Assets Delivery Group
Mechanical and Electrical Services Branch

# DESIGN STANDARD DS 92

## For the Design, Installation, Commissioning, Operation and Maintenance of Biogas Facilities.

Version 2
Revision 1

May 2016

## FOREWORD

Design Standards are prepared to ensure that the Corporation's staff, consultants and contractors are informed as to the Corporation's design requirements and recommended practices. Design standards are intended to promote uniformity to simplify design and drafting practice and have as their ultimate objective the provision of safe and functional plant at minimum whole of life cost.

The Corporation design standards and recommended practices described in this standard have evolved over a number of years as a result of design and field experience gained through the operation, maintenance and upgrade of our Bio-gas facilities at the Beenyup and Woodman Point WWTPs.

Users are invited to forward submissions for continuous improvement to the Principal Engineer Mechanical, Mechanical and Electrical Services Branch who will consider them for incorporation into future revisions.

Andrew Klita
**Manager, Mechanical and Electrical Services Branch**

REVISION STATUS

The revision status of this standard is shown section by section below:

| REVISION STATUS | | | | | | |
|---|---|---|---|---|---|---|
| **SECT.** | **VER./ REV.** | **DATE** | **PAGES REVISED** | **REVISION DESCRIPTION (Section, Clause, Sub-Clause)** | **RVWD.** | **APRV.** |
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| | | | | | | |
| APP D | 2/0 | 13.12.12 | All | New Version | BG | AK |
| | | | | | | |

| Document Revision History | |
|---|---|
| May 2016 | • Topics regarding required qualifications for installations, rework and modifications to systems have been discussed with the Energy Safety Principal Engineer Gas Utilisation.<br><br>The conclusion is that by following a proper engineering process which would include but would not be limited to –<br><br>- Engineering design<br>- Risk Assessment<br>- Safety in Design report<br>- HAZOP<br>Modification or alterations to installations is allowable with the above processes completed. This can include work on – process pipework, apparatus such as compressors, scrubbers, condensate traps etc. Trades workers should and the Supervision shall have relevant gas fitting qualifications for this work.<br><br>Modifications to **Appliances** (as defined in Definitions Section of this document) **is not** the intention of this clarification. If this work is required it would be mandatory to involve the manufacturer or a suitably qualified gas appliance designer as these are Type B appliances and subject to compliance with Australian Standards.<br><br>• Year of issue of relevant Australian Standards has been removed. Users should refer to the current issue of any standards referred to.<br>• Minor editorial changes. |

# DESIGN STANDARD DS 92

## For the Design, Installation, Commissioning, Operation and Maintenance of Biogas Facilities

## CONTENTS

# 1 SCOPE and GENERAL

## 1.1 Scope

## 1.2 General

The focus of this standard is primarily mechanical. The electrical aspects, Hazardous Area Ratings (Explosive Atmospheres) and associated competencies, Plant dossiers etc are covered by the Water Corporation's Hazardous Area Management System.

### 1.2.1 Abbreviations

| | |
|---|---|
| AGA | The Australian Gas Association |
| DoC | Department of Commerce |
| HAMS | Hazardous Area Management System |
| MESB | Mechanical & Electrical Services Branch |

# 2 DEFINITIONS

**Anaerobic** - Lacking free oxygen.

**Biogas** - Gas generated from the decomposition of organic material by anaerobic digestion, see also Section 4.

**Consumer Gas** - Refer extended definition in Section 5

**Hazardous Area** - (on account of explosive gas atmospheres) - an area in which an explosive gas atmosphere is or may be expected to be present in quantities such as to require special precautions for the construction, installation and use of equipment.

**HAMS** - The Hazardous Area Management System is the Water Corporation's process to manage the development and revision of standards, procedures and documentation associated with hazardous areas. Locations where flammable atmospheres could be present under normal operation and credible equipment failures are referred to as "Hazardous Areas" (e.g. a gasket failure in a pipe flange). Note that hazardous areas in this context only consider flammability. Areas where other hazards could exist (e.g. $H_2S$ in toxic amounts) are not Hazardous Areas in the context of this document.

**Facility** - Water Corporation Wastewater Treatment Plant (WWTP) that generates, collects and uses biogas.

**Installation** - A system of valves, pipes, tanks, equipment, components and devices arranged to collect , monitor, treat and distribute biogas for use on a Water Corporation WWTP.

**Process Piping** - All piping from the biogas source (Digester) to the isolation valve of an appliance.

**Process Equipment** - Items of equipment not associated with an appliance. Typically condensate, storage or scrubbing vessels/tanks, compressors, filters, gas treatment etc.

**Appliance** - Any appliance that consumes gas for any purpose.

# 3 STANDARDS and REFERENCES

Standards of design, materials and workmanship shall comply with latest revisions of the relevant codes and standards listed below.

**AS 1375** : Industrial fuel-fired appliances (known as the SAA Industrial Fuel-fired Appliances Code)

**AS/NZS 60079.10.1** : Explosive atmospheres - Classification of areas - Explosive gas atmospheres (IEC 60079-10-1, Ed.1.0(2008) MOD)

**AS 3814** : Industrial and commercial gas-fired appliances.

**AS 4041** : Pressure Piping.

**AS/NZS 4761** : Competencies for working with electrical equipment for hazardous areas (EEHA)

**AS/NZS 5601.1** : Gas installations Part 1 General Installations,

**AS 61508.0** : Functional safety of electrical/electronic/programmable electronic safety-related systems

**AS IEC 61511** : Functional safety - Safety instrumented systems for the process industry sector

**Also -**

**Water Corporation** Engineering Design Manual - Requirements of the Water Corporation's Design Process (aquadoc #1074204)

**Water Corporation** WS-1 Welding Specification Metal Arc Welding

**EnergySafety** publications as listed in Appendix A

**Water Corporation** Strategic Product Specifications (SPS)

Water Services Association of Australia (WSAA) Codes

In the absence of the above, relevant international or industry standards shall be referenced.

# 4 INTRODUCTION

## 4.1 What is Biogas

Biogas typically refers to a gas produced by the biological breakdown of organic matter in the absence of oxygen. Biogas originates from biogenic material and is a type of bio-fuel. The biogas produced at the Water Corporation sites is by anaerobic digestion of biodegradable materials i.e. a mixture of raw primary sludge, activated sludge and skimmings. The biogas comprises primarily methane and carbon dioxide.

The composition of biogas varies depending upon the origin of the sludge and variations in the anaerobic digestion process. The typical composition of biogas as it occurs in Water Corporation processes is given in Table 1. Representative sampling at the specific site should be performed prior to any new design being undertaken.

