UNC 0900: Amendment to the Gas Quality NTS Entry Specification at Biomethane System Entry Points

10 February 2025

Introduction

Exemption

NGT are in the process of documenting an evidence case for the HSE to enable us, and the higher-pressure tiers of the GDNs, to offer up to 1mol% on our networks. This is to support the biomethane industry.

An NIA funded study had been undertaken by to determine the impacts of an elevated level of oxygen of up to 1mol% on the NTS: https://smarter.energynetworks.org/projects/nia_ngt0236/

Managing requests

- Requests for non-standard gas quality parameters, which include requests for elevated levels of oxygen, will be reviewed on a case by-case-basis
- We are developing a methodology to determine how these requests will be managed

Analysis

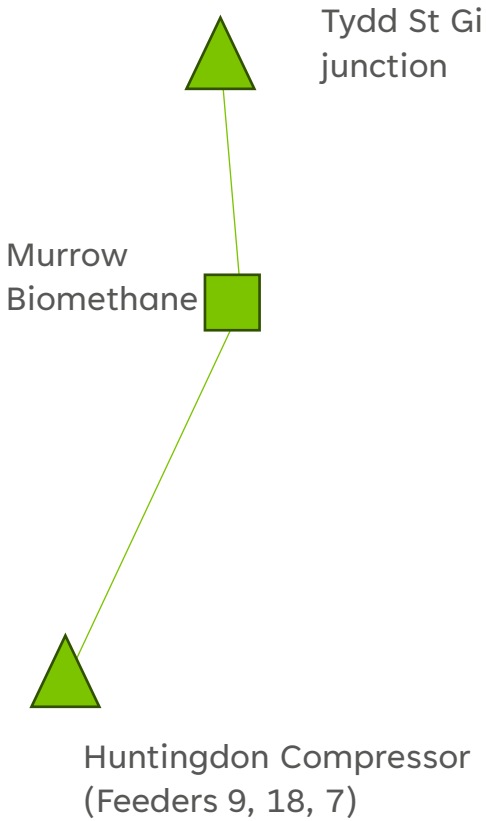
The following slides summarise the impacts of up to 1mol% oxygen being delivered by Murrow and Glentham biomethane sites

Note that any change to the allowable oxygen levels will be dependent on the exemption being granted by the HSE

Murrow Entry Point Analysis

Murrow: Site Overview

Simplified NTS Details (*not to scale)*



Murrow	Details
Site Location:	Feeder 9, circa 48km upstream of Huntington Compressor, 16km downstream of Tydd St Giles multijunction
Entry Connection:	Biomethane
Daily Maximum Flow rate:	48,000 standard cubic meters (scm) a day, 2,000scm/ hour (0.048 mcm/day) typical flows ~ 0.02 mcm/day
Gas Quality:	The site is operational and may deliver biomethane to the NTS with oxygen up to <0.2mol%, in line with current GS(M)R requirements. The site requests an increase to their allowable oxygen concentration of up to 1mol% oxygen. This will be dependent on an HSE exemption.
Connections:	There are no 3rd Party connections in the location of the site

Murrow: 3rd Party Connections and Flows (1 of 2)

The predominant flows in this area of the network are north to south. There are no off-takes between Murrow and Huntingdon compressor, where the gas will blend further with other NTS gas.

If the gas flows south to north, the gas will travel to Tydd St Giles multijunction. There have been some instances where the gas could potentially reach Hatton compressor (which will then blend further), and could therefore reach a power station, as well as GDN off-takes.

Given the low volumes of biomethane injection at the Murrow Biomethane site relative to the dilution flows in the feeder it is being injected into, the injection of the higher oxygen content biomethane from Murrow is highly unlikely to result in any significant change to the characteristics of gas in the NTS as under normal circumstances the higher oxygen content biomethane will be diluted to very low levels by blending with the pipeline gas flowing past the injection point.

Typical flows in this area of the network are 5mcm/day.

