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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

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PREFACE

This is the first revision of this document, which was originally issued in March 1992 as ES/ER-17&D1. It describes the strategy for meeting the Federal Facility Agreement requirements at Oak Ridge National Laboratory, summarizes the progress that has been made to date, and revises the plans and schedules that were submitted in the March 1992 issue of this document. The revisions reflect the technical and budgetary changes that have emerged as program implementation has proceeded, and this document will continue to be periodically reassessed and refined to reflect newly developed information and progress.

Revisions in the text are indicated by vertical bars in the margins of the document.

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TABLES AND EXHIBITS

ABBREVIATIONS

AAP	alternatives assessment plan
ALARA	as low as reasonably achievable
ALI	annual limits on intake
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
CPF	cancer potency factor
CRV	cancer reference volume
CSF	cancer slope factor
CWCH	central waste collection header
D&D	decontamination and decommissioning
DAA	detailed alternatives assessment
DAC	derived air concentrations
DCF	dose conversion factor
DCG	derived concentration guide
DOE	U.S. Department of Energy
DOE-OR	DOE Oak Ridge Field Office
EDE	effective dose equivalent
Energy Systems	Martin Marietta Energy Systems, Inc.
EPA	U.S. 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
HRE	Homogeneous Reactor Experiment
HRLAL	High-Radiation-Level Analytical Laboratory
HRLEL	High-Radiation-Level Examination Laboratory
ICM	interim corrective measure
ICRP	International Commission on Radiological Protection
IMET	Irradiated Materials Examination and Testing Facility
LIP	line item project
LLLW	liquid low-level radioactive waste
LLW	low-level radioactive waste
MCL	maximum concentration limit
MVLLW-CAT	Melton Valley low-level waste collection and transfer
MVPS	Melton Valley Pumping Station
MVST	Melton Valley Storage Tanks
NCRP	National Council on Radiation Protection
NEPA	National Environmental Protection Act

NHF	New Hydrofracture Facility
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
NRV	noncancer reference volume
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
RFD	reference dose
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
SIA	structural integrity assessment
TAG	Technical Advisory Group
TDEC	Tennessee Department of Environment and Conservation
TI	toxic index
TRU	transuranics
TSD	treatment, storage, and disposal
UST	underground storage tank
WAG	waste area grouping
WM	Waste Management
WMRAD	Waste Management and Remedial Action Division
WOC	White Oak Creek
WOCC	Waste Operations Control Center
WOL	White Oak Lake
WT	working team (Energy Systems)

GLOSSARY

ES&H tank system. A 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 that 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.

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 passage of a hazardous liquid through the primary containment or through the secondary containment structure at a rate greater than or equal to the criteria established in the *Leak Testing Plan for the Oak Ridge National Laboratory Liquid Low-Level Waste System (ORNL/ER/Sub/92-SK263/1)*

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 waste tank(s).

EXECUTIVE SUMMARY

This is the first revision of this document, which was initially issued in March 1992 as ES/ER-17&D1. It describes the strategy for meeting the Federal Facility Agreement requirements at Oak Ridge National Laboratory (ORNL), summarizes the progress that has been made to date, and revises the plans and schedules that were submitted in the initial issue of this document. The revisions reflect the technical and budgetary constraints that have emerged as program implementation has proceeded.

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 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 U.S. Environmental Protection Agency (EPA), the U.S. Department of Energy (DOE), and the Tennessee Department of Environment and Conservation (TDEC). The agreement went into effect on 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 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. It requires the DOE to remove leaking tank systems from service. Only if a system's immediate removal would result in unacceptable consequences to people or the environment can leaking tanks remain temporarily in service. Five such tank systems, referred to as "environmental, safety, and health (ES&H) systems, are identified in Chapter 1, and the rationale for this determination is explained in Chapter 4. The FFA also requires that singly contained tank systems be assessed to ensure they are safe until they can be removed from service. Further, the FFA requires DOE to demonstrate that doubly contained tank systems are structurally sound and capable of containing any spills or leaks.

ORNL has a comprehensive program underway to upgrade the LLLW system as necessary to meet the FFA requirements. The tank systems that are removed from service are being investigated and remediated through the CERCLA process. These systems are also being evaluated for early actions, emptied and stabilized as necessary, and monitored while the CERCLA remedial investigation/feasibility study (RI/FS) process is under way. The systems were prioritized for evaluation using the risk characterization plan described in Chap. 7. Waste and risk characterizations are being submitted in accordance with the schedules in Chap. 7. Additional data will be prepared and submitted to EPA/TDEC as required by the RI/FS process.

The plans and schedules for implementing the FFA compliance program that were submitted to EPA/TDEC in March 1992, in the initial issue of this document, are updated in this revision. Chapter 1 provides general background information and philosophies that lead to the plans and schedules that appear in Chaps. 2 through 7.

ORNL has been proactive in moving to meet FFA requirements. Fifty-two singly contained tanks were removed from service in the two years preceding the FFA effective date. Implementation activities during 1992 are discussed in this document. Milestones achieved during this period include submittal to EPA/TDEC of the following:

- a schedule for conducting secondary containment design demonstrations for doubly contained tank systems (ORO-91-331-001),
- a schedule for removing singly contained tanks from service (ORO-91-331-002),
- a schedule for periodic review and revision of the structural integrity assessments of singly contained tanks that temporarily remain in service (ORO-91-331-003),
- a schedule for evaluating the structural integrity assessments of singly contained tanks that temporarily remain in service (ORO-91-331-004),
- a schedule for providing waste characterization information for tank systems that are removed from service (ORO-91-331-005),
- a schedule for providing risk characterization information for tank systems that are removed from service (ORO-91-331-006),
- a plan for characterizing the risk for tank systems that are removed from service, and
- risk assessments for the ES&H tank systems.

In addition, the following documents were submitted to EPA/TDEC in accordance with the commitments made in the March 1992, submission of this document:

- the Leak Testing Plan for the Oak Ridge National Laboratory Liquid Low-Level Waste System (Active Tanks), ORNL/ER/Sub/92-SK263/1,
- the Waste Characterization Data Manual DOE/OR/01-1159 & D1 (supercedes ES/ER-80) for the Category D tanks,
- the first submittal of Risk Characterization Data Manual ORNL/ER/Sub/90-W068/1 for the Category D tanks,
- the Design Demonstrations Category-B Tank Systems, DOE/OR/01-1047,
- the Detailed Leak Detection Test Plan and Schedule for the Oak Ridge National Laboratory, LLLW Active Tanks (DOE/OR/01-1129&D1),
- Secondary Containment Design Demonstrations for the 19 Remaining LLLW Tanks, DOE/OR/03-1150&D1, and

- The Remediation Schedule for Inactive Liquid Low Level Waste Storage Tanks at ORNL, DOE/OR/01-1138&D1.

The ORNL tank systems to which the FFA applies are listed in Fig. 1.2 of this report and in Appendix F of the FFA. Periodic changes occur in tank categories as tank systems are tested, upgraded, removed from service, or for other reasons as agreed by the FFA signatories. Because of the time required to revise the FFA or this report, the lists in these documents may not reflect the latest approved status of some tanks. Any approved change in tank status that deviates from that shown in FFA Appendix F or this report will be supported by documentation on file in the Environmental Restoration Document Control Center and the Waste Management and Remedial Action Division Document Management Center. The FFA requirements applicable to each tank system are those for the latest approved category of that system.

1. BACKGROUND MATERIAL AND STRATEGY

1.1 INTRODUCTION

The Superfund Amendments and Reauthorization Act 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. The Oak Ridge Reservation was placed on that list on December 21, 1989, and the agreement was signed in November 1991 by the Department of Energy Oak Ridge Field Office (DOE-OR), the U.S. Environmental Protection Agency (EPA)-Region IV, and the Tennessee Department of Environment and Conservation (TDEC). The effective date of the FFA was January 1, 1992. Section 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, schedules, and assessments that must be submitted to EPA/TDEC for review or approval. The initial issue of this document in March 1992 transmitted to EPA/TDEC those plans and schedules that were required within 60 to 90 days of the FFA effective date. The current revision of this document updates the plans, schedules, and strategy for achieving compliance with the FFA, and it summarizes the progress that has been made over the past year. Chapter 1 describes the history and operation of the ORNL LLLW System, the objectives of the FFA, the organization that has been established to bring the system into compliance, and the plans for achieving compliance. Chapters 2 through 7 of this report contain the updated plans and schedules for meeting FFA requirements. This document will continue to 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, Bldg. 3019), nuclear reactors, radioisotope production facilities, and the Process Waste Treatment Plant (PWTP). DOE Order 5820.2A defines low level radioactive waste as waste that contains radioactivity and that is not classified as high-level waste, transuranic waste, or spent nuclear fuel or its byproducts. The ORNL waste acceptance criteria for LLLW allows solutions containing radioactivity above the trace levels permitted in the Process Waste Treatment system with the following provisions.

1. Solutions must have an activity level ≤ 2 Ci/gal (1.95 × 10^{10} Bq/L);

2. Solutions containing ^{233}U, ^{235}U, ^{239}Pu, or ^{241}Pu must be mixed with depleted uranium or natural thorium so that the resultant solution will contain at least 100 parts by weight of ^{238}U or ^{232}Th per part by weight of the fissile isotope(s);

3. Solutions containing TRU isotopes or ^{233}U which are added to the LLLW system must not have a total specific activity from those nuclides greater than 3.7 × 10^6 Bq/kg (100 nCi/g); and

4. Beta-gamma emitting waste greater than 5 × 10^{10} Bq/L (5 Ci/gal) and high toxicity alpha and TRU waste greater than 3.7 × 10^6 Bq/kg (100 nCi/g) must be diluted to levels below those limits prior to discharge.

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 their initial pH may be low, LLLW solutions often must be neutralized with sodium hydroxide (NaOH). The solutions are 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). LLLW collection tanks are equipped with liquid-level instrumentation with high-level and low-level alarms to alert the Waste Operations Control Center (WOCC) of unusual conditions. 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 a central off-gas collection and filtration system operating at a negative pressure or through an individual tank filter system.

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 older 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 during

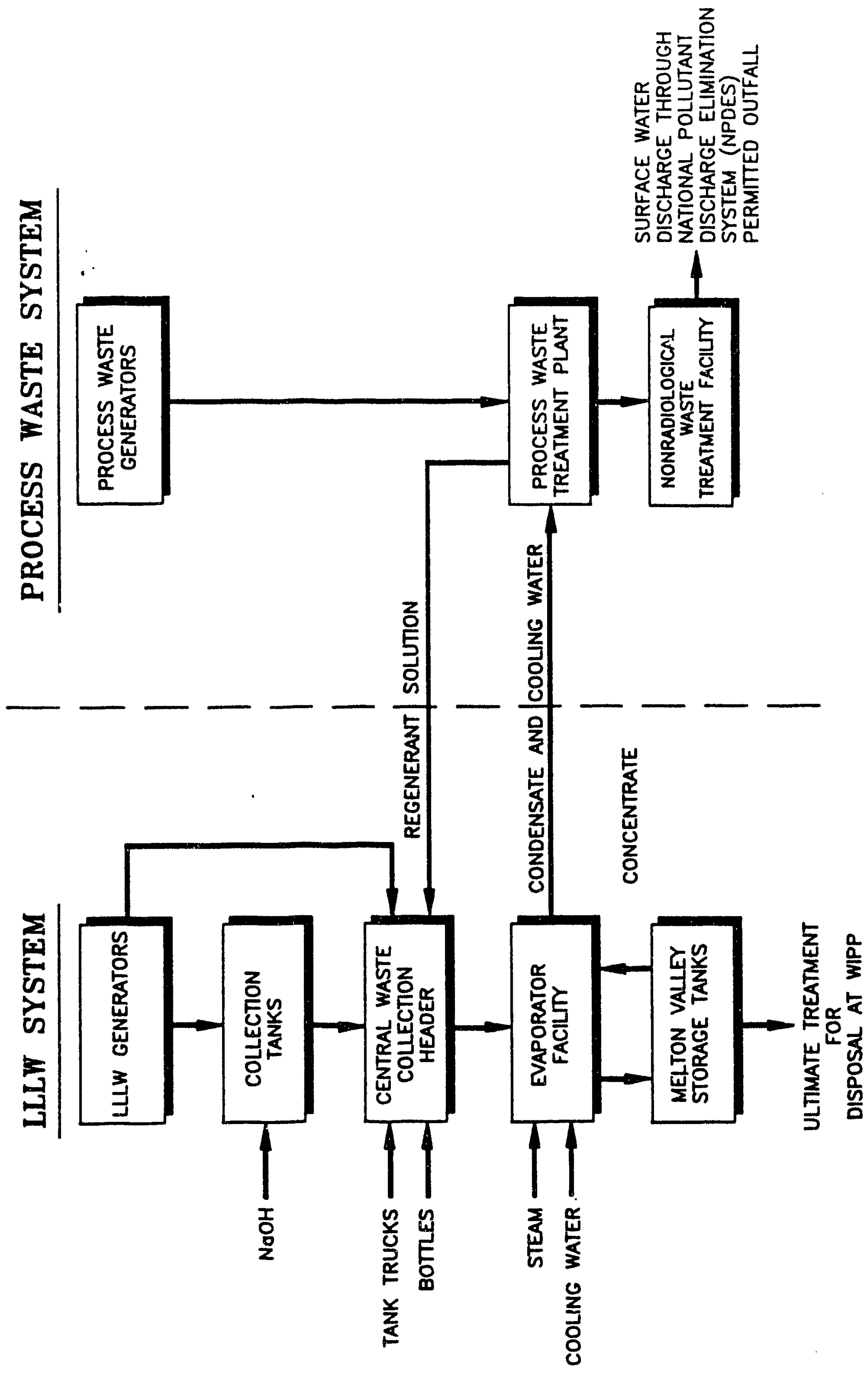

Fig. 1.1. Block flow diagram for the ORNL LLLW system.

the past 10 to 15 years, secondary containment and improved leak detection features were provided. The LLLW system is a mix of singly and doubly contained tank systems. The portions of the system that have been removed from service consist almost exclusively of tanks without secondary containment.

1.3 FFA OBJECTIVES

The objectives of the FFA are to ensure (1) that active tank systems slated to remain in service over the long term comply with the design and containment requirements specified in FFA Appendix F, Subsects. B and C, (2) that singly contained tank systems operated in the interim do not leak, and (3) that tank systems that are removed from service are evaluated and remediated through the CERCLA process. Figure 1.2 provides a breakdown of the LLLW tank systems by FFA category as proposed. Section 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 system, and Sect. 1.7 discusses the tank systems that are removed from service.

1.4 MANAGEMENT, ORGANIZATION, AND RESPONSIBILITIES

The DOE and Energy Systems organizational structure for managing ORNL LLLW system FFA activities is shown in Fig. 1.3. Two DOE-ORO divisions under the Assistant Manager for Environmental Restoration and Waste Management have primary responsibility for the FFA: the Waste Management and Technology Development Division and the Environmental Restoration (ER) Division. The DOE Assistant Manager for Energy Research and Development and other DOE organizations provide support. Two corresponding Energy Systems organizations have primary responsibility for FFA planning and implementation: the Energy Systems ER Division and the ORNL WM 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 Sect.1.4.2.

1.4.1 Department of Energy

1.4.1.1 Assistant Manager for Environmental Restoration and Waste Management

The office of the Assistant Manager for Environmental Restoration and Waste Management is responsible for implementing the ER Program, including the FFA. Implementation is accomplished through two divisions, the DOE-ORO ER Division and the DOE-ORO Waste Management and Technology Development Division.

