

Low Sulphur Operations Workbook

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1. Workbook Low Sulphur Operation

Introduction

Global sulphur cap

1 January 2020 a global 0.50% sulphur cap came into force. This means that a ship cannot use fuel with a sulphur content of more than 0.50% for propulsion or operation unless the ship is equipped with an exhaust gas cleaning such as a “scrubber”.

In addition to the global sulphur cap there are emission control areas (ECA) with even stricter sulphur regulations.

An Emission control area (ECA) is defined as an area where the adoption of special mandatory measures for emission from ships is required to prevent, reduce and control air pollution from NO_x or SO_x and particulate matter to their adverse impact on human health and the environment. Inside an ECA there is a sulphur limit of 0.10%

Ships can meet the 2020 sulphur cap requirement by using:

- Conventional compliant fuel such as sulphur controlled distillates or residual fuel oils.
- Alternative fuel types that meet the sulphur limits, such as LNG, methanol or hydrogen; some biofuels and synthetically manufactured fuel oils; or
- An equivalent means to remove sulphur oxides from post-combustion exhaust emissions, such as an exhaust gas cleaning system.

Carriage ban

An additional measure to support implementation and compliance with the 0.50% sulphur cap is the MARPOL amendment that prohibits the carriage of non-compliant fuel oils for propulsion or operation on board. Unless the ship has an exhaust gas scrubber fitted the ship cannot carry non-compliant fuel oils after 1 March 2020.

Non-compliant fuel

If a ship for some reason do not to comply with the standards for compliant fuel oils, the ship must be able to present a record of the actions taken to attempt to achieve compliance. It must provide evidence that it attempted to purchase compliant fuel. If compliant fuel is not available it must provide evidence that attempts were made to locate alternative sources of compliant fuel.

The ship should not be required to deviate from its intended voyage or to delay the voyage in order to achieve compliance, but the ships Administration and the authority of port of destination must be notified.

Exhaust gas cleaning system

Ships with an exhaust gas cleaning system, often referred to as a scrubber, can continue to use 3.5% sulphur fuel oils after 1 January 2020 and still be in compliance with the 0.50% sulphur cap.

However, there are areas and ports that ban the use of scrubbers.

Excerpts from MARPOL ANNEX VI

Regulation 14

After 1 January 2020 the sulphur content of fuel oil used or carried for use on board a ship shall not exceed 0.50% m/m.

While a ship is operating within an emission control area, the sulphur content of fuel used on board that ship shall not exceed 0.10% m/m.

Ships using separate fuel oils to comply with the regulation for operating within an emission control area, and entering or leaving an emission control area, shall carry a written procedure showing how the fuel oil changeover is to be done, allowing sufficient time for the fuel oil service system to be fully flushed of all fuel oils exceeding the applicable sulphur content prior to entry into an emission control area. The volume of low sulphur fuel oils in each tank as well as the date, time and position of the ship when any fuel oil changeover operation is completed prior to the entry into an emission control area or commenced after exit from such area shall be recorded.

Regulation 18

Fuel oil availability

If a ship is found by a Party not to be in compliance with the standards for compliant fuel oils set forth in MARPOL annex VI the competent authority of the Party is entitled to require the ship to:

- present a record of the actions taken to attempt to achieve compliance, and
- provide evidence that it attempted to purchase compliant fuel oil in accordance with its voyage plan and, if it was not made available where planned, that attempts were made to locate alternative sources for such fuel oil and that despite best efforts to obtain compliant fuel oil, no such fuel oil was made available for purchase.

The ship should not be required to deviate from its intended voyage or to delay unduly the voyage in order to achieve compliance.

If a ship provides all the information required a Party shall take into account all relevant circumstances and the evidence presented to determine the appropriate action to take, including not taking control measures.

A ship shall notify its Administration and the competent authority of the relevant port of destination when it cannot purchase compliant fuel oil.

