Resources Safety & Health
Queensland

Hydrogen Safety Code of Practice

Petroleum and Gas Inspectorate

August 2022 | FINAL DRAFT

Final Draft

Resources Safety and Health Queensland is publishing this draft Code of Practice for the purposes of providing a consolidated framework for current fuel gas requirements that apply to hydrogen applications.

Proposed requirements needing legislative amendment are highlighted in the Code. These are not statutory requirements and current legislation continues to apply. Legislative amendments are being progressed and are subject to Government processes and approval.

If you are undertaking a project that cannot comply with current legislative requirements, please contact the Petroleum and Gas Inspectorate at: hydrogensafety@rshq.qld.gov.au

Overview

The Queensland Government is committed to developing an effective, risk-based safety regulation that will support a sustainable and safe Queensland hydrogen industry. A safety code of practice is a tool that can inform industry specific stakeholders about safety requirements and approvals.

In Queensland, the safety of fuel gases, including hydrogen, is regulated under the *Petroleum and Gas (Production and Safety) Act 2004* (P&G Act) which is administered by the Petroleum and Gas Inspectorate of Resources Safety and Health Queensland (RSHQ).

RSHQ is publishing this draft *Hydrogen Safety Code of Practice* (the Code) for the purposes of providing a consolidated and accessible reference point for fuel gas requirements that apply to hydrogen applications. The Code provides certainty about legislative requirements for hydrogen as a fuel gas and guidance for compliance.

The Code has been developed in consultation with industry and government stakeholders and is designed to inform industry of approval pathways and safety requirements for operations that use hydrogen as a fuel. The Code also sets out proposed legislative changes where existing requirements under the P&G Act are not practicable.

This publication of the Code remains draft as Government approval is needed to amend legislation including a provision to call up the Code as a statutory instrument. It is anticipated that legislation will be amended by June 2023 subject to Government approvals and processes.

Sections 1-7 of the Code, read in conjunction with relevant provisions of petroleum and gas safety legislation, set out current and proposed safety and approval requirements for hydrogen activities. Appendices 1-8 include information about approvals, case studies and other resources. Proposed legislative changes are highlighted throughout the Code and collated in Appendix 7.

The Code will be periodically revised with consideration of new standards, competencies and applications.

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Acronyms and terms

Table 1 describes the meaning of terms and acronyms used in this document. For terms defined in legislation (see Legislative Reference column), the description in Table 1 may be simplified. The P&G Act, P&G Safety Reg and GP Regulation can be referenced for the full definition.

Table 1 Acronyms and terms.

Acronym / Term	Description	Legislative Reference
Acceptable level	The level of risk for the activities is within acceptable safety limits, having regard to each relevant safety requirement, and is as low as is reasonably practicable (ALARP)	P&G Act s700 (1)
AS/NZS 2885 series	The Australian Standard series for Gas and Liquid Petroleum Pipelines.	-
AS/NZS 4645 series	The Australian Standard series for Gas Distribution Networks	-
Appropriately authorised person	A person holding a GWL or GWA with approval to work with hydrogen	-
container	tank, vessel, cylinder used for fuel gas storage and transport	-
Code	the draft Hydrogen Safety Code of Practice (this document)	-
Fuel cell gas device	A device that uses the chemical energy of fuel gas (hydrogen) to produce electricity. • Mobile fuel cells refer to fuel cells used in vehicles and vessels. • Stationary fuel cells refer to fixed applications for power generation and include portable units.	-
Fuel cell gas system	Fuel cell gas systems are type B gas devices that include a fuel cell and any of the following: • hydrogen production unit • hydrogen storage containers • pipes • fittings • flues, and/or • instruments • ventilation • process controllers	-
Fuel gas	A substance including hydrogen, when used or intended to be used as fuel	GP Regulation s6 (a)
FGDN	*Fuel Gas Delivery Network.* Examples of fuel gas delivery networks: • the delivery of cylinders of fuel gas to a consumer or to a distributor • the filling and storing of cylinders of fuel gas	P&G Act Sch.2

Acronym / Term	Description	Legislative Reference
	• the bulk delivery of fuel gas to a container • the filling of a tanker for delivery of fuel gas • the maintenance of containers and storage equipment used for the supply of fuel gas • the dispensing of fuel gas to vehicles. • storage associated with the FGDN	
Fuel gas network	A distribution system, including meters and meter regulators whether or not the meters or meter regulators are owned by the operator of the distribution system	P&G Safety Reg Sch.7
GCC	A *gas compliance certificate* certifies the installation of a gas system meets required standards. It is commonly referred to as a Gas System Compliance Certificate. Access here Gas Compliance Certificate	P&G Safety Reg Sch.7
Gas Device	In general, a gas device is a device used or designed or intended for producing heat, light or power using fuel gas can is either a type A or type B gas device	P&G Act s724
GDAA	A *gas device approval authority* is granted by the Chief Inspector and authorises the holder to undertake gas device approval work	P&G s731AA
Gas Fuel System*	Current definition: A gas system that supplies gas as a fuel to an engine ***Proposed legislative change: A gas system that supplies gas as a fuel to an engine or mobile fuel cell***	P&G Safety Reg Sch.7
Gas Quality Agreement	An agreement between a supplier and recipient for the quality of the fuel gas to be supplied where the supply does not meet the prescribed quality and no gas quality approval is in place.	P&G Act s621
Gas Quality Approval	Quality of fuel gas approved by the Chief Inspector. The Chief Inspector may approve a quality that is outside the prescribed quality	P&G Act s622
Gas Work	The work of installing, removing, altering, repairing, servicing, testing or certifying a gas system	P&G Act s725
GWA	A *gas work authorisation* is granted by the Chief Inspector and authorises the holder, or an individual working under the holder's authority, to undertake gas work in relation to a gas device type B.	P&G Act s727
GWL	A *gas work licence* is granted by the Chief Inspector and authorises the holder to undertake gas work in relation to a gas device type A or a fuel gas refrigeration device	P&G Act s726
Gas related device	Means any of the following: • a gas device • a gas fitting • a gas system • a container of fuel gas • a device used to transfer fuel gas from one container to another	P&G Act Sch.2
GP Regulation	Petroleum and Gas (General Provisions) Regulation 2017.	-
Inspector	A public service officer appointed as an Inspector, Petroleum and Gas under s735(1)(c) of the P&G Act	P&G Act s735

Acronym / Term	Description	Legislative Reference
LEL	The *lower explosive limit* is the low end of the concentration range over which a flammable mixture of gas or vapour in air can be ignited at a given temperature and pressure	-
Operating plant	A legislative label for petroleum and fuel gas activities and facilities that are regulated under the P& G Act which includes a requirement for a Safety Management System For hydrogen, operating plant include: • Dispensing of hydrogen to a vehicle • Hydrogen transported via fuel gas delivery networks • Hydrogen transported via distribution systems and pipelines	P&G Act s670
P&G Act	*Petroleum and Gas (Production and Safety) Act 2004*	-
P&G safety legislation	The following instruments: • the *Petroleum and Gas (Production and Safety) Act 2004* (P&G Act), and • the Petroleum and Gas (Safety) Regulation 2018 (P&G Safety Reg)	-
P&G Safety Reg	Petroleum and Gas (Safety) Regulation 2018	-
Professional Engineering Service	an engineering service that requires, or is based on, the application of engineering principles and data to a design, or to a construction, production, operation or maintenance activity, relating to engineering, and does not include an engineering service that is provided only in accordance with a prescriptive standard	
RPEQ	A *Registered Professional Engineer of Queensland* is a person currently registered as a registered professional engineer under the Queensland Professional Engineers Act 2002 A RPEQ is required for all professional engineering services supplied in QLD under the Professional Engineers Act 2002	-
Reference standard	A standard that can be used as a reference when designing a hydrogen device or system. Compliance with a reference standard will generally be accepted as meeting the safety outcome for the component to which the standard applies	-
Safety Outcomes	Fuel gas is used safely, and its use will not cause harm to persons, domestic animals or property. Note, the PG Safety Reg currently defines these as safety outcomes for the design of a gas device	P&G Safety Reg s138E(3)
SMS	A *safety management system* is a comprehensive and integrated system for managing health and safety risks. The P&G Act requires a safety management system for operating plant and sets out the matters which must be included	P&G Act s674, s675
type A	A gas device type listed in the P&G Safety Reg s12 and Sch.1 that uses fuel gas for the purposes mentioned in the P&G Act s724(2)	P&G Act s724 (1) P&G Safety Reg s12

Acronym / Term	Description	Legislative Reference
	NOTE: the purposes mentioned in the P&G Act s724(2) are: for production of heat, light or power; or for refrigeration for which fuel gas is the fuel; or as a propellant	
type B	A gas device that uses fuel gas for the purposes mentioned in the P&G Act s724(2) and that is not listed in s12 or Sch.1 of the P&G Safety Reg	P&G Act s724 (3)
UN R 134	Regulation No 134 of the Economic Commission for Europe of the United Nations (UN/ECE) — Uniform provisions concerning the approval of motor vehicles and their components with regard to the safety-related performance of hydrogen-fuelled vehicles (HFCV) [2019/795]	-
WHS Act	*Work Health and Safety Act 2011*	-
WHS Regulation	Work Health and Safety Regulation 2011	-

1 Introduction

The Queensland Hydrogen Industry Strategy 2019-2024 identifies five key areas of focus, including, an effective policy framework. The Code consolidates legislative requirements under the P&G safety legislation that apply to hydrogen when used or intended to be used as a fuel gas. While existing legislation generally are effective for hydrogen fuel gas operations, stakeholder engagement has identified some obligations do not support operational needs for hydrogen fuel gas applications.

