Finalized Draft

AUTOMOTIVE INDUSTRY STANDARD

SAFETY AND PROCEDURAL REQUIREMENTS FOR TYPE APPROVAL OF COMPRESSED GASEOUS HYDROGEN FUEL CELL VEHICLES

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INTRODUCTION

The Government of India felt the need for a permanent agency to expedite the publication of standards and development of test facilities in parallel when the work on the preparation of the standards is going on, as the development of improved safety critical parts can be undertaken only after the publication of the standard and commissioning of test facilities. To this end, the erstwhile Ministry of Surface Transport (MOST) has constituted a permanent Automotive Industry Standards Committee (AISC) vide order No. RT-11028/11/97-MVL dated September 15, 1997. The standards prepared by AISC will be approved by the permanent CMVR Technical Standing Committee (CMVR-TSC). After approval, the Automotive Research Association of India, (ARAI), Pune, being the Secretariat of the AIS Committee, will publish this standard. For better dissemination of this information ARAI may publish this document on their Web site.

Hydrogen holds promise to provide clean, reliable and sustainable energy supply for meeting the growing demand of energy in the country. Hydrogen is a fuel with the highest energy content per unit mass of all known fuels, which can be used for power generation and transportation at near zero pollution. In order to accelerate the development and utilisation of hydrogen energy in the country, a National Hydrogen Energy Board has been set up under Ministry of New and Renewable Energy. As part of National Hydrogen Energy Roadmap of Govt. of India and Vision 2020, GOI aims to develop and demonstrate Hydrogen Powered Fuel Cell based vehicles.

In view of GOI's roadmap and vision and based on progressive development of fuel cell vehicle around the globe, this AISC panel has been constituted to formulate Automotive Industry Standard for type approval of compressed gaseous hydrogen fuel cell vehicles.

This standard specifies safety related performance and code of practice for hydrogen fuelled fuel cell vehicles. The purpose of this standard is to minimise human harm that may occur as a result of fire, burst or explosion related to the vehicle fuel system and/or from electric shock caused by the vehicle's high voltage system.

Composition of the Panel and Automotive Industry Standards Committee (AISC) responsible for preparation and approval of this standard are given in Annexure VI & VII respectively.

CONTENTS

List of Annexures

Safety And Procedural Requirements For Type Approval Of Compressed Gaseous Hydrogen Fuel Cell Vehicles	
1.0	**SCOPE**
	This standard is applicable to compressed gaseous hydrogen fuelled fuel cell vehicles of category M & N incorporating hydrogen fuelling system, compressed hydrogen storage system, hydrogen delivery system, fuel cell system and electric propulsion power management system.
	This standard is only applicable to compressed gaseous hydrogen fuelled fuel cell vehicles manufactured by Original Equipment Manufacturer (OEM) and not applicable for retro-fitted or converted fuel cell vehicles.
2.0	**REFERENCE STANDARDS**
	Considerable assistance has been taken from International and national standards in preparation of this standard. The list of reference standards are consolidated in Annexure-V.
3.0	**DEFINITIONS**
	For the purpose of this standard, the following definitions shall apply:
3.1	**"Compressed gaseous hydrogen"** Gaseous hydrogen which has been compressed and stored for use as a vehicle fuel. The composition of hydrogen fuel for fuel cell vehicles shall be as specified in CMVR.
3.2	**"Hydrogen-fuelled vehicle"** means any motor vehicle that uses compressed gaseous hydrogen as a fuel to propel the vehicle, including fuel cell vehicles.
3.3	**"Fuel cell system"** means a system containing the fuel cell stack(s), air processing system, fuel flow control system, exhaust system, thermal management system and water management system.
3.4	**"Vehicle fuel system"** means an assembly of components used to store or supply hydrogen fuel to a fuel cell system.
3.5	**"Fuelling receptacle"** means the equipment to which a fuelling station nozzle is attached to the vehicle and through which fuel is transferred to the vehicle. The fuelling receptacle is used as an alternative to a fuelling port.
3.6	**"Hydrogen storage system"** means a pressurized container(s), check valve, pressure relief devices (PRDs) and shut off device that isolate the stored hydrogen from the remainder of the fuel system and the environment.
3.7	**"Container (for hydrogen storage)"** is the component within the hydrogen storage system that stores the primary volume of compressed hydrogen fuel.
3.8	**"Check valve"** is a automatic non-return valve which allows gas to flow in only one direction.

3.9	**“Pressure relief device (PRD)”** is a device that, when activated under specified performance conditions, is used to release hydrogen from a pressurized system and thereby prevent failure of the system.
3.10	**“Thermally activated pressure relief device (TPRD)”** is a non-reclosing PRD activated by temperature to open and release hydrogen gas.
3.11	**“Automatic cylinder valve”** automatic valve rigidly fixed to the cylinder which controls the flow of gas to the fuel system.
3.12	“**Shut-off valve”** is a valve between the storage container and the vehicle fuel system that can be automatically activated; this valve defaults to “closed” position when not connected to a power source.
3.13	**“Pressure relief valve”** is a pressure relief device that opens at a preset pressure level and can re-close.
3.14	**“Excess flow valve”** valve which automatically shuts off, or limits, the gas flow when the flow exceeds a set design value.
3.15	**“Service shut-off valve”** a manually operated shut-off valve fitted on the cylinder which can open or shut-off the hydrogen supply for maintenance, servicing or emergency requirements.
3.16	**“Filters”** Component that is intended to remove contaminants from the compressed gaseous hydrogen.
3.17	**“Fittings”** connector used in joining a pipe or tubing.
3.18	**“Rigid fuel line”** is rigid tube which has been designed not to flex in normal operation and through which the compressed gaseous hydrogen flows.
3.19	**“Flexible fuel line”** is flexible tube or hose through which compressed gaseous hydrogen flows.
3.20	**“Gas tight housing”** means device which vents gas leakage to outside the vehicle including the gas ventilation hose.
3.21	**“Pressure indicator”** means pressurized device which indicates the gas pressure.
3.22	**“Pressure regulator”** means device used to control the delivery pressure of gaseous fuel in vehicle fuel system.
3.23	**“Exhaust point of discharge”** is the geometric centre of the area where fuel cell purged gas is discharged from the vehicle.
3.24	**“Service Pressure or Nominal working pressure (NWP)”** means the gauge pressure that characterizes typical operation of a system. For compressed hydrogen gas containers, NWP is the settled pressure of compressed gas in fully fuelled container or storage system at a uniform temperature of 15°C.

3.25	**"Maximum Working pressure"** means the maximum pressure to which a component is designed to be subjected to and which is the basis for determining the strength of the component under consideration.
3.26	**"Maximum fuelling pressure (MFP)"** means the maximum pressure applied to compressed system during fuelling. The maximum fuelling pressure is 125 percent of the service or nominal working pressure.
3.27	**"Electric energy conversion system"** is a system (e.g. fuel cell) that generates and provides electrical power for vehicle propulsion.
3.28	**"Electric power train"** means a system consisting of one or more electric energy storage devices (e.g. a battery, electrochemical flywheel or super capacitor), one or more electric power conditioning devices and one or more electric machines that convert stored electric energy to mechanical energy delivered at the wheels for propulsion of the vehicle.
3.29	**"Rechargeable Energy Storage System (REESS)"** means the rechargeable energy storage system that provides electric energy for electric propulsion. The REESS may include subsystem(s) together with the necessary ancillary systems for physical support, thermal management, electronic control and enclosures.
3.30	**"High voltage"** is the classification of an electric component or circuit, if its maximum working voltage is greater than 60V and less than or equal to 1500V of direct current (DC), or greater than 30V and less than or equal to 1000V of alternative current (AC).
3.31	**"High voltage bus"** is the electrical circuit, including the coupling system, for charging the REESS that operates on high voltage.
3.32	**"Drive train"** means specific components of power train, such as the traction motors, electronic control of the traction motor, the associated wiring harness and connectors.
3.33	**"Drive direction control unit"** means a specific device physically actuated by the driver in order to select the drive direction (forward or backward), in which the vehicle will travel if the accelerator is actuated.
3.34	**"IP code"** means a coding system to indicate the degrees of protection provided by an enclosure against access to hazardous parts, ingress of solid foreign objects, ingress of water to give additional information in connection with such protection.
3.35	**"Protection degree"** means protection provided by a barrier/enclosure related to the contact with live parts by a test probe, such as a test finger (IPXXB) or a test wire (IPXXD).
3.36	**"Degree of protection"** means the extent of protection provided by an enclosure against access to hazardous parts against ingress of solid foreign

