

Code of Practice

For leak management, detection and reporting for petroleum operating plant

Petroleum and Gas Inspectorate

Version 4

1 September 2018

Table: Document history

Version number	Date of publication	Date of effect	Key changes
V1	April 2011	15 April 2011	
V2	23 June 2011	1 July 2011	Inclusion of landholder notification requirements
V3	1 July 2017	1 September 2017 ¹	Scope expanded from wells to include all exploration and production facilities
V4	1 September 2018	1 September 2018	Associated water removed from scope, reporting requirements changed and revised to align with the commencement of Petroleum and Gas (Safety) Regulation 2018

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¹ Version 3 was not referenced in the Petroleum and Gas (Production and Safety) Regulation 2004.

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1 Overview

1.1 Background

Petroleum wells, gathering systems and their associated processing facilities are rated as low risk for leaks due to rigorous design standards, robust safety obligations and strong governance programs. While petroleum operators have their own operating procedures for leak detection and classification, this Code of Practice provides a consistent best practice minimum standard for identifying, classifying, rectifying and reporting leaks.

Petroleum is extracted from an increasing number of unmanned wells connected to a network of underground gathering pipeline systems. The petroleum is then processed, compressed and dehydrated before being piped to market via cross country transmission pipelines. Liquid petroleum products may also be trucked to other processing facilities. As wells and gathering systems are generally located on grazing or cultivated land, land owners and occupiers have raised concerns about how the petroleum industry identifies and manages potential petroleum leakage at their facilities.

The *Petroleum and Gas (Production and Safety) Act 2004* (P&G Act) requires petroleum operators to apply a rigorous, risk based approach to the safety of operations and possess a comprehensive asset integrity regime to minimise risks associated with the development and operations of petroleum infrastructure. Compliance with this legislation will result in an extremely low level of risk from leaks at petroleum operating plant.

The reporting resulting from this Code will ensure that the Petroleum and Gas Inspectorate, as the safety and technical regulator, is appropriately informed and the petroleum industry's performance on petroleum leak management is appropriately measured.

1.1.1 Other relevant industry standards

There is currently no standard specifically for the identification and management of leaks on petroleum operating plant.

However, *AS/NZS: 4645.1:2008 'Gas distribution network - Network management'* standard describes operational and leakage management obligations for natural gas distribution networks in CBD and metropolitan areas of all Australian and New Zealand cities. This urban environment provides greater risks and consequences for leaks than the rural gas field environment, and sets a high benchmark for the management of leaks for the production industry.

Therefore, this standard has been adopted as the basis for this Code, as it represents the most relevant and stringent standard to apply to identifying, classifying and managing gas leaks in rural gas fields. This Code has been drafted to meet or exceed the requirements of the *AS/NZS: 4645.1:2008 'Gas distribution networks Part 1: Network management'* standard.

Similarly, this Code adopts a conservative approach to the classification of reportable leaks-

A standard leak measuring methodology has been adopted for the industry under this Code.

2 Purpose and application

This Code standardises the detection, remediation and reporting of petroleum leaks from well site facilities, gathering systems, processing plants and places particular emphasis on community safety.

It is designed to be considered and used in conjunction with the petroleum operator's internal risk assessment processes and operating procedures under their safety management systems. This Code outlines a standard process for monitoring, identifying and managing petroleum leaks from production facilities in Queensland and ensures that leaks associated with petroleum operating plant are identified, responded to and classified in a consistent manner, and that their facilities are monitored effectively by the petroleum operators.

Petroleum is defined under s.10 of the P&G Act.

This Code will help to ensure that:

- a) risk to the public and production workers is managed to a level that is as low as reasonably practicable
- b) regulatory and applicable Australian Standard requirements, as well as the operator's internal requirements are understood and implemented
- c) the life of production operating plant is managed effectively through timely leak repair and periodic survey.

2.1 Objective

The objective of this Code is to set a standard:

- a) methodology to detect petroleum leaks
- b) procedure to classify and action reportable leaks
- c) notification procedure to the Petroleum and Gas Inspectorate for reportable leaks.

