FUNCTIONAL DESIGN CRITERIA
ADDITIONAL HIGH-LEVEL WASTE HANDLING
AND STORAGE FACILITIES

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MASTER

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FUNCTIONAL DESIGN CRITERIA
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1.0 INTRODUCTION

The goal of the Hanford Waste Solidification program is to immobilize all radioactive aqueous wastes. These wastes are processed through an evaporator-crystallizer in each 200 Area to reduce the waste volumes in the tank farms. Evaporation and crystallization produces salt cake and terminal liquor but will not completely immobilize all of the aqueous wastes. Until the technology and programs are developed and implemented to process these wastes into a permanently acceptable immobile form, the evaporator products must be stored in double-shell tanks for safe reliable containment.

The four existing double-shell tanks (241-AY and 241-AZ) were constructed for high-level boiling wastes. The three 241-SY Tanks (Project 74-1-i), presently under construction, will provide a feed tank and two storage tanks for the 242-S Evaporator. The six 241-AW Tanks budgeted for fiscal year (FY) 1976 will provide a feed-drain tank and five storage tanks for the 242-A Evaporator. The six 241-AN Tanks proposed for FY 1977 will store terminal liquor from the 242-A Evaporator.

Four one-million-gallon double-shell waste storage tanks are proposed for construction for FY 1978. Two tanks are required in the 200 East Area to store the additional terminal liquors anticipated from the updated Waste Management Model (WAMM) projections. Two tanks are required to eliminate a single-shell drain tank and to provide a spare double-shell tank in the 200 West Area. With the construction of these four new tanks, all of the double-shell tank requirements for boiling and non-boiling waste storage and spare tanks; evaporator feed, drain, and bottom tanks; and terminal liquor storage tanks will be fulfilled.

2.0 SUMMARY

Four one-million-gallon underground tanks will be constructed for safe and reliable containment and storage of high-level radioactive wastes. Transfer facilities and encased, insulated, and heat traced piping will provide transport connections to the existing evaporator-crystallizer and storage tank systems. Flushing facilities and associated utilities will be provided for tank farm operation. The tank, pumping, and ventilation equipment

and controls will be provided with instrumentation and alarms. Instrumentation will monitor the waste and facilities to detect high temperatures, waste levels, radiation, and process leakages. Gaseous radioactive containment will be provided by the high efficiency ventilation filtration. The tank farm facilities will provide personnel radiation protection.

3.0 FUNCTIONAL DESIGN CRITERIA

3.1 GENERAL TANK FARM CRITERIA

The four one-million-gallon double-shell tanks proposed for FY 1978 shall be similar in design to the 241-AW Tanks (reference 1). Existing designs shall be used wherever practical. Two tanks in the new 241-AP Tank Farm shall be constructed in the 200-East Area to interface with the 242-A Evaporator system. Two tanks in the new 241-SW Tank Farm shall be constructed in the 200 West Area and shall be integrated into the 242-S Evaporator system.

3.2 ARCHITECTURAL, STRUCTURAL, AND CIVIL

3.2.1 Double-Shell Tank

The maximum liquid storage capacity of each tank shall be one million gallons. The tanks shall be designed to store high caustic radioactive wastes which have a maximum specific gravity of 2.0 with a maximum temperature of 350°F and the maximum heat generation rate of 100,000 British thermal units (Btu) per hour.

Each underground tank shall consist of three concentric structures. The outer tank structure shall be a reinforced concrete tank designed to sustain all soil loadings, dead loads, live loads, seismic loads, and loads caused by temperature gradients between the radioactive wastes contained within the primary tank and the outside soil. The reinforced concrete tank shall be lined with a secondary carbon steel liner which extends from the bottom and sides along the concrete tank haunch and dome to the inner tank haunch. The inner free-standing, completely enclosed carbon steel tank, referred to as the primary tank, shall be located within the secondary liner and separated by an annular space. The primary tank shall be designed to contain the radioactive waste materials. The secondary liner shall safely contain any leakage that could occur due to a failure of the primary tank.

