NSUF Resources and the Combined Materials Experimental Toolkit (CoMET)

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Chief Irradiation Scientist, NSUF
National Technical Director, I2

INL/MIS-18-51686
Integrated Infrastructure Enhancement

1. Gather Data on Nuclear Energy R&D Capabilities
2. Estimate DOE-NE R&D Directions and Industry priorities
4. Assist funding decisions and incorporate the results into the NEID.
Award Announcement

3 RTE Call 3
Data Collection and Structure

Direct Infrastructure Sources

1. IAEA Databases (RTF, RTR & Beamline databases) ≤ 2014
2. Facility Site web site 2014
4. Facility Fact Sheets/Annual Reports/etc. 2014
5. lightsources.org web site 2014
7. Alternatives to APIE report & raw data 2012
8. DOE Facilities Inventory Draft (6.16.2014) 2014
10. NEUP RR Infrastructure Program Annual Reports 2012-3
11. INL Ten-Year Site Plans 2012-4
12. DOE-SC User Facilities Ten-Year Plan 2013
13. DOE-NE Infrastructure Awards 2014
14. INL iPIP Database 2012
15. INL NS&T Inventory System 2014
16. NRC TRTR Licensing Presentation 2014
17. NRC TRTR Licensing Presentation 2012
18. NS&E Education Sourcebook (ANS/DOE) 2013
20. NRC Compliance Certificate (RAMPAC) 2014
## Facilities Search Result

<table>
<thead>
<tr>
<th>Facility</th>
<th>Institution</th>
<th>Owner Type</th>
<th>Primary Type</th>
<th>Materials Allowed</th>
<th>NSUF Partner</th>
<th>Website</th>
</tr>
</thead>
<tbody>
<tr>
<td>Advanced Test Reactor</td>
<td>Idaho National Laboratory</td>
<td>Dept of Energy</td>
<td>Reactor</td>
<td>beta/gamma only</td>
<td>NSUF</td>
<td>Website</td>
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<td>Reactor</td>
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<td>NSUF</td>
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<td>Partner</td>
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<td>Annular Core Research Reactor</td>
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<td>beta/gamma only</td>
<td>Partner</td>
<td>Website</td>
</tr>
</tbody>
</table>

Showing 1 to 50 of 88 entries
NEID Entry for the ATR

Institution: Idaho National Laboratory
Name: Advanced Test Reactor (ATR)
Building: TNA-670
Primary Type: Reactor
Reactor Type: Test
Thermal Power (MW): 250
Pulse Power: 0
Thermal Flux (pcm*2s): 1e+15
Fast Flux (pcm*2s): 5e+14
In Core Locations: 66
Ex Core Locations: 34
PTS: 1
Flow Loops: 5
Beam Ports: 0
Core Functions: Advanced Fuels and materials irradiation. Water-cooled, high-flux test reactor
Unique Functions: Five in-pile pressurized water loops currently provide prototypic PWR conditions (pressure, temperature, flow, water chemistry) for fuel and material samples with the ability to tailor the neutron flux to meet desired conditions. Each loop has a full range of instrumentation capabilities. Two of the five loops have transient testing capabilities. There are proposed plans to reactivate a sixth water loop. The ATR has a capacity for up to nine water loops.

Hotwork Facilities: HFIF
Support Equipment: NFC Test Train Assembly Facility
Radiological Limit: >1R/hr @ 30cm
Materials Allowed: beta/gamma only
Sample Encapsulation: None
Atmosphere: gas/CO2
Commissioning Date: 1967
Recent Upgrade: 2013
R&D License: Department of Energy
License End Date: 2099
Docket Number: 0
User Facility: Yes
User Org Web Page: nsuf.fer.gov
Proposal Web Page: nsuf.fer.gov
Cost To Maintain: 1,250,000
Cost To Replace: 2,000,000
GAIN Partner: No
NSUF Partner: Yes
RTE Facility: No
NE Use Percentage: 50
Funding Sources: DOD, DOE-NE
Number Of Staff: 305
Point Of Contact: Shawn Hill
Email: shawn.hill@i.ni.gov
State: Idaho
Website URL: https://factsheets.fer.gov/Factsheets/AdvancedTestReactorSafety.pdf

