Paper Id :158

Effectiveness of a Blower in Reducing the Hazard of Hydrogen Leaking from a Hydrogen-fueled Vehicle

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Emergency response for HFCV

Appropriate emergency response information is required for first responder before HFCV will become widespread.

Introduction

- Max. wind velocity of 10 or 20m/s was applied to a vehicle leaking hydrogen gas at a rate of 2,000 NL/min.

- Hydrogen concentrations were measured around the vehicle and in the cabin.
- Ignition tests were conducted to evaluate the effectiveness of forced winds.

Introduction

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2,000NL/min represents a full power for passenger car of 200kW power which the excess flow check valve (EFCV) does not activate.

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  - Results & Considerations
- Ignition test with forced winds
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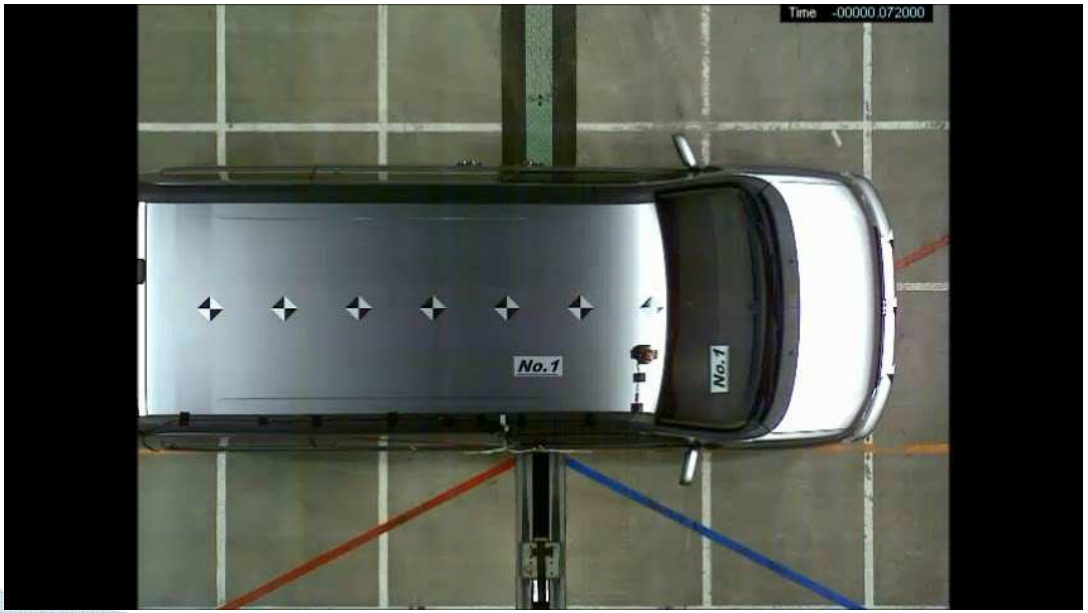
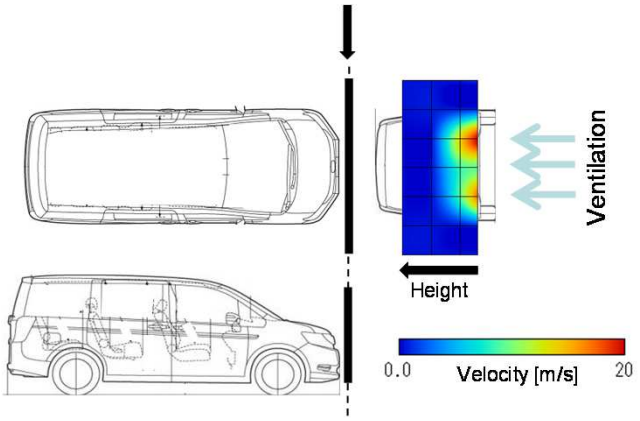
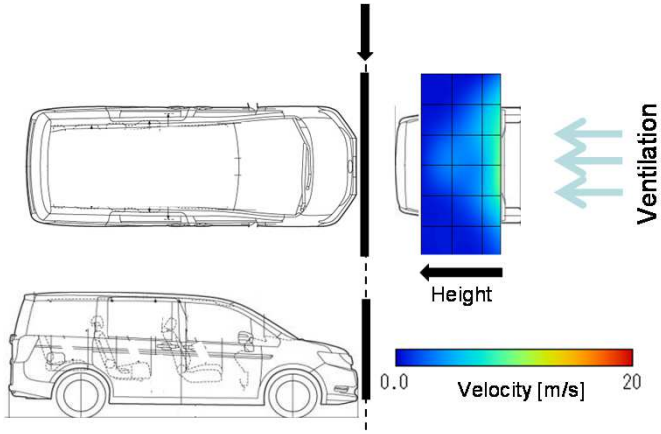
Test vehicle (Side crash test)



