LOW SULPHUR FUEL OIL FOR SHIP'S OPERATION



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The regulations introduced concerning low sulphur fuel oil are testing the shipping industry's ability to adapt their existing machinery and fuel management.

This article outlines the present situation with respect to the use of low sulphur fuel in ship's operation. Although the IMO regulations relating to the use of low sulphur fuel have been in the pipeline for some time, the recent EU requirement introduced on 1 January 2010 to use low sulphur fuels when in port has come as a bit of a surprise to many owners. The recent EU directive outlined below is already catching some shipowners out, particularly at some ports where these regulations appear to be enforced to the letter.

The technical issues are general in nature, and the engine and boiler manufacturers, fuel-analysing companies and Class should be approached for a more in-depth assessment on the impact of low sulphur fuel oils. Use of the incorrect fuel oil can lead to catastrophic damage to machinery and substantial claims, and can endanger the ship and those aboard.

CURRENT LEGISLATION

The current IMO sulphur emission limits (Marpol Annex VI regulation 14) are as follows:

- a global limit on sulphur emissions of 4.5% by mass (m/m)
- when within a sulphur emission control area (SECA) a limit of 1.0% m/m $\,$
- California's limit on sulphur limit emission is for marine diesel oil (MDO) and imposes 0.5% m/m limit

New EU legislation that came into effect on 1 January 2010 pertains to the EU Sulphur Directive 2005/33/EC, which defines limits on the sulphur content of marine fuels.

From 1 January 2010, under the directive, the maximum allowable sulphur content of fuel oil used by ships 'at berth' in European Union ports, other than those in the outermost regions, is 0.10% m/m.

This covers all grades of fuel oil and all types of combustion machinery, including main and auxiliary engines, main and auxiliary boilers, inert gas generators and incinerators.

_____"The use of the incorrect fuel oil can lead to catastrophic damage to machinery and substantial claims, and can endanger the ship and those aboard."

TABLE 1 – FUELS BEING USED

Ship Type	Area	Sulphur%	When implemented	Note
All	Baltic SECA	1.5	11/08/2006	
All	North Sea & English Channel SECA	1.5	11/08/2006	
All	All emission controlled areas (ECAs)	1.0	01/07/2010	
All	All EU ports	0.10	01/01/2010	1,2,3
Passenger ships	All EU	1.5	11/08/2006	4,3
Inland waterway vessels	All EU inland waterways	0.10	01/01/2010	

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Except for ships due to be at berth for less than two hours
Derogation for 16 Greek ships operating within Greece until 1 January, 2012
Not applicable in the outermost regions of the Community (French overseas departments, Azores, Madeira, Canary Islands)
Operators of cruise ships making regular cruises are advised to check with the relevant authorities whether their operation is affected by the definition in the directive:
"Passenger vessels on regular services to or from any Community. Alternatively emission abatement technology may be approved. Warships are subject to a special clause."

TABLE 2 – REGULATION SUMMARY

Ship Type	Area	Sulphur%	When implemented	Act
All	Baltic SECA	1.5	19/05/2006	Marpol
All	Baltic SECA	1.5	11/08/2006	EU
Passenger ships	All EU	1.5	11/08/2006	EU
All	North Sea & English Channel SECA	1.5	11/08/2007	EU
All	North Sea & English Channel SECA	1.5	22/11/2007	Marpol
All	Californian waters & 24 NM of the Californian baseline	1.5 GO ¹ 0.5 MDO ²	01/07/2009	CARB ³
All	All EU ports	0.10	01/01/2010	EU ⁴
Inland waterway vessels	All EU inland waterways	0.10	01/01/2010	EU
All	Californian waters & 24 NM of the Californian baseline	0.10	01/01/2010	CARB
All	All emission controlled areas (ECAs)	1.0	01/07/2010	Marpol
16 Greek ferries	Greek ports	0.10	01/01/2012	EU

FIGURE 1 - EMISSIONS LEGISLATIVE OVERVIEW

14 April	11 August	California 01 July	01 January
EU Parliament passes Sulphur	North Sea SECA 1.5%		All SECAs reduced to 0.1%
Directive 199/32/EC	November		
19 May	Baltic Sea 1.5%		
Global sulphur limit 4.5%		—	
Sulphur content on BDN			
22 July			
Publication of Sulphur Directive			
2005/33/EC			

