



Number: CTSO-C20a

Date of approval: Apr 29,2019

Approved by: Xu Chaoqun

China Civil Aviation Technical Standard Order

This China Civil Aviation Technical Standard Order (CTSO) is issued according to Part 37 of the China Civil Aviation Regulations (CCAR-37). Each CTSO is a criterion which the concerned aeronautical materials, parts or appliances used on civil aircraft must comply with when it is presented for airworthiness certification.

Combustion Heaters and Accessories

1. Purpose.

This China Civil Aviation Technical Standard Order (CTSO) is for manufacturers applying for Combustion Heaters and Accessories CTSO authorization (CTSOA). This CTSO prescribes the minimum performance standards(MPS) that Combustion Heaters and Accessories must first meet for approval and identification with the applicable CTSO marking.

2. Applicability.

This CTSO affects new application submitted after its effective date. Major design changes to article approved under this CTSO will require a new authorization in accordance with section 21.353 of CCAR-21R4.

3. Requirements

New models of Combustion Heaters and Accessories identified and manufactured on or after the effective date of this CTSO must meet the MPS qualification and documentation requirements in SAE International's Aerospace Standard AS8040B, Heater-Aircraft Internal Combustion Heat Exchanger Type, dated February 2013, as amended by appendix 1 and 2 of this TSO.

a. Functionality.

This CTSO's standards apply to equipment intended to provide heated air for civil aircraft.

b. Failure Condition Classifications.

(1) Failure of the function defined in paragraph 3.a is a major failure condition.

(2) Loss of the function defined in paragraph 3.a is a minor failure condition.

(3) Design the system to at least these failure condition classifications.

Note: The maintenance and inspection of the combustion heaters and accessories for the continued airworthiness plays an important role in preventing combustion products from entering the cabin/cockpit.

c. Functional Qualification.

Demonstrate the required functional performance under the test

conditions in appendix 1 of this CTSO.

d. Environmental Qualification.

Demonstrate the required performance under the test conditions in appendix 1 of this CTSO, using standard environmental conditions and test procedures appropriate for airborne equipment.

Note: The use of RTCA/DO-160D (with Changes 1 and 2 only, incorporated) or earlier versions is generally not considered appropriate and will require substantiation via the deviation process as discussed in paragraph 3.g of this CTSO.

e. Software Qualification.

If the article includes software, develop the software according to RTCA/DO-178C, Software Considerations in Airborne Systems and Equipment Certification, dated December 13, 2011, to at least the software level consistent with the failure condition classification defined in paragraph 3.b of this CTSO.

Note: The certification liaison process objectives will be considered satisfied after CAAC reviews of the applicable life cycle data.

f. Electronic Hardware Qualification.

If the article includes complex custom airborne electronic hardware, develop the component according to RTCA/DO-254, dated April 19, 2000, Design Assurance Guidance for Airborne Electronic Hardware, to at least the design assurance level consistent with the failure condition

classification defined in paragraph 3.b of this CTSO. For custom airborne electronic hardware determined to be simple, RTCA/DO-254, paragraph 1.6 applies.

g. Deviations.

CAAC has provisions for using alternate or equivalent means of compliance to the criteria in the MPS of this CTSO. If the applicant invokes these provisions, the applicant must show that the equipment maintains an equivalent level of safety. Apply for a deviation under the provision of 21.368(a) in CCAR-21R4.

4. Marking.

a. Mark at least one major component permanently and legibly with all the information in 21.423(b) of CCAR-21R4. The marking must include the serial number.

b. Also, mark the following permanently and legibly, with at least the manufacturer's name, subassembly part number, and the CTSO number:

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

(2) Each subassembly of the article that manufacturer determined may be interchangeable.

c. If the article includes software and/or airborne electronic hardware,

then the article part numbering scheme must identify the software and airborne electronic hardware configuration. The part numbering scheme can use separate, unique part numbers for software, hardware, and airborne electronic hardware.

d. If the Combustion Heater includes a deviation per paragraph 3.g of this TSO, the marking must include a means to indicate a deviation was granted.

5. Application Data Requirements.

The applicant must furnish the responsible certification personnel with the related data to support design and production approval. The application data include a statement of conformance as specified in section 21.353(a)(1) in CCAR-21R4 and one copy each of the following technical data:

a. A Manual(s) containing the following:

(1) Operating instructions and equipment limitations sufficient to describe the equipment's operational capability.

(2) Describe in detail any deviations.