DOE-ORO Environmental Restoration Division. The DOE-ORO ER Division provides coordination of DOE FFA activities for ORNL. This division has overall responsibility and authority for ER Program planning and execution, including FFA compliance and remediation of all tank systems in Category D. In addition, the Division is responsible for negotiating

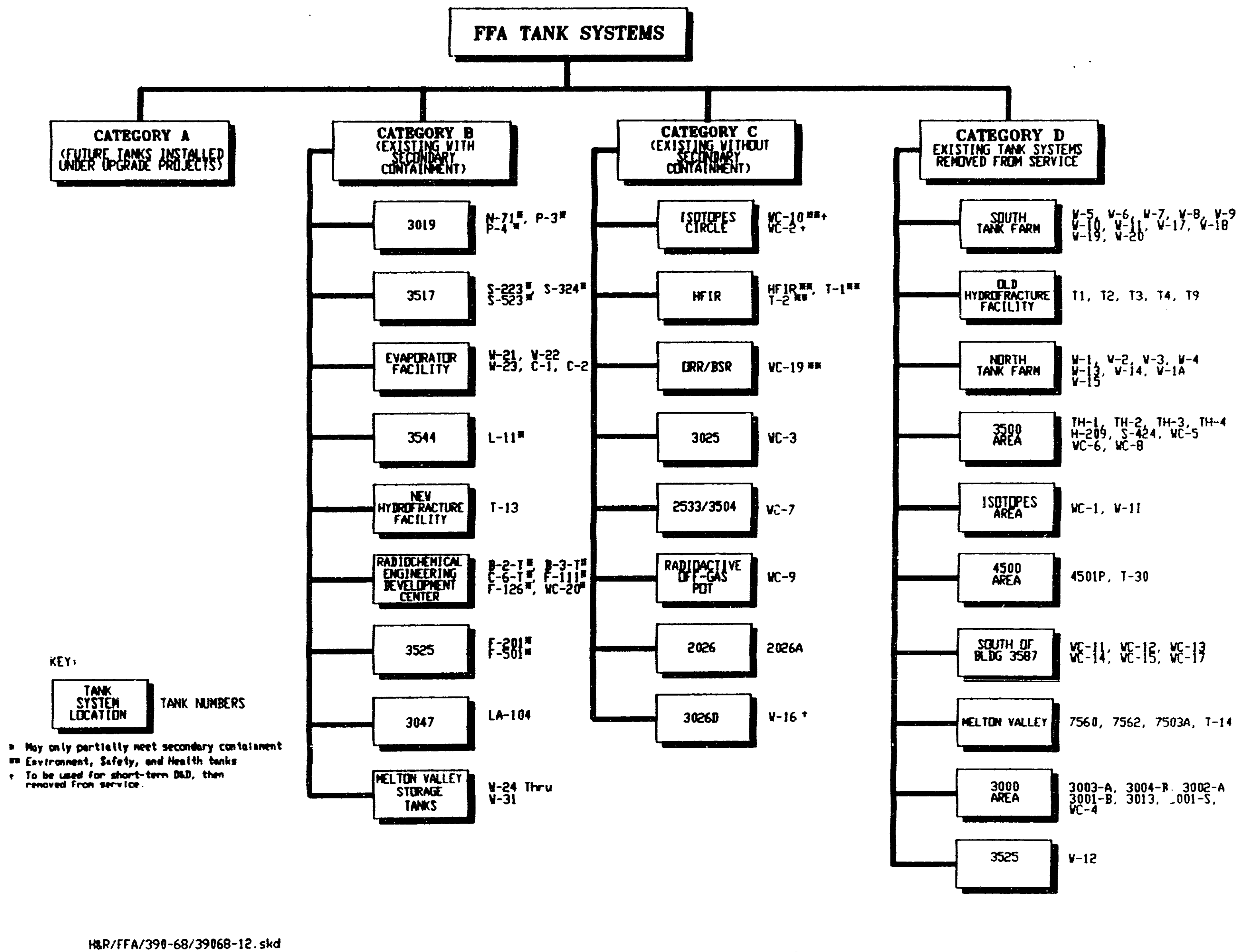

Fig. 1.2. ORNL LLLW tank systems by FFA category.

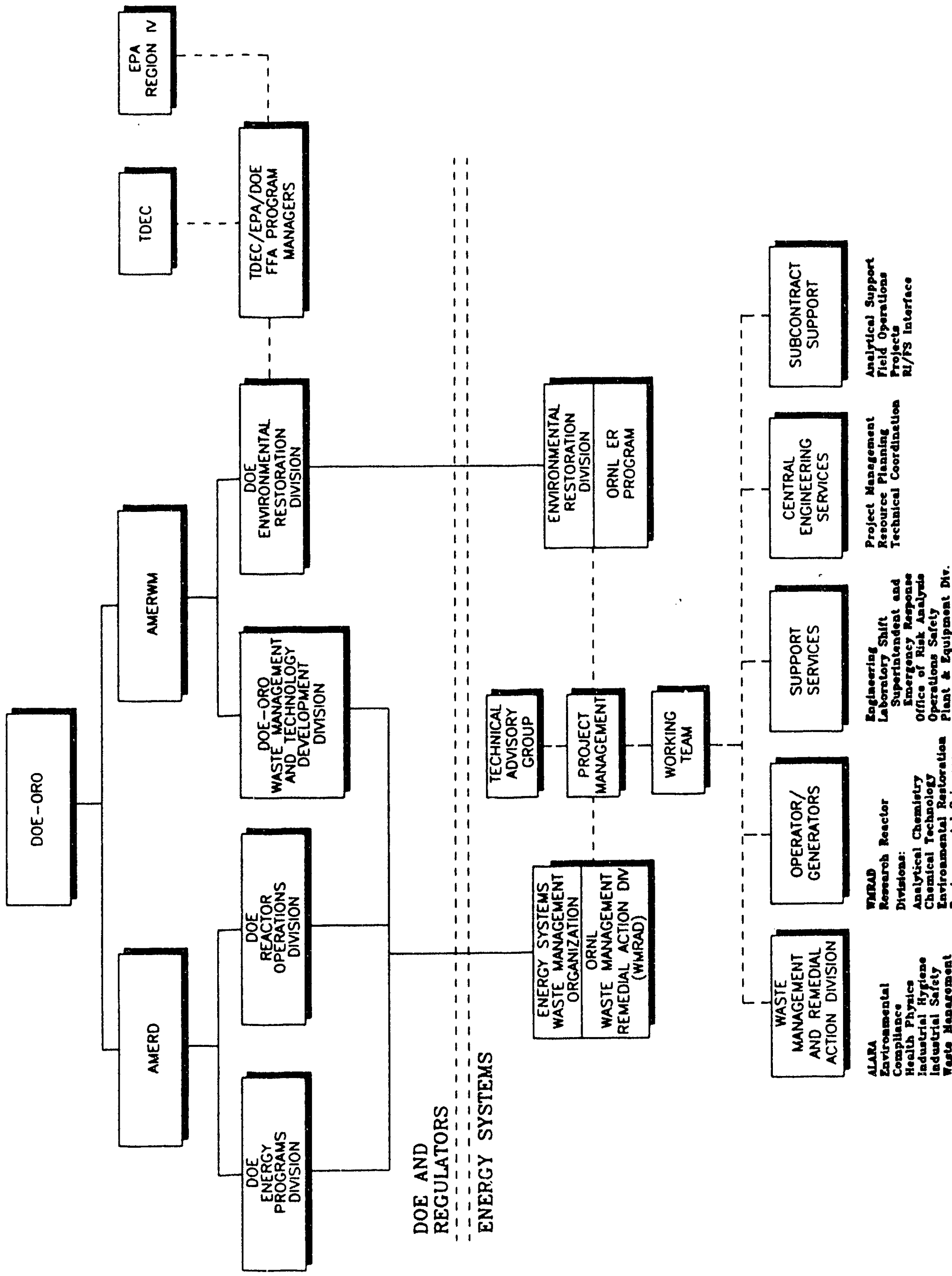

Fig. 1.3. Project organization chart for ORNL LLLW system FFA compliance activities.

changes to the FFA through the DOE FFA Program Manager. The Division's responsibilities are discussed in detail in DOE-OR 931.[1]

DOE-ORO Waste Management and Technology Development Division. This Division is responsible for overall DOE management of the LLLW system at ORNL, including FFA Category A-C tank systems and Category D systems until they are transferred to the EP program. It interfaces with Energy Systems WMRAD through the Energy Systems WM Organization.

1.4.1.2 Assistant Manager for Energy Research and Development

The Energy Programs Division and the Reactor Operations Division report to the Assistant Manager for Energy Research and Development, who is responsible for managing LLLW piping within production and research and development 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 Assistant Manager identifies plans for removing production and research and development facility LLLW tank systems from service and transferring them to the Assistant Manager for Environmental Restoration and Waste Management. The Assistant Manager for Energy Research and Development 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. This group is also responsible for ensuring compliance with environmental, safety, and health requirements.

1.4.1.3 Assistant Manager for Construction and Engineering

The Assistant Manager for Construction and Engineering 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 Waste Management Organization and Environmental Restoration Division are primarily responsible for ORNL FFA activities. The responsibility for day-to-day activities is delegated to the ORNL WMRAD and the ORNL ER Program. Other Energy Systems organizations also play significant roles in FFA-related LLLW activities, including Engineering, Environmental Safety and Health, the operating divisions, and the Energy Systems Waste Management Organization. Program coordination is provided by an FFA Working Team composed of representatives from the involved organizations, and technical consultation is provided by an independent Technical Advisory Group. 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 WM operations. This includes program management for upgrading the ORNL LLLW system to meet FFA requirements.

1.4.2.2 Energy Systems Environmental Restoration Division

The Energy Systems ER Division is responsible for managing and remediating the ORNL Category D tank systems that have been accepted into the ER 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 ER 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 coordinating and preparing 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 ER Division, Engineering, Chemical Technology, and other ORNL divisions that generate LLLW. 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 FFA Configuration Control Board

The FFA Configuration Control Board is composed of representatives from WMRAD, Engineering, ALARA, Chemical Technology, Environmental Compliance, Quality Assurance, Environmental Restoration, Remedial Action, Decommissioning and Decontamination, and DOE-ORO Waste Management and Technology Division. The Configuration Control Board is chartered to monitor and control all technical aspects of the LLLW System to ensure compliance with the FFA.

1.4.2.8 Technical Advisory Group (TAG)

The TAG is a group of experts who are nationally recognized in technical fields that relate to FFA activities. Table 1.1 lists the TAG members and summarizes their qualifications. The TAG was established by Energy Systems to provide independent technical 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 may include any ORNL FFA program activities. The TAG operates as an independent group that meets approximately three times per year. The TAG issues formal reports after each meeting to document its recommendations.

1.5 STRATEGY FOR MEETING THE FFA OBJECTIVES

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 that meet all FFA requirements
- Category C: existing tank systems without secondary containment, and
- Category D: existing tank systems that have been removed from service.

A list of the ORNL LLLW tank systems by category is included in FFA Appendix F, Table 1 and Fig. 1.2 of this report. This list is subject to change as tank systems are upgraded, removed from service, or remediated. The list may also require revision as structural integrity assessments (SIAs) and secondary containment design demonstrations are completed, or for other reasons as agreed to by the FFA signatories. Because of the time required to issue formal changes to the FFA, the tank list in Appendix F (and the list in this document) may not reflect the current status of each tank. In all such cases, documentation describing the changes in tank status will be on file in the ER Document Center and the Waste Management and Remedial Action Division (WMRAD) Data Management Center. The FFA requirements for each tank system are those that apply to the tank category for which approval is documented (not necessarily the category that currently appears in FFA Appendix F or in this report).

1.5.1 Integrated LLLW System Strategy

ORNL's basic strategy for meeting the objectives of the FFA includes evaluating the risks to health and the environment associated with noncomplying tanks and components and then effectively allocating available funds to reduce that risk. This section provides an overview of the plans for meeting the objectives of the FFA. Figure 1.4 illustrates the overall process

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

Name	Background	Experience	Organization
Percy Brewington	B.S. Civil Engineering	Project management Strategic Petroleum Reserve Gas Centrifuge Enrichment Project	Consultant Oak Ridge, Tennessee
Milton Levenson	B.S. Chemical Engineering; M.B.A.	National Academy of Engineering Member of several advisory committees Argonne National Laboratory Associate Laboratory Director, H. E. Wilson AIChE Award	Consultant Menlo Park, California
Frank Parker	Ph.D. Civil Engineering	National Academy of Engineering IAEA—Radioactive waste disposal Waste risk analysis	Vanderbilt University Nashville, Tennessee
Ken Wilcox	Ph.D. Chemistry	Leak Detection Equipment and Testing Regulatory Compliance (Underground Storage Tanks) Quality Assurance	Consultant Blue Springs, Missouri
Kent Hepworth	Ph.D., PE, Mechanical Engineering	Professor of engineering and technology, Northern Arizona University; thermal/fluids engineering member of several advisory committees.	Consultant Flagstaff, Arizona

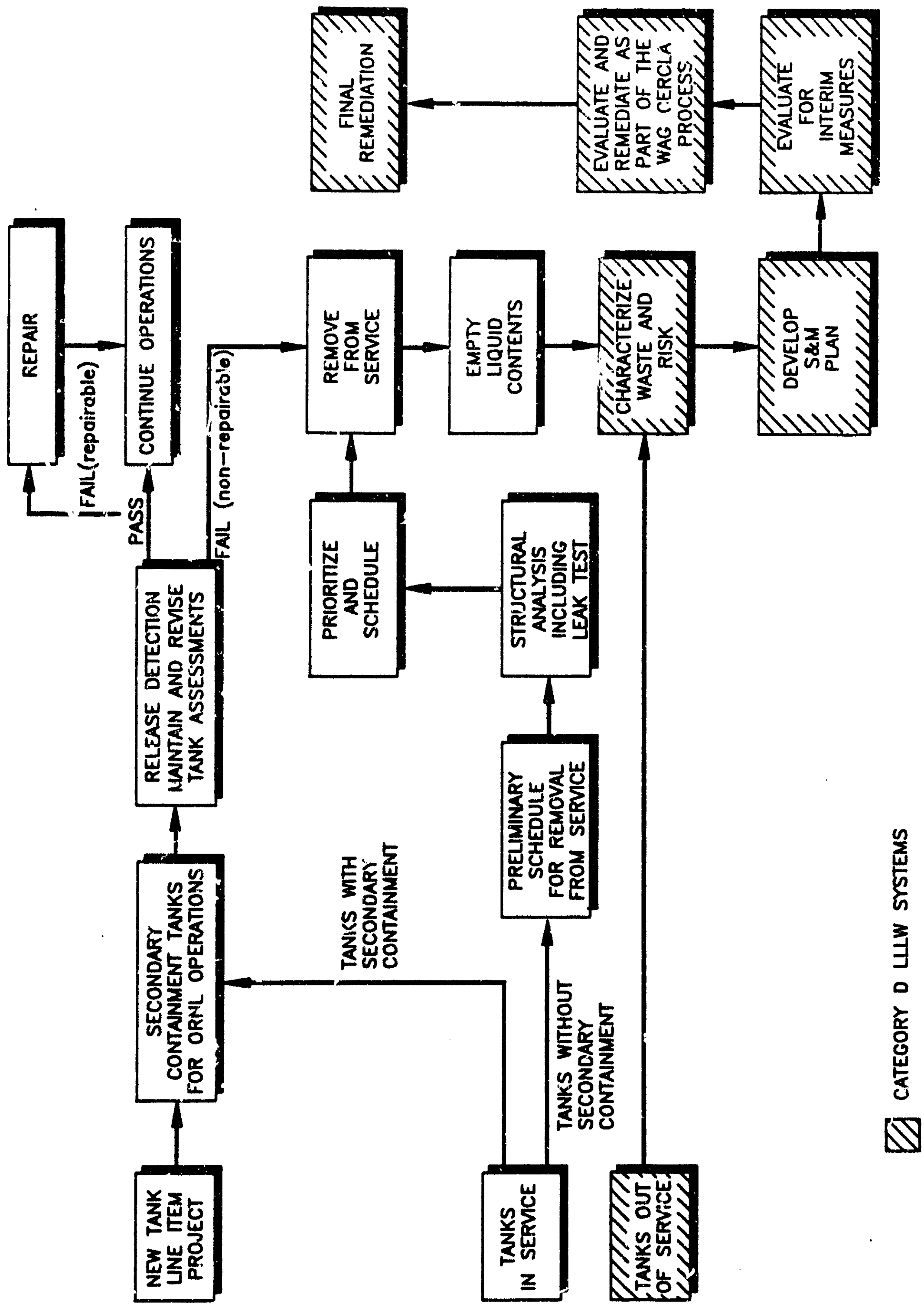

Fig. 1.4. FFA Compliance process.

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for achieving compliance with FFA requirements. Because of the division of organiz tional responsibilities and funding sources, FFA compliance planning and implementation at ORNL is organized on the basis of tank systems that are in service (Category A-C) and those that have been removed from service (Category D). The FFA Working Team described in Sect. 1.4.2.6 functions as the coordinating body to integrate activities between these two areas.

1.5.1.1 Category B and C LLLW tank systems

Category A tank systems are new, fully complying systems that will be installed after the effective date of the FFA. Figure 1.5 illustrates the strategy for meeting FFA objectives for the LLLW tank systems of categories B and C. This strategy incorporates several decision nodes.

At the first node, the need for the tank system is determined. Any tank system that is no longer required to support ORNL programs is identified for removal from service. Plans have been prepared to replace all singly contained tank systems that remain in service with systems that fully meet FFA requirements.

At the second decision node, systems suspected of leaking were deactivated before the effective date of the FFA. Exceptions are the ES&H tank systems that cannot be shut down immediately (refer to Chap. 4). At that point a decision was made as to whether tank systems suspected of leaking would be repaired or removed from service.

At the final decision node (secondarily contained versus singly contained) plans for secondary containment design 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 to remain temporarily in operation, and/or (2) upgrade or replacement. Four Category B tank systems (S-223, S-324, S-523 and LA-104) and three Category C tank systems (WC-10, W-16 and WC-2) will be used for decontamination activities through FY 2002. If no future uses are identified, these systems are expected to be removed from service by the end of FY 2003.

1.5.1.2 Category D LLLW tank systems

The Category D tank systems are listed in Fig. 1.2. The FFA remediation process for these tanks, which follows the CERCLA requirements, is indicated by the cross-hatched blocks in Fig. 1.4. Upon removal from service, system contents are characterized and prioritized for further evaluation. Each Category D tank system will be evaluated to determine whether it requires interim actions 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.

