Accession #: D196070696

Document #: SD-W151-FDC-001

Title/Desc:
TANK 101-AZ WASTE RETRIEVAL SYSTEM

COMPLETE

ENGINEERING CHANGE NOTICE

Page 1 of 2

1. ECN № 616698

Proj. ECN ——

2. ECN Category (mark one)		Supplemental	[]	Change ECN	[]	Supersedure	[]
Cancel/Void	[]	Direct Revision	[X]	Temporary	[]	Discovery	[]

3. Originator's Name, Organization, MSIN, and Telephone No. Michael Manthei, DST Retrieval Projects, S2-48, 372-2682.	4. Date May 12, 1995

5. Project Title/No./Work Order No. Project W151, Tank 101-AZ Waste Retrieval System	6. Bldg./Sys./Fac. No. 241-AZ-101	7. Impact Level 3Q
8. Document Number Affected (include rev. and sheet no.) WHC-SD-W151-FDC-001 Rev. 2	9. Related ECN No(s). N/A	10. Related PO No. N/A

11a. Modification Work [] Yes (fill out Blk. 11b) [X] No (NA Blks. 11b, 11c, 11d)	11b. Work Package Doc. No. N/A	11c. Complete Installation Work N/A Cog. Engineer Signature & Date	11d. Complete Restoration (Temp. ECN only) N/A Cog. Engineer Signature & Date

12. Description of Change

Revised FDC to be consistent with requirement changes which were incorporated into the project design.

Changes to Project W151 FDC are:

- deletion of reference to portable substation power
- addition of impact limiter requirement per CR-W151-016
- removal of stress measurement devices on mixer pump support columns
- eliminate flow rate monitoring on bearing/seal water
- updated removal of waste classification from RH LLW III to the new debris rule requirements. Removed items will be stored verses the buried requirements identified in the document

The existing USQ (TF-94-0266) is applicable for this revision, and all project modifications will be incorporated in an FSAR modification to be approved prior to mixer pump operation. MRM

13a. Justification (mark one)		Criteria Change	[X]	Environmental	[]	Facilitate Const.	[]
Design Error/Omission	[]	Design Improvement	[]	As-Found	[]	Const. Error/Omission	[]

13b. Justification Details

The FDC is revised to reflect changing project requirements including the debris rule (supersedes previous removal requirements), addition of an impact limiting device for mixer pump insertion and removal, and items associated with approved project change requests.

Design verification by informal review, performed by M. E. McKinney.

14. Distribution (include name, MSIN, and no. of copies) see attached distribution cover sheet.	RELEASE STAMP OFFICIAL RELEASE 3 BY WHC DATE OCT 24 1995 Sta. 4

ENGINEERING CHANGE NOTICE

1. ECN (use no. from pg. 1): 616698

15. Design Verification Required	16. Cost Impact				17. Schedule Impact (days)	
	ENGINEERING		CONSTRUCTION			
[X] Yes	Additional	[] $0	Additional	[] $0	Improvement	[] None
[] No	Savings	[] $0	Savings	[] $0	Delay	[] None

18. Change Impact Review: Indicate the related documents (other than the engineering documents identified on Side 1) that will be affected by the change described in Block 12. Enter the affected document number in Block 19.

SDRD	[X]	Seismic/Stress Analysis	[]	Tank Calibration Manual	[]
Functional Design Criteria	[]	Stress/Design Report	[]	Health Physics Procedure	[]
Operating Specification	[]	Interface Control Drawing	[]	Spares Multiple Unit Listing	[]
Criticality Specification	[]	Calibration Procedure	[]	Test Procedures/Specification	[]
Conceptual Design Report	[]	Installation Procedure	[]	Component Index	[]
Equipment Spec.	[]	Maintenance Procedure	[]	ASME Coded Item	[]
Const. Spec.	[]	Engineering Procedure	[]	Human Factor Consideration	[]
Procurement Spec.	[]	Operating Instruction	[]	Computer Software	[]
Vendor Information	[]	Operating Procedure	[]	Electric Circuit Schedule	[]
OM Manual	[]	Operational Safety Requirement	[]	ICRS Procedure	[]
FSAR/SAR	[]	IEFD Drawing	[]	Process Control Manual/Plan	[]
Safety Equipment List	[]	Cell Arrangement Drawing	[]	Process Flow Chart	[]
Radiation Work Permit	[]	Essential Material Specification	[]	Purchase Requisition	[]
Environmental Impact Statement	[]	Fac. Proc. Samp. Schedule	[]		[]
Environmental Report	[]	Inspection Plan	[]		[]
Environmental Permit	[]	Inventory Adjustment Request	[]		[]

19. Other Affected Documents: (NOTE: Documents listed below will not be revised by this ECN.) Signatures below indicate that the signing organization has been notified of other affected documents listed below.

Document Number/Revision	Document Number/Revision	Document Number Revision
WHC-SD-W151-SDRD-001, Rev. 0		

20. Approvals

	Signature	Date
OPERATIONS AND ENGINEERING		
Cog./Project Engineer	EM Nordquist	5/12/95
Cog./Project Engr. Mgr.	JE Van Beek	5/12/95
QA	RE Clayton	5/16/95
Safety	MN Islam	5/16/95
Security	N/A	
Proj. Prog./Dept. Mgr.	~~N/A~~ G A. Mayer	7/24/95
Def. React. Div.	N/A	
Chem. Proc. Div.	N/A	
Def. Wst. Mgmt. Div.	N/A	
Adv. React. Dev. Div.	N/A	
Proj. Dept.	N/A	
Environ. Div.	N/A	
IRM Dept.	N/A	
Facility Rep. (Ops.)	DE Bowers	5-12-95
Other	N/A	

	Signature	Date
ARCHITECT-ENGINEER		
PE	N/A	
QA	N/A	
Safety	N/A	
Design	N/A	
Other	N/A	
DEPARTMENT OF ENERGY	Bruce Nevill	10/20/95
ADDITIONAL		
Safety & Env. Permit		
Project Engineer	ME Manthei	5/12/95
Component Engr.	DW Crass	15 May 95
Retrieval Technology	WL Knecht	5/15/95

RELEASE AUTHORIZATION

Document Number:	WHC-SD-W151-FDC-001, REV 3
Document Title:	Tank 101-AZ Waste Retrieval System
Release Date:	10/24/95

This document was reviewed following the procedures described in WHC-CM-3-4 and is:

APPROVED FOR PUBLIC RELEASE

WHC Information Release Administration Specialist:

Kara L Broz 10/24/95

Kara Broz

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SUPPORTING DOCUMENT

1. Total Pages 28

2. Title

TANK 101-AZ WASTE RETRIEVAL SYSTEM

3. Number

WHC-SD-W151-FDC-001

4. Rev No.

3

5. Key Words

Aging waste, retrieval, mixer pumps, component removal, process test, sludge, DST.

