ENGINEERING CHANGE NOTICE

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1. ECN 650128

Proj.
ECN

2. ECN Category (mark one) Supplemental ☐ Direct Revision ☒ Change ECN ☐ Temporary ☐ Standby ☐ Supersedeure ☐ Cancel/Void ☐	3. Originator's Name, Organization, MSIN, and Telephone No. Thomas W. Staehr, TWRS Retrieval Engineering, R3-74, 372-3013	4. USQ Required? Yes ☒ No ☐ TF-96-0610R2, R1 (TF-96-0690, R2)	5. Date 1/11/99
	6. Project Title/No./Work Order No. Mixer Pump Test Plan for Double Shell Tank AZ-101	7. Bldg./Sys./Fac. No. 241-AZ-101	8. Approval Designator ESQ
	9. Document Numbers Changed by this ECN (includes sheet no. and rev.) WHC-SD-WM-PTP-027, Rev. 2	10. Related ECN No(s). NA	11. Related PO No. NA
12a. Modification Work ☐ Yes (fill out Blk. 12b). ☒ No (NA Blks. 12b, 12c, 12d)	12b. Work Package No. NA	12c. Modification Work Complete NA Design Authority/Cog. Engineer Signature & Date	12d. Restored to Original Condition (Temp. or Standby ECN only) NA Design Authority/Cog. Engineer Signature & Date

13a. Description of Change

13b. Design Baseline Document? ☒ Yes ☒ No

This ECN is being generated in order to incorporate additional requirements from the TWRS Basis for Interim Operation, and Addendum 4, "Safety Analysis for Tank 241-AZ-101 Mixer Pump Test", including controls per TSR-006 and structural testing of in-tank components. Other changes include the addition of minimum equipment/instrumentation requirements, description and use of suspended solids monitor and sludge weights, the addition of a sludge settling testing sequence, and the addition of a start up section.

14a. Justification (mark one)

Criteria Change ☒	Design Improvement ☐	Environmental ☐	Facility Deactivation ☐
As-Found ☐	Facilitate Const ☐	Const. Error/Omission ☐	Design Error/Omission ☐

14b. Justification Details

Changes are required to be in compliance with the TWRS BIO.
~~A USQ is not required for the test plan because it is not a specific activity, implementing document as specified in TWRS USQ Process Bulletin #6, dated June 4, 1998. Operating procedures will require USQ screening.~~
 TW 3-1A-99

15. Distribution (include name, MSIN, and no. of copies)

See distribution sheet.

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650128

16. Design Verification Required		17. Cost Impact		18. Schedule Impact (days)	
		ENGINEERING		CONSTRUCTION	
☐ Yes		Additional ☐ \$		Additional ☐ \$	
☐ No		Savings ☐ \$		Savings ☐ \$	
19. 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 13. Enter the affected document number in Block 20.					
SDD/DD	☐	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	☐	Tickler File	☐
Environmental Report	☐	Inspection Plan	☐		☐
Environmental Permit	☐	Inventory Adjustment Request	☐		☐

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21. Approvals

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Signature or a Control Number that tracks the Approval Signature

ADDITIONAL

Mixer Pump Test Plan for Double Shell Tank AZ-101

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Abstract: Mixer pump systems have been chosen as the method for retrieval of tank wastes contained in double shell tanks at Hanford. This document describes the plan for testing and demonstrating the ability of two 300 hp mixer pumps to mobilize waste in tank AZ-101. The mixer pumps, equipment and instrumentation to monitor the test were installed by Project W-151.

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Thomas W. Staehr 2/9/99
Release Approval Date

Approved for Public Release

MIXER PUMP TEST PLAN FOR DOUBLE-SHELL TANK AZ-101

prepared for

NUMATEC HANFORD CORPORATION

January 8, 1999

prepared by

T. W. Staehr

COGEMA Engineering Corporation
Richland, Washington

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ACRONYMS AND ABBREVIATIONS

AC	Administrative Control
ASTM	American Society for Testing Materials
AWF	Aging Waste Facility
CAM	Continuous Air Monitoring
CCTV	Closed-Circuit Television
SER	Safety Evaluation Report
D	Nozzle diameter
DST	Double-Shell Tank
ECR	Effective Cleaning Radius
JTRG	Joint Test Review Group
K	Proportionality Constant
LCO	Limiting Condition of Operation
MPT	Mixer Pump Test
MSA	Management Self assessment
NCO	Nuclear Chemical Operator
NOC	Notice of Construction
OE	Operating Engineer
OPC	Operator Personal Computer
OSD	Operating Specification Document
PNNL	Pacific Northwest National Laboratory
SHMS	Standard Hydrogen Monitoring System
SSP	Suspended Solids Profiler
SRS	Savannah River Site
τ	Shear stress
TOC	Total Organic Compounds
TSR	Technical Safety Requirement
TWRS	Tank Waste Remediation System
U_0	Fluid velocity
URSILLA	Ultrasonic interface level analyzer
USQ	Unreviewed Safety Question
VCR	Video Cassette Recorder
VFD	Variable Frequency Drive
WVNS	West Valley Nuclear Services

MIXER PUMP TEST PLAN FOR DOUBLE-SHELL TANK 241-AZ-101

1.0 INTRODUCTION

Fluor Daniel Hanford, Inc. has undertaken the task to develop and demonstrate a method for retrieval of double-shell tank (DST) wastes using mixer pumps. Mixer pump systems were chosen as the planned retrieval method for DSTs based on engineering technology studies, past experience with hydraulic sluicing at the Hanford Site, and experience with mixer pumps at the Savannah River (SRS) and West Valley Nuclear Services (WVNS) sites.

1.1 BACKGROUND

Limited testing and use of single mixer pumps has been performed in waste tanks at Hanford for mitigation of safety issues such as hydrogen generation. Retrieval work at SRS and WVNS has shown that more than one mixer pump must be used in a tank to achieve waste mobilization of a large fraction of the settled solids (Waters 1992). Hanford DST waste is thought to be similar to the SRS waste, and thus it is probable that multiple mixer pumps will be required.

Tank AZ-101 has been selected for the first full-scale demonstration testing of a retrieval system. Tank AZ-101 is located in the AZ Tank Farm in the 200 East Area. The tank is a 3,785,400-liter (1 million-gal), 23-meter (75-ft) diameter double-shell underground storage tank. The tank currently holds over 3,000,000 liters (800,000 gal) of neutralized current acid waste, including approximately 40 cm (16 in.) of sludge (settled solids) at the tank bottom.

Project W-151 has installed two mixer pumps and support equipment for operation in tank AZ-101. The test of the retrieval system will follow the completion of Project W-151 utilizing both existing and newly installed instrumentation. The test will be performed by DST Tank Farm Operations.

This test plan describes the mixer pump test (MPT) objectives, predicted results, test procedure, data analysis, and start up plan.

1.2 TEST OBJECTIVES

The purpose of the test is to demonstrate that the two 300 horsepower mixer pumps installed in tank AZ-101 can safely and adequately mobilize the settled sludge so that it can be transferred to a private contractor facility for treatment and vitrification. The execution of the mixer pump test will provide information to determine if:

- a) the mixer pumps can mobilize the sludge in sufficient quantities to provide feed to the private contractor facility,
- b) the mixer pumps can be operated within safety requirements,
- c) the tank instrumentation is sufficient to monitor sludge mobilization and mixer pump operation.