3.2.2 Primary Tank

The primary tank shall be designed to have adequate corrosion allowance for a 50-year tank life based on an average corrosion rate of 1.0 mil per year. The primary tank shall be thermally stress relieved after fabrication to relieve residual fabrication stresses and to minimize stress corrosion cracking caused by high concentration of sodium hydroxide and nitrates in the radioactive waste materials. The underlying base of the reinforced concrete tank shall be protected from excessive thermal gradients during the primary tank stress relieving operation.

The primary tank shall be designed not to exceed the stresses allowed for Section VIII, Division 2 of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code. The primary tank vessel shall be designed to withstand stresses caused by the most severe combination of the following loads:

- ° The hydrostatic load caused by one million gallons of 2.0 specific gravity material contained within the tank;
- ° The internal pressure loads of up to six inches of water vacuum or up to 60 inches of water positive pressure;
- ° The thermal loads caused by one million gallons of material at temperatures up to 350°F with 100,000 Btu per hour uniformly distributed heat generation; and
- ° The stresses imposed by a seismic event as defined by the Safe Shutdown Earthquake (SSE) in the Natural Forces Criteria section of this document.

3.2.3 Secondary Liner

The purpose of the secondary liner is to ensure that no radioactive materials escape to the environment in the event of a failure of the primary tank. The secondary liner shall be designed to contain the primary tank and its contents. The secondary liner shall be designed to collect for detection and contain any materials that may leak from the primary tank for a period of time (approximately one week) sufficient to allow the liquids to be removed to another tank. An annular space between the primary tank and secondary liner shall be of sufficient width to allow penetrations from the top for inserting liquid level and leak detection devices; inspection and photographic equipment; ventilation air supply and exhaust ducts; and pumping equipment for removing leaked materials out of the annular space.

The secondary liner shall be designed to withstand the combination of the following loads:

- ° The hydrostatic load of one million gallons of 2.0 specific gravity material;
- ° The pressure loads of up to six inches of water vacuum or up to 60 inches of water positive pressure.

3.2.4 Reinforced Concrete Tank

The primary tank and the secondary liner shall be contained within a reinforced concrete structure. The reinforced concrete tank shall support the bottom and walls of the secondary steel liner and support the free-standing primary tank and waste. The reinforced concrete tank shall have provisions to transport any leakage from the bottom of the secondary liner to detection and collection facilities. The reinforced concrete tank shall be designed to withstand the most severe combination of the following loads, including nonlinear creep and cracking due to long exposure to earth cover, temperature, and live loads.

- ° Six and one-half feet of earth cover compacted to maximum density;
- ° Uniform live loading of 40 pounds per foot² plus a concentrated live load of up to 50 tons;
- ° Up to six inches of water pressure below ambient atmospheric pressure;
- ° Up to 60 inches of water pressure above ambient atmospheric pressure;
- ° Thermal loads caused by a temperature gradient induced by material in the primary tank at temperatures up to 350°F with a heat generation rate up to 100,000 Btu per hour; and
- ° Seismic loads induced by a seismic event defined as the Safe Shutdown Earthquake in the Natural Forces section of this document.

3.2.5 Tank Dome Penetrations

Primary tank dome penetrations shall be provided for all primary tank monitoring and processing activities. Monitoring facilities are required for the primary tank liquid level, sludge level, temperature, and pressure measurements, and an observation port. Processing operations that require tank penetrations include the tank ventilation, slurry distribution, supernatant pumpout, drainage from the evaporator, and drainage collection from various pits and encasements located on or near the tank.

Secondary liner penetrations through the tank dome shall be provided for all annulus monitoring and processing activities. These penetrations shall include annulus pump pit, ventilation air supply and exhaust, instrument leads, annular inspection, and construction access.

Additional spare penetrations into the annulus and primary tank shall also be provided including as a minimum at least one spare for each size penetration or ten percent of the total of each size, whichever is the greater. Tank penetration risers above grade shall be located so as to permit crane access for pump pit work.

