MANAGING FUGITIVE EMISSIONS OF GAS TRANSPORT: ECONOMICALLY FEASIBLE WHILE REDUCING THE ENVIRONMENTAL IMPACT

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Keywords:

Fugitive emissions, Leak Detection and Repair, environmental impact, working practice, footprint reduction

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1 BACKGROUND

1.1 General

In 1954, almost 10 years before the formation of Gasunie (1963), a memorandum was written concerning the leak losses in the gas pipeline systems. The issues at hand were categorized as "*extremely difficult and complicated. Getting useful information about the real amount of leak losses could only be done by setting the requirements as to how to determine leak losses and the extent of accuracy*". Losses are assigned to different groups, such as condensation *of hydrocarbons*, *own use*, etc. but also *gas theft* and even *street lighting*. One specific group, called *actual pipe losses*, describes losses also due to *leakage at connections*.

Leakage at connections is nowadays often referred to as *fugitive emissions*. Managing these emissions is the topic of this paper, written almost 60 years later in 2012.

Gasunie is a European gas infrastructure company. Its network ranks among the largest high pressure gas pipeline grids in Europe, consisting of over 15,000 kilometres of pipeline in the Netherlands and northern Germany, with its related facilities with a throughput of approximately 125 billion cubic meters. Gasunie is the first independent gas transport provider with a cross-border network in Europe and it offers transport services.

As far back as the 1980s, Gasunie has initiated its first footprint reduction activities. The company's efforts are mainly based on the improvement of energy efficiency and the reduction of methane (natural gas) emissions, since methane is a greenhouse gas with large impact.

Managing fugitive emissions has taken an important and effective role in Gasunie's footprint reduction programme. This paper will describe Gasunie's experiences with the fugitive natural gas emissions and the results achieved by the so-called *Leak Detection And Repair* programme (**LDAR**). But it will also elaborate on the possibilities (given through the aforementioned results) of creating further options in managing the fugitive emissions.

1.2 Context

The natural gas industry is a highly developed sector from a technological standpoint, and it takes its responsibility towards the safety, financial and the environmental issues very seriously. There is a growing awareness about the fact that methane emissions caused by the activities of various companies along the gas chain (production, transmission and distribution) can be significant. This is due to the fact that methane's (CH_4) Global Warming

Potential (GWP-index) is 23 times the effect that of carbon dioxide (CO_2) on the weight basis, and therefore its environmental impact is high. However this index is based on the average lifespan of one hundred years, the same lifespan is used by the climatologists for CO_2 the sake of convenience. Methane however, as F. Pearce states in *The Last Generation: How Nature Will Take Her Revenge for Climate Change (*Ref. 1)*,* has a short life span in the atmosphere (about 12 years) and is in this short term a very damaging greenhouse gas. In other words, the gas strikes quickly. In the first ten years after the methane emission has taken place, the harming effect is hundred times greater than that of carbon dioxide as also shown in Table 1. Many climate experts agree on the fact that rapid warming in vulnerable systems causes more disorder than slow warming. For this reason, it sometimes may be important that some urgent measures are taken to limit warming in the short term, while getting carbon dioxide emissions under control. By adhering to the conventional time period of the Kyoto Protocol, scientists have underestimated the potential benefits of the approach to the CH_4 emissions in the short term. This underpins the necessity of reducing the fugitive emissions of gas transport all the more.

Table 1 GWP-index of CO_2 and CH_4 according to the IPCC

Common name	*Lifetime (years)*	*GWP given time horizon*		
		20 yr	**100 yr**	**500 yr**
Carbon dioxide (CO_2)	>100	1	**1**	1
Methane (CH_4)	12	72	**25**	7,6

Typical Dutch natural gas consists of at least 85 vol% CH_4. For consistency with IPCC and legislation, Gasunie calculates with a GWP-index for CH_4 of 23.

The ambition of Gasunie is in line with European 20-20-20 goals: Gasunie aims to reduce its emissions by 20% by 2020 as compared to the base year of 1990. The company has both direct and indirect emissions. Direct emissions are produced as the result of Gasunie's activities on its own premises. Indirect emissions are caused outside Gasunie’s own premises, and are mainly produced by the electricity usage for Nitrogen production (gas blending) and electricity-driven compressor drives. *Fugitive emissions* are part of the direct CH_4-emissions and the focus of the current paper is on them.

