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1	1	Design Authority	W.J. Powell	6/25/99							
1	1	Design Agent	T.R. Benegas	6/15/99							
2	1	Cog. Eng.	S.D. Estey	5/17/99	R2-11	1	1	J.R. Biggs		6/18/99	
2	1	Cog. Mgr.	N.W. Kirch	5/11/99	R2-11	1	1	J.M. Grigsby		6/22/99	
		QA				1	1	R.W. Reed		6/22/99	
2	1	Safety	L.S. Krogsrud	6/29/99							
		Env.									

18. A.E. Young Signature of EDT Originator 5-16-99		19. N/A Authorized Representative Date for Receiving Organization		20. N.W. Kirch Signature of Design Authority/ Cognizant Manager 6/29/99		21. DOE APPROVAL (if required) Ctrl. No. <input type="checkbox"/> Approved <input type="checkbox"/> Approved w/comments <input type="checkbox"/> Disapproved w/comments	
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**TANK WASTE REMEDIATION SYSTEM (TWRS)
UNREVIEWED SAFETY QUESTION (USQ)
SCREENING/DETERMINATION**

USQ Tracking Number
TF-99-0511

Rev 0

TITLE: Process Control Plan for 241-SY-101 Transfer, HNF-4264, Rev 0

IDENTIFICATION INFORMATION

Source of Review: Proposed Activity Reportable PIAB

Document Type(s) and Identification Number(s): HNF-4264, Rev 0

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Facility: SST DST AWF

Other(specify): []

INTRODUCTION

The tank 241-SY-101 transfer system was conceived and designed to address the immediate needs presented by rapidly changing waste conditions in tank 241-SY-101. Within the past year or so, the waste in this tank has exhibited unexpected behavior in the form of rapidly increasing crust growth. The Process Control Plan (PCP), HNF-4264, was written to translate high-level guidance and regulatory criteria and express it in terms of operating instructions for the waste transfer system. These controls include:

- Tank Farm Operations Administrative Controls developed in response to DOE-ORP direction regarding supplemental controls placed upon tank 241-SY-101 surface level rise remediation activities specifically involving waste transfer activities.
- Authorization Basis controls (Basis for Interim Operation (BIO)/Technical Safety Requirements (TSRs) and supplemental DOE direction.
- Environmental, Industrial Hygiene and Safety controls.
- Operating Specification Document (OSD) controls.
- Good operating practices.

Included in the document are descriptions of tank conditions, waste conditions, major equipment, and a high-level overview of the system and the line-ups in which it operates. Primarily, the PCP addresses how the waste transfer will be managed, defining the monitoring and control methods including material balances to determine the progress and to define completion criteria for the transfer. The actual plant modifications and waste transfer will be authorized and controlled by plant procedures.

**TANK WASTE REMEDIATION SYSTEM (TWRS)
UNREVIEWED SAFETY QUESTION (USQ)
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Rev 0

SCOPE

The scope of this screening covers Revision 0 of HNF-4264, Process Control Plan for Tank 241-SY-101 Surface Level Rise Remediation.

AUTHORIZATION BASIS

The Authorization Basis documents applicable to the review of documents relating to SY-101 are:

HNF-SD-WM-BIO-001 Rev 1-E *Tank Waste Remediation Systems Basis for Interim Operation*, March, 1999

HNF-SD-WM-TSR-006 Rev 0-S, *Tank Waste Remediation Systems Technical Safety Requirements*, March, 1999

LA-UR-92-3196 Rev 14a, *A Safety Assessment for Proposed Pump Mixing Operations to Mitigate Episodic Gas Releases in Tank 241-SY-101: Hanford Site, Richland, Washington*, May, 1996

Wagoner, J.D., 1998, Contract Number DE-AC06-96RL13200-Supplemental Controls for Continued Operations in Tank 241-SY-101 (Letter 98-SCD-140 to R.D. Hanson, FDH), U.S. Department of Energy, Richland Operations Office, Richland, WA, October 22, 1998

French, R.T., 1999, Contract Number DE-AC06-96RL13200-Submittal of Updated Unreviewed Safety Question (USQ) Evaluation and Supplemental Controls for Tank 241-SY-101 (Letter 99-TSD-051 to R.D. Hanson, FDH), U.S. Department of Energy, Office of River Protection, Richland, WA, April 27, 1999

CONCLUSION

AB Change Required/Recommended? Yes(detail below) No

PRC Review Required? Yes No

As all screening questions are answered either "No" or "N/A", a USQ Determination is not required.

REFERENCES

TF-97-0975, Rev 3, USQ Determination *Waste Surface Change in Tank 241-SY-101*, L.S. Krogsrud and W.L. Cowley, April 8, 1999.

HNF-IP-1266, *Tank Farms Operations Administrative Controls*.

TANK WASTE REMEDIATION SYSTEM (TWRS)
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USQ SCREENING:

A. Does the Proposed Activity represent a change to the facility as described in the Authorization Basis?
 No Yes/Maybe N/A

Basis: The PCP does not implement changes or discuss changes to the facility. Installation of the equipment for the planned transfer from tank 241-SY-101 will be reviewed separately.

B. Does the Proposed Activity represent a change to procedures as described in the Authorization Basis?
 No Yes/Maybe N/A

Basis: The BIO, section B2.5.2 gives the example of a in-farm DST to DST transfer as a type of transfer that was considered in the BIO, but gives no specifics. The BIO does discuss numerous accidents that can occur during transfers and this has resulted in a number of TSR controls. TSR requirements are considered in question D.

C. Does the test or experiment represent a test or experiment not described in the Authorization Basis?
 No Yes/Maybe N/A

Basis: The proposed plan is not a test or experiment.

D. Does the Proposed Activity or Reportable Occurrence impact any TSRs or other Authorization Basis controls?
 No Yes/Maybe N/A

Basis: As stated in the introduction section, numerous controls were considered in writing the PCP. However, this screening will concentrate on AB controls such as SLs, LCOs, SRs, ACs, JCS controls, etc. Controls approved by the Plant Review Committee (PRC) as prudent controls will also be considered. Applicable controls include:

- AC 5.10, as implemented by chapter 5.10 of HNF-IP-1266 (prudent contractor control), provides ignition source controls to be applied to operations in tank 241-SY-101. The installed equipment and processes described in the PCP are consistent with Ignition Source Control (IC) set 2.
- AC 5.11, as implemented by chapter 5.11 of HNF-IP-1266 (prudent contractor control), provides flammable gas monitoring controls. As specified in HNF-IP-1266, and also by DOE (French, 1999), transfer operations will be halted if the flammable gas concentration is greater than or equal to 25% of the Lower Flammability Limit (LFL).
- AC 5.12, section 5.12.2b requires a material balance to be performed periodically during the transfer and the transfer stopped if the material balance exceeds the criteria set. The PCP states that the material balance will be determined using flowmeters on both the dilution water going into tank 241-SY-101 and the waste mixture leaving the tank. As implemented in HNF-IP-1266, an additional

TANK WASTE REMEDIATION SYSTEM (TWRS)
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requirement is added to ensure that the transfer does not lower the bottom of the waste crust to within one foot of the mixer pump suction. The amount to be transferred will be specified by process memo at the time of the transfer and the transfer stopped when the maximum allowable amount is transferred.

E. Does the Reportable Occurrence or PIAB involve analytical errors, omissions, and/or deficiencies in the Authorization Basis?

- No
- Yes/Maybe
- N/A

Basis: The PCP is not a reportable occurrence or a PIAB.

NOTE: IF ANY SCREENING QUESTION IS ANSWERED "YES/MAYBE" FOR A REPORTABLE OCCURRENCE OR POTENTIAL INADEQUACY IN THE AUTHORIZATION BASIS, THEN THE COMPLETED SCREENING WILL HAVE TO BE PROMPTLY REFERRED TO THE PLANT REVIEW COMMITTEE. SEE THE TWRS USQ PROCEDURE FOR DETAILS CONCERNING WHO TO CONTACT AND WHEN THESE ACTIONS MUST BE COMPLETED.

USQ SCREENER: USQ EVALUATOR:

TANK WASTE REMEDIATION SYSTEM (TWRS)
UNREVIEWED SAFETY QUESTION (USQ)
SCREENING/DETERMINATION

USQ Tracking Number
TF-99-0511

Rev 0

L.S. Krogsrud

Print Name

R.W. Reed

Print Name

L.S. Krogsrud

Signature

6/28/99

Date

R.W. Reed

Signature

28 Jun 99

Date

PRC APPROVAL/CONCURRENCE (as required):

Meeting number/date:

PRC Chairperson, Print Name

PRC Chairperson, Signature

Date

S

Process Control Plan for Tank 241-SY-101 Surface Level Rise Remediation

S. D. Estey
Lockheed Martin Hanford, Corp., Richland, WA 99352

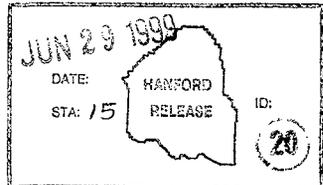
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Abstract: N/A

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Janis Aardal 6-29-99
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HNF-4264
Revision 0

**PROCESS CONTROL PLAN FOR TANK 241-SY-101 SURFACE
LEVEL RISE REMEDIATION**

S. D. Estey
W.B. Barton
Lockheed Martin Hanford Corporation

Date Published
June 1999

Prepared for the U. S. Department of Energy
Assistant Secretary for Environmental Management

Project Hanford Management Contractor for the
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LIST OF TERMS

AC	Administrative Control
ACC	accumulator
ASSD	Anti-siphoning slurry distributor
BIO	Basis for Interim Operation
Btu/lb	British thermal units per pound
CGM	combustible gas meter
cP	centi-Poise
DACS	Data Acquisition and Control System
DCP	DACS control panel
DOE	U.S. Department of Energy
DOE-ORP	U.S. Department of Energy, Office of River Protection
DR	dilution ratio
DST	double-shell tank
EIN	equipment identification number
ESH&QA	Environmental, safety, health, and quality assurance
FCP	Farm Control Panel
FDH	Fluor Daniel Hanford, Inc.
ft	feet
ft/sec	feet per second
FY	fiscal year
gal	gallon
gal/in.	gallons per inch
gm/cc	grams per cubic centimeter
gpm	gallons per minute
HP	horse power
ID	internal diameter
in.	inch
kg	kilogram
kg/gal	kilograms per gallon
kg/L	kilograms per liter
kgal	kilogallon
LFL	lower flammability limit
lb	pound
LMHC	Lockheed Martin Hanford Corporation
<u>M</u>	molar
MCC	Motor Control Center
NGTP	new generation transfer pump
OSD	Operating Specification Document
P&ID	process and instrumentation drawing
PCP	Process Control Plan
PCV	pressure control valve
PFD	Process Flow Diagram
ppm	parts per million
PPP	Prefabricated Pump Pit

PNNL	Pacific Northwest National Laboratory
PRV	pressure-regulating valve
psi	pounds per square inch
RAPID	respond and pump in days
sec ⁻¹	per second
SEL	safety equipment list
SOV	solenoid-operated valve
SpG	specific gravity
SSCs	structures, systems and components
SST	single-shell tank
TFO	tank farm operations
TMACS	Tank Monitoring and Control System
TSR	Technical Safety Requirement
TWRS	Tank Waste Remediation System
USQ	unreviewed safety question
VFD	variable frequency drive
VOC	volatile organic compound
vol %	volume percent
WSCP	water skid control panel
wt %	weight percent
WSS	Water Support Skid
°C	degrees Celsius
°F	degrees Fahrenheit
%	percent

1.0 INTRODUCTION

The tank 241-SY-101 transfer system was conceived and designed to address the immediate needs presented by rapidly changing waste conditions in tank 241-SY-101. Within the last year or so, the waste in this tank has exhibited unexpected behavior (Rassat et al. 1999) in the form of rapidly increasing crust growth. This growth has been brought about by a rapidly increasing rate of gas entrapment within the crust. It has been conceived that the lack of crust agitation beginning upon the advent of mixer pump operations may have set-up a more consolidated, gas impermeable barrier when compared to a crust regularly broken up by the prior buoyant displacement events within the tank. The crust growth rate is such that by September 1999, the waste level within the tank may violate regulatory definitions of a double-shell tank (DST).

As a result, a series of level-growth remediation activities have been developed for tank 241-SY-101. The initial activities are also known as near-term crust mitigation. The first activity of near-term mitigation is to perform the small transfer of convective waste from tank 241-SY-101 into tank 241-SY-102 beginning in September 1999. A 100 kgal transfer represents about a 10% volume reduction allowing a 10% water back-dilution. Current thinking holds that this should be enough to dissolve nitrite solids in the crust and perhaps largely eliminate gas retention problem in the crust (Raymond 1999).

Additional mitigation activities are also planned on less constrained schedules. The net affect of the small transfer and follow-on mitigation activities for tank 241-SY-101 is strongly believed to be the remediation of tank 241-SY-101 as a flammable gas safety concern.

This Process Control Plan deals with the first remediation activity, the small transfer. This transfer requires a dedicated system. To facilitate design, construction, and operation, this transfer system conveys waste from tank to tank via a transfer line composed of an overground, encased flexible hose. An existing waste transfer pump, known alternately as the new generation transfer pump (NGTP) or pump P-350, is installed in 241-SY-101 to accomplish the transfer. Instrumentation and control features are kept as simple as possible to facilitate the mitigation activity, yet comply with the necessary safety constraints. The design incorporates a pressurized, heated water supply to provide a high degree of operational flexibility and reliability by limiting the concentration of waste slurries in transfer.

The Process Control Plan (PCP) provides translation of the high-level guidance and regulatory criteria and expresses it in terms of operating instructions for the waste transfer system. These controls include:

- Tank Farm Operations Administrative Controls developed in response to the U.S. Department of Energy, Office of River Protection (DOE-ORP) direction regarding supplemental controls placed upon tank 241-SY-101 surface level rise remediation activities specifically involving waste transfer activities

- Authorization Basis controls (Basis for Interim Operation [BIO]/Technical Safety Requirements [TSRs] and supplemental U.S. Department of Energy [DOE] direction)
- Environmental, Industrial Hygiene and Safety controls
- Operating Specification Document (OSD) controls
- Good operating practices

A current listing of these controls as identified can be found in Appendix A.

Included in this document are descriptions of tank conditions, waste conditions, major equipment, and a high-level overview of the system and the line-ups in which it operates. Primarily, the PCP addresses how the waste transfer will be managed, defining the monitoring and control methods including material balances to determine the progress and to define completion criteria for the small transfer.

The general concept of the initial transfer is to dilute a volume of tank 241-SY-101 wastes with an equal volume of water and to transport the combined volume to tank 241-SY-102. The water dilution is specified to minimize operational risk in the form of solids precipitation in and potential plugging of the transfer line. The waste volume in tank 241-SY-102 at the start of the transfer is in the range of 500 to 750 kgal. The anticipated waste volume in tank 241-SY-102 at transfer completion will be in the range of 700 kgal to 950 kgal. Flammable gas hazards associated with this transfer have been postulated and control implemented appropriately. Additionally, it is intended that the "post-transfer" condition of tank 241-SY-102 will not be maintained for an extended period as this waste volume will need to be cross-sited to create additional tank 241-SY-102 volume for continuing saltwell pumping and further tank 241-SY-101 remediation activities.

This document was written with the best information available at the time. However, this information is subject to frequent change. For the most current information, see the project H-14 drawings, the Functional Requirements and Technical Criteria for the 241-SY-101 RAPID Mitigation System (HNF-3885), and the applicable Authorization Basis documents.

2.0 PROCESS DESCRIPTION

2.1 WASTE CHARACTERISTICS

From a physical standpoint, the bulk behavior of the convective wastes from tank 241-SY-101 is of great concern to a transfer system. These wastes are a saturated, high-salt material with high specific gravity and high viscosity. These properties exist at the in-situ waste temperature of 120 °F. This transfer system poses the potential to, upon a process upset, to allow the waste to be cooled to ambient (i.e., approximately atmospheric) temperatures. At these low temperatures, both the degree of waste saturation and viscosity rapidly increases, posing the scenario of essentially freezing solid in the transfer line. Driven by these concerns, both water dilution and temperature control are specified for the transfer of tank 241-SY-101 wastes.

As a result of these estimated behaviors, the volumetric dilution range specified for the waste transfer system varies from 2 parts waste to 1 part water to 1 part waste to 2 parts water. The mean dilution ratio is specified as 1 part waste to 1 part water. The low dilution limit is specified due to concerns about the build-up of high salt concentrations in tank 241-SY-102. Some of the 200 West area single-shell tank (SST) saltwell wastes possess high concentrations of phosphate. Interim stabilization activities accumulate these wastes in tank 241-SY-102. By limiting the nitrate/nitrite salt concentrations in tank 241-SY-102, the probability of phosphate precipitation will be minimized. The high dilution limit is specified from a desire to limit the impact of tank 241-SY-101 transfer activities on operational DST volume.

2.1.1 Waste Solids Composition Dependence on Waste Dilution and Temperature

The volume percent precipitated solids contained in the in-situ convective regions of tank 241-SY-101 are stated as 5% to 25% with a mean of 15%. This corresponds to the solids concentration at 120 °F. During the actual transfer of waste from tank 241-SY-101 to tank 241-SY-102, the waste will be in the piping system for only a few seconds. It is prudent to assume that no dissolution of precipitated solids occurs during slurry transfer. Therefore, the solids concentrations in the transferred waste are diluted proportional to the dilution volume of water. Assuming that tank 241-SY-101 waste with 25 volume % solids is diluted with water at the low dilution limit, the maximum expected solids concentration in the transfer line is approximately 17 volume % and the minimum somewhere around 2 volume %. The mean slurry solids concentration derived the mean value of 241-SY-101 convective waste solids concentration and the mean water dilution value would be in the vicinity of 7.5 volume %. This means the resulting slurry solids concentration in the transfer line is expected to range from about 2 vol % to 17 vol % with about 7.5 vol % as the mean.

Insoluble Solids

The insoluble solids concentration of 241-SY-101 in the convective layer is estimated to be 3 weight percent or less. This is consistent with laboratory data and expert opinion. The concentration would be slightly lower on a volumetric basis because of the higher density of solids. The laboratory data (Steen 1999) indicate insoluble metals (Ca, Cr, Fe, Mn, Ni, Si, and U) are present at around 0.5 weight percent. This corresponds to approximately 1 to 1.5 weight percent as metal oxides in the waste. The remainder of the solids is at least partially soluble, depending on temperature and concentration.

Dissolution/Precipitation Kinetics

The overall kinetics of dissolution will be measured in the dilution and mixing study (Estey 1999). The consensus of tank waste chemistry experts is that dissolution of the nitrate, nitrite, carbonate, and phosphate solids should be fairly rapid (minutes). This may not have much effect on transfer properties, as the transit time to tank 241-SY-102 will be less than one minute. Dissolution of oxalate is expected to take longer (hours).

Some precipitation of aluminum hydroxide is expected to occur because of the reduced pH of the diluted waste. This is known to be a slow process (days) and will not affect the pipeline behavior of the waste during the transfer. Although not expected to be a problem in the pipeline because of dilution, the precipitation of phosphates might occur within minutes and precipitation of oxalate and fluoro-phosphates within hours. The phosphate concentration in 241-SY-101 waste is fairly low at around 0.5 weight percent (Steen 1999). Precipitation of phosphates or fluoro-phosphate double salts may occur upon mixing with high phosphate saltwell liquors in 241-SY-102. However, this is neither a pumping nor a pipeline transfer issue.

The effect of the water dilution ratio on solids dissolution has been studied using OLI Systems Inc. Environmental Simulation Program (ESP). The simulations indicate that dissolution of soluble salts is 87 percent complete at a dilution of 35 parts water to 100 parts waste and 98 percent complete at 50 parts water to 100 parts waste (Reynolds 1998). Further dilution actually results in a slight increase in solids because of pH-induced precipitation of aluminum hydroxide.

