ANNEX 3

RESOLUTION MEPC.399(83)
(adopted on 11 April 2025)

2025 GUIDELINES ON SELECTIVE CATALYTIC REDUCTION (SCR) SYSTEMS

THE MARINE ENVIRONMENT PROTECTION COMMITTEE,

RECALLING Article 38(a) of the Convention on the International Maritime Organization concerning the functions of the Marine Environment Protection Committee conferred upon it by international conventions for the prevention and control of marine pollution from ships,

RECALLING ALSO that, at its fifty-eighth session, it adopted, by resolution MEPC.176(58), a revised MARPOL Annex VI (hereinafter "MARPOL Annex VI") and, by resolution MEPC.177(58), a revised Technical Code on Control of Emission of Nitrogen Oxides from Marine Diesel Engines (hereinafter "NO_x Technical Code 2008"),

NOTING regulation 13 of MARPOL Annex VI, which makes the NO_x Technical Code 2008 mandatory under that Annex,

NOTING ALSO that the use of NO_x-reducing devices is envisaged in the NO_x Technical Code 2008 and that selective catalytic reduction (SCR) systems are such NO_x-reducing devices for compliance with the Tier III NO_x limit,

NOTING FURTHER that, at its seventy-first session, it adopted, by resolution MEPC.291(71), the *2017 Guidelines addressing additional aspects to the NO_x Technical Code 2008 with regard to particular requirements related to marine diesel engines fitted with Selective Catalytic Reduction (SCR) Systems* (2017 SCR Guidelines), and, at its seventy-fourth session, by resolution MEPC.313(74), amendments thereto,

RECOGNIZING the need to update the 2017 SCR Guidelines in line with the latest developments,

HAVING CONSIDERED, at its eighty-third session, a draft revision of the 2017 SCR Guidelines, prepared by the Sub-Committee on Pollution Prevention and Response,

1 ADOPTS the *2025 Guidelines on selective catalytic reduction (SCR) systems*, as set out in the annex to the present resolution;

2 INVITES Administrations to implement the 2025 SCR Guidelines and apply them to SCR systems installed on ships the keels of which are laid or which are at a similar stage of construction on or after 1 November 2025; or SCR systems installed on ships the keels of which are laid or which are at a similar stage of construction before 1 November 2025 which have a contractual delivery date of SCR systems to the ship on or after 1 May 2026 or, in the absence of a contractual delivery date, the actual delivery of the SCR system to the ship on or after 1 May 2026;

3 REQUESTS Parties to MARPOL Annex VI and other Member Governments to bring the annexed Guidelines to the attention of shipowners, ship operators, shipbuilders, marine diesel engine manufacturers and any other interested parties;

4 AGREES to keep these Guidelines under review in light of experience gained with their application, with a view to incorporating them into the NO_x Technical Code 2008;

5 ALSO AGREES that these Guidelines supersede the 2017 SCR Guidelines, adopted by resolution MEPC.291(71) and amended by resolution MEPC.313(74).

ANNEX

2025 GUIDELINES ON SELECTIVE CATALYTIC REDUCTION (SCR) SYSTEMS

TABLE OF CONTENTS

1 INTRODUCTION

1.1 The use of NO_x-reducing devices is envisaged in section 2.2.5 of the NO_x Technical Code 2008 (NTC 2008) and a Selective Catalytic Reduction (SCR) system is one of such devices.

1.2 The NTC 2008 contains two ways for pre-certification of engine systems fitted with NO_x-reducing devices:

.1 engine fitted with SCR: approval in accordance with paragraph 2.2.5.1 and test in accordance with chapter 5 of the NTC 2008; and

.2 a simplified measurement method in accordance with section 6.3 of the NTC 2008 as regulated in paragraph 2.2.5.2 (Primary failure case) of the Code.

1.3 According to paragraph 2.2.5.1 of the NTC 2008, where a NO_x-reducing device is to be included within the EIAPP certification, it must be recognized as a component of the engine, and its presence shall be recorded in the engine's Technical File.

1.4 Administrations are invited to take these Guidelines into account when certifying engines fitted with SCR.

2 GENERAL

2.1 Purpose

The purpose of these Guidelines is to provide guidance in addition to the requirements of the NTC 2008 for design, testing, surveys and certification of marine diesel engines fitted with an SCR system to ensure its compliance with the requirements of regulation 13 of MARPOL Annex VI.

