

OAK RIDGE NATIONAL LABORATORY TANK REMEDIATION PROJECT: SUCCESSFUL REMEDIATION OF 25 LIQUID LOW-LEVEL RADIOACTIVE WASTE TANKS

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ABSTRACT

This paper summarizes the tools used for cost-effective remediation of liquid low-level radioactive waste (LLW) tanks at the Oak Ridge National Laboratory, Oak Ridge, Tennessee. This remediation strategy was originally presented in the Waste Management 1998 proceedings (1). Since publishing the 1998 paper, the Tank Remediation Project has remediated five more tanks, successfully integrated the remediation decision process with the larger watershed remedial investigation/feasibility study (RI/FS), and transitioned to the Bechtel Jacobs Company LLC for management under the new management and integration (M&I) contract.

Since 1995 the Tank Remediation Project has remediated 25 tanks by integrating waste management (WM) tank isolation activities with the environmental restoration (ER) field remediation activities. Most of the tanks remediated contained only residual LLW that was removed and placed directly into the ORNL LLW System for subsequent treatment. However, in 1998 the project began remediating tanks with residual sludge containing transuranic (TRU), Resource Conservation and Recovery Act (RCRA), and Toxic Substance Control Act (TSCA) constituents. This sludge could not be placed directly into the ORNL LLW system without pretreatment. This paper will detail how these types of tanks were remediated in a cost-effective manner with regulatory involvement.

The ORNL site is establishing long-term remedial action objectives (RAOs), including future land use determination, in watersheds RI/FS that include these tanks. This paper will address how tanks are being considered in this document and the future watershed record of decision (ROD). The paper will also address the new direction of the Tank Remediation Project under the M&I contractor.

BACKGROUND

The ORNL is a multidisciplinary research facility that began operation in 1943 as part of the Manhattan Project. The original mission of the laboratory was to develop a prototype graphite reactor and the reactor fuel reprocessing facility and more recently multidisciplinary research activities that has generated LLW. This LLW is typically accumulated at source buildings, often in collection tanks located inside the buildings, and discharged to below-grade collection tanks that receive wastes from several different source buildings. These LLW tanks are being remediated as part of the Federal Facility Agreement (FFA) between the U.S. Department of Energy (DOE), State of Tennessee, and Region 4 U.S. Environmental Protection Agency (EPA).

The overall objective of the Tank Remediation Project is to remediate all LLLW tanks that have been removed from service. The project focuses on remediation of tank residues (i.e., contents after tank has been removed from service) and tank shell.

Since 1995 the FFA Tank Remediation Project has been responsible for remediation of 25 tanks by integrating WM and ER isolation and remediation planning and implementation activities. The location of these tanks and their remediation status is shown in Fig. 1 and summarized below.

- Three tanks have been emptied, removed, and disposed of by smelting at a licensed facility in Oak Ridge, Tennessee.
- One tank has been removed and placed in long-term storage.
- Twenty-one tanks have been emptied of residual contents and stabilized in place with grout (controlled-low strength material - CLSM).

This has been accomplished by working with the state and federal regulatory agencies, DOE, the ORNL facility management contractor, various local consulting firms, and the Oak Ridge community. The concurrence of all these stakeholders to the remediation decision process has been essential to the success of this project. These same stakeholders are involved with establishing the ORNL site RAOs for future site cleanup standards in the watershed ROD. The Tank Remediation Project is working with the watershed ROD teams and stakeholders to ensure that interim actions taken to remediate LLLW tanks will not preclude final action prescribed in the ROD.

TANK REMEDIATION STRATEGY

The overall objective of the Tank Remediation Project is to evaluate and remediate all LLLW tanks that have been removed from service to the extent practicable in accordance with FFA requirements. As stated in the FFA, "to the extent practicable, the DOE shall remove or decontaminate, or otherwise remediate all residues, contaminated containment system components (liners, etc.), contaminated soils and structures and equipment associated with the tank system(s)" (2). The primary task of the Tank Remediation Project is to remediate the tank residues and tank shell. Equipment (e.g., piping and valve pit) and contaminated media (soil and groundwater) associated with the tank system will be remediated in conjunction with similar remediation activities for adjacent areas and/or watershed ROD scheduled for approval by the end of the year 2000.