2.2 Application

The Petroleum and Gas (Safety) Regulation 2018 (P&G Regulation) requires operators of petroleum operating plant (referred to in this Code as 'petroleum operators') to comply with this Code in assessing, detecting, remediating and reporting gas leaks at petroleum operating plant. The P&G Regulation defines petroleum operating plant as well site facilities, gathering systems and processing plants located on petroleum tenure.

2.3 General safety

Petroleum is a safe energy source that is a by-product of the natural conversion of plant material to coal. Natural gas which is the main petroleum component produced in Queensland, can be used as a fuel in heaters, stoves and hot water systems in homes and businesses.

Methane is non-toxic and is only flammable when the gas concentration is between 5% and 15% of the total gas/air mixture.

Natural gas is lighter than air, meaning it will rise naturally and quickly dilute and dissipate into the air in an outdoor environment. In addition to its application in domestic and business environments, natural gas is safely used in many other areas including transport fuels and as feedstock or fuel for industrial plants.

Petroleum wells, gathering systems and processing facilities are constructed to Australian or international standards or codes of practices where applicable. These plant are pressure tested prior to commissioning to verify the integrity of the plant and the petroleum operators conduct routine monitoring to ensure ongoing safe operation of the operating plant.

This Code describes the actions that petroleum operators shall undertake for all petroleum leaks. This covers all types of petroleum that is produced including oil, condensate and gas.

For methane to reach a flammable state, it must first form a concentration level of between 5% and 15% of gas in air. A typical potential gas leak at a well or processing facility is likely to emanate from a gas flange or screwed joint.

The lower explosive limit (LEL) or lower flammable limit (LFL) of a combustible gas describes the smallest amount of gas that supports a self-propagating flame when mixed with air (or oxygen) and ignited. In gas-detection systems, the amount of gas present is specified as a percentage (%) LFL.

Zero percent (0%) LFL denotes an atmosphere that is free from a combustible gas. One hundred percent (100%) LFL denotes an atmosphere in which the gas concentration has reached its lower flammable limit. The relationship between percentage LFL and percent by volume differs from gas to gas (for example liquid petroleum gas (LPG) has a different LFL to CSG).

In addition, the actions in this Code are required to be undertaken by petroleum operators for petroleum leaks.

Appendix 1 provides a comparison of the properties of CSG compared with LPG.

2.4 Definitions

Definitions for terms used in this Code are outlined in *Appendix 2 and 3*.

3 Code operational requirements

At a minimum, petroleum operators shall comply with the following requirements to ensure that risks from gas leaks at petroleum operating plant are reduced to as low as reasonably practicable.

3.1 Risk assessment

Petroleum operators shall carry out a risk assessment to identify the risks posed by leaks from their operating plant and implement appropriate actions to reduce those risks to as low as reasonably practicable as required under the P&G Act.

As part of their safety management system (SMS) as required under the P&G Act, each petroleum operator shall develop a risk-based management system (Leak Management Plan) for leaks from wells, gathering systems and processing facilities, to ensure that leaks are:

- a) identified
- b) classified
- c) controlled (e.g. isolated, rectified, monitored) as determined by considering the risk and determining the appropriate controls; and
- d) reported.

Note: there shall be systems in place, and initiated, to ensure the control actions are completed.

This Code does not remove the obligation to adequately assess and manage risk.

3.2 Inspection frequency and procedure

Petroleum operators shall ensure routine visits to operational well sites, gathering systems and processing facilities are undertaken on a regular basis in accordance with their operating and maintenance plans.

Petroleum operators shall at a minimum:

- a) ensure that petroleum production operators carry and monitor personal calibrated gas detectors during every routine operational visit to well sites, gathering systems and processing facilities
- b) ensure that petroleum production operators are properly trained and competency-assured to identify leaks detected by their personal gas monitors, and to take appropriate actions in line with this Code, during routine operational visits to operating plant
- c) ensure that petroleum production operators use calibrated gas monitors to investigate and classify any audible/visible leaks at petroleum operating plant if safe to do so, and that the appropriate actions to manage those leaks are taken in line with this Code
- d) ensure formal leak inspections are conducted on the minimum frequencies detailed in the table
- e) undertake leak inspections of individual operating plant at an increased frequency as determined by the risk assessment and in consideration of previous audit/inspection findings for those specific facilities.