Fuel oil quality

Fuel oil for combustion purposes delivered to and used onboard ships shall meet the following requirements:

- the fuel oil shall be blends of hydrocarbon derived from petroleum refining.
- The fuel oil shall be free from inorganic acid.
- The fuel shall not include any added substance or chemical waste that jeopardizes the safety of ships or adversely affect the performance of the machinery, or is harmful to personnel, or contributes overall to additional air

pollution.

Fuel oil for combustion purposes derived by methods other than petroleum refining shall not:

- Exceed the applicable sulphur content set forth in regulation 14.
- Cause an engine to exceed the applicable NO_x emission limit.
- Contain inorganic acids.
- Jeopardize the safety of ships or adversely affect the performance of the machinery.
- Be harmful to personnel.
- Contribute overall to additional air pollution

Economic consequences when switching between fuels with varying sulphur content.

Except from the operational challenges, there is an economical consequence of operating a vessel on fuel oils with varying sulphur level. Since fuel oils with different sulphur content often have very different properties and tend to be incompatible in certain mixed ratios, it can lead to major modifications of the fuel oil system. These modifications and incorrect operation can lead to major economic impact for these vessels. Vessels equipped with 2-stroke slow speed engines, switching between high and low sulphur fuels, may also need modifications of the cylinder oil system. In addition to this the cost of low sulphur fuel is significantly higher than for higher sulphur content fuel oils. Due to the high relative cost of ultra-low sulphur fuel oils it will be natural, if possible, to reduce engine load, and vessel speed, in order to consume less fuel in an ECA. Some authorities have announced to strengthening their effort to ensure compliance and will check bunker delivery notes, logbooks, and take fuel samples. Historically, penalties will increase if the industry is slow to comply.

Switching between fuels with varying sulphur content.

Before a vessel powered with fuel oil containing more than 0,10% sulphur enters an ECA it must change-over to a ultra-low sulphur fuel, generally this means switching to Marine Gas Oil (MGO). This change-over needs training, preparation, and attention from all involved personnel. Change-over from one type of fuel to another is an operation with many pitfalls and risks, as a result of this it is important that the vessel has a detailed change-over procedure. If this is not taken seriously it may result in engine failure, loss of power, or engine break down. You should consult your engine manufacture for advice and best practice before switching between high and ultra-low sulphur fuels.

The buyer of the fuel oil is responsible for specifying the bunker quality ordered, and should have knowledge of the exact sulphur content for the fuels used. The difference in sulphur level has a major impact on the time it takes to change from one fuel to another. The greater the difference in sulphur content, the longer it will take to change-over and fulfil ECA requirements.

To be in compliance with MARPOL vessels using separate fuel oils to comply with ECA requirements must carry a written procedure showing how the fuel oil change-over is to be done, allowing sufficient time for the fuel oil service system to be fully flushed of all

fuel oils exceeding the applicable sulphur content prior to entry into an ECA. The volume of low sulphur fuel oils in each tank as well as the date, time and position of the ship when any fuel oil change-over.

Incompatibilities

During a change-over period, and depending of the fuel supply system configuration there will be a mix of fuel oils with varying sulphur content. In order to prevent operational problems like clogging of filters etc. it is recommended to carry out compatibility tests, if possible before the fuel oils are bunkered. There are also test kits available that can be used on board, and it is possible to send in samples to a land based laboratory, but that will cause time lag before receiving the results.

2-stroke engines

The effect from the different fuel oils and cylinder oil types can appear quickly. Therefore, it can be beneficial to shorten the intervals between inspections of piston and piston rings when switching between fuel oils with different sulphur content fuels.

It should be ensured that deposits do not build up on the piston side (above the piston rings). This can break the oil film and lead to polishing of the cylinder liner surface. Too much deposit will stop gas flow to piston rings and the result will be insufficient piston ring action.

It is also important to check that all piston ring grooves are clean and free of deposits to ensure free ring movement. Deposits building up in the ring grooves can lead to deposits behind the piston ring, which again can lead to sticking piston rings and scuffing.

