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WASTE MANAGEMENT SYSTEM FUNCTIONAL REQUIREMENTS FOR INTERIM WASTE MANAGEMENT FACILITIES (IWMFs) AND TECHNOLOGY DEMONSTRATIONS, LLWDDD PROGRAM

OPERATED BY
MARTIN MARIETTA ENERGY SYSTEMS, INC.
FOR THE UNITED STATES
DEPARTMENT OF ENERGY

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EXECUTIVE SUMMARY

The purpose of this report is to build upon the preceding decisions and body of information to prepare draft system functional requirements for each classification of waste disposal currently proposed for Low-Level Waste Disposal Development Demonstration (LLWDDD) projects. System functional requirements is interpreted as those technical requirements necessary to achieve the LLWDDD program goals within the context of existing legislation. Functional requirements identify specific information and data needs necessary to satisfy engineering design criteria/objectives for (Interim Waste Management Facilities (IWMFs). This draft will support the alternatives evaluation process and will continue to evolve as the LLWDDD strategy is implemented, regulatory limits are established, technical and economic uncertainties are resolved, and waste management plans are being implemented. This document will become the planning basis for the new generation of solid LLW management facilities on new sites on the Reservation.

Eighteen (18) general system requirements are identified which are applicable to all four Low-Level Waste (LLW) disposal classifications. These requirements are based upon federal and state statutes governing the design, construction, operation, closure/post closure, and institutional control period of LLW disposal facilities. Application of those statutes is specific to the Oak Ridge Reservation and is intended to identify opportunities which require further definition or resolution.

Each classification of LLW disposal is individually addressed with respect to waste characteristics, site considerations, facility operations, facility closure/post-closure, intruder barriers, institutional control, and performance monitoring requirements. Three initial LLW disposal sites have been proposed as locations on the ORR for the first demonstrations. These three sites serve as "strawmen" for further defining, testing, and refining the LLWDDD strategy.

1.0 INTRODUCTION

The Department of Energy (DOE) operates three separate nuclear facilities at the Oak Ridge Reservation (ORR). The Oak Ridge National Laboratory (ORNL), Y-12 Plant, and the Oak Ridge Gaseous Diffusion Plant (K-25) all generate quantities of radioactive low-level waste (LLW) that require safe and environmentally acceptable disposal.

These disposal requirements are currently being satisfied for ORNL at Solid Waste Storage Area Number 6 (SWSA 6) and at Bear Creek Burial Ground (BCBG) for ORGDP and the Y-12 Plant. Both disposal sites are approaching the end of their useful life with a remaining combined capacity of approximately 1 million cubic feet. SWSA 6 and BCBG have an estimated remaining service life of approximately 10 and 5 years, respectively, based upon current generation rates and management practices. Anticipated changes in regulatory requirements and possible increases in LLW generation on the Oak Ridge Reservation (ORR) are expected to further reduce the capacity and life expectancy of these existing disposal sites.

1.1 Low-Level Waste Disposal Development and Demonstration (LLWDDD)

The ability to effectively manage solid LLW generated on the ORR is crucial to the continued operation of the three facilities. Without acceptable disposal capabilities, the facilities may be subject to operational curtailment or shutdown. The Low-Level Waste Disposal Development Demonstration was established to provide technical and scientific information leading to the development of new and improved waste disposal facilities for the management of solid LLW generated on the ORR. The ultimate goal of the Program is disposal of solid LLW on the ORR in a manner that protects the environment and ensure the present and the future health and safety of the public.

The scope of the LLWDDD Program has been defined to include the following activities:

a) support improved LLW management operations conducted by waste management organization at plants on the ORR;
b) development of technical bases for an LLW/ORR management strategy;
c) define functional requirements for development of new disposal facilities;
d) site characterization and environmental monitoring to support the siting of new disposal facilities;
e) development of an environmental report for submission to DOE/ORO and support to DOE/ORO during the development of an environmental impact statement;
f) conduct demonstrations of treatment/packaging, storage, and disposal technologies to reduce technical and economic uncertainties associated with deployment of new disposal facilities; and
g) preparation of new sites and construction of new prototype disposal facilities for operation by waste management organizations at ORR facilities.

Completion of these activities is expected before FY'92 and should culminate with occupancy on the ORR of a large-scale demonstration facility based on new disposal technology. This demonstration will be coupled with the opening of new sites on the ORR and the gradual deployment of other large scale demonstrations of best-management-practice disposal technologies to serve the ORR. The complex of new sites and disposal demonstrations is referred to as Interim Waste Management Facilities (IWMFs). IWMFs is defined as a waste management facility providing LLW disposal, processing, packaging, and other support functions located at new sites (SWSA-7, WBCV, and WCR) on the ORR and to be developed within the background of an Environmental Impact Statement (EIS). Other elements of the LLW management system not located at the new sites on the ORR or outside the scope of an EIS will be developed within the background of the LLWDDD Strategy and coordinated through the LLWDDD program.

1.2 LLWDDD Strategy - Waste Segregation/Trigger Dose

During FY 1987, the LLWDDD Program has made significant progress in development of a proposed strategy for future LLW management practices on the ORR. The LLWDDD strategy is based upon waste segregation and certification, site-specific pathways analysis, and the selection of sites and technologies needed to assure that performance requirements are met.

The LLWDDD strategy relies heavily upon the concept of waste segregation to provide needed control of the concentration and isotopic composition of radioactive wastes prior to disposal. The strategy does not address disposal of sanitary wastes or those wastes that are defined by the Environmental Protection Agency (EPA) as Below Regulatory Concern (BRC) for LLW disposal. The strategy is directed toward developing future disposal facilities on the ORR that will assure the protection of the general public, radiation workers, and the inadvertent intruder.

Waste segregation limits for classifying radioactive waste will be performed through use of an interactive "trigger dose" technique. The trigger dose has been defined by the LLWDDD Strategy as a dose limit below the regulatory standards for waste disposal and corresponds to the principles of Below Regulatory Concern (BRC) waste. Exceeding these doses "triggers" initiation of mitigating measures or remedial actions. Waste segregation limits are established such that waste disposal units will not be associated with exceeding the trigger dose at the time that active institutional control over the wastes no longer occurs. At present, the trigger dose limit is proposed to be 10 mrem/yr effective dose equivalent to any member of the public or an inadvertent intruder.

Four classes of waste have been defined by the waste segregation strategy. Class I is waste which is suitable for unrestricted burial and which has levels of contamination that would result in doses below the trigger dose at the time of disposal. Class II is waste which is suitable for engineered disposal and which has contamination levels that will

result in doses below the trigger dose at the end of a period of active institutional control. Class III is waste which is suitable for restricted disposal and which contains constituents with long half-lives that could result in doses to an inadvertent intruder that could exceed the trigger dose at the end of the institutional control period unless intruder protection is provided. Class IV is waste which is not acceptable for near-surface disposal and requires either treatment to reduce the level of contamination to a level consistent with one of the other waste classifications or shipment to an off-site disposal facility.