The Gasunie transport network system is one of the largest in Europe, and has therefore inevitable many Potential Leakage Sources (**PLSs**). A large gas transport network presumes a large number of physical connections within the network. These connections, when not optimally adjoined, can permit the CH_4 escape into the atmosphere.

2 AIMS AND OBJECTIVES OF MANAGING FUGITIVE EMISSIONS

Gasunie has been making an inventory of its fugitive emissions since the 1980s. Desk studies and field studies have been conducted to find a way to give more insight in the fugitive emissions; were did they occur, how big they were, how to identify or measure them, etc. What a good and useful method of investigation was much-discussed at that time. All gained momentum in 2004 as requirements related to the environmental permits set a compulsory method of investigation.

One of the most important considerations is the environmental effect of fugitive emissions. Besides the environmental considerations, CH_4 leakage causes economical commodity losses. Another important reason is safety: leaking CH_4 contributes to a less safe work environment. Furthermore, the CH_4 leakage has a number of subjective costs, expressed in the company reputation, corporate social responsibility, satisfying the expectations of various stakeholders, etc. Therefore decreasing this leakage brings other benefits to the company as well. These were all good reasons to initiate the LDAR programme and to start setting up the fugitive emission management.

3 METHODS

3.1 Assessment method

Gasunie has searched for new ways to make the assessment of fugitive emissions more accurate and economically feasible. But what is a good and effective approach? The commonly used method uses *activity factors* and *emissions factors* to estimate the leakage rate with the following equation:

$$Emission = \sum \left(Activity\_Factor * Emission\_Factor \right)$$

Activity factors are the population of emitting equipments such as the length of pipes, the number and type of valves, the number and type of pneumatic devices. The activity factors, because of the high number and types of emitting equipments in the gas chain, must be often estimated with a statistical approach.

Emission factors are defined as the quantity of CH_4 emitted from each emitting source and for each emitting event. Some emission factors can be evaluated on the basis of the characteristic of components, others are very difficult to evaluate.

In this approach no information is obtained about the actual leaks and, since neither leaks nor individual leak rates are available, it is not possible to pinpoint the exact actions to be taken in order to reduce the fugitive emissions.

The working practice of Gasunie is to measure 100% of PLSs and in this way to identify the actual leaks. Typical PLSs are the following:

- Pump seals;
- Compressor seals;
- Relief valves ATM;
- Connections;
- Flanges;
- Valve stem;
- Control valve stem;
- Open Ends;
- Mixer- and agitator seals;
- Sample points.

The huge amount of data produced by LDAR, is handled in an especially developed database. The total amount of leakage is calculated through a set of calculations rules.

3.2 Leak Detection and Repair (LDAR) method

For some of Gasunie's installations more stringent requirements, related to the environmental permits, apply. In view of these requirements, Gasunie was obliged to make a 100% survey of its potential leak sources, as well as to introduce an adequate database system and a working practice to control and manage the leakage. All these demands were met in performing LDAR. LDAR's method is described in detailed in the *National Code of Practice* called *Milieumonitor 15* (Ref. 2), as laid down in the permit demands.

LDAR is based upon the NEN-EN 15446:2008 (EN): *Fugitive and diffuse emissions of common concern to industry sectors. Measurement of fugitive emission of vapours generating from equipment and piping leaks* (Ref. 3). This standard follows the *EPA Method 21 EPA Determination of Volatile Organic Compound Leaks* (Ref. 4) and *EPA 453 Protocol for Equipment Leak Emission Estimates (1995)* (Ref. 5). The measurement procedures themselves are based upon the *Code of Good Practice of Measurements of diffuse Volatile Organic Compound emissions* from the *Reference Laboratory Air* in Belgium (Ref. 6).

The accuracy of the leak measurement method is an important factor; however the costs and the speed should also be taken into account because of the large number of measurements. The measurement method used should be performed as an optimum between the necessary accuracy on one hand, and the speed and the costs of the whole procedure on the other hand. The level of accuracy achieved in LDAR measurements is lower than, for example, the *bagging* method, however the LDAR method provides a good balance between speed, costs and accuracy (Ref. 7) and presents detailed information for the necessary repair actions. These conclusions are corroborated in the Code of Good Practice (Ref. 6). The measuring devices and method were evaluated in order to draw up this code.

