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Development of Major Process Improvements for Decontamination of Large, Complex, Highly Radioactive Mixed Waste Items at the Hanford Site T Plant

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DEVELOPMENT OF MAJOR PROCESS IMPROVEMENTS FOR DECONTAMINATION OF LARGE, COMPLEX, HIGHLY RADIOACTIVE MIXED WASTE ITEMS AT THE HANFORD SITE T PLANT

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ABSTRACT

As part of the decontamination/treatment mission at the Hanford Site, Westinghouse Hanford Company, under contract to the U.S. Department of Energy, conducts decontamination activities at the T Plant complex. Currently, the 221-T canyon High-Level Waste Decontamination Facility and the 2706-T Low-Level Waste Decontamination Facility capabilities are limited because upgrades are needed. Major process improvements must be developed to decontaminate large, complex, highly radioactive mixed-waste items. At the T Plant complex, an engineering team process was used to project possible solid mixed-waste feed streams and develop a preconceptual system to decontaminate and treat the waste. Treatment objectives and benefits were identified. Selected technologies were reviewed and improvements required to implement a preconceptual system at T Plant were considered. Decontamination facility alternatives were discussed in conjunction with ongoing and future decontamination activities at the Hanford Site, including efforts to enhance overall decontamination operations and capabilities.

INTRODUCTION

The Hanford Site (currently owned by the U.S. Department of Energy) was acquired by the Federal Government in 1943 to house facilities for the World War II production of plutonium. For more than 20 years, the facilities were dedicated primarily to plutonium production and management of the associated wastes. In later years, programs were diversified to include advanced reactor research and development of renewable energy technologies. In recent years, the mission has changed from production of special nuclear materials to primarily waste management and environmental restoration. Westinghouse Hanford Company is the current Management and Operations Contractor for the Hanford Site, which comprises approximately 1,450 km^2 of semiarid land located in south-central Washington State.

T Plant, located in the 200 West Area of the Hanford Site, was constructed from 1943 to 1944 as a wartime plutonium separations facility. It began chemical processing using the bismuth phosphate process in 1944 and operated under that mission until August 1956. In 1957, T Plant was converted into a decontamination and waste management facility and continues in this mission today. The T Plant canyon is a reinforced concrete structure 259 m (850 ft) long by 22.5 m (74 ft) high by 20.7 m (68 ft) wide. The canyon building contains 40 cells, each of which has a 1.8-m- (6-ft-) thick concrete cover block with 78.7-cm- (31-in.-) high protruding cover bails. Decontamination operations occur above these cells on the canyon deck. The T Plant canyon is currently conducting only limited decontamination activities because upgrades are necessary before items can be accepted that have detectable alpha contamination or dose rates that exceed 100 mrem/hr on contact.

T Plant complex support facilities include the 221-T canyon, 2706-T Low-Level Waste Decontamination Facility, 214-T Storage Facility, 271-T Office Facility, 211-T Chemical Storage Facility, and mobile offices and change rooms. Fig. 1 shows the T Plant complex layout and a cross-sectional view of the 221-T canyon.

The 2706-T facility, constructed in 1960 and upgraded in 1994, provides decontamination services for large transportable equipment having low levels of radioactive and hazardous contamination. The facility is used to decontaminate railroad equipment, plant process equipment, vehicles, and tools. The facility is equipped with a bridge crane, work pits for cleaning rail and highway rolling stock, steam cleaners, ice blasters, and various tanks. The facility cannot routinely accept items with detectable alpha contamination or items with dose rates exceeding 100 mRem/hour on contact.

WASTE STREAM EVALUATION

A waste stream analysis was performed to identify all potential feed streams to a centralized decontamination facility (Ref. 1). It was estimated that over 350,000 m^3 of contaminated equipment waste could potentially be generated over the next 30 years. This estimate included over 1,800 pieces of long-length equipment from tank farms (equipment items requiring size reduction for disposal in a standard burial box), a substantial mixed waste portion of the waste stream (over 35 percent of the total waste stream), and significant transuranic contaminated material.

