EVS-06-23e

Japanese Study for Propagation

JASIC

EVS-gtr IWG #6 in Korea
18th-20th Nov, 2014

Agenda

1. Study about propagation

2. Report for research about propagation test methods from Japan

Background

- The research for propagation are now on going in each countries according to the “outline”.

  <Reference: EVS-04-20e Comparison between Outline (Part B) and OICA GTR Draft(Future plan)>

- Japan presented we research and report for propagation in IWG #4@China.

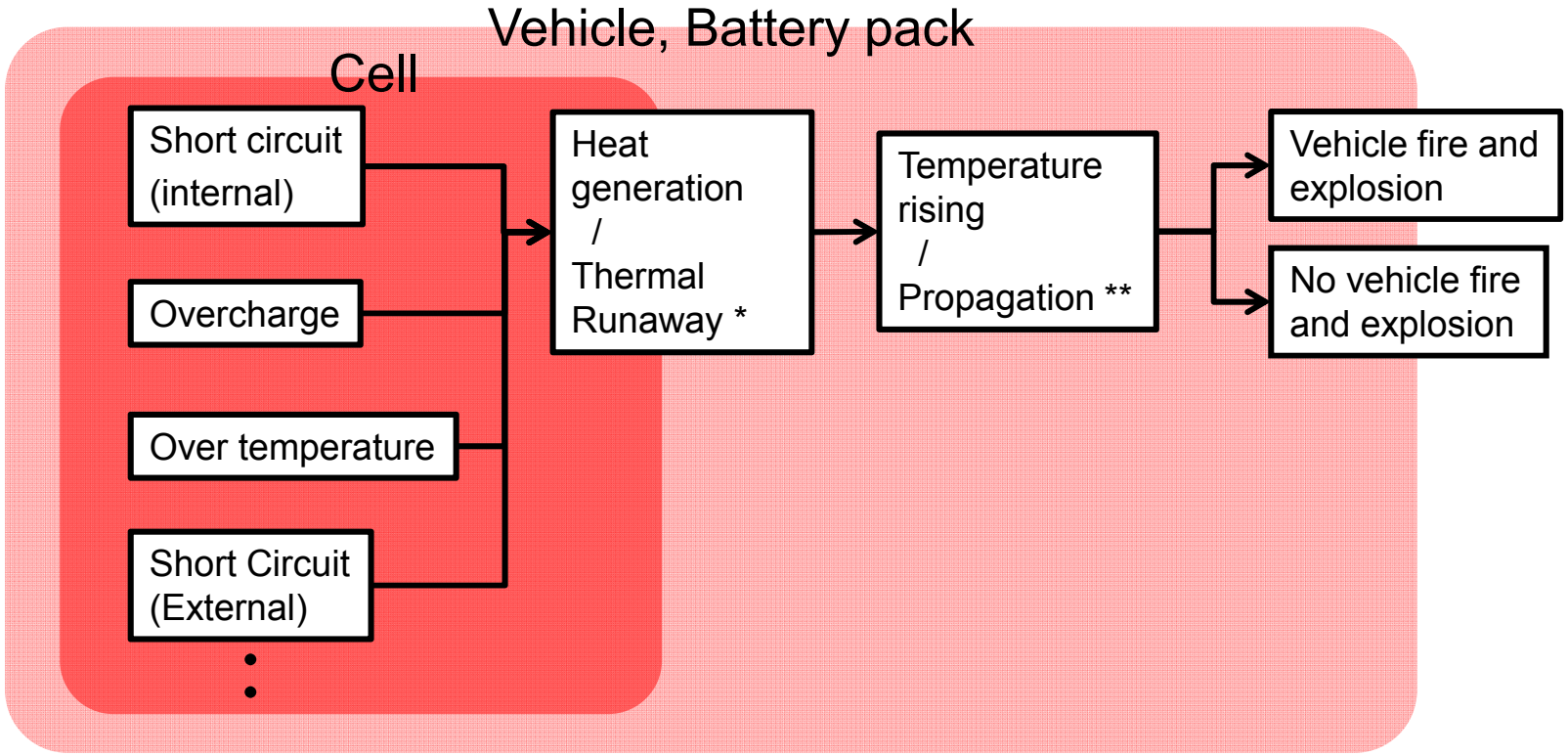
  <Reference: EVS-04-22e minutes of Beijing meeting >

- Japan present propagation research progress in IWG #6@Korea. This is decided on TF5 discussion.

  <Reference: EVS-GTR Progress Report on TF5, send from TF5 leader in Nov. 5th>

Relation between cell hazards and vehicle fire

- Flow from cell hazards to events of cell, battery pack and vehicle are clarified.
- “Propagation” is included in this flow.



*Thermal Runaway

Uncontrolled intensive increase in the temperature of a cell driven by exothermic reactions. (reference: IEC/CD62619)

**Propagation

To propagate thermal runaway from an original cell to surrounding cells.

Relation between phenomenon and EVS-gtr draft

- Hazards except internal short circuit are reflected in EVS-gtr draft as the requirements of regulation.