Instruments

<table>
<thead>
<tr>
<th>Abbr</th>
<th>Name</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>VPR</td>
<td>Video Probe (baroscope)</td>
<td>Electromagnetic</td>
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<tr>
<td>ITfC</td>
<td>Instron Tensile Tester</td>
<td>Mechanical Properties</td>
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<tr>
<td>NFR</td>
<td>NFR Neutron Radiography Facility</td>
<td>Neutron Detection and Measurement</td>
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<tr>
<td>ATRFFC</td>
<td>ATR Fresh Fuel Cask</td>
<td>Cask</td>
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<tr>
<td>ATRGF</td>
<td>Gamma Facility (ATR Canal)</td>
<td>Gamma/Neutron/Ion Irradiator</td>
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<tr>
<td>Loop2A</td>
<td>Loop 2A</td>
<td>Reactor Irradiation Position</td>
</tr>
<tr>
<td>A(1-8)</td>
<td>A Positions (Inboard)</td>
<td>Reactor Irradiation Position</td>
</tr>
<tr>
<td>A(9-16)</td>
<td>A Positions (Outboard)</td>
<td>Reactor Irradiation Position</td>
</tr>
</tbody>
</table>
Text Search Tool for all Databases

Index

Search: "cobalt gamma iradation"

Instrument: Gamma Irradiation Facility
Cask Ridge Irradiation Laboratory / High Flux Isotope Reactor / Gamma Irradiation Facility
Matches:
Primary Capability Gamma Irradiation

Facility: Gamma Irradiator - FASB Irradiation Room
National Institute of Standards and Technology / Advanced Photon Source / FASB Irradiation Room
Matches:
Co-60 functions gamma irradiation

Instrument: Wet Gamma Irradiation Facility
Pennsylvania State University / Radiation Science and Engineering Center / Wet Gamma Irradiation Facility
Matches:
Co-60 cobalt 60 sources
Instrument: Wet Gamma Irradiation Facility
Co-functions gamma irradiation of small samples using Co-60 or Cs-137 sources

Facility: Albany Cobalt 60 Facility
National Energy Technology Laboratory / Albany Cobalt 60 Facility
Matches:
Facility Albany Cobalt 60 Facility

Facility: Gamma Irradiation Facility
Sands Nuclear Laboratory / Gamma Irradiation Facility
Matches:
Facility Gamma Irradiation Facility
Web Site: http://www.sandi.gov/search/facilities/gamma_irradiation_facility.html

Facility: Gamma Irradiation Facilities
Pennsylvania State University / Radiation Science and Engineering Center / Gamma Irradiation Facilities
Matches:
Gamma Irradiation Facilities
Co-functions gamma irradiation of small samples using Co-60 or Cs-137 sources

Instrument: Dry Gamma Irradiation Facility
Pennsylvania State University / Radiation Science and Engineering Center / Dry Gamma Irradiation Facility
Matches:
Instrument Dry Gamma Irradiation Facility
Co-functions gamma irradiation of small samples using Co-60 or Cs-137 sources

Facility: Gamma Irradiation Facility
Sandia National Laboratory / Gamma Irradiation Facility
Matches:
Facility Gamma Irradiation Facility

Project: Effect of Gamma Irradiation on the Microstructure and Mechanical Properties of Nano-modified Concrete
University of Massachusetts Lowell / Pulsed van-de-Graaff (6.5 MV)
Matches:
Support equipment, proton, neutron and gamma irradiation facilities.

Project: Effect of Gamma Irradiation on the Microstructure and Mechanical Properties of Nano-modified Concrete
/ Effect of Gamma Irradiation on the Microstructure and Mechanical Properties of Nano-modified Concrete
Matches:
Irradiation Facility Oak Ridge National Laboratory / Gamma Irradiation Facility
Project: Effect of Gamma Irradiation on the Microstructure and Mechanical Properties of Nano-modified Concrete
Proposal: Effect of Gamma Irradiation on the Microstructure and Mechanical Properties of Nano-modified Concrete

Instrument: Gamma Facility (ATR Cana)
National Institute of Standards and Technology / Advanced Photon Source / Gamma Facility (ATR Cana)
Matches:
Primary Capability Gamma Irradiation using ATR fuel elements
Uniqe functions... the dry fuel in place.

