

Technical Guidance Document: LNG shipping

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Introduction

The purpose of this technical guidance document is to provide additional guidance on the quantification of methane emissions from LNG carriers, which transport LNG from liquefaction plants to regasification terminals.

While the primary source of methane emissions is the incomplete combustion of natural gas in the main propulsion engines, as well as in the auxiliary engines and generators that support vessel operations, this document addresses all potential sources of methane emissions.

It consolidates the insights gained over recent years and offers further clarification on reporting requirements to support consistent, transparent, and accurate emissions quantification. The document also clarifies Level 5 reporting requirements for this segment of the value chain.

Clarification of the scope of reporting

LNG carriers involve complex commercial arrangements, and in some cases, it can be challenging to assign emissions correctly. This section clarifies under which circumstances methane emissions from LNG ships, including chartered vessels, fall under the OGMP 2.0 scope.

The distinction is based on who has operational control of the ship, which in shipping refers primarily to who controls the fuel combustion and gas-handling activities on board:

- **Shipowner:** This refers to the legal entity that owns the vessel, which may be an individual or a financial institution.
- **Ship manager or technical operator:** This entity daily manages the vessel on the cargo owner's behalf and must hold a DOC (Document of Compliance) as required by the International Safety Management (ISM) Code. Their responsibilities include crew hiring, technical maintenance, upkeep of ship class certificates, insurance, and—crucially—reporting ship emissions and paying any associated taxes.
- **Charterer:** Typically, the cargo owner, the charterer directs vessel operations (destination, speed, etc.), arranges and pays for bunkering, and decides the onboard fuel type (gas mode, HFO, LSMGO, or combinations). Ultimately, they are usually responsible for the shipping emission costs, such as those under FuelEU and ETS.

These definitions form the basis for determining whether vessels should be reported as operated, non-operated or considered out of scope for reporting under the OGMP 2.0 program:

- When the OGMP 2.0 member is the **technical operator** of the vessel, the vessel will be reported as operated.
- When the OGMP 2.0 member is the **shipowner**:
 - If the member is also the **technical operator**, the vessel will be reported as operated.
 - If the member is **not** the **technical operator**, the vessel will be reported as non-operated.

- When the OGMP 2.0 member is the **charterer** (time and voyage charters¹):
 - If the member is also the **technical operator**, the vessel will be reported as operated
 - If the member is **neither** the **shipowner** nor the **technical operator**, the vessel may be reported on a voluntary basis.

In accordance with the OGMP 2.0 reporting framework, when the vessel's technical operator is a joint-venture partner of a company member, the vessel must be reported by the company member as **non-operated**.

System boundaries

The member is responsible for reporting all methane emissions from equipment and components linked to the LNG value chain for the duration of their custody of the gas. The custody transfer point can be defined at the flange connecting the shore arm to the ship's manifold. Emissions occurring before or after this point are the responsibility of the operator holding custody of the gas at that time, including emissions from loading and unloading operations. The reporting scope also includes emissions during return voyages carrying only the heel LNG, as well as emissions arising during maintenance activities.

Quantification of the main sources of methane emissions

There is limited documentation of generic or specific source-level emission factors for LNG carriers. However, emission factors or other quantification methods used in other natural gas value chain processes or other shipping industries could be relevant for use in LNG shipping. For example, methane emissions from incomplete combustion of natural gas in ship engines may be estimated using methane slip data derived from other vessels operating with similar engine technologies and operating under comparable conditions. Likewise, methane emissions from compressor seals may be estimated using emission factors from the LNG liquefaction or regasification segment, as the processes and gas compositions can be similar between the segments.

Relevant information on methods and technologies for reporting at Level 3 and Level 4 is included in the *General principles TGD* and the corresponding equipment or sources TGDs.

Level 3

Reporting at this level involves using different quantification methodologies depending on the source type, such as generic emission factors, simple engineering calculations, or manufacturer's guarantees for the vessel (e.g., daily fuel consumption rates and expected boil-off gas rates during normal operations).

