



Resources Safety & Health
Queensland

Guideline for operating plant - Biogas

RSHQ - Petroleum and Gas Inspectorate

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What is biogas?

Biogas is generated through the natural process of bacterial decomposition (anaerobic digestion or fermentation) of organic materials such as biomass, manure, sewage, general waste, septic tanks, green waste, and energy crops.

Biogas contains primarily methane, carbon dioxide and water but other compounds may also be present in low amount or as trace elements depending on the type of feedstock being digested. Biogas produced by the biodegradation of general waste (typically referred to as 'landfill gas') is flammable and may contain harmful inorganic and organic components. Exposure to these pollutants can result in serious adverse health effects and in some cases can be fatal.

Biogas is gas produced by anaerobic digestion of organic matter, gasification of biomass or power to gas from biomass sources and without further upgrading or purification (ISO 20675: 2018)

Biomethane is methane-rich gas with the properties similar to natural gas derived from biogas produced by anaerobic digestion or gasification or from power to gas by upgrading (ISO 20675: 2018)

Depending on the source, biogas can include:

- Methane (50-85%)
- Carbon dioxide (5-50%)
- Hydrogen (0-1%)
- Hydrogen sulphide (0-3%)
- Nitrogen (0-5%)
- Oxygen (0-2%)

Requirements

The *Petroleum and Gas (Production and Safety) Act 2004* (the Act) and subordinate legislation regulate the safe operation and management of biogas or biomethane operating plant. The extent of the operating plant is the place or part of the place associated with the activities of collecting, transporting, or using of biogas or biomethane. This includes any equipment required to conduct these activities.

Requirements relevant to biogas / biomethane activities include:

- giving the chief inspector notice of statutory position holders.
- giving the chief inspector notice of commissioning and decommissioning of plant.
- making, implementing, and maintaining a safety management system (SMS) for each stage of the plant.
- ensuring gas devices are approved as required under the Act.
- ensuring installers are licensed or authorised under the Act or otherwise assessed as competent under the SMS.
- compliance with relevant safety requirements under the Act or its subordinate legislation.

These requirements are outlined in more detail in the following sections.

Operator

Under the Act the 'operator' is the person (individual or corporation) responsible for managing and ensuring safe operation of the biogas / biomethane operating plant. Typically, the operator will be the legal entity conducting the business or undertaking.

When the operator is a corporation, an individual is to be nominated as an 'operator's representative' for giving and receiving information under the Act. This facilitates communications between the operating plant entity and the Petroleum and Gas Inspectorate (PGI).

What are the operator's obligations?

The Act requires the operator to make, implement, and maintain an SMS that complies with the Act for each stage of the plant. The operator must not begin a stage of the plant unless the operator has made the SMS for that stage. The SMS does not need to be submitted or approved by the PGI.

Where there are separate entities conducting biogas activities, each activity is considered operating plant and each operator must have an SMS for their activity.

Example *Where biogas is produced by one company and the use of gas (e.g., power generation) is managed by another, then they are separate operating plant, and each operator is required to make, implement and maintain an SMS that complies with section 675 of the Act.*

The operator of a biogas or biomethane operating plant must give the chief inspector an information notice about commissioning or decommissioning of the operating plant. The information notice must be given at least 20 business days before commissioning and no later than 20 business days after decommissioning.

Executive Safety Manager

Section 687 of the Act provides that the executive safety manager (ESM) of an operating plant is:

- a) the operator, if the operator is an individual or
- b) the senior managing officer of the corporation or organisation responsible for the management and safe operation of the operating plant.

'Senior managing officer, of a corporation or organisation', means the person in Australia who is the most senior officer (however called) of the corporation or organisation in Australia responsible for managing the corporation or organisation. This is usually the most senior person responsible for managing the organisation such as the Chief Executive Officer.

What are the ESM's obligations?

The ESM must:

- give the chief inspector an information notice stating who is the ESM, the operator and if the operator is a corporation, the operator's representative. This is to be done within 10 business days after commencement or any time the holders of these positions change
- ensure the operator of the biogas / biomethane operating plant has made or adopted an SMS for each stage (commissioning, operation, maintenance or modification, decommissioning)
- ensure the operator has made the SMS after consulting with workers at the plant and
- approve the SMS before it is put into effect and ensure it is implemented to effectively manage risks associated with the plant.

Site Safety Manager

If the SMS for a biogas / biomethane operating plant states that a site safety manager (SSM) is to be appointed, the operator must appoint an appropriately qualified person as an SSM. An SSM would be expected for any site where multiple persons are working on a regular basis. If an SSM is not appointed, the chief inspector can direct the operator to appoint one or more.

What are the site safety manager's obligations?

The SSM must ensure:

- each person who enters the site is given an appropriate induction.
- each person at the site complies with standard operating procedures, the emergency response procedure, and other measures necessary for the safety of the site and the person.
- each person at the site performs their functions safely and follows standard operating procedures for the plant.
- necessary first aid, safety and other equipment is available and maintained.
- relevant staff are trained in first aid and general safety procedures.

