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ABSTRACT

The Waste Handling and Packaging Plant (WHPP) is identified as a key element in the U. S. Department of Energy's transuranic (TRU) waste program for both remote handled (RH) and special case (SC) waste. The mission of the facility is to retrieve, receive, repackage, certify, and ship TRU waste to the Waste Isolation Pilot Plant (WIPP) located near Carlsbad, New Mexico.

The conceptual design of the WHPP was initiated in March 1988, and the preliminary report was issued in May 1989. The development activities to support the WHPP were initiated during the summer of 1988 and will continue to provide technical information and data to the project over the next several years. An environmental assessment for the WHPP is planned and will be issued in 1991. A summary of each of these areas and the status of the project will be provided in this paper.

INTRODUCTION

The WHPP has been identified as a key element in the United States Department of Energy's (DOE) TRU waste program for both RH and SC waste (1). Thus, the WHPP has been proposed as a FY 1993 line item project for construction at the Oak Ridge National Laboratory (ORNL) at a total estimated cost of $245 million. The mission of the facility is to retrieve, receive, repackage, certify, and ship TRU waste to the WIPP located near Carlsbad, NM. The inventory of RH TRU waste stored at ORNL is about 90% of the RH TRU waste stored in the entire DOE system. The proposed WHPP would also receive RH TRU solid waste from other DOE sites, such as the Idaho National Engineering Laboratory, and the Hanford, Washington facilities.

The conceptual design task was initiated in March 1988, and the preliminary report was issued in May 1989 (2). The development activities to support the WHPP were initiated during the summer of 1988 and will continue to provide technical information and data to the project over the next several years. An environmental assessment for the WHPP is planned and will be issued in 1991.

OVERVIEW OF THE WHPP

The WHPP project scope includes processing of both stored liquid and solid transuranic wastes. Stored solid waste will be retrieved in the original concrete casks. The waste material inside the casks will be removed in the

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WHPP, sorted, processed, repackaged, and certified to meet the WIPP waste acceptance criteria (WAC) before being transported to WIPP for final entombment. Special case waste will also be processed through the plant on a case-by-case basis. Solid waste stored at other DOE sites will be transported to WHPP and processed in a fashion similar to that used for ORNL solid wastes. All waste handling activities will be conducted remotely in shielded hot cells, which are an integral part of the WHPP design.

The slurry processing portion of the plant includes mobilization of liquids and sludges from the Melton Valley Storage Tank(s) [MVST(s)], adjustment of the loading of salt and TRU solids in the slurried material, transport of the slurry to the WHPP, and processing to form a transportable waste that meets the WIPP-WAC. The WIPP-WAC covers many parameters (3), the ones most crucial to WHPP performance with the MVST material are the requirements limiting free liquid and fine particulate matter.

ORNL currently has in retrievable storage in trenches and a bunker) about 300 m^3 of RH TRU solid waste. This material is comprised of waste materials from about 20 years of operation of radiochemical processing and packaging facilities. The RH TRU wastes have been retrievably stored since the early 1970s. The predominant constituents are: sample bottles, wipes and gloves, small tools and equipment, polyethylene bags, equipment racks, and miscellaneous fuel materials. These materials contain TRU concentrations of >100 nCi/g and have a contact dose rate in excess of 200 mrad/h. All of this material will be processed through WHPP.

Characterization data for the contents of the MVSTs is sparse. In general, the supernatant is a highly basic, concentrated sodium nitrate solution that also contains lower concentrations of calcium and magnesium cations and hydroxide, carbonate, bicarbonate, chloride, phosphate, and sulfate anions. The tanks contain significant quantities of alpha-, beta-, and gamma-emitting radioisotopes. The alpha activity is concentrated in the sludges and is a result of the presence of TRU isotopes. The beta-gamma activity is predominantly due to the presence of ^{137}Cs and ^{90}Sr. The sludge consists of hydroxide and carbonate precipitates of the species present in the supernatant. In addition, significant quantities of bentonite clay and sand are present which were introduced during the clean-out of the gunite waste storage tanks and during disposal of liquid low-level waste (LLLW). It is assumed that ~500,000 gal (1900 m^3) of supernatant/sludge mixture (hereafter referred to as slurry) will be processed through the WHPP. This will result in about 5,000 55-gal drums of solidified RH TRU waste to be shipped to WIPP.

