Ministry of Land, Infrastructure and Transport

Korea Transportation Safety Authority
Korea Automobile Testing & Research Institute

International Transport Forum

EXPERT WORKSHOP

Mapping standards for low- and zero-emission electric heavy duty vehicles

17-18 February 2020 – Paris, France

Heavy Duty HFCV

Safety Issues and Research plan in KOREA

[2020.02.17]

Siwoo KIM(Ph D) / KATRI / KOREA

Contents

"The fourth industrial revolution is not something new, but it's an extension of the innovation activities we have always been doing.."

Convergence Technology Innovation

Smart car

Green car

Future car

Smart technology application

Eco-friendly

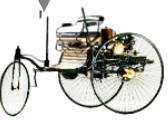
Car+Service Convergence

Google car

Apple car

Nexo

EQ900



1886 1900 1913 1966 1993 2013 2015 2018 2019 2020

Gasoline Car

Mass production

1900 IC-centred, driver-oriented hardware-centered car ••• ▶ **2019** Eco-friendly, ICT-oriented, software-driven cars in Convergence-era

1 **Protect Environment** (Greenhouse Gas, Emissions) | 2 Stabilize Traffic Accidents | 3 Assessment & Inspection Technology / Test Devices | 4 Regulation / Int'l Harmonization

Strengthen Air Quality in Urban Areas

Ban on sales of IC vehicles
(Mandatory Sales of Zero-emission Vehicles)

Reduce GHG

Manage Particulate Matters(Pm2.5)

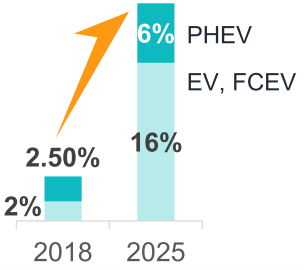
HFCV Deployment and Promotion Policy

Review of Ban on Sales for IC vehicles

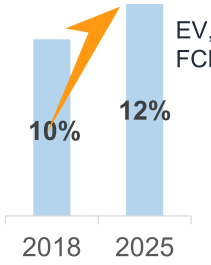
Country	Time	Regulation	Remarks
Norway	'25~	Ban	Agreed in Nat'ls Assembly('16.6)
Netherland			Senate Agreed('16.4)
Germany	'30~	Ban	Senate Agreed
India		EV only	Announcement by Transport Minister('17.4)
England	'40~	EV only	Announcement by Government('17.7)
France		Ban	Announcement by ENV Minister('17.7)

Mandatory share of ZEV

US



China

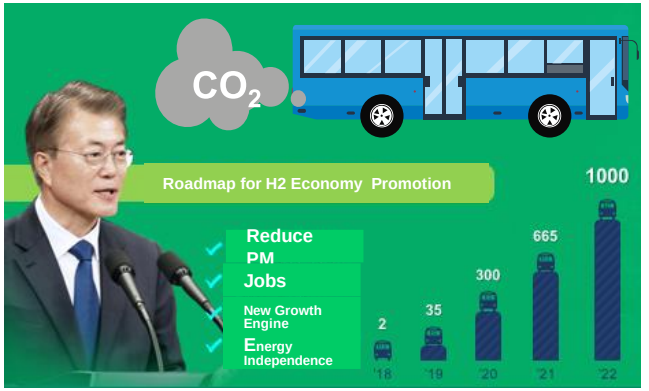


Strength Fuel Economy

Country	'17 → '25
US	40 → 56 mpg (+40%)
Europe	130 → 80 g/km(+39%)
China	6.4 → 4.0 L/100km(+38%)
Korea	140 → 82 g/km(+41%)

- Increase FE by 5% every yr from 2015
- In case of noncompliance, ban on sale of conventional vehicles or prorated penalty

Road Map for Hydrogen Economy in KOREA



I Background & Necessity(2/4)

