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ENGINEERING CHANGE NOTICE

Page 1 of 2

1. ECN 656002

Proj. ECN

2. ECN Category (mark one) Supplemental [] Direct Revision [X] Change ECN [] Temporary [] Standby [] Supersedure [] Cancel/Void []	3. Originator's Name, Organization, MSIN, and Telephone No. Scott D. Estey, Process Control, R2-11, 373-2461	4. USQ Required? [X] Yes [] No TF-99-0838	5. Date 10/13/99
	6. Project Title/No./Work Order No. Tank 241-SY-101	7. Bldg./Sys./Fac. No. 241-SY-101	8. Approval Designator S
	9. Document Numbers Changed by this ECN (includes sheet no. and rev.) HNF-4264, Rev. 1	10. Related ECN No(s). ECN-655994	11. Related PO No. N/A

12a. Modification Work	12b. Work Package No.	12c. Modification Work Complete	12d. Restored to Original Condition (Temp. or Standby ECN only)
[] Yes (fill out Blk. 12b) [X] No (NA Blks. 12b, 12c, 12d)	N/A	N/A Design Authority/Cog. Engineer Signature & Date	N/A Design Authority/Cog. Engineer Signature & Date

13a. Description of Change 13b. Design Baseline Document? [X] Yes ~~[X]~~ No (initialed 10/28/99)

Complete revision to incorporate process control guidance for the initial in-tank dilution of tank 241-SY-101 wastes.

14a. Justification (mark one)

Criteria Change	[X]	Design Improvement	[]	Environmental	[]	Facility Deactivation	[]
As-Found	[]	Facilitate Const	[]	Const. Error/Omission	[]	Design Error/Omission	[]

14b. Justification Details

PCP changes reflect continuing project development.

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

See attached distribution.

RELEASE STAMP

DATE: NOV 01 1999
STA. 4
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ID: 2

A-7900-013-2 (05/96) GEF095

ENGINEERING CHANGE NOTICE	Page 2 of 2	1. ECN (use no. from pg. 1) ECN-656002

16. Design Verification Required	17. Cost Impact				18. Schedule Impact (days)	
	ENGINEERING		CONSTRUCTION			
[ ] Yes	Additional	[ ] $	Additional	[ ] $	Improvement	[ ]
[X] No	Savings	[ ] $	Savings	[ ] $	Delay	[ ]

19. Change Impact Review: Indicate the related documents (other than the engineering documents identified on Side 1) that will be affected by the change described in Block 13. Enter the affected document number in Block 20.

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

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

Document Number/Revision	Document Number/Revision	Document Number Revision
~~N/A~~ TO-430-100 LE		
TO-430-190 28 Oct 99		

21. Approvals

	Signature	Date		Signature	Date
Design Authority	RW Reed	28 Oct 99	Design Agent		
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DEPARTMENT OF ENERGY

Signature or a Control Number that tracks the Approval Signature

ADDITIONAL

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

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EDT/ECN: ECN-656002 UC: 2070
Org Code: 74B50 CACN/COA: 108979/BA10
B&R Code: EW 3120074 Total Pages: 123

Key Words: Tank 241-SY-101, Tank SY-101, SY-101, SY Farm, Mitigation, Transfer, Overground, Pump, PPP, Piping, Pump Pit, Drop Leg, New Generation Transfer Pump, NGTP, Prefabricated Pump Pit

Abstract: N/A

Release Approval 11/1/99
Date

DATE: NOV 01 1999
STA: 4
HANFORD RELEASE
ID: 2
Release Stamp

Approved for Public Release

RECORD OF REVISION

(1) Document Number: HNF-4264

Page 1

(2) Title
Process Control Plan for Tank 241-SY-101 Surface Level Rise Remediation

CHANGE CONTROL RECORD

(3) Revision	(4) Description of Change - Replace, Add, and Delete Pages	Authorized for Release (5) Cog. Engr.	Authorized for Release (6) Cog. Mgr. Date
0	(7) Initially released 06/29/99 on EDT-611465.	S.D. Estey	N.W. Kirch
1 RS	Incorporate per ECN-655994.	S.D. Estey	N.W. Kirch 9/28/99
2 RS	Incorporate per ECN-656002.	S.D. Estey	N.W. Kirch 10/28/99

A-7320-005 (08/91) WEF168

HNF-4264
Revision 2

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

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Lockheed Martin Hanford Corporation

Date Published
November 1999

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

Project Hanford Management Contractor for the
U.S. Department of Energy under Contract DE-AC06-96RL13200

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF TERMS

AC	Administrative Control
ACC	accumulator
ASSD	Anti-siphoning slurry distributor
Btu/lb	British thermal units per pound
Ci/yr	Curies per year
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
FCP	Farm Control Panel
FDH	Fluor Daniel Hanford, Inc.
FSAR	Final Safety Analysis Report
ft	feet
ft/sec	feet per second
FY	fiscal year
gal	gallon
gm/cc	grams per cubic centimeter
GMS	Gas Monitoring System
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
kPa	kilo-Pascal
LFL	lower flammability limit
lb	pound
LMHC	Lockheed Martin Hanford Corporation
M	molar
MCC	Motor Control Center
NGTP	new generation transfer pump
OSD	Operating Specification Document
Pa	Pascal
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
psig	pounds per square inch (gauge)
RAPID	respond and pump in days
sec^{-1}	per second
SHMS	Standard Hydrogen Monitoring System
SLRRP	Surface Level Rise Remediation Project
SOV	solenoid-operated valve
SpG	specific gravity
SSCs	structures, systems and components
SST	single-shell tank
TAP	technical advisory panel
TMACS	Tank Monitoring and Control System
TRG	Technical Review Group
TRU	transuranic
TSR	Technical Safety Requirement
TWRS	Tank Waste Remediation System
VFD	variable frequency drive
VOC	volatile organic compound
vol %	volume percent
w.g.	inches water gauge
WSCP	water skid control panel
wt %	weight percent
WSS	Water Support Skid
°C	degrees Celsius
°F	degrees Fahrenheit
%	percent

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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 approximately the last year, 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.

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. A 100 kgal transfer represents about a 10% volume reduction allowing a 10% water tank 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.

The process for remediating the tank will require two or more transfer/dilution cycles. Tank back-dilution will begin shortly after the initial transfer and the total dilution required to reach the final state is estimated to be between 250 to 400K gallons. The final state of the waste will not require any active measures to safely store the waste and operation of the mixer pump will no longer be necessary.

The remediation activities are centered on a purpose designed and built waste transfer and dilution system. This Process Control Plan (PCP) deals with the operation of the 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 tank 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 transfer system water supply also provides the water for dilution of the waste in tank 241-SY-101. Various connections are provided to supply dilution water addition devices from the dedicated transfer system water supply.

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 (Final Safety Analysis Report [FSAR]/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 transfers and tank back-dilutions will be managed, defining the monitoring and control methods including material balances to determine the progress and to define completion criteria for the remediation activities.

The general concept of the waste transfers 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. These limits are specified to maintain the functions of the mixer pump and tank operation. 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.

The dilutions in tank 241-SY-101 are specified with an immediate goal of maintaining mixer pump operability and with a longer-term goal of releasing gas trapped in the waste and particularly the crust. Any other goals specified for tank back-dilutions can ultimately be expressed in these terms. These goals are accomplished by the addition of water to tank 241-SY-101 waste at specific locations by the use of different in-tank equipment. All this equipment is supplied by the dilution/flush water system. The choice of the tank back-dilution location is determined by the immediate goal. Protection of mixer pump operation indicates that water injection deep in the convective waste is optimal, whereas the release of gas from the crust is more efficiently served by addition of water in, on, or immediately beneath the crust.

Goals for the project: The interim goals of the project are to: 1) protect the mixer pump operability 2) begin releasing gas from the crust, and 3) begin dissolving the crust and solids in the slurry layer. The final goals of the project (Final State) are to solve both the level growth and BD-GRE safety issues in this tank by achieving a condition of the waste such that no active measures are required to safely store the waste, i.e., crust and non convective layer are mostly dissolved, and therefore the mixer pump will no longer be needed to prevent BD-GREs in excess of 100% LFL. Transfers (which are designed to create space in the tank) and dilution (which will dissolve the solids) will accomplish this. Dissolution of solids will result in a release of gas retained by those solids and remove that volume of solids as a future retention site.

In support of the interim project goals, the first tank back-dilution sequence is specified as up to a 72 kgal water addition through the waste transfer pump (P-350) and up to 30 kgal through the transfer system vent line (via valve V-355).

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.

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2.0 PROCESS DESCRIPTION

2.1 WASTE CHARACTERISTICS

The bulk physical behavior of the convective wastes from tank 241-SY-101 is of great concern to a transfer system. These wastes are saturated, high-salt materials 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, 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 average dilution 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 double-shell tank (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 an average 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 vol % solids is diluted with water at the low dilution limit, the maximum expected solids concentration in the transfer line is approximately 17 vol % and the minimum somewhere around 2 vol %. The average slurry solids concentration thus derived from tank 241-SY-101 convective waste and water dilution would be in the vicinity of 7.5 vol % with an expected range from about 2 vol % to 17 vol %.

Insoluble Solids

The insoluble solids concentration of tank 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 tank 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 tank 241-SY-102. However, this is neither a pumping nor a pipeline transfer issue.

The effect of the water dilution 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. At a dilution 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 102 °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 tank 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 tank 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 tank 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 tank 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:

$\alpha_c + \alpha_d = 1$

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

$\rho_\infty = \rho_m$ 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:

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

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	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:

μ_m = 0.55 cP exp[k(ρ_m – 1.0 gm/cc)/ 1.0 gm/cc]

where 100 cP = 0.55 cP exp[k(1.6 gm/cc – 1.0 gm/cc)/ 1.0 gm/cc]

since μ_m = 100 cP when ρ_m= 1.6 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:

μ_m = 0.55 cP exp[8.67(ρ_m – 1.0 gm/cc)/ 1.0 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 ant 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 undiluted tank 241-SY-101 wastes posses 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 150-kgal waste transfer to occur.

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_20	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_20_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_2O_3	0.50	0.48
SO_4	0.35	0.34
K	0.35	0.34
$C_2H_3O_2$	0.18	0.17

2.1.5 Other Waste Property Issues

Concern has been expressed about the formation of hydrates (hydrogen rich compounds) in tank 241-SY-101 and their contribution to the total inventory of hydrogen in the tank. Hydrates are not considered in estimating the retained gas volume in the tank. Hydrates generally are not reactive (prone to releasing hydrogen) and, therefore, are no more of a source of hydrogen than water itself. In any event, tank safety is premised upon the control of the hydrogen concentration in the dome space. Gaseous hydrates require low temperatures and high pressures in order to form. The TAP has concluded that temperatures and pressures in Tank 241-SY-101 preclude the formation of gaseous hydrates in this tank and, therefore, gaseous hydrates are not a safety issue for this project.