3.2.6 Processing and Transfer Facilities

Structures, components, and piping shall be provided to transfer process and flush materials between tanks within the tank farm and between the tank farm and other processing facilities. Primary processing pits, such as pump pits, drain pits, leak detection pits, and valve pits, shall be designed to protect personnel to as low a radiation level as practicable but not to exceed one milliroentgen per hour dose rate (mr/hr dose rate) based on the process solution concentration of six curies ^{137}Cs per gallon. Annulus pump pits, central pump pits, and drain pits shall drain into the tank on which they were constructed. The pits shall be provided with pit and riser flushing facilities.

Auxiliary facilities such as service pits, flush pits, and instrument buildings shall supply utility services, flushing capabilities, equipment control, and instrumentation functions for each tank farm.

3.3 PIPING

The process piping and components shall be designed to safely transport the radioactive, corrosive alkaline slurry material and supernatant liquids. The slurry piping and components shall be designed in accordance with American National Standards Institute (ANSI) B-31.1 to operate at maximum evaporator slurry pump discharge pressure of 400 pounds per square inch gauge (psig) at 200°F, and to withstand 100 psig saturated steam purging.

The slurry piping shall be designed to maintain a slurry velocity of three to ten feet per second over the slurry pump range of 32 to 100 gallons per minute to keep the slurry solids from settling in the piping. The supernatant piping and components shall be designed in accordance with ANSI B-31.1 to withstand the maximum pressure of 275 psig at 200°F and 100 psig saturated steam purging. Provisions shall be made for the removal of material in plugged slurry lines through cleanout facilities. The cleanout material shall be transported in drainlines to a storage tank.

process piping, including process drainlines except as noted below, shall be encased in carbon steel pipe to collect and detect any leakage in the primary process piping. Primary process lines shall be free-draining to prevent fluid accumulation in traps. Slurry and supernatant encasements shall be insulated and heat traced to maintain any selected temperature from 120° to 200°F. Encasements shall drain to the valve pits, pump pit, annulus pump pit, leak detection pit, or drain pit into which they terminate. Both the primary process piping and its encasement shall be provided with capabilities for periodic pressure testing.

Leakage from the secondary liner shall be transported to the leak detection pit via an unencased drainline. The evaporator building floor drainline shall be unencased.

4. AUXILIARY EQUIPMENT

4.1 Tank Farm Pumps

A supernatant pump for each storage tank shall be provided with this project. A process pump and a spare shall be provided for one leak detection pump pit and one annulus pump pit in each tank farm.

4.2 Jumpers

All piping jumpers required for both tank farms shall be provided with this project. Existing jumper designs shall be used wherever practical.

4.2 Slurry Distributors

This project shall not supply slurry distributors. Existing distributors on other tank farms shall be used if and when needed.

5. VENTILATION

The primary tank ventilation system shall be designed to control radioactive particulate emissions to the environment below Energy Research and Development Administration (ERDA) Manual Chapter 0524 release guides for release to an uncontrolled area. The tank shall be operated under a slight negative pressure to ensure containment of radioactive airborne materials. Contaminated gases and vapors that are vented from the tank shall be heated, double filtered by high-efficiency particulate air (HEPA) filters, sampled, and monitored for radioactivity before being released to the atmosphere. Flow measurement, psychrometric measurement, and in-place testing of HEPA filters shall be provided.

The quantity of air supplied to the annulus shall be sufficient in combination with the primary tank ventilation for heat removal of up to 100,000 Btu per hour. Part of this air shall be delivered beneath the center of the primary tank to aid in the early detection of leaks from the primary tank. The exhaust air shall be continuously monitored to detect any radioactivity, heated, passed through two stages of HEPA filters, then sampled to ensure gaseous releases to the atmosphere are below ERDA Manual Chapter 0524 release guides to an uncontrolled area. Airflow measurement and in-place filter testing of HEPA filters shall be provided.