	objects and/or against ingress of water and verified by standardized test methods.
3.37	**“Barrier”** means the part providing protection against direct contact to the live parts from any direction of access.
3.38	**“Direct contact”** means contact of persons with the live parts.
3.39	**“Live parts”** means the conductive part(s) intended to be electrically energized in normal use.
3.40	**“Indirect contact”** means contact of persons or livestock with exposed conductive parts.
3.41	**“Solid insulator”** means the insulating coating of wiring harness provided in order to cover and protect the live parts against direct contact from any direction of access, covers for insulating the live parts of connectors, and varnish or paint for the purpose of insulation.
3.42	**“Enclosure”** means the part enclosing the internal units and providing protection against direct contact from any direction of access.
3.43	**“Active driving possible mode”** is the vehicle mode when application of pressure to the accelerator pedal (or activation of an equivalent control) or release of the brake system causes the electric power train to move the vehicle.
3.44	**“Automatic disconnect”** is a device that, when triggered, conductively separates the electrical energy sources from the rest of high voltage circuit of the electrical powertrain.
3.45	**“Service disconnect”** means the device for deactivation of the electrical circuit when conducting checks and services of the REESS, fuel cell stack, etc.
3.46	**“State of Charge (SOC)”** means the available electrical charge in a tested-device expressed as a percentage of its rated capacity.
3.47	**“Maximum Net power”** means the power obtained at the wheels of electric vehicle when tested on chassis dynamometer or at motor shaft when measured at bench dynamometer at corresponding vehicle/motor speed at reference atmospheric conditions and full load on wheels of vehicle/motor.
3.48	**“Maximum 30 minute power”** means the maximum net power at wheels of an electric vehicle drive train at appropriate rated voltage, which the vehicle drive train can deliver over a period of 30 minutes as an average.
3.49	**“Electric range”** for vehicles powered by an electric power train only, means distance that can be driven electrically on one fully charged REESS.

3.50	**"Coupling system"** for charging the Rechargeable Energy Storage System (REESS) means the electrical circuit used for charging the REESS from an external electric power supply (alternative or direct current supply).		
3.51	**"Electrical chassis"** means a set made of conductive parts electrically linked together, whose potential is taken as reference.		
3.52	**"Electrical circuit"** means an assembly of connected live parts which is designed to be electrically energised in normal operation.		
3.53	**"Electronic converter"** means a device capable of controlling and/or converting electric power for electric propulsion.		
3.54	**"Luggage compartment"** is the space in the vehicle for luggage accommodation, bounded by the roof, hood, floor, side walls, as well as by the electrical barrier and enclosure provided for protecting the power train from direct contact with live parts, being separated from the passenger compartment by the front bulkhead or the rear bulkhead.		
3.55	**"Passenger compartment (for electric safety assessment)"** is the space for occupant accommodation, bounded by the roof, floor, side walls, doors, window glass, front bulkhead and rear bulkhead, or rear gate, as well as by the barriers and enclosures provided for protecting the power train from direct contact with live parts.		
3.56	**"On-board isolation resistance monitoring system"** is the device that monitors isolation resistance between the high voltage buses and the electrical chassis.		
3.57	**"Fuel Cell Vehicle (FCV)"** electrically propelled vehicle with a fuel cell system as power source for vehicle propulsion. Fuel cell vehicle (FCV) includes the following types:		
	• **Pure fuel cell vehicles (PFCV)**, in which the fuel cell system is the only on-board energy source for propulsion and auxiliary systems.		
	• **Fuel cell hybrid electric vehicles (FCHEV)**, in which the fuel cell system is integrated with an on-board rechargeable energy storage system (REESS) for electric energy supply to propulsion and auxiliary system. FCHEV design options include the following:		
	a) Externally chargeable (Off vehicle charging FCV) or non-externally chargeable (Not Off vehicle charging FCV),		
	b) Rechargeable energy storage system (REESS): battery or capacitor,		
	c) Driver-selected operating modes: if FCHEV has no driver-selected operating mode, it has only an FCHEV mode		
	Table below shows the classification of FCHEV		
		Chargeability	Operating Mode
	FCHEV	Externally chargeable	FCHEV mode
			EV mode

		(Off vehicle charging FCV)	
		Non-externally chargeable (Not Off vehicle charging FCV),	FCHEV mode
			EV mode

3.58	**"Fuel Cell Hybrid Electric Vehicle Operation Mode"** mode of an FCHEV in which both REESS and fuel cell systems are used sequentially or simultaneously for vehicle propulsion.
4.0	**REQUIREMENTS**
4.1	**Requirements for hydrogen fuelling receptacle**
4.1.1	The hydrogen fuelling receptacle shall comply with test requirements laid down in ISO 17268 standards. The typical profile of H35 hydrogen receptacle is illustrated in Annexure-I.
4.1.2	The compressed hydrogen fuelling receptacle must be integrated with a non-return valve which shall prevent reverse flow to the atmosphere. Test procedure is by visual inspection.
4.1.3	If the refuelling connection is not mounted directly on the container, the refuelling line must be secured by a non-return valve or a valve with the same function which is directly mounted on or within the container.
4.1.4	A label shall be affixed close to the fuelling receptacle, for instance inside a refilling hatch, showing the following information: Fuel type (e.g. "CHG" for gaseous hydrogen/H2 gas, Maximum fuelling pressure (MFP), Nominal working pressure (NWP), date of removal from service of containers E.g. **H_2 gas** **'XX' MPa** Where 'XX'= nominal working pressure of the container.
4.1.5	The fuelling receptacle shall be mounted on the vehicle to ensure positive locking of the fuelling nozzle. The receptacle shall be protected from tempering and the ingress of dirt and water (e.g. installed in a compartment which can be locked. Test procedure is by visual inspection.
4.1.6	The fuelling receptacle shall not be mounted within external energy absorbing elements of the vehicle (e.g. bumper) and shall not be installed in the passenger compartment, luggage compartment and other places where hydrogen gas could accumulate and where ventilation is not sufficient. Test procedure is by visual inspection.
4.1.7	The nominal working pressure of the receptacle shall be equal to the nominal working pressure of class 0 hydrogen components (fuel lines and fittings

	containing hydrogen at nominal working pressure greater than 3MPa) upstream of and including the first pressure regulator.
4.1.8	It shall be ensured that the propulsion system or hydrogen conversion system(s) excluding safety devices are not operating and that the vehicle is immobilised while refilling. Measures must be taken to prevent misfuelling of the vehicle and hydrogen leakage during fuelling.
4.1.9	The compliance plate shall be installed near the filling connection and shall be clearly visible to the person filling the H2 gas. The compliance plate shall contain following information:
	Fuel
	NWP-Nominal working pressure
	H2 cylinder Identification number(s)
	Date of installation
	Water capacity (Liters) of the total installed.
	Date of retesting
	Date of removal from service of containers
4.2	**General requirements for Hydrogen component and system**
4.2.1	The vehicle fuel system including components of compressed gaseous hydrogen storage system and hydrogen fuel system components used in fuel supply line shall comply with test requirements laid down in standard as specified in Annexure-II.
4.2.2	Hydrogen components and systems function in a correct and safe way and reliably withstand electrical, mechanical, thermal and chemical operating conditions without leaking or visibly deforming.
4.2.3	Hydrogen components and systems reliably withstand range of operating temperatures and pressures laid down in the standard and protected against over pressurisation.
4.2.4	The material used for those parts of hydrogen components and systems are to be in direct contact with hydrogen are compatible with hydrogen.
4.2.5	Hydrogen components and systems are designed in such a way that they can be installed in accordance with the requirements of this standard.
4.2.6	The hydrogen system must be installed in such a way that it is protected against damage so far as reasonably practicable, such as damage due to moving vehicle components, impacts, grit, the loading or unloading of shifting of loads. Hydrogen components and systems must be isolated from heat source.