6. Author

Name: M. E. Manthei

M E Manthei 10/23/95
Signature

Organization/Charge Code 8K520/D2DA1

7. Abstract

Presented is the functional design criteria for equipment and subsystems required to test the mobilization of sludge in anticipation of retrieval of waste slurry from tank 241-AZ-101. The system utilizes jet forces from two high capacity pumps (mixer pumps) which recirculate liquid within the tank to mobilize the sludge and disperse it in the supernate and produce a slurry suitable for feed to the pretreatment process.

This project provides the systems and equipment to prepare Tank AZ-101 for a functional test to verify sludge mobilization capabilities with use of mixer pumps. A retrieval functional test will be conducted by others (not part of the project) to confirm laboratory studies of waste mobilization characteristics and design parameters, to provide basis for system optimization for mobilization of other wastes, and to provide final verification of the effects of the retrieval process on other tank farm operational parameters. No waste will be transferred from the tank during the FT. Prior to the test, some existing in-tank components must be removed and disposed of, and replaced with components with increased structural strength and rigidity. Special instrumentation will be provided to measure the effectiveness of the mixer pumps for sludge mobilization. Designing and providing equipment for component removal, handling, and solid waste disposal is a significant part of the project work scope.

8. RELEASE STAMP

OFFICIAL RELEASE BY WHC (3)

DATE OCT 24 1995

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RECORD OF REVISION

(1) Document Number: WHC-SD-W151-FDC-001

Page 1

(2) Title
Functional Design Criteria, Tank 101-AZ Waste Retrieval System

CHANGE CONTROL RECORD

(3) Revision	(4) Description of Change - Replace, Add, and Delete Pages	Authorized for Release (5) Cog. Engr.	(6) Cog. Mgr. Date
0	(7) EDT #112680 6/26/90	E.D. Waters (original signature on EDT 112680)	J.N. Appel (original signature on EDT 112680)
1	Per ECN #162758 1/21/92	J.P. Mullally (original signature on ECN 162758)	B.K. Horsager (original signature on ECN 162758)
2	Per ECN #169774 9/4/92	EM Nordquist (original signature on ECN 169774)	GL Parsons (original signature on ECN 169774)
3 RS	Per ECN #616698 10/23/95	EM Nordquist [signature] 10/24/95	JE Van Beek [signature]

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WHC-SD-W151-FDC-001

REV. 3

FUNCTIONAL DESIGN CRITERIA

Project W-151

TANK 101-AZ WASTE RETRIEVAL SYSTEM

July 1995

Prepared for

U. S. Department of Energy
Richland Field Office
Richland, Washington

by

Westinghouse Hanford Company
Under Contract DE-ACOF-87RL10930
Richland, Washington

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FUNCTIONAL DESIGN CRITERIA
TANK 101-AZ WASTE RETRIEVAL SYSTEM

1.0 INTRODUCTION

1.1 Background and Purpose

The reference case for disposal of Hanford defense wastes includes conversion of liquids and solids from double-shell tanks (DSTs) into a solid form as either high level or low level waste. The first step in accomplishing these processes is the physical retrieval of the liquids and solids from the tanks. The accomplishment of retrieval operations will also allow optimum utilization of existing DST space and will be one step in the preparation of the DSTs for final disposal at the end of their service life.

Westinghouse Hanford Company (WHC) has been assigned the task to develop and demonstrate a method of retrieval for DST waste. Tank 241-AZ-101 has been selected as the first location for demonstration testing of a retrieval system (Lawler 1986a, Lawler 1986b, Sasaki 1986, Stegen 1988).

The material stored in tank 101-AZ (and other 'aging waste' tanks) has a high concentration of radioactive solids and a high rate of radioactive heat generation which requires special design parameters and extra equipment for agitation of the wastes to maintain conditions within tank operating specifications and to monitor tank and waste conditions. The extra equipment includes airlift circulators, thermocouple assemblies, sludge radiation measurement dry wells, and a steam coil for use during the initial filling operations. This in-tank equipment will cause interference and special problems during mixer pump retrieval operations. Retrieval of waste under these conditions has not been demonstrated at Hanford.

In this document, the term 'retrieval system' includes not only the equipment necessary to mobilize and remove solids and supernate from the DST, but also the support equipment needed to qualify, install, and operate the retrieval system equipment. The 'retrieval system' also includes the support equipment needed to remove and dispose of the retrieval equipment and any existing DST equipment which must be modified or replaced to accommodate the retrieval process.

Tank 241-AZ-101 contains approximately one million gallons of neutralized current acid waste (NCAW), including about 20 inches of solids settled on the bottom of the tank, in addition to solids that are presently suspended in the supernate by the airlift circulators.

Mixer pumps were chosen as the planned method of waste retrieval from DSTs (Lawler 1986b, Lawler 1986c, Stegen 1988) based on engineering technology studies (Scott 1986), past experience with hydraulic sluicing at Hanford (Rasmussen 1980), experience with mixer pumps at the Savannah River Plant (SRP) (Comly 1979, Goslen 1986), and by the recommendations from two engineering studies: "Engineering Study Tank Farm Solids Retrieval System," WHC-SD-WM-ES-083, Rev. 0 (RHO March 1987) and the "Mixer Pump Study for Project W151" (Shaw 1992). Safety, versatility, schedule, and cost considerations were the principal factors which led to the choice of in-tank mixer pumps rather than remotely operated hydraulic sluicing nozzles.

