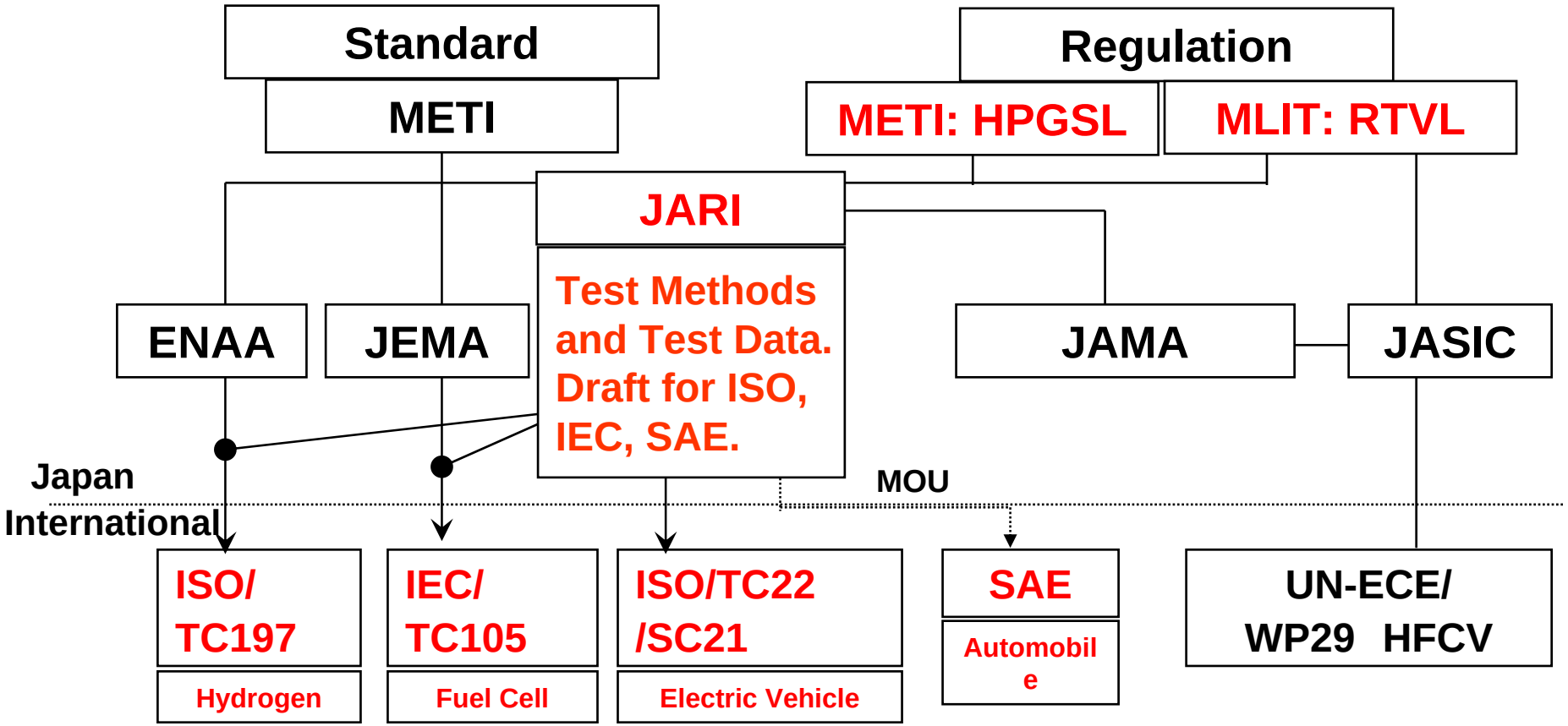
The Activities of Regulation, Codes and Standards in Japan

Shogo WATANABE
Japan Automobile Research Institute

HarmonHy

Structure of RCS for Hydrogen and Fuel Cell Vehicles



METI: Ministry of Economy, Trade and Industry
MLIT: Ministry of Land, Infrastructure and Transportation
ENAA: Engineering Advancement Association of Japan
JEMA: Japan Electrical Manufacturers' Association
JAMA: Japan Automobile Manufacturers Association
JASIC: Japan Automobile Standards Internationalization Center

HPGSL: High Pressure Gas Safety Law
RTVL: Road Transportation Vehicle Law
JARI: Japan Automobile Research institute
SAE: Society of Automotive Engineers
UN:United Nations ECE:Economic Commission for Europe
WP29:World Forum for Harmonization of Vehicle Regulations
HFCV: Hydrogen Fuel Cell Vehicle

