Sample Preparation Laboratory-SPL

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Outline

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• Design Basis of SPL
• Shielded Sample Preparation Line
• Mechanical Properties Test Cell
• Robotic Arms
• Instrument Enclosures
• Laboratory Features
• Office Area Features
• Timeline
Motivation-Why SPL?

- Post irradiated examination (PIE) of structural materials
- Facility with alpha free contamination for ease shipping low dose samples to universities and other national laboratories
- Hot cell to handle full sized irradiated structural experiments (up to 1.22m long)
  - Disassembly, PIE, storage, and transfer to instruments
- User facility with remote operation of instruments
- Designed source term: 557 Ci-Co$^{60}$
Location of SPL

- Located within 100 meters each of HFEF and IMCL
- Provides “trifecta” of hot cell facilities to handle structural and fuel experiments
  - HFEF handles full sized fueled experiments
  - IMCL provides high end microscopy of irradiated materials including sample preparation of commercial fuel pellet sized experiments
  - SPL handles alpha clean structural experiments for microstructural characterization
Design Basis SPL

- **Approx. 4,087 m² (3 stories)**
  - Braced frame structural steel with 0.3 m. solid, grouted, reinforced concrete masonry unit exterior walls
  - Seismic Design Category 2
- **Divided into office space and laboratory space**
  - User facility building designed for easy access by visiting researchers
  - 761 m² office space/ 3,100 m² laboratory space
  - Office space provided on all three floors
- **1st floor**-Majority of the shielded sample preparation line, truck bay, and instrument enclosures
- **2nd floor**-Hoods, gloveboxes, transfer cell of the shielded sample preparation line
- **3rd floor**-Manipulator repair area, personnel decontamination room, and ventilation

Cross-section of SPL

Inside view of SPL
Sample Preparation Line-Overall Design

- 2 story hot cell design with cask transfer cell, sizing, polishing, and grinding cell (SPG), decontamination cell, and sample storage cell
- Mechanical properties cell attached to sample storage cell and will be discussed later
- Sides of sample preparation cell are 1.2 m thick (base concrete) with ceiling thickness of 0.9 m (high density concrete)
- 5 sets of manipulators
- Pneumatic transfer station
Sample Preparation Line-Transfer Cell

- Transfer cell primary task is to receive experiments and decontaminate any alpha contamination on the experiment
- Size 5.2m x 1.83m x 3.81m tall
- Various casks can mate up to the transfer cell with use of various collars
  - Support waste removal activities including experimental hardware
  - BEA Research Reactor (BRR) Cask, primary cask for transfer between ATR and SPL, HFEF-5 waste cask, Shielded 55 gal drum, GE-100, Direct transfer port for IMCL cask, and the Flying Pig
- Experiments loaded vertically using screw type lift
- Crane in to open cask and remove experiments
  - Lower experiments into the sample and grinding cell
- Man door entry for maintenance and decontamination activities
- Associated glovebox for contamination measurements
Sample Preparation Line-Sizing, Polishing, and Grinding Cell (SPG)

- Primary focus: experiment disassembly, cataloging samples, sizing, grinding, polishing, and decontamination of samples
- 4.33m x 1.83 m x 4.57m tall (3.58m working distance-manipulators)
- Various sample preparation items
  - Low speed saw, polisher/grinder, electro-discharge machine (EDM-Viteris), and others
- 2-ton bridge crane connected to decontamination cell through false wall between the cells
  - Folding wall operated by manipulators
  - Allows for larger items to be passed between the cells
  - Smaller transfer port below folding wall to allow for movement of smaller materials
- Various false floor locations to support storage of supplies and experiments
- Two shielded storage wells to accommodate full experiments
  - 0.381m diameter/ 1.46 m deep wells
  - Shielded plugs over wells
- Man access door to the EDM to support maintenance of the machine
Sample Preparation Line-Decontamination Cell

- Primary function is to support decontamination activities of samples
- Optical microscopy
- Roof hatch over cell
  - Maintenance of the crane supporting the SPG and decontamination cell
  - Introduction/removal of new instruments and waste removal
- Access to a glovebox outside of the cell to support contamination surveys
- Size: 2.90m x 1.82 m x 4.57m tall
- Storage wells for equipment and samples
Sample Preparation Line-Sample Storage Cell

- Primary functions are to store samples and transfer to samples to various locations using a pneumatic transfer system
- 2.90m x 1.82m x 4.57m tall
- Two storage boxes to accommodate samples
  - 1800 metallurgical samples
  - 200 mechanical properties samples
- **Pneumatic transfer system-rabbit system**
  - 3 current lines to the shielded enclosures
  - 2 future lines to shielded enclosures
  - 1 line to the glovebox system
  - 1 line to the mechanical properties testing cell (MPTC)
- Roof Hatch for access to cell for maintenance
**Mechanical Properties Test Cell-MPTC**

- **Primary purpose** is to support mechanical properties testing of irradiated materials
- **5.18m x 3.66m by 4.87m high**
- **Shares a common wall with the sample storage cell**
- **Bridge crane to support moving instruments around**
- **Cell has 0.91 m to safely shield 10 Ci of Co\textsuperscript{60}**
- **Instruments include**
  - Charpy, Instron mechanical testing, optical microscope, and a furnace
- **Instruments loaded using robotic arms**
- **Instruments operated outside of the MPTC at work stations**
- **Man door for access to room**

![Floor loadout of the MPTC](image)
Robotic Arm System

- To reduce cost of using manipulators and leaded glass, robotic tele-manipulators are being incorporated into SPL
- Primary use is to load/unload instruments
  - Mechanical properties test cell
  - Shielded instrument enclosures
- 6 Degrees of Freedom
- Universal robots/UR series with Technalia integration
- Programmable to repeat common activities
- Manual operation mode with 3D vision capabilities
- Able to change grips for various activities

Robot practicing loading a sample into a FIB
**Instrument Enclosures**

- Instrument cells designed to house high end characterization equipment
- Shielded and unshielded cells
- Various sizes to support specific instruments
- Instruments designed to run in instrument control rooms outside of the radiological buffer area
- Allows for easy access for users to come into SPL and use instruments
- Vibrating and support equipment located on second floor
- Rooms designed to minimize electromagnetic interference, vibration, temperature variation
- 3 planned shielded enclosures
  - 0.23 m thick walls
  - 0.25 Ci of Co$^{60}$
  - Room for additional shielded cells

![Layout of instrument enclosures in SPL](image)
Planned Instruments for SPL

- X-ray photoelectron spectroscopy (XPS) for surface science
  - Shielded
- Plasma Focused Ion Beam
  - Shielded
- X-ray Diffraction (XRD)
  - Shielded
- Transmission Electron Microscopy-TEM
- Scanning Electron Microscopy-SEM
- Room for 3-4 more instruments
Additional SPL Laboratory Features

- Double sided glovebox with 6 attached hoods
  - Sample preparation and decontamination activities
  - Radiological and non-radiological hoods
- Back up generator
- Stack
- Freight elevator
- Robotic test area
- Manipulator repair area
- Ventilation
Office Area Features

- 27 office spaces
  - Views of Idaho mountains
- Conference rooms on each floor
- IT/Dial room
- User collaboration area
- Data/Visualization area
Timeline

- Completion of 100% Design-End of Sept. ‘18
- Break ground by end of USA-FY’18 (Sept ’19)
Questions? Comments? Advise?