

Waste Management Best Practices for Decommissioning of Nuclear Power Plants – 15274

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ABSTRACT

Decommissioning of a nuclear power plant involves the safe disposition of a large quantity of radioactive, hazardous and conventional waste. A number of nuclear power plant decommissioning projects have been completed or are nearing completion in the US, Germany and Spain. These projects have used various waste disposal and interim storage options, and have developed successful methods for handling the large quantities of waste created by the decommissioning. Additionally, decommissioning projects in several Asian and European countries are in progress or are in the planning stages such that strategies for the handling of decommissioning waste are being developed and/or implemented to address the regulatory requirements and disposal options available in these countries. These experiences provide important lessons learned and successful strategies for the handling of waste from power plant decommissioning projects. As the handling and disposition of decommissioning waste have a substantial effect on power plant decommissioning cost, schedule and complexity, these lessons learned are valuable for planning future decommissioning projects.

INTRODUCTION

A large quantity of radioactive, hazardous and conventional waste is generated during decommissioning of a commercial nuclear power plant. The cost of waste disposal is a large component of the total decommissioning budget. Consequently, the optimal treatment and disposal option needs to be chosen for each type of waste. Waste that is generated must be classified and segregated in such a manner as to take advantage of all available disposal pathways: free release, direct reuse or processing for recycle; disposal in appropriate radioactive or hazardous waste disposal facilities; or decay storage or interim storage awaiting final disposal or release.

There is a very large unit cost difference between disposal of Class A waste and Class B/C waste in the US (likewise between VLLW/LLW and ILW in countries that follow IAEA waste classification). Additionally, there is currently no disposal pathway for higher activity level wastes in most countries (e.g., Greater than Class C waste in the US or HLW under IAEA). As such, it is important to minimize the quantity of higher activity waste generated through selective segmentation of contaminated/activated components and careful segregation of all wastes. There may be alternative disposal options for very low level or non-impacted wastes or debris coming from nuclear power plant decommissioning such as soil and concrete (and other building materials) that are much less costly than disposal as low level radioactive waste.

For non-activated materials, on-site and off-site decontamination options are available to allow the bulk of the material to meet clearance or very low level waste levels. For example, in the case of concrete structures, contaminated portions of the concrete may be selectively removed, thereby generating a small volume of contaminated concrete and larger volume of releasable or very low level waste concrete. There may also be potentials for recycling very low level metal wastes, dependent on the regulations of the country where decommissioning is being conducted and availability of waste processing services. Evaluation of decontamination or recycling options must consider the cost savings due to reduced waste volume compared to the costs of decontamination and additional radiological characterization to reclassify or release the material.

When benchmarking waste management practices at different facilities, it is important to note that the regulatory, social and economic drivers for waste management may vary substantially, even within an individual country. For example:

- The clearance of material and/or disposal as very low level waste (VLLW) are not available waste management options in all countries;
- Final waste acceptance criteria, including waste packaging requirements, have not been developed in all countries;
- Centralized waste processing facilities capable of handling large components are available only in a limited number of countries;
- One-piece disposal of large components is not an acceptable practice in most countries; and
- The cost for disposal of Class A, B and C waste (or LL/ILW) is typically much lower in the US than in most other countries.

DECOMMISSIONING WASTES

Generation of waste during decommissioning follows a typical sequence based on removal and remediation of systems, structures and components. The following provides a high level summary of the typical sequence and the rationale behind it.

Types of Wastes Generated during Decommissioning Phases:

Disposition of operational waste

There is typically some quantity of waste present on the site that were generated or accumulated during the operation of the plant, such as spent resins and filters, irradiated metals stored in the spent fuel pool and mixed hazardous and radioactive waste.

It is advantageous to dispose of these materials early in the decommissioning to allow components containing the waste materials to be drained in preparation for their removal. This is particularly critical for materials stored in the spent fuel pool to allow the pool to be used as a dry or flooded space during the reactor and/or reactor internals segmentation projects.

