is also recognized that, in special applications and in special purpose aircraft, equipment may be installed in locations where an explosive atmosphere may exist in the course of normal aircraft operations. For these installations, the Explosion Test is applicable and the equipment is designated as Category "E" equipment.

b. Apparatus. The test chamber shall be a type capable of providing the test environment. A suitable test chamber is described in Military Specification MIL-C-9435.

c. Fuel. The fuel used shall be 100/130 octane gasoline.

d. Failure Criteria. If the equipment causes explosion at any of the test altitudes, it shall be considered to have failed to pass the test and no further trials need be attempted.

e. Applicability Exceptions. Sealed equipment, connecting wires, and cables shall be considered explosion-proof and require no test.

f. General Conditions.

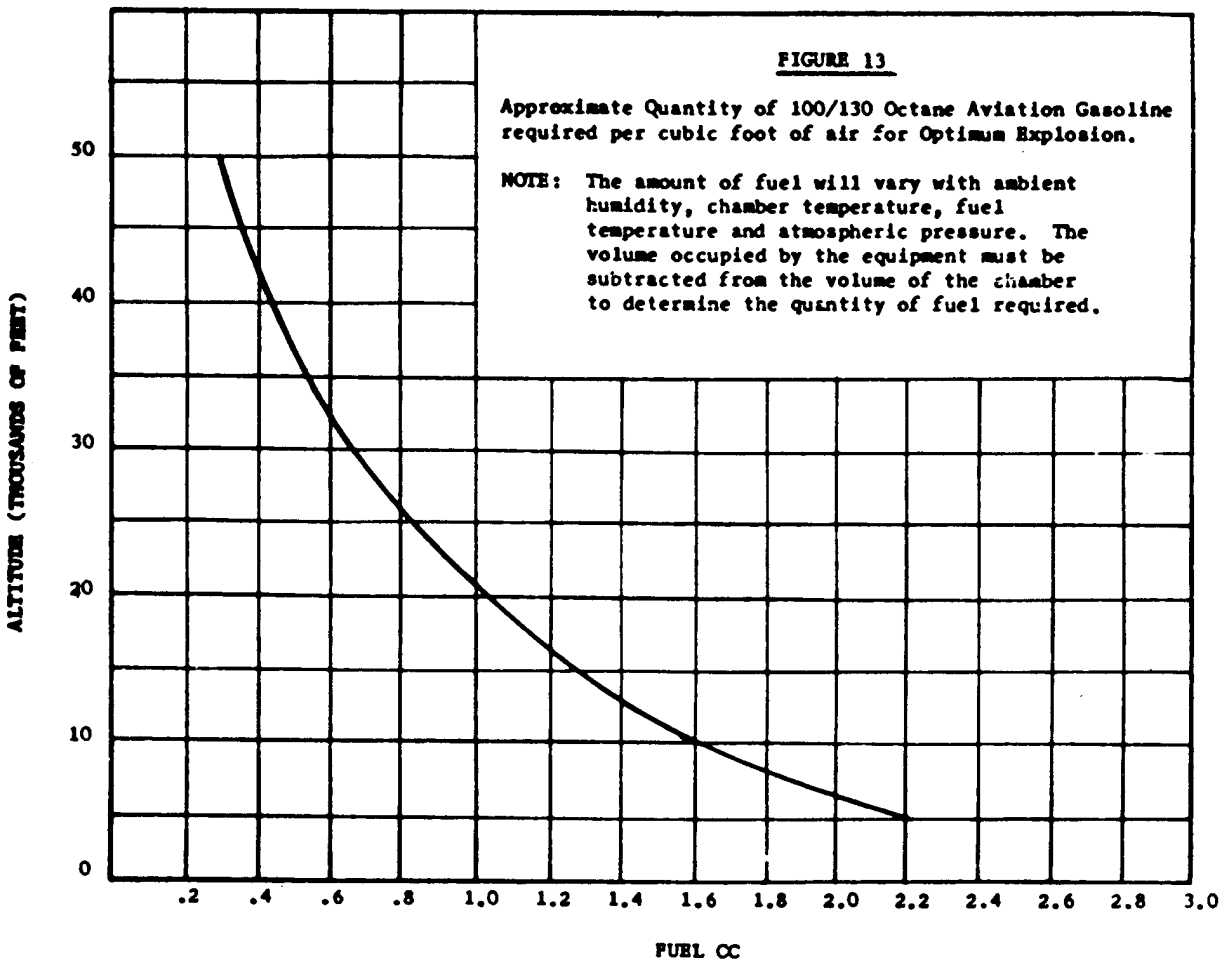
(1) When necessary, large items of electrical equipment, such as motors, large relays, etc., shall be prepared for explosion-proof testing by drilling and tapping openings in the case of inlet and outlet connections to the fuel vapor air mixture circulating system and for mounting a spark plug. The spark plug is used only for igniting the vapor air mixture in the equipment to insure the presence of an explosive mixture inside the equipment on test. Small items of equipment such as switches, circuit breakers, etc., shall not be drilled and tapped for mounting a spark plug when it is not practicable.

(2) When the explosion-proof test of paragraph 14.2*a.*(2) is being performed, dust or other auxiliary covers not intended to be explosion-proof may be removed or loosened to facilitate penetration of the explosive mixture.

14.2 *Test Procedures.*

a. Procedure I. This procedure is designed to determine the explosion producing characteristics of equipment not provided with cases designed to prevent flame or explosion propagation.*

* See additional test procedure under paragraph 14.2*b.*



(1) Preparation for Test.

(*a*) The equipment shall be installed in the test chamber in such a manner that normal electrical operation is possible and that mechanical controls may be operated through the pressure seals from the exterior of the chamber. All external covers of the equipment shall be removed or opened to insure adequate circulation of the explosive mixture. Large equipment, comprising multiple units, may be tested one or more units at a time by extending electrical connections through the cable port to units located externally.

(*b*) The equipment shall be operated to determine that it is functioning properly and to observe the location of any sparking or high temperature components which may constitute potential explosion hazards.

(*c*) Mechanical loads on drive assemblies and servomechanical and electrical loads on switches and relays may be simulated when necessary, if proper precaution is given to duplicating the normal load in respect to torque, voltage, current, inductive reactance, etc. In all instances, it is preferable to operate the equipment as it normally functions in the system during service use.

(2) Test Procedure. The test shall be conducted at test altitudes of ground level to 5,000 feet, 20,000 feet, and 40,000 feet, except that the highest test altitude shall not exceed the design requirement of the equipment.

(*a*) The test chamber shall be sealed and the ambient temperature within shall be raised to $+71 \pm 3°$ C., or to the maximum temperature for which the equipment is designed to operate (if lower than 71° C.). The temperature of the test item and the chamber walls shall be permitted to rise to within 11° C. of that of the chamber ambient air, prior to introduction of the explosive mixture.

(*b*) The internal test chamber pressure shall be reduced sufficiently to simulate an altitude approximately 10,000 feet above the desired test altitude. The quantity of fuel, as determined from Figure 13 shall be introduced into the chamber. A time of 3 ± 1 minutes shall be allowed for the introduction and vaporization of the fuel. Air shall be admitted into

the chamber until a simulated altitude of 5,000 feet above the test altitude is attained.

(*c*) Operation of the equipment shall then be commenced, all making and breaking electrical contacts being actuated. If high temperature components are present, a warmup time of 15 minutes shall be permitted. If no explosion results, air shall be admitted into the chamber so as to steadily reduce the altitude below the desired test altitude to an elevation 5,000 feet below that altitude. The operation of the equipment shall be continuous throughout this period of altitude reduction and all making and breaking electrical contacts shall be operated as frequently as possible.

(*d*) If by the time the simulated altitude has been reduced to 5,000 feet below the test altitude, no explosion has occurred as a result of operation of the equipment, the potential explosiveness of the air-vapor mixture shall be verified by attempting to ignite the mixture with the igniter furnished with the chamber. If the air-vapor mixture is not found to be explosive, the test shall be considered void and the entire procedure repeated.

b. Procedure II. This procedure is designed to determine the flame and explosion arresting characteristics of equipment cases which are designed to prevent the propagation of internal case explosions.*

(1) Preparation for Test.

(*a*) The case, with the equipment in position within, shall be installed in the explosion chamber. Testing shall be accomplished without consideration of the equipment operating characteristics; accordingly, the equipment need not be operated. Adequate circulation of the explosive mixture throughout the case shall be provided by optional means.

(*b*) If it necessary to drill the case for insertion of a hose from a blower, adequate precaution shall be taken to prevent ignition of the explosive mixture by backfire or release of pressure through the supply hose. The case volume shall not be altered by more than ±5 percent by any modification to facilitate the introduction of explosive vapor.

(*c*) A positive means of igniting the explosive mixture within the case shall be provided. The case may be drilled and tapped for the spark plug or the spark plug may be mounted internally.

(2) Test Procedure. The test shall be accomplished as follows:

(*a*) The chamber shall be sealed and the internal pressure reduced sufficiently to simulate an altitude between local ground level and 5,000 feet. The ambient chamber temperature shall be at least 25° C. An explosive mixture shall be obtained within the test chamber. (See paragraph 14.2*a*.(2)(*b*)).

(*b*) The internal case ignition source shall be energized, in order to cause an explosion within the case. The occurrence of an explosion within the case may be detected by use of a thermocouple inserted in the case and connected to a sensitive galvanometer outside the test chamber. If ignition of the mixture within the case does not occur immediately, the test shall be considered void and shall be repeated with a new explosive charge.

(*c*) At least five internal case explosions shall be accomplished at the test altitude selected. If the case being tested is small (not in excess of one-fiftieth of the test chamber volume) and if the reaction within the case upon ignition is of an explosive nature without continued burning of the mixture as it circulates into the case, more than one internal case explosion but not more than five may be produced without recharging the entire chamber. Ample time must be allowed between internal case explosions for replacement of burnt gases with a fresh explosive mixture within the case. If the internal case explosions produced did not cause a main chamber explosion, the explosiveness of the fuel-air mixture in the main chamber shall be verified. If the air-vapor mixture in the main chamber is not found to be explosive, the test shall be considered void and the entire procedure repeated, using an explosive mixture.

* See additional test procedure under paragraph 14.2a.

APPENDIX A

Standards on Emission of Spurious Radio Frequency Energy (Conducted and Radiated Interference) and Associated Test Procedures

The problem of describing the gross radio frequency interference environment (RF Conducted and Radiated Susceptibility Test) in an aircraft is inseparably related to the delineation of the maximum level of spurious radio frequency energy that any one electrical or electronic equipment in that aircraft will emit. It is concluded, therefore, that if the foregoing RF Conducted and Radiated Susceptibility Tests are to achieve their intended purposes, a compatible standard on the maximum permissible level of spurious emission of radio frequency energy from any one electrical or electronic equipment in an aircraft must be applied to that equipment.

Accordingly, one of the following standards (and associated test procedure) as appropiate for the maximum weight of the aircraft in which the electrical/electronic equipment is intended to be installed must be applied to each unit of equipment incorporated in such installation:

1.0 Standards on Emission of Spurious Radio Frequency Energy.

a. Categories of Equipment.

Category A—Equipment intended for installation in aircraft having a Maximum Weight of more than 12,500 pounds.

Category B—Equipment intended for installation

in aircraft having a Maximum Weight of 12,500 pounds, or less.

b. Conducted RF Interference. Radio interference voltages generated by the equipment within the frequency ranges and in excess of the values shown in Figures 16, 17, 18, and 19 for Categories A and B, respectively, shall not appear on any power line normally connected to an aircraft bus or other equipment.

c. Radiated RF Interference. Radiated interference fields generated by the equipment within the frequency ranges and in excess of the values shown in Figures 20, 21, 22, and 23 for Categories A and B, respectively, shall not be radiated from any unit, cable (including, but not limited to, control, pulse, i-f, video, antenna transmission and power cables) or interconnecting wiring. This requirement includes, but is not limited to, oscillator radiation, other spurious emanations and broadband interference. This does not include radiation emanating from antennas or, in the case of transmitters, any radiation on the selected frequency ±50 percent of the band of frequencies between adjacent channels.

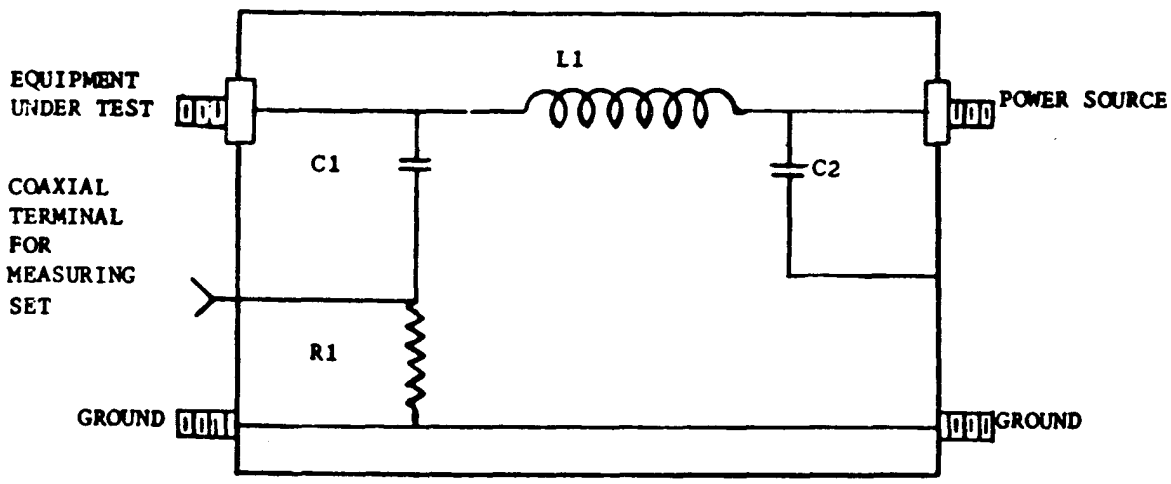
NOTE: The emission of suprious radio-frequency energy from the equipment resulting from manual operation of switches, but not including any electrical or electro-mechanical operations resulting from manual operation of switches, may exceed the limits stated in paragraphs 1.0*b.* and 1.0*c.* if its duration does not exceed one second.

2.0 Test Procedure.

a. Equipment Required.

(1) Interference measuring instrument.—Empire Devices Model NF-105 (including heads and antennas), or equivalent.

(2) Line stabilization networks that meet the requirements of paragraph 2.*b.*(2)(*b*).