Blower-vehicle & wind velocity distribution

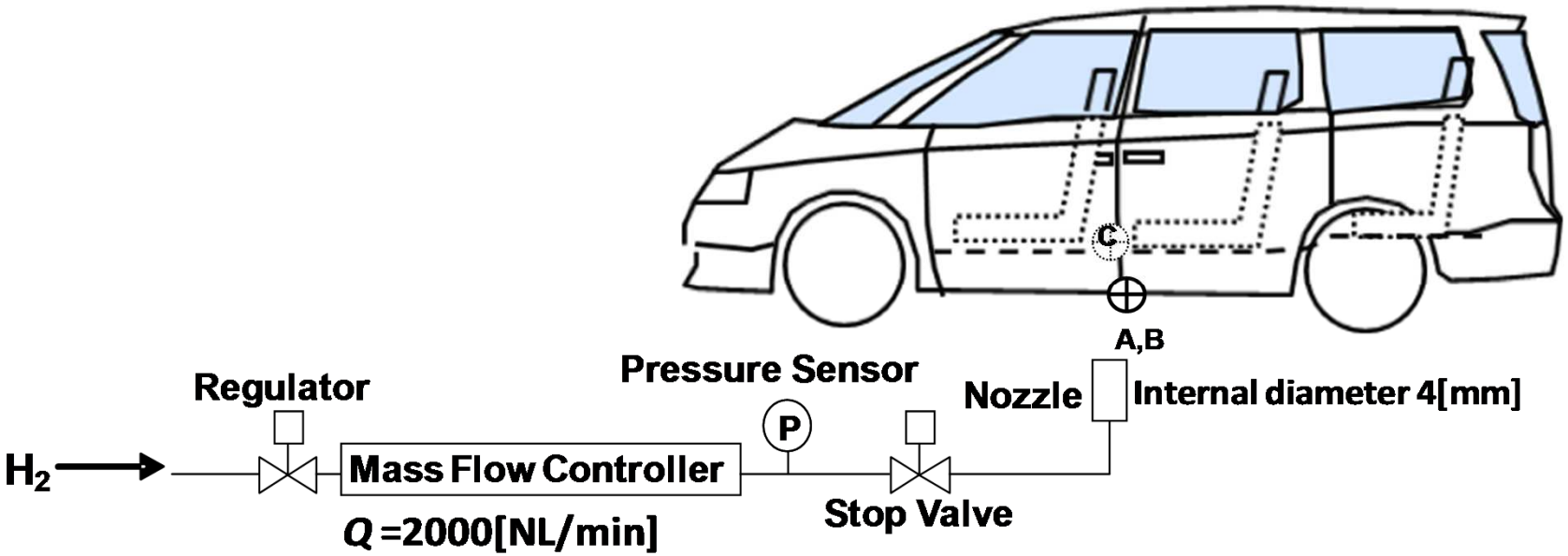


Blower 2 m forward to vehicle; wind velocity distribution on vehicle front



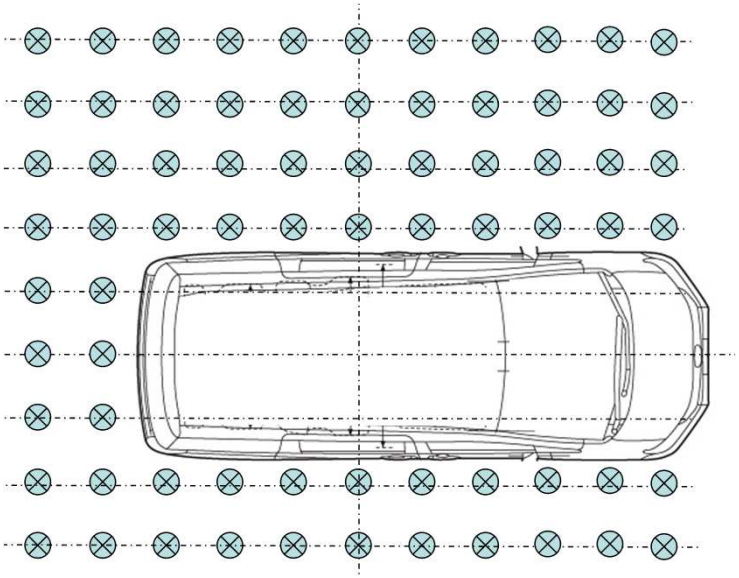
Blower 5 m forward to vehicle; wind velocity distribution on vehicle front

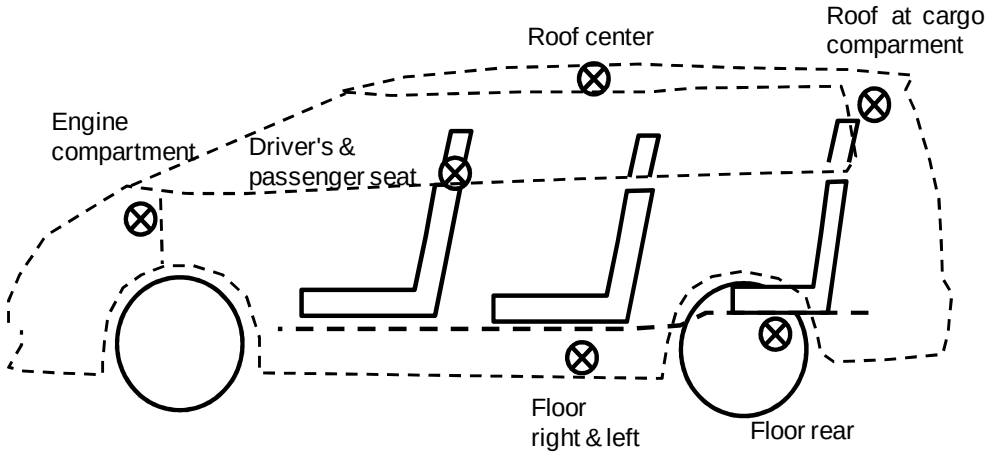
Hydrogen leakage method



<Under the vehicle floor>	(A) Centre position under the floor
	(B) Wind side under the floor at impact side
<In the cabin >	(C) Centre position on the rear seat floor

