ECSA
European Community Shipowners' Associations

SULPHUR DIRECTIVE 2012/33/EU IMPLEMENTATION

LNG Carrier Vessels – Use of the emission abatement technology 'mixture of boil-off gas and Heavy Fuel Oil' in navigation in ECAs as from 2015. Application of Decision 2010/769/EU.

ECSA POSITION PAPER

(Version 2: 27.03.2014)

ECSA is concerned about a potential legal issue arising from the possibility to use, while sailing in European Emission Control Areas (ECA - Baltic Sea, North Sea/Channel) as from 2015, a mixture of boil-off gas and Heavy Fuel Oil (HFO) by LNG carrier vessels.

While the final interpretation of the Commission Legal Services on the most appropriate legal procedure is pending, ECSA herewith requests the support of Member States for a smooth solution within an acceptable timeframe before the 2015 requirement application date in European ECAs.

The 'Sulphur' Directive 1999/32/EC establishes the upper limits of sulphur content in marine fuels. This Directive was amended in 2005, through Directive 2005/33/EC to improve air quality, in particular by establishing an upper limit requirement of 0.1% sulphur in marine fuels for ships while at berth in EU ports.

In order to facilitate the fulfillment of this requirement at berth by LNG tankers, by making use of the concept of "equivalence", and on the basis of a proposal from the Committee on Safe Seas (COSS), the Commission adopted the *Decision 2010/769/EU of 13 December 2010 on the establishment of criteria for the use by liquefied natural gas carriers of technological methods as an alternative to using low sulphur marine fuels*. This decision allowed LNG tankers to burn, while in port, a mixture of boil-off natural gas and Heavy Fuel Oil (HFO) which achieves a reduction in sulphur emissions at least equivalent to the reduction that would be achieved through the limits of the sulphur in fuel specified in the Directive.

This Directive was further amended in 2012 through Directive 2012/33/EU, introducing stricter sulphur content upper limits (0.1%) for fuels used by ships while navigating through Emission Control Areas (ECAs), from 1 January 2015, in line with MARPOL Annex VI, as amended in 2008.

In ECSA view, the 'Sulphur' Directive as amended in 2012 should allow the application of the Decision 2010/769/EU to LNG tankers while in navigation through ECAs as from 2015 and, specifically, to manoeuvre in ports prior to berth using a mixture of boil-off natural gas and HFO which, according to this Decision, is at least equivalent to the reduction that would be achieved through the limits of the sulphur in fuel specified in the 'Sulphur' Directive.

LNG carriers using this method can easily reach levels below the 0.1% sulphur requirement when sailing and calling EU ports in ECAs. It is however recognized that for some types of LNG tankers, especially those propelled by boilers and turbines, the 0.1% limit may momentary be exceeded (up to 0.2%) for a short period of time due to propulsion load changes when in maneuvring conditions**. However, on average during the full time spent in ECAs, SOx emissions will be lower than the maximum established in Directive 1999/32/EU as amended.**

Until today, all records show that the safety and environmental performance of steam turbine LNG carriers have been excellent. Therefore, ECSA believes that there is no compelling argument to prevent such an efficient way of operation from being used in Emission Control Areas. ECSA therefore urges Member States to take a pragmatic approach and support the use of this 'equivalent' abatement method taking into account the following additional supportive elements:

a. **The EU has already approved the mixture of HFO and boil-off gas as an emission abatement method.** In addition, implementation of this method has proved very satisfactory till today, as LNG carriers are equipped for continuous monitoring and measuring of the boil-off gas and marine fuel consumption.

b. **Safety should be ensured:**

- High pressure boilers using the mixture of LNG boil-off gas and HFO to produce steam for the ship's propulsion turbine cannot be easily converted to burn low sulphur content MGO[1] as there are explosion risks associated due to the lower ignition point of MGO. In fact, these safety reasons were the basis for the adoption of the 2010 Comission's Decision 2010/769/EU allowing the use of this 'equivalent' method.
- Although the ship can operate boiler using 100% boil-off natural gas while sailing in the open sea, during maneuvring periods when approaching or leaving ports, the ship always operates in dual mode to meet any sudden load change required to ensure the safety of navigation in the port area and of the vessel itself.

c. **The overall environmental impact should be negligible:**

- The world steam turbine LNG carriers fleet currently amounts to about 269 vessels – this amount is expected to decline as newbuilds since 2010 are most exclusively dual fuel diesel engine vessels (different from boilers-turbines configuration). Over the last two years, only 38 of these vessels entered European ECA areas.
- Use of this method during the whole ECA transit not only improves, in average, the requirements of the SOx emissions regulations, but also leads to significant additional benefits in terms of NOx (beyond Tier III), CO2 emissions (up to 20% less) and nearly 100% reduction in total particulate matters compared to low sulphur marine fuels. As such, the environmental and health benefits go beyond reduction in SOx emissions.

