



Standard Guide for Shipboard Fire Detection Systems¹

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1. Scope

1.1 This guide covers the selection, installation, maintenance, and testing of shipboard fire detection systems other than sprinkler systems.

1.2 This guide is intended for use by all persons planning, designing, installing, or using fire alarm systems onboard vessels. As it includes regulatory requirements, this guide addresses those vessels subject to regulations and ship classification rules. However, the principles stated herein are also suitable for unregulated commercial vessels, pleasure craft, military vessels, and similar vessels that are not required to meet regulations for fire detection and alarm systems.

1.3 *Limitations*—This guide does not constitute regulations or ship classification rules, which must be consulted when applicable.

1.4 The values stated in inch-pound units are to be regarded as the standard. The values given in parentheses are for information only.

1.5 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *Code of Federal Regulations*:²

Title 46, Part 76.25

Title 46, Part 76.30

Title 46, Part 76.33

Title 46, Part 161.002

2.2 *NFPA Publications*:³

NFPA 72E Standard on Automatic Fire Detectors

2.3 *SOLAS Regulations*:⁴

SOLAS II-2/13-1

SOLAS II-2/12

3. Terminology

3.1 *Definitions*:

3.1.1 *accommodation space*—those spaces used for public spaces, corridors, lavatories, cabins, bunkrooms, staterooms, offices, hospitals, cinemas, game and hobby rooms, barber shops, pantries containing no cooking appliances, and similar spaces.

3.1.2 *alarm signalling device*—an audible or visual device such as a bell, horn, siren, strobe, flashing, or rotating light used to warn of a fire condition.

3.1.3 *annunciator*—an audible and visual signalling panel that indicates and displays the alarm, trouble, and power conditions of the fire detection system.

3.1.4 *approved*—acceptable to the organization, office, or individual responsible for accepting equipment, an installation, or a procedure.

3.1.5 *automated machinery space*—a space containing machinery that is automated to allow: (a) periodic unattended operation by the crew; and (b) continuous manual supervision by the crew from a central room (enclosed) or remote location.

3.1.6 *control panel*—an electrical panel that monitors and controls all of the equipment associated with the fire detection and alarm system.

3.1.7 *control space*—an enclosed space within which is located a ship's radio, main navigating equipment, emergency source of power, or the centralized fire recording or fire control equipment, but not including firefighting apparatus that must be located in the cargo area or individual pieces of firefighting equipment.

3.1.8 *hazardous (classified location)*—locations where fire or explosion hazards may exist due to flammable gases or vapors, flammable or combustible liquids, combustible dust, or ignitable fibers or flyings.

3.1.9 *listings*—equipment or materials included in a list published by an organization certified to perform product

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² Available from Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.

³ Available from National Fire Protection Association (NFPA), 1 Batterymarch Park, Quincy, MA 02169-7471, <http://www.nfpa.org>.

⁴ Available from International Maritime Organization, 4 Albert Embankment, London, England SE1 7SR.

evaluations. This organization maintains periodic inspections of production of the listed equipment or materials. The listing states either that the equipment or material meets appropriate standards or has been tested and found suitable for use in a specified manner.

3.1.10 *machinery spaces of Category A*—those spaces and trunks to such spaces which contain: (a) internal combustion machinery used for main propulsion; or (b) internal combustion machinery used for purposes other than main propulsion where such machinery has, in the aggregate, a total power output of not less than 500 hp (375 kW); or (c) any oil-fired boiler or oil fuel unit.

3.1.11 *main vertical zones*—those sections, the mean length of which does not, in general, exceed 131 ft (40 m) on any one deck, into which the hull, superstructure, and deck houses are required to be divided by fire-resisting bulkheads.

3.1.12 *manually activated fire alarm box*—a box containing an electrical switch which, when manually operated, sends an alarm signal to the control panel (referred to as “Manually Operated Call Points” by SOLAS).

3.1.13 *RO/RO cargo space (roll on/roll off cargo spaces)*—a space not normally subdivided in any way and extending to either a substantial length or the entire length of the ship in which cargo, including packaged cargo, in or on rail or road cars, vehicles (including road or rail tankers), trailers, containers, pallets, or demountable tanks (in or on similar stowage units or other receptacles), can be loaded and unloaded normally in a horizontal direction.

