SOLVING THE ROCKY FLATS ORPHAN WASTE PROBLEM

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ABSTRACT

This paper discusses the activities Kaiser-Hill Company, LLC (Kaiser-Hill) has implemented to solve the orphan waste issues to achieve closure of the Rocky Flats Environmental Technology Site (RFETS) by December 2006. Orphan wastes are those wastes generated from past weapons program operations that have no simple solution for treatment and disposal. The technical challenges are discussed, along with the innovative concepts and solutions that are being explored or employed to render all RFETS wastes disposable.

INTRODUCTION

As a result of current and past operations at RFETS, the site has generated a number of waste types containing both low-level radioactive and hazardous constituents, known as mixed waste. The hazardous components of low-level mixed waste must be treated to Land Disposal Restrictions (LDR) standards prior to disposal in a radioactive waste landfill with a RCRA Subtitle C permit. The schedule for treatment of these mixed wastes is established in the RFETS Site Treatment Plan (STP), an enforceable Consent Order between the State of Colorado and the Department of Energy (DOE) Rocky Flats Project Office (RFPO).

The Rocky Flats Closure Project is working toward a schedule to complete closure activities by December 2006. The current inventory of low-level mixed wastes (LLMW) at RFETS is approximately 8,000 m^3. A substantial portion of the waste inventory is more difficult to treat legacy wastes from past weapons program operations, sometimes referred to as "orphan" wastes. Treatment and disposal of the orphan wastes at RFETS presents perhaps the biggest challenge to fulfilling the Closure Project goal.

One of the largest orphan waste populations consists of LLMW that exhibits a transuranic activity greater than 10 nCi/g. There are currently no disposal sites available to RFETS for disposal of this waste, since the activity is too high for commercial disposal and DOE disposal at Hanford or Nevada Test Site (NTS) is not available. To solve this waste issue, Kaiser-Hill has implemented several project initiatives, some of them EM50 funded, to render the greater than 10 nCi/g waste disposable.

In addition, there are several waste types for which a current treatment process is not identified, proven, or available. One example is LLMW that contains organic solvents and/or polychlorinated biphenyls (PCBs), but also contains an activity that is too high for the TSCA incinerator in Oak Ridge. In this case Kaiser-Hill is working with commercial treatment vendors to develop and implement the needed technology to treat the waste to the appropriate treatment standards.

This paper discusses activities Kaiser-Hill has implemented to solve the orphan waste issues so that full site closure can be achieved. The technical challenges will be discussed, along with the innovative concepts and solutions that are being explored or employed to render all RFETS wastes disposable.

COMPLETED PROJECTS TO DATE

Bypass Sludge

A large portion of the orphan waste population is bypass sludge. Bypass sludge consists of wet sludge, cement, and diatomaceous earth that were placed in approximately 2,100 drums (441 m^3). The wet sludge consists of solids that were precipitated from process wastewater during wastewater treatment operation in Building 374 until August 1991. Cement and diatomaceous earth were metered into the drum in layers with wet sludge to absorb free liquids. The transuranic alpha activity in the waste is between 10 and 100 nCi/g. The RCRA waste codes for bypass sludge are F001, F002, F005, F006, F007, and F009. Analytical data obtained from various sampling evolutions indicated that the waste did not require treatment for organic contaminants before land disposal due to the concentrations being below the appropriate treatment standards but needed treatment to stabilize the metals such as chromium and mercury. Although mercury is not an F-listed metal, treatment is required due to it being an Underlying Hazardous Constituent (UHC) since corrosive wastes were treated at the B374 treatment facilities.

Technical challenges to this waste included determining a process that could treat sludge stored in drums. Although mixing was not done to combine the sludge with inert materials, it was expected that some hardening of the drum contents occurred due to absorption of free liquids. Another technical challenge was to determine the final waste form for disposal at an unavailable disposal site.

A treatment demonstration study was planned to determine if the bypass sludge could be processed to meet RCRA land disposal criteria. The treatment demonstration would also provide information to verify the actual physical and radiological properties of the population. Three commercial treatment vendors were selected to receive 20 drums each: ATG, Perma-Fix (M&EC), and Waste Control Specialists (WCS). The three batches of 20 drums received by each facility were similar to each other in terms of generation dates and range of activities (4 to 86 nCi/g). These facilities were tasked to sample the incoming drums to determine physical and chemical properties, process the sludge using their proprietary treatment process, sample the final waste form, and package the waste. Each vendor then prepared a report summarizing its results and lessons learned. The lessons learned were to be used by each vendor for preparation of a proposal for treating the entire population.

