United States Idaho National Laboratory and Oak Ridge National Laboratory

ICERR Description

1. General Presentation of Idaho National Laboratory and Oak Ridge National Laboratory

The International Atomic Energy Agency (IAEA) has established a designation for an International Centre based on Research Reactors (ICERR). The intention of this designation is to provide a vehicle for IAEA member-states to access international research reactor and ancillary nuclear research and development infrastructure.

The U.S. Department of Energy (DOE) has made a commitment to world leadership in the development of advanced nuclear energy, science, and technology. To this end, DOE has established programs and initiatives to enhance this leadership role.

The Idaho National Laboratory (INL), along with its partner laboratory Oak Ridge National Laboratory (ORNL) is leading these initiatives for DOE. Both INL and ORNL have a decades-long and storied history that supports nuclear research, development, and deployment both nationally and internationally. Both have a history of safe and efficient nuclear operations and have a demonstrated a track record of international collaboration and cooperation.

2. Short descriptions of facilities included in the U.S. ICERR designation

INL's Advanced Test Reactor (ATR): The Advanced Test Reactor supports nuclear science and engineering missions for the U.S. Department of Energy's Office of Nuclear Energy research and development programs, Naval Reactors, universities, as well as other government and industry-sponsored commercial and international research. It is the only U.S. research reactor capable of providing large-volume, high-flux neutron irradiation in a prototypical (e.g. pressure, temperature and chemistry) environment. ATR makes it possible to study the effects of intense neutron and gamma radiation on reactor fuels and materials in a much shorter time frame, permitting accelerated research efforts.

Basic Capabilities and Features

- High-power (250 MW) test reactor operating at low temperature and pressure
- Individual experiment loops capable of replicating physical environments for experiments (temperatures >500^0 C, pressures >17.9 MPa and chemistry)
- Light water reactor design with a beryllium reflector for high neutron efficiency
- Unique serpentine core allows the reactor's four lobes to operate at different power levels, allowing multiple simultaneous experiments under different testing conditions
- Large test volumes – up to 48 inches long and from 0.5 to 5 inches diameter
- 75 testing positions
- High neutron flux (up to ~10^{15} n/cm^2/sec) available
- Fast/thermal flux ratios ranging from 0.1-1.0

- Constant axial power profile
- Frequent experiment changes possible each outage
- Programmatic operational commitment for decades to come

ORNL's High Flux Isotope Reactor (HFIR): Operating at 85 MW, HFIR is the highest flux reactor-based source of neutrons for condensed matter research in the U.S., and it provides one of the highest steady-state neutron fluxes of any research reactor in the world. The fast, thermal and cold neutrons produced by HFIR are used to study physics, chemistry, materials, engineering and biology. HFIR is currently scheduled to provide 140 days of 100% power operation per year.

Basic Capabilities and Features

- 30 target positions in the flux trap
- Hydraulic tube facility, allowing installation/removal during reactor operation
- Two flux trap positions accommodating instrumented experiments
- Six peripheral target positions
- Twenty-one vertical irradiation facilities
- Two pneumatic tube facilities in the beryllium reflector to allow insertion and removal of experiments during reactor operation
- Two slant-access facilities
- Small, removable irradiation positions for radioisotope production
- Large removable beryllium facilities for experiments requiring a fast neutron flux
- Peak neutron flux in the flux trap is 2.5×10^{15} n/cm^2/sec
- Fast/thermal flux ratio in flux trap of 2.0

INL's Transient Reactor Test Facility (TREAT): The TREAT reactor provides transient testing of nuclear fuels. It is an air-cooled, thermal spectrum test facility specifically designed to evaluate the response of reactor fuels and structural materials to accident conditions, ranging from mild upsets to severe accidents. TREAT is used to study fuel melting behavior, interactions between fuel and coolant and the potential for propagation of failure to adjacent fuel pins. It has an open core design that allows for ease of experiment instrumentation and real-time imaging of fuel motion during irradiation, which also makes TREAT an ideal platform for understanding the irradiation response of materials and fuels on a fundamental level.

Basic Capabilities and Features

- High-intensity (18 GW), short-duration (100 ms) neutron pulses for severe accident testing
- Shaped transients at intermediate powers and times (3 GW, several seconds)
- 100 kW steady-state operation
- Testing capability for static capsules, as well as sodium and water loops
- Neutron radiography facility
- Neutron "Hodoscope" providing real-time imaging of fuel motion during testing

INL's Hot Fuel Examination Facility (HFEF): The Hot Fuel Examination Facility (HFEF) is a multi-program hot facility. There are two adjacent shielded hot cells (the main cell and decontamination cell), a shielded metallography box, an unshielded hot repair area, and a waste-characterization area. HFEF provides shielding and containment for remote examination, processing, and handling of highly radioactive and transuranic-bearing materials in its argon-atmosphere hot cells, unshielded labs, support areas and special equipment for handling, examining, and testing of highly radioactive materials.