2.2 Application

These Guidelines apply to marine diesel engines fitted with SCR for compliance with regulation 13 of MARPOL Annex VI.

2.3 Definitions

Unless provided otherwise, the terms in these Guidelines have the same meaning as the terms defined in regulation 2 of MARPOL Annex VI and in section 1.3 of the NTC 2008.

2.3.1 "Engine system fitted with SCR" means a system consisting of a marine diesel engine, an SCR chamber and a reductant injection system. When a control device on NO_x-reducing performance is provided, it is also regarded as a part of the system.

2.3.2 "Catalyst block" means a block of certain dimension through which exhaust gas passes and which contains catalyst composition on its inside surface to reduce NO_x from the exhaust gas.

2.3.3 "SCR chamber" means an integrated unit which contains the catalyst block(s) and into which flow exhaust gas and reductant.

2.3.4 "Reductant injection system" means a system which consists of the pump(s) to supply reductant to the nozzle(s), the nozzle(s) spraying reductant into the exhaust gas stream and control device(s) of the spray.

2.3.5 "AV (area velocity) value" means a value of the exhaust gas flow rate passing through the catalyst blocks (m^3/h) per total active surface area of the catalyst blocks in the SCR chamber (m^2). Therefore, the unit of AV value is (m/h). The exhaust gas flow volume is the volume defined at 0°C and 101.3 kPa.

2.3.6 "SV (space velocity) value" means a value of the exhaust gas flow rate passing through the catalyst block(s) (m^3/h) per total volume of the catalyst block(s) in the SCR chamber (m^3). Therefore, the unit of SV value is (1/h). The exhaust gas flow volume is the volume defined at 0°C and 101.3 kPa.

2.3.7 "Total volume of the catalyst block" means the volume (m^3) based on the outer dimensions of the catalyst block.

2.3.8 "LV (linear velocity) value" means a value of the exhaust gas flow rate passing through the catalyst blocks (m^3/h) per catalyst block's section (m^2) in a normal direction of exhaust gas flow. Therefore, the unit of LV value is (m/h). The exhaust gas flow volume is the volume defined at 0°C and 101.3 kPa.

2.3.9 "Block section" means the cross-sectional area (m^2) of the catalyst block based on the outer dimensions.

2.3.10 "NO_x reduction rate η" means a value deriving from the following formula. Unit of η is (%):

$$\eta = \frac{(c_{inlet} - c_{outlet})}{c_{inlet}} \cdot 100$$

Where: c_{inlet} is NO_x concentration (ppm) as measured at the inlet of the SCR chamber;

c_{outlet} is NO_x concentration (ppm) as measured at the outlet of the SCR chamber.

2.3.11 "Catalyst block casing or frame" means a casing or frame of an assembly (module) of several catalyst blocks.

3 PRE-CERTIFICATION PROCEDURE

3.1 General

3.1.1 Engine systems fitted with SCR should be certified in accordance with chapter 2 of the NTC 2008. The procedures provided by Scheme A or Scheme B of these Guidelines should be applied.

3.1.2 The applicant for certification should be the entity responsible for the complete engine system fitted with SCR.

3.1.3 The applicant should supply all necessary documentation, including the Technical File for the complete system, a description of the required onboard NO_x verification procedure and, where applicable, the description of the confirmation test procedure.

3.2 Technical File and onboard NO_x verification procedures

In addition to the information supplied in paragraph 3.1.3 of these Guidelines and items in section 2.4 of the NTC 2008, engine systems fitted with SCR should include the following information in the Technical File:

.1 reductant: component/type and concentration;

.2 reductant injection system including critical dimensions and supply volume;

.3 design features of SCR specific components in the exhaust duct from the engine exhaust manifold to the SCR chamber. The design features are to be specified by the applicant and may include, but are not limited to:

.1 any restrictions specified by the applicant relating to exhaust duct configuration/design, including the position and number of bends in the exhaust duct along with orientation and geometry, exhaust duct changes of diameter and arrangements fitted to manipulate exhaust flow, where applicable;

.2 minimum distance between reductant injection point(s) and SCR chamber;

.3 position of reductant injection equipment within the duct and the direction of reductant injection, e.g. counter flow or parallel flow;

.4 reductant mixing arrangements;

.5 reductant lances, nozzles, atomizing arrangement;

.6 inlet plenum design, top entry or bottom entry;