H_2 concentration measurement point





Around vehicle

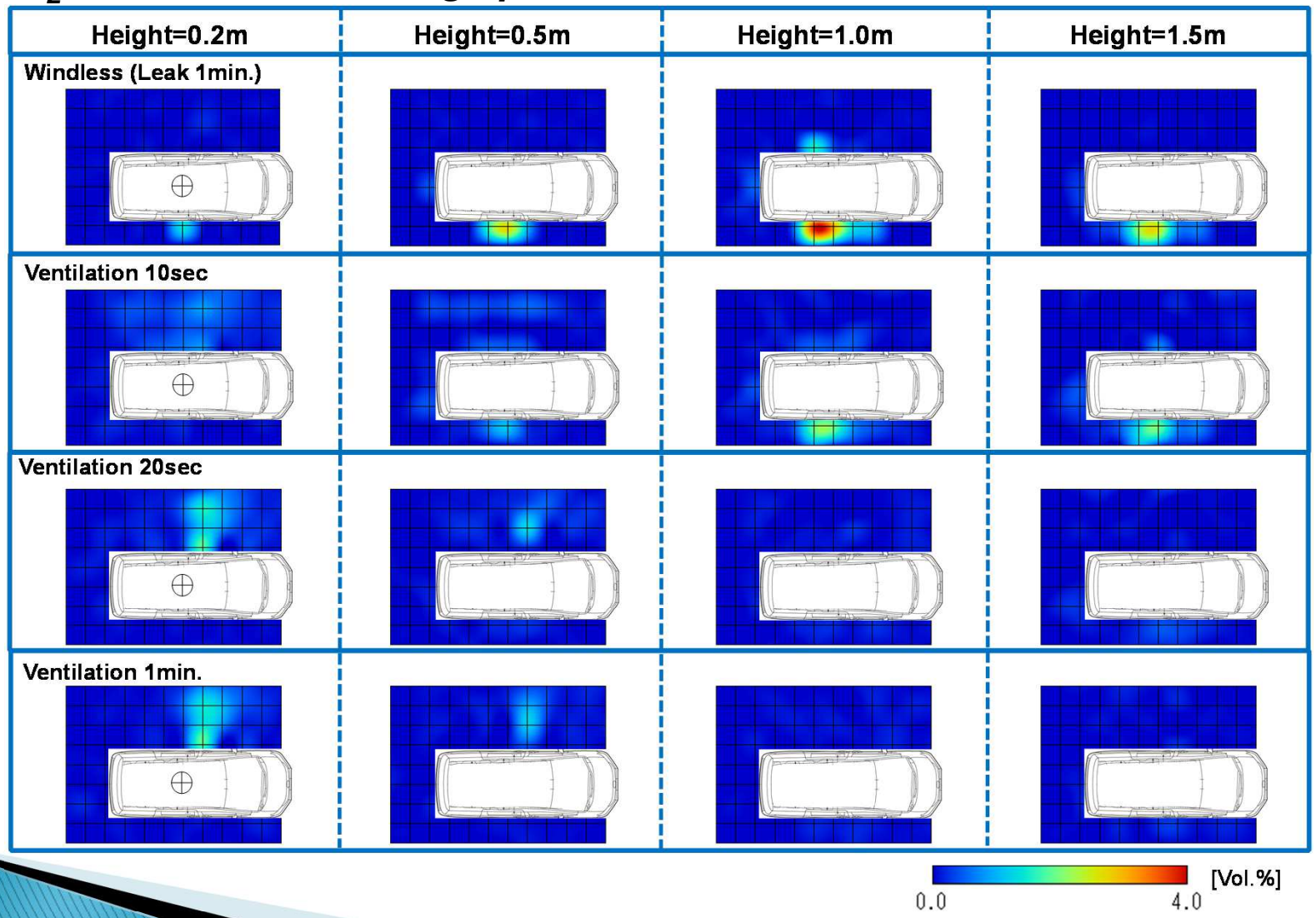
Cabin

H_2 concentration measurement

H_2 2,000 NL/min, leakage point A, blower 2 m from vehicle side

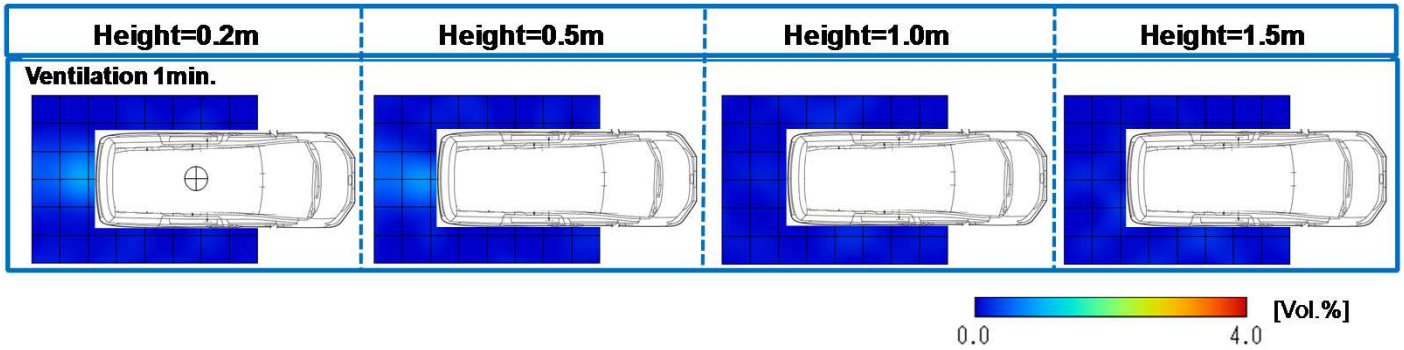
H_2 concentration distribution

H_2 2,000 NL/min, leakage point A, blower 2 m from vehicle side

