INCORPORATION OF AN "UNREVIEWED SAFETY QUESTION" AND OTHER NUCLEAR REGULATORY REQUIREMENTS INTO A CERCLA CHARACTERIZATION PROCESS

Authors: Fluor Hanford: A. M. Hopkins, L. J. Olguin, D. M. Bogen, K. Hampton, DOE-RL: S. E. Clarke, Ph.D., IT Group: S. C. Adams, Ph.D., Performance Enhancement Company: C. Negin

ABSTRACT

This paper describes the integration necessary between the regulations and orders of different federal agencies during the environmental waste site characterization and remediation of a tank in western Washington.

The environmental cleanup activities at the U.S. Department of Energy's (DOE) Hanford Nuclear Reservation are formalized through a Federal Facilities Compliance Act Consent Order, the *Hanford Federal Facility Agreement and Consent Order* (Ecology et al. 1994) referred to as the Tri-Party Agreement or TPA. At Hanford, cleanup activities are performed under the authority of the order to comply with *Comprehensive Environmental Response, Compensation and Liability Act of 1980* (CERCLA) and the *Resource Conservation and Recovery Act of 1976* (RCRA) corrective action program. Nuclear safety issues are incorporated into CERCLA/RCRA activities as appropriate. Generally, waste sites with Nuclear Safety concerns are incorporated into the associated facility authorization basis. Sometimes, however, nuclear safety issues and the analysis they require take precedence over CERCLA/RCRA authorities. The nuclear safety issues associated with Hanford's Plutonium Finishing Plant (PFP) settling tank 241-Z-361 is the example discussed in this paper.

During a chemical hazards' review at the PFP facility, it was discovered that settling tank 241-Z-361 was not evaluated as part of the PFP authorization basis as required by DOE Order 5480.21. The tank was used as a settling tank for plutonium containing wastes discharged from the PFP facility during the process of extracting plutonium from spent nuclear fuel. The potential hazards presented by the tank were so significant, that the attention and concern of several agencies was immediately expressed. An Unreviewed Safety Question (USQ) was declared immediately and the hazards presented by the tank and its contents were analyzed using set criteria of nuclear and worker safety criteria. An authorization basis was developed for the tank. This document is called a Justification for Continued Operations (JCO) and was mandated by DOE before any CERCLA activities could be initiated. The hazards identified for the tank included the risk of a criticality event (uncontrolled nuclear reaction resulting in high radiation), an explosion due to the combination of chemicals in the tank, a collapse of the tank because of diminished structural integrity, and a possible deflagration due to hydrogen buildup within the tank.

BACKGROUND

Tank 241-Z-361 is an underground inactive settling tank within the protected area of the PFP. It is approximately 240 feet south of Building 236-Z. This settling tank received all low-salt (caustic) liquid effluent discharged from plant processes from 1949 to May 1973. As such, the

tank contents are expected to include constituents from nearly all PFP processes used during that period, including alpha and beta emitters, organics, and inorganic salts.

The DOE nuclear safety process involves the use of safety analysis reports called SARs. These reports provide an evaluation of hazards (physical and chemical) with respect to risks and probabilities that an event would occur. This analysis results in the assignment of a hazard category and the establishment of facility specific technical safety requirements. If there is insufficient information to evaluate risk for a facility or site, then an unreveiwed safety question or USQ is declared with respect to the facility/site.

The 1997 PFP SAR review identified that the potential hazards associated with the tank, primarily that associated with a potential hydrogen concentration increase, had not been evaluated in the formulation of the current PFP nuclear safety authorization basis. Also, concerns were raised regarding the tank's structural integrity as a result of corrosion, and with the high plutonium content, the potential for inadvertent criticality. A potential inadequacy in the PFP authorization basis was identified per DOE Order 5480.21, "Unreviewed Safety Question." After completing its evaluation, PFP recommended to DOE-Richland Operations Office (DOE-RL) that a USQ be declared on the tank.

The tank is being managed using the operating restrictions imposed by PFP under DOE Order 5480.21 and agreed to by DOE-RL. These controls, drawn from the requirements of the *Occupational Safety and Health Act of 1970* (OSHA) (29 CFR 1910.103), restrict access and spark or flame-producing activities within the vicinity of the tank. In addition, controls were adopted that restrict any waste disturbing activities because of the potential criticality hazard. Traffic over the tank is prohibited due to uncertainty regarding the tank structural integrity.

The DOE directed the preparation of a JCO to provide a basis for DOE to approve the controls needed to open the tank safely for vapor sampling and videotaping. The JCO also addressed safety controls necessary for tank characterization activities. A two-phased approach to developing the JCO was decided to streamline the characterization process. The information from the vapor sampling and video would resolve structural integrity and flammable gas concerns and assess the physical condition of the sludge (dry or wet) before core sampling characterization (CERCLA) activities would be authorized. Once the tank is characterized, further steps to establish a final authorization basis may be undertaken. This phased approach to establishing an authorization basis is consistent with DOE Order 5480.23, "Nuclear Safety Analysis" and DOE Standard 3011-94, "Guidance for Preparation of DOE 5480.22 (TSR) and DOE 5480.23 (SAR) Implementation Plans."

Tank 241-Z-361 is identified in the Tri-Party Agreement, Appendix C (Ecology et al. 1994) as part of Operable Unit (OU) 200-PW-1 to be remediated under the authority of the CERCLA. The DOE owns and operates the Hanford Site with Fluor Hanford as the primary contractor responsible for site management. The U.S. Environmental Protection Agency (EPA) serves as the lead regulatory agency for remediation of this tank under the CERCLA past-practice process described in the TPA (Ecology et al. 1994). Tank 241-Z-361 is identified within the CERCLA Plutonium/Organic-rich Waste Group. Although completion of the Remedial Investigation/ Feasibility Study (RI/FS) work plan for this OU is not planned until the end of calendar year

2001, the resolution of safety issues necessitated early characterization of the contents of tank 241-Z-361. The EPA requested that DOE formalize commitments for the planned work by establishing TPA milestones for this project. If evaluation of risk posed by this tank indicates the need for earlier actions, then DOE will evaluate removal and disposal alternatives through the appropriate CERCLA pathway after consultation with the EPA.

