Brief description of the source

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, such as extreme weather events or acts of sabotage.

Following is a non-exhaustive list of potential incidents or incident causes, which are covered by this TGD:

- Mishaps/dig-ins of pipelines
- Unstabilized hydrocarbon and LNG spills
- Blowouts
- Breakage, rupture or fatigue
- Explosion/Boiling Liquid Expanding Vapor Explosion (BLEVE)
- Fire
- Third party damages
- Emissions from corroded components
- Flare flame-out/cold flaring
- Construction defect/material failure
- System failure (e.g., overpressure)
- Emergency venting to avoid equipment malfunction
- Climate impact (e.g. floods, lightning strike)

Events considered as incidents might vary according to the jurisdiction in which they occur or based on company classification. Incidents may trigger an alert, and its occurrence will typically be detected rapidly.

Malfunctions, on the other hand, might not be instantly detected and may be identified during inspections . They lead to unexpected and unplanned emissions due to an equipment not functioning as it was intended to

Following is a non-exhaustive list of potential malfunctions, which are covered by this TGD:

- Continuously open or rusty PRV
- Rupture disc rupture
- Flare ignition issues
- Plugged compressor vent
- Stuck open intermittent controller
- Stuck open dump valve
- Storage tank fire extinguisher left loose to release vapors
- Malfunctioning vent capture systems or vapor recovery units that lead to atmospheric release

Typically, incidents are quantified after the event is resolved. Quantification of incidents should never be prioritized over its resolution.

System boundaries

All emissions from incidents, emergency stops, and malfunctions are included in this TGD. Emissions from unintended equipment leaks should be reported under the corresponding category. The distinction between incidents and leaks is to be considered based on the regulations and practices in place at the facility. Unintended methane emissions, considered to fall within the *leaks* category should be reported as such (Leaks TGD). As defined in the *General Principles TGD*, these should be allocated to the most appropriate reporting category.

Any emissions resulting from an incident, emergency stop or malfunction which are sent to a flare fall under that category (Flaring TGD), emissions which are vented are covered by the *Incidents TGD*.

All intended or expected emissions (vents) are to be reported under their respective category (Pneumatics, centrifugal compressors, reciprocating compressor rod packing, glycol dehydrators, un-stabilized liquid storage tanks, gas well liquids unloading, oil well casinghead venting, gas well hydraulic fracture completion venting and other venting and purging).

Guidance on materiality is presented in the *General principles TGD*.

Level 3 Quantification Methodologies

Emission factors

Accepted source-level emission factors, as defined in the *General Principles TGD,* or those prescribed by local regulation are considered as providing Level 3 estimates, provided they are specific for the source type. Practitioners are encouraged to use emission factors that best represent conditions and practices at their facilities and adjust factors, where warranted, to more accurately estimate emissions given differences between the reference system on which the emission factor is based, and their systems.

The following references provide example emission factors for certain types of incidents and can be used to quantify methane emissions at level 3.

- API compendium, detailed for some emission sources, at equipment level (e.g. stuck open dump valve for tanks, upsets and mishaps in distribution networks)

It is important to note that this list is non-exhaustive and that all types of incidents and malfunctions might not be covered by the references provided above. If no emission factor is available for a specific emission source, the emission factor of a similar source or reasonable estimate can be used based on the Partner's best judgement.

For distribution networks, it is possible to quantify methane emissions depicting emissions from incidents per length of network.

Level 4 Quantification Methodologies

Depending on the emission source, measurements, measurement-based emission factors, process simulation and/or engineering calculations can be accepted for level 4 quantification.

Direct measurement and Measurement-based Emission factors

The general principal to level 4 quantification of methane emissions from incidents and malfunctions is to quantify:

- Gas release flowrate
- Methane content
- Duration of the incident or malfunction

Methane emissions from gas emitted for each emission category is the multiplication of these three elements.

Incidents

As incidents are, by definition, unpredictable, level 4 quantification must be conducted on the best available data. The following data sources (or a combination of them in order to cross-check the results) should be considered to quantify methane emissions from incidents

- Measurements (including any top-down measurements from satellites which might have been covering the area at the time of the incident, vent line can be a good measurement point if has meter)
- Engineering calculations (based on recorded operational parameter of the emission source at the time of the incident, and its physical specifications)
- Mass-balance

Methane content can be evaluated based on facility specifications, as described in the *General Principles TGD*.

The duration of each incident should be measured or estimated based on best available data.

It is essential that all incidents leading to release of methane are recorded, along with the required information, in the facility log or similar.

