RULES

PUBLICATION 78/P

GUIDELINES FOR EXHAUST GAS SO_X-CLEANING SYSTEMS

July
2022

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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1 INTRODUCTION

1.1 This Publication has been developed in accordance with the requirements specified in *Resolution MEPC.259(68)* of 15.05.2015.

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

1.2 Similar to a NO_x emission reduction system, an EGC unit may be approved subject to periodic parameter and SO_X emission checks or the system may be equipped with a continuous SO_X emission monitoring system. Furthermore, the use of SO_2 (ppm)/CO_2(%) ratio method will simplify the monitoring of SO_X emission and facilitate approval of an EGC unit. See *Appendix II* hereto for detailed explanation.

1.3 Compliance shall be demonstrated on the basis of the SO_2 (ppm)/CO_2 (% v/v) ratio values.

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)
4.50	195.0
3.50	151.7
1.50	65.0
1.00	43.3
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* 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 – certification of an EGC system with parameter and SO_X emission checks,

Scheme B – certification of an EGC system with continuous SO_X emission monitoring and parameter checks.

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

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*.

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.

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 system/unit – exhaust gas SO_X cleaning system/unit.

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

ETM – EGC Technical Manual.

Fuel oil combustion unit – any engine, boiler, gas turbine or other fuel oil fired equipment, excluding shipboard incinerators.

GNSS – Global Navigation Satellite System.

Load range – maximum rated power of diesel engine or maximum steaming rate of a boiler.

MCR – maximum continuous rating.

OMM – Onboard Monitoring Manual.

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.

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 Logging System	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.

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

3.3 In locating discharge outlet of washwater used in the EGC unit, due consideration shall be given to the location of the ship's seawater inlet. In all operating conditions the pH should be maintained at a level that avoids damage to the vessel's antifouling system, the propeller, rudder and other components that may be vulnerable to acidic discharges, potentially causing accelerated corrosion of critical metal components.

4 SCHEME A

4.1 Approval of EGC Systems

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

4.1.1 EGC Unit Approval

4.1.1.1 EGC unit 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 4.2.1.3, 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 EGC unit and to demonstrate that the certified value can be met if the EGC unit 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, EGC units.

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 4.2.1.3 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 EGC unit 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 EGC Units

4.1.2.1 In the case of nominally similar EGC units of the same mass flow ratings as that certified in accordance with 4.1.1, and to avoid testing of each EGC unit, the equipment manufacturer may submit, for acceptance by PRS, the conformity of production arrangement. The certification of each EGC unit under this arrangement should be subject to such surveys that PRS may consider necessary as to ensure that each EGC unit has an emission value of not more than the certified value when operated in accordance with the parameters defined in 4.2.1.3.

4.1.2.2 Certification of each EGC unit 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 EGC units 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 EGC unit types.

4.1.3.3 For EGC units 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 4.2.1.3. 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 EGC 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 EGC unit, 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 EGC unit 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 EGC system manufacturer or shipowner.

4.1.4.3 Subsequent EGC units 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 EGC units 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 EGC units 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 identification of the unit: manufacturer name, model/type, serial number and other details as necessary;

.2 description of the unit and any required ancillary systems;

.3 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 power, type and other relevant parameters of the fuel oil combustion unit for which the EGC unit is intended, 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,
- maximum and minimum washwater flow rate, inlet pressures and minimum inlet water alkalinity (ISO 9963-1-2),
- exhaust gas inlet temperature ranges and maximum and minimum exhaust gas outlet temperature with the EGC unit in operation,
- exhaust gas differential pressure range and the maximum exhaust gas inlet pressure with the fuel oil combustion unit operating at MCR or 80% of power rating whichever is appropriate,
- salinity levels or fresh water elements necessary to provide adequate neutralizing agents,
- other factors concerning the design and operation of the EGC unit relevant to achieving a maximum SO_x emission value no higher than the certified value,

.4 any requirements or restrictions applicable to the EGC unit 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. The maintenance, servicing and adjustment parameters shall be recorded in the *EGC Record Book*;

.5 corrective actions in case of exceedances of the applicable maximum allowable SO_2/CO_2 ratio, or washwater discharge criteria;

.6 verification procedure to be used at surveys to ensure that its performance is maintained and that the unit is used as required;

.7 through range performance variation in washwater characteristics;

.8 design requirements of the washwater system; and

.9 the *SECC*.

