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Ships and marine technology — Maintenance and testing to reduce losses in critical systems for propulsion

Navires et technologie maritime — Maintenance et essais pour réduire les pertes dans les systèmes critiques pour la propulsion

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Foreword

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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/PAS 13613 was prepared by Technical Committee ISO/TC 8, *Ships and marine technology*, Subcommittee SC 3, *Piping and machinery*.

0 Introduction

0.1 General

This Publicly Available Specification informs shipboard personnel and other parties about the need to consider factors affecting operational maintenance and testing for certain systems that have been linked to ship propulsion losses. A recently completed survey of SOLAS ship casualties from 2003 to 2007 revealed that a number of the reported casualties were propulsion losses involving

— air start systems for engine,

— fuel oil quality problems, and

— fuel switching.

Industry groups have stated that current procedures for fuel switching underway, in compliance with air quality regulations, may increase the risk of propulsion losses.

0.2 Air start system failure

Air start system failure typically occurs when a ship with direct drive diesel propulsion is changing direction. Air valves needed to stop and restart the engine in the other direction seize or fail to respond. Maintenance and testing of the air systems minimize the risk of failure.

0.3 Fuel oil quality problems

Fuel oil problems can cause propulsion loss by clogging a filter and starving the engine. Use of incorrect fuel over prolonged periods can cause damage to pumps and cylinders. A ship can also lose propulsion when a generator shuts down due to fuel problems because electric power is generally needed to provide cooling and lubrication to the propulsion engine. Maintenance and testing of fuel oil purifying equipment, tanks and piping minimize quality problems.

0.4 Fuel switching

In order to comply with air quality regulations, ships may need to switch to low sulfur fuel while underway. They perform the switch before they enter an emission control area (ECA). This procedure can involve a changeover from heavy fuel oil to a distillate fuel. Proper fuel switching procedures and awareness of possible fuel compatibility problems can minimize the risk of propulsion loss.

0.5 Informative annexes

Annexes A to E are provided for information only as examples of recommendations for ship engineering systems and components. The survey of ship propulsion casualties identified only high pressure air and fuel system (fuel quality and fuel switching) problems as being linked to a number of casualties.

Ships and marine technology — Maintenance and testing to reduce losses in critical systems for propulsion

1 Scope

This Publicly Available Specification informs shipboard personnel and other parties about the need to consider factors affecting operational maintenance and testing for certain systems that have been linked to ship propulsion losses.

2 Terms and definitions

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

2.1
delta p
differential pressure
Δp
difference in pressure between two points in a system, and often used in filtering devices to indicate condition (clean or clogged) of the filter

2.2
viscosity
measure of a liquid's resistance to flow

NOTE Specified minimum and maximum flow rates are required for all fuel oils. A fuel oil's viscosity indicates how the oil will flow, the extent to which it can be atomized, and the temperature at which the oil must be maintained to atomize properly.

3 Requirements

3.1 General maintenance of ship systems

The purpose of general maintenance of ship systems is to maximize efficiency of systems and minimize downtime. Suitable maintenance intervals help avoid equipment failures.

3.1.1 Types of maintenance

3.1.1.1 Preventative

a) Routine

— greasing, lubricating, level checking (tanks, sump, etc.)

— operator checks (buttons/switches, valves/flaps, lamps, alarms)

— measurements (gauges, clearances, voltage, pressure, temperature, vacuum)

b) Planned

- calendar time (weekly, monthly, quarterly, annually, etc.)
- operating (running) hours

3.1.1.2 Condition based

- vibration analysis, diesel trend analysis
- oil analysis (fuel, lube, hydraulic)
- performance based (deviation from reference points), database building
- ultrasonic thickness/leak detection, etc. – non-destructive exam

3.1.1.3 Breakdown maintenance

- unplanned maintenance
- fix only when broken
- do minimum maintenance to keep equipment running (e.g. filters), until something breaks

NOTE It is important to remember that, even with proper maintenance, breakdown is possible on virtually any system at any time.

3.1.2 Logistical support

Detailed information for replacement parts is needed, such as

- manufacturer,
- make/model/serial number,
- warranty information,
- maintenance recommendations,
- maintenance and repair history,
- vendor locations, and
- required spare parts to be kept on board, and on-board inventories.

The following may be associated with nearly all systems and equipment:

- scheduled maintenance intervals;
- equipment operating records;
- lubrication procedures and schedules;
- repair and maintenance parts details, notes, diagrams, and even digital photographs;
- complete listing of instruments and tests required during maintenance procedures;
- experience and time requirements of maintenance personnel (level of competence and man hours expected).

3.2 Compressed air systems maintenance

Compressed air systems require periodic maintenance. Inadequate maintenance can lead to

- lower efficiency,
- air leakage,
- high operating temperatures,
- poor moisture control, leading to too much moisture in system,
- contamination by dirt or rust,
- excessive contamination, and
- unsafe working environments.

Maintenance of compressed air systems should take into account manufacturer's recommendations for inspection and service, as well as company-specific requirements. Annex A provides some basic compressed air system maintenance recommendations.

