RULES

PUBLICATION 78/P

GUIDELINES FOR EXHAUST GAS SO_X-CLEANING SYSTEMS

January
2023

Publications P (Additional Rule Requirements) issued by Polski Rejestr Statków
complete or extend the Rules and are mandatory where applicable.

GDAŃSK

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PRS/RP, 12/2022

CONTENTS

Page

1 INTRODUCTION

1.1 This Publication has been developed in accordance with the requirements specified in *Resolution MEPC.340(77)* of 26.11.2021.

Regulation 14(4) of Annex VI to *MARPOL 73/78*, hereinafter referred to as the *Convention*, requires ships to use oil fuel with a sulphur content not exceeding that stipulated either in regulation 14.1 or 14.4. Regulation 4 of Annex VI permits alternative methods which are at least as effective in terms of emission reductions as that required by the Annex, including the standards set forth in regulation 14.

The EGCS unit is subject to the approval by PRS acting under the authority of the flag state Administration.

1.2 These Guidelines have been developed to allow for the testing, survey, certification, and approval of Exhaust Gas Cleaning Systems (EGCSs) in accordance with regulation 4 of MARPOL Annex VI.

1.3 Equivalency with the relevant requirements of regulation 14 of MARPOL Annex VI should be demonstrated by using these Guidelines as a basis of compliance with the relevant Emission Ratio limit value as given in table 1.3. Where the design or operation of an EGCS requires controls in addition to those given in these Guidelines in order to meet the requirements of regulation 4.4 of the above-mentioned Annex, they should be subject to special consideration by the PRS and should be communicated to the PRS when submitting the notification required by regulation 4.2 of MARPOL Annex VI.

Table 1.3
Fuel oil sulphur limits recorded in regulations 14.1 and 14.4 and corresponding emissions values

Fuel Oil Sulphur Content [% m/m]	Ratio Emission SO_2 (ppm)/CO_2 (% v/v)
0.50	21.7
0.10	4.3

Note: The use of the SO_2/CO_2 ratio emissions limits is only applicable when using petroleum based distillate or residual fuel oils. See *Appendix II* for application of the SO_2/CO_2 ratio method.

2 GENERAL

2.1 Purpose and Application

2.1.1 This *Publication* applies to any EGC unit as fitted to fuel oil combustion machinery excluding shipboard incinerators.

2.1.2 For the purpose of these Publication, the term "EGCS" should be generally, but not exclusively (see 2.1.3), understood as "wet EGCS".

2.1.3 In the absence of specific guidelines for EGCSs which use technologies or operate in modes that are not defined in 2.2, these Guidelines may also be applied as appropriate.

2.1.4 These Guidelines apply to:

.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; or

.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 the EGCS to the ship on or after 1 June 2022; or

.3 amendments as those specified in 4.2.2 or 5.5.3 to existing EGCSs undertaken on or after 1 June 2022.

2.1.5 This Publication specifies the requirements for type approval tests, type approval certification and periodical surveys of exhaust gas cleaning (EGC) systems aboard the ship in accordance with the following two Schemes:

Scheme A – system certification with in-service continuous operational parameter monitoring and periodic emission checks, the EGCS is subject to approval by the PRS and should be as given in section 4 subject to performance tests, sea trials or other similar physical tests that verify that the system in service will result in the intended performance; and

Scheme B –continuous emission monitoring by means of an approved monitoring system together with periodic operational parameter checks. The exhaust gas monitoring system of the EGCS is subject to approval by the Administration and should be as given in section 5. Approved exhaust gas monitoring system should continuously indicate the Emission Ratio while the EGCS is in operation, allowing verification against the applicable limit.

2.1.6 Emission testing in relation to either Scheme A or Scheme B should be undertaken, as appropriate, as given in section 6.

2.1.7 Data recording, retention and the preparation of reports using that data in relation to either Scheme A or Scheme B should be, as appropriate, as given in section 7.

2.1.8 Details of the monitoring systems for exhaust emissions, operating parameters, inlet water, washwater and discharge water in relation to either Scheme A or Scheme B should be documented, as appropriate, as given in section 8.

2.1.9 For ships which are to use an EGCS in part or in total as an approved equivalent to the requirements of regulations 14.1 and/or 14.4 of MARPOL Annex VI, there should be an approved SOX Emissions Compliance Plan (SECP) as given in section 9.

2.1.10 Discharge water monitoring which is equally applicable to Scheme A and Scheme B should be undertaken as given in section 10.

2.2 Definitions and Explanations

[ppm] – number of parts per million. For the purpose of this *Publication*, it is assumed that this number is measured by gas analysers on a molar basis, assuming ideal micro-moles of substance per mole of total amount [µmol/mol], but [ppm] is used in order to be consistent with the units in the *NOx Technical Code*.

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 SO_2/CO_2 ratio specified by the manufacturer that the EGC unit is certified as meeting, when operating on a continuous basis on the manufacturers specified maximum sulphur content.

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 Record Book – a record of the EGC unit in-service operating parameters, component adjustments, maintenance and service records, storage and disposal of EGC residues; or a record in Electronic Logging System.

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 (or Electronic Record Book) - A user-input record of the EGCS, component adjustments, corrective and planned maintenance 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.

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 EGC units may utilize a common washwater, water supply, treatment and/or overboard system and discharge water monitoring equipment.

Emission Ratio - SO2 expressed in ppm/CO2 expressed in % v/v.

EGC unit capacity – maximum exhaust gas mass flow through the EGC unit.

ETM – EGC Technical Manual.

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.

GNSS – Global Navigation Satellite System.

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.

MCR – maximum continuous rating.

OMM – Onboard Monitoring Manual.

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.

PAH – Polycyclic Aromatic Hydrocarbons Manual

PAH_{phe} – Polycyclic Aromatic Manual as phenanthrene equivalents

Phenanthrene equivalent - It corresponds to the signal produced by a PAH monitor with excitation wavelengths between 244 nm and 264 nm (254±10 nm) and detection wavelengths 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.

Proof of the SO_2/CO_2 ratio method – the method for determining SO_X emission which consists in counting and monitoring of the proportion of the number of SO_2 parts per million to CO_2 percentage in exhaust gas after the EGC.

PSC – Port State Control.

SECA – SO_X Emission Control Area.

SECC –SO_X Emission Compliance Certificate.

SECP – SO_X Emission Compliance Plan.

UTC – Coordinated Universal Time.

Washwater - Cleaning medium brought into contact with the exhaust gas stream for the reduction of SOX.

Wet EGCS - EGCS using liquid cleaning medium.

2.3 Required Documents

Table 2.3

Document	Scheme	
	A	B
SECP (SO_X Emission Compliance Plan)	x	x
SECC (SO_X Emission Compliance Certificate)	x	
ETM "Scheme A" (EGC Technical Manual for Scheme A)	x	
ETM "Scheme B" (EGC Technical Manual for Scheme B)		x
OMM (Onboard Monitoring Manual)	x	x
EGC Record Book or Electronic Record Book	x	x

3 SAFETY NOTE

3.1 Due attention shall be paid to the safety implications related to the handling and proximity of exhaust gases, the measurement equipment and the storage and use of pressurized containers of pure and calibration gases. Description of safety measures against chemical treatment fluids used for exhaust gas cleaning systems and the residues which have hazardous properties is contained in Appendix IV of this Publication.

Sampling positions and permanent access platforms should be such that this monitoring may be performed safely.

For positioning the EGCS discharge water outlet, due consideration should be given to the locations of the existing seawater inlets. 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.

3.2 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.

4 SCHEME A

4.1 Approval of EGC Systems

Method A shall be applied in the case of:
- Individual EGCS approval;
- Serially manufactured units; and
- Production range approval.

4.1.1 Individual EGCS Approval

4.1.1.1 EGCS should be certified as capable of meeting the limit value, (*the certified value*), specified by the manufacturer (e.g. the emission level the unit is capable of achieving on a continuous basis) with fuel oils of up to the manufacturer's specified maximum % m/m sulphur content and for the range of operating parameters, as specified in 4.2.1.2, for which they are to be approved. The certified value shall at least be suitable for ships operations under requirements given by MARPOL Annex VI regulations 14.1 and/or 14.4.

4.1.1.2 Where testing is not undertaken with fuel oils of the manufacturer's specified maximum % m/m sulphur content, the use of two test fuels with a lower % m/m sulphur content is permitted. The two fuels selected shall have a difference in % m/m sulphur content sufficient to demonstrate the operational behaviour of the EGCS and to demonstrate that the certified value can be met if the EGCS were to be operated with a fuel of the manufacturer's specified maximum % m/m sulphur content. In such cases a minimum of two tests, in accordance with sub-chapter 4.3 as appropriate, should be performed. These need not be sequential and may be undertaken on two different, but identical, EGCSs.