Although there is typically a low quantity of such waste, it is typically high activity waste (Class B/C or Intermediate Level Waste, or higher). Additionally, disposal may be complicated due to the presence of mixed hazards (for example, chemical and radioactivity hazards) or the lack of accurate characterization data.

Disposition of reactor vessel and internal components

The removal of the reactor and internals has been a major task during all decommissioning projects. As a number of plant systems and structures must be in place and operable to support these removals (for example, segmentation of the reactor internals underwater requires the reactor cavity to be flooded to provide shielding during the cutting), removal of these components is typically accomplished early in the decommissioning. Also, as these activities may create airborne contamination, the plant ventilation system will likely need to still be in service to provide a high air flow rate for the removal of airborne radioactivity.

This is typically the highest activity non-fuel waste generated during decommissioning. Thus, careful planning is required in segmentation of these components to minimize the quantity of high activity waste generated. Since much of this material is activated by neutron exposure, options to perform decontamination or other waste reduction processing techniques are limited.

Removal of other highly contaminated systems and components

The removal of highly contaminated systems and components requires the availability of high flow rate ventilation due to the potential for airborne radioactivity. These removals need to be accomplished after the removal of the reactor (or in parallel if the work occurs in a different building and does not impact the reactor removal). Although the sequence of these removals is plant specific, removal of large components first is a typical goal during this period as this creates more space to facilitate removal of the remaining smaller commodities. Plant ventilation equipment is generally removed at the end of this period as it is no longer needed for airborne radioactivity control.

This waste stream generally includes large contaminated, but not activated, metal components. Options are available to process these components, including surface decontamination, segmentation and segregation, or metal melting for release or recycle.

Decontamination of buildings

The decontamination of site buildings is generally performed after all installed plant equipment has been removed from an area. Illumination is typically provided by portable lighting equipment. Ventilation during this period has normally been provided by modular packaged units located outside of buildings or using portable equipment located local to the area being decontaminated. Some plants in the US elected not to decontaminate the buildings in the Radiological Control Area due to the high cost of decontamination and final status survey compared to the relatively low cost of disposal at the time. Building basements are almost always decontaminated and left in place, unless contamination levels, regulatory requirements or other factors necessitate complete removal.

Once the buildings have been decontaminated to the site release limits, they may be demolished immediately or left standing until after site license termination.

This waste stream is predominated by concrete waste and represents the largest volume of waste generated during decommissioning. As such, the degree to which buildings are decontaminated has a substantial effect on the total quantity of radioactive waste generated during decommissioning. It should be noted that this waste stream includes some volume of neutron activated material, such as bioshield concrete, that cannot be decontaminated.

Decontamination of land and water areas

The decontamination of site land and water areas usually occurs last as there is some potential that the removal of systems and decontamination of buildings could introduce new contamination to these areas. If there are areas that are not in waste travel paths or adjacent to buildings to be demolished, they may be decontaminated earlier in the decommissioning.

This waste stream includes contaminated soil, silt and rock, which typically contains very low levels of radioactivity and/or potentially hazardous substances. The volume of such waste may be substantial and is very site dependent. Processing options are limited, but soil washing techniques are available to separate contaminated from uncontaminated fractions of non-homogeneous material.

End of Project Demobilization

There will be significant waste management activities that typically occur as the end of a decommissioning nears. These actions primarily involve equipment and waste containers that have been contaminated over the course of the decommissioning. There will likely be some amount of equipment that has become contaminated and cannot be or is impractical to decontaminate. This quantity of contaminated equipment may be higher if the site has a relatively low ratio of gamma/beta to alpha radioactivity.

