Society of Automotive Engineers, Inc.
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New York City

AERONAUTICAL RECOMMENDED PRACTICE

ARP 89A

TEMPERATURE CONTROL EQUIPMENT, AUTOMATIC, AIRPLANE CABIN

Issued 1-1-43
Revised 2-1-49

1. PURPOSE:

1.1 ARP - This identification is used for design and dimension standards or performance specifications based on sound engineering principals and intended as guides for further standard engineering practices for the aircraft industry.

1.2 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.

1.3 The following recommendations are based on practical engineering requirements for the design and testing of such types of heating and ventilating equipment as are now used on airplanes and for such as may be developed to meet the demand imposed in the field of service.

2. SCOPE: These recommendations are written to cover automatic cabin temperature controls under three classifications, namely:

2.1 Automatic Temperature Controls - General Requirements - Applicable to all types and uses of cabin temperature control systems.

2.2 Automatic Temperature Controls - Specific Requirements - Dealing with performance of components of a cabin temperature control system.

2.3 Desirable Design Features - General recommendations for meeting the requirements of paragraphs 2.1 and 2.2 above.

3. AUTOMATIC TEMPERATURE CONTROLS - GENERAL REQUIREMENTS

3.1 Definition:

A system of automatically controlling temperature in an airplane cabin during the process of heating and cooling. It consists of one or more of the following parts:

a. Temperature Sensitive Elements
b. Regulators
c. Lag Devices
d. Anticipators
e. Control Motors or Actuators
f. Indicating Instruments
g. Valves
h. Amplifiers
i. Sensitive Relays

3.2 Materials and Workmanship:

All units should be constructed of materials which are considered acceptable for the particular use, and should be furnished with the degree, uniformity, and grade of workmanship generally acceptable in the aircraft industry and satisfactory to the user.

3.2.1 Dependability:

Temperature regulating and indicating units and assemblies should be manufactured and assembled with the necessary rigidity to withstand normal vibration, shock and long usage. Prolonged exposure to normal environmental conditions encountered in service should cause no permanent malfunctioning of the system.

3.2.2 Operation:

Units may be designed for electrical, hydraulic, or pneumatic operation.

3.2.3 Sensitivity:

3.2.3.1 Control units should be designed to provide maximum sensitivity consistent with good temperature control practice and the recommendations contained herein.

3.2.3.2 Sensitivity as applied to temperature sensitive elements should be the smallest change in air temperature to effect a correction.

3.2.4 Identification: The following information should be legibly and permanently marked to the instrument or attached thereto:

a. Name of instrument (Thermostatic Element).
b. SAE Specification ARP 89A.
c. Manufacturer's part number.
d. Manufacturer's serial number or date of manufacture.
e. Manufacturer's name or trademark.
f. Range.

3.2.5 Tests:

Units should meet satisfactory tests as determined between supplier and user for accuracy of calibration, accuracy of response, and accuracy of movement.

3.2.6 Samples:

Samples submitted for test should be representative of the device as regularly manufactured and marketed.

4. AUTOMATIC TEMPERATURE CONTROLS - SPECIFIC REQUIREMENTS:

4.1 Temperature Sensitive Elements

4.1.1 Types:

The following types of sensitive elements are currently being incorporated in the design of automatic units for temperature control:

a. Bi-Metal or Differential Expansion
b. Resistance
c. Expansible Fluid
d. Mercury Column
e. Thermocouple

4.1.2 Performance:

Representative commercial samples of temperature indicating and regulating units should be subjected to the following tests for determination of performance and, in addition, a combined humidity, temperature, velocity, and life test should be run.

4.1.2.1 Endurance:

Temperature sensitive elements should be subjected to from 10,000 to 500,000 cycles of operation under service or simulated service conditions. Upon completion of this test, there should be no evidence of mechanical or electrical failure or undue burning or pitting of electric contacts when employed and calibration should remain within specification tolerances. Generally the 10,000 cycles will apply to safety devices which will be called upon to operate only in emergency and the 500,000 cycles should apply to proportioning or floating control devices which call for more frequent operation for short duration.

4.1.2.2 Accuracy of Scale:

4.1.2.2.1 Calibration should be made at the mid point of the scale and the temperature sensitive element should have an end-of-scale accuracy of plus or minus 5% of the scale length or plus or minus 2 F., whichever is the larger.

4.1.2.2.2 If the elements are of the resistance, thermocouple or mercury column type, the scale referred to should be considered to be the dial on the range adjustment rheostat.

4.1.2.3 Accuracy of Calibration:

4.1.2.3.1 Calibration of temperature sensitive units should be within plus or minus 2 F. at the mid point of the scale range.

4.1.2.3.2 To test, the pointer of the temperature control selector should first be set at the mid point of its scale range. The temperature sensing element should then be placed in a well-stirred water bath or a blast of air at a temperature approximately 10 F. lower or higher than the scale setting. Temperature readings should be taken at several locations in the bath to assure good distribution. The temperature of the water or air should then be raised or lowered slowly (not over 1/2 F. per minute change) until the unit reacts. The temperature (measured by a thermometer in the water or air) at which the reaction is noted should agree with the setting on the scale within the above limits.

4.1.2.4 Humidity:

4.1.2.4.1 All elements should be designed to withstand the humidity conditions encountered in normal service.

4.1.2.4.2 The elements should be placed in an atmosphere of clear vapor maintained at 95% humidity and 122 F. temperature for a period of 48 hours. The humidity should be maintained within plus or minus 5% of 95% and the temperature within plus or minus 5 degrees of 122 F. The percentage of humidity may be less than the maximum indicated above if the design of the unit is such that any inherent defects will be disclosed at a lower temperature or percentage of humidity. During this test the electrical unit should be energized on a duty cycle of one hour on and one hour off to disclose any moisture penetration or electrolytic action.

