

# Water Immersion

WI working group  
April, 2021

# **Research progress of WI working group**

- **According to the conclusion of the 20th IWG meeting, CN undertook the organization and discussion of the WI working group.**
- **Feb.03—a contact group (CN, KR and RUS) was formed via Skype.**
- **Mar.13—a web meeting was held to discuss the WI draft proposal (CN, KR, RUS and JP) .**
  - ✓ **Necessity of water immersion test was discussed**
  - ✓ **Draft regulations were discussed**
- **Apr.02—the final draft was formed.**

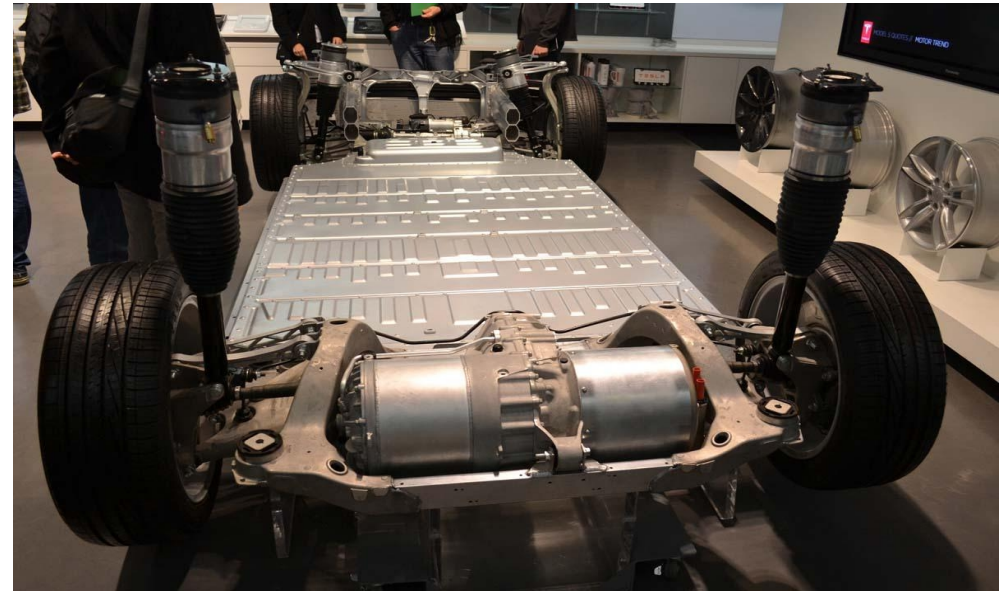
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# Necessity of water immersion test

- The integrated design of battery and chassis is a common design solution for the OEM
- Product quality, vibration, impact and other issues will reduce the sealing of the chassis



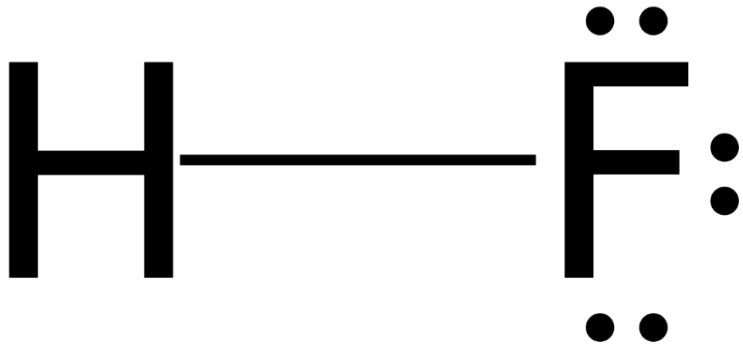
# Necessity of water immersion test

- Natural environments such as rain and stagnant water will make the electric vehicle chassis in a state of water immersion, which will cause certain safety hazards to the vehicle.