.7 where an SCR bypass arrangement is stipulated by the applicant, the control specifications, identification of the bypass valve and its control device; and

.8 where an integrated reductant injection and SCR chamber arrangement is supplied as a packaged item to be fitted into an exhaust duct, the parameters of such a unit which may affect NO_x emissions;

.4 catalyst block specification and arrangement in the SCR chamber. The details of the catalyst block specification and the arrangement of catalyst blocks within the SCR chamber may include, but are not limited to:

.1 installation of blocks within the SCR chamber, including the number of blocks, number of layers and the SCR chamber casing and frame to prevent exhaust gas slip;

.2 catalyst block geometry;

.3 limiting characteristics such as CPSI (cells per square inch) and ranges for physical parameters such as the space velocity (SV), area velocity (AV) and linear velocity (LV), or a part number or specification number specified by the applicant on the catalyst block;

.4 catalyst material: this may be identified by means of a part number or specification number. The means to ensure a correct catalyst block installed on board against the Technical File, where a part number or specification number specified by the applicant on the catalyst block casing or frame is acceptable;

.5 arrangement of soot-blowing equipment;

.6 inspection and access arrangements. The inspection of the SCR chamber should be limited to ensuring that the correct catalyst blocks are fitted during assembly of the SCR and the inspection of spare catalyst blocks can be accepted to demonstrate compliance at surveys other than at the initial assembly of the SCR; and

.7 any baffle plates or other devices installed within the SCR chamber for exhaust gas and reductant flow distribution;

.5 inlet parameters, including allowable exhaust gas temperature (maximum and minimum) at the inlet of the SCR chamber;

.6 cross-unit parameters: allowable pressure loss (Δp) between inlet and outlet of the SCR chamber and in the exhaust duct caused by SCR components. Where there is any element of the SCR system upstream and/or downstream of the SCR chamber which affects the allowable pressure loss, then this allowable pressure loss (Δp) is to be based on the entire SCR system;

.7 aspects related to the fuel oil quality resulting in continued compliance of the engine with the applicable NO_x emission limit to assure continued NO_x reduction may include, but are not limited to:

.1 the maximum allowable sulphur content of fuel oil which can be combusted, while maintaining compliance; and

.2 guidance on applicable fuel oil composition and fuel oil contaminants under operational conditions;

.8 factors related to the deterioration rate of SCR performance, e.g. exchange condition for SCR catalyst blocks and recommended exchange time of SCR catalyst blocks:

.1 where a reductant control strategy incorporates a NO_x measurement device, this is acceptable as a means of monitoring catalyst condition/degradation. A NO_x measurement device, incorporated in an SCR feedback or feed-forward reductant control system, should not be required to be in compliance with appendix III of the NTC 2008 if the suitability of this NO_x measurement device is proven by a comparison with measurements according to chapter 5 of NTC 2008.

The applicant should specify a procedure and/or calculation routine that utilizes the readings of the NO_x measurement device to generate criteria for the determination of the catalyst condition/ degradation.

The applicant should demonstrate that the outcome of the proposed method is sufficiently accurate to adequately monitor the catalyst condition/degradation. This may be achieved by comparing the outcome of the proposed method with the results from the same method, calculated with the readings from an analyser complying with 3.4 of appendix III of the NTC 2008, during an exhaust emission test conducted in accordance with chapter 5 of NTC 2008. The applicant should specify the accuracy of the NO_x measurement device based on a defined calibration procedure and/or exchange requirements for the device. The justified frequency of monitoring should be stated by the applicant.

The exchange criteria of catalyst blocks against the reading of the NO_x measurement device are to be specified by the applicant as well as the maintenance, service and calibration requirements for the NO_x measurement device. The criteria should ensure timely exchange of the catalyst blocks.

Depending on the proposed onboard verification procedure for the assessment of catalyst condition/degradation, an allowance may be given according to section 7.5 of these Guidelines. Generated alarms or failure codes, in case of exceeded threshold values as defined by the applicant, are to be provided;

.2 where a strategy without a NO_x measurement device is applied, the applicant should additionally specify periodical spot checks as the method to assess the NO_x reduction rate as an indicator for catalyst condition/degradation. The applicant is to provide the details of:

.1 the expected deterioration curve under expected operating conditions or the life of the catalyst under expected operating conditions;

.2 factors which can influence catalyst NO_x reduction efficiency; and

.3 guidance on how to assess catalyst NO_x reduction efficiency based on periodical spot checks or monitoring as specified by the applicant, if applicable; records are to be kept for inspection during annual, intermediate and renewal surveys. The frequency of periodical spot checks is to be defined by the applicant considering the expected deterioration of the catalyst. The frequency for spot-checks should be after installation and at least once every 12 months.

