

Certification of False Alarm Resistant Cargo Smoke Detectors

Presented to: International Aircraft Systems Fire Protection
Working Group

By: Robert I. Ochs

Date: May 8, 2018




**Federal Aviation
Administration**



25.858 Cargo Fire Protection, 2/10/1998

- If certification with cargo or baggage compartment smoke or fire detection provisions is requested, the following must be met for each cargo or baggage compartment with those provisions:
 - (a) The detection system must provide a visual indication to the flight crew within one minute after the start of a fire.
 - (b) The system must be capable of detecting a fire at a temperature significantly below that at which the structural integrity of the airplane is substantially decreased.
 - (c) There must be means to allow the crew to check in flight, the functioning of each fire detector circuit.
 - (d) The effectiveness of the detection system must be shown for all approved operating configurations and conditions.



Federal Aviation Administration

RGL Home

Code of Federal Regulations

▼ **Sec. 25.858**

| | |
|---|-----------------|
| Part 25 AIRWORTHINESS STANDARDS: TRANSPORT CATEGORY AIRPLANES | |
| Subpart D--Design and Construction | Fire Protection |

Sec. 25.858

Cargo [or baggage compartment smoke or fire detection systems.]

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Amdt. 25-93, Eff. 3/19/98

► **Comments**

▼ **Document History**

Notice of Proposed Rulemaking Actions:
Notice of Proposed Rulemaking. Notice No. [97-10](#); Issued on 06/09/97.

Final Rule Actions:
Final Rule. Docket No. [28937](#); Issued on 02/10/98.



AC 25-9A, 1/6/1994

- Provides guidelines for the conduct of certification tests relating to smoke detection, penetration, and evacuation.
 - Provides a list of acceptable smoke generators for smoke detection tests
 - Emphasizes that only a small amount of smoke should be generated to simulate a smoldering fire



Advisory Circular

Subject: SMOKE DETECTION, PENETRATION, AND EVACUATION TESTS AND RELATED FLIGHT MANUAL EMERGENCY PROCEDURES Date: 1/6/94 Initiated by: ANM-110 AC No: 25-9A Change:

1. **PURPOSE.** This advisory circular (AC) provides guidelines for the conduct of certification tests relating to smoke detection, penetration, and evacuation, and to evaluate related Airplane Flight Manual (AFM) procedures. These guidelines may be used to reduce the number of decisions based solely on judgment in conducting tests and evaluating test results. While this AC is not mandatory, it offers a method of demonstrating compliance with the applicable airworthiness requirements. In some cases designers have chosen to design beyond what is prescribed in the airworthiness requirements. A limited discussion of the use of such designs/devices is included. This AC does not constitute a regulation and is not intended to require anything beyond that specifically required by the regulations.

2. **CANCELLATION.** Advisory Circular 25-9, "Smoke Detection, Penetration, and Evacuation Tests and Related Flight Manual Emergency Procedures," dated July 29, 1986, is canceled.

3. **RELATED FAR SECTIONS.** The related sections of the Federal Aviation Regulations (FAR), as amended through Amendment 25-74, are as follows. Where applicable, corresponding sections of Part 4b of the Civil Air Regulations (CAR) of 1962 follow each cited Part 25 section of the FAR.

| | |
|----------------------------|---|
| 25.831/4b.371/121.219 | Ventilation. |
| 25.854/121.308 | Lavatory fire protection. |
| 25.855/4b.382,384 | Cargo or baggage compartments. |
| 25.857/4b.383 | Cargo compartment classification. |
| 25.858 | Cargo compartment fire detection systems. |
| 25.869/25.1359/4b.626 | Fire protection: systems/Electrical system fire and smoke protection. |
| 25.1301/4b.600,601 | Function and installation. |
| 25.1309/4b.606 | Equipment, systems, and installations. |
| 25.1439/4b.380,651/121.337 | Protective breathing equipment. |
| 25.1585/4b.742 | Operating procedures. |
| Part 25, Appendix 'F' | Test Criteria and Procedures for Showing |
| (Part 1) | Compliance with § 25.853, or 25.855 |
| 121.221 | Fire precaution. |



