



SCHOTT
glass made of ideas

**Small component –
Big impact.**

The safety of the nuclear
containment is only as strong
as its smallest elements.

Key to nuclear safety: The reactor containment and its components

Containment structure

Nuclear power plant containment structures are entirely sealed off constructions designed to safely contain the nuclear reactor. They are also the core means to maintain control during and after severe accident conditions.

In order to keep the radioactive high-energy source controlled, electrical and instrumentation cables are needed through the containment structure to provide power, control signals and monitoring for the reactor.

Electrical Penetration Assemblies

Electrical Penetration Assemblies (EPA) provide a leak-tight pass-through for power, control and instrumentation cables through the containment structure. They also maintain the pressure boundary integrity of the entire containment structure, especially during a severe accident.

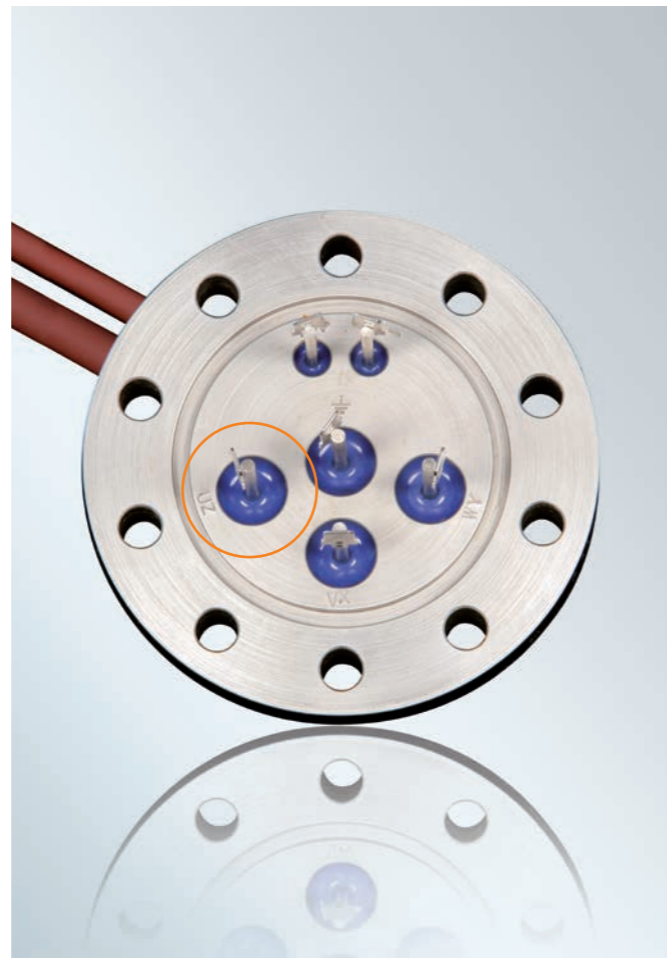
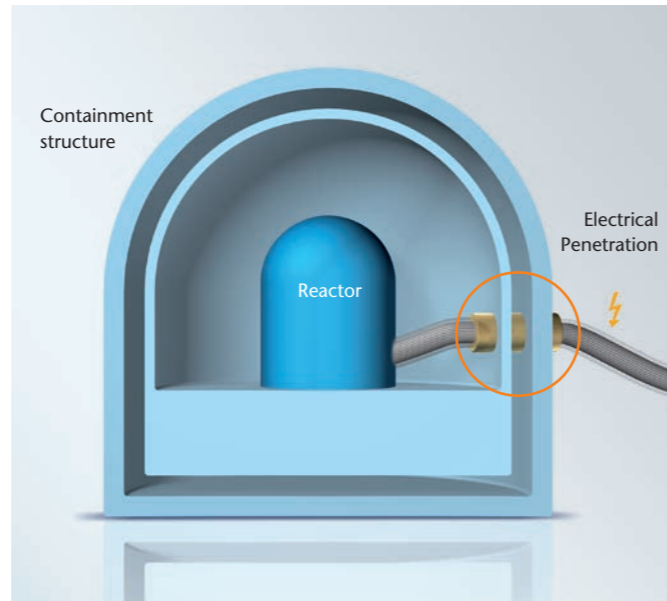
For EPAs there are two principal sealing technologies available that influence the performance and safety level of the entire unit:

- Sealing with organic materials like epoxy or polymers
- Sealing with inorganic materials like glass.