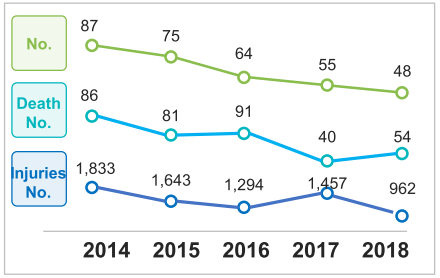
Cause for Accidents involving HDV

Various Cause for Accidents / Firs

Reflect commercial HFCV characteristics & Need to improve accidents safety

'18 Statistics of Accidents involving HDV (Fatal > 3, Casualties > 20)

Trends in Latest 5 years



Vehicle Types

Buses casualties 50.0%

- Buses 50.0%
- Passenger 29.5%
- Trucks 9.6%
- Other 10.1%

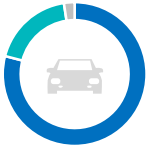
Usage (commercial)

Fixed route 36.4%

- Fixed route 36.4%
- Chartered 36.4%
- Truck 13.6%
- Rent 9.1%
- Taxi 4.5%

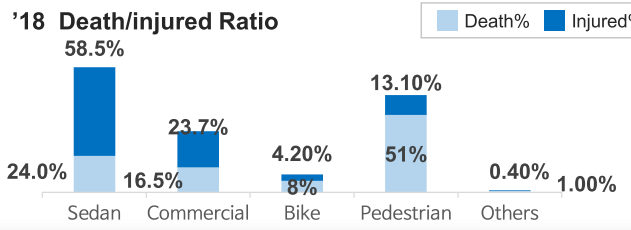
'18 Casualties(Death 3,781 / Injured 323,037)

'18 Vehicle registration ratio



Sedan 80.5% Com. 19.1% Special 0.4%

'18 Death/injured Ratio



Various Accidents

Rear 18% Side 22% Frontal 7% Rollover 1% Others 51%

I Ref. Case of Accidents

01 Rollover

- **Date** | ‘17.5
- **Status** | Slippery rain road
- **Type** | Single
- **Place** | City road
- **Cause** | Road condition
- **Casualty** | Death 1/ injured 6

02 Fire

- **Date** | ’16.10
- **Status** | Impact to guard rail & fire
- **Type** | Single
- **Place** | High qay
- **Cause** | -
- **Casualty** | Death 10

03 Side crash

- **Date** | ‘16.7
- **Status** | Side crash/rollover
- **Type** | Side crash
- **Place** | City road
- **Cause** | Slipped on hill
- **Casualty** | Injured 7

04 Rear-end Impact

- **Date** | ‘16.8
- **Status** | Rear impact
- **Type** | Single
- **Place** | City road
- **Cause** | vehicle
- **Casualty** | Injured 12

Consider various accidents & Need to reinforce safety of H2 leakage in HFC HDV

I Background & Necessity(3/4)