Instrument: Cs-137 Gamma Calibration Facility
Pennsylvania State University / Radiation Science and Engineering Center / Cs-137 Gamma Calibration Facility
Matches:
Co-functions gamma irradiation of small samples using Cs-137 sources

Facility: Nuclear Facilities Resource Center
Sandia National Laboratory / Nuclear Facilities Resource Center
Matches:
Uniqe functions associated with ACR, Gamma Irradiation Facilities and Sandia Pulse Reactor/Critical Experiments

Facility: Materials Science and Engineering Center
Sandia National Laboratory / Materials Science and Engineering Center
Matches:
Uniqe functions associated with ACR, Gamma Irradiation Facilities and Sandia Pulse Reactor/Critical Experiments

Facility: Radiation Science and Engineering Center
Pennsylvania State University / Radiation Science and Engineering Center
Matches:
Co-functions gamma irradiation of small samples using Co-60 or Cs-137 sources

Facility: McMaster Nuclear Reactor Hot Cell
McMaster University / McMaster Nuclear Reactor Hot Cell
Matches:
Uniqe functions gamma irradiation in cell, large door with 13 ton crane and transfer rack to move cells

Facility: Fast Burst Reactor Facility
White Sands Missile Range / Fast Burst Reactor Facility
Matches:
Responses White Sands Missile Range, Flash X-ray associated as well as gamma irradiation facility, thermal test site, etc.

Project: Changes in viscoelastic behavior, morphology and chemical structure of gamma irradiated calcium silicate hydrates
Oak Ridge National Laboratory / Changes in viscoelastic behavior, morphology and chemical structure of gamma irradiated calcium silicate hydrates with respect to non-irradiated samples
Matches:
Analysis... 2 sessions of 5 days each.
NSUF Resource Browser

NSUF Resources

ABOUT US
ANNOUNCEMENTS
USERS ORGANIZATION
CALL/SOLICITATION
INFORMATION
RESOURCES
MY NSUF

Date White

NSUF Resources

Dept of Energy — Select Facility Type — Select Instrument Type

- Idaho National Laboratory
- Advanced Test Reactor
- Gamma Facility (ATR Canal) — custom manufactured

Facility
Advanced Test Reactor (TRA-4270)

Contact
Shawn Hill

Description
Advanced Fuels and Materials Irradiation. Water-cooled, high flux test reactor. Five in-piles pressurized water loops currently provide prototypic PWR conditions (pressure, temperature flow water chemistry) for fuel and material samples with the ability to tailor the neutron flux to meet desired conditions. Each loop has a full range of instrumentation capabilities. Two of the five loops have transient testing capabilities. There are proposals plans to reinitialize a sixth water loop. The ATR has a capacity for up to five water loops.

Instrument
Gamma Facility (ATR Canal) (ATR-GF) — custom manufactured

Functions
Located in the ATR canal, the Gamma Facility is an aluminum dry tube projecting from the spent fuel rack to the top of the ATR canal. The tube contains a removable shielded plug at the top to block shine and is sealed at the bottom and weighted with lead. Spent fuel can be placed in the fuel grid around the gamma facility to generate high gamma fields. The gamma facility has historically been used to determine material degradation in a high gamma field. For example, it has been used to determine effects on electronics, wire insulation, and even oil. Test samples must fit inside an aluminum dry tube sealed at the bottom and weighted with lead to prevent floating. The 24-foot tube has a stainless inner diameter of 12.7 cm (5 inches) and a swiveling length of 0.6 m (10 feet - 2 inches) from the top of the tube. During testing, the dry tube is inserted vertically into one of the gamma grid positions. Test samples are monitored through the open end of the dry tube to the gamma field. A shield plug caps the open end of the dry tube and shields the gamma beam emitted from the fuel elements near the lower end of the dry tube. Radiological control surveillance is required whenever the shield plug is removed for sample handling. The ATR Gamma Facility, formerly designated the ATR Drum Gamma Facility, is located on the east unit and at the north-east side of the ATR storage canal. This is not the original EGGIC "Large" Gamma Irradiation Facility, that has been decommissioned. The gamma field is produced by placing irradiated fuel elements in grid locations around the position where the test is inserted. The dose rate of the field produced is approximately 10 Mrem/hr, but can be varied (70-150 Mrem maximum) by selecting the distance of elements from the test or by selecting fuel of different gamma strengths. The intensity will fall off at the rate of approximately 5% per day as the fission products in the fuel elements decay away. The peak field at the center of the tube was recently measured to be approximately 2.15 mR/hr. These rates are normally measured by using high range potassium chambers and instrumentation. These can be lowered into the dry tube for actual counting before installing the test sample hardware. Fuel elements can be moved from one location to another with the dry tube in place.
Nuclear Fuels and Materials Library