Periodical spot checks do not need to be witnessed by the Administration. In cases where spot checks are required, the checks should be performed at least at 50% of the rated power (for propulsion engines, 75% is preferable), and the guidance on how to assess catalyst condition/degradation should include the following items:

.1 procedure for spot checks:

.1 details of NO_x measurement device including calibration requirements. NO_x measurement device should meet the requirements of appendix III of the NTC 2008;

.2 performance of zero and span check;

.3 test condition (e.g. power and speed setting ranges as well as other applicable engine and SCR settings);

.4 a test report template for the data to be recorded;

.5 sampling probe position(s) for NO_x measurement;

.6 test procedures including time duration for "engine with SCR" stabilization and the NO_x emission measurement; and

.7 records and results of spot checks should be kept and logged in the record book of engine parameters and should be made available during the initial, annual, intermediate and renewal surveys.

.2 criteria to assess catalyst NO_x reduction rate in accordance with the specification as provided by the applicant; and

.3 other strategies on monitoring the catalyst condition/degradation are subject to the approval of the Administration. These strategies should be accepted only if they cover the entire SCR chamber with all catalyst blocks installed. Testing of single catalyst blocks after removing them from the SCR chamber should not be considered as representative for the entire SCR system;

.9 controlling arrangements and settings of the SCR, e.g. model, specification of control device. This is to include, but not be limited to:

.1 the reductant injection control strategy should include whether it is a feed-forward reductant injection control or feedback reductant injection control strategy;

.2 instrumentation and sensors which are part of the SCR control arrangement, as applicable;

.3 crew instructions for allowable adjustment of control parameters including details of how to prevent unauthorized alteration of the system configuration parameters, programmable logic controller (PLC) data, and central processing units (CPU) as applicable;

.4 where a NO_x measurement device is used, the following details should be included:

.1 type/model (identification number);

.2 calibration, zero and span check procedures and the periodicity of such checks, if applicable;

.3 zero and span gases to be carried on board if applicable; and

.4 servicing, maintenance and/or exchange requirements;

.5 where the engine system fitted with SCR has different operating modes (e.g. modes for Tier II and Tier III compliance separately), details of the control philosophy for selecting different modes of operation and recording the mode of operation together with means of changing between modes; and

.6 auxiliary control devices, as mentioned in regulation 13.9 and defined in regulation 2.4 of MARPOL Annex VI, respectively, may be used on engine systems fitted with SCR, covering starting and stopping, low load operation and reversing operation, subject to the approval of the Administration;

.10 measures to minimize reductant slip. The maximum reductant slip may be specified by the applicant. Supporting information, including reductant injection rates under certain engine loads, the catalyst temperature or exhaust gas temperature when reductant injection occurs, etc. may be included in order to prevent reductant slip from exceeding the specified maximum level. Reductant slip monitoring in the exhaust duct downstream of the SCR or an equivalent means may be accepted as a means to minimize reductant slip. Alternatively, means of alleviating reductant slip (for example, through the use of an ammonia slip catalyst or active catalyst thermal management) may be accepted as a means to minimize reductant slip;

.11 where the parameter check method is used as the verification procedure:

For systems without NO_x measurement devices, the applicant should provide details of the relationship between engine load and reductant consumption and the means of checking that reductant flow is appropriate. The Technical File should include proposals for maintaining records of reductant consumption and also reductant composition and quality. Records of reductant composition and quality may be based on delivery notes where these delivery notes include reductant concentration and quality parameters.

Reductant delivery notes may also be accepted for the purposes of verifying that the system has been operated by using reductant. In such cases, the reductant delivery notes should be made available at annual, intermediate and renewal surveys.
Where it is proposed to produce aqueous reductant on board, the recording system should consider records of feedstock deliveries and quality;

.12 any other parameter(s) as specified by the applicant; and

.13 a description of a method of storing records should be included for the purpose of maintenance, surveys and inspections:

.1 if paragraph 3.2.8.1 is applied as a means for monitoring catalyst condition/degradation, the readings from the NO_x measurement device documenting the deterioration rate of SCR performance, including threshold values, alarms or failure codes; or

.2 if paragraph 3.2.8.2 is applied as a means for monitoring catalyst condition/degradation, records and results of spot checks should be available on board; and

.3 for the parameter check method as described in paragraph 3.2.8.11, records of reductant composition and quality may be based on delivery notes where these delivery notes include reductant concentration and quality parameters. Reductant delivery notes may also be accepted for the purposes of verifying that the system has been operated using reductant. Where it is proposed to produce aqueous reductant on board, the recording system should consider records of feedstock deliveries and quality.

