LOW LEVEL WASTE MANAGEMENT
AT THE
IDAHO NATIONAL ENGINEERING LABORATORY[a]

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ABSTRACT

EG&G Idaho, Inc. is the lead contractor for the Department of Energy (DOE) National Low Level Waste Management Program, established in 1979. In this role, the company uses its waste management expertise to provide management and technical direction to support the disposal of low-level waste (LLW) in a manner that protects the environment and the public health and safety while improving efficiency and cost-effectiveness. Program activities are divided into two areas: defense-related and commercial nuclear reactor programs. The defense program was established to develop technology improvements, provide technology transfer, and to ensure a more efficient and uniform system for low level waste disposal. To achieve the program's goals, it is necessary to improve, document, and, where necessary, develop new methods for waste generation reduction, waste treatment, shallow-land burial, greater confinement disposal, and measures to correct existing site deficiencies. The commercial low level waste management program provides support to assist the states in developing an effective national low level waste management system and provides technical assistance for siting of regional commercial LLW disposal sites. The program provides technical and informational support to state officials, low level waste generators, managers, and facility operators to resolve low level waste problems and to improve the systems' overall effectiveness. Procedures are developed and documented and made available to commercial users through this program. Additional work is being conducted to demonstrate the stabilization and closure of low level radioactive waste disposal sites and develop the criteria and procedures for acceptance of such sites by the Department of Energy after closure has been completed.

The Idaho National Engineering Laboratory (INEL) is one of the Department of Energy's principal centers for conducting nuclear energy research and development. It contains the largest group of operating nuclear reactors in the world, a nuclear fuel reprocessing plant, and fuel fabrication and examination facilities. Solid LLW generated from these federal programs is disposed of using shallow-land burial techniques at the Radioactive Waste Management Complex (RWMC). The RWMC opened in 1952 as a 13-acre disposal site for waste generated at the INEL. In 34 years of operation it has been expanded to its present size of 144 acres. The RWMC retrievably stores transuranic wastes on asphalt pads and in engineered vaults in a 56-acre section. The remaining 88 acres is the Subsurface Disposal Area (SDA) where LLW disposal operations are conducted.

This paper presents an overview of selected low level waste (LLW) management operations activities conducted at the INEL. As a prime operating contractor, EG&G Idaho has the major responsibility for the safe and cost-effective management of radioactive wastes. EG&G Idaho has therefore directed its efforts toward developing the improved technologies required to conserve waste disposal space and enhance waste isolation from the biosphere. Activities to be presented include waste generation reduction, waste processing for volume reduction and disposal operations. Enhancements planned to these present waste management practices will also be discussed herein.

INEL WASTE GENERATION REDUCTION PROGRAM

Background and Need for the Waste Reduction Program

The Subsurface Disposal Area (SDA), at the Radioactive Waste Management Complex (RWMC), is the only active low level waste disposal facility at the INEL. The prospects for opening another shallow-land burial disposal facility at the INEL are uncertain. Therefore, it is incumbent upon the Department of Energy-Idaho Operations and EG&G Idaho to make every reasonable effort to extend the "disposal life" of the SDA.

EG&G Idaho's Waste Management Programs is working to extend the SDA disposal life through the INEL Waste Reduction Program. This Program is charged with providing assistance to INEL facilities in reducing low level waste generation rates, while at the same time encouraging waste segregation and optimum utilization of INEL waste processing facilities.

Waste Reduction Program Goals

The primary goal of the INEL Waste Reduction Program is to maximize the disposal life of the SDA. Secondary goals being pursued in support of that goal include:

- Analyzing waste streams and management practices at the several INEL low level waste generating facilities in order to implement waste reduction techniques.
- Establishing facility 5-year waste reduction goals and monitoring facility progress.

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- Providing computer applications programming assistance and training to support facility waste information management needs.

- Providing waste reduction awareness training for affected INEL personnel.

Waste Reduction Program Activities

The principal program activity this fiscal year is the preparation of facility waste reduction plans. It is within this activity that waste stream and management practice analysis is performed and 5-year waste reduction goals are set. The INEL Waste Reduction Coordinator visits each generator facility, conducting meetings with the facility managers and their cognizant waste coordinators to introduce the waste reduction planning process. Since the facility personnel are the most knowledgeable of their practices, they are encouraged to write their own waste reduction plans, using guidelines supplied by the Waste Reduction Program. Discussions and "brainstorming" sessions are held to develop both strategies and specific action items. The written plan is then prepared and distributed to facility managers throughout the INEL.

Another program activity being developed this year is a facility-customized waste database system. The waste database system will consist of personal computer software, documentation, and user training to allow each generator facility manager to collect, store, and analyze data on internal waste streams. The database system will function as a tool for managers in evaluating opportunities for waste reduction.

Other major activities implemented this year include preparation of a set of guidelines for incorporating waste reduction topics into formal site worker training programs; reviews of EG&G operational, work control, and quality documentation for inclusion of waste reduction criteria; and pursuit of a waste reduction awareness campaign. Beyond this fiscal year, the Waste Reduction Program will concentrate on periodic updates of facility waste reduction plans and assessments of facility waste reduction effectiveness.

LLW Volume Reduction Operations

Analyses of the composition of LLW being disposed of at the RWMC indicate that about one-third of the volume is metal and another third is combustible material. To reduce the volumes of contaminated metals and combustible waste and thereby extend the useful life of the SDA, the Waste Experimental Reduction Facility (WERF) was established at a site nine miles northeast of the RWMC. Mechanically reducing the size of metallic material, followed by processing in a smelter, reduces the total metallic waste volume by about 90%. Incineration of combustible waste results in a volume reduction of about 80:1 to 150:1. In total, the combined effect of sizing, smelting, and incinerating operations at WERF will approximately double the remaining useful life of the RWMC.

