

EVS-GTR Protection against Water

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1. Standard interpretation

■ EVS GTR waterproof test **Standard interpretation**

✓ Requirement

- Vehicles should maintain insulation resistance after exposure to water (such as washing and driving through standing water).

✓ Simulation scenes

- Washing (special washing of non-high pressure water)
- Driving through standing water

✓ Test procedure

- IPX5
- The vehicle shall be driven in a wade pool, with 10 cm water depth, over a distance of 500 m at a speed of 20 km/h.

✓ Insulation test

- The test procedure shall be performed for insulation test immediately after each exposure to water and when the vehicle is still wet. In addition, after 24 hours of suspension, the insulation resistance test shall be performed again.
- **Requirement** : DC : $\geq 100\Omega/V$; AC : $\geq 500\Omega/V$.

5	Spray water, figure.6 Nozzle diameter:6.3mm Spacing:2.5m-3m	12.5L/min \pm 5%	About 30KPa (Refer to notes)
6	Spray water, figure.6 Nozzle diameter:12.5mm Spacing:2.5m-3m	100L/min \pm 5%	About 100KPa (Refer to notes)
6K	Spray water, figure.6 Nozzle diameter:6.3mm Spacing:2.5m-3m	75L/min \pm 5%	About 1000KPa (Refer to notes)

■ EVS GTR waterproof **insufficient**

- ✓ **Waterproof test is performed only on the vehicle level, no requirement on REESS level: only to verify the insulation properties of car wash in normal scene or short time driving in shallow water.**

- No sealing performance assessment of REESS immersion in severe floods;
- No seal durability performance assessment of REESS under dynamic integrated stress.

2. Soaking scene

■ Wading and soaking scene



2016/07/04,Wuhan,Heavy rain wading



2017/07/18,Shenzhen, Heavy rain wading



2011/03/11,Japan,Tsunami



Soaking when charging

■ Soaking failure case



■ Comments

The vehicle soaking scene really exists in real life, and there are also soaking failure cases in the market.