4.1.1.3 The maximum and, if applicable, minimum exhaust gas mass flow rate of the unit shall be stated. The effect of variation of the other parameters defined in 4.2.1.2 should be justified by the equipment manufacturer. The effect of variations in these factors should be assessed by testing or otherwise as appropriate (accepted by PRS). No variation in these factors, or

combination of variations in these factors, should be such that SO_X emission value of the EGCS could be in excess of the certified value.

4.1.1.4 Data obtained during the tests should be submitted together with the ETM-A to PRS for approval.

4.1.2 Approval of serially-manufactured EGCS

4.1.2.1 In the case of nominally similar EGCSs of the same mass flow ratings as that certified in accordance with 4.1.1, and to avoid the testing of each EGCS, PRS, 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 arrangement. The certification of each EGCS under this arrangement should be subject to such surveys that the PRS should consider necessary as to assure that each EGCS has an Emission Ratio value of not more than the Certified Value when operated in accordance with the parameters defined in 4.2.1.2.

4.1.2.2 Certification of each EGCS under this arrangement is subject to periodical surveys performed by PRS at the manufacturer's shop.

4.1.3 Product Range Approval

4.1.3.1 In the case of an EGC unit of the same design, but of different maximum exhaust gas mass flow capacities, PRS may accept, in lieu of tests on an EGC unit of all capacities in accordance with 4.1.1, tests of EGC systems of three different capacities provided that the three tests are performed at intervals including the highest, lowest and one intermediate capacity rating within the range.

4.1.3.2 Where there are significant differences in the design of EGCSs of different capacities, the procedure mentioned in 4.1.3.1 should not be applied unless it can be shown, by the manufacturer, that in practice those differences do not materially alter the performance between the various EGCS types.

4.1.3.3 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 their parameters listed in 4.2.1.2. This should be on the basis of testing, or other data as appropriate (accepted by PRS).

4.1.3.4 The effect of changes of EGCS capacity on washwater characteristics should be detailed by the manufacturer.

4.1.3.5 All supporting data obtained from the performed tests, together with the ETM-A for each capacity of the EGCS, should be submitted to PRS for approval.

4.1.4 Survey and Certification

4.1.4.1 Either prior to, or after installation on board, each EGCS should be certified provided with the *SOx Emission Compliance Certificate* (*SECC*) as meeting the emission limit (certified value) specified by the manufacturer (eg., the emission level the unit is capable of achieving on the continuous basis) under the operating conditions and restrictions as indicated in the EGC Technical Manual (ETM-A) approved by PRS. Example form of *SO_X Emission Compliance Certificate* (SECC) is provided in *Appendix I*.

4.1.4.2 Application for the SECC should be made by the EGCS manufacturer or shipowner.

4.1.4.3 Subsequent EGCS of the same design and rating may be issued with the *SECC* without the need for additional testing in accordance with the requirements specified in 4.1.4.1 subject to fulfilment of those specified in sub-chapter 4.1.2.

4.1.4.4 EGCSs of the same design, but with ratings different from those of the units certified in accordance with the requirements specified in 4.1.4.1 may be issued with the SECC subject to fulfilment of those specified in sub-chapter 4.1.3.

4.1.4.5 EGCSs which treat only part of the exhaust gas flow of the uptake in which they are fitted are be subject to special consideration by PRS to ensure that under all expected operating conditions the overall SO_X emission value of the exhaust gas down stream of the system is no more than the certified value.

4.2 EGC System Technical Manual (ETM) "Scheme A"

4.2.1 Each EGC unit shall be supplied with an approved ETM "Scheme A". This ETM should contain at least the following information:

.1 the identification of the system (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 operating limits, or range of operating values, for which the unit is certified.
- maximum and, if applicable, minimum mass flow rate of exhaust gas,
- the maximum and, if applicable, minimum exhaust gas mass flow rate capacity of the EGC unit;
- the maximum fuel oil sulphur content the EGCS is certified for;
- the Certified Value;
- the power, type and other relevant parameters of the fuel oil combustion unit which the EGCS is to be connected to, and also:
  - for diesel engines – information whether the engine is of 2 or 4 stroke cycle,
  - for boilers – the maximum air/fuel ratio at 100% load,
- the maximum and minimum washwater flow rate, inlet pressures and minimum inlet water alkalinity (ISO 9963-1-2:1994);
- the exhaust gas inlet temperature ranges and maximum and minimum exhaust gas outlet temperature with the EGCS in operation;
- the maximum exhaust gas differential pressure across the EGC unit
- and the maximum exhaust gas inlet pressure;
- the salinity levels or fresh water elements necessary to provide adequate neutralizing agents,
- 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 including maintenance, service or adjustment requirements necessary to enable the unit to achieve a maximum emission 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, servicing 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; or exceedances of the Certified Value;

.6 verification procedure to be used at surveys to ensure that its performance is maintained and that the unit is used as required(see subsection 4.5);
.7 washwater and discharge water characteristics across the operating load range;
.8 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;
.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 8.2.8.

4.2.2 Amendments to the ETM "Scheme A" which reflect EGCS changes that affect performance with respect to emissions to air and/or water are subject to PRS approval. Where additions, deletions or amendments to the ETM "Scheme A" are separate to the ETM as initially approved, they should be retained with the ETM "Scheme A" and should be considered as part of the ETM "Scheme A".

4.3 In-service Surveys of EGC System

4.3.1 EGCS is subject to survey on installation at Initial, Annual/Intermediate and Renewals Surveys in accordance with the procedure of survey for the issue or renewal of the *International Air Pollution Prevention Certificate* (*IAPP Certificate*).

4.3.1.1 In accordance with *MARPOL 73/78* Annex VI regulation 10, EGC units may also be subject to inspection by PSC.

4.3.1.2 Prior to use, each EGCS should be issued with an SECC by PRS.

4.3.1.3 In those instances where EGCS is installed, section 2.6 of the Supplement to the ship's *International Pollution Prevention Certificate* (*IAPP Certificate*) should be duly completed.

4.4 SO_X Emission Limits

4.4.1 Each EGCS should be capable of reducing emissions to equal to or less than the Certified Value at any load point, including fuel oil combustion unit idling, when operated in accordance with 4.2.1.2.

4.4.2 In order to demonstrate performance, emission measurements shall be undertaken, in agreement with PRS, at a minimum of four load points:
– one load point should be at 95-100% of the maximum exhaust gas mass flow rate for which the unit is to be certified,
– one load point should be within ± 5% of the minimum exhaust gas mass flow rate for which the unit is to be certified,
– the other two load points should be equally spaced between the maximum and minimum exhaust gas mass flow rates.

Where there are discontinuities in the operation of the system, the number of load points shall be increased, in agreement with PRS, so that it is demonstrated that the required performance over the stated exhaust gas mass flow rate range is retained.

Additional intermediate load points shall be tested if there is evidence of SO_X emission peak below the maximum exhaust gas mass flow rate and above, if applicable, the minimum exhaust gas flow rate. The number of these additional tests shall be sufficient to establish the SO_X emission peak value.

4.5 Onboard Procedures for Demonstrating Compliance with Emission Limit

4.5.1 For each EGCS, the ETM-A should contain a verification procedure for use 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 EGCS should be designed in such a way as to facilitate inspection as required. The basis of the verification procedure is that if all relevant components and operating values or settings are within the approved ranges, then the performance of the EGCS can be assumed to meet the requirements without the need for actual continuous exhaust emission monitoring.

4.5.2 Included in the verification procedure shall be all components and operating values or settings which may affect the operation of the EGCS and its ability to meet the Certified Value.

4.5.3 Verification procedure should be submitted by the EGCS manufacturer and approved by PRS.

4.5.4 Verification procedure should cover both a documentation check and a physical check of the EGC unit.

4.5.5 PRS Surveyor should verify that each EGCS is installed in accordance with the ETM and has an SECC as required.

4.5.6 PRS Surveyor should have the option of checking one or all of the identified EGC components, operating values or settings. Where there is more than one EGC unit within the EGCS, PRS may, at their discretion, abbreviate or reduce the extent of the survey on board, however, 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.

4.5.7 EGCS should include means to automatically record, at least at the frequency specified in 5.3.2, when the system is in use. This shall automatically record at least:
- washwater pressure and flow rate at the EGC unit's inlet connection,
- exhaust gas pressure before and pressure drop across the EGC unit,
- fuel oil combustion unit load,
- exhaust gas temperature before and after the EGC unit against the respective operating limits, or range of operating values.

Data recording system should fulfil the requirements specified in chapters 7 and 8. In the case of a unit consuming chemicals at a known rate as documented in the ETM-A, records of such consumption in the *EGCS Record Book* also serve this purpose.

4.5.8 If a continuous exhaust gas monitoring system is not fitted, a daily spot check of the Emission Ratio for a duration of not less than five minutes at a minimum recording frequency of 0.1 Hz 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 stipulated in 4.5.7. 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 listed in paragraph 4.5.7 would be needed to verify proper operation of the EGC unit.