The specific objectives of the mixer pump test include:

1.2.1. SLUDGE MOBILIZATION

- a. Determine the effective cleaning radius achieved during operation of the pumps at various speeds.
- b. Estimate the volume and concentration of sludge mobilized.
- c. Determine the minimum mixer pump speed required to maintain the mobilized solids in suspension.
- d. Determine the sludge settling rates and compare to predicted results from models (MacLean 1998).

1.2.2. EFFECTS OF MIXER PUMP OPERATION

- a. Determine the maximum speeds that the pumps can be safely operated within allowable structural limits for in tank components (Juryk 1997, Waters 1993).
- b. Determine the effects of possible waste entrainment in the ventilation exhaust stream as a function of the mixer pump operating conditions.
- c. Evaluate the accuracy of thermal models and calculations to predict DST waste temperature increase during mixer pump operation by comparing actual data to the predicted data (Sathyanarayana 1994).

1.2.3. EQUIPMENT EVALUATION

- a. Evaluate the operation and adequacy of monitoring instrumentation.
- b. Characterize the operation of the mixer pumps

1.3 PREDICTED RESULTS

Acceptance criteria for meeting the test objectives include:

- Demonstration of mixer pump operation
- Gathering of sufficient data to evaluate mixer pump sludge mobilization effectiveness
- Demonstration of instrument operation/usefulness in measuring sludge mobilization parameters

The following are the expected results of the test:

1.3.1. SLUDGE MOBILIZATION

Models have shown that a U_0D of $2.7 \text{ m}^2/\text{s}$ ($29.4 \text{ ft}^2/\text{s}$) should be achieved at 1000 rpm resulting in an effective cleaning radius of 9.8 m (32.2 ft) (Fow 1987). A reasonable duration for mixing the waste to achieve maximum mobilization is estimated at less than 20 days (Powell 1995).

After initial mobilization of the sludge, it is expected that the mixer pumps will be operated at minimum speed (700 rpm) to maintain sludge mobilization. After the mixer pumps have been turned off, the sludge is expected to settle rapidly over the first few days and then settle at a more moderate rate for several months, based on laboratory tests with simulants. (MacLean 1998)

1.3.2. EFFECTS OF MIXER PUMP OPERATION

All in-tank components are structurally adequate over the full range of pump speeds for a sludge buildup thickness up to 8.9 cm (3.5 in), with the exception of the radiation drywell in riser 14A. The riser 14A drywell is structurally adequate at the minimum pump flow (approximately 70% of rated flow), if it has an estimated sludge buildup of 8.9 cm (3.5 in). (Juryk, 1997)

Mixer pump operation is not expected to increase the potential for aerosol or radioactive vapor production. (Waters 1994)

At full-speed operation of the two mixer pumps, the predicted waste temperature increase will be less than 0.0833 C/hr (0.15 F/hr) (Sathyanarayana 1997).

1.3.3. EQUIPMENT EVALUATION

Two mixer pumps are expected to be adequate for mobilization of solids in tank AZ-101. Monitoring equipment and instrumentation including a suspended solids monitor, gamma profilers and ultrasonic interface level detectors are expected to provide acceptable information to evaluate test results.

2.0 TEST EQUIPMENT AND INSTRUMENTATION

2.1 MIXER PUMPS

Two mixer pumps have been installed on opposite sides of tank AZ-101 in 107 cm (42 in.) risers 1C (south riser) and 1A (north riser). Pump characteristics are provided in Table 2.1.1.

Table 2.1.1 MIXER PUMP CHARACTERISTICS

Pump type	Vertical line-shaft drive mixer pump
Motor type	300 hp, 1200 rpm, 480V/3PH/60HZ weather-protected enclosure
Total pump weight	12,247 kg (27,000 lb) (water column filled)
Number of jet nozzles	(2) 180° opposed
Diameter of each nozzle	15 cm (6 in.)
Flow rate of each nozzle	19,680 L/min (5,200 gal/min) @ 1000 rpm
$U_0 D$ each nozzle	2.7 m ² /s (29.4 ft ² /s)
Jet flow direction	horizontal
Nozzle centerline distribution above floor	43 cm (17 in.)
Pump rotation	180° oscillating at 0.05 to 0.2 rpm

2.2 MIXER PUMP MONITORING AND CONTROL SYSTEM

Mixer pump operation is monitored through a monitoring and control console located in the AZ-156 building. Parameters that will be monitored include pump column water pressure and the supply filter status, mixer pump motor bearing temperature, speed, frequency, current, voltage, and orientation. Pump vibration will be measured locally using accelerometers during pump startup, speed changes and operation. Table 2.2.1 shows the indications and actions for the console instrumentation.

Table 2.2.1 MIXER PUMP MONITORING AND CONTROL SYSTEM

Parameter	Range/Limit	Indication	Action
Pump Column H ₂ O Pressure:			
• Normal	40 - 60 psi	Green	None required
• Low	< 40 psi	Red	Stop pump
Pump Column Supply Filter Differential Pressure			
• Normal	> 0 to < 5 psi	Green	None required
• High	≥ 5 psi	Red	Stop pump ¹
Motor bearing temperature:	-10°C to 130°C (14°F to 266°F)		
• High temperature limit	90°C (194°F)	Alarm	Acknowledge
• Maximum temperature limit	95°C (203°F)	Alarm	Stop pump
Pump current range:	50 to 364 A		
• High current limit	320 A	Alarm	Acknowledge
• Maximum current limit	364 A	Alarm	Stop pump
Pump motor speed range: (calculated)	700 to 1200 rpm		
• Minimum speed	700 rpm	Display	Stop pump ²
Pump vibration:			
• High vibration limit	Manual Setpoint	Display	Stop pump

¹ Place standby pump column water filter in service. If differential pressure is still high stop pump.

² The variable frequency drives are programmed to not allow pump speed below 700 rpm.

2.3 DATA ACQUISITION EQUIPMENT AND INSTRUMENTATION

The following instrumentation and equipment will be used to evaluate the mixer pump test objectives:

- CCTV with VCR capabilities
- Gamma profilers
- Strain gauges
- URSILLA's
- Suspended Solids Profiler
- ENRAF liquid level detector
- In-tank thermocouples
- Tank Head Space/Ventilation System Monitoring Equipment
- Sludge Weights
- Vibration Monitors

Descriptions and functions of the instrumentation listed are described below. The location of instrumentation used to monitor the AZ-101 process test are shown in Figure 1. The location of thermocouples used to monitor the AZ-101 process test are shown in Figure 2.

2.3.1 Closed-Circuit Television (CCTV)

A CCTV camera will be installed through riser 16B in tank AZ-101. The camera will be used to provide a quantitative measurement of component deflection at the waste surface to validate calculations of forces on in tank components. The CCTV monitor will also be used to visually monitor conditions and equipment in the tank vapor space and at the waste surface. The CCTV will have scan and VCR capabilities for use during the mixer pump test.

2.3.2 Gamma Profiler

The sludge mobilization monitoring system is designed to monitor total gamma activity at energies above Cesium-137. The system consists of a cadmium tellurium gamma detector deployed through the use of a portable utility cart. The utility cart contains a motorized cable spool and boom, position indicator, above-tank electronics, and power connections. Two gamma detectors are provided that can be utilized in numerous drywell locations in the tank (see figure 1). The gamma detectors will be used to determine gamma activity at a fixed location (drywell bottom), and to provide gamma profiles by recording data while moving the detectors to various elevations within the drywells. The gamma detectors will be read at specific intervals in the bottom position to provide additional data for determining the ECR, and at the end of each pump run in the profiling mode to help determine the degree of solids mobilization, the sludge settling rate, and the minimum pump speed required for maintaining waste mobilization. Baseline measurements will be taken at specific drywells prior to operating the pumps. This instrument is manually operated and data will be recorded through an operator personal computer (OPC) located in the AZ-156 building.

