# Managing Requests for 'Non-Standard' Gas Quality Parameters – Outline Methodology

**August 2025**

**Issue: Approved**

**Version: 1**

# Version control

| Version/revision number | Date of issue | Notes |
|---|---|---|
| V0.1 | 7th April 2025 | Managing Requests for 'Non-Standard' Gas Quality Parameters – Outline Methodology – first draft published to JO website and presented to Gas Quality Workgroup |
| V0.2 | 27th June 2025 | Amendments made to Heat Map, and table 1.1 following industry consultation on methodology presented to Gas Quality Workgroup |
| V1 | 29th August 2025 | Following Gas Quality Workgroup in August 2025 – all changes accepted by group. V1 to be uploaded to NGT website and to the Joint Office website. |
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**Managing Requests for 'Non-Standard' Gas Quality Parameters – Outline Methodology**

To ensure safe, reliable and efficient gas use, there are gas quality requirements that must be adhered to. These are encapsulated by a multi-faceted framework that includes the following:

- **Legal requirements:** Gas Safety (Management) Regulations (GS(M)R);
- **Contractual requirements:** Network Entry Agreements (NEA); Interconnection Agreements (IA), Storage Connection Agreements (SCA) and
- **Operational requirements:** National Gas Transmission Policy for- assessing the Requirements for Gas Quality, Calorific Value and Flow Measurement Systems.

## Legal and Contractual Requirements

With GS(M)R providing details of the underlying legal requirements for gas quality, the actual limits for gas quality at entry points are included within a contractual agreement, the Network Entry Agreement (NEA) (or similar for Interconnectors and storage). The limits in the NEA cannot be wider than those detailed in the GS(M)R, but they can be narrower and introduce other factors to provide additional control on specific components, such as carbon dioxide.

Regulation 8(1) of the Gas Safety (Management) Regulations 1996 (GS(M)R) prohibits the conveyance of gas in a network which does not conform with the gas quality parameters as specified in Part 1 of Schedule 3, one of these being that the oxygen content of the gas conveyed must be ≤0.2mol% at pressures above 38 barg. This could increase further if NGT submits and the HSE accepts an Evidence Case for a GS(M)R exemption to allow the delivery of gas onto the NTS at concentrations of up to 1mol% oxygen.

## Current Limits

The standard oxygen limit that NGT offers to new NTS entry connections is 10ppm, or 0.001mol%. Historically this was needed to avoid the presence of oxygen disrupting the liquefaction process at the LNG storage facilities, however, although these have now all been decommissioned, this specification remains in many NEAs resulting in overall very low levels of oxygen in the NTS. The standard oxygen content of 0.001mol% will be offered, unless a higher amount is requested (up to the GS(M)R specification), subject to a risk assessment.

Carbon dioxide is not specified under GS(M)R but is limited to 2.5mol% on entry to the NTS, or as agreed by risk assessment, and is then documented in the NEA.

A template Network Entry Agreement is published on the NGT website and can be found here: https://www.nationalgas.com/sites/default/files/documents/Network-Entry-Agreement-NEA.pdf

**Background:**

NGT are receiving increasing numbers of non-standard gas quality requests – i.e. requests for oxygen over 0.001mol% and carbon dioxide above 2.5mol%, from both existing and new NTS entry connections. Existing NTS exit connections may have concerns and therefore we see a need to clarify how non-standard requests are managed and considered.

**Transparency**

To ensure consistency and transparency, NGT have developed this methodology detailing how such requests from new NTS entry connections will be managed. Each request will be reviewed on a case-by-case basis to determine the level of risk to the NTS, and to existing connected parties. This will be determined following detailed network analysis.

