FEDERAL AVIATION AGENCY
Washington 25, D. C.

TECHNICAL STANDARD ORDER

Regulations of the Administrator

Part 514

Subject: AIRBORNE STATIC ("DC TO DC") ELECTRICAL POWER CONVERTER (FOR AIR CARRIER AIRCRAFT) TSO-C71

Technical Standard Orders for Aircraft Materials, Parts, Processes, and Appliances

Part 514 contains minimum performance standards and specifications of materials, parts, processes, and appliances used in aircraft and implements the provisions of sections 3.18, 4a.31, 4b.18, 6.18 and 7.18 of the Civil Air Regulations. The regulation uses the Technical Standard Order system which, in brief, provides for FAA-industry cooperation in the development of performance standards and specifications which are adopted by the Administrator as Technical Standard Orders, and a form of self-regulation by industry in demonstrating compliance with these orders.

Part 514 consists of two subparts. Subpart A contains the general requirements applicable to all Technical Standard Orders. These provisions are summarized below for the convenient reference of the public. Subpart B contains the technical standards and specifications to which a particular product must conform, and each Technical Standard Order is set forth in the appropriate section of Subpart B. The subject Technical Standard Order is printed below. ANY TECHNICAL STANDARD ORDER MAY BE OBTAINED BY SENDING A REQUEST TO FAA, WASHINGTON 25, D.C.

Subpart A—GENERAL

This subpart provides, in part, that a manufacturer of an aircraft material, part, process, or appliance for which standards are established in Subpart B, prior to its distribution for use on a civil aircraft of the United States, shall furnish a written statement of conformance certifying that the material, part, process, or appliance meets the applicable performance standards established in this part. The statement of conformance must be signed by a person duly authorized by the manufacturer, and furnished to the Chief, Engineering and Manufacturing Division, Bureau of Flight Standards, Federal Aviation Agency, Washington 25, D.C.

Subpart A also requires appropriate marking of materials, parts, processes, and appliances as follows:

(*a*) Name and address of the manufacturer responsible for compliance,

(*b*) Equipment name, or type or model designation,

(*c*) Weight to the nearest pound and fraction thereof,

(*d*) Serial number and/or date of manufacture, and

(*e*) Applicable Technical Standard Order (TSO) number.

In addition, Subpart A provides that no deviation will be granted from the performance standards established in Subpart B, and that the Administrator may take appropriate action in the event of noncompliance with Part 514.

Subpart B

§ 514.77 *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 aircraft on or after June 15, 1961, 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.[1] Manufacturers of such equipment shall also comply with the requirements of paragraphs (b), (c), and (d) for acceptance of their equipment under this section.

(*b*) *Marking.* In addition to the marking specified in Subpart A, 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 Division, Bureau of Flight Standards, Federal Aviation Agency, Washington 25, D.C.

(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. 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.* Airborne static ("DC to DC") electrical power converter equipment aproved prior to June 15, 1961, may continue to be manufactured under the provisions of its original approval.

(*f*) *Effective date.* June 15, 1961.

[1] Copies of RTCA Paper 100–54/DO–60 may be obtained from the RTCA Secretariate, Room 1072, T–5 Building, 16th & Constitution Avenue, N.W., Washington 25, D.C., for 20c per copy.

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Subject: AIRBORNE STATIC ("DC TO DC") ELECTRICAL POWER CONVERTER (FOR AIR CARRIER AIRCRAFT) TSO-C71

The date of the FAA Standard, which is a part of the subject TSO, was inadvertently omitted. The date April 15, 1961, should be inserted in the upper right hand corner of the FAA Standard.

ABOVE

FAA STANDARD
FOR
AIRBORNE STATIC ("DC TO DC") ELECTRICAL POWER CONVERTER

INTRODUCTION

This paper sets forth the minimum performance standards for airborne static ("DC to DC") electrical power converter equipment when used as a part of a navigation or communication system.

Compliance with these standards is required as a means of assuring that the equipment will satisfactorily perform its intended function under all conditions normally encountered in routine aeronautical operations.

