Conceptual Design of the Sample Preparation Laboratory (SPL) at Idaho National Laboratory

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The Idaho National Laboratory is designing a new hot cell facility, designated as the Sample Preparation Laboratory (SPL), to support beta-gamma bearing materials such as structural materials and alpha-free claddings. The building is currently under design stage with design completion scheduled for the end of 2018. The main feature of SPL is a hot cell line that consists of bays for experimental receipt and decontamination, a sizing and grinding cell, a sample decontamination cell, and a sample storage cell. Attached to the hot cell line is a shielded mechanical properties testing cell. Instrument cells are present in the laboratory to house advanced characterization equipment, including 4 shielded instrument cells for high dose material characterization. Robotics are being employed in the shielded instrument cells for loading/unloading activities of the instruments. A glovebox/hood line is available for sample preparation activities for lower dose materials. Additional features of the SPL include a manipulator repair area, increased office space for researchers, operators, and users, and future instrument cell growth possibilities.

Purpose for SPL

Sample Preparation Laboratory, SPL, is being constructed at the Materials and Fuels Complex, MFC, at Idaho National Laboratory. This facility supports a need for a facility to accept and manipulate highly radioactive beta-gamma bearing materials that are alpha contamination free. The Advanced Test Reactor, ATR, is used by various programs to irradiate structural and cladding based materials to high doses to study their irradiation behaviour. Typically, these experiments are transferred to the Hot Fuels Examination Facility, HFEF, at MFC for experimental disassembly and other activities. In HFEF, irradiated fuel is characterized and significant alpha, beta, and gamma contamination is present. As a part of the Nuclear Scientific User Facility, low dose structural samples from the irradiated ATR experiments are shipped to other national laboratories and universities for characterization. This requires decontamination of the NSUF samples from alpha bearing contamination from HFEF. This process can be difficult compared to materials with only beta-gamma contamination and often leads to increased dose to personnel to achieve contamination levels acceptable to universities. SPL is being designed with the purpose of being alpha contamination free excluding some use of fixed alpha bearing materials in advanced characterization equipment. Another feature of SPL of interest for INL is a shielded mechanical properties cell. The shielded cell will provide capability to characterize high gamma dose materials that previously could not be analysed at INL. SPL will have other features which will be discussed in detail a later section.

Design Features of SPL

SPL is a three story building that will support sample preparation activities, advanced characterization of irradiated materials, and office space. Figure 1 shows a general layout of the three stories of the SPL building and a conceptual design of the outside of SPL. Office space is designed to provide collaboration between researchers, operators, and outside users of facility.

Figure 1: General layout of the three floors of SPL

Hot Cell Line of SPL

The primary feature of SPL is the hot cell for sample preparation of beta-gamma materials. A source term of 550 Ci of Co-60 (2.035E13 Bq) is assumed for the hot cell line. Figure 2 shows a general layout of the hot cell line. The cell is a partial two story design. Experimental casks enter a cave to mate up to the hot cell. Various casks can be mated up to the cell including the Flying Pig, the BRR cask, the GE-100, and others. Experiments are removed from their cask by use of a crane and lifted into second floor shielded bay. Experiments are decontaminated and checked for any alpha contamination from the shipping cask in this cell. Experiments are dropped into the sizing and grinding cell for disassembly and sample preparation. The sizing and grinding cell contains experimental drop down plugs to store experiments in. Traditional sample preparation equipment including polishers, grinders, and saws will be used for sample preparation activities and disassembly of experiments. An electron discharge machine, EDM, will be used to shape and size larger samples down to sizes appropriate for mechanical property testing and other activities. The EDM will be stationed in a location where a man door is present for the sizing and grinding cell for service ease. A crane is used to move equipment in the sizing and grinding cell with access for the crane to reach the decontamination cell adjacent the sizing cell. A false wall is present between the sizing and grinding cell and the decontamination cell. This false wall can be opened to move larger items between the two cells with an additional basic pass through present below the false wall for transfer of smaller items.

