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Federal Facility Agreement Plans and Schedules for Liquid Low-Level Radioactive Waste Tank Systems at Oak Ridge National Laboratory, Oak Ridge, Tennessee

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managing the
Oak Ridge National Laboratory
Oak Ridge K-25 Site
Oak Ridge Y-12 Plant
Paducah Gaseous Diffusion Plant
under contract DE-AC05-84OR21400
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for the
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ABBREVIATIONS AND ACRONYMS

AAP	alternatives assessment plan
ALARA	as low as reasonably achievable
BSR	Bulk Shielding Reactor
BVLLW-CAT	Bethel Valley Low-Level Waste Collection and Transfer
CAT	collection and transfer
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CMS	corrective measures study
CR	Clinch River
CWCH	central waste collection header
CWMD	Central Waste Management Division
D&D	decontamination and decommissioning
DAA	detailed alternatives assessment
DOE	U.S. Department of Energy
DOE-OR	Department of Energy Field Office, Oak Ridge
EDE	effective dose equivalent
Energy Systems	Martin Marietta Energy Systems, Inc.
EPA	Environmental Protection Agency
ER	environmental restoration
ES&H	environmental, safety, and health
FDPL	Fission Products Development Laboratory
FFA	Federal Facility Agreement
GPP	general plant project
HEPA	high efficiency particulate air filter
HFIR	High Flux Isotopes Reactor
HRLAL	High-Radiation Level Analytical Laboratory
HRLEL	High-Radiation Level Examination Laboratory
ICM	interim corrective measure
IMET	Irradiated Materials Examination and Testing Facility
LIP	line item project
LLLW	liquid low-level radioactive waste
LLW	low level radioactive waste
MVLLW-CAT	Melton Valley low-level waste collection and transfer
MVPS	Melton Valley Pumping Station
MVST	Melton Valley Storage Tank
NEPA	National Environmental Protection Act
NHF	New Hydrofracture Facility
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
ORNL	Oak Ridge National Laboratory
ORR	Oak Ridge Research Reactor
PAA	preliminary alternatives assessment
P&E	Plant and Equipment Division
PW	process waste
PWTP	Process Waste Treatment Plant

QA	quality assurance
R&D	research and development
RCRA	Resource Conservation and Recovery Act
REDC	Radiochemical Engineering Development Center
RFI	RCRA facility investigation
RI	remedial investigation
RI/FS	remedial investigation/feasibility study
RPPP	Radiochemical Processing Pilot Plant
S&M	surveillance and maintenance
SARA	Superfund Amendments and Reauthorization Act
Sect	section
SIA	structural integrity assessment
TAG	Technical Advisory Group
TDEC	Tennessee Department of Environment and Conservation
TRU	transuranics
TSD	treatment, storage, and disposal
UST	underground storage tank
WAG	Waste Area Grouping
WM	wast management
WMRAD	Waste Management and Remedial Action Division
WOC	White Oak Creek
WOCC	Waste Operations Control Center
WOL	White Oak Lake

GLOSSARY

active tank—an LLLW tank capable of receiving wastes from program activities.

ES&H tank system—an active tank system that cannot be shut down immediately without creating unacceptable environmental, safety, or health risks.

hot cell—an enclosure and its associated ancillary equipment which provides shielding, containment, and remote handling capabilities for work involving radioactive sources and materials. Ancillary equipment includes radioactive off-gas filtration and drains to the LLLW system.

inactive tank—a LLLW tank that has been removed from service and will no longer receive program generated wastes.

LLLW tank—a stationary device, designed to contain an accumulation of LLLW. It is constructed primarily of non-earthen materials (e.g., concrete or steel) to provide structural support and containment. This tank will function as a waste storage or neutralization tank. This definition does not include tanks in which processing other than neutralization occurs or in which the entire tank contents may be recycled to a process.

leaking—the escape of a hazardous substance from primary or secondary containment. Leaking does not include overflow or venting between tanks (refer to FFA Subsect.IX.D.1).

raffinate—the part of a liquid remaining after its more soluble components have been extracted by a solvent.

secondary containment tank system—for the purpose of the FFA, tank systems will be categorized as secondarily contained if the capability exists to contain regulated substances released from the primary tank system until such wastes are detected and removed. Some ORNL LLLW tank systems may require modification of ancillary equipment and the upgrade of secondary containment to meet FFA requirements.

tank system—a waste storage or waste treatment tank and its associated ancillary equipment and containment system. In the ORNL LLLW system, ancillary equipment includes sumps, piping and valves to the waste tank(s), and piping and valves from the tank(s).

EXECUTIVE SUMMARY

Pursuant to the provisions of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) as amended by the Superfund Amendments and Reauthorization Act, the Oak Ridge Reservation, consisting of ~58,000 acres owned by the United States and under the jurisdiction of the United States Department of Energy (DOE), was placed on the National Priorities List on December 21, 1989. A Federal Facility Agreement (FFA) for the Oak Ridge Reservation was approved in November 1991 by the United States Environmental Protection Agency (EPA), Region IV; DOE; and the Tennessee Department of Environment and Conservation (TDEC). The effective date for the agreement is January 1, 1992. The objective of the agreement is to ensure that environmental impacts resulting from operations at the Oak Ridge Reservation, both past and present, are thoroughly investigated and remediated to protect the public health, welfare, and environment.

Although the FFA addresses the entire Oak Ridge Reservation, specific requirements are set forth for the liquid low-level radioactive waste (LLLW) storage tanks and their associated piping and equipment, tank systems, at ORNL. The stated objective of the FFA as it relates to these tank systems is to ensure that structural integrity, containment and detection of releases, and source control are maintained pending final remedial action at the site. The FFA requires that leaking LLLW tank systems be immediately removed from service. It also requires that LLLW tank systems that do not meet the design and performance requirements established for secondary containment and leak detection be either upgraded or replaced.

The FFA establishes a procedural framework for implementing the environmental laws. For the LLLW tank systems, this framework requires that specified plans and schedules be submitted to EPA and TDEC for approval within 60 days, or in some cases, within 90 days, of the effective date of the agreement. For the active LLLW tank systems, the following deliverables are required:

- A schedule for submitting the results of secondary containment design demonstrations for the existing secondarily contained tank system,

- A plan and schedule for removal from service of tank systems that do not meet the secondary containment and/or leak detection design and performance standards,

- An assessment of risk for tank systems that cannot be immediately removed from service without causing unacceptable risk to worker health and safety or an immediate risk to human health or the environment, and

- A schedule for submitting structural integrity assessments for existing tank systems without secondary containment which remain in active service.

For the LLLW tank systems that are removed from service, inactive, the following deliverables are required:

- A schedule for characterizing the contents of the tank systems, and
- A plan and schedule for characterizing the risk associated with the tank systems.

The FFA plans and schedules required for submittal within 60 or 90 days are contained in this document. Chapter 1 provides general background information that is intended to integrate and reinforce the required plans, schedules, and risk assessment plan that are presented in Chaps 2 through 7. This document describes the strategy for preparing the FFA deliverables. This strategy is organized based on whether the tank systems are in active service, or they have been permanently removed from service. This document addresses the remaining 96 ORNL LLLW tank systems listed in Appendix F of the FFA. Of these 96 tank systems, 42 are currently in active service, and 54 have been removed from service.

The schedules in Chaps 2, 5, and 6 show work commencing in fiscal 1991 on leak testing, preparing secondary containment design demonstrations, and conducting structural integrity assessments for the active tank systems. Submittal of the results of these activities for regulatory approval is scheduled to begin in FY 1993. The schedules assume approval of requested funding levels. If less funding is ultimately approved for FY 1993, these plans and schedules must be revised.

Of the 42 LLLW tank systems in active service, five singly contained systems have been designated by DOE as environmental, safety, and health tank systems. Removing these tank systems from service poses an unacceptable risk to health and the environment (refer to Chap 4).

The inactive tank systems will be evaluated for interim actions, emptied and corrected as necessary, monitored, and removed or remediated in accordance with the CERCLA remedial investigation/feasibility study (RI/FS) process. These systems will be prioritized for evaluation using the risk characterization plan described in Chap 7. Waste characterizations will be submitted as an FFA deliverable in accordance with the schedules in Chap 7. Risk characterizations will also be submitted and updated as FFA deliverables as shown in the Chap 7 schedules. Additional data regarding structural integrity, level trend analysis, soil, etc will be prepared and submitted to EPA/TDEC as required by the RI/FS process. The plan for emptying and remediating the inactive tanks in illustrated in Fig. 1.7.

1. BACKGROUND MATERIAL AND STRATEGY

1.1 INTRODUCTION

The Superfund Amendments and Reauthorization Act (SARA) of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) requires a Federal Facility Agreement (FFA) for federal facilities placed on the National Priorities List (NPL). The Oak Ridge Reservation was placed on the NPL on December 21, 1989, and the agreement was signed in November, 1991, by the Department of Energy Field Office, Oak Ridge (DOE-OR), the Environmental Protection Agency (EPA)-Region IV, and the Tennessee Department of Environment and Conservation (TDEC). The effective date of the FFA is January 1, 1992. Sect. IX and Appendix F of the agreement impose design and operating requirements on the Oak Ridge National Laboratory (ORNL) liquid low-level radioactive waste (LLLW) tank systems and identify several plans and schedules that must be submitted to EPA/TDEC for review or approval within 60 to 90 days of the FFA effective date. This ORNL document describes the required plans and schedules. Chapter 1 provides the context for understanding the proposed plans and schedules, including identification of objectives, a description of proposed compliance strategies and potential vulnerabilities, and background information. Chapters 2 through 7 of this report contain the required plans and schedules. This document will be periodically reassessed and refined to reflect newly developed information and progress.

1.2 LLLW SYSTEM BACKGROUND

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 reprocess the reactor fuel for plutonium recovery. Subsequent to World War II, the primary functions of ORNL were fuel reprocessing research; radioisotopes production and applications development; and development, testing, and operation of nuclear reactor concepts. More recently, the laboratory has increased its role in biological, environmental, energy, and materials research. As a consequence of these multidisciplinary research activities, heterogeneous wastes, including solid and liquid radioactive, hazardous, and mixed wastes, have been generated in varying amounts over time.

Since its establishment, ORNL has operated numerous facilities that generate LLLW. LLLW originates from radioactive liquid discarded into sinks and drains in research and development (R&D) laboratories and from facilities such as the Radiochemical Processing Pilot Plant (RPPP, Building 3019), nuclear reactors, radioisotope production facilities, and the Process Waste Treatment Plant (PWTP). DOE Order 5820.2A defines LLW as waste that contains radioactivity and that is not classified as high-level waste, transuranic waste, or spent nuclear fuel or its byproducts. At ORNL, LLW is characterized as having an activity greater than the trace levels permitted in process wastes, provided the activity is less than or equal to 2 Ci/gal of Strontium-90 equivalent and less than 100 nCi/g of alpha-emitting transuranic elements.

The LLLW system is a complex system with multiple facilities, users, and operators. The system is used for collection, neutralization, transfer, and concentration of aqueous radioactive waste solutions from generator facilities, followed by storage of the LLLW concentrate. A block flow diagram is shown in Fig. 1.1. Waste solutions are 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. However, in many instances, LLLW is transferred directly to underground collection tanks or the central waste collection header (CWCH) from laboratory and hot-cell drains through unvalved piping.

A network of below-grade piping interconnects the various system components. Because of their initial low pH, LLLW solutions are neutralized with sodium hydroxide (NaOH) and periodically transferred via the CWCH to the LLLW evaporator service tanks. From there, they are sent to the LLLW evaporator facility where the solutions are concentrated to approximately a 30:1 ratio. The evaporator concentrate is then transferred via pipeline to the Melton Valley Storage Tanks (MVST). Most LLLW collection tanks are equipped with liquid-level instrumentation with high-level alarms to the Waste Operations Control Center (WOCC). The air space over the liquid in the LLLW tanks is typically maintained at less than atmospheric pressure. The tanks are vented to the atmosphere through either a central off-gas collection and filtration system operating at a negative pressure or an individual tank filter system. Negative pressure operation of many of these tanks, which are usually small-volume systems, may serve to reduce leaks to the environment and thereby reduce the risks associated with leaks.

Most of the LLLW system was installed more than 30 years ago. The initial system and its subsequent modifications were designed to minimize radiation exposure to LLLW system users and operators. The system includes features such as unvalved, gravity-drained transfer lines to prevent waste backup into generator areas; shielded lines and tanks; and provisions for remote operations to minimize personnel exposure. As-built drawings for most of the tank systems do not exist. Over the years, tank systems were abandoned as their integrity was breached or as programs were terminated. Some of the tanks were abandoned in place with liquid wastes and sludge left in them. As new tank systems were installed over the past 10 to 15 years, some secondary containment features and improved leak detection were provided. The active LLLW system is a mix of single and double contained tank systems. The inactive portion of the LLLW system consists almost exclusively of tanks without secondary containment. Approximately 95–98% of the curie content of the active LLLW system is located in the newer, doubly contained systems. To begin essential planning and implementation of FFA compliance activities, a set of working definitions was developed. The glossary contains a set of definitions for the ORNL LLLW system used in interpreting FFA requirements.

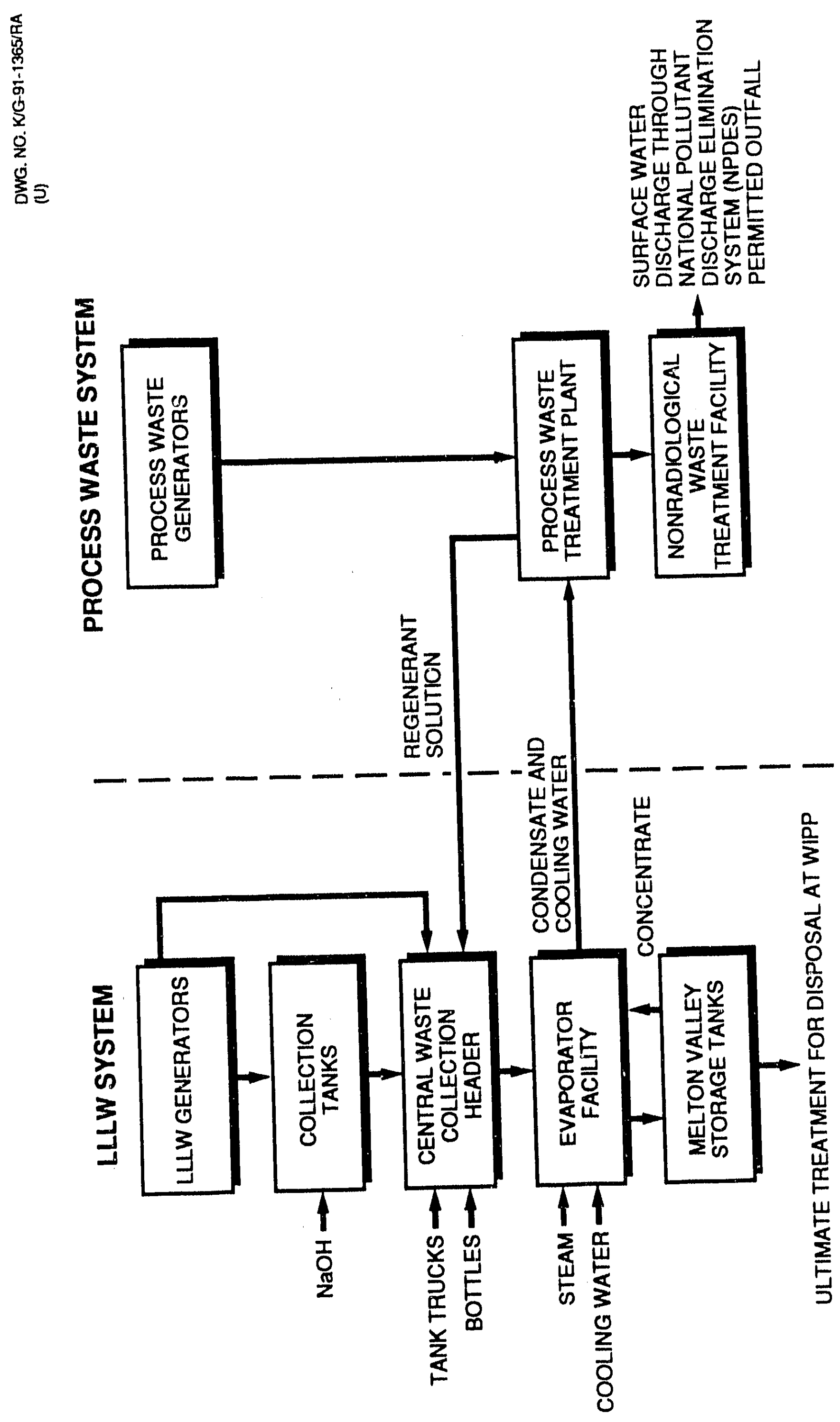

Fig. 1.1. Block flow diagram for the ORNL LLLW system.

1.3 OBJECTIVES

The purpose of this document is to describe the methods by which the objectives of the FFA will be achieved and to provide a vehicle for submittal and coordination of FFA plans and schedules with EPA/TDEC. The FFA establishes four categories of tank systems as follows.

- Category A: new or replacement tank systems with secondary containment,
- Category B: existing tank systems with secondary containment (secondarily contained),
- Category C: existing tank systems without secondary containment (singly contained), and
- Category D: existing tank systems without secondary containment that are removed from service (inactive).

A list of the ORNL LLLW tank systems is included in FFA Appendix F, Table 1. The following variations appear in the tank list shown in Fig. 1.2 of this document. Tanks 4501-C and 4501-D have been remediated, and they have been removed from the tank list. Tanks F-201, F-501, and LA-104 have been changed from Category C to Category B due to a clarification of the FFA requirements for secondary containment. In addition, DOE has determined that tank W-12 may be repairable. Thus, a proposal will be submitted to change its category from D to C to allow it to be repaired and returned to service after approval by the regulators. Fig. 1.2 provides a breakdown of the LLLW tank systems by FFA category as proposed. After incorporating the described revisions into the FFA tank list, there are 96 LLLW tank systems—30 active doubly contained (either partially or completely) tank systems, 12 singly contained active tank systems, and 54 inactive tanks.

The objectives of the FFA are to ensure that (1) all active tank systems slated to remain in service over the long term comply with the design and containment requirements specified in Appendix F, Subsects. B and C of the FFA, (2) all singly contained tank systems operated in the interim do not leak, and (3) all inactive tanks are evaluated to determine the need for interim corrective measures (ICM) prior to final remediation. The FFA requires that plans and schedules for implementing these objectives be submitted for review and approval. This ORNL document provides these plans and schedules. Sect. 1.4 of this document addresses ORNL FFA management interfaces, Sect. 1.5 discusses the overall strategy for meeting the FFA objectives, Sect. 1.6 describes the FFA plans and schedules for the active tank systems, and Sect. 1.7 discusses the inactive tank systems.

1.4 MANAGEMENT, ORGANIZATION, AND AUTHORITY

The DOE and Martin Marietta Energy Systems, Inc., organizational structure for managing ORNL LLLW system FFA activities is shown in Fig. 1.3. One DOE Headquarters organization and two DOE-OR divisions under the Assistant Manager for Environmental Restoration and Waste Management (AMERWM) have primary responsibility for the FFA.

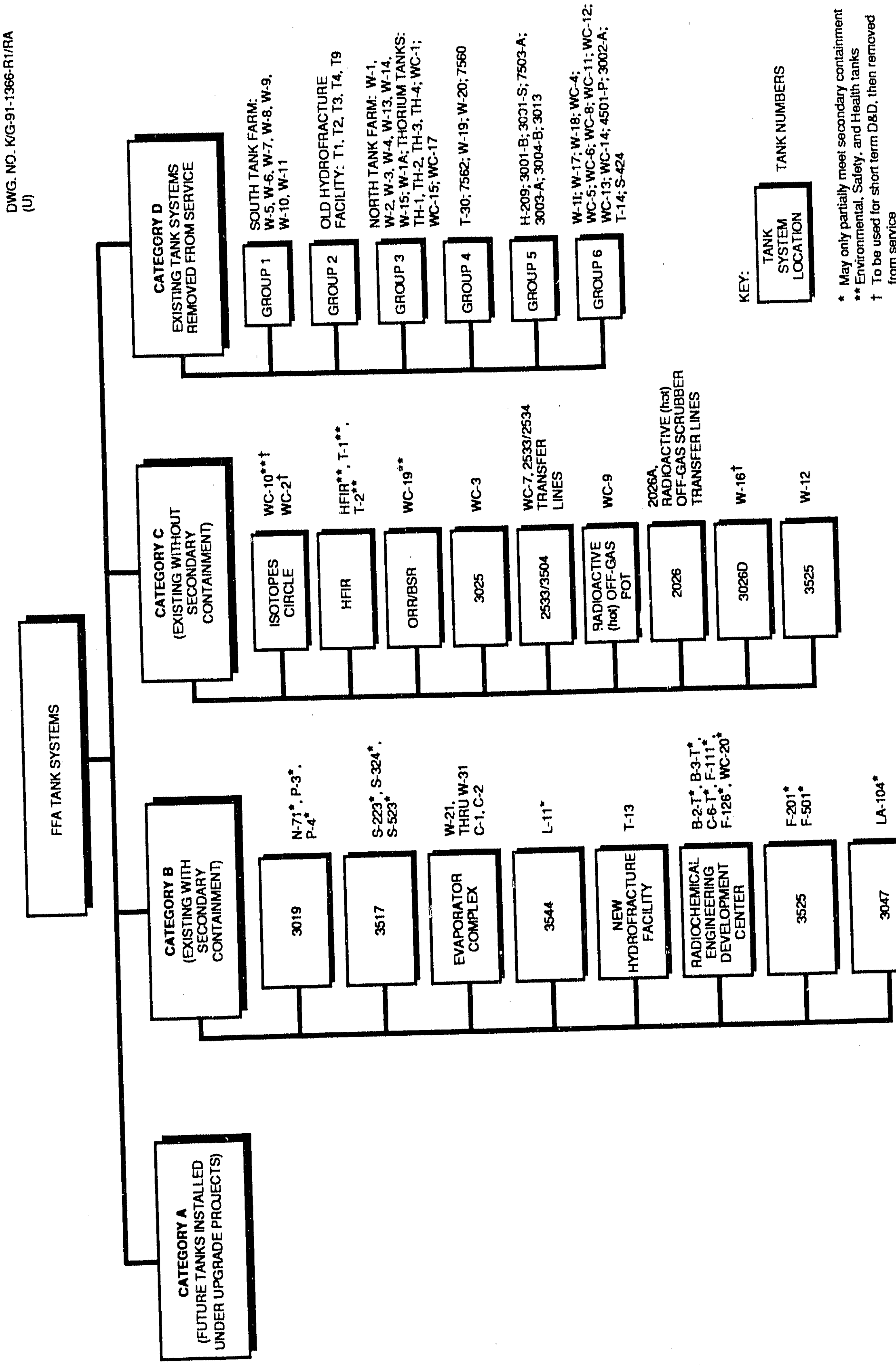

Fig. 1.2. ORNL LLLW tank systems by FFA category.

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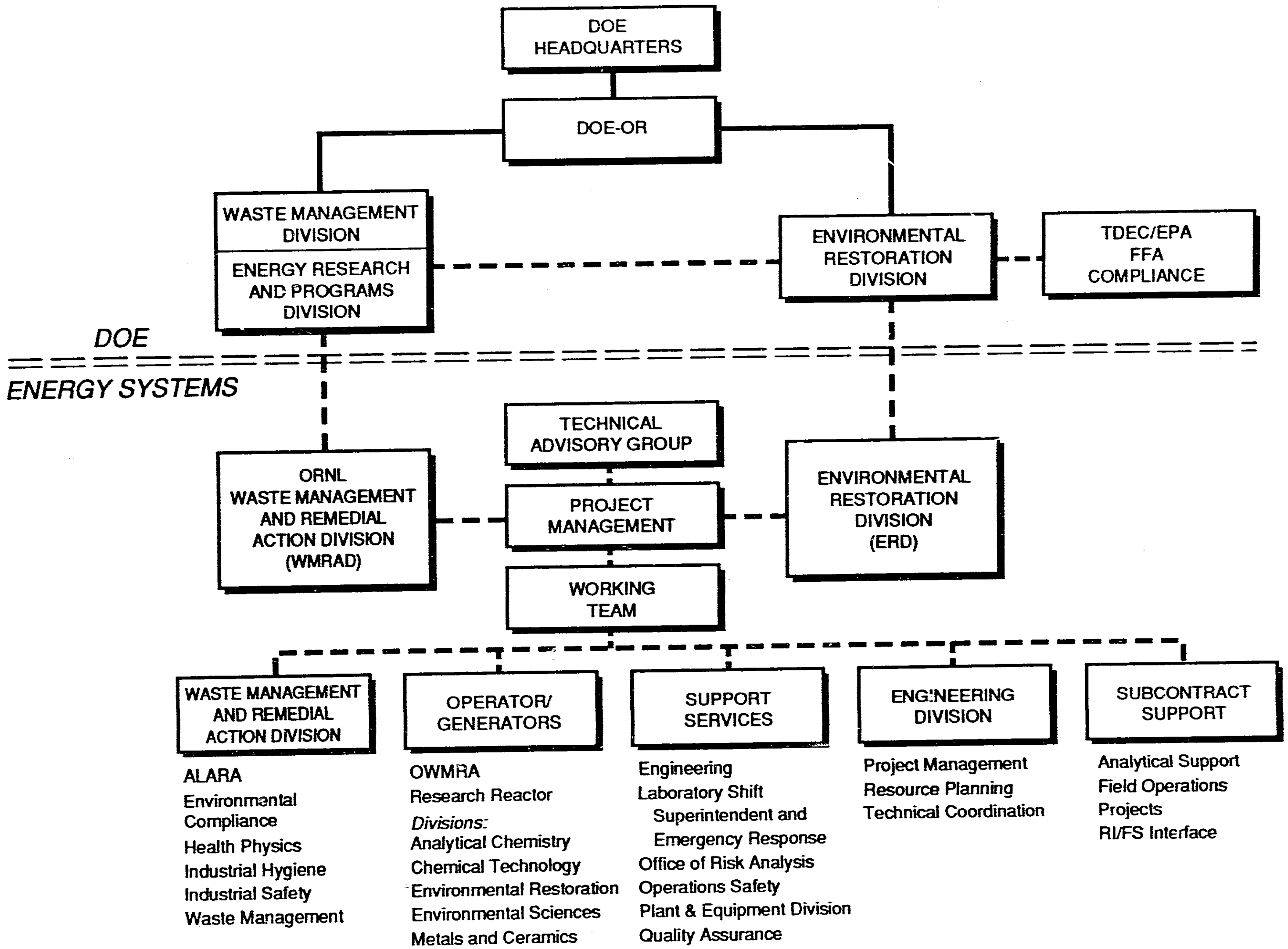

Fig. 1.3. Project organization chart for ORNL LLLW system FFA compliance activities.

