February 2022

ClassNK

Guidelines for Exhaust Gas Cleaning Systems (Ver.4)

[English]

Introduction

In accordance with a revision of Regulation 14 ("Sulphur oxides (SOx) and Particulate Matter (PM)") of Annex VI of MARPOL 73/78 (hereinafter referred to as "Annex VI") that came into force on 1 January 2020, the sulphur content of fuel oil used on board ships is now limited to a maximum of 0.10% in Emission Control Areas (ECA) and 0.50% in open sea areas. In response to some early concerns regarding the possible difficulty of implementing the 0.50% limit by 2020, The IMO commissioned a fuel oil availability study and review of the implementation date to determine whether it needed to be postponed until 2025. The results of this study were submitted for review at the 70th Session of the IMO Marine Environment Protection Committee (MEPC70) held in October 2016, where it was decided that the 0.50% limit was to be implemented as originally scheduled in 2020.

Although the above-mentioned Regulation 14 restricts the sulphur content of fuel oil used on board ships, Regulation 4 of Annex VI does allow equivalent means (i.e. ways other than the actual reduction of fuel oil sulphur content) to be adopted as a way of complying with Regulation 14 in cases where it is demonstrated that said means are as effective in terms of reducing emissions. One example of such an equivalent means is an "Exhaust Gas Cleaning System" (hereinafter referred to as "EGCS"). An EGCS allows ships to continue using fuel oils for which the sulphur content exceeds regulation values by reducing their SOx emissions through the post-processing of exhaust gas; an existing ship, therefore, is able to comply with the SOx restrictions without undergoing any of the major modifications that might be needed to convert to low-sulphur fuel oil operations and also avoid the increased operating costs associated with low-sulphur fuel oil use. In 2009, the IMO adopted (as resolution MEPC.184(59)) the "2009 Guidelines for Exhaust Gas Cleaning Systems" (hereinafter referred to as the "2009 IMO EGCS Guidelines") to specify requirements related to the installation of EGCS on ships. The guidelines were subsequently revised in 2015 (hereinafter referred to as the "2015 IMO EGCS Guidelines") and adopted as resolution MEPC.259(68). Since shipowners wanting to adopt EGCS on their ships must receive approval from their respective Flag Administrations in accordance with the IMO's EGCS Guidelines, the number of EGCS installed in accordance with these guidelines has continued to increase worldwide.

For the reasons given above, ClassNK—in cooperation with the Japanese National Maritime Research Institute (NMRI) (currently a division of the National Institute of Maritime, Port and Aviation Technology)—released the first edition of its own "Guidelines for Exhaust Gas Cleaning Systems" (hereinafter referred to as "this Guidelines") in October 2014 related to the introduction of EGCS. This first edition explained the contents of the 2009 IMO EGCS Guidelines and clarified some of its requirements; moreover, it also included safety requirements for EGCS which were deemed necessary by ClassNK. A second edition subsequently released in August 2017 incorporated changes introduced by the 2015 IMO EGCS Guidelines, while a third edition released

in October 2018 made some editorial changes and clarifications.

At this time, ClassNK is releasing a fourth edition of this Guidelines in response to the adoption by the IMO of its "2021 Guidelines for Exhaust Gas Cleaning Systems" (hereinafter referred to as the "IMO EGCS Guidelines"). This latest version is expected to be adopted as resolution MEPC.340(77)) by the IMO's MEPC at its 77th Session in November 2021, and will be a further revision of the IMO's guidelines for EGCS installation.

It is our hope that this Guidelines will be a helpful introduction to EGCS for those looking for an equivalent means that complies with current IMO SOx and PM regulations.

Correction/Revision Record

Version	Date	Part	Details
Ver.1.0	October 2014	—	—
Ver.2.0	—	—	Publication of Japanese version only
Ver.2.1	August 2017	Chapter 1, Appendix I	Addition of new information relevant to the IMO discussions, review of contents
		Chapter 2	Update to include amendments to the IMO guidelines for EGCS installation (resolution MEPC.259(68))
		Chapter 3, Chapter 4, Chapter 5, Appendix III	New addition
		Appendix II	Review of expressions
Ver.3.0	October 2018	Chapter 2	Review of expressions
		Chapter 3 3.4.1-3.(5)	New addition
		Chapter 3 3.6.1-2	Review of expressions
		Chapter 4	Review of expressions
		Chapter 5	Amendment to class notation , review of expressions
		Appendix I	Addition of new information , review of expressions
		Appendix III	Addition of new information , review of expressions
Ver.4.0	February 2022	Chapter 1, Appendix I	Addition of new information relevant to IMO discussions, review of contents
		Chapter 2	Update to include amendments to the IMO guidelines for EGCS installation (resolution MEPC.3**40**(77))
		Chapter 3, Chapter 4 Chapter 5	Update to include amendments to the ClassNK Rules
		Appendix II	Deleted

		Appendix III	Addition of new information, review of expressions, rename a**s "Appendix II".**

Guidelines for Exhaust Gas Cleaning Systems (Ver.4)

CONTENTS

Chapter 1 General

This chapter summarizes the IMO SOx and PM regulations as well as the EGCS which are used as an equivalent means in terms of the SOx and PM emission controls. The terminology and abbreviations used in this Guidelines are also explained.

1.1 Terminology and abbreviations

For the purpose of this Guidelines, the terminology and abbreviations listed in **Table 1.1** apply.

Table 1.1 Terminology and abbreviations

Annex VI	Annex VI of MARPOL 73/78
BLG	IMO Bulk Liquids and Gases Sub-committee
BS	British standard
ECA	Emission Control Area
EGCS	Exhaust Gas Cleaning System
EIAPP	Engine International Air Pollution Prevention Certificate
EN	European standard (Europäische Norm)
EPA	Environmental Protection Agency
ETM-A	EGCS Technical Manual for Scheme A
ETM-B	EGCS Technical Manual for Scheme B
EU	European Union
FNU	Formazin nephlometric units
GESAMP	Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection
GNSS	Global Navigational Satellite System
ICS	International Chamber of Shipping
IMarEST	Institute of Marine Engineering Science and Technology
IMO	International Maritime Organization
In situ	Measuring directly within an exhaust gas stream
ISO	International Organization for Standardization
MCR	Maximum continuous rating
MEPC	Marine Environment Protection Committee
MSDS	Material Safety Data Sheet

Table 1.1 Terminology and abbreviations (continued)

NaOH	Sodium hydroxide (caustic soda)
NDIR	Nondispersive infrared
NDUV	Nondispersive ultraviolet
NOx	Nitrogen oxides
NTU	Nephlometric turbidity units
NTC	NOx Technical Code 2008
OMM	Onboard Monitoring Manual
PAH	Polycyclic aromatic hydrocarbons
PM	Particulate matter
PPM	Parts per million (in volume concentration ratio)
PPR	Sub-Committee on Pollution Prevention and Response
PSC	Port State Control
SECC	SOx Emission Compliance Certificate
SECP	SOx Emission Compliance Plan
SO_2	Sulphur dioxide
SOF	Soluble organic fraction
SOx	Sulphur oxides
SPM	Suspended particulate matter
UCT	Coordinated Universal Time

1.2 IMO SOx and PM regulations

The IMO requirements related to SOx and PM regulation are specified in regulation 14 in Annex VI.

As of February 2022, ships are subject to maximum limits on sulphur content of 0.10% for fuel oil used in SOx and PM Emission Control Areas (ECA) and 0.50% for fuel oil used in open sea areas. (see **Figure 1.1**)

Furthermore, the sulphur content of fuel oil carried for use on board a ship shall not exceed 0.50% on or after 1 March 2020. (this excludes those ships installed with EGCS approved as an equivalent means by the Flag Administration)

Regarding the implementation date of the 0.50% sulphur limit, the IMO adopted a revised version of Annex VI in 2008 which added a paragraph to Regulation 14 which specifies that fuel oil availability study and review needed to be undertaken to determine whether the implementation of the 0.50% limit could be achieved in 2020 or whether said implementation should be deferred

until 1 January 2025.

At MEPC70 (October 2016), the results of a study which concluded that implementation from 2020 would be possible was submitted by the IMO Secretariat. This study was conducted by a consortium led by CE Delft (the Netherlands) commissioned by the IMO. However, IPIECA (International Petroleum Industry Environmental Conservation Association) and BIMCO (Baltic and International Maritime Council) also submitted a collaborative study report which concluded that implementation from 2020 would be impossible. This study was conducted by EnSys Energy (the United States) and commissioned by IPIECA and BIMCO. As a result of a discussion of these reports, it was agreed to implement the 0.50% sulphur limit from 2020 as originally scheduled.

The following have been designated as the ECAs for SOx and PM regulations: the North Sea area, the Baltic Sea area, the North American area (most of the coastal waters of the United States and Canada up to 200 nautical miles from the coastline) and the United States Caribbean Sea area (the Atlantic and Caribbean coasts of the Commonwealth of Puerto Rico and the United States Virgin Islands) (see **Figure 1.2**). In addition, in certain ports or areas their own local regulations for sulphur content limits are established separately from the IMO regulations. Information about local regulations for sulphur content limits is provided in **Appendix II** for further reference.

Regulation 4 of Annex VI permits the use of equivalent means (e.g., EGCS) as long as such methods reduce emissions to levels equivalent to those required by Regulation 14. At the 77th Session of the IMO Marine Environment Protection Committee (MEPC77) in 2021, the IMO adopted the *2021 Guidelines for Exhaust Gas Cleaning Systems* (hereinafter referred to as the "IMO EGCS Guidelines") as resolution MEPC.340(77) to provide guidelines for EGCS installation. For reference, **Appendix I** shows the history of the IMO discussions related to the IMO EGCS Guidelines.

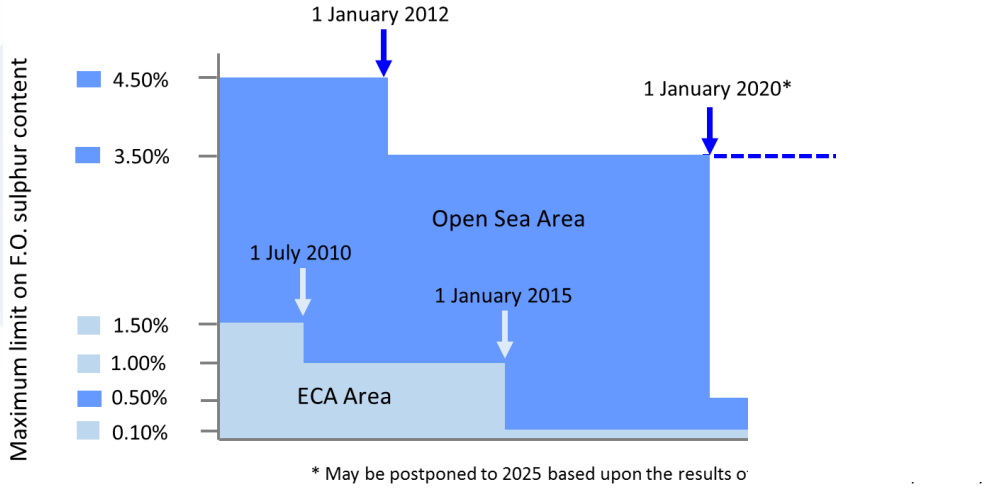


Figure 1.1 Maximum limits on fuel oil sulphur content

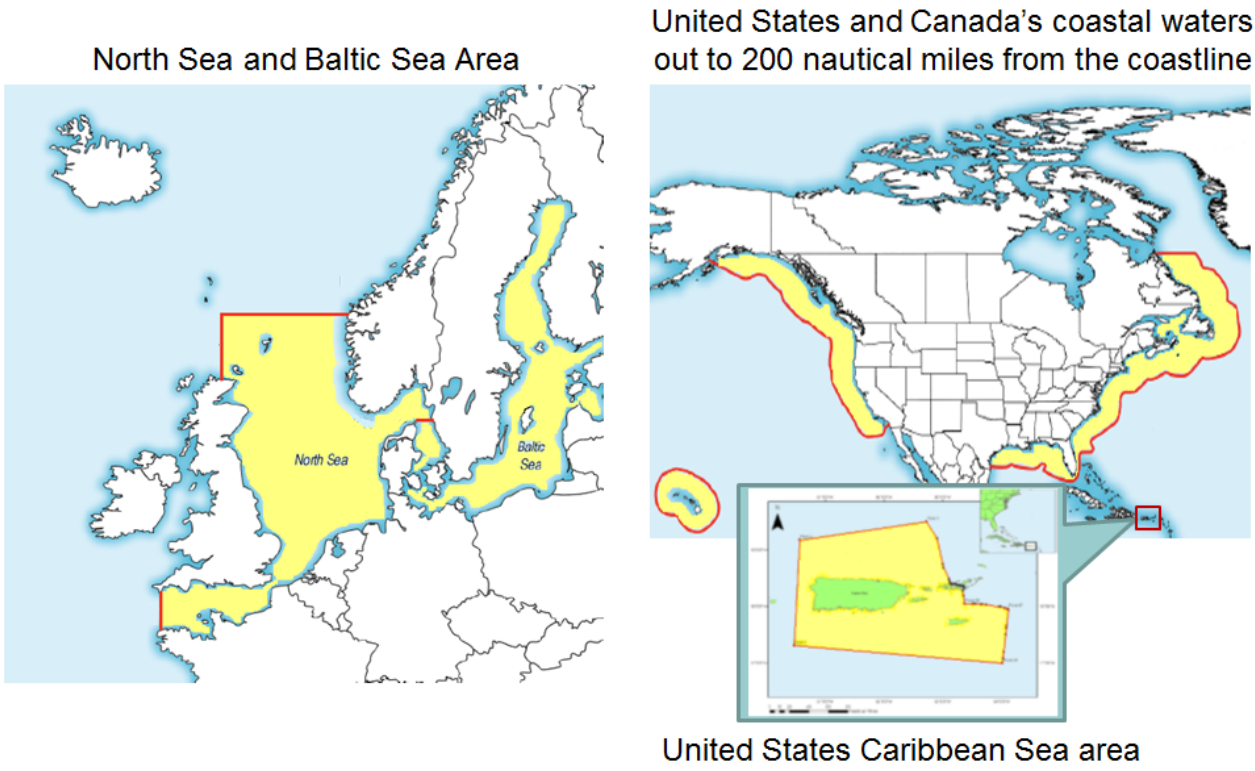


Figure 1.2 Designated SOx and PM ECAs

1.3 Emission control compliance methods

In principle, the use of low-sulphur fuel oils which satisfy sulphur content limits is a prerequisite for compliance with the IMO SOx and PM regulations. On the other hand, there is an increasing number of ships being installed with EGCS because EGCS might allow the continued use of high-sulphur fuel oils, which are considered to be cheaper than low-sulphur counterparts. This type of system reduces SOx emissions to required levels by treating exhaust gas before it is released into the atmosphere, thus making it possible to use fuel oils for which the sulphur content exceeds required limits. For example, a fuel oil for which the sulphur content is 3.50% is not, in principal, allowed to be used in ECAs for which the SOx limits are 0.10%. However, if desulphurization by 97.1% or greater is achieved using an EGCS, a fuel oil for which the sulphur content is 3.50% can be used in such ECAs with authorization from the relevant Flag Administration because it is deemed to be equivalent to use of a fuel oil for which the sulphur content is 0.10% or less.

1.4 EGCS

An EGCS, also known as a "SOx scrubber", is a system which desulphurizes exhaust gas on board ship. There are two types of EGCS: a "wet" EGCS and a "dry" EGCS. A wet EGCS uses

either seawater or pH-adjusted freshwater containing caustic soda (NaOH), etc. as its desulphurizing agent, whereas a dry EGCS uses solid particles of calcium hydroxide ($Ca(OH)_2$), etc. instead. For marine use, the focus has been primarily on the development and installation of wet EGCS.

1.5 Wet EGCS

Figure 1.3 shows an example of a wet EGCS. Exhaust gas is cooled by spraying it with washwater in the EGC unit (in some cases washwater is sprayed at multiple positions including the exhaust gas inlet). As the temperature of the exhaust gas drops during the cooling process, condensed components in chemical compounds containing SOx (such as sulphates, soluble organic fractions (SOF), etc. which change from a gas to either a liquid or solid) are physically captured by the spraying washwater. Gas components containing SOx are removed either by being absorbed into the washwater or by a chemical reaction caused by gas-liquid contact. In some cases, porous media, etc. are inserted into the EGC unit to promote gas-liquid contact.

Washwater cleaning may also be performed to remove PM and other residues captured in the washwater as deemed necessary. In such cases, the removed residue is not allowed to be discharged into the sea or incinerated on board, but and must instead be delivered ashore to adequate reception facilities.

The washwater used for a wet EGCS is typically seawater or pH-adjusted freshwater. An EGCS which uses seawater is referred to as an “open loop” type. For this type, seawater is pumped in from outside the ship and discharged after passing through the EGCS. An EGCS containing a system which purifies and reuses treated washwater, on the other hand, is referred to as a “closed loop” type. For this type, a neutralizing agent (typically NaOH) is provided to maintain the pH of the washwater. After a series of processing and cooling cycles, the washwater is then reused by the EGCS and the loop is completed. Some open loop types using seawater also use neutralizing agents to adjust the pH of the washwater.

Open loop types and closed loop types each have advantages and disadvantages. Open loop types tend to have lower operating costs, but ships may be prohibited by local regulations from discharging washwater in certain sea areas. Information about known local regulations related to the discharge washwater from an EGCS is provided in **Appendix II** for further reference.

In contrast, closed loop types tend to be more costly to run because of the constant use of neutralizing agents, but it is possible to operate them without washwater discharge. In attempt to have the best of both worlds, hybrid types which can be switched from one type to the other according to sea area have been also adopted.

Examples of various types of system construction are shown in **Figs. 1.4** to **1.6** for reference.

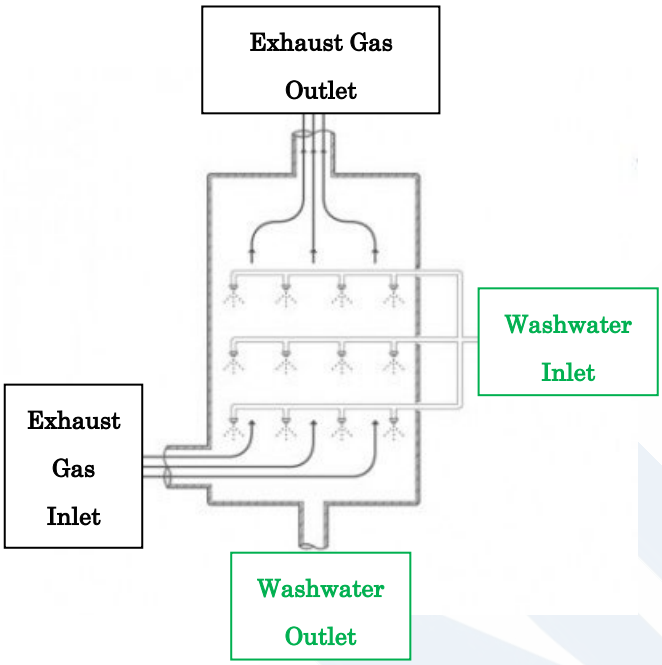


Figure 1.3 Example of wet EGCS (partially modified version of image found on the Exhaust Gas Cleaning System Association (EGCSA) website))

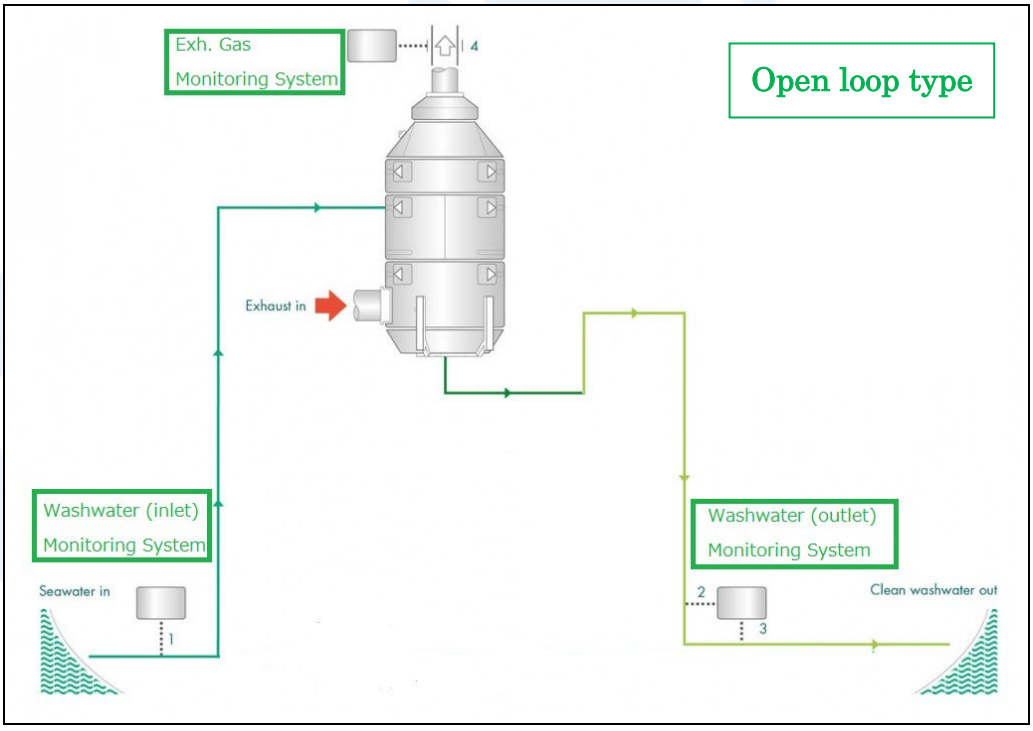


Figure 1.4 Example of an open loop type EGCS
(partially modified version of image found on the EGCSA website)