2005	2006	2007	2008	2009	2010	2011	2012	2015	2020
	19 May Baltic Sea SECA 11 August EU Member Sta enacted: - 1.5 % for all pa sailing betwee - Use of abatem as an alternati	tes laws ECA assenger ships in EU ports nent technology ve to 1.5% fuel	6-10 October MEPC 58 meet of proposed dra amendments to	s for adoption aft 9 Annex VI	January 2010 0.1% sulphur li fuel used on sh EU ports 1 July All SECAs redu	mit on all marine hips at berth in liced to 1.0%	California 01 C 0.1% sulphur lin 1 January Global cap to b 3.5%	luly nit on MDO e reduced to	1 January Global cap to be reduced to 0.5%

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HOW DOES THIS AFFECT SHIPS?

These low sulphur fuel oil requirements apply to all ships irrespective of Flag (EU or non-EU), ship type, and date of construction or tonnage.

At present, it has been stated that there will be no dispensations granted to ships other than those visiting the outermost EU regions. The outermost regions are the French overseas departments, the Azores, Madeira and the Canary Islands. In each of these cases, the local air quality standards must be maintained. Members should note that local regulations may strictly follow the most stringent legislation.

The use of residual fuel in slow speed main engines will still be allowed as these are not run continuously in port and the regulations do allow for the ship to enter and leave the berth using low sulphur residual fuel. Time is allowed for manoeuvring alongside and start-up prior to leaving the berth. The legislation is applicable to machinery using fuel oil that will only be running when the ship is berthed.

A limit of 0.10% m/m sulphur content means that the use of residual fuel oil (HFO) during time at the berth is not possible unless the use of exhaust gas scrubbers or selective catalytic reduction is employed and monitored by the use of emissions monitoring equipment. This is commonly referred to as the use of abatement technology. Members are therefore faced with the use of gas oil only when at EU berths unless they have abatement technology fitted to the equipment in use at that time. All members are familiar with the current Marpol Annex VI regulations with respect to Sulphur Emission Controlled Areas (SECA). Members may already have low sulphur fuel for the use in main and auxiliary engines. However, the continuous use of gas oil in diesel generators, boilers and incinerators designed for running on HFO, may pose some operational problems.

TECHNICAL ISSUES

There are a number of technical issues that members should be aware of with respect to the use of low sulphur fuel:

LOW VISCOSITY

It is required to determine what the viscosity limitations are for the machinery in which the fuel is to be used. If a machine is designed to run on HFO, then the fuel system components will have been designed to run at HFO temperatures (approximately 110-120°C). Depending on the fuel system configuration, it may be necessary to fit some or even all of the following:

- new fuel pumps
- fuel injector nozzles
- fuel line coolers to control the temperature of the gas oil in the fuel supply system to ensure correct atomisation
- new return lines may have to be installed if contamination by HFO is to be avoided
- the replacement or the addition of gear-type supply pumps may also have to be considered

The above list is not complete and may be expanded upon.

LOW TEMPERATURE PERFORMANCE

Due to the possibility of the low sulphur fuels having a substantial wax content, due diligence must be given to the temperature of these fuels at any point in the system. Ensure that the fuel temperature is not so reduced so that solidification or wax deposition problems occur. This can lead to problems with filter blockages and, consequently, fuel starvation of the machine. A note of the cloud point from the bunker delivery note for the fuel may be a good indication as to when this waxing may start to occur.

LUBRICITY AND LUBRICATION

Lubricity as a characteristic relates to boundary lubrication performance that affects the ability to generate a hydrodynamic lubrication film (oil wedge). Manufacturer's recommendations should be sought to ensure that the continuous use of gas oil is not detrimental to the lubrication of the fuel system components in the machine.