Sampling and characterization of tank 241-Z-361 are required to resolve the USQ (Wagoner 1997) concerning uncertain hazards and risks associated with the tank. In addition to the plutonium inventory, other constituents of the sludge need to be identified in order to evaluate removal alternatives and disposal options. Signatories of the TPA (Ecology et al. 1994) have agreed that sludge characterization is appropriate to assess whether an early removal should be performed for the sludge.

The tank 241-Z-361 JCO (DOE 1998) describes a phased authorization to conduct activities to address hazards posed by this tank and to characterize it in preparation for remediation. Phase I activities included surveys of the site and vapor sampling of headspace gases within the tank. Activities associated with sludge sampling are described as JCO Phase II activities.

The tank characterization encompasses the evaluation of safety and security concerns and consideration of removal and disposal alternatives. Other USQ requirements include evaluating the tank structure to assess the risk of collapse due to a seismic event or other natural hazards and assessing the potential for flammable gas build-up and deflagration from natural or work-induced ignition sources.

TANK 241-Z-361 DESCRIPTION

Tank 241-Z-361 is a rectangular, underground structure 8 m (26 ft) long, 4 m (13 ft) wide, and ranges from 5.2 m (17 ft) deep at the north (influent) end to 5.5 m (18 ft) deep on the south (effluent) end. The tank is constructed of steel-lined concrete with 30 cm (12 in.) thick concrete walls, a layer of waterproofing, and a 1-cm (3/8 in.) thick carbon-steel liner that covers the bottom and side walls up to 15 cm (6 in.) of the roof. The base of the tank is 23 cm (9 in.) thick, with grout and waterproofing added for a total thickness of 30 cm (12 in.) The roof is 25 cm (10 in.) thick. The top was sealed with mastic and approximately 10 cm (4 in.) of concrete was poured over the mastic. The elevation of the top of the tank is 204.83 m 15.24 cm (672 ft 6 in.). Grade elevation is 205.44 m 15.24 cm (674 ft 6 in.). The tank is located southeast of Building 241-Z in the 200 West Area of the Hanford Site and was placed in service in 1949.

The tank provided settling capacity for solids entrained in liquid wastes that were generated by plutonium finishing processes. Liquid entered the tank from retention basins and sump tank 241-Z-6 through two 15.24 cm (6 in.) stainless steel pipes, which penetrated the tank wall through a baffled opening, and exited as overflow through a baffle into one 20.32 cm (8 in.) stainless steel pipe into Cribs 216-Z-1, 216-Z-2, 216-Z-3, and 216-Z-12. The bottom of the inlet piping is at elevation 669 feet and the bottom of the discharge pipe is at elevation 668 feet. Figure 1 provides a cross-sectional and top view of the tank.

The tank roof has three large manhole penetrations and eight riser pipe penetrations (Figure 2). A 1-m (3 ft) manhole exists at the north end of the tank. A second manhole is centered near the south, outside wall of the tank. A large concrete plug (1.2 m [4 ft] diameter) is located in the geometric center of the tank roof. There are two 20-cm (8 in.) risers (A and B), one 5-cm (2 in.) riser, one 8-cm (3 in.) riser built into the southwest corner of the tank, and one 8-cm (3 in.) riser in the northeast corner of the tank. One 15-cm (6 in.) riser was installed through the concrete plug in the center of the tank (riser E) and two 20-cm (8 in.) risers (F and G) were installed north of the center plug. Both 20-cm (8 in.) risers (G&FG) contain 10-cm (4 in.) dry wells that appear to extend from the tank roof into the sludge for an undetermined distance. Although one of the 20-cm (8 in.) risers in the south end had a pipe installed, the middle of the pipe has corroded away (riser A). Riser B has a 10-cm (4 in.) pipe installed that appears to extend from the tank roof into the sludge for an undermined depth. All eight risers are capped or flanged closed and no equipment remains in the tank.

The inlet and outlet pipes have been isolated and plugged or flanged 0.61 m (2 ft) from the outer wall of the tank. The reinforced concrete that was poured over the top of the tank has been removed over the manholes, and the tank was opened for sampling and photography in the mid-1970s. The manholes were subsequently reinstalled, covered with weather covers, and buried. The tank is covered with approximately 0.61 m (2 ft) of soil.

Figure 1. Cross-Section of Tank 241-Z-361.

