Design safety guidelines for CALs and related infrastructure

Careful consideration should be given to the safe siting, design and operation of biogas systems. This factsheet provides some general minimum guidelines. It is important meat processing plants developed their own site-specific safety practices which will often improve on and may be different or more stringent than those outlined below.

Covered Anaerobic Lagoon
Image: Teys, Beenleigh

General Siting and Exclusion Zones

The large size of CALs and the risks associated with them typically requires them to be located distant from food processing operations and residents.

Positioning of CALs and related equipment

- ☐ Locate the CALs on the site well away from other major ignition, traffic and areas where people are working. A minimum distance of 50 metres is recommended subject to site limitations.
- ☐ Minimise ignition sources near the CAL and biogas train as much as practicable, including vehicles, electrical equipment, hot work (grinding and cutting operations) and open flames.
- ☐ Where electrical equipment is required (for example stormwater removal, sludge or effluent pumps, motors and controls), site it outside the hazardous areas (classified according to the relevant Australian Standard 60079.10.1:2009) associated with the CAL.
- ☐ Ensure electrical equipment situated within the hazardous areas meet the requirements for the zone identified.
- ☐ Ensure control panel enclosures are rated IP55 minimum.
- ☐ Ensure there is an exclusion zone of at least 3 metres around the CAL and associated inlet and outlet pits so as to prevent public and animal access. The exclusion zone should be secured using a security fence (at least 1800 mm in height) and all access points are locked.
- ☐ Erect safety signs near the main entry point to inform of the hazards and required safety measures within fenced area. Recommended signage - No entry – Authorised personnel only, Exclusion of ignition sources, Biogas properties and hazards and Deep tanks.
- ☐ Clearly identify the biogas pipeline with signage to prevent damage by third parties.
- ☐ Position tall objects such as light stands, power poles and trees a suitable distance from the CAL and biogas infrastructure
- ☐ Control vegetation in the surrounding areas to reduce fire risk to the cover in the case of bushfire or where a fire event occurs nearby. Consideration might be given to fire suppression systems if a high risk

Design for Cover Protection

The cover is the integral part of the CAL that captures the biogas. It is imperative that the cover is not compromised. Holes in the cover will not only allow loss of biogas to the atmosphere but also create a potentially hazardous environment.

Design features to reduce the likelihood of damage

- ☐ Ensure biogas collection piping is at least 500 mm above the maximum operating water level so that the risk of scum, foam or mousse entering the collection system is minimised.
- ☐ Install overpressure release systems to prevent cover over-inflation in the event that biogas cannot be withdrawn via the biogas train for any reason which may include safety spears, Hydrostatic release valves or weighted or mechanically operated flaps.

- ☐ Use split head wedge and/or extrusion welding techniques to join HDPE CAL cover sheets to ensure gas tightness during construction.
- ☐ Reinforce penetrations through the CAL liner or cover to minimise the risk of tearing.
- ☐ Design stormwater removal systems to remove large volumes of accumulated stormwater on the cover surface.
- ☐ Fit temperature cut-outs on any electrical items on the cover (e.g. stormwater pumps).
- ☐ Where possible and appropriate, provide larger exclusion distances for potential ignition sources to minimise the possibility of flash fires in the event of major releases from covers. Use a hazardous area analysis consistent with AS/NZ 60079.10.1:2009 Explosive atmospheres – Classification of areas to assess the extent of suitable zones of separation of potential biogas release points from identified hazards.

Types of biogas release valves

Simple pipe spears
Image: NB Foods, Oakey

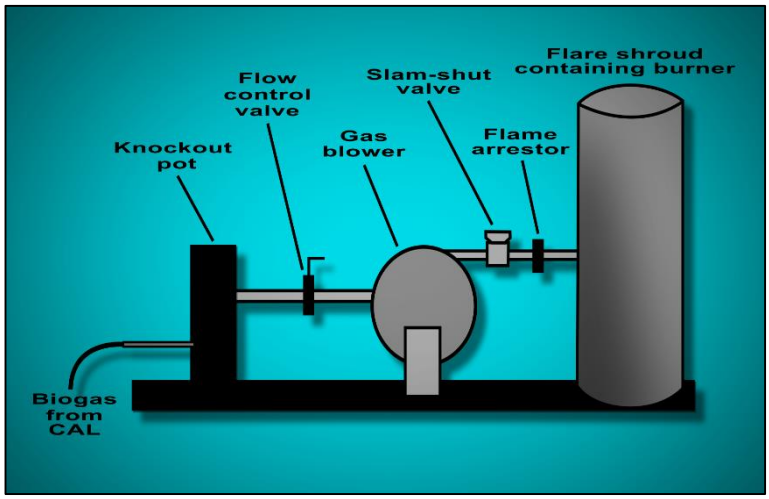
Water seals or hydrostatic valves
Image: Teys, Beenleigh

Weighted flaps
Images: Kilcoy Pastoral Company Limited, Kilcoy

Biogas Train Design

The biogas train includes biogas piping, blower, instrumentation, gas conditioning equipment and all biogas combustion units.