Analysis undertaken has been conducted on a worst-case scenario:

- 1mol% oxygen delivered by Murrow*:
- Flow at the maximum rate of 0.002 mcm per hour
- Assuming the average oxygen level in the NTS gas is 0.1mol%

a flow of 0.016 mcm per hour (0.384 mcm/day) or greater would be required past the connection point for the gas to remain at or below the GS(M)R limit of 0.2mol%.

Blending Calculation	
Oxygen from Murrow (mol%)	1
Max Hourly Flow	0.002
Assumed O2 level in NTS gas	0.1
Min hourly flow to ensure compliance	**0.016**
Required level of O2 (mol%)	0.2

***Assuming the exemption is granted, the site would operate at ~0.5mol% O2 under normal conditions. Assuming 0.1% O2 in NTS, a flow of 0.0075mcm/hour would be required for blending to the current GS(M)R limit.**

Murrow: 3rd Party Connections and Flows (2 of 2)

Four years of flow data have been considered:

Flow rates have been calculated based on the recorded hourly pressure data at Huntingdon and Tydd Multi-junction over a 4.5-year period

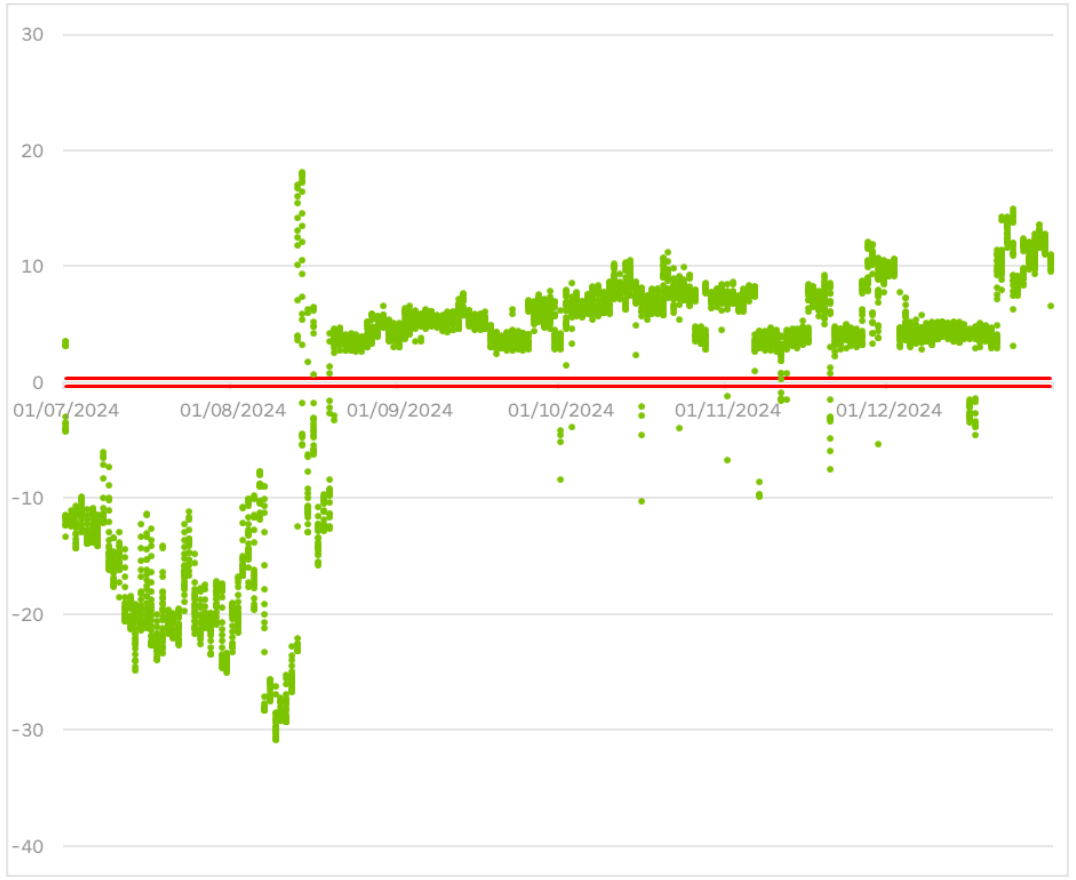
There have been 25 instances during the period (over 39k data points) where flows have been less than required (0.384mcm daily rate) for blending to 0.2mol%.