ENCLOSURE DATA: 14 GAGE (B & S) ALUMINUM SUGGESTED SIZE 9¾ IN. BY 4 BY 4 IN.
FORM DATA: 5¼ IN. LENGTH, 3 IN. DIA (OD), .125 IN. WALL DRILL ⅜ IN. HOLE 7/16 IN. FROM EACH END.
COIL DATA: L1=5 MICROHENRIES, 13 TURNS SINGLE LAYER, 4 IN. WINDING LENGTH.
WIRE DATA: AWG 6, 600 VOLT, .310 IN. DIA (OD). (FOR 50-AMPERE NETWORK.)
CAPACITOR: C1 SHALL BE MOUNTED ON 1 IN. INSULATING BLOCK ABOVE GROUND.
CAPACITOR DATA: C1=.1 UF, 600,VOLT DC, BATHTUB.
C2=1 UF, 600-VOLT DC, BATHTUB, SINGLE TERMINAL CASE MOUNTED ON GROUND.
RESISTOR DATA: R1=5,000-OHM, 5-WATT CARBON.

1. The values given for the component parts of the network are nominal. Regardless of the construction or deviation from nominal values, the network must have an impedance within 20 percent of that given in Figure 15.
2. Connecting leads to condensers and resistors should be as nearly as possible to zero length.
3. Networks may also be constructed having a 1-ohm series resistor between the line and capacitor C2. This 1-ohm resistor shall be made up from ten 10-ohm, 1-watt composition resistors.
4. The data given in this figure is suitable for the construction of 50-ampere networks. Other current-carrying networks may be constructed by changing the wire size given for the coil and the size of the over-all enclosure.
5. The 50-ohm transmission line should be extended within the enclosure right up to the location where it connects with capacitor C1.

FIGURE 14—Powerline stabilization network schematic diagram.

b. General Requirements.

(1) The equipment under test shall be set up on a ground plane and operated in accordance with the following criteria:

(*a*) Ground Plane.—A copper or brass ground plane, 0.01 inch thick minimum for copper, 0.025 inch thick minimum for brass, 12-square feet or more in area with a minimum width of 30 inches, shall be used. In all cases where a shielded room is employed, the ground plane shall be bonded to the shielded room at intervals no greater than 3 feet and at both ends of the ground plane.

(*b*) Shock and Vibration Isolators.—The equipment under test shall be secured to mounting bases incorporating shock or vibration isolators, if such mounting bases are specified by the manufacturer. The bonding straps furnished with the mounting base shall be connected to the ground plane. Where mounting bases do not incorporate bonding straps, bonding straps shall not be used in the test setup.

(*c*) Bonding.—Only the provisions included in the design of the equipment and specified in the installation instructions shall be used to bond units, such as equipment case and mount, together or to the ground plane. Where bonding straps are required to complete the test setup they shall have a length not greater than 5 times the width, shall have a minimum thickness of 0.025 inch, and shall be copper or brass metal straps, not braid. Connections made with such bond straps shall have clean metal-to-metal contact.

(*d*) External Ground Terminal.—When an external terminal is available for a ground connection on the equipment under test, this terminal shall be connected to the ground plane if the terminal is normally grounded in the installation. If the installation conditions are unknown, the terminal shall not be grounded.

(*e*) Interconnecting Cables.—All equipment interconnecting cables and RF transmission lines shall be in accordance with the manufacturer's installation wiring diagram and shall use shielded or twisted wires only where specified. Where no length of interconnecting cables is specified, the cables shall be at least five (5) feet long. Any inputs or outputs from or to other equipments associated with the equipment under test shall be adequately simulated.

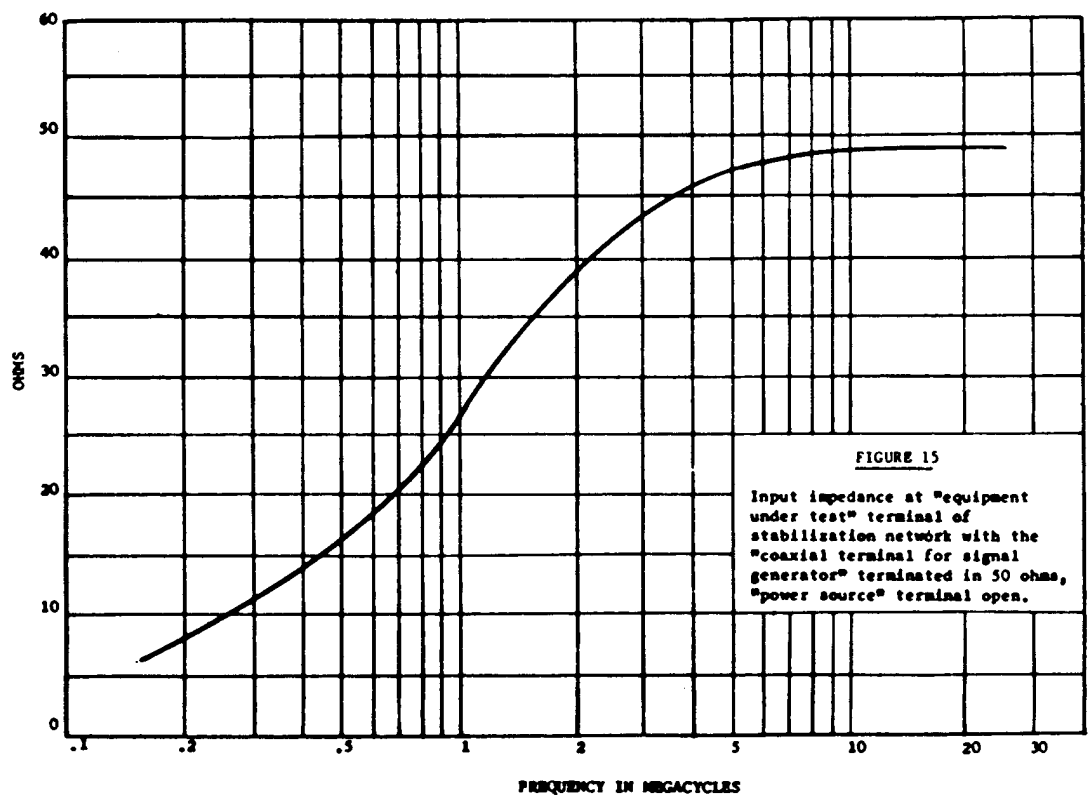


FIGURE 15

Input impedance at "equipment under test" terminal of stabilization network with the "coaxial terminal for signal generator" terminated in 50 ohms, "power source" terminal open.

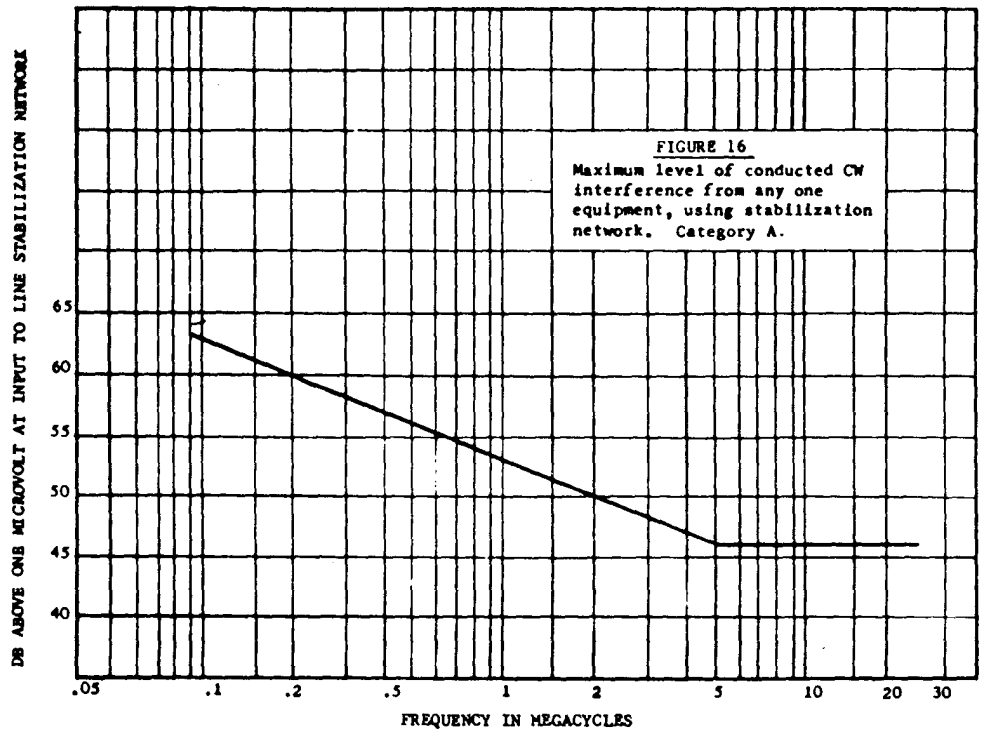


FIGURE 16
Maximum level of conducted CW interference from any one equipment, using stabilization network. Category A.

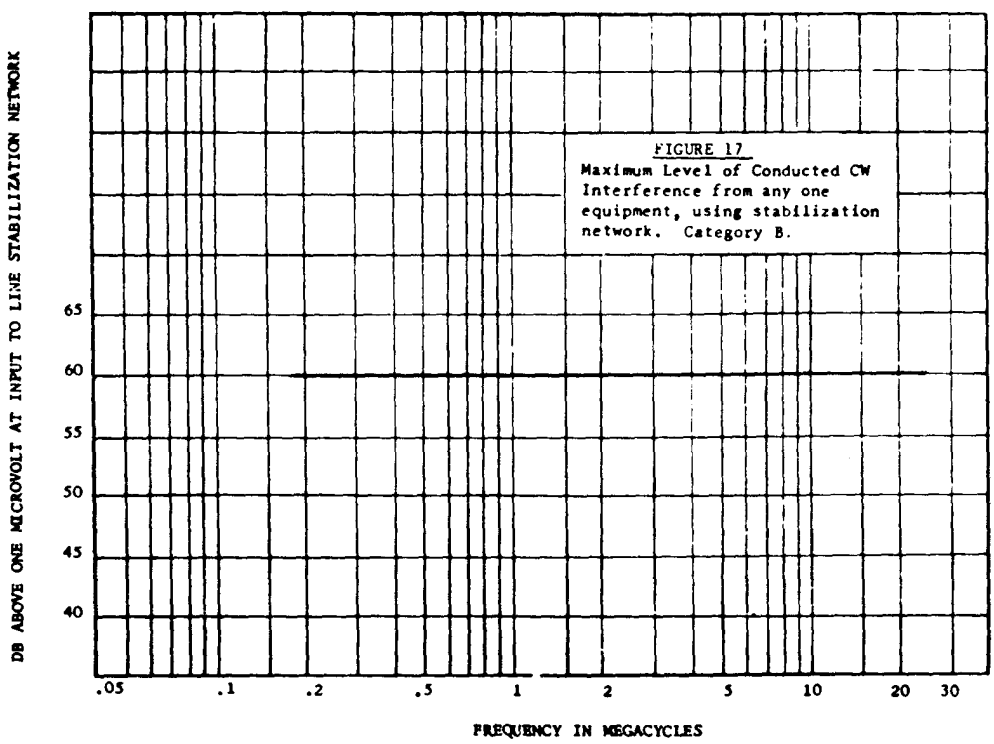


FIGURE 17
Maximum Level of Conducted CW Interference from any one equipment, using stabilization network. Category B.

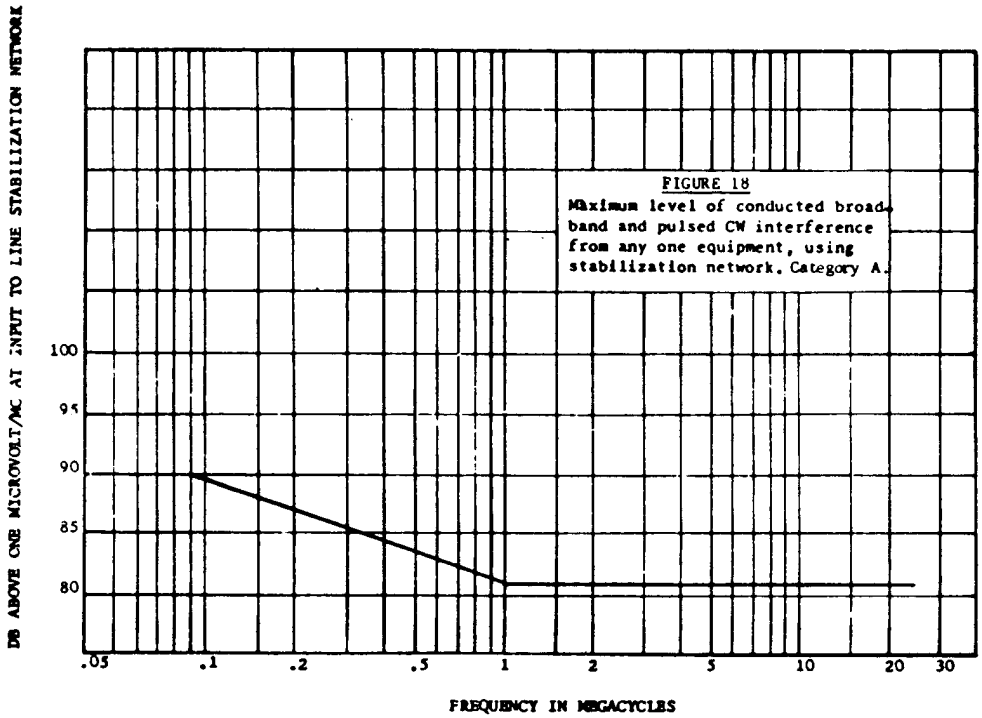


FIGURE 18
Maximum level of conducted broadband and pulsed CW interference from any one equipment, using stabilization network. Category A.

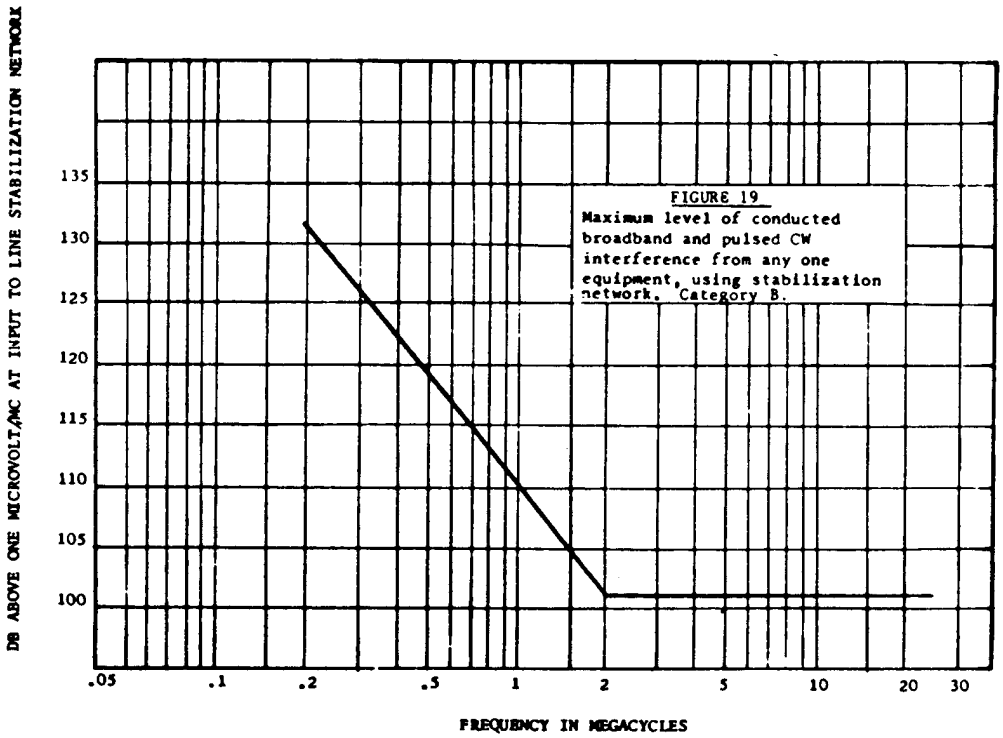


FIGURE 19
Maximum level of conducted broadband and pulsed CW interference from any one equipment, using stabilization network. Category B.

