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FEDERAL AVIATION AGENCY
FLIGHT STANDARDS SERVICE
Washington 25, D. C.

August 23, 1962

REGULATIONS OF THE ADMINISTRATOR DRAFT RELEASE NO. 62-40

SUBJECT: Technical Standard Order C73 "Airborne Static Electrical Power Inverter (For ~~Air Carrier~~ Aircraft)"

The Flight Standards Service of the Federal Aviation Agency has under consideration an amendment to Part 514 of the Regulations of the Administrator to add a new Technical Standard Order TSO-C73 "Airborne Static Electrical Power Inverter (For Air Carrier Aircraft)". The reasons therefor are set forth in the explanatory statement of the attached proposal which is being published in the Federal Register as a notice of proposed rule making.

The Flight Standards Service desires that all persons who will be affected by the requirements of the proposal be fully informed as to its effect upon them and is therefore circulating copies in order to afford interested persons ample opportunity to submit comments as they may desire.

Because of the large number of comments which we anticipate receiving in response to this draft release, we will be unable to acknowledge receipt of each reply. However, you may be assured that all comment will be given careful consideration.

It should be noted that comments should be submitted, preferably in duplicate, to the Docket Section of the Federal Aviation Agency, and in order to insure consideration must be received on or before October 15, 1962.

George C. Pratt

Director
Flight Standards Service

FEDERAL AVIATION AGENCY

FLIGHT STANDARDS SERVICE

(14 CFR 514)

[Regulatory Docket No. 775 ; Draft Release No. 62-40]

TECHNICAL STANDARD ORDERS FOR AIRCRAFT MATERIALS PARTS AND APPLIANCES

NOTICE OF PROPOSED RULE MAKING

Pursuant to the authority delegated to me by the Administrator (14 CFR 405) notice is hereby given that the Federal Aviation Agency has under consideration a proposal to amend Part 514 of the Regulations of the Administrator by adding a section 514.79 establishing minimum performance standards for airborne static electrical power inverter equipment which is to be used on air carrier aircraft. These standards are necessary to provide a basis for the approval of such equipment under the Technical Standard Order system.

A previous notice of proposed rule making setting forth minimum standards for airborne static electrical power inverter equipment was published in 26 F. R. 5472. However, based upon the comments received in reference to such notice it was determined that certain substantive changes were necessary to the proposed standards. In this connection, a new paragraph 2.12 specifying radio interference requirements has been added to the proposal. Accordingly, this proposal will replace the notice of proposed rule making, 26 F.R. 5472, which is hereby withdrawn.

Interested persons may participate in the making of the proposed rule by submitting such written data, views or arguments as they may desire. Communications should be submitted in duplicate to the Docket Section of the Federal Aviation Agency, Room A-103, 1711 New York Avenue, N..W., Washington 25, D. C. All communications received on or before October 15, 1962, will be considered by the Administrator before taking action on the proposed rule. The proposals contained in this notice may be changed in light of comments received. All comments submitted will be available in the Docket Section for examination by interested persons at any time.

This amendment is proposed under the authority of Sections 313(a) and 601 of the Federal Aviation Act of 1958 (72 Stat. 752, 775; 49 U.S.C. 1354(a), 1421).

In consideration of the foregoing it is proposed to amend Part 514 as follows:

By adding the following section 514.79:

§ 514.79 Airborne static electrical power inverter (for air carrier aircraft) - TSO-C73--(a) Applicability-- Minimum performance standards. Minimum performance standards are hereby established for airborne static electrical power inverter equipment which is to be used on civil aircraft of the United States engaged in air carrier operations. New models of airborne static electrical power inverter equipment manufactured for use on civil air carrier aircraft on or after the effective date of this section shall meet the standards set forth in FAA Standard, "Airborne Static Electrical Power Inverter", dated June 15, 1962.[1/]

(b) Marking. In addition to the markings specified in § 514.3(d), the equipment rating, as specified by the manufacturer, shall be shown.