The key factors considered when making remediation decisions include:

- preliminary screening risk assessment,
- tank accessibility (e.g., located in a vault, buried under a building, etc.),
- waste acceptance criteria (WAC) for disposal facility to receive tank shell,
- contamination adjacent to the site (soil and groundwater),
- watershed ROD RAOs (e.g., land use considerations), and

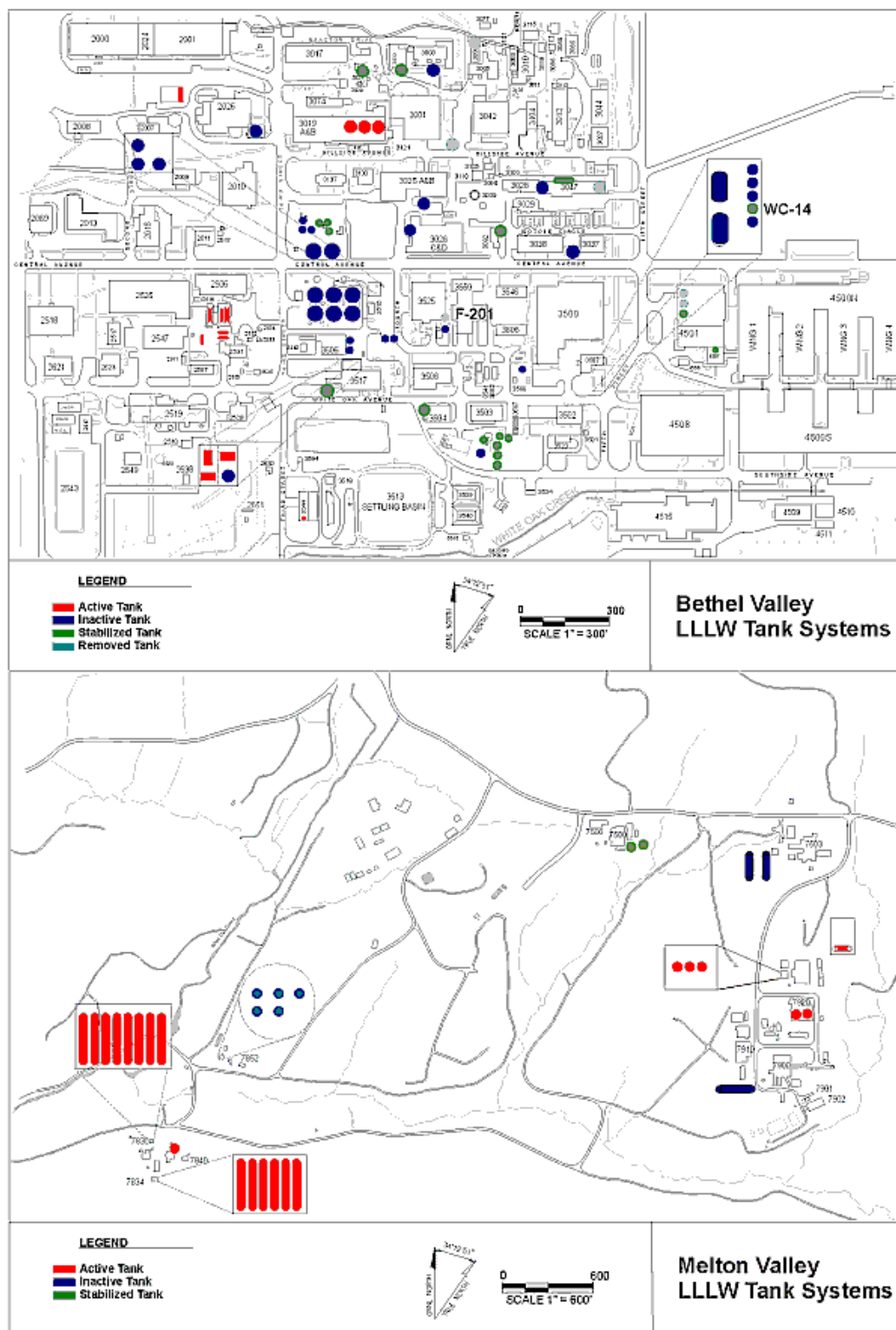


Fig. 1. ORNL LLLW tanks location maps.

- future activities associated with adjacent facilities [e.g., decontamination and decommissioning (D&D)].

