NORWEGIAN HULL CLUB

Casualty Information

No. 102 – October 2019

Norwegian Hull Club wishes to emphasise increased safety onboard with a focus on **welfare, the environment, assets** and the distribution of **useful experience**. In this newsletter, we focus **on being prepared for the 0.50% global limit for marine sulphur fuels, effective 1 January 2020.**

Dear seafarer,

Norwegian Hull Club wishes to share information related to the 0.50% sulphur fuels limit coming into force on 1 January 2020. In October 2016, the International Maritime Organization (IMO) confirmed a global limit for sulphur in marine fuels of 0.50% (mass by mass), effective from the above date. For this reason, a Joint Industry Project was established to raise awareness. A subsequent publication entitled "Joint Industry Guidance – The Supply and Use of 0.50%-Sulphur Marine Fuel" was published in August 2019.

This special-edition Casualty Information newsletter highlights some of the main issues published in the Joint Industry Guidance. The Club will emphasise on-board procedures and routines, as well as the potential risks involved in the handling and treatment of 2020-compliant fuels.

Section 1. Fuel Characteristics and Properties

Ship-specific procedures should be prepared to promote good practice regarding on-board fuel management and care.

Both the fuel purchaser and the end user (the vessel) should note the following:

- On-board fuel management is an essential element of preventing operational issues. Improper handling of fuel on board may contravene MARPOL (Marine Pollution) requirements on fuel quality and safety, even if the fuel received was compliant. **In this regard, the following should therefore be noted**:

  - Once fuel is delivered on board, ships should have documented procedures for its safe handling and use. These procedures should form part of the company's Safety Management System (SMS) which should be established as a measure of good practice and/or as required by the International Safety Management (ISM) Code, as applicable, supported by equipment operation and maintenance manuals.

  - Each ship should have fuel switching procedures in place (where applicable). The crew should be familiar with the implementation of these procedures.

  - Marine fuel which fully meets statutory requirements and purchase specifications such as ISO 8217:2017 will, nevertheless, still require treatment before it meets most engine manufacturers' requirements.

An independent analysis of a representative sample of the fuel to be delivered is highly advisable. Such a sample must be taken over the entire period of the bunker operation (manual or automatic drip).

The subsequent analysis report must be carefully reviewed by the shipowner / technical department manager, as well as the officers responsible on board. Technical management should provide the vessel with guidance and support, taking into consideration the results of the analyses. Comments made by the laboratory should be noted and adhered to.

Understanding fuel characteristics is crucial in order to be able to adjust machinery settings accordingly. Note that, even if the analysis report states that the fuel is fit for use, actions may be required to ensure that said fuel can be used for the engines.

Shipowners and operators should continue to procure fuels against ISO 8217:2017, as this standard covers max. 0.50%-sulphur fuels in the same way that it covers present-day fuels.

It should be noted that a wide variability in the formulation of max. 0.50%-sulphur fuels - from light distillates to heavier residual blends – is anticipated. Increased risk of incompatibility may arise from the introduction of max. 0.50%-sulphur fuel. The need to reduce the mixing of bunker deliveries is, therefore, more important than ever before. Prior to transferring new bunker fuel to the settling tank, any remaining bunker fuel in these settling tanks and service tank should be consumed as much as possible.

The condition of fuel-oil purifiers, heaters, viscosimeters and filters must be designed and well maintained in order to handle the variation in viscosity and density of the new fuel.

The engine maker's specification regarding min. / max. fuel viscosity inlet to the engine must be followed. To check that the on-board fuel treatment system can handle the fuel to satisfy the required engine criteria, fuel samples should be drawn before the treatment plant and before the inlet to engine. These two samples can then be sent to a laboratory. Based on the difference between the two analyses, the effectiveness of the on-board treatment plant can be verified.

As for all bunker fuel used on board, close attention must be paid to subsequent engine performance. Any abnormal parameters and sludge accumulation should be reported.

