INEL-95/00549
CONF-960804--27

FACILITY STATUS AND PROGRESS OF THE INEL'S WERF MLLW AND LLW INCINERATOR

Dennis Conley
Idaho National Engineering Laboratory
Lockheed Idaho Technologies Company
P.O. Box 1625
Idaho Falls, Idaho 83415
(208) 526-4029

Shannon Corrigan
Idaho National Engineering Laboratory
Lockheed Idaho Technologies Company
P.O. Box 1625
Idaho Falls, Idaho 83415
(208) 526-7886

ABSTRACT

The Idaho National Engineering Laboratory's (INEL) Waste Experimental Reduction Facility (WERF) incinerator began processing beta/gamma-emitting low-level waste (LLW) in September 1984. A Resource Conservation and Recovery Act (RCRA) trial burn for the WERF incinerator was conducted in 1986, and in 1989 WERF began processing (hazardous and low-level radioactive) waste known as mixed low-level waste (MLLW). On February 14, 1991 WERF operations were suspended to improve operating procedures and configuration management. In December of 1993, the decision was made to include WERF operations with the site-wide Environmental Impact Statement, and with this announcement, the State of Idaho delayed the RCRA Part B Permit Application process until WERF resumed processing the MLLW.

On July 12, 1995, WERF initiated incineration of LLW; and on September 20, 1995 WERF resumed its primary mission of incinerating MLLW. MLLW incineration is proceeding under RCRA interim status. State of Idaho issuance of the Part B permit is one of the State's highest permitting priorities. The State of Idaho's Division of Environmental Quality is reviewing the permit application along with a revised trial burn plan that was also submitted with the application. The trial burn has been proposed to be performed in 1996 to demonstrate compliance with the current incinerator guidance.

This paper describes the experiences and problems associated with WERF's operations, incineration of MLLW, and the RCRA Part B Permit Application. Some of the challenges that have been overcome include waste characterization, waste repackaging, repackaged waste storage, and implementation of RCRA interim status requirements. A number of challenges remain. They include revision of the RCRA Part B Permit Application and the Trial Burn Plan in response to comments from the state permit application reviewers as well as facility and equipment upgrades required to meet RCRA Permitted Status.

I. INTRODUCTION

The Waste Experimental Reduction Facility (WERF) is located at the Idaho National Engineering Laboratory (INEL). It is a versatile mixed low-level and low-level radioactive waste treatment facility that has been in operation since August 1982. WERF's purpose is to treat, reduce the volume, and enhance the form of MLLW and LLW.

In addition, the WERF employs waste repackaging, stabilization, sizing, and compaction. The incinerator has been processing beta/gamma LLW and MLLW since September 1984. WERF incinerator operation is regulated by the State of Idaho, the Department of Energy, and other Federal agencies. The primary regulations governing incinerator operations include the RCRA and the Clean Air Act (CAA). The WERF has a State of Idaho Air Quality Permit To Construct which establishes limitations on incinerator emissions and operations, and identifies the required emissions monitoring. Mixed waste operations are primarily regulated by the RCRA.

Incineration achieves 200:1 or more volume reduction while detoxifying and homogenizing solid wastes into a form (ash) suitable for stabilization via solidification. Waste burned in the WERF incinerator consists primarily of wood, paper, cloth and plastics. Additional waste feed includes small quantities of solid and liquid combustible mixed and hazardous wastes, and aqueous mixed and hazardous wastes. Waste feed for the incinerator is typically supplied from the day-to-day operations of the nuclear facilities operated at the INEL. LLW feed comes prepackaged, in cardboard boxes no larger than 0.6 x 0.6 x 0.6 m (2 x 2 x 2 ft), from the waste generators in accordance with an approved Waste Acceptance Criteria. These cardboard boxes are transported to the WERF in cargo

containers. MLLW feed typically comes in various containers meeting the storage facility requirements, and must be repackaged to meet incinerator feed requirements.

The WERF incinerator is a Model 1000 TLE, dual chambered, controlled-air incinerator manufactured by Environmental Control Products of Charlotte, North Carolina. The incinerator has a thermal capacity of five MBtu/hr. Each chamber of the incinerator is cylindrical, 4.27 m (168 in.) long and 1.62 m (64 in.) in diameter, with a volume of 8.78 m^3 (310 ft^3). Both combustion chambers are equipped with auxiliary fuel-oil fired burners to preheat the system and maintain the temperatures that are required during waste processing operations. The typical operating temperature is 870 to 1150°C (1600 to 2100°F) in the primary chamber and 980 to 1150°C (1800 to 2100°F) in the secondary chamber.