The 1998 paper illustrated how these factors are evaluated in the remediation decision process (1). The results of this evaluation is provided to regulators prior to remediation of a particular tank to gain consensus on the remediation decision (e.g., removal versus in-place remediation) and path forward (maintenance action versus removal action) prior to implementation. The maintenance action path is preferred because DOE makes the remediation decision and gains the regulators' concurrence with correspondence and meetings versus CERCLA documents (i.e., less time and money required to remediate a tank). These factors are expanded upon in the following paragraphs.

The preliminary screening risk assessment is based on an incremental approach in which quantitative decision rules are used to help ensure a conservative method with a minimum of modeling (3). This risk assessment is used as a decision tool to determine if a tank can be remediated as a maintenance action. Ingestion of groundwater is the only exposure pathway that is evaluated for the future residential exposure scenario. This pathway reflects the most conservative risk evaluation as compared to other potential residential exposure pathways (i.e., inhalation or dermal contact) because contaminants released from the tank into the groundwater are assumed to be at 100 percent concentration in the drinking water. If the risk is below the EPA target limit, the tank shell and residuals are a candidate for remediation as a maintenance action versus a more costly CERCLA process.

Tank accessibility includes an evaluation of the size and location of the tank in a vault or soil, as well as, the diameter and presence of an access riser(s). The size of the tank will determine if a tank filled with flowable fill/grout can be removed in the future using conventional equipment readily available at ORNL. The location of the tank in a vault or soil will help determine the difficulty and cost effectiveness in accessing the tank for removal. The presence of a riser of adequate diameter and accessible without excavation establishes the ability to perform sampling/characterization, remove contents, and place grout for stabilization in place.

If a tank is determined to be accessible, the WAC of the disposal facility must be evaluated, along with, Department of Transportation (DOT) requirements for transport of contaminated tank and residues on public highways. If analysis of the tank shell and contents indicates the WAC and DOT requirements can not be met with out expensive, aggressive pretreatment, the tank should be a prime candidate for in-place stabilization if this is compatible with future plans for the surrounding area.

If the tank is surrounded by soil or groundwater contamination due to past leaks it should be remediated as a CERCLA action via the watershed ROD at the same time as the contaminated media remediation. The watershed ROD will address consideration of the long-term remediation goals for the overall site that will address land use considerations. If there were other activities, such as D&D of buildings adjacent to a tank site it would be more cost-effective to include tank remediation in the scope of the D&D activity and utilize one contractor.

Most of the tanks remediated contained only residual LLLW that was removed and placed directly in the ORNL LLLW System for subsequent treatment and disposal prior to tank stabilization or removal. However, in 1998 tanks containing problematic sludge that could not be placed directly into the ORNL LLLW System due to contaminants present (e.g., TRU, TSCA, and/or RCRA constituents) or physical properties (e.g., percent solids) were scheduled to be remediated. The successful remediation of two of these types of tanks (Tank WC-14 and F-201) is discussed in the following sections.

TANK WC-14 REMEDIATION

Tank WC-14 was installed in 1951 to collect waste from various research laboratories and taken out of service in 1992 when it was no longer needed. This 3788-L capacity, stainless-steel tank is buried under 2.4 meters of soil on a common concrete pad with 6 other tanks. It is a 2.2-meter high vertical tank with a 1.7-meter diameter. The tank is located within the groundwater table and was collecting up to 568 liters per month of incidental groundwater inflows. This high inflow into the tank required the liquid to be pumped out of the tank, treated, and transferred to ORNL LLW Storage Facility, which increased the surveillance and maintenance (S&M) cost. Characterization of Tank WC-14 contents revealed approximately 265 to 492 liters of sludge containing remote-handled (RH) TRU, TSCA, and RCRA constituents (Fig. 2). The sludge had polychlorinated biphenyl (PCBs) concentrations of up to 240 parts per million (ppm).

Because of the risk to human health and the environment from a potential release of the tank contents and non-programmatic inflows that required frequent removal and treatment, the decision was made to remediate this tank as a time-critical removal action and an action memorandum was prepared (4, 5). The action memorandum was approved by DOE and concurred by regulators in September 1997 and sludge mobilization/removal activities began in February 1998. It took two months to remove and process the 80 gallons of sludge and 500 gallons of liquid. The technical objectives of the time-critical removal action that were achieved during tank remediation include the following.

