Australian Government

Rural Industries Research and Development Corporation

Assessment of Australian Biogas Flaring Standards

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By GHD Pty Ltd

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Foreword

Methane is the dominant agricultural greenhouse gas in Australia, representing about 12 per cent of national greenhouse gas emissions. Installation of biogas capture systems to reduce methane emissions is one of the most cost-effective ways to realise immediate environmental benefits while also providing the opportunity for secondary income streams or cost reductions and improved waste management.

Provision of biogas flaring systems in Australian agriculture is considered to be more costly than it is in other comparable countries due, in part at least, to the requirements of meeting the current Australian environmental standards and Australian manufacturing costs. This report examines the environmental and safety regulatory requirements covering the supply and use of flares in Australia and compares them with overseas requirements. It presents information on the costs of flares made in Australia and those from overseas. The report identifies impediments that influence the cost of flaring systems for agricultural industries and makes recommendations on addressing these impediments.

The research will benefit producers in Australia's intensive livestock industries by providing a clearer understanding of the regulations for biogas flares, in order to clarify expectations and avoid undue delays and costs in the development stages of projects. For the agricultural industry as a whole it will facilitate the uptake of biogas projects, which in turn will provide environmental benefits by reducing greenhouse gas emissions.

The Methane to Markets Partnership was launched in 2004 and currently there are 20 members, including Australia. The Partners made formal declarations to minimise methane emissions from key sources, stressing the importance of implementing methane capture and use projects in developing countries with economies in transition.

The Methane to Markets in Australian Agriculture Program is a collaborative research and development program (combining Government, research and industry partners); the purpose of which is to identify and respond to the issues important for the mitigation of methane emissions from the wastes of intensive livestock production. Through the Methane to Markets in Australian Agriculture Program, and as part of the international Methane to Market partnership, Australia's intensive livestock industries (pigs, beef feedlots and dairy) have capacity to improve their ability to capture and use methane emissions from animal wastes.

Rural Industries Research and Development Corporation (RIRDC) manages the Methane to Markets in Australian Agriculture Program under the supervision of a Program Steering Committee.

This project was funded under the RIRDC's "Methane to Markets in Australian Agriculture" Program, a program that is funded by the Australian Government through the Natural Heritage Trust and National Landcare Program, and four R&D Corporations – RIRDC, Australian Pork Limited, Meat and Livestock Australia, and Dairy Australia.

This report, an addition to RIRDC's diverse range of over 1800 research publications, forms part of our Methane to Markets in Australian Agriculture R&D program, which aims to develop/adapt methane capture and use technology for application in the Australian intensive animal industries.

Most of our publications are available for viewing, downloading or purchasing online through our website:

- downloads at www.rirdc.gov.au/fullreports/index.html
- purchases at www.rirdc.gov.au/eshop

Peter O'Brien
Managing Director
Rural Industries Research and Development Corporation

Abbreviations

AGA	Australian Gas Association
AS	Australian Standard
CO	Carbon monoxide
DIY	Do-it-yourself
EPA	Environmental Protection Agency
ERA	Environmentally relevant activity
GJ	Gigajoule
IEA	International Energy Agency
kW	kilowatt
LPG	Liquid petroleum gas
MJ	Megajoule
MW	Megawatt
NEPM	National environmental protection measure
NMCH	Normal cubic meter per hour (approximately 0.95 SCMH)
NOx	Nitrogen oxides
PAHs	Polyaromatic hydrocarbons
ppm	Parts per million
RIRDC	Rural Industries Research and Development Corporation
SCMH	Standard cubic meter per hour
VOC	Volatile organic compound

Contents

Executive Summary

What the report is about
This report examines the environmental and safety regulatory requirements covering the supply and use of biogas flares in Australia and compares them with overseas requirements. It presents information on the costs of flares made in Australia and compares that with those from overseas. The report identifies impediments to a reduction in the cost of flaring systems for agricultural industries and makes recommendations on removing these impediments in order to make biogas capture more viable.

Who is the report targeted at
The research will benefit producers in Australia's intensive livestock industries by providing a clearer understanding of the regulations for biogas flares, in order to clarify expectations and avoid undue delays and costs in the development stages of projects. For the agricultural industry as a whole it will facilitate the uptake of biogas projects, which in turn will provide environmental benefits by reducing the industries' greenhouse gas emissions.

Background
Where methane in biogas is captured by Australian industries, a flare is always required whether or not other equipment is installed to use the gas. Therefore the cost of providing a flare is always a factor in the cost of a biogas capturing system and will influence its viability. Provision of methane flaring systems in Australian agriculture is perceived to be more costly than it is in other comparable countries due, in part at least, to the requirements of meeting the current Australian environmental standards and Australian manufacturing costs.

Methods used
A literature search was done of both environmental and safety standards covering biogas flares in each of the states of Australian and overseas. Australian state government regulators were also contacted for further information and clarifications.

Agricultural industry groups in Australia likely to use biogas systems were contacted to determine whether the cost of biogas flares had been or was likely to be an issue.

Flare suppliers in Australia and overseas were identified and a number were approached to provide prices for open and enclosed flares over a range of sizes.

Results/Key findings
The cost of biogas flares is seen by many industry participants as being only a small part of any biogas capture project and is therefore not a major factor in the overall project cost. However flares are considered to cost more in Australia than they should, possibly due to local environmental and safety regulations, which are perceived to be strict. This perception could be due to confusion about the application of environmental and safety regulations to biogas, both of which change from state to state.

A clearer understanding of the regulatory requirements may assist agricultural industries to understand what is actually required so that they are able to negotiate with contractors and flare suppliers to get the best value option, rather than the best performing one.

Flare costs in Australia appear to be consistent with European costs and possibly USA, but higher than those in India/Asia. The market in Australia is relatively small and even a threefold increase in the number of flares is not expected to provide the economies of scale required to significantly reduce the price.

Environmental legislation can have a significant impact on flare costs. Good emission performance requires an enclosed, high temperature flare, which costs 1.5-2 times the amount of a simple open flare.

Flares consuming up to 600 SCMH of biogas will not require an environmental license in any state in Australia unless they are on a site or are part of an activity that already requires a license. In this case the environmental limits for the flare will be determined on a case-by-case basis.

Flares that do not require an environmental license are regulated by local councils or authorities. They are covered by local council planning schemes and general guidelines issued by the state government. The general nature of the guidelines introduces a high degree of subjectivity to the assessment process, or it requires expensive plume dispersion modelling to be undertaken. Although this approach provides flexibility in determining an outcome, it does not provide the simplicity and certainty that more specific guidelines would.

European environmental standards for biogas flaring appear to be more stringent than those in Australia. Less expensive “open” flares are only allowed for emergency or short-term back-up operation.

Each state and territory has its own legislation covering the safety of gas appliances. In Queensland and Victoria the legislation covers appliances using any fuel gas, but in the others it covers only appliances that use gas from a commercial network. A flare using an LPG pilot gas would probably be regulated by gas safety legislation in all states, but a flare using biogas alone would be regulated in Queensland and Victoria only.

The same distinction applies with the Australian Standards for fuel burning appliances. AS 3814/AG 501 (Industrial and Commercial Gas-fired Appliances) applies to flares using LPG pilot fuel, possibly applies to enclosed flares using biogas only, and does not apply to open flares using biogas. However, AS 1375 (Industrial Fuel Fired Appliances Code) applies to all biogas flares.

Implications for relevant stakeholders
Agricultural industries should look at sourcing flares that are manufactured overseas, especially for open flares, which would have less onerous environmental performance requirements.

It is important to determine environmental performance requirements by liaising with the local council or approving authority. This will determine the type of flare required which will have a large influence on the price. Discussions with the council may take some time due to the subjective nature of the assessment so they should be started early in the project development process.

In many states a biogas flare may not be regulated by the gas safety regulator, especially if it does not use an LPG fuelled pilot. This means the onus is on the purchaser to ensure they get a system that complies with the Australian Standard AS 1375 (Industrial Fuel Fired Appliances Code) as a minimum.

Recommendations
Agricultural industries planning to install a biogas system should consult with the office of the gas regulator and the local council early in the project development process.

When developing a biogas project, agricultural industries should ensure quotes are also received for overseas manufactured flares. However the supplier should be responsible for appliance approvals or compliance with AS 1375.

A do-it-yourself approach may be suitable for small, open flare installations not using an LPG pilot flame. However, the person manufacturing and installing the flare must recognise there is a duty of care to ensure the installation meets industry standard health and safety guidelines

Introduction

The Rural Industries Research and Development Corporation (RIRDC) is a statutory Corporation formed in July 1990 under the Primary Industries and Energy Research and Development (PIERD) Act 1989. It was set up by the Commonwealth Government to work closely with Australian rural industries on the organisation and funding of their R&D needs.