TSO-C1e, 8/19/2014

- **TSO-C1e describes Minimum Performance Standards (MPS) for cargo compartment fire detection instruments**
 - Requires new models of cargo compartment fire detection instruments meet MPS qualification requirements in SAE Aerospace Standard AS8036



Department of Transportation
Federal Aviation Administration
Aircraft Certification Service
Washington, D.C.

TSO-C1e

Effective
Date: 08/19/14

Technical Standard Order

Subject: Cargo Compartment Fire Detection Instruments

- 1. PURPOSE.** This technical standard order (TSO) is for manufacturers applying for a TSO authorization (TSOA) or letter of design approval (LODA). In it, we (the Federal Aviation Administration, FAA) tell you what minimum performance standards (MPS) your Cargo Compartment Fire Detection Instruments must first meet for approval and identification with the applicable TSO marking.
- 2. APPLICABILITY.** This TSO affects new applications submitted after its effective date.
 - a. TSO-C1d will remain effective until February 19, 2016. After this date, we will no longer accept applications for TSO-C1d.
 - b. A Cargo Compartment Fire Detection Instrument approved under a previous TSOA may still be manufactured under the provisions of its original approval.
 - c. Major design changes to Cargo Compartment Fire Detection Instruments approved under this TSO will require a new authorization. See Title 14 of Code of Federal Regulations (14 CFR) § 21.619(b).
- 3. REQUIREMENTS.** New models of Cargo Compartment Fire Detection Instruments identified and manufactured on or after the effective date of this TSO must meet the MPS qualification and documentation requirements in SAE, Inc., Aerospace Standard (AS) Document No. AS8036 "Cargo Compartment Fire Detection Instruments," Revision A, dated December 17, 2013 except for paragraphs 4.9, 4.10 and 4.11.
 - a. **Functionality.** This TSO standard applies to equipment intended to provide protection by fire detection in aircraft cargo compartments, galleys, electronic equipment bays, and other similar installations.
 - b. **Failure Condition Classifications.** There is no standard minimum failure condition classification for this TSO. The failure condition classification appropriate for



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AS8036, 12/2013

- **SAE AS8036 includes criteria for resisting false alarms from various sources**
- **Section 6. False Alarm Signals**
 - Air Velocity
 - Dust
 - Insecticide
 - Ambient Light
 - Combined Temperature, Pressure and Humidity Cycling



**AEROSPACE
STANDARD**

AS8036

REV. A

Issued 1985-04
Revised 2013-12

Superseding AS8036

(R) Cargo Compartment Fire Detection Instruments

RATIONALE

The document was revised to incorporate minimum performance standard testing for smoke detector false alarm immunity and to refer to the latest revision of DO-160, revision G.

1. SCOPE

1.1 This SAE Aerospace Standard (AS) specifies minimum performance standards for the following types of fire detection instruments intended for use in protecting aircraft cargo compartments, galleys, electronic equipment bays and other similar installations.

1.2 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: Deleted

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 feet (5486 m) when installed in a non-pressurized area.

2. NORMATIVE REFERENCES

The following Standard contains provisions which, through reference in this text, constitute provisions of this Standard. At the time of publication, the edition indicated was valid. All standards are subject to revision, and parties to agreements based on this Standard are encouraged to investigate the possibility of applying the most recent edition of the Standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

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Problem

- **AS8036 false alarm conditions are similar to theatrical smoke aerosols**
 - Detectors that are designed to not alarm for insecticide aerosols may also not alarm for theatrical smoke, thus proving difficult to certify with current smoke generators