1.3 Controlling Documents

The following documents were used to develop the system function requirements proposed in this draft report:

a) R. K. Genung, et al, Strategic Planning for the Low-Level Waste Disposal Development And Demonstration (LLWDDD) Program, July 1987;
b) Department of Energy Order 5700.6, "Quality Assurance - ORO Site Implementation Plan";
c) Department of Energy Order 5820.2, "Radioactive Waste Management", (1983);
d) Department of Energy Order 5700.4, "Project Management System";
e) Nuclear Regulatory Commission, Code of Federal regulations, Title 10, Part 61, "Licensing Requirements for Land Disposal of Radioactive Wastes";
f) U.S. Nuclear Regulatory Commission, Code of Federal Regulations, Title 10, Part 20, "Standards for Protection Against Radiation",
g) U.S. Environmental Protection Agency, Code of Federal regulations, Title 40, Part 264, "Standards For Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities";
h) Tennessee Department of Public Health, Chapter 1200-1-7, "Regulations Governing Solid Waste Processing and Disposal in Tennessee";
i) T. W. Thompson, X-OE-139, "Feasibility Study for Oak Ridge Solid Waste Disposal Facilities" September 1981;

j) E. C. Davis, et al, ORNL/TM-9146, "Site Characterization Techniques Used at a Low-Level Waste Shallow Land Burial Field Demonstration Facility";

k) Lockwood Greene Engineers, "Oak Ridge Reservation Low-Level Radioactive Waste Storage and Disposal Capacity Evaluation", August 1987.

2.0 GENERAL SYSTEM REQUIREMENTS

2.1 Capacity and Longevity Requirements

2.1.1 Capacity

The IWMFs shall provide for disposal of the following quantities of LLW generated for each class beginning in 1991 and extending through 2021 (Table 2.1.1).

Table 2.1.1 Annual Disposal Capacity Needs for LLWDDD, IWMFs

	Disposal Capacity Needs ($X10^3$ ft^3/year)			
DOE/ORO Plant	Class I	Class II	Class III	Class IV
ORNL	40-60	60-80	5-15	5-15
ORGDP	5-15	10-30	5-15	5-15
Y-12	1500-2000	1000-1500	1000-1500	200-250
Total	1545-2075	1070-1610	1010-1530	210-280

Potential Disposal Capacity for Development on the ORR has been estimated as presented in Table 2.1.2.

2.1.2 Longevity

The IWMFs shall be capable of meeting the LLW disposal requirements for all waste classes produced on the ORR for at least 20-30 years. The facilities must be capable of demonstrating acceptable performance during the institutional control period. The proposed periods of institutional control for each LLW class are presented in Table 2.1.3.

Table 2.1.3 Institutional Control Periods for LLW Classes I-IV

LLW Class	Time (yrs)
Class I	20-30
Class II	100-300
Class III	Undetermined
Class IV	NA

Table 2.1.2 Preliminary Onsite Disposal Capacity Development Scenarios [a]

Disposal Site	Status	Major DOE Site Serviced	Potential Disposal Capacity for Development (ft^3)	Reference Disposal Technology/Facility	Reference Waste Stream, Category, or Class
SWSA 6	Current	ORNL	551,005	Below Grade Silo	
			6,742	Below Grade Well	
			345,564	Above Grade Tumulus[b]	
Bear Creek Burial Ground[c]	Current	ORGDP,Y-12	270,000	Below Grade Trench (A-16)	
			486,000	Below Grade Trench (A-17)	
			27,000	Below Grade Trench (A-17E)	
			864,000	Below Grade Trench (A-18)	
			1,752,204	Above Grade Tumulus	
SWSA 7	New	ORNL	68,749	Below Grade Silo	Class II
			4,312	Below Grade Well	
			2,435,479	Above Grade Tumulus	
West Bear Creek Valley	New		2,080,038	Below Grade Hill Cut Trench	Class II, III
			5,114,537	Above Grade Tumulus	
West Chestnut Ridge	New		5,195,175	Below Grade Trench (Area A)	Class I
			2,149,362	Below Grade Trench (Area B)	
			1,880,334	Below Grade Trench (Area C)	
East Chestnut Ridge	New		17,767,296	Below Grade Hill Cut Trench	ERC/Sanitary/Industrial Class I

a. Oak Ridge Reservation Low-Level Radioactive Waste Storage and Disposal Capacity Evaluation. Prepared by Lockwood Greene Engineers, Inc., Oak Ridge, TN. August 1987.
b. The capacity given is for a 2-layer tumulus. For a 3-layer tumulus multiply the capacity given by 1.50331.
c. As of March 1, 1987.
d. Technology is used as a generic term to include waste package, form, and disposal unit.

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2.2 Life Cycle Cost

Recognizing that cost estimating for technology demonstrations is not an exact science, adherence to DOE Order 5700.4 should result in minimizing life cycle costs associated with program development and implementation.

2.3 Site

Suitability Requirements

Site suitability for near-surface disposal of LLW on the ORR depends upon many factors ranging from geology to climatology. The primary consideration in defining a set of site requirements is to promote the stability and isolation of LLW in the event of failure of the disposal facility. These characteristics should also facilitate design and construction while promoting ease of operations and closure. Since disposal facilities for LLW may be constructed at different locations on the ORR, disposal sites can be expected to present a range of geologic, hydrologic, micro-metorological, and environmental conditions. The contribution of site characteristics toward stability and isolation of LLW on the ORR can therefore be expected to vary from site to site.

A survey and assessment of the ORR has been performed to define areas with the greatest potential as initial sites for the LLWDDD program. Three sites that have been identified for the first demonstrations on the ORR: West Chestnut Ridge (Class I), SWSA 7 (Class II), and West Bear Creek (Class II and/or III). A fourth location, East Chestnut Ridge has initially been designed for disposal of wastes which are classified as below regulatory concern, sanitary, or industrial (Class I) wastes. The fourth site was not considered in this report. Site designation was necessary for data collection and to establish the framework for testing the LLWDDD strategy. The three primary sites represent the first attempt to demonstrate the LLWDDD strategy under actual (real world) operating

conditions. It is expected that these initial sites will represent "strawmen" against which preliminary assumptions of performance will be tested assessed and ultimately refined to reflect the optimum strategy for LLW disposal on the ORR.

Development Plan

A site development plan specific to each disposal site must be developed and approved before construction of the disposal facility. The plan must consider selection of the best combination of waste class, disposal technology, and site to maximize the site development capacity.

The design concept shall minimize the requirements for land in terms of area disturbed during construction, operation, and closure. The concept shall also attempt to limit the total amount of land removed from alternative use for the anticipated hazardous life of the waste.

Every effort shall be made to maximize disposal potential within the boundaries of the site. Disposal units shall be arranged to minimize separation distances and to centralize common functions. Consideration should be given to disposal of more than one waste class at an IWMF. As more information becomes available, optimum site organization parameters can be developed. From these site parameters, optimal disposal configurations and related support functions can be developed to insure efficient land utilization and minimized cost.

2.4 Transfer Reductions - Onsite/Offsite

Handling and transporting LLW on the ORR site shall be approached with the prospective of minimizing both the distance and number of operations involved in managing radioactive waste.

LLW (Class IV) requiring offsite transfer for disposal shall be treated to minimize the volume of waste shipped and the number of waste shipments. Shipments will be performed in compliance with applicable

Department of Transportation (DOT), state, and local regulations. Appropriate LLW personnel shall receive approval from the disposal site and certify prior to shipment that waste meets the receiving site waste acceptance requirements.

2.5 Strategic Storage

Provisions for strategic storage must be addressed as part of the design requirements for IWMFs. Strategic storage is necessary to assure the efficient management of LLW from collection to ultimate disposal. Storage is also required for LLW management during periods of system disruption and to afford a strategic buffer to optimize overall system performance. Strategic storage is not intended to provide long-term isolation of LLW or as a substitute for acceptable disposal practices.

Disposal of Class I wastes can be performed on demand and therefore is not expected to require interim storage. Class II, III, and IV wastes will require storage prior to treatment, packaging, certification, transport, and disposal. Location of storage areas will be dependent upon the design of the IWMFs.

