### **18-4. ElectroChemical Hydrogen Refrigeration (ECHR)**

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NASA and Meta Vista have been actively working the development of a new type of cryogenic refrigeration cycle, one that uses hydrogen as the working fluid and compresses this hydrogen using an electrochemical hydrogen compressor. This new cycle has many advantages compared to current state of the art. The electrochemical compressor is more efficient than a mechanical compressor. It is a solid-state device with no moving parts, no vibration, and no lubrication requirements. The compressor is powered by direct current, so there is no Electromagnetic Interference (EMI). The power systems integration will be simpler and more efficient than typical space cryocooler power systems.

NASA has been leading the design, fabrication and testing of the cold box portion of the system, while Meta Vista USA has been working with Skyre, Inc. to design, fabricate and test the compressor. The cold box detailed design has been completed, the fabrication has been completed, and performance testing is currently underway at the Cryogenic Test Laboratory (CTL). The compressor design and fabrication have also been completed, and the compressor performance testing is currently underway at the Skyre facility in West Hartford, Connecticut. There have been several developmental issues with the electrochemical compressor fabrication that have delayed the fabrication. These issues have been resolved and delivery of the compressor for integrated testing with the cold box should occur in the next several months.

An assessment on the possible use of the ECHR technology for other NASA applications has been completed. There are multiple potential infusion points for this technology. These range from small scale cryocoolers for science missions, to mid-scale zero boil off systems for in-space propulsion including Nuclear Thermal Propulsion (NTP), to large scale Liquid Oxygen (LOX) and Liquid Hydrogen (LH2) liquefaction of In Situ Resource Utilization (ISRU) produced propellants. There will be some modifications required to accommodate the challenging space environment but there appear to be no showstoppers in either the scaling of environment that would prevent use of the ECHR. Meta Vista USA and NASA CTL will continue the development and testing of this technology into the near future.