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FUNCTIONAL DESIGN CRITERIA
ADDITIONAL HIGH-LEVEL WASTE STORAGE FACILITIES

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Waste Solidification Engineering and Design
Development Engineering Department
Research and Engineering Division

MASTER

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July 25, 1975

This document has been reviewed and approved as a basis for project action.

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FUNCTIONAL DESIGN CRITERIA
ADDITIONAL HIGH-LEVEL WASTE STORAGE FACILITIES

INTRODUCTION

The goal of the Hanford Waste Solidification program is to immobilize all radioactive aqueous waste solutions. This objective is currently being partially achieved by evaporation and crystallization in 242-T and 242-S evaporators, and storage in existing single-shell tanks. A new vacuum evaporator-crystallizer identical to the 242-S Evaporator is presently under construction in 200 East Area.

Evaporation and crystallization alone, however, will not completely immobilize all of the aqueous wastes. The evaporation cycle approaches a point where very little, if any, acceptable crystals for salt cake will be formed due to the high caustic and aluminum concentrations. Thus, concentrated terminal liquors are produced. Further evaporation forms solids that are unsuitable for single-shell tank storage. Terminal liquors will be side-pocketed and stored, preferably in double-shell tanks, until the technology is developed to process this material into an acceptable, immobile form.

Six one-million-gallon double-shell waste storage tanks are proposed for construction in 200 East Area for fiscal year 1976, and would be available about mid-FY 1979. They would supplement the single-shell salt cake storage tanks and provide additional terminal liquor storage capacity necessary in 200 East Area. Five new FY 1976 tanks will be used primarily for terminal liquor storage, but will be provided with slurry handling facilities. The sixth tank will be used as a feed and drain tank for the new 242-A Evaporator. The new tanks will be of the tank-in-tank (double-shell) design, similar to the 241-SY Tanks (Project 74-1-i) presently under construction.

FUNCTIONAL DESIGN CRITERIA

GENERAL TANK FARM CRITERIA

Six one-million-gallon underground storage tanks shall be constructed in 200 East Area to store and process high-level radioactive liquid and slurry wastes. Designated the 241-AW Tank Farm, the tanks shall be located as close to the 242-A Evaporator as practicable to minimize transfer distances. The tank farm facilities shall interface with related facilities

both existing and under construction. Existing designs shall be used wherever practical.

Vehicle accesses shall be provided for tank farm operation and maintenance. The tank farm shall be enclosed within a perimeter fence. Area radiation monitoring and floodlighting shall be provided.

ARCHITECTURAL, STRUCTURAL, AND CIVIL

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 maximum heat generation rate of 100,000 British thermal units 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 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. Tanks shall be similar in design to those double-shell tanks in the 241-SY Tank Farm¹.

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 mill per year. The primary tank shall be thermally stress relieved after fabrication to release 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 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.

Secondary Liner

The secondary liner shall be designed to contain and support 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. 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 equipment; ventilation air supply and exhaust ducts; and pumping equipment for pumping leaked materials out of the annular space. The secondary liner shall contain the radioactive caustic liquids, that should leak from a failure of the primary tank, for a period of time (approximately one week) sufficient for the removal of the liquids to another tank. The purpose of the secondary liner is to insure that no radioactive materials escape to the environment (soil) in the event of a failure of the primary tank.

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 lbs/ft² 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/hr; and
- . Seismic loads induced by a seismic event defined as the Safe Shutdown Earthquake in the Natural Forces section of this document.

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, 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 tank annulus monitoring and processing activities. These penetrations shall include annulus pump pit, ventilation air inlets and outlets, 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.

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)² based on the process solution concentration of six curies ¹³⁷Cs per gallon. Annulus pump pits, central pump pits, feed pump pit and drain pit 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 building shall supply utility services, flushing capabilities, equipment control, and instrumentation functions for the tank farm.

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 B-31.1 to operate at maximum 242-A Evaporator slurry pump discharge pressure of 400 pounds per square inch gauge 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.

All process piping, including process drainlines, shall be encased in carbon steel pipe to collect and detect any leakage from 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 test.

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

AUXILIARY EQUIPMENT

Tank Farm Pumps

A supernate pump for each storage tank and a feed pump for the feed tank shall be provided with this project. One process pump and a spare shall be provided for one leak detection pump pit and one annulus pump pit.

Jumpers

All piping jumpers required for the 241-AW Tank Farm shall be provided with this project. Existing jumper designs shall be used wherever practical.

Slurry Distributors

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

VENTILATION

The primary tank ventilation system shall be designed to control radioactive particulate emissions to the environment below Energy Research and Development Administration Manual Chapter 0524² 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 double filtered by high-efficiency particulate air (HEPA) filters, sampled, and monitored for radioactivity before being released to the atmosphere. Airflow 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, passed through two stages of HEPA filters, then sampled to ensure gaseous releases to the atmosphere are below ERDA Manual Chapter 0524² release guides to an uncontrolled area. Airflow measurement and in-place filter testing of HEPA filters shall be provided.