2 Objective

The objectives of this Code are to:

1. identify activities and facilities regulated by the P&G safety legislation that apply when hydrogen is used or intended to be used as a fuel gas
2. provide guidance on how to comply with the P&G safety legislation requirements, and
3. outline policy proposals for alternate means of achieving safe outcomes where current requirements are not effective

3 Scope and application

Figure 1 summarises the scope of hydrogen activities and facilities that are operating plant, gas devices, and gas systems subject to the P&G safety legislation and those that are outside of the scope and application of the Code.

Hydrogen facilities and activities not regulated by the P&G safety legislation include:

a) Aviation and space gas systems regulated by the Civil Aviation Safety Authority (CASA).
b) Marine applications regulated by the Australian Maritime Safety Authority (AMSA).
c) Vehicle applications where hydrogen is being used as a fuel enhancer at levels below LEL of hydrogen (i.e., 4% by volume in air), and where the vehicle does not require hydrogen to operate.
d) Applications where hydrogen is not used, or not intended to be used, as a fuel gas, including other substances used as hydrogen carriers (e.g., ammonia).
e) Production of hydrogen except in fuel cell gas systems.
   Note: Production units at operating plant should be included in the Safety Management System
f) Storage of hydrogen at sites determined to be Major Hazard Facilities.

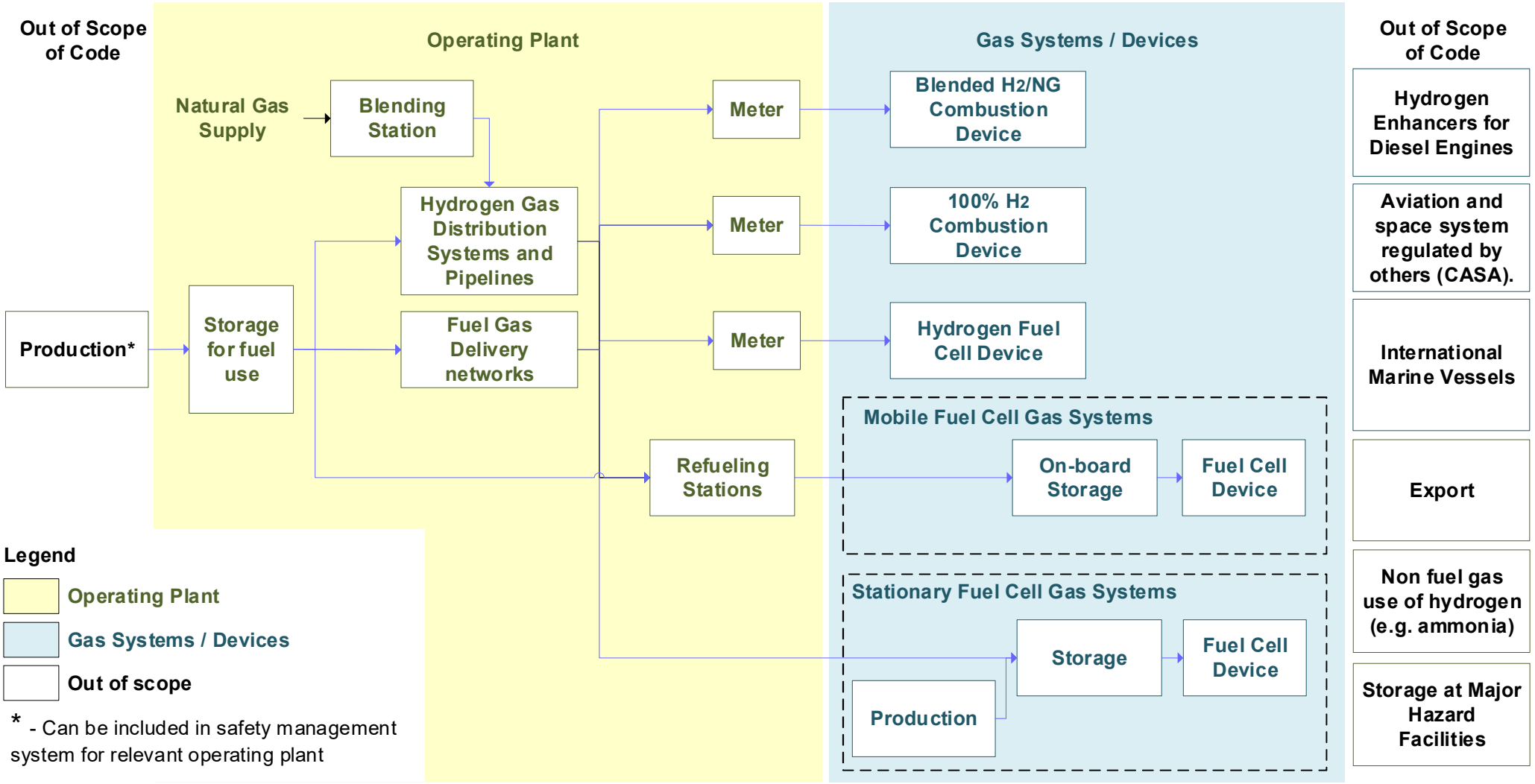


Figure 1 Scope of common operating plant and gas devices related to hydrogen.

4 How the Code works with legislation

4.1 P&G safety legislation

The P&G Act s3(1) prescribes as the main purpose of the P&G Act:

> "*to facilitate and regulate the carrying out of responsible petroleum activities and the development of a safe, efficient and viable petroleum and fuel gas industry*."

The Code has been developed to provide a consolidated document of requirements of the P&G safety legislation that apply to applications using hydrogen as a fuel gas. Section 5-7 of the Code, read in conjunction with the provisions of the P&G safety legislation, set out current and proposed minimum compliance requirements for activities and facilities that use, or intend to use, hydrogen as a fuel gas.

Where there is a conflict between the Code and the requirements or other relevant provisions in the P&G Act, the P&G Safety Reg or the GP Regulation, the provisions of the P&G Act, P&G Safety Reg or GP Regulation prevail.

4.2 Other relevant legislation

Other legislative instruments and frameworks also apply to the safety of hydrogen related activities. Appendix 1 references relevant statutory bodies and Appendix 2 outlines key elements of legislative frameworks for work health and safety, electrical safety, national heavy vehicles, rail safety and professional engineer requirements.

5 Operating Plant

Section 5 of the Code describes hydrogen activities that are operating plant and relevant obligations under P&G safety legislation. It also lists specific requirements for distribution systems, pipelines and fuel gas delivery networks.

5.1 Hydrogen activities / facilities that are operating plant

Operating plant is defined in s670 of the P&G Act and includes fuel gas facilities, plant and activities. Table 2 summarises types of fuel gas operating plant that are relevant to hydrogen.

Table 2 Fuel gas operating plant relevant to hydrogen.

Operating plant type	Examples of hydrogen operating plant	Legislative Reference
Distribution pipeline	A pipeline that transports hydrogen as part of a gas reticulation system from a gate station to the reticulation system, or as a single 'point to point' pipeline to a specific commercial or industrial facility direct from a well or processing plant to an industrial facility, for use as a fuel source.	P&G Act s670(2)(e) P&G Act s16A
Distribution System	Distribution system - a system of distribution pipelines, meters and other equipment used in the supply of fuel gas, including hydrogen, to more than one consumer within a fuel gas market. A distribution system may convey pure hydrogen or hydrogen blended with another fuel gas.	P&G Act s670(2)(f) P&G Act Sch.2
Fuel gas delivery network (FGDN)	A FGDN includes any of the following: • Hydrogen dispensing at a refuelling fuel station. This could include dispensers, tanks, vessels, containers, piping, compressors, pumps and hydrogen production. • A network that transports hydrogen in containers, cylinders or tanks. May include: - Delivery by tube-trailer or tanker of hydrogen in bulk to fuel gas consumer or fuel gas supplier - The bulk delivery of hydrogen to a container. - Supply of hydrogen from containers to a distribution system - Storage of hydrogen that is part of the FGDN	P&G Act s670(5)(a) P&G Act Sch.2 P&G Safety Reg s11(1) s11(1)(d)
Prescribed activities – gas utilisation	Activities prescribed in the P&G Safety Reg: • Use of gas devices with 50GJ/h or more gas capacity • Using fuel gas to produce theatrical or other special effects.	P&G Act s670(5)(d) P&G Safety Reg s11(2)(a) s11(2)(b)

5.2 Obligations for operating plant

Chapter 9, Part 1 of the P&G Act specifies safety obligations for petroleum and gas operating plant so that risk is managed to an acceptable level. These obligations include responsibilities of key persons.

Section 699 of the P&G Act states an operator of operating plant has an obligation for risk to person or property to be at an acceptable level. Section 700 of the P&G Act defines acceptable level of risk.

Under the P&G safety legislation the primary method for managing risk at operating plant is through implementation of a SMS. Section 674 of the P&G Act requires an operator to make, implement and maintain a SMS as part of the overall obligation to reduce risk to an acceptable level.

For smaller, FGDNs, s18 of the P&G Safety Reg specifies a generic SMS may be applied to operating plant if the combined water capacity of fuel gas containers in the network is not more than 5,000 L. A generic SMS is defined in s675A(3) of the P&G Act.

Key obligations required for operating plant in the P&G Act are listed in Table 3. This should be read in conjunction with the relevant legislative sections and information at the Petroleum and Gas Inspectorate website and the web pages specified in Table 3.

Table 3 Operating plant obligations.