These data support the preliminary conclusion that a dilution of 35 parts water to 100 parts waste is adequate, but ratios of at least 50 parts water to 100 parts waste are desired. The permitted dilution range is from 50 to 200 parts water to 100 parts waste. Experimental results using actual waste samples have confirmed these ratios (Person 1999).

The effect of dilution water temperature on solubility has also been modeled (Reynolds 1998). Increasing the temperature of the dilution water does not have as great an effect as increasing the dilution ratio. At a dilution ratio of 30 parts water to 100 parts waste, approximately 25% more soluble solids are present using 85 °F dilution water than 130 °F water. The target temperature range for dilution water has been specified as

110 F to 130 °F to allow operational flexibility. Any dilutions using water in this temperature range will result in lower overall solids concentrations.

A specific concern is the net effect of diluting 241-SY-101 waste with water at a nominal 1:1 ratio and allowing the mixture to equilibrate and cool to 65 °F (which could happen in the discharge drop leg in 241-SY-102 if transfer line flushing were significantly delayed). Although not modeled, it is anticipated that the final solids concentration would be lower than the initial, just-mixed concentration. That is, dissolution with the diluent is expected to have a stronger effect than the reduction in temperature. A 1:1 dilution is about 3 times more dilution water than is necessary to dissolve all NaNO_3 at the temperature of 241-SY-101 (120 °F). Even upon cooling to 65 °F, much more NaNO_3 will be dissolved in the diluted waste than in the original 241-SY-101 waste.

2.1.2 Waste Viscosity Dependence on Waste Dilution and Temperature

Viscosity of slurries is highly complex and essentially indeterminate. The viscosity and viscosity behavior of many liquids, such as water, is well defined. However, when suspended solids are included in a liquid (i.e., a slurry), no universally known method exists to specify the viscosity of a slurry, even if other physical properties of the slurry are well known. For example, whereas most liquids can be considered Newtonian fluids, most slurries cannot. The only way the viscosity of actual slurry in a specific application can be positively determined is to measure it in that application. Such a measurement cannot be made in the application of the transfer from tank 241-SY-101.

The best known means of estimating a slurry viscosity from other known slurry parameters is via an "Einstein" type relationship. This relationship can at best be considered as only a rough rule-of-thumb. In its simplest form, this relationship expresses the slurry viscosity as a linear function of the carrier liquid viscosity and an exponential function of the solids loading or slurry density. Some terms are useful to define:

c = carrier or liquid phase of a slurry

d = dispersed or solid phase of a slurry

m = bulk property of a slurry

α = phase volume fraction in a slurry (dimensionless)

ρ = phase density of slurry (units of mass per volume)

μ = dynamic viscosity (units of mass per length per time)

The following relationships apply:

$$\alpha_c + \alpha_d = 1$$

$$\rho_m = \alpha_c \rho_c + \alpha_d \rho_d$$

$$\rho_\infty = \rho_m \text{ at infinite dilution, where } \rho_m = \rho_c$$

α_d must be distinguished from the volume fraction of settled solids. Settled solids always contain void volumes occupied by the liquid phase so that the volume fraction of settled solids would be greater than the volume fraction of dispersed solids, or true solids.

The desired quantity is the effective, or slurry viscosity, μ_m . A relationship can be defined as for Newtonian slurries:

$$\mu_m = \mu_c \exp[k(\rho_m - \rho_\infty)/\rho_\infty] \quad \text{where "k" is an arbitrary constant}$$

The term "Newtonian slurries" refers to slurries with slowly settling solids that possess an effective viscosity that can be measured in a viscometer. This form of an empirical expression for slurry viscosity is similar to other simplified models available in the literature (Shook and Rocco 1991). In their most simplified forms, these models state slurry viscosity as a function of the carrier liquid viscosity and the difference in density between the slurry and its carrier liquid.

To determine the constant in the relationship, the value of μ_m must be known for at least one set of μ_c , ρ_c , and ρ_m values. ρ_m is a value established fairly well for the waste in question. The range of ρ_m values for tank 241-SY-101 convective wastes at 120 °F is stated as 1.45 to 1.75 gm/cc with a mean of 1.60 gm/cc. For tank 241-SY-101 wastes, the value of ρ_c at any non-infinite dilution is not known with much precision. The only thing that can be positively stated for tank 241-SY-101 waste is that at infinite dilution, $\rho_m = \rho_c = 1.0$ gm/cc.

Tingey et al. (1994) and Stewart (1996) document viscosity analyses performed on tank 241-SY-101 wastes. The former investigated material from core 22 taken during Window C while the latter reported results from ball rheometer testing in tank 241-SY-101. Both references report Non-Newtonian, shear-thinning (thixotropic) behavior of the tank wastes.

Analyses documented in Tingey et al. (1994) looked at parameters of ρ_m , settled solids density, settled solids volume fraction, filtered solids weight fraction, and viscosity at a 400 sec⁻¹ shear rate at a 0, 20, 40, 70, and 100 vol % 2 M NaOH dilution and 50, 70, and 90 °C. The results indicate that little difference could be noted between ρ_m and the settled solids density at any dilution or temperature. Differences in viscosity, volume percent settled solids, and weight percent filtered solids showed much more variation at differing dilutions and temperatures. In this application, 2 M NaOH can be considered equivalent to water.

Tingey et al. (1994) reported a dynamic viscosity of 40 cP at a 400 sec⁻¹ shear rate for undiluted waste at 50 °C. Stewart (1996) reported ball rheometer viscosity behavior with an uncertainty factor of two, shown in Table 2-1.

Table 2-1 In-Situ Tank 241-SY-101 Apparent Viscosity

Shear rate (sec ⁻¹)	1	10	100	400
Viscosity (cP)	~600	~150	~80	~40

The viscosity results from both references for undiluted wastes at tank temperature and a 400 sec⁻¹ shear rate show good agreement. When shear rate is expressed as the pipe flow velocity divided by the pipe inner radius, a 6 ft/sec flow velocity corresponds to a shear rate of about 50 sec⁻¹ in a 3-inch ID pipe. At this shear rate, Stewart (1996) indicates an in situ waste viscosity of about 100 cP.

A summary of selected data for tank 241-SY-101 waste at 50 °C at various water dilutions from Tingey et al. (1994) is shown in Table 2-2.

Table 2-2 In-Situ Tank 241-SY-101 Physical Properties

Dilution ▶ (water/waste) Property ▼	0:1	0.2:1	0.4:1	0.7:1	1:1
Apparent Viscosity at 400 sec ⁻¹ (cP)	39.4	35.8	12.3	6.8	2.9
Vol % settled solids	100	100	96	89	34
Wt % filtered solids	83	60	68	40	25
Settled solids density	1.72	1.68	1.59	1.51	1.42
Slurry density	1.72	1.68	1.60	1.48	1.34

The value of 1:1 100 vol % dilution corresponds to the minimum dilution specified for the waste transfer system. Based on the shear viscosity behavior reported by Tingey et al. (1994), the viscosity at 50 sec⁻¹ shear rate would appear to be 2.4 times larger than the value at 400 sec⁻¹. The viscosity of water at 50 °C is 0.55 cP.

For a 50 sec⁻¹ shear rate, tank 241-SY-101 waste viscosities can be derived from data in Tingey et al. (1994) and Stewart (1996). These are shown in Table 2-3:

Table 2-3 In-Situ Tank 241-SY-101 Apparent Viscosity

Dilution ▶ (water/waste) Property ▼	0:1	0.2:1.0	0.4:1	0.7:1	1:1
Apparent Viscosity at 50 sec⁻¹ (cP)	100	85	30	16	7.0

This suggests a slurry viscosity expression in the form of:

$$\mu_m = 0.55 \text{ cP exp}[k(\rho_m - 1.0 \text{ gm/cc})/ 1.0 \text{ gm/cc}]$$

$$\text{where } 100 \text{ cP} = 0.55 \text{ cP exp}[k(1.6 \text{ gm/cc} - 1.0 \text{ gm/cc})/ 1.0 \text{ gm/cc}]$$

$$\text{since } \mu_m = 100 \text{ cP when } \rho_m = 1.6 \text{ gm/cc. This yields } k = 8.67.$$

Therefore, at 50 °C, (~120 °F) and a shear rate of 50 sec⁻¹, the expression for the slurry viscosity produced by the waste transfer system becomes:

$$\mu_m = 0.55 \text{ cP exp}[8.67(\rho_m - 1.0 \text{ gm/cc})/ 1.0 \text{ gm/cc}]$$

This expression yields the results shown in Table 2-4.

Table 2-4 Slurry Viscosity Behavior at 120°F and 50 sec⁻¹ Shear Rate

Slurry Density (gm/cc)	Mean Viscosity (cP)	Maximum Viscosity (cP)
1.6 (corresponding to no dilution)	100	200
1.4 (corresponding to minimum specified dilution of 1 part water to 2 parts waste)	18	36
1.3 (corresponding to mean dilution of 1 part water to 1 part waste)	7.4	15
1.2 (corresponding to maximum dilution of 2 parts water to 1 part waste)	3.1.0	6.2
1.0 (corresponding to infinite dilution)	0.55	0.55

From the above table, at the specified waste transfer system operating temperature of 120 °F, the minimum specified dilution of 1 part by volume water to 2 parts by volume waste yields a slurry with an estimated viscosity of less than 30 cP. Only in the extreme of low dilution at the high viscosity bound does it exceed 30 cP. At the mean 1:1 dilution, the expected slurry viscosity is about 7.5 cP with an expected maximum of 15 cP.

2.1.3 Waste Critical Velocity Dependence on Waste Dilution and Temperature

Critical velocity in slurry flow is an estimated fluid flow velocity at which the effects of random, turbulent fluid motions provide enough agitation to keep individual solid particles in the slurry suspended in the slurry. The idea is that if the velocity of slurry transport is kept above the critical velocity, that solids deposition and the attendant potential of line plugging can be avoided. The concept of a critical velocity is generally acknowledged as having no hard scientific definition, but rather results from experimental data fits as determined from various researchers.

A review of many critical velocity correlations as applied to Hanford tank wastes has been performed (Estey and Hu 1998). Specific application of the concept to the tank 241-SY-101 transfer has also been performed by Pacific Northwest National Laboratory (PNNL) (Onishi and Recknagle 1999). Both analysis surveys indicate that a specified slurry flow velocity of 6 ft/sec meet all practical requirements for critical velocity, provided some amount of water dilution of the waste is performed.

The specific analyses documented by PNNL indicate that there are values of water dilution and slurry temperature that optimize (i.e., minimize) the resultant critical velocity. The concept behind this finding is that high carrier liquid viscosities are more efficient at momentum transfer to solid particles, yet impose higher pressure drops in piping and require larger velocities to achieve turbulent flow. In contrast, low carrier liquid viscosities make possible turbulent flow at lower velocities, yet are less efficient at transferring momentum to the solid particles in a slurry.

Both increasing water dilution and, to a lesser extent, increasing slurry temperature, lower the carrier liquid viscosity in a slurry. At higher values of changes in water dilutions and temperatures, the affect on critical velocity is small. However, very evident in the PNNL findings is that no water dilution of tank 241-SY-101 wastes results in a significant carrier liquid viscosity. The net effect is to require extremely high flow velocities to achieve turbulent flow in the transport of undiluted wastes. This result is strong evidence for the need of at least some water dilution of tank 241-SY-101 wastes.

2.1.4 Waste Compatibility with Tank 241-SY-102 Wastes

The tank 241-SY-101 level-rise remediation project acknowledges the need to perform a waste transfer compatibility assessment (Fowler 1995; Mulkey 1997) for this transfer. This is a requirement specified by Administrative Control AC 5.12 (LMHC 1999c). The

assessment must be successfully completed in order for the 100-kgal waste transfer to occur in September 1999.

The waste transfer compatibility assessment acts as a screening tool that determines if any safety or operationally related concerns might arise as a result of the proposed transfer. Upon Process Engineering request, or upon any positive findings for the waste compatibility criteria, a more in-depth analysis must be performed before a disposition is determined. The findings of the in-depth analysis of the Complexed Waste compatibility criteria has been reported (Beck 1999) with favorable results. At this time, no additional waste incompatibilities are expected from this assessment.

Table 2-5 shows the preliminary chemical compound distribution based on fiscal year (FY) 1999 core sample of tank 241-SY-101.

Table 2-5. Preliminary FY 1999 Core Sample Characterization

Chemical Species	Mass Percentage of Waste Reported to Two Significant Figures	Mass Percentage of Waste Normalized to Two Significant Figures
H ₂ O	40	39
Na	19	18
Al(OH) ₄	12	12
NO ₃	11	11
NO ₂	11	11
OH	2.8	2.7
CO ₃	2.2	2.1
C ₂ O ₄	1.3	1.3
Cl	0.85	0.82
CHO ₂	0.75	0.72
SiO ₂	0.64	0.62
PO ₄	0.55	0.53
Cr ₂ O ₃	0.50	0.48
SO ₄	0.35	0.34
K	0.35	0.34
C ₂ H ₃ O ₂	0.18	0.17

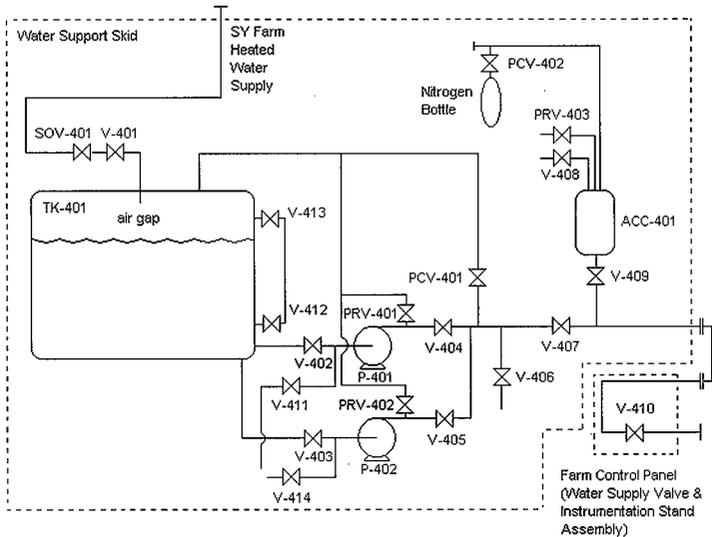
3.0 EQUIPMENT DESCRIPTIONS

This section provides an overview of the primary piping and instrumentation systems associated with the Surface Level Rise Remediation Project (SLRRP) transfer system. The current list of transfer system H-14 drawings is shown in Figure 3.1:

3.1 WATER SUPPORT SKID

A dedicated water supply for dilution and flushing is provided with the transfer system. The major features are two 20-HP water supply pumps, a 2,000-gallon supply tank, and a 75-gallon nitrogen pressurized flush accumulation tank mounted on an 8x20 ft skid. The total weight of the Water Support Skid is approximately 11,000 lbs. ACC-401 supplies the capability to flush the transfer line in the event of loss of electrical power. This flush is driven by pressure from the nitrogen bottle. The bottle is normally pressurized to a nominal 2,000 psi, but is regulated to 180 psi. Figure 3-2 shows a schematic of the Water Support Skid. The 2000 gal supply tank incorporates an air-gap between the site raw water supply and the transfer system water supply. This provides the site raw water system with a degree of protection from radioactive contamination.

Figure 3-2. Water Support Skid



Key:

- ACC = accumulator
- P = pump
- PCV = pressure control valve
- PRV = pressure-regulating valve
- SOV = solenoid-operated valve
- TK = tank
- V = valve

Table 3-1. Water Support Skid Valve Functions

Valve EIN	Description of Valve Function
POR32-RW-SOV-401	Raw Water Supply to Skid Solenoid Operated Isolation
POR32-RW-PCV-401	Raw Water Outlet Line Pressure Control Valve
POR32-RW-PCV-402	Accumulator Pressure Control Valve
POR32-RW-PRV-401	P-401 Outlet Line Pressure Relief Valve
POR32-RW-PRV-402	P-402 Outlet Line Pressure Relief Valve
POR32-RW-PRV-403	Accumulator ACC-401 Pressure Relief Valve
POR32-RW-V-401	Raw Water Supply to Skid Isolation Valve
POR32-RW-V-402	Pump P-401 Inlet Isolation Valve
POR32-RW-V-403	Pump P-402 Inlet Isolation Valve
POR32-RW-V-404	Pump P-401 Outlet Isolation Valve
POR32-RW-V-405	Pump P-402 Outlet Isolation Valve
POR32-RW-V-406	Flush Drain Isolation Valve
POR32-RW-V-407	Outlet Line Isolation Valve
POR32-RW-V-408	Accumulator ACC-401 Vent Isolation Valve
POR32-RW-V-409	Accumulator ACC-401 Isolation Valve
POR32-RW-V-410	Valve Stand Raw Water Line Isolation Valve
POR32-RW-V-411	Pump Inlet Line Drain Isolation Valve
POR32-RW-V-412	Tank TK-401 Sight-Glass Lower Isolation Valve
POR32-RW-V-413	Isolation Valve
POR32-RW-V-414	WSS: Pump Inlet Line Drain Isolation Valve

FCP = Farm Control Panel
WSS = Water Support Skid

During steady-state dilution flow operation the water skid is capable of providing water at 110 °F to 130 °F. The maximum flow rate of 70 gpm is specified. This flow rate can be maintained for the duration required to accomplish the specified transfer of 100 to 150 kgal of tank 241-SY-101 waste. Upon a loss of electric power, ACC-401 provides the means to clear the process lines of waste slurry.

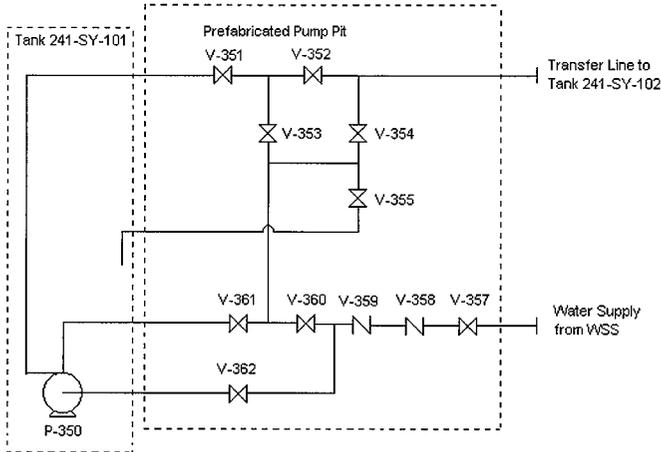
3.2 TANK 241-SY-101 PREFABRICATED PUMP PIT (PPP) AND NEW GENERATION TRANSFER PUMP (NGTP, P-350)

The Prefabricated Pump Pit (PPP) at tank 241-SY-101 contains waste and water supply piping and routing valves for the transfer system, various instrumentation, and the mounting for the P-350 pump. The PPP also provides for a drain, seal loop, and manually operated system high-point vent, which return to tank 241-SY-101. The PPP drain is capable of a flow rate of 20 gpm.

The P-350 pump extends through the PPP baseplate into the tank 241-SY-101 waste. The pump would have the most versatility if the inlet were placed as low in the tank as possible. However, concerns about the physical properties of settled solids in this tank and uncertainties about corresponding waste viscosities has dictated placing the pump inlet well above the settled solids layer in the well mixed convective regions of the waste at an elevation of approximately 8 ft above tank bottom.

A representation of the PPP and P-350 pump is shown in Figure 3-3.