4.5.9 An EGCS Record Book should be maintained on board the ship recording maintenance and service of the system including like-for-like replacement. 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 PRS. Alternatively, this information may be recorded in the ship's planned maintenance record system as approved by PRS. Alternatively, this information may be recorded in an Electronic Record Book as approved by PRS. 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.

5 SCHEME B

Scheme B provides for the approval of the means of continuous Emission Ratio monitoring, supported by daily parameter checks, which will subsequently be used at surveys, and otherwise as required, to demonstrate compliance with the objectives as given in the SECP.

5.1 EGC System Approval

Continuous EGC monitoring system is subject to PRS approval and the results of that monitoring available to the PRS surveyors as necessary to demonstrate compliance as required.

5.2 In-service Surveys of EGC System

5.2.1 The EGCS's exhaust gas monitoring system should be subject to survey on installation and at initial, annual/intermediate and renewals surveys by the 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.

5.2.2 Following the installation survey given in 5.2.1 and approval of documents as listed in 2.3, sections 2.3 and 2.6 of the Supplement to the ship's International Air Pollution Prevention Certificate should be duly completed.

5.3 Calculation of SO_X Emission Rate

5.3.1 The exhaust gas composition of the Emission Ratio should be measured at an appropriate position after the EGC unit and that measurement should be as given in section 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.

5.3.2 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 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.

5.3.3 If more than one analyser is to be used to determine the SO_2/CO_2 ratio, these should be tuned to have similar sampling and measurement times and the data outputs aligned so that the SO_2/CO_2 ratio is fully representative of the exhaust gas composition.

5.4 Data Recording

5.4.1 The data recording system should be as given in sections 7 and 8. Data and the associated reports should be available to the 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.

5.4.2 Daily spot checks of the parameters listed in 4.5.7 are needed to verify proper operation of the EGCS and should be recorded in the EGCS Record Book or in the engine-room logger system.

5.5 System Technical Manual "Scheme B" (ETM-B)

5.5.1 Each EGCS shall be supplied with an ETM-B provided by the manufacturer. This ETM-B should contain at least:

.1 the identification of the system (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 certified:
- the maximum and, if applicable, minimum mass flow rate of exhaust gas,
- the 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);
- the power, type and other relevant parameters of the fuel oil combustion unit for which the EGCS is to be connected to:
  - for diesel engines – information whether the engine is of 2 or 4 stroke cycle,
  - for boilers – the maximum air/fuel ratio at 100% load,
- the maximum and minimum washwater flow rate, inlet pressures and minimum inlet water alkalinity (ISO 9963-1-2:1994),
- the exhaust gas inlet temperature ranges and maximum and minimum exhaust gas outlet temperature with the EGCS in operation;
- the maximum exhaust gas differential pressure across the EGC unit and the maximum exhaust gas inlet pressure;
- the salinity levels or fresh water elements necessary to provide adequate neutralizing agents,
- other parameters as necessary concerning the operation of the EGCS;

.3 any requirements or restrictions applicable to the EGCS or 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 indicated in accordance with 8.2.8.

5.5.2 ETM-B shall be retained onboard the ship being fitted with the EGCS. The ETM-B shall be available for surveys as required.

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

5.6 Onboard procedures for demonstrating compliance

5.6.1 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 PRS. 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 PRS. Alternatively, this information may be recorded in an Electronic Record Book as approved by PRS. 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.

6 EMISSION TESTING

6.1 Emission testing shall follow the requirements of the *NO_X Technical Code*, Chapter 5 and associated Annexes, except as provided in this *Publication*.

6.2 CO_2, should be measured on a dry basis using an analyser operating on non-dispersive infrared (NDIR) principle, and with additional equipment such as dryers as necessary. SO_2 should be measured using analysers operating on non-dispersive infrared (NDIR) or non-dispersive ultra-violet (NDUV) principles and with additional equipment such as dryers as necessary. Other systems or analysers principles may be accepted, subject to the approval of PRS, provided they yield equivalent or better results to those of the equipment referenced above. For acceptance of other CO_2 systems or analyser principles, the reference method should be in accordance with the requirements of appendix III of the NO_X Technical Code 2008.

6.3 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 NOX Technical Code 2008 are met at all times the equipment is in operation.

6.4 An exhaust gas sample for SO_2 should be obtained from a representative sampling point downstream of the EGC unit.

6.5 SO_2 and CO_2 should be monitored using either in situ or extractive sample systems.

6.6 Extractive exhaust gas samples for SO_2 determination should be maintained at a sufficient temperature to avoid condensed water in the sampling system and hence the loss of SO_2.

6.7 If an extractive exhaust gas sample for determination needs to be dried prior to the analysis, it should be done in such a manner that does not result in the loss of SO_2 in the sample as analysed.

6.8 The SO_2 and CO_2 values should be compared on the basis of the same residual water content (e.g. dry or with the same wetness fraction).

6.9 In justified cases where the CO_2 concentration is reduced by EGC unit, the 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 NO_X Technical Code 2008.

6.10 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.

6.11 The span gases for the SO2 and CO2 analyser should be a mixture of SO2 and/or CO2 and nitrogen at a concentration of more than 80% of the full scale of the measuring range used. The span gas for the CO2 should conform to the requirements of section 2 of appendix IV of the NOX Technical Code 2008. Other equivalent arrangements, as detailed in the OMM, may be accepted by PRS.

7 DATA RECORDING AND PROCESSING DEVICE

7.1 Recording and processing device should be of robust, tamper-proof design with read-only capability.

7.2 The recording and processing device should record, whenever the EGCS is in operation, the data described in 4.5.7, 5.3.2, and 10.3 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 Emission Control Area as given by regulation 14.3 at that time. The device should also be capable of:

- **.1** (Scheme B only) being automatically set, or pre-set, with the Emission Ratio limit value as appropriate to the sea area, in relation to regulation 14.3, where the ship is operating;
- **.2** being automatically set, or pre-set, with the applicable overboard pH limit value;
- **.3** being automatically set with the applicable PAH limit value;
- **.4** 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%;
- **.5** being pre-set with the applicable turbidity limit value;
- **.6** 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%; and
- **.7** recording preset and set limit values.

7.3 Recording and processing device should be capable of preparing reports over specified time periods.

7.4 Data should be retained for a period of not less than 18 months from the date of recording. If the unit is changed over that period, the shipowner should ensure that the required data is retained onboard and available as required.

7.5 The device should be capable of downloading a copy of the recorded data and reports in a readily useable format. Such copy of the data and reports should be available to the Administration or Port State authority on request.

8 ON-BOARD MONITORING MANUAL (OMM)

8.1 *OMM* should be prepared to cover each EGC unit installed in conjunction with fuel oil combustion unit, which shall be identified, for which compliance is to be demonstrated.

8.2 *OMM* should include at least the information concerning:

- **.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 the 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;
.5 the 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 4.5.7 or 5.4.2;
.7 the installation, operation, adjustment, maintenance, servicing and calibration requirements and procedures of the analysers, associated ancillary equipment and operating parameter measurement instruments;
.8 the 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 the 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; and
.12 where 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's documentation) which should be considered part of the OMM.

8.3 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 that:
.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; and
.5 the operating parameter instruments and the exhaust gas and discharge water monitoring systems are correctly functioning.

8.4 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 paragraph 5.2.1. The description of operational condition(s) may include:
.1 the connected fuel oil combustion unit load point(s); and
.2 the minimum operating time at a given load point.

8.5 The *OMM* should be:

.1 approved by PRS/Administration; and

.2 retained on board the ship onto which the EGCS is installed and should be available for surveys as required.

9 SHIP COMPLIANCE

9.1 SOx Emisson Compliance Plan (SECP)

9.1.1 For all ships using an EGCS, in part or in total, in order to fulfil the requirements of regulations 14.1 and/or 14.4 of Annex VI to MARPOL, there should be the SECP for the ship, approved by PRS/Administration.

9.1.2 SECP should list each item of fuel oil combustion unit which is subject to the requirements of regulations 14.1 and/or 14.4 of Annex VI to MARPOL

9.1.3 The SECP should list each fuel oil combustion unit which may use Scheme A and/or 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.

9.1.4 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.

9.2 Demonstration of Compliance

9.2.1 Scheme A

9.2.1.1 *SECP* should refer to rather than reproduce, the *ETM-A*, *EGCS Record Book* or Engine Room logger system and *OMM* as specified under Scheme A.

9.2.1.2 For all fuel oil combustion unit mentioned in paragraph 9.1.3, details should be provided demonstrating that the rating and restrictions specified in for the EGC unit as approved, 4.2.1.2, are fulfilled.

9.2.1.3 Required parameters should be monitored and recorded in accordance with the requirements specified in paragraph 4.5.7 while within a SECA in order to demonstrate compliance.

9.2.2 Scheme B

The SECP should refer to, not reproduce the *ETM*, *EGC Record Book* or Engine Room logger system and *OMM* as specified under Scheme B.