Waste Sizing. Waste sizing is conducted in a building on the waste storage pad adjacent to WERF. The sizing area is self-contained and metal-lined for ease of decontamination, and is exhausted upstream of the main WERF HEPA and baghouse filters. Waste is limited to <100 mrem/hr at near-contact and is transferred into the sizing area through an airlock to minimize the possibility of spreading contamination into the remainder of the building. Thermal insulation and other undesirable materials are removed from objects before they are sized in this room. Due to the nature of these operations, it is required that full-time, approved respiratory protection (respirators, forced-air breathing apparatus) be worn while sizing work is in progress. Various sizing techniques used at WERF are described below.

1. Plasma-arc torch cutting--A Thermal Dynamics PAK-44 plasma-arc torch and a Linde PCM-250 plasma cutting system are available for cutting thick gauge material. These torches are transferred-arc types using nitrogen, hydrogen, or a combination hydrogen/argon as the plasma gas, and nitrogen or argon as the shield gas.

2. Guillotine saw--Medium-to-large-diameter pipes and similarly sized structural material may be cut using the guillotine saw. This reciprocating cutter clamps to the object being cut. Due to the short stroke of the blade, airborne contaminants are minimized.

3. Pipe saw--A Wach's Model E "Trav-l-cutter" is available for use. Used in several decommissioning projects, this saw can cut large-diameter pipes and tanks up to 18 ft in diameter. The model at WERF will handle pipes up to 4.5 in. in diameter. The sectioning of these objects requires approximately one minute for every inch of diameter.

4. Plate shear--Large sheets of steel up to 3/8 in. thick are cut using this hand-held, portable electric plate shear. This tool cuts rapidly (5 ft/min. or 1.5 m/min.) and no undesirable chips are generated in the process, as with sheet metal nibblers. One continuous piece of metal results from the shear-like action of the tool.

5. Oxy-Acetylene Cutting Torch--With some carbon steels it is more efficient to use Oxygen-Acetylene cutting methods. This is due to the rapid oxidation of carbon steel as compared to stainless steel. A plasma torch shows little advantage when cutting carbon steel. Since oxy-acetylene is a more economical method, it is used whenever practical for sizing carbon steel.

The ventilation system exhausts the sizing area. This exhaust is combined with the main facility exhaust and passes through the baghouse and HEPA filter bank. Point of operation exhaust is used to the maximum extent practical for all cutting operations. This serves to minimize fugitive emissions and resultant airborne radioactivity, surface contamination, and personnel exposure to toxic fumes.

Waste Smelting. The purpose of smelting is to reduce radioactive metal scrap volumes of generally low-density (due to voids) components into compact, high-density ingots. Only ferrous metals with radiation levels of less than 10 mrem/hr are accepted for smelting. Smelting process capacity is 7500 lbs. per shift.

The smelting facility is located in the WERF basement and is comprised of an observation and control room, power supply room, furnace room, and an ingot cooling room (Fig. 1). The control and observation room is used as the main entrance for personnel access to the basement, provides a place for viewing smelting activities and serves as a central point for controlling operations. Explosion resistant, wire-mesh windows with a heat resistant inner window (furnace room side) have been installed, enabling

