

**GUIDELINES TO MINIMIZE LEAKAGES FROM FLAMMABLE
LIQUID SYSTEMS**

(SOLAS reg. II-2/15, MSC/Circ.851)

1 The Maritime Safety Committee, at its sixty-third session (16 to 25 May 1994), approved Guidelines to Minimize Leakages from Flammable Liquid Systems, set out at annex to the present circular, as prepared by the Sub-Committee on Ship Design and Equipment at its thirty-seventh session.

2 Member Governments are invited to bring the Guidelines and the measures that should be taken to reduce fires originating from machinery space flammable oil systems to the attention of designers, shipyard personnel, engine-room personnel, owners, operators and maintenance personnel.

ANNEX

GUIDELINES TO MINIMIZE LEAKAGES FROM FLAMMABLE LIQUID SYSTEMS

1 OVERVIEW

1.1 Purpose

- .1 The International Maritime Organization recognizes that oil fuel, lubricating oil and other flammable oil system failures are a major source of shipboard fires.
- .2 These guidelines, including appendices, are developed to assist designers, shipyard personnel, engine-room personnel, owners, operators and maintenance personnel to be aware of measures that should be taken to reduce fires originating from machinery space flammable oil systems.

1.2 Scope

- .1 The status of the guidelines is that of a recommendation. Attention is drawn to the importance of the design, construction, testing, installation, maintenance and inspection of systems containing flammable oils in order to reduce the risk of fire.
- .2 The guidelines supplement the regulation II/2-15, "Arrangements for oil fuel, lubricating oil and other flammable oils", of the International Convention for the Safety of Life at Sea (SOLAS 74), as amended, and are applicable to new and existing ships, including non-convention ships and ships covered by instruments other than SOLAS Convention.
- .3 The guidelines have been developed without prejudice to the requirements of existing SOLAS regulations, MSC circulars, or other IMO safety instruments.

Appendix 1

GENERAL PIPING SYSTEM CONSIDERATIONS

1 Introduction

Based on past experience, it is known that the combination of combustible and flammable materials and sources of ignition is the main cause of machinery space fires. The combustible and flammable materials involved in the majority of cases are oils, i.e., oil fuel, lubricating oil, thermal 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 may result in fire. Other frequent ignition sources are those associated with human activities, e.g., smoking, welding, and grinding.

2 Human element

The role of the human element should always be considered and personnel involved should be properly trained and follow established procedures.

3 Inspection, maintenance and repairs

Inspection, maintenance and repairs should be carried out in a professional manner. Owners should ensure that this is done and that the necessary skills, equipment and spares are available.

4 Operations

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 should be routinely checked. Care should be taken not to overtighten fittings during these checks.

4.2 When maintenance or repair to the main or auxiliary engines has been carried out checks should be made to ensure that the insulation covering the heated surfaces has been properly replaced. A regular check of the engines should be made to confirm that the insulation is in place.

4.3 Any fuel, lubricating or hydraulic oil leakages should be dealt with promptly. The screening arrangements and pipe securing devices should be kept in good order.

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 may 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 should always be maintained.

4.5 Woodwork or other readily combustible materials should not be used in boiler rooms and machinery spaces where oil fuel is used. No combustible material should be stored near any part of the oil installations. The use of bituminous or similar flammable

compounds should be kept to a minimum in machinery and boiler spaces.

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

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 which has already started and may help to avoid permanent disablement of the ship.

Appendix 2

FLEXIBLE HOSE AND FLEXIBLE HOSE ASSEMBLIES

1 Scope

SOLAS Regulations II-2/15.2.8, II-2/15.3, II-2/15.4 permit the limited use of flexible pipes in fuel oil, lubricating oil and other flammable oil systems. This appendix provides guidance in complying with these regulations.

2 Application

Flexible pipes or hose assemblies, which are flexible hoses with end fittings attached, should be in as short lengths as practicable and only used where necessary to accommodate relative movement between fixed piping and machinery parts.

3 Design and construction

Hoses should 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 impulse where applicable. Each hose assembly should be provided with a certificate of hydrostatic pressure testing and conformity of production.