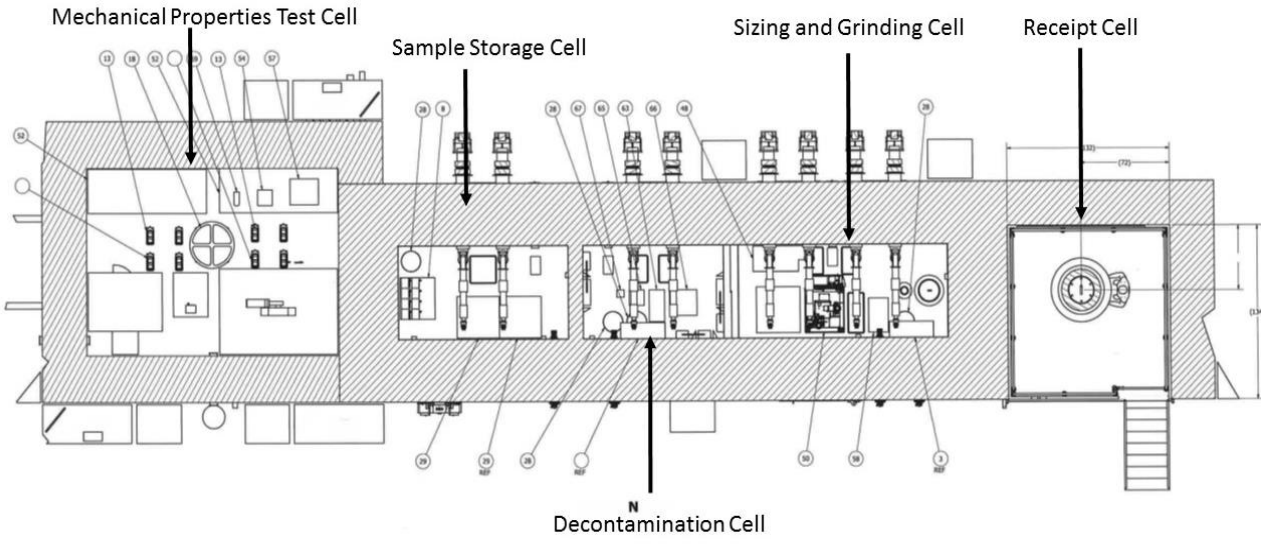

Figure 2: General layout of the hot cell in SPL

The decontamination cell's primary purpose is decontamination of equipment and samples. Radiological waste will be packed in this cell as well. The cell has a plug in the ceiling, allowing access to the crane and to provide another method to allow larger items to be placed into and out of the cells. A small pass through port allows samples to be transferred to the sample storage cell. In the sample storage cell, multiple thousands of samples can be stored in drawers for future use. A ceiling plug is present to have access to the cell when samples are not present. Another feature of the sample storage cell is a pneumatic air transfer system for transferring samples to various locations in the facility such as the shielded instrument cells and glovebox system.

Advanced Characterization Instrument Cells

SPL is designed to have individual instrument cells that will house various advanced characterization equipment. Four of the cells are shielded cells designed to shield 0.25 Ci/9.25E9 Bq of Co-60. Each instrument cell has a separate individual room that is outside of the radiological buffer area that will allow for operation of the instruments. These separate rooms will allow outside users access to run the instruments without having to undergo the radiological training to enter the laboratory. The pneumatic air transfer system is used to transfer high dose materials from the sample storage cell to the shielded cells. A robot system will be used to load/unload the instruments. Vibrating equipment associated with the instruments will be located above the instruments on the second floor of SPL. Some targeted advanced characterization equipment include X-ray diffractometer (XRD), X-ray photoelectron spectroscopy (XPS), and scanning electron/focused ion beam microscopy (SEM/FIB).

Additional Key Features of SPL

Various other key features of SPL are listed below.

- A glovebox/fume hood line is located on the second floor of SPL. Its purpose is sample preparation of materials with low radiation dose. Six fume hoods are associated with the line to support various activities including two non-radiological hoods. All of the radiological hoods and the glovebox are connect using transfer chambers to allow transferring of items easily.
- A manipulator repair area is present on the third floor of SPL. This is needed due to no facility at MFC capable of repair of beta-gamma only contaminated manipulators.
- Additional space on the 1st and 2nd floor of SPL for installation of new equipment and shielded cells.

Timeframe

- End of 2018: Completion of 100% design
- Start construction in 2019 depending on funding from U.S. Government.