Results from three vendors indicated that all RCRA metals were successfully treated to below RCRA treatment standards using available stabilization treatment processes and equipment. Final volume increases ranged from 1.9 to 3.2. It was found that after processing the radiological activities of the processed sludge were still above 10 nCi/g. Disposal of the processed bypass sludge will have to wait until a disposal facility becomes available.

As a result of successful treatment, the three treatment vendors were invited to bid on processing approximately 2,100 drums. Based on evaluations of the proposals, Kaiser-Hill awarded the treatment contract to WCS. Current scope is for WCS to treat the bypass sludge and package into approximately 330 IP-1 B-25 containers. WCS will store the treated waste packages until a disposal facility becomes available. Should Hanford or NTS become available, then final packaging of the waste will be done, if needed, such as packaging to Category 3 criteria as required by the Hanford disposal facility. This would involve placement of the IP-1 package into an IP-2 overpack container and encapsulating the inner container in at least 2" of grout within the overpack container.

This strategy will successfully treat 441 m^3 of this orphan waste to meet RCRA land disposal criteria. Shipments of the drums to WCS will be completed by February 2004 with treatment expected to start in March 2004. Final disposition will depend on when a disposal facility becomes available. In the meantime, the treated waste will be stored either at WCS or RFETS.

Co-Processing Sludge at RFETS 750 Pad

As part of D&D activities in Building 374, additional orphan wastes were generated during clean out of five tanks. Approximately 249 m^3 of B374 sludge was generated. The RCRA waste codes for these Building 374 sludges are F001, F002, F005, F006, F007, F009, P030, P098, P099, P106, U003, U103, and U108. Analytical data obtained from various sampling evolutions indicated that the waste did not require treatment for organic contaminants before land disposal due to the concentrations being below the appropriate treatment standards but needed treatment to stabilize the metals such as chromium and cadmium. The transuranic alpha activity ranged from 0.8 to 31 nCi/g. The technical challenge was to find a solution on making the entire waste amenable to disposal.

Technical personnel proposed using sludge processing equipment located at the 750 Pad that was available due to having completed processing of Solar Pond sludge. This processing equipment had been installed and operated by Duratek LATA. In addition, due to closure of the Building 374 wastewater processes, 56,000 gallons of non-LDR compliant LLMW water had accumulated in a storage tank waiting treatment. The alpha activity of the water was found to be 0.1 nCi/g.

Kaiser-Hill contracted with Duratek LATA to develop recipes similar to that used for processing Solar Pond sludge. The recipe was to use the Building 374 sludge, LLMW water, and Wastelock 770 absorbent polymer to treat chromium and cadmium to below RCRA treatment standards. Treatability studies were done to confirm that the proposed treatment recipe would treat the hazardous constituents and would result in a treated product with alpha activities less than 10 nCi/g.

Duratek LATA personnel treated these wastes meeting all waste acceptance criteria of EOU. The treated waste has been disposed of at EOU. This project is another successful path forward for eliminating orphan wastes by treating similar populations of wastes with various alpha activities to produce a final treated waste product that can be disposed of immediately.

Repackaging of Greater than 10 nCi/g Debris

RFETS maintains a population of legacy debris with an assayed transuranic activity greater than 10 nCi/g. Most of this waste is packaged in drums at very low densities due to packaging inefficiencies. Due to the low density, assigned assay values are based on lower detection limits. The technical challenge is to determine a solution to make this waste amenable to disposal at an available disposal facility. Technical personnel evaluated two options. In one option, the legacy debris drums would be reassayed using instrumentation with lower detection limits. The second option is to process the debris into a more efficiently packaged waste form thus reducing the waste volume and generating a waste package with transuranic alpha activity of less than 10 nCi/g.

Kaiser-Hill opted for the second option since calculations indicated that a more efficiently package waste form would be more economical for disposal and would minimize the amount of waste disposed of at EOU. Kaiser-Hill contracted with PEcoS (formerly known as ATG) to repackage a waste population comprised of low activity empty lead-lined 55-gallon drums with a subpopulation of higher activity debris drums comprised primarily of combustibles and light metals. The total shipped waste population included 652 drums. PEcoS supercompacted each drum and packaged the resulting pucks in 85-gallon overpacks. The transuranic alpha activities were calculated using existing assay data to ensure that the transuranic activity of an 85-gallon drum was less than 10 nCi/g. PEcoS produced 117 85-gallon drums out of 652 55-gallon drums. These drums were shipped to EOU for macroencapsulation and disposal.