¹ A **time charter** is a contract under which the charterer hires an LNG carrier for a specified period of time (e.g., months or years), while in a **voyage charter**, the charterer purchases a transportation service for a specific cargo movement.

Level 4

This reporting level may involve the use of direct measurements, measurement-based emissions factors, detailed engineering calculations, process simulations, or a combination of them, depending on the methane emissions source.

It is important for operators to ensure that the inputs to the quantification method are representative of their specific asset and operations, rather than relying on generic activity data estimates. Some examples include:

- Quantification of some vents with detailed engineering calculations, process simulations and models using operational and safety logs:
 - Tank pressures and temperatures
 - Tank levels
 - BOG generation rate and handling (consumption by engines, reliquefaction, or venting)
 - Voyage duration and operating profile
 - Methane content
 - Frequency and duration of events
- Direct measurements of gas release flow rate.
- Manufacturer's estimates of emission rates provided they are representative based on the engine build and specific operating conditions and have procedures in place to identify abnormal events.
- Emission factors derived from academic or industry measurement campaigns that are of high data quality and representative.
- Source-resolved data provided by site-level technology.

Fugitive emissions

Fugitive emissions refer to the unintentional release of gas to the atmosphere, which can be caused by corrosion, material defects, loss of tightness, fitting defects, or failures².

Based on the data reported by OGMP 2.0 members, fugitive emissions from LNG carriers are normally non-material, but cannot be considered negligible.

The OGMP 2.0 *Unintended equipment leaks TGD* includes guidance on Level 3 and Level 4 quantification for this source.

Annual LDAR surveys and fugitive emissions quantification are recommended. However, conducting periodic LDAR surveys may be challenging due to logistical and approval requirements. An acceptable alternative is to perform detection only, which can be carried out through various monitoring approaches, such as fixed or portable gas detection sensors, thermal imaging during scheduled rounds or sniffer-based surveys at defined intervals, or

² SIGTTO, *Detection and Reporting of Fugitive Methane Emissions from LNG Carriers*,
<https://www.sigtto.org/publications/detection-and-reporting-of-fugitive-methane-emissions-from-lng-carriers/>

other applicable methods. These might be implemented by the ship crew during routine preventive/safety inspections, conducted at least annually. Details on leak detection methods and results should be fully documented in the implementation plan.

For reporting leaks at Level 3, publicly available component-specific emission factors (e.g., connectors, valves) for LNG carriers are limited. It is recommended to use emission factors from the segment most comparable to LNG carriers, such as LNG storage facilities or LNG liquefaction and regasification plants. An alternative is to use an average LNG carrier emission factor (tons of methane from leaks per LNG carrier).

For Level 4 reporting, component-specific emission factors (e.g. connectors, valves, flanges, etc.) derived from direct measurements and specific to LNG carriers will be used in combination with the activity data collected during the LDAR campaigns.

Also deemed suitable for Level 4 reporting would be any representative average emission factors for leaks that may be derived based on measurements conducted across the OGMP 2.0 partnership.

Vents

Purging & venting (maintenance, process, operations)

Venting refers to the intentional release of gas to the atmosphere, typically required by the design, operation, or maintenance of equipment. These releases can originate from multiple sources and may occur either continuously or intermittently.

Member companies are responsible for ensuring that all venting emissions are identified, quantified, and reported under this source category.

Following is a non-exhaustive list of potential purging and venting sources associated with LNG carriers:

- **Connection and disconnection of loading and unloading arms (nitrogen and methane purge)**

These emissions are typically under the responsibility of the export or import terminal and should be reported by the respective asset under the purging and venting source category.

- **Controllers and pumps**

For guidance on how to quantify this source, please refer to the *Pneumatic controllers, pumps, shutoff valves and control instruments TGD*.

