

ANNEX 16

RESOLUTION MEPC.414(84) (adopted on 1 May 2026)

2026 GUIDELINES FOR TEST-BED AND ONBOARD MEASUREMENTS OF METHANE (CH₄) AND/OR NITROUS OXIDE (N₂O) EMISSIONS FROM MARINE DIESEL ENGINES

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 eightieth session, it adopted, by resolution MEPC.377(80), the *2023 IMO Strategy on reduction of GHG emissions from ships* (2023 IMO GHG Strategy) setting out the levels of ambition for the international shipping sector in reducing GHG emissions,

NOTING that the 2023 IMO GHG Strategy provides that in order to support the global availability and uptake of zero or near-zero GHG emission technologies, fuels and/or energy sources, the Organization may consider and analyse measures to address emissions of methane (CH₄) and nitrous oxide (N₂O),

RECALLING that, at its eighty-third session, it adopted, by resolution MEPC.402(83), the *Guidelines for test-bed and onboard measurements of methane (CH₄) and/or nitrous oxide (N₂O) emissions from marine diesel engines*,

HAVING CONSIDERED, at its eighty-fourth session, draft revised guidelines for test-bed and onboard measurements of methane (CH₄) and/or nitrous oxide (N₂O) emissions from marine diesel engines,

1 ADOPTS the *2026 Guidelines for test-bed and onboard measurements of methane (CH₄) and/or nitrous oxide (N₂O) emissions from marine diesel engines*, as set out in the annex to the present resolution;

2 INVITES Member States to encourage shipowners, ship operators, shipbuilders, marine diesel engine manufacturers and any other interested groups to voluntarily apply these Guidelines when undertaking measurements, calculation and reporting of CH₄ and/or N₂O emission values from marine diesel engines;

3 ALSO INVITES Member States to share data gathered in applying these Guidelines to future sessions of the Committee;

4 AGREES to keep these Guidelines under review in light of the experience gained with their implementation.

5 AGREES that these Guidelines supersede the *Guidelines for test-bed and onboard measurements of methane (CH₄) and/or nitrous oxide (N₂O) emissions from marine diesel engines* adopted by resolution MEPC.402(83).

ANNEX

2026 GUIDELINES FOR TEST-BED AND ONBOARD MEASUREMENTS OF METHANE (CH₄) AND/OR NITROUS OXIDE (N₂O) EMISSIONS FROM MARINE DIESEL ENGINES

1 Introduction

1.1 The purpose of these Guidelines is to specify the protocol for test-bed and onboard measurements, calculation and reporting of methane (CH₄) and/or nitrous oxide (N₂O) emission values from marine diesel engines, as well as documentation and verification of CH₄ and/or N₂O emission values.

1.2 For the purpose of these Guidelines, "methane-containing fuel" means natural gas, bio-methane, e-methane, and mixtures of these fuels.

1.3 The measurements, calculations and reporting for CH₄ and/or N₂O emission values should be carried out in accordance with the NO_x Technical Code 2008 as amended, (NTC 2008) other than as specifically provided for in the protocol set out in appendix 1 of these Guidelines. All references in appendix 1 are to NTC 2008.

1.4 For onboard measurements, the protocol set out in appendix 1 may be accepted for an Individual Engine or for an Engine Group represented by the Parent Engine. It should not be accepted for an Engine Family without further justifications. For test-bed measurements, the protocol may also be accepted for an Engine Family.¹

2 Information to be included in the CH₄ and/or N₂O file

2.1 The applicant for the establishment of the emission values should prepare a CH₄ and/or N₂O file that should contain the following information:

- .1 details of the engine as tested should include but are not limited to:
 - .1 model and designation;
 - .2 rated power and rated speed;
 - .3 listing of NO_x critical components as fitted and settings / operating values as applied including, for CH₄, NO_x certified maximum liquid-to-gas fuel ratios across load range; and
 - .4 other components and settings / operating values which affect CH₄ and/or N₂O emissions;
- .2 details, including drawings of exhaust system, showing sampling position(s);

¹ The composition of an Engine Family or an Engine Group as defined in NTC 2008 is set solely by factors affecting NO_x emissions; those cannot be assumed to be equally applicable to CH₄ and/or N₂O emissions. In some instances, such as liquid-to-gas fuel ratio, the requirements for highest NO_x will tend to result in lowest CH₄.

- .3 where $C_{slip-CH_4}$ is reported, crankcase emissions should only be included for trunk piston engines without closed crankcase ventilation. Details of how that was determined should be provided. If crankcase emissions are not measured, an emission value based on technical justification and relevant emission data may be used. If the manufacturer does not have such data, an emission value of 1 g/kWh should be used;
- .4 a copy of the relevant engine test data, as given in appendix 2 of these Guidelines and any additional data to fully define the engine performance and enable calculation of the gaseous emissions of CH₄ and/or N₂O. For test-bed measurements, this information can also be provided in the test report as referred to in section 5.10 of the NTC 2008;
- .5 where a CH₄ and/or N₂O reducing device or system is used, the CH₄ and/or N₂O file should contain documentation on the emission abatement device, giving details of its intended purpose, manner of operation, critical components and settings / operating values together with information on any consumables necessary for its operation. Where exhaust gas samples are to be drawn from both before and after the device, details of analyser changeover arrangements and sequencing should be given if only one set of analysers is to be used.