LDAR consists of a systemic and comprehensive monitoring and recording of the emissions and therefore gives a detailed overview of gas leakage. A typical LDAR program consists of three main parts:

1. Preparation:
    a. Database preparation;
    b. Source inventory: importing all gathered information into database, preparation of measuring phase etc.;
    c. Measuring & first repair attempt.

2. Performing initial measurement at PLSs:
    a. Executing first repair attempt at leaks, which consists of simple corrective maintenance action on the leakage found, done by the means of re-tightening;
    b. Re-measuring in order to establish the result of first repair attempt;
3. Reporting:
    a. Consolidating all gathered data;
    b. Creating LDAR report with an overview of losses in kilogramme per year (kg/a), with specifying the top leaks (in costs and losses), sorted by the most leaking sources and an average leakage per source;
    c. Three types of total emission per year:
        i. Initial: the total amount of leakage as found without doing any repair actions (i.e. result of only the measurements as found);
        ii. Year to Date: the total amount of leakage for the year of measurement. This is lower than *Initial* because the effect of the first repair attempt has been considered;
        iii. Estimation: the total amount of leakage for the next full calendar year.

The leak sources are split up into four classes:
1. Class 1: non-detectible are non-detectible emissions, in practice with a detection level lower than 9 parts per million (ppm);
2. Class 2: small leak sources between 9 ppm and 100.000 ppm;
3. Class 3: leak sources above 100.000 ppm;
4. Class 4: non-accessible leak sources. These can not be reached without removing isolation or excavation or building scaffolds.

A repair threshold is set at 1000 ppm. This means that leakages above 1000 ppm need to be resolved.

The emission is measured in concentrations -ppm - and are converted into kg/a. The calculation rules are described in the aforementioned standard (Ref. 5). Expressing the emissions in the unit of kg/a makes the communication easy and gives a clear insight into the amount of commodity, economic losses and the environmental impact. This paper often uses the term *ton*, which is a metrical ton meaning 1000 kg.

3.3 **Status Quo LDAR**

Since its introduction in 2004, LDAR has been conducted on 8 compressor stations (out of 13), 40 pressure reductions stations (out of 1200), a gas blending station and a gas export station. This large amount of measurements was carried out by a service provider *The Sniffers* from Belgium. In total, almost 200 thousand PLSs have been identified and over 180

thousand have been measured (around 90%). The use of the high sensitive devices compared to the rather rough leak detection with soap has resulted into the identification of approximately 5000 actual fugitive gas leakage sources. With these numbers Gasunie's leak rate –number of actual gas leakage sources divide by the PLS's- compared to the leak rate of other, mostly chemical process plants is on average.
A company strategy for managing the fugitive emissions has been developed together with KEMA.

Recently about 14 out of 30 valve stations have been examined. The data-analysis is not complete yet, so the outcome has not been fully incorporated into this paper.

3.4 **Results LDAR**

The results of the leakage measurements can be summarized into three categories, as follows:

- An *overall gas transport network category*;
- A *specific facility category*;
- A *detailed installation equipment category*.

The *overall gas transport network category* brings important input for the management decision making, related to the maintenance and designing rules. The *specific facility category* gives valuable input for prioritising actions to be taken at facility level. The *detailed installation equipment category* serves as input for the onsite service technicians.

3.4.1 **The Overall gas transport network category**

Every industry has its own typical profile of PLSs. For Gasunie this profile is given below in figure 1. This result is based upon an inventory of all potential leak sources of 6 compressor stations, 33 pressure reducing stations and 1 blending station. Of the 200 thousand potential leakage sources, 180 thousand where measured (ca. 90%). Twelve groups have been identified according to required standards. From figure 1 it can be concluded that the largest numbers of potential leak sources are found in the group connections, flanges (see Figure 2) and valves.