4.2.2 ETM "Scheme A" shall be available onboard the ship being fitted with the EGC unit.

4.2.3 Amendments to the ETM "Scheme A" which reflect EGC unit 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 EGC unit 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 EGC unit should be issued with an SECC by PRS.

4.3.1.3 In those instances where EGC system 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 EGC unit shall be capable of reducing SO_X emissions to equal to or less than the certified value at any load within the specified range of operation of the oil fuel combustion machinery as excepted in paragraphs 4.4.7 and 4.4.8.

4.4.2 EGC units fitted to main propulsion diesel engines should fulfil the requirements specified in paragraph 4.4.1 at all loads between 25% and 100% of the load range of the engines to which they are fitted.

4.4.3 EGC units fitted to auxiliary diesel engines should fulfil the requirements of 4.4.1 at all loads between 10% and 100% of the load range of the engines to which they are fitted.

4.4.4 EGC units fitted to boilers shall fulfil the requirements specified in paragraph 4.4.1 at all loads between 10-100% of the load range (steaming rates) or, if the turn down ratio is smaller, over the actual load range of the boilers to which they are fitted.

4.4.5 EGC units fitted to diesel engines which supply power for both main propulsion and auxiliary purposes shall fulfil the requirements specified in paragraph 4.4.3.

4.4.6 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.

4.4.7 For loads below those specified in paragraphs 4.4.2 and 4.4.3, the EGC unit should continue in operation. In those cases where the fuel oil combustion unit may be required to operate under idling conditions, the SO_2 emission concentration (ppm) at standardized O_2 concentration (15.0% diesel engines, 3.0% boilers) should not exceed 50 ppm.

4.5 Onboard Procedures for Demonstrating Compliance with Emission Limit

4.5.1 For each EGC unit, the ETM "Scheme A" should contain a verification procedure to be used at surveys as required. This procedure should not require specialized equipment or an in-depth knowledge of the system. and the EGC unit shall be designed in such a way as to facilitate inspection as required. Where particular devices are required they shall be provided and maintained as part of the EGC system. The basis of this verification procedure is that if all the relevant components and operating values or settings are within those as approved, then the performance of the EGC system is within that required without the need for actual exhaust SO_X emission measurements. It is also necessary to ensure that the EGC unit is fitted to a fuel oil combustion unit for which it is rated – this forms ~~a~~ part of the SECP. Technical File related to the EIAPP certificate, if available, or Exhaust Gas Declaration issued by the engine maker or designer or another competent party or Flue Gas Declaration issued by the boiler maker or designer or another competent party serves this purpose to the satisfaction of PRS.

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

4.5.3 Verification procedure should be submitted by the EGC system 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 EGC unit 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 aboard, 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 EGC unit 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.

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, records of such consumption in the *EGC Record Book* also serve this purpose.

4.5.8 If a continuous exhaust gas monitoring system is not fitted, it is recommended that a daily spot check of the exhaust gas quality in terms of SO_2 (ppm)/CO_2 (%) ratio, be used to verify compliance together with parameter checks specified in paragraph 4.5.7. If a continuous exhaust gas monitoring system is fitted, only daily spot checks of the parameters listed in paragraph 4.5.7 shall be needed to verify proper operation of the EGC unit.

4.5.9 If the EGC system manufacturer is unable to provide assurance that the EGC unit will meet the certified value or below between surveys, by means of the verification procedure specified in paragraph 4.5.1, or if this requires specialist equipment or in-depth knowledge, it is recommended that continuous exhaust gas monitoring of each EGC unit be used, in accordance with Scheme B, to assure compliance with regulations 14.1 and/or 14.4.