Figure 3-3. Prefabricated Pump Pit and P-350 Pump



The PPP contains the process routing values listed in Table 3-2

Table 3-2. Prefabricated Pump Pit Valve Functions

Valve EIN	Description of Valve Function
SY101-WT-V-351	Transfer Pump Outlet Isolation Valve
SY101-WT-V-352	Transfer Line Isolation Valve
SY101-WT-V-353	Transfer Line Flush Isolation Valve
SY101-WT-V-354	Downstream Vent Valve
SY101-WT-V-355	Upstream Vent Valve
SY101-WT-V-357	Raw Water Isolation Valve
SY101-WT-V-358	Raw Water Upstream Check Valve
SY101-WT-V-359	Raw Water Downstream Check Valve
SY101-WT-V-360	Raw Water Flush Isolation Valve
SY101-WT-V-361	Pump Flush Isolation Valve
SY101-WT-V-362	Pump Dilution Water Isolation Valve

3.3 WASTE TRANSFER LINE

The waste transfer line is an overground, 2-inch ID, flexible hose-in-hose conveying system wastes at velocities of 6 ft/sec (60 gpm) or greater. The primary hose is encased in a flexible 4-inch ID hose. The transfer line incorporates bends with radii no less than five line diameters to minimize flow disruptions and associated probability of solids deposition. The transfer hose assembly is approximately 125 ft long, the slope of 1/33 to 1/16. Heat tracing is wrapped around the outside of the encasement hose and a layer of insulation is applied over the assembly. Portable lead blankets provide radiation shielding for the transfer line assembly.

3.4 TANK 241-SY-102 DROP LEG

A submerged drop leg at tank 241-SY-102 is incorporated to minimize SY-Farm ventilation system ammonia and volatile organic compound (VOC) concentrations. This device is known as the anti-siphoning slurry distributor (ASSD). The design detail of the ASSD is shown in Figure 3-4.

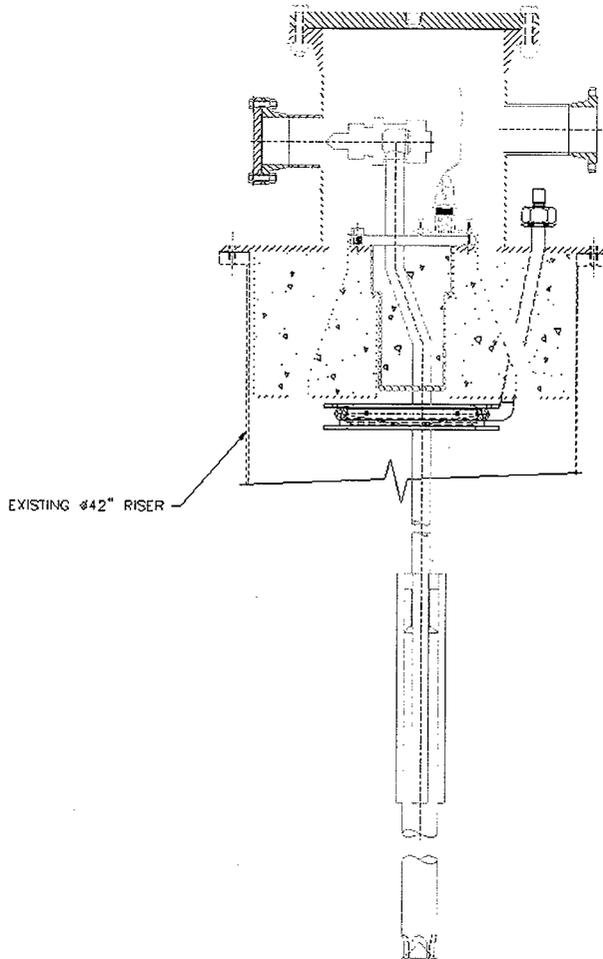
The primary purpose of the ASSD is to minimize the direct contact of tank 241-SY-101 convective wastes with tank atmosphere. This purpose was justified based on ammonia characterization information for tank 241-SY-101 wastes (e.g., Herting 1995) and engineering analysis of subsequent waste ammonia behavior when exposed to a tank atmosphere (Hedengren 1999). Minimizing the direct contact of the tank 241-SY-101 wastes with the air minimizes the mass transfer of ammonia from the waste slurry to the tank atmosphere. A short air gap is incorporated in the drop leg as protection against tank-to-tank siphoning of wastes. Additionally, by submerging the drop leg discharge, the ammonia in the transferred wastes will seek to enter liquid phase equilibria with the

large amount of aqueous tank 241-SY-102 supernate. By being rapidly absorbed into this supernate, the probability of large, immediate ammonia releases from tank 241-SY-102 will be minimized.

Along with its primary function, the design of the ASSD incorporates other performance enhancing features.

The drop leg discharge design injects the transferred wastes into tank 241-SY-102 horizontally at a depth of 160 inches. To accomplish this, the drop leg discharge has openings in the horizontal direction, diverting the flow from the axial to the radial direction in the tank. This design and location minimizes the probability of disturbing the presently settled solids of high transuranic (TRU) activity while providing reasonable mixing of the incoming wastes considering the waste volumes and flow rates involved. The horizontal openings at the discharge are sized to maintain a total flow cross-sectional area at least equivalent to that of the 2-inch transfer line.

Figure 3-4. Anti-Siphoning Slurry Distributor Detail



DROP LEG ASSEMBLY

The ASSD also serves as a passive siphon break device for the transfer system. At the top of the drop leg, the 2-inch diameter transfer-line pipe ends in a nozzle. At this location, the 2-inch diameter pipe transitions to a 4-inch diameter pipe through a diffuser. The diffuser narrows around the 2-inch pipe, but leaves a quarter-inch air gap between the 4-inch and 2-inch pipes. This air-gap provides a vacuum break to protect against tank-to-tank siphoning while minimizing the amount of process fluid entering the tank headspace through the air gap.

The drop leg discharge is positioned at 160 inches to achieve a balance among:

- (1) Concerns against minimizing agitation of the TRU settled solids in 241-SY-102 while optimizing mixing of incoming 241-SY-101 slurry with 241-SY-102 supernate indicate the drop leg discharge should be located as high off the bottom as possible.
- (2) Desiring to maximize the operating volumes in 241-SY-102 indicates a location as close to the bottom as possible. This would allow larger batch transfers out of 241-SY-102 without exposing the drop leg nozzles to atmosphere - a situation not desired because of the ammonia issues associated with 241-SY-101 wastes.
- (3) Adhering to a 160-inch minimum liquid level for 241-SY-101 transfer satisfies Operations requirement to keep 241-SY-102 level higher than 130 inches.

3.5 TRANSFER CONTROL SYSTEM

Control of the waste transfer system is achieved by the manual positioning of the system routing valves and operation of the system pumps.

The pumps are the P-350 transfer pump and the water supply pumps (P-401 and P-402) on the Water Support Skid (WSS). Control of the water pumps is via on/off switches. Pump P-350 incorporates a variable frequency drive (VFD) so in addition to the on/off switches, the pump speed is controlled via a keypad.

Limited instrumentation capability is provided with the system. Mass flow/flow density capabilities are not included in the design because of the short runs of system lines and the short transit times incorporated with them severely limit the response time required to control the composition of the transfer line slurry. Cost and schedule limitations also precluded the incorporation of this sort of instrumentation. Controlling the volumetric ratio of the transfer line flow rate to the dilution water flow rate (valve V-410 position and/or pump P-350 speed) provides control of mass flow and density.

The prime operational concerns are protected by a limited system of interlocks and design features. These operational concerns and the associated interlocks/alarms/design features (shown in parenthesis) are listed below:

- (1) Do not fill the transfer line with undiluted waste or water supply lines with any waste upon an electrical or mechanical failure (protective features include (a) interlock to shutdown pump P-350 upon detection of low dilution water flow at the farm control panel; (b) interlock to shutdown of pump P-350 upon detection of high dilution water flow at the farm control panel, (c) alarm indicating high pressure upstream the flush water isolation during transfer operations; (d) two process water check valves V-358 and V-359 in the PPP; (e) the nitrogen pressurized water flush tank on the water support skid).
- (2) Do not allow an electrical or mechanical failure to result in uncontrolled water addition to tanks 241-SY-101 or -102 (protective features include the 2,000-gal capacity of the water skid supply tank, which ensures no more than 2,000 gallons of water can be added to the tanks upon loss of electrical power).

Instrumentation and controls are provided at four locations for the transfer system. These are:

- The Farm control panel where the PPP routing and control valves are positioned and operated, and a pump P-350 shutdown switch is provided. Local leak detection alarms are provided for the PPP and transfer line.
- The Remote control location (DACS [Data Acquisition and Control System] control console). The on-off switch is located here. A summary alarm is provided for all leak detection systems.
- The water skid (Water Skid control console). This location provides the water supply valve and pump controls.
- The Motor Control Center (MCC) where the P-350 pump VFD is located.

Table 3-3 lists specific instrumentation and controls associated directly with the waste transfer system.

Table 3-3. Transfer System Controls, Indications, Interlocks and Alarms

Type	Description	Location
Control	P-350 pump on/off	DCP
	P-350 pump shutoff	FCP, DCP
	P-350 pump speed control/setting	MCC
	Transfer system valve position administrative control	PPP, WSS
Indication	P-350 pump on/off	FCP, DCP
	P-401/P-402 on/off	WSCP
	Transfer line volumetric flow rate indication	FCP, DCP
	Transfer line volumetric flow totalizer	FCP, DCP
	Transfer line temperature indication	FCP, DCP
	Transfer line pressure indication	FCP
	Process water volumetric flow rate indication	WSCP, FCP
	Process water volumetric flow totalizer	WSCP, FCP
	WSS inlet hose temperature	WSCP
	TK-401 temperature	WSCP
	WSS discharge hose temperature	WSCP
	WSS accumulator temperature	WSCP
	Process water supply pressure at WSS	WSCP
	Process water supply pressure at PPP	FCP
	Process water supply temperature at PPP	FCP, DCP
Flush line isolation pressure	FCP, DCP	
Interlock	Process water high/low flow rate shuts down pump P-350	FCP
	TK-401 low-low water level shuts off TK-401 heat trace	WSS
Alarm	PPP and transfer line/drop leg leak detection indication	FCP, DCP, local
	Low process water supply temperature	FCP, DCP
	Low seal loop level	FCP, DCP
	PPP transfer line-up V-353 leak-by pressure switch	FCP, DCP
	TK-401 low water level	WSCP
	TK-401 high water level	WSCP
	Flush line isolation pressure	FCP, DCP
	Low transfer line flow	FCP, DCP
	High transfer line pressure	FCP, DCP

DCP = DACS Control Panel
 FCP = Farm Control Panel
 MCC = Motor Control Center
 WSS = Water Support Skid
 WSCP = Water Skid Control Panel

4.0 PROCESS FLOWSHEET

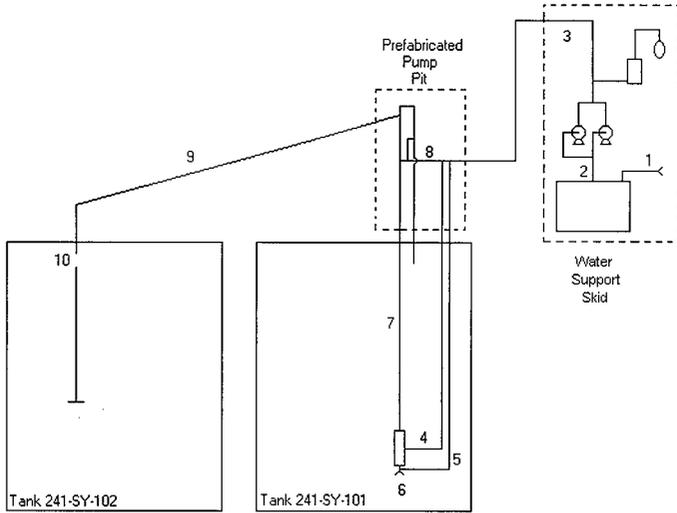
The tank 241-SY-101 waste transfer system is a slurry pumping system. The design provides for heated water dilution at the inlet of the waste transfer pump to permit control of important transport and other physical properties. It provides pre-heating, water-flushing and flow velocity in the waste transfer lines both to minimize the probability of solids formation as well as subsequent solids settling in the lines. The system incorporates three independent design features to minimize the probability of inadvertent waste transfer. These siphon break features include the transfer hose vent valves in the PPP, the air gap in the tank 241-SY-102 drop leg, and the air gap in tank TK-401. The siphon breaks in the WSS and the tank 241-SY-102 drop-leg are passive design features. The siphon break in the PPP requires manual valve operation. Administrative control of system valve positions also provides this function. Further design and operational control features are incorporated to satisfy the requirements or recommendations made by the TWRS Authorization Basis, Environmental, Industrial Hygiene, and Safety controls, as well as Operational Specification Controls and Good Operating Practices. Primary among the latter are features to protect against waste solidification in the transfer lines.

Figure 4-1 shows the Process Flow Diagram (PFD) for the transfer system. Page 1 of The H-14 drawing of the same PFD is shown in Figure 4-2.

4.1 TANK 241-SY-101 TRANSFER SYSTEM PROCESS FLOWS

- (1) TK-401 Inlet
- (2) TK-401 Outlet
- (3) PPP Water Supply
- (4) P-350 Pump Internal Flush
- (5) P-350 Pump Dilution Water
- (6) P-350 Pump Waste Inlet
- (7) P-350 Pump Discharge
- (8) Flush Cross Connect
- (9) Transfer Line
- (10) Siphon Break

Figure 4-1. Process Flowsheet



RAPID Process Flow Modes

- Normal Waste Transfer
- Transfer Line Flush
- Transfer Pump Outlet Line Flush
- Transfer Pump Inlet Line Flush

Explanation of Table Symbols

(N/A) : not applicable, as this section of process piping is valued out from the piping sections in active use - or - this parameter has no meaning for the flow mode in question.
 (-) : process piping is in active use but the parameter value is not of significance to the process. However, specification of parameter values limits requires prudent engineering judgment.
 (R) : symbol used for waste transfer operations expressing the required transfer flow rate as a variable to be optimized depending upon determination of the process piping diameter. Waste transfer flow control is specified based on a flow velocity requirement as opposed to a flow rate requirement. Specifying the transfer flow rate as a variable allows the convenient expression of the substrate waste and dilution water flow rates.
 For process line flushes, the primary objective is to simply displace process waste fluid from the lines and replace it with fresh water. Prudent engineering suggests that additional recommendations be stated to maximize the efficiency of the flush within the limits of the RAPID infrastructure (i.e., a volumetric flush water flow rate of 70 gpm). The specified process line flush volume is equal to two times the either:
 -two times the volume of the process line being flushed
 -two minutes of flow at the specified line flow velocity

Permissible Process Limits for Transfer Line Flush

Flow Parameter	Water Skid Inlet (1)	Water Skid Outlet (2)	PPP Supply Line (3)	Pump Internal Line (4)	Pump Transfer Inlet (5)	Pump Transfer Outlet (6)	Flush Pump Waste Inlet (7)	Flush Pump Waste Outlet (8)	Transfer Line Cross-Connect (9)	Siphon Break Line (10)
Flow Rate	-	40-70 gpm	40-70 gpm	N/A	N/A	N/A	N/A	40-70 gpm	40-70 gpm	N/A
Flush Volume	2 line volumes or 2 minutes whichever ever is greater	2 line volumes or 2 minutes whichever ever is greater	2 line volumes or 2 minutes whichever ever is greater	N/A	N/A	N/A	N/A	2 line volumes or 2 minutes whichever ever is greater	2 line volumes or 2 minutes whichever ever is greater	N/A
Flow Velocity (ft/min)	-	-	-	N/A	N/A	N/A	N/A	4 to 6	4 to 6	N/A
Temperature (°F)	-	110 to 130	110 to 130	N/A	N/A	N/A	N/A	110 to 130	110 to 130	N/A
Viscosity (cP)	-	0.50 to 0.62	0.50 to 0.62	N/A	N/A	N/A	N/A	0.50 to 0.62	0.50 to 0.62	N/A
Density (g/cm ³)	-	< 1	< 1	N/A	N/A	N/A	N/A	< 1	< 1	N/A
Volume % Solids	-	< 0.01	< 0.01	N/A	N/A	N/A	N/A	< 0.01	< 0.01	N/A
Mass % Water	100	100	100	N/A	N/A	N/A	N/A	100	100	N/A
Mass % Completely Insoluble Solids	0	0	0	N/A	N/A	N/A	N/A	0	0	N/A

Permissible Process Limits for Normal Waste Transfer

Flow Parameter	Water Skid Inlet (1)	Water Skid Outlet (2)	PPP Supply Line (3)	Transfer Internal Line (4)	Transfer Pump Supply Inlet (5)	Transfer Pump Supply Outlet (6)	Transfer Pump Waste Inlet (7)	Transfer Pump Waste Outlet (8)	Flush Line Cross-Connect (9)	Siphon Break Line (10)
Flow Rate	-	1/2 R to 1 R not to exceed 70 gpm	1/2 R to 1 R not to exceed 70 gpm	N/A	1/2 R to 1 R	1/2 R to 1 R	N/A	N/A	N/A	N/A
Flush Volume	-	1/2 R to 1 R not to exceed 70 gpm	1/2 R to 1 R not to exceed 70 gpm	N/A	1/2 R to 1 R	1/2 R to 1 R	N/A	N/A	N/A	N/A
Flow Velocity (ft/min)	-	-	-	N/A	-	-	-	2 to 6	2 to 6	N/A
Temperature (°F)	-	110 to 130	110 to 130	N/A	110 to 130	110 to 130	N/A	110 to 130	110 to 130	N/A
Viscosity (cP)	-	0.50 to 0.62	0.50 to 0.62	N/A	0.50 to 0.62	0.50 to 0.62	N/A	0.50 to 0.62	0.50 to 0.62	N/A
Density (g/cm ³)	-	< 1	< 1	N/A	< 1	< 1	N/A	< 1	< 1	N/A
Volume % Solids	-	< 0.01	< 0.01	N/A	< 0.01	< 0.01	N/A	< 0.01	< 0.01	N/A
Mass % Water	100	100	100	N/A	100	100	N/A	100	100	N/A
Mass % Sodium	0	0	0	N/A	0	0	N/A	0	0	N/A
Mass % Nitrate	0	0	0	N/A	0	0	N/A	0	0	N/A
Mass % Nitrite	0	0	0	N/A	0	0	N/A	0	0	N/A
Mass % Hydroxide	0	0	0	N/A	0	0	N/A	0	0	N/A
Mass % Carbonate	0	0	0	N/A	0	0	N/A	0	0	N/A
Mass % Aluminum	0	0	0	N/A	0	0	N/A	0	0	N/A
Mass % Phosphate	0	0	0	N/A	0	0	N/A	0	0	N/A
Mass % TOC	0	0	0	N/A	0	0	N/A	0	0	N/A
Mass % Other	0	0	0	N/A	0	0	N/A	0	0	N/A
Quantities Completely Insoluble Solids	0	0	0	N/A	0	0	N/A	0	0	N/A

