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Modification of liquid hydrogen tank for integrated refrigeration and storage

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The modification and outfitting of a 125,000-liter liquid hydrogen tank was performed to provide integrated refrigeration and storage capability. These functions include zero boiloff, liquefaction, and densification and therefore requires provisions for sub-atmospheric tank pressures within the vacuum-jacketed, multilayer insulated tank. The primary structural modification was to add stiffening rings inside the inner vessel. The internal stiffening rings were designed, built, and installed per the ASME Boiler and Pressure Vessel Code, Section VIII, to prevent collapse in the case of vacuum jacket failure in combination with sub-atmospheric pressure within the tank. For the integrated refrigeration loop, a modular, skeleton-type heat exchanger, with refrigerant temperature instrumentation, was constructed using the stiffening rings as supports. To support the system thermal performance testing, three custom temperature rakes were designed and installed along the 21-meter length of the tank, once again using rings as supports. The temperature rakes included a total of 24 silicon diode temperature sensors mounted both vertically and radially to map the bulk liquid temperature within the tank. The tank modifications were successful and the system is now operational for the research and development of integrated refrigeration technology.

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