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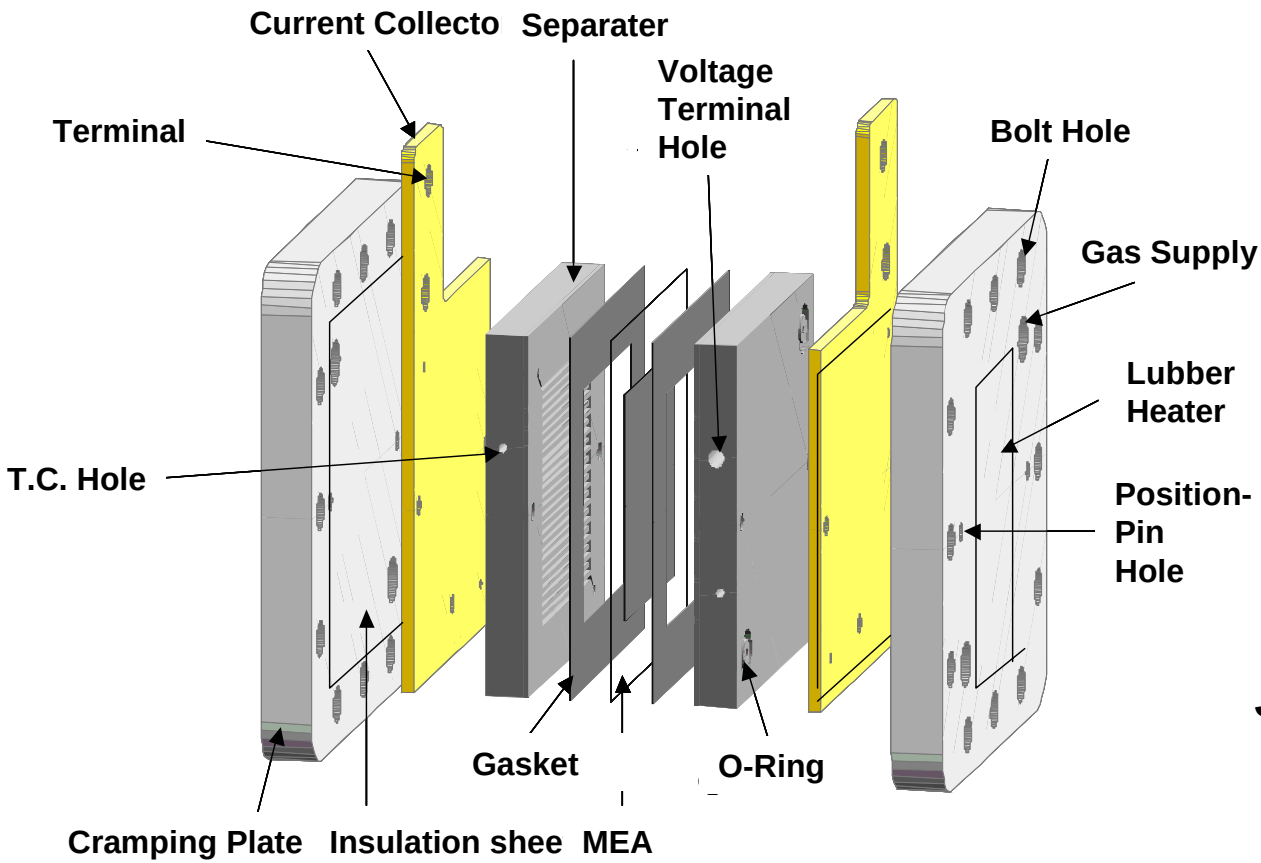
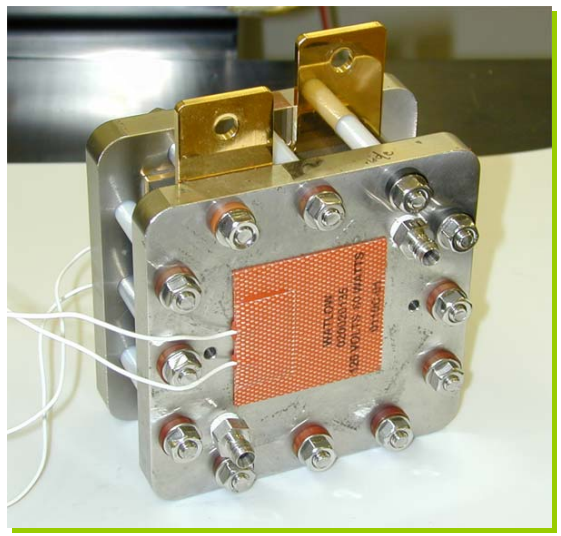
IEC/TC105(Fuel Cell) Single Cell Testing Protocol

Evaluation of materials' properties, effects of fuel impurities and so on.



The structure of JARI standard single cell (Open to the public)



JARI standard single cell (on the market)

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IEC/TC105(Fuel Cell) Single Cell Testing Protocol

Base data for establishment of single cell hardware

(1) Selection of cell materials

Separator: Machined artificial graphite
Current collector: Gold plated cupper plate
Gas diffusion layer: Carbon paper (Compared with carbon cloth)
Gasket: Three layered structure (Silicon lubber + PEN + Silicon lubber)
Insulation sheet: High thermal conductivity material

(2) Structure studies

Gas channel dimension: Serpentine single channel, 1mm width, 1mm depth, 1mm land width
Thickness of gasket: Less than 10 micron-meter difference from GDL
Cramping bolts: Layout and cramping torque for uniform surface pressure

(3) Operation control

Temperature control: Lubber heater or heat medium
Temperature measurement point: Temperature distribution of electrode area
Break-in and pre-conditioning

(4) Performance relation to stacks

Effect of the electrode area: Distribution of surface pressure, temperature, gas composition, humidification, flow velocity and so on.
Effect of stacking: Gas distribution, temperature difference and so on.