Although some tests of mixer pumps have been performed in actual waste tanks at Hanford, those tests have been of limited scope, using only one mixer pump at a time. Retrieval work at the SRP and at West Valley Nuclear Services has shown that more than one mixer pump must be used in a tank to achieve mobilization of a large fraction of the settled solids (Comly 1979, Goslen 1986). The Hanford DST waste is thought to be similar to the SRP waste and thus it is probable that multiple mixer pumps will be required. Pacific Northwest Laboratories (PNL) has investigated waste characteristics and recommended mixer pump/tank configurations needed to retrieve NCAW (Fow 1987).

Based on this background, Project W-151 will provide two mixer pumps of the largest practical size (along with essential ancillary equipment) which can be installed and operated safely within this DST. Following project completion a functional test (FT) will be conducted under the direction of DST Retrieval Technology.

The operational goal of the 241-AZ-101 FT is to achieve 90 percent mobilization of approximately 20 inches of solids which have settled to the tank bottom and to demonstrate that a slurry suitable for transfer to the treatment facility can be maintained within the tank. The information and experience gained during this FT is expected to:

- Provide data for comparison of the observed waste solids mobilization in Tank 241-AZ-101 to studies of solids mobilization. Solids mobilization studies have been generated from small scale experiments with sludge simulants, and scale model testing for prediction of the maximum solids cleaning radius.

- Provide data for comparison with sludge mobilization prediction models to estimate the number and location of mixer pumps, and the clean-out time cycles needed for various other Hanford waste tanks.

- Provide data to compare to analytical models and laboratory test data used to estimate forces on in-tank components. Verify the effects of mixer pump operation on other DST operating parameters, including the ventilation system.

- Identify design or operational improvements for future in-tank mixing or retrieval systems at Hanford.

Data obtained during the test will provide bases information for establishing mobilization and suspension criteria for later DST retrieval systems. Upon conclusion of the FT (i.e., determination of the degree of mobilization and suspension of waste solids), the retrieval system equipment shall be left in place for use during retrieval operations.

1.2 Justification

The results of the FT will determine whether the two mixer pump system is suitable or requires modification to make it suitable to support initial sludge mobilization retrieval operations.

Although no waste solution will actually be transferred from the tank during the test, the performance of the equipment will provide a basis for the decision as to whether the NCAW will meet the treatment/transfer feed requirements.

1.3 Scope

This document provides criteria for design of equipment to be used at tank 241-AZ-101 in the retrieval system FT. The scope of work to be accomplished by Project W-151 to support the criteria presented in this document includes the following:

1.3.1 Design, procure, acceptance test, run-in test, and install two mixer pump assemblies in 241-AZ-101.

1.3.2 Design and provide control and monitor equipment for operation of two mixer pumps and necessary ancillary equipment. This equipment will be used for the initial run-in testing of the pumps and may be of use in future pump operations.

1.3.3 Design and supply an electrical substation with capacity to supply two mixer pumps and associated equipment. This substation will replace existing transformer C8-S27 and must be capable of supplying the existing C8-S27 loads as well.

1.3.4 Design and provide a mixer pump operation and speed control facility at the AZ Tank Farms.

1.3.5 Design and provide the DST upgrades and the tank internal equipment upgrades with sufficient structural strength to withstand the jet forces which will result from mixer pump operation.

1.3.6 Provide equipment capable of removing, cleaning and contamination reduction, transport, and storage or disposal, of contaminated equipment and fixtures as required to support the test. This will include all waste retrieval system equipment installed to support the FT and any equipment removed from the tank prior to the test.

1.3.7 Design and provide instrumentation required to measure the effects and results of mixer pump operation during the functional test, and also provide instrumentation required to replace existing instrumentation removed from the tank to satisfy internal equipment structural upgrades.

1.3.8 Provide filtered water supply and control for the mixer pump bearings and seals, as required.

1.3.9 Provide necessary site preparation work.

1.3.10 Provide a facility for onsite run-in test of mixer pumps.

The actual functional testing of the retrieval system is not within the scope of Project W-151.

2.0 SYSTEM FUNCTIONAL REQUIREMENTS

A final and complete DST waste retrieval system will have the capabilities to perform four functions:

- Mobilize solids which are presently settled in the tank.
- Maintain the solids in a slurry suspension while waste is transferred out of the tank.
- Transfer the slurry out of the DST.
- Removal and storage or disposal of contaminated retrieval system equipment.

The systems installed by Project W-151 will not provide all of these capabilities. Project W-151 shall provide the capabilities required to perform the mixer pump FT. Project W-151 will not provide transfer capabilities.

2.1 Location and Interfaces

The location of all facilities and equipment associated with this work is in the 200 Areas on the Hanford Site except for the onsite run-in test facility which is located in the 400 Area at the Maintenance and Storage Facility (MASF). Principal work will occur in the 241-AZ Tank Farm. Two mixer pumps shall be installed in tank 241-AZ-101 through existing 42" risers.

The connection location of the permanent mixer pump power supply to the Hanford electrical grid has been determined during the electrical design activities and is located outside the corner of AZ Tank Farm fence line next to AN Tank Farm.

Equipment to control and monitor the mixer pumps during the FT shall be in an environmentally controlled structure at the tank farm. A mixer pump running status indicator/alarm shall be located on the Tank Monitoring and Control System (TMACS).

The retrieval system design shall not eliminate any of the existing 101-AZ operating equipment or monitor and control systems. Operation, control, and monitoring functions for all existing tank equipment shall be retained at the same location as with current Tank Farm Operations. Existing equipment monitors and records selected waste and structural temperatures, and dome space pressure in tank AZ-101. This equipment will provide input to attain complete mixer pump shutdown upon failure of the primary tank ventilation system or upon loss of DST vacuum.

Equipment to supply and control filtered raw water to the mixer pump bearings/seals shall be located in building AZ-801A or a suitable alternate location.

The existing transfer pump in sluicing pit 241-AZ-01C shall be removed. A new transfer pump shall be provided by others for later installation. A new transfer pump is not in the scope of this project.

Although the present FT will not involve actual waste transfer through underground process pipe lines, such connections will be required at a later date for waste transfer to a treatment facility.