Malfunctions

If malfunctions are detected, the gas flow from these malfunctions should be quantified either through measurements or engineering calculations, provided obtaining measurement data does not pose a threat to safety or unreasonably delay the repair of the malfunction. Malfunctions can generally be identified using methane detection technologies and methods (OGI camera, laser, soap bubbles, …) which are often conducted alongside detection surveys.

Measurements (including continuous and periodic monitoring), emission factors developed based on representative measured emissions or engineering calculations are considered Level 4 emissions quantification. Measurements must be taken that represent the total flow of each gas stream that is emitted to atmosphere.

Where relevant, Level 4 emission factors for malfunctions may be determined. In which case, they should be based on measurements conducted on a representative sample. Type of malfunction and other relevant characteristics should be considered in determining 'like' systems that carry a common emission factor. Each system that is not 'like' will require determination of a separate emission 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].

Gas flow of the malfunction

Accepted equipment and techniques, as defined in the *General Principles TGD,* for determining gas flow of the malfunction are to be employed. Practitioners are encouraged to select an appropriate measurement device depending on the characteristics of the vent. Following are typical equipment to measure emissions from vents, but the list is not exhaustive[1] [2]:

- Vane anemometer.
- Hotwire anemometer.
- Turbine meter.
- electronic packing vent monitor (for compressor packing vents)
- Orifice meter
- Hi-flow sampler

[1] More details on various detection and measurement equipment can be found at CCAC, *Conduction Emissions Surveys, Including Emission Detection and Quantification Equipment – Appendix A of the OGMP Technical Guidance Document*, 2017
[2] More details on various detection and measurement equipment can be found at Marcogaz, *Assessment of methane emissions for gas Transmission and Distribution system operators*, 2019 – Section 7 (p. 34-39)

Methane content of the malfunction

It is possible that the methane content changes as a consequence of the malfunction and in such circumstances, it may be necessary to determine the methane content of the gas flow of the malfunction to quantify methane emissions from malfunctions. Depending on the equipment which is malfunctioning and/or the segment in which it occurs, the methane content can differ from the average methane content of the facility. In cases where the malfunctioning equipment emits gas similar to that of the rest of the facility, methane content from facility specification, previously determined through measurements, can be employed, or it can be specified based on sampling & analysis of the gas from the same emission source(s).

Accepted equipment and techniques, as defined in the *General Principles TGD,* for determining methane content can be employed. In cases where the gas characteristics can be assumed to meet a regulated specification (e.g. underground gas storage, gas transmission, gas distribution and LNG terminals), the methane content can be determined based on the methodology defined in the *General Principles TGD*.

Duration of the malfunction

The time from the start of the event to its repair and verification should be considered to determine the duration of the malfunction. If the start of the event is unknown, to allow for an estimation of emissions, the previous inspection, when the equipment was functioning properly, can be considered as the start of the malfunction as a conservative approach, from half-time since the previous survey, from the start of the reporting period for immaterial sources or using other leak duration estimate methodology, provided the methodology can be explained and justified. Material emissions can require a restatement of previously reported emissions. Duration of malfunctions can be treated similarly to duration of leaks. Examples of ways to account for the duration are presented in the *Leaks TGD.*

If the start of the event can be clearly identified (e.g., triggers an alert at the facility, notification sent), a more precise estimate of when the malfunction started can be used.

Malfunctions might not emit constantly over the duration of the event. Where applicable, a linear ramp up rate of emissions may be considered.

Engineering calculations and models

Engineering calculations and models can be considered as Level 4 quantification methodologies for incidents and malfunctions.

For example, emissions from depressurization of systems, equipment or pipelines can be calculated using physical volume, pressure drop and temperature data, specific to the equipment or pipeline being depressurized.

$$\frac{p_i * V_i * T_f}{p_r * T_i} = V_f$$

Where:

p_i = Initial pressure of the equipment/system
p_r = Remaining pressure of the equipment/system (generally, atmospheric pressure)
T_i = Initial temperature of the gas being released (kelvin)
T_f = Temperature of the gas after being released (generally, atmospheric temperature) (kelvin)
V_i = Physical volume of the vented equipment or system (m^3)

V_f = Volume of gas released (scm)

Where applicable, standard/normal/atmospheric conditions for the vented equipment or system may be considered (typically, atmospheric pressure and 0 or 20˚C atmospheric temperature)

Alternative quantification methods

If none of the abovementioned data is available or feasible, the Partner can use best available methodology, such as Level 3 quantification, in lieu of prescribed Level 4 methodologies but must be able to justify the approach used. The methodology used to quantify emissions from incidents and malfunctions can be described and justified as part of the Annual Report, and in such circumstances may be considered as equivalent to Level 4.