Phenomenon of Battery pack	State of vehicle				EVS-gtr draft	comment
	① Active driving possible	② Recharge, Feeding	③ Post-crash	④ Unusual circumstance		
Overcharge	●	●		○ (EVSE)	Inc	
Over-discharge	●	●		○ (EVSE)	Inc	
External heat				●	-	Over temperature can cover
Over temperature	●	●			Inc	
Over current charge		●		○ (EVSE)	-	Over temperature and overcharge can cover
Short circuit (external)	●	●	●		Inc	
Dew condensation	●	●			-	External short circuit can cover
Short circuit (internal)	●	●	●		-	Cell internal short circuit is considered as production failure
Shock	●		●		Inc	
Crush			●		Inc	
Vibration	●				Inc	
Thermal cycle	●	●			Inc	
Low-pressure	●	●			-	Not relevant for vehicle use-cases

Reminder regarding the selection of device under tested

EVS-gtr 4th session Japan presentation

Points to be considered

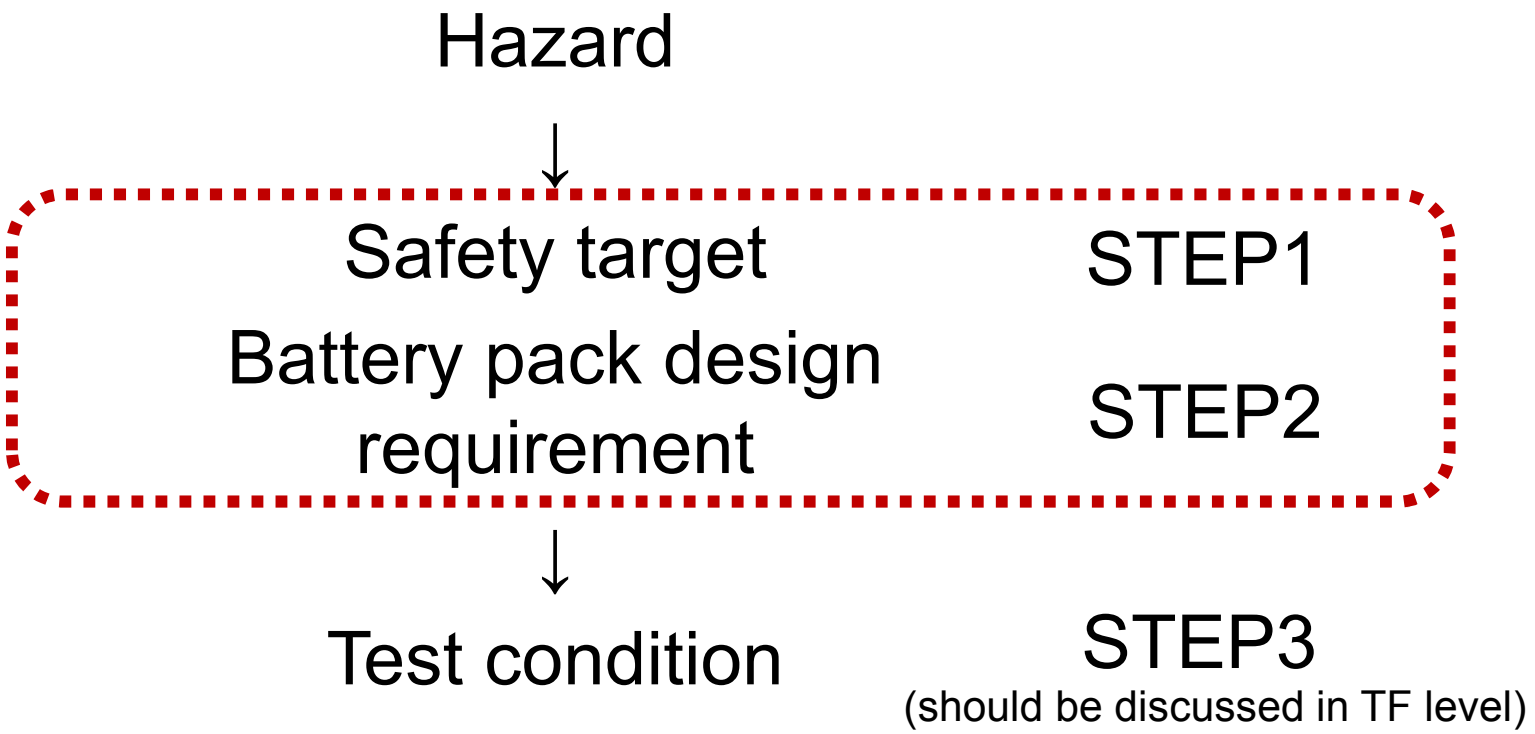
- In principle, the safety evaluation should be conducted as the vehicle.
- However, depending on the test procedure, it might be difficult to conduct with the vehicle.
- In that case, the evaluation of REESS (or its subsystem) will be considered as an alternative/substitute for the evaluation by the vehicle, if the performance of the vehicle can be represented sufficiently.
- The evaluation with smaller level such as module or cell may not adequately represent the performance of the vehicle.
- This is because the representativeness may vary depending on the configuration of the REESS.

