Hydrogen Technologies Standards

DISCUSSION PAPER

STANDARDS Australia

Contents

Standards Australia

Standards Australia is the nation's peak standards body and Australia's representative to the International Electrotechnical Commission (IEC) and International Organization for Standardization (ISO).

Australian Standards® are developed and approved by technical committees, constituted of members representing national nominating organisations including industry associations, government bodies, and universities.

Compliance with Australian Standards is voluntary, unless they are called up in local, state, or Commonwealth regulations. Standards Australia also publishes lower consensus documents, including Technical Specifications and Handbooks.

Introduction

The hydrogen sector in Australia is gaining momentum. The potential role of hydrogen across the Australian industry to decarbonise, improve fuel security, and create new investment opportunities is being recognised. As the Australian economy transitions to a low-carbon future, in line with our international commitments, hydrogen is recognised as a 'clean' energy source and feedstock, which can support this transition.

Additionally, the recent investment signals from nearby trade partners to develop hydrogen supply chains, means Australia is incredibly well positioned to lead in large-scale production, storage and transportation for both a domestic market as well as pursuing export opportunities. It is increasingly recognised that the hydrogen sector has shifted from exploring technological viability, towards realising market potential. However, this shift requires a coordinated and strategic response from industry and government.

Across the energy sector, standards have always played a key role in supporting policy and regulatory frameworks. Standards allow for interoperability between technologies, provide consistent frameworks for design and implementation, and ensure safety. In the gas sector, standards set requirements for all phases of the gas supply chain, from production and distribution, through to installations and appliance specifications. These standards ensure consistency of outcomes across the supply chain, increase efficiencies, enhance safety and facilitate international trade.

To support the hydrogen industry and its evolution, Standards Australia is engaging with stakeholders to establish the current and future needs of the sector and identify the role standards can play. The process will be stakeholder driven, in the form of a public forum and culminate in a report outlining priorities and next steps for standards in this sector.

This paper has been developed to help facilitate future planning, and is intended to form the basis of discussions during the upcoming Hydrogen Standards Forum on **Wednesday 17th October 2018**. The forum is open and participation from a wide range of stakeholders is encouraged. Please note that spaces are limited and early registration is advised.

Stakeholders

Key stakeholders that are being invited to participate in the hydrogen discussion include industry bodies, government representatives, regulators, consumers and academia. We have sought out broad participation at the Hydrogen Standards Forum, to ensure that we can capture the broad views regarding the future standards needs of the hydrogen sector.

Goals and outcomes

This discussion paper is intended to stimulate discussion prior to the upcoming Hydrogen Standards Forum. During the forum, we will seek to undertake the following activities:

1. Provide a snapshot of the current standards in the sector

This paper presents the current snapshot of standards-based activities in the hydrogen sector (see “A standards snapshot” on page 6), and outlines Australia’s relative level of involvement and engagement in those activities. This paper is also intended to assist in identifying any potential standards gaps.

2. Identify the priority areas

Based on the current areas of hydrogen standards, as well as any identifiable gaps, during the forum, Standards Australia will facilitate a breakout activity where stakeholders can discuss what the priority areas are. This breakout activity will see stakeholders split into 4 groups, where they will discuss: (a) production, (b) storage, (c) transport and (d) end users. These groups will discuss the standards needs in their respective category, and report back to the group. This feedback will be recorded by Standards Australia and included in the final Hydrogen Standards Report.

3. Identify areas for further engagement

Based on a prioritisation of work, there may be areas which require further consultation and coordination at a future time. Furthermore, during the forum we will be discussing how to best achieve engagement in the existing standards work at the international level. And where standards do not currently exist, we will explore how they can most effectively be developed.

4. Next steps and timelines

During the forum we will discuss the next steps and timelines to achieve those outcomes. These will be captured in the Hydrogen Standards Report.

Ahead of the forum

In the lead up to the Hydrogen Standards Forum, we ask you to consider the following questions:

1) What are the priority areas for hydrogen standards?
2) What areas require further discussion?
3) Should Australia participate actively in the international committees listed in this discussion paper?
4) Should Australia adopt the standards listed in this discussion paper? If so, which ones?
5) Have you identified any gaps where standards do not currently exist?