2.6 Contingency Plan

A contingency plan shall be developed which permits recovery of LLW in the event that facility performance is not achieved. Each facility shall be designed and managed to allow for recovery of LLW at least through the end of the institutional control period. For example, recoverability shall be a design feature which improves the ability to locate and retrieve materials, containers, or waste modules which are performing unacceptably. This requirement is intended to extend the design basis of the disposal facility to include a measure of emergency management capability.

2.7 Quality Assurance Program

The IWMFs shall comply with DOE Order 5700.6 (Quality Assurance - ORO Site Implementation Plan) and be consistent with the objectives set forth in the Quality Assurance Program Requirements for Nuclear Facilities (ANSI/ASME NQA-1, 1986).

As defined in DOE Order 5700.6, the goal of quality assurance is to "assure that research, development, demonstration, and production activities are performed in a controlled manner; that components, systems, and processes are designed, developed, constructed, tested, operated, and maintained according to sound engineering standards, quality practices, and technical specifications; and that resulting technology data are valid and retrievable. Quality assurance includes quality control, which comprises all those actions necessary to control and verify the features and characteristics of a material, process, product, or service to specified requirements".

2.8 Passive Isolation

The engineering design shall provide long-term passive isolation of the LLW thereby reducing the need for continuing active maintenance following site closure and institutional control.

2.9 Minimizing Direct and Airborne Radiation Exposure During Operations

The design concept shall maintain direct and airborne radiation doses at levels which are as low as reasonably achievable (ALARA) during operations for both the general public and employees at the LLW facility.

2.10 Long-Term Stability

The design concept shall provide for long-term stability of the waste disposal site. The following characteristics are considered appropriate for enhancement of long-term stability of the site:

a) Maximize waste density,
b) Emplacing the waste in a manner that maintains waste integrity,
c) Minimization of all void spaces,
d) Filling all void spaces,
e) Adopting a consistent closure and stabilization plan which enhances stability, and
f) Avoid construction on fill or cut locations.

2.11 Monitoring

2.11.1 Performance Monitoring

The IWMFs shall be designed to include a monitoring system for verification of disposal facility performance. Because the IWMFs represent a demonstration of LLWDDD program which relies upon engineering barriers, each facility should be instrumented to assure fundamental engineering performance. Information from the monitoring system(s) will be used to evaluate and update contingency plans for remedial actions and other activities related to the long-term management of the site. An integrated monitoring strategy must be designed to indicate performance of individual system components and define the relationship among monitors to permit independent evaluations of performance (redundancy and reliability). Performance monitors should also be accessible to permit testing, repair, removal, and/or replacement. Redundancy must be considered for monitors that are not accessible for replacement.

Each LLWDDD facility shall be required to have an approved monitoring program prior to construction. The program shall include plans for taking corrective measure if migration of radionuclides would indicate that the performance objectives of the demonstration have not been met. A comprehensive performance monitoring program shall include, but not be restricted to, the following:

a) A design to measure (a) operational effluent releases, (b) significant migration of radionuclides and chemicals in (and, if appropriate, beyond) the buffer zone, (c) disposal unit subsidence, and (d) changes in facility parameters which may affect long-term site performance;
b) The program shall include, but not necessarily be limited to, monitoring soil, air, surface water, and in the subsurface, soil and water both in the saturated and unsaturated zones;
c) Changing trends in site performance shall be detected and documented sufficiently in advance to allow application of any necessary corrective action prior to exceeding performance standards;
d) The program shall be able to ascertain whether or not discharge concentrations from the treatment, storage or disposal facility at the facility compliance point are less than the concentration guides for uncontrolled areas;
e) Requirements shall include, monitoring points for radionuclide compliance limit, monitoring plans; and
f) A part of the post-operational surveillance requirement, a monitoring system shall be maintained based on the operating history and the closure and stabilization of the disposal site.

Site meteorological and climatological data are required to determine a water budget, establish the ranges and frequency of occurrence of unusual phenomena, and perform atmospheric dispersion analyses. For analysis of Class I waste sites, the following data shall be collected:

2.11.2 Disposal Monitoring

Disposal monitoring of the LLW demonstration sites must be designed to provide reasonable assurance that the performance objectives, as defined by the trigger dose, are being met. For this report, monitoring requirements will be considered as an extension of the LLW site data collection activities currently being performed on the ORR. These

activities are designed to provide a statistical data base for background values on the radiological, chemical, physical, and environmental properties of specific media in the vicinity of the proposed LLWDDD sites.

The disposal monitoring program shall build upon the information developed from preoperational investigations to insure that performance objectives are met during the operational, closure, and institutional control phases of the LLW disposal process. The objectives take the form of dose rates for site operators, individuals, inadvertent intruders, and the general public. During the post closure period of active institutional control, the trigger dose becomes the primary indicator for initiation of corrective actions.

It is not the purpose of this report to propose specific monitoring programs, equipment, test methods, and sampling strategies for the LLWDDD Program. During discussion of each LLW classification, types of information will be identified which require development and implementation of individual monitoring programs.

It is presumed that if the IWMFs are properly sited, designed, and operated, the major function of the monitoring program is to provide an indication of satisfactory facility performance.

2.12 Multiple Class Disposal Unit

Design for individual IWMFs should not preclude disposal of more than one LLW class at a particular site. In the event that multiple class disposal units (MCDU) are proposed for a candidate site, special attention must be given to assuring proper waste segregation and handling. The MCDU must provide a waste receiving area sufficient to prevent mixing of the waste classes. Different waste classes shall be segregated and not handled or stored in the same location(s). The IWMF shall provide a system for assuring that the appropriate waste class is disposed of in the proper disposal unit.

2.13 Modeling and Characterization

The design concept and the site must be capable of being characterized, analyzed, and modeled to demonstrate anticipated performance of the various design elements and interactions between the facility design and the natural environment.

2.14 Waste Certification Program

Before any LLW class can be accepted for disposal in an IWMF, the LLW must meet the appropriate waste acceptance criteria. A waste certification program similar to the current TRU program must be designed and implemented to assure the quality and integrity of the wastes presented for disposal at IWMFs. The certification program should include the waste acceptance criteria required by offsite disposal facilities. The certification program should represent a fundamental component in the LLWDDD's Quality Assurance Program.

2.15 Unacceptable Waste

No sanitary, hazardous, or mixed waste materials shall be placed in the IWMFs. Hazardous and mixed wastes means those waste designated as hazardous by Environmental Protection Agency regulations in 40 CFR Part 264.

a) Solid waste shall contain as little freestanding and non-corrosive liquid as reasonably achievable, but in no case shall the liquid exceed 1% of the volume;
b) Waste must not be readily capable of detonation or of explosive decomposition or react at normal temperatures and pressures, or explosive reaction with water;
c) Waste must not contain or be capable of generating quantities of harmful gases, vapors, fumes, or liquids;

d) Waste, packaging, and containment must meet RCRA requirements before disposal;

No waste is acceptable for disposal in the IWMFs which contains more than 100 nCi/g of TRU radionuclides.

2.16 Waste Acceptance Criteria

Waste acceptance criteria for determining the isotope concentrations and segregation criteria for waste streams are prepared using the trigger dose and institutional control period defined in consultation with regulatory agencies. Isotopes associated with a trigger dose require that the waste acceptance criteria be developed with consideration of the site and the disposal and treatment technologies to be deployed. Acceptance of a limit based on dose requires a pathways analysis to determine the acceptable concentrations of waste to be disposed of. The waste acceptance criteria developed from the pathways analysis become the concentration limits for the isotopes at the selected sites using the proposed disposal and treatment technologies.

Pathways analyses used for developing the waste acceptance criteria rely on data developed during site characterization, facility design, waste characterization, and site monitoring. By using these data and scenarios of future activity by the public or an individual who inadvertently intrudes into the waste, concentration limits for the disposal of waste are determined with predictive models.