4.5.10 *EGC Record Book* should be maintained by the shipowner recording maintenance and service of the unit including like-for-like replacement. This record shall be submitted by the EGC system manufacturer and approved by PRS. EGC Record Book shall be available at surveys as required and may be read in conjunction with engine room log-books and other data as necessary to confirm the correction operation of the EGC unit. Alternatively, this information should be recorded in the ship's planned maintenance record system as approved by PRS.

5 SCHEME B

This Scheme shall be used to demonstrate that the emissions from a fuel oil combustion unit fitted with an EGC will, with that system in operation, result in the required emission value (e.g., as stated in the SECP) or below at any load point, including during transient operation and thus to demonstrate compliance with the requirements of regulations 14.1 and/or 14.4 of MARPOL Annex VI.

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 EGC unit is subject to survey on installation at Initial, Annual/Intermediate and Renewals Surveys by PRS.

5.2.1.1 In accordance with regulation 10 of MARPOL Annex VI monitoring systems of EGC units may also be subject to inspection by Port State control.

5.2.1.2 Prior to use, each EGC unit should be issued with an SECC by PRS.

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

5.3 Calculation of SO_X Emission Rate

5.3.1 Exhaust gas composition SO_2 (ppm)/CO_2 (%) ratio method should be measured at an appropriate position after the EGC unit and fulfil the requirements specified in paragraphs 6.2 to 6.15.

5.3.2 SO_2 (ppm) and CO_2 (%) to be continuously monitored and entered into the data recording and processing device at a rate which will not be less than 0.0035 Hz.

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 Data recording system shall fulfil the requirements specified in chapters 7 and 8.

5.4.2 Daily spot checks of the operating parameters are needed to verify proper operation of the EGC unit and shall be entered in the *EGC Record Book* or in the engine room logger system.

5.5 System Technical Manual (ETM) "Scheme B"

5.5.1 Each EGC unit shall be supplied with an EGC – SO_X Technical Manual for Scheme B, hereinafter referred to as ETM "Scheme B", provided by the manufacturer. This ETM "Scheme B" should contain at least:

.1 identification of the unit (manufacturer, model/type, serial number and other details as necessary);

.2 description of the unit and any required ancillary systems;

.3 operating limits, or range of operating values, for which the unit is certified:

- maximum and, if applicable, minimum mass flow rate of exhaust gas,
- power, type of the fuel oil combustion unit for which the EGC unit is to be fitted and also other relevant parameters:

  for diesel engines – information whether the engine is of 2 or 4 stroke cycle,

  for boilers – the maximum air/fuel ratio at 100% load,
- maximum and minimum washwater flow rate, inlet pressures and minimum inlet water alkalinity (ISO 9963-1-2),
- exhaust gas inlet temperature ranges and maximum and minimum exhaust gas outlet temperature,
- exhaust gas differential pressure range and the maximum exhaust gas inlet pressure with the fuel oil combustion unit operating at MCR or 80% of power rating whichever is appropriate,
- salinity levels or fresh water elements necessary to provide adequate neutralizing agents,
- other parameters as necessary concerning the operation of the EGC unit;

.4 any requirements or restrictions applicable to the EGC unit or associated equipment;

.5 corrective actions in case of exceedances of the applicable maximum allowable SO2/CO2 ratio, or washwater discharge criteria;

.6 through range performance variation in washwater characteristics;

.7 design requirements of the washwater system.

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

5.5.3 Amendments to the ETM "Scheme B" which reflect EGC 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 are separate to the ETM as initially approved, they should be retained with the ETM and should be considered as part of the ETM "Scheme B".

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 Analyser performance should be in accordance with the requirements of sections 1.6 to 1.10 of Appendix III to the NO_X Technical Code 2008.

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.

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 Recording and processing device should record the data required in paragraphs 4.5.7, 5.5.2, and 10.3 against UTC and ship's position by the Global Navigational Satellite System (GNSS).