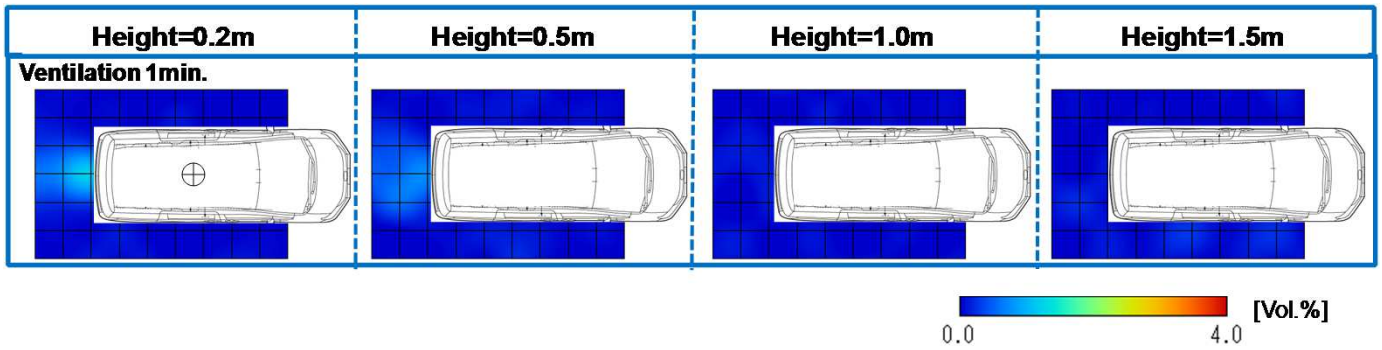


H_2 concentration distribution

H_2 2,000 NL/min, leakage point A, blower 2 m from vehicle front

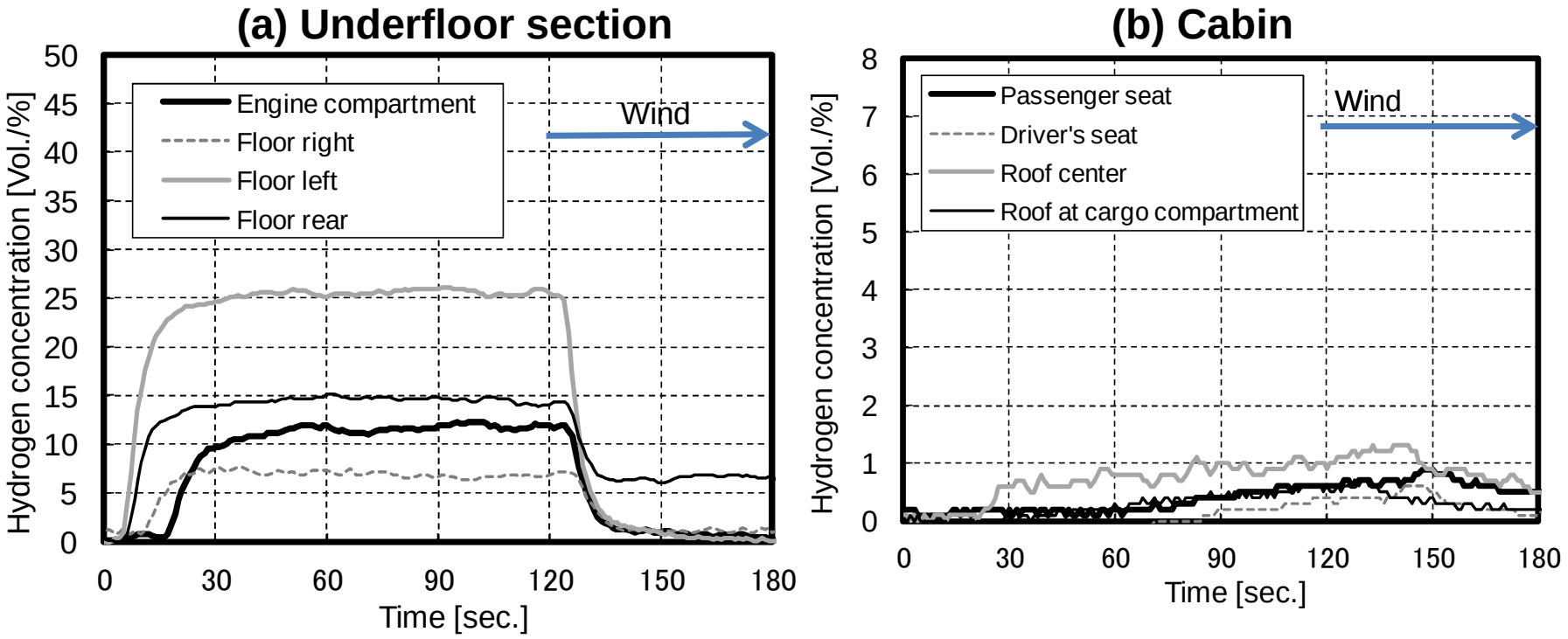


H_2 2,000 NL/min, leakage point A, blower 5 m from vehicle front



H_2 concentration (case #1)

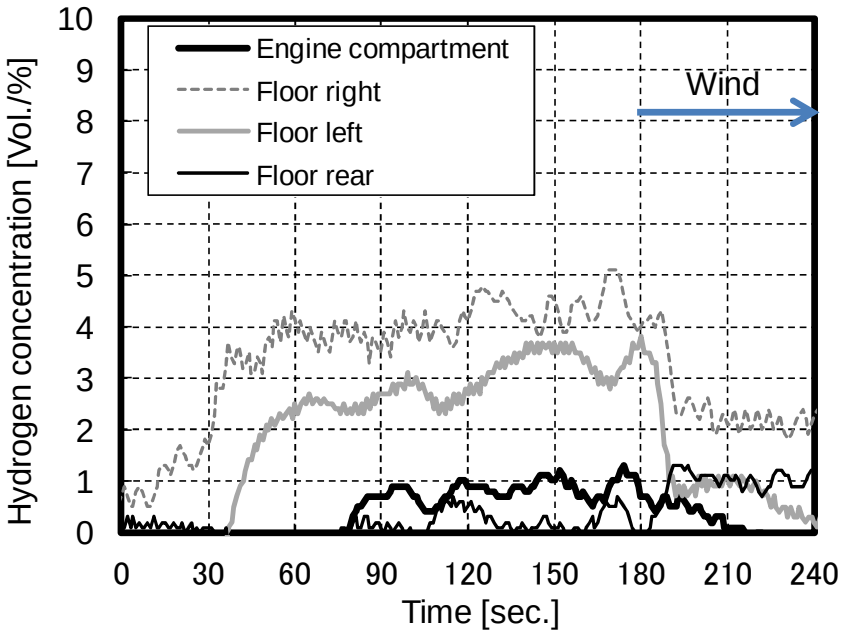
Hydrogen 2,000 NL/min, Leakage point A, Blower 2m from vehicle front



