# DEMONSTRATION OF THE VIABILITY TO SORT, INCINERATE, AND ASH TREAT Y-12 COMBUSTIBLE SOLID LOW-LEVEL WASTE*

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## ABSTRACT

The Waste Management Technology Center has completed a demonstration to evaluate incineration as a volume reduction option for the treatment of Y-12 combustible low-level waste. Y-12 currently produces approximately 450,000 $ft^3$/year (12,143 $m^3$/year) of this waste. This demonstration was the very first commercial burn of radioactive waste in the United States using a private sector contractor. The main constraint for the project was the very tight schedule. The project had to be organized, statement of work and sole source justification completed, contract awarded, vendor audited for qualification, and the waste sorted, analyzed, and delivered within a five-week period. If the schedule could not be met, the window of opportunity to perform the demonstration would be lost forever.

The project was successfully completed, and results from the demonstration show a greater than 300 to 1 or 99.7% volume reduction prior to ash treatment and a greater than 600 to 1 or 99.9% volume reduction after ash treatment, a 26-fold weight reduction, and 95+ wt % depleted uranium was retained in the ash. As an added benefit, this project met the objective of the Department of Energy's (DOE) privatization efforts under the DOE model. Upon completion of this demonstration, a full-scale procurement for treatment of this waste stream was initiated.

## INTRODUCTION

In recent years, the available space in DOE's radioactive disposal facilities has been shrinking and public opposition to the opening of new land disposal facilities has increased. These facts, coupled with the ever increasing large capital cost and scheduling time required to site such facilities, have made the need to develop and demonstrate viable technologies to reduce the volume of radioactive waste paramount. Such demonstrations develop the understanding of possible solutions to waste problems not only on the Oak Ridge Reservation but throughout the entire DOE system. One of the stated goals under the DOE Model is to use technologies developed and available from the private sector to solve waste management problems.

## PROBLEM

One of the major waste streams at DOE's plants in Oak Ridge is produced from the depleted uranium processing and handling operations at the Y-12 facility. These operations produce approximately 500,000 $ft^3$/year (14.2 $m^3$/year) of volume reducible waste (VRW), which is solid low-level waste. The VRW contains greater than 120 g and less than 50 kg of depleted uranium per 12 $yd^3$ (~9.2 $m^3$) dumpster as determined by the Y-12 Plant Trash Monitor, which employs three iodide detectors. This waste stream is approximately 90% combustible and 10% noncombustible and consists of plastic, cloth, wood, paper scrap, wipes, filters, respirator cartridges, scuffs, incidental metal, and construction debris contaminated primarily with low levels of depleted uranium. At the time of the demonstration, the majority of this waste stream was being baled through use of standard compaction equipment and then shipped to the K-25 Site for storage. The baling operation resulted in approximately a 7 to 1 volume reduction.

## PROJECT OBJECTIVE

DOE-Oak Ridge Operations (ORO) commissioned Martin Marietta Energy Systems (Energy Systems), the operating contractor for the DOE plants in Oak Ridge, to conduct a demonstration using a private sector vendor in order to obtain data to assess the viability of incineration as a volume reduction option for treatment of the Y-12 volume reducible solid low-level waste.

## PROJECT DISCUSSION

Currently, the only licensed commercial radioactive incinerator in the United States is owned and operated by Scientific Ecology Group, Inc. (SEG), a subsidiary of Westinghouse Electric Corporation, located in Oak Ridge, TN. At the initiation of this project in October 1989, SEG was in the process of starting up this facility. When in operation, the major wastes processed in the incinerator would be those produced by power plants and hospitals. The Power Plant medical type wastes typically contain mainly fission products. Because the Y-12 Plant VRW contains only

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depleted uranium, the Y-12 Plant did not want the possibility of cross contaminating the waste with fission products. Therefore, as a further constraint on the project, the waste had to be the first radioactive waste burned in the incinerator. This meant that Energy Systems would have to award a contract, audit the facility, sort, analyze, and ship the waste within a five-week period of time. After this time, SEG would be processing commercial waste and the opportunity to burn the Y-12 Plant VRW in a clean incinerator would be lost.

The project was initiated on October 2, 1989. The statement of work (SOW) and sole source justification was provided to Energy System's Purchasing Division on October 7, 1989. A request for proposal (RFP) was issued by Energy System's Purchasing to SEG on October 17, 1989 and a contract was awarded to SEG on November 1, 1989. Also, within this period of time, the project team audited the SEG facility. The SEG procedures were reviewed by Energy Systems personnel representing environmental, safety, industrial hygiene, and health physics disciplines to ensure that they met Energy Systems standards. Finally, a National Environmental Policy Act (NEPA) determination was conducted for the project.

Hand sorting of the waste by Y-12 personnel, supervised by SEG personnel, began on November 2, 1989. Sorting of the waste was necessary in order to meet the SEG waste acceptance criteria for the incinerator. The basic sorting criteria were:

1. no metal pieces greater than 5 x 5 x 3 in. (12.6 x 12.7 x 7.6-cm) thick (nails, buttons, and other small incidental metal pieces are acceptable);
2. no Resource Conservation and Recovery Act (RCRA), Toxic Substances Control Act (TSCA), or medical wastes;
3. no glass bottles, glass, cans, or liquids;
4. no non-combustibles; and
5. minimization of polyvinyl chloride (less than 5% of the total waste).

