ENGINEERING CHANGE NOTICE

Page 1 of 3 ^{KN} ~~6~~ ⁶

1. ECN 187421

Proj.
ECN

2. ECN Category (mark one) Supplemental ☐ Direct Revision ☒ Change ECN ☐ Temporary ☐ Standby ☐ Supersedure ☐ Cancel/Void ☐		3. Originator's Name, Organization, MSIN, and Telephone No. ^{7E870} J. J. Irwin, Thermal Hydraulics, HO-33, 376-0615		4. Date September 7, 1994																																																																			
		5. Project Title/No./Work Order No. Mixer Pump Long Term Operations Plan for Tank 241-SY-101/NA/N2B22		6. Bldg./Sys./Fac. No. NA																																																																			
		8. Document Numbers Changed by this ECN (includes sheet no. and rev.) WHC-SD-WM-PLN-081, Rev. 2		9. Related ECN No(s). None																																																																			
				7. Impact Level QS None-																																																																			
				10. Related PO No. N/A																																																																			
11a. Modification Work ☐ Yes (fill out Blk. 11b) ☒ No (NA Blks. 11b, 11c, 11d)		11b. Work Package No. N/A		11c. Modification Work Complete N/A																																																																			
		Cog. Engineer Signature & Date		11d. Restored to Original Condition (Temp. or Standby ECN only) N/A																																																																			
		Cog. Engineer Signature & Date		Cog. Engineer Signature & Date																																																																			
12. Description of Change This represents a revision of WHC-SD-WM-PLN-081, Rev. 2. Changes include changing the recommended pump operations to a minimum on at least two times a week and at least once every four days; changed maximum waste level limit to 1030.5 cm (405.7 inches); converted all units to SI units from US customary units; deleted attachment 1 (Pump Oil predicitions).																																																																							
13a. Justification (mark one) Criteria Change ☐ Design Improvement ☒ Environmental ☐ As-Found ☐ Facilitate Const. ☐ Const. Error/Omission ☐ Design Error/Omission ☐																																																																							
13b. Justification Details General purpose upgrade.																																																																							
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WASTE TANKS ADMINISTRATION

Manual
Section

WHC-IP-0842

UNREVIEWED SAFETY QUESTIONS

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Effective Date

15.9, REV 1
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September 3, 1993

APPENDIX B

Unreviewed Safety Question Forms

Figure B-1. Unreviewed Safety Question - Changes Screening Form. (1 Sheet)

REFERENCE ITEM # WHC-SD-WM-PLN REV. 3

TITLE MIXER PUMP LONG-TERM OPERATIONS PLAN FOR TANK 241-SY-101 MITIGATION

Does the referenced item:

A. Make PROPOSED CHANGES to the facility or procedures which differ from conditions described in the AUTHORIZATION BASIS documentation?

N/A ☐ NO ☒ Yes/Maybe ☐

Basis: The above mentioned reference item was evaluated for its impact on the Safety Assessment for Proposed Pump Operation to Mitigate Episodic Gas Releases in Tank 241-SY-101 LAUR-92-3196 REV 12, in particular chapter 6 (level I and II Controls for Mixer Pump Operations) and appendix AN. Based on the evaluation, WHC-SD-WM-PLN REV. 3 is covered under this safety assessment.

B. Make PROPOSED CHANGES that represent conditions that have not been analyzed in the AUTHORIZATION BASIS?

N/A ☐ NO ☒ Yes/Maybe ☐

Basis: The above mentioned reference item was evaluated for its impact on the Safety Assessment for Proposed Pump Operation to Mitigate Episodic Gas Releases in Tank 241-SY-101 LAUR-92-3196 REV 12, in particular chapter 6 (level I and II Controls for Mixer Pump Operations) and appendix AN. Based on the evaluation, WHC-SD-WM-PLN REV. 3 does not represent conditions that have not been analyzed in the safety assessment.

C. Describe tests or experiments which differ from those described in the AUTHORIZATION BASIS documentation?

N/A ☐ NO ☒ Yes/Maybe ☐

Basis: The above mentioned reference item was evaluated to determine its impact on the Safety Assessment for Proposed Pump Operation to Mitigate Episodic Gas Releases in Tank 241-SY-101 LAUR-92-3196 REV 12. Based on the evaluation of WHC-SD-WM-PLN REV. 3, the proposed changes do not represent tests or experiments that have not been analyzed in the safety assessment.