Support is provided by the DOE Assistant Manager for Energy Research and Development (AMERD) and other DOE organizations. Two corresponding Energy Systems organizations have primary responsibility for FFA planning and implementation: the Energy Systems ER Division and the ORNL Waste Management and Remedial Action Division (WMRAD). Energy Systems Project Engineering provides project management support and prepares coordinated ORNL responses to FFA issues. Other Energy Systems organizations that provide support are discussed in the following subsections.

1.4.1 Department of Energy

1.4.1.1 Assistant Manager for Environmental Restoration and Waste Management (AMERWM)

The office of the AMERWM is responsible for implementation of the ER Program, including the FFA. Implementation is accomplished through the AMERWM's two divisions, the DOE-OR Environmental Restoration Division and the DOE-OR Waste Management Division.

DOE-OR Environmental Restoration (ER) Division. Coordination of DOE FFA activities for ORNL is provided by DOE-OR ER Division. This division has overall responsibility and authority for ER Program planning and execution. In addition, DOE-OR ER Division is primarily responsible for negotiating changes to the FFA with EPA/TDEC. DOE-OR ER Division responsibilities are discussed in detail in DOE-OR 931.[1]

DOE-OR Waste Management (WM) Division. The DOE-OR WM Division is responsible for overall DOE management of the active LLLW system at ORNL. DOE-OR WM Division interfaces with Energy Systems WMRAD through the Energy Systems Central Waste Management Division (CWMD).

1.4.1.2 Assistant Manager for Energy Research and Development (AMERD)

The AMERD is responsible for managing active LLLW piping within production and R&D facilities to the point of delivery to the first valve outside the facility (or 5 ft past the facility exterior wall if there is no valve in the line). The AMERD identifies plans for removing active tank systems from service and transferring them to the AMERWM. The AMERD is responsible for eliminating flow to waste systems that are determined to be leaking and for ensuring that waste acceptance criteria are met for waste generated in their facilities. The AMERD is also responsible for ensuring compliance with environmental, safety, and health requirements.

1.4.1.3 Assistant Manager for Construction and Engineering (AMCE)

The AMCE is responsible for managing and directing the contracts for the Remedial Design Architect-Engineer and the Construction Manager.

1.4.2 Energy Systems

The Energy Systems organizations primarily responsible for ORNL FFA activities are the ORNL WMRAD and the Energy Systems ER Division. Other Energy Systems organizations also play significant roles in FFA-related LLLW activities, including Engineering, ES&H, the operating divisions, and CWMD. Program coordination is provided by a Working Team (WT) composed of representatives from the involved organizations, and general oversight and consultation are provided by an independent Technical Advisory Group (TAG). The following paragraphs describe the FFA LLLW responsibilities and authorities of these organizations.

1.4.2.1 ORNL Waste Management and Remedial Action Division (WMRAD)

In general, the ORNL WMRAD is responsible for routine waste management operations. This includes program management for upgrading the active ORNL LLLW to meet FFA requirements.

1.4.2.2 Energy Systems Environmental Restoration Division

The Energy Systems Environmental Restoration Division is responsible for managing and remediating the ORNL Category D tank systems that have been accepted into the Environmental Restoration Program. This includes conducting the investigations required by the FFA and taking interim and final remedial actions as needed for the LLLW systems that have been transferred to the Environmental Restoration Program.

1.4.2.3 Energy Systems Engineering

Energy Systems Engineering is responsible for establishing and managing projects as necessary to support FFA activities and for the coordination and preparation of ORNL FFA deliverable documents.

1.4.2.4 Environmental Safety and Health (ES&H)

ES&H organizations such as Industrial Safety, Health Physics, and Industrial Hygiene provide support as necessary to FFA activities to ensure compliance with applicable health and safety regulations.

1.4.2.5 ORNL LLLW Generators

The operating divisions such as Chemical Technology, the High Flux Isotopes Reactor (HFIR), and the Radiochemical Engineering Development Center (REDC) are the organizations that generate LLLW at ORNL. These organizations are responsible for compliance with the requirements and procedures established to meet FFA requirements.

1.4.2.6 FFA Working Team

The ORNL FFA Working Team is a core group of technical representatives from the involved organizations, including ORNL WMRAD, Energy Systems Environmental Restoration Division, Engineering, and Chemical Technology. The Team meets regularly to provide coordination for the planning and implementation of FFA compliance activities. The Team provides a mechanism for integrated responses to FFA issues.

1.4.2.7 Technical Advisory Group (TAG)

The TAG is a group of experts who are nationally recognized in technical fields that relate to FFA activities. Table 1.2 lists the TAG members and summarizes their qualifications. The TAG was established by Energy Systems to provide independent technical and managerial oversight and consultation to ensure that the ORNL FFA program meets the FFA requirements and that it protects health, safety, and the environment. The TAG's scope includes oversight of the total ORNL FFA program and review of the technical approach and plans for technical adequacy and safety. The TAG operates as an independent group that meets approximately once per quarter. The TAG issues formal reports after each meeting to document its findings and recommendations.

1.5 STRATEGY FOR MEETING THE FFA OBJECTIVES

1.5.1 Integrated LLLW System Strategy

This section provides an overview of the plans for meeting the objectives of the FFA. Fig. 1.4 illustrates the overall process for achieving compliance with FFA requirements. Due to the division of organizational responsibilities and funding sources, FFA compliance planning and implementation at ORNL is organized on the basis of active tank systems (those capable of receiving wastes from program activities), and inactive tank systems (those permanently removed from service). The FFA Working Team described in Sect. 1.4.2.6 functions as the coordinating body to integrate FFA activities in the active and inactive parts of the LLLW system.

1.5.1.1 LLLW active tank systems

Fig. 1.5 illustrates the strategy for meeting FFA objectives for the Category B and C (active) LLLW tank systems. This strategy incorporates several decision nodes. At the first node, the need for the tank system is determined. Eight tank systems were inactivated prior to the effective date of the FFA because no further programmatic use was identified for them. Removal from service plans have been prepared for the singly contained tank systems that remain in service.

Table 1.1. Technical advisory group (TAG) members and experience

Name	Education	Years Experience	Experience	Organization
Dr. John Auxier	Ph.D. Nuclear Engineering	37	Nationally recognized health physicist Member of several advisory committees Certified Health Physicist	International Technology Corporation
Mr. Percy Brewington	B.S. Civil Engineering	36	Project management Strategic Petroleum Reserve Gas Centrifuge Enrichment Project	Consultant
Dr. Jerry Fussell	Ph.D. Nuclear Engineering	26	Adjunct Professor at The University of Tennessee Reliability engineering Probabilistic risk assessment Safety analysis and engineering statistics	JBF Associates
Mr. Milton Levenson	B.S. of Chemical Engineering M.B.A.	43	National Academy of Engineering Member of several advisory committees Argonne National Laboratory Associate Laboratory Director, H. E. Wilson AlChe Award	Consultant
Dr. Frank Parker	Ph.D.	33	National Academy of Engineering IAEA - Radioactive waste disposal waste risk analysis	Vanderbilt University
Dr. Norman Rasmussen	Ph.D. Nuclear Engineering	40	MIT McAfee Professor National Academy of Engineering and Science Technical risk assessment, risk assessment	Massachusetts Institute of Technology
Mr. Lombard Squires	B.S. Chemistry	50	National Academy of Engineering Member of several advisory committees Technical Director for DuPont, Atomic Energy Division	Consultant
Mr. Bill Thomas	M.S. Environmental Health	14	Director of Corporate Health and Safety Health Physics Program for Decommissioning Transuranic Facilities Health and Safety	John Mathes and Associates
Dr. Ken Wilcox	Ph.D. Chemistry	25	Leak Detection Equipment and Testing Regulatory Compliance (Underground Storage Tanks) Quality Assurance	Consultant

At the second decision node, systems suspected of leaking were inactivated before the effective date of the FFA. Exceptions are the ES&H tank systems that cannot be shut down immediately. At that point a decision was made as to whether tank systems suspected of leaking would be repaired or removed from service. Nine tank systems were inactivated because of their potential for leakage.

Risk assessments have shown that three sets of singly contained active tank systems cannot be shut down without creating unacceptable risks to worker health and safety. However, continued operation of these tank systems will pose no immediate risk to human health or the environment. In accordance with the provisions of the FFA, these tank systems are identified and have been designated as ES&H systems that will remain in service:

1. WC-19;
2. WC-10; and
3. HFIR tank systems: HFIR, T-1, and T-2.

Risk assessments that form the basis for maintaining the ES&H tank systems in service have been prepared as required by FFA Sect. IX.E.1 and are included in Chapter 4 of this document. The assessments take into account the consequences of possible leaks from these tank systems.

From currently available information, tank system WC-19 is known to collect inleakage, system WC-10 may be leaking, and the HFIR tank systems are not leaking at the present time. The ES&H assessment for the HFIR systems was conducted to cover the eventuality of a future leak should one occur in the interim period before planned upgrade and replacement projects are completed.

At the final decision node, secondarily contained versus singly contained, plans for secondary containment demonstrations are prepared in compliance with FFA Appendix F, Subsect. C, requirements. Singly contained tank systems are identified and slated for (1) assessment of integrity and leak tightness to remain temporarily in operation, or (2) upgrade or replacement. Three of the active tank systems with single containment (WC-10, W-16 and WC-2) and four doubly contained tank systems (S-223, S-324, S-523, and LA-104) will be used for decontamination activities from FY 1991 through FY 1994. If no future uses are identified, these systems will be removed from service within the next 3 to 5 years.

1.5.1.2 LLLW inactive tank systems (Category D)

The inactive tank systems covered by the FFA are listed in Fig. 1.2. The FFA remediation process for these tanks is indicated by the cross-hatched blocks in Fig. 1.4. Each inactive tank system will be evaluated to determine whether it requires interim corrective measures or whether it can await remediation as part of the normal CERCLA process for the operable unit. Chapter 7 describes the plans and schedules for meeting the FFA objectives for the Category D tank systems.

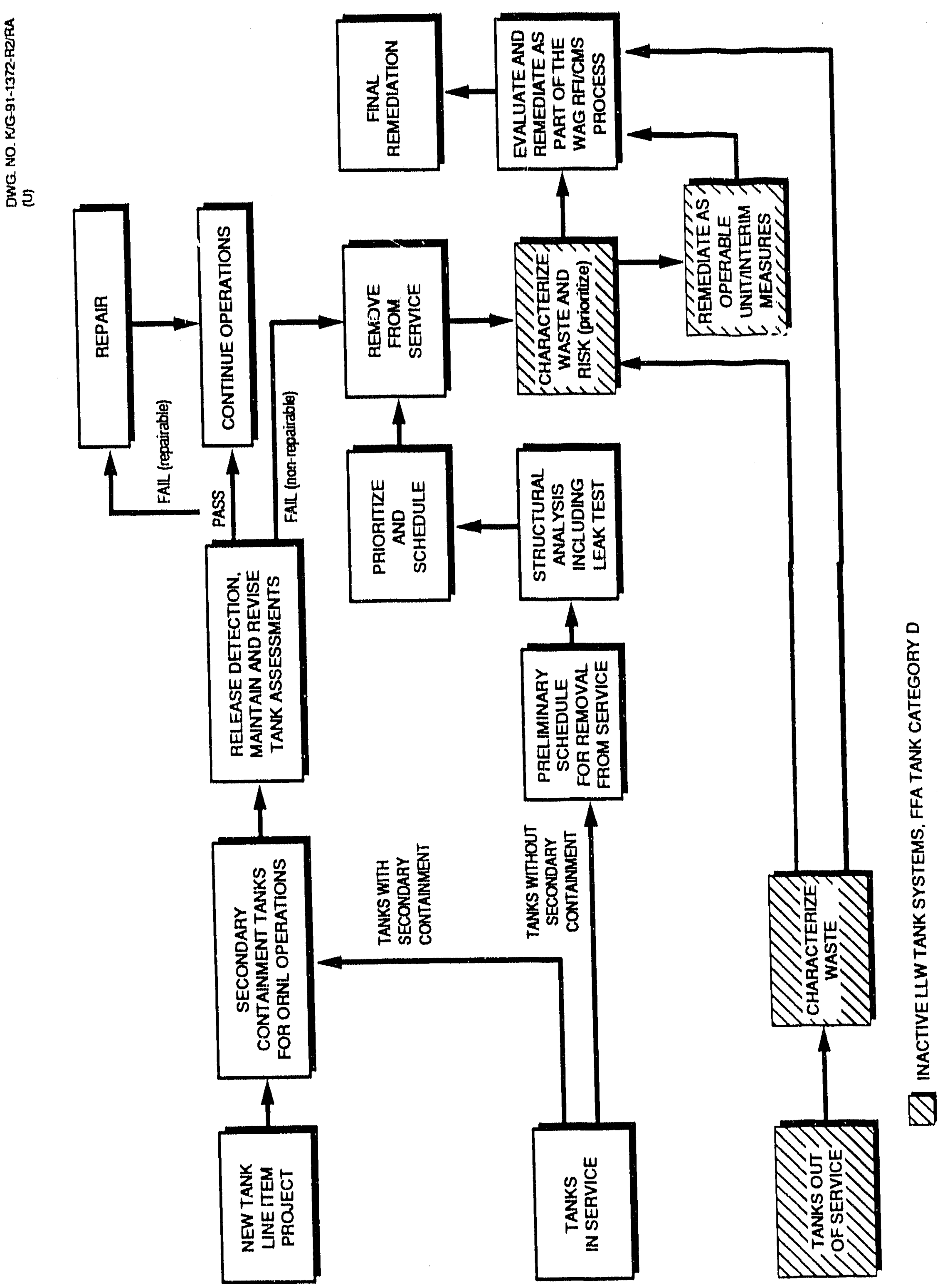

Fig. 1.4. FFA compliance process.

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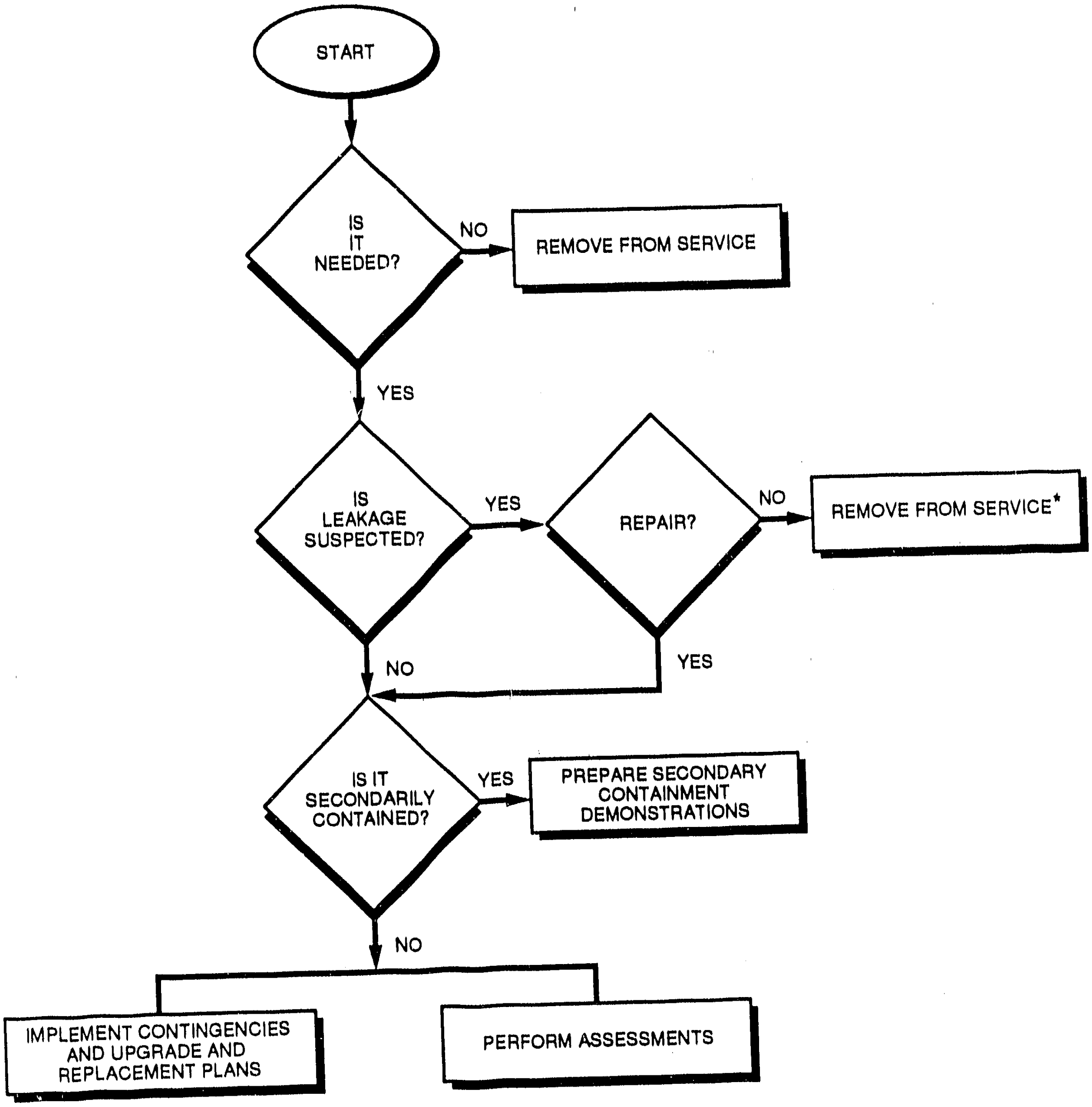


* Unless environmental, safety, and health risks of premature removal from service are excessive, or tank is repaired and returned to service.

Fig. 1.5. Categories B and C tank systems compliance strategy.

1.5.2 Uncertainties, Vulnerabilities, and Assumptions

The plans and schedules contained in Chaps 2 through 7 of this document are based on assumptions related to budget and cost. They are also based on interpretations of certain requirements in the FFA including the definitions presented in the glossary. Realistic technical and fiscal constraints based on requested funding levels have been applied to the FFA compliance strategies. Near-term fiscal resources (FY 1992) are provided at a level commensurate with current technical understanding as well as the ability to effectively implement planned objectives. Near-term technical emphasis is placed on leak testing and interim upgrade/replacement for the active LLLW system and evaluations of tank integrity for the inactive system. Assumptions regarding (1) leak testing, structural integrity assessment, upgrade, and replacement for the active system and (2) evaluation, implementation of interim corrective measures, maintenance and surveillance, and final remediation for the inactive tanks will be refined continuously as additional information becomes available. Annual updates of program milestones will be required. The review and approval cycles of subcontractors, Energy Systems, DOE, EPA, and TDEC complicate the scheduling process and may affect updates to milestones and schedules.

Securing capital funding for tank system upgrades and replacements requires documentation, preliminary studies, requests, budget reviews, authorizations, and approvals. The time period from the initial request for funds to completion of construction can require up to 10 years for projects in the active LLLW system, depending on the size and complexity of the project. Several major line item projects (LIPs) as well as numerous general plant projects (GPPs) have been defined to provide required active system upgrade and replacement. Because of the established process for initiation of LIPs, FY 1994 is the earliest a new LIP can be initiated. Approval of funding for remediation of inactive tanks through the CERCLA remedial investigation/feasibility study (RI/FS) process is not expected to require as long a time frame as approval of line item capital projects.

Technical uncertainties related to leak-testing, particularly for piping, may require the development and demonstration of some leak-testing technologies to prove their effectiveness. The ORNL LLLW system is largely made up of tank systems that operate at a negative pressure and cannot be isolated from either the inlet drains or, in some cases, from the interconnecting transfer piping. Given this situation, several technical challenges must be overcome before effective leak testing methods are developed for some of the components within the ORNL LLLW system. Demonstrations of these methods are incorporated into the detailed leak-testing plan and schedules.

1.6 PLANS AND SCHEDULES BASES FOR LLLW ACTIVE TANK SYSTEMS

1.6.1 Introduction

The FFA imposes requirements on existing tank systems depending upon whether or not they are doubly contained. For systems that are doubly contained, it must be demonstrated that the secondary containment is capable of safely containing waste leaked from the system, and that provisions have been made for the detection of any leaks from the primary containment. In the case of singly contained tank systems, assessments of the structural integrity of the tank must show that the tank is not leaking and that it will not collapse, rupture, or fail prior to its removal from service or re-assessment.

1.6.2 Active tank Systems With Double Containment

The FFA employs secondary containment design demonstrations, as defined in Appendix F, Part C, "Standards for Containment/Leak Detection" to verify the adequacy of the secondary containment. The schedule for conducting these demonstrations is presented in Chapter 2.

The doubly contained tanks shown in Fig. 1.2 are located in the following areas:

- Bldg. 3019, RPPP;
- Bldg. 3517, Fission Products Development Laboratory (FPDL);
- Evaporator Complex, consisting of Radioactive Waste Evaporator Bldg 2531 and MVSTs, Bldg. 7830;
- Bldg. 3525, High-Radiation Level Examination Laboratory (HRLEL);
- Bldg. 3544, PWTP;
- New Hydrofracture Facility (NHF), Bldg. 7860;
- REDC, Bldg. 7920 and Bldg. 7930; and
- Bldg. 3047 (tank LA-104).

Information on the tank systems at these locations is provided in Appendix A, Exhibits A.1-A.6 of this report. These exhibits present a general overview of the tank systems, provide summary tank system data, and assess the degree of secondary containment currently provided.

Tanks at two of the six facilities, the Evaporator Complex and the NHF, are expected to satisfy the secondary containment criteria. The remaining tank systems may only partially meet the secondary containment criteria. The secondary containment design demonstrations will be used to assess the upgrades or replacements required to bring these systems into full compliance.

1.6.3 Tank Systems That Do Not Meet Secondary Containment Criteria

The FFA contains several requirements for tank systems that do not meet secondary containment criteria. FFA Sect. IX.E.1 requires a plan and schedule for upgrade or removal from service. Risk assessments are required by Sect. IX.E.1 for tank systems posing unacceptable ES&H risks if immediately removed from service. Structural integrity assessments are required by Sects. IX.F.1 and 3, Appendix F, Subsect. A; and a leak detection plan and schedule with a schedule for structural integrity assessment review/revision are required by Sect. IX.F.4.

LLLW tank systems that do not meet the FFA secondary containment criteria are identified in Fig. 1.2 and include those at the following locations:

- Isotopes Circle Facilities;
- HFIR, Bldg. 7900;
- Oak Ridge Research Reactor/Bulk Shielding Reactor (ORR/BSR), Bldgs. 3042/3010;
- Bldg. 3025, Irradiated Materials Examination and Testing Facility (IMET);
- Bldgs. 2533/3504, Cell Ventilation Filter Pit for Bldg. 2531/Geosciences Laboratory, Bldg. 3504;
- Radioactive (Hot) Off-Gas Pot Collection;
- Bldg. 2026, High Radiation Level Analytical Laboratory (HRLAL);
- Bldg. 3026D, Segmenting Hot Cells Facility; and
- Bldg. 3525, High-Radiation-Level Examination Laboratory (tank W-12).

Exhibits A.7-A.15 in Appendix A provide data on the tank systems at these locations.

1.6.3.1 Plan and schedule for upgrade or removal of active tank systems from service

Sect. IX.E.1 of the FFA requires a plan for removing from service all LLLW tank systems that cannot meet secondary containment criteria. Tank systems that partially meet the criteria may be either upgraded or removed from service. Fig. 1.6 and Table 1.3 illustrate the current plans for upgrading or removing singly contained tanks. Expense-funded projects, GPPs, and LIPs are being planned and implemented to upgrade or replace these tank systems. Some of these projects may require several years to implement; therefore, interim projects are being implemented in some cases to upgrade the existing tank systems until full compliance can be achieved. Most of these projects will be implemented as expense-funded projects that can be initiated and executed within a shorter time frame and with more flexibility than the GPPs and LIPs. The plan and schedule for projects that upgrade systems to fully meet the FFA requirements or remove a system from service are described in Chapter 3 of this report. Projects for interim actions are described in Tables 1.4, 1.5, and 1.6.

