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Ships and marine technology — Machinery-space flammable oil systems — Prevention of leakage of flammable oil

Navires et technologie maritime — Systèmes d'huiles inflammables dans les salles de machines — Lignes directrices pour la prévention de fuites d'huiles inflammables

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Foreword

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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 18770 was prepared by Technical Committee ISO/TC 8, *Ships and marine technology*, Subcommittee SC 3, *Piping and machinery*.

Introduction

Fuel oil, lubricating oil and other flammable oil system failures are a major source of shipboard fires. This International Standard specifies the measures that shall be taken to reduce fires originating from machinery-space flammable oil systems, and is intended for designers, shipyard personnel, engine-room personnel, owners, operators and maintenance personnel. Requirements contained herein address the design, construction, testing, installation, maintenance and inspection of systems containing flammable oils.

It is the intent of this International Standard to supplement and provide guidance in support of the following International Maritime Organization circulars, with the eventual goal of replacing these circulars.

— MSC/Circular 647 (1994), "*Guidelines to Minimize Leakages from Flammable Liquid Systems*", a supplement for SOLAS Regulation II/2-15 ("*Arrangements for Flammable Oils*"). It addresses several aspects of the fuel oil, lubricating oil and other flammable oil systems, such as hoses, spray shields, insulation, connectors, joints and supports.

— MSC/Circular 851 (1998), "*Guidelines on Engine-Room Oil Fuel Systems*", a supplement to MSC/Circular 647. This circular addresses causes of oil fuel leakage, which sometimes result in machinery space fires. It discusses design, installation, maintenance and inspection issues, and explains some contributing factors such as frequent dismantling, short-duration pressure pulses, and vibration.

Ships and marine technology — Machinery-space flammable oil systems — Prevention of leakage of flammable oil

1 Scope

This International Standard specifies the measures to be taken to reduce fires originating from machinery-space flammable oil systems and to prevent leakage of flammable oil. It is intended for designers, shipyard personnel, engine-room personnel, owners, operators and maintenance personnel. Requirements contained herein address the design, construction, testing, installation, maintenance and inspection of systems containing flammable oil.

This International Standard is applicable to new and existing vessels, and is intended to be used as a supplement to the regulations for fuel oil, lubricating oil and other flammable oils contained in the *International Convention for the Safety of Life At Sea (SOLAS 74)*, as amended, issued by the International Maritime Organization (IMO).

2 Terms and definitions

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

3.1
flammable oil
oil easily ignitable and burned, generally found in machinery spaces

EXAMPLE fuel oil, lubricating oil, thermal oil or hydraulic oil

3.2
machinery space
space, generally containing main and auxiliary propulsion equipment and associated systems, as defined in the *International Convention for the Safety of Life At Sea (SOLAS 74)*, as amended, issued by the International Maritime Organization

3.3
hot surface
surface whose temperature exceeds 220 °C

3.4
electrical component
switchboard, instrument panel, electrical controller, instrumentation cabinet or other shipboard electrical equipment, whose wetting or spray by liquids could result in fire or loss of propulsion

3 General piping system considerations

3.1 General

Based on past experience, it is known that the combination of flammable materials and sources of ignition is the main cause of machinery-space fires. The flammable materials involved in the majority of cases are oils, i.e. fuel oil, lubricating oil or hydraulic oil. There are many potential ignition sources in a machinery space, the

most common being hot surfaces, e.g. exhaust pipes and steam pipes. Overheating of machinery, ignition from electrical installations due to short-circuiting or arcing of switchgear and other fault conditions can result in fire. Other frequent ignition sources are those associated with human activities, e.g. smoking, welding and grinding.

3.2 Human element

The role of the human element shall always be considered. Personnel shall be properly trained and follow established procedures. Knowledge of the operation of engine fuel systems and other flammable oil systems, as well as the magnitude of pressures generated within them and hazards associated with leaks, should be included in training for engineer officers. These topics should receive detailed attention when candidates sit for their Certificate of Competency examinations.

3.3 Inspection, maintenance and repairs

Inspection, maintenance and repairs to flammable oil systems shall be carried out in a professional manner. Owners shall ensure that the necessary training, equipment and parts are available. Records of significant repairs and maintenance to these systems shall be noted in the engineer's daily log and/or maintenance log.

3.4 Operational considerations

3.4.1 Many fires have been caused by pipe connections and fittings working loose. The fuel, lubricating and hydraulic oil pipes, their fittings, connections and securing arrangements shall be routinely checked as part of a preventive maintenance plan. Care shall be taken not to overtighten fittings during checks.