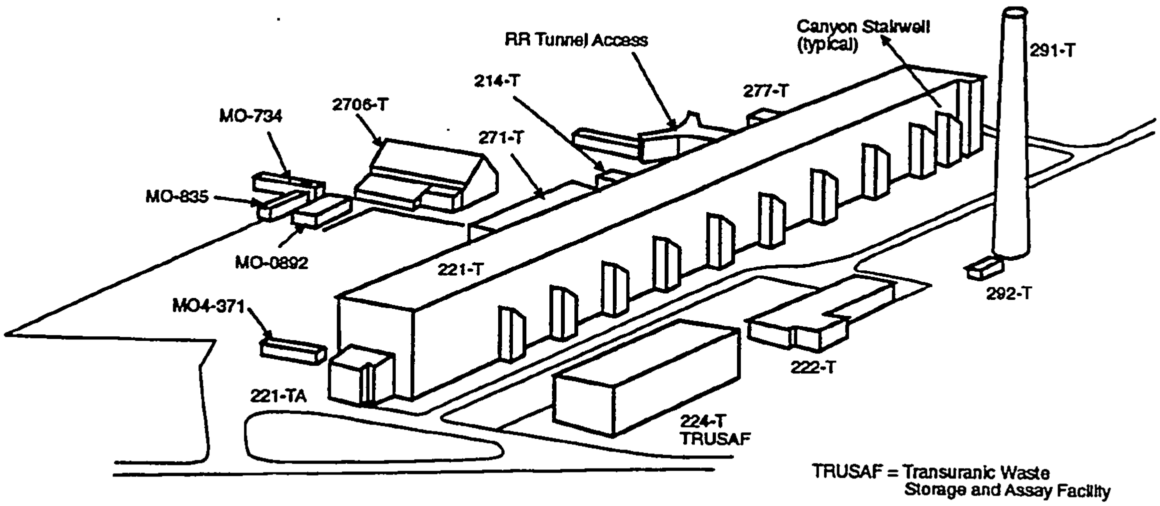
To date at the Hanford Site, the mission to decontaminate and treat large complex equipment items and components that are currently installed in high-level nuclear waste storage tanks has received the greatest attention. These components (e.g., pumps, instrument trees, and air lances) can be up to 21.3 m (70 ft) long, 167.6 cm (66 in.) in diameter, and weigh over 70 tons when installed in the shielded transfer containers. These items are highly radioactive (up to 66 Rem/hour on contact) and are also designated as radioactive mixed waste because of the presence of a variety of chemical contaminants.

Uncertainties of the projected waste stream have a significant effect on the development of a long-term decontamination/treatment strategy and the development of a definitive processing approach. Further analysis of the preliminary waste stream projection indicates that a large portion of the contaminated equipment may never be removed from existing facilities and will either remain in place in a stabilized manner or be decontaminated/treated in the field. Recent studies indicate that only 200 pieces of long-length contaminated equipment will be retrieved over the next 10 to 15 years instead of the 1,000 pieces originally projected.

If a substantial feed stream develops, a centralized decontamination facility will likely be required. However, if the key generators at the Hanford Site perform their own decontamination and treatment in the field or obtain acceptance from the regulators to stabilize contaminated equipment in place, capital funding for a new treatment facility may not be warranted.

DECONTAMINATION/TREATMENT OBJECTIVES

Decontamination/treatment of surface-contaminated equipment as an alternative to reduce solid waste volumes and storage requirements has been deemed an option which should be evaluated further.



