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Remote Refurbishment of the Metallography Preparation Box at the INL

HOTLABS

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REMOTE REFURBISHMENT OF THE METALLOGRAPHY PREPARATION BOX AT THE INL

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ABSTRACT

One of the most utilized hot cell capabilities at the Idaho National Laboratory is referred to as the containment box. This is where all destructive examination samples are prepared for analysis. This one window box is contained within the much larger Hot Fuels Examination Facility which consists of a 21x10x8 meter hot cell with an inert argon atmosphere. The refurbishment of this box entailed removing of all sample preparation equipment and support systems, as well as the design and installation of new preparation equipment. The new equipment consists of low and high speed saws, grinding and polishing equipment, water recirculation systems, and sample storage units. This paper includes the details of this refurbishment.

1. Introduction

Within the Hot Fuels Examination facility at Idaho National Laboratory, a containment box, sealed to the cell wall is used for sectioning, mounting, grinding, and polishing irradiated fuel, cladding and structural materials. The box is served by its own argon atmosphere and controls in order to prevent alpha contamination to the main cell.

A significant increase in the throughput of this containment box has led to the recent refurbishment of the equipment, controls and capabilities. All of this refurbishment was required to be done remotely due to the atmosphere of the cell as well as the contamination levels of the equipment.

The equipment chosen to upgrade this containment box needed to be capable of withstanding an oxygen/moisture free environment as well as very high radiation fields during fuel sample preparation.

2. Outdated Equipment and Capabilities

Legacy equipment in the containment box consisted of a grinding wheel with water recirculation system, a polishing wheel, a slow speed cut off saw and an optical periscope system with magnification up to 25 times. The grinding and polishing systems were outdated and unreliable causing delays in sample preparation.

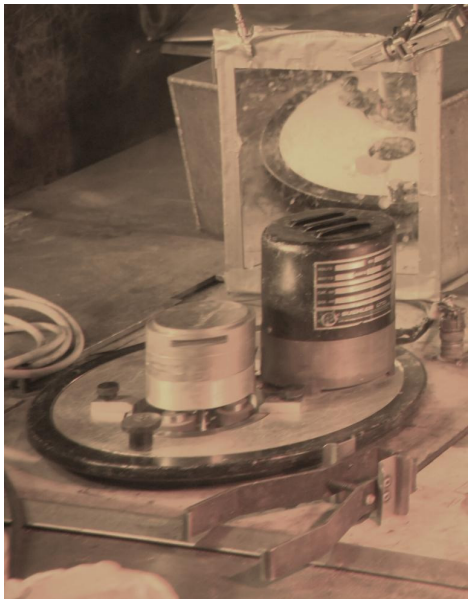

Fig 1. Existing polishing wheel with mounts

The lighting within the containment box was provided by two large ambient light sources which did not provide sufficient focused light for detailed examinations. Portable lights were required for this purpose.

3. New Equipment

Equipment purchased for the refurbishment included three Struers Hot Cell Grinders/Polishers with two being installed into the hot cell and one reserved for technique development. The units are called a TegraForce-1 for Hot Cell, a TegraPol-15 control, and TegraDouser-5. This equipment was designed with specific hot cell applications in mind including easy installation, easily operated with manipulators, radiation resistance, easy to decontaminate, and easy maintenance. The three units can be seen in Figure 3.

The TegraDouser was designed to go outside the hot cell with 7 plastic tubes designed for feed through supply of polishing solution and water. The tubes are connected to a nozzle block which supplies the liquids. The unit is designed to feed a set quantity of polishing solution in user defined intervals depending on the application.

A Minitom Hot Cell low speed precision cut-off machine also by Struers was purchased for installation. This will primarily be used to section specimens for final dimension for mounting. The unit was also designed for hot cell use and will provide better control of small specimen sectioning.

Fig 2. TegraForce, TegraPol, and TegraDouser by Struers

Other equipment installed included improved lighting which could be moved to where it was needed, an ultrasonic cleaner, a modified scale which will be used to weigh samples of interest, and a visual examination camera capable of providing higher magnification checks of sample quality prior to transfer to the metallography station.

