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**LICENSING AND OPERATIONS OF THE CLIVE, UTAH LOW-LEVEL
CONTAINERIZED RADIOACTIVE WASTE DISPOSAL FACILITY- A
CONTINUATION OF EXCELLENCE**

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ABSTRACT

Envirocare's Containerized Waste Facility (CWF) is the first commercial low-level radioactive waste disposal facility to be licensed in the 21st century and the first new site to be opened and operated since the late 1970's. The licensing of this facility has been the culmination of over a decade's effort by Envirocare of Utah at their Clive, Utah site. With the authorization to receive and dispose of higher activity containerized Class A low-level radioactive waste (LLRW), this facility has provided critical access to disposal for the nuclear power industry, as well as the related research and medical communities.

This paper chronicles the licensing history and operational efforts designed to address the disposal of containerized LLRW in accordance with state and federal regulations.

The Clive, Utah facility was initially licensed for naturally-occurring radioactive material wastes (NORM) in 1988. The facility has expanded in size and capabilities over the years. Currently, in addition to NORM, the facility is licensed to receive Class A LLRW, low-activity radioactive wastes (LARW), mixed radioactive and hazardous wastes (MW), and 11e.(2) byproduct wastes, also known as uranium mill tailings and similar materials. Envirocare received a new license to dispose of all classes of LLRW (Class A, B and C) on June 9, 2001. Prior to implementation of the Class A, B, and C license, the Utah State Legislature and Governor must approve operation.

Envirocare's Class "A" LLRW disposal license reflects many years of operations, as well as over 40-years of experience derived from the nation's commercial LLRW disposal industry. Envirocare has applied lessons learned from previous and ongoing disposal operations at other low-level disposal sites. These lessons, combined with Envirocare's superior siting criteria, ensure maximum protectiveness of human health and the environment throughout the design life of the disposal facility.

The above grade disposal operation reflects a distinct break from prior commercial LLRW disposal facility design. This type of disposal is more typical of the European LLRW disposal facility design. It presents both long-term isolation and maintenance advantages as well as current operational challenges. The current challenges are related to the management of personnel and public exposure from the higher activity waste materials. This involves dose modeling for direct dose and skyshine. These exposure challenges have been identified and addressed with engineering, radiological and procedural controls. With continued experience, Envirocare's management and CWF staff is defining its upper limits of activity and dose that the site can receive while continuing to meet the personnel and public exposure criteria.

INTRODUCTION

Envirocare's newly expanded Radioactive Material License is effectively the first commercial containerized waste Class A low-level radioactive waste (LLRW) disposal facility of the 21st century. This is the first new site to be opened for operation since the Barnwell facility was opened in the mid 1970's. The licensing of Envirocare's CWF has been the culmination of over a decade's effort to establish these types of services at the Clive, Utah facility. With the authorization to receive and dispose of higher activity containerized Class A LLRW, this facility provides critical, cost effective access to disposal for the power generating, medical and research industries that generate LLRW.

FACILITY PHYSICAL BACKGROUND AND CHARACTERISTICS

The facility is located in Section 32 of Township 1 South and Range 11 West, Tooele County, Utah. This area has been designated by Tooele County as a Hazardous Industrial Zone, and is home to two hazardous waste incinerators (one active, one being decommissioned) and a hazardous waste landfill in addition to Envirocare's operation. The Hazardous Industrial Zone is a 100-square mile area specifically zoned for hazardous waste operations away from populated cities and residential areas.

The site for the Envirocare facility is ideal for radioactive waste disposal operations:

| | |
|-------------------------------|-----------------------------|
| Distance to Population Center | 30 miles |
| Population Within 5 Miles | 0 |
| Nearest Residence | 7 miles |
| Primary Transportation Routes | Interstate Highway or Rail |
| Surface Water | None |
| Nearest Surface Water | 15 miles to Great Salt Lake |
| Climate | Arid |
| Average Precipitation | 8 inches per year |
| Average Evaporation | 50 to 60 inches per year |
| Surrounding Area | Desert |
| Ground Water Quality | Saline, Non-usable |

Envirocare's Class "A" LLRW disposal license reflects many years of operations, as well as over 40-years of experience derived from the nation's commercial LLRW disposal industry. Envirocare has applied lessons learned from previous and ongoing disposal operations at other LLRW disposal sites. These lessons, combined with Envirocare's superior siting criteria, ensure maximum protectiveness of human health and the environment throughout the design life of the disposal facility.

