

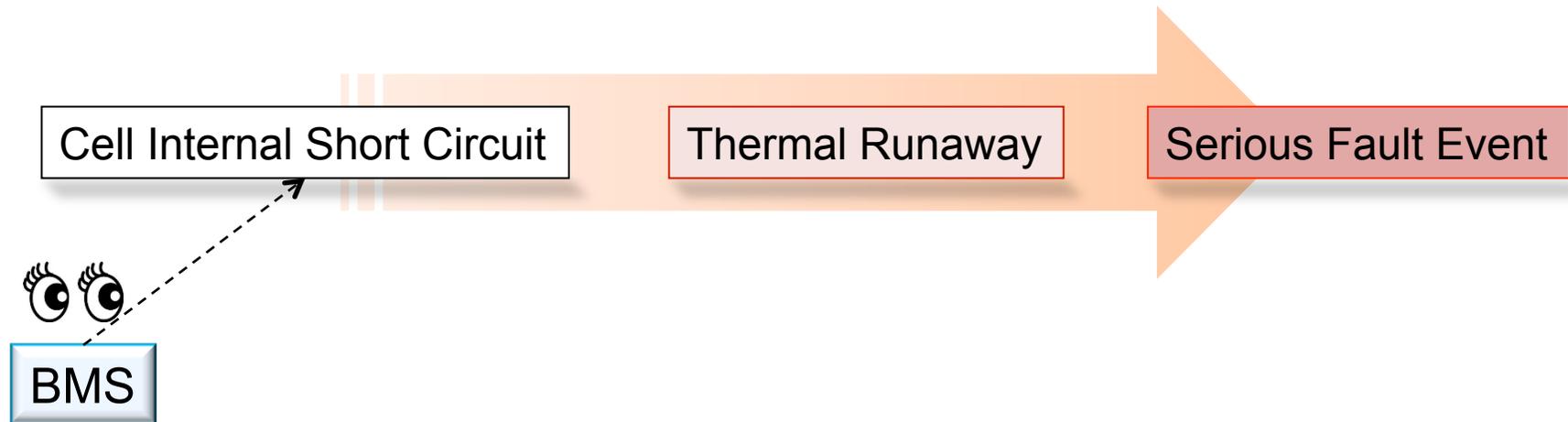
RESEARCH ON INTERNAL SHORT CIRCUIT AND THERMAL PROPAGATION PERFORMANCE

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JAPAN AUTOMOBILE STANDARDS INTERNATIONALIZATION CENTER

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PURPOSE OF RESEARCH



In order to eliminate any possibilities of fatal accidents of EVs, Japan believes that we should consider whether required performance can be put into a technical requirement.

We will conduct research on phenomenon of thermal runaway and thermal propagation in the battery with the following procedure.

1. POTENTIAL RISKS

An event resulting in the fire or explosion of the battery system/ vehicle due to unusual high heating of a single cell in a battery system.

Possible causes of the unusual heat includes internal short circuit due to foreign matters contained in the manufacturing process and the deformation of parts.

2. RELEVANT VEHICLE CONDITIONS

In normal use

3. Research objectives and schedule

(1) To Research the Phenomenon which occurs at Unusual Heating of a Cell (to be completed in March 2014)

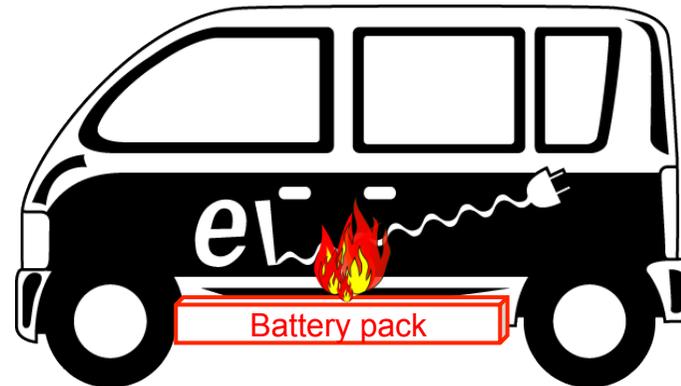
Objectives:

- * Determine which types of batteries should be considered.
- * Confirm the phenomenon from single cell internal short circuit leading up to heat generation and ignition.

Outlines of the tests:

- (1) Using an electric vehicle, thermal behaviors in the event of thermal runaway of a single battery in the battery pack installed in the vehicle for its propulsion, e.g., how it develops into a vehicle fire, was investigated. (1 case)
- (2) Heat generation in a single battery caused by its thermal runaway was simulated, and the battery pack alone was evaluated for the purpose of investigating how the heat/flame propagates in the battery pack alone. (3 cases)

Test 1: Thermal Event at Unusual Heating of a Battery



Test method

- (1) Replace a single cell with a heater, and after inserting the heater into the battery pack, install the battery pack in the vehicle.
- (2) Heat the heater up to the pre-determined temperature at the pre-determined rate.
- (3) Investigate the battery pack temperatures, its ignition conditions, spread of fire in the vehicle, etc. as well as the warning indication conditions.