3.1.14 *self restoring*—the ability of a device to reset itself automatically after being activated.

3.1.15 *service space*—those spaces used for galleys, pantries containing cooking appliances, lockers, mail, and specie rooms, store rooms, workshops other than those forming part of the machinery spaces, and similar spaces as well as trunks to such spaces.

3.1.16 *special category space*—an enclosed space above or below the bulkhead deck intended for the carriage of motor vehicles with fuel in their tanks for their own propulsion, into and from which such vehicles can be driven and to which passengers have access.

3.1.17 *supervised*—describes an electronic method of monitoring the electrical continuity of the circuits and devices of a fire detection and alarm system. This is normally accomplished by constantly passing a small current through the circuits and devices.

4. Significance and Use

4.1 The purpose of a shipboard fire detection system is to provide warning so as to reduce the life safety threat from fire and to minimize the fire threat to the operation of the ship. Given that few ships are identical either in size or layout, it follows that the fire detection system will have to be custom designed accordingly. A well-designed system provides a reasonable substitute to having crew members on constant fire watch in every protected space where a fire might occur.

4.2 The basic function of the fire detection system is to automatically and reliably indicate a fire condition as quickly as is practical and to alert responsible individuals of a fire's existence and location. This system design and application guide addresses the individual steps in the layout of the system as well as an overview of the information needed to design a system.

4.3 The U.S. Coast Guard and the International Convention for the Safety of Life at Sea (SOLAS) regulations have been stated as requirements within this guide. Additional guidelines to assure complete and effective systems or to incorporate good industry practices are stated as recommendations.

DESIGN AND APPLICATION

5. System Types

5.1 Fire detection and alarm systems used on vessels are typically of the following types:

5.1.1 Electrical automatic fire detection and alarm systems consist of a control panel, various types of fire detectors, manually actuated fire alarm boxes, audible and visual alarms, and appropriate power supplies. The control panel monitors the fire detection and alarm circuits and generates appropriate signals when an automatic fire detector or manual fire alarm box is activated.

5.1.2 A similar system without automatic fire detectors is referred to as a manual fire alarm system but is otherwise identical. Operation is initiated by individuals who activate a manually actuated fire alarm box that incorporates an electrical switch. This guide is primarily concerned with electrically operated automatic and manual fire detection and alarm systems.

5.1.3 Pneumatic fire detection systems consist of a closed length of pneumatic tubing attached to a control unit. Air chambers called heat actuated devices (HADs) are often attached to the tubing in the protected area to increase the volume and thus the sensitivity of the system. As temperature builds up in a fire, the air in the tubing expands, moving a diaphragm in the control unit. A small calibrated vent compensates for normal changes in ambient temperature. The diaphragm activates a release mechanism or a set of contacts. Because pneumatic fire detection systems are self-contained (that is, independent of outside sources of power), they are often used to activate small automatic fire extinguishing systems such as are installed in paint lockers and emergency generator enclosures. U.S. Coast Guard Requirements for pneumatic fire detection systems may be found in Title 46, Code of Federal Regulations, Part 76.30.

5.1.4 Sample extraction smoke detection systems consist of a piping system connected to a control unit with a suction blower. These systems continually draw samples from the protected spaces to the control unit where a light source and photocell monitor the sample for smoke. Sample extraction smoke detection systems are often used in cargo holds because they are less likely than individual spot-type smoke detectors to operate from dust or localized sources of smoke such as vehicle exhausts. Also, the more delicate electronics and control equipment can be located remote from the protected spaces.

of a cargo hold. These systems are often combined with a carbon dioxide extinguishing system, using the carbon dioxide distribution piping to draw samples from the protected areas. Detailed requirements for sample extraction smoke detection systems are contained in proposed SOLAS Regulation II-2/13-1 and in U.S. Coast Guard regulations found in Title 46, Code of Federal Regulations Parts 76.33 and 161.002.

5.1.5 Automatic sprinkler systems that are constantly pressurized and connected to a continuous supply of water and fitted with a suitable means for automatically giving visual and audible alarm signals may also be considered to be fire (heat) detection and alarm systems. Detailed requirements are found in SOLAS Regulation II-2/12 and U.S. Coast Guard Regulations, Part 76.25.