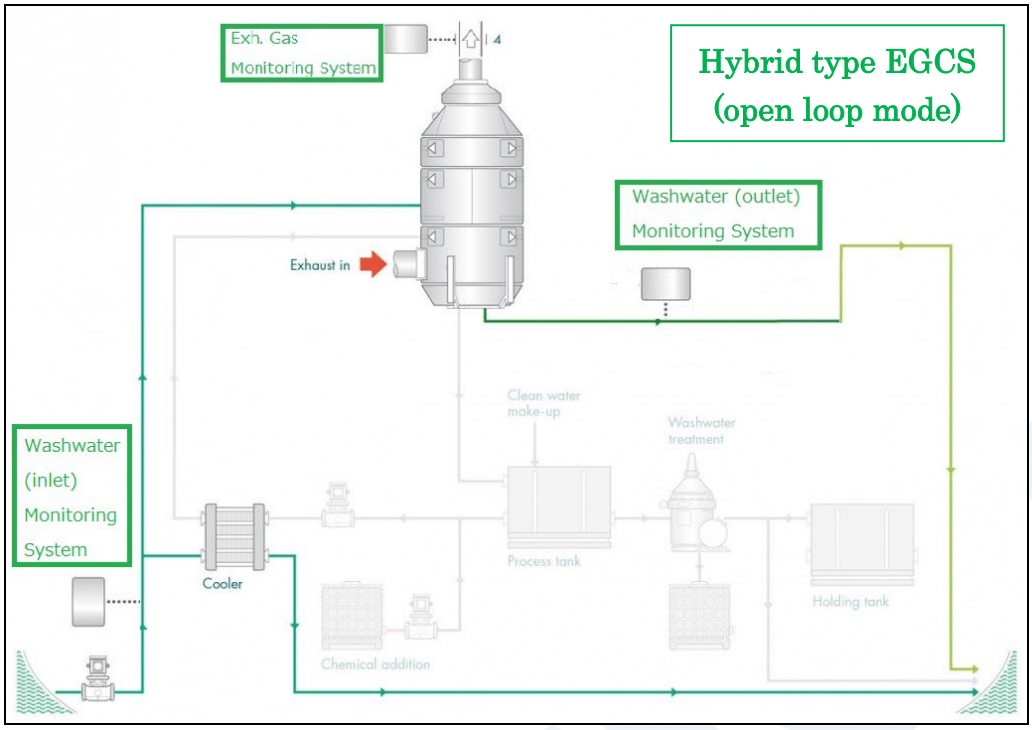


Figure 1.5 Example of a hybrid type EGCS open-loop mode
(partially modified version of image found on the EGCSA website)

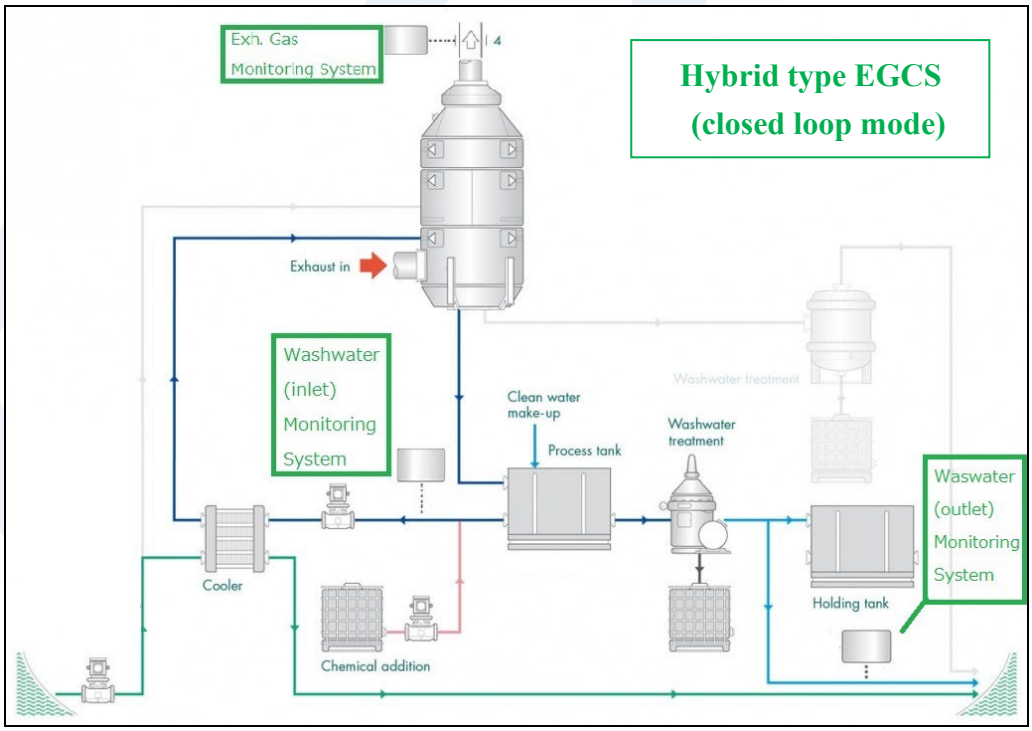


Figure 1.6 Example of a hybrid type EGCS closed loop mode
(partially modified version of image found on the EGCSA website)

Chapter 2 IMO EGCS Guidelines

This chapter summarizes and introduces the contents of each chapter of the IMO EGCS Guidelines (Resolution MEPC340(77)) adopted at MEPC77 in 2021. The IMO EGCS Guidelines apply to the following EGCSs:

(1) EGCSs installed on ships the keels of which are laid or which are at a similar stage of construction on or after 1 June 2022; and

(2) EGCSs installed on ships the keels of which are laid or which are at a similar stage of construction before 1 June 2022, which have a contractual delivery date of EGCS to the ship on or after 1 June 2022 or, in the absence of a contractual delivery date, the actual delivery of EGCS to the ship on or after 1 June 2022.

(3) Amendments as those specified in **2.4.2.3** or **2.5.5.2** to existing EGCSs undertaken on or after 1 June 2022.

For EGCSs that fall under none of the above cases because they are still subject to an earlier version of the EGCS Guidelines (resolution MEPC.259(68)), refer to the same chapter of the *Guidelines for Exhaust Gas Cleaning Systems (Ver.3)*.

In addition, supplementary information such as the technical background, etc. of the requirements specified in the IMO EGCS Guidelines is provided in Supplements 1 to 3.

2.1 Introduction

Chapter 1 of the IMO EGCS Guidelines specifies requirements related to the fuel oil sulphur content specified in Annex VI as well as the equivalency compliance standards associated with EGCS usage. A summary of these requirements is given below.

Annex VI requires ships use fuel oil with a sulphur content not exceeding that stipulated in regulations 14.1 or 14.4 (see **Figure 2.1**). Regulation 4, however, allows, , equivalent compliance methods which do not depend upon fuel oil sulphur content as long as the original targets specified in the regulations (emission reductions of SOx and PM caused by sulphur content) are achieved to be used when approved by the Flag Administration. For confirmation of compliance, checks of exhaust gas emissions are required for using EGCS as an equivalent compliance method. In order to check SOx emissions, an evaluation method using the SO_2 (ppm)/CO_2 (%) ratio of exhaust gas is adopted and it is required to demonstrate that the EGCS complies with the requirements for sulphur content based upon this evaluation method. **Table 2.1** shows the relationship between the SO_2/CO_2 ratio for exhaust gas and fuel oil sulphur content limits. This means that if ships use fuel oils with high sulphur content but the SO_2/CO_2 ratio in exhaust gas is below the value listed in the table, then it is considered to comply with the requirements for sulphur content. For example, in cases where ships may navigate in ECAs applying the 0.10% sulphur limit on or after 1 January 2015, the

SO_2/CO_2 ratio in exhaust gas is to be 4.3 or below.

The technical background related to applying the evaluation method using the SO_2/CO_2 ratio is specified in Appendix II of the IMO EGCS Guidelines. The proportion of the carbon content of petroleum-based fuel oil is almost same regardless of the kind of oil. The carbon contained in fuel oil is emitted as mainly CO_2 and the sulphur content in fuel is emitted mainly as SO_2 after combustion. Therefore, the SO_2/CO_2 ratio is proportional to the sulphur concentration of the fuel oil and it can be applied to both residual fuel oil and distillate fuel oil. In addition, the SO_2/CO_2 ratio is not affected by concentration changes due to the air excess ratio of an engine or dilution due to the steam of EGCS washwater. For the above reasons, SOx emissions in exhaust gas during operation of EGCS can be appropriately evaluated.

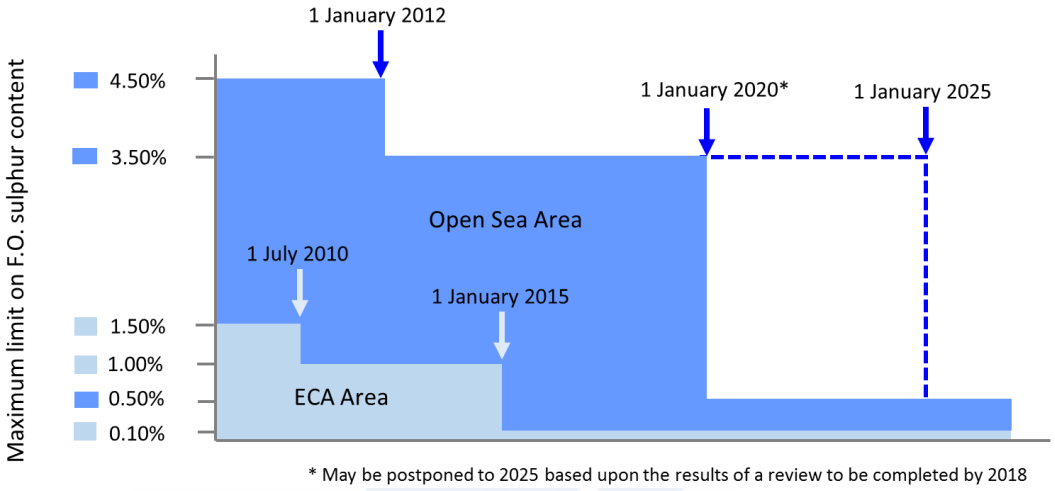


Figure 2.1 Maximum limits on fuel oil sulphur content

2.2 General

Chapter 2 of the IMO EGCS Guidelines specifies the purpose of the guidelines and the definition of terms, etc. A summary of this chapter is given below.

1 The purpose of IMO EGCS Guidelines is to specify requirements related to the testing, survey, certification and verification of an EGCS in order to ensure that it is equivalent in effectiveness and satisfy the IMO's requirements for fuel oil sulphur content. It is specified that the IMO EGCS Guidelines apply to any EGCS which is connected to fuel oil combustion unit(s) (excluding shipboard incinerators) installed on board a ship. The term "EGCS" should be, generally understood to refer to a "wet EGCS".

2 In the absence of specific guidelines for EGCS which use technologies or operate in modes that are not regulated in the term "EGCS" of **Table 2.2 Definitions**, the IMO EGCS Guidelines may also be applied as appropriate.

3 There are two EGCS certification schemes which are considered acceptable: Scheme A which certifies an EGCS after confirming SOx emissions by testing, and Scheme B which demonstrates

compliance through the continuous monitoring of SOx emissions by using an exhaust gas monitoring system approved by the Flag Administration. See **2.4** and **2.5** for more details on each of these schemes. The required documents for each scheme are shown in **Table 2.3**.

Table 2.1 Emission ratios for fuel oil sulphur content

Fuel oil sulphur content (% m/m)	Emission ratio SO_2 (ppm)/CO_2 (% v/v)	Restricted period according to sea area	
0.50	21.7	All non-ECA sea areas	On or after 1 January 2020
0.10	4.3	ECA	On or after 1 January 2015

Note: The use of the emission ratio limits is only applicable when using petroleum-based distillate or residual fuel oils.

Table 2.2 Definitions

12-hour period	A period of 12 consecutive hours determined on a rolling basis with new 12-hour periods beginning past each hour of EGCS operation.
Bleed-off water	An amount of aqueous solution removed from the washwater of an EGCS operating in closed-loop mode to keep its required operating properties and efficiency.
Certified Value	The Emission Ratio specified by the manufacturer that the EGCS is certified as meeting when operating on a continuous basis on the manufacturer-specified maximum fuel sulphur content and within the specified operational parameters. Applicable to Scheme A only.
Closed-loop mode	EGCS operating mode in which the washwater is passed several times, through the EGC unit. In order for the washwater to keep its required operating properties and efficiency, its pH usually has to be adjusted, e.g. by adding chemicals such as NaOH. In addition, a small amount of washwater is bled, periodically or continuously, from the system. This bleed-off water, unless meeting discharge water criteria, needs to be treated to meet discharge water criteria, or is regarded as EGCS residue.
Continuous monitoring	Process and technology used for evaluation of EGCS compliance through representative measurement, at a specified frequency, for selected parameters.
Discharge water	Any water from an EGCS to be discharged overboard.
EGC unit	Device within which exhaust gas and cleaning medium are mixed. An EGC unit may have a single or multiple fuel oil combustion unit(s) connected to it.
EGCS Electronic Data Recording or Electronic Logging System	Automatic record of the EGCS in service operating parameters. The record of parameters does not involve any user input.
EGCS Record Book	A user-input record of the EGCS, component adjustments, corrective and planned maintenance

(or Electronic Record Book)	and service records as appropriate. It can have an electronic format.
EGCS residue	Material removed from the washwater or the bleed-off water by a treatment system or discharge water that does not meet the discharge criterion, or other residue material removed from the EGCS.
Emission Ratio	SO_2 expressed in ppm / CO_2 expressed in % v/v.
Exhaust Gas Cleaning System (EGCS)	A system that includes one or more EGC units and which is based on technology that uses a wet cleaning medium for the reduction of SOx from an exhaust gas stream from installed fuel oil combustion unit(s), operating in either open-loop or closed-loop mode. A hybrid EGCS can operate in both open-loop mode and closed-loop mode. Several EGC units may utilize a common uptake system with a single exhaust gas monitoring system. Several EGCS units may utilize a common washwater, water supply, treatment and/or overboard system, and discharge water monitoring equipment.
Extractive sampling system	System which extracts a sample flow from the exhaust gas stream and transfers it by heated lines to the measurement instrument.
Fuel oil combustion unit	Any engine, boiler, gas turbine, or other fuel oil fired equipment, excluding shipboard incinerators.
Inlet water	Water entering the ship as a cleaning medium for an EGC unit.
In situ	Measuring directly within an exhaust gas stream.
Load range	Interval ranging from minimum practicable to maximum rated power of diesel engine or maximum steaming rate of the boiler.
Open loop mode	EGCS operating mode in which the washwater, typically seawater, is passed through the EGC unit only once before it is being discharged overboard as discharge water.
Phenanthrene equivalent	It corresponds to the signal produced by a PAH monitor with excitation wavelength between 244 nm and 264 nm (254±10 nm) and detection wavelength between 310 nm and 410 nm (360±50 nm) calibrated against a known set of phenanthrene concentrations within the expected measurement range when exposed to EGCS discharge water containing a range of different PAH species.
Washwater	Cleaning medium brought into contact with the exhaust gas stream for the reduction of SOx.
Wet EGCS	EGCS using liquid cleaning medium.

Table 2.3 List of required documents

Documents	Scheme A	Scheme B	Relevant specification in this Guidelines
SOx Emission Compliance Plan (SECP)	○	○	**2.9**
SOx Emission Compliance Certificate (SECC)	○	-	**2.4.2-1.**
EGCS Technical Manual for Scheme A (ETM-A)	○	-	**2.4.2-2.**
EGCS Technical Manual for Scheme B (ETM-B)	-	○	**2.5.5**
Onboard Monitoring Manual (OMM)	○	○	**2.8**
EGC Record Book or Electronic Record Book	○	○	**2.4.4-6, 2.5.6**

2.3 Safety Note

Chapter 3 of the IMO EGCS Guidelines specifies general instructions for EGCS onboard design, for ensuring the safety EGCS operators as well as for the impact an EGCS may have upon surrounding hull structures. A summary of these requirements is given below.

1 Due attention should be given to the safety of persons working near exhaust gas piping for the purpose of exhaust gas monitoring, the handling of the measurement equipment as well as the use of pressurized containers of pure and calibration gases. Sampling positions and access staging should be such that the monitoring may be performed safely.

2 When locating the EGCS washwater discharge outlet, due consideration should be given to the location of the ship's existing seawater inlet.

3 With regard to the discharge of washwater, since the washwater used for desulphurization is acidified. In all operating conditions the design of the EGCS should take into consideration the necessary balance between low pH water discharge and the anti-corrosive resistance of the surfaces in contact with that discharge stream. To avoid premature failure of sea chests, discharge pipework and hull penetration finishes due care should be taken in the preparation of surfaces and the correct selection and application of protective coatings to withstand the corrosive effects of low pH discharge water.

4 In cases where exhaust gas duct bypass lines are arranged on board, appropriate measures should be taken to prevent leakage of exhaust gases from the damper to bypass lines.

Supplement 1

The IMO EGCS Guidelines, as stated in **2.3.2.**, requires that due consideration should be given to the location of the ship's seawater inlet when locating the EGCS washwater discharge outlet.

2.3.3 specifies requirements related to the pH of washwater discharge; for example, since the zinc used for sacrificial anodes has a corrosion resistance area of near neutral (a pH of 6 to 12.5) and has a corrosion area of both acidic (less than a pH of 6) and alkaline (above a pH of 12.5), the pH of the discharge and the arrangement of the discharge outlets need to be carefully taken into account to prevent excessive consumption of the sacrificial anode. (reference [1])

With regard to anti-fouling coatings, elution behaviour of coating components may largely vary depending on pH, and the degree of influence may show markedly different tendencies depending upon the coating. For some particular hydrolysable coatings, care needs to be taken since the pH dependence of initial elution of the anti-fouling coating is prominent and the elution rate increases as the pH gets lower. (references [2], [3])

2.4 Scheme A – EGCS approval, survey and certification using parameter and emission checks

Chapter 4 of the IMO EGCS Guidelines specifies the Scheme A EGCS certification method. Under Scheme A, EGCS approval is required to confirm that the SOx emissions from the EGCS satisfy the Certified Values specified by the EGCS manufacturer, and a SOx Emission Compliance Certificate (SECC) will be issued for approved EGCS. In addition, Flag Administration approval is also required for discharge water monitoring systems. (For more details, refer to **2.10**.) Furthermore, an environmental impact assessment for washwater is required for EGCS which use chemicals, additives, or preparations to create their own relevant chemicals. Among the documents required to be maintained on board, Flag Administration approval is required for the ETM-A, the OMM, the SECP and the EGCS Record Book. The EGCS should be subject to surveys upon installation as well as at initial, annual, intermediate and renewal surveys required by the Flag Administration. **Figure 2.2** shows a flow diagram for certification under Scheme A.