- **Purging of fuel gas lines (including fuel switching and inerting operations)**

Venting takes place during fuel switching and inerting operations. In dual-fuel engines, the fuel gas lines are vented automatically as part of the changeover routine.

For guidance on how to quantify this source, please refer to the *Purging and venting, starts and stops and other process and maintenance vents TGD*.

- **Purging and venting of the cargo tank**

LNG carriers may vent gas to ensure that cargo tank internal pressure remains below the set-point opening pressure of the cargo tank safety valves. Venting may also be executed as part of cargo conditioning operations, for example, to adjust cargo temperature or pressure to meet terminal requirements or to prepare for the ballast voyage after unloading. In some cases, pre- and post-voyage operations might involve purging, inerting, warming-up, or gassing-up procedures.

For guidance on how to quantify this source, please refer to the *Purging and venting TGD*.

- **Purging and venting due to cargo containment permeation**

On LNG carriers fitted with membrane-type cargo containment systems, small quantities of natural gas might permeate from the cargo tank into the interbarrier and insulation spaces and be released to atmosphere through normal breathing or active nitrogen purging of the affected space.³ Companies should check the technical information specified by the containment system manufacturer.

For guidance on how to quantify this source, please refer to the *Purging and venting, starts and stops and other process and maintenance vents TGD*.

- **Maintenance activities**

When LNG carriers undergo dry-dock or major maintenance, cargo tanks must be warmed from cryogenic temperatures before entry and then returned to LNG service afterwards. This process often involves:

- Venting gas as tanks warm and methane desorbs from surfaces, when not routed to the engines and gas combustion unit.
- Purging with inert gas or nitrogen, which pushes methane out of the tanks.
- Depressurization of cargo handling systems, lines and pipes, compressors, fuel gas supply lines, vapor return lines, valves, and manifolds.
- Gas freeing (replacing inert gas with fresh air) to allow safe opening of the cargo tanks and entry for personnel.
- Gassing up after dry-dock, where LNG vapor displaces the inert gas and prepares tanks for cryogenic conditions.

For guidance on how to quantify this source, please refer to the *Purging and venting, starts and stops and other process and maintenance vents TGD*.

Compressor units (seals or rod packing)

For guidance on how to quantify this source, please refer to the *Centrifugal compressors TGD* and *Reciprocating compressors TGD*.

³ SIGTTO, *Gas Concentrations in the Insulation Spaces of Membrane LNG Carriers*, <https://www.sigtto.org/publications/gas-concentrations-in-the-insulation-spaces-of-membrane-lng-carriers/>

Incident / Emergency vents / BOG vents

Incidents and emergency stops are unintended and unplanned events/venting which are not part of routine operations. They can be due to equipment failure, over pressurization beyond control valve limits, human error or other causes.

Member companies are responsible for ensuring that all vented emissions are identified, quantified, and reported under this source category.

To quantify these sources, member companies should collect detailed onboard operational data, including:

- Flowmeter readings from vent masts or gas-handling systems
- Records of pressure relief valve activations associated with safety-critical events
- Operational and safety logs covering among others:
 - Tank pressures and temperatures
 - Tank levels
 - BOG generation rate and handling (consumption by engines, reliquefaction, or venting)
 - Voyage duration and operating profile
- **Boil-off Gas (BOG) emissions management on the ship**

Specially designed double-hulled vessels are used for shipping LNG to ensure safe and reliable transport, while reducing the LNG that boils-off from the vessel. The BOG management system maintains the cargo tank pressure below the maximum allowable relief valve settings, by ensuring safe management of the BOG and temperature.

