EFFECTIVE ENVIRONMENTAL COMPLIANCE STRATEGY FOR THE CLEANUP OF K BASINS AT HANFORD SITE, WASHINGTON

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ABSTRACT

K Basins, consisting of two water-filled storage basins (KW and KE) for spent nuclear fuel (SNF), are part of the 100-K Area of the Hanford Site, along the shoreline of the Columbia River, situated approximately 40 km (25 miles) northwest of the City of Richland, Washington. The KW contained 964 metric tons of SNF in sealed canisters and the KE contained 1152 metric tons of SNF under water in open canisters. The cladding on much of the fuel was damaged allowing the fuel to corrode and degrade during storage underwater. An estimated 1,700 cubic feet of sludge, containing radionuclides and sediments, have accumulated in the KE basin. Various alternatives for removing and processing the SNF, sludge, debris and water were originally evaluated, by USDOE (DOE), in the Environmental Impact Statement (EIS) with a preferred alternative identified in a 1996 Record of Decision (1). The SNF, sludge, debris and water are 'hazardous substances' under the Comprehensive, Environmental, Response, Compensation and Liability Act of 1980 (CERCLA). Leakage of radiologically contaminated water from one of the basins and subsequent detection of increased contamination in a down-gradient monitoring well formed the regulatory bases for placing this cleanup action under CERCLA.

Cleanup of the K Basins as a CERCLA site required SNF retrieval, processing, packaging, vacuum drying and transport to a vaulted storage facility for storage, in conformance with a quality assurance program approved by the Office of Civilian Radioactive Waste Management (OCRWM). Excluding the facilities built for SNF drying and vaulted storage, the scope of CERCLA interim remedial action was limited to the removal of fuel, sludge, debris and water. At present, almost all of the spent fuel has been removed from the basins and other activities to remove sludge, debris and water are scheduled to be completed in 2007.

Developing environmental documentation and obtaining regulatory approvals for a project which was initiated outside CERCLA and came under CERCLA during execution, was a significant priority to the successful completion of the SNF retrieval, transfer, drying, transport and storage of fuel, within the purview of strong conduct-of-operations culture associated with nuclear facilities. Environmental requirements promulgated in the state regulations were also recognized as "applicable or relevant and appropriate." Effective implementation of the environmental compliance strategy was unique from the perspective that environmental documentation and permits had already been obtained when cleanup action came under CERCLA authority.

This paper provides an overview of the development and implementation of an environmental permitting and surveillance strategy that enabled us to achieve full compliance in a challenging

environment, with milestones and cost constraints, while meeting the high safety standards. The details of the strategy as to how continuous rapport with the regulators, facility operators and surveillance groups helped to avoid impacts on the cleanup schedule are discussed. Highlighted are the role of engineered controls, surveillance protocols and triggers for monitoring and reporting, and active administrative controls that were established for the control of emissions, water loss and transport of waste shipments, during the different phases of the project.

Background

The Hanford Site occupies approximately 1,517 km^2 (586 mile^2) in the Columbia Basin of south-central Washington State. The site was selected as the nation's first large-scale nuclear materials production site in January 1943. It is divided into several operational areas, including the 100 Area, which is located in the north-central part of the site and contains nine nuclear reactors, now inactive.

The 100-K Area is one of six reactor areas in the 100 Area. It consists of the K East Reactor, the K West Reactor, and associated support facilities and waste sites. The reactors were constructed in the early 1950s and are located about 420m (1,400 ft) from the Columbia River. Each reactor building contains a SNF storage basin that originally served as a collection, storage, and transfer facility for the fuel elements discharged from the reactor. The basins are unlined, concrete water pools each with a capacity of 4.9 million L (1.3 million gal), which were originally cooled SNF by a once-through cooling process using filtered water. The SNF is stored in the indoor pools under approximately 5 meters (16 feet) of water and the basins' air space is ventilated to the outside without a filter system. An asphaltic membrane is located beneath each pool. In 1981, after the KW Basin had been in service for about 30 years, the concrete surfaces inside that basin were reconditioned by applying an epoxy coating to keep radioactive elements from being absorbed into the concrete. The KE Basin was not similarly reconditioned. Each basin is divided into three main zones: the SNF discharge chute, the storage area (main basin floor), and the transfer areas.