The primary physical differences between biogas and consumer gas are the variance in composition (e.g. biogas has lower percentage of methane & more carbon dioxide), the quantity of moisture and the quantity of Hydrogen Sulphide ($H_2S$). These characteristics demand higher material and equipment specifications as well as regular inspection and maintenance requirements due to their toxicity and effect on system components.

| Component | % (Range) | WC Typical Values (%) | |
|---|---|---|---|
| | | Beenyup WWTP | Woodman Point WWTP |
| Methane ($CH_4$) | 15 - 75 | 63 | 54 |
| Carbon Dioxide ($CO_2$) | 25 - 50 | 36 | 44 |
| Nitrogen ($N_2$) | 0 - 10 | 0.75 | 0.25 |
| Hydrogen ($H_2$) | 0 - 1 | NA | 1900ppm |
| Hydrogen Sulphide ($H_2S$) | 0 - 4 | 2700ppm | 3500ppm |
| Oxygen ($O_2$) | 0 - 2 | 0.15 | 0.05 |

**Table 1:** Typical Biogas Composition

## 4.2 Sources of Biogas at the Water Corporation

### 4.2.1 Sludge Digestion Process

The primary source of biogas in the Water Corporation is the sludge digestion process, an anaerobic process used to break down the solid waste product at two major metropolitan wastewater treatment plants (Beenyup and Woodman Point) into a material suitable for re-use in agriculture. The digestion process takes place in large cylindrical or egg shaped digesters in which the sludge is continuously circulated whilst being maintained at a temperature of approximately 35$^{o}$C. During this process, significant quantities (approx. 20,000 m3 per day at Beenyup and 25,000m3 per day at Woodman Point) of biogas are produced.

The composition, moisture content and quantity of the biogas produced at the metropolitan wastewater treatment plants varies slightly as noted previously, depending on composition of the incoming sludge and the time of year.

The majority of biogas produced is used to provide heat energy to maintain the sludge digesters at the optimum temperature. This is achieved by either feeding the gas into gas fired water heaters (Beenyup) or gas powered engines (Woodman Pt) which have energy

recovery heat exchangers on their cooling water and exhaust systems . In the latter case, a significant quantity of electricity is also produced which can be used to supplement the power supply for the plant. In the case of Beenyup, some of the gas is compressed and recirculated back into the digesters to aid in mixing and the release of gas. If either plant is producing more gas than is required at a given time, the surplus gas is disposed of through a Waste Gas Burner (WGB). Venting to atmosphere through pressure relief valves on the top of the digesters or gas storage tank is an emergency measure only and considered highly undesirable because of the potential risk of an explosion and the likelihood of odour complaints.

### 4.2.2 Other Sources

Other minor sources of biogas production include waste products that may spill into galleries, pump station wet wells and other confined spaces, and gas that is given off in main sewers where the sewage has gone septic (high $H_2S$ levels) due to long retention times. In these situations, it is desirable for the gas to be vented either to waste or through some form of odour control unit, to prevent a build-up which is not only dangerous from an explosive or toxicity point of view but is also very aggressive when combined with moisture (forms Sulphuric Acid - $H_2SO4$) on the exposed concrete linings of sewer pipes, manholes and wet wells.

Major Components of Water Corporation Biogas Systems may include:

- Sludge Digesters;
- Gas storage facilities;
- Sludge Heaters;
- Gas powered engines;
- Gas compressors;
- Waste Gas Burners;
- Condensate traps / drains;
- Regulating and Isolating Valves; and
- Interconnecting pipework and fittings.

### 4.2.3 Properties of Biogas

The methane in biogas forms explosive mixtures in air. The lower explosive limit is 5% methane and the upper explosive limit is 15% methane. Methane is also an asphyxiant and may displace oxygen in an enclosed space. Asphyxia may result if the oxygen concentration is reduced to below 19.5% by displacement. The concentrations at which flammable or explosive mixtures form are much lower than the concentration at which asphyxiation risk is significant. It is also worth noting that the methane contained within biogas is 20 times more potent as a greenhouse gas than carbon dioxide.

The biogas' water vapour content as it exits the digesters is high and some of this condenses out during its path through the process. This condensate must be collected and removed from the gas system to prevent blockages and carry over into equipment and appliances.

### 4.2.4 Siloxanes

Biogas may contain substances called siloxanes. These compounds are found in personal care products (cosmetics, shampoo, etc) and come to the plant in the wastewater stream. During combustion of biogas containing siloxanes, silicon compounds are formed. Deposits formed contain mostly silica ($SiO_2$) or silicates ($Si_xO_y$) and may also contain calcium, sulfur, zinc and phosphorus. These deposits affect heat transfer and lubrication effectiveness in reciprocating gas engines.

Siloxanes have been a problem in many biogas engine facilities around the world and have certainly caused excessive maintenance cost and downtime on the gas engines in the energy recovery facility at the Woodman Point WWTP. The material builds up on exhaust valves, combustion chambers, pistons and turbochargers on the gas engines and significantly increases the maintenance required.

# 5 APPROACH

Water Corporation facilities with biogas do not fall under the authority of Energy*Safety* as the gas is produced and used on the same site ('sole use'). However, this definition may change in the future and it is logical that the conformance of the Water Corporation's biogas installations to the requirements of consumer gas installations be adopted from both a safety and risk perspective. The intent of this standard is to provide guidance for designers and maintainers on the requirements for WC biogas installations with the current Energy Safety position.

The Water Corporation's Biogas installations incur a Hazardous Area zoning due to their classification under AS/NZS 60079.10.1. Areas around fuel fired appliance gas train equipment can be classified Non Hazardous if it complies with gas industry codes.

Energy*Safety* (Dept of Commerce) is responsible for the technical and safety regulation of the electrical industry, and most of the gas industry in Western Australia. An (Energy*Safety*) approved consumer gas installation does not, by definition, constitute a hazardous area.

In this Standard, reference to Biogas installations refers primarily to fuel fired appliances (e.g. water heater, waste gas burner, gas engine). Biogas pipework, devices and fittings not associated with an appliance and upstream of the appliance isolation valve is classified as process equipment or pipework. Having made this distinction however, process pipework (including valves, fittings, connections etc.) shall be suitable for the biogas service and comply with the appropriate industry standard/s.

The Gas Standards (Gasfitting and Consumer Gas Installations) Regulations 1999 apply to any gas installation which falls under the definition of a consumer gas installation and therefore their adoption for biogas installations would infer conformance to Energy*Safety* requirements

The purpose of this Design Standard is to set the requirement to design, install, operate and maintain biogas appliances to meet the approval requirements of Energy*Safety*. Note that although Energy*Safety* currently have no jurisdiction over biogas installations, the compliance to the Energy*Safety* requirements will eliminate the Hazardous Area Zoning status of these installations.

For consumer gas appliances and installations, in order to meet the approval requirements of Energy*Safety*, the following criteria must be met:

1. Components used must be AGA approved where suitable approved fittings are available,
2. The design must meet the relevant requirements of AS3814, AS/NZS5601.1, AS1375, AS61508 and AS61511 where applicable,
3. The system must be approved by an appropriately certified inspector as defined by the gas standards,
4. The system operational procedures must conform to those required by the Gas Standards (Gasfitting and Consumer Gas Installations) Regulations 1999,
5. The system maintenance procedures must conform to those required by the Gas Standards (Gasfitting and Consumer Gas Installations) Regulations 1999.

An appropriately certified inspector as defined by the gas standards shall review the biogas appliance system design and installation. With respect to item 3 however, the Office of Energy cannot issue a compliance certificate for a biogas installation however they can issue a statement that the installation meets the requirements for Consumer gas and where relevant the certified standards AS/NZS5601.1, AS3814 and AS1375

This Design Standard has been written to provide guidelines for the implementation of items 1 to 5 above, as criteria and/or procedures are not defined for biogas systems. The standard is also applicable to the modification or upgrade of existing biogas appliances. The requirements of hazardous areas concerning instrumentation and other electrical devices shall still apply.