After the minimum temperatures and all other operating conditions have been achieved, solid waste is gravity-fed to the primary chamber through the solid-waste feed chute. In the primary chamber, a substoichiometric environment is maintained by controlling the introduction of air through the underfire air ports, located in the hearth. By maintaining a substoichiometric environment in the primary chamber, volatile materials can be driven off in a controlled manner. As the volatile materials enter the secondary chamber, they pass through the flameport region where additional air is added to provide an excess air environment. The secondary chamber provides 2 seconds residence time at 1150°C (2100°F) at five MBtu/hr of heat release with 100% excess air.

Controlled-air incinerators are recognized as being one of the lowest for particulate emissions of current incinerator designs. Low gas velocities in the primary chamber and complete combustion in the secondary chamber result in low particulate carryover. Controlled-air incinerators have been very popular because the starved-air operation effectively limits particulate releases to below regulatory requirements without air pollution control equipment. Since most of the radioactivity associated with burning LLW is in the form of particulate, this feature is an effective method of controlling radioactive contamination. Contaminated soils and other inorganic wastes, which require mixing within the combustion chamber to enhance the heat and mass transfer, cannot be easily processed because of operational parameters and incinerator geometry. While large volumes of contaminated soils and other inorganic waste are not processed in the WERF incinerator, small volumes of these wastes may be taken on a case-by-case basis in specially modified "burn campaigns".

An ash ram, located on the primary chamber hearth, is used to push ash toward a discharge chute just before to introducing each new waste box. This reciprocating action gradually moves the ash down the length of the primary chamber and into the ash hopper for cooling and discharge.

The incinerator offgas system is a dry mechanical filtering system employing air mixing, a shell and tube heat exchanger for cooling, and a baghouse and High Efficiency Particulate Air (HEPA) filters to remove particulate matter. The baghouse employs fabric filter "bags" to capture particulate entrained in the offgas. Industry recognizes baghouses as the most efficient means of particle removal available, collecting more than 99% of all particulates greater than 0.5 microns in diameter. Following the baghouse is a stage of HEPA filters. The HEPA filters are capable of removing 99.97% of all particulate in the range of 0.1 to 0.3 microns in diameter. This degree of offgas cleanup maintains radioactive emissions at less than 2 µCi/yr.

Since starting operations in October of 1984, the WERF incinerator has logged approximately 11,900 hours without any major incidents or failures. Approximately 725,750 kg (1,600,000 lbs) of waste were incinerated during this time with an average waste volume reduction ratio of approximately 200:1. Of the 725,750 kg (1,600,000 lbs) burned approximately 30,850 kg (68,000 lbs) was MLLW. The incinerator is normally operated once a month, in 10-day campaigns of around-the-clock operation, to incinerate MLLW supplemented by LLW. Listed and characteristic MLLW streams are normally incinerated in separate burn campaigns to minimize the amount of listed waste ash generated.

II. INCINERATOR OPERATIONS

A typical incineration campaign begins with identification, characterization, and repackaging of the mixed waste to be incinerated. Repackaging is done according to a repackaging plan that is developed from the characterization data to maintain feed limit controls. When repackaging, is completed a burn plan is developed that ensures no feed limitations are exceeded during incineration. The repackaged waste is staged in the WERF waste storage building and is inspected daily to verify that the integrity of the waste has not been compromised. After completing waste preparation , the incinerator is brought up to a temperature of 870°C (1600°F) which takes approximately 16 hours. A controlled heat up of 16 hours is necessary to minimize the thermal stress on the incinerator refractory. The first waste fed to the incinerator is typically LLW for several hours to develop an ash pile that helps maintain steady temperatures in both the primary and secondary chambers. When the secondary chamber temperature is above 980°C (1800°F), mixed waste incineration is started. LLW is used to supplement MLLW feed as necessary to maintain the incinerator chamber temperatures. An ash heel burnout is performed as necessary to burn the volatiles in the ash pile by stopping waste feed and stirring the ash pile with the ash ram. This process is continued until the waste identified in the burn plan is completed. Then, the incinerator is cooled down for ash removal and refractory inspection. When the ash is below 50°C (120°F) it is sampled and analyzed for radioactive and hazardous constituents. The ash is then transferred to metal drums for stabilization or direct disposal.

Waste incineration began at WERF in 1984 and on February 14, 1991 operations were suspended to improve operating procedures and configuration management, and to upgrade some facility equipment. On July 12, 1995 after 1619 days; WERF started incinerating waste again. Throughout this extended down time and restart effort, a number of challenges were identified. Some of these challenges have been overcome while work continues on the remainder.

