An Example from Fukushima: Why Electrical Penetrations are Critical to Nuclear Safety

Small components can have a big impact

Industry requirements for longer lifetimes and higher operating temperatures have put increased demands on nuclear reactor designs. With these changes, it is crucial for safety standards to be correspondingly evaluated.

Small components can have a big impact

While safety is of paramount importance in nuclear applications, not all components are designed to withstand the high temperatures and extreme pressures found in severe accident conditions. Failure at any point in the instrumentation and control chain – even with the smallest components – can result in loss of information transmission and reactor control, both of which are crucial to maintain in a severe accident, like what happened at Fukushima.

IAEA: test components to withstand severe accidents

In July 2017, the IAEA (International Atomic Energy Agency) issued a report explaining how components can be subject to conditions exceeding original design basis assumptions in severe accidents. As such, the agency recommended establishing 'an international technical basis to be considered when assessing the electrical and I&C equipment reliable performance under severe accident conditions.'
Read the full IAEA report here.

Use of high-quality, inorganic materials like glass, ceramics, and metal in nuclear safety components are key for improvement

Organic materials represent an inferior option compared to inorganic counterparts. Organic, epoxy-based polymers are an example of a material that can rapidly degrade and lead to component failure under high temperatures, pressures, and radiation levels in a severe accident – especially when used as a sealing material for electrical feedthroughs. The IAEA recommends 'the use of some materials, e.g. metals, glass, ceramics, high performance polymers which have good resistance to high radiation.'

Lessons Learned After What Happened at Fukushima

The analysis of the 2011 Fukushima disaster confirms the reality of the IAEA report: shortcomings of components not designed to withstand severe accident conditions played a role in the rapid degradation of plant infrastructure. Failure of hatches and electrical penetrations using organic, epoxy-based materials were a suspected catalyst of hydrogen leakage and subsequent explosions, further worsening the situation. In-depth analysis of the investigation as well as updates about the situation is available on Tepco's website.

Glass-to-metal sealed penetrations: an existing alternative for higher safety

Glass-sealed penetrations are already installed and performing maintenance-free in over 100 nuclear plants worldwide. With a 60-year lifetime and resistance to 400 °C temperature and 400 bar pressure, they are maintenance-free and well-suited to maintain integrity for several hours in severe accident conditions.