Operating plant obligations	P&G Act Reference
STATUTORY POSITION HOLDERS • Operator / operator's representative if operator is a corporation • Executive Safety Manager (ESM) • Site Safety Manager OBLIGATIONS OF STATUTORY POSITION HOLDERS • Notification requirements • ESM general obligation For more information, access: Safety & health notices for petroleum & gas	s673 s687 s692 s694A s688
SAFETY MANAGEMENT SYSTEM • Operator must ensure SMS is made or adopted • Content requirements (NOTE: If an existing SMS meets these requirements, a new SMS is not needed) • Operator to must take reasonable steps to ensure SMS obligation holders comply with their obligations • A person at an operating plant must take all reasonable steps to comply with SMS obligations.	s674 s675 s677 s702

Operating plant obligations	P&G Act Reference
PLANT & EQUIPMENT • Designers, importers, manufacturers and suppliers of plant and equipment for use at operating plant must take reasonable steps to ensure the plant or equipment complies with any relevant safety requirement • Installers must ensure plant and equipment they install at operating plant complies with all relevant safety requirements.	s696 s697
RISK MANAGEMENT • Risk to be kept to acceptable level by person with obligation under Act or SMS • Acceptable level of risk • Achieving acceptable level of risk • The SMS is to include a formal risk assessment consisting of the systematic assessment of risk and a description of technical and other measures to control the identified risk.	s699 s700 s701 s675(e)
COMMISSIONING / DECOMMISSIONING • The chief inspector is given notice at least 20 business days before a plant is commissioned / decommissioned. For more information, access: Safety & health notices for petroleum & gas	s694A

WHS Act requirements (refer to Appendix 2) also apply to the hydrogen related operating plant. Safety matters can be addressed under one SMS to avoid duplication.

5.3 Quality

When hydrogen is supplied as fuel to a consumer it must either:

- meet the prescribed quality; or
- the quality must be approved by the Chief Inspector; or
- there must be a gas quality agreement in place.

Where hydrogen is the fuel gas there is no prescribed quality, however a gas quality approval is in place called the "***hydrogen fuel gas quality approval 2022***".

The ***hydrogen fuel gas quality approval 2022*** states that the Chief Inspector, under section 622 of the P&G Act has approved *AS/ISO 19880.8 Gaseous hydrogen fuelling stations Part 8:Fuel quality*

control section 8 (AS/ISO 19880.8 section 8 Hydrogen quality assurance methodology) for hydrogen supplied as a fuel to consumers in Queensland. The ***hydrogen fuel gas quality approval 2022*** is effective until 30 June 2025 unless updated prior.

Section 8 of the standard enables suppliers to use a risk-based methodology to meet the requirements of ISO 14687-2 *Hydrogen fuel – Product specification*.

The ***hydrogen fuel gas quality approval 2022*** states that the standard should be used for the supply of hydrogen to all consumers with gas devices.

Note: Hydrogen blends that meet the quality requirements of natural gas as outlined in AS 4564 meet the prescribed quality of processed natural gas and do not require further approval. Hydrogen or hydrogen blends that do not meet the requirements of AS 4564 or the ***Chief Inspector gas quality approval for hydrogen fuel gas*** require a separate ***gas quality agreement*** or ***gas quality approval***.

The P&G Act sections 621 and 622 outlines the requirements for obtaining a ***gas quality agreement*** or ***gas quality approval***.

5.4 Safety requirements for gas distribution systems and pipelines

5.4.1 Gas distribution systems

Section 81 of the P&G Safety Reg requires the operator of a gas distribution system to ensure the design, construction, operation, maintenance and abandonment of a gas distribution system complies with the AS/NZS 4645 series. The AS/NZS 4645 series currently excludes mixtures of gases with a hydrogen content in excess of 15% by volume [AS/NZS 4645.1-2018 1.2 (d)].

Proposed legislative amendment: If an operator proposes to supply gas through a distribution network with more than 15% hydrogen, they may meet the safety requirement by giving the chief inspector notice stating that the supply is outside the allowed limits of AS/NZS 4645 and that they have conducted a formal safety assessment ensuring that an equal or less level of risk has been achieved.

5.4.2 Pipelines

Section 67(2) of the P&G Safety Reg specifies that the operator of the pipeline must ensure the design, construction, operation, maintenance and abandonment of the pipeline comply with one of the listed standards. Standards relevant for hydrogen in pipelines will be the AS/NZS 4645 series or the AS/NZS 2885 series.

Most hydrogen fuel gas pipelines are defined as operating plant and require a Safety Management System that complies with s675(1) of the P&G Act.

5.5 Safety requirements for fuel gas delivery networks

Fuel gas delivery network (FGDN) are operating plant when one of the criteria in the P&G Safety Reg s11(1) are satisfied. Under current provisions some fuel gas delivery networks are not operating plant if the network does not meet criteria outlined in the P&G Safety Reg s11(1).

Proposed legislative amendment: To ensure effective and appropriate management of risk it is proposed all hydrogen fuel gas delivery networks are operating plant

FGDN are required to have a Safety Management System that complies with requirements of the P&G Act s675(1). Operators must identify, assess and control risk as low as reasonably practicable. This includes, where relevant, the risk of storing and handling unodourised fuel gas.

Note: The prescribed odour requirement only applies legislatively when fuel gas is supplied to a consumer. Section 7 outlines the proposed process for operators intending to supply unodourised fuel gas to a consumer.

5.6 Training and Competencies at Operating Plant

There are no mandatory competencies prescribed for working on hydrogen operating plant. However, competencies have been developed and are available for companies and training organisations to deliver.

The Gas Industry Reference Committee, with support from Technical Advisory Committees, has developed six new Units of Competency, three new Skill Sets and updated 13 units. The new Units of Competency and Skill Sets have been drafted specifically for hydrogen gas, and the existing units were updated to allow for hydrogen contextualisation as well as other gases. The revised Training Package addresses the skills needs of gas technicians working with hydrogen.

Appendix 8 outlines the approved UEG Gas Industry Training Package that has been updated to include hydrogen competencies.

Companies may use these qualifications and competencies to deliver training and satisfy relevant training related requirements of the Safety Management System.

5.7 Hydrogen Production at Operating Plant

Where a facility that is operating plant produces hydrogen for use as a fuel as an integral part of its operation, the safety of the hydrogen production process should be included in the Safety Management System.

This includes hydrogen production at refuelling stations and blending facilities.

6 Gas devices, gas systems and gas work

Section 6 of the Code describes hydrogen activities that are regulated by provisions of the P&G safety legislation for gas devices, gas systems and gas work. This part of the Code also describes the following requirements and provides guidance on how to comply with them:

- approval of gas devices
- installation and certification of gas systems
- holding a Gas Device Approval Authority (GDAA)
- obtaining a Gas Work License (GWL) and Gas Work Authorisation (GWA)
- conducting gas work on a gas system
- periodic inspections, and
- workshop requirements.

6.1 Gas devices that use hydrogen as a fuel gas

Section 724 of the P&G Act defines gas devices – type A and type B. In general, both are designed for producing heat, light or power using fuel gas. Section 724 also sets out specific devices for each type and provides for gas devices, type A, to be prescribed the P&G Safety Reg (refer to s12 and Sch.1). A gas device type listed in Sch.1 of the P&G Safety Reg that uses hydrogen as fuel is a gas device (type A). Table 4 lists gas devices that use hydrogen as fuel.

Table 4 Examples of gas devices that use hydrogen.

Gas device	Description
Catalytic reactor gas device	Catalytic reactors are not listed in the P&G Safety Reg Sch.1 and are a gas device (type B)
Combustion gas device	A combustion gas device uses hydrogen in a combustion reaction and hydrogen applications could be:

Gas device	Description
	• hydrogen blended with natural gas, or • pure hydrogen For hydrogen blends: • If an approved device is to be supplied with fuel gas within the gas quality specification for which the gas device is approved, no additional approval is required • Where an approved device is to be supplied with fuel gas outside the gas quality specification for which the device is approved, a new device approval is required A gas device type listed in the P&G Safety Reg s12 and Sch.1 that uses hydrogen as fuel is a gas device (type A). Common type A combustion gas devices include cooktops, BBQs and hot water systems A device that is not listed in the P&G Safety Reg s12 or Sch.1 is a type B
Fuel cell gas device	Fuel cells are not currently listed in the P&G Safety Reg s12 or Sch.1 and therefore are a type B gas device Mobile fuel cell gas systems refer to fuel cells used in vehicles and vessels Stationary fuel cell gas systems refer to fixed applications for power generation and include portable units A fuel cell gas system is a type b device. A fuel cell gas system device may be a ***designed packaged system*** or ***construct and install in place*** A ***designed packaged system*** device is built by the manufacturer with no, or very minimal, site installation requirements. Examples include FCEV and self-contained hydrogen energy storage systems A ***construct and install in place*** device is installed onsite by the holder of an appropriate gas work authority. The devices, pipework and related instruments and controls are installed on site. Examples include hydrogen power systems that are not supplied in a package, hydrogen supplied to a combustion device

6.2 Approval of gas devices

Section 731AA of the P&G Act requires all gas devices (type A and type B) to be approved before installation or use. The proposed process for approval of a gas device using hydrogen is shown in Figure 2. It is proposed that a fuel cell (type B gas device) is approved as part of the fuel cell gas

system.

The P&G Safety Reg requires that gas devices are designed and approved to a preferred standard. If a preferred standard is not used compliance can be achieved by following the process outlined in section 15 of the P&G Safety Reg. Preferred standards are listed in Schedule 2 of the P&G Safety Reg.