4. Installation Preparation

The containment box as it was operational needed to be completely disassembled prior to upgrading. Disassembly was accomplished by removing the hinged roof on top of the containment box and using a combination of the Electro-Manipulators and overhead crane. The grinders, polishers, slow speed saw and deck plates were all removed, sized down, and disposed of in the high level waste stream. The removal of the grinding wheel can be seen in figure 3 and the disassembled box can be seen in figure 4.

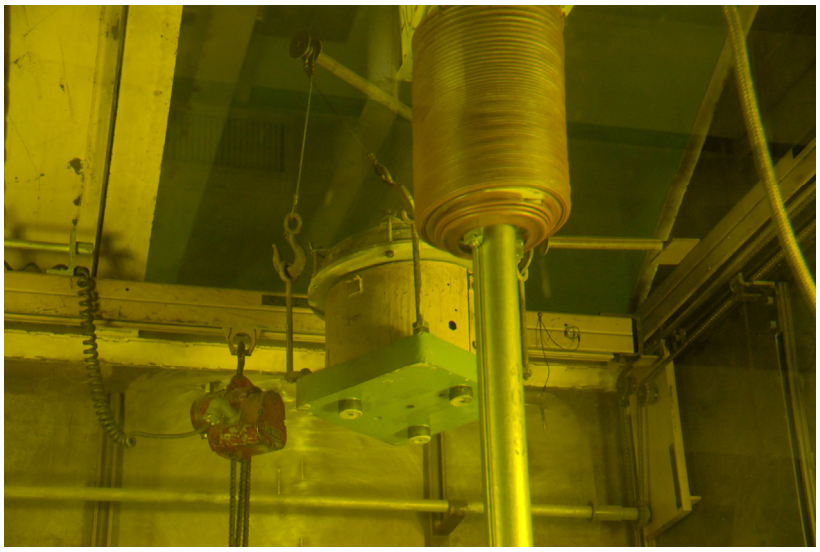
Fig 3. Removing existing polisher through ‘containment-box’ roof

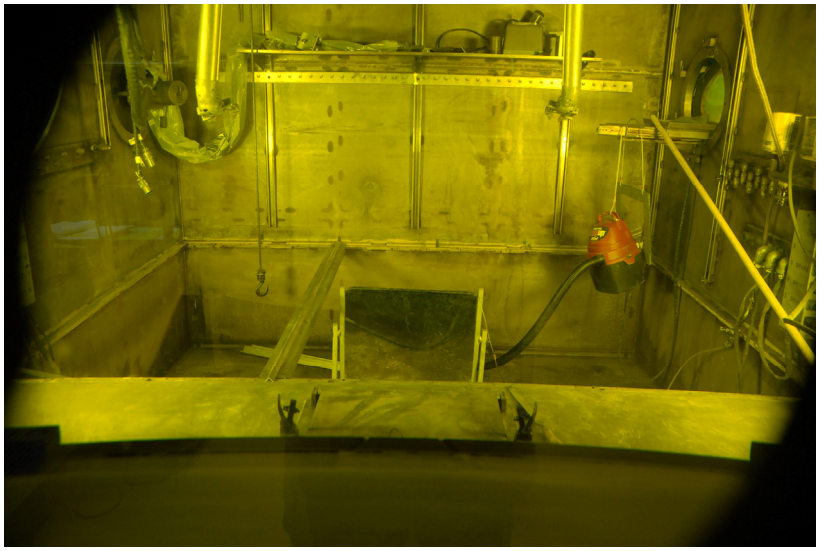

Fig 3. Containment box with equipment and deck plates removed

During the 'mock-up' phase prior to installation, several issues were identified with the equipment that would have prevented optimum use in this particular installation mode of the equipment. Some of those modifications are outlined here.