10 WASHWATER

10.1 Washwater Discharge Criteria

10.1.1 EGCS discharge water should comply with the following criteria prior to being discharged into the sea:

10.1.2 pH Criteria

10.1.2.1 Washwater pH should fulfil one of the following requirements which should be recorded in the ETM –A or ETM – B as applicable:

.1 discharge washwater should have a pH of no less than 6.5 at the ship's overboard discharge with the exception that during manoeuvring and/or transit, the maximum difference between inlet and outlet of 2 pH units is allowed this being measured at ship's inlet and overboard discharge;

.2 pH discharge limit, at the overboard monitoring position, is the value that will achieve as a minimum pH 6.5 at 4 m from the overboard discharge point with the ship stationary, and which 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) to be left to the approval by PRS, and in accordance with the following conditions to be recorded in the ETM-A or ETM-B:

- all EGC units connected to the same outlets are operating at their full loads (or highest practicable load) and with the fuel oil of a maximum sulphur content for which the units are to be certified (Scheme A) or used with (Scheme B);
- if a test fuel with lower sulphur content, and/or test load lower than maximum, sufficient for demonstrating the behaviour of the washwater 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 washwater plume and that the overboard pH discharge limit has been met if the EGCS is operated at the highest fuel sulphur content and load for which the EGCS is certified (Scheme A) or used with (Scheme B);
- where the washwater 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;
- reference should be made to a seawater alkalinity of 2.2 mmol/L and pH 8.2; [1] an amended titration curve should be applied where the testing conditions differ from the reference seawater, as agreed by the Administration (example titration curve for reference seawater conditions is presented in appendix 4); and
- if a calculation-based methodology is to be used, details to allow its verification such as but not limited to supporting scientific formulae, discharge point specification, washwater discharge flow rates, designed pH values at both the discharge and 4 m location, titration and dilution data should be submitted.

10.1.3 PAHs Criteria

Washwater PAH (polycyclic aromatic hydrocarbons) concentration should fulfil the following requirements and the appropriate limit shall be specified in the ETM-A or ETM-B:

10.1.3.1 Maximum continuous PAH concentration in the washwater shall not be greater than 50 µg/L PAH_{phe} (phenanthrene equivalence) above the inlet water PAH concentration. For the purposes of this criterion, PAH concentration in the washwater should be measured downstream of the water treatment equipment including any reactant dosing unit, if used, but upstream of any washwater dilution or other reactant dosing unit, if used, prior to discharge.

[1] The values may be changed within 2 years from adoption of MEPC.259(68) Resolution based on acquired data on seas physical state, in result of using exhaust gas cleaning systems.

10.1.3.2 The 50 µg/L limit described above is normalized for a discharge flow rate, before any dilution for pH control, 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. This limit would have to be adjusted upward for lower washwater flow rates (t/h) per MW, and vice versa, according to the table 10.1.2.

Table 10.1.2
PAH concentration limits in discharge water

Washwater flow rate [t/MWh]	Discharge PAH concentration limit [µg/l PAH_{ph} (equivalents)]	Measurement technique
up to 1.00	2250	ultraviolet light
2.50	900	ultraviolet light
5.00	450	Fluorescence [2]
11.25	200	fluorescence
22.50	100	fluorescence
45.00	50	fluorescence
90.00	25	fluorescence

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

10.1.3.3 For an aggregated 15-minute period in any rolling 12-hour period, the continuous PAHphe concentration limit may exceed the limit described above by up to 100%. This would allow for an abnormal start-up of the EGC unit.

10.1.4 Turbidity/Suspense Particle Matter Criterion

10.1.4.1 The discharge water treatment system should be designed to minimize suspended particulate matter, including heavy metals and ash. The turbidity of the discharge water, following treatment equipment, including any reactant dosing, but upstream of any other dilution unit, if used, should meet the criteria below. The limit should be recorded in the ETM-A or ETM-B.

10.1.4.2 The maximum continuous turbidity in washwater 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 shall be a rolling average over a 15-minute period to a maximum of 25 FNU. For the purposes of this criterion the turbidity in the washwater shall be measured downstream of the water treatment equipment but upstream of washwater dilution (or other reactant dosing) prior to discharge.

10.1.4.3 For an aggregated 15-minute period in any rolling 12-hour period, the continuous turbidity discharge limit may be exceeded by 20%.

10.1.5 Nitrates

10.1.5.1 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 discharge water flow rate of 45 t/MWh, whichever is the greater, where the MW refers to the MCR or 80% of the power rating of the fuel oil combustion unit.

[2] For any Flow rate > 2.5 t/MWh Fluorescence technology should be used.

10.1.5.2 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 PRS. However, the PRS may require an additional sample to be drawn and analysed at its discretion. The nitrate discharge data and analysis certificate is to be retained on board the ship as part of the EGCS Record Book and to be available for inspection as required by port State control or other parties. Criteria in respect of sampling, storage, handling and analysis should be detailed in the ETM-A or ETM-B as applicable. To assure comparable nitrate discharge rate assessment, the sampling procedures should take into account 10.1.4.1, which specifies the need for discharge water flow normalization. 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).

10.1.5.3 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 10.1.4.2 with the agreement of the Administration based on an engineering analysis which demonstrates the design similarities in respect of nitrate concentrations in the discharge water.

10.1.6 Washwater and discharge water additives and other substances

10.1.6.1 Additional assessment of the discharge water may be required for those EGCS technologies which make use of chemicals, additives, preparations or create relevant chemicals in situ. 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)), 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 (Na2CO3); and

.2 flocculants, which are used for approved marine oily-water separating equipment.

10.1.6.2 Environmental risk assessment (ERA)

2022 Guidelines for Risk and Impact Assessments of the Discharge Water From Exhaust Gas Cleaning Systems (MEPC.1/Circ.899) can be used when undertaking risk and impact assessments to ascertain whether EGCS discharge water can be discharged in their ports, harbours, estuaries, or coastal and other territorial waters.

10.1.7 Discharge water from temporary storage

10.1.7.1 In sea areas including ports, harbours and estuaries where the discharge of EGCS discharge water is prohibited, ships using an EGCS should keep their discharge water on board in dedicated holding tank(s) for delivery to port reception facilities, either in the port of call or in the next port of call able to accept the discharge water accordingly. However, outside these areas, the temporary stored discharge water could be discharged into the sea in accordance with the discharge criteria given in paragraph 10.1.7.2-3.

10.1.7.2 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 10.2.1, and meet, independent of any flow rate, the following discharge water criteria:

pH	See paragraph 10.1.2

PAH	Maximum of 50 µg/L PAHphe (phenanthrene equivalence) before any dilution for control of pH
Turbidity	Not greater than 25 FNU (formazin nephlometric units) or 25 NTU (nephlometric turbidity units) or equivalent units, before any dilution for pH control

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

10.1.7.4 Port States should provide adequate reception facilities for this discharge. However, depending on the number of ships that will need this service and the frequency and amount of discharge water to be delivered, the port, in conjunction with the port State, may decide if the appropriate reception facilities at their berths should be permanent or provided on an individual basis.

10.1.7.5 In cases where discharge water is to be disposed of in non-permanent facilities, ports should have arrangements with a hazardous waste contractor(s), who can supply a suitable portable/mobile facility depending on the amount of discharge water to be collected. For EGCS discharge water collected in either permanent or mobile facilities, the water should be disposed of according to the appropriate and environmentally sound waste disposal methods.

10.2 Discharge water monitoring

10.2.1 When the EGCS is operated in ports, harbours or estuaries, or during any discharges from temporary storage, the discharge water monitoring and recording should be continuous. 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. Whenever there are overboard discharges of discharge water from temporary onboard storage, no maintenance or cleaning of the monitoring equipment should take place. 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.

10.2.2 The permissible deviations of the discharge water monitoring equipment should not exceed the following:

pH	0.2 pH units
PAH	5% of nominal standard test concentration used. That nominal concentration value should be not less than 80% of the scale range used
Turbidity	2 FNU or NTU

10.2.3 Calibration intervals should be such that the above performance requirements are met. Calibration and calibration checks should be done according to the manufacturer's specification.

10.2.4 The pH electrode and pH meter should have a resolution of 0.1 pH units and temperature compensation. The electrode performance and accuracy should at least comply with the requirements defined in BS 2586 or ASTM D1293-18 and the meter should meet or exceed IEC 60746-2:2003 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.

10.2.5 The PAH monitoring equipment should be capable of monitoring PAH in water in a range to at least twice the discharge concentration limit given in the table above. The equipment should

be demonstrated to operate correctly and not deviate more than 5% in discharge water with turbidity within the working range of the application.

10.2.6 For those applications discharging at lower flow rates and higher PAH concentrations, ultraviolet light monitoring technology or equivalent should be used due to its reliable operating range.

10.2.7 The turbidity monitoring equipment should meet requirements defined in ISO 7027. The turbidimeter should identify when the turbidity is unable to be reliably quantified.