4.1.2.4.3 All elements located in air scoops and/or ducts subject to water should be exposed to water spray for 48 hours without damage. During this test the electrical unit should be energized on a duty cycle of one hour on and one hour off to disclose any moisture penetration or electrolytic action.

4.1.2.5 Temperature:

4.1.2.5.1 All elements should be designed to withstand temperatures as low as minus 65 F.

4.1.2.5.2 The elements should be tested by placing in a test chamber at minus 65 F. for 72 hours without damage.

4.1.2.5.3 Elements used in the ventilating air discharge of a heat exchanger should be designed to withstand a maximum temperature of 450 F. for 72 hours without damage.

4.1.2.5.4 Elements subject primarily to radiated and/or conducted heat from a heat exchanger should be designed to withstand a maximum temperature of 600 F. for 12 hours without damage.

4.1.2.6 Corrosive Atmosphere:

All elements should be designed to stand exposure to salt laden air such as encountered in over ocean flight.

4.1.2.7 Vibration:

4.1.2.7.1 The elements should be designed to withstand normal vibration encountered in aircraft.

4.1.2.7.2 The elements should be vibrated for a period of four hours at a frequency between 15 and 60 cycles per second, with an amplitude and waveform sufficient to produce a vertical acceleration of 10G. During this period of vibration the equipment is to be in operating condition. At the termination of this portion of the test a visual inspection should be made, and should disclose no conditions produced by the vibration, the presence of, or continuation of which would be detrimental to the satisfactory performance of the element.

The element should then be operated over a continuously variable frequency range from 15 to 60 cycles with sufficient amplitude to permit the vibration to be easily felt by placing the hand on the vibration table. This test is to be of sufficient duration to observe the behavior of all component parts throughout the specified frequency range for evidence of resonant vibration. Parts which show such tendencies should be redesigned or remounted to eliminate the resonant condition. Where redesigning or remounting is not practical, it should be demonstrated that the resonant vibration of the part will in no manner be detrimental to the airworthiness of the unit. The use of shock mounts should not be permitted during the integral part of the design of the unit, or the equipment is placarded to indicate that it should not be used unless mounted on a shock mount equivalent to that used in the test.

Strobotac or other satisfactory stroboscopic device should be used for observing the equipment under vibration.

Equipment incorporating instruments as an integral part of the design should be subjected to the full 10G acceleration during the test, although an individual instrument need only be subjected to acceleration of 5G, provided that ammeters subjected to an acceleration test of only 5G are equipped with a shunt having sufficient current carrying capacity to carry the full load current of the circuit in which the instrument is intended to be used. This provision will prevent equipment failures resulting from failures of the instrument itself. The failure of a voltmeter will not normally render inoperative the equipment with which it is used. Since the spring-loaded moving coil of the instrument movements is inherently a mechanically resonant circuit, such resonance will not be considered unsatisfactory and no redesign of such a system will be required nor will the equipment be necessarily operated at the resonant frequency of the instrument movement.

4.1.2.8 Pressure Test:

The element should be operated in a pressure chamber under variable pressures from 29.92 to 7.036 inches of mercury (sea level to 35,000 feet altitude). The period of observation at the reduced pressures should be of sufficient duration to disclose any defects which may be aggravated by the reduced pressure. The elements should operate satisfactorily throughout the pressure range specified.

4.1.2.9 Control Cabinets:

If the temperature control system consists of additional equipment such as resistors, condensers, relays, etc., mounted in a control cabinet, the control cabinet should be subjected to the same tests as the elements where applicable.

4.1.2.10 Method of Determining Rate of Response:

Rate of response should be measured by determining the time required to respond to 63% of the temperature change.

4.2 Regulators, Lag Devices And Anticipators:

If the temperature control system includes regulators, lag devices or anticipators, these units should be subjected to the applicable portions of tests specified for elements.

4.3 Control Motors Or Actuators:

4.3.1 Types:

These include the following:

4.3.1.1 Electric

4.3.1.2 Air

4.3.1.3 Hydraulic

4.3.2 Performance:

4.3.2.1 All control motors should conform to requirements as set forth in applicable SAE Specifications covering the particular type of motor.

4.3.2.2 Endurance:

When used with temperature sensitive elements, all motors should be capable of enduring from 10,000 to 50,000 operations under normal conditions of service. When the motor is used in an ON-OFF control system, an operation should necessarily require that the control motor move from one limiting position to the other. When the motor is used in any other type of control system, an operation should be at least 10% of the operating stroke. All tests will be conducted at sea level pressure.

4.3.2.3 Humidity:

4.3.2.3.1 All motors should be designed to withstand the humidity conditions encountered in normal service.

4.3.2.3.2 The control motors should be placed in an atmosphere of clear vapor maintained at 95% humidity and 122 F. temperature for a period of 48 hours. The humidity should be maintained within plus or minus 5% of 95% and the temperature within plus or minus 5 degrees of 122 F.

4.3.2.4 Temperature:

4.3.2.4.1 All motors should be designed to operate at temperatures as low as minus 65 F. and as high as 160 F.

4.3.2.4.2 The motors should be tested by placing in a test chamber at minus 65 F. for 72 hours and at 160 F. for 72 hours.