3.3 Measures to minimize reductant slip

When SCR uses urea solution, ammonia solution or ammonia gas as reductant, measures to prevent reductant slip should be provided to avoid the supply of an excessive amount of reductant in the system. The reductant injection system should be designed to prevent emissions of any harmful substance from the system.

3.4 Pre-certification procedure

Test and pre-certification of an engine system fitted with SCR should be conducted either by Scheme A (as given in section 5 of these Guidelines), or by Scheme B (as given in sections 6 and 7 of these Guidelines), as appropriate.

3.5 EIAPP certificate

3.5.1 An Engine International Air Pollution Prevention (EIAPP) certificate (see appendix I of NTC 2008) should be issued by the Administration after approval of the Technical File.

3.5.2 When an applicant chooses Scheme B for pre-certification, the IAPP initial survey should not be completed until the onboard initial confirmation test provides compliant results. The applicant remains the responsible entity until final acceptance of the system.

3.5.3 When the engine is to be certified to both Tier II and Tier III, the EIAPP certificate should be completed for both Tier II and Tier III with a single Technical File covering both Tier modes.

3.5.4 In the context of the EIAPP certificate the term "Engine manufacturer" is the applicant for the certification of a system consisting of a marine diesel engine, an SCR chamber and a reductant injection system in accordance with the provisions of paragraph 4.4.4 of NTC 2008.

4 FAMILY AND GROUP CONCEPTS FOR ENGINE SYSTEMS FITTED WITH SCR

4.1 The requirements in chapter 4 of NTC 2008 apply equally to engine systems fitted with SCR.

4.2 The parent engine is to be the engine system fitted with SCR with the highest NO_X emission value of the group/family as specified in paragraphs 4.3.9.1 and 4.4.8.1 of NTC 2008. In cases where there is more than one combined engine/SCR system with the same highest NO_x emission value given to two decimal places (cycle value in g/kWh) within an engine family or an engine group, the parent engine is the system with the highest raw NO_x value emitted from the engine.

4.3 The parent engine for Tier II compliance is not necessarily the same parent of the combined engine/SCR system for Tier III compliance.

5 TEST PROCEDURES FOR SCHEME A

5.1 General

5.1.1 A test for a combined system of an engine fitted with an SCR in Scheme A is to ensure compliance with the applicable NO_x emission limits of MARPOL Annex VI, as required. The test bed measurement procedures of chapter 5 of NTC 2008 should apply.

5.1.2 Notwithstanding paragraph 5.1.1, the applicant may choose to test the combined system of an engine fitted with an SCR with a bypass arrangement without that bypass installed for the purpose of test bed measurement. Any effect on the fluid dynamics or reductant distribution caused by the absence of the by-pass arrangement is to be presented by the applicant.

5.2 Calculation of gaseous emissions

5.2.1 The calculation method in section 5.12 of NTC 2008 is also applied to engine systems fitted with SCR. No allowance is made for the reductant solution injected into the exhaust gas stream in respect of its effect on exhaust gas mass flow rate calculation (appendix VI) or dry/wet correction factor (equation (11), paragraph 5.12.3.2.2 of NTC 2008). The NO_x correction factor for humidity and temperature (equations (16) or (17), paragraphs 5.12.4.5 and 5.12.4.6, respectively, of NTC 2008) should not be applied.

5.2.2 For an engine system fitted with SCR, the following parameters should be measured and recorded in the engine test report in accordance with section 5.10 of NTC 2008:

.1 injection rate of reductant at each load point (kg/h);

.2 exhaust gas temperature at the inlet and outlet of the SCR chamber (°C);

.3 pressure loss (kPa): it is necessary to measure the pressure at the inlet and at the outlet of the SCR chamber and to calculate pressure loss Δp. It would also be permissible to measure the pressure loss Δp of the SCR chamber with a differential pressure sensor. The allowable Δp limit should be confirmed; and

.4 other parameter(s) as specified by the Administration.