The FT can not be performed without completion of Project W-030 which provides upgrades to the ventilation system for Tank AZ-101.

2.2 Description of Functional Test Procedure Testing Functions

Upon completion of installation, checkout, and acceptance of all retrieval system equipment, the equipment will be operated under an approved test procedure. The test activities are expected to last from two to six months. The FT test shall provide information to:

2.2.1 Determine the maximum acceptable speed of the mixer pump(s) based on measurements of the jet force on in-tank components or the rated pump speed, whichever is greater.

2.2.2 Determine the degree of solids mobilization as a function of pump speed and operating time for individual pumps and for both pumps operating.

2.2.3 Determine the effects of aerosol loading in the ventilation exhaust stream as a function of mixer pump operating conditions.

2.2.4 Determine the minimum pump speed (motor rpm) required to maintain the solids in suspension after mobilization.

2.2.5 Determine and evaluate any changes in mixer pump performance, other DST equipment including in-tank components, and tank farm operating parameters during the FT.

2.2.6 Evaluate mixer pump controls and monitoring instruments, and determine their adequacy for future retrieval system operation.

2.3 Design Life

The operating design life of the individual mixer pump components is five years or 44,000 hours. This design life will support the functional test and future waste retrieval operations associated with Tank AZ-101.

Upon conclusion of the test the retrieval system equipment shall be left in place for use in retrieval operations.

The design life of permanent modifications of tank 101-AZ and non-replaceable ancillary and support equipment shall be consistent with the remainder of the 50-year design life of the 241-AZ Tank Farm, which was completed in 1976. Replaceable equipment and components may have a design life of a lesser number of years, but generally not less than five years.

2.4 Operating Environment

All equipment exposed to ambient conditions outside the tank shall be designed to operate under adverse open field conditions as defined in Hanford Standard Design Criteria (SDC) 4.1, Rev. 11.

Retrieval system components and assemblies located at or within the DST shall be designed to withstand the radiation environment shown in Table 2.4.

Table 2.4

Dose Rates to Retrieval Mixer Pumps in Neutralized Current Acid Waste (Based on in-tank measurements)

Worst Case for Pump Assembly: Tank sludge completely settled in bottom 36 inches of tank.

Dose Rate = 670 R/hr

Total Integrated Dose = 2.9E+07 R*

Worst Case for Pump Support Column Assy: Tank sludge well mixed with supernate.

Pump Assembly in Slurry Below Riser		Parts in S. Pit Above Rad. Shield	
Dose Rate (R/hr)	Total Integrated Dose (R)*	Dose Rate (R/hr)	Total Integrated Dose (R)*
670	2.9E+07	50	2.2E+06

Worst Case for Pump Motor and Components: Tank Sludge well mixed with supernate.

<u>Items Above Cover Blocks and 1-in Mount Flange</u>

Dose Rate = 0.5 mrem/hr

* Indicates total integrated dose for 44,000-hour life.

2.5 Tank Waste Properties

Retrieval system components and assemblies which will contact the waste shall be compatible with the waste fluid properties presented in Table 2.5A and compositions in Tables 2.5B, 2.5C, and 2.5D. Those in-tank parts of the mixer pump or other in-tank equipment which are not submerged in the liquid will be exposed to waste vapor at temperatures from 40°C to 100°C.

TABLE 2.5A

Pump Design Fluid Composition and Property Ranges (Major Components)

COMPONENT	RANGE	PUMP DESIGN POINT
NaOH (M)	0 to 2.5 (generally ≥1.0)	
$NaAlO_2$ (M)	0 to 2.0	
$NaNO_2$ (M)	0 to 3.0	
$NaNO_3$ (M)	0 to 4.0	
Na_2CO_3	0 to 0.5	
Na_3PO_4 (M)	0 to 1.0	
Na_2SO_4 (M)	0 to 1.0	
NaF (M)	0 to 0.2	
Total Na^+ (M)	≤5.5	
pH	≥12.0	
Specific Gravity	1.0 to 1.4	1.2
H_2O (%)	50 to 100	
Temperature (°C)	10 to 130	130
Solids (vol%)	0 to 50	20
Size (microns)	1 to 1000 (95% < 50 micron)	
Miller Number (ASTM G75-82)	<10	
Viscosity (cP)	1.0 to 50	5.0
Tank Vacuum	-0.25" to -3.0" wc	-2.0" wc

TABLE 2.5B	
SUPERNATE COMPOSITION	
WASTE COMPONENT	WASTE COMPOSITION(A)
239/240-Pu	4.300E-10 Ci/g
238-Pu	6.600E-11 Ci/g
241-Am	1.100E-08 Ci/g
237-Np	5.900E-11 Ci/g
Total TRU (α)	1.155E-08 Ci/g
243,244-Cm	1.200E-10 Ci/g
241-Pu	3.600E-09 Ci/g
242-Cm	3.400E-11 Ci/g
14-C	1.200E-09 Ci/g
3-H	3.200E-08 Ci/g
129-I	6.000E-10 Ci/g
79-Se	2.100E-10 Ci/g
90-Sr	4.800E-06 Ci/g
99-Tc	3.200E-07 Ci/g
144-Ce	1.700E-05 Ci/g
60-Co	7.500E-07 Ci/g
134-Cs	3.000E-05 Ci/g
137-Cs	1.700E-03 Ci/g
154-Eu	5.500E-06 Ci/g
106-Ru	2.700E-05 Ci/g
125-Sb	2.100E-05 Ci/g

(A) From PNL report PNL-7758 (UC-721), September 1989.