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 sensors to be used in evaluating EGC system performance and washwater monitoring, their service, maintenance and calibration requirements;

.2 positions from which exhaust emission measurements and washwater monitoring will be taken together with details of any necessary ancillary services such as sample transfer lines and sample treatment units and any related service or maintenance requirements;
.3 analysers to be used, their service, maintenance, and calibration requirements;
.4 analyser zero and span check procedures;
.5 other information or data relevant to the correct functioning of the monitoring systems or its use in demonstrating compliance.

8.3 *OMM* shall specify how the monitoring is to be surveyed.

8.4 *OMM* shall be submitted to PRS/Administration for approval.

9 SHIP COMPLIANCE

9.1 SO_x Emisson Compliance Plan (SECP)

9.1.1 For all ships using an EGC unit, 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 Under Scheme A, the SECP should present how continuous monitoring data will demonstrate that the parameters mentioned in paragraph 4.5.7 are maintained within the manufacturer's recommended specifications.

Under Scheme B, this would be demonstrated using daily recordings of the key parameters.

9.1.4 Under Scheme B, the SECP should present how continuous exhaust gas emissions monitoring will demonstrate that the ship total SO_2 (ppm)/CO_2 (%) ratio is comparable to requirements of 14.1 and/or 14.4 or below as prescribed in paragraph 1.3.

Under Scheme A, this would be demonstrated using daily exhaust gas emission recordings.

9.1.5 There may be some equipment such as small engines and boilers to which the fitting of EGC units would not be practical, particularly where such equipment is located in a position remote from the main machinery spaces. All such oil fuel combustion units should be listed in the SECP. For these fuel oil combustion units which are not fitted with EGC units, compliance may be achieved by means of regulation 14(4)(a) of Annex VI to MARPOL.

9.2 Demonstration of Compliance

9.2.1 Scheme A

9.2.1.1 *SECP* shall refer to rather than reproduce, the *ETM-A*, *EGC Record Book* or Engine Room logger system and *OMM* as specified under Scheme A. It should be noted that as an alternative, the maintenance records may be recorded in the ship's planned maintenance record system, as allowed by the PRS.

9.2.1.2 For all fuel oil combustion unit mentioned in paragraph 9.1.1, details should be provided demonstrating that the rating and restrictions specified in for the EGC unit as approved, 4.2.1.3, are fulfilled.

9.2.1.3 Required parameters shall 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

When the EGC System is operated in a ports, harbours, or estuaries, the washwater monitoring and recording shall be continuous. The values monitored and recorded shall include pH, PAH, turbidity and temperature. In other areas the continuous monitoring and recording equipment should also be in operation, except for short periods of maintenance and cleaning of equipment. The discharge water shall comply with the following limits:

10.1.1 pH Criteria

10.1.1.1 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 EGC system is operated at the highest fuel sulphur content and load for which the EGC system is certified (Scheme A) or used with (Scheme B);
- where the washwater flow rate is varied in accordance with the EGC system 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 sea-water alkalinity of 2,200 µmol/litre 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; and

[1] These values could be revised within two years for new installations following the adoption of MEPC.259(68) upon further inputs of the physical state of seas resulting from the use of exhaust gas cleaning systems.

– 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.

10.1.2 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:

10.1.2.1 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, but upstream of any washwater dilution or other reactant dosing unit, if used, prior to discharge.

10.1.2.2 The 50 µg/L limit described above is normalized for a washwater flow rate through the EGC unit of 45t/MWh where the MW refers to the MCR (100%) or 80% of the power rating of the fuel oil combustion unit. This limit would have to be adjusted upward for lower washwater flow rates per MWh, and vice-versa, in accordance with 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_{phe} (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

10.1.2.3 For a 15-minute period in any 12-hour period, the continuous PAH_{phe} concentration limit may exceed the limit described above by up to 100%. This would allow for an abnormal start up of the EGC.

10.1.3 Turbidity/Suspense Particle Matter Criterion

Washwater turbidity shall fulfil the following requirements. The limit should be recorded in the ETM-A or ETM-B.

