Nuclear Science User Facilities

Nuclear Fuels and Materials Library

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Established in ~2009 with the Nuclear Science User Facilities

The original library included ~3500 specimens
  • Legacy materials
  • Volunteered materials
  • NSUF Project specimens
**NFML NOW and Beyond**

### Current Nuclear Fuels and Materials Library

<table>
<thead>
<tr>
<th>Project</th>
<th>Material</th>
<th>Specimen Count</th>
<th>Organization</th>
<th>Availability</th>
<th>Library Utilization</th>
</tr>
</thead>
<tbody>
<tr>
<td>*08-75</td>
<td>Ceramics</td>
<td>120</td>
<td>University of Florida</td>
<td>Online and available</td>
<td></td>
</tr>
<tr>
<td>*08-92</td>
<td>Steels/Alloys</td>
<td>665</td>
<td>University of Illinois</td>
<td>Online and available</td>
<td></td>
</tr>
<tr>
<td>*08-96</td>
<td>Steels/Alloys</td>
<td>80</td>
<td>North Carolina State University</td>
<td>Online and available</td>
<td>multiple RTE proposal requests</td>
</tr>
<tr>
<td>*08-139</td>
<td>Steels/Alloys</td>
<td>1572</td>
<td>University of California- Santa Barbara</td>
<td>Online and available</td>
<td></td>
</tr>
<tr>
<td>08-331</td>
<td>Steels/Alloys, Ceramics</td>
<td>149</td>
<td>University of Wisconsin</td>
<td>Online and available</td>
<td>RTE &amp; NEET-funded APS requests</td>
</tr>
<tr>
<td>*09-157</td>
<td>Ceramics</td>
<td>160</td>
<td>Utah State University</td>
<td>Online and available</td>
<td></td>
</tr>
<tr>
<td>*09-204</td>
<td>Ceramics</td>
<td>72</td>
<td>Drexel University</td>
<td>Online and available</td>
<td></td>
</tr>
<tr>
<td>10-197</td>
<td>Fuels</td>
<td>78</td>
<td>Idaho State University</td>
<td>Online and available</td>
<td></td>
</tr>
<tr>
<td>*65-SURV-81</td>
<td>Steels/Alloys</td>
<td>482</td>
<td>Idaho National Laboratory</td>
<td>Online and available</td>
<td></td>
</tr>
<tr>
<td>70-CREEP-85</td>
<td>Steels/Alloys</td>
<td>49</td>
<td>Idaho National Laboratory</td>
<td>Online and available</td>
<td></td>
</tr>
<tr>
<td>*Legacy</td>
<td>Steels/Alloys</td>
<td>150</td>
<td>Idaho National Laboratory</td>
<td>Available</td>
<td>F. Garner collaborative plan</td>
</tr>
<tr>
<td>LANSCE</td>
<td>Steels/Alloys</td>
<td>2202</td>
<td>Los Alamos National National Laboratory</td>
<td>Online and available</td>
<td></td>
</tr>
<tr>
<td>SAM-1</td>
<td>Graphite, Fiber</td>
<td>55</td>
<td>Idaho National Laboratory</td>
<td>Scheduled July 2017</td>
<td></td>
</tr>
</tbody>
</table>