2.2 SPECIFIC WASTE PROPERTY ISSUES FOR REMEDIATION ACTIVITIES

Table 2-6 shows current relevant tank waste parameters for tank back-dilution:

Table 2-6. Parameters of Concern for Tank 241-SY-101 Level Growth

Tank Parameter	Value
Gas generation rate	700 ± 140 ft^3/week
Significant Tank Levels Recent high crust level Approximate level of bottom of crust (bubble slurry layer) Mixer pump suction Transfer pump suction Mixer pump burrowing ring	 434.5 inches (on 5/24/99) 310 inches 235 inches 96 inches 9 inches
Gas release rate	Variable: (700 ft^3/week ≤gas release rate ≥700 ft^3/week)
Typical Baseline Steady-State Gas Release Concentrations	NH_3 80 ppm H_2 50 ppm N_2O 20 ppm
Estimated volume of retained gas	approximately 12,000 ft^3
Historical crust growth rate	0.08 inches/day
Current crust growth rate (since April 1, 1999)	approximately 0 inches/day
Estimated crust shear-strengths through the vertical profile	Top (freeboard) layer: ~20k to 50k Pa Middle (paste) layer: ~ 3k to 10k Pa Bottom (bubble slurry) layer: ~400 Pa Bulk crust: ~ 1.6 to 3.0 kPa
Estimated date when double shell height (458") will be exceeded	•November 1999 (planning basis) •March 2000 (historical trend of 0.08 in./day) •No projection for current crust growth rate

The general findings of various tank back-dilution analyses has revealed unintuitive results. From consideration of sinking the crust, the findings favor adding as much of the allowable dilution water volume as possible to the top of the crust. A transfer out of tank 241-SY-101 of 150 kgal and hypothetical back dilutions of 100 kgal at the transfer pump and 50 kgal on top of the crust show that:

- Dissolution of the freeboard (20 inches) and 6 inches into the upper paste layer below occurs, but the bubble slurry layer is unaffected.
- The resulting crust will float with plenty of margin, even considering imperfect mixing for the entire layer.

A 35 kgal water addition on top of the crust and 125 kgal through the transfer pump starts getting close to the point where the crust bulk density becomes higher than the density of the fluid in which it floats. It is anticipated that 30 kgal top / 120 kgal deep dilution will sink the crust. But 75 kgal on top and 75 kgal below works well in thinning the crust without getting too close the bubble slurry. It thins the upper part of the crust to get ready for purposeful sinking the next transfer/back dilution.

Additionally, no temperature controls were deemed necessary for any tank back-dilution water applied directly to the upper surface of the crust.

It is recognized that the AB controls for the dilution activities may not be fully developed at the time of the initial tank back-dilution. As such, it is not necessary to commence tank back-dilution activities immediately following the initial waste transfer. Various analyses were performed to determine the optimal tank back-dilution sequence:

<u>Mixer Pump Survivability/Operability Versus Crust Encroachment</u>:

> Analysis of the mixer pump to determine if a crust level control is needed (Meyer, et al. 1999) showed that the ingestion of a moderate amount of either solids, gases, or air should not damage the pump unless unusual and unexpected conditions are encountered. The amount of these materials that could be drawn into the pump through the small volute gap at a 262 inch elevation is inconsequential and the effective suction elevation of the pump is at 235 inches. Additionally, the suction vortex associated with submerged suction pumps essentially renders the separation specified by the previous 12 inch control margin as ineffective. As such, the recommended criterion is to monitor the mixer pump discharge pressure and cease operation if this pressure falls below a certain value.
>
> The concept will be, after initial waste transfer, to review the mixer pump operating parameters following each pump run for evidence of mixer pump performance degradation. This review after each pump run will continue until the TRG determines that changed tank conditions have not significantly degraded the capability of the mixer pump to perform its intended function. (hopefully, a few runs after the back dilution should be adequate to address this). In addition, the normal quarterly review of mixer pump performance would continue.

Crust Vertical Location versus Water Addition:

This analysis investigated the effects of adding dilution water on / in / just below crust to predict what happens; and to predict the rate of gas release as function of water addition rate, water addition location, and time. This analysis has shown that the crust in tank 241-SY-101 is composed of three regions of differing properties through a vertical profile. The lowest crust layer is commonly called the "bubble slurry" which is composed of significant void volume and has the lowest density. The next layer, the so-called "paste layer" has more mechanical strength but less void volume than the bubble slurry. Nevertheless, the paste layer comprises the largest total solids and void volumes within the crust. The upper layer is commonly called the "freeboard" as it extends above the liquid level and has drained of its liquid content. Although it possess voids, these are filled with air. Being composed of dried salts, it possesses the highest density within the crust profile.

It is estimated that the entire crust has a bulk density of 1.41 gm/cc, a bulk yield strength on the range of 1.6 kPa to 3.0 kPa, and contains 7200 SCF of gas. The majority of the gas volume (5200 SCF) resides in the paste layer. In various dilution scenarios, a major concern is the sinking of the crust. This would occur if the bulk density of the crust became greater than the density of the saturated salt solution in which it floats. It was found that the most efficient way to provide margin against this happening is to remove the freeboard layer by direct addition of dilution water on top of the crust. This action dissolves the solid salts forming the freeboard (and thus the crust deadweight), significantly lowering the effective bulk density of the crust. Protecting the low-density bubble slurry layer against water dilution and resultant gas bubble release also works to maintain a lower bulk crust density.

Gas releases from the crust due to dissolution of solids matrices forming the void volumes was deemed to be a controllable phenomena bounded by established safety controls.

Crust-Equipment Structural Analysis:

This was specified to determine the force term development and perform failure analysis on the tank structure and equipment. The upcoming transfer from and tank back-dilution to Tank 241-SY-101 have raised concerns about the potential for damage as the crust rises and falls with changing liquid level. The project analyzed how much of the crust mass (1500 metric tons) might remain attached to the tank wall or suspended hardware (multifunction instrument trees, velocity - density temperature trees, and mixer pump) as the liquid is removed and what motions might result if the attached sections of the crust were to break away and fall.

The observed and measured behavior of the crust indicates that it will follow the liquid level through transfer and dilution. The properties and dimensions of the crust layer make it impossible for any large section of it to attach to the tank wall or to bridge between available supports, such as in-tank equipment. Analysis has shown that the crust does not have enough mechanical strength to cause localized stress concentration damage to in-tank equipment due to the vertical displacements associated with the waste transfers and dilutions in tank 241-SY-101. Contrary to this evidence, even if it is assumed that the largest possible block of crust is attached and then falls, there is no obvious mechanism to cause damage to equipment. Even if the bulk crust were to sink as a coherent mass, which is deemed highly unlikely, the stresses imparted by this event would not damage the tank structure or equipment contained therein. More likely the crust would sink as much smaller solid masses, perhaps as small as individual granules of precipitated salts in the micron size range, as dissolution releases bound gas bubbles or dissolves the binding salt species.

The design of the in-tank equipment is able to withstand much larger loads than are possible given the current configuration of the crust. In any event, in-tank monitoring of the crust condition will permit the transfer to be stopped if significant crust attachment or distortion occurs.

If Crust Sinks, What is Impact to Mixer Pump Performance:

Analysis has shown that the mixer pump can impart a shear force of 1600 Pa at a radial distance of 20 ft from the discharge nozzle. This force would not, however, be enough to disrupt the majority of the solid mass of crust if it retained the same mechanical properties it is estimated to possess at present. Therefore, disruption of such a mass would be dependent upon dissolution of the solids matrices, which would eventually occur upon crust sinking. However, as referred to above, the most likely mechanism for crust sinking would occur as small granules of precipitate salts once the gas bubbles or binding structure composed of the more soluble precipitated salts are dissolved by the dilution water.

Identify if a Control Needs to be Developed for the Water Addition Rate during Tank Back-Dilution:

Preliminary analysis indicates that constraining the addition of dilution water to the convective layer by a volume of 150 kgal and an addition rate of <125 gpm will prevent the headspace of tank 241-SY-101 from exceeding 25% of LFL.

(FY2000) Define Criteria for USQ Closure / End State Analysis:

This criteria has been informally defined as a minimum goal of altering the properties of the waste to eliminate the need for mixer pump operation to demonstrate safety of tank 241-SY-101. A more ambitious goal will be to alter the waste properties sufficiently to remove the tank from the Flammable Gas Watchlist. The ultimate goal will be to transfer enough waste out of the tank to restore it as an operational DST.

Conclusion: The project continues to evaluate parameters that are critical to determining the optimum volume and method of application of the tank back-dilution for Tank 241-SY-101. No new (beyond those already identified with the transfer) or major hazards have been identified to be associated with dilution of the top of the crust in tank 241-SY-101 (via valve V-355) and with dilution of the mixed slurry layer via various flow paths through the transfer pump (pump P-350). It is now considered safe to initiate dilution within days after the initial transfer. The remediation project intends to complete all transfer and tank back-dilution steps early in Fiscal Year 2000.

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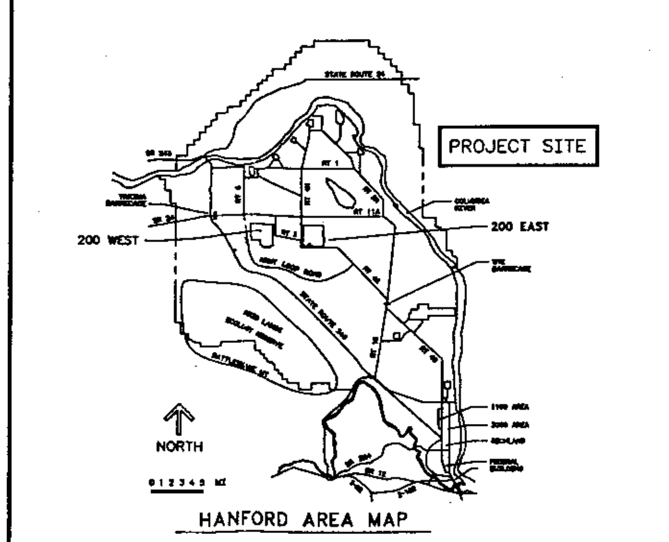
3.0 EQUIPMENT DESCRIPTIONS

This section provides an overview of the primary piping and instrumentation systems associated with the Respond and Pump in Days (RAPID) transfer system. The current list of transfer system H-14 drawings is shown in Figure 3.1:

INDEX #	DRAWING TITLE	VENDOR DWG #	HANFORD DWG #	SHEET
	GENERAL			
0000	RAPID MITIGATION SYSTEM DRAWING TREE/ LIST		H-14-103558-1	1
0000	RAPID MITIGATION SYSTEM DRAWING TREE/ LIST		H-14-103558-2	2
	CIVIL			
0100	RAPID MITIGATION SYSTEM CIVIL SITE PLAN		H-14-103559-1	1
	MECHANICAL			
4750	RAPID MITIGATION SYS TRANSFER PREPARATION ARRANGEMENT		H-14-103564-1	1
4750	RAPID MITIGATION SYS TRANSFER PREPARATION ARRANGEMENT		H-14-103564-2	2
2600, 4750	RAPID MITIGATION SYS PUMP INSTALLATION		H-14-103565-1	1
4750	RAPID MITIGATION SYS PUMP INSTALLATION		H-14-103565-2	2
4750	RAPID MITIGATION SYS PUMP MODIFICATION		H-14-103566-1	1
4750	RAPID MITIGATION SYS 241-SY-101 PPP INSTALLATION		H-14-103570-1	1
4750	RAPID MITIGATION SYS 241-SY-101 PPP INSTALLATION		H-14-103570-2	2
4750	RAPID MITIGATION SYS 241-SY-101 PPP INSTALLATION		H-14-103570-3	3
4750	RAPID MITIGATION SYS PREFABRICATED PUMP PIT (PPP) ASSY	PE305	H-14-103571-1	1
4750	RAPID MITIGATION SYS PPP ENCLOSURE ASSY	PE304-1	H-14-103572-1	1
4750	RAPID MITIGATION SYS PPP ENCLOSURE ASSY	PE304-2	H-14-103572-2	2
4750	RAPID MITIGATION SYS PPP SHIELD PLUG ASSY	PE315	H-14-103573-1	1
4750	RAPID MITIGATION SYS PPP COVER ASSEMBLY	PE316	H-14-103574-1	1
4750	RAPID MITIGATION SYS RISER AND PLUG GASKETS		H-14-103575-1	1
4750	RAPID MITIGATION SYS SEAL LOOP PLUG ASSEMBLY		H-14-103576-1	1
4750	RAPID MITIGATION SYS PPP ENCL COVER WELDMENT ASSY	PE301-1	H-14-103578-1	1
4750	RAPID MITIGATION SYS PPP ENCL COVER WELDMENT	PE301-2	H-14-103578-2	2
4750	RAPID MITIGATION SYS PPP SHIELDING	PE302	H-14-103579-1	1
4750	RAPID MITIGATION SYS PPP BACK END PLATE ASSY	PE306	H-14-103580-1	1
4750	RAPID MITIGATION SYS PPP FRONT PLATE ASSY	PE307	H-14-103581-1	1
4750	RAPID MITIGATION SYS PPP LEFT SIDE PLATE ASSY	PE308	H-14-103582-1	1
4750	RAPID MITIGATION SYS PPP RIGHT SIDE PLATE ASSY	PE309	H-14-103583-1	1
4750	RAPID MITIGATION SYS PPP FRONT PAN BOTTOM PLATE	PE310	H-14-103584-1	1
4750	RAPID MITIGATION SYS PPP SUPPORT FRAME WELDMENT	PE303	H-14-103585-1	1
4750	RAPID MITIGATION SYS PPP VALVE HANDLE ASSEMBLY	3642-G1	H-14-103587-1	1
4750	RAPID MITIGATION SYS PPP VALVE HANDLE DETAILS	3642-G2	H-14-103587-2	2
4750	RAPID MITIGATION SYS PPP REAR PAN BOTTOM PLATE	PE311	H-14-103588-1	1
4750	RAPID MITIGATION SYS PPP ENCL MISC DETAILS	PE314-1	H-14-103589-1	1
4750	RAPID MITIGATION SYS PPP ENCL MISC DETAILS	PE314-2	H-14-103589-2	2
4750	RAPID MITIGATION SYS ASSO INSTALLATION		H-14-103590-1	1
4750	RAPID MITIGATION SYS ASSO DAM DRAIN PIPE		H-14-103591-1	1
4750	RAPID MITIGATION SYS ASSO GENERAL ARRANGEMENT	99-192-1	H-14-103592-1	1
4750	RAPID MITIGATION SYS ASSO SHIELD PLUG SUBASSY	99-192-2	H-14-103592-2	2
4750	RAPID MITIGATION SYS ASSO MISC DETAILS	99-192-3	H-14-103592-3	3
4750	RAPID MITIGATION SYS ASSO RISER EXTENSION SUBASSY	99-192-4	H-14-103592-4	4
4750	RAPID MITIGATION SYS ASSO SHIELD PLUG SUBASSY	99-192-5	H-14-103592-5	5
4750	RAPID MIT SYS ASSO PLUG & TEMP SHIELD PLUG	99-192-6	H-14-103592-6	6
4750	RAPID MITIGATION SYS ASSO WASHER BODY SUBASSY	99-192-7	H-14-103592-7	7
4750	RAPID MITIGATION SYS ASSO LIFTING FLANGE	99-192-8	H-14-103592-8	8
4750	RAPID MITIGATION SYS ASSO STRONG BACK SUBASSY	99-192-9	H-14-103592-9	9
4750	RAPID MITIGATION SYS ASSO PARTS LIST	99-192-10	H-14-103592-10	10
4750	RAPID MITIGATION SYS HOSE AND HOSE INSTALLATION		H-14-103595-1	1
4750	RAPID MITIGATION SYS HOSE AND HOSE INSTALLATION DETAILS		H-14-103595-2	2
4750	RAPID MITIGATION SYS HOSE AND HOSE INSTALLATION		H-14-103595-3	3
4750	RAPID MITIGATION SYS HOSE AND HOSE ASSEMBLY		H-14-103596-1	1
4750	RAPID MITIGATION SYS HOSE AND HOSE END FITTINGS	3642-H	H-14-103597-1	1
4750	RAPID MITIGATION SYS HOSE AND HOSE SUPPORT BRACES	3642-10	H-14-103598-1	1
4750	RAPID MITIGATION SYS HOSE AND HOSE SUPPORT BRACES	3642-I1	H-14-103598-2	2
4750	RAPID MITIGATION SYS HOSE AND HOSE SUPPORT BRACES	3642-I2	H-14-103598-3	3
4750	RAPID MITIGATION SYS WATER SUPPORT SKID ARRANGEMENT	9903-LMH-046A1	H-14-103605-1	1
4750	RAPID MITIGATION SYS WATER SUPPORT SKID ARRANGEMENT	9903-LMH-046A2	H-14-103605-2	2
4750	RAPID MITIGATION SYS WATER SUPPORT SKID ARRANGEMENT	9903-LMH-046A3	H-14-103605-3	3
4750	RAPID MITIGATION SYS WATER SUPPORT SKID ARRANGEMENT	9903-LMH-046A4	H-14-103605-4	4
4750	RAPID MITIGATION SYS WATER SUPPORT SKID ASSEMBLY	9903-LMH-046B1	H-14-103606-1	1
4750	RAPID MITIGATION SYS WATER SUPPORT SKID DETAILS	9903-LMH-046B2	H-14-103606-2	2
4750	RAPID MITIGATION SYS WATER SUPPORT SKID DETAILS	9903-LMH-046B3	H-14-103606-3	3
4750	RAPID MITIGATION SYS WATER SUPPORT SKID DETAILS	9903-LMH-046B4	H-14-103606-4	4
4750	RAPID MITIGATION SYS WATER SUPPLY VALVE & INSTM STAND ARRANG	9903-LMH-046I	H-14-103612-1	1
4750	RAPID MITIGATION SYS WATER SUPPLY VALVE & INSTM STAND ASSY	9903-LMH-046L	H-14-103613-1	1
4750	RAPID MITIGATION SYS PPP SEAL LOOP DAM ASSY	PE312	H-14-103661-1	1
4750	RAPID MITIGATION SYS PPP GASKETS	PE313	H-14-103662-1	1
4750	RAPID MITIGATION SYS PPP CONCRETE FOOTING	PE317	H-14-103663-1	1
4750	RAPID MITIGATION SYS PPP TIE DOWN AND BASE PLATE	PE318	H-14-103664-1	1
4750	RAPID MITIGATION SYS JUMPER BAIL ASSEMBLY	3642-EF1	H-14-103666-1	1
4750	RAPID MITIGATION SYS PPP SITE POURED FOOTING		H-14-103668-1	1
4750	RAPID MITIGATION SYS WATER SUPPORT SKID ORIFICE	9903-LMH-046H1	H-14-103674-1	1
4750	RAPID MITIGATION SYS WATER SUPPORT SKID HOSE REEL MOD	9903-LMH-046J1	H-14-103675-1	1
4750	RAPID MIT SYS WTR SUPPLY VALVE & INST STAND CONC FOOTING	9903-LMH-046N	H-14-103677-1	1
4750	RAPID MIT SYS JUMPER MOUNT ASSEMBLY		H-14-103678-1	1
4750	RAPID MIT SYS PUMP SHIELDING ASSEMBLY		H-14-103681-1	1
4750	RAPID MIT SYSTEM PPP PIT COVER		H-14-103682-1	1
4750	RAPID MIT SYSTEM PPP PIT COVER		H-14-103682-2	2

INDEX #	DRAWING TITLE	VENDOR DWG #	HANFORD DWG #	SHEET
	PIPING			
4750	RAPID MITIGATION SYS WATER SUPPLY SPOOL PIECES	9903-LMH-046M	H-14-103614-1	1
4750	RAPID MITIGATION SYS 241-SY-101 PPP DECON SPRAY RING ASSY	3642-A1	H-14-103615-1	1
4750	RAPID MITIGATION SYS 241-SY-101 PPP DECON SPRAY RING DETAILS	3642-A2	H-14-103615-2	2
4750	RAPID MITIGATION SYS 241-SY-101 PPP DECON SPRAY RING DETAILS	3642-A3	H-14-103615-3	3
0402	RAPID MITIGATION SYS PIPING INSTALLATION		H-14-103616-1	1
0402	RAPID MITIGATION SYS PIPING INSTALLATION		H-14-103616-2	2
4750	RAPID MITIGATION SYS PROCESS PIPING MANIFOLD ASSY	3642-E1A	H-14-103618-1	1
4750	RAPID MITIGATION SYS PROCESS PIPING MANIFOLD ASSY	3642-E1	H-14-103618-2	2
4750	RAPID MITIGATION SYS PROCESS PIPING MANIFOLD FRAME SUBASSY	3642-E2	H-14-103618-3	3
4750	RAPID MITIGATION SYS PROCESS PIPING MANIFOLD SPOOL SUBASSY	3642-E3	H-14-103618-4	4
4750	RAPID MITIGATION SYS SERVICE PIPING MANIFOLD ASSY	3642-F1	H-14-103619-1	1
4750	RAPID MITIGATION SYS SERVICE PIPING MANIFOLD FRAME SUBASSY	3642-F2	H-14-103619-2	2
4750	RAPID MITIGATION SYS SERVICE PIPING MANIFOLD SPOOL SUBASSY	3642-F3	H-14-103619-3	3
4750	RAPID MITIGATION SYS PPP VALVE FUNNEL & STOP ASSY	3642-C1	H-14-103620-1	1
4750	RAPID MITIGATION SYS PPP VALVE FUNNEL & STOP SUBASSY	3642-C2.1	H-14-103620-2	2
4750	RAPID MITIGATION SYS PPP VALVE FUNNEL & STOP DETAILS	3642-C2.2	H-14-103620-3	3
4750	RAPID MITIGATION SYS PPP VALVE FUNNEL & STOP DETAILS	3642-C3.1	H-14-103620-4	4
4750	RAPID MITIGATION SYS PPP VALVE FUNNEL & STOP DETAILS	3642-C3.2	H-14-103620-5	5
4750	HOSE ADAPTER AND FLEX HOSE ASSEMBLIES		H-14-103621-1	1
4750	RAPID MITIGATION SYS MODIFIED CONNECTOR HEAD	3642-D	H-14-103622-1	1
4750	RAPID MITIGATION SYS DECON SPRAY RING SUPPLY QUICK DISCONNECT	3642-A4	H-14-103623-1	1
4750	RAPID MITIGATION SYS 241-SY-101 PPP SEAL LOOP ASSY	3642-B1	H-14-103624-1	1
7004	RAPID MITIGATION SYSTEM PROCESS FLOW DIAGRAM		H-14-103640-1	1
7004	RAPID MITIGATION SYSTEM PROCESS FLOW DIAGRAM		H-14-103640-2	2
4750	RAPID MITIGATION SYS PPP FLEX & BULKHEAD ASSY	3642-F4	H-14-103665-1	1
4750	RAPID MITIGATION SYS WATER SUPPORT SKID PIPING ISO	9903-LMH-046F	H-14-103673-1	1
4750	RAPID MITIGATION SYS WATER SUPPORT SKID SPOOL PIECES	9903-LMH-046K1	H-14-103676-1	1
4750	RAPID MITIGATION SYS WTR SUPPORT SKID SPOOL PIECE DETAILS	9903-LMH-046K2	H-14-103676-2	2
	ELECTRICAL / INSTRUMENTATION			
0110	RAPID MITIGATION SYSTEM TRANSFER UTILITY LAYOUT		H-14-103610-1	1
8204, 5901	RAPID MITIGATION SYSTEM TRANSFER UTILITY LAYOUT		H-14-103610-2	2
5901,7506	RAPID MITIGATION SYSTEM VALVE & INST STAND ELECTRICAL ASSY		H-14-103611-1	1
5903	RAPID MITIGATION SYS ELECTRICAL INTERCONNECTION DIA		H-14-103641-1	1
5903	RAPID MITIGATION SYS ELECTRICAL INTERCONNECTION DIA		H-14-103641-2	2
5903	RAPID MITIGATION SYS ELECTRICAL INTERCONNECTION DIA		H-14-103641-3	3
5903	RAPID MITIGATION SYS ELECTRICAL INTERCONNECTION DIA		H-14-103641-4	4
5903	RAPID MITIGATION SYS ELECTRICAL INTERCONNECTION DIA		H-14-103641-5	5
7505	RAPID MITIGATION SYSTEM ELECTRICAL CABLE ASSEMBLIES		H-14-103642-1	1
7505	RAPID MITIGATION SYSTEM ELECTRICAL CABLE ASSEMBLIES		H-14-103642-2	2
5900, 7106	RAPID MITIGATION SYS SY101-WT-ENCL-350 ELECTRICAL DETAILS	9904-LMH-060K1	H-14-103643-1	1
7506,5901,5907	RAPID MITIGATION SYS SY101-WT-ENCL-350 ELECTRICAL DETAILS	9904-LMH-060K2	H-14-103643-2	2
5907,7506, 5901	RAPID MITIGATION SYS SY101-WT-ENCL-350 ELECTRICAL DETAILS	9904-LMH-060K3	H-14-103643-3	3
8204	RAPID MITIGATION SYS HEAT TRACE WIRING DIAGRAM		H-14-103646-1	1
8204	RAPID MITIGATION SYS HEAT TRACE RACK ASSY		H-14-103649-1	1
8204	RAPID MITIGATION SYS HEAT TRACE RACK ASSY		H-14-103649-2	2
5903	RAPID MITIGATION SYSTEM INSTRUMENTATION LOOP DIAGRAMS		H-14-103651-1	1
5907, 7501	RAPID MITIGATION SYS SY-101 FIELD RACK ASSY		H-14-103652-1	1
5907, 7501	RAPID MITIGATION SYS SY-101 FIELD RACK ASSY		H-14-103652-2	2
5907, 7501	RAPID MITIGATION SYS PANEL ASSEMBLIES		H-14-103653-1	1
5907, 7501	RAPID MITIGATION SYS SY101-WT-CP-350A FIELD PANEL ASSEMBLY		H-14-103653-2	2
5907, 7501	RAPID MITIGATION SYS SY461-WT-CP-350B DACS PANEL ASSEMBLY		H-14-103653-3	3
5907, 7501	RAPID MITIGATION SYS WTR SUPPLY VALVE & INST STAND PANEL ASSY		H-14-103653-4	4
7502	RAPID MITIGATION SYS SY101-WT-CP-350A PANEL WIRING DIAGRAM		H-14-103654-1	1
7502	RAPID MITIGATION SYS SY101-WT-CP-350A PANEL WIRING DIAGRAM		H-14-103654-2	2
7502	RAPID MITIGATION SYS SY461-WT-CP-350B PANEL WIRING DIAGRAM		H-14-103654-3	3
7502	RAPID MITIGATION SYS SY461-WT-CP-350B PANEL WIRING DIAGRAM		H-14-103654-4	4
7502	RAPID MITIGATION SYS ELECTRICAL ELEMENTARY DIAGRAM		H-14-103655-1	1
7502	RAPID MITIGATION SYS ELECTRICAL ELEMENTARY DIAGRAM		H-14-103655-2	2
7004	RAPID MITIGATION SYSTEM P&ID		H-14-103656-1	1
7004	RAPID MITIGATION SYS WATER SUPPORT SKID P&ID	9903-LMH-046C1	H-14-103657-1	1
7004	RAPID MITIGATION SYS WATER SUPPORT SKID P&ID	9903-LMH-046C2	H-14-103657-2	2
7502	RAPID MITIGATION SYSTEM WATER SUPPORT SKID ONE LINE DIAGRAM	9903-LMH-046D1	H-14-103670-1	1
7502	RAPID MITIGATION SYSTEM WATER SUPPORT SKID ELEMENTARY DIAGRAM	9903-LMH-046D2	H-14-103671-1	1
7502	RAPID MITIGATION SYSTEM WATER SUPPORT SKID ELEMENTARY DIAGRAM	9903-LMH-046D3	H-14-103671-2	2
7502	RAPID MITIGATION SYSTEM WATER SUPPORT SKID ELEMENTARY DIAGRAM	9903-LMH-046D4	H-14-103671-3	3
5907, 7501	RAPID MITIGATION SYSTEM WATER SUPPORT SKID INST CONTROL PNL	9903-LMH-046E1	H-14-103672-1	1
5907, 7501	RAPID MITIGATION SYSTEM WATER SUPPORT SKID INST CONTROL PNL	9903-LMH-046E2	H-14-103672-2	2
5907, 7501	RAPID MITIGATION SYSTEM WATER SUPPORT SKID INST CONTROL PNL	9903-LMH-046E3	H-14-103672-3	3
5907, 7501	RAPID MITIGATION SYSTEM SY461-WT-CP-350B DACS PANEL MTG		H-14-103760-1	1



PROJECT TITLE: **RAPID MITIGATION PROJECT**

PROJECT SPECIFICATIONS:

SPECIFICATION FOR SY-101 RAPID MITIGATION PREFABRICATED PUMP PIT, HNF-4169

SPECIFICATION FOR SY-101 RAPID MITIGATION ANTI-SIPHONING SLURRY DISTRIBUTOR ASSY, HNF-4216

SPECIFICATION FOR SY-101 RAPID MITIGATION TRANSFER PUMP PIPING, HNF-4170

SPECIFICATION FOR SY-101 RAPID MITIGATION SKID , HNF-????

PROJECT CALCULATIONS:

SY-101 TRANSFER SYSTEM CALCULATIONS, HNF-4359

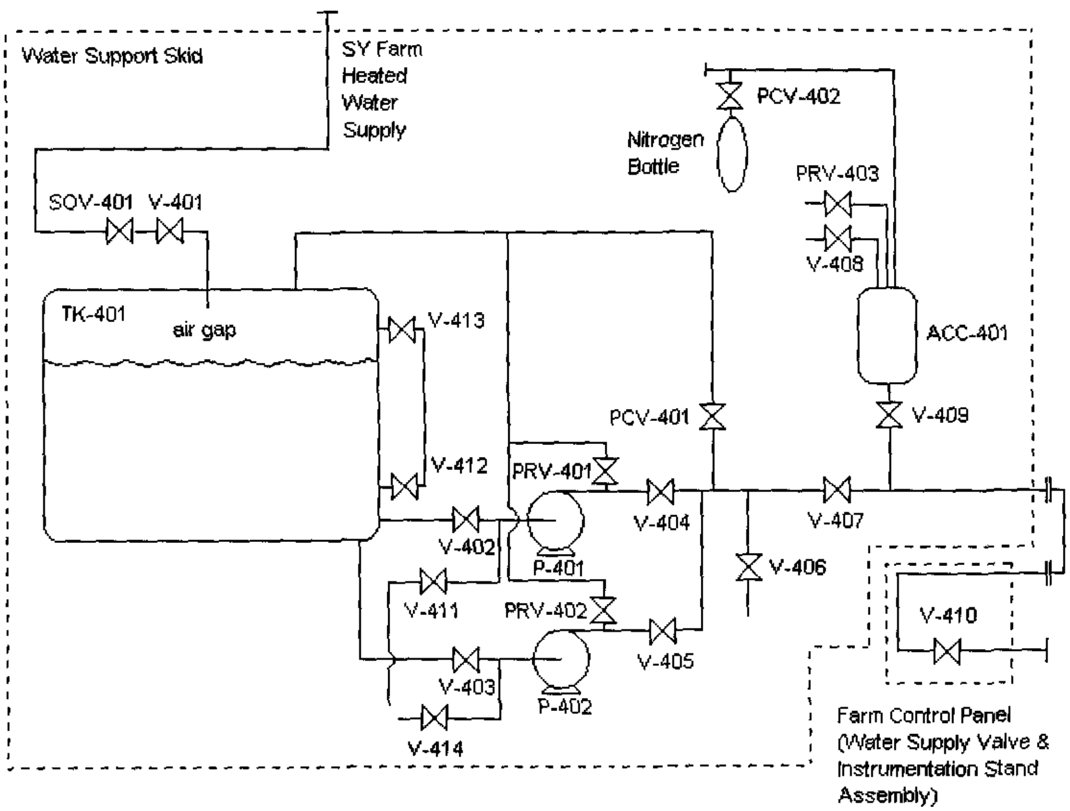
PROJECT CVI FILE:

CVI FILE NUMBER 50071

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-gal supply tank, and a 75-gal 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 100 psi. Figure 3-2 shows a schematic of the Water Support Skid. The 2,000-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

The Water Support Skid (WSS) contains the process routing valves listed in Table 3-1

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

EIN = Equipment Identification Number
FCP = Farm Control Panel
WSS = Water Support Skid

During steady-state dilution flow operation the water skid is capable of providing water at 102 °F to 130 °F The 130 °F limit is specified to comply with Authorization Basis temperature controls in tank 241-SY-101, whereas the 102 °F limit is specified to avoid problems attendant to potential precipitation of saturated salts. The dilution water flow rates in steady-state operation are specified as 20 to 70 gpm. The 20 gpm limit is specified to avoid problems attendant to potential precipitation of saturated salts, whereas the 70 gpm limit is specified by heating capabilities of the water supply equipment. Upon a loss of electric power, ACC-401 provides the means to clear the process lines of waste slurry.

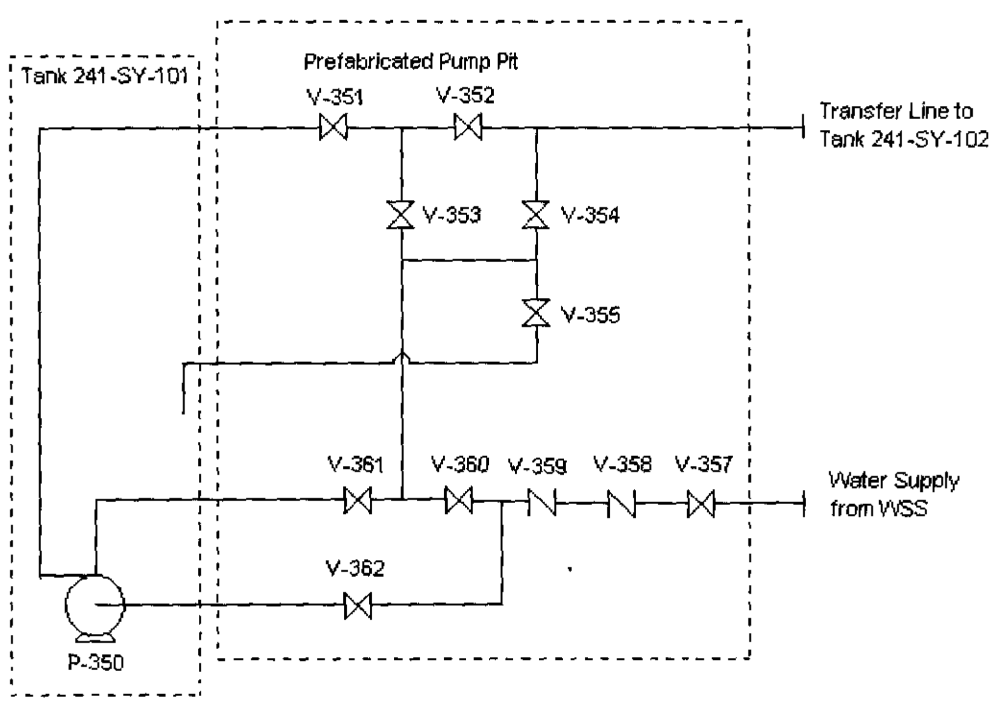
3.2 TANK 241-SY-101 PREFABRICATED PUMP PIT (PPP) AND NEW GENERATION TRANSPER PUMP (NGTP, P-350)

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 base plate 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

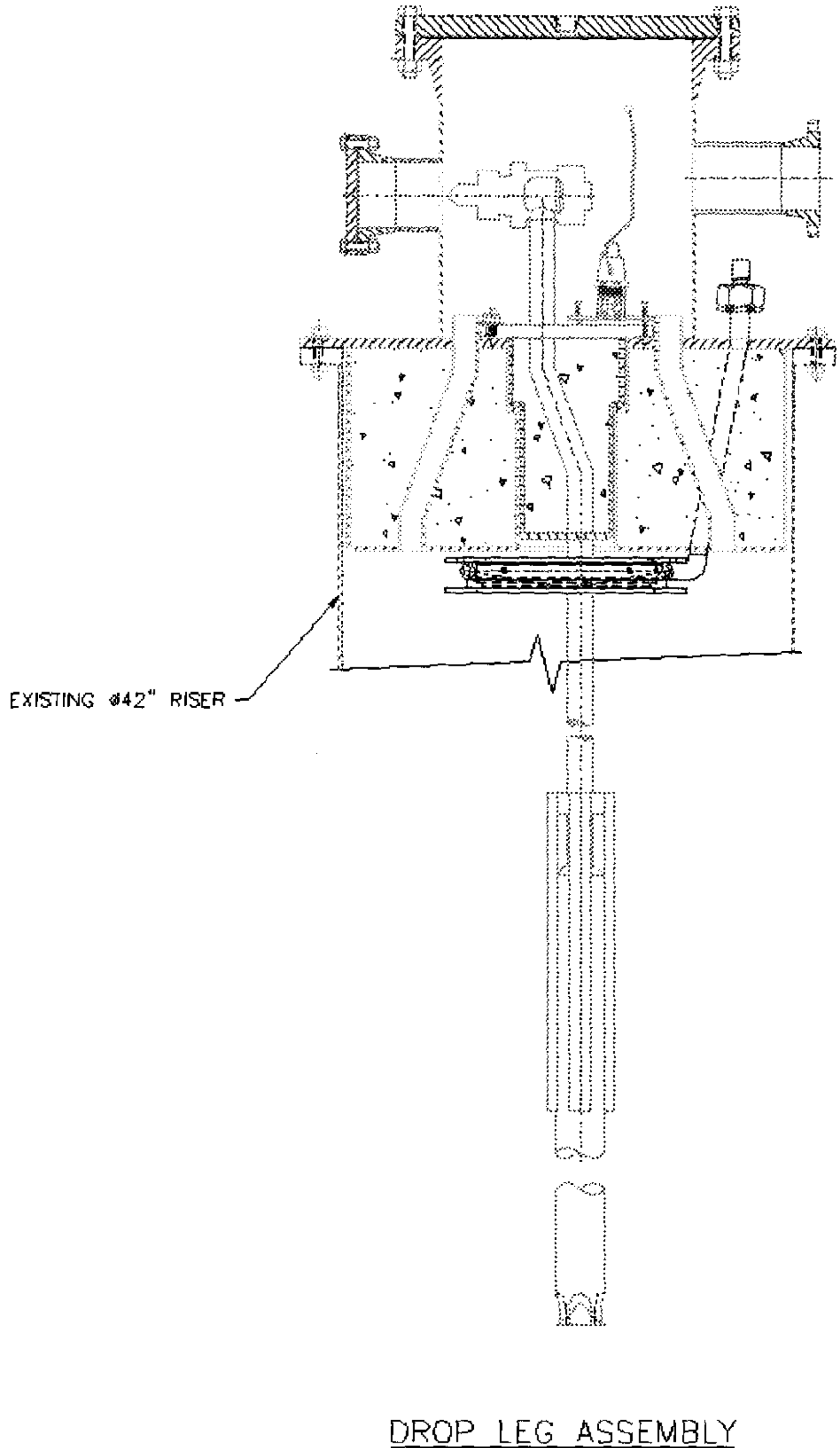
A submerged drop leg at tank 241-SY-102 is incorporated to minimize SY-Farm ventilation system ammonia and volatile organic compound (VOC) concentrations. This device is known as the anti-siphoning slurry distributor (ASSD). The design detail of the ASSD is shown in Figure 3-4.

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 equilibrium 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



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 tank 241-SY-102 while optimizing mixing of incoming tank 241-SY-101 slurry with tank 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 tank 241-SY-102 indicates a location as close to the bottom as possible. This would allow larger batch transfers out of tank 241-SY-102 without exposing the drop leg nozzles to atmosphere - a situation not desired because of the ammonia issues associated with tank 241-SY-101 wastes.

(3) A 160-inch liquid level in tank 241-SY-102 satisfies the operational requirement to keep the waste level higher than 130 inches, minimizing the possibility of entrainment of TRU solids during transfers out of the tank.

3.5 TRANSFER CONTROL SYSTEM

The manual positioning of the system routing values and operation of the system pumps achieves control of the waste transfer system.