No vehicle level test protocols for HFC HDV

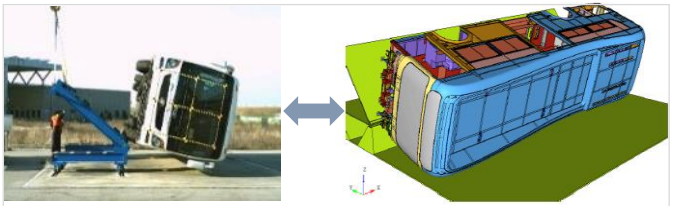
No Periodic Inspection method

No heavy size CHSS test regulations

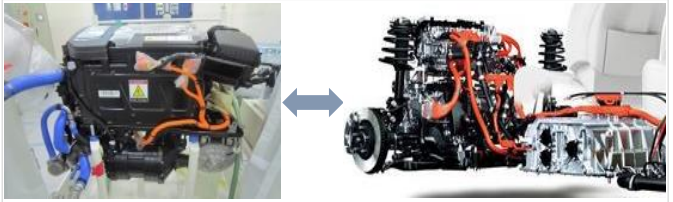
No GTR harmonization

Necessity for Development of safety assessment technology & Test devices

No test and inspection protocols for HFC HDV



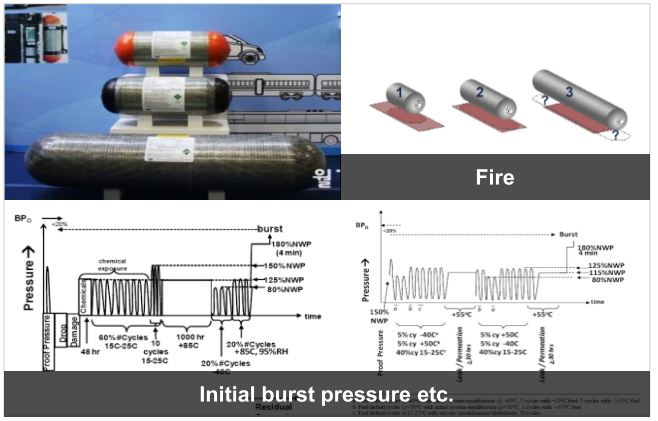
KMVSS 91 : Rollover regulation was revise but detail test protocols is not yet provided also simulation



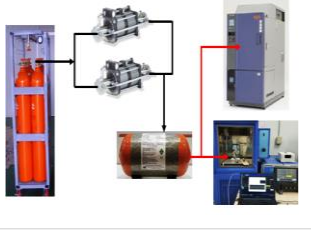
KMVSS 111 : Regulation of power of traction motor Is not cover the motor performance on multi power source.

No test devices and inspection procedures in periodic inspection for leakage of CHSS in-use HFC HDV

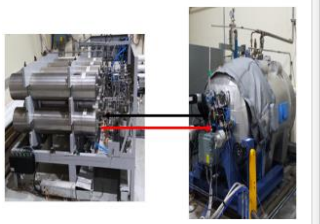
No safety regulation for HDV CHSS



KMVSS for the CHSS isn't harmonized with GTR 13. Test Devices need to upgrade.



Test Devices



Pressure cycling test

I Background & Necessity(4/4)

1 Protect Environment (Greenhouse Gas, Emissions) → 2 Stabilize Traffic Accidents → 3 Assessment & Inspection Technology / Test Devices → **4 Regulation / Int'l Harmonization**

- UN GTR 13 2 Phase
- IWG vice-chair & TF leader
- Domestic committee consultation
- Harmonize KMVSS to GTR 13-2

Needs for Strategic Plan & Execution Measures for Developing Hydrogen Industry

Plan for Development of Hydrogen Economy Society (H2 Vehicle Deployment and promotion Policy) + Direction for technology development of Domestic industry

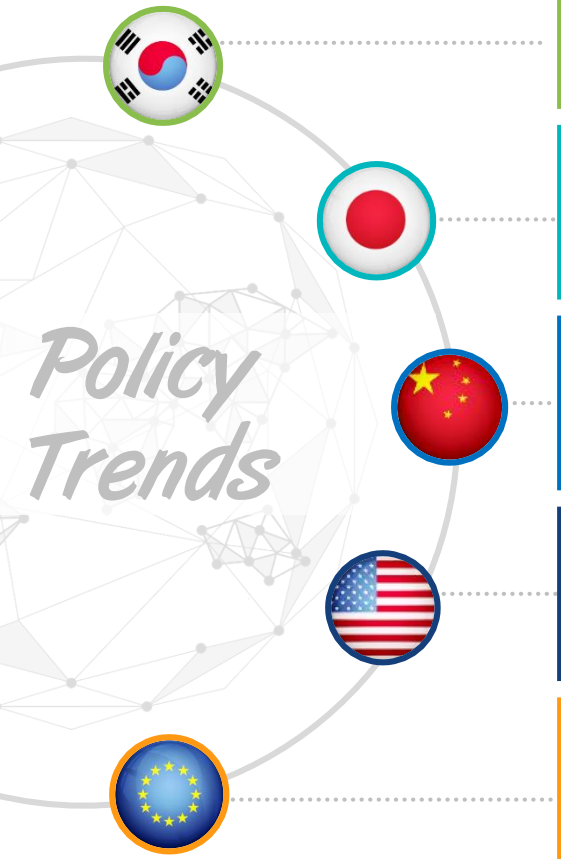
Amendment of a Reasonable safety level of GTR