INDUSTRY HISTORY

The path to successful licensing and operating Envirocare's commercial Class A containerized LLRW disposal facility dates back to the original 1960 AEC rulemaking that provided for shallow land disposal of low-level radioactive wastes.

To date only seven commercial containerized low-level radioactive waste disposal facilities have been licensed and operated. They are:

1. USEcology, Beatty Nevada, operated from 1962 to 1992
2. USEcology, Maxey Flats Kentucky, operated from 1963 to 1976
3. Westinghouse, West Valley New York, operated from 1969 to 1973
4. USEcology, Sheffield Illinois, operated from 1965 to 1977
5. USEcology, Richland Washington, operated from 1966 to the present
6. CNSI, Barnwell South Carolina, operated from 1974 to the present
7. Envirocare, Clive, Utah, operated from 2001 to the present

Only two of the six licensed and operated commercial containerized LLRW disposal facilities that began operations prior to 2001 are currently operating. They are the facilities in Richland, Washington and Barnwell, South Carolina. Environmental concerns have been identified at many of these sites as a result of past waste management and disposal practices. Lessons learned from these experiences were incorporated into the design and permit for Envirocare's commercial containerized LLRW disposal facility.

Four of the six pre-2001 sites were in a humid climatic region, while the others were in the arid western region. Of the two remaining operating sites, the Barnwell facility is located in the humid southeastern region of the central part of South Carolina, while the Richland facility is in the northwestern desert in southeast Washington State. The facilities in the humid climate have all experienced water-related operational issues that involved subsidence and groundwater contamination. Many of these items were addressed in the development of 10 CFR Part 61 disposal regulations. The design and operation of the Clive commercial containerized low-level radioactive waste disposal facility meets or exceeds all requirements for waste form, packaging, and disposal operations. In addition, Envirocare is the first and only LLRW disposal facility sited since implementation of 10 CFR 61.

BRIEF HISTORY OF ENVIROCARE

The Clive, Utah site initially accepted uranium mill tailings-derived waste from the former Vitro Chemical Company site in south Salt Lake City, Utah. This cleanup was conducted by the State of Utah and DOE under the Uranium Mill Tailings Remedial Action Project in 1988. After completion of the cleanup, 540 acres of the 640-acre site remained unused. The remaining area was then purchased by the owner of Envirocare of Utah, who then applied for a license to replicate the disposal operations for commercial disposal of similar waste materials.

Envirocare was initially licensed for NORM in 1988. The facility has expanded in size and capabilities over the years. Currently, in addition to NORM, the facility is licensed to receive LARW, mixed radioactive and hazardous wastes (MW), and 11e.(2) byproduct wastes, also known as uranium mill tailings and similar materials. On October 5, 2000, Envirocare's LARW license (isotope specific) was amended to enable receipt of all Class A LLRW. Envirocare received a new license that would enable containerized disposal of all classes of radioactive waste (Class A, B and C) on June 9, 2001. Prior to implementation of the Class A, B, and C license, the Utah State Legislature and Governor must approve operation.

The disposal of containerized Class A LLRW was sought by Envirocare as a direct outcome of the October 5, 2000 license amendment. The increase in waste activity triggered ALARA concerns, should higher-activity waste be handled using traditional bulk disposal practices. Accordingly, Envirocare submitted a license amendment on January 29, 2001 to allow for the disposal of containerized Class A LLRW.

Envirocare's above grade disposal operation reflects a distinct break from prior commercial containerized LLRW disposal facility designs implemented in this country. The above-grade design is more typical of the European LLRW disposal facility design. It presents both long-term isolation and maintenance advantages as well as current operational challenges. The current challenges are related to the management of personnel and public exposure from the higher activity waste materials in an above-grade disposal facility. These exposure challenges have been identified and addressed with both engineering and procedural controls. With continued experience Envirocare's management and CWF staff are defining its upper limits of activity and dose that the site can receive and meet these immediate personnel and public exposure criteria.

