

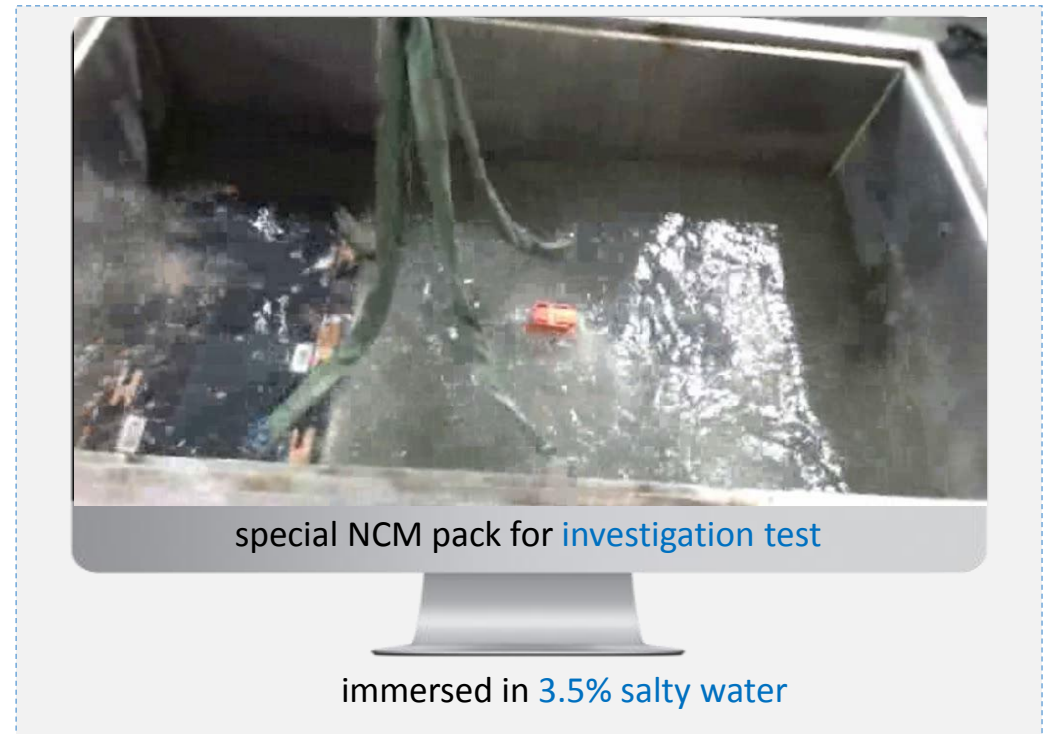
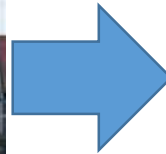
EVS-GTR Protection against Water

EVS-GTR 16th

China

2018.09

1. Water Protection Failure Influence



fire and explosion happened after 19s into the water

■ Comments

Water immersion test is a **safety issue** rather than an reliability issue.

