U.S. University-Led Integrated Research Project

Advanced Capabilities for Underwater Nuclearized Robotics (IRP-EM-2)

Webinar Follow-Up – August 21, 2015

Statement of Need

- **This IRP seeks a functional prototype of a robotic solution that will:**
  1) **Remotely maneuver in a water-filled basin, pool or tank within a nuclear facility while afloat and while submerged at depth;**
  2) **Obtain high-resolution color video footage;**
  3) **Perform simultaneous localization and mapping;**
  4) **perform radiation measurements;**
  5) **Perform appropriate non-destructive, *in situ* measurements of the materials of construction to help determine structural integrity; and**
  6) **Integrate and correlate SLAM and radiation data for analysis, scientific visualization and computer simulation.**

Requirements

- **Proposals submitted in response to this IRP must:**
  - **(1) Indicate the intention for collaboration with at least one other US university/college having established robotics expertise and assets;**
  - **(2A) Indicate the intention for collaboration with at least one DOE national laboratory/technology center OR**
  - **(2B) Indicate the intention for collaboration with a laboratory/ technology center of another federal agency having established robotics expertise and assets;**
  - **(3) Demonstrate full functionality of the robotics system to meet the aforementioned technical objective at a field mock-up;**
  - **(4) Provide a strategy for advancing the robotic solution to the next phase of EM radioactive test bed demonstration; and**
  - **(5) Demonstrate utility at one of EM's nuclear facilities.**