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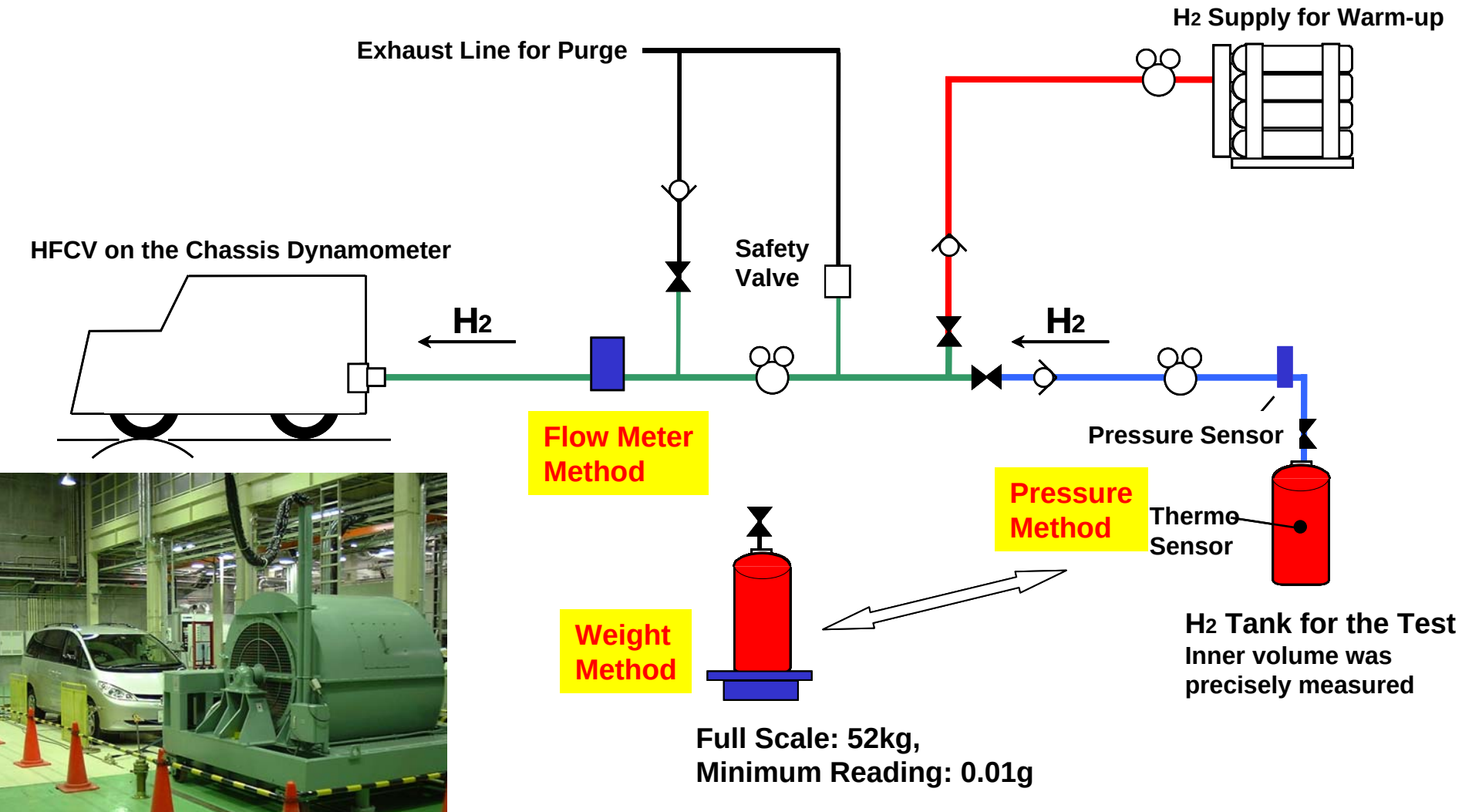
ISO/TC22/SC21(Electric Vehicle) Hydrogen Consumption Measurement

Evaluation of the environmental effect of HFCV



ISO/TC22/SC21(Electric Vehicle) Hydrogen Consumption Measurement

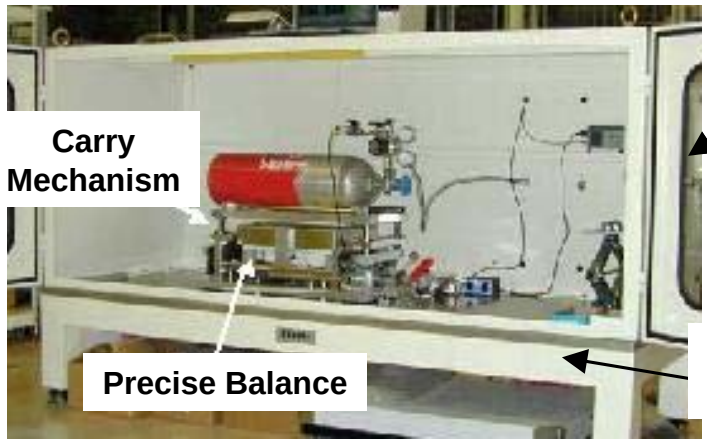
Pressure sensor

Range: 0-16MPa
Error: +/- 0.05% F.S.
Minimum reading: 1kPa
Equivalent to 0.2L of H2

Temperature sensor

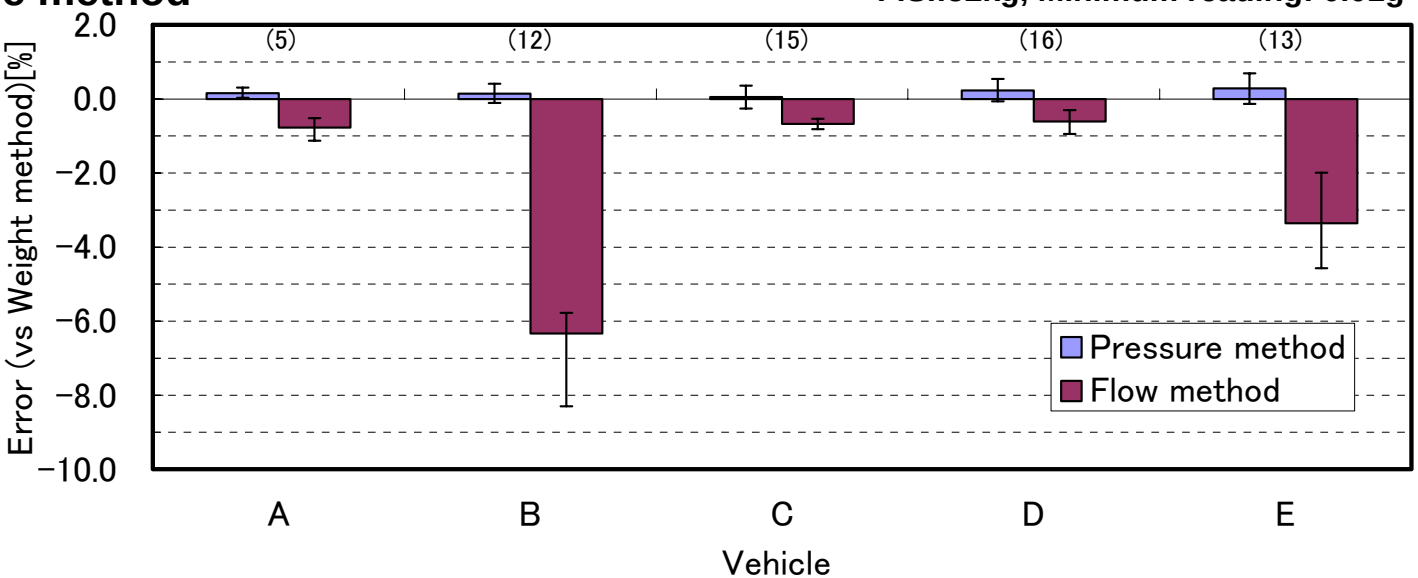
Range: 0-50 deg.C
Error: 0.01-0.03 (10-30 deg.C)
Minimum reading: 0.01 deg.C