2.1 Usage scenario – Immersion vehicle in flood events

■ Immersion scenario



2014/11 Carrara Italia, flood event caused by heavy rain

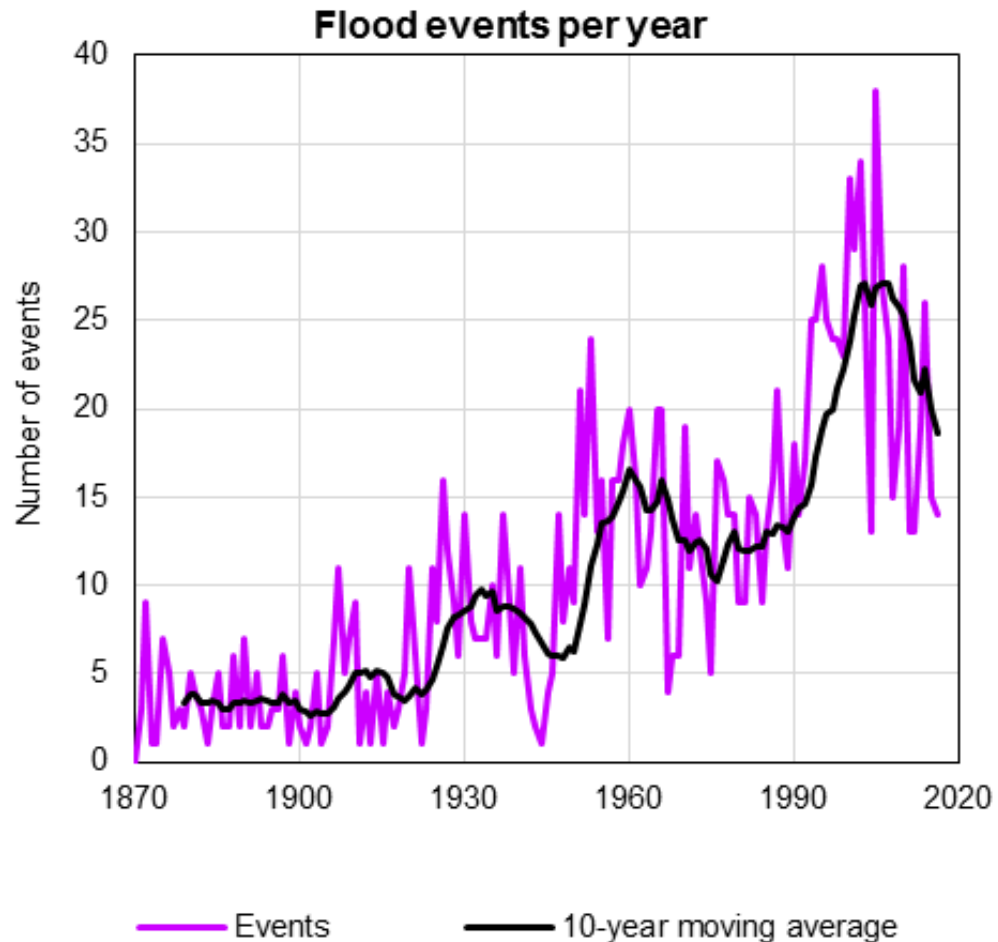


2017/08 Houston USA, flood event caused by hurricane

■ Comments

The **vehicle immersion scenario** can be found in real life.

2.2 Flood Events in European Countries



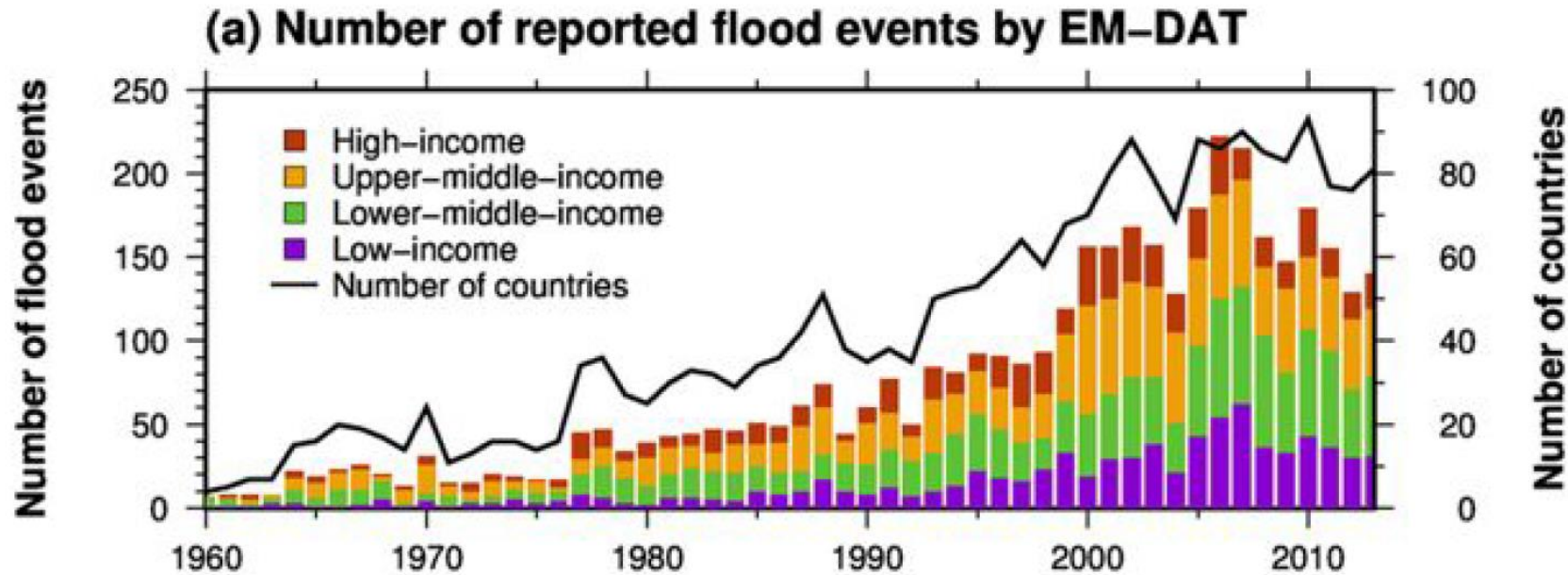
■ Comments

Although it seems flood events are rare and irrelevant to most of the majority, **an increasing trend of flood events** can be found in European countries .