TABLE 2.5C	
SLUDGE COMPOSITION	
WASTE COMPONENT	WASTE COMPOSITION[A]
239/240-Pu	4.400E-06 Ci/g
238-Pu	6.900E-07 Ci/g
241-Am	5.900E-05 Ci/g
237-Np	2.300E-08 Ci/g
Total TRU (α)	6.411E-05 Ci/g
243,244-Cm	6.700E-07 Ci/g
241-Pu	3.700E-05 Ci/g
242-Cm	1.300E-07 Ci/g
14-C	1.900E-09 Ci/g
3-H	1.500E-08 Ci/g
129-I	6.500E-10 Ci/g
79-Se	4.500E-09 Ci/g
90-Sr	2.400E-02 Ci/g
99-Tc	8.100E-07 Ci/g
144-Ce	2.700E-03 Ci/g
60-Co	1.200E-05 Ci/g
134-Cs	2.700E-05 Ci/g
137-Cs	1.700E-03 Ci/g
154-Eu	8.200E-05 Ci/g
106-Ru	1.400E-03 Ci/g
125-Sb	1.600E-04 Ci/g

(A) From PNL report PNL-7758 (UC-721), September 1989.

TABLE 2.5D

SLUDGE & SUPERNATE COMPOSITION

WASTE COMPONENT	WASTE COMPOSITION[A]
239/240-Pu	3.671E-07 Ci/g
238-Pu	5.757E-08 Ci/g
241-Am	4.928E-06 Ci/g
237-Np	1.976E-09 Ci/g
Total TRU (α)	5.354E-06 Ci/g
243,244-Cm	5.595E-08 Ci/g
241-Pu	3.087E-06 Ci/g
242-Cm	1.087E-08 Ci/g
14-C	1.358E-09 Ci/g
3-H	3.325E-08 Ci/g
129-I	6.542E-10 Ci/g
79-Se	5.850E-10 Ci/g
90-Sr	2.005E-03 Ci/g
99-Tc	3.875E-07 Ci/g
144-Ce	2.420E-04 Ci/g
60-Co	1.750E-06 Ci/g
134-Cs	3.225E-05 Ci/g
137-Cs	1.842E-03 Ci/g
154-Eu	1.233E-05 Ci/g
106-Ru	1.437E-04 Ci/g
125-Sb	3.433E-05 Ci/g

(A) From PNL report PNL-7758 (UC-721), September 1989.

2.6 Decontamination and Decommissioning

Design features shall be identified and utilized which enhance the ability to decontaminate equipment and to control contamination spread during installation, removal, and decommissioning of the mixer pumps and all retrieval system supporting equipment and the existing in-tank components which require removal to support the operation of the tank waste retrieval system.

Appropriate containers shall be provided to effect removal, receipt, transport, and storage or disposal of equipment which must be removed from DST 241-AZ-101 before testing, with the exception that containers shall be provided for removal of a failed mixer pump if required in support of the FT.

3.0 EQUIPMENT DESIGN CRITERIA

The equipment shall maintain the tank operating requirements listed in the tank operating specifications for 241-AN, AP, AW, AY, AZ, and SY Tank Farms; OSD-T-151-00007 and tank operating specification for AY and AZ; and OSD-T-151-00017.

3.1 Mixer Pumps

The functional requirements and design criteria for the mixer pumps are defined in the following sections with additional supporting information on pump design parameters identified in the Mixer Pump Study for Project W-151, WHC-SD-WM-ES-195, Rev. 0 (Shaw 1992) and Stress Cycles and Forces on In-Tank Components Resulting From Mixer Pump Operation in DST 101-AZ (Water 1993).

3.1.1 Function - Each mixer pump shall take in fluid from the tank bottom and discharge the fluid horizontally through two opposing nozzles located 12 to 18 inches above the tank bottom. The nozzle assembly shall oscillate rotationally (180°) or rotate 360° at 0.05 to 0.2 rpm to sweep the entire projected area of the tank bottom. The mixer pump shall be designed to operate within the temperature range of 10°C to 130°C (approximate liquid boiling point), and shall be capable of operation with the 30 ft liquid waste at temperatures up to 130° C and as defined below.

Waste mobilization by mixer pump operation has been shown (Comly 1979, Fow 1987) to be a function of the pump head and capacity, expressed as the product of nozzle discharge velocity and nozzle diameter,

$$ECR = f(U_oD)$$

where ECR = effective cleaning radius, feet
U_o = discharge velocity, feet/second
D = nozzle diameter, feet

The 241-AZ-101 mixer pump nozzles shall have a discharge velocity in the range 40 to 100 feet/second and a corresponding nozzle diameter to provide a head/capacity value (U_oD) of 25 to 29.4 ft^2/second with a tank liquid level of 30 feet and liquid at 130° C. Head/capacity values less than 25 are acceptable at liquid levels below 22 feet, but it is desired that the mixer pump be capable of full capacity operation with a 4- to 6-foot liquid level of waste water remaining in the tank at 75°C or less.

A variable speed pump motor control shall be provided to allow control of the pump speed and thus vary the rate of discharge from the nozzles. The speed control equipment as a minimum shall allow speed variation between 25 and 100 percent of full rated speed. To minimize the potential for pump inlet cavitation, a reduced pump speed and capacity will be used when the liquid is at its boiling point (approximately 130° C) and the liquid level drops below about 22 feet.

The pumps shall be capable of 5,000 hours of operation (including intermittent operation) and have a design life of at least five years. Instrumentation shall be provided to monitor for safe operation of the mixer pumps.

3.1.2 Form - Each mixer pump assembly shall include a pump body, pump intake with intake screen, two horizontally opposed discharge nozzles, a pump drive motor with variable speed control, a mounting turntable, and a turntable drive mechanism. The assembly shall be suspended in the DST roof through a 42" riser. The weight shall be supported from either the riser flange, the sluice pit, or external supports, as determined by structural analyses. The pump support column shall suspend the pump intake within 7 to 12 inches of the tank bottom and the discharge nozzles at an elevation of 12 to 18 inches above the tank bottom.

The support column shall have sufficient strength to withstand a lateral force of 450 lbs, applied 47 feet below the sluice pit riser. This force is caused by the impact on the pump casing and the support column of the liquid jet from the second mixer pump in the tank.

Auxiliary sluice nozzles shall be provided as part of the pump intake to allow injection of 80-100 psig raw water to provide removal of waste sludge from below the pump as it is lowered into the tank.

A pump bearing/seal water supply and control system shall provide filtered raw water at a pressure of 50 to 60 psig with a flow rate as determined by the pump vendor. The bearing and seal water supply shall be designed for ambient conditions from 10°C to 130°C. The supply water above the riser shall be designed for ambient conditions from -30°C to 50°C.