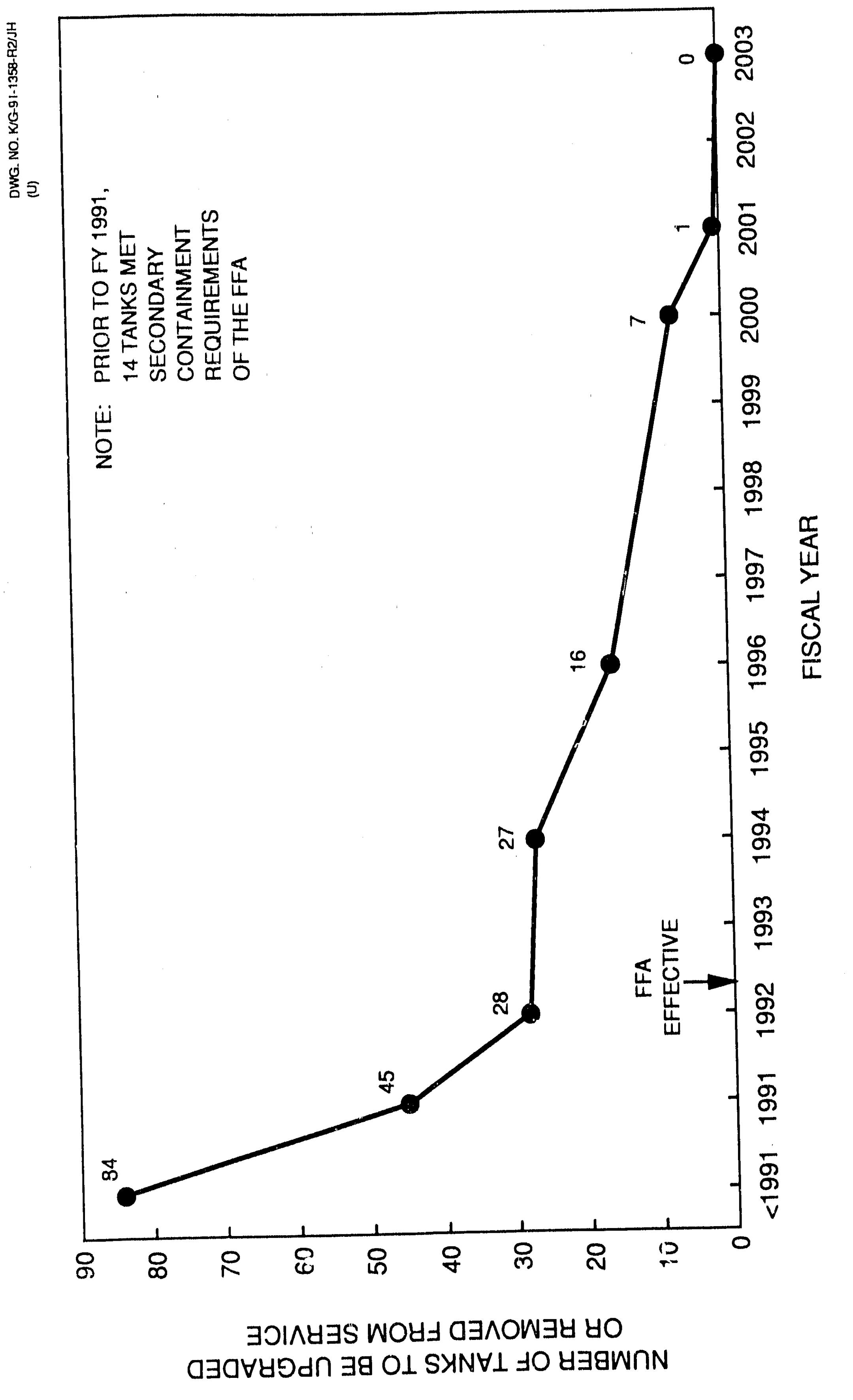
GPPs are capital construction projects that have a total estimated cost less than $1.2 million. This limit is congressionally authorized, and the GPP funding level is established annually for ORNL. Each GPP will be a stand-alone project. A 4- to 5-year project cycle is required to meet program management and project requirements and constraints. Two years are usually required for project definition and planning and another 2 to 3 years for execution. Few LLLW upgrades and replacements can be done for under $1.2 million; most will require LIP funding.

LIPs are large capital construction projects with total estimated costs greater than $1.2 million. Each LIP is identified and authorized as a specific entry in the congressional budget approval process. Because of the complexity and magnitude of these types of projects, LIPs can take up to 10 years to complete; however, the LIP life cycle averages 7 years overall—3 years for project planning and 4 years for execution. The majority of LLLW upgrade and replacement projects fall into this category. Specific projects planned for replacement of LLLW tank systems not meeting secondary containment and leak detection standards are shown in Sect. 3.1.

Because most of the upgrade and replacement projects will not be completed until the late 1990s, ORNL is initiating several interim action projects using GPP and expense funding. Options being considered for interim action include (1) local or area collection and transport of waste to the central LLLW system, (2) actions required to keep the systems in interim service, (3) source treatment, (4) waste reduction at the source, (5) process relocation, and (6) program shutdown.

Table 1.2. Schedule for upgrade or removal from service of Category B and C tank systems

Year	Tank	Total
1993	W-16	1
1995	WC-19, WC-2, WC-10, 2026A, LA-104, S-523,S-324, S-223, P-4,P-3, N-71	11
1999	B-2-T, B-3-T, C-6-T, F-111, F-126, WC-20, HFIR, T-1, T-2	9
2000	F-201, F-501, WC-3, WC-9, W-12, WC-7	6
2002	L-11	1



*The FAA effective date is January 1, 1992

Fig. 1.6. Time history of removal from service of LLW tanks not fully meeting secondary-containment and leak detection standards.

Table 1.3. Expense-funded projects for FFA interim actions for active LLLW systems[a]

Funding Year	Title	Scope	Locations[a] of interim upgraded	Tanks[b] inactivated prior to FFA
1990-92	Temporary Bottling Stations	Installs bottling stations for tanks removed from service in 1991. 1992 Gpps will upgrade stations as necessary for permanent use		WC-11, WC-12, WC-13, WC-14
1990-92	3525 Trucking Station	Installs a temporary trucking station for Tank F-501 to allow repair of Tank W-12 while it is out of service.	3525	W-12
1991-92	Relocation Activities	Relocates activities in buildings utilizing tanks W-17 and W-18, which are removed from service in 1991		W-17, W-18
1990-92	HFIR Source Treatment	Installs source treatment to reduce volume and radioactivity of LLLW	HFIR	
1990-94	REDC Source Treatment	Installs source treatment to reduce volume and radioactivity of LLLW	REDC	
1990	ORR/BSR Contingencies	ORR/BST ion exchange columns regenerated	ORR/BSR	
1990	4501 Source	Install source treatment to reduce radioactivitiy of LLLW to meet bottling requirements	WC-14	

[a]Based on FY 1994 Activity Data Sheets (ADS), requested funding leve.
[b]See Fig. 1.2 for LLLW tank systems associated with a given facility.

Table 1.4. Capital projects for FFA interim actions[a] for singly contained active tank systems.

Funding Year	Completion Year	Title	Scope	Tank[b] locations
1992	1996	Upgrade Process Waste Treatment System	Doubly contained Tank L-11	3544
1992	1994	3000-Area LLW Upgrade	Provides bottling stations for low-volume generators	3000 Complex
1992	1994	4500-Area LLW Upgrade	Provides bottling stations for low-volume generators	4500 Complex
1992	1994	Bldg. 3525 FFA LLLW Upgrade	Installs doubly contained piping to bypass leaking LLLW tank at 3525	3525
1993	1995	FFA Compliance Work, 3025	Provides bottling/trucking stations for 3025	3025
1993	1995	Filter Pit Upgrade	Enclose filter pit at REDC	REDC
1993	1995	3108 Filter Pit Enclosure	Enclose filter pit 3108 that services Building 3019	3019
1994	1996	Piping Additions for FFA	Pipes 4500 area floor sumps to process waste	4500 Complex
1994	1996	Misc. Bethel Valley upgrades	Eliminate non-programmatic waste generation or upgrade appropriate collection/transport system for secondary containment	3000 complex
1994	1996	NHF filter pits	Eliminate non-programmatic waste generation or upgrade appropriate collection/transport system for secondary containment	New Hydrofracture facility
1994	1996	Pretreatment of REDC (7920) LLLW	Eliminate non-programmatic waste generation or upgrade appropriate collection/transport system for secondary containment	REDC
1995	1997	3 GPPs to be defined	Eliminate non-programmatic waste generation or upgrade appropriate collection/transport system for secondary containment	
1996	1998	3 GPPs to be defined	Eliminate non-programmatic waste generation or upgrade appropriate collection/transport system for secondary containment	

[a]Based on FY 1994 Activity Data Sheets (ADS), requested funding levels.
[b]See Fig. 1.2 for LLLW tanks associated with a given facility.

Table 1.5. Projects for retrofitting, upgrading, or replacing active LLLW tank systems that partially meet the FFA requirements for secondary containment and leak detection[a]

Tank grouping	Tank system	Project title	Project scope	Type of funding	Year of Fund. (FY)	Projected completion date (FY)[b]
3019	N-71, P-3, P-4	FFA Compliance Work, Bldg. 3019A	Doubly contained noninspectable piping for 3019	GPP	1992	1994
3544	L-11	ORNL Process Waste Treatment Facility	Provides source treatment to convert LLLW to solid waste	LIP	1995	2001
REDC	B-2-T, B-3-T, C-T-6, F-111, F-126, WC-20	Melton Valley CAT System Upgrade	Replaces or upgrades tank systems for REDC and HFIR	LIP	1992	1998
3525	F-201 F-501	Bethel Valley FFA Upgrades	Replaces tank system	LIP	1994	1999

[a]Based on FY 1994 Activity Data Sheets (ADS), requested funding levels.
[b]Tank systems to be removed from service within one year.

The expense-funded projects and GPPs for implementation of interim actions are listed in Tables 1.4 and 1.5. Tentative plans for upgrades and replacements of systems that are expected to partially meet secondary containment standards are listed in Table 1.5. These projects will be fully scoped after the secondary containment design demonstrations are complete.

An evaluation was made of the active portion of the LLLW system to determine the current status, as well as the future need, of each tank system. This evaluation resulted in removal from service of 17 tank systems and the remediation of two tanks prior to the effective date of the FFA. Activities are progressing to provide interim waste bottling and trucking stations at the source to temporarily replace several of these tank systems. Upgrade projects will be required in the near future to provide permanent replacement of these systems. In addition, projects have been identified to relocate program activities to buildings with LLLW service. These projects are needed to provide continued LLLW service to programs until the associated tank system is replaced.

In preparing the upgrade or removal-from-service plan, it has been assumed that tank system assessments are successfully completed or that repairs can be made to maintain system operations until upgrade or replacement plans can be implemented. If leaks in the tank systems are identified, all programmatic inputs except for ES&H-related activities (see Sect. 1.6.3.2) will be stopped, and the system will be repaired or replaced as soon as possible. The system may continue to collect non-programmatic wastes such as inleakage, inadvertent wastes from floor drains and sumps, and condensate collected in the off-gas ventilation systems during this period.

Studies are currently in place to identify waste collected from non-programmatic sources. The studies will evaluate whether these wastes can be eliminated or diverted to the process waste system or whether the Collection and Transfer (CAT) System will be upgraded to meet secondary containment standards. GPPs for 1993-96 have been planned to address these issues.

1.6.3.2 Risk assessments for ES&H tank systems

Sect. IX.E.1 of the FFA requires risk assessments for tank systems that cannot be shut down without creating unacceptable ES&H risks. Three sets of ES&H tank systems have been identified: WC-19, WC-10, and the HFIR tank systems—HFIR, T-1, and T-2. The risk assessments in Chap 4 demonstrate that, even in the event these tanks leak, the risk to human health and the environment from their immediate removal is unacceptable. From currently available information, tank system WC-19 is known to collect inleakage, system WC-10 may be leaking, and the HFIR tank systems are not leaking at the present time. The ES&H assessment for the HFIR systems was conducted to cover the eventuality of a future leak should one occur in the interim period before planned upgrade and replacement projects are completed.

1.6.3.3 Structural integrity assessment schedules for active LLLW tank systems

Structural integrity assessments (SIAs) that follow FFA Appendix F, Subsect. A requirements must be prepared for tank systems that do not meet FFA secondary containment standards. SIAs are being prepared for the active, singly contained tanks (Category C).

The schedule for submission of system integrity information to EPA/TDEC is presented in Chapter 5 of this document for the active LLLW systems.

1.6.3.4 Leak-testing plan and schedule for active LLLW tank systems

Sect. IX.F.4 of the FFA requires that a schedule for providing the results of leak detection tests, together with a schedule for the periodic review and revision of the structural integrity assessments, be submitted for tank systems that do not meet FFA secondary containment standards. The leak detection plan and schedule are provided in Chapter 6 of this document.

1.7 PLANS AND SCHEDULES BASES FOR INACTIVE LLLW TANK SYSTEMS (CATEGORY D)

1.7.1 Introduction

Fifty-four LLLW tank systems were removed from service, on or before the FFA effective date, because they leaked or they no longer had any programmatic use. Because most of these tank systems contain liquid or a combination of liquid and sludge that is contaminated with radioactive materials or with hazardous and radioactive materials, the FFA requires that they be remediated to reduce the potential risks to health and the environment. Fig. 1.7 illustrates the process for remediating the Category D tank systems. Sect. 1.7.3.7 discusses implementation of the activities in this figure.

1.7.2 Compliance Strategy Summary for Inactive LLLW Tank Systems

The basic plan for remediating the Category D LLLW tank systems at ORNL is to (1) evaluate the tank systems; (2) determine the need for interim action prior to remediation; (3) empty the liquids from the tanks and perform interim corrective actions as appropriate; and (4) monitor the tanks until they are removed or remediated (see Fig. 1.7). The emphasis of this strategy is on the removal of the tank contents so that the risks to health and the environment associated with the tanks are minimized while the tank is awaiting final remediation. If appropriate, remediation of the tank shell, the surrounding soil, and the underlying groundwater may be performed concurrently with remediation of the tank contents. In some cases, tanks are already included in an ongoing RI/FS action.

Tanks will be prioritized for remediation based on risk, as well as location in areas currently involved in CERCLA investigation or remediation processes. Remediation planning for tanks will follow CERCLA guidance.[2] Remedial investigation will build on data that are already available. An alternatives evaluation and feasibility study will be performed for tank systems or tank farms, either individually, or as part of a larger area undergoing remediation. The alternatives evaluation will include development and detailed analysis of remediation alternatives, supported by treatability studies where necessary. Periodic working group meetings will be held with EPA/TDEC to communicate plans for interim measures and the status of remediation planning. Detailed alternatives assessments will be prepared and submitted to EPA/TDEC for review and approval as part of an RI/FS report.

1.7.3 Implementation

Implementation of the ORNL strategy for inactive LLLW tanks began prior to the FFA effective date. A plan has been developed to prioritize the tanks based on risk (see Sect. 7.5). From this plan, six tank groups have been established for administrative purposes during evaluation. Sampling and analysis of tank contents began in 1989, and the results for Groups 1-4 have been reported by Autrey et. al.[3,4] Chapter 7 describes the tank groups and the tests, inspections, and assessments that are planned for the 54 Category D LLLW tanks.

The Category D LLLW tanks were reviewed in 1990 to identify tanks whose contents could be transferred to the active LLLW system in the near term. The objective of this review was to reduce the potential sources of environmental contamination, reduce the number of tanks requiring leak testing and waste characterization, and reduce ER Program costs. The criteria used to select tanks for early action were as follows.

1. Tank contents:
   (a) volume is <10,000 gal,
   (b) radiation level is manageable, and
   (c) tank contains no sludge;
2. Accessibility:
   tank must be accessible for contents transfer;
3. Tank integrity:
   tank should not leak after emptying; and
4. Tank construction:
   steel tanks suitable for extraction from the ground.

Plans have been made to empty nine tanks (T-30, TH-1, TH-2, TH-3, W-13, W-14, W-15, WC-1, and 7562) that meet these criteria. The plans assume that the tank contents can be transferred by tank trucks or pumped by temporary equipment to active LLLW tanks.

1.7.3.1 Waste characterizations

Waste characterization studies were started in 1987 when the contents of 29 inactive LLLW tanks were sampled and analyzed.[3] Three of the first 29 tanks were found to be empty. Three additional tanks were characterized in 1990[4], bringing the total number of tanks characterized or known to be empty by the end of 1990 to 32. These 32 tanks constitute tank Groups 1-4. The exhaustive characterization data that have been obtained for tank Groups 1–4 will be assembled in a data manual and submitted to EPA/TDEC for approval as specified by the FFA. Procedures are being developed to sample and analyze the contents of the seven Group 5 tanks (3013, 3004-B, 3003-A, 3001-B, 3001-S, 7503A, and H-209). Waste characterization data for the Group 5 tanks will be submitted to EPA/TDEC as specified by the FFA. The Group 6 tanks (see Fig. 1.2) will be emptied to the extent possible. Characterization of these wastes will be limited because they will be moved to the active system for processing.

1.7.3.2 Risk characterization plan for the inactive LLLW tanks

The FFA requires that a risk characterization plan that ranks the Category D LLLW tanks in terms of risk be prepared and submitted for EPA/TDEC approval. The ORNL plan, which is contained in Chapter 7 of this document, is based on a methodology developed by V. Chidambariah in 1990 and refined in 1992. It evaluates the tank construction's propensity for leaking, the tank's physical location, and the toxicological characteristics of the tank contents. The tanks are arranged into 6 groups in Fig. 1.2. Groups 1-4 represent tank

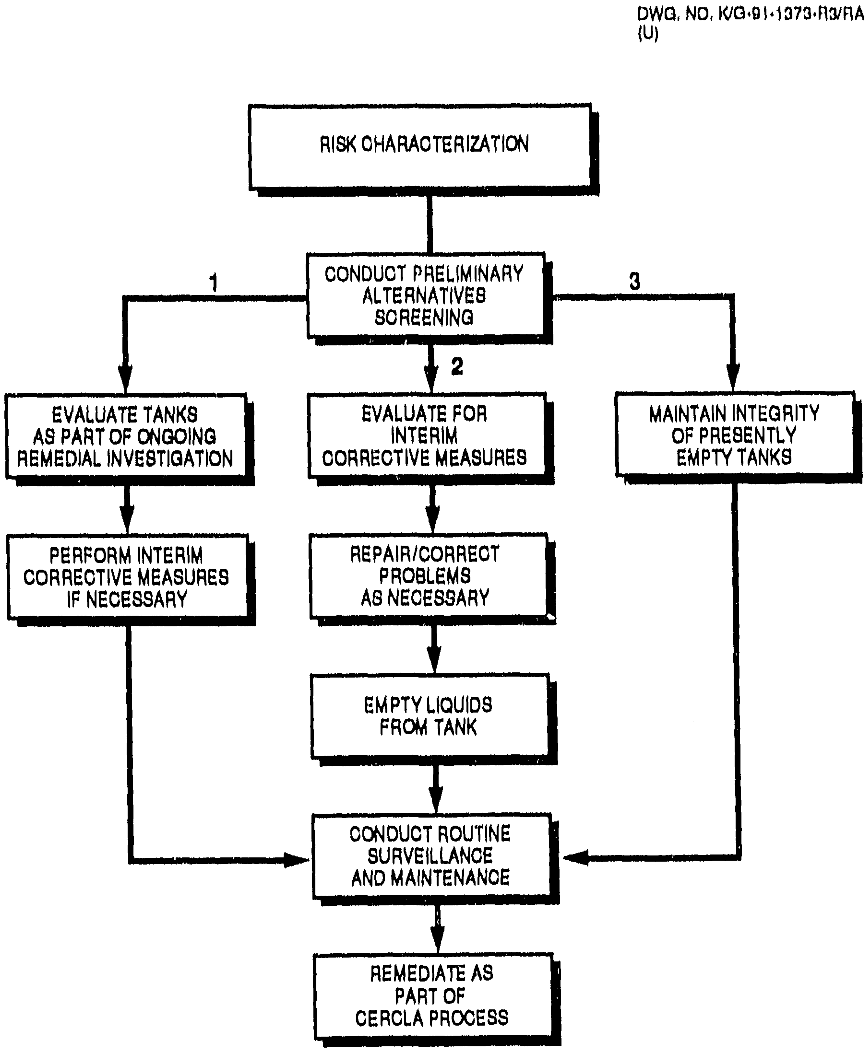


Fig. 1.7. Strategy for remediating Category D LLLW tank systems.

systems whose contents have been sampled and analyzed. A fifth group constitutes those tank systems that have not yet been sampled and are therefore not prioritized. As sampling is completed, these tanks will be factored into the priority groups. A sixth group was defined for tank systems that are no longer in service but have not yet been transferred to the ER Program. As these tanks are evaluated for interim corrections, they will also be prioritized, as appropriate.

1.7.3.3 Alternatives assessment for the inactive LLLW tanks

A preliminary screening has been completed for 30 inactive tank systems. As shown in Fig. 1.7, the path each tank follows through the alternatives process depends on whether the tank is already empty, is undergoing evaluation as part of an active RI/FS, or whether it requires evaluation for interim measures. Three tanks are already empty, and will follow path 3 (W-19, W-20, and 7560). Nine tanks have already been evaluated on path 2, and will be emptied in the near term (T-30, TH-1, TH-2, TH-3, W-13, W-14, W-15, WC-1, and 7562). Eighteen tanks are currently included in active CERCLA RIs or RI/FSs and will follow path 1 (W-1 through W-11, W-1A, TH-4, T-1, T-2, T-3, T-4, and T-9). The remaining 24 tanks will be evaluated through path 2 to determine if interim actions are necessary.

1.7.3.4 Maintenance and surveillance plans

Category D tanks that are empty, tanks that have been stabilized, and tanks that have been remediated on an interim basis pending final disposition will be monitored and maintained to ensure they remain in stable condition.

REFERENCES FOR CHAPTER 1

1. *Management Plan for the Oak Ridge Operations Environmental Restoration Program*, DOE/OR 931, U.S. Department of Energy, Oak Ridge, TN, December 1990.

2. *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA*, EPA/540/G-89/004, Office of Emergency and Remedial Response, U.S. Environmental Protection Agency, Washington, D.C., October 1988.

3. Autrey, J. W., et. al. 1990a. *Sampling and Analysis of the Inactive Waste Tanks TH-2, WC-1, and WC-15*, ORNL/ER-19, Martin Marietta Energy Systems, Inc., Oak Ridge TN, September 1990.

4. Autrey, J. W., et. al. 1990b. *Sampling and Analysis of the Inactive Waste Storage Tank Contents at ORNL*, ORNL/ER-13, Martin Marietta Energy Systems, Inc., Oak Ridge Tennessee, September 1990.

2. SECONDARY CONTAINMENT DESIGN DEMONSTRATION SCHEDULE FOR CATEGORY B TANK SYSTEMS (FFA 1X.C.3)

2.1 FFA DELIVERABLE

This chapter contains the schedule for conducting secondary containment design demonstrations for Category B (existing doubly contained) tank systems as required for submittal to EPA/TDEC for approval (FFA Sect. IX.C.3). The design demonstrations will follow the criteria of FFA Appendix F, Sect. C, "Standards for Containment/Release Detection."

2.2 BACKGROUND

Some Category B tank systems may only partially meet the secondary containment requirements. The design demonstrations will be conducted to identify and document the portions of these systems that meet the Appendix F, Subsect. C, standards. The FFA also requires that the design demonstrations include plans and schedules for any retrofitting necessary to meet the standards for containment and release detection (FFA IX.C.4).

2.3 SCHEDULE

The results of the secondary containment design demonstrations will be issued for regulatory approval as shown in Fig. 2.1. The bases for this schedule are as follows.

- Schedules for leak tests, structural integrity assessments, and upgrade or replacement plans for systems or portions of systems which do not meet secondary containment requirements will be submitted to EPA/TDEC as necessary.

- Schedules for activities beyond FY 1993 are based on preliminary information for both funding requirements and project scopes. Assumptions regarding system integrity, leak testing capabilities, and expectations of systems to pass secondary containment demonstrations will be refined as additional information becomes available. The impact on plans for interim corrective measures, surveillance and maintenance (S&M) upgrade or replacement projects, removal from service schedules, and incorporation into the schedule for Category D tank systems will be evaluated and schedules will be updated accordingly.

- The schedules and plan in this section of this document are submitted for EPA/TDEC approval.

- The schedules presented in this section will be subject to annual renegotiation to adjust for updated information based on duration of activities or for changes in priorities and funding.

- Annual update of program milestones will be required.

