NOTE: This amendment contains TSO-C1b

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# Title 14—AERONAUTICS AND SPACE

## Chapter I—Federal Aviation Agency

[Docket No. 7356; Amdt. 37-12]

## PART 37—TECHNICAL STANDARD ORDER AUTHORIZATIONS

### Cargo and Baggage Compartment Smoke Detection Instruments—TSO-C1b

The purpose of this amendment is to revise the Technical Standard Order (TSO) for "Smoke detectors" contained in § 37.111 of the Federal Aviation Regulations. This action was published as a notice of proposed rule making (31 F.R. 7084, May 13, 1966) and circulated as Notice No. 66-19 dated May 9, 1966.

Notice 66-19 proposed to amend TSO-C1a by changing the title to indicate more clearly the TSO scope and purpose and to eliminate reference to industry specifications. Substantively the notice proposed reduced sensitivity requirements for some existing type instruments and added standards that would reflect new type smoke detector instruments.

Several comments were received in response to the notice. These generally favored the proposed action although they contained recommendations for further changes. These comments, together with the changes to the proposal resulting therefrom, are discussed in detail hereinafter.

One commentator agreed that an updated TSO for smoke detectors would be good but suggested, in effect, that the real need is for cargo and baggage compartments to be equipped with improved fire detection and fire extinguishing systems. While this general recommendation relating to antifire systems is meritorious, it exceeds the scope of the Notice. Standards applicable to antifire devices would properly be stated in TSO's for fire detectors and fire extinguishers, while cargo and baggage compartment requirements for any particular aircraft would be covered in the applicable airworthiness regulations. The Agency is continuing its studies of baggage and cargo compartment fires and will welcome any specific recommendations for rule-making action in this regard.

One observer noted that the proposed TSO omitted the "sniffer" type detector which it considered the only really practical device today. We assume that "sniffer" has reference to a flexible tube arrangement by which a pilot, holding the tube to his nose, may detect smoke in the compartment being checked. Such devices are extremely simple and would be included by the aircraft manufacturer as an integral part of an aircraft design rather than supplied as a separate article. The omission of the so-called "sniffer" devices from the TSO has no bearing on the utilization of such devices under airworthiness regulations applicable to a particular aircraft.

These comments on "sniffer" devices and other comments with reference to Type III instruments, indicate a possible misunderstanding concerning what constitutes the "instrument" under this TSO. Paragraph 3 has been amended, therefore, to make it clear that the "instrument" excludes any tubing used to conduct air samples from sampling stations to the sensing or measuring device by which the smoke concentration is determined.

Apparently failing to realize that the proposal as applied to Type II instruments would tend to lessen false alarms in service, one commentator alleged a high incidence of false smoke warnings on present instruments but did not indicate what changes to the proposal, if any, it considered necessary to improve reliability. Another commentator did contend, however, that the relaxed sensitivity standard of 60 percent would be next to useless in an early warning device and recommended the low limit be raised from 60 to 85 percent. In support of this, it was stated that two transport airplane manufacturers were using 90-95 percent settings and that similar industrial-home units that were set even higher (96-98 percent) were never troubled with false alarms. The commentator also cited the extensive smoke tests conducted by the Agency which were said to confirm that high percentage settings are desirable for maximum effectiveness.

The Agency tests referred to above, as well as service experience, indicate that the larger the cargo and baggage compartments, the higher the sensitivity required. Thus, while 60 percent may be adequate for a small compartment, it would be too low for proper protection of a larger compartment. Similarly, 90 percent may be appropriate for a large compartment but would be oversensitive and cause false alarms in small compartments. The notice, therefore, proposed a broad range of instrument sensitivity settings so that an operator or airplane manufacturer might select one for a particular installation. The instrument setting to be used will be determined by the airworthiness standards applicable to that airplane rather than by the TSO which does not contain operating instructions. For the above reasons, the lower limit of 60 percent as proposed for Type II instruments is being retained in the revised standard. However, the Agency agrees with the recommendation that the upper limit of the Type II instrument be raised from 90 percent to 95 percent light transmission at which the instrument may actuate the circuit. This will enable the instrument manufacturer to provide the higher sensitivity desired by some users yet also meet any lower sensitivity requirements.

