

The Annual Mercury Monitoring Report 2019 NAM and GTS

NAM Document Details

| | | |
|--------------------|--|----------|
| Document Reference | EP202001264666 | |
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| Approval | 5.1.2.e [redacted] (Process Engineering) | Signed : |

GTS Document Details

| | | |
|--------------------|--|----------|
| Document Reference | | |
| Authors | 5.1.2.e [redacted] (Metering & Allocation) | |
| Approval | 5.1.2.e [redacted] | Signed : |

Revision Details

| | |
|-------------------|-----------------------|
| Current Revision | Draft 2019 - Jan 2020 |
| Previous Revision | Final 2018 - Jan 2019 |

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Section 1: Executive Summary

As part of the "Joint Principles for Conducting Mercury Monitoring in Sales Gas" agreed between NAM and GTS, NAM and GTS have executed a sampling plan of which the results are reflected in this report.

NAM: For the Groningen facilities, the Groningen Transfer Stations and both the UGS Grijpskerk and UGS Norg, the measured results are in agreement with the indicative mercury quantity in sales gas.

In 2018 the Minister of Economic Affairs and Climate Policy decided to close the Loppersum area clusters (LOPPZ: Leermens, Overschild, De Paauwen, Ten Post and 't Zandt) and take them permanently out of service. Therefore, they have been removed from the results list.

Transfer stations TJM Z-1 and TJM Z-2 have been taken out of service at the end of 2019. The measurement for the Zuiderpolder outlet header could not be performed in the second half of the year, due to required repair of a damaged electricity line powering the cluster.

The planned measurements for the locations Tjuchem, Spitsbergen and Zuiderpolder could not be performed due to required repairs and reduced production capacity.

GTS: Due to changes at M&R and GOS facilities, some measurements were relocated. All results are within the indicative mercury quantity in sales gas.

Section 2: Measurements

NAM Measurement Plan

NAM has agreed to conduct the tests as part of the "Joint Principles for Conducting Mercury Monitoring in Sales Gas". Please refer to document EP201601204309, Revision 1.

NAM Measurement Results by Plant Type

Transfer Stations Schematic

Below is a schematic of the configuration of Transfer Stations on the Groningen Ring. Transfer stations TJM Z-1 and TJM Z-2 have been taken out of service at the end of 2019.

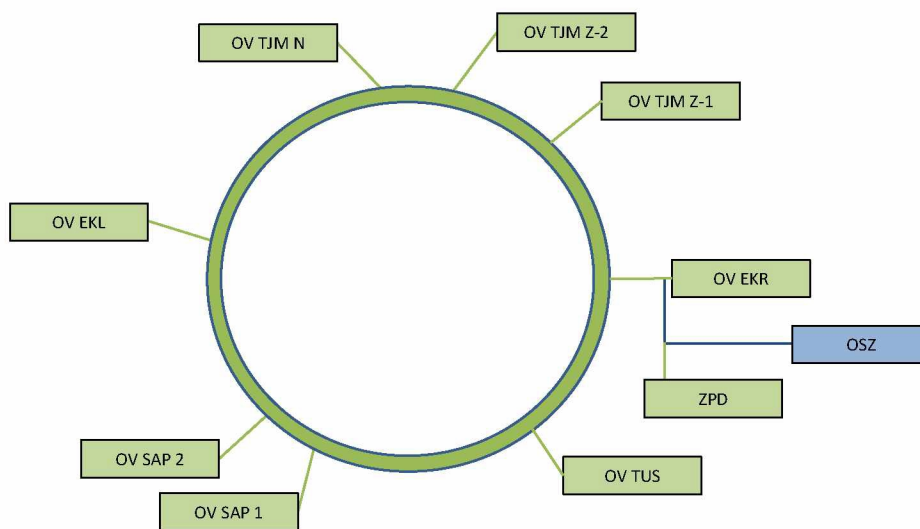


Figure 1: Groningen Ring Schematic (Green is NAM, Blue is GTS)

Oude Statenzijl, OSZ, is a GTS governed transfer facility for Groningen gas fed by both transfer station De Eeker and location Zuiderpolder.