The sealing must remain leak-tight over years to maintain the safety level, even when exposed to radiation, humidity and fluctuating temperatures. Organic materials naturally age and thus their sealing performance deteriorates over time, especially in harsh environments.



Polymer ages naturally



Glass sealing does not age as it is inorganic

Why are electrical penetrations safety critical components for the nuclear power plants?

Consequences of EPA failure can be disastrous

The U.S. Nuclear Regulatory Commission has concluded that the accident at Fukushima Daiichi was caused by a long-lasting, complete loss of power due to common-cause failure of electrical equipment following the March 11, 2011, tsunami and to insufficient provision against severe accidents.¹

The excessive environmental conditions exceeded the capability of electrical and mechanical penetrations and door and hatch seals and resulted in leakage paths for radiation and hydrogen. Hydrogen leakage outside of containment at Fukushima resulted in hydrogen explosions and loss of secondary containment. The electrical penetrations were reported to have organic epoxy seals that could not withstand the temperature and pressure levels and thus leaked hydrogen gas.²

Technology and Quality of EPA is critical for preventing leakage

As electrical penetrations are an integral part of the containment structure, they must be capable of approx. two to three times the normal design pressure of the containment to prevent leakage and provide the necessary electrical integrity for power and instrumentation.²

Today, however, the international safety requirements for electrical penetrations are substantially lower than the safety margin of the containment. This makes electrical penetrations, depending on the technology chosen, potentially a weak link for the entire safety design of the reactor containment. In order for the containment to fulfill its purpose, it is necessary that the electrical penetrations used are based on an inorganic sealing technology, like glass-to-metal sealing, that does not degrade over time like organic-based materials do.

¹ G.Apostolakis, "A Proposed Risk Management Regulatory Framework", Nuclear Regulatory Commission, Washington, D.C. (2012)

² Post-Fukushima safety enhancements to nuclear power plants, James F. Gleason et al, Nuclear News, Sept 2014

SCHOTT Eternaloc® Electrical Penetrations – Key to containment safety

SAFE

- Manufactured using only inorganic, non-aging Glass-to-Metal Sealing in unique compression technology
- Proven to withstand extremely high pressure and thermal shocks

PROVEN

- Performing maintenance-free in more than 50 Nuclear Power Plants worldwide since 1962
- SCHOTT's glass-to-metal sealing technology is also proven in other safety-critical applications, such as Liquidified Natural Gas (LNG) Vessels and Terminals

MAINTENANCE-FREE

- The use of non-aging materials means that Eternaloc® penetrations are maintenance-free, thereby reducing the total cost of ownership.



100% Quality Assurance

About SCHOTT

SCHOTT is an international technology group with a workforce of around 15,400 employees worldwide and more than 130 years of experience in the areas of specialty glasses and materials and advanced technologies.

About SCHOTT Electronic Packaging

SCHOTT's Business Unit Electronic Packaging is a world-wide leading supplier of hermetic feedthroughs for harsh environment applications that require the highest level of safety and reliability, e.g. electrical penetration assemblies for nuclear power plants.

Since the 1930s, we have been developing, manufacturing and optimizing hermetic packaging solutions by using specialized glass, glass-to-metal and today also ceramic-to-metal sealing technology.

With 1,500 employees at five production locations in Germany, the Czech Republic, Singapore, U.S.A. and Japan as well as competence centers worldwide, local customer support and co-developments are at the heart of the business.

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