UTAH DIVISION OF RADIATION CONTROL LICENSE REQUIREMENTS

On October 19, 2001, the Utah Division of Radiation Control (DRC) approved Amendment 12 to Envirocare's Radioactive Material License # UT 2300249. This amendment authorized Envirocare to dispose of containerized Class A LLRW at Envirocare's CWF (see Figure 1). This authorization requires disposal of these wastes in containers, a first for Envirocare. Previous disposal operations were in bulk waste material.

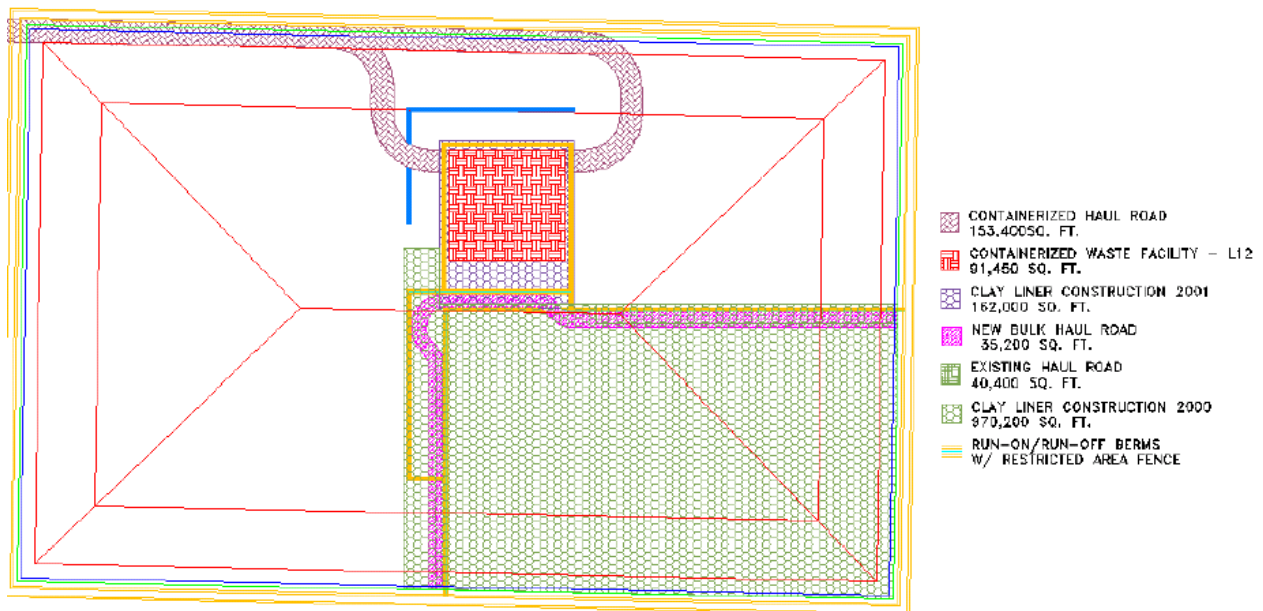


Fig. 1- Plan View of Envirocare's CWF Disposal Cell

Implementation of the CWF required revisions to the following documents or processes:

- Radioactive Material License
- Waste Management Plan
- Waste Characterization Plan
- Waste Acceptance Criteria
- Construction Quality Assurance/Quality Control Manual
- Numerous operating procedures

Many of the site underlying licensing documents did not require revision, including:

- Quality Assurance Program
- Radiation Safety Program
- Ground Water Discharge Permit
- Environmental Monitoring Program
- Financial assurance requirements

ALARA AT THE CONTAINERIZED WASTE FACILITY

State and federal regulations, as well as Envirocare's ALARA program, require that the dose for occupational workers and members of the public be ALARA (As Low As Reasonably Achievable).

