



GAS QUALITY GUIDELINES

OPERATING PROCEDURE

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HISTORY

| VERSION | DATE | CHANGES | AUTHOR | CHECKED | APPROVED |
|---------|--------------|---|--------------|-------------|----------|
| 8 | 16 June 2010 | Rebranded | H Wright | J Hutchison | |
| 9 | 1 April 2014 | Updated in accordance with AS 4464-2011 | J Hutchinson | L Atkins | |

GLOSSARY

The *italicised* words and phrases in this document have the same meaning as the National Gas Rules (NGR).

In this document, capitalised words or phrases or acronyms have the meaning set out opposite those words, phrases, or acronyms in the table below.

Unless stated otherwise, this document will be interpreted in accordance with Schedule 2 of the National Gas Law (NGL).

Table 1 – Abbreviations and symbols

| ABBREVIATION | TERM |
|--------------|-----------------------------|
| AGA | Australian Gas Association |
| Bq | Becquerel |
| CNG | Compressed natural gas |
| HHV | Higher heating value |
| ESV | Energy Safe Victoria |
| NGV | Natural gas vehicles |
| TPO | Transmission pipeline owner |
| THT | Tetrahydrothiophene |
| TBM | Tertiary butyl mercaptan |

Table 2 –Defined terms

| TERM | DEFINITION |
|--------------------------------------|--|
| Affected Parties | Defined in Schedule B1. |
| Becquerel | Number of nucleus decays per second in a given quantity of radioactive substance. |
| Confirm (level for given parameter) | Within specification but close to limit – a trigger point to check monitoring equipment. |
| Curtail (level for given parameter) | The point at which there may be significant impact on one or more parties – a trigger point for the injection of the gas in question to be stopped. |
| Compressed Natural Gas | Natural gas, that is stored under pressure, usually as a fuel for vehicles. |
| Gas businesses | Includes all participants and market participants as defined in the NGR. |
| Gas Quality Specification | As defined in the NGR – AEMO's "Gas Quality Standard – System Injection Points". |
| Higher heating value | (As defined in AS 4564 – 2011.) The amount of energy in MJ/m ³ released when one cubic metre of dry gas, at standard conditions, is completely burnt in air with the products of combustion brought to standard conditions and with the water produced by combustion condensed to the liquid state. Note: Higher heating value is also known as gross heating value, superior heating value or calorific value (references to heating value in this document refer to HHV (MJ/m ³)). |
| Injecting Party | Any company registered with AEMO as a market participant or participant who is injecting gas directly or indirectly into the gas transmission system operated by AEMO. |
| Joule Thompson cooling | Cooling of a gas that usually occurs when the gas is expanded adiabatically, for example by throttling from high pressure to a lower pressure. |
| Limit | (As defined in AS 4564 – 2011.) The value beyond which the specified characteristic or concentration of the component shall not be permitted to vary. |
| Mitigate (level for given parameter) | The point at which there may be an impact on some parties – a trigger point for actions to be taken by relevant parties to mitigate any risk from the off-specification gas and indicates possible curtailment of injection. |
| Natural gas vehicles | Motor vehicles that use natural gas as their fuel. |
| Notify (level for given parameter) | The gas quality specification limit and trigger point for notifying relevant parties and for producers to take immediate action to bring the given parameter within specification. |
| Off-specification gas | (As defined in the NGR.) Gas, which is injected into the transmission system at a system injection point, which does not comply with the gas quality specifications for that system injection point. |
| Slug | Refers to an accumulation of liquid, which may move along natural gas pipelines. |
| Slug Catcher | Device used to collect and remove "slugs" of liquid from pipelines. |
| Standard Conditions | (As defined in AS 4564 – 2011.) A temperature of 15°C and an absolute pressure of 101.325 kPa. |
| Transmission Pipeline Owner | (As defined in the NGR.) A person who owns or holds under a lease a transmission pipeline which is, or is to be operated by AEMO. |
| Tetrahydrothiophene | A cyclic sulphide used in gas odourisation. |
| Tertiary butyl mercaptan | A mercaptan used in gas odourisation. |

SECTION A – General Information

1 Introduction

This document outlines how AEMO Gas Real Time Operations will respond if it becomes aware that off-specification gas is being injected into the declared transmission system (DTS), and outlines AEMO's management of these types of events.

- a. This document is not intended to be a substitute for the *gas quality specifications* of the National Gas Rules (NGR).
- b. This document may be amended from time to time.
- c. If there is any inconsistency between this document and the NGR, the NGR will prevail.

2 Purpose

These guidelines outline the technical issues associated with gas quality parameters and AEMO's operational protocols for managing gas quality at *system injection points* in the DTS operated by AEMO. Section 32 of the Victorian Gas Safety Act 1997 requires that risks and hazards to the safety of the public and customers arising from interruptions to the delivery of gas or reinstatement of an interrupted gas supply are minimised.

Section 33 of the Act (relating to gas quality) requires that, as far as practicable, all prescribed requirements for natural gas are met.

These guidelines are based on a critical balance between risks to public safety by the supply of *off-specification gas*, compared with the risks to public safety associated with curtailment of the injection, subsequent system disruption and re-lights within the premises of gas consumers.

AEMO acknowledges that it may be necessary to continue injection of *off-specification gas* if the impact will be less than a loss of gas supply.

Where off-specification conditions become protracted, extreme and/or frequent, or otherwise represent a situation not adequately covered by these guidelines, AEMO management (in consultation with Energy Safe Victoria) may implement different risk management strategies. For example, in the event that repeated excursions may compromise gas safety, potential curtailment actions will be evaluated on the level of impact and risk involved.

In the event of off-specification gas flows, injections may be rescheduled to minimise the overall risk by reducing the quantity of *off-specification gas* injected.

The guidelines cover short-term gas quality excursions outside the *gas quality specifications* that may result from transient plant malfunctions at injection points.

These guidelines do not cover the mitigation of the effects of the level of quality or changes in gas quality within the gas quality specification range.

3 Related policies and procedures

- AS 2885.1 2007 – Pipelines – Gas and Liquid Petroleum. Part 1: Design and construction. Appendix P “Environment-Related Cracking”.
- AS 4564-2011 – "Specification for general purpose natural gas".
- AS 4838:2002/ISO 11439:2000 “Gas cylinders – High pressure cylinders for the on-board storage of natural gas as a fuel for automotive vehicles.
- ASTM D 1142-95 – "Standard Test Method for Water Vapor Content of Gaseous Fuels by Measurement of Dew Point Temperature".
- Bergman D. F., Tek M. R. & Katz D. L. 1975 – “Retrograde Condensation in Natural Gas Pipelines”. American Gas Association.
- Church B.J. & Winckles G.D. 1999 – “High Wobbe Index gas” – A report on the 5th Draft report prepared on behalf of OGS in Victoria.
- Gas & Fuel Corporation – “Natural Gas Data” (Various editions).
- Gas & Fuel Corporation, 1991 – Engineering Policy EP.DD.4005 – “Policy on design temperatures for system components”.
- Gas Safety (Gas Quality) Regulations 2007 – Victoria.
- Huffaker R. W. 1995 – “Results of Gas Integration Project Gas Quality Task Force” – Natural Gas Quality & Energy Measurement Practices and Applications, February 5-7, 1996, Clearwater Florida, IGT.
- ISO 13686 – International Organisation for Standardisation 1998 – “Natural Gas -Quality Designation”.
- ISO 6976 – International Organisation for Standardisation 1995 (Corrected and reprinted 1996) – “Natural Gas – Calculation of calorific values, density, relative density and Wobbe index from composition.”
- ISO/TS 16922:2002 Natural Gas – Guidelines for odorising gases.
- NACE MR0175/ISO 15156-2-2003 – Petroleum and natural gas industries – Materials for use in H₂S-containing environments in oil and gas production.
- NZS 5442:1990 – New Zealand standard – “Specification for Reticulated Natural Gas.”
- Office of Gas Safety 2001 – “Specification for Combustion Quality and Excess Air Level When Utilising Natural Gas”, September 2001.
- Petroleum and Gas (Production and Safety) Regulation 2004 – Queensland.
- Shnidman L. (Editor) “Gaseous Fuels” – American Gas Association. 1954.
- AEMO “Gas Quality Standard – System Injection Points”.
- Watkins and Vaughn – Materials Performance, January 1986 – “Effects of H₂S Partial Pressure on the Sulphide Stress Cracking Resistance of Steel”.