Proposal of consideration steps

STEP 1: Consideration of safety target

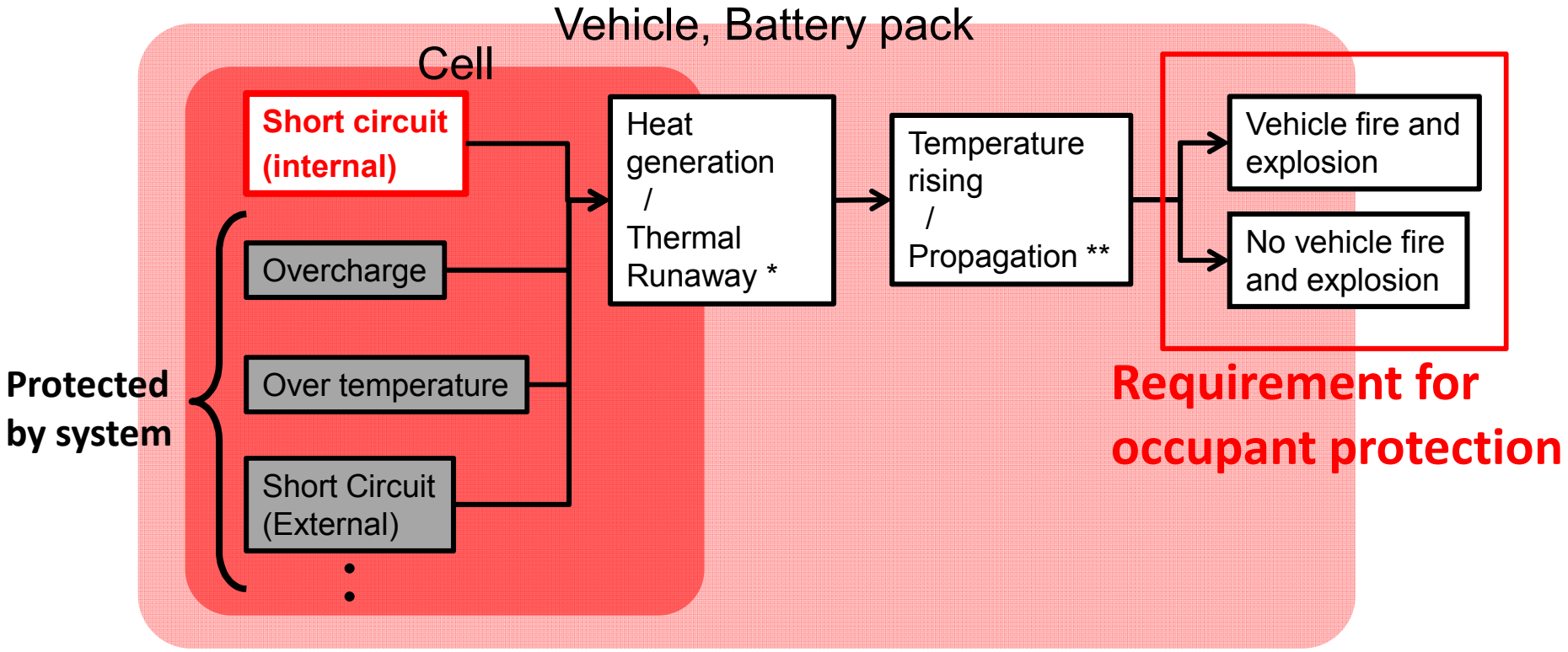
STEP 2: Consideration of requirement of battery pack