(c) Data requirements. Six copies each, except where noted, of the following shall be furnished to the Chief, Engineering and Manufacturing Branch, Flight Standards Division, Federal Aviation Agency, 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.

1/ Copies may be obtained upon request addressed to Publishing and Graphics Branch, Inquiry Section, MS-158, Federal Aviation Agency, Washington 25, D. C.

June 15, 1962

FAA STANDARD
MINIMUM PERFORMANCE STANDARDS
AIRBORNE STATIC ELECTRICAL POWER INVERTER

1.0 GENERAL STANDARDS

1.1 Ratings of Components

The equipment shall not incorporate in its design any component of such rating that, when the equipment is operated throughout the range of the specified test, the ratings established by the manufacturer of the component are exceeded.

1.2 Effects of Test

The design of the equipment shall be such that the application of the specified test produces no condition which would be detrimental to the reliability of equipment manufactured in accordance with such design.

2.0 MINIMUM PERFORMANCE STANDARDS UNDER ENVIRONMENTAL TEST CONDITIONS

The environmental test procedures applicable to a determination of the performance of the airborne static electrical power inverter equipment are set forth in Appendix "A" of this paper.

2.1 Power Output

With rated input voltage, the power output shall not be less than that specified in the manufacturer's rating. In specifying the rating, the manufacturer shall also state:

(a) Output load power factor.

(b) Conditions of cooling required.

(c) Tolerance envelope for application and removal of rated loads.

(d) Conditions of loading.

The equipment shall be capable of delivering at least 10 percent more output power than the specified rating for a period of two (2) hours without damage.

2.2 Voltage Input

The rated input voltage, as measured at the inverter input terminals, shall be 28 volts d.c. The inverter shall:

(a) Be capable of continuous operation under full load without degradation of performance over an input voltage range of ±2 volts.

(b) Operate electrically at an input voltage of 20 volts.

(c) Withstand, without damage, input voltage transients of 88 volts for a time period of 1 millisecond.

2.3 Frequency

The frequency of the inverter under all conditions of load and test environment shall be 400 cycles per second ±5 percent at the input voltages specified in 2.2(a) and 2.2(b) above.

2.4 Voltage Output

The average phase output voltage, under the conditions of input specified in 2.2(a) and 2.2(b) above and under all conditions of test environment, shall be 115 volts a.c. +5 percent -10 percent.

2.5 Waveform

The output waveform shall be substantially sinusoidal and contain less than 7 percent harmonic distortion under all load conditions not exceeding 110 percent rated output.

2.6 Phase Balance

Output phase voltages, for three phase units, shall not be unbalanced by more than ±5 percent when applied to balanced loads within a power factor range of ±0.80. Displacement between phases shall be within the limits of $120^{\circ} \pm 5^{\circ}$.

2.7 Overload capacity

The inverter shall be capable of withstanding, without damage, a current overload of at least 150 percent for a time duration of five (5) minutes.

2.8 Input Overvoltage

The inverter shall be capable of withstanding, without damage, input overvoltage up to 130 percent of the rated input voltage for a time period of five (5) minutes while supplying full rated output power.

2.9 Short Circuit Condition

The inverter shall be capable of withstanding, without damage, an output short circuit applied separately to each phase or simultaneously to all phases for a time period of one minute. Within five (5) minutes after removal of the short circuit condition, the unit shall be energized and run continuously for a period of at least twenty (20) hours. During this period the unit shall, without degradation of performance, deliver the specified output.

2.10 Dielectric Strength

The equipment shall withstand, without damage, the application of 1,500 volts RMS 60 cycles between windings and between each winding and frame for a time period of one (1) minute.

NOTE: If this method of testing is not feasible, dielectric tests may be conducted on components prior to final assembly or with the critical components disconnected."