10.1.3.1 Washwater treatment system should be so designed as to minimize suspended particulate matter, including heavy metals and ash.

10.1.3.2 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

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

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.

10.1.3.3 For a 15-minute period in any 12-hour period, the continuous turbidity discharge limit may be exceeded by 20%.

10.1.4 Nitrates

10.1.4.1 Washwater treatment system shall prevent the discharge of nitrates beyond that associated with a 12% removal of NOx from the exhaust, or beyond 60 mg/*l* normalized for washwater discharge rate of 45 tons/MWh whichever is greater.

10.1.4.2 At each renewal survey nitrate discharge, data is to be available in respect of sample overboard discharge drawn from each EGC system for the previous three months prior to the survey. PRS may, however, require and additional sample to be drawn and analysed at their discretion. The nitrate discharge data and analysis certificate is to be retained on board the ship as part of the EGC Record Book and be available for inspection as required by Port State Control or other parties. Requirements 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 the requirements specified in paragraph 10.1.4.1 which specifies the need for washwater flow normalization. The test method for the analysis of nitrates should be according to standard seawater analysis as described in Grasshoff et al.

10.1.4.3 All systems should be tested for nitrates in the discharge water. If typical nitrate amounts are above 80% of the upper limit, it should be recorded in the ETM-A or ETM-B.

10.1.5 Washwater Additives and other Substances

10.1.5.1 Assessment of the washwater is required for those EGC technologies which make use of chemicals, additives, preparations or create relevant chemicals *in situ*. The assessment could also take into account relevant guidelines such as resolution MEPC 169.(57) – *Procedure for approval of ballast water management systems that make use of active substances* (G9) and, if necessary, additional washwater discharge criteria should be established.

10.2 Washwater Monitoring

Such parameters as pH, oil content (as measured by PAH levels), and turbidity should be continuously monitored and recorded. The monitoring equipment shall also fulfil the performance criteria described below.

10.2.1 pH Measurement

10.2.1.1 Both pH electrode and pH meter should have a resolution of 0.1 pH units and temperature compensation. The electrode shall fulfil the requirements specified in BS 2586 or of equivalent or have better performance and the meter should meet or exceed the requirements specified in BS EN ISO 60746-2:2003.

10.2.2 PAH Monitoring

10.2.2.1 PAH monitoring equipment should be capable of monitoring PAH in water in a range to at least twice the discharge concentration limit specified in Table 10.1.2. The equipment should be demonstrated to operate correctly and not deviate more than 5% in washwater with turbidity within the working range of the application.

10.2.2.2 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.

10.2.3 Turbidity Monitoring

10.2.3.1 Turbidity monitoring equipment should fulfil the requirements specified in ISO 7027:1999 as amended or USEPA 180.1.

10.3 Washwater Monitoring Data Recording

10.3.1 Data recording system should fulfil the requirements specified in chapters 7 and 8 and shall continuously record pH, PAH and turbidity in accordance with washwater criteria specified in Chapter 10.

10.4 Washwater Residue

10.4.1 Residues generated by the EGC unit should be delivered ashore to adequate reception facilities. Such residues shall not be discharged to the sea or incinerated on board.

10.4.2 Each ship fitted with an EGC unit should record the storage and disposal of washwater residues in the *EGC Record Boo*k, including the date, time and location of such storage and disposal. The EGC log may form a part of an existing log-book or electronic data recording book.

APPENDIX I
FORM OF SO_X EMISSION COMPLIANCE CERTIFICATE

NAME OF ADMINISTRATION

SO_X EMISSION COMPLIANCE CERTIFICATE

CERTIFICATE OF UNIT APPROVAL FOR EXHAUST GAS CLEANING SYSTEM

Issued under the provisions of the Protocol of 1997, as amended by resolution MEPC.176(58) in 2008, to amend the International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 related 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 (EGC) unit/system has been surveyed in accordance with the requirements of the specifications contained under Scheme A in the Guidelines for exhaust gas cleaning systems – adopted by resolution MEPC.259(68).

