INL Visual Examination Machine Periscope Upgrade
Philip Winston, Gregory Housley, Steven Marschmann, Collin Knight, Katelyn Wheeler

Idaho National Laboratory
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- Idaho Snake River Plain (lava-sagebrush desert)
- WWII Gunnery Range
- Became National Reactor Testing Station
- 52 reactor designs built and tested
- Including EBR-1, MTR, EBR-II, PBF, ATR, TREAT
Hot Fuel Examination Facility

- Part of the INL Materials & Fuels Complex, formerly Argonne National Laboratory West, designed to examine EBR-II sodium bonded fuel
- Argon filled hot cell in service 1974
- Multiple devices to do fuel examination
  - Optical Viewing by Through-wall Periscopes. (1.3 m walls)
  - Visual Exam Machine Kollmorgen Type F Model 894
- Estimates for maintenance and lead time determined to be excessive
- Plan to visually inspect commercial PWR fuel rods
Why do you need a direct view into your hot cell?
Design Replacement Premise

- Need replacement periscope to allow clear focus and position control
- Intended to be used to provide visual comparison of high burnup PWR fuel rods in conjunction with eddy current measurements
- Design adaptable periscope insert independent of specific lens or camera combination
- Design to be independent of rad hardened specialized components
- Allow replacement with new components or technology with minimum modification
- Use video display and digital camera with long working-distance lens inside shielded configuration

- Initially started in 2013 with Used Fuel Disposition campaign funding provided by Dr. Steve Marschmann.
- Design, Phil Winston, Greg Housley;

- Restarted in 2018 under direction of Mr. Collin Knight

- Planned to be deployed 2019, responsibility Ms. Katelyn Wheeler
Stage-Periscope Position and Travel

In cell stage provides nominal 144 inch (3650 mm) vertical travel.

96 inch (2440 mm) pit below grade allows additional movement.

Primary stage located 44 inches (1120 mm) from wall.

Vertical position precision 76 microns.
Design Requirements

- Identify defects <50 microns
- Provide display and digital image recording
- Focus on target nominal distance 44 inches from cell wall
- Be able to view 12 ft long component with stage movement of 147 in
- Feedthrough shell gas tight seal per TFR-589; Leak test 1E-5cc/sec He
- Assembled feedthrough He leak test < 5E-5 cc/sec per TPR-13438
General Configuration

- Keyence VHX Microscope Camera
- Keyence VW-Z2 2 m WD 4:1 zoom Machine vision lens

Differences:
- Tungsten Shield above camera
- Potted connection through back plate
- Extension mirror assembly not installed
Components

- Keyence VHX-2000 Microscope Camera and Monitor
- Keyence VW-Z2 Long Distance Macro Zoom Lens
Components

- Front Surface Mirrors
- No concern for browning of glass


Components

- Rail and Cart
- Camera, mirrors and shield block can be repositioned depending on optics used
- Facilitates removal of components without removing in-wall insert
Shield Plates

- Slotted/Angled 2” thick
- Carbon Steel Plates
- Individual Plates 50 lb
Components

- Rail and Cart Insertion
Components

- Potted Rear Plate Seal
- Used to assure that the copper and fibre optic conductors are sealed to meet the isolation criteria for the argon filled cell.
**Components**

- Potted Rear Plate Seal
- Used to assure that the copper and fibre optic conductors are sealed to meet the isolation criteria for the argon filled cell.
Image Quality

- Image @ 44” max zoom
- Target USAF 1951
- Graphite cylinder 1” long
- ½” Stainless tubing on right
Front (In Cell) End

- Double O-ring seal (edge and face)
- 12.7 mm thick silica window (non browning)
- Angle steel hooks allow attachment of periscope extension or close positioning stage
Image Quality

Corrosion specimen
2” away Full Zoom
Image Quality

- 44” from wall; full zoom
- Dino Lite 200 micron scale
- Dummy PWR Fuel rod on right
Image Quality

- Olympus 0.01 mm (10 micron) microscopy target
- Full zoom, 4” away from tube end
- Front Lighting
**Image Quality**

- TRISO particles in polished met mount; full zoom @ 2 inches
- 30-40 micron SiC layer
- 30-50 micron OPyC layer
- 40-60 micron
Additional Work

- Additional software work and/or electronic linkage to linking image data to stage position.

- A close-range positioning stage in progress for small samples needing maximum magnification.

- Supplemental In Cell Lighting has been purchased and modified
Conclusions

The system will work for the original purpose of inspecting fuel rod cladding at the 44 inch (1120mm) working distance.

The system will be effective for inspecting TRISO compacts at the nominal 2 – 4 inch (50 to 100 mm) distance.

Thanks for your attention.

Phil Winston
Idaho National Laboratory

Philip.Winston@inl.gov
208.526.3679