Table: Leak inspection

Facility or system	Leak inspection frequency
Petroleum well - subsurface	5 years
Above ground facility - Well pad equipment	5 years
Gathering system - HPV	5 years
Gathering system - Valve manifold	5 years
Gathering system - LPD	5 years
Processing plant	5 years
Gathering system - subsurface	5 years

3.3 Standard leak classification

The following standard leak classification definition has been adopted and requires reportable leaks to be notified to the Petroleum and Gas Inspectorate.

A 'reportable leak' is defined in Appendix 2.

An 'internally reportable leak' is defined in Appendix 3.

3.4 Standard leak detection methodology

3.4.1 Above ground facilities.

A suitably trained and competent petroleum production operator shall survey for leaks on above ground facilities including well pads, processing facilities and HPV, LPD and valve manifolds on gathering systems, by using a method that is approved by the petroleum operator.

Should an indication of gas be found and it is safe to do so, the petroleum production operator will:

- a) record the % LFL or % methane sustained for 15 seconds
- b) comply with the detector's manufacturer's instrument instructions for retest (e.g. a purge in clean atmosphere), then retest at a distance of 150 mm from the leak source in all directions to determine the highest leak zone (potentially immediately above and in a downwind situation from the source)
- c) record the highest confirmed % LFL of gas sustained for 15 seconds with the gas probe held at 150 mm from the potential source; and
- d) clearly identify and record the source of the leak.

Should an indication of liquid petroleum be found, the petroleum production operator will:

- a) record the estimated volume of liquid leaking or leaked over time; and
- b) clearly identify and record the source of the leak .

Note: if the leak is too large or not safe to measure it will be assumed that the leak is above the reportable threshold level for reporting.

3.4.2 Gathering system – sub surface piping

A suitably trained and competent petroleum production operator shall survey for leaks on gathering systems by using a method that is approved by the petroleum operator.

Should an indication of gas be found and it is safe to do so, the petroleum production operator will:

- a) record the % PPM or % LFL sustained for 15 seconds; and
- b) clearly identify and record the source of leak.

Should an indication of liquid petroleum be found, the petroleum production operator will:

- a) record the estimated volume of liquid leaking or leaked over time; and
- b) clearly identify and record the source of leak.

Note if the leak is too large or not safe to measure it will be assumed that the leak is above the reportable threshold level for reporting.

3.4.3 Petroleum well – subsurface components

A suitably trained and competent petroleum production operator shall survey for leaks (subsurface gas migration) on petroleum wells by using a method that is approved by the petroleum operator. Should an indication of subsurface migration be found, the petroleum production operator will engage the petroleum operator to undertake a leak path assessment. This assessment will be based on the petroleum operator interpretation on information such as:

- a) annulus pressure build up rate
- b) annulus fluid properties
- c) annulus gas samples
- d) wellhead mechanical integrity
- e) tubular properties; and
- f) formation properties.

3.4.4 High point vent releases

Petroleum gathering systems in CSG developments are generally installed with high point vents (HPV) at key locations. These HPVs are designed to release small quantities of gas when a buildup occurs in the gathering system. HPVs are not designed to release large quantities of gas over extended periods of time.

3.5 Tester and instrument certification

All gas leak surveys will be conducted by trained personnel using industry-accepted gas detection instruments calibrated in accordance with the manufacturer's requirements. Gas detectors shall be maintained and tested in accordance with manufacturer's instructions, and be capable of testing to a low reading of 1% LFL and have sensitivity of +/-0.5% LFL for the above ground facilities and to 10 PPM for

sub surface gathering systems.

3.6 Remediation and notification

3.6.1 Reportable leaks

In the event that a petroleum operator detects a *reportable leak* at a petroleum site, the operator shall:

1. Comply with the petroleum operators safety management system requirements for risk assessment and emergency response;
2. For all reportable leaks:
 - a) Immediately establish an exclusion zone around the leak and impose appropriate restrictions on access to the exclusion zone, along with any other necessary immediate controls.
 - b) Immediately notify any leaks to the Petroleum and Gas Inspectorate via their 24/7 emergency numbers (*see Appendix 4*).
 - i. This notification shall include the date of identification, nature and level of leak, operating plant site name, number and location as well as initial steps taken to minimise the risk.
 - ii. The leak shall be repaired or made safe as soon as practicable immediately after detection.
 - c) Immediately notify the land owner or occupier of the property on which these leaks are occurring if the leak cannot be repaired immediately and is likely to impact any of the land owner or occupier facilities or activities.

