Lessons Learned from Decontamination and Decommissioning Projects

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Nuclear Capabilities and Expertise

- More than 20 years experience in nuclear industry
  - Decommissioning and demolishing of highly radioactive facilities
  - Retrieval, characterization, treatment, packaging, storage and disposal of waste; and repository solutions
  - Nuclear remediation
  - Emergency Planning
  - Plant decommissioning services
  - Spent fuel handling, management and operations
Rocky Flats Closure Project, USA

- More than 800 contaminated and non-contaminated structures
- More than 21 tons of weapons-grade nuclear materials, much of it improperly stored
- More than 30,000 liters of plutonium and enriched uranium solutions in aging tanks and pipes, some leaking
- Extensive contamination across the site
- Decontaminated and demolished five major plutonium processing facilities comprising more than 1 million square feet
- Located in the “back yard” of nearly 3 million people
- Closing the site was estimated to take 70 years and cost more than $36 billion
- Site is now a National Wildlife Refuge
13 “infinity rooms” were so contaminated that radiological monitoring equipment of the day could not measure it.

B771, Room 141 airborne radioactivity was upward of **20 million DAC** - room was sealed for 25 years.

DAC lowered to 10,000 through innovative decontamination techniques and fixative applied to interior surfaces remotely.

Entire room size reduced.

**Lessons Learned**: methodical planning and engineered controls (fixatives, decontamination, ventilation, wet methods, fogging, wire saw cutting), and protective equipment may be slow but reduce risk.
Located in southeastern Idaho, USA, on the Snake River Plain

6 major facility areas across an 2,300 square km area and several laboratories 80 km east of Idaho Falls

Extensive contamination from over 50 years of reactor testing

Focus on risk reduction to workers, public, environment, and drinking water source for >300,000 people
Safely Decommissioning Idaho’s Reactors

- Dose rates inside of the Engineering Test Reactor (ETR) were as high as 1100 R/hr
- **Innovation:** Engineered grout was used to provide the proper shielding so that workers could enter the reactor and perform work with general body fields of only 20 mrem/hr
- Grouting reduced the external dose rates on the reactor from ~ 100 R/hr to ~100 mrem/hr. Radiation area only extended ~10 ft from the reactor during removal

- The Experimental Breeder Reactor II broke new ground with sodium coolant, built-in fail safes, a closed fuel cycle and other innovations
  - Had not been designed to be safely dismantled
- Dose rates varied from 15 R/hr to 3000 R/hr
- **Innovation:** Grouted in place for safety and health
  - The lifting, transport and disposal of a fully grouted reactor vessel involved too much technical risk
Safely Decommissioning Idaho’s Reactors

- The Power Burst Facility (PBF) reactor was not grouted so that it could be removed by conventional cranes

Innovations

- To reduce dose rates above the reactor opening and in the annulus to allow for extended work the reactor was re-filled with water
- Fixative was applied to the PBF annulus to decrease the loose contamination

- The Materials Test Reactor (MTR) had dose rates of 6 R/hr

Innovation: A standard, commercially available Culvert was used to shield the reactor as it was removed
Located in southeast Washington State, USA

1,500 square kilometer site

Significant contamination including 12 groundwater plumes threatening the Columbia River

Today, undergoing reactor decommissioning, demolition and environmental remediation
Decontamination Area Perspective
The Sludge Treatment Project was one of DOE’s top national cleanup priorities.

Stored 17 feet under water in a large concrete basin adjacent to Hanford’s K-West Reactor for more than 30 years.

Using long-handled tools, workers processed the material under water, transferring it to copper inserts and then into stainless steel structures.

**Lessons Learned**

A mock-up of the reactor basin was constructed to create a non-radiological site where workers could master the retrieval tools and processes.

- Full-scale test and training setup increased worker safety while reducing cost and schedule.
Approximately 80 square miles of groundwater beneath the Hanford Site were contaminated above the drinking water standard from past nuclear processing activities.
Hanford Groundwater Treatment

- The 200 West Pump and Treat system was designed and constructed by CH2M HILL to remove the contamination and slow the movement of the contamination toward the Columbia River.
- The treatment system combines several technologies to address multiple contaminants in the groundwater.
- Capability of removing more types of radioactive and chemical contaminants than any other systems of its kind in the DOE Environmental Management complex.
Conceptual Illustration of the Emplaced Apatite Permeable Barrier System
- £1.6 billion environmental cleanup through 2022-25
- Radioactive waste to be placed into a condition that is safe for long-term storage or disposal

**Shaft and Silo**
- Licensed as a disposal facility for radioactive wastes and routinely used for the disposal of unconditioned intermediate level waste (ILW) until 1970
- An explosion occurred in 1977 at the shaft which caused severe damage to the superstructure
- Currently developing concept designs for waste retrieval, treatment and storage facilities
- A number of innovative approaches have been introduced to accelerate the decommissioning and reduce the cost

**Lessons Learned:** use of proven, commercially available off-the-shelf technology and equipment such as industrial grabs and robotic mechanisms reduces cost and risk
Broader Lessons Learned - Stakeholders

- Empathy and execution are required
- Stakeholder collaboration is critical
- Successful clean up is an evolution
- Integration and coordination at all levels

Sharing Lessons Learned from the Hanford Groundwater Treatment Program with Japanese delegations.

Demonstrating reactor component removal to the public using a mock-up of the reactor.

Dounreay End State Public Consultation
Decontamination and Decommissioning Technology Applicability

- Proper application of a wide range of technologies will:
  - Allow personnel to work in an efficient manner
  - Minimize waste generation
  - Reduce cost and time
  - Safely achieve the project goals
  - Minimize personnel exposure

- To summarize, there is no single answer or technology to nuclear decommissioning and decontamination—it is the approach and correct application of multiple technologies

- Successfully decontaminating and decommissioning highly contaminated facilities and reactors is achieved by correctly applying multiple technologies
Summary of Critical Success Factors

- Simplicity and reliability of technology/equipment for Decontamination - Easy to say but most difficult to achieve!
  - Remote operated equipment
  - Novel and First of A Kind
  - High Potential for Rapidly Escalated Costs
- Cultural transition from operations or generating organization to a project-based decommissioning organization
- Effective regulatory/stakeholder interaction and involvement is key to regaining trust and acceptance.
- Training/reskilling of the workforce to the unique challenges and skills required of the nuclear decontamination and decommissioning industry is paramount –
  - Worker involvement in planning, implementation and feedback essential
Discussion