Section 2. The Blend Process

Under MARPOL Annex VI, it is statutory that a Bunker Delivery Note (BDN) includes at least the stipulated information and declarations and these must be provided by the supplier to the ship. As well as the minimum MARPOL requirement relating to the supply of information on a fuel's density and sulphur content, additional information that should be provided in writing includes, but is not limited to, data (i.e. actual value) relating to:

- Pour Point (if higher that -6°c actual value)
- Viscosity
- Water

For distillate fuels, the information should also include data on:

- Cloud point (only applicable to clear and bright distillates)
- Coil filter plugging point (CFPP)

Additionally, confirmation that the flashpoint of the fuel complies with SOLAS limit, i.e. a minimum of 60°C should be ascertained.

A Material Safety Data Sheet (MSDS) should be provided as per SOLAS requirements.

The supplier must state the actual sulphur content in accordance with the MARPOL Annex VI BDN requirement, rather than advising that the sulphur constitutes <X%. A specific value will enable the ship's crew to manage the fuel-grade switching when entering an Emission Control Area (ECA) and to monitor the effectiveness of any abatement technology used on board.

Section 3. Guidance on the storage, handling and safe use of max. 0.50%-sulphur fuels

As mentioned in Section 1, fuels should be handled as they currently are, with particular attention to the avoidance of commingling. The default preferred situation for bunkers coming on board a ship is complete segregation. However, this may not always be

possible or practical.

Given the basic framework of ISO 8217:2017, an assessment of the quality of a fuel as supplied may be divided into three subsets: **statutory requirements**, **defined limits** and **general requirements**.

Statutory requirements
The SOLAS and MARPOL conventions include mandatory specific requirements for parameters such as flashpoint and sulphur content, as well as mandatory general provisions for fuel oil quality and safety.

Defined limits
These would be seen as the numeric limits as given in Table 1 or Table 2 of ISO 8217:2017. These limits are in respect of certain physical properties, composition or performance indicators.

Summary of requirements (best practice/risk mitigation):

Do:

- Avoid mixing bunker fuels: if possible, receive new fuels into empty tank(s)
- Conduct a spot test first on the proposed mixture if you arrive in a port without an empty tank to load into; if that fails, take advice and/or confirm with the Total Sediment Potential (TSP) test to confirm whether there are potential issues if the products are mixed
- Purchase fuels with similar viscosities and densities whenever possible.

Do not:

- Mix a residual fuel oil with a marine diesel oil (MDO) or marine gas oil (MGO).
- Mix fuels with greatly dissimilar viscosities, densities, Maximum Continuous Rating (MCR) or pour point; dissimilar characteristics may provide an early indication of possible incompatibility.

Preparing the fuel switching procedure

With regard to on-board management of unacceptable fuels or fuels exceeding the 0.50%-sulphur limit: a number of important issues will need to be addressed when preparing the fuel switching procedure. These include:

1. Conduct an assessment of the fuel system on board the ship to determine what actions are required to ensure the safe and effective operation of the vessel using the various grades of fuel.

2. The fuel storage, settling and service tank arrangement should be assessed; this will determine the extent of commingling between fuels during the fuel switching procedure. Segregating fuels is the preferred approach as this may allow for quicker switching and reduces the potential for compatibility issues. Due to the requirements of SOLAS, most ships built after 1998 have double service tanks and more than two storage tanks, so the possibility for segregation exists.

3. If the ship does not have a tank arrangement that permits segregation of fuel beyond the storage tanks, procedures for fuel mixing will need developing. One way to approach this is to reduce the level of fuel in the settling tank to as low as possible without losing suction before filling with the alternate fuel. A significantly longer duration of operation may be required to complete the fuel switching using this approach.

4. Before fuel switching commences, it is generally recommended that the ship's power be reduced to the level specified in the fuel switching procedure. Typically, this may be a power level of 30-to-70% of the MCR, depending on the specifics of the propulsion plant.

