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Guidance on the application of the EU regulation on methane emissions reduction

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ABOUT MARCOGAZ

Founded in 1968, MARCOGAZ represents 29 member organisations from 21 countries. Its mission encompasses monitoring and policy advisory activities related to the European technical regulation, standardisation and certification with respect to safety and integrity of gas systems and equipment, rational use of energy as well as environment, health and safety issues. It is registered in Brussels under number BE0877 785 464.

DISCLAIMER

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1. Introduction

- Generally accepted science leads to growing awareness of the contribution of methane emissions to climate change. Although there might be different thoughts about the size of this contribution there is a shared strong conviction that reduction of methane emission is absolutely necessary.
- Recently, the EU regulation was finalised to minimise methane emissions in the whole energy sector. Marcogaz welcomes that regulation and commits to the regulation as such, as well as its spirit. Following, Marcogaz promotes transparency and is in favour of commitment to the Oil & Gas Methane Partnership (OGMP) and its OGMP 2.0 reporting framework. Also, commitment to standardization as in CEN and to research via GERG is contributing to the reduction of methane emission and the accurate reporting of the decreasing amounts.
- This document aims to make relevant information available and to contribute to an appropriate interpretation of the EU regulation, in full awareness that the total costs, in terms of the resulting impact of emissions on the environment and the costs of the emission remediating activities are, or will be, a burden to society in some way. As a result from that, this document provides wide supported guidance in translating the requirements of the regulation into policies and strategies regarding methane emissions for the individual companies.
- To support the industry and other stakeholders in the use of consistent terminology, Marcogaz composed a "Glossary on methane emissions" that is and can be used in further elaborations about the subject.
- Available standards are identified in the Marcogaz document "Technical Standards for Methane Emissions".
- Marcogaz strongly supports the standardisation activities on quantification, Leak Detection and Repair (LDAR) and venting and flaring that is done in CEN TC 234 WG 14 that will provide additional guidance.
- Placed within the context of safety, the lower explosive limit (LEL) is 5 % of methane in air, resulting in 50.000 ppm. Below this limit the mixture will be too lean to burn.

2. Aiming for zero emission

In the mid- and downstream sectors, emissions can be categorized according to a list of categories:

OGMP naming	**Addressed to in EU regulation**
Fugitives	LDAR
Vents	Venting and Flaring
Incomplete combustion (Unburned)	Venting and Flaring (in part) [1])

[1]) OGMP clearly distinguishes "unburned" from "venting and flaring", the EU regulation does not.

Source of OGMP phrasing: OGMP Guidance document.

Emissions originating from incidents are categorized as "vents".

The undisputed goal is to eliminate all methane emissions, bearing in mind that the burden to society shall not be disproportional (EU regulation recital 10; see also section 7 below).

3. Monitoring, Reporting and Verification (MRV)

It is crucial to determine, quantify and report all methane emissions at source level. It is not possible to direct measure really all sources contributing to the total of methane emissions, other ways of quantification like proper use of statistical sampling and engineering calculations based on measured data like material characteristics and process parameters, are necessary too. That makes it even more important to establish a transparent and traceable line of reporting. Guidance can be obtained from OGMP technical guidance documents.

The OGMP guidance mentions not "material" and de-minimis emissions that might be reported with less certainty than material emissions in the reporting. The EU regulation doesn't mention explicitly the materiality of the emissions. However, since the OGMP guidance consider both materiality and de-minimis it seems useful to consider those concepts for MRV, Marcogaz recommends aligning reporting conditions with the competent authority.

In the near future, the European Commission will provide in implementing acts more specific rules, requirements and templates regarding measurement and quantification. Within CEN TC234 relating standards are under development. Until the implementing acts are in place and the standards are completed, Marcogaz recommends applying the technical guidance documents of OGMP.