As noted the intent of this standard is to consider the biogas as consumer gas - 'as far as practicable'. For many of the Type B gas appliances (burner, heater etc), they are fitted with a LPG or NG pilot and for this system - compliance to all Energy Safety requirements is mandatory. For appliances such as heaters or engines with dual fuel capability, the expectation is that the biogas train is designed and installed capable of being certified compliant to the same standard as the consumer gas train.

## 5.1 Consumer Gas

The Principal Engineer Gas Utilisation, Energy Safety Division of the Department of Commerce, provided the following definition:

"This is how the Gas Standard Act 1972 and the Gas Standards (Gasfitting and Consumer Gas Installations) Regulations 1999 are interpreted regarding gas installations where the gas is generated and consumed on the one site.

In Western Australia consumer gas installations must comply with the Gas Standards (Gasfitting and Consumer Gas Installations) Regulations 1999. The Gas Standards Act 1972 defines a consumer as;

**consumer** means any person (not being an undertaker) to whom gas is supplied by an undertaker or a pipeline licensee;

**pipeline licensee** is defined the holder of a pipeline licence granted under the Petroleum Pipelines Act 1969;

**undertaker** means any licensee within the meaning of the Energy Coordination Act 1994 and any local government, regional local government, body corporate, firm or person making or supplying gas other than solely for its or his own use.

Where the gas is generated and consumed on site ('sole use') then they are not an undertaker, and the gas has not been supplied by a pipeline licensee, therefore they are not a consumer, the installation is not a consumer installation and hence not subject to the Gas Standards (Gasfitting and Consumer Gas Installations) Regulations 1999".

Other clarifications on the Gas Standards Act and the Gas Standards Regulations have concluded that the biogas systems are not subject to the Act / Regulations. Studies for Australian Government bodies focussing on agricultural use across various states and the regulation of biogas for own use (heating or flaring) show very few States including WA have (Gas Safety) regulations that cover this.

It is recommended by EnergySafety that the systems are designed, installed, operated and maintained to reflect Consumer Gas standards. This is the intent of DS92.

# 6 PROCESS

The person or persons supervising, approving or reviewing the design or design modification of Water Corporation biogas appliances must have at least five years of proven design experience in consumer and/or non-consumer gas (generation, storage and fired) facilities and possess a recognised qualification in the relevant competency standards as defined in AS4761:2008 *Competencies For Working With Electrical Equipment For Hazardous Areas (EEHA) - Competency Standards.* They must also be familiar with, or be able to draw directly upon persons experienced in, installation, commissioning, operation and maintenance of consumer gas (generation, storage and fired) installations.

The adoption of the requirements of consumer gas installations also requires approval of the design and installation process which includes a third party review, as outlined in figures 1 to 4 in the Water Corporation's Engineering Design Manual , and a statement that the works meet the requirements of the certified standards (see Appendix D).

The Water Corporation's Asset Acquisition Process includes External Approval steps that would be relevant to a biogas installation. Items such as Third Party review and final inspection by a gas inspector and any special or additional requirements relating to gas installations would be captured here.

Section 6.4 of the Energy*Safety* publication 'Guidelines for the approval of Type B appliances in Western Australia' contains flowcharts for Approvals for Installation, Commissioning and Certification of appliances.

It should be understood that the process by which appliances are certified by Energy*Safety* refers to two distinct stages of a submission, namely:

- Approval for Installation; and
- Inspection and Certification of the installed and commissioned appliance.

These two stages are incorporated in the Water Corporation Design Process, which is described below:

- ***Approval for Design*** – defined as the process by which the preferred consultant reviews the design brief and submits an estimate to undertake the entire works, to include design, installation and commissioning as well as the generation of a detailed Technical Submission.
- ***Preliminary Design*** – defined as the verification of planning decisions, definition of the primary engineering outline of the works, definition of the required operator facilities and preparation of an estimate for completion of the design, installation and commissioning of the works, to allow a technical review and acceptance of the recommended design concept (i.e. **Approved for Installation**). This phase shall also include a HAZOP.
- ***Engineering & Detail Design*** **-** defined as the detailing of the major components, definition of the functional requirements, preparation of significant engineering calculations and detailed drawings and specifications. It also involves preparation of a detailed estimate for completion of the design, installation and commissioning of the works. On completion, the design will be subject to third party review to confirm that the design conforms to Energy*Safety* codes and practices, and any existing Hazardous area rating for the area of the plant concerned.

This phase shall also include a 'Safety in Design Report'.

- ***Aquisition*** – This phase includes purchase of all equipment, including Principal supplied equipment, preparation of tender documents, contract award and physical construction.
- ***Commissioning & Handover*** – defined as the pre-commissioning, commissioning and approval to handover (to customer) stages. This shall include updated HAMS documentation for the area of plant concerned. (i.e. **Inspected and Certified**).

  A Water Corporation Certificate of Compliance template is supplied in Appendix D.

  The Commissioning and Handover requirements (see Section 6.3 and Appendix C) have been tailored to meet the requirements of the Water Corporation's Asset Handover Guidelines

Requirement for AGA compliant valves and fittings

The design shall identify or specify that all valves used or replaced in Water Corporation appliance biogas systems must be AGA compliant, unless:

a) an AGA compliant valve is not available due to size limitations, in which case it would be acceptable to use a valve from the same supplier and family of valves which is identical in design, function, performance and material composition but a larger size (generally 300mm max.); or

b) an AGA compliant valve is available but it is preferred to use a valve from the same supplier and family of valves which is identical in size, design, function and performance but has a superior material composition in terms of long term exposure to biogas (e.g. Oil and Gas industry specification suitable for 'sour' gas use);

In either case, full details of the valve's physical and performance characteristics shall be recorded, along with a detailed explanation of why the valve was selected.

Table 2 indicates the material recommendations for items to be used in biogas systems.

| Component | Material | Note |
|---|---|---|
| Pipework[1] | 316L Stainless Steel[2] or<br>Hot Dip Galvanised Carbon Steel | Refer also AS4041 |
| Component bodies | SS 316 / CF8M | |
| Valve seats[3] | Fluoro Elastomer (FKM) | Preferred |
| Seals / gaskets[3] | FKM, Nitrile, NBR | Static applications |
| | | |
| | | |

**Table 2**: Material (minimum) requirements for biogas system components

NOTES

1. Pipework joints should be fully welded where possible (Refer WS-1 Water Corporation Welding Specification). The use of flanged connections within buildings and ducting should be avoided to reduce Hazardous Area Rating and the possibility of leaks.

2. If stainless steel pipework is used correct welding and passivation procedures must be followed to preserve the corrosion resistant properties of the stainless steel. Consideration also needs to be given to the temperature effects and limitations on components and fittings that are used on process circuits such as the gas recirculation / mixing compressors.

3. Chemical compatibility tables vary slightly, the suitability of the material rated for the concentrated environment (e.g. Methane, H2S etc) rather than a mixture of gases like Digester / Bio gas. The Fluoroelastomer category generally rates highly. Historically NBR has given good service. Failures have been observed on valves liners believed to be EPDM.