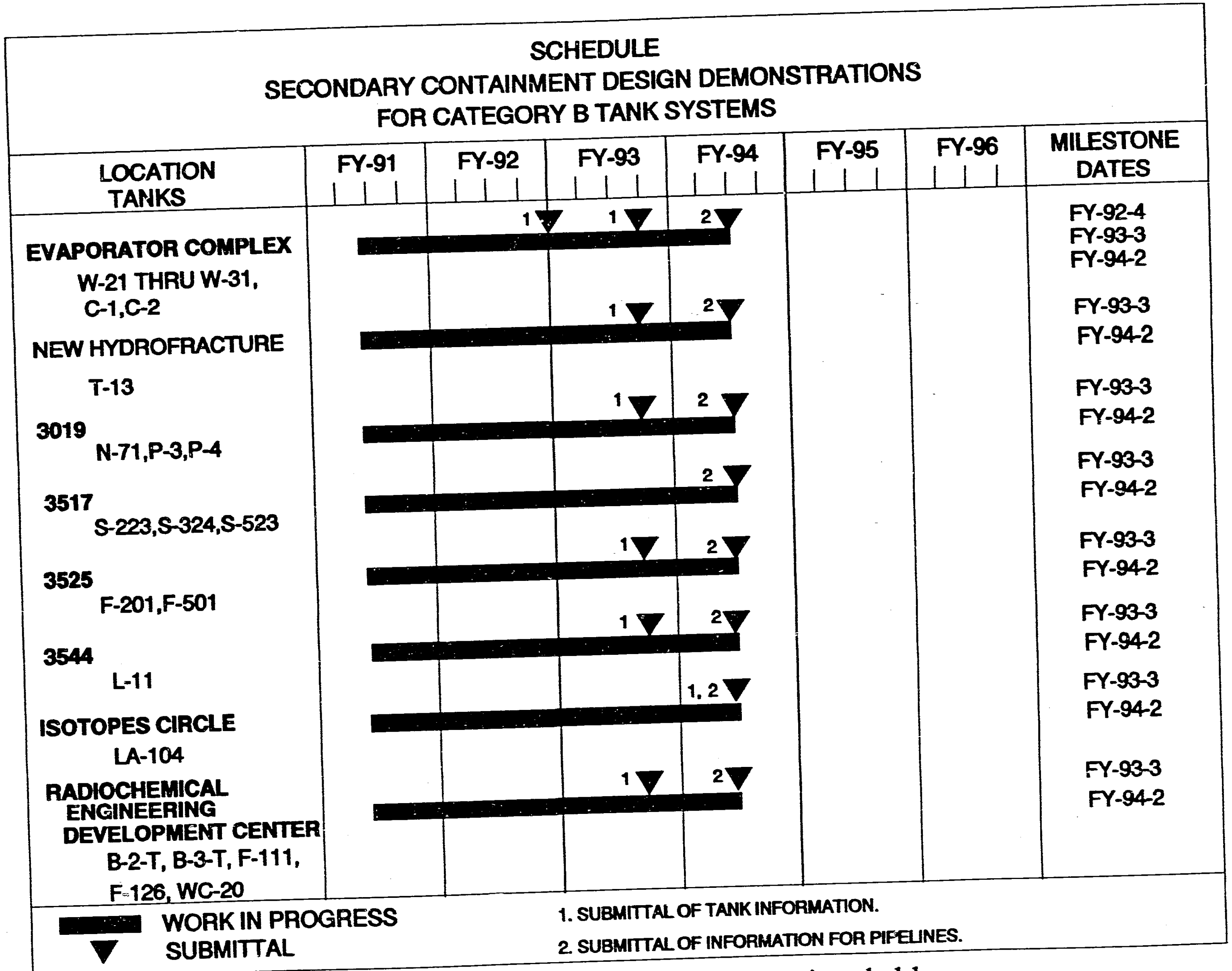


Fig. 2.1. Secondary containment design demonstration schedule.

3. PLAN AND SCHEDULE FOR REMOVAL FROM SERVICE OF TANK SYSTEMS NOT MEETING FFA SECONDARY CONTAINMENT AND LEAK DETECTION STANDARDS (FFA IX.E.1)

3.1 FFA DELIVERABLE

This chapter contains the plan and schedule for the removal-from-service of tank systems that do not meet the secondary containment standards in FFA Appendix F, Subsect. C. This plan and schedule are submitted to EPA/TDEC for approval (FFA Sect. IX.E.1).

3.2 BACKGROUND

In general, singly contained tank systems must be replaced, and systems that partially meet secondary containment requirements must be upgraded or replaced.

The FFA allows tank systems that do not meet secondary containment standards to remain in service until the system can be upgraded or replaced, as long as structural integrity assessments and leak tests indicate that the tanks are unlikely to fail structurally and are not leaking. If leaking tank systems are identified, all programmatic inputs will be stopped, provided complete shutdown of the tank system would not pose unacceptable environmental, health, or safety risks (e.g., reactor cooling-water treatment systems). Such systems will be repaired or replaced as soon as practicable.

3.3 PLANNED LLLW REPLACEMENT/UPGRADE PROJECTS

GPPs and LIPs are being planned and implemented to upgrade or replace the LLLW tank systems that do not meet secondary containment and leak detection standards.

Projects proposed for FY 1993 and beyond are currently in the planning phases. The scopes, cost estimates, and schedules are subject to change as the project details are developed and as yearly budgets are authorized by Congress. Yearly updates to this plan will be required.

Table 3.1 shows the plan and schedule for removal from service of tanks that do not meet secondary containment standards. The bases for this schedule are as follows.

- Schedules for activities beyond FY 1993 are based on preliminary information for both funding requirements and project scopes. The impact on plans for interim corrective measures, maintenance and surveillance, upgrade or replacement projects, removal from service schedules, and incorporation into the schedule for Category D tank systems will be evaluated and schedules will be updated accordingly.

- Tanks which are removed from service that contain liquids, or liquids and sludge, will be emptied to the extent practicable. The remaining waste will be sampled and analyzed as required for remediation. Tanks that have been emptied so that only a very small residual remains will not be characterized.

- Tanks which are removed from service will be physically or administratively isolated so that they no longer receive program-generated wastes. Where practical, other waste inputs will be eliminated prior to, or during, remediation.

- The schedules and plan in this section of this document are submitted for EPA/TDEC approval.

- The schedules presented in this section will be subject to annual renegotiation to adjust for updated information based on duration of activities or for changes in priorities and funding.

- Annual update of program milestones will be required.

Table 3.1. Upgrade or replacement plans for LLLW tank systems not meeting secondary containment and leak detection standards

Tank location	Tank system	Project title	Project scope	Type of funding	Funding year (FY)	Projected[a] completion date (FY)
Isotopes Circle Facilities	WC-10	Isotope facility shutdown	Remove WC-10 from service	Expense	NA[b]	1994
	WC-2	Isotope facility shutdown	Remove WC-2 from service	Expense	NA[b]	1994
HFIR	HFIR T-1 T-2	Melton Valley CAT System Upgrade	Provide source treatment to convert LLLW to a solid and process waste and thus eliminate the need for the tank system	LIP	1992	1998
ORR/BSR	WC-19	BSR LLLW Upgrade	Provide source treatment to convert LLLW to a solid and process waste and thus eliminate the need for the tank system	GPP	1992	1994
	WC-19	ORR LLLW Upgrade	Provide source treatment to convert LLLW to a solid and process waste and thus eliminate the need for the tank system	GPP	1993	1995
3025	WC-3	Bethel Valley FFA Upgrades	Replace WC-3	LIP	1994	1999
2533/3504	WC-7	3000 Area LLLW Upgrade	Provide bottling station and eliminate the need for the tank system	GPP	1992	1994 (tank)
		Bethel Valley FFA Upgrades	Doubly contain LLLW piping for 2533/2534 transfer line	LIP	1994	1999 (piping)
Radioactive (hot) Off Gas	WC-9	Bethel Valley FFA Upgrades	Replaces WC-9 Tank System	LIP	1994	1999
2026	2026A	Bethel Valley CAT System Upgrades	Replaces 2026 tank system and hot off gas scrubber transfer lines	LIP	1988	1994
3026D	WC-16	Isotope Facilities Shutdown	Remove WC-16 from service	Expense	NA[b]	1992
3525	W-12	Bethel Valley FFA Upgrades	Replaces W-12 Tank Systems	LIP	1994	1999

[a]Tank systems to be removed from service within 1 year.
[b]NA implies the data is not available.

4. RISK ASSESSMENT FOR ENVIRONMENTAL, SAFETY, AND HEALTH TANK SYSTEMS (FFA IX.E.1)

4.1 INTRODUCTION

The Federal Facility Agreement (FFA) for the Oak Ridge Reservation, effective January 1, 1992, includes provisions concerning the liquid low-level radioactive waste (LLLW) storage tanks and their associated piping and equipment at ORNL. The provisions are designed to ensure that the structural integrity of the tank systems, containment and detection of releases, and source control are maintained until final remedial action occurs at the site. The FFA requires that leaking (either outleaking or inleaking) LLLW tank systems be immediately removed from service. It also requires that LLLW tank systems that do not meet the design and performance requirements established for secondary containment and leak detection be either upgraded or replaced. However, the FFA contains provisions for the continued use of tank systems that cannot be immediately removed from service without causing unacceptable risk to worker health and safety or an immediate risk to human health or the environment. The continued use of a tank system for this reason constitutes an environmental, safety, and health (ES&H) exemption for that system.

4.2 PURPOSE

It has been determined that three sets of singly contained active LLLW tank systems at ORNL cannot be shut down without creating unacceptable risks to worker health and safety. In accordance with the provisions of the FFA, these have been identified and designated as ES&H tank systems that should remain in service. Risk assessments were performed to provide justification for the continued use of the following ES&H tank systems:

- Oak Ridge Research Reactor (ORR)/Bulk Shielding Reactor (BSR): WC-19 tank system;
- Isotopes Area: WC-10 tank system; and
- High Flux Isotope Reactor (HFIR): HFIR tank systems, including the HFIR, T-1, and T-2 tank systems.

From currently available information, tank system WC-19 is known to collect inleakage, system WC-10 may be leaking, and the HFIR tank systems are not leaking at the present time. The ES&H assessment for the HFIR systems was conducted to cover the eventuality of a future leak should one occur in the interim period before planned upgrade and replacement projects are completed.

4.3 OAK RIDGE RESEARCH REACTOR (ORR)/BULK SHIELDING REACTOR (BSR): WC-19 TANK SYSTEM

The WC-19 tank system is a singly contained collection and transfer (CAT) system utilizing a 2250-gallon stainless steel tank (WC-19). The system collects LLLW from (1) the inactive ORR, (2) the inactive Old Graphite Reactor (3002 filter house and 3001 storage canal), (3) the currently shutdown BSR, and (4) several off-gas and cell ventilation filter pits that serve other facilities. The WC-19 system also collects considerable inleakage of water. The inleakage is transported with the LLLW under negative pressure to an evaporator for treatment. Because the WC-19 tank system is leaking, the FFA requires that the system be removed from active service unless its continued operation is justified on an ES&H basis. Use of the WC-19 system to support remediation of the leaking 3001 storage canal is covered by a regulatory agreement independent of the FFA, and thus this ES&H use is not discussed here.

The most significant wastes, other than LLLW from the 3001 Canal remediation, handled by the WC-19 system are generated from the periodic regeneration of ion-exchange resins used for the demineralization of reactor pool waters at the inactive ORR and the shutdown BSR. These ion-exchange resins prevent the corrosion of the 20-mm thick aluminum jackets that surround the BSR reactor fuel elements and the aluminum reactor pool liner of the ORR by continually removing dissolved materials from the reactor pool waters. Dissolved radioactive materials are removed in the regeneration process, reducing radioactivity in the reactor pool waters while simultaneously producing a buildup in the resins. The regeneration of the resins is necessary to maintain their efficiency; however, the dissolution of ions and radionuclides during the process produces LLLW.

To justify the continued operation of the WC-19 tank system as an ES&H system, three options were evaluated:

- *Option 1*: Upgrade and replacement projects either repair the WC-19 system or remove the need for its operation by installing an alternative CAT method.

- *Option 2*: The ORR/BSR demineralizers are shut down, thereby eliminating the need to discharge the ion-exchange regenerant to the WC-19 system.

- *Option 3*: The leaking or potentially leaking WC-19 system remains in use as the CAT method for the ORR/BSR ion-exchange regenerant.

Each of these alternatives and the assumptions used to estimate the risk associated with each alternative are discussed in Sects. 4.3.1 through 4.3.4.

4.3.1 Upgrade/Replacement Option

This option involves the implementation of upgrade and replacement projects designed to remove the need for the WC-19 tank system. The needed upgrade and replacement projects have been identified and are designated as a general plant project (GPP) entitled "ORR/BSR LLLW Upgrade" (Table 3.1 in Sect. 3.3). The planned upgrades will include one of the following: (1) the diversion of the pool overflows and floor drains to the process waste system, (2) the replacement of the ion-exchange columns with a system that will allow direct disposal of the loaded resins as a solid waste for treatment of the pool water, or (3) the installation of a trucking station to allow transport of the ion-exchange regenerate to the central collection system.

GPPs are capital construction projects that have a total estimated cost of less than $1.2 million. Because GPPs are congressionally authorized annually, a 4- to 5-year project cycle is required to meet program management and project requirements and constraints (Sect. 1.6.2.1). Hence, any upgrade and replacement options for the WC-19 tank system could not be implemented until at least 1995. However, regeneration of the ORR/BSR ion-exchange resins will be needed in approximately 3 years, before the upgrade/replacement projects are implemented as the new CAT method for ORR/BSR LLLW. Because the upgrade/replacement projects will not be completed before the next planned regeneration of the ORR/BSR demineralizers, this option will not be considered further.

4.3.2 Demineralizer Shutdown Option

This option involves the shutdown of the ORR/BSR demineralizers in order to eliminate the need for the WC-19 tank system as the CAT point for the ORR/BSR ion-exchange regenerate. Although this option eliminates the use of the WC-19 tank system for programmatic waste collection and transfer, the failure to regenerate the ion-exchange resins could produce the following consequences:

- The thin aluminum cladding of the fuel elements in the BSR will corrode, leading to potentially serious releases of contained fission products. The released fission products will cause extreme contamination of the pool water at the BSR. Because the contaminated pool water is transferred to a separate building, there is potential risk to any individual entering the building in an area near the pool water transfer lines.

- The aluminum reactor pool liner at the ORR will corrode. The corrosion of the aluminum pool liner at the ORR could result in the leakage of contaminated pool water into the surrounding environment.

- The release of fission products could result in increased exposures to personnel occupying and responsible for monitoring the active but temporarily shut down BSR. Approximately one dozen occupants of the building, as well as routine surveillance personnel, could be at risk from exposure to the released fission products.

- The volume of pool water will be much more highly radioactive after a fission product

- The volume of pool water will be much more highly radioactive after a fission product release. The contaminated pool water will present a greater potential risk to workers involved in its eventual decontamination.

Because shutdown of the BSR/ORR demineralizers produces unacceptable ES&H consequences, this option will not be considered further.

4.3.3 Tank Use Option

The tank system use option assumes that the WC-19 tank system continues to collect LLLW from the required operation of the ORR/BSR demineralizers. Any materials leaking from the tank system could seep into White Oak Creek (WOC) and subsequently flow into White Oak Lake (WOL), the Clinch River (CR), and the Tennessee River (TR). Because the duration of the postulated release and subsequent nuclide residences at any downstream location will be very short (hours or less), the drinking water pathway will dominate human exposures. Aquatic organisms will not be exposed long enough to accumulate significant amounts of radionuclides, and human exposures resulting from swimming, boating, and shoreline activities will be of short duration.

The potential consequences of this option are expressed in terms of committed 50-year excess effective dose equivalents [EDE(50)s or EDEs]. In theory, the health risk associated with receiving an EDE is directly proportional to the magnitude of the EDE (approximately 4×10^{-4} per rem of EDE). However, there is controversy concerning the existence of any health risk resulting from an exposure that produces an EDE of less than 0.1 mrem per year.

The following assumptions were used to estimate potential excess EDEs resulting from the use of the leaking tank system:

- Ten percent of the liquids entering the tank system leak from the system.
- Transit time from leakage to the point of ingestion is 1 week.
- The radionuclides are not removed (e.g., by adsorption, sedimentation, or filtration) during transport from the point of leakage to the drinker (a very conservative assumption).
- The radionuclides mix uniformly with the receiving water body under three flow scenarios: "average" (WOC flow = 0.03×10^9 L/day, CR flow = 11×10^9 L/day), "maximum" (WOC flow = 0.08×10^9 L/day, CR flow = 24×10^9 L/day), and "minimum" (WOC flow = 0.02×10^9 L/day, CR flow = 1.7×10^9 L/day). The TR flow was taken to be its 81-year average at the Chickamauga Dam, 66×10^9 L/day for all three cases.
- The radionuclides are available in drinking water for one day (this assumption is made only for computational convenience; any assumed time span would give similar results because longer availability involves dilution by a proportionately greater volume of river water).

- An estimated 2000 K-25 Plant workers drink CR water, and 400,000 persons drink water from public water systems drawn from the TR from Kingston to Chattanooga.

- Each person drinks 2.0 L of water per day.

The principal contaminants present in the resins and cooling water of the ORR/BSR are ^{60}Co, ^{134}Cs, and ^{137}Cs. Table 4.1 lists the principal radionuclides and their concentrations (activities per unit volume) in the ORR and BSR cooling water, and in the demineralizer column after three years.

The potential individual and collective dose equivalents resulting from the continued use of the WC-19 tank system are presented in Table 4.2. For the ORR demineralizers, continued use of the WC-19 tank system after development of a significant leak could cause a person to receive an EDE of between 3.0×10^{-5} and 5.0×10^{-4} mrem and between 9.0×10^{-6} and 1.0×10^{-5} mrem from drinking Clinch River and Tennessee River water, respectively. The collective EDEs to drinkers of water from both rivers could be between 0.004 and 0.005 person-rem. These EDEs are very low when compared with annual doses resulting from exposure to natural background sources, namely, 300 mrem per year to the average individual and 121,000 person-rem per year to the 402,000 persons who drink water from either river. For the BSR demineralizers, continued use of the WC-19 tank system after development of a significant leak could cause a person who drinks CR water to receive an EDE of between 5.0×10^{-6} and 7.0×10^{-5} mrem and a person who drinks TR water to receive between 1.0×10^{-6} and 2.0×10^{-4} mrem. The collective EDE (50) to drinkers of water from both waters could be between 0.0005 and 0.0008 person-rem. When compared with background doses, these EDEs are also low.

4.3.4 WC-19 Tank System Conclusions

The analysis of the preceding options yielded the following conclusions:

- Upgrade/replacement projects are scheduled but cannot be implemented before the production of LLLW caused by the necessary regeneration of the ORR/BSR demineralizers.

- The ORR/BSR demineralizers must remain in operation in order to prevent the unacceptable consequences resulting from the corrosion of reactor fuel cladding at the BSR or the pool liner at the ORR.

- EDEs to an individual of the general public resulting from the use of the potentially leaking WC-19 tank system are low, on the order of 10^{-4} mrem or lower.

Based on these findings, this risk assessment justifies the continued operation of the WC-19 tank system according to the provisions stated in the FFA.

Table 4.1. Radionuclides and their activities in ORR and BSR water and demineralizer columns

Nuclide	Concentration in water (μCi/L)	Column activity after 3 years (μCi)
ORR		
^{60}Co	5.4×10^{-6}	3.32×10^{3}
^{134}Cs	1.3×10^{-5}	6.07×10^{3}
^{137}Cs	9.5×10^{-5}	6.85×10^{4}
BSR		
^{60}Co	1.3×10^{-5}	8.12×10^{3}
^{137}Cs	1.0×10^{-5}	7.42×10^{3}

Table 4.2. Potential individual (mrem) and collective (person-rem) effective dose equivalents (EDEs) from the tank system use option

	ORR	BSR
Clinch River water drinkers (individual):		
Average	7×10^{-5}	1×10^{-5}
Minimum	3×10^{-5}	5×10^{-6}
Maximum	5×10^{-4}	7×10^{-5}
Clinch River water drinkers (collective):		
Average	1×10^{-4}	2×10^{-5}
Minimum	7×10^{-5}	1×10^{-5}
Maximum	9×10^{-4}	1×10^{-4}
Tennessee River water drinkers (individual):		
Average	1×10^{-5}	2×10^{-5}
Minimum	9×10^{-6}	1×10^{-6}
Maximum	1×10^{-5}	2×10^{-4}
Tennessee River water drinkers (collective):		
Average	4×10^{-3}	6×10^{-4}
Minimum	4×10^{-3}	5×10^{-4}
Maximum	5×10^{-3}	7×10^{-4}

4.4 ISOTOPES AREA: WC-10 TANK SYSTEM

The WC-10 tank farm consists of five tank systems (WC-10 through WC-14) varying in capacity from 1000 to 4600 gallons. All are singly contained, constructed of stainless steel, and share a common underground discharge pipeline to the central waste collection header. These tank systems served the Isotopes Area and the 4500 Area, with the 2300-gallon WC-10 tank being the principal LLLW collection point for radioisotopes facilities.

Although volumetric LLLW transfer data do not indicate that either the tanks or the common discharge line are leaking, this pipeline has failed recent pressure tests. The failure of the discharge line to maintain pressurization is believed to be caused by a vertical, flanged access pipe connected to the line at about its midpoint rather than an actual LLLW leak. However, it has not been possible to inspect the section of pipeline in question to confirm this belief prior to the effective date of the FFA. Thus, (1) all programmatic inputs of LLLW (i.e., LLLW from radioisotopes production and R&D activities) to the WC-10 tank farm from both the Isotopes and the 4500 Area at ORNL have been eliminated by the implementation of interim waste bottling and transportation measures and (2) tanks WC-11 through WC-14 have been inactivated.

The safe shutdown of the Isotopes Area facilities is scheduled for completion by the end of FY 1994 and requires that all major contamination sources be removed. Hence, some Isotopes Area facilities will require decontamination of hot cells, glove boxes, and other contained areas. Limited facility decontamination and other related activities associated with the safe shutdown of the Isotopes Area facilities require access to the WC-10 tank system to handle the LLLW generated during the decontamination process.

To justify the continued operation of the WC-10 tank system as an ES&H system, three options were evaluated:

- *Option 1*: Replacement projects eliminate the need for the WC-10 tank system by installing an alternative CAT method for LLLW produced during decontamination and safe shutdown.
- *Option 2*: Gross decontamination is performed without the use of the WC-10 tank system for disposal of the LLLW generated during the decontamination process.
- *Option 3*: Gross decontamination is performed using the WC-10 tank system as the CAT method for LLLW generated during the decontamination process.

Each of these alternatives and the assumptions used to estimate risk associated with each alternative are discussed in Sects. 4.4.1 through 4.4.4.

4.4.1 Upgrade/Replacement Option

This option involves the implementation of an upgrade or replacement project designed to remove the need for the WC-10 tank system. The most timely option would entail using a GPP for installation of a LLLW trucking station that would serve as an alternative CAT point for wastes generated by the decontamination of the Isotopes facilities.

Because GPP's are capital projects that are congressionally authorized annually, a 4 to 5-year project cycle is required to meet program management and project requirements and constraints (Sect. 1.6.2.1). Hence, the potential replacement project would not be operational prior to the near-term decontamination of the Isotopes Area facilities necessary to achieve safe shutdown. Because the replacement project could not be completed prior to the decontamination process occurring in FY 1991-1994 (the period for which the ES&H exemption is required), this option will not be explored further as a viable alternative.

4.4.2 Decontamination (without WC-10 tank use) Option

This option assumes that the continual gross decontamination of the Isotopes Area facilities necessary to achieve safe shutdown proceeds without the use of the WC-10 tank system. Gross decontamination of the Isotopes Area facilities will require that hot cells, glove boxes, and other contained areas be decontaminated. Decontamination activities would have to be delayed until a trucking station could be installed to serve as an alternative CAT point (Sect. 4.4.1). The LLLW produced during the decontamination of these areas will be contained and transported by truck to the central waste collection header. Table 4.3 lists the Isotopes Area buildings, the principal radionuclides contained in them, and engineering estimates of the volumes of liquid wastes that could be generated by gross decontamination efforts. As before, the consequences of the gross decontamination process without use of the WC-10 tank system are expressed in terms of excess effective dose equivalents (EDEs). Excess EDEs will be incurred by decontamination workers as a result of the extra hours of exposure required to decontaminate the Isotopes Area facilities without the use of the WC-10 tank system as the CAT point for LLLW generated during the process. It should be noted that the decontamination operations will take place over a 3- to 4-year period, and the predicted doses to workers will be received over that time span.

Table 4.4 lists the potential excess individual and collective EDEs from decontamination options. If the WC-10 tank system is not used during the decontamination process, two types of workers could receive excess radiation doses, decontaminators and waste transporters (truckers). Decontamination worker doses are much higher than trucker doses. Decontamination workers could receive several thousand millirems, and truckers could receive as much as 40 mrem. The excess collective EDE to workers could be 33 person-rem for decontamination workers and 9 person-rem for truckers. Individual worker doses can be reduced by assigning several workers to do part of the total job, but collective doses cannot be reduced by such controls.

Because the doses received by workers involved in the implementation of this option are unacceptably high, this option will not be considered further.

4.4.3 Decontamination (with use of the WC-10 tank system) Option

This option involves the continued use of the leaking or potentially leaking WC-10 tank system as the CAT point for the LLLW generated during the decontamination of the Isotopes Area facilities. Table 4.3 lists the Isotopes Area buildings, the principal radionuclides contained in them, and engineering estimates of the volumes of liquid wastes that could be generated by gross decontamination efforts. As before, the consequences of the gross decontamination process are expressed in terms of excess effective dose equivalents (EDEs).

