

# ABS Notes

## Use of Low- Sulphur Marine Fuel for Main and Auxiliary Diesel Engines

Note: The following suggestions are provided for information purposes only and are not intended to replace any applicable local, national or international safety, operational or material requirements. It is recognized that safe operation of the vessel is the owner's responsibility.

### Regulations:

- (1) Article 4b of "EU COUNCIL DIRECTIVE 1999/32/EC of 26 April 1999 relating to a reduction in the sulphur content of certain liquid fuels and amending Directive 93/12/EEC", as amended, introduces 0.1% sulphur limit (m/m) for marine fuel.

- a. **Effective Date:** January 1, 2010.

- b. **Applies to:** All types of marine fuel used by ships at berth for more than two hours in EU ports unless an approved emission abatement technology is employed or shore power is available.

- (2) California Air Resources Board (CARB)

- a. **Effective Dates:**

- Phase I** (in force) since July 1, 2009 [MGO (ISO 8217, DMA Grade) at or below 1.5%S or MDO (ISO 8217, DMB Grade) at or below 0.5%S]

- Phase II - January 1, 2012** [MGO (ISO 8217, DMA Grade) or MDO (ISO 8217, DMB Grade) at or below 0.1%S]

- b. **Applies to:** All types of marine fuel used by ships within California Waters (within 24NM of the California baseline – see "Foot Note -1" )

[Note: MGO = Marine Gas Oil; MDO = Marine Diesel Oil]

Foot Note 1 - Definition of California baseline:

"Baseline" means the mean low water line along the California coast, as shown on the following National Oceanic and Atmospheric Administration (NOAA) Nautical Charts as authored by the NOAA office of Coast Survey, which are incorporated in CARB by reference:

- (A) Chart 18600, Trinidad Head to Cape Blanco (January 2002);
- (B) Chart 18620, Point Arena to Trinidad Head (June 2002);
- (C) Chart 18640, San Francisco to Point Arena (August 2005);
- (D) Chart 18680, Point Sur to San Francisco (June 2005);
- (E) Chart 18700, Point Conception to Point Sur (July 2003);
- (F) Chart 18720, Point Dume to Purisima Point (August 2008); and
- (G) Chart 18740, San Diego to Santa Rosa Island (April 2005).

All engines (main and auxiliary engines) and boilers are affected by the above Regulations (As for boilers, please note that the EU Directive applies to main and auxiliary boilers, while the CARB Regulations apply only to the auxiliary boilers, i.e., non-propulsion boilers). This document addresses those issues that are associated with diesel engines operating on low-sulphur marine fuel.

See also, "ABS Notes - Use of Low- Sulphur Marine Fuel for Boilers"

Please note that currently the requirements in the ABS Rules that cover the general requirements for piping, automation and electrical apply to systems/equipment used for low-sulphur fuels, for example, MGO (0.1%S by m/m) as fuel for engines. Attention is drawn to the above mentioned Regulations relating to a reduction in the sulphur content of certain liquid fuels and the USCG Marine Safety Alert 03-09, dated June 16 2009 regarding the switching of fuel oil from residual fuel to distillate fuels in order to reduce emissions. Vessel owners and operators are invited to use the following for guidance.

ABS is aware that as a consequence of the above regulations, main engines, auxiliary engines and boilers will be required to operate on low-sulphur fuels, (unless under Regulation (1) above, an approved exhaust gas scrubber/treatment system is fitted or shore power is made available, i.e., cold-ironing) which will likely be marine gas oil (MGO). Please note that many of these engines and equipment (e.g. boilers) were specifically designed to operate on heavy fuel oil (HFO) or marine diesel oil (MDO). Thus, ABS considers some design modifications and operational adjustments may be necessary to some of these engines/equipment. In addition, where these engines/equipment are capable of operating on MGO, though originally designed to operate on HFO, a well-designed and efficient change-over procedure to and from MGO (i.e., low-sulphur marine fuel oil) needs to be followed in order to maintain engine/equipment safety and availability. ABS does caution that ABS is not an engine or system design expert, so this information should be used in working with such experts, not in place of such expertise.

In light of the above regulations and with a view to assist the owners/operators and/or shipyards/designers as appropriate, ABS highlights below certain issues (design and operational), makes the following suggestions, and specifies the requirements that are to be satisfied for ABS classification purposes. It is important to recognize that many systems are directly supplied by the engine manufacturer. In modern engines, typically the engine control is integrated with an outside sourced control system. As such, involving the engine manufacturer or another entity recognized by the engine manufacturer to be responsible for the overall arrangement including any needed design adjustments may be a prudent course of action.

## **1. Design and operational issues:**

### **Design issues:**

- a) New fuel pump: With the introduction of low-sulphur fuel oil such as MGO into the fuel system, the existing HFO pumps may have difficulties with suction of the light gas oil (MGO) because of reduced fuel oil viscosity and lubricity. Accordingly, due to lack of lubrication, this may eventually result in overheating of the existing HFO pumps (if not designed to handle MGO). Therefore, it may be necessary to install different types of pumps to deal with MGO.