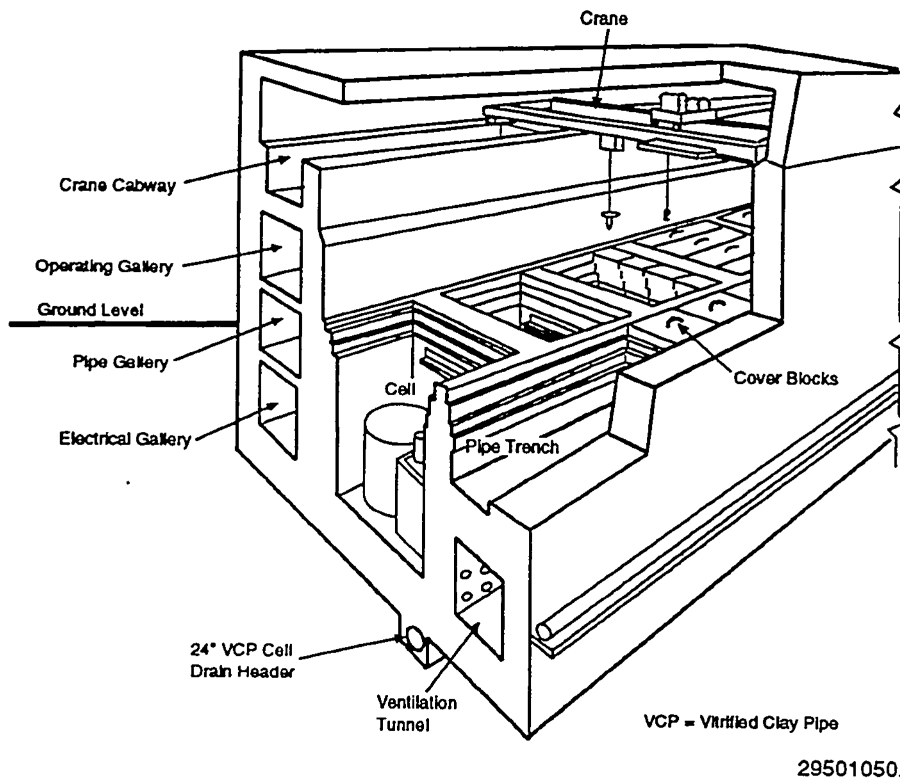


Fig. 1. T Plant complex and T Plant canyon cross section

The benefits directly associated with the decontamination/treatment of the equipment can be summarized as follows:

- Significantly reduces radioactive mixed waste volumes and costs associated with packaging and subsequent disposal (Low-level disposal over radioactive mixed waste disposal is more economical by an approximate factor of three [Ref. 2].)
- Provides a means for disposal of land-disposal-restricted hazardous waste (defined in 40 CFR 268 [Ref. 3] and WAC 173-303-140 [Ref. 4]), which requires treatment before disposal, mandated by the Resource Conservation and Recovery Act (RCRA) of 1976 (Ref. 5)
- Contributes to waste minimization, conserves natural resources, and reduces personnel radiation exposure
- Reduces the cost for direct replacement of failed equipment
- Reduces the area required to store contaminated equipment.

By achieving these objectives, considerable cost savings can be realized through the reduction of waste volumes, mobility, and toxicity. Also, the possibility of reuse or recycling can minimize waste storage and disposal costs. Fig. 2 illustrates the desired end states of the material following decontamination/treatment.

TECHNOLOGY/PROCESS EQUIPMENT SELECTION

Team Engineering Approach

Central to developing major process improvements at T Plant is the process for selecting decontamination technologies and process equipment. To tackle this effort, T Plant personnel used a team engineering approach to define and evaluate waste and equipment treatment, handling, and volume reduction technologies and processes. This team, known as the T Plant Treatment and Disposal Evaluation (TRADE) team, was tasked with identifying technologies that could be implemented to support the waste and equipment decontamination mission. Also, the team was to identify the most viable technologies and the processes for application of those technologies.

To accomplish the process development objectives, the TRADE team formed several focus groups to examine containment systems, handling technologies, size-reduction technologies, treatment technologies, existing plant systems and capabilities, and waste stream identification and characterization methods. Throughout this process, the TRADE team followed the general methodology outlined below:

- Review existing plant capabilities to determine what is usable, acceptable, and viable or could be made so through improvements (e.g., retrofit or operational changes)
- Establish contact with industry experts, manufacturers, and suppliers to obtain information on existing and new technology developments and processes.