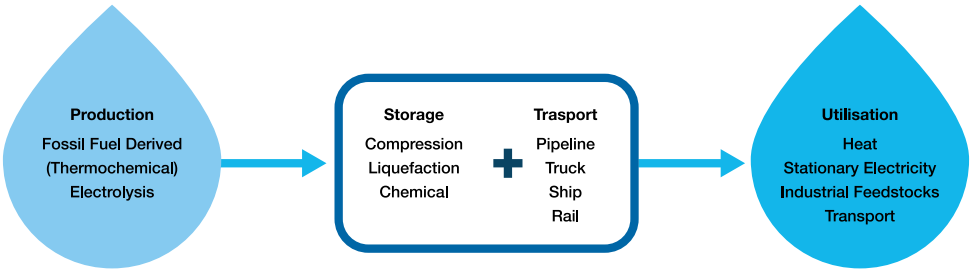
On the day of the forum, Standards Australia will be facilitating a breakout discussion to further discuss the above mentioned questions. We will be splitting the forum participants into four discussion groups: **Production**; **Storage**; **Transport**; and **End users**. Please consider which group you would like to participate in ahead of the forum, and you will be asked to nominate a group on the day.

Background

Both domestically and internationally, a considerable amount of work has been undertaken to establish the economic, technological and policy viability of hydrogen industries. In Australia, this work has been spearheaded by the CSIRO Futures Hydrogen Roadmap Report as well as the Chief Scientists' COAG Energy Council Briefing Paper Hydrogen for Australia's Future.

The *CSIRO Futures Hydrogen Roadmap* seeks to outline how the benefit of a hydrogen industry could be realised in the Australian context and what next steps need to be taken in the form of coordinated investment, policy and research strategies. The report identifies three critical elements in the hydrogen value chain; production, storage and transportation, and utilisation, as shown in Figure 1. Each of these elements require technology and infrastructure investments, complimented by appropriate policy frameworks to support a commercially competitive industry in Australia.

Figure 1 : Hydrogen value chain



Source: National Hydrogen Roadmap CSIRO Futures

Standards Australia, in its role as the peak standards development organisation, contributed to that Roadmap, by outlining what the current snapshot of international and domestic hydrogen standards are, and where there are potential opportunities for further development to support the industry.

The development of the *Chief Scientist's COAG Energy Council Briefing Paper* further supports the establishment of a hydrogen sector in Australia and outlines the key benefits to policy makers. The paper stresses the need for a coordinated and strategic approach by government, industry and researchers alike, to ensure Australia can capitalise on this potentially multi-billion dollar industry. The report identifies the emerging import demand signalled by Japan and Korea, as well as Australia's relative competitive advantage as an existing energy exporter with an associated supply chain, as the critical tipping point in the viability of the hydrogen sector in Australia.

In addition to these two critical reports, Standards Australia has been engaging with one of the peak hydrogen industry groups, Hydrogen Mobility Australia, who have been eager to progress the agenda on how standards can support the further development of the hydrogen industry in Australia.

In response to these recent developments, Standards Australia is supporting the evolution and innovations in the hydrogen sector by facilitating a Hydrogen Standards Forum. This forum will seek to establish what standards are needed to ensure safety, efficiency, and international compatibility. We aim to capture the views of all relevant stakeholders and to determine where the priorities lie, and what next steps need to be taken to achieve optimal outcomes for the industry, through a standards-based approach.