Gas device approval for a ***construct and install in place*** device takes into consideration location specific elements including ventilation and hazardous area requirements, public access and proximity to the device, vehicle movements near the gas system etc

Gas device approval for a ***designed packaged system*** should consider location requirements for where the device will be used and ensure relevant information is included in installation instructions. For example, vent locations, protection requirements

Gas devices must be designed and approved to a preferred standard in the P&G Safety Reg. If a preferred standard is not used the process outlined in section 15 of the P&G Safety Reg must be followed, including notifying the Chief Inspector

Proposed legislative amendment: this Code is added as a safety requirement in Schedule 2 of the P&G Safety Reg for the design of gas systems and devices.

6.3 Installation and certification of gas systems

Section 734 of the P&G Act sets out requirements for gas systems to be installed in compliance with applicable safety requirements and for the gas system installation to be certified by the installer. The proposed process for approval of a gas device and installation and verification of a gas system using hydrogen is shown in Figure 2.

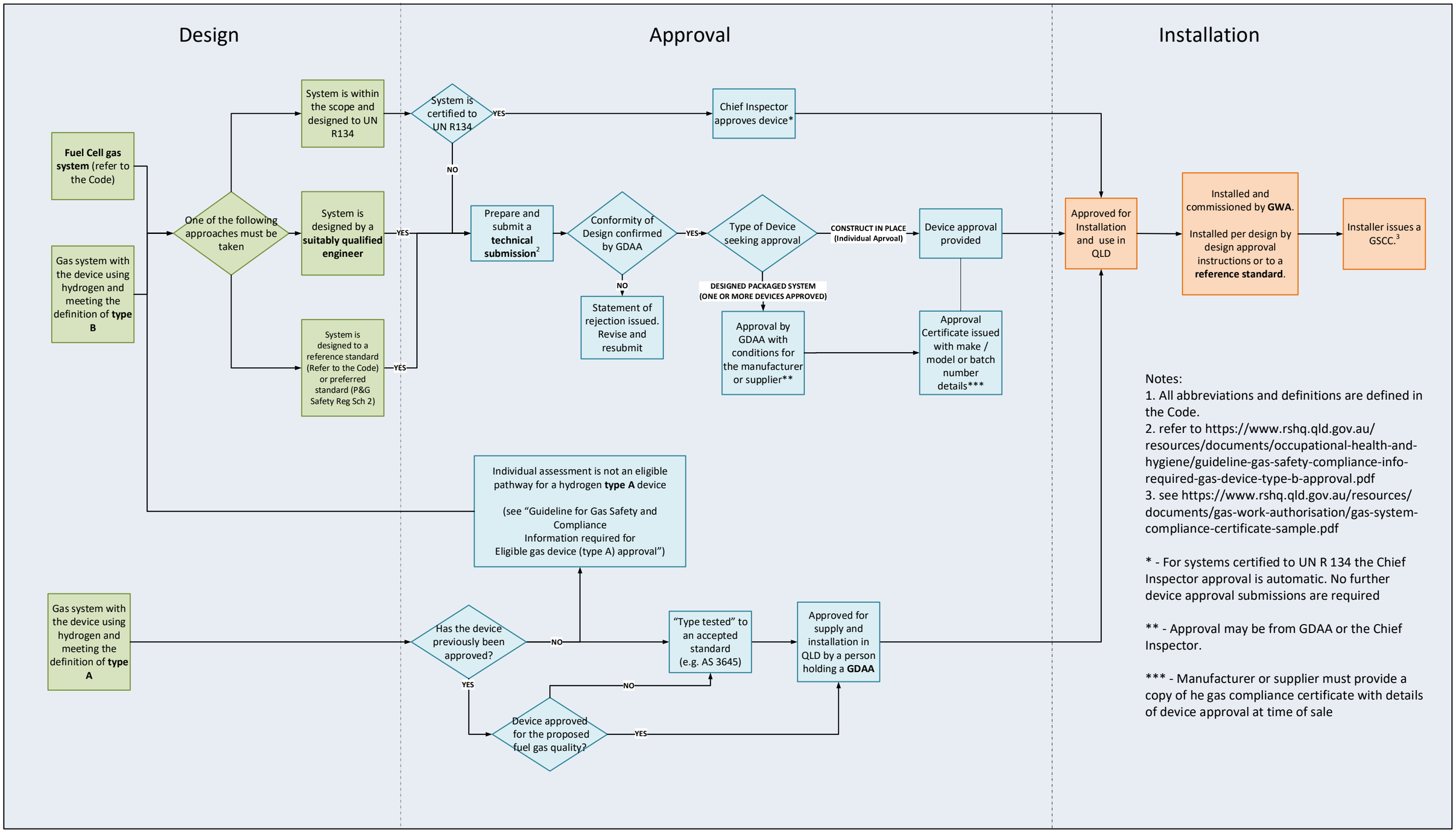
AS/NZS5601 is the preferred standard for gas system installation. Section 2 of AS/NZS5601.1 provides an outcome-based approach and if utilised would require a notice to the Chief Inspector as outlined in section 15 of the P&G Safety Reg.

The current preferred standards do not adequately incorporate all hydrogen gas devices (e.g., fuel cells). As the industry develops, many hydrogen gas devices will require approval. It is not practical to notify the Chief Inspector for every device.

Proposed legislative amendment: this Code is added as a safety requirement in Schedule 2 of the P&G Safety Reg for the installation of gas systems and devices.

Where the process outlined in the Code is followed there no need to follow the section 15 process in the P&G Safety Reg.

Figure 2 Proposed Gas device and gas system approval pathway.



6.4 Holding a GDAA

Under section 731AD of the P&G Act, the chief inspector may grant a GDAA that authorises the holder to undertake gas device approval work with the scope specified in the granted authority. GDAA applications must be in the approved form which can be accessed at Application to become a gas device approval authority.

A *GDAA type B Class FC* is able to approve a hydrogen fuel cell gas system. Specific information to support making an application can be accessed at Gas device approval authority's requirements. Information and conditions for holders of a GDAA type be accessed at Gas device approval authority holders – Queensland code of practice.

To apply for a GDAA with fuel cell gas systems included in the scope, a person must have:

- the appropriate engineering qualifications (e.g. RPEQ with appropriate registration) (For more information, access: Gas device approval authority's requirements),
- a qualification in risk management, and
- the skills and knowledge (experience) to perform approval work under the authority described in Table 5.

Table 5 GDAA types relevant for hydrogen gas devices/systems.

Type	GDAA category	Skills and knowledge
Fuel Cell Gas Systems[1]	type B Class FC	Examples of skills and knowledge that would support an application are: • Previous experience working on similar devices • Formal training and qualifications on similar systems • Knowledge of hazardous area and electrical equipment requirements for hydrogen and/or other similar gases. • Knowledge of electrical systems and electrical safety requirements • Knowledge of the characteristics and properties of hydrogen hazard identification and risk management – general WHS and hydrogen specific (qualifications and experience)

[1] Fuel cell gas system include the fuel cell and system into which it is installed. Storage, piping, instruments and controls are to be considered and assessed as part of the device approval.

Type	GDAA category	Skills and knowledge
Hydrogen Catalytic reactor system	type B Class C	For GDAA type B, requirements are as per the existing with additional information to support hydrogen use. For more information, access: Gas device approval authority's requirements. Examples of the additional skills and knowledge that would support an application are: • Knowledge of characteristics of hydrogen • Knowledge of suitable materials, components and fittings for use in hydrogen service.

6.5 Obtaining a GWL and GWA for hydrogen

Under s725 of the P&G Act gas work is the work of installing, removing, altering, repairing, servicing, testing or certifying a gas system. Sections 725 and 726 requires gas work to only be undertaken by a person that holds a GWL or GWA that authorises the person to carry out the work.

Gas systems using hydrogen must be installed by a person who has hydrogen in the scope of their GWL or GWA. For type A devices, a GWL is required and for type B devices, a GWA is required.

Section 124 of the P&G Safety Reg prescribes the qualifications or experience required to obtain a GWL or GWA. Mostly, applicants meet the requirements of s124 of the P&G Safety Reg by completing a listed qualification (refer also Sch.5 of the P&G Safety Reg and the Gas Work Licence Requirements and Gas Work Authorisation Requirements).

Until the qualification framework is established, a person that wants to undertake gas work on hydrogen systems must be able to demonstrate a need for the GWL or GWA and skills and demonstrate skills and knowledge to work safely with hydrogen.

Evidence of skills and knowledge that would support an application for a GWL or GWA conditioned for hydrogen gas work could include:

- Previous experience working on similar devices and systems
- Formal training and qualifications working on similar device and systems
- Knowledge of the characteristics and properties of hydrogen hazard identification and risk management – general OHS and hydrogen specific (qualifications and experience)
- Knowledge of the suitable materials, components and fittings for use with hydrogen and/or other similar gases

- Knowledge of the storage and handling of hydrogen
- Working with (storage, transportation and use) gas pressures greater than 200kPag
- Awareness of hazardous area classification and requirements of electrical equipment to be installed in hazardous areas for hydrogen and/or other similar gases.

The application must be in the approved form with the chief inspector assessing applications on a case-by-case basis process that may include:

- a desktop review of the evidence provided,
- a meeting or discussion with the applicant, and
- as per s124(4) of the P&G Safety Reg, completion by the applicant of a written, oral or practical examination.

Under s728C(3) of the P&G Act, the chief inspector may limit the type of gas work or impose conditions. The chief inspector will provide the applicant with details of this at the time of application. As a practical example, the chief inspector may impose the condition that the holder completes the relevant qualifications within a reasonable timeframe when they are available. These conditions will be determined on a case-by-case basis.

6.6 Periodic Inspection

For commercial vehicles, and vessels, the owner must ensure twelve monthly inspections of the fuel cell gas system are completed by an appropriately authorised person as required by s107 of the P&G Safety Reg. Appendix 4 provides further detail on periodic inspection.

