INTEGRATED MANAGEMENT OF LIQUID EFFLUENTS AT THE HANFORD SITE

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ABSTRACT

This poster session illustrates the integrated approach that the Hanford Site has taken in managing high-priority liquid effluent streams. These waste waters are produced from a variety of process- and utility-related sources. The Hanford Site approach to management of liquid effluents focusses on eliminating the source, reusing where possible, and treating and disposing of the water that cannot be eliminated or recycled prior to disposal.

Thirteen of the high-priority waste water streams have been or will be eliminated by the end of 1995. Some of these streams have been eliminated as the result of shutting down the associated operation. However, the elimination of other streams has been the result of process modifications, equipment substitutions, or recycling.

Several of the waste water streams will receive treatment at the individual generating facility before being discharged into a new industrial sewer (the 200 Area Treated Effluent Disposal Facility). The industrial sewer will collect treated streams from various plants in the 200 Areas and dispose of the clean effluent at two uncontaminated new 20,235-square meter (5-acre) ponds permitted by Washington State.

Finally, condensate from the 200 Areas tank waste evaporator and waste water from operations in the 300 Area will be treated at two end-of-the-pipe treatment facilities. The 200 Area Effluent Treatment Facility will treat condensate (a *Resource Conservation and Recovery Act of 1976* (1)-listed waste) from the tank waste evaporator, thereby allowing the waste to be delisted prior to disposal. The treated effluent will be pumped to a state-approved land disposal site selected to maximize the migration time to the river. This disposal site allows for the decay of tritium, which will be present in the condensate but cannot be removed using current technologies.

The 300 Area Treated Effluent Disposal Facility will treat laboratory waste water, effluent from power house operations, and various other smaller streams. The treated effluent will be disposed of to the river using a National Pollutant Discharge Elimination System-permitted outfall.

BACKGROUND

The Hanford Site, located in south-central Washington State, covers approximately 1,450 square kilometers (560 square miles) of semi-arid land that is owned by the U.S. Government and managed by the U.S. Department of Energy (DOE). In 1943, the Hanford Site was selected for nuclear reactors, chemical separations, and other activities related to the production and purification of special nuclear materials. Today, the mission of the Hanford Site is environmental remediation and restoration. This poster session illustrates the integrated approach that the Hanford Site has taken in managing high-priority liquid effluent streams.

Production activities at the Hanford Site occurred in four main areas, the 100, 200, 300, and 400 Areas. These activities included: nuclear fuel fabrication in the 300 Area, irradiation of nuclear fuel elements in nine reactors in the 100 Areas, chemical separation of plutonium from uranium and attendant fission products, and manufacture of metallic plutonium in the 200 Areas, and an experimental breeder reactor in the 400 Area. Additional facilities provided research, process and reactor development, maintenance support, and steam and water to the Hanford Site. Most of the facilities onsite were constructed between 1943 and mid-1970.

Historically, operating facilities on the Hanford Site discharged large quantities of liquid effluent directly to the soil column. While most of the effluent streams were the result of one-pass heating or cooling of the buildings or processes and are therefore essentially clean water, some effluent streams contained chemical and radiological contaminants. Soil column disposal was chosen because the soil characteristics, groundwater travel times, and remote location of the Hanford Site were well suited to isolate the radioactive or chemical contamination that might be present in the discharges.

In 1986, the DOE committed to Congress that DOE facilities would eliminate the untreated discharge of radioactive liquid to the soil column by 1995. Subsequently in 1989, the DOE, the U.S. Environmental Protection Agency, and the Washington State Department of Ecology entered into a formal compliance agreement governing planned actions for major effluent stream discharges (2). The agreement required implementation of Best Available Technology (BAT) for treatment of the waste water. In addition, it was agreed to permit the liquid effluent discharges under Washington State Department of Ecology regulations for disposal of waste water discharges to the soil column. These agreements were formally agreed to in a compliance order that specified specific time tables for completion of the required upgrades. Based on these agreements, the DOE and Westinghouse Hanford Company are designing and constructing liquid effluent treatment facilities for the Hanford Site. These facilities are expected to begin operation in 1994, and 1995, with additional facilities coming online through 1997.