STEP 3: Consideration of test condition



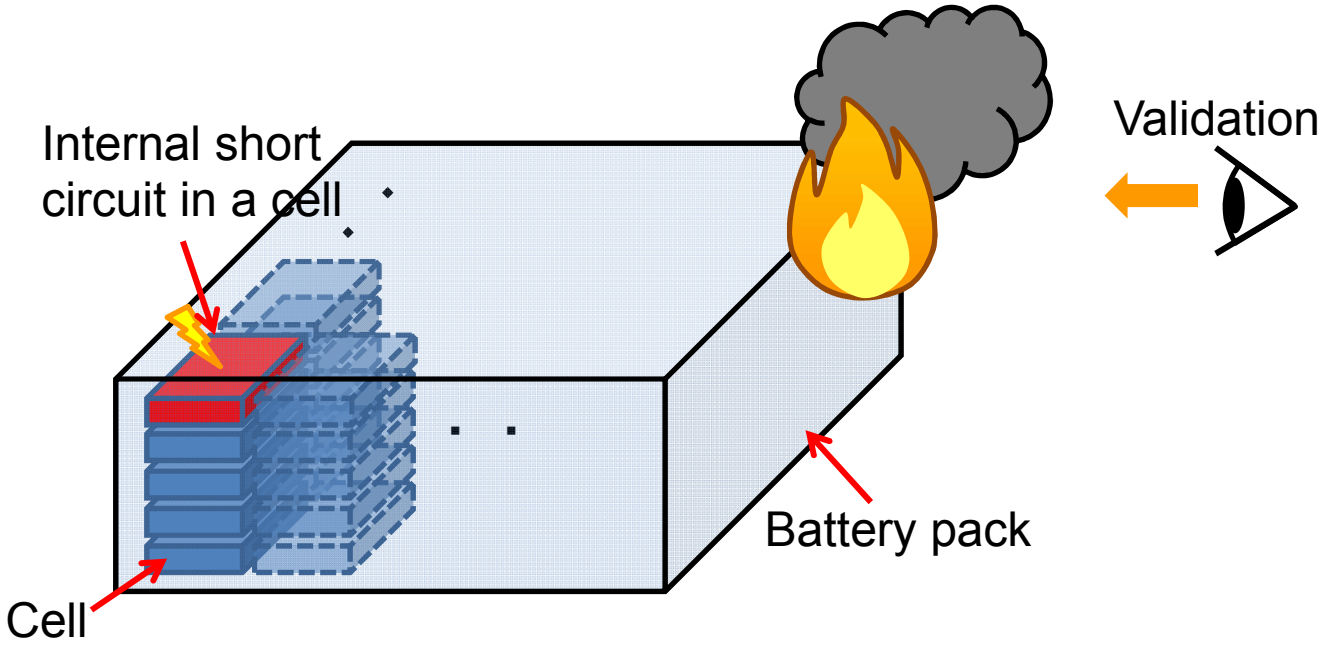
STEP1 Safety target

- Internal short circuit may produce thermal runaway and it is not prevent occurrence by system protection. So, it should be considered as trigger of propagation.
- Battery pack should be designed to achieve ”occupant protection (e.g. keeping enough time to evacuate)” in this situation.



STEP2 Battery pack design requirement

- Requirement for battery pack :
  “not to harm occupants even if a including cell occurs internal short circuit”.
- This requirement could be achieved by whole vehicle. So means for achieving (battery pack design) are not limited.



Requirement for Battery pack

Agenda

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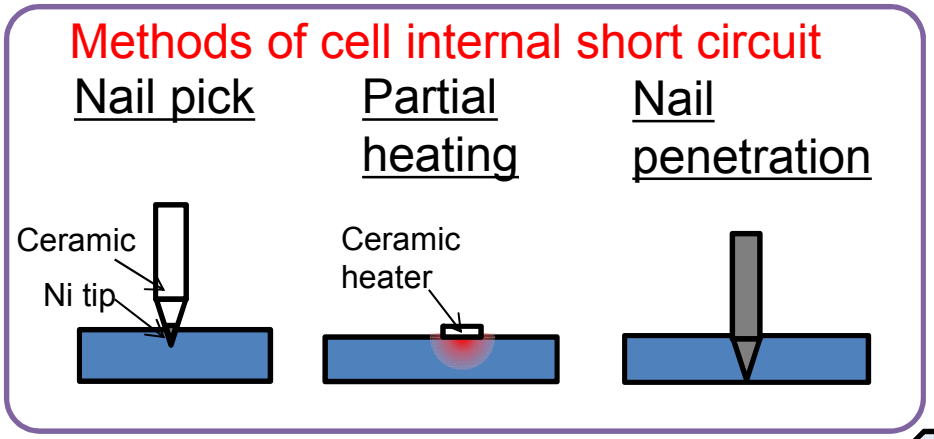
Research of battery pack propagation test in Japan

- Making cell internal short circuit forcibly by several methods for three types of battery pack.
- Confirm phenomenon expressed on battery pack.