5. It is crucial that avoiding thermal shock to the fuel system is a consideration in a fuel-switching procedure. Engine manufacturers normally offer guidance on the maximum permissible rate of temperature change in fuel systems, such as the commonly used rate of 2°C/minute. This will have an impact on the time it will take to complete the fuel switching process. For example, if a ship is using Heavy Fuel Oil (HFO) heated to about 150°C prior to the fuel injection pumps, and is switching to MGO at 40°C, the temperature difference is about 110°C. Under these conditions - and considering a 2°C/minute permitted rate of change - the temperature reduction from 150°C to 40°C during the fuel-switching process should take a minimum of 55 minutes to complete safely. However, it may be prudent to use a longer period than the minimum calculated time so that short-term rapid temperature changes are

avoided during the process, which may not consist of smooth, even temperature changes.
Extending the duration of the fuel switching process to control the rate of temperature change can present a number of challenges, as summarized as follows:

On many ships, carrying out fuel switching is achieved by manually operating a single three-way valve. This operation changes the fuel source immediately and, if the fuel switching is undertaken at high-power levels, the fuel change will be carried out in a relatively short period of time as the fuel circulates at a high rate through the mixing tank.

A fast changeover from HFO to MGO can lead to overheating of the MGO, causing a rapid loss of viscosity and possible gassing in the fuel system. Too rapid a change from unheated MGO to HFO can lead to excessive cooling of the HFO and excessive viscosity at the fuel injectors, again causing loss of power and a possible shutdown. If a single switching valve is provided, it is recommended that fuel switching is carried out with the engine at low-power levels, typically between 30-to-70% MCR, so that the fuel change occurs gradually enough to remain within the temperature rate-of-change limits.

For fuel switching to be carried out at higher-power levels, the fuel-switching system may need to be modified; this may involve the installation of an automated fuel-switching system that changes the fuel in a timed, regulated manner. Such automated systems are offered by some engine makers and fuel-system equipment suppliers.

• When switching from heated HFO to MGO, engine components and fuel in the mixing tank will retain heat during the switching process. As the still-hot fuel mix becomes purer MGO, there is a real danger of 'gassing' at the booster pumps, causing the engine to stop. The fuel temperature should therefore be monitored closely during this process; components should be given sufficient time to cool down before running the engine on pure MGO. Fuel coolers, or even chillers, can be of value in such circumstances.

• When changing over to a low-viscosity fuel, fuel heaters and pipe heat tracing should be turned off in a controlled manner during the fuel switching process. Most ships have a viscosity-control system that controls the heat supply to the fuel preheaters located in the fuel supply system. This system will adjust the heat supply to the preheaters as the fuel viscosity changes during the fuel switch.

6. If a fuel cooler or chiller is installed, it should be turned on and the valves to the cooler opened carefully while closely monitoring the temperature of the fuel to prevent an excessive rate of cool-down. When changing from cooled MGO to heated HFO, the cooler can usually be bypassed and shut off at the start of the process.

7. As discussed previously, the potential for incompatibility of the mixed fuels may present certain challenges. It is therefore essential that, during the fuel switching process, the pressure difference across fuel filters, strainers and the mixing tank should be carefully monitored for evidence of clogging and the formation of excessive sludge. This is one reason why fuel switching is best done in advance, in open waters and clear of hazards.

8. Purifier systems should be adjusted as appropriate for the new fuel. It is important to make sure that the suction and return pipes go to the correct tanks. If using MGO, a separate purifier may be put in operation.

9. If the engine incorporates fuel-valve injector cooling, this may need to be turned on or off, as appropriate, during fuel switching. For example, after switching to MGO, fuel-valve injector cooling may not be needed. If this is the case - and if the engine will be operated on MGO for extended periods of time - injector cooling should be turned off to prevent overcooling of the fuel. If cooling was turned off prior to switching to heated HFO fuel, it will need to be turned on again. It is important to consult with the engine manufacturer regarding this item.

10. It is essential that the temperatures of the engine and its components are monitored to ensure that they are maintained at normal service levels. Engine control equipment such as control valves, temperature sensors, viscosity controller, etc. should be adjusted or reset as necessary to account for the new fuel type, unless this is carried out automatically. As experience is gained with fuel switching, there will be improved understanding of what needs to be adjusted and monitored during the switching process and during sustained operation with different fuels. During initial fuel switches, vigilance is needed to spot potential problems before they become serious. Fuel switching procedures should be adjusted to account for identified problems.