4 Basic principles

4.1 Safety requirements

As these guidelines involve matters which may increase risk to the wider community, the understanding of these guidelines and notification procedures is critical to all *market participants* and *participants*.

4.2 General

Reports of *off-specification gas* entering the system may originate from monitoring equipment at the *system injection point(s)*, or from faxed or telephoned reports. In the event of major plant failure there may also be supplementary notification from the production plant operator. Major *off-specification gas* conditions usually only occur as a result of plant malfunction or operator error.

Some gas quality monitoring equipment is located within production facilities, which is remote from the system injection point. In these circumstances *off-specification gas* quality notifications will be issued based on readings from within the production facility where there is no comparable monitoring at the injection point. This may mean that the notification of *off-specification gas* may be many hours (or days) before the gas is actually injected. It may not be possible to accurately predict the time when *off-specification gas* is injected.

Repeated off-specification excursions over extended periods are indicative of inadequate plant design, operation or maintenance. Repeated excursions or protracted oscillation between on-specification and *off-specification gas* will be cause for curtailment until the Injecting Party can demonstrate these excursions have been adequately addressed. AEMO will base this judgement on the level of risk involved.

4.3 Gas quality data

As the decisions made using these guidelines may impact upon the health and safety of the wider community, it is essential that such decisions be based on data that is as reliable as practical.

Although notifications of *off-specification gas* are based on readings from monitoring equipment, where feasible, these readings will be confirmed. Typical confirmation involves contacting the parties responsible for the monitoring equipment and any other parties who may have additional information and by comparing related data. The confirmation process may continue after the initial notification of *off-specification gas*.

4.4 Responses to *off-specification gas*

AEMO applies a hierarchy of responses to *off-specification gas*, based on the severity and duration of the event outside specification. The hierarchy of responses can be briefly outlined as follows:

Confirm: This response level applies to gas that is in specification, but close to the specified limit. It is a trigger point to check the gas quality monitoring equipment and to confirm that it is measuring correctly.

Notify (gas quality specification limit): This response level applies to gas that has breached specification. It is a trigger point for Affected Parties to be notified and for the Injecting Facility to take immediate action to bring the given parameter within specification.

Mitigate: This response level applies to gas that may adversely impact certain parties. It is a trigger point for actions to be taken by relevant parties to mitigate any risk from the *off-specification gas* and indicates possible curtailment of injections.

Curtail: This response level applies to gas that may cause significant adverse impacts to one or more parties. It is a trigger point for the injection of the gas to be stopped.

The responses to the injection of *off-specification gas* are listed in Section B below. Different off-specification conditions may require different responses.

The limits include specific excursion duration and a physical limit for a given parameter.

The relevant Injecting Facility control centre will be notified by telephone when gas composition parameters reach the Confirm limit.

4.5 Duration of Excursions

The Confirm and Notify limits for each gas parameter set out in Section C, Appendix A, and in the parameter information tables. They are based on a 10-minute continuous excursion or separate excursions that occur in any 30-minute period for a time totalling more than 10 minutes. For example, such excursions may involve a two-minute, five-minute and four-minute excursion in the same 30-minute time block.

Confirm limit

Any excursion of a gas parameter that is greater than the Confirm limit will result in the relevant parties being contacted to perform confirmation and/or validation checks.

Notify limit

The Notify limit in this document is the gas quality specification limit. Any excursion of a gas parameter that is greater than the Notify limit will result in the relevant parties in Schedule B1 being notified in accordance with AEMO notification procedures.

Where *off-specification gas* excursions are intermittent, an interval where the gas is within specification for more than 30 minutes before again exceeding the Notify limit defines the start of a separate excursion and further notifications are required.

Injection of *off-specification gas* for a prolonged period may result in curtailment of the Injecting Facility.

Mitigate limits and industry response requirements

Any excursion of a gas parameter that is greater than the Mitigate limit will result in the relevant affected parties in Schedule B1 being notified.

The onus is on the respective *market participants* to carry out any necessary mitigation for *off-specification gas* appropriate for their organisations based on independent expert advice. Mitigation steps may include notifications to specific categories of gas consumer.

The Mitigate limits for each gas parameter are set out in Section C, Appendix A and in the parameter information tables. The limits include specific excursion duration and a physical limit for a given parameter. For example, the Wobbe index (maximum) exceeds the Mitigate limit if it is above 52.5 MJ/m³ for 30 minutes.

These excursion durations are based on cumulative times within any 30-minute period (as for Confirm and Notify limits). Where the excursion duration set out is more than 30 minutes, the excursion needs to be continuous before AEMO commences the Mitigate notifications or actions.

Market participants and *participants* need to be aware that if gas quality remains outside the mitigate limits for more than three hours the injection will be curtailed and the source of the *off-specification gas* will be scheduled down until the gas can be injected at an acceptable quality.

Curtail limits and required response

The Curtail limits for each gas parameter are set out in Section C, Appendix A, and in the parameter information tables. When the Curtail limit is reached, the Injecting Party will be instructed to cease injections until the gas can be injected at an acceptable quality. For example the Wobbe index (maximum) exceeds the Curtail limit if Wobbe is above 53.5 MJ/m³ for 30 minutes.

These excursion durations are based on cumulative times within any 30-minute period (as for Confirm and Notify limits). Where the excursion duration set out is more than 30 minutes, the excursion needs to be continuous before AEMO commences the Curtail notifications or actions.

The onus is on the Injecting Party to carry out any necessary mitigation for *off-specification gas* and the curtailment of gas injections appropriate for their organisations.

Reinstate Level

The Reinstate Level is the quality level that the Injecting Party must be able to achieve before injection can be recommenced after curtailment. The Injecting Party must notify AEMO in writing when they are able to achieve this.

4.6 Acceptance of off-specification gas for system security

Where long-term acceptance of *off-specification* gas is required for continuing system security, AEMO is unlikely to accept gas with gas quality parameters more than halfway from the Notify limit to the Mitigate limit for any extended period.

SECTION B – (PART 1) Parameters specified in the Gas Safety (Gas Quality) Regulations including parameters specified in AS 4564.