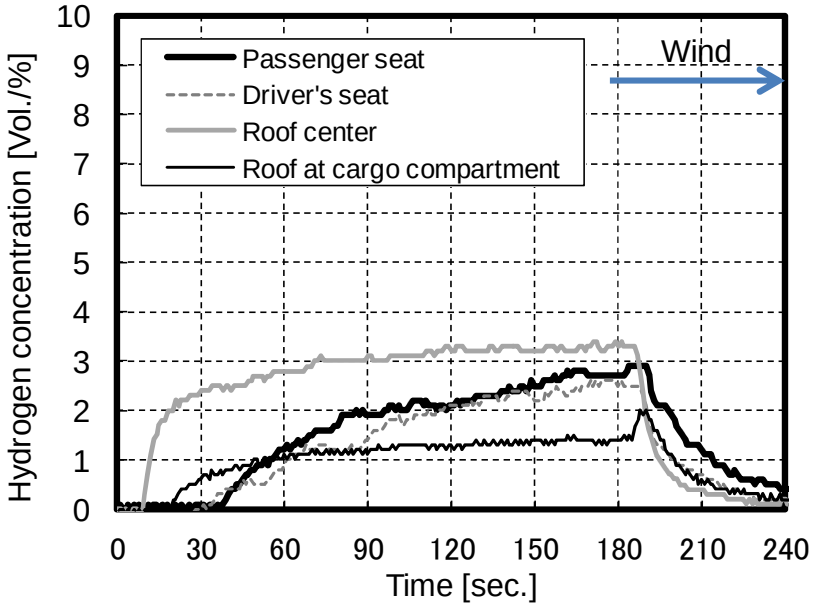
H_2 concentration (Case #2)

Hydrogen 2,000 NL/min, leakage point B, Blower 5m from vehicle front

(a) Underfloor section



(b) Cabin



Ignition test

An ignition test was conducted on leaked hydrogen under ventilated conditions to examine the effect of ignition on the vehicle and its surroundings.

