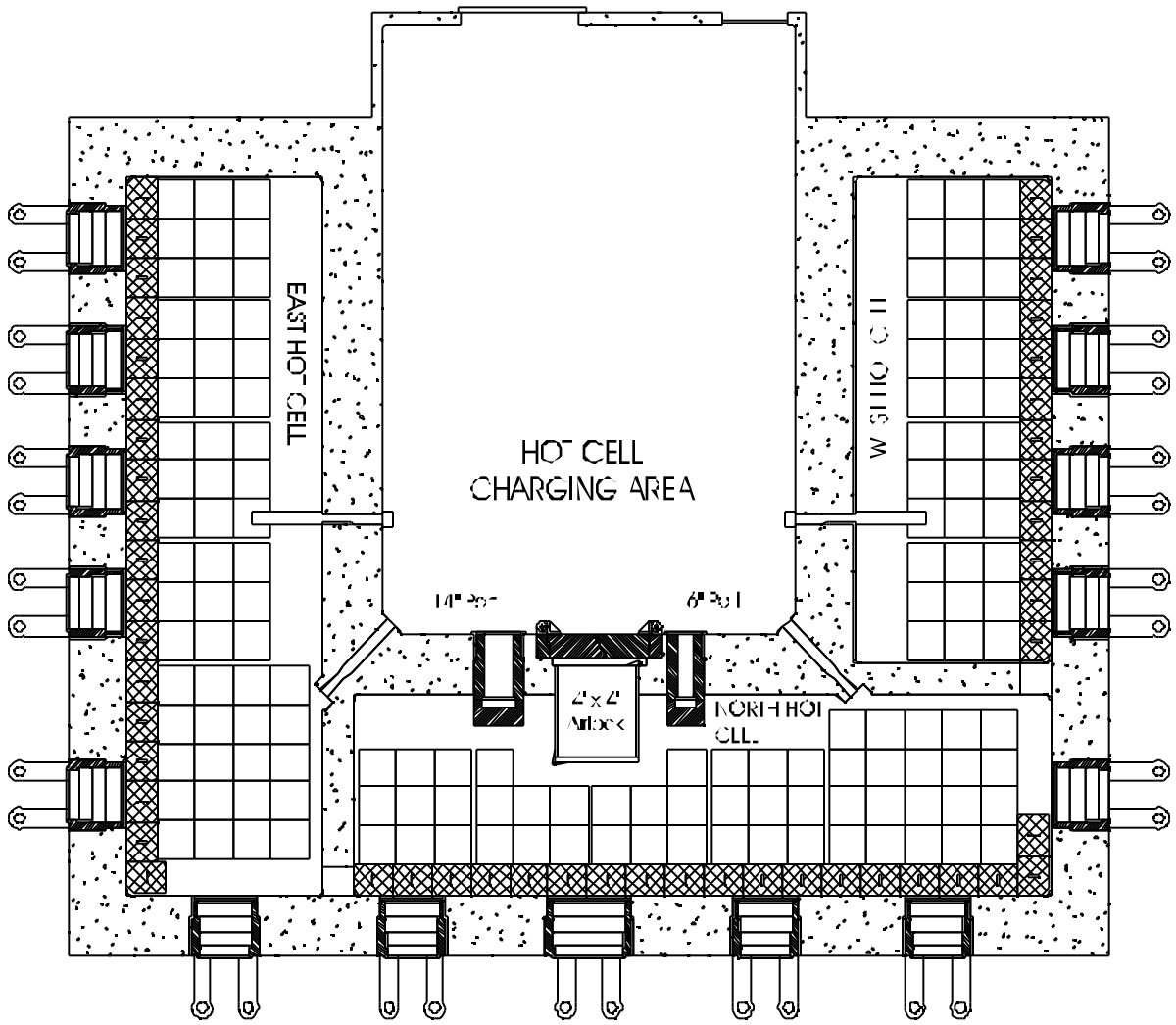
Irradiated Fuels Examination Laboratory
[Building 3525]

Facility

The Irradiated Fuels Examination Laboratory (IFEL), Building 3525, has a long history of fuel research and examination. It is in the Bethel Valley portion of Oak Ridge National Laboratory (ORNL), approximately 8 miles southwest of the city of Oak Ridge, Tennessee. Over a period of three decades this facility has handled a wide variety of fuels including aluminum clad research reactor fuel, both stainless and zircaloy clad LWR fuel, coated-particle gas cooled reactor fuel, and numerous one of a kind fuel test experiments. In addition, the facility has also done iridium isotope processing and irradiated capsule disassembly.