## 6.1 Technical Submission

The Technical Submission to Energy Safety for appliances shall follow the procedures described in Appendix A and Appendix B of AS3814 and is a mandatory deliverable for all consumer gas installations. The Template given in Appendix B summarises the requirements for the biogas deliverable information. The technical submission demonstrates due diligence in the design of the system and selection of system components. A copy of this documentation is also required as a deliverable at handover of the asset / system.

## 6.2 Construction and installation

Prior to commencement of construction all necessary approvals and authorizations as defined AS 3814 shall be obtained. All construction and installation work of an appliance shall be carried out by appropriately qualified tradespersons as described in the DoC Energy Safety publication *Gasfitting Authorisation Guidelines and Requirements*.

It is also a requirement that all construction and installation procedures must comply with Water Corporation safety and work procedures, including:

- Clearance to Work Permit/s;
- Hot Work Permit/s;
- Job Hazard Analysis and Job Safety and Environment Analysis (JSEA) documentation and procedures.

Construction and installation work undertaken in and around biogas systems (brownfield site) must also comply with the requirements of the Corporation's Hazardous Area Management System (HAMS).

## 6.3 Commissioning and Handover Requirements

Commissioning and handover requirements shall comply with the following:

- Water Corporation Asset Commissioning Guidelines (aquadoc #457191);

For further reference the following should be used;

- AS3814 App I - Typical Commissioning Procedure and App J - Typical Field Check List

Documentation shall include, but not be limited to,

- Updated Safety in Design document.
- A Copy of all technical submissions.
- Completed Technical Submission Template given in Appendix B
- As-built detailed valve, pipe and component schedule (e.g. size, materials, approvals, component ID reference)
- As-built General Arrangement and P&ID drawings for each appliance including the appliance valve train.
- Statutory approval documents.
- Pre-commissioning and Commissioning records.
- Tables detailing volumes of all pipe sections and components (e.g. condensate vessels) for purging volume calculation purposes.
- Other documentation as required through the Water Corporation's Asset Commissioning and Handover guidelines.

# 7 MAINTENANCE OF BIOGAS SYSTEMS

The adoption of the design and approval requirements for consumer gas installations dictates that a **Gas Fitting Log Book** is installed and maintained for each biogas installation (Refer HAMS process). All maintenance, servicing and repair information shall be entered into the logbook.

All maintenance work must be carried out as described in the DoC Energy Safety publication *Gasfitting Authorisation Guidelines and Requirements*. This EnergySafety document describes the requirements and limitations of Gasfitting Authorisations issued to Supervising Gas Fitters and Supervised Gas Fitters. Depending on the nature of the work a licensed Gas Fitter (external contractor) may need to be engaged to do work on the burner pilot systems, as these are typically Consumer gas (Natural or LP gas).

The Gasfitting Authorisations process is primarily intended for the consumer gas installation and maintenance part of the industry. Its rigid application to the biogas area brings up many conflicts. Topics regarding required qualifications for installations, rework and modifications to systems have been discussed with the Energy Safety Principal Engineer Gas Utilisation.

The conclusion here is that by following a proper engineering process which would include but would not be limited to –

- Engineering design
- Risk Assessment
- Safety in Design report
- HAZOP

Modification or alterations to installations is allowable with the above processes completed. This can include work on – process pipework, apparatus such as compressors, scrubbers, condensate traps etc. Trades workers should and the Supervision shall have relevant gas fitting qualifications for this work.

Modifications to Appliances is not the intention of this clarification. If this work is required it would be mandatory to involve the manufacturer or a suitably qualified gas appliance designer as these are Type B appliances and subject to the Australian Standards noted.

Particular attention is drawn to the Like for Like definition in the above Guideline document (*Gasfitting Authorisation Guidelines and Requirements*) regarding component replacement on the gas appliances.

It is a requirement that maintenance procedures must comply with all Water Corporation safety and work procedures, including:

- Clearance to Work Permit/s;
- Hot Work Permit/s;
- Job Hazard Analysis and Job Safety and Environment Analysis (JSEA) documentation and procedures.

All maintenance work undertaken in and around biogas systems must comply with the requirements of the Corporation's Hazardous Area Management System (HAMS).

# 8 APPENDIX A - Dept. of Commerce publication links

Full documents available from -- EnergySafety publication link

1 Gas Standards (Gasfitting and Consumer Gas Installations) Regulations 1999 (Cover page only)

2 Safety Regulatory regime for industrial gas-fired appliances and installations in Western Australia. (Cover page only)

3 Guidelines for the approval of Type B (industrial) gas appliances in Western Australia. (Cover page only)

4 Code of Practice for Inspectors (Gas) in Western Australia. (Cover page only)

5 Guidelines for Safe Working with Gas in Consumers' Installations. (Cover page only)

6 Gasfitting Authorisation Guidelines and Requirements. (Cover page only)

7 Guidelines for Basic Combustion and Flue Gas / Exhaust Principles (Cover page only)

8 Guidelines for Gas Safety Training (Cover page only)

9 Guidelines for Gasfitting Legislation Course (Cover page only)

## Reference 1

Western Australia

Gas Standards Act 1972

# Gas Standards (Gasfitting and Consumer Gas Installations) Regulations 1999

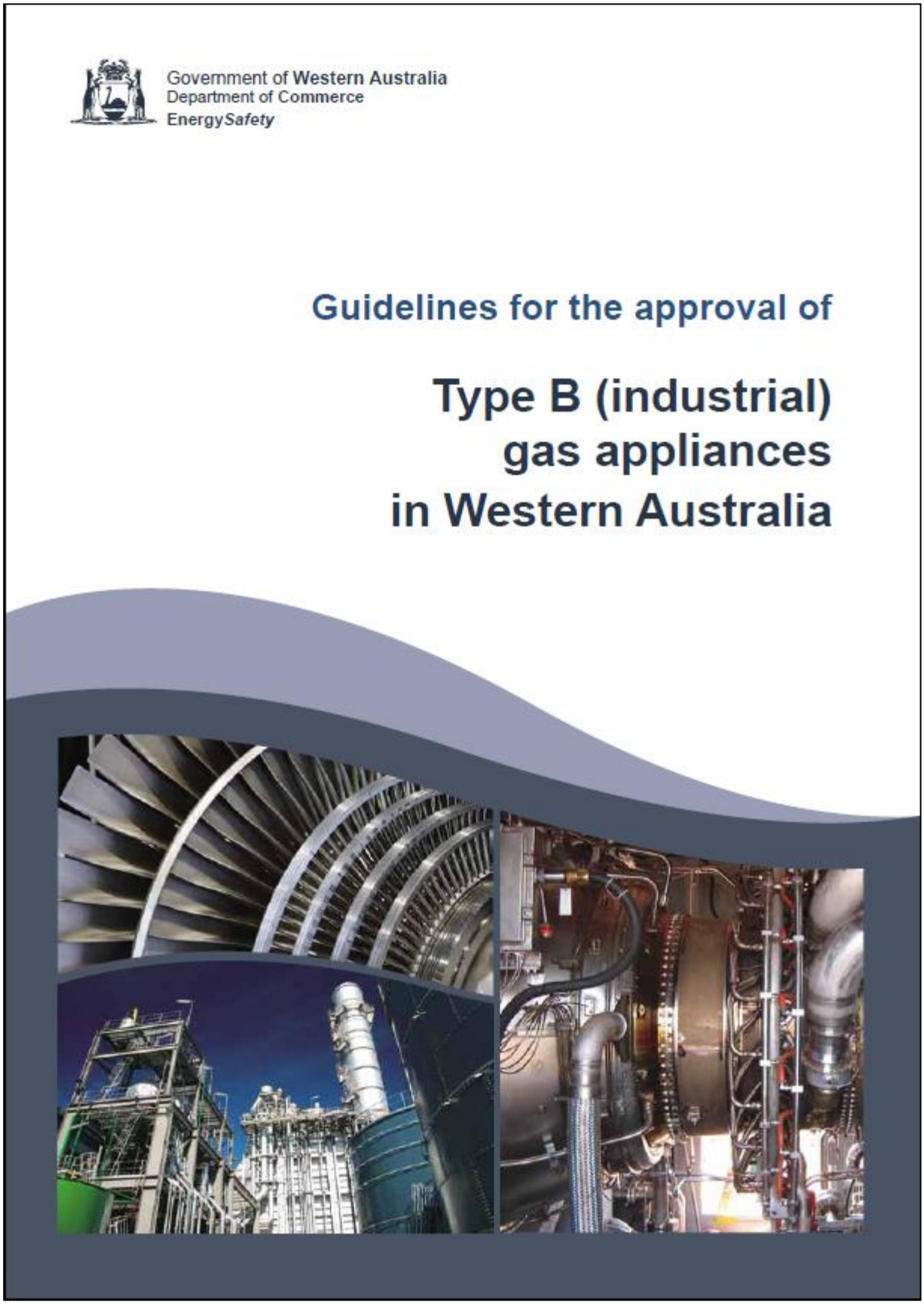
As at 08 Jul 2011 Version 04-a0-01
Extract from www.slp.wa.gov.au, see that website for further information