5 Wobbe Index maximum

| | |
|-------------|--|
| Description | <p>The Wobbe Index of a gas is an indicator of its combustion acceptability for a given population of appliances. It is the most significant parameter in terms of gas combustion safety.</p> <p>The Wobbe Index is the higher heating value (HHV) divided by the square root of the relative density (RD), sometimes called the specific gravity.</p> $WobbeIndex = \frac{HHV}{\sqrt{RD}}$ <p>Gas with a Wobbe Index that is too high can result in overheating and eventual burning out or perforation of heat exchangers, and “spillage” (some combustion products entering the room rather than all passing up the flue).</p> <p>High Wobbe Index gases can also cause excessive carbon monoxide formation. Whilst this may not be an issue with flued appliances, there are unflued appliances and there may be appliances with faulty fluing systems.</p> <p>High Wobbe Index gas can increase the likelihood of soot build-up on finned heat exchangers.</p> <p>Industrial furnaces that have been adjusted to the minimum air for combustion may also be adversely affected if “combustion quality excess air” levels (minimum air/gas ratio) set by Energy Safe Victoria (ESV) have not been adhered to. High Wobbe Index gases tend to have a higher combustion air requirement. If a furnace has been adjusted for low Wobbe Index gases, there is the potential for these furnaces to have insufficient air for combustion when receiving very high Wobbe Index gas. The resulting incomplete combustion may create sufficient amounts of carbon monoxide and hydrogen to cause an explosion if additional air is inadvertently admitted to the combustion chamber during operation.</p> |
| Limits | <p>Short-term small excursions can be tolerated from a safety perspective provided the average levels are kept within specification.</p> <p>The curtailment limit has been chosen to ensure that the levels of carbon monoxide and hydrogen created by incomplete combustion will not create an explosive mixture with air for a wide range of gas compositions for furnaces adjusted at the low Wobbe Index limit, provided minimum air/gas ratios set by ESV are adhered to.</p> |

Wobbe Index maximum

| | CONFIRM | NOTIFY | MITIGATE | CURTAIL | REINSTATE LEVEL |
|----------------------------------|---------|--------|----------|---------|-----------------|
| Wobbe Index (MJ/m ³) | 51.5 | 52.0 | 52.5 | 53.5 | 52.0 |
| Excursion duration (minimums) | 10 | 10 | 30 | 30 | N/A |

| | |
|---------------|--|
| Notifications | <p>When the Notify level has been exceeded continuously for more than 10 minutes (or more than 10 minutes in any 30-minute period), affected parties will be notified according to AEMO notification protocols.</p> <p>The affected parties will also be notified when the Mitigate and Curtail limits are exceeded.</p> |
| Mitigation | <p>Mitigation steps may include:</p> <ul style="list-style-type: none"> • Scheduled quantities may be adjusted down. • Allowing the Injecting Facility to change injection rate to assist in bringing plant under control. • Gas retail businesses may choose to provide notifications to their customers based on their assessment of the situation. • Restricting the transmission of <i>off-specification</i> gas to limited areas (using linepack to maintain other areas) until the episode has passed. |
| Curtailment | <p>Once the curtailment limit has been breached for the specified time, the Injecting Party will be instructed to cease injection.</p> <p>Note also the curtailment criteria under mitigation above.</p> |
| Reinstatement | The injection of gas can be reinstated once the gas quality is brought to within the Reinstate Level above. |

6 Wobbe Index minimum

| | |
|-------------|---|
| Description | $\text{WobbeIndex} = \frac{\text{HHV}}{\sqrt{\text{RD}}}$ <p>A low Wobbe Index can result in flame instability, “flashback”, and ignition difficulties, which may lead to flame loss and resultant gas accumulations where there is no auto shut-off. Low Wobbe index gases may cause increased carbon monoxide formation in surface-combustion tile type appliances.</p> |
| Limits | <p>Short-term small excursions can be tolerated from a safety perspective provided the average levels are kept within specification.</p> <p>The curtailment limit has been set at the AGA test gas limit. At these limits, AGA approved (Type A) domestic appliances should still function safely.</p> |

Wobbe Index minimum

| | CONFIRM | NOTIFY | MITIGATE | CURTAIL | REINSTATE LEVEL |
|----------------------------------|---------|--------|----------|---------|-----------------|
| Wobbe Index (MJ/m ³) | 47.0 | 46.0 | 45.0 | 44.0 | 46.0 |
| Excursion duration (minimums) | 10 | 10 | 30 | 30 | N/A |

| | |
|---------------|--|
| Notifications | <p>When the Notify level has been exceeded continuously for more than 10 minutes (or more than 10 minutes in any 30-minute period), affected parties will be notified according to AEMO notification protocols.</p> <p>The affected parties will also be notified when the Mitigate and Curtail Limits are exceeded.</p> |
| Mitigation | <p>Mitigation steps may include:</p> <ul style="list-style-type: none"> • Scheduled quantities may be adjusted down. • Allowing the Injecting Facility to change injection rate to assist in bringing plant under control. • Gas retail businesses may choose to provide notifications to their customers based on their assessment of the situation. • Restricting the transmission of <i>off-specification</i> gas to limited areas (using linepack to maintain other areas) until the episode has passed. |
| Curtailment | <p>Once the curtailment limit has been breached for the specified time, the Injecting Party will be instructed to cease injection.</p> <p>Note also the curtailment criteria under mitigation above.</p> |
| Reinstatement | The injection of gas can be reinstated once the gas quality is brought to within the Reinstate Level above. |

7 Higher heating value maximum

| | |
|-------------|---|
| Description | <p>The higher heating value of a gas is defined as: “The amount of energy, in MJ/m³, released when one cubic meter of dry gas, at standard conditions, is completely burnt in air. With the products of combustion brought to standard conditions, and the water produced by combustion condensed to the liquid state.”</p> <p>Testing, as part of AS 4564-2011, has found that gases with a higher heating value over 42.3 MJ/m³ can result in the build-up of soot on finned heat exchangers, even if the Wobbe Index is below 52 MJ/m³. In severe cases soot build-up can result in a blockage of the flue and spillage of the products of combustion into a building via the burner.</p> |
| Limits | <p>Short-term small excursions can be tolerated from a safety perspective provided the average levels are kept within specification.</p> <p>The curtailment limit has been chosen to ensure that the heating value limit is not set at a level that would cause the high curtail Wobbe Index limit to be exceeded. This was determined by analysing heating value and Wobbe data for gas produced in Victoria.</p> |

Higher heating value maximum

| | CONFIRM | NOTIFY | MITIGATE | CURTAIL | REINSTATE LEVEL |
|------------------------------------|---------|--------|----------|---------|-----------------|
| Heating value (MJ/m ³) | 41.8 | 42.3 | 42.6 | 43.0 | 42.3 |
| Excursion duration (minimums) | 10 | 10 | 30 | 30 | N/A |

| | |
|----------------------|--|
| Notifications | When the Notify level has been exceeded continuously for more than 10 minutes (or more than 10 minutes in any 30-minute period), affected parties will be notified according to AEMO notification protocols. The affected parties will also be notified when the Mitigate and Curtail limits are exceeded. |
| Mitigation | Mitigation steps may include: <ul style="list-style-type: none"> • Scheduled quantities may be adjusted down. • Allowing the Injecting Facility to change injection rate to assist in bringing plant under control. • Gas retail businesses may choose to provide notifications to their customers based on their assessment of the situation. • Restricting the transmission of off-specification gas to limited areas (using linepack to maintain other areas) until the episode has passed. |
| Curtailment | Once the curtailment limit has been breached for the specified time, the Injecting Party will be instructed to cease injection. Note also the curtailment criteria under mitigation above. |
| Reinstatement | The injection of gas can be reinstated once the gas quality is brought to within the Reinstate Level above. |

8 Oxygen maximum

| | |
|--------------------|---|
| Description | Oxygen can cause corrosion within pipelines. At very high levels there is the potential for forming an explosive mixture. |
| Limits | Relatively long periods of higher than specification oxygen content can be tolerated from a safety perspective provided the average levels are kept within specification. The curtailment limit is based upon keeping the gas and oxygen mixture above the upper explosive limit for natural gas and is aligned with the total inerts limit. |

