Department of Transportation
Federal Aviation Administration
Aircraft Certification Service
Washington, DC

TSO-C16a

Effective
Date: 10/06/06

Technical Standard Order

Subject: ELECTRICALLY HEATED PITOT AND PITOT-STATIC TUBES

1. PURPOSE. This technical standard order (TSO) is for manufacturers applying for a TSO authorization (TSOA) or letter of design approval (LODA). In it, we (the Federal Aviation Administration, or FAA) tell you what minimum performance standards (MPS) your electrically heated pitot and pitot-static tubes must meet for approval and identification with the applicable TSO marking.

2. APPLICABILITY.

a. This TSO affects new applications submitted after its effective date. The standards apply to the following basic types:

- Type I - Pitot pressure, straight and L-shaped, electrically heated.
- Type II - Pitot and static pressures, straight and L-shaped, electrically heated.

b. All prior revisions to this TSO are no longer effective. Generally we will not accept applications after the effective date of this TSO. However we may do so up to six months after it, if we know that you were working against the earlier MPS before the new change became effective.

c. Electrically heated pitot and pitot-static tubes currently approved under a previous TSOA may still be manufactured under the provisions of the original approval.

d. Major design changes to a tube manufactured under this TSO will require a new authorization. See Title 14 of the Code of Federal Regulations (14 CFR) § 21.611(b).

3. REQUIREMENTS. New models of electrically heated pitot and pitot-static tubes identified and manufactured on or after the effective date of this TSO must meet the MPS in appendix 1 of this TSO and the requirements in SAE International's Aerospace Standard (AS) 8006, *Minimum Performance Standard for Pitot and Pitot-Static Tubes*, dated April 28, 1988, Sections 1, 2, 3, 4, and 5, as amended by appendix 1 of this TSO.

a. Functionality. This TSO's standards apply to electrically heated pitot and pitot-static tubes, heated by aircraft electrical power, and intended to provide pitot and/or static pressure.

b. Environmental Qualification. Test the pitot and pitot-static tube according to appendix 1 of this TSO, and RTCA Inc. document (RTCA/DO)-160E, *Environmental Conditions and Test Procedures for Airborne Equipment*, dated December 9, 2004.

c. Deviations. We have provisions for using alternate or equivalent means of compliance to the criteria in the MPS of this TSO. If you invoke these provisions, you must show that your electrically heated pitot and pitot-static tube maintains an equivalent level of safety. Apply for a deviation under 14 CFR § 21.609 before submitting your data package.

4. MARKING. Mark at least one major component permanently and legibly with all the information in 14 CFR § 21.607(d), and the identification information required in SAE AS8006. You may use the manufacturer's trademark or contractor and government entity (CAGE) code instead of the manufacturer name and address. Mark the article's date of manufacture.

a. Include the "Type I" or "Type II" of the pitot and pitot-static tube in the marking.

b. Include the nominal rated voltage of the pitot and pitot-static tube in the marking.

c. In addition to the requirements of 14 CFR § 21.607(d), mark the following permanently and legibly marked with at least the name of the manufacturer, manufacturer's sub-assembly part number, and the TSO number:

(1) Each component that is easily removable (without hand tools),

(2) Each interchangeable element, and

(3) Each separate sub-assembly of the article that the manufacturer determines may be interchangeable.

d. If applicable, identify deviations granted to the equipment by marking "Deviation. See installation/instruction manual (IM)" after the TSO number. You can abbreviate the marking to "(Dev. See IM)."

e. When applicable, identify the component or equipment as an incomplete system, or state that the article performs additional functions beyond that described in paragraph **3.a** of this TSO.

f. Optional marking is permitted to allow use of aircraft-specific or operational-specific installation limitations, such as: **"FOR USE ON {insert aircraft type or serial number} ONLY,**" or **"FOR USE ON AIRCRAFT USED IN PART {insert number} OPERATIONS ONLY,"** or **"SEE DRAWING NO. XYZ FOR INSTALLATION LIMITATIONS."**

5. APPLICATION DATA REQUIREMENTS. As a TSO manufacturer-applicant, you must give the FAA aircraft certification office (ACO) manager responsible for your facilities a statement of conformance, as specified in 14 CFR § 21.605(a)(1), and one copy each of the following technical data, as generated by the TSO manufacturer-applicant, to support our design and production approval. (Under 14 CFR § 21.617(a)(2), LODA applicants submit the same data through their civil aviation authority:)

a. Operating instructions and limitations in an IM, sufficient to describe the pitot and pitot-static tube operational capability. If needed, identify equipment by part number, version, revision, and criticality level of software/hardware, classification for use, and environmental categories.