Any materials leaking from the tank system could seep into White Oak Creek and subsequently flow into the White Oak Lake, the Clinch River, and the Tennessee River. For the reasons discussed in Sect. 4.3.3, the drinking water pathway dominates potential exposure to the general public. The following assumptions were used to estimate potential excess EDEs resulting from the use of the leaking tank system:

- Ten percent of liquids entering the tank system leak from the system.
- Transit time from leakage to ingestion is one week. (This assumption is conservative for the location of the tanks and the nuclides of consequence but should have little effect on the dose estimates unless the transit time is very short. Most of the high-activity, short-lived radionuclides decay away in a day or two.)
- The radionuclides are not removed (e.g., by adsorption, sedimentation, or filtration) during transport from the point of leakage to the drinker (a very conservative assumption).
- The radionuclides mix uniformly with the receiving water body under the three flow scenarios described in the WC-19 assessment (Sect. 4.3.3).
- The radionuclides are available in drinking water for one day. (This assumption is made only for computational convenience; any assumed time span would give similar results because longer availability involves dilution by a proportionately greater volume of river water.)
- An estimated 2000 workers at the Oak Ridge K-25 Site drink Clinch River water, and 400,000 persons drink water from public water systems on the Tennessee River.
- Each person drinks 2.0 L of water per day.

The potential individual and collective dose equivalents resulting from the continued use of the leaking or potentially leaking WC-10 tank system as the CAT point for LLLW generated during the decontamination process are listed in Table 4.4. If the leaking system is used, the radionuclides could reach the Clinch and Tennessee Rivers. A person who drinks Clinch River water could receive a total EDE(50) of between 1×10^{-3} and 1×10^{-2} mrem, and a person who drinks Tennessee River water could receive between 2×10^{-4} and 4×10^{-4} mrem. The collective 50-year committed EDE to drinkers of water from both rivers could be between 0.1 and 0.2 person-rem.

Table 4.3. Radionuclide inventories and liquid waste generation estimates for the Isotopes Area facilities

Bldg. 3028	Bldg. 3029	Bldg. 3030	Bldg. 3031	Bldg. 3047
		Nuclides (Ci)		
^{241}Am(1) ^{244}Cm(1) ^{147}Pm(0.1)	^{90}Sr(1) ^{137}Cs(16)	^{90}Sr(1)	^{152}Eu(1) ^{154}Eu(1) ^{60}Co(50) ^{14}C(0.5)	^{152}Eu(250) ^{154}Eu(250)
		Liquids (gal)		
465	560	550	60	10,250

Table 4.4. Potential excess individual (mrem) and collective (person-rem) effective dose equivalents from decontamination options

	Bldg. 3028	Bldg. 3029	Bldg. 3030	Bldg. 3031	Bldg. 3047
Gross decontamination without use of WC-10 tank system (EDE):					
Workers, individual	2×10^3	2×10^3	5.4×10^2	3.2×10^2	6×10^3
Workers, collective	3.8×10^0	6.4×10^0	1.1×10^0	6×10^{-1}	2.1×10^1
Gross decontamination with use of WC-10tank system use (EDE):					
Clinch River water drinkers (individual):					
Minumum	5×10^{-4}	5×10^{-5}	1×10^{-5}	1×10^{-6}	5×10^{-4}
Maximum	6×10^{-3}	7×10^{-4}	2×10^{-4}	2×10^{-5}	6×10^{-3}
Clinch River water drinkers (collective):					
Minimum	1×10^{-3}	1×10^{-4}	2×10^{-5}	3×10^{-6}	9×10^{-4}
Maximum	1×10^{-2}	1×10^{-3}	3×10^{-4}	4×10^{-5}	1×10^{-2}
Tennessee River water drinkers (individual):					
Minimum	1×10^{-4}	1×10^{-5}	3×10^{-6}	4×10^{-7}	1×10^{-4}
Maximum	2×10^{-4}	2×10^{-5}	4×10^{-6}	5×10^{-7}	2×10^{-4}
Tennessee River water drinkers (collective):					
Minimum	5×10^{-2}	5×10^{-3}	1×10^{-3}	1×10^{-4}	5×10^{-2}
Maximum	7×10^{-2}	7×10^{-3}	2×10^{-3}	2×10^{-4}	6×10^{-2}

4.4.4 WC-10 Tank System Conclusions

The analysis of the preceding options yielded the following conclusions:

- Decontamination of the Isotopes Area facilities is necessary to achieve the safe shutdown of the Isotopes Area by the end of FY 1994.
- Upgrade/replacement projects could not be completed prior to the decontamination of the Isotopes Area facilities necessary to achieve safe shutdown.
- Decontamination options that eliminate the use of the WC-10 tank system result in unacceptably high worker doses.
- EDEs to an individual of the general public resulting from the use of the potentially leaking WC-10 tank system are several orders of magnitude below those resulting from exposure to natural background sources.

Based on these findings, this risk assessment justifies the continued operation of the WC-10 tank system as an ES&H tank system according to provisions stated in the FFA.

4.5 HIGH FLUX ISOTOPES REACTOR (HFIR): HFIR, T-1, AND T-2 TANK SYSTEMS

The HFIR tank systems, including the HFIR, T-1, and T-2 systems, collect and transfer LLLW from (1) the active HFIR facility and associated research and development laboratories, (2) the reactor's radioactive off-gas system (Building 7911 stack), and (3) the filter pits serving Buildings 7919 and 7920. The LLLW from these sources is transferred first to the singly contained 13,000-gallon stainless steel HFIR tank. From there the waste is carried via a cast-iron pipeline to either Tank T-1 or Tank T-2, both of which are singly contained 15,000-gallon stainless steel tanks. Waste in Tanks T-1 or T-2 is transferred to the Melton Valley Pumping Station before its transfer to the evaporator (2531).

The principal LLLW-producing activities involve the periodic regeneration of ion-exchange resins in the primary and pool demineralizer systems. The ion-exchange resins prevent the corrosion of the 10-mm-thick aluminum jacket that surrounds the HFIR fuel element. The regeneration of the ion-exchange resins is necessary to maintain their efficiency. However, the radioactive materials that are dissolved during the regeneration process produce LLLW.

As noted in Sect. 4.2, the HFIR tank systems (including the HFIR, T-1, and T-2 tanks) are not leaking at the present time. Thus, the assessment for the HFIR systems was conducted to cover the eventuality of a future leak should one occur in the interim period before planned upgrade and replacement projects are completed. Although the HFIR facility would be shut down as soon as safety procedures permit following the discovery of a major leak in its associated LLLW systems, the regeneration of the system demineralizers is necessary in the shutdown state to keep the pool waters free of corrosion-producing products.

However, the regeneration frequency would be reduced from every 3 months to approximately once a year.

To justify the continued operation of the HFIR tank systems, including the HFIR, T-1, and T-2 tanks, three options were evaluated:

- *Option 1*: Upgrade and replacement projects remove the need for the continued use of the HFIR tank systems by installing an alternative CAT method.
- *Option 2*: The HFIR demineralizers are shut down, thereby eliminating the need to discharge the ion-exchange regenerant to the HFIR tank systems.
- *Option 3*: The HFIR tank systems remain in use as the CAT method for the HFIR LLLW in the event of a future leak.

Each of these alternatives and the assumptions used to estimate risk associated with each alternative are discussed in Sects. 4.5.1 through 4.5.4.

4.5.1 Upgrade/Replacement Option

This option involves the implementation of upgrade and replacement projects designed to eliminate the need for the HFIR tank systems. The planned upgrade is a line item project (LIP) entitled "Melton Valley CAT System Upgrade" (Table 3.1 in Sect. 3.3). The improvements call for the installation of an ion-exchange system in which the loaded resins will be disposed of as solid waste. Upgrades include installing lines to sluice resins out of the ion-exchange columns into shielded containers, installing a dewatering system, and installing a transfer station to prepare the resins for shipment and disposal as solid waste. The stack drainage from Building 7911 and filter pit waste will be diverted to process waste after decontamination and upgrades of the filter system.

LIPs are large capital construction projects with total estimated cost of greater than \$1.2 million. Each LIP is identified and authorized as a specific entry in the congressional budget approval process. Because of the complexity and magnitude of these types of projects, LIPs can take up to 10 years for congressional approval and completion (Sect. 1.6.2.1). However, the LIP life cycle averages 7 years overall. Hence, the HFIR system upgrade and replacement projects, while already in the design process, will not be completed until the late 1990s. The necessity of using the HFIR tank systems as the CAT system for the ion-exchange regenerate produced during the interim period requires the evaluation of available alternatives before the upgrade projects are complete. Because the upgrade and replacement projects will not be completed in the interim period (the period in which the ES&H exemption may be required in the case of a future leak), this option will not be explored further.

4.5.2 Demineralizer Shutdown Option

This option involves the shutdown of the HFIR system demineralizers in order to eliminate the need for the HFIR tank systems as the CAT point for the HFIR ion-exchange regenerate. Although this option eliminates the use of the HFIR tank systems for HFIR LLLW collection and transfer, the failure to regenerate the ion-exchange resins of the demineralizer could produce the following unacceptable consequences:

- The 10-mm-thick aluminum jackets that surround the HFIR fuel will corrode, leading to fuel element rupture. Radioactivity released during fuel element rupture will cause gross contamination of the reactor pool water.

- Fuel element rupture could cause increased radiation exposures to HFIR facility personnel. Radioactivity released during fuel element rupture would be transported to the reactor pool system by a series of pipes within HFIR. Fifty to one hundred HFIR facility employees work in close proximity to the transfer pipelines and could experience increased radiation exposure.

- The volume of pool water will be much more highly radioactive after a fission product release. The contaminated pool water will present a greater potential risk to workers involved in its eventual decontamination.

Because the shutdown of the HFIR demineralizer system produces unacceptable ES&H consequences, this option will not be considered further.

4.5.3 Tank System Use Option

This option assumes continued operation of the HFIR, T-1, and T-2 tank systems in the presence of a significant leak until upgrade/replacement projects are completed. The consequences of a future leak of the HFIR tank systems depend on the time at which the leak occurs. Therefore, to assess the potential impacts of a future leak, four scenarios were considered in evaluating this option: (1) A leak is discovered during reactor operation, at the time of a required demineralizer regeneration; (2) a leak is discovered in the case when regeneration is required 91 days after reactor shutdown; (3) a leak is discovered in the case when regeneration is required 182.5 days after reactor shutdown; and (4) a leak is discovered in the case when regeneration is required 365 days after reactor shutdown.

Table 4.5 presents a list of principal radionuclides and their measured concentrations (activities per unit volume) in the primary cooling water during normal reactor operation, and estimates of their activities in the demineralizer column 91, 182.5, and 365 days after reactor shutdown.

Any materials leaking from the tank system could seep into Melton Branch and subsequently flow into White Oak Creek, White Oak Lake, the Clinch River, and the Tennessee River. For the reasons discussed in Sect. 4.3.3, the drinking water pathway dominates potential exposure to the general public. The following assumptions were used to estimate potential excess EDEs resulting from the use of the leaking tank system:

- Ten percent of liquids entering the tank system leak from the system.

- Transit time from leakage to ingestion is one week. (This assumption is conservative for the location of the tanks and the nuclides of consequence but should have little effect on the dose estimates unless the transit time is very short. Most of the high-activity, short-lived radionuclides decay away in a day or two.)

- The radionuclides are not removed (e.g., by adsorption, sedimentation, or filtration) during transport from the point of leakage to the drinker (a very conservative assumption).

- The radionuclides mix uniformly with the receiving water body under the three flow scenarios described in the WC-19 assessment (Sect. 4.3.3).

- The radionuclides are available in drinking water for one day. (This assumption is made only for computational convenience; any assumed time span would give similar results because longer availability involves dilution by a proportionately greater volume of river water.)

- An estimated 2000 workers at the Oak Ridge K-25 Site drink CR water, and 400,000 persons drink water from public water systems on the TR.

- Each person drinks 2.0 L of water per day.

The consequences of this option are expressed in terms of 50-year committed excess effective dose equivalents [EDE(50)s or EDEs]. As noted earlier, the health risk associated with receiving an EDE is directly proportional to the magnitude of the EDE (approximately 4×10^{-4} per rem of EDE). However, there is controversy concerning the existence of any health risk resulting from an exposure that produces an EDE of less than 0.1 mrem per year.

The potential individual and collective dose equivalents resulting from the continued use of the HFIR, T-1, and T-2 tank system are listed in Table 4.6. The highest EDEs resulting from the use of this option are incurred if a leak occurs in the case where regeneration is necessary 365 days after reactor shutdown. The continued use of the HFIR tank systems after the development of a significant leak could cause a person who drinks CR water to receive an EDE of between 5×10^{-4} and 6×10^{-3} mrem, and a person who drinks Tennessee River water to receive between 1×10^{-4} and 2×10^{-4} mrem. The collective EDE to drinkers of water from both rivers could be between 5×10^{-2} and 8×10^{-2} person-rem. These EDEs are low in comparison to the average individual dose of 300 mrem/yr and the collective dose of 121,000 person-rem per year that results from exposure to natural background sources (Sect. 4.3.3).

4.5.4 HFIR Tank Systems Conclusions

The analysis of the preceding options yielded the following conclusions:

- The scheduled upgrade and replacement projects cannot be implemented prior to the production of LLLW resulting from the necessary regeneration of the HFIR facility demineralizers.
- The HFIR facility demineralizers must remain in operation in order to prevent the unacceptable consequences resulting from the corrosion of the reactor fuel-element jackets.
- The EDEs for an individual of the general public resulting from the use of the HFIR tank systems, should a future leak occur, are low, approximately three orders of magnitude below that of average background exposure.

Based on these findings, this risk assessment justifies the continued operation of the HFIR tank systems, including the HFIR, T-1, and T-2 tanks, in accordance with provisions stated in the FFA.

Table 4.5. Radionuclides and their activities in HFIR primary cooling water and demineralizer columns

Nuclide	Concentration in primary water (μCi/L)	Column activity after 91 days of operation (μCi)	Column activity 91 days after shutdown (μCi)	Column activity 182.5 days after shutdown (μCi)	Column activity 365 days after shutdown (μCi)
^{24}Na	160	98,300,000	974,000	486,000	243,000
^{27}Mg	400	2,580,000	268	134	67
^{38}Cl	1.00	25,400	10	5	3
^{46}Sc	0.00300	131,000	98,800	99,300	74,000
^{52}V	9.00	23,000	1	0	0
^{54}Mn	0.00140	78,600	71,200	118,000	164,000
^{56}Mn	0.170	17,900	31	15	8
^{59}Fe	0.00140	46,500	24,900	19,200	108,000
^{60}Co	0.0240	1,710,000	1,680,000	3,260,000	6,110,000
^{65}Zn	0.00150	82,000	72,200	114,000	145,000
^{95}Zr	0.000270	10,600	6,770	6,380	4,130
^{95}Nb	0.000140	4,030	1,870	1,270	668
^{137}Cs	0.0000510	3,150	3,140	6,270	12,400
^{140}Ba	0.0110	138,000	27,900	14,100	7,050
^{141}Ce	0.00160	43,800	19,300	12,600	6,570
^{51}Cr	0.861	21,000,000	8,270,000	5,010,000	2,560,000
^{103}Ru	0.000810	25,000	12,400	8,930	4,830
^{131}Sb	0.100	1,570	0	0	0
^{133m}Te	0.200	7,550	5	2	1
^{134}Te	0.200	5,730	3	1	1
^{131}I	0.0150	119,000	15,100	7,540	3,770
^{132}I	0.0400	3,770	6	3	1
^{133}I	0.100	85,200	1,170	584	292
^{134}I	0.400	14,400	8	4	2
^{135}I	0.100	27,100	118	59	30
^{187}W	1.10	1,070,000	16,900	8,430	4,210

Table 4.6. Potential individual (mrem) and collective (person-rem) effective dose equivalents from the tank use option

	After 91 d of operation	91 d after shutdown	182.5 d after shutdown	365 d after shutdown
Clinch River water drinkers (individual):				
Average	1×10^{-3}	9×10^{-4}	2×10^{-3}	3×10^{-3}
Minimum	5×10^{-4}	4×10^{-4}	8×10^{-4}	1×10^{-3}
Maximum	6×10^{-3}	6×10^{-3}	1×10^{-2}	2×10^{-2}
Clinch River water drinkers (collective):				
Average	2×10^{-3}	2×10^{-3}	3×10^{-3}	6×10^{-3}
Minimum	9×10^{-4}	8×10^{-4}	2×10^{-3}	3×10^{-3}
Maximum	1×10^{-2}	1×10^{-2}	2×10^{-2}	4×10^{-2}
Tennessee River water drinkers (individual):				
Average	1×10^{-4}	1×10^{-4}	2×10^{-4}	4×10^{-4}
Minimum	1×10^{-4}	1×10^{-4}	2×10^{-4}	4×10^{-4}
Maximum	2×10^{-4}	1×10^{-4}	3×10^{-4}	5×10^{-4}
Tennessee River water drinkers (collective):				
Average	6×10^{-2}	5×10^{-2}	9×10^{-2}	2×10^{-1}
Minimum	5×10^{-2}	4×10^{-2}	8×10^{-2}	2×10^{-1}
Maximum	7×10^{-2}	6×10^{-2}	1×10^{-1}	2×10^{-1}

5. STRUCTURAL INTEGRITY ASSESSMENTS FOR EXISTING TANK SYSTEMS THAT DO NOT MEET FFA SECONDARY CONTAINMENT STANDARDS (FFA IX.F.1)

5.1 FFA DELIVERABLES

This chapter contains the schedule for providing information concerning the structural integrity of tank systems not meeting the secondary containment standards (Category C) which must be submitted to EPA/TDEC for approval (FFA Sect. IX.F.1).

5.2 BACKGROUND

The information to be submitted will be provided as described in FFA Appendix F, Subsect. A., entitled "Standards for Integrity Assessment for Tank System(s)." The SIAs will include tank system design data, generic descriptions of the hazardous or radioactive contents, a description of the system's corrosion protection measures, the age of the tank system, and the results of leak tests on the tank system. Fig. 5.1 shows the proposed schedule for submitting structural integrity assessments for the singly contained tank systems. The bases for this schedule are as follows.

- The schedules and plan in this section will be submitted for EPA/TDEC approval.
- The schedules presented in this section will be subject to annual renegotiation to adjust for updated information based on duration of activities or for changes in priorities and funding.
- Annual update of program milestones will be required.

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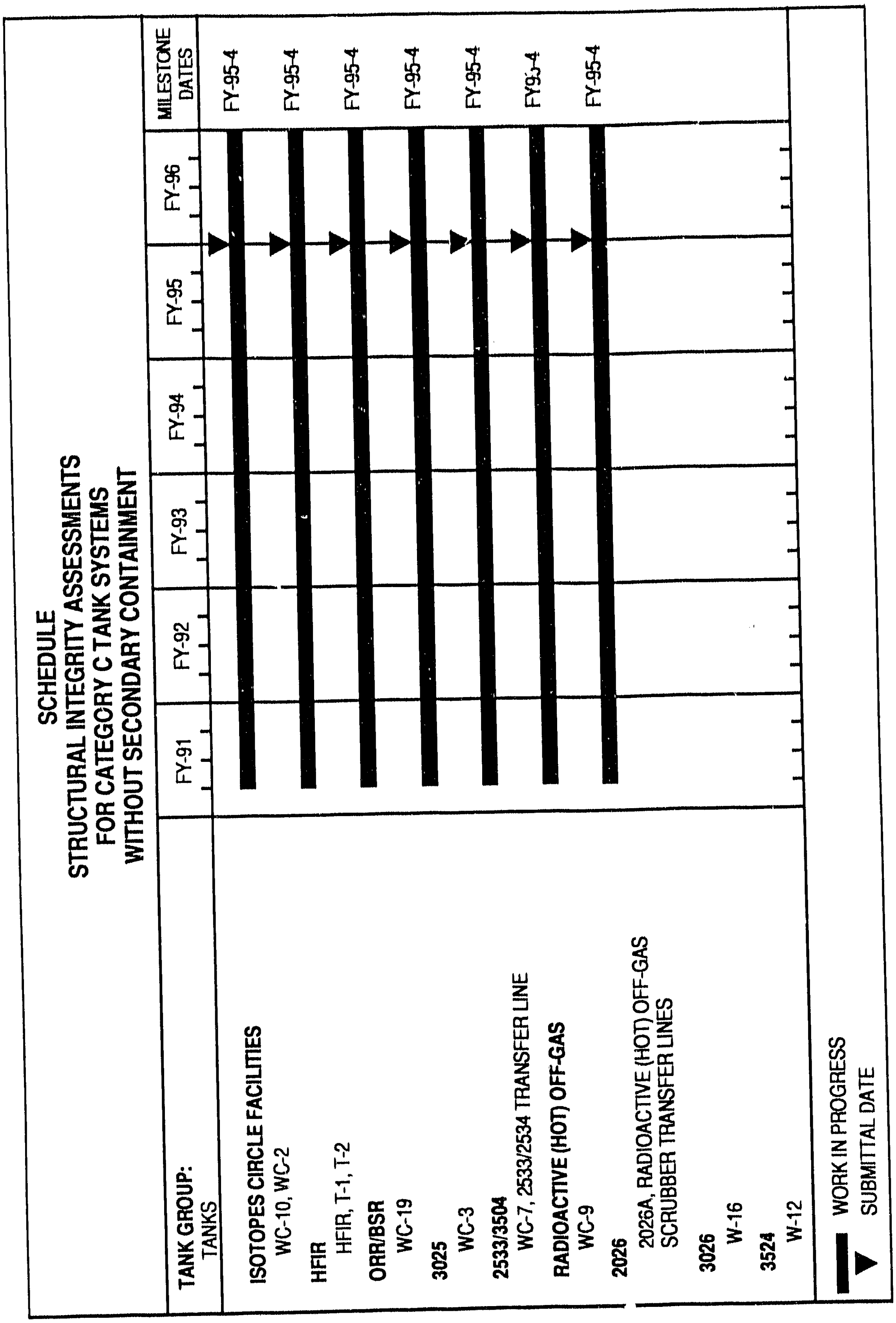

Fig. 5.1. Structural integrity assessments for Category C tank systems not meeting secondary containment standards.

6. PLAN AND SCHEDULE FOR LEAK DETECTION TESTS AND SCHEDULE FOR PERIODIC REVIEW OF THE STRUCTURAL INTEGRITY ASSESSMENTS FOR EXISTING TANK SYSTEMS THAT DO NOT MEET THE FFA SECONDARY CONTAINMENT STANDARDS (FFA IX.F.4)

6.1 FFA DELIVERABLE

This section contains the schedule for providing the results of leak detection tests, and the schedule for the periodic review and revision of the structural integrity assessments of Category C tank systems that must be submitted to EPA/TDEC for approval (FFA Sect. IX.F.4). These requirements apply to singly contained tank systems and portions of secondarily contained tank systems that do not meet secondary containment and leak detection standards in FFA Appendix F, Part C.

6.2 INTRODUCTION

Category C tanks that will be leak tested are located at the following facilities:

- Isotopes Circle Facilities; (tanks WC-10 and WC-2);
- HFIR, Bldg. 7900;
- ORR/BSR, Bldgs. 3042/3010;
- Bldg. 3025, IMET;
- Bldgs. 2533/3504, Cell Ventilation Filter Pit for Building;
- Radioactive (hot) Off-Gas Pot Collection;
- Bldg. 2026, HRLAL;
- Bldg. 3525, tank W-12; and
- Bldg. 3026D, tank W-16.