Annual number of flood events in European countries*

*Paprotny , D., T. et al. Trends in European flood risk over the past 150 years. arXiv. 2017 Oct 26; 1710.11044

2.3 Flood Events Around the World



(a) Number of flood events for each income level (bar) and number of countries in which a flood event was reported in the Emergency Events Database (EM-DAT) (solid line) from 1960 to 2013. The definition of income level was obtained from the World Bank (<http://data.worldbank.org/about/country-and-lending-groups>).*

■ Comments

Same increasing trend of flood events and affected countries can be found from the EM-DAT (Emergency Events Database) between 1960 and 2013 around the world.

Considering safety issue is critical to drivers and rescuers, **OEMs shall have obligation to consider the water immersion scenario in a safety perspective and design electric vehicles accordingly.**

*Tanoue, M., T. et al. Global-scale river flood vulnerability in the last 50 years. Scientific Reports. 2016 Oct 26;6:36021

<https://www.nature.com/articles/srep36021>

2.4 Different Results during Flood Events

■ Good Result



2011/3 Fukushima Japan, two dozen Nissan Leaf electric cars were mangled in the tsunami, but with no adverse anything from the battery pack(**IP67**)*

■ Bad Result



2012/11 New Jersey USA, 16 EVs caught fire after being submerged by the surge**

■ Bad Result



2016/07 Nanjing China, 2 EV-buses caught fire due to pack (**IP54**) immersion in flooding water***

■ Comments

Severe incidents caused by immersion failure were found in EV market.

*<https://longtailpipe.com/2011/12/22/nissans-leaf-survived-fine-in-fukushima-tsunami-no-fires/>

**<https://www.treehugger.com/cars/16-fisker-karma-cars-explode-and-burn-during-superstorm-sandy.html>

***https://m.sohu.com/a/102132564_3201

3 Requirements from OEM

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

■ Comments

IP67 is required by typical OEMs over the world .

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

4 Recommendation to EVS-GTR

Type	Phase	Present Status	Scenario	Note
EVS-GTR	Phase 1	<ul style="list-style-type: none"> IPX5 wading in shallow water 	<ul style="list-style-type: none"> Vehicle washing Vehicle wading 	-
	Phase2	<ul style="list-style-type: none"> IPX5 wading in shallow water Water immersion 	<ul style="list-style-type: none"> Vehicle washing Vehicle wading Vehicle under flooding event 	<p>Water immersion safety test can be conducted alternatively in vehicle level or REESS level (recommendation) with 2 options.</p> <ul style="list-style-type: none"> Option 1: Pass IPX7 test Option 2: Immersion with salty water (3.5% NaCl), no fire and no explosion in 2 hours.

■ Remark

Bolts loosing, housing crack and seals interface mismatch caused by vibration over lifetime may lead a sealing failure to REESS. Meanwhile, water immersion scenario can happen during the whole life of vehicle.

We recommend to **conduct the water immersion safety test after vibration test.**

Thanks for your attention!

Appendix -- Immersion Safety Test Procedure

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

- a) If the test is performed in Option 1, there shall be no evidence of fire or explosion;
- b) 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 .

Water immersion safety

The tested-device shall be a battery pack or system which has passed the vibration test.

Connect the wiring harnesses, connectors and other parts of the tested-device in the manner of vehicle connection, and perform the test in one of the following two options:

- a) Option 1: Immerse the tested-device into 3.5% (mass fraction) NaCl solution in the real vehicle assembly direction for 2h, the water shall be deep enough to immerse the tested-device;
- b) Option 2: Perform the test in accordance with the method and process of ISO 20653. The test object shall be completely immersed into water according to the installation state specified by the manufacturer. For test object with a height less than 850 mm, the lowest point shall be 1,000 mm below the water surface; for subjects 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 test object shall be not more than 5 °C.