RIRDC manages and funds priority research and translates the results into practical outcomes for industry development. The focus of this business is on new and emerging industries as a means of diversification of rural enterprises in Australia. This role is enhanced by responsibility for research and development for a range of established rural industries and for key generic issues confronting the rural sector.

GHD Pty Ltd (GHD) is an international professional services company whose people deliver innovative solutions by combining technical skill and experience with an understanding of the clients' objectives and aspirations. GHD employs over 4,700 people in a network of offices throughout Australia, New Zealand, Asia, the Middle East and the Americas. It serves the global market sectors of Infrastructure, Energy, Mining & Industry, Defence, Property & Buildings and the Environment amongst others.

GHD have been engaged by RIRDC to:

- Identify the cost impact of Australian standards and regulations on small biogas flaring systems (25-600 SCMH) and identify potential opportunities for reducing these costs without impacting adversely on environmental benefits and safety. This involves comparing Australian standards with European and American standards to identify potentially acceptable but less expensive standards.
- Compare the cost of producing biogas flares in Australia with the cost of producing them in US, Europe and Asia.
- Ascertain from the agricultural industry the current and future impact the cost of biogas flares on the development of biogas capture systems.
- Produce, to the extent allowable by State and Territory regulations, a Do-It-Yourself manual for the construction of a flare.

This report presents the findings of the assessment.

Biogas Flaring

Biogas

Biogas is a product of the anaerobic decomposition of organic materials. In most commercial or industrial applications it is produced as a by-product of the treatment of waste water that contains high levels of organic waste.

Biogas typically consists of two major components (methane and carbon dioxide) and a number of minor components (volatile organic compounds, hydrogen sulphide and water vapour). A typical composition is shown in Table 1.

Table 1: Typical biogas composition

Compound	**Chemical Formula**	**Molecular Weight**	**% by dry volume**
Methane	CH_4	16	60-70%
Carbon Dioxide	CO_2	44	30-40%
Volatile Organic Compounds (VOCs)	Various	Various	<1%
Hydrogen sulphide	H_2S	37	20-2000 ppm

Both the composition of the biogas and the rate of production depend on many factors such as the organic material, process, temperature, and air leakage. The key characteristics of biogas are that it is flammable, lighter than air, odorous, sometimes toxic and environmentally damaging. The cause and key consequences of these characteristics are listed in Table 2.

Table 2: Biogas characteristics

Characterisitic	**Cause**	**Consequence**
Flammability	Methane	Methane is flammable in air at concentrations between 5% and 15% by volume. Biogas will burn if mixed with air in the correct proportions.
Lighter than air	Methane	The high methane content makes biogas lighter than air, which can improve gas safety. Biogas will rise into the air and away from equipment and personnel if accidentally released.
Odour	Some VOCs, Hydrogen sulphide (rotten egg smell)	Biogas can cause an odour problem to neighbours if released into the atmosphere. However the odour provides a safety feature because it allows any unintentional leak from a gas system to be detected. Methane is odourless.
Toxicity	Carbon dioxide, hydrogen sulphide	Carbon dioxide has detrimental health effects above 4% concentration if breathed for 15 minutes, and 10% if breathed for 1 minute. Fatalities have occurred at concentrations of 30%. Hydrogen sulphide can cause eye damage above 50ppm, is toxic above 350ppm, and lethal at 800-1000ppm.
Environmental Impact	Methane	Methane is a potent greenhouse gas. One tonne of methane has the same greenhouse impact as 21 tonnes of carbon dioxide. Methane in the air at moderate concentrations can also hinder the growth of vegetation.

Burning biogas rather than letting it disperse into the atmosphere has two major benefits: reduction in the greenhouse impact and elimination of odours. The global warming potential of one tonne of methane is equivalent to 21 tonnes of carbon dioxide. Burning one tonne of methane produces 2.75 tonnes of carbon dioxide, thereby reducing the greenhouse gas impact by 18.25 tonnes of carbon dioxide. Burning also eliminates the odour by destroying the VOCs and converting the hydrogen sulphide to sulphur dioxide.

However there are also three potential disadvantages of burning biogas: unwanted pollutants, noise and light pollution at night. Unwanted pollutants can be caused by:

- the oxidisation of some compounds, such as sulphur compounds to become sulphur dioxide;
- poor combustion which can produce oxides of carbon other than CO_2 (CO and sometimes formaldehyde HCHO) and polyaromatic hydrocarbons (PAHs);
- high temperatures which lead to the formation of nitrogen oxides (NOx); and
- partial combustion of the biogas resulting in some of it passing through the flare and being emitted to atmosphere.

Noise is produced by the ancillary equipment such as blowers, as well as by the combustion process. Noise is generally not a problem on smaller flares of the size used on biogas systems. Visual pollution at night caused by a visible flame can be an issue with “open” flares in some locations

The different types of biogas flares are described in the following section.

Flare Types

There are two broad categories of flares: open flares and enclosed flares. Figure 1 shows an enclosed flare on the left, an open flare on the right and a hybrid flare in the centre.

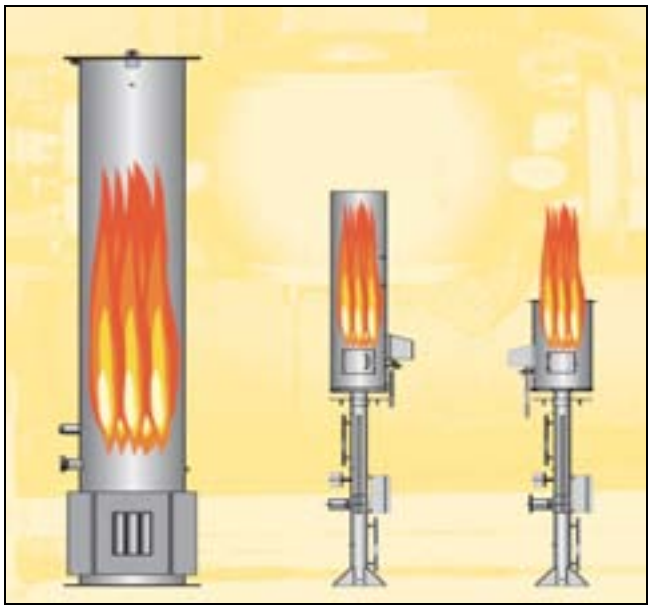

Figure 1: Flare types. Enclosed flare on the left, open flare on the right and hybrid flare in the middle

In an enclosed flare the flame burns entirely within the flare stack. The amount of air is controlled to suit the amount of gas being burnt in order to maintain high temperatures within the enclosure. The shell is internally insulated to prevent cooling of the combustion products near the wall and also to protect personnel from hot surfaces. The enclosure is sized to ensure the exhaust products are retained for a minimum amount of time. This combination of high temperature, minimum retention time and elimination of cold zones ensures both a high destruction efficiency and complete combustion of the biogas. Destruction efficiencies of 98-99.95% can be achieved in enclosed flares. The temperature and time requirements vary from country to country, and range from 760°C for 0.6 seconds, to 1000°C for 0.3 seconds. There is a sample port at the top of the enclosure to enable the quality of the exhaust to be properly measured before it mixes with the ambient air.

Figure 2: Enclosed flares with containerised auxiliaries

The ability to monitor the exhaust means that the performance of the flare can be measured. This is particularly important if the flare installation is being used to generate carbon credits. The amount of methane destroyed by the flare can only be determined by measuring the amount of methane being both delivered to and leaving the flare.

Open flares (also called candlestick and elevated flares) are essentially big Bunsen burners with the air ports closed. The flame burns with a low intensity at the flare nozzle and the ambient air quickly cools the flame and the exhaust gases. The cool flame and rapid cooling mean that a significant amount of the biogas may not be burnt. Destruction efficiencies of 90-95% can be expected.

Poor mixing of the combustion air with the gas results in some regions of the flame having too much air and other regions having too little. Partial combustion of the biogas can occur in theses regions, which can produce unwanted pollutants such as carbon monoxide and PAHs. .

The biggest safety risk associated with gas burners is an explosion due to the ignition of unburnt gas in the combustion chamber. This risk is eliminated in an open flare because there is no combustion chamber in an open flare as the flame burns in the open.

Figure 3: Open flare with blower, control panel and electrical cabinet in the foreground

Figure 5; Skid mounted open flare

Figure 4: Visual impact of an open flare at night

Because the flame is exposed it is generally elevated to reduce the radiant heating for personnel and auxiliary equipment. This means the pilot burner and the flame detectors are elevated and have poor access for maintenance. A shroud is put around the flame to protect it from the wind and make it easier to ignite. The shroud is generally not tall enough to contain the flame, which can be visible for several kilometres at night.