4.2.7	Hydrogen components, including any protective materials that form part of such components, must not project beyond the outline of the vehicle or protective structure. This does not apply to hydrogen component which is adequately protected and no part of which is located outside the protective structure.
4.2.8	Electrically operated devices containing hydrogen must be installed in such a manner that no current passes through hydrogen containing parts in order to prevent electric spark in the case of a fracture. Metallic components of the hydrogen system must have electrical continuity with the vehicle's electrical chassis.
4.2.9	Hydrogen components are marked in accordance with the standard. Hydrogen components with directional flow have the flow direction clearly indicated.
4.2.10	Vehicle identification labels must be used to indicate to rescue services that the vehicles is powered by hydrogen and compressed gaseous hydrogen is used for propulsion of vehicle. The details of vehicle identification requirements are defined in Annexure-III.
4.3	**Requirements for Hydrogen cylinder/container**
4.3.1	The compressed gaseous hydrogen cylinder (container) shall comply with Gas Cylinder Rule, 2016. PESO may evaluate hydrogen cylinders based on BIS standard or international standards such as ISO 19881:2019, UN ECE R134, GTR 13
4.3.2	The vehicle fuel system including compressed gaseous hydrogen storage system shall comply with frontal impact (AIS-096) and lateral impact (AIS-099) crash safety requirements. International standards to be accepted as per CMVR norms.
4.3.3	In case one or both of the vehicle crash tests specified above are not applicable for vehicle category, the container or container assembly including safety devices shall be mounted and fixed so that the following accelerations can be absorbed without breaking of the fixation or loosening of the container(s) (demonstrated by testing or calculation). The mass used shall be representative for a fully equipped and filled container or container assembly.
	Vehicles of categories M1 and N1:
	(a) +/- 20 g in the direction of travel.
	(b) +/- 8 g horizontally perpendicular to the direction of travel.
	Vehicles of categories M2 and N2:
	(a) +/- 10 g in the direction of travel.
	(b) +/- 5 g horizontally perpendicular to the direction of travel.

	Vehicles of categories M3 and N3:
	(a) +/- 6.6 g in the direction of travel.
	(b) +/- 5 g horizontally perpendicular to the direction of travel.
4.3.4	In the case where hydrogen storage system is not subjected to frontal impact test, the container shall be mounted in a position which is rearward of a vertical plane perpendicular to centre line of the vehicle and located 420mm rearward from the front edge of the vehicle.
4.3.5	In the case where hydrogen storage system is not subjected to lateral impact test, the container shall be mounted in a position which is between the two vertical planes parallel to the centre line of vehicle located 200mm inside from the both outermost edge of the vehicle in the proximity of the container.
4.3.6	The hydrogen container may only be removed for replacement with another hydrogen container, for the purpose of refuelling or for maintenance and it shall be performed safely. It must be adequately protected against all kinds of corrosion.
4.3.7	A label shall be permanently affixed on each cylinder/container with at least the following information or as per PESO guidelines and approvals:
	• Name of the manufacture
	• Serial number
	• Date of manufacture
	• NWP
	• Date of removal from service
4.4	**Requirements for Check Valve/Automatic shut-off valve**
4.4.1	The check valve of compressed gaseous hydrogen storage system shall comply with test requirements laid down in ISO 12619-4 or UN ECE R134 standard.
4.4.2	The automatic shut-off valve of compressed gaseous hydrogen storage system shall comply with test requirements laid down in ISO 12619-6 or UN ECE R134 standard.
4.4.3	The hydrogen supply line must be secured with an automatic shut-off valve mounted directly on or within the container. In the event of an accident, the automatic shut-off valve mounted directly on or within the container shall interrupt the flow of gas from the container.
4.4.4	The automatic valve shall close if a malfunction of a hydrogen system so requires or any other event that results in leakage of hydrogen. When the propulsion system is switched-off, the fuel supply from the container to the

	propulsion system must be switched off and remain closed until the system is required to operate.
4.5	**Requirements for Pressure Relief Device (PRD/TPRD)**
4.5.1	For the purpose of containers designed to use compressed gaseous hydrogen, a pressure relief device shall be non-reclosing thermally activated device that prevents a container from bursting due to fire effect. The thermally activated pressure relief device shall comply with ISO 12619-10 or UN ECE R134 standard.
4.5.2	A pressure relief device shall be directly installed into the opening of a container or at least one container in a container assembly, or into an opening in a valve assembled into the container, in such a manner that it shall discharge the hydrogen into an atmospheric outlet that vents to the outside of the vehicle.
4.5.3	It shall not be possible to isolate the pressure relief device from the container due to normal operation or failure of another component.
4.5.4	The hydrogen gas discharge from pressure relief device shall not be directed:
	(a) Towards exposed electrical terminals, exposed electrical switches or other ignition sources.
	(b) Into or towards the vehicle passenger/luggage compartments, enclosed/semi-enclosed spaces, wheel housing.
	(c) Towards any class 0 components (Hydrogen components with NWP greater than 3MPa), towards hydrogen gas container.
	(d) Forward from the vehicle, or horizontally (parallel to road) from the back or sides of the vehicle.
4.5.5	The vent of pressure relief device shall be protected by a cap. It shall also be protected against blockage e.g. by dirt, ice, and ingress of water, so far as is reasonably possible.
4.6	**Requirements for Pressure Relief Valve (PRV)**
4.6.1	The Pressure Relief Valve (PRV) used in fuel supply line shall comply with test requirements laid down in ISO 12619-9 standards.
4.6.2	If a pressure relief valve is used, it shall be installed in such a manner that it shall discharge the hydrogen into an atmospheric outlet that vents to the outside of the vehicle.
4.6.3	The hydrogen gas discharged from pressure relief valve shall not be directed:
	(a) Towards exposed electrical terminals, exposed electrical switches or other ignition sources.

