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400 COMMONWEALTH DRIVE, WARRENDALE, PA 15096

AEROSPACE STANDARD

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Revised

CARGO COMPARTMENT FIRE DETECTION INSTRUMENTS

1. PURPOSE: This standard establishes minimum requirements for cargo compartment fire detection instruments primarily for use in reciprocating and turbine engine powered aircraft.

2. SCOPE:

2.1 This standard covers the following types of fire detection instruments intended for use in protecting aircraft cargo compartments, galleys, electronic equipment bays and other similar installations.

2.2 Types:

Type I: Carbon monoxide, an instrument which will actuate an alarm signal when the concentration of carbon monoxide in air exceeds a specified value.

Type II: Smoke detector, electronic, an instrument operating on the principle of smoke particles modifying the relationship between a light beam and electronic light sensor which will actuate an alarm signal when the concentration of smoke in air exceeds a specified value.

Type III: Smoke detector, visual, an instrument which, by visual means, will show in a positive manner the presence of smoke when the concentration of smoke in air exceeds a specified value.

Type IV: Smoke detector, electronic, an instrument operating on the principle of smoke particles modifying the current in an ionization chamber which will actuate an alarm signal when the concentrations of smoke in air exceeds a specified value.

Type V: Same as Type IV except maximum operating altitude is 18,000 ft. (5,486 M) when installed in a non-pressurized area.

2.3 Applicable Documents: The following documents shall form a part of this specification to the extent specified herein:

2.3.1 Federal Aviation Regulation 25.1359(d) and Appendix F thereto.

2.3.2 "Rules For SAE Use of SI (Metric) Units - SAE Document J916B", Dated July 1975 - Copies may be obtained from Society of Automotive Engineers, 400 Commonwealth Drive, Warrendale, PA., 15096.

2.3.3 Radio Technical Commission of Aeronautics (RTCA) Document DO-160B "Environmental Conditions and Test Procedures for Airborne Equipment", Dated July 20, 1984 (copies may be obtained from the RTCA Secretariat, 1425 K Street, N.W. Washington, D.C. 20005).

3. GENERAL STANDARDS:

3.1 Materials: Materials shall be of a quality which experience and/or tests have demonstrated to be suitable and dependable for use in aircraft instruments.

3.2 Workmanship: Workmanship shall be consistent with high-grade aircraft instrument manufacturing practice.

3.3 Accessibility of Controls: Controls which are not normally adjustable in flight shall not be readily accessible to flight personnel when the instrument is installed in accordance with the manufacturer's instructions.

3.4 Interchangeability: Instruments which are identified with the same manufacturer's part or model number range and/or setting shall be completely interchangeable.

3.5 Integrity Test Means: The instrument shall be of such design to provide a means for testing the integrity of the instrument when the aircraft is operating.

3.6 Identification: The following information shall be legibly and permanently marked on the instrument or attached thereto:

(a) Name of Instrument
(b) Manufacturer's Part Number
(c) Manufacturer's Serial Number or Date of Manufacture
(d) Manufacturer's Name and/or Trademark
(e) Type Number
(f) Alarm Range and/or Setting
(g) Rating (Electrical, Vacuum, etc.)
(h) Qualification Specification Number (SAE or TSO)

3.7 Environmental Conditions: The following conditions have been established as minimum design requirements:

3.7.1 Temperature: When installed in accordance with the manufacturer's recommendations, the instrument shall function over the range of ambient temperatures shown in Column A below and shall not be adversely affected by exposure to the temperatures shown in Column B below:

Instrument Location	A (deg. C)	A (deg. F)	B (deg. C)	B (deg. F)
Pressurized Areas	-30 to 60	-22 to 140	-65 to 70	-85 to 158
Non Pressurized areas	-55 to 70	-67 to 158	-65 to 70	-85 to 158

3.7.2 Humidity: The instrument shall function and shall not be adversely affected when exposed to any relative humidity in the range from 0 to 95%.