6.7 Workshop Requirements

Requirements for safe workshops are a condition of GWAs issued for vehicle workshops. Installation, conversion and maintenance of vehicles using hydrogen as a fuel must be undertaken in a workshop that complies with the conditions of the GWA and as set out in the Queensland gas work authorisation requirements document. Appendix 4 provides further detail on workshop requirements.

7 Proposed process for supply of unodourised hydrogen

Section 627 of the P&G Act provides for a regulation to prescribe an odour for fuel gas when it is supplied for consumer use. Section 73 of the P&G Safety Reg prescribes the odour requirements for fuel gas when supplied through a fuel gas network.

Proposed legislative amendment: No odour is prescribed for hydrogen when safety requirements of this Code are met

Section 7 outlines a means of compliance where an operator proposes to supply fuel gas to a consumer without the prescribed odour, for example, a hydrogen refuelling station.

7.1 Proposed requirements for an operator supplying unodourised hydrogen

It is proposed an operator will be able to supply unodourised hydrogen to a consumer, if:

- the supply is to a vehicle or vessel through a dispenser, or
- they have obtained a copy of the gas compliance certificate (GCC), and
- that GCC shows that the system being supplied to is safe for use with unodourised fuel gas.

Note: when supply is to a vehicle or vessel through a dispenser the supplier does not require a copy of the GCC prior to supply.

7.2 Proposed requirements for a consumer being supplied unodourised hydrogen

It is proposed that, other than for supply to a mobile fuel cell gas system, where a consumer requires fuel gas to be supplied unodourised, it will be the responsibility of the system owner to:

- obtain approval for the gas device from an appropriate GDAA
- ensure the gas system being supplied to is designed for unodourised fuel gas supply by a suitably qualified engineer
- have an appropriately authorised person install the gas system in line with system design and device approval and issue a GCC
- operate and maintain the gas system safety in line with the approval requirements including any conditions imposed, and
- retain evidence of the approval and GCC for the operating life of the gas system.

For the purpose of this section a suitably qualified engineer is a Registered Professional Engineer of Queensland (RPEQ) registered in the appropriate area of engineering, or equivalent.

Note: equivalent to RPEQ with appropriate registration could be a chartered engineer with appropriate expertise. Note also that requirements of the Queensland Professional

Engineers Act (2002) apply in addition to requirements of this Code.

It is proposed that to supply a mobile gas system the owner of the vehicle or vessel must:

- ensure the mobile fuel cell gas system is certified (approved) to *UN Regulation No. 134 - Hydrogen fuel cell vehicle safety* (UNR 134) or approved by an appropriate GDAA
- ensure the fuel cell gas system is installed by an appropriately authorised person (i.e., holder of an appropriate *gas work authorisation*)
- retain evidence of the UNR 134 certification or GDAA approval and GCC for the life of the gas system, and
- for commercial vehicles and vessels, retain records of the twelve monthly inspections of the fuel cell gas system.

7.2.1 Meeting Regulatory Requirements – Gas System Owners (Mobile and Stationary)

It is a requirement that owners of gas systems ensure the system is safely installed, operated and maintained. Section 97 of the P&G Safety Reg outlines the General obligations of the owner of a gas system:

"The owner of a gas system must take all reasonable steps to ensure a suitably qualified person carries out the installation, servicing, repair, decommissioning and disposal of all or part of the gas system, and if a suitably qualified person or an inspector notifies the owner that the gas system is unsafe, the gas system is not used until it is safe"

Additionally, the user of a gas system must take reasonable steps to ensure it is used safely. Owners of gas systems satisfy their requirements by:

- Using authorised installers
- Retaining the Gas Compliance Certificate provided by the installer
- Following manufacturer's instructions for operation of the gas device and system
- Engaging authorised persons to service or maintain the device and system as required in the manufacturer's instructions

7.3 Process for design and installation of a gas system using unodourised hydrogen

Figure 2 gives an overview of the proposed process for approval of gas systems (including the gas device) to enable supply of unodourised hydrogen.

The design of a gas system must achieve an acceptable level of risk in the P&G safety legislation. It is proposed that one way to achieve the safety outcome for a gas system is to meet the requirements of a reference standard.

Proposed reference standards for stationary and mobile fuel cell gas systems are listed in Table 6.

Note: preferred and mandatory standards in Schedule 2 of the P&G Safety Reg continue to apply where relevant. The reference standards provided below may be used where a preferred standard does not apply or in addition to a preferred standard

Meeting the requirements of a reference standard is taken to be meeting the safety requirement.

Table 6 Reference standards for fuel cell gas systems.

System Type	Reference Standard
Stationary fuel cell gas systems	• AS 62282.3.11:2021 Fuel cell technologies, Part 3.100: Stationary fuel cell power systems – Safety (IEC 62282-3-100:2019 (ED 2.0), MOD), and • AS 62282.3.300:2021 Fuel cell technologies, Part 3.300: Stationary fuel cell power systems – Installation (IEC 62282-3-300:2012 (ED.1.0), MOD). • AS/NZS IEC 60079 series • AS ISO 16111:2020 Transportable gas storage devices - Hydrogen absorbed in reversible metal hydride • AS 26142:2020 Hydrogen detection apparatus - Stationary applications • AS 22764:2020 Hydrogen detection apparatus - Stationary applications • AS 16110 series Hydrogen generators using fuel processing technologies • AS 4041-2006 Pressure piping
Mobile fuel cell gas systems	• UN Regulation No. 134 - Hydrogen fuel cell vehicle safety (UNR 134). • AS ISO 19881:2020 Gaseous hydrogen - Land vehicle fuel containers •

It is proposed that the design of a gas system using unodourised hydrogen must include appropriate:

- leak detection and automatic shut-off, and
- risk assessment and controls.

The design must consider hazardous area and ventilation conditions to ensure unsafe concentrations of hydrogen gas cannot accumulate undetected.

Design documentation submitted for approval must include:

- Installation instructions
- Operating instructions
- Maintenance instructions

Specific guidance on the proposed process for the design of a fuel cell gas system using unodourised hydrogen is described below.

7.3.1 Process for design of a fuel cell gas system using unodourised hydrogen

There are two types of fuel cell gas systems.

1. Stationary. A stationary fuel cell gas system could be either a fixed or a portable generator.
2. Mobile. A mobile fuel cell gas system is one that is used to power an electric vehicle or vessel.

A typical stationary fuel cell gas system is shown in Figure 3. Where applicable, design of a stationary gas system for use with hydrogen as a fuel should consider the performance requirements in AS/NZS 5601.1 Section 2.

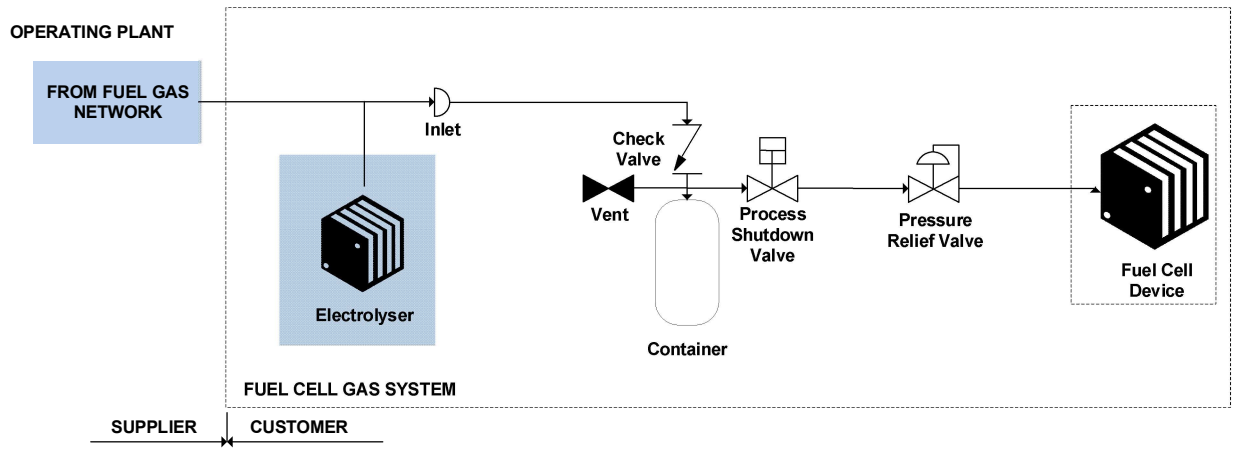


Figure 3 Typical stationary fuel cell gas schematic.

A typical mobile fuel cell gas system is shown in Figure 4.

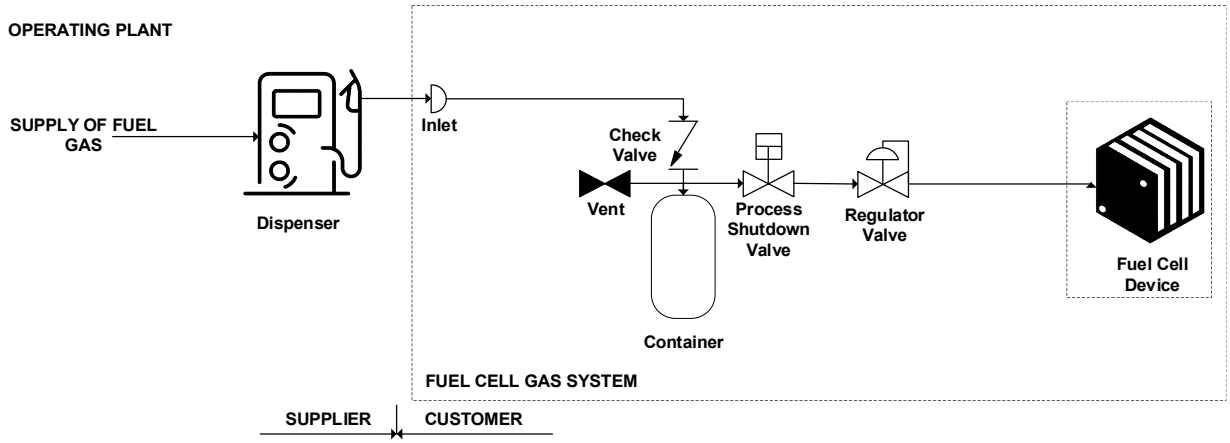


Figure 4 Typical mobile fuel cell gas system schematic.

