Lessons Learned from EPRI Decommissioning Program

Decommissioning and Demolition

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Overview

- General Dismantlement
- Removal of Large Components
- Characterization, Remediation and Removal of Concrete
- Demolition of Large Concrete Structures
Factors that Affect General Dismantlement Method Selected

- Contamination Level:
  - Highly contaminated systems are typically cut:
    - With Low Energy (Cold) Methods such as
      - Orbital (Clamshell) Cutters
      - Portable Band Saws
      - Shears
    - Contamination lockdown methods such as grouting and/or painting the inside of piping may also be used
  - If the contamination level is low, gas torches are used (faster method)

- Size of Piping (Typically Used Methods)
  - Large Piping (> 30 cm in diameter) – Gas Torch or Orbital Cutter
  - Intermediate Piping (10 to 30 cm in diameter) – Gas Torch or Portable Band Saw
  - Small Piping (< 10 cm in diameter) – Shear
Removal of Large Components

- Nuclear power plant decommissioning requires removal and disposal of large contaminated components
- In the U.S., some components may be disposed of in one piece, for example
  - Reactor vessel
  - Steam generator
  - Pressurizer
- Outside of the U.S., one-piece disposal of large components typically not allowed
Removal of Large Components

*Reactor Internals Segmentation*

- In all countries, due to size and activity content, reactor internals must be segmented for disposal.
- Reactor internals segmentation is one of the most complex and challenging activities during decommissioning.
  - Highly irradiated metal requires underwater cutting.
  - Complex geometry.
  - Irradiation hardening of metal makes cutting difficult.

BWR Reactor Internals
Large Component Management: US Experience

- No Clearance Levels – Very difficult to decontaminate for release
- Large Components can go intact to Shallow Land Disposal (France has also allowed one piece disposal if activity is reduced to Very Low Level Waste limits)
- PWR Steam Generators typically only cut into 2 sections to reduce disposal costs and facilitate shipping
- More costly to segment and/or decontaminate large components

Steam Generator Lower Assembly

Steam Generator Dome
Large Component Management: European Experience

- Management of large components driven by regulatory and other requirements that are different than those that exist in the US
  - Most countries have much higher waste disposal costs than the U.S.
  - Economics favor decontamination for Free Release or Recycle
  - Radiological criteria to avoid unnecessary disposal exist that allow:
    - Release of materials containing very low levels of radioactivity for unrestricted use
    - The release of metal to the recycle industry often takes credit for the dilution of the metal by “Clean” metal in the recycle process.
  - One piece disposal of components generally not allowed
    - Large components must be segmented to fit into relatively small packages (generally a few cubic meters in size)

These factors have resulted in the development of various technologies for the segmentation and/or decontamination of large components
Lessons Learned in Dismantlement

- The Disposition of Large Components can be Challenging but Successful Processing Methods have been Developed
- The Large Component Processing Method Chosen is Driven by:
  - Waste Disposal Regulations
  - Is Clearance and/or Recycling of Metal Allowed by Regulation
- General Dismantlement Method Choice is Driven by:
  - Contamination Levels in Components
  - Size of Component/Piping
  - Necessary Radiological Controls and Speed of Cutting both need to be Considered
Concrete Management

Concrete Remediation Inside Maine Yankee Containment
Factors in US Affecting Concrete Remediation and Building Demolition

- Low Disposal Cost for Class A Waste (generally < 40 Taiwan Dollars per kg)
- Remediation to Release Limits (DCGL-Derived Concentration Guideline Levels): Very Difficult in Some Cases
- Final Status Surveys (FSS) - Expensive and Time Consuming
- For Release of the Site Quickly: Dispose of Affected Above Grade Structures as Radioactive Waste
- Utilities Retaining Ownership of the Site have Generally Decided to Decontaminate and Leave Structures Standing
Concrete Remediation Inside Maine Yankee Containment
Connecticut Yankee D&D Approach

Connecticut Yankee Atomic Power Company
General Arrangement Drawing
Potentially Contaminated Below Grade Concrete
Concrete Remediation Options

- **Shallow or Localized Remediation**
  - Concrete Shavers
  - Media Blasting (Sand, CO₂, Ice, High Pressure Washing)
  - Hand Held Tools (Hilti Chisel, Needle Gun, Hammer Mill)

- **Advantages of Shallow Remediation**
  - Minimizes waste generation
  - Can provide smooth surface for Final Status Survey

- **Disadvantages of Shallow Remediation**
  - Remediation rate slow and labor intensive
  - Rework often needed to reach DCGLs

Generally viewed as more costly approach in US due to low waste disposal costs
Concrete Remediation Options
Shallow or Localized Remediation

- Typical techniques
  - Concrete shavers (i.e. Marcrist diamond shaver)
  - Media blasting (sand, CO₂, Ice, high pressure washing)
  - Hand held tools (Hilti chisel, needle gun, hammer mill, Jackhammer)

- Advantages
  - Minimizes waste generation
  - Can provide smooth surface for Final Status Survey

- Disadvantages
  - Slow and labor intensive
  - Rework often needed to reach DCGLs
  - Generally more costly approach in US
Concrete Remediation Options

Aggressive Remediation

- Typical techniques used for building interiors
  - Hydraulic hammers
    - Mounted on excavators at CY and MY
    - Mounted on Brokk Manipulator at Rancho Seco and Yankee Rowe
  - Diamond wire saw used for Bioshield removal at Big Rock Point (BWR) and LaCrosse (BWR)

- Advantages
  - Typically faster than shallow remediation techniques when contamination is deep in the concrete (i.e., > 1 cm)
  - Logical technique when concrete is highly activated (i.e., contamination is deep in concrete)

- Disadvantage: Creates more radioactive waste when contamination is relatively shallow
Marcrist Shaver at Rancho Seco

Test of Shaver for Wall Use

Floor shaver in Actual Use
Vacuum Filtration System for Concrete Shaver at Rancho Seco
Remediation of Areas Inaccessible to Concrete Shaver at Rancho Seco (Hilti Chisel being used)
Typical Demolition Techniques
Hydraulic Hammer with Dust Suppression

Removal of Concrete Shielding Around Base of Outdoor Tank at Trojan Plant

Demolition of Reinforced Concrete Building At Connecticut Yankee Plant
Activated Concrete Removal with Diamond Wire at Big Rock Point Plant
Typical Concrete Cutting Wire Saw Setup
Diamond Wire Saw Equipment

Typical Wire Saw Drive and Pulley Equipment

Diamond Wire Segmenting
Rancho Seco NPP Steam Generator

Typical Concrete Cutting Wire with Diamonds
Wire Saw Cutting of Reactor Enclosure Building at San Onofre Nuclear Power Plant
Containment Demolition Examples
Preparing Maine Yankee Containment for Explosive Demo
Maine Yankee Containment Building Ready for Explosive Demolition
Preparing Connecticut Yankee (CY) Containment for 1st Drop
CY Containment Settles Down 3 meters
Demolition of Top of Connecticut Yankee Dome
Lessons Learned in Addressing Contaminated Concrete Building Demolition

- Successful building demolition techniques have been developed
- Preparation work needed for most contaminated building demolitions
  - Decontamination/Lockdown to allow “Open Air Demolition”
  - Support concrete/rebar removal for Explosive Demo
- Innovative techniques (i.e. Connecticut Yankee containment demolition method) can save time and cost
- Alternate material disposition approaches can save cost and disposal site capacity
  - Disposal at a Non-Radioactive Waste Controlled Landfill
  - Reuse on-site as backfill
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