- b) Excessive wear within the fuel pump can result from the lower lubricating properties of MGO (0.1%S fuels). This could also necessitate replacement of the existing HFO pump with a new fuel pump. This includes fuel injection pumps which may necessitate replacement with a special pump (e.g. Tungsten Carbide Coated Fuel Injection Pump).
- c) For new designs, consideration might be appropriate to incorporate electronic fuel control and direct fuel injection combustion systems into the engine systems allowing the engines to burn fuel more efficiently, resulting in more power, cleaner emissions, and increased fuel economy.
- d) Consideration must be given to MARPOL Annex VI compliance when modifying anything that affects the combustion process. It may be necessary for an engine manufacturer to install some specific components for operation on certain fuel grades or for certain operational requirements. In such instances, these components must have been covered by testing to demonstrate their suitability as allowable alternative NOx components or settings of that particular Engine group or Family. In essence, the engine manufacturer must confirm that the modification was covered by the configurations used during emission testing of the engine. Otherwise additional testing may be needed.

ABS does not anticipate any major effects when techniques such as a coating or surface treatment are adopted to resolve the fuel pump lubricity issues. However, the differences in ignition quality of the different fuel types may demand a different fuel oil injection system, including a new setting for injection timing. This could result in major modifications requiring re-certification of the engines.

- e) It is to be noted that MGO with a minimum viscosity of 1.5 cSt at 40<sup>0</sup> C (ISO 8217) requires approximately 22<sup>0</sup> C to keep the limit to 2 cSt. Maintaining the fuel oil temperature in the required range may be difficult with existing systems. The consequence of not doing so may be “sticking” of fuel system components. Thus, to maintain a minimum viscosity of 2 cSt it may be necessary to install a new cooler together with appropriate controls in the design of the modified fuel oil system.
- f) For the lowest viscosity MGOs, a cooler may not be sufficient. In such cases, it may be necessary to include in the design a so-called “Chiller” (along with appropriate controls), which removes heat through vapor-compression or an absorption refrigeration cycle.
- g) In some industries additives have been used to improve lubrication and mitigate the viscosity issue. Fuel suppliers, engine and pump suppliers should be consulted.
- h) MGO tanks (including capacity) and systems should be arranged to facilitate effective change over. Sufficient capacity for the intended operation should be carefully considered and planned. While not specifically mandated, installation of dedicated MGO Service tanks may be necessary due to operational considerations.
- i) HFO and MGO piping systems (including pipe fittings and equipment) should be arranged so as to carry out effective flushing of HFO from the system.
- j) Low-BN cylinder oil tank(s) may also be needed. See item (p) below.

**Operational issues:**

- k) There exists a concern during a fuel changeover from HFO to low-sulphur fuel such as MGO because the pipes and other parts of the fuel oil pumping system are heated when using HFO. MGO flowing through the same hot piping may vaporize creating vapor locks and causing irregular fuel flow to injectors resulting in engine stoppage. Therefore, MGO is not to be used through heated pipes to engines.
- l) Sticking/scuffing of high pressure fuel oil injection components: When changing engine operation from HFO to MGO, rapid or uneven temperature change could cause thermal shock creating uncontrolled clearance adaptation which can lead to sticking/scuffing of the fuel valves, fuel pump plungers, suction valves or fuel pump seizure.
- m) Accelerated piston ring/liner wear: Prolonged engine operation with incompatible crankcase or cylinder lubricating oil could result in accelerated piston ring/liner wear.
- n) There may be a loss of sufficient oil film thickness due to liner lacquering.
- o) One or more of the above events in item l), m) or n) could lead to unexpected shut down of the main or auxiliary engine(s).
- p) Lubricating oil with high levels of alkaline additives, i.e., high-BN (base number) oil is recommended by many manufacturers for use with high sulphur fuels. Therefore, a lower TBN (total base number) crankcase oil for medium speed engines (i.e., trunk-type) or cylinder lube oil for slow speed engines (cross-head type) should be selected if a low sulphur fuel (MDO or MGO) is going to be used permanently or for a prolonged period of time.
- q) In addition to selecting lower TBN lubricating oil with the use of low-sulphur fuel oil, it may also be necessary to adjust the cylinder lubrication feed rate to match the total alkaline content of the cylinder oil with that in the fuel oil in accordance with a specific formula. If low-sulphur fuels are used predominantly, low-BN cylinder oil is generally recommended by manufacturers, either BN40 or BN50 oil as compared to the typical BN70 cylinder lubricating oil used with HFO. Where frequent fuel oil changes are necessary due to the vessel's trading pattern, it is recommended that a second grade of cylinder lubricating oil with a lower base number (BN) than the first be considered.
- r) In general, the purification of MGO may not be required. However, some engine makers may recommend purification. In that case, the purifier operational details should be in accordance with the purifier maker's instructions and recommendations.
- s) During engine operation with MGO, since the engine jacket cooling water temperature can be lower than that with the engine operating with HFO, the Fresh Water Generator system should be checked, temperature carefully monitored, and re-adjustment made if necessary.
- t) During the change-over process it may be necessary to re-set or re-adjust various equipment (such as control valves, temperature sensors, viscosity meter/controller, etc.) employed in the monitoring and control systems, unless this is accomplished automatically. Where manually adjusted, this should be in accordance with the engine maker's recommendations.
- u) "Cat fines" are substances like silicon and aluminum compounds which are required as catalysts in the refining process known as catalytic cracking ("cat cracking"). This process takes place in special cracking towers at a temperature of around 500 °C. After the

conversion, there may be a large quantity of catalyst fines (“cat fines”) in both the residues of the cracking towers and the distilled crude oil products.

