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Ships and marine technology — Lifesaving and fire protection — Atmospheric oil mist detectors for ships

Navires et technologie maritime — Sauvetage et protection contre le feu — Détecteurs de brouillard d'huile atmosphériques pour navires

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 16437 was prepared by Technical Committee ISO/TC 8, *Ships and marine technology*, Subcommittee SC 1, *Lifesaving and fire protection*.

Introduction

The majority of fires which have occurred in engine rooms are generally caused by a leak or fracture from a flammable liquid system. Most engine room fires begin as a result of the ignition of oil mist. The mist can be formed in one of two ways:

— when oil mist is generated through minute leaks in oil lines which, under pressure, give off a very fine atomized spray: and,

— when oil hits a hot surface and boils, generating a mist.

Detection at this stage could therefore provide a pre-alarm warning to the risk of fire.

Oil mist detection systems are available to continuously monitor the machinery space atmosphere. They can give early warning of a dangerous onset of oil mist accumulation and can be incorporated in arrangements to automatically shut down valves, machinery, etc., to prevent the outbreak of fire.

For this purpose, atmospheric oil mist detection systems should be installed where an identified risk of fire hazard exists from the potential generation of oil mist from flammable liquids such as hydraulic, fuel and lubricating oil systems. Oil mist detection systems are particularly useful in engine rooms, oil purifying rooms, and hydraulic pump rooms on board ships, as well as fixed and floating offshore hydrocarbon platforms.

This International Standard has been developed for oil mist detectors on board ships and specifies the requirements for detectors used to detect volatile mist that can result in a fire. It is based on the document *Guidelines for the manufacture and installation of oil mist detectors* prepared by the International Maritime Organization (IMO) sub-committee on fire protection (FP).

Ships and marine technology — Lifesaving and fire protection — Atmospheric oil mist detectors for ships

1 Scope

1.1 This International Standard specifies requirements, test methods and performance criteria for resettable oil mist detectors for use in fire hazard alarm systems installed on marine vessels. Oil mist detectors may be installed where an identified risk of fire caused by ignition of flammable liquids, such as hydraulic, fuel and lubricating oil systems, exists.

1.2 This International Standard specifies requirements for the following detectors:

— point type detectors employing a point aspirating sampling device or relying on dispersion of oil mist;

— aspirating detectors, whereby the sampling point is separated from the sensing unit(s) and uses a pipe network for carrying the sampling air to the sensing unit(s);

— open path or beam type detectors, whereby the concept of the point detector is expanded to a sampling path which can be 20 m or more, as opposed to a few centimetres in the point type detector.

1.3 For the testing of other types of detector working on different principles, this International Standard is only for guidance. Detectors with special characteristics and developed for specific risks, as well as those designed for use in explosive atmospheres, are not covered by this International Standard.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 7240-2, *Fire detection and alarm systems — Part 2: Control and indicating equipment*

ISO 7240-4, *Fire detection and alarm systems — Part 4: Power supply equipment*

IEC 60068-1, *Environmental testing — Part 1: General and guidance*

IEC 60068-2-1, *Environmental testing — Part 2-1: Tests — Test A: Cold*

IEC 60068-2-2, *Environmental testing — Part 2-2: Tests — Test B: Dry heat*

IEC 60068-2-6, *Environmental testing — Part 2-6: Tests — Test Fc: Vibration (sinusoidal)*

IEC 60068-2-30, *Environmental testing — Part 2-30: Tests — Test Db: Damp heat, cyclic (12 h + 12 h cycle)*

IEC 61000-4-2, *Electromagnetic compatibility (EMC) — Part 4-2: Testing and measurement techniques — Electrostatic discharge immunity test*

IEC 61000-4-4, *Electromagnetic compatibility (EMC) — Part 4-4: Testing and measurement techniques — Electrical fast transient/burst immunity test*

IEC 61000-4-5, *Electromagnetic compatibility (EMC) — Part 4-5: Testing and measurement techniques — Surge immunity test*

IEC 61000-4-6, *Electromagnetic compatibility (EMC) — Part 4-6: Testing and measurement techniques — Immunity to conducted disturbances, induced by radio-frequency fields*

EN 50086-1:1994, *Specification for conduit systems for cable management — Part 1: General requirements*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
alarm set point(s)
oil mist density in the proximity of the specimen at the moment that it generates an alarm signal, when tested as specified in 5.1.6

3.2
aspirating detector
sampling device which consists of a pipe network and sampling point which is separated from the sensing unit(s)

NOTE Sampling air and aerosols are drawn through the sampling device, using the pipe network, and carried to one or more sensing elements by an integral aspirator (e.g. fan or pump). Each sensing element may contain more than one sensor exposed to the same air.