2.3.3 Strain Gages

Strain gages at three elevations are mounted on two profile thermocouple assemblies installed in risers 15E and 15F. The strain gages will be used to determine the impinging jet forces from the mixer pump. Strain gage data will be measured during mixer pump operation in the fixed and oscillating modes and recorded through the OPC.

2.3.4 Ultrasonic Interface Level Analyzer

Three Ultrasonic Interface Level Analyzers (URSILLA) will be installed for the mixer pump test in risers 5B, 13A, and 16C. The URSILLA Model 2511 uses an ultrasonic ranging technique to measure the depth of the sludge interfaces within the tanks. A sensor is mounted approximately 5 m (15 ft) off the tank bottom. One of two crystals in the sensor assembly acts as a transmitter and generates short bursts of ultrasonic energy which travels in a narrow beam towards the tank bottom. The second crystal acts as a receiver to detect any resulting echoes. The analyzer measures the time delay and magnitude of these returning signals and stores this information in the form of a tank profile. The URSILLAs will be operated continuously, and measurements will be taken and stored in the OPC at specific intervals.

2.3.5 Suspended Solids Profiler

A suspended solids profiler is planned to be installed in riser 24A which is located between the two mixer pumps. The profiler is a light-scatter instrument that will be used to determine suspended solids as a function of height from the bottom of the tank. The profiler lowers a probe that will automatically take suspended solids readings at 20 equally spaced elevations throughout the height of the waste. The data will be used to supplement gamma profiler data to determine the degree of solids mobilized, the sludge settling rate, and the minimum pump speed required for maintaining waste mobilization. Data will be recorded through the OPC in the AZ-156 building.

2.3.6 Liquid Level Instrumentation

The existing ENRAF liquid level detector is a microprocessor-controlled tank gauge which accurately measures the tank liquid level. ENRAF data will be manually measured and recorded. As an alternative to the ENRAF instrument, liquid level may also be measured with a manual tape. Measurements will be taken at intervals specified in tank operating procedures. Liquid level measurements will be taken only when the mixer pumps are off.

2.3.7 In-Tank Thermocouples

In-tank thermocouples will be used to measure the growth of the ECR, the degree of solids mobilization, and the change to the overall tank waste temperature, by monitoring temperature changes due to sludge movement and mobilization caused by the operation of the mixer pumps. Existing thermocouples include those at the tank bottom located just under the primary liner, and airlift circulator (ALC) thermocouples which protrude from the

ALCs to within approximately 10 cm (4 in) off the tank bottom. Additional thermocouples installed by the W-151 Project test include sludge thermocouples located at the bottom of tank drywells, and profile thermocouple assemblies, which will monitor waste temperatures at approximately 10, 35, and 355 centimeters (4, 14 and 140 inches) off the tank floor. All thermocouple data will be read and recorded at the OPC at specific intervals, before, during, and after pump operation.

2.3.8 Tank Head Space/Ventilation System Monitoring

Existing equipment and instrumentation will be used to monitor the effects of mixer pump operation on the tank head space and ventilation system. The tank head space will be monitored for flammable gases and organics through Standard Hydrogen Monitoring System (SHMS) cabinet installed in riser 24C. Differential pressures across the HEME, and HEGA AND HEPA filters will be monitored using existing instrumentation provided in the 702-AZ ventilation system. Stack emissions will be monitored by sampling and using the existing continuous air monitor (CAM).

2.3.9 Sludge Weights

Sludge weights are manually operated and will be used to measure the sludge level at various locations when the mixer pumps have been turned off. A float assembly is lowered to the sludge interface and a manual tape is read to determine its elevation. Sludge weights are located near the center of the tank in riser 24B, and near the tank perimeter in risers 24D, E, and F.

2.3.10 Vibration Monitors

Accelerometers will be used to measure vibration at pump start up, speed changes and operation. Two Vibration detectors will also be mounted on the pump motors near the upper and lower bearings. Indication of high vibration will be displayed on the console screen in the AZ-156 building.

3.0 PROCEDURE

3.1 PRECAUTIONS AND LIMITATIONS

As a prerequisite to the start of the test, the Project W-151 readiness activities will be completed, including authorization and safety basis documentation. Addendum 4 to the TWRS Basis for Interim Operations (BIO) (LMHC 1997) has been issued to evaluate safety considerations associated with operation of the mixer pumps for testing (See also Section 5.0, *Safety*). Limits and requirements applicable to tank AZ-101 per current Technical Safety Requirements (TSR), Limiting Conditions of Operations (LCO), and operating procedures will apply during the test. In addition, the precautions and limitations listed below are also applicable during the conduct of this test.

3.1.1 Motor Bearing Temperature

An alarm will be sounded when the motor bearing temperature reaches 90°C (194°F). When the motor bearing temperatures reaches 95°C (203°F), an additional alarm will be sounded and the pumps will be manually turned off.

3.1.2 Pump Current

The rated full load current is 364 A. Depending on fluid characteristics, the pump may reach full rated current at less than 1200 RPM. Exceeding this current the motor will become overheated. Output from the VFD is interlocked with pump power and will trip if the sustained amperage exceeds a value of 364 A.

3.1.3 Minimum and Maximum Pump Operation

The mixer pump design operational speed varies between 700 and 1200 rpm, or not to exceed 364 A. The design of the lower mechanical seal limits low-speed operation of the mixer pumps to ≥ 700 rpm. If the pump speed falls below the lower limit the pump will be stopped. The pump motor speed is calculated by the VFD based on output frequency and motor slip characteristics. Minimum and maximum speeds are set in the VFD.

3.1.4 Air Emissions

Air emissions resulting from the operation of the mixer pumps are limited to 0.05 pounds per hour for ammonia and 50 parts per million of volatile organic compounds (VOC) measured as total organic carbon per Notice of Construction Permit No. 94-07. The pump(s) shall be stopped if the NOC limits are exceeded.

3.1.5 Structural Limits for In-Tank Equipment

All in-tank components, with the exception of the radiation drywell in riser 14A, have been calculated to be structurally adequate over the full range of pump speeds for an assumed sludge buildup thickness up to 9 cm (3.5 in). The drywell located in riser 14A, assuming a sludge buildup thickness of 9 cm (3.5 in), has been calculated to be structurally adequate only at the minimum pump flow (Julyk 1997).

To verify the structural calculations, pump number 1 will be initially aimed at the strain gage/thermocouple assemblies in risers 15E and 15F, respectively. These components are not expected to have any sludge buildup since they will be installed shortly before the start of testing. With the pump operating in the fixed mode, strain gage readings will be taken to compare the actual loads to the calculated loads, through a range of pump speeds. The CCTV will also be used to measure the actual deflection of the components at the waste surface and compare them to the calculated deflections. If the structural calculations cannot be verified from test data or because of instrument failure, the test shall be suspended and reviewed by the Joint Test Review Group before being restarted.

To ensure that the structural limits of other critical in-tank components are not exceeded during pump operation, the CCTV will be used to monitor and evaluate the component deflections at the waste surface. Figure 3 shows the calculated deflections at the waste surface at yield load for the various components. If the actual deflections of critical components observed during the test are more than 85% of the deflection at the yield load, the test shall be suspended and reviewed by the Joint Test Review Group before being restarted. If the observed deflection reaches the calculated deflection at yield load, the pump will have to be operated at a lower speed or "indexed" around that component in future pump operations.