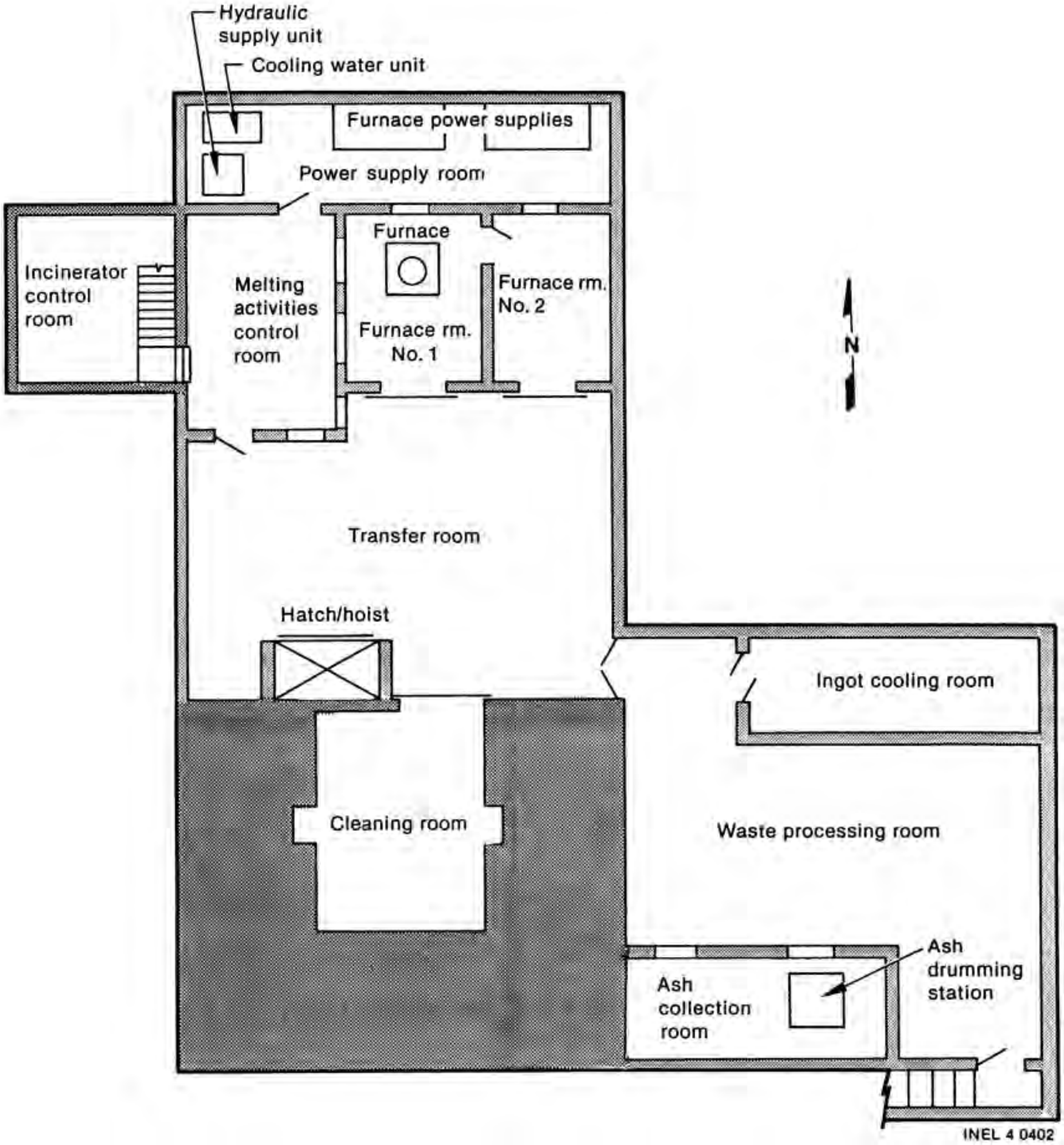

Fig. 1. Waste Experimental Reduction Facility--basement floor plan.

operators and visitors to monitor operations. Hydraulic controls, furnace hoist controls, and remote furnace controls have been installed, allowing control of smelting and pouring remotely as well as locally.

The furnace room houses a coreless electric induction Pillar furnace, point of operation exhaust ventilation, and associated equipment. The transite box furnace is one of the most familiar members of the induction melting furnace family and the basic design has not changed significantly for many decades. Its inherent simplicity makes it suitable for a very wide range of applications, covering sizes from 50-lb. capacity through 2,000-lb. capacity in design frequencies of 540 Hz through 10 KHz. The Pillar furnace used at the WERF facility has a capacity of 1500 lb., at a design frequency of 1000 Hz.

Once the metal is molten, it is poured into an ingot mold. The mold is then transferred to the ingot cooling room and allowed to cool and solidify. The ingots are then removed from the mold and banded together with four to a bundle. The bundles are then shipped to the RWMC for disposal.

Waste Incineration. LLW of less than 10 mrem/hr is segregated as to combustible contents and prepackaged at the generator facility in corrugated cardboard boxes with internally sealed polyethylene liners. Waste is transferred from the generator in approved, weather-resistant containers to the WERF facility.

A pallet of boxes containing waste is removed from the transport container using a forklift and transferred to the feed staging area located in the WERF high bay (Fig. 2). The boxes are loaded onto a conveyor system. The conveyor transports each of the boxes through inspection instrumentation to ensure the waste is suitable for incineration. First, each box is measured for radiation intensity using a portal monitor mounted on the conveyor system. Only those boxes reading 10 mrem/hr or less will be processed. This level may be increased in the future as experience is gained with the system. Next, each box passes through an airport-type x-ray unit to detect large noncombustibles, or other materials that violate the combustible waste packaging criteria. A video monitor is provided in the incinerator control room along with controls to allow remote operation of the x-ray