3 The use of existing measurement data

3.1 Existing measurements conducted prior to the adoption of these Guidelines may be accepted, provided that they were carried out in accordance with the NTC 2008. In such cases, the provisions applicable exclusively to onboard measurements, as set out in these Guidelines, may have been applied.

3.2 If existing measurements for CH₄ have not been conducted, emission values for total hydrocarbons (HC), as set out in the engine's NO_x technical file, may be used as a proxy. The CH₄ emission values may be established based on the weighted percentage of methane in the gas fuel. Where the fuel composition is not available in the engine's NO_x technical file, total HC emissions should be assumed to consist of 100% CH₄.

3.3 If the existing measurements based on the E2 test cycle do not contain emission values for the 10% load point or the lowest mode point at which gas fuel would be used, data from the D2 test cycle of the same parent engine may be considered representative provided that the same parent engine is certified for both D2 and E2 cycles and operates with identical settings.

4 Verification of the CH₄ and/or N₂O emission values

4.1 In order to confirm that the emission values have been established in accordance with these Guidelines, the CH₄ and/or N₂O file should be submitted to the Administration for verification.

4.2 On receipt of the CH₄ and/or N₂O file from the applicant and satisfactory completion of the verification, a Statement of emission values for CH₄ and/or N₂O should be issued by the Administration. The form of Statement of emission values for CH₄ and/or N₂O is set out in appendix 3 of these Guidelines.

APPENDIX 1

PROTOCOL FOR TEST-BED AND ONBOARD MEASUREMENTS OF CH₄ AND/OR N₂O EMISSIONS FROM MARINE DIESEL ENGINES BASED ON THE NO_x TECHNICAL CODE 2008

Explanatory note:

This protocol does not amend mandatory provisions in NTC 2008. Measurements, calculations and reporting of CH₄ and/or N₂O emission values should be carried out in accordance with NTC 2008, other than as specifically provided for in the protocol.

Paragraph of NO _x Technical Code 2008	Addition to NTC 2008								
Abbreviations, subscripts and symbols									
	In table 1, the definitions of N₂O and NMHC are added as follows: <table border="1"> <thead> <tr> <th>Symbol</th><th>Definition</th></tr> </thead> <tbody> <tr> <td>N₂O</td><td>Nitrous oxide</td></tr> <tr> <td>NMHC</td><td>Non-methane hydrocarbons</td></tr> </tbody> </table>	Symbol	Definition	N ₂ O	Nitrous oxide	NMHC	Non-methane hydrocarbons		
Symbol	Definition								
N ₂ O	Nitrous oxide								
NMHC	Non-methane hydrocarbons								
	In table 2, abbreviations for FTIR, NDUV, NMC are added as follows: <table border="1"> <thead> <tr> <th>Symbol</th><th>Definition</th></tr> </thead> <tbody> <tr> <td>FTIR</td><td>Fourier transform infrared (analyser)</td></tr> <tr> <td>NDUV</td><td>Non-dispersive ultraviolet (analyser)</td></tr> <tr> <td>NMC</td><td>Non-methane cutter</td></tr> </tbody> </table> Note: NMC = flame ionization detector (FID) with non-methane cutter	Symbol	Definition	FTIR	Fourier transform infrared (analyser)	NDUV	Non-dispersive ultraviolet (analyser)	NMC	Non-methane cutter
Symbol	Definition								
FTIR	Fourier transform infrared (analyser)								
NDUV	Non-dispersive ultraviolet (analyser)								
NMC	Non-methane cutter								
	In table 3, symbols and terms for C_{fCH_4}, C_{fN_2O} and $C_{slip-CH_4}$ are added as follows: <table border="1"> <thead> <tr> <th>Symbol</th><th>Term</th></tr> </thead> <tbody> <tr> <td>C_{fCH_4}</td><td>g CH₄ / g fuel² (applicable to liquid fuels and non-methane gas fuels)</td></tr> <tr> <td>C_{fN_2O}</td><td>g N₂O / g total fuel (applies to both gas and liquid fuels)</td></tr> <tr> <td>$C_{slip-CH_4}$</td><td>% (of the mass of the methane-containing fuel used by the energy converter), corrected to reference gas composition (applicable to methane-containing fuels, excluding pilot fuel³)</td></tr> </tbody> </table>	Symbol	Term	C_{fCH_4}	g CH ₄ / g fuel ² (applicable to liquid fuels and non-methane gas fuels)	C_{fN_2O}	g N ₂ O / g total fuel (applies to both gas and liquid fuels)	$C_{slip-CH_4}$	% (of the mass of the methane-containing fuel used by the energy converter), corrected to reference gas composition (applicable to methane-containing fuels, excluding pilot fuel ³)
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² For methane containing fuels, the $C_{slip-CH_4}$ covers the role of C_{fCH_4} , so C_{fCH_4} is set to zero for these fuels. For the purpose of these Guidelines, non-methane gas fuels should be regarded as liquid fuels.