6. Classification of Fire Detectors

6.1 Heat detectors are devices that sense a fixed temperature or rate of temperature rise. Heat detectors work on one of the three operating principles outlined in 6.2, 6.3, and 6.4.

6.2 A fixed temperature detector is a device that responds when its operating element becomes heated to a predetermined level. Because of the time required to heat the mass of element to its preset level, there is usually a lag time, referred to as the “thermal lag,” between the time the surrounding air reaches the operating temperature and the time the operating element reaches its preset operating temperature. There are seven temperature classification ranges. In locations where the ceiling temperature does not exceed 100°F (38°C), detectors with an operating range of 135 to 174°F (57.2 to 78.9°C) should be used. These are termed “ordinary” temperature classifications. Several types of temperature sensitive operating elements are used such as:

6.2.1 Bimetallic elements consist of two metal strips with different coefficients of expansion fused together so that heating will cause the element to deflect, making electrical contact.

6.2.2 Electrical conductivity elements are devices whose electrical resistance varies as a function of temperature.

6.2.3 Certain automatic heat detectors use fusible alloy elements or liquid expansion elements that operate at a fixed temperature. These devices are nonrestorable and are prohibited by SOLAS.

6.3 A rate-of-rise detector is a device that operates when the temperature rises at a faster than predetermined rate. Since operation does not depend on having reached a fixed temperature level, it responds to a rapid temperature rise more quickly than a fixed temperature detector. However, it does not respond to a slow developing fire regardless of how high the temperature gets. In a typical rate-of-rise detector, heated air in a chamber expands to deflect a diaphragm that operates electric contacts.

6.4 A rate of compensation detector is a device which, because of differential expansion of several components, responds when the temperature of the air surrounding the detector reaches a predetermined level, regardless of the rate at which the temperature rises. It is designed to avoid the thermal lag time that is inherent in a fixed temperature detector. This device is also known as a rate anticipation detector.

6.5 Combination heat detectors take advantage of more than one operating principle in a single detector housing. Combination fixed temperature and rate-of-rise detectors are most common.

6.6 Smoke detectors are devices that detect visible or invisible products of combustion. They work on several operating principles as follows:

6.6.1 Ionization smoke detectors have a small radioactive source that ionizes the air within a chamber, making it conductive so that a small current flows between electrodes. Smoke particles entering the chamber interfere with the free flow of ions and reduce the current, activating the detector.

6.6.2 Photoelectric smoke detectors use a light source and photocell to detect the presence of smoke. Several types may be used on ships:

6.6.2.1 In the light obscuration type of detector, smoke particles that enter between the light source and the photocell reduce the amount of light reaching the photocell, causing the detector to activate. Projected linear beam smoke detectors are light obscuration smoke detectors. The light source and photocell are separately housed, and the light beam is projected across the protected area. The alignment between transmitter and receiver is critical for proper operation of this device. Shipboard vibration and flexing may affect proper alignment.

6.6.2.2 In a photoelectric light-scattering smoke detector, the components are arranged so that light does not normally reach the photocell. When smoke particles enter the chamber, they reflect or scatter some of the light onto the photocell, activating the detector.

6.6.3 Sample extraction smoke detection systems as described in 5.1.3 operate on one of the principles covered in 6.6.2.1 and 6.6.2.2.

6.7 Flame detectors are devices that detect infrared (IR), ultraviolet (UV), or visible light produced by a fire. To avoid activation by sources or radiation other than fires such as welding, sunlight, and so forth, flame detectors are usually designed to sense light modulated at a rate characteristic of the flicker rate of flames, or to detect certain bands of IR or UV or visible radiation characteristic of flames, or some combination of these features. A combination of these features is used in some applications to reduce the probability of false alarms.

6.8 Other classifications of fire detectors include: (a) gas detectors that sense gases produced by burning substances; (b) resistance bridge smoke detectors that sense change in conductivity when smoke particles and moisture from fire are deposited on an electrical grid; (c) cloud chamber smoke detectors in which moisture is caused to condense on smoke particles drawn into a chamber; and (d) heat-sensitive cable in which high temperature softens the insulation separating two conductors, causing reduced resistance or shorting of the conductors, as well as devices that operate on other principles. Such detectors are seldom used on ships.

6.9 Combination detectors combine the principles of one or more classifications of fire detectors or detection principles in a single device. A common example is a fixed temperature-rate-of-rise heat detector.