

Regulatory requirements towards liquid fuels to be used on dual-fuel (DF) engines, including pilot fuels

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Summary

This Technical Information Note gives an overview of the different types of liquid fuel utilisation on DF engines, of regulations existing with respect to such fuels, and provides guidance on how compliance with those legal requirements can be achieved and what measures may be needed for verification.

1 Introduction

In addition to operational requirements governing the selection of liquid fuel to be used on DF engines, the choice of such fuel also needs to account for any regulatory requirements in place either globally or in specifically designated areas that the respective vessel is visiting. In particular, the sulphur limits imposed by the International Maritime Organisation (IMO) and other authorities have to be observed.

2 Liquid fuel utilisation on DF engines

DF engines may use liquid fuels for various purposes. We begin by distinguishing two fuel types:

1. Pilot fuel

The pilot fuel is the small amount of liquid fuel needed when operating the engine on gas, for the safe ignition of the premixed charge. On X-DF engines, the target of minimising this amount has been achieved by means of a dedicated micro-pilot common-rail injection system, which is designed for operation on distillate fuel.

2. Backup fuel

This is the fuel type the engine uses when operated in diesel mode, hence without any gas being fed to the engine. This fuel is admitted via a common-rail injection system equivalent to the ones used on pure diesel engines, which are designed for the operation of either distillate or residual fuels. With vessels featuring only one single liquid fuel system, the distillate fuel used for pilot injection also serves as backup fuel. On the other ships, residual fuels are often chosen as backup fuel.

On this basis, the utilisation of the fuels in the different operating modes can be determined as follows:

Table 2-1: Fuel utilisation in different DF operating modes

Operating mode \ fuel	Gas	Pilot fuel	Backup fuel
Gas mode	On	On	Off
Diesel mode	Off	On	On
Gas plus diesel modes	On (fraction)	On	On (fraction)

Note that the gas plus diesel modes above relate to any variants involving injection of liquid fuel via the main injection system in addition to gas being admitted. This includes operation in fuel sharing mode as well as dynamic combustion control (DCC), the special feature of WinGD-s X-DF engines for maintaining efficient gas combustion and full power output under any operating conditions.

3 Fuel Sulphur limits

Such limits were specified by the IMO for global waters as well as specifically designated Emission Control Areas (ECAs) and have then been transposed into national regulations, which may sometimes involve special features. Furthermore, individual countries or groups of countries have decided to impose their own limits to regions under their authority, i.e. coastal waters and / or ports. In the following, we provide a brief overview of the regulations in place by the end 2018. The regions covered by such regulations are highlighted on the world map below:

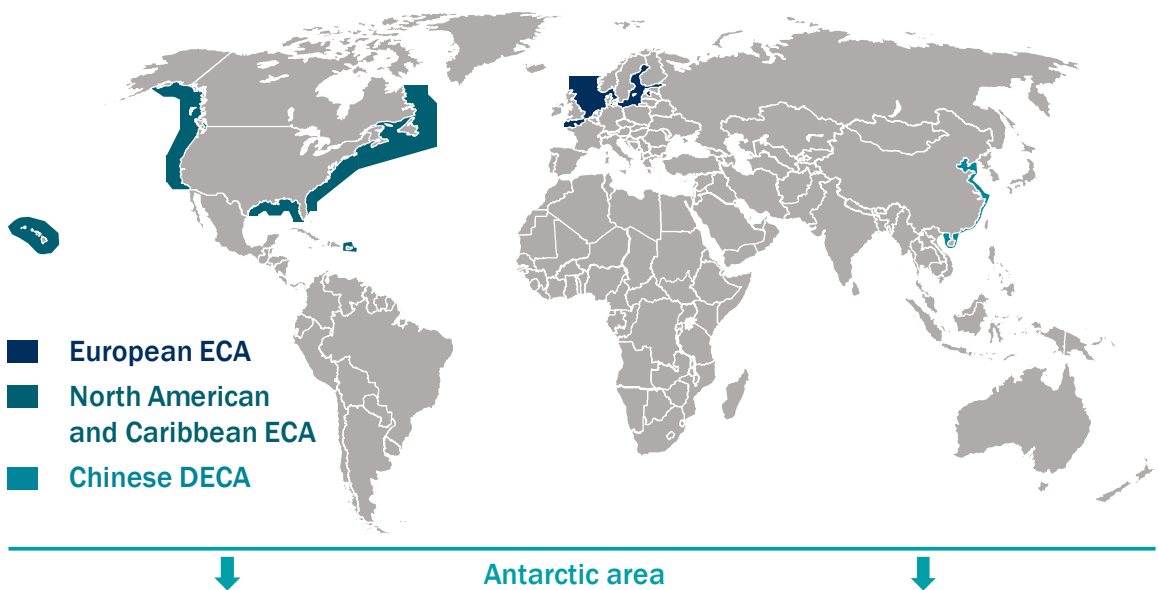


Figure 3-1: Regions covered by regulations of fuel sulphur content or other fuels related requirements

3.1 IMO regulations: MARPOL Annex VI

The maximum allowable sulphur content of “fuel oil carried for use on board a ship” is specified in Regulation 14 of the Revised MARPOL Annex VI [1] as amended during the 73rd session of the IMO’s Marine Environmental Protection Committee “MEPC73” in October 2018. This last amendment, known as “carriage ban” for non-compliant fuel, is expected to enter into force on March 1st, 2020 [2]. Regulation 4 of Annex VI specifies the requirements towards potential alternative means for reaching the same emissions reduction targets as with low sulphur fuels.

3.1.1 Regulation 14

The sulphur content expressed in mass percentage of any fuel oil shall not exceed the following limits:

- Globally:
 - 3.5% up to December 31st, 2019
 - 0.5% after January 1st, 2020
- When operating within Emission Control Areas (ECAs):
 - 0.1%

For the purpose of this regulation, to date, the following ECAs have been designated by the IMO:

- “European ECA”:
 - The Baltic Sea area and the North Sea, which includes the English Channel (acc. to Annexes I, V of MARPOL 73/78 [3])
- “North American ECA”:
 - Waters along the coasts of Canada, the United States (including Hawaii) and the French overseas collectivity of Saint-Pierre and Miquelon [4]
- “U.S. Caribbean Sea ECA”:
 - Waters adjacent to the coasts of Puerto Rico and the Virgin Islands (United States) [5]

For simplicity and since also covered by U.S. regulations, the U.S. Caribbean Sea ECA is often included in references to the North American ECA; the same applies for the remainder of this document.

3.1.2 Regulation 4

Alternative solutions in order to achieve the targets associated with the introduction of the above fuel sulphur limits are permissible under certain conditions:

1. The fitting, material, appliance, apparatus, procedures, alternative fuel oils or compliance methods that the respective solution consists of must be at least as effective in terms of emissions reduction as applying fuel oils in accordance with regulation 14.
2. Any such solution must be officially approved by the Administration of a Party or any recognised organisation acting on behalf of said Administration. Any approval shall be based on due consideration of the relevant guidelines developed by the IMO and should not impair the environment, human health, property or resources of the Party in question or any other State. Such approval shall be communicated to the IMO for circulation to all Parties.

This regulation has been put in place primarily for exhaust gas cleaning systems and the guidelines developed so far as well as any approvals granted to date only refer to such technology. The demonstration and verification of compliance has been given much attention in the present guidelines for exhaust gas cleaning systems [6] and it involves, as a minimum, very frequent (daily) performance spot checks. In fact, the use of continuous exhaust gas monitoring is strongly recommended and must be considered almost a standard requirement for any alternative solution.

Note that, even if activities in respect of regulation 4 have so far been limited to exhaust gas cleaning system approvals, other potential solutions are not excluded. On their website, the IMO explicitly mention “primary methods (which could encompass, for example, onboard blending of liquid fuel oils or dual fuel (gas / liquid) use)” as possible alternative [7].