Previous to approval of Amendment 12 to the Radioactive Material License, Envirocare was limited to bulk disposal of LARW. In bulk disposal, soil and soil-like waste are removed from the containers and placed on the disposal cell in one-foot lifts. Debris is mixed with soil or placed using a flowable grout called CLSM (controlled low-strength material). CLSM is essentially a low-strength concrete. Due to the lower radionuclide concentrations received in the bulk waste, this type of disposal operation has been conducted successfully, maintaining the total effective dose equivalent (TEDE) for disposal operations personnel well below Envirocare's individual ALARA goals of 200 mrem/year and ensuring the performance objectives of Utah R313-25-19 (250/750/250 μ Sv) are met.

The CWF allows disposal of higher-activity wastes than have historically been disposed in bulk fashion. Bulk disposal assures that material is compacted to engineering standards and voids in the waste materials were non-existing. This insures that waste subsidence is minimized. In an above-grade disposal embankment, subsidence is an engineering concern because it may allow the final cover to be breached due to differential settlement. To continue operations with wastes at or near the Class A limits under the existing license conditions (e.g., requiring emptying containers, blending wastes with soil and compaction of wastes) would increase total occupational exposures.

Allowing disposal of these containerized wastes in their shipping containers reduces the TEDE through better management of time, distance and shielding. Keeping waste in secure packages will virtually eliminate the potential for contamination or airborne transfer to personnel. This leaves only the direct dose that can be controlled more effectively in containers because the

source term is in a discrete form. In addition, the containerized waste can be shielded with portable shields or equivalent, thereby reducing direct exposure during handling and particularly following disposal.

PROCEDURAL AND ENGINEERING CONTROLS

The CWF is managed as a separate facility from Envirocare's current bulk disposal operations in many respects, including barriers against physical contamination, restricted personnel access, and dedicated management personnel for operations and radiation safety. This will assist in dose management. The CWF will be managed as a contamination-free Restricted Area until containerized waste disposal is completed. Following completion of the CWF, this section of the cell will be incorporated into the overall Class A LLRW Disposal Cell. Engineering analyses have been performed to demonstrate that this waste placement strategy will not negatively impact long-term performance of the overall disposal cell.

To dispose of waste in the CWF, each generator must become a "certified generator."

Generator Certification Program

To ensure that wastes received for disposal in the CWF meets license and regulatory requirements, a generator certification program has been implemented. Envirocare will review a generator's procedures, processes and management of radioactive waste to ensure that the waste will be prepared, packaged, transported and verified in accordance with applicable regulations, the Radioactive Material License and the CWF Waste Acceptance Criteria (WAC). Approvals are required from Envirocare's Environmental Engineer, Corporate Quality Assurance Manager and the CWF Radiation Protection Manager. In addition, Envirocare must ensure that the generator has a current, unencumbered Utah Site Access Permit issued by the Utah Division of Radiation Control.

Waste Acceptance Criteria

Envirocare's CWF WAC describes the details necessary to ship radioactive material to the CWF. In addition, it augments the radioactive material license explaining how shipments must be prepared, required paper work, how to load conveyances with different type containers, etc.

One of the keynotes of the WAC is the Advanced Shipment Notification Form. This form is submitted by the shipper to request scheduling for a shipment to the CWF. The shipper lists specific information necessary for the CWF staff to ensure that the CWF has the proper resources necessary to dispose of that shipment. Critical information includes package type, weight, dose rate, and unusual hazards. CWF staff use this information to plan receipt and offloading operations for the shipment, ensuring that appropriate handling equipment and disposal location are identified in advance. The advance shipment notification is reviewed and approved by the CWF Operations Manager and the Site RSO.

CWF Organization

The CWF has distinct operations and radiation safety management personnel and staff from the other operations at the Clive, Utah site. This group is experienced in the handling and disposal of typical containerized waste generated by the industry.

Other organizational groups, including Quality Assurance, Compliance/Permitting, Business Development, and operational support functions, will assume additional responsibilities relative to implementation and operation of the CWF.

