3.6.23 Foam injection pumps, if fitted, shall be duplicated. The backup pumps shall be installed in a manner that minimises the risk of both pumps being stuck by foam concentrate or any other means of being put out of operation. One acceptable solution is keep the valves to one foam pump closed after flushing, while the other is in open standby mode.

3.6.24 It shall be possible to operate the foam system and the exhaust fan defined in [3.1.3] simultaneously.

3.6.25 Equivalent gaseous agent
Any equivalent gaseous agent for the machinery spaces category A shall comply with IMO MSC/Circ. 848 as amended.

3.7 Portable fire extinguishers

3.7.1 Number and location
Only approved 12 kg powder or 9 litre foam portable extinguishers shall be installed in the category A machinery spaces.

3.7.2 The numbers of portable extinguishers shall comply with SOLAS. In addition the following minimum numbers shall be provided at readily accessible positions:

— four (4) at the lower level and four (4) at the platform level for each main engine (extinguisher can be combined if there are several main engines in one space)
— one (1) near each auxiliary engine (three (3) required for three (3) auxiliary engines)
— one (1) at the entrance to and one (1) inside the spaces defined under [3.2.2].

Guidance note:
The required location of the extinguishers is general, and efforts should be made to place these in the vicinity of the installations representing the greatest risk of fire. When installations are placed in separate rooms of limited size, some or all of the required extinguishers can be placed immediately outside the doors leading into these rooms.

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4 Machinery spaces, prevention - F(M-P)

4.1 General

4.1.1 Objective
The objective of class notation **F(M-P)** is to improve the strength and integrity of the following main safety barriers that prevent fire in machinery spaces:

— Prevention of oil leakage
— detection of oil leakage and shutdown system
— containment oil leakage
— prevention of ignition.

4.1.2 Application
The requirements apply to the design and operation of pressurized oil systems and other systems that are critical with regards to fire prevention in machinery spaces of cat. A, as defined by SOLAS Reg. II-2/3.

4.1.3 On board documentation
All required documentation for **F(M-P)** class notation as listed in [1.5] shall be kept onboard the vessel to be used as support during surveys and audits.

4.2 Prevention of oil leakage

4.2.1 Vibration control

4.2.1.1 The vessel shall have a procedure for vibration control of critical systems for fire prevention, as a minimum those mentioned in [4.2.1.2] The procedure shall be included in the vessel safety management system and/or planned maintenance system and shall as a minimum include the following:

- a vibration measurement protocol to record measurements
- a list of the precise positions where the vibration levels shall be measured
- vibration acceptance levels for these positions, see [4.2.1.3] for details
- measurement intervals, see [4.2.1.4] for details
- relevant reference values such as engine running conditions and fuel type
- requirements for preparations and execution
- procedure and guidance for reporting, analysis and follow-up, see [4.2.1.5] for details.

4.2.1.2 Vibration control shall as a minimum be performed on the following components:

- oil piping in category A machinery spaces, including on engines
- engines
- turbochargers
- electric motors, separators and motor driven hydraulic pumps in oil systems in category A machinery spaces.

4.2.1.3 Levels of vibrations on the components shall either comply with the principles and criteria as given for the class notation **VIBR** in Ch.8 Sec.2 or with maker's recommendations.

4.2.1.4 The vibration measurements shall initially be performed at newbuilding delivery. In operation, the vibration measurements shall be performed at a minimum after every main periodical overhaul of an engine or as recommended by the maker.

4.2.1.5 The vibration levels shall be recorded in a way that allows for detection of abnormalities, data capture and fleet-wide trending over time.

4.2.2 Early manual detection of failure

4.2.2.1 A procedure for manual detection of failure shall be included in the vessel’s safety management system and/or planned maintenance system for periodical inspections of category A machinery spaces which as a minimum shall include the following:

- requirements for preparations and execution
- safety precautions
- inspection intervals
- procedure and guidance for reporting, analysis and follow-up, see [4.2.2.2] for details
- rating and assessment criteria
- areas of attention for inspection such as:
  - loose connection points that are identified by e.g. offset white markers on bolt and pipe, see [4.2.3.2] for details
  - damaged or missing secondary containment, see [4.4.1] for details
  - abnormal vibrations
  - damaged or missing pipe supports
  - oil spills
  - damaged or missing hot surface insulation.

4.2.2.2 The findings from the periodical inspections shall be recorded in a way that allows for detection of abnormalities, data capture and fleetwide trending over time.