2.17 Operating Procedures for Disposal Facilities

Each LLW disposal facility on the ORR shall have approved Operating Procedures designed to meet the specific needs and requirements of that waste class. Waste Acceptance Criteria should be considered as part of the operating procedures for the disposal unit. Primary unit operations required for LLW segregation, processing, and disposal will be developed.

Each disposal facility shall have a layout and plan of operations designed to insure employee safety, permit efficient operation, and minimize adverse impacts associated with the construction, operation, closure, post-closure, and maintenance of the disposal site. Remediation procedures shall be included for each facility to minimize adverse impacts resulting from accidental spills, design failures and other events that release unacceptable amounts of LLW.

During the operational phase, the following measures must be undertaken to assure both employee safety and environmental protection:

a) Operations at the disposal site must be conducted in compliance with the standards for radiation protection set out in 10 CFR 20. Every reasonable effort should be made to maintain radiation exposure to workers as low as reasonably achievable (ALARA);
b) Wastes shall be emplaced in a manner that maintains package integrity, minimizes void spaces between packages, and permits the void spaces to be filled;
c) Void spaces between waste packages shall be filled with earth or other acceptable materials to insure stability and prevent subsidence;
d) Boundaries and locations of each disposal unit must be accurately located and mapped by means of a land survey;
e) An administrative area and a three dimensional buffer zone of sufficient size must be maintained to allow unrestricted use beyond the buffer zone boundary;
f) The buffer zone shall be of sufficient size to permit environmental monitoring and to allow performance of mitigating measures if required; and
g) Active waste disposal operations must not have adverse effect upon completed closure and stabilization measures.

2.18 Facility Closure/Post Closure

A site-specific comprehensive closure plan must be developed and approved prior to initiation of closure activities at Class I waste disposal sites. The closure plan shall meet the criteria set forth in DOE Order 5820.2. The facility closure plan must address:

a) Placement of waste packages that does not violate barrier and/or leachate collection systems;
b) Soil placement above the disposal facility shall be conducted in a manner that will not damage waste packages or their containers (if appropriate);
c) Sufficient soil must be applied to the surface above the disposal facility to prevent slumping and insure proper drainage;
d) Stabilization of the disposal site for post-closure care including filling and capping of disposal excavations, as specified in the design requirements, and removal of unneeded equipment and facilities;
e) Residual radioactivity levels for surface soils that comply with site threshold requirements;
f) Installation of a security system to prevent unauthorized entry or removal of equipment or materials during closure and a passive security system for the post-closure period;
g) Installation of permanent identification markers for locating disposal excavations and monitoring wells when closure is complete;
h) Performance of periodic surveillance and maintenance programs until closure is complete and modification of these programs, as necessary, to measure performance and assess the need for corrective measures following closure; and
i) The closed disposal facility shall be maintained in a closed and controlled condition for the period of time that the deposited waste remains a radioactive hazard.

j) A long-lived and very reliable intruder barrier system must be designed. The system must first be able to function for the institutional control period with virtually no maintenance or repairs. The system must be designed to provide an effective barrier to burrowing animals and inhibit root penetration. In addition, the barrier system should be repairable in the event that remedial action is required.

3.0 CLASS I - UNRESTRICTED BURIAL OF WASTE

Class I waste has levels of radionuclide contamination at the time of disposal which would result in doses less than the 10 mrem prescribed trigger level. Neither the waste form nor the radionuclide content of the waste is anticipated to create a public health or environmental concern. The maximum permissible levels of contamination in the Class I waste disposal will be dependent upon the Waste Acceptance Criteria (WAC) developed from pathways analysis of the Waste Disposal Facility. The WAC will be used to establish the isotope concentration and segregation criteria for waste stream that will ultimately be disposed of in Class I sites. As part of this process, all wastes emplaced at Class I disposal sites will be certified by the same procedures used for the other waste classifications. Current disposal techniques for Class I waste are trench and silo/containment well systems. Given the low level of contamination, industrial-type landfills might provide the most appropriate future disposal practice. Tennessee State Regulations require all industrial landfill operations to employ liners and establish an approved leachate monitoring program. These state requirements are consistent with the IWMF objectives which rely upon a combination of internal, effluent, and perimeter monitoring to verify the performance of the IWMF.

3.1 Waste Characteristics

Radionuclide composition and concentration of Class I waste can be expected to be highly variable due to the broad spectrum of research, production, and decontamination activities conducted on the ORR. The general guidelines for concentration limits proposed in the LLWDDD strategy plan should be used as a preliminary guide to define long- and short-lived radionuclide composition and concentration in Class I waste. The radionuclide concentration proposed by the LLWDDD strategy shall serve as initial guidelines for establishing the relative volumes of each waste class and as a means of defining capacity needs. For mixtures of radionuclides in the LLW, the sum of fractions rule for determining waste

category will be used to establish acceptability requirements for Class I waste. It is anticipated that more refined ORR-specific radionuclide concentrations will be developed in the future to aid in engineering design activities.

It is estimated that in calendar year 1986, over 960 thousand cubic feet of Class I-type solid LLW was generated on the Reservation. These wastes were either compacted, shredded, or left in bulk for disposal. The majority of Class I wastes are expected to be generated in bulk form and require relatively little preparation/handling prior to disposal. No interim storage facilities are anticipated for Class I wastes. Depending upon the type and degree of contamination, Class I wastes may be compacted directly or combined with other categories of Class I waste. Combining waste streams would be performed to optimize waste characteristics for the waste acceptance criteria. At the site, Class I wastes are expected to be mixed with an equal part of uncontaminated soil and deposited in a lined-trench for disposal.

3.2 Site

Site suitability for near-surface disposal of radioactive waste depends upon many factors including, geologic, hydrologic, pedologic, and physical conditions. The following is a discussion of parameters associated with each site element as it relates to Class I rad-waste disposal.

3.2.1 Development Constraints

Criteria have been previously proposed for LLW disposal sites on the ORR. Criteria applicable to Class I waste include:

a) A distance of 3280-ft is required to separate waste trenches from any surface water.
b) A distance of 200-ft is required to separate waste trenches from any other public or private water supply.

c) A 200-ft buffer zone must separate active portions of the disposal facility and the facility's barrier fence.
d) Buried waste must be no closer than 5-ft above the maximum historic groundwater table with greater distances preferred.
e) In-site soil permeability should be no greater than 10^{-4} cm/s if engineered barriers are not used.
f) The facility must be located out of the 500-year floodplain.
g) The facility should not be located on the recharge zone of a sole-source aquifer, nor should it lie in the zone of groundwater discharge.
h) The facility should not be located in an active fault zone.
i) Various types of erosion that could enhance waste migration will be avoided such as mass wasting, slumping, landsliding, and chemical weathering.
j) Other geologic areas to be avoided that would enhance, make unpredictable, or lessen detection of possible waste migration include karst development, fractured bedrock, and interbedded permeability anomalies and anisotrophies.
k) Tectonic activity should be a negligible concern in site development.

3.2.2 Engineering Requirements

The following areas have been identified as potential constraints for design of a Class I waste disposal facility:

a) The site should be located in areas with slope gradients of less than 20%, with lower values preferred.
b) The site should lie within close proximity of established utility services, such as electricity, potable water, natural gas, telephone lines, sanitary sewers, and process sewers.
c) Access via existing roadways, or extensions of existing roadways, that are passable during all weather conditions are preferred.

