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Committee representation

This standard was prepared by the P3652 Hydrogen Standards Committee. Membership of the committee was approved by the New Zealand Standards Approval Board and appointed by the New Zealand Standards Executive under the Standards and Accreditation Act 2015.

The committee consisted of representatives of the following nominating organisations:

Coregas

Energy Resources Aotearoa

Fabrum

Fonterra Co-operative Group

Gas Appliance Industry

GasNZ

GNS

Hiringa Energy

HW Richardson Group

HyPotential

Methanex

New Zealand Hydrogen Council

PEC

WorkSafe New Zealand − Energy Safety

Z Energy

Acknowledgement

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New Zealand Standard

Fuel cell road vehicles – Safety specifications – Protection against hydrogen hazards for vehicles fuelled with compressed hydrogen

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Preface

The government has a legislated 2050 target of net zero greenhouse gas (GHG) emissions, other than from biogenic methane, and a target under the Paris Agreement to reduce net GHG emissions to 50 per cent below gross 2005 levels by 2030.

Hydrogen is set to play a key role in meeting these targets. (New Zealand has considerable renewable energy resources which could be harnessed to sustainably produce hydrogen for use as a next-generation green fuel source and industrial feedstock.)

To enable the safe integration and novel use of hydrogen in all its forms across New Zealand's energy landscape, a suite of hydrogen-related equipment standards is being adopted.

This standard specifies the essential requirements for fuel cell vehicles (FCV) with respect to the protection of persons and the environment inside and outside the vehicle against hydrogen-related hazards. It applies only to such FCV where compressed hydrogen is used as fuel for the fuel cell system.

This standard does not apply to manufacturing, maintenance, and repair.

The requirements of this standard address both normal operating (fault-free) and single-fault conditions of the vehicles.

The standard was prepared by the P3652 Hydrogen Standards Committee and is identical to and has been reproduced from ISO 23273:2013 *Fuel cell road vehicles − Safety specifications − Protection against hydrogen hazards for vehicles fuelled with compressed hydrogen.*

As this standard is reproduced from an international standard, the following applies:
(a) In the source text, 'this International Standard' should read 'this New Zealand standard';
(b) A full point substitutes for a comma when referring to a decimal marker.

The terms 'normative' and 'informative' have been used in this standard to define the application of the appendix or annex to which they apply. A 'normative' appendix or annex is an integral part of a standard whereas an 'informative' appendix or annex is for information and guidance.

INTERNATIONAL STANDARD

ISO 23273

First edition
2013-06-15

Fuel cell road vehicles — Safety specifications — Protection against hydrogen hazards for vehicles fuelled with compressed hydrogen

Véhicules routiers alimentés par pile à combustible — Spécifications de sécurité — Protection contre les dangers de l'hydrogène pour les véhicules utilisant de l'hydrogène comprimé

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2. www.iso.org/directives

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received. www.iso.org/patents

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

The committee responsible for this document is ISO/TC 22, *Road vehicles*, Subcommittee SC 21, *Electrically propelled road vehicles*.

This first edition of ISO 23273 cancels and replaces ISO 23273-2:2006, of which it constitutes a minor revision.

Fuel cell road vehicles — Safety specifications — Protection against hydrogen hazards for vehicles fuelled with compressed hydrogen

1 Scope

This International Standard specifies the essential requirements for fuel cell vehicles (FCV) with respect to the protection of persons and the environment inside and outside the vehicle against hydrogen-related hazards.

It applies only to such FCV where compressed hydrogen is used as fuel for the fuel cell system.

This International Standard does not apply to manufacturing, maintenance, and repair.

The requirements of this International Standard address both normal operating (fault-free) and single-fault conditions of the vehicles.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 17268, *Gaseous hydrogen land vehicle refuelling connection devices*

ISO 6469-2, *Electrically propelled road vehicles — Safety specifications — Part 2: Vehicle operational safety means and protection against failures*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
air processing system
system that processes (i.e. that filters, meters, conditions, and pressurizes) the incoming air for the fuel cell system

3.2
contaminant
substances within raw fuel, such as sulphur, that, at or above a specified concentration level, may poison reaction catalysts

3.3
electric chassis
conductive mechanical structure of the vehicle, including all associated electric and electronic components, whose parts are electrically connected and whose potential is taken as reference

3.4
excess flow valve
valve which automatically shuts off or limits the gas flow when the flow exceeds a set design value

3.5
fuel cell
electrochemical device that generates electricity by the conversion of fuel and an oxidant without any physical or chemical consumption of the electrodes or electrolyte

3.6
fuel cell stack
assembly of two or more fuel cells, which are electrically connected

3.7
fuel cell system
system typically containing the following subsystems: fuel cell stack, air processing system, fuel processing system, thermal management, water management, and their control system

3.8
fuel cell vehicle
FCV
vehicle that receives propulsion power from an on-board fuel cell power system

Note 1 to entry: The general term FCV also includes vehicles with an additional other source of propulsion power.