H_2 tank for pressure method



Precise balance for weight method

F.S.:52kg, Minimum reading: 0.01g



Verification of the accuracy of the measurement methods

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ISO/TC197(Hydrogen)/WG12
H_2 Quality Specification

Allowable impurity concentrations in hydrogen fuel

Impurities	Concentration	GORE, Pt/Pt	GORE, Pt-Ru/Pt
CH_4	1 %	0%	0%
	5 %	0%	0%
C_2H_6	100 ppm	0%	0%
	5 %	0%	0%
C_2H_4	100 ppm	0%	0%
	5 %	0%	1.9% (12mV)
C_6H_6*	100 ppm	0%	0%
	500 ppm	0.6% (4mV)	0%
	750 ppm	1.1% (7mV)	1.5% (9mV)
	1000 ppm	**3.5% (22mV)**	**4.8% (30mV)**
CO_2	5 %	0%	0%
CO	0.2 ppm	0%	–
	0.5 ppm	**3.5% (21mV)**	–
	1 ppm	**9.6% (57mV)**	1.1% (7mV)
	2 ppm	–	**2.0% (12mV)**
	3 ppm	–	**2.0% (12mV)**
	5 ppm	**22% (141mV)**	**3.1% (20mV)**
	10 ppm	–	**5.0% (31mV)**
SO_2	0.1 ppm	–	0.8% (5mV)
	0.2 ppm	0.6% (4mV)	1.9% (12mV)
	0.5 ppm	**2.4% (15mV)**	**36% (222mV)**
	1 ppm	**3.1% (20mV)**	**> 50%**
	1.5 ppm	**> 50%**	–
	2 ppm	**> 50%**	**> 50%**

Impurities	Concentration	GORE, Pt/Pt	GORE, Pt-Ru/Pt
H_2S	0.1 ppm	–	0.6% (4mV)
	0.2 ppm	0.5% (3mV)	**3.3% (21mV)**
	0.5 ppm	**2.6% (16mV)**	**> 50%**
	1 ppm	**3.4% (21mV)**	**> 50%**
	2 ppm	**> 50%**	**> 50%**
CH_3OH*	500 ppm	0%	0%
	1500 ppm	–	**0.8%(5mV)**
	2000 ppm		
	2500 ppm	0%	**2.7% (17mV)**
HCHO	3 ppm	–	1.4% (9mV)
	5 ppm	–	1.9% (11mV)
	10 ppm	1.1% (7mV)	**2.6% (17mV)**
	20 ppm	**3.5% (21mV)**	–
HCOOH	10 ppm	–	0.8% (5mV)
	20 ppm	–	1.5% (9mV)
	50 ppm	–	**2.5% (15mV)**
	100 ppm	1.0% (6mV)	–
	500 ppm	**2.5% (16mV)**	–
CH_3COCH_3*	100 ppm	0%	0%
	250 ppm	1.8% (11mV)	–
	500 ppm	**2.4% (15mV)**	0%
NH_3*	0.3 ppm	0.5% (3mV)	1.3% (8mV)
	0.5 ppm	**3.1% (18mV)**	**2.2% (14mV)**
	1.0 ppm	**4.0% (24mV)**	**5.2% (32mV)**

The number of % shows the voltage decrease ratio to the voltage of pure hydrogen fuel.

Review and Revise of Regulations On H_2 and FCV in Japan

1.Road Transportation Vehicle Law

Establishment of safety and technical regulations for H_2 FCVs

2. High Pressure Gas Safety Law

Regulation of high pressure hydrogen cylinder for vehicles
Regulation of attachment of hydrogen cylinder
Review of re-inspection method of hydrogen cylinder

3. Road Safety Law

Review of the regulation of hydrogen trailers going through tunnels

4. Fire Safety Law

Verification of the validity of fire safety equipment of underground parking lots