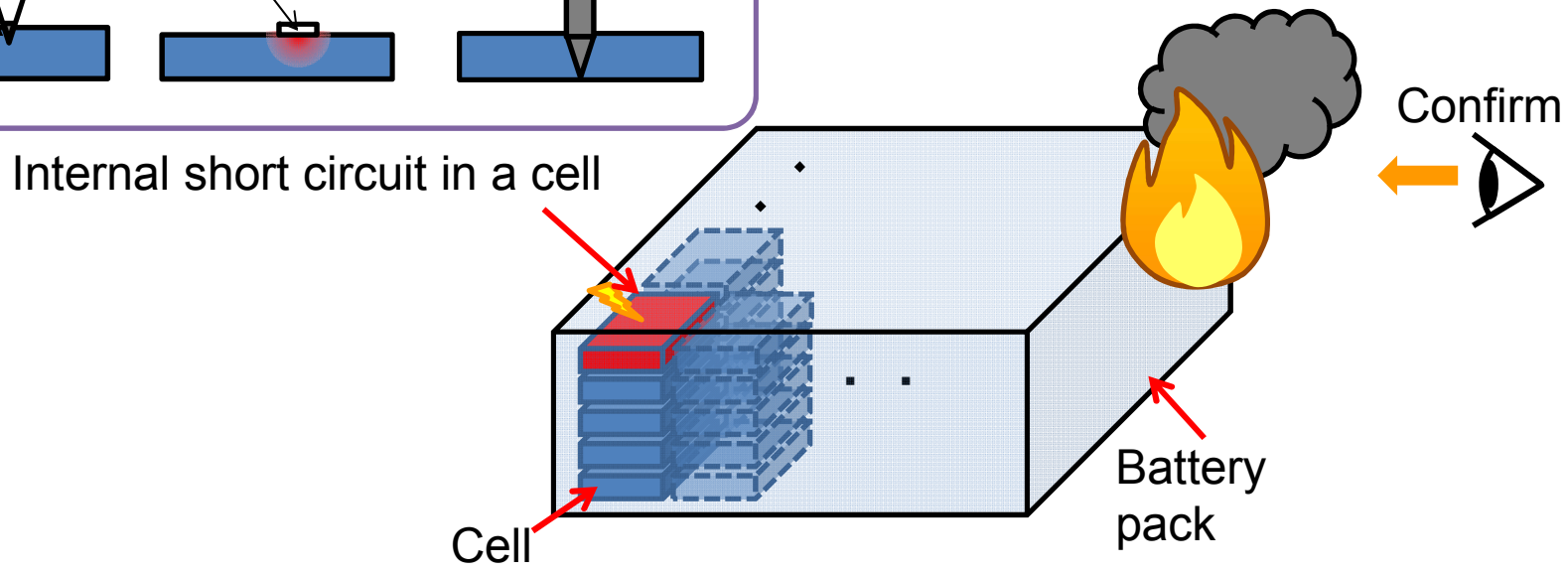
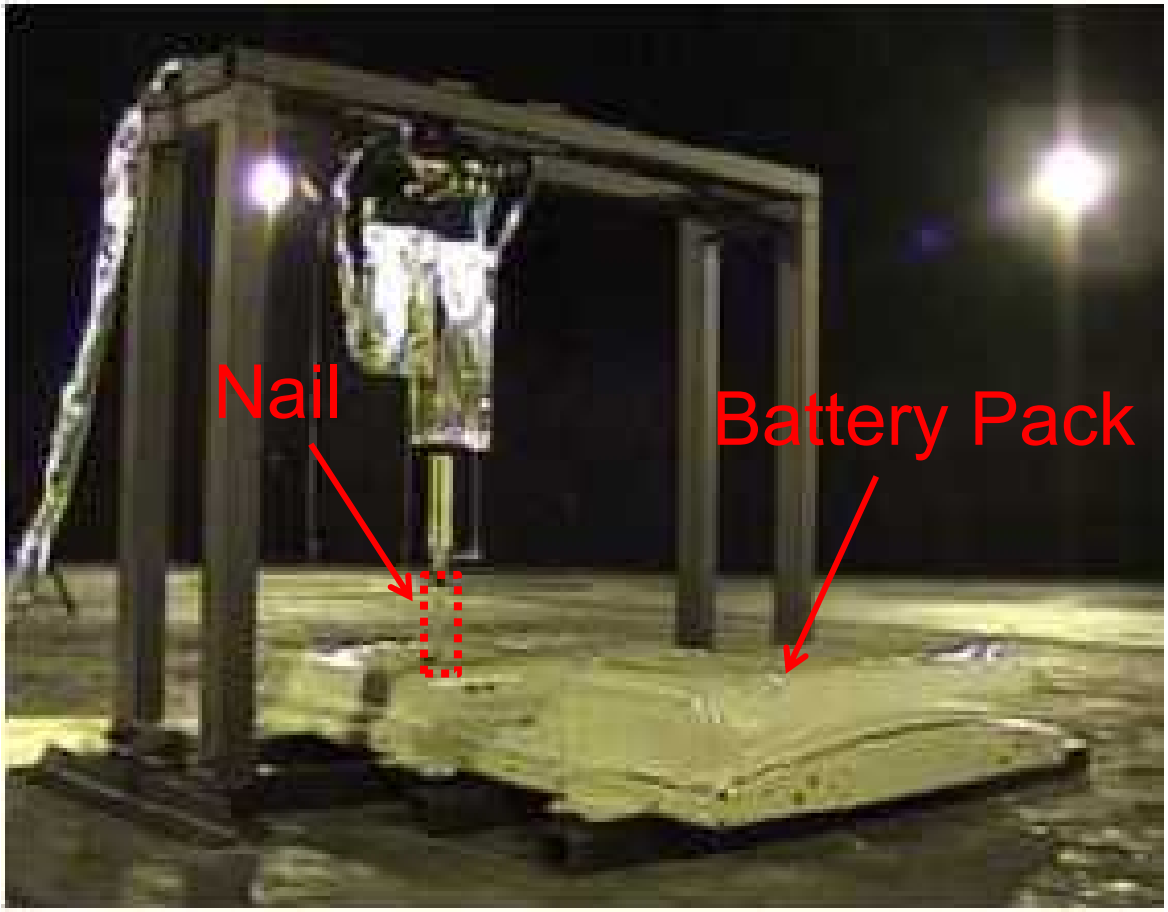


Image of Battery pack propagation test

Example of battery pack propagation test

Nail pick test



Ni tip pointed ceramic nail shallowly inserted into a cell included in battery pack.

Methods of cell internal short circuit in battery pack

- Internal short circuit methods were recommended by each manufacturer.
- There is a representative method of internal short circuit test in IEC62133 and IEC/CD62619(inserting L shape Ni particle). However, it was difficult to conduct the test with all samples.