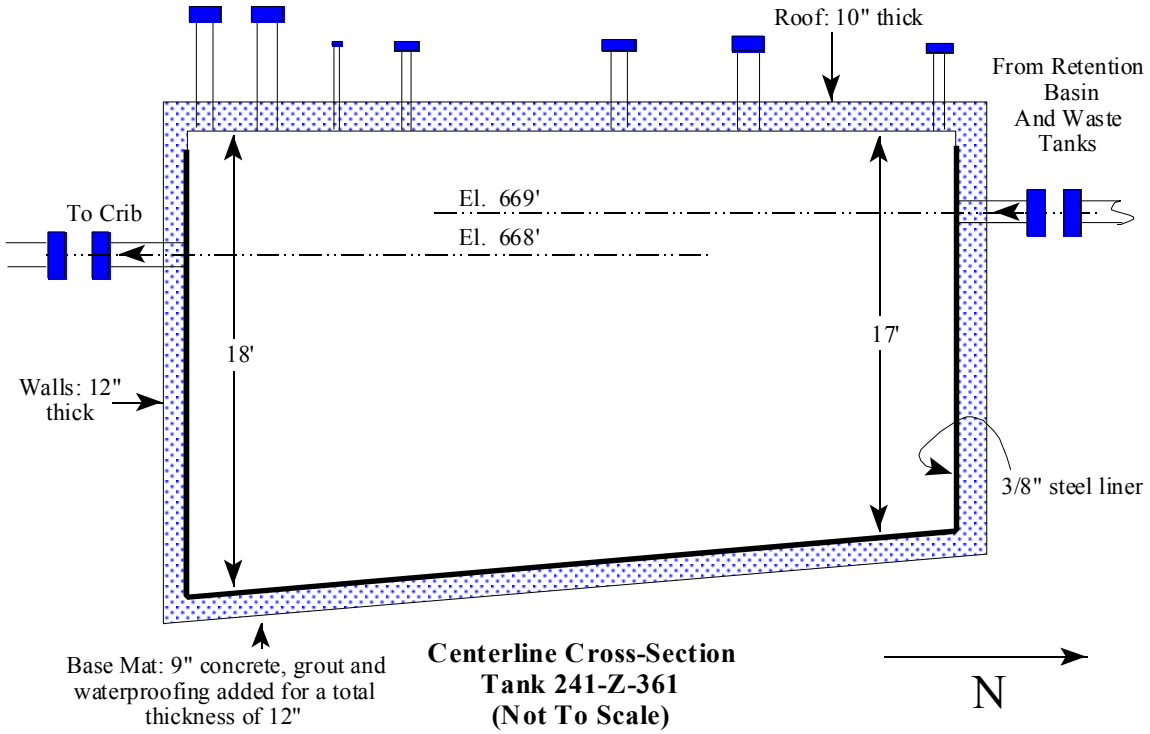
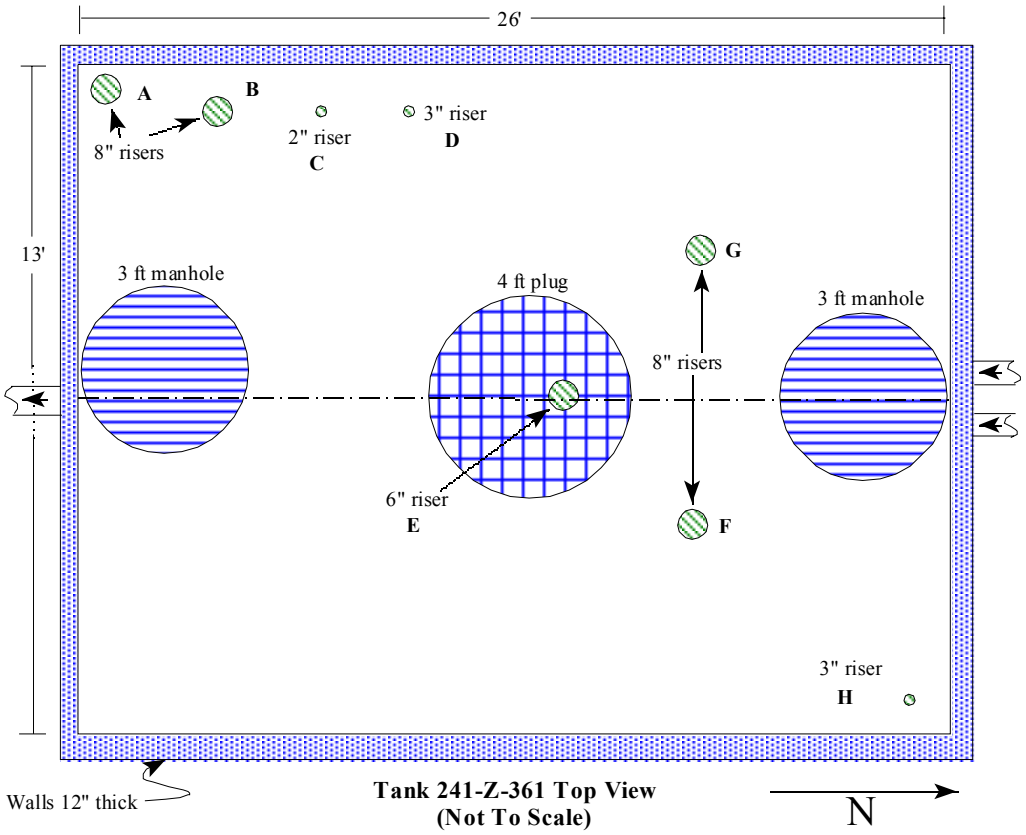


Figure 2. Top View Tank 241-Z-361.



Photographs of the tank taken in 1975 (PHMC 1999) showed the inside of the tank, including walls and the surface of the sludge. It appeared at that time that the steel liner had corroded from the walls of the tank above the surface of the sludge. Pieces of the plastic waterproofing material are hanging down, exposing the concrete.

The following discussion provides an overview of the processes that contributed to the tank sludge. The discussion covers a review of process knowledge and includes a preliminary evaluation of the likely constituents of concern.

TANK CONTENTS

Tank 241-Z-361 was in service from 1949-1973. In 1975, all but approximately 800 L (210 gal) of the supernate was pumped from the tank and the tank was isolated. The tank was sealed in 1985 to prevent gas-phase communication with the surface. The tank contents are expected to include constituents from nearly all of the PFP processes from its operating life span. The sludge is expected to be dominated by the non-water soluble components of effluent from Buildings 234-Z, 236-Z, and 232-Z. The sludge is believed to contain between 26 and 75 kg of plutonium (Freeman-Pollard 1994). This same document suggests a probable inventory of 26.8 kg.

An assessment of material unaccounted for estimated the tank contents as 31.2 kg plutonium (Lipke et al. 1997). The same document presented a criticality evaluation based on the core and bottle samples taken. This evaluation concluded that a criticality event was unlikely under the conditions existing in the tank. A recent review of the tank conditions, based on current knowledge of tank contents and conservative assumptions, has confirmed that a criticality event in tank 241-Z-361, while not entirely incredible, is highly unlikely during the planned characterization activities. Following completion of characterization activities, criticality hazards will be re-evaluated using the results of sludge analysis to support selection and evaluation of remedial alternatives. While the tank was in use, adding fly ash, and later sodium hydroxide, to raise the pH to 8-10, neutralized the contents. Liquid samples collected in March of 1975, however, had a pH as low as 4. It is assumed that the pH will be greater than 2, which will render the plutonium mostly insoluble.