D. Is a change in a TSR, OSR, or compliance plan to OSR involved?

N/A ☐ NO ☒ Yes/Maybe ☐

Basis: The above mentioned reference item does not make changes to the TSR, OSR, or compliance plan to OSR.

USQE #1 M. F. Erhart

USQE #2 D. C. Larsen

Print Name

M F Erhart
Signature

Date

10/25/94

Print Name

D C Larsen
Signature

Date

10/25/94

RELEASE AUTHORIZATION

Document Number: WHC-SD-WM-PLN-081, REV. 3

Document Title: Mixer Pump Long Term Operations Plan for Tank 241-SY-101 Mitigation

Release Date: 11/07/94

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

APPROVED FOR PUBLIC RELEASE

WHC Information Release Administration Specialist:

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Niki L. Solis

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<p align="center">SUPPORTING DOCUMENT</p>		<p>1. Total Pages 18 ^{11/7/94} ^{KN}</p>
<p>2. Title</p> <p>Mixer Pump Long Term Operations Plan for Tank 241-SY-101 Mitigation</p>	<p>3. Number</p> <p>WHC-SD-WM-PLN-081</p>	<p>4. Rev No.</p> <p>3</p>
<p>5. Key Words</p> <p>Tank 241-SY-101, Mitigation, Mixing</p>	<p>6. Author</p> <p>Name: J. J. Irwin</p> <p><i>J. J. Irwin</i> 10/27/94 Signature</p> <p>Organization/Charge Code 7E870/N2B22</p>	
<p>7. Abstract</p> <p>This document provides the general Operations Plan for performance of the mixer pump long term operations for Tank 241-SY-101 mitigation of gas retention and periodic release in Tank 101-SY. This operations plan will utilize a 112 kW (150 hp) mixing pump to agitate/suspend the particulates in the tank.</p>		
<p>8. RELEASE STAMP</p> <div> <p>OFFICIAL RELEASE BY WHC DATE NOV 07 1994 <i>Sta. 21</i></p> <p align="right">(21)</p> </div>		

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**MIXER PUMP LONG-TERM OPERATIONS PLAN FOR
TANK 241-SY-101 MITIGATION**

October 1994

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LONG-TERM MIXER PUMP OPERATIONS PLAN FOR TANK 241-SY-101 MITIGATION

1.0 PURPOSE AND PHILOSOPHY

1.1 PURPOSE

The purpose of this plan is to identify, describe and define those basic mixer pump operations that are to be used to maintain Tank 241-SY-101 in a mitigated state. The desired mitigated state is that which resulted from Full Scale (WHC, 1994a) as well as Phase A and Phase B (PNL, 1994) testing of the mixer pump, i.e., hydrogen gas release was controlled and its concentration in the tank dome space was prevented from exceeding safety limits.

1.2 MIXER PUMP OPERATION PHILOSOPHY

1.2.1 Background

The current mixing pump was installed in Hanford Tank 241-SY-101 on July 3, 1993. A cautious initial test series, Phase A, confirmed that no large gas releases would be triggered by very brief and gentle pump operation. High-speed testing in Phase B, which began October 21, 1993, released a large volume of retained gas and lowered the waste level to a historic low of 1016 cm (400 inches). By the end of Phase B testing on December 17, 1993, the waste was well-mixed except for approximately 127 cm (50 inches) of sludge at the bottom. Because hydrogen concentrations have remained below 400 ppm and the waste level remained below 1021 cm (402 inches) since late November 1993, the jet mixer pump successfully mitigated the tank and is capable of maintaining mitigation indefinitely.

Between the end of Phase B and the start of Full-Scale Testing, from December 18, 1993, through February 3, 1994, the pump was intentionally operated very little, and the waste level grew steadily, finally reaching about 1021 cm (402 inches). The pump injected very little hydraulic energy into the waste during this interim period, and the previously well-mixed state gave way to slow but distinct settling. A second convective layer about 127 cm (50 inches) thick formed above the suspended slurry layer by density stratification. This settling trend actually continued until the Full Tank Sweep tests, end of March, 1994.