One objection was voiced to the proposed photocell light transmission calibration procedure of paragraph 3.1 with respect to Type II instruments. It was pointed out that calibration at 50 percent light transmission may give 5 to 8 percent errors at the 90 percent light

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transmission level due to photocell nonlinear characteristics and, therefore, calibration should be conducted within the range required for a specific smoke detection system. The Agency agrees with the underlying basis for this objection and, on further consideration, believes it unnecessary for purposes of this standard to specify the details of the calibrating method. Accordingly, we have deleted the final sentence of paragraph 3.1, Type II, as contained in the proposal.

One commentator noted that it could be difficult for a Type III instrument manufacturer to demonstrate compliance with light transmission percentages without a pressure differential and calibration system being defined. However, where a certain pressure differential across an instrument is required for proper operation, the manufacturer would include such information in the technical data required by § 37.111(c)(1) and furnish this to the user in the form of installation procedures and equipment limitations to be observed in a particular application.

Notice 66–19 proposed a relaxation in the response time characteristics of all three types instruments from 30 seconds for a sample introduced into the instrument (as stated in the current TSO) to one minute when the air sample is introduced at a sampling station. One commentator pointed out that for a Type III "instrument" the response time as proposed would necessarily include the time required to traverse the pipe from sampling station to viewing station. Since the length and size of the pipe will affect response time and is necessarily an airplane system characteristic over which the instrument manufacturer has no control, the proposed amendment cannot be a TSO requirement. The Agency agrees, and paragraph 3.5 has been changed to predicate response time on an air sample introduced into the instrument. This change will not affect Types I and II instruments in which the sampling or detecting element is part of the instrument and electrically actuates an alarm or control circuit.

Another commentator favored a 30-second system response time in the interest of providing early warning of a hazardous condition. The foregoing discussion has indicated the advisability of setting the response time requirement on an instrument rather than a system basis. However, the 30-second instrument response time which has been a requirement for many years has not been shown to be impracticable or a burden on smoke detector manufacturers. The Agency concurs as to the need for early warning of a hazardous condition and is, therefore, retaining the 30-second instrument response time requirement contained in the present TSO–C1a. Paragraphs 3.5 and 6 of the proposal have been amended accordingly.

In response to a suggestion that the "air sample" specified in proposed paragraph 3.5 be more clearly defined, we have added a sentence referring this term to the applicable concentrations or light transmission characteristics specified in paragraph 3.1.

The Agency must reject a recommendation that the paragraph 3.8 AC voltage variation, through which the instrument must properly function, be increased from ±10 percent to ±15 percent. While the reason given is to assure that the voltage range is compatible with that encountered in today's aircraft, we have no evidence that AC voltage in current aircraft will vary more than ±10 percent. Moreover, the 10 percent variation has been widely accepted for many years and continues to be accepted as the range through which AC electrical equipment must continue to operate. Since there appears to be no justification for making the AC power variation more strict, we are retaining the ±10 percent value of the present TSO and of the proposal.

The purpose of paragraph 3.11 is to safeguard against all hazards to the aircraft in the event of malfunction or failure of the smoke detector. Inasmuch as fire is only one type of hazard that might be caused, the paragraph 3.11 catchline is amended to read "Hazards due to malfunction or failure".

Noting that the environmental conditions, paragraphs 4.1 through 4.3 of the proposal, did not appear to take into consideration future SST altitude and temperature ranges, it was recommended that paragraph 4.2 be revised to require an unpressurized altitude capability of 80,000 feet or that the device be limited to subsonic aircraft. The Agency, however, considers it premature at this time to include provisions for the SST environment. Furthermore, since the instrument manufacturers will include installation limitations in accordance with § 37.111(c)(1), it is believed unnecessary to include a provision expressly limiting the instruments to subsonic aircraft.

One commentator recommended lower low temperature values in the table of paragraph 4.1 which would be more representative of unheated (uncontrolled) areas. While the temperature values given in the proposal may be exceeded, experience has not shown such occurrences to be sufficiently frequent or serious to justify imposition of the more severe design restrictions on instrument manufacturers. The temperature ranges in the proposal are the same as in other Agency standards (i.e., TSO–C7c and TSO–C44a) and industry specifications and, for the reasons given, are being retained.

Because the technical complexity would impose an unreasonable burden on detector manufacturers disproportionate to any value that might be realized, the Agency must reject a suggestion that paragraph 4.2 be amended to require that the equipment not false alarm when submitted to an explosive or high rate decompression to 40,000 feet.

Other minor changes of an editorial or clarifying nature have been made to the TSO as it was proposed. They are not substantive, however, and do not impose any additional burden on regulated persons.

Interested persons have been afforded the opportunity to participate in the making of this amendment and all relevant material submitted has been fully considered.