2.11 Altitude (To be conducted at room temperature)

The inverter shall be capable of providing continuous rated performance at an operating altitude of 30,000 feet. In addition, the unit shall provide rated performance at an altitude of 40,000 feet for a time period of two (2) minutes without damage.

2.12 Emission of Spurious Radio Frequency Energy

The levels of conducted and radiated spurious radio frequency energy emitted by the inverter shall not exceed those levels specified in Appendix A of RTCA Paper 120-61/DO-108[1]/ -

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1/ Copies of this paper may be obtained from the RTCA Secretariat, Room 1072, T-5 Building, 16th & Constitution Avenue, N.W. Washington 25, D.C., at a cost of 75 cents per copy.

APPENDIX A

ENVIRONMENTAL TEST PROCEDURES: ELECTRICAL EQUIPMENT

A. TEST EQUIPMENT STANDARDS

1. Test Facilities - The apparatus used in conducting the tests described in this Appendix should be capable of producing the specified environmental conditions. The equipment under test should not occupy more than 50 percent of the volume of the test chamber. Heat sources should be disposed so that radiant heat does not fall directly on the equipment under test.

2. Measurement Tolerances - Allowable tolerances on test condition measurements are as follows:

   (a) Temperature: Plus or minus 4° F.
   (b) Altitude : Plus or minus 5 percent.
   (c) Humidity : Plus or minus 5 percent relative.
   (d) Vibration Amplitude : Plus or minus 5 percent.
   (e) Vibration Frequency : Plus or minus 2 percent.

3. Temperature Stabilization - Temperature stabilization may be checked by a temperature sensing device in good thermal contact with the largest centrally-located internal mass in the equipment under test.

4. Deterioration - Deterioration or corrosion of any internal or external components which could in any manner prevent the continued safe operation of the equipment during its service life will constitute failure to meet the environmental test to which the equipment was subjected.

B. TEST PROCEDURES

1. High Temperature Test - The equipment shall be placed within the test chamber and the internal temperature of the chamber raised to 160° F. with an internal relative humidity of not more than 5 percent. The item of equipment shall be maintained at 160° F. for a period of 50 hours. While still at this temperature, the equipment shall be operated to determine compliance with the requirements of Paragraphs 2.1 through 2.10. The temperature shall then be reduced to prevailing room conditions and a visual examination conducted in accordance with Paragraph A.4.

2. Low Temperature Tests -

(a) Method 1 - The item of equipment shall be placed within the test chamber and the chamber cooled to and maintained at a temperature of -65° F. until temperature stabilization (See Paragraph A.3) of the equipment is reached. While at this temperature, the equipment shall be operated to determine compliance with the requirements of Paragraphs 2.1 through 2.10.

(b) Method II (alternate to Method 1) - The equipment shall be placed within the test chamber and the chamber cooled to and maintained at a temperature of -80° F. for a period of 48 hours, at which time the equipment shall be examined in accordance with Paragraph A.4. The temperature of the chamber shall then be raised to -65° F. and maintained for an additional 24-hour period, or until temperature stabilization is reached (See Paragraph A.3), whichever is the longer. At the conclusion of this exposure period, while at this temperature, the equipment shall be operated to determine compliance with the requirements of Paragraphs 2.1 through 2.10 and visually examined in accordance with Paragraph A.4.

3. Temperature Shock Tests -

(a) Method I - The equipment shall be placed within a test chamber wherein a temperature of 185° F. is maintained. The equipment shall be subjected to this temperature for a period of 4 hours, at the conclusion of which, and within 5 minutes, the equipment shall be transferred to a chamber having an internal temperature of -40° F. The equipment shall be subjected to this temperature for a period of 4 hours. This completes one cycle. The equipment may be restored to room temperature before starting the next cycle. The number of complete cycles shall be three. At the conclusion of the third cycle, the equipment shall be removed from the test chamber and within a period of one hour shall be operated to determine compliance with the requirements of Paragraphs 2.1 through 2.10. A visual examination shall then be completed in accordance with Paragraph A.4.