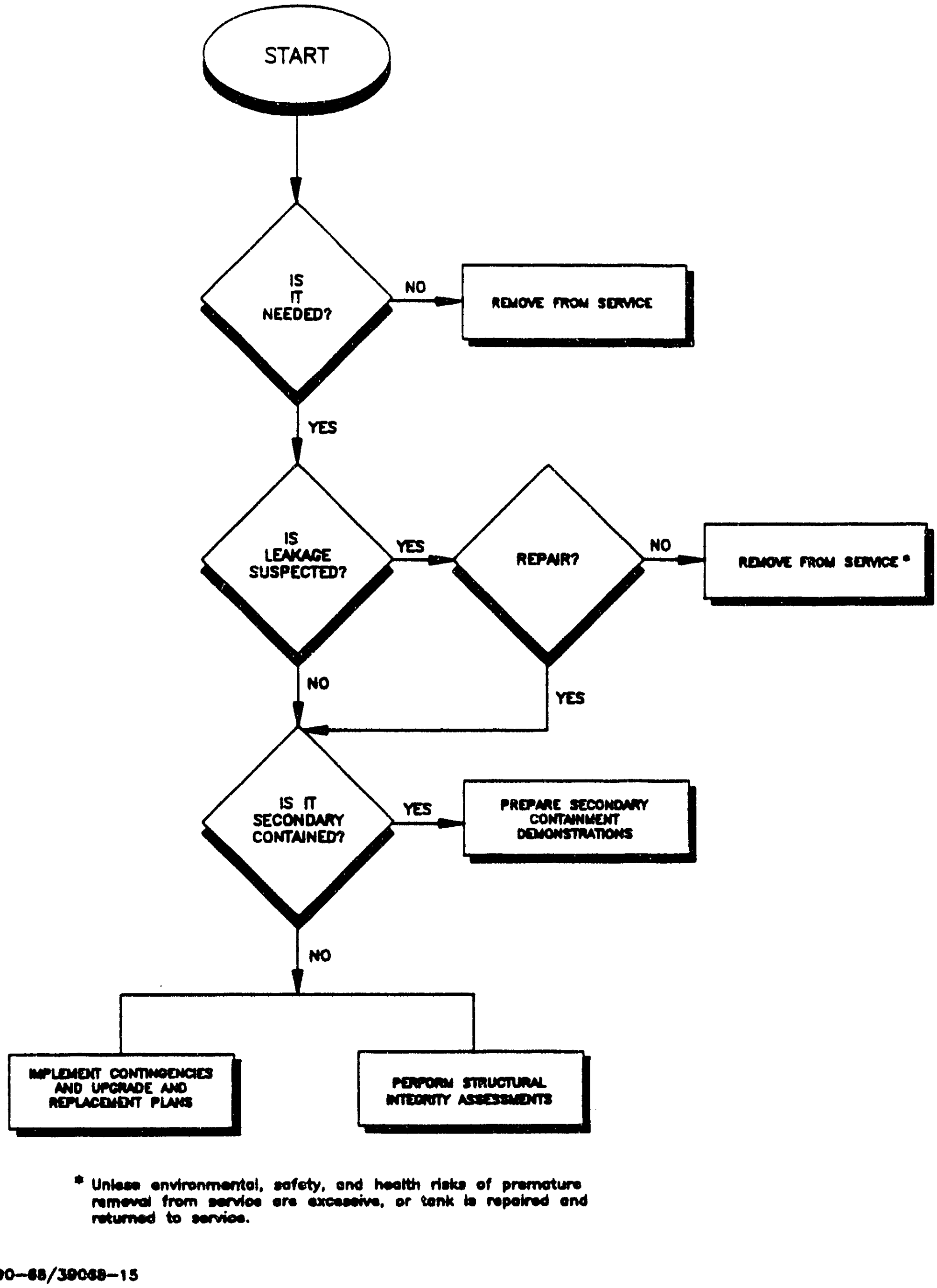


Fig. 1.5. Active LLLW tank systems compliance strategy.

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 DOE's interpretations of the FFA requirements. Realistic technical and fiscal constraints based on requested funding levels have been applied to the FFA compliance strategies. Near-term fiscal resources 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 Category B and C LLLW tank systems. For the Category D tank systems, the emphasis is on tank characterization, removal of liquids when practical, and evaluation of the tanks for interim actions. Assumptions regarding leak testing, structural integrity assessment, upgrade, and replacement for the Category B and C systems and evaluation, implementation of interim actions, maintenance and surveillance, and final remediation for the Category D tanks will be refined as additional information becomes available. Annual updates of program milestones are planned. The review and approval cycles of subcontractors, Energy Systems, DOE, EPA, and TDEC may affect 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 LLLW system, depending on the size and complexity of the project. Several major line item projects as well as numerous general plant projects (GPPs) are under way to provide required system upgrades and replacements. Approval of funding for remediation of Category D tanks through the CERCLA remedial investigation/feasibility study (RI/FS) process is not expected to require as much time as approval of line item capital projects. However, funding for Category D tank remediation is included in prioritization of funding for all other ER program activities.

Expense projects are those whose funds that are provided annually for research, development, reproduction, etc., in support of routine plant operation, maintenance and repair, or experimental projects.

GPPs are capital construction projects that have a total estimated cost of less than $1.2 million. This limit is congressionally imposed, and the GPP funding level is established annually for ORNL. Each GPP is a stand-alone project. A 4- to 5-year project cycle is required to meet program management and project requirements and constraints. Two years is 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 line item project funding. The schedules in this document assume that sufficient funding will be authorized to allow identified GPPs to proceed as planned.

Line item projects are large capital construction projects with total estimated costs greater than $1.2 million. Each line item project 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, line item projects can take up to 10 years to complete; however, the line item project 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 Table 3.1. The schedules in this document assume that sufficient funding will be authorized to allow identified line item projects to proceed as planned.

Leak testing, particularly for piping and larger tanks, requires the development of new leak-testing technologies and demonstrations to prove the effectiveness of these technologies. 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. Methods currently under development to test components in these systems must overcome formidable technical challenges. Demonstrations of these methods have been incorporated into the detailed leak-testing plan and schedules.

1.6 PLANS AND SCHEDULES BASES FOR CATEGORY B AND C LLLW TANK SYSTEMS

1.6.1 Introduction

The FFA imposes requirements on existing tank systems depending upon whether or not they are doubly contained. Systems that are doubly contained must demonstrate 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 shows no evidence that collapse, rupture, or failure is likely.

1.6.2 Category B 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 doubly contained tanks shown in Fig. 1.2 are located in the following areas:

- Bldg. 3019, RPPP;
- Bldg. 3517, Fission Products Development Laboratory (FPDL);
- Bldg 2531, Radioactive Waste Evaporator;
- Bldg. 7830, MVSTs;
- Bldg. 3525, High-Radiation Level Examination Laboratory (HRLEL);

- Bldg. 3544, PWTP;
- Bldg. 7860, New Hydrofracture Facility (NHF);
- REDC, Bldg. 7920 and Bldg. 7930; and
- Bldg. 3047.

Summary 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.

The schedule for completing demonstrations of the remaining Category B pipelines is presented in Chap. 2. The secondary containment design demonstrations for all tanks have been submitted to EPA/TDEC[9,10]. Chapter 2 describes the results of these demonstrations.

1.6.3 Tank Systems That Do Not Meet Secondary Containment Criteria

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

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

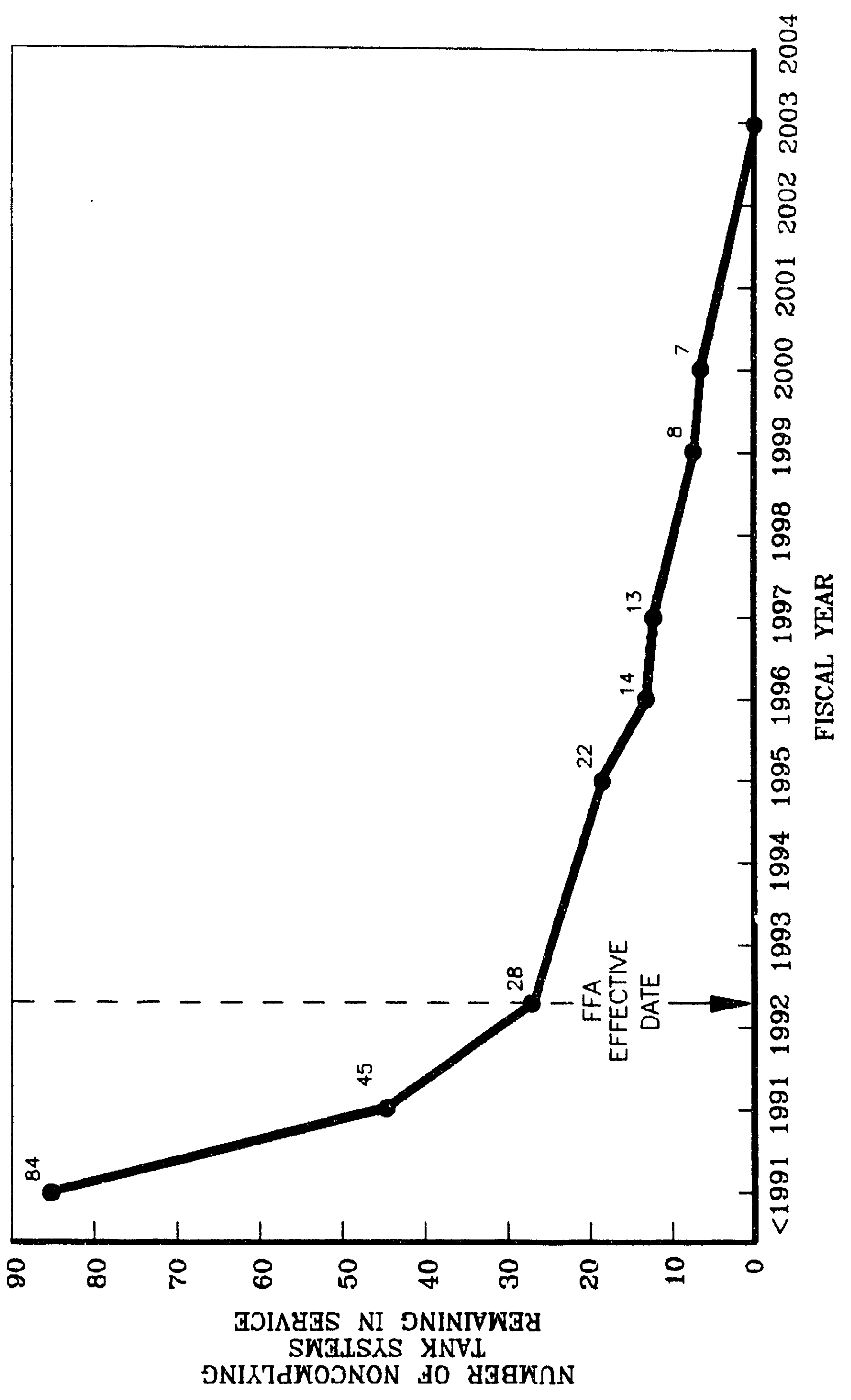
1.6.3.1 Plan and schedule for upgrade or removal of tank systems from service

Section IX.E.1 of the FFA requires a plan for removing from service all LLLW tank systems that cannot meet the secondary containment criteria in FFA Appendix F. Tank systems that partially meet the criteria may be either upgraded or removed from service. Figure 1.6 and Table 1.2 illustrate the current plans for upgrading or removing singly contained tanks from service. Expense-funded projects, GPPs, and line item projects 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 line item projects. Steps have been taken to reduce the number of noncomplying tanks in service as quickly as possible. Figure 1.6 shows that more than 60% of the noncomplying tanks were either surplussed or upgraded to meet FFA requirements in the 2 years before the FFA effective date. Figure 1.6 also shows that, by 2000, only 7 noncomplying tanks (8% of the original number) will be in use. The last 7 tanks are required for shutdown and decontamination of decommissioned ORNL facilities. They do not support operating facilities. The plan and schedule for projects that upgrade systems to fully meet the FFA requirements or remove a system from service are described in Chap. 3 of this report. Projects for interim actions are described in Tables 1.3, 1.4, and 1.5.

Because two of the four line item 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.

The expense-funded projects and GPPs for implementation of interim actions are listed in Tables 1.3 and 1.4. 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 to determine the current status, as well as the future need, for each LLLW tank system. This evaluation resulted in removal from service of a number of tank systems and the remediation of two tanks prior to the effective date of the FFA. Interim waste bottling and trucking stations have been installed at the source to temporarily replace several of these tank systems. Upgrade projects to provide permanent replacement of these systems are in the planning stage. 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.



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* The FFA effective date is January 1, 1992

Fig. 1.6. Schedule of removal from service of LLLW tanks not fully meeting secondary containment and leak detection standards.

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

Year	Tank	Total
1995	2026A, WC-19, P-3, P-4, N-71	5
1996	B-2-T, B-3-T, C-6-T, F-111, F-126, HFIR, T-1, T-2,	8
1997	WC-20	1
1999	F-201, F-501, WC-3, WC-9, WC-7	5
2000	L-11	1
2003	WC-2, WC-10, W-16, S-223, S-324, S-523, LA-104	7

Table 1.3. Expense-funded projects for FFA early actions for active LLLW systems

Funding Year	Title	Scope	Locations of interim upgrades[a]
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.	
1992-93	W-12 Repair	Installs a steam jet on tank W-12 and bypasses the valve pit with the leaking flange until Bethel Valley line item project is complete.	3525
1992-93	3517 Source Treatment	Upgrades filter pit sump to reduce nonprogrammatic waste inputs	3517
1990-94	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 of LLLW; installs temporary trucking station.	REDC
1990	ORR/BSR Contingencies	Adds capability to route ORR/BSR waste to either Process Waste or LLLW	ORR/BSR
1990	4501 Source Treatment	Installs source treatment to reduce radioactivity of LLLW to meet bottling requirements.	4501

Note: Based on FY 1995 Activity Data Sheets (ADS), requested funding level.
[a]See Fig. 1.2 for LLLW tank systems associated with a given facility.

Table 1.4. Capital projects for FFA early actions for singly contained LLLW tank systems

Funding Year	Completion Year	Title	Scope	Tank locations[a]
1992	1995	3000-Area LLW Upgrade	Provides bottling stations for low-volume generators	3000 Complex
1992	1995	4500-Area LLW Upgrade	Provides bottling stations for low-volume generators	4500 Complex
1993	1995	Bldg. 3525 FFA LLLW Upgrade	Modification of existing piping system from Bldg. 3525	3525
1993	1995	FFA Compliance Work, 3025	Provides trucking station for 3025	3025
1993	1995	7930 Filter Pit Cover	Encloses filter pit at REDC	REDC
1993	1995	3108 Filter Pit Enclosure	Encloses filter pit 3108 that services Building 3019	3019
1994	1996	NHF Cell Plugs Enclosures	Eliminates non-programmatic waste generation at 7830 and 7860	New Hydrofracture facility
1995	1997	W-6 Valve Box Upgrade	Upgrades valve box to meet FFA requirements	South Tank Farm
1995	1997	Old Hydrofracture Valve Box Upgrade	Upgrades valve box to meet FFA requirements	Old Hydrofracture Facility
1996	1998	Incinerator Drive Valve Box Upgrade	Upgrades valve box to meet FFA requirements	Melton Valley Facilities
1996	1998	3 GPPs to be defined	Eliminates nonprogrammatic waste generation or upgrades appropriate collection/transport system	
1997	1999	3 GPPs to be defined	Eliminates nonprogrammatic waste generation or upgrades appropriate collection/transport system	
1998	2001	3 GPPs to be defined	Eliminates nonprogrammatic waste generation or upgrades appropriate collection/transport system	

Note: Based on FY 1995 Activity Data Sheets (ADS), requested funding levels.
[a]See Fig. 1.2 for LLLW tanks associated with a given facility.

Table 1.5. Projects for upgrading LLLW secondary containment, leak detection, and system capacity

Year of Fund. (FY)	Projected completion date (FY)[a]	Project title	Project scope	Tank system	Type of funding
1992	1995	FFA Compliance Work, Bldg. 3019A	Doubly contains piping for 3019	N-71, P-3, P-4	GPP
1996	2000	ORNL Process Waste Treatment Facility	Eliminates generation of LLLW by process waste treatment operations	L-11	line item project
1992	1996	Melton Valley LLLW-CAT System Upgrade	Deletes, replaces or upgrades tank systems for REDC and HFIR	B-2-T, B-3-T, C-T-6, F-111, F-126, WC-20	line item project
1994	1998	Bethel Valley FFA Upgrades	Replaces tank system	F-201 F-501	line item project
1988	1997	Bethel Valley LLW-CAT System Upgrade	Upgrades LLW-CAT systems for Bldgs. 2026, 3092, and 3525	-	line item project
1994	1999	Melton Valley Storage Tank Capacity Increase	Provides additional storage capacity for LLLW concentrates	-	line item project

Note: Based on FY 1995 Activity Data Sheets (ADS), requested funding levels.
[a]Tank systems to be removed from service within one year.