Transfer Stations Results

The table shows measurements of mercury concentrations in sales gas for the past year, as measured at the Transfer Stations on the Groningen Ring, and at the outlet header of location Zuiderpolder, all values are in agreement with the indicative mercury quantity.

Since startup of the Norgron pipeline, sales gas transfer at station SAP-1/2 is used irregularly. During the injection season the station is closed to maximize injection capacity, and during the winter season transfer is maximized at the Norg station and at TUS station for clusters. For this reason, sales gas at station SAP-1/2 cannot be tested every year.

Transfer stations TJM Z-1 and TJM Z-2 have been taken out of service at the end of 2019.

The measurement for the Zuiderpolder outlet header could not be performed in the second half of the year, due to required repair of a damaged electricity line powering the cluster.

| Transfer Station / Overslag | | Measurement [ug/Nm3] | | | |
|--|----------|----------------------|------------|-------|------------|
| Location | Acronym | Value | Month/Year | Value | Month/Year |
| Tjuchem | TJMO Z-1 | (1) | (1) | 5,3 | 4/2019 |
| Tjuchem | TJMO Z-2 | (1) | (1) | 15,0 | 4/2019 |
| Tjuchem | TJMO N | 9,6 | 10/2019 | 11,0 | 4/2019 |
| De Eeker | EKRO | 4,3 | 10/2019 | 2,7 | 4/2019 |
| Tusschenklappen | TUSO | (1) | (1) | (1) | (1) |
| Sappemeer | SAPO 1 | (1) | (1) | (1) | (1) |
| Sappemeer | SAPO 2 | (1) | (1) | (1) | (1) |
| Eemskanaal | EKLO | (1) | (1) | (1) | (1) |
| Zuiderpolder (2) | ZPD | (1) | (1) | 15,0 | 4/2019 |
| (1) Transfer station was not used in this period | | | | | |
| (2) This is the outlet header at the production location ZPD | | | | | |

Table 1: Transfer Station Mercury Measurement Results

LTS Clusters

The table below shows measurements of mercury concentrations in sales gas according to the monitoring principles in EP201601204309, revision 1, as measured at the outlet of the LTS units of the clusters. From the measurements, conducted for individual LTS units, the minimum and maximum measurement and average for the measurements from all LTS units is given.

In 2018 the Minister of Economic Affairs and Climate Policy decided to close the Loppersum area clusters (LOPPZ: Leermens, Overschild, De Paauwen, Ten Post and 't Zandt) and take them permanently out of service. Therefore, they have been removed from the results list.

The planned measurements for the locations Tjuchem, Spitsbergen and Zuiderpolder could not be performed due to required repairs and reduced production capacity.

| Location | Code | Units Tested | Measurement [$\mu\text{g}/\text{Nm}^3$] | | | Month/Year |
|--|---------|--------------|---|---------|---------|------------|
| | | | Average | Minimum | Maximum | |
| Bierum | BIR | 5/5 | 10,8 | 9,1 | 13,0 | 10/2019 |
| Tjuchem | TJM (2) | 3/5 | 15,3 | 15,0 | 16,0 | 10/2018 |
| Oudeweg | OWG | 5/5 | 13,4 | 12,0 | 15,0 | 11/2018 |
| Schaapbulten | SCB | 5/5 | 12,4 | 11,0 | 14,0 | 6/2019 |
| Zuiderpolder | ZPD | 5/5 | 15,4 | 14,0 | 17,0 | 3/2018 |
| Zuiderveen | ZVN | 5/5 | 12,8 | 11,0 | 14,0 | 11/2018 |
| Eemskanaal | EKL (1) | 2/5 | 9,5 | 9,4 | 9,5 | 11/2017 |
| Kooipolder | KPD | 5/5 | 13,6 | 9,8 | 15,0 | 5/2019 |
| Amsweer | AMR | 5/5 | 13,2 | 11,0 | 14,0 | 6/2019 |
| Siddeburen | SDB (2) | 4/5 | 12,8 | 10,0 | 15,0 | 10/2019 |
| Scheemderzwaag | SZW (2) | 1/3 | 16 | - | - | 5/2019 |
| Spitsbergen | SPI (2) | 2/3 | 13,3 | 7,6 | 19,0 | 5/2018 |
| De Eeker | EKR | 3/3 | 13,7 | 13,0 | 14,0 | 9/2018 |
| Slochteren | SLO | 3/3 | 12,3 | 11,0 | 13,0 | 5/2018 |
| Tusschenklappen | TUS | 3/3 | 15,0 | 14,0 | 16,0 | 5/2019 |
| (1) Due to production restraint, two LTS units in production | | | | | | |
| (2) One or more LTS units temporarily out of service | | | | | | |