There are three options proposed for mobile fuel cell gas system designs to be approved:

1. meet the requirements of *UN Regulation No. 134 - Hydrogen fuel cell vehicle safety (UN R134)*, or
2. meet the requirements of a reference standard, or
3. be designed by a suitability qualified engineer.

The proposed reference standards for a fuel cell gas system are listed in Table 6.

Table 7 provides a summary of the proposed approval methods for gas systems using unodourised hydrogen.

Table 7 Approval of gas systems using unodourised hydrogen.

System Type	Proposed Approval Process
Stationary fuel cell gas system	• The system must be approved by an appropriate GDAA. • To obtain gas system approval, a technical submission is required to be submitted to an appropriate GDAA. • An example technical submission for a fuel cell gas system is at the following link Fuel Cell Gas System Example Technical Submission. For more information, access: Gas Device Approval Authority List.
Mobile fuel cell gas system using option 1	The system must be certified by an independent certification body.
Mobile fuel cell gas system using option 2 or 3	• The system must be approved by an appropriate GDAA. • To obtain gas system approval, a technical submission is required to be submitted to an appropriate GDAA. • An example technical submission for a fuel cell gas system is at the following link Fuel Cell Gas System Example Technical Submission. • For more information, access: Gas Device Approval Authority List.

The process requires that the gas device approval indicates the system is approved for supply of unodourised fuel gas.

7.3.2 Process for installation of a gas system for unodourised hydrogen

- Gas systems must only be installed by an appropriately authorised person.
- The installer must install the system as per the approved design.
- Where the system is supplied with unodourised fuel gas, the commissioning check must test all controls associated with the unodourised fuel gas, including:
    - Leak detection
    - Automated shut-off
    - Mechanical ventilation, and
    - Interlocks, where installed.
- The installer must issue a gas compliance certificate (GCC) for the installation, which must indicate that the system is approved and safe for supply of unodourised fuel gas.
- The GCC shall reference or include a copy of the system design, technical submission and commissioning information.

Appendix 1 - Relevant Statutory Bodies and Contact Details

Table 8 summarises the key relevant statutory bodies. This list is not exhaustive.

Table 8 Relevant statutory body.

Statutory Body	Responsible for	Website contact details
Workplace Health and Safety Queensland (WSHQ)	Safety of workplaces	https://www.worksafe.qld.gov.au/contact
Queensland Electrical Safety Office (ESO)	Safety of electrical equipment and installation	https://www.electricalsafety.qld.gov.au/contact-us
Board of Professional Engineers of Queensland (BPEQ)	Regulating the engineering profession	https://bpeq.qld.gov.au/
Civil Aviation Safety Authority (CASA)	Regulation of civil aviation	https://www.casa.gov.au/about-us/contact-us
Department of Environment and Science (DES)	Avoiding, minimising or mitigating impacts to the environment. Developing and delivering programs supporting climate action Delivering scientific expertise to protect and manage our environment and natural resource base	https://www.des.qld.gov.au/contactus/general
Department of Transport and Main Roads (TMR)	Planning, managing and delivering Queensland's integrated transport environment	https://www.tmr.qld.gov.au/contactus
Australian Maritime Safety Authority (AMSA)	Regulation and safety oversight of Australia's shipping fleet and management of Australia's international maritime obligations	https://www.amsa.gov.au/about/contact-us
Department of Energy and Public Works	Delivering projects to provide safe, secure, reliable, affordable, and sustainable energy resources to Queensland households and businesses	https://www.epw.qld.gov.au/contact/find
Department of Resources	Regulating mining, and resources in the state	https://www.resources.qld.gov.au/
Department of State	Economic strategy, industry stimulation, and infrastructure, local government and	https://www.statedevelopment.qld.gov.au/about-

Development, Infrastructure, Local Government and Planning	planning in Queensland	us/contact-us
Department of Infrastructure, Transport, Regional Development and Communication	Delivering Australian Government policy and programs for infrastructure, transport, regional development, communications, cultural affairs, and the arts	https://www.infrastructure.gov.au/contact-us
Department of Climate Change, Energy, the Environment and Water	Leading Australia's response to climate change and sustainable energy use, and protect our environment, heritage and water.	www.dcceew.gov.au

Appendix 2 - Guidance on interaction with other legislation

A2.1 - Queensland Work Health and Safety Legislation

The work, health and safety legislation provides a framework to protect the health, safety and welfare of all persons in the conduct of a business or undertaking and other personnel who might be affected by the business or undertaking.

This legislation includes:

- the Work Health and Safety Act 2011 (WHS Act)
- the Work Health and Safety Regulation 2011 (WHS Reg).

While both the P&G and WHS legislative frameworks apply, safety matters can be addressed under one safety management system approach with minimal duplication.

Particular items under WHS legislation that may have applicability to hydrogen projects include:

- Hazardous Chemical requirements. Refer:
  - WHS Reg Chapter 7
  - Managing risks of hazardous chemicals in the workplace code of practice 2021.
- Pressure vessel design and registration. Refer:
  - WHS Reg Chapter 5 Part 5.3 and Sch.5
  - Managing the risks of plant in the workplace Code of Practice.

A2.2 - Electrical Safety Legislation and Requirements

The purpose of the *Electrical Safety Act 2002* (the Electrical Safety Act) is to establish a legislative framework for preventing persons from being killed or injured by electricity and preventing property from being destroyed or damaged by electricity.

During the design, construction, installation and operation of hydrogen operating plant the requirements of the Electrical Safety Act 2002 and *Electrical Safety Regulation 2013* must be met.

The Electrical Safety Act includes requires the duties of care relevant to the situation are met (a person or business may have more than one duty). This includes:

- primary duty of care on all businesses that they operate in a way that is electrically safe,
- duties on designers of electrical installations and electrical equipment to ensure the equipment or installation is designed to be electrically safe and information is provided

about the way the electrical equipment or installation must be used or installed to ensure the equipment or installation is electrically safe,
- duties on manufacturers and importers of electrical equipment when made is electrically safe and is tested and examined to ensure it is electrically safe, and
- duties on installers and repairers of electrical equipment or electrical installations to ensure the electrical equipment or installation is electrically safe and is tested to ensure it is electrically safe.

Refer to *Electrical Safety Act 2002* Part 2 for all duties.

Where equipment is suitable for household, personal or similar situations the requirements of the in-scope electrical equipment safety system (EESS) also apply.

All electrical installations are required to comply with *AS/NZS 3000 – electrical installations (also known as the wiring rules)*.

It is electrical work to install electrical equipment in an electrical installation or to repair electrical equipment or electrical installations. All electrical work must be performed by a suitably licensed electrical worker and if the performance of electrical work is conducted under a contract of work, it must be performed under a Queensland electrical contractor licence.

The Electrical Safety Act specifies the requirements of the following key Australian electrical safety standards must be met:

- AS/NZS 3000:2018 - *Electrical installations (known as the Australian/New Zealand Wiring Rules*,
- The AS/NZS 60079 series for hazardous areas equipment and installations, and
- AS/NZS 3820 - *Essential safety requirements of electrical equipment.*

A2.3 - National Heavy Vehicle Legislation

The National Heavy Vehicle Regulator (NHVR) administers one set of laws (the HVNL) for heavy vehicles over 4.5 tonnes gross vehicle mass. The HVNL consists of the Heavy Vehicle National Law and five sets of regulations.

The HNVL does not regulate new vehicles. This is captured by the Australian government legislation and the requirement are set in the Australian Design Rules (ADR). Generally, the HVNL applies to vehicles having modifications post being supplied for use.

The HVNL s84 defines that a modification to a vehicle includes:

- the addition of a component, or
- a change to the vehicle from the manufacturer's specification.

A modification under NHVL could include:

- Addition of a gas system, supplied by an on-board hydrogen canister that delivers hydrogen to the existing diesel engine for blending
- Removing and replacing a diesel engine with a hydrogen fuel cell from a vehicle that has been approved for use under ADR.

For the modifications above, under the HVNL s85, approvals must be approved by:

1. An approved examiner under the HVNL s86, or
2. The National Heavy Vehicle Regulator.

In addition to the provisions in the NHVL, requirements under the P&G safety legislation apply.

The requirements under WHS legislation also need to be considered, for example, design and plant registration for pressure vessels.

A2.4 - Professional Engineers Legislation

To carry out a professional engineering service in Queensland or for Queensland, engineers are required to be registered with the Board of Professional Engineers Queensland (BPEQ). The only exceptions are if an unregistered person carries out the professional engineering service under the direct supervision of an RPEQ or the service is carried out only in accordance with a prescriptive standard. Once an engineer is registered they are awarded the protected title RPEQ.

The Professional Engineers Act 2002 provides for the registration of professional engineers, and for other purposes. It is an offence to provide a *professional engineering service* while unregistered (unless supervised).

Further guidance is provided at this link: BPEQ.