Despite settling, the waste's uniform temperature profile showed that the suspended slurry remained mobile, in marked contrast to the rapid formation of a deep, non-convective sludge layer following historical rollover events. Evidently, once the waste is thoroughly mixed by passing through the pump impellers, it does not regain its sludge-like character easily.

Full-Scale Testing began February 4, 1994. The first test sequence of operation pump was intended to maintain a constant waste level by running the pump at 78.5 radian/s (750 rpm) for 3600 s (one hour) thrice per week in a different direction each time. The waste level remained approximately constant as desired during this test sequence, but the solid material continued to settle slowly. This suggested that it may be necessary to run the pump at or near full speed for a longer period occasionally to reverse this trend.

During the second test sequence, mixing was reduced to a minimum to allow gas to begin accumulating. Minimum pump operation, 300 s at 105 radian/s (1000 rpm) with the pump nozzle in the direction of the 0.6 radian (35°) azimuth, were run for four weeks to disturb as little of the waste as possible while preventing nozzle plugging. Gas accumulation and the

corresponding waste level growth resumed, but the waste level remained approximately constant for the last two weeks after gaining about 2 cm.

The third test sequence thoroughly mixed the waste and rapidly released the accumulated gas with sweeps of 30 minutes in each of six directions at 78.5 radian/s (750 rpm), performed March 28 and 30, 1994. This dropped the waste level nearly 2.5 cm (one inch) to the 1016 cm (400-inch) limit, which halted testing.

The last sequence of tests in the Full-Scale program studied jet penetration by running the pump at the highest practical power level with the nozzles at 1.7 radian (97°). This direction was chosen to align the jet with a thermocouple tree at the 8.5 m (28-foot) radius, so that changes in temperature profile under the influence of the jet could be observed. Transient temperature observed on the thermocouple tree confirmed jet flow at that location. The jet also clearly reduced the thickness of the bottom sludge layer and evidently triggered a small gas release event.

Long-term pump operations began soon after full-scale testing ended on April 13, 1994. Since then the pump nozzles remained open, sometimes using the pump for 300 s runs at 105 radian/s (1000 rpm), about three times a week. The waste level was maintained about constant using 78.5 radian/s (750 rpm) pump runs for an hour about three times a week but more effective were runs using 105 radian/s (1000 rpm) for 1500 s (25 minutes). During September 1994, it was clearly demonstrated that 3 pump runs per week at 105 rad/s (1000 rpm) for 1500 s, covering each of the 6 directions during a two-week interval, resulted in gas release equal to or greater than the rate of gas generation. Pump sweep operations were effective over several days, in reducing the waste height to minimum levels.

1.2.2 Long-Term Mixer Pump Operation Philosophy

The long term mixer pump operation philosophy is to utilize in a simple and straight forward manner the successful jet mixing techniques developed during the testing phases (Tests A, B, Full Scale) and during the first five months of long term operations, to continue to mitigate Tank 101-SY by preventing the periodic gas releases that result in hydrogen concentrations that exceed 25% of the Lower Flammability Limit¹ (LFL) at the tank exhaust (WHC, 1991). By controlling the hydrogen releases and maintaining its concentrations below the LFL in the tank dome to well below the value that could be ignited, mitigation is achieved and the concern for tank structural damage and related radiological consequences is eliminated.

The intent of the plan is to mitigate hydrogen release while extending the pump lifetime by minimizing 1) the number of pump starts, 2) the run time and 3) pump motor oil excessive temperature.

An objective of this operating plan is to keep the tank level as low as possible so that, in the event of pump failure, the maximum amount of the time would be available to replace the failed pump.

The current mixer pump as installed in Tank 241-SY-101 located at riser 12A as depicted in Figure 1. The predicted pump performance obtained from Phase B testing is shown in Figure 2.

¹ LFL defined as 3% volume fraction H₂ in a nitrous oxide atmosphere.

2.0 PUMP OPERATION DESCRIPTION

This plan describes two required and three optional modes of pump operations that are to be used over the long term.

2.1 DESCRIPTIONS OF PUMP OPERATIONS

The pump operations for both the required and optional modes are based on and replicate selected operations used during the testing phases and the first five months of long term operation.