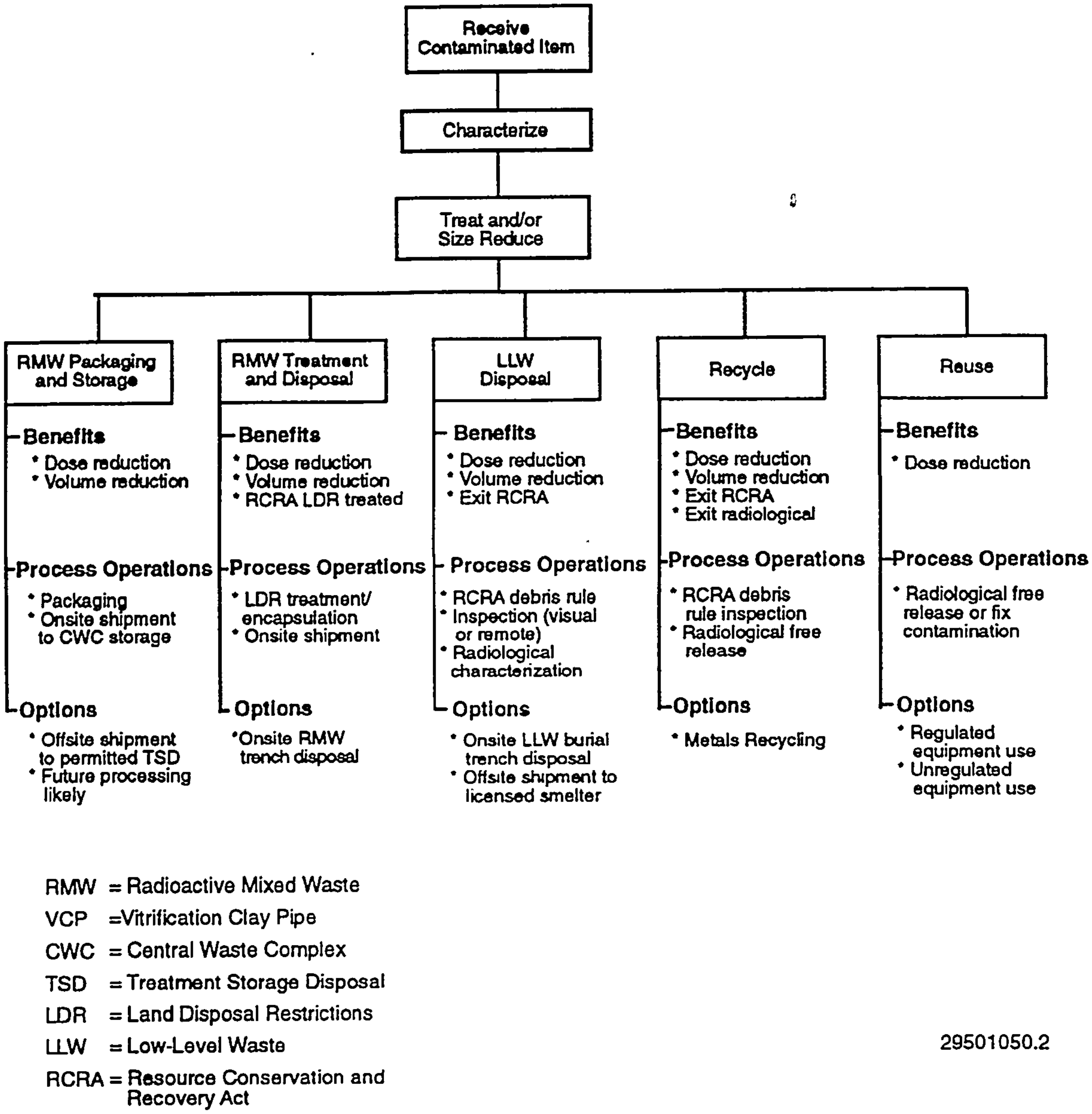


Fig. 2. End state options for debris and equipment treatment.

- Evaluate data in a team format to determine the most viable treatment/process options and the best methods for incorporating the options into plant functions in a manner consistent with "debris" rules and accepted by cognizant regulatory authorities.

- Provide recommendations for option selections to management and develop conceptual engineering information for implementation of the selected options.

Decontamination/Treatment Process Development

The team engineering efforts of T Plant's TRADE team resulted in the development of a process flow referred to as the primary decontamination module/secondary decontamination module (PDM/SDM). The PDM/SDM process flow will provide sufficient throughput capability to meet the expected contaminated equipment generation rates over the next 10 to 15 years. The concept includes two decontamination modules. In the first module, size reduction and chemical decontamination to reduce radiation levels will be performed. In the second module, abrasive cleaning and waste packaging will be performed to meet RCRA hazardous debris rule requirements. It is intended for the PDM/SDM process to be primarily remote-handled; however, waste packaging operations and material handling between the PDM and the SDM can include some contact-handled activities. A process flow schematic is provided as Fig. 3. Conceptual layouts for the PDM/SDM are shown in Fig. 4.

The following is a brief description of the PDM/SDM process:

- Upon transfer into the facility, the equipment item will be remotely removed from the container using manipulators and an overhead crane. The container will be decontaminated using a water spray or by steam cleaning in the 2706-T facility. These decontamination methods will be adequate because the containers are expected to have only slight amounts of smearable contamination.