(3) Installation procedures and limitations sufficient to ensure that the Combustion Heater, when installed according to the installation or operational procedures, still meet this CTSO's requirements. Limitations must identify any unique aspects of the installation. The limitations must

include a note with the following statement:

“This article meets the minimum performance and quality control standards required by a CTSO. Installation of this article requires separate approval.”

(4) For each unique configuration of software and airborne electronic hardware, reference the following:

(a) Software part number including revision and design assurance level;

(b) Airborne electronic hardware part number including revision and design assurance level;

(c) Functional description.

(5) A summary of the test conditions used for environmental qualifications for each component of the article. For example, a form as described in RTCA/DO-160G, Environmental Conditions and Test Procedures for Airborne Equipment, Appendix A.

(6) Schematic drawings, wiring diagrams, and any other documentation necessary for installation of the Combustion Heater.

(7) List of replaceable components, by part number, that makes up the Combustion Heater. Include vendor part number cross-references, when applicable.

b. Instructions covering periodic maintenance, calibration, and repair, for the continued airworthiness of the Combustion Heater. Include

recommended inspection intervals and service life, as appropriate.

c. If the article includes software: a plan for software aspects of certification (PSAC), software configuration index, and software accomplishment summary.

d. If the article includes simple or complex custom airborne electronic hardware: a plan for hardware aspects of certification (PHAC), hardware verification plan, top-level drawing, and hardware accomplishment summary (or similar document, as applicable).

e. A drawing depicting how the article will be marked with the information required by paragraph 4 of this CTSO.

f. Identify functionality or performance contained in the article not evaluated under paragraph 3 of this CTSO (that is, non-CTSO functions). Non-CTSO functions are accepted in parallel with the CTSO authorization. For those non-CTSO functions to be accepted, the applicant must declare these functions and include the following information with CTSO application:

(1) Description of the non-CTSO function(s), such as performance specifications, failure condition classifications, software, hardware, and environmental qualification levels. Include a statement confirming that the non-CTSO function(s) don't interfere with the article's compliance with the requirements of paragraph 3.

(2) Installation procedures and limitations sufficient to ensure that

the non-CTSO function(s) meets the declared functions and performance specification(s) described in paragraph 5.f.(1).

(3) Instructions for continued performance applicable to the non-CTSO function(s) described in paragraph 5.f.(1).

(4) Interface requirements and applicable installation test procedures to ensure compliance with the performance data defined in paragraph 5.f.(1).

(5) Test plans, analysis and results, as appropriate, to verify that performance of the hosting CTSO article is not affected by the non-CTSO function(s).

(6) Test plans, analysis and results, as appropriate, to verify the function and performance of the non-CTSO function(s) as described in paragraph 5.f.(1).

g. The quality system description required by section 21.358 of CCAR-21R4, including functional test specifications. The quality system should ensure that it will detect any change to the approved design that could adversely affect compliance with the CTSO MPS, and reject the article accordingly.

h. Material and process specifications list (including revision level).

i. List of all drawings and processes (including revision level) that define the article's design.

j. Manufacturer's CTSO qualification report showing results of

testing accomplished according to paragraph 3.c of this CTSO.

6. Manufacturer Data Requirements.

Besides the data given directly to the authorities, have the following technical data available for review by the authorities:

a. Functional qualification specifications for qualifying each production article to ensure compliance with this CTSO.

b. Equipment calibration procedures.

c. Schematic drawings.

d. Wiring diagrams.

e. Material and process specifications.

f. The results of the environmental qualification tests conducted according to paragraph 3.d of this CTSO.

g. If the article includes software, the appropriate documentation defined in the version of RTCA/DO-178B specified by paragraph 3.e of this CTSO, including all data supporting the applicable objectives in Annex A, Process Objectives and Outputs by Software Level.

h. If the article includes complex custom airborne electronic hardware, the appropriate hardware life cycle data in combination with design assurance level, as defined in RTCA/DO-254, Appendix A, Table A-1. For simple custom airborne electronic hardware, the following data: test cases or procedures, test results, test coverage analysis, tool

assessment and qualification data, and configuration management records, including problem reports.

i. If the article contains non-CTSO function(s), the applicant must also make available items 6.a through 6.h as they pertain to the non-CTSO function(s).