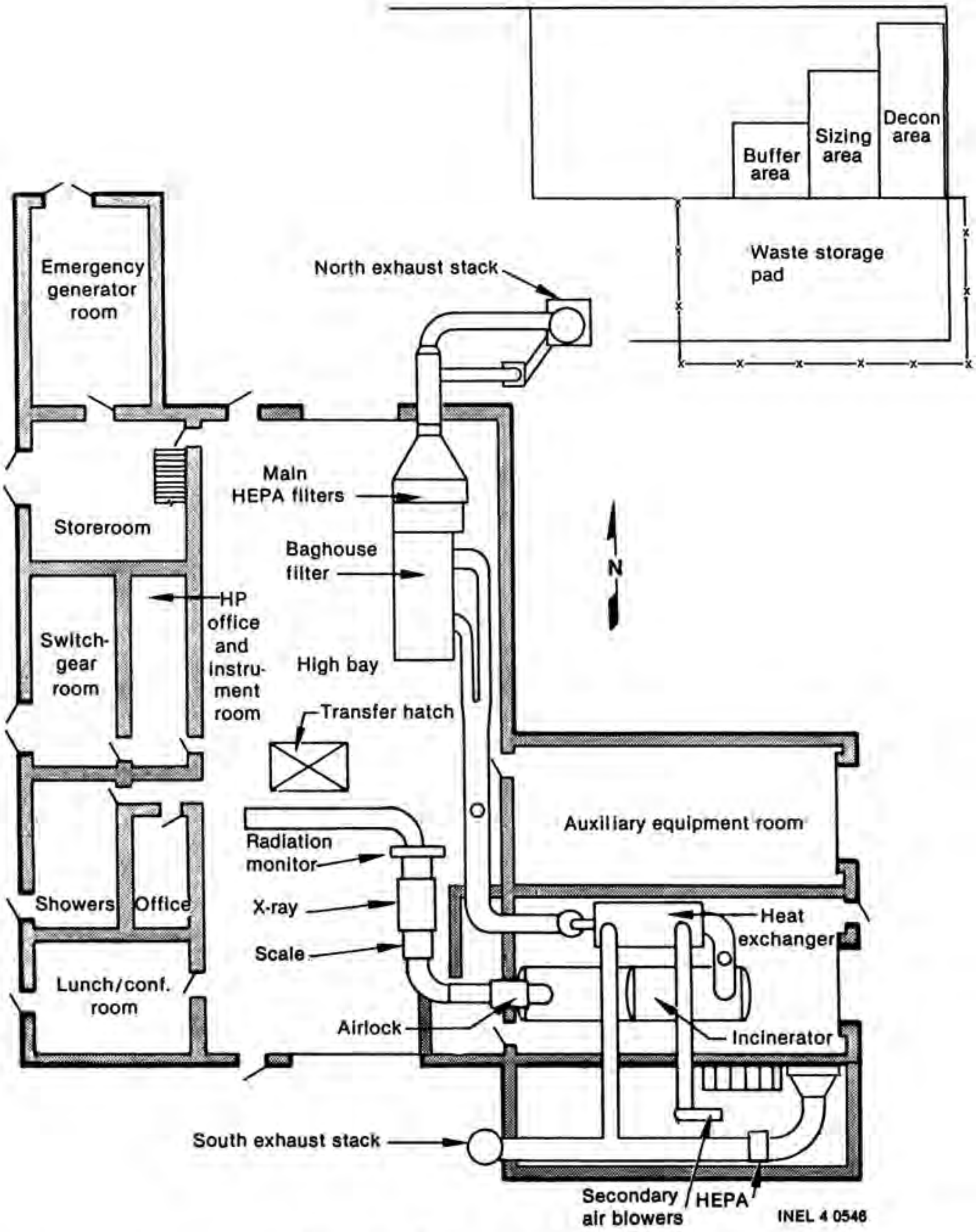

Fig. 2. WERF main floor plan.

unit. If a box fails to meet any of the characterization criteria, it will be rejected by the incinerator console operator. If rejected, it is remotely removed from the conveyor system and deposited nearby for later, alternate disposal.

Each box is then weighed by a conveyor mounted scale. This data provides the operator with a guide to either slow down or increase the feed rate. The incinerator is designed to process up to 400 lbs/hr of 12,000 Btu/lb waste. This is 6 to 10 boxes per hour, using a waste density of 5 to 8 lbs/ft^3. These data are recorded for use in evaluating and reporting the incinerator's performance.

Prior to entering the incinerator room, the boxed waste passes through an airlock room. This provides process isolation and a contamination control barrier between the incinerator room and the WERF high bay. The airlock doors are automatically opened and closed to permit the boxes to enter and exit the room. The airlock material entry doors are interlocked to prevent both doors from being open at the same time.

After entry into the incinerator room, an elevator raises the box to the conveyor that feeds the incinerator gravity-fed loading chute (Fig. 3). The incinerator console operator remotely opens the top hatch of the loading chute *and loads* a box into the upper portion of the loading chute. The operator then closes the hatch. A program timer is interlocked into the incinerator control circuitry, and after all process conditions are satisfied and the timer has timed out, the loading sequence is initiated. First, the ash ram located in the lower chamber pushes the ash approximately 25% of the hearth length toward the rear of the incinerator. This short stroke clears a location for the next box to be dropped, and slowly causes the ash to work toward the rear of the chamber and into the ash cooling and drumming hopper. After

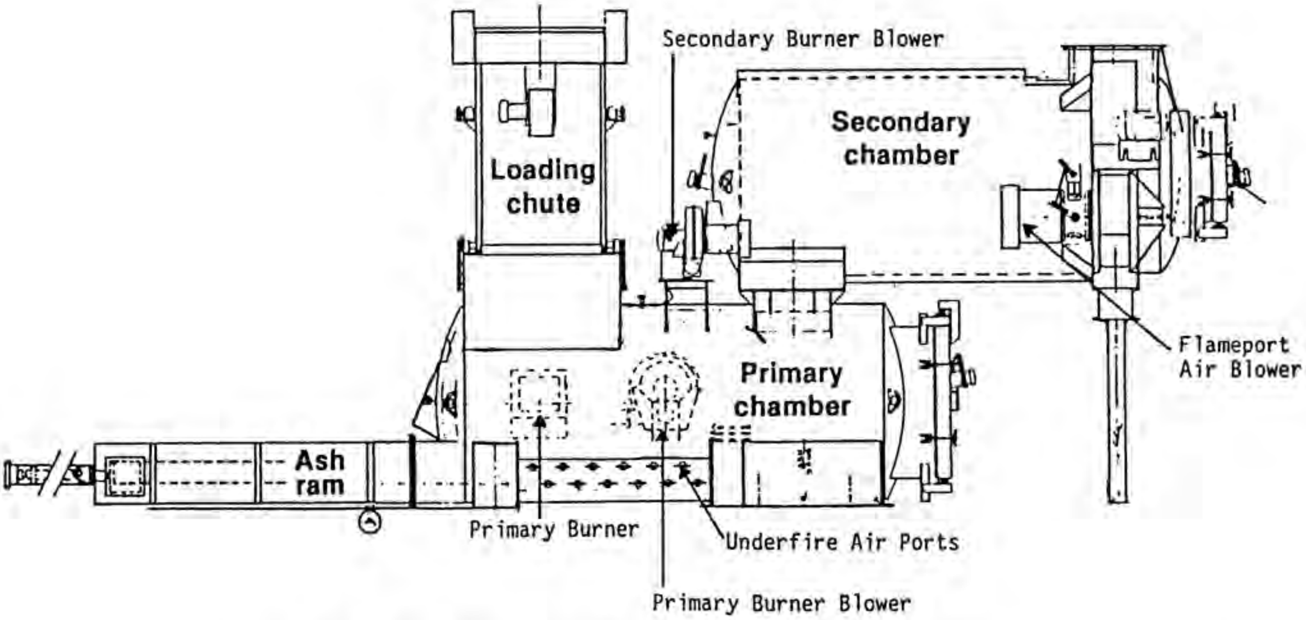

Fig. 3. WERF radioactive waste controlled-air incinerator.