Note: Steps 2a and step 2bii take priority over steps 2bi and 2c and complying with steps 2bi and 2c shall not compromise, impair or delay the operator's actions to immediately make the site safe and establish exclusion zones.
3. Ensure that the gas leak is isolated, repaired (if possible), contained or otherwise made safe within 48 hours of detection of the leak.
4. Notify the Petroleum and Gas Inspectorate in writing within 2 business days of the detection of any leak within the reportable leak range (*see Appendix 2*). This notification is using the prescribed incident process detailed in the P&G Regulation and shall include the date of identification, nature and level of leak, site name, number and location.
5. In the event of the 48 hour repair deadline being unachievable, the petroleum operator shall notify the Petroleum and Gas Inspectorate of the reason for the delay and provide a target date for completion of the work. Remediation work must be conducted as follows:
 - a) Only commence work after a suitable risk assessment has been undertaken and relevant safety procedures are followed including consideration of all the required Personal Protective Equipment (PPE) and emergency response materials.
 - b) For leaks identified on well equipment - higher order controls, such as containment by repair, must be implemented wherever possible.

- c) For leaks identified on well casings or adjacent to the well casing (where a work over rig is necessary to affect repair) - determine whether the leak requires immediate repair, or whether the risk can be adequately managed via other control measures until a work over of the well is scheduled for normal operational reasons. The risk assessment to determine the above shall consider the location of the well, likely access to the well from landholders or the general public, and landholder/community concerns in relation to the leak.
 - d) For leaks identified on gathering systems (where an excavation is necessary to affect repair) - determine whether the leak requires immediate repair, or whether the risk can be adequately managed via other control measures until a planned excavation can be undertaken. The risk assessment to determine the above shall consider the location of the site, likely access to the site from landholders or the general public, and landholder/community concerns in relation to the leak.
6. Provide a written close-out report to the Petroleum and Gas Inspectorate within 5 business days of the remediation of the leak, specifying the date of identification, nature and level of leak, location and name of the operating plant, and the rectification actions taken.
 7. If remediation is delayed more than 7 business days from the identification of the leak an update shall be provided to the Petroleum and Gas Inspectorate. The final close out report shall be provided when all work is completed.

Written close out reports and any update reports will be made via email (PGIHotline@dnrme.qld.gov.au)

The Petroleum and Gas Inspectorate may, upon review of the report and risk assessment, require further information or action in accordance with its enforcement policy and regulatory role.

3.6.2 Liquid petroleum reportable leaks

Liquid petroleum reportable leaks may also be required to be reported to Department of Environment and Science (DES) in line with the production company's environmental approvals.

3.6.3 Extensions

If a risk assessment determines that the risks of immediately repairing a leak exceed the risk posed by the leak, this can be considered as grounds for extension of the 48 hour remediation period, provided that other measures to mitigate the risk are undertaken (e.g. ensuring no ignition sources or personnel are permitted in the exclusion zone). The Petroleum and Gas Inspectorate shall be notified (before the expiry of the 48 hour remediation period) of the proposed delay.

3.6.4 Internally reportable leaks

In the event that an operator detects an *internally reportable leak* at any petroleum operating plant, the operator shall promptly respond in accordance with the actions specified in the relevant operator's leak management plan and other safety management plan requirements.

3.6.5 Protection of petroleum site facilities

Appropriate signage, barriers and/or security fencing to isolate the petroleum operating plant shall be in place for all petroleum facilities as determined by the petroleum operators risk assessment and management. The risk assessment shall be consistent with *AS/NZS 60079 'Explosive atmospheres' Part 10.1:2009* and will consider:

- a) risks posed by third parties and the general public based on proximity of the petroleum site facilities, the ownership of land, and the accessibility of the site facilities to the general public; and
- b) the magnitude of the risk posed by the petroleum site facilities, which may be dependent on the type of facilities installed at these sites and the pressure, flow rate and composition of the gas contained by the facilities.