(b) Method II (alternate to Method I) - The equipment shall be placed within the test chamber and maintained for a period of at least one hour or until the equipment performance stabilizes at a temperature of $77^{\circ} \pm 27^{\circ}$ F. The chamber temperature shall then be reduced to -67° F. and maintained at this condition for at least one hour or until the equipment performance stabilizes. The internal temperature of the chamber shall then be increased to 160° F. and maintained at this condition for at least one hour or until the equipment performance stabilizes. The internal temperature shall then be returned to $77^{\circ} \pm 27^{\circ}$ F. The equipment shall then be operated to determine compliance with the requirements of Paragraphs 2.1 through 2.10.

4. Humidity Tests -

(a) Method I - The equipment shall be placed in the test chamber and set up to simulate installed conditions. The chamber temperature shall be between 68° F. and 100° F. with uncontrolled humidity. During the first 2-hour period the temperature shall be gradually raised to 160° F. The 160° F. temperature shall be maintained during the next 6-hour period. During the following 16-hour period, the temperature in the chamber shall be gradually reduced to between 68° F. and 100° F., which constitutes one cycle. The relative humidity throughout the cycle shall be not less than 95 percent. The cycle shall be repeated a sufficient number of times to extend the total time of the test to 240 hours (10 cycles). At the conclusion of the 240-hour period, the equipment shall be operated to determine compliance with the requirements of Paragraphs 2.1 through 2.10 and a visual examination made in accordance with Paragraph A.4. Distilled or demineralized water having a pH value of between 6.5 and 7.5 at 77° F. shall be used to obtain the desired humidity. The velocity of the air throughout the test area shall not exceed 150 feet per minute.

(b) Method II (alternate to Method I) - The equipment shall be placed in the test chamber and set up to simulate installed conditions. The temperature in the chamber shall be 120° F. and the relative humidity not less than 95 percent. The test conditions shall be maintained for 360 hours. At

the conclusion of this period, the equipment shall be operated to determine compliance with the requirements of Paragraphs 2.1 through 2.10. An examination in accordance with Paragraph A.4 shall then be made.

5. Altitude Test - The equipment shall be placed within the test chamber and the internal pressure of the chamber reduced to 34,500 feet. The ambient temperature in the chamber (irrespective of test altitude) shall be -65° F. The equipment shall be maintained at this condition until temperature stabilizes (See Paragraph A.3). While at this condition, the equipment shall be operated to determine compliance with the requirements of Paragraphs 2.1 through 2.10.

6. Vibration Tests -

(a) Method I (Applies to equipment which mounts directly on the structure of aircraft powered by reciprocating, turbo-jet or turbo-propeller engines and to equipment which mounts directly on gas turbine engines) - The test specimen shall be mounted on the apparatus in a manner which is dynamically similar to the most severe condition likely to be encountered in service. The test specimen shall be performing its function during the entire test period whenever practicable. At the end of the test period, the test specimen shall be inspected thoroughly for damage or defects resulting from the vibration tests. The amplitude or acceleration for the frequency cycling test shall be within ± 10 percent of the specified values. Vibration tests shall be conducted under both resonant and cycling conditions according to the following vibration test schedule (Table I):

TABLE I - VIBRATION TEST SCHEDULE

Types	Vibration at Room Temp. (Minutes)	Vibration at 160° F. (Minutes)	Vibration at -65° F. (Minutes)
Resonance	60	15	15
Cycling	60	15	15