³ CH₄ emissions from the pilot fuel are accounted for in the $C_{slip-CH_4}$ value. For pilot fuel used in a dual fuel engine, CH₄ emissions should not therefore be determined separately on the basis of the quantity of pilot fuel used.

	Note: $C_{slip-CH_4}$ is a factor accounting for CH ₄ (expressed in % of mass of methane containing fuel consumed in the energy converter) which is emitted from the energy converter (including fuel from combustion chamber/oxidation process and from crankcase, as appropriate).
Chapter 3	
3.2 Test cycles and weighting factors to be applied	For the test cycles E2 and E3, the specific emission at the 10% mode point or the lowest mode point at which gas fuel would be used should be measured and reported in addition to the existing mode points. For onboard measurements only: In setting the load points of the test cycle to be followed the provisions of 6.4.6.7 should apply. In the case of the 100% load point this should, subject to the engine emission test plan, be allowed to be no lower than 85% of rated power. If that value cannot be achieved, then the test should be deferred to such time that at least that power level can be achieved. The test cycle 100% power weighting factor under 3.2 should be applied irrespective of the actual power developed at that load point.
Chapter 5	
5.2.5.3 Positioning of abatement device or system	Requirements do not necessarily apply to CH ₄ and/or N ₂ O abatement device or system. The installation requirements of the device should be respected and provided in the CH ₄ and/or N ₂ O file.
5.6.1 Permissible deviations of instruments for engine-related parameters and other essential parameters	For onboard measurements only: Engine performance and ambient condition monitoring equipment requirements should be in accordance with the requirements of 6.4.5.1.
5.9.2	CH ₄ and/or N ₂ O should be added to the list of main exhaust components. In the case of CH ₄ , this means CH ₄ as reported by the measurement device before correction for NMC efficiency.
5.9.3.2 Exhaust gas temperature at sample probe for HC	For the measurement of CH ₄ and/or N ₂ O, there are no minimum temperature requirements.
5.9.6.2 Test sequence	For onboard measurements only: At each load point of a test cycle the provisions of 6.4.6.8 should apply rather than those of 5.9.6.2. In the case of the E3 test cycle, if the actual propeller curve differs from the E3 curve, the load point used should be set using the measured engine power.
5.11 Data evaluation for gaseous emissions	In addition to the concentrations for the species to be determined as specified by 5.11 of NTC 2008, the concentrations of CH ₄ and/or N ₂ O are to be determined. The averaged results are to be given in ppm.