b. Installation procedures and limitations in an IM, sufficient to ensure that the electrically heated pitot and pitot-static tube, when installed according to installation procedures, still meets this TSO's requirements. Limitations must identify any unique aspects of the installation. Finally, the limitations must include a note with the following statement:

> The conditions and tests for TSO approval of this pitot and pitot-static tube are minimum performance standards. Those installing this pitot and pitot-static tube on or in a specific type or class of aircraft must determine that the aircraft installation conditions are within the TSO standards. TSO articles must have separate approval for installation in an aircraft. The article may be installed only according to 14 CFR part 43 or the applicable airworthiness requirements.

c. Schematic drawings of the installation procedures.

d. Wiring diagrams of the installation procedures.

e. List of components by part number that make up the pitot and pitot-static tube complying with the standards of this TSO. Include vendor part number cross-references when applicable.

f. A component maintenance manual (CMM) covering periodic maintenance, calibration, and repair, for the continued airworthiness of installed pitot and pitot-static tubes. Include recommended inspection intervals and service life.

h. The quality control system (QCS) description required by 14 CFR §§ 21.143(a) and 21.605(a)(3), including functional test specifications. The QCS tests each production article to ensure compliance with this TSO. The QCS should ensure that you will detect any change to the equipment that could adversely affect compliance with the TSO MPS, and reject the item accordingly. (Not required for LODA applicants).

i. Manufacturer's TSO qualification test report.

j. Nameplate drawing with the information required in paragraph **4** of this TSO.

k. List of all drawings (including revision level) to define the pitot and pitot-static tube's design. For a minor change, follow the directions in 14 CFR § 21.611(a). Show any revisions to the drawing list only on our request.

l. An environmental qualification form describing the environmental tests conducted under appendix 1 of this TSO, SAE AS8006, and RTCA/DO-160E.

6. MANUFACTURER DATA REQUIREMENTS. Besides the data given directly to us, have the following technical data available for review, by the responsible ACO or civil aviation authority:

a. The functional qualification specifications to be used to qualify each production article to ensure compliance with this TSO.

b. Equipment calibration procedures.

c. Corrective maintenance procedures within 12 months after TSO authorization or LODA.

d. Schematic drawings.

e. Wiring diagrams.

f. The results of qualification tests conducted by appendix 1 of this TSO, and SAE AS8006.

g. Material and process specifications.

7. FURNISHED DATA REQUIREMENTS. If furnishing one or more pitot and pitot-static tubes manufactured under this TSO to one entity (such as an operator or repair station), send one copy of the data and information specified in paragraphs **5.a** through **5.f** of this TSO. Add any other data needed for the proper installation, certification, use, or for continued airworthiness of the pitot and pitot-static tubes.

8. HOW TO GET REFERENCED DOCUMENTS.

a. Order SAE documents from SAE International, 400 Commonwealth Drive, Warrendale PA 15096. Telephone (724) 776-4970; or fax (724) 776-0790. You can also order copies online at www.sae.org.

b. Order RTCA documents from RTCA Inc., 1828 L Street NW, Suite 805, Washington DC 20036-4001. Telephone (202) 833-9339, fax (202) 833-9434. You can also order them online at www.rtca.org.

c. Order British Standards Institution (BSI) documents from British Standards Institution, 389 Chiswick High Road, London, United Kingdom W4 4AL. Telephone 011-44-208-9967555, or fax 011-44 208-9967001. You can also contact BSI online and order documents at www.bsonline.bsi-global.com.

d. Order copies of 14 CFR part 21, Subpart O, from the Superintendent of Documents, Government Printing Office, P.O. Box 37154, Pittsburgh, PA 15250-7954. You can also order online at www.access.gpo.gov. Select “Access,” then “Online Bookstore.” Select “Aviation,” then “Code of Federal Regulations.”

e. You can find a current list of technical standard orders and advisory circulars on the FAA Internet website Regulatory and Guidance Library at www.airweb.faa.gov/rgl. You will also find the TSO Index of Articles at the same site..

