Fire risks due to leakage from low pressure fuel pipes

Tripartite 2019

Tokyo, 18 October 2019

Introduction

Every year fires on board vessels lead to the tragic loss of lives and severe damages to vessels. More than one third of all fires on board start in the ER, and one of the most common reasons for such fires is flammable oil hitting hot surfaces.

The SOLAS provides the key regulatory framework for fire safety on board ships. Measures to control leaks of flammable liquids and ignition sources in the ER are described in Reg.II-2/4.2, and require, among others, ship designers and operators to:

- use suitable materials in piping conveying flammable oils;
- minimize the number of joints in such piping;
- use screening and jacketed high pressure fuel oil pipes

to prevent flammable oil sprays; and

- properly insulate hot surfaces.

In other words, the underlying principles of SOLAS Reg.II-2/4 clearly focus on the most relevant risk factors associated with ER fires.

Statistics

From the insurers' statistics (IUMI, Cefor) it may be seen that for period of 2008-2018 there were at least 56 engine room (ER) fires related to leaks from low pressure pipes/systems for flammable liquids (HFO/MGO/LO/thermal oil/hyd. Oil) on various types of machinery:

Incident Period	No. of Cases
2008-2009:	2
2010-2011:	8
2012-2013:	9
2014-2015:	27
2016-2018:	10

Type of Machinery	No. of Cases
Auxiliary Engines	21
Main Engines	16
Engines, not identified	5
Thermal Oil Plant	3
Purifier	1
Boilers	1
Other/unknown	9

Statistics

The following “root causes” of the above 56 fires are based on the available information and mainly describing the reason for the leaks, but not identify the reason for the ignition:

Root Cause (Category):	Quantity
Pipe Connection Failure -Wrong tightening/Torque	10
Loose Flange/studs to HP pumps /incl. foundation)	8
Vibration –Insufficient Pipe Support –Fatigue	8
Loose Pipe Flange - Burst Sealing	4
Pipe Welding Crack (flange/conn. welding)	2
Modification of pipe system (crew)	2
Flexible Hoses incl. Connections	2
Overflow	1
Unknown	19

Objectives

Often, the cause of ER fires is a leaking oil pipe or equipment placed in the proximity of a potential ignition source – a hot spot.

The risk of fires resulting from leaks in **high pressure** systems has decreased with the implementation of new design rules for the fuel pipes in 2003 (requiring double walled or jacketed pipes).

However, the **low pressure** oil system still imposes a significant risk and a major concern is that this risk might be overlooked or considered less important.

Shielding by way of physical barriers constraining potential leaks and/or insulation of hot spots with a surface temperature > 220 ºC, are often found to be either insufficient, poorly maintained or degraded. Furthermore, due to the nature of “low pressure leaks” the droplets may be small but significant in quantity and the reach of the spray large, making it likely to reach a hot spot penetrating insulations, especially since the insulation is not required to be “watertight”.

Insulation deteriorates because of maintenance to the engine but also by normal operation. Typically the engines requiring the most (corrective) maintenance have the poorest insulation.

Regulations

The sheer number of incidents indicate the need to reassess whether the procedures for control and enforcement of the many rules/requirements are adequate?

SOLAS Convention, Chapter II-2 Construction –protection –fire detection and fire extinction
IMO Resolution MSC.31(63) (1994) Amendments to SOLAS Convention
MSC/Circ.601 (1993) Fire protection in Machinery Spaces
MSC/Circ.647 (1994) Guidelines to minimize leakages from flammable liquid systems
MSC/Circ.851 (1998) Guidelines on Engine Room Oil Fuel Systems
MSC.1/Circ.1321 (2009) Guidelines for Measures to Prevent Fires in Engine-Rooms and Pump Rooms
IACS Rec. No.18 (1999) Fire prevention in machinery Spaces of Ships in Service/Guidance to Owners
IACS Rec. No.58 (2004) Fire protection of Machinery Spaces
IACS UR “F”-series on requirements concerning Fire Protection
IACS UR F35 rev. 8 (June 2005) Fire Protection of Machinery Spaces (with ref to SOLAS Chapter II-2)
IACS UR Z 20 Planned Maintenance Scheme (PMS for Machinery)
SiO Guidelines to SOLAS Ch II-2 Splash Protection -Screening/Shielding of pipe connections
OCIMF Ship Inspection Program (ship vetting regime)
CSSF Recommendation 321/2018 Machinery Space Fire Prevention

Improvement areas

To reduce the fire risk due to leakage from low pressure fuel pipes onto hot spots, the following areas are important:

Improvement areas	Improvement Points
Routing of pipes	✓ Flammable liquid piping related to potential ignition sources ✓ Screening of piping joints and pressurized equipment ✓ Easy inspection and observation of leaks
Flexible hoses	✓ Only allowed for facilitating relative movement between two connections ✓ Max length 1.5m, full screening ✓ Limited lifetime, bends, scuffling, contact
Filters	✓ Suitable means for venting and depressurizing ✓ Only cocks or valves with drain to safe location allowed
Insulation material	✓ Exhaust gas casings & TC vs direct lagging and shielding ✓ Need for regular inspection & maintenance
Safety culture	✓ Crucial to the safety of crew, passengers and ship ✓ Engine room cleanliness ✓ Home-made drip buckets and leak deflectors ✓ Overhauling standard and techniques ✓ ISM Code requirements

Recommendations

The following recommendations may be considered in order to address the ER fire issue:

1) **During newbuilding stage**, the pipe installation including insulation and cladding to be given more focus with regards to quality.
   - Yard Standard Specification good enough? (pipe routing, pipe supports-clamps, insulation and cladding quality/type)
   - Check for pipe vibration (pipe tension and chafing –pipe clamp/support arrangement)
   - Class survey of fuel and luboil piping arrangement during newbuilding stage (joint inspection prior delivery of the vessel to ensure according to approved drawings and included any agreed changes).
   - Assessment of the piping system including shielding of hot-spots prior delivery of the vessel.