	Where the NMC methane efficiency is not 0% and/or the NMC ethane efficiency is not 100% the CH₄ concentration to be used in equation 18a is calculated as follows: The concentration of CH₄ should be calculated as follows for propane as calibration gas, bypassing NMC: $c_{CH_4} = \frac{c_{HC(wCutter)} - c_{HC(w/oCutter)} * (1 - E_e)}{f_{RF\ CH_4(HC-FID)} * (E_e - E_m)}$ The concentration of CH₄ should be calculated as follows for methane as calibration gas, passing through the NMC: $c_{CH_4} = \frac{c_{HC(wCutter)} * f_{RF\ CH_4(HC-FID)} * (1 - E_m) - c_{HC(w/oCutter)} * (1 - E_e)}{f_{RF\ CH_4(HC-FID)} * (E_e - E_m)}$ where: $c_{HC(wCutter)}$ is the HC concentration with the sample gas flowing through the NMC; $c_{HC(w/oCutter)}$ is the HC concentration with the sample gas bypassing the NMC; $f_{RF\ CH_4(HC-FID)}$ is the methane response factor; E_m is the methane efficiency as determined per appendix IV, 8.5.1 ; and E_e is the ethane efficiency as determined per appendix IV, 8.5.2.																														
5.12.5.1 Calculation of the emission mass flow rates	For the calculation of the emission mass flow rates in 5.12.5.1, u_{gas} values for N₂O and/or CH₄ should be calculated using table 5 as extended: <table><tr><th colspan="2">Gas</th><th>HC</th><th>CH₄</th><th>N₂O</th></tr><tr><th colspan="2">ρ_{gas} kg/m³</th><th>*</th><td>0.716</td><td>1.9631</td></tr><tr><td></td><td>$\rho_e^\dagger$</td><td colspan="3">Coefficient $u_{gas}^\ddagger$</td></tr><tr><td>Liquid fuel**</td><td>1.2943</td><td>0.000479</td><td>0.000553</td><td>0.001517</td></tr><tr><td>Rapeseed Methyl Ester</td><td>1.2950</td><td>0.000536</td><td>0.000553</td><td>0.001516</td></tr><tr><td>Methanol</td><td>1.2610</td><td>0.001133</td><td>0.000568</td><td>0.001557</td></tr></table>	Gas		HC	CH ₄	N ₂ O	ρ_{gas} kg/m ³		*	0.716	1.9631		$\rho_e^\dagger$	Coefficient $u_{gas}^\ddagger$			Liquid fuel**	1.2943	0.000479	0.000553	0.001517	Rapeseed Methyl Ester	1.2950	0.000536	0.000553	0.001516	Methanol	1.2610	0.001133	0.000568	0.001557
Gas		HC	CH ₄	N ₂ O																											
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	<table><tr><td>Ethanol</td><td>1.2757</td><td>0.000805</td><td>0.000561</td><td>0.001539</td></tr><tr><td>Natural gas</td><td>1.2661</td><td>0.000558*</td><td>0.000565</td><td>0.001551</td></tr><tr><td>Propane</td><td>1.2805</td><td>0.000512</td><td>0.000559</td><td>0.001533</td></tr><tr><td>Butane</td><td>1.2832</td><td>0.000505</td><td>0.000558</td><td>0.001530</td></tr></table> * In the case of HC emissions when using natural gas as the fuel, the given u_{gas} value of 0.000558 should be used for NMHC on the basis of CH2.93. For total HC, the u_{gas} of CH4 should be used.	Ethanol	1.2757	0.000805	0.000561	0.001539	Natural gas	1.2661	0.000558*	0.000565	0.001551	Propane	1.2805	0.000512	0.000559	0.001533	Butane	1.2832	0.000505	0.000558	0.001530
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5.12.5.2	The CH4 and/or N2O concentration to be entered into equation 18a is the value from 5.11 on a wet basis.																				
5.12.6 Calculation of the specific emission	Calculate C_{fCH4} (g/g fuel and g/kWh), C_{fN2O} (g/g fuel and g/kWh) and $C_{slip-CH4}$ (% of the mass of the methane containing fuel used by the engine) for each load point where emissions are measured. For liquid fuels and non-methane gas fuels: $C_{fgas} = q_{mgas} / fuel\ flow$ where: q_{mgas} (g/h): mass flow of CH4/N2O as measured (from combustion); $fuel\ flow$ (g/h): total mass flow of fuels applicable to C_{fCH4} (i.e. the total flow of liquid fuels and/or non-methane gas fuels). For methane-containing fuels: $C_{slip-CH4,act} = (q_{mCH4} / fuel\ flow) \cdot 100$ where: q_{mCH4} (g/h): mass flow of CH4 as measured (unburned slip); $fuel\ flow$ (g/h): total mass flow of methane containing fuels (excluding pilot fuels). Calculate the average weighed emissions $C_{fgas} = \sum_{i=1...n} (q_{mgas} \cdot W_{Fi}) / \sum_{i=1...n} (q_{fuel,i} \cdot W_{Fi})$ With $q_{fuel,i}$ being the fuel flow at each mode point. $C_{slip-CH4, act} = \sum_{i=1...n} (q_{mCH4, act} \cdot W_{Fi}) / 10 / \sum_{i=1...n} (q_{fuel,i} \cdot W_{Fi})$ $C_{slip-CH4} = C_{slip-CH4,act} \times \frac{X_{CH4ref}}{X_{CH4act}}$																				

	where: $C_{slip-CH_4,act}$ = C_{slip} value calculated with actual fuel gas composition during testing X_{CH_4ref} = mass fraction of methane in the reference fuel (w-%) X_{CH_4act} = mass fraction of methane in the test fuel (w-%) Reference fuel methane fraction 84.6 w-% (92.2 mol-%) as in the mathematical average of LNG compositions in ISO 23306:2020. q_{mgas} (g/h): see section 5.12.5.2 of the NTC 2008, equation 18a Fuel flow (g/h) as measured.
Appendix III	
	Section 1.1 CH₄ and/or N₂O are added to the list of components included in the exhaust gas analysis system.
	Figure 1 - For arrangements of exhaust gas analysis measurement systems for the measurement of CH₄, refer to ISO 8178-1 section 7.4.4. - Alternatively, the arrangements described in 3.6 below should be accepted. - NMC and N₂O analyser should be arranged, installed and operated in accordance with the respective manufacturer's recommendations.
	Section 1.2 Analysers for CH₄ and N₂O: see section 3
	Section 3 3.6 Methane (CH₄) analysis The reference method for CH₄ should be FID + NMC. Alternatively, a dual FID set-up as described in appendix 4 to these guidelines should be accepted. Other principles / systems should be accepted if proven against FID+NMC with exhaust gases of the compositions to be measured. It should be ensured that the HC / CH₄ analyser(s) to be used have duly calibrated ranges for the respective concentrations to be measured. The NMC should have the capacity to handle the expected CH₄ and NMHC concentrations. 3.7 Nitrous oxide (N₂O) analysis An FTIR analyser, an NDIR (non-dispersive infrared) analyser, laser infrared analyser or NDUV analyser may be used in accordance with the instrument supplier's instructions.