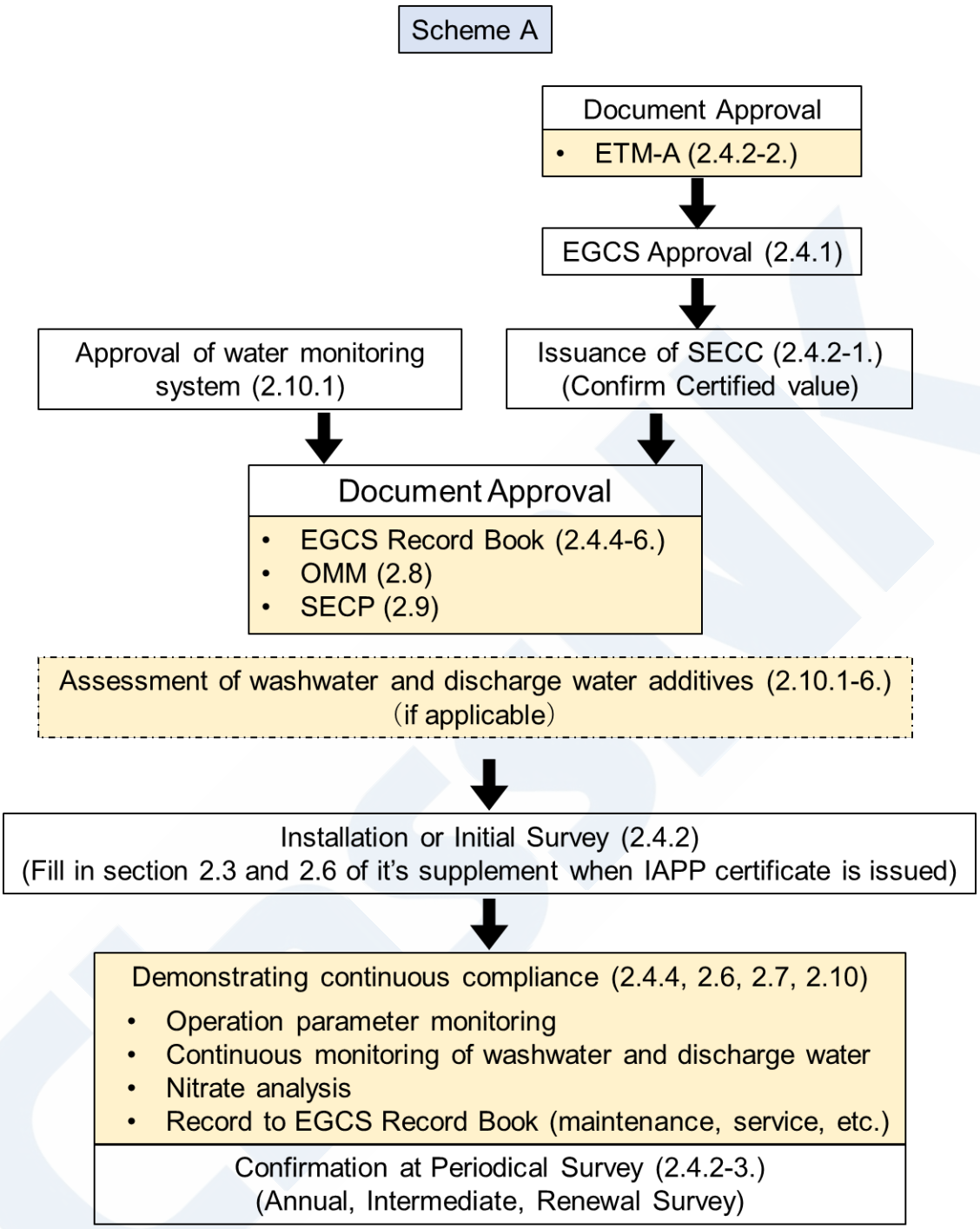


Figure 2.2 Scheme A flow diagram

2.4.1 EGCS approval

Section 4.1 of Chapter 4 of the IMO EGCS Guidelines specifies the Scheme A approval method for EGCS. In principle, EGCS approval is required for each individual EGCS; however, in cases where identical systems are manufactured based upon a single approved EGCS, surveys only deemed necessary by the Flag Administration need be carried out for the subsequently manufactured identical systems. In addition, in the case of EGCS of the same design but different exhaust gas capacities, product range approval can be extended to all systems within the exhaust gas flow rate range by emission measurement testing those EGCS with the highest and lowest capacities as well as one with an intermediate capacity which means that emission measurement tests are not required for all systems within the same range. A summary of these requirements is given below.

1 Individual EGCS approval

During EGCS approval, it should be demonstrated that in cases where a maximum sulphur content fuel oil specified by the manufacturer is continuously used, all operating parameters shown in **2.4.2-2(2)** are within relevant limits or ranges, and that all emission values comply with the Emission Ratio values: (Certified Values) specified by the manufacturer. The Certified Values should reduce SOx emissions to at least a level complying with MARPOL Annex VI, regulation 14.1 and/or regulation 14.4 and ensure the concerned fuel oil is suitable for ship operation.

When it is not possible to conduct tests using fuel oils of maximum sulphur content, the use of two different fuel oils with a lower percentage of sulphur content is allowed provided that the test is sufficient to demonstrate the operational behavior of the EGCS and to demonstrate that the Certified Values can be met if the EGCS was to be operated with a fuel of maximum sulphur content. Such EGCS approval tests should be performed in accordance with **2.4.3**. These need not be performed sequentially for the same design, and they may be performed using two different, but identical, EGCS.

The maximum and, if applicable, the minimum exhaust gas mass flow rates of the system should be identified. In addition, it should be assessed through testing, etc. that the actual emission values can satisfy the Certified Values even if other operation parameters such as washwater flow rate or alkalinity (as shown in **2.4.2.2(2))** vary within manufacturer specified ranges.

Data obtained through such testing should be submitted to the Flag Administration for approval together with the ETM-A specified in **2.4.2.2**.

2 Serially manufactured systems

In cases where EGCSs of the same design are manufactured, the emission measurement testing of each EGCS may be omitted. In such cases, the Flag Administration, based on a submission of the equipment manufacturer, should take the necessary measures to verify that adequate arrangements have been made to ensure effective control of the conformity of production arrangements. However, such EGCSs are subject to any surveys deemed necessary by the Flag

Administration in order to ensure that each EGCS has an Emission Ratio value of not more than the Certified Value when operated in accordance with the parameters specified in **2.4.2.2(2)**.

3 Product range approval

In cases where EGCS of the same design but of different maximum exhaust gas mass flow capacities are manufactured, emission measurement testing of three different capacities (including the highest, lowest and one intermediate capacity rating by the manufacturer) may be accepted in lieu of emission testing for each individual EGCS. In cases where there are significant differences in the design of EGCS of different capacities, this procedure should not be applied unless it can be shown, to the satisfaction of the Flag Administration, that in practice those differences do not materially alter the performance between the various EGCS types.

For EGCSs of different capacities, the sensitivity to variations in the type of combustion machinery to which they are fitted should be detailed together with sensitivity to the variations in the parameters listed in **2.4.2.2(2)**. This should be on the basis of testing, or other data as appropriate. In addition, the effect of changes of EGCS capacity on washwater and discharge water characteristics should be detailed. All supporting data obtained in accordance with **2.4.1.3**, together with the ETM-A for each capacity system, should be submitted to the Flag Administration for approval.

2.4.2 Survey and certification

Section 4.2 of Chapter 4 of the IMO EGCS Guidelines specifies procedures for EGCS certification as well as procedures for onboard verification. A summary of these requirements is given below.

1 EGCS certification procedures

EGCS are to be approved by carrying out the emission measurement testing specified in **2.4.3.2**. Said testing should be performed either before or after onboard installation. During the approval process, it should be verified that the EGCS satisfies the Certified Values specified by manufacturers under the operating conditions and restrictions specified in the EGCS Technical Manual for Scheme A (ETM-A), as approved by the Flag Administration.

SECCs should be issued for EGCS approved by Flag Administrations. Application for the issuance of an SECC should be made by the EGCS manufacturer, the shipowner or other parties. For EGCS of the same design for which the capacity is different from that of the certified unit, Flag Administrations may approve the installation of such EGCS in accordance with the product range approval specified in **2.4.1.3**. Moreover, Flag Administrations may issue the SECC for the serially manufactured systems specified in **2.4.1.2** without conducting emission measurement testing.

EGCS which treat only a part of the exhaust gas flow from the uptake in which they are fitted should follow any additional requirements enacted by the Flag Administration in order to ensure that the overall Emission Ratio value of exhaust gas downstream of the system does not exceed the respective Certified Value under all of the operating conditions defined in the ETM-A.

2 EGCS Technical Manual for Scheme A (ETM-A)

Ships installed with an EGCS approved under Scheme A should be provided with an ETM-A issued by the manufacturer and approved by the Flag Administration. This ETM-A should, at a minimum, contain the information listed in the following **(1)** to **(9)** (see **Figure 2.3**):

(1) System identification information (e.g. manufacturer, model/type, serial number and other details as necessary) including a description of the system and any required ancillary systems. In case a system contains more than one EGC unit, each EGC unit should be identified.

(2) Certified system operating limits, or operating value ranges. These should, at a minimum, include the following:
   (a) The maximum and, if applicable, the minimum mass flow rate of exhaust gas.
   (b) The maximum and, if applicable, minimum exhaust gas mass flow rate capacity of the EGC unit;
   (c) The maximum fuel oil sulphur content the EGCS is certified for;
   (d) The Certified Value;
   (e) The power, type and other relevant parameters of the fuel oil combustion unit which the EGCS is to be connected to; for boilers also the maximum air/fuel ratio at 100% load should be given; and for diesel engines whether the engine is two-stroke or four-stroke cycle should be indicated.
   (f) The maximum and minimum washwater flow rates, the inlet pressure and the minimum inlet water alkalinity (refer to ISO 9963-1-2:1994 “Water quality - Determination of alkalinity”).
   (g) The exhaust gas inlet temperature ranges as well as the maximum and minimum exhaust gas outlet temperatures when the EGCS is in operation.
   (h) The maximum exhaust gas differential pressure across the EGC unit and the maximum exhaust gas inlet pressure.
   (i) The salinity levels or freshwater elements necessary to provide adequate neutralizing agents.
   (j) Other factors concerning the design and operation of the EGCS relevant to achieving a maximum Emission Ratio value no higher than the Certified Value.

(3) Any requirements or restrictions applicable to the EGCS or associated equipment necessary to enable the system to achieve a maximum Emission Ratio value no higher than the Certified Value.

(4) Maintenance, service or adjustment requirements in order that the EGCS can continue to achieve a maximum Emission Ratio value no higher than the Certified Value. The maintenance, service and adjustments should be recorded in the EGCS Record Book

(5) Corrective actions to be applied if the following occurs or is expected to occur:
   - Operating conditions are outside approved ranges or limits.
   - The discharge water quality criteria are not met.

– Exceedances of the Certified Value.

(6) Verification procedure to be used during surveys to ensure that the system's performance is maintained and that the system is used as required.

(7) Washwater and discharge water characteristics across the operating load range.

(8) Design requirements for the treatment and monitoring of washwater as well as the control of discharge water; this includes, for example, bleed-off water from closed-loop EGCS operations or discharge water temporarily stored within the EGCS.

(9) detail the procedure to produce reports regarding operation in a non-compliant condition, or in a condition where the ongoing compliance would be temporary indicated in accordance with **2.8-2(8)**.

3 Modification of EGCS

Amendments to the ETM-A which reflect EGCS changes that affect performance with respect to emissions to air and/or water should be approved by the Flag Administration. Where additions, deletions or amendments to the ETM-A are separate to the ETM-A as initially approved, they should be retained with the ETM-A and should be considered as part of it.

4 Installation surveys, initial surveys and periodical surveys

EGCS are subject to surveys on installation and initial, annual/intermediate and renewal surveys by the Flag Administration. EGCS may also be subject to PSC inspections.

Prior to use, an EGCS should be issued with an SECC by the Flag Administration. Following the installation survey, Sections 2.3 and 2.6 of the ship's Supplement to the International Air Pollution Prevention (IAPP) Certificate should be completed.

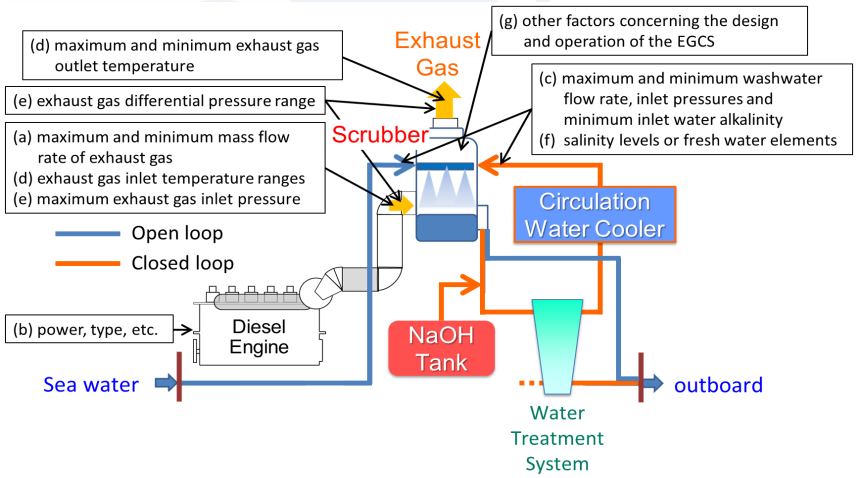


Figure 2.3 Operating limits or range of operating values which should be included in ETM-A

Supplement 2

The IMO EGCS Guidelines (as specified in **2.4.2-2(2)** of this Guidelines) requires that an EGCS achieves a maximum Emission Ratio value no higher than its Certified Value when parameters such as exhaust gas mass flow rate, water alkalinity, etc. vary. Factors which affect EGCS performance (e.g. the desulfurizing ratio) are to be reported in detail such as in the case of a land-based flue gas desulfurization plant (reference [4]). **Table 2.3** shows examples of factors which affect EGCS performance and their effects.

Table 2.3 Examples of factors which affect EGCS performance and their effects

Factor	Effect
SO_2 concentration in exhaust gas	Increases lead to performance degradation
Fuel oil combustion unit load	Affects exhaust gas flow rate
Exhaust gas velocity	Lower flow velocity leads to increased performance by fixing washwater flow rate
Washwater pH at EGC unit inlet	Alkalization leads to improved performance
Ratio of washwater flow rate to exhaust gas flow rate (L/G ratio)	Increases lead to improved performance (This is due to increased contact time between exhaust gas and washwater.)
EGC unit size	Increases lead to improved performance (This is due to increased contact time between exhaust gas and washwater.)
Amount of additive when chemical agents are added to improve performance	Increases lead to improved performance
Number of times exhaust gas is cleaned	Increases lead to improved performance

2.4.3 Emission limits

Section 4.3 of Chapter 4 of the IMO EGCS Guidelines requires that an EGCS be capable of reducing SOx emission to less than its Certified Value at any load point (including fuel oil combustion unit idling) when operated in accordance with **2.4.2-2(2)**. In addition, it specifies that emission measurement testing should be performed to confirm this. A summary of these requirements is given below.

1 Emission measurement testing

In order to demonstrate performance, emission measurements, as agreed upon by the Flag Administration, should be carried out at a minimum of the four load points shown in **(1)** to **(3)** below.

(1) Load point 1: 95%–100% of the maximum exhaust gas mass flow rate

(2) Load point 2: within ± 5% of the minimum exhaust gas mass flow rate

(3) Load points 3 and 4: two load points which are equally spaced between the maximum and minimum exhaust gas mass flow rates

In cases where there are discontinuities in system operation, the number of load points should be increased (as agreed upon by the Flag Administration) so that it is demonstrated that the required performance over the stated exhaust gas mass flow rate range is retained. Additional intermediate load points should be tested if there is evidence of an emission peak below the maximum exhaust gas mass flow rate and above, if applicable, the minimum exhaust gas flow rate. These additional tests should be of a number sufficient to establish the emission peak value.

2.4.4 Onboard verification procedures for demonstrating compliance with emission limits

Section 4.4 of Chapter 4 of the IMO EGCS Guidelines specifies requirements with respect to onboard verification procedures under Scheme A for demonstrating EGCS compliance. A summary of these requirements is given below.

1 The ETM-A should include a verification procedure for demonstrating EGCS compliance during surveys as required. This procedure should not require specialized equipment or an in-depth knowledge of the system. Where particular devices are required, they should be provided and maintained as part of the system. The EGC unit should be designed in such a way as to facilitate inspection as required. With respect to the verification procedure, it is specified that if all the relevant components and operating values or settings are within the approved ranges, the performance of the EGCS can be assumed to meet the requirements without the need for actual continuous exhaust emission monitoring.

2 Onboard verification procedures should be in accordance with the following **(1)** to **(4)**:

(1) Verification of all components and operating values or settings which may affect the operation of the EGCS and its ability to satisfy Certified Values should be included.

(2) The verification procedure should be provided by the EGCS manufacturer and approved by the Flag Administration.

(3) Both a documentation check and on-site verification of the EGCS should be covered.

(4) Surveyors should verify that each EGCS is installed in accordance with the ETM-A and has an SECC as required.

3 At the discretion of the Flag Administration, the surveyor should have the option of checking one or all of the identified components, operating values or settings. In cases where there is more than one EGC unit within the EGCS, the Flag Administration may, at its discretion, abbreviate or reduce the extent of the survey on board. In such cases, the entire survey should be completed for at least one of each type of EGC unit on board provided that it is expected that the other EGC units perform in the same manner.

4 To demonstrate compliance when an EGCS is in use, the following **(1)** to **(4)** should at least be automatically recorded at a rate which should not be less than 0.0035 Hz (35 times per 10000 sec. in which once per about 285.7 sec. is equal to once every 4 min. 45.7 sec.).

(1) Washwater pressure and flow rate at the EGC unit inlet connection;

(2) Exhaust gas pressure before and pressure drop across each EGC unit;

(3) Fuel oil combustion unit load; and

(4) Exhaust gas temperature before and after the EGC unit against the respective operating limits, or range of operating values.

The data recording system should comply with the requirements for data recording and processing devices specified in **2.7** as well as relevant requirements related to the Onboard Monitoring Manual (OMM) specified in **2.8**. In the case of a system consuming chemicals at a known rate as documented in ETM-A, recordings of such consumption in the EGCS Record Book also serves this purpose.

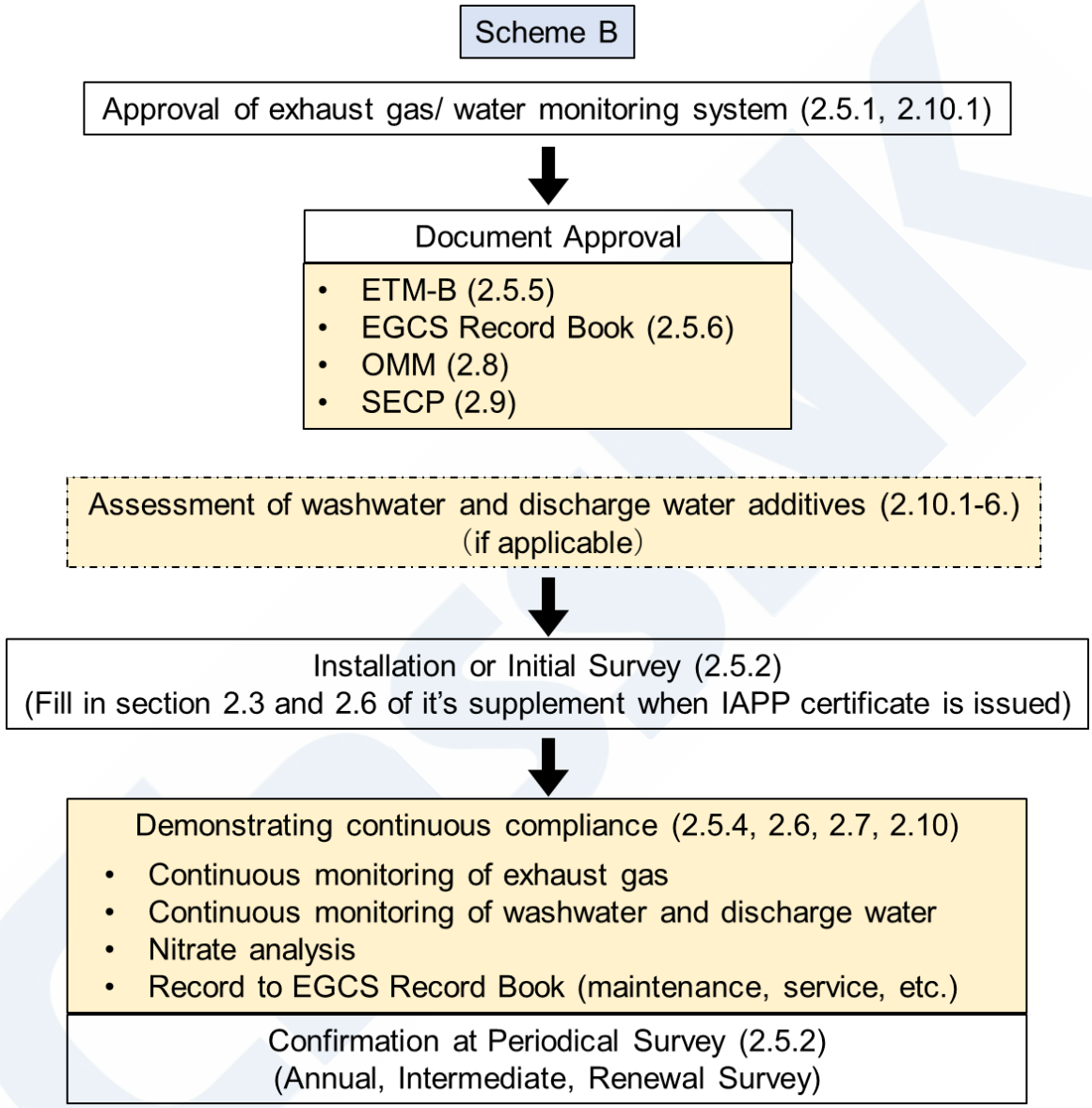
5 Under Scheme A, if a continuous exhaust gas monitoring system is not fitted, daily spot checks of the Emission Ratio for a duration of not less than five minutes at a minimum recording frequency of 0.1 Hz (once every 10 sec.) at normal working condition for each outlet to the atmosphere should be undertaken to verify compliance in conjunction with the continuous monitoring of the parameters specified in **2.4.4-4**. The exhaust gas readings should be allowed to stabilize before commencing recording. Readings from the calibration procedure should be automatically recorded or noted in a calibration protocol. Emission values, which are used to determine the Emission Ratio, obtained after stabilization should be recorded. If a continuous exhaust gas monitoring system is fitted, only daily spot checks of the parameters specified in **2.4.4-4** would be required to verify proper operation of the EGC unit.