## Reference 2


**Safety regulatory regime for industrial gas-fired appliances and installations in Western Australia**

Table of contents

## Reference 3



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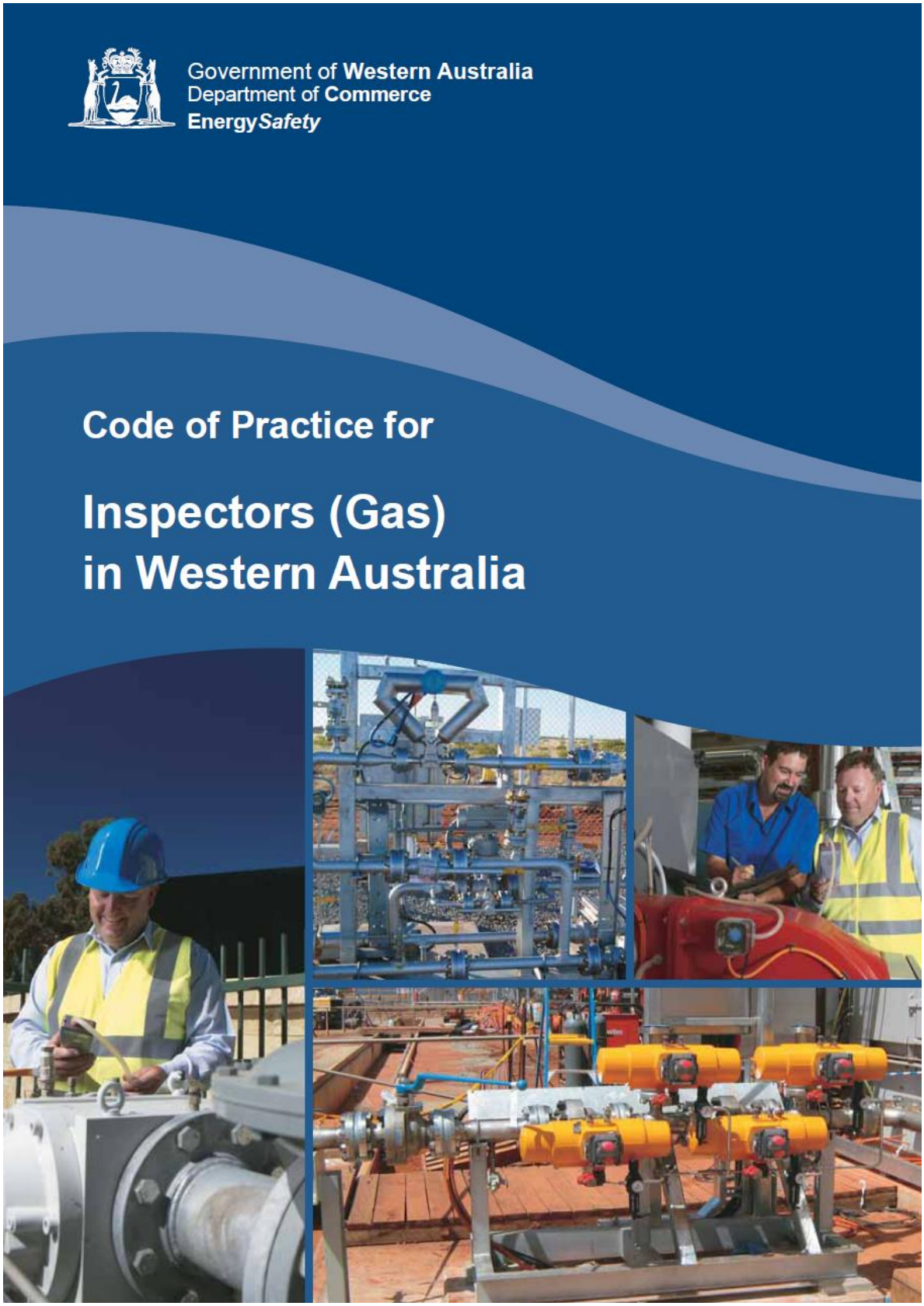