Task Group Formation

- **A task group was formed to discuss this issue and work together to develop smoke certification procedures that will cause all detectors to alarm, even those that are false-alarm resistant**
- **Task group met several times either in person or on Webex**
- **Ideal Smoke Generator Characteristics**
 - Capable of producing aerosols in the 200-300nm size range with refractive index of 1.4
 - More consistent and repeatable, perhaps with control of mass flow rate of liquid
 - It was asked of the group to provide what type/brand of smoke generator is being used when testing/developing C1e complaint detectors
 - The group agreed that the most critical parameter of an artificial smoke source is the particle size



Task Group Update

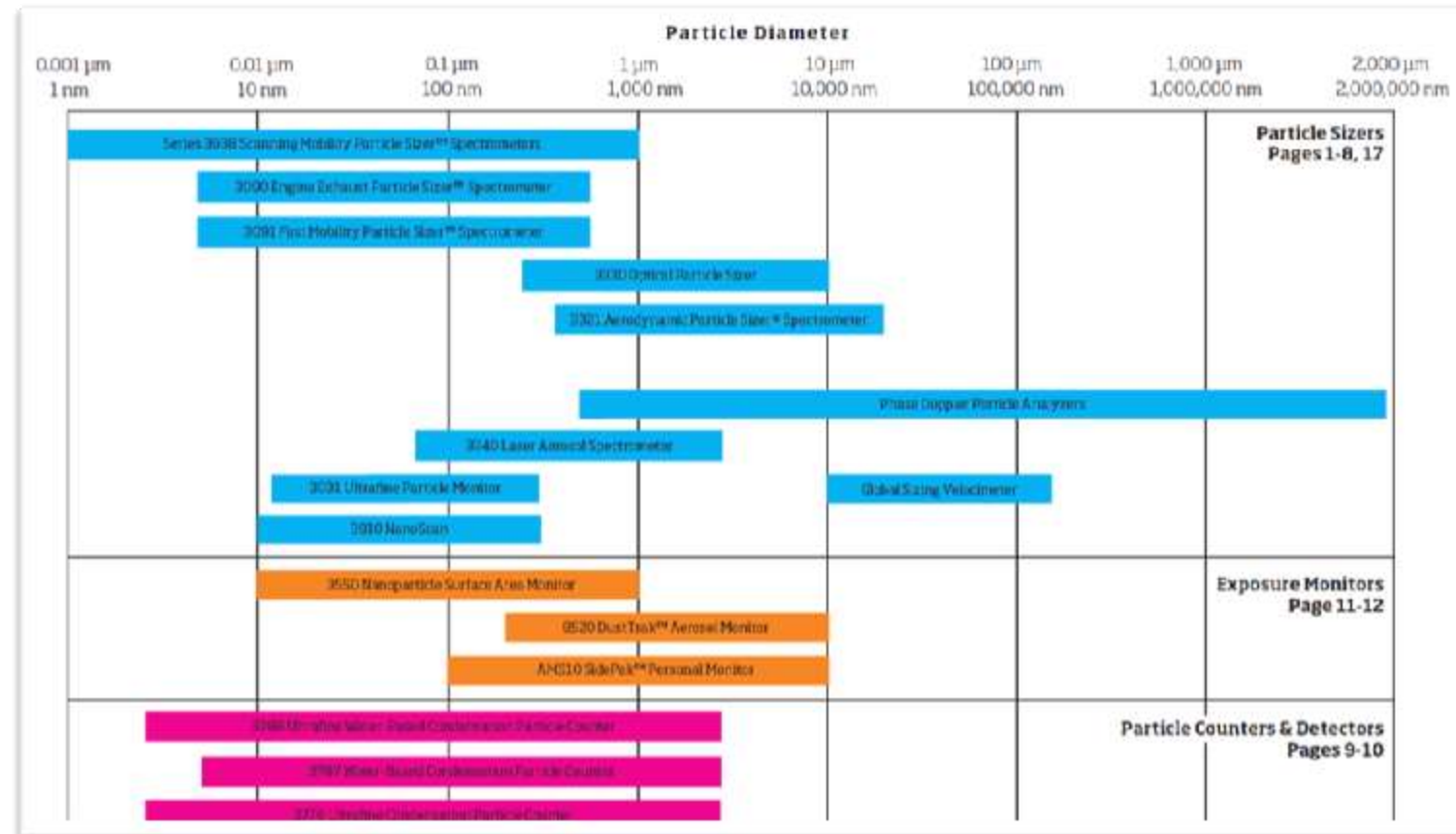
- **Task group met 11/2/2017 in Atlantic City**
 - 36 Attendees
- **Next meeting Tomorrow May 9 2018**
- **Group Charter**
 - Development of parameters for generating smoke
 - Particle Size
 - Refractive Index
 - Quantity
 - Dynamics
 - Focus on C1E detector certification
 - Optical detection including C1E compliant detectors Type 2 AS8036
 - Class C, E compartments
 - Develop standardized calibration methodology and definition of measurement parameters