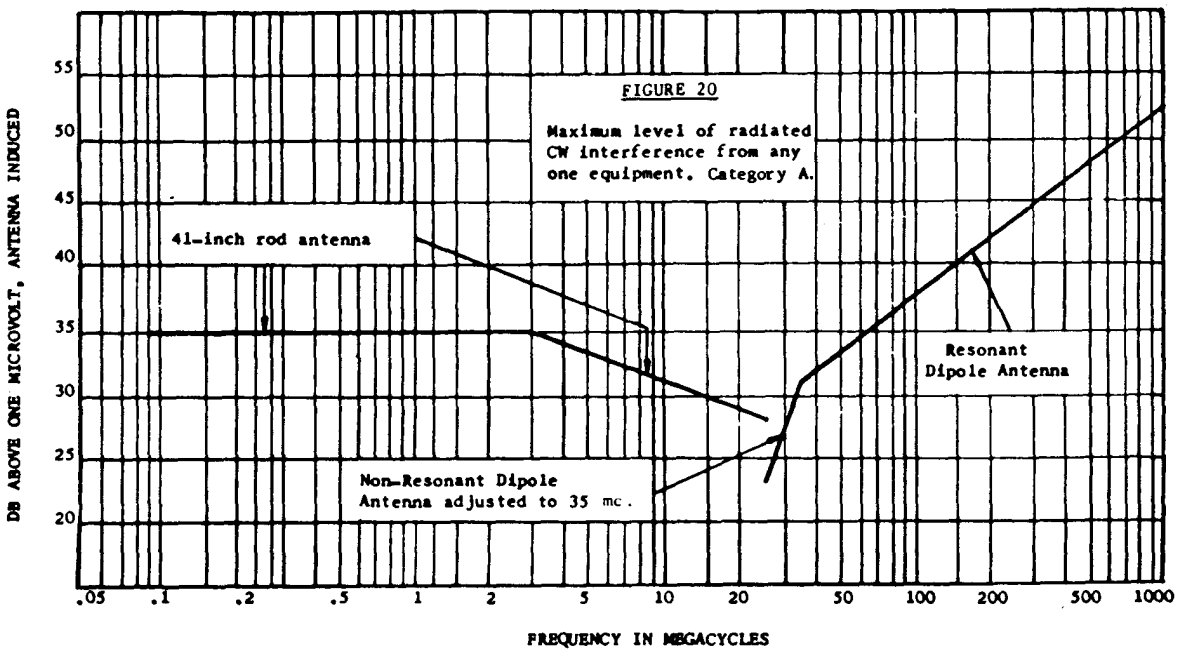


FIGURE 20
Maximum level of radiated CW interference from any one equipment. Category A.
41-inch rod antenna
Resonant Dipole Antenna
Non-Resonant Dipole Antenna adjusted to 35 mc.
DB ABOVE ONE MICROVOLT, ANTENNA INDUCED
55
50
45
40
35
30
25
20
.05
.1
.2
.5
1
2
5
10
20
50
100
200
500
1000
FREQUENCY IN MEGACYCLES

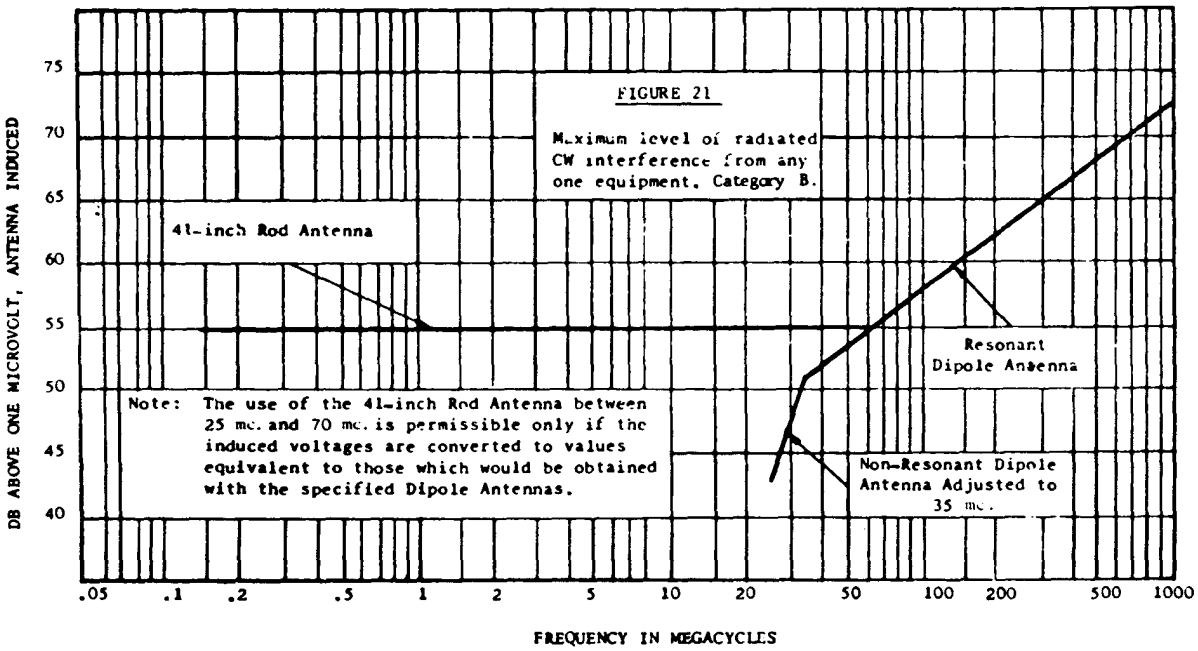


FIGURE 21
Maximum level of radiated CW interference from any one equipment. Category B.
41-inch Rod Antenna
Resonant Dipole Antenna
Non-Resonant Dipole Antenna Adjusted to 35 mc.
Note: The use of the 41-inch Rod Antenna between 25 mc. and 70 mc. is permissible only if the induced voltages are converted to values equivalent to those which would be obtained with the specified Dipole Antennas.
DB ABOVE ONE MICROVOLT, ANTENNA INDUCED
75
70
65
60
55
50
45
40
.05
.1
.2
.5
1
2
5
10
20
50
100
200
500
1000
FREQUENCY IN MEGACYCLES

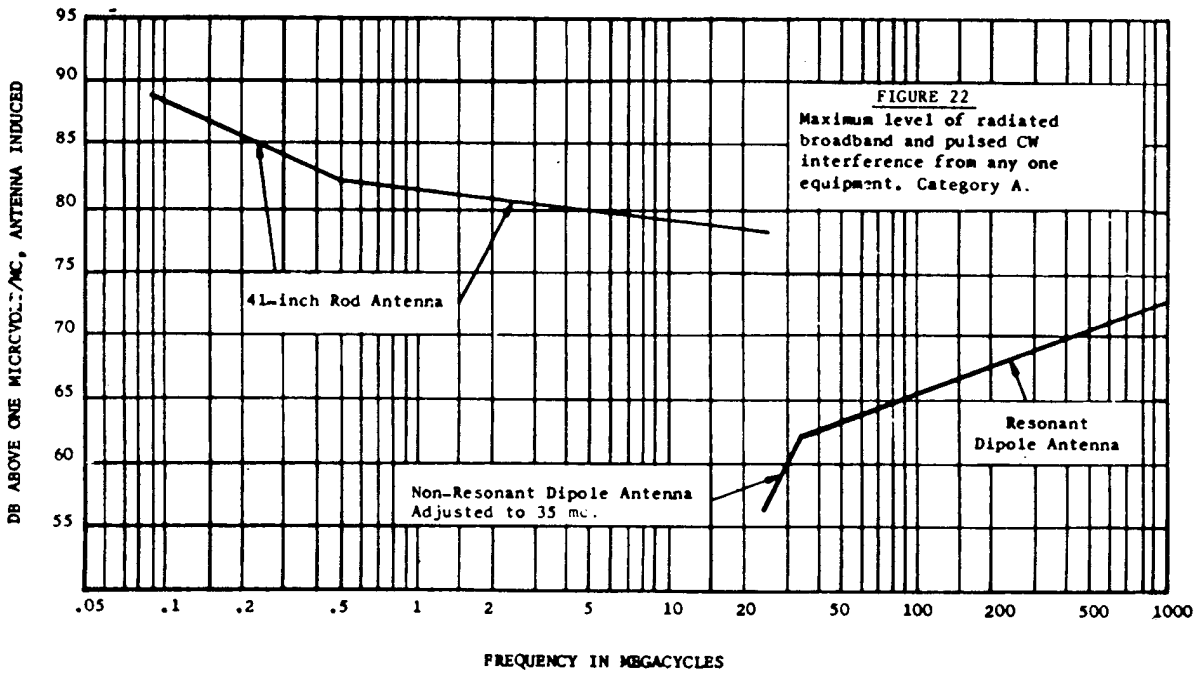


FIGURE 22
Maximum level of radiated broadband and pulsed CW interference from any one equipment. Category A.
41-inch Rod Antenna
Non-Resonant Dipole Antenna Adjusted to 35 mc.
Resonant Dipole Antenna
DB ABOVE ONE MICROVOLT/MC, ANTENNA INDUCED
95
90
85
80
75
70
65
60
55
.05
.1
.2
.5
1
2
5
10
20
50
100
200
500
1000
FREQUENCY IN MEGACYCLES

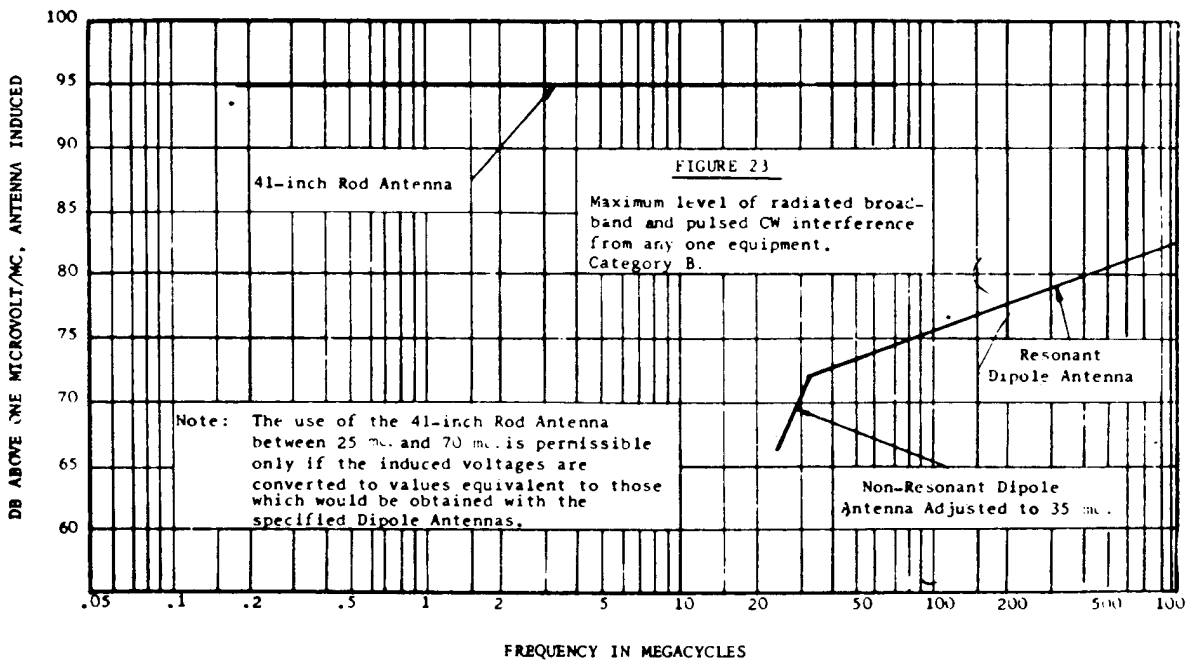


FIGURE 23
Maximum level of radiated broadband and pulsed CW interference from any one equipment. Category B.
41-inch Rod Antenna
Note: The use of the 41-inch Rod Antenna between 25 mc. and 70 mc. is permissible only if the induced voltages are converted to values equivalent to those which would be obtained with the specified Dipole Antennas.
Resonant Dipole Antenna
Non-Resonant Dipole Antenna Adjusted to 35 mc.
DB ABOVE ONE MICROVOLT/MC, ANTENNA INDUCED
100
95
90
85
80
75
70
65
60
.05
.1
.2
.5
1
2
5
10
20
50
100
200
500
1000
FREQUENCY IN MEGACYCLES

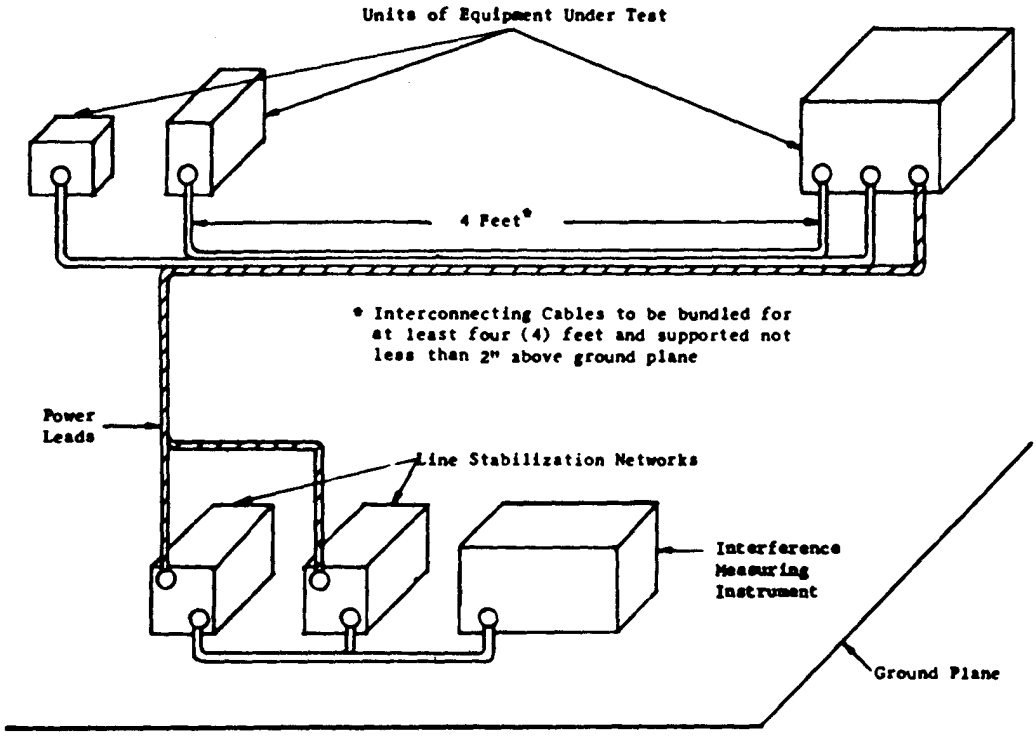


FIGURE 24—Arrangement of equipment for conducted RF interference test.