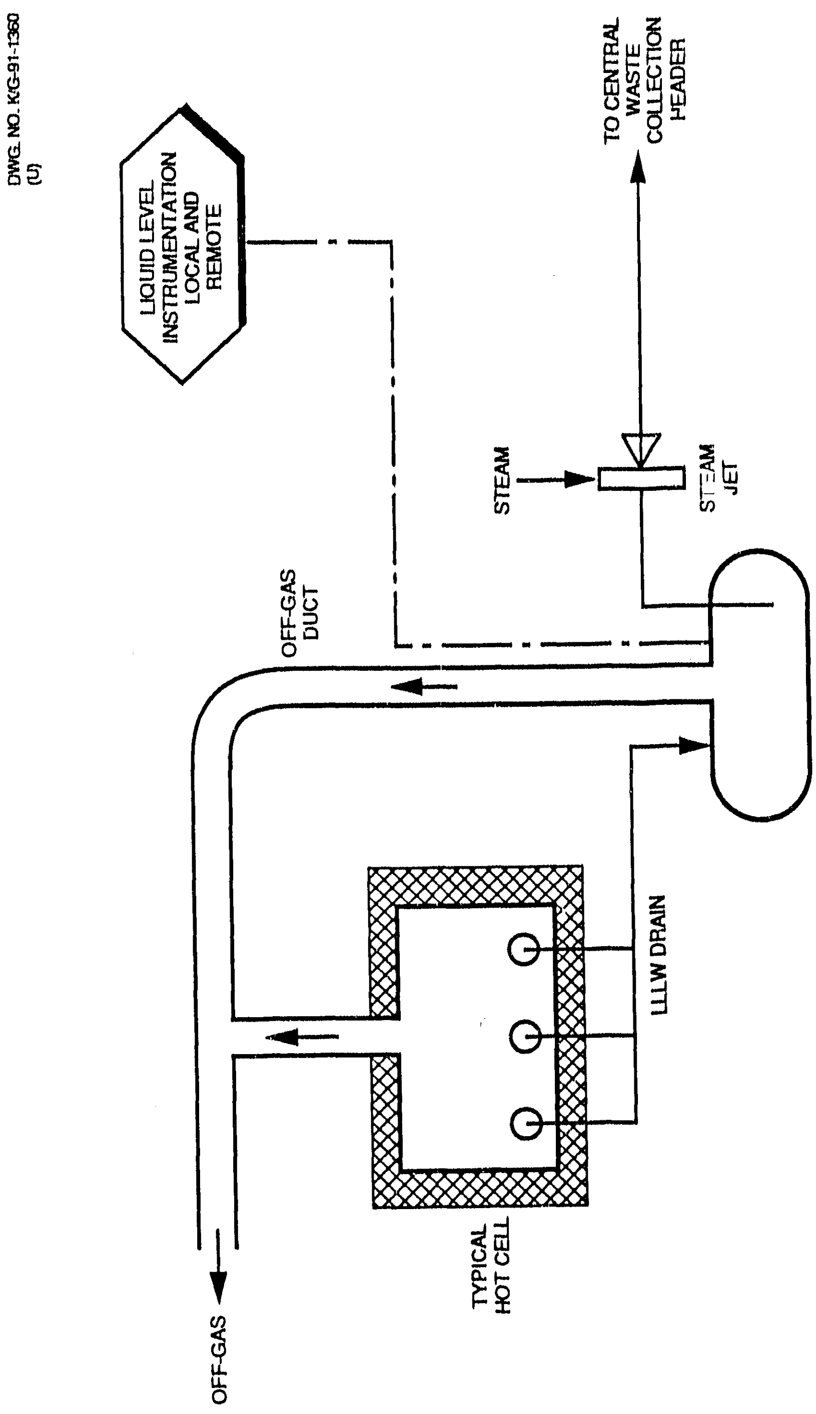

Fig. 6.1. Typical LLLW tank system components.

6.3 LLLW SYSTEM COMPONENTS

In general, each tank system includes three components (Fig. 6.1):

- drain piping from the LLLW Source to a collection tank,
- a collection tank, and
- discharge piping from the collection tank to the Central Waste Collection Header.

Each of these components has unique characteristics. The tank system inlet piping is typically a stainless steel, singly contained pipe with a nominal diameter of 2 in. or less, that drains by gravity to an area collection tank. There are generally no valves or isolation flanges in the inlet piping. These lines are typically kept under negative pressure and carry infrequent, small batch flows.

The collection tanks are usually stainless steel tanks with capacities less than 2000 gal which are used to accumulate wastes temporarily and to neutralize acidic waste with sodium hydroxide (NaOH). These tanks are periodically emptied to the central treatment system using steam jets and pumps (Fig. 6.1). Generally, a heel of up to ~20% of the tank volume remains after each transfer. Collection tanks are usually located in the service building or installed outside in close proximity to the service building. Several of the collection tank systems requiring leak detection tests contain tanks that meet the secondary containment design standards but require some piping and/or other upgrades (e.g., vault upgrades) to meet FFA requirements for secondary containment and leak detection.

The discharge piping component of the tank system typically consists of stainless steel lines with a nominal diameter of 2 in., although hastelloy and cast iron piping have been used in portions of some systems. These lines are used for batch transfers of LLLW, under pressure on an as-needed basis, to maintain inventory control at the collection tanks and to transfer LLLW to the LLLW evaporator for treatment. The transfer is generally initiated when the collection tank reaches 60% of capacity. The line pressure during transfer is normally less than 5 psi for steam jet systems and up to 60 psi for pumped systems.

Tank system components will be considered separately in establishing testing procedures because there are significant differences in components in terms of vulnerability to leakage and relative risks associated with leaks.

6.4 LEAK DETECTION TESTING

A strategy for developing leak detection test schedules for the Category C systems has been developed and is illustrated in Fig. 6.2. Leak detection testing for Category C tanks not meeting secondary containment standards will be defined in a test plan being prepared by a nationally recognized, independent consulting firm with established expertise and credibility with regulatory agencies in tank system testing. This plan will document available testing

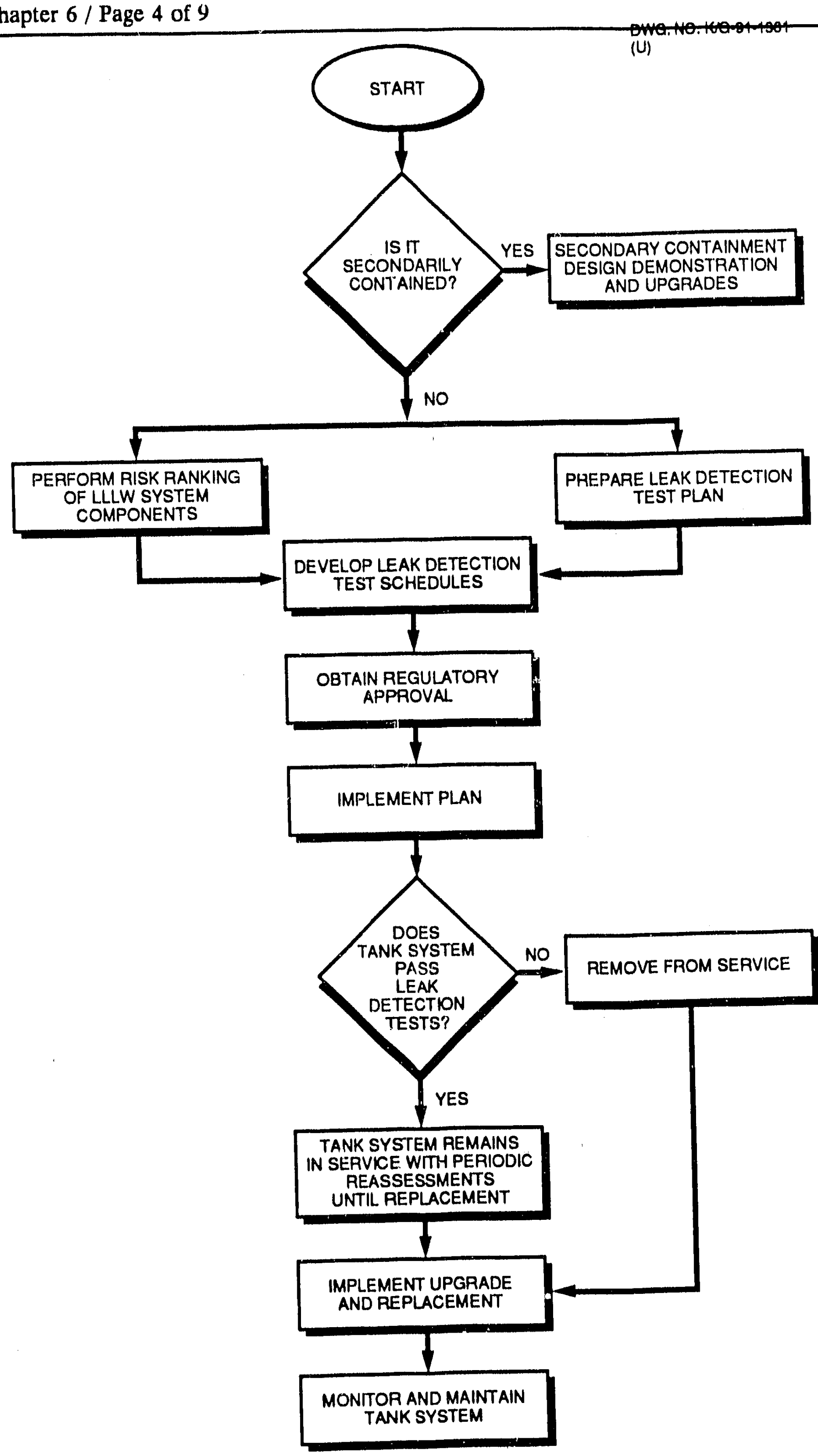

Fig. 6.2. Strategy for leak testing, upgrading, and/or replacing Category C tank systems.

technology and recommend technologies to be implemented on LLLW tank system components. The plan will indicate whether leak testing is easily implemented, difficult to implement, or unfeasible.

In a parallel effort, a risk ranking will be developed for the same LLLW tank system components for use in prioritizing the Category C tank systems for the leak detection effort. These efforts will be integrated to provide a basis for developing specific leak detection test schedules for LLLW system components.

6.4.1 Leak Detection Test Criteria

Although the FFA requires plans and demonstrations of leak detection tests, it does not provide guidance regarding the minimum performance of the leak detection methods or the test intervals to be included in the plan. To address these factors, the ORNL LLLW systems leak-testing plan is based on current leak detection technology and technical standards from relevant portions of existing federal regulations are used as comparative guidelines. This ensures that the performance requirements for the leak detection methods described in the LLLW plan are technically achievable and that the degree of environmental protection provided by the plan is consistent with other federal regulations.

Guidelines for leak detection performance standards are taken from RCRA part 280, which addresses underground storage tanks (USTs) containing petroleum products and other hazardous substances.

The relevant portion of RCRA Part 280 that may provide a comparative basis for the LLLW system leak-testing plan includes

> 280.40 (a)(3), which requires that leak detection methods be capable of detecting the leak rate or quantity specified for that method with probability of detection of (no less than) 0.95 and a probability of false alarm of (no greater than) 0.05.

Leak testing of underground tanks and pipelines in the petroleum industry and for other hazardous substances is well established; however, some issues must be considered that are unique to the ORNL LLLW system. Leak testing of unvalved piping and tanks, for example, will likely require some adaptation of current technology and could require the development of new leak-testing technology. In addition, testing will be constrained by radiological exposure concerns, severely limited access to the system, disposal of secondary wastes produced, and limitations in modifying the system.

The leak detection test plan will utilize proven leak-test methods and will be based on a technically sound approach that is consistent with existing regulations and the unique constraints imposed by the LLLW system, as discussed in the preceding. The plan will recommend leak detection test methods for various LLLW system components, evaluate the ease of implementation, and identity LLLW components where leak testing is not feasible. System components will be ranked into the categories for leak detection testing: easy, difficult, and not feasible.

6.4.2 Prioritization For Leak Testing

A ranking based on the relative probability of failure and associated consequences for the LLLW system components will be developed for use in prioritization of components for leak-testing. Waste characterization factors based on FFA Appendix F, Subsect. A information and operational characteristics will be used in this effort. A prioritization system will be established for the three components (i.e., inlet lines, area collection tanks, and discharge lines) of each tank system evaluated for leak testing. Based on this evaluation, components will be classified as low, moderate, or high risk.

6.4.3 Leak Detection Test Schedule

The leak detection test plan and the risk ranking will be integrated to establish LLLW system component testing schedules. Schedule priority levels will be established using a matrix such as that shown in Fig. 6.3. The overall schedule for addressing leak detection testing is shown in Fig. 6.4. The bases for this schedule are as follows.

- Leak testing will be performed in accordance with the leak testing methods and schedules being developed by independent expert consultants.
- Leak detection test schedules will be developed based on the leak detection test plan and risk ranking which are presently being developed. Testing will be constrained by radiological exposure concerns, severely limited access to the system, disposal of secondary wastes produced, and limitations in modifying the system.
- Technical uncertainties related to leak testing may require the development and demonstration of some leak-testing technologies to prove their effectiveness. These demonstrations will be incorporated into the detailed leak-testing plan and schedules.
- Progress on the development of the detailed leak test plan and schedule will be primarily communicated to EPA/TDEC in periodic working group meetings rather than in written reports.
- The schedules and plan in this chapter of this document are submitted for EPA/TDEC approval.
- The schedules presented in this chapter of this document will be subject to annual renegotiation to adjust for updated information based on duration of activities or for changes in priorities and funding.
- Annual update of program milestones will be required.
- All submittals shown in Fig. 6.4, except for the detailed leak protection plan and schedule, will be provided to EPA/TDEC for information only.

6.5 SCHEDULE FOR PERIODIC REVIEW OF THE STRUCTURAL INTEGRITY ASSESSMENTS

The structural integrity assessments for the tank systems not meeting secondary containment standards will be submitted in accordance with the schedule in Chap 5. The schedule extension beyond the initial submittal of SIAs, as shown in Fig. 5.1, indicates the periodic review of SIAs.

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Leak Detection Test
Priority Matrix

Probability of Leak	Easy	Difficult	Not feasible
High	A	A	D
Moderate	A	B	D
Low	B	C	D

Difficulty of Testing

A Highest leak detection test priority

B Moderate leak detection test priority

C Low leak detection test priority

D Further evaluation and discussion with EPA and TDEC required

Fig. 6.3. Leak detection test priorities for Category B and Category C tank systems.

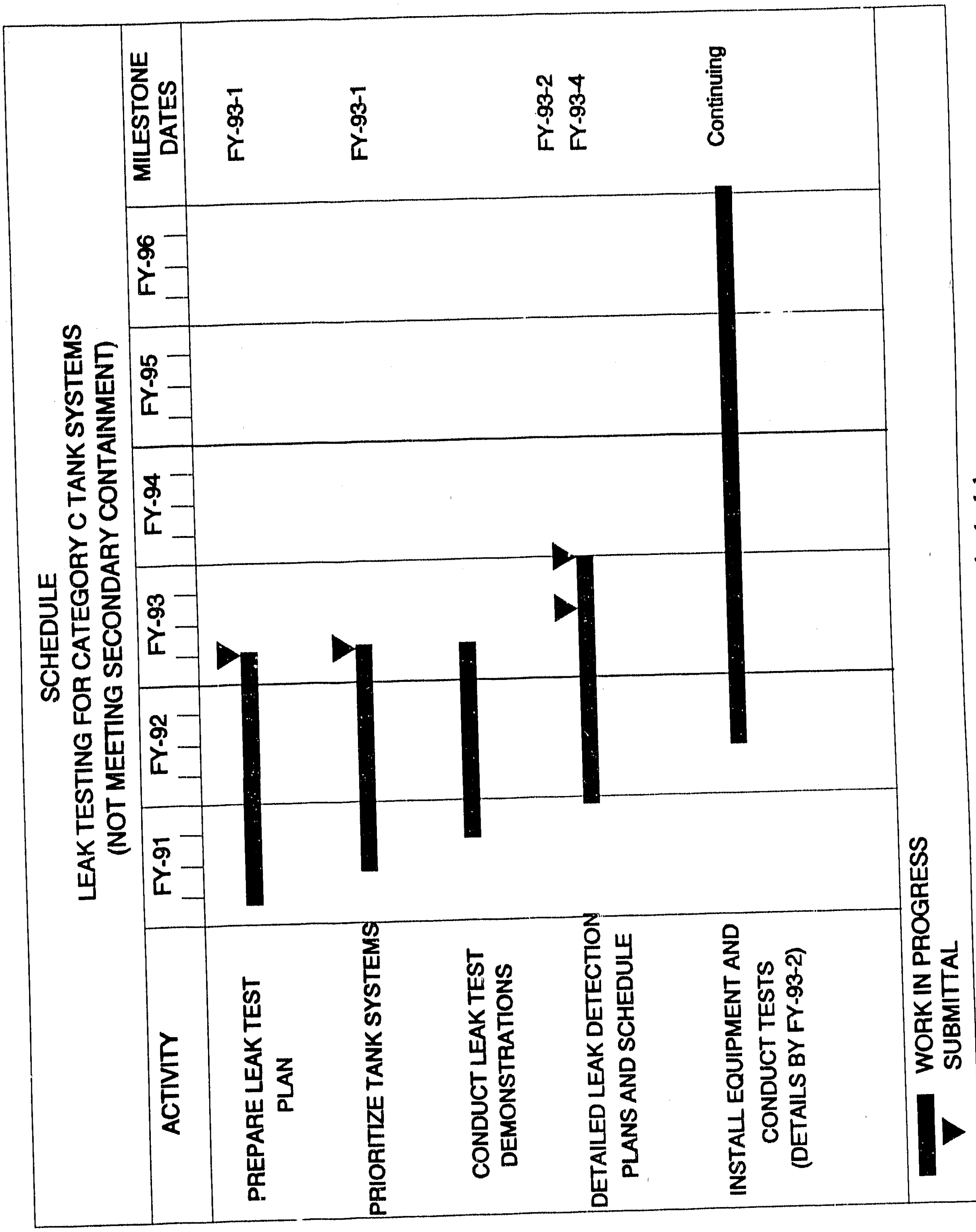

Fig. 6.4. Leak detection test plan and schedule.

7. CATEGORY D LLLW TANK SYSTEMS 90-DAY FFA DELIVERABLES

7.1 FFA DELIVERABLES

This chapter contains the schedules and risk characterization plan for the Category D inactive LLLW tank systems that must be submitted to EPA/TDEC for approval. The preparation of the FFA deliverables is organized based on the six inactive tank groups that are described in Sect. 1.7. Included in this chapter are the schedules for preparing waste characterizations and risk characterizations. In addition, a schedule is provided for submitting detailed remediation schedules for the Category D tanks. The plan for conducting risk characterizations to prioritize the tanks for further evaluation is presented in Sect. 7.5.

The schedules are organized according to whether the tank contents have been characterized, Groups 1 - 4; whether sampling and analysis are not yet complete, Group 5; or whether the tanks have not been transferred to the ER Program, Group 6. Refer to Figs. 7.1, 7.2, and 7.3, respectively. The bases for the schedules presented in this section are as follows.

- Tanks that contain liquids, or liquids and sludge, will be sampled and analyzed. Tanks that have been emptied so that only a residual "heel" remains that cannot practicably be removed will not be characterized.

- Risk characterization will be conducted in accordance with the plan presented in Sect. 7.4 of this document. The risk characterization will be used to prioritize the tanks for further evaluation. No detailed risk assessment or pathways analysis is planned in response to the FFA requirements.

- Progress on the evaluation of tanks for interim corrective Group 1-5 actions will primarily be communicated to EPA/TDEC in periodic working group meetings rather than in written reports.

- It is assumed the schedules presented in Chapter 7 of this document will be subject to annual renegotiation, per FFA Sect. XVIII, to adjust for updated information based on duration of activities or for changes in priorities and funding.

7.2 WASTE CHARACTERIZATION SCHEDULE FOR THE CATEGORY D TANK SYSTEMS

The schedule for submitting the waste characterizations for the Groups 1-5 tank systems to EPA/TDEC is shown in Figs. 7.1 and 7.2. Section 1.7.3.2 of this document describes the plans for conducting these waste characterizations. Tanks that are removed from service that contain liquids or liquids and sludge will be emptied to the extent practical. The remaining waste will be sampled and analyzed as required for remediation. Tanks that have been have been emptied so that only a very small residue remains will not be characterized.

7.3 RISK CHARACTERIZATION SCHEDULE FOR THE CATEGORY D TANK SYSTEMS

The schedules for submitting the risk characterizations to EPA/TDEC for approval are shown in Figs. 7.1, 7.2, and 7.3. The risk characterizations are performed in accordance with the plan in described in Sect. 7.6 of this document. An update to the risk characterization for tank Groups 1 - 4 will be prepared to include tank Groups 5 and 6. The updated risk characterization will be submitted to EPA/TDEC in accordance with the schedule in Figs. 7.1 through 7.3.

7.4 REMEDIATION SCHEDULE FOR THE CATEGORY D TANK SYSTEMS

Plans are to empty, perform interim actions, and remediate the Category D tanks through the CERCLA RI/FS process. DOE will provide, during the first quarter of fiscal 1993, a detailed remediation schedule for the Category D tanks.

7.5 RISK CHARACTERIZATION PLAN FOR THE CATEGORY D TANK SYSTEMS

This risk characterization plan for the Category D LLLW tank systems is based on a methodology developed at ORNL in 1991 by V. Chidambariah, et al. The objective of the plan is to establish a ranking of the Category D LLLW tanks, by proximate groups, for possible interim corrective actions.

7.5.1 Methodology

This risk-based approach for prioritizing the Category D LLLW tanks for further evaluation is based on three major criteria: (1) the propensity of the tanks to leak, (2) the location of the tanks, and (3) the toxic potential of the tank contents. These criteria are discussed in the following paragraphs.

7.5.1.1 Propensity for leaking

The structural characteristics of the Category D LLLW tanks help to establish the extent and the likelihood that the contents will leak to the environment. For tanks that are known to leak, the criteria are based on the quantity or degree of leakage. For the remaining tanks, the criteria are based on the structural material of the tank. For example, tanks constructed of porous concrete or mild steel that is susceptible to corrosion are more likely to leak than tanks constructed of stainless steel.

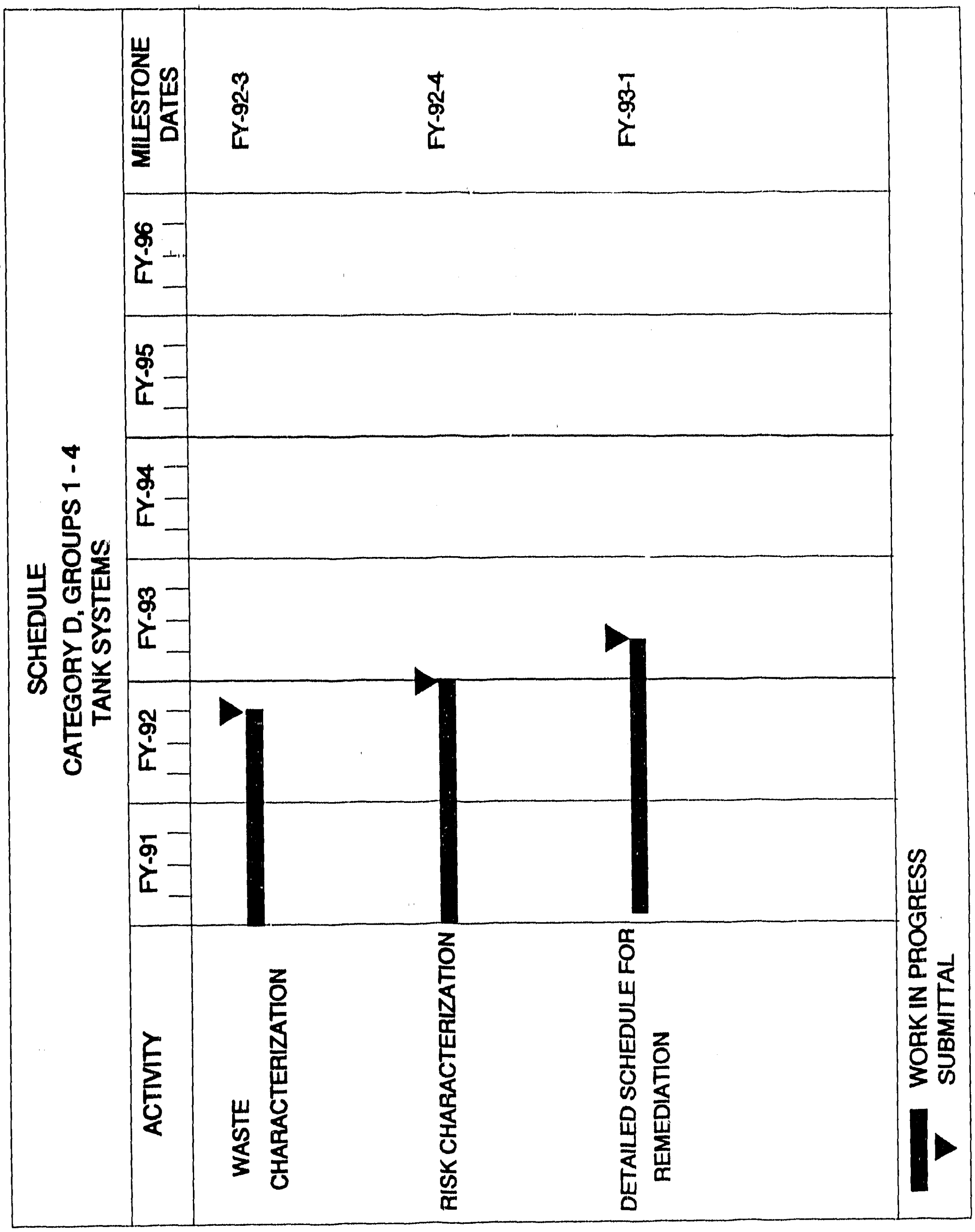

Fig. 7.1. Schedule for development of FFA deliverables for Category D, Groups 1 - 4 tank systems.