Where a low sulphur fuel is being used in two-stroke or four-stroke diesel engines, the engine builder's recommendations should be strictly followed with respect to cylinder lubrication Total Base Number (TBN). The running of an engine with incorrect cylinder oil lubrication for the fuel being used can very rapidly cause severe liner wear, piston ring wear, exhaust valve wear and turbocharger problems, to name but a few. Ultimately, it may cause engine failure. It may be prudent for the ship's medium speed engines to have an engine or engines permanently set up for running on gas oil only. These engines can then be used when the ship is berthed and would avoid the need to change the engine's crankcase oil to a lower TBN when using low sulphur gas oil rather than HFO. In all cases, the member is asked to contact the engine manufacturer for technical advice and recommendations.

vFuel pump plunger scoring



DENSITY

Due to the density of gas oil, the actual quantity of fuel, in terms of tonnes, contained within a tank will be reduced as compared to residual fuels (HFO). This would be reflected in the amount of fuel injected per fuel pump stroke, resulting in a higher fuel rack-setting for a given load irrespective of the higher calorific value of the gas oil.

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POWER SHORTFALL

Problems with power shortfall may occur on engines that have higher running hours on the fuel injection equipment and hence have been subjected to wear. Fuel injection may not be affected when running on HFO at high fuel temperatures, but when subjected to the colder temperatures of running with gas oil, then problems with low fuel injection pressures may arise. The fuel pump's ability to generate the desired injection pressure may be dramatically reduced and, in extreme cases, the pumps may not be able to produce the desired pressure for effective injection. This may be caused by the pump clearances at the low temperature being too large to effectively pump the gas oil. The engine consequently may not be able to achieve full power or may not even start.

PRE-HEATING

Since the heating of gas oil is not required, the systems in place for the HFO fuel operation must be switched off. Trace heating of lines must be shut down during the use of gas oil and reinstated when using HFO.

SOLVENT CHARACTERISTICS

Gas oil will have a cleaning effect on systems normally run on HFO. This may clear accumulated sludge materials within the system, with the possibility of fuel filter fouling or fuel injection equipment faults. Additionally, seals and joints may leak due to the searching nature of gas oil. This is compounded by the reduced temperature of operation. There may also be an increased tendency for fuel dribble from injection nozzles that may cause combustion chamber faults such as diesel knock, piston crown burning or boiler burner firing problems. v Boiler burner



MAIN, AUXILIARY BOILERS, INCINERATORS AND INERT GAS GENERATORS

The manufacturer of the boiler or burner control system has to ensure that the system is suitable for continuous operation on gas oil as well as HFO. Members may have been required to change the fuel nozzles and/or control system to adapt to the long-term use of gas oil. The furnace purging process must be functioning correctly and all combustion safety devices must be operating effectively. Flame monitoring sensors may not be suitable for gas oil use due to the differing spectral emission ranges, and this may result in false alarms, boiler shutdowns and, in the worst case, undetected flame failures. Combustion air settings may need to be readjusted for the use of gas oil. Members should ensure that boiler/burner manufacturer's advice is strictly followed at all times. In the case of incinerators, the member may find it an easier option to simply not run the incinerator whilst berthed.

APPROVAL OF MODIFICATIONS

All the proposed modifications to combustion equipment should have been assessed by a Hazardous Operations (HAZOP) workshop or other suitable risk assessment. Where any modifications have been made, then these must have been approved by the ship's classification society prior to their application.

CHANGEOVER PROCEDURES

It is important that a detailed changeover procedure is readily available and that the crew are well practised. Insufficient knowledge of the required actions may result in boiler shutdowns or engine failures. It is highly recommended, especially for ships that do not perform fuel changeovers on a regular basis, to practise their procedure for this in conjunction with manoeuvring trials before entering restricted navigable waters.

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FREQUENTLY ASKED QUESTIONS

1_____ 'AT BERTH' – WHAT IS MEANT BY THIS TERM?

This covers ships in EU ports that are secured at anchor, on moorings (including single buoy moorings) or alongside a quay or berth, irrespective of whether they are working cargo or not.

WHEN DOES THE REQUIREMENT TO USE FUEL NOT EXCEEDING 0.1% M/M MAXIMUM SULPHUR CONTENT ENTER INTO EFFECT AND CAN IT BE POSTPONED?

This requirement is now in effect as from 1 January 2010. The Directive does not allow for any delay, nor for exemptions other than those already included.

IS A SHIP EXEMPT WHEN THE CHANGEOVER OF FUEL IS UNSAFE BECAUSE THE NECESSARY MODIFICATIONS TO THE COMBUSTION EQUIPMENT HAVE NOT YET BEEN IMPLEMENTED?

No. Directive 2005/33/EC was published in 2005 and therefore plenty of time has been given to prepare for this and it does not justify non-compliance based on alleged emergency situations.