- Mobilized and removed sludge to the maximum extent practicable using conventional sparging and pumping equipment techniques.
- Rinsed tank with high-pressure sprayer.
- Videotaped the tank interior to assess the success of the sludge removal operations.
- Stabilized and isolated the tank in place by filling it with grout.
- Dewatered the sludge (< 0.5% free liquids) to provide a solid waste form that meets long-term storage requirements at ORNL.
- Treated liquids resulting from the dewatering operations to meet the WAC for ORNL LLLW treatment system (PCBs < 2 ppm).
- Packaged dewatered sludge in shielded storage containers that are compliant with regulatory requirements, storage facility acceptance criteria, and health and safety requirements.
- Placed container in ORNL TRU Waste Storage Facility.

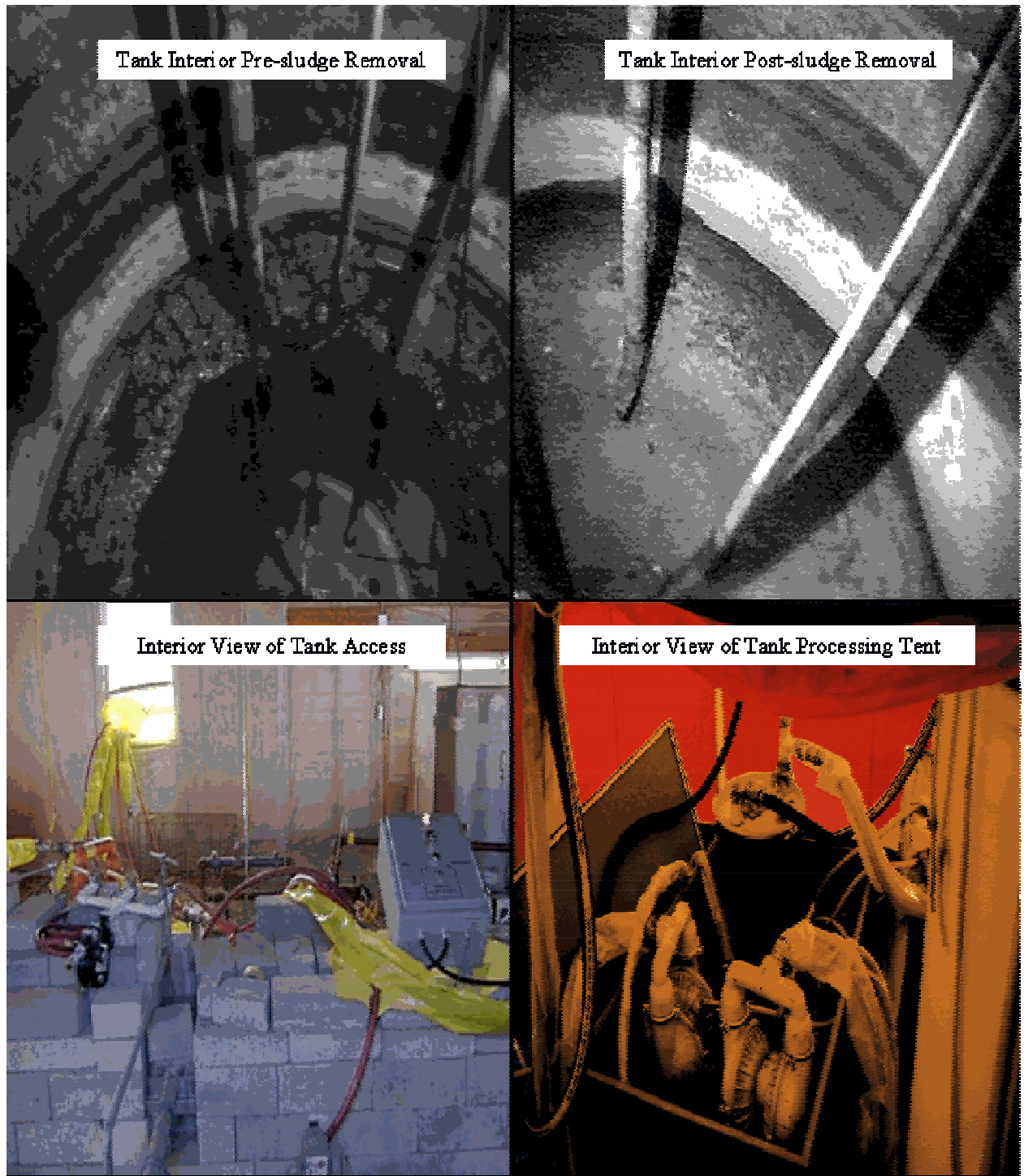


Fig. 2. Tank WC-14 interior photos and sludge removal equipment setup.