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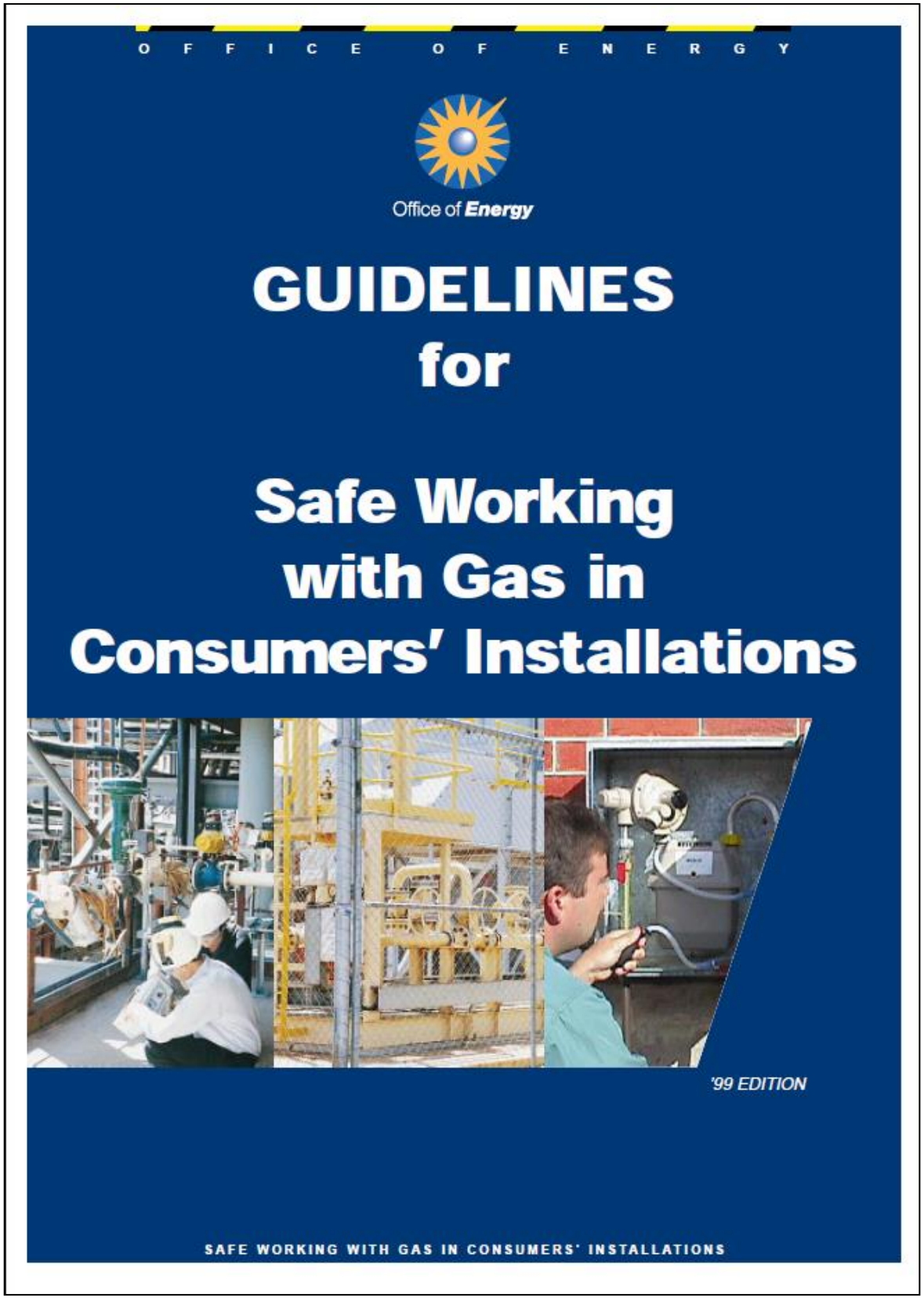

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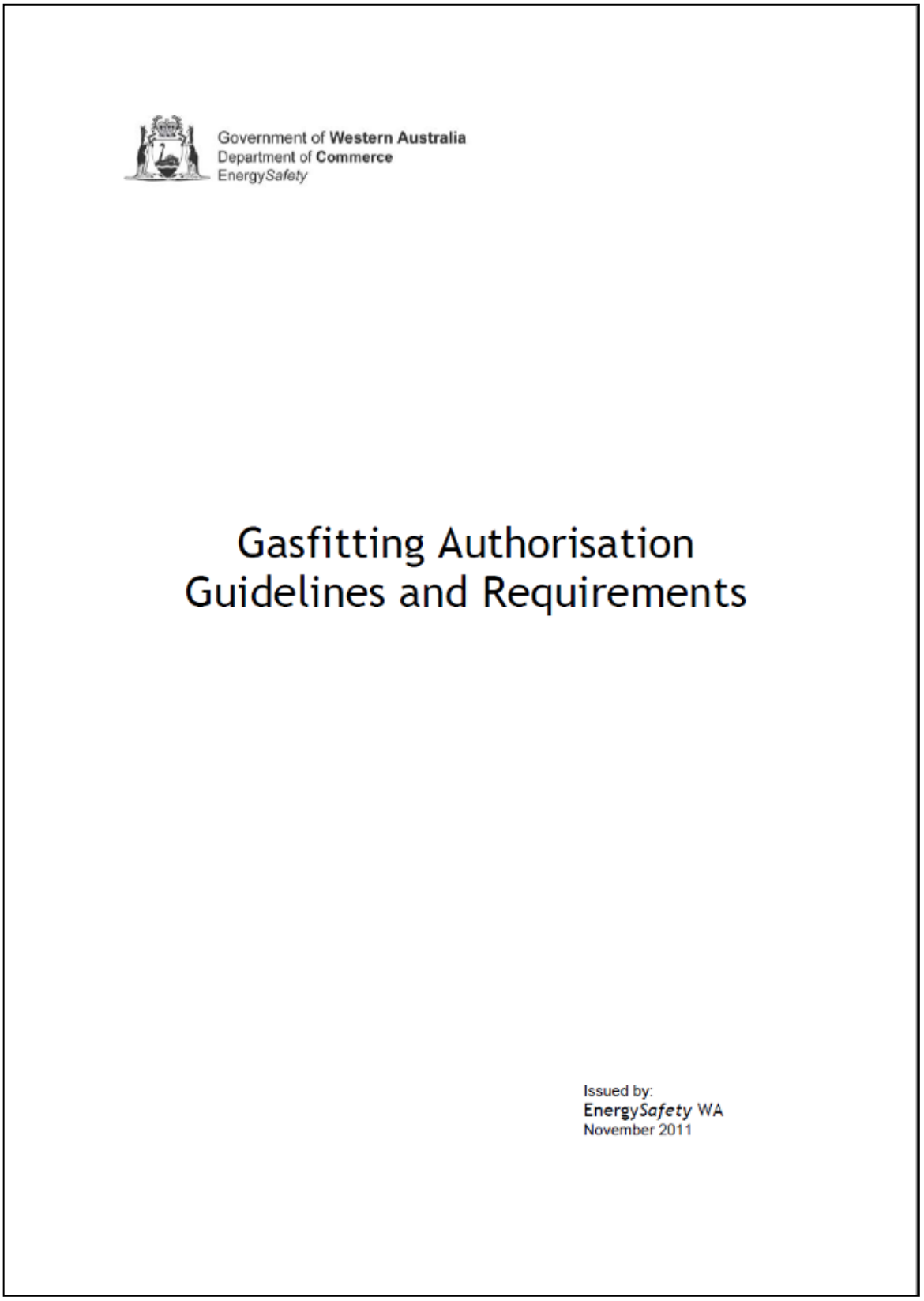
Government of **Western Australia**
Department of **Commerce**
Energy*Safety*

Gasfitting Authorisation
Guidelines and Requirements

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Energy*Safety* WA
November 2011