10.3 Approval of the discharge water monitoring systems

10.3.1 The discharge water monitoring system should be approved by PRS/Administration.

10.4 Water monitoring data recording

10.4.1 The data recording system should comply with the requirements of sections 7 and 8 and should continuously record pH, PAH and turbidity in accordance with 10.2.1 at a frequency of not less than 0.0111 Hz.

10.4.2 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.

10.5 EGCS Residues

10.5.1 Residues generated by the EGCS should be appropriately managed on board and delivered ashore to adequate reception facilities according to the *2011 Guidelines for Reception Facilities under MARPOL Annex VI* (resolution MEPC.199(62)). Such residues should not be discharged into the sea. Additionally, they should not be mixed with other waste streams and not be burnt in the ship's incinerators.

10.5.2 Each ship fitted with an EGCS should record the storage and disposal of EGCS residues in the EGCS Record Book, including the date, time and location of such storage and disposal.

10.5.3 As EGCS residues are not to be discharged into the sea, the ships that produce these types of waste should have on board:

- **.1** where applicable, evidence of a contract to prove that arrangements are in place to deliver the waste in the region where the ship is operating;
- **.2** waste receipts from the use of that contract to prove previous deliveries of such waste; such receipts should be kept on board for a period of 12 months after the delivery has been made; and
- **.3** an estimation of the amount of EGCS residues the produced on a daily basis, with records of the volume of solids and sludge produced.

10.6 Maintenance and servicing records

10.6.1 The EGCS Record Book as required by either 4.5.9 or 5.6.1 should also be used to record maintenance and servicing of the washwater and discharge water monitoring systems and ancillary components as given in the OMM including like-for-like replacement.

10.7 Design guidance for water sampling points/valves

10.7.1 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.

APPENDIX I

FORM OF SO_X EMISSION COMPLIANCE CERTIFICATE

Badge or Cipher

NAME OF ADMINISTRATION

SO_X EMISSION COMPLIANCE CERTIFICATE

CERTIFICATE OF APPROVAL FOR EXHAUST GAS CLEANING SYSTEMS

Issued under the provisions of the Protocol of 1997, as amended, to amend the International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 relating thereto under the authority of the Government of:

.....

(full designation of the country)

by.....

(full designation of the competent person or organization authorized under the provisions of the Convention)

This is to certify that the exhaust gas cleaning system (EGCS) listed below has been surveyed in accordance with the specifications contained under Scheme A in the 20XX Guidelines for exhaust gas cleaning systems adopted by resolution MEPC.YYY(ZZ).

This Certificate is valid only for the EGCS referred to below:

System manufacturer	Model/ type	Serial number	This EGCS is certified as providing following equivalency:		EGCS – Technical Manual for Scheme A (ETM-A) approval reference
			Fuel oil sulphur limit values	Maximum sulphur content of fuel oils to be used:	
			0.10%	_____%/n/a*	
			0.50%	_____%	

*delete as applicable

A copy of this Certificate should be carried on board the ship fitted with this EGCS at all times.

This Certificate is valid for the life of the EGCS, subject to surveys in accordance with subsection 4.2 of the Guidelines and regulation 5 of MARPOL Annex VI, installed in ships under the authority of this Government.

Issued at .....

(place of issue certificate)

dd/mm/yyyy

....

(date of issue) (signature of duly authorized official issuing the certificate)

(Seal or Stamp of the authority, as appropriate)

APPENDIX II

Emission ratio

1. This appendix is included to explain the background to the use of the Emission Ratio, defined in 2.2 of these Guidelines, as the criterion for the demonstration of equivalency with the fuel oil sulphur limits given in regulation 14 of MARPOL Annex VI. In addition, the basis of the Emission Ratio limit values as given in 1.3 of these Guidelines is also explained.

2. The carbon content of any fuel oil used for power generation by combustion exits that system essentially in the form of carbon dioxide (CO_2). While certain amounts of the inflow carbon may form deposits within that system, be incorporated into any direct contact lubricant or exit in the exhaust gas as carbon monoxide or gaseous or particulate hydrocarbons, overall these quantities are not significant in comparison to the flow of CO_2. This applies equally to all combustion systems: internal combustion engines, boilers and gas turbines.

3. Similarly, the sulphur content of a fuel oil used for combustion will exit that system essentially as sulphur dioxide (SO_2) in the hot exhaust gas stream. Again, although a certain amount may be retained as sulphur compounds within the system or as other sulphur compounds in the exhaust gas stream, these are not significant in comparison to the flow of SO_2.

4. Hence, although the CO_2 concentration in the exhaust gas will vary in accordance with the excess air ratio applied, the ratio of CO_2 to SO_2 concentrations will be fixed by the carbon/sulphur ratio of the fuel oil used. In those instances where an exhaust gas cleaning system (EGCS) covered by these Guidelines is fitted, the effect will be to reduce the SO_2, but not the CO_2 content of the exhaust gas. Consequently, the SO_2/CO_2 ratio after the system will reflect the effectiveness of that system in removing SO_2 from the exhaust gas.1 The post-EGCS SO_2/CO_2 ratio, the Emission Ratio, will largely correspond to that which would otherwise have been obtained if a lower sulphur fuel oil had been used but without the EGCS.

5. The principal elements present in petroleum-derived liquid fuel oils are carbon, hydrogen and sulphur and in some instances also nitrogen and oxygen. The actual proportions differ in each case. In order to derive the Emission Ratios corresponding to different fuel oil sulphur limit values, the fuel oil compositions given in 6.4.11.1.2 (table 9) of the NO_X Technical Code 2008 are taken as the starting points in table 1 below. The given compositions for both distillate and residual fuel oils omit sulphur content, but these are simply the difference between the summation of the given values and 100% and hence are 0.20% for the distillate example and 2.60% for the residual. In order to estimate the carbon and hydrogen proportions of fuel oils with other sulphur content values the carbon/hydrogen ratio and the "nitrogen+oxygen" content are assumed to be unchanged for the respective fuel oils. In table 1 the carbon contents are calculated for fuel oil having a sulphur content for both the distillate and the residual fuel oil of 1.50% as has been used in earlier versions of these Guidelines.

6. From the derived carbon contents and selected sulphur content value the molar ratio of fuel sulphur to fuel carbon is obtained in table 2 and from those the corresponding ratios of SO_2 and CO_2. One of the particular features of petroleum-derived liquid fuel oils is that despite the wide range of physical properties, such as viscosity and density, between distillates and residuals there is only a very limited range in terms of carbon composition. Hence it is a reasonable proposition to use a single SO_2/CO_2 ratio in order to represent all such fuel oils; in this instance 65 has been taken to correspond to the Emission Ratio which would be obtained if using a fuel oil of 1.50% sulphur content.2 The value of 1.50% sulphur content was used as the basis of these calculations as that was the original limit value for Emission Control Areas as given by the MARPOL Annex VI text as adopted in 1997, and which has been subsequently amended.

7. From the Emission Ratio corresponding to 1.50% sulphur the Emission Ratios corresponding to the various sulphur limits now given in regulation 14 of MARPOL Annex VI are obtained (see table 3).

Table 1:
Fuel oil carbon content values Distillate fuel oil – petroleum-derived

Carbon	Given	% m/m	86.2	
	Calculated	% m/m		85.08
Hydrogen	Given	% m/m	13.6	
	Calculated	% m/m		13.42
Sulphur		% m/m	0.2	1.50
Nitrogen + Oxygen		% m/m	0	0
Carbon / Hydrogen ratio			6.338	6.338

Residual fuel oil – petroleum-derived

Carbon	Given	% m/m	86.1	
	Calculated	% m/m		87.08
Hydrogen	Given	% m/m	10.9	
	Calculated	% m/m		11.02
Sulphur		% m/m	2.60	1.50
Nitrogen + Oxygen		% m/m	0.40	0.40
Carbon / Hydrogen ratio			7.899	7.899

Table 2:
Emission Ratio values for 1.50% sulphur fuel oil

			Distillate	Residual
Fuel	Carbon	% m/m	85.08	87.08
	Sulphur	% m/m	1.50	1.50
	Carbon	mol/kg	70.90	72.57
	Sulphur	mol/kg	0.469	0.469
	S/C ratio	mol/mol	0.00661	0.00646
Exhaust gas Emission Ratio		SO_2 ppm / CO_2 %	66.12	64.60
			65	

Table 3:
Emission Ratios corresponding to fuel oil sulphur content[2]

Fuel oil sulphur content % m/m	Emission Ratio
1.50	65
0.50	21.7
0.10	4.3

Note 1. Should treatment systems be developed that also reduce the CO_2 content, the core principle still applies except that in order to assess effectiveness in terms of SO_2 reduction the CO_2 value used would be that prior to that reduction i.e. CO_2 being measured at a point upstream of that treatment device.
Note 2. The given Emission Ratios only apply where a petroleum-derived liquid fuel oil is being used. For other fuel oils specific Emission Ratio values would need to be determined, and approved by the Administration, based on the particular composition of the fuel oil in question.