the ram returns, the lower doors in the loading chute open to allow the box to drop into the lower chamber. The waste is burned to yield gaseous effluents and solid ash. The ash amounts to approximately 5-10% by weight of the original combustible feed. The volatile gases, after partial combustion in the lower chamber, are mixed with excess air in the upper chamber to complete combustion. The combustion gases, primarily CO_2, N_2, O_2, and $H_2O(g)$, are released from the stack after cooling and HEPA filtration to remove radioactive and nonradioactive particulate.

As the incineration ash works toward the rear of the lower chamber, underfire air is injected through the hearth floor to bring about burnout of the fixed carbon. At the rear of the chamber the ash drops into a cooling and drumming hopper. The hopper is designed to hold up to 32 ft^3 of ash, and cools the ash by percolating a small amount of bleed air up through the ash bed.

Once the ash at the bottom of the hopper is sufficiently cool, it is discharged into a 55-gallon drum. The drum is secured against a gasket to prevent discharge during the process. A glove box prevents contamination spread during the lidding operation. The drum is removed; the outside is checked for contamination; a new drum is positioned; and the cycle is repeated as required.

A liquid-waste injection system has been installed in the incinerator and tested. The system will be used for treatment of radioactive and hazardous liquid wastes. EPA approval is pending as part of the INEL Part B permit.

RWMC HYDROLOGY AND GEOLOGY

The RWMC is located on the semiarid Eastern Idaho Snake River Plain in the southwestern portion of the INEL (Fig. 4). The climate of the Snake River Plain is characterized as cool desert. That is, summer days are warm and nights are cool, while in the winter the days and nights are cold and dry. Annual precipitation averages 8.5 inches, with peak seasons during the winter and spring. The surrounding mountains strongly influence the climate. The most important environmental concern is for the hydrology of the area. The Snake River Plain aquifer underlies the RWMC by a depth of approximately 580 ft., while the Big Lost River is located three miles northwest (Fig. 4 and Fig. 5).

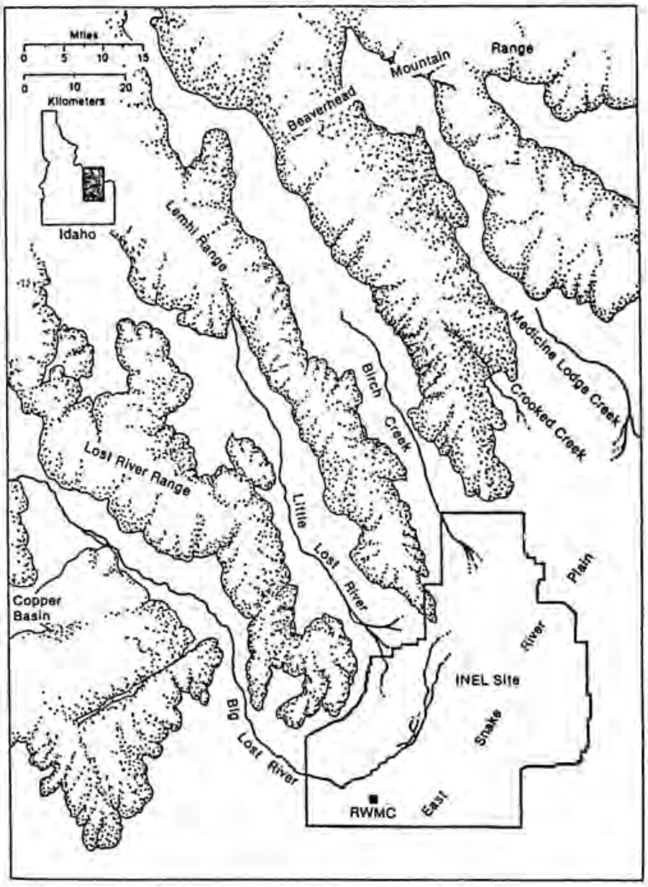

Fig. 4. Location of the RWMC on the INEL, and its relation to nearby mountain ranges and drainages.

The Subsurface Disposal Area (SDA) is located in a shallow valley surrounded by natural basalt ridges and hills. The geologic features consist of successive subsurface basalt flows and interbedded sediments overlain by an average of 16 ft. of lacustrine (lakebed) and eolian (wind-deposited) soils (Fig. 5). The fill material used in the SDA is obtained from a series of lakebeds south of the SDA, created by the diversion of part of the Big Lost River flow into four spreading areas.

routine waste is stacked as densely as possible in the bulk disposal section of the same pit. Occasionally permission is granted to dispose of remote-handled waste in the pits.

Although the RWMC is located in an arid environment, the soil becomes saturated with moisture in the spring due to melting snow and thawing of the frozen ground, and in the fall due to rain. The soil at the RWMC has very poor drainage and requires relatively small amounts of moisture to become saturated. This saturation of the soil has caused problems in the past, such as restricted equipment and personnel access to the SDA, and waste stack instability in the SDA pit.