These cat fines have a negative impact on the end products. They vary both in size and hardness. The fines are also extremely abrasive. Since the heavier fuels go through less refining they will have less Cat fines. The low-sulphur fuels often contain higher levels of “cat fines”.

The usual procedure to reduce “cat fines” includes settling out oil in the storage tanks, regular draining of tanks, purification (centrifuge), and other suitable treatment.

If the “cat fines” are not reduced to an acceptable limit, the scouring action of these fines can cause extremely rapid wear or damage to certain engine moving parts or components, particularly items such as fuel pumps, injectors, piston rings and liners with potentially severe consequences or total failure.

## **2. ABS Suggestions:**

Owners are urged to determine whether they intend to operate within the areas affected by the above regulations. If such operation is intended and the vessel does not currently operate on low sulphur fuels, some modifications to the vessels’ installed equipment and systems may need to be carried out. The owners/operators are required to evaluate the engine and other associated machinery/equipment operation with low sulphur fuel by systematically assessing related systems taking into consideration (but not limited to) the potential risks identified in items 1 (a) through (u) above as applicable, and appropriate measures are to be taken. The vessel owner is responsible for the vessel and its safe operation. It is recommended that the engine manufacturer or another entity recognized by the engine manufacturer be employed to carry out the design evaluation and oversee any modifications.

- a) A detailed fuel change-over procedure (or manual) should be developed by vessel owner/operators in consultation with engine/machinery manufacturers and placed onboard.

If the engines are capable of operating on low-sulphur marine fuel such as MGO, although they were originally designed to operate on HFO/MDO, this fuel change-over procedure (or manual) should still be developed and placed onboard.

- b) Fuel oil suppliers should be consulted to select and receive proper MGO onboard.
- c) Manufacturers and associated systems providers should be consulted to determine whether or not their existing fuel systems/arrangements require modifications or additional safeguards for the intended fuels.
- d) Engine manufacturers should be consulted regarding any service or maintenance requirements when operating on MGO (i.e., low-sulphur fuel). A fuel system/component inspection and maintenance schedule should be established.
- e) System seals, gaskets, flanges, and other fittings should be carefully maintained since fuel seepage and leakage may occur from the use of MGO in systems which have previously used HFO/MDO.

- f) System purifiers, filters and strainers should be maintained.
- g) Control systems including pressure and temperature alarms, flow indicators, filter differential pressure transmitters, etc., should all be operational.
- h) Crew training (initial and periodic) should be conducted. Their training needs assessments should be kept up to date.
- i) Fuel change over should be completed well before entering the Regulated California Waters.
- j) Cylinder lubrication consumption should be carefully monitored since a high consumption may be indicative of liner lacquering.

### 3. **ABS Requirements to be satisfied:**

#### A. General

- a. Where modifications are identified, details of all modifications together with the aforementioned design evaluation are required to be submitted to ABS for approval.
- b. Where the owner is satisfied that modifications to the vessels' installed equipment and systems are not required, it is recommended that the design evaluation be maintained on board. As this is a safety issue, the above analysis substantiating the safe operation with low-sulphur fuel is to be available only for consideration during ISM audits as evidence that safe operation has been considered.
- c. The design evaluation is to consider under all normal and abnormal modes of operation, including (but not limited to) the following:
  - Switch over to low-sulphur, low viscosity fuel
  - Switch over to HFO from MGO
  - Maneuvering in congested waters /harbor while switching over
  - Long idle times
  - Starting engine at berth or anchorage

#### B For modified systems, ABS requires the following:

- a. Design modifications, if any, are to be carried out by the original manufacturer or a competent entity that will be responsible for the modified design.
- b. Any modification to existing installations (including piping arrangements, control systems, equipment and other fittings) will be subject to ABS review and approval for both design assessment and survey. Accordingly, the details of the modifications considering the above recommendations are required to be submitted to an ABS technical office for review of general piping (such as pipe materials suitability, pressure, and fittings), automation and controls systems and other safety requirements in accordance with the applicable Rules. A copy of the design evaluation in conjunction with the modifications is to be submitted to ABS for approval.
- c. If new fuel oil pumps are installed, they are required to be certified by the attending Surveyor at the manufacturer's plant as required by 4-6-1/7.3.1 of the Rules.

- d. All modifications are to be carried out in accordance with approved drawings/details to the satisfaction of the attending Surveyor.