6 TEST PROCEDURES FOR SCHEME B

6.1 General

6.1.1 A test for an engine system fitted with SCR in Scheme B is to ensure that the system complies with the applicable NO_x emission limits in MARPOL Annex VI, as required. The test procedures in Scheme B are as follows:

.1 an engine is tested to obtain the NO_x emission value (g/kWh) in accordance with paragraph 6.2.1 of these Guidelines;

.2 the SCR NO_x reduction rate may be calculated by modelling tools, taking into account geometrical reference conditions, chemical NO_x conversion models as well as other parameters to be considered;

.3 for every type of catalytic element, an SCR chamber, not necessarily to full scale, is to be tested in accordance with section 6.3 of these Guidelines in order to generate data for the calculation model as that used in paragraph 6.1.1.2 of these Guidelines;

.4 the NO_x emission from the engine system fitted with SCR, which is calculated in accordance with section 6.4 of these Guidelines using the NO_x emission value from the engine and the NO_x reduction rate of the SCR chamber; at this point the Technical File will be completed and this NO_x emission value will be entered into the supplement of the EIAPP certificate; and

.5 the NO_x emission performance of the engine combined with the SCR is verified by a confirmation test in accordance with the procedure in paragraph 7.5 of these Guidelines.

6.1.2 The calculation of gaseous emissions in paragraph 6.1.1.1 of these Guidelines should be undertaken in accordance with paragraph 5.2.1 of these Guidelines.

6.2 Verification test procedures for an engine

6.2.1 The purpose of the test of an engine is to establish the emission values for use in section 6.4 of these Guidelines. These measurements should be in accordance with chapter 5 of NTC 2008.

6.2.2 Paragraph 5.9.8.1 of the NTC 2008 requires engine conditions to be measured at each mode point, for an engine system. This equally applies in the case of an engine fitted with SCR. Additionally, exhaust gas temperature at the intended inlet of the SCR chamber should be determined and recorded in the test report as required by section 5.10 of NTC 2008.

6.3 Test procedures for SCR chambers

6.3.1 General

6.3.1.1 The SCR chamber for validation testing may be either a full-scale SCR chamber or a scaled version. A SCR chamber should demonstrate the reduction in NO_x concentrations (ppm) expected in exhaust gas measured in section 6.2 of these Guidelines. Therefore, the NO_x reduction rate of the SCR chamber should be determined for each individual mode point. Where undertaken on a scaled version of the SCR chamber the scaling process should be validated to the satisfaction of the Administration.

6.3.1.2 The scaling process is to correspond with the modelling tool of paragraph 6.1.1.2 of these Guidelines, and take into account geometrical reference conditions, and chemical NO_x conversion models, and other parameters which have an influence on the NO_x conversion rate in the modelling tool. If the scaling process could not be validated satisfactorily by theoretical analysis or calculations taking into consideration the complex conditions in the SCR chamber, such as uniformity of gas speed and reductant, a combined engine and SCR system validation test in accordance with Scheme A should be undertaken.

6.3.1.3 The modelling tool of paragraph 6.1.1.2 of these Guidelines is acceptable for use in other engine groups which operate within the same defined boundary conditions.

6.3.2 Test conditions at each mode point

Exhaust gas, catalyst, reductant and an injection system should satisfy the following conditions at each mode point:

.1 **Exhaust gas flow**
Exhaust gas flow rate for the test should be scaled accordingly to account for the dimension of the catalyst model.

.2 **Exhaust gas component**
Exhaust gas for the test should either be diesel engine exhaust gas or simulated gas.

Where diesel exhaust gas is used, it should correspond, in terms of concentrations, to the exhaust gas in section 6.2 of these Guidelines, in terms of NO_x, O_2, CO_2, H_2O and SO_2 (±5% of the required concentration for each emission species).

Where simulated gas is used, it should correspond, in terms of concentrations, to the exhaust gas in section 6.2 of these Guidelines, in terms of NO, NO_2, O_2, CO_2, H_2O and SO_2 (±5% of the required concentration for each emission species) balance N_2.

An exemption for one or more of the above-mentioned gas species' concentration requirements may be allowed subject to a demonstration test showing that the gas or gases do not affect the NO_x reduction rate by more than 2%.