Table 2: Cluster Mercury Measurement Results

Underground Storages

The below table shows the last test results for gas from the UGS's, and the measurement date. The results show that the mercury in sales gas levels are comparable to the levels in injected gas (for GRK this is 3,0 ug/Nm³ – measured in June 2017; for Norg this is Groningen cluster levels).

| Location | Measurement [ug/Nm³] | Month/Year | Measurement [ug/Nm³] | Month/Year |
|-----------------------|--|-------------------|--|-------------------|
| GRK (Production) | (1) | 2019 | 11,0 | 2/2018 |
| NORG (Production) | <0,3 | 12/2019 | 5,3 | 3/2018 |
| (1) No production yet | | | | |

Table 3: UGS Mercury Measurement Results

GTS Measurement Plan

GTS has agreed to conduct the following tests as part of the Joint Principles for Conducting Mercury Monitoring in Sales Gas:

| Unit Type | Indicative Mercury Quantity in Sales Gas | Sampling Frequency | Plants |
|--|--|--------------------|---|
| HTL - North-South pipeline corridor - North West pipeline corridor | < 15 µg/m ³ (n) | Once per year. | North-South pipeline corridor at CS. Ommen North-West pipeline corridor at CS. Oldeboorn |
| RTL - Pipeline M&R Scheemda – GOS Nieuweschans | <15 µg/m ³ (n) (M&R Scheemda) < 5 µg/m ³ (n) (GOS Scheemderzwaag) < 2 µg/m ³ (n) (GOS Koningsstraat, GOS Nieuweschans) | Once per year | Measurements are carried out at M&R Scheemda, GOS Scheemderzwaag, GOS Koningsstraat GOS Nieuweschans Remark: M&R Scheemda is situated downstream of OV De Eeker |

Table 4: GTS Tests

GTS Measurement Results by Unit Type

High Pressure Grid: (HTL)

GTS has conducted the agreed measurements on the High Pressure Grid (HTL) in 2019.

The High Pressure Grid is split into in a network transporting Groningen gas (G-gas) and a network transporting High Calorific gas (H-gas). This report focusses on G-gas. The measured values are:

A541 M&R Schuilenburg : 4 ng/m³(n)
A540 M&R Opsterland : 5 ng/m³(n)
M&R Zuideropgaande : 10 ng/m³(n)

All results are less than the indicative mercury quantity in sales gas.

The Intermediate Pressure Grid: (RTL)

GTS has conducted the measurements on the Intermediate Pressure Grid (RTL) in 2019.

G-gas passes from the High Pressure Grid to the Intermediate Pressure grid at the Metering and Pressure control stations (M&R). G-gas then travels through the pipeline network, before exiting the

Intermediate Pressure Grid via a Metering and Fiscal Measuring Station (GOS). At this station, gas is metered and the pressure is adjusted.

Below is a schematic of the flow of gas through the intermediate pressure grid.