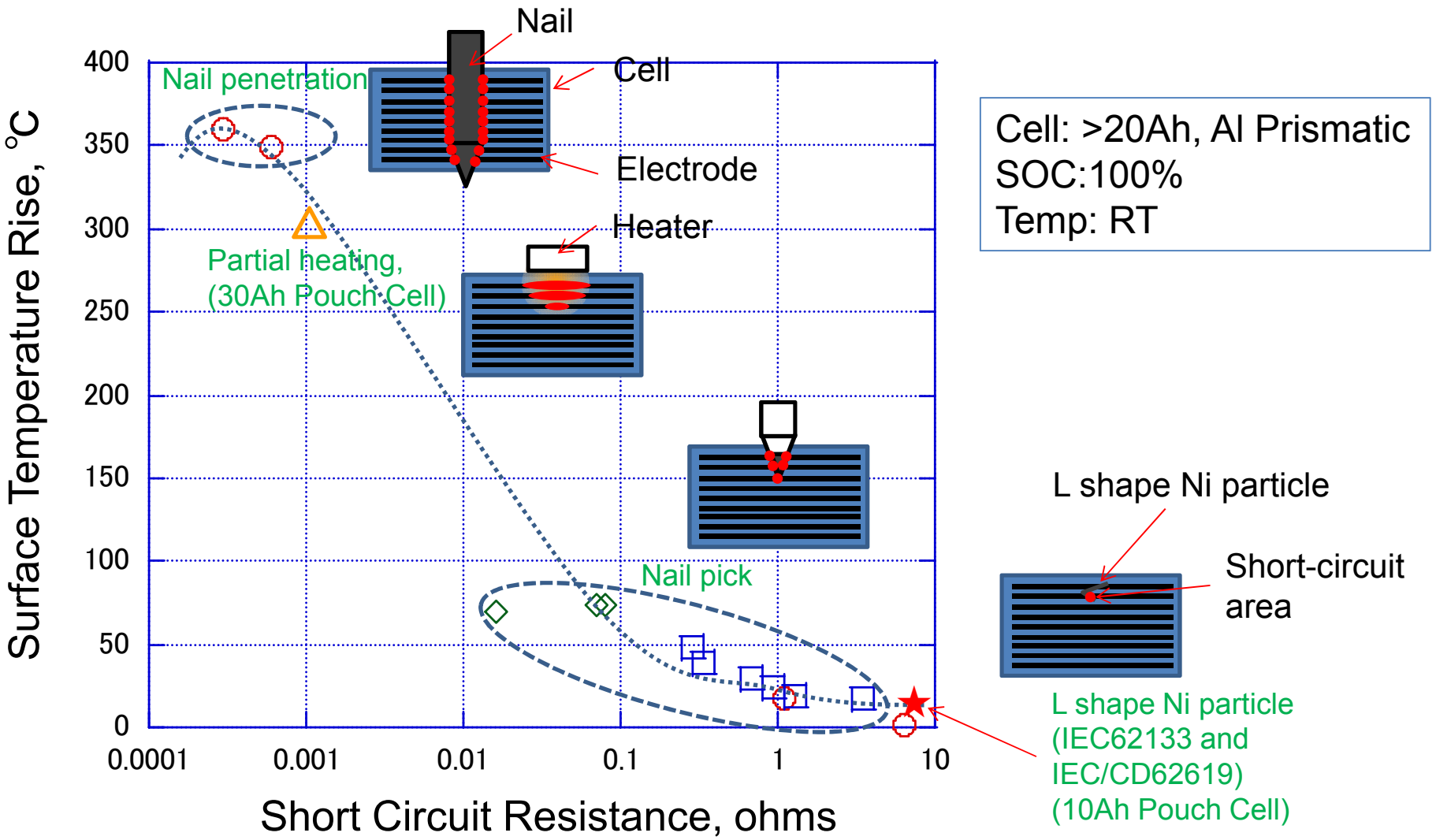
Small ← Size of short circuit area → Large

Battery pack Sample \ Methods of cell internal short circuit		L shape Ni particle*	Nail pick	Partial heating	Nail penetration
A	PHEV Battery pack (Prismatic cell)		●	●	●
B	EV Battery pack (Prismatic cell)		●	●	●
C	EV Battery pack (Pouch cell)		●	●	