	(b) Into or towards the vehicle passenger or luggage compartments.
	(c) Into or towards any vehicle wheel housing.
	(d) Towards any class 0 components, towards hydrogen gas container.
4.6.4	It shall not be possible to isolate the pressure relief valve from the hydrogen components/system due to normal operation or failure of another component.
4.6.5	The vent of pressure relief valve shall be protected against blockage e.g. by dirt, ice, ingress of water, etc. so far as is reasonably practicable.
4.7	**Requirements for Rigid & Flexible Fuel Lines**
4.7.1	The rigid fuel line used in hydrogen fuel supply line shall comply with test requirements laid down in ISO 12619-13 standards.
4.7.2	The flexible fuel lines used in hydrogen fuel supply line shall comply with test requirements laid down in ISO 12619-14 standards.
4.7.3	Rigid fuel line shall be secured such that they shall not be subjected to critical vibration or other stress. Flexible fuel lines shall be secured such that they shall not be subjected to torsional stress and abrasion is avoided.
4.7.4	Rigid fuel line and flexible fuel lines shall be designed to reasonably minimise stresses in the lines during removal or installation of adjoining hydrogen components.
4.7.5	At fixing points, rigid fuel lines and flexible fuel lines shall be fitted in such a way that galvanic and crevice corrosion are prevented.
4.7.6	Rigid fuel lines and flexible fuel lines shall be routed to reasonably minimise exposure to accident damage whether inside the vehicle, e.g. due to placing or movement of luggage or other loads, or outside the vehicle, e.g. due to rough ground or vehicle jacks etc.
4.7.7	The fuel lines shall be fitted with grommets or other protective material at passage through the vehicle body or other hydrogen components.
4.7.8	If fittings are installed in the passenger or enclosed luggage compartment, the fuel lines and fittings shall be enclosed in a sleeve which meets the same requirements as specified for gas tight housing.
4.8	**Requirements for Gas tight housing & Ventilation hoses**
4.8.1	The gas tight housing and ventilation hoses used in hydrogen fuel supply line shall comply with test requirements laid down in ISO 12619-12 standards. The clear opening of gas tight housing and ventilation hoses shall be at least 450 mm2.
4.8.2	The gas tight housing shall be vented to the atmosphere. The ventilation opening of the gas tight housing shall be at the highest point of the housing

	when installed in the vehicle, as far as reasonably practicable. It shall not ventilate into a wheel arch, nor shall it be aimed at any heat source. Additionally it shall vent such that hydrogen cannot enter the inside of the vehicle, passenger and/or luggage compartment.
4.8.3	The passenger compartment of the vehicle must be separated from the hydrogen system in order to avoid accumulation of hydrogen. It must be ensured that any fuel leaking from the container or its accessories does not escape to the passenger compartment of vehicle.
4.8.4	Hydrogen components that could leak hydrogen within the passenger or luggage compartment or other non-ventilated compartment must be enclosed by a gas tight housing or by an equivalent solution.
4.8.5	The electrical connections and components in the gas tight housing shall be constructed such that no sparks are generated.
4.8.6	During leak proof testing, the vent line shall be hermetically sealed and the gas tight housing shall meet leakage requirements at pressure 0.01 MPa and without any permanent deformations.
4.8.7	Any connecting system shall be secured by clamps, or other means, to the gas tight housing or sleeve and the lead-through to ensure that a joint is formed meeting the leakage requirements at pressure 0.01 MPa and without any permanent deformations.
4.9	**Requirements for Fittings**
4.9.1	The fittings used in hydrogen fuel supply line shall comply with test requirements laid down in ISO 12619-16 standards.
4.9.2	The vehicle manufacturer shall ensure that the materials used in fittings are chosen in such a way that galvanic and crevice corrosion are prevented.
4.9.3	The number of joints in hydrogen fuel supply line shall be limited to minimum.
4.9.4	Means shall be specified by the manufacturer for leak testing of joints for the purpose of inspection. If leak testing with a surface active agent is specified, any joints shall be made in locations where access is possible.
4.10	**Requirements for other hydrogen components & systems**
	The other components of compressed gaseous hydrogen storage system and fuel system components namely Manual cylinder valve, Pressure regulator, Pressure indicator, Excess flow valve, Filters, Pressure/Temperature/Hydrogen/Flow sensors and hydrogen leakage detection sensors shall comply with test requirements laid down in ISO 12619 standards as applicable.
4.11	**Over protection to low pressure system**

	The hydrogen system downstream of a pressure regulator shall be protected against overpressure due to the possible failure of the pressure regulator. The set pressure of the overpressure protection device shall be lower than or equal to the maximum allowable working pressure for the appropriate section of the hydrogen system.
4.12	**Vehicle exhaust system (Point of Discharge)**
	At the vehicle exhaust system's point of discharge, the hydrogen concentration level shall:
	(a) Not exceed 4 percent average by volume during any moving three-second time interval during normal operation including start-up and shut-down.
	(b) And not exceed 8 percent at any time when tested according to Annexure 5, Paragraph 4 of UN ECE R134.
4.13	**Protection against flammable conditions: Single failure conditions**
4.13.1	Hydrogen leakage and/or permeation from the hydrogen storage system shall not directly vent into the passenger or luggage compartments, or to any enclosed or semi-enclosed spaces within the vehicle that contains unprotected ignition source.
4.13.2	Any single failure downstream of the main hydrogen shut-off valve shall not result in accumulations in the levels of hydrogen concentration in the passenger compartment according to following test procedure defined in Annexure 5, paragraph 3.2 of UN ECE R134.
4.13.3	If during operation, a single failure results in a hydrogen concentration exceeding 3.0 percent by volume in air in the enclosed or semi-enclosed spaces of the vehicle, then a warning shall be provided in accordance with 4.15.1(b). If the hydrogen concentration exceeds 4.0 percent by volume in the air in the enclosed or semi-enclosed spaces of the vehicle, the main shut-off valve shall be closed to isolate the storage system (Annexure 5, paragraph 3 of UN ECE R134).
4.14	**Fuel system leakage**
	The hydrogen fuelling line (e.g. piping, joint, etc.) downstream of the main shut-off valve(s) to the fuel cell system shall not leak. Compliance shall be verified at NWP (Annexure 5, paragraph 5 of UN ECE R 134).
4.15	**Tell-tale signal warning to driver**
4.15.1	The warning shall be given by a visual signal or display text with the following properties:
	(a) Visible to the driver while in the driver's designated seating position with the driver's seat belt fastened.

	(b) Yellow in colour if the detection system malfunctions (e.g. circuit disconnection, shot-circuit, sensor fault). It shall be red in compliance with section 4.13.3.
	(c) When illuminated, shall be visible to the driver under both daylight and night time driving conditions.
	(d) Remains illuminated when 3.0 percent concentration or detection system malfunction exists and the ignition locking system is in the "On" ("Run") position or the propulsion system is activated.
4.15.2	The compressed hydrogen storage system shall be provided with suitable device to indicate level and pressure of hydrogen in the system.
4.16	**Post-crash fuel system integrity (for vehicle fuel system)**
4.16.1	The vehicle fuel system shall comply with crash safety test requirements as specified in clause 4.3.2, 4.3.3, 4.3.4 and 4.3.5 of this standard.
4.16.2	**Fuel leakage limit**
	The volumetric flow of hydrogen gas leakage shall not exceed an average of 118 Nl per minute of time interval, Δt, as determined in accordance with Annexure 5, paragraph 1.1 or 1.2 of UNR 134.
4.16.3	**Concentration limit in enclosed spaces**
	Hydrogen gas leakage shall not result in a hydrogen concentration in the air greater than 4.0 percent by volume in the passenger and luggage compartments (Annexure 5, paragraph 2 of UNR 134). The requirement is satisfied if it is confirmed that the shut-off valve of the storage system has closed within 5 seconds of the crash and no leakage from the storage system.
4.16.4	**Container Displacement**
	The storage container(s) shall remain attached to the vehicle at a minimum of one attachment point.
4.17	**Requirements for electric propulsion and power management system**
	The electric propulsion and power management system of fuel cell vehicle shall comply with safety and performance requirements laid down in following Automotive Indian Standards:
	AIS-038: Battery operated vehicles – Requirements for construction and functional safety.
	AIS-039: Electric power train vehicles-Measurement of electric energy consumption.
	AIS-040: Electric power train vehicles- Method of measuring the range.