Enclosed is a **DNV study on the verification of sulphur equivalence** commissioned by the shipping company MARAN GAS Maritime Inc**.**

Brussels, 27 March 2014

The European Community Shipowners' Associations (ECSA), formed in 1965, comprises the national shipowners' associations of the EU and Norway. ECSA aims at promoting the interests of European shipping so that industry can best serve European and international trade and commerce in a competitive and free business environment, to the benefit of both shippers and consumers. The European Economic Area maintains its very prominent position with a controlled fleet of 40% of the global commercial fleet.

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[1] MGO : Low sulphur Marine Gas Oil

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REPORT

TECHNICAL REVIEW OF SULPHUR EMISSIONS CALCULATION

Verification of Sulphur Equivalence Calculations for Maran Gas

Maran Gas Maritime Inc.

DNV Doc. No./Report No.: 18QB05U-12/2014-0025
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Project Name: **Technical review of sulphur emissions calculation**	DNV GL AS *BDL Environment and Operations* P.O.Box 300 1322 Høvik Norway +47 67 57 99 00 www.dnv.com
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2014-01-07	1	18QB05U-12	BDL Environment and Operations

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PP094084	2014-0025	Verification of Sulphur Equivalence Calculations for Maran Gas

Task and Objective:

Maran Gas has calculated the sulphur equivalence of the boil-off gas and fuel oil mixture used onboard one of their LNG carriers, employed during each transit mode of a typical trip in and out of the North Sea ECA to discharge in Zeebrugge, Belgium.

The objective of this report is to verify the Maran Gas sulphur equivalence calculations and to ensure that the calculations are in accordance with the methodology for doing so outlined the Annex to Commission Decision 2010/769.

DNV GL verifies that the calculation has been performed correctly, and in accordance with the IMO guideline.

Prepared by:	Verified by:	Approved by:
Sarah Lasselle **Consultant**	**Per Holmvang** **Environmental Programme Director**	**Terje Sverud** **Section Leader**
Signature	Signature	Signature

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1 EXECUTIVE SUMMARY

Maran Gas Maritime Inc.'s LNG carriers use a mixture of boil-off gas and fuel oil while at berth in European Community ports. According to Commission Decision 2010/769, LNG carriers running on such fuel mixtures can calculate the sulphur equivalence of their fuel mixture in order to illustrate compliance with Article 4b of the Council Directive 1999/32/EC as amended by Directive 2005/33/EC.

Maran Gas has calculated their sulphur equivalence for each of the transit modes employed during a trip through the European ECA zone to discharge in Zeebrugge, as well as their average sulphur equivalence for the entire trip.

DNV GL was tasked with verifying these calculations, ensuring they were performed correctly and in accordance with Commission Decision 2010/769. DNV GL can verify that Maran Gas has performed the calculations correctly according to the Commission Decision.

2 INTRODUCTION

Article 4b of the Council Directive 1999/32/EC as amended by Directive 2005/33/EC stipulates that ships at berth in European Community ports must use marine fuels with a maximum sulphur content of 0.1% (m/m). According to the Commission Decision 2010/769, LNG carriers can meet this requirement by using a mixture of boil-off gas (BOG) and marine fuel oil.

LNG carriers must prove that the sulphur emission reductions achieved by using a mixture of BOG and HFO are equivalent to or greater than the emissions reductions achieved by using marine fuels with a sulphur content of 0.1% or less. To do this the annex of the Commission Decision 2010/769, outlines the methodology for calculating the equivalent sulphur content of the mixed fuel.

Maran Gas has performed the same calculation as outlined in the annex of the Commission Decision 2010/769 to check the sulphur equivalence of one of their LNG carriers travelling to discharge in the port of Zeebrugge, Belgium. They have calculated the sulphur equivalence of their fuel mixture for each transit mode during the part of their voyage which transverses the European Emissions Control Area (ECA), as well as the average sulphur equivalent of their fuel mixture throughout the ECA part of the voyage to Zeebrugge.

3 METHODOLOGY

3.1 Calculating sulphur equivalent

The equivalent sulphur content of the mixed fuel is the sulphur content of the mixed fuel consumed during berth as a percentage of the mass of low sulphur marine distillates equivalent to the energy content of the fuel mix used at berth. Performing this calculation requires converting the mass of the mixture of BOG and FO consumed at berth to the mass of marine distillate fuel with the same energy content.