Some potential disposition paths for contaminated equipment include:

- Remediation equipment such as scabblers, hammers and ventilation equipment that has been used in highly contaminated buildings will likely need to be disposed of as radioactive waste.
- For large equipment such as excavators that have been used inside highly contaminated buildings it may be impractical to verify these as radiologically clean due to the inaccessibility of equipment air intakes. For equipment such as this, transfer for use at another contaminated facility will save waste disposal costs. It is expected, based on experiences at other sites, that equipment used only for soil remediation can be decontaminated and will be free releasable.
- Should the project purchase a number of reusable waste boxes such as “Inter-Modals”, these may need to be considered contaminated “empty” packages at the end of the project. Cleaning and/or disposition of these boxes may be expensive if a buyer cannot be found. Consideration should be given to leasing these boxes with the agreement that the owner retrieve them in a contaminated state at the end of the project.
- Disposition of radioactive sources being used during the operation and decommissioning of a power plant may be a relative large cost at the end of the decommissioning. If they cannot be sold, it may be cost effective to give them to another licensee instead of paying for waste disposal. Alternatively, it will likely be more cost effective to have the manufacturer retrieve high activity calibration sources rather than pay for disposal as radioactive waste.
- Some contaminated specialty equipment such as radiation protection survey meters generally can be sold to another site.

Radioactive Waste Volumes

Table 1 shows a summary of the volumes of radioactive waste resulting from select US decommissioning projects. The volume of radioactive waste generated during a power plant decommissioning project is dependent on a number of factors. Some more important factors include:

- Plant age and power rating – Smaller, older plants such as Big Rock Point and Humboldt Bay have much smaller components and less building space;
- Volume of contaminated concrete - Plants that chose to “Rip and Ship” all concrete from buildings in the radiological controls area (e.g., Connecticut Yankee and Maine Yankee) created much more low level concrete waste than a plant such as Rancho Seco where the buildings were left standing at the end of the decommissioning; and
- Volume of contaminated soil - Groundwater contamination at Connecticut Yankee resulted in remediation of a high volume of contaminated soil to meet site release limits.

It can be seen from Table 1 that the second bullet above has shown the greatest impact on decommissioning radioactive waste volumes. Available data suggests that the quantity of high activity waste (GTCC by US classification) that remains after a decommissioning is complete is a very small fraction of the total waste. This shows the effects of aggressive waste minimization efforts for high activity waste as there is currently

no disposal option for this waste and it therefore needs to be stored at the reactor sites until an option becomes available.

Table 1 shows almost all of the waste from decommissioning is low or very low activity waste (Class A by US classification). Additionally, experience has shown that most of the waste from decommissioning has activity that is a small fraction of Class A disposal limits.

Table 1 Comparison of Radioactive Waste Volumes for Selected US Decommissioning Projects

Plant	Connecticut Yankee ft ³ /(m ³)	Maine Yankee ft ³ /(m ³)	Rancho Seco ft ³ /(m ³)	San Onofre Unit 1 ft ³ /(m ³)	Trojan ft ³ /(m ³)
Startup year/ MWe-Type	1967/ 691 MWe-PWR	1972/ 860 MWe-PWR	1975/ 913 MWe-PWR	1968/ 410 MWe- PWR	1975/1130 MWe-PWR
Waste Type					
Primary Components and High Activity	10,354 (293)	20,000 (600)	Included in Systems and Class B/C Waste	Not Available	Not Available
Building Demolition	3,166,000 (89,650)	2,076,000 (58,790)	402,420* (11,395)	Not Available	Not Available
Soil/ Sediment Remediation	576,671 (16,330)	1,034,000 (29,280)	Included w/ Building Demolition	Not Available	Not Available
Systems (Commodities)	Included w/ Building Demolition	71,000 (2,000)	206,293 (5,842)	Not Available	Not Available
Other Class A	11,901 (337)	43,000 (1,200)	Not Applicable	Not Available	Not Available
Total Class A	3,754,572 (106,318)	3,224,000 (91,290)	608,713 (17,237)	1,680,558 (47,588)	Not Available
Class B/C**	10,354 (293)	20,000 (600)	3,284 (93)	1,050 (30)	Not Available
GTCC	Not Available	Not Available	378 (11)	96 (3)	Not Available
Total All Waste	3,764,926 (106,611)	3,244,000 (91,860)	612,375 (17,341)	1,681,704 (47,621)	275,000 (7,790)