.3 **Exhaust gas temperature**
The temperature of exhaust gas used for the test should correspond to the temperatures obtained from testing in section 6.2 of these Guidelines, ensuring that the SCR chamber is activated at every load point, other than as provided for by 3.1.4 of the NTC 2008, and that no ammonia bisulphate formation, or reductant destruction, takes place.

.4 **Catalyst blocks and AV, SV value**
The catalyst blocks used in the test should be representative of the catalyst blocks to be used in the SCR chamber in service. AV, SV or LV value should, in the case of full scale tests, be within -5% or above of the required value as obtained in testing from section 6.2 of these Guidelines. In the case of scaled tests it should correspond to the above.

.5 **Reductant**
The reductant concentration on the surface of the tested catalyst should be representative of the reductant concentration on the surface of the catalyst during actual engine operation. Ammonia gas may be used as a reductant for the SCR chamber test, provided that it results in an equivalent concentration on the catalyst surface.

6.3.3 Stability for measurement

All measurements should be recorded after they have stabilized.

6.3.4 List of data to be derived from the model

6.3.4.1 Operating data which is to be given in the Technical File should be derived from the modelling process or otherwise justified.

6.3.4.2 Exhaust gas analysers should be in accordance with appendix III and appendix IV of NTC 2008 or otherwise to the satisfaction of the Administration.

6.3.5 Test report for SCR chamber

Data recorded under paragraph 6.3.1.1 of these Guidelines should be recorded in the test report as required by section 5.10 of NTC 2008.

6.4 Calculation of the specific emission

6.4.1 The NO_x emission value of the engine system fitted with SCR should be calculated as follows:

$$\text{gas}_x = \frac{\sum_{i=1}^{i=n} \left((100 - \eta_i)/100 \right) \cdot q_{mgas_i} \cdot W_{F_i}}{\sum_{i=1}^{i=n} \left(P_{\text{i}} \cdot W_{F_i} \right)}$$

Where: η_i NO_x reduction rate (%) derived in accordance with section 6.3 of these Guidelines;

q_{mgas_i} = Mass flow of NO_x gas measured in accordance with section 6.2 of these Guidelines;

W_{F_i} = Weighting factor;

P_{i} = Measured power at individual mode points in accordance with section 6.2 of these Guidelines.

The weighting factors and number of modes (n) used in the above calculation shall be according to the provisions of section 3.2 of the NTC 2008.

6.4.2 The NO_x emission value (g/kWh) calculated in accordance with paragraph 6.4.1 of these Guidelines should be compared to the applicable emission limit. This emission value is entered into 1.9.6 of the Supplement to the EIAPP certificate (appendix I of NTC 2008).

6.5 Test report to be submitted to the Administration

The test report referenced under paragraphs 6.2.2 and 6.3.5 of these Guidelines, together with the data from section 6.4 of these Guidelines should be consolidated into the overall documentation to be submitted to the Administration.

7 ONBOARD CONFIRMATION TEST FOR SCHEME B

7.1 After installation on board of an engine system fitted with SCR and before entry into service an initial confirmation test should be performed on board.

7.2 The engine system fitted with the SCR should be verified as corresponding to the description given in the Technical File.

7.3 The confirmation test should be undertaken as close as possible to 25%, 50% and 75% of rated power, independent of test cycle.

7.4 At each mode point of the confirmation test the operating values as given in the Technical File should be verified.

7.5 NO_x emission concentrations should be measured at the inlet and outlet of the SCR chamber. The NO_x reduction rate should be calculated. Both values should either be dry or wet. The value obtained for NO_x reduction rate should be compared to the initial confirmation test required value at each mode point as given in the Technical File. Reduction efficiency values obtained at each of the test points should not be less than the corresponding values as given in the Technical File by more than 5%.

7.6 The NO_x analyser should meet the requirements of chapter 5 of NTC 2008.

7.7 When an engine system fitted with SCR is in a group defined in chapter 4 of these Guidelines, the confirmation test should be conducted only for the parent engine system of the group. Where the parent engine system of the group is not the first one to complete the onboard confirmation test as required by chapter 7 of these Guidelines, the onboard confirmation test is to be done for all installed engine systems within the engine group unless it is an identical NO_x specification member engine or the parent engine system has been installed and tested successfully. Where the parent engine system is not available to be installed on board, the first installed member engine system of the engine group can be chosen and adjusted to the worst-case NO_x emission for confirmation test on board instead. The test results should be verified as described in the Technical File.

***