4 2 Installation

Hoses should be installed in accordance with the manufacturers instruction, having regard to: minimum bend radius, twist angle and orientation, also support where necessary. In locations where hoses are likely to suffer external damage, adequate protection should be provided. After installation, the system should be operated at maximum pressure and checked for possible malfunctions and freedom from leaks. General installation guidelines are given in figures 2.1 and 2.2.

5 Inspection and maintenance

Hose assemblies should be inspected frequently and maintained in good order or replaced when there is evidence of distress likely to lead to failure. Any of the following conditions may require replacement of the hose assembly:

- .1 leaks at fitting or in flexible hose;
- .2 damaged, cut, or abraded cover;
- .3 kinked, crushed, flattened, or twisted flexible hose;
- .4 hard, stiff, heat cracked, or charred flexible hose;
- .5 blistered, soft, degraded, or loose cover;
- .6 cracked, damaged, or badly corroded fittings;
- .7 fitting slippage on flexible hose.

It is expected that hose assemblies may need to be replaced several times in the life of the ship. Manufacturer's recommendations should be followed in this respect. However hoses should be replaced in good time whenever there is doubt as to their suitability to continue in service.

FIGURE 2.1 METALLIC FLEXIBLE HOSE GENERAL INSTALLATION GUIDELINES

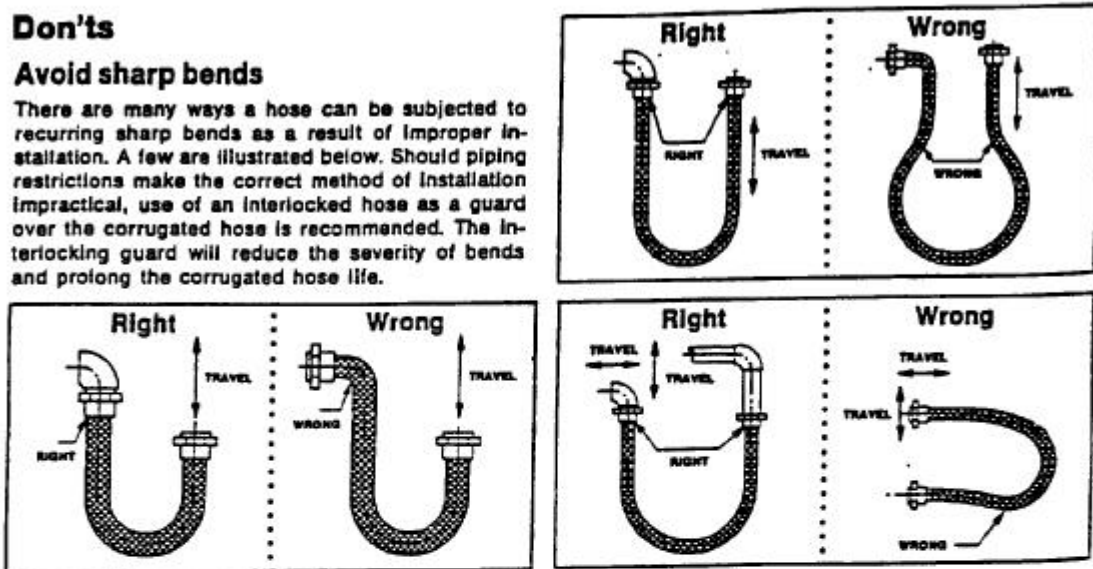
FIGURE 2.1

METALLIC FLEXIBLE HOSE GENERAL INSTALLATION GUIDELINES

Don'ts

Avoid sharp bends

There are many ways a hose can be subjected to recurring sharp bends as a result of improper installation. A few are illustrated below. Should piping restrictions make the correct method of installation impractical, use of an interlocked hose as a guard over the corrugated hose is recommended. The interlocking guard will reduce the severity of bends and prolong the corrugated hose life.



Do not torque

A hose is subjected to torque by:

- A. Twisting on installation. To minimize the possibility of damage to a hose from this cause, it is recommended that a union or floating flange be provided at one end of each hose assembly.
- B. Twisting on flexure. Always install hose so that flexing takes place in one plane.