Documentation about the individual chemical processes at Z-Plant is sketchy. Although records describing the finishing process and the reclamation process for the radionuclides, especially plutonium, are quite complete, any discussions about additives like organic reagents and solvents are very limited. Large volumes of water were discharged through tank 241-Z-361; however, soluble components should have been washed away and future additions of water to the tank would not dissolve the plutonium or other solids (Jones 1998).

NUCLEAR SAFETY ISSUES AND THE CERCLA PROCESS

The DOE, through implementing orders, has established nuclear safety controls for facilities and ancillary structures. DOE Order 5480.23*, Nuclear Safety Analysis Reports* establishes the overall safety requirements for facilities with an inventory of defense nuclear materials. The safety analysis report or SAR, involves evaluation of all applicable safety requirements, all components, inventories of nuclear materials, occupational health and safety, waste requirements, nuclear criticality, radiation protection, hazardous materials, the human factor, quality assurance and emergency preparedness. DOE Order 5480.22, *Technical Safety Requirements,* provides for the development of specific controls for specific risks related to the facility. If a new issue is discovered that is not covered under the analysis for the SAR and therefore, is not part of the facility's safety authorization basis, a USQ is declared using DOE Order 5480.21. Declaring a USQ is a formal process that declares that insufficient information is available to fully identify a hazard at the facility. After declaring a USQ, the safety issue or question that is unreviewed goes through a review process to determine what safety risks are present.

The result of the 1997 USQ evaluation of Tank 361 was a determination that there were several factors that indicated there were issues in the safety analysis for the tank: (1) the hazards associated with the tank were not assessed in the PFP facility authorization basis, (2) the Pu content in the tank is sufficiently large that it would require a formal analysis of the hazards using DOE guidance DOE-STD-1027, and (3) there are potential scenarios that cannot be discounted that could lead to significant releases for which controls have not yet been established. These potential scenarios include seismic, flammable gas build-up and deflagration from an ignition source, a criticality event, and a structural collapse (ref. TK-41-Z-361 USQ

Evaluation). CERCLA characterization efforts could not begin until these safety issues had been resolved by DOE.

Regarding the issue of a possible criticality, the historical data provide no additional input to either the spatial or vertical distribution of tank solids; however, they do provide enough information to conclude that a criticality event is unlikely (Lipke et al. 1997). Based on the analysis presented in the criticality report, Lipke estimated that the tank contains between 30 and 32 kg of plutonium. Analysis by PFP scientists determined that the anticipated stratification and geometries of the plutonium in the tank contents make it highly unlikely that a criticality event would take place during either sampling or retrieval. Examination of worst-case geometries led to the same conclusion.

Due to the potential amount of plutonium in the tank, it is important to understand the horizontal and vertical distribution of the waste to determine whether there is a need to expedite removal of sludge from the tank. Data were also required to evaluate worker health and safety and criticality concerns during the CERCLA characterization and remediation activities. The conceptual model for the tank 241-Z-361 puts the historical data into context with the site history and process knowledge.

The flammable/explosive issue also needed to be evaluated before any CERCLA characterization work could be accomplished. Calculations performed during the analysis section of the JCO indicated that the tank's structure did not allow for hydrogen buildup. However, a careful venting of the tank was planned as the first safety priority. Additionally, an analysis of the chemical constituents reported to be in the tank led to the conclusion that explosion was unlikely. Again, for safety reasons, headspace sampling of the tank was planned to ensure certain organic species were not present.

Regarding the issue of structural collapse, controls were immediately put into place prohibiting any loading of the tank's surface. Load tests were required by the JCO before CERCLA characterization activities could proceed.

Once all nuclear and worker safety controls had been put into place per the analysis in the JCO, the DOE was prepared to allow further work to continue on the tank. This included the characterization work that was required under the CERCLA emergency removal process. Representatives from EPA and the Washington State Department of Ecology (Ecology) were very interested in the Nuclear Safety process and the JCO analysis. Before the tank was vented for safety, regulatory representatives attended a mockup of the venting procedure. After tank venting, EPA authorized the initial sampling of the tank through signing the CERCLA workplan for sampling or tank sampling and analysis plan. Figure 3 presents a schematic of the relationship of the JCO to the CERCLA workplan.

REGULATORY APPROACH

Portions of the Hanford Site were placed on the federal agency hazardous waste compliance docket under CERCLA Section 120, on February 12, 1988. Subsequently, the DOE, EPA, and Ecology entered into a Federal Facility Agreement and Consent Order in 1989. The consent

order is often referred to as the Tri-Party Agreement. The purpose of the Tri-Party Agreement, in part, is to establish a procedural framework for developing, prioritizing, implementing and monitoring response actions in compliance with CERCLA, the National Contingency Plan (NCP), and Superfund guidance and policy.

With the declaration of a USQ, the public and the regulatory agencies showed great interest in PFP's 241-Z-361 tank. The regulatory authorities interested in tank 241-Z-361 include the DOE and the Defense Nuclear Facilities Safety Board (DNFSB), EPA Region 10, Ecology, the Hanford Advisory Board (HAB), and the media.

From the standpoint of nuclear safety, the Price Anderson Amendments Act of 1988, Safeguards and Security, and OSHA considerations and requirements, the DOE and the DNFSB have lead authority to determine and abate the risks associated with safety issues. These issues included criticality events, deflagrations that could spread alpha contamination outside the confines of the tank, and tank collapse and subsequent alpha contamination spread.

The EPA has authority under CERCLA and the consent order to regulate response actions associated with the tank and any emergency actions needed to reduce the threat of an imminent release to the public or the environment of a hazardous substance. EPA informed DOE of their concerns regarding the tank, and requested existing characterization documentation. Additionally, EPA notified DOE that, after the nuclear safety issues were investigated, a tank investigation under EPA's emergency removal powers was warranted.

Ecology, as a signatory to the consent order for Hanford, provides approval, in addition to EPA, on engineering documents and work plans associated with any response actions taken on tank 241-Z-361. Ecology also has an interest in ensuring that all applicable Ecology requirements are incorporated in the CERCLA Applicable, Relevant and Appropriate Requirements (ARARs) analysis documents.