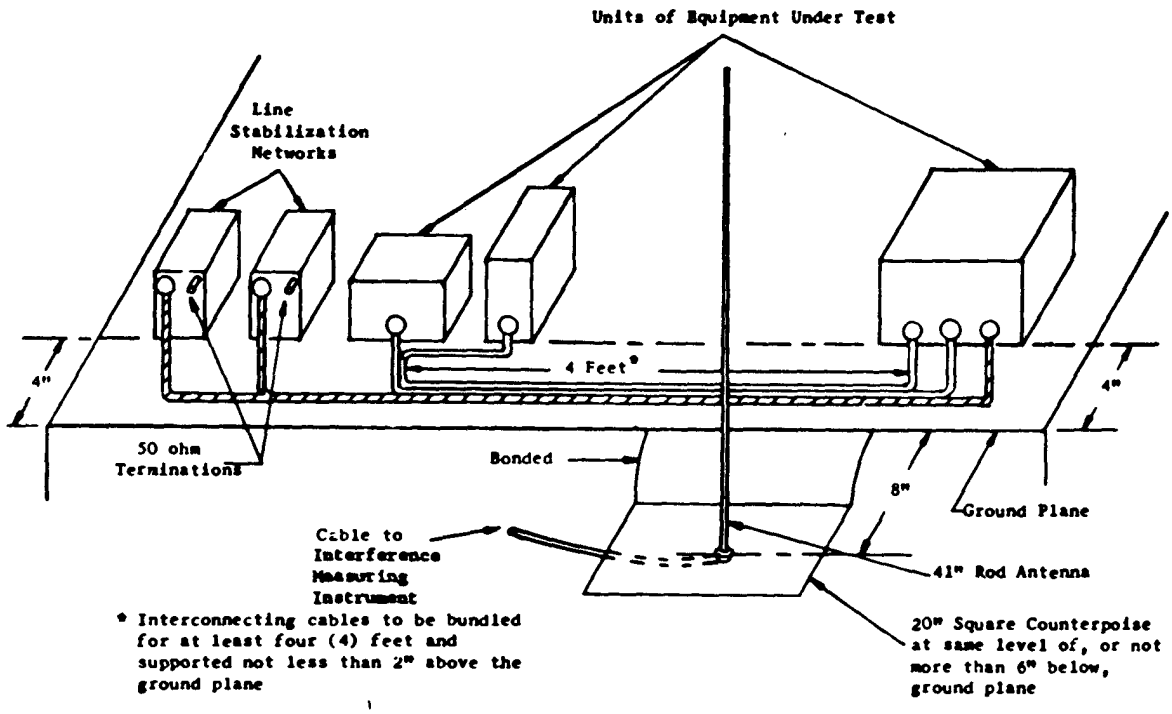


FIGURE 25—Location of rod antenna and arrangement of equipment.

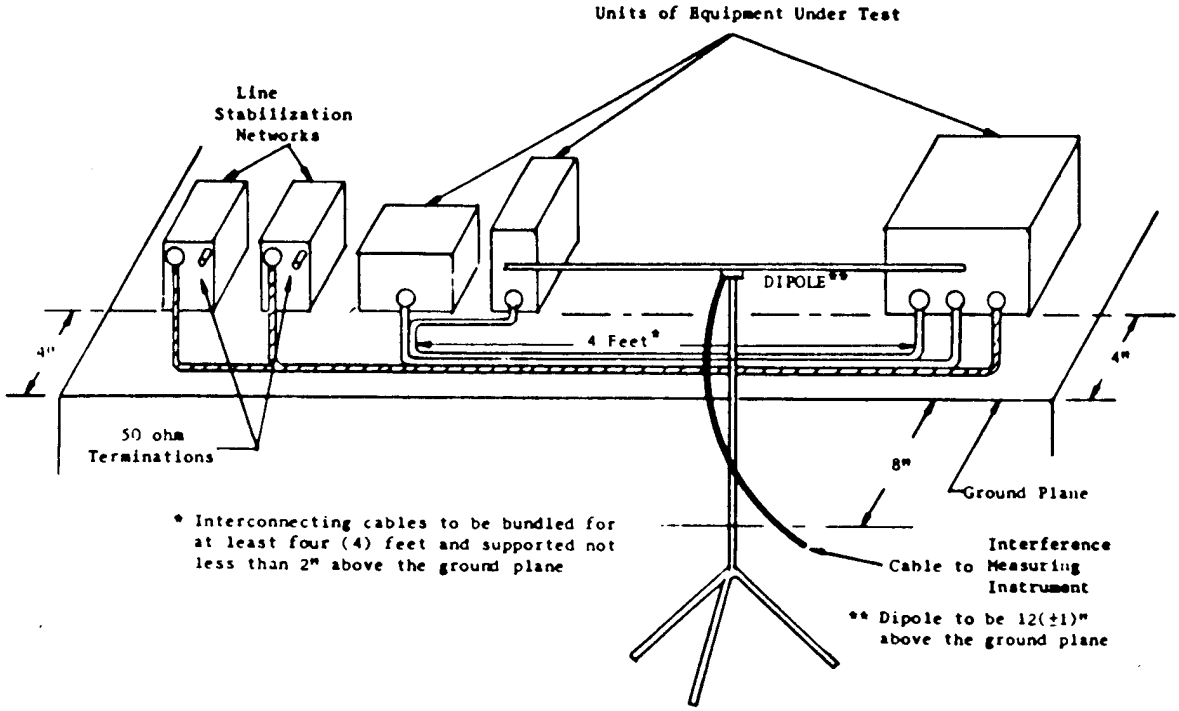


FIGURE 26—Location of dipole antenna and arrangement of equipment.

(*f*) Dummy Antennas.—The dummy antenna shall have electrical characteristics which closely simulate those of the normal antenna, and should be shielded. It shall contain electrical components which are used in the normal antenna (such as filters, crystal diodes, synchros, motors, etc.).

(2) Test instruments shall be set up and operated in accordance with the following criteria:

(*a*) Bonding.—Interference meters used for measurement during the "conducted" test shall not be bonded to the ground plane except through the interconnecting coaxial cable. The counterpoise on rod antennas shall be bonded to the ground plane with a strap of such length that the rod antenna can be positioned correctly. The strap shall be as wide as the counterpoise.

(*b*) Powerline Stabilization Network.—One stabilization network shall be inserted in each ungrounded primary input power lead of the equipment under test. The network enclosure shall be bonded to the ground plane. The network shall be made in accordance with Figure 14. The input impedance characteristics of the stabilization network are shown in Figure 15.

(*c*) Antenna Orientation and Positioning in Shielded Enclosures.—The rod or dipole antenna shall be located as shown in Figures 25 or 26. The rod antenna shall be so placed that the antenna is in a vertical position. The rod antenna shall be located at the point where maximum radiation pickup is obtained when it is moved along a line parallel with the edge of the ground plane. Those measurements which use a resonant dipole antenna shall have the dipole positioned parallel with the edge of the ground plane. The antenna shall be centered 12 inches ±1 inch above the level of the ground plane. The rod or the dipole antenna shall be located at the distance from the equipment under test specified in Figures 25 or 26. When the dimensions of the dipole antenna become smaller than the test layout, the antenna shall be moved parallel to the edge of the ground plane to keep its sensitive elements adjacent to the point of maximum radiation. At frequencies from 25 up to and including 35 megacycles, the measurements shall be taken with the dipole antenna adjusted to resonance at 35 megacycles. The dipole antenna shall be adjusted to resonance at all frequencies above 35 megacycles. In screen room tests, the antennas shall be at least 1 foot away from any wall.

c. Detailed Procedure.

(1) Conducted Interference.

(*a*) Set up equipment in accordance with Figure 24.

(*b*) Search the frequency range specified for the applicable category for each equipment configuration required.

(2) Radiated Interference.

(*a*) Set up the equipment in accordance with Figure 25.

(*b*) Search the frequency range specified in the applicable category for each equipment configuration required.

(*c*) Set up the equipment in accordance with Figure 26.

(*d*) Search the frequency range specified for the applicable category for each equipment configuration required.

§ 37.197 Automatic pressure altitude digitizer equipment—TSO–C88.

(a) *Applicability.* This technical standard order prescribes the minimum performance standards which automatic pressure altitude digitizer equipment must meet in order to be identified with the applicable TSO marking. New models of the equipment that are to be so identified and that are manufactured on or after February 10, 1967, must meet the "Federal Aviation Administration Standard for Automatic Pressure Altitude Digitizer Equipment," set forth at the end of this section.

(b) *Data requirements.* In accordance with § 37.5, the manufacturer must furnish the Chief, Engineering and Manufacturing Branch, Flight Standards Division, Federal Aviation Administration, in the region in which the manufacturer is located, the following technical data:

(1) Seven copies of the manufacturer's operating instructions, equipment limitations (including environmental conditions, and where compatibility with other airborne equipment is required, identification of all characteristics to assure proper matching) and installation procedures; and

(2) One copy of the manufacturer's test report.

(c) *Previously approved equipment.* Automatic pressure altitude digitizer models approved prior to February 10, 1967, may continue to be manufactured under the provisions of their original approvel.

FEDERAL AVIATION ADMINISTRATION STANDARD

Automatic Pressure Altitude Digitizer Equipment

1. Purpose.

1.1 This document specifies minimum performance standards and test procedures for 100-foot increment automatic altitude digitizing equipment which is to be approved under this Standard.

1.2 The digitizer equipment is defined as the combination of components needed for conversion of an input related to pressure altitude into the parallel digital code set forth in the International (ICAO) Standard Code for SSR Pressure Altitude Transmission.

2. General Requirements.

2.1 To be eligible for approval under a TSO authorization, each automatic altitude reporting digitizer equipment manufactured must comply with the requirements of this Standard up to its maximum range as indicated on the equipment nameplate.

2.2 The digitized altitude output must be in accordance with the International (ICAO) Standard Code for SSR Pressure Altitude Transmission contained in ICAO International Standards and Recommended Practices; Aeronautical Telecommunications, Annex 10, Volume I, Part I, Equipment and Systems. This ICAO code is the same as specified in the U.S. National Standard for Common System Component Characteristics for the IFF Mark X (SIF)/Air Traffic Control Radar Beacon System SIF/ATCRBS as amended December 27, 1963.

2.3 In those cases where the digitizing equipment forms part of an aircraft system such as an altimeter, an air data computer, or an ATC transponder, this Standard applies only to the digitizing equipment element as defined in paragraph 1.2. The other elements are covered by separate airworthiness requirements, technical standard orders, and operating rules.

3. Detail Requirements.

3.1 *Marking.* In addition to the information required to be marked by section 37.7(d), the information must include the maximum operating altitude.

3.2 *Accessibility of controls.* Controls which are not normally adjusted in flight must not be readily accessible to flight personnel.

3.3 *Compatibility of components.* The automatic altitude digitizer equipment may be qualified either separately or in association with a pressure altitude device and/or an ATC transponder. If the digitizer equipment is qualified separately, but requires matching, it must be identified in a manner that will assure proper matching.

3.4 *Operating range.* The operating range for all digitizers must begin at or below −1,000 feet. The upper limit must be as indicated on equipment nameplate.

3.5 *Pressure datum.* The digitized altitude information transmitted to the transponder must be referenced to 29.9213 inches of mercury, absolute (1013.25 millibars). If the digitizer equipment is part of an altimeter system, the altimeter barometric setting system must not affect this pressure datum.

3.6 *Power loss.* If electrical power is used to drive the digitizer, means must be incorporated in the equipment to detect loss of power or the effect thereof (not including excitation power from the ATC transponder). Under this failure condition the equipment must—

(a) Deactivate the digitizer output in a manner which removes the altitude information pulses; and

(b) Provide for operation of a warning device in the event of loss of digitizer drive power.

3.7 *Performance.*

3.7.1 The digitizer equipment must be capable of functioning and not be adversely affected over the ranges of conditions expected in the environment in which the equipment is to be used.

3.7.2 The digitizer must reproduce its input (related to pressure altitude) in digital form with a tolerance of ±50 feet measured at the transition points. When the pressure altitude information and the digitizer are incorporated in the same device (including properly identified matched components in accordance with § 3.3), the total tolerance of the combination must not exceed the ap licable altimeter tolerance plus a maximum digitizing error increment of 50 feet at the transition points.

3.7.3 If the pressure altitude input which drives the digitizer also actuates a display in the cockpit, the system, including the display indicator, must meet the accuracy requirements applicable to the pilot's altimeter. The information fed to the digitizer and the displayed altitude shall agree within ±25 feet. The altitude displayed (when corrected for the difference between the altimeter barometric setting and 29.9213 inches of mercury, absolute) must correspond with the digitized information given to the transponder within ±125 feet on a 95 percent probability basis.

3.8 *Power Variation.* The device must properly function with plus or minus 15 percent variation in D.C. voltage and/or plus or minus 10 percent variation in A.C. voltage and plus or minus 5 percent variation in frequency.

4. Test Conditions.

4.1 Unless otherwise specified herein, all tests must be conducted under the conditions specified in para 3.7.1. Standard pressures used in testing must conform with the U.S. Standard Atmosphere, 1962. (Geopotential altitude tables.)