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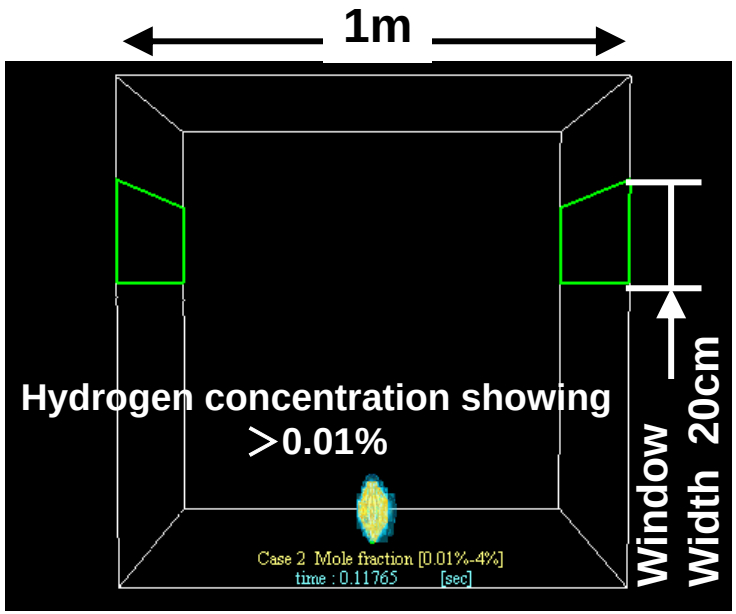
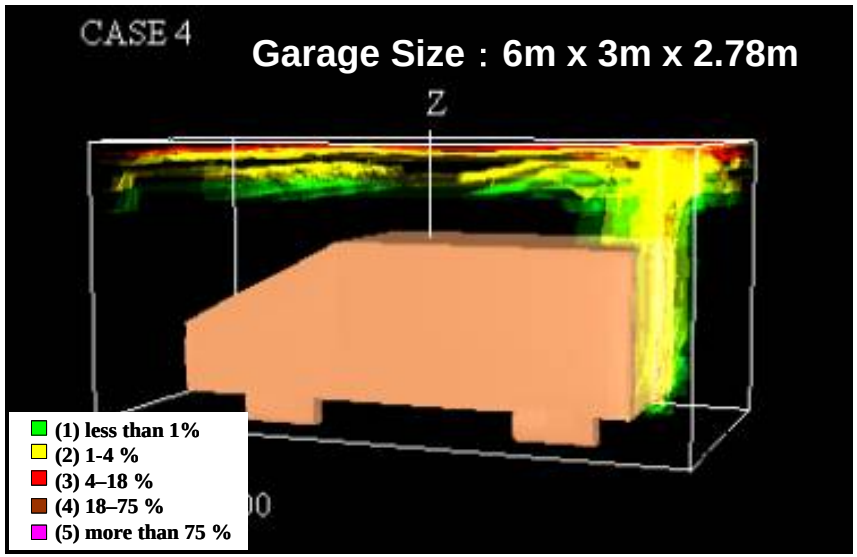
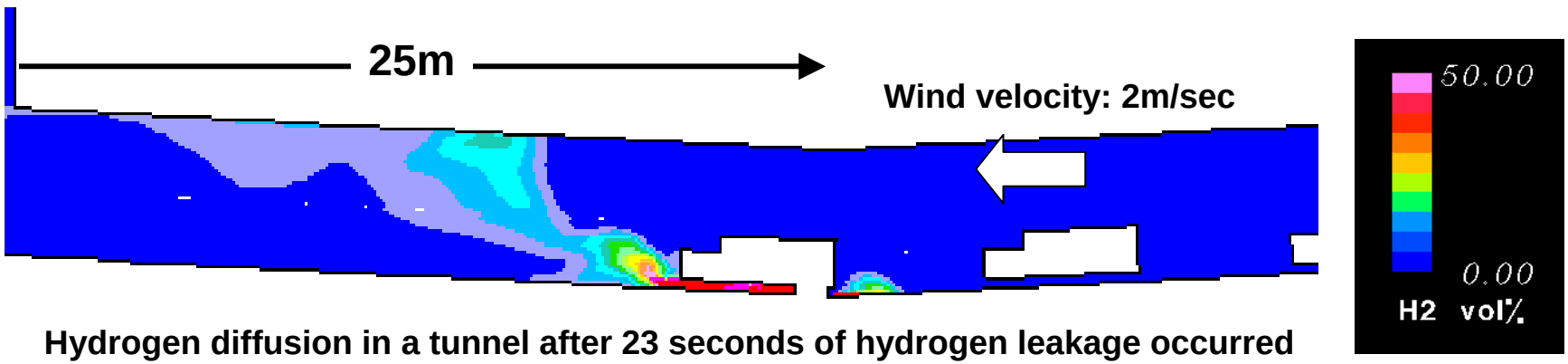
Basic Studies on Hydrogen Diffusion Behavior



Hydrogen flow rate: 10L/min



Hydrogen diffusion in a garage
(135L/min x 30sec)



Hydrogen diffusion in a tunnel after 23 seconds of hydrogen leakage occurred
Flow Rate: 60Nm3 in a minute (Pressure in the tank decrease from 35MPa to 0MPa in a minute)

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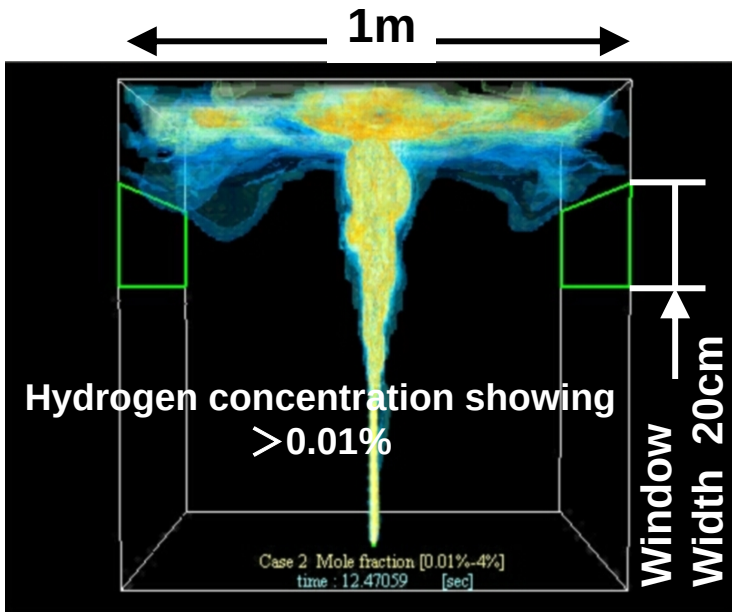
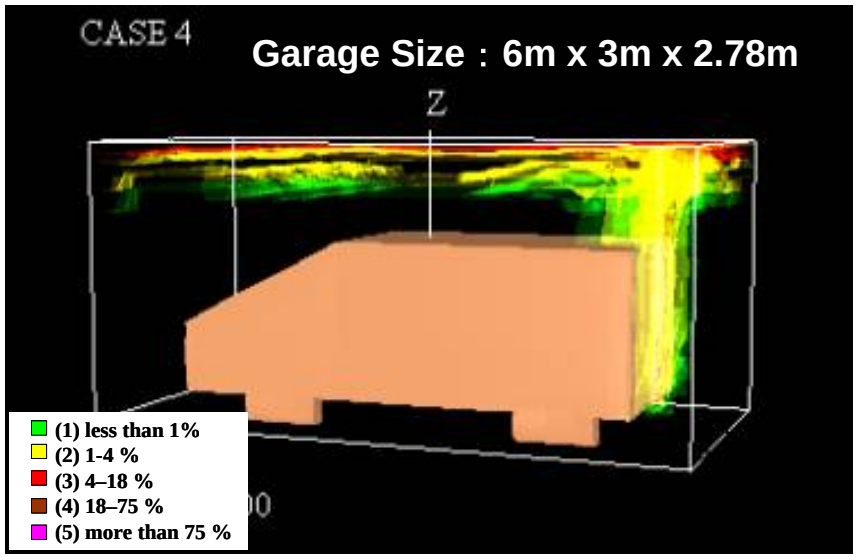
Basic Studies on Hydrogen Diffusion Behavior