The IFEL contains a large horseshoe-shaped array of hot cells which are divided into three work areas. The hot cells are constructed of 3-ft thick high density concrete walls with oil filled lead glass viewing windows. The inside surfaces of the cell bank are lined with stainless steel to provide containment of particulate matter and to facilitate decontamination. Special penetrations are provided for the sealed entry of services such as instrument lines, lights, and electrical power. A pair of manipulators is located at each of 15 window stations for remote cell operations and periscopes allow for magnified views of in-cell objects. Heavy objects within each cell bank can be moved by electromechanical manipulators or a 3 ton crane. Fuel materials enter and leave the cells through three shielded transfer stations provided at the rear face of the North cell. Two small diameter (6.5 & 14.5 in) horizontal transfer stations are used for small objects (less than 8 ft in length). Items up to 4 by 4 by 6 ft in size can be transferred through the shielded air-lock door system. In addition, with minor modifications for cask handling, full length light water reactor fuel rods can be handled

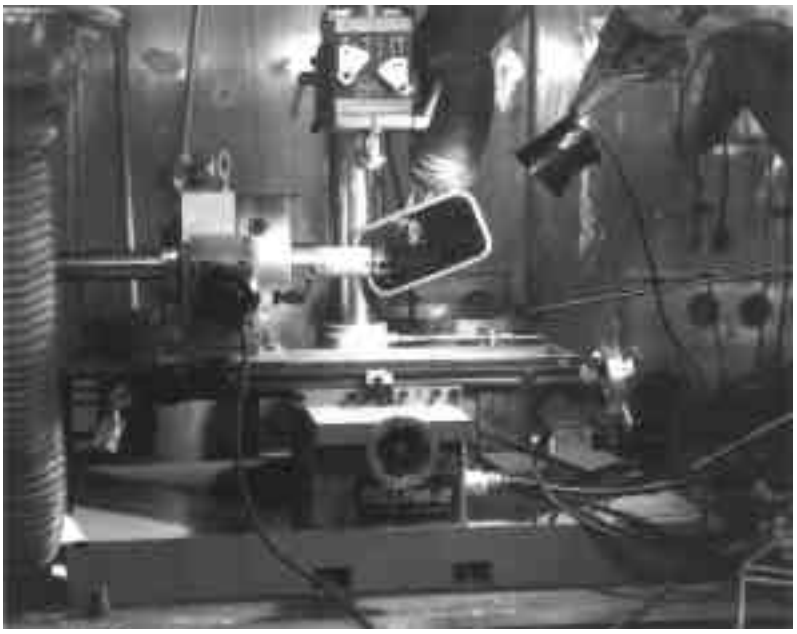
The remainder of the laboratory outside the hot cell complex is subdivided into: (1) the charging area; (2) the equipment maintenance air lock areas; (3) the operating area; (4) the truck unloading



area, the change room, and a work room; (5) the rooms housing supporting mechanical equipment; (6) the decontamination area; and (7) the hot equipment storage area.

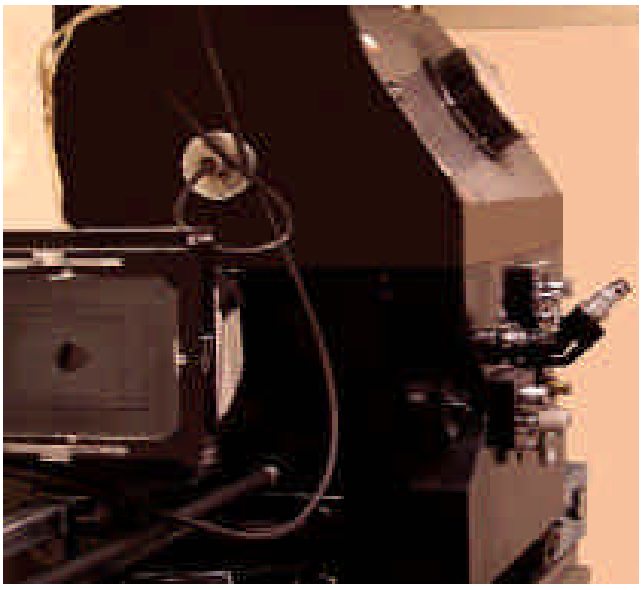
The shielded decontamination area and the hot equipment storage area, located on the second floor of the building, are connected via hatches to the cells below. A maintenance area incorporating glove box facilities for servicing equipment items adjoins the decontamination area. Sliding doors separate the decontamination area, storage area, and glove maintenance room; a remote crane system provides for retrieval of equipment into and transfer of items between these second floor facilities. Equipment may be transferred between cells through the second floor pathway. An upper level of the second floor houses ventilation system ducts, control valves,