(i) Resonance - Resonant frequencies of the test specimen shall be determined by varying the frequency of applied vibration slowly through the specified range of frequencies at vibratory accelerations not exceeding those shown in Figure I. Individual resonant frequency surveys shall be conducted with vibration applied along each of any set of three mutually perpendicular axes of the test speciment. Whenever practicable, functioning of the test specimen should be checked against the requirements of Paragraphs 2.1 through 2.10 concurrently with the operation of scanning the frequency range for resonant frequencies. The test specimen shall be vibrated at the indicated resonant conditions for the periods shown in the vibrations test schedule (Table I) and with the applied double amplitude or vibratory acceleration specified in Figure I. These periods of vibration shall be accomplished with vibration applied along each of three mutually perpendicular axes of vibrations. When more than one resonant frequency is encountered with vibration applied along any one axis, the test period may be accomplished at the most severe resonance or the period may be divided among the resonant frequencies, whichever is considered most likely to produce failure. However, in no instance shall the specimen be vibrated on any resonant mode for periods less than half as long as those shown for resonance in the vibration test schedule. When resonant frequencies are not apparant within the specified frequency range, the specimen shall be vibrated for periods twice as long as those shown for resonance in the vibration test schedule (Table I) at a frequency of 55 c.p.s. and an applied double amplitude of 0.060 inch.

(ii) Cycling - For test specimens mounted on vibration isolators, a vibration test shall be conducted with a constant applied double amplitude of 0.060 inch and the frequency cycling between 10 and 55 c.p.s. in one-minute cycles. Vibration shall be

applied along each of three mutually perpendicular axes according to the vibration test schedule (Table I). For specimens which are to be installed in aircraft without vibration isolators, a vibration test shall be conducted with the frequency cycling between 10 and 500 c.p.s. in 15-minute cycles at an applied double amplitude of 0.036 inch or an applied acceleration of ± 10g, whichever is the limiting value. Vibration shall be applied along each of three mutually perpendicular axes according to the vibration test schedule (Table I).

(b) Method II (Apply to equipment which mounts directly to reciprocating engines) - The test specimen shall be mounted on the apparatus in a position dynamically similar to the most severe mounting likely to be used in service. Resonant frequencies of the test specimen shall be determined by varying the frequency of applied vibration slowly through the specified frequency range at vibratory accelerations not exceeding those shown in Figure I. Individual resonant frequency surveys shall be conducted with vibration applied along each of any set of three perpendicular axes of the test specimen. Whenever practicable, the functioning of the test specimen should be checked against the requirements of Paragraphs 2.1 through 2.10 concurrently with the operation of scanning the frequency range for resonant frequencies. If resonant frequencies are encountered, the test specimen shall be vibrated successively along each of three mutually perpendicular axes for four hours at the resonant conditions with the applied double amplitude or vibratory acceleration shown in Figure I. When more than one resonant frequency is encountered with vibration applied along any one axis, the test period may be carried out at the most severe resonance, or the period may be divided uniformly among the resonant frequencies, whichever procedure is considered most likely to produce failure. When clearly defined resonant frequencies are not encountered within the specified frequency range, the test specimen shall be vibrated for 12 hours along each of its mutually perpendicular axes at an applied double amplitude of 0.018 inch and a frequency of 150 cycles per second. The test specimen shall be performing its function during the entire test period whenever practicable. At the end of the test period the test specimen shall be inspected thoroughly for damage or defects resulting from the vibration tests.

7. Shock Test - The equipment shall be subjected to the shock conditions as normally used in service, including any shock mount assembly. A check testing machine conforming to Military Specification MIL-S-4456 is suitable for this test.

The test specimen should be subjected to 18 impact shocks of 10g, each shock impulse having a time duration of 11 ± 1 milliseconds. The intensity should be within ±10 percent when measured with a filter having a band width of 5 to 100 cycles per second. The maximum g should be reached in approximately 5½ milliseconds. The shock should be applied in the following directions:

(a) Vertically, 3 shocks in each direction.

(b) Parallel to the major horizontal axis, 3 shocks in each direction.

(c) Parallel to the minor horizontal axis, 3 shocks in each direction.

The test specimen should not suffer damage.

The equipment shall be operated to determine compliance with the requirements of Paragraphs 2.1 through 2.10.