4.2.3 Maintenance of critical components

4.2.3.1 Procedures for maintenance of oil piping components in category A machinery spaces shall be included in the vessel's planned maintenance system and/or safety management system and shall as minimum include the following:

- Overview of critical oil piping which may be determined based on e.g. probability of oil leak, vibration exposure and vicinity of potential ignition points.
- Common briefing and review of maintenance prior to commencing task, including safety precautions.
- Quality checks, such as two-person checks or two-person tightening.
- Installation of secondary containment, see [4.4.1] for details.
- Testing prior to start-up.
- Debriefing after maintenance.
- Vibration measurements, if applicable, see [4.2.1] for details.
- Monitoring of components and systems in critical phase just after maintenance.

4.2.3.2 A procedure shall be in place for using white markers on bolts and nuts for early detection of loosening connections, especially critical connections that are subject to vibrations because of their vicinity to engines. Equivalent solutions may be accepted. This shall be included in the maintenance procedure required in [4.2.3.1].

4.2.4 Continuous improvement by data analytics

4.2.4.1 A procedure to ensure continuous improvement of the safety barrier integrity shall be included in the safety management system and/or planned maintenance system.

Data captured should allow for fleetwide analytics and safety management and should at least contain data from the following sources:

- Manually reported oil leaks: the incident reporting system should capture necessary details such as exact location of leak, details of the component where the leak occurred, type of fuel, engine load, assumed cause of leak and rating of severity.
- Sensor data from automatic rapid oil leak detection systems, see [4.3] for details.
- Sensor data from regular automatic oil leak detection, which is typically a level switch capturing leaks in the fuel oil manifold cover or from double walled high-pressure oil piping.
- Vibration measurements, see for details [4.2.1].

4.3 Detection of oil leakage and shutdown system

4.3.1 Rapid oil leak detection system

4.3.1.1 The critical leakage points in oil piping systems shall be covered by a rapid oil leakage detection system. This may be exempted provided that the requirements in [4.3.1.2] are met.

Guidance note:

A critical leakage point is defined as any leakage point on engine mounted oil piping systems and the oil piping connections between the engine and the vessel mounted oil piping systems. These leakage points are defined as critical due to their exposure to vibrations and their vicinity of potential ignition points. However, the definition of critical leakage points and thereby the requirement for rapid oil leakage detection system may be reconsidered if a study is presented that clearly indicates an acceptably low risk of oil leakage.

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Guidance note:

Acceptable detection times for a rapid oil leak detection system are the best practices for detection of oil leaks in e.g. high pressure double walled oil pipes or detection times for major fuel leaks in alternative fuel systems.

Examples of rapid oil leak detection systems are:

- atmospheric hydrocarbon detection
- laser hydrocarbon leak detection
- pressure monitoring of annular space of double walled flexible hoses
- automatic oil leak detection by video analytics
- level switches, as typically used on high pressure oil pipes.

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4.3.1.2 The requirement of [4.3.1.1] to install rapid oil leak detection systems on critical oil leakage points may be exempted if the following conditions are in place:

- The leakage point is covered by a secondary containment which is in compliance with all requirements in [4.4.1].
- The leakage point is given additional attention through the following procedures:
  - procedure for maintenance of oil piping, see [4.2.3] for details
  - procedure for manual inspection of oil leaks, see [4.2.2.1] for details
  - vibration measurement protocol, see [4.2.1.1] for details
  - procedure for continuous improvement process by data analytics, see [4.2.4.1] for details.

4.3.1.3 The automatic rapid oil leak detection system shall be connected to the vessel's control and monitoring system and as a minimum trigger a visual and audible alarm both in the space where the leakage has occurred and in the engine control room.

4.3.1.4 Maintenance of the rapid oil leak detection system shall be covered in the required maintenance procedure as mentioned in [1.5].

4.3.2 Manual detection of oil leaks

4.3.2.1 The secondary containment of leakage points in category A machinery spaces, as described in [4.4.1], that are not covered by a rapid oil leak detection system, shall be designed in such a way that a leakage can easily be detected by manual inspection. Manual leakage detection shall be possible without removing the secondary containment by the following or equivalent solutions:

- The oil leakage points shall, if practically possible, be contained within transparent shielding solutions such as plexiglass or similar. Such solutions may typically be applicable for duplex filters, booster units, valves and to other flange connections that are not a part of the engine mounted oil piping.
- Secondary containment which are not transparent shall provide drainage to a safe location where the leak can easily be visually detected.
- Secondary containment that are neither transparent nor provide easy visual detection of the drainage, shall be equipped with an automatic leakage detection system within the shielding solution.

4.3.2.2 The tank top or floor plating below oil piping located within category A machinery spaces shall be painted white or with a light colour to ensure easy visual leakage detection.

4.3.2.3 To allow for easy manual detection of leaks, the maintenance procedure required in [1.5] shall include a procedure that ensures cleanliness of the tank top and machinery spaces in general.

4.3.3 Shutdown of system

4.3.3.1 An emergency response procedures shall be in place to ensure an efficient response to a severe oil leak. The procedures shall as a minimum cover: