

1.1 Draft Proposal

5.4.xx Water immersion

The battery pack or system shall be subject to the water immersion safety test in accordance with 6.2.xx, the following requirements shall be fulfilled:

——If the test is performed in Option 1, there shall be no evidence of fire or explosion.

——If the test is performed in Option 2, 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 .

6.2.xx Water immersion

6.2.xx.1 Connect the wiring harnesses, connectors and other parts of the DUT in the manner of vehicle connection, and perform the test in one of the following two options:

——Option 1: Immerse the DUT into salt water (3.5% by weight NaCl in H_2O) in the real vehicle assembly direction for 2h, the water shall be deep enough to immerse the DUT.

——Option 2: Perform the test in accordance with the method and process described in ISO 20653 / IEC 60529 . The DUT shall be completely immersed into water according to the installation state specified by the manufacturer. For DUT with a height less than 850 mm, the lowest point shall be 1,000 mm below the water surface, for DUT with a height equal to or greater than 850 mm, the highest point shall be 150 mm below the water surface. The test lasts for 30 min. The temperature difference between the water and the DUT shall be not more than 5°C.

6.2.xx.2 Remove the DUT out of the water, let stand at the test ambient temperature and observe for 2h.

2.1 Usage Scenario and Test Result

- During the whole life cycle, vehicles often encounter wading or soaking problems:
 - a) Driving in the raining day
 - b) Parking in the garage with stand water.
- May cause fire and explosion due to short circuit.

Scenario 1: Driving in raining day



Scenario 2: Vehicles parked in the underground garage




Test Video: immersed in salty water(3.5%) for 30min and catch fire after 21min rest



3.1 Comparison of waterproof test methods

- The test of Washing and driving through standing water cannot fully identify the safety risk of electric vehicles:
 - a) Environmental effects such as exposure to water may deteriorate the isolation resistance of high voltage bus. This may first lead to an electric system degradation and eventually lead to an **unsafe electrical system** and electrocution of vehicle occupants, operators (during charging) or third parties/passers-by. (EVS-GTR Phase1 E. Technical rationale and justification 97)
 - b) EV equipped with high-voltage and high-energy battery pack could lead to fire and explosion after being immersed.

	Test method	Failure effect	Operation mode
EVS-GTR Phase1	EVS-GTR Phase1 6.1.5 Washing and Driving through standing water	<p>99. Washing and driving through shallow standing water are considered as the examples of usual conditions in normal vehicle operation, and in principle, all vehicles shall maintain isolation resistance after being exposed to water under such environmental conditions. Two test procedures for protection against water effects are foreseen with a view to evaluate the robustness of electrical isolation under such environmental conditions, in particular, for vehicles with a poor electrical and vehicle design.</p> <p>(EVS-GTR Phase1 E. Technical rationale and justification)</p>	<ul style="list-style-type: none"> • Check the insulation impedance after the test Or • A warning shall be indicated to the driver
Proposal	<p>Testing Proposal</p> <div style="border: 1px solid black; padding: 10px; margin: 10px 0;"> <p style="text-align: center; border: 1px solid black; display: inline-block; padding: 5px;">Immersion safety</p></div> <div style="display: flex; justify-content: space-around; margin-top: 10px;"> <div style="border: 1px solid black; padding: 5px; text-align: center;"> <p>Seawater immersion</p> <p style="font-size: small;">It proves that there is no fire and explosion after water inflow</p> </div> <div style="border: 1px solid black; padding: 5px; text-align: center;"> <p>IPX7</p> <p style="font-size: small;">Ensuring no water inflow</p> </div> </div>	<p>The battery may causes fire and explosion</p> <div style="text-align: center; margin-top: 20px;">  </div>	<ul style="list-style-type: none"> • Observe for two hours after the test. • Open the box to check whether there is any sign of water ingress.

4.1 Requirements from OEMs

- IPx7 is 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

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

4.2 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>



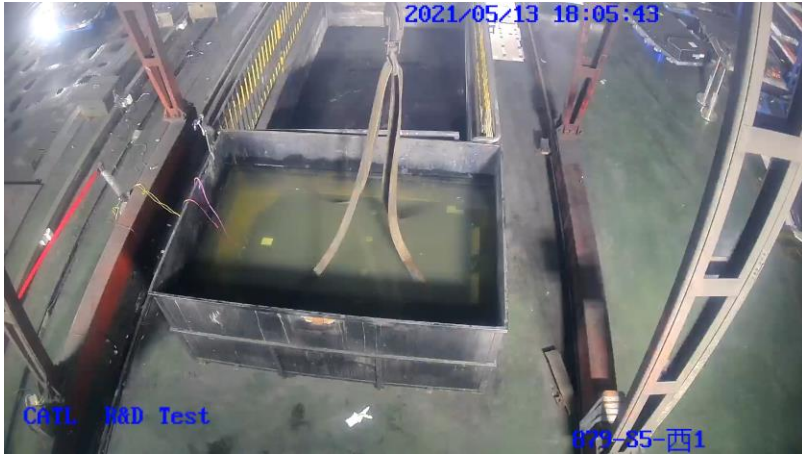
Safety feature of battery from OEMs' website

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

Thanks for your attention!

Appendix 1

➤ Salt Water Immersion test



start, 17: 39: 43 → 26min → smoke, 18: 05: 48



Smoking when the battery pack was soaked in salt water after 26min

➤ The waterproofing broke during the test and exploded



Picture come from Korea Automobile Testing and Research Institute