The CCTV will also be used to monitor critical components for flow-induced resonant vibration coupling, and to monitor the waste for any unexpected vortex effects caused by mixer pump operation. If resonant vibration coupling on a component occurs for more than one hour, or if vortexing is observed, the test shall be suspended and reviewed by the Joint Test Review Group before being restarted.

Analysis was performed to determine the allowable number of stress cycles from mixer pump forces could be withstood by the existing steam coil assembly. It was calculated that the steam coil could undergo 160,000 stress cycles which at 0.2 rpm translates to 6,650 hours of pump operation (Crass 1996). A large portion of the test will be run at a slower rotational speed of 0.05 rpm and the test is scheduled to take around 1300 hours. However, mixer pump run time, pump speed, and oscillating speed will be recorded to ensure stress cycle limits are not exceeded.

3.1.6 Sludge Depth Limit

Sludge depth may contribute to the safety significant air lift circulators becoming plugged and may allow the sludge to overheat. The draft tubes of the ALC's are 76 cm (30 in) off the bottom of the tank. If the sludge reaches a depth of more than 58 cm (23 in), there is a potential for plugging the draft tubes of the air lift circulators (ALC) making them inoperable. Sludge depth can also cause the sludge to increase to saturation temperature and result in bumping. Sathya (1997) calculated that sludge depths above 63.5 cm (25 in) may force temperatures into the LCO 3.3.4 range.

Sludge may accumulate under two conditions. The first condition is when sludge is suspended by mixer pumps and allowed to settle. If suspension and settling is performed several times, sludge depth could increase in those areas that the mixer pumps do not reach. The second condition occurs during mixer pump operation when sludge that has not been suspended may be pushed and piled up in certain locations in the tank. Most important are two potential "dead zones" that are located on the east and west sides of the tank that may be beyond the reach of both mixer pump cleaning circles, thus having the potential of piling up sludge in these areas Fow et al, 1987. LCO 3.3.4 requires that during the mixer pump test at least 14 ALC's are required to be operable at all times with no more than 2 adjacent ALC's inoperable (Noorani 1998b).

Sludge depth around and ahead of the pump discharge stream path will be monitored during the mixer pump test per Table 3.1.6, using the URSILLA's and gamma detectors. Table 3.1.6 is arranged so that primary and secondary instruments are listed for measuring both settled sludge depth and piled up sludge depth respectively, for each test sequence. Use of gamma probes and URSILLA's for monitoring sludge height will be approved by the JTG prior to the start of the test. Approval will be based on acceptance testing and data collection analysis. Determination of instrument failure can be made anytime during the test by the Test Director, Design Authority or Cognizant Engineer.

For each test sequence, both primary and secondary instruments listed in Table 3.1.6 shall be monitored at hourly intervals during mixer pump operation and for a minimum of 4 hours after the pumps have been turned off until there is indication that sludge depths will not increase beyond critical depths.

If any of the primary or secondary sludge level instruments indicate a sludge depth of 51 cm (20 in), the test director will be notified that the sludge level has increased and that the ALC's may have to be operated. If the sludge depth reaches 58 cm (23 in), or if both primary and secondary instruments do not provide a reliable reading, operation of the ALC's shall be initiated in strategic areas, as a minimum as specified in table 3.1.6, to ensure that a minimum of 14 critically located ALC's are kept operational. The ALC's will be operated at a flow above 5 cfm. In general, in order to redistribute sludge, operation of the ALC's should continue for at least 24 hours once they are initiated. Operation of the ALC's should continue until there is a clear indication of acceptable sludge height and temperature. If the sludge depth reaches 63.5 cm (25 in), the ALC's will be operated to decrease the sludge depth or move the sludge, which may require increasing the flow rate or operating additional ALC's. Operation of alternate ALC's shall be specified by the Design Authority in conjunction with the JTG.

Thermocouples are to be used as indicators of sludge build up as well as sludge detectors. Temperature instrumentation tends to be slower to react than real time or near real time sludge level instrumentation (URSILLA's and GAMMA probes). If sludge were to build up to 63.5 cm (25 in) it is anticipated that local temperatures could increase to LCO levels. A temperature increase trend should be evident within 24 hours if it is to occur. This is based on past operating experience during peak heat operations in the 1980's. ALC operations would be initiated per LCO 3.3.4 when the waste temperatures in the supernate are more than 88°C (190°F) or if the sludge reaches 110°C (230°F). LCO 3.3.3 actions are entered when the supernate reaches 91°C (195°F) in the top 4.6 m (15 ft) of liquid, or 102°C (215°F) in the waste below 4.6 m (15 ft) of liquid.

To minimize the sludge level increase in areas of low flow velocity it is desired to perform the test as rapidly as possible. This will allow minimal time for the sludge to settle between pump operations. By allowing minimal settling time the settling sludge will not compact and become difficult to move. Simulant testing has indicated that initially the sludge settles quickly (1 to 7 days) and then compacts slowly (weeks) MacLean, 1998. As the sludge compacts it becomes more difficult to move by pumps or ALCs.

Accumulations of sludge in dead zones could lead to increased temperatures and entering action items in LCOs 3.3.4, and 3.3.2.

Pilot studies (Powell et. al. 1995b) have indicated that settled sludge tends to accumulate near the tank walls, when only one mixer pump is used in the center of the tank. Therefore, the ALCs should be operated to decrease the sludge height in the dead zones between the two mixer pumps and in the areas near the walls. The ALC operation noted in Table 3.1.6 was designed to move sludge from these two areas.

Table 3.1.6 REQUIRED SLUDGE DEPTH MONITORING INSTRUMENTS

PUMP OPER. MODE POSITION	PRIMARY INSTRUMENTS	SECONDARY INSTRUMENTS	ALC'S REQUIRED FOR MITIGATION Note 3
PUMP #1 FIXED MODE POSITION A (riser 15E)	URSILLA @13A and GAMMA DET @15E	→ GAMMA DET @14D → GAMMA DET @15I	→ (See Note 1) → (See Note 1)
PUMP #1 FIXED MODE POSITION B (Riser 15 F)	URSILLA @13A and URSILLA @16C	→ GAMMA DET @14D → GAMMA DET @14C, → GAMMA DET @14G	→ ALC 9,17,19,21 → ALC 3,4, or → ALC 15,16
PUMP #1 FIXED MODE POSITION C (ALC 10)	URSILLA @ 13A and URSILLA @ 5B	→ GAMMA DET @14D → GAMMA DET @15I	→ ALC 9,15,17,19, 21,15,7 → ALC 3,13,15
PUMP #1 FIXED MODE POSITION D (ALC 2)	URSILLA @ 13A and GAMMA DET @ 14A	→ GAMMA DET @14D → SSP @ 24A	→ ALC 9,19,21,7,8,12 → ALC 5,6,17,19
PUMP #2 FIXED MODE POSITION E (ALC 18)	URSILLA @ 13A and URSILLA @ 5B	→ GAMMA DET @14F,15C → GAMMA DET @15I	→ ALC 9,19,21,7,8,12 → ALC 13,15
PUMP #2 FIXED MODE POSITION F (ALC 17)	GAMMA DET @ 14F and GAMMA DET @ 15C	→ GAMMA DET @14G → GAMMA DET @14E	→ ALC 9,19,21,15,8,12 → ALC 7,9,19,21
PUMP #2 FIXED MODE POSITION G (Riser 14A)	GAMMA DET @ 14F (See Note 2)	→ GAMMA DET @14G	→ ALC 7,8,9,12,19,21
PUMP #1 OSCILLATING MODE	URSILLA @ 13A GAMMA DET @ 15C,14G and URSILLA @ 5B, GAMMA DET @ 15C	→ GAMMA DET @14D,15I → GAMMA DET @15I,14A	→ ALC 5,7,15,17,19,21 → ALC 5,7,15,21
PUMP #1 & 2 OSCILLATING MODE	URSILLA @ 5B and GAMMA DET @ 15C	→ GAMMA DET @15I	→ ALC 13,15,4,7, 19,21,22