APPENDIX III

Discharge water data collection

1. Introduction

1.1 The discharge water quality criteria are intended to act as initial guidance for implementing EGCS designs. The criteria should be reviewed in the future as more data become available on the contents of the discharge and its effects, taking into account any advice given by GESAMP.

1.2 Administrations should therefore invite the collection of relevant data. To this end, shipowners in conjunction with the EGCS manufacturer are invited to sample and analyse samples of EGCSs, taking into account section 2 and section 3 of this appendix, as appropriate.

1.3 The sampling could be conducted during approval testing or shortly after commissioning and at about 12-monthly intervals.

2. Recommended procedure for sampling

In order to evaluate the contents of the discharge water and its effects, it is recommended that samples be analysed for the parameters listed under paragraph 2.4.1 of this appendix.

2.1 Preparation

2.1.1 This section describes preparations recommended prior to any sampling.

2.1.2 The EGCS should be equipped with sampling points for sampling of the following water streams:

.1 inlet water (for background);
.2 water after the EGC unit after treatment (if applicable) but before any kind of dilution; and
.3 discharge water after treatment and dilution.

2.1.3 Preparation for sampling, handling and transport

2.1.3.1 Sampling equipment

The sampling equipment and pre-prepared sample containers should be made ready prior to sampling. The equipment can be ordered from the laboratory performing the analysis. The equipment should be ordered well before the sampling takes place, taking into consideration the itinerary of the ship.

The table below lists the recommended physical properties of the sampling bottles needed. It takes ISO 5667-3 and the appropriate analytical standard into account, but other equivalent standards can also be used. The table furthermore informs how the samples should be stored when drawn and when at the latest they need to reach the laboratory for analysis.

Parameter	Bottle material	Volume	Method specifying sampling bottle requirements	Preservative	Storage temperature	Maximum time until analysis
NO_2/NO_3	PE	250 mL	ISO 10304-1	No preservative	Frozen (≤-18°C)	8 days
Total Metals	PE	500 mL	ISO 17294-2	HNO_3 Acid	Cooled (4°C)/ dark	1 month
Dissolved Metals	PE	500 mL	ISO 17294-2	No preservative	Cooled (4°C)/ dark	1 month
PAHs	Amber-glass with PTFE seal	2L (OL), 1L (CL)	DIN EN 16691 or EPA 8270	No preservative	Cooled (4°C) / dark	7 days
Hydrocarbon oil index (GC-FID analysis)	Glass	1L	ISO 9377-2	Mineral acid pH<2	Cooled (4°C)/ dark	4 days

It is practical to label sampling bottles before sampling. Identify each bottle such that it can be tracked back to sampling point, sampling parameter, EGCS operation mode and EGCS load.

2.1.3.2 Preparation for storage and holding of samples

To ensure proper storage and holding, crew need to appoint an appropriate space on board for samples and ice packs, preferably in an enclosed container in a cool space without direct sunlight.

2.1.3.3 Preparation for transport

If samples need to be transported with ice packs, the ice packs should be deep-frozen at least 48 h prior to sampling.

It is recommended to arrange shipping of the samples in advance with the port agent of the destination port.

2.1.3.4 Preparation of personnel conducting the sampling

To ensure the health and safety of the personnel, it is recommended to wear the following equipment:

2.1.3.4.1 Protective eyeglasses/goggles, ear protection, gloves, protective clothing and safety shoes

2.1.3.5 Personnel qualifications and responsibilities.

It is important that the personnel taking the samples are well trained. They should be aware of:

.1 how the system is working and where the sampling points are located; and
.2 how to dispose of the flushing water collected during flushing.

2.1.3.6 Information prior to sampling

It is recommended to complete the templates under 3.1 prior to sampling.

2.2 Collection

2.2.1 Sample time schedule

It is recommended to prepare a sampling time plan in advance in agreement with the crew, considering when at the latest the samples need to be analysed at laboratory. The sampling plan should contain information that can identify which bottle contains which water (OL/CL, inlet/outlet, etc.) and at which hour the sample was drawn. In this manner, continuous recorded EGCS control parameters can be retrieved at a later stage. Sampling should be undertaken with the EGCS operating above 50% of maximum exhaust gas flow (4.2.1.2/ 5.5.1.2).

2.2.2 Filling the sampling bottle

To prevent contamination during sampling, the following practices are recommended:

- **.1** use sampling bottles prepared by the laboratory;
- **.2** the water flow and thus the engine load(s) should be steady before and during sampling;
- **.3** the sampling valve should be flushed with a minimum of 10 litres of sampling water before samples are taken and it should not be closed or touched after flushing or before the sampling is done;
- **.4** if more than one bottle is filled, the sampling valve should not be closed in between;
- **.5** the use of any hydrocarbon-based cleaning agents at the sampling point should be avoided; and
- **.6** fill the sampling bottles to the brim and close firmly to avoid air in the bottles.

2.2.3 Information while sampling

It is recommended to complete the template under 3.2 while sampling.

2.3 Transportation

Sampling equipment to be used during transportation should meet provisions under 2.1.3.1 above.

2.3.1 Transportation container

For transportation an insulated and leak-proof container should be used. The transportation container should be provided by the laboratory. It should be able to hold a sufficient quantity of ice packs.

2.3.2 Shipping to the laboratory

Samples should be shipped to the laboratory as fast as possible. The transportation container should be labelled in accordance with local requirements for shipping and handling of water samples.

Immediately before handing over the samples to the port agent, the ice packs should be put into the box.

2.3.3 Chain of custody

A formal chain of custody process is required, with records.

Usually it is not necessary to include a customs declaration as these are water samples of zero commercial value.

2.3.4 Information from the laboratory

Take into consideration any information provided by the laboratory.

2.4 Sample preparation and analysis

Analysis should be undertaken by ISO 17025-accredited laboratories using EPA, ISO or equivalent test procedures. Methods used in the laboratories need to be within the scope of ISO 17025 accreditation of the laboratory.

2.4.1 To ensure comparability of laboratory results, the following methods are recommended:

Parameter	Recommended method for sample analysis	Recommended method for sample preparation
Polycyclic Aromatic Hydrocarbons (PAH): 16 EPA PAHs: Acenaphthene Acenaphthylene Anthracene Benzo-a-anthracene Benzo-a-pyrene Benzo-b-fluoranthene Benzo-g,h,i-perylene Benzo-k-fluoranthene Chrysene Dibenzo-a, h-anthracene Fluoranthene Fluorene Indeno-1,2,3-pyrene Naphthalene Phenanthrene Pyrene Sum of 16 PAHs	EN 16691:2015 or ISO 28540:2011 (recognizing EN 16691 as ISO is currently under consideration) or EPA 8270	* * EPA 3510; or EPA 3511; or EPA 3520.
Oil detailed GC FID analysis	ISO 9377-2:2000	*
Determination of Hydrocarbons Oil Index		
Nitrate and nitrite (NO3-/NO2-)	ISO 10304-1:2007 or ISO 15923-1:2013 or ISO 13395:1996 or EPA 353.2	* * * *
Total Metals: - Cd - Cu - Ni - Pb - Zn - As - Cr - V - Se	ISO 17294-2:2016 or EPA 200.8 or EPA 200.9	ISO 15587-1:2002 * *

Dissolved Metals: - Cd - Cu - Ni - Pb - Zn - As - Cr - V - Se	ISO 17294-2:2016 or EPA 200.8 or EPA 200.9	ISO 17294-2:2016 and filtration on 0.45 µm+HNO3 EPA 200.8 and filtration on 0.45 µm+HNO3 EPA 200.9 and filtration
Discharge water pH should be determined by instant onboard measurements	Record pH immediately on board	Record pH immediately on board

* Preparation method is included in the analytical method.

3. Recommended template for submitting sampling data

When submitting sampling data to the Administration, the data should include information according to paragraphs 1 and 2 as well as the results from the analyses as described under paragraph 2.4.

When submitting sampling data to the Administration, the following template is recommended.