	AIS-041: Electric power train vehicles-Measurement of net power and the maximum 30 minute power.
	AIS-048: Battery operated vehicles – Safety requirements of traction batteries.
	AIS-049: Electric power train vehicles- CMVR type approval for electric power train vehicles.
4.18	**Electromagnetic Compatibility**
4.18.1	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.
4.18.2	The FCV shall be tested according to the AIS-004 (Part 3).
4.19	**Operational Safety**
4.19.1	**Main switch function**
4.19.1.1	**General**
	• A main switch function shall be provided so that operator can disconnect traction power sources and shut off the fuel supply.
	• The control of the main switch function shall be accessible similar to a conventional original switch, and shall be capable of being actuated by the driver.
	• If deactivated by the main switch function, the fuel cell system may remain in a position to perform certain function such as purge.
4.19.1.2	**Fuel cell power system, power-on/power-off procedure**
	• For the power-on procedure of 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.

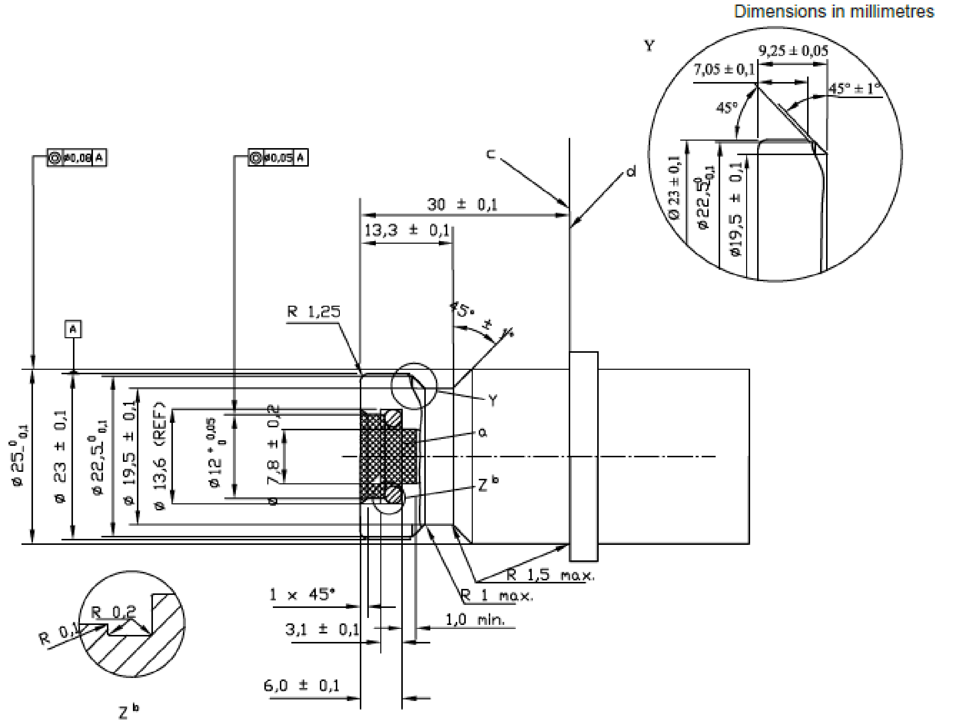
4.19.2	**Driving**
4.19.2.1	**Indication of reduced power**
	• If the fuel cell power system is equipped with a means to automatically reduce the propulsion power, significant reductions should be indicated to the driver. Such means could limit the effects of a fault in the fuel cell power system or of an excessive power demand by the driver.
4.19.2.2	**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 requirements mentioned in CMVR for vehicles propelled by internal combustion engines backward, shall apply.
4.19.2.3	**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.
4.20	**Protection against failures**
4.20.1	**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.
4.20.2	**First failure response**
	• Safety measures shall be provided to reduce hazards for persons caused by single-point hardware or software failures (first failures) in system 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 hazard in 4.20.3 & 4.20.4 shall be avoided.
	• Safety measures shall include the ability to perform shutdowns safely when faults are detected that could lead to hazardous condition. Safe shutdowns shall consider the operational state of the vehicle.
4.20.3	**Unintentional vehicle behaviour**
	Unintentional acceleration, deceleration and reversal of direction of the FCV shall be managed as per 4.20.1.
4.20.4	**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.
4.21	**Owners guide or manual**
	Due to large degree of variation possible in fuel cell vehicle systems, the vehicle manufacturer should provide an owner's guide or manual that addresses the unique operating, fuelling, and safety characteristics of the vehicle. It is recommended that the following items be addressed.
	a. Procedure for safe vehicle operation, including operating environments.
	b. Precautions related to the fluids and materials stored, used, or processed in the vehicle.
	c. Possible safety hazards posed by vehicle or system operation and appropriate action(s) if a problem is detected. Any restrictions or building requirements related to operation, parking or storage in residential garages or commercial structurers, and any special requirements for sealed shipping shall be noted.
	d. Fuelling procedures and safety precautions.
	e. Precautions related to operator replacement of parts or fluids.
	f. Information for roadside emergencies.
	g. Operator service procedures, checks, and maintenance schedules.
4.22	**Emergency Response**
	The manufacturer of the FCV should have available information for safety personnel and/or emergency responders with regard to dealing with accidents involving a FCV. The following information may be requested:

	a. Explanation of hazards associated with the fluids, hazardous voltage systems, and any materials or components in the fuel cell system or vehicle in general.
	b. Identification of vehicle by safety labels.
	c. Procedure for verifying that automatic fuel shut-off and electrical disconnection functions have occurred.
	d. Location and procedures for manual shut-off of fuels and disconnection of electrical bus, if applicable.
	e. Information should be provided that situations may occur where some tanks have vented and others are still pressurised.
4.23	**Service Manual**
	Due to large degree of variation possible in fuel cell vehicle systems, the vehicle manufacturer should be responsible for the compilation of information related to vehicle service and maintenance. It is recommended that following items be addressed:
	a. Chemical and physical properties of hazardous material stored or processed in the vehicle.
	b. Possible safety hazard posed by the vehicle or its systems during maintenance and appropriate action(s) if a fault is detected.
	c. First aid procedures specific to the unique hazards of the vehicle.
	d. Maintenance tools, equipment, and personal protective equipment (PPE).
	e. Methods and procedures for specific operations (such as defaulting).
	f. Suggested and required maintenance items and their schedules.

Typical Profile of Hydrogen Fuelling Receptacle

H35 Hydrogen Receptacle (For Illustration Purpose only)



Material shall demonstrate hydrogen compatibility as described in clause 4.5 of ISO 17268 and a minimum hardness of 80 Rockwell B (HRB). Unless otherwise specified, surface finish shall be 0.4µm to 3.2 µm.

a) Shaded area represents an area, which shall be kept free of all components except for the seal. Surface finish shall be 0.8 µm±0.05µm.

b) Reference sealing material surface to a no. 110 O-Ring with the following dimensions: internal diameter: 9.19mm±0.13mm; width: 2.62mm±0.08mm.

c) Nozzle side: No part of the nozzle assembly shall extend beyond the receptacle stop ring.

d) Vehicle side: The stop ring shall have a continuous shape that has an effective diameter of 30mm or more and a thickness greater than 5mm.