Note 1: The volume of sludge that could be mobilized by this operation is not sufficient to exceed allowable sludge height limits

Note 2: There are no applicable sludge measurement instruments to measure "drifting" sludge in this position however, since the majority of this sludge has already been mobilized by a previous operation it is not expected that the sludge will exceed allowable height limits

Note 3: It was assumed that 3 of 4 ALCs were made operable by repairing their associated thermocouples, or could be shown to be operable by camera. Currently 4 ALC TCs are out of service, numbers 9, 13, 18 and 22. ALC 18 is plugged as well as having no temperature reading. ALC 18 was not used. The ALCs which were not assumed to be operable due to plugging were 6, 14, 18 and 20.

3.1.7 Minimum Equipment/Instrumentation

Table 3.1.7 contains a listing of non-safety equipment and instruments required for data acquisition during the test. The non-availability of the minimum required equipment for one test sequence may not preclude the performance of other test sequences.

Table 3.1.7 DATA ACQUISITION EQUIPMENT/INSTRUMENTATION REQUIREMENTS

TEST SEQUENCE	REQUIRED EQUIPMENT/ INSTRUMENTS	SUPPORTING INSTRUMENTS
1. General mixer pump operation.	<ul style="list-style-type: none"> • Mixer pump(s) - Those sections of the mixer pump test that require only single pump operation may be performed if only one pump is operable. 	
2. Test For Forces on In-tank Components	<ul style="list-style-type: none"> • CCTV 	<ul style="list-style-type: none"> • Strain Gages
3. Test to Determine Effective Cleaning Radius	<ul style="list-style-type: none"> • Thermocouples - A sufficient amount of ALC, tank bottom, sludge or bottom profile thermocouples are required for each pump to be able to determine an effective cleaning radius. 	<ul style="list-style-type: none"> • Gamma profiler • URSILLA's
4. Test to Determine Percent Mobilization	<ul style="list-style-type: none"> • Thermocouples (per sequence 3), and • URSILLAs - Minimum of 2 with one being at riser 16C, or, • Sludge Weights - Minimum of 2 with one being at riser 24B. 	<ul style="list-style-type: none"> • SSP • Gamma profiler
5. Test to Determine Minimum Pump Speed to Suspend Solids	<ul style="list-style-type: none"> • SSP, or, • Gamma profiler 	
6. Test to Determine Waste Settling Rates.	<ul style="list-style-type: none"> • URSILLAs - Minimum of 2 with one being at riser 16C, or • Sludge Weights - Minimum of 2 with one being at riser 24B. 	<ul style="list-style-type: none"> • SSP • Gamma profiler

3.2 TEST SEQUENCE FOR MIXER PUMP PERFORMANCE AND MOBILIZATION OF SOLIDS

The general sequence of testing is outlined below. A detailed test procedure will be prepared by Retrieval Engineering and DST Operations outlining specific instructions for conducting the mixer pump test. Throughout the duration of the test, while the pumps are operated at various speeds both in a fixed and oscillating mode, data from CCTV, thermocouples, gamma probes, suspended solids profiler, and URSILLAs will be monitored and recorded. Data from other instrumentation will be monitored and recorded at specific times during the test as stipulated below.

3.2.1 Obtain Baseline Data

1. Before pump operation, measure and record the following: liquid level, thermocouple temperatures, gamma profiles, suspended solids

profile, strain gauge readings, sludge weight measurements and URSILLA profiles.

3.2.2 Testing for Forces on In Tank Components

1. Operate pump no. 1 in the fixed mode through pump speeds of 700 rpm, 1000 rpm, and maximum to determine forces on critical in-tank components. Orient the pump and operate sequentially through the positions listed in Table 3.2.1. Monitor and record strain gage measurements for profile thermocouple assemblies and surface deflections via the CCTV for each component during mixer pump operation. If deflections and/or calculated forces are determined to be greater than those calculated at yield load (see Section 3.1.5) for a particular component stop or move pump to the next location and restart testing on the next component. If forces on a component are determined to be within allowable limits at one position, ECR testing per step 3.2.3(1) may be performed before orienting the pump to the next position.

Table 3.2.1 MIXER PUMP NO. 1 ORIENTATION

POSITION	COMPONENT/PUMP ORIENTATION
A	Profile t/c assembly with strain gages - riser 15E
B	Profile t/c assembly with strain gages - riser 15F
C	Air lift circulator #10.
D	Air lift circulator #2.

2. Operate pump no. 2 in the fixed mode through pump speeds of 700 rpm, 1000 rpm, and maximum to determine forces on critical in-tank components. Orient the pump and operate sequentially through the positions listed in Table 3.2.2. Monitor and record surface deflections via the CCTV for each component during mixer pump operation. If deflections are determined to be greater than those calculated at yield load (see Section 3.1.5) for a particular component stop or move pump to the next location and restart testing on the next component.

Table 3.2.2 MIXER PUMP NO. 2 ORIENTATION

POSITION	COMPONENT/PUMP ORIENTATION
E	Air lift circulator #18.
F	Air lift circulator #17.
G	Radiation drywell located in riser 14A.

3.2.3 Testing to Determine Effective Cleaning Radius

1. Operate mixer pump No. 1 at pump speeds of 700 rpm, 1000 rpm, and maximum in the fixed mode to determine the effective cleaning radius. Operate pump in the positions listed in Table 3.2.1. Record temperature changes at thermocouple locations to determine the extent of sludge mobilization. Continue operating pump at each speed until the instrumentation indicates that there is no further sludge mobilization.
2. Operate mixer pump No. 1 in the oscillating mode at 0.05 rpm, and at pump speeds of 700 rpm, 1000 rpm, and maximum. Record temperature changes at thermocouple locations to determine the extent of sludge mobilization. During operation of the pump monitor strain gauge readings through a minimum of five complete oscillations of the pump. Continue operating pump at each speed until the instrumentation indicates that there is no further sludge mobilization.
3. Operate both mixer pumps No. 1 and 2 in the oscillating mode at 0.05 rpm, and at pump speeds of 700 rpm, 1000 rpm, and maximum. Record temperature changes at thermocouple locations to determine extent of sludge mobilization. Monitor strain gage readings through a minimum of five complete oscillations of each pump. Continue operating pumps at each speed until the instrumentation indicates that there is no further sludge mobilization.

3.3 TEST SEQUENCE FOR MAINTAINING MOBILIZED SOLIDS IN SUSPENSION

3.3.1 Testing to Determine Mixer Pump Speed for Solids Suspension

1. Operate both pumps in the oscillating mode at 0.2 rpm, and at full pump speed until instrument readings are constant and indicate sludge is fully mobilized. Stop pumps and record readings from Gamma Profilers, URSILLA's, and Suspended Solids Profiler (SSP).
2. Decrease pump speed to 1000 rpm and run pumps for a minimum of 2 hours or until instrument readings are constant. Stop pumps and record readings from Gamma Profilers, URSILLA's, and SSP. If solids are still fully mobilized continue to decrease pump speed per step 3.
3. Decrease pump speed to 700 rpm and run pumps for a minimum of 2 hours or until instrument readings are constant. Stop pumps and record readings from Gamma Profilers, URSILLA's, and SSP. If solids are still fully mobilized repeat steps 1, 2 and 3 using only one pump.