3.7.3 Altitude: When installed in accordance with the instrument manufacturer's instructions, the instruments shall function from sea level up to the altitudes listed below. Altitude pressures are per U.S. Standard Atmosphere, 1962.

Type I, II, III, IV Instrument Location	Altitude Ft.	Altitude M
Pressurized and Non-Pressurized Areas	50,000	15,240

Instruments to be used in pressurized locations shall not be adversely affected following exposure to an ambient pressure of 50 in. (127 cm) of mercury absolute nor false warn when subjected to a pressure drop to 3.42 in. (8.69 cm) of mercury absolute.

Type V Instrument Location	Altitude Ft.	Altitude M
Non-Pressurized Areas	18,000	5,490

Instruments to be used in pressurized locations shall not be adversely affected following exposure to an ambient pressure of 50 in. (127 cm) of mercury absolute nor false warn when subjected to a pressure drop to 14.94 in. (37.95 cm) of mercury absolute.

3.7.4 Vibration: When installed in accordance with the instrument manufacturer's instructions, the instrument shall function and shall not be adversely affected when subjected to vibration of the following characteristics:

Reciprocating Engines	Frequency Cycles Per Sec.	Max. Double Amplitude In.	Max. Double Amplitude Cm.	Maximum Acceleration
Airframe Structure Mounted	5-500	.050	.127	10g
Shock-Mounted Panel	5-50	.020	.051	1.5g

Turbine Engines	Frequency Cycles Per Sec.	Max. Double Amplitude In.	Max. Double Amplitude Cm.	Maximum Acceleration
Wings, Empennage	5-2000	0.036	.091	10g
Fuselage				
Forward of Spar Area	5-500	0.036	.091	2g
Center of Spar Area	5-1000	0.036	.091	4g
Aft of Spar Area	5-500	0.036	.091	7g
	500-1000	-----	----	5g
Vibration Isolated	5-50	0.020	.051	1.5g
Racks	50-500	-----	----	0.5g
Instrument Panel	5-500	.030	.076	1.0g

3.8 Radio Interference: The instrument shall not be the source of objectionable interference, under operating conditions at any frequencies used on aircraft, either by radiation or feedback in electronic equipment installed in the same aircraft as the instrument.

3.9 Magnetic Effect: The magnetic effect of the instrument shall not adversely affect the operation of other instruments in the same aircraft.

3.10 Fire Resistance: Except for small parts (such as knobs, fasteners, seals, grommets and small electrical parts) that would not contribute significantly to the propagation of a fire, all materials used must be self-extinguishing when tested in accordance with the requirements of Federal Aviation Regulations 25.1359(d) and Appendix F thereto, with the exception that materials tested may be configured in accordance with paragraph (b) of Appendix F or may be configured as used.

3.11 Water Spray: Instruments that are to be marked with a Water Proofness Category "W" rating shall not allow penetration of water and shall comply with all applicable equipment performance standards when tested in accordance with paragraph 10.0 of DO-160B.

3.12 Salt Spray: Instruments that are to be marked with a Salt Spray Category "S" rating shall not exhibit evidence of corrosion of metals, clogging or binding of moving parts, insulation fault or damage to contacts or uncoated wiring, and shall comply with all equipment performance standards when tested in accordance with paragraph 14.0 of DO-160B.

3.13 Indication Means: The instrument shall be capable of actuating visual and/or aural alarm indicators.

Anti-reflection treatment shall be required on any cover glass through which the indication means is viewed.

3.13.1 Instrument Cover Glass Reflectance: The total reflectance of the instrument cover glass, including the integral lighting wedge, if applicable, shall not exceed 10 percent of the incident light. This reflectance applies over the visible light spectrum from 450 nanometers to 600 nanometers, and over an incident solid angle of 60 degrees perpendicular to the viewing plane.

3.14 Calibration Means: An instrument designed to be adjustable shall be such that all calibration means be provided with tamper-proof seals.