DOES THIS REQUIREMENT APPLY TO OTHER EUROPEAN COUNTRIES?

Generally, both Norway and Iceland have followed the EU approach as regards the Sulphur Directive. It is understood that Norway intends to apply the 'at berth' requirements; however, the situation as regards Iceland is unclear. Ships visiting Icelandic ports are therefore requested to verify whether the requirements apply and, if so, ensure that compliance is met.

5 COULD A RESIDUAL FUEL (HFO) BE USED 'AT BERTH'? In theory yes, since it is only the maximum sulphur content that is stipulated, not the fuel type. However, in practice, it must be expected that generally only distillate type fuel oils will be produced that meet the 0.10% m/m maximum sulphur limit. If the ship is fitted with abatement technology, then HFO may be used as the exhaust emissions are practically sulphur-free and emissions monitoring is used.

WHAT ARE THE IMPLICATIONS FOR A SHIP THAT ALSO OPERATES OUTSIDE THE EU AND THAT DOES NOT HAVE THE CAPABILITY TO HANDLE TWO DIFFERENT GRADES OF GAS OIL?

Under these circumstances, it would be necessary that the ship only uses gas oil with a maximum content of 0.1% m/m even at sea and at ports outside the EU.

IF A SHIP ALREADY HAS GAS OIL ONBOARD EXCEEDING 0.1% M/M MAXIMUM SULPHUR CONTENT, CAN IT CONTINUE TO USE THIS FUEL?

No. As from 1 January 2010, only fuel not exceeding 0.1% maximum sulphur content can be used. The member must use bunker-compliant fuel for use in 'at berth' and use the non-compliant gas oil outside the port limits.

DOES THE CHANGEOVER REQUIREMENT APPLY TO ALL SHIPS THAT ARE 'AT BERTH' FOR LESS THAN TWO HOURS?

No, the two hours given in the directive only apply where there is a published timetable (i.e. in the case of ferries on scheduled services) that gives the time 'at berth' as less than two hours. There is not a general exemption for ships that will be 'at berth' for less than two hours.

WHAT ENGINES OR OTHER COMBUSTION DEVICES NEED TO BE CHANGED OVER TO A 0.1% M/M MAXIMUM SULPHUR FUEL?

Only those engines, boilers, incinerators or other combustion devices that are to be used whilst the ship is 'at berth' need to be changed over. Consequently, attention is also necessary to intermittently operated combustion machinery with separate, stand-alone, ready-use tanks, such as incinerators, to ensure that the fuel in those tanks is compliant.

DO THE 'AT BERTH' REQUIREMENTS APPLY TO MAIN ENGINES?

Only in machinery arrangements where the engines used for ship propulsion is also used for power supply or other purposes while the ship is 'at berth'. This includes diesel electric systems and declutched main engines powering pumps or other devices.

DO THE 'AT BERTH' REQUIREMENTS APPLY TO AUXILIARY BOILERS?

Yes. The requirements apply to any fuel oil used by any type or size of boiler. This can range from small domestic water heating boilers through to large water tube boilers. With all boilers, the manufacturers' advice must have been sought prior to operation on low sulphur gas oil. Many classification societies have produced guidance notes relating to this and the member should contact the relevant class society for this documentation.

DO THE REQUIREMENTS APPLY TO FUEL OIL-FIRED INERT GAS GENERATORS?

Although such units typically incorporate a water wash stage, which tends to remove most of the sulphur oxides from the exhaust stream, under normal operation, the gases produced do not vent directly to atmosphere unless the unit is on purge mode. In the directive, there is no exemption for this type of equipment and, therefore, it must be followed that the requirements apply in full. Application to the applicable authority may be sought to determine what its views are on this equipment. It should be noted that individual member states could take differing views on this point.

WHEN IS A SHIP CONSIDERED TO HAVE ARRIVED AT THE BERTH?

The point at which a ship is considered to have 'arrived' would be when the 'Finished with Engines' is given. Alternatively, for a ship anchoring, it could be when the anchoring crew are stood down.

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IS THE ANCHORAGE OUTSIDE A PORT CONSIDERED AS PART OF THE PORT AS REGARDS THE APPLICATION OF THE 'AT BERTH' REQUIREMENTS?