5. Required Tests.

5.1 A prototype of a production article of digitizer equipment must be tested to show compliance with the performance requirements in paragraph 3.7 and the additional requirements in paragra h 3.8. After these tests have been completed, the prototype must be subjected to the following test:

The digitizer altitude-equivalent input must slowly be changed in altitude, either increasing or decreasing in value, until a transition to the values shown in Column (A) occurs in the digital output. The altitude input reading at transition must be as shown in Column (B), if increasing values of altitude input are used; or in Column (C), if decreasing altitude inputs are used. The table is to be used to the maximum altitude as shown on the equipment nameplate.

READING OF ALTITUDE-EQUIVALENT INPUT

(A) *Digital Output (in feet)*	(B) *Increasing Altitude (in feet)*	(C) *Decreasing Altitude (in feet)*
0	−50 ±50	+50 ±50
10,000	9,950 ±50	10,050 ±50
20,000	19,950 ±50	20,050 ±50
40,000	39,950 ±50	40,050 ±50
60,000	59,950 ±50	60,050 ±50
80,000	79,950 ±50	80,050 ±50

5.1.1 For combination devices, if pressure is used as the altitude-equivalent input in showing compliance with para 5.1, the tolerance specified may be increased by the applicable altimeter tolerance.

5.2 The manufacturers must determine the presence of each required digitizer coded position.

§ 37.198 Oxygen regulators, demand—TSO-C89.

(a) *Applicability.* This technical standard order prescribes the minimum performance standards that aircraft demand oxygen regulators must meet in order to be identified with the applicable TSO marking. New models of demand oxygen regulators that are to be so identified and that are manufactured on or after February 10, 1967, must meet the requirements of the following "Federal Aviation Administration Standard, Oxygen Regulators, Demand."

(b) *Marking.* In addition to the markings required by § 37.7, the inlet supply pressure range and the maximum environmental (cabin) altitude must also be marked on the regulator.

(c) *Data requirements.* The manufacturer must furnish the Chief, Engineering and Manufacturing Branch, Flight Standards Division, Federal Aviation Administration, in the region in which the manufacturer is located, the following technical data:

(1) Seven copies of the manufacturer's operating instructions, equipment limitations, and installation procedures.

(2) One copy of the manufacturer's test report.

(d) *Previously approved equipment.* Oxygen regulators approved prior to February 10, 1967, may continue to be manufactured under the provisions of the original approval.

FEDERAL AVIATION ADMINISTRATION STANDARD

Oxygen Regulators, Demand

1. Purpose.

This standard contains minimum performance and quality control standards for the manufacture of demand oxygen system regulators.

2. Classification.

The term "demand regulator" includes all of the following classes of regulators:

(a) Straight demand regulators designed to deliver oxygen only.

(b) Diluter demand regulators designed to deliver a mixture of oxygen and air, and oxygen only.

(c) Straight demand pressure breathing regulators (straight demand regulators designed to deliver undiluted oxygen under positive pressure).

(d) Diluter demand pressure breathing regulators (diluter demand regulators designed to deliver undiluted oxygen under positive pressure).

3. Design and Construction of Regulator.

To be eligible for approval under a TSO authorization, the regulator must possess the following design and construction characteristics:

3.1 Demand regulators designed to be mounted directly upon an oxygen mask or the crewmember's clothing or safety harness must include a flexible oxygen supply tube connecting the regulator inlet with the oxygen supply system.

3.2 Demand regulators must be constructed of materials that—

(a) Do not contaminate air or oxygen;

(b) Are not adversely affected by continuous contact with oxygen; and

(c) Are at least flame resistant.

3.3 (a) Demand regulators must be equipped with a 200 mesh screen, or equivalent filter, at the oxygen inlet port or at the oxygen inlet hose assembly.

(b) Diluter demand and diluter demand pressure regulators must be equipped with screening of not more than 100 mesh and not less than 30 mesh, or equivalent filter, at the air inlet port.

3.4 Diluter demand and diluter demand pressure breathing regulators must be provided with a means for manually selecting a delivery of undiluted oxygen. If the selection means is controlled by a rotating handle or lever, the travel must be limited to not more than 180 degrees from the "normal oxygen" position to the "100 percent oxygen" position. The dilution position of the selection means must be designated "normal oxygen" and the nondilution position must be designated "100 percent oxygen." The selection means must be such that it will not assume a position between the "normal oxygen" and "100 percent oxygen" positions.

3.5 Straight demand pressure breathing and diluter demand pressure breathing regulators must be designed to provide oxygen at a positive pressure of 11.0 ±3.0 inches H_2O to determine mask peripheral leakage at altitudes below which positive pressures are hereinafter required. The means of obtaining this pressure must be by push, pull, or toggle control appropriately marked to indicate its purpose.

3.6 Diluter demand and diluter demand pressure breathing regulators must incorporate means to indicate when oxygen is and is not flowing from the regulator outlet. This requirement does not apply to mask mounted regulators.

4. Performance.

Two demand regulators of each class for which approval is sought must be shown to comply with the minimum performance standards set forth in paragraphs 4.1 through 4.10 in any position which the regulators can be mounted. Tests must be conducted at ambient atmospheric conditions of approximately 30 inches Hg and 70°F., except as otherwise specified. It is permissible to correct gas flow rates and pressures to STPD conditions by computation.

4.1 (a) Demand regulators must supply the following oxygen or oxygen-air flows at not more than the specified outlet pressures. These characteristics must be displayed at all altitudes, with the oxygen supply pressure at all values within the design inlet pressure range, and with the diluter valve open and closed.

Flow, LPM, ATPD:	Maximum Outlet Suction Pressure, Inches of Water
20	0.40
70	.80
100	1.00

(b) Demand regulators must not flow more than 0.01 LPM, STPD, when the outlet suction pressure is reduced to 0 inches of H_2O under the conditions specified in subparagraph (a) of this paragraph.

4.2 (a) Diluter demand and diluter demand pressure breathing regulators must supply the following percentages of cylinder oxygen, by volume, at the specified atmospheric pressures and corresponding altitudes. These oxygen percentages must be delivered at regulator outlet gas flows of 20, 70, and 100 LPM, ATPD, with the oxygen supply pressure at all values within the design inlet pressure range.

Pressure mm Hg	Altitude feet	Minimum percent oxygen	
		Diluter demand	Diluter demand pressure breathing
760	0	0	40
632.4	5,000	0	40
522.8	10,000	6	40
429.1	15,000	14	40
349.5	20,000	25	40
282.4	25,000	40	40
226.1	30,000	61	61
179.3	35,000	91	91
178.5	35,100	98	98
141.2	40,000	98	98
111.1	45,000	Not applicable	98

(b) Straight demand and straight demand pressure breathing regulators must supply not less than 98 percent oxygen, by volume, at all altitudes under the conditions specified in subparagraph (a) of this paragraph.

4.3 (a) Diluter demand pressure breathing regulators with the diluter valve o en or closed, and straight demand pressure breathing regulators, must provide positive breathing pressure at a flow of 20 LPM, ATPD, in accordance with the following table:

Altitude 1,000 Feet	Positive Outlet Pressure—H_2O
30	0.0 +3.5 −0.0
40	2.5 ±2.5
42	6.0 ±1.5
44	10.0 ±1.0
45	12.0 ±1.0

(b) The positive pressure at 100 LPM, ATPD, must not increase by more than 0.8 inches H_2O from the positive pressure at 20 LPM, ATPD.

(c) The positive pressure at 0.01 LPM, ATPD, must not decrease by more than 0.8 inches H_2O from the positive pressure at 20 LPM, ATPD.

4.4 (a) The inward leakage of air through the regulator at sea level must not exceed 0.1 LPM, STPD, with a suction pressure of 1.0 inches H_2O applied to the outlet port, the oxygen supply inlet port sealed, and the diluter valve closed.

(b) The outward leakage of air through the regulator at sea level must not exceed 0.1 LPM, STPD, with a positive pressure of 12 inches H_2O applied to the outlet port, the oxygen supply inlet port sealed, and the diluter valve open and closed.

(c) The regulator outlet leakage must not exceed 0.01 LPM, STPD, with the regulator outlet port open and any oxygen supply pressure within the specified operating range applied at the regulator inlet port.

(d) The regulator overall leakage must not exceed 0.01 LPM, STPD, with the regulator outlet port sealed and the regulator inlet port pressurized to a value equal to the maximum specified oxygen supply pressure.

4.5 (a) Straight demand pressure breathing and diluter demand pressure breathing regulators must comply with paragraphs 4.1 through 4.4 after a negative pressure of 29 inches H_2O and a positive pressure of 24 inches H_2O are applied to the outlet port for a period of 2 minutes. The diluter valve and the regulator inlet port must be closed during these two pressure tests.

(b) Straight demand and diluter demand regulators must comply with paragraphs 4.1 through 4.4 after a negative pressure of 29 inches H_2O and a positive pressure of 12 inches H_2O are applied to the outlet port for a period of 2 minutes. The diluter valve and the regulator inlet port must be closed during these two pressure tests.

(c) Demand regulators must comply with paragraphs 4.1 through 4.4 after a positive pressure of 1.5 times the maximum oxygen supply pressure is applied to the inlet port, or to the inlet of the oxygen supply tube in the case of mask mounted regulators, for a period of 2 minutes. The positive pressure must be applied rapidly to simulate rapid opening of the supply valve. The diluter valve must be closed and the outlet port must be sealed during the test.

4.6 (a) Straight demand and diluter demand regulators must comply with paragraphs 4.1 through 4.4 after being subjected to a change in pressure from not less than 12.2 p.s.i.a. to not less than 2.7 p.s.i.a. in not more than one second.

(b) Straight demand pressure breathing and diluter demand pressure breathing regulators must comply with paragraphs 4.1 through 4.4 after being subjected to a change in pressure from not less than 12.2 p.s.i.a. to not less than 2.1 p.s.i.a. in not more than one second.

4.7 Demand regulators must comply with paragraphs 4.1 through 4.4 under each condition specified in subparagraphs (a) through (d) of this paragraph with the maximum oxygen supply pressure applied to the regulator inlet:

(a) At a temperature of approximately 70° F. after being stored at a temperature of not less than 160° F. for 12 hours.

(b) At a temperature of 70° F. after being stored at a temperature of not warmer than −67° F. for 2 hours.

(c) At a temperature of not less than 130° F.

(d) At a temperature of not more than 20° F.

4.8 Demand regulators must comply with paragraphs 4.1 through 4.4 after being subjected to the tests specified in subparagraphs (a) and (b) of this paragraph.

(a) The regulator must be vibrated along each mutually perpendicular axis for one hour (three hours total), at a frequency of 5 to 500 cps, and at a double amplitude of 0.036 inches or an acceleration of 2 "g," whichever occurs first. Mask mounted regulators need not be subjected to this vibration test.

(b) The regulator must be subjected to an endurance test of a total of 250,000 breathing cycles. The peak breathing rate must be 30 LPM, STPD, for 200,000 cycles, and 70 LPM, STPD, for 50,000 cycles. The dilution valve must be open during one half of the 200,000 cycles and one half of the 50,000 cycles, and it must be closed during the remaining cycles. During the nonflow portion of the 30 LPM and 70 LPM breathing cycles, a back pressure of 0.5 and 1.0 inches H_2O, respectively, must be applied to the regulator outlet.

4.9 Demand regulators must be free of vibration, flutter, or chatter that will prevent compliance with paragraphs 4.1 through 4.3 when subjected to the following simulated flow conditions:

Cycles	Peak flow per cycle LPM, STPD	Back pressure at 0 LPM, inches H_2O	Diluter valve
5,000	100	1.5	Closed
5,000	100	1.5	Open

4.10 Demand regulators, when subject to accelerations up to 3 "g" in any position, must comply with paragraph 4.1(a) except that the specified suction pressures may be exceeded by not more than 0.6 inches H_2O.

5. Maximum Environmental (Cabin) Altitude.

The minimum pressure to which the regulator has been shown to comply under paragraph 4.6(a) or (b) of this standard determines the maximum environmental (cabin) altitude of the regulator, except that the maximum environmental (cabin) altitude must not exceed the value shown in the following table:

CLASS	FEET
Straight or diluter-demand	40,000
Pressure demand	45,000

6. Quality Control.

6.1 Each production regulator must be shown to comply with paragraphs 4.1 through 4.4.

6.2 One regulator selected at random from each lot must be shown to comply with paragraphs 4.1 through 4.10. The lot size may be selected by the applicant subject to the approval of the Federal Aviation Administration on the basis of evaluation of the quality control system of the applicant (see FAR, § 37.5).

7. Abbreviations and Definitions.

LPM	Liters per minute.
STPD	Standard temperature and pressure, dry (0° C., 760 mm Hg., $PH_2O=0$).
ATPD	Ambient temperature and pressure, dry (70° F.; ambient pressure; $PH_2O=0$).
c.p.s.	Cycles per second.
p.s.i.a.	Pounds per square inch absolute.
g	Acceleration of gravity, 32 feet/second/second.

[§ 37.199 Cargo pallets, nets, and containers, TSO–C90a.

[(a) *Applicability*—(1) Minimum performance standards. This Technical Standard Order prescribes the minimum performance standards that aircraft cargo pallets, nets, and containers must meet in order to be identified with the applicable TSO marking. New models of such equipment which are so identified that are manufactured on or after January 22, 1979, must meet the minimum performance standards for cargo pallets, nets, and containers as set forth in National Aerospace Standard, NAS 3610, Revision 6, dated April 30, 1977. National Aerospace Standard, NAS 3610, Revision 6, entitled "CARGO UNIT LOAD DEVICES-SPECIFICATION FOR", is incorporated by reference herein in accordance with 5 U.S.C. 552(a)(1) and § 37.23 and is available as indicated in § 37.23. Additionally, National Aerospace Standard NAS 3610, Revision 6, may be examined at any FAA regional office of the Chief, Engineering and Manufacturing Branch (or in the case of the Western Region, the Chief, Aircraft Engineering Division), and may be obtained from the National Standards Association, Inc., 1321 14th Street, NW., Washington, D.C. 20005, at a cost of twenty-nine dollars and forty cents ($29.40).]

(2) *Exceptions.* Paragraph 3.5 of NAS 3610 is not essential to compliance with this section since paragraph (b) of this TSO provides the necessary marking requirements.

(b) *Markings.* In lieu of the marking requirements of § 37.7(d), cargo pallets, nets, and containers must be legibly and perma-

nently marked in an area clearly visible after the article is loaded with cargo, with the following information:

(1) Name and address of the manufacturer.

(2) The weight of the article to the nearest pound.

(3) The serial number or date of manufacture or both.

(4) The identification of the article in the code system set out in paragraph 1.2.1 of NAS 3610, Revision 1, approved April 30, 1970.

(5) Any limitations or restrictions.

(6) If the article is not omnidirectional, the words "FORWARD", "AFT", and "SIDE" must be conspicuously and appropriately placed.

[(7) The burning rate determined for the article under paragraph 3.7 of NAS 3610, Revision 6, dated April 30, 1977.]

(8) The applicable TSO number.

