BEST AVAILABLE TECHNOLOGY (ECONOMICALLY ACHIEVABLE) GUIDANCE DOCUMENT FOR THE HANFORD SITE

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ABSTRACT

The "Best Available Technology (economically achievable) Guidance Document for the Hanford Site" was written to provide the Westinghouse Hanford Company (Westinghouse Hanford) and the U.S. Department of Energy-Richland Operations Office (DOE-RL) with a step-by-step procedure for the identification and documentation of Best Available Technology (BAT) (economically achievable). Although the document was written to be applied for discharges traditionally regulated under the Clean Water Act (CWA), the determination procedure has been modified for application to effluent regulated under the Resource Conservation and Recovery Act (RCRA) (1). Determination of BAT on a liquid effluent is to occur only after the effluent has met all applicable release limits. As a result, the application of BAT may involve an additional level of control, as well as contribute to the overall Hanford Site as low as reasonably achievable (ALARA) program.

INTRODUCTION

The U.S. Department of Energy (DOE) has established requirements for disposal of liquid effluents on the Hanford Site and requires compliance with applicable U.S. Environmental Protection Agency (EPA) and Washington State regulations. Although current liquid effluent disposal practices at the Hanford Site are conducted in accordance with DOE requirements, continued use of the soil column for disposal of liquid effluents and protection of surface groundwaters is of concern to the DOE. It is the DOE policy to replace the use of soil column disposal practices for contaminated liquid effluents with alternative effluent treatment and disposal methods (2).

In the DOE strategy to replace the use of the soil column for the disposal of contaminated effluents, a key element is the determination of BAT. This paper will describe a step-by-step procedure that was developed by the Westinghouse Hanford and the DOE-RL for selecting and documenting BAT for the treatment of contaminated liquid effluents. Although the document was written to be applied for discharges traditionally regulated under the CWA, the determination procedure has been modified for application to effluents regulated under the RCRA.

Regulatory Concepts under the Clean Water Act

Under the CWA, the U.S. Congress established the National Pollution Discharge Elimination System (NPDES) Program. This program requires that BAT be applied to control toxic pollutants in effluents before discharge to navigable waters. The BAT is an aggressive level of treatment, but is still limited by the requirement of economic achievability. The CWA and NPDES Program do not regulate nor authorize regulation of the discharge of source, special nuclear, or by-product materials covered by the Atomic Energy Act (AEA), nor do they govern discharges other than discharges to navigable waters.

The NPDES Program has been implemented by the EPA in states with approved NPDES Programs for major industrial categories through rulemakings that have set binding liquid effluent limits for discharges to navigable waters. These technology-based limits are based on detailed studies of industrial effluents and control technologies to determine applicable control approaches and achievable contaminant concentrations in liquid effluents. Presently no federal or state industrial category liquid effluent limits exist that are applicable to the Hanford Site liquid effluents, which are discharged to the soil column. However, the BAT determination process presented is based upon concepts used in the NPDES Program.

Regulatory Concepts under the Resource Conservation and Recovery Act

The Hazardous and Solid Waste Amendments (HSWA) were promulgated in 1984 and directly affected the RCRA and the hazardous waste regulatory program. Included within these amendments was the prohibition of land disposal of untreated hazardous wastes. As a result, the EPA developed a phased statutory program based upon the intrinsic hazard and volume of the waste. The first of the phased program applied to solvent and dioxin wastes and became effective November 8, 1986. The next phase, which applied to "California List" wastes became effective in July 1987. The remaining hazardous wastes were divided into three parts and addressed one part at a time. The schedule for evaluating the "First Third," "Second Third," and "Third Third" wastes is August 8, 1988, June 8, 1989, and May 8, 1990, respectively. Because the federal land disposal restrictions were enacted under the HSWA, they are enforceable on the Hanford Site.

When the U.S. Congress implemented the land disposal prohibitions, it also established a requirement that EPA must issue regulations that specify the methods of treatment, if any, that substantially reduce the toxicity and the likelihood of migration of the wastes from land disposal facilities.

The development of treatment standards through land disposal restricted wastes was achieved by the EPA through

assessing best demonstrated available technologies (BDAT) for each waste. Constituent concentration limits established by BDAT were then compared to risk-based standards. If BDAT levels were equal to or lower than risk-based levels, the EPA issued the treatment standard based on the risk-based levels. If application of BDAT resulted in levels above the risk-based standards, but the technology would substantially reduce the mobility and toxicity of the waste, then the EPA issued treatment standards based on BDAT. In this latter instance, the risk-based standard would remain an EPA goal that could be achieved by development of new technologies. Hazardous wastes that are treated in accordance with these methods are to be exempted from the land disposal restrictions.