01 Expand Vehicle Type
02 Receptacle
03 Improve & update
04 Fir test
05 ISO Harmo nizaion

Establishment and operation of the consultation body on the internationalization

Ⅱ Trends of Policies for HFCV

Each country announced development & promotion of HFCV



- 2019 Government announcement of Roadmap for promotion of hydrogen Economy
- Establishment of special purpose corporation for Installation/Operation of H2 fueling station
- Various subsidies for HFCV deployment (Bus : Grant 500,000 US $)

- Announcement of three-phase roadmap for promoting hydrogen society
- At 2020 Tokyo Olympic, Plan to announce H2 society (over 100 H2 Buses, 160 charging stations)
- Wide Deployment of Eco-friendly H2 Bus for Public Transport (grant of up to 80% bus price)

- China Government announced HFCV Bus Roadmap(H2 Vehicle: 2020(3,000 units), 2025(10,000 units)
- At 22 Olympic Winter Games, Open the Era for H2 vehicles (2,000 H2 Buses)
- Mandatory Sales of Vehicles with new energy (subsidy : No EV('20년), H2 Bus(.0.5 mil RMB¥)

- H2 Industries are being established in California
- DOE promotes pilot projects
- Strengthen Mandatory sales of Zero-emission vehicles

- EU and members promote and deploy H2 vehicles and Infrastructure in parallel
- Consider ban on sale of vehicles with IC engine, Subsidy for Eco-friendly vehicles (England, France ; 120,000 Euro)
- In 200 major cities , Low EM Zone(LEZ) , regulate vehicles with diesel engine

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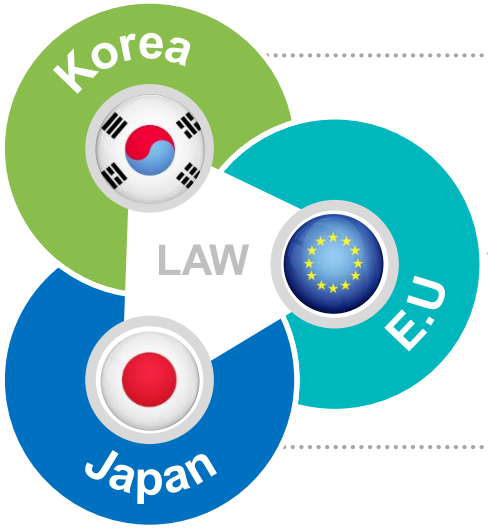
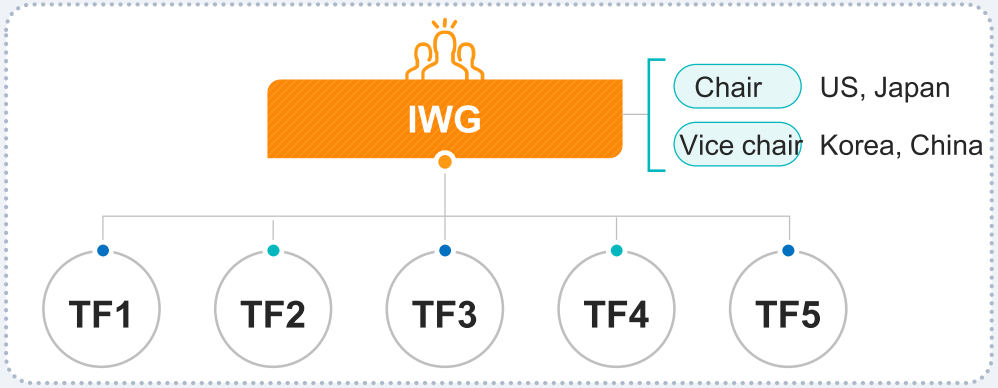


- **Completion of harm. GTR 13**
  - KMVSS 11, 17, 91, 111
- **CHSS Parts Regulation**
  - In progress with GTR 13
  - Direction : Manufacture may choose the GTR and Current regulation
- **Introduce UN R 134 (19.12.16)**
- **EC 79/2014 will be repeal**
  - Receptacle, Material, LHSS will be added
- **Harmonization of domestic regulation with UN R 134**