6 An EGCS Record Book should be maintained on board the ship and records of maintenance and service of the system (including like-for-like replacement) should be kept. This EGCS Record Book should be available during surveys as required and may be read in conjunction with engine-room logbooks and other data, as necessary, to confirm the correct operation of the EGCS. The form of this record should be provided by the EGCS manufacturer and approved by the Flag Administration. Alternatively, this information may be recorded in the ship's planned maintenance record system as approved by the Flag Administration. Alternatively, this information may be recorded in an Electronic Record Book as approved by the Flag Administration. The EGCS Record Book entries should be maintained on board the ship for a minimum period of three years after the last entry has been made.

2.5 Scheme B – Approval of monitoring systems and surveys based upon continuous monitoring of Emission Ratio

Chapter 5 of the IMO EGCS Guidelines specifies the Scheme B EGCS certification method and survey procedures. Under Scheme B, approval of a continuous exhaust gas monitoring system by the Flag Administration is required and compliance with the objectives given in the SECP is to be demonstrated under continuous monitoring by the approved exhaust gas monitoring system. An environmental impact assessment for washwater is required for EGCS which use chemicals, additives, or preparations to create their own relevant chemicals. In addition, among the documents

required to be maintained on board, Flag Administration approval is required for the ETM-B, OMM, SECP and the EGCS Record Book. Furthermore, either an installation survey or an initial survey is required when the EGCS is installed to verify initial compliance and a periodical survey is required after installation to verify continued compliance. **Figure 2.4** shows a flow diagram for certification under Scheme B.



Note: Figures in parenthesis indicate the relevant sections in this guideline.

Figure 2.4 Scheme B flow diagram

2.5.1 Approval

Section 5.1.1 of Chapter 5 of the IMO EGCS Guidelines specifies that compliance of an EGCS in service under Scheme B should be demonstrated through continuous exhaust gas monitoring. It is also specified that monitoring systems and discharge water monitoring systems should be approved by the Flag Administration. (For more details, refer to **2.10**.) In cases where ClassNK verifies compliance with the IMO EGCS Guidelines for an EGCS under the Scheme B, the relevant exhaust gas monitoring systems and discharge water monitoring systems are required to obtain Type Approval from ClassNK through the carrying out of environmental tests witnessed by a surveyor in accordance with **Chapter 1, Part 7 of the Guidance for the Approval and Type Approval of Materials and Equipment for Marine Use**; however, the EGCS approval required under Scheme A is not required under this scheme.

2.5.2 Survey and certification

Section 5.3 of Chapter 5 of the IMO EGCS Guidelines specifies matters related to Scheme B EGCS surveys and certification. A summary of these requirements is given below.

EGCS monitoring systems are subject to survey on installation and initial, annual, intermediate and renewal surveys by the Flag Administration in order to demonstrate that it functions as given in the OMM. The scope of the installation or initial survey should include EGCS operation, as required, in order to demonstrate the functionality of the exhaust gas monitoring system. Following the installation survey, Sections 2.3 and 2.6 of the ship's Supplement to the IAPP Certificate should be completed.

2.5.3 Exhaust gas monitoring

Section 5.4 of Chapter 5 of the IMO EGCS Guidelines specifies requirements related to the measuring and recording of SO_2/CO_2 ratios under Scheme B. A summary of these requirements is given below.

Exhaust gas composition of the Emission Ratio should be measured at an appropriate position downstream of the EGC unit and such measurement should be as given in **2.6** as applicable. A suitable position could be downstream of the EGC unit, but before any possible mixing of outside ambient air or other additional air or gases with the exhaust gas. SO_2 (ppm) and CO_2 (%) and, to not less than one decimal place, the Emission Ratio should be continuously monitored and recorded against the applicable Emission Ratio limit onto a data recording and processing device at a rate which should not be less than 0.0035 Hz (35 times per 10000 sec. in which once per 285.7 sec. is equal to once every 4 min. 45.7 sec.) whenever the EGCS is in operation. This monitoring may be suspended for service and maintenance periods of gas analyser and associated equipment as required by the OMM. Zero and span check calibration and instrument drift data should, as given in the OMM, be either recorded by the data recording system or manually entered in the EGCS Record Book as appropriate to the means used. If more than one analyser is to be used to determine

the Emission Ratio, these should have similar sampling and measurement times and the data outputs aligned to ensure that the Emission Ratio is fully representative of the exhaust gas composition.

2.5.4 Onboard verification procedures for demonstrating compliance with emission limits

1 Section 5.5 of Chapter 5 of the IMO EGCS Guidelines specifies that data recording systems should comply with the requirements for data recording and processing devices specified in **2.7** as well as relevant requirements for the Onboard Monitoring Manual (OMM) specified in **2.8**. Data and the associated reports should be available to the Flag Administration as necessary to demonstrate compliance as required and, in accordance with regulation 10 of MARPOL Annex VI, may also be subject to inspection by port State control.

2 Section 5.5 also specifies that daily spot checks of the parameters listed in **2.4.4.4** are needed to verify proper operation of the EGCS and that the results of such checks should be recorded in either the EGCS Record Book or in the engine-room logger system.

2.5.5 EGCS Technical Manual – Scheme B (ETM-B)

Section 5.6 of Chapter 5 of the IMO EGCS Guidelines specifies the following requirements for an ETM-B:

1 Ships intended to be installed with an EGCS based upon Scheme B should be equipped with an ETM-B provided by the manufacturer and approved by the Flag Administration. This ETM-B should, at a minimum, contain the following information:

(1) System identification information (e.g. manufacturer, model/type, serial number and other details as necessary) including a description of the system and any required ancillary systems. If a system consists of more than one EGC unit, each EGC unit should be identified.

(2) The operating limits or range of operating values for which the system is designed. These should, as a minimum, include the following:
   (a) The maximum and, if applicable, minimum mass flow rate of the exhaust gas.
   (b) The advised maximum fuel sulphur content for the operational conditions the EGCS is designed for (Note: higher sulphur content fuel oils may be used provided the relevant Emission Ratio value is not exceeded).
   (c) The power, type and other relevant parameters of the fuel oil combustion unit for which the EGCS is to be connected. For boilers, the maximum air/fuel ratio at 100% load should also be given. For diesel engines, it should be indicated whether the engine is two-stroke or four-stroke cycle.
   (d) The maximum and minimum washwater flow rate, inlet pressures and minimum inlet water alkalinity (refer to ISO 9963-1-2:1994 “Water quality—Determination of alkalinity”).
   (e) The exhaust gas inlet temperature ranges as well as the maximum and minimum exhaust

gas outlet temperature when the EGCS is in operation.

(f) The maximum exhaust gas differential pressure across the EGC unit and the maximum exhaust gas inlet pressure.

(g) The salinity levels or freshwater elements necessary to provide adequate neutralizing agents.

(h) Other parameters as necessary concerning the operation of the EGCS.

(3) Any requirements or restrictions applicable to the EGCS or its associated equipment.

(4) Corrective actions to be applied if the following occurs or is expected to occur:

• Operating conditions are outside approved ranges or limits; • The discharge water quality criteria are not met; or

• Exceedances of the maximum allowable Emission Ratio.

(5) Washwater and discharge water characteristics across the operating load range.

(6) Design requirements for the treatment and monitoring of washwater and control of discharge water (including, for example, bleed-off water from closed-loop EGCS operation or discharge water temporarily stored within the EGCS).

(7) Detail the procedure for producing reports regarding operation in a non-compliant condition, or in a condition where the ongoing compliance would be temporary (as indicated in accordance with **2.8-2(8)**).

2 Amendments to the ETM-B which reflect EGCS changes that affect performance with respect to emissions to air and/or water should be approved by the Flag Administration. Where additions, deletions or amendments to the ETM-B are separate from the ETM-B as initially approved, they should be retained with the ETM-B and should be considered as part of it.

2.5.6 Onboard procedures for demonstrating compliance

An EGCS Record Book should be maintained on board the ship recording maintenance and servicing of the emission monitoring and ancillary components as given in the OMM (including like-for-like replacements). The form of this record book should be approved by the Flag Administration. In addition, this EGCS Record Book should be available at surveys as required and may be read in conjunction with engine-room logbooks and other data as necessary to confirm the correct operation of the EGCS. Alternatively, this information may be recorded in the ship's planned maintenance record system as approved by the Administration. Alternatively, this information may be recorded in an Electronic Record Book as approved by the Flag Administration. The EGCS Record Book entries should be maintained on board the ship for a minimum period of three years after the last entry has been made.

2.6 Emission Testing

Chapter 6 of the IMO EGCS Guidelines specifies requirements related to exhaust gas measurements during emissions testing. Such requirements and other relevant requirements related to exhaust gas measurement specified in the IMO EGCS Guidelines are listed in **Table 2.4**. In addition to the requirements in this Guidelines, compliance with the requirements in **NOx Technical Code 2008 (NTC)** is also required.

Table 2.4 IMO EGCS Guidelines requirements related to exhaust gas measurements

Items		Requirements		EGCS Guidelines references
Measurement position	CO_2 measurement	To be measured at an appropriate position downstream of the EGC unit. In cases where CO_2 concentration is reduced by the EGC unit, CO_2 concentration can be measured at the EGC unit inlet, provided that the correctness of such a methodology can be clearly demonstrated. In such cases, the SO_2 and CO_2 values should be compared on a dry basis. If measured on a wet basis, the water content in the exhaust gas stream at those points should also be determined in order to correct the readings to dry basis values. For calculation of the CO_2 value on a dry basis, the dry/wet correction factor may be calculated in accordance with paragraph 5.12.3.2.2 of the NTC 2008.		5.4.1, 6.9
	SO_2 measurement	To be measured at an appropriate position downstream of the EGC unit.		5.4.1, 6.4
Measurement frequency		To be continuously monitored and recorded onto a data recording and processing device at a rate which should not be less than 0.0035 Hz.		5.4.2
Measurement method	CO_2 measurement	To be measured using an analyzer operating on the non-dispersive infrared (NDIR) principle with additional equipment such as dryers as necessary.	Other systems or analyzer principles may be accepted, subject to the Flag Administration approval, provided they yield equivalent or better results.	6.2
	SO_2 measurement	To be measured using analyzers operating on NDIR or non-dispersive ultra-violet (NDUV) principles with additional equipment such as dryers as necessary.		
	CO_2 measurement SO_2 measurement	In situ or extractive sample systems		6.5
Measures to prevent the loss of SO_2 for extractive sample systems		Extractive exhaust gas samples should be maintained at a sufficient temperature to avoid condensed water in the sampling system and hence the loss of SO_2.		6.6
		If an extractive exhaust gas sample for determination needs to be dried prior to analysis, it should be done in a manner that does not result in the loss of SO_2.		6.7
Consideration of the water content		The SO_2 and CO_2 should be compared on the basis of the same residual water content (e.g. dry or with the same wetness fraction).		6.8

Items	Requirements		EGCS Guidelines references
Analyzer specifications	The analysing equipment should be installed, operated, maintained, serviced and calibrated in accordance with the requirements as given in the OMM, at a frequency which ensures that the requirements of 1.7 to 1.10 of appendix III of the NTC 2008 are met at all times the equipment is in operation. These requirements are given below.		6.3
	Precision	Precision, defined as 2.5 times the standard deviation of 10 repetitive responses to a given calibration or span gas, should satisfy the following: (1) For concentrations above 100 ppm (or ppmC): not greater than ± 1% of full-scale concentration for each range (2) For concentration below 100 ppm (or ppmC): not greater than ± 2% of each range	Section 1.7 of Appendix III of the NTC
	Noise	The analyzer peak-to-peak response to zero and the calibration or span gases over any 10-second period should not exceed 2% of the full scale value of all ranges used.	Section 1.8 of Appendix III of the NTC
	Zero drift	Zero response is defined as the mean response, including noise, to a zero gas during a 30-second time interval. The drift of the zero response during a one-hour period should be less than 2% of the full scale value of the lowest range used.	Section 1.9 of Appendix III of the NTC
	Span drift	Span response is defined as the mean response, including noise, to a span gas during a 30-second time interval. The drift of the span response during a one-hour period should be less than 2% of the full scale value of the lowest range used.	Section 1.10 of Appendix III of the NTC
Leak test	Extractive sample systems should be verified to be free of ingress leakage in accordance with the analysing equipment manufacturers' recommendations at intervals as defined in the OMM. It should be verified that the system is free of ingress on initial start-up and as given in the OMM with the findings from those checks recorded in the EGCS Record Book.		6.10
Span gases	The span gases for the SO_2 and CO_2 analyser should be a mixture of SO_2 and/or CO_2 and nitrogen at a concentration of more than 80% of the full scale of the measuring range used. The span gas for the CO_2 should conform to the requirements of section 2 of appendix IV of the NTC 2008. Other equivalent arrangements, as detailed in the OMM, may be accepted by the Administration.		6.11

2.7 Emission Recording and Processing Device

Chapter 7 of the IMO EGCS Guidelines specifies requirements related to data recording and processing devices as given below.

1 Such devices should be of a robust, tamper-proof design with read-only capability.

2 Such devices should record, whenever the EGCS is in operation, the data described in **2.4.4.4**, **2.5.3** and **2.10.1** as applicable (including overboard discharges from any associated tanks within the system) against UTC and ship's position as given by a Global Navigational Satellite System (GNSS) and whether the ship was inside or outside an ECA (refer to **Figure 1.2**) at that time.

3 Such devices should be capable of being automatically set, or pre-set, with the Emission Ratio limit value as appropriate to the sea area, in relation to the ECA in which the ship is operating. (Scheme B only)

4 Such devices should be capable of being automatically set, or pre-set, with the applicable overboard pH limit value.

5 Such devices should be capable of being automatically set with the applicable PAH limit value.

6 Such devices should be capable of recording the aggregated time in excess of 15 minutes over any rolling 12-hour period that the differential PAH value is above the set limit value by more than 100%.

7 Such devices should be capable of being pre-set with the applicable turbidity limit value.

8 Such devices should be capable of recording the aggregated time in excess of 15 minutes over any rolling 12-hour period that the rolling average differential turbidity value is above the set limit value by more than 20%.

9 Such devices should be capable of recording pre-set and set limit values.

10 Such devices should be capable of preparing reports over specified time periods.

11 Recorded data should be maintained for a period of not less than 18 months from the date of recording. If the device is replaced during that period, it should be ensured that the required data is maintained on board and available as required for inspection.

12 Such devices should be capable of downloading a copy of the recorded data and reports in a readily useable format clearly indicating periods of non-compliance. Such copies of data and reports should be available to the Flag Administration or PSC as required.

2.8 Onboard Monitoring Manual (OMM)

Chapter 8 of the IMO EGCS Guidelines specifies requirements for the OMM as given below.

1 An OMM should be prepared to cover each EGCS provided for a fuel oil combustion unit, so that each EGCS can be identified and its compliance verified.

2 The OMM should, as a minimum, include the following:

(1) For extractive exhaust gas sampling systems, the position from which the gas sample is drawn together with details, arrangement and operating ranges of the analysers and all necessary ancillary components or requirements including (but not limited to) sample probe assembly, sample transfer line and sample treatment unit

(2) For in situ exhaust gas analysers, the location and arrangement of the analyser in the exhaust duct, operating ranges and all necessary ancillary components or requirements.

(3) For inlet water and discharge water monitoring, the positions from which the water samples are drawn, the location and arrangement of the analysers together with details of any necessary ancillary services such as sample transfer lines and sample treatment units.

(4) Analysers to be used for monitoring of exhaust gas, inlet water, discharge water, their service, maintenance, and calibration requirements. Templates covering the minimum information, which should be included, are provided in appendix 5 of the IMO EGCS Guidelines.

(5) Zero and span check procedures of the exhaust gas analysers and calibration of washwater, discharge water and inlet water analysers together with reference materials to be used and the

required frequency of those checks.

(6) The operating parameter instruments to be used described in **2.4.4-4** or **2.5.5-2**.

(7) Installation, operation, adjustment, maintenance, servicing and calibration requirements and procedures of the analysers, associated ancillary equipment and operating parameter measurement instruments.

(8) Means by which ongoing compliance would be temporarily indicated in the case of the failure of a single monitoring device, taking into account that transitory periods of emission exceedances and/or isolated spikes in the recorded output in the Emissions Ratio do not necessarily mean non-compliant exceedance of emissions and should therefore not be considered as a breach of requirements.

(9) The data recording system and how it is to be operated, data retained and the types of reports which it can produce.

(10) Guidance as to data or other indications which may signify a malfunction of either an analyser, an item of ancillary equipment or an operating parameter sensor together with the fault-finding and corrective actions which should be taken

(11) Other information or data relevant to the correct functioning or use of the monitoring system or its use in demonstrating compliance.

(12) The information described in (1) to (11) above is referring to detailed descriptions of procedures, reference can be made to additional documents (e.g. manufacturer documentation) which should be considered part of the OMM.

3 The OMM should specify how the EGCS, operating parameter measurement instruments and the exhaust gas and discharge water monitoring systems are to be surveyed in order to verify the following.

(1) The EGCS conforms to the ETM-A or ETM-B as applicable.

(2) The operating parameter instruments installed and used on board are as approved per the OMM.

(3) The exhaust gas and discharge water monitoring systems used on board are as approved per the OMM.

(4) Inspection, maintenance, servicing, calibration and adjustments have been undertaken as required and those actions recorded in the EGCS Record Book as required.

(5) The operating parameter instruments and the exhaust gas and discharge water monitoring systems are correctly functioning.

4 Under scheme B, where operation of the EGCS is required in order to demonstrate the functionality of the monitoring system during installation or initial surveys, the OMM should describe the operational condition(s) which demonstrate the operational behaviour of the monitoring system and which should be used when surveying in accordance with **2.5.2**. The description of operational condition(s) may include the following.

(1) Connected fuel oil combustion unit load point(s), and

(2) Minimum operating time at a given load point.

5 The OMM should be approved by the Flag Administration and retained on board the ship onto which the EGCS is installed and should be available for surveys as required.

2.9 Ship compliance

Chapter 9 of the IMO EGCS Guidelines specifies requirements related to SOx Emission Compliance Plans (SECP) and demonstration of compliance. An SECP is required to be maintained on board so that it can be used to demonstrate that an EGCS satisfies the requirements for alternative methods of fuel oil sulphur content compliance. A summary of these requirements is given below.

2.9.1 SECP

1 An SECP approved by the Flag Administration is required for each ship using an EGCS.

2 The SECP should list each fuel oil combustion unit which may use fuel oil supplied in accordance with the requirements of regulations 14.1 and/or 14.4 of MARPOL Annex VI.

3 The SECP should list each fuel oil combustion unit which may use Scheme A and/or Scheme B of these Guidelines together with identification of the EGCS to which it is connected and whether this control may be applied continuously, or only inside or only outside the Emission Control Areas given by regulation 14.3 of MARPOL Annex VI.

4 The SECP should advise that records should be kept of actions initiated to meet the requirement of these Guidelines in case of breakdown of the EGCS or associated equipment, and that the relevant flag and port State's Administration should be notified in accordance with MEPC.1/Circ.883/Rev.1.

5 The following should be included for reference purposes:

(a) ETM-A or ETM-B,

(b) EGCS Record Book or Engine-Room logger system, and

(c) OMM.

2.9.2 Demonstration of compliance

1 Under Scheme A, for all fuel oil combustion units listed under **2.9.3**, details should be provided demonstrating that the rating and restrictions for the EGCS (as approved) comply with **2.4.2.2(2)**.

2 Under Scheme A, required parameters should be monitored and recorded as described in **2.4.4.4** when the EGCS is in operation in order to demonstrate compliance.

2.10 Discharge water

2.10.1 Discharge water quality criteria and requirements related to water monitoring and recording

Sections 10.1 to 10.3 of Chapter 10 of the IMO EGCS Guidelines specify discharge water quality criteria and requirements related to water monitoring and recording. A summary of these

requirements is given below.

When an EGCS is operated in ports, harbours, estuaries or during any discharges from temporary storage, the discharge water is to be continuously monitored by water monitoring systems approved by the Flag Administration and recorded by a data recording and processing device. The values monitored and recorded should include pH, PAH, turbidity and temperature. In other areas, the continuous monitoring and recording equipment should also be in operation whenever the EGCS is in operation, except for short periods of maintenance and cleaning of the monitoring equipment as defined in the OMM. In cases where ClassNK verifies compliance with the IMO EGCS Guidelines for an EGCS under Scheme B, discharge water monitoring systems are required to obtain Type Approval from ClassNK through the carrying out of environmental tests witnessed by a surveyor in accordance with **Chapter 1, Part 7 of the Guidance for the Approval and Type Approval of Materials and Equipment for Marine Use**. The discharge criteria and monitoring criteria are given below.