PROCEDURE FOR DETERMINING BEST AVAILABLE TECHNOLOGY

The decision tree for the BAT selection procedure is shown in Fig. 1. The procedure involves a five-step approach to a BAT determination for a particular liquid effluent stream. The steps in this hierarchical approach are as follows:

- Assemble all relevant liquid effluent data
- Identify BAT by the effluent guidelines method
- In the absence of relevant effluent guidelines, determine BAT by the technology transfer method
- In the absence of technology transfer, determine BAT through the treatability studies method
- If treatability studies are not adequate to establish BAT, use the generic treatment system method to identify a range of potentially applicable and acceptable treatment systems.

As part of each BAT determination step, an assessment is made of the economic achievability of the control technology.

Assemble and Assess Liquid Effluent Data

The first step in applying the BAT guidance procedure is to identify and quantify the radioactive and nonradioactive requirements and identify practical treatment technology.

The characterization of liquid effluent volume is as important as the radiological and nonradiological characterization of the liquid effluent quality because the size of the treatment system is flow dependent. The use of water recycle, reuse, cascading, or zero discharge can reduce significantly the volume of an effluent stream. Another important factor is flow equalization, which directly affects the operability and pollutant removal efficiency of the selected treatment system.

Liquid Effluent Guidelines Method

Liquid effluent guidelines have been established for several source categories under the CWA and the RCRA. These categories and additional effluent guidelines to be considered when determining BAT under the liquid effluent guidelines method are summarized below:

- Technology-based limits establish the BAT for industrial source categories regulated under the CWA. Where matches between processes which correspond to subactivities regulated under existing industrial source effluent guidelines can be made, the discharge limits set are strong candidates for consideration in establishing BAT.
- Radiation protection standards established by the DOE, EPA, and U.S. Nuclear Regulatory Commission (NRC) for offsite or uncontrolled areas may be considered analogous to water quality standards within the NPDES Program. These standards set upper bounds on the acceptable consequences of a discharge, with these bounds expressed in terms of health risk, rather than effluent concentrations, and must be considered when determining BAT under the effluent guidelines method.
- The EPA developed three hazardous waste lists: (1) hazardous wastes from nonspecific sources, (2) hazardous wastes from specific sources, and (3) discarded commercial chemical product. Operations that result in producing an effluent stream that matches the first two lists automatically is designated as a hazardous listed waste. Treatment technology standards that have been established under the land disposal restrictions for effluent streams that contain listed wastes establish BAT.

Technology Transfer Method

The BAT determination by the technology transfer method involves a comparison of BAT effluent treatment systems used on similar effluent streams to a chosen effluent stream. It entails the assembly of data on potentially comparable treatment systems, followed by a determination of comparability. If the selected effluent is comparable, it is likely that similar control technologies may be used and established effluent limitations may be adapted. Significant differences in pollutants, concentrations, flow, or flow variability may indicate that technology transfer is inappropriate from an engineering standpoint. In determining whether technology transfer is feasible and in adjusting effluent limitations, the following factors must be considered: source of the effluent, compositional differences,