ANNEXURE-II

Safety checklist and type approval requirements for hydrogen fuel cell vehicles			
Sr.No.	**Systems/Components**	**Test Details & Certifying Authority**	**Reference Standard**
1	Compressed gaseous hydrogen cylinder/container	PESO, Nagpur to certify or endorse in case of foreign make	Gas cylinder rules 2016 or as endorsed by PESO.
2	Fitment of cylinder on vehicle	Test agency to verify as per clause 4.3 of this standard	Clause no. 4.3
3	Hydrogen cylinder automatic shut-off valve	PESO, Nagpur to certify or endorse in case of foreign make	ISO 12619-6 or UN ECE R134
4	Thermally activated pressure relief device (TPRD)	Testing of the component as per ISO 12619-10 or UN ECE R134 by authorised test agency	ISO 12619-10 or UN ECE R134
5	Check valve	Testing of the component as per ISO 12619-3 or UN ECE R134 by authorised test agency	ISO 12619-3 or UN ECE R134
6	Fuelling receptacle	Testing of the component as per ISO 17268 by authorised test agency	ISO 17268
7	Pressure regulator	Testing of the component as per ISO 12619-3 or by authorised test agency	ISO 12619-3
8	Manual cylinder valve	Testing of the component as per ISO 12619-5 by authorised test agency	ISO 12619-5

9	Gas injector	Testing of the component as per ISO 12619 by authorised test agency	ISO 12619-7
10	Pressure indicator	Testing of the component as per ISO 12619-8 by authorised test agency	ISO 12619-8
11	Pressure relief valve	Testing of the component as per ISO 12619-9 by authorised test agency	ISO 12619-9
12	Excess flow valve	Testing of the component as per ISO 12619-11 by authorised test agency	ISO 12619-11
13	Gas tight housing and ventilation hose	Testing of the component as per ISO 12619-12 by authorised test agency	ISO 12619-12
14	Rigid fuel line in stainless steel	Testing of the component as per ISO 12619-13 by authorised test agency	ISO 12619-13
15	Flexible fuel line	Testing of the component as per ISO 12619-14 by authorised test agency	ISO 12619-14
16	Filters	Testing of the component as per ISO 12619-15 by authorised test agency	ISO 12619-15
17	Fittings	Testing of the component as per	ISO 12619-16

		ISO 12619-16 by authorised test agency	
18	Pressure/Temperature/H2 leakage sensor	Testing of the component as per EC79/2009 by authorised test agency	EC 79/2009
19	Construction and functional safety of battery operated vehicles	Testing of component and vehicle as per AIS-038 by certifying agency	AIS-038
20	Measurement of electric energy consumption	Testing of vehicle as per AIS-039 by certifying agency	AIS-039
21	Measurement of vehicle range for electric power train vehicles	Testing of vehicle as per AIS-040 by certifying agency	AIS-040
22	Measurement of net power and the maximum 30 minute power	Testing of vehicle as per AIS-041 by certifying agency	AIS-041
23	Safety requirement of traction battery	Testing of vehicle as per AIS-048 by certifying agency	AIS-048
24	Hydrogen Fuel consumption measurement	Measurement of energy consumption in km/l or km/kg or km/MJ	ISO 23828
	Note:		
	1) The corrigendum, amendment and revision of standards referred in this document to be governed by AIS-000.		
	2) International standards to be accepted for compliance as per CMVR norms.		
	3) AIS standards mentioned in this document to be referred till the time corresponding BIS specifications are notified under the Bureau of Indian Standard Act, 1986 (63 of 1986)		

ANNEXURE-III

Vehicle Identification Requirements			
1.	Hydrogen vehicle shall be equipped with means of identification as set out in this annexure.		
2.	Hydrogen vehicle shall carry labels as specified in section 3 and 4.		
2.1	In case of hydrogen vehicles of categories M1 and N1, one label shall be installed within engine compartment of the vehicle and one in the vicinity of the refuelling device or receptacle.		
2.2	In case of hydrogen vehicles of categories M2 and M3, labels shall be installed: on the front and rear of the vehicle, in the vicinity of the refuelling device or receptacle, and to the side of each set of doors.		
2.3	In the case of public service vehicles of categories M2 and M3, the labels installed on the front and rear of the vehicle shall be of the size as set out in section 4.		
2.4	In the case of hydrogen vehicles of categories N2 and N3, labels shall be installed: on the front and rear of the vehicle, and in the vicinity of the refuelling device or receptacle.		
2.5	The label shall be either a weather resistant adhesive label or weather resistant plate.		
2.5.1	Labels for hydrogen vehicle using compressed (gaseous) hydrogen		
			
	The colour and dimensions of the label shall fulfil the following requirements:		
	Colours:		
	Background	:	Red
	Border	:	White
	Letters	:	White
	Either the borders and letters or the background shall be retro-reflective.		

	Colorimetric and photometric properties shall comply with the requirements of clause 11 of ISO 3864-1.		
	Dimensions:		
	Width	:	40mm (side length)
	Height	:	40mm (side length)
	Border width	:	2mm
	Font size:		
	Font height	:	9mm
	Font thickness	:	2mm
	The words shall be in upper case characters and shall be centred in the middle of label.		
2.5.2	Labels for public service hydrogen vehicles of categories M2 and M3 to be installed on front and rear of the vehicle.		
			
	The colour and dimensions of the label shall fulfil the following requirements:		
	Colours:		
	Background	:	Red
	Border	:	White
	Letters	:	White
	Either the borders and letters or the background shall be retro-reflective.		
	Colorimetric and photometric properties shall comply with the requirements of clause 11 of ISO 3864-1.		

	Dimensions:		
	Width	:	125mm (side length)
	Height	:	125mm (side length)
	Border width	:	5mm
	Font size:		
	Font height	:	25mm
	Font thickness	:	5mm
	The words shall be in upper case characters and shall be centred in the middle of label.		

ANNEXURE-IV

Additional Technical Specification of Fuel Cell Vehicle To Be Submitted By Vehicle Manufacturer

1.0	**General description of vehicle**	
1.1	Name of the manufacturer	
1.2	Vehicle model name	
1.3	Vehicle type & category	
1.4	Variants (if any)	
2.0	**Hydrogen Cylinder (PESO Approved/Endorsed)**	
2.1	Make	
2.2	Identification No.	
2.3	Working pressure (kg/cm2)	
2.4	Max. test pressure (kg/cm2)	
2.5	Cylinder capacity (water equivalent)	
2.6	Approval No.	
3.0	**Cylinder Valves (PESO Approved/Endorsed)**	
3.1	Make	
3.2	Model name/Identification No.	
3.3	Type	
3.4	Working pressure (kg/cm2)	
3.5	Max. test pressure (kg/cm2)	
3.6	Approval No.	
3.7	**TPRD (Thermally Activated Pressure Relief Device)**	
3.7.1	Make	
3.7.2	Model name/Identification No.	
3.7.3	Type	

3.7.4	Working pressure (kg/cm2)	
3.7.5	Max. test pressure (kg/cm2)	
3.7.6	Approval No.	
3.8	**Check valve**	
3.8.1	Make	
3.8.2	Model name/Identification No.	
3.8.3	Type	
3.8.4	Working pressure (kg/cm2)	
3.8.5	Max. test pressure (kg/cm2)	
3.8.6	Approval No.	
3.9	**Gas Injectors**	
3.9.1	Make	
3.9.2	Model name/Identification No.	
3.9.3	Type	
3.9.4	Working pressure (kg/cm2)	
3.9.5	Max. test pressure (kg/cm2)	
3.9.6	Approval No.	
3.10	**Excess flow valve**	
3.10.1	Make	
3.10.2	Model name/Identification No.	
3.10.3	Type	
3.10.4	Working pressure (kg/cm2)	
3.10.5	Max. test pressure (kg/cm2)	
3.10.6	Approval No.	
4.0	**Refilling valve**	
4.1	Make	
4.2	Model name/Identification No.	