(Sec. 313(a), 601, Federal Aviation Act of 1958; 49 U.S.C. 1354, 1423)

In consideration of the foregoing, and pursuant to the authority delegated to me by the Administrator (25 F.R. 6489), § 37.111, Part 37 of the Federal Aviation Regulations is amended to read as hereinafter set forth, effective March 24, 1967.

Issued in Washington, D.C., on February 14, 1967.

C. W. WALKER,
*Director, Flight Standards Service.*

**§ 37.111 Cargo and baggage compartment smoke detection instruments—TSO–C1b.**

(a) *Applicability.* This technical standard order prescribes the minimum performance standards that cargo and baggage compartment smoke detection instruments must meet in order to be identified with the applicable TSO marking. New models of equipment that are to be so identified, and that are manufactured on or after March 24, 1967, must meet the requirements of the "Federal Aviation Standard, Cargo and Baggage Compartment Smoke Detection Instruments" set forth at the end of this section.

(b) *Marking.* In addition to the markings specified in § 37.7, the equipment must be marked to indicate the following:

(1) Eligibility for installation in either piston or turbine-powered aircraft, or both.

(2) Operational ratings (electrical, vacuum, etc.).

(c) *Data requirements.* The technical data to be submitted in accordance with § 37.5(a)(2) is as follows:

(1) Seven copies of the manufacturer's operating instructions, equipment limitations, and installation procedures; and

(2) One copy of the manufacturer's test report.

(d) *Previously approved equipment.* Smoke detector models approved prior to March 24, 1967, may continue to be manufactured under the provisions of their original approval.

FEDERAL AVIATION STANDARD CARGO AND BAGGAGE COMPARTMENT SMOKE DETECTION INSTRUMENTS

1. *Purpose.* This document provides minimum performance standards and test procedures for cargo and baggage compartment smoke detection instruments which are to be approved under this TSO.

2. *Classification.* Smoke detection instruments are classified by method of detection as follows:

Type I—Measurement of carbon monoxide gas (CO detectors).

Type II—Measurement of light transmissibility in air (photoelectric devices).

Type III—Visual detection of the presence of smoke by directly viewing air samples (visual devices).

3. *Minimum performance standards.* Except where otherwise indicated, the minimum performance standards of this section are applicable to Types I, II, and III instruments. The term "instrument", wherever referred to in this TSO, does not include any lengths of tubing used to conduct air sam-

ples from sampling stations to testing stations.

3.1 *Type characteristics.* The instruments must perform as follows:

Type I—By testing air for carbon monoxide content, the instrument must be capable of actuating an alarm (or control) circuit at all concentrations of CO that are 0.025 percent and greater by volume. At concentrations over 0.015 but less than 0.025 percent the instrument may actuate the circuit but at concentrations 0.015 percent and less, it must not actuate the circuit.

Type II—By testing air for smoke content of all colors or particle sizes, the instrument must be capable of actuating an alarm (or control) circuit to indicate the presence of smoke particles at all concentrations at which the light transmission percentage is 60 percent or less. At light transmission percentages over 60 but less than 96, the instrument may actuate the circuit but at percentages 96 and over, it must not actuate the circuit. Light transmission percentage is defined as the light falling on a photoelectric cell through a 1-foot distance occupied by smoke particles in air, expressed as a percentage of the light transmitted through 1 foot of clean air.

Type III—By testing air for the presence of smoke of all colors or particle sizes, the instrument must provide a visual display to indicate clearly all smoke concentrations in which the light transmission percentage is 60 percent or less. The instrument may, but is not required to, indicate smoke concentrations for which the light transmission percentage is over 60. Light transmission percentage is as defined for Type II instruments.

3.2 *Materials.* Smoke detection instruments must be constructed of materials of a quality that experience or tests or both have demonstrated to be suitable and dependable for use in aircraft application.

3.3 *False alarm signals.* Type I and Type II instruments conforming to the requirements of this standard must not actuate the alarm (or control) circuit as a result of dust and haze normally present in the cargo compartment, nor of the dust that normally accumulates within the instrument. The design must be such that the instrument will not produce a false alarm (or control) signal as a result of abnormal attitudes, ambient light conditions, variations in voltage between 0 and 125 percent of the rated value, nor of accelerations encountered during takeoff, flight, and landing.

3.4 *Functional test provisions.* Type I and Type II instrument design must incorporate a means for testing the functioning of the system in flight.