The reduced combustion performance of open flares is due to their simplicity and consequently their lower cost.

Advantages of enclosed flares are:

- High biogas destruction efficiency
- Low level of unwanted pollutants
- Emissions able to be monitored
- Improved heat safety
- No visual impact from flame

Advantages of open flares are:

- Lower cost
- No containment of gas/air mixture

Flaring Systems

Biogas is generally produced in a covered lagoon or a digester tank. In the covered lagoon or digester the biogas is saturated with water vapour and is generally at a slight positive pressure. A typical installation to flare the biogas is illustrated in Figure 6. The pressure needs to be boosted to convey it through the piping, control equipment and flare at a sufficient rate. A fan or a blower is used to boost the biogas pressure. A knock out pot is installed upstream of the blower to prevent it being damaged from any water that may have condensed in the pipework. Between the booster and the flare is a quick acting on-off valve to shut-off the gas supply when the system is not functioning, and a flame arrestor to prevent the flame burning back up the system. Not shown in the diagram are the pilot gas system and the control system.

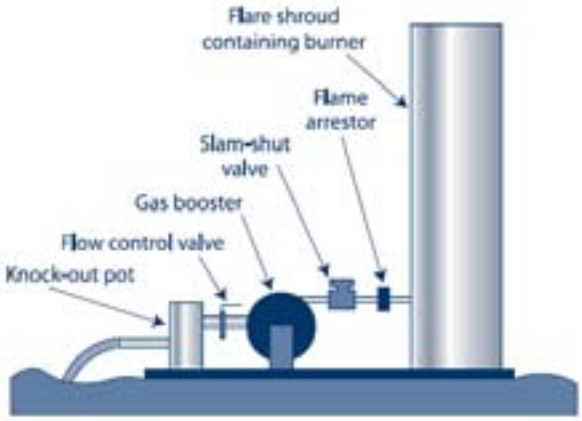

Figure 6: Schematic illustration of the essential features of a flaring system

A typical system for an enclosed flare has a control system on the combustion air, which maintains the combustion temperature. This is illustrated in Figure 7 which is extracted from a brochure produced by John Zinc Inc.

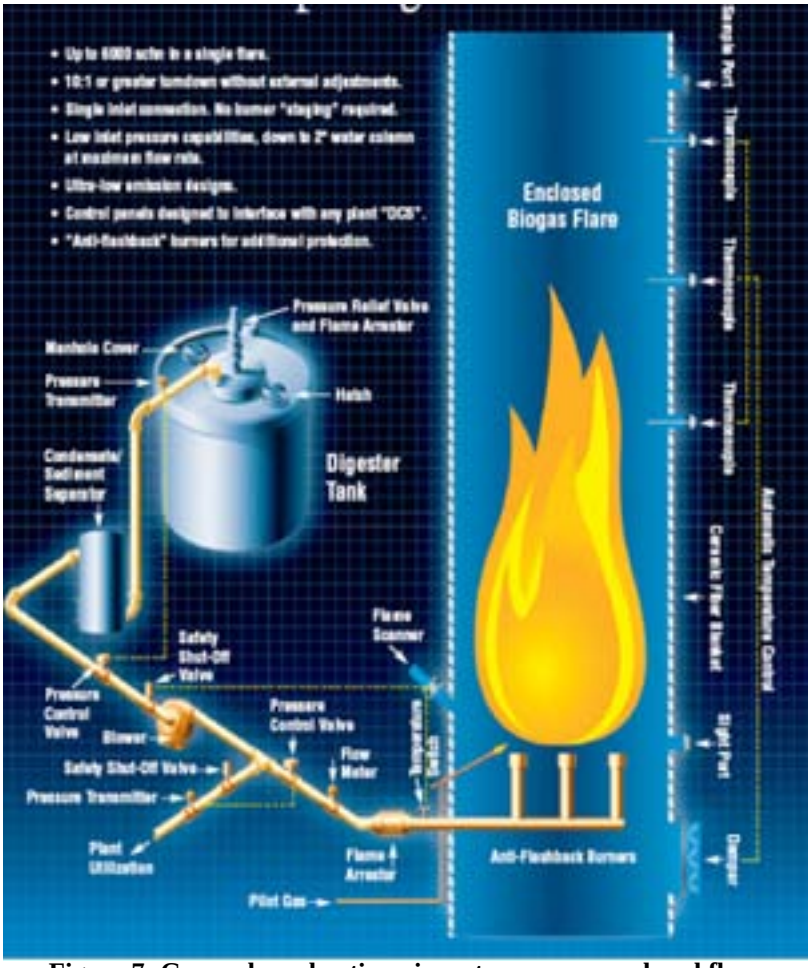

Figure 7: Gas and combustion air systems on an enclosed flare

Typical systems for an open flare are shown in Figure 8 and Figure 9.

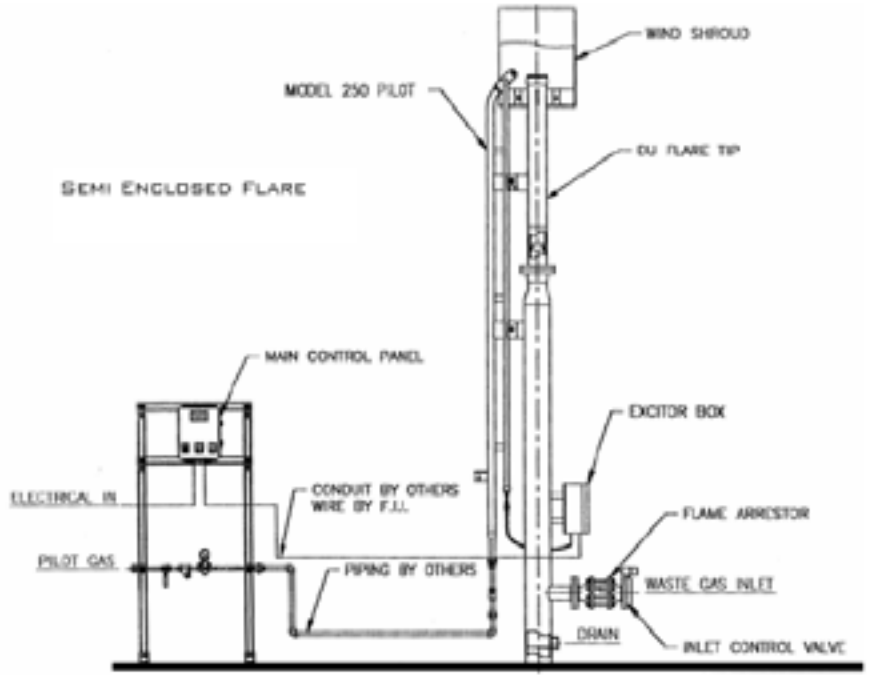

Figure 8: Components of an open flare

Figure 9: Open flare with knock-out pot, flow meter, fan, air operated shut down valves (2), air compressor and flame arrestor (red)

Safety Standards and Regulations

Australia

General

This section of the report examines which parts of the Australian Fired Appliance Standards are applicable to biogas flares, and the views of each state's gas safety office on their responsibility to regulate biogas flares.

In Australia, gas burning appliances are controlled by state legislation and associated regulations to ensure that they satisfy explicit safety criteria However the legislation and regulations differ from state to state. Each state has a Regulator of Gas Safety who is responsible for administering that state's regulations. The regulators from Australia and one from New Zealand have formed the Gas Technical Regulators Committee to be responsible for the liaison between the technical and safety authorities of each state. The legislation and regulations incorporate some of the Australian Standards for gas burning equipment, which are standard throughout Australia and New Zealand.

Despite the effort of the Technical Regulators to obtain a degree of consistency, the reality is that the legislation in each state is different and in some cases the interpretation of similar regulations is different. This has caused some confusion and conflicting advice when consulting with the departments of the gas safety regulators in each state.

Australian Standards

The key Australian Standards pertaining to gas burning appliances are:

- AS 1375-Industrial Fuel Fired Appliances Code
- AS 3814/AG 501-Industrial and Commercial Gas-fired Appliances
- AS 5601/AG 601-Gas Installations

AS 1375-Industrial Fuel Fired Appliances Code

The scope section of AS 1375 states that it "*sets out the safety principles relating to the design, installation and operation of industrial appliances that involve the combustion of gas or oil, or other fuel in air suspension, or the generation of combustible vapours in such appliances*".

It is clear that both open and enclosed flares are industrial appliances that involve the combustion of gas, so AS 1375 is applicable to both.

AS 3814/AG 501-Industrial and Commercial Gas-fired Appliances

The scope section of AS 3814 states that it "*provides minimum requirements for the design, construction and safe operation of Type B appliances that use town gas, natural gas, simulated natural gas, liquefied petroleum gas, tempered liquefied petroleum gas, or any combination of these gases either together or with other fuels*". The standard specifically excludes "*simple atmospheric burners that are not fitted into a combustion chamber and burn in an open ventilated space under the control of an operator*".

