SAE Aerospace
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AEROSPACE RECOMMENDED PRACTICE

SAE ARP86

REV. B

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Heater, Airplane, Engine Exhaust Gas to Air Heat Exchanger Type

FOREWORD

This document has been declared “NONCURRENT”. It is recommended, therefore, that this document not be specified for new designs. “NONCURRENT” refers to those documents which have previously been widely referenced and may continue to be required on some existing designs. “NONCURRENT” documents are available from SAE upon request.

1. PURPOSE:

1.1 This recommended practice is to be considered as being currently applicable and necessarily subject to revision from time to time, due to rapid development of the aircraft industry.

1.2 The following recommendations are based on practical engineering requirements for the design and testing of such engine exhaust gas to air type heat exchangers as are now used on airplanes and for such as may be developed to meet later requirements.

2. SCOPE:

2.1 These recommendations are written to cover the subject of engine exhaust gas to air type heat exchangers under the following classifications:

2.1.1 Cabin Heating: (All occupied regions and windshields heating).

2.1.2 Wing and empennage heating

2.1.3 Engine and Accessory Heating: (When heater is installed as part of the aircraft).

2.2 These recommendations are not intended to cover the design of secondary exchangers which may be required when engine exhaust gas to air type heat exchangers are used in supplying ventilating air.

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3. DEFINITION:

3.1 An engine exhaust gas to air heat exchanger type heater is one which provides a means of utilization of the heat of the exhaust gases (either undiluted or diluted) from an aircraft engine (either main or auxiliary) for the purpose of heating the air which is supplied to the airplane.

4. GENERAL REQUIREMENTS:

4.1 An engine exhaust gas to air type heat exchanger should include all of the following:

4.1.1 Heat exchanger assembly (core).

4.1.2 Casing or shroud for heat exchanger assembly.

4.1.3 Air Inlet

4.1.4 Air Outlet

4.1.5 Exhaust gas inlet.

4.1.6 Exhaust gas outlet.

4.1.7 Provisions for mounting.

4.2 Materials and Workmanship:

4.2.1 The heater should be constructed throughout of materials which are considered acceptable for the particular use intended and should be made and furnished with a grade and uniformity of workmanship generally accepted in the aircraft industry.

4.2.2 The heat exchanger assembly, including casing or shroud and the inlet and outlet duct adapters should be constructed of fire proof corrosion resistant, and non-wicking material.

4.3 Desirable Design Features:

4.3.1 The design should be such as to preclude harmful effects on construction or performance due to vibration and thermal stress.

4.3.2 The design should be such that repair or removal of the heater should not be required prior to 1000 hours of flight time.

4.3.3 The design should be such as to allow for ease of cleaning.

4.3.4 In order to minimize casing or shroud surface temperatures the exchanger should be so designed as to provide a flow of ventilating air next to all parts of the inside surface of the casing.

4.3.5 Pressure losses through, and weight of the heater should be as low as possible, consistent with the other design requirements stated in this recommended practice.

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

4.3.7 The design of the casing or shroud and any other exposed parts should be of adequate strength to permit normal handling during storage, shipping and installation.

4.3.8 Requirements for installation of drain lines should be considered.

4.4 Identification:

The following minimum information should be legibly and permanently marked on the heater, or on a nameplate attached thereto:

4.4.1 Manufacturers name and/or trade mark.

4.4.2 Manufacturers part number.

4.4.3 Manufacturers serial number.

4.4.4 Application - occupied or unoccupied areas or anti-icing.

5. TECHNICAL REQUIREMENTS:

5.1 Heat Exchanger Assembly:

5.1.1 Means should be provided to minimize effects due to deposition of products of combustion, and to permit removal of such deposits.

5.1.2 In an exchanger which is to supply air to personnel, leakage shall not exceed an amount which will permit a concentration of CO in the ventilating air flow through the exchanger of .003% under the test conditions of Section 6.5.

5.1.3 Where air is not to be supplied to compartments occupied by personnel and where there is no possibility of accumulation of dangerous quantities of liquid fuel or explosive fuel air mixtures in the air side of the exchanger or in the air side duct work, the heat exchanger may be so constructed as to permit leakage between exhaust gas and air sides provided that small concentrations of products of combustion would not be harmful to materials. Applicable test conditions of Section 6.5 must be met.

6. TEST REQUIREMENTS AND METHOD:

6.1 Performance Test:

6.1.1 Temperature Measurements: Temperature measurements for output should be made in a manner which will provide representative average temperatures of the inlet and discharge air and inlet exhaust gas. Temperature sensing elements used in tests should be protected against effects of radiation from the heater.

6.1.2 Test Condition: Tests should be conducted to establish the heat output, air pressure drop, exhaust gas pressure drop, exhaust outlet temperature and air temperature rise under the following conditions:

6.1.2.1 Sea level ambient pressure.

6.1.2.2 Sea level exhaust gas rate as specified by heater manufacturer.

6.1.2.3 Exhaust gas inlet temperature of 1600 F for heaters using undiluted exhaust gas, or 1000 F for heaters using diluted exhaust gas. For special application, the test shall be conducted at maximum anticipated temperatures.

6.1.2.4 Air temperature rise of 300 F.

6.1.2.5 Inlet temperatures of air between 50 F and 125 F.

6.1.3 Additional Tests: Additional tests will be run as required to present the data of 6.1.2 in a form suitable to calculate the performance of the heater at varying flows and conditions of inlet pressure and temperature.

6.2 Collapsing Pressure:

The exchanger should be set up in such a manner that the normal flow of exhaust gases can be passed through it at ambient pressure, while pressures above ambient can be applied to the air side of the case (no air flow). The exchanger should be operated with maximum exhaust gas flow and inlet temperature and an air side pressure of 1.5 times maximum differential pressure.

6.2.1 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.

6.3 Vibration Test:

The heater should be capable of withstanding a steady vibration over a range of frequencies from 600 to 2700 cycles per minute with a total excursion of 1/16”, and from 2700 to 3200 cycles per minute with an acceleration not exceeding 6G’s. Unless otherwise specified in detail specifications, the equipment should 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. The test may be run with the exchanger at room temperature.

6.3.1 The heater should be vibrated over a range of from 600 to 2700 cycles per minute with a total excursion of 1/16”. Any frequencies at which resonance occurs should be observed and noted.