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Fuel cell road vehicles — Safety specifications — Part 2: Protection against hydrogen hazards for vehicles fuelled with compressed hydrogen

Véhicules routiers pile à combustible — Spécifications de sécurité — Partie 2: Protection contre les dangers de l'hydrogène pour les véhicules utilisant l'hydrogène compressé

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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.

ISO xxxxx-2 was prepared by Technical Committee ISO/TC 22, *Road vehicle*, Subcommittee SC 21, *Electric road vehicles*.

ISO xxxxx consists of the following parts, under the general title *Fuel cell road vehicles — Safety specifications*:

— *Part 1: Vehicle functional safety*

— *Part 2*: *Protection against hydrogen hazards for vehicles fuelled with compressed hydrogen*

— *Part 3: Protection of persons against electric shock*

Fuel cell road vehicles — Safety specifications — Part 2: Protection against hydrogen hazards for vehicles fuelled with compressed hydrogen

1 Scope

This part of ISO XXXXX specifies the essential requirements for fuel cell powered road vehicles with respect to the protection of persons and the environment inside and outside the vehicle against hydrogen related hazards.

This part of ISO XXXXX applies only to such fuel cell powered road vehicles where high and low compressed hydrogen is used as fuel for the fuel cell system.

This part of ISO XXXXX does not apply to manufacturing, maintenance and repair.

The requirements of this part of ISO XXXXX address both normal operating (fault free) and single fault conditions of the vehicles.

2 Normative references

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

ISO 17268, *Compressed hydrogen surface vehicle refuelling connection devices*

ISO 15501-1, *Road vehicles -- Compressed natural gas (CNG) fuel systems -- Part 1: Safety*

ISO/PWD XXXXX-1, *Fuel cell powered road vehicles – Safety specifications – Part 1: Vehicle functional safety*

3 Terms and definitions

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

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

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 galvanically connected and whose potential is taken as reference

NOTE The primary function of the chassis of a vehicle is to mechanically support all kinds of components.

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 for a *fuel cell vehicle*, typically containing the following subsystems: *fuel cell stack*, air processing *system*, *fuel processing system*, thermal management, water management, and automatic control system

3.8
fuel processing system
system that converts (if necessary), and/or conditions the fuel as stored in the on-board storage into fuel suitable for operation in the *fuel cell stack*

3.9
fuel system
combination of the on-board fuel storage, the *fuel processing system*, and the *fuel cell stack*

3.10
main hydrogen shut-off valve
valve designed to automatically isolate the high pressure hydrogen source

3.11
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: 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

3.12
pressure relief valve
PRV
pressure-triggered, reclosing device, that protects the system from rupture by overpressure

3.13
purge
process to eliminate unwanted gases from the hydrogen system

3.14
tank valve
valve installed directly on the tank

3.15
temperature triggered pressure relief device
temperature triggered PRD
excessive temperature- triggered, non-reclosing device which vents gas to protect the cylinder from rupture

4 Environmental and operational conditions

The requirement given in this Part of ISO/PWD XXXXX 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 tank, and an intermediate to low pressure section, where the inner pressure is lower than that of the high pressure section, see Annex A for example.

The *fuel system* shall be equipped with:

- a *tank valve* and a *pressure relief device (PRD)* for each tank;
- a main hydrogen shut-off valve that shall be closed when the energising power to the valve is lost. This valve shall also be closed when the vehicle fuel cell system is not operating. If the tank valve is electrically actuated, it may be considered as a main hydrogen shut-off valve;
- 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 over the lifetime of the vehicle under the environmental and operational conditions as specified by the manufacturer. These conditions include the working temperatures, vibrations, the impact of road debris, fluids as brake fluid, oil, petrol, cooling liquid, salt water (corrosion).

All components used in the high pressure section shall have a suitable pressure rating based on the nominal working pressure, as described in ISO15501-1(CNG).

All components used in the intermediate and low pressure sections shall have a suitable pressure rating based on the *maximum allowed working pressure*.

Electrically conductive housings of components should be bonded to the *electric chassis* to prevent inadvertent ignition of hydrogen discharges.

5.2.2 Fuel tank

A vehicle fuel tank according to national or international regulations, if applicable, shall be used.

The fuel tank shall be equipped with a tank valve and a *temperature triggered PRD* located near to the hydrogen tank thus following quickly the tank temperature, see also Clause 5.3.

5.2.3 Overpressure protection

Any parts located in the intermediate or low pressure section, shall be capable of withstanding or 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 preventing unwanted discharge of hydrogen or other hazards arising from single-point failures, as per ISO XXXXX-1.

5.3 Location and installation of components

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

All components shall not be placed at the outermost position of the vehicle or shall be secluded with an protective board.

Ignition sources shall not be located at hydrogen outlets where flammable gas mixtures can form.

Fuel pipes shall be located and protected in such a way that no damages can be caused by vehicle vibrations under nominal 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 national or international legal requirements shall be met. Normal discharges from the vehicle to the outside shall be non-flammable.

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.

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.

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

Tests shall be performed according to applicable national or international standards or regulations.

NOTE Guidance relative to testing 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.

7 Complementary or alternative approach to verify hydrogen related safety requirements

7.1 General

Complementarily to the requirements in Clauses 5 and 6, 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, Clauses 5 and 6 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, e. g. for motor vehicles and their components using compressed gaseous hydrogen (draft).