Oxygen maximum

| | CONFIRM | NOTIFY | MITIGATE | CURTAIL | REINSTATE LEVEL |
|-------------------------------|---------|--------|----------|---------|-----------------|
| Oxygen Maximum. (mol %) | 0.15% | 0.2% | 2.0% | 5.0% | 2.0% |
| Excursion Duration (minimums) | 10 | 10 | 30 | 30 | N/A |

| | |
|---------------|---|
| Notifications | When the Notify level has been exceeded continuously for more than 10 minutes (or more than 10 minutes in any 30-minute period), affected parties will be notified according to AEMO notification protocols. The affected parties will also be notified when the Mitigate and Curtail limits are exceeded. |
| Mitigation | If the oxygen content is over the Mitigate limit for more than three hours, the injection will be curtailed. Scheduled quantities may be adjusted down. |
| Curtailment | Once the curtailment limit has been exceeded for the specified time the Injecting Party will be instructed to cease injection. Note that this limit is unlikely to ever be reached because there is no practical supply of oxygen in the system of sufficient magnitude to reach the curtailment figure. Note also the curtailment criteria under mitigation above. |
| Reinstatement | The injection of gas can be reinstated once the gas quality is brought to within the Reinstate Level above. |

9 Hydrogen sulphide maximum

| | |
|-------------|--|
| Description | <p>Hydrogen sulphide (H_2S) is a corrosive, poisonous gas which as a cumulative effect on pipelines and copper components in gas installations.</p> <p>Short periods of high hydrogen sulphide can be tolerated from a safety perspective provided the average levels are kept within specification.</p> <p>Hydrogen sulphide is also a stress-cracking agent for steel. The likelihood of creating stress cracks depends on the partial pressure of H_2S. At higher gas pressures require a lower H_2S level. A maximum partial pressure of 0.1 kPa (0.015 psi) was used in defining the mitigation and curtailment limits, as this is the lowest partial pressure reported to create stress.¹ cracking. This provides a margin for safety over the NACE standard (MR01750/ISO 15156 -2003) 0.3 kPa (0.05 psi) H_2S partial pressure lower limit requirement for resistant steels.</p> <p>High levels of hydrogen sulphide can pose a threat to the CNG (Compressed natural gas) cylinders of NGVs as they are exposed to pressures up to 26,000 kPa.* The current standard for NGV cylinders (AS 4838-2002) specifies that they should be designed to handle hydrogen sulphide levels up to 23 mg/m³ however some cylinders may pre-date the first issue of the standard (2002).</p> <p>* AS 4838-2002 (section 4.2) – the maximum filling pressure limit for NGV cylinders.</p> |
| Limits | <p>The mitigate limit has been chosen at the hydrogen sulphide level likely to be of concern for NGV cylinders (not compliant with AS 4838-2002) being exposed to pressures up to 26,000 kPa.</p> <p>The Curtail limit has been chosen based on an expected maximum transmission pressure of 15,000 kPa. Gas injected into the AEMO operated gas transmission system may pass into connected 15,000 kPa transmission systems.</p> |

¹ Watkins & Vaughn, 1986

Hydrogen Sulphide maximum

| | CONFIRM | NOTIFY | MITIGATE | CURTAIL | REINSTATE LEVEL |
|---|---------|--------|----------|---------|-----------------|
| Hydrogen sulphide (H ₂ S) maximum (mg/m ³) | 4.5 | 5.7 | 5.8 | 10.0 | 5.7 |
| Excursion Duration (minimums) | 10 | 10 | 30 | 30 | N/A |

| | |
|---------------|---|
| Notifications | <p>When the Notify level has been exceeded continuously for more than 10 minutes (or more than 10 minutes in any 30-minute period), affected parties will be notified according to AEMO notification protocols.</p> <p>The affected parties will also be notified when the Mitigate and Curtail limits are exceeded.</p> |
| Mitigation | <p>AEMO will continue to accept the <i>off-specification gas</i> up to the curtailment limit provided gas businesses associated with CNG/NGV refilling stations advise AEMO in writing (i.e. via email or fax) within three hours, of their acceptance of the <i>off-specification gas</i> up to the curtailment limit. They also need to demonstrate appropriate mitigation steps are in place.</p> <p>The above gas businesses will also need to contact Energy Safe Victoria as the injection will be curtailed unless they are satisfied that CNG/NGV refillers have been adequately notified.</p> <p>Mitigation steps may include:</p> <ul style="list-style-type: none"> • Scheduled quantities may be adjusted down. • Allowing the Injecting Facility to change injection rate to assist in bringing plant under control. • Retail businesses may choose to notify users of CNG that they should not refill cylinders that may be susceptible to H₂S concentrations up to 10 mg/m³ until after high H₂S has been eliminated from the gas transmission system. This is the most critical hydrogen sulphide mitigation. Cylinders constructed to AS 4838-2002 “Gas cylinders – High pressure cylinders for the on-board storage of natural gas as a fuel for automotive vehicles” would not require any mitigation steps under these guidelines. • Retail businesses may choose to notify consumers known to be affected by sulphur compounds in the gas (e.g. glass manufacturers). |
| Curtailment | <p>Once the curtailment limit has been exceeded for the specified time, the Injecting Party will be instructed to cease injection.</p> <p>Note also the curtailment criteria under mitigation above. The notification to users of CNG should still be made by the retail businesses.</p> |
| Reinstatement | The injection of gas can be reinstated once the gas quality is brought to within the Reinstate Level above. |

10 Total sulphur maximum

| | |
|-------------|--|
| Description | <p>This parameter is the quantity of sulphur contained in compounds within the gas. This includes any sulphur containing odorants.</p> <p>This specification is related to air pollution and indoor air quality control. High levels of sulphur compounds in the gas increase the amount of sulphur dioxide created when the gas is burnt and may lead to corrosion of appliances.</p> <p>Sulphur compounds in the gas may lead to the deposition of elemental sulphur in pipelines.</p> <p>The sulphur compounds may have a very strong unpleasant smell and may lead to “nuisance” leak reports.</p> <p>Short excursions can be tolerated from a safety perspective provided the average levels are kept within specification.</p> |
| Limits | The Mitigate limit is based on twice the injection specification limit and the Curtail limit four times the injection specification limit. |

Total sulphur maximum

| | CONFIRM | NOTIFY | MITIGATE | CURTAIL | REINSTATE LEVEL |
|--|---------|--------|----------|---------|-----------------|
| Sulphur Maximum. (mg/m ³) | 45 | 50 | 100 | 200 | 50 |
| Excursion Duration (minimums) | 10 | 10 | 30 | 30 | N/A |

| | |
|---------------|---|
| Notifications | <p>When the Notify level has been exceeded continuously for more than 10 minutes (or more than 10 minutes in any 30-minute period), affected parties will be notified according to AEMO notification protocols.</p> <p>The affected parties will also be notified when the Mitigate and Curtail limits are exceeded.</p> |
| Mitigation | <p>The onus is on the respective businesses to carry out any necessary mitigation steps appropriate for their organisations as they see fit.</p> <p>If the total sulphur content is over the Mitigate limit for more than three hours, then the injection will be curtailed.</p> <p>Mitigation steps may include:</p> <ul style="list-style-type: none"> • Scheduled quantities may be adjusted down. • Allowing the Injecting Facility to change injection rate to assist in bringing plant under control. • Retail businesses may choose to notify consumers known to be affected by sulphur compounds in the gas [e.g. glass manufacturers]. • Gas retail and distribution businesses may prepare for an increase in reported gas leaks. |
| Curtailment | <p>Once the curtailment limit has been exceeded for the specified time, the Injecting Party will be instructed to cease injection.</p> <p>Note also the curtailment criteria under mitigation above.</p> |
| Reinstatement | The injection of gas can be reinstated once the gas quality is brought to within the Reinstate Level above. |