4. When the minimum pump speed to maintain solids in suspension has been determined, and after solids have begun to settle, operate the pump(s) again to re-suspend solids at the minimum solids suspension speed, but for a shorter length of time (ie. one hour versus two hours) to determine the minimum time required to keep solids in suspension.

3.4 TEST SEQUENCE TO DETERMINE SOLIDS SETTLING RATES

3.4.1 Testing to Determine Solids Settling Rates

1. Operate both pumps in the oscillating mode at 0.2 rpm and at full speed until instrument readings are constant and indicate sludge is fully mobilized. Stop pumps and record baseline sludge interface level readings using URSILLA's and sludge weights. Obtain additional measurements from suspended solids profiler and gamma profilers.
2. At regular intervals obtain sludge interface level readings using URSILLA's and sludge weights to determine sludge settling rates. Obtain additional information using gamma profilers and suspended solids profiler.

3.5 WASTE SAMPLING

3.5.1 Waste Slurry Sampling

Waste slurry samples are required for determination of mixer pump mobilization effectiveness, for calibration of monitoring instruments and comparison of test data, and for waste feed delivery characterization. Grab samples of the Tank AZ-101 mobilized sludge will be taken to determine the amount of suspended solids compared to baseline data and to confirm waste feed properties. The grab samples will be obtained as soon as possible after solids have been fully mobilized, and mixer pumps have been turned off. Samples will be obtained as follows:

1. Set up sampling equipment over an available sampling riser. Risers currently available for sampling include risers 15A, 15D, 15G, and 15H.
2. Move gamma profiler to drywell that is closest to sampling riser to obtain reference profile.
3. If waste has not previously been mobilized, operate both pumps in the oscillating mode at full speed until instrument readings are constant and indicate sludge is fully mobilized.

4. Stop pumps and obtain grab samples as soon as possible after mixer pumps have been shut off. Samples for Waste Mobilization and Waste Feed Delivery shall be taken at the same sampling event.

Waste Mobilization - Take waste slurry samples at a minimum of five elevations. Record readings from Gamma Profilers, URSILLA's, and Suspended Solids Profiler, as close to the time of sampling as possible.

Waste Feed Delivery - Take a minimum of ten samples at two foot elevation increments for waste feed delivery characterization. Accumulative samples should total at least 1 liter of waste slurry.

3.5.2 Vapor Sampling

Vapor sampling and monitoring will be performed both outside the tank, and within the tank head space and ventilation system during the mixer pump test. Vapors will be monitored for organics, ammonia, nitrogen oxides, and sulfur dioxide. A screening of organics and other chemicals will be performed prior to beginning the test to establish a baseline. Breathing zone readings will also be taken on chemicals indicated by stack monitoring when/if 20 ppm organics in the 702-Z stack is reached, when 40 ppm (or highest level) is reached, and additionally as directed by the hygienist. If chemicals in the breathing zone reach levels established in the HASP, HASP respiratory protection guidelines shall be followed.

1. Outside the Tank

An IHT will perform breathing zone monitoring inside the AY and AZ farms and outside the farm near the 702-AZ and AZ-156 control buildings. This periodic monitoring will occur when changes to the system are being made (e.g. speed change to mixer pump) and as directed by the project industrial hygienist. The periodic monitoring will begin when the test is started and continue until the test is concluded and/or if it can be assured that the 702-AZ stack levels of organics at maximum pump operation are at pre-test levels (<10 ppm).

Area sampling will be conducted during the test using a charcoal tube (organics), carbon bead tube (ammonia), and passive badge (nitrous oxide). Sample locations will be in the AZ farm near where personnel are working and outside the 702-AZ ventilation building. Additional sample locations or sampling media may be added at the discretion of the industrial hygienist. Area samples will run for 6 to 8 hours on days specified by the project industrial hygienist.

Personal sampling will be conducted during the test on personnel working in the AZ farm. Personal sampling may be conducted on an HPT, IHT, operator, or other personnel. Sampling

media will be the same as for area sampling on days specified by the project industrial hygienist.

2. Tank head space and ventilation system

The tank headspace and 702-AZ stack will be monitored for organics through the tank AZ-101 SHMS probe, and the 702-AZ stack sample probe in the stack monitoring room, respectively. Instruments will be set up to datalog (on five minute intervals) prior to the start of the mixer pump test and will continue throughout the test. An IH tech will continuously monitor the stack instrument when pump speed changes are made and continue until OVM readings stabilize. After the readings stabilize, the instruments will be checked periodically and replaced with a fresh instrument as needed. Periodic monitoring will continue until the test is concluded and 702-AZ stack organic levels drop to pre-test levels (<10ppm). The instruments may be disconnected for short intervals to allow other chemical screening and sampling to take place.

A screening for other chemicals will be made on stack and tank headspace gasses as a baseline. Screenings will also be made after OVM readings stabilize (or reach highest level) after changing pump speeds or as directed by the project industrial hygienist. Screening will be performed using colorimetric tubes (draeger or sensidyne) for the following constituents: Nitrogen oxides, sulfur dioxide, and ammonia.

4.0 TEST DATA ANALYSIS

Retrieval Engineering will analyze the test data to meet the objectives listed in section 1.2. The analysis will include comparison of the mixer pump test data to analytical models and laboratory test data to provide design or operational improvements for future mixer pump retrieval systems. Retrieval Engineering will issue a preliminary mixer pump test report as soon as sufficient data has been collected to make preliminary conclusions. A final mixer pump test report will be issued after completion of the test. The analysis will be performed as follows:

1. Estimate the ECR by monitoring sludge and tank bottom thermocouple temperatures. A decrease in thermocouple temperature will indicate that the sludge has been mobilized out to that thermocouple location. A comparison of the thermocouple locations will be used to plot the ECR for fixed and oscillating modes.
2. Compare mixer pump test ECR data with ECR equations developed from laboratory testing. ECR data as described above will be collected for different pump speeds versus time for comparison to the ECR formulas.
3. Estimate the percent of sludge mobilization by calculating the volume of waste mobilized. Sludge depth measurements obtained from URSILLA's and/or sludge weights will be used with the ECR footprint to compute the sludge volume that has been mobilized. The gamma probe and suspended solids profiler readings will also be used to provide a profile of sludge mobilization homogeneity.

Laboratory analysis will be performed on the grab samples to determine density, weight per cent total solids and dissolved solids, pH, and particle size. The samples will also be analyzed for chemical and radiochemical composition for high level waste feed characterization, however, that analysis is outside the scope of this test.

4. Determine the minimum mixer pump speed required to maintain the mobilized solids in suspension by operating the mixer pumps at a speed where no settling is detected. The sludge particle settling rate will also be determined by plotting the increased sludge depth as measured by the URSILLA's and/or sludge weights over time. Suspended solids profiles as measured with the SSP, and gamma activity profiles as measured by the gamma probes, will also be plotted versus time to provide additional settling rate data.
5. Determine the forces caused by the mixer pump jets on in-tank components by measuring the strain on profile thermocouple assemblies installed in riser 15E and 15F. The measured strains will be compared to predictive models. Forces on other critical in-tank components will also be determined by measurement of the component movement at the waste surface as viewed through the in tank CCTV. Actual component movement will be compared to calculated movements.