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 waste from nonprogrammatic sources. Programmatic sources are those that can be controlled by the waste generators, such as production waste, facility floor drains, and facility equipment drains. Nonprogrammatic sources are those that do not result from planned program activities. Examples include condensate collected from off-gas ventilation systems and liquids that accumulate in pits and sumps in facilities that have been removed from service. These sources are often difficult to eliminate in the short term. For example, the hot off-gas ventilation system must remain in operation for many facilities for personnel safety reasons, even for some facilities that were removed from service years ago. In some cases, condensate from the ventilation system still collects in LLLW tanks, even though the tanks may have been placed in the ER Program. This is considered a nonprogrammatic source. Liquids from nonprogrammatic sources enter tanks through inlet pipes. Inleakage through tank shells is not considered a nonprogrammatic source.

Projects are currently in place to identify waste collected from nonprogrammatic sources. The projects will eliminate the waste at its source or divert the waste to the process waste system or the LLLW system through upgraded system components. GPPs for 1994-1997 have been planned to address these issues.

1.6.3.2 Risk assessments for ES&H tank systems

Section IX.E.1 of the FFA requires risk assessments for tank systems that cannot be removed from service without creating unacceptable ES&H risks. Five tank systems (WC-19, WC-10, HFIR, T-1, and T-2) were identified whose immediate removal would result in significant safety and operating problems. The risk assessments in Chap. 4 demonstrate that continued short term operation of these tanks would pose no substantial risk to health or the environment.

1.6.3.3 Structural integrity assessment schedules for Category C LLLW tank systems

SIAs that follow FFA Appendix F, Subsect. A requirements are being prepared for tank systems that do not meet FFA secondary containment standards. The objective of the SIAs is to ensure that the tank system can safely contain its contents. The SIAs consist of baseline design and operating information for the system and the results of leak tests. Because the baseline design and operating data are unlikely to change over time, the primary means of periodically reviewing the systems' structural integrity is based on the leak test results.

The schedule for submission of system integrity information for Category C tank systems to EPA/TDEC is presented in Chap. 5 of this document.

1.6.3.4 Leak-testing plan and schedule for Category C LLLW tank systems

Section 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 outlined in Chap. 6. The leak test program plan[2] was submitted to EPA/TDEC for information in June 1992. Procedures for testing tanks were submitted to EPA/TDEC in March 1993.[8] Detailed procedures for testing pipes are under development and submitted to EPA/TDEC, along with a complete test schedule, in FY 1993 as shown in Chap. 6.

1.7 PLANS AND SCHEDULES BASES FOR CATEGORY D LLLW TANK SYSTEMS

1.7.1 Introduction

LLLW tank systems that leak or no longer have any programmatic use have been removed from service. Because some of these tank systems may 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. Figure 1.7 illustrates the process for remediating the Category D tank systems. Section 1.7.3.7 discusses implementation of the activities in this figure.

1.7.2 Compliance Strategy Summary for Category D LLLW Tank Systems

The basic plan for remediating the Category D LLLW tank systems at ORNL is to (1) evaluate the tank systems to determine the need for early action prior to remediation; (2) perform early actions as appropriate; (3) empty the liquids from the tanks; and (4) monitor the tanks until they are removed or remediated (see Fig. 1.7). The emphasis of this strategy is to empty liquids from the tanks so that 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 and the surrounding soil 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 on the basis of risk as well as location in areas currently involved in CERCLA investigation or remediation processes. Remediation planning for tanks will follow CERCLA guidance.[3] Remedial investigation will build on data that are already available. An alternatives evaluation and feasibility study will be performed for complex 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. Detailed alternatives assessments will be prepared and submitted to EPA/TDEC for review and approval as part of an RI/FS report. In some cases, tanks may be remediated as removal actions and will require a less detailed evaluation. Periodic working group meetings will be

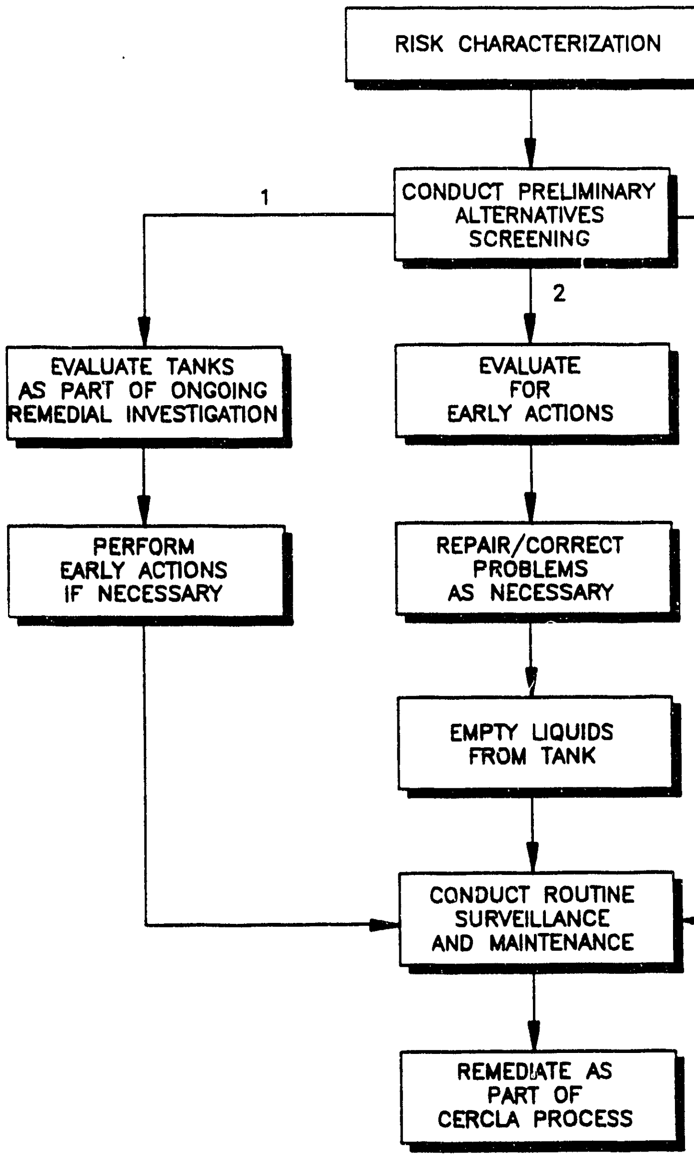

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Fig. 1.7. Process for remediating Category D LLLW tank systems.

held with EPA/TDEC to communicate plans for early actions and the status of remediation planning.

1.7.3 Implementation

Implementation of the ORNL strategy for Category D LLLW tanks began prior to the FFA effective date. A plan was developed to prioritize the tanks on the basis of risk (see Sect. 7.5). Sampling and analysis of tank contents began in 1988.

The Category D tanks were reviewed in 1990 to identify those the contents of which could be transferred to the 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 level trend analysis and waste characterization, and reduce ER Program costs. The criteria used to select tanks for this 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 inleak after empying; and
4. Tank construction:
   steel tanks should be suitable for extraction from the ground.

Seven such tanks were emptied in FY 1992: TH-1, TH-2, TH-3, W-13, W-14, W-15, and WC-1. Two additional tanks that meet these criteria, T-30 and T562, will be emptied in FY 1993.

Other Category D tanks may be emptied in FY 1993, if practicable. EPA/TDEC will be advised in writing of any plans for emptying additional tanks.

1.7.3.1 Waste characterization for the Category D tanks

Waste characterization studies were started in 1988 when the contents of 29 Category D tanks were sampled and analyzed.[4] Three of these tanks were found to be empty, and three additional tanks were characterized in 1990[5], bringing the total number of tanks characterized or known to be empty by the end of 1990 to 32. The 22 remaining Category D tanks were characterized in 1992-1993. The characterization data for these tanks were submitted to EPA/TDEC in the Waste Characterization Data Manual[6], as required by the FFA.

1.7.3.2 Risk characterization for the Category D 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 Chap. 7 of this document, is based on a methodology developed by V. Chidambariah in 1991 and refined in 1992. It evaluates the tank's propensity for leaking to the environment and the hazard associated with the tank contents. Risk characterizations that have been completed to date were submitted to EPA/TDEC in the Risk Characterization Data Manual[7] in June 1992. Risk characterizations of the remaining Category D tanks will be completed and submitted to EPA/TDEC in FY 1993.

1.7.3.3 Alternatives assessment for the Category D LLLW tanks

A preliminary screening has been completed for 30 Category D 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 requires evaluation for early action. Ten tanks have been emptied and will follow path 3 (W-19, W-20, TH-1, TH-2, TH-3, W-13, W-14, W-15, WC-1, and 7560). At least two additional tanks will be emptied in FY 1993 (T-30 and 7562). Eighteen tanks are currently included in active CERCLA RIs or RI/FSs in WAG-1 and WAG-5 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 Category D tanks will be evaluated through path 2 to determine if early actions are necessary.

1.7.3.4 Surveillance and maintenance plans

Category D tanks, including those that are empty, those that have been stabilized, and those 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, Tennessee, December 1990.

2. *Leak Testing Plan for the Oak Ridge National Laboratory Liquid Low-Level Waste System (Active Tanks),* Dennis G., Douglas, et. al., ORNL/ER/Sub/92-SK263/1, Vista Research, Inc., Mountain View, California, June 1992.

3. *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.

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

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

6. *Waste Characterization Data for the Oak Ridge National Laboratory Inactive Liquid Low-Level Radioactive Waste Tank Systems*, DOE/OR/01-1159&D1 (Supercedes ORNL/ER-80), Martin Marietta Energy Systems, Inc., Oak Ridge, Tennessee, June 1993.

7. *Risk Characterization Data Manual for Inactive Liquid Low-Level Waste Tank Systems at Oak Ridge National Laboratory, Oak Ridge, Tennessee*, ORNL/ER/Sub/90-LJ068/1, H&R Technical Associates, Inc., Oak Ridge, Tennessee, September 1992.

8. *Detailed Leak Detection Test Plan and Schedule for the Oak Ridge National Laboratory LLLW Active Tanks*, Dennis G. Douglas and Joseph W. Maresca, Jr., DOE/OR/01-1129&D1 (ORNL/ER/Sub/92-SK263/2&D1), Martin Marietta Energy Systems, Inc., Oak Ridge, Tenessee, March 1993.

9. *Design Demonstrations - Category B Tank Systems*, Rev. 2, DOE/OR/01-1047&D2, EBASCO, Oak Ridge, Tennessee, May 1993.

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

2.1 FFA DELIVERABLE

The FFA requires the DOE to demonstrate that the secondary containments for Category B tank systems meet the design and operating conditions specified in FFA Appendix F, Sect. C. This chapter contains the schedules by which these demonstrations are being conducted and indicates the dates for submittal of information to the EPA/TDEC.

2.2 STATUS

Demonstrations have been submitted for all Category B tanks. Demonstrations for pipelines are currently underway. The objective of each assessment is to demonstrate that the design of the secondary containment system meets the requirements of Appendix F, Section C of the FFA. Twelve tank systems (T-13, W-21, W-22, W-23, W-24, W-25, W-26, W-27, W-28, W-29, W-30, and W-31) meet the requirements of the FFA. Fourteen Tank Systems (N-71, P-3, P-4, C-1, C-2, L-11, B-2-T, B-3-T, C-6-T, F-111, F-126, S-223, S-324, and S-523) have minor deficiencies for which there are one or more mitigating design features that adequately resolve the deficiency. Four Tank Systems (WC-20, F-201, F-501, and LA-104) have deficiencies which do not fully meet the secondary containment requirements. Tank System WC-20 will be replaced through the Melton Valley LLLW Collection and Transfer System Upgrade, which is a line item project scheduled to be completed in FY 1997. Tank Systems F-201 and F-501 will be removed from service upon completion of the Bethel Valley LLLW Collection and Transfer System Upgrade Project in FY 1997.

2.3 SCHEDULE

The bases for the schedule shown in Fig. 2.1 are as follows.

- The schedules presented in this section are subject to annual renegotiation to adjust for updated information based on duration of activities or for changes in priorities and funding.
- Annual updates of program milestones are required.

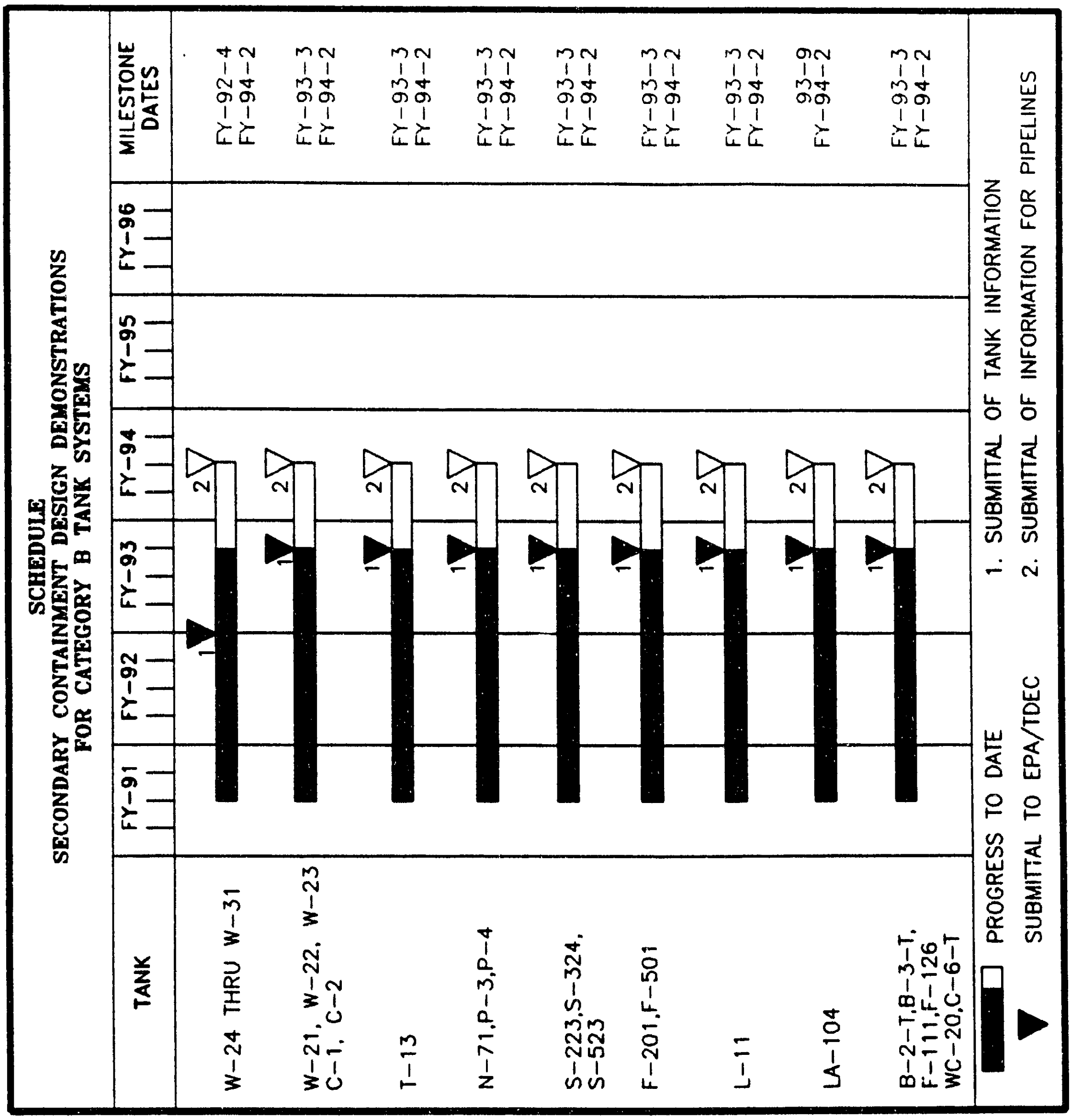

Fig. 2.1. Secondary containment design demonstration schedule.

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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. The plan and schedule were submitted to EPA/TDEC for approval in March 1992.

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 the tank systems are not leaking and no adverse change occurs in the tank systems' baseline structural integrity data. If a tank system leaks, 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 line item projects 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 1994 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. Continued yearly updates to this plan are 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.

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

- Tanks that 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.

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

- Continued 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	Removes WC-10 from service	Expense	NA[b]	2002
	WC-2	Isotope facility shutdown	Removes WC-2 from service	Expense	NA[b]	2002
HFIR	HFIR T-1 T-2	Melton Valley LLLW-CAT System Upgrade	Provides an ion exchange treatment system to convert LLLW to process waste and thus eliminate the need for the tank system	LIP	1992	1996
BSR/ORR	WC-19	BSR/ORR LLLW Upgrade	Diverts waste from LLLW system to process waste.	GPP	1992	1994
3025	WC-3	Bethel Valley FFA Upgrades	Replaces WC-3	LIP	1994	1998
2533/3504	WC-7	3000 Area LLLW Upgrade	Provides bottling station and eliminates the need for the tank system	GPP	1992	1995 (tank)
		Bethel Valley FFA Upgrades	Doubly contains LLLW piping for 2533/2534 transfer line	LIP	1994	1998 (piping)
Radioactive (hot) Off Gas	WC-9	Bethel Valley FFA Upgrades	Replaces WC-9 Tank System	LIP	1994	1998
2026	2026A	Bethel Valley LLLW-CAT System Upgrades	Upgrades High Rad Level Analytical Lab (Bldg. 2026) LLW-CAT system	LIP	1988	1994
3026D	W-16	Isotope Facilities Shutdown	Removes W-16 from service	Expense	NA[b]	2002
3525	F-201 F-501 W-12	Bethel Valley LLLW-Cat System Upgrades	Upgrades High Rad Level Examination Lab (Bldg. 3525) LLW-CAT system	LIP	1988	1997

[a]Tank systems to be removed from service within 1 year.
[b]NA - not applicable.