**5834 TOTAL NFML SPECIMENS**

* Original library

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**Library Material Types**

- **Fuels**
- **Ceramics**
- **Steels/Alloys**
- **Graphite**
- **Fiber**

**Library Materials Research Area Per Project**

- **Cladding and Other Structural Materials**
- **Advanced Fuel Cycles**
- **Advanced Instrumentation and Control**
<table>
<thead>
<tr>
<th>Project</th>
<th>Material</th>
<th>Organization</th>
<th>Organization Details</th>
<th>Availability</th>
</tr>
</thead>
<tbody>
<tr>
<td>10-242 -1, -2, -3</td>
<td>Fuels</td>
<td>University of Central Florida</td>
<td>Low Fluence Behavior of Metallic Fuels</td>
<td>UCF-1 available Feb 2017, UCF-2, -3 TBD</td>
</tr>
<tr>
<td>10-269</td>
<td>Fuels</td>
<td>Boise State University</td>
<td>High Temperature In-pile Irradiation Test of Single Phase U3Si2</td>
<td>projected completion 02/2022, available 02/2025</td>
</tr>
<tr>
<td>15-8242</td>
<td>F/M Steels, Austenitic Steels/Alloys</td>
<td>Boise State University</td>
<td>Irradiation Influence on Alloys Fabricated by Powder Metallurgy and Hot Isostatic Pressing for Nuclear Applications</td>
<td>projected completion 2022, available 2025</td>
</tr>
<tr>
<td>15-8242 add-on's</td>
<td>Metal Alloys/Hf3Al-Al</td>
<td></td>
<td>Add'I material added into empy slots with 8242 irradiation</td>
<td>TBD</td>
</tr>
<tr>
<td>16-10537</td>
<td>F/M Steels, Austenitic Steels/Alloys, RPV Steels</td>
<td>Idaho State University</td>
<td>Enhancing irradiation tolerance of steels via nanostructuring by innovative manufacturing techniques</td>
<td>TBD</td>
</tr>
<tr>
<td>16-10584</td>
<td>Austenitic Steels/Alloys</td>
<td>Colorado School of Mines</td>
<td>Irradiation performance testing of specimens produced by commercially available additive manufacturing techniques</td>
<td>TBD</td>
</tr>
<tr>
<td>16-10393</td>
<td>Austenitic Steels/Alloys</td>
<td>GE Hitachi</td>
<td>Irradiation Testing of LWR Additively Manufactured Materials</td>
<td>TBD</td>
</tr>
<tr>
<td>Naval Reactors</td>
<td>Unirradiated and irradiated SiC and conventional &amp; non-ferritic steels</td>
<td>Bechtel Marine Propulsion Corporation</td>
<td>Samples are currently stored at WestOne in Idaho Falls, ATR Canal, and ORNL.</td>
<td>Unirradiated samples received, irradiated in process</td>
</tr>
<tr>
<td>Zorita</td>
<td>Austenitic Steels/Alloys</td>
<td>Studsvik</td>
<td>394SS under PWR conditions for 26.5 EFPY</td>
<td>Title Transfer complete deliver to INL TBD</td>
</tr>
<tr>
<td>Zion NPP</td>
<td>Low alloy steel</td>
<td>Oak Ridge National Laboratory</td>
<td>RPV &amp; core internals exposed to high doses neutron radiation</td>
<td>Ongoing discussions with ORNL staff</td>
</tr>
<tr>
<td>ORNL-IMET</td>
<td>Fuels</td>
<td>Oak Ridge National Laboratory</td>
<td></td>
<td>Ongoing discussions with ORNL staff</td>
</tr>
<tr>
<td>INL</td>
<td>Fuels</td>
<td>INL Fuels &amp; Materials Division</td>
<td>HFIR low dose irradiation materials</td>
<td>Will be shipped to INL when HFEF shutdown ends</td>
</tr>
</tbody>
</table>
Database Design

Preparation

- **Resource Collection**
  - Consolidated all files and versions (electronic, hard copy, hand written) into one workbook
  - Compared spreadsheets to hardcopy printout of INL facility inventories for storage ID #s and locations
  - Searched INL EDMS, (electronic document management system) for reports, drawings, as-runs analysis, raw data in order to populate project spreadsheets.
  - Reached out to contacts for additional information or documentation

- **IM interface**
  - Made all project data within spreadsheets consistent (units of measure, scientific notation, consistent ID numbers, etc.
  - Worked with IM staff (Learn and improve as-you-go process)
  - Reviewed all project information to confirm successful import

- **Database design**
  - The NFML contains project information such as abstract, PI, reactor, planned irradiation conditions linked to individual specimens linked to each cycle with as-run irradiation conditions.
Lessons Learned/Challenges