11. Once the propulsion and generating plant are stabilised on the new fuel, with all components at normal service temperatures, it should be possible to bring the propulsion plant back to normal power to enable the ship to proceed into restricted and port areas.
12. It is advisable to contact the lubricant supplier and follow Original Equipment Manufacturer (OEM) guidelines to determine the recommended feed rate and base number of the lubricant, to ensure that the appropriate degree of cylinder lubrication is maintained. It is recommended that, after prolonged running with MGO, lube oil samples from both the main engine and diesel

generators are tested in a laboratory to determine possible leakage of fuel into the crankcases.

Boiler Operation

Where boiler equipment manufacturers have issued specific guidance on the use of distillate fuels - as opposed to residual fuels - that guidance *must* be followed. For boiler combustion systems this may include - but is not limited to - aspects such as the size and specification of burner-fuel supply pumps, positioning of burners, type of burner lance and tips, flame eye / scanner type and positioning, and guidance on purge duration, combustion control settings and burner management systems including sequences for purging / relighting of boiler flames.

Initial set-up and commissioning of boiler installations and retrofits for a different fuel should be carried out by qualified personnel, with approval by the ship's classification society.

Key fuel quality characteristics and the significance of off-specification test results:

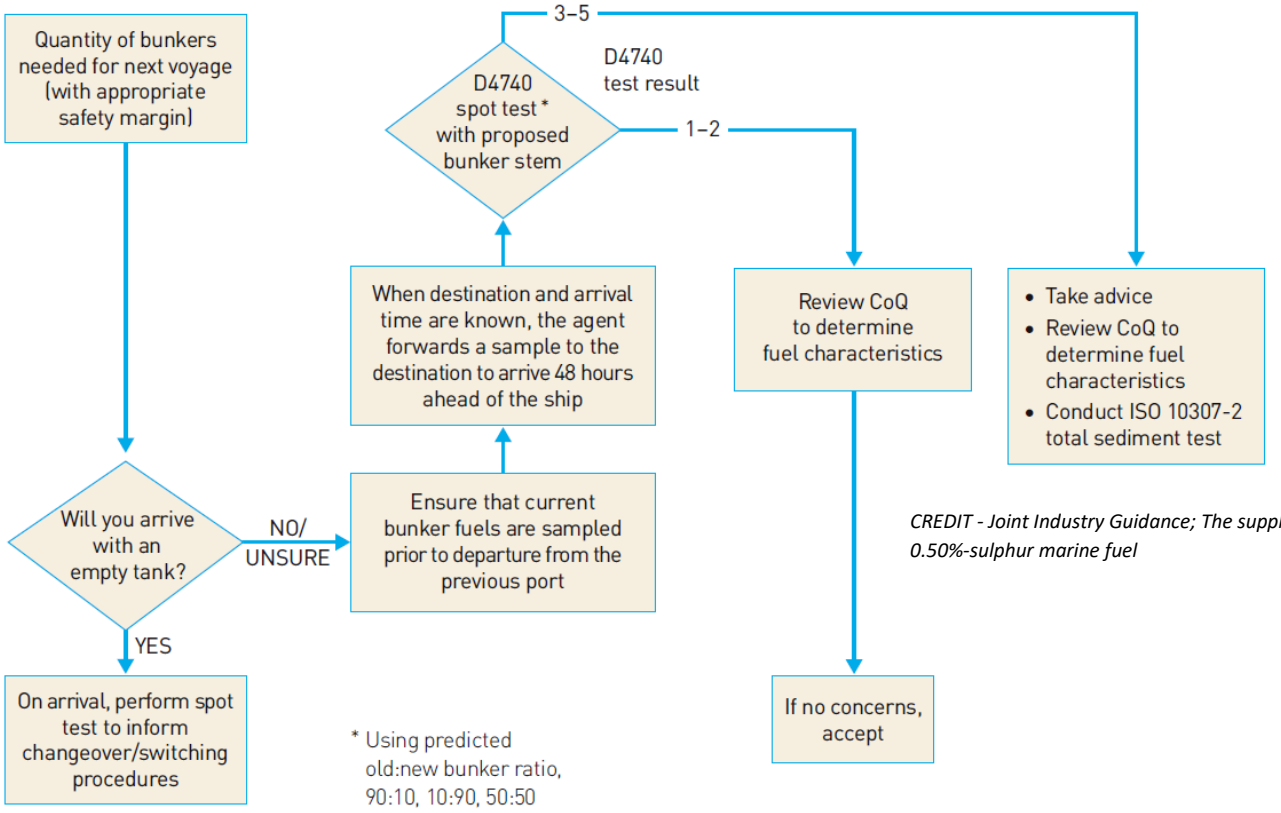
Characteristics	Significance	Implications of off-specification
Viscosity at 40°c	Ease of flow	Values below the minimum limit are normally a concern for distillates: there is potential for insufficient dynamic lubrication under higher temperature conditions. There is increased tendency to flow through fine clearances, particularly under the high pressures of fuel injection pumps, especially where those clearances have increased due to wear, resulting in an inability to generate the required pressure/flow. Can also lead to a shortfall of spray penetration on injection. Receiving a distillate with a viscosity value above the maximum limit as ordered is extremely rare for a distillate; however, if this occurs it could compromise the injection spray pattern and lead to an increased mechanical load on fuel pumps and drive arrangements. Suitability is dependent on combustion machinery requirements. Response: apply cooling or heating, as applicable. Ensure that the bunker order has highlighted any minimum and/or maximum viscosity requirements.