*Defined in IEC62133 and IEC/CD 62619

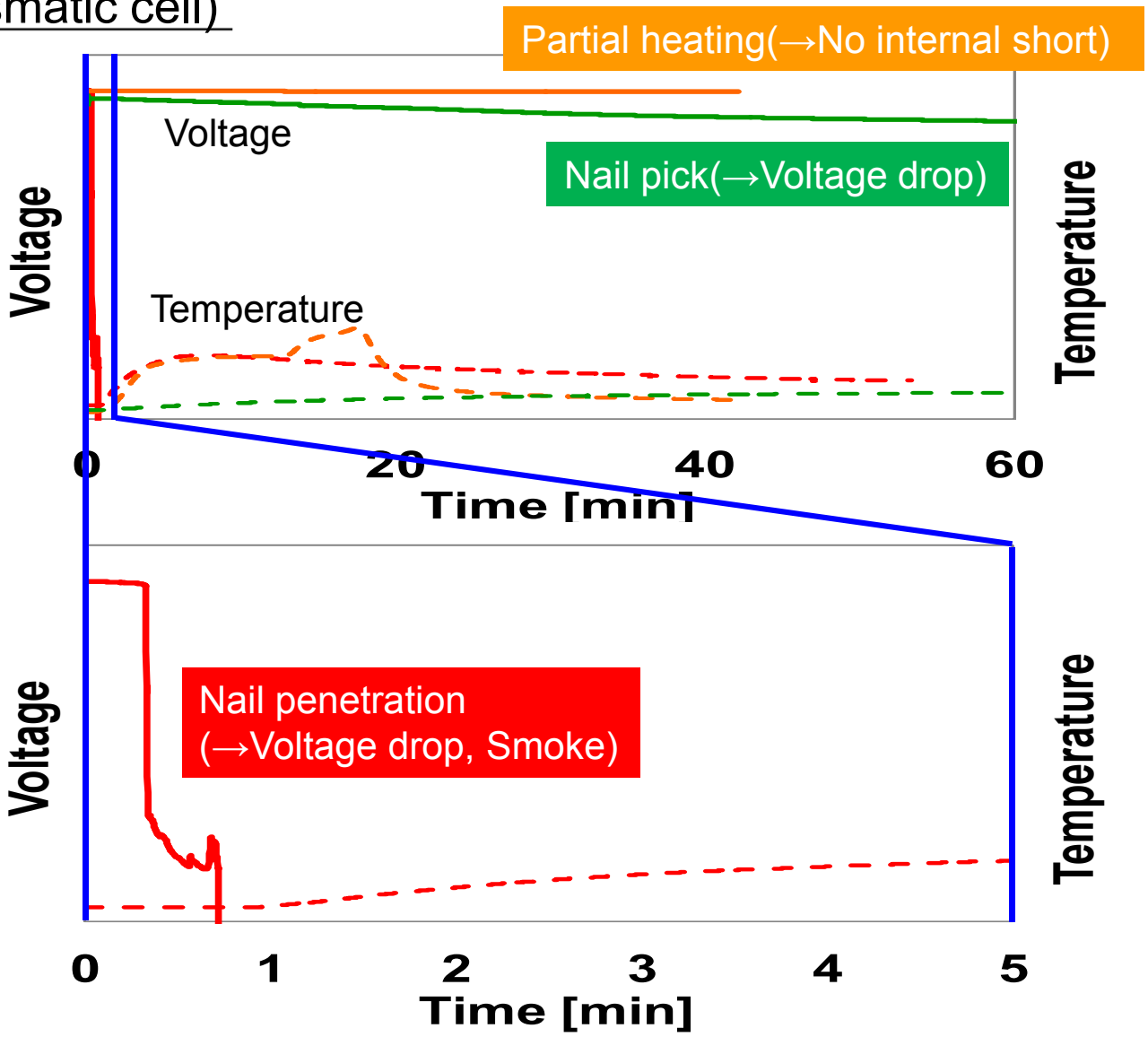
Levels of cell internal short circuit

■ Levels of cell internal short circuit are different by methods.



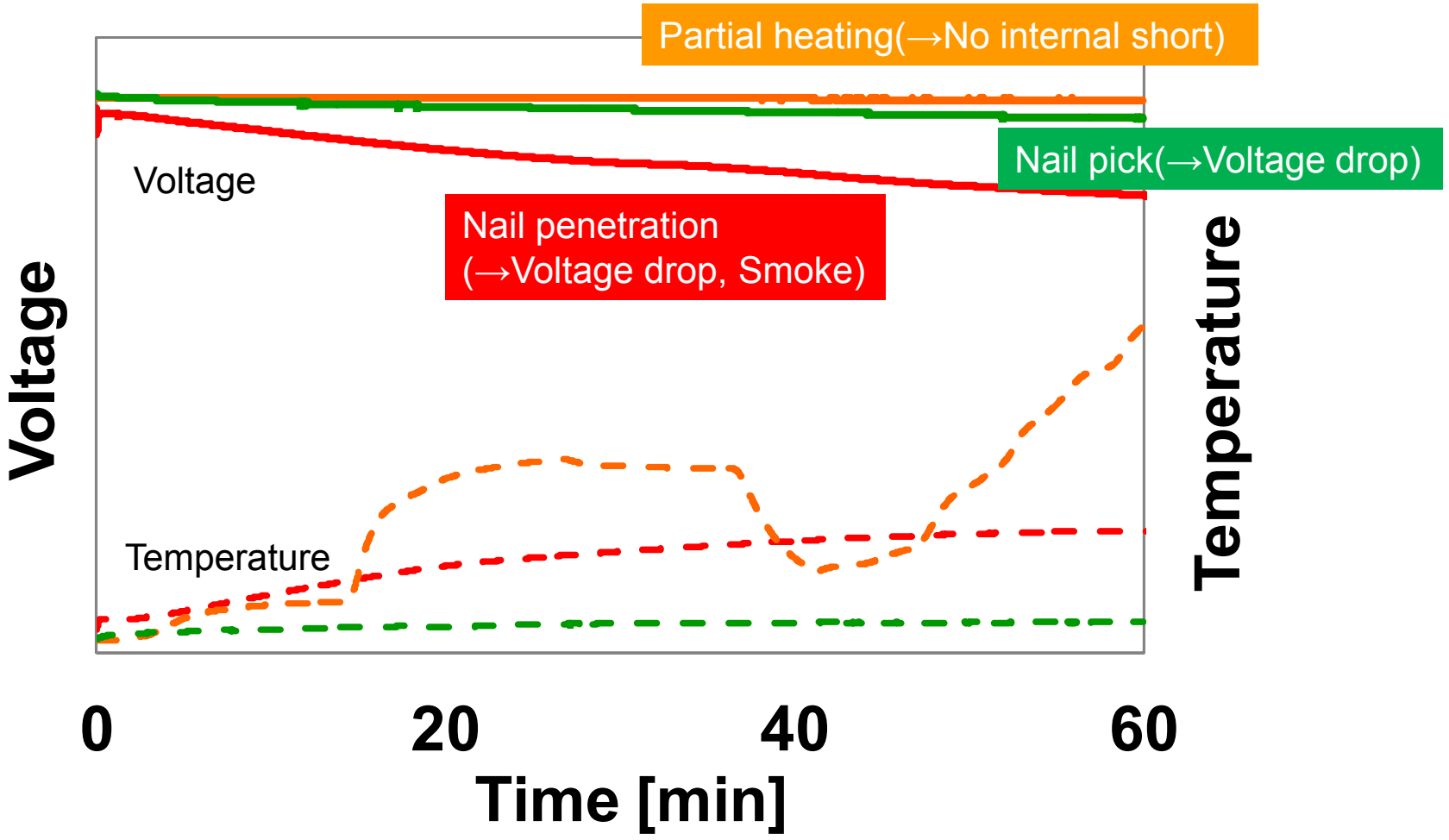
Results of propagation test

A:PHEV Battery pack
(Prismatic cell)