3.3
conditioning
exposure of a specimen to environmental conditions to determine the effect of such conditions on the specimen

3.4
fault indication
audible, visible or other type of output different from an alarm signal conveying, directly or indirectly, a warning or indication that the detector is not working satisfactorily

3.5
gravimetric deterministic method
process where the difference in weight of a 0,8 µm pore size membrane filter is ascertained from weighing the filter before and after drawing one litre of oil mist from the test chamber

3.6
lower explosive limit
volume concentration of oil mist, flammable gas or vapour in air, below which the mixture is not explosive

NOTE 1 Also referred to as the lower flammable limit (LFL).

NOTE 2 The lower explosive limit corresponds to an oil mist concentration of approximately 50 mg/l.

3.7
minimum flow rate
minimum flow rate claimed by the manufacturer as meeting the requirements of this International Standard

3.8
non-volatile memory
memory elements which do not require the presence of an energy source for the retention of their contents

3.9
point type detector
point sampling device, sensor type, which operates by aspirating or relying on dispersion of oil mist

3.10
recovery
treatment of a specimen, after conditioning, so that the properties of the specimen can be stabilized before measurement of the said property as required by this International Standard

3.11
repeatability
closeness of agreements between the results of successive measurements of the same value of the same quantity carried out by the same method, with the same measuring instruments, by the same observer, in the same laboratory within a quite short interval of time in unchanged conditions

3.12
sampling device
component or series of components or dedicated device (e.g. a pipe network, dedicated duct, probe or hood) which transfers samples of air to the oil mist sensing element(s)

3.13
sampling point
point at which an air sample is drawn into the sampling device

3.14
sensitivity adjustment
adjustment during or after commissioning which leads to a change in the response to oil mist density

3.15
site-specific detector data
alterable data required for the detector to operate in a defined detector configuration

3.16
transport time
time for aerosols to transfer from a sampling point to the oil mist sensing element

4 Requirements

4.1 General

4.1.1 The detector shall reliably measure the oil mist concentration under the stated application conditions, produce an alarm signal and, if applicable, shall be able to initiate external alarm and protective actions, whenever the level exceeds or falls below a pre-selected alarm concentration.

4.1.2 Detector parts shall be able to withstand the stresses due to vibration, dust, corrosive media and climatic influences during normal use.

4.1.3 Materials and components shall be used within the ratings or limits specified by the material or component manufacturer, unless otherwise specified by appropriate safety standards taking into account the limits of specific operating conditions.

4.1.4 Materials that come into contact with the oil mist shall not affect the measured value in milligrams per litre for the oil mist.

4.1.5 Detectors shall be constructed to

— facilitate easy access for regular function checks and calibration, and

— allow periodic maintenance of serviceable parts and cleaning of sensing surfaces.

4.1.6 The oil mist path of the detector, including any filter and sampling device, shall not be affected by gases expected to be present in the environment.

4.1.7 Any zero-point and gain adjustments shall be independent of each other.

4.1.8 Detectors with more than one measuring range shall clearly identify the selected range.

4.1.9 This International Standard is drafted on the basis of functions which are required to be provided on all oil mist detectors, and optional functions with requirements which may be provided. It is intended that the options will be used for specific applications, as recommended in application guidelines.

4.1.10 Each optional function is included as a separate entity with its own set of associated requirements in order to permit oil mist detectors on board ships with different combinations of functions to conform to this International Standard. If an option is taken, all the corresponding requirements shall be met.

4.1.11 Other functions associated with fire detection and fire alarm may also be provided, even if not specified in this International Standard. However, such options shall not contradict any requirements of this International Standard and must not, in case of a fault, jeopardize any function required by this International Standard.