3.1 Data Template Part 1		
Information prior to sampling		
Parameter	Value	Unit
3.1.1 Ship information		
Ship's name		
IMO number		
Ship build date		dd.mm.yyyy
3.1.2 Combustion unit(s) details		
Engine questions should be answered for every fuel-burning facility connected to the EGCS		
Number of combustion units connected to EGCS		
Combustion unit(s) manufacturer(s)		
Type of combustion unit(s) (ME, AE, 2/4-stroke, boiler)		
EGCS capacity in MW		
3.1.3 EGCS general		
Name of manufacturer		
Name of system		
Number of streams	single/multiple	
System operation mode	open/closed/hybrid	
Type of washwater treatment		
EGCS retrofit or new building		
Installation date		
ETM scheme A or B approval		

Additional notes:		
3.2 Information in conjunction with sampling for each operation mode (OL and/or CL)		
Parameter	Value	Unit
3.2.1 Ship information during sampling		
Cruise speed		knots
Start of sampling date and time		UTC
Stop of sampling date and time		UTC
Ship's position start of sampling		GPS
Ship's position end of sampling		GPS
Weather conditions (during sampling)		calm/rough
3.2.2 EGCS operation		
Approx. EGCS load		%
System operation mode		
Type of washwater treatment, if any		
Added chemicals for treatment		Name
Dosage rate of added chemicals for treatment during sampling		l/m^3
Average washwater flow rate to EGCS during sampling period		m^3/h
Average dilution water flow rate during sampling period, if given or relevant		m^3/h
3.2.3 Combustion unit(s) operation		
Approx. total combustion unit(s) load to EGCS		
Total fuel consumption		t/h
Fuel sulphur content (according BDN)		
Fuel viscosity if available		
Additional notes:		

3.2.4 Online monitoring readings during sampling, for each sampling point			
Monitoring unit	pH	PAH_{phe} µg/L or ppb	Turbidity FNU or NTU
Inlet (if available), average during sampling period			
Discharge point, average during sampling period		NA	NA
Before dilution, average during sampling period	NA		

3.2.5 Results to be reported by the laboratory		
Question	Answer	Comments
Satisfactory temperature at arrival	Yes/No	
Sampling bottles and transportation container prepared by laboratory	Yes/No	

Methods within the scope of ISO 17025 accreditation of the laboratory	Yes/No			
Date and time samples arrived at laboratory				
Date and time of analyses				
Parameter	Bottle ID	Preparation method	Analytical method	Result + unit
Polycyclic Aromatic Hydrocarbons (PAH): 16 EPA PAHs: Acenaphthene Acenaphthylene Anthracene Benzo-a-anthracene Benzo-a-pyrene Benzo-b-fluoranthene Benzo-g,h,i-perylene Benzo-k-fluoranthene Chrysene Dibenzo-a,h-anthracene Fluoranthene Fluorene Indeno-1,2,3-c,d-pyrene Naphthalene Phenanthrene Pyrene				
Hydrocarbon Oil Index GC-FID analysis				
Nitrate and nitrite ($NO3^-$/$NO2^-$)				
Total Metals: - Cd - Cu - Ni - Pb - Zn - As - Cr - V - Se				
Dissolved Metals: - Cd - Cu - Ni - Pb - Zn - As - Cr - V - Se				

3.2.6 List of bottle IDs or chain of custody (COC)

Sampling point	Parameter PAH	Parameter Metals	Parameter X
Inlet	Bottle #1 + time stamp	Bottle #2 + time stamp	Etc.
	Bottle # + time stamp	Bottle # + time stamp	Etc.
Etc.	Etc.	Etc.	Etc.

APPENDIX IV

Standard seawater titration curve

1. The following is a description of the chemical equilibrium model and the resulting titration curve shown in the graph below (figure 1 for pure seawater). The equilibrium model may include the effect of adding an additional alkali to the seawater (e.g. NaOH).

2. The titration curve in figure 1 is prepared by using a chemical equilibrium model for seawater. The model includes inorganic carbon, boric acid, sulphate, fluoride and dissolved SO2 equilibria; the equilibrium constants are functions of salinity (ionic strength) and temperature. The apparent pKa values for the equilibrium reactions are found in general oceanography literature, e.g. An Introduction to the Chemistry of the Sea, Michael E.Q. Pilson, Cambridge University Press (2013), and in the publication "The solubility of SO2 and the dissociation of H2SO3 in NaCl solutions", F. Millero, P. Hershey, G. Johnson and J. Zhang, Journal of Atmospheric Chemistry, 8 (1989). pH is given on the NBS scale.

3. Basis for the computed curve:
   - .1 Released CO2 retained in solution, i.e. no forced stripping of CO2;
   - .2 10% of dissolved S(IV) oxidized to S(VI) inside EGCS;
   - .3 Seawater alkalinity 2.2 mmol/L;
   - .4 Seawater salinity 35 psu;
   - .5 Seawater pH 8.2; and
   - .6 Seawater temperature 32°C.

4. Fit equation. The fit equation for pure seawater is provided based on an empirical equation fit to the EM curve. The equation is:

$$pH = 3.84 - 0.2308 \cdot SO_2 + \frac{1.403}{\left(0.0403 + exp\left(2.966 \cdot (SO_2 - 0.189)\right)\right)} + \frac{9.947}{\left(4.605 + exp\left(4.554 \cdot (SO_2 - 1.588)\right)\right)}$$

where the variable SO2 is defined as SO2 absorbed in mmol/kg seawater.

The "fit equation" is used for the determination of the dilution factor.

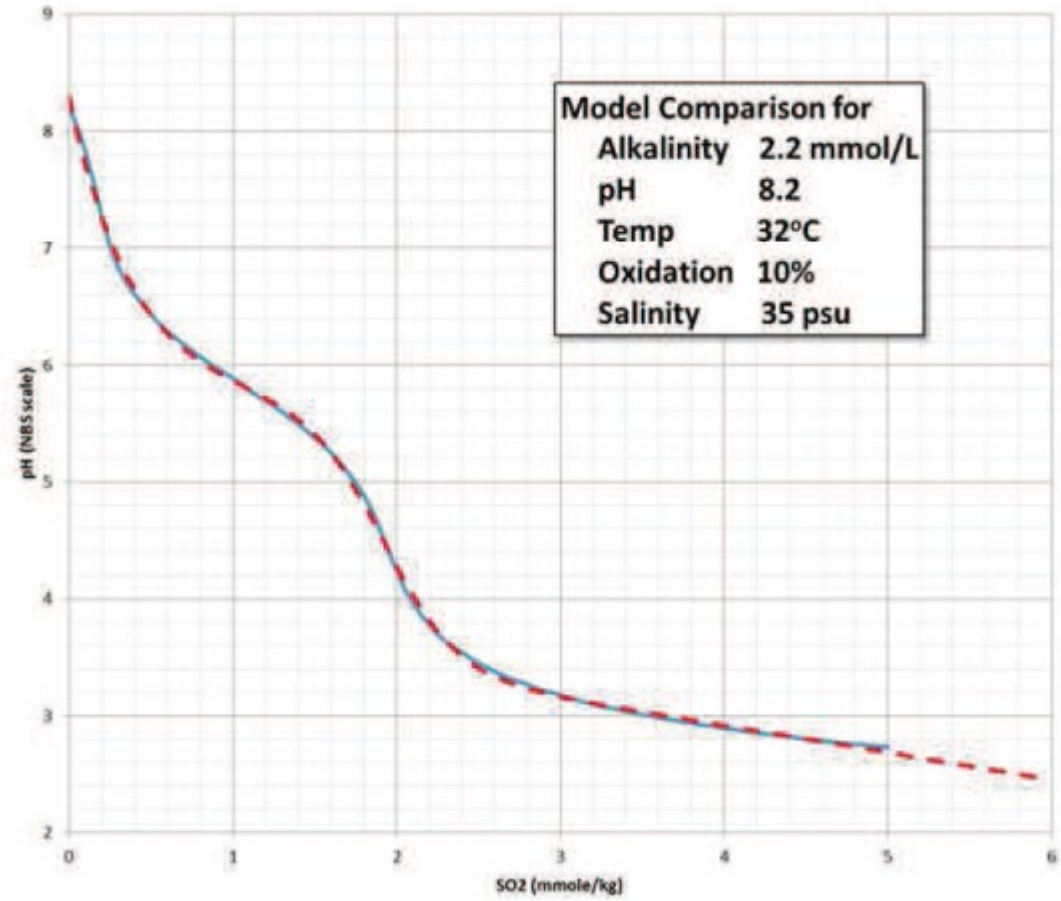

Figure 1 – pure seawater titration curve

APPENDIX V

Analyser information templates

Under subsection 8.2 of these Guidelines certain information, as a minimum, should be included in the OMM in order to facilitate surveys and inspections.

Paragraph 8.2.4 requires that information should be given in respect of the exhaust gas and discharge water analysers used in the respective monitoring systems. In order to provide a common approach to the layout and detail which should be included, the following templates are provided and may be used in the OMM. These templates represent the minimum information which should be given. Additional information may be required by the Administration.

The use of these templates is voluntary; however, a standardized layout will assist all users of the OMM.