Permissible Process Limits for Transfer Pump Outlet Line Flush

Flow Parameter	Water Skid Inlet (1)	Water Skid Outlet (2)	PPP Supply Line (3)	Transfer Pump Internal Line (4)	Transfer Pump Supply Inlet (5)	Transfer Pump Supply Outlet (6)	Transfer Pump Waste Inlet (7)	Transfer Pump Waste Outlet (8)	Flush Line Cross-Connect (9)	Siphon Break Line (10)
Flow Rate	-	40-70 gpm	40-70 gpm	N/A	40-70 gpm	40-70 gpm	N/A	40-70 gpm	40-70 gpm	N/A
Flush Volume	2 line volumes or 2 minutes whichever ever is greater	2 line volumes or 2 minutes whichever ever is greater	2 line volumes or 2 minutes whichever ever is greater	N/A	2 line volumes or 2 minutes whichever ever is greater	2 line volumes or 2 minutes whichever ever is greater	N/A	2 line volumes or 2 minutes whichever ever is greater	2 line volumes or 2 minutes whichever ever is greater	N/A
Flow Velocity (ft/min)	-	-	-	N/A	-	-	-	4 to 6	4 to 6	N/A
Temperature (°F)	-	110 to 130	110 to 130	N/A	110 to 130	110 to 130	N/A	110 to 130	110 to 130	N/A
Viscosity (cP)	-	0.50 to 0.62	0.50 to 0.62	N/A	0.50 to 0.62	0.50 to 0.62	N/A	0.50 to 0.62	0.50 to 0.62	N/A
Density (g/cm ³)	-	< 1	< 1	N/A	< 1	< 1	N/A	< 1	< 1	N/A
Volume % Solids	-	< 0.01	< 0.01	N/A	< 0.01	< 0.01	N/A	< 0.01	< 0.01	N/A
Mass % Water	100	100	100	N/A	100	100	N/A	100	100	N/A
Mass % Completely Insoluble Solids	0	0	0	N/A	0	0	N/A	0	0	N/A

Permissible Process Limits for Transfer Pump Purge

Flow Parameter	Water Skid Inlet (1)	Water Skid Outlet (2)	PPP Supply Line (3)	Transfer Pump Internal Line (4)	Transfer Pump Supply Inlet (5)	Transfer Pump Supply Outlet (6)	Transfer Pump Waste Inlet (7)	Transfer Pump Waste Outlet (8)	Flush Line Cross-Connect (9)	Siphon Break Line (10)
Flow Rate	-	10-70 gpm	10-70 gpm	N/A	10-70 gpm	10-70 gpm	N/A	10-70 gpm	10-70 gpm	N/A
Flush Volume	-	50 gal	50 gal	N/A	50 gal	50 gal	N/A	50 gal	50 gal	N/A
Flow Velocity (ft/min)	-	-	-	N/A	-	-	-	-	-	N/A
Temperature (°F)	-	110 to 130	110 to 130	N/A	110 to 130	110 to 130	N/A	110 to 130	110 to 130	N/A
Viscosity (cP)	-	0.50 to 0.62	0.50 to 0.62	N/A	0.50 to 0.62	0.50 to 0.62	N/A	0.50 to 0.62	0.50 to 0.62	N/A
Density (g/cm ³)	-	< 1	< 1	N/A	< 1	< 1	N/A	< 1	< 1	N/A
Volume % Solids	-	< 0.01	< 0.01	N/A	< 0.01	< 0.01	N/A	< 0.01	< 0.01	N/A
Mass % Water	100	100	100	N/A	100	100	N/A	100	100	N/A
Mass % Completely Insoluble Solids	0	0	0	N/A	0	0	N/A	0	0	N/A

CONSTRUCTION NOTE:
 1. MECHANICAL, PIPING, STRUCTURAL, SYSTEM ELECTRICAL, STUDY, SEISMIC AND WIND LOAD (IF APPLICABLE) FOR RAPID MITIGATION SYSTEM COMPONENTS 241-S1-01 PUMP ENCLOSURE, DROP LEG ASSEMBLY, STATIONARY WATER TREATMENT TANK, AND PORTABLE LEAK DETECTORS MUST BE COMPLETED AND APPROVED BY DESIGN AUTHORITY PRIOR TO FIELD INSTALLATION. REFERENCE HNF-4359.

FOR GENERAL NOTES SEE SHEET 1.

FOR CONSTRUCTION ONLY
 ISSUED FOR CONSTRUCTION
 DATE: 5-17-99

SEE CONSTRUCTION NOTE 1

U.S. DEPARTMENT OF ENERGY
 National Operations Office

NAME: J. JACKSON
 TITLE: PROJECT MANAGER

DATE: 24-1-99

PROJECT: HNF-4358 SY101 TRANSFER SYS CALCS

FIGURE: 4-2

FIGURE TITLE: RAPID MITIGATION SYS PROCESS FLOW DIAGRAM

REVISIONS:

NO.	DESCRIPTION	DATE
1	ISSUED FOR CONSTRUCTION	5-17-99

DWG NO. HNF-4358-001
 DRAWING TRACEABILITY LIST
 SHEET USED ON: HNF-103640 SH-1

4.2 TANK 241-SY-101 TRANSFER SYSTEM PROCESS FLOW LINE-UPS

Standby

Flush or Preheat Line-ups

- Transfer Line Flush
- Transfer Line Back-Flush
- P-350 Pump Purge
- Siphon Break Flush to Transfer Line

ACC-401 Transfer Line Flush

Waste Transfer

5.0 SYSTEM OPERATIONAL CONFIGURATIONS

The transfer system valve arrangement is indicated in Figure 5-1 with the nomenclature described in Table 5-1. This listing of valves constitutes the process valves in the transfer system and is used in describing the line-ups of operation.

Figure 5-1. Tank 241-SY-101 Transfer System Schematic

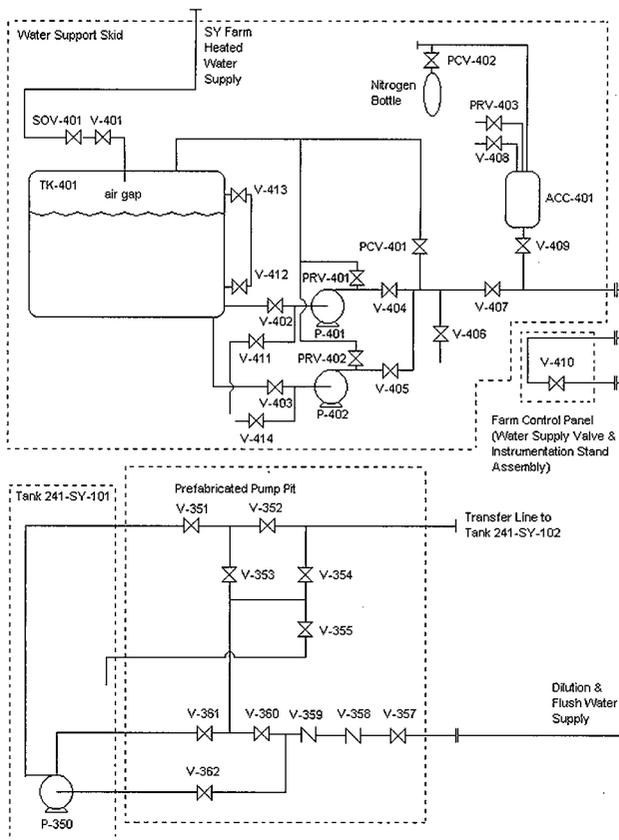


Table 5-1. Transfer System Valve Nomenclature

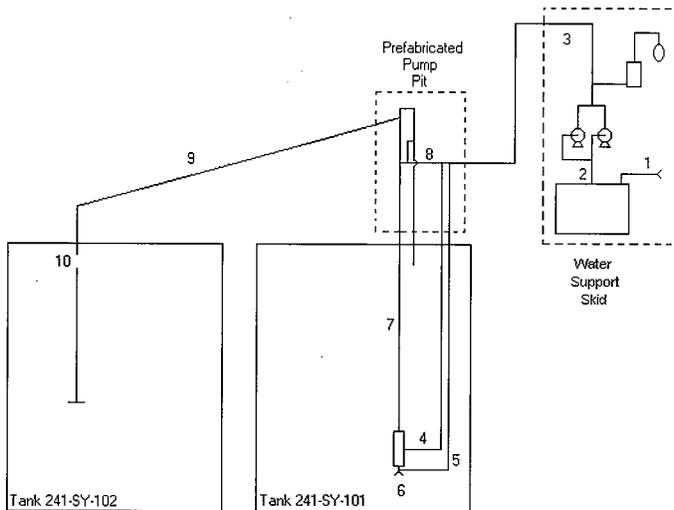
Valve EIN	Valve Function
*SOV-401	WSS: Raw Water Supply to Skid Solenoid Operated Isolation
*PCV-401	WSS: Raw Water Outlet Line Pressure Control Valve
*PCV-402	WSS: Accumulator Pressure Control Valve
*PRV-401	WSS: P-401 Outlet Line Pressure Relief Valve
*PRV-402	WSS: P-402 Outlet Line Pressure Relief Valve
*PRV-403	WSS: Accumulator ACC-401 Pressure Relief Valve
*V-401	WSS: Raw Water Supply to Skid Isolation Valve
*V-402	WSS: Pump P-401 Inlet Isolation Valve
*V-403	WSS: Pump P-402 Inlet Isolation Valve
*V-404	WSS: Pump P-401 Outlet Isolation Valve
*V-405	WSS: Pump P-402 Outlet Isolation Valve
*V-406	WSS: Flush Drain Isolation Valve
*V-407	WSS: Outlet Line Isolation Valve
*V-408	WSS: Accumulator ACC-401 Vent Isolation Valve
*V-409	WSS: Accumulator ACC-401 Isolation Valve
*V-410	FCP: Valve Stand Raw Water Line Isolation Valve
*V-411	WSS: Pump Inlet Line Drain Isolation Valve
*V-412	WSS: Tank TK-401 Sight-Glass Lower Isolation Valve
*V-413	WSS: Tank TK-401 Sight-Glass Upper Isolation Valve
*V-414	WSS: Pump Inlet Line Drain Isolation Valve
**V-351	PPP: Transfer Pump Outlet Isolation Valve
**V-352	PPP: Transfer Line Isolation Valve
**V-353	PPP: Transfer Line Flush Isolation Valve
**V-354	PPP: Downstream Vent Valve
**V-355	PPP: Upstream Vent Valve
**V-357	PPP: Raw Water Isolation Valve
**V-358	PPP: Raw Water Upstream Check Valve
**V-359	PPP: Raw Water Downstream Check Valve
**V-360	PPP: Raw Water Flush Isolation Valve
**V-361	PPP: Pump Flush Isolation Valve
**V-362	PPP: Pump Dilution Water Isolation Valve

Key:

- * valve EIN begins with POR32-RW-
- ** valve EIN begins with SY101-WT-
- FCP =Farm Control Panel
- PPP =Prefabricated Pump Pit
- WSS = Water Support Skid

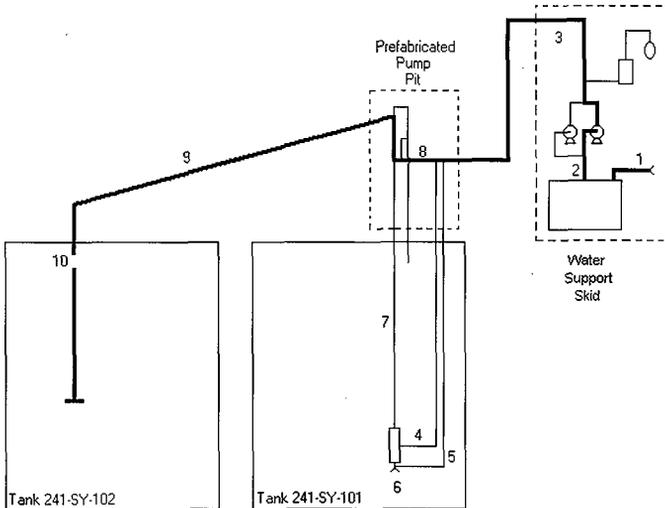
5.1 STANDBY

Transfer System Process Flow Line-up	Line-up Notes and General Procedure
Standby	<p>This line-up constitutes the de-energized or standby lineup of the transfer system. All system valves are shut except the sight-glass isolation valves on TK-401.</p> <p>Pumps P-350, P-401, P-402 are de-energized</p>



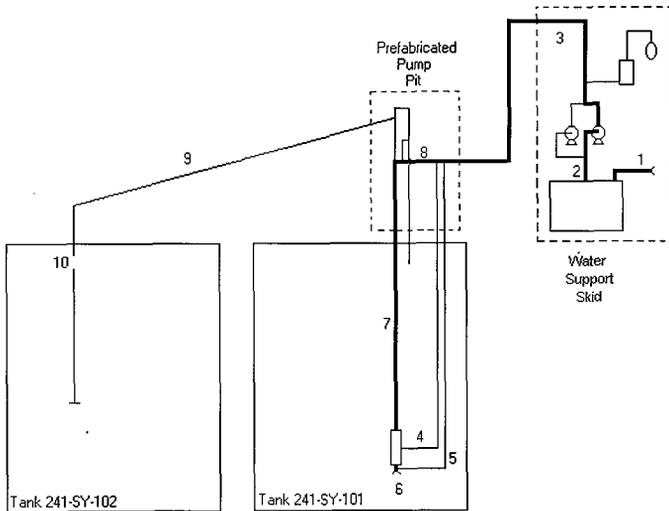
5.2 TRANSFER LINE FLUSH

Transfer System Process Flow Line-up	Line-up Notes and General Procedure
<p>Transfer Line Flush</p>	<p>This line-up is established immediately prior to or immediately following waste transfer operations, to either flush or pre-heat system lines.</p> <p>P-350 is de-energized / P-401 or P-402 is energized and running as necessary to provide flush water pressure/flow rate as needed:</p> <ul style="list-style-type: none"> • 2 x line volumes or 2 minutes of flow, which-ever is greater • 110 °F to 130 °F • flow rate not to exceed 70 gpm • when possible, flush flow velocity should exceed 4 ft/sec



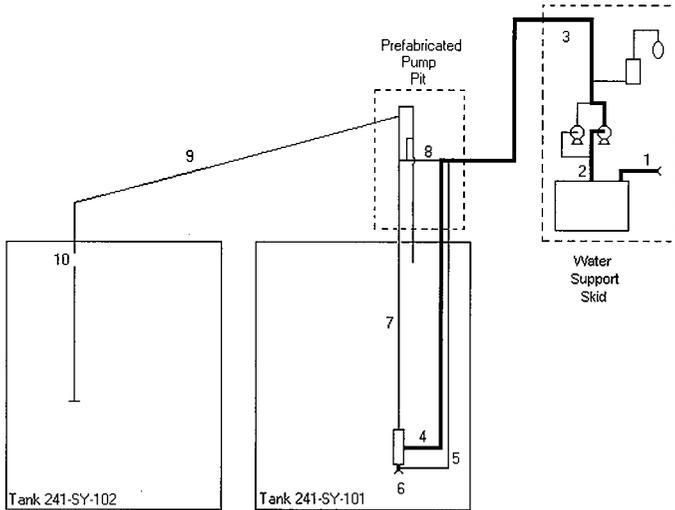
5.3 TRANSFER LINE BACK-FLUSH

Transfer System Process Flow Line-up	Line-up Notes and General Procedure
<p>Transfer Line Back-Flush</p>	<p>This line-up is established immediately prior to or immediately following waste transfer operations, to either flush or pre-heat system lines or pump P-350.</p> <p>P-350 is de-energized / P-401 or P-402 is energized and running as necessary to provide flush water pressure/flow rate as needed:</p> <ul style="list-style-type: none"> • 2 x line volumes or 2 minutes of flow, which-ever is greater • 110 °F to 130 °F • flow rate not to exceed 70 gpm • when possible, flush flow velocity should exceed 4 ft/sec



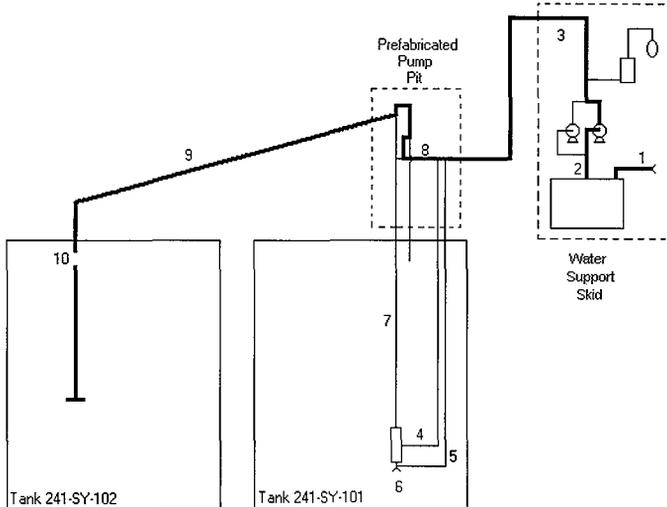
5.4 PUMP P-350 PURGE

Transfer System Process Flow Line-up	Line-up Notes and General Procedure
<p>Pump P-350 Purge</p>	<p>This line-up is established prior to startup and immediately following pump P-350 operations in accordance with manufacturer recommendations.</p> <p>P-350 is de-energized / P-401 or P-402 is energized and running as necessary to provide flush water pressure/flow rate as needed:</p> <ul style="list-style-type: none"> • flush volume = 50 gallons • 110 °F to 130 °F • flow rate is approximately 10 gpm



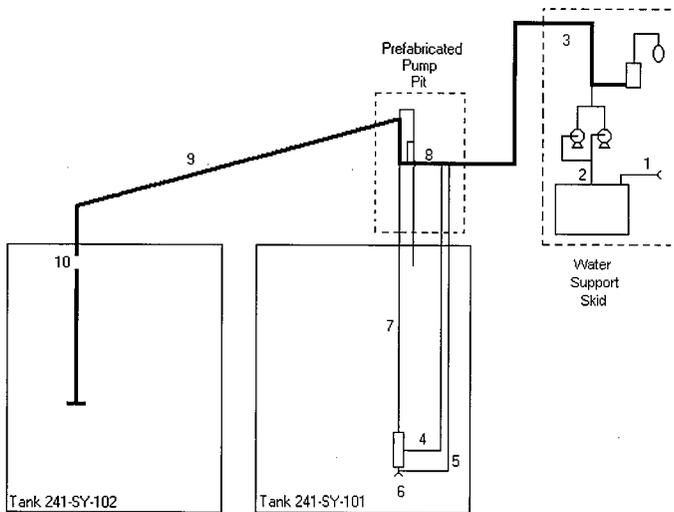
5.5 SIPHON BREAK FLUSH

Transfer System Process Flow Line-up	Line-up Notes and General Procedure
<p>Vent Line Flush</p>	<p>This line-up is used to clear the system vent line of potential contamination with routing to tank 241-SY-102 via the transfer line.</p> <p>P-350 is de-energized / P-401 or P-402 is energized and running as necessary to provide flush water pressure/flow rate as needed:</p> <ul style="list-style-type: none"> • 2 x line volumes or 2 minutes of flow, which-ever is greater • 110 °F to 130 °F • flow rate not to exceed 70 gpm • when possible, flush flow velocity should exceed 4 ft/sec



5.6 ACC-401 TRANSFER LINE FLUSH

Transfer System Process Flow Line-up	Line-up Notes and General Procedure
<p>Air-Powered Transfer Line Flush</p>	<p>This line-up is established immediately upon loss of electrical power, P-350, or dilution water supply.</p> <p>Pumps P-350, P-401 and P-402 are de-energized</p> <ul style="list-style-type: none"> • ACC-401 volume is flushed this direction • 110 °F to 130 °F



5.7 WASTE TRANSFER

Transfer System Process Flow Line-up	Line-up Notes and General Procedure
<p>Waste Transfer</p>	<p>This line-up is used to generate, control, and transfer waste slurry from tank 241-SY-101 to tank 241-SY-102.</p> <p>P-401 or P-402 is energized and running as necessary to provide dilution water flow to the pump P-350 inlet. P-350 is energized and running as necessary to provide a specified volumetric flow rate through the transfer line.</p> <p>Process Flows 1, 2, 3, and 5: <70 gpm; 110 °F to 130 °F Process Flow 6: <140 gpm Process Flow 7 and 9: <210 gpm</p> <p>Process Flow Ratios: P-350 inlet + P-350 dilution = P-350 discharge $0.5 < (P-350 \text{ inlet} / P-350 \text{ dilution}) < 2$</p>

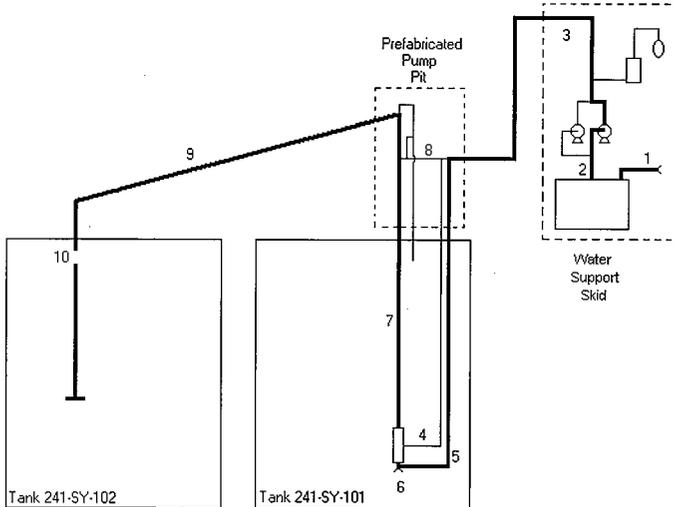


Table 5-2. Permissible Process Limits for Waste Transfer (2 Sheets)

Fluid/Flow Parameter	Pump P-350 Dilution Water Flow	Pump P-350 Waste Inlet	Pump P-350 Discharge; Transfer Line
Flow Rate	$\frac{1}{3}$ R to $\frac{2}{3}$ R not to exceed 70 gpm	$\frac{1}{3}$ R to $\frac{2}{3}$ R	R
Flow Velocity (ft/sec)	–	–	≥ 6
Temperature ($^{\circ}F$)	110 to 130	–	–
Viscosity (cP)	0.50 to 0.62	50 to 200	2 to 15
Density ($\frac{grams}{cc}$)	< 1	1.45 to 1.75	1.16 to 1.50
Mass % Non-Soluble Solids	0	1 to 3	0 to 2
Volume % Solids	< 0.01	5 to 25	2 to 17
Mass % Water	100	27.8 to 46.2	40 to 81
Mass % Sodium	0	14.2 to 23.8	7 to 17
Mass % Nitrate	0	8.2 to 13.8	4 to 10
Mass % Nitrite	0	8.2 to 13.8	4 to 10
Mass % Hydroxide	0	4 to 12	2 to 9
Mass % Carbonate	0	2 to 6	1 to 4
Mass % Aluminum	0	1.5 to 4.5	0 to 3

Table 5-2. Permissible Process Limits for Waste Transfer (2 Sheets)

Fluid/Flow Parameter	Pump P-350 Dilution Water Flow	Pump P-350 Waste Inlet	Pump P-350 Discharge; Transfer Line
Mass % Chloride + Sulfate + Phosphate	0	1 to 3	0 to 2
Mass % TOC	0	0 to 2	0 to 1
Mass % Other Constituents	0	2 to 6	1 to 4

R = transfer flow rate

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6.0 AUTHORIZATION BASIS CONTROLS IMPLEMENTED BY THIS PROCESS CONTROL PLAN

The Authorization Basis for waste transfers from tank 241-SY-101 to tank 241-SY-102 via the RAPID waste transfer system is unique, involving a DOE approved Unreviewed Safety Question (TF-97-0975, Rev. 3), and DOE directed safety requirements (Wagoner 1998 and French 1999). In addition, the requirements of the BIO (LMHC 199b) and TSRs (LMHC 1999c) are applicable, as modified and described in HNF-3737, *Tank 241-SY-101 Safety Basis for Remediation Actions and Operations Before Closure of the Unreviewed Safety Question on Waste Surface Change* (LMHC 1999d). Of special note is the DOE directed requirement (French 1999) for the Contractor to impose prudent controls necessary to safely operate. These Contractor imposed prudent controls necessary to safely operate are approved by the River Protection Project Plant Review Committee (PRC) and documented in HNF-IP-1266, *Tank Farms Operations Administrative Controls*, Chapter 7, "Contractor Imposed Controls for 241-SY-101 Level Growth Remediation.

Several Authorization Basis requirements, including Contractor imposed prudent controls necessary to safely operate, require that additional process control related details be provided to be implemented properly. These details are provided in this chapter. In any instance where there is a conflict between the Authorization Basis requirements described in the Authorization Basis references above, and requirements in this process control plan, the Authorization Basis requirements, described in the references above, take precedence.

6.1 IMPLEMENTATION OF TSR AC5.12.b, MATERIAL BALANCE REQUIREMENTS

Waste transfer material balances are required to detect transfer system leaks as a back up to the transfer system leak detectors located in the PPP and in the ASSD enclosure. TSR AC5.12.b specifies the Authorization Basis requirements, which are implemented by HNF-IP-1266 as follows:

- AC5.12.3.c. The following actions shall be performed 30 minutes and 60 minutes after initiation of the waste transfer and each 2 hours thereafter until the transfer is complete.

NOTE: Material balance monitoring criteria based on planned waste transfer rates shall be identified in the specific transfer procedures.

1. Perform material balance calculations to provide early leak detection and avoid filling tanks above safe levels.

- A. If periodic material balance calculations indicate a variance that exceeds the criteria, the transfer shall be stopped.

Waste tank level indication is typically used as the input for the material balance calculation. However, because of crust gas retention and growth in tank 241-SY-101, the waste level indicator in tank 241-SY-101 may not measure the volume of material (waste and dilution water) transferred out of tank 241-SY-101 accurately. The material balance calculation for waste transfer from tank 241-SY-101 to tank 241-SY-102 via the RAPID waste transfer system, therefore, is performed in a unique manner, utilizing the waste level indicator in tank 241-SY-102 and the waste transfer flow totalizer (FE-367). These instruments shall meet the requirements of TSR AC5.19, "Process Instrumentation and measuring and Test Equipment," for the purpose of satisfying this control. The material balance must show that the waste volume entering tank 241-SY-102 is within the smaller of 5% or 2,000 gallons of the totaled flow through FE-367. This criterion is based on the sensitivity of the instruments. The material balance equation is as follows:

$(\text{SY-102 waste level} - \text{SY-102 initial waste level}) \times 2,750 - \text{FE-367} = 5\% \times \text{FE-367}$
or 2,000 gal, whichever is lower.

If the equation is not satisfied, the transfer shall be stopped. The controlled transfer shutdown can be used (see Section 7.4.2).

6.2 ALLOWABLE MAXIMUM VOLUME OF WASTE TRANSFERRED OUT OF TANK 241-SY-101

In order to maintain operability of the mixer pump in light of possible encroachment of the waste crust on the mixer pump suction, the crust must be maintained above the mixer pump suction. Controls to ensure this are specified as Contractor imposed prudent controls necessary to safely operate in HNF-IP-1266 as follows:

- AC5.12.2.n. Operability of the 241-SY-101 mixer pump requires maintenance of a minimum distance of one (1) foot between the mixer pump suction and the bottom of the crust. Prior to transferring WASTE from 241-SY-101, the maximum quantity of WASTE that can be transferred without violating this requirement shall be calculated. The calculation shall consider uncertainties in measuring the bottom of the crust, including level monitoring system accuracy, and the growth of the crust subsequent to transfer.
- AC5.12.3.j. WASTE transfers from 241-SY-101 shall be monitored to ensure that the maximum quantity of WASTE approved for transfer is not exceeded. This is the calculated quantity to ensure maintenance of the minimum one-foot distance between the 241-SY-101 mixer pump and the bottom of the crust.

The maximum volume of water that can be transferred out of tank 241-SY-101 will be calculated just prior to the waste transfer and specified in a Process Memo.

The waste transfer from 241-SY-101 shall be monitored using the waste level indicator in tank 241-SY-101 (SY-102-WST-LIT-101) and either dilution water flow totalizer (POR32-RW-FQI-419 as the primary or POR32-RW-FQI-418B as a backup). These instruments shall meet the requirements of TSR AC 5.19, "Process Instrumentation and measuring and Test Equipment," for the purpose of satisfying this control. The waste transfer must be stopped in time to satisfy the following equation:

$FQ-367 - \text{total flow from FQI-418 (or FQI-419)} < \text{Maximum specified in Process Memo}$

7.0 PROCESS CONTROL

The expected waste level in tank 241-SY-101 prior to transfer will be about 450 inches. A transfer of about 100 to 150 kgal is expected to eventually reduce the tank level by a corresponding volume. This volume provides margin to avoid filling the tank to a level above the primary/secondary tank interface. These waste transfer volumes are specified for various reasons:

- (1) 100 kgal of waste removal from tank 241-SY-101 is about the smallest transfer that would create volume for sufficient back-dilution to permit dissolution of sodium nitrite solids in the crust. It is believed that this dissolution is sufficient to alter the crust properties enough to largely eliminate the crust gas retention problems.
- (2) A transfer of more than 150 kgal from tank 241-SY-101 without concurrent back-dilution might create interference problems between the crust and the mixer pump inlet and may create untoward impacts on DST operational volume and planning.

The removal of the waste volume from tank 241-SY-101 will reduce the heat load in the tank tending lower the bulk waste temperatures in the tank. The result of such a temperature reduction, in the absence of any water dilution, may be to precipitate additional salts resulting in additional crust growth, potentially negating the benefit of the waste removal. This issue has been analyzed (Antoniak 1998). Results show that the removal of 100 kgal of waste should eventually lower the bulk temperature of the tank wastes by 5 °F. This temperature reduction might cause the precipitation of up to 18 additional inches of solids. Operational actions will serve to alleviate concerns over additional solids precipitation. For example, further reduction of tank 241-SY-101 heat-loss rate via reduction of the tank annulus or primary ventilation-rates remain considerations.

Back dilution is specified as the next step in remediation activities for this tank, and it is known that the affects of planned water dilution greatly outweigh the opposing physical effects of cooling of tank wastes (Person 1999, Erhart 1999; Reynolds 1998).

The primary operational concern of the transfer system is to prevent line plugging due to inadvertent cooling of undiluted waste within the system transfer lines. The transfer system incorporates multiple features to protect against this occurrence:

- (1) Heat tracing on the Water Support Skid and the overground transfer line to protect against temperature induced solids precipitation within transfer lines.
- (2) Multiple temperature indication incorporated throughout the transfer system.
- (3) Maximum permitted water flow rates based upon support infrastructure heating capabilities.

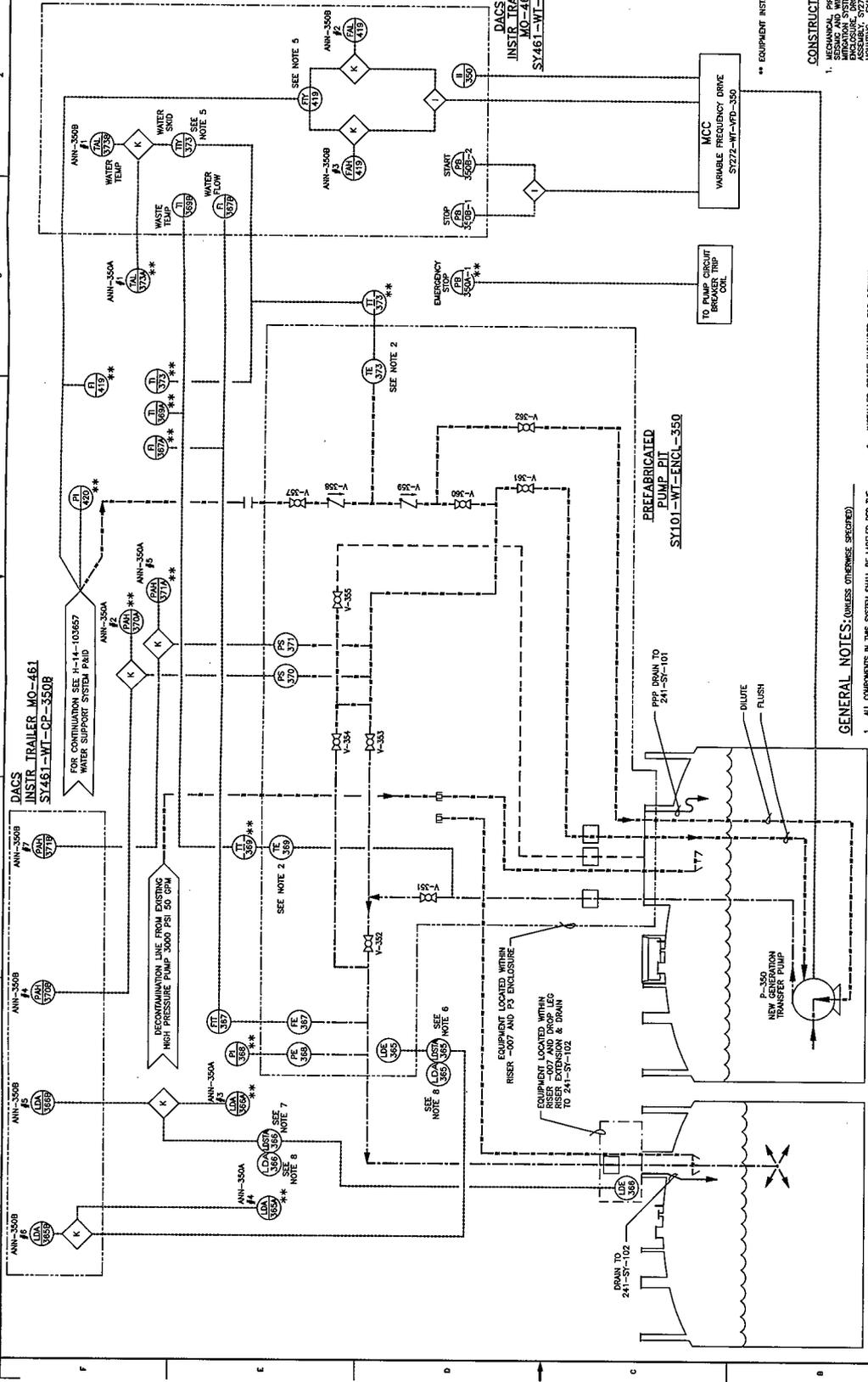
- (4) Heated water dilution and flush capabilities to either protect against the insertion of saturated salt solutions in system transfer lines - or - to remove these solutions immediately should an upset condition introduce them to the transfer lines.
- (5) An nitrogen powered, 75-gallon heated water flush accumulation tank (ACC-401) to provide flush capability to the system should a loss of electric power occur.
- (6) Water supply line and waste transfer line magnetic flow meters providing volumetric flow indication. These flow rates are the most immediate indication of the dilution ratio achieved within the P-350. At periodic intervals the indicated transfer line flow rates can be compared to level changes in tank 241-SY-102. P-350 pump speed, transfer control valve positions, and the Water Support Skid regulation pressure are all adjusted to maintain the desired waste transfer and dilution water supply flow rates.

Operationally, the primary objective is achieved by controlling the dilution of the wastes pumped from tank 241-SY-101. Specifically controlling the dilution achieves control over the density of the transferred waste slurry. By controlling the slurry density and temperature within preferred ranges, the best balance can be achieved between the often-conflicting requirements of viscosity, critical velocity, and impact on the DST system operational volume. Process engineering determines the ideal slurry density range with which to operate the transfer system and the dilution ratios to achieve this density are stated in this document.

This section makes reference to the two process and instrumentation drawings (P&IDs) that depict the transfer system and its dedicated water supply. These drawings are H-14-103656,"RAPID MITIGATION SYSTEM P&ID," and H-14-03657,"WATER SUPPORT SYSTEM P&ID." Drawing H-14-103656 is reproduced in Figure 7-1 and drawing H-14-103657 is reproduced in Figure 7-2, pages 1 and 2.

LEGEND	
(Symbol)	COMPONENT INDICATING EQUIPMENT
(Symbol)	FLOW INDICATING EQUIPMENT
(Symbol)	SECOND SPRAY BRAS
(Symbol)	WASTE TRANSFER LINE
(Symbol)	HOT WATER
(Symbol)	H-POINT LEVEL LINE

HNF-4264 Revision 0
 Figure 6-1
 Sheet 1 of 1
 Page 4-3



CONSTRUCTION NOTE:

1. MECHANICAL PIPING, STRUCTURAL SYSTEM ELECTRICAL STUDY, INSTRUMENTATION SYSTEM COMPONENTS 241-SY-101 PUMP ASSEMBLY, 51722-WT-CP-350, 51481-WT-CP-350, 51482-WT-CP-350, 51483-WT-CP-350, 51484-WT-CP-350, 51485-WT-CP-350, 51486-WT-CP-350, 51487-WT-CP-350, 51488-WT-CP-350, 51489-WT-CP-350, 51490-WT-CP-350, 51491-WT-CP-350, 51492-WT-CP-350, 51493-WT-CP-350, 51494-WT-CP-350, 51495-WT-CP-350, 51496-WT-CP-350, 51497-WT-CP-350, 51498-WT-CP-350, 51499-WT-CP-350, 51500-WT-CP-350. TO FIELD INSTALLATION. REFERENCE HNF-4359.

FOR CONSTRUCTION ONLY
 ISSUED FOR CONSTRUCTION
 DATE: 5-11-99

SEE CONSTRUCTION NOTE

GENERAL NOTES: (UNLESS OTHERWISE SPECIFIED)

- ALL COMPONENTS IN THIS SYSTEM SHALL BE IDENTIFIED BY THE FOLLOWING EQUIPMENT IDENTIFICATION NUMBERS (EIN) EXAMPLE: SY101-WT-CP-374.
 - EQUIPMENT NUMBER
 - COMPONENT IDENTIFIER
 - SYSTEM DESIGNATOR
 - STRUCTURE LOCATION
 - TANK FRAME
- INSTALLED SPARE INCLUDED FOR REDUNDANCY.
- EQUIPMENT IN OR NEAR PIP PRETEXT WITH SY101-WT-350.
- PROCESS INDICATOR WITH CONTACTS OUT.
- PORTABLE LEAK DETECTOR STATION POR23-WST-LD274-101
- PORTABLE LEAK DETECTOR STATION POR24-WST-LD274-101
- SEE DRAWING H-2-34865 FOR LEAK DETECTOR DESIGN.
- CALCULATIONS FOR THE MECHANICAL, PIPING, STRUCTURAL, ELECTRICAL, SEISMIC AND TANK LOAD APPLICABLE FOR PUMP MITIGATION SYSTEM COMPONENTS. SEE HNF-4359.

COMPONENTS ON THIS SYSTEM DRAWING SHALL ONLY SHOW THE EQUIPMENT IDENTIFIER AND SEISMICAL NUMBER (EXAMPLE FE-374).

