The Annual Mercury Monitoring Report 2014 NAM and GTS

Contents

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Section 1: Measurements

NAM Measurement Plan

NAM 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
Silica Gel adsorption beds	< 1 µg/m^3(n)	*Once per year; when quantity > 2 µg/m3(n) monitoring is increased to once per 3 months.*	*UGS GRK (has active coal filters which are currently bypassed; no mercury is present in the reservoir and trace mercury is expected to be injected);* *UGS NOR (has no active coal filter; no mercury is present in the reservoir and trace mercury is expected to be injected)*
LTS Units - No (off) gas injection downstream cold separator - Deep cooling employed	5 - 15 µg/m3(n)	*Sampling will be done on the gas from individual LTS units at cluster level according to frequency defined in the Mercury Monitoring Management Plan/Joint Principles. The objective is to obtain better understanding of mercury distribution and production, and to monitor sales gas mercury content);*	*All GLT clusters (KSC/DSSC/SCC)*
Transfer Stations (OV, overslagstations)	< 15 µg/m3(n)	*Twice per year*	*OV's*

Figure 1: NAM Tests

NAM Measurement Results by Plant Type

Transfer Stations Schematic

Below is a schematic of the configuration of Transfer Stations on the Groningen Ring.

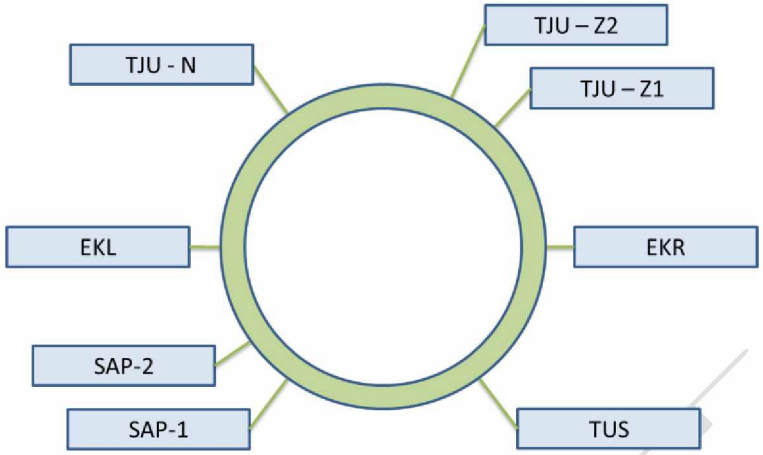

Figure 2: Groningen Ring Schematic

Transfer Stations Results

The table shows measurements of mercury concentrations in gas for 2014, as measured at the Transfer Stations on the Groningen Ring. All results are within the indicative mercury quantity in sales gas, except for one measurement taken at Tjuchem Zuid 2. This measurement will be addressed in section 2.

Transfer Station / Overslag		Measurement [ug/Nm3]			
Location	Code; -OV	Value	Month/Year	Value	Month/Year
Tjuchem	TJU-Z1	11	10/2014	14	5/2014
Tjuchem	TJU-Z2	4,3	10/2014	18	5/2014
Tjuchem	TJU-N	1,0	10/2014	7,2	5/2014
De Eeker	EKR	3,0	10/2014	5,0	5/2014
Tusschenklappen	TUS	2,4	10/2014	11	5/2014
Sappemeer	SAP1	1,0	12/2014	5,3	2/2014
Sappemeer	SAP2	0,3	10/2014	3,9	3/2014
Eemskanaal	EKL	3,0	10/2014	10	5/2014

Table 1: Transfer Station Mercury Measurement Results

LTS Clusters

The table below shows measurements of mercury concentrations in gas according to the monitoring principles, as measured at the outlet of the LTS units of the clusters. From the measurements, one for each LTS unit, the minimum and maximum measurement and average for the measurements from all LTS units is given.