• Provides irradiated samples for users to access and conduct research through a competitively reviewed proposal process.

• The library includes >3500 specimens as part of the NSUF awarded research.

<table>
<thead>
<tr>
<th>Steels</th>
<th>Other Alloys</th>
<th>Ceramics</th>
<th>Pure Materials</th>
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<tbody>
<tr>
<td>17-4 PH SS</td>
<td>Fe-Cr Alloys</td>
<td>Al₂Hf</td>
<td>Copper</td>
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<tr>
<td>304 SS</td>
<td>HCM12-A</td>
<td>Al1100</td>
<td>Iron</td>
</tr>
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<td>304 SS welds</td>
<td>HT-9</td>
<td>Al6061</td>
<td>Ni/Cu/Nb (DC)</td>
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<tr>
<td>Super 304H</td>
<td>MA-956</td>
<td>Aluminum Bronze</td>
<td>Niobium</td>
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<td>316 SS</td>
<td>MA-957</td>
<td>Beryllco #25</td>
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<td>C276 Hasteloy</td>
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<td>F82H-IEA</td>
<td>various model alloys</td>
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Keyword Tags: Metallic Alloy, Alloy, Metal, Austenitic Alloy, Steel, Stainless Steel, INCOLOY Alloy, Ferrous, Control Rods, High Temperature Gas Reactor
Nuclear Science User Facilities

EXPERIMENT WIZARD
NSUF Experiment Process (Actual)

Graphic courtesy of Kaecee Holden
Wizard Guide through NSUF Resources

- **NSUF Databases** – information about Databases managed by NSUF
- **User Facility References** – Pages co-managed with a representative at each institution, this section provides live user guides, interactive help, and other information that the facilities would want the user to know.
- **Nuclear Science Tools** – Links to databases, codes, and other resources that are helpful for nuclear science (END/F, EXFOR databases, IAEA tools, etc).
- **Tutorial** – Helps the user and content managers (i.e. for User Facility References) understand how to use the wizard tool.

Graphic courtesy of Jordan Argyle
Wizard Guide to Proposal Submission

Project Summary

This page provides an overview of proposed experiment. It is designed to give collaborators a place to start, and to help unify the teams' understanding of the project before they begin to write up the project documents. For NSUF workscopes, this page will introduce the Technical Leads to your project.

To best use this tool, review the information on this page often throughout the pre-proposal, and modify it as needed. Some of the fields on this summary will appear later in the wizard. You can return to this screen at any time by selecting it in history.

Project Title

[Form Field]

Applicable Workscopes/Technical Areas

[Form Field]

PI Contact Information

[Form Field]

Partners / Collaborators Contact Information

[Form Field]

Please list the contact information for any research partners or collaborators, one per line, in the same format as your contact information.

Provide a brief summary of your project. Note that this isn’t the project narrative or the technical abstract—those will come later. This is a place for you and your team to capture what you want to do at a high level. This should also provide the technical leads with a few paragraphs to get on the same page as your team.

Project Summary

This should explain the purpose of the project, general goals, and the benefits of the research to scientific advancement, as well as anything else you feel necessary to explain your project to your team.
Wizard as a Collaboration Tool

• This history shows how the tool is envisioned to be used. A main path is augmented with visits to references (ATR in this History) and other tools to accomplish their work.

• The tool allows multiple content creators to simultaneously manage content for their respective areas.

• Multiple users, Tech Leads, and others can all work on an experiment at the same time, keeping all information in one place.