1 pH

(1) pH criteria

pH criteria should comply with the following **(a)** or **(b)** (see **Figure 2.5**). Which requirements are applied should be stated in the ETM-A or ETM-B.

(a) Discharge water should have a pH no lower than 6.5 measured at the ship's overboard discharge. During maneuvering and transit, however, a maximum difference of 2 pH units between the inlet and outlet is allowed between the inlet water and overboard discharge values.

(b) The pH discharge limit at the overboard monitoring position is the value that will ensure a pH no lower than 6.5 at a distance of 4 *m* from the overboard discharge point with the ship stationary, and is to be recorded as the overboard pH discharge limit in the ETM-A or ETM-B. The overboard pH discharge limit can be determined either by means of direct measurement, or by using a calculation-based methodology (computational fluid dynamics or other equally scientifically established empirical formulae) as agreed by the Flag Administration and in accordance with the following conditions to be recorded in the ETM-A or ETM-B.

(i) All EGC units connected to the same outlets are operating at their full loads (or highest practicable load) and with fuel oil of the maximum sulphur content.

(ii) If a test fuel with lower sulphur content, and/or test load lower than maximum, sufficient for demonstrating the behaviour of the discharge water plume is used, the plume's mixing ratio must be established based on the titration curve of seawater. The mixing ratio would be used to demonstrate the behaviour of the discharge water plume and that the overboard pH discharge limit has been met if the EGCS is operated at the highest fuel sulphur content and load.

(iii) Where the discharge water flow rate is varied in accordance with the EGCS gas flow

rate, the implications of this for the part load performance should also be evaluated to ensure that the overboard pH discharge limit is met under any load.

(iv) Reference should be made to a seawater alkalinity of 2.2 mmol/L and pH 8.2. An amended titration curve should be applied where the testing conditions differ from the reference seawater, as agreed by the Flag Administration. An example titration curve for reference seawater conditions is presented in Appendix 4 of the IMO EGCS Guidelines.

(v) If a calculation-based methodology is to be used, details should be submitted to allow its verification such as (but not limited to) supporting scientific formulae, discharge point specification, discharge water flow rates, designated pH values at both the discharge and 4 *m* location, titration and dilution data.

(2) pH monitoring

pH should be continuously monitored by pH monitoring equipment which has a resolution of 0.1 pH units and temperature compensation. pH electrode performance and accuracy should comply with the requirements defined in BS 2586 ("Specification for Glass and Reference Electrodes for the Measurement of pH") or ASTM D1293-18 ("Standard Test Methods for pH of Water"). The pH meter should satisfy IEC 60746-2:2003 ("Expression of Performance of Electrochemical Analyzers – pH Value) or other internationally accepted equivalent standards. pH electrodes or pH meters which comply with another accepted standard or technical specification, which is in force, are deemed to be the equivalent of the equipment, provided these standards or technical specifications conform to standards BS 2586 or ASTM D1293-18 or IEC 60746-2:2003, and ensure at least a like-for-like level of requirements.

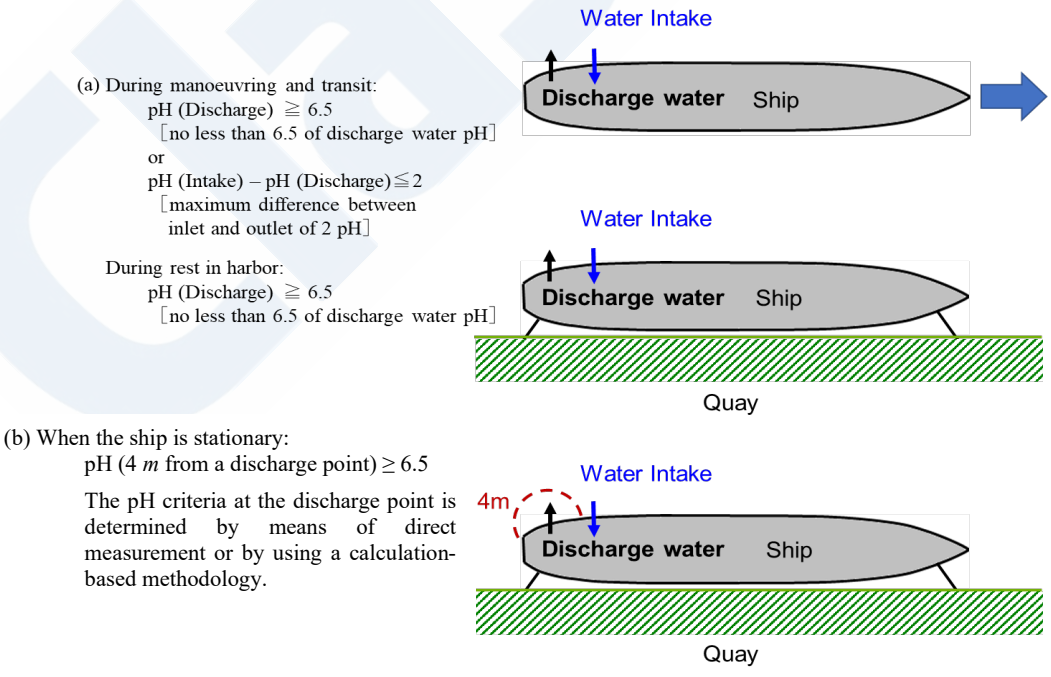


Figure 2.5 pH criteria

2 Polycyclic Aromatic Hydrocarbons (PAH)

(1) PAH criteria

PAH criteria should comply with the following. The discharge limit should be stated in the ETM-A or ETM-B.

(a) The PAH concentration in the discharge water should not be greater than 50 µg/L PAHphe (phenanthrene equivalent) compared to the inlet water PAH concentration with 45t/MWh of discharge water flow rate. The PAH concentration should be measured downstream of the water treatment equipment (including any reactant dosing unit, if used), but upstream of any dilution for control of pH (if used) prior to discharge.

(b) The discharge limit specified in **(a)** above is the limit which is normalized for a discharge flow rate of 45 t/MWh where the "MW" refers to the aggregated MCR of all those fuel oil combustion units whose EGCS discharge water PAH is being monitored at that point. In cases where sensors are installed in a separate measurement cell, the PAH limit applies to the flow in the main discharge pipe, from which the water is bypassed. In cases where the discharge water flow rate is varied, the limit should be adjusted in accordance with **Table 2.5**.

(c) In consideration of starting up of the EGCS, etc., the continuous PAHphe concentration limit may exceed the limit described above by up to 100% (100 µg/L PAHphe at 45t/MWh of discharge water flow rate) for an aggregated 15-minute period during any rolling 12-hour period.

(2) PAH monitoring

PAH monitoring equipment should be capable of monitoring PAH in water in a range to at least twice the discharge concentration limit specified in **Table 2.5**. Ultraviolet light or fluorescent light should be used to measure according to flow rate. All equipment should be verified to operate correctly and not deviate more than 5% in discharge water with turbidity within its working range.

Table 2.5 Criteria for discharge water PAH concentration

Specific Discharge Water flow rate (before dilution for pH control) (t/MWh)	Discharge concentration limit (µg/L PAH_{phe} equivalents)	Measurement technology
0-1	2,250	Ultraviolet light**
2.5	900	Ultraviolet light **
5	450	Fluorescent light *
11.25	200	Fluorescent light
22.5	100	Fluorescent light
45	50	Fluorescent light
90	25	Fluorescent light

* For any flow rate > 2.5 t/MWh, the fluorescence light method should be used.

** Alternative measurement methods may be used with the agreement of the Flag Administration.

Supplement 3.

The IMO EGCS Guidelines requires (as shown in **2.10.1.2(1)**) that the PAH concentration in the water should not be greater than 50 μg/L PAHphe (phenanthrene equivalence) in comparison to the inlet water PAH concentration. "Phenanthrene equivalence PAH concentration" means monitoring oil concentration in the water using the fluorescent properties of phenanthrene as the standard material. For PAH monitoring equipment, excitation wavelength and fluorescent wavelength are fixed to 254 *nm* and 360 *nm* respectively, which are the maximum absorption and the maximum emission wavelength of phenanthrene. Since the optical measurement method is influenced to a great degree in samples which includes black particles such as EGCS discharge water, measurement at as low a turbidity as possible is preferable in addition to any correction made for turbidity. Furthermore, since any dirt or oil film stuck to the window used for taking measurements may affect measurement accuracy, care needs to be taken.

3 Turbidity / Suspended Particulate Matter (SPM)

The turbidity and SPM should comply with the following. The discharge limit of turbidity should be stated in the ETM-A or ETM-B.

(1) Turbidity / SPM criteria

(a) The discharge water treatment system should be designed to minimize SPM, including any heavy metals and ash.

(b) The maximum continuous turbidity in discharge water should not be greater than 25 FNU (formazin nephlometric units) or 25 NTU (nephlometric turbidity units) or equivalent units, above the inlet water turbidity. However, during periods of high inlet turbidity, the precision of the measurement device and the time lapse between inlet measurement and outlet measurement are such that the use of a difference limit is unreliable. Therefore, all turbidity difference readings should be a rolling average over a maximum 15-minute period to a maximum of 25 FNU. The turbidity in the discharge water should be measured following treatment equipment, including any reactant dosing, but upstream of any other dilution unit, if used.

(c) The continuous turbidity discharge limit may be exceeded by 20% for an aggregated 15-minute period in any rolling 12-hour period.

(2) Turbidity / SPM monitoring

Turbidity should be continuously monitored and the monitoring equipment should meet requirements defined in ISO 7027 ("Water quality – Determination of turbidity"). The turbidimeter should identify when the turbidity is unable to be reliably quantified.

(3) Degassing system

Those EGCS which apply degassing of the sampled discharge water for the purpose of turbidity monitoring should ensure that particles do not settle during degassing, as this would underestimate the real turbidity value.

4 Permissible deviations of discharge water monitoring equipment

The permissible deviations of the discharge water monitoring equipment should not exceed the following, and calibration intervals should be such that the below performance requirements are met. In addition, calibration and calibration checks should be done according to the manufacturer specifications.

(1) pH: 0.2 pH units

(2) PAH: 5% of nominal standard test concentration used.
(The nominal concentration value should be not less than 80% of the scale range used)

(3) Turbidity: 2 FNU or NTU

5 Nitrates criteria

(1) The discharge water treatment system should prevent the discharge of nitrates beyond that associated with a 12% removal of NOx from the exhaust, or beyond 60 mg/l normalized for a discharge water flow rate of 45 t/MWh (see **Table 2.6**), whichever is the greater, where the "MW" refers to the MCR or 80% of the power rating of the fuel oil combustion unit.

(2) Within the first three months of operation after installation/initial survey and three months prior to each renewal survey, a sample of the discharge water from each EGCS should be drawn and analysed for nitrate content and results should be made available to the Flag Administration. However, the Flag Administration may require an additional sample to be drawn and analyzed at its discretion. The nitrate discharge data and analysis certificate should be retained on board the ship as part of the EGCS Record Book to be available for inspection as required by port State control or other parties. Criteria related to sampling, storage, handling and analysis should be detailed in the ETM-A or ETM-B as applicable. Nitrates discharge data is to be presented as the difference between concentrations in the inlet water and in the discharge water. The test method for nitrate should be ISO 13395:1996, ISO 10304-1:2007, US EPA 353.2 or other internationally accepted equivalent test standard (suitable for seawater).

(3) Data on discharge water nitrate concentrations gathered from EGCSs of similar design could be used as an alternative to the sampling, analysis and quantification requirements of **2.10.1-5.(2)** with the agreement of the Flag Administration based on an engineering analysis which demonstrates the design similarities in respect of nitrate concentrations in the discharge water.

Table 2.6 Nitrate concentration limit in discharge water

Discharge water flow rate (t/MWh)	Nitrate concentration limit (mg/L nitrates)
1	2,700
2.5	1,080
5	540
11.25	240
22.5	120
45	60
90	30

6 Washwater and discharge water additives and other substances

Additional environmental impact assessment of discharge water may be required for an EGCS which makes use of chemicals, additives, preparations or create relevant chemicals. The assessment may take into account relevant guidelines such as the "*Procedure for approval of ballast water management systems that make use of Active Substances (G9)*" (Resolution MEPC.169(57)), etc. to determine if additional discharge water quality criteria are appropriate. If only the following chemicals are used and the discharge water pH does not exceed 8.0, no additional assessment is needed.

(1) Neutralization agent (caustic substance), such as sodium hydroxide (NaOH) or sodium carbonate (Na_2CO_3); and

(2) Flocculants, which are used for approved marine oily-water separating equipment.

7 Discharge water from temporary storage

Any discharge water originating from the EGCS and discharged overboard following temporary storage within any tank designed for that purpose and featured in the ETM-A or ETM-B should be monitored/recorded in accordance with **2.10.1**, and meet, independent of any flow rate, the following discharge water criteria.

(1) pH: See paragraph **2.10.1-1(1)**

(2) PAH: Maximum of 50 µg/L PAHphe (before any dilution for control of pH)

(3) Turbidity: Not greater than 25 FNU or 25 NTU or equivalent units (before any dilution for pH control)

When demonstration of compliance with the provisions contained within this section is not possible, the water intended for discharge should be considered EGCS residue.

2.10.2 Water monitoring data recording

Section 10.4 of Chapter 10 of the IMO EGCS Guidelines specifies the recording of water monitoring data. A summary of these requirements is given below.

1 The data recording system should comply with the requirements of **2.7** and **2.8** and should continuously record pH, PAH and turbidity in accordance with **2.10.1** at a frequency of not less than 0.0111 Hz.

2 Calibration and instrument drift data should, as given in the OMM be either recorded by the data recording system or manually entered in the EGCS Record Book as appropriate to the means used.

2.10.3 Treatment of EGCS Residues

Section 10.5 of Chapter 10 of the IMO EGCS Guidelines specifies the treatment of residue removed from washwater. Such residue is required to be delivered ashore to adequate reception facilities and should not be discharged into the sea or incinerated on board. In addition, the date, time and location of said storage and disposal of such residue is required to be recorded in the EGCS Record Book.

2.10.4 Maintenance and servicing records

The EGCS Record Book (as required by either **2.4.4-6** or **2.5.6**) should also be used to record the maintenance and servicing of washwater and discharge water monitoring systems and ancillary components as given in the OMM, including like-for-like replacement.

2.10.5 Design guidance for water sampling points/valves

Each sampling point should be installed at a location that is representative of the main washwater or discharge water stream and accessible to personnel. The sampling extraction point should be open in the direction of the water flow.

Chapter 3 EGCS Installation Standards and Relevant Equipment

3.1 General

3.1.1 Application

1 The requirements in this Guidance apply to EGCS and associated equipment installed to reduce sulphur oxides and particular matter emitted from fuel oil combustion units such as reciprocating internal combustion engines and boilers, and which use sodium hydroxide solutions.

2 In cases where EGCS which use chemical agents other than those specified in **1** above are used, special consideration will be given to such systems in accordance with their respective designs.

3 In cases where EGCS which do not use chemical agents are used, the term "liquids containing sodium hydroxide solutions" is to be read as "liquids which have passed through scrubber chambers" (excluding **3.5.1.4**, **3.5.1.9** and **3.5.1.10** of this Guidelines).

4 In addition to the requirements in this chapter, additional requirements may be applied in accordance with instructions issued by the relevant Flag or Port Administration.

3.2 Design

Ships which install the EGCS specified in **3.1.1** are to comply with requirements in this chapter.

3.2.1 General Requirements

1 In addition to the requirements in this Chapter, pipes, valves, pipe fittings and auxiliaries are to satisfy the requirements in **Chapter 12, Part D of the Rules for the Survey and Construction of Steel Ships**. In such cases, the term "seawater" is to be read as "liquids containing sodium hydroxide solutions". However, pipes containing sodium hydroxide solutions only are to be classified as Group I.

2 In addition to the requirements in this Chapter, air pipes and sounding pipes are to satisfy the requirements in **13.6** and **13.8** (excluding **13.6.1-6** and **13.6.2-3**) in **Chapter 13** of **Part D of the Rules for the Survey and Construction of Steel Ships**. In such cases, the term "fuel oil" is to be read as "liquids containing sodium hydroxide solutions".

3 In addition to the requirements in this chapter, the EGCS control systems, safety systems and alarm systems are to satisfy the requirements in **Chapter 18** of **Part D of the Rules for the Survey and Construction of Steel Ships**.

4 Appropriate means are to be provided to allow continuous proper operation of fuel oil combustion units (such as diesel engines and boilers) which are connected to EGCS in cases where a single component of the system or associated equipment fails or becomes otherwise inoperable.

5 EGCS and relevant equipment are to be in accordance with the applicable requirements in other parts of the **Rules for the Survey and Construction of Steel Ships** in addition to those specified in **1** to **4** above.

3.3 Materials

3.3.1 Materials to be used

Materials used for EGCS are to be selected in consideration of notch ductility at operating temperatures and pressures, their corrosive effects and the possibility of hazardous reactions.

3.4 EGCS

3.4.1 Construction

1 Considerations for exhaust gas allowable back pressure and temperature

EGCS suitable for fuel oil combustion units are to be installed and the systems are to be arranged so that the back pressure and temperature do not exceed the allowable limits specified by the fuel oil combustion unit manufacturer.

2 Considerations for exhaust gas heating

EGCS are to be provided with suitable means to ensure the system do not suffer any damage caused by exhaust gas heating even when the EGCS is not cleaning exhaust gas with washwater, or are to be provided with devices at their exhaust gas inlets to shut down the exhaust gas supply.

3 Changeover of exhaust gas pipes

(1) In cases of EGCS failure as well as any blocking or clogging of scrubber chambers, bypass pipes are to be provided except for such fuel oil combustion units connected to systems that can be satisfactory operated under the possible operating ranges of the units without bypass pipes in the event of back pressure increases due to such a failure or blocking or clogging.

(2) For fuel oil combustion units with changeover arrangements from exhaust gas pipes in which a scrubber chamber is installed to bypass pipes, changeover devices for those pipes are to be fitted at the branch positions of the pipes.

(3) The devices specified in **(2)** above are to be fitted with appropriate means to prevent the simultaneous closing of the exhaust pipes in which the scrubber chamber is installed and bypass pipes such as interlock devices so that the proper operation of the fuel oil combustion units emitting exhaust gas will be maintained.

(4) The devices specified in **(2)** above are to be provided with indicators which show which exhaust gas pipe is being used. These indicators are to be fitted at both local positions and EGCS control stations.

4 Prevention of reverse flow of washwater

EGCS are to be fitted with appropriate means to prevent the reverse flow of washwater from

scrubber chambers to fuel oil combustion units.

5 Arrangement of pipes for overboard discharges

Pipes for overboard discharges of washwater used in EGCS are to be entirely separate from other pipes. The position and direction of the discharge is to be arranged so as to preserve the integrity of hull and propeller, etc.

6 Prohibition of connection of exhaust gas pipes

In principle, exhaust gas pipes of fuel oil combustion units, such as diesel engines and boilers, are not to be connected to common EGCS except where exhaust pipes of more than one fuel oil combustion unit are required to be connected to a common EGCS and the systems satisfy the following requirements in addition to **3** above.

(1) The EGCS is to be fitted with appropriate devices to prevent the reverse flow of exhaust gas to fuel oil combustion units such as other engines and boilers.

(2) The devices specified in **(1)** above are to be fitted with appropriate means to prevent the simultaneous closing of the bypass pipes and the exhaust pipes in which the scrubber chamber is installed, such as interlock devices in order to maintain the proper operation of the fuel oil combustion units, such as engines and boilers, emitting exhaust gas.

(3) The devices specified in **(1)** above are to be provided with indicators which show which exhaust gas pipe is being used. These indicators are to be fitted at both local positions and EGCS control stations.

(4) Safety measures are to be provided for preventing the propagation of fire between fuel oil combustion units, such as diesel engines and boilers, connected to common EGCS.

3.5 Requirements for construction and arrangement, etc.

3.5.1 Construction and arrangement

1 Sodium hydroxide solution storage tanks may be located within the engine room.

2 Sodium hydroxide solution storage tanks are to be protected from excessively high or low temperatures applicable to the particular concentration of the solution. Depending on the operational area of the ship, this may necessitate the fitting of heating and/or cooling systems.

3 Drip trays of a sufficient size are to be provided under storage tanks for liquids containing sodium hydroxide solutions as well as any equipment using or handling such liquids, such as pumps, to prevent the spread of any spillage in the compartments where they are installed.

4 The drip trays specified in **3** above are to be fitted with drain pipes which lead to appropriate tanks, such as residue tanks, which are fitted with high level alarm, or are to be fitted with alarms for leak detection.

5 Where sodium hydroxide solution is stored in tanks which form part of the ship's hull, the following are to be considered during the design and construction:

(1) These tanks may be designed and constructed as integral part of the hull (e.g. double bottom,

wing tanks).

(2) These tanks are to be coated with appropriate anti-corrosion coating.