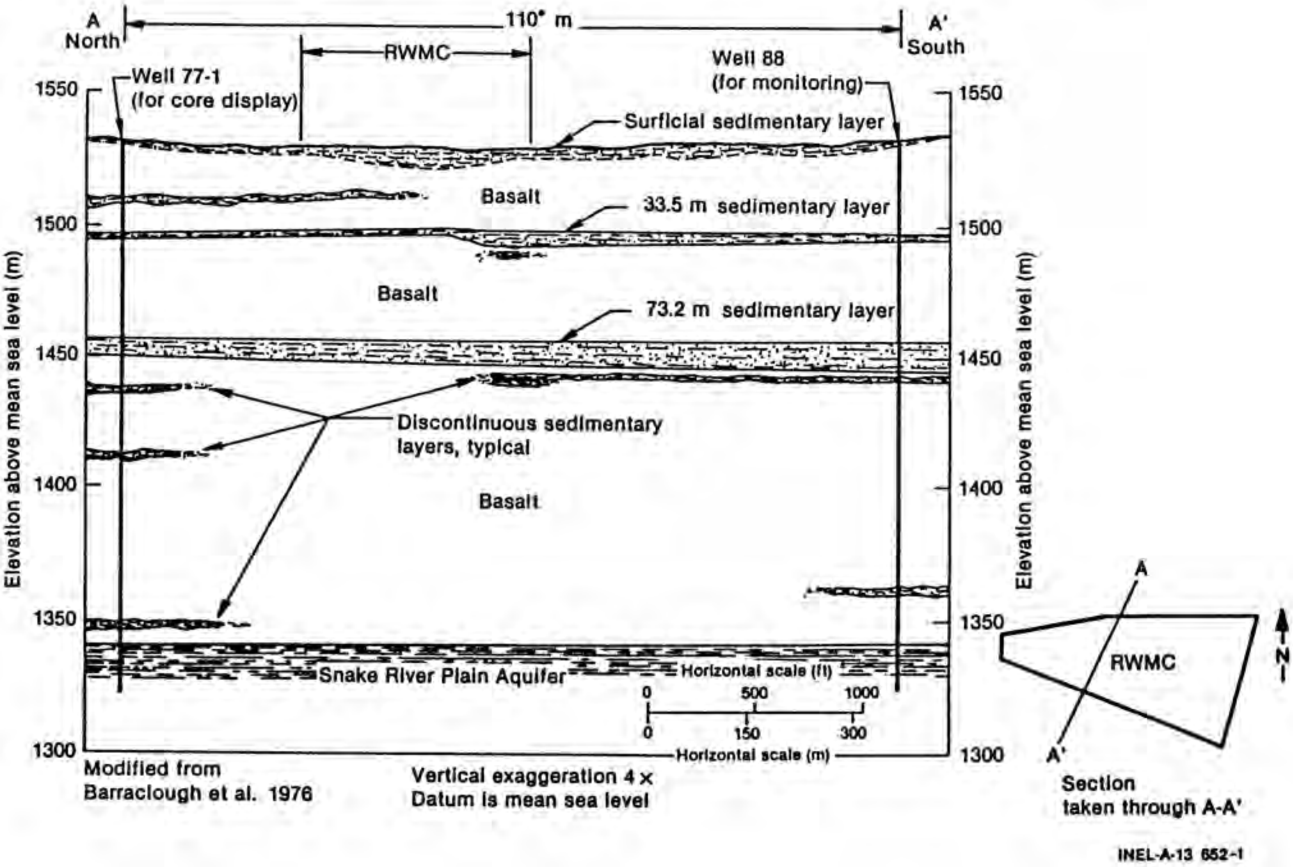

Fig. 5. Geologic cross section (north to south) through the RWMC.

LLW DISPOSAL OPERATIONS

The SDA provides the disposal area at the RWMC for LLW generated at the INEL and DOE-selected non-INEL facilities. All LLW disposed of in the SDA is done in accordance with the INEL Low Level Radioactive Waste Acceptance Criteria document DOE/ID 10112. The document establishes the criteria for waste classification, standard and nonstandard waste containment requirements, documentation, and waste generator quality program plans. Two general classifications of LLW are:

> Contact-Handled LLW - Waste with external radiation levels of <500 mrem/hr at three feet.
>
> Remote-Handled LLW - Waste with external radiation levels of <500 mrem/hr at three feet.

Large open excavations, or pits, are used to dispose of routine and nonroutine, solid contact-handled LLW. Routine LLW is disposed of by high density stacking of approved waste containers. Non-

The soil covering the RWMC is relatively shallow and overlies highly porous and fractured basaltic rock. This geological characteristic necessitates the construction of disposal pits using explosive fracturing and subsequent excavation of basalt to a depth of 30 feet. Once excavation is complete, the pits are backfilled with *approximately* two feet of pit run gravel mixed with equal parts of topsoil. This layer is leveled and mechanically compacted with heavy vibra-rollers. Geotextile porous fabric is then placed over the area, and being certain to overlap the fabric sections as recommended by the manufacturer, a final foot of gravel mix is emplaced. Once again the area is leveled and compacted and is then ready for use. The purpose of preparing the pit floors in this manner is to provide mechanical strength to the pit floor by distributing the mechanical loading of equipment, preventing moisture saturation of the gravel/soil mix below the fabric, and to prevent pumping of silt up into the gravel mix above the fabric.