Global Technical Regulation Phase2 in progress



01 **TF1** | Expansion of scope(leader Korea)

02 **TF2** | Receptacle

03 **TF3** | Update & Amend current GTR 13

04 **TF4** | Fire test

05 **TF5** | Harmonization with SO

06 **IWG meeting** | 3 times/yr, TF : An necessary

Status of Hydrogen HDV

Technology Trends

City Bus
- Stack : 95kW x 2ea
- Tank : 33kg
- **Pressure : 700bar/6EA**
- Driving range : 440km

Garbage truck
- Under development

SORA
- Stack : 228kW
- Tank : 24kg
- **Pressure : 700bar/10EA**
- Driving range : 200km

Truck
- Stack : 114kW
- Tank : 7kg
- Pressure : -
- Driving : 200km

Yutong city Bus
- Stack : 60kW
- Tank : 25kg
- **Pressure : 350bar/8EA**
- Driving range : 500km

Dongfeng Truck
- Stack : 32kW
- Tank : 9.3kg
- **Pressure : 350bar**
- Driving range : 320km

- Stack : 85kW
- Tank : 60kg
- **Pressure : 350bar/8EA**
- Driving range : 483km

- Stack : 300kW
- Tank : -
- **Pressure : 350bar/-EA**
- Driving range : 1,000km more

Citaro(Daimler)

A330(Van Hool)

VDL 200(Wright)

Urbino(Solaris)

350bar city Bus

Status of Market trends for Hydrogen HDV

market trends

- ’18 : Operating two H2 buses(Seoul, Ulsan)
- ’19: Deploy 21 H2 buses in 7 cities
- Roadmap for H2 Economy : ’20(300 units), ’21(665 units), ’22(1000 units)

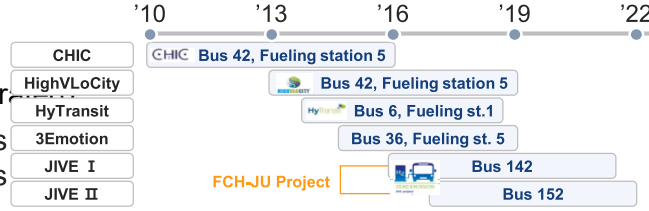
- Pilot project of city buses is being conducted in Tokyo
  - 18(2 units), ’19(5 units) are being operated
- H2 bus ’20(100 units), ’30(1200 units)

- First commercially operating buses : 159 units
  - During Int’l meeting s of G20, APEC, etc. H2 buses are being operated
- H2 Commercial vehicle ’20(3,ooo units), ’25(10,000 units)

- In California, Pilot Project and Assessment
  - ‘19, 68 H2 buses are being operated. (over 300 units accumulate

Goal H2 vehicles	~2020	~2025	~2030
	100,000	500,000	1,600,000

- European Pilot Project
  (’19: 294 units are being oper
  - JIV1 (142 units of H2 Buses
  - JIV2 (152 units of H2 Buses



Ⅱ Comprehensive Review in Korea

Policy

1. Low and Zero-emission policy (GHG)
2. Amendment of GTR 13 Phase 2
3. Harmonize Domestic regulation with GTR 13

Market

1. Purchasing Assistance policy at national level
2. Expect to develop of HFC HDV
3. Export of HFC Truck & Expect the expansion of HFC HDV

Technology

1. Secure technology for CHSS with 700bar and PRD, etc.
2. Immature technology for periodic inspection of In-use HDV and test devices
3. Upgrade facility and develop test equipment

Securing safety for HFC HDV to support the policy	Urgent development for Inspection protocol & test equipment	Utilizing developed equipment	Participating in IWG GTR 13-2
⌄	⌄	⌄	⌄
Securing safety of leakage for In-use & accidents	Securing the reliability for the developed equipment	Reducing Research Cost	Propose the regulation for the HFC HDV

Ⅲ Vison & Goal (Focus on Hydrogen Bus)

Vision

Securing World-class Hydrogen HDV safety(H2 leakage Zero)

Goal

Development of safety regulation & test equipment to secure safety of hydrogen HDV