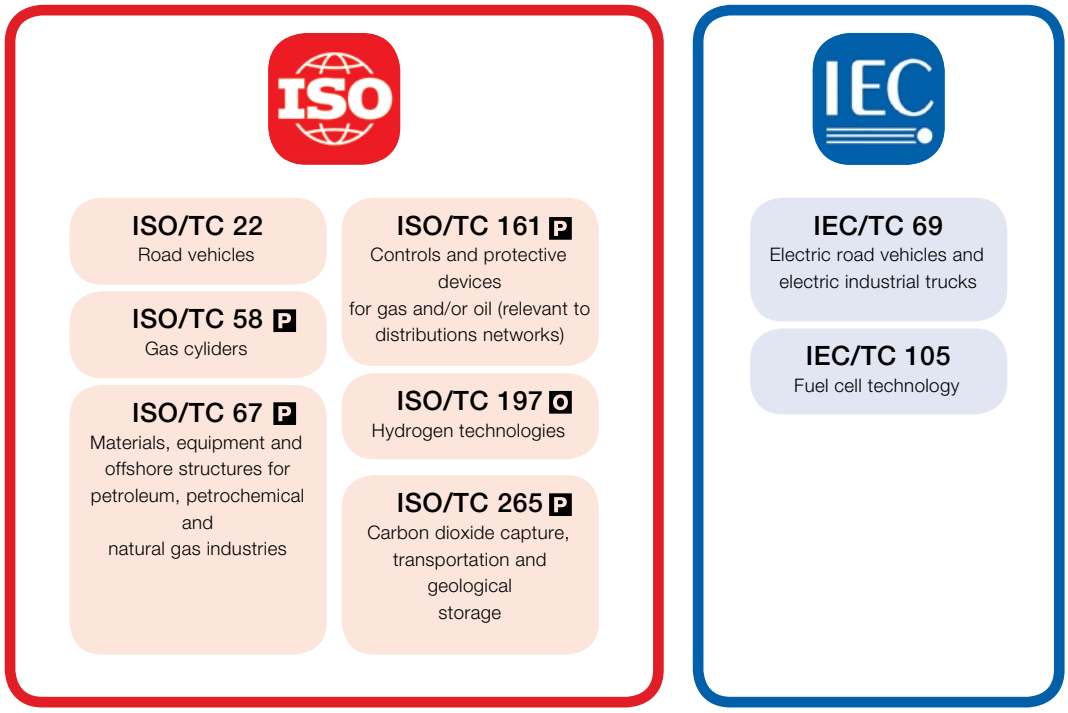
A standards snapshot

The benefits of international standards adoption are significant. Internationally developed standards allow for harmonisation, which facilitates trade and can deliver alignment between production, storage and usage technologies common within other global markets. Participation in committees at the international level also allows an Australian perspective to be incorporated into international standards, ensuring that regional, environmental or existing regulatory factors are considered. This positions Australian stakeholders, including industry, as contributors to international standards, as opposed to consumers of them.

Internationally, at both the International Organisation for Standardization (ISO) and the International Electrotechnical Commission (IEC), standards already exist and are being developed to enable the efficient, repeatable and safe introduction of hydrogen technologies. However, there are also potential standards gaps across production, transport, storage and the various applications for hydrogen.

A number of international technical committees exist for hydrogen and hydrogen related technologies, including areas relating to hydrogen production, storage, transportation and potential utilisation. These committees, and Australia's relative levels of engagement, are depicted in Figure 2.

Figure 2



Membership
P Participating
O Observing

International technical committees

ISO/TC 197 – Hydrogen technologies

Relevance: Production

Scope: Standardization in the field of systems and devices for the production, storage, transport, measurement and use of hydrogen.

Australian membership: Observing member

Australian mirror committee: ME-046 – Gas fuel systems for vehicle engines

https://www.iso.org/committee/54560.html

ISO/TC 58 – Gas cylinders

Relevance: Storage

Scope: Standardization of gas cylinders and other pressure receptacles, their fittings and requirements relating to their manufacture and use.

Excluded: Cryogenic vessels (ISO/TC 220) and aerosol containers

Note: Pressure receptacles, cryogenic receptacles and aerosols are defined in the international regulations for the transport of dangerous goods by sea, air, road and rail and in the United National Recommendations on the Transport of Dangerous Goods, Model Regulations (ST/SG/AC.10/1 as amended from time to time).