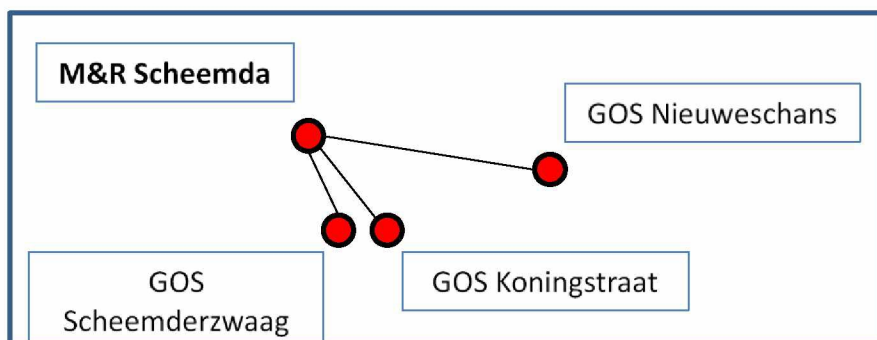


Figure 2: RTL Schematic

The table shows measurements of mercury concentrations in gas for the past years. All results are within the indicative mercury quantity in sales gas.

| Year/Location | M&R Scheemda [µg/m3(n)] | GOS Scheemderswaag [µg/m3(n)] | GOS Koningstraat [µg/m3(n)] | GOS Nieuweschans [µg/m3(n)] |
|---------------|----------------------------|-------------------------------------|--------------------------------|--------------------------------|
| 2005 | 11,9 | 0,6 | 0,3 | 0,1 |
| 2006 | 5,7 | 0,2 | 0,2 | 0,4 |
| 2007 | 9 | 3,8 | 0,4 | 0,5 |
| 2008 | / | / | / | / |
| 2009 | 3,7 | 0,5 | 0,5 | 0,3 |
| 2010 | 12 | 0 | 0 | - |
| 2011 | 6,2 | 0,3 | 0,1 | - |
| 2012 | 10,7 | 0 | 0,1 | 0 |
| 2013 | 5,3 | 0,2 | 0 | 0 |
| 2014 | 5,9 | 1 | 0 | 0 |
| 2015 | 2,2 | 0,0 | 0,0 | 0,0 |
| 2016 | 1,7 | 0,5 | 0,0 | 0,0 |
| 2017 | 4,6 | 0,0 | 0,0 | 0,0 |
| 2018 | 3,9 | 2,6 | 0,1 | 0,1 |
| 2019 | 1,4 | 1,3 | 0 | 0 |

Table 5: Test Results RTL Network

Section 3: Analysis

This section provides commentary and analysis, based upon the results in Section 2.

Total Transfer Stations:

A stabiling trend for the average concentration of mercury in Groningen Sales Gas was observed in 2015 through 2019.