	Note: According to sections 5.4.2 and 5.4.3 of the NTC 2008, other systems or analysers may, subject to the approval of the Administration, be accepted if they yield equivalent results to that of the equipment referenced.
Appendix IV	Calibration of the analytical and measurement instruments
	Requirements of table 1 or table 3 regarding fuel measurement device apply separately to both liquid fuel meter and gas fuel meter.
	In addition to the calibration procedures of appendix IV of the NTC 2008, relevant parts of ISO 8178-1 for calibration of CH₄ and/or N₂O measurement instruments should be applied. FID should be calibrated with NMC bypassed with NMC efficiencies E_e and E_m determined separately.
	Section 2 "C₂H₆ and purified synthetic air" is added to 2.2.1.5. A new sub-paragraph "2.2.1.6 N₂O and purified nitrogen" is added after the existing 2.2.1.5.
	Section 5 N₂O is added to the list of analysers in the first sentence of 5.4.2.
8.4	For measurement of N ₂ O, a new section 8.4 applies
8.4.1	The interference should be checked prior to first use of an analyser and after major servicing or updating of software.
8.4.2	In those cases where the analyser applies compensation algorithms which use as inputs the concentrations of other measured gases those measurements should be undertaken concurrently with this verification check.
8.4.3	For NDIR - The potential for cross interferences effects of CO, CO ₂ , H ₂ O, CH ₄ and SO ₂ as applicable should be checked.
8.4.3.1	Apart from H ₂ O the interference species are dependent on the selected N ₂ O absorption band used by the device which should be known. From that knowledge good engineering judgement should be used to determine the interference gases to be used based on those which may be expected to be present in the exhaust gases to be measured.
8.4.4	For FTIR or Laser Infrared – The interference gases depend on the selected N ₂ O absorption band used by the device which should be known. Based on that knowledge good engineering judgement should be used to determine the interference gases to be used.
8.4.5	The combined effect of the interference gases should not be more 1.0 µmol/mol.

8.4.6	Verification procedure: .1 The concentrations of the interference span gases as identified from 8.4.3 or 8.4.4 should be at least as high as the maximum values to be encountered in service. Those interference gases may be presented in the form of a multi-component span gas. .2 The N₂O analyser is started, operated, zeroed and spanned as in service. .3 Humified interference test gas should be fed into the analyser. That test gas should be generated by bubbling the multi-component span gas through distilled H₂O in a sealed container. If the sample is not treated by a dryer the container temperature should be controlled to generate a H₂O concentration at least as high as the expected maximum when in service. If the sample is treated by a dryer the container temperature should be controlled to generate a H₂O concentration at least as high as the expected maximum based on the dryer outlet temperature when in service. .4 The water mole fraction of the test gas should be determined from measurements taken as close as possible to the analyser inlet. Those measurements may be dew point and absolute pressure. .5 Condensation in the piping leading from the container generating the humidified test gas to the analyser should be minimized by maintaining an adequate minimum temperature. .6 Following stabilization, the analyser output should be recorded for 30 s. The arithmetic mean response over that period should be compared with the limit in 8.4.5.
8.4.6.1	As an alternative to the multi-component span gas in 8.4.6 individual span gases may be run separately. Where an interference gas concentration is higher than that to be measured in service the determined interference value should be scaled down by the ratio of in-service maximum / span concentration. Where the H₂O concentration is below that to be measured in service, but not below 0.025 mol/mol H₂O content, the determined interference may be scaled up by the ratio of maximum in-service value / the value used. The sum of the individual interferences should be compared with the limit in 8.4.5.
8.4.7	An interference verification check report documenting the procedure as followed, including the rational for the interference gases used and their concentrations, and the outcomes of that procedure is to be prepared and should be available as may be required.

8.4.8	Alternative approaches to the verification of N₂O analyser interference may be acceptable. Where so used the justification for the approach taken should be included in the report as required by 8.4.7. Irrespective of the procedure followed the limit given by 8.4.5 remains applicable.
8.5	Efficiency of the non-methane cutter (NMC) The NMC is used for the removal of the non-methane hydrocarbons from the sample gas by oxidizing all hydrocarbons except CH₄. Ideally, the conversion rate for CH₄ is 0% and for the other hydrocarbons, as represented by ethane, is 100%. The efficiency of the NMC may be checked as part of the pretest verification procedures under 6.1 and again on completion of the measurement exercise (at the time of rechecking the analysers in accordance with 5.9.9 of NTC 2008) with the average of the two <i>Em</i> and <i>Ee</i> values so obtained being used to correct the measured CH₄ concentrations. In any case, the efficiency verification should be done within 185 days before testing, and after major maintenance. With the agreement of the Administration, alternative approaches to the assessment of NMC efficiency may be accepted. Methane efficiency ≤ 15% Ethane efficiency ≥ 98%
8.5.1	NMC methane efficiency Methane calibration gas at a concentration typical of that to be measured is flowed through the FID analyser with and without the NMC bypassed. The methane efficiency, <i>Em</i>, is determined as: $E_m = 1 - \frac{c_M(wCutter)}{c_M(w/oCutter)}$ Where: <i>c_M (wCutter)</i> HC concentration with CH₄ flowing through the NMC (ppmC1) <i>c_M (w/oCutter)</i> HC concentration with CH₄ bypassing NMC (ppmC1)