* Mostly Concrete from Inside the Containment Building

**Mostly Large Components

Table 2 compares the volume of radioactive waste expected to be generated during the decommissioning of a medium sized BWR plant (approximately 600 MWe) in Europe to that from decommissioning projects in the U.S. It is logical that expected volume of waste from the decommissioning of a European plant is considerably less than U.S. plants as much of the waste that would be classified as Low Level Waste in the U.S. would meet the clearance criteria in Europe and be disposed of as conventional waste. Also, due to higher waste disposal costs in Europe, much more waste is decontaminated to clearance levels compared to the U.S. where decontamination to “Free Release” levels is typically not cost beneficial.

Table 2 Comparison of Estimated Waste Volume for European Plant to Actual Values for US Plants

Waste Type	Estimated for Medium Sized European BWR ft ³ (m ³)	Maine Yankee (860 MWe PWR) ft ³ (m ³)	Connecticut Yankee (619 MWe PWR) ft ³ (m ³)	San Onofre (410 MWe PWR) ft ³ (m ³)	Rancho Seco (913 MWe PWR) ft ³ (m ³)
Total Class A, B and C	230,614 (6,530)*	3,244,000 (91,860)	3,764,926 (106,611)	1,681,608 (47,618)	611,996 (17,3)30
Greater Than Class C Waste**	3,848 (109)**	N/A	N/A	96 (3)	388 (11)
Totals	234,462 (6,639)	3,244,000 (91,860)	3,764,926 (106,611)	1,681,704 (47,621)	612,384 (17,341)

*Total is for Very Low Level, Low Level and Intermediated Level Waste

**Activity Greater than Intermediate Level Waste

Decommissioning Waste Management Lessons Learned and Best Practices

The techniques described in this section are based on successful methods used during completed plant decommissioning projects, primarily in the US.

Lessons Learned from Completed Decommissioning Projects

- Use as large packages as is practical, consistent with disposal facility limitations – The use of large packages saves on labor in a number of ways. Large packages allow fewer cuts of piping and fewer packages saves time and costs in package handling and shipping paperwork preparation. The use of 20 foot (6 m) long Inter-Modal packages has been shown to be the most efficient at a number of decommissioning projects.
- Load the packages as close to the removal areas as is practical – Material handling can be a very time consuming task. By moving the waste packages as close to the removal areas as is practical has saved on handling time. This method needs to be balanced with waste processing and conditioning requirements.
- Locate the waste shipping area away from the waste removal and processing areas. Experience has shown that shipping of the large volumes of waste created during a decommissioning does not allow shipping immediately after loading of the waste into packages. The most efficient approach is to move the loaded waste boxes to another area of the site where shipping surveys can be performed

and the shipping paperwork prepared. By separating these two activities, removal and packaging activities can continue unaffected by shipping activities.