3.3 Fuel oil system maintenance

3.3.1 General

Fuel systems on ships are a potential source of fire and/or explosion, and therefore must be maintained in proper operational condition. Poor fuel quality can potentially cause an engine breakdown at sea, which could endanger the ship and cause loss of business.

Components of fuel systems from the fuel tank through to the engine and back to the tank should be checked regularly for leaks, wear, deterioration, and general damage. Components can include valves, pumps, heat exchangers, filters and strainers.

Ship and company personnel should ensure that proper fuel filters are available for the types of fuel to be used.

As with other critical ship systems, owners and operators should keep an accurate record of all maintenance work performed on the fuel systems.

3.3.2 Testing of fuel received

MARPOL Annex VI requires that a sample of bunker fuel be provided during each bunkering operation. A testing programme for fuel received may be beneficial in verifying fuel quality. In some instances, reports provided by suppliers may be considered inadequate or inaccurate when compared to the importance of the product to proper engine operation.

Users should consider the engine manufacturer's recommendations and ISO 8217 for more specific details on marine fuel oil properties in determining the most appropriate fuel for their installation.

3.3.3 Purifier maintenance

In addition to planned maintenance, most purifiers require at least occasional cleaning. Non-self-cleaning types may need more frequent cleaning.

Sludge, wax and other solids are normally cleaned from discs manually.

Sludge disposal timer (self-cleaning), correct RPM, and correct temperature of fluid are all important.

Cleaning intervals are often determined by experience with various fuel quality types.

3.3.4 Properties of fuel that can affect maintenance and operation

In order to avoid fuel pump and injector difficulties, fuels must be delivered to the engine in a condition as close to the manufacturer's recommended technical specifications as possible. Water in fuel can cause ragged operation and may corrode the fuel handling system. Important fuel properties include

— viscosity (see 2.2),

— flashpoint – fuels having a flashpoint of less than 60 °C are generally not permitted, see Reference [4],

— sulfur content,

— total sediment,

— water (percent by volume), and

— density.

Some engine manufacturers may prescribe guidelines that differ from those above when burning heavy fuel oil (HFO). Correct viscosity, however, is essential to engines burning HFO, and adjusting viscosity may require fuel heating systems. Conversely, when ships switch from HFO to distillate, a cooling process may be required to ensure the distillate fuel temperature is not excessive.

3.3.5 Fuel switching

Fuel switching may involve a change-over from high sulfur fuel (HSF) to low sulfur fuel (LSF), either for the main engine(s), ship service diesel generators, or both. Fuel switching may be required by local area law for vessels mandating the use of LSF in order to limit oxides of sulfur (SOx).

There are a number of important considerations involved with fuel switching, including

— separate storage tanks required for HSF and LSF,

— potential for clogged filters when “blending” or mixing HSF and LSF fuels during the switching process, resulting in loss of fuel supply to engine,

— engine is normally designed for optimum performance based on specific fuel oil temperature and viscosity range,

— improper fuel for a particular engine can result in premature wear to critical engine components, including injection pumps, cylinder liners, piston rings, and lubricating oil,

— in certain engines, fuel leaks may cause fuel dilution of lubricating oil, which can degrade the lubricating properties,

— improper control of LSF temperature may result in excessively high temperatures of fuel,

— the total base number (TBN) of the lubricating oil should be considered when the sulfur content of the fuel is not consistent,

— consult engine and boiler manufacturers for fuel switching guidance,

— consult fuel suppliers and engine manufacturers for proper fuel selection,

— exercise tight control when possible over the quality of the fuel oils received,

— consult manufacturers to determine if system modifications or additional safeguards are necessary for intended fuels,

- develop detailed fuel switching procedures,
- establish a fuel system inspection and maintenance schedule,
- ensure system pressure and temperature alarms, flow indicators, filter differential pressure transmitters, etc., are all operational,
- ensure system purifiers, filters and strainers are maintained,
- ensure system seals, gaskets, flanges, fittings, brackets and supports are maintained,
- ensure a detailed system diagram is available,
- conduct initial and periodic crew training,
- complete fuel switching well offshore prior to entering restricted waters or traffic lanes, such that the system is stabilized, and
- consider that some distillates may not be compatible with residual fuels that are rich in asphaltenes; this incompatibility can result in precipitation of asphaltenes during the mixing process, and further clog filters or injection pumps.

It is imperative that owners and operators realize the importance of maintaining optimum fuel quality as recommended by the engine manufacturer.

Vessels should have a specific plan in place that outlines the steps and associated timelines in the fuel switching process. Switching involving fuels with substantially different viscosities will likely necessitate a controlled rate of change in the switching process. Lack of a controlled process when switching from HFO to distillate can result in overheating of the distillate, which can result in improper fuel flow and engine shutdown. Some engine manufacturers have recommended a transition temperature change rate of no greater than 2 °C per minute.