7. Furnished Data Requirements.

a. If furnishing one or more articles manufactured under this CTSO to one entity (such as an operator or repair station), provide one copy or technical data and information specified in paragraphs 5.a and 5.b of this CTSO. Add any data needed for the proper installation, certification, use, or for continued compliance with the CTSO, of the Combustion Heater.

b. If the article contains declared non-CTSO function(s), include one copy of the data in paragraphs 5.f.(1) through 5.f.(4).

8. Availability of Referenced Documents.

a. Order SAE documents from:

Society of Automotive Engineers, Inc.

400 Commonwealth Drive, WARRENDALE, PA 15096-001, USA

You may also order them online from the SAE Internet website at:

www.sae.org.

b. Order RTCA documents from:

Radio Technical Commission for Aeronautics, Inc.

English Translation Version for Reference Only

CAAC

CTSO-C20a

1150 18th Street NW, Suite 910, Washington D.C. 20036

You may also order them online from the RTCA Internet website at:

www.rtca.org.

**APPENDIX 1 - MPS FOR COMBUSTION HEATER BASED ON
SAE AS 8040B**

This appendix prescribes the MPS for Combustion Heaters. The applicable standard is SAE International’s Aerospace Standard (AS) 8040B, Heater-Aircraft Internal Combustion Heat Exchanger Type, dated February 2013. We modified it as follows:

Section: 3. Accessories

3.2.a. Includes fuel/air ratio controller, fuel lines and preheater.

3.2.b. Rewritten to read “Ignition System: The ignition system uses an aircraft supplied energy source to enable proper functioning of the igniter. Examples of accessory devices that may be utilized in a heater ignition system include but are not limited to:”

3.2.b.2. Replaces the term “spark plug” with “igniter”.

3.2.b.3. Removes the statement, “Heaters with output ratings of 11,700 W (40,000 Btu/hour) or less may use an electrically heated resistance wire as an ignition source.”

3.2.c. Includes the requirement, “Any component whose failure could lead to an unsafe condition, such as ducting, that is in a fire zone must be fireproof.”

3.2.c. Includes ducting/tubing, combustion air blower, combustion air flow sensor, ventilation air flow sensor, and air flow/pressure regulator.

3.2.d.1. Revised to read, “Cabin temperature controls”.

3.2.e. Includes a device to sense differential pressure across the combustion chamber, a device to sense combustion, a device that senses excessive combustion byproducts in the ventilation air, a device to shut off fuel flow when required, and a device to alert crew that a safety system engaged.

3.3.2. Includes the phrase, “having the capacity to withstand at least as well as .015” thick stainless steel, the heat produced when there is a severe fire of extended duration.”

3.5. Includes service ceiling.

3.6. Includes the statement, “It is best practice to set inspection, maintenance and/or replacement intervals based on individual component performance during design qualification testing (such as endurance testing).

Section: 4. Detail Requirements

4.3.1. Replaces “gasoline or aviation grade kerosene, or both” with “fuel”.

4.3.4. Adds “fittings and controls” after “All fuel lines”.

4.3.5. Replaces “no lead or low lead type gasoline and kerosene” with the word “applicable”. Adds “Low starting temperature limits for other types of fuels need to be addressed on a case-by case basis.” to the end of this paragraph.

4.5. Replaces “649°C (1200°F)” with “material capabilities in this section of the heater”. Adds the sentence, “Best practice is to ensure that the temperature at the point of discharge shall not exceed 649 °C (1200 °F). Consideration should also be given to the impact of heat impingement on the aircraft region surrounding the Combustion Heater.” to the end of the paragraph.

4.6.3. Adds to the end of the paragraph the following: “or heated solid surface, though it is not considered a best practice to use resistance wires as an ignition sources for power levels above 11,700 W.”

4.6.8. Adds the statement, “Other types of fuels need to be addressed on a case-by-case basis.” to the end of the paragraph.

4.6.9. Adds the statement, “Other types of fuels need to be addressed on a case-by-case basis.” to the end of the paragraph.

4.7.d. Replaced with this paragraph: “These safety controls shall be independent of the controls normally used to control heater operation. The shut off of ignition and fuel shall occur at a point remote from the heater itself. The Combustion Heater shall have a means to warn the crew when any heater whose heat output is essential for safe operation has been shut off by the automatic means. The requirement to shut off ignition and fuel at a point remote from the heater until restarted by the crew, may require a safety interlock relay and additional fuel shut off device be supplied in addition to the valve usually supplied with the

heater as an accessory. This relay and valve are the responsibility of the installer. See 5.2.10.6 for tests conducted on safety controls.”