Igniter : Spark source
(Ignition energy : 30 mJ, Spark gap:1 mm)

Blast-wave pressures : Blast-pressure pencil probe

Existence and non-existence of the ignition

Blower position		Leakage position	Ignition position	Ignition
None		A:Center position under the floor	Rear of the leakage position	Yes
Front side	2m			No
	5m			No
Side	2m			No
	5m			No
None		A:Center position under the floor	Side of the leakage positon	Yes
Front	2m			No
	5m			No
Side	2m			Yes
None		A:Center position under the floor	Wheel housing	Yes
Front	2m			No
	5m			No
Side	2m			No
None		Center position under the rear floor	Backside of the rear bumper	Yes
Front	5m			Yes
None		Under the engine compertment	Upper of the firewall	Yes
Side	5m			Yes
None		C: Center position on the rear seat floor	Center of the cabin roof	Yes
Side	5m			No

Ignition test (case #3)

Center of the cabin roof

Center position on the rear seat floor

The situation of ignition (Case #3)

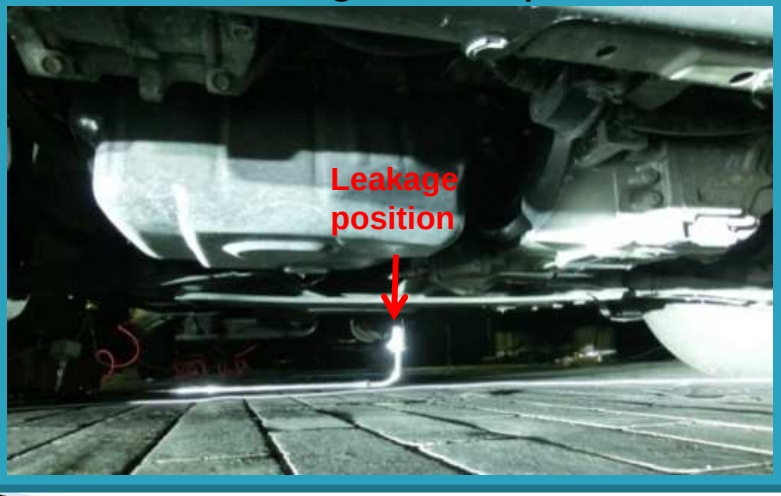
Windlessness

Blower 5m from vehicle’s side

Ignition test (case #4)

Engine compartment

Under engine compartment



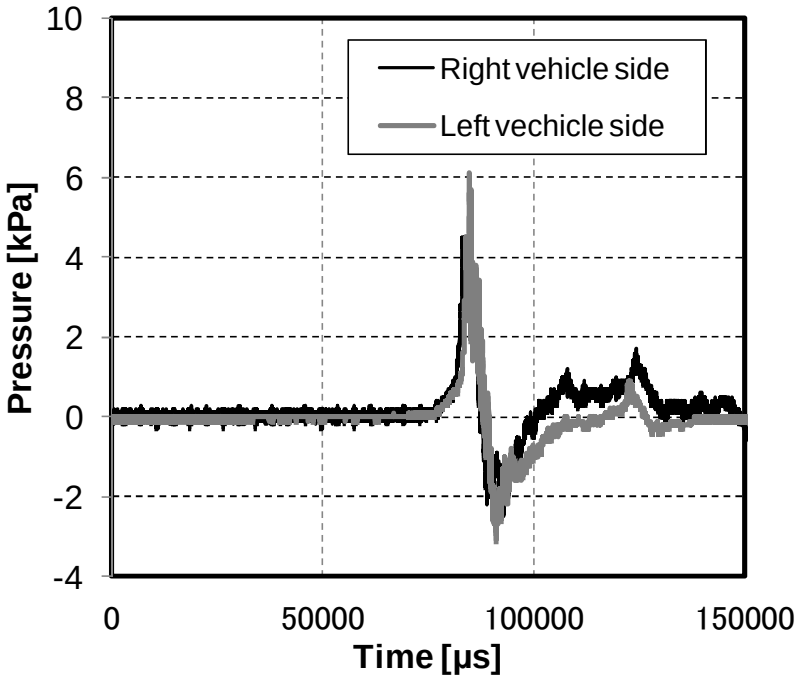
The situation of ignition (Case #4)