In addition to determination of emissions at source level, the findings shall be evaluated using measurements at site level (ref art. 12.6). In case of discrepancies between source and site level measurement, a reconciliation process shall be carried out, knowing that the site level measurements methodologies are not yet mature and mainly because of that, the reconciliation process is still under development in OGMP. More details regarding the maturity of site level measurement methodologies are given in a GERG project on the technology benchmark of site-level technologies. It gives more details about how large uncertainties are. Marcogaz strongly supports the standardisation activities on reconciliation, that are done in CEN TC 234 WG 14.

As stated earlier, the site level measurements have not matured yet and that leads to high uncertainties. Marcogaz strongly supports innovation activities within the European Gas Research Group (GERG) on this topic.

The annual methane emission reports shall be verified by an independent verifier and be submitted to the competent authorities before May 31 in the year after the reporting year, as specified in art. 11 and 12 of the regulation. The first report for operated assets that includes an independent verification statement must be submitted before 05 February 2027.

The limited maturity of site level measurements should not cause extensive discussions until the site level measurements are more trustworthy. Marcogaz suggests appropriate alignment with the competent authority regarding reconciliation.

4. Leak Detection and Repair (LDAR)

The EU regulation on methane emission enforces a very strict program for Leakage Detection And Repair (LDAR). For a specific component or material, a high frequency of LDAR surveys is required for leaks in general and somewhat less frequent for smaller leaks too, referred to as type 1 and type 2 in the regulation. The main objective of this program is early detection and rapid repair.

The regulation requires that leaks above specified thresholds shall be repaired. Marcogaz however, recommends performing first line of maintenance repairs for all leaks detected above ground during of immediately following detection if possible, or at least to determine whether or not a shutdown is

required to repair and whether or not it is possible to minimise the leak. This way of working will comply with the requirement specified in art. 14.10, obligating minimizing the leak within one day after detection in case of a shutdown for repair is required. The regulation defines "shutdown" as follows (Art. 2 definition 30):

'shutdown' means a situation where a site or part of its components no longer operates under normal operating conditions and is shut down, and where complete or partial pressure reduction is required before repair or maintenance works can be initiated".

In accordance with art. 14.10, the security of supply shall be respected. Reference is made there to small connected systems as defined in Directive (EU) 2019/944. Marcogaz considers this requirement to be general and also applicable for larger systems. A necessary shutdown shall be scheduled in alignment with competent authorities and consumers connected to the parts of the system that are taken out of service temporally.

Further details regarding LDAR are provided in the Marcogaz document "Recommendations on LDAR campaigns". Latest insights are shown in Appendix A.

In art. 14.5, for operators producing or processing natural gas the regulation allows for altering inspection intervals based on performance. Although not explicitly specified, since it is about similar equipment, it is suggested to discuss with the competent authority that the same rules should apply to operators operating similar plants like for instance compressor stations, underground storage and LNG facilities.

5. Vents

OGMP categorize vents in (quoted from: Guidance for completing Reporting Template Mid and downstream)

- Operational emissions
- Purging and venting (Maintenance, process commissioning and decommissioning)
- Regular emission technical devices (pneumatic devices, gas analysers, compressor seals..)
- Start & stops
- Incidents / emergency situations

Venting due to operational conditions is allowed only when no alternatives are available. Marcogaz composed Recommendations on Venting and Flaring as well as a number of Best Available Techniques (BAT) to reduce venting emissions that are published on the Marcogaz website. The application of mobile compressors and flares are included in the BAT's.

Extensive application of the Marcogaz BATs (in compliance with the regulation) will reduce emissions caused by operational circumstances significantly. The remaining emissions will be very small and need to be accepted, as in line with art. 15.3 of the regulation.