3.9
fuel processing system
system that converts (if necessary) and/or conditions the fuel as stored in the on-board fuel storage into fuel suitable for operation in the fuel cell stack

3.10
fuel system
combination of the on-board fuel storage, the fuel processing system, and the fuel cell stack

3.11
main hydrogen shut-off valve
valve designed to automatically isolate the high-pressure hydrogen source

3.12
maximum allowable working pressure
MAWP
maximum working pressure at which a component or system may be normally operated without damage, including leakage and deformation

Note 1 to entry: The maximum allowable working pressure is used in determining the setting of pressure-limiting/relieving devices installed to protect the part or system from accidental over-pressurizing.

3.13
nominal working pressure
pressure level at which a component typically operates

Note 1 to entry: For fuel containers, it is the settled pressure at a uniformed temperature of 15 °C (288 K) for a full fuel container.

3.14
purge
process to eliminate unwanted gas constituents from the hydrogen system

3.15
temperature-triggered pressure relief device
PRD
excessive temperature-triggered, activated non-reclosing resealing device which vents gas to protect the fuel container from rupture when subjected to a standard fire test

4 Environmental and operational conditions

The requirement given in this International Standard shall be met across the range of environmental and operational conditions for which the vehicle is designed to operate, as specified by the vehicle manufacturer.

5 Design and performance requirements of the fuel system

5.1 General

The fuel system consists of a high-pressure section, where the inner pressure is the same as in the fuel container, and an intermediate- to low-pressure section, where the inner pressure is lower than that of the high-pressure section.

The fuel system shall be equipped with

— a fire protection system incorporating one or more temperature-triggered PRD(s),

— a main hydrogen shut-off valve that shall be closed when the energizing power to the valve is lost, and which shall also be closed when the vehicle fuel cell system is not operating,

— a hydrogen shut-off system according to 5.2.4, and

— an excess flow valve or a system providing the same function.

5.2 Components

5.2.1 General

The components of the fuel system shall satisfy the following requirements.

The components shall be designed, installed, and serviced in such a way that they can operate safely under the environmental and operational conditions as specified by the manufacturer.

All components used in the high-pressure section shall have an adequate pressure rating based on the nominal working pressure.

All components used in the intermediate- and low-pressure sections shall have an adequate pressure rating based on the maximum allowable working pressure.

Electrically conductive housings of components in possible flammable areas should be bonded to the electric chassis to prevent inadvertent ignition of hydrogen discharges.

5.2.2 Fuel container

A vehicle fuel container according to legal requirements, if applicable, shall be used. Otherwise, requirements shall be specified by the vehicle manufacturer.

The fuel container system shall be equipped with at least one temperature-triggered PRD located near the hydrogen fuel container(s) so that hydrogen in the fuel container can be discharged before rupture (see also 5.3).

5.2.3 Overpressure protection

Any parts located in the intermediate or low pressure section shall be capable of withstanding or be protected against an extraordinary pressure increase due to a single failure of the first pressure regulator upstream.

NOTE For guidance, see SAE J2578.

5.2.4 Hydrogen shut-off system

The fuel system and its control shall provide a means to close the main hydrogen shut-off valve and thereby prevent unwanted discharge of hydrogen or other hazards arising from single-point failures, as per ISO 6469-2.

5.3 Location and installation of components

All components and interconnecting piping and wiring shall be securely mounted or supported in the vehicle to minimize damage and prevent leakage and/or malfunction.

Components shall be located within the vehicle to reduce the possibility of accidental damage, unless the components are adequately protected and no part of the component lies outside of the protective structure.

Fuel pipes shall be located and protected in such a way that no damage can be caused by vehicle vibrations under normal operational conditions as specified by the vehicle manufacturer.