Bench-scale tests were conducted to verify the sludge dewatering methodology prior to operation of the sludge removal system. The tank contents were pumped to a shielded, stainless steel dewatering vessel containing filter media (Fig. 2). A dewatering pump withdrew the liquid through the filter media and transferred it through an activated carbon filter (to remove PCBs) to a holding tank. The used carbon and containers of dewatered sludge were transferred to the ORNL TRU Waste Storage Facility. An August 19, 1997 modification to the Oak Ridge Reservation Polychlorinated Biphenyl Federal Facility Compliance Agreement provides an alternate inspection method for remote handled class III/IV radioactive PCB waste that allows for the storage of this waste (and Tank F-201) in this facility (6).

Once the sludge had been removed, it was confirmed by interior videotape that sludge removal objectives were met (Fig. 2). The tank was then stabilized in place by filling it with grout to eliminate groundwater inflows and contaminant migration pathways. The interior video was key to gaining consensus from DOE and the regulators to stabilize the tank in place. Achieving these time-critical removal action objectives eliminates the need for further surveillance and maintenance expenses.

TANK F-201 REMEDIATION

Tank F-201 was placed in service in 1962 and received waste from the post-irradiation mechanical disassembly of reactor components so that physical and metallurgical examinations could be conducted. The tank was removed from service September 30, 1997 when it was no longer needed. This 152-L capacity, stainless-steel tank was located in a concrete vault 3.7 meters below the ground surface (Fig. 3). It is a 0.8-meters high vertical tank with a 0.6-meter diameter. Tank F-201 was inspected with a video camera in November 1997 and found to be dry (i.e., no free liquids) with a small amount of fine, dry solids on the bottom. The tank walls were shiny and appeared to be relatively "clean". Subsequent sampling indicated that the dry solids contained radiological, RCRA and TSCA constituents.

Tank F-201 remediation activities involved cutting and capping connected piping, removing the tank (with dried solids) from the vault, and packaging the tank in a manner acceptable for long-term storage. Since the tank contents are dry, the waste form was acceptable (i.e., no free liquids) for storage at ORNL without pretreatment. Due to the relatively small size of this tank, the tank with the contents intact was placed in a container. Thus, it was not necessary nor cost effective to remove dried solids from the tank. This containerized waste was transferred to the ORNL TRU Waste Storage Facility for future disposition.

The remediation of Tank F-201 and the other LLLW tanks were done in close coordination with the watershed ROD team to ensure interim actions would not preclude future actions that may be required at these sites as discussed in the following sections.