11 Water content / water dew point

| | |
|-------------|---|
| Description | <p>Excess water in natural gas can condense and absorb CO₂ and sulphur compounds from the gas thus creating a corrosive liquid in the pipe.</p> <p>Excess water in natural gas can also cause the formation of solid or semi-solid hydrates. Hydrates are an ice-like mixture of water and hydrocarbons. Hydrates can block or cause problems in metering equipment, pressure regulators or the pipeline itself. There is the potential for hydrates to block pressure control sensing lines.</p> <p>There is also the potential to form hydrates in high-pressure NGV cylinders.</p> <p>Short-term small excursions can be tolerated from a safety perspective provided the average levels are kept well within specification.</p> <p>To provide for uniformity in reporting, the water content is the parameter that is monitored and reported.</p> |
| Limits | <p>For the purposes of gas injected at an injection point, the relevant transmission pressure is deemed to be 15,000 kPa unless otherwise approved by AEMO. For typical natural gas compositions, a 0°C dew point corresponds to a water content of 73 mg/m³, and AEMO shall use this as the basis for limits in these guidelines.</p> <p>The Confirm limit (65 mg/m³) is based on a water dew point of -2°C at 15,000 kPa.</p> <p>The Notify limit (73 mg/m³) is based on a water dew point of 0°C at 15,000 kPa.</p> <p>The curtailment limit of 6°C is based on maintaining a water dew point margin that is 6°C below Victoria's winter ground temperature (12°C). A water dew point of 6°C at 15,000 kPa corresponds to a water content of 105 mg/m³.</p> <p>The 6°C margin between the winter ground temperature and the curtailment limit is to allow for Joule Thompson cooling that may occur at regulator stations, plus a small additional safety factor because of the potential for (solid) hydrates to block regulators and pressure control sensing lines.</p> |

Injection temperature considerations

If the gas injection temperature is below 2° (i.e. Notify level) and the water content is above 73 mg/m³ (i.e. Notify level) the injection should be curtailed if the injection pressure is above 11,000 kPa.

If the gas injection temperature is below 2° (i.e. Notify level) and the water content is above 93 mg/m³ (i.e. Mitigate level) the injection should be curtailed if the injection pressure is above 7,000 kPa.

If the gas injection temperature is below -2° (i.e. Mitigate level) and the water content is above 73 mg/m³ (i.e. Notify level) the injection should be curtailed if the injection pressure is above 4,500 kPa.

The above is summarised in Section 18.

Water content / water dew point

| BOTH PARAMETERS TO BE MET | CONFIRM | NOTIFY | MITIGATE | CURTAIL | REINSTATE LEVEL |
|---|---------|--------|----------|---------|-----------------|
| Content (H₂O) Maximum. (mg/m³) | 65 | 73 | 93 | 105 | 73 |
| Dew point @ 15,000 kPa | -2° C | 0° C | 4° C | 6° C | 0° C |
| Excursion duration (minimums) | 10 | 10 | 30 | 30 | N/A |

The equivalent water dew point readings are shown for information only; monitoring is based on water concentration.

| | |
|---------------|---|
| Notifications | When the Notify level has been exceeded continuously for more than 10 minutes (or more than 10 minutes in any 30-minute period), affected parties will be notified according to AEMO notification protocols. The affected parties will also be notified when the Mitigate and Curtail limits are exceeded. |
| Mitigation | If the water content is over the Mitigate limit for more than three hours, then the injection will be curtailed. Mitigation steps may include: <ul style="list-style-type: none"> • Scheduled quantities may be adjusted down. • Allowing the Injecting Facility to change injection rate to assist in bringing plant under control. • The temperature settings of pre-heaters at pressure reduction stations may be increased to reduce the risk of the formation of ice or liquid water. • The gas retail businesses may choose to notify NGV refillers. |
| Curtailment | Once the curtailment limit has been exceeded for the specified time, the Injecting Party will be instructed to cease injection. Note also the curtailment criteria under mitigation above. |
| Reinstatement | The injection of gas can be reinstated once the gas quality is brought to within the Reinstate Level above. |

12 Hydrocarbon dew point

| | |
|-------------|--|
| Description | <p>The hydrocarbon dew point is the temperature at which hydrocarbon liquids begin to condense. A high hydrocarbon dew point may mean that liquid can collect and form waves or “slugs” of liquid which could travel along the pipeline.</p> <p>These slugs of liquid can potentially damage flow regulation and measuring equipment and may cause local loss of supply. Liquids may also pass into the distribution system and cause damage to consumers’ meters and appliances.</p> <p>The hydrocarbon dew point is a measure of the point at which hydrocarbon liquids start to form. It does not allow a prediction of the quantity of liquid that will condense at temperatures below the dew point.</p> <p>Hydrocarbon liquids also cause odourant removal from the gas phase. The presence of both hydrocarbons and odourant in the liquid phase can cause degradation of the rubber components of regulating stations.</p> <p>Short-term small excursions can be tolerated from a safety perspective provided the average levels are kept well within specification.</p> <p>There are relatively few purpose-built permanent liquid “slug catchers” in the DTS or at withdrawal points, so even relatively small quantities of liquid may create problems.</p> |
| Limits | <p>The curtailment limit of 5°C is based on a hydrocarbon dew point that is 7°C below Victoria’s winter ground temperature (12°C). The 7°C margin between the winter ground temperature and the curtailment limit is to allow for Joule Thompson cooling that may occur at regulator stations, which may cool the gas significantly below 12°C and that the actual dew point at pressures other than 3,500 kPa may be slightly higher.</p> <p>Note that the maximum dew point temperature (cricidentherm) may not be at the 3,500kPa pressure in AS4654.</p> <p>It should be noted that actual gas temperature might be significantly below the local ground temperature if there are pressure reduction stations upstream. This should be taken into account in the design of gas withdrawal and pressure reduction installations.</p> |

Injection temperature considerations:

If the gas injection temperature is below the hydrocarbon dew point (@3,500 kPa) temperature, the injection should be curtailed if the injection pressure is below 6,000 kPa.

The calculation of hydrocarbon dew point is not precise and the risk of liquid drop-out is high when the calculated hydrocarbon dew point and gas temperature are similar.