A2.5 – Rail Safety Legislation

The main purpose of the Rail Safety legislation is to provide for safe railway operations in Australia through effective management of safety risks associated with railway operations. The rail safety legislation includes:

- Rail Safety National Law (Queensland) Act 2017

- Transport Infrastructure (Rail) Regulation 2017

For hydrogen powered rolling stock, the requirements of the Rail Safety National Law (Queensland) Act 2017 and Transport Infrastructure (Rail) Regulation 2017 must be met as well as gas safety requirements under P&G safety legislation.

Where hydrogen gas systems are installed on rolling stock requirements for gas device approval and authorised installers applies.

The Rail Safety National Law (Queensland) Act 2017 contains rail safety duties that are a shared responsibility of, rail transport operators, rail safety workers and the Rail Safety Regulator (ONRSR) as well as other persons.

This includes:

- Managing risks associated with the carrying out of rail infrastructure operations or rolling stock operations

- Managing risk to eliminate or minimise risk so far as is reasonably practicable.

Refer to Rail Safety National Law (Queensland) Act 2017 Part 3 for all duties.

Appendix 3 - Case Studies

Table 9 summarises hydrogen project cases studies in Queensland.

Table 9 Hydrogen project case studies.

Type	Approvals Pathway
Domestic power generation unit including small electrolyser, hydride storage canister and fuel cell.	RSHQ determined the fuel cell as a type B device which was a part of a fuel cell gas system [P&G Act s724 (3)]. As there were no prescriptive standards, the proponent was required to submit a technical submission that was reviewed by the chief inspector. Electrical and other approval requirements were assessed separately to the gas device approval
Imported hydrogen fuel cell light vehicles which met ADR for use on roads.	RSHQ determined that the device within the vehicle was a type B appliance/device and in their legislative jurisdiction [P&G Act s724 (3)]. The hydrogen fuel system in the vehicles is designed and certified to UN134. The installation had been completed by competent persons. It was determined that UN R134 addresses gas safety risks.
A hydrogen refuelling station including onsite hydrogen production and storage.	RSHQ determined that the refuelling station supplied via an onsite electrolyser is operating plant [P&G Act s670, P&G Safety Reg s11]. The operator prepared an SMS [P&G Act s674]. A commissioning notice was submitted to RSHQ. The relevant requirements for WHS and Electrical Safety also apply [the Code Appendix 2].
Hydrogen facility that injects hydrogen gas into an existing gas distribution pipeline system.	RSHQ determined that the project is a part of existing operating plant [P&G Act s670]. The operator updated their existing safety management system [P&G Act s674] to ensure risks at the operating plant are

Type	Approvals Pathway
	maintained at an acceptable level. The operator also needs to ensure the gas quality requirements are met [P&G Act 620, P&G Safety Reg 72]. The operator consulted with RSHQ on safety and quality control throughout the planning stages of the project.
Large scale hydrogen production facility for export.	The production facility which includes storage is a Major Hazard Facility (MHF). The hydrogen production is a manufacturing activity. For these reasons the production facility is regulated by WHS. Relevant hydrogen pipeline may be included in the MHF or as operating plant under the P&G safety legislation.
Hydrogen pipeline transporting hydrogen fuel from the production facility to the port liquefaction facility.	RSHQ have determined that the hydrogen pipeline is a distribution pipeline as defined in P&G Act s16A. Distribution pipelines are operating plant and require a Safety Management System. Note: There is a difference between a pipeline and a distribution pipeline – A pipeline has a pipeline license (PPL) and a distribution pipeline does not. Both are operating plant but if a pipeline license is issued then some WHS provisions are excluded

Appendix 4 - General hydrogen safety considerations

A4.1 - International standards for mobile fuel cell gas systems

A number of international standards exist that may provide guidance for the design, installation and use of a fuel cell gas system.

- IEC 62282-4-101: Fuel cell technologies – Part 4-101: Fuel cell power systems for propulsion other than road vehicles and auxiliary power units (APU) – Fuel cell power systems for electrically powered industrial trucks – Safety.
- IEC 62282-4-102: Fuel cell technologies - Part 4-102: Fuel cell power systems for propulsion other than road vehicles and auxiliary power units (APU) - Fuel cell power systems for electrically powered industrial trucks - Performance test methods.
- SAE J2578 Recommended Practice for General Fuel Cell Vehicle Safety.
- SAE J2579 (R) Standard for Fuel Systems in Fuel Cell and Other Hydrogen Vehicles.
- SAE J2600 Compressed Hydrogen Surface Vehicle Fueling Connection Devices
- IEC 63341 series Railway applications – Rolling stock – Fuel cell systems for propulsion
- Gaseous Hydrogen Installations (published by ANZIGA)

These documents are not reference standards.

A4.2 - Hydrogen refuelling stations standards

Hydrogen refuelling stations are a critical component to unlocking the opportunity for hydrogen mobility and while a number of standards exist, the framework is evolving.

In Australia, hydrogen refuelling stations have been built to a number of standards. While development of a complete safety framework is well underway in Australia, there is further work to be completed.

A number of existing Australian Standards apply to refuelling stations using hydrogen e.g. *AS 3000 –The wiring rules*.

To support the uptake of hydrogen in the mobility industry, the *ME-093 Hydrogen Technologies Committee* has adopted thirteen ISO (International Organization for Standardization) standards specific to hydrogen refuelling stations shown in Table 10.

Table 10 ISO standards that have been adopted as Australian Standards relevant for hydrogen refuelling stations.

Standard	Designation
AS 22734	Hydrogen generators using water electrolysis – Industrial, commercial, and residential applications
AS 16110.1	Hydrogen generators using fuel processing technologies
AS ISO 16110.2	Hydrogen generators using fuel processing technologies
SA TS 19883	Safety of pressure swing adsorption systems for hydrogen separation and purification
AS ISO 16111	Transportable gas storage devices – Hydrogen absorbed in reversible metal hydride
AS ISO 19881	Gaseous hydrogen – Land vehicle fuel containers
AS 19880.3	Gaseous hydrogen – Fuelling stations
AS 26142	Hydrogen detection apparatus – Stationary applications
AS ISO 14687	Hydrogen fuel quality – Product specification
AS ISO/TR 15916	Basic considerations for the safety of hydrogen systems
AS ISO 19880.8	Gaseous hydrogen — Fuelling stations, Part 8: Fuel quality control
AS ISO 19880.5	Gaseous hydrogen - Fuelling stations, Part 5: Dispenser hoses and hose assemblies
AS ISO 19880.8	Gaseous hydrogen - Fuelling stations, Part 8: Fuel quality control

There are a number of International Standards that exist for hydrogen refuelling stations. Key standards include:

- the ISO 19880 Series (Except the standards listed in Table 10)
- Guidance on hydrogen delivery systems for refuelling of motor vehicles, co-located with petrol fuelling stations (published by Energy Institute, London)
- NFPA 2 - Hydrogen Technologies Code
- EIGA Doc 6/02 - Safety in storage, handling and distribution of liquid hydrogen
- EIGA Doc 211/17 - hydrogen vent systems for customer applications
- SAE J2799, SAE J2600 and the SAE J2601 series
- ASME B31.12 - Hydrogen Piping and Pipelines.Gaseous Hydrogen Installations (published by ANZIGA)
- Hydrogen Cylinders and Transport Vessels (published by ANZIGA)
- Hydrogen Pipeline Systems (published by ANZIGA)
- Hydrogen Vent Systems for Customers Applications (published by ANZIGA)

The International Standards listed above have not been adopted in Australia; they may be used for

guidance while ensuring compliance with relevant Australian requirements.

A4.4 – Periodic inspection

For mobile gas systems, periodic inspections should be carried out to verify ongoing safety of the installation. Typical items that should be inspected include:

- Gas tightness
- Container test date
- Pressure vessel external inspection
- Leak detection instrument
- Automatic shut-off operation

A4.5 - Workshops

When parking and storing a hydrogen vehicle the workshop, garage and carpark need to be considered to ensure a safe work environment.

Currently, there are no Australian Standards for hydrogen workshops specifically; however, following standards may provide some guidance:

- *AS 2746 – Working areas for gas fuelled vehicles*, while hydrogen is not currently within the scope of the standard it provides good information on the considerations for workshop design that may be applied when designing hydrogen workshops

The National Fire Protection Agency (NFPA*)* has also produced the following codes:

- *NFPA2 - Hydrogen Technologies Code* (NFPA2) Chapter 18, which provides guidance on minor repair garages, and
- *NFPA30 - Flammable and Combustible Liquids Code*, which provides guidance on major repair garages.

Requirements or recommendations from NFPA standards should be taken in context with other requirements that might apply in Australia. Including application of the AS/NZS 60079 series for ventilation and requirements of electrical equipment in hazardous areas.

General considerations for workshops include the following:

- design of the facility
- requirements for electrical installation and hazardous areas

- requirements for ventilation, and
- specific considerations for industrial truck repair garages.

Other Considerations:

During normal operation, hydrogen gas is expected to permeate through the walls of plastic materials such as the tank liners of all-composite tanks and through O-ring seals. This is known as fuel system permeation.

A limit of the fuel system permeation rate is set to control the risk of fire in confined spaces such as vehicle garages.

Internationally, the method for calculating the limit is based on typical air changes in the garage and the lower flammability limit of hydrogen in air. The resultant fuel system permeation limit rate is specified to be 46 millilitres per hour per litre water tank capacity for each tank in the fuel system for ventilated enclosures.

For non-ventilated enclosures, the limit should be calculated and compared against the fuel system permeation rate.

A4.6 - Pipelines and gas distribution networks

For pipelines outside of the scope of AS 4645, the AS 2885 series applies. The AS 2885 series is predominantly for hydrocarbon fluid or carbon dioxide and was not developed with consideration for hydrogen service. The AS 2885 series does allow for transport of other fluids, including non-hydrocarbon gases, under AS 2885.0, Clause 1.2.2, but special considerations are required.