		Measurement [ug/Nm3]			
Location	**Code**	**Average**	**Minimum**	**Maximum**	**Month/Year**
Ten Post	POS	12	11	12	11/2013
t Zand	ZND	12	11	12	1/2014
Leermens	LRM	4,5	2,3	10	10/2013
De Paauwen	PAU	11	7,6	13	12/2013
Overschild	OVS	5,0	3,6	7,3	10/2013
Bierum	BIR	5,0	3,7	6,2	11/2013
Tjuchem	TJM	13	11	14	1/2014
Oudeweg	OWG	10	7,9	12	11/2013
Schaapbulten	SCB	8,6	7,4	9,6	2/2014
Zuiderpolder	ZPD	11	10	13	2/2014
Zuiderveen	ZVN	11	11	11	2/2014
Eemskanaal	EKL	8,8	8,1	10	2/2014
Kooipolder	KPD	10	8,6	12	9/2013
Amsweer	AMR	10	8,4	11	9/2013
Siddeburen	SDB	12	11	13	5/2014
Scheemderzwaag	SZW	11	10	11	12/2013
Spitsbergen	SPI	13	12	14	6/2014
De Eeker	EKR	10	7,3	12	10/2013
Slochteren	SLO	13	13	14	1/2014
Tusschenklappen	TUS	10	9,2	11	12/2013

Table 2: Cluster Mercury Measurement Results

Underground Storages

NAM has not conducted tests on the UGS's in 2014.

For NORG, stable production was only established in December 2014, after a major shutdown. For GRK, due to miscommunication no measurement is available.

Measurements for both UGS's are planned for 2015, and will be executed as per the Joint Principles for mercury monitoring.

The below table shows that last test result for gas from the UGS, and the test year.

Location	**Last Test Result** [ug/Nm3]	**Test Year**
GRK (Injection)	<0,3	2010
GRK (Production)	No Data	No Data
NORG (Injection)	5,3	2013
NORG (Production)	<0,3	2013

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. Wieringermeer
RTL - *Pipeline M&R Scheemda – GOS Nieuweschans*	<15 µg/m^3(n) (M&R Scheemda) < 5 µg/m^3 (n) (GOS Scheemda) < 2 µg/m^3 (n) (GOS Hoorntjesweg, GOS Nieuweschans)	*Once per year*	Measurements are carried out at M&R Scheemda, GOS Scheemda, GOS Hoorntjesweg GOS Nieuweschans Remark: M&R Scheemda is situated downstream of OV De Eeker

Figure 3: 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 2014.

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 table shows measurements of mercury concentrations in gas in the High Pressure Grid for 2014. All results are less than the indicative mercury quantity in sales gas.

Location	Low	High	Average
Oude Statenzijl	9.70	10.30	10.10
Oostum	8.70	9.70	9.20
Scheemda	3.50	4.10	3.90
Ommen	1.80	2.40	2.10
Bornerbroek	0.00	0.20	0.00
Wezep	0.00	0.00	0.00
Schinnen	0.00	0.00	0.00
Axel	0.00	0.00	0.00

Wijngaarden	0.00	0.00	0.00
Beverwijk	PENDING	PENDING	PENDING

Table 4:Test Results RTL Network, µg/m3(n)

The Intermediate Pressure Grid: (RTL)

GTS has conducted the agreed measurements on the Intermediate Pressure Grid (RTL) in 2014.

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 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.

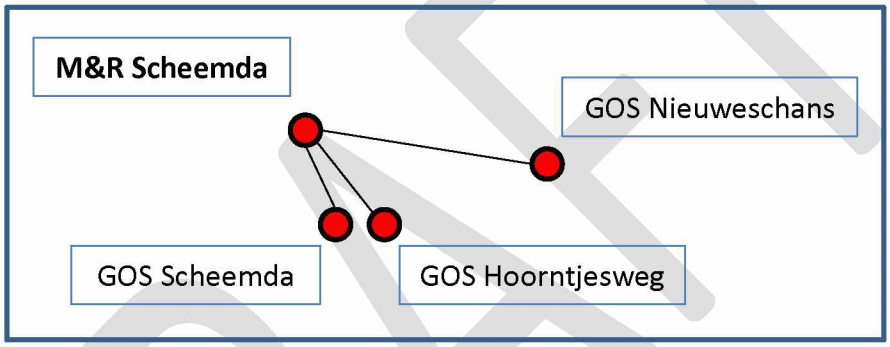

Figure 4: RTL Schematic

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

Location	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
M&R Scheemda	11,9	5,7	9	/	3,7	12	6,2	10,7	5,3	5,9
GOS Scheemda	0,6	0,2	3,8	/	0,5	0	0,3	0	0,2	1
GOS Nieuweschans	0,3	0,2	0,4	/	0,5	0	0,1	0,1	0	0
GOS Hoorntjesweg	0,1	0,4	0,5	/	0,3	-	-	0	0	0