Core value	**Safety**	**Internationalization**	**Responsibility**
Strategy Direction	**Safety assessment & Inspection technology** • Build the monitoring system & develop crash testing Scenarios • Develop inspection technology of in-use Hydrogen HDV • Develop Safety Assessment for CHSS in HDV	**International Harmonization** • Develop Regulations for safety assessment & inspection • International harmonization & internationalization of regulation	**Development of test Devices for HDV & CHSS** • Develop Test facilities of motor power performance • Develop inspection devices & CHSS test equipment
Main Subject	1 Develop rollover/crash regulation & Internationalization	2 Develop regulation and test equipment of Multi power parallel drive system	3 Develop Inspection technology and Test devices	4 Develop CHSS regulation & Test equipment

*Dev. : Development

Title: Development of Safety Assessment Technology & Test Devices of HFC Bus
Period / Budget : 2020 ~ 2024 / $25 million(grant)

Part 1 — Dev. Crash regulation & Internationalization

1 Dev. crash testing Scenario base on the monitoring analysis

2 Dev. Rollover / crash regulation

- 2-1 Rollover(vehicle & simulation) Testing protocols
- 2-2 Crash testing protocols

3 Legislation & Internationalization

- 3-1 Propose the domestic regulations
- 3-2 Propose the Int'l regulations

Part 2 — Dev. regulation and test equipment of Multi power parallel drive system

1 Dev. Regulation for the Parallel drive system

- 1-1 Power assessment regulation for fuel cell and drive system

2 Dev. Integrated performance test equipment for drive system

- 2-1 Dev. test equipment of multi power parallel drive system

Part 3 — Dev. Periodic inspection Regulation and Devices

1 Dev. inspection protocols & devices for permeation of CHSS

- 1-1 Dev. protocol to verify permeation rate
- 1-2 Dev. inspection device to verify permeation rate(1ea)

2 Dev. Inspection protocols & Devices for H2 exhaust system

- 2-1 Dev. protocol to verify H2 exhaust system
- 2-2 Dev. inspection device to verify H2 exhaust system (1ea)

3 Dev. Non-destructive inspection protocols

- 3-1 Establishment of non-destructive Inspection results DB
- 3-2 Dev. algorithm to check the crack using inspection devices

Part 4 — Dev. HDV CHSS regulation & Test equipment

1 Dev. fire test protocols & Burner (1ea)

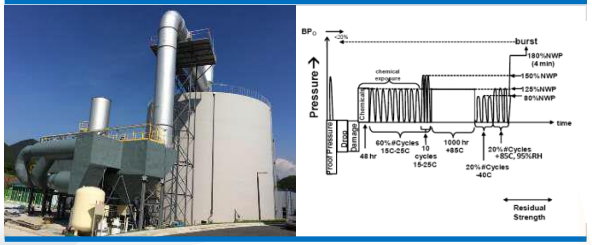
2 Dev. test equipment for GTR harmonization (7ea)

3 Dev. HDV CHSS test protocols & equipment

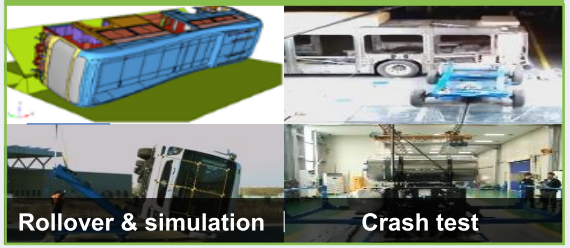
- 3-1 Upgrade hydraulic & pneumatic Test protocols in HDV CHSS
- 3-2 Dev. test equipment For HDV CHSS(8ea)