The Future Fuels Cooperative Research Centre is currently developing a hydrogen pipelines Code of Practice. This document will provide guidance on the design, construction and operation of hydrogen pipelines in Australia. Further guidance on this document is provided at this link: Hydrogen Pipeline Code of Practice: Design, Construction and Operation.

Other resources:

- Hydrogen Pipeline Systems (published by ANZIGA)

A4.7 - Separation distances for hydrogen facilities

Currently, no Australian Standards provide guidance for hydrogen separation distances. The

provision of adequate distances or separation zones around equipment is a fundamental consideration for a safe layout of plant, equipment, and buildings.

Separation distances are used to:

- Protect people from harmful events
- Protect buildings, structures and sensitive receptors from damage
- Prevent escalation (of events) within the facility.

Hydrogen in air has a wide explosive range and hydrogen itself has a very low ignition energy. In the event of a leak, these properties can lead to the any of the following:

- jet fire (the leak is ignited after release, resulting in the formation of a long, stable flame from the source of the leak)
- flash fire (a flash fire occurs when a cloud of flammable gas mixed with air is ignited)
- vapour cloud explosion [VCE] (the leak is within a confined area, accumulates, and is subsequently ignited). *Note, confinement should be avoided; hydrogen is significantly lighter than air and can readily disperse if there is adequate ventilation.*

For each credible event (ignoring likelihood), the unmitigated consequences are evaluated to determine the separation distance. Typically, event contours are added to layout drawings showing the separation distances associated with each event and each source.

The location of facility plant and equipment should ensure populated buildings, critical assets, and public access are outside the worst case event contour zones (refer State Code 21). Where this is not possible, the likelihood of the events and their consequences will need to be evaluated using risk assessment techniques. Engineering controls should be implemented to reduce the risk to as low as reasonably practicable (ALARP) and to demonstrate that the risk is below the tolerable risk target applicable to the land use.

Thus the final layout and separation distances take into account the following:

a) The nature of the hazard(s)
b) The equipment design and the operating conditions (pressure, temperature, inventory) and/or physical properties of the substance under those conditions
c) Any external mitigating protection measures (e.g., fire walls, diking, deluge system, etc.) which reduce the escalation of the incident
d) The “object” which is protected by the separation distance, i.e., the harm potential (e.g., people, environment or equipment).

Table 11 summarises useful international standards and codes for evaluating separation distances and consequences.

Table 11 Standards that provide guidance on separation distances.

Standard	Guidance Provided
Guidance on hydrogen delivery systems for refuelling of motor vehicles, co-located with petrol fuelling stations (published by Energy Institute, London)	Separation distances for hydrogen dispensing facilities
NFPA 2 Hydrogen Technologies code	Minimum separation distances based on pressure and maximum pipe size.
API 521	Defines heat radiation levels (of interest) and their consequences.
API 752 / 753	Management of Hazards Associated With Location of Process Plant Permanent / Portable Buildings

A4.8 - Pressure Vessel Design Registration

The WHS Act Sch.5, provides the relevant information for plant and plant design registrations.

An indicative list of the documents that are required for design registration:

- Basis of Design
- Calculations
- Drawings
- Datasheets
- Technical specifications
- Bill of materials
- Statement signed by the designer
- Design verification statement.

Further guidance on the design registration for plant items is provided at this link: Plant Design Registration.

Appendix 5 - Resources

Table 12 provides a list of useful hydrogen related resources.

Table 12 List of useful hydrogen related resources.

Resource	Description	Details
HyResource	Hydrogen related research.	https://research.csiro.au/hyresource/
Hydrogen Investor Toolkit	Hydrogen project development in Queensland.	https://www.statedevelopment.qld.gov.au/__data/assets/pdf_file/0023/17843/queensland-hydrogen-investor-toolkit.pdf
Standard Australia ME-093 Hydrogen Technologies	Australia standards for hydrogen.	https://www.standards.org.au/getmedia/da6c6fcb-96bb-4b45-a1b0-1f2882c03ec4/ME-093-Hydrogen-Technologies-Strategic-Work-Plan.pdf.aspx
Future Fuels CRC	Hydrogen related research.	https://www.futurefuelscrc.com/
Fuel Cell Standards	International standards for hydrogen.	https://www.fuelcellstandards.com/
H2Tools	International website for hydrogen safety.	https://h2tools.org/
ISO/TC 197 Hydrogen technologies	ISO standards for hydrogen.	https://www.iso.org/committee/54560.html
ANZIGA	Publication of EIGA Hydrogen Documents	Publications – Australia New Zealand Industrial Gas Association (anziga.org)
ADG	Australian Dangerous Goods Code for transport of Dangerous Goods (including hydrogen)	https://www.ntc.gov.au/sites/default/files/assets/files/ADG%20Code%207.7_0.pdf

Appendix 6 – Contributors, Reviewers and Advisors

Table 13 is a list of the Contributors, Reviewers and Advisors involved in the preparation of the draft Code.

Table 13 List of Contributors, Reviewers and Advisors.

Contributors, Reviewers and Advisors	
AECOM Australia	Hyundai Motor Company Australia
Ark Energy	Hyzon Motors Australia
Armarna Energy	Kandls Engineering
Australian Gas Networks	Master Plumbers Association of Queensland
Australian Marine Safety Authority	National Heavy Vehicle Regulator
Assure International	North Queensland Hydrogen Industry Work Group
Australian Hydrogen Council	Origin Energy
Board of Professional Engineers of Queensland	Plumbing and Pipe Trades Employees Union Queensland
Department of Resources (Queensland)	Queensland Electrical Safety Office
Endua	Queensland University of Technology
Energy Safe Victoria	Risk and Energy Services
Federal Chamber of Automotive Industries	Standards Australia
Foton Mobility Australia	Stanwell
Gas Energy Australia	TfA Project Group
Gas Technical Regulator Committee	Vehicle Standards – Department of Infrastructure, Transport, Regional Development and Communications
GHD	Viva Energy
GPA Engineering	Western Australian Department Industry and Mines
H2Q	Workplace Health and Safety Queensland
H2H Energy	

Appendix 7 – Proposed Legislative Amendments

Appendix 7 a temporary section that collates the proposed legislative amendments highlighted in the Code. The proposals have been informed by stakeholder feedback to address shortcomings of current legislative provisions.

- Updated definition of gas fuel system to: "A gas system that supplies gas as a fuel to an engine or mobile fuel cell"
- If an operator proposes to supply gas through a distribution network with more than 15% hydrogen, they may meet the safety requirement by giving the chief inspector notice stating that the supply is outside the allowed limits of AS/NZS 4645 and that they have conducted a formal safety assessment ensuring that an equal or less level of risk has been achieved.
- All hydrogen fuel gas delivery networks are operating plant
- This Code is added as a safety requirement in Schedule 2 of the P&G Safety Reg for the design of gas systems and devices.
- This Code is added as a safety requirement in Schedule 2 of the P&G Safety Reg for the installation of gas systems and devices.
- No odour is prescribed for hydrogen when safety requirements of this Code are met

Appendix 8 – UEG Gas Industry Training Package

The following qualifications that have been updated to include hydrogen:

- UEG20121 Certificate II in Gas Supply Industry Operations
- UEG30121 Certificate III in Gas Supply Industry Operations
- UEG40221 Certificate IV in Gas Supply Industry Operations

These include the following new and revised units:

- UEGNSG102 Prepare safe design specifications of a gas system
- UEGNSG205 Commission or decommission gas distribution pipelines
- UEGNSG206 Construct and lay copper and stainless steel gas distribution pipelines
- UEGNSG208 Construct and lay large copper gas distribution pipelines
- UEGNSG209 Construct and lay polyethylene gas distribution mains
- UEGNSG211 Construct and lay steel gas distribution pipelines
- UEGNSG214 Coordinate and conduct gas distribution pipeline repair and modifications
- UEGNSG215 Coordinate construction, laying and testing of gas distribution pipelines

- UEGNSG303 Carry out transmission pipeline construction work activities
- UEGNSG304 Commission or decommission gas transmission pipelines
- UEGNSG306 Control gas processing, storage or regasification operations in an LNG storage facility
- UEGNSG307 Coordinate the operation of relevant plant and equipment for transmission pipeline construction
- UEGNSG309 Coordinate transmission pipeline construction operations
- UEGNSG312 Inject gas into underground storage
- UEGNSG313 Monitor and operate flow control, pressure measuring and regulating devices for gas transmission
- UEGNSG315 Withdraw gas from underground storage
- UEGNSG316 Work in proximity of transmission pipeline construction plant and equipment
- UEGNSG509 Remotely monitor and operate gas transmission flow and pressure measuring and regulating devices
- UEGNSG701 Disconnect and reconnect data logging equipment
- UEGNSG702 Disconnect and reconnect small capacity gas meters
- UEGNSG703 Fault find and repair data logging equipment
- UEGNSG704 Install and commission data logging equipment
- UEGNSG707 Process data logging information
- UEGNSG709 Process meter reading information using appropriate technology
- UEGNSG710 Read and record meter readings
- UEGNSG715 Use data logging equipment
- UEGNSG901 Apply safety practices, procedures, and compliance standards for handling hydrogen gas
- UEGNSG902 Commission, operate and maintain electrolysers
- UEGNSG903 Fault find and repair hydrogen storage equipment
- UEGNSG904 Inject hydrogen gas into distribution networks
- UEGNSG905 Monitor and control hydrogen in gas distribution networks
- UEGNSG906 Undertake routine hydrogen storage operations

Information from this appendix is sourced from:
https://www.australianindustrystandards.org.au/projects/ueg-hydrogen-technology/