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, MCC
	P-350 pump shutoff	FCP, DCP, MCC
	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
	TK-401 high-high water level or WSS power failure shuts off WSS inlet water supply	
Alarm	PPP and transfer line/drop leg leak detection indication	FCP, DCP, local
	Low process water supply temperature	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

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

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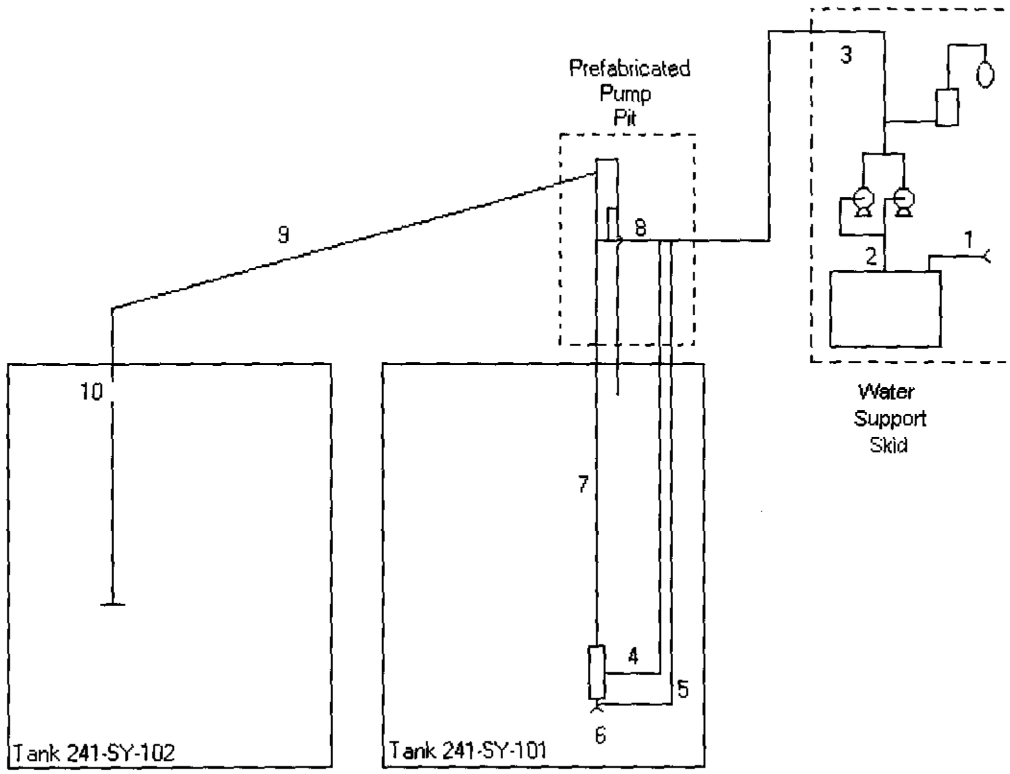
4.0 PROCESS FLOWSHEET

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 line 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 indicates the process flowsheet for the transfer system.

Figure 4-1. RAPID Transfer System Process Flowsheet



RAPID 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

4.1 RAPID TRANSFER SYSTEM CONFIGURATION

The transfer system valve arrangement is indicated in Figure 4-1 with the nomenclature described in Table 4-1. This listing of valves constitutes the process valves in the transfer system and is used in describing the line-ups of operation.

Figure 4-2. RAPID Transfer System Schematic

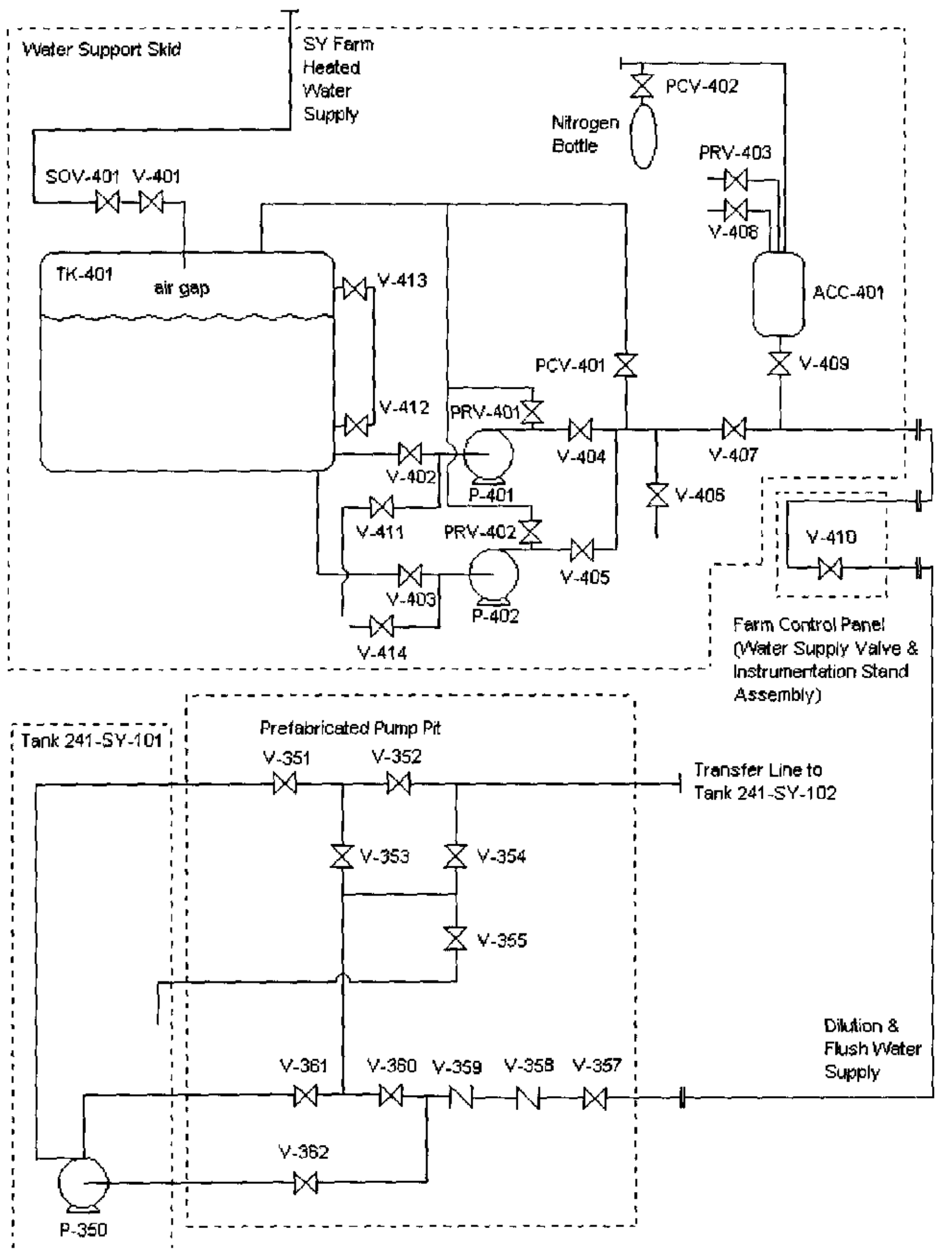


Table 4-4-1. RAPID Transfer System Valve Nomenclature

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

4.2 RAPID TRANSFER SYSTEM PROCESS FLOW VALVE 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
ACC-401 Transfer Line Back-Flush

Waste Transfer

Tank Water Addition via Transfer Pump Dilution Line

Tank Water Addition via Transfer System Vent Line

Notes

For Tank back-dilution: The initial tank back-dilution of tank 241-SY-101 is accomplished by the already existing infrastructure provided by the transfer system. When the transfer system is back-flushed, or the transfer pump purged, or dilution water supplied to the transfer pump (see Sections 5.3, 5.4 and 5.9), water is directly added to the convective waste at a tank level of 96 inches. When dilution water is supplied through valve V-355 (see Section 4.2.10), the water is added directly to the top of the crust. These tank back-dilution flow rates are controlled via valve V-410. No temperature controls are required for the tank back-dilution water supplied through the PPP. Control of the process is achieved via feedback from the tank level changes, in-tank video observations, and continuous monitoring of the tank off gassing.

Explanation Valve Line-Up Tables

(N/A): not applicable, as this section of process piping is valved 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 specific concern to the process. However, specification of parameter value/limits requires prudent engineering judgement

(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 specifically stated as a flow velocity requirement as opposed to a flow rate requirement. Specifying the transfer flowrate as a variable allows the convenient expression of the allowable waste and dilution water flowrates.

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 requirements 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 the larger of either:

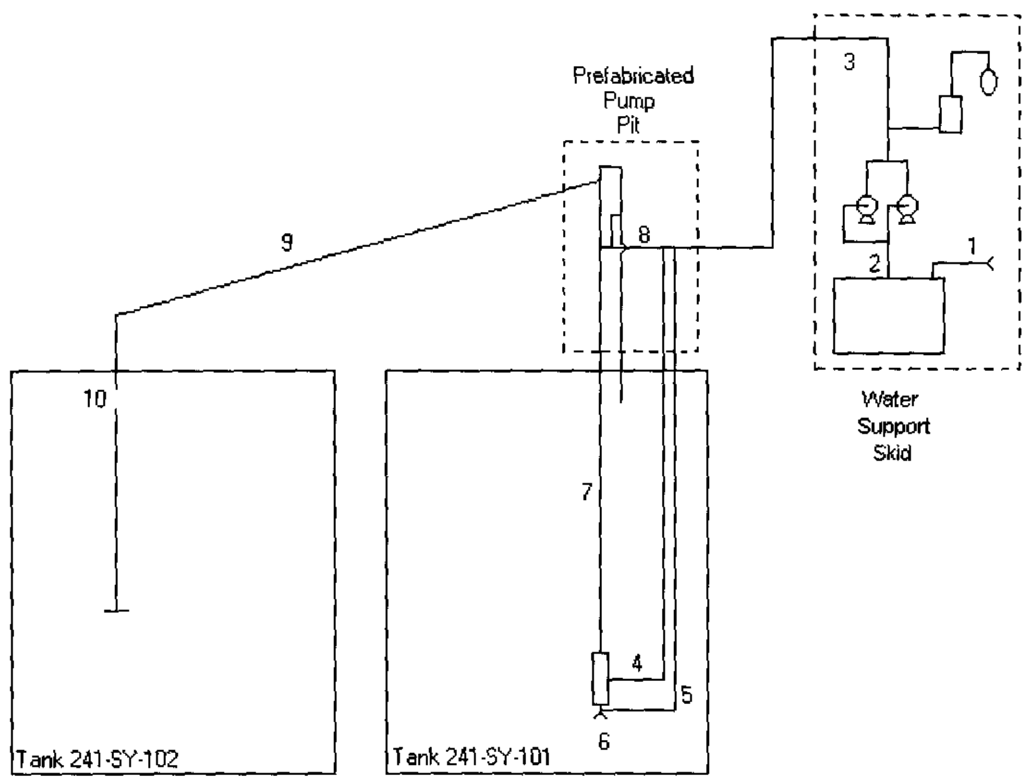
-two times the volume of the process line being flushed
-two minutes of flow at the specified line flow velocity

The process line flush flow rate is specified as 4 $^{ft}/_{sec}$ to 6 $^{ft}/_{sec}$. This velocity is estimated to meet critical velocity requirements for the process lines.

The transfer pump internal flush requirement is stated as flow rate of approximately 10 gpm. The transfer pump internal flush volume and temperature limits are then defined by the limits on water addition to tank 241-SY-101 (i.e., a volume not to exceed the capacity of the water skid tank that is within the water addition temperature limits of 102°F to 130°F).