4.3	Type	
4.4	Working pressure (kg/cm2)	
4.5	Max. test pressure (kg/cm2)	
4.6	Approval No.	
5.0	**Pressure Regulator**	
5.1	Make	
5.2	Model name/Identification No.	
5.3	Type	
5.4	Inlet pressure (kg/cm2)	
5.5	Outlet pressure (kg/cm2)	
5.6	No. of stages	
5.7	Approval No.	
6.0	**Hydrogen Filters**	
6.1	Make	
6.2	Model name/Identification No.	
6.3	Type	
6.4	Inlet pressure (kg/cm2)	
6.5	Outlet pressure (kg/cm2)	
6.6	Approval No.	
7.0	**Hydrogen Rigid Fuel Lines**	
7.1	Make	
7.2	Model name/Identification No.	
7.3	Type	
7.4	Working pressure (kg/cm2)	
7.5	Max. test pressure (kg/cm2)	
7.6	Outer diameter/Inner diameter	
7.7	Protection quality (material used)	

7.8	Approval No.	
8.0	**Hydrogen Flexible Fuel Lines**	
8.1	Make	
8.2	Model name/Identification No.	
8.3	Type	
8.4	Working pressure (kg/cm2)	
8.5	Max. test pressure (kg/cm2)	
8.6	Outer diameter/Inner diameter	
8.7	Protection quality (material used)	
8.8	Approval No.	
9.0	**Refilling valve interlocking switch**	
9.1	Make	
9.2	Identification No.	
9.3	Type	
10.0	**Current limiting device (Fuse)**	
10.1	Make	
10.2	Identification No.	
10.3	Voltage/Current ratings	
10.4	Type	
11.0	**Pressure Indicator**	
11.1	Make	
11.2	Identification No.	
11.3	Type	
12.0	**Service shut-off valve**	
12.1	Make	
12.2	Identification No.	
12.3	Type	

13.0	**Gas tight housing**	
13.1	Make	
13.2	Identification No.	
13.3	Type	
14.0	**Ventilation hoses**	
14.1	Make	
14.2	Identification No.	
14.3	Type	
14.4	Inner & outer diameter	
14.5	**Pressure Sensors**	
14.5.1	Make	
14.5.2	Identification No.	
14.5.3	Type	
14.6	**Temperature Sensors**	
14.6.1	Make	
14.6.2	Identification No.	
14.6.3	Type	
14.7	**Leakage Sensors**	
14.7.1	Make	
14.7.2	Identification No.	
14.7.3	Type	
15.0	**Fuel Cell**	
15.1	Make, Trade name and mark of the fuel cell	
15.2	Types of fuel cell	
15.3	Nominal voltage (V)	
15.4	Number of cells	
15.5	Type of cooling system (if any)	

15.6	Max Power (kW)	
15.7	**Brief description of system including schematic layouts of hydrogen fuel cell vehicles.**	
16.0	**Description of The Traction Battery Pack**	
16.1	Make and Trade name (If any)	
16.2	Kind of Electro – Chemical Chemistry	
16.3	Nominal Voltage (V) at Pack level	
16.3.1	Nominal Voltage (V) at Cell Level	
16.4	Number of Cells/Modules and its Configuration	
16.5	Battery Energy (kWh)	
16.6	Battery Capacity (C_5),	
16.7	End of Discharge Voltage Value (V) at Pack Level	
16.8	Provision of ventilation for battery Yes / No	
16.8.1	Brief description of the battery pack ventilation system adopted in the vehicle. Provide drawing if necessary.	
16.9	Traction Battery Approval as per AIS 048 :Report Number	
16.10	On-board Indication of battery state of charge (SOC)	
16.10.1	Details of indication when state of charge (SOC) of the battery reaches a level when the manufacturer recommends re-charging.	
16.10.1.1	Indication format.	
16.10.1.2	Relationship of state of charge indicator and the indication.	
16.10.1.3	Make	
16.10.1.4	Model	

16.10.2	Indication of state of charge of battery reaches a level at which driving vehicle further may cause damage to batteries	
16.10.2.1	Indication format.	
16.10.2.2	Relationship of state of charge indicator and the indication.	
16.11	Battery Mass (kg)	
16.12	Brief description of maintenance procedure of battery pack, if any	
17.0	**Battery Management System (BMS)** (If any)	
17.1	Make	
17.2	Model Number / Part Number	
17.3	Software Version	
17.4	Hardware Version	
17.5	Architecture (attach circuit board diagram and Cell configuration structure)	
17.6	Balancing Type (Active/Passive)	
17.7	Communication Protocol	
18.0	**DC – DC Converter**	
18.1	Make	
18.2	Model Number / Part Number	
18.3	Hardware Version	
18.4	Input Range (Current in A and Voltage in V)	
18.5	Output Range (Current in A and Voltage in V)	
19.0	**Description of The Drive Train**	
19.1	General	
19.1.1	Make	
19.1.2	Type	
19.1.3	Use : Mono motor / multi motors (number)	

19.1.4	Transmission Arrangement parallel / Transaxial / others to precise	
19.1.5	Test Voltage (V)	
19.1.6	Motor Nominal Speed (min $^{-1}$)	
19.1.7	Motor Maximum Speed, Min $^{-1}$ or by default reducer outlet shaft / gear box speed (specify gear engaged)	
19.1.8	Maximum Power Speed (min $^{-1}$) and (km/h)	
19.1.9	Maximum Power (kW)	
19.1.10	Maximum Thirty Minutes Power (kW)	
19.1.11	Maximum Thirty Minutes speed km/h (Reference in AIS-039 (Rev.1) and AIS-040 (Rev.2)	
19.1.12	Range as per AIS 040 (Rev.1) (km)	
19.1.13	Speed at the beginning of the range (min $^{-1}$)	
19.1.14	Speed at the end of the range (min $^{-1}$)	
19.2	**Traction Motor**	
19.2.1	Make	
19.2.2	Model Number / Part number	
19.2.3	Type (BLDC, DC, AC etc)	
19.2.4	Working Principle	
19.2.4.1	Direct current / alternating current / number of phases	
19.2.4.2	Separate excitation / series / compound	
19.2.4.3	Synchron / asynchron	
19.2.4.4	Coiled rotor / with permanent magnets / with housing	
19.2.4.5	Number of Poles of the Motor	

19.2.5	Motor power curve (kW) with motor RPM (min^{-1}) / vehicle speed in (km/h), (Provide Graph)	
19.3	**Power Controller**	
19.3.1	Make	
19.3.2	Model Number / Part number	
19.3.3	Software Version	
19.3.4	Hardware Version	
19.3.5	Type	
19.3.6	Control Principle : vectorial / open loop / closed / other (to be specified)	
19.3.7	Maximum effective current supplied to the Motor (A)	
19.3.8	Voltage range use (V to V)	
19.4	Cooling System	
	Motor (Liquid / Air)	
	Controller (Liquid / Air)	
	Battery (Liquid / Air)	
19.4.1	Liquid cooling equipment characteristics	
19.4.1.1	Nature of the liquid , circulating pumps (Yes / No)	
19.4.1.2	Characteristics or make(s) and type(s) of the pump	
19.4.1.3	Thermostat : setting	
19.4.1.4	Radiator : drawing(s) or make(s) and type(s)	
19.4.1.5	Relief valve : pressure setting	
19.4.1.6	Fan : Characteristics or make(s) and type(s)	
19.4.1.7	Fan : duct	
19.4.2	Air-cooling equipment characteristics	

19.4.2.1	Blower : Characteristics or make(s) and type(s)	
19.4.2.2	Standard air ducting	
19.4.2.3	Temperature regulating system (Yes / No)	
19.4.2.4	Brief description	
19.4.2.5	Air filter	
19.4.2.5.1	Make(s)	
19.4.2.5.2	Type(s)	
19.4.3	**Maximum temperatures recommended by the manufacturer:**	
19.4.3.1	Motor Outlet (^oC)	
19.4.3.2	Controller inlet (^oC)	
19.4.3.3	Battery inlet (^oC)	
19.4.3.4	At motor reference point(s) (^oC)	
19.4.3.5	At controller reference point(s) (^oC)	
19.4.3.6	At Battery reference point(s) (^oC)	
19.5	Insulating Category	
19.5.1	Ingress Protection (IP)-Code	
19.6	Lubrication System Principle	
19.6.1	Bearings (Friction / Ball)	
19.6.2	Lubricant (Grease / Oil)	
19.6.3	Seal (Yes / No)	
19.6.4	Circulation (With / Without)	
20.0	**Charger** (If any)	
20.1	Charger (On board / External)	
20.1.1	Make	
20.1.2	Model	
20.1.3	Software Version	

