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for Transuranic Waste Management
Alternatives***

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CALCULATION OF PROJECTED WASTE LOADS FOR TRANSURANIC WASTE MANAGEMENT ALTERNATIVES*

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ABSTRACT


The level of treatment and the treatment and interim storage site configurations (decentralized, regional, or centralized) impact transuranic (TRU) waste loads at and en route to sites in the U.S. Department of Energy (DOE) complex. Other elements that impact waste loads are the volume and characteristics of the waste and the unit operation parameters of the technologies used to treat it. Projected annual complexwide TRU waste loads under various TRU waste management alternatives were calculated using the WASTE_MGMT computational model. WASTE_MGMT accepts as input three types of data: (1) the waste stream inventory volume, mass, and contaminant characteristics by generating site and waste stream category; (2) unit operation parameters of treatment technologies; and (3) waste management alternative definitions. Results indicate that the designed capacity of the Waste Isolation Pilot Plant, identified under all waste management alternatives as the permanent disposal facility for DOE-generated TRU waste, is sufficient for the projected complexwide TRU waste load under any of the alternatives.

INTRODUCTION

Projected waste loads are important considerations in evaluating management alternatives for transuranic (TRU) waste generated at sites in the U.S. Department of Energy (DOE) complex. Projected TRU waste loads can be used to (1) determine whether the capacities of existing treatment, storage, and disposal (TSD) facilities are sufficient, (2) estimate the required sizes and expected costs of new TSD facilities, and (3) assess the potential health risks from transportation of the waste and operation of the facilities.

This paper describes the parameters used to calculate TRU waste loads and compares waste loads calculated for the TSD of TRU waste under various management alternatives considered for sites in the DOE complex.

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TRU WASTE MANAGEMENT ALTERNATIVES

The 10 TRU waste management alternatives evaluated for DOE sites consist of various combinations of treatment levels, treatment processes, and treatment and storage locations, including no action. The three levels of treatment considered are described below.

- The minimum level of treatment reduces TRU components in the waste to levels acceptable for disposal under the current waste acceptance criteria of the Waste Isolation Pilot Plant (WIPP) in New Mexico, currently identified as the permanent disposal facility for DOE-generated TRU waste. Only waste streams that do not already meet these disposal criteria will be treated, usually by solidification and appropriate packaging.
- The intermediate level of treatment meets the waste acceptance criteria of WIPP and further treats the waste to reduce gas generation during degradation of organic materials and corrodible metals. Shredding and grouting debris waste and using non-iron-based containers reduces gas generation in the treated waste after disposal.
- The highest level of treatment considered would destroy or stabilize all hazardous constituents in the waste to comply with the Land Disposal Restrictions (LDRs) of the Resource Conservation and Recovery Act. For the purposes of this study, incineration is considered a representative process for treating TRU waste to meet LDRs.

Treatment and interim storage sites also vary among the TRU waste management alternatives. TRU waste from individual DOE sites may be treated on the site where it was generated (decentralized configuration), it may be sent to regional centers for treatment (regional configuration), or it may be sent from all sites to WIPP for treatment (centralized configuration). All treated TRU waste would be stored at the treatment site until being shipped to WIPP for disposal.

TRU WASTE LOAD CALCULATION PARAMETERS

The level of treatment and the site of treatment and interim storage impact TRU waste loads at and en route to a given DOE site. Other elements that impact these waste loads are the volume and characteristics of the waste and the unit operation parameters of the technologies used to treat it.

Waste Volumes

The treatment sites identified in a given alternative determine the volume of waste treated at a site. For example, the volume of TRU waste to be treated at Site 1 under Alternative A is derived by combining the TRU waste contributed by all sites whose TRU waste is being sent to Site 1 for treatment under Alternative A.

The annual waste loads contributed include TRU waste inventories plus 20 years of projected TRU waste generation, divided by 10 (assuming treatment will begin 10 years from now). TRU waste inventory and projected generation volumes for each DOE site can be found in the *Interim Mixed Waste Inventory Report* (DOE 1993) and the *Integrated Data Base for 1992* (DOE 1992). At the end of 1991, there were approximately 65,000 m³ of retrievably stored contact-handled (CH) TRU waste and about 4,300 m³ of retrievably stored remote-handled (RH) TRU waste at DOE sites (DOE 1993). (Packaged TRU waste with a surface dose rate less than or equal to 200 mrem/h is categorized as CH-TRU waste, and that with a surface dose rate of greater than 200 mrem/h is categorized as RH-TRU waste.)

An estimated 54,000 m³ of the waste (PNL 1994) could result from environmental restoration (ER) activities under a mixed-land-use scenario (assuming semi-restricted access to sites after remediation).