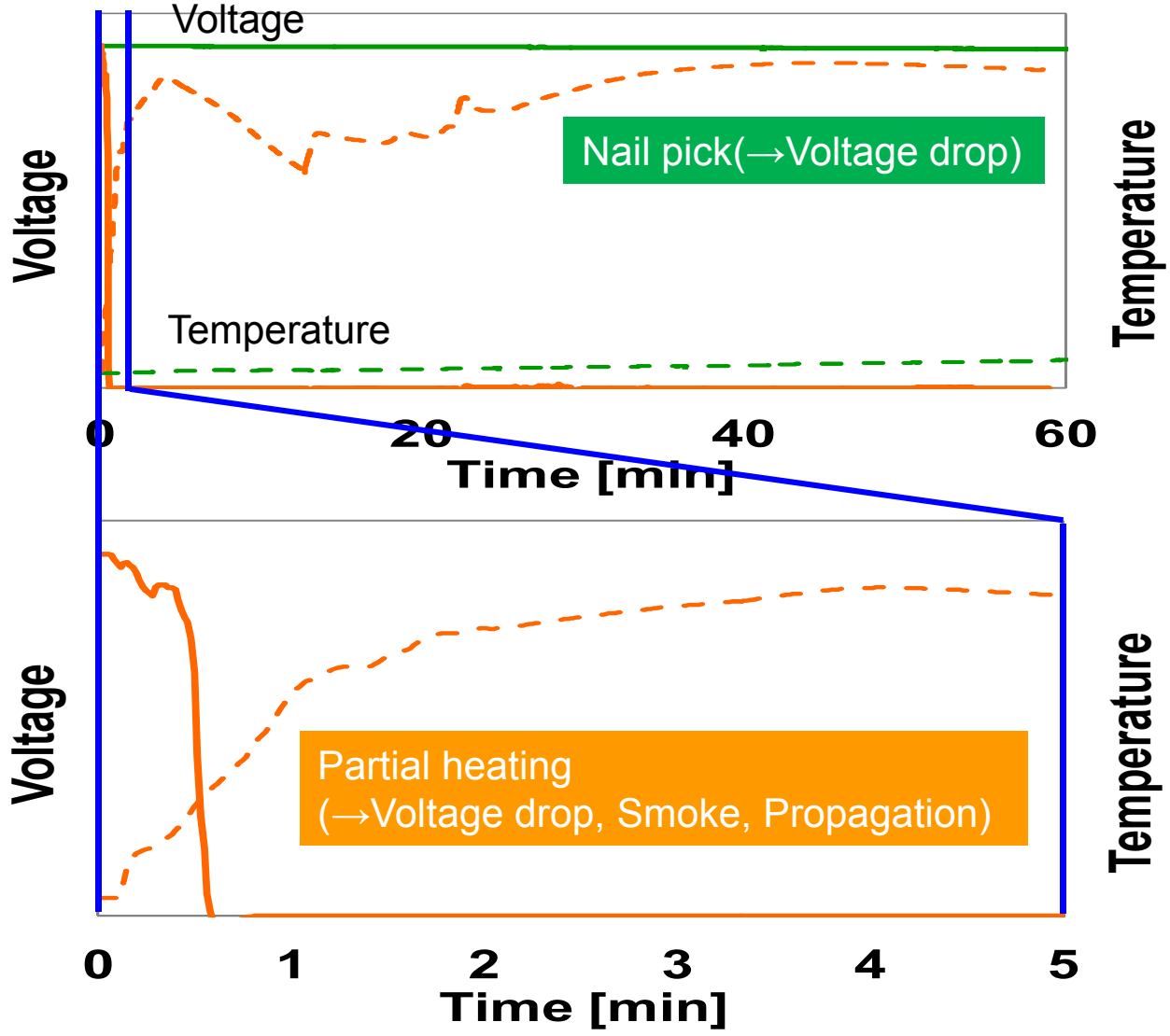
Results of propagation test

B:EV Battery pack
(Prismatic cell)



Results of propagation test

C:EV Battery pack
(Pouch cell)



Summary of our test result

- Methods which can easily cause a cell internal short circuit including in battery pack are different depending on cell type and battery structure.
- Difference of short circuit level (short circuit electrode layers and size) cause difference of battery pack phenomenon in spite of a same battery.

		Nail pick	Partial heating	Nail penetration
A	Voltage drop(V)(1h later)	0.32	0	Max→0
	Cell temperature(℃) (1h later)	44	No internal short	192
	Phenomenon	Nothing		Smoke
B	Voltage drop(V)(1h later)	0.12	0	0.41
	Cell temperature(℃) (1h later)	30	No internal short	119
	Phenomenon	Nothing		Smoke
C	Voltage drop(V)(1h later)	0.04	Max→0	
	Cell temperature(℃) (1h later)	45	634	
	Phenomenon	Nothing	Smoke Propagation	

Thank you for your attention