Hydrocarbon dew point

| | CONFIRM | NOTIFY | MITIGATE | CURTAIL | REINSTATE LEVEL |
|-----------------------------------|---------|--------|----------|---------|-----------------|
| Hydrocarbon dew point @ 3,500 kPa | 1.0° C | 2.0° C | 3.0° C | 5.0° C | 2.0° C |
| Excursion duration (minimums) | 10 | 10 | 30 | 30 | N/A |

| | |
|---------------|---|
| Notifications | <p>When the Notify level has been exceeded continuously for more than 10 minutes (or more than 10 minutes in any 30-minute period), affected parties will be notified according to AEMO notification protocols.</p> <p>The affected parties will also be notified when the Mitigate and Curtail limits are exceeded.</p> |
| Mitigation | <p>If the hydrocarbon dew point is over the Mitigate limit for more than three hours, then the injection will be curtailed.</p> <p>Mitigation steps may include:</p> <ul style="list-style-type: none"> • Scheduled quantities may be adjusted down. • Allowing the Injecting Facility to change injection rate to assist in bringing plant under control. • Retail businesses may choose to notify consumers likely to be affected by high hydrocarbon dew point [e.g. fuel cells, large gas engines]. • The temperature settings of pre-heaters at pressure reduction stations may be increased to reduce the risk of the formation of liquids. • Responsible parties may choose to monitor the operation of regulator stations likely to be affected. |
| Curtailment | <p>Once the curtailment limit has been exceeded for the specified time, the Injecting Party will be instructed to stop injections unless they are able to demonstrate that there is no safety hazard. The Injecting Party would need to show that the gas injected only contains quantities of liquids that could be handled safely within the transmission system.</p> <p>Note also the curtailment criteria under mitigation above.</p> |
| Reinstatement | The injection of gas can be reinstated once the gas quality is brought to within the Reinstate Level above. |

13 Total inerts maximum

| | |
|-------------|---|
| Description | <p>Inerts in natural gas under the Gas Safety (Gas Quality) Regulations are carbon dioxide (CO_2), nitrogen (N_2), helium (He), argon (Ar) and oxygen (O_2). Where a process gas chromatograph is used for measuring gas composition the total inerts is obtained by adding the mol % of the CO_2 and N_2 readings from the chromatograph. The N_2 reading will actually include the O_2 and Ar composition. Any helium content would have to be added separately. Mol % is essentially equivalent to the volume %.</p> <p>Note that for the purposes of this document and for consistency with the regulations, oxygen is classed as an “inert”.</p> <p>Inerts by themselves do not create a safety hazard. The specification for inerts is a method of controlling the levels of non-methane hydrocarbons such as ethane or propane. Limiting the total amount of inerts in a gas restricts the amount of non-methane hydrocarbons that can be present in the gas without exceeding the Wobbe Index limits. High levels of non-methane hydrocarbons may cause incorrect combustion and create soot in gas appliances.</p> |
| Limits | The level of inerts is relatively high compared to what has been distributed in Victoria in the past, which is why the Mitigate and Curtail limits are set only slightly above the specification (Notify) limit. |

Total inerts maximum

| | CONFIRM | NOTIFY | MITIGATE | CURTAIL | REINSTATE LEVEL |
|-------------------------------|---------|--------|----------|---------|-----------------|
| Inerts maximum (mol %) | 6.5% | 7.0% | 7.2% | 7.5% | 7.0% |
| Excursion duration (minimums) | 10 | 10 | 30 | 30 | N/A |

| | |
|---------------|--|
| Notifications | When the Notify level has been exceeded continuously for more than 10 minutes (or more than 10 minutes in any 30-minute period), affected parties will be notified according to AEMO notification protocols. The affected parties will also be notified when the Mitigate and Curtail limits are exceeded. |
| Mitigation | Mitigation steps may include: <ul style="list-style-type: none"> • Scheduled quantities may be adjusted down. • Allowing the Injecting Facility to change injection rate to assist in bringing plant under control. • Retailers could notify domestic consumers to not leave heaters unattended for extended periods. • Retailers could notify operators of industrial burners that burners might require adjustment to burn correctly and re-adjustment when gas quality returns to normal. • Retailers could notify manufacturing plants that use natural gas as a feedstock where high carbon dioxide or nitrogen levels may impact their processes. |
| Curtailment | Once the curtailment limit has been exceeded for the specified time, the Injecting Party will be instructed to cease injection. Note also the curtailment criteria under mitigation above. |
| Reinstatement | The injection of gas can be reinstated once the gas quality is brought to within the Reinstate Level above. |

14 Objectionable constituents

As stated in AS 4564, the gas shall not contain:

- a) Materials, dust, and other solid or liquid matter, waxes, gums, gum-forming constituents, and unsaturated or aromatic hydrocarbons to an extent which might cause damage to, or interference with the proper operation of pipes, meters, regulators, control systems, equipment or appliances.
- b) Unsaturated or aromatic hydrocarbons to an extent which causes unacceptable sooting.
- c) Other substances that cause damage to, or problems in the operation of, pipelines or appliances, or that cause the products of combustion to be toxic or hazardous to health, other than substances that are usually found in natural gas combustion products.

| | |
|---------------|--|
| Description | Solid and liquid substances can collect on meters, moving parts of compressors, valves, and pipe walls to cause inefficiencies and malfunctions. They can plug consumer's burners, extinguish pilots, and interfere with process equipment or can be hazardous to health. |
| Examples | Objectionable substances sometimes found in gas transmission pipelines include liquid hydrocarbons, compressor lubricating oils, amines and glycols from processing plants, mill scale, valve grease, and dust. Substances that are hazardous to health include halogens, halogenated hydrocarbons, PCBs (polychlorinated biphenyls), and mercury vapour. |
| Limits | There are no facilities to provide continuous monitoring of "objectionable constituents", so they are usually detected during regular inspections and maintenance by asset owners. The presence of objectionable constituents along the gas supply chain should be notified to AEMO as soon as practical. AEMO will notify all affected parties only after due notification by a participant or responsible person of the detection of any such objectionable constituents. Complaints by consumers can be taken as an indication that the quantity of objectionable constituent has exceeded the limit to an extent which causes problems. Limits for some objectionable constituents are contained in the AEMO "Gas Quality Standard – System Injection Points". |
| Curtailment | An Injecting Party that injects gas containing objectionable constituents to an unacceptable level will be instructed to cease injection. |
| Reinstatement | Reinstatement of a curtailed injection source will be based on rectification of the matters allowing the objectionable constituents to be injected. |

15 Gas odorisation

The Victorian Gas Safety (Gas Quality) Regulations require that gas must:

- (a) have an odour which is distinctive and unpleasant; and
- (b) have an odour level that is discernible at one-fifth of the lower explosive limit of the gas.

| | |
|------------------|--|
| Description | <p>Odorant (chemicals that have a distinct smell) are added to the normally odourless natural gas to facilitate the detection of leaks.</p> <p>While under-odorisation of natural gas creates a community safety risk, over-odorisation creates a community cost in attending to “nuisance” leak reporting.</p> <p>Odorants can sometimes lose their impact (fade) by absorption onto the walls of pipelines or by absorption in liquids present in the pipeline. Pipeline owners should allow for this during the commissioning of new pipelines and should ensure that gas exiting the pipeline is adequately odourised.</p> |
| Acceptable level | <p>The preferred gas odorisation is a blend of 70% tetrahydrothiophene (THT) and 30% tertiary butyl mercaptan (TBM) injected into the gas stream at a rate of 7 mg/m³ of gas. This gas odorisation regime has traditionally been considered adequate to meet the requirements of the Victorian Gas Safety (Gas Quality) Regulations.</p> <p>The preference is based on what has been used in the past as the odour is familiar to the community. Other odorant blends and injection rates are acceptable if they meet the requirements of the Victorian Gas Safety (Gas Quality) Regulations.</p> <p>At some sites, where gas previously withdrawn from the transmission system is re-injected, the odour levels are “topped up” to compensate for changes in odorant concentration associated with gas processing. At these sites specific odour alarm levels have been set to ensure adequate final odour levels.</p> <p>Odorant injection rates in the range of 7 to 14 mg/m³ of gas are acceptable; rates up to 23 mg/m³ (usually limited-term associated with “conditioning” new pipelines) are acceptable provided the injection is such that they do not create “nuisance” leak reporting. Blending of highly odoured gas with “normally” odoured gas reduces the likelihood of “nuisance” leak reporting.</p> |

Lower limits (under odorisation)

| | CONFIRM | NOTIFY | MITIGATE | CURTAIL | REINSTATE LEVEL |
|-------------------------------|---------|--------|----------|---------|-----------------|
| Odorant (mg/m ³) | 6.5 | 6.0 | 4.0 | 2.0 | 6.0 |
| Excursion duration (minimums) | 10 | 10 | 30 | 120 | N/A |

The above table does not cover “top up” odorisation.