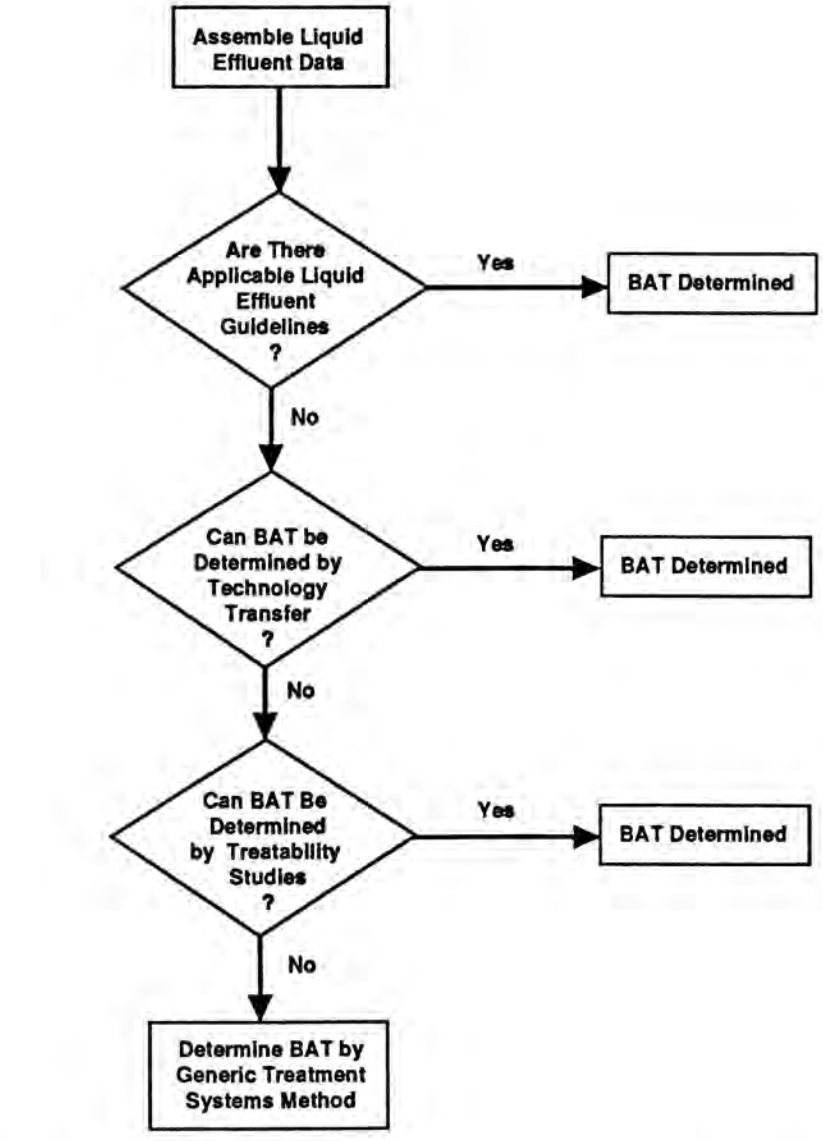

Fig. 1. Best Available Technology Guidance Procedure.

performance data resulting from the treatment of identical pollutants, and system reliability.

Treatability Studies Method

If effluent guidelines do not exist and technology transfer is not feasible, the treatability studies method can be used to identify BAT. Treatability studies may suggest several control options that could be BAT, based on technical applicability. This method of BAT should be used when one treatment technology or treatment system is well established on existing effluent streams. Assembling the information and screening the technologies for the BAT determination process is similar to the technology transfer method as described above. Through an industry-wide review of control approach practices, it may be possible to identify a level of control that is acceptable as BAT. This will be possible if one of the following two conditions are met:

- A level of treated effluent quality has been accepted for discharge by regulatory agencies
- Current control practices establish a pattern of control efficiency (i.e., percentage removal) or treatment intensity (i.e., number and type of treatment steps).

Generic Treatment System Method

The generic treatment system method for determining BAT provides a procedure that can be used to select control alternatives when there is little or no relevant data available on controls for similar effluent streams. The method examines alternative treatment systems where additional control steps are implemented progressively as required by site-specific conditions. Applicable generic treatment systems may consist of the following:

- Source controls (applicable only for effluents regulated under the CWA)
- Source controls, pretreatment, and suspended solids removal technology
- Source controls, pretreatment, suspended solids removal, and a one-step dissolved solids removal technology
- Source controls, pretreatment, suspended solids removal, and a two-step dissolved solids removal technology.

Economic Achievability Analysis

There are two methods that have been patterned after tests applied by the EPA for determining the economic achievability of a project: the "cost ratio method" and the "cost-effectiveness method."

- Cost Ratio Method

The proposed cost ratio method is a surrogate for a revenue ratio test described in EPA guidance documents (3,4). A revenue ratio test *cannot be directly* applied at the Hanford Site because government facilities do not have actual facilities.

The application of this method requires calculating the annualized cost of the liquid effluent treatment system and the annualized total cost of the waste generating facility. Annualized values are the sum of the net present value of the facility and the facility operating expenses, averaged over the remaining life of the facility. In the simple case of an initial capital investment and annual operating and maintenance (O&M) costs, the annualized costs are equivalent to the annual payment that would be needed to service and retire a loan (of the capital cost) over the life of the facility plus annual O&M costs. Care must be taken in calculating annualized values to ensure they are representative of future conditions.

- Cost-Effectiveness Method

The EPA assesses the cost effectiveness of many effluent guidelines by comparing the incremental removal of toxic pollutants to the incremental cost of controls. To allow comparisons of various pollutants, the EPA has developed equivalency factors.

Weights for toxic contaminants begin with human health and water quality criteria as developed by the EPA. Human health criteria are based on the ingestion of 6.5 g/day of fish taken from water contaminated by the effluent. Chronic ambient water quality criteria are based on the 4-day maximum allowable concentration. Most pollutants have a reference criteria for at least one of the two, and often for both the human and the water quality criteria.