The heavy equipment operators, specifically the crane operator, are experienced in removing HICs/liners, in an expeditious manner, from transportation casks and placing them for disposal. Most importantly, CWF operators qualify for placing high dose liners/HICs by spend a significant amount of time, training and practicing with non-contaminated “mock” packages.

All Health Physics Technicians (HPT) are National Registry of Radiation Protection Technologist (NRRPT) members or eligible. Radioactive waste shipping and receiving activities are performed by the same HPTs that will be handling the waste for disposal. This provides for clear communication and understanding of specific shipment issues.

Cell Construction

The LARW and Class A waste disposal facility includes two landfill embankments with the necessary surface drainage systems and security fencing. The CWF is a portion of the Class A disposal embankment, and will be overlain by bulk wastes following containerized waste disposal. Envirocare has prepared an Engineering Justification Report to assess the impacts of the CWF on long-term performance of the embankment. This report has determined that no changes to the current cell cover or liner design are required. This report has also demonstrated that container placement specifications for the CWF will protect against differential settlement between different containers and between the containerized and bulk waste placement areas of the embankment.

Figure 1 provides a plan view of this area. Figure 2 provides a cross section view of the CWF to illustrate how this facility will be incorporated into the completed Class A LLRW Disposal Cell.

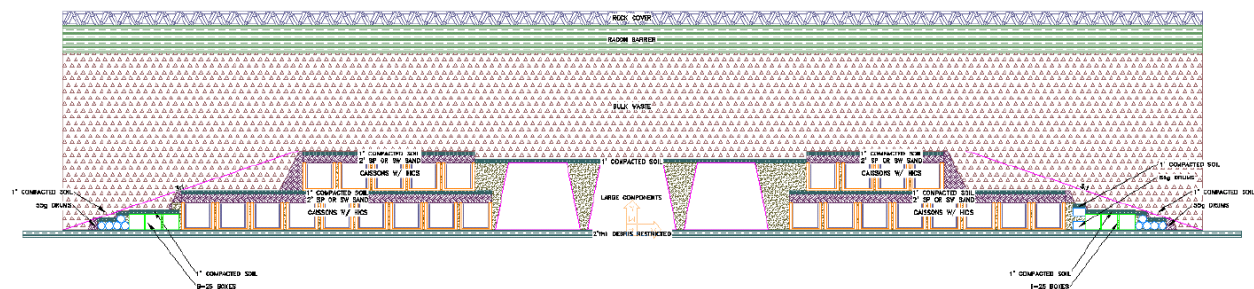


Fig. 2- Cross Section View of CWF Within the LLRW Disposal Cell

Extensive engineering analyses have been performed to ensure that the LARW and Class A embankments are constructed to properly isolate the waste. Characteristics common to areas with land subsidence do not exist at the Envirocare site. Waste placement controls are implemented for both bulk and containerized disposal operations to ensure that the disposal embankments are inherently stable. The settlement potential has been conservatively modeled in engineering evaluations prepared in support of Envirocare’s design. In addition, Envirocare has committed to perform settlement monitoring of the embankments as they close and for at least 20 years following site closure. Therefore, subsidence is not a concern for the Class “A” LLRW disposal cell.

The cell foundation is established on in-situ formations at the site. Each cell has its foundation below the existing ground level, and approximately 15-20 feet above the groundwater table. The foundation consists of in-situ clays or sands that are compacted to at least 95 percent of a standard proctor.

The cell bottom liner is constructed of a compacted two-foot thick low-permeability (10^{-6} cm/sec) clay layer. The clay liner is placed and compacted using the approved method with full QA/QC inspection and documentation of the placement process. Final approval by the DRC is required prior to waste placement on a newly constructed liner.

The embankment side slopes and top following final waste placement are covered with a compacted seven-foot thick low-permeability radon barrier. The radon barrier is then overlain by drainage and frost protection layers, with a final rock armor "erosion barrier" of large-diameter riprap 1.5 feet thick. The final cover slope will be 4% with side slopes of approximately 5:1. The DRC is notified of radon barrier construction and also performs regular inspections of construction activities and documentation.