The two required modes of pump operations are:

- o Basic Pump Operation - agitate the waste to release gases at about the same rate that they are generated. Operation of the pump is required at least two times per week and at least once every four days for 25 minutes, at 105 radian/s (1000 rpm), with the nozzles advanced 0.5 radian (30 degrees) between each operation. The pump is required to be operated at least 25 minutes in each of the six directions over a two week span (150 minutes of operation).
- o Pump Bump Operation - West Area Operations is allowed to use this operation mode to keep nozzles open to meet the requirement to operate the pump at least once every 4 days. Operation of the pump is for relatively short times, 5 minutes, at 105 radian/s (1000 rpm). The waste level is expected to grow at about 0.08 cm/d (0.03 inches/day) during this mode of operation.

The three optional modes with TRG approval are:

- o Maximum Pump Operation - to replace or supplement the basic mode of pump operations. If the waste level exceeds 1015 cm (399.5 inch), the TRG shall determine if aggressive agitation is necessary. Pump operation at 78.5 rad/s (750 rpm) for 1800 s in stepped sweep operation, in each of the 6 orientations. If necessary this mode shall be used at a frequency determined by the TRG.
- o Two other Pump Operations - to replace or supplement the basic mode of pump operations. Operate the pump at 78.5 radian/s (750 rpm) for 3600 s or at 96.3 radian/s (920 rpm) for 2400 s. These modes shall be used at a frequency determined by the TRG.

Any deviations in these modes of pump operation must be approved by the TRG.

The orientation of the pump nozzles for the above operations shall follow the sequence 0.5, 1.1, 1.7, 2.2, 2.7 and 3.2 radians (28, 65, 97, 125, 155, and 185 degrees), per Figure 1, unless otherwise specified.

Waste level is the main indicator to determine the mode of pump operation. The FIC instrument and manual tape shall normally be used to measure waste level². However, the Test Review group (TRG) may specify other measures (i.e. radar gauge). The objective of the Long Term Pump operations

² Flushing of the FIC and or manual tape shall be considered after evidence of significant deposit buildup is observed (observed by the TV camera) or if the manual tape and FIC disagree by 5 cm (2 inches) or more.

is to maintain the tank waste level as low as possible below 1013 cm (399 inches).

The TRG will periodically review the data associated with the tank such as waste axial temperatures and temperature profiles³, peak temperatures, hydrogen concentration and associated vent header flow rate, total gas releases, ratios of hydrogen, nitrous oxide and ammonia, change in level, pump motor current, voltage, volute pressure, flows to determine if there are any undesirable conditions starting to develop that would require changes in this pump operations plan. The TRG will review pump and tank operations at least once per quarter as required by the Safety Assessment (LANL 1994).

2.2 PRECAUTIONS AND LIMITATIONS

All modes of pump operations in this plan are in accordance with the Safety Assessment (LANL 1994). As a precaution, the pump shall be shutdown by a normal shutdown when the pump motor oil temperature reaches 88°C (190°F). This requirement is in addition to, not a replacement for, the requirements in the Safety Assessment (LANL 1994).

If any pump operations are aborted due to non-instrument conditions the TRG will review the tank/pump data before the pump is restarted. Finally, if a pump run is aborted due to violation of any of the abort criteria, the approvals specified in Section 2.3 are required before restarting the pump.

2.3 ABORT CRITERIA

Pump operation will be aborted by immediately turning the pump off if any of the abort criteria listed in the Safety Assessment (LANL 1994) are exceeded. Many of the abort criteria are implemented as automatic pump trips as indicated in the test procedures (WHC 1993b and 1993c) and alarm response procedures. These abort criteria are divided into three different levels.

The level of authority required to change the abort criteria or to restart the pump when one of the abort criteria has been exceeded is as follows:

Level	Change authority	Restart authority
1	DOE-RL*	TRG
2	TRG	TRG
3	TRG	Test Manager

* Per WHC procedural requirements for changing OSRs.

3.0 REQUIRED CONDITIONS

1. The mixer pump and instrumentation required per the Safety Assessment (LANL 1994) and DACS shall be installed and verified to be operational.
2. The alarm and abort parameters listed in Safety Assessment (LANL 1994) shall be functional.

³ The MIT temperatures shall be compared with a validation probe at least once per quarter.

4.0 SPECIAL EQUIPMENT

No additional special equipment is necessary for long term pump operation.

1. The minimum instrumentation as listed in the Level Maintenance for Tank 101SY Mitigation by Mixing Procedure (WHC 1994b) and the Full Scale Test Procedure.
2. The DACS for controlling pump operation and automatically recording and displaying the required data.