4.9. Adds at end of first paragraph: “Use electrical load analysis to show the worst-case situation is safe to operate.”.

4.12. Adds a new paragraph:

Radio Interference

4.12.1 If the manufacturer elects to demonstrate compliance with standard radio interference requirements, it is considered a best practice to test the Combustion heat Exchanger per RTCA DO-160F Chapter 21, or later FAA accepted revision, and report the result in the aircraft flight manual supplement.

4.12.2 If the manufacturer elects not to demonstrate compliance with radio interference requirements, the manufacturer shall include in the Combustion heat Exchanger aircraft flight manual supplement the following statement:

“This Combustion Heat Exchanger assembly does not include protection against nor it is tested for radio and/or avionics interference”

Section: 5 Required Testing

Initial paragraph includes the statement, “Test plans and reports shall be generated and retained for the life of the design.”

5.2.2.2. Revised to include, “A suitable instrument with a resolution no higher than 5 ppm, calibrated against a known standard, will be used

to determine CO concentration.”

5.2.2.3. Adds the statement, “A pressure decay test may alternatively be used provided that the decay rate can be determined to be equivalent to the requirements listed above.” at the end of the paragraph.

5.2.3. Replaces:

“The service ceiling determined by this test shall meet the requirement specified by the purchaser.” With:

“It is typical for a Combustion Heater’s service ceiling to be at least 6100 m (20,000 feet), and in order to ensure an adequate margin with this test being done on only one heater, a safety margin of 5% shall be applied. Therefore, in order to set a service ceiling of 6,100 m (20,000 feet) the peak of the ignition characteristics curve shall be no lower than 6,405 m (21,000 feet).”

5.2.4. Replaced with the following:

“Install the test unit in to the test set up used in 5.2.2.1. and cold-soak the Combustion Heater assembly to -54 °C (-65 °F) for gasoline type heaters and -29 °C (-20 °F) for kerosene type heaters (for other fuel types, the applicable temperature will be determined on a case by-case basis). The valve leakage in the closed position with either rated fuel pressure or minimum practical fuel pressure shall not exceed 0.068 fluid ounces (2 mL) of fuel in 10 minutes. Supply combustion air and ventilating air to the heater at sea level pressure and -54 °C (-65 °F)

temperature. The fuel temperature supplied to the heater shall be -54 °C (65 °F) for gasoline type heaters and -29 °C (-20 °F) for kerosene type heaters. Combustion and ventilating air pressure levels and mass flow rates shall be the same as 5.2.2.1. Glow plug ignited heaters shall ignite within 200 seconds. Spark ignited heaters shall ignite within 15 seconds when burning gasoline type fuels, and within 60 seconds when burning kerosene type fuels. Measure and record the parameters specified in 5.2.2.1.”

5.2.10.6.2.1. Includes the following statement after the first sentence in the second paragraph:

“Leakage through the fuel valve shall then be measured and shall not exceed 0.068 fluid ounces (2 mL) in 10 minutes.”

Section: 6 Desirable Features

6.1.2 Includes the statement “Other types of fuels need to be addressed on a case-by-case basis.”

**APPENDIX 2 - INSTRUCTIONS for CONTINUED
AIRWORTHINESS of the AIRCRAFT COMBUSTION HEATER
AND ACCESSORIES**

1.0 The following information contained in this Appendix must be included into the manual, as required by paragraph 5.b. of this CTSO to ensure the Combustion Heater and Accessories continues to meet the CTSO once it is installed in a product.

1.1 Scheduling information for each part of the Combustion Heater stating inspection criteria and service limits. Necessary cross-references to the Airworthiness Limitations section must also be included.

1.2 Troubleshooting information describing probable malfunctions, how to recognize and resolve those malfunctions.

1.3 Information describing the order and method of removing and replacing parts, the order and method of disassembly and assembly, with any necessary precautions to be taken.

1.4 Cleaning and inspection instructions that cover the material and apparatus to be used and methods and precautions to be taken. Methods of inspection must also be included.

1.5 Details of repair methods for worn or otherwise substandard parts and components along with the information necessary to determine when replacement is necessary.

1.6 Instructions for testing including test equipment and instrumentation.

1.7 A list of the tools and equipment necessary for maintenance and guidance for their use.

1.8 Instructions on how to ensure the Combustion Heater assembly is fit for return to service after maintenance and prior to installation (for example, procedures for a pressure decay test).