NGT will continue to develop this methodology in response to operational and contractual needs. We are committed to reviewing our processes regularly, engaging with stakeholders, and updating our approach as new information becomes available. Details of version changes can be found on page 2 of this report, under "version control".Industry will be informed and be provided with a summary of the request and assessment. This will follow the requirements as introduced under UNC Modification 0882. This modification introduces new obligations on NGT to provide notices to industry for new connections requesting non-standard gas quality parameters. This modification is effective from 1st April 2025, and the templates and notices can be found on our website in the Connections Document Library here:

https://www.nationalgas.com/our-businesses/gas-connections-process/connections-document-library

For requests which would result in modifications to existing connection agreements a UNC enabling Modification is required and network analysis is carried out as part of this transparent modification process.

**Response to increasing requests to support Green Gas to the NTS**

NGT are seeing increasing numbers of enquiries from biomethane producers to connect to the NTS and wish to enable green gas connections. Due to the production and upgrading process of biogas to biomethane, the gas will have inherently higher levels of oxygen. NGT secured NIA (Network Innovation Allowance) funding to conduct a study to determine the impacts of an elevated level of oxygen on the NTS. The study, Oxygen in the NTS, is published on the Energy Networks portal and can be found here: https://smarter.energynetworks.org/projects/nia_ngt0236/.

NGT are currently preparing an evidence case to support a request to the HSE for a GS(M)R exemption to permit NGT to convey up to 1mol% oxygen.

NGT believe the sites requesting the higher oxygen levels will be biomethane connections which at present produce relatively small volumes of gas per day. In NTS terms, the flows these sites will deliver will be significantly lower than the flow of gas in the NTS pipeline the connection is flowing into. The two streams will co-mingle and due to the very low oxygen content of the bulk gas in the feeder, the oxygen content of the combined gas flow will still be very low.

NGT are aware that an increase in oxygen content may raise some concerns for parties whose sites offtake gas from the NTS. Network analysis will be undertaken for each potential new site requesting oxygen above 0.001mol%. This will include network penetration analysis, identification of connected parties, historical flows and propensity for blending.

**Oxygen**

Under normal operation, the elevated oxygen gas flow will be significantly lower than the main NTS pipeline flow and the gases will co-mingle. Network analysis will determine what flows are required in the NTS past the injection point, for the oxygen content from the requesting site to blend to the levels specified in Table 1.1 below. Following a consultation with industry, we have devised a

summary of NGT's current understanding of sensitivities to elevated oxygen, and NGT's blending requirements which is contained in the below table[1]:

**Table 1.1**

| Connected Party | Sensitivity to Oxygen | Requirements |
|---|---|---|
| Gas Distribution Networks | As the current GS(M)R permits conveyance of gas with up to 1 mol% O2 at pressures of <38 barg, there is no issue for those offtakes | If GDN offtake is at a pressure greater than 38 barg, 0.2mol% oxygen limit (as per GS(M)R) will apply until an appropriate exemption is granted |
| Power Generation | Although there may be small changes to the overall operation of some installations, it is not expected that the increased oxygen limit would have any significant negative impact above 0.5% but one OEM indicated a maximum acceptable limit of 0.2% | Will base Network Analysis on flows past the site required for <=0.2mol% oxygen, the current GS(M)R limit and a 2.5% CO2 limit |
| Industrial | Burners used in many industrial processes have sophisticated control systems - most will be able to accommodate up to 1 mol% oxygen | Non specific |
| Interconnectors | Interconnection Agreements have requirements for O2 specified which we will fulfil as follows:<br><br>Bacton BBL: up to 0.02mol%<br><br>Bacton Interconnector: up to 0.1mol%<br><br>Moffat: Able to accept level as specified by GS(M)R | Will base Network Analysis on flows past the site required for blending to O2 and CO2 as specified by the contract. |

[1] These sensitivities have been determined from the outputs of the NIA funded study – Oxygen in the NTS, which can be found https://smarter.energynetworks.org/projects/nia_ngt0236/. We have also added to this list based on feedback obtained following an industry consultation on this methodology.