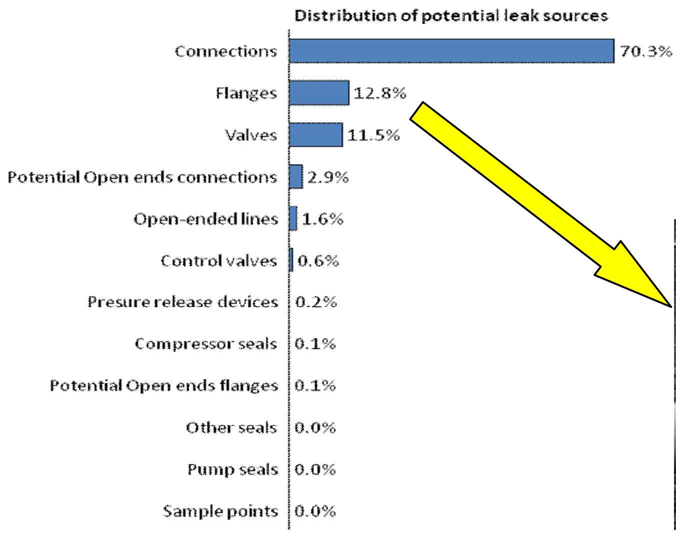

Figure 1 Typical profile of PLSs

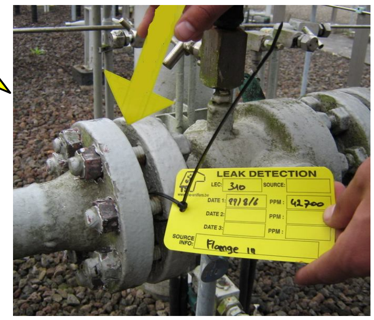

Figure 2 Tagged flange after first repair attempt

In figure 3 the total leak amount per group is given. From Figure 1 and 3 the following conclusions can be derived:

- As expected, the group connection has the largest number of potential leakage sources and, consequently, the largest amount of emissions;
- The second largest amount of emissions is, however, caused by the group of open-ended lines (see Figure 4) and not as expected by the flanges (see Figure 2);
- The third largest amount of emissions is caused by the flanges.

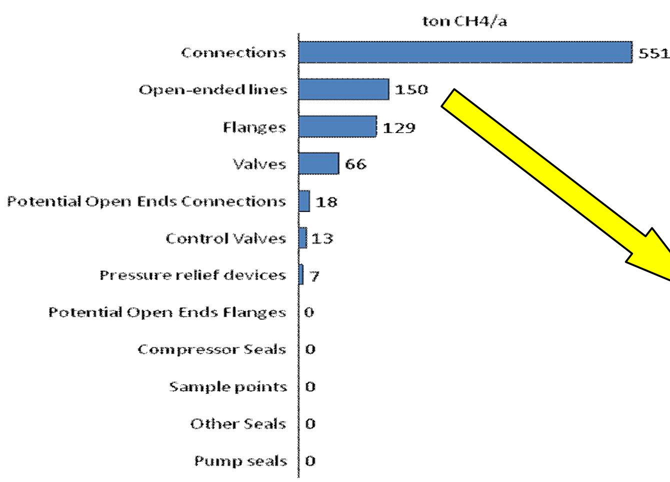

Figure 3 Total initial fugitive emissions per group

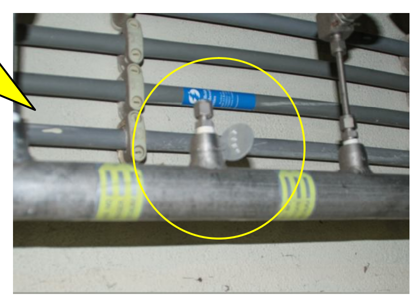

Figure 4 Example open ended line

The conclusion is that LDAR provides detailed information for taking the most effective measures for reducing the fugitive emissions.

More than 5000 fugitive gas leakage sources have been identified in our investigation with total emissions of approximately 935 ton/a CH_4. It is noted that this result is in line with general findings for gas transport networks. The LDAR initial measurements were directly followed by an effective *first repair attempt* with impressive results. The *first repair attempt* gave a reduction over 37% (355 ton/a CH_4, see Figure. Not all the leakages could be immediately successfully repaired (success rate of approximately 56% (523 ton/a CH_4)). For these sources of leakage additional maintenance measures need to be taken. The remaining emissions of 57 ton/a CH_4 (6%) is the summation of all the other emissions caused by *non-accessible*, *non-detectible* and leaks below the repair threshold of 1000 ppm. In compliance with the calculation rules of the *Protocol for Equipment Leak Emission Estimates* (Ref. 4), a certain amount of leakage is assigned to the *non-accesibles* and the *non-deductibles* (with a calculation factor).

