The heat is on in Darwin, Australia’s gateway to Asia, but the reason is cool: LNG. In January 2012, the Japanese company INPEX and its French partner Total announced the official go-ahead for a US$ 34 billion project: the development of the Ichthys field, located 850 km offshore from Darwin, Australia. Scheduled to start production by the end of 2016, it is estimated to yield a peak output of 8.4 million tpy of LNG.

With this deal, Australia could challenge Qatar as the world’s biggest producer of LNG by 2020. Fueled by urgent orders from Japan and the energy-hungry economies of China, India, and other Asian countries, the demand for LNG is expanding much faster than projects can come onstream. Gas companies are spending billions of dollars building LNG plants. In Australia, they are currently working on seven of the world’s 10 major LNG projects.

Performing reliably
One fundamental contributor to the effectiveness of such huge investments is extremely reliable, high-performance equipment. Since 1974, Ebara International Corp.’s Cryodynamics Division has been supplying more than 6000 pumps and expanders for LNG carriers and land-based facilities, including major projects, such as those operated by Qatargas and RasGas or KNPC’s North Tank Farm.

Soon, Ebara will also contribute to the Ichthys LNG project, the world’s longest undersea gas pipeline venture, as well as to Shell’s Prelude facility, a groundbreaking...
achievement using innovative FLNG technology off the coast of Western Australia. Its pumps and expanders are designed to operate completely immersed in cryogenic liquids. This calls for a commitment to safety and quality that embraces all related components.

Safely powering the pumps
Utmost attention is given to the electrical system. The pumps mounted aboard the cryogenic containment require electricity for control, instrumentation and power of up to 6600 V. The penetration from atmosphere into the cryogenic liquid is accomplished using specially designed electrical feedthroughs, also called terminal headers. Since the late 1990s, Ebara has increasingly been equipping its installations with feedthroughs made by Schott Electronic Packaging, which use a unique compression glass-to-metal sealing technology.

Terminal headers perform two main functions: they safely provide electricity to highly susceptible appliances potentially exposed to explosive atmospheres, and they maintain the pressure boundary integrity of the containment structure. Meeting the most demanding applications for hermetic terminal headers, Schott’s feedthrough modules are resilient to thermo-cycling, thermo-shock, and temperature ranges from -196 to +100 °C (-320 to +212 °F).

Gastight contraction
The feedthroughs are sealed with non-ageing glass that remains pressure and vacuum-proof for many decades. Be it in LNG applications, hydrogen-cooled generators or even nuclear power plants and submarines, Schott’s sealing technology has proven its maintenance-free durability and reliability in more than 12 000 installations around the world since the early 1960s.

The terminal headers basically consist of only three components: metal conductors, a glass sealant and a metal housing. The preassembled components are heated up to a temperature at which the special glass melts to the metal. During the cooling process, the metal housing contracts to a greater extent than the glass, creating a robust, compression-sealed unit that guarantees practically unlimited pressure-proof hermeticity.

Advantages
In contrast, epoxy seals contain organic substances that age naturally, particularly when exposed to severe temperature fluctuations. An inorganic alternative is ceramic, but this material cannot be melted directly to metals like steel or copper. Soldering or welding is required that often tends to corrode in harsh environments, starting with surface imperfections that can develop into fissures. Due to the lack of compression sealing, ceramic isolators are also more likely to develop surface cracks over time. Such developments can impair the isolator’s dielectric function and lower the resistance of the seal following an accident. In addition, loss of tightness may occur.

However, glass-to-metal seals are proven to withstand extremely high pressure and thermal shocks. Before shipment, Schott tests each product vigorously at one-and-a-half times the maximum design pressure, up to 225 bar. It is thoroughly checked for leak tightness with helium mass spectrometers. An electrical test ensures that no short circuits result when electric power of up to 11 000 V and 1000 A flow through the glass-insulated conductors.

Approved and certified
As they are employed in hazardous environments, most cryogenic pumps require cable penetrations with a double safety barrier. Conventionally, two feedthroughs connected by cables are integrated in a row. However, a more compact double penetration developed by the company in close cooperation with its customers allows

Figure 1. LNG already accounts for nearly 35% of the world’s natural gas shipments. This success has been made possible by the fact that the highest possible safety standards apply. Gas-tight feedthroughs maintain the integrity of the pressure vessels.

Figure 2. Schott’s electrical penetration assemblies serve as the hermetic feedthroughs for the three-phase electrical power, as well as the control and instrumentation signals.
for smaller dimensioning of the feed lines. This offers the possibility of nitrogen purging for periodic or permanent leakage-monitoring or inertisation of both pressure barriers. The inner chamber can also be closed and certified as a flameproof enclosure. Therefore, no nitrogen purging equipment is required.

Both single barrier and double penetrations were thoroughly tested at Ebara’s cryogenic performance test facility in Nevada, US. The positive test results add to the feedthrough’s international quality certifications, which facilitate the approval of installations by customers and regulatory authorities. Schott’s explosion-proof glass-to-metal seals comply with the European ATEX directive and international IECEx standard, as well as specific local regulations, such as those from KOSHA (Korea Occupational Safety and Health Agency) for South Korea.

**Expanding offshore**

Schott has now arranged for all of its products designed for offshore applications to also be certified according to special standards for ship classifications. This certification, based on the so-called ‘plan approval,’ means it is no longer necessary to obtain a project-related approval for each separate use of the product. Once this certification is obtained, it will save the company’s customers a lot of time and effort, because products can be made available much more quickly.

This arrangement additionally supports the use of the company’s feedthrough technology not only in LNG shipping, but also in young and strongly expanding markets, such as maritime propulsion and smaller-scale LNG facilities near harbours. On top of that, the race for FLNG facilities, needed to tap more than 2000 trillion ft³ of proven undeveloped offshore gas reserves around the world, has just begun. Supplying Shell’s *Prelude* project, Schott and Ebara continue their pioneering partnership.

**Conclusion**

Providing safe, effective and reliable appliances required in LNG process technology demands expertise and state-of-the-art equipment. Schott’s hermetic glass-to-metal-sealed feedthroughs adhere to the highest quality standards and can be considered a safe technology for supplying electrical signals and power amidst the harshest environments. Their proven performance amplifies the efficiency and safety of submerged cryogenic pumps and expanders that serve in most of the world’s LNG facilities and aboard marine vessels. **LNG**
Hermetic. Safe. Maintenance-free.

Glass-to-Metal Sealed Electrical Terminal Headers for LNG Pumps

- **Non-aging** hermetic glass-to-metal sealing technology enables the safe and reliable supply of electricity to the submerged cryogenic pumps
- **Explosion-proof** electrical feedthroughs, manufactured according to ATEX and IECEx standards
- **Maintenance-free** in more than 2,500 pumps worldwide, after more than 35 years in the field