The term 'Port' is not defined within the Sulphur Directive and is therefore subject to interpretation by the individual member states. Consequently, when a ship is directed to the anchorage, the member should seek clarification by the relevant authority as to whether the ship should be considered as being under the 'at berth' requirements.

HOW LONG SHOULD BE ALLOWED FOR THE CHANGEOVER TO 0.1% M/M MAXIMUM SULPHUR FUEL OIL?

No time is stipulated in the directive as this will differ from ship to ship. Whatever procedures are to be followed should commence as soon as is reasonably possible after arrival. The shipowner may just simply change over to a machine already set up to run on the low sulphur gas oil or follow a changeover procedure as in accordance with the machinery manufacturer's guidelines. The member should have established effective changeover procedures in order to meet ISM requirements to ensure that safe and efficient fuel changeover is carried out. These procedures, however, do not need to be specifically approved.

WHAT CHANGEOVER ARRANGEMENTS APPLY TO ENGINES OR OTHER COMBUSTION DEVICES THAT ARE NOT IN OPERATION WHEN THE SHIP ARRIVES BUT ARE SUBSEQUENTLY USED WHEN THE SHIP IS 'AT BERTH'? The temporary allowance for non-compliance is only for the engines or devices running on arrival. Any other combustion machinery should have been suitably prepared prior to arrival to ensure

17 WHAT DEFINES DEPARTURE TIME?

compliance when used 'at berth'.

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Departure time should be set on the basis as when the engines are required in hours and minutes. It is recognised that the actual departure time from the 'at berth' may be later due to a number of factors that impact on a ship's leaving schedule.

WHEN SHOULD THE CHANGEOVER FROM A 0.1% M/M MAXIMUM SULPHUR FUEL OIL TO ANOTHER FUEL OIL (THAT IS HFO) COMMENCE?

The ship should have established procedures to ensure that when changeover to the other fuel (HFO) commences, the ship is in a safe position and the proven changeover procedures are strictly followed. In the case of diesel generators, the engine(s) must be satisfactorily running on the other fuel oil before dependent load is applied. In all cases, the member must be aware that safety of the ship and the environment is paramount.

WHAT TIMES SHOULD BE RECORDED IN THE SHIP'S __ LOGBOOK?

It is recommended that the member records three specific entries in the ship's logbook as part of a block of data:

- The time given for 'finish with engines'
- The time for the commencement of changeover
- The time at which it is considered that the machine is operating on the fuel to be used.

20 WOULD THESE CHANGEOVER RECORDS BE SUBJECT TO INSPECTION?

Yes, in addition to verifying that a fuel oil of the required sulphur content was being used, it is fully expected that inspectors will be particularly concerned as to whether the changeovers have been carried out promptly after arrival and not commenced too early upon departure.

21 ARE THERE ANY ALTERNATIVES TO USING 0.1% M/M MAXIMUM SULPHUR FUEL OILS?

The directive allows for the use of approved abatement technology. This can be the use of exhaust gas scrubbers or engines fitted with selective catalytic reduction systems (SCR). Whatever device is used, it must be fitted with continuous recorded emissions monitoring equipment and, in the case of scrubbers, the wash water must have no impact on the local ecosystems.

WHAT PENALTIES WOULD BE APPLIED IN THE CASE OF NON-COMPLIANCE WITH THE 'AT BERTH' 22 REQUIREMENTS?

The Directive requires that each member state shall incorporate into the legislation penalties for non-compliance. This may be in the form of financial penalties or the ship being banned from the port.

WHILE 'AT BERTH', IS IT PERMITTED TO TEST EMERGENCY EQUIPMENT, SUCH AS ENGINE-DRIVEN FIRE PUMPS AND/OR GENERATORS ON FUEL OIL WITH A SULPHUR CONTENT ABOVE 0.1% M/M?

No. Since the requirements apply to all fuels used while at berth, it is necessary to ensure that the fuel oil in the emergency equipment fuel storage tank is compliant. If it is not intended to test such equipment while 'at berth', then the fuel in those tanks would not need to be compliant. The member must be made aware that some ship inspectors/surveyors may need to see emergency equipment run, and therefore it would be recommended to have all emergency equipment fuelled with 0.1% m/m maximum sulphur content to ensure compliance at all times.

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