An open flare satisfies the exclusion requirement provided it is considered to be under the control of an operator. The enclosed area of an enclosed flare may be considered to be a combustion chamber. A dictionary definition of a chamber is "*a natural or artificial enclosed space or cavity*".

A common feature of the fuel gases listed in AS 3814 is that they are hydrocarbon based, their composition is regulated, and they are or were sold to consumers. Biogas is none of those so it is questionable whether a biogas burning appliance could be considered a Type B appliance. However, a

biogas flare using LPG as a pilot gas would use one of the listed fuels (LPG) in combination with biogas, and would therefore come under the scope of AS3814.

Table 3: Biogas flares subject to AS 3814

Fuel Used	Open Flare	Enclosed flare
Biogas only	Not subject to AS 3814	Possibly subject to AS 3814
Biogas and LPG pilot	Not subject to AS 3814	Subject to AS 3814

AS 5601/AG 601-Gas Installations

The scope section of AS 5601 states that it "*sets out requirements for consumer piping, flueing, ventilation and appliance installations which are associated with the use or intended use of fuel gases such as town gas, natural gas, liquefied petroleum gas in the vapour phase, tempered liquefied petroleum gas, simulated natural gas or any similar substance. The requirements cover piping systems from the outlet of—*
(a) the consumer billing meter installation; or
(b) the first regulator on a fixed gas installation where an LP Gas container is installed on the same site; or
(c) the first regulator on site (if no meter is installed) where LP Gas is reticulated from storage off the site;
to the inlet of the appliance."

AS 5601 has a similar fuel constraint to AS 3814 and biogas flares would only be subject to AS5601 if LPG were used as pilot fuel. Furthermore it is very specific in what sections of a gas system the standard refers to. In the case of most small on-farm biogas flare systems there may be none of the items listed in (a)-(c). A biogas flare may only be subject to AS 5601 if it uses LPG as a pilot fuel.

Gas Safety Legislation

General

Each state and territory has its own legislation covering the safety of gas appliances. In most states the legislation appears restricted to appliances that either only use prescribed gases or use gases that are supplied through a consumer gas network. Most do not cover biogas systems or flares unless the flare uses LPG pilot gas. For example, in NSW the Gas Supply (Gas Appliances) Regulation 2004 regulates gas appliances that use gas supplied from a gas network. Biogas generated and used on the same site does not come from a gas network. This is discussed in the following sections.

For appliances that do fall under the state legislation there is a common approach amongst all states in that there are generally two certification or approval steps required for the installation of a gas fuelled burner. The first is for the importer/manufacturer to certify that the **gas appliance** meets the safety requirements and then the regulator can approve it for sale, installation or use. The second is for the construction and operation of the **gas installation**, which consists of the appliance and associated electrical and mechanical equipment. The mechanical installation must be certified by a licensed gas fitter, and the electrical installation by a licensed electrician.

Appliances are categorised in the Australian Standards in two broad groups termed Type A and Type B. Type A appliances are typically for use in residential installations and Type B are industrial appliances. Biogas flares that are subject to the legislation would be type B appliances.
Table 4 provides a summary of the comments received from the regulators when asked about biogas flare regulations.

Victoria

The Gas Safety Act in Victoria covers all fuel gases. The Office of Gas Safety (now Energy Safe Victoria) has provided some guidelines on biogas and landfill gas flares (refer Appendix B). The guidelines incorporate some of the requirements of AS 3814 and AS 1375. However the guidelines are less stringent than the requirements in AS 3814 because the flame burns in the open and not in a combustion chamber.

Overseas

No overseas standards were found relating specifically to the safety of biogas flares. There are several overseas standards for landfill gas. The common features of these standards are:

- flame arrestors and backflow protection devices to prevent flash back and landfill fires,
- a flame detector with an automatic slam shut valve and
- blower isolation to prevent unburnt discharges of landfill gas.

Conclusion

Each state and territory has its own legislation covering the safety of gas appliances. In Queensland and Victoria the legislation covers appliances using any fuel gas, but in the others it covers only appliances that use gas from a commercial network. A flare using an LPG pilot gas would probably be regulated by gas safety legislation in all states, but a flare using biogas alone would be regulated in Queensland and Victoria only.

The same distinction applies with the Australian Standards for fuel burning appliances. AS 3814/AG 501 (Industrial and Commercial Gas-fired Appliances) applies to flares using LPG pilot fuel, possibly applies to enclosed flares using only biogas, and does not apply to open flares using biogas. However, AS 1375 (Industrial Fuel Fired Appliances Code) applies to all biogas flares.

Table 4: Summary of Australian State Safety Requirement for biogas flaring systems

State	Regulation	Certifying Authority	Biogas Regulated	Standards for Biogas Flares	Contacts
NSW		Department of Planning – Hazards Unit		There are no defined requirements for this type of flare. The department is aware of certain companies, viz., EDL in QLD and Landfill Management Services in SA who have performed designs for these flares. The department considers that industry design should ensure safe installation, which they will review upon installation.	Mr. Sohan Fernando Department of Planning – Hazard & Risk Unit (02) 9228 6151
	The Gas Supply (Gas Appliances) Regulation 2004	Work Cover Authority, Department of Fair Trading	No	Work Cover Authority recognises that there are no defined standards for this type of flare. However, it expects that the equipment should be designed to meet industry standard health and safety guidelines.	Mr. Doug Gibbon NSW Work Cover Authority (02) 4321 5192
QLD	Petroleum and Gas (Production and Safety) Act 2004	Office of Energy, Department of Natural Resources and Mines	Yes	The department recognises that this is an area that is not well defined. There is no standard specifically applicable to these flares. Most manufacturers make them to their own standards. The department is aware of the Victorian draft landfill flare guidelines, and also that there are some reputed manufacturers overseas who have supplied these flares in Australia.	Mr. John M. Fleming Chief Inspector, Petroleum and Gas (07) 3237 1415
VIC	Gas Safety Act 1997 (Version 025, 1 July 2006)	Energy Safe Victoria	Yes	The Act covers all fuel gases. The department has issued a draft Landfill gas / Biogas flare system guideline.	Energy Safe Victoria Telephone: (03) 9203 9700 Email: info@esv.vic.gov.au
TAS		Workplace Standards Tasmania, under the Department of Justice	Probably not.	GHD has contacted the department, but was unable to get a response. Review of the Act indicates that biogas is not included. However an LPG pilot may come under the Act.	Mr. Keven Williams keven.williams@justice.tas.gov.au (03) 6233 7657
SA	Gas Act 1997	Office of the Technical Regulator, Dept for Transport, Energy and Infrastructure	No	Office of the Technical Regulator operates under the Gas Act 1997 (SA). The Act covers reticulated natural gas and commercial LPG as used in residential / commercial and industrial gas appliances only. The Act does not cover biogas. However, the LPG pilot would come under the Act.	Bill Patience. Manager Gas Installation and Appliance Safety Office of the Technical Regulator, Dept for Transport, Energy and Infrastructure. ph - 08 8226 5790 fax - 08 8226 5866 email patience.bill@saugov.sa.gov.au

State	Regulation	Certifying Authority	Biogas Regulated	Standards for Biogas Flares	Contacts
WA	Gas Standards (Gasfitting and Consumer Gas Installations) Regulations 1999	Energy Safety WA, Department of Consumer and Employee Protection	No	In WA the flares in consumer installations are treated as a Type B gas appliance and require certification by a Type B Designated Gas Inspector. The Gas Standards (Gasfitting and Consumer Gas Installations) Regulations 1999 refer in Schedule 7 to relevant Australian standards. AS 3814: Industrial and commercial gas-fired appliances, is the applicable code for appliances and AS 5601: Gas installations, relates to the gas installation. If a landfill or other operator/owner were a gas supplier and did not intend using or selling the gas to a consumer, then the flare used for their own purposes may not need to be certified. If the gas supplier were to sell the generator and flare to a third party then appliances would need to be certified.	Kim Martin Senior Engineer EnergySafety WA Department of Consumer and Employment Protection Ph: +61 8 9422 5288(Direct) or 9422 5200 (Switchboard) Email: kmartin@docep.wa.gov.au www.energysafety.wa.gov.au
NT		NT Work Health and Electrical Safety Authority	Probably not	GHD has contacted the department, but was unable to get a response. Review of the Act indicates that biogas is not included. However an LPG pilot may come under the Act.	John Hayden NT Work Safe ntworksafe.deet@nt.gov.au (08) 8999 5141

Environmental Standards and Regulations

Australia

General

Environmental performance of gas burning appliances is regulated at a state level. All states have slightly different regulations, but all have a similar regulatory structure. An activity that has a potentially significant environmental impact, is regulated by the state government usually through the EPA. Companies that undertake these activities are required to have an environmental license.