Measurement items include

- * Heated heater temperatures
- * Temperatures at several locations in the battery pack and in the vehicle
- * Total voltage of the battery pack and voltages of cells
- * Warning lamp indication (to be filmed, etc.)
- * Optical measurement (video cameras at several locations around the battery pack)

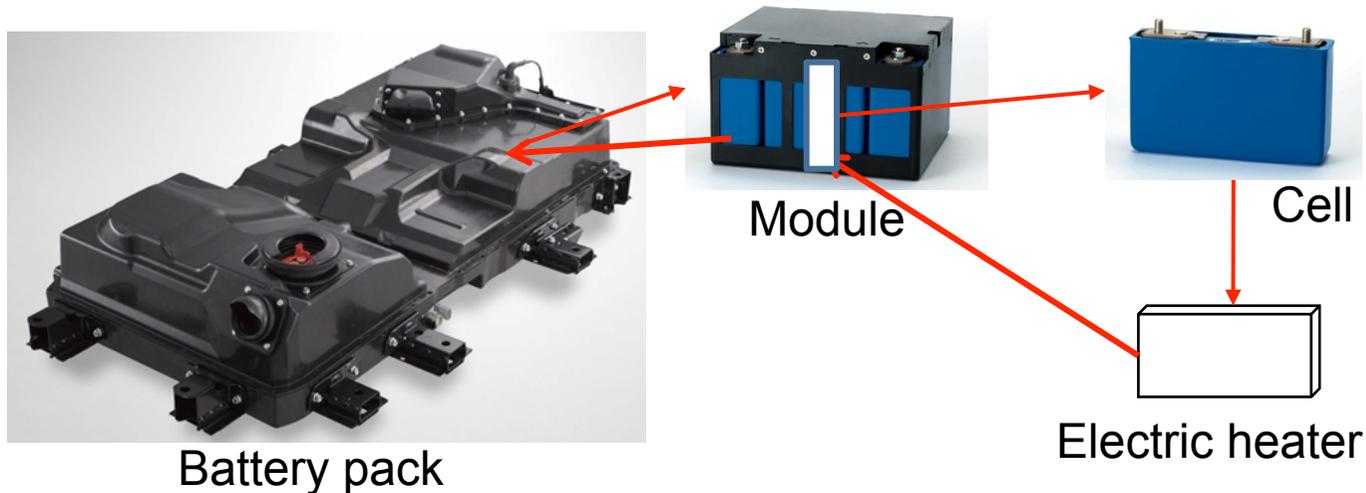
Number of test: 1 time (1 EV used)

The following is to be determined upon consultation:
Heater location: Center of the battery pack (location that would yield the severest conditions)

Heater heating rate and target temperature:

Results of the internal short circuit test will be applied.

Test 2: Battery Pack Thermal Chain Reaction Test



Test method (Heating method: To be determined upon consultation, based on the heater heating)

- (1) Replace a single cell with a heater and insert the heater into the battery pack.
- (2) Heat the heater up to the pre-determined temperature at the pre-determined rate.
- (3) Investigate the temperatures and ignition conditions of single batteries around the heater.
- (4) Investigate the heat/flame propagation outside the battery pack.

Measurement items include

- * Heater temperatures
- * Temperatures at several locations in the battery pack
- * Total voltage of the battery pack and voltages of cells
- * Optical measurement (video cameras at several locations around the battery pack)

Number of test: 3 times (3 different battery packs used)

The following is to be determined upon consultation:
Heater location: Center of the battery pack
(location that would yield the severest conditions)

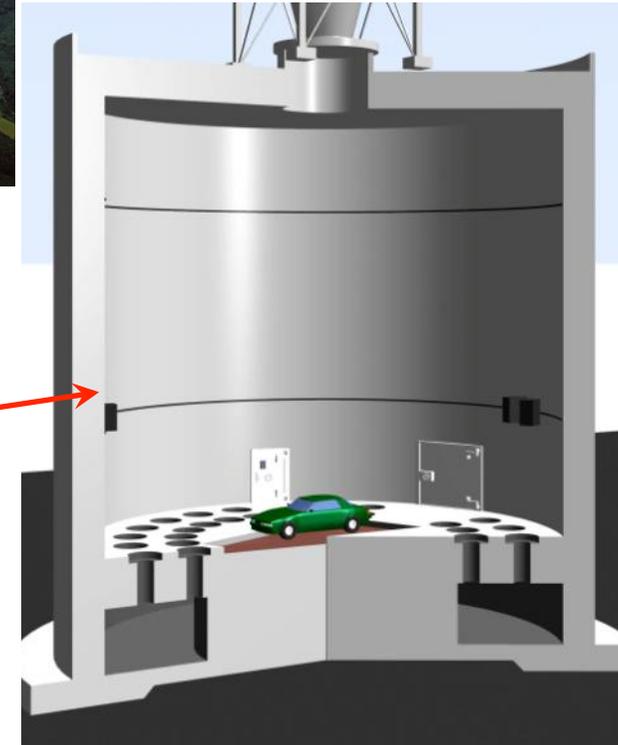
Heater heating rate and target temperature:
Results of the internal short circuit test will be applied.

Where heating is evaluated: Heater-adjacent battery or
heater temperature

Test Facility



Hy-SEF
(Hydrogen and Fuel Cell Vehicle Safety Evaluation Facility)



Explosion Resistant Fire Test Cell
(16m Height, 18m Diameter)

3. Research objectives and schedule

(2) To develop and validate technical requirements and test methods (to be completed in March 2015)

- Based on the results considered under (1), develop the definition of the resistance to thermal propagation of a battery pack and applicable technical requirements.
- Consider and verify the performance test methods of resistance to thermal propagation to find whether feasible and appropriate test methods can be established for various battery designs at battery system levels.

多謝
Thanks a lot
Danke schön
Merci Beaucoup
감사합니다
Grazie!
Gracias.
ありがとうございました.