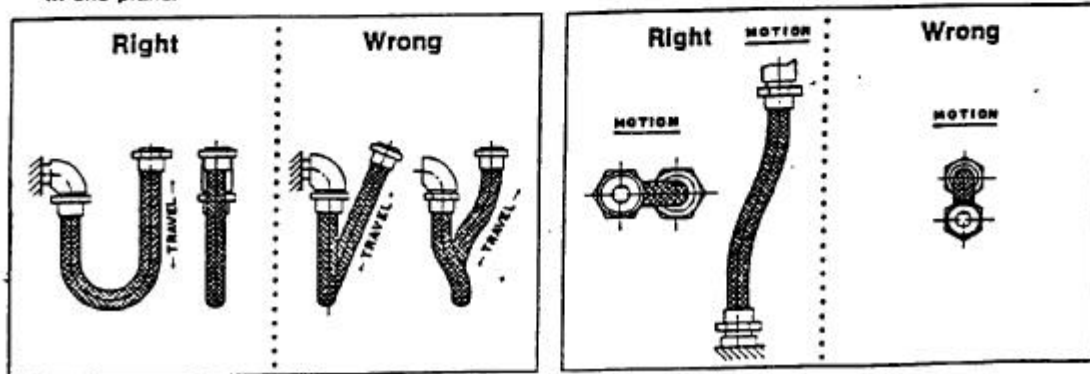
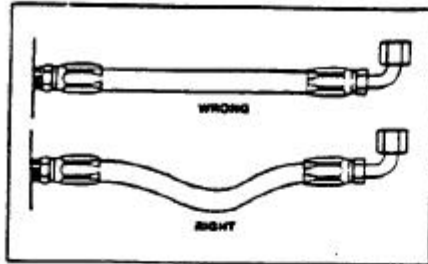


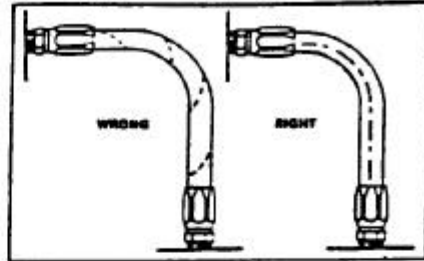
FIGURE 2.2 NON-METALLIC FLEXIBLE HOSE GENERAL INSTALLATION GUIDELINES

FIGURE 2.2

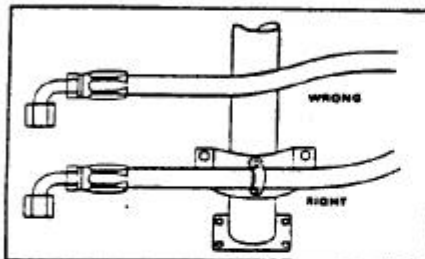
NON-METALLIC FLEXIBLE HOSE GENERAL INSTALLATION GUIDELINES



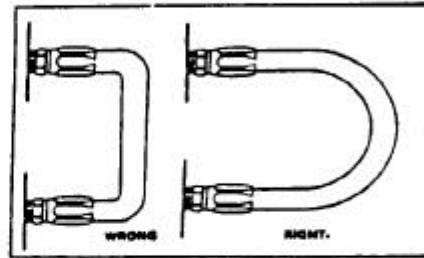
Under pressure, a hose may change in length. Always provide some slack in the hose to allow for this shrinkage or expansion. (However, excessive slack in hose lines is one of the most common causes of poor appearance.)



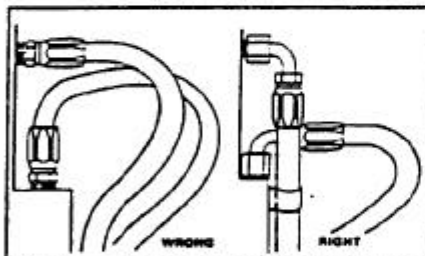
If a hose is installed with a twist in it, high operating pressures tend to force it straight. This can loosen the fitting nut. Twisting can cause reinforcement separation and the hose could burst at the point of strain.