A specified reference value based on the criteria for copper is divided by the specific water quality criteria values. If both human health and water quality criteria are present, these quotients are added. The resulting value is the estimated "toxic weight" which corresponds to the incremental cost of liquid effluent treatment control options by the incremental pound equivalent of pollutants removed. The EPA has not developed toxic weights for radionuclides. However, toxic weights developed for radionuclides may be calculated based on federal and state regulations with the as-

sumption that these limits are equivalent to EPA aquatic toxicity standards (5).

BEST AVAILABLE TECHNOLOGY FOR LIQUID EFFLUENT STREAMS ON THE HANFORD SITE

Effluent streams discharging to the soil column on the Hanford Site have been divided into six categories: (1) N Reactor effluents, (2) laboratory and chemical sewers, (3) process condensates, (4) laundry wastewater, (5) cooling water, and (6) steam condensates. Pollutants that are commonly encountered in these wastewaters include particulates, organics, ammonia, inorganics, and radionuclides. Technologies being considered as BAT for treating these constituents are shown in Fig. 2. The pollutant categories and associated treatment technologies are discussed further below.

Organics

There are numerous organic constituents present in wastewaters on the Hanford Site. Organic constituents of concern regarding land disposal prohibitions include acetone, n-butyl alcohol, and carbon tetrachloride. Treatment technologies currently being considered for treating these constituents include oxidation, biological treatment, critical fluid extraction, steam and air stripping, and breakpoint chlorination.

Ammonia

One of the by-products from processing operations on the Hanford Site is ammonia. The amount of ammonia present in the effluent streams has become of concern to the DOE because of its potential to be regulated under the Washington State Dangerous Waste Regulations (6). As a result, several types of treatment technologies are currently being evaluated to reduce or destroy the compound. Treatment technologies currently being evaluated include steam and air stripping, ion exchange, chemical destruction, breakpoint chlorination, and acid treatment.

INORGANICS

Many of the effluent streams on the Hanford Site contain inorganics. Example pollutants include mercury, aluminum, cadmium, chromium, and cyanide. The concentration of these constituents do not qualify as regulated under the RCRA; however, they are regulated under the CWA. Treatment technologies currently being considered for removing the pollutants include electrodialysis and reverse osmosis.

Radionuclides

Many of the effluent streams that routinely discharge to the soil column on the Hanford Site are potentially contaminated with low levels of radionuclides. Most of the radionuclides are present in the form of dissolved solids. Treatment technologies currently being considered on the Hanford Site for reducing or removing the radionuclides include ion exchange, reverse osmosis, coprecipitation, and bone char.

SUMMARY

The application and documentation of the BAT methodology on the Hanford Site is currently being implemented. Because very few BAT treatment systems exist for radioactive effluents similar to those at the Hanford Site, the generic treatment system method has proved to be most useful.

Following the application of BAT for a particular effluent stream, significant bench-scale testing on the proposed technology is performed to verify the level of decontamination achieved. Additional issues that are being addressed when selecting the appropriate treatment technology include compatibility of other constituents in the effluent with the proposed treatment technology, differences in levels of decontamination between land disposal restriction limits versus proposed state groundwater limits, and the environmental impact resulting from operating a particular treatment technology.

REFERENCES

1. WHC, 1988, "Best Available Technology (economically achievable) Guidance Document for the Hanford Site," WHC-EP-0137, Westinghouse Hanford Company, Richland, Washington.
2. DOE, 1984, "Radioactive Waste Management," DOE Order 5820.1, U.S. Department of Energy, Washington, D.C.
3. EPA, 1983, "Guidance Manual for Estimating the Economic Effects of Pollution Control," U.S. Environmental Protection Agency, Office of Analysis and Evaluation, Washington, D.C.
4. EPA, 1983, "Workbook for Estimating the Economic Effects of Pollution Control," U.S. Environmental Protection Agency, Office of Analysis and Evaluation, Washington, D.C.
5. EPA, 1986, "Quality Criteria for Water - 1986," EPA 440/5-86-001, U.S. Environmental Protection Agency, Office of Water Regulations and Standards, Washington, D.C.
6. WDOE, 1989, "Dangerous Waste Regulations," WAC 173-303, Washington Department of Ecology, Olympia, Washington.

BIBLIOGRAPHY

Freeman, 1989, "Standard Handbook of Hazardous Waste Treatment and Disposal," McGraw-Hill Company, New York, New York.

Fig. 2. Example Treatment Technology.

EPA, 1988, "Protection of the Environment," Title 40, Code of Federal Regulation, U.S. Environmental Protection Agency, Washington, D.C.

AEA, 1954, "Atomic Energy Act of 1954 (as amended)," 42 U.S.C. 2011 et seq, U.S. Congress, Washington, D.C.