The production of LNG is comprised of several highly complex steps, all of which offer unique challenges to the project engineers who design and construct LNG facilities. The safe and reliable operation of any part of the LNG system is of utmost importance, and requires meticulous planning and execution by everyone involved. One particular safety aspect that must be considered is the design of tanks used in the processing and storage of LNG. Tank design, in particular tank base design, is crucial when dealing with the extremely low temperatures present in LNG applications. Freezing and frost formation at the base of the tank or the soil below may deform the tank base and can cause severe structural damage to the foundation. Plant operators risk long-term downturns to repair equipment or emergency shut down (ESD) to prevent the risk of fugitive emissions and possible explosions, which could lead to long-term financial disasters.

**Electrical heating**

The most effective way to prevent this effect from occurring is by means of electrical heating of the tank base. One of the most
result of a partial or complete failure of the base heating system. In many instances when frost heave has occurred, the affected tank must be emptied and decommissioned until the damage is repaired – insofar as repair is technically possible and financially reasonable.

**Heating cables**

The type of heating cable used is crucial to providing an effective and reliable tank heating system. Eltherm’s heating cable product offering includes a complete line of heating cable designs, including resistance, as well as parallel heating cables based on continuous wattage and self-regulating technology. This provides the company with the unique capability to offer a custom-fit heating solution for cryogenic tank applications. Choosing the design that best fits the particular challenge ensures the plant owner and operator avoids or limits unnecessary operation, energy and maintenance costs.

**Continued operation**

Regardless of the type of heating cable used, the most important performance requirement is that the heating system continues to operate during partial or total failure. This requires the design and installation of a redundant system, identical in design to the primary, which may be operated during maintenance and repair periods of the primary system. This configuration avoids a complete system failure and minimises the risk of damage to the tank structure. However, the heating system supplier must ensure that only the highest quality raw materials are used in the production of the heating cables and all parts of the system must undergo strict quality requirements and controls prior to delivery. Eltherm meets these challenges by providing heating cables designed for use in highly corrosive environments, and by offering products with high chemical resistance, which ensure long product life cycles and minimum maintenance requirements. The cables used for LNG applications are approved and certified for hazardous areas and are designed and manufactured in accordance with many internationally recognised standards, including VDE requirements.

**Ring wall heaters**

The scope of supply in a foundation tank heating system is generally not limited to the primary and secondary (redundant) base heating system. Ring wall heaters are incorporated into the design to optimise the temperature profile within the heated plane and reduce heat losses due to the high thermal conductivity of the material of construction. Heating of supply and transport piping, pumps and processing equipment associated with the upstream gas processing plant or downstream gasification units when present, may also be incorporated into a fully integrated system to complete the heating requirement in the LNG process and tank heating supply system.

**Control and monitoring**

The implementation of efficient control and monitoring technology is vital to ensure the safe and effective operation of any heating system design. An incorporated temperature control system, which includes the proper placement and installation of temperature sensing and monitoring
control system should be capable of notifying the operator of critical malfunctions of monitoring equipment, which include loss of signal or failure of temperature measurement equipment and controllers. Provisions for alarm indications for low or total loss of current and temperature must be made so that operations can make necessary corrections to minimise down time. State-of-the-art monitoring and control systems can be configured to communicate with and provide information to a facility’s distributed control system (DCS), or the system may be provided with an integrated supervisory control and data acquisition (SCADA) system to allow for local and remote monitoring and provide the ability to make adjustments as necessary.

**Conclusion**

The proper design and implementation of an LNG tank base heating system is critical to ensure a safe, reliable and efficient operation. There are many choices in heating cable designs, and the appropriate design should be carefully considered based on the requirements of each application. The harsh environment that all components of the heating system will be exposed to must also be considered, and material selection and workmanship of the heating cables is critical to ensure a long operational life-time.

The use of state-of-the-art design tools during the planning phase, including multi-dimensional modeling software which provide optimum layout and failure analysis, are vital to the successful implementation of a reliable tank base heating system.