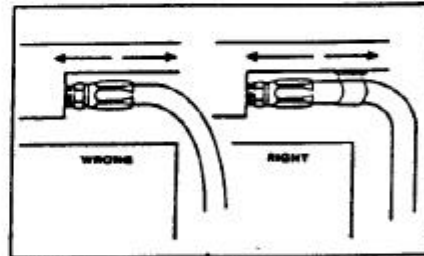
When hose lines pass near an exhaust manifold or other heat source, they should be insulated by a heat resistant boot, firesleeve or a metal baffle. In any application, brackets and clamps keep hoses in place and reduce abrasion. For installations where abrasion to hose cover cannot be prevented with the use of clamps or brackets, a steel or plastic protective coil or abrasion resistant sleeve should be placed over the hose.



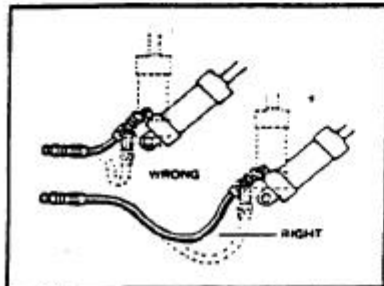
At bends, provide enough hose for a wide radius curve. Too tight a bend pinches the hose and restricts the flow. The line could even kink and close entirely. In many cases, use of the right fittings or adapters can eliminate bends or kinks.



Use elbows and adapters in the installation to relieve strain on the assembly, and to provide easier and neater installations that are accessible for inspection and maintenance. Remember that metal end fittings cannot be considered as part of the flexible portion of the assembly.



Install hose runs to avoid rubbing or abrasion. Clamps are often needed to support long runs of hose or to keep hose away from moving parts. It is important that the clamps be of the correct size. A clamp that is too large will allow the hose to move in the clamp, causing abrasion at this point.



In applications where there is considerable vibration or flexing, allow additional hose length. The metal hose fittings, of course, are not flexible, and proper installation protects metal parts from undue stress, and avoids kinks in the hose.

Appendix 3

SPRAY SHIELDS

1 Scope

SOLAS regulations II-2/15.2.11, II-2/15.3 and II-2/15.4, require oil fuel, lubricating oil and other flammable oil piping to be screened or otherwise suitably protected to avoid as far as practicable oil spray. This appendix provides guidance to comply with these regulations.

2 Application

Spray shields are intended for use around flanged joints, flanged bonnets and any other flanged connection in oil pressure systems which are located above the floor plates and which have no insulation in way of the joints. The purpose of spray shields is to prevent the impingement of leaked or sprayed flammable liquid onto a hot surface or other source of ignition. (Refer to appendix 7, guidance for insulation of hot surfaces.)

3 Design

Many types of spray shields are possible and they need not necessarily be attached to the joint, or totally enclose the joint. An example of a spray shield which provides a total enclosure is given in figure 3.1. 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 finished width is equal to or exceeds "A+B+A". The shield is laced tightly with wire and the overlap is pointed away from potential ignition sources.

4 Inspection and maintenance

Spray shields should be inspected regularly for their integrity and any which have been removed for maintenance purposes should be refitted on completion of the task.

Appendix 4

JACKETED HIGH PRESSURE FUEL LINES

1 Scope

SOLAS regulation II-2/15.2.9 requires all external high pressure fuel delivery lines between the high pressure fuel pumps and fuel injectors to be protected with a jacketed piping system capable of containing fuel from a high pressure 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 is to include a means for collection of leakages and arrangements are to be provided for an alarm to be given of a fuel line failure. Regulation II-2/15.2.12 will require existing ships to retrofit engines having an output greater than 375 kW.

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 is to fully enclose the pipe and is to resist penetration by a fine spray or jet of oil from a failure in the pipe during service. Also the annular space and drainage arrangements should be sufficient to ensure that in the event of 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 should be demonstrated by prototype testing. The drainage arrangement should prevent contamination of lubricating oil by fuel oil.

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 should be inspected regularly and any drainage arrangement which may have been disconnected for maintenance purposes should be refitted on completion of the task.

Appendix 5

BELLOWS EXPANSION JOINTS

1 Scope

This appendix covers metallic bellows expansion joints. Nonmetallic expansion joints are not addressed since their use is generally limited to water systems. To ensure adequate piping system flexibility, bends, loops, offsets or bellows expansion joints are required in most piping systems.

2 Design

Expansion joints are designed to accommodate axial and lateral movement and should not be used to compensate for pipe misalignment. Design may 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 should be suitably protected. Each bellows expansion joint should be provided with a certificate of hydrostatic pressure testing and conformity of production.