The pump drive motor (line shaft drive type) shall be located above grade to allow self cooling or submerged internally (direct drive) in the pump column with external cooling provided. The turntable drive motor and gearbox shall be capable of operating over a temperature range of -10°C to +50°C, humidity from 0 to 100 percent, and atmospheric pressure without need for auxiliary environmental control. The pump drive motor shall be 3 ø, 60 Hz, 480 V.

The mixer pump materials of construction shall be compatible with the fluid and environment as described in Section 2.4. All metals below the riser flange shall be stainless steel or equivalent non-oxidizing type material and shall have a surface finish to facilitate decontamination for transport and burial.

The mixer pump assembly shall provide seals to prevent contamination spread from the DST tank interior to the sluice pit or the external environment. Lifting fixtures shall be provided to allow handling of the mixer pump in the horizontal position, vertical position, to rotate the pump from one position to another, and to allow straight vertical insertion of the assembly into the DST.

3.1.3 Fit - All in-tank portions of the mixer pump assembly shall have a maximum overall diameter of 41 inches to allow insertion of the assembly through a 42-inch inside diameter riser without an interference fit.

All portions of the mixer pump assembly above the riser flange shall be designed to fit within a 52-inch diameter envelope to accommodate use of the removal equipment. Provisions shall be made for sequential installation and proper critical alignment of the pump shaft and the motor shaft (line shaft driven pump).

The pump discharge nozzles shall direct the liquid in a horizontal direction at an angle of 90 degrees +5 -0 from the vertical pump support column (i.e., the nozzle discharge is at or below the horizontal).

3.1.4 Run-in Testing - The mixer pumps shall undergo a run-in test at the Fast Flux Test Facility's Maintenance and Storage Facility in the 400 Area of the Hanford Site prior to installation in tank 101-AZ.

3.1.5 The mixer pumps may require installation utilizing a removable impact limiter designed to absorb the impact of a dropped pump from full insertion height (CR-W151-016). The impact limiter shall be designed for both insertion and removal of the pump, and shall be compatible with the flexible receiver.

3.2 Power Supply

One permanent substation power supply is associated with this project, with capacity to operate 2 mixer pumps, ancillary equipment and existing AZ loads.

Permanent - An electrical substation and pump control facility will be installed at the tank farm. The substation will replace existing transformer C8-S27 and, in addition to the current C8-S27 loads, will have capacity to supply two mixer pumps and any associated loads. The pump control facility will be a pre-engineered metal building housing the substation instrumentation and switchgear necessary to serve two pump motors. The building will be equipped with a heating, ventilating, and air conditioning system. Underground duct banks will be used for routing of cables between the transformer, switchgear, and tank 101-AZ.

3.3 Ventilation

Results of laboratory and field tests indicate mixer pumps will not significantly increase the aerosol loading on the ventilation filtration equipment. No change in this equipment is warranted for the retrieval system FT (Ruecker 1988). Radioactive aerosol loading on the filters will be monitored using existing equipment prior to and during the FT. The new ventilation system for 101-AZ (part of Project W-030) will be sized for two 300 hp mixer pumps with a thermal input into the waste of 201 kw (687,000 Btu/h) each or a total of 402 kw (1.37 E6 Btu/h). Larger horsepower pumps will be acceptable if their energy input is equal to or less than that specified above. Provisions for cooling may be required if their thermal input is greater.

3.4 Instrumentation and Controls

All instrumentation and controls necessary to control and monitor operation of the two 101-AZ mixer pumps during the conduct of the functional test shall be installed in the 241-AZ tank farm control room. Existing equipment is available to monitor and record selected waste and structural temperatures (existing) and the vapor pressure in tank AZ-101. This equipment will provide input to attain complete mixer pump shutdown upon failure of the primary tank ventilation system or upon loss of DST vacuum. A mixer pump running status indicator shall be provided on TMACS for on/off indication of the mixer pumps.

Special instrumentation to measure the effects and results of mixer pump operation shall be designed and installed for use during the test. As a minimum, the instrumentation shall include means to:

- measure the stress on two profile thermocouple assemblies;
- detect changes in solids content of the waste liquid and the extent of sludge mobilization;
- monitor temperatures of mixer pump drive motor and motor bearings;
- locally monitor mixer pump bearing/seal lubrication water flow;
- measure mixer pump discharge pressure (during run-in test);
- locally measure vibration of the mixer pump assembly;
- mixer pump rotation speed and direction indication;

Mixer pump control and monitoring equipment installation and use shall not preclude the use of essential existing instrumentation for normal monitoring of tank farm operations.

3.5 Clearances and Tolerances

All equipment design and construction tolerances shall be completely and clearly defined on the engineering drawings, documents, and specifications prepared in accordance with this document.

3.6 Structural

Analyses shall be performed to ensure that mixer pump installation does not compromise the structural integrity of the DST and DST equipment, and its ability to meet the requirements of Section 5.4.

The mixer pump jet forces which impact on existing tank internal equipment, including another mixer pump and a waste transfer pump installed within tank AZ-101, have been calculated using two different approaches (Allemann 1989, Valdiviez 1989). Based on these studies, the forces presented in Table 3.6 are expected to represent upper limits.

Analysis has shown that removal, rotation, or raising of some existing 101-AZ in-tank equipment items will be necessary (Waters 1993 and Winkel 1989). The equipment items indicated cannot withstand the forces imposed upon them by the liquid jets, including the fatigue stresses which result from the oscillatory motion of the mixer pump jet streams.

Equipment designs and modifications shall be provided, within allowable stress limits, to withstand the forces in Table 3.6 and to ensure control of radioactive materials and airborne particulates, and to control radiation exposure to Operations personnel and the public.

Liquid level and sludge level indicators are omitted from Table 3.6 because these devices will either be on or above the surface of the waste liquid and will not experience significant forces.