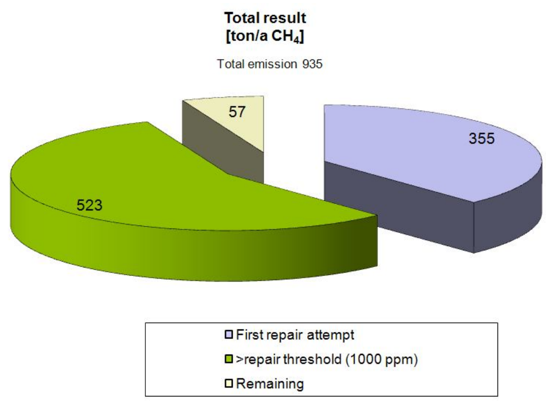

Figure 5 Results of the First Repair attempt

Therefore the conclusion is that the measures for reducing the emissions should be focused at the groups with the largest amount of emissions and not the largest number of potential leakage sources.

3.4.2 **The specific facility category**

A well known fact is that 20% of the PLCs cause 80% of the emissions in gas transport networks- this is often referred to as “80-20 rule”. An example of the 80-20 rule can be found in the results of LDAR at the specific facility category. After the first repair attempt at a compressor facility, 107 remaining leakage sources above the repair threshold were responsible for just over 50 ton CH_4/a emission. Of the total 107 sources, only 21 leak sources above 100,000 ppm contributed to 39 ton/a CH_4 emission. In resolving the 20% of the large leakage sources, a reduction of 80% could be achieved.

3.4.3 **The Detailed installation equipment category**

At the detailed installation equipment category level, the leakage database gives information of every potential leakage source. The specific repair orders can be generated from this information. Such repair orders provide specific and detailed information of the remaining leaks, based on which the adequate maintenance activities can be performed. Moreover, the data of the individual “bad” actors within the population of installation equipment can be derived. This information can be linked to the specific equipment (brand and type), and this,

> LDAR provides detailed information for generating the repair orders, but also data regarding the specific equipment, used for the improvement of the procurement and design standards.

in its turn, can be used to improve the procurement and engineering standards.

3.4.4 **CS Spijk Case: Leak Development over the period of 8 years**

At one of Gasunie’s compressor station an LDAR program has been carried out in 2004, 2007 and then in 2011. In 2004 and 2007 a 100% screening was conducted, while in 2011 only a 25 % spot check of the population of the potential leak sources was performed, and 100% of leaks from the 2007 programme were screened. The results are given in Table 1.

Table 1 Results Compressor station Spijk (ton CH_4/a)

Year	Scope	Initial	Estimation	Reduction %
2004	100% PLS’s	117.6	40.0	65
2007	100% PLS’s	35.8	21.7	40
2011	100 % leaks 2007 + 25 % spot check PLS’s	21.9	20.7	5
Note: Due to operational constraints repair orders could only executed at a small scale. This status is preserved for research purposes.				

The recurrence of the LDAR at the same site over a number of years makes it possible to learn more about the leakage behaviour and the LDAR cycle over a longer period of time.

When comparing the estimation of 2004 (40.0 ton/a CH_4) with the initial 2007 data (35.8 ton/a CH_4), and subsequently the estimation of 2007 (21.7 ton/a CH_4) with the initial 2011 data (20.7 ton/a CH_4), it is justified to say that:

- The measurements have a good level of repeatability;
- The leakage behaviour seems stable through the time and therefore the first repair attempt's effect has lasted longer than 4 years. It needs to be said that there are also experiences outside Gasunie, which indicate a somewhat shorter period (maximum of three year) over which the first repair attempt's effect will last.

The effect of the first repair attempt is expressed as the reduction in %. It is clear that the first LDAR has achieved the greatest success of all years (2004, 2007 and 2011), and the effect is strongly diminished for the third LDAR programme in 2011.