(c) *Data requirements.* In addition to the data specified in § 37.5, the manufacturer must furnish to the Chief, Engineering and Manufacturing Branch, Flight Standards Division, Federal Aviation Administration, in the region in which the manufacturer is located (or in the case of the Western Region, the Chief, Aircraft Engineering Division), the following technical data:

(1) One copy of the manufacturer's analysis and/or test results showing compliance with the requirements of this TSO.

(2) One copy of the manufacturer's instructions for installation, operation, servicing, maintenance, and repair of the article.

(3) An assembly drawing of the article showing and describing the actual language of all markings, their location, and size of print.

[(d) *Previously approved equipment.* Cargo pallets, nets, and containers approved prior to January 22, 1979, may continue to be manufactured under the provisions of their original approval.]

§ 37.200 Emergency locator transmitters—TSO–C91.

(a) *Applicability.* This Technical Standard Order prescribes the minimum performance standards that airborne emergency locator transmitters must meet in order to be identified with the applicable TSO marking. Emergency locator transmitters which are to be so identified must meet the requirements prescribed in paragraphs (b) and (c) of this section.

(b) *Basic performance standards.* Basic performance standards are hereby established for the following types of emergency locator transmitters:

(1) *Type ELT(P), (personnel type).* Personnel type emergency locator transmitters must meet the standards prescribed in Radio Technical Commission for Aeronautics Document No. DO–145 titled "Minimum Performance Standards—Personnel Type Emergency Locator Transmitters, ELT(P), Operating on 121.5 and 243.0 Megahertz," dated November 5, 1970.

(2) *Type ELT(AF), (automatic fixed type).* Automatic fixed type emergency locator transmitters must meet the standards for Automatic Fixed (AF) Type equipment set forth in Radio Technical Commission for Aeronautics Document No. DO–147 titled "Minimum Performance Standards—Automatic Fixed, Automatic Portable, and Automatic Deployable Type Emergency Locator Transmitters ELT(AF)(AP)(AD), Operating on 121.5 and 243.0 Megahertz," dated November 5, 1970. Notwithstanding the requirements of paragraphs 2.3.1(a)(1) and 2.3.1(c) of DO–147, a tolerance of $^{+5}_{-0}$ milliseconds may be applied to the value "11 milliseconds" prescribed therein.

(3) *Type ELT(AP), (automatic portable type).* Automatic portable type emergency locator transmitters must meet the standards for Automatic Portable (AP) Type equipment prescribed in Radio Technical Commission for Aeronautics Document No. DO–147 titled "Minimum Performance Standards—Automatic Fixed, Automatic

Portable, and Automatic Deployable Type Emergency Locator Transmitters, ELT-(AF)(AP)(AD), Operating on 121.5 and 243.0 Megahertz," dated November 5, 1970. Notwithstanding the requirements of paragraph 2.3.1(a)(1) and 2.3.1(c) of DO-147, a tolerance of $^{+5}_{-0}$ milliseconds may be applied to the value "11 milliseconds" prescribed therein.

(4) *Type ELT(AD), (automatic deployable type).* Automatic deployable type emergency locator transmitters must meet the standards for Automatic Deployable (AD) Type equipment prescribed in Radio Technical Commission for Aeronautics Document No. DO-147 titled "Minimum Performance Standards—Automatic Fixed, Automatic Portable, and Automatic Deployable Type Emergency Locator Transmitters, ELT(AF)(AP)(AD), Operating on 121.5 and 243.0 Megahertz," dated November 5, 1970. Notwithstanding the requirements of paragraphs 2.3.1(a)(1) and 2.3.1(c) of DO-147, a tolerance of $^{+5}_{-0}$ milliseconds may be applied to the value "11 milliseconds" prescribed therein.

(5) *Type ELT(S), (survival type).* Survival type emergency locator transmitters must meet the standards prescribed in Radio Technical Commission for Aeronautics Document No. DO-146 titled "Minimum Performance Standards—Survival Type Emergency Locator Transmitters, ELT(S), Operating on 121.5 and 243.0 Megahertz," dated November 5, 1970.

(c) *Additional performance standards.* In addition to meeting the basic performance standards (as applicable) prescribed in paragraph (b) of this section—

(1) Each personnel type emergency locator transmitter must, when installed in accordance with the manufacturer's instructions—

(i) Be automatically activated when subject to a force of 5.0^{+2}_{-0} g. and greater for a duration of 11^{+5}_{-0} milliseconds and greater in the direction of the longitudinal axis of the aircraft;

(ii) Not be activated under conditions less severe than those prescribed in subparagraph (c)(1)(i); and

(iii) After activation, remain activated when subsequently subjected to shock forces in any direction of up to 50 g. and having durations up to 11^{+5}_{-0} milliseconds.

Alternate means of transmitter activation may be used, including, but not limited to, skin deformation sensors, provided that such alternate means are shown to be substantially equivalent to sensors responsive to the crash forces otherwise prescribed in this subparagraph.

(2) Notwithstanding the requirements of paragraph 3.1 of DO-145, the "low operating temperature" for each personnel type emergency location transmitter shall be −20°C. In addition, notwithstanding the requirements of paragraph 3.5 of DO-145, the maximum low temperature for the temperature variation test shall be −40°C.

(3) The electrical connections to the battery, in each personnel, automatic, and survival type emergency locator transmitter must be corrosion resistant and positive in action.

(4) Each personnel, automatic portable, and survival type emergency locator transmitter must be equipped with a guard for the manual activation switch.

(5) Each automatic fixed, automatic portable, and automatic deployable type emergency locator transmitter that is installed with a remote switch for activation, must be equipped with a guard for the remote switch. In addition, the placard required in subparagraph (f)(1)(iii) of this section must be installed adjacent to the remote switch, as well as on the transmitter.

(d) *Environmental standards.* Unless otherwise stated in RTCA documents referenced in paragraphs (b) and (c) of this section, environmental testing must be done in accordance with RTCA Document No. DO-138 titled "Environmental Conditions and Test Proce-

dures for Airborne Electronic/Electrical Equipment and Instruments," dated June27, 1968.

(e) *Availability of documents.* RTCA Document Nos. DO-138, DO-145, DO-146, and DO-147 are incorporated herein in accordance with 5 U.S.C. 552(a)(1) and § 37.23 of this Part and are available as indicated in § 37.23. Additionally, these RTCA documents may be examined at any FAA Regional Office of the Chief, Engineering and Manufacturing Branch (or, in the case of the Western Region, the Chief, Aircraft Engineering Division). The above documents may be obtained from the RTCA Secretariat, Suite 655, 1717 H Street, N.W., Washington, D. C. 20006.

(f) *Marking.* (1) In addition to the markings prescribed in § 37.7(d) of this Part, the equipment must be permanently and legibly marked with—

(i) Its type designation as prescribed in paragraph (b) of this section;

(ii) The date on, or before, which the battery must be replaced or recharged, as applicable, to comply with the useful life limitation prescribed in paragraph (g)(2) of this section; and

(iii) The following placard: "For aviation emergency use only. Unlicensed operation unlawful. Operation in violation of FCC rules subject to fine or license revocation."

(2) In addition to the markings prescribed in § 37.7(d) of this Part and subparagraph (1) of this paragraph, each personnel type emergency locator transmitter, and each automatic portable type emergency locator transmitter must be permanently and legibly marked with the following placard: "When using in temperatures below freezing, keep transmitter inside your jacket with antenna outside for longest operating life."

(3) Each separate component of the equipment (antenna, transmitter, or other) must be permanently and legibly marked with at least the manufacturer's name and the TSO number.

(g) *Data requirements.* In accordance with § 37.5 of this Part, the manufacturer must furnish to the Chief, Engineering and Manufacturing Branch, Flight Standards Division (or, in the case of the Western Region, to the Chief, Aircraft Engineering Division), Federal Aviation Administration in the region in which the manufacturer is located, one copy of the following technical data, except that additional copies must be furnished upon request by the FAA:

(1) Manufacturer's operating instructions and equipment limitations, containing a statement identifying the type designation of the equipment as prescribed in paragraph (b) of this section.

(2) Installation instructions, including applicable schematic diagrams, wiring diagrams, procedures, and specifications. The specifications must set forth all limitations, restrictions, or other conditions, pertinent to the installation. The limitations must include, for batteries other than those that are essentially unaffected during probable storage intervals, a limitation on the use of the battery beyond 50 percent of its useful life (or in the case of a rechargeable battery, beyond 50 percent of its useful life of charge) as established by the transmitter manufacturer. For the purpose of this subparagraph, the useful life of the battery (established by the transmitter manufacturer) is the length of time, after its date of manufacture, that the battery may be stored on the shelf under normal environmental conditions without losing its ability to meet the power supply requirements prescribed in the applicable performance standards of paragraph (b) of this section.

(3) List of components (by part number) that make up the equipment system complying with the applicable standards prescribed in this section.

(4) Manufacturer's test report.

(5) Equipment data sheets specifying, within the prescribed range of environmental conditions, the actual performance of equipment of that type with respect to

each performance factor prescribed in the applicable standard.

(h) *Data furnished with each manufactured unit.* A copy of the operating instructions and equipment limitations prescribed in paragraph (g)(1) of this section, the installation instructions prescribed in paragraph (g)-(2) of this section, and the equipment data sheets prescribed in paragraph (g)(5) of this section, must be furnished with each emergency locator transmitter manufactured under this TSO.

[§ 37.201 Ground proximity warning-glide slope deviation alerting equipment; TSO–C92b.

[(a) *Applicability—Minimum performance standards.* This Technical Standard Order prescribes the minimum performance standards that ground proximity warning-glide slope deviation alerting equipment must meet in order to be identified with the applicable TSO marking. Equipment to be so identified must meet the minimum performance standards prescribed in Radio Technical Commission for Aeronautics (RTCA) Document No. DO–161A, titled "Minimum Performance Standards, Airborne Ground Proximity Warning System" (DO–161A), revised May 27, 1976, with the exception specified in paragraph (c)(4) of this section, and the additional standards contained in paragraphs (c)(1) through (c)(3) of this section.]

(b) *Environmental standards.* RTCA Document No. DO–138, dated June 27, 1968, including Change Number 2, dated October 29, 1969, or RTCA Document No. DO–160, dated February 28, 1975, both titled "Environmental Conditions and Test Procedures for Airborne Electronic/Electrical Equipment and Instruments", must be used to determine the environmental conditions over which the equipment has been designed to operate.

[(c) *Additional standards and exception.*

[(1) *Fire protection.* Except for small parts (such as knobs, fasteners, seals, grommets, and small electrical parts) that the Administrator finds would not contribute significantly to the propagation of a fire, all materials used must be self-extinguishing when tested in accordance with the requirements of § 25.853 and § 25.1359(d), as applicable, and Appendix F to Part 25 of this chapter, effective May 1, 1972, except that the materials may be of a size and be mounted for the test in accordance with paragraph (b) of Appendix F or may be of a size and be mounted as used in the aircraft.

[(2) *Aural and visual warnings.* The required aural and visual warnings must initiate simultaneously.

[(3) *Deactivation control.* If the equipment incorporates a deactivation control other than a circuit breaker, the control must be a switch with a protective cover. The cover must be safety wired so that the wire must be broken in order to gain access to the switch.

[(4) *Mode 4 flap warning inhibition.* A separate guarded control may be provided to inhibit Mode 4 warnings based on flaps being in other than the landing configuration.]

(d) *Markings.* In addition to the markings specified in § 37.7(d), the equipment must be marked as follows:

(1) The environmental categories over which it has been designed to operate as set forth in Appendix B of RTCA Document No. DO–138 or Appendix A of Document No. DO–160 must be permanently and legibly marked on the equipment. Where an environmental test procedure is not applicable and the test is not conducted, an "X" must be placed in the space assigned for that category.

(2) Each separate component of equipment (computer, transducer, etc.) must be permanently and legibly marked with, at least, the name of the manufacturer, the TSO number, and the environmental categories over which it has been tested.

(e) *Data requirements.* In accordance with § 37.5, the manufacturer must furnish to the Chief, Engineering and Manufacturing Branch, Flight Standards Division (or in the

case of the Western Region, the Chief, Aircraft Engineering Division) Federal Aviation Administration, in the region in which the manufacturer is located, one copy of the following technical data, except that additional copies must be furnished upon request:

(1) Manufacturer's operating instructions and equipment limitations.

(2) Installation procedures with applicable schematic drawings, wiring diagrams, and specifications. Any limitations, restrictions, or other conditions pertinent to installation must be included.

(3) List of the components (by part number) that make up the equipment system complying with the standards prescribed in this section.

(4) Equipment data sheets specifying, within the prescribed ranges of environmental conditions, the actual performance of equipment of that type with respect to each performance factor prescribed in the standard.

(5) Manufacturer's test report.

(f) *Data to be furnished with each manufactured unit.* One copy of the data and information specified in paragraph (e)(1), (e)(2), (e)(3), and (e)(4) of this section must be furnished to each person receiving for use one or more articles manufactured under this TSO.

(g) *Availability of referenced documents.* RTCA Document Nos. DO–138, dated June 27, 1968, including Change Number 2, dated October 29, 1969, DO–160, dated February 28, 1975, and DO–161A, revised May 27, 1976, are incorporated herein in accordance with 5 U.S.C. 552(a)(1) and § 37.23 and are available as indicated in § 37.23. Additionally, RTCA Document Nos. DO–138, DO–160, and DO–161A may be examined at any FAA Regional Office of the Chief, Engineering and Manufacturing Branch (or, in the case of the Western Region, the Chief, Aircraft Engineering Division), and may be obtained from the RTCA Secretariat, Suite 655, 1717 H Street, N.W., Washington, D.C. 20006 at a cost of $16.00 per copy for Document No. DO–138, $20.00 per copy for Document No. DO–160, and $16.00 per copy for Document No. DO–161A.

(h) *TSO–C92a equipment.* TSO-authorizations for the manufacture of ground proximity warning-glide slope deviation alerting equipment may continue to be obtained under TSO–C92a and equipment approved under TSO–C92a may continue to be manufactured under its original approval.

[§ 37.203 Airborne interim standard microwave landing system converter equipment—TSO–C93.

(a) *Applicability.* This technical standard order prescribes the minimum performance standards that airborne interim standard microwave landing system converter equipment must meet in order to be identified with the applicable TSO marking. Equipment that is to be so identified must meet the requirements of the "Federal Aviation Administration Standard, Airborne Interim Standard Microwave Landing System Converter Equipment" set forth at the end of this section.

(b) *Environmental standards.* Radio Technical Commission for Aeronautics (RTCA) Document No. DO–138, titled "Environmental Conditions and Test Procedures for Airborne Electronic/Electrical Equipment and Instruments", dated June 27, 1968, including Change Number 2, dated October 29, 1969, or RTCA Document No. DO–160, dated February 28, 1975, having the same title, must be used to determine the environmental conditions over which the equipment has been designed to operate.