(3) These tanks are to be designed and constructed as per the structural requirements applicable to hull and primary support members for deep tank construction after taking into account the specific gravity of sodium hydroxide solution.

(4) These tanks are to be fitted with but not limited to level gauge, temperature gauge, high temperature alarm, high and low level alarm, etc.

(5) These tanks are to be segregated by cofferdams, void spaces, pump rooms, empty tanks or other similar spaces so as to not be located adjacent to accommodation, service spaces, cargo spaces containing cargoes which react with sodium hydroxide solutions in a hazardous manner as well as any food stores, fuel oil tanks and freshwater tanks.

(6) These tanks are to be included in the ship's stability calculation.

6 Piping for liquids containing sodium hydroxide solutions and venting systems are to be independent of other ship service piping and/or systems.

7 Piping systems for liquids containing sodium hydroxide solutions are not to pass through or to extend into accommodation, service spaces, or control stations.

8 Piping systems for liquids containing sodium hydroxide solutions are not to pass through or to extend into any storage tanks for other liquids, except where deemed appropriate by ClassNK.

9 Piping systems for liquids containing sodium hydroxide solutions (excluding those near nozzles spraying washwater, are to be so arranged to prevent any outflows or leakage from the piping system from coming into contact with any high temperature equipment surfaces. Such piping systems are especially not to be located immediately above or near equipment such as boilers, steam pipes or exhaust gas pipes.

10 Storage tanks for liquids containing sodium hydroxide solutions are to satisfy the following requirements:

(1) The tanks are to be so arranged to prevent liquids containing sodium hydroxide solutions escaping or leaked from the tanks from coming into contact with high temperature equipment surfaces. Such tanks are especially not to be located immediately above or near equipment such as boilers, steam pipes or exhaust gas pipes.

(2) In cases where shore connections with standard couplings are fitted onto filling-up pipe lines, proper protection against any spraying of sodium hydroxide solutions, such as effective enclosures, is to be provided in consideration of the sodium hydroxide solution spraying out during filling-up operations.

11 Discharge pipes from storage tanks for liquids containing sodium hydroxide solutions are to be fitted with stop valves directly on the tank.

12 Piping systems for sodium hydroxide solutions which, if damaged, would allow the solution to escape from storage tanks are to be fitted with cocks or valves directly onto the tank. Such cocks or valves are to be capable of being closed from accessible positions even in the event of solution

leakages.

13 Residue tanks are to satisfy the following requirements:

(1) Residues removed from washwater used in scrubber chambers are to be stored in tanks independent of the oil residue (sludge) tanks fitted in accordance with **Chapter 2, Part 3 of the Rules for Marine Pollution Prevention Systems**. In addition, such residues are to be discharged to appropriate reception facilities.

(2) Manholes or access holes in a sufficient size are to be provided at such locations that each part of the tank can be cleaned without difficulties.

(3) Tank capacities are to be decided in consideration of the number and kinds of installed EGCS as well as the maximum number of days between ports where residue can be discharged ashore.

14 Piping systems for washwater which has been used in scrubber chambers are to be constructed of corrosion resistance materials or are to be otherwise appropriately protected, taking into account of the corrosive effects of the water.

15 For distance pieces fitted onto the piping systems specified in **14** above, where materials other than the hull construction materials are used and where two or more kinds of different metallic materials are arranged adjacent to each other, appropriate measures are to be taken to prevent bimetallic corrosion.

3.5.2 Ventilation systems

1 If storage tanks for sodium hydroxide solutions or equipment for using or handling sodium hydroxide solutions, such as solution supply pumps, is installed in a closed compartment, the area is to be served by an effective mechanical ventilation system of extraction type providing not less than 6 air changes per hour which is independent from the ventilation system of accommodation, service spaces, or control stations. The ventilation system is to be capable of being controlled from outside the compartment. If the ventilation stops, an audible and visual alarm shall be provided outside the compartment adjacent to each point of entry and inside the compartment, together with a warning notice requiring the use of such ventilation.

2 Notwithstanding the requirements specified in **1** above, where storage tanks for sodium hydroxide solutions or equipment for using or handling sodium hydroxide solutions, such as the solution supply pump are located within an engine room a separate ventilation system is not required when the general ventilation system for the space is arranged so as to provide an effective movement of air in the vicinity of the storage tank and equipment, and is to be maintained in operation continuously except when the storage tank is empty and has been thoroughly air purged.

3 In cases where sodium hydroxide solutions are stored within tanks which form part of the ship's hull, ventilation systems for enclosed compartments normally entered by ship personnel which are located adjacent to such tanks are to be capable of giving at least 20 air changes per hour and of being operated from outside the compartment in accordance with the following (1) or (2).

(1) In cases where the tanks are adjacent to the engine room, the requirements of **2** above apply.

(2) In cases where the tanks are adjacent to enclosed compartment normally entered by ship personnel, the requirements of **1** above apply.

3.5.3 Safety devices and alarm devices

1 EGCS are to be provided safety devices which are capable of automatically stopping exhaust gas washwater supply pumps and sodium hydroxide solution pumps in the event of any of the following failures:

(1) Abnormal rise of the liquid level in the scrubber; or

(2) Abnormal increase of the pressure at scrubber chamber inlet or differential pressure across the scrubber chamber (in cases where changeover devices for exhaust gas pipes are not fitted).

2 In cases where changeover devices for exhaust gas pipes are fitted, devices capable of automatically operating changeover devices to bypass sides in the event of any of the following failures are to be fitted.

(1) Abnormal rise of the liquid level in the scrubber;

(2) Abnormal increase of the exhaust gas pressure at the scrubber chamber inlet or the differential pressure across the scrubber chamber; or

(3) Abnormal increase of the exhaust gas temperature at the scrubber chamber outlet.

3 Alarm devices, to be activated in the event of any of the abnormal conditions given in **Table 1**, are to be provided at EGCS control stations.

4 EGCS are to be fitted with monitoring devices at EGCS control stations, and these devices are to indicate the information listed in **(1)** to **(5)**:

(1) Liquid levels in scrubber chambers;

(2) Liquid levels in tanks for sodium hydroxide solutions;

(3) Temperatures in tanks for sodium hydroxide solutions;

(4) Exhaust gas temperatures at scrubber chamber outlets; and

(5) Pressures at scrubber chamber inlets or differential pressures across scrubber chambers.

5 Additional safety, alarm and monitoring device may be required to be fitted based upon engineering analysis results, such as Failure Mode Effect Analysis (FMEA), for EGCS.

6 Level switches which activate high-high level alarms and stop washwater supply pumps are recommended to be provided for bilge wells, etc. installed in spaces in which EGCS washwater or seawater piping is located in preparation for any washwater or seawater leakage.

Table 3.1 EGCS alarm points

Monitored variables	
Liquid level in scrubber chamber *1	H
Temperature of washwater supply (in cases where the washwater includes sodium hydroxide solutions) *2	H
Liquid levels in tank for sodium hydroxide solution *3	H L
Temperature in tank for sodium hydroxide solution *4	H L
Exhaust gas pressure at scrubber chamber inlet or differential pressure across scrubber chamber *5	H
Exhaust gas temperature at scrubber chamber outlet *6	H
Power loss of control, alarm, monitoring or safety devices	O

Note: "H" and "L" mean "high" and "low", while "O" means that abnormal condition occurred.

*1: To prevent the flow of washwater into fuel oil combustion units connected to the EGCS as a result of rising liquid levels in scrubber chambers due to poor washwater drainage.

*2: To detect high washwater temperatures due to any abnormal condition of heat exchangers. Alarms need not be fitted in cases where heat exchangers are not used.

*3: To prevent the overflow and unanticipated leakage of sodium hydroxide solutions.

*4: To store sodium hydroxide solutions at appropriate temperatures to prevent substantial corrosion in the tanks due to excessively high temperatures and deposition due to low temperatures. This does not depend on whether a temperature control device is installed.

*5: To prevent any adverse effects on fuel oil combustion units due to the backflow or clogging of exhaust gas.

*6: To detect problems such as decreases of material strength which may be caused when scrubber chamber temperature is higher than expected in cases where washwater is not injected due to the clogging of nozzles, etc.

3.6 Electrical installations

3.6.1 General

1 Capacities of main sources of electrical power are to cover maximum electric demand during EGCS operation, including normal seagoing conditions, cargo loading and unloading conditions, and departure and arrival conditions.

2 Where EGCS is installed on an existing ship, the short circuit current increased by the newly installed electrical equipment is not to exceed the rated breaking/making current of the existing protective device. In addition, in cases where the rated capacity of the existing protective is exceeded, the device is to be replaced with one capable of handling the increase in short circuit current.

3 For items not specified in **1** and **2** above, electrical installations are to comply with relevant requirements specified in **Part H of the Rules for the Survey and Construction of Steel Ships**.

3.7 Safety and protective equipment

3.7.1 General

1 For the protection of crew members, the safety and protective equipment specified in the

following **(1)** to **(4)** is to be stored at locations outside the compartment containing the EGCS and easily accessible in the event of any leakages of liquids containing sodium hydroxide solutions. The safety and protective equipment is to cover all skin so that no part of the body is unprotected. The locations at which the equipment is stored are to be clearly marked so as to be easily identifiable.

(1) Large apron of chemical-resistant material,
(2) Special gloves with long sleeves,
(3) Suitable footwear, and
(4) Suitable protective equipment consisting of coveralls and tight-fitting goggles or face shields or both.

2 Eyewash and safety showers are to be located in the vicinity of sodium hydroxide solution filling stations and sodium hydroxide solution supply pumps.

3.8 Additional requirements for periodically unattended machinery spaces, etc.

Ships affixed with the notation **MC** or **M0** in accordance with the **Rules for Automatic and Remote Control Systems** are to satisfy the requirements in **3.8.1** and **3.8.2**, in addition to the requirements in **3.2** to **3.7**.

3.8.1 Requirements for MC ships

For ships affixed with the notation **MC**, EGCS remote control devices and monitoring devices and exhaust gas pipe changeover devices are considered to be the "centralized monitoring and control systems for machinery" specified in **3.2.2(12) of the Rules for Automatic and Remote Control Systems**. In cases where EGCS and exhaust gas pipe changeover devices are fully automatically controlled, alarm devices indicating abnormal conditions of related devices may be accepted.

3.8.2 Requirements for M0 ships

For ships affixed with the notation **M0**, alarm devices provided in accordance with **3.8.1** are to satisfy the requirements of **4.3.3 of the Rules for Automatic and Remote Control Systems** in addition to the requirements of **3.8.1**.

3.9 Other

3.9.1 Stability

In cases where ship particulars such as lightweight and lightship longitudinal centre of gravity are changed, the documents specified in **4.2.1.1** may be required.

3.9.2 Equipment numbers

In cases where compartments located above open decks are increased due to EGCS installation, equipment numbers may be increased. In such case, it is necessary to calculate equipment numbers in accordance with **27.1.2** of **Part C of the Rules for the Survey and Construction of Steel Ships**. In cases where existing anchors, chain cables and mooring ropes do not comply with the requirements in **Chapter 27** of **Part C of the Rules for the Survey and Construction of Steel Ships** due to an increase of equipment numbers, they are to be replaced with ones that do comply.

3.9.3 Firefighting equipment

In cases where existing compartments are modified, it may be necessary to install additional portable fire extinguishers, hydrants, fire hoses and fire detectors, etc. Furthermore, consideration need to be given to effectiveness, especially in the capacity of the existing fixed fire extinguishing systems, and modification of the system may be needed.

3.9.4 Navigation light arrangement

In cases where the screened angles of navigation lights (e.g. NUC lights) increase due to an expansion of the funnel, rearrangement of the navigation lights may be required.

3.9.5 Fuel oil service tank capacity calculation

In cases where the normal operating loads of generators are increased due to EGCS installation, it is to be confirmed that the capacity of each fuel service tank is sufficient for at least eight hours at the maximum continuous rating of the main engine and the normal operating load of the generators at sea in accordance with **13.9.1-7** of **Part D of the Rules for the Survey and Construction of Steel Ships**.

Chapter 4 Survey

4.1 General

The plans, drawings and relevant documents specified in this chapter are required to be submitted for approval, and the surveys specified in this chapter are required to be carried out for ships intended to be installed with the EGCS specified in **3.1.1**.

4.1.1 Application

1 The requirements in this chapter include some that are only applicable to ships installed with an EGCS subject to the IMO EGCS Guidelines adopted at MEPC77 in November 2021 (i.e. resolution MEPC.340(77)). The IMO EGCS Guidelines apply to the following EGCS installed on the ships:

(1) EGCSs installed on ships the keels of which are laid or which are at a similar stage of construction on or after 1 June 2022; and

(2) EGCSs installed on ships the keels of which are laid or which are at a similar stage of construction before 1 June 2022, which have a contractual delivery date of EGCS to the ship on or after 1 June 2022 or, in the absence of a contractual delivery date, the actual delivery of EGCS to the ship on or after 1 June 2022.

(3) Amendments as those specified in **2.4.2.3** or **2.5.5.2** to existing EGCSs undertaken on or after 1 June 2022.

For EGCSs that fall under none of the above cases because they are still subject to an earlier version of the EGCS Guidelines (resolution MEPC.259(68)), refer to the same chapter of the *Guidelines for Exhaust Gas Cleaning Systems (Ver.3)*.

2 In cases where EGCSs which do not use chemical agents are used, the term "liquids containing sodium hydroxide solutions" is to be read as "liquids which have passed through scrubber chambers"; this, however, excludes **4.3.1.1(2)** and **2(2)(a)**.

4.2 Submission of documents

4.2.1 Submission of plans and documents

The drawings and data to be submitted are generally as follows:

1 Plans and documents for approval

(1) Hull

(a) General arrangements

(b) Construction drawings

(c) Construction for fire protection and plans showing ventilation systems or ventilation arrangements

(d) Loading manuals and stability information booklets

(e) Calculation sheets for damage stability
(f) Navigation bridge visibility
(g) Piping diagrams
(h) Accuracy check documentation for loading computers or stability computers
(i) Equipment number calculations
(j) Plans showing fire extinguishing arrangements and plans showing fixed fire extinguishing system in cases where the system is modified
(k) Plans showing means of escape

(2) Machinery
(a) Particulars
(b) Specifications
(c) Material specifications
(d) General arrangements
(e) Construction of scrubber chambers
(f) Construction of storage tanks for sodium hydroxide solutions or liquid containing sodium hydroxide solution and their arrangements.
(g) Ventilation systems for compartments installed with equipment for using or handling sodium hydroxide solutions (such as storage tanks), or for the compartments specified in **3.5.2-3**
(h) Piping diagrams
(i) Distance piece construction and details
(j) Machinery arrangements in machinery spaces
(k) Engine room piping diagrams
(l) Wiring system diagrams
(m) Electrical equipment arrangements and cable installation
(n) Electrical power investigation tables
(o) Prospective short-circuit current calculation sheets
(p) List of explosion-protected electrical equipment (if required by **1.1.6** of **Part H of the Rules for the Survey and Construction of Steel Ships**)
(q) Control system arrangements, and hydraulic and electrical system (including safety systems and alarm systems) diagrams
(r) Plans and documents concerning automation
i) List of measuring points
ii) List of alarm points
iii) Control systems and safety systems (list of controlled objects and controlled variables, list of conditions for safety systems, and kinds of control energy sources (e.g. self-actuated, pneumatic, electric))
(s) Plans and documents for EGCS control and monitoring systems for ships provided with

monitoring and control systems for periodically unattended machinery spaces

2 Plans and documents for reference

(1) EGCS operation manuals

(2) Automatic control and safety system operation manuals

(3) Documents related to allowable back pressure

(4) Documents related to any studies and corresponding results explaining cases where bypass pipes are not fitted for the EGCS in accordance with **3.4.1-3(1)**

(5) Engineering analysis results such as Failure Mode Effect Analysis (FMEA)

(6) Fuel oil service tank capacity calculation sheets

(7) Calculation sheets for deviation limits of lightweight and lightship longitudinal center of gravity

(8) Onboard test procedures

3 Documents related to compliance with statutory requirements

(1) General

(a) SECP

(b) ETM-A (Scheme A) or ETM-B (Scheme B)

(c) OMM

(d) EGCS Record Book

(e) Washwater environmental assessments (in cases where chemicals are used)

(f) Documentation detailing the calculation method for pH at 4 *m* from the overboard discharge point (in the case of applying **2.10.1.-1.(b)**)

(g) Recording device specifications and construction drawings

(h) Onboard test procedures

(2) Exhaust gas monitoring system

(a) Specifications

(b) System diagram

(c) Construction drawings (general dimensions and sectional assembly plans, etc.)

(d) Instructions manual (including service and maintenance procedures)

(e) Other data considered necessary by ClassNK

(3) Washwater monitoring system

(a) Specifications

(b) System diagram

(c) Construction drawings (general dimensions and sectional assembly plans, etc.)

(d) Instructions manual (including service and maintenance procedures)

(e) Other data considered necessary by ClassNK

4.3 Initial surveys

4.3.1 Tests and surveys

1 Tests at facilities (Shop tests)

(1) Sodium hydroxide solution independent storage tanks are to be subject to hydrostatic tests at a pressure corresponding to a water head of 2.5 *m* above the top plate.

(2) After completion of the fabrication process, piping, valves and pipe fittings, for liquids containing sodium hydroxide solutions, design pressure of which exceeds 0.35 *MPa* are to be subject to hydrostatic tests together with the welded fittings at a pressure equal to 1.5 times the design pressure.

(3) The pressure parts of sodium hydroxide solution supply pumps and washwater supply pumps are to be subject to hydrostatic tests at a pressure equal to 1.5 times their design pressure or 0.2 *MPa*, whichever is greater. Tests carried out in the presence of a surveyor may be replaced by manufacturer's tests. In such cases, submission or presentation of test records may be required by ClassNK.

(4) For sodium hydroxide solution supply pumps and washwater supply pumps, shop trials are to be carried out according to test procedures deemed appropriate by ClassNK.

(5) Electrical motors and their corresponding control gears used for sodium hydroxide solution supply pumps and washwater supply pumps are to be tested in accordance with relevant requirements in **Part H of the Rules for the Survey and Construction of Steel Ships**. Shop tests for electrical motors whose continuous rated capacities are less than 100 *kW*, and their corresponding control gears may be replaced by manufacturer test. In such cases, submission or presentation of test records may be required by ClassNK.

2 Tests after installation on board

(1) In cases where sodium hydroxide solutions are carried in tanks which form part of the ship hull, the tanks are to be subject to hydrostatic tests in accordance with **2.1.5(1)** of **Part B of the Rules for the Survey and Construction of Steel Ships**. Where the specific gravities of the liquids used for the tests are less than those of the sodium hydroxide solution, an appropriate additional head is to be considered.

(2) After installation on board, EGCSs are to be tested in accordance with the following:

(a) Piping systems for liquids containing sodium hydroxide solutions (except overboard discharge pipes) are to be subject to leak tests at pressures equal to 1.5 times their design pressures or 0.4 *MPa*, whichever is greater.

(b) Operation tests of EGCS are to be carried out at maximum quantities of emitted exhaust gas.

(c) Performance tests for control, safety and alarm devices are to be carried out.

(d) Operation tests for changeover devices of exhaust gas pipes and their corresponding indicators are to be carried out.

3 Documents to be maintained on board

At the completion of a classification survey during construction, the surveyor is to confirm that EGCS instructions and operation manuals, including cautionary notes related to operator safety, are kept on board the ship.

4 Survey to verify MARPOL compliance

The following **(1)** or **(2)** are to be examined according to the type of EGCS certification scheme adopted:

(1) Scheme A

(i) The following approved documents are to be kept on board:

(a) SECC,

(b) ETM-A,

(c) OMM,

(d) SECP, and

(e) EGCS Record Book.

(ii) The following items are to be verified in accordance with the OMM etc.

(a) The EGCS conforms to the ETM-A as applicable.

(b) The operating parameter instruments installed and used on board are as approved per the OMM.

(c) Applicable systems of exhaust gas and discharge water monitoring systems used on board are as approved per the OMM.

(d) Inspection, maintenance, servicing, calibration and adjustments have been undertaken as required and those actions recorded in the EGCS Record Book or data recording and processing devices as required.

(e) The operating parameter instruments and the exhaust gas and the discharge water monitoring systems are correctly functioning.

(iii) Data recording and processing devices are to have functions as specified in **2.7**.

(iv) Applicable systems of exhaust gas monitoring systems, the water monitoring systems and data recording and processing devices are to be in good condition as specified below.

(a) Applicable values of limit values for exhaust gas (SO_2/CO_2 ratio) and discharge water (pH, PAH, turbidity) and operating limit value or the range of operating values specified in **2.4.4-4** are to be properly set as specified in the ETM-A.

(b) It is to be verified that there is no abnormal data in the log data.

(v) The results of nitrate analysis in accordance with **2.10.1-5(2)**, or the data on discharge water nitrate concentrations in accordance with **2.10.1-5(3)** are to be verified. For the results of the initial nitrate analysis, it may be verified within 3 months of operation after the installation/initial survey.