high efficiency particulate air filters, heat exchangers, and air inlets for the equipment storage area, the decontamination area, and the glove maintenance area.
Gases and particulates exhausted from the cell complex are completely contained and shielded until subjected to sufficient filtration to ensure safe stack disposal. The cell air is maintained at negative pressure with respect to the operating areas to ensure confinement. Liquid effluent from the hot cells is handled in a batch mode for disposal to the ORNL low-level liquid waste system.



Remote Examination

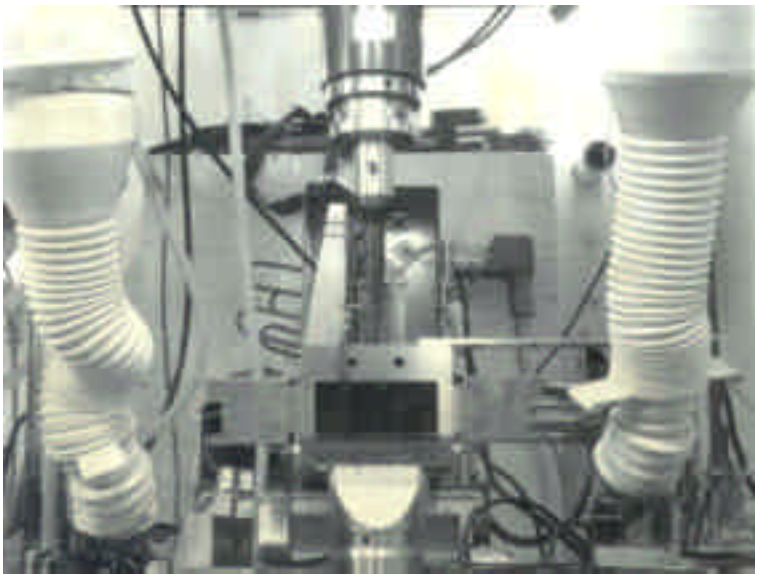
A variety of shears, machine tools, and cutoff saws are available within the cell for the disassembly of irradiation capsules and the preparation of fuel specimens. The facility has experience in the handling and cutting of a wide variety of capsule and clad materials such as Inconel, stainless steel, zircaloy, aluminum matrix, and graphite based materials. A gamma scanner is available for the non- destructive examination of moderate length fuel rods and individual specimens. Metrology equipment such as mass scales and dimensional tools are routinely used and available.



Metallography & Ceramography

Metallographic equipment including precision cutoff saws, polishers, and a shielded metallograph are available for the preparation, handling, and examination of both fuel specimens and clad material. A fully equipped metallographic line is maintained in the West Hot Cell. Radiochemical specimens can be prepared within the facility and delivered to other ORNL laboratories for detailed analysis. The facility has prepared samples of oxide fuels, carbide

fuels, and metal matrix fuels. Extensive testing of non-fuel items such as cladding can be carried out at a sister facility, Building 3025E. ORNL also has extensive computational abilities which can be used to process the hot cell data for comparison with fuel performance models.



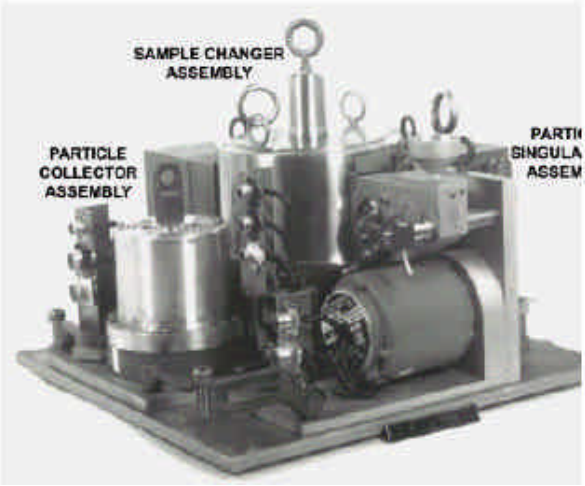
Additional Capabilities

The IFEL also has other facilities outside the main bank of cells. Three free standing shielded cubicles are located on the first and second floors of the building which contain specialized equipment which was associated with the post-irradiation examination and accident condition testing of HTGR type fuels.