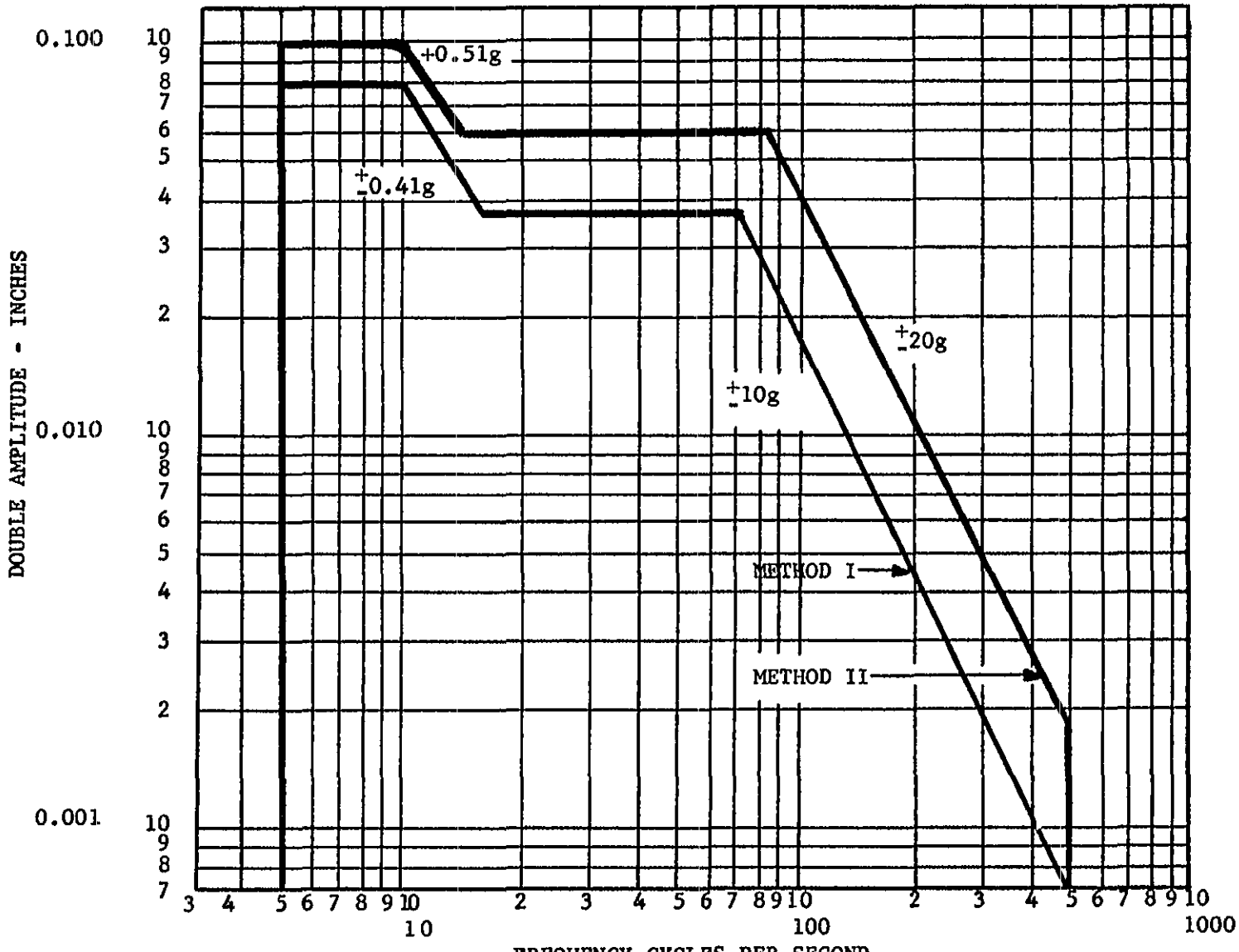


Figure I - Range Curves for Vibration Tests