2) **During overhaul and repairs** in service and in connection with schedule/unscheduled yard stay.
   - Ensure that pipes that have been removed/replaced are installed back properly. Correct assembling of pipe flanges and fittings. (correct tightening procedures and torques).
   - Pressure testing after installation.
   - Insulation and cladding to be fixed back in place properly (procedure preferably to be included in the specification of repairs).

Recommendations

3) Routing control of piping, insulation and cladding to be included in **Planned Maintenance System.**
   - Carry out assessment in the engine room to identify dangerous areas (fuel/luboil pipes with flanges/fittings that could in case of leakage could spray onto hot surfaces.
   - Tagging and implementation into Maintenance System.
   - Routing inspection.
   - After work carried out to a system, pressure test to be performed prior fitting the insulation.
   - Infrared measurements.
4) It is noted that **Engine Manufacturer** (4-stroke) have increased the focus on controlling and monitoring leakages from both High Pressure and Low Pressure pipes fitted on the engine before delivery. E.g. enclosed top covers with drains and leakage alarms. Focus on preventing leakage from low pressure fuel pipes to be improved.
5) The **insulation and cladding quality** have not improved much over the years, although some Engine Manufacturer offers special insulation solution for their engines to increase safety. However, the improved insulation methods may also increase the workload of for the crew in connection with overhaul.

Recommendations

Fuel pipes may fail due to errors in either design, lack of or faulty maintenance and/or the human element (operation).

To prevent fires and reduce the consequences, the following suggestions were discussed and may be considered:

Possible preventive measures:

- Use thermography routinely on board to measure hot spots (temperature areas above SOLAS requirement of 220 C) during normal operation of the machinery with a particular focus on extent and quality of insulation.
- Include maintenance & inspection of insulation in the Planned Maintenance System.
- Include maintenance & inspection of low pressure systems in the Planned Maintenance System.
- Establish procedures for control and enforcement of requirements during annual/renewal Class surveys during operation.
- Establish procedures for design approval and survey applied during the newbuilding phase.

The important thing is to carry out the correct surveys without missing in the field.

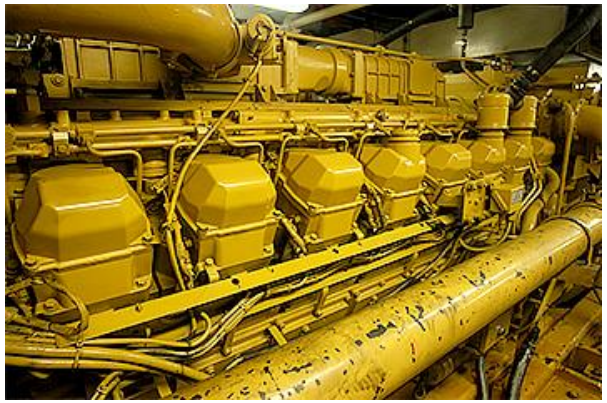
Recommendations

Further preventive measures:

- Consider port state campaign to effectively raise the awareness.
- Consider the need for a possible revision of SOLAS.

Possible mitigating measures:

- Establish secondary barriers and firefighting preparedness to avoid escalation of a fire.



Conclusions

1) **Engine manufacturers** to offer better insulation solutions for DE to address the issue of fuel piping leakages and hot surfaces.

2) **Ship's designers** to develop further the secondary barriers and firefighting preparedness to avoid escalation of a fire caused by leakage from fuel pipes.

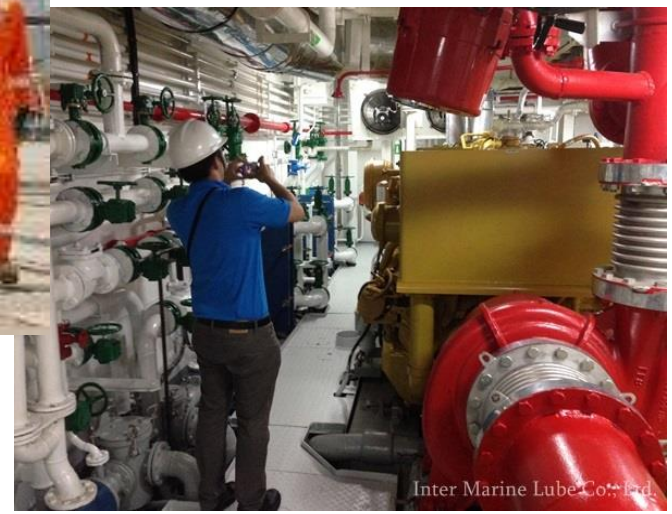
3) **Shipbuilders** to carry out the detailed assessment of ER first in order to identify the hot spots and take long term measures.

4) **Shipowners** to provide the vessels with thermography routinely on board to measure hot spots (temperature areas above SOLAS requirement of 220 C) during normal operation of the machinery.

The maintenance & inspection of insulation can be included in ship's SMS.

Conclusions

Shipowner and Class to maintain:



1) The particular attention on
   - Loose flange
   - Vibration
   - Leakage after modification of fuel or lubrication system
   - Pipe welding joint crack
   - Damaged sealing
   - Connection failure (wrong torque applied)
   - Leakage from flexible hoses
2) The detailed visual check of exposed areas of insulation as part of the annual survey.
3) The verification of proper installation of insulation with improved procedures, assessment and verification (approval) prior to vessel delivery.


IACS thanks for your attention
and cooperation