TF1 Vehicle Classes

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(KOTSA / KATRI)

Contents

1. Purpose

- In GTR 13 Phase 1, we have decided to discuss how to expand the vehicle classes in Phase 2

- TF#1 will discuss about the requiring revision of test method or standard in GTR 13 Phase1 for expanding of the vehicle classes

Topics for the next phase in developing the gtr for hydrogen-fuelled vehicles

158. Since hydrogen fuelled vehicles and fuel cell technologies are in early stages of development of commercial deployment, it is expected that revisions to these requirements may be suggested by an extended time of on-road experience and technical evaluations. It is further expected that with additional experience or additional time for fuller technical consideration, the requirements presented as optional requirements in this document (LHSS Section G of the preamble) s could be adopted as requirements with appropriate modifications.

Focus topics for Phase 2 are expected to include:

(a) Potential scope revision to address additional vehicle classes;

(b) Potential harmonization of crash test specifications;

(c) Requirements for material compatibility and hydrogen embrittlement;

(d) Requirements for the fuelling receptacle;

2. TF#1 Participants

- Participants in TF#1 are as follows

Name	Institution/Corporation	Name	Institution/Corporation
Molkov, Vladimir	Ulster.unv	A. Ryan	TOYOTA
Patrick Breuer	Hexagon Lincoln LLC	Tatsuo.kiuchi	Mitsubishi Fuso Truck and Bus
Dijkhof, Paul	KIWA	Y. Ookura	ISUZU
Veenstra, Mike	FORD	T. Koto	HINO
Keller Jay	ZCES	Brain Lindgern	PACCAR
Glenn Scheffler	Gws Solutions of Tolland LLC (Consultant, US DOE)	Min Sik Cho	DAE HEUNG
Pfeifer, Sascha	VDA	Jeong Hak Ahn	HYUNDAI
Andrei V. Tchouvelev	A.V.Tchouvelev	Woo Yong Ji	HYUNDAI
Livio Gambone	CSA	Ki Ho Hwang	HYUNDAI
Paolo Alburno	EAAS	Yeongtae Ko	HYUNDAI
I. Yamashita	HONDA	Sung Chul Kim	TK-Fujikin
H. Tamura	JARI	Gyehyoung Yoo	ILJIN Composites
Y. Fujimoto	TOYOTA	JESSE Schneider	NIKOLA
Sinwook Kwon	KOTSA / KATRI	Michael Gunnewig	MAN
Nha Nguyen	NHTSA	Shashi.Kuppa	NHTSA

3. Scope: Vehicle Classes (1/2)

- The scope of GTR 13 Phase 1 is a category 1-1, 1-2, with GVM less than 4,536 kg

1.1. "Category 1 vehicle" means a power driven vehicle with four or more wheels designed and constructed primarily for the carriage of (a) person(s).

1.1.1. "Category 1-1 vehicle" means a category 1 vehicle comprising not more than eight seating positions in addition to the driver's seating position. A category 1-1 vehicle cannot have standing passengers.

1.1.2. "Category 1-2 vehicle" means a category 1 vehicle designed for the carriage of more than eight passengers, whether seated or standing, in addition to the driver.

1.2. "Category 2 vehicle" means a power driven vehicle with four or more wheels designed and constructed primarily for the carriage of goods. This category shall also include:
i) tractive units
ii) chassis designed specifically to be equipped with special equipment.

- Vehicles with GVM 4,536 or higher in category 1, and category 2 need to be included in GTR 13 scope

Scope

This regulation applies to all hydrogen fuelled vehicles of ~~Category 1-1 and 1-2, with a gross vehicle mass (GVM) of 4,536 kilograms or less~~.