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

4.1 INTRODUCTION

The FFA contains provisions for the continued use of noncomplying 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, temporary use of these tank systems constitutes an environmental, safety, and health (ES&H) exemption for these systems.

4.2 PURPOSE

Three sets of singly contained LLLW tank systems at ORNL have been identified as tank systems that should remain temporarily in service, even if they experience uncontrolled inflow or if leaks occur. This screening-level evaluation uses conservative assumptions and worst-case accident scenarios to bound the potential consequences of an LLLW leak. The purpose of this screening is to identify scenarios for which more rigorous analysis is not needed. This chapter shows that, even in the event of a leak of a full tank volume, radionuclide doses via the drinking water route are within EPA proposed limits for drinking water; therefore, no further analysis is required. The assessments in this chapter were performed to evaluate the consequences of the continued, near-term use of these 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, the HFIR tank systems and tank WC-19 collect flow from unidentified sources in their respective facilities, and the tank discharge piping in system WC-10 may be leaking.

4.3 APPLICABLE STANDARDS

Because the tank systems in this evaluation are buried, it is conservative to assume that leaking contaminants will follow the geologic gradients or other preferential flow paths, if such exist, toward the Clinch River tributaries that drain the ORNL site. This analysis evaluates the effects of LLLW leaks on persons who use the Clinch River as a source of drinking water.

To assess the potential radionuclide dose to persons whose drinking water source is the Clinch River, we must determine an appropriate comparative index. EPA has proposed general regulations for radionuclides in terms of allowable (and, by definition, acceptable) doses under the Clean Water Act. EPA has not developed concentration limits for every radionuclide. However, given the proposed 4 mrem dose limit for a 1 year exposure, and factors to convert from exposures to dose, limits for individual radionuclides can be derived. EPA has adopted the factors to convert from intakes to doses for individual radionuclides (dose conversion factors or DCFs) recommended by the International Commission on Radiological Protection (ICRP) and the National Council on Radiation Protection (NCRP). Derived air concentrations (DACs) and annual limits on intake (ALI) for workers have also been developed (Eckerman et al; 1988).[1] For most radionuclides, the same DCFs are used by DOE to develop DACs for radiation workers (DOE Order 5480.11) and derived concentration guides (DCGs) for the public (DOE Order 5400.5). DOE has developed radionuclide-specific water and air concentration guides for public exposures. These can be used and adjusted to EPA total allowable dose values to meet the "spirit" of EPA regulations. With this adjustment, the DOE values are considered to be appropriate maximum concentration limits (MCLs) for radionuclides in drinking water. Alternately, a single dose limit of 4 mrem EDE for all radionuclides, including alpha emitters, can be used if proposed EPA regulations are assumed. Such a limit is functionally equivalent to the proposed revisions of present standards and, for most alpha emitters, is more restrictive than either the interim or proposed standards. This limit, along with DCFs for each isotope, may be used to derive MCLs.

DOE Order 5400.5 requires that liquid effluents from activities on the Oak Ridge Reservation shall not cause levels of radioactivity in private or public drinking water systems downstream of facility discharge to exceed limits specified in EPA standards in 40 CFR Part 141. Under current conditions at the ORNL site, surface water is not a source of public water supply before it reaches the Clinch River, where effluents are greatly diluted before any use of the water for a public water supply. Doses to the public have been determined through monitoring and assessment activities as reported annually in the DOE Environmental Reports. No significant public doses (concentrations are far below MCLs) have resulted from total releases from Y-12, K-25, and ORNL.[2]

Under current conditions, discussed in the annual Environmental Reports, dilution of contaminant concentrations before they become drinking water contaminants is several orders of magnitude and the 4 mrem/year dose limit from drinking water would not be exceeded either for individual radionuclides or for the summation.

Because we are treating releases that might occur now and in the future, we will use an approach that includes EPA's proposed revisions to the interim standards given in 40 CFR Part 141. The 4 mrem/year value is the most current EPA dose limit for radionuclides in drinking water. Average concentration limits for WC-19, WC-10 and HFIR tank radionuclides in drinking water based on DCFs from EPA guidance (Federal Guidance Report Number 11) and the 4 mrem/year dose limit are given in Table 4.1. The limiting concentrations may also be obtained by dividing the DOE DCGs (DOE Order 5400.5), which correspond to a 100 mrem/year dose, by 25. Also indicated in Table 4.1 are EPA proposed or established limits for specific radionuclides given in the ANPR (FR 56, No. 138, July 18, 1991).

Table 4.1. Dose conversion factors and limiting concentrations for selected radiological contaminants

Nuclide	Ingestion Dose Conversion Factor[a] (rem/μCi)	4 mrem/year[b] Concentration (pCi/L)
^{241}Am	3.6E+00	1.5E+00
^{140}Ba	9.5E-03	5.8E+02
^{14}C	2.1E-03	2.6E+03
^{141}Ce	2.1E-02	2.6E+02
^{38}Cl	2.3E-04	2.4E+04
^{244}Cm	2.0	2.7
^{60}Co	2.7E-02	2.0E+02
^{51}Cr	1.5E-04	3.6E+04
^{134}Cs	7.3E-02	7.5E+01
^{137}Cs	5.0E-02	1.1E+02
^{152}Eu	6.5E-03	8.5E+02
^{154}Eu	9.5E-03	5.8E+02
^{59}Fe	6.7E-03	8.2E+02
^{131}I	5.3E-02	1.0E+02
^{132}I	6.7E-04	8.1E+03
^{133}I	1.0E-02	5.3E+02
^{134}I	7.3E-02	7.5E+01
^{135}I	2.2E-03	2.4E+03
^{27}Mg	Half life less than 10 min	
^{54}Mn	2.8E-03	9.5E+02
^{56}Mn	9.8E-04	3.3E+02
^{24}Na	1.4E-03	3.8E+03
^{95}Nb	2.6E-03	2.1E+03
^{147}Pm	1.0E-03	5.5E+03
^{103}Ru	1.5E-03	3.6E+03
^{131}Sb	3.0E-04	1.8E+04
^{46}Sc	6.4E-03	8.4E+02
^{46}Sl	6.4E-03	8.6E+02
^{90}Sr	1.4E-01	3.8E+01[c]
^{133m}Te	8.4E-04	6.5E+03

Table 4.1 (continued)

Nuclide	Ingestion Dose Conversion Factor[a] (rem/μCi)	4 mrem/year[b] Concentration (pCi/L)
^{134}Te	2.4E-04	2.2E+04
^{52}V	Half life less than 10 min.	
^{187}W	2.8E-03	2.0E+03
^{65}Zn	1.4E-02	4.9E+03
^{95}Zr	3.8E-03	1.5E+03

[a]Dose conversion factors from Eckerman et al, 1988, which is Federal Guidance Report No. 11.

[b]The listed concentrations would yield a dose of 4 mrem in one year assuming a 2 L daily intake of drinking water containing the listed concentrations. A one-day (2L) intake producing 4 mrem would be 365 times higher.

[c]The EPA Clean Water Act (40 CFR 141.1b) value for strontium is 8 pCi/L (for bone marrow), which would yield about a 1 mrem/year dose under continuous 2 L/d intake conditions.

Use of secondary limits (e.g., concentrations) derived from general dose limits has been the standard practice of the ICRP, NCRP, the United Nations Scientific Committee on the Effects of Atomic Radiation, and other advisory bodies and regulatory agencies for at least 30 years. For multiple radionuclides, the usual practice is to sum the site-specific doses and ensure that the total dose does not exceed the limiting dose. In terms of concentrations, the sum rule is applied such that if the sum of estimated concentrations (measured or calculated) divided by the limit for each radionuclide does not exceed unity, then the combined concentrations are within limits.

Thus, the sum rule for concentrations is

$$\sum_{i=1}^{n} \frac{C_i}{C_{Li}} < 1$$

where C_i is the concentration of radioisotope i in a particular environmental pathway and C_{Li} is the concentration limit for radioisotope i in that pathway.

4.4 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 system with a 2250-gal stainless steel tank. The system collects LLLW from the inactive ORR, the inactive Old Graphite Reactor (3002 filter house and 3001 storage canal), the currently shut down BSR, and several off-gas and cell ventilation filter pits that serve other facilities. No evidence has been found to substantiate that WC-19 leaks. The tank does, however, collect approximately 5 gpm of liquid from undefined sources within the 3000 area facilities. During FY 1992, the WC-19 system was used to support RCRA closure activities of the Building 3001 Storage Canal. These activities were completed in September 1992.

The most significant wastes handled by the WC-19 system result from the regeneration of ion-exchange resins used for the demineralization of reactor pool waters at the inactive ORR and BSR. These ion-exchange resins control the water chemistry to slow the corrosion rate of the 20-mm thick aluminum jackets that surround the BSR reactor fuel elements and the aluminum reactor pool liner of the ORR. Dissolved radioactive materials are removed from the pools by the demineralizers reducing radioactivity in the reactor pool waters while simultaneously producing a buildup in the demineralizer resins. Regeneration of the resins is likely to be required at least once before the upgrade and replacement projects are completed. Dissolution of ions and radionuclides from the resins during the regeneration process produces LLLW.

To evaluate the continued operation of the WC-19 tank system in view of its undefined inflow, two options were considered:

- *Option 1*: Shutdown the ORR/BSR demineralizers, thereby eliminating the need to discharge the ion-exchange regenerant to the WC-19 system.

- *Option 2*: Take no interim mitigating action. Allow the upgrade and replacement projects, when complete, to eliminate the need for operation of WC-19 by installing an alternative collection and transfer method.

These alternatives and the assumptions used to estimate the consequences associated with each alternative are discussed in Sects. 4.4.1 through 4.4.3.

To determine the consequences of leaving the system in service pending completion of the replacement project, a worst case assessment of its effects on the off-site population must be made.

The following assumptions were used to estimate exposure to the public resulting from the use of the leaking tank system:

- All radioisotopes that are present in the demineralizers are removed from ion-exchange resins during regeneration.

- The entire volume of the tank, 2,250 gal, leaks to the Clinch River in one day. This very conservative assumption is made to ensure the consequences of any spill or leak are bounded by this evaluation. In fact, the operational maximum volume in the tank is limited to 2,022 gal. In practice, the tank volume is typically less than 1,000 gal.

- No radionuclides are removed by adsorption, sedimentation, filtration, or other means during transport from the point of leakage to the point where they are consumed in drinking water. This assumption is made to assure that the results of this assessment are conservative.

- The radionuclides mix uniformly with the receiving water body. Flow conditions are as follows: "average" (White Oak Creek flow = 0.03×10^9 L/day, Clinch River flow = 11×10^9 L/day), "maximum" (White Oak Creek flow = 0.08×10^9 L/day, Clinch River flow = 24×10^9 L/day), and "minimum" (White Oak Creek flow = 0.02×10^9 L/day, Clinch River flow = 1.7×10^9 L/day). The Tennessee River 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; shorter release times would be partly offset by shorter use periods for potential consumers).

- Each person drinks 2.0 L of water per day. This is a standard reference intake (ICRP, NCRP, EPA, DOE Orders, etc.).

The principal contaminants present in the resins and cooling water of the ORR/BSR are ^{60}Co, ^{134}Cs, and ^{137}Cs[3]. Table 4.2 lists the principal radionuclides and their concentrations (activities per unit volume) in the ORR and BSR cooling water and in the demineralizer column after 3 years.

The predicted concentrations of these radioisotopes in the Clinch River and the resulting doses are given in Table 4.3. Even the maximum concentrations are less than the derived MCL that would produce a 4 mrem dose given 1 year of continuous exposure for continuous intake of drinking water. Tennessee River water concentrations would be even lower. Therefore, release of the entire contents of the tank would not produce long term or short term unacceptable consequences.

Table 4.2. Radionuclides and their activities in ORR and BSR water and demineralizer columns

Nuclide	Concentration in pool 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 4.3. Potential concentrations and doses for major radionuclides in Clinch River water from tank WC-19

Nuclide[a]	Average annual[b] Clinch River concentration (pCi/L)	Annual dose (mrem)
^{60}Co (total)	1.8×10^{-2}	5.6×10^{-8}
^{134}Cs (total)	9.6×10^{-3}	8.1×10^{-8}
^{137}Cs (total)	1.2×10^{-1}	6.9×10^{-7}

$$\sum \frac{C_i}{CL_i} \sim 1.3\times10^{-3\,c}$$

[a]Total activity in ORR and BSR columns assuming all activity is released into water during the regeneration process.

[b]Total tank volume divided by average Clinch River annual volume flow rate multiplied by the nuclide content of tank.

[c]The 50-year effective dose equivalent would be (4 mrem/year) × (1.3×10^{-3}) ~5.2×10^{-3} mrem.

4.4.1 Demineralizer Shutdown Option

This option involves the shutdown of the ORR/BSR demineralizers to eliminate the need for the WC-19 tank system as the collection and transfer point for the ORR/BSR ion-exchange regenerant. 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 at an accelerated rate, increasing the potential for serious releases of contained fission products. The released fission products will cause 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 at an accelerated rate. Corrosion of the liner 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 shutdown 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 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 increases the likelihood of contaminating the pools and exposing workers, this option will not be considered further.

4.4.2 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 selected upgrade and replacement project is designated as the general plant project "BSR/ORR LLLW Upgrade" (Table 3.1 in Chap. 3). Upgrade alternatives that were considered include: (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, or (3) the installation of a trucking station to allow transport of the ion-exchange regenerant to the central collection system. The selected upgrade is the installation of a valve station that allows diversion of the waste to the process waste system when it meets the process waste acceptance criteria. Routing of the waste to the LLLW system is expected to occur only if the ORR or BSR pool demineralizers are regenerated.

The upgrade and replacement GPP for the WC-19 tank system can not be completed through the standard funding request/approval process until at least 1994. Regeneration of the ORR/BSR ion-exchange resins may be required before the upgrade project can be completed. Thus, this option, although it will ultimately be implemented, does not achieve FFA compliance in the near term.

4.4.3 WC-19 Tank System Conclusions

The analysis yielded the following conclusions:

- The replacement project is scheduled but will not be implemented before regeneration of the ORR/BSR demineralizers, using WC-19, is necessary.

- The ORR/BSR demineralizers must remain in operation to reduce the likelihood of unacceptable on-site consequences resulting from failure by corrosion of reactor fuel cladding at the BSR or the pool liner at the ORR.

- The consequences to the general public resulting from use of WC-19 tank system, even in the event of a major leak, are within drinking water criteria.

On the basis of these conclusions, operation of the WC-19 tank system should continue until the replacement project is complete.

4.5 ISOTOPES AREA: WC-10 TANK SYSTEM

The WC-10 tank system served the Isotopes Area in Bethel Valley. The 2000-gal tank was the principal LLLW collection point for the radioisotopes facilities. The WC-10 discharge line, which failed a helium leak test in FY 1992, has been repaired. In January 1992, (1) all programmatic inputs of LLLW (i.e., LLLW from radioisotopes production and R&D activities) to the WC-10 tank from both the Isotopes and the 4500 Area at ORNL were eliminated by the implementation of interim waste bottling and transportation measures and (2) tanks WC-11 through WC-14 were inactivated.

The shutdown of the Isotopes Area facilities, originally scheduled for completion by the end of FY 1994, has been delayed until at least FY 2002 due to funding limitations. These isotopes facilities will require decontamination of hot cells, glove boxes, and similar contained areas. Although WC-10 no longer supports operating facilities, 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 evaluate the continued operation of the WC-10 tank system in view of potential leakage in its discharge line two options were evaluated:

- *Option 1*: Gross decontamination is performed without the use of the WC-10 tank system for disposal of the LLLW generated during the decontamination process.
- *Option 2*: Allow the system to remain in service until the replacement projects eliminate the need for the WC-10 tank system by installing an alternative collection and transfer method for LLLW produced during decontamination and safe shutdown.

These alternatives and the assumptions used to estimate the consequences associated with each alternative are discussed in Sects. 4.5.1 through 4.5.3.

4.5.1 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. Hot cells, glove boxes, and other contained areas must be decontaminated.

to serve as an alternative collection and transfer point. The LLLW produced during the decontamination of these areas will be contained and transported by truck to the central waste collection system. Table 4.4 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. 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 collection and transfer 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. Radionuclide inventories and liquid waste generation estimates for the Isotopes Area facilities

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

The potential excess individual and collective EDEs to workers from decontamination options are listed in Table 4.5. 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). In practice, worker doses will be controlled on a real time basis so that maximum permissible doses will not be exceeded. The current annual permissible dose is 5 rem, but it is typical to control doses to less than 1 rem on an annual basis. Doses are controlled to levels below permissible doses under as low as reasonably achievable (ALARA) principles. Straight forward calculations indicate that decontamination worker doses are much higher than trucker doses. Decontamination workers could receive several thousand mrem, 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. These are, of course, only possible doses, as stated above, actual doses will be controlled on a real time basis. 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 is not viable.

