Coal Ash Usage in Environmental Restoration at the Hanford Site

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COAL ASH USAGE IN ENVIRONMENTAL RESTORATION AT THE HANFORD SITE

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1.0 Background

The Hanford Nuclear Reservation is situated in south-central Washington, in an area known as the Columbia Basin. Hanford spreads out over 560 square miles of desert, which has an average annual precipitation of less than 8 inches per year. There are three steam plants on the Hanford Site: one in the 300 Area (denoted as 304), one in the 200E Area (denoted as 284E), and one in the 200W Area (denoted as 284W). This paper concerns itself mainly with the 284E steam plant.

The 284E steam plant has been operational since 1945. Its original mission was to provide steam used to heat buildings, and process steam used by various chemical separations facilities. In February 1995, the 284W steam plant was decommissioned, and the 284E steam plant is now providing heating and process steam to both the 200E and 200W Areas. The future is uncertain for the 284E steam plant; some possible scenarios for the plant area: (1) continued operations with no changes, (2) refurbishing the existing boilers to increase efficiency, (3) closing the steam plant and replacing it with packaged boilers at the points of use, and (4) converting the existing coal-fired boilers to natural gas usage. However, none of these options has been finalized; a decision on the future of the 284E steam plant will be made within the next three to five years (Strege, 1995).

Meanwhile, the pile of ash from 284E steam production keeps growing. At the last estimate, there was more than 500,000 metric tonnes of mixed fly ash, boiler slag, and clinker stored next to the 284E steam plant. This ash was deregulated by the Environmental Protection Agency (EPA) in 1993; after nearly 15 years of study and debate, the EPA decided that fly ash, bottom ash, boiler slag, and clinker stored next to the 284E steam plant. This ash was deregulated by the Environmental Protection Agency (EPA) in 1993; after nearly 15 years of study and debate, the EPA decided that fly ash, bottom ash, boiler slag, and clinker stored next to the 284E steam plant. This ash was deregulated by the Environmental Protection Agency (EPA) in 1993; after nearly 15 years of study and debate, the EPA decided that fly ash, bottom ash, boiler slag, and clinker stored next to the 284E steam plant.

In 1991, a Toxicity Characteristic Leaching Procedure (TCLP) was performed on several samples of this ash (Hazen Research 1991). This procedure is designed to determine the mobility of organic and inorganic analytes present in liquid, solid, or multiphasic wastes (EPA 1994). The ash tested came from surge bins, conveyor samples, and bottom ash and fly ash from the boilers at 284E. Antimony, cadmium, germanium, molybdenum, silver, thallium, tungsten, and vanadium were tested for, but on all samples were below detection limits for the testing method. Analytes present in relatively high concentrations (but less than one part per thousand) included barium, boron, chromium, fluorine, and zinc. The size of ash particles passing through a Taylor sieve series was very evenly distributed from 1 to 200m.

In 1994, a Total Activity test was run on 0.3 m (1 ft) samples from 10 different boreholes in the ash pile. One of the most frequently expressed concerns by potential ash users was whether the ash would contain radioactive species. Ten holes were bored in the ash pile, and split-spoon samples were taken every foot of depth in each hole. The results of this testing showed that the radiation levels in the ash pile were less than 50 picocuries, which is the level of normal background radiation in the Columbia Basin. Therefore, the ash pile does not contain radioactive species.

4.0 Potential Uses for Ash

There are several potential uses for the 284E steam plant ash. These uses can be divided into two major categories: (1) large-scale uses, including on-site usage as codisposal wastewater treatment or tank stabilization material, and off-site usage as a fuel source for energy recovery, as pipe or foundation backfill, or as an ornamental brick additive; and (2) small-scale uses, such as...
Another large-scale use for the 284E ash is in control prior to placement of the landfill cap.

Subsidence. Rather than buying this dirt for projects, one of the uses was successfully in engineering-scale demonstrations of wasterock is the 284E ash. The results from the unconfined compressive strength testing of ash-containing wasterock samples show an average strength of around 11.7 MPa (1700 psi) at 7 days, increasing to an average strength of 34.5 MPa (5000 psi) at 100 days. These results meet or exceed American Society of Testing and Materials (ASTM) standards for materials used in landfills for stabilization materials. The ash-containing wasterock samples also have surpassed Nuclear Regulatory Commission (NRC) testing requirements for the disposal of radioactive wastes. Codisposal technology was used in an engineering-scale demonstration in January 1995 at the 100K East Reactor Complex at the Hanford Site. The wasterock used in this demonstration included uranium fuel elements, uranium oxide metal, and the 284E ash, as well as Type I/II portland cement and a superplasticizer additive. Codisposal technology has the potential for cost savings of hundreds of millions of dollars for the DOE Complex, through both increasing waste loading in landfills and burial box and caisson stabilization. Because of this potential and the successful engineering-scale demonstration of the technology, it is expected that codisposal will be pursued in the future.

