HIGH LEVEL WASTE/WASTE PROCESSING

PROJECT: Chemical Process Alternatives for Radioactive Waste. *Evaluation of FIU's Solid-Liquid Interface Monitor (SLIM) for Estimating the Onset of Deep Sludge Gas Release Events*

CLIENT: U.S. Department of Energy
PRINCIPAL INVESTIGATOR: Dr. Leonel Lagos
LOCATION: Miami, FL

Description: The ability to monitor the interface between liquids containing suspended solids and settled solids in HLW tanks has multiple, important applications at Hanford including:

- Measurement of the height of HLW solids added to double-shelled tanks to ensure it is below the critical value determined from a safety basis;
- Imaging in single-shelled tanks to support pump emplacement to minimize plugging potential;
- Rapid imaging of the floors of mixing, conditioning tanks to ensure effective mixing and retrieval of waste by Pulsed Jet Mixers (PJMs);
- Imaging and volume estimation of settled solids in HLW tanks to monitor for hydrogen gas retention in deep sludge layers as seen by increased volume (height) of waste.

FIU's Applied Research Center (ARC) has developed a near-real-time solid-liquid interface monitor (SLIM) able to be deployed into 1 million gallon HLW tanks at Hanford.

SLIM consists of:

- A profiling 3D sonar;
- A mechanical system for deployment of the monitor into HLW tanks.

SLIM is capable of:

- Functioning in high-nuclear radiation in HLW;
- Functioning in highly caustic solutions (pH>14);
- Being deployed through a 4-inch riser at the top of the HLW tank;
- Operating from many meters to as low as 10 inches above the settled solids layer;
- Measuring the interface elevation across the sonar's field of view and mapping the surface;
- Measuring the change in elevation of surface (hence the volume of waste under that surface) over time in the tank;
- Measuring the height of the solids layer to 1% resolution (i.e., 1 cm for sonar 1 m above surface: 3 mm for sonar 30 cm or 1 ft above the surface).

Fig. 1. 3D profiling sonar and controller

Fig. 2. Deployment platform with gooseneck reel

Benefits:

Benefits of developing the Solid-Liquid Interface Monitor are:

- Improves HLW retrieval efficiency;
- Assists in maximizing the utilization of available tank space in the double-shell receiver tanks;
- Protects workers and minimizes dose by remote operation of monitoring activities;
- Reduces environmental risk by ensuring that HLW tanks cannot be overfilled.

ABOUT

Since 1995, the Applied Research Center at Florida International University has provided critical support to the Department of Energy's Office of Environmental Management mission of accelerated risk reduction and cleanup of the environmental legacy of the nation's nuclear weapons program. ARC's research performed under the DOE-FIU Cooperative Agreement (Contract # DE-EM0000598) can be classified as fundamental/basic, proof of principle, prototyping and laboratory experimentation.

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Accomplishments:

- Completed several prototypes of SLIM and tested against functional requirements for in-tank deployment;
- Mechanical, instrumentation and control design of system follow Hanford specifications;
- Performed system structural Finite Element Analysis (FEA) of the deployment platform;
- Completed system in-house fabrication;
- Completed 25+ tests on SLIM or the sonar alone and demonstrated that it met the Hanford site's needs for 4 different applications in HLW tanks (described above).

4th Application Area for SLIM's Sonar:

Measuring the change in volume of HLW in tanks as an indicator of Deep Sludge Gas Release Events (DSGREs).

In Fall 2015, FIU initiated testing of the 3D sonar to determine if it could be deployed as a monitor to enable operators to see evidence of hydrogen gas build-up over time in the deep sludge layer from an increase in the solids surface of 6 mm or more.

Success!

In January 2016, FIU successfully imaged a solids layer that was raised 10 mm through insertion of air into a bladder under a solids (sand) layer. This mimics the rise in HLW solids from gas generation and retention in a deep sludge layer.

Experimental Process:

An air bladder was taped to a plastic lid and weighted with flat metal pieces to keep it securely on the tank floor and not floating to the water surface (see **Error! Reference source not found.**). Paver sand was then placed upon the bladder and then smoothed over in order to ensure the sand would remain over the entire bladder even after addition of air while underwater. In **Error! Reference source not found.** the sand covers the bladder with a slight mounding.

Fig. 3. Air bladder with metal weights underneath taped to a plastic lid.

Fig. 4. Same air bladder covered with paver sand to create object to be imaged by the 3D sonar.

In Fig. 5 the 3D sonar images are shown with: no air in the bladder (left); increment of air to raise center point of sand 10 mm (center); and 2nd increment of air to raise the center point of sand to 20 mm (right).

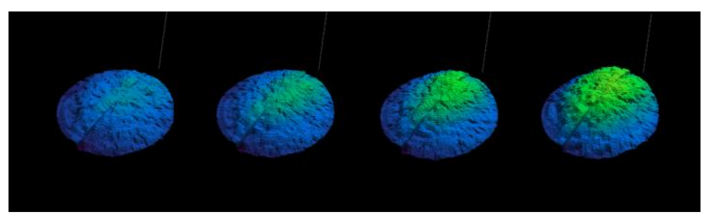

Fig. 5. Four 3D sonar images: no air in bladder (left); after successive air additions in next 3 images.

Future Work:

- Implement test plan to quantify the minimum volume change measurable with the sonar.
- Complete software improvements: data filtering algorithms; image display for post-processed data; and volume measurements.
- Move to 2 new efforts: (1) measuring the solids settling rates for HLW surrogates with sonar; and (2) imaging bubbles with the sonar.