3.5 Managing the fugitive emissions

The execution of the LDAR as describe above provided information and experiences which was important input for developing a appropriated management concept, which is still under development. The first important step in managing the fugitive emissions is finding where they are and how large they are. The second step is executing measures in reducing the leakage and thirdly the taken actions are evaluated, all according to the Plan-Do-Check-Act cycle (PDCA-cycle). By following the PDCA-cycle a continuing improvement process is achieved. Gasunie strives to adapt this approach into the asset management system in accordance with *Public Available Standard 55* (PAS 55).
In relation to above Gasunie made a distinction between large, more complex installations (large amount of PLSs) and smaller, less complex installations (small amount of PLS's).

3.5.1 ***Full*** **LDAR cycle for complex installations (large amount of PLS >1500)**

For this type of installations, it is often necessary to do a full LDAR cycle because of permit demands. This working practice is now implemented at Gasunie. It provides both a qualitative (number of leaks) and a quantitative outcome (total amount of leakage). The full LDAR cycle is given in Figure 6.

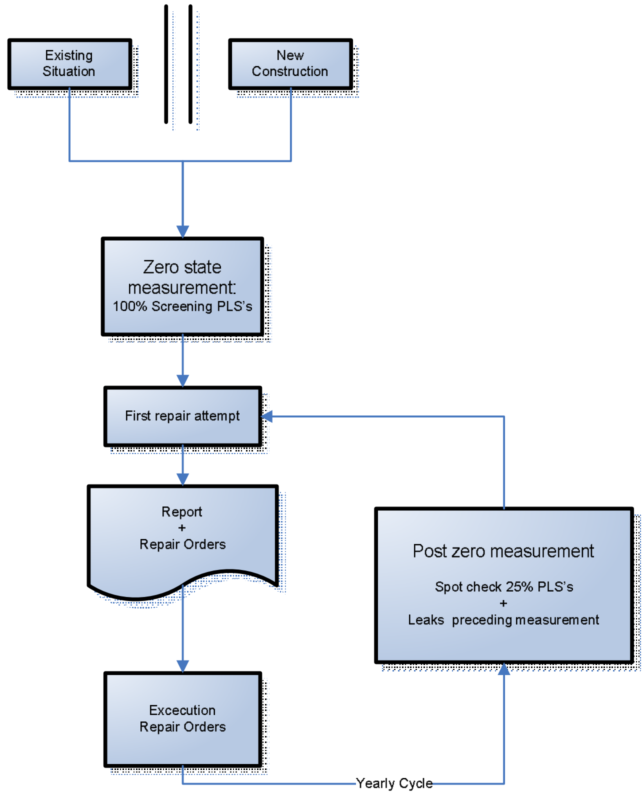

Figure 6 *Full* LDAR cycle

The cycle starts with a *zero state* measurement. This can be an already *existing* site or a *newly constructed* site and all of the PLSs are measured. The steps are given in 3.2.
A year later a *post zero* measurement is conducted. This means that a 25% spot check of the PLSs is executed, together with all the leaks as identified during the preceding measurement. This cycle is repeated every year, so after four years 100% of the PLSs are measured.

3.5.2 **LDAR for simple installations (small number of PLSs <= 1500)**

This working practice is still in development. It presumes that instead of doing a full LDAR cycle the installations are checked by the service technicians themselves. The technicians are equipped with hand-held explosion-proof gas detectors for locating the leaks, but these devices are not compliant with the requirements for full LDAR (Ref. 2). The measured value is not recorded and no large database is build. Nevertheless, a first repair attempt is executed, and when a leak remains, it can be marked via the normal maintenance systems and repaired later on. In order to check the effectiveness and to evaluate this method, qualitative LDAR spot checks are performed.