Variances from LDR Standard

Several RFETS orphans have activity levels that are acceptable for receipt by EOU except that these do not have available treatments to allow for disposition at EOU. In these cases, Kaiser-Hill implemented a strategy to work with EOU to submit variances from LDR technology-based treatment standards through the State of Utah, which is the RCRA regulating authority for EOU. This section provides two examples of variances that have been obtained.

Sludges generated after 1991 in the Building 887 process wastewater system and debris contacting such sludges carry the U103 waste code. Wastes carrying the U103 waste code need to undergo combustion treatment (technology standard). Kaiser-Hill was able to demonstrate to EOU that the volume of dimethyl sulfate (U103) introduced to the process waste water system was extremely small relative to the volume of waste processed in the building. A variance was prepared and submitted by EOU for disposal of the tanks as LDR-compliant and for treatment of the sludge using chemical oxidation. The State of Utah agreed to allow EOU to dispose the tanks without explicitly complying with the U103 LDR technology-based treatment standards as long as all other treatment standards were met.

During past operations, process chemists stabilized a variety of reactive chemicals using cement and creating a small "puck". Four reactive cemented pucks that were packaged in a 10-gallon drum carry P028 and U020 waste codes. These waste codes require the technology-based treatment standard of combustion. Kaiser-Hill requested that Envirocare submit a treatment variance to allow for macroencapsulation of the cemented pucks before disposal.
It was shown that the original volume was less than one liter and that the waste was mixed with ten times the solidification reagents. The State of Utah granted this variance to EOU. EOU will macroencapsulate the 10-gallon drum containing the cemented pucks.

These two examples show that working with the disposal facility and the RCRA regulatory authority could result in obtaining variances to open a path forward for eventual disposition of the orphan waste. Sufficient supporting material is required to convince the RCRA regulatory authority to grant the variance. Additional use of this methodology of using variances is also shown in the last section of this paper.

PROJECTS IN PROGRESS

Re-Characterization of Radioactive Content of LLMW

A population of orphan wastes consists of wastes that were radiologically characterized based on the lower limit of detection (LLD) of the assay instrument. Using this characterization method, there are approximately 792 drums and 146 crates of LLMW with transuranic alpha activities greater than 10 nCi/g, which eliminates disposal at EOU.

An initial proposal was to characterize this population based on the Department Of Transportation classifications: Low Specific Activity (LSA) or Surface Contaminated Object (SCO). Technical personnel proposed that SCO waste would be characterized using established RFETS procedures to derive at the proper activity. A technical challenge was found for characterization of the LSA population since the procedure was revised recently and is in the initial implementation phase. Technical questions have arisen regarding acquisition of representative samples and sampling of this population is controlled by several additional procedures. Initial implementation of the process for LSA waste has had limited success in identifying waste less than 10 nCi/g. An alternative is needed to support RFETS closure schedule and safety goals.

Technical personnel then proposed using an innovative application of high-resolution gamma spectroscopy assay technology combined with real time radiography (RTR) and statistical analysis. This method would be used to determine a more accurate measure of source activity concentration for RFETS LLM wastes with the overall goal of making a better distinction between wastes that are greater than and less than 10 nCi/g.

Application of this technique is expected to eliminate up to 380 drums and 140 crates of the existing LLM orphan inventory by characterizing a portion of this inventory as less than 10 nCi/g allowing these to be sent to EOU for treatment and/or disposal. This path forward shows how review of existing radiological data for legacy wastes combined with better assay equipment could result in transforming orphan wastes to shippable wastes thus reducing overall schedule risk to the RFETS Closure Project.

Trench 1 Wastes

RFETS currently stores approximately 159 containers of depleted uranium wastes exhumed from Trench 1 (T-1) during the source removal project conducted in 1998. Historical documentation indicated depleted uranium (DU) metal chips (lathe and machine turnings) originating from Building 444 were packed with lathe coolant and buried in the west end and possibly the east end of T-1. The matrix for these wastes ranges from machining turnings and chips to pasty sludge to chips in soil. All the T-1 wastes exhibit contamination from RCRA-regulated solvents (F001 and F002) and characteristic metals (D006). Additionally, the wastes are contaminated with polychlorinated biphenyls (PCBs) at regulated levels and are potentially reactive.

Treatment of these wastes is necessary before they can be disposed of at available disposal facilities such as EOU. For wastes from T-1, treatments include elimination of characteristic metal codes, treatment of listed wastes, elimination or reduction of PCB concentration, and elimination of the reactive nature of the depleted uranium. The technical challenge for this orphan waste is that treatment was not available at the time they were generated. Treatment capacity has only recently been developed by Perma-Fix. Kaiser-Hill contracted with Perma-Fix to provide four drums from T-1 to test this process. [1] The technology demonstrated at the Perma-Fix facility uses a solvent extraction step using a proprietary solvent mixture to remove RCRA and PCB contamination. The spent solvent mixture is then treated at a TSCA-permitted facility to destroy the PCBs. The second step in the treatment process is a grouting step that eliminates the pyrophoricity of the waste. Reference 1 indicated that the treated waste is acceptable for land disposal at EOU.