Both reactors operated from the mid-1950s until the early 1970's, respectively. The SNF discharged from the reactors was stored in the K Basins until it was transferred to the 200 Areas at the Hanford Site for reprocessing. Water in the basins provided both radiation shielding for workers and cooling to remove decay heat until the SNF was transferred. Most of the SNF discharged from the KE and KW Reactors was removed from the basins when the reactors were shut down. Beginning in 1975 for the KE and 1981 for the KW, the basins were refurbished to store N-Reactor SNF with the addition of a recirculation-based water cooling and treatment systems. Since then the basins have been used to store N Reactor SNF and small quantities of single-pass reactor SNF.

Spent nuclear fuel was stored on the floor of the in each basin. The canisters were stored directly on the basin floor, housed in storage racks that maintain the canisters upright, in a fixed geometric array. The canisters consist of two cylinders that are approximately 230mm (9 in) in diameter and 660 mm (26 in) tall, and are joined together by a trunnion that facilitates handling. Each canister can hold a maximum of 14 N Reactor fuel elements.

In 1992, the decision was made to cease SNF processing at Hanford, leaving approximately 2,100 metric tons (2,300 tons) of SNF in the K Basins with no means for reprocessing. An estimated 1 percent of the original mass of this SNF has corroded and become radioactive sludge. The water and debris (piping, canisters, pumps etc) in the basins are also radioactively contaminated.

The KE Basin leaked up to 56.8 million L (15 million gal) of contaminated water to the soil in the 1970s and another 341,000 L (90,000 gal) in early 1993. It was suspected that the water was coming from leakage at the construction joints between the foundation of the basin and the foundation of the reactor. To mitigate the consequences of a seismic event, the construction joints in both basins were isolated from the rest of the basin by metal isolation barriers. The epoxy coating previously applied in the K West Basin provided additional protection.

The integrity of the basins continued to degrade with age, as does the condition of the SNF, which increased the risk to the environment and potential safety issues. Basin leaks have contaminated underlying soil and groundwater which contributes to the risk from the basins and hence the need for this interim remedial action.

Risk Evaluation

Contaminants of concern in the K Basins are primarily radionuclides from the corroding SNF. The SNF inventory at one time was approximately 55 million curies. Concentrations in the sludge and fuel were such that unshielded exposure would result in significant radiation dose. Potential risk to human health and environment associated with continued storage of SNF and sludge at the basins were as follows:

- Potential for release. The basins have leaked approximately 15 million gallons of contaminated water to the aquifer that discharges to the Columbia River. Tritium and strontium-90 concentrations in the ground water plume have been measured at 20000 pCi/l and 8 pCi/l respectively, several times greater than drinking water standards
- Fuel degradation. The SNF was not designed for long-term storage and the some of fuel was corroded due to failure of cladding. The corrosion further damaged the fuel, releasing material to basin water and built up as sludge.
- Design and seismic adequacy. The basins lacked seismic integrity and have exceeded their design life of 20 years by more than 20 years and upgrades to ventilation, electrical and water treatment equipment system were needed to ensure occupational safety and environmental protection. The basins do not provide containment for radioactive materials released to the air, or liquid released in the event of a leak. Basin water serves to provide cooling for the SNF, satisfactory shielding and contamination control by preventing the sludge from drying and becoming air borne.
- Occupational Exposure. The lack of confinement for the corroding fuel in the K-East Basin has resulted in higher than desired radiological hazards to workers during routine and non-routine activities.
- Location. The proximity of the basins to the Columbia River increased the likelihood that the river would be contaminated as result of an extensive leak.

In May 1989, the DOE, the EPA, and the Washington State Department of Ecology signed the Hanford Federal Facility Agreement and Consent Order, commonly known as the Tri-Party Agreement (TPA). The TPA, 1) defines and ranks CERCLA and RCRA cleanup commitments, 2) establishes responsibilities, 3) provides a basis for budgeting, and 4) reflects a concerted goal of achieving full regulatory compliance and remediation, with enforceable milestones in an aggressive manner, for the entire cleanup at the site.

In the early 1990s, the DOE determined that action was necessary to mitigate further releases from the basin and SNF degradation. An EIS was prepared and an ROD with the selected alternative being to remove the SNF from the basins, stabilize SNF with vacuum drying and place it in interim storage away from the river at the 200 Area.