3.2 Regulations applicable in Chinese coastal waters

China has designated its own Domestic Emissions Control Areas (DECAs) and introduced specific emissions control measures, including fuel sulphur limits. These DECAs are not to be mixed up with the abovementioned ECAs according to IMO regulations as the procedures towards formal designation based on those principles are still in their early stages. Nonetheless, vessels operating in these regions under Chinese jurisdiction need to comply with the requirements set forth in the respective regulations. The initially designated Chinese DECAs include [8]:

- The Yangtze River Delta including the port regions of Shanghai, Suzhou and Nantong as well as Ningbo-Zhoushan
- The Pearl River Delta including the port regions of Shenzhen, Guangzhou and Zhuhai
- The Bohai Rim area with the ports of Tianjin, Qinhuangdao, Tangshan and Huanghua

Recently, following the introduction of specific regulations applicable to imported vessels as well as Chinese flagged vessels operating in all domestic trade [9], all Chinese DECAs were merged into one. The resulting combined DECA additionally covers the complete 12 nautical mile zone along the Chinese coast, including Hainan Island waters [10]. At the same time, inland river emission control areas covering the navigable waters of the Yangtse River and the Xijiang trunk lines were defined.

To begin, a fuel sulphur limit of 0.5% per mass was introduced for all vessels at berth in the eleven major ports associated with the initially designated DECAs mentioned above. As of October 1st, 2018, the applicability range of the same limit was extended to the operation in the complete port regions of the Yangtze River Delta DECA [11]. From January 1st, 2019 on, this 0.5% limit applies identically to the operation within the entire combined DECA and, from January 1st, 2020 onwards, all vessels entering the inland river emission control areas shall use marine fuels with maximum 0.1% sulphur. This limit will also apply to Hainan Island waters after January 1st, 2022. Possible next steps such as the enforcement of the 0.1% limit in the combined DECA by January 1st, 2025 are already outlined and their feasibility “shall be evaluated in a timely manner” [10].

The regulation contains provisions similar to regulation 4 of MARPOL Annex VI with respect to equivalent solutions.

3.3 Regulations applicable in the North American ECA

The MARPOL Annex VI regulations have been transposed into national law applicable to all vessels operating in the North American ECA by the U.S. Environmental Protection Agency (U.S. EPA, [12]) as well as Transport Canada and Environment Canada [13].

3.3.1 U.S. regulations

It is important to note that the recommendation to use continuous monitoring for demonstration and verification of compliance when applying alternative solutions in accordance with regulation 4 is emphasized. Likewise, the need for requesting approval of such regulation 4 equivalents from the U.S. Coast Guard (USCG) in the case of U.S. flagged vessels or having such approval obtained from another Administration recognized in the case of foreign vessels is stressed. USCG is claimed to handle such requests for approval or recognition on a case by case basis.

Note, however, that the possibility of obtaining such approval for using pilot fuel with a sulphur content of up to 0.5% is explicitly mentioned in an FAQ document issued by the U.S. EPA [14].

3.3.2 Canadian regulations

Regarding the applicability of alternative solutions, there is some lack of clarity in the Canadian regulations: Whereas, in the Regulatory Impact Analysis Statement (explanatory text not part of the regulations), the range of potential options is non-restricted, the regulatory text only refers to the operation of an exhaust gas cleaning system as an alternative measure.

3.4 Regulations issued by the European Union, applicable in the European ECA

Directive (EU) 2016/802 of the European Parliament and of the Council, often referred to as “Sulphur Directive” [15], also stresses the need for proper enforcement of the obligations with regard to the sulphur content of marine fuels in accordance with MARPOL Annex VI. The formulation contained therein related to alternative solutions is of less general nature and refers to “emissions abatement methods” instead.