The certificate is valid only for the following EGC unit/system:

Unit manufacturer	Model/ type	Serial number	EGC System/Unit and Technical Manual approval number

A copy of this Certificate, together with the EGC System Technical Manual, shall be carried on board of the ship fitted with this EGC System unit at all times.

This Certificate is valid for the life of the EGC System/unit subject to surveys in accordance with section 4.2 of the Guidelines and regulation 5 of the revised 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
PROOF OF SO_2/CO_2 RATIO METHOD

1 The SO_2/CO_2 ratio method enables direct monitoring of exhaust gas emissions to verify compliance with emissions limits set out in Table 1 of this *Publication*. In the case of the EGC systems that absorb CO_2 during the exhaust gas cleaning process it is necessary to measure the CO_2 prior to cleaning process and use the CO_2 concentration before cleaning with the SO_2 concentration after cleaning. For conventional low alkali cleaning systems virtually no CO_2 is absorbed during exhaust gas cleaning and therefore monitoring of both gases can be undertaken after the cleaning process.

2 Correspondence between the SO_2/CO_2 ratio can be determined by simple inspection of the respective carbon contents per unit mass of distillate and residual fuel. For this group of hydrocarbon fuel the carbon content as a percentage of mass remains closely similar, whereas the hydrogen content differs. Thus it can be concluded that for given carbon consumption by combustion there will be a consumption of sulphur in proportion to the sulphur content of the fuel, or in other words a constant ratio between carbon and sulphur adjusted for the molecular weight of oxygen from combustion.

3 The first development of the SO_2/CO_2 ratio considered its use to verify compliance with emissions from 1.5% S fuel. The limit of 65 [ppm/%] SO_2/CO_2 for 1.5% sulphur in fuel can be demonstrated by first calculating the mass ratio of fuel sulphur to fuel carbon, which is tabulated in Table 1 for various fuels and fuel sulphur contents; including 1.5% sulphur for both distillate and residual fuels.

These ratios were used to solve for the corresponding SO_2 and CO_2 concentrations in exhaust, which are indicated in Table 2.

Molecular weights (MW) were taken into account to convert mass fractions to mole fractions.

For the 1.5% sulphur fuels specified in Table 2, the amount of CO_2 is set first at 8% and then changed to 0.5% to show that there is no effect due to changes in excess air. As expected, the absolute SO_2 concentration changes, but the SO_2 /CO_2 ratio does not. This indicates that the SO_2/CO_2 ratio is independent of fuel-to-air ratios. Therefore, SO_2/CO_2 ratio can be used robustly at any point of operation, including operation where no brake power is produced.

Note that the SO_2/CO_2 ratio varies slightly from distillate to residual fuel. This occurs because of the very different atomic hydrogen-to-carbon ratios (H:C) of the two fuels. The diagram in Fig. 1 illustrates the extent of the SO_2/CO_2 ratios' sensitivity to H:C over a broad range of H:C and fuel sulphur concentrations. From Figure 1, it can be concluded that for fuel sulphur levels less than 3.00% S, the difference in S/C ratios for distillate and residual fuel is less than 5.0%

In the case of using non-petroleum fuel oils, the appropriate SO_2/CO_2 ratio applicable to the values given in regulations 14.1 and/or 14.4 is subject to approval by the Administration.

Table 1
Fuel properties for marine distillate and residual fuel*

	Carbon ©	Hydrogen (H)	Sulphur (S)	Other	C	H	S	Fuel S/C	Exhaust gas SO_2/CO_2
Fuel type	% (m/m)	% (m/m)	% (m/m)	% (m/m)	mol/kg	mol/kg	mol/kg	mol/mol	ppm/%(v/v)
Distillate	86.20	13.60	0.17	0.03	71.8333	136	0.0531	0.00074	7.39559
Residual	86.10	10.90	2.70	0.30	71.7500	109	0.8438	0.01176	117.5958
Distillate	85.,05	13.42	1.50	0.03	70.8750	134.2	0,4688	0.006614	66.1376
Residual	87.17	11.03	1.50	0.30	72.6417	110.3	0.4688	0.006453	64.5291

* Based on the properties in the IMO No_x *Monitoring Guidelines* (MEPC.103(49)).