4.2.1 Standby

Transfer System Process Flow Line-up	Line-up Notes and General Procedure
Standby	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. Pumps P-350, P-401, P-402 are de-energized

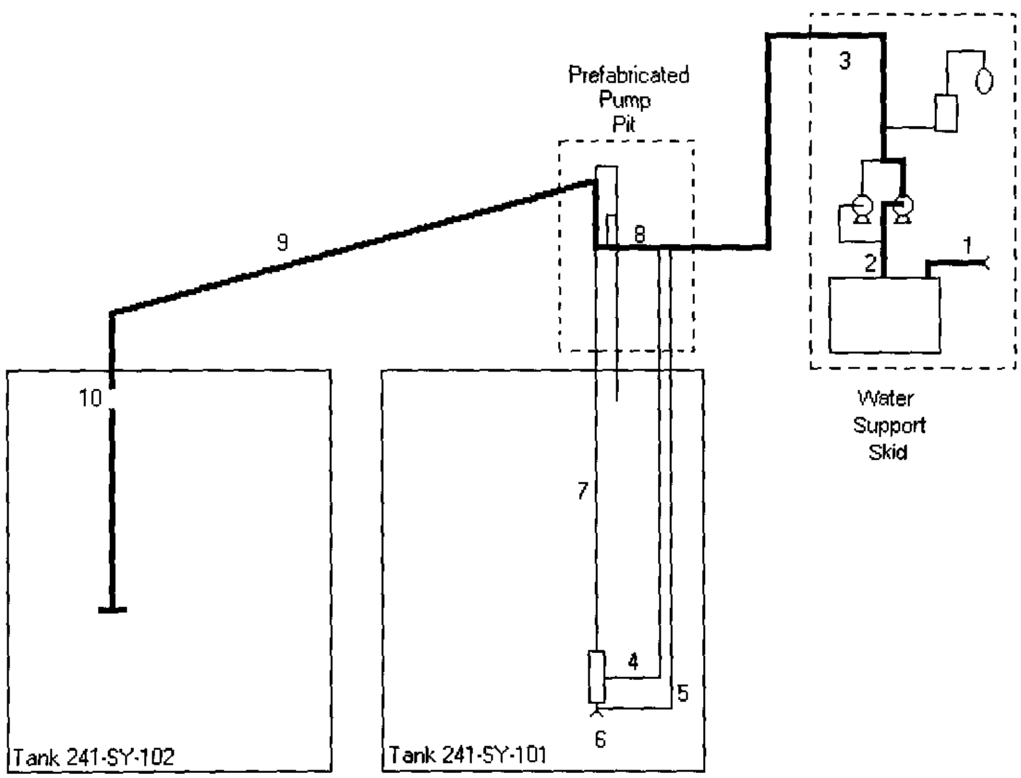


Permissible Process Limits for Standby Condition

Flow Parameter	Water Skid Inlet (1)	Water Skid Outlet (2)	PPP Water Supply Line (3)	Transfer Pump Internal Flush Line (4)	Transfer Pump Water Supply Line (5)	Transfer Pump Waste Inlet (6)	Transfer Pump Outlet (7)	Flush Cross-Connect (8)	Transfer Line (9)
Flow Rate	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Flush Volume	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Flow Velocity ($^{ft}/_{sec}$)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Temperature (°F)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Viscosity (cP)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Density ($^{grams}/_{cc}$)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Volume % Solids	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Mass % Water	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Mass % Completely Insoluble Solids	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

4.2.2 Transfer Line Flush

Transfer System Process Flow Line-up	Line-up Notes and General Procedure
Transfer Line Flush	This line-up is established immediately prior to or immediately following waste transfer operations, to either flush or pre-heat system lines. 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: • 2 x line volumes or 2 minutes of flow, which-ever is greater • 102 °F to 130 °F • flow rate not to exceed 70 gpm • when possible, flush flow velocity should exceed 4 ft/sec

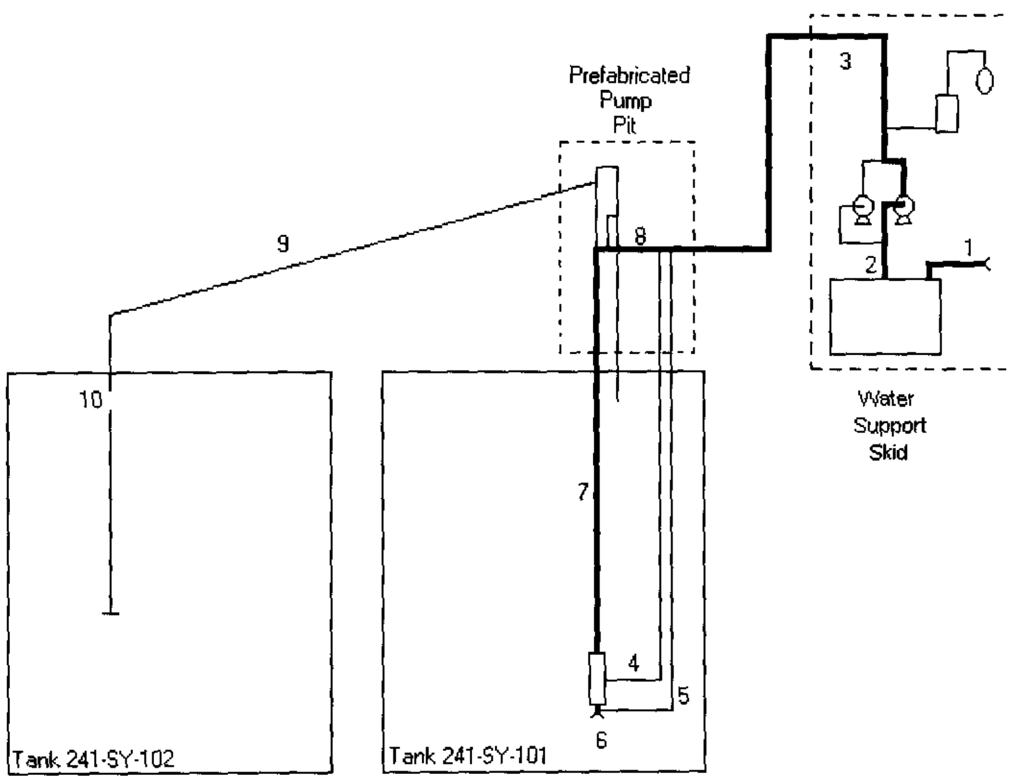


Permissible Process Limits for Transfer Line Flush

Flow Parameter	Water Skid Inlet (1)	Water Skid Outlet (2)	PPP Water Supply Line (3)	Transfer Pump Internal Flush Line (4)	Transfer Pump Water Supply Line (5)	Transfer Pump Waste Inlet (6)	Transfer Pump Outlet (7)	Flush Cross-Connect (8)	Transfer Line (9)
Flow Rate	–	< 70 gpm	< 70 gpm	N/A	N/A	N/A	N/A	< 70 gpm	< 70 gpm
Flush Volume	2 line volumes or 2 minutes of flow, whichever is greater	2 line volumes or 2 minutes of flow, whichever is greater	2 line volumes or 2 minutes of flow, whichever is greater	N/A	N/A	N/A	N/A	2 line volumes or 2 minutes of flow, whichever is greater	2 line volumes or 2 minutes of flow, whichever is greater
Flow Velocity (ft/sec)	–	–	–	N/A	N/A	N/A	N/A	4 to 6	4 to 6
Temperature (°F)	–	102 to 130	102 to 130	N/A	N/A	N/A	N/A	102 to 130	102 to 130
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
Density (grams/cc)	< 1	< 1	< 1	N/A	N/A	N/A	N/A	< 1	< 1
Volume % Solids	< 0.01	< 0.01	< 0.01	N/A	N/A	N/A	N/A	< 0.01	< 0.01
Mass % Water	100	100	100	N/A	N/A	N/A	N/A	100	100
Mass % Completely Insoluble Solids	0	0	0	N/A	N/A	N/A	N/A	0	0

4.2.3 Transfer Line Back-Flush

Transfer System Process Flow Line-up	Line-up Notes and General Procedure
Transfer Line Back-Flush	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. Additionally, this line-up can be used to add dilution water to the convective waste in the tank through the transfer pump inlet. 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: • 2 x line volumes or 2 minutes of flow, which-ever is greater • 102 °F to 130 °F • flow rate not to exceed 70 gpm • when possible, flush flow velocity should exceed 4 ft/sec