/s/ ***David W. Hempe***

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APPENDIX 1. MINIMUM PERFORMANCE STANDARD FOR ELECTRICALLY HEATED PITOT AND PITOT-STATIC TUBES

1. You can improve the performance of specific equipment, or make it superior to this specification, depending on your intended application and configuration. This TSO modifies SAE AS 8006, Sections 1, 3, and 5 as follows:

FAA Modifications to AS8006

AS8006	*FAA Modification*
Section 1	**Replace** "…for subsonic transport aircraft." **Substitute:** "…for use in civil aircraft."
Section 3.3	**Replace** "Materials shall be corrosion–resistant and suitably treated to resist corrosion due to atmospheric conditions and salt spray. Non-magnetic materials shall be used for all parts except where magnetic materials are essential. Non-ferrous materials shall be used for all parts except where ferrous materials are essential." **Substitute:** "Materials must be shown by experience or tests to be suitable and dependable. Materials must be corrosion–resistant and suitably treated to resist corrosion due to atmospheric conditions and salt spray."
Section 3.4.2	**Delete** "The minimum drain hole size is 0.029 in (0.74mm)."
Section 3.4.5	**Delete** Section 3.4.5 of AS8006, and renumber the remaining paragraphs in section 3 of AS8006 accordingly.
Section 3.4.9	**Delete** Section 3.4.9 of AS8006, and renumber the remaining paragraphs in section 3 of AS8006 accordingly.
Section 3.4.10	**Delete** "The heater shall be regulated automatically in such a manner that the power dissipation through the heater will be an inverse function of the heating element temperature."
Section 3.5.7	**Delete** "Initial power surge shall not exceed four times the rated power under deicing conditions."
Section 3.5.7	**Add** at the end of Section 3.5.7 of AS8006: "Provide instructions for installation limitations in component

	maintenance manual (CMM). Require the use of properly rated circuit breaker for the sensor installation."
Section 3.7	**Replace** "Pitot pressure and static pressure tube lines shall be identified by the letters "P" and "S", respectively, which shall be stamped, edged, or engraved on the fittings or couplings." **Substitute:** "Identify pitot pressure and static pressure tube lines by the letters "P" and "S" respectively. Stamp, edge or engrave the letters on the lines or fittings."
Section 4.5	**Replace** "After the 5 min period, the power shall be measured and shall not exceed 60% of rated power for operation under deicing conditions specified in 5.4." **Substitute:** "After the 5-minute period, measure the power. The heater will operate according to the conditions specified on the probe's specification control drawing."
Section 5	**Replace** "Representative samples shall be subjected to whatever tests the manufacturer deems necessary to demonstrating compliance with the requirements of this specification, but as a minimum must include the following tests on at least one sample." **Substitute:** "Manufacturers must subject representative samples to whatever tests they deem necessary to demonstrate compliance with this specification. As a minimum they must include the following tests."
Section 5.4	**Replace** "At the conclusion of the tests, any moisture accumulating in the pitot connection line shall be removed and measured and shall not exceed 1 gram." **Substitute:** "Any moisture accumulating inside the probe must not freeze or affect the pressure measurements."
Section 5.4	**Use the following** for the de-icing and anti-icing tests in place of the temperature and liquid water content requirements of Section 5.4 of SAE AS8006: "Use test conditions defined in 14 CFR part 25, Appendix C (b) *Intermittent maximum icing*, for the icing test conditions. Specifically, three conditions should be accomplished at a drop diameter of 20 micron: a liquid water content of 2.2 grams per cubic meter at an ambient

	temperature of -10 degrees C or colder, a liquid water content of 1.7 grams per cubic meter at an ambient temperature of -20 degrees C or colder, and a liquid water content of 1.0 grams per cubic meter at an ambient temperature of -30 degrees C or colder. Accomplish the icing test at a voltage 10% below the nominal rated voltage. In addition, use the liquid water content tests of the supercooled liquid water test No.1 of paragraph 8.7.2(1), and test No.2 of paragraph 8.7.2(2) of the British Standards Institution (BSI) 2G 135, *Electrically-Heated Pitot and Pitot-Static Pressure Heads*, dated January 01, 1967, Section 8.7, and Amendment 1, dated July 31, 1973 (R 1998). Accomplish this icing test at a voltage 10% below the nominal rated voltage."
Section 5.5	**Delete** "Initial power surge shall not exceed four times the deicing rated power."
Section 5.11	**Add:** "Section 5.11 Magnetic Effect: Determine the magnetic effect of the tube in terms of the deflection of a free magnet approximately 1-1/2 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 12 inches from the center of the magnet. (An aircraft compass with the compensating magnets removed may be used as the free magnet for this test.) The maximum deflection for the free magnet must not exceed 5 degrees from any indication or reference position."

2. Use AS8006 and RTCA DO-160E for environmental testing.

a. Replace all references of RTCA/DO-160B in AS8006 with RTCA/DO-160E.

b. Add to AS8006 the following for temperature and altitude tests: RTCA/DO-160E, Section 4, Temperature and Altitude Tests.