After sorting, the waste was packaged in plastic bags and taken to the box monitor, (plastic scintillation detector) for passive determination of the depleted uranium content. The waste was then loaded into sea/land containers provided by SEG for shipment to their facility. The waste shipped to SEG consisted of two sea/land containers with a volume of 4000 $ft^3$ (~113 $m^3$) and a net weight of 20,045 lb (~9092 kg). This waste contained 1,774 g of depleted uranium with an activity of 70 pCi/g. The final shipment of this waste was made on November 8, 1989.

When the waste arrived at the SEG facility, it was unloaded and placed in fire boxes that are used to transport the waste on a conveyer system to feed the incinerator. The boxed waste was then placed in storage. The incinerator was in the process of final checkout and a trial burn on nonradioactive material. The demonstration burn on the Y-12 VRW began on November 20, 1989 and took approximately 22 h to complete. The incineration system was manufactured by Envikraft of Denmark. The incinerator is a partial-pyrolysis type two chamber system with a capacity of 12 million Btu/h (~12.6 million J/h) or approximately 1000 lbs/h (454 kg/h) of waste. The primary chamber operates under reduced oxygen conditions at a temperature range of 1,300-1,650°F (704-899°C). The secondary chamber operates under excess oxygen conditions at a temperature range of 1,800-2,200°F (982-1204°C). The off-gas passes through a waste-heat recovery boiler followed by baghouse filters, high efficiency particulate air (HEPA) filters and a wet scrubber and exits the stack. Following incineration, the ash was collected, sampled, and analyzed for RCRA metals and radioactive isotopes.

## RESULTS

The resultant ash waste produced from the incinerator operation consisted of the following:

| | |
|---|---|
| 1. Incinerator Hearth Ash | weight = 744 lbs (337 kg)<br>volume = 9.5 $ft^3$ (0.269 $m^3$)<br>depleted uranium = 1.689 g |
| 2. Bag House (fly) Ash | weight = 13 lbs (5.9 kg)<br>volume = 3.5 $ft^3$ (0.99 $m^3$)<br>depleted uranium = 6 g |
| 3. Total Ash | weight = 757 lbs (343 kg)<br>volume = 13 $ft^3$ (0.368 $m^3$)<br>depleted uranium = 1,695 g |

Summary results of the incineration operations before any type of ash treatment were:

- volume reduction ratio, 308;
- volume reduction percent, 99.7%;
- weight reduction ratio, 26.6;
- weight percent ash, 3.8%; and
- uranium accountability percent, 95 + %.

The results from the RCRA metals testing of the hearth ash and the baghouse ash are shown in Table I.

The hearth ash passed the extraction procedure (EP)-Toxicity test and, therefore, no additional treatment was required. However, in order to further reduce the volume, the hearth ash was compacted in the SEG super compactor. Compaction of the hearth ash resulted in an additional four-fold volume reduction.

The baghouse ash failed the EP-toxicity test and therefore required stabilization in order to render the ash nonhazardous in compliance with the RCRA protocols. The ash was stabilized in cement using a 4:1 ratio of cement to waste. The resultant waste was tested again and passed the

**TABLE I**

EP-Toxicity (40CFR261) Testing of Hearth and Baghouse Ash

| Element | Standard (ppm) | Hearth (ppm) | Baghouse (ppm) |
|---|---|---|---|
| Arsenic | 5.0 | 0.005 | 0.012 |
| Barium | 100 | 0.61 | |
| Cadmium | 1.0 | 0.0077 | 130 |
| Chromium | 5.0 | 0.047 | |
| Selenium | 1.0 | | 0.022 |
| Lead | 5.0 | 0.083 | 18.0 |
| Mercury | 0.2 | 0.0002 | 0.0043 |
| Silver | 5.0 | | |

EP-toxicity test. The results from the RCRA metals testing of the baghouse ash after stabilization are shown in Table II.

**TABLE II**

Baghouse Ash in Cement EP-Toxicity (40CFR261)

| Element | Standard (ppm) | Result (ppm) |
|---|---|---|
| Arsenic | 5.0 | < 0.01 |
| Barium | 100 | < 0.10 |
| Cadmium | 1.0 | 0.025 |
| Chromium | 5.0 | < 0.01 |
| Selenium | 1.0 | < 0.01 |
| Lead | 5.0 | 0.01 |
| Mercury | 0.2 | < 0.0004 |
| Silver | 5.0 | < 0.01 |

Summary results after treatment of both the hearth and baghouse ash consisted of the following:

- volume reduction ratio, 680;
- volume reduction percent, 99.85%;
- weight reduction ratio, 24; and
- uranium accountability percent, 95 + %.*

## CONCLUSIONS

The large volume reduction achieved through incineration of the waste materials and subsequent compaction of the hearth ash and stabilization of the baghouse ash demonstrated that incineration is a viable method for volume reduction of this waste stream. The volume reduction ratio (greater than 600) achieved significantly reduces the need for large areas for temporary storage and final disposal. In addition, it was determined that the baghouse ash was a mixed waste. However, after stabilization, the baghouse ash was rendered nonhazardous.

Over 95% of the depleted uranium was recovered in the ash. Furthermore, this demonstration was performed with no detectable releases of radioactivity or hazardous components to the environment. Thus, incineration seems to be a viable alternative for reducing the volume of combustible low-level waste at the Y-12 facility.

* All content of the waste was based on passive non-destructive monitoring. Ash was analyzed by wet chemical analysis.