5.4 Discharges

The vehicle design for all fuel system exhausts, purges, vents, and other discharges that occur during normal operation of the vehicle shall prevent hydrogen-related hazardous conditions. All normal operating modes including start, run, stop, and off (parked) should be considered in these requirements.

Discharges into all vehicle compartments under normal operation and single-failure conditions shall not lead to any hazardous conditions.

In areas of contemplated use, such as outdoors, mechanically ventilated buildings and structures, and non-mechanically ventilated residential garages, legal requirements shall be met. Normal discharges from the vehicle to the outside shall be non-flammable.

NOTE Guidance relative to evaluating vehicles for commonly contemplated situations such as driving outdoors, idling the vehicle in commercial buildings, and parking in a residential garage is provided in SAE J2578.

Discharges from the PRD shall be vented to the outside of the vehicle, and shall be protected as well as all associated piping and outlet, such that functionality is not compromised due to flow restrictions.

The release of hydrogen from traction batteries shall not lead to any hazardous conditions.

6 Test methods for determining flammability around the vehicle from fuel discharges

Tests shall be performed according to applicable national or International Standards or legal requirements. Otherwise, test methods shall be specified by the vehicle manufacturer.

7 Complementary or alternative approach to verify hydrogen-related safety requirements

7.1 General

Complementary to the requirements in Clause 5, protection for persons and the environment inside and outside the vehicle against hydrogen-related hazards may be achieved by the following procedure. This procedure may also be applied instead of the requirements in Clause 5, resulting in requirements more specific to the conditions of a given fuel cell vehicle design.

NOTE Such approach is applied to vehicle electronic systems in several ECE Regulations (R13, R79).

7.2 Hydrogen-related components and systems

Components and systems containing and/or carrying and/or processing hydrogen shall be specified by the vehicle manufacturer unless legal requirements apply.

7.3 Integration of the hydrogen-related components and systems into the FCV

7.3.1 Normal (fault-free) hydrogen-related conditions of the vehicle

The vehicle manufacturer shall establish a process that, under normal (fault-free) conditions of the hydrogen-related components and systems, no hazard for persons in or in the vicinity of the FCV in normal environmental and operational conditions can occur.

7.3.2 Hydrogen-related fault conditions of the vehicle

A hazard analysis in relation to hydrogen shall be performed considering primarily the interface between the components and systems, as established during assembly into the vehicle. This analysis may use an FMEA (failure mode and effect analysis), an FTA (fault tree analysis), or another appropriate method, and shall determine potential single hardware and software failures or conditions which could form a hazard for persons in or around the vicinity of the vehicle.

Based on this analysis, a description shall be provided of the hardware and software measures enacted to prevent or limit failures or conditions to non-hazardous levels for persons, i.e. such that the fundamental safety requirements and criteria expressed in this International Standard are met (safety concept).

7.4 Verification of the safety concept

The vehicle manufacturer shall define and perform an appropriate combination of necessary analyses and tests that are required to sufficiently demonstrate that the alternative concept provides protection against potential hazards that is equivalent to the means provided in this International Standard.

8 Fuelling requirements

8.1 General

Vehicle movement by its own propulsion system should be prevented when the vehicle is being refuelled.

NOTE 1 For guidance on design of fuel systems, see also SAE J2578.

NOTE 2 Safety for persons during refuelling at a hydrogen filling station has mainly been provided by appropriate measures regarding safety-related design and operation of the station, including the interface between pump/nozzle and vehicle/receptacle (see also 8.2).

8.2 Fuelling inlet

See ISO 17268 for nozzle and receptacle requirements. Nozzle and receptacle shall be provided with a cap to prevent invasion of dust, liquid, contaminants, etc.

The fuelling location on the vehicle shall be designed so as to prevent the accumulation of flammable gases and the ingress of foreign material. It shall be placed in an appropriate position to ensure safe operation. The side of the vehicle is preferable.

Measures against electrostatic discharges of the vehicle at the receptacle should be taken.

The receptacle shall be able to withstand a minimum of 670 N of loading in any direction without its gas tightness being affected (e.g. in the case of a refuelling hose breakaway).

Bibliography

[1] SAE J2578, *Recommended practice for general fuel cell vehicle safety*

[2] United Nations ECE R13, *Uniform provisions concerning the approval of vehicles of categories M, N, and O with regard to braking*

[3] United Nations ECE R79, *Uniform provisions concerning the approval of vehicles with regard to steering equipment*

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