Windlessness

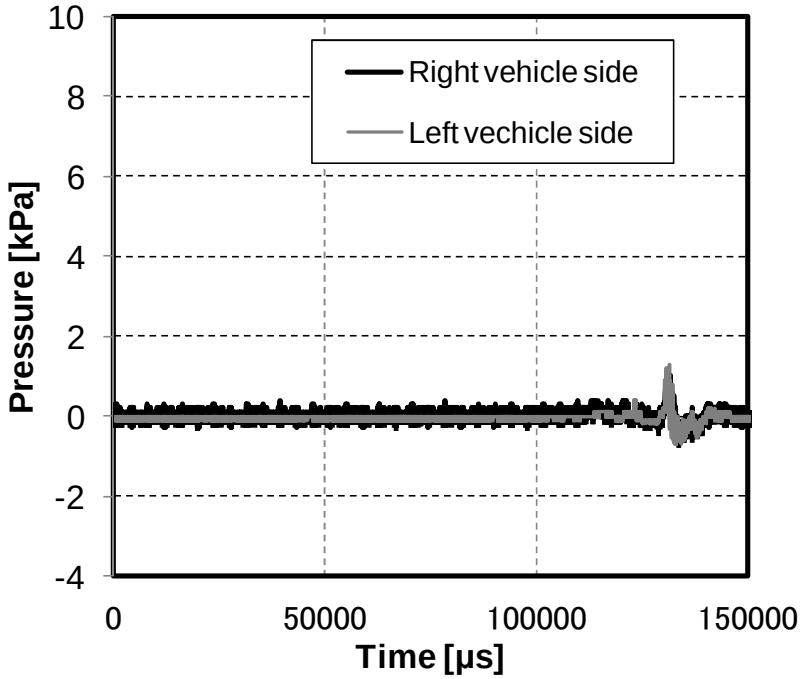
Blower 5m from vehicle's front

Blast-wave pressure(Case #4)

at vehicle's both sides, 0.2m above ground



Windlessness



Blower 5m from vehicle's front

Conclusions

This study investigated the effectiveness of a blower in reducing the hazard of hydrogen leaking from a vehicle.

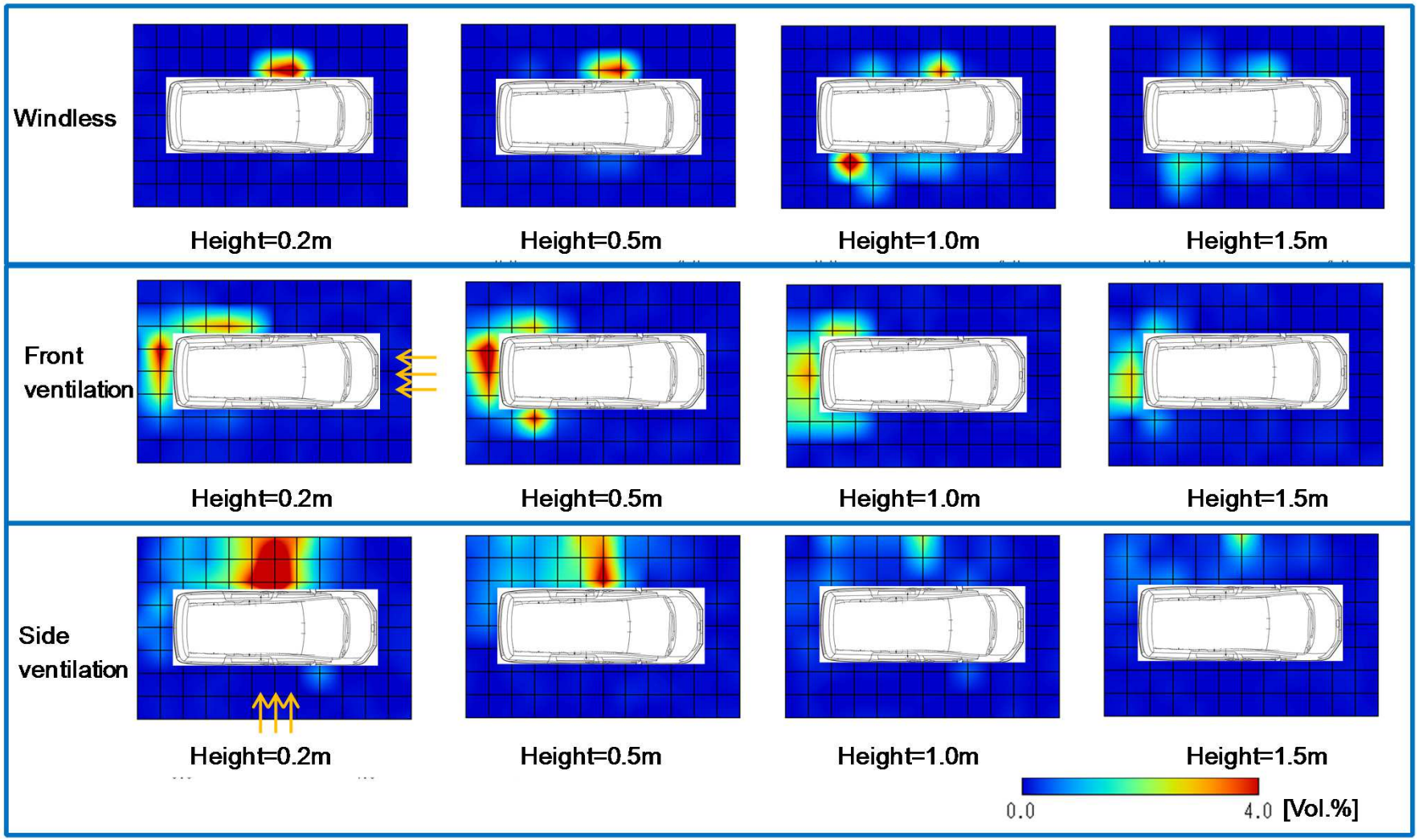
Hydrogen flow rate : 2000NL/min.
Max. wind velocity :10 or 20m/sec.