4.2 Compliance

In order to comply with this International Standard, the detector shall meet the requirements of this clause, which shall be verified by visual inspection or engineering assessment, shall be tested as specified in Clause 5 and shall meet the requirements of the tests.

4.3 Detector calibration

Detectors should have at least two calibrated set points, one at the lowest detection point or zero concentration and the other at the highest detection point determined by the manufacturer, which must be at least 2,0 mg/l or 4 % of the lower explosive limit (LEL). For this reason the measuring system should indicate up to at least 4 % of LEL.

4.4 Cleaning alarm

Detectors must be able to indicate that sensors need cleaning to stop false alarms.

4.5 Indicating devices

An indication shall be provided to show that the detector is switched on. For alarm-only detectors, the manufacturer shall identify suitable points for connecting indicating or recording devices for the purpose of testing. If the apparatus has more than one measuring range, the range selected shall be clearly identified.

4.6 Individual detector indicators

4.6.1 The monitors or individual detector indicators should indicate a maximum reading, e.g. 2,0 mg/l or 4 % of the LEL.

4.6.2 Each detector shall be provided with an integral visual indicator or indicators, by which the individual detector which created an alarm can be identified until the alarm condition is reset. Where other conditions of the detector can be visually indicated, these shall be clearly distinguishable from the alarm indication, except when the detector is switched into a service mode. For detachable detectors, the indicator may be integral with the base or the detector head.

4.6.3 Each detector shall be provided with a fault indication in the event of

— failure of power to the detector,

— loss of continuity or short circuit in one or more of the wires to the detector,

— loss of electrical continuity within the detector, or

— need for cleaning of the sensor.

4.6.4 Where other conditions of the status of the detector are indicated visually, the following colours shall be used:

— red, for indication of a percentage of a potentially high oil mist level;

— green, for power supply normal.

4.6.5 Each indicator shall be labelled to show its function.

4.7 Connection of ancillary devices

The detector may provide for connections to ancillary devices (remote indicators, control relays, etc.), but open- or short-circuit failures of these connections shall not prevent the correct operation of the detector.

4.8 Monitoring of detachable detectors

For detachable detectors, a means shall be provided for a remote monitoring system (e.g. the control and indicating equipment) to detect the removal of the head from the base, in order to give a fault signal.

4.9 Manufacturer's adjustments

It shall not be possible to change the manufacturer's settings except by special means, e.g. with the use of a special code or tool, or by breaking or removing a seal.

4.10 On-site adjustment of response behaviour

4.10.1 If there is provision for on-site adjustment of the response behaviour of the detector, then:

a) for all of the settings at which the manufacturer claims compliance with this International Standard, the detector shall comply with the requirements of this International Standard and access to the adjustment means shall only be possible by the use of a code or special tool or by removing the detector from its base or mounting;

b) any setting(s) at which the manufacturer does not claim compliance with this International Standard shall only be accessible by the use of a code or special tool, and it shall be clearly marked on the detector or in the associated data that if these setting(s) are used, the detector does not comply with this International Standard.

4.10.2 These adjustments may be carried out at the detector or at the control and indicating equipment.

4.11 Response to slow increases of oil mist concentrations

4.11.1 Compensation may be used to mitigate changes in sensitivity due to the build-up of dust and other contaminants on the sensing surfaces.

4.11.2 The provision of drift compensation and/or the provision of algorithms to match a detector to its environment shall not lead to a significant reduction in the sensitivity of the detector to slow increases in the concentration levels of oil mist.

4.11.3 The detector shall cause either a fault or alarm signal at the limit of compensation for the effect of a slowly changing signal response.