3.14.1 Adjustable Detector Systems: Instruments which incorporate means for adjustment shall be tested to prove compliance with this standard.

4. MINIMUM PERFORMANCE REQUIREMENTS UNDER STANDARD TEST CONDITIONS:

4.1 Atmospheric Conditions: Unless otherwise specified, all tests required by this Standard shall be conducted at an atmospheric pressure of approximately 29.92 in. (76 cm) of mercury and at an ambient temperature of approximately 25°C (77°F) and at a relative humidity of not greater than 85 percent. When tests are conducted with the atmospheric pressure or the temperature substantially different from these values, allowance shall be made for the variation from the specified conditions.

4.2 Vibration to Minimize Friction: Unless otherwise specified, all tests for performance may be conducted with the instrument subjected to a vibration of 0.002 to 0.005 in. (0.005 to 0.013 cm) double amplitude at a frequency of 1500 to 2000 cycles per minute.

4.3 Vibration Equipment: Vibration equipment shall be used which will provide frequencies and amplitudes consistent with the requirements of Section 3.7.4 with the following characteristics:

4.3.1 Linear Motion Vibration: Vibration equipment for airframe structure-mounted or powerplant-mounted instrument components shall be such as to allow vibration to be applied along each of three mutually perpendicular axes of the test specimen.

4.3.2 Circular Motion Vibration: Vibration equipment for shock mounted panel instrument component shall be such that a point on the instrument case will describe, in a plane 45° to the horizontal plane, a circle the diameter of which is equal to the double amplitude specified.

4.4 Power Conditions: Unless otherwise specified, all tests shall be conducted at a power rating recommended by the manufacturer.

4.5 Test Position: Unless otherwise specified, the instrument shall be mounted and tested in its normal operating position.

4.6 Test Stimulus Measurement:

4.6.1 Type I Instrument: All carbon monoxide measurements shall be expressed as a percentage of CO per air volume.

4.6.2 Type II, Type III, Type IV, and Type V Instruments: All smoke measurements containing smoke of all colors and particle sizes shall be expressed as a percentage of light transmission. Light transmission percentage is defined as the light falling on a photo-electric cell (Weston Model 594RR or equivalent) through a one foot (0.3 M) distance occupied by smoke particles in air, expressed as a percentage of the light transmitted through one foot (0.3 M) of clear air.

A preferred embodiment is a test chamber using a five foot (1.5 M) distance between light source and cell as shown and described in Underwriters Laboratories Inc. Standards UL217 and UL268 (U.L. Publications Stock, 333 Pfingsten Road, Northbrook, Illinois 60062.)

4.7 Individual Performance Requirements: All instruments or components of such shall be subjected to whatever tests the manufacturer deems necessary to demonstrate the production articles comply with this Aerospace Standard including the following requirements where applicable:

4.7.1 Sensitivity and Calibration: The sensor shall be tested as specified in Paragraph 5.1, or in an equivalent manner which will test the response sensitivity and calibration.

4.7.2 Dielectric: Each instrument shall be tested by the methods of inspection listed in Paragraphs 4.7.2.1 and 4.7.2.2.

4.7.2.1 Insulation Resistance: The insulation resistance measured at 200 volts D.C. for five seconds between all electrical circuits connected together (except electrical case ground) and the metallic case shall not be less than 5 megohms. Insulation resistance measurements shall not be made to circuits where the potential will appear across elements such as windings, resistors, capacitors, etc. since this measurement is intended only to determine adequacy of insulation.

4.7.2.2 Overpotential Tests: Equipment shall not be damaged by the application of a test potential between electrical circuits, and between electrical circuits and the metallic case. The test potential shall be a sinusoidal voltage of a commercial frequency with an R.M.S. value of five times the maximum circuit voltage or per Paragraph 4.7.2.3. The potential shall start from zero and be increased at a uniform rate to its test value.

It shall be maintained at this value for five seconds, and then reduced at a uniform rate to zero.