(vi) In cases where special structures are fitted to EGCS washwater discharge outlets, said structures are to be fitted as specified in approval documents (e.g. “Arrangement of

overboard discharge", "ETM-A").

(2) Scheme B

(i) The following approved documents are to be kept on board:
  (a) ETM-B,
  (b) OMM,
  (c) SECP, and
  (d) EGCS Record Book.

(ii) The following items are to be verified in accordance with the OMM etc.
  (a) The EGCS conforms to the ETM-B as applicable.
  (b) The operating parameter instruments installed and used on board are as approved per the OMM.
  (c) The exhaust gas and discharge water monitoring systems used on board are as approved per the OMM.
  (d) Inspection, maintenance, servicing, calibration and adjustments have been undertaken as required and those actions recorded in the EGCS Record Book as required.
  (e) The operating parameter instruments and the exhaust gas and the discharge water monitoring systems are correctly functioning.

(iii) Data recording and processing devices are to have functions as specified in **2.7**.

(iv) The exhaust gas monitoring system, the water monitoring system and data recording and processing devices are to be in good condition as specified below.
  (a) Limit values for SO_2/CO_2 ratio, pH, PAH and turbidity are to be properly set as specified in the ETM-B.
  (b) EGCS operation test in order to demonstrate the functionality of the monitoring system is to be verified under the operational condition described in OMM, as required.
  (c) It is to be verified that there is no abnormal data in the log data.

(v) The results of nitrate analysis in accordance with **2.10.1-5(2)**, or the data on discharge water nitrate concentrations in accordance with **2.10.1-5(3)** are to be verified. For the results of the initial nitrate analysis, it may be verified within 3 months of operation after the installation/initial survey.

(vi) In cases where special structures are fitted to EGCS washwater discharge outlets, said structures are to be fitted as specified in approval documents (e.g. "Arrangement of overboard discharge", "ETM-B").

4.4 Periodical surveys

4.4.1 Annual and Intermediate Surveys

1 Surveys are to be carried out in accordance with the following (1) to (4):

(1) The general conditions of EGCS are to be confirmed to be in good order. In particular, the general conditions of piping systems for washwater used in scrubber chambers is to be confirmed to be in good order.
(2) General examinations of safety and protective equipment for EGCS
(3) Instruction and operation manuals of EGCS are to be confirmed to be kept on board.
(4) Performance tests of the following (a) to (f) are to be carried out:
  (a) Control, safety and alarm devices;
  (b) Changeover devices of exhaust gas pipes and their corresponding indicators;
  (c) Remote shut-off devices for sodium hydroxide solution storage tank valves (if fitted);
  (d) Remote stopping devices for sodium hydroxide solution supply pumps (if fitted);
  (e) Safety showers (if fitted); and
  (f) Eyewashers (if fitted).

2 Survey to verify MARPOL compliance

The following **(1)** or **(2)** are to be examined according to the type of EGCS certification scheme adopted:

(1) Scheme A
  (i) The items specified in **4.3.1-4(1)(i)**, **(ii)** and **(iv)(a)**.
  (ii) The amount of storage and disposal of EGCS residues are recorded with the date, time and location, etc. in the EGCS Record Book.
  (iii)The EGCS Record Book entries are to be maintained on board the ship for a minimum period of three years after the last entry has been made.
(2) Scheme B
  (i) The items specified in **4.3.1-4(2)(i)**, **(ii)** and **(iv)(a)**.
  (ii) The amount of storage and disposal of EGCS residues are recorded with the date, time and location, etc. in the EGCS Record Book.
  (iii) The EGCS Record Book entries are to be maintained on board the ship for a minimum period of three years after the last entry has been made.

4.4.2 Special/Renewal Surveys

1 For ships fitted with exhaust gas cleaning systems, in addition to the surveys specified in **4.4.1-1**, the surveys are to be carried out in accordance with the following (1) to (3):

(1) Internal examinations of sodium hydroxide solution storage tanks (if fitted).
(2) In cases where sodium hydroxide solutions are carried in tanks which form part of the ship hull, the pressure tests required for "cargo tank" in **Table B5.23-1** of **Part B of the Rules for the Survey and Construction of Steel Ships** are to be carried out. In cases where pressure tests at specified pressures have been conducted in the presence of the Master or any other representative personnel of the ship at suitable occasions prior to the survey, such pressure tests may be regarded as the pressure tests required for Special Surveys.

(3) The following **(a)** and **(b)** equipment is to be opened for examinations:
(a) Sodium hydroxide solution supply pumps and washwater supply pumps (if fitted), and
(b) Other items as deemed necessary by ClassNK

2 Survey to verify MARPOL compliance

The following **(1)** or **(2)** is to be examined according to the EGCS certification scheme adopted:

(1) Scheme A
The items specified in **4.3.1-4(1)(i)**, **(ii)**, **(iv)(a),** and **(v)** and **4.4.1-2(1)(ii)** and **(iii)**.
For the nitrate analysis result in **4.3.1-4(1)(v)**, the sample water is to be drawn and analysed three months prior to each renewal survey.

(2) Scheme B
The items specified in **4.3.1-4(2)(i)**, **(ii)**, **(iv)(a),** and **(v)** and **4.4.1-2(2)(ii)** and **(iii)**.
For the nitrate analysis result in **4.3.1-4(2)(v)**, the sample water is to be drawn and analysed three months prior to each renewal survey.

4.5 Installation surveys

4.5.1 Occasional Surveys

The survey for ships newly installed with EGCS subject to the requirements of this chapter are to be carried out in accordance with **4.2.1** and **4.3.1**.

Chapter 5 Class Notation

5.1 General

5.1.1 General

The notation specified in this chapter may be affixed to ships installed with an EGCS and ships that undergo measures in preparation for the possible future installation of an EGCS.

5.2 Class notation for EGCS Installed Ships

5.2.1 Application

This section applies to ships classed with "ClassNK" which are installed with an EGCS approved by the Flag Administration.

5.2.2 Affixation of class notation

The notation "Sulphur Oxides (Exhaust Gas Cleaning System)" (abbreviated to "SOx(EGCS)") is to be affixed to the classification characters of ships which have been approved by their Flag Administration and have installed an EGCS on board in accordance with this Guidelines.

In addition to the above, in order to specify equipment connected to an EGCS, such equipment will be registered in the Classification Register as descriptive notes for the ship using the abbreviations contained in the following **Table 5.1**. The descriptive notes will be indicated on the certificate of classification. (see the example given below)

[Example]

In cases where one main engine, three generator engines and one auxiliary boiler are connected to the EGCS, "SOx-EGCS-M/E, G/E(Nos.1, 2, 3), A/B" will be indicated as the descriptive note.

Table 5.1 Equipment connected to EGCS and corresponding abbreviations

Equipment connected to EGCS	Abbreviations
Main engine	M/E
Generator engine	G/E
Main boiler	M/B
Auxiliary boiler	A/B
Other	OTH

5.2.3 Termination of class notation

ClassNK will withdraw the class notation specified in **5.2.2** in cases where ClassNK determines that the EGCS is not being maintained.

5.3 Class notation for EGCS Ready Ships

5.3.1 Application

This chapter applies to ships classed with ClassNK which is designed to install EGCS and which have submitted an application for the affixation of notation related to EGCS to their classification characters.

5.3.2 Applicable requirements

For safety requirements for ship structures and equipment, the latest EGCS guideline and the Rules for the Survey and Construction of Steel Ships at the time of application are to be applied.

5.3.3 Class notation

For ships implemented EGCS Ready, the following class notation may be affixed corresponding to the status of implementation of each category. Such notation may be affixed after a review of the plans and documents specified in **5.3.5**, and the actual installation work (e.g. installation of the relevant equipment, securing space etc.) and relevant surveys are not necessary for the affixation of such notation.

(1) Exhaust Gas Cleaning System Ready – General (abbreviated as "EGCSR-G")
This notation may be affixed to the classification characters of ships that have been confirmed as complying with the standards for installation specified in Chapter 3 of this Guidelines.

(2) Exhaust Gas Cleaning System Ready – Full (abbreviated as "EGCSR-F")
This notation may be affixed to the classification characters of ships that have been confirmed as complying with both the statutory requirements specified in Chapter 2 and the standards for installation specified in Chapter 3 of this Guidelines.

5.3.4 Statement

For ships affixed with the class notation specified in **5.3.3**, a statement will be issued.

5.3.5 Required drawings and documents

For ships that have applied for the affixation of the class notation specified in **5.3.3**, the approval drawings and related documents specified below are to be submitted. ClassNK may also require the separate submission of detailed plans and documents in certain cases. In cases where the EGCS is not installed at the newbuilding stage, drawings and documents submitted for approval should clearly show the following:

- Items that are to be completed during the newbuilding stage, and
- Items that need to be completed as part of some future modification.

1 Drawings and documents for ships applying for the class notation "EGCSR-G"

(1) Plans and documents for approval

(a) Hull

i) General arrangements
ii) Construction drawings
iii) Fire protection construction and ventilation system or ventilation arrangement plans
iv) Loading manuals and stability information booklets
v) Calculation sheets for damage stability
vi) Navigation bridge visibility
vii) Piping diagrams
viii) Accuracy check documentation for loading computers or stability computers
ix) Equipment number calculations
x) Plans showing fire extinguishing arrangement, and plans showing fixed fire extinguishing system in cases where the system is modified
xi) Means of escape plans

(b) Machinery
i) Particulars
ii) Specifications
iii) Material specifications
iv) General arrangements
v) Construction of scrubber chambers
vi) Construction of storage tanks for sodium hydroxide solutions or liquids containing sodium hydroxide solution and their arrangements
vii) Ventilation systems for compartments installed with equipment for using or handling sodium hydroxide solutions (such as storage tanks), or for the compartments specified in **3.5.2-3**
viii) EGCS piping diagrams
ix) Distance piece construction and details
x) Machinery arrangements in machinery spaces
xi) Engine room piping diagrams
xii) Wiring system diagrams
xiii) Electrical equipment arrangements and cable installation
xiv) Electrical power investigation tables
xv) Prospective short-circuit current calculation sheets
xvi) List of explosion-protected electrical equipment (if required by **1.1.6** of **Part H of the Rules for the Survey and Construction of Steel Ships**)
xvii) Arrangements of control systems and diagrams for hydraulic and electrical systems (including safety systems and alarm systems)
xviii) Plans and documents concerning automation
1) List of measuring points
2) List of alarm points

3) Control systems and safety systems (list of controlled objects and controlled variables, list of conditions for safety systems, and kinds of control energy sources (e.g. self-actuated, pneumatic and electric)

xix) Plans and documents for EGCS control and monitoring systems for ships provided with monitoring and control systems for periodically unattended machinery spaces

(c) Plans and documents for reference

i) EGCS operation manuals

ii) Automatic control and safety system operation manuals

iii) Documents related to allowable back pressure

iv) Documents related to any studies and corresponding results explaining cases where bypass pipes are not fitted for the EGCS in accordance with **3.4.1-3.(1)**

v) Engineering analyses such as Failure Mode Effect Analysis (FMEA)

vi) Fuel oil service tank capacity calculation sheets

2 Drawings and documents for ships applying for the class notation "EGCSR-F"

In addition to **5.3.5-1**, the following documents are to be submitted for confirmation of statutory requirement compliance of the EGCS, the relevant equipment of the exhaust gas monitoring system, and the documents required to be kept on board.

(a) General

i) SECP

ii) ETM-A (Scheme A) or ETM-B (Scheme B)

iii) OMM

iv) EGCS Record Book

v) Washwater environmental assessments (in cases where chemicals are used)

vi) Documentation detailing the calculation method for pH at 4 *m* from the overboard discharge point (in the case of applying **2.10.1.-1(b)**)

vii) Recording device specifications and construction drawings

(b) Exhaust gas monitoring systems

i) Specifications

ii) System diagrams

iii) Construction drawings (general dimensions and sectional assembly plans, etc.)

iv) Instructions manual (including service and maintenance procedures)

v) Other data considered necessary by ClassNK

(c) Water monitoring systems

i) Specifications

ii) System construction drawings

iii) Construction drawings (general dimensions and sectional assembly plans, etc.)

iv) Instructions manuals (including shakedown and maintenance procedures)

v) Other data considered necessary by ClassNK

References

[1] Japan Society of Corrosion Engineering. “Zairyo Kankyogaku Nyumon” [tr. Introduction to Eco-materials Science], 1993, Maruzen.

[2] Kojima, Ryuji. Toshiaki Shibata, Osamu Miyata, Kiyoshi Shibata, Tetsuya Senda. “Fundamental Leaching Behavior on Antifouling Agents from Ships’ Hull Paints”, *Journal of the Japan Institution of Marine Engineering* (2009), 44(4), pp. 648–652.

[3] Woods Hole Oceanographic Institution. “Marine Fouling and its Prevention”, 1952, U. S. Naval Institute, Annapolis, Maryland.

[4] “Flue Gas Desulfurization Systems: Design and Operating Consideration Volume II Technical Report” (EPA-600/7-78-030b).

Related Links

ClassNK “SOx・PM regulations” section
(URL：https://www.classnk.or.jp/hp/en/activities/statutory/soxpm/index.html)

Appendix I History of IMO Discussions related to EGCS Guidelines

This appendix provides a summary of IMO discussions related to the adoption of EGCS Guidelines that have taken place over the years.

The IMO EGCS Guidelines (resolution MEPC.340(77)) was adopted in November 2021, which was an amendment of the previous version of the Guidelines adopted as resolution MEPC.130(53), resolution MEPC.170(57), and resolution MEPC.184(59) and resolution MEPC.259(68).The first version of the IMO EGCS Guidelines (i.e. the "Guidelines for On-board Exhaust Gas-SOx Cleaning Systems") was adopted as resolution MEPC.130(53) at the 53rd Session of IMO Marine Environment Protection Committee (MEPC53) in 2005. This version, however, is quite different from subsequent amended versions because it was developed prior to Annex VI being revised in 2008. As a result, MEPC.130(53) only dealt with EGCS installed on board ships operating within the SOx ECAs specifically designated at that time: the North Sea area and the Baltic Sea area. In addition, MEPC.130(53) only specified requirements related to the use of equivalent compliance methods in SOx ECAs, and such requirements only stated that systems capable of reducing total SOx emissions to 6.0 g/kWh or less of the total weight of sulphur dioxide emissions could be used as long as they reduced emissions to the levels equivalent to the maximum fuel oil sulphur content limit of 1.50% for such designated areas. The reasons why only SOx ECAs were subject to MEPC.130(53) is believed to be because the use of EGCS in non-SOx ECAs was not anticipated at the time due to the fact that Annex VI only required fuel oil sulphur content to be less than or equal to 4.50% in non-SOx ECAs and the fact that such fuel was fairly easy to obtain.

Although MEPC.130(53) specified requirements similar to those found in subsequently adopted resolutions (MEPC.170(57) in April 2008, MEPC.184(59) in July 2009,MEPC.259(68) in May 2015 and MEPC.340(77) in November 2021) with respect to emission limits, the requirements related to washwater discharge limits in MEPC.130(53) were quite different because they only restricted the discharge of washwater in ports, harbours, or estuaries, while the subsequent resolutions restricted such discharges in all sea areas. Moreover, whereas the subsequent resolutions specified concrete washwater discharge limits for each substance in discharge water, MEPC.130(53) just specified qualitative requirements which only stated that hydrocarbons, ash and heavy metals, etc. included in discharge water were not to adversely affect ecosystems. Furthermore, MEPC.130(53) only specified that the pH and oil content of discharge water was to be subject to monitoring, but did not go as far as specifying concrete discharge limits.

After MEPC53, a request for the strengthening the discharge criteria found in the EGCS Guidelines was submitted by Sweden at MEPC54, which in turn was then discussed in detail at MEPC55. In response to the Swedish request, specific proposals by England related to the restriction of Polycyclic Aromatic Hydrocarbons (PAH), and by Finland related to information for heavy metal content ratios such as lead in discharge washwater, etc. were submitted at MEPC55,

and it was agreed to conduct a full-fledged study of the matter.

Initially, this study was scheduled to be conducted for the purpose of amending MEPC.130(53); however, since an overall review of Annex VI (adopted in 1997) had been previously agreed upon, it was decided to add the review of the EGCS Guidelines (including washwater discharge criteria) to the discussions related to the amendment to Annex VI. This review of the EGCS Guidelines was tasked to the MEPC's Bulk Liquids and Gases Sub-committee (BLG).

The BLG met several times to discuss discharge limits, eventually agreeing to draft guidelines which recommend the strengthening of discharge criteria by newly specifying the discharge pH criteria of 6.5 and by adding PAH as a regulated material. Moreover, since the strengthening of fuel oil sulphur content requirements had been agreed upon in the discussions of revision of the Annex VI, the BLG agreed to add non-ECAs, which were not covered by MEPC.130(53), to the sea areas subject to discharge controls. Since there were, however, still some members who felt that discharge control areas should only be within ports, harbours, and estuaries as stated in the draft for the revision of Annex VI, the BLG decided to submit two proposals to the MEPC: one which applied discharge limits to only ports, harbours, and estuaries and one which applied discharge limits to all sea areas. In addition to the above, requirements related to SO_2/CO_2 ratios and the limit values of fuel oil sulphur content that had been previously agreed upon during the BLG discussions, were also strengthened. A draft of the new Guidelines developed by the BLG was submitted for review at MEPC57 in April 2008.

As a result of the MEPC57 discussions, the proposal that discharge controls should apply to all sea areas was supported by the majority; therefore, the draft Guidelines were amended accordingly and adopted as MEPC.170(57).

Although resolution MEPC.170(57) was adopted, it was agreed that the opinion of the United Nations' Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection (GESAMP) be consulted before establishing specific discharge criteria and that these criteria should be reviewed as needed in the future to take into account any new knowledge regarding the effects of washwater discharge.

In response to the request of MEPC57, GESAMP submitted a document at MEPC58 which proposed that some content of the EGCS Guidelines be further clarified and that the discharge criteria should be reconsidered as needed in consideration of the development of future technologies. Member opinions on the GESAMP proposal were requested at MEPC58 and, as a result, responses were submitted by Finland, the Marshall Islands, the International Chamber of Shipping (ICS) and the Institute of Marine Engineering, Science & Technology (IMarEST) at MEPC59. Some at MEPC59 were of the opinion that the diffusion of seawater after discharge needed to be considered, but this could not be agreed upon so no action was taken. There was, however, an agreement reached to clarify some parts of MEPC.170(57); so, MEPC.170(57) was amended and adopted as MEPC.184(59) (i.e. the "2009 Guidelines for Exhaust Gas Cleaning

Systems") in July 2009.

The amendment of MEPC.184(59) was also proposed several times by some members and discussed after MEPC59. Denmark, for example, provided new information related to discharged washwater and proposed a relaxation of the discharge criteria during MEPC65 held in October 2013, but the Nordic countries and quite a few others were opposed to such a relaxation and, as a result, an amendment was not agreed upon. It was, however, agreed upon to necessitate a review of the proposed amendments to MEPC.184(59) and to request technical investigations of such amendments be carried out by the IMO Sub-Committee on Pollution Prevention and Response (PPR), the successor of the BLG.

At the 1st Session of the PPR (PPR1) in February 2014, Japan proposed a draft amendment to MEPC.184(59) that would allow CO_2 measurement on a wet basis in addition to the dry basis because technologies capable of CO_2 measurements on the wet basis had been developed. At PPR2 in January 2015, the EU Member States proposed a draft amendment to MEPC.184(59) which was related to the verification of pH criteria of the discharge washwater at overboard discharge points. The EU Member States' proposal would accept the verification of pH criteria based upon a calculation-based methodology in addition to the direct measurement because it was difficult to directly measure the pH of the discharge washwater at 4 *m* from the overboard discharge point while operating fuel oil combustion units during commissioning. At MEPC 68 in May 2015, MEPC.259(68): "2015 Guidelines for Exhaust Gas Cleaning Systems" was adopted(including a draft amendment based upon the proposals of Japan and the EU Member States).

At MEPC 69 in May 2016, the EU Member States proposed to amend MEPC.259(68) in order to clarify any unclear points such as the definitions of certain terms such as "EGC system" and "EGC unit" as well as PAH (polycyclic aromatic hydrocarbons) monitoring", "emission testing" and "approval of scrubbers in accordance with Schemes A and B" were unclear. Furthermore, Norway proposed to develop guidance related to the accidental breakdown, instrument malfunction, perceived temporary non-compliance and transient performance of an EGCS. As a result of discussions, a new work plan (including the following items (1) and (2)) was agreed upon, and relevant discussions were scheduled to be started at PPR5 in February 2018 with the goal of completion in 2020.

(1) Further refinement of the EGCS Guidelines, including clarification of the terms "EGC system" and "EGC unit", "PAH (polycyclic aromatic hydrocarbons) monitoring", "emission testing", "approval of scrubbers in accordance with Schemes A and B".

(2) Development of specific guidance regarding the accidental breakdown, instrument malfunction and perceived temporary non-compliance and transient performance of an EGCS, if appropriate.