3.2.3 Public Exposure Minimization

Long-term environmental isolation of LLW must be planned to minimize public exposure to radionuclides from the disposal facility. Site location within the ORR guarantees an initial level of isolation from the general public. Given the size of the ORR, location of LLW disposal sites must take into consideration maximization of geographic separation from the public to maintain isolation and reduce the potential risk of exposure to individuals, the general public, and inadvertent intruders. Additional requirements necessary to insure public exposure minimization include:

a) Isolation oriented site selection,
b) Land use planning, and
c) Preservation of the ORR boundary.

These procedures if properly implemented should assure non-development local to LLW disposal sites and intruder exposure minimization through security.

3.3 Intruder Barriers

Construction of barriers designed to prevent inadvertent intrusion into Class I disposal sites is not considered necessary. The quality and quantity of radionuclides at the disposal site is not anticipated to pose a potential threat to health or safety of an inadvertent intruder.

3.4 Facility Operations

During the operational phase of introducing LLW into the disposal facility, the following measures shall be undertaken to insure both employee safety and environmental protection:

a) Operations at the disposal site must be conducted in compliance with the standards for radiation protection set out in 10 CFR 20. Every

reasonable effort should be made to maintain radiation exposure to workers as low as reasonably achievable (ALARA);

b) Class I waste shall be segregated and physically removed from potential sources of additional contamination that might result in failure to meet waste acceptance criteria;

c) No liquids will be disposed of in the Class I waste facility;

d) Boundaries and locations of each disposal unit must be accurately located and mapped by means of a land survey;

e) An administrative area and a three dimensional buffer zone of sufficient size must be maintained to allow unrestricted use beyond the buffer zone boundary;

f) The buffer zone shall be of sufficient size to permit environmental monitoring and to allow performance of mitigating measures if required; and

g) Active waste disposal operations must not have adverse effect upon completed closure and stabilization measures.

3.4 Facility Operations

3.4.1 Support Facilities

Regulations governing landfill operations in Tennessee provide guidance for defining the facilities that will be required to support a Class I IWMF. These facilities include:

a) Access Roads - All weather roads shall be provided to the site and shall be of such design and construction as to safely accommodate the traffic using the site. Onsite roads shall be all-weather.

b) Site Fencing - Access to the site shall be controlled by means of gates which may be locked and by fencing if such is deemed necessary.

c) Onsite Structures - There shall be provided onsite a structure for the use of operating personnel. The structure shall be heated and shall provide shelter during inclement weather. At or near the

structure there shall be provided sanitary toilet facilities. No structures are anticipated to shelter or support operating equipment, monitoring equipment, or leachate collection operations.

d) Utilities - Electrical service must be available onsite to support monitoring and security operations. Communication capabilities will be dependent upon specific monitoring/alarm requirements.

e) Operating Equipment- The equipment specified shall meet the performance requirements necessary for operating the landfill in accordance with the operating requirements established for Class I IWMFs. The operating equipment shall include as a minimum:

    1) Tractor/Dozier
    2) Soil Compacting Equipment
    3) Backhoe

f) Monitoring Equipment - A collection system shall be installed to accumulate leachate from the IWMF. Contingency plans shall be prepared for providing onsite leachate treatment if the IWMF does not system performance requirements.

3.4.2 Operational Requirements

The following operational requirements apply to IWMF which employ landfill techniques for disposal of Class I waste:

a) Class I waste shall be segregated and physically removed from potential sources of additional contamination that might result in failure to meet waste acceptance criteria,

b) Unloading of Waste - Unloading of waste shall be controlled and restricted to an area such that the material can be easily incorporated into the working place with the available equipment,

c) Daily Cover - At least six (6) inches of compacted cover material shall be placed on all exposed solid waste by the end of each working day,

d) Intermediate Cover - In all but the final life, twelve (12) inches of compacted cover material shall be placed on all surfaces which will be left exposed for a period of over one month,

e) A depth of at least twenty-four (24) inches of compacted cover material shall be placed on the fill not later than one (1) week after final lift is completed. To minimize erosion and surface deterioration, the final cover shall be stabilized immediately to the satisfaction of the appropriate government agency.

3.5 Facility Closure/Post Closure

The closure/post closure activities for Class I IWMFs shall conform to those requirements established in Section 2.18 of this report.

3.6 Institutional Control

Due to the nature of Class I waste, the disposal site is not expected to require additional resources to maintain active institutional control over the site. However, an institutional control plan for Class I waste disposal sites must be established and approved before permission is granted to proceed with design and development. An institutional control period of 20-30 years will be required. Disposal sites are expected to remain within the jurisdiction of the federally-owned and -operated ORR. Potential disposal sites at ORR will be under the security and control of the Department of Energy.

A program of institutional control shall include:

a) Performance of an approved performance monitoring program at the disposal site;
b) Periodic surveillance;
c) Minor custodial care, and
d) Administration of funds to cover the cost of these activities.

3.7 Performance Monitoring

In addition to the general performance monitoring requirements proposed in section 2.11.1, the following Class I-specific areas have been identified:

a) Groundwater monitoring between burner layers and beyond the last impermeable layer,
b) Atmospheric vents originating from the disposal site shall be sampled for radioactive gases and vapors.

3.8 LLWDDD Strategy - Test Case

The West Chestnut Ridge site has been determined to be well suited for the disposal of Class I wastes on the ORR. Since these wastes will not pose an unacceptable risk to public health and safety at the time of disposal, the public health and safety can be assured.

Preliminary Class I waste concentration limits have been calculated using West Chestnut Ridge as the disposal site. Employing the best available site data, making assumptions about disposal technology performance, and waste form, estimates of Class I concentration limits were developed. These estimate from the LLWDDD strategy document are presented in Table 3.2.1.

The results presented in Table 3.2.1 give an understanding of the concentration limits that would be imposed on a Class I waste disposal facility.

Table 3.8.1 Class I waste concentration limits calculated according to LLWDDD waste disposal strategy using preliminary site and waste characterization data for West Chestnut Ridge site

Isotope	Half-life (years)	Water pathway ($\mu Ci/m^3$)	Intruder pathway ($\mu Ci/m^3$)	Intruder/water pathway ($\mu Ci/m^3$)
^{3}H	1.23E+01	4.18E+05	3.43E+05	1.88E+05
^{10}Be	1.60E+06	3.20E+06	3.64E+03	3.63E+03
^{14}C	5.73E+03	1.06E+05	7.32E+04	4.32E+04
^{22}Na	2.60E+00	a	a	a
^{55}Fe	2.70E+00	a	a	a
^{60}Co	5.30E+00	3.87E+08	1.49E+04	1.49E+04
^{63}Ni	1.00E+02	4.53E+07	4.71E+04	4.71E+04
^{90}Sr	2.86E+01	3.96E+05	9.27E+02	9.24E+02
^{93}Zr	1.53E+06	6.70E+07	1.95E+05	1.95E+05
^{99}Tc	2.13E+05	1.38E+04	8.51E+02	8.02E+02
^{106}Ru	1.00E+00	a	a	a
^{113m}Cd	1.37E+01	2.04E+04	3.04E+03	2.65E+03
^{121m}Sn	5.50E+01	1.75E+07	2.09E+06	1.86E+06
^{134}Cs	2.06E+00	a	a	a
^{137}Cs	3.02E+01	1.30E+07	3.07E+02	3.07E+02
^{147}Pm	2.62E+00	a	a	a
^{151}Sm	9.00E+01	7.06E+07	4.05E+06	3.83E+06
^{152}Eu	1.36E+01	3.58E+07	6.39E+02	6.39E+02
^{154}Eu	8.80E+00	9.85E+07	2.28E+03	2.28E+03
^{155}Eu	4.96E+00	1.28E+10	2.98E+06	2.98E+06
^{232}Th	1.41E+05	5.96E+04	1.78E+01	1.78E+01
^{233}U	1.59E+05	8.01E+01	6.67E+03	7.92E+01
^{235}U	7.00E+08	8.99E+01	5.71E+02	7.77E+01
^{238}U	4.40E+09	8.90E+01	2.29E+03	8.57E+01
^{237}Np	2.14E+06	6.50E+01	1.86E+01	1.45E+01
^{238}Pu	8.78E+01	1.14E+05	1.95E+03	1.91E+03
^{239}Pu	2.41E+04	6.71E+04	1.16E+03	1.14E+03
^{241}Am	4.32E+02	4.55E+03	1.24E+03	9.74E+02
^{243}Am	7.38E+03	4.22E+03	3.49E+02	3.23E+02
^{242}Cm	4.50E-01	a	a	a
^{244}Cm	1.81E+01	9.33E+04	1.60E+04	1.36E+04
^{249}Bk	8.80E-01	a	a	a
^{252}Cf	2.64E+00	a	a	a