(c) *Markings.* In addition to the markings specified in § 37.7(d), the equipment must be marked as follows:

(1) The environmental categories over which it has been designed to operate, as set forth in Appendix B of RTCA Document DO–138 or Appendix A of RTCA Document DO–160 must be permanently and legibly marked on the equipment. Where an environmental test procedure is not applicable and the test is not conducted, an]

["X" must be placed in the space assigned for that category.

(2) Each separate component of the equipment must be permanently and legibly marked with at least the name of the manufacturer, model or part number, the TSO number, and the environmental categories over which it has been tested. Where an environmental test procedure described in DO–138 or DO–160 is not applicable to that component and the test is not conducted, an "X" must be placed in the space assigned for that environmental category.

(d) *Data requirements.* In accordance with § 37.5, the manufacturer must furnish to the Chief, Engineering and Manufacturing Branch, Flight Standards Division (or in the case of the Western Region, the Chief, Aircraft Engineering Division), Federal Aviation Administration, in the region in which the manufacturer is located, one copy of the following technical data, except that additional copies must be furnished upon request:

(1) Manufacturer's operating instructions and equipment limitations.

(2) Installation procedures with applicable schematic drawings, wiring diagrams, and specifications. Any limitations, restrictions, or other conditions pertinent to the installation must be included.

(3) Manufacturer's test reports of the tests conducted to show compliance with the requirements of this TSO.

(4) Equipment data sheets specifying, within the prescribed range of environmental conditions, the actual performance of equipment of that type with respect to each performance factor prescribed in the standard. If RTCA Document No. DO–160 is used under paragraph (b) of this section, the data sheets must identify the paragraph of DO–160 used to show compliance with each of the requirements of paragraphs 4.1 through 4.10 of the standard set forth at the end of this section.

(5) A drawing list enumerating all the drawings and processes that are necessary to define the article design.

(e) *Data to be furnished with each manufactured unit.* A copy of the instructions specified in paragraphs (d)(1) and (d)(2) of this section must be furnished to each person receiving for use one or more articles manufactured under this TSO.

(f) *Availability of Documents.* RTCA Document Nos. DO–138, including Change Number 2, and DO–160 are incorporated herein in accordance with 5 U.S.C. 552(a)(1) and § 37.23 of the Federal Aviation Regulations and are available for inspection as indicated in § 37.23. Additionally, RTCA Document Nos. DO–138 and DO–160 may be examined at any FAA Regional Office of the Chief, Engineering and Manufacturing Branch (or in the case of the Western Region, the Chief, Aircraft Engineering Division). RTCA Document Nos. DO–138 and DO–160 may also be obtained from the RTCA Secretariat, Suite 655, 1717 H Street, N.W., Washington, D.C. 20006, at acost of $16.00 per copy for DO–138 and $20.00 per copy for DO–160.]

[FEDERAL AVIATION ADMINISTRATION STANDARD

AIRBORNE INTERIM STANDARD MICROWAVE LANDING SYSTEM CONVERTER EQUIPMENT

1.0 Purpose. This standard contains minimum performance and test requirements for Airborne Interim Standard Microwave Landing System Converter Equipment (Converter equipment).

2.0 General Standards.

2.1 *Operations of Controls.* The operation of controls intended for use during flight must not, in any possible combination or sequence, result in a condition whose presence or continuation would be detrimental to the proper functioning of the equipment.

2.2 *Accessibility of Controls.* Controls not intended for in-flight adjustment must be located so as not to be readily accessible to flight personnel.

2.3 *Effects of Tests.* Except as expressly provided in this standard, the design of the equipment must be such that subsequent to the application of the specified tests, no condition may exist which would be detrimental to the proper functioning of the equipment.

3.0 Minimum Performance Standards Under Standard Conditions. The equipment must be tested to show compliance with the following minimum performance requirements under standard conditions.

3.1 *Sensitivity.* The noise figure of the equipment must not be more than 20 db over the frequency range for which the equipment is designed.

NOTE: Maximum cable attenuations of 3 db between the antenna and converter and 3 db between the converter and ILS receivers were considered in developing this provision.

3.2 *Conversion Gain.* Input signals of not more than −54 dbm for localizer and −43 dbm for glide slope must produce outputs of at least −23 dbm for localizer and −17 dbm for glide slope. This standard must be met over the frequency range for which the equipment is designed.

3.3 *Spurious Response.* Spurious responses in the outputs must not exceed the values in the following table when input signals of −54 dbm for localizer and −43 dbm for glide slope are applied throughout the frequency bands specified.

Frequency Band (Megahertz)	Response Limit Relative to Center Response (db)
0.09–4599.99	−60
4600–4899.99	−45
4900–4998.99	−30
4999–5249.99*	−35
5250–5298.99	−40
5299–10,000	−60

* Exclusive of assigned input frequency band.

3.4 *Stability.* The frequency of the output must be within ±5 kHz of the assigned VHF localizer/UHF glide slope frequencies when assigned microwave frequencies are applied throughout the frequency range for which the equipment is designed.

3.5 *Intermodulation.* When equal level two-tone test signals within the bands 5000 MHz to 5030 MHz for localizer and 5220 MHz to 5250 MHz for glide slope are applied at input signal levels of −54 dbm for localizer and −43 dbm for glide slope, intermodulation products must be down at least 30 db from the desired output signals.

3.6 *Antenna Efficiency.*

(a) Over the frequency band from 5000 MHz to 5250 MHz, the desired component of the radiated signal in the forward direction must be at least +8.5 db when compared to an isotropic source.

(2) At any frequency from 5000 MHz to 5250 MHz, the desired component of the radiated signal must not be less than 0 db when compared to an isotropic source at any point in the principal horizontal plane from 60 degrees left to 60 degrees right of]

[directly forward of the antenna nor less than 5.5 db above an isotropic source at any point in the principal elevation plan from 17.5 degrees below to 17.5 degrees above directly forward of the antenna.

3.7 *Antenna Polarization.* Over the frequency range from 5000 MHz to 5250 MHz, the reception of signals with horizontal (H plane) polarization from the forward direction with respect to the antenna must be at least 20 db below the reception of signals with the vertical (E plane) polarization from the same direction.

3.8 *Voltage Standing Wave Ratio (Antenna).* The voltage standing wave ratio on the transmission line connecting the antenna and a signal source may not exceed a value of 2.2:1 over the frequency range from 5000 MHz to 5250 MHz.

3.9 *Voltage Standing Wave Ratio (Converter Input).* The voltage standing wave ratio on the transmission line connecting the receiver and a signal source may not exceed a value of 2.2:1 over the frequency range for which the equipment is designed.

4. Minimum Performance Requirements Under Environmental Conditions. The equipment must be tested to show compliance with the following minimum performance requirements under environmental conditions.

Unless otherwise specified in this standard, the measurement procedures applicable to a determination of the performance of the equipment under the environmental conditions specified are those set forth in either RTCA Document DO-138 titled "Environmental Conditions and Test Procedures for Electronic/Electrical Equipment and Instruments" dated June 27, 1968, including Change Number 2, dated October 29, 1969, or RTCA Document No. 160 dated February 28, 1975, having the same title. Performance testing may be done following a series of environmental exposures. However, the order of tests must be in accordance with paragraph 3.2 of Document Nos. DO-138 or DO-160.

4.1 *Temperature—Altitude.*

(a) *Low Temperature.*

(1) When the equipment is subjected to this environment, the requirements of paragraphs 3.1, 3.2, and 3.4 of this standard must be met. All mechanical devices must perform their intended functions.

(2) After subjection to this environment, the requirements of paragraph 3.8 of this standard must be met.

(b) *High Temperature.*

(1) When operated at the High Short-time Operating Temperature, the equipment must operate both electrically and mechanically.

(2) When the equipment is exposed to the High Operating Temperature, the requirements of paragraphs 3.1, 3.2, and 3.4 of this standard must be met.

(3) After the equipment is subjected to the environments specified in subparagraphs (1) and (2) of this paragraph, the requirements of paragraph 3.8 of this standard must be met.

(c) *Altitude.*

(1) When the equipment is subjected to this environment, the requirements of paragraphs 3.1, 3.2 and 3.4 of this standard must be met.

(2) After subjection to this environment, the requirements of paragraph 3.8 of this standard must be met.

4.2 *Humidity.* After subjection to the humidity environment and—

(a) Within 15 minutes after the time primary power is applied, the noise figure may not be more than 26 db; and

(b) Within 4 hours from the time primary power is applied, the requirements of paragraphs 3.1, 3.2, and 3.4 of this standard must be met.

4.3 *Stock.*

(a) Following the application of the operational shocks, the requirements of paragraphs 3.1, 3.2, and 3.4 of this standard must be met.]

[(b) The equipment must remain in its mounting, and no part of the equipment or its mounting may become detached and free of the shock test table or the equipment under test during or following the application of the crash safety shocks. Paragraph 2.3 of this standard does not apply to the crash safety shock environment.

4.4 *Vibration.*

(a) When the equipment is subjected to this environment the requirements of paragraph 3.2 of this standard must be met.

(b) After subjection to this environment, the requirements of paragraphs 3.1, 3.2, 3.4, and 3.8 of this standard must be met.

4.5 *Temperature Variation.* When subjected to this environment—

(a) The noise figure may not be more than 26 db;

(b) The requirements of paragraph 3.2 of this standard must be met; and

(c) The stability requirement of paragraph 3.4 of this standard must be met within ±2.5 kHz (7.5 ±kHz total).

4.6 *Electrical Input Variation.* When subjected to this environment, the requirements of paragraphs 3.1, 3.2, and 3.4 of this standard must be met.

4.7 *Low Voltage.*

(a) *AC and DC Equipment.* When the primary power voltages of DC operated equipment is 80% of the design voltages, and when that of AC operated equipment is 87½% of the design voltages, the equipment must operate both mechanically and electrically, the requirements of paragraph 3.1 of this standard must be met within 3 db, and the signal output requirements of paragraph 3.2 of this standard must be met within 3 db.

(b) *DC Equipment.*

(1) DC operated equipment must meet the requirements of paragraphs 3.1, 3.2, and 3.4 of this standard within 2 minutes after the primary power voltages are returned to the design voltages after operating at 50% of the design voltages for at least 10 minutes.

(2) The reduction of the primary power voltages of DC operated equipment from 50% of design voltages to zero volts may not produce fire or smoke. Paragraph 2.3 of this standard does not apply after the exposure to zero volts.

4.8 *Conducted Voltage Transients.*

(a) *DC Equipment.*

(1) *Intermittent Transients.* Following the application of the intermittent transients, the requirements of paragraphs 3.1, 3.2, and 3.4 of this standard must be met.

(2) *Repetive Transients.* While the repetitive transients are being applied, the requirements of paragraph 3.1 of this standard must be met.

(b) *AC Equipment.* While the transients are being applied, the requirements of paragraph 3.1 of this standard must be met.

4.9 *Radio-Frequency Susceptibility.* When subjected to this environment, the requirements of paragraph 3.1 of this standard must be met.

4.10 *Emission of Spurious Radio Frequency Energy.* The levels of conducted and radiated spurious radio frequency energy emitted by the equipment may not exceed those levels specified in Appendix A to RTCA Document No. DO-138 or paragraph 21 of Document No. DO-160.]

★U.S. GOVERNMENT PRINTING OFFICE : 1979 O - 281-682/3

[§ 37.205 Airborne Omega receiving equipment—TSO–C94.

[(a) *Applicability—Minimum performance standards.* This Technical Standard Order prescribes the minimum performance standards that airborne Omega receiving equipment must meet in order to be identified with the applicable TSO marking. Equipment to be so identified must meet the minimum performance standards prescribed in either Section One, Two, or Three of Radio Technical Commisison for Aeronautics (RTCA) Document No. DO–164, titled "Minimum Performance Standards—Airborne Omego Receiving Equipment," dated March 19, 1976, and the additional standard specified in paragraph (c) of this section.

[(b) *Environmental standards.* RTCA Document No. DO–160 titled "Environmental Conditions and Test Procedures for Airborne Electronic/Electrical Equipment and Instruments, "dated February 28, 1975, must be used to determine the environmental conditions over which the equipment has been designed to operate.

[(c) *Additional standard—Fire protection.* Except for small parts (such as knobs, fasteners, seals, grommets, and small electrical parts) that the Administrator finds would not contribute significantly to the propagation of a fire, all materials used must be self extinguishing when tested in accordance with the requirements of §§ 25.853 and 25.1359(d), as applicable, and Appendix F to Part 25 of this chapter, effective May 1, 1972, except that the materials may be of a size and be mounted for the test in accordance with paragraph (b) of Appendix F or may be of a size and be mounted as used in the aircraft.

[(d) *Markings.* In addition to the markings specified in § 37.7(d), the equipment must be marked as follows:

[(1) The environmental categories over which it has been designed to operate as set forth in Appendix A of RTCA Document No. DO–160 must permanently and legibly marked on the equipment. Where an environmental test procedure is not applicable and the test is not conducted, an "X" must be placed in the space assigned for that category.

[(2) Each separate component of equipment (antenna, receiver, controller, etc.) must be permanently and legibly marked with, at least, the name of the manufacturer, the TSO number, and the environmental categories over which it has been tested.

[(e) *Data requirements.* In accordance with § 37.5, the manufacturer must furnish to the Chief, Engineering and Manufacturing Branch, Flight Standards Division (or, in the case of the Western Region, the Chief, Aircraft Engineering Division) Federal Aviation Administration, in the region in which the manufacturer is located, one copy of the following technical data, except that additional copies must be furnished upon request:

[(1) Manufacturer's operating instructions and equipment limitations.

[(2) Installation procedures with applicable schematic drawings, wiring diagrams, and specifications. Any limitations, restrictions, or other conditions pertinent to installation must be included.

[(3) List of the components (by parts number) that make up the equipment system complying with the standards prescribed in this section.

[(4) Equipment data sheets specifying within the prescribed ranges of environmental conditions, the actual performance of equipment of that type with respect to each performance factor prescribed in the standard.

[(5) A drawing list, enumerating all the drawings and processes that are necessary to define the article design.

[(6) Manufacturer's test report.

[(f) *Data to be furnished with manufactured units.* One copy of the data and information specified in paragraphs (e)(1), (e)(2), (e)(3), and (e)(4) of this section must be furnished to each person receiving for use, one or more articles manufactured under this TSO.

[(g) *Availability or referenced documents.* RTCA Document Nos. DO–160, dated Febru-

ary 28, 1975, and DO-164, dated March 19, 1976, are incorporated herein in accordance with 5 U.S.C. 552(a)(1) and § 37.23, and are available as indicated in § 37.23. Additionally, RTCA Document Nos. DO-160 and DO-164 may be examined at any FAA Regional Office of the Chief, Engineering and Manufacturing Branch (or, in the case of the Western Region, the Chief, Aircraft Engineering Division) and may be obtained from the RTCA Secretariat, Suite 655, 1717 H Street, N.W., Washington, D.C. 20006, at a cost of $20.00 per copy for Document No. DO-160, and $16.00 per copy for Document No. DO-164.