Hydrogen flow rate: 10L/min



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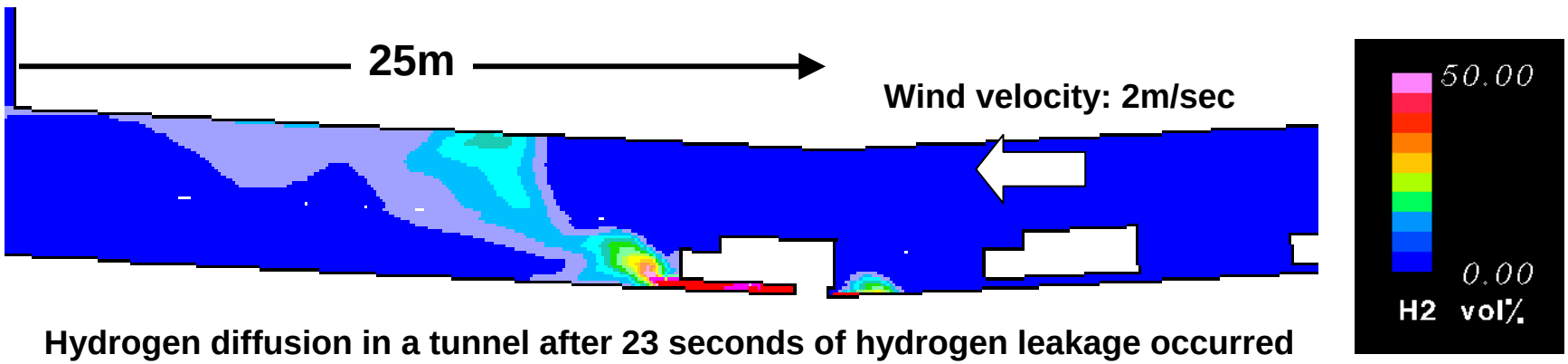

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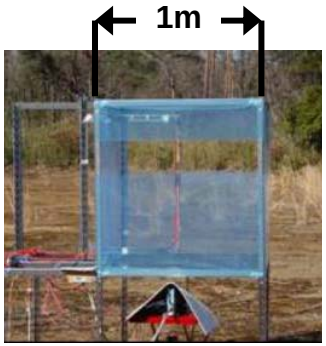
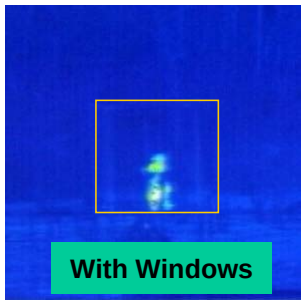
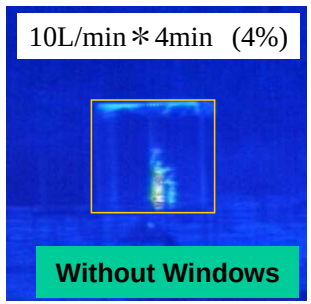
Basic Studies on Hydrogen Ignition and Combustion



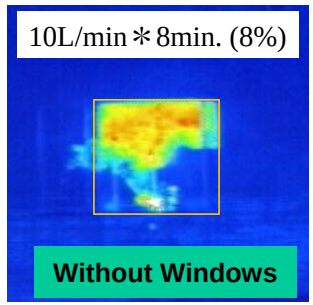
Test apparatus



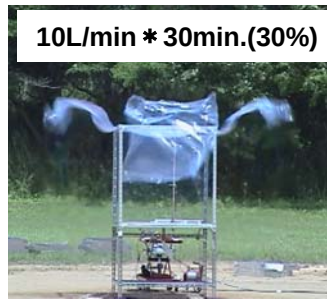
Hydrogen flame
(Infra-red Image)



Good relation to the result of simulation

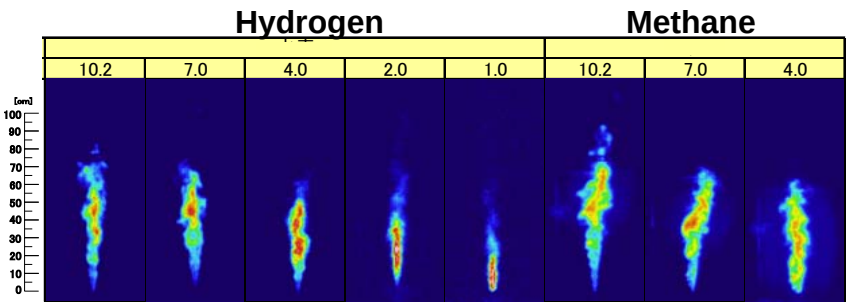


Hydrogen flame is stopped by thin film



Explosion is occurred at 30% average hydrogen concentration

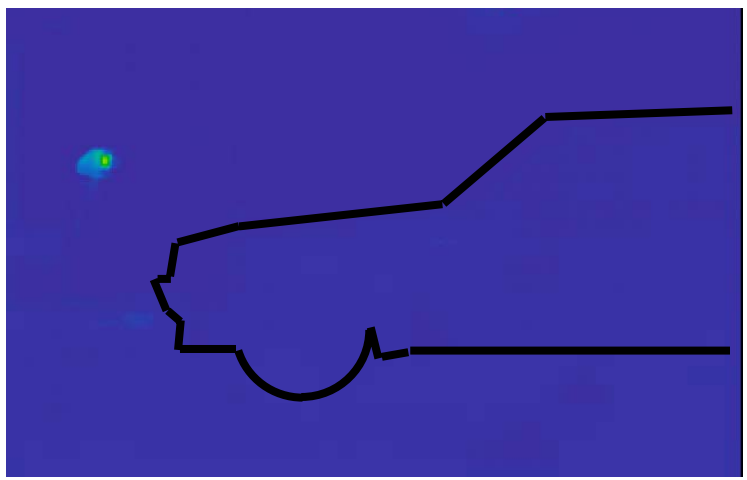
Hydrogen ignition and combustion



Hydrogen:131NL/min
Methane : 40NL/min

Flame comparison at heat equivalent flow rate

Hydrogen release, ignition and combustion



Release point: Center of the under-floor
Flow rate: 131NL/min x 10min
H_2 concentration beneath the engine hood: 24%