Table 4.5. Potential excess individual (mrem) and collective (person-rem) effective dose equivalents from decontamination

	Bldg. 3028	Bldg. 3029	Bldg. 3030	Bldg. 3031	Bldg. 3047
	Gross decontamination without use of WC-10 tank system (EDE):				
Workers, Individual (mrem)	2×10^{3}	2×10^{3}	5.4×10^{2}	3.2×10^{2}	6×10^{3}
Workers, collective (person-rem)	3.8×10^{0}	6.4×10^{0}	1.1×10^{0}	6×10^{-1}	2.1×10^{1}

4.5.2 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 an LLLW trucking station that would serve as an alternative collection and transfer point for wastes generated by the decontamination of the Isotopes facilities.

The replacement GPP for the WC-10 system can not be completed through the standard funding request/approval process prior to the near-term decontamination of the Isotopes Area facilities necessary to achieve safe shutdown. Thus, this option, although it will ultimately be implemented, does not achieve near-term FFA compliance.

To determine the consequences of continuing to use the leaking WC-10 tank system pending completion of the replacement project, a worst-case assessment of its effects on the off-site population must be made.

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

- The 2000 gal WC-10 tank contains about 1/6 of the total radionuclide inventory of the facilities being decontaminated at any given time. The expected duration of decontamination activities is approximately 6 years. The production of LLLW is expected to be relatively constant throughout the project.
- An entire tank contents leak to the Clinch River in one day.

- The probability that a person will consume 2 L of the contaminated Clinch River water in one day is assumed to be 100%.

- No radionuclides are removed by adsorption, sedimentation, filtration or by any other means during transport from the point of leakage to the drinker (a very conservative assumption).

- The radionuclides mix uniformly with the receiving water body.

- The radionuclides are available in drinking water for one day. (This assumption is made only for computational convenience; shorter release times would be partially offset by shorter use times for potential consumers.)

Predicted average concentrations of these radionuclides in the Clinch River and the resulting doses are given in Table 4.6. As shown in the third footnote to Table 4.6, the total dose from all radionuclides listed is about 2.4 mrem. Such a once-in-a-lifetime dose rate would be equivalent to about a 0.014 mrem/year chronic dose rate compared to a background dose rate of over 300 mrem/year varying by ± 60 mrem/year. Given the conservatism of these screening calculations, release of the entire contents of the WC-10 tank would not produce concentrations in the Clinch River exceeding drinking water criteria and, therefore, would not produce long-term or short-term unacceptable consequences.

4.5.3 WC-10 Tank System Conclusions

The analysis of the preceding options yielded the following conclusions:

- Upgrade/replacement projects will not be completed prior to the decontamination of the Isotopes Area facilities necessary to achieve safe shutdown.

- Handling LLLW by bottling and trucking to eliminate the use of the WC-10 tank system results 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 below drinking water criteria.

On the basis of these conclusions, operation of the WC-10 tank system should continue in support of Isotopes Area Shutdown until safe shutdown of the facilities is completed.

Table 4.6. Potential concentrations and doses for major radionuclides in Clinch River water from the WC-10 tank system

Nuclide[a]	Annual Average Clinch River[b] concentration (pCi/L)	Annual dose (mrem)
^{241}Am	0.27	0.66
^{244}Cm	0.27	0.37
^{147}Pm	0.03	2×10^{-5}
^{90}Sr	0.54	5.7×10^{-2}
^{137}Cs	4.38	1.6×10^{-1}
^{152}Eu	68.49	3.2×10^{-1}
^{154}Eu	68.49	4.7×10^{-1}
^{14}C	0.13	2×10^{-4}

$$\sum \frac{C_i}{CL_i} \sim 0.59^{c}$$

[a]One-sixth total activity of nuclide from isotopes area in tank.

[b]Total tank volume divided by average annual Clinch River volume flow multiplied by total nuclide content of tank.

[c]The 50-year effective dose equivalent from all nuclides would be about (4 mrem/year) × (0.6) ~2.4 mrem.

4.6 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 HFIR 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-gal stainless steel HFIR tank. From there the waste is carried via a cast iron or stainless steel pipeline to either Tank T-1 or Tank T-2, both of which are singly contained 15,000-gal stainless steel tanks. Waste in Tanks T-1 or T-2 is transferred to the Melton Valley Pumping Station before it is transferred 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. Regeneration of the ion-exchange resins is necessary to maintain their efficiency. The radioactive materials that are removed from the resins during the regeneration process produce LLLW.

The HFIR tank systems (including the HFIR, T-1, and T-2 tanks) are not known to leak. This assessment 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 even in the shutdown state to keep the pool waters free of corrosion-producing products. Under shutdown conditions, the regeneration frequency would be reduced from every 3 months to approximately once a year.

4.6.1 Evaluation of HFIR Tank Systems

To evaluate the effects of continued operation of the HFIR tank systems, including the HFIR, T-1, and T-2 tanks, should a leak develop before the upgrade/replacement project is completed, the following analysis was conducted.

The planned upgrade is a line item project entitled "Melton Valley CAT System Upgrade" (Table 3.1 in Chap. 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.

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: (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.

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 is presented in Table 4.7. It should be noted that the demineralizer continues to operate after the reactor is shut down. Thus concentrations of some isotopes increase in the column.

Table 4.7. 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

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

- All radionuclides are removed from the ion-exchange column during regeneration.

- The entire contents of the tank system, 15,000 gal, leak from the system to the Clinch River in one day.

- No radionuclides are removed by adsorption, sedimentation, filtration or any other means 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. 4.4).

- The radionuclides are available in drinking water for one day. (This assumption is made only for computational convenience; shorter release times are in part offset by shorter use times for potential users.)

- Each person drinks 2.0 L of water per day.

Predicted average annual concentrations of these radionuclides in the Clinch River and the resulting doses are given in Table 4.8 for the 365-days-after-shutdown case, which produces the highest doses. As indicated in the third footnote to Table 4.8, the maximum 50-year effective dose equivalent possible is only about 0.2 mrem. Such a once-in-a-lifetime dose would be equivalent to about a 0.003 mrem/year chronic dose rate compared to a background dose rate of over 300 mrem/year that varies by about 60 mrem/year. Given the conservatism of these screening calculations, release of the entire contents of the HFIR tank would not produce concentrations exceeding drinking water criteria and, therefore, would not produce long-term or short-term unacceptable consequences.

4.6.2 HFIR Tank Systems Conclusions

The analysis concludes that the EDEs for an individual of the general public resulting from the use of the HFIR tank systems, should a future leak occur, would be less than drinking water criteria.

Table 4.8. Potential concentrations and doses for major radionuclides in Clinch River water from the HFIR tank system

Nuclide	Average annual Clinch River[a] concentration (pCi/L)	Annual dose (mrem)
^{140}Ba	1.7×10^{-3}	1.2×10^{-5}
^{141}Ce	1.1×10^{-2}	2.5×10^{-5}
^{38}Cl	4.9×10^{-6}	1.2×10^{-10}
^{60}Co	9.8	2.9×10^{-2}
^{51}Cr	4.1	7.0×10^{-5}
^{137}Cs	2.0×10^{-2}	1.1×10^{-4}
^{59}Fe	1.7×10^{-1}	1.3×10^{-4}
^{131}I	6.0×10^{-3}	3.6×10^{-5}
^{132}I	1.6×10^{-6}	1.2×10^{-10}
^{133}I	4.6×10^{-4}	5.3×10^{-7}
^{134}I	3.3×10^{-6}	2.7×10^{-8}
^{135}I	4.9×10^{-5}	1.2×10^{-8}
^{27}Mg	1.1×10^{-4}	Half life less than 10 min
^{54}Mn	2.6×10^{-1}	8.4×10^{-5}
^{56}Mn	1.3×10^{-5}	1.4×10^{-9}
^{24}Na[b]	3.9×10^{-1}	6.2×10^{-5}
^{95}Nb	1.1×10^{-3}	3.2×10^{-7}
^{103}Ru	7.7×10^{-3}	1.3×10^{-6}
^{131}Sb	0	-
^{46}Sc	1.2×10^{-1}	8.6×10^{-5}
^{133m}Te	1.6×10^{-6}	1.5×10^{-10}
^{134}Te	1.6×10^{-6}	4.4×10^{-11}
^{52}V	0	-
^{187}W	6.8×10^{-3}	2.2×10^{-6}
^{65}Zn	2.3×10^{-1}	3.7×10^{-4}
^{95}Zr	6.6×10^{-3}	2.9×10^{-6}

$$\sum \frac{C_i}{CL_i} \sim 0.05^{c}$$

[a]Total tank volume divided by average annual Clinch River volume flow multiplied by the total nuclide content of tank.

[b]All activity from column 365 days after shutdown is assumed to be in the tank.

[c]The 50 year effective dose equivalent from all nuclides would be about (4 mrem/year) × (0.05) ~0.2 mrem.

REFERENCES FOR CHAPTER 4

1. K. F. Eckerman, A. B. Wolbarst, and Alan C. B. Richardson, *Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion* Federal Guidance Report No. 11, EPA-520/1-88-020, 1988.

2. *Oak Ridge Reservation Environmental Report for 1991,* Martin Marietta Energy Systems, Oak Ridge, Tennessee, 1991.

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) that was submitted to EPA/TDEC for approval in March 1992.

5.2 BACKGROUND

The information to be submitted will follow the requirements of FFA Appendix F, Subsect. A., titled "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.

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. The results of the periodic reviews will be submitted to EPA/TDEC. They will consist of the results of leak tests and notice of any change in the baseline design data provided in the SIA.

Figure 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 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.
- Continued annual updates of program milestones will be required.

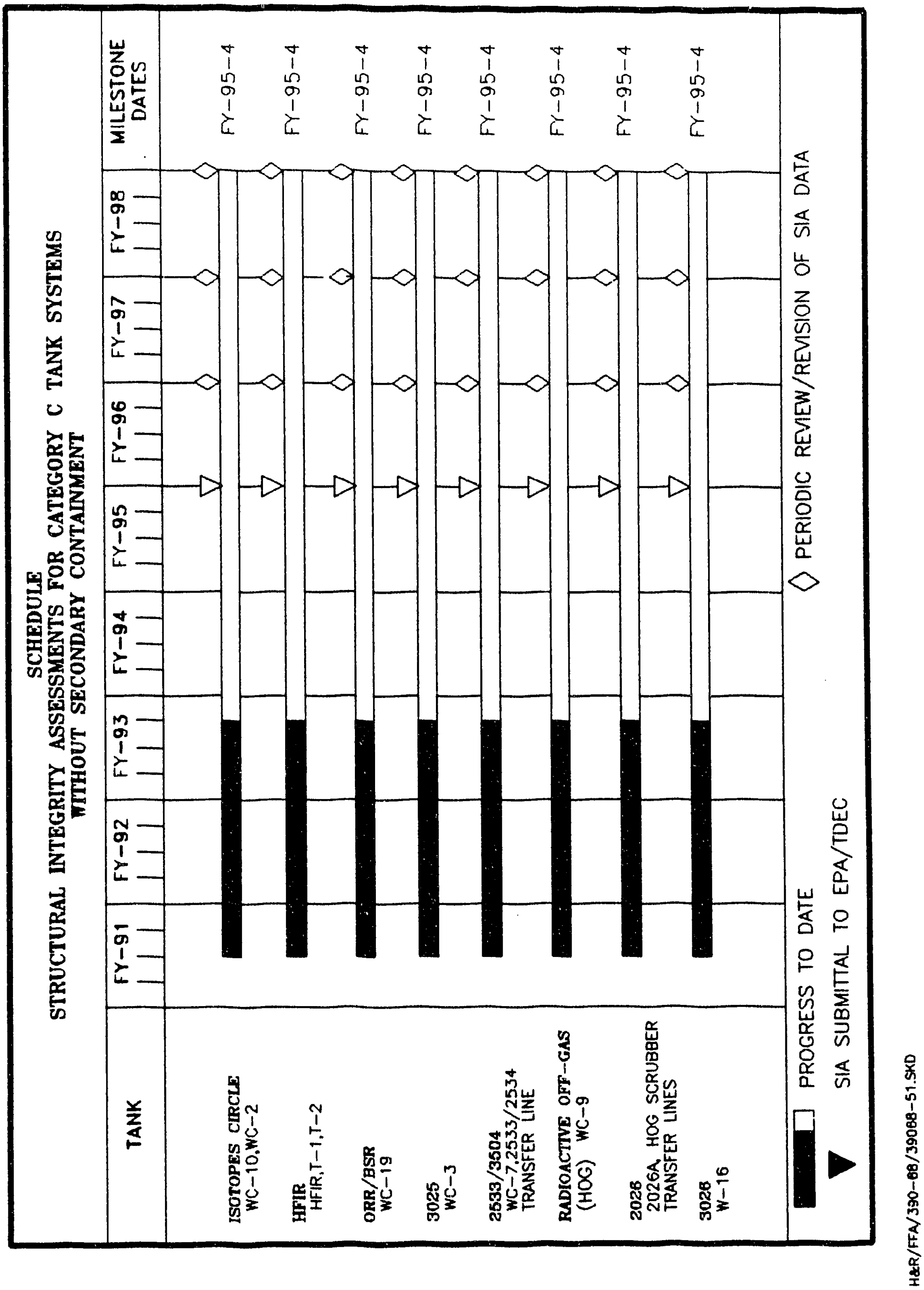

Fig. 5.1. Structural integrity assessments for tank systems not meeting secondary containment standards.

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. These schedules were submitted to EPA/TDEC for approval in March 1992.

The tank systems slated for leak testing include the Category C tanks plus four Category B tanks (F-201, F-501, WC-20, and LA-104) which did not fully meet the requirements for secondary containment. The remaining Category B tanks which demonstrated secondary containment have been removed from the Leak Testing Program. The pipelines for several Category B Tank Systems will be evaluated for inclusion in the Leak Testing Program based on the results of the Secondary Containment Design Demonstration documents.

6.2 LLLW SYSTEM COMPONENTS

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

- drain piping from the LLLW source to a collection tank,
- 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. Generally no valves or isolation flanges are found 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. They 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

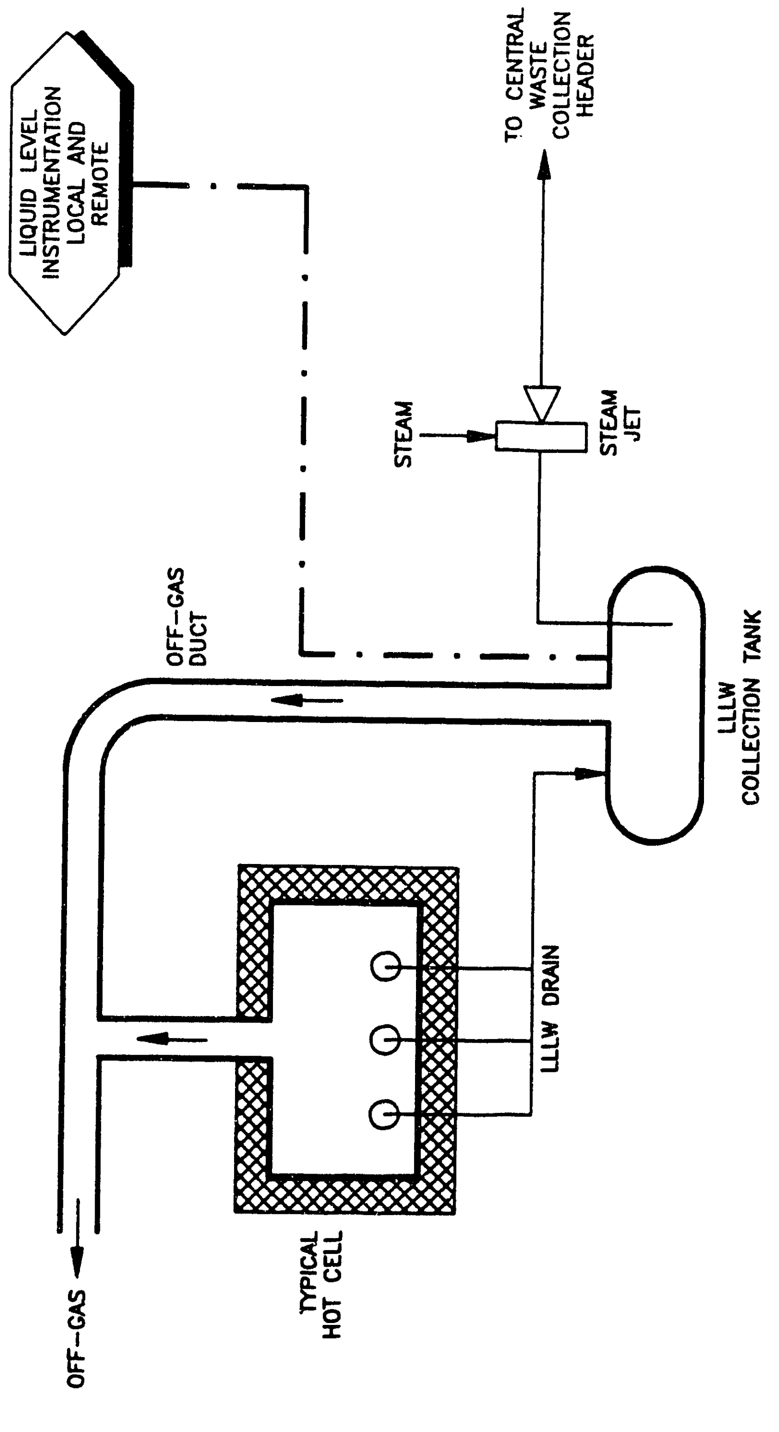

Fig. 6.1. Typical LLLW tank system components.