Australian membership: Participating member

Australian mirror committee: ME-002 – Gas cylinders

https://www.iso.org/committee/49008.html

ISO/TC 67 – Materials, equipment and offshore structures for petroleum, petrochemical and natural gas industries

Relevance: Transportation through pipelines

Scope: Standardization of the materials, equipment and offshore structures used in the drilling, production, transport by pipelines and processing of liquid and gaseous hydrocarbons within the petroleum, petrochemical and natural gas industries.

Australian membership: Participating member

Australian mirror committee: ME-038 – Petroleum pipelines and ME-092 - Materials, equipment, structures and related services for petroleum, petrochemical and natural gas industries.

https://www.iso.org/committee/49506.html

- ISO/TC 161 – Controls and protective devices for gas and/or oil

  Relevance: Distribution networks

  Scope: Controls and protective devices for burners, appliances using gas and/or oil. This includes controls for residential, commercial and industrial applications and fuel supply installations, also includes high pressure controls for use in gas transmission, distribution and installations.

  Excluded: materials, equipment and offshore structures for petroleum, petrochemical and natural gas industries applications which are covered by the scope of ISO/TC 67.

  Australian membership: Participating member

  Australian mirror committee: AG-008 – Gas distribution, AG-011 – Industrial and commercial gas-fired appliances & AG-013 – Components used for gas appliances and equipment.

  https://www.iso.org/committee/53436.html

- ISO/TC 22 – Road vehicles

  Relevance: End users

  Scope: All questions of standardization concerning compatibility, interchangeability and safety, with particular reference to terminology and test procedures (including the characteristics of instrumentation) for evaluating the performance of the following types of road vehicles and their equipment as defined in the relevant items of Article 1 of the convention on Road Traffic, Vienna in 1968 concluded under the auspices of the United Nations: mopeds, motor cycles, motor vehicles, trailers, semi-trailers, light trailers, combination vehicles, articulated vehicles.

  Australian membership: non-member.

  https://www.iso.org/committee/46706.html

- ISO/TC 265 – Carbon dioxide capture, transportation, and geological storage

  Relevance: Production

  Scope: Standardization of design, construction, operation, environmental planning and management, risk management, quantification, monitoring and verification, and related activities in the field of carbon dioxide capture, transportation, and geological storage (CCS).

  Australian membership: Participating member

  Australian mirror committee: EE-002 - Carbon dioxide capture, transportation, and geological storage.

  https://www.iso.org/committee/648607.html

- IEC/TC 105 – Fuel cell technologies

  Relevance: End users

  Scope: To prepare international standards regarding fuel cell (FC) technologies for all FC types and various associated applications such as stationary FC power systems for distributed power generators and combined heat and power systems, FCs for transportation such as propulsion systems (see note below), range extenders, auxiliary power units, portable FC power systems, micro FC power systems, reverse operating FC power systems, and general electrochemical flow systems and processes. NOTE: Projects with applications in the field of road vehicles will be coordinated with ISO/TC 22 and its relevant SCs using the cooperation modes defined in the ISO/IEC Directives.

  Australian membership: Non-member

  Australian mirror committee: Non-member

  https://www.iec.ch/dyn/www/f?p=103:29:11656696375218::::FSP_ORG_ID,FSP_LANG_ID:1309,25#1

- IEC/TC 69 – Electric road vehicles and electric industrial trucks

  Relevance: End users

  Scope: To prepare international standards for road vehicles, totally or partly electrically propelled from self-contained power sources, and for electric industrial trucks.

  Australian membership: non-member (used to be a P-member)

  Australian mirror committee: EM-001 – Electric vehicle operation

  https://www.iec.ch/dyn/www/f?p=103:29:11656696375218::::FSP_ORG_ID,FSP_LANG_ID:1255,25#1

Relevant standards

Hydrogen production

The most relevant standards relating to electrolysis as a production method are:

- ISO 22734-1 - Hydrogen generators using water electrolysis process – Part 1: Industrial and commercial applications and
- ISO 22734-2 - Hydrogen generators using water electrolysis process – Part 2: Residential applications.