Flows past the site the vast majority (99.94%) of the time are sufficient for blending
Typical flows in this area of the network are 5mcm/day.

Assuming a flow past the site of 5mcm/day and max flows at 1% oxygen:

- If NTS oxygen past site is 0.1mol%, blended O2 is 0.1036mol%
- If NTS oxygen past site 0.01mol%, blended O2 is 0.014 mol%

Derived flows past Murrow



Snapshot: July 24 – December 24

Conclusions:

The analysis of hourly average feeder flowrates has shown that there were only 25 instances over 39,000 hourly data points considered where the flow in the feeder was insufficient to dilute the maximum flow of biomethane from the Murrow facility from 1% to 0.2% oxygen.

There are no 3rd party sites in the vicinity of Murrow. Flows in this area of the network are predominately (over 90%) from north to south, where the gas will blend further with other NTS gas at Huntingdon. However, if certain network conditions are seen, gas from Murrow could potentially reach a power station and GDN. The power station is located over 20km away. Any high oxygen content gas will further blend rapidly once flow rates increase and therefore long before the first of any offtakes is reached.

Glentham Entry Point Analysis

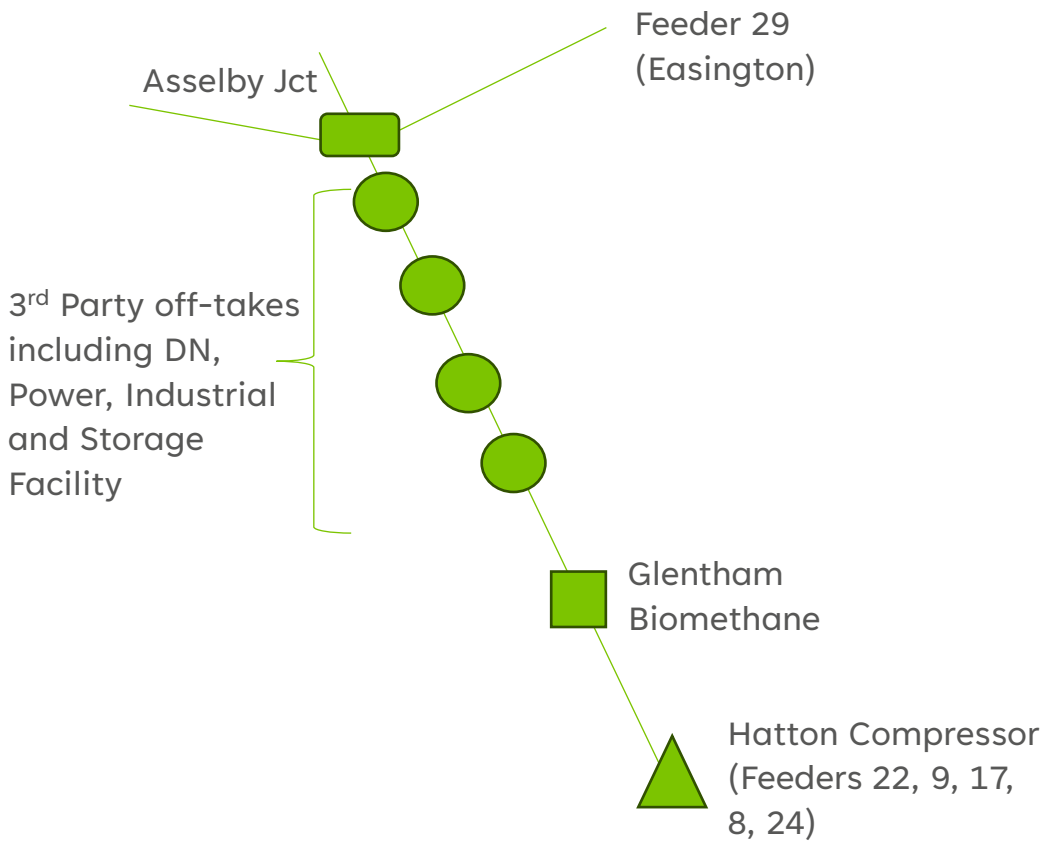
Glentham: Site Overview

Glentham Green Energy Limited have submitted an application to NGT for a new entry/exit connection to the NTS.