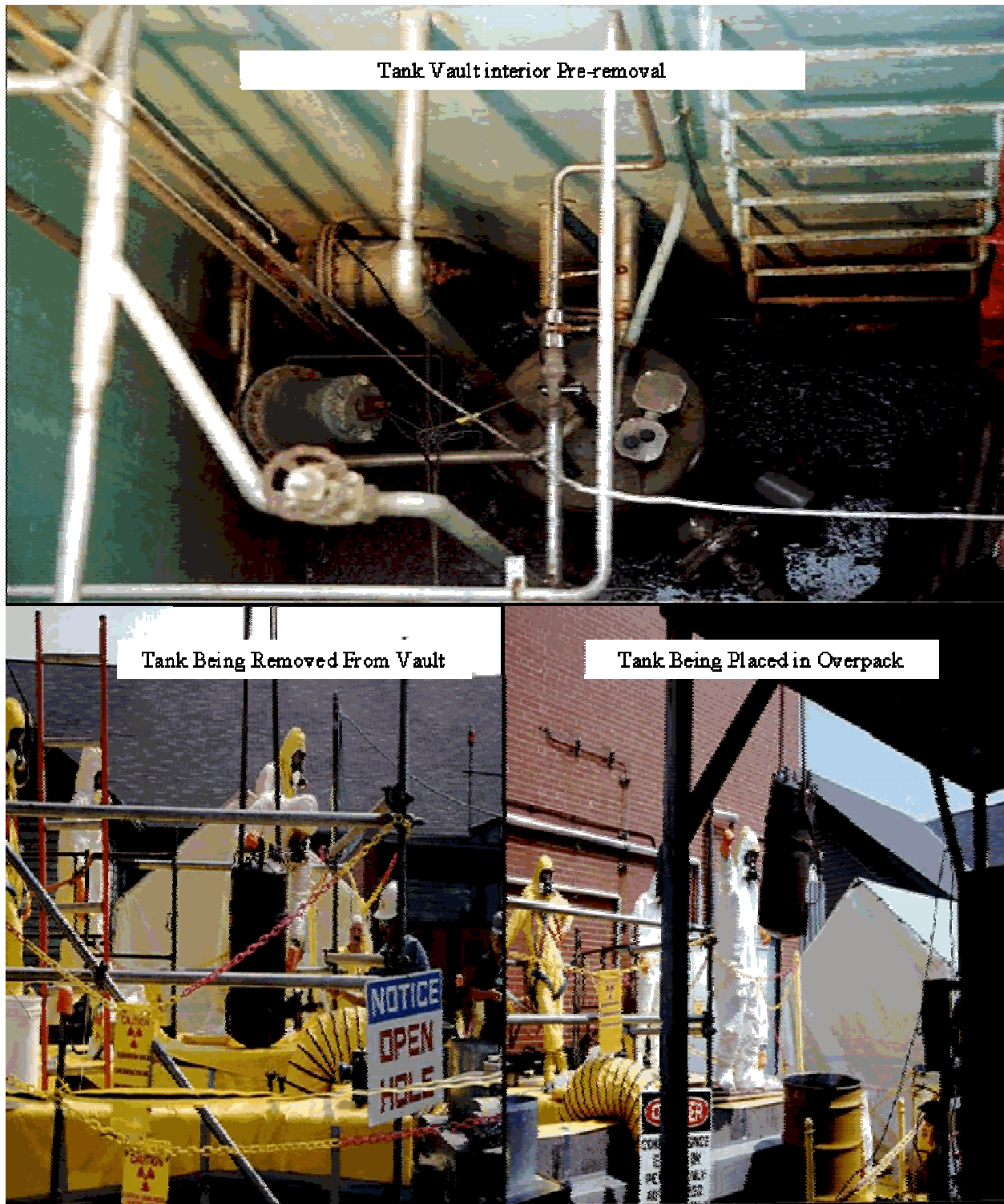


Fig. 3. Tank F-201 remediation activities.

WATERSHED RECORD OF DECISION

The ORNL site is comprised of two valleys (Bethel and Melton) where contaminated sites requiring remediation from past waste operations is required. Past remediation activities for contaminated sites have typically been prioritized based on risk due to potential of release of contaminants to the environment now and in the future. Some smaller projects have been implemented using the CERCLA removal action process, such as Tank WC-14. However, to achieve final site RAOs watershed ROD was initiated in 1997 to document the remedial actions required to achieve these objectives.

The two land uses being considered in these RAOs is DOE-controlled industrial and unrestricted industrial. The following rationale addresses how the LLLW tank remediation decisions made in the past and near future will be addressed in the watershed ROD.

Stabilization of inactive tanks is based primarily on a conservative preliminary screening risk assessment that provides future protection of DOE-controlled industrial user (i.e., no further tank remediation is required). The no further action (NFA) decision for the DOE-controlled industrial user is based on the following factors.

- The conservative preliminary risk screening assessment that the tank stabilization decision is based upon evaluated the contaminant future release potential under the worst case condition (e.g., maximum contaminant concentration released from the tank today) and determined that the risk was below the EPA target limit.
- These stabilized tanks prevent future releases of contaminants to the groundwater and surface water by providing a barrier to groundwater intrusion (tank shell and grout) thus meeting these RAOs.

If a portion of the main plant is needed for future construction of a new facility, this may require that a tank that has been stabilized in place be removed with a large crane for either a basement or foundation stability reasons. This is a future construction need-based decision and not a remediation decision considered by the Tank Remediation Project.

If it is determined that the stakeholders want the future land use to be unrestricted industrial, then tanks that have been remediated by in-place stabilization will need to be removed because most of them are buried within the top 10 feet of soil with minor amounts of residual contamination on the tank interior. The preliminary screening risk assessment does not evaluate the risk to workers due to direct contact of this residual contamination; thus unrestricted use at the tank site is not acceptable. Also, the existence of the tank as a concrete monolith restricts subsurface construction. If the unrestricted-industrial land use is selected then there is high potential for removal of associated tank piping and other ancillary equipment (and most of downtown ORNL) so the tanks can be removed at this time with a large crane.