Biogas pressures are typically low for meat processing industry CALs. Biogas pressure upstream of the blower and under the CAL cover is usually less than 0.1 kPa. In some cases, it may be under negative pressure for some covers.



Downstream of the blower, a typical biogas delivery pressure to the flare using centrifugal blowers is still low at less than 5 kPa. Higher pressures may be used for delivery to gas boilers and cogeneration gensets.

A hazardous area analysis is recommended for the biogas pipeline to the point of connection with the biogas flare and skid. Where the biogas train and flare is a Type B device with a certificate of compliance, the flare vendor will have generally conducted their own assessment.

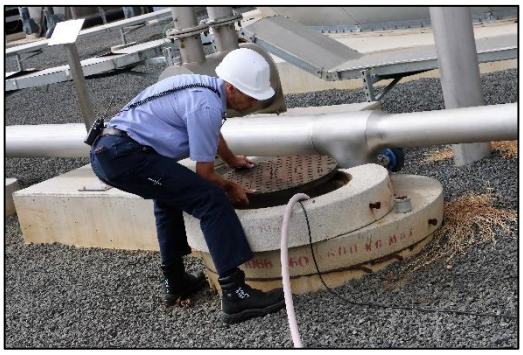
Pipeline from CAL delivering biogas: Stainless steel knockout pot(right) to blower (left)
Image: Teys, Beenleigh

Considerations during design: CAL to the blower

- ☐ Ensure there is a manual isolation valve in the biogas pipeline adjacent to the CAL to permit isolation of the biogas train from the CAL.
- ☐ Consider the potential damage on nearby objects that may be caused by gas releases and ignition when laying out pipe runs and equipment.
- ☐ Consider isolation strategies, particularly for long biogas pipe runs.
- ☐ Consider the potential for fire escalation if flames cause grass fires which propagate. Open areas reduce escalation and minimise hazards.
- ☐ Use stainless steel pipeline for above ground biogas piping as it has good corrosion resistance and fire protection properties.
- ☐ Install PVC and HDPE piping underground as protection against fire risk (from external fires). Carefully consider the impact of high biogas temperatures in the use of all plastic piping.
- ☐ Take care with plastic piping in regards to potential static electricity discharges especially when working on the pipeline. Ensure good earthing practice (see AS 5601.1-2010).
- ☐ Ensure the pipeline is able to handle significant amounts of condensate drainage due to the high degree of humidification of the biogas. Biogas is often at elevated temperatures under the cover and then cools in above ground stainless steel piping.
- ☐ Ensure the pipeline grades back to the CAL or a knock out pot at a constant minimum slope of 2% to prevent accumulation.
- ☐ Install a suitably designed knockout pot at low points in the biogas pipeline to remove condensate and to ensure hazards such as mousse or scum are captured and does not enter the blower. These units are manufactured from non-combustible material.

Considerations during design: Blower to the flare

- ☐ Design and install the biogas system downstream of the blower in accordance with AS 3814-2009 (industrial & commercial gas-fired appliances) and ensure it complies with the safety requirements of AS 1375-1985 (SAA Industrial fuel-fired appliances code).
- ☐ Ensure the mechanical installation is certified by a licensed gas fitter.
- ☐ Design this section of the biogas train according to anticipated biogas fuel load e.g. large meat processing plants and independent renderers treating a high proportion (>80%) of their raw wastewater through CALs can be expected to fall into the range 5 – 20 GJ/h. Smaller abattoirs will typically be less than 5 GJ/hour.



Inground knockout pot to collect condensate
Image: NB Foods, Oakey

Australian standards: CAL to the Blower

- **Australian Standard AS 4645.2:2008 Steel pipe systems** provides guidance for design and construction of gas piping systems, although in the context of higher gas pressures (up to 1,050 MAOP).

- **Australian Standard AS 4645.3:2008 Gas Distribution Network: Plastics pipe systems** provides guidance for design and construction of gas piping systems, although in the context of higher gas pressures (up to 700 kPa). For most HDPE pipes the operating temperature tolerance is up to 65°C, but AS 4645.3:2008 limits PE80B and PE100 pipes to operating temperatures of less than 40°C. Any biogas recirculation system must take into account heat added through the recirculation blower

Biogas combustion units, such as flares, boilers and cogeneration units, are classified as a Type B appliance.

☐ Design of the flare-burner management system to comply with AS 3814-2009 (industrial & commercial gas-fired appliances). Imported flares must obtain Australian approval befor use.

☐ Ensure electrical services at the biogas train comply with AS 3000 Electrical installations and have been certified by a registered electrician. Locate electrical equipment outside any hazardous area (e.g. Zones 1 or 2), or ensure it is compatible with operation in the designated hazardous zone.