3.5.3 **Assessment of repair activities**

The working policy for the assessment of repair activities is still under development. However a line of thought has been developed. The approach is in case a leakage is not solved by the first repair attempt an assessment should be made if and when the repair should take place In contrast to the chemical/process industry in the Netherlands, Gasunie does not use large maintenance stops (stop-over's) in which a compressor station becomes unavailable for a period of time during the maintenance activities. For the repair at hand it is necessary to determine if and when it can be done effectively and efficiently. To do so, an judgement needs to be reached and the following issues should be considered:

- Assessment of integral environmental impact: For performing the maintenance it is necessary to release the gas in the specific part of the installation. The amount of vented gas should be looked at in comparison to the amount of leakage per year of the leak that is going to be repaired. This amount can be influenced by, for instance, combining the repair with other maintenance activities for which it already was necessary to vent the gas. Other possibilities are the evacuation of the gas by using recompression or the gas flaring. In case of the complex situations, excavations and drainage activities can affect the environmental impact of the repair. This is not often thought of, but the footprint of the supply parts should be considered when producing the integral environmental impact assessments. This will not be an issue when replacing a gasket, but if a replacement of a 48"-valve is necessary to repair a leak it could be a factor to take in consideration;
- Constraints: As the components are a part of the gas transport system, their unavailability will effect the gas transport planning. Because some parts need to be available at all times there can be constraints and the repair could be difficult or impossible to execute.

3.5.4 **LDAR economics**

Besides the environmental and safety benefits, there is also a financial part of the equation. As said, the emission of CH_4 means an actual loss of commodity and this commodity has a value of its own. If the out-of-pocket costs for outsourcing the measurements and the internal costs for the maintenance personnel for the first repair attempt are taken into account, the simple pay-out time (SPOT) for larger and more complex installations is less than 2 years . Therefore LDAR is profitable and it can also show the hidden investment capital to execute repairs depending on the policy of required return on investments. This is particularly the case for the zero state measurement. For simple installations, such as pressure reducing stations or valve stations, the SPOT is often longer than 5 years.

The remaining commodity savings, i.e. the value of the remaining emitted commodity, can be used for justifying the investments needed for repairing the remaining leakage. With careful appraisal it is straightforward to keep a balance between environmental impact, repair preconditions and economics.

3.6 Noteworthy Considerations

Gasunie is aware of discussions around the accuracy of the LDAR method. At present this method is compulsory (Ref. 2) and is recognized as a best available technique (Ref. 6 and Ref. 7). Moreover, the measurements at CS Spijk are consistent in their results over a period of 7 years. When in doubt, it is always possible to do a bagging measurement. Most likely, the outcome will not change the approach of reducing the fugitive emissions

At the network level, a clear insight is given into which equipment modules are the “bad performers” and, consequently, which effective measures can be taken. For instance, Gasunie has started studies on the improvement of the flanges and the use of screw-in connections.

With “only” 0.03% leaks at initial of a total of 180.000 measured PLSs, it is clear that over 175.000 PLS’s (88%) have been measured “utterly in vain”. This demonstrates the need for further development of LDAR measuring methods, which is commonly referred as smart-LDAR.

There are promising developments in the field of infrared gas cameras. Gasunie has done some preliminary testing with two different cameras. Although different, both cameras are using the infrared measuring principle called IR-Spectroscopy. In short, an optical and infrared image of a (potential) leak is taken. Making use of the specific absorption bands in the infrared spectrum, in this case for CH_4, the difference between the background infrared radiation and the leak is visualized in the image. Figure shows two examples of the images taken with the cameras.

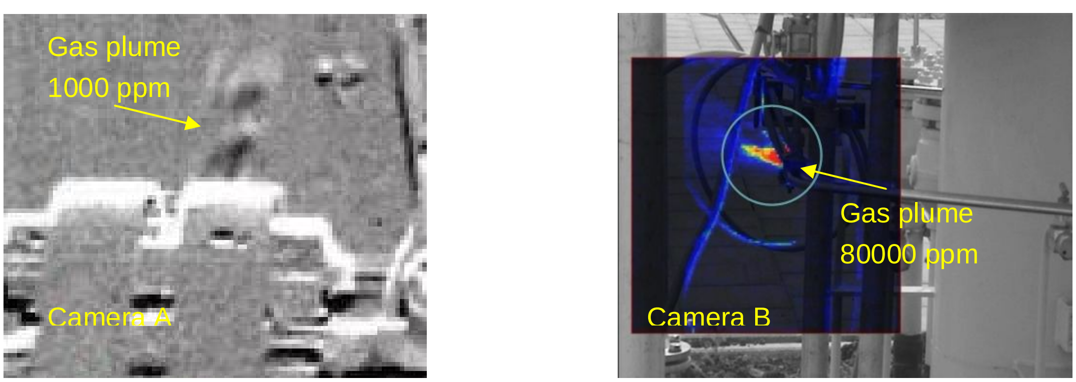

Figure 7 Gas camera images

collateral damages of the initial repair, such as the damaging of coating, as can be seen in Figure 2. The consequences of these *collateral damages* must be further investigated.