[a]Indicates that there was not a dose conversion factor developed for this isotope. Further analysis will be necessary to determine the waste concentration limit.

4.0 CLASS II - ENGINEERED DISPOSAL OF WASTE

Class II waste is defined as waste that would decay to levels of contamination at the end of institutional control that would result in doses to an individual or intruder that would be less than the prescribed trigger dose. The majority of Class II wastes would be composed of short-lived fission products generated at the Oak Ridge National Laboratory. Isotope concentrations and segregation criteria for each Class II disposal facility will be determined by site-specific Waste Acceptance Criteria. Waste packages will be certified before acceptance onto the Class II disposal facility. These wastes are expected to be placed in disposal units designed to maintain zero release throughout the entire proposed 300 year period of institutional control. Leachate from the disposal unit would be monitored to verify performance. Leachate contaminated above acceptable regulatory limits shall be treated prior to release. It is anticipated that by the end of the active institutional control period that Class II wastes would have decayed to levels below the trigger dose.

4.1 Waste Characteristics

Class II wastes are expected to be composed predominantly of short-lived fission products generated at the Oak Ridge National Laboratory. Classification of LLW into the category of Class II waste will follow the approach defined in the LLWDDD strategy plan. Waste streams with mixtures of radionuclides must meet the requirements of the sum of fractions rule for inclusion into Class II waste. Within this classification the primary radionuclides of concern are Cs^{137} and Sr^{90}. These isotopes have biological analogues and therefore represent a potential threat to the health and safety of individuals, inadvertent intruders, and the general public. Management of short-lived isotopes will require that disposal units be designed and operated so that the principal of ALARA is defensibly demonstrated for personnel protection.

Disposal facilities shall be designed to incorporate adequate shielding and waste emplacment without excessive exposure.

Class II waste shall meet Waste Acceptance Criteria. Waste form stability is required to assure that the waste does not structurally degrade and affect overall site stability. Structural waste instability could result in slumping, collapse, or other failures of the disposal unit which might result in water infiltration. A structurally stable waste form shall be expected to maintain physical dimensions under expected disposal conditions of:

a) weight of overburden and compaction equipment,
b) moisture,
c) microbial activity,
d) radiation effects, and
e) chemical reactions.

Structural stability can be provided by the waste form itself, or by processing, or placement in a container or structure designed to provide stability after disposal. Voids within the waste and between the waste and its packaging shall be minimized to the extent practicable.

4.2 Site Requirements

The conditions that shall be evaluated for Class II disposal sites are primarily those defined in Section 2.4 of this report.

4.3 Intruder Barrier

Class II waste disposal units are expected to have zero discharge to the environment over the proposed 100-300 year period of active institutional control. During this period, the disposal facility is expected to be protected from intruders that might inadvertently release wastes in excess of the prescribed trigger dose At the end of the institutional control period, Class II should not represent a significant radiological hazard. Therefore, no intruder barrier will be required.

4.4 Facility Operations

4.4.1 Support Facilities

Three types of disposal units have been proposed for the Class II IWMF. Those units are: tumulus, silos, and vaults. All are disposal strategies intended to exclude moisture from reaching Class II waste during the period of institutional control. Due to the nature of Class II waste, the IWMF will require the following support facilities:

a) Access Roads - All weather roads shall be provided to the site and shall be of such design and construction as to safety accommodate the traffic using the site. Onsite roads shall be all-weather.
b) Fencing - Access to the site shall be controlled by means of gates which may be locked and by fencing if such is deemed necessary.
c) Onsite Structures - There shall be provided onsite a structure for the use of operating personnel. The structure shall be heated and shall provide shelter during inclement weather. At or near the structure shall be provided sanitary toilet facilities. A structure shall be provided onsite to receive and store Class II waste packages. No structures are anticipated to shelter or support operating equipment, monitoring equipment, or leachate collection operations.
d) Utilities - Utility service should be provided to the IWMF site.
e) Operating Equipment - The following equipment are expected to provide the minimal operational support for the IWMF:

    1) Crane
    2) Fork Lift

f) Monitoring Equipment - A collection system and performance monitoring system shall be installed.

4.4.2 Operational Requirements

Development and implementation of approved operation procedures is required by DOE Order 5820.2 before construction of Class II waste facilities can be undertaken. Disposal site operation procedures must include:

a) Protection of the environment and the health and safety of site personnel;
b) Assure the security of the site;
c) Encourage good housekeeping practices;
d) Minimize the need for long-term control, and
e) Be capable of meeting the requirements of the closure/post-closure plan.

In addition, the operating plan shall recognize that:

a) Only those materials classified as Class II waste shall be disposed of that Class II facilities;
b) Wastes designated as Class II must be segregated from other wastes to prevent any interaction between classes that might result in the failure to meet performance criteria;
c) Waste packages must be emplaced in a manner that maintains package integrity during emplacement, minimizes the void spaces between packages, and permits the void spaces to be filled;
d) A contingency plan must be in place for handling waste shipments that fail to meet waste acceptance criteria;
e) Every opportunity shall be taken to prevent moisture intrusion into the waste packages and the disposal facility; and
f) A unit operations analysis shall be performed for Class II operations to minimize employee exposure and insure ALARA considerations.

4.5 Facility Closure/Post-Closure

Closure/Post-closure requirements for Class II waste shall be consistent with those described in Section 2.18. Special attention must be directed to insuring that precipitation and surface water are not allowed to contaminate the waste packaging and disposal facility.

4.6 Institutional Control

A 100-300 year period of institutional control has been proposed as a requirement for Class II waste disposal sites. The 300 year period proposed by the LLWDDD strategy is necessary for in situ decay of short-lived radionuclides to levels below the trigger dose. During the proposed period of institutional control, continuing responsibility must be exercised for the following activities:

a) Performance of a performance monitoring program at the IWMFs,
b) Periodic surveillance,
c) Minor custodial care, and
d) Any other requirements deemed necessary to insure that the disposal facility is performing in accordance with design criteria.

4.7 Performance Monitoring

Performance monitoring requirements for Class II waste disposal facilities shall conform to those identified in Section 2.11 of this report.

4.8 LLWDDD Strategy - Test Case

The SWSA 7 site has been determined to be the most appropriate site for installation of the initial Class II waste disposal facilities. Waste concentration limits calculated according to the LLWDDD waste disposal Strategy are presented in Table 4.2.1 These results can be used to get an understanding of the concentration limits associated with the implementation of the strategy.