Waste Characteristics

Information about the characteristics of TRU waste has been obtained through process knowledge supplemented by x-ray examination, radioassay, analysis of the gas in storage drum headspace, and sampling of the contents of a limited number of waste containers. Most TRU waste exists in solid form (e.g., contaminated protective clothing, rags, glassware, and machine parts), but some is in liquid sludge form. On the basis of its physical and chemical characteristics, TRU waste is grouped into waste stream categories, each of which has its own treatment train to facilitate efficient processing. The waste stream categories include aqueous liquids, organic liquids, solid process residues, soils, debris, special waste, inherently hazardous waste, and unknown.

Fig. 1 illustrates treatment trains for five TRU waste streams being treated at a high level in order to meet LDRs. All treatment trains include a pretreatment step to segregate the waste into waste streams by separating liquids from solids or sorting out solids that have different physical properties. Currently, waste load calculations do not include three of the waste streams. The three, special waste, inherently hazardous waste, and unknown, constitute less than 10% of total TRU waste volume and are assumed to be set aside to await special processing.

PLACE FIG 1 HERE

Technology-Specific Unit Operation Parameters

The unit operation parameters of the technologies used to treat the waste influence waste load as well. These parameters include (1) volume factor, which is the ratio of product output stream volume to incoming stream volume, (2) mass fraction of product stream relative to input mass, and (3) mass fractions of secondary output streams relative to input mass. Unit operation parameters are specific to treatment technologies. For example, the volume factor for incineration is 0.1, for wet oxidation is 0.9, and for solidification is 1.2.

The ratios of specific contaminant quantities in TRU waste after treatment to their quantities in the waste before treatment are also calculated using unit operation parameters. The ratio of mercury in the treated product to mercury in the incoming waste stream, for example, is 0.01 for incineration, 0.1 for wet oxidation, and 1 for solidification. (In this case, solidification does not reduce contamination levels, but reduces a waste's ability to release the contaminant.)

Calculation of waste loads requires identifying the portions or combination of portions of incoming and secondary output waste streams assigned for each of the unit operations in a treatment train. For the incoming waste streams the assignments selected are generally averages of values conservatively estimated from analysis of data in the *Interim Mixed Waste Inventory Report* (DOE 1993). The assignments of secondary output streams are based on the expected makeups of the incoming streams and, in some instances, on engineering judgements about the expected waste stream behavior in a given process operation.

CALCULATED TRU WASTE LOADS

Total projected CH-TRU waste loads were calculated for the various TRU waste management alternatives using the WASTE_MGMT computational model (AVCI 1995). WASTE_MGMT accepts as input three types of data: (1) the waste stream inventory volume, mass, and contaminant characteristics by generating site and waste stream category; (2) TSD unit operation parameters; and (3) waste management alternative definitions. Some TSD processes generate secondary output streams that are also followed through the treatment process. For example, the primary output stream of incineration is ash, but a secondary stream of high-chloride salt waste is generated in the off-gas treatment of combustion gases (see Fig. 1).

Table I shows the projected annual complexwide waste loads of CH-TRU waste for four representative treatment technologies under three of the alternatives evaluated. As expected, the decentralization/treat-to-meet-minimum-disposal-criteria alternative, which does not use shredding or incineration, has the highest waste load for packaging among the three alternatives. The high waste load for shredding and low waste load for packaging in the regionalization/intermediate-level-of-treatment alternative indicates the effectiveness of the shredding process for reducing the volume of TRU waste, as well as for reducing gas generation to improve performance at WIPP.

PLACE TABLE I HERE

Table II shows the projected total complexwide CH-TRU waste loads for storage and disposal, including waste loads from ER activities. The ER waste loads, which constitute approximately 30% of the total, were calculated from ER waste volumes projected to be generated under the mixed-land-use scenario assuming semi-restricted access to the site after remediation.

PLACE TABLE II HERE

The maximum total projected CH-TRU waste load for disposal at WIPP under any of the waste management alternatives is approximately 130,000 m³, which is less than the designed capacity of 170,000 m³ for CH-TRU waste at WIPP.

SUMMARY

CH-TRU waste loads were projected for treatment and storage facilities at each DOE site for all management alternatives considered. Results indicate that the designed capacity of WIPP is sufficient for CH-TRU waste loads currently projected for the DOE complex under any of the alternatives, as well as for projected TRU waste loads from ER activities assuming semi-restricted access to sites after remediation. The projected waste loads can be used to calculate size requirements and estimated costs of new treatment or storage facilities and to assess potential health risks from transportation of waste and operation of facilities. TRU waste management decision making can be facilitated by comparing calculated waste loads, costs, and risk among TRU waste management alternatives.