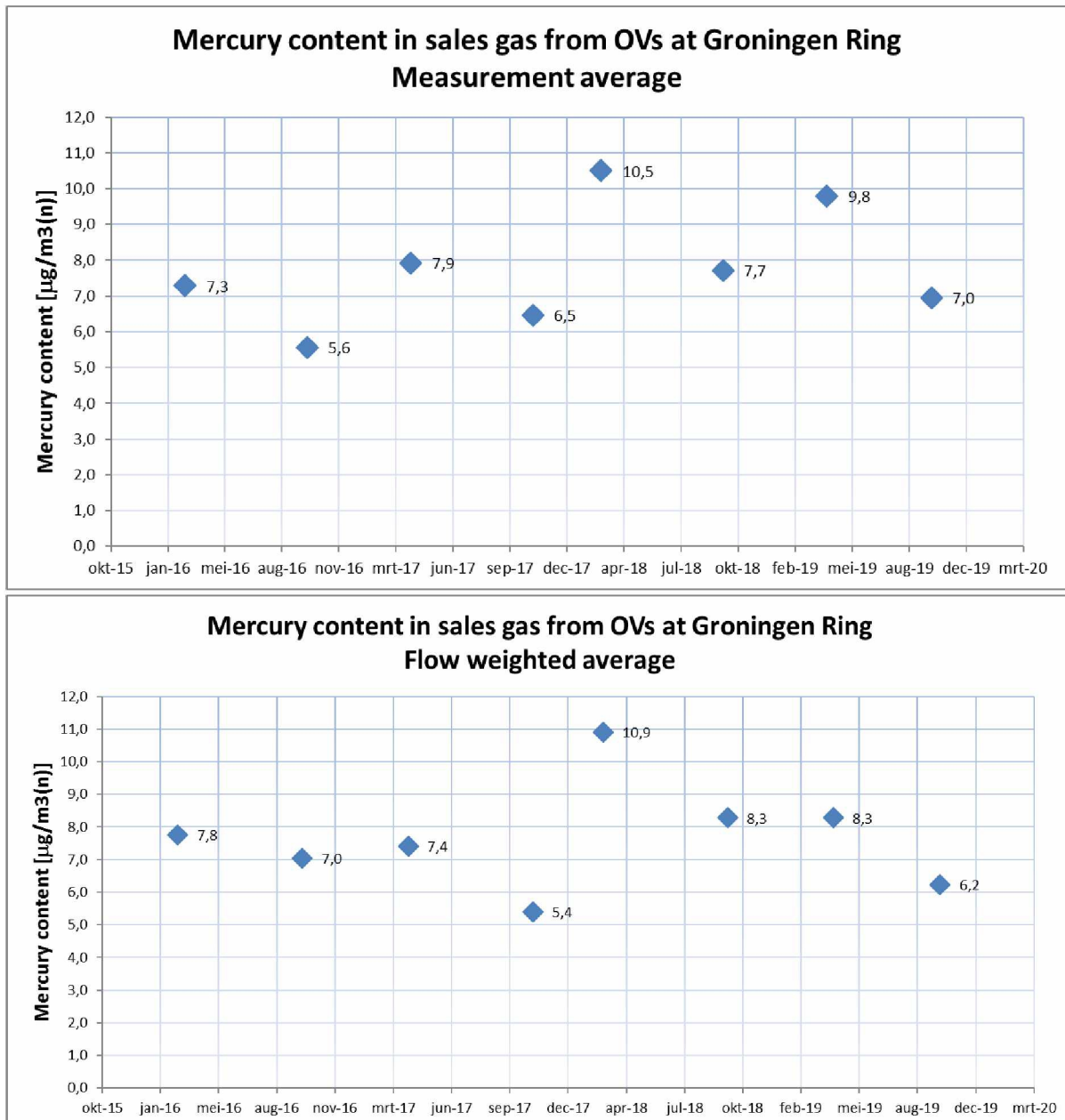


Figure 3: Flow Weighted Average Concentration of Mercury in Groningen Sales Gas

Individual Transfer Stations

Individual Transfer Stations and Cluster measurement results can be discussed and drawn out for further commentary and analysis when above the Indicative Mercury Quantity in this section

This year there are no locations singled out for further analysis as all measurements are not exceeding the indicative quantity.

Section 4: Regulations

In October 2018 NAM legal has reviewed/evaluated the Hg regulatory arena for changes. Conclusion was that this section 4 does not need adjustment compared to the previous revision of this document

NAM & GTS

Introduction

The Joint Principles for Conducting Mercury Monitoring in Sales Gas require that NAM and GTS conduct a review of existing regulations relevant to mercury in sales gas. This is completed in this section of the report.

In the Netherlands, there is not a specific threshold on quantities of mercury in natural gas. However, there are other regulations that must be interpreted and adhered to. These are outlined below, together with NAM's status with regards to compliance.

REACH/CLP

NAM Status: Compliant

Reference: Regulation (EC) No 1907/2006

REACH is the European Regulation on chemicals and their safe use. It deals with the **Registration, Evaluation, Authorisation and Restriction of Chemical** substances. This regulation entered into force on 1st June 2007 and is implemented verbatim via the Dutch Environmental Management Act. The aim of REACH is to improve the protection of human health and the environment through better and earlier identification of the intrinsic properties of chemical substances. The REACH Regulation gives greater responsibility to industry to manage the risks from chemicals and to provide safety information throughout the supply chain on these substances. REACH also applies to mercury in sales gas.

According to REACH legislation, mercury as an individual component in natural gas must not exceed the threshold of 0.1 % volume. Groningen sales gas has a concentration of 0.00000000147 vol% (an equivalent of 20 µg/Nm³), as calculated by the NAM Laboratory in 2013. Consequently, NAM is compliant with REACH, and NAM does not have to include mercury in the Safety Data Sheets for natural gas.