In addition to regulatory authorities, stakeholder groups such as the HAB and other citizen watchdog groups have shown great interest in the characterization efforts and risk analysis efforts performed to date on the tank. The HAB represents the concerns of the public regarding risks to the environment and the public in the Hanford Site surrounding area.

RESPONSE ACTIONS

EPA's authority to regulate or act comes from CERCLA's Section 104(a)(1). Under this section, EPA is authorized to remove and provide for remedial actions when any hazardous substance is released or there is a substantial threat of release into the environment, or the contaminant may present an imminent and substantial danger to the public health or welfare. Under CERCLA, response actions can be characterized as removal actions or remedial actions. Removal actions are generally undertaken to deal with environmental emergencies and any action that reduces the threat posed by the hazardous substance release and that can be done quickly qualifies as a removal (Environmental Law Handbook). Additionally, removals provide a rapid mechanism for risk reduction. In the case of tank 241-Z-361, further characterization of the tank was needed

to determine the extent of the threat of release that existed. These characterization efforts could be considered part of the removal process.

Remedial actions are generally long-term and permanent clean-up actions. A remedial action is designed to permanently eliminate the threat imposed by the tank. A remedial action is planned for the Operable Unit in which tank 241-Z-361 resides in the future. It was decided that conducting the characterization effort consistent with a removal action at this time does not preclude further remedial action in the future.

For tank 241-Z-361, the initial characterization efforts that were non-tank disturbing were conducted under the DOE's nuclear safety provisions. Further characterization of the tank was performed under a workplan authorized by EPA under its CERCLA emergency removal power.

EPA required under the consent order, that milestones be negotiated regarding the characterization of tank 241-Z-361 to ensure that risk was evaluated expeditiously. The first milestone required sampling and sample delivery to a qualified lab. The second milestone requires data evaluation and a proposed risk reduction path forward for the tank.