No international standards relevant to hydrogen production have been adopted in the Australian market as Australian Standards to date.

Designation	Title	Adopted in Aus?	Int'l Parent C'ttee
ISO/DIS 14687 [Under development]	Hydrogen fuel quality – Product specification	No	ISO/TC 197
ISO/DIS 22734 [Under development]	Hydrogen generators using water electrolysis process – Industrial, commercial, and residential applications	No	ISO/TC 197
ISO 14687-1:1999	Hydrogen fuel – Product specification – Part 1: All applications except proton exchange membrane (PEM) fuel cell for road vehicles	No	ISO/TC 197
ISO 14687-2:2012	Hydrogen fuel – Product specification – Part 2: Proton exchange membrane (PEM) fuel cell applications for road vehicles	No	ISO/TC 197
ISO 14687-3:2014	Hydrogen fuel – Product specification – Part 3: Proton exchange membrane (PEM) fuel cell applications for stationary appliances	No	ISO/TC 197
ISO 16110-1:2007	Hydrogen generators using fuel processing technologies – Part 1: Safety	No	ISO/TC 197
ISO 16110-2:2010	Hydrogen generators using fuel processing technologies – Part 2: Test methods for performance	No	ISO/TC197
ISO/TS 19883:2017	Safety of pressure swing adsorption systems for hydrogen separation and purification	No	ISO/TC 197
ISO 22734-1:2008	Hydrogen generators using water electrolysis process – Part 1: Industrial and commercial applications	No	ISO/TC 197
ISO 22734-2:2011	Hydrogen generators using water electrolysis process – Part 2: Residential applications	No	ISO/TC 197

Carbon capture

Another critical factor relevant to hydrogen production technologies and their commercial viability is the availability of carbon capture technologies. A number of international standards exist in this field, outlining the minimum requirements for carbon capture systems, carbon transportation systems and geological storage requirements.

Designation	Title	Adopted in Aus	Int'l Parent C'ttee
ISO/TR 27912:2016	Carbon dioxide capture – Carbon dioxide capture systems, technologies and processes	No	ISO/TC 265
ISO 27913:2016	Carbon dioxide capture, transportation and geological storage – Pipeline transportation systems	No	ISO/TC 265
ISO 27914:2017	Carbon dioxide capture, transportation and geological storage – Geological storage	No	ISO/TC 265
ISO/TR 27915:2017	Carbon dioxide capture, transportation and geological storage – Quantification and verification	No	ISO/TC 265
ISO 27917:2017	Carbon dioxide capture, transportation and geological storage – Vocabulary – Cross cutting terms	No	ISO/TC 265
ISO/TR 27918:2018	Lifecycle risk management for integrated CCS projects	No	ISO/TC 265
ISO/TR 27912:2016	Carbon dioxide capture – Carbon dioxide capture systems, technologies and processes	Yes	ISO/TC 265
ISO 27913:2016	Carbon dioxide capture, transportation and geological storage – Pipeline transportation systems	No	ISO/TC 265
ISO 27914:2017	Carbon dioxide capture, transportation and geological storage – Geological storage	No	ISO/TC 265
ISO/TR 27915:2017	Carbon dioxide capture, transportation and geological storage – Quantification and verification	No	ISO/TC 265
ISO/DIS 27916 [Under development]	Carbon dioxide capture, transportation and geological storage – Carbon dioxide storage using enhanced oil recovery (CO2-EOR)	No	ISO/TC 265
ISO 27917:2017	Carbon dioxide capture, transportation and geological storage – Vocabulary – Cross cutting terms	No	ISO/TC 265
ISO/TR 27918:2018	Lifecycle risk management for integrated CCS projects	No	ISO/TC 265

Storage and transport

There are long established national and international standards for natural gas and LPG gas storage, however, there are now international standards being developed specifically for both stationary and portable storage of hydrogen, critical for ensuring safety in the hydrogen industry.