→ Category 1 and 2

3. Scope: Vehicle Classes (2/2)

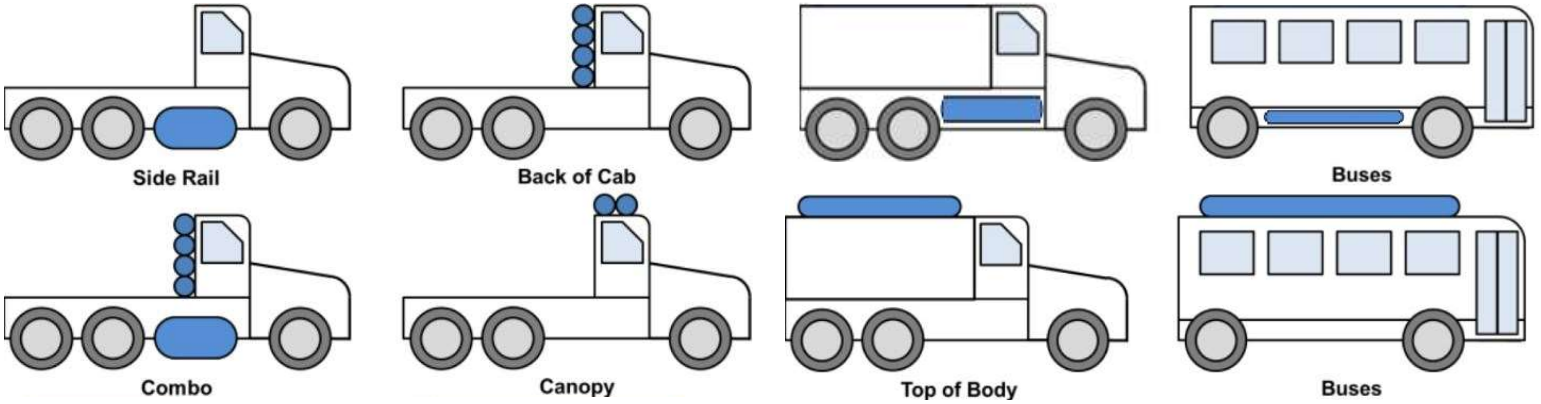
- There is an opinion to refer EVS-GTR classification standards (Y. Fujimoto, Toyota)

	Category 1-1	Category 1-2			Category 2		
EVS-GTR	nonHD	GVM ≤3500	3500< GVM ≤4536	4536 <GVM	GVM ≤3500	3500< GVM ≤4536	4536< GVM
		nonHD	nonHD/ HD by CP	HD	nonHD	nonHD/ HD by CP	HD

- In Korea, category 2 vehicle is divided into medium and large vehicles based on the GVM 3,500 kg
- UN Regulation also divided into N2/N3 based on GVM 3,500 kg
- If a vehicle weighs 3,500 kg < GVM < 4,536kg, it may be subject to different standards depending on Contracting Parties
- TF#1 would like to ask to some ideas on this matter

4. Post-Crash Fuel System Integrity (1/6)

- LDV require to check fuel leakage limit post crash
- Necessity for discussion on the adoption of this requirement for HDV
- Different test methods need to be developed according to locations of CHSS
- CHSS in HDV could be installed in a various locations



Source (Modified): Design Space Assessment of Hydrogen Storage Onboard Medium and Heavy Duty Fuel Cell Electric Trucks (J.Electrochem. En. Conv. Stor. 14 (2), 021001 (May 09, 2017))

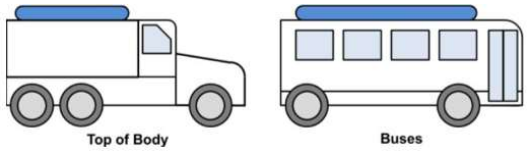
4. Post-Crash Fuel System Integrity (2/6)

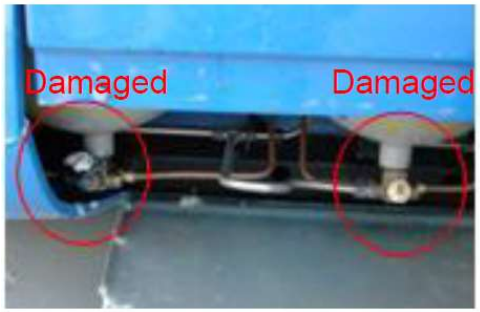
- If the CHSS is located on the roof, there is the probability of hydrogen leakage in case of rollover crash (GTR-1-23)

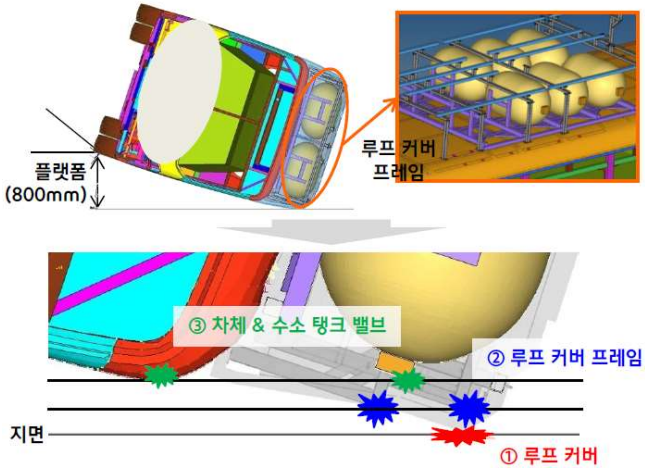
- If the CHSS is located at the lower position, there is the probability of hydrogen leakage in case of side impact crash