| | | |
|---|---|---|
| Gas Storage Sites – salt cavern and depleted field | Underground storage facilities are known to be sensitive to oxygen content in the gas, irrespective of whether it is from natural gas or biomethane sources. These are not dry networks and there is risk of corrosion if consistent elevated oxygen is received. Underground storage sites due to operating wet gas systems, will have sensitivities to continuous levels of elevated oxygen. | Network analysis will be tailored to the sensitivities of underground storage operators where we will apply a significantly stricter threshold of 10 ppm for oxygen. This reflects the operational reality that storage facilities face—handling wet gas systems—and therefore sensitive to elevated oxygen levels, which pose a corrosion risk. Therefore, storage sites will be assessed specifically against the 10 ppm limit during network analysis.<br><br>**For CO2, NGT will be fulfilling contractual limit of 2.5%.**<br><br>In addition, consideration will be given to average flows and location of proposed site in relation to storage, to determine overall risk to the site. This must be considered minimal for the elevated oxygen request to be granted due to the increased risk of corrosion in wet gas systems. |

Moreover, if other customer types can demonstrate sensitivities to non-standard gas quality parameters, then we will review and consider this new information and update the table accordingly. The table currently covers most of our customer groups, but we are open to including concerns from industrial customers or others who express any issues.

**Network Analysis**

Network Analysis will be undertaken on a worst-case scenario; that the gas injected by the site will deliver the maximum specification requested, even if this would be lower under normal operation.

In the case of oxygen, it is anticipated that the flowrate of gas containing an elevated oxygen concentration will be significantly lower than the flowrate of very low oxygen content gas in the feeder to which the site is connected. Mixing theory and Computational Fluid Dynamic (CFD) modelling shows that dilution and blending out of the biomethane containing 1 mol% oxygen occurs within about 20D (a distance equivalent to 20 pipe diameters) downstream of the injection point. (further detail can be found in the NIA report – see earlier link).

Network analysis will determine the flows required past the (proposed) injection point for blending the oxygen to the levels contained in the above table.

**Carbon Dioxide**

The focus has been on oxygen primarily as these are expected to be the majority of non-standard requests based on biomethane new connection enquiries and in support of NTS oxygen exemption case.

Although NGT have not had an NIA study conducted on $CO_2$ specifically, we do have carbon dioxide analysis that has been carried out for several UNC enabling modifications, and this can be used as a methodology to adapt. $CO_2$ is more widely analysed across the network—by both NGT and the DNs—and is telemetered to NCC, which supports easier analysis of predominant flow patterns. NGT are aware that storage sites may be sensitive to $CO_2$, which will be taken into consideration.

**Network Analysis may include as appropriate:**

- Penetration analysis based on:
    - Site location
    - Site Daily maximum flow rates
    - Maximum O2/CO2 requested (as opposed to normal operations)
- Identification of any sensitive off-takes (See table 1.1 for oxygen)
- Determination of flows past the site and any bi-directional flows
    - Hourly flow data over a minimum two-year period
    - Bi-directional flows indicate there will be periods of 'null' flow which will require further review to determine frequency of duration of low/null flows for oxygen
- Flows required past the site for blending to levels specified in table 1.1 for oxygen.
    - This will be determined by blending calculation
    - Hourly data interrogated to determine compliance percentage
    - Additional integration to determine how long periods of non-compliance last in duration
- Average summer/winter flows will be determined
    - Which can then be used to derive an average blended oxygen level (based on assumptions of existing NTS gas, and worse-case elevated O2 by the site)
- Any known information that may need consideration
    - E.g. if we know of any decommissioning that will affect future flows in the area
- If there are existing connections with elevated O2/CO2 in the area, this will be taken into account, and analysis based on the cumulative impacts
- The impact of maintenance such as isolations either side of the connection point

Examples of previously completed O2 analysis can be found here:
https://www.gasgovernance.co.uk/sites/default/files/related-files/2025-02/0900%20NGT%20Impact%20Assessment%20%2803%20February%202025%29.pdf