- The equipment item will be transferred by conveyor to a mechanical cutting apparatus for size reduction. Size reduction will accomplish two objectives, (1) long-length items can be reduced to lengths that can be packaged in standard burial boxes, and (2) equipment can be cut and separated into portions having different levels of contamination. A typical tank farm pump can provide an example of the advantage associated with portioning contaminated items before decontamination/treatment. Highly contaminated portions of the pump that have been submerged in the tank waste could be cut and separated from less contaminated portions of the pump exposed only to the airspace between the surface of the waste and the tank dome. Another advantage would be the capability for separation of mixed waste parts of a piece of equipment from parts designated as low-level waste.

- Following size reduction, The equipment pieces will be decontaminated using chemical dip tanks. Current chelating, oxidizing, and acid/base chemical technologies provide excellent radionuclide removal efficiencies. Three dip tanks will be used, each with its own rinse tank. Secondary containment will be provided for each of the dip and rinse tanks. A filtration and treatment system, an integral part of this equipment, will provide treated recycled chemical fluids to the process.

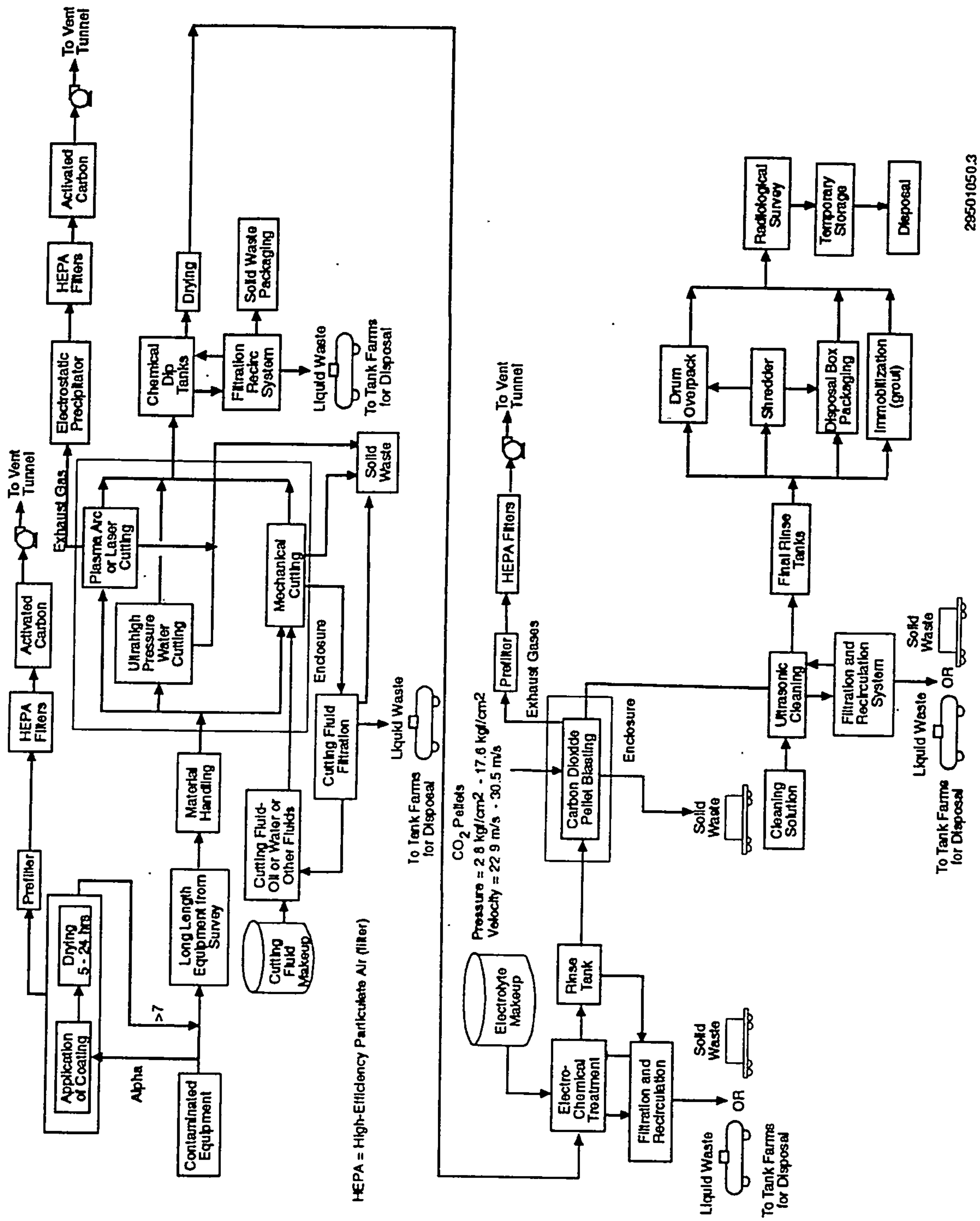


Fig. 3. Decontamination process functional flow.

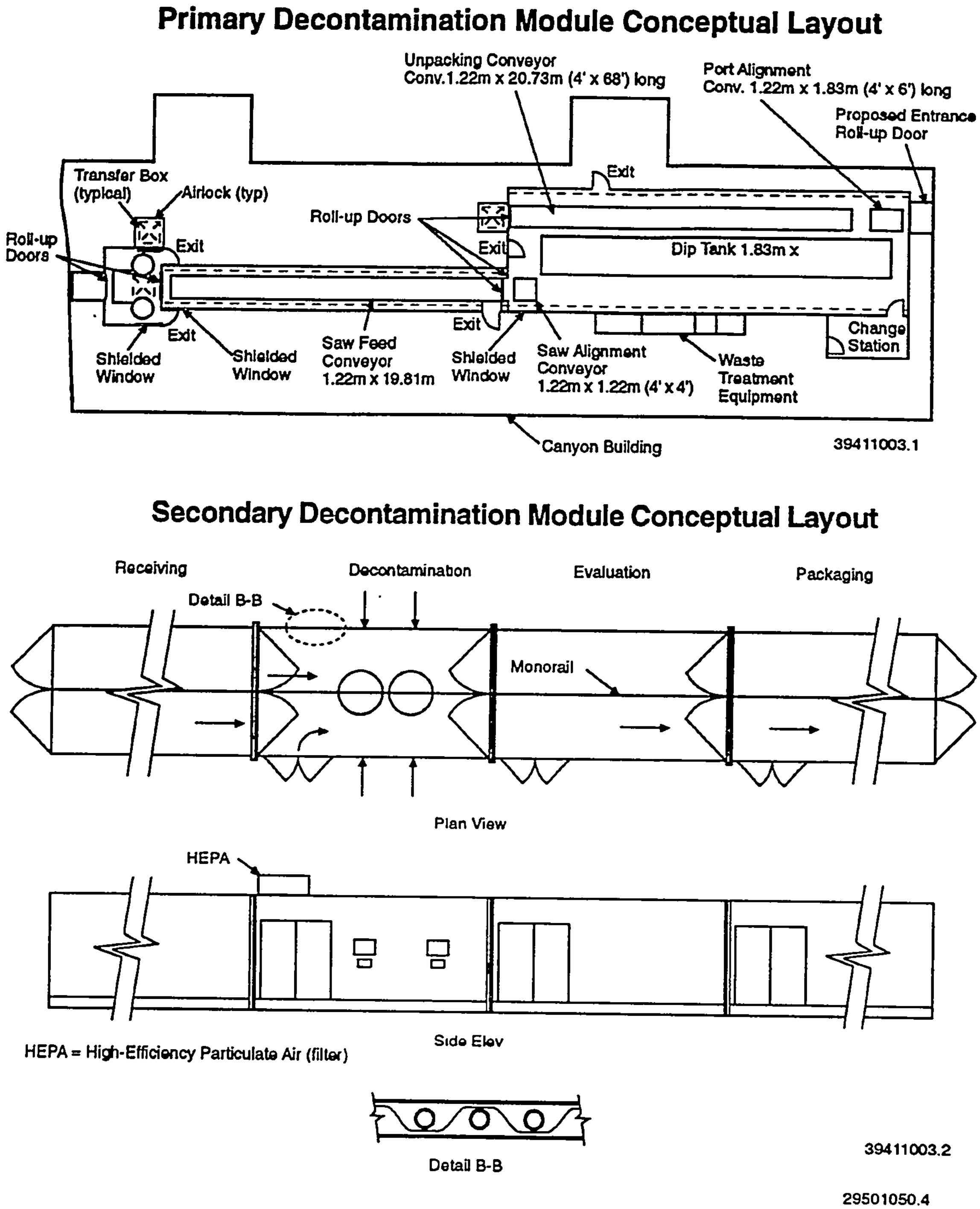


Fig. 4. Primary and secondary decontamination module layouts.