Figure 3: Relationship of JCO to CERCLA Workplan

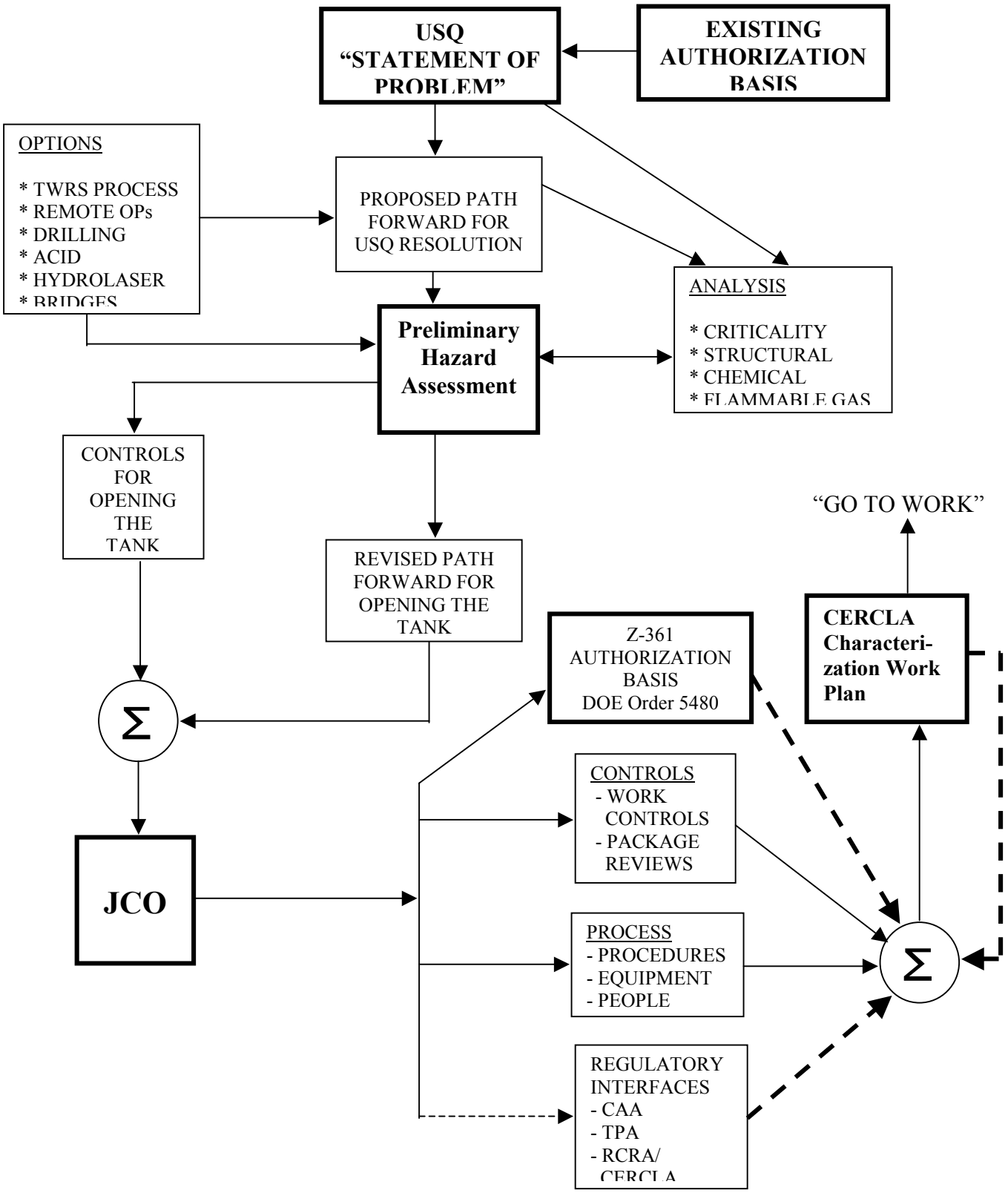
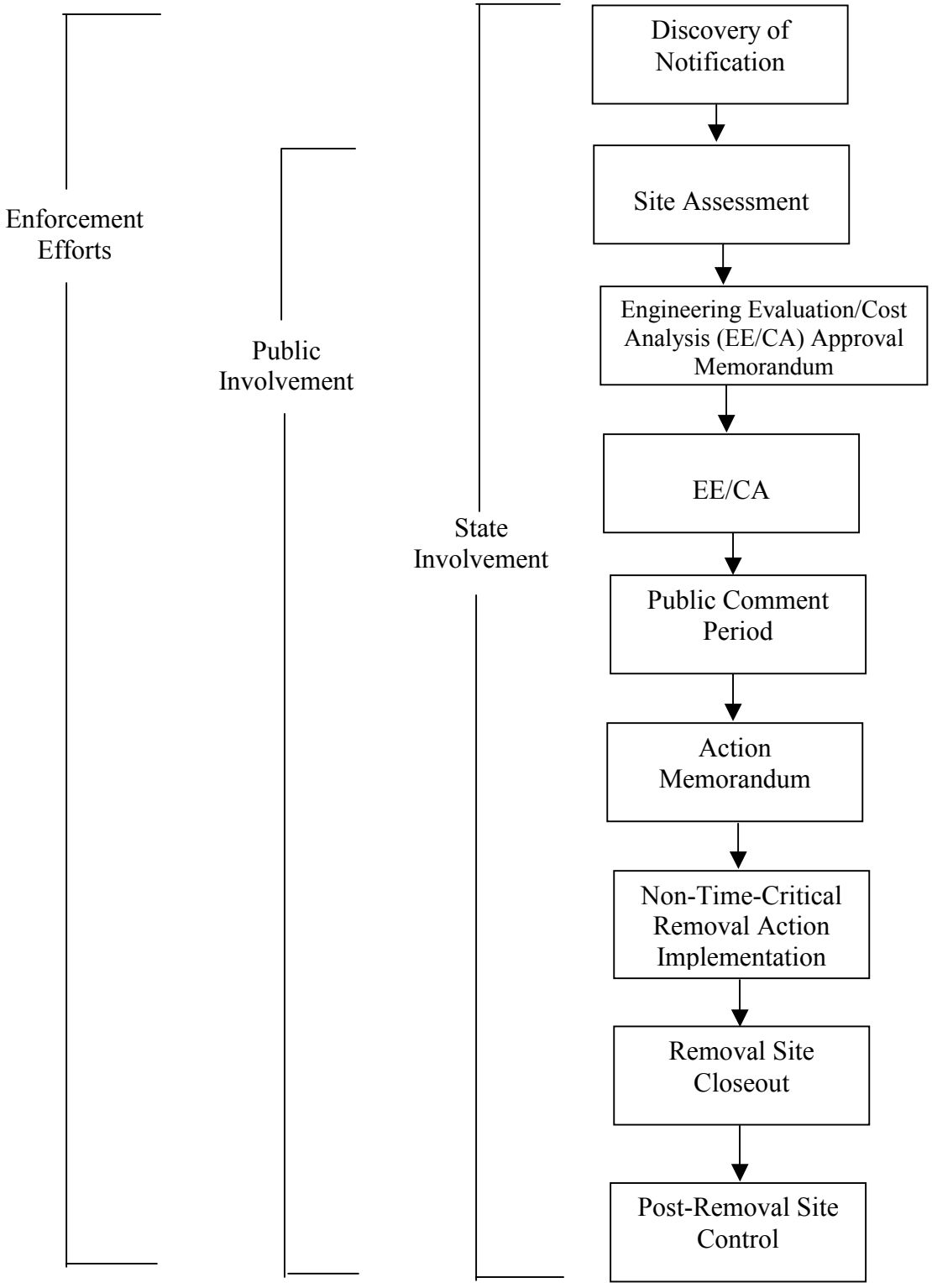
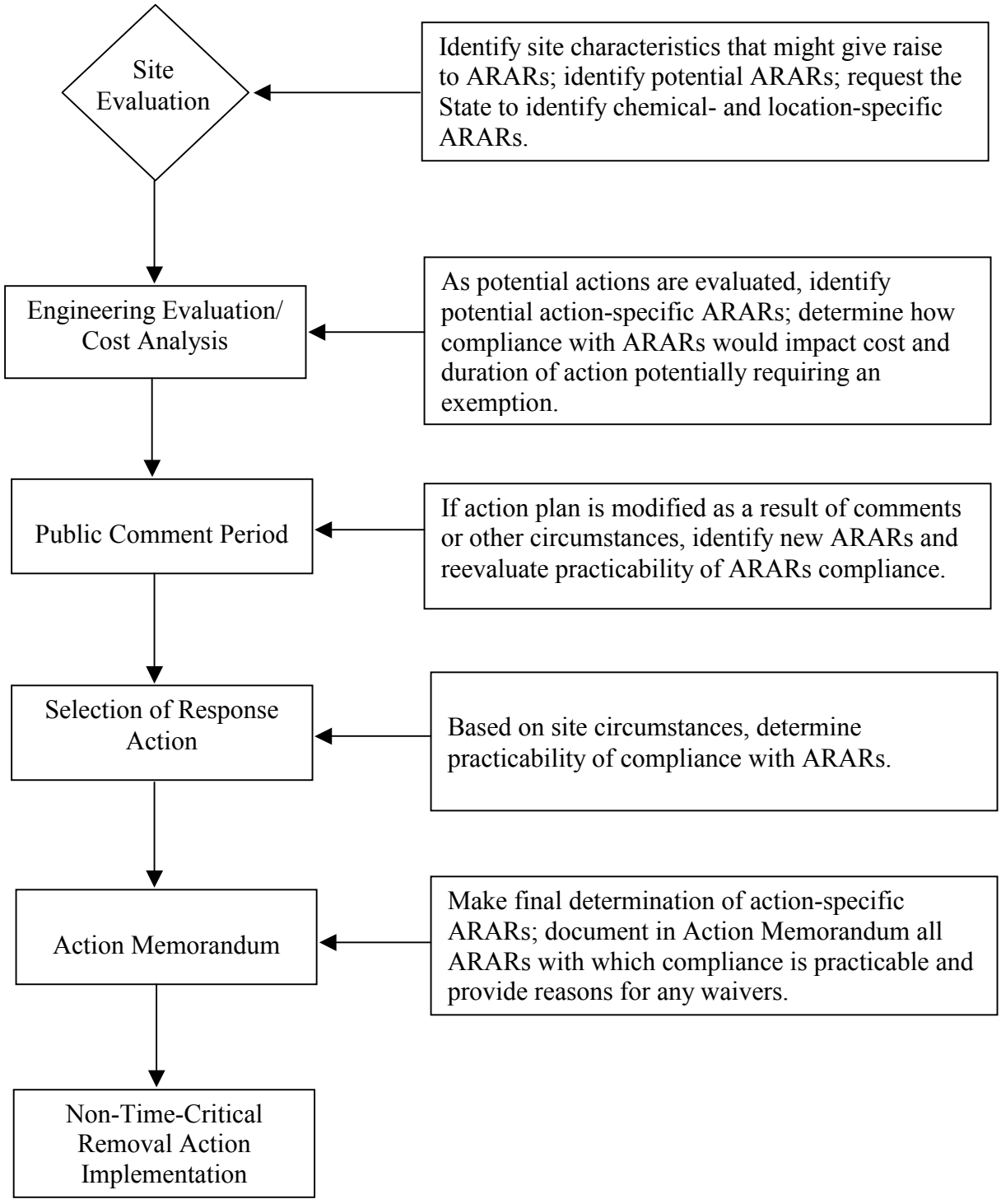