- Staging areas for box loading activities – It has been shown during decommissioning projects that buildings can be demolished much faster than the resulting demolition debris can be loaded into packages. The most efficient approach is to move the demolition debris into a staging area from which waste packages can be filled. If there is a chance for significant precipitation, the demolition debris has been stockpiled under large tents to keep the waste reasonably dry so as to meet shipping requirements. For large soil remediation projects, the soil has been protected if heavy rainfall is expected.
- Provide adequate space for waste staging and shipping operations – During building demolition and soil remediation activities, a large number of Inter-Modal (or rail cars) packages have been filled and shipped in a relatively short time period. The logistics of having enough empty packages and space for storage of empty, filled and packages ready for shipment has been a challenge at some sites. The experience has shown that it is very important to have sufficient space allotted to allow these operations to be carried out efficiently.
- Class B and C waste (or ILW) are much more costly to prepare for disposal than the Class A waste (or VLLW/LLW) as they require containers for disposal and generally shielded casks during shipping. The unit disposal costs for this type of waste is also considerably higher than that for lower activity waste.
- Experiences at some sites related to the mechanical aspects of concrete and soil remediation have offered important lessons learned. They include:
 - The need to tent some areas at Connecticut Yankee during remediation of buildings and soil due to high alpha contamination levels. All work inside of this tent was performed using respirators for radiological protection. Exhaust from diesel fuel machinery used inside of this tent needed to be routed outside of the tent.
 - The need to dewater a large portion of the Radiological Control Area at Connecticut Yankee to allow remediation below the water table.
 - Remediation of contamination in the discharge and intake canal may require special sediment dewatering techniques such as agglomeration to increase particle size, filter presses or large filter socks. The dewatered sediment will also need to be dried. If the quantity of sediment is large an open air drying pit such as that used at Connecticut Yankee could be used.

Wholesale Disposal of Demolition Material as Radioactive Waste

For sites that have decided to pursue a wholesale demolition and radioactive waste disposal approach, the logistics of shipping activities can be very demanding. The following lessons learned capture some of the experiences with waste disposal during completed decommissioning projects. Numerous lessons learned are related to different approaches evaluated and/or utilized by some licensees that involve alternative disposal options. Although this approach is primarily applicable to decommissioning projects in the US, many of these lessons learned are generally applicable to handling large quantities of bulk materials, irrespective of final disposition.

- Transporting the large quantities of very low level radioactive waste created by the complete demolition of above ground structures requires careful planning to ensure these large volumes are effectively managed so as not to adversely impact other decommissioning activities. This management can involve:

- Defining adequate areas and site routing of waste processing for shipment. This may involve large stockpiling concrete debris which could include tented areas to keep the debris relatively dry (to meet shipping requirements) prior to loading into packages.
- Having sufficient waste packages available so as not to delay waste package loading and shipping activities.
- The use of rail shipping and packaging techniques to increase shipping rates.
- In the US where the VLLW option is not available, disposal of very low level building demolition debris at a Resource Conservation and Recovery Act (RCRA) Class C disposal facility under a 10 CFR 20.2002 alternative disposal procedure presents a lower cost option for disposal than that at NRC licensed facility.
- Regulators may require the licensee to obtain a “beneficial use determination” which will allow the beneficial re-use of concrete building demolition debris as backfill on the plant site.

General Guidance for Decommissioning Waste Management

- Complete and thorough characterization of a facility prior to decommissioning is essential to minimize uncertainties in decommissioning work scope. The cost and potential schedule impact to remediate discovered contamination escalates as the project proceeds.
- When cost and schedule constraints are of comparable weight, contaminated systems or structures should be removed for burial or volume reduction instead of attempting to decontaminate them in place. The cost of comprehensive surveys of complex, formerly contaminated piping systems is high and the probability of success is uncertain. The majority of decommissioning projects have found that removal and discard is the best approach for dealing with contaminated piping. It should be noted that this guidance does not apply to the chemical decontamination of primary and auxiliary systems. Experience with the decontamination of these systems has been shown to result in large savings in radiation exposure to workers and has facilitated the disposal of the systems decontaminated.
- An onsite program to survey materials for unrestricted release can be cost effective for some types of materials, but there is an increased liability as compared to performing this activity at an offsite vendor facility. Before initiating such a program for a decommissioning plant, perform a comprehensive review of survey/release procedures and balance them against current regulatory guidance. Include requirements for extensive documentation. Evaluate the use of automated survey equipment and large area survey probes. Next implement some type of aggregate quantity monitoring program, such as a truck monitor or micro-meter. Finally, be selective as to which materials are evaluated via the onsite survey/release program to minimize rejects and ensure a high probability of detecting small amounts of activity.
- Performing the dismantlement and waste disposal activities in parallel with the final radiological survey of rooms and systems adds complexity but helps to compress the project schedule.
- Proven processes are strongly favored over new and untried approaches for plant system dismantlement, size reduction, decontamination, and radiological release surveys.
- Before beginning to cut concrete out of buildings, identify the residual contamination limits (clean survey limits) for leaving the concrete in place. Once the concrete is removed, it will generally need to be processed and disposed. However, if it remains attached as part of the post-termination structure, then it will be much easier to justify applying termination survey contamination limits.