• The Wizard clearly communicates requirements, expectations, and suggestions to help steer applicants to create more meaningful proposals.
Nuclear Science User Facilities

IRRADIATION TOOLKIT
Testing Strategy for Novel Materials

Irradiation Testing Hierarchy

1. Ion Beams Irradiation Facilities
   • Allow immediate feedback of performance
   • Ease of instrumentation
   • Ease of environmental tuning

2. Low-Power Research Reactors
   • Proof-of-concept (First 1% and 10% testing)
   • Instrumentation development (pulsing for TREAT)
   • Neutron radiography
   • Experiment modeling & validation efforts

3. High-Performance Test Reactors
   • Proof-of-performance
   • Prototypical environment
Small Specimen Tensile Testing Challenge

- Tensile testing has long been an important method for determining the material properties of different structural steel components.

- The effect of irradiation on these steel components is of particular interest to the nuclear power industry.

- The large (E8) specimens typically used are not efficient for test reactor irradiations. They also usually require a hot cell for performing post-irradiation examination.

- Research into using small-scale tensile specimens has been of great interest in the nuclear industry for quite some time.

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<th>Alloy</th>
<th>Dose Rate</th>
<th>6 dpa</th>
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<td>304L</td>
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</tr>
</tbody>
</table>

R/hr @ 30cm
Calculator Data Flow

- Neutron Damage Calculator
  - Input
    - Desired DPA
    - Material Composition
  - Output
    - Days to desired DPA
    - Reactor Positions
- Radioactivity Calculator
  - Input
    - Irradiation time
    - Material composition
  - Output
    - Radioactivity at set decay times
    - Gamma Dose Rate

Graphic courtesy of Kaecee Holden
Web Application – Position Selection

- Representative reactor positions for:
  - INL ATR
  - ORNL HFIR
  - MITR-II (coming soon!)
  - BR-2
  - OSURR
  - NCSU Pulstar

Select a row to calculate radioactivity and gamma dose rate:

<table>
<thead>
<tr>
<th>Select</th>
<th>Reactor</th>
<th>Position</th>
<th>Diameter (cm)</th>
<th>Days</th>
<th>Cycles</th>
<th>Years</th>
<th>Thermal Fluence</th>
<th>Fast Fluence</th>
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<tbody>
<tr>
<td></td>
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<td>A1</td>
<td>1.6</td>
<td>68.2</td>
<td>1.2</td>
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<td>3.73e+020</td>
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<td>0.3</td>
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<tr>
<td></td>
<td>ATR</td>
<td>I21</td>
<td>3.8</td>
<td>6699.3</td>
<td>121.8</td>
<td>18.4</td>
<td>3.96e+021</td>
<td>4.33e+020</td>
</tr>
</tbody>
</table>
Your sample contains Fe-9.6Cr-0.03Y-0.01C-0.003N

ATR

Position: B1
Diameter (cm): 2.2
Days: 123.9
Cycle: 2.3
Years: 0.3
Thermal Fluence: 6.06e+020
Fast Fluence: 3.15e+020

The activity of your sample is as follows:
- after 0 days: 2.47E+11 Bq/g or 5.66 Ci/g
- after 30 days: 6.42E+10 Bq/g or 1.47 Ci/g
- after 60 days: 2.64E+10 Bq/g or 0.714 Ci/g
- after 90 days: 1.33E+10 Bq/g or 0.359 Ci/g
- after 120 days: 2.87E+09 Bq/g or 0.0723 Ci/g
- after 3098 days: 1.87E+08 Bq/g or 0.00505 Ci/g

The effective gamma dose rate of the sample at 30cm:
- after 0 days: 892 mrem/hr/g
- after 30 days: 431 mrem/hr/g
- after 60 days: 213 mrem/hr/g
- after 90 days: 107 mrem/hr/g
- after 180 days: 14.8 mrem/hr/g
- after 3098 days: 0.000901 mrem/hr/g

Select a different position
Radioactivity Calculator Validation

- Utilizes 252-energy group neutron flux and activation cross-sections (JEFF)
- Improvement over available online calculators and previous calculator iterations

- Added a safety factor to improve accuracy.
- Only neutron activation/capture reaction included
- Meta-stable states not included

Future Work

• Internal and external validation of the calculators
• Build the experiment wizard & test on CINR proposals
• Incorporate other tools as needed (e.g. EXSAN from LANL)
Questions?