Atlantic Richfield Hanford Company

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REVISION NO.

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FUNCTIONAL DESIGN CRITERIA - ADDITIONAL HIGH-LEVEL WASTE STORAGE FACILITIES

PROJECT NO.

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10-28-75

REVISION DETAILS

Add the following to the second paragraph under Primary Tank on page 6:

"The primary tank shall be designed not to exceed the stresses allowed for Class 1 components of Section III of the ASME Pressure Vessel Code".

REASON FOR REVISION

To clarify which ASME code to apply to the design stress analyses of the primary tank.

EFFECT ON COST AND SCHEDULE

NONE

REQUESTED BY

DATE

R. J. Thompson

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APPROVED FOR ERDA-RL PROGRAMS DIVISION

DATE

PROJECT MANAGEMENT

DATE

MANUFACTURING

DATE

OPERATIONS SUPPORT ENGINEERING

DATE

PERSONNEL PROTECTION

DATE

Atlantic Richfield Hanford Company

REVISION TO DESIGN CRITERIA

ARH- CD-362

REVISION NO.

2

TITLE

Functional Design Criteria - Additional High-Level Waste Storage Facilities

PROJECT NO.

B-120

DATE

1-11-77

REVISION DETAILS

Add the following paragraph under AUXILIARY EQUIPMENT on page 9:

Airlift Circulator

An airlift circulator similar in design to the one being provided in Tank 241-SY-102 shall be provided for the new feed tank of the 242-A Evaporator.

REASON FOR REVISION

The airlift circulator is needed to blend the feed solutions to reduce short-term variations in feed composition, thus reducing the need to adjust steam and process flow rates. The circulator may also help prevent the formation of floating crusts in slurry receiver tanks, which are believed formed from fine particles in the recycle feed solutions, by providing better blending of recycle and fresh feeds, thus giving the fine particles in the recycle feed a better opportunity to dissolve.

EFFECT ON COST AND SCHEDULE

The revision is estimated to increase the project cost \$5,000 for design and \$50,000 for construction. No effect on the schedule should result from this revision.

Submitted by

DATE

1/12/77

APPROVED FOR ARHCO

DATE

1/17/77

Project Engineering

DATE

1-13-77

APPROVED FOR TRPA PROGRAMS DIVISION

DATE

1/20/77

Quality Assurance

DATE

1/13/77

Tank Farm Operations

DATE

1/24/77

DATE

DATE

INSTRUMENTATION

All instrumentation and facilities required to operate and maintain the 241-AW 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 pit, valve pits, feed pump pit, 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 building shall be a noncombustible structure that shall have refrigerated cooling and heating for instrument protection. This building shall also be used as the central switching station for the 241-AW Tank Farm. The instrument Building shall be provided with a products-of-combustion fire detection system that shall be connected into the 200 Area fire alarm loop.

All instrumentation shall readout and/or alarm in the 241-AW Instrument Building. Selected leak and radiation detection instrumentation shall interlock with the tank farm pump and 242-A slurry pump controls, and shall alarm at the 242-A Building control room. All instrumentation shall be designed for "fail safe operation" in the event of an air or electrical outage.

UTILITIES

Compressed dry, oil-free air shall be provided to operate instrumentation and ventilation stack samplers and for instrument air purging. Raw water and steam shall be provided primarily for flushing purposes and cleaning of plugged process slurry lines. Backflow preventer and flow measurement of the raw water supply and radiation detection facilities 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 outlets for remotely operated impact wrenches. Emergency electrical power will not be required. Floodlighting for the 241-AW 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.

NATURAL FORCES

Wind

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

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 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 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.

QUALITY ASSURANCE

Quality assurance 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 required by safety considerations for system designs, as defined in reference 3.

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.

REGULATIONS, CODES, AND STANDARDS

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

- American National Standards Institute (ANSI) B-31.1, "Codes for Pressure Piping"
- Energy Research and Development Administration Manual Chapter 6101, "Administration of the Construction Program"
- Energy Research and Development Administration Manual Chapter Appendix 6301, "General Design Criteria"

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.

SAFETY DISCUSSION

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 241-AW Tank Farm 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 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 241-AW 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 which invoke concentration limits for radioactive materials at the site boundary. 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.

APPENDIX

TABLE I

Quality Assurance Classification
For High-Level Waste Storage Facilities at
241-AW Tank Farm

<u>COMPONENT</u>	<u>LEVEL I</u>	<u>LEVEL II</u>	<u>LEVEL III</u>
Tank structures, (primary tank, secondary steel liner and reinforced concrete tank)	X	<i>see Revision attached to this document</i>	
Pump pit and valve pit structures (including pit cover and imbedded piping)	X		
Drain pit, diversion box 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	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 and pit structures			X
All civil groundwork, instrument building and control switching station			X