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

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

Submitted:

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5/14/75
Date

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5/13/75
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FUNCTIONAL DESIGN CRITERIA
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INTRODUCTION

The goal of the Hanford Waste Solidification program is to immobilize all radioactive aqueous waste solutions as salt cake in underground tanks. This objective is currently being partially achieved by evaporation and crystallization in 242-T, 242-S, and existing single-shell storage tanks. A new vacuum evaporator crystallizer identical to 242-S 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.

The interim waste management plan is to place all liquid wastes into double-shell tanks as soon as possible, to utilize existing single-shell tanks for salt cake storage to the extent practicable, and to process the evaporator feed and bottoms materials in double-shell tanks.

Six 1,000,000-gallon double-shell waste storage tanks are proposed for construction in the 200 Area for fiscal year 1977. These six tanks would be available about mid-fiscal year 1980 and would supplement and provide additional storage capacity to the six tanks proposed for fiscal year 1976 (Project 76-6-b). The new FY-1977 tanks will be used primarily for terminal liquor storage but will be provided with slurry handling facilities. Similar to the 241-SY Tanks (Project 74-1-i) presently under construction, the new tanks will be of the tank-in-tank (double-shell) design.

FUNCTIONAL DESIGN CRITERIA

GENERAL TANK FARM CRITERIA

Six 1,000,000-gallon underground storage tanks shall be constructed in the 200 Area to store high-level radioactive liquid and/or slurry wastes. These tanks shall be located as close to

as practicable to minimize transfer distances. The tank farm facilities shall interface with existing and new processing facilities. Existing designs shall be used wherever practical.

Vehicle accesses shall be provided for tank farm operation and maintenance. The tank farm shall be enclosed in 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 1,000,000 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 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 to those double-shell tanks in the 241-SY Tank Farm.(1)

Primary Tank

The primary tank shall be designed to have adequate corrosion resistance for a 50-year life. It 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 vessel shall be designed to withstand stresses caused by the most severe combination of the following loads:

- the hydrostatic load caused by 1,000,000 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 1,000,000 gallons of material at temperatures up to 350° F, 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. It shall be designed to collect for detection and contain any materials that may leak from the primary tank. There shall be an annular space between the primary tank and secondary liner of sufficient width to allow penetrations from the top for inserting liquid level 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 should they leak from a failure of the primary tank for a period 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 secondary liner shall be contained within a reinforced concrete structure. It shall support the bottom and walls of the secondary steel liner and support the free-standing primary tank and its contents. 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 Criteria 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 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 route and 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, diversion boxes, leak detection pits, and valve pits, shall be designed to protect personnel to as low a 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.

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 evaporator-crystallizer 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 drain lines to a storage tank.

All process piping, including process drain lines, shall be encased in carbon steel pipe to collect and detect any leakage from the primary process piping. All primary process lines shall be free-draining to prevent fluid accumulation in traps. All slurry and supernatant encasements shall be insulated and heat traced to maintain any selected temperature from 120° F 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. Annulus pump pits, central pump pits, and drain pits shall drain into the tank on which they are constructed. Leakage from the secondary liner shall be transported to the leak detection pit via an unencased drain line. Both the primary process piping and its encasement shall be provided with capabilities for periodic pressure test.

AUXILIARY EQUIPMENT

Tank Farm Pumps

The supernate pump for each tank shall be provided by 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 new tank farm shall be provided by 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 Administration Manual Chapter 0524(2) 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. These 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. Air flow measurement and in-place testing of HEPA filters shall be provided.

The amount of air supplied to the annulus shall be sufficient in combination with the primary tank ventilation for heat removal of approximately 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 insure environmental releases to the atmosphere are below ERDA Manual Chapter 0524(2) release guides to an uncontrolled area. Air flow measurement and in-place filter testing of HEPA filters shall be provided.

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, and haunch thermocouples shall be installed in the reinforced concrete tank to aid administrative control of thermal gradients and resulting stress. Thermocouples shall be located in the tank base 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. In the annulus space, leak detectors 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 tank. 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, diversion box, cleanout boxes, and leak detection pits. Area radiation monitors shall be installed to detect surface leaks in the tank farm area. The service pit shall have a radiation monitoring system 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 new tank farm.

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.

UTILITIES

Compressed dry 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 prevention and flow measurement on the raw water supply, and radiation detecting facilities on the steam supply shall be provided.

Atlantic Richfield Hanford Company

REVISION TO DESIGN CRITERIA

ARH- CD-304

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Functional Design Criteria - Additional High-Level Waste Storage and Handling Facilities

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REVISION DETAILS

On Page 10 the first sentence under the subheading Seismic will be changed to read, "All new structures, equipment and piping classified in quality assurance Level I, except the tank farm ventilation system and components, shall be designed and analyzed for the safe shutdown earthquake."

REASON FOR REVISION

Damage to the ventilation system during a seismic event would not result in a significant release of contamination from the AN Tanks. Ventilation design requirements for seismic should be consistent with wind.

The ventilation system and components will be designed for compliance with the Uniform Building Code rather than the safe shutdown earthquake criteria.

EFFECT ON COST AND SCHEDULE

Eliminates need for seismic analysis to comply with safe shutdown earthquake criteria.

Submitted by <i>J. S. Gayfield</i>	DATE 11/24/76	APPROVED FOR ARHCO <i>Robert G. Yoder</i>	DATE 12-21-76
Quality Assurance <i>A. J. Sarno</i>	DATE 12/3/76	APPROVED FOR CRDA/RL PROGRAMS DIVISION <i>MS. G. A. S. Sarno</i>	DATE 2/1/77
Engineering <i>J. P. Kuzman</i>	DATE 12/9/76	Environmental & Occupational Safety <i>J. P. Kuzman</i>	DATE 12/2/76
Operations <i>J. P. Kuzman</i>	DATE 12/17/76	Project Engineering <i>M. G. Huff</i>	DATE 11/30/76

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. Flood-lighting for the 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, applicable 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, personnel will be protected from radiation by adequate shielding provided from cover blocks or earth cover.

Detection of leaks from 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 tank farm and in other related facilities.

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

<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 pit structures			X
All civil groundwork, instrument building and control switching station			X

Rockwell International
Atomics International Division
Rockwell Hanford Operations

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FUNCTIONAL DESIGN CRITERIA - ADDITIONAL HIGH-LEVEL WASTE STORAGE FACILITIES

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DATE

10-28-77

REVISION DETAILS

In Table I of the Appendix, the reinforced concrete tank shall be Q.A. Level II.

REASON FOR REVISION

- o The concrete tank doesn't hold waste material.
- o With this revision, the functional will be consistent with the Q.A. Plan (ARH-CD-544).

EFFECT ON COST AND SCHEDULE

None.

Submitted by:	DATE	Quality Assurance	DATE
<i>JS Garfield</i>	<i>11/1/77</i>	<i>MMB isk</i>	<i>11/2/77</i>
Environmental & Occupational Safety	DATE	Process Engineering	DATE
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Tank Farm Operations	DATE	Approved by Rockwell	DATE
<i>Trk [unclear]</i>	<i>11/1/77</i>	<i>[unclear]</i>	<i>11-16-77</i>
Project Engineering	DATE	Approved by DOE-RL	DATE
<i>A. C. [unclear]</i>	<i>11-3-77</i>	<i>[unclear]</i>	<i>1-27-78</i>