- We need a process/task for library coordination early in the project design process.
- Need to create standard (mandatory) categories to use when adding sample information to the library.
Lessons Learned/Challenges (continued)
- How do we confirm specimen locations and track shipments/transfers?
- How do we keep track of what specimens are being/have been used or have been totally depleted
  - Gap analysis for library inventory?
- How do we display (or hide) fuel specimens in the library
  - Determine access levels

Storage
- Need physical space for new samples
- Storing and retrieving samples from HFEF is time consuming, expensive, and introduces contamination to otherwise clean specimens

Donations to the Library
- We need a transfer of ownership procedure/process for donated material
- Do we decline volunteered samples that don’t have adequate provenance?

Export Control
- Documentation attached to projects needs to be export controlled
The NFML had ~3500 specimens listed in various composition spreadsheets.

<table>
<thead>
<tr>
<th>Material ID &amp; Supplier</th>
<th>Density (g/cm³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;Pure’ Nickel&quot; Goodfellow (nano and reg)</td>
<td>8.90 - 99.9999</td>
</tr>
<tr>
<td>'Nano' Carbon Steel</td>
<td>7.90 - bal 0.10 - 0.27 - 0.50 -</td>
</tr>
<tr>
<td>MA956, ODS</td>
<td>7.70 max 0.15 - 0.5 max 4.75 0.02 max 0.4 20.0 0.3 max 0.3 max</td>
</tr>
<tr>
<td>MA754 ODS</td>
<td>8.80 max 78.0 1.0 0.05 0.3 max 0.5 20.0</td>
</tr>
</tbody>
</table>

† Composition in weight percent
Database Design
Where We’re Going

PROJECT DATABASE
- **PROJECT NAME**
  - Project ID
  - Proposal
  - CINR #
  - RTE #
  - NSUF Call
  - Award Date
- **Notes**
  - # of Samples
  - Capsule
  - Packet
  - Material Code
  - Material Name
  - Material Description
  - KGT #
  - Specimen Type
  - Dimensions

SME DATABASE
- PI Name
- Subject Matter

NEID DATABASE
- INSTITUTION
- FACILITY
- REACTOR
- REACTOR POSITION

SAMPLE LIBRARY
- PLANNED
  - Temperature
  - Dose (DPA)
  - Fluence \( \times 10^{20} \)
  - Flux \( \times 10^{14} \)
  - Environment
- AS RUN
  - Temperature
  - Actual Dose (DPA)
  - Fluence \( \times 10^{20} \)
  - Flux \( \times 10^{14} \)
  - Environment

Database Design
Where We’re Going
• Access is granted at the NSUF homepage log-on
Users have access to projects, corresponding specimens, and supporting documentation from one screen.

Select a project to view information and specimens.

Text search for key words in project titles.

Click to see all projects that contain library specimens.
Further drill down accesses in-depth information about the project and individual specimens.
Planned and As-Run conditions are listed per specimen, per cycle.
NEID lists provide a way to create a wish list of specimens for proposals.
Text searches will be more efficient and faster
Common queries can be run for reports
Dropdown searches with standardized material names and types
Attributes can be added to searches
All databases within NEID will be linked (pages can be accessed from any database)
Work with the NEID Database Review Panel to learn their vision
Project documents and provenance information will be linked to library
In order to better support the users of the NSUF access programs:

- Request for Information (RFI) in FY 17 for additional materials (Level 3 milestone due 3/31/2017)
- Survey the NSUF Users Organization for input
- Possible characterization and location confirmation for NSUF samples within HFEF
- FY 2017 report on the status of the NFML:
  - Results of the RFI
  - NFML policy and user agreements
  - Future development plans
  - Level 3 milestone due 9/29/2017
Licensing Quality Data

- Possible collaboration w/ Gen IV Handbook – William Corwin
- Nuclear Data Management and Analysis System (NDMAS) - https://ndmas.inl.gov
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