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## Vacuum-Insulated Pipe vs. Conventional Foam-Insulated Pipe

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### The Challenge

In today's rapidly growing LNG supply market, Owner's, EPC's and Operators are researching a multitude of solutions to bring LNG terminals, export and import, online faster with greater efficiency. In addition to shortening the construction cycle, more and more companies are looking at all options to reduce the amount of time it takes a project to complete the initial FEED study and obtain Government approvals.

Traditional methods of field fabrication and insulation of LNG transfer piping leaves great opportunities for improvement.

The design and insulation requirements for handling a cryogenic liquid require extensive attention to thermal performance and safety. The extremely low temperature of LNG (-260F) and the fact its main component methane is a hydrocarbon, present terminal designers with added challenges.

A common obstacle to transferring LNG from ship to shore, and vice versa, is the site conditions of the terminal, its exact location along the coastline, as well as its proximity to wildlife refuges, residential communities and existing harbor activities. Many terminal locations, or proposed locations, provide a challenge to prospective owners in dealing with the environmental impact to the surrounding land and water access points along the coastline. With these challenges in mind, the owner can now deploy design options that until now have not been available for installing an LNG transfer system. Such options include below ground and sub-sea installations. In certain locations, the option of routing LNG transfer piping underground or under water, offers significant advantages. Traditional mechanical insulation systems can only be installed above ground. Due to the limitations of mechanically insulated piping systems, below ground installations and sub-sea applications would require significant advancements and investments in containment technology and therefore are not a viable alternative. The robust design associated with Vacuum Insulated Pipe allows innovations to

be considered for installing LNG transfer piping above ground, underground and sub-sea.

### Traditional Technology

Historically, LNG terminal fabricators field fabricate all necessary cryogenic pipe onsite and mechanically insulate it with polyisocyanurate, cellular glass or other mechanical insulation materials. Onsite fabrication requires a significant investment and resource commitment to manage labor, materials, field equipment and adds several months to the construction schedule. Traditional foam insulation technology also requires EPC firms to dedicate more space in piping racks to accommodate the larger diameters associated with thick layers of mechanical insulation. Once the mechanical piping system is installed, upon start up, the thermal efficiency of the insulation begins to deteriorate. The deterioration is due breeches in the vapor retarding barrier, a result of thermal contraction when the cryogenic liquid is introduced to the system. Over time, moisture is drawn into the insulation, causing it to freeze and over a short period of time deteriorate. The deterioration causes the operator of the terminal to constantly patch and re-insulate the piping system, all the while costing the terminal lost profits due to unwanted vaporization of the liquid.

Traditional technology also requires incorporation of expansion loops to allow for the thermal expansion and contraction of the piping system. Expansion loops increase the overall total footage of piping required for the system. Expansion loops contribute additional material costs, greater system pressure drop, increased heat entering the liquid and larger pipe racks which are needed to support the large expansion loops.

### Vacuum Insulated Technology

Vacuum Insulated Piping systems are by far the most thermally efficient solution for transferring liquids at cryogenic temperatures. Recently there have been several new insulations introduced to the market. Such new technologies include dynamic vacuum insulation and aero-gel insulation. While these insulations are more advanced than foam insulation, they are by no means equivalent to static Vacuum Insulated Pipe in terms of thermal performance. Dynamic vacuum (continuously pumping) systems are comparable in thermal performance, but increase the overall project costs with the added amounts of electricity and maintenance. Aero-gel insulation technologies, while expensive to procure still