Do not assume that every item remaining within the licensed area can be incorporated into the decommissioning plan termination survey.

- The low level waste manager at a decommissioning plant typically becomes, by default, the “all-waste manager.” This is necessary because that individual (or staff) needs to be involved with all waste released from the plant. As the decommissioning project nears completion, all remaining waste falls under the direct purview of the low level waste manager.
- When planning the decommissioning project, an emphasis should be placed on selecting tools, equipment and instrumentation that can be transferred or used at another corporate facility or which would be of value to another facility outside your corporation. The planning process will require evaluation of the equipment currently in use at the other facility and its willingness and ability to transfer and use the equipment at the end of the decommissioning project. This will minimize the quantity of tools and equipment which will need to be disposed of at the end of the project.
- When preparing removal back-out strategies, it will be necessary to initiate numerous engineering modifications to systems and components within the plant. It is to be expected that the engineering modification process will change during decommissioning as compared against the plant’s previous operational engineering processes. The radiation protection and radioactive waste groups need to be informed of the changes being planned. It is necessary to work hand-in-hand with the engineering staff to ensure that all decommissioning modifications are constructed in a fashion that will minimize contamination, thus allowing the new structures, systems and components to be either recycled or surveyed and released.
- Decommissioning work packages should be planned to identify hazardous materials and hazardous waste constituents at the beginning of the planning process. During the dismantlement process, some additional hazardous materials will be identified. These should be anticipated and planned for in advance to minimize work delays and the potential for mixed waste generation.
- One plant implemented a waste collection program that included separate distinct color coded bags to segregate hazardous material at the work site. This approach ensures that the waste is handled appropriately at the point of dismantlement, thereby allowing the waste to be inventoried, properly stored, and disposed.
- During the demolition of some older buildings, it was discovered that some EXIT signs contain tritium. Such signs were manufactured under an NRC general license and were, therefore, exempt from disposal/transportation requirements even though they contained several curies of tritium. One solution is to ship the signs back to the original manufacturer as radioactive material.
- Many plants have several installed radioactive sources, some of which have not been used in years but which remain in place. Plant records should be reviewed (including early FSAR versions) to identify the potential location of such sources and to plan for their removal and disposal (or possible salvage).
- One plant discovered residual activity in the vicinity of an old septic tank of the type commonly used for sewage treatment in small power plants. An investigation determined that small amounts of activity had backed into the tank drain piping through a check valve near the point where the drain piping connected to the plant main discharge piping. Further evaluation determined that the septic tank and drain piping contained small amounts of activity. Leaks in the piping also contributed to localized soil contamination. This points to three lessons applicable to many nuclear facilities.

- The first is that sewage treatment plants have a potential for containing small amounts of activity, including old, abandoned sewage plants and septic tanks.
- The second lesson is that there are many drain lines that are connected to the main plant discharge line. As many of these are tied to clean systems, a potential exists for water containing small amounts of activity to back into any of these lines. This is particularly true when the system relies on check valves to prevent discharged water from entering the system. The probability increases for plants which are located on large bodies of water affected by tidal movement.
- The third lesson is that abandoned, underground equipment which was used as a conduit for contaminated or potentially contaminated liquids are still likely to be contaminated. If the abandoned equipment is sufficiently old to have deteriorated (i.e., leaks), then some of the surrounding soil could be contaminated as well.