A regulation specifically applicable to LNG carriers while at berth had previously been issued, allowing a “mixture” of marine fuel and boil-off gas to be used if achieving at least the same reduction in sulphur emissions as when using compliant marine fuel [16]. It introduces a simplified formula for determining the minimum required ratio per mass of the boil-off gas and the marine fuel M_{BOG}/M_F and the fuel sulphur content of the latter S_F :

$$\frac{M_{BOG}}{M_F} \geq 8.6 S_F (\%) - 0.816 \quad (3-1)$$

4 Regulations on fuels used in the polar regions

A new chapter 9 on special requirements for the use or carriage of oils in the Antarctic area was added to MARPOL Annex I in 2010. It bans heavy fuel oil from the Antarctic by prohibiting both the carriage in bulk as cargo and the carriage and use as fuel of oils with density or kinematic viscosity above certain limits as well as of bitumen, tar and their emulsions [17]. This ban is applicable to the sea area south of latitude 60°S. As this regulation is not aiming at controlling exhaust gas emissions, the ban is mandatory and there are no alternative solutions.

At present, similar requirements for the Arctic area are being discussed at the IMO [18] and can be expected to become effective, once adopted, in the course of the 2020s.

5 Resulting requirements for operators of DF engines

Theoretically, more than one option exists for achieving compliance with the regulatory requirements towards liquid fuels to be used on dual-fuel (DF) engines, including pilot fuels. However, when aiming at using fuels with sulphur content higher than the limits applicable in respective areas, this requires non-negligible administrative efforts in advance, except for emergency cases or defined exemptions.

5.1 Use of compliant fuels

Using fuel oil, the sulphur content of which does not exceed the limits in the respective areas, be they global waters, ECAs officially designated by the IMO or DECAs, domestic variants implemented by any state is the most straightforward and safe option for achieving compliance. This allows operating the engine in all possible modes without any restriction.

5.2 Application for approval of equivalent alternative

As a matter of principle, alternative solutions are provided for as options in the different regulations. Exhaust gas cleaning systems, i.e. scrubbers, are the solution referred to most frequently – though they can hardly be considered a viable option for vessels equipped with DF engines. However, combinations of different fuels, including dual-fuel technologies, are also often mentioned as possible solutions. WinGD is not aware of any approval granted to date but would encourage the submission of applications to this end.

Such application needs to be prepared to the attention of the Administration or any Recognized Organisation put in charge by the Administration. We recommend liaising with the Administration beforehand in order to agree on the form and extent of the application and the scope of any

supporting documentation. The application should clearly specify which operating modes of the DF engine (compare Table 2-1) shall be covered. Obviously, operation on a pilot fuel with sulphur content above the applicable limit would yield emissions lower than running the same engine on compliant liquid fuel only; however, using the same fuel as backup fuel would still be prohibited and, in gas plus diesel operating modes, the share of liquid fuel would be limited to a maximum permissible level.

It must be considered highly probable that the Administration will request continuous emissions monitoring for the verification of compliance.

Any approval granted by an Administration will have to be communicated to the IMO by said Administration for bringing it to the attention of interested parties, the Administrations of ECA states in particular. It is recommended however, that any ship owner or operator having obtained such approval and planning visits to any ECA proactively informs the respective Administration in charge in advance in order to have the approval recognised in time before entering said ECA.

5.3 Exceptions

Generally, the owner or operator of a ship is responsible for the availability of sufficient quantities of compliant fuel on board for the voyage ahead. Exceptions are only possible in the following cases:

- The engagement of a vessel for the specific purpose of securing the safety of a ship or saving life at sea necessitates the use of non-compliant fuel.
- Damage of the ship or its equipment requires reverting to non-compliant fuel, provided that all reasonable measures are taken after the occurrence of the damage to prevent or minimise excess emissions and that measures are taken as soon as possible to repair the damage, except if the owner or operator has acted either intentionally or recklessly to cause the damage.
- Compliant fuel was not commercially available on the vessel's voyage. In such case, the owner or operator of a ship must present a record of the actions taken to attempt to achieve compliance and provide evidence that it attempted to purchase compliant fuel 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 and that, despite best efforts to obtain compliant fuel, no such fuel was made available for purchase.

In any of these cases, the respective Administration must be informed immediately.

6 References

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