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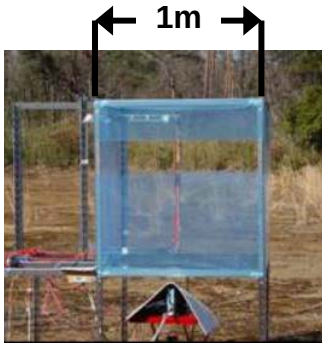
Basic Studies on Hydrogen Ignition and Combustion



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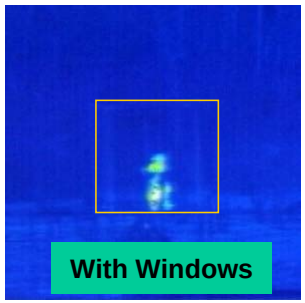

Hydrogen flame
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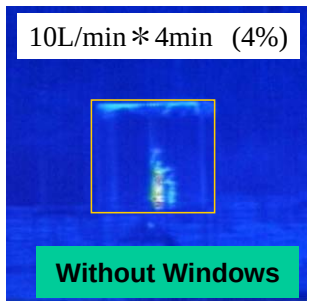

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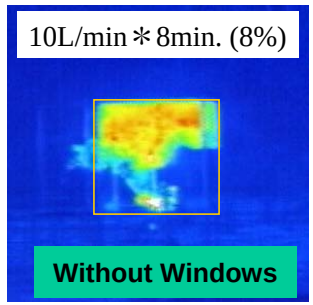

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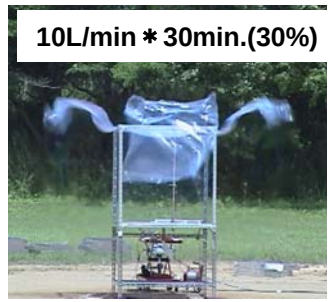

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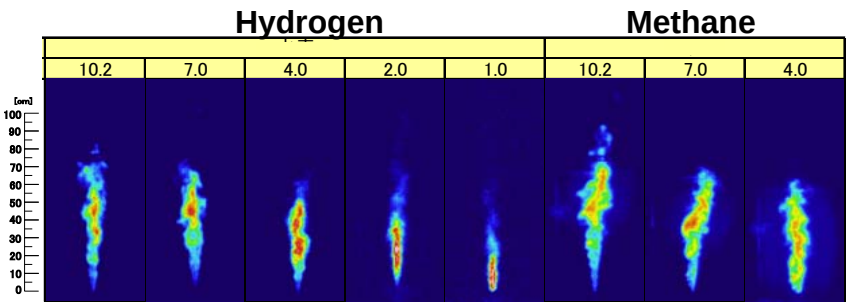

Hydrogen:131NL/min
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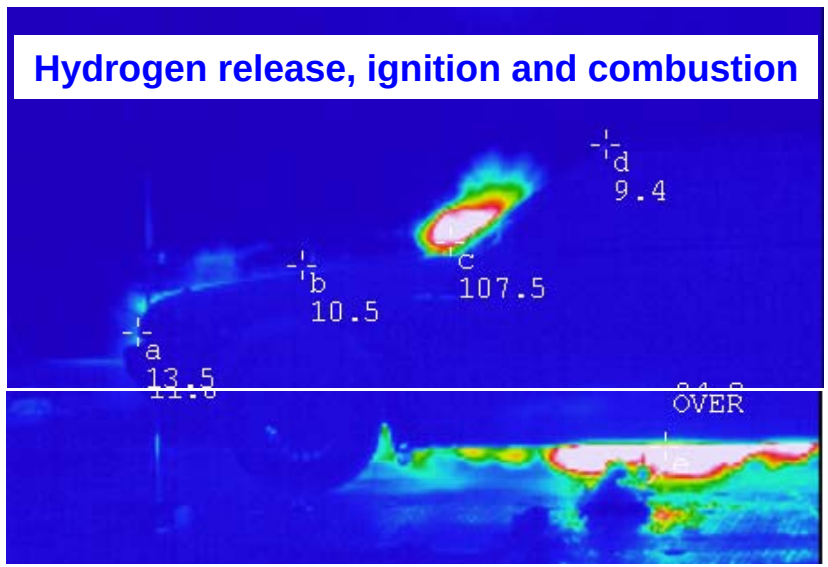
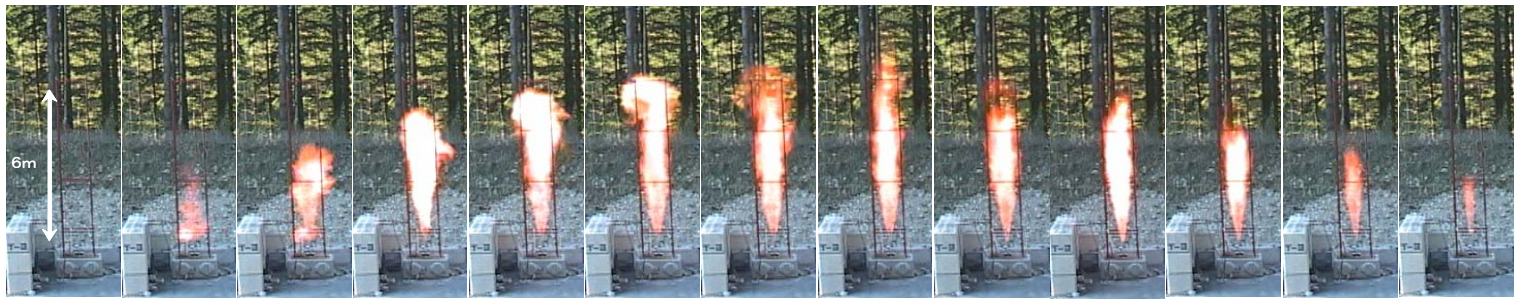
Flame comparison at heat equivalent flow rate