Waste Placement Methods

Containerized waste is placed in the embankment in accordance with the engineering specifications to ensure a stable waste column in the CWF and allow adequate filling of the void spaces surrounding the waste.

Waste placement specifications and procedures have been developed to ensure that void space in the waste column is minimized. Waste placement geometry, methods, and backfill materials are evaluated through construction of a non-contaminated test pad prior to waste placement. Test pad reports are reviewed and approved by the DRC. Envirocare currently has the DRC approval for placement of boxes up to 5 feet tall and for cylindrical HICs or liners. At this time, HICs and liners are limited to a maximum nominal volume of 215 cubic feet. Drum placement specifications have not yet been finalized through test pad approval; however, it is anticipated that drums will be stacked up to 3 high when placed horizontally before backfilling commences. Pending satisfactory completion and approval of a test pad, drums may also be placed upright for disposal.

All stacked waste packages within the embankment are placed in a way that minimizes the void spaces between the containers. Non-cohesive backfill material (sand meeting approved gradation with low moisture content) is placed over and between the waste packages in a manner that encourages flow into any and all voids within the layer. For HICs and liners, the container is generally placed inside a reinforced concrete caisson prior to backfilling. The caisson provides shielding for high dose rate containers as well as a form for backfill placement; but does not provide structural stability. Each caisson will also be overlain by a 2-foot thick intermediate sand layer prior to backfill cover. Finally, each lift is covered by placing backfill cover (typically a clay, road base, or other native soil) over the waste containers to a minimum thickness of 1 foot prior to beginning placement of the next layer of waste. See Figure 2.

Envirocare is now able to dispose of higher-activity resins in the CWF in either solidified or non-solidified waste forms. Non-solidified resins are required to be disposed in HICs or liners within caissons as described above. Because groundwater modeling has assumed that all radionuclides

are immediately available for transport, with no credit taken for container life, resin disposal will not lead to release of radionuclides under the conditions that will occur in the Class A LLRW disposal cell.

Unusually shaped packages or large containers greater than five-feet tall shall be placed and backfilled in a manner that allows voids to be filled. Large components and oversized DOT containers (larger than 215 cubic feet) require prior approval by the DRC on a case-by-case basis for disposal in the CWF. A significant amount of void space is five percent of the volume of the unusually shaped package, unless otherwise approved by the DRC.

Observation of the approved backfill compaction method during backfill placement of each lift in the waste layer verifies the compaction specification during the construction of each waste column.

Waste stream knowledge, in cell engineering controls and waste placement requirements address the needed controls that limit personnel and public exposure from these higher dose containerized waste streams in the above grade facility. The combined use of package content, temporary shielding, backfill and other controls allow Envirocare to utilize the proven above grade disposal configuration for the disposal of containerized Class "A" LLRW to address short term ALARA issues while ensuring long term facility stability and waste isolation.

CONCLUSION

Envirocare's commitment to provide critical access to disposal for the generators of higher activity Class "A" LLRW is demonstrated by the permitting of the first commercial low-level radioactive waste disposal facility to be licensed in the 21st century.

Envirocare's ability to provide this waste disposal option was the direct outcome of its previous disposal operations at the Clive, Utah facility. The CWF design and operation reflects the many years of operations at Clive, Utah, as well as over 40-years of experience derived from the nation's commercial LLRW disposal industry.

The above grade disposal facility design reflects a distinct break from prior commercial LLRW waste operations in the United States. It presents both long-term isolation and maintenance advantages as compared to fully below grade facilities. Challenges related to the management of personnel and public exposure from the higher activity waste materials in the above grade facility have been identified and addressed with both engineering and procedural controls. With continued experience, Envirocare's management and the CWF's staff are defining the upper limits of activity and dose that the site can receive while continuing to meet personnel and public exposure criteria.

The legacy of Envirocare's Class "A" LLRW facility will be that it was built on over 40-years of experience derived from the nations commercial LLRW disposal industry. Envirocare has provided critical access to disposal for the nuclear power, research and medical communities when no other national options appeared to have any continued viability.