GTS Status: Compliant

Best Available Technique (BAT)

NAM Status: Compliant

Reference: Reference Document for the Refining of Mineral Oil and Gas (July 2013)

Best Available Technique (BAT) is a principle in environmental legislation. The EU uses this principle to create a Best Available Technique Reference Document (BREF); a document that lays down the

conclusions on current best available techniques that must be applied within a specific industry. Specific to the natural gas producing industry is the BREF titled: "The Refining of Mineral Oil and Gas". Within this BREF, the following techniques and conclusions with regards to mercury are stipulated:

Natural Gas Plants: Techniques to reduce waste generation (Section 4.17.6)

Some of the gas fields contain mercury vapour in very low concentrations. This mercury is removed from the gas in a 'cold trap' (e.g. by gas expansion) and recovered as a mercury-containing sludge. A specialised company processes this sludge by treatment in a vacuum distillation unit.

BAT conclusions for the natural gas refinery (Section 5.12)

BAT # 43: In order to prevent emissions of mercury when present in raw natural gas, BAT is to remove it and recover the mercury-containing sludge for waste disposal.

The EU officially adopted this BAT conclusion on 9/10/2014, published in the Official Journal of the European Union.

NAM notes that there are no BAT-associated emission levels set in gas refining for mercury to air emissions, with which it must comply.

NAM executes the techniques of the BAT by using Low Temperature Separation in all of its gas streams, with waste mercury being removed and contained within sludge for treatment by a specialized company. They therefore comply with BAT #43.

GTS Status: Not Applicable

Minimization Principle: ('minimalisatieverplichte stof')

NAM Status: Compliant

Reference: Besluit algemene regels voor inrichtingen milieubeheer (Activiteitenbesluit)

The Minimization Principle is legislation specific to the Netherlands, and prescribes a five step process to identify and reduce emissions to levels deemed to be both technically and economically viable.

NAM executed the assessment mandated by the Minimization Principle in 2013, as part of the Mercury Management Study 2013 (NAM GTS). This study found that NAM complies with the requirements of the minimization principle, and recorded the following conclusions:

"NAM has reviewed existing regulations related to mercury in natural gas. [...]Regarding the Minimization Principle, NAM complies by re-assessing the viability of Filter Removal every five years, along with other reduction techniques. In accordance with the NeR's guidance for applying the Minimization Principle, the latest review demonstrated that filter removal at NAM locations is not justified."

GTS Status: Compliant

The Occupational Exposure Limit

NAM Status: Compliant

Reference: Directive 2009/161/EU - indicative occupational exposure limit values.

The Occupational Exposure Limit is a workplace safety standard set by the EU. It represents the maximum permissible concentration of a given substance in the air of a work place.

For mercury, the EU sets an Occupational Exposure Limit in air for a time window of 8 hours at 0.02 milligrams per cubic meter of air at 20 °C.

When burning Groningen gas in a room with a volume of 15 m³ and a ventilation rate of 2.5 turnovers/hour, one would expect a peak mercury concentration of 0.00035 milligrams per cubic meter of air. Therefore, using Groningen Gas at the workplace will not cause employers to break the Occupational Exposure Limit.

GTS Status: Compliant

Private Households: RIVM Tolerable Concentration in Air

NAM Status: Compliant

Reference: RIVM Rapport 609300021/2011

Within the Netherlands, the RIVM has adopted a Tolerable Concentration of Mercury in Air of 0.05 µg/m³ air for a lifetime exposure limit. Concentrations of mercury in a room are to be tested over a period of 24 hours and one week, in order to detect all sources of mercury and to extrapolate to a lifetime exposure level.

The NAM used a model they developed in-house to establish the threshold concentration for mercury in gas required to breach the RIVM norm in a worst case scenario. This exposure model has received a second look by DNV-GL, in order to verify the assumptions and approach taken in building the model. The threshold concentration for mercury in sales gas at which the RIVM limit is breached is 34 µg/Nm³. Groningen sales gas has a concentration of mercury in gas below this level.

GTS Status: Compliant