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FIGURE CAPTION

Fig. 1 Treatment Trains for Treatment to Meet LDRs

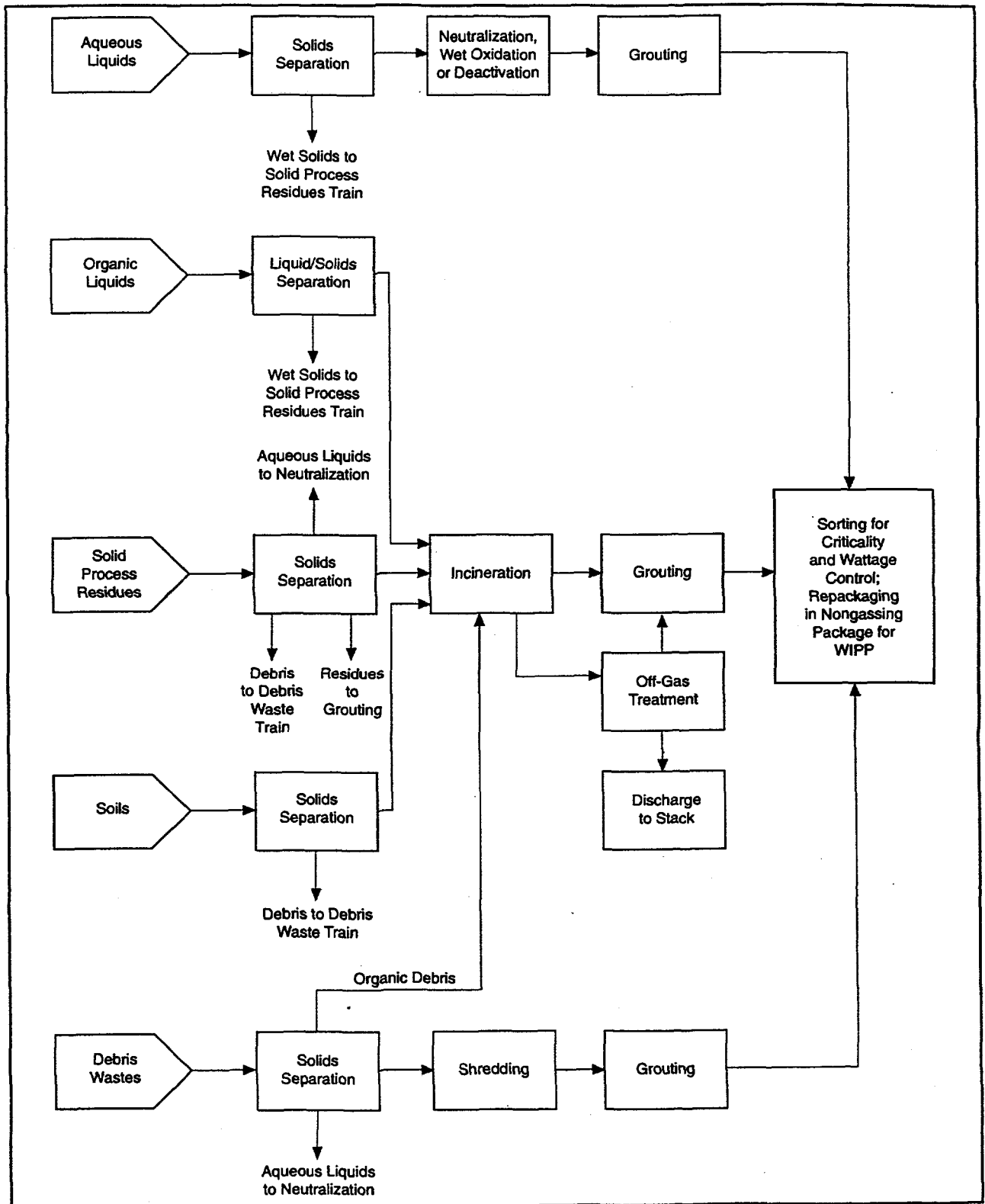


Fig. 1 Treatment Trains for Treatment to Meet LDRs

TABLE I. Annual Complexwide CH-TRU Waste Loads (m³/yr) for Representative Treatment Technologies

Treatment Technology	Decentralization: Treat at 16 sites to meet WIPP WAC	Regionalization: Treat at 5 sites to reduce gas generation	Centralization: Treat at WIPP to meet LDRs
Incineration	NA ^a	NA	2.6×10 ³
Solidification	1.0×10 ³	3.9×10 ³	3.8×10 ³
Shredding	NA	6.3×10 ³	4.9×10 ³
Packaging	8.6×10 ³	6.1×10 ³	4.9×10 ³

^a NA = Not applicable.

TABLE II. Total Complexwide CH-TRU Waste Loads (m³) for Storage and Disposal

TRU Source	Decentralization: Treat at 16 sites to meet WIPP WAC	Regionalization: Treat at 5 sites to reduce gas generation	Centralization: Treat at WIPP to meet LDRs
Waste management	9.5×10^4	6.7×10^4	5.4×10^4
Environmental restoration	3.2×10^4	2.4×10^4	2.3×10^4
Total	1.3×10^5	9.1×10^4	7.7×10^4