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upgrading scientific capabilities at the high flux isotope reactor*

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Abstract

Following termination of the Advanced Neutron Source (ANS) Project, a program of upgrades to the Department of Energy's High Flux Isotope Reactor (HFIR) was devised by a team of researchers and reactor operators and has been proposed to the department.

HFIR is a multipurpose research reactor, commissioned in 1965, with missions in four nationally important areas: isotope production, especially transuranic isotopes; neutron scattering; neutron activation analysis; and irradiation testing of materials.

For neutron scattering, there are two major enhancements and several smaller ones. The first is the installation of a small, hydrogen cold neutron source in one of the four existing beam tubes: because of the high reactor power, and the use of new design concepts developed for ANS, the cold source will be as bright as, or brighter than, the Institut Laue-Langevin liquid deuterium vertical cold source, although space limitations mean that there will be far fewer cold beams and instruments at HFIR. This project is underway, and the cold source is expected to come on line following an extended shutdown in 1999 to replace the reactor's beryllium reflector.

The second major change proposed would put five thermal neutron guides at an existing beam port and construct a new guide hall to accommodate instruments on these very intense beams.

Keywords: cold source, thermal neutrons, HFIR

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Recent reviews in the United States of the need for neutron sources have all recognized that there are important scientific and isotope production needs that can only be met with a high-powered research reactor. The High Flux Isotope Reactor (HFIR) at Oak Ridge has the highest thermal neutron flux (the single most important measure of neutron source capabilities) of any research reactor in the western world. It is a multipurpose reactor, serving many areas of science, including neutron scattering, isotope production, neutron activation analysis, and materials irradiation testing. Although HFIR first went critical in 1965, recent measurements and analysis have shown that with minor replacements and appropriate maintenance, it can operate for many more years (at least until 2035). A set of upgrades has been proposed that will benefit all of these applications, but this paper concentrates on the neutron scattering enhancements.

First, a cold neutron source, with a moderator of supercritical hydrogen at 20 K (see Fig. 1), will be installed during the long shutdown planned to replace the beryllium reflector that will begin in 1999. Figure 2 shows the location of the cold source. The design of this cold source, based on work done for the Advanced Neutron Source Project (now terminated), uses a forced convection cooling system that will allow the cryogenic moderator to be placed very close to the core: despite the lower efficiency of a small hydrogen cold source compared with a large deuterium one, the extremely high thermal neutron flux near the HFIR core will give cold neutron beams comparable to those at the Institut Laue-Langevin, the leading facility in this field.

Second, the new beryllium reflector will be provided with a larger thermal beam tube in place of the present HB-2 radial beam (see Fig. 2), and this larger tube will contain specially shaped beryllium inserts invented by Lee Robertson. The combination of a larger area and the inserts is expected to give a fivefold increase in the useful neutron current. Eventually, an array of five supermirror thermal neutron guides and a large new guide hall outside the existing HFIR containment building are proposed that will provide the world's most intense thermal beams to as many as 15 new instruments. Pending

funding for that project, a smaller array of six instruments will be placed on the beams from the new, enlarged HB-2, inside the existing containment (see Fig. 2).

Third, it is proposed to return to the original 100-MW_{th} operating power, which would increase the neutron flux by almost 20% compared with the present 85-MW_{th} operation.

Fig. 1. Isometric Sketch of Cold Source Capsule

Fig. 2. Cold Source and HB-2 Thermal Beam Proposals

Figure Captions

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