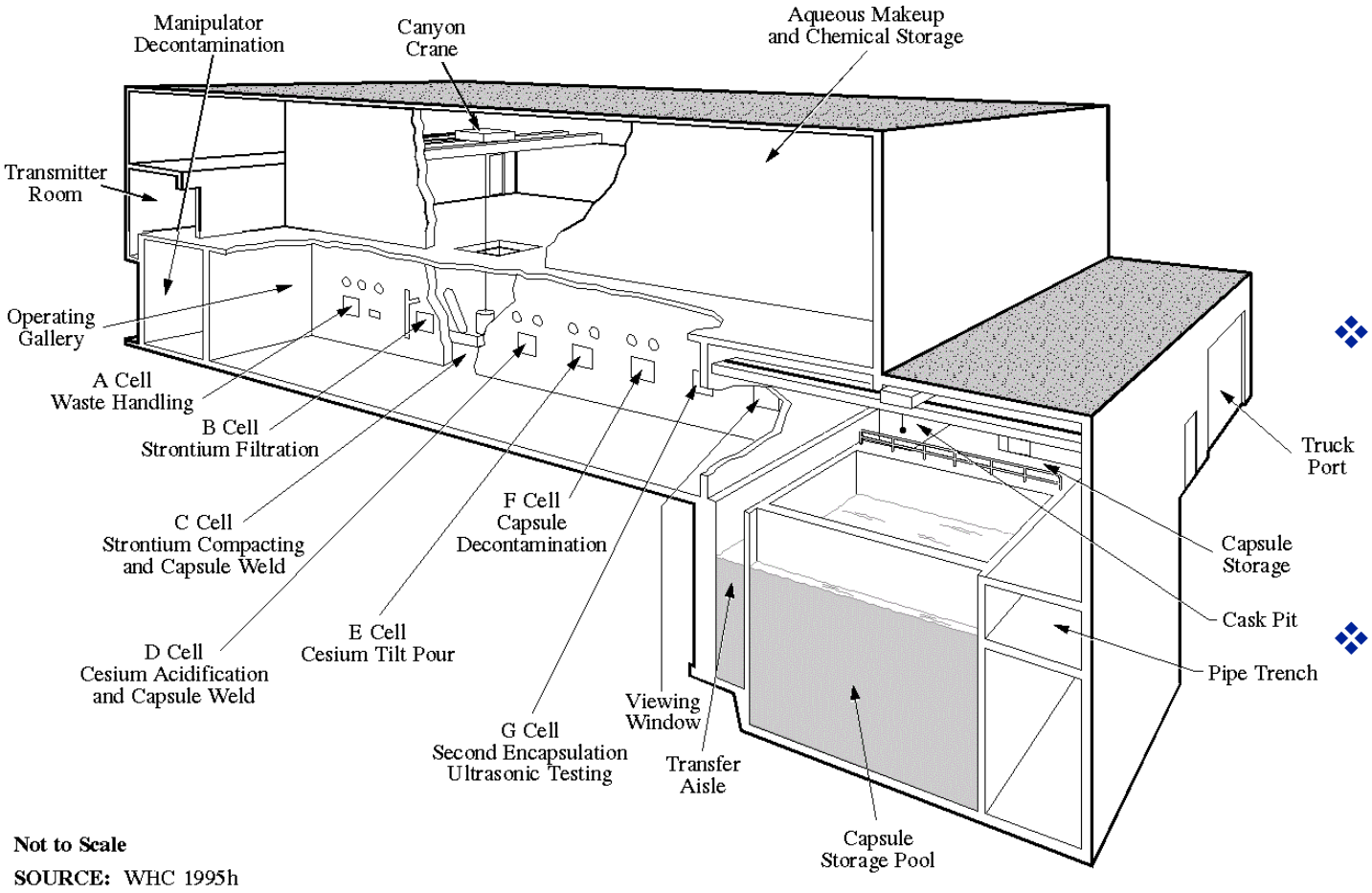
Representative Applications

- Representative EM nuclear facilities for this application of robotics include, but are not limited to
  - Hanford Waste Encapsulation Storage Facility (example #1) and
  - Savannah River Site L-Basin Spent Fuel Storage (example #2).
- High levels of radiation exist

Example #1: Hanford WESF

The Waste Encapsulation Storage Facility (WESF), Operating Unit Group 14, was constructed on the west end of B Plant in 1974. Its mission was to encapsulate and store cesium chloride and strontium fluoride salts that had been separated from Hanford's high-level tank waste.

Schematic Diagram of WESF

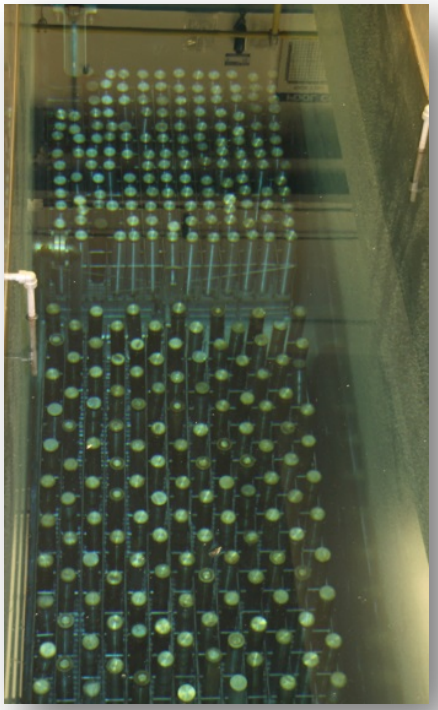


Not to Scale

SOURCE: WHC 1995h

- **WESF provides underwater pool storage of stainless steel capsules containing Cs-137 and Sr-90.**
- **Each pool has a monitoring system to detect any leakage from capsules.**
- **The water cools the cesium and strontium capsules and provides radiation shielding.**

Hanford WESF



The pool consists of 12 cells lined with stainless steel. Each of these pools contains one small (13-by-13 grid) and two large (18-by-21 grid) capsule storage racks. Capsules are placed vertically in the storage racks and are stored in 13 feet of water for shielding and cooling. The depth of the pool is about 33 feet. Pool cells 1 through 8 and cell 12 are used for capsule storage.

Cesium and Strontium Capsules

- 1,936 cesium and strontium capsules
  - 1,335 cesium capsules (74 million curies)
  - 601 strontium capsules (32 million curies)
- Cesium capsules (1,312 each)
  - Inner barrier: Stainless steel/316L, OD = 5.72 cm, L = 50.10 cm
  - Outer barrier: Stainless steel/316L , OD = 6.67 cm, L = 52.77 cm
- Type W overpack mixed waste cesium capsules (23 each)
  - Stainless steel/316L , OD = 8.3 cm, L = 55.4 cm
- Strontium capsules (601 each)
  - Inner barrier: Hastelloy/C-276, OD = 5.72 cm, L = 50.10 cm
  - Outer barrier: Stainless steel/316L , OD = 6.67 cm, L = 51.05 cm

Example #2: Savannah River Site L-Basin

Underwater storage facilities, called disassembly basins, were located in all five SRS production reactor areas. These facilities were designed to store SNF and target assemblies discharged from the reactor cores. This storage allowed the nuclear material to cool after being irradiated in the reactors.

In 1996, L Basin equipment was reconfigured to safely handle and store SNF from off-site (foreign and domestic) research reactors. In February 1997, the first off-site fuel was received and stored in L Basin. To avoid the cost of operating multiple facilities, SRS decided in 1998 to consolidate all of SRS's stored spent fuel into the much larger, recently refurbished L Basin. By 2003, L Basin was SRS's only fuel receipt and storage facility.

L-Basin Structure

- Steel reinforced concrete basin
  - Walls 2.5’ to 7’ thick
  - Floors 5’ to 7’ thick
- Approximately 3.4 million gallons
  - Working areas 17’ and 30’ deep

L-Basin Inventory

- **Approximately 18,400 Assemblies**
  - **Aluminum (Al) Based & Stainless Steel/Zirconium Based UNF (~90% Al)**
  - **Highly Enriched & Low Enriched UNF (75% vs 25%)**
  - **Various shapes, sizes, burn-up percentage, degradation**