Particle Size Measurement

- Met with representatives from TSI, inc for a demonstration of their particle sizing instruments:

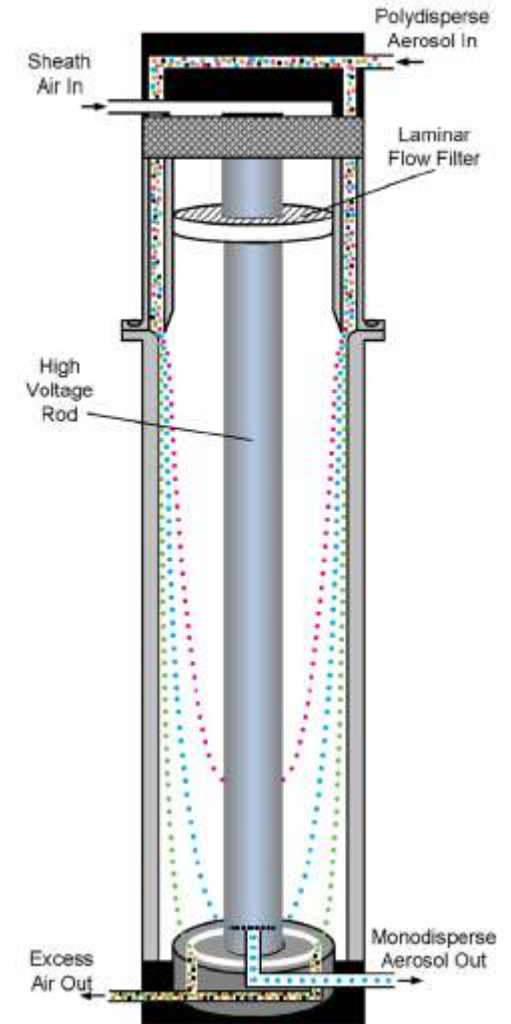
- Scanning Mobility Particle Sizer Spectrometer
- Engine Exhaust Particle Sizer
- Aerodynamics Particle Sizer
- Laser Aerosol Spectrometer