The SNF, sludge, debris and water are ‘hazardous substances’ under CERCLA. Leakage of radiologically contaminated water from the KE Basin and subsequent detection of increased contamination in a down-gradient monitoring well helped to form the regulatory bases for cleanup action under CERCLA. The realization that actual or threatened release of hazardous substances from the waste sites and K Basins, if not addressed, timely, may present an imminent and substantial endangerment to public health, welfare and environment led to a remedial action under CERCLA, with EPA as the lead regulatory agency. CERCLA provided EPA with the vehicle for a legally enforceable schedule under the TPA and also allows for cost-effective disposal of waste, excluding the SNF, to the Environmental Restoration Disposal Facility (ERDF) which only accepts Hanford Site CERCLA waste.

Regulatory Requirements

Regulatory requirements were either classified as “applicable or relevant and appropriate requirements (ARARs)” or “to be considered (TBCs)”. ARARs are standards or limitations promulgated under federal or State of Washington laws that must be met or waived for actions under CERCLA and TBCs are non-promulgated standards or guidance such as federal or state advisories and the DOE orders that are to be considered to the extent necessary for the response action.

Several radioactive waste management standards established by the DOE, the EPA and Nuclear Regulatory Commission (NRC) such as 10 CFR 20 (radiation standards), 10 CFR 61 (land disposal of radioactive wastes), 40CFR 61 (radioactive air borne emission standards) and 40 CFR 191 (standards for disposal of SNF and TRU wastes) were considered ARARs. Under the State of Washington authority, the term "dangerous waste" is used instead of "hazardous waste" and part of the sludge may have to be regulated under WAC 173-303 as mixed waste (a mix of dangerous waste and radioactive constituents) due to concentration of toxicity characteristic metals in excess of the limits. However, polychlorinated biphenyls (PCBs) in the sludge were found to be below leachable concentration limits and the sludge is neither ignitable nor reactive and therefore not considered dangerous waste under WAC 173-303. Sludge, debris and water will be considered as PCB remediation waste under Toxic Substances Control Act. WAC 173-216 regulated effluent discharges to Columbia River and WAC 246-247 limits air borne radionuclide emissions. WAC 246-247 also requires verification of compliance either through continuous monitoring or confirmatory sampling and application of best available radionuclide control technology. In addition to WAC 173-216 and WAC 246-247, WAC-173-400 (hazardous air pollutants) was termed ARARs. Though much of the waste transportation was limited to the site, 49 CFR 100-179 was considered ARARs for fuel, sludge and water shipments.

To achieve compliance with the requirements and other safety objectives, the SNF project developed a Standards/Requirements Identification Document(S/RID) to identify requirements relevant to the project and clearly connect the requirements to implementing procedures. S/RIDs are project-specific and encompass rules and regulations as well as the DOE policies, orders and guidance. S/RIDs are approved by the DOE. Programs and procedures for work control are driven by S/RIDs. The SNF project Integrated Environment Safety and Health Management System (ISMS) implements organizational and operational requirements to ensure environmental compliance, safety and health controls are integrated into work performed including the rigorous requirements for readiness reviews, conduct of operations applicable to nuclear facilities.

Remedial Action Plan

The scope of the K Basins interim remedial action, as defined in the CERCLA interim action Record of Decision (ROD) (2), addressed the level of action required to mitigate the potential of contaminant release. A Remedial Design Report was prepared subsequent to the ROD to describe the design aspects associated with the following cleanup action work scope:

- Remove and transfer the SNF to Cold Vacuum Drying facility (CVDF).
- Remove sludge as Remote Handled TRU waste upon removal from water and transfer to 200 Area sludge treatment or storage facility.
- Remove basin water with the Integrated Water Treatment System (IWTS) and transfer to Effluent Treatment Facility.
- Remove and treat debris as necessary and transfer to disposal or storage facility in the 200 Area.
- Deactivate the basins including their removal for disposal in the 200 Area.

In addition, institutional and engineered controls will be established and maintained to monitor air, ground water, basin water and prevent access until final remedial actions are completed. The scope of the CERCLA interim action did not include the stabilization or interim storage of the SNF at Canister Storage Building, a vaulted dry-storage facility.

The SNF Multi-Year Work Plan (work plan) was proposed to implement the steps necessary to achieve the remedial action goals. The plan contains the SNF project technical, schedule and cost base lines, and reflects the project execution strategies, subject to change control processes which are continuously updated. Several projects for the facility modifications to the K Basins, water treatment system and modifications to the CVDF and the CSB were proposed for the retrieval, transfer and storage of fuel, sludge, debris and water. Concurrent with project construction, environmental permitting from local, state and federal agencies was to be completed to meet with project deadlines to assure environmental compliance.