Glentham	Details
Site Location:	Feeder 7, circa 20km upstream of Hatton Compressor
Entry Connection:	Biomethane
Daily Maximum Flow rate:	24,000 standard cubic meters (scm) a day, 1,000scm/ hour (0.024mcm/day)
Flight Time:	The site will be located within approximately 200m of the NTS, with an approximate travel time of 4 minutes.
Gas Quality:	The maximum level of oxygen the site may deliver into the NTS is <0.2mol%, in line with current GS(M)R requirements. The site is proceeding with the construction on this basis and will only deliver oxygen with an elevated level of oxygen if the exemption is granted.
Connections:	There are a number of 3rd Party connections north of the site

Glentham: Third Party Connections

Simplified NTS Details (*not to scale)*



Analysis of flow and pressure data has shown that the gas in this section of feeder 7 travels both north to south and south to north depending on the prevailing supply and demand patterns.

If flows are travelling from north to south, there are no third-party connections between Glentham and Hatton Compressor Station and AGI, where the gas will mix with gas from Easington flowing via feeders 9 & 22 before being transported to other parts of the network.

If the gas is travelling from south to north, there is the potential for the gas from Glentham Biomethane Connection to travel as far as Asselby before it will blend further with gas feeding in via Feeder 29. There are a number of third-party connections north of Glentham on the section between there and Asselby. The salt cavity storage site, which is believed to be sensitive to increased oxygen levels, is circa 30km away from Glentham.

Given the extremely low volumes of biomethane injection at the Glentham Biomethane site relative to the dilution flows in the feeder it is being injected into, the injection of the higher oxygen content biomethane from Glentham is highly unlikely to result in any significant change to the characteristics of gas in the NTS as under normal circumstances the higher oxygen content biomethane will be diluted to very low levels by blending with the pipeline gas flowing past the injection point.

 Note that NGT have been in contact with all 3rd Party sites (apart from GDNs) between Glentham site and Asselby

Glentham: Oxygen and Flows (1 of 2)

Analysis undertaken has been conducted on a worst-case scenario:

- 1mol% oxygen delivered by Glentham*:
- Flow at the maximum rate of 0.001 mcm per hour
- Assuming the average oxygen level in the NTS gas is 0.1mol%

a flow of 0.008 mcm per hour (0.192 mcm/day) or greater would be required past the connection point for the gas to remain at or below the GS(M)R limit of 0.2mol%.

Blending Calculation	
Oxygen from Glentham (mol%)	1.000
Max Glentham hourly flow (mcm)	0.001
Assumed O2 level in NTS past site (mol%)	0.100
Min hourly flow to ensure compliance	**0.008**
Required O2 level (mol%)	0.200

The level of oxygen in the gas going past the connection is likely to contain a much lower level of oxygen due to entry connection agreements.

If we amend the assumed level of oxygen in the gas to 0.01mol%, **a flow of 0.004 mcm per hour** (0.096mcm/day) or greater would be required past the pipe for the gas to remain at or below the GS(M)R limit of 0.2mol%.

Blending Calculation	
Oxygen from Glentham (mol%)	1.000
Max Glentham hourly flow (mcm)	0.001
Assumed O2 level in NTS past site (mol%)	0.010
Min hourly flow to ensure compliance	**0.004**
Required O2 level (mol%)	0.200

Note that in practice, the gas in the NTS is unlikely to have an oxygen concentration this high because the 0.001% applies to most entry connections

***Note that the site would operate at 0.5mol% O2 under normal conditions, assuming 0.1% O2 in NTS, a flow of 0.003mcm/hour would be required for blending to the current GS(M)R limit.**

Glentham: Oxygen and Flows (2 of 2)

Two years of flow data have been considered:

Flow rates have been calculated based on the recorded hourly pressure data at Hatton Compressor Station and the closet off-take

There have been 7 instances during the 2-year period (18,610 data points) where flows have been less than required (0.192mcm daily rate) for blending to 0.2mol%.