Scanning Mobility Particle Sizer

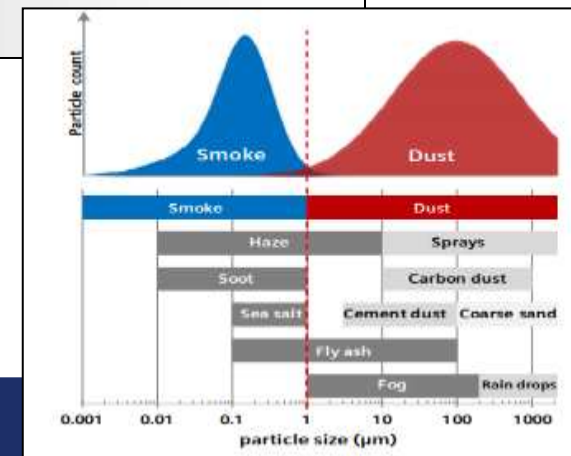
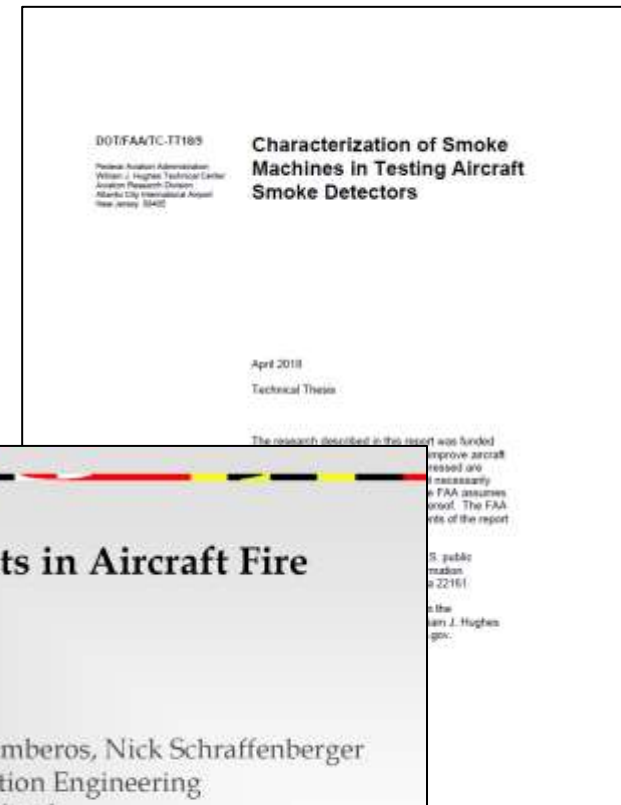
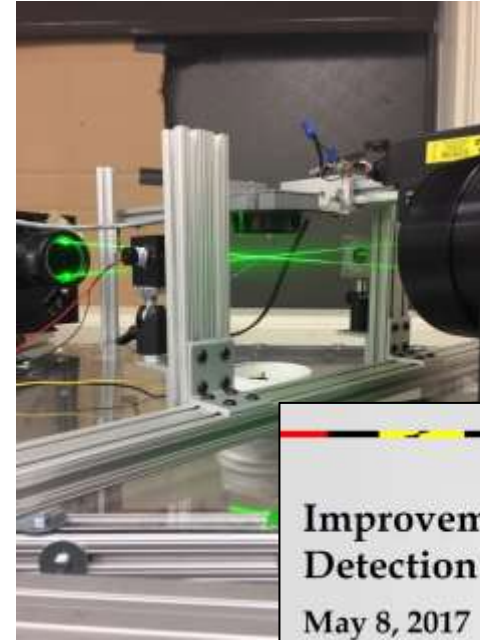


- **SMPS**
 - Measurement range
 - 1 to 1,000 nm
 - Concentration range
 - 1 to 10,000,000 particles/cm³
 - Independent of refractive index of particle or fluid
 - Differential Mobility Analysis
 - The ability of a particle to traverse an electric field is fundamentally related to particle size
 - No calibration necessary (first principle measurement)
 - Sizing uncertainty of <2%
- **FAATC looking to procure SMPS for R&D Q3-4 2018**
 - Artificial smoke particle size
 - Water mist size measurement
 - Fire Suppression Aerosols



Related Research

- Particle size measurement of artificially generated smoke aerosols (Tina Emami, Rutgers University, Final Report:
– <https://www.fire.tc.faa.gov/pdf/TC-TT18-9.pdf>
- Improvements in Aircraft Fire Detection (Jim Milke, University of Maryland)
- Evaluation of response of C1e compliant detector to a variety of smoke sources (Matt Karp, FAATC)



Questions?

For Further Information

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