Art. 15.5 of the EU regulation requires that "Equipment that vents shall be replaced by non-emitting alternatives where those are commercially available and if they meet the standards or technical prescriptions for components designed to vent.". Because it is not very well defined what the scope of "equipment" is in this context, it is suggested to discuss with the competent authority that if significant changes in the design of the installation, outside of the piece of equipment that is going to be replaced are required to apply a "non-emitting" piece of equipment, this means that this new equipment does not meet the standards or technical prescriptions of the original components and replacement is not

obligatory. The standards developed in CEN TC 234 WG 14 should provide more guidance on these situations when they are completed.

6. Incomplete combustion

Methane emissions from incomplete combustion originates from flaring or gas combusting devices like boilers, engines and turbines. The unburned emissions from gas combusting devices such as boilers, engines and turbines (not flaring devices) are not within the scope of the regulation, in accordance to art. 2.1.

In line with definition 31 in art. 2, emissions from gas combustion devices other than flares are not "direct" emissions and not considered as vented. That emissions are not subject to the considerations in art. 15 about venting and flaring.

In line with the regulation art. 17, flares shall have methane conversion efficiency of at least 99%.

Combustion devices designed to use gas for other purposes than the sole aim of destroying methane and converting it to CO2 are not considered to be subject to the requirements specified in art 17. They may be maintained as long as they meet their design specifications and comply with the Industrial Emissions Directive (IED) if applicable, the Machine Directive with its safety requirements that affect the proper functioning of combusting equipment, such as the EN 746-2:2020 and the Energy Efficiency Directive (EED), knowing that their methane conversion efficiency should be better than 99%.

7. Considerations about measures

As stated before, Marcogaz strongly supports the transparent reporting of remaining emissions and the execution of measures that are reducing methane emissions. Marcogaz as well as OGMP compiled Best Available Techniques (BAT'S) documents to achieve that. The BAT documents will evolve according to technological development and evolving practices. This includes also the ongoing prevention of incidents and the related emissions.

Marcogaz recognize the obligation to repair all leaks above the given threshold limit, but also that a clarification of the art. 13 stating that "*Operators shall take all **appropriate mitigation** measures ..*" is needed.

For small leaks

- Where emissions as sum of scope I, II and III of repair greatly exceeds the lifetime emission of the leak (art. 14.9 point b)

or

- Where the societal cost of the repair greatly exceeds the lifetime societal cost of the leak

In those two cases Marcogaz suggests that operators have an open discussion with the competent authorities to clarify what the appropriate mitigation measure will be.

It should be clear that in addition to the environmental impact of the emitted gas, this emission causes a small scope 3 CO2 emission in the provision chain due to up-stream activities too. It is suggested to discuss with the competent authority to either neglect this scope 3 portion of the emissions or to agree on the way of settling it in the evaluation of the balance of the methane emission and the emission caused by the repair.

Example of lifetime emissions:

If for example an underground valve leaks just more than 5 g/h, without remediation, the annual emission is approximately 44 kg/year. In this example the expected remaining lifetime of the valve is 20 years. The lifetime emission of the leak can be estimated to be: 44 kg/year x 29,8 in GWP_{100} x 20 years = 26224 kg CO_2 equivalent.

Scope I, II and III repair emissions can be estimated as follows:

- Scope I, the unavoidable emission due to removing the gas for repair and re-commissioning the component, excavation and transportation emissions. Some of these emissions will be emitted by contractors and be allocated in scope 3. By spending more money, these emissions can be reduced. Remember that this emission of methane must be minimized as best technical possible.
- Scope II emissions, mainly to cover the power needed for evacuation and repair.
- Scope III emissions, mainly CO_2 emission from production and transport of a new component and for contractors involved in the repair or replacement. A starting point could be that the scope 1 emission cost of raw production steel is approximately 1,4 tons CO_2 for each ton of steel[1].

In case the sum of scope I, II and III greatly exceeds the lifetime emission Marcogaz suggests that the operator discuss with the national competent authorities what appropriate mitigation measures will be.

Example of societal cost:

The societal cost of the above-mentioned leaking valve will be the lifetime emission times the societal cost of each ton of CO_2 emission. Here the societal CO_2 emission cost shall be determined by an authoritative institute or legal entity.