Activities with lesser environmental impacts are regulated by local council or authorities and do not require a license.

The following sections describe for each state:

- at what point a biogas flare would be considered to have a potentially significant environmental impact to require a license
- what requirements apply below this level.

NSW

There is no specific licence threshold for methane burning, fuel burning, or flaring. Licences are determined according to a list of “scheduled activities” (activities listed in a schedule appended to the Act). These are based upon the fundamental activity and the extent of the activity carried out at a specific site, rather than the magnitude of the emissions from the site. Examples of scheduled activities that require environmental licenses are a piggery that accommodates more than 2000 pigs, or a sewage treatment system with a capacity of more than 750 kilolitres per day. Each emission point from any activity on the site may be assigned emission limits in the license.

Emissions from biogas flaring will only be included on an environmental license if there are any “scheduled activities” on the site. License limits on emissions are stipulated in regulations or can be assigned on a case by case basis.

Some emissions from non-scheduled activities are also stipulated in the regulations (Protection of the Environment Operations (Clean Air) Regulation 2002). However for flares this is limited to particulate emissions from flares with a larger capacity than those considered in this report.

Queensland

Licences are required for any “Environmentally Relevant Activity” (ERA) listed in the Environmental Protection Regulation 1998. For biogas flaring, a fuel burning licence is required for all equipment with a fuel burning capacity of 500 kg/h or more, as per 'ERA 17' in this regulation.

For installations that already have a licence with the EPA for another activity, a change to licence will apply for introducing biogas flaring, even if the fuel consumption is less than the amount given in ERA 17. For installations not requiring a licence, the general intention of the Environmental Protection Act is to be complied with and all reasonable practicable measures taken to prevent environmental harm.

Victoria
The list of “Scheduled Premises” does not include flaring or fuel burning. A waste-to-energy licence is the most similar, although it refers exclusively to energy recovery in an engine. The license threshold is 1MW of generated power, which will require approximately 260SCMH of methane or 410 SCMH of biogas. EPA Victoria indicated that flaring was preferred to venting for a point source of biogas, and energy recovery was preferred if practical. The licence or recommendation is very site specific, and the regional EPA branch and local council should be consulted for each case.

Tasmania
Under the Environmental Management and Pollution Control Act 1994, Schedule 2 lists "Level 2 activities" which require a licence. The fuel burning licence is the most relevant, as it applies to both fuel burning and waste incineration, and has a threshold limit of 1 tonne per hour of combustible matter consumed.

Flaring of biogas under this limit is not considered a Level 2 activity. However Schedule 1 of “Environment Protection Policy (Air Quality) 2004” includes some limits on in-stack emission concentrations from any combustion system, based on levels that can be achieved using accepted modern technology. The Policy also provides for these limits to be exceeded in certain circumstances at the discretion of the regulatory authority “having regard to the net environmental impacts of management options”.

This provision may allow for open flares to be used for non-Level 2 activities, even though the emission concentrations cannot be properly measured.

South Australia
The Environmental Protection Act 1993 lists “prescribed activities” that require a licence. The Fuel Burning licence, which has a threshold limit of 5 MW of heat output from the burning process, is applicable to biogas flares. The maximum heat output from a 600SCMH biogas flare is 4.4MW.

For installations with no licence requirement, flaring must still comply with the “Air Quality Impact Assessment”. This assessment requires that the combustion process adequately disperses NOx and other pollutants that may be detrimental to human health, and may be applied differently depending on the proximity to residential areas. This assessment criteria creates two potential problems for flare installations:

- Either good judgement or expensive plume dispersion modelling is required to determine if the quantity of pollutants emitted from the flare will disperse adequately
- It is difficult to establish the quantity of pollutants emitted from open flares, and therefore even more difficult to determine if they will disperse adequately.

These problems were raised with the SA EPA and it was acknowledged that further work or guidelines were required to make the criteria workable for small, low cost installations.

Western Australia
The Environmental Protection Regulation 1987, Schedule 1, lists the “prescribed acts” that require an EPA licence. Again, a fuel burning licence applies to flaring, which is based upon the mass flowrate of fuel consumed, and is more stringent for fuels with a higher sulphur content.

For non-licenced premises, The Environmental Protection Policy (EPP) for "Ambient Air Quality" will apply, but is still in development. It is based on the same dispersion principles as the SA regulations. The problems of the SA system were raised with the WA authority and it was acknowledged that these would have to be taken into consideration.

Table 5: Summary of State Environmental Requirements for Biogas flares

State	Regulation	Licence Authority	Limit for Licensing and Applicability	Standards for Non-licensed Flares	Contacts
NSW	POEO Act 1997 "Protection of the Environment Operations" POEO (Clean Air) Regulation 2002 www.legislation.nsw.gov.au	Department of Environment and Climate Change incorporating Environmental Protection Authority	No specific licence: depends on fundamental activity, not on the burning of methane.	Restrictions are very much site and activity specific, however: http://www.environment.nsw.gov.au/legal/envacts.htm - acts - go to: POEO (Clean Air) Regulation 2002 Part 4 Division 4 "Additional provisions for Group 6 afterburners, flares and vapour recovery units etc" Gives some guidelines on flaring landfill gas. eg Residence time.	Sandra.Guy@environment.nsw.gov.au DECC Information Line (02) 9995 5000 http://www.epa.nsw.gov.au/
Qld	Environmental Protection Regulation 1998	Qld EPA	"Environmentally Relevant Activity" ERA 17: Fuel Burning License: Capacity of equipment is 500 kg/hr of fuel or more *[600SCMH of biogas (70% methane and 30% carbon dioxide) corresponds to approx 620 kg/h biogas, or 284 kg/h of methane]*	No controls are on flaring in sewage/landfill, at best could be a "change to licence" "All reasonable practical measures to prevent environmental harm" - EPAct Recommended referring to engineers/suppliers for OHS and design, which are the main concerns	Licensing: Scott, Ph 3896 9252 www.epa.qld.gov.au Standards for Non-licensed Flares Warren Muller 3227 8920
Vic	Environment Protection (Scheduled Premises and Exemptions) Regulations 2007 Search under "Statutory Rules" at the following: www.dms.dpc.vic.gov.au State Environment Protection Policy (Air Quality Management) http://www.gazette.vic.gov.au/Gazettes1999/GG1999S019.pdf	Victoria EPA	No specific licence relative to fuel burning.	Based on individual situation, apply "best practice" - preferable to capture of methane, but flaring is still preferred to venting. If gas volume is large enough, then the possibility of methane capture and use in an engine or heating application must be investigated. There is a negotiated outcome in the context of what is practicable in each situation In industry - more likely to encourage usage/flaring. Rural application is not as stringent - recommend consulting regional office for each case.	geoff.latimer@epa.vic.gov.au Received no return email (03) 9695 2765 Chris - gave info on non-licensed flares. http://www.epa.vic.gov.au/

State	Regulation	Licence Authority	Limit for Licensing and Applicability	Standards for Non-licensed Flares	Contacts
Tas	Environmental Management and Pollution Control Act 1994 - Schedule 2 "Level 2 activities"	Department of Tourism, Arts and the Environment	Fuel Burning: any process … fuel burning equipment or incineration ...capable of burning combustible matter at a rate of one tonne or more per hour. *[600SCMH of biogas (70% methane and 30% carbon dioxide) corresponds to approx 620 kg/h biogas, or 284 kg/h of methane]*	Not considered a Level 2 activity However, emissions must comply with "state air policy", refer to: "Environmental protection policy - air quality 2004" http://www.environment.tas.gov.au/em_epps_environmental_protection_policy_2004.html Schedule 1: Gives list of in-stack concentrations for pollutants.	http://www.environment.tas.gov.au/ www.thelaw.tas.gov.au Listed online document Bob Hyde (03) 6233 6206
SA	Environmental Protection Act 1993	Dept of Environment and Natural Resources SA EPA	Act lists "prescribed activities" Fuel burning Licence: Heat output is 5 MW or more *[600SCMH of biogas (70% methane and 30% carbon dioxide) corresponds to approx 4.4MW heat output]*	Main concern is that combustion process adequately disperses NOx - requirements for this differ based on proximity to residential areas. Even if licence is not required, still require compliance with "Air Quality Impact Assessment" pdf below http://www.epa.sa.gov.au/pdfs/guide_airquality.pdf Extensive list of (non CO2) pollutants that must be dispersed or concentrations limited.	http://www.epa.sa.gov.au/permits.html Info centre (08) 8204 2004 peter.reilly@epa.sa.gov.au 0434565340 for non-licensing regulation
WA	Environmental Protection Regulation 1987 Schedule Part 1,	Department of Environment and Conservation, WA EPA	Regulation schedule gives list of "Prescribed Acts" Item #67 Fuel burning licence: 500 kg/hr for sulphur content >0.25% 2000 kg/hr for sulphur <0.25% *[600SCMH of biogas (70% methane and 30% carbon dioxide) corresponds to approx 620 kg/h biogas, or 284 kg/h of methane]*	Environmental Protection Policy (EPP) for "Ambient Air Quality" is still in development	Paul Burns (08) 6467 5382 in licensing Online list of licences: http://www.slp.wa.gov.au/statutes/swans.nsf Drew (08) 9219 8721 for air quality information http://www.epa.wa.gov.au/
NT		Department of Natural Resources, Environment and the Arts			http://www.nt.gov.au/nreta/environment/index.html