8.5.2	NMC ethane efficiency
	Ethane calibration gas at a concentration typical of the expected non-methane hydrocarbon concentration to be measured is flowed through the FID analyser with and without the NMC bypassed. The ethane efficiency, E_e, is determined as: $E_e = 1 - \frac{c_E (wCutter)}{c_E (w/oCutter)}$ Where: $c_E (wCutter)$ HC concentration with C₂H₆ flowing through the NMC (ppmC1) $c_E (w/oCutter)$ HC concentration with C₂H₆ bypassing NMC (ppmC1)

APPENDIX 2

ENGINE TEST REPORT AND TEST DATA – CH₄ AND/OR N₂O CALCULATIONS

Engine	
Manufacturer	
Engine type	
Emission abatement device	
Engine family or Engine group identification	
Serial number	
Rated power	
Rated speed	

Emissions test results:					
Test cycle					
C_{fCH_4} weighted					g/g fuel
$C_{slip-CH_4}$ weighted					% (of the mass of the methane containing fuel used by the engine)
N ₂ O (weighted)					g/g total fuel
Test identification					
Date/time					
Test site					
Test number					
Company					
Date and place of report					
Signature					

Measurement equipment					
	Manufacturer	Model	Measurement ranges	Calibration	
				Span gas conc.	Deviation of calibration
Analyser					
HC / CH ₄ Analyser*			ppm		%
N ₂ O Analyser			ppm		%
CO Analyser			ppm		%
CO ₂ Analyser			%		%
O ₂ Analyser			%		%
Speed			rpm		%

Torque			Nm		%
Power, if applicable			kW		%
Fuel flow-liquid					%
Fuel flow-gas					%
Air flow					%
Exhaust flow					%
Temperatures					
Charge air			°C		°C
coolant inlet					
Exhaust gas			°C		°C
Inlet air			°C		°C
Charge air			°C		°C
Fuel-liquid			°C		°C
Fuel-gas			°C		°C
Pressures					
Exhaust gas			kPa		kPa
Charge air			kPa		kPa
Atmospheric			kPa		kPa
Vapour pressure					
Intake air			kPa		%
Humidity					
Intake air			%		%

* For FID+NMC

Make and model of NMC		
	Before measurement	After measurement
NMC CH ₄ gas concentration	ppmC	ppmC
HC with CH ₄ through NMC	ppmC	ppmC
HC with CH ₄ bypassing NMC	ppmC	ppmC
NMC methane efficiency <i>Em</i>		
NMC C ₂ H ₆ gas concentration	ppmC	ppmC
HC with C ₂ H ₆ through NMC	ppmC	ppmC
HC with C ₂ H ₆ bypassing NMC	ppmC	ppmC
NMC ethane efficiency <i>Ee</i>		

Liquid fuel characteristics

Fuel type				
Fuel properties:			Fuel elemental analysis:	
Density	ISO 3675	kg/m ³	Carbon	% m/m
Viscosity	ISO 3104	mm ² /s	Hydrogen	% m/m
Water	ISO 3733	% V/V	Nitrogen	% m/m
Lower heating value/Hu		MJ/kg	Oxygen	% m/m
			Sulphur	% m/m

Gas fuel characteristics

Fuel type:				
Fuel properties			Fuel elemental analysis	
Methane number	EN16726:2015		Carbon	% m/m
Lower heating value		MJ/kg	Hydrogen	% m/m
Boiling point		°C	Nitrogen	% m/m
Density at boiling point		kg/m ³	Oxygen	% m/m
Pressure at boiling point		Bar (abs)	Sulphur	% m/m
			Methane, CH ₄	mol%
			Ethane, C ₂ H ₆	mol%
			Propane, C ₃ H ₈	mol%
			Isobutane, i C ₄ H ₁₀	mol%
			N-Butane, n C ₄ H ₁₀	mol%
			Pentane, C ₅ H ₁₂	mol%
			C ₆ +	mol%
			CO ₂	mol%

Gaseous emissions data

Mode	1	2	3	4	5	6	7	8	9	10
Power/Torque (%)										
Speed (%)										
Time at beginning of mode										

Gaseous emissions data:										
Sampling position										
HC concentration (ppmC)										
CH ₄ concentration (ppmC)* recorded [#]										
CH ₄ concentration (ppmC)* - corrected [#]										
N ₂ O concentration (ppm)*										
CO concentration (ppm)										
CO ₂ concentration (%)										
O ₂ concentration (%)										
CH ₄ mass flow (kg/h)* [#]										
N ₂ O mass flow (kg/h)*										
CO mass flow (kg/h)										
CO ₂ mass flow (kg/h)										
O ₂ mass flow (kg/h)										
CH ₄ (g/g)* [#]										
CH ₄ (g/kWh)* [#]										
N ₂ O (g/g)*										
N ₂ O (g/kWh)*										

* As applicable.