The societal cost of repairing the leak can include the following items:

- Societal cost of the component
- Societal cost of labor and services doing the repair
- Saved societal cost of not having to monitor the leak for the lifetime
- Societal cost of the scope I emission of doing the repair

In case the societal cost of the repair greatly exceeds the societal cost of the emission Marcogaz suggests that the operator discuss with the competent authorities what appropriate mitigation measures will be.

A more detailed description of how the societal costs of the emissions and the societal cost of the mitigation could be balanced is provided in Annex B.

8. Studies and Innovation

Currently, not for all the requirements of the regulation, adequate techniques and methods are available. Marcogaz strongly supports innovation contributing to improved detection, quantification and reporting, as well as to further reduction of methane emissions.

[1] IEA direct CO2 emission intensity of steel: https://www.iea.org/data-and-statistics/charts/direct-co2-intensity-of-the-iron-and-steel-sector-in-the-net-zero-scenario-2010-2030

Within GERG, already a lot of effort is dedicated to top-down measurements, emission reduction of gas-sample systems and evaluation of Flame Ionisation Detectors (FID). It is recommended to support and contribute to additional projects to develop adequate LDAR equipment and methods for underground pipelines, as well as the same for undersea pipelines and water crossings, but also other research and innovation should be stimulated.

ANNEX A: Insights in Leak Detection and Repair (LDAR) and related issues.

Article 14 of the regulation is dedicated to LDAR. Survey intervals are specified in ANNEX I of the regulation.

Two different types of LDAR surveys are specified in article 14 and shall detect leaks:

- Type 1 is applicable for components with design pressure > 16 bar only and aims at early detection of large leaks. If it's guaranteed that the operating pressure < 16 bar, this obligation is considered to be not applicable. The survey method is supposed to be rapid and less time-consuming and expensive than type 2. This survey can, depending on the detection device and environmental characteristics, be done from some distance from the individual sources that can be hard to access or be underground even. For underground system parts the survey follows a "two step approach": after first finding from some distance as a first step, the second step is to find out the individual leak source(s). Due to the very restricted availability of suitable survey methods for underground TSO pipelines, the type 1 survey for TSOs will often be equal or similar to site level measurements as specified for MRV.
- Type 2 aims to find also small leaks, knowing that the majority of leaks will be small in leak rate. Also here, the "two step approach" is appropriate for underground pipes and for DSO's survey methods are available. For TSO's, underground pipelines that are outside the physical fences of the operator's assets, currently limited survey methods are available that meet the requirements for type 2 survey. The limited methods that are available are not applicable for the whole length of the pipeline, leaving parts of it uninspected. A suggestion in this case is to use the same survey methods for type 2 as for type 1 surveys, to be agreed with the national competent authority. Also, these methods are not suitable for all parts of the pipeline, these parts cannot be surveyed with the currently known surveying methods.

Leaks can also be detected during other inspections, site visits or during (or resulting from) site level measurements as specified as part of the MRV.

Repair criteria are depending on specific situations and specified in art 14.8:

"Operators shall repair or replace all components found to be emitting methane at or above the following levels at standard temperature and pressure in compliance with the manufacturer specifications for operation and maintenance:

a) *In case of type 1 leak detection and repair surveys: 7000 parts per million in volume of methane or 17 grams per hour of methane.*
b) *In case of **type 2** leak detection and repair surveys:*
   i. ***500 parts per million** in volume of methane or **1 gram per hour** of methane for aboveground components and for offshore components above the sea level;*
   ii. ***1000 parts per million** in volume of methane or **5 grams per hour** of methane for the second step of underground components*
   iii. *7000 parts per million in volume of methane or 17 grams per hour for offshore components below the sea level and below the seabed."*

It should be kept in mind that:

- The use of OGI camaras by DSO's is very limited or not at all. The required resolution of type 1 detection using the OGI camara can only be achieved under very specific atmospheric circumstances.
- When detection is the result of a gas concentration measurement (units [ppm]), and quantification is performed (e.g. for decision making, reconciliation purposes, or other reasons) the CEN EN 15446 or EPA 21 can be used to find the related mass flow (units [kg/h]). This way of mass flow calculation is not very accurate and can lead to overestimation. It is not applicable for underground pipelines. If the leak is above the repair threshold and can't be repaired within the prescribed 30 days, a useful option (in particular when a particular leak is hard and expensive to repair) could be to measure (if possible) the mass flow using a more accurate technique like for instance bagging and the High Flow Sampler (HFS). This will provide a more accurate mass flow and might reduce high impact repair or replace obligations, because the leakage can prove to be smaller than suggested by the CEN EN 15446 calculation (below repair threshold). Bagging is not possible for underground pipelines without excavation and other locations that are hard to access. TSO's repair a detected leak in underground pipelines without consideration of its size for reasons of safety and integrity.
- LDAR campaigns can be carried out by specialized service providers and take several days up to several weeks for larger plants. Not every individual leak is reported to the principal operator immediately, but reporting can take a couple of days after finishing the survey by providing a survey report. Where the EU regulation demands intervals from "the day of detection", this is considered to be the date on which the operator became aware of the individual leak and its position by means of the survey report or otherwise. This interpretation needs to be aligned with the competent authorities.
- For TSO's currently no adequate survey methods for underground pipelines are available for type 1 and 2 LDAR (apart from the site level measurements as referred to in art. 12 that might comply in part with the demands for type 1 survey). For water crossings and off-shore pipelines, no survey methods are available at all. Managing these specific pipeline sections shall be aligned with the competent authority until more details from CEN TC234 W14 are received, or new methods are developed.
- Some potential emission sources are non-accessible. Examples are above ground connections that cannot be accessed due to obstacles, height or altitude, water crossings constructed in or at bridges or other crossovers, underground pipelines and water- railway- and road crossings. It needs to be agreed with the competent authority how to manage these situations. In part, EN 15446 provides guidance in estimating the leakage rates of such potential emission sources.
- Where Annex II requires to report an "inventory and identification of all components that have been checked ", this is with the granularity of the component definition in Annex I, for instance "compressor stations", "valve stations" and so forth. It is clear that not all potential emission sources that are not leaking should be reported.
- Smaller components as specified in Annex I like for instance valve stations and regulating and metering stations can be part of a larger component like for instance a compressor station. It might be efficient to align the survey intervals of the smaller components with the larger component and to combine surveys (to avoid fragmented work).
- Additionally, RMS (Regulation and metering Station) refers to the entire physical site where the RMS and its associated valve nodes are located.

In line with the requirements described in the regulation, in managing the leak the following working method is suggested:

After becoming aware of the leak emitting above the repair threshold and its precise location, the operator first tries to minimise or repair the leak immediately (within one day, if not already done during the campaign). As an alternative, the operator decides within one day whether or not a shutdown is required for repair and minimises that leak within that day (in accordance with Art 14 par 10). Within 5 days after obtaining knowledge of the leak a first attempt to repair shall be made. If not successful, the leak shall be repaired within 30 days. If the operator anticipates that the repair is not possible within 30 days, the operator will inform the competent authority within 12 days after becoming aware of the leak and will provide a repair and monitoring schedule with transparent justification included. The competent authority may require the operator to amend the repair and monitoring schedules.

In the case that a shutdown is required to repair the leak, the shutdown must be scheduled within one year after detection but that will often lead to disproportional measures. Please be informed that the regulation defines a shutdown in definition (30) as:

'shutdown' means a situation where a site or part of its components no longer operates under normal operating conditions and is shut down, and where complete or partial pressure reduction is required before repair or maintenance works can be initiated.'