Overseas

Holland

Dutch standards are contained in the Nederlandse Emissie Richtlijn Lucht (NER). Chapter 3 of that document provides requirements and restrictions for landfill gas flaring, and in particular paragraph 3.3 details 47 special guidelines for specific processes. Amongst these guidelines is G1 Treatment of gases from landfills, waste fermentation and anaerobic wastewater treatment plant. The Dutch regulators recognise that measuring emissions is difficult; therefore standards relate to the operation of the flare. Flaring requirements contained in Section G1 are that the exit temperature must be 900°C and the retention time must be at least 0.3 seconds. The flare must be of the enclosed type unless it is intended only as back-up for occasional maintenance or disruption of utilisation, in which case an open flare will suffice.

Germany

Limits are specified at national and state level. Limits given in the national Technical Directive for Air Pollution Abatement (TA Luft) and by the Hessisches Ministry for Environmental Protection and Reactor Safety (HMfUR)

USA

The details of regulation differ from state to state. Typically, a destruction and removal efficiency (DRE) of 95, 98 or 99% is required, and emissions of NOx and CO are limited according to the thermal output (expressed as MJ) of the flare. Limit values for NOx and CO are expressed in terms of thermal capacity and lie in the ranges 25.8–34.4 mg NOx/MJ and 51.6–120 mg CO/MJ, respectively.

NZ

There appears to be no standard for flaring of biogas but a standard for flaring landfill gas has been proposed. A minimum flare temperature of 750°C for a resonance time of 0.5 seconds is proposed based on international best practice. (Proposed National Environmental Standards for Landfill Gas - Report on Submissions, 2004, Ministry for the Environment).

Conclusion

Flares consuming up to 600 SCMH of biogas will not require an environmental license in any state in Australia unless they are on a site or are part of an activity that requires a license. In this case the environmental limits will be determined on a case by case basis.

Flares that do not require an environmental license are regulated by local council or authorities. They are covered by local council planning schemes and general guidelines issued by the state government.

The environmental spokespeople contacted about the general guidelines expected that the council or consent authority would not be too stringent and would likely accept open flares. This is based on the fact that the sizes of flares under consideration are not large and that they will likely be in a rural environment some distance from neighbouring properties. However this would be at the council's discretion. This is yet to be tested in some states that have either recently implemented, or are in the process of developing, emission limits based on adequate dispersion to meet NEPM ambient air quality standards.

Although this approach provides the flexibility in determining an outcome it does not provide the certainty that more specific guidelines would.

European environmental standards for biogas flaring appear to be more stringent than those in Australia. Open flares are only allowed for emergency or short-term back-up operation. Enclosed flares are required where gas will be flared continually.

Flare Costs

Australian Flare Suppliers

The following flare suppliers were identified in Australia. Contact details are included in Appendix A.

- LMS
- Gasco
- Energen
- EPCO
- Aquatec Maxcon
- GCD
- Varec Biogas

Four suppliers agreed to provide indicative prices for both open and closed flares in the size range of interest. The suppliers providing the prices are not identified for confidentiality reasons. The prices are summarised in Table 6.

Table 6: Cost to supply various biogas flares to a rural site

	Supplier A	Supplier B	Supplier C	Supplier D
Open (candlestick) flares				
25 SCMH	$30,000	$58,500		
100 SCMH	$40,000	$76,500		$66,000
300 SCMH	$50,000	$99,000	$60 ~ 75,000	$81,000
600 SCMH	$80,000	$139,500	$80,000	
Enclosed Flare				
100 SCMH	$65,000			
300 SCMH			$150,000	$192,000
600 SCMH	$120,000		$165,000	

The costs are for the following scope of supply:

- gas isolation system and flame arrestor
- flare support structure (eg baseplates and guys if required)
- burner management system
- LPG pilot system
- automatic ignition system
- delivery to rural location 500km from major centre.

Not included in the scope are:

- blower
- installation
- foundations
- gas analysis (methane or oxygen) unless required for combustion control.

Prices from Supplier B included a blower. The figures in the table have been reduced by 10% to provide a comparative price.

The number of sales of biogas and landfill gas flares in Australia is small and they are manufactured to order. Vendors indicated that a threefold increase in orders would not change this and would not result in a significant cost savings.

Overseas Prices

UK/Europe

Information from a study titled "Biogas Flares - State of the Art and Market Review" prepared for IEA Bioenergy Task 24 in December 2000 provided the following information

The price range (in 2000 $US) for open and enclosed flares (basic specification excluding civil engineering and monitoring etc.) were:

Table 7: Cost of biogas flares in UK/Europe

Open flare (Temperature 850°C, 250-2000 NMCH)	$27,000 to $150,000
Enclosed flare (Temperature 1200°C, 0.3 seconds, 250-2000 NMCH)	$105,000 to $195,000

The prices for flares vary widely depending on a number of factors, but as a general guide, enclosed flares are about 1.5 to 2 times the price of an open flare with the equivalent duty.

The prices were obtained form the following established suppliers of biogas flares

- Biogas (UK),
- Organics (UK)
- Hofstetter (Switzerland)
- Haase Energie Technik (Germany),
- John Zink (USA)

The current price for the 250 NMCH flares would be A$54,000 for open flares and A$207,000 for an enclosed flares, based on:

- a price increase of 4% per year,
- an exchange rate of US$0.8 to the Australian dollar
- a minimum allowance of $3,000 or 20% of the ex works price for export packaging, freight in Europe, shipping to Australian port, freight to site and import duty.

No current pricing information was received from European suppliers.

USA

A study titled "Returns Analysis of Manure Management Systems Evaluated in 2004 under the North Carolina Attorney General Agreements with Smithfield Foods, Premium Standard Farms, and Front Line Farmers" prepared by North Carolina University Cost in 2006 reported that flare construction costs for a system calculated to be around 50SCMH of biogas was US$10,755.

The current price would be A$18,000 based on:

- a price increase of 4% per year,
- an exchange rate of US$0.8 to the Australian dollar
- a minimum allowance of $3,000 or 20% of the ex works price for export packaging, freight in US, shipping to Australian port, freight to site and import duty.

No current pricing information was received from North American suppliers. However one Australian flare supplier indicated that it sourced a number of components from USA, but fabricated the flare in Australia.

Asia/India

Several Asian vendors of biogas flares were contacted for pricing information and prices were received for flares manufactured in Pune, India.

These flares do not have a pilot gas system; the ignition system directly ignites the main flame. This will make ignition more difficult for flares that are to operate at variable flowrates and on variable and low quality gas.

Table 8: Cost of biogas flares in Asia/India

	Ex Works	Delivered to Site (est)
Open (candlestick) flares		
Up to 100 SCMH	US$8,500	$13,500
250 SCMH	US$14,700	$22,000
450 SCMH	US$16,500	$25,000
Enclosed Flare		
100 SCMH	US$38,200	$57,500
300 SCMH	US$58,000	$87,000
600 SCMH	US$62,000	$93,000

A minimum allowance of $3,000 or 20% of the ex works price has been included for export packaging, freight in India, shipping to Australian port, freight to site and import duty. An exchange rate of US$0.8 has been used to the convert the price to Australian dollars. The figure has been rounded to the nearest five hundred dollars.

These prices are for flares that may use materials that are not approved by AGA for use in Australia. There is likely to be additional costs for using Australian approved equipment, which could cost up to $8,000. Adding a pilot system for more reliable ignition will also increase the price.

Conclusion

Environmental legislation can have a significant impact on flare costs. Good emission performance requires an enclosed, high temperature flare and enclosed flares cost 1.5-2 times the amount of a simple open flare. This magnitude of the increase appears consistent in Australia and Europe.

The market in Australia is relatively small and a threefold increase in the number of flares is not expected to provide the economies of scale required to significantly reduce the price.