4. Post-Crash Fuel System Integrity (3/6): Static Rollover

- If the CHSS is located on the roof, static rollover test would be needed
- The result of the rollover test represents the damage of fuel valve system (GTR-1-23)
- The CFD (Computational Fluid Dynamics) analysis shows the high risk of hydrogen leakage from contacting between roof cover and CHSS



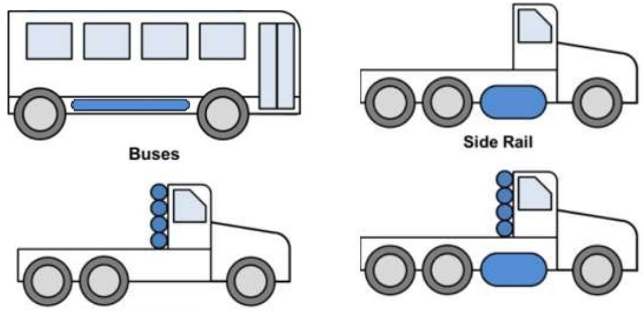




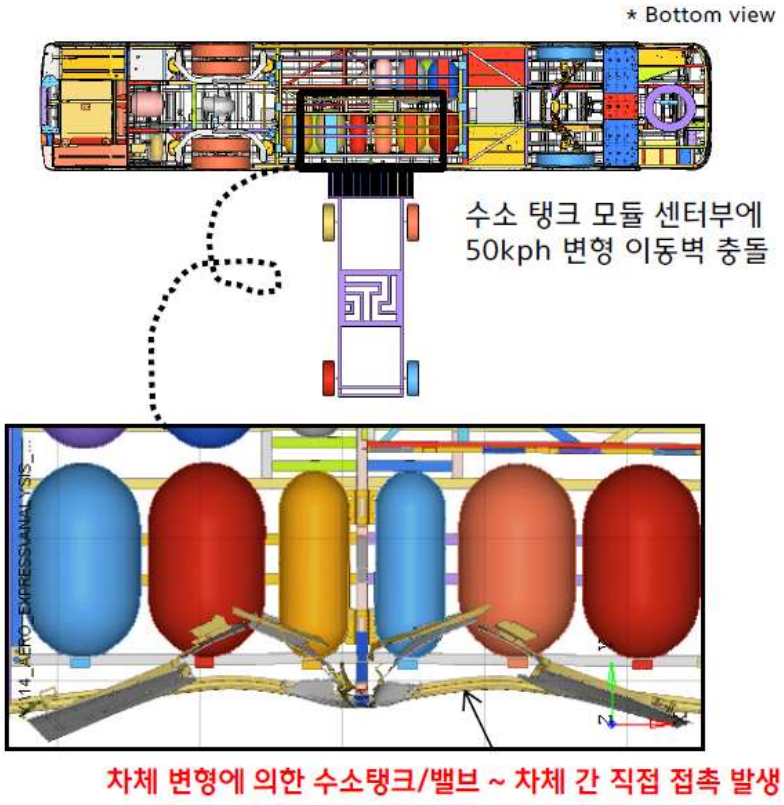
Test method is the same as in UN Regulation 66

4. Post-Crash Fuel System Integrity (4/6): Side Impact Test

- If the CHSS is located at the lower position, side impact test would be needed
- The CFD analysis represents the high risk of hydrogen leakage from contacting between the side panel of the vehicle and CHSS



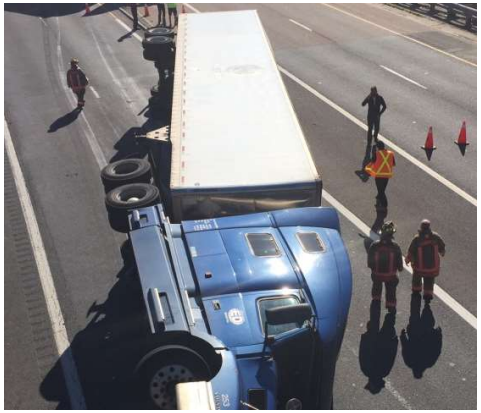
- Test speed: 50 km/h
- Impact location: center of CHSS
- Using the side impact MDB



차체 변형에 의한 수소탱크/밸브 ~ 차체 간 직접 접촉 발생

4. Post-Crash Fuel System Integrity (5/6): Accident Cases

- Need to objective evidence to establish the requirement



4. Post-Crash Fuel System Integrity (6/6): Sled test

- In UN R134, if vehicle crash tests are not applicable to the vehicle, CHSS shall be subject to following requirement

- KMVSS also have same requirement

Accelerations for vehicles of categories M_1 and N_1:

(a) 20 g in the direction of travel (forward and rearward direction);

(b) 8 g horizontally perpendicular to the direction of travel (to left and right).