Several options exist to manage the gas released from the tank to avoid over pressure. Depending on how the BOG is managed, the emissions are reported under different categories in the OGMP 2.0 reporting template:

- BOG used as fuel to power the vessel's main or auxiliary engines: *Incomplete combustion - Propulsion system or Incomplete combustion - Generators / Auxiliary engines.*
- BOG redirected to a Gas Combustion Unit (GCU) (not commonly part of typical operations) – *Incomplete combustion - Gas Combustion Unit*
- Leaks anywhere across the BOG management stream – *Fugitive emissions*
- BOG routed to the onboard reliquefaction unit, to be reinjected in the cargo tanks – *Fugitive emissions* (if any leaks) BOG vented to the atmosphere (not commonly part of typical operations) - *Incident / Emergency vents / BOG vents*

Typically, the BOG can be routed as fuel via a fuel gas supply system (FGSS) for the main propulsion system and onboard power generation. When BOG is used as fuel, it can typically be used directly in the gas engine or for boilers in a steam engine. Depending on the boil-off rate, ships can typically adjust power generation in their engines by consuming more or less of the BOG. The BOG may be combined with supplementary fuel oil to power the engines or boilers. Some newer vessels also have reliquefaction facilities onboard, to reliquefy the BOG, to be returned to the ship's tank as LNG.

Recent trends in LNG carrier vessels are designed to have on-board full or partial reliquefaction units, or subcoolers, to manage excess BOG from the LNG cargo tanks at times when the engine load is not sufficient to consume all BOG. It works following the same principles as land-based liquefaction plants with a series of compressors, heat exchangers (typically, nitrogen-based), expanders, and flash tanks where the cooled gas is condensed.⁴ In full reliquefaction systems, the BOG is sent back to the cargo tanks whilst a partial reliquefaction system will be sized to handle any of the remaining BOG that can either be looped back into the system or consumed as fuel.

In the case of upset events where the FGSS and reliquefaction systems are unable to handle the boil off volume, it may be redirected to a GCU where the gas is burned or vented.

For the **Level 3 reporting** when the BOG is vented, a typical BOG rate for older self-supporting carriers can be estimated as 0.15% of the total tank volume per day⁵, but BOG rate values depend on the size of the tank, insulation performance and other vessel design characteristics. This value is often provided by the ship manufacturer. BOG rates in modern membrane-type LNG carriers under laden conditions are usually below 0.10% of tank capacity per day, with some designs approaching 0.07% per day⁶. The integration of partial or full BOG reliquefaction systems further reduces net BOG generation by enabling onboard re-condensation of vaporized LNG, thereby minimizing or eliminating the need combustion in propulsion systems or GCU or venting.

$$\begin{aligned} \text{BOG from LNG Vessel Storage Tank per day} \\ = \text{Tank volume} * \text{Daily Boil off rate of vessel} * \text{number of days} \end{aligned}$$

BOG might not always be managed in the same manner over time. It is therefore recommended that Vessel Operators maintain records on the distribution of the methods used to manage the BOG throughout operations (e.g. used as fuel when at sea, sent to the GCU when the ship is idle as the fuel requirements are lower, or vented – not commonly part of typical operations) to best reflect methane emissions from BOG management. Operational and safety logs, including data on fuels consumed on board, will provide detailed information to be used to perform detailed engineering calculations and simulations to move this source to **Level 4 reporting**.

- **Incident, emergency stop or malfunction**

Any emissions resulting from an incident, emergency stop or malfunction which are sent to a gas combustion unit (GCU) fall under Incomplete Combustion category and should be reported under “Gas Combustion Unit”. For guidance on how to quantify this source, please refer to the *Flaring TGD*.

Emissions that are vented should be reported under Incident / Emergency vents / BOG vents. For guidance on how to quantify this source, please refer to the *Incidents, emergency stops and malfunctions TGD*.

⁴ Wartsila, *Encyclopedia of Marine and Energy Technology*, <https://www.wartsila.com/encyclopedia/term/lng-reliquefaction-system>

⁵ K. Kyunghwa, K. Park, G. Roh, K. Chun, *Case Study on Boil-Off Gas (BOG) Minimization for LNG Bunkering Vessel Using Energy Storage System (ESS)*, 2019

⁶ IGU World LNG report - 2025 Edition – Annex 1 – LNG Shipping, <https://www.datocms-assets.com/146580/1763396210-1747916410-igu-world-lng-report-2025.pdf>

- **Pressure Relief for Safety**

Tanks have safety valves that can release gas if pressure rises beyond design limits. This is uncommon in normal operations, but can occur due to equipment malfunction, emergency conditions or extended idle periods.