6. Determine if there is an increase in the amount of aerosols in the ventilation system exhaust stream caused by mixer pump operation by comparing differential pressure readings across the HEPA filters, and record samples taken before, during and after the test. Exhaust samples will be analyzed for ammonia and TOC's and compared to similar samples taken before the test.
7. Determine if there is an increase in flammable gas (hydrogen) concentration in the tank head space by plotting SHMS readings taken during the testing, or hand testing from SHIMS test port if the SHMS is not operating.
8. Determine the accuracy and applicability of existing thermal models by comparing waste temperatures recorded during the test with predicted model data. Waste thermocouple temperature changes will be compared to the mixer pump(s) operating profile (pump power versus time).
9. Review the compiled data after completion of the test to determine which equipment and/or instrumentation was most effective, as well as what is needed for follow-on retrieval systems. Recommend design or operational improvements for future in-tank mixing or retrieval systems.
10. Determine the sludge particle settling rate after mixer pumps have been turned off. Data from the URSILLA, the gamma probes, the suspended solids profiler, and sludge weights will be used to plot settlement versus time curves.

5.0 SAFETY

Evaluation of the safety considerations associated with the operation of the mixer pumps in tank AZ-101 during the mixer pump test has been documented in Addendum 4 to the TWRS Basis for Interim Operation (BIO) (Noorani, 1998a). The evaluation resulted in the identification of four design basis accidents including: (1) unfiltered release of radionuclides and toxic aerosols from the tank, (2) tank bump, (3) breach of containment, and (4) over-pressurization caused by criticality. A summary of the preventive and mitigative features is provided in table 5.1.

Addendum 4 augments the existing Aging Waste Farm authorization basis in the BIO. The TWRS Technical Safety Requirements (Noorani, 1998b) will be used to control the mixer pump test. Requirements contained in OSD-T-152-00017, *Operating Specifications for Aging-Waste Operations in 241-AZ and 241-AZ*, will remain in effect during operation of the mixer pump test.

Testing and work activities shall be planned and managed to comply with safety and health requirements imposed by sitewide Project Hanford Management Contract procedures and the following Department of Energy prescribed Occupational Safety and Health Administration standards:

- "Occupational Safety and Health Standards", Title 29 CFR Part 1910.
- "Safety and Health Regulations for Construction", Title 29 CFR Part 1926.

Table 5.1 SUMMARY OF PREVENTIVE/MITIGATIVE ACTIONS

Accident Scenario	Preventive or Mitigation Actions during mixer pump test	Applicable TSR Control or Other Document
Unfiltered release of radionuclides and toxic aerosols from the tank (Section 3.4.2.1)	<ul style="list-style-type: none"> Limiting the maximum activity on each filter to a level that gives an equivalent dose of 200 mrem/h on contact controls the amount of particulates that could be expelled. Also, ensuring the primary ventilation stack CAM is operable to shutdown the ventilation system within 10 minutes. The mixer pumps will be turned off if NOC limits for VOCs and ammonia are reached. 	TSR LCO 3.1.4, TSR AC 5.18
Tank Bump (Section 3.4.2.2)	<ul style="list-style-type: none"> Localized high temperatures may be caused by mixer pump operation. The mixer pumps will be turned off if the top 15 feet of waste reaches 195°F or the waste below 15 feet reaches 215°F. ALCs will be operated to provide more uniform temperature distributions per limits described below. Upon loss of the primary ventilation system, the mixer pump(s) will be turned off to control gas and heat buildup in the tank. During normal operation of the pump(s) and at the end of the test while the mixer pumps are turned off, the waste temperature will be monitored and the air lift circulators operated as soon as the temperature reaches 230°F for waste below 20 feet and 190°F for the average waste solution. 	TSR LCOs 3.3.2, 3.3.4 SL 2.1 TSR LCO 3.2.1 TSR LCO 3.3.4
Breach of Containment (Section 3.4.2.3)	<ul style="list-style-type: none"> High Temperature (3.4.2.3.5): <ul style="list-style-type: none"> Primary tank exhaust ventilation system shall be operable. Flammable gas deflagration (3.4.2.3.1): <ul style="list-style-type: none"> Implementation of Ignition Source Controls as well as monitoring for flammable gas are preventive measures against deflagration, breach of tank, and breach of ventilation confinement in the event that an episodic gas release exceeds 100% of the lower flammability limit. LCO 3.2.1 requires ventilation operability to prevent flammable gas accumulations. The vent system operation also prevents tank pressurization and an unfiltered release. Tank dome collapse due to overload (3.4.2.3.6) <ul style="list-style-type: none"> This event is deemed beyond extremely unlikely for the mixer pump test based on analysis of dead load, live load, jet impingement, and seismic loads. All components of the support system were found adequate to support the mixer pumps for both normal service and extreme conditions. Seismic (3.4.2.3.7): <ul style="list-style-type: none"> Structural analysis of seismic loads show that the pump support and riser configuration are acceptable for the applied design requirements. 	TSR LCO 3.2.1 TSR AC 5.9, 5.10, 5.11 TSR LCO 3.2.1 TSR AC 5.16 Moody 1996
Criticality (Section 3.4.2.4)	<ul style="list-style-type: none"> A Criticality Safety Evaluation Report prepared for Project W-151 identified no scenario associated with the mixer pump test that could credibly lead to criticality. 	TSR AC 5.7

(Section number refers to sections of B10 addendum 4)

6.0 QUALITY ASSURANCE

6.1 INSTRUMENT CALIBRATION

Instruments will be calibrated in a manner appropriate to their use in the test. For instruments which are not addressed by ASTM standards, calibration procedures will be prepared as applicable, taking into account limitations that may be imposed by operation in a nuclear waste tank.

6.2 WITNESSING TESTS

Quality Assurance personnel will witness the testing, as necessary, provide concurrence of test exceptions, and review/approve test results.

7.0 SCHEDULE

Testing to determine forces on in-tank components and the effective cleaning radius, including baseline data collection, is scheduled to last for 60 days. Testing to determine the requirements for maintaining solids in suspension is expected to last an additional 10 days. Data analysis and a final test report will be issued within 4 months of test completion. Following the test, sludge level will be monitored for approximately one year to determine sludge settling rates.

8.0 START UP PLAN

This section identifies the activities, organizational roles and responsibilities to ensure a safe start up of the AZ-101 mixer pump operational testing.

8.1 DESCRIPTION

Start up activities for the AZ-101 mixer pump test have been scheduled to include 1) Equipment Installation and Construction, 2) Functional/Acceptance Testing 3) Preliminary Testing, 4) Operational Testing, and 5) Readiness Review. These activities are briefly described below.

8.1.1 Equipment Installation and Construction

The Project W-151 will install radiation sensitive equipment into the tank prior to operational testing start up. This equipment includes a closed circuit television camera, two strain gage/thermocouple assemblies, three ultrasonic interface level analyzers, and a suspended solids profiler.

DST Operations will repair existing facility components and instrumentation required for mixer pump testing prior to start up.

8.1.2 Functional/Acceptance Testing

New equipment, including the suspended solids profiler, URSILLA's, and thermocouple and strain gage assemblies, will be tested for functionality prior to being installed in the AZ-101 tank.