Table 2
Emission calculations corresponding to 1.5% fuel sulphur

	CO_2	SO_2	Exhaust gas: SO_2/CO_2	Exhaust gas: S/C
Fuel type	%	ppm	ppm/%	g/g
Distillate 0.17 % S	8	59.1	7.4	0.00197
Residual 2.70 % S	8	939.7	117.5	0.03136
Distillate 1.5 % S	8	528.5	**66.1**	**0.01764**
Residual 1.5 % S	8	515.7	**64.5**	**0.01721**
Distillate 1,5 % S	0.5	33.0	**66.1**	**0.01764**
Residual 1,5 % S	0.5	32.2	**64.5**	**0.01721**

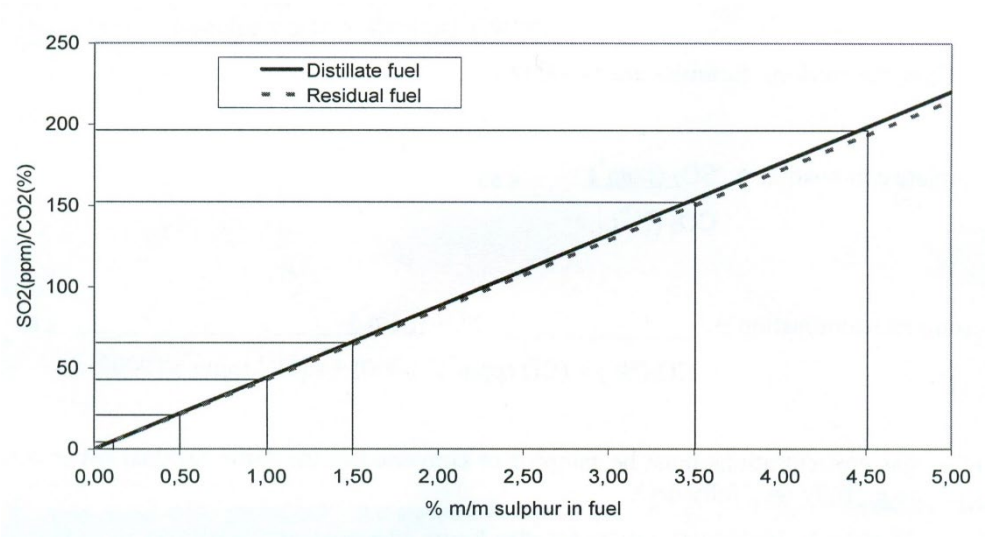

Fig. 1. SO_2/CO_2 ratio vs % sulphur in Fuel

4. Correspondence between 65 (ppm/%) SO_2/CO_2 and 6.0 g/kWh is demonstrated by showing that their S/C ratios are similar.

This requires the additional assumption of a brake-specific fuel consumption value of 200 g/kWh. This is an appropriate average for marine diesel engines.

The calculation is as follows:

Note 1: The S/C mass ratios calculated above, based on 6,0 g/kWh and 200 g/kWh BSFC, are both within 0.10% of the S/C mass ratios in the emissions table (Table 2). Therefore, 65 (ppm/%) SO_2/SO_2 corresponds well to 6.0 g/kWh.