Low Level Waste and Mixed Waste Management

- Coordination of traffic for shipping containers, casks and conveyances to and from major buildings is essential to eliminate congestion and nonproductive waiting time. This is particularly necessary where only one entrance/egress point exists, such as for the containment building or the various truck bays.
- Several plants report substantial cost savings by bidding out large quantities of individual, similar waste types (e.g., >25,000 pounds (11,000 kg) of similar metals or concrete). Several projects have found that a re-bid at regular intervals can result in an improvement in pricing. In the US, increased competition did drive prices down. If options are available, include the disposal site in the re-bid process as a competitor to volume reduction processors to obtain the best cradle-to-grave pricing.
- The use of rail shipments can be beneficial for some equipment applications, but rail shipments can introduce additional challenges. The adverse experiences reported by one plant include: waste pick-up was two weeks late; rail cars were in poor condition; banging of cars resulted in broken packaging and cribbing; poor waste tracking and poor paperwork management.
- Some plants cut the tips from spent incore instrumentation (ICI) to minimize storage space. They then discovered that the tips are so small that they were classified as greater than Class C waste (or HLW). If the entire ICI is retained, there is normally sufficient mass to allow concentration averaging so as to allow the ICI to be disposed as Class C waste (or ILW).

This same approach can be applied to other wastes, such as filters and activated metals, that have a high specific activity averaged over a small portion of the material. If the “hot spot” is cut out of the larger mass of material, then it may exceed Class C/HLW concentrations. However, if it is shipped as part of the original material, then the activity can be averaged over the entire mass of the material, thereby reducing the final waste classification.

- Use of waste disposal computer programs can optimize cost management of competing volume reduction and disposal alternatives.
- There is no standardized methodology or approach for the removal and packaging of large components. This is an area where additional guidance is needed, and plants should seek out experience, assistance and advice from those plants that have already worked through similar challenges.

- Some plants have discovered that some mixed wastes shipped to an offsite processor may produce a residual waste that is also a mixed waste. For example, a decontamination solution from a tool and parts cleaner was shipped for treatment of the liquid degreaser. The waste also contained a significant amount of sludge which also was a mixed waste. The decanted sludge had to be returned to the plant and staged for re-characterization, subsequent off site treatment and disposition. The treatment and shipping costs for the sludge were additive (paid twice for handling it twice; once by each vendor).

Hazardous Waste Management

Hazardous waste remediation can have a major impact on the decommissioning of a nuclear plant. A Hazardous Waste Material Remediation Technology Workshop held in 1999 emphasized the importance of this work and its potential for significant cost and scheduling impacts on the overall decommissioning project. The following key points are taken from the EPRI Report, Hazardous Waste Material Remediation Technology Workshop.

- The Big Rock Point plant estimated that approximately 60% of painted components contain polychlorinated biphenyls (PCB) above 50 ppm. This level of concentration required disposal as regulated material.
- Several unique approaches related to segregating hazardous materials for proper attention have been identified. For example, use of satellite storage areas, special colored bags, worker education, and increased plant walk downs.
- Yankee Rowe reported on the details of their PCB remediation program. Use of "scoping surveys" and site history information proved to be indispensable in guiding their efforts.
- Big Rock Point has found that incorporating waste identification and minimization actions into the work package planning process was a key element to effectively address hazardous waste remediation.
- The US Department of Energy's *Large Demonstration Program* has demonstrated several innovative hand-held instruments directed at real-time analysis of key materials (for example, lead, PCBs, and metal composition).
- The US EPA provided considerable insight into the regulatory requirements for identifying and treating hazardous materials.
- Non-radiological characterization needs to be factored into the preplanning of the characterization program. This aspect of the site characterization can have a significant impact on the site release at the end of plant decommissioning.

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