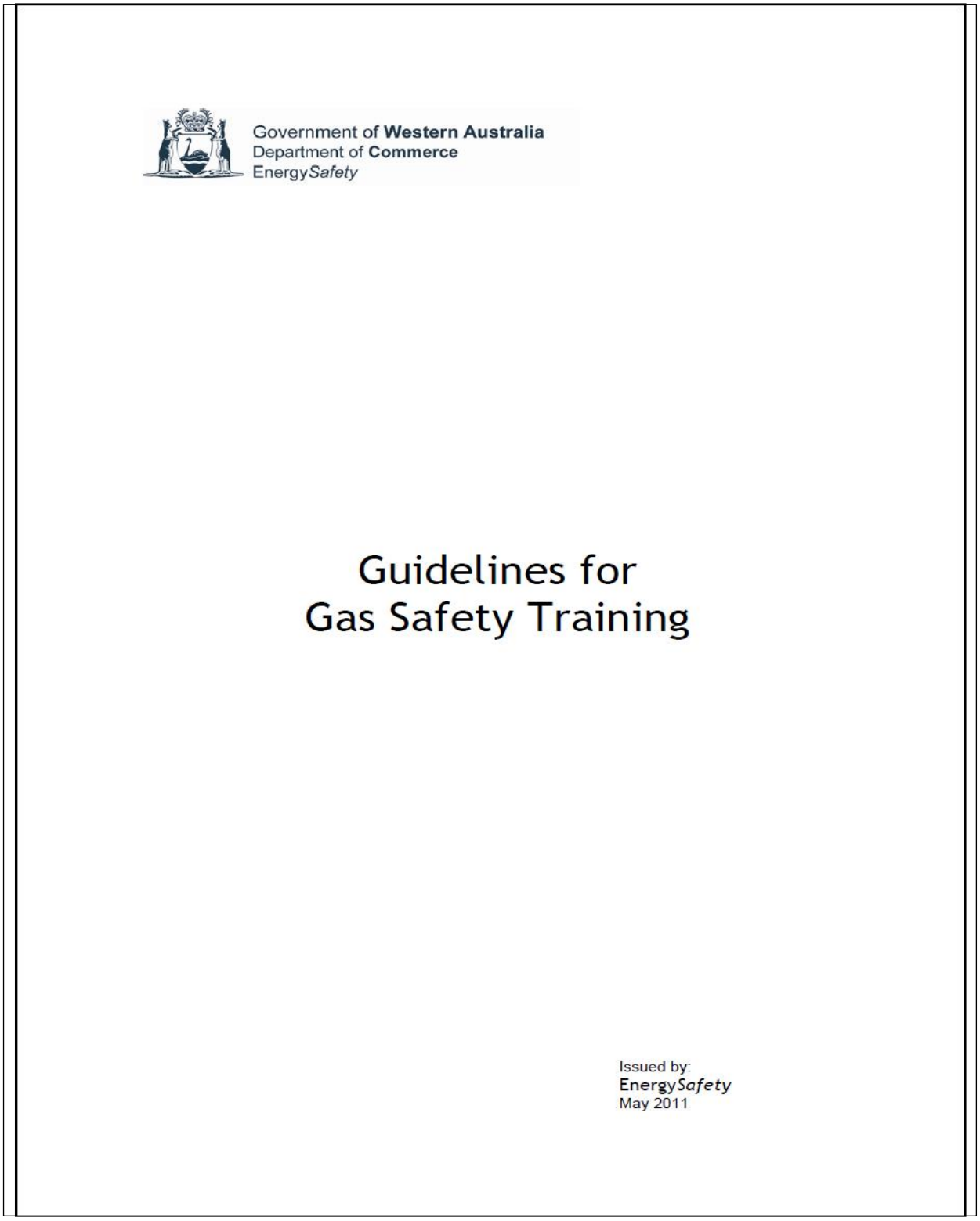
## Reference 7

Government of **Western Australia**
Department of **Commerce**
Energy*Safety*

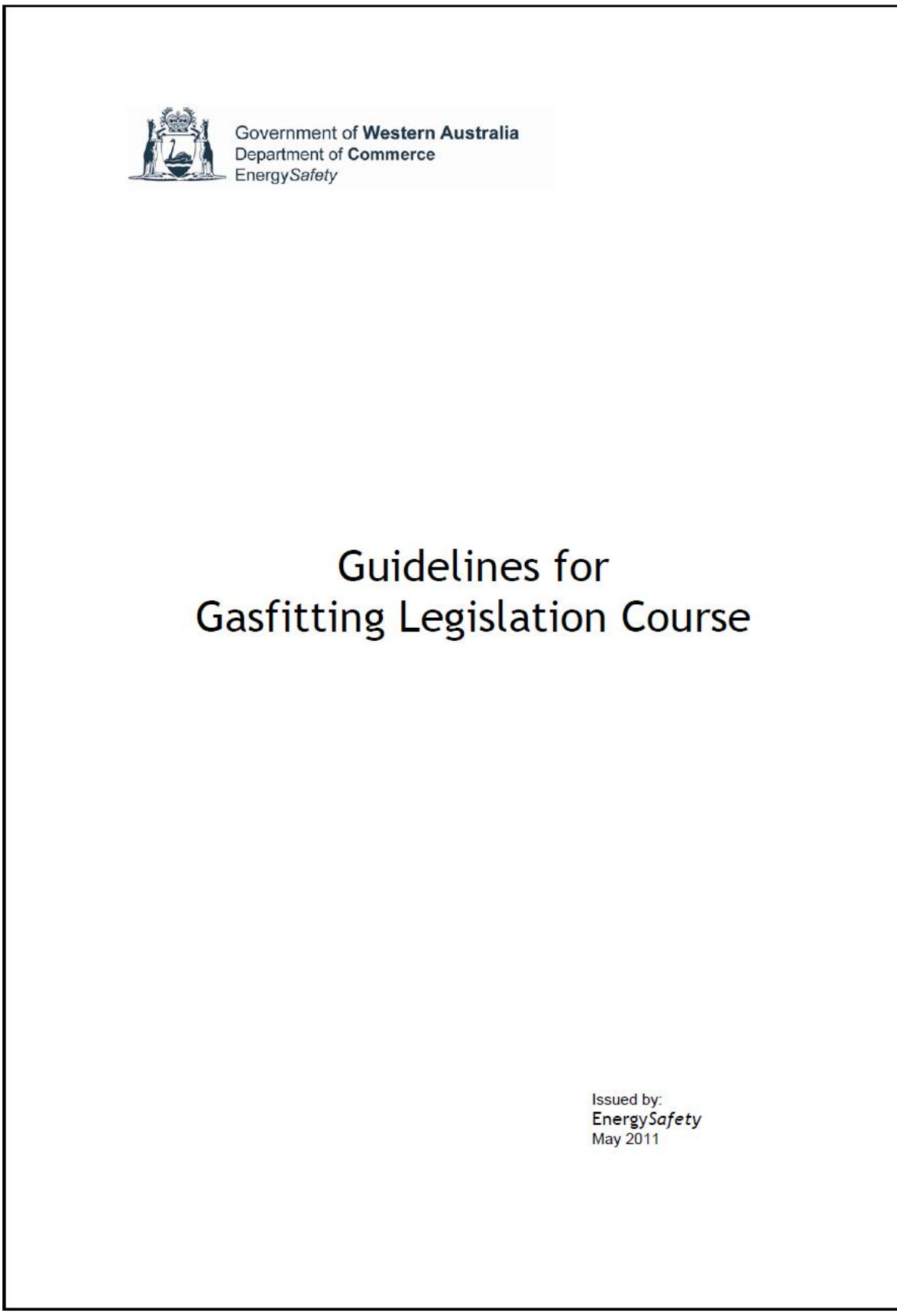
# Guidelines for Basic Combustion and Flue Gas/Exhaust Principles