Accelerations for vehicles of categories M_2 and N_2:

(a) 10 g in the direction of travel (forward and rearward direction);

(b) 5 g horizontally perpendicular to the direction of travel (to left and right).

Accelerations for vehicles of categories M_3 and N_3:

(a) 6.6 g in the direction of travel (forward and rearward direction);

(b) 5 g horizontally perpendicular to the direction of travel (to left and right).

7.2.4. Additional installation requirements

7.2.4.1. Requirements on installation of the hydrogen storage system not subject to the frontal impact test:

The container shall be mounted in a position which is rearward of a vertical plane perpendicular to the centre line of the vehicle and located 420 mm rearward from the front edge of the vehicle.

7.2.4.2. Requirements on installation of the hydrogen storage system not subject to the lateral impact test:

The container shall be mounted in a position which is between the two vertical planes parallel to the centre line of the vehicle located 200 mm inside from the both outermost edge of the vehicle in the proximity of its container(s).

- Acceleration of horizontally perpendicular to the direction of travel may be replaced in case of conducting rollover or side impact tests

- There is a low probability of direct contact with CHSS in the event of a frontal impact or rear-end collision, it is appropriate to apply the above requirement

5. Issue of Increasing Storage Capacity (1/3)

- leak-free parking at full fill (J. Schneider, NIKOLA Motor)

- The following comments were suggested about leak-free parking at full fill.
  - Regarding permeation and garages, etc.
  - ✓ The hydrogen storage volume of Heavy Duty vehicles is significantly larger than light duty vehicles. So there should be an assumption made regarding an appropriate volume of storage, above the 330L assumed as a upper volume for the first GTR. As a suggested upper limit of hydrogen onboard, 80kg total storage onboard would be a good reference. The size assumption of the garage (to fit a HD Vehicle) would be larger than 50m^3

Extreme temperature static pressure leak/permeation test.

(a) The test is performed after each group of 250 pneumatic pressure cycles in paragraph 5.1.3.2.;

(b) The maximum allowable hydrogen discharge from the compressed hydrogen storage system is 46 mL/h/L water capacity of the storage system. (para. 6.2.4.2. test procedure) ;

mL/h/L-water-capacity of the storage system. If the total water capacity of the vehicle storage system is less greater than 330 L and the garage size is no smaller than 50 m^3, then the 46 m L/h/L-water-capacity requirement results in a steady-state hydrogen concentration of no more than 1 per cent. (An upper limit per storage system of

5. Issue of Increasing Storage Capacity (2/3)

- Other comments (J. Schneider, NIKOLA Motor)

- There needs to be a hydrogen standard reference for heavy duty hydrogen fueling (up to 80kg)

- There needs to be a hydrogen standard reference for heavy duty hydrogen coupling. The flow rates for gaseous HD fueling at least in the US will be at maximum 170g/s. This is a new High Flow H70 nozzle not compatible with light duty due to flow rate.This is not covered in standards

- There will be bidirectional communications between the hydrogen storage and station that need to be developed in a new standard

5. Issue of Increasing Storage Capacity (3/3)

- Other comments (Gyehyoung.Yoo, ILJIN Composites)

  - The requirements of CHSS for heavy duty vehicles will be different from those of light duty vehicles.

    - ✓ Fueling cycles, fueling time & rate, etc. will be different
    - ✓ Is there a limit on hydrogen storage capacity or system size?
    - → Test specifications according to the requirements of heavy duty vehicles are required

  - For verification test for expected on-road system performance(pneumatic sequential tests), a review of the test method is required

    - ✓ In case of large containers, it is difficult to test because defueling time is too long
    - ✓ In addition, large facilities are required for the test
    - ✓ How about shortening the test time by using a container with a reduced length or by inserting a filler inside the test container?

  - I think it is necessary to introduce the test method for each part defined by EC or ISO regulations

    - ✓ ISO 19881, EC 79, HGV 2, HGV 3.1 etc

- Is it appropriate to discuss the above comments in TF1 ?

6. Summary

- The following agenda have been presented so far

  1. Expansion of Vehicle Classes in the scope of GTR 13
  2. Post-crash fuel leakage and system integrity
  3. Issue of increasing storage capacity

- Each agenda will be discussed in detail after the meeting

- Please let us know if you have any opinions about this agenda or if there is anything else you think needs to be discussed in TF1

Thank You

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