Exhaust gas

SO_2 / CO_2 measurement Where common, so indicate		
Analyser	SO_2	CO_2
Analyser manufacturer		
Model reference		
Onboard identification reference		
Arrangement	In situ/extractive	In situ/extractive
Probe location		
Probe description	(i.e. probe length, single/multiple hole/heated filter/heated pump)	
Maximum measurement range	ppm	%
Used measurement range(s)	ppm	%
Zero gas specification		
Span gas specification		
Details of: service, maintenance, calibration schedules	Task/interval	Task/interval
Additional information		
Extractive systems only:		
Application	Single or multiple exhaust ducts (if multiple – state which ducts covered and sampling sequence, residence and purge times)	Single or multiple exhaust ducts (if multiple – state which ducts covered and sampling sequence, residence and purge times)
Sample line heated (if yes – maintained temperature °C)	Yes/No	Yes/No

Sample line details	Length, inner diameter	Length, inner diameter
Cooler/dryer: Manufacturer Model reference		
Additional information		

Water monitoring

pH/PAH/Turbidity* *delete as applicable	
Application	Seawater inlet/discharge water*
Analyser manufacturer	
Model reference	
Onboard identification reference	
Arrangement	In situ/bypass*
Position of sensor	
Maximum measurement range/units	
Used measurement range(s)/units	
Calibration fluid(s) – specification/ concentration/units	
Details of: service, maintenance, calibration schedules	Task/interval
Additional information	

APPENDIX VI
Safety Measures Against Chemical Treatment Fluids Used for Exhaust Gas Cleaning Systems and the Residues which Have Hazardous Properties

1. General

1.1 With regard to regulation 14 of MARPOL Annex VI requiring ships to use fuel oil with a sulphur content not exceeding that stipulated in regulations 14.1 or 14.4, regulation 4 allows, with the approval of the Administration, the use of an alternative compliance method at least as effective in terms of emission reductions as that required by the MARPOL Annex VI including the standards set forth in regulation 14.

1.2 As some types of exhaust gas cleaning systems to be approved by the Administration as "alternative compliance method" consume chemicals which are typically carried on board in bulk quantities, the prescriptive requirements contained in this Publication Appendix related safety measures against chemical treatment fluids apply to exhaust gas cleaning systems using such fluids. In this context, the term "chemical treatment fluid" means the aqueous solution of sodium hydroxide (NaOH) or calcium hydroxide ($Ca(OH)_2$) that has corrosive properties or are considered to represent a hazard to personnel (See section 2 of this Appendix).

1.3 For exhaust gas cleaning systems using chemicals other than the above, safety measures are to be taken according to the result of a risk assessment to be conducted to analyze the risks, in order to eliminate or mitigate the hazards to personnel brought by the use of such exhaust gas cleaning systems, to an extent equivalent to systems complying with 2.1 to 2.16 of this Appendix.

2. Requirements for exhaust gas cleaning systems using aqueous solution of NaOH or Ca(OH)2 for chemical treatment fluid

2.1 The storage tank for chemical treatment fluids is to be arranged so that any leakage will be contained and prevented from making contact with heated surfaces. All pipes or other tank penetrations are to be provided with manual closing valves attached to the tank. In cases where such valves are provided below top of tank, they are to be arranged with quick acting shutoff valves which are to be capable of being remotely operated from a position accessible even in the event of chemical treatment fluid leakages. Tank and piping arrangements are to be approved.

2.2 The storage tank is to be protected from excessively high or low temperatures applicable to the particular concentration chemical treatment fluids. Depending on the operational area of the ship, this may necessitate the fitting of heating and/or cooling systems.

2.3 If a storage tank for chemical treatment fluids 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. A warning notice requiring the use of such ventilation before entering the compartment shall be provided outside the compartment adjacent to each point of entry.

2.4 The storage tank may be located within the engine room. In this case, a separate ventilation system is not required when the general ventilation system for the space providing not less than 6 air changes per hour is arranged so as to provide an effective movement of air in the vicinity of the storage tank and is maintained in operation continuously except when the storage tank is empty and has been thoroughly ventilated.

2.5 Each storage tank for chemical treatment fluids is to be provided with level monitoring arrangements and high/low level alarms. In cases where heating and/or cooling systems are provided, high and/or low temperature alarms or temperature monitoring are also to be provided accordingly.

2.6 The storage tanks are to have sufficient strength to withstand a pressure corresponding to the maximum height of a fluid column in the overflow pipe, with a minimum of 2.4 m above the top plate taking into consideration the specific density of the treatment fluid.

2.7 Where chemical treatment fluid is stored in integral tanks, 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 and 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, cargo spaces containing cargoes which react with chemical treatment fluids in a hazardous manner as well as any food stores, oil tanks and fresh water tanks.

.3 These tanks are to be designed and constructed as per the structural requirements applicable to hull and primary support members for a deep tank construction.

.4 These tanks are to be included in the ship's stability calculation.

2.8 The requirements specified in point 2.3 of this appendix also apply to closed compartments normally entered by persons:

.1 when they are adjacent to the integral storage tank for chemical treatment fluids and there are possible leak points (e.g. manhole, fittings) from these tanks; or

.2 when the treatment fluid piping systems pass through these compartments, unless the piping system is made of steel or other equivalent material with melting point above 925 degrees C and with fully welded joints.

2.9 The chemical treatment fluid piping and venting systems are to be independent of other ship service piping and/or systems. The chemical treatment fluid piping systems are not to be located in accommodation, service spaces, or control stations. The vent pipes of the storage tank are to terminate in a safe location on the weather deck and the tank venting system is to be arranged to prevent entrance of water into the tank for chemical treatment fluids.

2.10 Storage tanks and pipes/piping systems for chemical treatment fluids which transfer undiluted chemical treatment fluids are to be of steel or other equivalent material with a melting point above 925 degrees C.

2.11 Storage tanks and pipes/piping systems for chemical treatment fluids are to be made with a material compatible with chemical treatment fluids, or coated with appropriate anti- corrosion coating.*

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* *Several metals are incompatible with the chemical treatment fluids, e.g. NaOH is incompatible with zinc, aluminum, etc.*

2.12 Regardless of design pressure and temperature, piping systems containing chemical treatment fluids only are to comply with the requirements applicable to Class I piping systems. As far as practicable, e.g. except for the flange connections that connect to tank valves, the piping systems are to be joined by welding.

2.13 The following connections are to be screened and fitted with drip trays to prevent the spread of any spillage where they are installed:

.1 Detachable connections between pipes (flanged connections and mechanical joints, etc.);
.2 Detachable connections between pipes and equipment such as pumps, strainers, heaters, valves; and
.3 Detachable connections between equipment mentioned in the above subparagraph.

The drip trays 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. In cases where such tank is an integral tank, point 2.7.1 and 2.7.2 of this appendix, are to be applied to the tank.

2.14 For the protection of crew members, the ship is to have on board suitable personnel protective equipment. The number of personnel protective equipment carried onboard is to be appropriate for the number of personnel engaged in regular handling operations or that may be exposed in the event of a failure; but in no case is there to be less than two sets available onboard.

2.15 Personnel protective equipment is to consist of protective clothing, boots, gloves and tight-fitting goggles.

Eyewash and safety showers are to be provided, the location and number of these eyewash stations and safety showers are to be derived from the detailed installation arrangements. As a minimum, the following stations are to be provided:

.1 In the vicinity of transfer or treatment pump locations. If there are multiple transfer or treatment pump locations on the same deck then one eyewash and safety shower station may be considered for acceptance provided that the station is easily accessible from all such pump locations on the same deck.
.2 An eyewash station and safety shower is to be provided in the vicinity of a chemical bunkering station on deck. If the bunkering connections are located on both port and starboard sides, then consideration is to be given to providing two eyewash stations and safety showers, one for each side.
.3 An eyewash station and safety shower is to be provided in the vicinity of any part of the system where a spillage/drainage may occur and in the vicinity of system connections/components that require periodic maintenance.

2.16 Storage tanks for chemical treatment fluids are to be arranged so that they can be emptied of the fluids and ventilated by means of portable or permanent systems.

3. Miscellaneous

3.1 Tanks for residues generated from the exhaust gas cleaning process are to satisfy the following requirements:

.1 The tanks are to be independent from other tanks, except in cases where these tanks are also used as the over flow tanks for chemical treatment fluids storage tank.
.2 Tank capacities are to be decided in consideration of the number and kinds of installed exhaust gas cleaning systems as well as the maximum number of days between ports where residue can be discharged ashore. In the absence of precise data, a figure of 30 days is to be used.
.3 Where residue tanks used in closed loop chemical treatment systems are also used as the overflow tanks for chemical treatment fluids storage tank, the requirements for storage tanks apply.

List of amendments effective as of 1 January 2023

Item	*Title/Subject*	*Source*
1.1-1.2, 2.1.1-2.1.6 2.1.8-2.1.10, 2.2 3.3-3.4, 4.1.2.1, 4.2.1 4.4.1, 4.5.1, 4.5.7-4.5.9 5.2.1-5.2.2, 5.3.1-5.3.2 5.4.1-5.4.2, 5.5.1, 5.5.3 5.6, 6.3, 6.10-6.11 7.2, 8.2-8.5, 9.1-9.4 10.1.2.1.2, 10.1.3.2 10.1.4.1, 10.1.4.3 10.1.5, 10.1.6.1 10.1.7.2-10.1.7.3 10.2-10.4, 10.5.2 10.6-10.7 Apendix I-Apendix V	New or updated requirements	MEPC 340(77)
10.1.7.1, 10.1.7.4-5 10.5.1, 10.5.3	New guidelines added	MEPC.1-Circ.900
10.1.6.2	New point added	MEPC.1-Circ.899