Issued by:
Energy*Safety*
May 2011

## Reference 8



## Reference 9



# 9 APPENDIX B – Technical Submission Template

| Item | Description | Data | | | | |
|---|---|---|---|---|---|---|
| 1 | Full name and address of Appliance Manufacturer | | | | | |
| 2 | Full name of authorised designer | | | | | |
| 3 | Full name of authorised installer or conversion contractor | | | | | |
| 4 | Full name of commissioning person | | | | | |
| 5 | Water Corporation Site where appliance(s) is(are) to be installed | | | | | |
| 6 | Full name of site Operational Contact<br>Contact number of Site Operational Contact | | | | | |
| | **Gas Burner Installations Only** | | | | | |
| 7 | Number of Burners and type[1] | Burner 1 | | | | |
| | | Burner 2 | | | | |
| | | Burner 3 | | | | |
| | | Burner 4 | | | | |
| 8 | Nominal Gas Consumption for total appliance and for each burner (if applicable) | Item | Low | | High | |
| | | Appliance | | MJ/h | | MJ/h |
| | | Burner 1 | | MJ/h | | MJ/h |
| | | Burner 2 | | MJ/h | | MJ/h |
| 9 | Gas Consumption at ignition for each burner[1] | Burner 1 | | | | MJ/h |
| | | Burner 2 | | | | MJ/h |
| 10 | Air flow rate at ignition for each burner[1] | Burner 1 | | | | $m^3/h$ |
| | | Burner 2 | | | | $m^3/h$ |
| 11 | Volume of each combustion chamber[1] | Burner 1 | | | | $m^3$ |
| | | Burner 2 | | | | $m^3$ |
| | **Gas Engine Installations Only** | | | | | |
| 12 | Number of Engines and type[1] | Engine 1 | | | | |
| | | Engine 2 | | | | |
| | | Engine 3 | | | | |
| | | | | | | |
| 13 | Nominal Gas Consumption for each engine[1] | Item | Low | | High | |
| | | Engine 1 | | MJ/h | | MJ/h |
| | | Engine 2 | | MJ/h | | MJ/h |
| 14 | Gas Consumption at ignition for each engine[1] | Engine 1 | | | | MJ/h |
| | | Engine 2 | | | | MJ/h |
| 15 | Air flow rate at ignition for each engine[1] | Engine 1 | | | | $m^3/h$ |
| | | Engine 2 | | | | $m^3/h$ |
| 16 | Combined combustion chamber volume of each engine[1] | Engine 1 | | | | $m^3$ |
| | | Engine 2 | | | | $m^3$ |
| **Item** | **Description** | **Data** | | | | |
| | **All Appliances** | | | | | |
| 17 | Total volume swept by the combustion products from the combustion chanber(s) to each flue connection | | | | | $m^3$ |
| 18 | Air flow rate during purge periods | | | | | $m^3/h$ |
| 19 | Details and method of operation of any combustion air or flue dampers | Attach document and label TS13 | | | | |
| 20 | Details of any explosion reliefs including location, cross-sectional area and weight together with calculations | Attach document (refer AS1375 Appendix E) and label TS14 | | | | |
| 21 | Appliance marking plate details | Attach document (refer AS3814 Section 4.1) and label TS15 | | | | |
| | (a) Manufacturers name | | | | | |
| | (b) Model identification | | | | | |
| | (c) *Nominal gas consumption* | | | | | |
| | (d) *Gas* type | | | | | |
| | (e) Max. & min *gas* supply pressures | | | | | |
| | (f) *Purge* times | | | | | |
| | (g) Gas pressure at the burner head for the *nominal gas consumption* | | | | | |
| | (h) Combustion chamber volume (combined for engines) | | | | | |
| | (i) Total volume swept by the *combustion products* in passing from the *burner* to the *flue* connection | | | | | |
| | (j) Serial number | | | | | |
| | (k) Date of manufacture | | | | | |
| | (l) Dilution air volume $m^3$/min @ 20°C (where applicable) | | | | | |
| | (m) Any other markings required by the technical regulator | | | | | |

Notes

1 attach additional information if required

2 append other submission requirements

# 10 APPENDIX C – Documentation and Handover Requirements

**This table describes some key requirements in the design, commissioning and handover of biogas appliances. It does not replace or override any other requirements called for in the Water Corporation's Asset Acquisition Process and Asset Commissioning Guidelines.**

| Phase/Stage | | Deliverables |
|---|---|---|
| Engineering & Detail Design & Approval for Installation (Implementation Phase) | | |
| | | • Safety in Design Report including Risk Register.<br>• Technical Submission:<br>○ Completed valve train schematic specifying all valve train components (i.e. brand, model number, size, rated working pressure and AGA approval, or reasons for deviating from AGA approved components) and the proposed settings for all fixed and adjustable devices (AS3814 Appendix A Item 16)<br>○ Completed Electrical wiring diagram showing the safety and control circuits including details of the brand, model number and method of operation of each component and the proposed setting of all fixed and adjustable devices (AS3814 Appendix A Item 17)<br>○ Completed Logic and Loop diagrams<br>○ Completed P&IDs<br>○ All consumption, flow rate, purge, start gas, emergency shut down and critical energy calculations<br>○ Completed Functional Description and Functional Specification within the context of the process area.<br>○ Completed Operating Instructions within the context of the process area. These instructions should detail the complete operating sequence |

| | | |
|---|---|---|
| | | for each burner system, to include all set points, protective/safety interlocks and interactions between the burner management system and the PLC<br>○ Detailed description of the working of the burner management system and corresponding logic and timing diagrams<br>○ Cause and effect matrix / troubleshooting guide for the burner management system.<br>○ Recommended list of spares for the system developed using appropriate analysis tools. |
| Commission | | Signed Certificate of Compliance from a suitably qualified and experienced inspector confirming that the design and installation meets the requirements of the certified standards AS/NZS5601.1, AS3814 and AS1375 |
| Training | | • Generate training documentation<br>• Updated Safety in Design Report |
| Asset Handover | | • Updated information as originally supplied with Technical Submission<br>• MDR's generated and supplied<br>• Operational Instructions (As Commissioned) |

# 11 APPENDIX D – Certificate of Compliance

| Certificate of Compliance for Biogas Equipment | | |
|---|---|---|
| Site | | |
| Process Area | | |
| Equipment Description | | |
| Equipment Tag Number | | |
| Equipment Functional Location Number | | |
| This equipment has been inspected and assessed for compliance with DS92 and was found to comply with the requirements of the certified standards current at the date of inspection. Works meet the requirements of the certified standards | | |
| Equipment Supplier | Company | |
| | Title | |
| | Full Name | |
| Equipment Installer | Company | |
| | Title | |
| | Full Name | |
| Commissioning Person | Company | |
| | Title | |
| | Full Name | |
| If this appliance is modified or relocated, it must be upgraded to meet the requirements of DS92 current at the time of modification or relocation and be re-submitted to an appropriately qualified and licensed Gas Inspector for approval. | | |
| Gas Inspector | Company | |
| | Branch | |
| | Person (Full Name) | |
| | | |

Essential Maintenance
This equipment and its associated safety equipment must be maintained in a state of proper repair. All maintenance work must be supervised by an appropriately qualified Licensed Gas Fitters. Failure to do so may render the equipment unsafe.

**END OF DOCUMENT**