Supporting systems required for the test will also undergo functional testing. A functional test of the AZ-101 Air Lift Circulators will be performed per TF-FI-269-004, *Perform Functional Test of Air Lift Circulators for 241-AZ-101 and 241-AZ-102*, and an operational test of the 702-AZ ventilation system will be performed per OTP-W030-001, *W-030 Operational Test Procedure Integrated System Test*.

8.1.3 Preliminary Testing

Installed equipment and instrumentation will undergo preliminary testing prior to operational testing of the mixer pumps. The testing will provide for verification of operation and communication to the AZ-156 building. Operation of repaired equipment will be documented in the job specific work package.

8.1.4 Operational Testing

Operational Test Procedure TF-OTP-210-001, *AZ-101 Mixer Pump Operational Test Procedure* provides direction for mixer pump operational testing.

8.1.5 Readiness Assessment

Prior to start of operational testing, a management self assessment (MSA) will be performed by DST Operations (Lockheed Martin Hanford Corporation). The MSA will be followed by a contractor readiness assessment by Fluor Daniel Hanford, Inc., and a readiness assessment by DOE-RL.

8.2 SYSTEM BOUNDARIES

8.2.1 Purpose

Specific systems have been defined as a basis for completion of start up activities. System boundaries have been established to enable completion of start up activities in a organized manner.

8.2.2 Description

Test boundaries for the mixer pump test are described as follows:

Mixer Pump System - Includes all components required for start up of the mixer pumps including variable speed drives, motors, and the pumps.

Mixer Pump System Monitoring Equipment - Includes all components required for monitoring mixer pump operation, including the communication system, software and hardware to enable monitoring mixer pump operation at the console in the AZ-156 building.

Thermocouple Monitoring System - Includes in-tank thermocouples and equipment required for providing thermocouple indication from the scanner located in the AY-801A building to the AZ-156 building.

In-Tank Instrumentation - Includes the suspended solids profiler, URSILLA's, sludge mobilization carts (gamma probe), strain gages, CCTV, including the communication system, software and hardware to enable monitoring and recording mixer pump test data at the AZ-156 building.

Existing Equipment - Includes facility components used during the mixer pump test including the Standard Hydrogen System Monitoring cabinet, ENRAF liquid level detector, sludge weights, and tank pressure monitors.

Ventilation System - Includes the 702-AZ ventilation system.

Air Lift Circulators - Includes all components required for the operation of the tank AZ-101 air lift circulators.

8.3 RESPONSIBILITIES

8.3.1 Shift Manager:

The Shift Manager interfaces with the mixer pump Test Director and performs the Building Emergency Director functions defined in HNF-IP-1178, *Tank Farms Event Response Manual*.

8.3.2 Test Director:

The Test Director is responsible for the overall safe, efficient, and productive operation of the test. Primary responsibilities are to ensure: 1) safe working conditions and practices during tests; 2) compliance with test documents and Operational Safety Requirements/Documents (OSRs/OSDs) during testing; 3) communication and coordination of tests with the Shift Manager; and 4) appropriate review/approval of any modifications to test procedures prior to resumption of work. The Test Director must be in the AZ-156 building during changing plant conditions such as pump start up, changing pump speed, and changing pump nozzle position. The test director will be the direct line of communication and centralized point of control during normal, abnormal, and casualty situations.

8.3.3 Nuclear Chemical Operator:

The Nuclear Process Operators (NCO) are responsible for operation of the mixer pumps, monitoring equipment, instrumentation, and recording of data. An MPT qualified NCO is required to be in the AZ-156 building during any pump operation, and post pump operation until the tank is declared stable by the Test Director. The NCO's are responsible for:

- Perform start up and shut down of mixer pumps
- Man control console to monitor mixer pump operation
- Locate and set up Sludge mobilization (gamma) carts at risers, as directed by the Test Director

- Open/close valve for SSP operation
- Operate suspended solids profiler, URSILLA, and GAMMA probe instruments
- Monitor thermocouple data collection
- Download mixer pump test data from operator personal computer (OPC)
- Perform lock and tag per plant procedures
- Perform raw water valve line-up for start of pumps and shutdown
- Establish pump breaker line-up for start of pumps and shutdown

8.3.4 CCTV Operator:

The CCTV Operator is responsible for operation of the in tank closed circuit television camera and video equipment. The CCTV will be operated during testing for forces on in-tank components (Section 3.2.2) and during pump speed changes for initial one and two pump operations.

8.3.5 Joint Test Review Group:

The Joint Test Review Group (JTRG) performs an oversight role. The JTRG reviews test procedures to ensure compliance with applicable requirements and ensures the test meets the test objectives. The JTRG consists of the Test Director, W-151 Project Manager, DST Engineering Manager, Test Engineer and the Design Authority.

8.3.6 Test Engineer:

The Test Engineer will be responsible for providing technical support for operation of the mixer pumps, monitoring equipment and instrumentation, and data analysis. The Test Engineer will be responsible for assisting the Test Director in determining pump run times and tank conditions during the test.

8.3.7 W-151 Project Manager:

The W-151 Project Manager will be available as required and is responsible for providing project interfaces and resolving any project related problems.

8.3.8 Quality Assurance Engineer:

The Quality Assurance Engineer is responsible for verifying the test was performed per the test procedure on a surveillance basis.

8.3.9 Quality Control Inspector:

A Quality Control Inspector shall verify specific procedural steps as annotated by hold points in the test procedure.

8.3.10 Industrial Hygiene:

Industrial hygiene personnel will provide stack, area, and personal monitoring for toxic vapors and notify test director if limiting conditions are reached.

8.4 STAFFING AND TRAINING

8.4.1 STAFFING

The mixer pump testing may be conducted 24 hours a day. Staffing plans require two MPI qualified NCO's per shift. One NCO will be stationed in the AZ-156 building for monitoring mixer pump operation and instrumentation. The second NCO will be for relief and any field activities. Any assistance required for field activities, such as moving the gamma carts, will be performed by east tank farms NCO's. A CCTV operator is required in the AZ-156 building to operate and monitor the closed circuit television camera.

A mixer pump test qualified tank farm operating engineer will be required on each shift as the Test Director.

A health physics technician (HPT) will be required on a random basis on day shift for routine surveillance during operation of the gamma carts and the suspended solids profiler.

Two industrial hygiene technicians are required on day shift for routine monitoring during the test when mixer pump speed changes are made.

8.4.2 TRAINING

A minimum of four NCO's and three OE's to act as Test Director, will be qualified for performing the mixer pump test. These people will be trained in the operation of the mixer pumps, gamma probes, and suspended solids profiler, and monitoring the ultrasonic level analyzers, strain gages, and thermocouples. No special training will be required for HPT's and east tank farms NCO's assisting MPI NCO's on day shift.

8.5 ALARA PLAN

Prior to startup of the mixer pumps, the overall startup operation will be reviewed by the facility ALARA committee per HNF-IP-0842, Volume III, Section 1.2 (Noorani, 1997b). Startup plans and the Operating Test Procedure will be reviewed by the ALARA Committee.

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- TF-OTP-210-001, *AZ-101 Mixer Pump Operational Test Procedure*
- Title 29 CFR Part 1910, *Occupational Safety and Health Standards*.
- Title 29 CFR Part 1926, *Safety and Health Regulations for Construction*.

Figure 1. Location of Instrumentation to Monitor AZ-101 Process Test

Figure 2. Location of Thermocouples to Monitor AZ-101 Process Test

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Figure 3. Predicted Deflections of Tank AZ-101 In-Tank Components at Yield Load of Component

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