For additional information, please refer to the *Incidents, emergency stops and malfunctions TGD*.

Incomplete combustion/methane slip

The energy generation and heat processes are required for the transport of LNG to power propulsion systems and cover other energy needs onboard the LNG carrier (e.g. compressors of the reliquefaction unit).

In many cases, when gas is burned in main engines, auxiliary engines, generators, boilers, GCU (gas combustion units) and other combustion equipment, the entirety of the fuel is not transformed to CO₂. When gas is used as a fuel for such equipment, the incomplete combustion of methane and release into the atmosphere from the equipment exhaust stack is known as methane slip.⁷

- **Propulsion systems, auxiliary engines and generators**

Vessels generate most of their methane emissions through incomplete LNG combustion in their main propulsion engines, auxiliary engines, and onboard generators. The amount of incomplete combustion will depend mainly on the type of LNG engine technologies and how they are operated (methane slip increases at lower engine loads)^{8,9}.

Auxiliary engines and generators are often operated for extended periods, especially during loading and unloading operations, manoeuvring into port and at anchorage, and are also used frequently to provide hotel load (i.e. onboard power requirements). As a result, their cumulative methane emissions can be significant.

- **Gas combustion Units**

Gas Combustion Units (GCUs) are installed on majority LNG carriers to safely dispose of excess boil-off gas (BOG) when it cannot be used as fuel or sent to a reliquefaction plant. GCUs normally burn this gas in an enclosed, high-temperature combustion chamber where optimised air mixing, flame stability and adequate residence time. GCUs typically achieve high combustion efficiency. Methane emissions associated with GCUs should be assessed on a case-by-case basis, taking into account the specific GCU design, combustion technology and operating conditions.

⁷ Adapted from OGMP 2.0, *Incomplete combustion TGD*, 2022,

<https://www.ogmpartnership.org/sites/default/files/2025-04/Incomplete-Combustion-TGD-SG-Approved.pdf>

⁸ P. Balcombe, D. A. Heggø, M. Harrison, *Total Methane and CO₂ emissions from Liquefied Natural Gas Carrier Ships: The First Primary Measurements*, 2022, <https://pubs.acs.org/doi/10.1021/acs.est.2c01383>

⁹ Pavlenko, N. et al., *The climate implications of using LNG as a marine fuel*, 2020, ICCT, <https://theicct.org/publication/the-climate-implications-of-using-lng-as-a-marine-fuel/>

Level 3

The main elements to quantify methane emissions at Level 3 from incomplete combustion are covered by the *Incomplete combustion TGD*. Members are encouraged to rely on emission factors which are specific to the type of engine and fuel used. Default factors depending on engine type (% fuel consumption) and engine loads are often provided by engine manufacturers and can be used to estimate methane emissions.

In addition, since the data is already reported on annual fuel oil consumption, distance travelled and hours underway under the International Maritime Organization (IMO) Data Collection System (DCS), these data can serve as a further basis for estimating methane emissions from incomplete combustion at Level 3. This section provides additional examples, specific to marine engines running on LNG.

Table 1 presents examples of emission factors that can be used to estimate methane emissions from incomplete combustion¹⁰.

Table 1 - Default methane slip emission factors

Engine type	Methane slip (g CH ₄ /kWh)	Methane slip (%)
LBSI, medium-speed	4.1	2.6%
LPDF, medium-speed, four-stroke	5.5	3.5%
LPDF, slow-speed, two-stroke	2.5	1.7%
HPDF, slow-speed, two-stroke	0.2	0.15%
Steam turbine	0.04	0.01%
Gas turbine	0.06	0.03%

In addition, other factors such as exhaust temperature or the engine load^{8,9} have been shown to have a major impact on the methane slip of the marine engines of LNG carriers. Therefore, taking the variation of engine load over time into consideration when quantifying methane emissions from incomplete combustion is encouraged.