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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.

6.3 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 has been defined in a test plan prepared by a nationally recognized, independent consulting firm with established expertise and credibility with regulatory agencies in tank system testing. This plan documents available testing technology and recommends technologies to be implemented on LLLW tank system components. The leak test program plan was submitted to EPA/TDEC in June 1992[1].

In a parallel effort, the tanks were prioritized for testing on the basis of relative release potential and the hazard represented by a tank's contents. The ranking for prioritization was established based on the judgement of a group of experienced technical personnel who are familiar with ORNL operations and with the LLLW system. The ranking includes Category C systems and the Category B systems that do not currently meet all of the secondary containment requirements. The primary criterion for the ranking is leak potential of the tanks. The secondary criterion is the hazard associated with the tank contents. This considers the quantity, constituents, and use of the contents. The tanks are arranged into three priorities: high, moderate, and low. Within each priority, the sequence of leak testing will be determined by the complexities of the test itself. Testing began in FY 1993, initially on tanks that have, or can be readily equipped with, the necessary instrumentation. Work on installing or upgrading the instruments on the remaining tanks will coincide with the testing so that the testing program can be conducted in the most efficient manner. The detailed test plan and schedule for tanks was submitted to EPA/TDEC in March 1993.

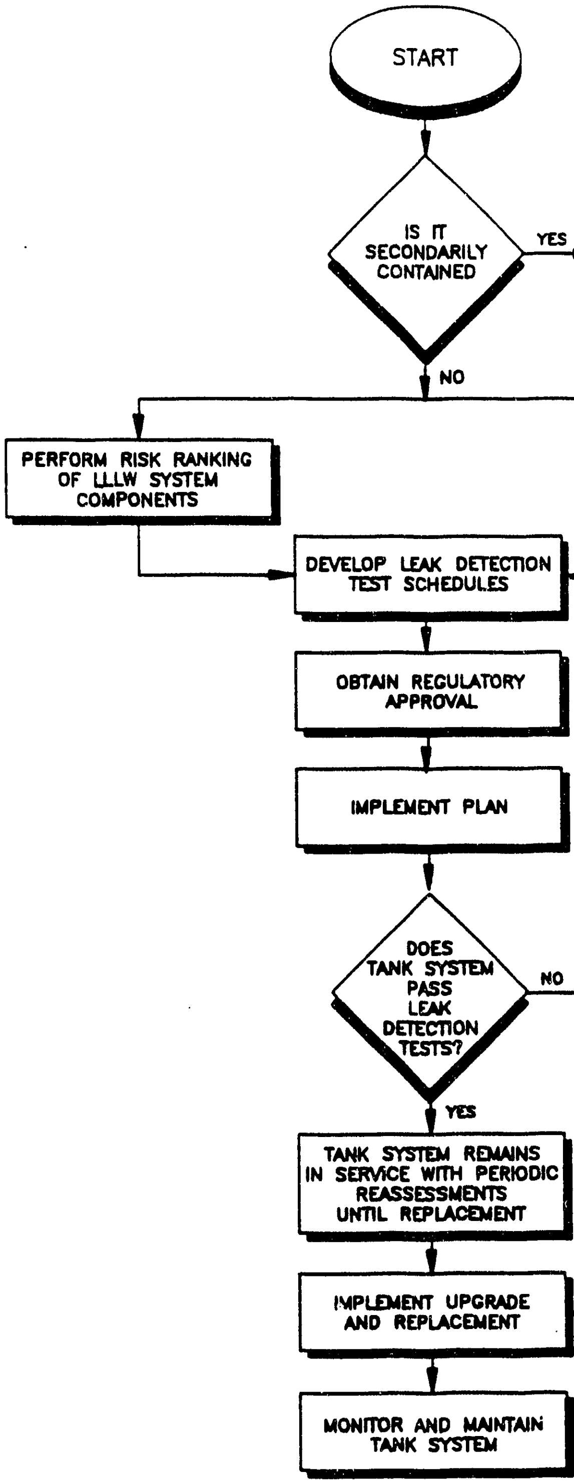

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Fig. 6.2. Strategy for leak testing, upgrading, and/or replacing Category C tank systems.

All Category C tank systems will be scheduled for leak testing. In addition, the Category B systems that must be upgraded to fully meet the FFA requirements and tank system W-12, the category of which is expected to be corrected to Category C, are scheduled for leak testing.

As part of the leak test program development, preliminary tests have been conducted on all Category C tanks except the HFIR tank and tank 2026A. None of the tested Category C tanks have been determined to leak on the basis of the preliminary leak test data. Periodic testing of these tanks will continue as the testing regime is finalized. The results of leak tests will be submitted to EPA/TDEC after development of the testing program is complete.

6.3.1 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 40 CFR 280, which addresses underground storage tanks (USTs) containing petroleum products and other hazardous substances.

The relevant portion of 40 CFR 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 paragraph. 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.

6.3.2 Prioritization For Leak Testing

A ranking based on the relative probability of failure resulting in environmental harm or unacceptable human exposure for the LLLW system components was developed for use in prioritizing the tanks for leak-testing. On the basis of this evaluation, components were classified as low, moderate, or high risk. Then, considering the risk, technical constraints, and available funding, tanks were prioritized for testing. This prioritization was submitted to EPA/TDEC in January 1993.

6.3.3 Leak Detection Test Schedule

The leak detection test plan and the risk ranking are being integrated to establish LLLW system component testing schedules. Schedule priority levels were 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 developed by independent expert consultants.

- Leak detection test schedules were developed on the basis of the leak detection test plan and risk ranking that 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.

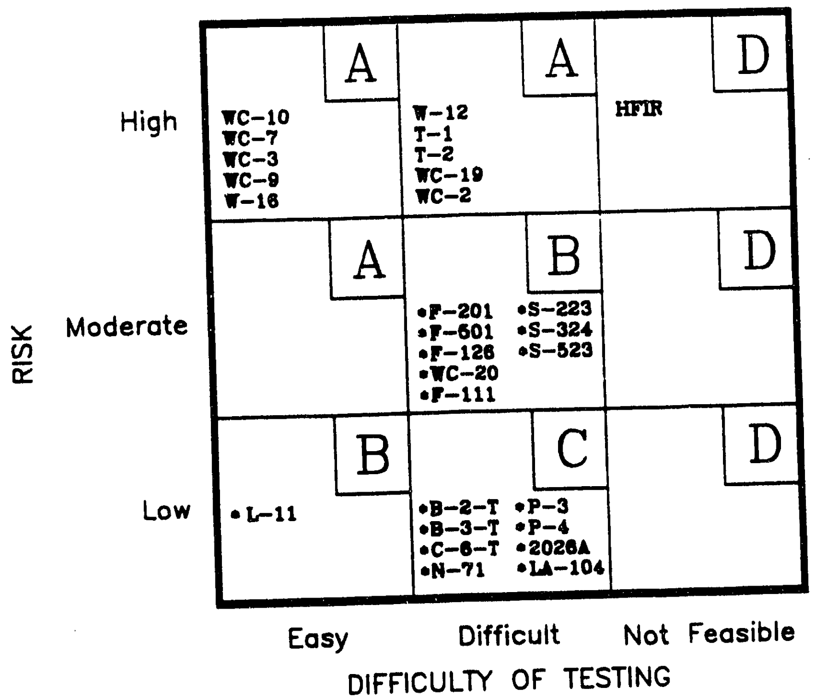
- The schedules presented in this chapter of this document will continue to be subject to annual renegotiation to adjust for updated information based on duration of activities or for changes in priorities and funding.

- Continued annual updates 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.

Leak Detection Test

Priority Matrix
FFA LLLW Tank Systems



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

*Category B tank systems that require upgrade to meet FFA secondary containment requirements.

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Fig. 6.3. Leak detection test schedule priorities.

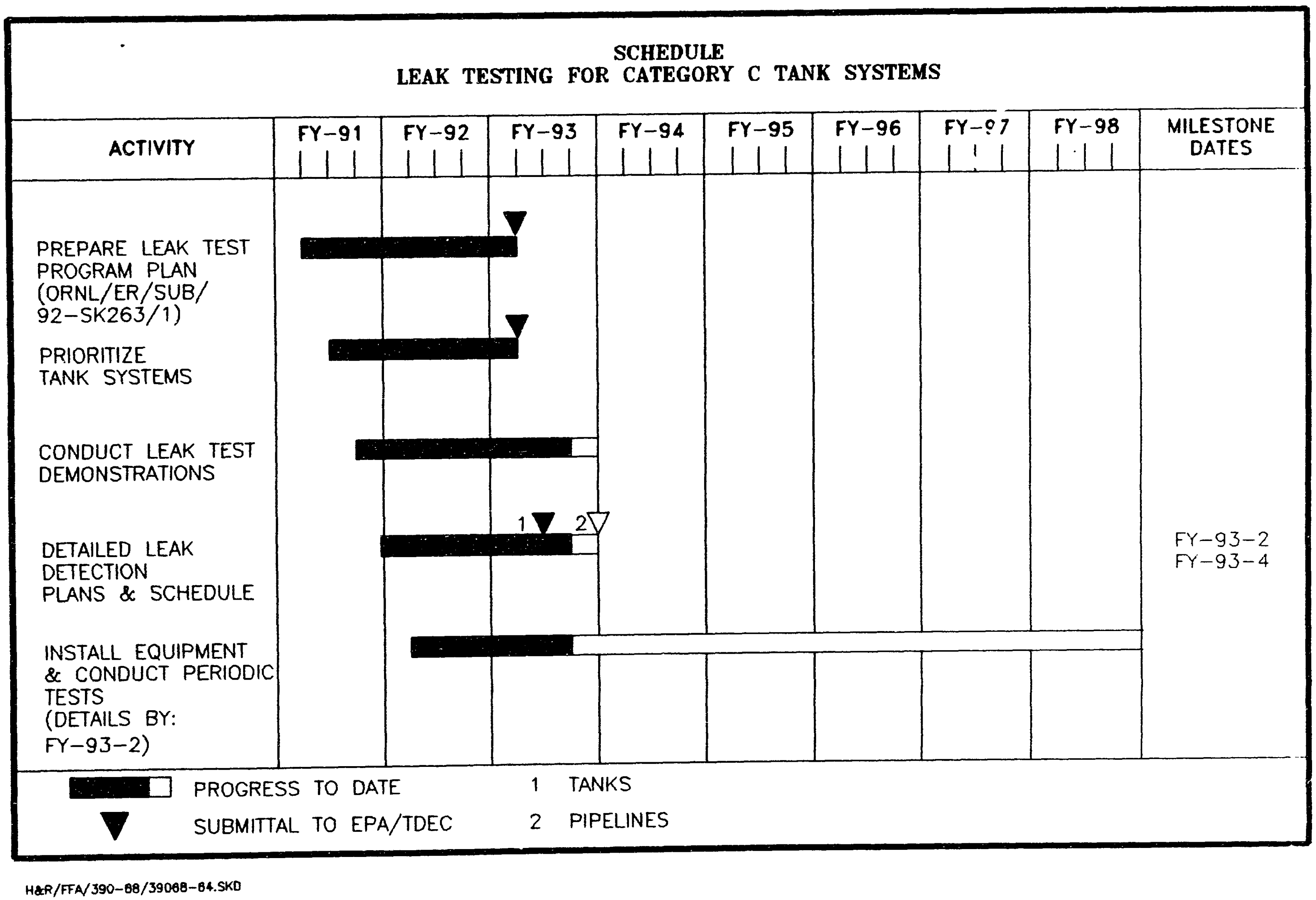

Fig. 6.4. Leak detection test plan and schedule.

REFERENCE FOR CHAPTER 6

1. Douglas, Dennis G., et. al., *Leak Testing Plan for the Oak Ridge National Laboratory Liquid Low-Level waste System (Active Tanks),* ORNL/ER/Sub/92-SK263/1, Vista Research, Inc., Mountain View California, June 1992.

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

7.1 FFA DELIVERABLES

This chapter contains the schedules for the Category D LLLW tank systems that were submitted to EPA/TDEC for approval in March 1992. It also contains a revision of the risk characterization plan description that was submitted in March 1992. The risk characterization plan has been revised to clarify the methodology. Included in this chapter are the schedules for preparing waste characterizations and risk characterizations. In addition, a schedule for detailed remediation of the Category D tanks is scheduled for submittal to EPA/TDEC in March 1993. The plan for conducting risk characterizations to prioritize the tanks for further evaluation is presented in Sect. 7.5.

The bases for the schedules presented in this section are as follows.

- Tanks that contain liquids, or liquids and sludge, will be characterized. Tanks will not be characterized if they have been emptied so that the only material that remains is a trace or residual "heel" that is too small to be removed by the installed equipment.

- If immediate sampling activities for a specific tank are judged by safety and operations personnel to pose a high risk of personnel exposure or environmental contamination, sampling may be postponed until the CERCLA remedial investigation. The location of the tank and type of contaminant present may influence this decision. In such a case, a screening characterization of tank contents will be based on process history. This screening characterization will be used to establish relative priorities for evaluating the need for early action.

- 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. The detailed risk assessments and pathways analyses for the Category D tanks will be conducted as part of the CERCLA RI/FS process rather than the FFA.

- Progress on the evaluation of tanks for interim corrective actions will primarily be communicated to EPA/TDEC in periodic working group meetings.

- The schedules presented in Chapter 7 of this document are 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 tank systems to EPA/TDEC is shown in Fig. 7.1. Section 1.7.3.2 of this document describes the plans for conducting these waste characterizations. Tanks that 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 Fig. 7.1. The risk characterizations are performed in accordance with the plan described in Sect. 7.6 of this document. An update to the risk characterization will be prepared to include the remaining Category D tank as waste characterization data for these tanks becomes available. The updated risk characterization will be submitted to EPA/TDEC in accordance with the schedule in Fig. 7.1.

7.4 REMEDIATION SCHEDULE FOR THE CATEGORY D TANK SYSTEMS

The long-term strategy for the Category D tanks is to remediate individual tanks or tank farms under the CERCLA process as part of the WAG in which the tank is located. Each tank will be evaluated to determine if interim measures or early removal of liquid contents is necessary to reduce to an acceptable level the risk associated with the tank. Final remediation of sludges, tank shells, and associated piping will be evaluated during the RI/FS for the WAG. DOE will submit a schedule for remediation of the Category D tanks to EPA/TDEC in March 1993. This schedule will be reviewed and renegotiated annually, if necessary.

7.5 RISK CHARACTERIZATION PLAN AND METHODOLOGY FOR THE CATEGORY D TANK SYSTEMS

The 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[1]. This methodology produces a first-cut relative ranking based on risk. Detailed risk assessments will be prepared as part of the RI/FS.

This approach for prioritizing the Category D LLLW tanks for further evaluation considers 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.

