



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'). 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:

- 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:

- 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 operating plant including facilities that collect, transport, or use biogas. Examples include the collection of sewage treatment or landfill gas for use in power generation.

There are several requirements relevant to biogas plants and installations including to:

- ensure appointment of statutory position holders (Operator, Executive Safety Manager, and Site Safety Manager) and that they understand their obligations under the Act
- make, implement and maintain a Safety Management System (SMS) for the plant
- prepare a thorough risk assessment for each stage of the project
- careful consideration of design, installation and operations
- ensure relevant gas devices are approved as required under the Act
- ensure installers are licensed or authorised under the Act or otherwise assessed as competent under the SMS for the plant

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

Executive Safety Manager

The Executive Safety Manager (ESM) is the senior managing officer of the business or undertaking responsible for the management and safe operation of the operating plant. This is usually the most senior person responsible for managing the organisation such as the Chief Executive Officer (or equivalent).

What are the ESM's obligations?

The ESM must:

- appoint an appropriately qualified person as the 'operator' of the biogas plant
- ensure that the operator of the biogas plant has, for each stage of the plant (such as commissioning and operation), an SMS made after consultation with the employees at the plant
- approve the SMS before it is put into effect
- ensure that the SMS is implemented in a way that effectively manages the risks associated with the plant.

Operator

Under the Act the 'operator' is the individual or corporation responsible for the management and safe operation of the biogas plant. Typically, the operator will be the legal entity carrying out the business or undertaking.

Operators Representative

The Act requires that if the operator is a corporation, the ESM must nominate an individual as a representative of the operator to give and receive information for the operator under the Act.

What are the operator's obligations?

The Act requires that the operator must 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 regulator.

Where there are separate entities operating parts of biogas plants, each part is considered operating plant and each operator must have an SMS that complies with section 675 for their plant.

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 plant, and each operator requires an SMP that complies with section 675 of the P&G Act.

The operator of a biogas plant that is being commissioned or recommissioned must give the Chief Inspector an information notice about the plant at least 20 business days before the proposed operation.

Site Safety Manager

The Site Safety Manager (SSM) is an appropriately qualified person who is responsible for managing safety and health at the operating plant. The SSM is appointed by the Operator under the SMS and an SSM must be appointed for any site where multiple persons are working on a regular basis would have a site safety manager. If an SSM is not appointed, the Operator can be directed to appoint one.

What are the site safety manager's obligations?

The site safety manager 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 a safety management system (SMS) that complies with section 675 of the Act before the operating plant is commissioned or operated. Australian Standards are available to assist in gaining compliance with s674 and 675 of the Act.

If you already have an SMS, you do not need to create a new one provided the SMS addresses the requirements of the Act. You may wish to create a document mapping the existing system against the elements listed in section 675 of the Act then address any gaps that are identified.

Risk assessment

Biogas plants must undergo a formal risk assessment consisting of the systematic identification of risk and a description of the technical and other measures undertaken to control the identified risks.

Anaerobic digestion can be regarded as a chemical process with all the associated risks:

- interaction with other operating plants or contractors
- hazardous areas
- flammable gas
- fire and explosion
- hazardous substances (e.g., H₂S)
- confined spaces
- pressure systems
- gas handling and gas storage
- use of un-odorised 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 at a biogas facility each operator must have an SMP that complies with the prescribed requirements under section 675 of the Act.

For 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 each operator requiring their own SMP.

In situations where interactions between multiple operators or contractors are likely; section 675(1)(f) of the Act requires the SMP to include details on the nature of the interactions, the associated risks and clear identification of safety responsibilities.

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 per cent.

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

Explosion hazards must be determined and assessed. In particular, potentially explosive areas must be identified and classified 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 and installation of biogas systems must consider relevant 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 areas

There are no specific provisions for tanks or ponds to be approved and certified. However, it is imperative that the SMP identifies and manages any 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.

Biogas Flares

Currently Gas devices (Type B) are defined under section 724 of the Act. 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 be prescribed under a regulation.

As gas flares are currently not prescribed under regulation, they are not considered a Type B device.

However, device ignition systems that utilise fuel gas (fuel gas pilot system) are defined as a gas device (type B) by virtue of section 724(3)(a)(1).

Therefore, in Queensland, only a fuel gas pilot system of a gas flare is defined as a Type B device but not the flare itself.

Gathering system design

The gathering system for a biogas facility needs to have a formal safety assessment 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 the plant).

Elements of AS 4645 – Gas distribution networks, AS 5601 – Gas installations and the Australian Pipeline and Gas Association (APIA) APGA Code of Practice for Upstream PE Gathering Networks in the CSG industry' may be used, so long as any deviations are clearly addressed in the formal safety assessment (as required during the design stage) and the following matters are 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 lines (i.e. to prevent accidental damage by a others)
- Routing of gas line(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 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

to APGA members online at www.apga.org.au and may be purchased by non-members by contacting APGA by email to apga@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 power generation systems).

Gas devices

Gas devices used at biogas plants typically include stationary engines, turbines, boilers and hot water heaters. Such industrial gas devices (i.e., which use gas to produce heat, light and power) 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 is available online.

Domestic Biogas Digesters

Small biogas digesters are becoming available for use at homes and small businesses. These digestors will be approved, together with the gas pipework and gas device, as a Type B device. As such, the device will require certification and to be installed by the holder of a Gas Work Authorisation.

Unodourised gas

Section 628 of the Act requires fuel gas to be odourised—unless the supply is to an industrial installation where a risk analysis has been carried out by an appropriately qualified person. Where unodourised gas is intended to be used, a hazard identification and risk assessment process must be undertaken. The risk analysis must be completed by an appropriately qualified person and must outline how the use will be managed safely. A guideline for the use of unodourised gas is available online.

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.

1. Exposure to H₂S at concentrations of 800 ppm (even for just a short time) can be fatal.
2. 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).

Other requirements

There may be other requirements or legislation that applies such as:

- The requirement for the operator of a facility that produces, processes, or uses biogas to pay the Petroleum and Gas Safety and Health fee. Nb: the biogas fee structure is currently under review. For further details, email safetyandhealthlevy@rshq.qld.gov.au general workplace safety requirements under the *Workplace Health and Safety Act 2011*.
- Environmental requirements under the *Environmental Protection Act 1994*.
- Local government requirements under relevant legislation or local laws (e.g. planning and development restrictions).

Contact the Petroleum and Gas Inspectorate

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

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