Density at 15°c	Weight/volume relationship of a fuel	Reduced tendency for settling out of water and solids, although this is more of an issue for the higher-density residual fuels due to the naturally lower densities of distillates. As density is generally used to convert the delivered quantity (m3) to the invoiced amount (tonnes), a value below that quoted on the bunker delivery note will result in a tonnage shortfall. The gravity disc selection for a purifier may need to be changed to match the density of the fuel.
Sulphur	SOx emission control. Controlled to limit SOx and related particulate emissions for environmental protection. Precursor of post-combustion low temperature corrosion of susceptible components in the engine and exhaust duct.	Statutory issue. Non-compliance with MARPOL Annex VI, Regulation 14 (and/or local controls). For two-stroke engines, ensure that suitable cylinder liner oil on board to address the anticipated sulphur content of the fuel to be used. Adjust feed rates as applicable.
Flashpoint	The temperature at which fuel vapor is ignited under specific closed-cup test conditions. Statutory	Statutory issue. Non-compliance with SOLAS. Values substantially below the minimum limit could indicate inclusion of particularly volatile components with potential for evolution of hydrocarbon-rich vapors. The SOLAS agreement specifies that the flashpoint for all fuels used on board ships should be a minimum of 60°C, except where: • allowed otherwise in SOLAS II-2, Regulation 4 which permits fuel oil with a minimum flashpoint of 43°C to be used in certain applications and under controlled conditions; or • a ship is certificated in accordance with the provisions of the *International Code of Safety for Ships Using Gases or Other Low-flashpoint Fuels* (IGF Code). If low flashpoint, report to Class
Acid number	Indicator of acidity; however, there is no direct correlation between acid number and	See page 19 in this guidance document for more details on this parameter. Where unusual acid number readings are recorded, further