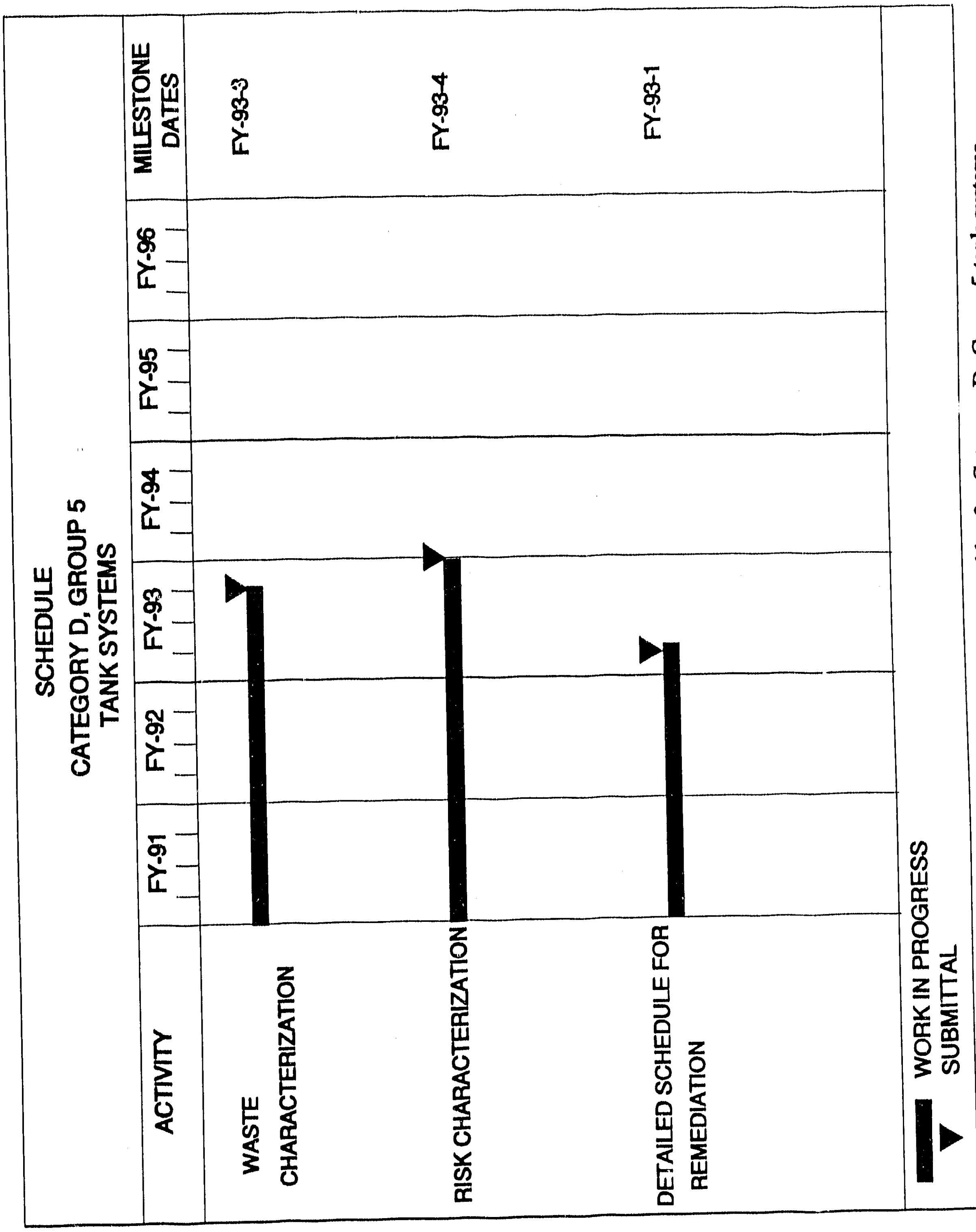

Fig. 7.2. Schedule for development of FFA deliverables for Category D, Group 5 tank systems.

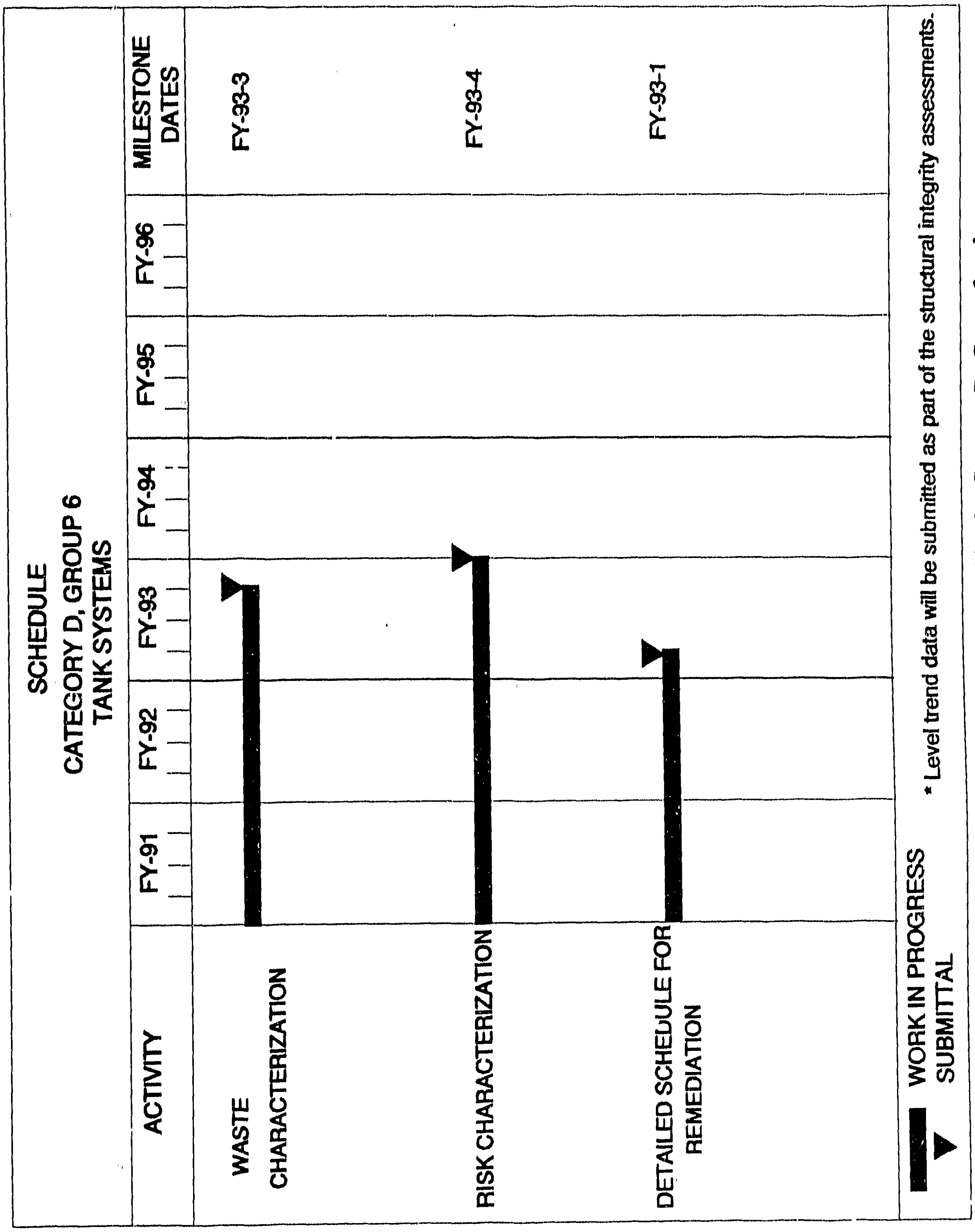

Fig. 7.3. Schedule for development of FFA deliverables for Category D, Group 6 tank systems.

7.5.1.2 Location

Tank location also influences the extent and likelihood that the contents will leak to the environment. The location criterion is site-specific. It is based on the proximity of the tank to groundwater or surface water and on the characteristics of the soil surrounding the tank. For ORNL, this criterion is based primarily on the proximity of the tanks to surface water.

7.5.1.3 Toxicological characteristics

Toxicological characteristics of contaminants in the tanks help to establish the potential for adverse impact on health and the environment. Although the tanks may contain both residual liquid wastes and sludge, only the toxicological characteristics of the liquid wastes are considered because of their greater tendency for mobility and migration to the environment.

Three factors are considered in establishing the toxicological characteristics of the tank contents: the toxicity, the concentration of the contaminants of concern in the liquid, and the liquid volume in each tank. The toxicity is determined by the reference dose (RfD) for noncarcinogenic chemicals, the cancer potency factor (CPF) for nonradioactive carcinogens, and the cancer slope factor (CSF) for radionuclides. These factors are combined into a single dimensionless number called the toxic index (TI). The steps necessary to calculate the TI for a Category D LLLW tank are shown below.

Lifetime Reference Dose. RfDs for noncarcinogenic chemicals, CPFs for nonradioactive carcinogenic chemicals, and CSFs for radionuclides are converted into lifetime reference doses.

For noncarcinogenic chemicals, a lifetime RfD (mg) is the total dose a person receives over a lifetime if that person takes in the RfD for 70 years. Lifetime RfD is a product of the RfD (mg/kg/d), the reference body weight (70 kg), and the average lifetime exposure (70 yr).

$$\textbf{Lifetime RfD (mg)} = \textbf{RfD (mg/kg/d)} \times \textbf{70 (kg)} \times 70\ (\text{yr}) \times 365\ (\text{d/yr})\ .$$

For nonradioactive carcinogenic chemicals, a lifetime RfD is the total dose a person receives over a lifetime of 70 years if that person takes in a daily dose equivalent to the 10-6 lifetime risk level. Lifetime RfD is a product of the acceptable lifetime cancer risk (10-6), reference body weight (70 kg), and average lifetime exposure (70 yr), divided by the oral CPF.

$$\textbf{Lifetime RfD (mg)} = \frac{10^{-6} \times 70\ (\text{kg}) \times 70\ (\text{yr}) \times 365\ (\text{d/yr})}{\text{CPF (mg/kg/d)}^{-1}}$$

For radionuclides, a lifetime RfD (pCi) is the total amount of radioactivity a person takes in if total exposure over a lifetime produces a 10-6 lifetime risk level. Lifetime RfDs (in pCi) are derived by dividing the 10-6 acceptable risk level by the ingestion CSFs (in pCi-1).

$$\text{Lifetime RfD (pCi)} = \frac{10^{-6}}{\text{CSF (pCi}^{-1})}$$

Reference volume. Reference volume is the volume of a contaminant-containing liquid that a person must ingest to receive a lifetime RfD. To define the reference volume in a Category D LLLW tank, a contaminant's lifetime RfD is divided by its highest concentration detected in the liquid.

$$\text{Reference Volume} = \frac{\text{Lifetime RfD for Contaminant}}{\text{Contaminant Concentration}}$$

Concentrations for noncarcinogenic and carcinogenic chemicals are expressed in mg/L. Concentrations for radionuclides are expressed in pCi/L. Reference volumes are computed for each contaminant of concern in a Category D LLLW tank. The resultant reference volumes for carcinogens and noncarcinogens are calculated separately as follows:

$$CRV = [\ \Sigma\ 1/V_i\ ]^{-1}$$

$$NRV = [\ \Sigma\ 1/V_i\ ]^{-1}$$

where CRV is the cancer reference volume, NRV is the noncancer reference volume, and i is the identity of a particular contaminant. The lower of the two reference volumes is chosen as the representative reference volume for the particular tank.

Toxic Index. The TI is the number of reference volumes in the volume of residual liquid found in a tank. The TI considers both the toxicity of the contaminant and the volume of the contaminant in the liquid. To calculate the TI for a Category D LLLW tank, liquid volume (the residual liquid in a tank, which is assumed to be constant over the period of sampling) is divided by the representative reference volume of the tank.

$$\text{Toxic Index} = \frac{\text{Liquid Volume}}{\text{Reference Volume}}$$

A range of TIs has been developed and suitably divided so that the tanks can be separated into distinct groups, based on their individual TIs. To identify the range, the TIs for the individual tanks are calculated and inspected. The indexes are arranged so that the high and low ends of the range can be identified. The range of TIs is then subdivided and assigned score values ranging from 1 to 5.

Scoring Process. The three criteria, leaking, location, and toxic potential, are used to rank the Category D tanks with respect to potential for adverse impact on the environment and human health. Using a scale of 0 to 5, a numeric score is assigned for each criteria, with 5 indicating the highest priority. The scores for the three criteria are weighted according to their perceived importance. The sum of the scores for the criteria is the composite score for a particular tank. the site-specific criteria for the ORNL tanks are shown in the following paragraphs.

Leaking.

Characteristic	Score
• Major outleaker	5
• Small outleaker	4
• Inleaker	3
• Nonleaker	
concrete	2
mild steel	1
stainless steel	0

This criterion carries a weight of 3.

Location. Category D tanks located at the Old Hydrofracture Facility and south of Central Avenue in the main plant area are scored higher because of their proximity to Melton Branch and White Oak Creek.

Location	Score
• Old Hydrofracture tanks	5
• South of Central Avenue	3
• North of Central Avenue	2
• HRE tanks	1
• Pumped to active LLLW System	0

This criterion carries a weight of 1.

Toxic Potential. Toxic potentials of the contents of the Category D tanks are scored on the basis of their relative TIs. A screening of toxic indexes indicated the following range to be suitable to separate the tanks with respect to toxic potential.

Toxic Index	Score
• $>10^{10}$	5
• 10^{10} to 10^{8}	4
• 10^{8} to 10^{6}	3
• 10^{6} to 10^{4}	2
• $<10^{4}$	1

This category carries a weight of 2.

7.6 FFA DELIVERABLES SCHEDULES

This section contains the schedules for preparing the FFA deliverables for the Category D, LLLW tanks. The schedules are organized according to whether the tank contents have been characterized, Groups 1 - 4; whether sampling and analysis are not yet complete, Group 5; or whether the tanks have been transferred to the ER Program, Group 6. Refer to Figs. 7.1, 7.2, and 7.3, respectively. The bases for the schedules presented in this section are as follows.

- Tanks that contain liquids, or liquids and sludge, will be sampled and analyzed. Tanks that have been emptied so that only a residual "heel" remains that cannot practicably be removed will not be characterized.

- Risk characterization will be conducted in accordance with the plan presented in Sect. 7.4 of this document. The risk characterization will be used to prioritize the tanks for further evaluation. No detailed risk assessment or pathways analysis is planned in response to the FFA requirements.

- Progress on the evaluation of tanks for interim corrective Group 1-5 actions will primarily be communicated to EPA/TDEC in periodic working group meetings rather than in written reports.

- It is assumed the schedules presented in Chapter 7 of this document will be subject to annual renegotiation, per FFA Sect. XVIII, to adjust for updated information based on duration of activities or for changes in priorities and funding.

Appendix A

DATA SUMMARIES FOR EXISTING ACTIVE TANK SYSTEMS

The data in this Appendix are based on technical information available in July 1991.

Exhibit A.1. Data summary for the LLLW tank systems at Building 3019

A. Facility: 3019 [Radiochemical Processing Pilot Plant (RPPP)]

B. Tank Location: Bethel Valley, Cells 6 and 7 of Building 3019

C. Tank User Divisions: Chemical Technology

D. Tank Data:

Tank No.	Date of Install.	Tank Loc.	Cap. (gal)	Material of Const.	Double Ctnment	Cathodic Prot.
N-71	Unknown	AGV	240	304SS	yes	NA
P-3	Unknown	AGV	197	347SS	yes	NA
P-4	Unknown	AGV	197	347SS	yes	NA

Legend: **AGV**—above-ground vault, **SS**—stainless steel, **IGV**—in-ground vault, **CS**—carbon Steel, **BT**—Buried tank, **C**—concrete, **NA**—not applicable

E. Original or Past Tank Usage:

These tanks were used for collection of a variety of production waste process streams such as raffinates from extraction processes, overheads from evaporation processes, and others. In addition, laboratory wastes, such as liquids left after analyses, and bench scale experimental processes were collected in the tanks. Also, any spills which might occur in the cells are jetted to these tanks.

F. Current or Future Tank Usage:

Same as above (E).

G. System Component Characteristics:

Percent Doubly Contained Pipe in Facilities: 100%
Length of Buried Piping: ~200 ft
Percent Doubly Contained Buried Pipe: 0%
Cathodic Protection for Buried Pipe: none
System Operation at Negative Pressure: yes

Exhibit A.2. Data summary for the LLLW tank systems at Building 3517

A. Facility: 3517 [Fission Products Development Laboratory (FPDL)]

B. Tank Location: Bethel Valley, Cells 23 and 24 of Building 3517

C. Tank User Division: Chemical Technology

D. Tank Data:

Tank No.	Date of Install.	Tank Loc.	Cap. (gal)	Material of Const.	Double Ctnment	Cathodic Prot.
S-223	1955	IGV	2500	304LSS	yes	NA
S-324	1955	IGV	1000	304LSS	yes	NA
S-523	1955	IGV	1000	304LSS	yes	NA

Legend:
AGV—above-ground vault
IGV—in-ground vault
BT—Buried tank
NA—not applicable
SS—stainless steel
CS—carbon Steel
C—concrete

E. Original or Past Tank Usage:

These tanks were used to collect production process wastes from a variety of operations such as supernate from cesium and strontium precipitation operations, raffinate from a cerium-144 extraction process, and general decontamination solutions which contained ^{60}Co, ^{90}Sr, ^{192}Ir, ^{147}Pm, and $^{137}Cs/^{134}Cs$.

F. Current or Future Tank Usage:

These tanks will be used for decontamination of facilities used in isotopes production programs that were discontinued in FY 1990. Building 3517 will then be used for isotopes storage. The LLLW system will be used to transfer waste generated by isotopes storage and transfer operations and possibly for future waste management treatment programs.

G. System Component Characteristics:

Percent Doubly Contained Pipe in Facilities: 100%
Length of Buried Piping: 75 ft
Percent Doubly Contained Buried Pipe: 98%
Cathodic Protection for Buried Pipe: yes
System Operation at Negative Pressure: yes

Exhibit A.3. Data summary for the Evaporator Complex LLLW tank systems

A. Facility: 2531 (Evaporator Complex and Melton Valley Storage Tanks)

B. Tank Location: C-1,C-2,W-21 through W-23 (ORNL Bethel Valley, North of Building 2531), W-24 through W-31 (ORNL Melton Valley, Hydrofracture Area)

C. Tank User Division: Waste Operations

D. Tank Data:

Tank No.	Date of Install.	Tank Loc.	Cap. (gal)	Material of Const.	Double Ctnment	Cathodic Prot.
C-1	1964	IGV	50000	SS	yes	NA
C-2	1964	IGV	50000	SS	yes	NA
W-21	1979	IGV	50000	SS	yes	NA
to						
W-23	1979	IGV	50000	SS	yes	NA
W-24	1980	IGV	50000	SS	yes	NA
to						
W-31	1980	IGV	50000	SS	yes	NA

Legend: **AGV**—above-ground vault **SS**—stainless steel
IGV—in-ground vault **CS**—carbon Steel
BT—Buried tank **C**—concrete
NA—not applicable

E. Original or Past Tank Usage:

Tanks C-1, C-2, and W-21 through W-23 are used as feed or concentrate storage tanks for the LLLW evaporator located in Building 2531.

F. Current or Future Tank Usage:

Current and future use remains unchanged for the tanks in the evaporator complex.

G. System Component Characteristics:

Percent Doubly Contained Pipe in Facilities: 100%
Length of Buried Piping: ~7500 ft
Percent Doubly Contained Buried Pipe: 100%
Cathodic Protection for Buried Pipe: All doubly contained piping has cathodic protection; none of the singly contained piping has cathodic protection.
System Operation at Negative Pressure: yes

Exhibit A.4. Data summary for the LLLW tank systems at Building 3544

A. Facility: 3544 [Process Waste Treatment Plant (PWTP)]

B. Tank Location: Bethel Valley, in Building 3544

C. Tank User Division: Waste Operations

D. Tank Data:

Tank No.	Date of Install.	Tank Loc.	Cap. (gal)	Material of Const.	Double Ctnment	Cathodic Prot.
L-11	Unknown	IF	400	SS	yes	NA

Legend:
AGV—above-ground vault
IGV—in-ground vault
BT—Buried tank
NA—not applicable
SS—stainless steel
CS—carbon Steel
C—concrete
IF—inside facility

E. Original or Past Tank Usage:

L-11 is used as a collection tank for the evaporator bottoms from the Process Waste Treatment Plant.

F. Current or Future Tank Usage:

Same as above (E).

G. System Component Characteristics:

Percent Doubly Contained Pipe in Facilities: 100%
Length of Buried Piping: 900 ft
Percent Doubly Contained Buried Pipe: 25%
Cathodic Protection for Buried Pipe: yes
System Operation at Negative Pressure: yes

Exhibit A.5. Data summary for the New Hydrofracture Facility LLLW tank system

A. Facility: NHF (New Hydrofracture Facility)

B. Tank Location: Melton Valley NHF area

C. Tank User Division: Waste Operations

D. Tank Data:

Tank No.	Date of Install.	Tank Loc.	Cap. (gal)	Material of Const.	Double Ctnment	Cathodic Prot.
T-13	1979	IGV	4000	SS	yes	yes

Legend:
AGV—above-ground vault
IGV—in-ground vault
BT—Buried tank
NA—not applicable
SS—stainless steel
CS—carbon Steel
C—concrete

E. Original or Past Tank Usage:

Used as a waste tank for the New Hydrofracture Facility. The NHF was used to solidify concentrated LLLW for disposal.

F. Current or Future Tank Usage:

Potential uses include pilot plant operations to develop new LLLW treatment processes and decontamination activities.

G. System Component Characteristics:

Percent Doubly Contained Pipe in Facilities: 100%
Length of Buried Piping: 110 ft
Percent Doubly Contained Buried Pipe: 100%
Cathodic Protection for Buried Pipe: yes
System Operation at Negative Pressure: yes

Exhibit A.6. Data summary for the Radiochemical Engineering Development Center LLLW tank systems

A. Facility: REDC (Radiochemical Engineering Development Center)

B. Tank Location: ORNL Melton Valley, HFIR Area

C. Tank User Division: Chemical Technology, Waste Operations

D. Tank Data:

Tank No.	Date of Install.	Tank Loc.	Cap. (gal)	Material of Const.	Double Ctnment	Cathodic Prot.
WC-20	1976	IGV	10000	SS	yes	NA
F-111	1962	IGV	125	SS	yes	NA
F-126	1962	IGV	1200	SS	yes	NA
C-6-T	1965	IGV	700	SS	yes	NA
B-2-T	1965	IGV	1870	SS	yes	NA
B-3-T	1965	IGV	1870	SS	yes	NA

Legend: **AGV**--above-ground vault; **IGV**—in-ground vault; **BT**—Buried tank; **NA**—not applicable; **SS**—stainless steel; **CS**—carbon Steel; **C**—concrete

E. Original or Past Tank Usage:

LLLW was produced from radiochemical operations designed to recover isotopes produced from irradiated HFIR targets and other sources. LLLW at the REDC was primarily generated from disposal of spent off-gas scrubber solutions. Other sources included routine and non-routine wash down of hot cells and other contaminated equipment. The REDC is the major contributor of transuranic radionuclides in the LLLW system.

F. Current or Future Tank Usage:

Same as above (E).

G. System Component Characteristics:

Percent Doubly Contained Pipe in Facilities: 60%
Length of Buried Piping: 7800 ft
Percent Doubly Contained Buried Pipe: 0%

Cathodic Protection for Buried Pipe: All underground lines cathodically protected except three LLLW lines from Building 7930 to the 7930 tank vault. The transfer line from Melton Valley to Bethel Valley is also protected. Approximately 90% of the system is protected.
System Operation at Negative Pressure: yes

Exhibit A.7. Data summary for the LLLW tank systems at Building 3525

A. Facility: 3525 (High Radiation Level Examination Laboratory)

B. Tank Location: ORNL Bethel Valley, South of Building 3525

C. Tank User Division: Chemical Technology, Metals and Ceramics

D. Tank Data:

Tank No.	Date of Install.	Tank Loc.	Cap. (gal)	Material of Const.	Double Ctnment	Cathodic Prot.
F-201	1962	IGV	40	SS	yes	NA
F-501	1962	IGV	200	SS	yes	NA
W-12	1947	BT	700	SS	no	no

Legend: AGV—above-ground vault; IGV—in-ground vault; BT—Buried tank; NA—not applicable; SS—stainless steel; CS—carbon Steel; C—concrete

E. Original or Past Tank Usage:

Building 3525 provides for the post-irradiation mechanical disassembly of reactor components so that physical and metallurgical examinations can be conducted. LLLW is produced from the decontamination and cleanup of the hot cells used in the disassembly and examination process.

F. Current or Future Tank Usage:

Same as above (E).

G. System Component Characteristics:

Percent Doubly Contained Pipe in Facilities: 50%
Length of Buried Piping: 290 ft
Percent Doubly Contained Buried Pipe: 0%
Cathodic Protection for Buried Pipe: none
System Operation at Negative Pressure: yes

Exhibit A.8. Data summary for the Isotopes Circle Facilities LLLW tank systems

A. Facility: Isotopes Circle

B. Tank Location: ORNL Bethel Valley, Isotopes Area

C. Tank User Division: Chemical Technology, Waste Operations

D. Tank Data:

Tank No.	Date of Install.	Tank Loc.	Cap. (gal)	Material of Const.	Double Ctnment	Cathodic Prot.
WC-10	1951	BT	2000	SS	no	no
LA-104	1960	IGV	296	SS	yes	NA
WC-2	1951	BT	1000	SS	no	no

Legend: **AGV**—above-ground vault
IGV—in-ground vault
BT—Buried tank
NA—not applicable
SS—stainless steel
CS—carbon Steel
C—concrete

E. Original or Past Tank Usage:

Multigram quantities of radioisotopes were separated, purified, stored, and distributed in facilities serviced by the LLLW system. A wide range of radionuclides were produced. Isotopes were produced for use in medical, research, and industrial applications. Most waste was generated as a result of hot-cell and equipment decontamination. Waste includes residual solutions used for isotope separation, isotopes, and other contaminated liquids.