Monitoring:

- **a)** After repair of leakages above the thresholds, the elimination of emission shall be proved by a survey completing the repair and within 45 days from the repair date to make sure the repair is successful (art. 14.12(a)).
- **b)** Leakages below the repair thresholds shall be checked within 3 months from the date on which the emissions were detected to make sure they are not increasing over time. If stable, succeeding surveys shall be part of the regular inspections as specified in Annex I of the regulation (art. 14.12(b)).)). Surveys of leakages below the repair threshold after 3 months should, therefore, cover at least newly detected leaks since the last regular inspection and not necessarily those already detected in previous regular inspections. It might be efficient to combine the monitoring activities a) and b) in one survey on a specific location.

In addition to the above we suggest interpretations and clarity about certain terms in the methane regulation that still can use further explanation:

Environmental impact (CH_4 or CO_{2eq})

Under art. 14.9 a selection of 5 different safety, administrative or technical considerations are mentioned. Here we focus on the interpretation of one of these considerations (art. 14.9(b)), which states:

"*Any adverse environmental impact if the operator can demonstrate that that impact would be greater than the environmental benefits, for example where a repair could lead to a higher overall level of methane emissions than would be the case in the absence of the repair*"

Here it is mentioned that a repair does not need to be executed when the environmental impact of a repair is higher than the environmental impact of the leak over its lifetime. Looking at the passage from

the regulation as mentioned above, the environmental impact of a repair is seen as the total emissions associated with a repair and goes beyond exclusively CH_4 emissions.

Which in fact means that all "life cycle footprint effects" within the 3 different scopes of the GHG protocol of the repair or replacements should be considered.

Leaks <500 ppm (3 months)

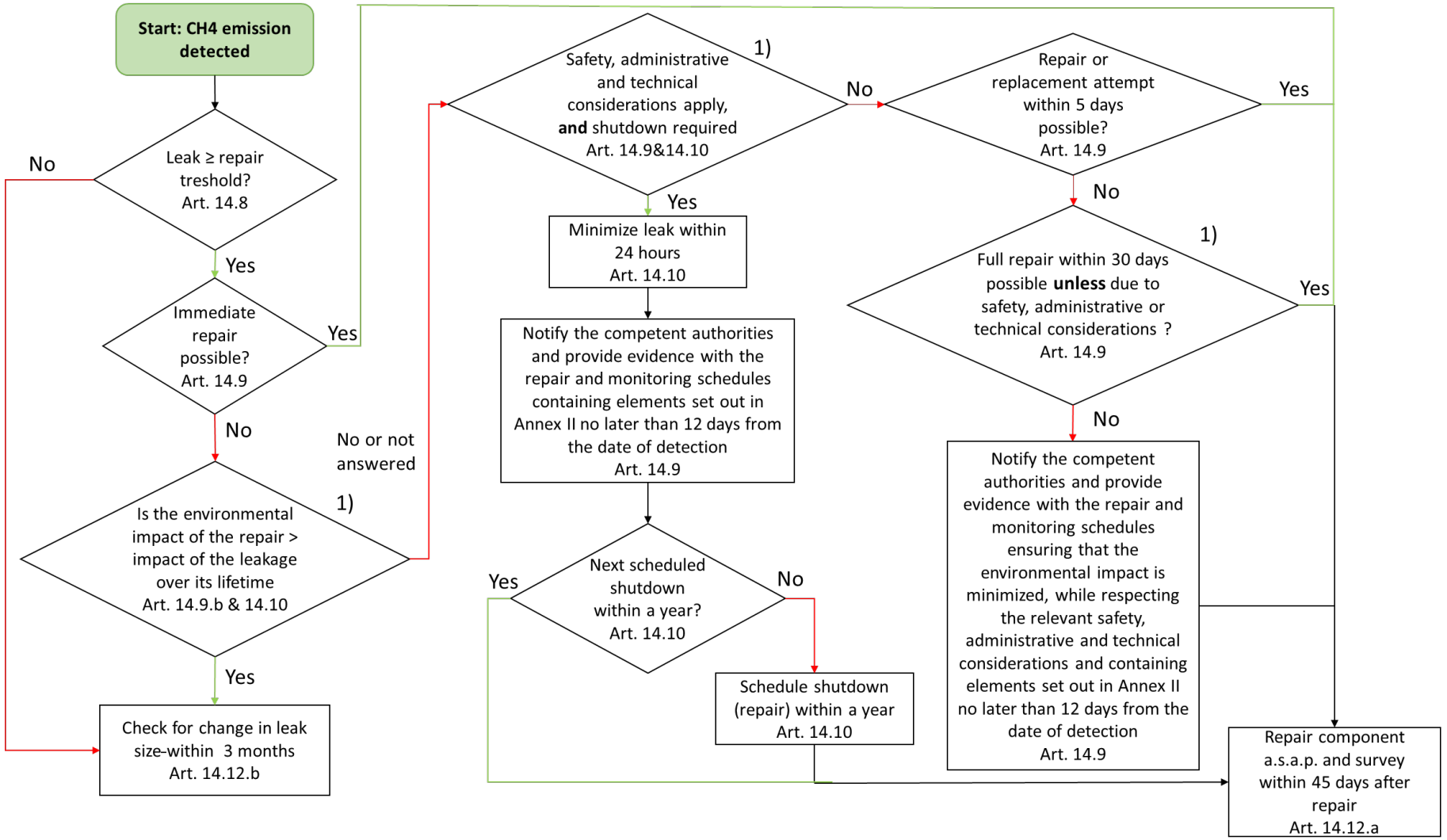
Repair of leaks that are detected but are below the repair threshold (<500ppm) is not obligatory. They do need to be monitored more intensively, or more precisely as the legislation describes it:

"*At levels of methane lower than the thresholds set out in paragraph 8 at standard temperature and pressure, no later than 3 months from the date on which the emissions were detected, to check at least once whether the size of methane loss has changed and whether a repair is necessary*"

We interpret this as a one-time check, no later than 3 months after the first detection of the leak to check whether the leak has grown in size. If the leak size is still below the threshold, it can be measured at a similar frequency to non-leaking components.

The interpretation of the LDAR decision tree is shown in Figure 1 on the next page.

LDAR: EU REGULATION ON METHANE EMISSIONS



Additional Clarification

1) These items are not persé sequential. f.e. the environmental check can be done at any of these stages

Art. 13* "Appropriate" definition should prevent disproportionate measures that hinder the ability of an organization to utilize assets most effectively to reduce emissions

The environmental impact of a repair is defined as the total emmissions associated with a repair and goes beyond exclusively CH4 emissions

Everything should be registered and reported yearly to the comptetent authority Art. 14.13 & 14.13

A "delayed repair as refered to in art 14 is considerd a repair that is excecuted more than 30 days after detection

*repairs or replacements should be made with the best available technologies that provide long-term protection against future leakage
*larger leaks should be prioritized over smaller leaks
* When no shutdown is required AND one or more conditions apply, repair date can exceed 1 year

Figure 1 Marcogaz interpretation of LDAR decision tree

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ANNEX B Example of balancing the impact of mitigating measures and leak size and duration

This ANNEX provides a more detailed description of how the societal costs of the emissions and the societal cost of the mitigation could be balanced.

In some situations, especially when the emitted amounts are very small but very hard to avoid or eliminate, the efforts and associated consequences might turn out that high that a mitigation measure cannot be considered appropriate or reasonable. In such situations, good alignment with the competent authority is crucial in balancing the impact of the emission to eliminate with the societal impact of mitigating measures, fully respecting the aims of the regulation.

The regulation recognizes that costs to adhere to the regulation should not result in a disproportionate burden on end users and consumers (recital 10). This is confirmed by the requirement that operators "shall take all **appropriate** mitigation measures to prevent and minimise methane emissions in their operations" in Article 13.