Flows past the site the vast majority (99.96%) of the time are sufficient for blending

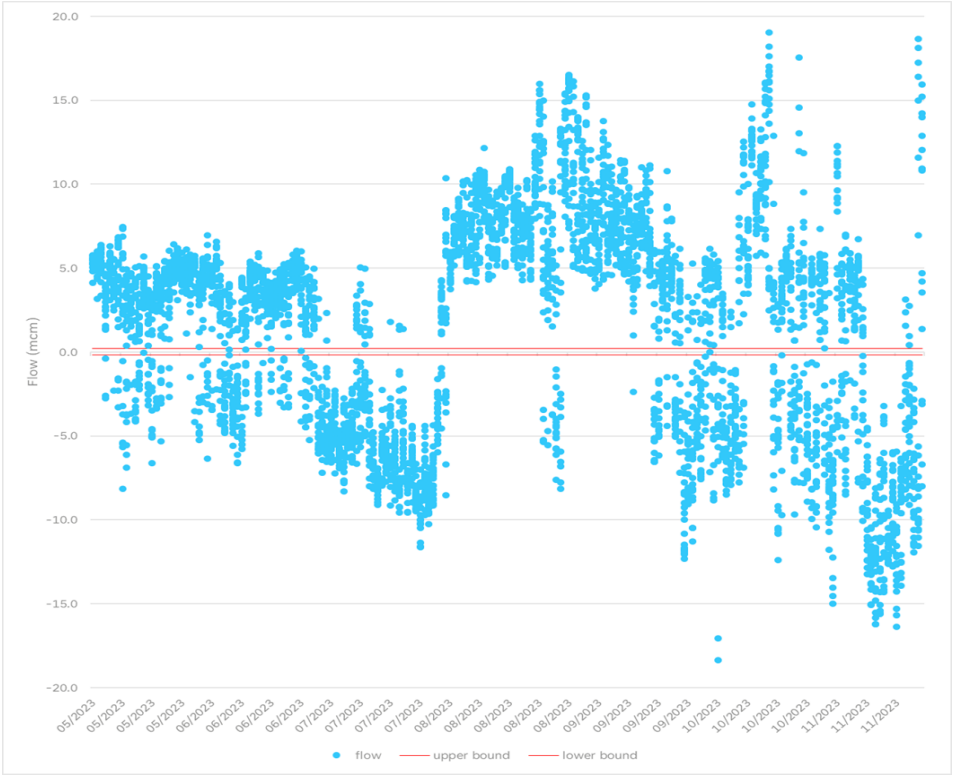
- Typical Winter Flow: 7.9 mcm
- Typical Summer Flow: 8.2 mcm

Assuming a flow past the site of 7.9mcm/day and max Glentham flows at 1% oxygen:

- If NTS oxygen past site is 0.1mol%, blended O2 is 0.103mol%
- If NTS oxygen past site 0.01mol%, blended O2 is 0.013 mol%

This, however, oversimplifies the situation. Every time there is a flow direction change, at some point flow will reduce to zero, before increasing in the reverse direction

Derived flows past Glentham



Snapshot: May 23 – November 23

Low/ Null Flow Scenario (1 of 2)

In the event there is no flow through feeder 7 past the Glentham injection point (during a flow reversal), and biomethane injection continues, a 'slug' of biomethane containing up to 1% oxygen might form in the vicinity of the injection point.