EFFLUENT DESCRIPTION

To support the compliance agreement requirements and long-term plans to remediate and stabilize the Hanford Site, the Liquid Waste Disposal Program is focused on eliminating untreated and unpermitted discharges of major liquid effluent streams to the soil column. These streams, which were identified when the original program scope was developed in March 1987, account for the highest concentrations of radionuclides

and contaminants being discharged to the soil column. Additional liquid effluent management and permitting activities of minor streams will continue to be developed as the Hanford Site moves toward final identification of future land uses.

Liquid effluent discharges are generated by facilities supporting restoration and remediation of the Hanford Site. In addition, older facilities that are no longer operational and have not been decontaminated and decommissioned, continue to produce contaminated liquid effluents. These facilities continue to require heating, cooling, and ventilation to maintain mandatory control of radiological, hazardous, and mixed materials present in the facilities preventing release to the environment.

Sources of typical liquid discharges include the following:

- Process equipment heating systems that use steam to achieve and maintain appropriate temperatures in process vessels for waste concentration and stabilization as well as facility support systems for freeze protection
- Cooling water systems that maintain facility and equipment operations within acceptable safety margins. Typically, cooling waters are generated at the Hanford Site by process equipment used to concentrate waste streams; cooling self-heating radioactive waste and spent nuclear fuels; and facility support equipment, such as air compressors
- Heating, ventilation, and air conditioning systems that maintain building temperature control and prevent the spread of contamination by maintaining negative building pressures in contaminated regions. These heating, ventilation, and air conditioning systems generate steam condensates, evaporative cooler blowdowns, and chiller system condensates. In addition, steam-powered backup ventilation system equipment is maintained to prevent loss of staged negative pressure gradients within the process areas in the event of a power failure
- Laboratory wash waters from sinks, drains, and other miscellaneous equipment
- Tank waste evaporator condensate resulting from the management and stabilization of radioactive waste stored in waste tanks at the Hanford Site
- Air monitoring systems that use water-sealed and water-cooled vacuum pumps to collect samples of air for radionuclide analysis to monitor facility air quality
- Miscellaneous waste water streams that are produced by Hanford Site utilities associated with the production of steam as well as raw and potable water. These waste waters or liquid effluents include boiler blowdowns, water reservoir overflows, demineralizer system spent regenerant, and filter backwashes
- Potentially contaminated storm water runoff that is generated by a limited number of facilities where releases of radioactive material have occurred in the past.

DETERMINATION OF BEST AVAILABLE TECHNOLOGY

Elimination of untreated discharges of liquid effluent streams to the soil column at the Hanford Site required implementation of BAT to satisfy Washington State Department of Ecology regulatory requirements. A guidance document (3), which documented an evaluation process based on applicable regulations and regulatory guidance used to select BAT for treatment and discharge of waste waters to the environment, was developed by the DOE and subsequently agreed to by the Washington State Department of Ecology. This document provided step-by-step instructions to evaluate and select BAT for waste waters currently discharged on the Hanford Site. This guidance document now serves as the basis for all Hanford Site evaluations of this type.

The guidance document evaluation approach employs the following five-step hierarchical approach for establishing BAT.

- Waste water characterization is established by assembling existing data and if needed, collecting additional data to characterize the waste stream.
- Applicable effluent guidelines are identified to determine if existing federal or state regulations define BAT. If a determination is not possible from the effluent guidelines method, the evaluation proceeds to the technology transfer method.
- Technology transfer is evaluated by examining existing full-scale technology applications currently treating waste water similar to the subject waste water. In the event that BAT cannot be determined by this method, the treatability study evaluation method is undertaken.
- The treatability study evaluation method identifies technologies where studies performed on similar waste provided a sufficient basis for selecting the technology. Treatability studies may also demonstrate that technologies identified in the technology transfer BAT evaluation step are applicable. Should the treatability study method fail to identify BAT, the generic treatment systems method is to be used.
- The generic treatment systems method involves developing and comparing generic source control and end-of-pipe treatment alternatives. Source controls include changes in administrative controls, equipment, and process technology, which eliminate or reduce waste stream discharges and/or constituent concentrations without treating the waste stream.