4.11.4 Since it is not practical to make tests with very slow increases in the concentration levels of oil mist, an assessment of the response of the detector to slow increases in the concentration levels of oil mist shall be made by analysis of the circuit/software, and/or physical tests and simulations. Where such algorithms are used, the detector shall be deemed to meet the requirements of this clause if the documentation and assessment shows:

a) how and why a sensor drifts;

b) how the compensation technique modifies the detector response to compensate for the drift;

c) that suitable limits to the compensation are in place to prevent the algorithms/means being applied outside the known limitations of the sensor and to ensure ongoing compliance with the clauses of this International Standard;

d) for any rate of increase in oil mist concentration, R, which is greater than $A/4$ per hour (where A is the detector's initial uncompensated alarm set point), the time for the detector to give an alarm does not exceed 1,6 A/R by more than 100 s;

e) the range of compensation is limited such that, throughout this range, the compensation does not cause the alarm set point of the detector to exceed its initial value by a factor greater than 1,6.

4.12 Marking

4.12.1 Each detector shall be clearly marked with the following information:

a) the number of this International Standard (i.e. ISO 16437);

b) the name or trademark of the manufacturer or supplier;

c) some mark(s) or code(s) (e.g. serial number or batch code), by which the manufacturer can identify, at least, the model designation (type or number), the date or batch and place of manufacture, and the version number(s) of any software contained within the detector.

4.12.2 Where any marking on the device uses symbols or abbreviations not in common use, these should be explained in the data supplied with the device.

4.12.3 The markings shall be visible after installation of the detector.

4.12.4 The markings shall not be placed on screws or other easily removable parts.

4.13 Instruction manual

Each detector shall be accompanied by an instruction manual. It shall include the following information:

1) intended use;
2) operational limitations (e.g. ambient temperature, humidity, pressure, flow rate, supply voltage);
3) tests and certificates;
4) measuring principles;
5) indication of alarms;
6) mechanical structure and diagram of apparatus;
7) description of apparatus function;
8) technical data;
9) start-up procedure;
10) calibration and adjustment procedure;
11) service and maintenance;
12) measure to be taken in case of malfunctions;
13) accessories and replacement parts.

4.14 Data

4.14.1 Detectors shall be supplied with sufficient technical, installation and maintenance data to enable their correct installation and operation. To enable correct operation of the detectors, this data should describe the requirements for the correct processing of the signals from the detector. This may be in the form of a full technical specification of these signals, a reference to the appropriate signalling protocol or a reference to suitable types of control and indicating equipment.

4.14.2 Installation and maintenance data shall include reference to an *in situ* test method to ensure that detectors operate correctly when installed.

NOTE Additional information may be required by organizations certifying that detectors produced by a manufacturer conform to the requirements of this International Standard.

4.15 Requirements for software-controlled detectors

4.15.1 General

The requirements of 4.15.2, 4.15.3 and 4.15.4 shall be met for detectors which rely on software control in order to fulfil the requirements of this International Standard.

4.15.2 Software documentation

4.15.2.1 The manufacturer shall have documentation available for inspection which gives an overview of the software design, and provide it to the testing authority if required. This documentation shall be in sufficient detail for the design to be inspected for compliance with this International Standard and shall include at least the following:

a) a functional description of the main program flow (e.g. as a flow diagram or structogram) including:

   1) a brief description of the modules and the functions that they perform,

   2) the way in which the modules interact,

   3) the overall hierarchy of the program,

   4) the way in which the software interacts with the hardware of the detector,

   5) the way in which the modules are called, including any interrupt processing;

b) a description of which areas of memory are used for the various purposes (e.g. the program, site-specific data and running data);

c) a designation, by which the software and its version can be uniquely identified.

4.15.2.2 The manufacturer shall have available detailed design documentation, which only needs to be provided if required by the testing authority. It shall comprise at least the following:

a) an overview of the whole system configuration, including all software and hardware components;

b) a description of each module of the program, containing at least:

   1) the name of the module,

   2) a description of the tasks performed,

   3) a description of the interfaces, including the type of data transfer, the valid data range and the checking for valid data;

c) full source code listings, as hard copy or in machine-readable form (e.g. ASCII-code), including all global and local variables, constants and labels used, and sufficient comment for the program flow to be recognized;

d) details of any software tools used in the design and implementation phase (e.g. CASE-Tools, Compilers, etc.).

4.15.3 Software design

In order to ensure the reliability of the detector, the following requirements for software design apply.

a) The software shall have a modular structure.

b) The design of the interfaces for manually and automatically generated data shall not permit invalid data to cause error in the program operation.

c) The software shall be designed to avoid the occurrence of deadlock of the program flow.