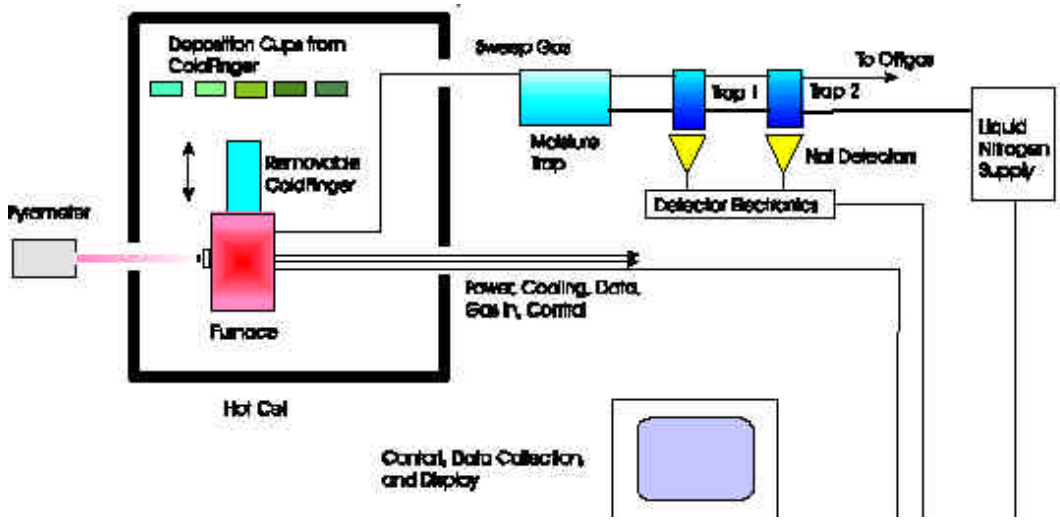
The Scanning Electron Microscope (SEM) cubicle is located on the second floor above the West Hot Cell and is connected to the West Cell by an in-wall shielded elevator. The cubicle contains a precision balance and a vacuum coating system for both gold and carbon coating of SEM specimens. A special transfer port is mounted on the side of the cubicle which allows remote handling of specimens to be loaded into the SEM system located adjacent to the cubicle. The SEM currently available is a JEOL JXA 840A system with both wavelength dispersive spectrometry (WDS) and energy dispersive spectrometry (EDS) capability. Radioactive specimens up to 1 R/hr can be examined in this system.

Extensive radiochemical analysis is available to support PIE work at Building 2026. Solution separations, isotope analysis, and gamma counting are available.

The Irradiated Microsphere Gamma Analyzer (IMGA) cubicle is located on the second floor above the East Hot Cell and is connected to the East Cell by an in-wall shielded elevator. The cubicle contains several pieces of equipment designed for handling individual HTGR microspheres (coated particles). The cubicle has a shielded stereo-microscope with a 3 axis stereo-stage and micro-manipulator for handling individual particles. It also houses the IMGA system which is a fully automated device for examining individual HTGR microspheres using a high-resolution gamma-ray spectrometer. The IMGA system measures the absolute activities of the particles it examines, and, by means of special user programmed instructions, is able to segregate particles based on the measured activities.

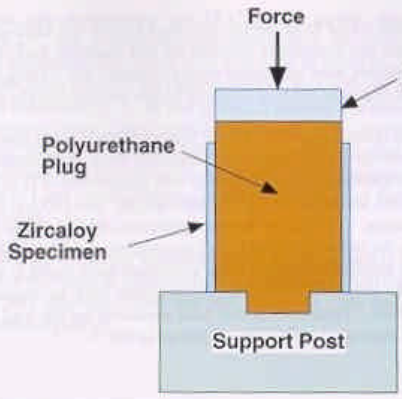


The Core Conduction Cooldown Test Facility (CCCTF) cubicle is located on the first floor of the IFEL. Samples to be tested are transferred to and from the cubicle using small shielded casks. The cubicle contains a fully programmable furnace facility with special sampling features. The