III. WASTE BACKLOG

During this extended upgrade period, a large backlog of both LLW and MLLW built up across the INEL in various storage areas. Approximately 26,800 kg (59,000 lbs) of MLLW and 190,500 kg (420,000 lbs) of LLW were stored or generated during the upgrade. Approximately 76,200 kg (168,000 lbs) of LLW were shipped to SEG in Oak Ridge, Tennessee for incineration to reduce the LLW backlog. The ash was compacted and returned to the INEL for disposal. The MLLW was stored in the Mixed Waste Storage Facility. This backlog was expected to require several years to complete considering past operating experience and current waste generation rates.

However, these projections were too conservative. Since restart, as of March 24, 1996, approximately 12,300 kg (27,000 lbs) of MLLW and 71,300 kg (157,235 lbs) of LLW has been incinerated. The LLW is used as supplemental feed during MLLW burns to maintain temperatures in the incinerator. After five buns, results indicate a volume reduction of approximately 300:1. This reduction indicates a significant increase over the average reduction ratio of 200:1 produced by incineration before the upgrades.

As of March 28, 1996; WERF has incinerated nearly 46% of the total waste backlog (MLLW and LLW) at the INEL has been incinerated. This includes 44% of the total MLLW backlog, which includes 59% of the characteristic MLLW and 24% of the listed MLLW. The MLLW backlog is expected to be incinerated by the end of 1996. Therefore, to continue the mission of the WERF, MLLW from other DOE laboratories/sites that meets the waste acceptance criteria is being accepted for processing.

IV. WASTE FEED TESTS

To determine if operating conditions of the incinerator are affected, WERF personnel performed several independent tests. These independent tests consisted of absorbing No. 2 diesel fuel, water, freon, and isopropyl alcohol on absorbent material in high density polyethylene (HDPE) bottles or on absorbent material directly in a conventional burn box. The amount of liquid absorbed was as follows:

- water - started with 100 mL and increased gradually to 6,000 mL
- No. 2 diesel fuel - started with 800 mL and increased to 8,400 mL
- isopropanol - started with 250 mL and increased to 14,000 mL in various poly bottles that were opened immediately prior to feeding
- FREON 113 - started with 250 mL and increased to 1,000 mL in HDPE bottles
- acetone - started with 250 mL and increased to 13,000 mL in HDPE bottles

These tests were performed to see if high or low flash point absorbed liquids caused unexpected temperature or pressure excursions. The quantities tested had no effect on incinerator operating conditions. FREON 113 quantities were limited to 1,000 mL because of the halogenated waste feed limitations. A total of 150 burn boxes, each containing 1,000 mL of FREON 113, were fed to the incinerator. The results of these tests will be used to determine the quantities and repackaging methods for MLLW, depending upon the flash point and vapor pressure of the waste. In addition these tests were performed to support a portion of the Trial Burn Plan of the WERF RCRA Part B Permit. This portion calls for the incineration of carbon tetrachloride and chlorobenzene to evaluate the destructive efficiency of the unit. Carbon tetrachloride is a known carcinogen; therefore, volatilizing it is undesirable. Chlorobenzene has a high vapor pressure and a low flash point of 29°C (84°F). Isopropanol is not listed as a hazardous substance.

However, it has a flash point of 12°C (54°F) and a vapor pressure between that of carbon tetrachloride and chlorobenzene.

V. LESSONS LEARNED

Throughout the upgrade and restart process many challenges were identified.

Repackaging - MLLW, that comes to the WERF for incineration, is normally packaged in metal drums and requires repackaging in burn boxes for incineration. This process was more involved than originally thought. Due to the limited availability of operations personnel and the facility, reprocessing has required careful scheduling to maintain the required repackaging rate for incineration. In addition, fire protection concerns have prevented repackaging of any materials with a flash point of less than 60°C (140°F). A new repackaging and sampling facility, that can handle all flammable materials, is being constructed but will not be available for approximately one year. In the mean time, several alternative temporary locations are being considered.

Characterization - Occasionally LLW, which is packaged by the generator, contains unacceptable items such as large metal objects or pressurized containers. These items are identified by the operator and the waste box is returned to the generator for proper characterization. A MLLW repackaging plan identifying how much waste is put into each burn box is based on waste generator characterization. Because WERF personnel repackage all mixed waste, any unacceptable items in the waste are identified and removed during repackaging. This ensures that waste fed to the incinerator complies with the Waste Acceptance Criteria.

