Field case of water immersion risk

2023.04

1. Introduction

With the increasing number of electric vehicles, battery pack soaking in water is a common situation encountered by consumers. Insufficient waterproofing caused by design or manufacturing defects may lead to safety accidents. It is important to pay attention to the relevant waterproof performance verification.

Vehicles parked in the underground garage

After battery pack immersed in salty water(3.5%) for 30mins , battery catch fire during lifting up from water tank.

2.1 Standard Requirement

Waterproof performance verification is an important test requirement in many standards.

No.	Standards	Test conditions	Requirement
1	ISO 6469-1	Option1:Immerse the DUT in ambient temperature salt water (3,5 % − 5 % by weight NaCl in H_2O) for 2 h. Option2:Immersion depth 1m, 0.15m water above highest housing location if housing larger than 0.85m. Exposure time is 30min.（It shall be tested in accordance with IPX7 in ISO 20653）	Option1: During the test and during the post-test observation period of 2 h, the RESS or RESS subsystem shall not exhibit any evidence of continuous emission of flames for more than 1 s, or explosion. Option2: No occurrence of water is allowed inside the RESS or RESS subsystem after the exposure to water.
2	SAE J2464	Immerse the DUT in ambient temperature salt water (5% by weight NaCl in H_2O) for a minimum of 2 h or until any visible reactions have stopped.	During the test, the battery system shall exhibit no evidence of battery enclosure rupture, fire, or explosion.（SAE J2929）
3	UL 2580	The DUT is to be immersed in salt water (5% by weight NaCl in H_2O) at room temperature for a minimum of 1 h or until any visible reactions have stopped.	there shall be no fire or explosion.

2.1 Regulation Requirement

Waterproof performance verification is an important test requirement in many regulations.

No.	Regulations	Test conditions	Requirement
1	KMVSS 48	Immerse into 0.6M(3.5% NaCl) salt water for 1h	No Fire & No Explosion
2	GB 38031-2020 2020.5.20	Option1:Immerse the DUT into 3.5% (mass fraction) NaCl solution in the real vehicle assembly direction for 2h, the water shall be deep enough to immerse the DUT ; . Option2:Immersion depth 1m, 0.15m water above highest housing location if housing larger than 0.85m. Exposure time is 30min.（It shall be tested in accordance with IPX7 in ISO 20653）	Option1: there shall be no evidence of fire or explosion Option2: the IPX7 requirements shall be fulfilled and there shall be no evidence of leakage, housing crack, fire or explosion, the isolation resistance after the test shall be not less than 100 Ω/V
3	AIS 038 (Rev.2)：2022.10.1	REESS with 100% SoC shall be tested for water ingress protection IP X7 as per IEC 60529. Alternatively, immersion into water test can be performed as per ISO 6469-1:2019.	There shall be no fire or explosion during IP X7 testing of REESS.

3.1 Requirements from OEMs

Waterproof performance required by typical OEMs over the whole world due to:

a) Vehicles often encounter usage scenarios with water during the whole life cycle.
b) There are safety risk if water infiltrate into the battery.
c) The vehicle wading test cannot fully identify the risk of battery.

No.	Requirement*
OEM1	The test shall be applied in accordance with [ISO 20653], Chapter 6 "Degrees of protection against water", second code element 7: "temporary immersion in water".
OEM2	The EES must comply with leak-tightness requirement IP67 (default: IP67) within the vehicle assembly.
OEM3	Requirement and testing of degree of protection (IP code) as per ISO 20653, High-voltage battery pack in installed condition fulfills the IPXXD/IP6K9K/IP6K7
OEM4	The battery pack should perform the test according to SAE J2464-2009 “4.3.5 Immersion Test (Module or Pack Level).

*Only key relevant information is listed here, because of confidential contracts with OEMs.

3.2 Promotional video from OEMs

Water inflow into vehicles is also a safety point that consumers care about. OEM is also happy to show it to consumers as a safety selling point.

Water immersion of Volvo vehicle

2021/07/19, Volvo XC40 pure electric version was immersed in a 1.7-meter vehicle, and the vehicle could still drive. After soaking for 12 hours, the battery still had no water

https://mp.weixin.qq.com/s/nF7GV4o6bF1p0rctwj2QBQ

Safety feature of battery from OEMs' website

https://tiguan.svw-volkswagen.com/PHEV/

4. Field Case

- **Many EVs Flooded During Hurricane Ian Are Spontaneously Igniting in its Aftermath**

Oct 10. 2022 news

One EV flooded by Hurricane Ian have spontaneously ignited more than a week after the storm.

The news also report this problem likely to be a common risk. Due to the **lack of waterproof** performance, the battery pack is prone to safety accidents after entering water

https://www.roadandtrack.com/news/a41573015/teslas-flooded-during-hurricane-ian-are-spontaneously-igniting-in-its-aftermath/

5. Summary

- **Field Case and test data mentioned above clearly shows safety risk related to water immersion or bad sealing scenario.**
- **By end of 2022, more and more countries including China, South Korea and India, has adopted water immersion test into their national regulations.**
- **Water immersion test is necessary for EVS-GTR，in order to ensure safety of electric vehicles.**