EXHIBIT 1
Non-Time-Critical Removal Action Process*



*Additional removal actions or remedial actions may occur at any time, depending on the exigencies of the site conditions.

EXHIBIT 2
Identification and Evaluation of ARARs During Non-Time-Critical Removal Actions



CERCLA REMOVAL PROCESS

CERCLA and the National Contingency Plan (NCP) define removal actions as "the cleanup or removal of released hazardous substances from the environment, such actions as may necessarily be taken in the event of the threat of release of hazardous substances into the environment, such actions as may be necessary to monitor, assess, and evaluate the release or threat of release of hazardous substances, the disposal of removed material, or the taking of such other actions as may be necessary to prevent, minimize, or mitigate damage to the public health or welfare or to the environment."

EPA removals can be categorized as emergency, time-critical, and non-time-critical depending on the urgency of action to prevent a threat or release. If the action is required to respond to the situation within six months, it is characterized as emergency or time-critical.

A non-time-critical removal action responds to situations posing a threat of release in which the required action can start later than six months after the discovery or determination that a response is necessary. Section 300.415(b)(2)(i)-(viii) of the NCP identifies potential removal actions applicable to tank 241-Z-361 such as:

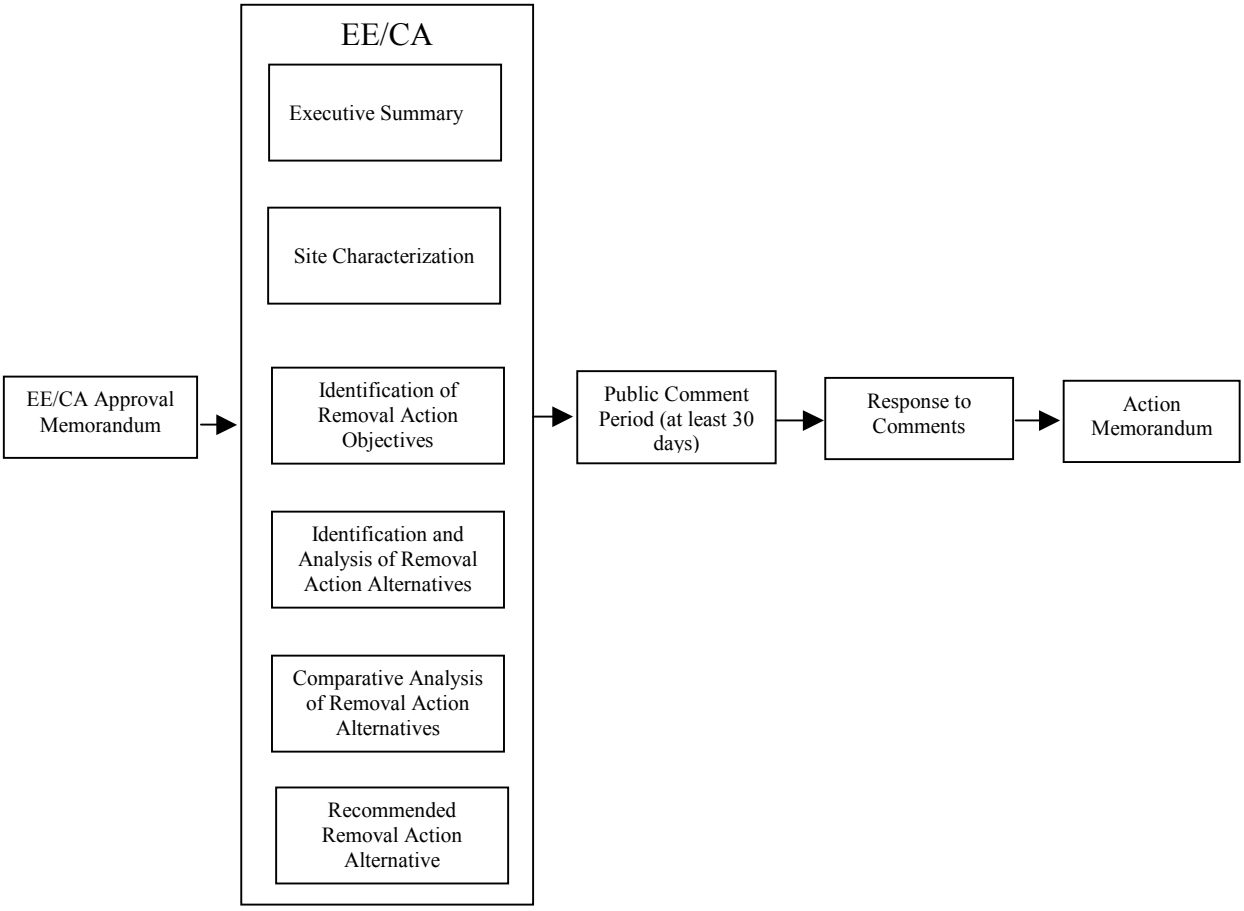
- Prevention or abatement of actual or potential exposure to nearby population.
- Stabilization of hazardous substances in tanks.
- Elimination of threat of fire or explosion.
- Availability of appropriate federal or state response mechanism.