3.6 INSTRUMENTATION

All instrumentation and facilities required to operate and maintain the tank farm shall be installed with due cognizance of existing instrumentation. Integral wall, dome, haunch, and base thermocouples shall be installed in the reinforced concrete tank to aid administrative control of thermal gradients and resulting stress during the stress relieving, processing, and storage operations. Thermocouples shall be located in the insulating concrete to provide similar control.

For the primary tank, thermocouples, liquid level measuring devices, and sludge level measuring devices shall be installed to monitor the tank contents. Leak detectors in the annulus space, and radiation detectors in the annulus ventilation shall be installed to detect leaks from the primary tank. Leak detectors, liquid level measuring devices, thermocouples, and radiation detectors shall be installed in the leak detection pits to detect and measure leakage from the secondary liner. Air samplers and radiation monitors shall be installed on both the tank and annulus ventilation systems to measure and control radioactive releases to the atmosphere. Leak detectors shall be installed in the central pump pits, annulus pump pits, drain pits, valve pits, cleanout boxes, and leak detection pump pits. Area radiation monitors shall be installed to detect surface leaks in the tank farm area. The service pit shall have a radiation detector and water flowmeter.

The instrument buildings shall be noncombustible structures that shall have refrigerated cooling and heating for instrument protection. These buildings shall be used also as the central switching station for each tank farm. The instrument buildings shall be provided with a products-of-combustion fire detection system that shall be connected to the 200 Area fire alarm loop.

All instrumentation shall readout and/or alarm in the instrument building. Selected leak and radiation detection instrumentation shall interlock with the tank farm pump and evaporator slurry pump controls, and shall alarm at the evaporator building control room. All instrumentation shall be designed for "fail safe operation" in the event of an air or electrical outage.

3.7 UTILITIES

Compressed dry, oil-free air shall be provided to operate instrumentation and ventilation stack samplers and for instrument air purging.

Raw water shall be provided primarily for flushing purposes and cleaning of plugged process slurry lines. Backflow prevention, flow measurement, and radiation detection facilities on the raw water supply shall be provided in the service pit. The raw water lines in the tank farm shall be provided with the capability for pressure testing and isolation from the raw water supply.

Steam shall be provided primarily for flushing purposes. Radiation detection on the steam supply shall be provided in the service pit.

Electrical power shall be provided for operation of instrumentation, pumps, ventilation exhaust units, heat tracing, lighting, building heating, air conditioning, air compressor, and for remotely operated impact wrenches. Emergency electrical power will not be required. Floodlighting for each tank farm shall be provided. Power cables to motor control centers and to individual motors, lights, panels, etc., shall be routed below grade whenever possible.

3.8 NATURAL FORCES

3.8.1 Wind

All new structures shall be designed in accordance with the Uniform Building Code, Section 2308.

3.8.2 Seismic

All new structures, equipment, and piping classified in quality assurance Level I shall be designed and analyzed for the Safe Shutdown Earthquake. The SSE shall be assumed to produce a maximum horizontal ground acceleration of 0.25g. The simultaneous maximum vertical ground acceleration shall be taken as two-thirds of the horizontal. The structures, equipment, and piping, so defined, shall be designed to withstand the SSE such that the facility can be rendered to a safe status without release of radioactivity to the environs which would result in undue risk to public health and safety. Structural response to the SSE must be mainly elastic. However, excursions into the plastic range are permitted, provided that no major collapse and/or nuclear contamination incident occur as a result of the SSE. All other structures and components shall be designed and constructed in accordance with the Uniform Building Code for Seismic Zone II.

3.9 QUALITY ASSURANCE

Quality Assurance (QA) programs for all contractors involved in the design, construction, and testing of the new facilities shall be formulated and executed to assure that the design, construction, and testing will be accomplished in a manner such that all components will perform as required for safe and reliable process operation.

Three levels have been established for classifying structures and components according to the degree of quality assurance required by safety considerations for system designs, as defined in reference 2.