In coastal cities tsunamis and typhoons may cause vehicles immersed

2. Soaking scene

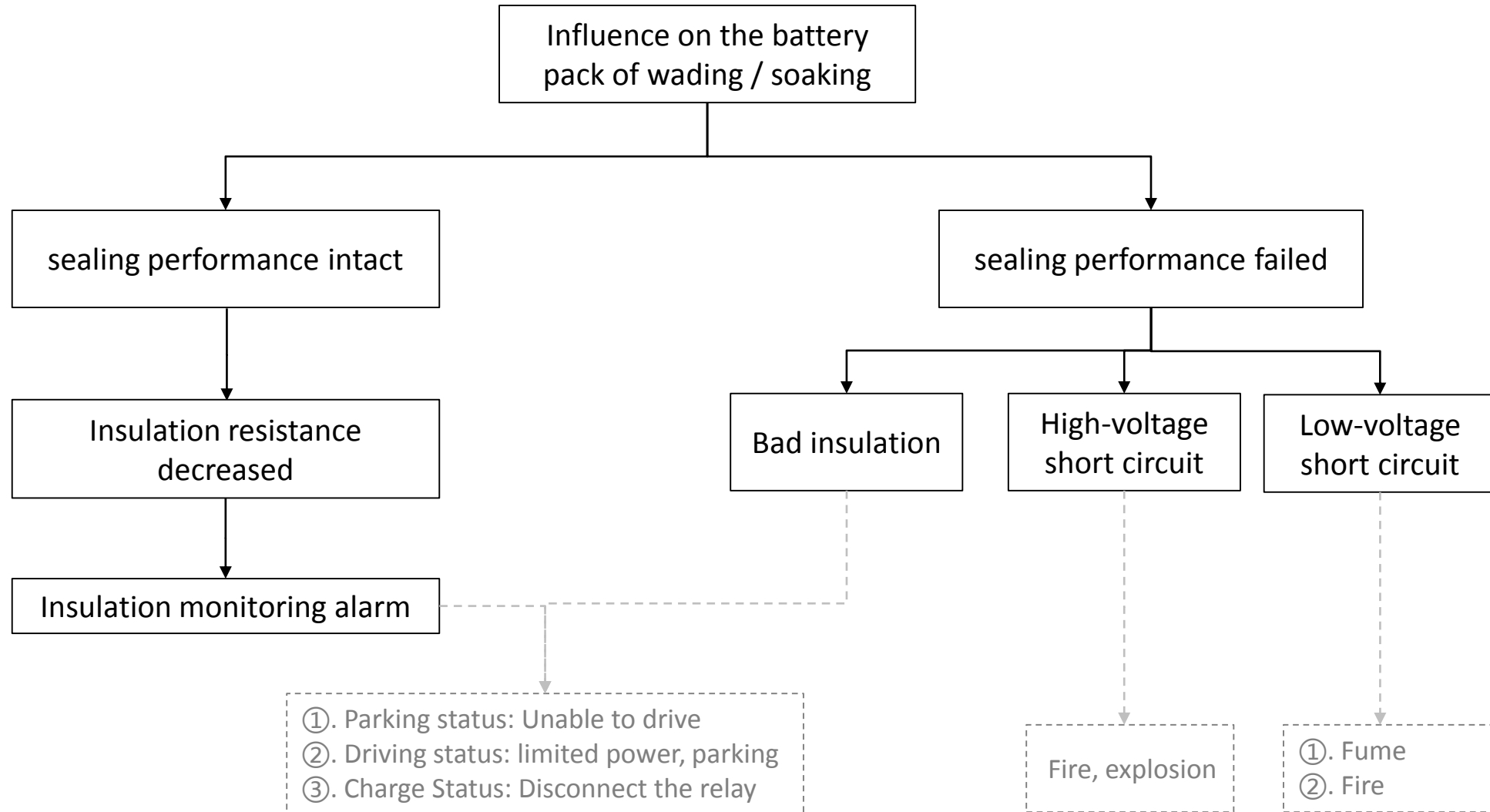
■ Wading and soaking scene



■ Comments

- There is no seal between Pack and vehicle:
For the car series, Pack is mounted on the bottom of the vehicle; For the bus series, PACK is assembled in battery compartment.
- Pack will face the soak scene when vehicle wading / soaking.

3. PACK soaking damage-influence recognition



3. Soaking damage-verification



44KWh NCM Pack

Case1 Immersed in **salty water** without cover

- **Description:**2015/08, NCM PACK (44KWh) immersed in salty water without cover
- **Result:** high-voltage short circuit – after 19s into the water, fired and exploded.



44KWh NCM Pack

Case3 Immersed in **clean water** without cover

- **Description:**2016/08, NCM PACK (44KWh) immersed in clean water without cover
- **Result:** no abnormality while immersing, : low-voltage short circuit happened after immersing.



26KWh LFP Pack

Case2 Immersed in **salty water** without cover

- **Description:**2016/05, LFP PACK(26KWh) immersed in salty water without cover
- **Result:** high-voltage short circuit – after 13min and 24s, fired and exploded.



2.2KWh NCM Module

Case4 After immersing in clean water

- **Description:** 2016/08, NCM Module after immersing in clean water
- **Result:** low-voltage short circuit – after 2.5h, the low-voltage cable fumed.