Based on the above work plan, relevant discussions took place in a Correspondence Group (CG) established at PPR5 and a report made by the CG was submitted to PPR6 in February 2019,

but the matter was not taken up for discussion and the target completion year to finalize the work was extended to PPR7 in February 2020. However, taking into account the urgent need for guidance on EGCS failure (i.e. item (2) above), a draft for a MEPC circular that was separate from the EGCS Guidelines was agreed upon and approved as MEPC.1/Circ.883 at MEPC74 in May 2019.

A draft revision of the EGCS Guidelines for items (1) and (2) above was agreed upon at PPR7(February 2020) and then was submitted for adoption at both MEPC75 (November 2020) and MEPC76 (June 2021), but discussion on the matter was put-off until MEPC77 (November 2021) where it was ultimately adopted as "resolution MEPC.340(77): 2021 Guidelines for Exhaust Gas Cleaning Systems". In addition, a revised guidance on EGCS failure (MEPC.1/Circ.883/Rev.1) was also approved at MEPC77, and this revised guidance applies to all versions of the EGCS Guidelines, including the aforementioned MEPC.340(77).

Appendix II Local regulations

This appendix introduces local regulations related to fuel oil and EGCS.

1.1 European Union (EU)

The major provisions specified in "Directive (EU) 2016/802" issued in May 2016 are given below.

1 Regulations for fuel oil

(1) Ships at berth in Union ports should not use marine fuels with a sulphur content exceeding 0.10% by mass from 1 January 2010, except the cases when ships are due to be at berth for less than two hours according to published timetables, or the cases when ships switch off all engines and use shore-side electricity while at berth in ports.

(2) Passenger ships operating on regular services to or from any EU port in territorial seas, exclusive economic zones and pollution control zones of an EU Member State falling outside SOx Emission Control Areas should not use marine fuels with a sulphur content exceeding 1.5 % by mass from 11 August 2006 until 1 January 2020.

(3) All ships of all flags, which voyage in territorial seas, exclusive economic zones and pollution control zones of an EU Member State falling outside SOx Emission Control Areas should not use marine fuels with a sulphur content exceeding 0.5% by mass from 1 January 2020.

2 Provisions for EGCS (for ships using an EGCS within waters under the jurisdiction of an EU Member State)

(1) Marine fuels with a sulphur content of exceeding 3.5% should not be used except for the fuels supplied to ships using EGCS operating in closed mode.

(2) For EU Member State-flagged ships, the EGCS shall be approved in accordance with Directive 96/98/EC on marine equipment (MED).

(3) For EU Member State-flagged ships, all of the following conditions during trial operation of EGCS shall be fulfilled:

(a) The European Commission and any Port State concerned are notified in writing at least six months before trials begin;

(b) Permits for trials do not exceed 18 months in duration;

(c) All ships involved install tamper-proof equipment for the continuous monitoring of funnel gas emissions and use it through the trial period;

(d) All ships involved achieve emission reductions which are at least equivalent to those which would be achieved through the sulphur limits for fuels specified in this Directive;

(e) There are proper waste management systems in place for any waste generated by the emission abatement methods throughout the trial period;

(f) A marine environmental impact assessment is carried out, particularly of ecosystems in enclosed ports, harbours and estuaries throughout the trial period; and

(g) Full results are provided to the European Commission and are made publicly available within six months of the end of the trials.

(4) Washwater resulting from EGCS which make use of chemicals, additives, preparations and relevant chemicals created in the systems, shall not be discharged into the sea, including enclosed ports, harbours and estuaries, unless it is demonstrated by the ship operator that such washwater discharge has no significant negative impact on and does not pose risks to human health and the environment. If NaOH is used, it is sufficient that the washwater satisfies the discharge criteria set out in the IMO EGCS Guidelines and that its pH does not exceed 8.0.

1.2 United States Coast Guard (USCG)

The methods and procedures for using an EGCS are as notified by the USCG in the "CG-CVC Policy letter 12-04" released in July 2012. According to this letter, in cases where ships other than U.S.-flagged ships use an EGCS within an ECA that falls under U.S. jurisdiction, the Flag Administration of the ship is required to submit a proposal to the USCG and obtain acceptance of the EGCS's use. For U.S. flagged ships, it is necessary to submit a request to the USCG and obtain USCG approval.

1.3 United States Environmental Protection Agency (US EPA)

Provisions relevant to EGCS use are specified in the "Final 2013 VGP (Vessel General Permit)" issued in December 2013. This permit applies to ships (excluding ships engaged in recreation only) which voyage within coastal three-mile water areas (including US inland waters and the Great Lakes). A summary of these provisions is given below.

(1) All continuous monitoring equipment of washwater must be calibrated at intervals recommended by measurement equipment manufacturers or EGCS manufacturers. At a minimum, the equipment must be calibrated at least annually.

(2) For the monitoring equipment of PAH discharges, its period of endurance is to be for a minimum of two years.

(3) Provisions on EGCS discharge water

(a) The discharge of washwater from the EGCS must have a pH of no less than 6.0 measured at the ship's overboard discharge, with the exception that during maneuvering and transit, the maximum difference between inlet and outlet of 2.0 pH units is allowed. This difference must be measured at the ship's inlet and overboard discharge.

(b) Two samples must be collected and analysed in the first year of permit coverage or system operation, whichever is first, for each of the constituents analysed in (c) below to demonstrate treatment equipment maintenance, probe accuracy, and compliance with this

permit. (Samples must not be collected within 14 days of each other.) The samples must be collected for inlet water (for background), water after the scrubber (but before any treatment system), and discharge water. After the first year, samples must be collected at least once per calendar year. Records of the sampling and testing results must be maintained on board for a period of three years.

(c) The following items must be analyzed in the analysis as shown in (b) above.
   i) Dissolved and total metals: As, Cd, Cr, Cu, Pb, Ni, Se, Tl, V, Zn (recommend using EPA Methods 200.8 or 200.9)
   ii) PAHs (recommend using EPA Method 550.1, 610, 625, 8100, 8270c, 8310)
   iii) Nitrate and Nitrite (recommend using EPA Method 353.2)
   iv) pH (using standard Methods (SM) 4500-H B)

1.4 California Air Resources Board (CARB)

A summary of the provisions specified in the "13 CCR § 2299.2" and "17 CCR § 93118.2" of the California Code of Regulations issued in October 2011 is given below.

1 Regulations for fuel oil

In all waters within 24 nautical miles of the California baseline (see **Figure II.1**), any main diesel engines, auxiliary diesel engines (including diesel engines for electric propulsion), and auxiliary boilers installed on ocean-going ships*[1] shall use MGO*[2] and MDO*[3] with a maximum of 0.1% sulphur or less on or after 1 January 2014.

*1:"Ocean going ship" means a commercial, government, or military ship satisfying any one of the following criteria:
   (i) Ships greater than or equal to 400 feet in length overall (LOA);
   (ii) Ships greater than or equal to 10,000 gross tons; or
   (iii) Ships fitting diesel engines for propulsion with a per-cylinder displacement of greater than or equal to 30 liters.

*2: Fuel oil satisfying all the specifications for DMX or DMA grades as defined in Table 1, ISO 8217(2005).

*3: Fuel oil satisfying all the specifications for DMB grades as defined in Table 1, ISO 8217(2005).

2 A notice on EGCS use, etc. relevant to the above regulations was released as "Marine Notice 2014-1" in August 2014.

In the case of complying with ECA regulations by using Alternative Emissions Control Technologies (an EGCS or low-sulphur residual oil), operators are required to notify California Air Resources Board prior to entering California Regulated Waters that they will comply under the Research Exemption. In addition, the discharge of EGCS washwater is prohibited.

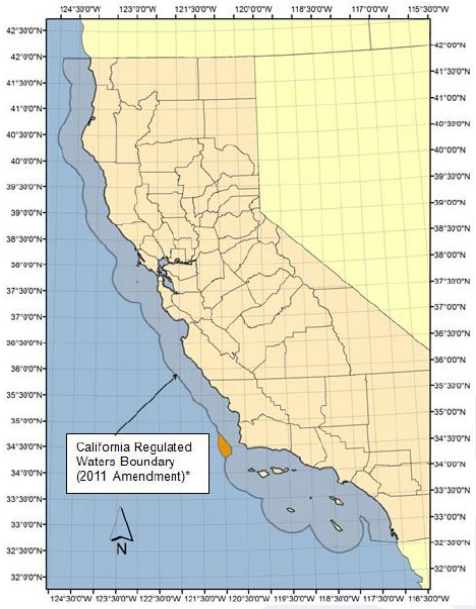


Figure II.1 Waters within 24 miles of the California baseline

1.5 Hong Kong

A summary of the provisions specified in the "2015 Air Pollution Control (Ocean Going Vessels) (Fuel at Berth) Regulation" issued in May 2015 is given below.

1 Regulations for fuel oil

Ships berthing in Hong Kong waters (see **Figure II.2**) on or after 1 July 2015 are required to use fuel oils for which the sulphur content does not exceed 0.5% by weight, liquefied natural gas or other fuels approved by the Hong Kong authorities. This regulation applies throughout the entire berthing period of the ship excluding the first hour after arrival and the last hour prior to departure. The definition of "arrival" as it pertains to this regulation refers to the moment the ship is moored or anchored at a berth, while the definition of "departure" refers to the moment the ship is untied from its berth.

2 Provisions for EGCS, etc.

In the case of being exempted from related regulations by using equivalent measures such as EGCS, an application must be made at least 14 days before the date on which the ship is intending to enter Hong Kong waters. An exemption is granted for a period of three years and must be renewed each time for a period of three years. An application for renewal must be made no earlier than three months before and no later than 14 days before the date on which the exemption expires.

Figure II.2 Hong Kong waters

1.6 China

1 Regulations implemented by the China MSA (Maritime Safety Administration)

A summary of the provisions specified in the official notification documents issued by the Chinese government in December 2015, November 2018 and December 2018 is given below.

(1) Regulations for fuel oil

(a) The Bohai Rim, the Pearl River Delta and the Yangtze River Delta (see **Figure 3.3**) are designated as emission control areas, and ships (excluding military ships, recreational ships and fishing boats) at berth and entering the area are required to use fuel oils with a maximum sulphur content of 0.5% or less from the dates shown in (i) to (v) below.

In applying these regulations, the following eleven ports are designated as core port areas.

- The Bohai Rim: Tianjin, Qinghuangdao, Tangshan, Huanghua
- The Pearl River Delta: Guangzhou, Shenzhen, Zhuhai
- The Yangtze River Delta: Shanghai, Suzhou, Nantong, Ningbo-Zhoushan (With respect to Ningbo-Zhoushan, only the Beilun, Chuanshan, Daxie, Zhenhai, Meishan, Shengsi, Liuheng, Dinghai, Qushan and Jintang port areas)

(i) Starting on 1 January 2016

Regulations can be arbitrarily applicable to ships at berth in ports within emission control areas prior to the commencement of regulations as shown in (b) below. Based on this provision, relevant regulations were implemented in the following waters.

1) Starting on 1 April 2016

Regulations apply to ships berthing at core ports within the Yangtze River Delta waters.

2) Starting on 1 October 2016

Regulations apply to ships berthing at Shenzhen port in the Pearl River Delta waters.

(ii) Starting on 1 January 2017

Regulations apply to ships berthing at core port areas within the emission control areas.

(iii) Starting on 1 September 2017

Regulations apply to ships berthing at any ports within the Yangtze River Delta waters.

(iv) Starting on 1 January 2018

Regulations apply to ships berthing at any ports within emission control areas.

(v) Starting on 1 January 2019

Regulations apply to ships entering emission control areas.

(b) From 1 January 2019, ships navigating, berthing and operating within Domestic Emission Control Areas (hereinafter referred to as "DECAs"), which includes both coastal control areas and inland river control areas throughout China, are required to use fuel oil for which the sulphur content does not exceed 0.5% m/m. Furthermore, these regulations are going to be strengthened gradually as per Table II.1.

Table II.1 Regulations related to the sulphur content of fuel oil

Applicable date	Regulation
From 1 January 2019	The sulphur content of fuel oil used on board should not exceed 0.5% m/m when operating within DECAs
From 1 January 2020	The sulphur content of fuel oil used on board should not exceed 0.1% m/m when operating within inland river control areas.
From 1 March 2020	Ships which do not use alternative arrangements should load and use fuel oil as required in the regulation when operating within DECAs.
From 1 January 2020	The sulphur content of fuel oil used on board should not exceed 0.1% m/m when operating within coastal control areas in Hainan waters.

In addition, existing ships (except for tankers) fitted with onboard devices for using shore power are required to use shore power from 1 July 2019 when berthing at locations which have shore power supply capabilities inside coastal emission control areas for more than three hours, or inside inland river emission control areas for more than two hours. This, however, does not apply to ships using other alternative or equivalent measures.

(c) In the case of ships using "clean energy" such as liquefied natural gas, the kind of "clean energy" is to be noted on the IAPP Certificate. Dual-fueled ships are to record information related to each changeover to "clean energy" (including the amount of each fuel used, dates and times of changeover operations, ship position and operator names) in the Engine Logbook.

(2) Provisions for EGCS, etc.

(a) In the case of ships using EGCS, the product certificate for the system is to be provided and the information that the ship uses an EGCS is to be noted on the IAPP Certificate. In addition, information related to EGCS use (including the start/end dates and times of the use, ship position and operator names) is to be recorded in the Engine Logbook.

(b) The Shanghai Maritime Safety Administration (SMSA) issued the "Notice on Supervision of Domestic Emission Control Area" which informed ships using EGCS in Shanghai Port that

they are required to report to the SMSA by VHF, phone, fax or email, etc. prior to berthing alongside in Shanghai Port.

(c) Discharge of EGCS washwater is prohibited in the port areas of Coastal Control Areas, the inland river control area and the Bohai area.

2 Regulations implemented by the Shanghai MSA, Jiangsu MSA and Zhejiang MSA

In addition to the above regulations implemented by the China MSA, the following additional regulations have been implemented by the Shanghai MSA, Jiangsu MSA and Zhejiang MSA.

(1) Shanghai MSA

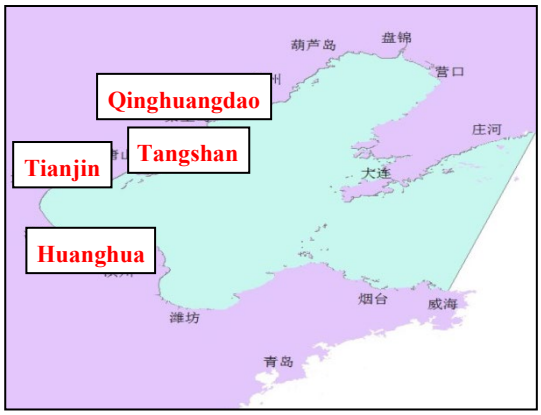
Ships navigating, anchoring or operating in Shanghai Port on or after 1 October 2018 should use fuel oils for which the sulphur content does not exceed 0.5%. In addition, all ships installed with devices for receiving shore power should use shore power if such facilities are available in Shanghai Port.

(2) Jiangsu MSA

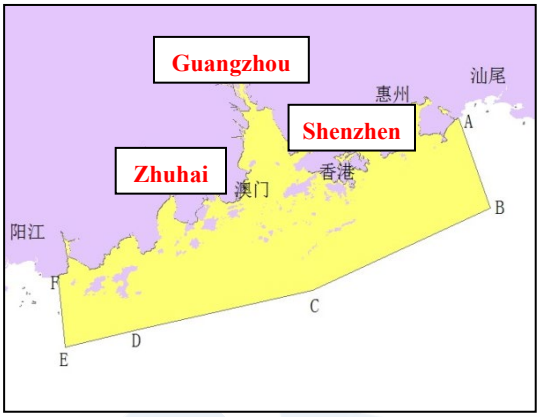
Sea-going ships sailing into either Suzhou Port or Nantong Port (which are the core ports of Yangtze River Delta emission control area) on or after 1 October 2018 should use fuel oils for which the sulphur content does not exceed 0.5%. In addition, ships installed with devices for receiving shore power should give priority to the use of shore power if such facilities are available in Suzhou Port and Nantong Port. Moreover, between 29 October 2018 and 11 November 2018, ships installed with devices for receiving shore power should use shore power if such facilities are available in Suzhou Port, Wuxi Port, Nantong Port and Changzhou Port.

(3) Zhejiang MSA

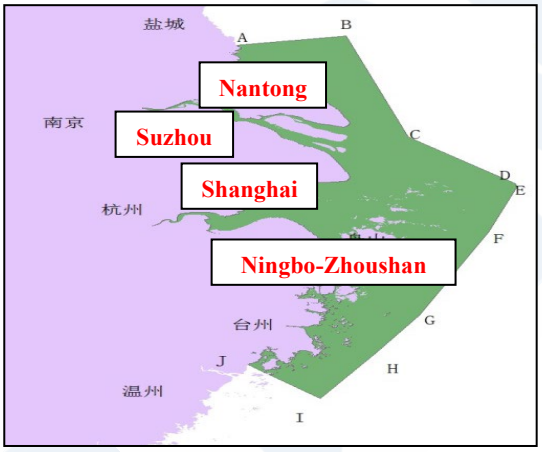
Sea-going ships navigating to Ningbo-Zhoushan Port as destination on or after 1 October 2018 should use fuel oils for which the sulphur content does not exceed 0.5% when operating within the Yangtze River Delta emission control area (see **Figure 3.3**). In addition, ships installed with devices for receiving shore power should give priority to the use of shore power if such facilities are available in Ningbo Zhoushan Port and Jiaxing Port. Moreover, between 29 October 2018 and 11 November 2018, ships installed with devices for receiving shore power should in principle use shore power if such facilities are available in Jiaxing Port.



The Bohai Rim



The Pearl River Delta



The Yangtze River Delta

Figure 3.3 The Bohai Rim, the Pearl River Delta and the Yangtze River Delta

1.7 Taiwan

Ministry of Transportation and Communications (MOTC) issued "Circular No: 10798001501" in July 2018 and informed that all ocean-going ships which intend to enter Taiwanese international commercial ports (the Port of Keelung, the Port of Taichung, the Port of Kaohsiung, the Port of Hualien, the Port of Taipei, the Port of Suao, and the Port of Anping) on or after 1 January 2019 will be required to use a fuel oil for which the sulphur content does not exceed 0.5% by weight. In addition, Taiwan International Ports Corporation Ltd. (TIPC) will provide reward to ocean-going ships using fuel oils for which the sulphur content is 0.5% or less which enter Taiwanese international commercial ports prior to 1 January 2019. Furthermore, for the Port of Mailiao, it is also required to use a fuel oil for which the sulphur content does not exceed 0.5% by weight on or after 1 January 2019 by harbor administration.

1.8 Regulations for fuel oil and EGCS washwater in other areas

1 Turkey

Republic of Turkey issued "Circular No: 517/2011" in September 2011 which states that ships on the quays of Turkish Ports as well as ships sailing in inland waters cannot use marine diesel for which the sulphur content exceeds 0.1% by mass as of 1 January 2012. Furthermore, passenger ships sailing in marine jurisdictions of Turkey cannot use marine fuels for which the sulphur content exceeds 1.5% by mass. In addition, the discharge of EGCS washwater is prohibited within territorial waters.

2 Norwegian ports

The sulphur content of fuel oil while ships are at berth in Norwegian ports shall not exceed 0.1% m/m as of 1 January 2010. In addition, the discharge of EGCS washwater is prohibited within fjord world heritage areas.

3 Icelandic ports

The sulphur content of fuel oil while ships are at berth in Icelandic ports shall not exceed 0.1% m/m as of 1 January 2010.

4 Sydney Harbour in Australia

The Australian Maritime Safety Authority (AMSA) issued "Marine Notice 21/2016" in December 2016 which introduced the major provisions of the "Protection of the Environment Operations (Clean Air) Amendment (Cruise Ships) Regulation 2015". The notice states that cruise ships capable of accommodating more than 100 passengers and which are at berth in Sydney Harbour are required to use fuel oil with a sulphur content not exceeding 0.1% m/m from December 2016, excluding the first hour after arrival and the last hour prior to departure. However, the regulation does not apply to ships using power sources external to the ship or exhaust gas cleaning systems certified and approved in accordance with the IMO EGCS Guidelines.

5 South Korea

The sulphur content of fuel oil of vessels around the major domestic ports such as Busan Port, Incheon Port, Yeosu Port, Gwangyang Port, Ulsan Port, Pyeongtaek and Dangjin Port, as from 1 September 2020, shall not exceed 0.1% m/m.

1.9 Other

In the following water areas, discharging of EGCS washwater is prohibited by domestic laws and state laws.

(1) German rivers and ports
(2) Belgian inland waters and ports
(3) Water areas of the State of Connecticut (United States)
(4) The Port of Fujairah (UAE)
(5) The Port of Dublin, Port of Cork and Port of Waterford (Ireland)
(6) Singapore
(7) The Panama canal
(8) Malaysian coastal water areas within 12 nautical miles from shore
(9) Bermudian territorial waters
(10) The Suez Canal
(11) Saudi Arabian ports
(12) Omani ports and territorial waters

Guidelines for Exhaust Gas Cleaning System (Ver.4)

[English]

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