In the event a gas leak cannot be isolated, repaired (if possible), contained or otherwise made safe within 48 hours of detection of the leak barrier fencing shall be installed and placed no closer than the appropriate classified hazardous area zone.

4 Review of this Code

This Code will be subject to review and revision every 24 months or in the event of significant change to operations or regulatory requirements.

Appendix 1 — Gas comparison table

The table below compares the specific gravity, energy content and the PPM (parts per million) values corresponding to 100%, 10%, 5% and 1% LFL readings for CSG (methane) and LPG respectively.

The table provides a comparison of the different measurement units (LFL and PPM) and demonstrates that compared to LPG, which is a gas in common domestic use, CSG/methane represents a much lower risk although both gases when managed appropriately are safe to use.

For example, the gravity for CSG/methane is much less than one, indicating that methane will rise and disperse into the atmosphere when released and will not form pools at ground level as in the case of LPG.

The heating value of LPG is much higher than CSG/methane, meaning LPG emits more energy per cubic metre of gas when it is burnt.

The PPM values indicate that LPG has a greater risk of flammability even at substantially lower levels of gas concentration in air.

This table is for informative purposes only.

Table: Gas comparison

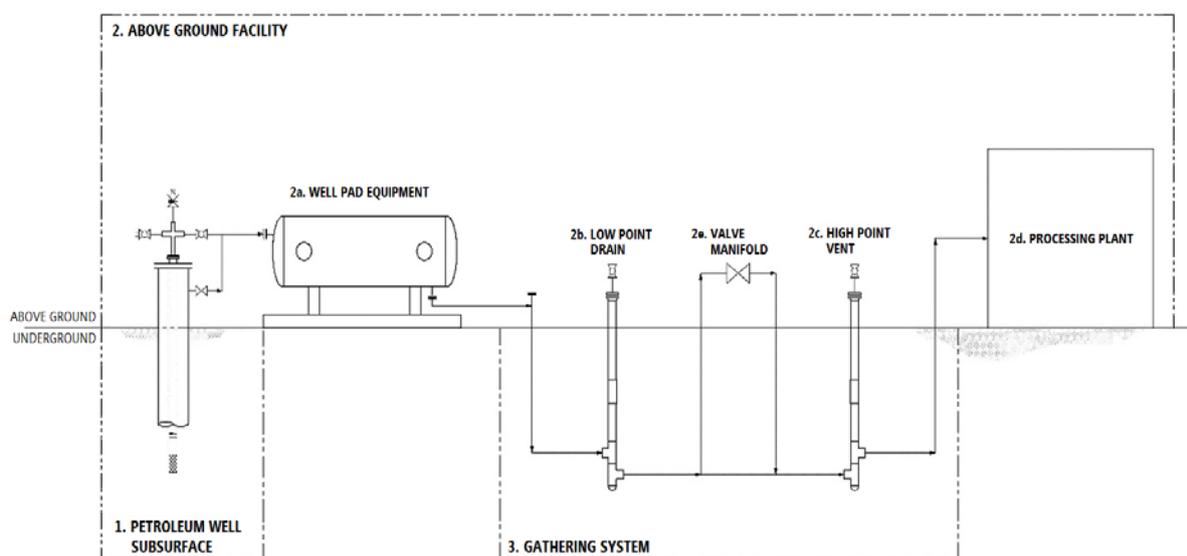
Gas	Specific Gravity ^{2,3}	Heating Value (mJ/m ³) ^{3,4}	PPM at LFL	PPM at 10% LFL	PPM at 5% LFL	PPM at 1% LFL
Methane (CSG)	0.554	38.7	53,000	5,300	2,650	530
LPG (typical)	1.609	95.5	21,000	2,100	1,050	210

² Specific gravity is the density of the gas relative to air. Values greater than one indicate that the gas is denser than air and can accumulate at ground level to form pools. Values given are at normal atmospheric temperature and pressure — 20°C and 1 atmosphere respectively.

³ Values in columns 2 and 3 are an average calculated from maximum and minimum Australian pipeline quality natural gas specifications.

⁴ Approximate gross heating value.