Flow data determines that null flows do not last long in duration (7 instances out of 18,610 hourly data points where average flows was less than required for blending)

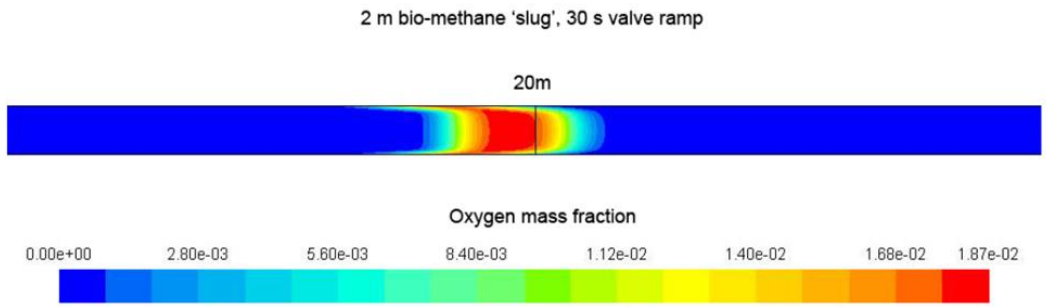
There is little concern if such a slug were to be transported south towards Hatton where it will be mixed with gas from Easington before being transported away from the locality.

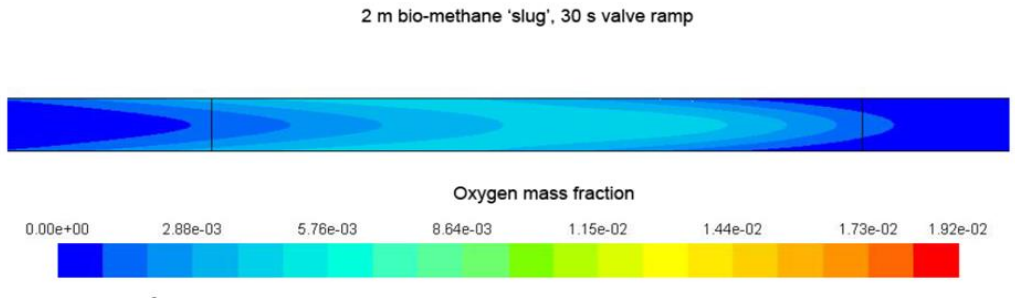
The greater potential concern is in the event of any such slug being propagated northwards towards the various offtakes and in particular the storage site.

NGT commissioned Computational Fluid Dynamic (CFD) Studies to better understand the behaviour of any slug of high oxygen content gas as the flow of gas in the feeder resumes. Output can be found in the NIA study: https://smarter.energynetworks.org/projects/nia_ngt0236/

Low/ Null Flow scenario (2 of 2)

Computation Fluid Dynamic Studies
The simulation of transient gas flows is quite complicated and requires considerable computing power and it has therefore been necessary to adopt a simplified model representing a worst-case scenario
The analysis has considered the behaviour of a pre-formed ‘slug’ of biomethane containing 1mol% oxygen with the flow in the feeder stationary as the flow in the main feeder restarts. For simplicity and as a worst-case, the flow geometry has been considered as a straight pipe with no branches or offtakes. Any branches or bends will increase the turbulence in the system which will lead to enhanced mixing.
It can be seen that the high oxygen content slug is blended out very rapidly and has been almost completely blended within a distance of around 100m.
It can therefore be concluded that any slug of biomethane which could accumulate in the event of a flow cessation or reversal will be effectively mixed out well before the slug of gas could reach any sensitive offtake.





Conclusions:

The analysis of hourly average feeder flowrates has shown that there were only 7 instances out of the 18,640 hourly data points considered where the flow in the feeder was insufficient to dilute the maximum flow of biomethane from the Glentham facility from 1% to 0.2% oxygen.

During the analysis, it has become apparent that the direction of flow in this section of the network changes. During any flow reversal, the flow must, of necessity, fall to zero before accelerating in the reverse direction.

During these flow reversals, a ‘slug’ of high oxygen gas could develop around the injection point. This will initially be diluted by the pipeline gas already present, however, the oxygen concentration will progressively increase until the flow restarts.

It has been shown by Computational Fluid Mechanics that any such slug of high oxygen content gas blends out rapidly once flow restarts even under the most adverse conditions (sharply defined plug of 1% oxygen gas, straight pipe with no branches or other flow disturbances). Blending is largely complete within a distance of around 100m. Mixing is found to be effective both longitudinally and axially. Any pockets of high oxygen content gas would be blended out within 1 – 200m and therefore long before the first of any offtakes is reached.

Thank you

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