U.S. DEPARTMENT OF ENERGY	
NAME	AL SHIBBERO
DESIGNER	AL SHIBBERO
CHECKER	AL SHIBBERO
DATE	5/11/99
PROJECT NO.	7000
SCALE	AS SHOWN
DRAWING NO.	H-14-103656.0

RAPID MITIGATION SYSTEM S&PID	
DATE	5/11/99
SCALE	AS SHOWN
DRAWING NO.	H-14-103656.0

VALVE	MANEUVER
V-351	2" TRANSFER PUMP ISOLATION VALVE
V-352	2" TRANSFER LINE ISOLATION VALVE
V-353	1" DOWNSTREAM FLUSH ISOLATION VALVE
V-354	1" DOWNSTREAM VACUUM BREAK VALVE
V-355	1" UPSTREAM VACUUM BREAK VALVE
V-357	2" SERVICE WATER ISOLATION VALVE
V-358	2" SERVICE WATER UPSTREAM CHECK VALVE
V-359	2" SERVICE WATER DOWNSTREAM CHECK VALVE
V-360	2" FLUSH WATER ISOLATION VALVE
V-361	2" PUMP FLUSH ISOLATION VALVE
V-362	2" DILUTION WATER ISOLATION VALVE

LINE CHART

LINE NUMBER	SIZE	TYPE	INSULATION	FLUID	LOC. SIZE	LOC. TYPE
L-1	200 PSIG, 130' F OPERATING	N	2"	9	WATER	2" CS PIPE SCH. 40, ASTN A-106, GR. B
L-2	ATMOSPHERIC, 130' F OPERATING	0	2"	9	WATER	2" CS PIPE SCH. 40, ASTN A-106, GR. B
L-3	TANK HEAD, 130' F OPERATING	0	2"	9	WATER	2" CS PIPE SCH. 40, ASTN A-106, GR. B
L-4	200 PSIG, 130' F OPERATING	N	2"	9	WATER	2" CS PIPE SCH. 40, ASTN A-106, GR. B
L-5	200 PSIG, 130' F OPERATING	N	2"	9	NITROGEN	PIPE/TUBING

GENERAL NOTES: (UNLESS OTHERWISE SPECIFIED)

- 1. CALIBRATION OF INDIVIDUAL COMPONENTS SHALL BE ACCORDING TO THE MANUFACTURER'S RECOMMENDATIONS AND ACCESSIBLE TO NIST STANDARDS WITH CORRECTED DATA.
- 2. GOVERNMENT FURNISHED EQUIPMENT.
- 3. THIS DRAWING IS FOR THE USE OF THE FACILITY AS AN INTEGRAL PART OF THE FACILITY.

4. ALL COMPONENTS IN THIS SYSTEM SHALL BE LABELED FOR THE FOLLOWING EQUIPMENT IDENTIFICATION NUMBER (EIN) EXAMPLE:

```

    P-31-1E-31A
    |
    |-----L-----> LINE IDENTIFICATION NUMBER
    |-----C-----> COMPONENT IDENTIFICATION NUMBER
    |-----S-----> SYSTEM IDENTIFICATION NUMBER
    |-----D-----> DRAWING IDENTIFICATION NUMBER
    |-----L-----> LOCATION IDENTIFICATION NUMBER
    
```

FOR-12 DESIGNATES BY TANK FARM USE
 FOR-13 DESIGNATES 200 AREA COLD TEST FACILITY USE
 COMPONENTS ON THIS SYSTEM DRAWING SHALL ONLY SHOW THE COMPONENT NUMBER AND SECTORAL NUMBER (EXAMPLE: PE-114).

PARTS/MATERIAL LIST

QTY	DESCRIPTION	REV	REV DATE	MANUFACTURER	WARRANTY/REMARKS	SHEET NO.
1	SKW-1	9903-UH-1468		MOBILE WATER SUPPORT SKID	HULME	1
1	SKW-2	9903-UH-0461		SKID & INSTRUMENTATION	HULME	2
1	TK-401			TANK	JUSTIN	3
1	TK-402			NITROGEN TANK W/VALVE	INROCO	4
1	SC-401			SKID CLASS	JUSTIN	5
1	HOSE-1	P/O 108976		2" HOSE, 150 FT. HEAT-TRACED	TECHNICAL HEATERS	6
1	HOSE-3	P/O 108976		2" HOSE, 15 FT. HEAT-TRACED	TECHNICAL HEATERS	7
1	HR-1	9903-UH-0461		HOSE REEL (MODIFIED)	HANNAY	8
1	ACC-401	8824-249-03		ACQUILATOR, 75 CALON	US FLUX	9
2	P-401.2	160-338		PUMP W/BASE	EDWARDS MANUFACTURING	10
2	MC-401.402	66X2224040		PUMP DRIVES	SIEMENS	11
1	SOV-401	813031232847/		SOLENOID OPERATED VALVE	JAMESBURY	12
1	V-401	FO07027Y		GLOBE VALVE, 2"-150LB RF	VELAN	13
1	V-410	F8P-453Z/505Z/		GLOBE VALVE, 2"	FRISER CONTROLS	14
0	V-402-9	1167582Z-FS1009-1		PRESSURE RELEASE VALVE, 2" FULL PORT	TRCO	15
2	PRV-401.2	91380801		PRESSURE RELEASE VALVE, 1 1/4" BRONZE, 200 PSIG, 36 OPM	HUNNLE	16
1	PRV-403	60100001-1M0250		PRESSURE RELEASE VALVE	KUNBLE	17
1	PCV-401	21880		PRESSURE CONTROL VALVE	SHAWROCK	18
1	PCV-402	0781-9134		REGULATOR, 0-250 PSIG	VICTOR	19
2	STR-11.2	20-114-01		Y-STRAINER, 2" CAST	MUELLER	20
1	FE-419	74000		FLOW METER	BROOKS	21
1	TE-412	AF0407XVXJ00		1/C, J-TYPE, 8"6"	WATLOW	22
1	LE-416	842-105-000		LEVEL ELEMENT	WACHETROL	23
2	TE-410.415	116916-09/6		THERMOCOUPLE	Cobra Wire & Cable	24
1	TE-411	07E W/ TK-401		HEAT CONTROL (BULB/CLAMP)	JUSTIN	25
1	TE-413	724MBD12A		1/C, J-TYPE, WASHER TYPE	WATLOW	26
1	TE-414	70X400012A		1/C, J-TYPE, WASHER TYPE	WATLOW	27
1	PE-417	822A7F1/2		PRESSURE ELEMENT	YOKOGAWA	28
1	ORF-1	9903-UH-0461		ORFACE PLATE, CUSTOM	HULME	29
1	CP-401	9903-UH-0461		CONTROL SYSTEM	HULME	30
2	V-412.13			SKID CLASS VALVES	JUSTIN	31
2	V-411.14			1" BALL VALVE, 600 W.O.G.	DOM'L	32
1	HR-2	9903-UH-0461		HOSE REEL (MODIFIED)	HANNAY	33
1	HOSE-2	P/O 108976		2" HOSE, 125 FT. HEAT-TRACED	TECHNICAL HEATERS	34

REVISIONS

NO.	DATE	DESCRIPTION
1	07/15/99	ISSUED FOR FABRICATION

PRELIMINARY
 NOT FOR FABRICATION.
 FOR COMMENT ONLY.
 DATE: 7/15/99

U.S. DEPARTMENT OF ENERGY
 Rapid Mitigation System (RMS)
**RAPID MITIGATION SYS
 WATER SUPPORT SKID**
 P&ID

DATE: 7/15/99
 DRAWN BY: []
 CHECKED BY: []
 APPROVED BY: []

DWG NO. HNF-4264-REV-0
DATE 7/15/99
TITLE WATER SUPPORT SYSTEM P&ID DRAWING
REF. NUMBER HNF-4264-REV-0
KEY USED ON HNF-4264-REV-0

7.1 DEVICES AND MONITORING PARAMETERS FOR PROCESS CONTROL

The control devices listed in Table 7-1 are used to regulate the volumetric flow rates through the transfer system piping. As a result, this allows the dilution of the transferred slurry to be controlled.

Table 7-1. Transfer System Flow Control Devices

<p>Control of Flush/ Dilution Water Flow to PPP</p>	<p>WSS discharge pressure regulation valve PCV-401 FCP process water throttle valve V-410 ACC-401 nitrogen Flask Regulated Pressure</p>
<p>Control of Transfer Line Flow</p>	<p>Pump P-350 VFD</p>

The instruments listed in Table 7-2 monitor the process parameters of the transfer system. These parameters are concerned with control of the waste dilution and transfer rate.

Table 7-2. New Instrumentation for SLRRP Transfer System (2 Sheets)

Process Parameter	Primary Element and Location	Primary Display and Location	Back-Up Element and Location	Backup Display and Location
Water Supply Flow rate	*FE-419 FCP	*FIT-419 FCP	*FE-418 WSS	*FIT-418 WSCP
Water Supply Flow Totalizer	*FE-419 FCP	*FQI-419 FCP	*FE-418 WSS	*FQI-418 WSCP
Water Supply Temperature	*TE-373 PPP	*TI-373 FCP	*TE-415 WSS	*TI-415 WSCP
Water Supply Pressure	*PE-420 FCP	*PI-420 FCP	*PE-417 WSS	*PI-417 WSCP
Transfer Line Flow rate	SY-102-WST-LIT-101 241-SY-102	SY-102-WST-LI-101 DCP	**FE-367 PPP	**FI-367A FCP
Transfer Line Flow Totalizer	SY-102-WST-LIT-101 241-SY-102	SY-102-WST-LI-101 DCP	Tank 241-SY-102 manual tape 241-SY-102	SY-102-WST-SLE-101/102
Transfer Line Temperature	**TE-369 PPP	**TI-369A FCP	N/A	N/A
Transfer Line Pressure	**PE-368 PPP	**PI-368A FCP	N/A	N/A
WSS Inlet Hose Temperature	*TI-410 WSS	*TI-410 WSCP	N/A	N/A
TK-401 Temperature	*TI-412 WSS	*TI-412 WSCP	N/A	N/A
ACC-401 Temperature	*TE-414 WSS	*TI-414 WSCP	N/A	N/A

Table 7-2. New Instrumentation for SLRRP Transfer System (2 Sheets)

Process Parameter	Primary Element and Location	Primary Display and Location	Back-Up Element and Location	Backup Display and Location
PPP Leak Detection Alarm	**LDE-365 PPP	**LDA-365 FCP	N/A	N/A
Transfer Line and Drop Leg Leak Detection Alarm	**LDE-366 241-SY-102	**LDA-366 FCP	N/A	N/A
Transfer Leak-By Pressure Switch/Alarm	**PS-370 PPP	**PAH-370A FCP	N/A	N/A
TK-401 Low / Low-Low Water Level Alarms	*LE-416 WSS	*LAL-416 / LALL-416 WSCP	N/A	N/A
TK-401 High / High-High Water Level Alarms	*LE-416 WSS	*LAH-416 / LAHH-416 WSCP	N/A	N/A

Key:

*EINs for instrumentation associated with the WSS begins with POR32-RW-

** EINs for instrumentation associated with the PPP begins with SY101-WT-

DCP = DACS Trailer Control Panel

FCP = Farm Control Panel (Water Supply Valve and Instrumentation Assembly)

MCC = Motor Control Center

WSS = Water Support Skid

WSCP = Water Skid Control Panel (Water Support Skid Electrical Enclosure)

Table 7-3 provides a summary of instrumentation used to support the operation of the transfer system. These controls are composed of indications and alarms that signal the presence of a threshold condition which requires some sort of operator action.

Table 7-3. Tank 241-SY-101 Transfer System Process Control Features (2 Sheets)

Transfer System Flow Controls	Location
Pump P-350 On/Off switch	DCP
Pump P-350 VFD Settings	MCC
Pumps P-401/P-402 On/Off Switches	WSCP
Dilution/Flush Water Flow Control Valve	FCP
WSS Pressure Regulating Valve (PCV-401) Setpoint	WSS
ACC-401 nitrogen Flask Pressure Regulator Setpoint	WSS
Transfer System Valve Position Administrative Control	FCP, WSS

Table 7-3. Tank 241-SY-101 Transfer System Process Control Features (2 Sheets)

Indications used in Process Control	Location
Pump P-350 On/Off	FCP, DCP
Pumps P-401/P-402 On/Off	WSCP
Transfer Line Volumetric Flow Indication	FCP, DCP
Transfer Line Temperature Indication	FCP, DCP
Transfer Line Pressure Indication	FCP
Service water volumetric flow indication	WSCP, FCP
Service water volumetric flow totalizer	WSCP, FCP
WSS inlet hose temperature	WSCP
TK-401 temperature	WSCP
WSS outlet hose temperature	WSCP
WSS accumulator temperature	WSCP
Service water supply pressure at WSS	WSCP
Service water supply pressure at PPP	FCP
Service water supply temperature at PPP	FCP, DCP
PPP transfer mode leak-by pressure switch.	FCP, DCP
PPP and transfer line/drop leg leak detection indication	FCP, DCP, local
SY-101 SHMS (H ₂)	DCP
SY-101 GMS (NH ₃)	DCP
SY-102 SHMS E+ (H ₂ , NH ₃)	Local, TMACS
Industrial Hygiene SY-Farm Surveys (NH ₃ /Flammable Gas)	SY-Farm
Tank 241-SY-101 Level, Temperature, Pressure, Ventilation Flow rate	DCP
Tank 241-SY-102 Level, Temperature, Pressure	Local, TMACS
Tank 241-SY-102 Grab Sample Analysis	222-S Labs
Interlocks providing Automatic Process Control Actions	Location
Service water high/low flow rate shuts down P-350	FCP
TK-401 low - low water level shuts off TK-401 heat trace	WSS

Key

DCP = DACS Trailer Control Panel
 FCP = Farm Control Panel (Water Supply Valve and Instrumentation Assembly)
 MCC = Motor Control Center
 WSS = Water Support Skid
 WSCP = Water Skid Control Panel (Water Support Skid Electrical Enclosure)
 SHMS = Standard Hydrogen Monitoring System
 GMS = Gas Monitoring System
 TMACS = Temperature Monitoring and Control System

7.2 OPERATIONAL CONTROL SCHEME

The key to reliable operation of the transfer system is to alter the physical properties of the waste removed from tank 241-SY-101 to make it more benign from a process standpoint and thus make the slurry pumping method more reliable. The change of the physical properties of the waste is achieved through dilution of the waste with heated water. The water dilution creates several beneficial changes in the properties of the waste:

- (1) Immediate reduction of the waste density and more importantly, a proportionally larger reduction in the effective viscosity of the slurry. This produces the beneficial affect of increasing transport Reynolds numbers at a given flow velocity with the attendant reduction in the slurry flow critical velocity.
- (2) The establishment of a concentration driving force to dissolve soluble solids in the waste slurry produced. Although the kinetics of the soluble solids dissolution is thought to be fairly well characterized, the time constants of the mechanisms are as long or longer than the transit time of the transfer system. However, great benefit is realized if an upset condition causes the slurry to be trapped in the transfer line. In this case, significant solids dissolution combats the effects of solids settling and additional precipitation, possibly avoiding a plugging situation.

Laboratory viscometry of the ~1.5 SpG pure liquid portion of the convective waste has shown a viscosity of about 10 to 13 cP at a 50 sec⁻¹ shear rate and 120 °F (Person 1999). When this liquid is diluted with one part water at 120°F, the viscosity becomes \cong 3 cP at the 50 sec⁻¹ shear rate. Because of the presence of significant amounts of solids in the in-situ convective wastes, the viscosity of this waste will be higher than its liquid-phase viscosity. It is currently estimated that the in-situ viscosity of the convective wastes in tank 241-SY-101 to be in the range of 50 to 200 cP at a 50 sec⁻¹ shear rate.

Dilution of tank 241-SY-101 wastes with heated water is expressed by the dilution ratio (DR):

$$DR = (W/R) \quad \text{where,} \quad \begin{array}{l} DR = \text{dilution ratio} \\ W = \text{dilution water flow rate (FE-419 or} \\ \text{FE-418)} \\ R = \text{transfer line flow rate (FE-367)} \end{array}$$

During steady state transfer operations, the DR value is maintained in the range of 0.33 to 0.67, with the operator seeking to maintain a value of DR = 0.5. The low dilution (DR = 0.33) limit has significant short-term implications since violating this limit produces the immediate result of filling the transfer line with concentrated salt solution. This is undesired since conceivable upset conditions could result in solids precipitation and potential plugging of the transfer line. The high dilution (DR = 0.67) limit is not as time

critical as the low-end limit since this results in the relatively slow addition of unneeded volume into the DST system. This situation does not present a process control problem.

If the control parameter values are automatically logged in a data logger, the material balance shall be done by the operator at startup, 30 minutes and 1 hour after startup and every two hours thereafter until shutdown when an additional material balance shall be performed. If automatic data logging is not available, the operator shall log the parameters and perform the material balance as above except the 2 hour frequency shall be reduced to every hour.

For the initial transfer from tank 241-SY-101, $DR = 0.33$ is expected to equate to a diluted slurry density of 1.4 kg/L. Likewise, $DR = 0.5$ corresponds to a diluted slurry density of 1.3kg/L, while $DR = 0.67$ corresponds to a diluted slurry density of 1.2 kg/L. As remediation activities progress on this tank, planned back dilution will lower the waste density in tank 241-SY-101. As a result, for subsequent transfers the dilution ratios specified may be adjusted to achieve a desired diluted slurry density.

During start-up and shutdown of the transfer system, the high end of the steady-state DR range must be exceeded. Prior to starting pump P-350, dilution water flow must be established. By the dilution ratio criteria, this situation represents $DR = \infty$. Then pump P-350 is started at a low speed that is slowly increased until the desired transfer flow rate (nominally 60 - 120 gpm at the 1:1 dilution ratio) is achieved. Similarly, at the point of intended pump P-350 shutdown, the value of DR should be as high as possible. This is achieved by ensuring that the transfer line flow rate is slowly adjusted to the minimum controllable or measurable value prior to P-350 pump shut down. This time period ensures that the transfer line contains waste with the maximum possible water dilution.

The objective of the transfer will be to move a specified volume of waste from tank 241-SY-101, mixing it with a specified volume of water, and transporting the waste to tank 241-SY-102. The transfer will be continued until the volume of waste transferred as measured by the material balance techniques (per TO-430-100, LMHC 1999a) equals the desired transfer volume. The assumption of these "on-line" or "real-time" process control measurements is that the volume of waste transferred from tank 241-SY-101 and the volume of dilution and flush water supplied to the PPP are additive in tank 241-SY-102. Three points are made about this:

- (1) The error inherent in this assumption (less than 3%) is insignificant to the "real-time" process decisions.
- (2) After shutdown of the transfer, "off-line" measurement (i.e., verification) techniques, as discussed in Sections 7.4 and 7.5, will determine the effect of supernate density changes on the resulting level in tank 241-SY-102 to determine if the current level actually corresponds to the transfer termination criteria.
- (3) It is assumed that one part by volume tank 241-SY-101 waste and one part by volume water forms two parts by volume diluted waste.

The magnetic flow meters provided for the transfer system indicate volumetric measurements only. Level changes in tank 241-SY-102, while measured easily, do not account for changes in waste density. Additionally, level changes in tank 241-SY-101 that may occur as a result of the transfer cannot be reliably predicted or used as a process control measurement due to the potential for gas release. Thus the "on-line" process control measurements will be incapable of determining the relationship between the volume of dilution water supplied to the PPP and the volume of dilution water transferred to tank 241-SY-102.

The concern of where the water added to the system end up may never be completely addressed. Common engineering sense indicates that when pump P-350 is running at a flow rate in excess of the dilution water flow rate that the majority of the water injected at the inlet will be directly entrained by the pump. Even if a small amount of dilution water impinges on the pump P-350 inlet screen with sufficient velocity to overcome the pressure drop across the screen, it should be rapidly entrained by the waste moving towards the inlet and thus return to the pump. If, however, a small volume of water can escape completely from the inlet of pump P-350 and buoy itself upward towards the crust, the instrumentation of the system will probably be incapable of detecting it. Even if this does occur, any undesired effects that may result are controlled by the 25% LFL and ignition controls established for remediation activities (French 1999).

Cold testing of the transfer pump has shown the potential for leakage around to press fit joints in the pump housing. This leak has been variously estimated from less than 1 gpm to 5 gpm. This leakage is reduced at higher temperature through better sealing. There is no way to account for this leakage in the material balance because no method exists to measure the actual leakage during transfer. The net effect of this leakage will be to leave a small percentage of the dilution water in 241-SY-101.

Section 7.3, Transfer Completion Criteria, discusses verification techniques for determining mass transfer between the tanks. These techniques may be used to obtain evidence that would suggest to a rough order, the amount of the water added to the system that actually did end up in tank 241-SY-102. However, these techniques can only be used when the system has been shutdown following a transfer.