3. Soaking damage-result verification

Sample type	Sealing performance	Water	Test result	Failure cause
Pack	OK	3.5% salty water	OK	/
		Clean water	OK	/
	NG	3.5% salty water	Spark/Fire	High-voltage short circuit
		Clean water	Smoke	Low-voltage short circuit
Module	Low-voltage cable not immersed in water	3.5% salty water	OK	/
		Clean water	OK	/
	Low-voltage cable immersed in water	3.5% salty water	Spark/Fire	Low-voltage short circuit
		Clean water	Smoke	Low-voltage short circuit

Comments

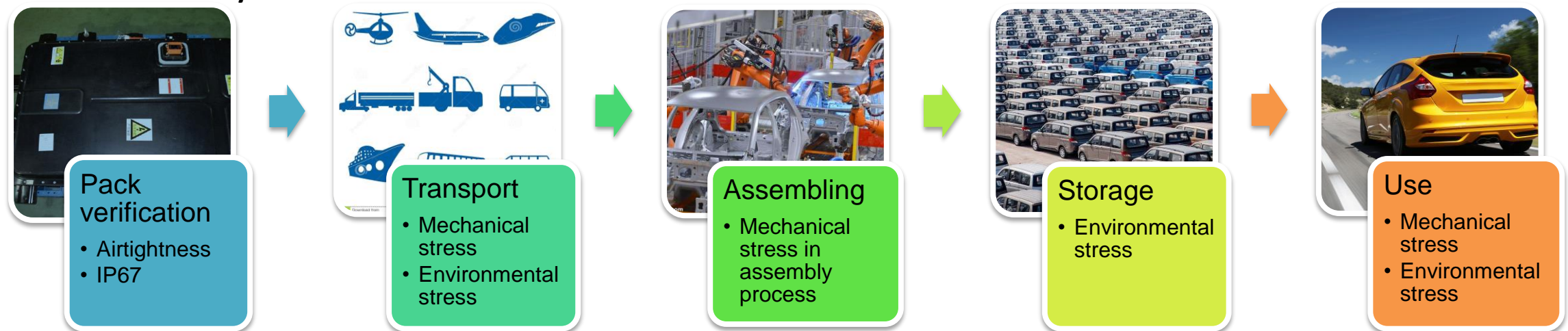
- Once sealing performance fails, there are safety issues caused by high-voltage or low-voltage short circuit in salty water.
- It is necessary to make corresponding requirements for the sealing performance of battery pack/system.

3. Soaking damage-seal waterproof status of pack/system level

■ Seal waterproof status of pack/system level

- ✓ Currently, the pack / system seal design requirements are mostly saline soaking or IP67. The tests are static test, but the vehicle sealing requirements are during the whole life cycle.

■ REESS full life cycle stress



Comments

- ✓ The mechanical and environmental stresses of the whole life cycle affect the reliability of the seal waterproofing.--- **Failure case:** There have been many seal failure cases in the market.
- ✓ In order to ensure the quality and safety of the product, it is necessary to put forward the seal durability requirements of the pack so that the product can be fully verified in the design verification stage.



4. Improve suggestions and feasibility

Type	Level	Present Status	Suggestions
EVS-GTR	Vehicle	<ul style="list-style-type: none">• IPX5• wading in shallow water	Continue to have
	REESS	No requirement	Waterproof assessment (sealing performance under dynamic integrated stress) Mechanical / environmental test → saline soaking

■ Feasibility

- **Vehicle** : No additional Costs of adding IPX5 or Wading Tests to Vehicles' road/environmental reliability testing;
- **REESS** : By adjusting the verification test sequence, a single test can be adjusted to a serial test without increasing test costs.

4. Improve suggestions and feasibility--- Progress in China

➤ Systematical level protection is emphasis

Chinese standards No.	Description	Test object	Type	Protection against water	Comment
GB/T 31485-2015	Safety requirements and test methods for traction battery of electric vehicles	Cell/Module	Recommend	Cell/Module level Salty Water (3.5% NaCl)	Replace by GB in 2019
GB/T 31467.3-2015	Lithium-ion traction battery pack and system for electric vehicles---Part 3: Safety requirements and test methods	Pack	Recommend	System level Salty Water (3.5% NaCl)	Replace by GB in 2019
GB XXXXX—XXXX	Lithium-ion traction battery used in electrically propelled road vehicles-	Pack	Forced	System level (after vibration) Salty Water (3.5% NaCl) /IPXX	Safety of high voltage system are take n seriously into consideration

Thank you for attention!