As an alternative to default emission factors, members may use engine-specific methane emission factors derived from test-bed measurements, including Factory Acceptance Testing (FAT)¹¹, where such data are available and appropriately verified. When applied, these factors should be combined with actual engine load information¹².

Alternatively, the emissions can be estimated through engineering calculations. One example of such an approach is the LNG Shipping Emissions Estimation Tool¹³, which estimates methane emissions based on chosen carrier, trip characteristics, time spent manoeuvring and docking, and the ballast remaining in containment, etc. By accounting for how engine activity varies across a typical voyage, this type of tool can provide an estimate of cumulative methane emissions.

Level 4

¹⁰ Faber J. et al. (2020). Fourth IMO GHG Study 2020, <https://www.imo.org/en/ourwork/environment/pages/fourth-imo-greenhouse-gas-study-2020.aspx>

¹¹ Documented in the methane file described in IMO Resolution MEPC.414(84).

¹² Obtained through Engine Load Monitoring (ELM) in accordance with IMO Resolution MEPC.415(84) to estimate methane emissions over the reporting period.

¹³ The University of Texas at Austin, LNG Shipping Emissions Estimation Tool, <https://www.eemdl.utexas.edu/lng-shipping-emissions-estimation-tool>

Measurements (including continuous or periodic monitoring), emission factors developed from representative measured emissions (including predicted emissions) or in some cases detailed engineering calculations (as discussed below) are considered Level 4 emissions quantification approaches. To quantify methane emissions from incomplete combustion, both the mass/volume and methane content of the exhaust gases must be quantified.

Detailed onboard operational data will be needed to report at Level 4, including:

- Fuel type used
- Fuel consumption rate
- BOG consumption
- Engine load
- Exhaust temperature

The following are considered to provide Level 4 estimates¹⁴:

Parameters	Continuous or Intermittent Combustion: Level 4 approaches
Mass of exhaust gases ¹⁵	• Direct measurements • Measurement-based emission factors, determined through the application of correlations based on representative sampling • Engineering calculations
Methane content of exhaust	• Direct measurements • Measurement-based emission factors, determined through the application of correlations based on representative sampling • Engineering calculations or modelling

System configurations and operating conditions should be considered in determining 'like' systems that carry common parameter value. Each system that is not 'like' will require determination of a separate parameter value (mass and methane content of the exhaust) for that system based on the appropriate measurement studies. For guidelines on the methodology to develop a statistically representative sample, please refer to the *Uncertainty and Reconciliation Guidance*¹⁶.

Measurement-based emission factors derived from a representative sample expressed in terms of emission per volume of fuel combusted allow for easy adjustment of activity data.

Mass of exhaust gases: Direct measurements, application of correlations based on representative sampling, or in some cases engineering calculations (as discussed below) are considered Level 4 quantification approaches.

- Measurements:

¹⁴ Aligned with the International Maritime Organization guidelines: *Guidelines for Test-bed and Onboard Measurements of Methane (CH₄) and/or Nitrous Oxide (N₂O) Emissions from Marine Diesel Engines*. Resolution MEPC.402(83) and Draft of MEPC 84.

¹⁵ Exhaust gas flow determination methods follow the NO_x Technical Code 2008 (NTC 2008): *Technical Code on Control of Emission of Nitrogen Oxides from Marine Diesel Engines, as amended*.

¹⁶ Adapted from OGMP 2.0, *Uncertainty and Reconciliation Guidance*, 2022, <https://www.ogmpartnership.org/sites/default/files/2025-04/OGMP-2.0-UR-Guidance-document-SG-approved%20%281%29.pdf>

Following is a non-exhaustive list of such measurement solutions:

- Ultrasonic Flowmeters
- Differential Pressure Flowmeters
- Pitot tubes
- Venturi meters

The volume should then be converted to mass using the measured gas density. Alternatively, a representative gas density value may be used, obtained by adjusting the default figure for the relevant temperature and pressure conditions.