F. Current or Future Tank Usage:

Significant isotopes production in the facilities serviced by the LLLW system was terminated in FY 1990. However, the LLLW system continues to collect waste from routine cleanup and washdown of hot cells and other components. The LLLW system will be used during formal cleanup and shutdown stabilization of the facility through FY 1994. Research and medical production activities will continue in a limited portion of these facilities for the foreseeable future.

G. System Component Characteristics:

Percent Doubly Contained Pipe in Facilities: 10%
Length of Buried Piping: 3900 ft
Percent Doubly Contained Buried Pipe: 0%
Cathodic Protection for Buried Pipe: no
System Operation at Negative Pressure: yes

Exhibit A.9. Data summary for the HFIR LLLW tank systems

A. Facility: HFIR (High Flux Isotopes Reactor)

B. Tank Location: ORNL Melton Valley Area, HFIR Area

C. Tank User Division: Research Reactors, Waste Operations

D. Tank Data:

Tank No.	Date of Install.	Tank Loc.	Cap. (gal)	Material of Const.	Double Ctnment	Cathodic Prot.
HFIR	1961	BT	13000	SS	no	no
T-1	1963	BT	15000	SS	no	no
T-2	1963	BT	15000	SS	no	no

Legend: AGV—above-ground vault, IGV—in-ground vault, BT—Buried tank, NA—not applicable, SS—stainless steel, CS—carbon Steel, C—concrete

E. Original or Past Tank Usage:

These LLLW systems service a major research reactor facility. LLLW from the HFIR primarily results from (1) regeneration and backwashing of primary and pool demineralizer systems, (2) sampling operations, (3) gaseous waste filter pit inleakage and condensation, and (4) stack drainage. Other waste is generated by routine maintenance and decontamination of contaminated equipment. When in operation, the HFIR is the primary source of ^{60}Co in the LLLW system.

F. Current or Future Tank Usage:

Same as above (E).

G. System Component Characteristics:

Percent Doubly Contained Pipe in Facilities: 100%
Length of Buried Piping: 3000 ft
Percent Doubly Contained Buried Pipe: 0%
Cathodic Protection for Buried Pipe: Transfer piping from T-1 and T-2 only.
System Operation at Negative Pressure: yes

Exhibit A.10. Data summary for the ORR/BSR LLLW tank system

A. Facility: Oak Ridge Research Reactor / Bulk Shielding Reactor (ORR/BSR)

B. Tank Location: Bethel Valley, North of Building 3047

C. Tank User Division: Research Reactors, Surplus Facilities

D. Tank Data:

Tank No.	Date of Install.	Tank Loc.	Cap. (gal)	Material of Const.	Double Ctnment	Cathodic Prot.
WC-19	1955	BT	2250	SS	no	no

Legend: **AGV**—above-ground vault; **IGV**—in-ground vault; **BT**—Buried tank; **NA**—not applicable; **SS**—stainless steel; **CS**—carbon Steel; **C**—concrete

E. Original or Past Tank Usage:

LLLW was produced from the regeneration of reactor pool and canal demineralizers at Buildings 3019, 3001, 3042, 3004, and 3010. Also, the tanks received condensate from off-gas High Efficiency Particulate Air Filter (HEPA) filter pits associated with these reactors.

F. Current or Future Tank Usage:

Although the reactors are not currently being operated, LLLW is produced from the regeneration of demineralizers at Buildings 3042 and 3019. Tank WC-19, which is an ES&H tank, will continue to be used after the FFA is signed to process ion exchange regenerant from the shutdown reactors. One reactor will be restarted in the near future.

G. System Component Characteristics:

Percent Doubly Contained Pipe in Facilities: 100%
Length of Buried Piping: 1200 ft
Percent Doubly Contained Buried Pipe: 0%
Cathodic Protection for Buried Pipe: no
System Operation at Negative Pressure: yes

Exhibit A.11. Data summary for the LLLW tank system at Building 3025

A. Facility: 3025 (Irradiated Materials Examination and Testing Facility)

B. Tank Location: Bethel Valley, South of Building 3025

C. Tank User Divisions: Waste Operations, Metals and Ceramics

D. Tank Data:

Tank No.	Date of Install.	Tank Loc.	Cap. (gal)	Material of Const.	Double Ctnment	Cathodic Prot.
WC-3	1951	BT	1000	347SS	no	NA

Legend: **AGV**—above-ground vault; **IGV**—in-ground vault; **BT**—Buried tank; **NA**—not applicable; **SS**—stainless steel; **CS**—carbon Steel; **C**—concrete

E. Original or Past Tank Usage:

WC-3 was used primarily to collect residuals from metallurgical sampling and analysis. The waste solutions came from etching, dissolution, and decontamination of particulate residue from physical property analysis (such as tensile and shear testing) of irradiated metals.

F. Current or Future Tank Usage:

Same as above (E).

G. System Component Characteristics:

Percent Doubly Contained Pipe in Facilities: 100%
Length of Buried Piping: 250 ft
Percent Doubly Contained Buried Pipe: 0%
Cathodic Protection for Buried Pipe: no
System Operation at Negative Pressure: yes

Exhibit A.12. Data summary for the LLLW tank system at Building 2533/3504

A. Facility: 2533/3504 (Cell Ventilation Filter Pit & Geosciences Laboratory)

B. Tank Location: ORNL Bethel Valley, West of Building 3504

C. Tank User Divisions: Environmental Science, Waste Operations

D. Tank Data:

Tank No.	Date of Install.	Tank Loc.	Cap. (gal)	Material of Const.	Double Ctnment	Cathodic Prot.
WC-7	1951	BT	1100	SS	no	no

Legend: **AGV**—above-ground vault, **IGV**—in-ground vault, **BT**—Buried tank, **NA**—not applicable, **SS**—stainless steel, **CS**—carbon Steel, **C**—concrete

E. Original or Past Tank Usage:

Waste solutions from health physics research of contaminated animals were stored in the LLLW tank. Original tank waste included fission products and other contaminated waste generated during animal contamination studies. LLLW from the Evaporator Complex Building 2533 sump is transferred to the central LLLW system via the WC-7 discharge line.

F. Current or Future Tank Usage:

Current waste in Building 3504 is generated from disposal of contaminated soil samples and from decontamination of equipment used in collecting soil samples. The tank discharge line will continue to receive condensate from the Evaporator Complex Building 2533 sump.

G. System Component Characteristics:

Percent Doubly Contained Pipe in Facilities: 100%
Length of Buried Piping: 1100 ft
Percent Doubly Contained Buried Pipe: 0%
Cathodic Protection for Buried Pipe: no
System Operation at Negative Pressure: no

Exhibit A.13. Data summary for the Radioactive (Hot) Off-Gas LLLW tank system

A. Facility Name: Radioactive (Hot) Off-Gas also referred to as HOG (Hot Off Gas Pot Collection)

B. Tank Location: Bethel Valley, South of Building 3503

C. Tank User Division: Environmental and Health Protection

D. Tank Data:

Tank No.	Date of Install.	Tank Loc.	Cap. (gal)	Material of Const.	Double Ctnment	Cathodic Prot.
WC-9	1952	BT	2150	SS	no	no

Legend:
AGV—above-ground vault
IGV—in-ground vault
BT—Buried tank
NA—not applicable
SS—stainless steel
CS—carbon Steel
C—concrete

E. Original or Past Tank Usage:

Tank WC-9 received LLLW from Building 3503. Building 3503 originally was a high-level radiation engineering laboratory. LLLW was generated by pilot plant studies. The tank also receives waste from the Hot Off-Gas Pot which collects condensate from the hot off gas pot and cell ventilation gaseous waste collection systems.

F. Current or Future Tank Usage:

Currently WC-9 receives condensate from the Hot Off-Gas Pot.

G. System Component Characteristics:

Percent Doubly Contained Pipe in Facilities: 0%
Length of Buried Piping: 125 ft
Percent Doubly Contained Buried Pipe: 0%
Cathodic Protection for Buried Pipe: none
System Operation at Negative Pressure: no

Exhibit A.14. Data summary for the LLLW tank system at Building 2026

A. Facility Name: 2026 [High Radiation Level Analytical Laboratory (HRLAL)]

B. Tank Location: ORNL Bethel Valley Area, East of Building 2026

C. Tank User Divisions: Analytical Chemistry, Waste Operations

D. Tank Data:

Tank No.	Date of Install.	Tank Loc.	Cap. (gal)	Material of Const.	Double Ctnment	Cathodic Prot.
2026A	1962	IGV	500	SS	no	NA

Legend:
AGV—above-ground vault
IGV—in-ground vault
BT—Buried tank
NA—not applicable
SS—stainless steel
CS—carbon Steel
C—concrete

E. Original or Past Tank Usage:

The 2026 facility provided analytical sample analysis for various programs at ORNL. LLLW was generated upon disposal of various samples once analysis was completed and from routine washdown and decontamination of hot cells and other contaminated equipment. The waste from the Hot Off-Gas Pot Scrubber treatment facility is transferred via a pipe which intersects the WC-2 tank discharge line.

F. Current or Future Tank Usage:

The 2026 facility continues to generate LLLW from analysis of samples at the ORNL. The primary activities conducted within the facility include analysis of LLLW waste tank contents, reactor fuel analysis, and work for others. The facility is key to environmental characterization of materials considered by the FFA and other environmental compliance programs. The Hot Off-Gas Pot Scrubber waste will continue to be collected.

G. System Component Characteristics:

Percent Doubly Contained Pipe in Facilities: 0%
Length of Buried Piping: 900 ft
Percent Doubly Contained Buried Pipe: 0%
Cathodic Protection for Buried Pipe: no
System Operation at Negative Pressure: yes

Exhibit A.15. Data summary for The LLLW tank system at Building 3026D

A. Facility Name: 3026D, (Segmenting Hot Cell Facility)

B. Tank Location: Melton Valley South Tank Farm

C. Tank User Divisions: Waste Operations, Metals and Ceramics

D. Tank Data:

Tank No.	Date of Install.	Tank Loc.	Cap. (gal)	Material of Const.	Double Ctnment	Cathodic Prot.
W-16	1951	BT	1000	347SS	no	no

Legend: **AGV**—above-ground vault, **IGV**—in-ground vault, **BT**—Buried tank, **NA**—not applicable, **SS**—stainless steel, **CS**—carbon Steel, **C**—concrete

E. Original or Past Tank Usage:

Tank W-16 serves Building 3026D in the Isotopes Complex. Multi-gram quantities of radioisotopes were separated, purified, stored, and distributed in facilities serviced by the LLLW system. A wide range of radionuclides was produced. Isotopes were produced for use in medical, research, and industrial applications. Most waste was generated as a result of routine and nonroutine hot-cell and equipment decontamination. Waste includes residual solutions used for isotope separation, trace quantities of isotopes, and other contaminated liquids.

F. Current or Future Tank Usage:

Potential use for decontamination of Building 3026D.

G. System Component Characteristics:

Percent Doubly Contained Pipe in Facilities: 100%
Length of Buried Piping: 550 ft
Percent Doubly Contained Buried Pipe: 0%
Cathodic Protection for Buried Pipe: no
System Operation at Negative Pressure: yes

Appendix B

DATA SUMMARIES FOR CATEGORY D TANK SYSTEMS WITHOUT SECONDARY CONTAINMENT THAT HAVE BEEN REMOVED FROM SERVICE

Exhibit B.1. Data summary for Category D, Group 1 inactive LLLW tank systems

A. Tank Group Name: Group 1

B. Tank Group Location: Bethel Valley, South Tank Farm

C. Tank User Divisions: Environmental Restoration

D. Tank Data Table:

Tank No.	Date of Install.	Tank Loc.	Cap. (gal)	Material of Const.	Double Ctnment	Cathodic Prot.
W-5	1943	BT	170000	C	no	NA
W-6	1943	BT	170000	C	no	NA
W-7	1943	BT	170000	C	no	NA
W-8	1943	BT	170000	C	no	NA
W-9	1943	BT	170000	C	no	NA
W-10	1943	BT	170000	C	no	NA
W-11	1943	BT	1500	C	no	NA

Legend:
AGV—above-ground vault
IGV—in-ground vault
BT—Buried tank
NA—not applicable
SS—stainless steel
CS—carbon Steel
C—concrete

E. Original or Past Tank Usage:

Tanks W-5 through W-10 were constructed in 1943 for permanent storage of LLLW. Because of the expanding needs of the Laboratory, the capacity of the tanks proved inadequate. The waste was directed to an evaporator between 1949 and 1954 and from 1959 until the tanks were taken out of service in 1980. Between 1953 and 1959 the waste was sent to open waste pits.

Tank W-11 was constructed in 1943 to serve as a waste collection and monitoring tank for research laboratories in Building 3550. The tank was removed from service in 1948 because of leaks.

F. Waste Characterization:

The results of a previous sampling campaign revealed that Tanks W-5 through W-10 contain sludge with transuranics (TRUs) and toxic metals. In addition, most of these tanks contain listed organics. Tank W-11 contains primarily low-level waste in aqueous form.

Exhibit B.2. Data summary for Category D, Group 2 inactive LLLW tank systems

A. Tank Group Name: Group 2

B. Tank Group Location: Melton Valley, Hydrofracture Area

C. Tank User Divisions: Environmental Restoration

D. Tank Data Table:

Tank No.	Date of Install.	Tank Loc.	Cap. (gal)	Material of Const.	Double Ctnment	Cathodic Prot.
T1	1963	BT	15000	CS	no	yes
T2	1963	BT	15000	CS	no	yes
T3	1963	BT	25000	CS/RL	no	yes
T4	1963	BT	25000	CS/RL	no	yes
T9	1963	BT	13000	CS	no	yes

Legend:
AGV—above-ground vault
IGV—in-ground vault
BT—Buried tank
NA—not applicable
SS—stainless steel
CS—carbon Steel
C—concrete
RL—rubber lining

E. Original or Past Tank Usage:

Tanks T1 through T4 and T9 were used during the Old Hydrofracture Facility operation to store liquid waste until it was ready to be blended with grout, before waste injection by hydrofracture. The Old Hydrofracture Facility operations were discontinued in 1980.

F. Waste Characterization:

From the results of a previous sampling campaign the Old Hydrofracture Facility tanks contain soft sludge with high transuranic and toxic metal concentrations.

Exhibit B.3. Data summary for the Category D, Group 3 inactive LLLW tank systems

A. Tank Group Name: Group 3

B. Tank Group Location: Bethel Valley, Area: (W-1, W-2, W-3, W-4, W-13, W-14, W-15, and W-1A North Tank Farm), (TH-1, TH-2, TH-3, & TH-4 South of 3503), (WC-1 Isotopes Circle), (WC-15 & WC-17 4500 Area).

C. Tank User Divisions: Environmental Restoration

D. Tank Data Table:

Tank No.	Date of Install.	Tank Loc.	Cap. (gal)	Material of Const.	Double Ctnment	Cathodic Prot.
W-1	1943	BT	4800	C	no	NA
W-2	1943	BT	4800	C	no	NA
W-3	1943	BT	42500	C	no	NA
W-4	1943	BT	42500	C	no	NA
W-13	1945	BT	2000	SS	no	no
W-14	1945	BT	2000	SS	no	no
W-15	1945	BT	2000	SS	no	no
W-1A	1951	BT	4000	SS	no	no
TH-1	1948	BT	2500	SS	no	no
TH-2	1952	BT	2400	SS	no	no
TH-3	1952	BT	3300	SS	no	no
TH-4	1952	BT	14000	C	no	NA
WC-1	1950	BT	2150	SS	no	no
WC-15	1951	BT	1000	SS	no	no
WC-17	1951	BT	1000	SS	no	no

Legend:
AGV—above-ground vault
IGV—in-ground vault
BT—Buried tank
NA—not applicable
SS—stainless steel
CS—carbon Steel
C—concrete

E. Original or Past Tank Usage:

Tanks W-1 through W-4 and W-1A received waste from Building 3019, a radiochemical processing facility. The principal radionuclides in the waste were cesium, strontium, and TRUs. Tanks W-1 through W-4 were taken out of service in the early 1960s, and tank W-1A was taken out of service in 1986 because of leaks. The tanks were emptied when removed from service.

Tanks W-13, W-14, and W-15 were connected to the metal waste drains from the Radiochemical Processing Facility, Building 3019, but also collected chemical waste from recovery of fission products. The tanks were taken out of service in 1958.

Tanks TH-1, TH-2, TH-3, and TH-4 received waste from the irradiated thorium and uranium pilot development plant development projects in Building 3503. The tanks were taken out of service in 1970.

WC-1 was used to collect and monitor process liquid waste from isotopes production and development laboratories in Buildings 3038, 3028, 3029, 3030, 3031, 3032, 3033, 3047, the filter in Building 3110, the stack in 3039, and the scrubber in 3092. The tank was taken out of service in 1968 because of a leaking discharge line.

Tanks WC-15 and WC-17 were used to collect LLLW from research laboratories in Building 4500. Tanks WC-15 and WC-17 were taken out of service in the 1960s (exact date unknown) because of leaks.

F. Waste Characterization:

The results of a previous sampling campaign revealed that the North Tank Farm varies from tanks with only liquids (W-1, W-2, and W-1A) to tanks that contain a liquid phase and a sludge with transuranic and toxic metals (W-3 and W-4).

Tanks W-13, W-14, W-15, TH-1, TH-2, TH-3, WC-1, WC-15, WC-17, and W1-A contain little or no sludge. The liquid phase contains low levels of radioactivity. Tank WC-15 contains an organic layer within the liquid phase.

Tank TH-4 is a medium sized Gunite tank that contains large quantities of sludge but is not known to leak.

Exhibit B.4. Data summary for the Category D, Group 4 inactive LLLW tank systems

A. Tank Group Name: Group 4

B. Tank Group Location: ORNL Bethel Valley Area: (T-30 south of 4507), (W-19 & W-20 South Tank Farm), ORNL Melton Valley Area: (7560 and 7562 Homogenous Reactor Experiment).

C. Tank User Divisions: Environmental Restoration

D. Tank Data Table:

Tank No.	Date of Install.	Tank Loc.	Cap. (gal)	Material of Const.	Double Ctnment	Cathodic Prot.
T-30	1961	IGV	825	SS	yes	NA
7560	1957	BT	1000	SS	no	no
7562	1957	BT	12000	SS	no	no
W-19	1955	BT	2250	SS	no	no
W-20	1955	BT	2250	SS	no	no

Legend: **AGV**—above-ground vault; **IGV**—in-ground vault; **BT**—Buried tank; **NA**—not applicable; **SS**—stainless steel; **CS**—carbon Steel; **C**—concrete

E. Original or Past Tank Usage:

Tank T-30 was used to store radioactive materials for the Curium Recovery Facility, Building 4507, which later became the High Radiation Level Chemical Recovery Facility. The out of service date for the tank is unknown.

Tank 7560 was originally used as a waste tank for the Homogenous Reactor Experiment (HRE) and later used as the clean vapor condensate tank for HRE-2. Tank 7562 was used as a waste tank for the HRE. The tanks were removed from active service in 1961.

Tanks W-19 and W-20 were used to collect waste produced from recovery and reprocessing of uranium and other nuclear material from the Metal Recovery Facility in Building 3505. The tanks were removed from service in 1960.

F. Waste Characterization:

The results of a previous sampling campaign revealed that the Group 4 tanks contain an aqueous phase with little or no sludge or are empty (7560, W-19, and W-20).

Exhibit B.5. Data summary for the Category D, Group 5 inactive LLLW tank systems

A. Tank Group Name: Group 5

B. Tank Group Location: Bethel Valley; (H209) West of Building 3517, (3001-B) South of Building 3001, (3003-A) South of Building 3003, (3004-B) East of Building 3008, (3013) South of Building 3013, (3001-S) South of Building 3001, and Melton Valley; (7503A) Northwest of Building 7503.

C. Tank User Divisions: Environmental Restoration

D. Tank Data Table:

Tank No.	Date of Install.	Tank Loc.	Cap. (gal)	Material of Const.	Double Ctnment	Cathodic Prot.
H-209	1961	BT	2500*	SS	no	no
3001-B	1943	BT	75*	SS	no	no
7503-A	1962	IGV	11000	SS	yes	NA
3003-A	1943	BT	16000	C	no	NA
3004-B	1956	IGV	30	SS	yes	NA
3013	1949	BT	400	SS	no	no
3001-S	Unknown	BT	2000*	SS	no	no

Legend:
AGV—above-ground vault; SS—stainless steel
IGV—in-ground vault; CS—carbon Steel
BT—buried tank; C—concrete
*—best estimate; NA—not applicable

E. Original or Past Tank Usage:

Tank H209 was used for condensate and floor drain holdup from Building 3517. The out of service date for this tank is unknown.

Tank 3001-B is thought to have been a hold up tank for hot lab drains in Building 3001. The tank was taken out of service in 1965.

Tank 7503A was a waste holding tank for the Molten Salt Reactor Experiment. The out of service date is unknown.

Tank 3003-A received LLLW from three cells and a stack in Building 3003. Building 3003 was the air-handling building for the graphite reactor (Building 3001). Because it was the air handling system, condensate from this equipment is expected to be contaminated with low levels of fission products. The tank was taken out of service in 1965.

Tank 3004-B was a waste holding tank for the Low Intensity Test Reactor. The out-of-service date is unknown.

Tank 3013 is connected to the drains in Building 3013. Building 3013 was originally an environmental processing laboratory that dealt with low-level contaminated environmental samples. The out-of-service date is unknown.

Tank 3001S is a tank that is shown on engineering drawings to be located south of Building 3001. This area is currently a parking lot, and the standpipes shown on the drawings are not visible. Investigative work is under way to determine if this tank exists.

F. Waste Characterization:

These tanks have not been evaluated.

Exhibit B.6. Data summary for the Category D, Group 6 inactive LLLW tank systems

A. Tank Group Name: Group 6

B. Tank Group Location: Bethel Valley Area: (3002A south of Building 3002), 4501-P in Building 4501), (S-424 in Building 3517), (WC-4 west of Building 3026), (WC-5, WC-6, and WC-8 south of Building 3503), (W-12 South Tank Farm), (W-1I under Building 3028), (W-17, and W-18 South Tank Farm), and (WC-11 through WC-14 south of Building 3587). Melton Valley Area: (T-14 in NHF),

C. Tank User Divisions: Chemical Technology, Waste Operations, Analytical Chemistry, Metals and Ceramics, Chemistry, Health and Safety Research, Office of Environment, and Safety and Health Compliance

D. Tank Data Table:

Tank No.	Date of Install.	Tank Loc.	Cap. (gal)	Material of Const.	Double Ctnment	Cathodic Prot.
3002-A	1943	BT	1600	SS	no	no
T-14	1979	BT	48500	C	no	no
4501-C	unknown	IGV	100	SS	yes	NA
S-424	1955	IGV	500	SS/GL	yes	no
WC-4	1944	BT	1700	SS	no	no
WC-5	1952	BT	1000	SS	no	no
WC-6	1952	BT	500	SS	no	no
WC-8	1952	BT	1000	SS	no	no
W-1I	1959	BT	500	SS	no	no
W-17	1951	BT	1000	SS	no	no
W-18	1951	BT	1000	SS	no	no
WC-11	1951	BT	4000	SS	no	no
WC-12	1951	BT	1000	SS	no	no
WC-13	1951	BT	1000	SS	no	no
WC-14	1951	BT	1000	SS	no	no

Legend:

AGV—above-ground vault	**SS**—stainless steel
IGV—in-ground vault	**CS**—carbon Steel
BT—Buried tank	**C**—concrete
NA—not applicable	**GL**—glass lined

No analysis of contents is available for these tanks. Low level waste is defined as greater than trace levels permitted in process waste, but with activity $\leq$ 2 Ci/gal of ^{90}Sr equivalent and < 100 nCi/g of L emitting transuranic elements.

E. Original or Past Tank Usage:

Tank 3002A was used to collect liquid condensate from Building 3002. Building 3002 was the filter house for the Old Graphite Reactor. The removal-from-service date is unknown.

Tank T-14 was used as an overflow emergency waste tank for the new Hydrofracture Facility. The removal-from-service date is unknown.

Tank 4501-P was used to store waste from the plutonium recovery loop experiment and other waste from experiments in Building 4501. The removal-from-service date is unknown.

S-424 was used to collect highly corrosive chloride-bearing supernate from a precipitation operation.

Tank WC-4 was used as a waste tank for Building 3026. Waste primarily generated from the Roll Up Process, which involved dissolving uranium targets and extracting isotopes. The tank was taken out of service in the 1950s.

Tanks WC-5, WC-6, and WC-8 received waste from development projects in Buildings 3508, 3541, and 3592.

Tank W-12 received waste from examination of reactor components in Building 3525.

Tank W-12 received waste from Building 3525 through Tank F-501. The removal-from-service date is unknown.

Tanks W-17 an W-18 served as waste tanks for isotope production in Building 3026.

Tank W-1l was used to collect waste liquids from isotope recovery operations in Building 3028. The exact removal-from-service date is unknown.

Tanks WC-11, WC-12, WC-13 and WC-14 were used as waste tanks for the 4500 complex.

F. Waste Characterization:

These tanks have not been evaluated.

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