7.2 Hydrogen related components and systems

Components and systems containing and/or carrying and/or processing hydrogen shall be designed, manufactured and tested according to legal requirements, if any, or to specifications set by the vehicle manufacturer which may refer to standards, if any.

7.3 Integration of the hydrogen related components and systems into the FC vehicle

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 FC vehicle 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 a FMEA (failure mode and effect analysis), a 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 the vehicle.

Based on this analysis the measures in relation to hardware and software shall be described by which such failures or conditions are prevented to occur or by which the effects of such failures or conditions are limited to non-hazardous levels for persons (safety concept).

7.4 Verification tests of the safety concept

If deemed necessary, tests to demonstrate the effectiveness of the safety concept shall simulate primarily the critical failures, which could result in severe hazards (without an effective safety concept). If sufficiently effective the safety concept then will avoid potential hazards or reduce their effects to non-hazardous levels.

8 Fuelling requirements

8.1 General

The vehicle system shall contain automatic systems to ensure that the vehicle traction system is de-energised and the vehicle is ready for fuelling.

NOTE Guidance for design of fuel systems see also SAE J2578.

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. Near the fuelling inlet the maximum fuelling pressure shall be displayed.

The fuelling location on the vehicle shall be designed such 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; side of the vehicle is preferable.

Measures against electrostatic discharges of the vehicle at the receptacle shall 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).

The minimum clearance around the fuelling inlet shall be specified after the details of the fuelling inlet for direct hydrogen fuel cell vehicles have been established.

Annex A
(informative)

Example of fuel system in direct hydrogen fuel cell vehicles

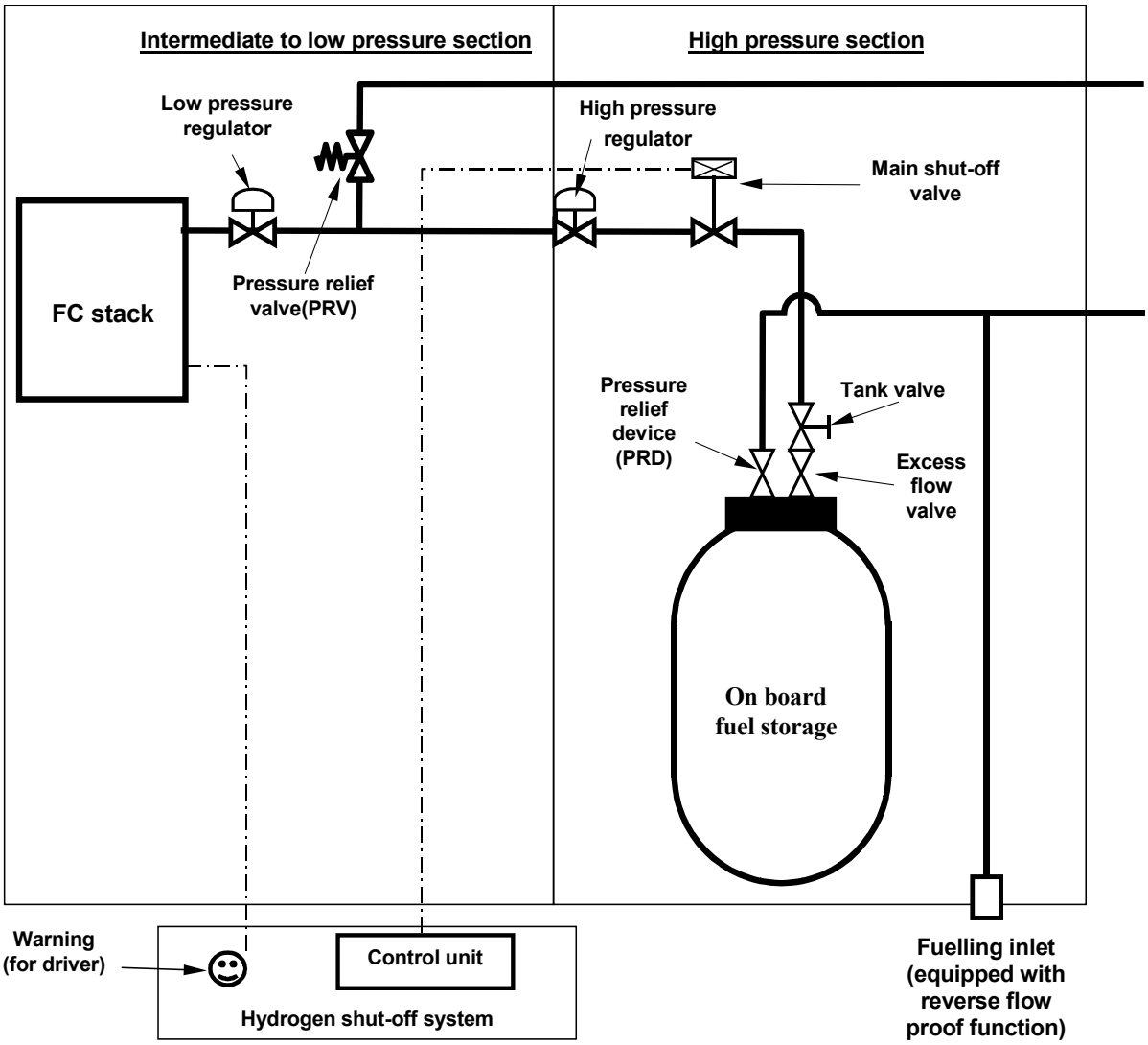

Figure A.1 — Example of fuel system in direct hydrogen fuel cell vehicles

Bibliography

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