Safety Management System

The operator must have an SMS that complies with section 675 of the Act before the operating plant is commissioned or operated. Australian Standards are available to assist in meeting the content requirements of an SMS e.g. AS/NZS ISO 45001.

If you already have an SMS, there is no need to create a new one provided the SMS addresses the requirements in section 675 of the Act. It will be helpful to document your mapping of the existing system against the elements in section 675 and address any gaps.

Risk assessment

A key element of the SMS for biogas / biomethane operating plant is a formal safety assessment consisting of the systematic assessment of risks and a description of the technical and other measures undertaken, or to be undertaken, to control the identified risks (s675(1)(e)).

Anaerobic digestion can be regarded as a chemical process with associated risks that include:

- interaction with other operating plants or contractors
- hazardous areas
- flammable gas
- fire and explosion
- hazardous substances (e.g., hydrogen sulphide (H₂S))
- confined spaces
- pressure systems
- gas handling and gas storage
- use of unodourised gas.

It is essential that thorough safety assessments are carried out at each stage of a project from design to installation, commissioning, implementation, and operation.

Interaction with other operating plant or contractors

Where there is more than one operating plant involved around the biogas / biomethane activities, each operator must have an SMS that complies with the Act.

Example *biogas is produced in a large landfill site managed by one operator; the biogas is collected and subsequently used for power generation by another operator. In this scenario, the landfill and the power generating system (if using more than 50 GJ/hr.) are two separate operating plants, with two SMSs.*

In situations where interactions between multiple operators or contractors is proposed or is anticipated, each SMS is to include details on the nature of the interactions, the associated risks and clear identification of safety responsibilities (s675(1)(f)).

Hazardous areas

Biogas, by virtue of the methane present, can be explosive if the concentration in air is within flammable limits. For methane, the concentration in air is between 4.4 and 16.5%.

Landfill gas can also contain variable concentrations of other flammable agents including hydrogen (flammable limits between 4 and 75%) and H₂S (flammable limits between 4 and 44%).

Explosion hazards must be determined and assessed to identify and classify explosive areas into zones according to 'AS/NZS 60079.10.1 Explosive atmospheres – Classification of areas' (e.g., refer to appendix ZA.8).

Hazardous substances

Some of the constituents of biogas, including carbon dioxide and several trace components, can have toxic effects if present in high enough concentrations. A fundamental part of the risk assessment is quantifying the trace components present in biogas and developing control measures to limit the risk of exposure to hazardous substances to an acceptable level.

Design, installation, and operation considerations

The design, installation, and operation of biogas and biomethane gas systems must consider relevant industry Standards including, but not limited to:

- AS 1375 Industrial fuel-fired appliances
- AS 3814 Industrial and commercial gas-fired appliances
- AS/NZS 5601.1 Gas installations – General installations
- AS/NZS 60079.10.1 Explosive atmospheres – Classification of area
- AS 61508 Parts 0 – 7 – Functional Safety (electrical related systems)
- AS 61511 Parts 1 – 3 Functional Safety (Safety instrumented systems for the process industry sector)

There are no requirements for biogas tanks or ponds to be approved and / or certified; however, the SMS should identify and provide for management of risks associated with biogas tanks and ponds. This includes the location, design, materials, construction, installation, operation and maintenance of the ponds and tanks and their associated collection and filtration systems.

Gathering system design

A formal safety assessment of any biogas gathering system is required to inform the design process. Risks associated with collecting and transporting the biogas (particularly if within a flammable range) and risks associated with proximity of any ignition sources must be identified and eliminated, or effectively controlled (to an acceptable level).

Currently, no Australian Standards cover the entire biogas pipe system (i.e. from collection at the source to use at a device). A variety of standards can be used together to achieve an acceptable level of risk. Relevant standards that can be used include:

- Elements of AS 4645 – Gas distribution networks,
- AS 5601 – Gas installations, and
- Australian Pipeline and Gas Association (APIA) APGA 'Code of Practice for Upstream PE Gathering Networks in the CSG industry'.

The formal safety assessment should address any deviations from these standards as required during the design stage.

The following matters are to be appropriately addressed:

- Landfill gas pipe construction materials to comply with AS 4130 Polyethylene (PE) pipes for pressure applications, or another applicable Standard.
- Use of stainless-steel materials (i.e., minimum 3 mm wall thickness to prevent stress corrosion/cracking)
- Clear identification of gas pipes (i.e., to prevent accidental damage by others)
- Routing of gas pipe(s), easements, and separation distances from other services
- Risks associated with above ground routing of any gas line(s)
- Potential for fire damage (e.g., from grass fires)
- Location of extraction system hardware in relation to safety devices and end use devices (e.g., gas flares, power generation systems, etc.)
- Treatment system construction material suitability (e.g., leachate separation, susceptibility to fire/chemical damage)
- Provision of automatic isolation.

Note the APGA Code of Practice for Upstream PE Gathering Networks in the CSG industry is available free [Code of Practice for Upstream PE Gathering Lines in the CSG Industry - Australian Pipelines and Gas Association \(apga.org.au\)](http://apga.org.au)

Note reticulated gas piping must be underground unless the site is owned or controlled by the operator of the biogas operating plant.