4.15.4 The storage of programs and data

4.15.4.1 The program necessary to comply with this International Standard and any preset data, such as manufacturer's settings, shall be held in non-volatile memory. Writing to areas of memory containing this program and data shall only be possible by the use of some special tool or code, and shall not be possible during normal operation of the detector.

4.15.4.2 Site-specific data shall be held in memory which will retain data for at least two weeks without external power to the detector, unless provision is made for the automatic renewal of such data, following loss of power, within 1 h of power being restored.

4.16 Monitoring of memory contents — optional function

Means may be provided for detecting the loss of site-specific data. If such a loss occurs, a signal shall be made available to the control and indicating equipment within a time limit specified by the manufacturer.

4.17 Additional requirements for aspirating detectors

4.17.1 General

Where the detector includes an aspirating device, the additional requirements of 4.17 apply.

4.17.2 Mechanical strength of the pipework

4.17.2.1 The sampling pipes and fittings shall have adequate mechanical strength and temperature resistance.

4.17.2.2 The minimum requirement shall be pipes classified in accordance with EN 50086-1 to at least Class 1131 (for the definition of "1131" see Table 1).

Table 1 — Mechanical requirements for sampling pipes

Property	Class	Severity
Resistance to compression	1	125 N
Resistance to impact	1	0,5 kg, 100 mm height to fall
Temperature range	31	–15 °C to +60 °C

4.17.2.3 Pipes which are not so classified by the manufacturer of the pipe shall either be tested in accordance with the tests in Table 2 for the above classes or the manufacturer shall provide evidence that the requirements of this clause are met.

Table 2 — Mechanical tests

Test	EN 50086-1 Clause
Compression test	10.2
Impact test[a]	10.3
Resistance to heat[b]	12.2

[a] Conduct the impact test at the minimum of the temperature range (i.e. –15 °C).

[b] The pipe is deemed to have passed the resistance to heat test if any crushing of the pipe does not reduce the internal diameter to less than 80 % of its original value.

4.17.2.4 Where the manufacturer of the aspirating detector does not supply the pipe for the sampling device, the product documentation shall specify that the requirements of this clause shall be met.

4.17.3 Hardware components and additional sensing elements in the sampling device

4.17.3.1 Components, including optional components (box, filter, sensor, valve, etc.) in the sampling device shall be described in the documentation. The aspirating detector, including the hardware components listed, shall meet the requirements of this International Standard.

4.17.3.2 If the component incorporates a sensing element which participates in the signal output of the aspirating detector (e.g. for localization information) then the performance of the aspirating detector, including these sensing elements, shall meet the requirements of this International Standard.

4.17.4 Alarm outputs providing localization information

When the aspirating detector is designed to provide several alarm outputs within a single zone, where each output relates to a subdivision within the area protected by the aspirating detector, then it shall be clearly indicated in the product documentation that the several alarm outputs are reported as alarm information within one zone at the control and indicating equipment.

4.17.5 Airflow monitoring

4.17.5.1 The airflow through the aspirating oil mist detector shall be monitored to detect leakage or obstruction of the sampling device or sampling point(s). A fault shall be indicated when the leakage or obstruction results in an increase or decrease in the volumetric airflow of 20 % or greater.

4.17.5.2 Where the aspirating detector incorporates technology which provides for constant, or near constant, volumetric flow rate which is largely independent of the sampling device (e.g. incorporates speed control of the fan or uses a positive displacement pump), then equivalent requirements for the flow monitoring device shall be agreed between the manufacturer and testing authority to verify the flow monitoring to detect loss of sampling points (caused by blockage or breakage in the sampling device).

4.17.5.3 Where an aspirating detector has a facility to memorize the “normal” flow (present when the detector is installed or serviced) and thereafter monitor for deviations from this normal flow, the action of setting the memorized “normal” flow shall be a voluntary action under access level 3 (as defined in ISO 7240-2).

4.17.5.4 Electrical power supply failure to the aspirating detector shall not result in a change to the memorized normal flow.

4.17.6 Power supplies

The power for the aspirating detector shall be supplied by a power supply conforming to ISO 7240-4.