Several components needed to be removed due to the high radiation levels and environment conditions. Several plastic components were replaced by machined aluminium pieces (splash guard, water hoses, etc). Electrical components located in the head were removed and modified to operate from outside of the hot cell. The bushings within the motors needed to be changed to operate in an inert environment where arcing would occur with the stock pieces.

Several ergonomic/operational changes also needed to occur. Decorative/protective pieces located on the front and sides of the unit were removed to ease with installation at floor level of the cell. The sides and bottom of the unit were also modified to allow the removal and especially re-installation of the drive belts as their composition will limit their life span. All cabling was removed and replaced with Amphenol type fittings.

A large undertaking was to change the automatic water flow system with a water recirculation unit. This unit will collect, filter and re-circulate the water through the grinding unit. This will be done to significantly reduce the quantity of waste water associated with sample preparation.

The largest modification that occurred was with the controls of the Tegra-Force Head. This unit is designed to pneumatically control the pressure applied to the samples. The unit is designed such that when the pressure is released from the samples the pressure gas is released back through the control unit. This was unacceptable due to radiation concerns. Modifications included both diverting the exhaust from the depressurization to the hot cell atmosphere as well as modify the control panel to acknowledge that the pressure had been relieved despite no indication through the panel itself.

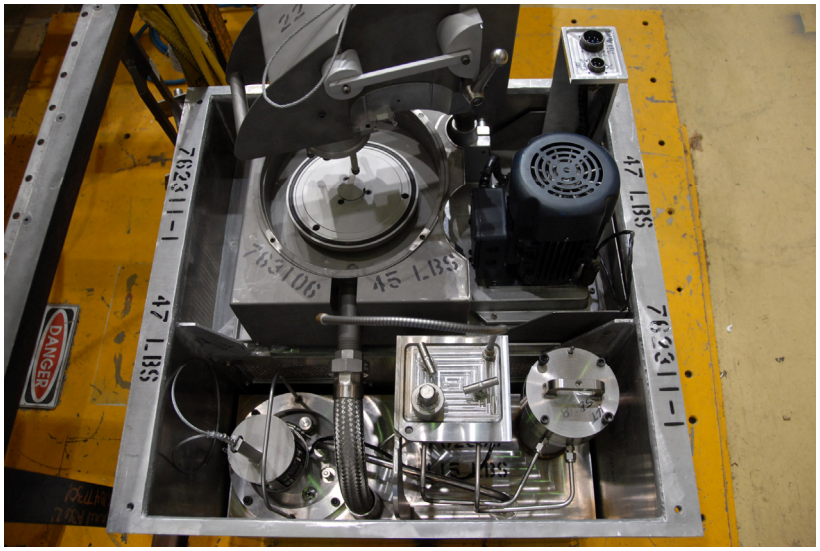

Fig 4. Grinding wheel modified with water recirculation unit

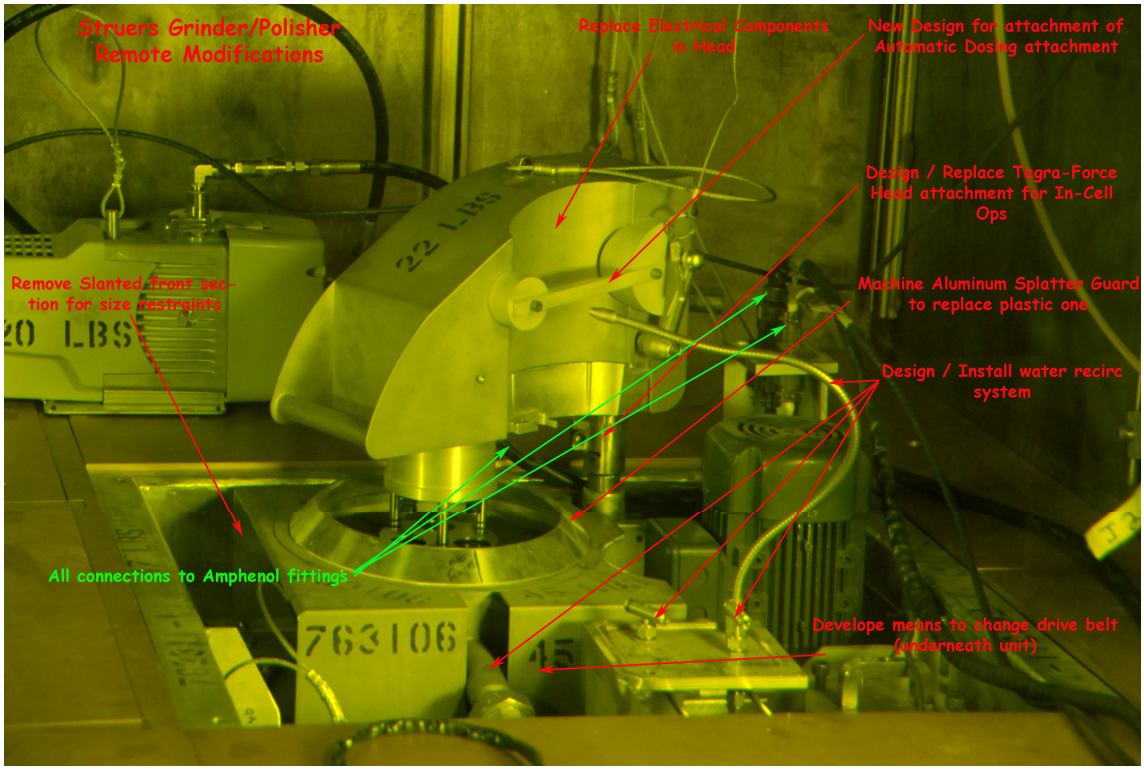

Fig 5. Grinding wheel with modifications listed

5. Installation

Installation of the upgraded equipment is currently underway. The grinding/polishing equipment has been installed without the automated polishing solution TegraDouser. Concerns over longevity, maintenance, and installation problems, it was decided to use a manual dousing method. Both units are functional and are currently awaiting final qualification pending the completion of installation of the remaining equipment.

The lighting upgrades have occurred and now include ambient lighting within the box as well as moveable lamps that can be directed where needed. This will greatly aid in identification of small specimens as well as allow for more detailed examinations within the containment

box. The camera system that was installed will also assist in determining sample quality during the preparation phase. The expected lifetime of these cameras is not yet known but is expected to be weeks to months. These upgrades can be seen in figures 6 and 7.