The conceptual flow sheet for processing solids through WHPP is depicted in Fig. 1. A docking cask with the concrete cask or drums, containing waste, will be brought to WHPP and introduced to the waste processing cell through a double-lid transfer device. Once inside the cell, the capability exists to evaluate the contents of the waste package by either real-time radiography or neutron-assay techniques. Once the cask or drum is opened, the waste will be sorted and processed as required through size reduction, compaction, and fixation (for liquids, corrosives, or particulates). The processed waste will be loaded into a clean drum liner and then into a clean drum. After confirmation of lack of external contamination, the drums will either be loaded into the proposed RH TRU drum shipping cask or loaded into a RH TRU canister and the canister cask for transport to WIPP.

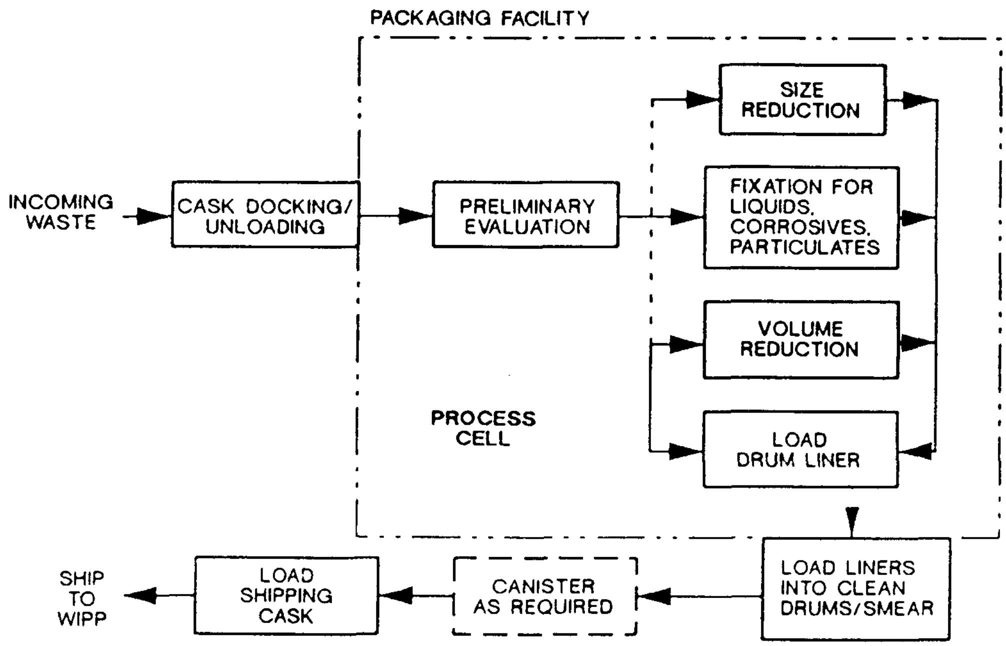

FIG. 1 WHPP CONCEPTUAL SOLIDS PROCESSING FLOW SHEET

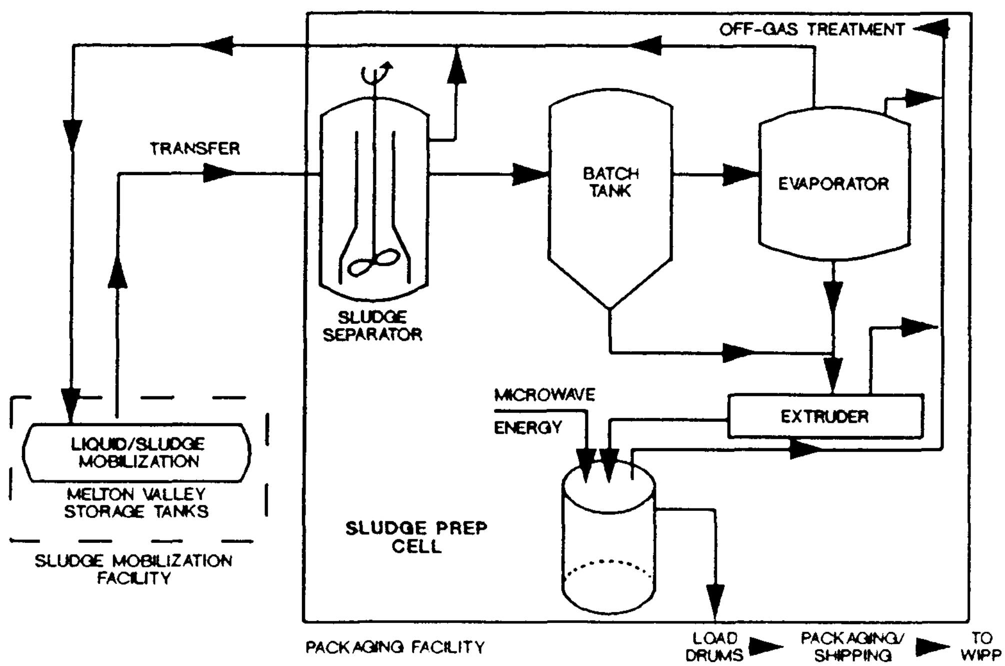

FIG. 2 WHPP CONCEPTUAL SLURRY PROCESSING FLOW SHEET

The slurry process flow diagram being utilized in the WHPP Conceptual Design Report is depicted in Fig. 2. Utilizing supernatant as the motive fluid, sludge will be mobilized from the bottom of one of the MVSTs. The mobilization device being considered in the CDR is an open impeller pump that is supported by a directionally controlled floating arm. The resultant slurry will be transported to a gravity separator where the solids will settle, and the supernatant will return to the sluicing operation. The sluicing process will continue until the required amount of solids are in inventory in the separator tank. When this concentration is reached, the separator device will be agitated and the slurry will be transferred to the WHPP batch tank. Samples of the slurry will be taken from the batch tank and analyzed to confirm that the required TRU and salt concentrations are present. From the batch tank, clarified supernatant will be passed sequentially through a kettle evaporator and an extruder. The high solids content stream from the