3.5 *Response time.* Type I and Type II instruments must be designed to actuate an alarm (or control) circuit, and Type III instruments to show visually the presence of smoke, within a maximum time period of 30 seconds after an air sample, applicable to the type of instrument, is introduced into the instrument. Air samples used to demonstrate compliance with this paragraph must contain the concentrations of carbon monoxide or possess the light transmission characteristics, as applicable, specified in paragraph 3.1.

3.6 *Air sampling cycle.* An instrument designed to sample the air from more than one sampling station on a cycling basis must cycle at a rate sufficient to sample all stations within a total time of one minute. When an alarm signal is given, the signal must indicate the location in which the smoke or gas is being detected and must continue to do so until the condition is eliminated. The instrument must begin cycling in a normal manner within 30 seconds after the alarm signal is cleared.

3.7 *Environmental ranges.* The design of any instrument conforming to this standard must ensure that it is capable of functioning without being adversely affected following prolonged exposure to the ranges of environmental conditions as stated under section 4.

3.8* *Power variation.* Each instrument type must be designed to ensure proper functioning with the following variations of power parameters (where applicable) from rated values: d.c. voltage, ±15 percent; a.c. voltage, ±10 percent; frequency, ±5 percent.

3.9 *Explosion protection.* Where the instrument is intended to be installed in areas of the airplane where flammable fluids or vapors might be liberated by leakage or failure in fluid systems, design precautions must be made to safeguard against the ignition of such fluids or vapors due to operation of the instrument.

3.10 *Humidity.* Each instrument type must be designed to function properly and not be adversely affected following exposure to any relative humidity in the range from 0 to 95 percent at a temperature of approximately 70° C.

3.11 *Hazards due to malfunction or failure.* Each instrument type must be designed to safeguard against hazards to the aircraft in the event of malfunction or failure. The maximum operating temperature of any instrument-component surface that comes in contact with air samples must not exceed 200° C.

4. *Environmental conditions.*

4.1 *Temperature.* Each instrument type must be designed to function properly over the range of ambient temperatures shown in Column A below and not be adversely affected by exposure to the range of temperature shown in Column B below:

| Instrument location | A | B |
|---|---|---|
| Heated areas (temperature controlled). | −30° to 50° C. | −65° to 70° C. |
| Unheated areas (temperature uncontrolled). | −55° to 70° C. | −65° to 70° C. |

4.2 *Altitude.* Each instrument type must be designed to function properly from sea level up to the altitudes listed below. The instrument must not be adversely affected when subjected to an ambient pressure of 50 inches of mercury absolute.

| *Instrument location* | *Altitude (feet)* |
|---|---|
| Pressurized areas | 15,000 |
| Nonpressurized areas | 45,000 |

4.3 *Vibration.* Each instrument type must be designed to function properly and not be adversely affected when subjected to vibrations of the following characteristics:

| | Frequency cycles per second | Maximum double amplitude in inches | Maximum acceleration |
|---|---|---|---|
| Piston engine powered: | | | |
| Wings or empennage | 5–500 | 0.036 | 10g |
| Fuselage | 5–500 | .036 | 5g |
| Panel or rack (vibration isolated) | 5–50 | .020 | 1.5g |
| Turbine engine powered: | | | |
| Fuselage | | | |
| Forward of spar area | 5–500 | .036 | 2g |
| Center of spar area | 5–1000 | .036 | 4g |
| Aft of spar area | 5–500 | .036 | 7g |
| | 500–1000 | ---------- | 5g |
| Vibration isolated rack | 5–1000 | .030 | 1g |
| Instrument panel | 5–30 | .020 | ---------- |
| | 30–1000 | ---------- | .25g |

5. *Qualification tests.* As evidence of compliance with this standard, the applicant must perform evaluation tests on prototype instruments to demonstrate proper design, reliability in performance of its intended functions, and conformity with the performance standards of section 3. Tests and test procedures employed for this purpose must reasonably demonstrate the absence of any adverse effect on the instrument's performance due to the following factors: power variations, pressure and altitude changes, humidity changes, high and low temperature conditions, airplane vibrations and prolonged operational usage.

6. *Individual performance.* Each instrument manufactured in accordance with this standard must be capable of meeting all the performance standards under section 3. Each instrument must be tested so that when an air sample applicable to the type of instrument per section 3.1 is introduced into the instrument under standard atmospheric conditions, the alarm (or control) circuit is actuated (for Type I and II instruments), or the visual display occurs (for Type III instruments), in 30 seconds or less.



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