Note 2: The value of 6.0 g/kWh, hence the 200g/kWh brake-specified fuel consumption is taken from MARPOL Annex VI.

$$S/C_{fuel} = \frac{\text{brake-specific } SO_2 \times (MW_S/MW_{SO2})}{\text{BSFC} \times (\%\text{ carbon in fuel}/100)}$$

where:
BSFC – brake-specific fuel consumption value
brake-specific SO_2 = 6.0 g/kWh

MW_S = 32.065 g/mol
MW_{SO2} = 64.064 g/mol
BSFC = 200g/kWh
% carbon in 1.5% S fuel (see Table 1)=85.05% (distillate)&87.17% (residual)

$$S/C_{\text{residual fuel}} = \frac{6.0\ (32.065/64.064)}{200\ (87.17\%\ /100)} = \mathbf{0.01723}$$

$$S/C_{\text{distillate fuel}} = \frac{6.0\ (32.065/64.064)}{200\ (85.05\%\ /100)} = \mathbf{0.01765}$$

5. Thus, the working formulae are as follows:

for complete combustion: $\dfrac{SO_2\ [ppm]\ *}{CO_2\ [\%]\ *} \leq 65$

for incomplete combustion: $\dfrac{SO_2\ [ppm]\ *}{CO_2\ [\%]\ * + (CO\ [ppm]*/10000\ THC[ppm]*/10000)} \leq 65$

* Gas concentrations must be sampled or converted to the same residual water content (e.g. fully wet, fully dry).

6. The following is the basis for using the 65(ppm/%) SO_2/CO_2 as the limit for determining compliance with regulation 14.1 or 14.4 of the *Convention*:

.1 This limit can be used to determine compliance from fuel oil burners that do not produce mechanical power,
.2 This limit can be used to determine compliance at any power output, including idle,
.3 This limit only requires two gas concentration measurements at one sampling location,
.4 There is no need to measure any engine parameters such as engine speed, engine torque, engine exhaust flow, or engine fuel flow,
.5 If both gas concentration measurements are made at the same residual water content in the sample (e.g. fully wet, fully dry), no dry-to-wet conversion factors are required in the calculation,
.6 This limit completely decouples the thermal efficiency of the fuel oil combustion unit from the EGC unit,
.7 No fuel properties need to be known,
.8 As only two measurements are being taken at a single location, transient engine or EGCS unit effects can be minimized by aligning signals from just these two analysers. (Note that the most appropriate points to align are the points where each analyser responds to a step change in emissions at the sample probe by 50% of the steady-state value),
.9 This limit is independent of the amount of exhaust gas dilution. Dilution may occur due to evaporation of water in an EGCS-SO_X unit, and as part of an exhaust sampler's preconditioning system.

APPENDIX III
WASHWATER DATA COLLECTION

The washwater discharge criteria are intended to act as initial guidance for implementing EGC system designs. The criteria should be revised in the future as more data becomes available on the contents of the discharge and its effects, taking into account any advice given by GESAMP.

PRS acting under the authority of the Administrations will therefore provide for collection of relevant data. To this end, shipowners in conjunction with the EGC manufacturer are requested to sample and analyse samples of:

- inlet water(for background);
- water after the scrubber (but before any treatment system); and
- discharge water.

This sampling may be performed during approval testing or shortly after commissioning and at about twelve-month intervals for a period of two years of operation (minimum of three samples).

Sampling quidance and analysis should be undertaken by laboratories using EPA or ISO test procedures for the following parameters:

- pH
- PAH and oil (detailed GC-MS analysis)
- nitrate
- nitrite
- Cd
- Cu
- Ni
- Pb
- Zn
- As
- Cr
- V

The extent of laboratory testing may be varied or enhanced in the light of developing knowledge.

When submitting sample, information on washwater discharge flow rates, dilution of discharge shall also be included, if applicable, and engine power should be included as well as specifications of the fuel used from the BDN as a minimum.

It is recommended that the ship that has provided this information to the satisfaction of the Administration should be granted a waiver for compliance of the existing installation(s) to possible future stricter washwater discharge standards.

APPENDIX IV
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.*

* *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 July 2022

Item	*Title/Subject*	*Source*
3.1 and Appendix IV	New Appendix IV added: Safety measures against chemical treatment fluids used for exhaust gas cleaning systems and the residues which have hazardous properties	IACS UR M81 (new Jan 21)