As the database increases, more information can be derived from it. “Bad” actors in the system can be recognized at the manufacturer, but also at the type of equipment. This information can be adopted in the procurement strategies and will in this way lead to the improved leak behaviour of the gas transport system. Design rules could require less numbers of PCL’s and the assembly techniques could be improved.

4 **CONCLUSIONS**

As a prudent operator Gasunie takes it responsibility towards the safety, financial and the environmental issues very seriously. The *Leak Detection And Repair* (**LDAR**) cycle and subsequently the managing of fugitive emissions is in full accordance with this.

The first important step in managing the fugitive emissions is finding where they are and how large they are. The second step is executing measures in reducing the leakage and thirdly the taken actions are evaluated. By following the PDCA-cycle a continuing improvement process is achieved. Gasunie strives to adapt this approach into the asset management system in accordance with *Public Available Standard 55* (PAS 55).

The leakage behaviour can be managed, producing good results in reducing the emissions while staying economically feasible. The first repair attempts were successful with an average efficiency of 37% (zero state). A result over a period of 8 years shows a continuous improvement of the leak behaviour.

The pay-out time for LDAR for larger and more complex installations is less than 2 years. Therefore LDAR is profitable and it can also show the hidden investment capital to execute repairs depending on the policy of required return on investments. This is particularly the case for the zero state measurement.

The accuracy of the leak measurement method is an important factor; however the costs and the speed of the large number of measurements should also be taken into account; the LDAR method offers a good balance between the speed, the costs and the accuracy. Gasunie is aware of the discussions around the accuracy of the LDAR method and the need for this issue to be investigated further.

In the LDAR approach information is obtained about the actual leaks and, since leaks and individual leak rates are available, it is possible to pinpoint the exact actions to be taken in order to reduce the fugitive emissions.

Performing LDAR creates awareness of the leak behaviour of the gas transport system. This awareness is necessary for people within the organization to make the reduction of the fugitive emissions successful. For instance, the tags at the remaining leaks make it obvious that at that point *invisible gold* is leaking away.

5 **SUMMARY**

This paper will describe Gasunie's experiences in a specific area of the footprint reduction programme, the reduction of fugitive natural gas emissions and the results achieved by the *Leak Detection And Repair* programme (LDAR) and setting up the fugitive emission management.

It focuses on the uncontrolled fugitive emissions of methane (CH_4). Fugitive emissions are small of gas leakages at physical connections which, when not optimally adjoined, can permit the CH_4 escape into the atmosphere.

LDAR consists of a systematic and comprehensive monitoring and recording of the emissions, and therefore gives a detailed overview of the gas leakages. A typical LDAR programme consists of three main parts: *Preparation*, *Measuring and first repair attempt*, and *Reporting*. The 100% inventory and measurement of all PLSs are essential for identifying the abnormalities in the leakage behaviour. It makes it possible to take the right measures effectively in order to reduce emissions. From the point of controlling the emissions, this is far more preferable to calculating the total emission based on a few measurements and extrapolating.

Within LDAR a first leak measurement is followed by a direct first repair attempt and then followed by another measurement. As the result, an average of approximately 37% of the leakage was. The pay-back time of such a campaign is typically between 1 to 2 years for larger and more complex facilities, such as compressor stations.

For the remaining repair of leakage, an assessment must be made before conducting the repair, in order to determine the environmental and economical feasibility. In this assessment, the effect of performing the repair of the leak flow (kg/a) is compared to the impact that performing a repair would have on safety, environment (blow down gas, CO_2 footprint, material etc.) and possible constraints because of gas transport planning.

The LDAR conducted by Gasunie gives a unique insight into the leakage behaviour of the whole span of gas transmission units at three different levels. It is found that leakage behaviour can be managed, giving good results in reducing emissions while staying economically feasible.

ACKNOWLEDGEMENT
The paper was written by Menno Bekker (N.V. Nederlandse Gasunie) and Floris de Groot (KEMA).

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