All components and structures in the new facilities are classified into QA levels in Table I of the appendix. The classification of components is based on an evaluation of the consequences of credible incidents which may influence the safe operation of the facilities.

3.10 REGULATIONS, CODES, AND STANDARDS

Design and construction shall be in accordance with the following regulations, codes, and standards.

- ° ANSI B-31.1, "Codes for Pressure Piping"
- ° ASME Section VIII, "Boiler and Pressure Vessel Codes"
- ° ERDA Manual Chapter 6101, "Administration of the Construction Program"
- ° ERDA Manual Chapter 6301, "General Design Criteria"
- ° ERDA Manual Chapter 0511, "Radioactive Waste Management"
- ° ERDA Manual Chapter 0524, "Standards for Radiation Protection"

In general, applicable Hanford Plant Standards, Occupational Safety and Health Act Standards, and the "national consensus" codes and standards as developed by such organizations as the American Society of Mechanical Engineers, American Concrete Institute, American National Standards Institute, and the Institute of Electrical and Electronic Engineers shall be used. The latest edition of all codes and standards shall be used.

4.0 DISCUSSION OF RISKS

The special hazards which need to be considered in the design of the new facilities are the containment of radioactive solutions and radiation exposure to personnel. New structures, equipment pits, equipment, and piping will be designed so that they provide complete containment of radioactive solutions including solutions which may be sprayed from loose or defective connector nozzles, valves, or other piping components. Although personnel occupancy will not be continuous in the tank farm, personnel will be protected from radiation by adequate shielding provided from cover blocks or earth cover.

Detection of leaks in the storage tanks will be accomplished by monitoring the radiation levels and leak detection elements in each tank annulus, annulus ventilation system, and leak detection pit. Liquids from any leaking tank will be pumped to an available spare tank.

All process piping will be encased in a secondary envelope designed to contain and detect any leakage from the primary process pipe. Leak detection systems will be provided such that a leak from a primary process line initiates an alarm and shuts down all process pumps in the new tank farm and in other related facilities.

The instrument building in the tank farm will be isolated from other operating facilities and usually provides only occasional occupancy for operating personnel. Although the structure will be constructed of noncombustible material, the instrument building will require fire protection for the tank farm control and monitoring equipment. A products-of-combustion fire detection system connected into the 200 Area fire alarm loop will be provided to minimize damage to equipment and instrumentation.

The design of the new facilities will be consistent with applicable guides and standards to assure that present and future radiation exposures to individuals and population groups are limited to the lowest levels technically and economically practical not exceeding limits established in ERDA Manual Chapter 0524 Appendix Parts I and II. The only normal releases to the environment by the facilities will be via the exhaust ventilation system which has two stages of HEPA filters and monitors to alert to off-standard releases.

6.0 APPENDIX

TABLE I

Quality Assurance Classification
For High-Level Waste Storage Facilities at
241-AP and 241-SW Tank Farms

	<u>LEVEL I</u>	<u>LEVEL II</u>	<u>LEVEL III</u>
Tank structures, (primary tank, secondary steel liner and reinforced concrete tank)	X		
Pump pit, annulus pump pit, and valve pit structures (including pit cover and imbedded piping)	X		
Drain pit and leak detection pit structures (including pit covers, imbedded piping and caissons)	X		
Tank farm ventilation system and components to and including HEPA filters and containment	X		
Tank farm ventilation system and components not included in the preceding category		X	
All pipe encasements, clean-out boxes and associated piping	X		
All encased piping and remote pit jumpers		X	
All primary tank risers and annulus pump pit risers	X		
All secondary tank risers		X	
All pumps and electrical equipment (including heat tracing)		X	
Leak and radiation detection components and systems	X		
All instrumentation (including electrical safety interlocks) not included in the preceding category		X	
All raw water, steam, and compressed air piping, components and piping structures			X
All civil groundwork, instrument buildings and control switching stations			X