bottom of the batch tank will be mixed with the feed to the extruder. The temperature of the solids exiting the extruder will be high enough (~350°C) to ensure a molten mass exiting the device. The molten salt will be poured into drum liners which are kept hot via microwave heating. When full, the drum liner contents will be allowed to solidify. After cooling, the drum liner will be loaded into a clean drum and then handled in a fashion identical to the solid waste drums.

The WHPP is proposed to be located on a site in the Southwest portion of the ORNL complex as shown in Fig. 3. It will be located about 500 ft of the MVSTs where the slurry is stored. This site is also close to where the solid waste is currently stored, and near where ORNL plans to construct new waste storage bunkers. The WHPP facility will have about 10,000 ft^2 of hot cell space for processing liquids and solids, for examination and certification, and for packaging and loading shipping casks. The hot cells will have walls 3 ft thick to provide shielding for gamma dose rates of up to 1500 rad/h. Double-lid transfer devices will be utilized to minimize the spread of contamination in the WHPP during transfer of incoming solid waste into the hot cell for processing, and for transferring out all completed 55-gal drum packages of waste. A cutaway illustration of the WHPP is shown in Fig. 4.

The first step in processing the currently stored TRU sludge is to form a slurry and remove it from the tanks. This process will be designed so that the sludge will be mobilized from each MVST by using liquid supernatant with minimal addition of water. This task is complicated by the fact that the waste is heterogeneous. Waste characteristics differ for each of the eight tanks and may vary within a given tank. The sludge will be characterized to ensure that it can be removed from the tanks and transported to the WHPP as a slurry without fouling or plugging pipes, pumps, and other equipment. A near full-scale MVST model will be constructed and operated to prove the effectiveness of the most promising sludge mobilization techniques.