IMPLEMENTATION OF BEST AVAILABLE TECHNOLOGY

Selection of BAT for many of the facilities has resulted in the identification of source controls that eliminated the effluent. Thirteen of the high-priority liquid effluent streams were eliminated. Additional waste stream source controls reduced discharges substantially upon implementation. Where source controls were not determined to be BAT, treatment systems were specified. Finally, it was decided that two large end-of-pipe treatment systems were needed. The following sections present a general description of these source controls and treatment systems.

Typical source control alternatives included equipment substitutions, process changes, decontamination, and installation of treatment systems. Examples of source controls and treatment systems that are being installed include the following:

- Replacement of single-pass cooling systems with closed loop cooling systems
- Substitution of vacuum pumps that require seal water with vacuum pumps that do not use seal water
- Clarification of water treatment plant filter backwash with recycle of the resulting overflow and dewatering of the sludge in drying beds
- Installation of vapor demister equipment on waste concentrator process condensate discharge systems
- Segregation of potentially noncompliant waste streams to retention tanks for verification sampling and batch release after verifying compliance with permitted discharge limits
- Treatment of waste water for radionulide removal.

Waste water streams generated by the above mentioned treatment processes will be collected from the facilities by a new industrial sewer (the 200 Area Treated Effluent Disposal Facility). The industrial sewer will collect the treated streams from various plants in the 200 Areas and dispose of the clean effluent at two new 20,235-square meter (5-acre) ponds permitted by Washington State.

END-OF-PIPE TREATMENT SYSTEMS

The two large end-of-pipe treatment systems selected as BAT include the 200 Area Effluent Treatment Facility and the 300 Area Treated Effluent Disposal Facility.

The 200 Area Effluent Treatment Facility will receive the process condensate waste stream from an evaporator, which is used to concentrate double-shell tank waste. The process condensate has been identified as a *Resource Conservation and Recovery Act* -listed waste and will be delisted through the treatment process with disposal to the soil column. The facility is designed to process 568 liters (150 gallons) per minute.

The 200 Area Effluent Treatment Facility will provide suspended solids removal through filtration, organic destruction using ultraviolet oxidation enhanced by the addition of hydrogen peroxide, total dissolved solids removal via reverse osmosis, and removal of residual ammonia, metal ions, and radionuclides using an ion exchange polishing step.

The treated effluent will be pumped to a state-approved land disposal site selected to maximize the migration time to the river. This disposal site allows for the decay of tritium, which cannot be removed by current technologies. The secondary waste streams produced by the reverse osmosis and ion-exchange regeneration steps will then be concentrated in a mechanical evaporator and dewatered in a thin film dryer. The resulting radioactive mixed waste will be drummed and sent to interim storage for future treatment.

The 200 Area Effluent Treatment Facility is currently under construction, with completion expected in June 1994 and facility operation to begin in June 1995.

The second large treatment process is the 300 Area Treated Effluent Disposal Facility. This facility will provide collection, treatment, and disposal for laboratory waste waters, boiler blowdown, steam condensate, spent softener regenerant, and heating, ventilation, and air conditioning condensate generated in the 300 Area. The facility is designed to treat 757 to 1,136 liters (200 to 300 gallons) per minute using BAT.

The treatment facility will provide suspended solids removal through clarification and filtration followed by mercury removal using ion exchange and organic destruction via ultraviolet oxidation coupled with hydrogen peroxide addition. The treated waste water will be discharged to the river under a National Pollutant Discharge Elimination System permit. Secondary waste produced by the treatment process will be dewatered using a filter press prior to disposal onsite.

The 300 Area Treated Effluent Disposal Facility is also under construction and expected to be completed in June 1994. Facility operations are scheduled to begin in December 1994.

REFERENCE

1. *Resource Conservation and Recovery Act of 1976*, 42 USC 6901, et seq.

2. *Clean Air Act of 1977*, 33 USC et seq.

3. *Hanford Federal Facility Agreement and Consent Order*, 1992, 2 volumes, Washington State Department of Ecology, U.S. Environmental Protection Agency, and U. S. Department of Energy, Olympia, Washington.

4. Westinghouse Hanford Company, 1988, *Best Available Technology (Economically Achievable) Guidance Document for the Hanford Site*, WHC-EP-0137, Westinghouse Hanford Company, Richland, Washington.