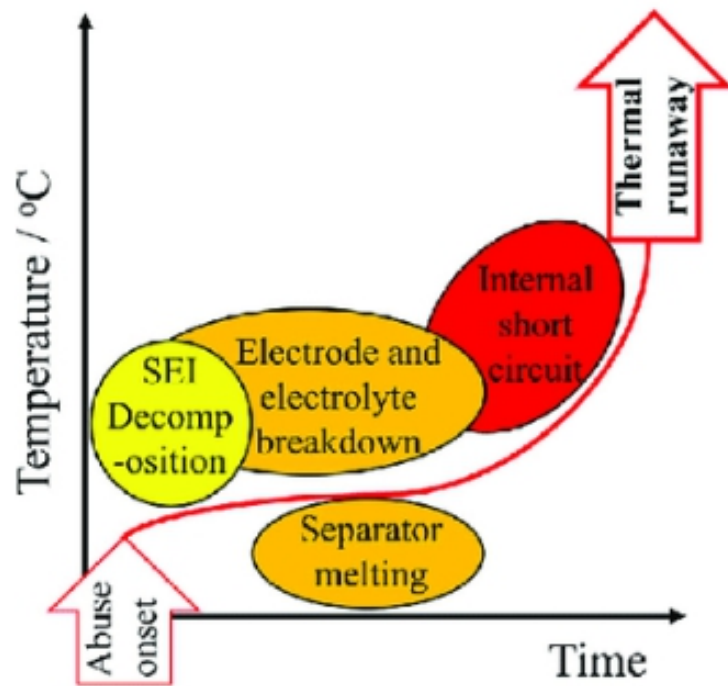
# Necessity of water immersion test

- Some materials are vulnerable to moisture due to their chemical properties
- One of them is that LiPF<sub>6</sub> (Lithium Hexafluorophosphate) is contained in the electrolyte of a lithium-ion battery
- When hydrolyzed, LiPF<sub>6</sub> releases HF (Hydrogen Fluoride) that causes serious damage to a human body when in contact with one's eye or swallowed



# Necessity of water immersion test

- Internal short circuit may occur when water is immersed in a battery without appropriate safety designs
- This may cause the battery cells rupture and release hazardous chemicals
- If it is severe, it may cause a thermal runaway in a battery cell, leading to fire or explosion



# Necessity of water immersion test

- GTR 20 specified test procedure for protection against water effects, which includes “washing” and “driving through standing water”
- Can not effectively detect the sealing performance of the battery pack
- The case has been described in “EVS19-E4WI-0100 [CN]EVS-GTR Protection Against Water”

6.1.5. Test procedure for Protection against water effects.

6.1.5.1. Washing.

This test is intended to simulate the normal washing of vehicles, but not specific cleaning using high water pressure or underbody washing.

The areas of the vehicle regarding this test are border lines, i.e. a seal of two parts such as flaps, glass seals, outline of opening parts, outline of front grille and seals of lamps.

All border lines shall be exposed and followed in all directions with the water stream using a hose nozzle and conditions in accordance with IPX5 as specified in Annex 2.

6.1.5.2. Driving through standing water.

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, in a time of approximately 1.5 min. If the wade pool used is less than 500 m in length, then the vehicle shall be driven through it several times. The total time, including the periods outside the wade pool, **shall be less than 10 min.**

**Poitin 1: The height of the passenger car chassis is generally around 120mm-150mm**

**Poitin 2: Test time is relatively short**

**Does not meet the requirements of the actual water immersion state**



# Related international standards

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## ■ The water immersion is a test item in most standards.