Vessel owners and operators should consult engine manufacturers to determine the potential long-term problems associated with fuel switching, and how best to avoid those problems. Such issues may include damage to cylinder liners, fuel pumps and valves. Cylinder liner damage can result from incompatibility of the cylinder lube oil with distillate fuel, and fuel pumps can be damaged because of the reduced viscosity and lubricity of distillate. It is important that the correct viscosity fuel is supplied to the engine fuel pumps. This may necessitate a cooling process for low viscosity distillate fuels. Engine and individual cylinder performance should be monitored to ensure that the correct amount of fuel is delivered, and that differences in fuel specifications are not negatively affecting fuel pump performance.

Vessel owners and operators may wish to seek the opinion of a third party such as a classification society expert to review and certify their fuel switching procedures.

3.4 Maintenance and testing of ship automation systems

Procedures for switching between the local manual, remote manual and automatic modes of operation of equipment should be defined for ship systems critical to propulsion and manoeuvring.

Annex A
(informative)

Example maintenance items for compressed air systems

Compressed air system component	**Maintenance check** **(per manufacturer recommendation or company policy)**
Propulsion system starting air valves	Inspect and/or overhaul or replace
Inlet filter cartridges	Inspect and clean or replace; required frequency may vary with operating conditions
Drain traps	Clean out debris and check operation
Compressor lubricant level	Inspect and top off, or renew oil
Air lubricant separator (lubricant-injected rotary screw compressors)	Change at high delta p (pressure differential)
Lubricant used	Use the motor and compressor lubricants recommended by the manufacturer for air compressors
Belt condition	Check belts for wear and proper tension
Operating temperature	Verify proper operating temperature
Air line filters	Replace particulate and lubricant removal elements when pressure drop limit or delta p (pressure differential) limits are exceeded
Water cooling system	For water-cooled systems, check water quality, flow, and temperature; clean strainers and heat exchangers
System cleanliness and leaks	Check lines (especially joints), fittings, clamps, valves, hoses, disconnects, regulators, filters, lubricators, gauge connections, and end-use equipment for leaks; adjust/replace o-rings as necessary
Reverse test of engine	Perform a reverse direction test of the engine while underway, ensuring air distribution system and valves are working correctly

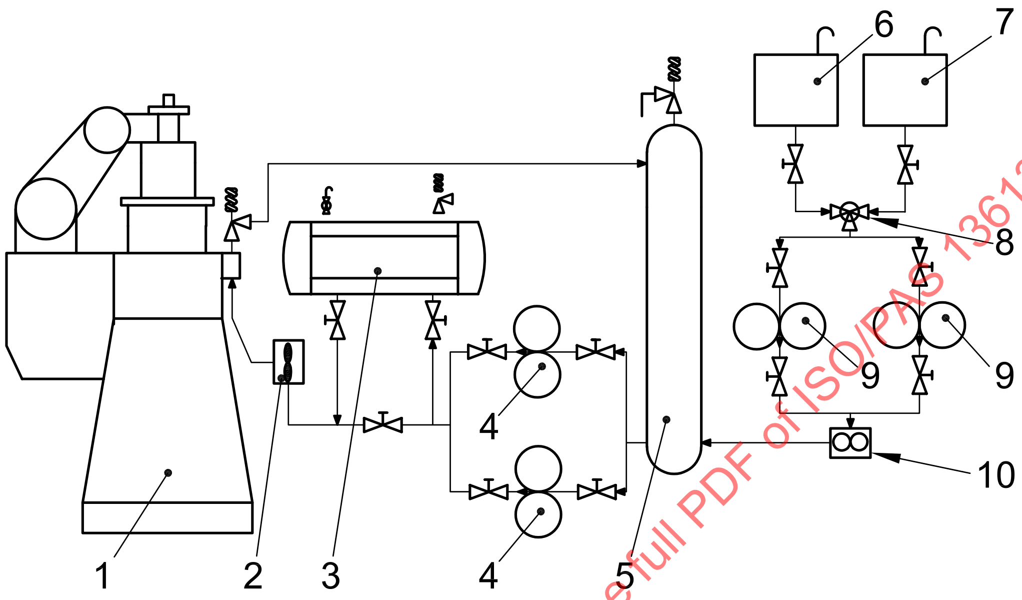
Annex B
(informative)

Sample record of periodic maintenance procedures

System	Equipment	Maintenance procedure	Frequency	Required personnel
Propulsion	Main engine	D1, Measure and record lube oil sump level	Daily	Qualified member of engineering department
Propulsion	Main engine	M1, Check and record all cylinder pressures	Monthly or every 500 running hours	Third Assistant Engineer
Propulsion	Main engine	Q1, Procure lube oil sample for analysis	Quarterly or every 1 000 running hours	Third Assistant Engineer

Annex C
(informative)

Example diagram of engine fuel supply and switching system



Key

1 main engine
2 viscometer
3 fuel oil heater
4 circulating pumps
5 mixing tank
6 HFO (heavy fuel oil) service tank
7 MDO (marine diesel oil) service tank
8 three-way cock
9 supply pumps
10 flow meter

Figure C.1 — Typical main engine fuel supply system