☐ Use a stainless steel pipeline downstream of the blower.

☐ Ensure all components of the biogas system especially safety shut off valves, blowers, meters and burner management system items are rated for operation with moist biogas, hydrogen sulphide, ammonia and other components likely to be present unless downstream of biogas conditioning equipment.

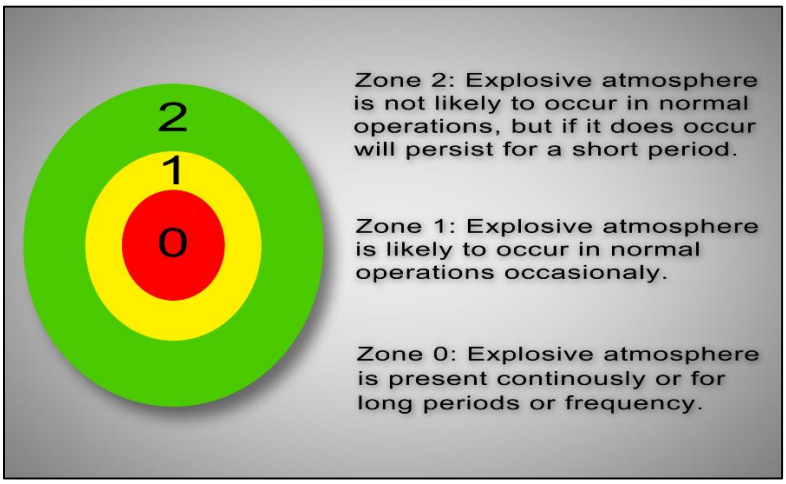
☐ Design the biogas blower to alarm at 30% v/v and trip at 25% v/v to prevent flare flame-out. Once the system is operating monitor biogas methane content and flow. Typical methane levels for biogas generated by meat processing CALs are 65 – 75% v/v. Independent render plants may generate biogas of lower quality (usually 60 – 65% v/v). Biogas with methane content less than 20%v/v is non-flammable.

☐ Ensure the following components are included in the flare system:
- A flame arrestor at the flare inlet and between points of use and the blower.
- A suitable safety shut off system for the biogas appropriate to the expected biogas rate.
- Interlocking of methane content to trip the biogas flare if methane content falls too low.
- Automatic ignition system.
- A blower management system which avoids drawing a negative pressure on the CAL cover. Where a single blower operates more than one CAL, care is needed to ensure the management system maintains positive pressure under all covers.

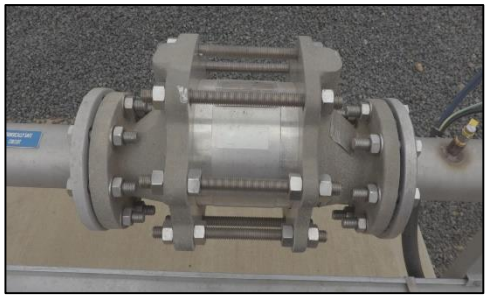
☐ Install the biogas flare to handle the entire design flow of biogas from the CALs to ensure that it is safely incinerated in the event of problems disrupting its use.

☐ Site the flare at separation distances from the release sources that complies with AS/NZ 60079.10.1:2009 Explosive atmospheres – Classification of areas. For general flare location, a minimum distance of 6 metres from the CAL is generally recommended. Special consideration is required where the CAL is built with a significant height above natural ground level, to prevent the heat plume in wind conditions pushing towards the CAL.

☐ Site blowers and compressors in open environments to minimise risk of biogas accumulation.



Hazardous zones 0,1 & 2



Flame arrestor
Image: NB Foods, Oakey

Shut off system
Image: NB Foods, Oakey

Methane analyser
Image: NB Foods, Oakey

Enclosed flare
Image: JBS, Dinmore

Candlestick flare
Image: NB Foods, Oakey

Biogas system: Genset Buildings

The use of biogas for generation of electricity on-site has led to the installation of generator sets, usually installed in enclosed structures for the purpose of noise control and security reasons. This poses a unique risk of explosion of released gas within the enclosure, and amplification of blast pressure in comparison to open structures.

Considerations during design: Genset buildings

- ☐ Site the gen-set facilities with consideration given to both on-site impacts and for off-site impacts in the event of an explosion.

- ☐ Ensure at least 2 sides of any genset enclosure are open to allow dispersion of any gas releases (may not be possible due to noise).
- ☐ Ensure there are strict controls on ignition sources and personnel access within the enclosure.
- ☐ Ensure the ventilation system within the enclosure is reliable.
- ☐ Use ventilation systems, interlocks and gas detection to ensure that initial biogas release events cannot propagate to an explosive situation.
- ☐ Design ventilation systems to effectively disperse any gas releases.

These fact sheets have been prepared by The Ecoefficiency Group Pty Ltd in association with Johns Environmental in 2017.