The second step in the process is to transport the slurry to the slurry preparation tank located at the WHPP facility. Accurate sizing of slurry transport hardware is important. Pipe diameter will be selected to be large enough to prevent plugging while being small enough to maintain a linear velocity adequate to keep solids in suspension.

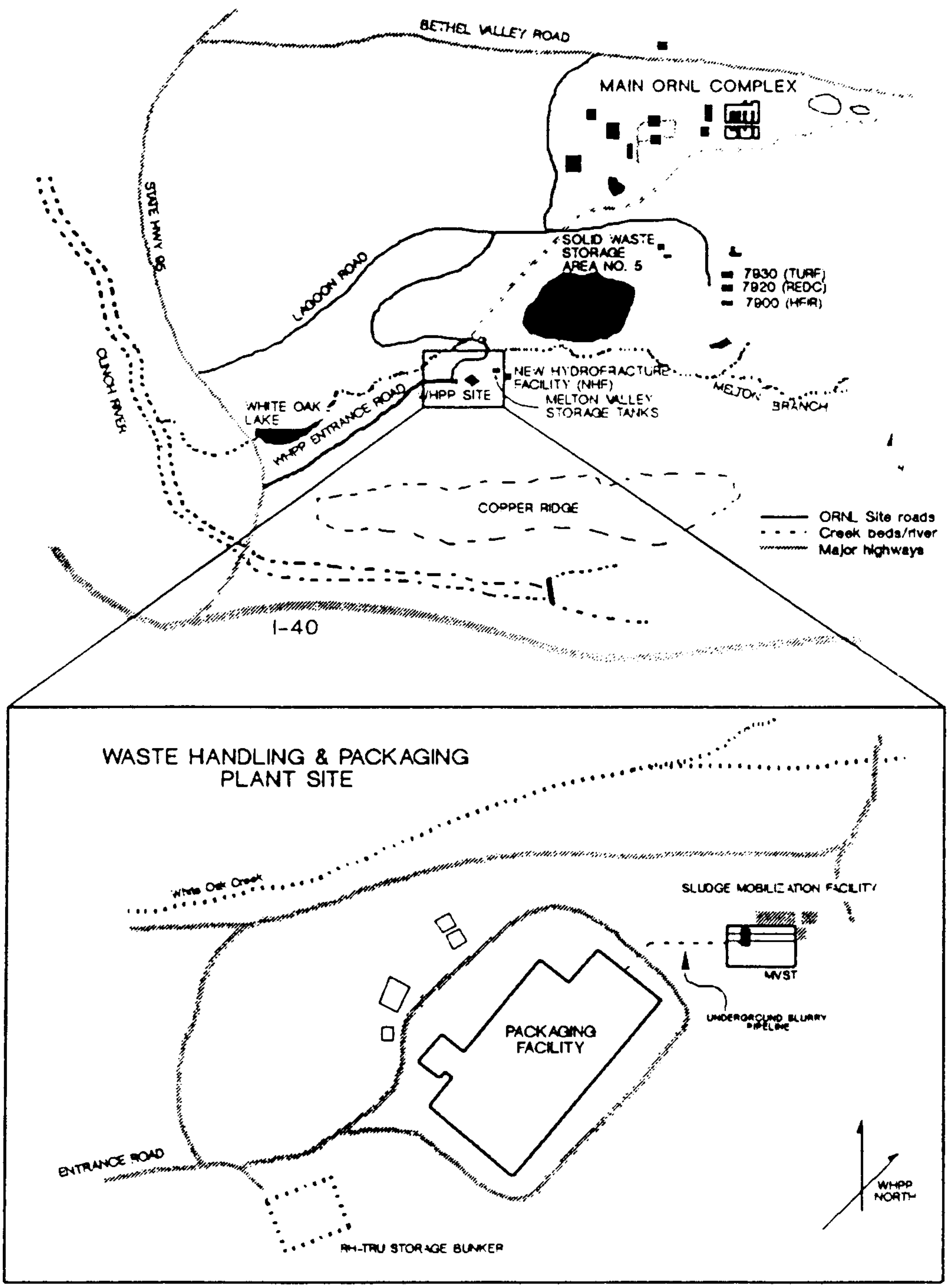

FIG. 3 ORNL SITE MAP

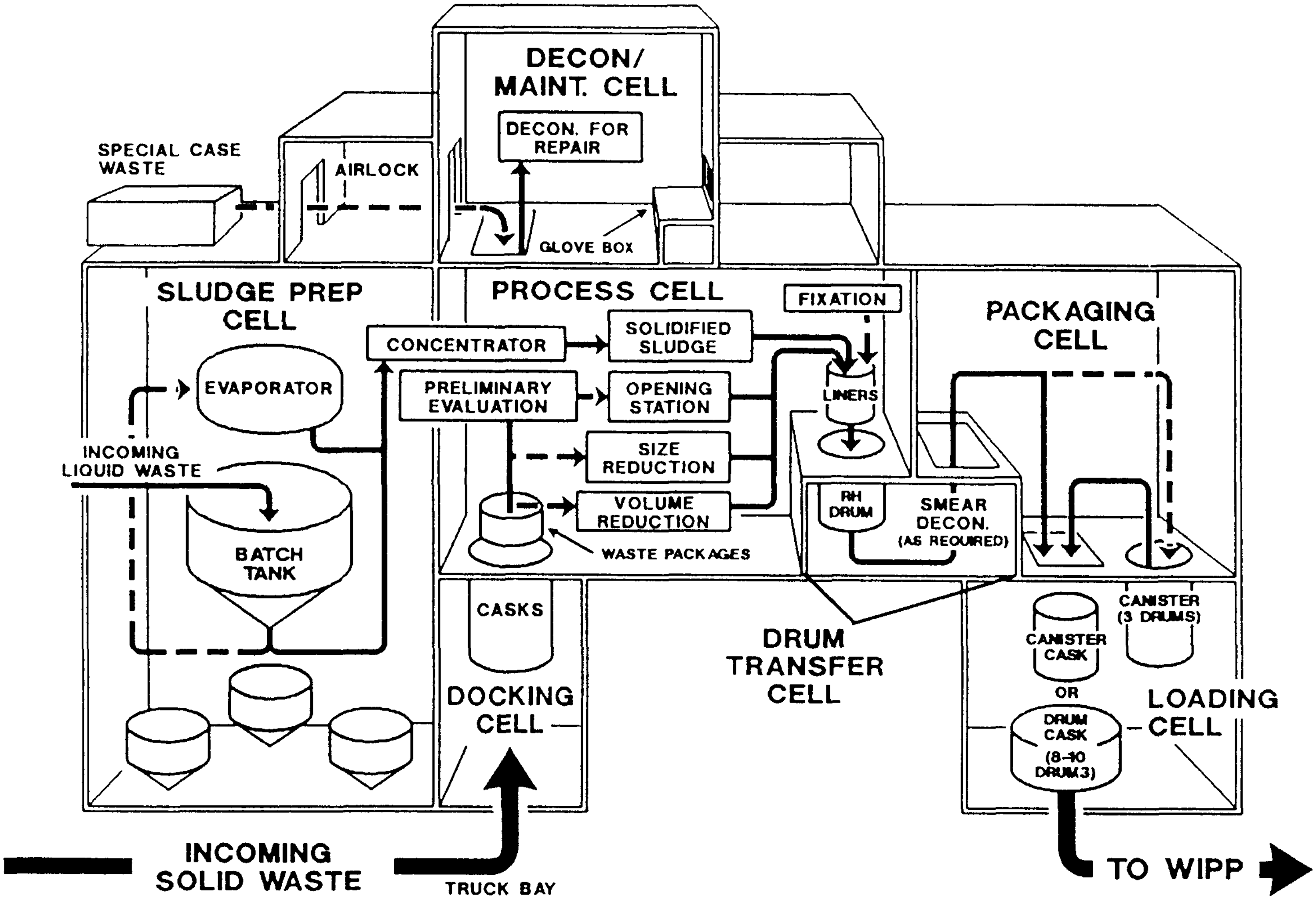

FIG. 4 CONCEPTUAL WHPP CUTAWAY

The third step in processing the slurry is to adjust the liquid/sludge ratio to attain the desired solids loading, and $NaNO_3$ concentration. Evaporation equipment will be designed to handle a range of solid concentrations that corresponds to the TRU solids loadings for which the process is qualified to operate. Sodium nitrate is necessary to bind molten solids and salts into a monolith. The slurry preparation step will be used to adjust the liquid/sludge ratio so that each batch meets the requirements for processing.

The final slurry processing step is to evaporate liquid from the slurry so that the solid product meets the WIPP-WAC. Methods for transferring heat to the slurry include steam heat, radiant heat, and