The High Flux Isotope Reactor (HFIR) Cold Source Project at ORNL

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In February 1995, Oak Ridge National Laboratory's (ORNL) deputy director formed a group to examine the need for upgrades to the High Flux Isotope Reactor (HFIR) system in light of the cancellation of the Advanced Neutron Source Project. One of the major findings of this study was that there was an immediate need for the installation of a cold neutron source facility in the HFIR complex. In May 1995, a team was formed to examine the feasibility of retrofitting a liquid hydrogen (LH_2) cold source facility into an existing HFIR beam tube. The results of this feasibility study indicated that the most practical location for such a cold source was the HB-4 beam tube. It was determined that at the 100 MW reactor power level the cold neutron beam produced by the proposed cold moderator would be comparable, in cold neutron brightness, to the best facilities in the world. As a result, a decision was made to proceed with the design, safety evaluation, and procurement necessary to install a working LH_2 cold source in the HFIR HB-4 beam tube. During the development of the reference design the liquid hydrogen concept was changed to a supercritical hydrogen system for a number of reasons.

The scope of this project includes the development, design, procurement/fabrication, testing, and installation of all of the components necessary to produce a working cold source within an existing HFIR beam tube hole in the pressure vessel. All aspects of the cold source design will be based on demonstrated technology adapted to the HFIR design and operating conditions.

The cold source project has been divided into four phases: (1) preconceptual, (2) conceptual design and testing, (3) detailed design and procurement, and (4) installation and operation. Although there is some time overlap between the phases, in general, they are sequential. The preconceptual design study was completed in early FY 1996, and the Preconceptual Design Report was issued in December 1995. The conceptual design and testing phase is now complete and a report (High Flux Isotope Reactor Cold Neutron Source Reference Design Concept - ORNL/TM-13498) will be issued shortly which includes a description of the design, the details of prototypic supercritical hydrogen loop tests, and the preliminary safety analysis.

Optimization is to be based on the neutron brightness ($/s/cm^2/steradian/Å$) delivered to instruments at wavelengths from 4 to 12 Å. The gain factor on brightness, as measured on HB-4, for these wavelengths should be comparable to existing cold sources of similar geometry (~10 to 20 at 7Å). Sensitivity studies of the ortho-/para-hydrogen ratio have been performed to address the physics design impact of the uncertainty of this ratio.

Hydrogen loop tests have been performed at the Arnold Engineering Development Center to evaluate the cold source loop behavior for normal operation and for certain transient conditions. This hydrogen test loop was constructed inside of a 12.8 m diameter, 25.0 m high vacuum chamber to prototypic designs in pipe diameters, lengths and elevations. The data obtained from these tests are being used to benchmark our analytical hydrogen loop system model.

The project schedule is based on the assumption that the cold source components to be located inside the HB-4 beam tube will be installed during the six-month reactor outage currently scheduled to begin in the summer of 2000 to replace the reactor beryllium reflector. Fabrication of a 3.5 KW refrigerator has been initiated with expected delivery in the fall of 1998. Final testing of the as-built hydrogen system is expected to begin in the fall of 1999 prior to installation into the reactor in the summer of 2000.

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