[§ 37.209 Lithium sulfur dioxide batteries—TSO-C97.

(a). *Applicability.* This technical standard order prescribes the minumum performance standards that lithium sulfur dioxide ($LiSO_2$) batteries must meet to be identified with the applicable TSO marking. Batteries that are to be so identified must meet the requirements of the "Federal Aviation Administration Standard, Lithium Sulfur Dioxide Batteries" set forth at the end of this section.

(b). *Marking.* Each battery must be marked in accordance with §37.7 and must be marked with the month and year of manufacture and the date on which it must be replaced. In addition, each cell and battery must be marked with the phrase, "$LiSO_2$ BATTERY CAUTION: PRESSURIZED CONTENTS; NEVER RECHARGE, SHORT CIRCUIT, OR EXPOSE TO TEMPERATURES ABOVE 70°C (158°F)".

(c). *Data requirements.* In accordance with §37.5, the manufacturer must furnish to the Chief, Aircraft Engineering Division, Office of Airworthiness, Federal Aviation Administration (or in the case of the Western Region, the Chief, Aircraft Engineering Division) in the region in which the manufacturer is located, the following technical data:

(1) One copy of the battery limitations and operating characteristics.

(2) One copy of the installation procedures and installation limitations with applicable drawings and specifications indicating all limitations, restrictions, and conditions pertinent to the installation.

(3) One copy of the manufacturer's test report.

(4) One copy of the Master Drawing List of the battery, including identification of all drawings and applicable revision status and all process specifications and revision status.

(5) Battery data sheets specifying, within the prescribed range of environmental conditions, the actual performance of batteries of that type with respect to each performance factor prescribed in the applicable standard.

(d) *Data to be furnished with manufactured units.*

(1) One copy of the data and information specified in paragraphs (c)(1), (c)(2), and (c)(5) of this section must be furnished to each person receiving for use one or more articles manufactured under this TSO.

(2) If a cell vents from any of the tests required by the Federal Aviation Administration Standard, Lithium Sulfur Dioxide Batteries, except those of §§T-1 and T-2 of Appendix B of the standard, one copy of the data must be furnished to each person receiving for use one or more cells manufactured under this TSO which will allow that person to design—

(i) A receptacle to contain the simultaneous violent venting or explosing of all cells within the battery; and

(ii) Provisions for venting overboard the gaseous products of the explosion.

FEDERAL AVIATION ADMINSITRATION STANDARD LITHIUM SULFUR DIOXIDE BATTERIES

1.0 General.

1.1 This standard applies to cells and batteries of a nonaguous $LiSO_2$ type. Batteries may consist of a single cell, cells connected in series or in parallel, or both, to obtain the necessary output for the intended application. Definitions for terms used in this standard are set forth in Appendix A of this standard.

2.0 Minimun Performance Under Standard Conditions.

2.1 *Cell Isolation.* Cells in a multi-cell battery or packs of more than one battery may not be connected in parallel unless provisions are made to prevent individual cells from being exposed to charging voltages greater than the cell's nominal open circuit voltage. When five or more cells are reconnected in series, each cell must be protected by a shunt diode.]

[2.2 *Cell connection.* All electrical connections between cells in a battery must be soldered, welded, or brazed in accordance with an approved process specification.

2.3 *Safety Relief.*

2.3.1 *Safety Relief Mechanism.* Each cell used in the battery must incorporate a safety relief mechanism that will relieve internal pressure at a value and rate which will preclude venting violently, or explosion. The safety relief must operate at a temperature below 130°C in accordance with §T-1 of Appendix B of this standard.

2.3.2 *Discharge Materials.* If a cell vents during any of the tests required by §§3.2, 3.3, 3.4, 3.5, 3.6, 3.7, 3.8, 3.9, and 3.10, the data requirements of §37.209 (d)(2) must be met.

2.4 *Encapsulation.* Encapsulation of the battery may not be used unless it is demonstrated, in accordance with §§T-2 and T-3 of Appendix B of this standard, that encapsulation does not inhibit the functioning of the safety release mechanism or cause the battery to overheat.

2.5 *Seal.* Each cell must be hermetically sealed. The seal must be tested in accordance with §T-4 of Appendix B of this standard. The difference in the weight of the cell before and after this test must be less than 50 milligrams.

2.6 *Current Limiting Protection.* The battery must have a current limiting device. This device must limit the current that can be drawn from the battery to a value lower than that which it was subjected to in §§3.8, 3.9, and 3.10 of this standard, and must be an integral part of the battery and not susceptible to shorting or any failure causing the device to be bypassed.

2.7 *Useful life.* The useful life of the battery may not exceed 4 years unless demonstrated. The useful life must be demonstrated at a minimum temperature of 40°C. When tested at periods in excess of 4 years, the battery must retain 80 percent of its ampere-hour capacity as demonstrated in accordance with §T-5 of Appendix B of this standard, and meet the requirements of §§2.9, 2.10, and all sections under §3.0 of this standard.

2.8 *Examination of Product.* When required, subsequent to a test required by §3.0 of this standard, each of the cells must be visually examined. Special emphasis must be placed on observing signs of leakage and overall appearance of the safety relief feature.

2.9 *Open Circuit Voltage.* Open circuit voltage of the battery must be measured and be within ±5 percent of its specified value, and the polarity must be correct.

2.10 *Capacity.* The variation in battery capacity may not vary more than ±10 percent when compared with the capacity as demonstrated in accordance with §T-6 of Appendix B of this standard.

3.0 Minimum Performance Standards Under Environmental Conditions.

3.1 *General.* Except as provided in §§3.6, 3.7, 3.8, 3.9, and 3.10 of this standard, the design of the battery must be such that subsequent to the application of the specified tests, no condition may exist that would be detrimental to the continued performance of the battery. The same battery must be used for the following tests and these tests must be performed in this order: §§3.2, 3.3, 3.4, 3.5, and 3.6.

3.2 *Shock Test.* The battery must be secured to a shock table by a mechanically secure device. The shock test machine must be capable of imparting to the battery a series of calibrated shock impulses. The shock impulse waveform must be a half sine pulse whose distortion at any point on the waveform may not be greater than 15 percent of the peak value of the shock pulse. For the purposes of this section, duration of the shock impulse is specified with reference to the zero points of the holf sine wave, and shock forces are specified in terms of peak amplitude G values. The shock impulse must be measured using a calibrated accelerometer and associated instrumentation having a 3dB response over a range of at least 5 to 250 Hertz. The shock test must be conducted as follows:

(a) Mount the battery on the shock test machine in such a manner that it can be subjected to shock impulses in each direction successively along the three mutually orthogonal axes of the battery.

(b) Apply a 100G shock impulse of duration 23±2 milliseconds to the battery in a direction coincident with the first orthogonal axis.

(c) Reset the activation mechanism.

(d) Repeat the procedures specified in §§3.2(b) and (c) applying an impulse shock in the remaining 5 axial directions.

3.3 *Vibration Test.* The battery must be secured to a vibration table so that sinusoidal vibratory motion can be exerted parallel to one of the three major orthogonal axes of the battery. The battery must be affixed to the vibration table by the means specified by the equipment manufacturer for service installations. The vibration frequency must be varied at a rate not to exceed 1.0 octave per minute. The vibration must exhibit a constant total excursion of 2.5mm from 5 Hertz to the frequency at which an acceleration of 7G (zero-to-peak) is reached and from that frequency to 2,000 Hertz at a constant acceleration of 7G. Continue the vibration for a minimum of 1 hour. The tests described in this section must be repeated with the vibratory motion being applied along each of the other major axes of the cell.

3.4 *Temperature Cycle Test.* The battery must be subjected to a temperature not greater than −65°C for a period of 20 hours. The test chamber temperature must then be raised at a rate of 5° ± 2°C per minute to a temperature of at least +71°C, and this temperature maintained for a period of 4 hours. After the 4-hour period, the test chamber temperature must be returned, at a rate of 5° ± 2°C per minute, to a temperature not greater than −65°C, and this temperature must be maintained for 20 hours. The temperature cycle must be repeated 5 times. After completion of the temperature cycle, the battery must be returned to room temperature.

3.5 *Altitude Test.* The battery must be stored for 6 hours at an atmospheric pressure corresponding to an altitude of 15,000 meters at 24° ± 4°C. The pressure must then be increased to sea level pressure.

3.6 *Immersion Test—Salt Water.* After being immersed in salt water (3.5 ± 0.1 percent sodium chloride), with terminals insulated, for a period of at least 15 hours, the battery must be tested for leakage in accordance with §T-4 of Appendix B of this standard, and meet the requirements of §§2.8, 2.9, and 2.10 of this standard.]

[3.7 *High Temperature Battery Capacity Test.* After 30 days of storage at a temperature of 71° ± 2°C, the battery must be returned to room temperature and must be capable of delivering 90 percent of its rated capacity with no more than ± 10 percent variation in cell capacity. The test must be performed in accordance with §T-6 of Appendix B of this standard.

3.8 *Reverse Discharge Test.* The cell must not be fuse protected. The cell must be discharged in series with an external power supply at a current equal to that of the rating of the fuse used in the battery at a temperature of 24° ± 3°C. The discharge must be maintained for a time correspinding to the rated capacity of the battery that the cell will be used in or until the cell has vented. The cell condition must be monitored for 24 hours after termination of reverse discharge.

3.9 *Forced Discharge Test.* The battery must be operative and have the fuse removed for purposes of this test. The test must be conducted pn (1) a battery that has not been discharged, and (2) a battery that has completed the high temperature battery capacity test of §3.7. A battery must be forced discharged at a current load equal to that of the rating of the fuse used in the battery at a temperature not greater that −20°C isothermally for a period corresponding to the rated capacity of the battery. The battery condition must be monitored for 24 hours after the rated capacity of the battery has been reached.

3.10 *Total Discharge Test.* The battery must be operative and have the fuse removed for purposes of this test. The battery must be discharged at a temperature of 24° ± 3°C at a current level equal to that of the rating of the fuse used in the battery for a period corresponding to the rated capacity of the battery. Immediately thereafter, a direct short must be placed and left across the battery terminals. The battery condition must be monitored for 24 hours after the direct short has been applied.

APPENDIX A

The following definitions of terms are applicable to the Lithium Sulfur Dioxide Batteries Standard.

1.0 Definitions. For purposes of this standard, the following definitions apply:

"Battery" means an electrical energy source made up of one or more cells, arranged in electrical series or parallel or in a series-parallel combinations.

"Capacity" means the total amount of electrical energy, measured in ampere hours, that a cell can generate.

"Cell" means an individual electrochemical unit.

"Hermetic sealed cells" means that each cell is sealed in such a manner that over the useful life of the cell there is no loss of gaseous or solid material from the cell.

"Venting" means the controlled release of the electrolyte or any chemical reactant products, or both, from a cell.

"Venting violently" means the rapid uncontrolled discharge of either harmful gases or liquid, or both, from a cell accompanied by the generation of heat.

APPENDIX B

The following test procedures give details for demonstrating that the requirements of the Lithium Sulfur Dioxide Batteries Standard are met.

T-1 Vertification of safety relief mechanism (§2.3.1).

Equipment Required:

Calibrated iron constantan thermocouple, accurate to within ± 1°C.
Electric heating tape.
Recording potentiometer.

Test Procedure:

a. Attach a thermocouple to the surface of the metal cell case under test and attach the thermocouple to the recording potentiometer.

b. Wrap the circumference of the cell, not covering the ends, with the electric heating tape.

c. Increase the temperature of the cell at a linear rate of 10° ± 3°C per minute.

d. Continuously monitor the temperature of the cell case and record the temperature at which the cell(s) vent.

T-3 Operation of safety relief in encapsulating material (§2.4).

a. Expose the battery to environmental conditions which will cause the battery to vent (e.g., high temperature or direct short with the current limiting device inoperative).

b. The operation of the safety relief mechanisms and the encapsulation should bi observed.

c. Determine that the encapsulation material does not cause the battery to vent in a manner different than that of the cell tested in §T-1.

T-3 Heat transfer properties of the encapsulation material (§2.4).

Equipment Required:

Two calibrated thermocouples accurate to ± 1°C.
Two recording potentiometers.

Test Procedure:

a. Attach a load to an encapsulated battery with the fuse removed which will draw a current equal to the ampere rating of the fuse used in the battery.

b. Attach a load to an identical battery without encapsulation and with the fuse removed which will draw a current equal to the ampere rating of the fuse used in the battery.

c. Continuously monitor the temperature of both batteries. The room ambient temperature should be 24° ± 3°C.

d. Continue the test until the ampere hour rating of the cell is reached.

T-4 Hermetic seal test (§2.5).

Equipment Required:

Temperature-controlled oven.
Scale (accurate to 1 milligram).

Test Procedure:

a. Weigh each cell under test.
b. Place each cell in the temperature-controlled oven.
c. Raise the temperature to 71°C.
d. Maintain this temperature for 30 days.]

[e. Lower the temperature to ambient.

f. Remove the cells and weigh each cell

g. Compare the weight of each cell with the weight before the test.

T-5 Useful life (§2.7).

Equipment Required:

Temperature-controlled oven.

Test Procedure:

a. Place each battery in the temperature-controlled oven, seals pointed down so that the seal is covered by the electrolyte.

b. Raise the temperature to at least 40°C.

c. Maintain this temperature for 4 years plus the additional time for which useful life is desired to be demonstrated.

d. Lower the temperature and remove each battery.

e. Measure the remaining capacity of the cell in accordance with §T-6 of this Appendix.

T-6 Battery Capacity (§2.10).

Equipment Required:

Resistive load.
Data recorder.
Digital printer.
Digital voltmeter.

Test Procedure:

a. Attach a resistive load to the battery under test which will initially draw a current equivalent to the value of the fuse used in the battery in which the cell under test is to be used.

b. Monitor the voltage time until the end-voltage of the battery reaches 0.5 volts.

c. Calculate the cell capacity using the timed averaged voltage method. The formula for this method is

$$\overline{V} = \frac{1}{tco} \sum_{i=1}^{n-1} \frac{(V_i + V_{i+1})}{2} (t_{i+1} - t_i)$$

$$AH = \overline{V} \frac{tco}{R_L}$$

where:

V = Time averaged voltage
tco = Elapsed discharge time to cutoff in hours
V_i = Voltage at time t_i
V_{i+1} = Voltage at time t_{i+1}
t_i = Time in hours at which V_i was measured
t_{i+1} = Time in hours at which V_{i+1} was measured
AH = Discharged capacity
R_L = Load resistance in ohms]