The 284E ash could also be used as a stabilization material in landfills and in waste tanks, for subsidence control. There are 177 single-shell and double-shell radioactive waste tanks on the Hanford Site. While a final decision on the fate of the liquid waste in these tanks is pending, it is apparent that some action will have to be taken - either removing the liquid from the tanks and treating it, or solidifying the waste in situ. If the waste is removed from the tanks, some sort of stabilization fill will have to be added to prevent catastrophic collapse of the empty tanks. An ideal source of tank fill material would be the 284E ash. If the waste is solidified in situ, a technology similar to codisposal could be used to provide a solidification material; the solidification agent could include 284E ash. Eight RCRA burial grounds for low-level radioactive waste (LLW) and one trench for mixed LLW are currently in use on the Hanford Site. At the present time, waste packages (such as barrels, boxes, etc.) are placed in the landfills, and "clean" (uncontaminated) dirt is used to fill around the packages to prevent subsidence. Rather than buying this dirt for backfill, 284E ash could be used as subsidence control prior to placement of the landfill cap. This ash could be used in a similar fashion for pipe or foundation backfill in new construction projects.

Another large-scale use for the 284E ash is in returning to reclaim some of the residual carbon content of the ash. A large percentage of the ash coming from the steam plant is uncombusted coal. If this ash were pelletized and then repiped into the boilers, energy could be reclaimed from this source. This is not the only advantage to this use; the cost savings from this operation is great. The price for uncombusted coal is approximately $70 per ton, and the price of disposal for the mixed fly and bottom ash is around $50 per cubic meter. Accounting for operational processing and waste handling costs and density variation, the cost savings for the reburning of uncombusted coal is estimated at $35 per ton of equivalent coal. In other words, the cost savings is roughly 67% of the original cost for coal. This estimate does not take into account the additional cost savings which would result from a reduction in additional landfill space to house this uncombusted coal. This option involves the purchase of a pelletizer (a cost of around $30K) and the use of support operations. Therefore, a company in search of an inexpensive source of fuel may be willing to take advantage of this opportunity.

The final large-scale usage of this ash is in ornamental brickmaking, a project which will team a major Hanford contractor with a community business. Work has been explored to team Westinghouse Hanford Site Utilities (who would supply the ash), the U.S. Department of Energy (who would supply the brickmaking equipment), and a community business (who would supply the labor and sales). The crackmaking equipment has been successfully demonstrated, and is capable of producing 4,000 bricks in an eight-hour shift. The bricks can be formed to various specifications, including interlocking bricks which require little or no mortar. If this project was pursued, it would be a lucrative venture for both the Hanford Site (in terms of getting rid of the ash and in improved public relations) and for the community business (for a source of inexpensive materials and new jobs for the surrounding area). However, this project is on hold for two reasons: (1) disposal of the ash is not a Tri-Party Agreement milestone, and (2) funding has been cut for all projects not directly related to radioactive and hazardous waste disposal.

There are several small-scale (limited volume) uses for this ash. One small-scale use for this ash is as aquarium rock. As an in the recombustion alternative, the ash would be pelletized, painted with non-toxic paint, and sold in bags to aquarium owners for use in the bottom of their tanks. This use might seem frivolous, until one considers that such rock can be sold for between $1 and $2 per pound. Another limited volume venture might be for use in jewelry. After the Mount St. Helens eruption in 1981, ash from the volcano was made into jewelry and sold as a commemorative novelty. Because the Hanford Site turned 50 years old last year, jewelry made from ash which comes from one of the oldest buildings on site may also sell as a novelty item. The final small-scale use for this ash is as oysterbed stabilizer material. As with many other forms of marine life, oysters' natural habitat has, in many cases, been destroyed by pollution. Cultured oysters are becoming more and more common. As demand for man-made oysterbeds
grows, the market for materials such as the 284E ash will increase. Enough small-scale usage will provide a home for the enormous amount of waste ash produced.

5.0 Government Excess Process

The process of bringing materials to the public involves several steps, and is known as the "excess" process. The first step in the excess process is verifying that the material is free from un-natural contamination. In an area such as the Hanford Site, this is especially important. Both the TCLP test and the total radiation count were performed on the ash to make sure that potential users of the ash were not accepting material containing radioactive species or hazardous chemicals.

The second step in excessing material such as the 284E ash is filling out a Declaration of Excess form, in which the type of material, amount of material, and other descriptors is contained. It also includes permission from the caretaker of the property to offer the material for sale. Depending on how eager the caretaker is to be rid of the material, this step of the process can take up to two weeks to complete.

An "Expressions of Interest" advertisement is then placed in the Commerce Business Daily, a government publication which lists information about potential projects and materials which are up for public bid. This advertisement is used to gauge interest in the purchase of material and to establish a mailing list for further information; it is not a formal bid.

If enough interested parties respond to this advertisement to warrant further action, then an "Information for Bid" advertisement is placed. This gives an exact description of the material being excessed, and also lists requirements for transporting the material offsite. Such requirements include an agreement to abide by site safety, training, and badging requirements; this ensures safety and environmental compliance by the buyer while he is on-site.

The bid is awarded to the highest bidder. Then the ash must be transported off-site. This portion of the process requires the badging and site-specific training of all individuals who transport the ash.

6.0 Waste Avoidance

Of course, the simplest method to remedy the problem of having so much waste in the first place would be a steam plant design which involves segregation of the ash into separate streams: fly ash and "other" ash. If the fly ash can be produced to Class C or Class F specifications, it may be used in concrete for load-bearing applications. Such applications include the construction of buildings and roads. The "other" ash may be used in any of the applications discussed above.

Also, identifying the needs of potential markets prior to generating the ash will enable a smoother transition between the "waste" stream and the reuse arena.

7.0 References