Table 4.8.1 Class II waste concentration limits calculated according to LLWDDD waste disposal strategy using preliminary site and waste characterization data for Bear Creek Valley site

Isotope	Half-life (years)	Water pathway ($\mu Ci/m^3$)	Intruder pathway ($\mu Ci/m^3$)	Intruder/water pathway ($\mu Ci/m^3$)
^{3}H	1.23E+01	5.48E+14	7,30E+11	7.29E+11
^{10}Be	1.60E+06	3.81E+05	5.91E+03	5.82E+03
^{14}C	5.73E+03	8.92E+05	1.23E+04	1.08E+05
^{22}Na	2.60E+00	a	a	a
^{55}Fe	2.70E+00	a	a	a
^{60}Co	5.30E+00	7.24E+21	3.82E+18	3.81E+18
^{63}Ni	1.00E+02	3.05E+07	4.33E+05	4.27E+05
^{90}Sr	2.86E+01	2.01E+07	6.43E+05	6.24E+52
^{93}Zr	1.53E+06	5.00E+05	3.17E+05	1.94E+05
^{99}Tc	2.13E+05	1.25E+06	1.38E+03	1.38E+03
^{106}Ru	1.00E+00	a	a	a
^{113m}Cd	1.37E+01	5.19E+10	1.53E+09	1.49E+09
^{121m}Sn	5.50E+01	4.87E+07	7.91E+07	3.01E+07
^{134}Cs	2.06E+00	a	a	a
^{137}Cs	3.02E+01	3.01E+07	1.57E+05	1.54E+05
^{147}Pm	2.62E+00	a	a	a
^{151}Sm	9.00E+01	5.76E+07	4.52E+07	2.53E+07
^{152}Eu	1.36E+01	1.45E+12	3.54E+08	3.54E+08
^{154}Eu	8.80E+00	4.16E+15	1318E+12	1.31E+12
^{155}Eu	4.96E+00	2.24E+24	7.16E+21	7.14E+21
^{232}Th	1.41E+05	4.45E+02	2.89E+01	2.72E+01
^{233}U	1.59E+05	7.28E+03	1.08E+04	4.36E+03
^{235}U	7.00E+08	8.16E+03	9.29E+02	8.34E+02
^{238}U	4.40E+09	8.08E+03	3.71E+03	2.54E+03
^{237}Np	2.14E+06	5.33E+02	3.02E+01	2.86E+01
^{238}Pu	8.78E+01	6.10E+03	2.27E+04	4.81E+03
^{239}Pu	2.41E+04	5.04E+02	1.90E+03	3.99E+02
^{241}Am	4.32E+02	8.09E+02	3.01E+03	6.37E+02
^{243}Am	7.38E+03	5.14E+02	5.81E+02	2.73E+02
^{242}Cm	4.50E-01	a	a	a
^{244}Cm	1.81E+01	9.16E+07	3.72E+08	7.35E+07
^{249}Bk	8.80E-01	a	a	a
^{252}Cf	2.64E+00	a	a	a

[a]Indicates that the decay of the isotope is sufficient to allow for any concentration in the waste for that particular isotope.

5.0 CLASS III - RESTRICTED DISPOSAL OF WASTE

Class III, Restricted Disposal of Waste, is waste that contains long-lived radionuclides, such as uranium, technecium, and thorium, which represent a potential hazard to an inadvertent intruder after the period of active institutional control. An inadvertent intruder might receive a dose greater than that defined by the trigger dose unless intruder protection is provided. Adequate intruder protection is a major requirement for Class III disposal facilities. Contaminated leachates from Class III units must be monitored, collected, and treated before release to the environment.

As part of the management strategy, the soluble uranium fraction in Class III waste is intended to be leached from the disposal facility during the institutional control period. At the end of the control period, the amount of soluble uranium remaining at the site is expected to be negligible and should not pose a problem to groundwater quality.

Wastes of the Class III-type have typically been disposed of on the Reservation in below-grade containment wells and in trenches.

5.1 Waste Characteristics

Long-half life materials present in Class III can be expected to conform to the requirements described in the LLWDDD strategy document. For wastes that contain a mixture of long-half life radionuclides, the total concentration (measured in curies per cubic meter) shall be determined by the sum of fractions rule. It is expected that ORR-specific standards will be defined in the future as more waste stream and site data are developed.

Class III wastes will comply with the waste form requirements established for the preceding classes. The form and packaging requirements of Class III wastes may be expected to vary from Class II due to the necessity for in situ leaching.

5.2 Site Requirements

The site of the IWMF shall conform to the appropriate general requirements posed in Section 2.4.

5.3 Intruder Protection

At the end of active institutional control, Class III wastes are still expected to contain radionuclides which could expose an inadvertent intruder to radiation levels greater than the prescribed trigger dose. For this reason, intruder protection must be engineered. For example, the NRC requires that the top of the waste must be 5 meters below the top surface of the cover or intruder barriers must be installed to protect against inadvertent intrusions for at least 500 years. Physical barriers may take the form of thick covers, barrier materials, or boulders which are intended to deny or limit access to the disposal unit. These materials must remain intact and functional during at least the institutional control period and probably for some, as yet specified, additional period thereafter.

Imposition of land use restrictions is another means of protecting the disposal site from inadvertent intruders. As long as the disposal site remains under DOE control and management, land use restrictions may not be required. However, provisions shall be undertaken to insure continuing control in the event of sale or reallocation of site ownership.

5.4 Facility Operation

5.4.1 Support Facilities

The following facilities have been identified as necessary to support the IWMF disposal of Class III waste:

a) Access Roads - All weather roads shall be provided to the disposal site and shall be of such design and construction as to safely accommodate the traffic using the site. Onsite roads shall be all-weather.

b) Site Fencing - Access to the site shall be controlled by means of gates which may be locked and by fencing if such become necessary. All fencing and gates shall be of sufficient height and strength to serve the purpose intended.

c) Onsite Structures - There shall be provided on the site a structure for the use of operating personnel. The structure shall be heated and shall provide shelter during inclement weather. At or near the structure there shall be provide sanitary toilet facilities. No additional structures are anticipated to shelter monitoring, communication, and leachate collection systems.

d) Utilities - The IWMF should have access to at least electrical and depending upon operational requirements, potable and waste water service may be necessary. Depending upon the treatment (leaching) strategy, a water supply should be available to the site.

e) Operating Equipment - Major equipment requirements for the operation of Class III waste disposal site include:

    1) Crane
    2) Fork Lift
    3) Bull Dozier

f) Monitoring - Requirements for monitoring an IWMF for Class III waste will depend upon the type of technology selected. Monitoring equipment should be installed that addresses the requirements identified in Section 2.11.

g) Leachate Collection System - A secure storage facility must be designed to accommodate the leachate from the IWMF. The size and performance of the system will depend upon the leachate process.

5.4.2 Operational Requirements

Operational requirements for disposal of Class III wastes will depend upon the disposal method. Disposal in a lined trench will require operational considerations similar to those proposed in Section 3.4.2 for Class I waste disposal. If IWMFs employ vault or tumulus units, then the facility could be operated in a manner similar to Class II disposal facilities. The major difference between Class III and other IWMF is the leaching and collection of soluble radionuclide from the waste class. This form of in situ processing will require special consideration for employee radiation exposure, management, treatment of the leachate, and conformance with appropriate surface water discharge requirements.

5.5 Facility Closure/Post-Closure

Due to the nature of the Class III disposal concept, care must be taken to insure that moisture can reach the disposal facility. Unlike Class II disposal facilities which are designed to repel moisture, Class III facilities must be able to admit moisture to leach soluble uranium fractions from the waste. This concept requires a collection system that must be monitored and serviced to remove the soluble uranium leachate. Contaminated leachate will be treated and released under approved discharge permit(s) to the environment.