Designation	Title	Adopted in Aus?	Int'l Parent C'ttee
ISO19884 [Under development]	Gaseous hydrogen – Cylinders and tubes for stationary storage	No	ISO/TC 197
ISO 16111	Transportable gas storage devices – Hydrogen absorbed in reversible metal hydride	No	ISO/TC 197

These combined with existing gas storage and transportation standards, provide a technical infrastructure (refer to page 13). Neither of the above mentioned standards are currently adopted as Australian Standards.

Safety

Safety is a critical factor to be considered and is vital for satisfying community expectations, but also ensuring workforce and environmental health and safety. The following international standards have already been developed specifically to ensure minimum safety requirements for the hydrogen gas industry.

Designation	Title	Adopted in Aus?	Int'l Parent C'ttee
ISO/TR 15916	Basic considerations for the safety of hydrogen systems	Yes	ISO/TC 197
ISO 26142	Hydrogen detection apparatus – Stationary applications	Yes	ISO/TC 197

Neither of the above standards are currently adopted as Australian Standards.

Utilisation

Transport

Of the many potential hydrogen applications in the Australian and global markets, the most standards exist for transportation utilisation, with either fuel cell technologies of gaseous hydrogen fuel.

Designation	Title	Adopted in Aus?	Int'l Parent C'ttee
ISO/DIS 17268 [Under development]	Gaseous hydrogen land vehicle refuelling connection devices	No	ISO/TC 197
ISO/DIS 19881 [Under development]	Gaseous hydrogen – Land vehicle fuel containers	No	ISO/TC 197
ISO/DIS 19882 [Under development]	Gaseous hydrogen – Thermally activated pressure relief devices for compressed hydrogen vehicle fuel containers	No	ISO/TC 197
ISO/DIS 19880-1 [Under development]	Gaseous hydrogen – Fueling stations – Part 1: General requirements	No	ISO/TC 197
ISO/FDIS 19880-3 [Under development]	Gaseous hydrogen – Fueling stations – Part 3: Valves	No	ISO/TC 197
ISO/DIS 19880-5 [Under development]	Gaseous hydrogen – Fueling stations – Part 5: Hoses and hose assemblies	No	ISO/TC 197
ISO/DIS 19880-8 [Under development]	Gaseous hydrogen – Fueling stations – Part 8: Fuel quality control	No	ISO/TC 197
ISO 13984:1999	Liquid hydrogen – Land vehicle fuelling system interface	No	ISO/TC 197
ISO 13985:2006	Liquid hydrogen – Land vehicle fuel tanks	No	ISO/TC 197
ISO/TS 15869:2009	Gaseous hydrogen and hydrogen blends – Land vehicle fuel tanks	No	ISO/TC 197
ISO 17268:2012	Gaseous hydrogen land vehicle refuelling connection devices	No	ISO/TC 197
ISO/TS 19880-1:2016	Gaseous hydrogen – Fuelling stations – Part 1: General requirements	No	ISO/TC 197

Heating

For heat applications of hydrogen, existing gas standards for appliances would likely need to be revised in order to accommodate the introduction of hydrogen into the network.

The relevant existing standards for heating applications are below.

Designation	Title
AS/NZS 5263 (series)	Gas appliances
AS 3645	Essential requirements for gas equipment

Potential gaps and additional standardisation needs

If hydrogen was introduced into the natural gas networks, existing natural gas standards would likely need to be reviewed. A gap analysis would need to be undertaken to determine the extent to which existing standards are appropriate for use with hydrogen gas technologies, or whether any hydrogen specific revisions would need to be undertaken. This is especially true for transmission and distribution standards, as well as those for gas installations and appliances. The existing Australian gas standards that could be relevant are listed below.

Potentially relevant existing gas standards

Designation	Title
AS 2885	Pipelines – Gas and liquid petroleum (5 parts)
AS 4645	Gas distribution networks Part 1: Network Management (3 sub-parts)
AS 4568	Preparation of a safety and operating plan for gas networks
AS 4564	Specification for general purpose natural gas
AS/NZS 5263.0	Gas appliances – General requirements
AS/NZS 5601.1	Gas installations – Part 1: General installations
AS 3814	Industrial and commercial gas-fired appliances

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