	corrosion risk.	investigative analysis may be carried out to determine the cause and whether naturally occurring or not.
Carbon residue (DMB)	Indicator of tendency for formation of post-combustion carbon deposition; significance depends on engine design and operating profile.	In cases of extreme exceedances, which are rare for distillates, there is a tendency for increased formation of post-combustion carbonaceous deposits in the engine, system lubricant, turbochargers and exhaust duct, particularly under low load or other non-optimum operating conditions. There is potential for cracking of fuel in uncooled injector tips, resulting in the formation of hard carbon deposits which compromise combustion by adversely affecting the injector spray pattern, resulting in further deposition. A point of note is that, for the most part, ships' machinery is designed to operate both on residual fuels and distillates, and can tolerate relatively high levels of carbon residue. Hence, this is rarely an issue today.
Cloud point	The temperature at which wax crystals are first evident on cooling.	If operating at temperatures where a proportion of the wax in a fuel begins to form as crystals, albeit they may be dispersed, this may tend to lead to the choking of filters and other fine clearances. Ensuring that the system has enough warming capability, or an anticipated return to warmer ambient conditions, will prevent any adverse outcomes or difficulties associated with emergency engine starts. Any ship constraints should be made clear in the fuel order specification.
Cold filter plugging point (CFPP)	The highest temperature at which a given volume of fuel fails to pass through a standardized filtration device in a specified time when cooled under standardized conditions (applicable only for distillate fuels).	See on *Cold flow properties* on page 16 of this guidance document.
Pour point	The lowest temperature at which fuel is still fluid under test conditions.	If a fuel essentially solidifies it becomes unpumpable and is not readily brought back to a liquid condition by heating due to its poor heat transfer characteristic. If it is not possible to await return to warmer ambient conditions, the fuel may literally have to be dug or steam lanced out of the tanks and transfer lines, which will need to be physically rodded through/dissembled to remove the solidified fuel. Fuel in tanks with surfaces exposed to ambient (water or air) temperatures below the pour point may form a solid mass on that surface, which can grow to the point where it breaks away to fall through the liquid phase as a solid mass and choke suction connections. Maintain storage and handling temperatures at 10°C above the pour point to avoid risk of solidification. Any constraints due to cold ambient conditions/winter zones should be determined.

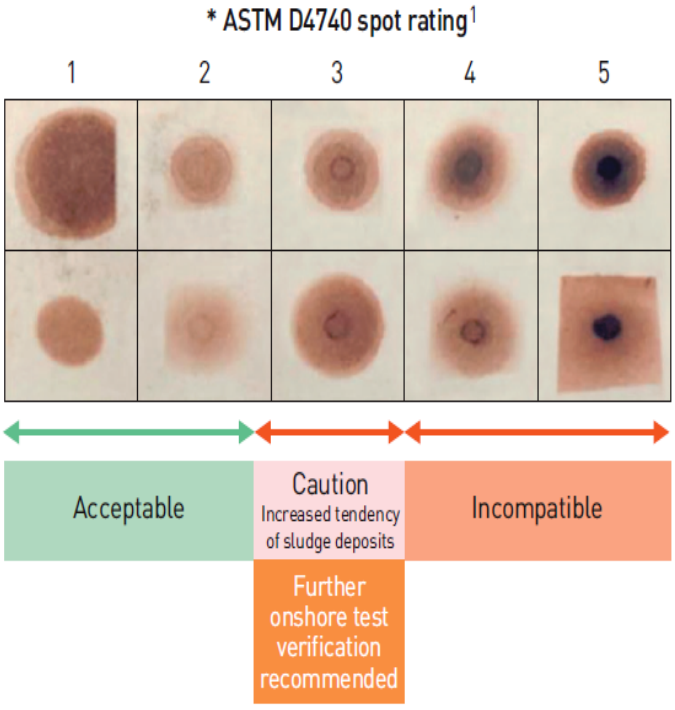
CREDIT - Joint Industry Guidance; The supply and use of 0.50%-sulphur marine fuel

Figure 1 Example of the steps that could be followed during a bunker delivery

(a high-level scheme more suited to those situations where segregated bunkering is the norm and the ship may unexpectedly have to commingle)



CREDIT - Joint Industry Guidance; The supply and use of 0.50%-sulphur marine fuel



Reference spot description (source: ASTM D4740: 2019)

Characterizing features according to spot number:

1. Homogenous spot (no inner ring).
2. Faint or poorly defined inner ring.
3. Well-defined thin inner ring, only slightly darker than the background.
4. Well-defined inner ring, thicker than the ring in reference spot no. 3 and somewhat darker than the background.
5. Very dark solid or nearly solid area in the centre; the central area is much darker than the background.

CREDIT - Joint Industry Guidance; The supply and use of 0.50%-sulphur marine fuel

Note

1. Where a spot rating is difficult to determine, i.e. whether the rating is '2' or '3', the higher rating number should be reported.