The table below summarises the costs of flares manufactured overseas and shipped to Australia. There may be additional costs for using Australian approved equipment. Flare costs in Australia appear to be consistent with European costs but higher than those in India/Asia. Insufficient information was obtained to comment of relative cost of flares manufactured in the USA. The projected price figures indicate a small open flare would be less expensive.

Table 9: Cost of biogas flares - summary across all countries

	Australia	India	UK/Europe	US
Open (candlestick) flare 50 SCMH	$32,000 ~ $60,000	$13,500 ~ $25,000		$18,000
Open (candlestick) flare 250 SCMH	$50,000 ~ $95,000	$22,000 ~ $35,000	$54,000	
Enclosed Flare 300 SCMH	$120,000 ~ $150,000	$87,000 ~ $100,000	$207,000	

Biogas Flaring in Australian Agricultural Industries

Affected Australian Agricultural Industries

The following agricultural industrial sites were identified as current or potential users of biogas flares:

- Piggeries
- Feedlots
- Meat processing plants (abattoirs and rendering plants)
- Dairy farms
- Dairy processing plants
- Poultry (bird and egg) farms
- Poultry processing plants
- Fruit processing plants

The following Australian agricultural industry groups were consulted to determine whether the cost of flares has been, or is expected to be an impediment to the development of biogas projects. A summary of their views is included.

Australian Pork (AP) – Bruce Edgerton
Some piggeries have been provided with high cost, high performance flares. These were provided based on the advice of the flare suppliers about the environmental requirements. This experience has made industry cautious and has been a deterrent to other projects.

Meat and Livestock Association (MLA) – Stewart McGlashen
Flare costs have not been identified as an issue in the past. It would only be a minor issue in future projects because the capital and operating cost of the flare is small in relation to the rest of the project, i.e. the digester or the sealed lagoon. However lower cost flares would improve the economics of projects and make them more viable.

Dairy Manufacturers Sustainability Council – Neil van Bueren
Comments as for MLA

Dairy Australia – Cathy Phillips
It is perceived to be a stumbling block on some projects, possible due to the uncertainty created by a lack of clear information on what is required. A better understand of what is required and lower costs would be a positive step.

Australian Meat and Chicken – Gary Samson
Not an issue because there are very few biogas installations or opportunities.

Conclusion

The cost of biogas flares is seen as being only a small part of any biogas project. Consequently flare costs are not a major factor in the project cost. However flares are perceived to cost more than they should, and this is attributed to compliance with regulations.

A clearer understanding of the regulatory requirements may assist agricultural industries to understand what is actually required so that they are able to negotiate with contractors and flare suppliers to get the best value option rather than the best performing one.

Do-It-Yourself Flares

Suitable Flare Type

A Do-It-Yourself (DIY) flare should only be used in simple applications, which do not require:

- High performance
- Large installations with high capacities
- Significant compliance with regulations
- Extensive understanding of codes
- Biogas being supplied by another party or being sourced from a property other than where it is being used

Enclosed flares should not be considered for DIY installations because the high performance requirements for either environmental license compliance or carbon credit generation require specialist design.

An open flare can be employed when the higher environmental performance of an enclosed flare is not required. This should be determined in consultation with the relevant local approval authority (eg shire council or city council).

Open biogas flares satisfy the above criteria if an LPG pilot is not used. An LPG pilot improves the reliability of igniting the main flame, but it does potentially involve more regulation in some states. This is illustrated in the table below.

	Open flare using biogas only	Open flare using LPG pilot
Applicable Australian Standards		
AS 1375	Yes	Yes
AS 3814	No	No
AS 5600	No	Possibly
Regulated by Gas Safety Office		
NSW	No	Probably
QLD	Yes	Yes
VIC	Yes	Yes
TAS	Probably not	Probably
SA	No	Probably
WA	No	Probably
NT	Probably not	Probably

Although an open flare using biogas only may not be regulated in some states, any DIY flare must still meet industry standard health and safety guidelines. An appropriate standard would be the guidelines put out by the Energy Safe Victoria, which are also the guidelines accepted by the Queensland and Victorian regulators. These guidelines are included in Appendix B.

Schematic Design

A schematic design based on the Energy Safe Victoria guidelines is included in figure Figure 10. There are other potential configurations that also comply with the guidelines.

The flame arrestor and upstream temperature sensor may be replaced with a flame trap that has a thermal fusible link to shut off the gas flow.

The flame nozzle should be located at least 3m above and all electrical items, except the igniter, should be located no higher than 2m above ground. Components within 1m of the flame should be made of stainless steel. Mild steel can be used for the balance of the components. Valve should be suitable to operate with damp gas containing up to 2000 ppm hydrogen sulphide.

It is recommended that the windshield is longer than 600m high or five times the pipe diameter, whichever is the larger.

Pipe sizes for 25, 100, 300 and 600 SCMH biogas capacities are also provided in Table 10. For smaller flares the pipe size can be increased to make it self supporting in strong winds. Alternatively guy wires can be used.

Table 10: Flare Capacities

Biogas Flowrate	Gross Energy		Pipe Nominal Diameter	Flame Safeguard Response Time
SCMH	GJ/h	kW	mm	seconds
25	0.6	172	50	15
100	2.5	686	100	3
300	7.4	2058	150	3
600	14.8	4117	250	3

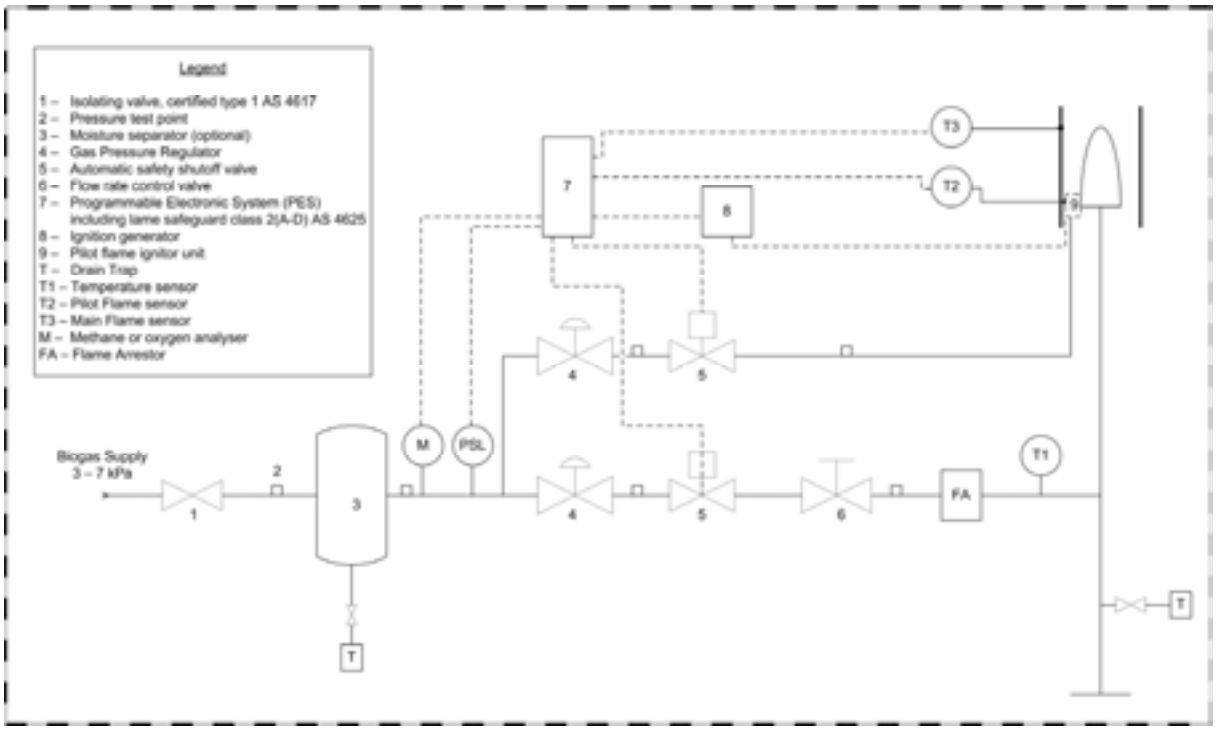

Figure 10: Biogas Flare Schematic

This schematic design is provided for illustrative purposes only to assist RIRDC evaluate the viability of DIY flares. It is not to be relied on by third parties.