Since these tests are intended to assure proper electrical isolation of the circuit components in question, these tests shall not be applied to circuits where the potential will appear across elements such as windings, resistors, capacitors, etc.

4.7.2.3 Circuits that operate at potentials below 15 volts are not to be subjected to overpotential tests.

5. MINIMUM PERFORMANCE STANDARDS UNDER ENVIRONMENTAL CONDITIONS: Unless otherwise specified herein, the measurement procedures applicable to a determination of the performance under environmental conditions are set forth in Radio Technical Commission for Aeronautics (RTCA Document No. DO-160B entitled "Environmental Conditions and Test Procedures for Airborne Electronic/Electrical Equipment and Instruments," dated 25 January 1980. Performance tests which must be made after subjection to test environments may be made after exposure to several environmental conditions. The order of tests must be in accordance with paragraph 3.2 of DO-160B. The test procedures specified or referenced are satisfactory for use in determining the performance of Fire Detection Instruments under normal and extreme environmental conditions; equipment category is to be as specified by the manufacturer. Alternate approved test procedures that provide equivalent results may be used. As many instruments as deemed necessary to demonstrate that the instruments comply with the requirements of this section shall be tested in accordance with the manufacturer's recommendations. After the tests have been initiated, further adjustments to the instrument shall not be permitted. A false alarm signal occurring during any of the tests shall disqualify the instrument from further testing.

5.1 Response Time and Calibration: Each instrument shall be subjected to the response time and calibration tests, listed below, applicable to its type classification. Instruments shall be tested by the application of appropriate test stimulus (Par. 4.6). For instruments in which the sensitivity and/or response time is affected by any factors which may be varied from one installation to another shall have tests conducted with the least sensitive and longest response time condition to be used.

5.1.1 Calibration Test: Unless otherwise specified, air samples shall be as follows:

Type I: Air containing 0.020% plus or minus 0.005% of carbon monoxide.

Type II, Type IV, and Type V: Air containing smoke having a light transmission value of 60% to 96% of that of clear air measured through a one foot (0.3 M) distance as defined in paragraph 4.6.2. The alarm range and/or setting marked on the instrument shall determine the actual transmission percentage (within 60% to 96%) to be used for the test.

Type III: Air containing smoke having a light transmission value of 70 ± 10% of that of clear air measured through a one foot (0.3 M) distance, as defined in paragraph 4.6.2.

5.1.2 Response Time Test: Instrument of Types I through V shall be tested so that when an air sample applicable to the type of instrument per paragraph 5.1.1 is introduced into the instrument, under standard atmospheric conditions, Type I, Type II, Type IV, and Type V shall actuate an alarm and Type III shall show visually the presence of smoke within a maximum time period of 30 seconds.

5.1.2.1 Sampling Characteristics: When an instrument is designed to sample the air from more than one sampling station on a cycling basis, it shall cycle at a rate sufficient to sample all stations within a total time of one minute. The dwell at each station shall be at least twice the response time of the specific model detector being used with the sampler. Response time is that defined in Paragraph 5.1.2. Flow of air through all the sampling conduits shall be maintained continuously. In addition, when a smoke alarm signal is indicated, an alarm signal shall be actuated to indicate the location in which the smoke or gas is being generated and to continue to indicate the alarm signal until the condition is eliminated. It shall begin cycling in a normal manner within 30 seconds after the alarm signal is cleared.

5.1.2.2 Differential Pressure Variation: The instrument where pressure differential is employed shall be operated continuously by varying the pressure differential from 25 percent below to 25 percent above the rated. At each of these values the instrument shall meet the requirements of Paragraph 5.1.2.

5.1.3 Saturation Characteristics: The unit shall not revert to "no smoke" signal condition following an alarm indication when held immersed in smoke levels at least 25% greater than the response level for the unit for a period of ten hours. The unit shall revert to a "no smoke" signal condition when the smoke level is reduced to 50% of the original response level.