- Detailed engineering calculations:

The volume of exhaust gas can also be calculated based on the measured fuel and air flows that are combusted, depending on the load at which the engine is running. Similarly, the total exhaust flow rate can be determined based on fuel flow rate and exhaust O₂ or CO₂ content using combustion stoichiometry.

Methane content in exhaust gases: Direct measurements or application of correlations based on representative sampling are considered Level 4 quantification approaches.

- Measurements

Accepted measurement equipment and techniques, as defined in the *General Principles TGD*, for determining methane content in the exhaust are to be employed. Following is a non-exhaustive list of methodologies and technologies to measure methane content.

Approaches:

- Continuous Emissions Monitoring Systems (CEMS)
 - Predictive emissions monitoring (PEMS)
 - Spot measurements
- Suitable technologies include, but are not limited to:
 - Fourier Transform Infrared (FTIR) Spectroscopy
 - Laser infrared absorption (LIA) techniques, including Tunable Diode Laser Absorption Spectroscopy (TDLAS)
 - Non-Dispersive Infrared (NDIR) Spectroscopy
 - Heated Flame Ionization Detection combined with a Non-Methane Cutter (HFID + NMC)
 - Detailed engineering calculations / modelling:

The methane content of the exhaust can also be derived from techniques that combine measured fuel and airflow parameters with other equipment metrics (such as temperature) and kinetic models, such as predictive emissions monitoring (PEMS) techniques. For such systems, there needs to be clear validation and calibration with physical measurements.

Level 5 for LNG carriers: Alternative pathway - Interim solution

The Level 5 estimate is defined as the best estimate of annual emissions from an asset, including all sources of methane emissions. It is based on the reconciliation between the source-level inventory (Level 4) and site-level measurements to ensure that all potential sources have been detected and accurately characterized, clearly attributed and included in the inventory.

Considering the OGMP 2.0 members' experience and data, the current scientific publications, the risk of having unidentified material emissions, the current technology limitations and constraints, and until other solutions are available for this asset type, the OGMP 2.0 team recognizes the combined application of the following approaches as an alternative way to achieve Level 5 reporting for LNG carriers:

- For **fugitive leaks**: Level 3 or Level 4 reporting, as described in the Section on Fugitive emissions, depending on their materiality. When robust and frequent LDAR campaigns are performed, the risk of having material unidentified leaks is very low.
- For **venting** emissions: Level 4 reporting is required. Details on quantification methods need to be included in the implementation plan.
- For **incomplete combustion**, representative CEMS (Continuous Emissions Monitoring Systems) or PEMS (Predictive Emissions Monitoring Systems) supported by periodic onboard stack testing to validate or recalibrate them in line with provider's recommendations. CEMS and PEMS provide continuous exhaust monitoring and derive real-time methane slip factors across the full range of operating conditions (operational load, fuel consumption rate). In this case the LNG carrier will be recognised at **Level 5**.

CEMS installation is typically viable on newbuild vessels or during major retrofits where system integration can be planned and engineered appropriately.

Where the installation of CEMS is not feasible, or the PEMS is not in place, a justification needs to be provided in the implementation plan. In this case, methane emissions will be estimated using load-dependent incomplete combustion curves, previously validated by spot measurement-based methane content in the exhaust. In such cases, LNG carriers will be considered to meet **Level 4** requirements, and this approach will **not constitute a Gold Standard issue**.

Members are encouraged to reach out to their OGMP 2.0 technical focal point prior to including any approach in their Implementation Plan to ensure alignment with this guidance. If members are additionally testing alternative approaches, they are equally encouraged to discuss these with their focal point and to document the details and analysis in the Implementation Plan.