Appendix A

Australian Flare Suppliers

LMS - Landfill Management Services

Part of the SimsMetal Limited group of companies
Enquiries: Brett Maple, Corporate Manager

1 Union Street
Stepney SA 5069

Email info@lms.com.au
Phone (08) 8363 0100
Fax (08) 8363 7700
Website www.lms.com.au

Gasco Pty Ltd

Enquiries: Richard Jones, Sales & Marketing Manager

Factory 8, 981 Mountain Highway
Boronia VIC 3155

Email r.jones@gasco.net.au
Phone (03) 9720 8577
Fax (03) 9720 4240
Website www.gasco.net.au

Energen Solutions

Enquiries: Jeremy Pringle, Business Development Manager

47 Proprietary St
Tingalpa QLD 4173

Email jeremy@energensolutions.com.au
Phone (07) 3390 8677 (direct)
Fax (07) 33909723

EPCO Australia

Enquiries - Grant Cobbin, Managing Director

17 Argon Street
Sumner Park QLD 4074

Email grantc@epco.com.au
Phone (07) 3279 3276
Fax (07) 3279 4250
Website www.epco.com.au

Aquatec-Maxcon Pty Ltd

Enquiries: Ron Howick - Manager, Products Division

119 Toongarra Road
PO Box 455
Ipswich QLD 4305

Email enquiries@aquatecmaxcon.com.au
Phone (07) 3813 7100
Fax (07) 3813 7199
Website www.aquatecmaxcon.com.au

Tyco Flow Control Pacific Pty Ltd (Varec Biogas)

Enquiries: Rob Raymont

1 Percival St
Smithfield, NSW 2164

Phone (02) 9612 2323
Fax (02) 9612 2324
Website www.tycoflowcontrol.com.au

Appendix B

Victorian Draft Landfill/Biogas Flare Systems Guidelines

The following Guideline is to assist with the design of landfill and Biogas Flare safety and control systems that are acceptable to the Office of Gas Safety. Each installation will have its special features unique to the operation of plant that will be associated with the utilisation of the gases. However there are a number of safety features that are considered as minimum requirements to ensure the safe and reliable operation of the flare and the associated facilities. (Note for the sake of brevity, there is reference to landfill gas only however the same will generally apply to other forms of Biogas systems)

Gathering System Design

Before the system is designed there must be clear identification of the risks and hazards associated with the operation of the facility. The gathering system for the Landfill site must conform to appropriate Australian standards. A HAZOP must be part of the design process and the following issues addressed.

- The materials of construction of the landfill gas line to comply with AS 4130 or other applicable standard,
- In the case of the use of stainless steel materials, problems associate with stress corrosion cracking and a minimum wall thickness of 3mm,
- Clear identification of the gas line(s) to prevent accidental damage by a third party,
- Routing of the lines, easements and separation distances from other services,
- Risks associated with above ground routing of any gas line,
- Potential for fire damage, eg grass fires, plastic piping is very vulnerable to damage,
- Location of extraction system hardware in relation to end use devices such as gas flares and power generation systems,
- Materials of construction for treatment systems eg leachate separation and the susceptibility to fire damage, chemical attack by leachate, and
- Provision of automatic isolation.

The reticulated gas piping must be underground unless the site is fenced off and on private property.

Where the routing of the landfill gas line passes through public property then there is a requirement to lodge a Safety Case with the Office of Gas Safety for the landfill gas gathering system assets. This is required under section 52 of the Gas Safety Act 1997. The safety case ensures the owner / operator of the landfill gas line maintains and operates the system at acceptable levels of safety.

Where the routing of the gas lines is entirely within the confines of private property, i.e. council land that is fenced off, a safety case is not required. However the operation of the installation would still come under the jurisdiction of the Office under section 73 of the Gas Safety Act.

Treatment Facility

The treatment facility will have a number of vessels that are used for the separation of the leachate and the conditioning of the gas to acceptable levels of impurities such as sulphur and moisture. These may vary form a simple separation and knockout pot to the more sophisticated chill water moisture separator. In the case of sulphur it may be in the form of a regenerative bed system.

The Office has concern with the use of plastic materials where, in the event of a fire, the isolation of the gas is not possible unless the gas conditioning system is downstream of the extraction blowers and operating under positive pressure. Where these systems are used the isolation of the gas and the gas lines must be metallic to reduce their vulnerability to fire damage.

The treatment system must incorporate the following interlocks to ensure safe operating conditions.

- The monitoring of the Oxygen content to trip the system if the level exceeds 5% but begins to alarm at greater than 1%. (This is normal practice with overseas installations such as the UK). The concern is the probability of conveying gas which is in the flammable range with in the reticulation system,
- The monitoring of the methane content to alarm at less than 30% but to trip at 25%. Gases with less than 20 % are not flammable and will result in flame failure and system unreliability,
- In the case where monitoring systems are not in place then, if there is the possibility of having a flammable gas being conveyed through the gathering system and the treatment system, explosion relief must be provided. The system is required to comply with AS 1375 SAA Industrial Fuel-fired Appliances Code, and
- Flame arresters compatible with the gas must be installed at locations where there is high likelihood that there will be a source of ignition or an opening to atmosphere.

Flare System

The design of the flare burner management system is required to comply with AS 3814 Industrial and commercial gas–fired appliances. However the Office suggests that the following be must provided as a minimum on any flare system:

- The location of the flare must be such that in the event of unburnt gas being vented it will not cause a hazard,
- The separation distances from sources of ignition must with comply with AS 2430 Classification of hazardous areas, or be no less than 6 metres,
- The materials selection for all valves and components must be compatible with Biogas and the associated leachate or condensates,
- The provision of a flame arrester at the flare inlet,
- The provision of a temperature sensor to initiate a shutdown if there is the presence of flame at the arrester. The use of a fusible link can also be used for this function and is the preferred option,
- The provision of a safety shut off system for the gas,
- Interlocking of the Oxygen and or Methane level as per above to trip the flare if the composition is outside acceptable limits,
- In the case of and enclosed flare the operating temperature not to fall below limits set by the EPA for the proper destruction of trace toxic

chemicals. The proper operation temperature of enclosed flares is in the order of 1000°C (refer to any EPA conditions of operation),

- Low flow conditions where the operation of the landfill flare may become unreliable and erratic,
- The electrical installation to be compliant with AS 3000 Electrical installations.
- The blower to be a non-sparking type, earthing requirements of the landfill gas blower and the flare system to be assessed,
- The flame monitoring of the flare to comply with AS 3814. The use of thermocouples will not be allowed unless the shut down time is comparable to that required in AS 3814,
- The flare to have flame monitoring that is self-checking prior to a start. It is acceptable to have a number of re-ignition start attempts before going to lockout. The number of allowable re-ignition attempts will be assessed at the time of submission to the Office,
- Provision of minimum air damper settings to ensure proper combustion of the landfill gas, and
- Specifically for flares associated with covered lagoons or sewage treatment system operating under negative pressure the extraction system must have some form of pressure control to ensure that oxygen is not induced into the gathering and covers.

All interlocks are to be hardwired and external to PES systems. The PES can be used to sequence and monitor the flare system.

These are minimum requirements and will vary between installations. The Office will review any submissions that require a departure from the above.

Operating And Maintenance

Operating and maintenance instructions are to be provided for review to the Office. These must include frequency of testing for the flare system treatment plant and other associated power plants associated with the landfill facility.

Where practical the settings of all interlocks and acceptable operating ranges to be provided to the owner operator a well as frequency of maintenance.

If there are no specific recommendations by the manufacturers or suppliers of gas components, equipment and piping; the Office recommends that Appendix B of AS 1375 be used as a guide maintenance frequency of the burner and gas systems.

Submissions For OGS Acceptance

For any Landfill or Biogas system section 73 of the Gas Safety Act requires that a submission for acceptance of the installation is made to the Office of Gas Safety. The submission must be in the writing and provide sufficient details as outlined in schedule 8 of the Gas Safety (Gas Installations) Regulations 1999. A Gasfitting notice signed by a licensed person preferably that will be involved in the commissioning and testing of the installation must accompany the submission.

Assessment of Australian Biogas Flaring Standards

RIRDC Publication No. 08/024

This report examines the environmental and safety regulatory requirements covering the supply and use of biogas flares in Australia and compares them with overseas requirements. It presents information on the cost and compares that with those from overseas. The report identifies impediments to a reduction in the cost of flaring systems for agricultural industries and makes recommendations on removing these impediments in order to make biogas capture more viable.

The research will benefit producers in Australia's intensive livestock industries by providing a clearer understanding of the regulations for biogas flares, in order to clarify expectations and avoid undue delays and costs in the development stages of projects. For the agricultural industry as a whole it will facilitate the uptake of biogas projects, which in turn will provide environmental benefits by reducing the industries' greenhouse gas emissions.

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Front and back over photos: Open flare with knock-out pot, flow meter, fan, air operated shut down valves (2), air compressor and flame arrestor (red). (Source: Windsor. This candle gas flare was originally designed and built by IPSCO for a landfill site owned by HG Leach Limited, New Zealand).

RIRDC Innovation for rural Australia