Not all the tanks are constructed of stainless steel and the assumption that the tank can be removed with a crane is only applicable in these cases. Remediations of tanks constructed of

other materials (concrete or Gunitite) are evaluated as part of the watershed ROD and not the Tank Remediation Project.

The watershed ROD will include a list of all the tanks that have been remediated by the Tank Remediation Project indicating “no further action” unless otherwise driven by a need to meet the unrestricted-industrial land use requirements. In an effort to determine which tanks could be addressed by the Tank Remediation Project prior to finalizing the watershed ROD, a decision matrix was developed to identify the critical evaluation criteria for determining the future remediation path (Fig. 4). The critical evaluation criteria are discussed below.

- Tank construction material was evaluated because it was determined that if a tank is constructed of material other than steel (Gunitite or concrete) then stabilization of this tank would preclude future excavation (due to its weight) if this were identified as the preferred alternative in the watershed ROD.
- Tank contents were evaluated because remediation of tanks would be dependent on availability of sludge mobilization removal, treatment, and disposal system.
- Tank residual risk to the surrounding environment was evaluated to determine if this tank would be better addressed in the watershed ROD due to inadequately decontaminated prior to stabilization.

This remediation decision matrix was developed by working with all stakeholders to gain consensus on the critical evaluation criteria. The results of individual tank remediation evaluations and accomplishments is documented in a yearly implementation plan (7) and the Bethel Valley Watershed RI/FS (8) where the majority of the tanks are located.

DIRECTION UNDER THE MANAGEMENT AND INTEGRATION CONTRACTOR

The Tank Remediation Project continues to move forward under the direction of Bechtel Jacobs Company LLC who began managing this project, as well as many others, on April 1, 1998. The approximately 30 LLLW tanks remaining to be remediated by this project will be more difficult than past tank remediation activities due to the residual sludge/solids that remains in the tanks. Past experiences with remediation of Tank WC-14 have demonstrated a need to know more about the physical nature of the tank contents than is currently available due to the lack of sophistication of the 1988 sampling equipment (9). Thus, the fiscal year (FY) 1999 activities will focus on tank characterization to facilitate future remediation decisions. Tank characterization activities will include videotaping tank interior to determine waste form present (liquid and sludge/solids or liquid only) and collecting content samples to determine waste physical and chemical properties.