microwave energy. Each method has unique processing requirements. The objective of the development effort is to gather design information sufficient to analyze and compare these processes. The evaporation and solidification method that meets processing criteria and ranks highest in terms of maintainability, operability, complexity, waste minimization, safety, and economy will be selected for installation in the WHPP facility.

The cask transfer system is a critical item that is required to support unloading of solid waste from the concrete waste storage casks to the process cell without breaching containment or contaminating surfaces of the system presented to the operator (the "clean side"). A promising approach, which has been conceptualized and will be demonstrated, utilizes a drum overpack with a double lid transfer port in which the concrete cask is sealed.

Linear accelerator (LINAC)-based nondestructive assay (NDA) and nondestructive examination (NDE) equipment will be utilized for the in-process examination and assay of RH TRU wastes processed through the WHPP. This will be developed and demonstrated for simulated and actual waste packages.

The WIPP-WAC limits the types of waste that can be shipped to WIPP. Materials requiring fixation (immobilization) within WHPP prior to shipment include: free liquids, particulate matter (outside WAC limits), and corrosive materials. A methodology for identification of waste conditions that require fixation will be developed.

The WHPP is currently being pursued as a FY 1993 line item project. A preliminary conceptual design was completed in May 1989. The Preliminary Safety Analysis Report was issued in conjunction with the Conceptual Design Report. The final CDR design will begin in April 1990 and be completed in January 1991. Before the detailed design of the line item project can begin in FY 1993, the design criteria and project management plan must be completed. Work on these documents will begin in FY 1991 and be completed in FY 1992. The development activities that support the project will feed information into the design criteria. The entire line item project will require about seven years to complete. Operational startup is currently planned for FY 2000. The environmental assessment is in the early stages of site characterization and will be completed in FY 1992. A summary of the WHPP project schedule is shown in Fig. 5.