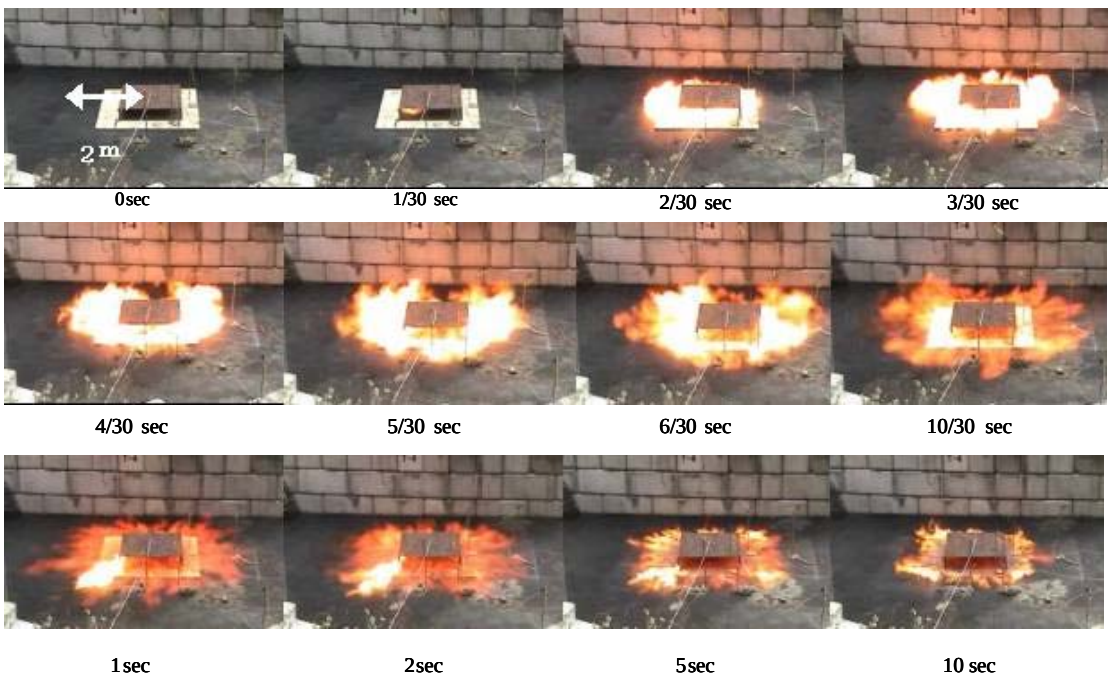


Release point: Center of the under-floor
Flow rate: 131NL/min x 10min
H_2 concentration beneath the engine hood: 24%

HarmonHy Hydrogen Flame Released from Tank Safety Valve (PRD)

To prevent the burst and explosion at the fire accident, safety valve, that is PRD (Pressure Relief Device) is attached on the high pressure hydrogen cylinder. When the PRD is operated, large amount of hydrogen is released and large flame is formed. However the duration is several ten seconds.





Released hydrogen flame will never been extinguished. However the duration of the release is in a short time. So the damage is small if it is Not exposed directly in the flame.

Keep a distance.
Waite for a time.
Be careful that H_2 tank installed is not one. Several tanks may be installed.

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H_2 Vehicle Fire Tests Compared with other Fuels

The effect of the fire to the surrounding area is not different from other fuels.

35MPa, 34L Tank
Maximum flame height reaches 10m, but in a very short time.

Gasoline 40L in a steel tank.
Intermittent flame comes our. Continue more than 30 minutes.

35MPa, 34L Tank
Maximum flame length reaches 7m, but in a very short time.

20MPa, 34L Tank
Larger and longer flame release than hydrogen.

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H_2 Vehicle Fire Tests Compared with other Fuels

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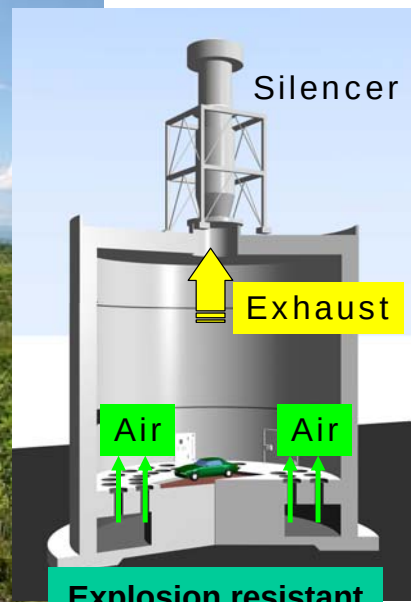
Hy-SEF Facility

Hydrogen and Fuel Cell Vehicle Safety Evaluation Facility



Explosion resistant fire test cell

Liquefied hydrogen

Hydraulic pressure 120MPa cycle, 300MPa burst

High pressure hydrogen compressor 110MPa,200Nm^3/h

Hydrogen storage tanks 110MPa, 72L x 9

Temperature controllable air tight chamber Range: -40-85 deg.C

For the Realization of Hydrogen World

1. Well understanding of hydrogen properties

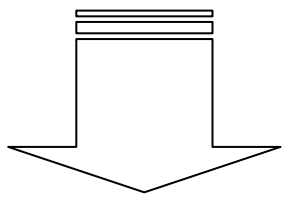
Diffusion, Ignition

2. Appropriate measures for preventing accidents

Ventilation, Detection of leakage, Regulations

3. Manuals to correspond accidents

Hydrogen release time, Hydrogen release duration,
Safety distance, Flame visibility



It will be possible to use hydrogen safely and conveniently, as we use firewood, coal, gasoline, kerosene, LPG ,natural gas and so on.