ORNL's Irradiated Fuels Examination Laboratory (IFEL): The IFEL was designed and constructed to permit the safe handling of increasing levels of radiation for chemical, physical and metallurgical examination of nuclear reactor parts.

ORNL's Low Activation Materials Development and Analysis Laboratory (LAMDA): LAMDA is specifically designed for working with low-activity samples, including materials that do not activate significantly under irradiation (such as composites or reactor-pressure -vessel steels) or higher-activity specimens that are either smaller in size or have decayed to lower levels. Samples are routinely received in LAMDA by way of the ORNL hot cell facilities where irradiation capsules are dismantled or higher activity packages are sorted. LAMDA can also receive specimens directly from facilities around the world if the activity is low enough.

INL's Electron Microscopy Laboratory (EML): The electron microscopy lab (EML) is a user facility dedicated to materials characterization, using primarily electron and optical microscopy tools. Sample-preparation capabilities for radioactive materials ensure that high-quality samples are available for characterization.

ORNL's Irradiated Materials Examination and Testing Facility (IMET): The Irradiated Material Examination and Testing Facility was designed and built as a hot cell facility. It is a block and brick structure with a two-story high bay that houses six heavily shielded cells and an array of 60 shielded storage wells. It includes the Specimen Preparation Lab (SPL) with its associated laboratory hood and glove boxes, an operating area, where the control and monitoring instruments supporting the in-cell test equipment are staged, a utility corridor, a hot equipment storage area, and a tank vault room. Tests and examinations are conducted in six examination "hot" cells and/or in a laboratory hood or modified glove boxes in the SPL.

INL's Experimental Fuels Facility (EFF): The Experimental Fuels Facility houses a wide range of fuel fabrication capabilities, supporting customers in DOE's Office of Nuclear Energy and private industry partners through INL's cooperative research & development program.

INL's Fuel Manufacturing Facility (FMF): The Fuel-Manufacturing Facility is a hazard category 2 nuclear facility that consists of multiple workrooms and a material storage vault. The workrooms house the equipment utilized to support multiscale fuel development. The vault contains and supplies the feedstock materials used for numerous programs in multiple facilities at MFC.

INL's Fuels and Applied Science Building (FASB): The Fuels and Applied Science Building is a radiological facility that has broad capability in fuel fabrication and characterization in support of nuclear-energy research and development. The most recent addition to FASB is the irradiation assisted stress corrosion cracking (IASSC) hot cell. This addition supports several program customers through the Department of Energy's Nuclear Science User Facilities (NSUF) program to perform crack growth rate measurements on irradiated structural materials to support light water reactor life extension.

INL's Irradiated Materials Characterization Laboratory (IMCL): The Irradiated Materials Characterization Laboratory is a Hazard Category 2 nuclear facility that focuses on microstructural, thermal, and mechanical characterization of irradiated nuclear fuels and materials. IMCL's unique design incorporates advanced characterization instruments that are sensitive to vibration, temperature, and electromagnetic interference into modular radiological shielding and confinement systems. The shielded instruments allow characterization of highly radioactive fuels and materials at the micro, nano and atomic levels, the scale at which irradiation damage processes occur. Enabled by its modular design, IMCL will continue to evolve and improve capability throughout its 40-year design life to meet the national and international user demand for high-end characterization instruments.

ORNL's Radiochemical Engineering Development Center (REDC): The Radiochemical Engineering Development Center is a multipurpose radiochemical processing and research facility that includes laboratories, glove- boxes and heavily shielded hot cells. The REDC includes personnel with radiochemical processing expertise and special equipment and systems to support the nation's research and development (R&D) needs in the production of unique radionuclides for use in research, defense, medical and industrial applications. The REDC is comprised of two facilities - Building 7920, a two-level structure built in 1966; and Building 7930, a three- level structure built in 1968. Both buildings are classified as hazard category 2 nuclear facilities and include hot and cold laboratories, hot cells and high bay space.

REDC's primary mission areas currently include the production of ^{238}Pu for use in radioisotope power systems for NASA, expanding the availability of isotopes for use in targeted alpha therapies in cancer treatment, and expanding the availability of transuranics (Cf, Bk, Es, Fm) for industrial and research applications.

3. U.S. ICERR Contact and more information

The primary contact for U.S. designated ICERR facilities is Dr. Sean O'Kelly, Associate Laboratory Director of the Advanced Test Reactor at Idaho National Laboratory.

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More information can be found at:

Idaho National Laboratory website, inl.gov.

ATR Fact Sheet

Oak Ridge National Laboratory website, ornl.gov.

HFIR Fact Sheet

Nuclear Science User Facilities