Four projects were proposed to achieve the remedial action goals with specific milestones and schedule for implementation. The Fuel Retrieval System was designed to retrieve the fuel from the basins for vacuum drying and vaulted dry-storage. Fuel Transfer System was designed to remove the fuel from the KE to the KW basin for safe retrieval and storage. Sludge Retrieval and Disposition Project is currently in progress to retrieve sludge from the floors and the pits for treatment and disposal. Deactivation of the Basins is being planned for the retrieval of the concrete basin for disposal after water and debris have been removed from the basins. Other steps for institutional controls, groundwater remediation, soil remediation will follow to complete the cleanup action at the Site by 2007.

Environmental Compliance

Environmental compliance strategy for the implementation of the SNF projects was guided by a commitment to systematically integrate safety into management and work practices at all levels of the organizations so that the project mission is accomplished while protecting the worker, the public and the environment. The strategy involved the following key environmental objectives:

- Maintaining safe, compliant storage and transport of the SNF from the K Basins to the CSB
- Treating water contaminated in the basins to maintain water quality and maintain air emissions and safety conditions with in the prescribed limits
- Developing environmental documents timely to obtain the DOE and agency approvals timely to meet project schedules
- Maintaining configuration control of the environmental documentation with revisions to meet the need of the changes.
- Maintaining flexibility in compliance approaches so the retrieval/transfer processes can be maximized to meet the schedule
- Developing cost effective approaches to monitoring, reporting of environmental data, with due recognition to the age and remaining service-life of the facilities

Contamination and Radioactivity

All activities associated with the remedial action plan should be managed to ensure that the occupation radiation exposure is within the DOE limit of 5000 mrem/year(total effective dose equivalent) to workers as per 10 CFR 835 and the EPA's off-site emission standard of 10 mrem/year, as per 40 CFR 60. Washington State Department of Health implements federal and state requirements for radioactive emissions mainly under WAC 246-247.

The radioactivity emitted by the basins comes from three sources in the facility, all of which originates from the basin water in both KE and KW basins. Based on the historical emission release data, condition of fuel, canisters and the basin, it was determined that the emissions from the KE basin rather than the KW would provide a bounding case, for conservative estimates on emission control. The three sources of radioactivity emitted by KE basin are radionuclides from the basin water, from the ring of contamination at the interface of water and the basin wall (referred to as "bath tub ring"), and the surface contamination on the floors, tools and equipment. The air borne emission data and surface contamination data, from 1972 to 1992, suggested that basin work activities both above and below water contributed to the over all release of emissions and that the above water activities play a far greater role in releasing the radioactivity than below water activities.

The radionuclides identified in the basin water from 1979-1987, excluding tritium, were Mn-54, Co-60, Sr-89, Sr-90, Ru-106, Cs-134, Cs-137, Ce-Pr-144, Eu-155, Pu-238, Pu-239/240. From 1989-1992, with the shutdown of N-reactor, the same radionuclides were increasing with the addition of Sb-125 and Am-241. At the same time, radionuclides identified in the air released to the environment at the KE basin were a mirror image of the radionuclides found in the fuel.

Corrosion of the fuel cladding is the main mechanism that contributed to the release of radioactivity due to partition. Partition coefficients, based on curies, for radionuclides migrating from the basin water to atmospheric air was determined to be in the range of 8.0E-8 to 1.0E-6, which means that only 0.0001 of one percent of the radionuclides in water reaches the air. Water is being an effective control agent for radioactivity release at an efficiency rate of about 99.999 percent exceeding the control efficiency of most other systems which are in the range of 98-99.9 percent. Based on the historical data, the over-all partition coefficient from irradiated fuel and fission products to air, on an annual basis, is in the range of 1.0E-10 to 1.0 E-13.

Selection of Control Technology

WAC 246-247 requires a notice of construction for the four projects planned for the retrieval and storage of SNF from K Basins and the selection of technology for emission control for the projects should be based on an assessment and evaluation alternatives that results in a Best Achievable Radiation Control Technology (BARCT). BARCT is defined as “technology which will result in a radionuclide emission limitation based on the maximum degree of reduction for radionuclides which would be emitted from any newly constructed source or significantly modified emission units that the licensing authority (Washington Department of Health-WDOH) determines is achievable on a case-by-case basis, taking into account energy, environmental, economic impacts and other costs.

WDOH had determined that High Efficiency Particulate Filtration (HEPA) filtration is BARCT for the control of emission of radioactive particulate matter. For all projects proposed be built in the basins, for the Removal Action Plan, BARCT assessment is only necessary for removal of radioactive particulates but such an evaluation is not needed for the control of radionuclides in gaseous state.