Collect & analysis of Accidents data of HFC Bus

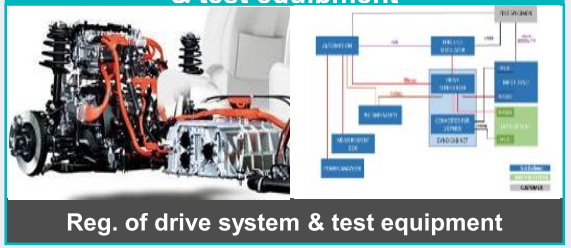
Upgrade domestic facility for GTR



Development of crash safety regulation

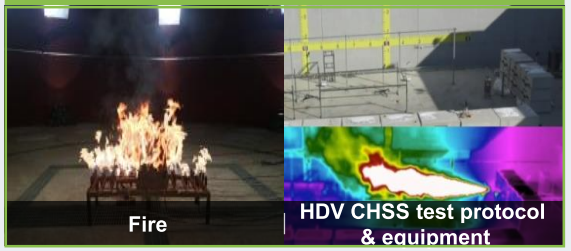


Development drive system reg. & test equipment

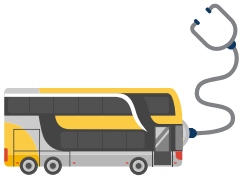


Development periodic inspection Reg. & devices

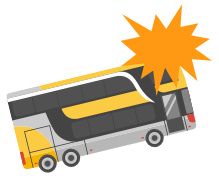
HDV CHSS regulation & test equipment



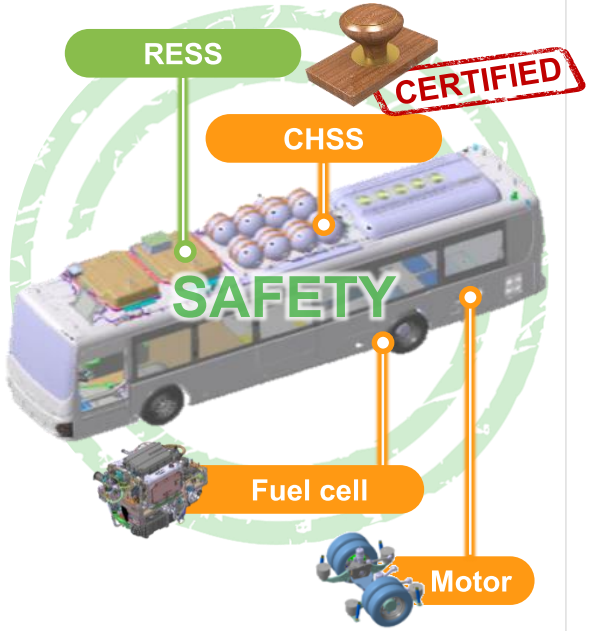
Ensure Operational & Accident Safety of in-use HFCV



Periodic inspection



Crash safety



Project Roadmap

Year	1st year	2nd year	3rd year	4th year	Output
Execution	Urgency	Advance	Legislation & internationalization		
Development Crash Regulation & Inter-nationalization	Testing scenario of fuel system integrity of H2 bus in crash				☑ Crash scenario ☑ Rollover test protocol ☑ Crash test protocol
	Rollover test & Simulation Reg.	Reg. for fuel system integrity of hydrogen bus in crash			
	Strategy for Reg. & internationalization	Propose of domestic regulation & Internationalization	Internationalization		
Dev. Regulation & test equipment of Multi power parallel drive system	Research Reg. & Std.	Testing method & Regulation	Support Internationalization		☑ Test protocol for multi Power drive system ☑ Test equipment
	Design of Integrated performance test equipment	Evaluation of test equipmemt	Enhance facility & Reliability verification		
Dev. Periodic inspection Regulation & Devices	Inspection technology and device for permeation & regulation	Establish legal system/ Enhance facility & Reliability verification			☑ Inspection protocol & device of permeation ☑ Inspection protocol & device of emission ☑ Non-destructive Inspection protocol
	Inspection technology and device for Exhausting system & regulation				
	Non-destructive Inspection technology optimization	DB for composite material defects	Pilot project for Non-destructive Inspection Reg.		
Dev. HDV CHSS reg. & Test equipment	Fire test protocol & Test equipment	Enhance facility & Reliability verification			☑ Fire test protocol & equipment ☑ GTR certi. equipment ☑ HDV CHSS test protocol & equipment
	Upgrade domestic facility for GTR	Enhance facility & Reliability verification			
	Assessment Device for high capacity CHSS & Hydraulic Assessment Technology, Regulation				

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Thank you