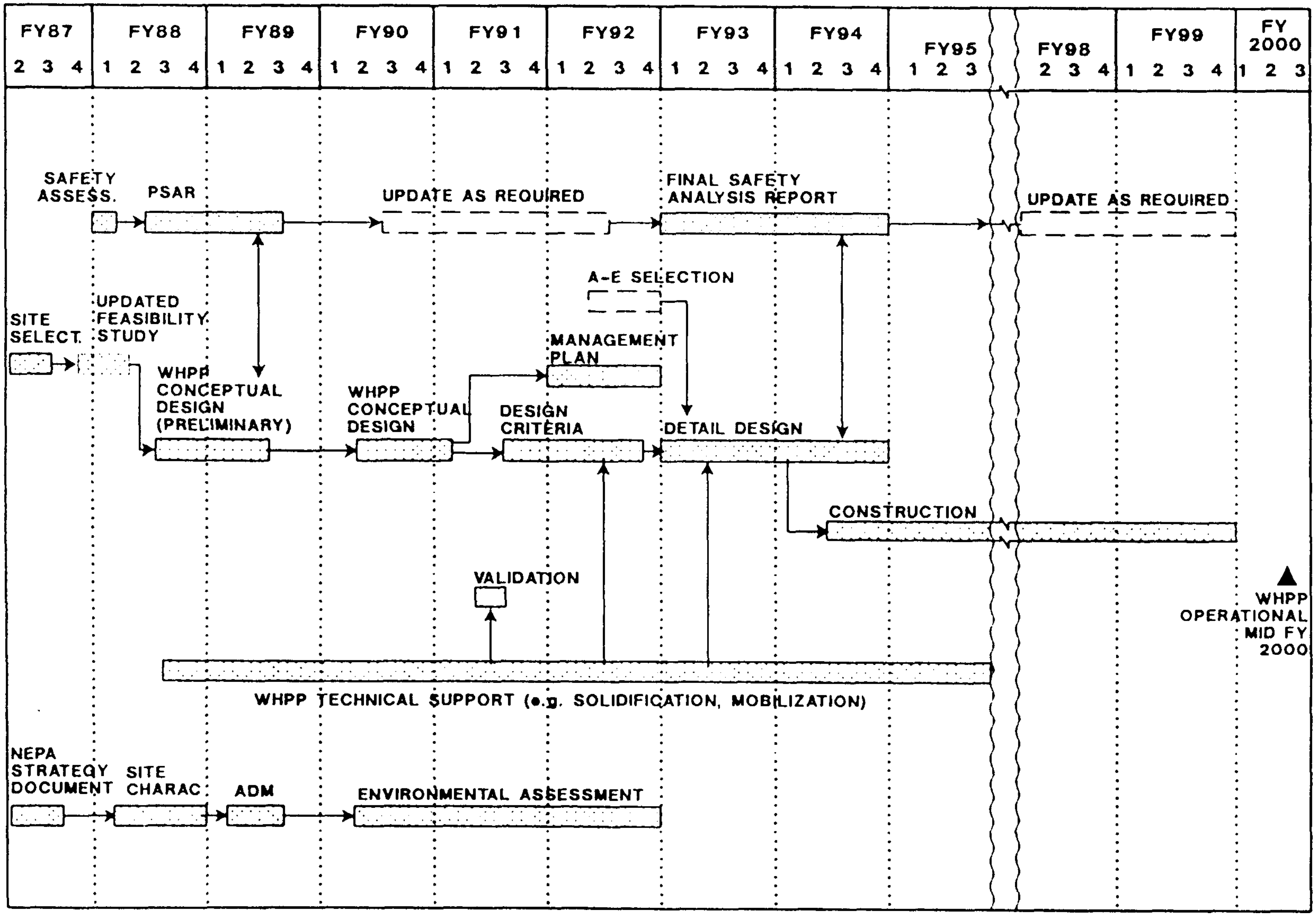

FIG. 5 WHPP SUMMARY PROGRAM PLAN

SUMMARY

Significant progress has been made toward design of the WHPP facility, a key element in the DOE TRU Waste Program, which is proposed to be built at the Oak Ridge National Laboratory in Oak Ridge, Tennessee. The preliminary conceptual design report for the project was issued in May of 1989. A development program has been initiated that addresses the currently envisioned development needs for design and operation of the WHPP. A major objective of the development program is to minimize the risk associated with process unknowns. The development program is organized such that the major input to the design effort will be made before the design criteria for the WHPP facility are completed. Testing for process qualification and for addressing issues raised during the design process will continue during the entire cycle of the project.

REFERENCES

1. Department of Energy Joint Integration Office, "Long-Range Master Plan for Defense Transuranic Waste Program," DOE-JIO-023, July 1987.

2. Preliminary Conceptual Design Report for the Waste Handling and Packaging Plant, X-OE-453, May 1989.

3. Department of Energy Joint Integration Office, "TRU Waste Acceptance Criteria for the Waste Isolation Pilot Plant," WIPP-DOE-069, Rev. 2, September 1985.