Draft Proposal for HFCV-gtr on Hydrogen Safety with Justification

A. Requirements for High-Pressure Hydrogen System

	Proposal	Comments and References	Justification
1	*** Hydrogen piping for high-pressure system** Piping, etc. from the receptacle to the first pressure regulator in the downstream of the gas container shall be durable and sturdy, having, the pressure resistance 1.5 times the general-use pressure, taking into account the embrittlement caused by hydrogen.	* Since hydrogen piping and parts for high-pressure system are exposed to high-pressure hydrogen, it is necessary to specify provisions on the pressure resistance and the hydrogen-embrittlement resistance. Japan 100 3–7–2 Piping, etc. from the receptacle to the first pressure-reducing valve in the downstream of the gas container shall be durable and sturdy, having, the pressure resistance 1.5 times the general-use pressure, taking into account the embrittlement caused by hydrogen. EC Reg. Article 5 General requirements for hydrogen components and systems (b) The hydrogen system is protected against over-pressurisation; (c) Materials of those parts of the hydrogen components and systems, which are to be in direct contact with hydrogen are compatible with hydrogen; ECE R110 Annex 5A OVERPRESSURE TEST (STRENGTH TEST) 1. A CNG containing component shall withstand without any visible evidence of rupture or permanent distortion a hydraulic pressure of 1.5-2 times the maximum working pressure during minimal 3 minutes at room temperature with the outlet of the highpressure part plugged. Water or any other suitable hydraulic fluid may be used as a test medium.	In general, the fuel piping system for fuel cell vehicles is operated by reducing the pressure of hydrogen from the high-pressure container. While the multilevel pressure-reduction structure is also possible, the system is generally divided into two levels: high-pressure part and low-pressure part. Since gas becomes more dangerous when it leaks at high pressures, it is more important to ensure safety at high pressures. Hence, based on the principle, that is, it is not desirable to set out detailed or complicated provisions that would jeopardize the development of new technologies, it is thought to be reasonable to set out provisions for the high-pressure part in addition to standards that cover the overall hydrogen system. Furthermore, this is general requirement in line with the general standards for high-pressure gases.
2	*** Installation location of container attachments** Container attachments shall be mounted directly on or within to the each gas container. Definitions: “Container attachments” mean a main shut off valve, a container non-return valve and a pressure relief device. “Container non-return valve” means a valve that prevents hydrogen gas from flowing backward from the gas container to the receptacle at pressures ranging from the nominal working pressure to the minimum pressure that is normally used.	* Requiring container attachments to be mounted directly on or within each container is an important provision that is essential for hydrogen safety of HFCV. Japan 100 3–1–1 Container attachments shall be attached directly to each gas container. EC Reg. ANNEX VI-6 The hydrogen fuel supply lines shall be secured with an automatic shut-off valve mounted directly on or within the container. ECE R110 17.5.1. An automatic cylinder valve shall be installed directly on each container. Japan 100 2–8 “Container check valve” means, among the container main valves, a valve that prevents hydrogen gas from flowing backward from the gas container to the receptacle. Japan 100 2–10 “Container attachments” mean a main shut off valve, a container check valve and a container safety valve.	There must be no gas leakage in the hydrogen system in principle. If parts for the high-pressure system are installed at inappropriate locations, even with the system for detecting hydrogen gas leaks, giving alarms, and shutting off the supply of hydrogen, operating normally, its shut-off function will be completely useless in the real-world leak situation such as parking in garages etc..
3	*** Provision of the overflow prevention valve** <u>Example of the provision on performance requirement</u> Any excessive increases in flow rate and pressure downstream of the main shut off valve in hydrogen system caused by any abnormality of the system must be prevented. <u>Example of the provision on equipment requirement</u> The system shall be equipped with an	* Requiring the overflow prevention valve to be installed is an important provision that is essential for hydrogen safety of HFCV. Japan 100 3-2-1 Any of the devices that prevent one of the overflow enumerated in following Items 3–2–1–1 to 3–2–1–3 shall be provided. 3–2–1–1 An overflow prevention valve (installed on the main shut off valve or in close proximity thereto); 3–2–1–2 A system consisting of a device that detects the pressure inside the gas container or piping, etc. and a main shut off valve that shuts off the supply of hydrogen gas from the gas container when the aforementioned device detects	For complying with the general standards for high-pressure gases for industrial use etc., the installation of a safety device that limits or shuts off the hydrogen gas flow, i.e., overflow prevention valve or overflow prevention function should be required, in the event of abnormal increase of the gas flow from the container due to some cause.