TABLE 3.6

Maximum Jet Forces Expected on 101-AZ Retrieval System Equipment

Component (Ref. H-2-67314)	Horizontal Force at Bottom of Item, lbs	Suggested Modification
Mixer pump	450	None
AL circulators with TCs	200	None
Present transfer pump	150	Remove
Heater coil	350	Raise/rotate
Profile temperature	90	Remove & replace
Rad. dry well	280	None
Sludge temperature	360	Remove & replace
Liquid inlets	15	None

The above information shall be used in the design and analysis of modifications to or replacement of equipment in the tank.

3.7 Component Removal/Storage Containers

Appropriate containment fixtures and enclosures shall be designed and provided to allow the removal, transport, storage, and/or burial of tank 101-AZ waste mobilization and retrieval system equipment, including the following.

- New mixer pumps (2)
- Existing profile thermocouple assemblies (4)
- Existing sludge thermocouple assemblies (3)
- Existing waste transfer pump (1)
- New special fixtures and enclosures to accomplish this work.

The criteria applicable to design and construction of the removal/storage containers and ancillary equipment include the following.

3.7.1 General - Materials selection, fabrication, inspection, and testing of waste containers shall be in accordance with WHC-EP-0063, Rev.3 and shielding requirements shall meet surface dose rates therein, or approved administrative controls shall be used for large size and/or weight packages. Dose rates to personnel and external surface contamination on reusable components shall be in accordance with WHC-EP-0063, Rev.3.

Waste volume of waste packages to be transported, stored and buried shall be minimized.

3.7.2 Removal - Removal equipment shall be designed with the goal of removing residual NCAW waste liquid and solids (that is, reducing dose fields) from equipment as it is removed from tank 101-AZ. The radioactive categorization given to removed equipment currently from tank 101-AZ, based on the debris rule, will be mixed waste.
The quantity of residual NCAW waste on the equipment shall be determined by measurement of activity level of the equipment as it is withdrawn from the tank, or through the receiver container walls, and back calculated based on known activity levels of waste samples from the DST.

Substances used for component dose reduction must be compatible with the waste tank and internals, its ancillary equipment, and containment system. This is to preclude rupture, leakage, or other failures of the system and to be compatible with future use of the tank for waste receipt and storage. Use of acid washes will not be acceptable. Treatment reagents which would cause the waste to be a 'Listed Waste' as defined in WAC 173-303-080 shall also be avoided.

During component removal and container handling, tank dome loads shall be limited to those specified in the Aging-Waste Tank Farm Operating Specification (Bergmann 1988).

Crane handled waste containers/packages shall be designed for safe lifting, including critical lifts, and in accordance with required safety factors for lift attachments, lift fixtures, and the waste package.

3.7.3 Transport - Waste packages shall be designed adequately for onsite transport in accordance with provisions of WHC-EP-0063, Rev. 3, WHC-CM-7-5 and WHC-CM-2-14, or designed such that adequate administrative controls can be written to provide the equivalent degree of safety and prevent the accident scenario from occurring. The transporter design shall include reusable shielding (e.g., overpacks, etc.), as far as practical, to minimize waste volumes in storage/burial.

3.7.4 Storage - Packages shall be stored based on the contents being mixed waste.

4.0 FACILITY DESIGN CRITERIA

4.1 Shielding

The design of the retrieval system equipment placed within 101-AZ shall provide shielding sufficient to attenuate dose rates to meet the requirements of WHC-CM-4-9 during the conduct of the FT and during normal tank farm operations. The DOE and WHC 'as low as reasonably achievable' (ALARA) guidelines (WHC-CM-4-11) shall be implemented in design of equipment and planning of construction, installation, operation, maintenance, and decommissioning activities. For use in shielding design, the isotopic content of the waste has been defined (Mihalik 1988).

4.2 Utilities

Appropriate utilities shall be provided for flushing capabilities, equipment control, and instrument functions for the mixer pumps. See Section 3.4 for required instrument and control functions.

Raw water shall be provided, with suitable controls and connections to the mixer pump, to provide:

4.2.1 Sluicing of waste sludge from beneath the mixer pump as it is lowered into the tank;

4.2.2 Seal and bearing water to the mixer pump mechanical seals and bearings (see Section 3.1.2);

4.2.3 Flushing of the mixer pump for decontamination during removal;

Raw water will also be required for cleaning of equipment as it is removed from the waste tank.

Water pressures and quantities needed during mixer pump installation and during equipment removal shall be determined during the design activities. Heat tracing of piping shall be provided, as required, to protect new equipment from freezing.

4.3 Reliability

The new structures, equipment, piping, and utilities shall be designed to permit the facilities to function throughout the design life without major repair or replacement.

5.0 GENERAL REQUIREMENTS

5.1 Safety

Safety analyses shall be performed in accordance with DOE Order 5481.1B, DOE Order 6430.1A, Section 0110-5.2, and WHC-CM-4-46.

A draft Preliminary Safety Evaluation (PSE) was completed prior to the end of conceptual design, and recommendations resulting from the draft PSE were incorporated into the conceptual design and cost estimate. The draft PSE was then updated to reflect design changes made during the completion of the conceptual design activities. The final PSE (Waters 1990a) was completed and issued with the conceptual design media.

The safety class systems are identified in the project Preliminary Safety Analysis Report (PSAR), WHC-SD-W151-PSAR-001.

A revision to the Aging Waste Facility Safety Analysis authorization basis shall be prepared, completed, and approved prior to initiation of the functional testing in Tank AZ-101. A Functional Test Plan for in-tank testing of mixer pumps shall also be prepared and approved prior to conduct of the test.

In the design of the retrieval facilities and equipment, attention shall be given to the containment of radioactive materials and airborne particulates and to radiation exposure of personnel. New equipment and components shall be designed to provide and maintain containment of radioactive solutions and vapors, including provisions for containment of any solutions which may leak from defective equipment or from equipment as it is being removed from the waste tank. Any leak of solution to ground surfaces is unacceptable.

5.2 Criticality Control

Criticality control shall be maintained during waste mobilization and retrieval operations in accordance with Criticality Prevention Specification CPS-T-149-00010, CSAR-79-007, U.S. Department of Energy, Richland Operations Office (RL) Order 5480.5 and WHC-CM-4-29, as applicable.