**Periods of low/ null flow:**

There may be periods of low or 'null' flow (such as during low-demand summer days or during maintenance) where the flows past the (proposed) injection point will not be sufficient for blending to the required levels as determined in table 1.1 for oxygen. This may result in conditions where the higher oxygen content gas could "accumulate" around the injection point and then mix as the overall pipe flow increased. This "null flow" condition was investigated in the NIA oxygen study using

transient CFD (computational fluid dynamic) studies[2] to understand the impact of the mixing as a function of time and distance. The results from the CFD work identified that the "slug" of high oxygen content biomethane from the "null flow" condition could be dispersed and "blended out" within a few hundred metres providing evidence that it would be unlikely for any end user to receive gas that contains 1 mol% oxygen.

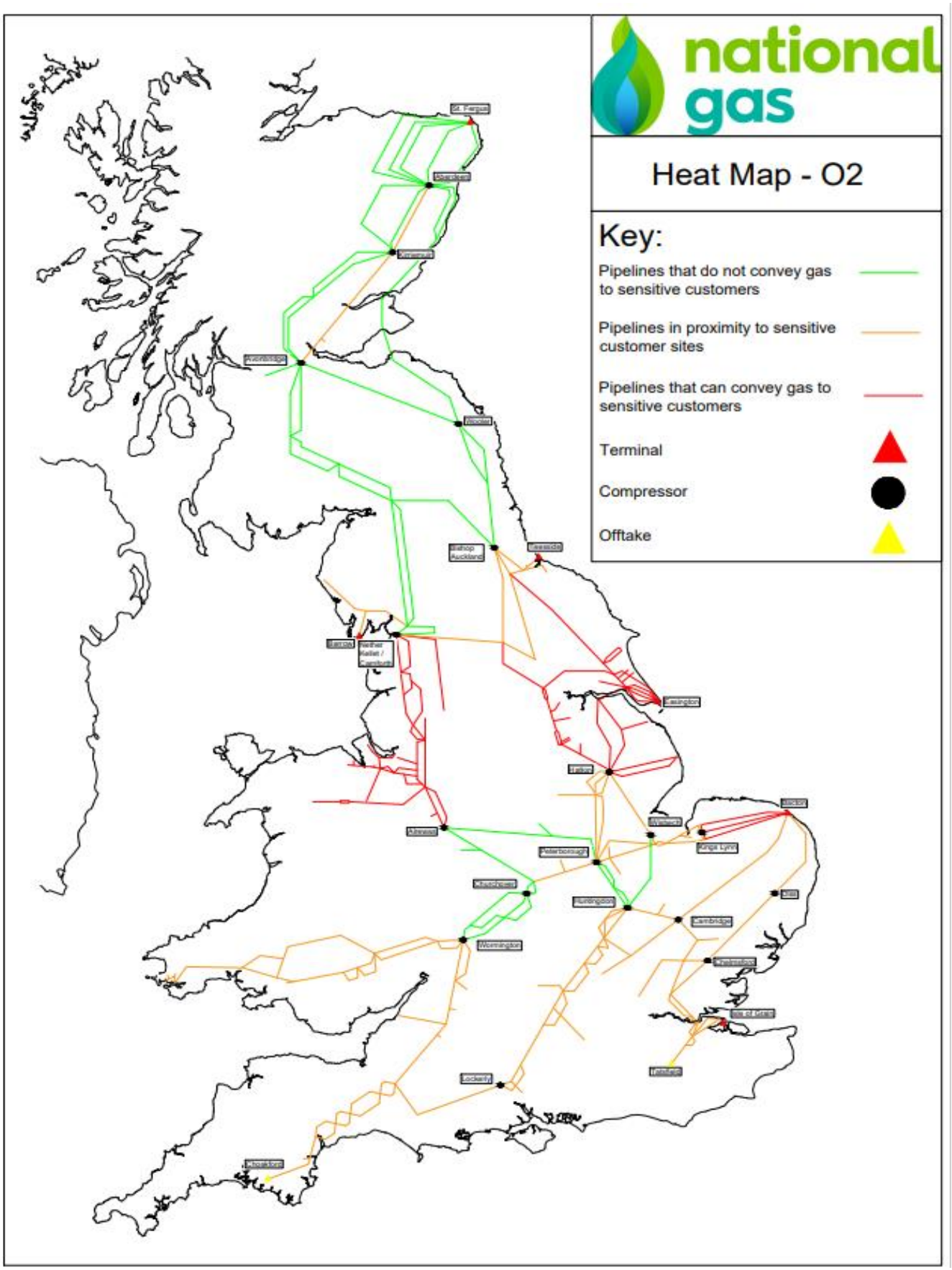
Network Analysis will be utilised to assess how often these periods of low/ null flow occur past the proposed biomethane injection point, and the duration of the low/null flow period could be expected to occur and the downstream impact.