5.0 EXPECTED WASTE AND PUMP BEHAVIOR

No special predictions are required for any of the modes of mixer pump operations given in this plan. Based on the data developed during the test phases and the first five months of long term operation, use of these modes of pump operations will maintain the tank in a mitigated state.

Use of the basic pump mode of operation at least twice a week and at least once in each of the six directions every two weeks will agitate the waste enough to release gases at about the same rate as they are generated.

Use of the optional minimal pump bump operation, whenever the pump needs to be operated every four days, will keep the nozzles from plugging.

Use of the optional (with TRG approval) maximum pump operation will agitate the waste enough to release more gas than is being generated and can be used when the waste level is above 1015 cm (399.5 inches) to decrease the level.

6.0 DATA REQUIREMENTS

The data listed in Table 1 are expected to be collected at the specified frequencies.

7.0 RESPONSIBILITY FOR CONDUCT OF OPERATIONS

Test Engineering West Area Operations are responsible for the long term operation of the pump and keeping the tank in a mitigated state. Additional details on the operational management are provided in WHC 1993a.

8.0 DATA MANAGEMENT

A data management team has prepared a plan, (WHC 1992c) which describes the requirements for the management of operational data. Since the data collected during long term operations are not strictly experimental some relaxation of the data collection/storage/reviews may occur in the future after the long term behavior of the pump and the waste are well established.

Figure 1. Plan View of Tank 241-SY-101.

NOTES: THERMOCOUPLE TREES AT 17B & 17C
GAS PROBES AT 16A, 17B & PUMP
VIDEO CAMERA AT 5B

Figure 2a. 241-SY-101 Mixer Pump Performance Prediction (SI Units)

Figure 2b. 241-SY-101 Mixer Pump Performance Prediction (Customary Units).

Table 1. Expected Data. (sheet 1 of 2)

Parameter	Location	Sampling Frequency
Waste level	Riser 1C (FIC) Riser 13A (Radar) ⁽¹⁾ (Manual Tape) ⁽¹⁾	1/day --
Hydrogen concentration	Exhaust duct Riser 12A Riser 16A (bottom) Riser 17B (bottom)	1/12 s 1/12 s 1/12 s 1/12 s
Gas composition (MS grab sampling)	Exhaust duct Riser 16A (bottom) Riser 17B (bottom)	1/week 1/week 1/week
Gas composition (FTIR)	Exhaust duct	1/10 min
Temperature distribution	Riser 17B (MIT) Riser 17C (MIT)	1/10 min 1/10 min
Probe strain	MIT (Riser 17B) MIT (Riser 17C) Riser 1B	1/6 s ⁽²⁾ 1/6 s ⁽²⁾ 1/6 s ⁽²⁾
Dome pressure	Riser 11B Riser 17B (MIT)	1/12 s 1/12 s
Ventilation flow rate (high & low range)	Exhaust duct	1/12 s
Exhaust humidity	Exhaust duct	1/12 s
Video inspection of FIC and Manual Tape	Riser 5B	1/month
Video ⁽³⁾	Riser 5B	--

- 1) Record for historical data, not to be used for determining mode of operations.
- 2) During pump operations only.
- 3) Not required during pump bumping.

Table 1. Expected Data. (sheet 2 of 2)

Parameter	Location	Sampling frequency
Flow (2 per discharge line)	Each discharge line	1/6 s ¹
Pump discharge pressure	Pump volute	1/6 s ¹
Discharge pressure (2 per discharge line at downcomer)	Each discharge line	1/6 s ¹
Discharge pressure (1 per discharge line at nozzle)	Each discharge line	1/6 s ¹
Motor current	Pump motor	1/6 s ¹
Motor voltage	Pump motor	1/6 s ¹
Motor power	Pump motor	1/6 s ¹
Pump column strain	Pump support column	1/6 s ¹
Pump discharge temperature	Each discharge line	1/6 s ¹
Pump column orientation	Pump support column	1/6 s ¹
Pump speed (r/min)	Variable speed drive	1/6 s ¹
Pump motor temperature	Motor oil	1/6 s ¹
Pump motor moisture	Motor oil	1/6 s ¹
Pump column gas pressure	Pump column	1/6 s ¹

1) During pump operations only.

9.0 REFERENCES

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