Upper limits (over odorisation)

| | CONFIRM | NOTIFY | MITIGATE | CURTAIL | REINSTATE LEVEL |
|-------------------------------|---------|--------|----------|-------------------|-----------------|
| Odorant (mg/m ³) | 14.5 | 15.0 | 24.0 | See Total Sulphur | 15.0 |
| Excursion duration (minimums) | 10 | 10 | 30 | See Total Sulphur | N/A |

The above table does not cover limited term “conditioning” odorisation where higher limits may be approved for specific periods.

| | |
|----------------------|---|
| Notifications | <p>In the event of odorant injection equipment failure, or if the indicated odour injection for previously un-odorised gas falls below 6 mg/m³ (TBM/THT mix) or rises above 15 mg/m³ for more than 10 minutes, the organisation responsible for gas odorant injection will be notified. Similarly, if “top-up” odourisation falls outside the appropriate agreed levels the organisation responsible for gas odorant injection will be notified.</p> <p>If either of the above conditions persists for more than a further 10 minutes (or more than 10 minutes in any 30-minute period) the affected parties will be notified according to AEMO notification protocols.</p> |
| Mitigation | <p>Mitigation steps may include:</p> <ul style="list-style-type: none"> • Scheduled quantities may be adjusted down. • Gas transmission or distribution organisations may apply supplementary odorant “dosing” into the transmission or distribution pipelines. • Gas retail businesses may choose to notify gas consumers. |
| Curtailment | <p>Once the curtailment limit has been exceeded for the specified time, the Injecting Party will be instructed to cease injection to the extent possible consistent with system security. Other (odorised) supplies will be utilised and the under-odorised supply will be reduced to the maximum extent possible.</p> |
| Reinstatement | <p>The injection of gas can be reinstated once the odourisation process has been rectified.</p> |

SECTION B – (PART 2) Parameters Specified by AEMO

16 Mercaptan sulphur maximum

| | |
|-------------|---|
| Description | <p>This is an AEMO-approved specification only and relates to the smell of gas before odorant is added.</p> <p>Short periods of high mercaptan sulphur can be tolerated from a safety perspective. If the excursions are significant, increased “nuisance” gas leak reports can be expected unless odorant is reduced to compensate.</p> <p>Mercaptan sulphur is continuously measured only if initial measurements indicate that significant levels of mercaptan sulphur are present in the gas-producing geological formations.</p> |
| Limits | The limits are based on the likely impact on gas odourisation. |

Mercaptan sulphur maximum

| | CONFIRM | NOTIFY | MITIGATE | CURTAIL | REINSTATE LEVEL |
|--------------------------------------|---------|--------|----------|-------------------|-----------------|
| Sulphur maximum (mg/m ³) | 4.5 | 5.0 | 10.0 | See Total Sulphur | 5.0 |
| Excursion duration (minimums) | 10 | 10 | 30 | See Total Sulphur | N/A |

| | |
|---------------|--|
| Notifications | <p>When the Notify level has been exceeded continuously for more than 10 minutes (or more than 10 minutes in any 30-minute period), affected parties will be notified according to AEMO notification protocols.</p> <p>The affected parties will also be notified when the Mitigate and Curtail limits are exceeded.</p> |
| Mitigation | <p>Mitigation steps may include:</p> <ul style="list-style-type: none"> • Scheduled quantities may be adjusted down. • Allowing the Injecting Facility to change injection rate to assist in bringing plant under control. • Retail businesses may notify consumers known to be affected by sulphur compounds in the gas. For example: glass manufacturers. • Gas retail and distribution businesses may prepare for an increase in publicly-reported gas leaks. • Mitigation may involve reducing the injection of gas odorant but this should only be the case if the level of mercaptan sulphur is likely to remain relatively constant and the reduction should be based on the odour level of the mercaptan sulphur compounds. |
| Curtailment | High mercaptan sulphur is not a cause for curtailing injection on safety grounds by itself unless the total sulphur curtailment level is exceeded. |
| Reinstatement | The injection of gas can be reinstated once the gas quality is brought to within the Reinstate Level above. |

17 Temperature maximum

| | |
|-------------|--|
| Description | Prolonged high gas temperatures can have a harmful effect on pipeline steels (stress cracking), valve and regulator seals and components, and corrosion protection coatings, |
| Limits | The curtailment limit is based on a short-term excursion from the standard upper design limit. Some sections of pipework may be able to tolerate higher temperatures by design and the TPO may agree to higher limits being set for specific injection locations. The impact on withdrawal points downstream needs to be taken into account. |

Temperature maximum

| | CONFIRM | NOTIFY | MITIGATE | CURTAIL | REINSTATE LEVEL |
|-------------------------------|---------|--------|----------|---------|-----------------|
| Temperature maximum | 45.0°C | 50.0°C | 55.0°C | 60.0°C | 50.0°C |
| Excursion duration (minimums) | 10 | 10 | 30 | 30 | N/A |

| | |
|---------------|---|
| Notifications | When the Notify level has been exceeded continuously for more than 10 minutes (or more than 10 minutes in any 30-minute period), affected parties will be notified according to AEMO notification protocols. The affected parties will also be notified when the Mitigate and Curtail limits are exceeded. |
| Mitigation | The TPO can accept and/or mitigate the effects of high temperature depending on the pipeline materials. Mitigation steps may include: <ul style="list-style-type: none"> Allowing the Injecting Facility to change injection rate to assist in bringing plant under control. |
| Curtailment | Once the curtailment limit has been exceeded for the specified time, the Injecting Party will be instructed to cease injection. |
| Reinstatement | The injection of gas can be reinstated once the temperature is brought to within the Reinstate Level above or earlier if the TPO accepts the gas. |

18 Temperature minimum

| | |
|-------------|--|
| Description | <p>Low gas temperatures could have disastrous effects on pipeline steels and other materials. The curtailment limit is based on maintaining pipeline temperature above that likely to cause brittle failure.</p> <p>A related danger is that at temperatures below 0°C, ice can form on the exterior of pipelines and equipment. Ice on control equipment can result in unstable pressure regulation or operational failure of the transmission system components.</p> <p>Low temperature also increases the risk of hydrate (ice-like materials) formation inside the pipeline system.</p> <p>Low temperatures also increase the risk of hydrocarbon liquids forming in the pipeline especially if the hydrocarbon dew point exceeds the gas temperature.</p> <p>Short-term small excursions can be tolerated from a safety perspective provided the average levels are maintained within specification.</p> |
| Limits | <p>The curtailment limit is based on the maximum likely brittle/ductile transitions for pipeline steel. Some sections of pipework may be able to tolerate lower temperatures by design and the TPO may agree to lower limits being set for specific injection locations. The impact on withdrawal points downstream would also need to be taken into account.</p> <p>Lower injection temperatures will only be accepted by AEMO if there are corresponding agreements with the gas producer/injector to maintain water dew point (at 15,000 kPa) and hydrocarbon dew point (@3,500 kPa) more than 2°C below the minimum injection temperature.</p> <p>Considerations with respect to other gas quality parameters:</p> <ul style="list-style-type: none"> • If the gas injection temperature is below the hydrocarbon dew point (@3,500 kPa) temperature, the injection should be curtailed if the injection pressure is below 6,000 kPa. • If the gas injection temperature is below 2° (i.e. Notify) and the water content is above 73 mg/m³ (i.e. Notify) the injection should be curtailed if the injection pressure is above 11,000 kPa. • If the gas injection temperature is below 2° (i.e. Notify) and the water content is above 93 mg/m³ (i.e. Mitigate) the injection should be curtailed if the injection pressure is above 7,000 kPa. • If the gas injection temperature is below -2° (i.e. Mitigate) and the water content is above 73 mg/m³ (i.e. Notify) the injection should be curtailed if the injection pressure is above 4,500 kPa. The water content impacts are summarised in a table below. |