When possible, the transfer system provides redundant indications for determining material balances. The listing of these "on-line" process measurements are shown in Table 7-4:

Table 7-4. Material Balance Indications

Water Supply Flow	Waste Transfer Line Flow	SY-102 Receipt
Primary: POR32-RW-FQI-419 (Service Water Totalized Flow Indicator) Instrument Accuracy* ± 0.5% of flow rate or totaled flow	Primary: FQI-367 (Waste Transfer Flow Totalizer) Instrument Accuracy* ±0.5% of flow rate or totaled flow	Primary: SY-102-WST-LIT-101 (Tank 241-SY-102 ENRAF level gage) Instrument Accuracy* ± 0.04 inches (± 110 gal)
Backup: POR32-RW-FQI-418B (Outlet Line Flow Totalizer Indicator) Instrument Accuracy* ± 0.5% of flow rate or totaled flow	Backup: NA	Backup: SY-102-WST-SLE-101/102 (Tank 241-SY-102 manual tape) Instrument Accuracy ± 0.5 inches (± 1400 gal)

* Per manufacturer's performance claim

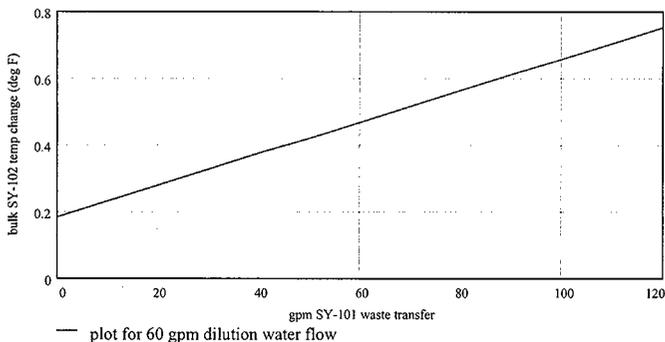
NA = not applicable

Per OSD-T-151-007, the allowable rate of temperature change in a DST with a 65 °F temperature is 10 °F per hour. Tank 241-SY-102 waste has an approximate temperature of 65 °F. The minimum volume of waste in tank 241-SY-102 at the start of the transfer is 500 kgal at a nominal 65 °F and 1.2 SpG.

For the assumptions:

- at start of the transfer , tank 241-SY-102 contains 500 kgal of 1.2 SpG waste at 65 °F
- that the heat capacities of the waste in tank 241-SY-102 is equal to that of the waste slurry transferred from tank 241-SY-101 (0.75 Btu/lb)
- and the dilution water flow rate is 60 gpm at 120 °F

The maximum hourly bulk waste temperature increase in tank 241-SY-102 is shown in Figure 6.3:

Figure 7-3. Maximum Hourly Bulk Temperature Change in Tank 241-SY-102

The 10 °F per hour OSD limit will not be approached during the small transfer from tank 241-SY-101.

7.3 TRANSFER COMPLETION CRITERIA

When the volumetric change indicated by the level rise in tank 241-SY-102 or the totalized / integrated flow meter reading indicates that the predetermined volume of tank 241-SY-101 waste has been moved to tank 241-SY-102, the transfer will be terminated and a verification of the transfer volume will be performed. This mass transfer verification uses waste level and density data from tank 241-SY-102, and the totalized water addition volume to calculate the mass as well as the volume of waste transferred. Other characterization information may also be used as determined by Process Engineering. Examples could include analysis of the changes in the concentrations of certain analytes. The material balance verification is performed by Process Engineering utilizing the expertise of PNNL, and the results are issued by Process Memo.

Transfer Termination Criteria

When the volume change in tank 241-SY-102 minus the water volume added to the system equals the predetermined transfer volume of tank 241-SY-101 waste (nominally 100 to 150 kgal)

If the actual removal of tank 241-SY-101 wastes should occur at 120 gpm, the small transfer should be completed on the order of 30 hours of continuous run time. Once the process has started and is running smoothly, there is no reason to shut the system down until the transfer is complete. As such, the time scale is so short that grab sampling and subsequent analysis of tank 241-SY-102 wastes could not be used as a "real-time" process control feature. Once the transfer is complete, or if a system shutdown followed by significant downtime occurs because of some off-normal condition, grab sampling may be warranted. Process engineering or other oversight/management authority during actual transfer operations may dictate the need for such sampling and analysis.

Supernate grab sample analyses will provide information on supernate physical and compositional changes that can be related to a volume of transferred tank 241-SY-101 wastes and a volume of dilution water required to effect such a composition change. In order to obtain a measurement of the mass transferred from tank 241-SY-101, a measure of the mass transferred to tank 241-SY-102 must be determined. Mass measurements can only be inferred by the product of volumes and densities. The process magnetic flow meters and tank 241-SY-102 level indication provides direct measures of the volume portion of the calculation. However, the normal technique for determining waste supernate density is via grab sample analysis. An ENRAF¹ gage operating in a densitometer mode is another technique, but this is not provided by the project.

Pacific Northwest National Laboratory is preparing a densitometer which can be installed in the transfer line. If it is installed and transfer density data are available, they may be used to refine the mass balance calculation.

Analysis of a supernate grab sample yields a density measurement that can be used in the mass transfer calculation. Additional chemical analysis considered standard with grab samples yields common analyte concentrations. These concentrations can be compared to the known transfer volumes and initial waste characterizations to yield further information on mass transfer and disposition of materials in tank 241-SY-102. Additionally, tank temperature profiles may be used to infer information about changes in settled solids volume in a tank. Such analyses must take into account the constantly changing waste composition resulting from continuous salt well waste additions.

The convective slurry transferred out of tank 241-SY-101 is attributed with a rather large range of specific gravity of 1.6 ± 0.15 . Any dilution or flush water added to the system will possess a specific gravity of approximately 0.99 in the operating temperature range. For the purposes of calculation, water will be attributed with a specific gravity of 1.00.

The following calculations are examples of how material balances would determine completion of the small transfer. The exact values in such a calculation will depend upon the actual initial conditions and the desired waste transfer volume. It should be noted that uncertainties in measurement accuracy and calculation assumptions limit the accuracy of the overall calculation to about 1%.

¹ ENRAF is a trademark of the ENRAF Corporation, Houston, Texas.

Initial Conditions:

Tank 241-SY-102 waste level:	200 inches
Tank 241-SY-102 solids level:	12 inches
Tank 241-SY-102 waste volume:	550 kgal
Tank 241-SY-102 supernate density:	1.20 kg/L

Transfer Volumetric Data:

Totalized water addition:	100 kgal
Integrated transfer line flow:	200 kgal
Integrated transfer line flow - Totalized water addition:	100 kgal

Final Conditions:

Tank 241-SY-102 waste level:	273 inches
Tank 241-SY-102 solids level:	12 inches
Tank 241-SY-102 waste volume:	750 kgal
Tank 241-SY-102 supernate density:	1.23 kg/L

The direct process control indications give the volumes of waste and water transferred.

The quantity desired is the change in mass of waste in tank 241-SY-102. If this change in mass equals the mass of 100 kgal of tank 241-SY-101 convective waste and the mass of the water added to the system, the transfer will be considered complete. The initial indication of this achievement comes when the integrated transfer line flow minus the totalized water flow into the system equals the predetermined small transfer volume. At this point, the transfer should be terminated and a verification of the amount of waste transferred should be performed.

Desired mass change in tank 241-SY-101:

$$(100 \text{ kgal})(3.785 \text{ kg/gal})(1.60 \text{ kg/L}) = 606,000 \text{ kg}$$

Mass of water added to the transfer system:

$$(100 \text{ kgal})(3.785 \text{ kg/gal})(1.00 \text{ kg/L}) = 379,000 \text{ kg}$$

Expected mass increase in tank 241-SY-102:

$$606,000 \text{ kg} + 379,000 \text{ kg} = 985,000 \text{ kg}$$

Initial tank 241-SY-102 supernate mass:

$$(200 \text{ inch} - 12 \text{ inch})(2,750 \text{ gal/inch})(3.785 \text{ kg/gal})(1.20 \text{ kg/L}) = 2,348,000 \text{ kg}$$

Final tank 241-SY-102 supernate mass:

$$(273 \text{ inch} - 12 \text{ inch})(2,750 \text{ gal/inch})(3.785 \text{ kg/gal})(1.23 \text{ kg/L}) = 3,342,000 \text{ kg}$$

Change in tank 241-SY-102 supernate mass:

$$3,342,000 \text{ kg} - 2,348,000 \text{ kg} = 994,000 \text{ kg}$$

Mass of tank 241-SY-101 waste transferred equals change in tank 241-SY-102 supernate mass - mass of water added:

$$994,000 \text{ kg} - 379,000 \text{ kg} = 615,000 \text{ kg}$$

Volume of tank 241-SY-101 waste removed:

$$\left(\frac{615,000 \text{ kg}}{1.60 \text{ kg/L}}\right)\left(\frac{\text{gal}}{3.785 \text{ L}}\right) = 102 \text{ kgal}$$

7.4 RUNNING MATERIAL BALANCE FOR DILUTION RATIO VERIFICATION

Good operating practice requires the use for a continuous material balance. The running material balance offers a way to double-check the performance of controlling the transfer line dilution ratio using FI-367. This function will be described subsequently.

In the example of Section 7.3, the volume of tank 241-SY-101 waste transferred as indicated by the process instrumentation matches the volume determined by material balance verification to three significant figures. In actuality, there will be discrepancies between the two figures. Assuming a baseline tank 241-SY-101 waste transfer volume of 100 kgal and baseline water addition volume of 100 kgal, the measurement errors that could be expected under ideal conditions are indicated in Table 7-5. This table provides a listing of back-up instrumentation that will permit continued transfer operation in the event of failure of the primary instrument:

Table 7-5. Ideal Material Balance Measurement Errors for 100 kgal Transfer¹

Water Supply Flow	Waste Transfer Line Flow
Primary: POR32-RW-FQI-419 (Service Water Totalized Flow Indicator) 0.005*100 kgal = 500 gal	Primary: SY-102-WST-LIT-101 (Tank 241-SY-102 ENRAF level gage) 0.04 inch*2,750 gal/inch = 110 gal
Backup: POR32-RW-FQI-418B (Outlet Line Flow Totalizer Indicator) 0.005*100 kgal = 500 gal	Backup: SY-102-WST-SLE-101/-102 (Tank 241-SY-102 manual tape) Instrument Accuracy ± 0.5 inches (± 1400 gal)

¹ assumes all water added to the transfer system ends up in tank 241-SY-102.

From Table 7-5, it can be seen that selection of the ENRAF level gage in tank 241-SY-102 as the primary waste transfer measurement device seems warranted, but the measurement errors listed correspond to instrument operation with known fluids under ideal conditions. The nature of the waste slurry to be transferred is not nearly as well known. In addition, these process control indications in themselves cannot account for the effect of waste density changes within the system. The example calculation showed a tank 241-SY-102 supernate SpG change of 0.03. Indeed, if the initial condition in tank 241-SY-101 were to be 500 kgal of water, the initial waste transfer would produce a supernate SpG change of >0.1. The best estimated initial conditions for tank 241-SY-102 suggest that a SpG change of not more than 0.05 would be more reasonable.

The concept of tank 241-SY-102 supernate density change is the only reliable means of determining if the water added to the system ends up in tank 241-SY-102 instead of tank 241-SY-101. Changes in various transfer pump performance parameters have been suggested as indicators for changes in the physical properties of the working fluid. However, these methods are generally deemed unsatisfactory for process control by themselves.

There is reasonable confidence in the waste fluid properties and the pump design that, if the transfer pump is operated at a higher flow rate than the flow rate of dilution water to it, that the dilution water will be entrained by the pump and moved to tank 241-SY-102. The significant crust and gas void volume in tank 241-SY-101 render any changes in tank level to be unusable for on-line process control.

There is also high confidence in the accuracy at which the volume changes in tank 241-SY-102 can be detected by the ENRAF level gage and in the accuracy at which the volume of water supplied to the PPP can be recorded via the instruments driven by FE-419 or FE-418.

This confidence suggests that a running material balance can double-check the actual average dilution ratio achieved by comparing the level change in tank 241-SY-102 to the totalized volume of water supplied to the PPP. Any discrepancy of a certain threshold magnitude may indicate an undesired average dilution ratio may have been achieved. Alternatively, it may provide indication of a malfunction of an instrument, a leak in the system, or indication that totalized FE-367 readings provide a poor measure of the actual transfer line flow.

Within a 30-minute time span, a nominal transfer line flow rate of 120 gpm would indicate a volume transfer of 3600 gallons. With a 110 gallon resolution on the ENRAF level gage in tank 241-SY-102, the level gage should be able to measure this volume change to within $(110/3600)*100\%$ or about 3.0%. The repeatability of the ENRAF is an order of magnitude better than the accuracy (0.004 inch vs 0.04 inch). The accuracy of the volume transfer measurement in tank 241-SY-102 via the ENRAF should improve at each additional 30-minute measurement as the resolution of the ENRAF in terms of the transferred volume increases. With the assumption that during waste transfer, all water supplied to the PPP is transferred to tank 241-SY-102, the following continuous material balance can be reasoned:

Let

W = volumetric rate of water addition to 241-SY-102
 R = volumetric rate of waste flow to 241-SY-102
 F = volumetric rate of waste removal from 241-SY-101

Referring to Figure 6-4, noting the prescribed dilution can develop relationship ratio limits of 2 volumes of water: 1 volume of waste at one extreme, and 1 volume of water:2 volumes of waste at the other.

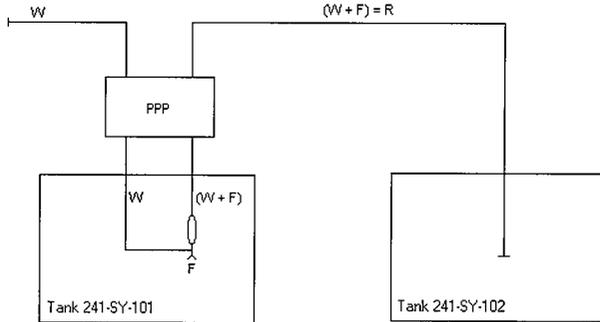
Figure 7-4. Dilution Ratio Verification

W = volumetric rate of water addition to the PPP
 F = volumetric rate of waste removal from tank 241-SY-101
 R = volumetric rate of waste slurry transfer to tank 241-SY-102

Assumption: during waste transfer, all water supplied to the PPP is transferred to tank 241-SY-102

Therefore, $R = (W + F)$

volume change in tank 241-SY-102 = R * total transfer time
 volume of water added to tank 241-SY-102 = W * total transfer time
 volume of waste removed from tank 241-SY-101 = F * total transfer time



$$R = (F + W) \quad \text{or} \quad F = (R - W)$$

$$\frac{1}{3} R < W < \frac{2}{3} R \quad \text{and} \quad \frac{1}{3} R < F < \frac{2}{3} R$$

$$0.5 W < F < 2.0 W \quad \text{or} \quad 0.5 W < (R - W) < 2.0 W$$

Divide inequality through by W:

$$0.5 < (R/W - 1) < 2.0$$

Add one (1) to the inequality:

$$1.5 < (R/W) < 3.0$$

This expression forms the "running material balance" and indicates that at any time during the waste transfer, the ratio of the volume of waste accumulated in tank 241-SY-102 to the volume of water supplied to the PPP must be within the range of 1.5 to 3.0.

Dilution Ratio Verification

$$1.5 \leq \left(\frac{\text{volume increase in tank 241-SY-102 during the transfer}}{\text{total volume of water supplied to the PPP during the transfer}} \right) \leq 3.0$$

It should be understood that the purpose of this running material balance is to provide a double check of the system performance as opposed to providing a comparison between two different measurements of the same quantity.

7.5 SPECIFIC OPERATING INSTRUCTIONS FOR TRANSFER

Process Engineering will determine a number of operational limits for the transfer. These limits will be communicated to Operations via a Process Memo prior to the transfer:

- (1) The desired volume to be transferred from tank 241-SY-101
- (2) The limiting volume to be transferred from tank 241-SY-101
- (3) The not-to-exceed level in tank 241-SY-102 (transfer will terminate if this level is reached)
- (4) The not-to-exceed volume of water to be supplied to the PPP. (transfer will terminate if this volume is reached.)

8.0 OPERATIONS PLAN

8.1 INITIAL PUMP P-350 INSTALLATION AND STANDBY LINE-UP MAINTENANCE

Current project planning calls for installation of the transfer pump P-350 in tank 241-SY-101 several months before system start-up and the commensurate operation of pump P-350. A significant concern is the affect this period of inactivity will have on this pump as it is submerged in a warm, high density, saturated salt solution in equilibrium with a sizeable mass of precipitated salts. Upon pump P-350 installation, the transfer line should be back-flushed and a hydraulic lock placed on the P-350 discharge leg to insure the pump column and pump itself is filled with fresh water. This should limit the mechanisms by which concentrated waste could enter the pump internals to that of static mass diffusion. The back-flush will minimize the exposure of the pump internals and piping to the waste during periods when the transfer system is in the standby line-up. Additionally, periodic P-350 purges should be performed.

The manufacturer recommends that the pump be installed with authorization to operate at very low speed to free the internals of crystallized waste, yet preclude developing enough head for fluid to reach the top of the pump column. In lieu of this operation, a weekly flush of two P-350 pump internal and column volumes (approximately 50 gallons) is recommended until it can be demonstrated that pump operation is not affected by this proposed mechanism of solids precipitation in the pump internals. A hydraulic lock should be placed on the P-350 discharge leg following the weekly flush. The manufacturer stated that a lower frequency of purge would be acceptable if the relationship between the purge frequency and rotor breakaway torque could be demonstrated. Such a relationship could only be shown by periodic bumping of the pump, an activity currently disallowed by the Authorization Basis.

8.2 TRANSFER SYSTEM PREHEAT

Immediately prior to waste transfer operations, those portions of the transfer line that will see waste slurry are preheated by performing a heated water flush and by use of the transfer line heat tape. These line sections include the transfer line, the P-350 pump discharge line, and the P-350 pump internal purge path. Therefore, prior to waste transfer activities, each of these three sections of process piping are flushed in sequence for two minutes per section. The flush flow rate is specified to be up to 60 gpm, with 60 gpm being the target flow rate. The actual flow rate achievable may be less because of the flow restriction in that leg of piping (i.e., pump P-350 internals). These flushes will add assurance against solids precipitation upon transfer start-up.

Once the system lines have been preheated, transfer operations must begin immediately or the preheat operation must be repeated.

8.3 SYSTEM STARTUP MANAGEMENT PLAN

The system startup management plan uses a process of developing an operational experience base during the initial operation of the transfer system. The basic mechanics of the system operation are covered by the Acceptance, Operational, and Functional Test Procedures. The system startup management plan accomplishes a number of goals for transfer system operations. These include

- Magnetic Flow Meter Installed Operation
- Operational Flammable Gas, Ammonia, and VOC Emissions

Ideally, each of these objectives will be accomplished in the same series of tests.

8.3.1 Magnetic Flow Meter (FE-367; FE-418; FE-419) Installed Operation

This test serves to calibrate the transfer system magnetic flow meters (FE-367, FE-418, FE-419) to actual system conditions. The general technique will be to compare integrated flow meter readings against actual tank level changes. These techniques are described in Section 6.0. The indicated dilution water and waste slurry flow rates from the respective magnetic flow meters are integrated over the pump run times and calibrated against the level rise in tank 241-SY-102. Practical level measurement difficulties in tank 241-SY-101 preclude its level change from being used as a volumetric measurement.