Inasmuch as the measured values of radio equipment performance characteristics may be a function of the method of measurement, standard test conditions and methods of test are also recommended in this paper.

MINIMUM PERFORMANCE STANDARDS
AIRBORNE STATIC ("DC TO DC") ELECTRICAL POWER CONVERTER

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 environmental test, the ratings established by the manufacturer of the component is exceeded.

1.2 *Effects of Test*

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

2.0 MINIMUM PERFORMANCE STANDARDS UNDER STANDARD TEST CONDITIONS

The test procedures applicable to a determination of the performances of the airborne static ("DC to DC") electrical power converter equipment are set forth in Appendix "A" of this paper.

2.1 *Nominal Output Voltage and Current*

The nominal output voltage and current shall not be less than that specified by the manufactuer's ratings. Further, the equipment shall be capable of delivering at least 10% more output power than the manufacturer's specified rating for a period of two (2) hours.

2.2 *Regulation*

Regulation under standard conditions shall not exceed 12%. For the purpose of this standard, regulation is defined as:

$$\% \text{ Reg} = \frac{\text{(Voltage at 20\% of load)} - \text{(Voltage at maximum rated load)}}{\text{(Voltage at maximum rated load)}} \times (100\%)$$

2.3 *Ripple*

Ripple in the output DC voltage at maximum rated output load shall not exceed $\frac{1}{10}\%$ of the output voltage when shunted by a 2 mfd capacitor and the ripple on the DC input leads is equal to 2 volts peak to peak at a frequency of 400 cps. For equipment designed for operation on 13.75 volts DC, the ripple on the input leads need not exceed 1 volt peak to peak.

2.4 *Over Voltage*

There shall be no permanent damage to any of the solid state devices (transistors) or the components when the power converter is delivering full rated output power and is subjected to the following over voltage conditions:

(*a*) The input DC voltage is increased to 50% above the standard operating voltage for a duration of not less than five minutes.

2.5 *Short Circuit Conditions*

There shall be no degradation of the power converter or its components as a result of a sustained short circuit applied separately to each output of a multiple output power converter, or simultaneously to all DC outputs for a period of not less than one minute. Within five minutes after removal of the short circuit condition, the equipment shall be capable of continuous operation at the manufacturer's rated output load for a period of eight hours without degradation of performance.

2.6 *Emission of Radio Frequency Energy*

The emission of radio frequency energy at discreet frequencies within the range of 90 kc to 1500 Mc shall not exceed 200 microvolts between any cable terminal to ground.

Note: It is recognized that the radio frequency emissions having a level considerably less than the maximum permitted by the above standard are capable of interfering with the operation of other electronic equipment in an aircraft installation. It is also recognized that the method of reducing the level of emission of radio frequency energy to much lower values are known. However, at the present state of the art, large and expensive filters are often required in addition to the exercise of care in the mechanical and electrical design of equipment. The end result is often a compromise between what is desired and cost.

In view of the above, the emission standards were set at a level which can be met by the exercise of reasonable care in design and yet effect the reduction in the present overall interference problem. Lower emission levels are desirable and it is, therefore, recommended that the equipment manufacturers make a determined effort to reduce the level of emission from electronic equipment to the lowest practicable value below that specified above.

2.7 *Dielectric Strength*

The equipment shall withstand without evidence of damage the application of a sinusoidal voltage between each transformer output winding and frame for a period of five seconds. The RMS value of the sinusoidal voltage applied shall be either five times the maximum operating voltage existing across that winding during operation when delivering full rated output, or 500 volts, whichever is greater. During the application of this test, all diodes, transistors, and capacitors may be disconnected.

