INTERNATIONAL STANDARD

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Fuel cell road vehicles — Safety specifications —

Part 1: Vehicle functional safety

Véhicules routiers alimentés par pile à combustible — Spécifications de sécurité —

Partie 1: Sécurité fonctionnelle du véhicule

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Foreword

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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 23273-1 was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 21, *Electrically propelled road vehicles*.

ISO 23273 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 1:
Vehicle functional safety

1 Scope

This part of ISO 23273 specifies the essential requirements for the functional safety of fuel cell (FCV) with respect to hazards to persons and the environment inside and outside of the vehicles caused by the operational characteristics of the fuel cell power system.

This part of ISO 23273 does not apply to manufacturing, maintenance or repair of the vehicles.

The requirements in this part of ISO 23273 address both normal operating (fault free) condition and single fault conditions of the vehicles.

This part of ISO 23273 applies only when the maximum working voltage of the on-board electrical circuits is lower than 1000 V a.c. or 1500 V d.c. according to national or International Standards and/or legal requirements.

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 8713, *Electric road vehicles — Vocabulary*

ISO 11451 (all parts), *Road vehicles — Vehicle test methods for electrical disturbances from narrowband radiated electromagnetic energy*

ISO 23273-2, *Fuel cell road vehicles — Safety specifications — Part 2: Protection against hydrogen hazards for vehicles fuelled with compressed hydrogen*

ISO 23273-3, *Fuel cell road vehicles — Safety specifications — Part 3: Protection of persons against electric shock*

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. filters, meters, conditions and pressurizes) the incoming air for the fuel cell system

3.2
driving enabled mode
only mode in which the vehicle can be moved by its own propulsion system

3.3
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

3.4
fuel cell power system
combination of the fuel cell system, electric power converter(s), power unit and RESS, if any

3.5
fuel cell propulsion system
combination of on-board fuel storage, fuel cell power system and transmission

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 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
maximum working voltage
highest value of a.c. voltage (rms) or d.c. voltage which may occur in an electric system under any normal operating conditions, according to manufacturers' specifications, disregarding transients

3.11
power unit
combination of electric motor, associated power electronics and their associated controls for the purpose of vehicle propulsion

3.12
purge
process of eliminating unwanted gas constituents from a system

3.13
rechargeable energy storage system
RESS
system that stores energy and is rechargeable by on-board and/or external energy sources and associated controls, if any

EXAMPLE batteries, capacitors and electromechanical fly wheels.

4 Environmental and operational conditions

4.1 General

The requirements given in this part of ISO 23273 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.

4.2 Electromagnetic compatibility

4.2.1 Susceptibility

All electric assemblies on FCV, which could effect safe operation of the vehicle, shall be functionally tolerant of the electromagnetic environment to which the vehicle normally will be exposed. This includes fluctuating voltage and load conditions, and electrical transients.

The FCV shall be tested according to the appropriate parts of ISO 11451. The reference field strength shall be according to national or international standards or legal requirements.

4.2.2 Emissions

Care shall be taken to minimize electromagnetic emissions from the FCV, taking into account national or international standards (i.e. CISPR 22) or legal requirements.

5 Operational safety

5.1 Main switch function

5.1.1 General

A main switch function shall be provided so that the operator can disconnect traction power sources and shut off the fuel supply.

The control for the main switch function shall be accessible similar to a conventional ignition switch, and shall be capable of being actuated by the driver.

See ISO 23273-2 and ISO 23273-3 for specific requirements.

NOTE If deactivated by the main switch function, the fuel cell system may remain in a position to perform certain functions such as purge.

5.1.2 Fuel cell power system, power-on/power-off procedure

For the power-on procedure of the FCV, at least two deliberate and distinctive actions shall be performed to go from the power-off mode to the driving enabled mode.

Only one action is required to go from the driving enabled mode to the power-off mode.

The power-on/off procedures may be performed using the same device as for the main switch function.

It shall be indicated to the driver, continuously or temporarily, that the fuel cell power system is ready for driving.

After an automatic or manual turn-off of the fuel cell power system, it shall only be possible to reactivate it by the power-on procedure as described.

5.2 Driving

5.2.1 Indication of reduced power

If the fuel cell power system is equipped with a means to automatically reduce the propulsion power, significant reductions should be indicated to the driver.

NOTE Such means could limit the effects of a fault in the fuel cell power system or of an excessive power demand by the driver.

5.2.2 Driving backward

If driving backward is achieved by reversing the rotational direction of the electric motor, the following requirements shall be met to prevent the danger of unintentional switching to backward direction when the vehicle is in motion:

Switching between forward and backward direction shall require:

— either two separate actions by the driver; or

— if only one action is required by the driver, a safety device that allows the transition only when the vehicle does not move or moves slowly as specified by the manufacturer.

If driving backward is not achieved by reversing the rotational direction of the electric motor, then national or international standards or legal requirements, for vehicles propelled by internal combustion engines backward, shall apply.

5.3 Parking

When leaving the vehicle, it shall be indicated to the driver if the fuel cell power system is still in the driving enabled mode.

No unexpected movement of the vehicle shall be possible after the driver has switched to the power-off mode.

5.4 FCV crashworthiness

Crashworthiness requirements for the FCV shall meet the applicable national or International Standards and legal requirements.

6 Protection against failures

6.1 General vehicle safety

6.1.1 Fail safe design

The design of systems and components specific to FCV shall consider fail-safe design for electric and hazardous fluid system controls. Electric circuits shall open and fuel shutoffs shall close to isolate electric and fuel sources of the fuel cell power system.

6.1.2 First failure response

Safety measures shall be provided to reduce hazards for persons caused by single-point hardware or software failures (first failures) in systems and components specific to FCVs, as identified in an appropriate hazard analysis performed by the vehicle manufacturer. Such hazard analysis may use a FMEA (failure mode and effect analysis), or a FTA (fault tree analysis), or another appropriate method. In particular, the potential hazards in 6.2 and 6.3 shall be avoided.

The safety measures shall include the ability to perform shutdowns safely when faults are detected that could lead to hazardous conditions. Safe shutdowns shall consider the operational state of the vehicle

NOTE For examples and details with regard to safe shutdowns, see SAE J2578.

6.2 Unintentional vehicle behaviour

Unintentional acceleration, deceleration and reversal of direction of the FCV shall be managed per 6.1.2.

6.3 Connections

The electric and/or mechanical connectors shall be provided with means to prevent unexpected disconnection which could result in hazardous behaviour of the vehicle.

7 Owners guide or manual

Special attention shall be drawn in the owner's manual to aspects specific to FCVs.

NOTE For examples, see SAE J2578.

8 Marking

The vehicle shall be marked in accordance with national or International Standards or legal requirements.

9 Emergency response

NOTE Guidance for appropriate emergency response can be found in SAE J2578.

Bibliography

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

[2] CISPR 22, *Information technology equipment — Radio disturbance characteristics — Limits and methods of measurement (1987-11)*

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