The Annex of the Commission Decision 2010/769 shows the specific steps for doing so. These are attached in Appendix A. Maran Gas has performed the exact same calculations for each transit mode used during their ECA voyage: sailing in open water, sailing congested waters, manoeuvring, stand-by, and discharging. Their explanation of their calculations is available in their report A Proposal for the extension of the application of the *Commission Decision 2010/769 related to the 0.1% Sulphur Limit during the total time period of operation in an ECA*. Their calculations are available in the accompanying Excel template.

Each transit mode utilizes a different BOG-to-FO ratio, and the sulphur equivalence must therefore be calculated individually.

3.2 Calculating the average sulphur equivalent

Maran Gas has calculated the sulphur equivalent of the fuel mixture for each of their transit modes. The results are shown in Figure 1.

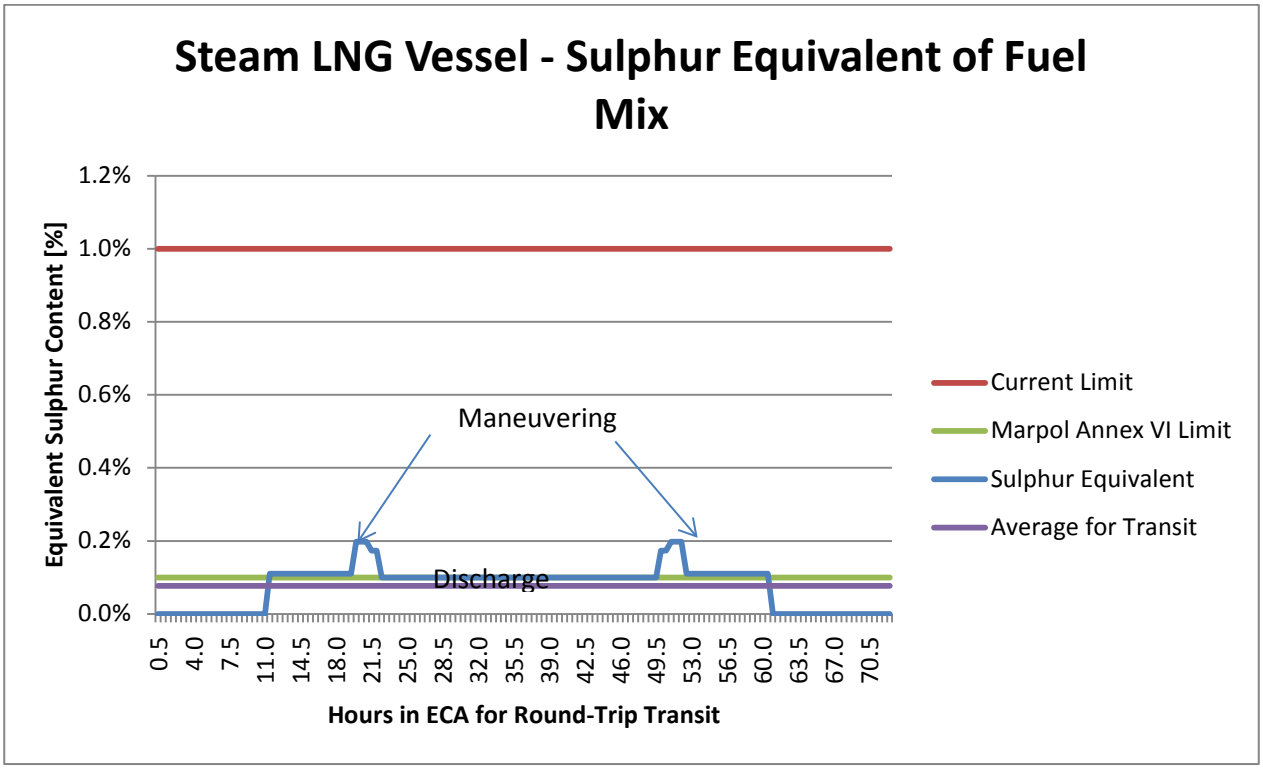

Figure 1 Sulphur equivalent of fuel mix, taken from Maran Gas's calculation template

Maran Gas has also calculated their average sulphur equivalence throughout the whole time in ECA, by taking the weighted average of the sulphur equivalent of each transit mode according to the number of hours spent in this mode during the trip.

4 CONCLUSIONS

4.1 Verification of calculation

DNV GL has verified that Maran Gas's calculation of the sulphur equivalent of their BOG and fuel oil mix for each of the transportation modes is correct and in accordance with the methodology laid out in Annex of Commission Decision 2010/769/EU.

Additionally, DNV GL has verified that the average sulphur equivalent for the whole trip has been calculated correctly.