3 Installation

The bellows expansion joints should be installed in accordance with the manufacturer's instructions and examined under working conditions.

4 Inspection and maintenance

Bellows expansion joints should be inspected regularly and be replaced whenever there is doubt as to their suitability to continue in service.

Appendix 6

FILTERS AND STRAINERS

1 Scope

This appendix covers filters and strainers used in fuel oil, lubricating oil or other flammable oil systems having metallic housings and bodies with a melting point above 930 degrees C. Other housing and body materials are not addressed and their use should be specially considered on a case by case basis in relation to the risk of fire.

2 Design

All pressure retaining parts should be suitable for the maximum operating temperature and pressures. The filter or strainer design and construction should facilitate cleaning and prevent or minimize spillage during maintenance. Filters and strainers should be designed such that they cannot be opened when under pressure.

3 Installation

Filters and strainers should be located as far away as practicable from hot surfaces and other sources of ignition. They should not be located in positions where spillages could fall onto the flywheel or other rotating machinery parts and be sprayed around. Suitable drip trays should be provided under filters and strainers.

4 Inspection and maintenance

Filters and strainers should be inspected every time they are opened for cleaning and the cover gaskets or seals should be renewed when necessary. Satisfactory seating and tightening of the cover should be verified before the system is put back into service.

Appendix 7

INSULATION

1 Scope

SOLAS regulations II-2/15.2.10, II-2/15.3 and II-2/15.4 require that all surfaces with temperatures above 220 degrees C (430 degrees F), which may be impinged as a result of a fuel oil, lubricating oil and other flammable oil system failure be properly insulated. This appendix provides guidance to comply with these regulations.

2 Purpose

Insulation of hot surfaces is primarily to reduce the risk of fire by reducing temperatures of surfaces below the auto-ignition temperature of oil fuel, lubricating oil or other flammable oils.

3 Installation

Manufacturers' instructions should be followed if available. Permanent insulation should be used to the greatest extent possible. Insulation should be provided with readily removable sections to allow access for normal maintenance. Where the insulation used is oil absorbent or may permit the penetration of oil, the insulation should be encased in steel sheathing or equivalent material.

4 Inspection and maintenance

A regular check of equipment should be made to confirm that the insulation is in place. When maintenance or repair to equipment has been carried out, checks should be made to ensure that the insulation covering the heated surfaces has been properly replaced.

Appendix 8

PRESSURE, TEMPERATURE AND OIL LEVEL GAUGES

1 Scope

SOLAS regulation II-2/15.2.6 contains requirements for oil level gauges. This appendix gives guidance to comply with this regulation and addresses pressure and temperature gauges and similar instrumentation which have featured in many fires aboard ships.

2 Design and installation

All pressure gauges and other similar instruments in oil systems should wherever possible be fitted with an isolating valve or cock at the connection to the pressure take off point. The number of pressure take off points should be kept to a minimum and gauge piping runs should be as short as practicable. Copper pipes may be joined by brazing but soldered connections should not be used in oil systems.

Temperature gauges in oil systems should be fitted into a fixed pocket (thermowell).

Oil level gauges should be of a design which is approved for the intended service. The installation of level gauges into the lower part of oil tanks is prohibited under SOLAS for passenger ships, and is discouraged for cargo ships. Suitably protected gauges having heat resistant flat glass of substantial thickness and self-closing fittings at each tank connection may be fitted to oil tanks in cargo ships. Round gauge glasses are not permitted.

3 Inspection and maintenance

Copper gauge piping is particularly sensitive to work-hardening. All gauge pipes and fittings should be regularly inspected and maintained in good working order.

Appendix 9

PIPE CONNECTORS, JOINTS, HANGERS AND SUPPORTS

There are many different types of pipe connectors and joints, some of which are not considered suitable for oil systems. In general, flanged joints conforming to recognized standards should be used. Compression fittings and other types of connectors should be approved for the intended service. The number of joints should be kept to a minimum in oil systems.

Pipes in oil systems should be adequately supported. Supports or hangers should not be used to force alignment of piping or system components where the alignment is incorrect. Any hangers or supports which have been removed for maintenance purposes should be refitted when the task is completed.