Other treatment vendors have indicated that they also have the necessary technology and expertise to successfully treat these wastes. Rocky Flats technical personnel will also provide drums from T-1 to these vendors to assist development of additional treatment capacity for such wastes. When these vendors have demonstrated that their treatment process is successful to produce treated waste that can be disposed of at EOU, Kaiser-Hill will then invite these vendors to bid on treating all or portions of the T-1 and DU orphan waste.

This technical approach provides a good example of assisting existing treatment vendors to develop treatment capacity for orphan wastes. This requires DOE facilities to advise vendors of current needs and to provide relevant information and wastes for treatability studies or treatment demonstrations. The end result is disposal of this orphan waste at EOU within the next 12 months.

PROJECTS IN THE FUTURE

Organics With/Without PCB Containing High Rad

RFETS currently stores approximately 590 containers of low-level and low-level mixed TSCA regulated waste. These containers are regulated under TSCA due to the presence of PCB contamination at concentrations exceeding 50 ppm. Regulations require that PCB liquids at concentrations ≥50 ppm must be disposed of in an incinerator which complies with §761.70, except that PCB at concentrations ≥50 ppm and <500 ppm may be disposed of in a high efficiency boiler according to §761.71(b).

RFETS has 30 containers that require incineration or for which incineration is the preferred treatment method, but with activity or contaminant levels that exceed the acceptance limits for the available thermal treatment systems at the TSCAI or the mixed waste boiler at DSSI. One population consists of 19 containers of liquid organics with activity levels exceeding the limit of 246 pCi/g at TSCAI. The second population consists of 11 containers of non-debris PCB solids that have a beryllium concentration of 319 ppm, which is above the TSCAI limit of 8 ppm.

The proposed technical solution is to identify alternative treatment and disposal paths for these wastes. These alternative treatments include vacuum thermal desorption or chemical oxidation. These two options are at a mixed state of technical and regulatory readiness. Some are available at production scale and others have been demonstrated at bench or pilot scale, but have not yet been developed on a production scale. Similarly, these technologies are in varying states of regulatory readiness with some fully permitted and licensed, while others are not. These alternative treatment and disposal options have not yet been fully demonstrated on the waste matrices and the contaminants described above. Therefore, Kaiser-Hill will contract with the treatment vendors to perform treatability demonstrations of their alternative processes with these thirty containers. The scope of the contracts will be to complete these demonstrations, provide evidence of compliance with disposal site acceptance criteria, and ship the treated wastes for disposal.

Successful implementation of this strategy will result in assisting commercial facilities to demonstrate that orphan wastes consisting of PCB-contaminated, RCRA-regulated, radioactive solid and liquid wastes that cannot be accepted for treatment at the TSCAI or DSSI boiler can now be treated and disposed of. This is another example of RFETS nurturing commercial facilities to develop processes for proper disposition and disposal of DOE orphan wastes.

Additional Variances from LDR Standard

As discussed in a previous section, Kaiser-Hill has pursued using variances to develop a path forward for disposition of orphan wastes. This section provides two more examples of this method.

Some orphan wastes consist of mercuric compound chemicals and sludges with high concentrations of mercury. The technology-based treatment standard for these wastes is retort followed by amalgamation and disposal. Kaiser-Hill is working with EOU to develop a treatment variance for submittal to the State of Utah. Kaiser-Hill has provided EOU with analytical data packages for development of a stabilization recipe that results in an LDR compliant waste form that meets concentration-based standards. EOU will submit a treatment variance to allow use of this stabilization recipe.

Another orphan waste is beryllium powder with a RCRA P015 waste code. This waste is pure beryllium powder. The technology-based treatment standard for beryllium is recovery. The technical challenge for this waste is that there is no facility in the country that can accept radioactively contaminated beryllium for recovery. Kaiser-Hill is working with EOU to develop a treatment variance to allow for stabilization and disposal of this powder rather than recovery.

REFERENCES

1 J. J. FERRADA and BEN FOARD, "Demonstration of Perma-Fix Stabilization Process for the Treatment and Disposal of Uranium and Thorium Chips," ORNL/LR-2003, Oak Ridge National Laboratory (2003)