Research Activities of HFCV Rule-making in Korea

Sept. 24 ~ 26, 2008

Ministry of Land, Transport and Maritime Affairs,

Korea Transportation Safety Authority

(Korea Automobile Testing and Research Institute)

Research Period and Budget

- Title : Development of Safety Assessment Procedures of HFCV
- Research Period : Dec. 2007 ~ Sept. 2012 (4 years and 9 months)
  - 1st year : Dec. 2007 ~ Sept. 2008 (9 months)
  - 2nd year : Oct. 2008 ~ Sept. 2009 (1 year), …
- Total Budget : $30 million (Government $15million, Industry $15million)
  - 1st year : $3million
  - 2nd year : $4million
- Main Research Institute : KATRI
  - Cooperation with 5 universities, 2 industries and 1 public corporation

Organization for HFCV Research

KATRI
(Korea Automobile Testing & Research Institute)

Rulemaking, Policy and Harmonization	Hydrogen Safety	Vehicle Operation Safety	Electric Safety
▪ Analysis of recent trend of regulation system and policy for HFCV ▪ International harmonization of safety standards for HFCV ▪ Advanced research for safety management, rescue system and recycling plan	▪ Research for hydrogen storage and supply system ▪ Safety assessment of vehicle safety from charge station while charging	▪ Assessment of HFCV in compliance with safety standards ▪ Research for fail safety mode of HFCV	▪ Research for electric safety of high-voltage and fuel cell system ▪ Research for electromagnetic compatibility in electrical/ electronic and fuel cell system

MLTM Ministry of Land, Transport and Maritime Affairs
TS Korea Transportation Safety Authority

Rulemaking, Policy and Harmonization

- Analysis of Recent Trend of Regulation System and Policy for HFCV
  - Analysis of foreign regulation system such as Europe, USA and Japan
  - Examination of compatibility of fuel cell components for vehicle application
  - Investigation of development status of HFCV and hydrogen fueled vehicle in domestic and foreign automobile manufacturers
- International Harmonization of Safety Standards for HFCV
  - Participate in HFCV-SGE, SGS and ELSA activities for harmonization work with HFCV GTR
  - Develop instruction manual to secure safety at emergency
- Advanced Research for Safety Management, Rescue System and Recycling Plan
  - Create documents for educational and P.R (Public Relation) purposes
  - Research for environmentally friendly recycling plan

Hydrogen safety

- Research for Hydrogen Storage and Supply System
  - Hydrogen leak test
  - Leak detection by sensor, pressure gage and flow meter
  - Research for Position of sensor installation and detection range
  - Flow dynamics of hydrogen leak in the underground parking lot
  - Safety standards for allowable hydrogen leak
- Safety Assessment of Vehicle Safety from Charge Station while Charging
  - Analysis of accident data and modeling results
  - Development of hydrogen charging process

Vehicle Operation Safety (1/2)

❑ Assessment of HFCV in Compliance with Safety Standards

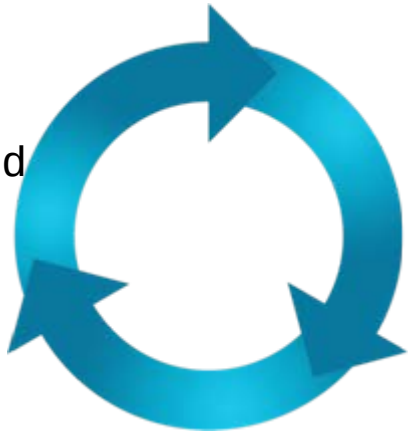
- Analysis of current domestic and foreign safety standards for HFCV
  - Occupant crash protection, fuel leakage in collision, engine power, windshield wiping and defrosting system, accelerator control, fuel economy
- Develop new safety standards for HFCV
  - Fuel cell power output, electric motor power output, installation standard for high-pressure pipeline, high voltage safety
- Establish necessary safety standards and detailed regulation for application for HFCV
- Prepare compliance test for each test item
- Develop a method to measure fuel efficiency for passenger vehicle/bus

Vehicle Operation Safety (2/2)

- Research for the Fail Safety Mode of HFCV

1. Search references and necessary documents

2. System definition
   - System component
   - Operating condition



4. Analysis of potential fail safety

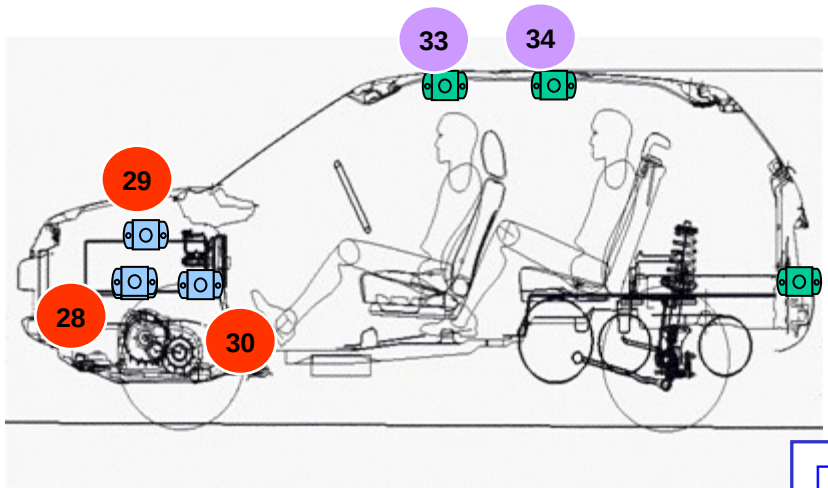
3. Analysis of fail safety mode
   - Electrical and mechanical malfunction mode
   - Air-tightness of fuel cell stack
   - Performance of fuel cell stack with tilted position
   - High voltage components safety