An additional part of this test will be to determine the pump P-350 VFD setpoint for the desired steady-state waste transfer slurry flow rate. A minimum transfer rate of 60 gpm is needed to achieve a flow velocity of 6 ft/sec. The dilution water flow can be supplied to the PPP at a rate of up to 70 gpm. While not to exceed 70 gpm, efficient operation indicates a steady state dilution water flow rate close to the high capacity limit is desired. The desired DR is one part waste to one part water by volume. At a dilution water flow rate of 60 gpm, the allowed waste flow rate would range between 30 gpm and 120 gpm within dilution limits. This would result in a transfer flow rate of 90 gpm to 180 gpm. Therefore, specifying a dilution water flow rate of 60 gpm and a transfer flow rate of 120 gpm is a good balance between transfer efficiency and operating margin. The pump P-350 VFD should be set to produce a 120 gpm flow rate through FE-367 at the 60 gpm dilution water flow rate.

8.3.2 Operational Flammable Gas, Ammonia, and VOC Emissions

Ammonia is indicated as being an extensive problem for the tank 241-SY-101 transfer effort (Hedengren 1999). The estimated ammonia concentrations in tank 241-SY-101

waste, and the estimated behavior of ammonia in those wastes when exposed to air, has driven incorporation of the ASSD into the transfer system. The primary purpose of the ASSD is to minimize the direct contact of tank 241-SY-101 convective wastes with tank atmosphere.

8.4 TRANSFER OPERATIONS

The transfer system is designed to be a simple, robust system to minimize training requirements and the probability of component/interface requirements that could compromise the system's operating reliability.

8.4.1 Transfer Start-Up

In order to initiate a waste transfer from tank 241-SY-101 to tank 241-SY-102, the waste level in tank 241-SY-102 must be greater than 180 inches (500 kgal) to limit ammonia emissions from the surface of the supernate. Additionally, this level cannot exceed 270 inches (750 kgal) in order to provide reserve operational volume for ongoing saltwell pumping activities. This adds the constraint that the small waste transfer at a nominal 1:1 water dilution cannot result in exceeding a tank 241-SY-102 level of 380 inches.

Initiating the waste transfer operations refers to the transition from the Stand-By configuration to the transfer operation configuration. This transition is achieved by first warming any section of system piping which, if not performed, could subject tank wastes to temperatures below 110 °F. This preheat is accomplished by performing three system flushes/preheats in rapid succession. These are:

- (1) Transfer Line Flush or Preheat (Section 5.2)
- (2) Transfer Line Back-Flush or Preheat (Section 5.3)
- (3) Pump P-350 Purge (Section 5.4)

Next, the Waste Transfer (Section 5.8) is established. To do this, the dilution water flow is established by the appropriate valve line-up. Throttle valve V-410 at the FCP is adjusted to the desired dilution water flow rate of 60 gpm. Pump P-350 is then started at a pre-selected speed. It is anticipated that the starting speed is less than the optimum transfer speed, and so pump speed must be adjusted to obtain the desired slurry transfer flow rate. The specifications of the transfer system state that at no time during standard transfer operations can the waste transfer flow rate exceed twice the dilution water flow rate. Therefore, the transfer flow rate for the waste/dilution water mixture should never exceed three times the dilution water flow rate.

8.4.2 Controlled Transfer Shut-Down

A controlled system shutdown is essentially the reverse of the transfer start-up. The idea is to adjust dilution water and pump P-350 flow rates to minimize the waste concentration

in the transfer line prior to stopping pump P-350. Once the maximum dilution has been achieved in the transfer line and pump P-350 has been shut down, the three standard system flushes are performed followed by placing the system in the System Standby line-up (Section 5.1). The operations required to return the transfer system to the Stand-By condition are:

- (1) Transfer Line Flush or Preheat (Section 5.2)
- (2) Pump P-350 Discharge Line Flush or Preheat (Section 5.3)
- (3) Pump P-350 Purge (Section 5.4)
- (4) Perform the Siphon Break Valve Operations
- (5) Establish the Stand-By Configuration (Section 5.1)

In order to minimize waste concentrations in the transfer line to shut down pump P-350, the dilution water flow rate is set to at least 60 gpm. Next, the speed of pump P-350 is slowly adjusted downwards until the transfer line flow rate is 60 gpm (or equal to the dilution water flow rate). Once the 60 gpm transfer flow rate is achieved, pump P-350 can be stopped.

8.4.3 Off-Normal Transfer Shut-Down and Flushing

Off-Normal transfer shut down and flushing, with a loss of normal flushing capability, is the evolution that uses ACC-401 on the WSS. This accumulator and its supporting equipment are used to respond to a major upset condition that requires the uncontrolled shut down of pump P-350. This condition might result from a loss of process water, a loss of electric power, or detection of high airborne contaminant concentrations. The objective is to clear the transfer line of wastes and this is achieved by flushing this line to both tanks 241-SY-102 and 241-SY-101. This is achieved by performing the ACC-401 Transfer Line Flush (Section 5.6).

At this point, the valve operation to establish a siphon break is performed followed by returning the transfer system to the Stand-By line-up (Section 5.1). The flush of the transfer line using ACC-401 need only be performed once, since normal operation of the water skid must be established before ACC-401 can be refilled.

8.4.4 Tank Farm Access Considerations

The design of the flexible hose-in-hose arrangement of the transfer line and its lead blanket shielding offers no structural protection from vehicular contact. Because of the susceptibility of the transfer system to vehicular damage, as a minimum, the control provided by TSR AC 5.10.2.b (LMHC 1999c) must be followed. This control begins at the time of transfer line installation and not just during transfer operations.

During transfer operation, the over-ground transfer line will be a source of ionizing radiation not normally present in the tank farm. This transfer line and certain associated

structures will be posted as a high-radiation area. Personnel access to these locations during transfer operations must consider this fact.

Transfer operations will require continuous operator interface at the water supply valve and instrumentation stand assembly (FCP) and the water support skid electrical enclosure (WSCP). The DACS Instrument Trailer should be monitored during transfer operations. Additionally, operator presence is required at the SY-Farm motor control center (MCC) whenever the speed of pump P-350 must be adjusted. Adequate data logging must be performed periodically per Section 8.4.5.

8.4.5 Monitored Parameters for Transfer Operations

A requirement for transfer operations is for tank 241-SY-101 and -102 temperatures and ENRAF levels and SHMS/GMS gas concentrations to be monitored with regular periodicity by the DACS/TMACS (Tank Monitoring and Control System) system. Additionally, the following process control parameters must be monitored and recorded at 60-minute intervals if data-logging capability is not provided or is not operational for the instrument. These parameters are required for process control, but also have use in subsequent engineering analysis of the transfer operations:

- Tank 241-SY-102 ENRAF level
- Tank 241-SY-101 1-A and 1-C ENRAF levels
- FCP water supply totalized flow (from FE-419).
- WSS water supply totalized flow (from FE-418).
- Transfer line totalized flow (from FE-367).
- Tank 241-SY-101 hydrogen concentration
- Tank 241-SY-101 ammonia concentration
- Tank 241-SY-102 hydrogen concentration
- Tank 241-SY-102 ammonia concentration
- SY-Farm stack hydrogen concentration
- SY-Farm stack ammonia concentration

Additional system parameters are to be recorded for use in subsequent engineering analysis of the transfer operation:

- Pump P-350 VFD output frequency
- Pump P-350 VFD output current
- Pump P-350 VFD output voltage
- Pump P-350 VFD output power factor

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9.0 OFF- NORMAL CONDITIONS

9.1 HIGH TANK HEADSPACE FLAMMABLE GAS CONCENTRATION

A safety control imposed upon the transfer operation is the flammable gas concentration control limit of 25% of the LFL (equivalent to 7500 ppm H₂). The safety action is to initiate immediate shutdown of transfer operations. However, good operating practice will dictate that significant control action be taken long before this concentration is achieved if the flammable condition is the result of a controlled release. Any process change that results in a significant headspace flammable gas concentration increase or rate of concentration increase should warrant immediate operator response to counter the change. Depending upon which tank is experiencing the change, the corrective action should be to either reduce the rate of water addition, reduce the rate of waste transfer, or both. If flammable gas concentrations do not respond to input corrective actions, the transfer will be terminated at 25% of the LFL.

9.2 EXCESSIVE SY-FARM VENTILATION SYSTEM AMMONIA OR VOC EMISSIONS

This condition is the result of the agitation and chemical alteration of the 241-SY-101 wastes as they commingle with the wastes in tank 241-SY-102. Therefore, the recovery action will be either a controlled reduction of the rate or shutdown of 241-SY-101 waste transfer. Ideally, if a correlation between the rate of waste transfer and concentration of off gases can be demonstrated, the corrective action for an undesired gas concentration or rate of concentration change may be to reduce the rate of waste transfer. A reduction in the rate of waste transfer would be preferable to a controlled shutdown of transfer operation. A controlled shutdown is preferable to an evacuation of the tank farm with the consequent shutdown of the transfer system.

ESH&QA (Environmental, Safety, Health, and Quality Assurance) Ammonia and VOC Monitoring in SY-Tank Farm

- Detection of 25 ppm ammonia at ground level requires mask use in-farm (VOC concentration is considered to be covered by ammonia limit)
- Detection of 300 ppm ammonia at ground level requires immediate transfer system shutdown and tank farm evacuation farm (VOC concentration is considered to be covered by ammonia limit)

9.3 LOSS OF SY-FARM PRIMARY VENTILATION

The concern here is the uncontrolled build-up of gas and vapor concentrations within the tank headspaces. Initiating a controlled shutdown of the 241-SY-101 waste transfer upon loss of ventilation will minimize this buildup.

9.4 LOSS OF SY-FARM ANNULUS VENTILATION

The concern here is the loss of leak detection capability. Limiting condition for operation (LCO) 3.2.6 permits continued operations upon loss of the annulus continuous air monitor if the annulus conductivity probes remain operable. If both annulus leak detection systems are inoperable, a controlled shutdown of the tank 241-SY-101 waste transfer is to be performed in accordance with LCO 3.2.6.

9.5 LOSS OF ELECTRIC POWER

The concern of this condition is to minimize the probability of line plugging. In this case, the action is to manually activate the Water Support Skid water accumulation tank and perform system flushing as soon as possible.

9.6 LOSS OF DILUTION WATER

Upon loss of dilution water supply, the low water supply flow detected at the PPP should trip pump P-350 to minimize the amount of undiluted slurry pumped into the transfer line. If this interlock does not operate properly, the operator response is to stop pump P-350 as soon as possible. This will be immediately followed by manual activation of the Water Support Skid water accumulation tank to perform system flushing as soon as possible. Both of these actions are designed to minimize the probabilities of salt precipitation in the transfer line resulting in a line plug.

9.7 LOSS OF P-350 PUMP

Upon loss of dilution water supply, the low water supply flow detected at the PPP should trip the P-350 pump to minimize the amount of undiluted slurry pumped into the transfer line. If this interlock does not operate properly, the operator response is to stop the P-350 pump as soon as possible. This will be immediately followed by manual activation of the Water Support Skid water accumulation tank to perform system flushing as soon as possible. Both of these actions are designed to minimize the probabilities of salt precipitation in the transfer line resulting in a line plug.

9.8 TRANSFER LINE LEAK

Responses to this condition may be dictated by the severity of the leak. A primary safety concern will be to minimize the amount of a potential environmental release. Upon detection of a small-contained leak, a controlled shutdown of the waste transfer system with subsequent water flushes will be specified. Upon a major leak or line break, an immediate P-350 pump shutdown is desired.

9.9 TRANSFER LINE PLUG

Recovery from pipeline plugging will utilize heated, pressurized water. Water pressure is gradually cycled on the plug. The slow nature of the pressure cycling prevents packing of the plug. The reapplication of the heated water increases the driving force for dissolution of soluble solids. The pressure can be cycled up to the system rating. If the plug is not immediately removed, the effect is to eventually create a small flow path through the solids plug. Eventually, the flow path will be enlarged through erosion and or dissolution, and the plug should fail under the applied pressure, clearing the line.

This pressurized, heated water can be supplied by either the water supply pumps (P-401 / -402), or the nitrogen pressurized water accumulation tank (ACC-401). Both sources can cycle water pressure to a plug. In the case of the water supply pumps, this can be accomplished with the pressure control valve PCV-401, or for ACC-1, by recharging its air flask. The PPP valve arrangement is such as to allow pressure to be applied to cause flow in the transfer line to either tank.

9.10 TRANSFER LINE BACK LEAKAGE

The pressure switches in the PPP (PS-370, PS-371) serve as indications of radioactive wastes leaking into water supply piping. During normal transfer operations, the flush water piping to the transfer line is isolated from:

- the waste flow by valves V-353 and V-354
- the tank headspace by valve V-355
- the dilution water supply by valve V-360
- pump P-350 internals by valve V-361

Therefore, in the valve line-up for transfer operations, this section of PPP piping is isolated. The pressure switch on this section of piping is set to both alarm and provide an interlocked shutdown of pump P-350 upon detection of 20 psi. Upon an interlocked shutdown, the normal procedures to flush and vent the system are performed followed by returning the system to the Stand-By configuration.

The cause of the pressure switch activation must be determined and corrected. Potential causes of such a condition could be an improper valve line-up, water leak-by at valve V-360 or waste leak-by at valves V-353 or V-354. If the latter, contamination within the PPP piping would also require evaluation and remediation activities. A remediation activity might be repeated flushes (transfer line flush and back flush and pump P-350 purge) through this section of piping.

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APPENDIX A

INDEX OF TECHNICAL OPERATING REQUIREMENTS

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APPENDIX A

INDEX OF TECHNICAL OPERATING REQUIREMENTS

- A-1. Basis for Interim Operations (BIO) Controls
See Table A-1.0
- A-2. Operating Specification Document (OSD) Controls
See Table A-2
- A-3. Environmental Controls
None Identified
- A-4. Industrial Safety (Tank Farm HASP) Controls
See Table A-3
- A-5. Waste Compatibility/Waste Acceptance Controls
None Identified

Table A-1. Safety SSCs and TSRs and Defense-in Depth for Representative Accidents.

See HNF-3737, Table 12 for these accidents and controls.

Table A-2. Operating Specification Document (OSD) Controls for Tanks 241-SY-101 and 241-SY-102. (2 Sheets)

REQUIREMENT	CONTROL PARAMETER	CONTROL LIMIT	METHOD OF CONTROL	SOURCE DOCUMENT ^{1,2}
Tank Composition	Temperature: 212 F For [NO3] 1-0M [NO3]/[OH] + [NO2] For 1.0M [NO3] 3.0 M For [NO3] > 3.0M	0.01M [OH] 5.0M 0.01M [NO ₂] 5-5M <2.5 [for solutions below 167 F, the [OH] limit is 8.0M] 0.1 ([NO3]), [OH] < 10M [OH] + [NO2] 0.4 ([NO ₃]) 0.3M [OH] < 10M [OH] + [NO2] 1.2M [NO3] 5-5M	Waste sampling & verification of compliance of waste transfers. Note: LCO 3.3.2 restricts the waste temperature to 195 F for the upper 15 feet of waste and 215 F for the waste below 15 feet.	OSD-T-151-00007 7.2.1.A
Liquid Levels	Primary Tank Liquid Level Minimum Leak detection pt liquid level	Min. 6 in. (when annulus vent system is operating) ≤ 74 inches (AZ & SY)	Liquid level taken per procedure TO-040-180 Auto liquid level measuring device and/or manual tape Dip tubes used to monitor liquid level in leak detection pt. Alarm activated if liquid level exceeds predetermined level.	OSD-T-151-00007 7.2.2
Vapor Space Pressure	No limits currently specified.			OSD-T-151-00007 7.2.5
Solution Temperatures	Waste Temperature Temperature Changeover Time for Solution in solution Temperature gradients of soln. in tanks soln/vapor interface	≤ 195°F in all levels of waste or ≤ 195°F in the top 15 ft. of waste and ≤ 215°F in the waste below 15 ft. <125°F: ≤ 10°F/hr ≥ 125°F: ≤ 20°F/day	Thermocouple trees installed in tanks. Temperatures taken per procedure TO-040-600 Note: Average bulk temperature. These temperature constraints are not applicable during initial tank filling.	HNF-SD-WM-TSR-006 LCO 3.3.2 OSD-T-151-00007 7.2.6
Total Fuel Concentration	Maximum total fuel concentration (Energetics)	480 joules/gram (dry basis)	Waste samples analyzed per appropriate sample analysis plan (SAP)	OSD-T-151-00007 7.2.12

Table A-2. Operating Specification Document (OSD) Controls for Tanks 241-SY-101 and 241-SY-102. (2 Sheets)

REQUIREMENT	CONTROL PARAMETER	CONTROL LIMIT	METHOD OF CONTROL	SOURCE DOCUMENT ^{1,2}
Ventilation System HEPA Filters Pressure Drop Across Filters at rates Flow	Pressure drop across first filter in a series Pressure drop across any other filter series Total pressure drop across filters in a series Air Inlet Temperature to HEPA Filter	<p>≤ 5.0 in. w.g.</p> <p>≤ 4.0 in. w.g.</p> <p>≤ 5.0 in. w.g.</p> <p>≤ 230°F</p>	Calibrated differential pressure gauges are used for each filter to monitor the pressure drop. The gauges are checked per SOP TO-060-240 for SY Farm. Gauges are read daily.	OSD-T-151-00007 7.3.1
Air Inlet Temperature	Single HEPA Filter System	99.95% of particles between 0.1	Temperatures are checked to determine the operating condition of the heater per applicable procedures, work plans, work packages or other documentation.	
Filter Efficiency	Multiple HEPA Filter System			
Gaseous Discharges from Ventilation System	Annual Average Concentrations*	Not to exceed 1 time the DCG-Public Value of WHC-CM-7-5, Appendix C, at point of release.	*Except for Krypton-85: Not to exceed a combined release of 4E+06 Ci/yr.	
Maximum permissible concentration of radionuclides	Weekly Average concentrations*	Not to exceed 10 times the annual average administrative control value (ACV) concentrations for that stack at point of release.	A Radiation Analyzer (RAN) and Effluent Record Sampler samples the air contained in the K1 and K2 Exhaust stacks. The sample is analyzed to determine conformance with DCG-Public limits.	
	Instantaneous Concentration	Not to exceed 5,000 times the DCG-Public Value of WHC-CM-7-5, Appendix C, averaged over any 4-hr period at point of release.		

¹LMHC, 1991, *Operating Specifications of the 241-AF, AIW, AZ & SY Tank Farms*, OSD-T-151-00007, Rev. H-211, Lockheed Martin Hanford Corporation, Richland, Washington.
²Noorani, Y. G., 1991, *TIRES Technical Safety Requirements*, HNF-SD-WM-TSR-006, Rev. 0E, DE&S Hanford, Inc., Richland, Washington.

Table A-3. Industrial Safety (Tank Farm HASP) Controls for Tanks 241-SY-101 and Tank 241-SY-102

Hazard	Control Limit	Method of Control	Source Document ¹
Noise	No stationary high-sources present in AY Farm. Only required if specified in work packages or permits to control intermittent noise sources from any equipment brought into the farm.	Work packages or permits	Appendix F, III.B.1
Chemicals Cautic Additions	Prevent and mitigate the consequences of caustic spray leaks.	Delivery piping encased in transparent plastic sleeving. Maximum operating pressure \leq 125 psig. Steel pipe with a wall thickness of no less than schedule 10. Proper eye, face, skin protection and emergency wash facilities.	Section 2.8.24
Confined Spaces	Listing in Table F-1 of Appendix F. See Section 10 of HASP		Appendix F, III.B.3
Asbestos	Anything painted pink is assumed to contain asbestos. This material is not to be disturbed.	Warning signs at AY farms alert workers that asbestos materials are present.	Appendix F, III.B.4
Lighting		Adequate lighting shall be provided when operations are to be performed in low light situations.	Appendix F, III.B.5
Tank-Based Hazards		Found in work packages & work permits developed for specific tank as part of work control process.	Appendix F, III.C Section 2.0

¹Carls, D. R., 1995, *Tank Farms Health and Safety Plan*, WHC-SD-WM-HSP-002, Rev. 21, Westinghouse Hanford Company, Richland, Washington.

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