4.2 Environment considerations

The calculations performed by Maran Gas show that they are not continuously compliant with Article 4b of the Council Directive 1999/32/EC. On average, for the trip outlined by Maran Gas, their sulphur equivalence is below that which is required in Article 4b. Whether or not an average sulphur equivalent below compliance is acceptable will be decided by the administrative authorities.

Compliance issues aside, it is notable that a Maran Gas LNG carrier will travel to Zeebrygge from the Suez Canal running on BOG with zero SO_x emissions for 90% of the voyage. If one compares a Maran Gas LNG carrier with a typical trade vessel sailing the same route running on HFO for most of the trip and only switching to low sulphur fuel while at berth in EU ports or while sailing through ECAs, the Maran Gas LNG carrier emits less SO_x into the environment than the trade vessel, even though the latter is compliant with Article 4b.

BOG also generally results in 20% CO_2 emissions reductions, 80% NO_x reductions, nearly 100% reduction in total particulate matter compared to low sulphur marine fuels /2/. As such, the benefits of using BOG go beyond reduction in SO_x emissions.

5 REFERENCES

/1/ Annex of Commission Decision 2010/769/EU
/2/ *Green Shipping in the Baltic*, Det Norske Veritas, June 2010

Appendix A
Annex of Commission Decision 2010/769/EU

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ANNEX

1. **The formula**

For the purpose of establishing equivalence within the meaning of Article 3, the following formula shall be used:

$$S_F\ (\%) \cdot M_F \leq 0{,}1\ \% \cdot M_{F0{,}1\ \%}$$

Where:

— S_F (%): percentage of sulphur content per unit of mass of the marine fuel used,

— M_F: mass of the marine fuel consumed while the ship is at berth in kg,

— $M_{F0{,}1\ \%}$: equivalent mass in kg of a fuel with a sulphur content ≤ 0,1 %. This factor shall be calculated according to the following formula:

$$M_{F0{,}1\ \%} = (M_{BOG} \cdot E_{BOG} + M_F \cdot E_F)/E_{F0{,}1\ \%}$$

Where:

— M_{BOG}: mass of the boil-off gas consumed at berth in kg,

— E_{BOG}: energy value of the boil-off gas used in MJ/kg,

— M_F: mass of the marine fuel consumed at berth in kg,

— E_F: energy value of the marine fuel used in MJ/kg.

— $E_{F0{,}1\ \%}$: energy value of a marine fuel with a sulphur content ≤ 0,1 % in MJ/kg

Development 1 of the formula

The two formulas referred to above can be combined as follows:

$$S_F\ (\%) \cdot M_F/(M_{BOG} \cdot E_{BOG} + M_F \cdot E_F) \leq 0{,}1\ \%/E_{F0{,}1\ \%}$$

Development 2 of the formula

The formula can be further developed as follows:

$$S_F\ (\%)/(R_{G/F} \cdot E_{BOG} + E_F) \leq 0{,}1\ \%/E_{F0{,}1\ \%}$$

Where:

— $R_{G/F}$: the ratio between the mass of boil-off gas and marine fuel consumed at berth (M_{BOG}/M_F)

This second development can also be expressed in the following way:

$$R_{G/F} \geq (S_F\ (\%) \cdot E_{F0{,}1\ \%} - 0{,}1\ \% \cdot E_F)/\ 0{,}1\ \% \cdot E_{BOG}$$

2. **Application of the formula**

Since the energy values of the different marine fuels involved in the formula are largely similar, it is justified to use standard values for $E_{F0{,}1\ \%}$, E_F and E_{BOG} in order to simplify the application of the formula in practice. More particularly, the following standard energy values may be presumed to apply:

$E_{F0{,}1\ \%}$ = 43,0 MJ/kg (source: DNV Petroleum Services)

E_F = 40,8 MJ/kg (source: DNV Petroleum Services)

E_{BOG} = 50,0 MJ/kg (ISO energy figure for methane)

The formula would accordingly be simplified as follows:

$$R_{G/F} \geq 8{,}6 \cdot S_F\ (\%) - 0{,}816$$

On this basis, the only value that needs to be introduced to the formula to arrive at the required ratio between the mass of boil-off gas and marine fuel consumed ($R_{G/F}$ or M_{BOG}/M_F) is the sulphur content of the marine fuel used while at berth. By means of examples, the table below indicates the minimum ratio required to meet the equivalence criteria for marine fuels with different sulphur contents.

Sulphur content (%)	1,0	1,5	2,0	2,5	3,0	3,5
M_{BOG}/M_F	7,8	12,1	16,4	20,7	25,0	29,3

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