- The chemically treated equipment pieces will be moved into the secondary decontamination module where abrasive cleaning will be performed by carbon dioxide pellet blasting. This activity will remove most of the surface and embedded contamination and will also be very effective on hazardous waste such as lead-based paint. The CO_2 pellet blasting operation will be performed in a self-contained module to ensure independent ventilation from the high rate of off-gas generation.

- An inspection will be performed at an inspection station following abrasive cleaning and before final waste packaging. This inspection station satisfies the RCRA hazardous debris rule requirement for visual inspection. Equipment pieces with remaining radionuclide or hazardous waste contamination in excess of allowable quantities will receive repeated treatment (by chemical and/or abrasive methods) until they are deemed acceptable at the inspection station.

- After passing inspection, the waste pieces will be moved to the waste packaging station. The waste packaging station includes a grout/stabilization station to meet RCRA requirements, a burial box packer, and a drum/drum overpack packing station. These various packaging stations provide flexibility for compliance with final waste disposal packaging requirements.

Facility Upgrades

To accomplish decontamination of large, complex, highly radioactive mixed waste items at T Plant in a manner compliant with all Federal and State environmental and safety standards, major process improvements to T Plant are required. These upgrades were identified after a thorough review of T Plant's viability to perform a long-term decontamination mission. These improvements include upgrading the electrical, ventilation, and liquid storage and handling systems at T Plant; upgrading a variety of other systems; and installing the new processing modules.

Alternative Evaluations

Alternatives to the installation of new decontamination/treatment process modules in the 221-T canyon are being considered. One alternative is installing the process modules in a annex to the 2706-T facility. Another alternative is performing treatment/stabilization activities in the field. The process of developing new decontamination/treatment capabilities at the Hanford Site is in its infancy and will be an evolutionary process driven by the cleanup mission and regulatory requirements.

CONCLUSIONS AND FUTURE ACTIVITIES

The evaluation and understanding of potential solid waste feed streams and the processes necessary to treat and decontaminate these streams is an ongoing, iterative process at the Hanford Site. Each step in the engineering process brings forth additional information and knowledge in the processing of unique waste types. Several decontamination facility alternatives have been developed and evaluated. These alternatives considered a full range of possibilities from no action through development of full-scale facilities.

Based on the analysis of data accumulated and the evaluation of alternatives, there is not sufficient justification to proceed with a centralized high-activity decontamination facility.

- Long-length highly contaminated equipment from the waste tanks may not be a viable near-term waste stream; treatment in the field is currently being evaluated.

- The waste streams are highly uncertain and will be formally evaluated in detail in the next six months.

- The capital costs are relatively high.

If the treatment of long-length contaminated equipment in the field does not prove to be viable or acceptable, or if another waste stream is identified with a high degree of certainty, the use of a small annexed facility should be pursued in conjunction with the low-level decontamination capabilities at the 2706-T facility.

It is vital that the low-level decontamination activities at the 2706-T facility continue and be enhanced as new or emerging technologies are identified. Any upgrades needed to maintain 2706-T should be pursued. In addition, efforts should continue in treating and disposing of the equipment and material already in the 221-T canyon and using the 221-T canyon for limited decontamination operations. The facilities and personnel associated with the 2706-T facility and the 221-T canyon can provide critical support in the areas of low-level decontamination, repackaging, and technology development. If the decision is made to decontaminate/treat material in the field, T Plant personnel (both at 221-T and 2706-T) can provide a valuable service by developing, demonstrating, and testing decontamination tools and techniques that can be transported to the field.

A single facility or approach for dealing with the diversity and volume of possible waste streams is not practical. The optimal solution will likely involve a combination of alternatives and will be phased in as the site decontamination/treatment needs evolve and regulations change.

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3. 40 CFR 268, 1992, "Land Disposal Restrictions," Code of Federal Regulations, as amended.

4. WAC 173-303, 1990, "Dangerous Waste Regulations," Washington Administrative Code, as amended.

5. Resource Conservation and Recovery Act of 1976, 42 U.S.C. 6901 et seq.