20.1.4	Hardware Version	
20.1.5	Type (AC/DC, Slow /Fast)	
20.1.6	Standard Protocol (BEVC DC001(or) BEVC AC001(or) CCS (or) GB/T (or) CHAdeMO (or) SAE J1772 (or) if other specify)	
20.2	Description of the normal profile of charging system	
20.3	Specifications	
20.3.1	Mains Supply : single phase/ three phase	
20.3.2	Input Nominal Voltage (V) & frequency (Hz) with tolerances.	
20.3.3	Output Voltage Range (V) and Current Range (A)	
20.4	Reset period recommended between the end of the discharge and the start of the charge	
20.5	Recommended duration of a complete charge	
20.6	In case of on-board charger	
20.6.1	Continuous rating of charger socket (A)	
20.6.2	Time rating (h) of charger socket, if any	
20.6.3	Whether soft-start facility (Yes / No)	
20.6.4	Maximum initial in-rush current (A)	
21.0	**Electrical details of vehicle for functional safety**	
21.1	Schematic diagram showing the electrical layout giving all major electrical items along with their physical location in the vehicle. It shall include batteries, power-train components, protection fuses, circuit breakers etc.	
21.2	Specifications of circuit breakers/ fuses used for protection of batteries / power-train	
21.2.1	IS / IEC specifications	
21.2.2	Rating (A)	

21.2.3	Opening time (ms)	
21.3	Working voltage V	
21.4	Schematic highlighting physical location of live parts having working voltage greater than 60 V DC or 25 V AC	
21.5	Electric cables / connectors / wiring harness	
21.5.1	IEC protection class	
21.5.2	Insulation material used	
21.5.3	Is Conduits provided? (Yes / No)	
21.6	List of exposed conductive parts of on-board equipment.	
21.6.1	Any potential equalization resistance used to electrically connect these parts (Yes/ No)	
21.6.2	If yes, give details	
21.7	List of failures due to which the vehicle will come to standstill	
21.8	List of conditions under which the performance of vehicle is limited and how.	
22.0	Electrical energy consumption of Vehicle in W-h/km, as per AIS-039	
23.0	Any other additional information the manufacturer would like to declare	

ANNEXURE-V

Reference Standards:

Considerable assistance has been taken from following International and national standards in preparation of this standard.

1.	UNR 134	Uniform provisions concerning the approval of motor vehicles and their components with regard to the safety related performance of hydrogen fuelled vehicles (HFCV).
2.	GTR 13	Global technical regulation on hydrogen and fuel cell vehicle.
3.	EC 79/2009	Type approval of hydrogen-powered motor vehicles.
4.	EU 406/2010	Type approval of hydrogen-powered motor vehicles.
5.	ISO 12619	Compressed gaseous hydrogen (CGH2) and hydrogen/natural gas blend fuel system components.
6.	ISO 17268	Gaseous hydrogen land vehicle refuelling connection device.
7.	ISO 23828	Fuel Cell Road Vehicles-Energy consumption measurement-vehicles fuelled with compressed hydrogen.
8.	ISO 23272-1	Fuel Cell Road Vehicles-Safety specifications-Vehicle functional safety.
9.	AIS-038	Battery operated vehicles – Requirements for construction and functional safety.
10.	AIS-039	Electric power train vehicles-Measurement of electric energy consumption.
11.	AIS-040	Electric power train vehicles- Method of measuring the range.
12.	AIS-041	Electric power train vehicles-Measurement of net power and the maximum 30 minute power.
13.	AIS-048	Battery operated vehicles – Safety requirements of traction batteries.

ANNEXURE-VI

(See Introduction)

Composition of AISC Panel*

Convener	**Organization**
Mr. Arikapudi Suresh	TATA Motors Ltd., Pune (SIAM)
Panel Secretariat	**Organization**
Mr. P S Gowrishankar	TATA Motors Ltd., Pune (SIAM)
Members	**Representing**
Mr. Akbar Badusha	Automotive Research Association of India (ARAI)
Dr. S S Thipse	Automotive Research Association of India (ARAI)
Dr. Abhijit Marathe	Automotive Research Association of India (ARAI)
Mr. Manoj Desai	Automotive Research Association of India (ARAI)
Mr. Ajay Dekate	Automotive Research Association of India (ARAI)
Mr. Parag Mengaji	Automotive Research Association of India (ARAI)
Mr. Kamalesh Patil	Automotive Research Association of India (ARAI)
Mr. N S Athale	Automotive Research Association of India (ARAI)
Mr. Pratik Nayak	Automotive Research Association of India (ARAI)
Ms. Vijayanta Ahuja	International Centre for Automotive Technology (ICAT)
Mr. Mahindrapal Singh	International Centre for Automotive Technology (ICAT)
Mr. Mayank Sharma	International Centre for Automotive Technology (ICAT)
Mr. Shekhar N Dhole	Central Institute of Road Transport (CIRT)
Mr. D H Perdhakar	Central Institute of Road Transport (CIRT)
Mr. Mahesh Shingade	Central Institute of Road Transport (CIRT)

Mr. Shailendra Dewangan	TATA Motors Limited (SIAM)
Mr. Ravikumar	TATA Motors Limited (SIAM)
Mr. Siddharth Kumar R	Ashok Leyland (SIAM)
Ms. Suchismita Chatterjee	Ashok Leyland (SIAM)
Mr. Vijeth R Gatty	Toyota Kirloskar Motor Pvt. Ltd. (SIAM)
Mr. Raju M	Toyota Kirloskar Motor Pvt. Ltd. (SIAM)
Mr. S.Muthu Kumar	Honda Cars R&D India (SIAM)
Mr. Kiran Dakale	KPIT Technologies Ltd. (SIAM)
Mr. Tejas Kshatriya	KPIT Technologies Ltd. (SIAM)
Mr. Uday Harite	Automotive Component Manufacturing Association (ACMA)
Mr. Stein	BOSCH (ACMA)
Mr. Arun Kuruuangattil	Air Products & Chemicals
Mr. Vikash Batra	Delhi Transport Corporation

* At the time of approval of this Automotive Industry Standard

ANNEXURE-VII

(See Introduction)

COMMITTEE COMPOSITION*

Automotive Industry Standards Committee

Chairperson	**Organization**
Mrs. Rashmi Urdhawareshe	Director The Automotive Research Association of India, Pune
Members	**Representing**
Representative from	Ministry of Road Transport and Highways (Dept. of Road Transport and Highways), New Delhi
Representative from	Ministry of Heavy Industries and Public Enterprises (Department of Heavy Industry), New Delhi
Shri S.M.Ahuja	Office of the Development Commissioner, MSME, Ministry of Micro, Small and Medium Enterprises, New Delhi
Shri Shrikant R Marathe	Former Chairman, AISC
Shri R.R.Singh	Bureau of Indian Standards, New Delhi
Director	Central Institute of Road Transport, Pune
Director	Global Automotive Research Centre
Director	International Centre for Automotive Technology, Manesar
Director	Indian Institute of Petroleum, Dehradun
Director	Vehicle Research and Development Establishment, Ahmednagar
Director	Indian Rubber Manufacturers Research Association
Representative from	Society of Indian Automobile Manufacturers
Shri R.P. Vasudevan	Tractor Manufacturers Association, New Delhi
Shri Uday Harite	Automotive Components Manufacturers Association of India, New Delhi

Member Secretary
Shri Vikram Tandon
Dy. General Manager
The Automotive Research Association of India, Pune

* At the time of approval of this Automotive Industry Standard