Temperature minimum

| | CONFIRM | NOTIFY | MITIGATE | CURTAIL | REINSTATE LEVEL |
|-------------------------------|---------|--------|-----------------|---------------|-----------------|
| Temperature minimum | 3.0°C | 2.0°C | -2.0°C | -10.0°C | 2.0°C |
| Excursion duration (minimums) | 10 | 10 | 1440 (24 hours) | 120 (2 hours) | N/A |

Maximum pressure before curtailment for combined water content and temperature excursions:

Curtail injection if above indicated pressure:

| | TEMPERATURE +2 TO -2 °C NOTIFY LIMIT | TEMPERATURE -2 TO -10 °C MITIGATE LIMIT |
|---|---|--|
| Water content 73 to 93 mg/m³ notify limit | 11,000 kPa | 4,500 kPa |
| Water content 93 to 105 mg/m³ mitigate limit | 7,000 kPa | All pressures |

| | |
|----------------------|--|
| Notifications | When the Notify level has been exceeded continuously for more than 10 minutes (or more than 10 minutes in any 30-minute period), affected parties will be notified according to AEMO notification protocols. The affected parties will also be notified when the Mitigate and Curtail limits are breached. |
| Mitigation | The TPO may be able to accept and/or mitigate the effects of low temperature depending on the pipeline materials and current levels of water and hydrocarbon dew point. Mitigation steps may include: <ul style="list-style-type: none"> • Allowing the Injecting Facility to change injection rate to assist in bringing plant under control. |
| Curtailment | Once the curtailment limit has been exceeded for the specified time, the Injecting Party will be instructed to cease injection. |
| Reinstatement | The injection of gas can be reinstated once the temperature is brought to within the Reinstate Level above, or earlier if the TPO accepts the gas. |

Appendix A - Summary of Gas Quality Limits

| PARAMETER | AEMO INJECTION LIMIT | CONFIRM (10 MINUTES) | NOTIFY (10 MINUTES) | MITIGATE (CURTAIL IF MORE THAN 3 HOURS) | CURTAIL | REINSTATE LEVELS |
|---|---|----------------------|---------------------|---|---------------------|-------------------|
| REQUIRED BY GAS SAFETY (GAS QUALITY) REGULATION | | | | | | |
| Wobbe maximum (MJ/m ³) | 52.0 | 51.5 | 52.0 | 52.5 30 minutes | 53.5 30 minutes | 52.0 |
| Wobbe minimum (MJ/m ³) | 46.0 | 47.0 | 46.0 | 45.0 30 minutes | 44.0 30 minutes | 46.0 |
| HHV maximum (MJ/m ³) | 42.3 | 41.8 | 42.3 | 42.8 30 minutes | 44.3 30 minutes | 42.3 |
| Oxygen maximum (mol %) | 0.2% | 0.15% | 0.2% | 2% 30 minutes | 5% 30 minutes | 2% |
| Hydrogen sulphide (H ₂ S) maximum (mg/m ³) | 5.7 | 4.5 | 5.7 | 5.8 30 minutes | 10 30 minutes | 5.7 |
| Total sulphur maximum (mg/m ³) | 50 | 45 | 50 | 100 30 minutes | 200 30 minutes | 50 |
| Water dew point @ 15,000 kPa | 0.0°C | -2.0°C | 0.0°C | 4.0°C 30 minutes | 6.0°C 30 minutes | 0.0°C |
| Water content (H ₂ O) maximum (mg/m ³) | 73 | 65 | 73 | 93 30 minutes | 105 30 minutes | 73 |
| Hydrocarbon Dew Point @ 3,500kPag | 2°C | 1°C | 2°C | 3°C 30 minutes | 5°C 30 minutes | 2°C |
| Total inerts maximum (mol %) | 7.0% | 6.5% | 7.0% | 7.2% 30 minutes | 7.5% 30 minutes | 7.0% |
| Objectionable constituents | Refer to Objectionable Constituents section | | | | | |
| Gas odourisation minimum (mg/m ³) | 7 | 6.5 | 6.0 | 4.0 30 minutes | 2.0 120 minutes | 6.0 |
| Gas odourisation maximum (mg/m ³) | 14 | 14.5 | 15.0 | 24 30 minutes | See Total Sulphur | See Total Sulphur |
| REQUIRED BY AEMO | | | | | | |
| Mercaptan sulphur maximum (mg/m ³) | 5.0 | 4.5 | 5.0 | 10.0 30 minutes | See Total Sulphur | 5.0 |

| Temperature maximum | 50°C | 45°C | 50°C | 55°C 30 minutes | 60°C 30 minutes | 50°C |
|---|-------|-------|-------|--------------------|--------------------|-------|
| Temperature minimum (unless HCDP or H ₂ O dew point is off specification) | 2.0°C | 3.0°C | 2.0°C | -2.0°C 24 hours | -10.0°C 2 hours | 2.0°C |

Appendix B - Notification Protocols

Affected parties are notified in line with AEMO procedures and protocols.

The list of parties that may be affected and need to be notified is shown in Schedule B1.

Contacts are outlined in the Operations Centre contact lists.

Security of supply notifications arising out of gas quality issues are described in the security of supply procedures and policies.

Schedule B1 – Affected parties

As at April 2014:

| CATEGORY | ORGANISATION |
|-------------------------------------|---|
| Management | AEMO management. |
| Safety regulators | Energy Safe Victoria (ESV) |
| Transmission pipeline owners (TPOs) | For example: APA GasNet (APA Group) or its successors |
| Interconnected pipeline owners | For example: Jemena, APA New South Wales, SEA Gas, Gas Pipelines Victoria Pty Ltd. |
| Injecting facility | Any <i>producer, interconnected transmission pipeline service provider or storage provider</i> injecting gas directly or indirectly into the gas transmission system. For example: ESSO-BHP, Iona Underground Gas Storage, BassGas. |
| Distributors | Any distribution company connected to the DTS (including interstate distribution companies). |
| Storage provider | LNG or underground storage operator. For example: Iona Underground Gas Storage. |
| Retailers and market customers | Any company registered with AEMO as a <i>market participant</i> . |

All the above parties are notified in the event of a gas quality excursion even though a particular event may only affect a smaller sub-group. It is not feasible for AEMO to reliably predict which parties may be eventually affected.

Appendix C - Recovery from injection curtailment

Recovery from an episode of significant off-specification injection will require careful control and cooperation from all participants in the wider gas industry.

Reinstatement of supply needs to be managed in coordination with the gas supply organisation to ensure minimal impact from *off-specification gas* already in the DTS.

The steps to be taken for recovery from injection curtailment will depend on the duration and effects of the curtailment and will require AEMO management intervention.