	overflow prevention valve or an overflow limiting device with the same function. Definitions: “Overflow prevention valve” means a valve that automatically shuts off hydrogen gas or regulates its flow when the flow of hydrogen gas from the gas container increases abnormally.	an abnormal drop in pressure; and 3–2–1–3 A system consisting of a device that detects the flow rate of hydrogen gas inside the gas container or piping, etc. and a main shut off valve that shuts off the supply of hydrogen gas from the gas container when the aforementioned device detects any abnormal rise in the flow rate. ECE R110 6.3.1. The container shall be equipped at least with the following components, which may be either separate or combined: 6.3.1.1. manual valve, 6.3.1.2. automatic cylinder valve, 6.3.1.3. pressure relief device, 6.3.1.4. excess flow limiting device. Japan 100 2-11 “Overflow prevention valve” means a valve that automatically shuts off hydrogen gas or regulates its flow when the flow of hydrogen gas from the gas container increases abnormally. ECE R110 2.10. "Excess flow valve" (excess flow limiting device) means a device which automatically shuts off, or limits, the gas flow when the flow exceeds a set design value.	
4	*** Functions of the main shut off valve** The main shut off valve shall be closed automatically. The main shut off valve shall be operatable at the driver’s seat.	* Requiring the main shut off valve to be closed automatically and operatable at the driver’s seat is an important provision that is essential for hydrogen safety of HFCV. Japan 100 3–1–2 The main shut off valve shall comply with each of the following Items 3–1–2–1 and 3–1–2–2. 3–1–2–1 The main shut off valve that supplies and shuts off hydrogen gas shall be operatable at the driver’s seat. The valve must operate without fail. 3–1–2–2 It shall be operated electromagnetically, and shall be closed automatically when the power source of its operation fails. EC Reg. ANNEX VI-6 When the propulsion system is switched off, the fuel supply from the container to the propulsion system shall be switched off and remain closed until the system is required to operate. ECE R110 17.5.1.2. The automatic cylinder valve shall be operated such that the fuel supply is cut off when the engine is switched off, irrespective of the position of the ignition switch, and shall remain closed while the engine in*/ not running. A delay of 2 seconds is permitted for diagnostic.	When the driver has turned off the ignition switch in the event of some trouble, or when the battery power has gone off due to failure, the main shut off valve must not open; otherwise the hydrogen supply would not be shut off.
5	*** Installation location of the first regulator** A pressure regulator shall not be attached upstream of the main shut off valve. However, this provision shall not apply to cases where the shut-off function is provided at the passage from the pressure regulator to the atmosphere or where there is no passage leading to the atmosphere.	* When a part with a passage to the atmosphere is provided upstream of the main shut off valve (on the container’s side) and if this part fails, the main shut off valve will not be able to shut off the hydrogen discharge to the atmosphere. * Specifying the positional relationship between the main shut off valve and the first regulator is an important provision that is essential for hydrogen safety of HFCV. Japan 100 3-3-1 A pressure-reducing valve shall not be attached upstream of the main shut off valve. However, this provision shall not apply to cases where the shut-off function is provided at the passage from the pressure-reducing valve to the atmosphere or where there is no passage leading to the atmosphere.	There must be no gas leakage in the hydrogen system in principle. If parts for the high-pressure system are installed at inappropriate locations, even with the system for detecting hydrogen gas leaks, giving alarms, and shutting off the supply of hydrogen, operating normally, its shut-off function will be completely useless in the real-world leak situation such as parking in garages. The pressure regulator has a small passage open to atmospheric pressure to balance the pressure in general, then, if a leakage occurs in the pressure regulator, no measures can stop the leakage. Therefore the installation location of the first regulator is important.
6	*** Requirements on the gas filling unit or receptacle** The gas filling unit or receptacle shall be secured against maladjustment and shall be protected from dirt and water. <u>Example of the provision on equipment requirement</u> The gas filling unit or receptacle shall be integrated with a non-return valve or a	* It is necessary to specify functional requirements on the gas filling unit or receptacle. Japan 3–6–1 The receptacle shall be provided with a gas filling valve having overflow prevention function. EC Reg. ANNEX VI-4 The refuelling connection or receptacle shall be secured against maladjustment and shall be protected from dirt and water. The refuelling connection or receptacle shall be	In order to prevent hydrogen leakage during the course of gas filling procedures, it is important to install the check valve on the receptacle. Without the check valve on the receptacle, there will be a possibility that high-pressured hydrogen gas in the piping to the inlet of the container would burst out after the filling.