3.0 MINIMUM PERFORMANCE STANDARDS UNDER ENVIRONMENTAL TEST CONDITIONS

The test procedures applicable to a determination of the performance of radio equipment under environmental test conditions are set forth in RTCA Paper 100–54/DO–60, "Environmental Test Procedures—Airborne Radio Equipment," and amendment Paper 256–58/EC–366 dated November 13, 1958. This paper outlines environmental test procedures for equipment designed to operate under three environmental test conditions as specified therein under Procedures A, B, and C. Only airborne static ("DC to DC") electrical power converter equipment which meets the operating requirements outlined under Procedure A or Procedure B of this paper, as amended, is applicable under this standard.

The applicable electrical test procedures are set forth in Appendix "A" of this standard.

3.1 *Low Temperature Test*

When the equipment is subjected to the low temperature test and, with primary power voltage 10% less than standard test voltage applied, the following requirements shall be met:

(*a*) The output voltage shall not vary more than 12½% from that obtained at standard test conditions.

(*b*) The requirements of paragraph 2.3 shall be met.

3.2 *Altitude Test*

When the equipment is subjected to the altitude test, the requirements of paragraphs 2.1, 2.2, and 2.3 shall be met.

3.3 *Humidity Test*

After subjection to humidity and within fifteen (15) minutes from the time primary power is applied, the requirements of 2.1, 2.2, and 2.3 shall be met.

3.4 *High Temperature Test*

When the equipment is subjected to the high temperature test and with primary power volt-

age 10% higher than standard test voltage applied, the following requirements shall be met:

(*a*) The output voltage shall not vary more than 12½% from that obtained at standard test conditions.

(*b*) The requirements of paragraphs 2.1, 2.2, and 2.3 shall be met.

3.5 *Temperature Variation Test*

When the equipment is subjected to the temperature variation tests, the requirements of paragraphs 2.2 and 2.3 shall be met.

3.6 *Vibration Test*

When the equipment is subjected to the vibration test, the requirements of paragraphs 2.2 and 2.3 shall be met.

3.7 *Shock Test*

(*a*) Following the application of 15 G shocks, the requirements of paragraphs 2.2 and 2.3 shall be met.

(*b*) Following the application of 30 G shocks, the power converter shall have remained in its mounting by its intended means and no parts of the equipment or its mounting shall have become detached and free from the equipment.*

3.8 *Low Voltage Test*

(*a*) When the primary power voltage(s) is 80% of the standard test voltage(s), the equipment shall operate electrically.

(*b*) Gradual reduction of the primary voltage(s) from 80% to 50% of standard test voltage(s) shall produce no condition detrimental to the reliability of the equipment.

(*c*) Gradual reduction of the primary power voltage(s) from 50% to 0% of standard test voltage(s) shall produce no evidence external to the equipment of the presence of fire or smoke.*

*These tests may be conducted after other tests are completed.

APPENDIX A

TEST PROCEDURES

AIRBORNE STATIC ("DC TO DC") ELECTRICAL POWER CONVERTER

A. ***Power Input Voltage*** Unless otherwise specified, all tests shall be conducted with the power input voltage adjusted to the design voltage within ±2%. The input voltage shall be measured at the power converter input terminals.

Note: Design voltages in use as of the date of this report are 13.75 VDC and 27.5 VDC and defined as standard condition.

B. ***Adjustment of Equipment.*** The equipment under test shall be properly adjusted in accordance with the manufacturer's recommended practices prior to the application of the specified tests.

C. ***Test Equipment Precautions.*** Due precautions shall be taken during the conduct of these tests to prevent the introduction of errors resulting from the improper connection of voltmeters, oscilloscopes and other test instruments across the input and output impedances of the equipment under test.

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

E. ***Warm-up Period.*** Unless otherwise speccified, all tests shall be conducted after a warm-up period of not less than fifteen (15) minutes.

F. ***Connected Loads.*** Unless otherwise specified, all tests shall be performed with the equipment connected to loads having the impedance value for which it is designed.

TEST PROCEDURES

The test procedures set forth below are satisfactory for use in determining the performance of airborne static ("DC to DC") electrical power converter equipment. Test procedures which provide equivalent information may also be used.

T–1 Power Output

EQUIPMENT REQUIRED

Voltmeter—Weston Model 931 or equivalent.