A test section of the pit floor was initially stabilized using geotextile porous fabric. Waste boxes were then stacked on the test section. Targets were placed on selected boxes to allow monitoring stack stability using surveying techniques. The test section was monitored for 24 months. During this time equipment and personnel had year-round access to the pit and stack movement was minimal (less than 2 in. settling and less than 2 in. horizontal movement at the top of a 24 ft. stack). Prior to stabilization, the pit was inaccessible for up to 3 months per year and much effort was expended restacking waste boxes due to their settling and tipping in the unstable soil. Additional pit floor and access roads have been stabilized following the success of the test section. The resulting benefits have significantly enhanced the safety and reliability of the waste stack and provided continuous access to the disposal locations.

Remote-handled LLW (waste having radiation levels of 100-1000 rem/hr at three feet are not uncommon) is normally disposed of in soil vaults. Soil vaults are unlined holes augered to various depths above the basalt. Removable liners are placed in the vaults to facilitate the disposal operation hardware and to prevent hole sloughing. Surface-level baseplates are attached to the liners to accommodate discharge casks. The casks utilized are of the electronically and manually operated bottom-discharge type (Fig. 6). The casks are designed to minimize personnel radiation exposure and prevent contamination releases to the environment. Personnel exposures average less than one mrem per person for these operations.

Driven by the abundance of INEL contaminated soils (an estimated 500,000 cubic feet) and the need to enhance volume utilization efficiency and control subsidence, and to reduce radionuclide migration from disposal units, a contaminated soil grout cost-benefit study was performed in 1985. Based on the assumption that 24,000 cubic feet of contaminated soil will be available each year for disposal, the benefit for steady state grouting operations will be $768,000 per year. The benefit is based on disposal unit volume costs. The construction cost of a production soil grouting facility is estimated to be $360,000 and is not considered in the benefit statement.

The soil grout formulation chosen for the cost benefit analysis and use at the RWMC was developed and tested at the Oak Ridge National Laboratory (ORNL) by the Grout Technology Development section of the Chemical Technology Division. Table I describes the grout formulation and certain parameters.

In that the effectiveness and safety of the technology necessary to perform in situ stabilization of a real closed disposal site have not been satisfactorily demonstrated (nor is it expected to occur in the near future) it is necessary to provide stability during the active life of disposal units. Federal regulations, DOE Orders 5820.2 and 5480.14, 10 CFR 61 and the Resource Conservation and Recovery Act (RCRA), require stability of both active and closed shallow-land burial sites.

A soil grout testing program has been funded for 1986 and is ongoing. The program is designed to validate soil grout technology as a viable means of both stabilizing and increasing the existing disposal volume efficiency of active disposal areas within the SDA. Results of the program will provide the data necessary to design and operate a contaminated soil grout production facility which is funded for construction in 1987. The program is expected to reveal modifications to both facility and equipment necessary to handle, mix, transport, and apply contaminated soil in a safe, effective, and efficient operation.

Testing to be conducted as part of this program will include, but not be limited to, the following:

1. Systems Operational Test: This testing will determine the system's ability to operate as designed.

2. Soil Grout Formulation Test: This test will either verify the soil grout formulation (Table I) based on studies performed at ORNL, provide the optimum soil content, or it will result in establishing a new formulation in which the soil content will be maximized.

3. Waste Container Grout Injection Tests: These tests will establish that soil grout is a viable stabilizer for both the interior and exterior of waste containers in an active disposal site, as follows:

    a. Interior Tests: These tests will be designed to verify that not only can soil grout be injected into partially filled waste container(s), but that it will migrate into the void volumes existing within the container(s). The results of this test will be verified by measuring the volume of grout injected, followed by nondestructive and destructive examination. Structural stability tests for grout-filled simulated waste containers may also be required depending upon the viability of the process. These tests should also provide some insights into present container deficiencies associated with grout injection, as well as identifying whether or not current waste containers are satisfactory or whether different types of containers are necessary.

    b. Exterior Tests: The external waste package tests will be designed to permit the soil grout to be injected around the exterior of a stack of waste containers, a filled soil vault, or poured into molds. The grout migration and waste stack structural stability will be verified using compression (load) tests and visual damage analysis.

4. Migration Tests: These tests are similar to No. 3 above, except that they will be performed using soil grout which is spiked with a tracer. These tests may be combined if economically justified. The tests will be designed to determine equipment and facility modifications necessary to control contamination in a full-scale radioactively contaminated soil grout facility, and to quantify the leachate potential.

The above tests will be performed in accordance with engineering procedures prepared to accomplish specific objectives. A final report, and any other supporting documentation generated or received, will be assembled to document the project subsequent to its completion and will be made available for use.

SDA surface ponding during rainfall/snowmelt events has consistently caused operational problems due to waste zone penetration which provides a radionuclide transport medium and accelerates subsidence.