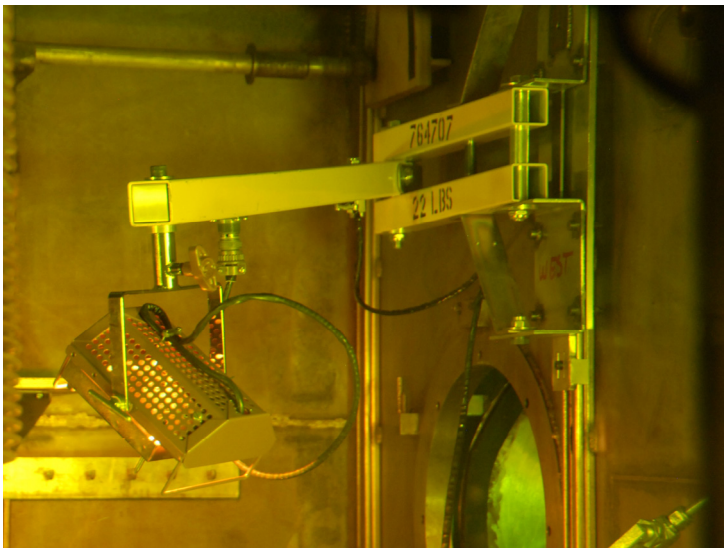

Fig 6. New movable lamps in containment box

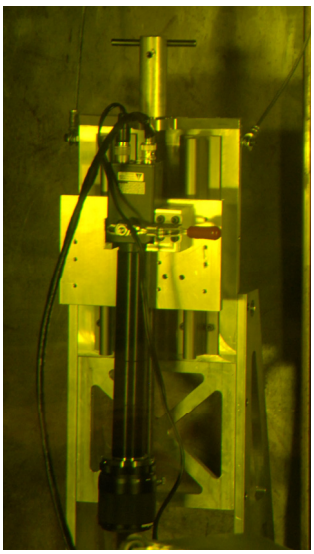
Fig 7. Camera inspection unit

The current state of the installation phase can be seen in figure 8. The equipment has now been located in the containment box and awaits final qualification. Final arrangement will be made to locate bench-top equipment, electrical cables will be properly situated, and all equipment will be thoroughly tested.

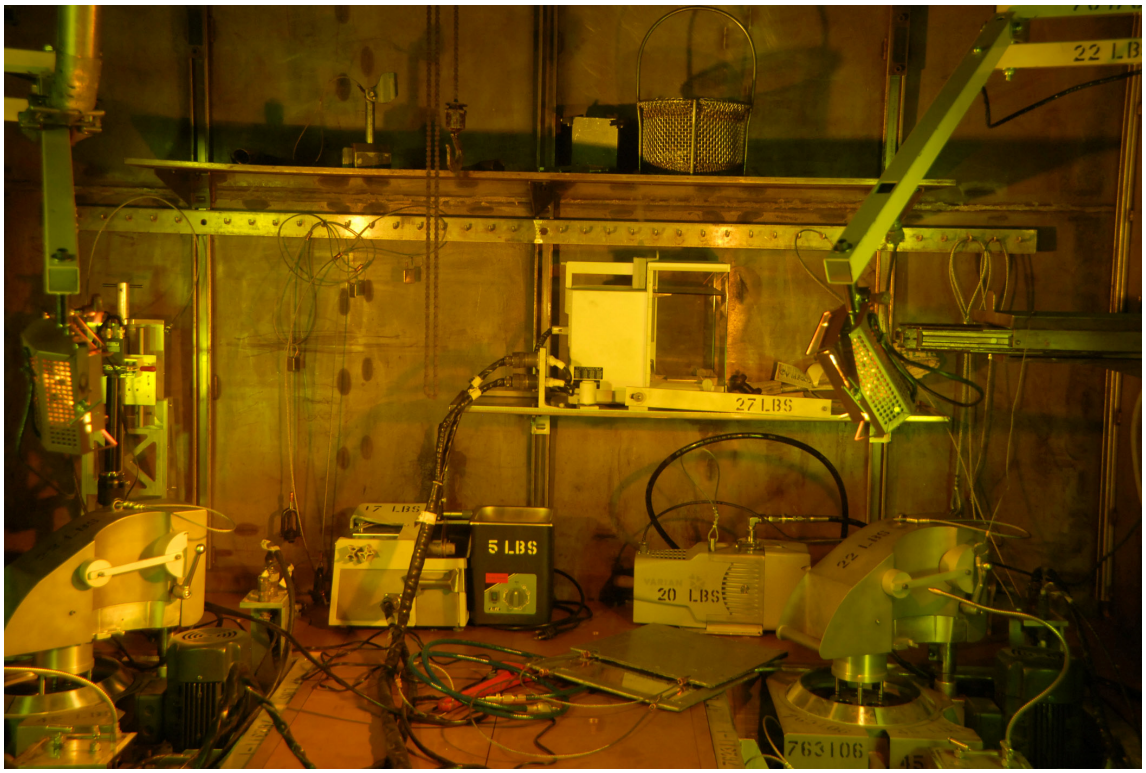

Fig 8. Containment box during equipment installation

6. Conclusions

The refurbishment of the containment box is expected to greatly increase capacity for work (3-5 times faster throughput) as well as increase the quality of samples that are prepared. While unexpected modifications were required to the hot-cell ready equipment, the final results appear to be nearing completion.