Table 5: Test Results RTL Network, µg/m3(n)

Section 2: Analysis

This section provides commentary and analysis, based upon the results in Section 1.

Total Transfer Stations

The average concentration of mercury in Groningen Sales Gas shows a reducing trend in 2014, relative to previous years. In October 2014, the average concentration was 3.4 µg/m^3(n).

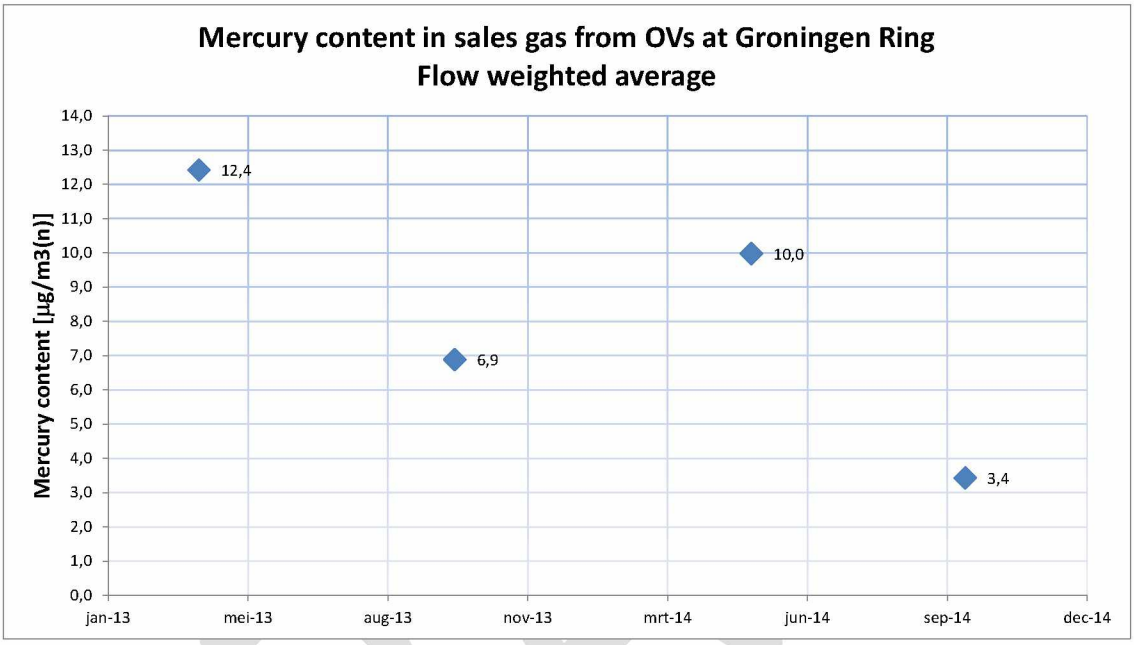

Figure 5: Flow Weighted Average Concentration of Mercury in Groningen Sales Gas

Individual Transfer Stations

Individual Transfer Stations and Cluster measurement results are discussed and drawn out for further commentary and analysis when above the Indicative Mercury Quantity.

Tjuchem Zuid-2

In Q2 2014, a sample of gas taken at Tjuchem Zuid-2 contained a concentration of mercury higher than the 15 µg/m3(n) Indicative Mercury Quantity. The below graph shows the results of tests taken at TJU Z2 since 2011.