Appendix 2 — Reportable leak definition



REPORTABLE LEAK IS DEFINED AS:

1. PETROLEUM WELL SUBSURFACE
2. ABOVE GROUND FACILITY
 - 2a. WELL PAD EQUIPMENT
 - 2b. LOW POINT DRAIN (LPD)
 - 2c. HIGH POINT VENT (HPV)
 - 2d. PROCESSING PLANT
 - 2e. VALVE MANIFOLD
3. GATHERING SYSTEM

A reportable leak is defined as:

For above ground petroleum facilities and gathering systems – subsurface pipelines

- a) A leak due to an unplanned release from an above ground petroleum facility that, at a measurement distance of 150 mm immediately above (and downwind) and surrounding the leak source in an open air environment above ground position; gives a sustained LFL reading greater than 50% of LFL.
- b) A leak due to an unplanned release from a gathering system - subsurface pipeline that, at ground level; gives a sustained LFL reading greater than 5% of LFL (2,650 PPM) for a 15 second duration.
- c) A liquid petroleum (condensate / oil) loss of containment that exceeds 200 litres of hydrocarbons.

Note - leaks identified during commissioning or bringing equipment back into service are not classified as reportable leaks.

Note - if the leak is too large or not safe to measure it will be assumed that the leak is above the reportable threshold level for reporting.

For petroleum wells – subsurface components

- a) A leak to the subsurface environment that is confirmed to have been:
 - i. caused by an integrity breach of casing and/or cement; and
 - ii. lead to an exceedance of the Maximum Allowable Surface Pressure (MAASP); and
 - iii. resulted in gas migration to the environment (surface or subsurface).

Note - The MAASP is the greatest pressure that an annulus can contain without compromising the integrity of any barrier elements of that annulus. This includes any exposed open-hole formations.

For high point vents on gathering systems

- a) A release from a high point vent that is continuously releasing gas for an extended period of time.

For all locations

- a) The following incidents/circumstances also fall under the definition and require petroleum operators to notify the Petroleum and Gas Inspectorate.
 - i. a petroleum release reported by the emergency services or a public authority;
 - ii. a petroleum release in a location that may receive media, government or public interest attention;
 - iii. a petroleum release resulting in an incident involving fire;
 - iv. a petroleum gas release with the potential for gas to enter any building or confined space.

Note - These leaks can be smaller than the sizes detailed above.

Appendix 3 — Definitions

Term	Definition
Internally reportable leak	Any leak of gas from a petroleum operating plant that falls outside of the definition of reportable leak. These leaks will be subject to reporting procedures and rectification treatment specified by each Petroleum operator's procedures and risk based assessments.
Petroleum operator	The operator of petroleum operating plant.
Leak management plan	<p>A plan that is part of the petroleum operator's safety management plan for leaks from petroleum operating plant to ensure that leaks are:</p> <ul style="list-style-type: none"> a) identified b) classified c) controlled (e.g. isolated, rectified, monitored) as determined by considering the risk and determining the appropriate controls; and d) reported <p><i>Note: there shall be systems in place and initiated to ensure the control actions are completed.</i></p>
Routine operational visit	<p>A routine check or visit by production operators to complete an operational check or complete planned or unplanned maintenance. These visits can include normal operational functions for example checking filters, drains etc.</p> <p>Petroleum production operators shall carry and monitor personal calibrated gas detectors during every routine operational visit to wells and processing site facilities.</p>
Leak inspection	A formal leak inspection of the petroleum operating plant. This inspection is required by the petroleum operator's asset integrity process and should be completed by a competent person and would make observations on the integrity of existing petroleum operating plant. This inspection will include (as a minimum), a comprehensive leak survey of all components of the petroleum operating plant.
Field technician	Any person involved in the operations and maintenance of petroleum operating plant.
Liquid petroleum	Petroleum that is transported from a petroleum well to a processing facility in a liquid phase excluding associated water.

Appendix 4 — Petroleum and Gas Inspectorate contact details

Telephone reporting

The Queensland Government's Petroleum and Gas Inspectorate emergency advice and notification hotline for petroleum or fuel gas incidents is:

1300 910 933

This is a 24/7 hotline number and is to be used to report petroleum gas leaks via telephone.

Reporting in writing

The email address to be used for reporting petroleum gas leaks in writing to the Petroleum and Gas Inspectorate is:

PGIHotline@dnrme.qld.gov.au