3.4.2 When completing maintenance or repairs to main or auxiliary engines, checks shall be made to ensure that the insulation covering hot surfaces has been properly replaced. Regular checks of the engines shall be made to confirm that the insulation is in place.

3.4.3 Any fuel, lubricating- or hydraulic-oil leak shall be dealt with promptly. In the event of a major leak, every effort should be made to stop the pump or source of the oil pressure. When underway, the navigation bridge shall be immediately informed of major flammable-liquid leaks.

3.4.4 Serious fires have originated because of a failure to recognize potential hazards (such as burning oil running out of furnace fronts onto the tank top, a spray of oil from a defective gland, joint or a fractured pipe) in areas where these may not be readily noticeable, but can be easily ignited. It is essential to avoid the dangerous situation in which a small fire could spread to waste oil in the bilges or on tank tops, where it could rapidly spread out of control. Cleanliness is essential for safety, and a high standard of cleanliness shall always be maintained.

3.4.5 Woodwork or other readily combustible materials shall not be used in machinery spaces where flammable oil is used. No combustible material shall be stored near any part of oil installations. The use of bituminous or similar flammable compounds shall be kept to a minimum in machinery and boiler spaces.

3.4.6 When repairs, however temporary, are carried out to oil lines, special attention shall be paid to fire risks. All repairs shall be adequate to prevent any danger of leakage and shall be to a standard which would endure exposure to fire.

3.4.7 If there is a leakage of fuel, lubricating or hydraulic oil, the chances of preventing the outbreak of fire or quickly extinguishing one which has started, will be greatly improved if all affected or adjacent machinery which may have heated surfaces, including ancillaries, can be immediately shut down. The prevention of further leakage will reduce the probability of fire, or reduce the intensity of one that has already started and can help to avoid permanent disablement of the ship.

4 Flexible hose and flexible-hose assemblies

4.1 Application

The limited use of flexible hose in flammable oil systems is permitted. This clause provides guidance concerning the safe application of flexible-hose assemblies. Flexible-hose assemblies, which are flexible hoses with end fittings attached, shall be as short in length as practicable and only used where necessary to accommodate relative movement between fixed piping and machinery parts.

4.2 Design and construction

Hoses shall be constructed to a recognized standard and be approved as suitable for the intended service, taking into account pressure, temperature, fluid compatibility and mechanical loading including impulses where applicable. Each hose assembly shall be provided with a certificate of hydrostatic pressure testing and conformity of production. In addition, non-metallic hoses shall be provided with a certificate of fire-resistance testing; guidance for fire-resistance testing is provided in ISO 15540 [1].

4.3 Installation

Hoses shall be installed in accordance with the manufacturer's instruction, with regard to minimum bend radius, twist angle and orientation, as well as support where necessary. In locations where hoses are likely to suffer external damage, adequate protection shall be provided. After installation, the system shall be operated at maximum working pressure and checked for malfunctions and leaks. General installation guidelines are given in Figures A.1 and A.2.

4.4 Inspection and maintenance

Hose assemblies shall be periodically inspected according to the manufacturer's or ship's maintenance programme. Results of periodic inspections shall be documented. Hose assemblies shall be replaced when there is evidence of distress likely to lead to failure, or doubt as to their continued suitability for service.

Any of the following conditions can require replacement of a hose assembly:

— leaks at fitting or in flexible hose;

— damaged, cut or abraded cover;

— kinked, crushed, flattened or twisted flexible hose;

— hardened, stiff, heat-cracked or charred flexible hose;

— blistered, soft, degraded or loose cover;

— cracked, damaged or badly corroded fittings;

— fitting slippage on flexible hose.

It is expected that hose assemblies may need to be replaced several times during the life of the ship. Manufacturer's recommendations for maximum hose service life shall be followed.

5 Spray shields

5.1 Application

Spray shields prevent the impingement of leaked or sprayed flammable liquid onto a hot surface or other source of ignition. Fuel oil, lubricating oil and other flammable oil piping shall be screened or otherwise suitably protected to avoid, as far as practicable, oil spray onto hot surfaces, into machinery air intakes, or other sources of ignition. Spray shields are intended for use on flanged joints, flanged bonnets and other flanged connections in oil pressure systems which are located above the floor plates and which are not lagged (insulated). The number of joints in such systems shall be kept to a minimum. Spray shields shall be installed for pressurized flammable-liquid systems in the main and auxiliary machinery spaces if the joint is within 3 m (10 ft) of an electrical component or a hot surface.