Although the ultimate objective is to eliminate all methane emissions, it is suggested to prioritise repairs in respect of their size and proportionality (ratio between abated emission and the impact of the repair activities). It is suggested to discuss with Competent Authorities the consideration that measures are disproportional and inappropriate, and because of that categorised as low priority, when the societal impact of the emission reduction achieved by them, using a comprehensive approach to get to the "real" societal impact, are significantly lower than the societal costs of the measure itself (including its environmental damage).

1. Example: leakage underground valve

If for example an underground valve leaks just more the 5 g/h, without remediation, the annual emission is approximately 44 kg/a. Repair could easily cost more than 500 k€, without accounting yet the emission incurred by the repair activity itself. Using a GWP of 29.8 this results in a CO_2 equivalent of 1,3 tons of CO_{2eq}/a. If the lifetime of the leak without remediation is 20 years for example, remediation will result in spending more than 19.000 €/ton avoided CO_{2eq}. Assuming a three times higher GWP (horizon of 20 years instead of 100 years) or a three time longer lifetime of the leak, the costs of CO_2 avoided is still more than 6000 €/ton, which is far beyond reasonability. In this situations it should be possible to agree with competent authorities postponement of the repair until other circumstances will make repair more appropriate.

A possible approach to be discussed with competent authorities is to define measures as appropriate and shall be executed if:

$$\left(\boldsymbol{Emission}_{\,tot} \times €_{fsoc} \times \boldsymbol{MEREF} + €_{commodity} + €_{monitoring}\right) > €_{mitig.measure}$$

Hereby:

$Emission_{tot}$ [tonne CH_4] is the total emission to avoid, this is the cumulative emission over the duration of the remaining lifespan of the emission; the emitted amount already emitted before intervention cannot be reduced anymore.

$€_{fsoc}$ [€/tonne CH_4] is the societal costs of methane emission per unit of mass CH_4. This is preferably established by an independent authority like the Agency for the Cooperation of Energy Regulators (ACER). For the moment, they can relate to the calculation value for CO_2 emission and the Global Warming Potential (GWP).

MEREF [-] is the Methane Emission Reduction Enhancement Factor. This is a mechanism to explicitly address *significance, ambition and resilience* against uncertainty in cost estimates. One of the uncertainties is the amount of scope 3 emissions related to the gas that is emitted due to upstream activities. Alternatively, if quantified, the scope 3 emissions might be added to the equation. It shall always be larger than one. The methodology and minimum value could be determined by e.g. ACER or the EC. As long as no further guidance is given from international authorities, agreeing on the

methodology and MEREF shall be the responsibility of the national competent authority or authorities. Again, as example: by applying the number 3 as MEREF, decision making is robust against measurement and calculation uncertainties and the result is similar to applying the GWP_{20} although it's clear that this number as GWP is not undisputed.

$€_{commodity}$ **[€]** is the total avoided commodity loss, this is the cumulative commodity loss over the duration of the remaining lifespan of the emission; the emitted amount already emitted before intervention cannot be reduced anymore.

$€_{monitoring}$ **[€]** is the additional costs of monitoring during the lifetime of the emission.

$€_{mitig.\ measure}$ **[€]** is the costs of emission reduction, which includes total costs of the repair or replacement activity including management, engineering and supervision, permitting, materials, construction, management of surroundings and the (societal) costs of emission caused by the repair or replacement (due to evacuation of the gas in the system to facilitate the works and the works itself). Recommended and in line with the aim of the regulation in general including the Corporate Sustainability Reporting Directive (CSRD) is to consider all emissions that arise in the whole chain of activities, including those in scope 3 of the GHG protocol.

It is suggested to discuss with competent authorities the postponement of measures that do not meet such appropriability criteria and would incur considerable societal impact if executed.

ANNEX C

The figure below shows the decision tree to be applied at vent demands