ANNEX 17

RESOLUTION MEPC.415(84)
(adopted on 1 May 2026)

GUIDELINES FOR ENGINE LOAD MONITORING (ELM) AND CALCULATION OF EMISSION VALUES

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 (CH_4) and nitrous oxide (N_2O),

HAVING CONSIDERED, at its eighty-fourth session, draft guidelines for engine load monitoring (ELM) and calculation of emission values,

1 ADOPTS the *Guidelines for engine load monitoring (ELM) and calculation of emission values*, 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 CH_4 and/or N_2O 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.

ANNEX

GUIDELINES FOR ENGINE LOAD MONITORING (ELM) AND CALCULATION OF EMISSION VALUES

1 Introduction

1.1 The purpose of this procedure is to specify the method for engine load monitoring (ELM) to establish factors that reflect the actual operation of a marine diesel engine, and for the calculation of emission values.

1.2 The ELM can be used to monitor actual engine load during operation instead of the pre-defined weighting factors as described in section 3.2 of the NO_x Technical Code 2008 (NTC 2008), as amended, and to be used in combination with verified CH_4/N_2O emission measurements to arrive at more representative emission values.

2 Emission values at different engine loads

2.1 The emission values for the different engine loads are based on the verified CH_4 and/or N_2O emission values established in accordance with the *2026 Guidelines for test-bed and onboard measurements of methane (CH_4) and/or nitrous oxide (N_2O) emissions from marine diesel engines* (resolution MEPC.414(84)). Between the measured points, the emission value is calculated by linear interpolation of the closest data points above and below the load point. For engine loads below the lowest measured load point, the emission value at the 10% load point or the lowest mode point at which gas fuel would be used should be used for the calculations. For engine loads above the highest measured load point, the emission value at the highest measured load point should be used.

3 Load monitoring

3.1 The load of each engine to which this ELM procedure is to be applied should be monitored. Load signal may be based on load measurement from the torque flange, the shaft strain gauge or calculated from the generator output, etc. In case no direct load measurement signal is available, estimated load based on e.g.: cylinder pressure, injection duration, etc. may also be used subject to the approval of the Administration, as in paragraph 6.4.3.4 of the NTC 2008. Measurement equipment used in conjunction with this ELM procedure should meet the requirements given in tables 3 and 4 of the NTC 2008, appendix IV and be calibrated in accordance with the manufacturer's recommendations.

3.2 Engine load should be continuously monitored and recorded onto a data recording and processing device at a rate which should not be less than 0.0035 Hz. Engine load is averaged in 30-minute intervals (or other time period approved by the Administration). Zero load or liquid fuel only operation should be excluded from the averaging.

3.3 When the engine has a gas fuel flow measurement device installed, calibration of the flow meters should be specified in the data collection procedure, and the calibration and maintenance records should be included in the yearly report referred to in section 5.

4 Calculations

4.1 Emission values for corresponding engine loads are calculated from verified measurements in unit g/g fuel, $C_{slip\text{-}CH4}$ (% of the mass of the methane containing fuel used by the energy converter), or g/kWh. Calculation of yearly emission values (g/g fuel) is done by following the procedure.

Option A: If an engine has a gas fuel flow measurement device installed (example in table 2):

.1 total fuel mass (kg) is calculated during the 30-minute period (or other appropriate time period) based on the fuel flowmeter;

.2 $C_{slip\text{-}CH4}$ (%) emission factor for the load averaged over the period is calculated from the measurement data as described in section 2;

.3 CH_4 emission mass in kg during the period is calculated by multiplying the fuel mass by the $C_{slip\text{-}CH4}$ (%) emission factor; and

.4 total weighted $C_{slip\text{-}CH4}$ (%) for the year is calculated by dividing the sum of the emissions (kg) by fuel mass (kg) and multiplied by 100.

Option B: If there is no gas fuel flow measurement device installed (example in table 3):

.1 specific emission factor in g/kWh for the load averaged over the 30-minute period (or other appropriate time period) is obtained from the measurement data as described in section 2;

.2 engine load is converted to power (kW);

.3 emission mass in kg during the period is calculated by multiplying the engine power output (kW) with time (h) and the specific emission factor in g/kWh, divided by 1000; and

.4 total weighted $C_{slip\text{-}CH4}$ (%) for the year is calculated by dividing the sum of the emission (kg) by fuel mass (kg) and multiplied by 100.

Table 1: Example data set to demonstrate interpolation and calculations in tables 2 and 3

Measurement points	Load (%)	Engine power (kW)	Fuel flow LNG (kg/h)	LNG (g/kWh)	CH_4 (g/kWh)	$C_{slip\text{-}CH4}$ (%)
5	92	4,031	608	151	3.54	2.3
4	77	3,410	512	150	3.08	2.0
3	50	2,239	350	156	3.91	2.5
2	26	1,152	204	177	7.30	4.1
1	11	500	108	216	13.10	6.1

Table 2: Example of calculation if gas fuel flow data is available (for Option A)

Interval	Load (avg)	Fuel (kg)	$C_{slip\text{-}CH4}$ (%)	Emission mass (kg)
00:00-00:30	5%	34.8	6.1%	2.1
00:30-01:00	15%	66.8	5.5%	3.7
01:00-01:30	55%	190	2.4%	4.6
01:30-02:00	55%	190	2.4%	4.6
02:00-02:30	73%	244	2.1%	5.1
02:30-03:00	95%	313.5	2.3%	7.2
03:00-03:30	32%	120.25	3.7%	4.4
Total		1,159		32
Weighted $C_{slip\text{-}CH4}$ (%)				**2.7%**

Table 3: Example of calculation if gas fuel flow data is not available (for Option B)
(Engine rated power: 4,400 kW, Total fuel used during the period: 1,159 kg)

Interval	Load (avg)	Engine power (kW)	CH_4 (g/kWh)	Emission mass (kg)
00:00-00:30	5%	220	13.1	1.4
00:30-01:00	15%	660	11.6	3.8
01:00-01:30	55%	2,420	3.8	4.6
01:30-02:00	55%	2,420	3.8	4.6
02:00-02:30	73%	3,212	3.2	5.1
02:30-03:00	95%	4,180	3.5	7.4
03:00-03:30	32%	1,408	6.5	4.6
Total				32
Weighted $C_{slip\text{-}CH4}$ (%)				**2.7%**

5 Approval and verification

The monitoring method, data collection procedure and yearly load monitoring data and corresponding emission calculations should be approved by the Administration.

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