Spray shields are not required for the following:

- suction piping, or piping not subject to pump discharge pressures;
- piping located in voids or cofferdams;
- tank-sounding tubes, air escapes, vents and overflows;
- piping located inside gas-turbine modules, reduction-gear enclosures, or otherwise protected by barriers such as lockers, decking or foundations;
- union-type fittings, consisting of a threaded three-piece (male, female, nut) assembly.

5.2 Design

Many types of spray shields are possible. An example of a spray shield that provides a total enclosure of a joint is given in Figure B.1. This spray shield is designed to wrap completely around the joint and is long enough to provide an overlap equal to one-quarter of the joint's circumference. The shield is wrapped around the sides of the flange far enough to cover the heads of the bolts. The shield is laced tightly with wire and the overlap is pointed away from potential ignition sources.

5.3 Inspection and maintenance

Spray shields shall be inspected regularly for their integrity, and any which have been removed for maintenance purposes shall be refitted on completion of the task. Oil-soaked spray shields normally indicate the presence of leaks. They shall be replaced as soon as possible, and the cause of the leak repaired.

6 Jacketed high-pressure fuel lines

6.1 Application

All external high-pressure fuel delivery lines between the high-pressure fuel pumps and fuel injectors shall be protected with a jacketed piping system capable of containing a high-pressure fuel line failure. A jacketed pipe incorporates an outer pipe into which the high-pressure fuel pipe is placed, forming a permanent assembly. The jacketed piping system shall include a means for collection of leakage, and arrangements shall be provided for a fuel line failure alarm.

6.2 Design

Two systems have been successfully used in meeting this requirement, namely, rigid-sheathed fuel pipe and flexible-sheathed fuel pipe. In either case, the sheathing shall fully enclose the pipe and resist penetration by the spray of oil from a pipe failure during service. Also, the annular space and drainage arrangements shall be sufficient to ensure that, in the event of a complete fracture of the internal pipe, an excessive build-up of

pressure cannot occur and cause rupture of the sheath. The suitability of such pipes shall be demonstrated by prototype testing, appropriate design analysis, or class-society-type approval. The drainage arrangement shall prevent contamination of lubricating oil by fuel oil.

6.3 Inspection and maintenance

Regardless of the system selected, little additional maintenance or periodic inspection is required to keep the jacketed fuel lines in proper working order. However, jacketed pipes shall be inspected regularly and any drainage arrangement which may have been disconnected for maintenance shall be properly refitted. Inspection and maintenance to these systems shall be noted in the engineering log or maintenance log.

7 Bellows expansion joints

7.1 Application

This clause refers specifically to metallic expansion joints used in flammable-oil systems. To ensure adequate piping system flexibility, bends, loops, offsets or bellows expansion joints are required in most piping systems. The use of non-metallic expansion joints shall be limited, and the requirements of Clause 4 for flexible hose shall apply, particularly fire-resistance testing.

7.2 Design

Expansion joints are designed to accommodate axial and lateral movement and shall not be used to compensate for pipe misalignment. Design shall be based on an acceptable code or on testing of expansion joints of similar construction, type, size and use. Thermal expansion and contraction and the fatigue life due to vibration are also important points to consider. Where external mechanical damage is possible, the bellows shall be suitably protected. Each bellows expansion joint shall be provided with a certificate of hydrostatic pressure testing and conformity of production. The manufacturer's name, the month and the year of manufacture shall be permanently marked on expansion joints.

7.3 Installation, inspection and maintenance

Bellows expansion joints shall be installed in accordance with the manufacturer's instructions and examined under working conditions, and shall be inspected regularly and be replaced whenever there is doubt as to their suitability to continue in service.

8 Filters and strainers

8.1 Design

In general, filters and strainers used in fuel-oil, lubricating-oil or other flammable-oil systems shall have metallic housings and bodies with a melting point above 930 °C. Other metallic housing and body materials may be acceptable provided they have successfully completed a fire test according to ISO 15540 [1]. All pressure-retaining parts shall be suitable for the maximum operating temperature and pressures. The filter or strainer design and construction shall facilitate cleaning, and prevent or minimize spillage during maintenance. Where filters and strainers are required to be opened for cleaning during operation, they shall be fitted with a means of depressurization before being opened.