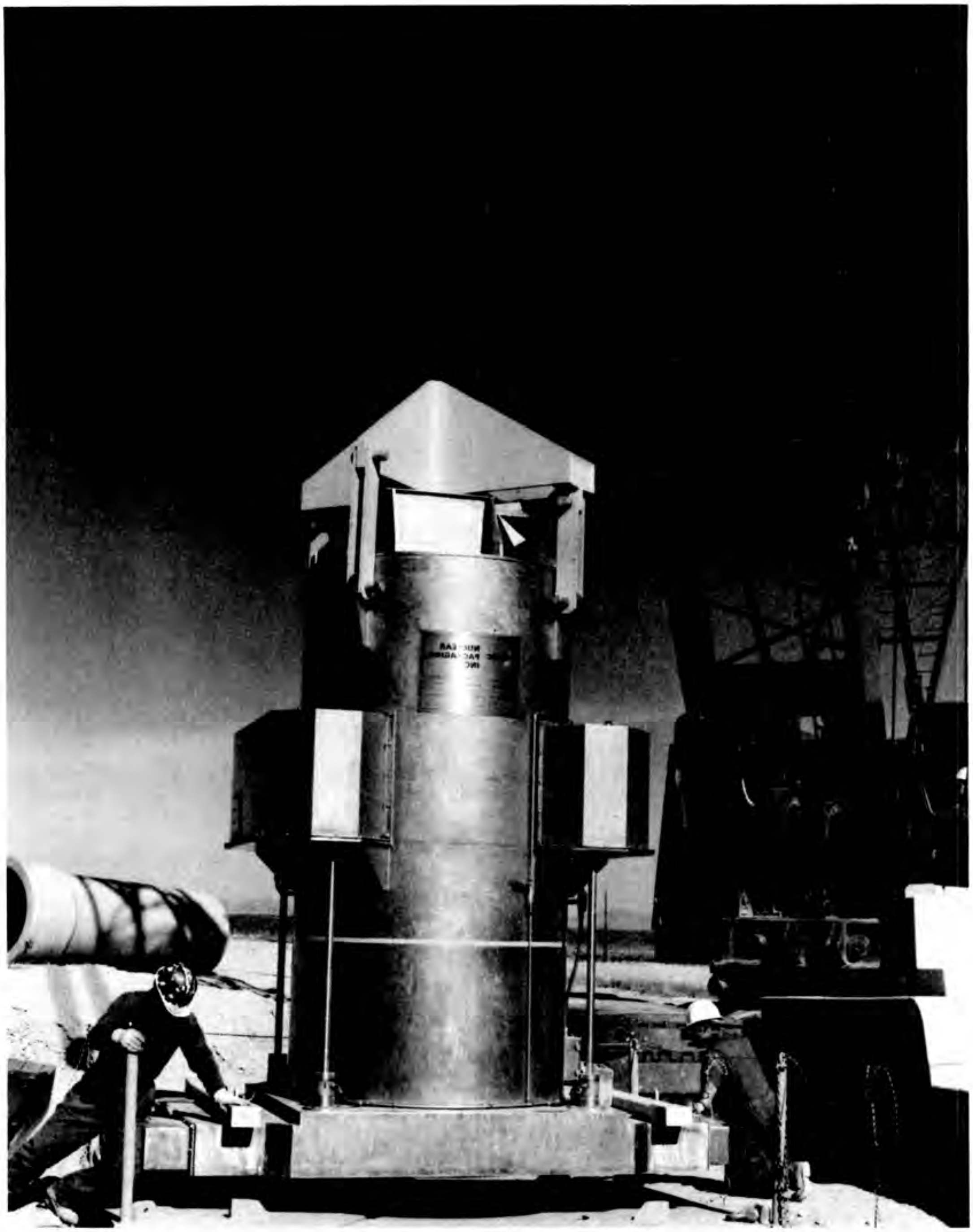

Fig. 6. Soil vault disposal utilizing a 55-ton cask.

TABLE I

Grout Formulations and Parameters

Item	Weight (lbs.)	Density (lb/cu.ft.)	Dry Volume (cu.ft.)	Factor (Ref. 5)	Slurry Volume (cu.ft.)
Cement	25	94	0.266	0.5	0.133
Water	25	62.4	0.401	1.0	0.401
Flyash	10	80	0.088	0.5	0.044
Soil	40	90	0.444	0.6	0.266
TOTALS	100		1.199		0.844

Volume increase - 1.9 cu.ft. grout/cu.ft. soil
Compressive strength - 1540-1653 psi
Density - 15.6 lb./gal.
24-hr. penetration resistance - >8000 psi
Water permeability (Darcy) - 2x10-6

High moisture conditions have also caused considerable expense for runoff sample *collection*. The SDA Maintenance Plan was written in 1984 and implemented in 1985. It will be completed in 1986. The plan identified those areas of the SDA which required additional soil fill and contour design to shed water away from the disposal units, collect the water in a new drainage system, and deliver the water to the SDA outlet.

In 1985, 130,000 cubic yards of soil were delivered to the SDA, contoured according to the plan, and reseeded with a 50/50 mixture of Ephraim crested wheatgrass and Sodar streambank wheatgrass (both species are shallow rooted dry rangeland grasses). The additional soil provides an average of 25% additional waste zone cover which reduces moisture migration into the waste, and, because of the design, will shed water away from the disposal units. This improvement is expected to significantly reduce hydrological radionuclide transport from the SDA waste zones.

A new SDA runoff outlet structure was also installed in 1985. The structure is a gravity-flow-designed culvert system with an installed effluent sampler and flowmeter. The sampler is an ISCO Model 2700, programmable AC/DC-powered effluent collector. The sampler can be set up to collect composite or individual samples at desired frequencies. Flow history is recorded on a Marsh-McBurney Model 265 Flowmeter. Where minimum sample frequencies are required during discharge periods at an unmanned facility, such as the RWMC, the system presents considerable manpower cost savings. The sampler and flowmeter are designed to be used in unsheltered, unheated areas where sample collection is necessary. The equipment is self-contained and may be exposed to the weather. Cost of the system was $3,000.

The 1986 maintenance plan efforts consist of final construction and grading of the new SDA drainage system and raising SDA roadways to the new fill elevations. The drainage grades will be established and documented for reference and additional replacement culverts will be sized and placed according to maximum design flow rates. The roadways will be raised and stabilized utilizing geotextile fabrics to promote moisture shedding into the drainages.

CONCLUSION

The Low Level Waste Management Program at the INEL is dedicated to reducing waste volumes and providing safe, ecologically protected disposal systems. Technology development, transfer and implementation is, and will continue to be, a primary objective.

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