**HEAT MAP – Oxygen risk to sensitive connections**

A "Heat map" of the NTS has been provided to give early indication of where on the NTS sites may be able to connect more readily with elevated oxygen. The heatmap below is indicative only – each request will be managed and reviewed individually on a case-by-case basis.

The map gives an indication on the likelihood of higher O2 content reaching a sensitive site, the colours are based on whether a sensitive site is on that pipeline, whether there is a blending point between the pipeline and a sensitive site and whether that sensitive site is a power station, interconnector or storage site, and if there is significant blending flow in the area based on the minimum flow rates.

[2] Full details can be found in the NIA report: Oxygen in the NTS, which can be found here: https://smarter.energynetworks.org/projects/nia_ngt0236/


national gas
Heat Map - O2
Key:
Pipelines that do not convey gas to sensitive customers
Pipelines in proximity to sensitive customer sites
Pipelines that can convey gas to sensitive customers
Terminal
Compressor
Offtake
St. Fergus
Peterborough
Cambridge
Lockerley
Theddlethorpe
Isle of Grain

**Determining Outcome**:

The Network Analysis will determine how far the elevated oxygen/ CO2 can reach and any parties that may be impacted as a result. Flows will determine likely blending and therefore what blended oxygen/ CO2 would be likely in the area.

After all available information has been considered, if the flows determine blending at acceptable levels (as detailed in table 1.1), NGT will agree to the elevated limit.