5.3 Quality Assurance

Quality Assurance/Control activities for all contractors involved in design, construction and acceptance testing shall be executed in accordance with the project specific Quality Assurance Program Plan (QAPP) WHC-SD-W151-QAPP-001, latest revision. The QAPP shall be developed during conceptual design and approved/released prior to definitive design. This QAPP shall be used by the design contractor to develop verification criteria in design documents (i.e., drawings, specifications, test procedures, etc.) and by all contractors to define quality assurance interfaces and specific quality requirements/ responsibilities on the project.

The QAPP shall endorse the quality criteria of DOE Order 5700.6C "Quality Assurance."

The basis for establishing Quality Assurance Program requirements is safety classification as defined in Management Requirements and Procedures 5.46 "Safety Classifications of Systems, Components and Structures." The safety classification of items provides a graded approach to application of quality requirements. This graded approach assigns requirements to items commensurate with the function of each system, component and structure in preventing or mitigating the consequences of hazards and postulated design basis accidents. The overall safety classifications will be defined in the project PSAR.

5.4 Natural Forces

All new or modified retrieval structures, equipment, and piping shall be analyzed and designed in accordance with the natural phenomena loading criteria as stated in SDC 4.1, Rev. 11. The loading of components and structures shall be a function of the safety classes listed in the PSAR.

All new retrieval structures, equipment and piping shall be analyzed and designed such that they will not cause or contribute to breach of containment or confinement of radioactive materials as the result of a natural phenomena. The new structures, equipment, and piping shall be designed to withstand the design criteria for such natural phenomena such that the facility can be rendered to a safe status without undue risk to public health and safety.

The mixer pumps and ancillary equipment are not required to operate during and immediately following a safe shutdown earthquake.

The design of new equipment shall ensure that provisions are made to maintain final containment and confinement following a design basis power failure, including a total loss of power for 60 seconds and a loss of normal power for two days.

6.0 REGULATIONS, CODES, AND STANDARDS

Project design and construction efforts shall be in accordance with the following standards, codes, and regulations, as applicable.

- American National Standards Institute (ANSI)/American Society of Mechanical Engineers (ASME) Nuclear Quality Assurance-1, Quality Assurance Program Requirements for Nuclear Facilities.
- CPS-T-149-00010, Criticality Prevention Specification - Waste Storage Tanks and Associated Equipment, 6/17/88.

- CSAR-79-0007, Criticality Safety Analysis Report - Underground Waste Storage Tanks and Associated Equipment, December 1980.
- DOE Order 5400.1, General Environmental Protection Program.
- DOE-RL RLIP 4700.1A, Project Management System.
- DOE-RL Order 5480.4B, Environmental Protection, Safety, and Health Protection Standards.
- DOE-RL Order 5480.5, Safety of Nuclear Facilities.
- DOE-RL RLIP 5480.7, Fire Protection.
- DOE-RL Order 5480.10, Industrial Hygiene Program.
- DOE-RL Order 5480.11, Requirements for Radiation Protection and Liability Act Program.
- DOE Order 5481.1B, Safety Analysis and Review System.
- DOE 5700.6C, Quality Assurance.
- DOE Order 5820.2A, Radioactive Waste Management.
- DOE Order 6430.1A, General Design Criteria.
- DOE-RL Order 6430.1B, Hanford Plant Standards/Specifications.
- Hanford Plant Standards SDC-4.1, Rev. 11, Standard Arch-Civil Design Criteria.
- SD-HS-SAR-010, Aging Waste Facility Safety Analysis Report.
- Title 10 CFR 260-270, Resource Conservation and Recovery Act Hazardous Waste Regulations.
- WAC 173-303, Dangerous Waste Regulations, State of Washington.
- WHC-CM-1-3, Management Requirements and Procedures, Impact Levels.
- WHC-CM-4-2, Quality Assurance Manual.
- WHC-CM-4-3, Industrial Safety Manuals, Volumes 1-3.
- WHC-CM-4-9, Radiological Design.
- WHC-CM-4-11, ALARA Program Manual.
- WHC-CM-4-13, Operational Health Physics Procedures Manual.

- WHC-CM-4-29, Nuclear Criticality Safety Manual.
- WHC-CM-4-46, Nonreactor Facility Safety Analysis Manual.
- DOE-RL-92-36 Hanford Hoisting and Rigging Manual.
- WHC-CM-7-5, Environmental Compliance Manual.
- WHC-EP-0063, Rev. 3, Hanford Radioactive Solid Waste Packaging, Storage, and Disposal Requirements.

In addition to the above standards, applicable "national consensus" codes and standards and pertinent state and local codes and standards shall be used. At the start of definitive design, the latest edition of all codes and standards shall be used. As a minimum, the following national standards shall be used, as applicable.

- American Institute of Steel Construction Specifications for the Design, Fabrication, Erection of Structural Steel for Buildings
- ASME Boiler and Pressure Vessel Code
  - Section II
  - Section III
  - Section V Nondestructive Examination
  - Section VIII Division I - Pressure Vessels
  - Section IX Welding and Brazing Qualifications
- ANSI/ASME B-31.1 Power Piping Code
- ANSI/ASME B-31.3 Chemical Plant and Petroleum Refinery Piping
- American Society for Testing and Materials (ASTM) A380 Cleaning and Descaling Stainless Steel Parts, Equipment, and Systems
- ASTM G-75-82 Determination of the Abrasivity of Slurries
- American Welding Society (AWS) B2.1 Welding Procedures and Performance Specifications
- AWS D1.1 Structural Welding Code - Steel
- AWS D1.3 Structural Welding Code - Sheet Steel
- Institute of Electrical and Electronics Engineers (IEEE) 142 Recommended Practice for Grounding Industrial and Commercial Power Systems
- IEEE-242 Recommended Practice for Protection and Coordination of Industrial & Commercial Power Systems

- National Electrical Code C50.21 Test Procedure for Three-Phase Induction Motors
- National Electrical Manufacturing Association (NEMA) MG1 Motors and Generators
- National Fire Protection Association (NFPA) 70 National Electric Code
- NFPA 101 Life Safety Code
- NEMA MG13 Frame Assignments for Alternating-Current Integral-Horsepower Induction Motors

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