The characterization of tank 241-Z-361 could be considered a non-time-critical removal. This process is described schematically in Exhibit 1. Exhibit 2 describes the identification and evaluation of ARARs during the non-time-critical removal process.

The work plan developed by DOE to address the CERCLA removal process was developed in two phases in order to facilitate gathering information for the EPA PM's decision on time-criticality.

The removal site evaluation (SI) was initiated by the vapor sampling and videotaping activities. As a result of the initial information gathered, the non-time-critical approach to the removal action appeared to be most appropriate. To support this activity, an Engineering Evaluation/Cost Analysis will be proposed. This process is described by Exhibit 3.

EXHIBIT 3
EE/CA Development Process



CONCLUSION

This paper uses Tank 241-Z-361 as an example of the integration of the DOE nuclear safety process and the CERCLA characterization process. The initial safety evaluation for initiating characterization work on the tank was done under DOE Orders following the nuclear safety program guidelines. This was necessary to ensure the tank could be approached safely for CERCLA characterization work to begin.

The eventual remediation of this inactive tank will be conducted under CERCLA either under an Action Memorandum, in the case of an EE/CA or a Record of Decision (ROD) in the case of an RI/FS.

Initial concepts for managing the remediation have been explored. Concepts for removing sludge from tank 241-Z-361 include mechanical removal or removal by sluicing.

Sludge treatment could include storage, in-situ vitrification or removal and cementation.

A preliminary study recommends the evaluation of four removal and treatment scenarios:

- Sludge removal for sluicing, cementation of sludge, and transfer of waste to WIPP.
- Mechanical sludge removal, cementation of sludge, and transport of waste to WIPP.
- In-situ vitrification and transport of waste to WIPP.
- Sludge removal by sluicing, storage, and eventual vitrification of waste into glass logs.

The evaluation necessary to choose the best alternative can be done as an EE/CA or if action on the tank is deferred, the evaluation of remedial alternatives can be done as part of the RI/FS for the operable unit in which the tank resides.

To determine the best path forward at this time, risk to human health and the environment, economic and political/perceptual consideration must be evaluated. These considerations will be evaluated fully as characterization data from the laboratories continue to become available.

REFERENCES

Atomic Energy Act of 1954, 42 USC Sect. 2011-Sect. 2259, et seq.

Bogen, D.M., 1997, *241-Z-361 Characterization Program Plan*, HNF-1532, Rev. 0, B & W Hanford Company.

BWHC, 1999a, *Tank 241-Z-361 Sludge Characterization Data Quality Objectives*, HNF-4224, April, 1999.

BWHC, 1999b, Tank 241-Z-361 Sludge Characterization Data Quality Objectives, HNF-4371, 1999.

Comprehansive Environmental Response, Compensation, and Liability Act of 1980, 42 USC 9601, et seq.

DOE-RL, 1992*, Z-Plant Source Aggregate Area Management study Report*, DOE/RL-91-58, Rev.0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE, 1994, *Control and Accountability of Nuclear Materials*, DOE Order 5633.3B, U.S. Department of Energy, Washington, D.C.

DOE, *Technical Safety Requirements*, DOE Order 5480.22, U.S. Department of Energy, Washington, D.C.

DOE, *Nuclear Safety Analysis Reports*, DOE Order 5480.23, U.S. Department of Energy, Washington, D.C.

Ecology, EPA, and DOE, 1994*, Hanford Federal Facility Agreement and Consent Order*, 2 vols., as amended Washington State Department of Ecology, U.S. Environmentsl Protection Agency, and the U.S. Department of Energy, Olympia, Washington.

FDNW, 1997, *Hazard Analysis of Tank Z-361*, HNF-SD-CP-CN-003, Fluor Daniel Northwest, Richland, Washington.

Field,J.G. and D.L. Banning, 1998, *Tank 241-Z-361 Waste Characterization Data Quality Objective: Headspace Vapor and Tank Structure*, HNF-2176, rev.1, Lockheed Martin Hanford Corporation, Richland, Washington.

Freeman-Pollard, J.R., 1994, *Engineering Study of 50 Miscellaneous Inactive Underground Radioactive Waste Tanks Located at the Hanford Site*, Washington, WHC-SD-EN-ES-040, Westinghouse Hanford Company, Richland, Washington.

Hill, S., M. Hughey, C. Miller, M. Miller, C. Narquis, 1998, *Tank 241-Z-361 Vapor Sampling and Analysis Plan*, HNF-2867, Rev.0, Waste Management Hanford Corporation and Environmental Quality Management Company, Richland, Washington.

Lipke, E.J., C.A. Rogers, and E.M. Miller, 1997*, Engineering Study of the Criticality Issues Associated with Hanford Tank 241-Z-361*, HNF-2012, Rev. 0, Duke Engineering & Services Hanford for Fluor Daniel Hanford, Inc. Richland, Washington.

PHMC, 1998*, Justification for Continued Operation for Tank 241-Z-361*, HNF-2024, Rev.0A, prepared by the PHMC Companies and The Chiron Group LLC, Richland, Washington.

PHMC, 1997, *Material Control and Accountability Plan*, HNF-PRO-502, Rev.0, Prepared by the Project Hanford Management Contractors, Richland, Washington.

Resource Conservation and Recovery Act of 1976, 42 USC 6901 et seq.

Wagoner, J.D., 1997, Contract No. DE-AC06-96RL13200- *Unreviewed Safety Question (USQ) Regarding Plutonium Finishing Plant (PFP) Tank 241-Z-361* (letter, 97-TPD-193, October 15), U.S. Department of Energy, Richland Operations Office, Richland, Washington.