KE basin has developed a base line control option consisting of two separate water treatment system to remove radionuclides from basin walls which will reduce the occupation exposure and emissions in the air. The first system is a modification of existing water treatment system with a cartridge filter, a chiller, and three ion-exchange columns. The second system consisted of skimmers, a sand filter and two auxiliary ion-exchange units to ensure emission control at the air/water interface and redundancy in water treatment.

Because HEPA system is the BARCT technology for radionuclide particulate removal, WDOH has stated that the base line option will not be acceptable as BARCT without over-whelming evidence showing that the baseline option will maintain the radionuclide concentration at acceptable levels and the adverse economic impact of a HEPA system on the project will be significant. WDOH indicated that an acceptable levels of emission concentration would be that would cause a member of public to receive in any year, a committed effective dose equivalent

(CEDE)1.0x1E-3 to 1.0xE-2 merm/yr or less. The emissions from all activities have been conservatively projected as 1.2E-3 Ci/year and to result in a CEDE of 7.9E-4 mrem/yr, well below the WDOH's limit.

However, no precedents to determine adverse economic impact criteria were available for the life-cycle cost analysis of radionuclide control technology. EPA has decided that an adverse economic impact for the control of radionuclides causing particulate emissions would result by a HEPA system, where the cost to benefit ratio exceeds $12 million dollars per person-rem.

Three options involving different emission control options using HEPA systems were considered:
Option 1 consisted of two roof mounted HEPA filter units each rated at 453.1 m^3 (16000 ft^3) per minute and replacement of existing four roof exhausters in the basins. Because existing roof structure was inadequate, extensive structural supports for equipment were included and an exhaust stack of 15 m (50 feet) high was also added.

Table I. Summary of BARCT Analysis for Radionuclide Emission Control
(Dollar costs in millions)

Emission Control Alternative	[1]AEDE Due to Emissions person-rem/ year	[2]AEDE Reductions person-rem/ year	[3]Total Capital Costs $	[4]Total Annualized Costs $	[5]Cost Effective-ness $/person-rem	Adverse Economic Impact Yes/No	Adverse Environmental Impact Yes/No	Adverse Energy Impact Yes/No
Option-1	6.30E-06	2.10E-02	5.94	1.961	93	Yes	No	No
Option-2	6.30E-06	2.10E-02	5.48	1.816	87	Yes	No	No
Option-3	6.30E-06	2.10E-02	6.58	2.158	103	Yes	No	No
Baseline	2.10E-02							

1. AEDE - Annual Effective Dose Equivalent
2. Emission reduction below baseline control option
3. Installed capital costs relative to base line costs
4. Installed capital, O&M costs based on capital recovery on a 4 years of service life at 10% discount rate
5. Average cost effectiveness is total annualized cost divided by emission reductions attributable to the option

Source: Best Available Radionuclide Control Technology Assessment for the 105-KE Basin Encapsulation Activity, WHC-SD-NR-TI-052, Rev. 0, June, 1993.

Option 2 consisted of ground-level skid mounted HEPA filtration units, similar to those units in Option 1, to be installed on a concrete pad outside the basin, to support the weight of the units. Both the units exhausted through a single stack of 27 m (90 feet) height mounted on grade.

Option 3 consisted of four roof mounted HEPA filtration units each rated at 226.5 m^3 (8000 ft^3) per minute with two stacks and supply air units. This option used twice the number of units in Option 1 at 50 percent capacity of the units and distributed the load on the roof more uniformly to reduce the structural support system necessary.

Common devices to capture particulate matter to reduce emissions consisted of hoods, canopies, tents, glove boxes are to be employed for all the options to be in compliance with ALARA requirements. The building enclosure serves as a containment system with negative pressures with respect to atmosphere and escape of emissions is minimized. Although the closures on penetrations for transit trolleys, doors etc, are normally closed except as required for basin operations, the enclosures are not of hermetically sealed design.

Impacts due to energy consumption and adverse impact to environment in all of the options were different but adverse consequences were not significant relative to base line control option. However, in term of economic impact, the difference in cost-effectiveness of the options for BARCT compared on annualized costs was significant.