If possible scavenge drain oil analysis should be carried out. Iron content and BN in the drain oil can give strong indications of the wear and the alkalinity reserve of the cylinder oil. If these analyses are taken on a regular basis and each time there has been a change of fuel they can be used to monitor and optimize cylinder lubrication.

The system oil should also be monitored to see if there is any contamination due to stuffing box leakages.

The experience of operating 2-stroke slow speed engines on ultra-low MGO is limited, per today and the long term durability of components are unknown. It is expected that especially lubricants will have a massive development in the coming years.

Boilers

Boilers have been identified as the most at-risk component on board when switching between different fuel oils, and you should always consult the manufacturer of the boiler for advice and best practice, there should also be developed a detailed change-over operational manual before switching between fuel oils with varying sulphur content. Components like burners, fuel system, and boiler control systems may need to be

adjusted when switching from one type of fuel to another. If the boiler is not adjusted to the fuel used the risk can be increased smoking, increased air pollution, furnace explosions and fire. Most boilers are designed to operate on MGO for shorter periods, but they are not designed to operate for longer periods and full capacity on the low viscosity MGO.

4-stroke engines

Operating 4-stroke engines on low viscosity fuel oils is normally not considered to be a problem. But if the viscosity drops too low it may damage the fuel injection equipment, and there may be a risk of loss in capability to produce full power or lead to engine failure. Operation on MGO can give less energy per pump stroke than HFO which will affect the engines output. Much will be dependent on the fuel and the condition of the fuel injection components, but it can be up to 15% or even more.

If changing between different fuel oils too quickly uneven temperature changes may cause uncontrolled clearances in the injection pump, which can lead to seizure, internal and external leaks.

Lubrication of fuel injection components as long as the viscosity is within the spec and the sulphur content is above 0.01% is often not considered a problem.

2. Workbook questions

Answer all questions. All questions have a maximum score; **try to answer all questions as comprehensive as possible**. 75% score is required to pass the course.

- 1) What types of machinery are affected when switching between fuel oils with different sulphur content on board your vessel? **(3 marks/score)**
- 2) How well is your vessel prepared to switch between fuel oils with varying sulphur content? **(3 marks/score)**
- 3) Does your vessel have a written procedure describing how the fuel oil changeover is to be done? If so, give a brief description of the procedure. **(3 marks/score)**
- 4) Which factors affect the time it takes to change over from a fuel oil containing 0.50% sulphur to a fuel oil containing 0.10% sulphur to ensure that you comply with the regulation before you enter an emission control area?**(5 marks/score)**
- 5) Have there been required any modifications from the engine and/or boiler manufactures regarding the use of fuel oils with varying sulphur content? **(3 marks/score)**
- 6) What do you considered to be the most likely problem switching between fuel oils with different sulphur content? **(5 marks/score)**
- 7) Have you experienced any problems, engine failure, loss of power, or engine break down due to switching between fuel oils with different sulphur content? **(3 marks/score)**
- 8) Which economic consequences will the global sulphur cap of 0.50% have for your ship? **(3 marks/score)**
- 9) Explain why boilers have been identified as the most at-risk component on board when switching between fuel oils with different sulphur levels. **(5 marks/score)**
- 10) What type of equipment do you have on board to test the compatibility of fuel oils with different sulphur content? If you don't have test equipment on board, what do you do to minimise the risk? **(3 marks/score)**

3. Document status

Issue no.	Date	Author
2174 A	12.03.2015	AB
2174 A1	16.08.2018	AB
2174 B1	05.08.2019	AB
2174 3.0		IG

4. Changes in the document

Issue no.	Paragraph no.	Description
A1	1.7 4	Updated text Updated evaluation form
B1		Updated text and questions in workbook, added module #0417.
3.0		New Ocean TG course template. Split procedure and workbook, changed version numbering