Those test results indicated that safe approach to an accident-struck HFCV for rescue activity will become possible if winds are continuously delivered towards a side or the front of the vehicle by using a blower with a wind velocity of 10 m/s or faster.

Thank you for your attention!

Hy-SEF
Hydrogen and Fuel Cell Vehicle
Safety Evaluation Facility

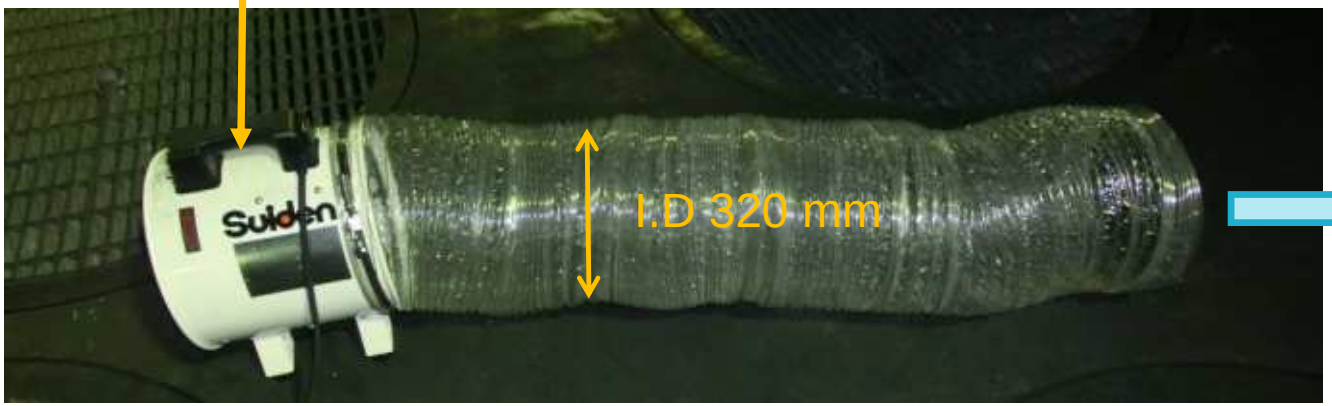
Low wind velocity case



Reference : SAE PAPER #2013-01-0211

Blower with duct

Max. air-capacity : 50 m^3

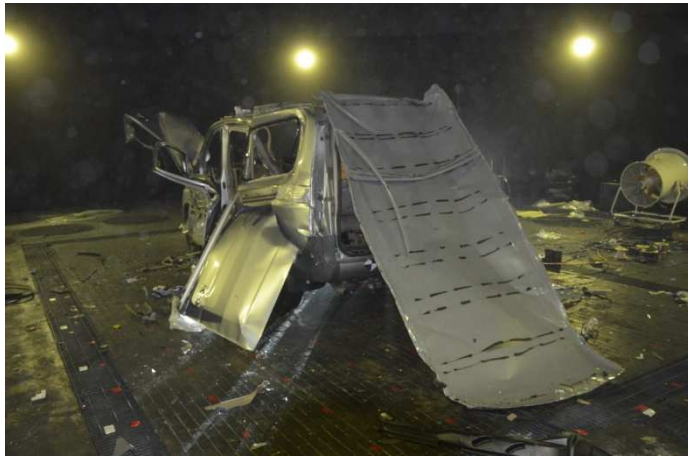


Wind

Max.10 m/s

When the hydrogen concentrations around the vehicle stabilized after hydrogen leakage, Winds was started towards the vehicle from its front or lateral side.

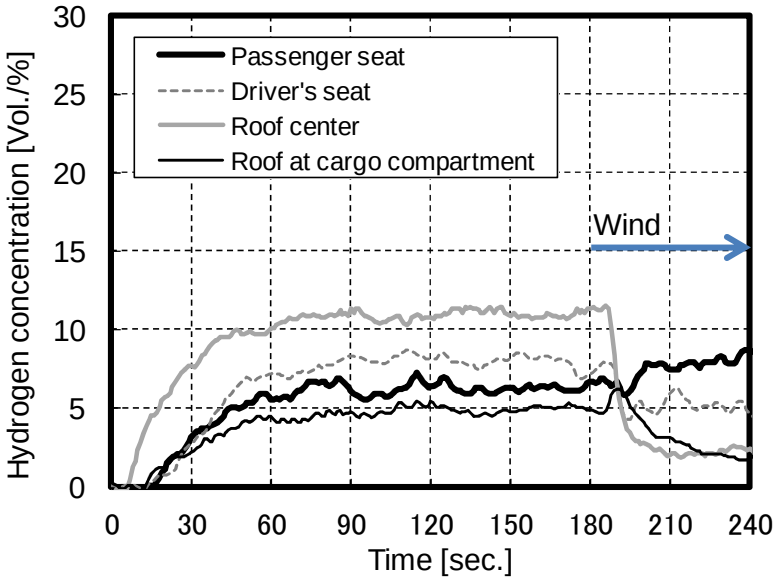
Ignition within closed spaces



H_2 concentration (case #5)

Hydrogen 2,000 NL/min, Leakage point C

(a) Blower 5m from vehicle side



(b) Blower 5m from vehicle front