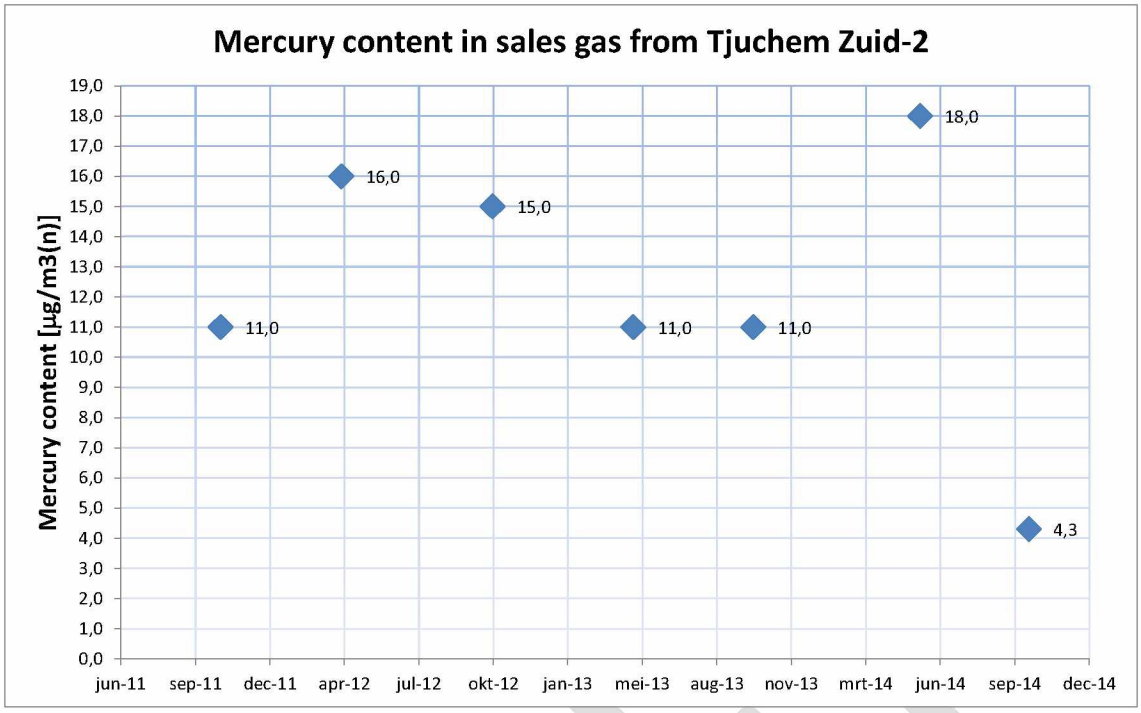

Figure 6: Graph showing Concentration of Mercury in Gas Tjuchem Zuid-2 (µg/m3(n))

"Deep Cooling" was implemented in the LTS units of the Groningen clusters in May 2013. For further details please refer to the Close out Report of the "Kwik Beheersing Studie".

The result on the test in Q2 2014 was followed by a level below the Indicative Mercury Quantity in Q4 2014. NAM could not identify the cause of the higher result in Q2-2014. No direct intervention was made to lower the concentration of mercury in gas.

Details of the conditions under which the two tests in 2014 were conducted are shown in the table below.

		Tjuchem Zuid-2	
Data Type	**Unit**	**Test 1**	**Test 2**
Test Result	µg/m3(n)	17.7	4.3
Test Date		14-05-2014	7-10-2014
Test Time		13:37	11:42
Production Level	mln Nm3/d	24.2	13.9
Outside Temperature	°C	~ 12	~ 15
Comment		No Intervention	

Table 6: TJU Z2 Test Conditions

The range of results in a given year is larger than in 2013. However, the annual average remains the same, at 11 µg/m3(n). The long term average mercury content in gas at the end of 2014 at TJU-Z2 is 11.8 µg/m3(n) , down from 12.0 µg/m3(n) at the end of 2013.

NAM notes that test 1 has both a higher mercury concentration, and a higher throughput. NAM will seek to plan a future test at a moment of high throughput, to test if these two items are correlated.

Section 3: Regulations

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 **R**egistration, **E**valuation, **A**uthorisation and Restriction of **Ch**emical 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 0.000000000147 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: Nederlandse Emissie Richtlijnen, NeR, www.infomil.nl

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."

A re-assessment is needed in 2018.

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