	valve with the same function. <u>Example of the provision on performance requirement</u> There must be no hydrogen leak from the gas filling unit or receptacle after filling of gas.	integrated with a non-return valve or a valve with the same function. If the refuelling connection is not nction, mounted directly on or within the container.mounted directly on the container, the refuelling line shall be secured by a non-return valve or a valve with the same fu ECE R110 17.9.1. The filling unit shall be secured against rotation and shall be protected against dirt and water.	

B. Requirements for Overall Hydrogen System

	Proposal	Comments and References	Justification
1	*** Prevention of hydrogen leakage under normal use** The hydrogen system must be durable and sturdy with airtightness from the outside under general-use pressure and allow no gas leakage when tested for airtightness of piping, etc. according to the procedures specified separately.	* In accordance with the principle of “no hydrogen leakage from HFCV,” it is necessary to specify the requirement for prevention of hydrogen leakage under normal use as well as the procedures to verify it (specific airtightness testing procedures). Japan 100 3–7–1 Piping, etc. shall be durable and sturdy, with airtightness from external atmosphere under general-use pressure, allowing no gas leakage when tested for airtightness of piping, etc. EC Reg. Article 5 The manufacturers shall ensure that: (a) the hydrogen components and systems function in a correct and safe way and they reliably withstand the electrical, mechanical, thermal and chemical operating conditions without leaking or visibly deforming; ECE R110 17.1.5. The CNG system shall show no leaks, i.e. stay bubble-free for 3 minutes.	There must be no gas leakage in the hydrogen system in principle. We believe this requirement is the performance requirement for hydrogen gas line.
2	*** Installation of the pressure relief valve** The system shall be equipped with a pressure relief valve capable of effectively preventing significant rise in pressure at the secondary side of the first regulator or a safety device with the same function.	* It is necessary to specify a requirement on installation of the pressure relief valve for the purpose of preventing abnormal rise in pressure at the secondary side of the first regulator. Japan 100 3–4–1 A safety device capable of preventing significant rise in pressure at the secondary side of the pressure-reducing valve, that complies with the following Items 3–4–1–1 or 3–4–1–2, shall be provided. However, this provision shall not apply to cases where all components at the secondary side of the pressure-reducing valve (in cases where another pressure-reducing valve is provided at the secondary side, all components down to the pressure-reducing valve concerned) have pressure-resistant performance toward the pressure at the primary side of the pressure-reducing valve. The provisions on the hydrogen discharge direction from the pressure relief valve have already been specified in the draft gtr. Draft gtr on hydrogen and fuel-cell vehicles 5.2.1.1 Hydrogen discharge direction: The hydrogen gas discharge from other pressure relief systems 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 hydrogen gas containers	Complying with the general standards for high-pressure gases and CNG vehicles standards, the installation of a PRD is required. This requirement is a base of the performance requirement of PRD discharge directions.
3	*** Installation location of the gas container, piping, and gas filling unit or receptacle** The gas container, piping, and gas filling unit or receptacle must not be installed in the passenger compartment, luggage compartment, or any other places where ventilation is not sufficient.	* While there is the principle of “no hydrogen leakage from HFCV,” it is nevertheless necessary to specify the requirement to prohibit the installation of hydrogen system in the passenger compartment and luggage compartment for the purpose of preventing accumulation of hydrogen in the event of hydrogen leakage. Japan 100 3–5–2 Gas containers, piping, etc. shall not be provided in the passenger compartment, luggage compartment or other places where ventilation is not sufficient.	To make sure there will be absolutely no hydrogen leakage in places where there are occupants, the basic structural requirement prohibiting the installation of the container, piping, and gas filling port in the passenger compartment and luggage compartment.