[#] As applicable to either liquid or gas fuel.

Engine parameters to be measured and recorded

Mode	1	2	3	4	5	6	7	8	9	10
Power/Torque (%)										
Speed (%)										
Time at beginning of mode										

Engine data										
Speed (rpm)										
Power (kW)										
Mean effective pressure (kPa)										
Fuel rack/gas admission duration** (mm/sec)										
Liquid-to-gas fuel ratio (on mass basis)										
Liquid Fuel flow (kg/h or m ³ /h*)										
Gas Fuel flow (kg/h)										
Exhaust flow (q_{mew}) (kg/h)										
Exhaust temperature at the sampling point (°C)										
Charge air coolant temperature in (°C)										
Charge air coolant temperature out (°C)										
Charge air temperature (°C)										
Charge air reference temperature (°C)										
Charge air pressure (kPa)										
Fuel-liquid temperature before the engine (°C)										
Fuel-gas temperature before the engine (°C)										

Ambient data										
Atmospheric pressure (kPa)										
Intake air temperature (°C)										
Intake air humidity (g/kg)										
Relative humidity (RH) of intake air* %										
Air temperature at RH sensor* (°C)										
Dry bulb temperature of intake air* (°C)										
Wet bulb temperature of intake air* (°C)										

* As applicable.

** Only for engines to be tested with gas fuel.

Abatement device:

The report should state whether reported data before or after device- hence the gaseous emission data page will need to be repeated, if both are to be given.

Additionally, if both before and after data given, the analyser data should, if relevant, be repeated to cover all analysers used.

For each mode point, the following device data should additionally be recorded: Settings, Operating values and Consumption (specified rates).

APPENDIX 3

FORM OF STATEMENT OF EMISSION VALUES FOR METHANE (CH₄) AND/OR NITROUS OXIDE (N₂O)

Issued in accordance with the *2026 Guidelines for test-bed and onboard measurements of methane (CH₄) and/or nitrous oxide (N₂O) emissions from marine diesel engines* (resolution MEPC.414(84)) under the authority of the Government of:

.....
(full designation of the country)

by.....
(full designation of the competent person or organization authorized)

Particulars of applicant

Name of applicant.....

THIS IS TO DECLARE THAT:

- 1 the applicant has submitted to this Administration the information recommended by the *2026 Guidelines for test-bed and onboard measurements of CH₄ and/or N₂O emissions from marine diesel engines* (resolution MEPC.414(84));
- 2 the emission value(s) have been established in accordance with the *2026 Guidelines for test-bed and onboard measurements of CH₄ and/or N₂O emissions from marine diesel engines* (resolution MEPC.414(84));
- 3 the engine weighted verified emissions value(s) are as follows:

1	Engine manufacturer and model	
2	Engine serial number	
3	Abatement device manufacturer and model	
4	Device serial number	
5	Use (applicable test cycle(s) – NTC 3.2)	
6	C _{fCH₄} (g/g fuel)*	
7	C _{slip-CH₄} % (of the mass of the methane containing fuel used by the engine)*	
8	C _{fN₂O} (g/g fuel)*	

* Include as appropriate

Issued at.....
(place of issue of the Statement)

(dd/mm/yyyy):
(date of issue)

.....
(signature of duly authorized official
issuing the Statement)

(seal or stamp of the authority, as appropriate)

APPENDIX 4

DUAL FLAME IONIZATION DETECTOR (FID) SET-UP TO MEASURE METHANE (CH₄)

1 Measuring set-up

1 A dual FID set-up to measure methane (CH₄) requires two FID analysers which should be compliant with the specifications of the NO_x Technical Code 2008 (NTC 2008), and one NMC equipment which should be compliant with the requirements of appendix 1 of these guidelines. The NMC should have a bypass function to enable the testing of the efficiency of the NMC. The bypass function is required only for testing the efficiency of the NMC. The sampling system also should be compliant with the NTC 2008. The analyser set-up is shown in figure 1:

- .1 One FID connected downstream of the NMC (called the NMC-FID); and
- .2 One FID connected to the sample system in parallel, without an NMC (called the HC-FID)

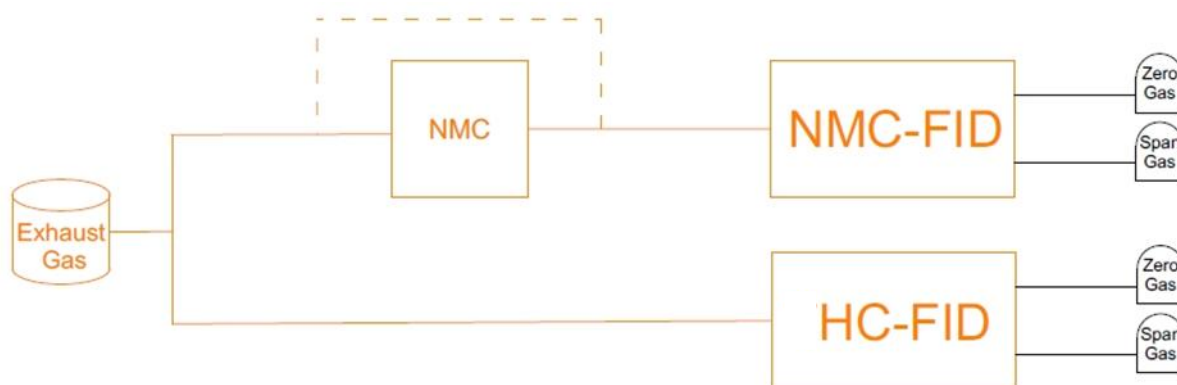


Figure 1 – Dual FID set-up for measurement of methane (CH₄)