Electric Safety

- Assessment of Electric Safety
  - Research for electrical characteristics of fuel cell stack
  - Electric safety of high voltage in HFCV
  - Safety standards for insulation of high-voltage system
  - Occupant protection against high voltage system in HFCV
  - Establish safety standards for application of electric safety
- Assessment of Electromagnetic Compatibility (EMC)
  - Investigation of electromagnetic wave emitted from fuel cell vehicles & parts
    - Refer to noise analysis data from diesel/gasoline/hybrid
  - Analysis of electromagnetic wave on electrical/electrical system in HFCV
    - Examine potential danger directly related to safety issue and find solutions

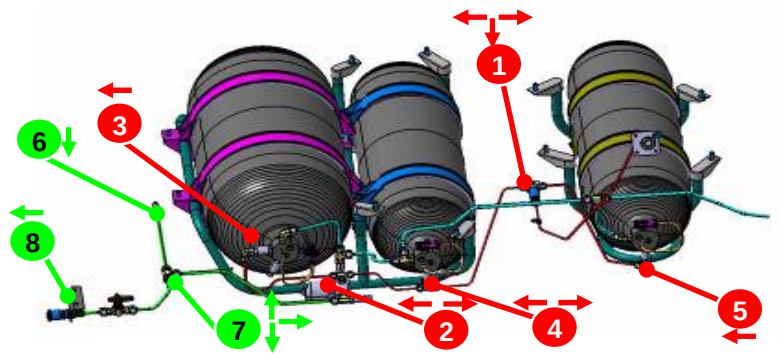
1st Year's Results (Hydrogen Safety)

❑ Positions of hydrogen leakage test sensor



❑ Hydrogen Leakage Test

❑ Expected Hydrogen Leakage Points (High/Low pressure line and engine room)



❑ Outcome : Establishment of Hydrogen Leakage Assessment Technique

- Prepare hydrogen leakage simulation equipment and mock-up vehicle
- Build comprehensive test facility for fire safety
- Build measurement system of hydrogen consumption
- Develop fuel cell NVH/impact assessment system
- Assess performance and durability of hydrogen leakage sensor

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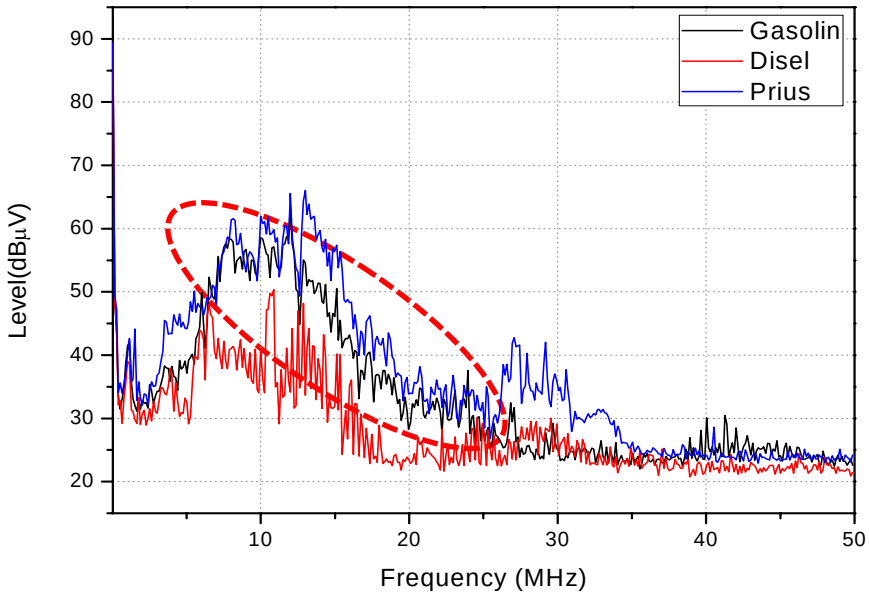
1st Year's Results (Vehicle Operation Safety)

- Fuel Efficiency Test

- **Outcome : Test Results from Fuel Efficiency and Fuel-cell Stack Stability**
  - Perform coast down test for driving resistance data
  - Obtain basic data for dynamometer input for fuel consumption test
  - Establish measurement system of hydrogen consumption rate
  - Basic study of fail safety mode in HFCV

1st Year's Results (Electric Safety)



- **Outcome : Noise and EMC analysis**
  - Noise analysis in the low frequency band (below 30MHz)
  - EMC research in HFCV and electrical system
  - Develop methodology of the electric safety assessment

2nd Year's Research Plans

- Rulemaking, Policy and Harmonization
  - Participate in HFCV-SGE, SGS and ELSA activities
  - Analyze severe crash accident data in Korea
- Hydrogen Safety
  - Find installation position of container and valves
  - Prepare mock-up for rear impact test
- Vehicle Operation Safety
  - Develop a method to measure fuel efficiency
  - Develop a test method of fail safety mode
- Electric Safety
  - Analysis of electromagnetic compatibility in HFCV
  - Analysis of electric shock and fire possibilities, etc