		Japan 100 3–6–2–2 The receptacle shall not be installed in the passenger compartment, luggage compartment and other places where ventilation is not sufficient. EC Reg. ANNEX VI-13 The passenger compartment of the vehicle shall be separated from the hydrogen system in order to avoid accumulation of hydrogen. It shall be ensured that any fuel leaking from the container or its accessories does not escape to the passenger compartment of the vehicle. EC Reg. ANNEX VI-14 Hydrogen components that could leak hydrogen within the passenger or luggage compartment or other non-ventilated compartment shall be enclosed by a gas tight housing or by an equivalent solution as specified in the implementing measures. ECE R110 17.7.7. In a passenger compartment or enclosed luggage compartment the fuel lines shall be no longer than reasonably required, and in any case shall be protected by a gas-tight housing.	
4	*** Method for installing the gas container and piping** Gas container and piping, etc. shall be securely installed so as to prevent shifting or damage while traveling.	* It is necessary to specify the requirement to install the gas container and piping securely. Japan 100 3–5–3 Gas containers and piping, etc. shall be securely installed so as to prevent shifting or damage while traveling, and sections thereof that is liable to damage shall be protected by covering. ECE R110 17.6. Rigid and flexible fuel lines 17.6.4. Rigid fuel lines, shall be secured such that they shall not be subjected to vibration of stresses.	To make sure there will be absolutely no hydrogen leakage in places where there are occupants.
5	*** Covering of the gas container and piping** The hydrogen system shall be protected by covering reasonably practical, against damage due to moving vehicle components, impacts, grit or due to the loading or unloading of the vehicle or the shifting of loads. The hydrogen system shall be protected by insulating shield reasonably practical, against heat, due to the internal combustion engine exhaust, sunlight or other heat source. The gas containers exposed to direct sunlight shall be provided with an adequate cover or other adequate sunshade.	* It is necessary to specify requirements for protecting the hydrogen system components (gas container, piping, etc.) against the outside environment. * In particular, for the gas container, only the performance requirement for the standalone state has been provided. Therefore, it is necessary to specify requirements to ensure safety with the container actually installed in a vehicle. Japan 100 3–5–3 Gas containers and piping, etc. shall be securely installed so as to prevent shifting or damage while traveling, and sections thereof that is liable to damage shall be protected by covering. Japan 100 3–5–9 Gas containers, piping, etc. that may be affected significantly by the heat of the exhaust pipes, mufflers, etc., shall be protected by appropriate heat-insulating measures. Moreover, gas containers exposed to direct sunlight shall be provided with an adequate cover or other adequate sunshade. EC Reg. ANNEX VI-9 The hydrogen system shall be installed such that it is protected against damage so far as is reasonably practical, such as damage due to moving vehicle components, impacts, grit.	In general, high-pressure gas containers are required to have provisions for preventing the container temperature from rising above a specified level with regard to its storage. The purpose of this requirement is to prevent the container from bursting, etc. by suppressing internal pressure increase caused by a rise in temperature. It is basic to require the installation of a sun shade, etc. for the preventing of temperature rises in the container due to direct sunlight when the vehicle is parked, and it also accords with the general standards for high-pressure gases. Since the container’s internal pressure that is increased as the temperature rises cannot be lowered through hydrogen consumption when the vehicle is parked, the structural requirement is the only way to prevent such pressure increase.

C. Discussion Items

	Item	Point of discussion	Justification
1	Receptacle to be located away from any ignition source	* When requiring the gas filling unit or receptacle to be located away from any ignition source, is it not necessary to specify the distance between the gas filling unit or receptacle and the ignition source? References Japan 100 3–6–2–3 The receptacle shall be located at least 200 mm away from	If the unified receptacle that has the proper performance to prevent leakages, is introduced to all fuel cell vehicles, this requirement will be not needed. We hope further discussion will be held in TF meeting.

		exposed electrical terminals, electrical switches, and other ignition sources.	
2	Attaching/securing methods for hydrogen piping	* In addition to requiring piping, etc. to be securely installed so as to prevent shifting or damage while traveling, is it not necessary to specify the installation method? References Japan 100 3–5–7 Metal parts of the supporting fixtures for the piping shall not be in direct contact with the piping. However, this provision shall not apply to cases where the piping is soldered or welded to the supporting fixtures. Japan 100 3–5–8 Gas piping with both ends secured shall have an appropriate bend at its midpoint, and shall be supported at an interval of 1 m or less. ECE R110 17.6.6. At the fixing point, the fuel line, flexible or rigid, shall be fitted in such a way that there is no metal to metal contact.	This requirement closely related to B4 in this document. We hope further discussion will be held in TF meeting.