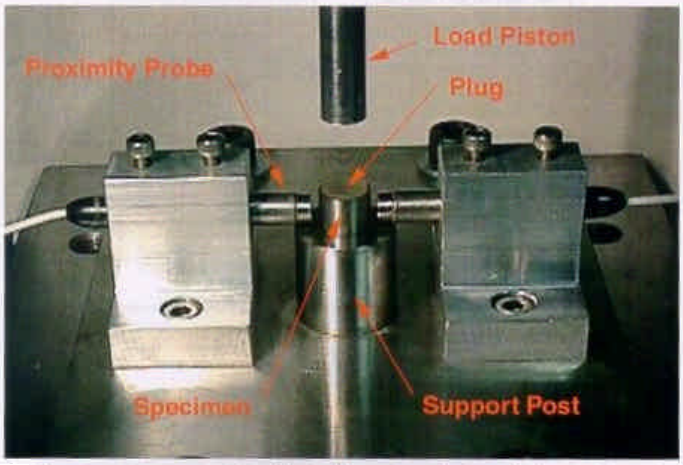


furnace is capable of temperatures up to 2000EC when using an inert atmosphere such as helium.

Recently, a novel apparatus for fuel cladding ductility testing has been developed. This apparatus uses an expanded plug method to apply a tensile force to a small ring of clad material. The advantage of this method is that only small amounts of material are required, no special machining is needed, and no slots that introduce stress risers are cut into the specimens. The stress field is symmetric and relatively simple to analyze.



Schematic of ORNL developed Expanded Plug test setup for clad ductility testing.



Prototype of test setup for clad ductility testing showing relative positions of plug, specimens, and proximity transducers.

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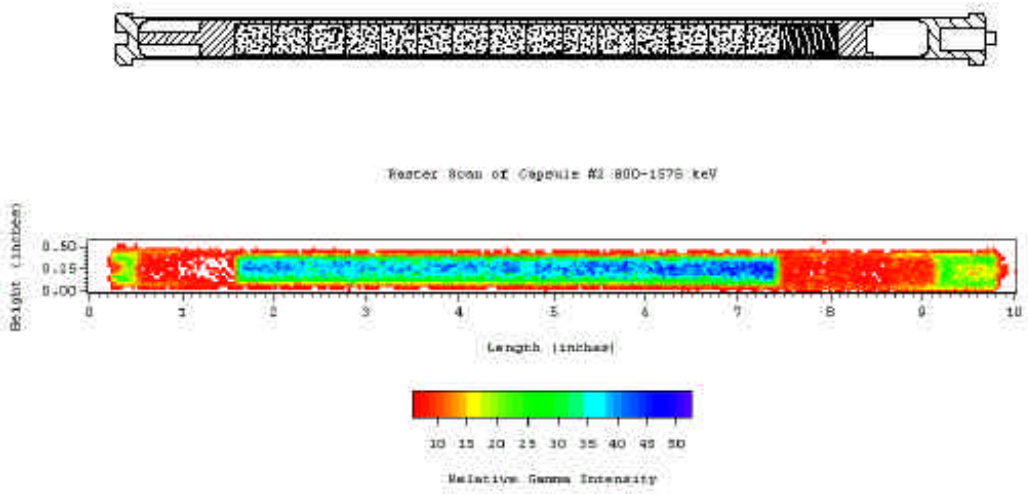
Past Programs

Past work includes extensive support for the Gas Turbine Modular High Temperature Gas

Cooled Reactor (GT-MHR) program, the New Production Reactor (NPR), a cooperative gas cooled reactor agreement with Japan, and handling of legacy fuel under the National Spent Fuel program. Personnel are available with experience in a wide variety of fuel post irradiation examination programs and analysis techniques along with the detailed reporting and quality control requirements for nuclear programs. The Metals and Ceramics (M&C) division contains a wealth of experience in fuel fabrication, metal and ceramic material behavior, irradiated material behavior, and material testing. Ongoing programs at ORNL maintain experience in hot cell techniques and analysis. In addition, academic and industrial consultants are available to meet special program needs and to conduct reviews.

MOX Work in Support of the FMDP

The IFEL is currently preparing for the last post irradiation examination of the MOX average power test capsules. These capsules examined irradiation issues surrounding the use the weapons derived plutonium in MOX fuel for commercial power reactors. The first set of capsules was withdrawn from the Advanced Test Reactor in the Fall of 1998 and examinations have been undertaken at 10, 21, 30, and 40 GWd/MT. The final examination at 50 GWd/MT will be undertaken in the Spring of 2004. This work is being conducted under the auspices of the Fissile Materials Disposition Program.



Full Length LWR Rods

ORNL is planning an upgrade of the Building 3525 hot cells to allow the handling and examination of full length LWR fuel rods. This upgrade is expected to be started during CY 2004 and to be ready for PIE work in the Spring of 2005. A series of PIE tools for a typical LWR fuel examination is planned for installation during the same time frame.