Storage - A MLLW incineration campaign requires a large quantity of repackaged waste to be prepared before starting the burn. Therefore, repackaged waste must be stored until it is staged for incineration. This quantity of repackaged waste uses a large portion of the WERF mixed waste storage building and it must be located to allow required container inspections and aisle spacing. Fire protection concerns also limit the amount of combustible material that can be stored in the building. This could be a problem in the future if a large quantity of MLLW in original containers is stored in the building and a large quantity of repackaged waste needs to be stored for the next burn campaign. In hindsight, the mixed waste storage building could have been designed to provide for more waste storage.

Waste Transitioning - A challenge identified during the MLLW restart preparation was how to identify completion of a characteristic MLLW burn so that incineration of LLW could be used to complete a 10 day burn campaign. The benefit to identifying this transition point is to allow burning LLW after a MLLW campaign without cooling down the incinerator and starting a new burn campaign. This transition is accomplished by completing an ash heel burnout, which mixes and maintains the ash pile at a high temperature to ensure the hazardous constituents are no longer present in the ash. A listed MLLW campaign will normally include removing ash and cleaning out the incinerator before and after the listed waste burn campaign to minimize the volume of listed waste ash generated. However, approximately 272 kg (600 lbs) of ash or inert material must be placed in the incinerator ash hopper to protect the ash shredder knives.

VI. RCRA PART B PERMIT APPLICATION

When MLLW incineration was restarted, the RCRA Part B permit application process that was started in 1991 was reactivated. This process includes revision of the Part B permit application and resubmittal to the State of Idaho. Included in this application is the proposed Trial Burn Plan that identifies the details and schedule for the upcoming RCRA Trial Burn. The State RCRA personnel are currently reviewing the application and preparing the first Notice of Deficiency. When this notice is received, a number of resolutions will be required in a limited time frame and before the trial burn. These resolutions may include facility upgrades and additional descriptive information. Some of the facility upgrades required for RCRA permitted status that are currently underway are overhauling the existing CO and HCl monitors, adding oxygen monitoring for carbon monoxide correction to 7% oxygen, installing automatic waste feed cutoffs, and installing a data collection system.

VII. TRIAL BURN PLAN

A Trial Burn Plan for the second WERF trial burn was submitted to the State of Idaho in February 1996. Negotiations with the State are under way with the goal of completing a trial burn in 1996. The first trial burn, conducted in 1986, was successful for liquid waste, but problems with fugitive emissions resulted in an inconclusive demonstration of destruction and removal efficiency while processing solid waste. The second trial burn is designed to address these problems and demonstrate a higher solid feed rate.

Since the 1986 trial burn, the RCRA requirements for incinerators have changed. The objectives of the second trial burn will be to:

- Demonstrate compliance with the current EPA performance standards and the EPA Hazardous Waste Combustion Strategy,

- Obtain a highly flexible operating permit, and

- Obtain a single set of operating conditions for processing all waste.

Flexibility is important because the INEL generates and stores a wide variety of waste. Therefore, the WERF incinerator must have a permit that allows for the burning of a wide range of waste types. To simplify operations and compliance, the permits is also intended to establish a single set of operating limits (temperature, pressure, residence time, etc.) that apply to all permitted waste being incinerated.

The low and high temperature trial burns will demonstrate the processing of solid MLLW spiked with a combination of carbon tetrachloride and chlorobenzene absorbed on a shredded polypropylene absorbent in HDPE bottles. The waste will be fed batchwise in 0.5 x 0.5 x 0.5 m (20 x 20 x 20 in.) boxes. The solid MLLW fed during the high temperature burns will also contain a metal spike of cadmium and chromium.

The sequence of burns will be a low temperature burn, a high temperature burn, an ash heel burnout, and ash sampling. This cycle will be repeated three more times during the trial burn.

VIII. CONCLUSION

Incineration is the most effective treatment process performed at the WERF giving a volume reduction of approximately 300:1 and 80:1 after stabilization, if required. A RCRA permit application has been submitted to the State of Idaho and a second trial burn is expected to be performed in 1996. Through five years of effort accomplishing the restart of WERF incinerator operations, a number of challenges have been met and much experience has been gained. However, many tasks still remain to be accomplished in preparation for the trial burn. This effort will create new challenges to be met in the near future.

Work supported by the U.S. Department of Energy, Assistant Secretary for Environmental Management, under DOE Idaho Operations Office Contract DE-AC07-94ID13223.