Planning

Without going into fine detail, the importance of implementing the following in due time prior to 1 January 2020 should be noted:

1. **Ship Specific 0.50% Sulphur Implementation Plans.**
   a) As appropriate, the ship-specific implementation plan will need to consider when and where any new 0.50% Sulphur fuels will be bunkered and the designated tanks into which they will be loaded.
      - Cleaning tanks designated for the bunkering of compliant fuel; or
      - Loading compliant fuel into designated tanks on top of the remnants of 3.5% Sulphur fuel as part of a dilution/flushing process, commencing this within an appropriate period of time before 1 January 2020 to ensure all non-compliant fuel is out of the system before this date. The process should be carried out carefully, keeping in mind the possible associated risks resulting from incompatibility between the two fuel grades.

   b) The IMO has developed guidelines which include a template for a ship-specific implementation plan which shipping companies can use.

   c) There will be a significant increase in compliance checks by Port State Control (PSC) following the implementation date of the Global Sulphur Cap. If a ship has a suitably developed implementation plan on board, with corresponding records maintained on board demonstrating how the plan has been followed, then a ship's crew should be in a better position to demonstrate during any PSC inspection that they have acted in good faith and done all that could be reasonably expected to ensure implementation by 1 January 2020. The IMO has agreed that administrations and PSC authorities may take into account the implementation plan when verifying compliance with 0.5%-sulphur limit requirements.

2. **Risk Assessment and Mitigation Plan**
   Appropriate action plans should be developed in order to address and mitigate any specific safety risks identified. The following is presented as an example only. Plans to be included in a ship's Safety Management System (SMS) need to cover:
   - Procedures to segregate different types of fuels from different sources
   - Procedure for compatibility testing and segregating fuels from different sources until compatibility can be confirmed
   - Plans to address any mechanical constraints with respect to handling specific fuels, including ensuring that minimum/maximum characteristics of fuel oil as identified in fuel standards such as ISO 8217 can be safely handled onboard the ship
   - Procedures to verify machinery performance using fuel oil with characteristics with which the ship has no prior experience.

3. **Fuel Oil System Modifications and Tank Cleaning**
   For identifying any required modifications, it is recommended to use information provided by the International Association of Classification Societies (IACS). Rec 151: Recommendation for petroleum fuel treatment systems for marine diesel engines.

   The entire ship's fuel-storage system, fuel-treatment system and fuel-supply system should be comprehensively reviewed to assess its suitability prior to bunkering distillate fuels. The fuel to be used should be confirmed as meeting the fuel-quality parameters specified by the engine maker.

4. **Training of On-board Personnel**
   Proper training of the crew is crucial. Knowledge of the characteristics of the fuel, together with the possible effect on engine operation, is vital in order to avoid operating problems. The crew should be made aware of possible changes in the on-board procedures with regards to operation of the Fuel Treatment Plant. Training should encompass proper fuel sampling and subsequent analysis – understanding the analysis report and how to take the right actions based on the recommendations.

Based on the JIP publication document, Norwegian Hull Club urges you to remember the following key points:

SAFE BUNKER OPERATION	Check barge soundings and complete safety-check list.
BUNKER DELIVERY NOTE (BDN)	Check bunker delivery note against ordered fuel grade and specification.
BUNKER INTO CLEAN FUEL TANKS	Cleaning of tanks prior to receiving 0.50%-sulphur fuel; avoid commingling; if mixing if fuels is required, compatability tests should be conducted.
FUEL SAMPLING	Fuel sampling to be performed over the entire bunkeing period; continuous drip (automatic or manual).
PREPARING SAMPLES AND BUNKER REPORT	Prepare fuel samples, including documentation to be sent to a laboratory. Any bunker fuel should preferably not be used before results are received and reviewed
FUEL TREATMENT PLANT AND SUPPLY SYSTEM	Fuel Oil Treatment Plant/fuel supply system to be tuned and operated as per recommendations for the actual fuel bunkered. Purifiers, heaters, viscosimeters, man/auto filters to be well maintained and adjusted for fuel to be treated. In order to check that your fuel treatment plant is working, samples should be drawn before the treatment plant and the inlet to engine. Analysis of these samples enables you to verify that your treatment plant is “doing its job”.
CHECK ENGINE PERFORMANCE	When the fuel is used, adjust engine parameters as recommended. Check engine performance and operation condition. Any change in engine condition to be reported.

Norwegian Hull Club wishes you all fair winds and following seas.