5.6 Institutional Control

A period of active leaching no greater than that of institutional control period shall constitute a minimum requirement for managing Class III waste disposal sites. It is projected that this period will be required for the natural leaching process to remove the soluble uranium fraction from Class III wastes. During this period, leachate from the disposal site must be collected, monitored, treated, and released to the environment. If the site performs as expected, leachate collection and monitoring can be discontinued and institutional control will enter a

passive phase. During the period of active institutional control, the leachate monitoring and collection system must be maintained and serviced. Service roads, security systems, alarms, and support services must remain intact during the period of active institutional control.

The presence of long-lived isotopes in Class III wastes indicates the need for land use controls. As long as the site remains within the ORR or under DOE control, land use control can be exercised by the federal government.

5.7 Performance Monitoring

The performance monitoring requirements for Class III waste disposal facilities will comply (but not be limited to) with those defined in Section 2.11.1 of this report. Monitoring strategy and appropriate analytical equipment will be determined by the designated disposal technology.

5.8 LLWDDD Strategy - Test Case

Radionuclide concentration limits were reported in the LLWDDD strategy document using Bear Creek Valley as the initial site for Class III disposal facilities. The results of the application of the strategy to Class III waste presented in Table 5.8.1 provide an interpretation of the concentration limits at the time of waste disposal.

The application of the strategy to the disposal of Class III waste identifies numerous demonstration activities to be performed prior to the development of a full-scale development waste disposal facility. Most important from the standpoint of design is the determination of the nature of the leachate generated from the disposal unit during the institutional control period. These data will not only be needed for determining the disposal technology but also for defining the regulatory criteria for discharge of leachate to surface waters. The discharge of treated

effluent to surface waters will require the determination of the chemical and biological impacts of the effluent in the receiving waters as well as the radiological impacts. Once the characteristics of the leachate have been established, the design of the facility can be developed to optimize the site and waste characteristics with the costs of disposal. The design must include the development of leachate treatment systems to treat the leachate prior to release. Additionally, the appropriate monitoring and mitigation strategies can be defined. Given this rather length list of issues to be resolved, the application of the strategy presented in this section can be considered as only a preliminary review of the potential for a Class III waste disposal facility on the ORR.

Table 5.8.1 Class III waste concentration limits calculated according to LLWDDD waste disposal strategy using preliminary site and waste characterization data for Bear Creek Valley site

Isotope	Half-life (years)	Water pathway ($\mu Ci/m^3$)	Intruder pathway ($\mu Ci/m^3$)	Intruder/water pathway ($\mu Ci/m^3$)
^{10}Be	1.60E+06	4.57E+05	1.40E+06	3.45E+05
^{14}C	5.73E+03	1.07E+06	1.09E+06	5.40E+05
^{93}Zr	1.53E+06	6.00E+05	4.53E+08	5.99E+05
^{99}Tc	2.13E+06	1.50E+06	7.51E+05	5.00E+05
^{232}Th	1.41E+05	5.34E+02	1.10E+04	5.09E+02
^{233}U	1.59E+05	8.74E+03	1.81E+06	8.70E+03
^{235}U	7.00E+08	9.80E+03	2.80E+05	9.46E+03
^{238}U	4.40E+09	9.70E+03	1.03E+06	9.61E+03
^{237}Np	2.14E+06	6.40E+02	2.80E+03	5.21E+02
^{239}Pu	2.41E+04	6.05E+02	6.09E+05	6.05E+02
^{241}Am	4.32E+02	9.71E+02	7.40E+04	9.58E+02
^{243}Am	7.38E+03	6.17E+02	2.58E+04	6.03E+02

6.0 CLASS IV - NOT ACCEPTABLE FOR DISPOSAL OF WASTE

Class IV waste is composed of materials which can not be defined by the preceding classes and does not meet the criteria for classification as high-level waste. Class IV waste may be considered analogous to NRC's "beyond C" category of LLW. In this respect, Class IV waste is considered to be unsuitable for near-surface disposal on the ORR. Class IV wastes have been determined to pose a substantial risk to the health and safety of the general public at the end of institutional control. These wastes are expected to include materials contaminated with significant levels of TRU isotopes (<100 nCi/g), uranium and thorium, high activity levels of cesium and strontium, or heavily contaminated with fission products. Management of these wastes may indicate treatment designed to convert Class IV bulk wastes into another disposal classification. Isotopes extracted from the treatment process(s) shall be conditioned and packaged to permit shipment to an acceptable disposal site as defined in DOE Order 5820.2 (49 CFR 173-178, 10 CFR 71, and with state and local regulations).

6.1 Waste Characteristics

As currently defined, Class IV wastes are unacceptable for near-surface disposal. At least three alternatives exist for managing Class IV waste:

- Treatment to isolate radionuclides of concern and reclassification and onsite disposal of the remaining materials,
- Disposal of Class IV waste at sites other than near-surface locations, or
- Disposal of Class IV waste at offsite facilities.

Treatment processes designed to concentrate radionuclides of concern are likely to generate additional volumes of contaminated materials for disposal in Classes I-III. Derated materials must be treated according to

requirements of the individual waste classes. Residual materials remaining in Class IV must comply with all appropriate DOE and other federal agency requirements for offsite shipment. Waste form and packaging requirements for Class IV wastes must comply with all appropriate federal transportation regulations.

Disposal of Class IV waste at locations on the ORR selected for other than near-surface disposal will not be considered in this report.

6.2 Site Requirements

Although Class IV waste has been defined as unacceptable for near-surface disposal on the ORR, consideration should be given to processing sites on the reservation, and to the requirements (Waste Acceptance Criteria) for offsite disposal. Locations may also have to be identified and assessed as acceptable strategic (interim) storage sites.

Treatment facilities which might leach uranium, provide compaction, employ incineration, or concrete fixation have not been identified for Class IV waste. Lockwood Greene has performed an investigation and assessment of space suitability for storage of LLW in ORGDP buildings. It appears that some space within the ORGDP could be available to provide buffer storage for Class III waste prior to and following treatment. This space may also serve as a staging area prior to shipment for offsite disposal.

6.3 Intruder Barriers

Since Class IV wastes have been determined to be unacceptable for near-surface disposal on the ORR, protection from inadvertent intruders should be a security consideration.

6.4 Facility Operations

6.4.1 Support Facilities

Many different support facilities may be required to treat, prepare, package, and provide interim storage for Class IV waste. Definition of the appropriate facilities, their configuration, and operational practices will be governed by many different considerations including, safety, cost, handling requirements (staging/packaging), availability of resources, and waste acceptance criteria of the offsite disposal facility. Until these considerations are assessed, definition of specific support facilities is not possible.

6.4.2 Operational Requirement

Operational requirements will be defined after preliminary decisions have been made concerning Class IV disposal strategy.

6.5 Facility Closure/Post-Closure

If Class IV wastes are not disposed of on the ORR, then development and implementation of a comprehensive closure/post-closure program is not warranted.

6.6 Institutional Control

The need to exercise institutional control over Class IV waste on the ORR is not an issue if jurisdiction of these materials is transferred offsite. Institutional control is only a local concern if these materials are planned to be retained (stored) onsite for an extended period or treatment other than near-surface disposal is anticipated.

6.7 Performance Monitoring

The need for environmental monitoring requirements designed for Class IV waste disposal facilities will be dependent upon the decision to emplace these materials on the ORR. If long-term storage or non near-surface disposal options are exercised, then environmental monitoring requirements shall comply (but not be limited to) with those defined in Section 3.7 of this report.

6.8 LLWDDD Strategy - Test Case

No scenario was developed in the LLWDDD strategy document for disposal of Class IV wastes on the ORR.

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