Ammeter—Weston Model 931 or equivalent.

MEASUREMENT PROCEDURE

Connect the power converter to the appropriate input power source with the ammeter in series with the output and the voltmeter connected across the output. The manufacturer's specified load shall be connected across the output(s). The output load impedance should be adjusted to the manufacturer's specified rating.

Determine that the nominal output voltage and current is at least that specified by the manufacturer and that the equipment is capable of delivering at least 10% more output power than the manufacturer's specified rating for a period of two (2) hours.

T–2 Regulation

EQUIPMENT REQUIRED

Voltmeter—Weston Model 931 or equivalent.

Ammeter—Weston Model 931 or equivalent.

MEASUREMENT PROCEDURE

Connect the power converter to the appropriate input power source with the ammeter in series with the output and the voltmeter connected across the output. The manufacturer's rated load should be connected across the output(s).

Vary the load impedance from maximum rated load to 20% of maximum rated load and note the output voltage(s) at these two load settings. Calculate the percent regulation using the formula specified in paragraph 2.2.

T–3 Ripple

EQUIPMENT REQUIRED

Hewlett Packard Oscilloscope Model 150A or equivalent.

MEASUREMENT PROCEDURE

Connect the power converter to the appropriate input power source with the power converter delivering maximum rated load. Also connect a two (2) microfarad capacitor of the proper DC working voltage across the output under test.

Using the oscilloscope as a peak to peak voltage indicating device, measure the ripple on the output power source and all output voltage(s) when ripple on the DC input leads is equal to 2 volts peak to peak at a frequency of 400 cps or 1 volt peak to peak, whichever is applicable.

T–4 Overvoltage

EQUIPMENT REQUIRED

Perkins Power Supply Model MR 1040–30A or equivalent.

MEASUREMENT PROCEDURE

(*a*) Connect the equipment to the Perkins Model MR 1040–30A power supply with the equipment delivering full rated output power. Increase the output voltage from the Model MR 1040–30A power supply to 50% greater than the input voltage for which the equipment is designed for a duration of five (5) minutes.

(*b*) Following this, determine that the output voltage and current is the same as that prior to the application of the overvoltage.

T–5 Short Circuit Conditions

EQUIPMENT REQUIRED

Voltmeter—Weston Model 931 or equivalent.

Ammeter—Weston Model 931 or equivalent.

MEASUREMENT PROCEDURE

With the power converter connected to the appropriate input power source and the equipment delivering full rated output power, apply a sustained short circuit separately to each output of multiple output power converters or simultaneously to all DC outputs for a period of not less than one (1) minute.

Following this, determine that the equipment is capable of delivering the manufacturer's rated output power for a period of at least eight (8) hours.

This test shall be conducted after the overvoltage test specified in *T–4, Overvoltage*, is completed.

T–6 Emission of Radio Frequency Energy

EQUIPMENT REQUIRED

Noise and Field Strength Meters as follows:

Stoddard Models NM–20B, NM–5A, NM–10A, and NM–50A or equivalent.

MEASUREMENT PROCEDURE

Connect the power converter to the appropriate input power source with the equipment delivering full rated output power. The input power leads shall be from 10 to 12 feet in length, normally terminated and cabled, and shall not be enclosed in conduit.

With the noise meter, measure the rf voltage developed between ground and each of the primary input and power output leads, tuning the noise meter throughout the range of frequencies from 90 kc to 1500 Mc.

T–7 Dielectric Strength

EQUIPMENT REQUIRED

Variable AC power source.

MEASUREMENT PROCEDURE

(*a*) Apply an a-c voltage, at the frequency used in normal operation, between each transformer output winding and frame for a period of five (5) seconds. The RMS value of the sinusoidal voltage applied shall be either five (5) times the maximum operating voltage existing across that winding during operation when delivering full rated output, or 500 volts, whichever is greater.

(*b*) Following this, determine that the output voltage and current under full load conditions is the same as that prior to the application of the tests.