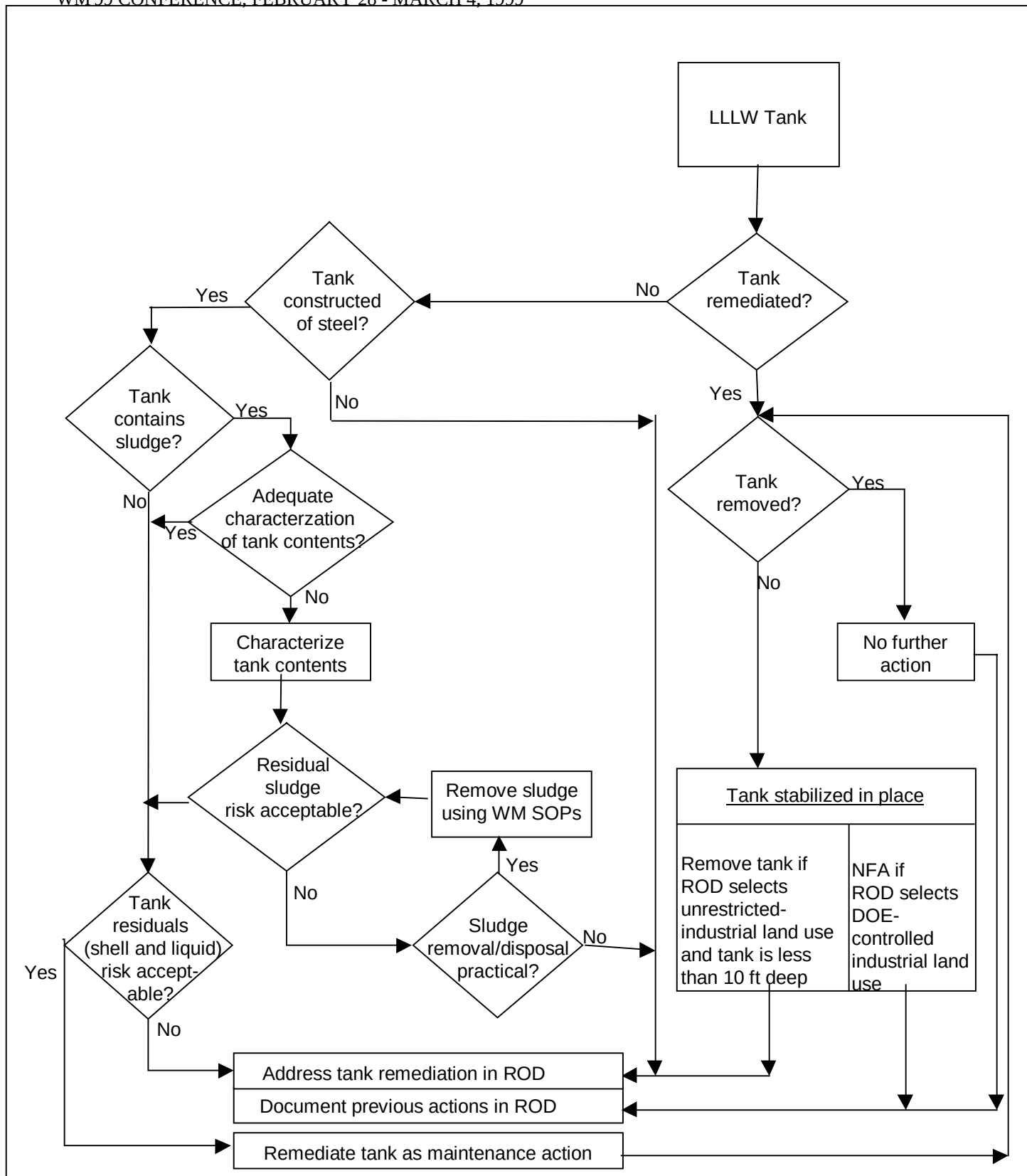


Fig. 4. ORNL LLLW Tank Remediation Decision Matrix

This tank characterization information will be used in conjunction with the decision matrix presented previously to determine the preferred tank remediation alternative and implementation strategy. Bechtel Jacobs Company LLC will package this information in a request for proposal and award one contract in FY 2000 for the remediation of the remaining tanks. This will result in an overall lifecycle cost savings due to streamlining the remediation activities to be performed by one contractor which minimizes mobilization and personnel training requirements. Remediation of these tanks will require innovative sludge mobilization/removal technologies. The project team is currently working with DOE EM-50 technology development program to co-fund the deployment of a mobile tank waste retrieval system that can be moved from one tank site to another.

Under the direction of Bechtel Jacobs Company LLC, the Tank Remediation Project will complete tank remediation activities in 2003 with estimated life-cycle cost savings of \$7 million. Some of these savings have already been realized due to the past three years of work performed under the direction of Lockheed Martin Energy Research by integrating WM and ER isolation and remediation activities (1).

CONCLUSIONS

The remediation of LLLW tanks is a dynamic, flexible, customized process that must be adapted in response to the specific circumstances of individual tank systems and site conditions. Thus, the remediation strategy will be tailored to accommodate feedback from lessons learned from previous maintenance/removal. The Tank Remediation Project will continue to integrate activities with other on-going projects and the watershed ROD to provide consistency, and strive to find new and innovative approaches to tank remediation.

Remediation of LLLW tanks at ORNL over the past four years has resulted in lessons learned that should be shared with other sites considering using this methodology. The most important lessons learned are summarized below.

- Integration of ER and WM planning and implementation activities resulted in schedule and cost savings of up to 50% as compared to independent ER/WM efforts.
- Remediation planning starts prior to tank characterization activities and should involve stakeholders in defining key factors that need to be evaluated to make remediation decisions.
- Establish risk assessment process tailored to site conditions that minimizes the need for elaborate computer models, such as FTWORK, but still satisfies regulatory community. This risk assessment should be used as a tool to convince stakeholders that a maintenance action is adequate thus eliminating the need for expensive and time-consuming CERCLA documents.
- Coordinate individual tank remediation activities with other larger site remediation and D&D projects to reduce cost due to duplication of documents and contract support.

- Videotaping the interior of the tank to determine waste forms present and potential leaks is essential to a successful project and gains credibility with stakeholders.

The future of the Tank Remediation Project under the direction of Bechtel Jacobs Company LLC will continue to be a success with a renewed focus on full characterization of the tank contents to support the planning and implementation of one large tank remediation field effort in FY 2000.

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