Operation and maintenance

Operating and maintenance instructions are to be addressed in the SMS. This must include information on the frequency of testing for the gathering system, treatment system and associated gas devices (including any gas flares, power generation systems and any other Type B devices).

Gas devices

Gas devices used at biogas plants typically include stationary engines, turbines, boilers, flares, and hot water heaters. Such industrial gas devices are defined as Type B gas devices under section 724 of the Act. In Queensland, all Type B gas devices must be approved and certified prior to installation and use. Additional information about Type B gas devices and associated requirements are [available online](#).

Flares

Under section 724(3)(b) a gas flare is listed as a Type B device, with two qualifying conditions under section 724(5): that it uses combustion to dispose of fuel gas; and that it is prescribed under a regulation.

As of 1 January 2022, a flare that uses combustion to dispose of biogas or biomethane is prescribed as a gas device (type B) by section 12A of the Petroleum and Gas (Safety) Regulation 2018 (the Regulation). A gas flare that uses combustion to dispose of biogas or biomethane, that is installed after 1 January 2022, requires approval as a gas device (type B).

There is no change for gas flares at biogas or biomethane operating plant, that were in place on 1 January 2022, unless:

- the gas flare is relocated to a new biogas / biomethane operating plant or
- the gas flare is modified or altered from its original design. For example, an integral part of the flare is replaced with another part that differs in design or function.

A gas device (type B) must be approved by the holder of an appropriate gas device approval authority (GDAA). Information on gas device approvals and a register of GDAA holders is available on the [PGI website page here](#).

The safety requirement for the design and certification of gas devices (type B) is AS 3814 - Industrial and commercial gas-fired appliances. Informative guidance relating to biogas flares and treatment systems can be found in Appendix P of AS 3814.

Unodourised gas

Fuel gas must be supplied to a consumer with the prescribed odour. Section 628 of the Act allows for fuel gas to be supplied to a consumer without the prescribed odour if the supply is to an industrial installation with appropriate gas detectors and shut-down systems and a risk analysis has been carried out by an appropriately qualified person showing the supply is safe. This applies to persons supplying unodourised gas to another person (consumer). For more information please refer to the [Guideline for the supply of unodourised gas | Business Queensland](#)

In situations where an operating plant uses gas as part of the production, processing, or transportation life cycle of fuel gas, the risks associated with unodourised gas must still be assessed and controlled.

Can hydrogen sulphide (H₂S) be used as an odorant?

While H₂S produces a 'rotten egg' smell; under no circumstances can H₂S be used to satisfy the requirements under the Act for odourisation of biogas.

Exposure to H₂S is particularly dangerous for two reasons:

- a) Exposure to H₂S at concentrations of 800 ppm (even for just a short time) can be fatal.
- b) A person can become desensitized to the smell of H₂S from prolonged low-level exposure (meaning a person may inadvertently become unaware of exposure to concentrations that could be potentially hazardous).

Calculations for the petroleum and gas safety and health fee

The Regulation provides that operators of operating plant are liable to pay a petroleum and gas safety and health fee. For biogas / biomethane operating plant, the obligation to pay is for the operator that produces, processes, or uses biogas or biomethane. The fees established in the Regulation are applied to actual gas usage at a biogas / biomethane operating plant.

Gas devices used at biogas operating plant typically include stationary engines, turbines, boilers, and hot water heaters. Any gas device that uses biogas, including a flare, is to be included in the actual gas usage calculation.

From 1st July 2022 a new fee structure for a biogas facility has been implemented.

Any biogas plant that has gas devices installed at the site and has an actual gas usage of 50 GJ/h or more must also enter details into the Major Consumer category.

The calculations for actual gas usage are to be carried out using any of the four methods listed below:

1. Find the MJ or GJ input rating for the appliance (nameplate capacity).
 - 100 MJ/h = 0.1 GJ/h
2. Find the kW or MW input rating of the appliance (nameplate capacity).
 - 1 MW = 1000 kW
 - 1 MJ/h = 0.277 kW
 - 1 GJ/h = 0.277 MW
3. Find the maximum hourly gas usage via a compliant measurement system and the lowest calorific value recorded during the financial year (actual gas usage).
4. STATIONARY ENGINE ONLY - Find the actual MW (or kW) output of the appliance, then use the following conversion to convert to the input figure.
 - $\text{MW (or kW) output} \times 36\% \text{ efficiency} = \text{input of the appliance}$ (36% efficiency has been used as an average efficiency factor to maintain consistency in calculations). Then convert to GJ/h (or MJ/h).

For further details, email: safetyandhealthfee@rshq.qld.gov.au

Contact the Petroleum and Gas Inspectorate

Potential owners or operators of a biogas or biomethane operating plant should seek advice from the Inspectorate early to ensure they are properly informed of their legislative obligations.

Email: gassafe@rshq.qld.gov.au

Telephone: (+617) 3199 8027