No.	Standards
1	ISO 20653:2013 Road vehicles — Degrees of protection (IP code) — Protection of electrical equipment against foreign objects, water and access
2	ISO 6469-1:2019 Electrically propelled road vehicles — Safety specifications — Part 1: Rechargeable energy storage system (RESS)
3	SAE J2464:2009 Electric and Hybrid Electric Vehicle Rechargeable Energy Storage System (RESS) Safety and Abuse
4	SAE J2929 Safety standard for EV and HEV propulsion battery systems utilising lithium-based rechargeable cells
5	SAND 2005-3123 FreedomCAR electric energy storage system abuse test manual for electric and hybrid electric vehicle applications
6	UL 2580 Standards for batteries of use in EV
7	UL 2271 Batteries for use in LEVs
8	KMVSS 48 Traction battery
9	GB 38031-2020 Electric vehicles traction battery safety requirements

# Related international standards

## ■ ISO 6469-1:2019 Electrically propelled road vehicles—Safety specifications—Part 1: Rechargeable energy storage system (RESS)

### 5.3.2 Immersion into water

The RESS shall provide the safety performance as specified below when it is exposed to water due to water immersion.

**NOTE** This requirement does not cover incidents in which the primary hazard for persons is caused by the presence of water, e.g. high flooding, flooded underground parking, flooded underpass.

The requirement is fulfilled if the RESS or RESS subsystem meets one of the following conditions:

- The RESS or RESS subsystem shall be tested in accordance with 6.4.2. 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.
- The RESS or RESS subsystem including all connectors, air ducts and connections for cooling attached is water protected. It shall be tested in accordance with IPX7 in ISO 20653 and no occurrence of water is allowed inside the RESS or RESS subsystem after the exposure to water. The test may be conducted with only the housing of an RESS or RESS subsystem and all connectors, air ducts and connections for cooling attached.

Minimal appearance of water due to the condensation of air humidity is possible and not considered as an occurrence of water. In case of doubt the test may be performed with coloured water.

### 6.4.2 Immersion into water

Immerse the DUT in ambient temperature salt water (3,5 % – 5 % by weight NaCl in H<sub>2</sub>O) for 2 h.

The DUT shall be built up and prepared with all connectors, ducts and flanges, interfaces for cooling and coolant according to the vehicle manufacturer's specification for vehicle operation.

If the water depth  $w$  is defined, immerse the DUT as deep as the RESS installed in the vehicle operated in the specified water depth  $w$ .

If the water depth  $w$  is not defined, the immersion depth shall be 1 m (deepest housing location) or 0,15 m water above the highest housing location, if the housing is larger than 0,85 m.

**Method 1**

**Method 2**

# Related international standards

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## ■ SAE J2464:2009 Electric and Hybrid Electric Vehicle Rechargeable Energy Storage System (RESS) Safety and Abuse Testing

### 4.3.5 Immersion Test (Module or Pack Level)

#### 4.3.5.1 Test Description

With the DUT in its normal operating orientation and at full state of charge, immerse the DUT in ambient temperature salt water (5% by weight NaCl in H<sub>2</sub>O) for a minimum of 2 h or until any visible reactions have stopped. The water depth must be enough to completely submerge the DUT. The DUT may be placed into a tank filled with water or may be placed in an empty tank and water pumped into the tank to fully submerge the DUT.

**Same as the method 1  
of ISO 6469-1**

## ■ SAE J2464:2009 Electric and Hybrid Electric Vehicle Rechargeable Energy Storage System (RESS) Safety and Abuse Testing

### 24 Resistance to Moisture Test

24.1 This test is conducted on a fully charged battery pack and is intended to determine its resistance to temporary immersion in water from flooding of a vehicle, etc.

24.2 With the battery pack in its normal operating orientation, it shall be subjected to the immersion test for protection against temporary immersion as outlined in the Standard for Enclosures for Electrical Equipment, Environmental Consideration, UL 50E.

24.3 As a result of the immersion, there shall be no fire or explosion.

# Draft proposal

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## 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  $\Omega/V$ .

## 6.2.xx Water immersion

6.2.xx.1 The DUT shall be a battery pack or system which has passed the vibration test in 6.2.2.

6.2.xx.2 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 3.5% (mass fraction) NaCl solution 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 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.3 Remove the DUT out of the water, let stand at the test ambient temperature and observe for 2h.

**Thanks for your attention!**