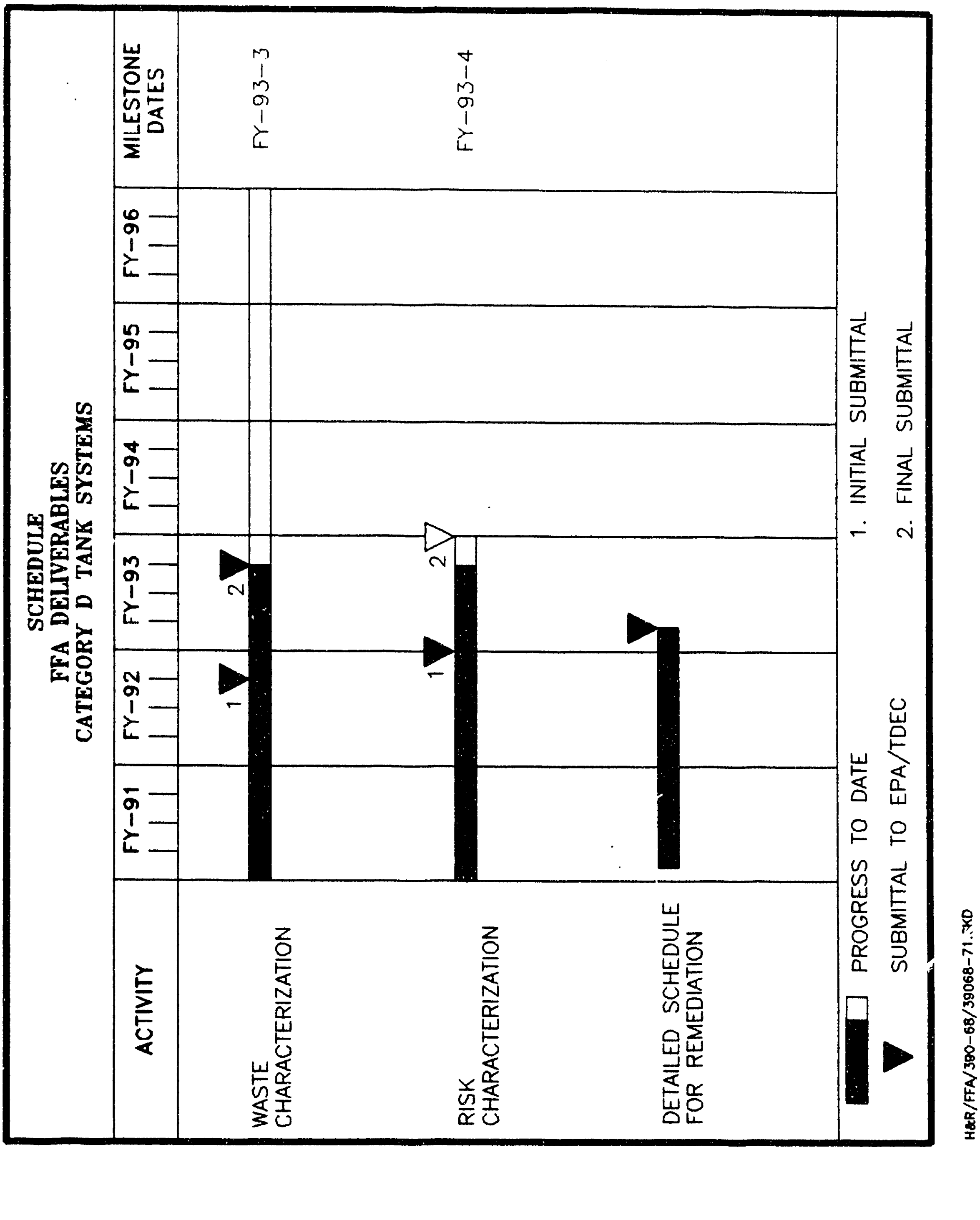

Fig. 7.1. Schedule for development of FFA deliverables for Category D tank systems.

7.5.1 Propensity for Leaking

The structural characteristics of the Category D LLLW tanks help to establish the likelihood that the contents will leak to the environment and the probable extent of any leaks that do occur. 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 concrete or mild steel that is susceptible to corrosion are more likely to leak than tanks constructed of stainless steel.

7.5.2 Location

Tank location also influences the likelihood that the contents will leak to the environment and the probable extent of any leaks that do occur. 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.

7.5.3 Toxicological Index

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 index 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).

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

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.

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

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}).

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

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 on the basis of 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 index, 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 criterion; 5 indicates the highest priority. The scores for the three criteria were weighted according to their perceived importance by a group of people who are knowledgeable of the history and condition of the tanks. The weighting factors were adjusted so that relative ranking is reasonable and consistent with available information. 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 is assigned 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 is assigned a weight of 1.

Toxic Index. The toxic indexes of the contents of the Category D tanks ranged from less than 10^2 to greater than 10^{10}. This range was divided into five groups and assigned scores as shown to allow the TI factor to be combined with the other selected risk criteria.

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 is assigned a weight of 2.

Prioritization Rank. The total score for each tank is the sum of its three weighted risk factors.

$$S = (3 \times \textit{Leaking Score}) + (1 \times \textit{Location Score}) + (2 \times \textit{TI}) .$$

The total score distinguishes the relative risk of the tanks and corresponds to the order in which they are evaluated for early action. Through the use of this method, prioritization has been performed for 32 Category D tanks with data from sampling activities conducted in 1988–1990, and the results of this prioritization were published in ORNL/ER-84. The remaining Category D tanks will be prioritized as sampling data become available in FY 1993.

REFERENCE FOR CHAPTER 7

1. V. Chidambariah, C. C. Travis, J. R. Trabalka, and J. K. Thomas, *Risk-Based Prioritization for the Remediation of Inactive Low-Level Liquid Radioactive Waste Underground Storage Tanks at Oak Ridge National Laboratory, Oak Ridge, Tennessee*, ORNL/ER-84, Martin Marietta Energy Systems, Inc., 1992.

Appendix A

DATA SUMMARIES FOR CATEGORY B AND C LLLW TANK SYSTEMS

The data in this Appendix are based on technical information available in November 1992.

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; 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 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 that 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: ~700 ft
Percent Doubly Contained Buried Pipe: 60%
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 that contained ^{60}Co, ^{90}Sr, ^{192}Ir, ^{147}Pm, and ^{137}Cs/^{134}Cs.

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 2002. 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: 100%
Length of Buried Piping: 360 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 Facility LLLW tank systems.

A. Facility: 2531 (Evaporator Facility)

B. Tank Location: C-1,C-2, W-21, and W-23 are located in Bethel Valley, north of Building 2531.

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
W-22	1979	IGV	50000	SS	yes	NA
W-23	1979	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, d 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: ~400 ft
Percent Doubly Contained Buried Pipe: 100%
Cathodic Protection for Buried Pipe: All doubly 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: 0%
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 SS—stainless steel
IGV—in-ground vault CS—carbon steel
BT—buried tank C—concrete
NA—not applicable

E. Original or Past Tank Usage:

Served as a waste tank for the New Hydrofracture Facility, which 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: 0 ft
Percent Doubly Contained Buried Pipe: NA
Cathodic Protection for Buried Pipe: NA
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 nonroutine washdown 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: 6%

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

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 Building 3047 LLLW tank systems.

A. Facility: Building 3047

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.
LA-104	1960	IGV	296	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:

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 2002. 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: 100%
Length of Buried Piping: 0 ft
Percent Doubly Contained Buried Pipe: 0%
Cathodic Protection for Buried Pipe: NA
System Operation at Negative Pressure: yes

Exhibit A.9. Data summary for the Melton Valley Storage Tank systems.

A. Facility: Melton valley Storage Tanks

B. Tank Location: 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.
W-24	1980	IGV	50000	SS	yes	NA
W-25	1980	IGV	50000	SS	yes	NA
W-26	1980	IGV	50000	SS	yes	NA
W-27	1980	IGV	50000	SS	yes	NA
W-28	1980	IGV	50000	SS	yes	NA
W-29	1980	IGV	50000	SS	yes	NA
W-30	1980	IGV	50000	SS	yes	NA
W-31	1980	IGV	50000	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. Tank Usage:

These tanks store the evaporator bottoms from the LLLW evaporators in Bethel Valley. This material, which includes TRU waste, must be stored at ORNL until a DOE facility that can accept it becomes operational.

F. System Component Characteristics:

Percent Doubly Contained Pipe in Facilities: 100%
Length of Buried Piping: 6,300 ft
Percent Doubly Contained Buried Pipe: 100%
Cathodic Protection for Buried Pipe: yes
System Operation at Negative Pressure: yes

Exhibit A.10. 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
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 2002. 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: 100%
Length of Buried Piping: 3900 ft
Percent Doubly Contained Buried Pipe: 0%
Cathodic Protection for Buried Pipe: no
System Operation at Negative Pressure: yes

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Inches

2 of 2

Exhibit A.10. 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
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 2002. 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: 100%
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.11. 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.12. 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 may 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.13. 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.14. 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.15. 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 received 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:

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 2002. 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: 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.16. 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	**SS**—stainless steel
IGV—in-ground vault	**CS**—carbon steel
BT—buried tank	**C**—concrete
NA—not applicable	

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 that 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.17. 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. Multigram 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 (THAT ARE REMOVED FROM SERVICE)

Exhibit B.1. Data summary for South Tank Farm Category D LLLW tank systems.

A. Tanks Located at: Bethel Valley, South Tank Farm (W-5, W-6, W-7, W-8, W-9, W-10, W-11, W-17); south of the South Tank Farm (W-18, W-19, and W-20).

B. Tank User Divisions: Environmental Restoration

C. 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
W-17	1951	BT	1000	SS	no	no
W-18	1951	BT	1000	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

D. 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.

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

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.

E. 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 organics. Tank W-11 contains primarily low-level waste in aqueous form.

The results of a previous sampling campaign revealed that tanks W-19 and W-20 are empty.

The results of the 1992-1992 sampling campaign showed that tanks W-17 and W-18 have very low levels of contaminants.

Exhibit B.2. Data summary for Old Hydrofracture Facility Category D LLLW tank systems.

A. Tanks Located at: Melton Valley Hydrofracture Area

B. Tank User Divisions: Environmental Restoration

C. 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

D. 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.

E. Waste Characterization:

From the results of a previous sampling campaign, the Old Hydrofracture Facility tanks (T-1 through T-4 and T-9) contain soft sludge with high transuranic and toxic metal concentrations.

Exhibit B.3. Data summary for the North Tank Farm Category D LLLW tank systems.

A. Tanks Located at: Bethel Valley, North Tank Farm Area

B. Tank User Divisions:

C. 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-1A	1951	BT	4000	SS	no	no
W-15	1945	BT	2000	SS	no	no

D. 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.

E. Waste Characterization:

The results of a previous sampling campaign revealed that the North Tank Farm varies from tanks with only liquids (W-1, W-1A, W-2, W-13, W-14, and W-15) to tanks that contain a liquid phase and a sludge with transuranic and toxic metals (W-3 and W-4).

Exhibit B.4. Data summary for the 3500 Area Category D LLLW tank systems.

A. Tank Group Location: Bethel Valley, 3500 Area

B. Tank User Divisions: Environmental Restoration

C. Tank Data Table:

Tank No.	Date of Install.	Tank Loc.	Cap. (gal)	Material of Const.	Double Ctnment	Cathodic Prot.
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
S-424	1955	IGV	500	SS/GL	yes	no
H-209	1961	BT	2500*	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

Legend: AGV—Above Ground Vault; IGV—In-Ground Vault; BT—Buried Tank; NA—Not Applicable; SS—Stainless Steel; CS—Carbon Steel; C—Concrete; *—Estimated

D. Original or Past Tank Usage:

Tanks TH-1, TH-2, and TH-3, received waste from the irradiated thorium and uranium pilot development plant development projects in Building 3503. TH-4 received waste from thorium and uranium projects in Bldg. 3550. The tanks were taken out of service in 1970.

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

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

E. Waste Characterization:

Tanks TH-1, TH-2, and TH-3 contain little or no sludge. The liquid phase contains low levels of radioactivity.

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

Tanks S-424, H-209, WC-5, WC-6, and WC-8 were sampled in FY 92 and early FY 93. Tank S-424 contains no liquids and will be further characterized as part of the RI/FS process. Tank H-209 contains no sludge, and its liquid has low levels of chemical and radiological contaminants. Tanks WC-5, WC-6, and WC-8 contain no sludge, and their liquids have very low levels of chemical and radiological contaminants.

Exhibit B.5. Data summary for the Isotopes Circle Category D LLLW tank systems.

A. Tanks Located at: Bethel Valley, Isotopes Circle. Tank W-11 is located under the floor slab in the east airlock of Building 3028.

B. Tank User Divisions: Environmental Restoration

C. Tank Data Table:

Tank No.	Date of Install.	Tank Loc.	Cap. (gal)	Material of Const.	Double Ctnment	Cathodic Prot.
W-1I	1959	BT	500	SS	no	no
WC-1	1950	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

D. Original or Past Tank Usage:

Tank W-1I was used to collect waste liquids from isotope recovery operations in Building 3028. Although the actual date is uncertain, the tank was removed from service by 1987.

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.

E. Waste Characterization:

Tank WC-1 contains little or no sludge. The liquid phase contains low levels of radioactivity. Tank W-1I has no liquids, and its sludge contains high levels of alpha contamination..

Exhibit B.6. Data summary for the 4500 Area Category D LLLW tank systems.

A. Tanks Located at: Bethel Valley, 4500 Area

B. Tank User Divisions: Environmental Restoration

C. Tank Data Table:

Tank No.	Date of Install.	Tank Loc.	Cap. (gal)	Material of Const.	Double Ctnment	Cathodic Prot.
4501-P	unknown	IGV	100	SS	yes	NA
T-30	1961	IGV	825	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

D. **Original or Past Tank Usage:**

Tank 4501-P was used to store waste from the plutonium recovery loop experiment and other waste from experiments in Building 4501. The tank was flushed and drained in 1990.

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.

E. **Waste Characterization:**

The results of a previous sampling campaign revealed that tank T-30 contains an aqueous phase with little or no sludge. Tank 4501-P is empty.

Exhibit B.7. Data summary for the 3587 Area Category D LLLW tank systems.

A. Tank Located at: South of Building 3587

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

C. Tank Data Table:

Tank No.	Date of Install.	Tank Loc.	Cap. (gal)	Material of Const.	Double Ctnment	Cathodic Prot.
WC-11	1951	BT	4000	SS	no	no
WC-12	1947	BT	700	SS	no	no
WC-13	1951	BT	1000	SS	no	no
WC-14	1951	BT	1000	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; GL—Glass lined

D. Original or Past Tank Usage:

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

Tank W-15 was 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 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.

E. Waste Characterization:

Tanks WC-11, WC-13, and WC-14 were sampled in FY 92 and early FY 93. Tanks WC-11 and WC-13 contain a thin, floating organic layer. The liquid is radioactive. Tank WC-14 contains liquid contaminated primarily with ^{137}Cs.

Tanks WC-15, and WC-17 contain little or no sludge. The liquid phase contains low levels of radioactivity with an organic layer within the liquid phase.

Exhibit B.8. Data summary for Melton Valley Area Category D LLLW tank systems.

A. Tanks Located at: Melton Valley Area

B. Tank User Divisions: Environmental Restoration

C. Tank Data Table:

Tank No.	Date of Install.	Tank Loc.	Cap. (gal)	Material of Const.	Double Ctnment	Cathodic Prot.
T14	1979	BT	48500	C	no	no
7503-A	1962	IGV	11000	SS	yes	NA
7560	1957	BT	1000	SS	no	no
7562	1957	BT	12000	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; RL—Rubber lining

D. Original or Past Tank Usage:

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

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

E. Waste Characterization:

The results of a previous sampling campaign revealed that the tank 7562 contains an aqueous phase with little or no sludge and 7560 is empty.

Tank 7503-A was sampled in FY 92 or early FY 93, but analysis is not yet complete. Tank T-14 contains low levels of chemicals and radiological contaminants.

Exhibit B.9. Data summary for the 3000 Area Category D LLLW tank systems.

A. Tank Location: Bethel Valley, 3000 Area

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

C. Tank Data Table:

Tank No.	Date of Install.	Tank Loc.	Cap. (gal)	Material of Const.	Double Ctnment	Cathodic Prot.
3001-B	1943	BT	75*	SS	no	no
3003-A	1943	BT	16000	C	no	NA
3001-S	NA	NA	NA	NA	NA	NA
3004-B	1956	IGV	30	SS	yes	NA
3013	1949	BT	400	SS	no	no
3002-A	1943	BT	1600	SS	no	no
WC-4	1944	BT	1700	SS	no	no

Legend: AGV—Above Ground Vault; IGV—In-Ground Vault; BT—Buried Tank; NA—Not Applicable; *—Estimated; SS—Stainless Steel; CS—Carbon Steel; C—Concrete; GL—Glass lined

D. Original or Past Tank Usage:

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 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.

3001S is a tank that was shown on 1940s vintage engineering drawings as located south of Building 3001. Investigative work completed in December 1992 verified that no tank exists at this location.

Tank 3002-A 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 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.

E. Waste Characterization:

Tank 3001-B has <1 in. of liquid containing low levels of chemical and radiological contaminants. Tank 3003-A contains liquid and sludge with chemical and radiological contaminants. Tank 3004-B is a very small tank containing liquid with low levels of chemical and radiological contaminants. Tank 3013 contains liquid with very low chemical and radiological contamination. Tank 3002-A contains liquid and a thin sludge layer with very low levels of chemical and radiological contaminants. Tank WC-4 contains liquids with low levels of radiological and chemical contaminants.

Exhibit B.10. Data summary for the 3525 Area Category D LLLW tank systems.

A. Tank Location: Bethel Valley, Southwest of Building 3525

B. Tank User Divisions: Chemical Technology, Metals and Ceramics, and Reactor Research Division.

C. Tank Data Table:

Tank No.	Date of Install.	Tank Loc.	Cap. (gal)	Material of Const.	Double Ctnment	Cathodic Prot.
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
GL—Glass lined

D. Original or Past Tank Usage:

Tank W-12 is designed to receive waste from the examination of reactor components in Building 3525 from tanks F-501 and F-201. Tank system is being repaired and will be returned to service. W-12 will be removed from service when the system replacement project, Bethel Valley FFA Upgrades 1 line item project, is completed in 2000. This tank is actually a Category C tank. It was mistakenly placed in Category D when the original tank inventory was made. A request has been made to EPA and TDEC to correct its category.

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