TSIB HPT Lab – Lessons learned

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TSIB HPT Lab Conceptual Design Review

01 April 2021

Introduction

In order to include best practices and incorporate lessons learned from other facilities we “interviewed” three different facilities with hot cells under operational

- Interviewed hot cell user/operator/manager with a focus on the hot cell design and operation
  - Pacific Northwest National Laboratory (PNNL)
    - Robert Orton, Shielded Facilities Operations
    - Dave Senor, Researcher and RaDIATE collaborator
  - Argonne National Laboratory (ANL)
    - Mike Billone, Program Lead, Irradiation Performace
  - Oak Ridge National Laboratory (ORNL)
    - Tom Muth, LAMDA Lab Manager
- More interviews to come with focus on the safety aspect
- In the following slides you will see check marks
  - ✓ – Green : Means that we already incorporated them in our design or in our future procedures to operate
  - ✓ – Black: Means that we are considering using their advice in our future procedures, but it is not part of the design

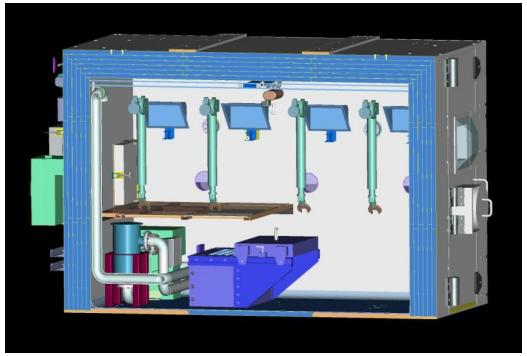
Introduction

It should be noted that some of the facilities “interviewed” perform work under different regulatory requirements than what will be required for the work performed in the HPT Hot Cells. The facility at Fermilab will perform work on R&D samples within capsules that are ~66x below the Hazard Category 3 limits , and ~42,400x below the Hazard Category 2 limits, and will not be subject to the nuclear safety order. It will be managed under the Accelerator Safety Order (DOE O 420.2c) and 10 CFR 835 *Occupational Radiation Protection*.

The following should be understood as general best practices and would be very conservative for our application.

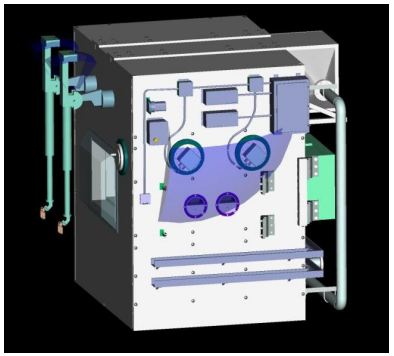
PNNL Hot Cells

- In previous irradiation experiment, RaDIATE collaboration material PIE work were performed in one of these two hot cells
- Hot cells are customed hot cells



MEC1

PDC1/2



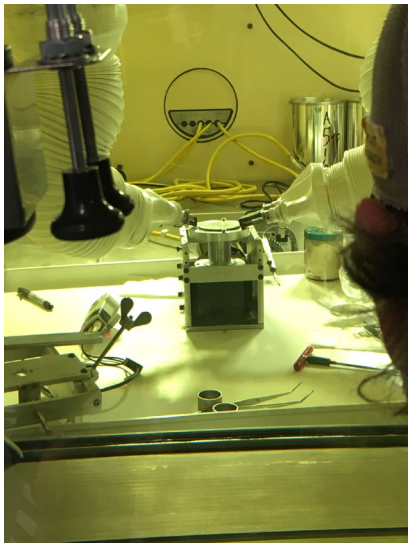
Internal volume: **12' wide x 6' deep x 8.3' high** (with 1' thick steel walls)
Weight: ~250,000 lbs
Two manipulator workstations (four mechanical manipulators)
✓ In-cell lifting capability of 1000 lbs
✓ 5 replaceable feed-through penetration ports
✓ In-cell storage below worktable

Internal volume: **6.5' wide x 4.5' deep x 8.3' high** (with 1' thick steel walls) ✓
Weight: 160,000 lbs
✓ One manipulator workstation (two mechanical manipulators)
✓ 5 replaceable feed-through penetration ports
Allows for operation in inert environment
✓ Work trays are removable

PNNL Hot Cells

- They are using standard equipment in hot cells but we should consider design them for remote maintenance with telemanipulator
- No cooling/fluid tank inside the hot cells
  - The furnace doesn't have active cooling (Tmax ~ 500°C)
  - No drainage in the hot cell but they install any equipment in a large stainless-steel tray with lip to keep contamination in.
- Storage of activated materials is made by using few shielded container
- No fire protection system inside the hot cells. They have extinguisher outside of the cells.
- They have Mercury baker light in the hot cell which can be remotely maintained.
- Epoxy on concrete for contamination mitigation and ease to clean
  - Consider to have stainless steel wall if any plan to use chemical
- HVAC uses bag-in/bag-out system with high efficiency filters
- The designed a capsule opener

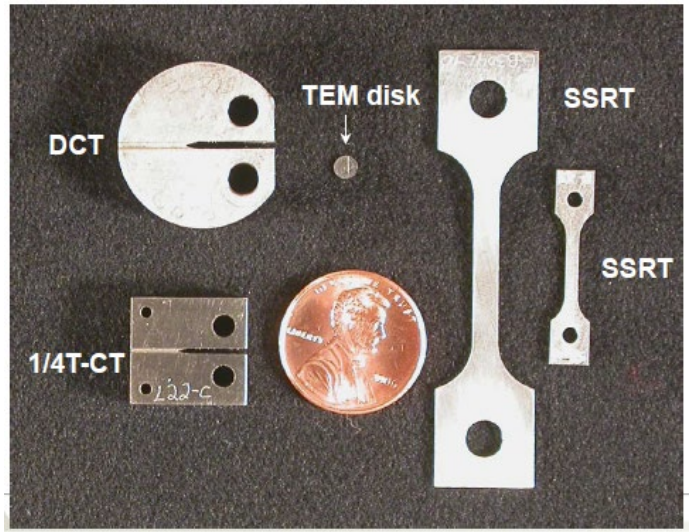
Capsule opener



ANL - Radioactive Materials Characterization in the Irradiated Materials Laboratory (IML)