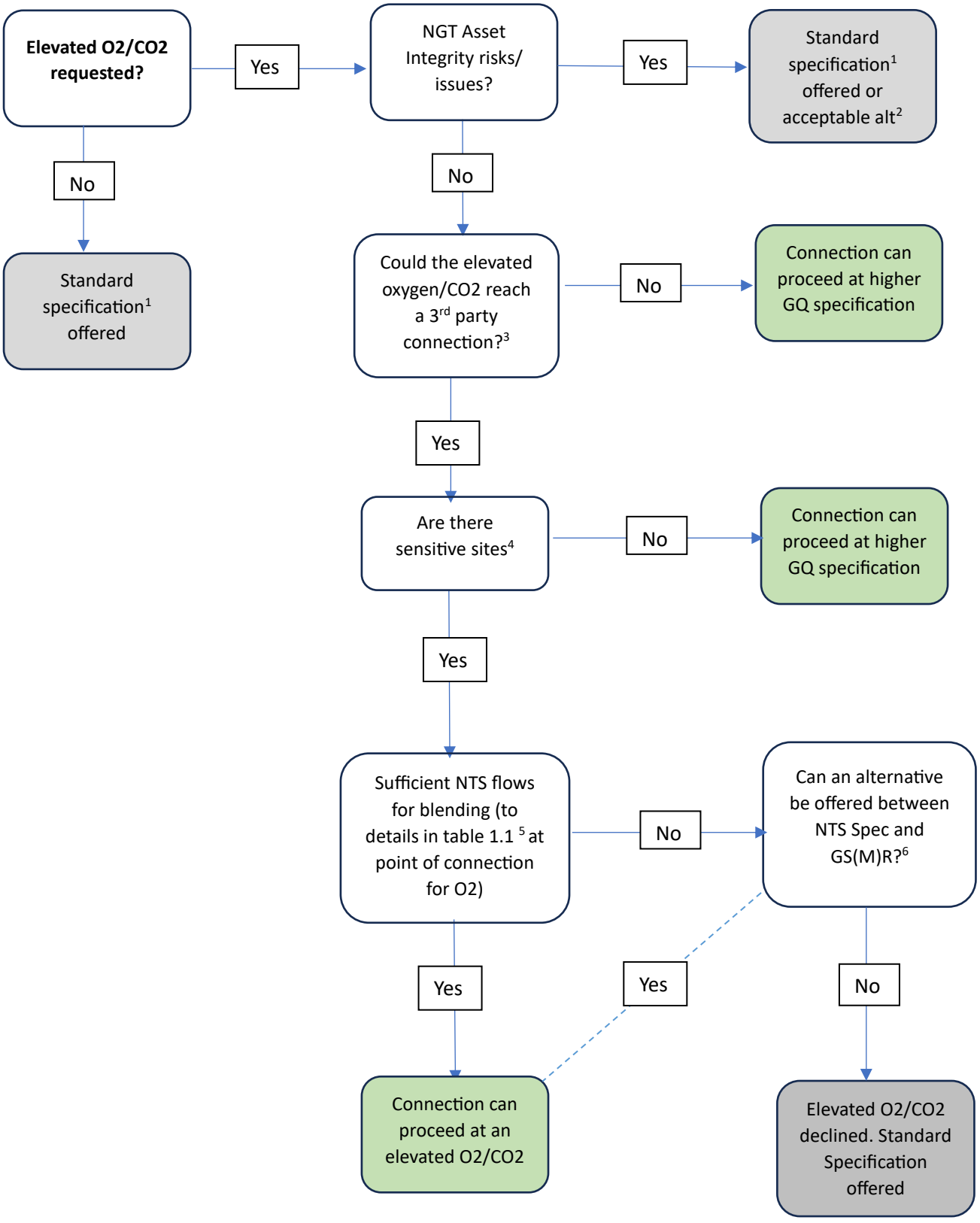
A process flow diagram is included below in Appendix 1 to summarise the agreed decision process to be followed for consistency**.**

**Timings:**

This process will be carried out in 2 stages:

1. The Heat map used to provide an indicative view of the request on connection enquiry or application.
2. The Network analysis and case by case assessment after a competent connection application has been received for a new connection including payment of the relevant connection application fee.

**Appendix 1: Process Flow Chart - Network Analysis will have been completed, based on a worst-case assessment.**



**Process Flow Chart Notes:**

1. The standard specification for oxygen is 0.001mol% and 2.5mol% for CO2
2. Acceptable alternative for oxygen will be up to GS(M)R limit of 0.2mol%. If there are also 3rd party connections in the vicinity, the decision tree will need to be followed further to determine if other considerations
3. 3rd parties include industrial connections, power stations, storage sites and interconnectors. This will be determined by Network Analysis
4. Sensitive sites for oxygen are determined in table 1.1. This includes power, interconnectors and underground storage sites.
5. Network analysis will determine what flows are required past the proposed site to ensure blending to requirements as per table 1.1 for oxygen. Analysis methodology shall be consistent including assumptions of NTS oxygen/carbon dioxide past site.
6. Network Analysis may determine that for example, the NTS can accommodate 0.1mol% oxygen as opposed to 0.2mol%. As long as all the conditions of the decision tree are met, this revised level of oxygen may be offered