Table 1 contains a summary of the assessment for the selection of BARCT for emission control. Due to low emissions attributable to base-line option, during retrieval and transfer operations at the basins, implementation of any of the HEPA filtration options impacted cost-benefit ratios adversely. Because the basins are in a terminal mode upon on completion of CERCLA action, the service life of the HEPA units is limited to four years and amortization costs rise significantly. The estimated radionuclide air emissions, based on air quality analysis of the KE basin due to remedial activities, have been conservatively estimated as 1.2 E-03 Ci/yr and the project population dose as 2.1E-02 person-rem/yr. Option 2 resulted in lowest annualized cost of $ 87 million per person-rem to provide HEPA filtration, exceeding the threshold cost-benefit ratio of $12 million per person-rem.

Therefore, the selection of base-line option, with two water treatment systems, was determined to be BARCT for radionuclide emission control for the basins. Administrative and engineered controls for water quality, ALARA practices plant operations, contamination control for particulate matter were also strengthened along with radiation monitoring and surveillance to ensure that radioactive particulate emissions were not exceeded above the limits.

Challenging Environment

While the projects were in the developmental stage with conceptual designs, it became necessary to prepare state and federal permit applications. Based on historical inventory data of the spent fuel, the potential-to-emit for radionuclides from the basins was estimated. Due to age and limitations in the basins, high-efficiency filters for the control of air emissions were not cost effective and basin-water treatment is the BARCT for emission control. Administrative and process controls were designed to control air emissions from the source with stringent standards for basin-water quality. In addition to monitoring the emissions from the roof vents in the basins, air quality in the vicinity of the basins was monitored by near-field monitors.

Basin air quality is paramount to worker safety within the basins and to increase productivity in removing the fuel. Treating basin water with treatment systems such as sand filters, settlers and ion-exchange columns was necessary to maintain clarity of water and reduce air borne emissions. Basin water controls and monitoring for radionuclide concentrations were designed to limit the activities that have a potential to raise the risk of contamination in the air within the basin and eventually emissions through the roof vents to the environment. Water loss from the basin was monitored accounting for nominal loss due to evaporation, water withdrawals etc., to assure the integrity of the basins.

Alert levels for Cs-137 concentrations in the basin water were established and sampling frequencies, operational controls were established if pre-set water quality thresholds were exceeded. In-basin air quality, measured by continuous air monitors and air samplers by radiological control operations, were monitored and used to guide process controls for retrieval, water treatment and maintenance operations to prevent release of radiological air borne contaminants to the atmosphere exceeding the threshold limits. Due to marked increase in radiation levels in the KW basin during transfer of corroded fuel from the KE basin, the frequency of emission control sampling, testing and surveillance has been revised to assure compliance.

Current Status

The SNF project completed fuel retrieval shipments for all irradiated fuel elements on October 15, 2004. It is of major significance in that 2400 tons (55 million curies of radioactivity) of fuel has been removed into dry, safe and long-term storage away from the Columbia River at the Hanford Site. Notwithstanding the condition of the fuel, the facility constraints and regulatory requirements, the fact that K basin fuel was high in metallic uranium content, unlike commercial spent fuel, was a key factor in making the job one of the toughest and riskiest in the cleanup universe.

Sludge retrieval and storage is scheduled for completion in March of 2005. Water removal is to be followed by debris removal from the basins. Deactivation of the basin will be followed by debris and water removal later and the CERCLA cleanup is scheduled for completion in 2007.

CONCLUSIONS

Implementing spent fuel retrieval, drying and storage in vaults in a multi-contractor/multiple layered regulatory environment at the Hanford Site, to meet the cleanup goals of the DOE is a complex undertaking and required a dedicated team of operators, engineers, managers and other participants. Transition of a cleanup project under NEPA to a CERCLA interim remedial action provides unique opportunities in terms of environmental documentation and regulatory interfaces. Water treatment as the sole means of control for radioactive emissions (BARCT) proved to be cost-effective, not withstanding the fact that maintaining water quality is essential for worker safety and production efficiency in fuel removal and transfer operations. Concurrent approaches to obtain environmental permitting and approval, while the design was in progress, demanded continuous rapport with the regulators and the project team. Effective environmental strategies with a view to cost, schedule and yet adequate in response to multi-faceted environmental requirements entailed a thorough understanding of the scope of the project, regulations and being versatile to changes in the cleanup approaches.

REFERENCES

1. Environmental Impact Statement-Management of Spent Nuclear Fuel from the K Basins at the Hanford Site, Richland, Washington – Record of Decision (Federal Register 61 FR 10736, dated March 16, 1996), DOE.EIS-0245.
2. EPA, 1999, Record of Decision for the K Basins Interim Remedial Action, US EPA, Region 10, EPA/541/R-99/059.