2 The FIDs and the NMC should be operated according to the manufacturer's specification.

2 Gases and calibration

3 The following gases should be available for the establishment of a calibration curve, daily adjustments and span checks in accordance with 5.9.9 of the NTC 2008:

- .1 CH₄ span gas, at a concentration of at least 80% of the NMC-FID measurement range;
- .2 C₃H₈ span gas, at a concentration of at least 80% of the HC-FID measurement range (calculated on a C1 basis, according to the NTC 2008);
- .3 a zero gas, that can be either purified nitrogen or purified synthetic air; and
- .4 hydrogen/helium mixture and purified synthetic air for the operation of the FIDs.

4 All aforementioned gases should be compliant with section 2 of appendix IV of the NTC 2008.

5 Both FIDs should be zeroed with the zero gas. The linearity check, establishment of calibration curve and span calibration of the HC-FID and the NMC-FID should be done with the C₃H₈ and CH₄ gas mixtures respectively. The NMC should not be bypassed during this check.

3 Efficiency of the NMC and CH₄ response factor

3.1 CH₄ response factor

6 The CH₄ response factor RF_{CH_4} is calculated only for the HC-FID. The procedure for determining the response factor should be done according to section 8.2 of appendix IV of the NTC 2008. According to the NTC 2008, the test should be performed when the analyser is first commissioned and after major service has taken place.

7 The CH₄ response factor for the NMC-FID is set to 1.

3.2 Efficiency of NMC

8 This section details the procedure for determining the Ethane efficiency E_e and Methane efficiency E_m , as described in section 8.5 of appendix 1 to these Guidelines. The procedure described below is performed on the NMC-FID only.

- .1 A zero gas (as mentioned in section 2) and gas mixtures containing CH₄ and C₂H₆ at a concentration above 80% of the analyser's measuring range are prepared, as well as a hydrogen/helium mixture and purified synthetic air for the operation of the FID. All gases need to be compliant with section 2 of appendix IV of the NTC 2008;
- .2 The NMC-FID is warmed up and operated according to the instructions of the manufacturer;
- .3 The NMC-FID is calibrated with zero gas and CH₄ gas, through the NMC;
- .4 C₂H₆ gas is introduced to the analyser, through the NMC and the concentration is recorded as $c_{C_2H_6}(wCutter)$;
- .5 C₂H₆ gas is introduced to the analyser, bypassing the NMC and the concentration is recorded as $c_{C_2H_6}(w/oCutter)$;
- .6 CH₄ gas is introduced to the analyser, through the NMC and the concentration is recorded as $c_{CH_4}(wCutter)$;
- .7 CH₄ gas is introduced to the analyser, bypassing the NMC and the concentration is recorded as $c_{CH_4}(w/oCutter)$; and
- .8 The Ethane efficiency (E_e) and Methane efficiency (E_m) are calculated as follows:

$$E_e = 1 - \frac{c_{C_2H_6}(wCutter)}{c_{C_2H_6}(w/oCutter)} \quad (\text{eqn. 1})$$

$$E_m = 1 - \frac{c_{CH_4}(wCutter)}{c_{CH_4}(w/oCutter)} \quad (\text{eqn. 2})$$

9 In order comply with section 8.5 of appendix 1 to these Guidelines the achieved efficiencies should be: $E_e \geq 98\%$ and $E_m \leq 15\%$.

10 It is important to note that the value of E_m calculated based on (eqn. 2) is only relevant for the NMC efficiency check. For the calculations in section 4, E_m is set to 0.

4 Calculation of corrected CH₄ concentration

11 The corrected CH₄ concentration (c_{CH_4cor}) can be calculated with the following formula:

$$c_{CH_4cor} = \frac{c_{CH_4} - c_{HC}(1 - E_e)}{1 - ((1 - E_e) * RF_{CH_4})} \quad (\text{eqn. 3})$$

where:

c_{CH_4cor} : corrected CH₄ concentration (ppm)

c_{CH_4} : CH₄ concentration (ppm) as measured with the NMC-FID

c_{HC} : HC concentration (ppmC1) as measured with the HC-FID

E_e : Ethane efficiency (see section 3.2)

RF_{CH_4} : CH₄ response factor of the HC-FID (see section 3.1)

12 The corrected CH₄ concentration c_{CH_4cor} should be used to determine the methane mass flow rate as explained in section 5.12.5 of appendix 1 to these Guidelines.