- ANL Facilities for Testing Nuclear Fuel Cladding and Reactor Materials
  - Operation mode not relevant with the TSIB HPT Lab, nevertheless the use of hot cell and how they operate provides us good lessons learned

✓ Preparation of samples (polishing) at low dose for SEM characterization in fume hood and if high dose in glovebox



- DCT: Disk-shaped compact tension
- 1/4T-CT: 1/4T compact tension
- TEM: Transmission Electron Microscope
- SSRT: Slow-Strain-Rate-Tensile

ANL – Testing Equipment

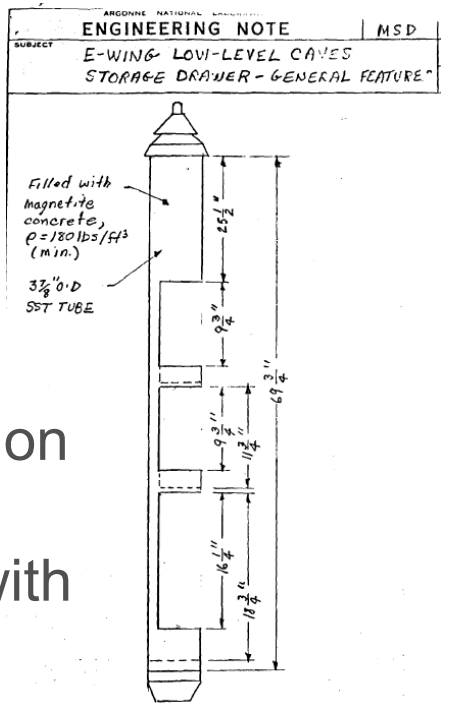
- Large equipment (tensile test machine) installed in dedicated glovebox

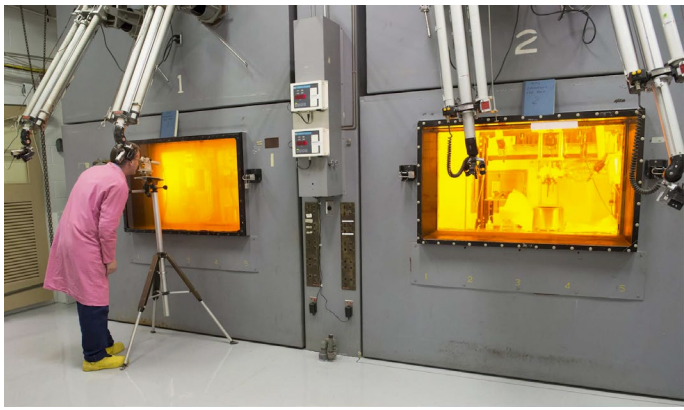
Instron 8511
Prior to Installation

Instron 8511 in
Glovebox Containment

ANL - IML Cells 1 and 2 – Irradiated Nuclear Materials

- ✓ Each hot cell are dedicated to specific purpose
- ✓ Hot cell (inside 6’ wide x 5’ deep x 9’8” height) with 6’ wide door in front of the hot cell
- ✓ 3’ of regular concrete for the walls.
- • 2’ of magnetite concrete for the viewing wall
- ✓ Plexiglass door inside the hot cell as barrier ventilation door to limit airborne while large door opened
- ✓ ZrBr zinc-bromide shield windows that aged badly with time ⇨ use lead-glass window
- ✓ Large window (30”Hx50”Wx30” thick)
- ✓ 5 shielded storage wells installed at the back hot cell allow entrance of worker for a short period of time
- ✓ One pair of telemanipulator + a special crane of ~ 150 lb capacity for lifting the storage shield plugs





ANL

- ✓ Have well qualified worker to operate the hot cell and the telemanipulator. Anticipate a long period of training
- ✓ Have constant monitoring of the negative pressure
- ✓ Have also a smoke test during commissioning of the fume hood and the hot cell
- ✓ Have smooth surface for every equipment and tray to avoid contamination accumulation and to facilitate the cleaning / decontamination process

ORNL– LAMDA Laboratory

- Low Activation Materials Development and Analysis Laboratory (LAMDA)
  - Multipurpose laboratory for low activated material analysis without the need for remote manipulation – NO Hot Cells
  - Samples < 100 mR/hr at 1ft
    - This mode of operation allows for more precise and delicate sample handling than in traditional hot cells
- The LAMDA laboratory typically utilizes small, compact samples to allow characterization and test equipment to study materials phenomenon not possible at a hot cell facility
  - Mechanical testing, physical properties and microstructural characterization

ORNL

- Dose rate based on isotope production calculation
  - ✓– Always have initial screening before hands-on activity on the samples
  - ✓– Perform gamma spectroscopy in the fume hood to verify the sample activity. Survey at LAMDA lab is done by using a portable Falcon ® γ spectrometer
- ✓ Always keep the hot cell cleaned. Remove regularly any unused samples and dispose any waste as soon as possible
- Store all samples if possible, outside of the hot cell
- ✓ For volatile gas emission they advice to use adsorber type filter (charcoal)