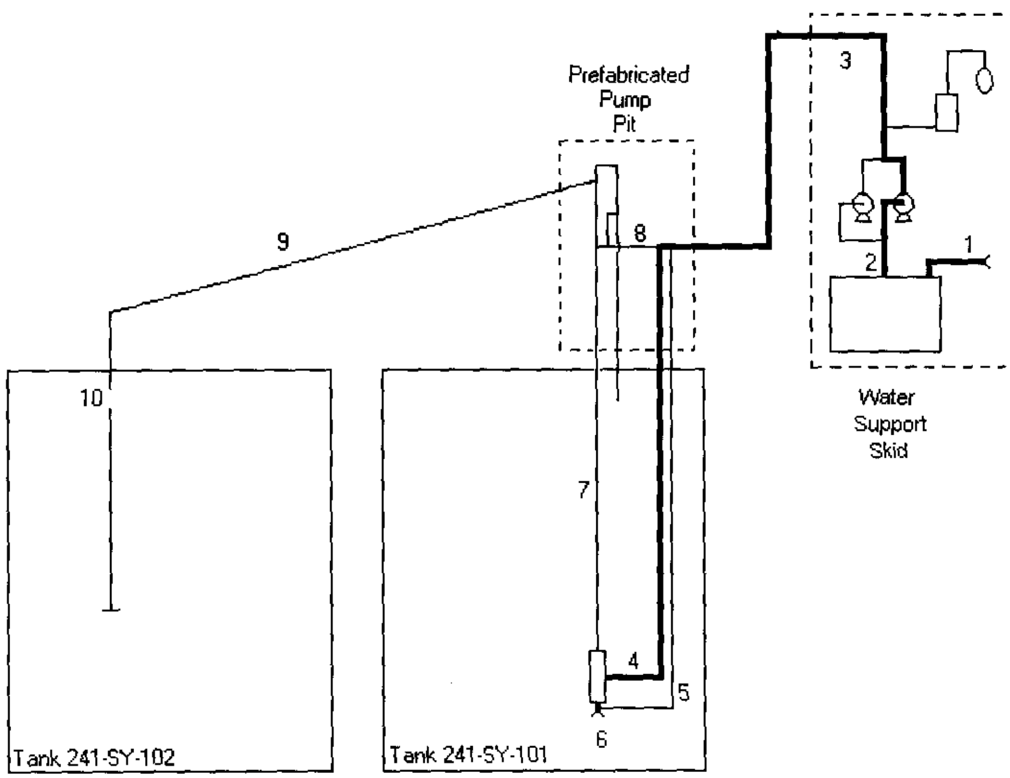


Permissible Process Limits for Transfer Line Back-Flush

Flow Parameter	Water Skid Inlet (1)	Water Skid Outlet (2)	PPP Water Supply Line (3)	Transfer Pump Internal Flush Line (4)	Transfer Pump Water Supply Line (5)	Transfer Pump Waste Inlet (6)	Transfer Pump Outlet (7)	Flush Cross-Connect (8)	Transfer Line (9)
Flow Rate	–	< 70 gpm	< 70 gpm	N/A	N/A	< 70 gpm	< 70 gpm	< 70 gpm	N/A
Flush Volume	2 line volumes or 2 minutes of flow, which-ever is greater	2 line volumes or 2 minutes of flow, which-ever is greater	2 line volumes or 2 minutes of flow, which-ever is greater	N/A	N/A	2 line volumes or 2 minutes of flow, which-ever is greater	2 line volumes or 2 minutes of flow, which-ever is greater	2 line volumes or 2 minutes of flow, which-ever is greater	N/A
Flow Velocity ($^{ft}/_{sec}$)	–	–	–	N/A	N/A	–	4 to 6	4 to 6	N/A
Temperature (°F)	–	102 to 130	102 to 130	N/A	N/A	102 to 130	102 to 130	102 to 130	N/A
Viscosity (cP)	–	0.50 to 0.62	0.50 to 0.62	N/A	N/A	0.50 to 0.62	0.50 to 0.62	0.50 to 0.62	N/A
Density ($^{grams}/_{cc}$)	< 1	< 1	< 1	N/A	N/A	< 1	< 1	< 1	N/A
Volume % Solids	< 0.01	< 0.01	< 0.01	N/A	N/A	< 0.01	< 0.01	< 0.01	N/A
Mass % Water	100	100	100	N/A	N/A	100	100	100	N/A
Mass % Completely Insoluble Solids	0	0	0	N/A	N/A	0	0	0	N/A

4.2.4 Pump P-350 Purge

Transfer System Process Flow Line-up	Line-up Notes and General Procedure
Pump P-350 Purge	This line-up is established prior to startup and immediately following pump P-350 operations in accordance with manufacturer recommendations. Additionally, this line-up can be used to add dilution water to the convective waste in the tank through the transfer pump inlet. 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: • flush volume = 50 gallons • 102 °F to 130 °F • flow rate is approximately 10 gpm

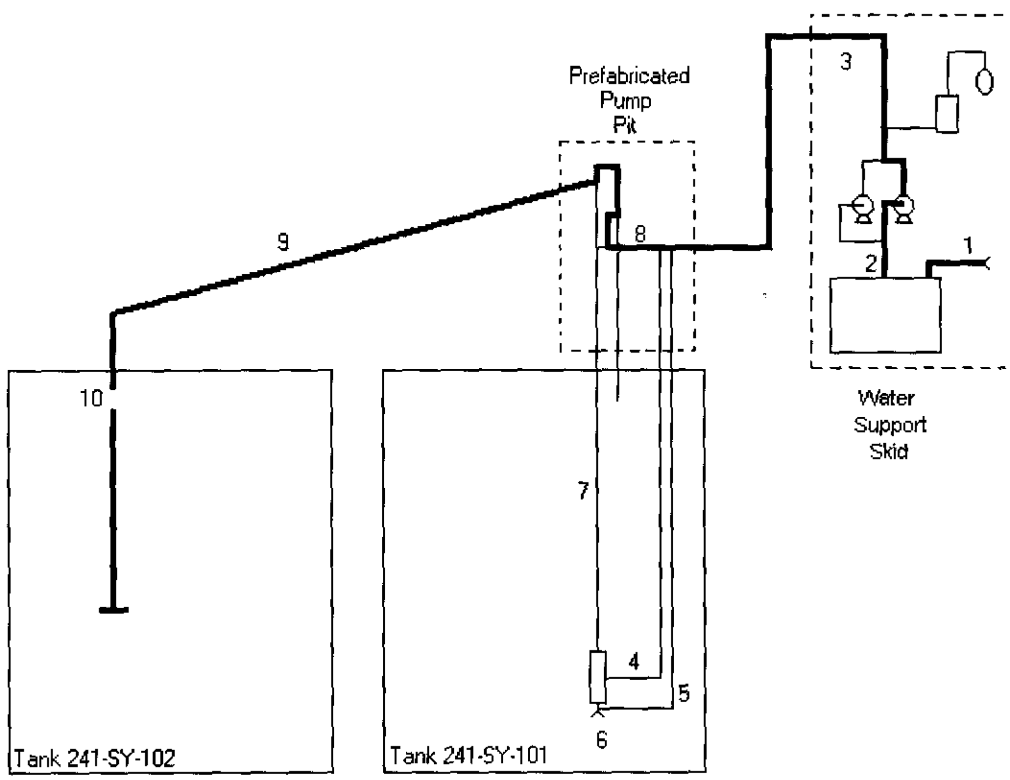


Permissible Process Limits for Pump P-350 Purge

Flow Parameter	Water Skid Inlet (1)	Water Skid Outlet (2)	PPP Water Supply Line (3)	Transfer Pump Internal Flush Line (4)	Transfer Pump Water Supply Line (5)	Transfer Pump Waste Inlet (6)	Transfer Pump Outlet (7)	Flush Cross-Connect (8)	Transfer Line (9)
Flow Rate	–	~10 gpm	~10 gpm	~10 gpm	N/A	~10 gpm	N/A	N/A	N/A
Flush Volume	–	–	–	–	N/A	–	N/A	N/A	N/A
Flow Velocity ($^{ft}/_{sec}$)	–	–	–	–	N/A	–	N/A	N/A	N/A
Temperature (°F)	–	102 to 130	102 to 130	102 to 130	N/A	102 to 130	N/A	N/A	N/A
Viscosity (cP)	–	0.50 to 0.62	0.50 to 0.62	0.50 to 0.62	N/A	0.50 to 0.62	N/A	N/A	N/A
Density ($^{grams}/_{cc}$)	< 1	< 1	< 1	< 1	N/A	< 1	N/A	N/A	N/A
Volume % Solids	< 0.01	< 0.01	< 0.01	< 0.01	N/A	< 0.01	N/A	N/A	N/A
Mass % Water	100	100	100	100	N/A	100	N/A	N/A	N/A
Mass % Completely Insoluble Solids	0	0	0	0	N/A	0	N/A	N/A	N/A

4.2.5 Siphon Break Flush

Transfer System Process Flow Line-up	Line-up Notes and General Procedure
Vent Line Flush	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-350 is de-energized / P-401 or P-402 is energized and running as necessary to provide flush water pressure/flow rate as needed: • 2 x line volumes or 2 minutes of flow, which-ever is greater • 102 °F to 130 °F • flow rate not to exceed 70 gpm • when possible, flush flow velocity should exceed 4 ft/sec

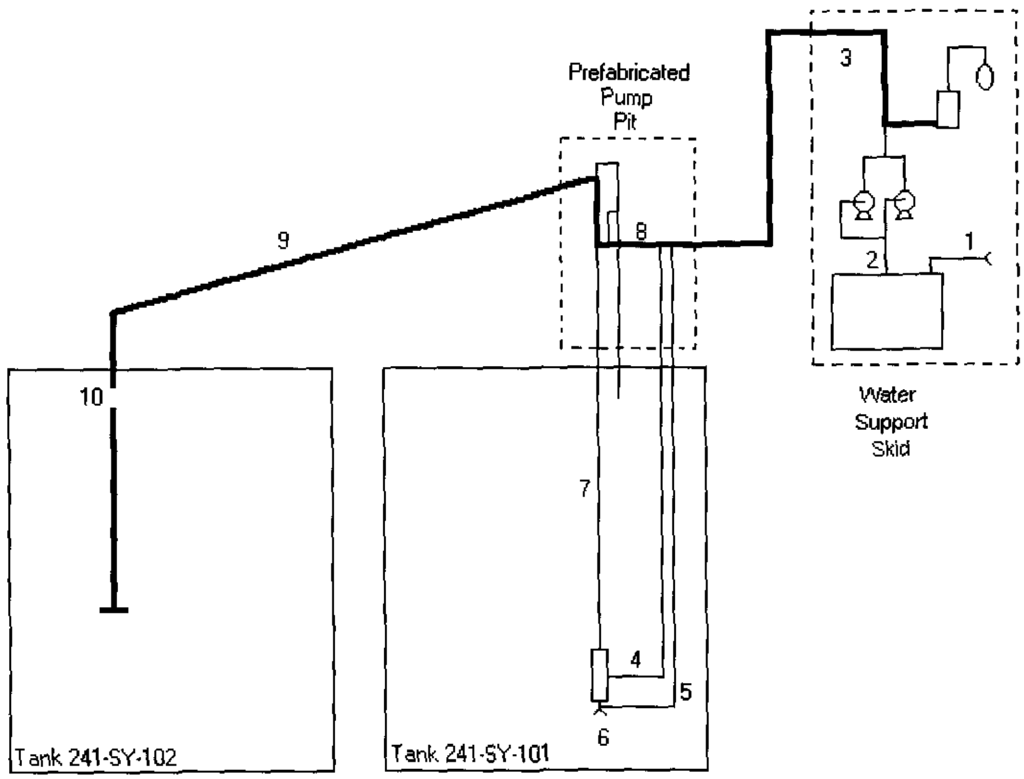


Permissible Process Limits for Siphon Break Flush

Flow Parameter	Water Skid Inlet (1)	Water Skid Outlet (2)	PPP Water Supply Line (3)	Transfer Pump Internal Flush Line (4)	Transfer Pump Water Supply Line (5)	Transfer Pump Waste Inlet (6)	Transfer Pump Outlet (7)	Flush Cross-Connect (8)	Transfer Line (9)
Flow Rate	–	< 70 gpm	< 70 gpm	N/A	N/A	N/A	N/A	< 70 gpm	< 70 gpm
Flush Volume	2 line volumes or 2 minutes of flow, which-ever is greater	2 line volumes or 2 minutes of flow, which-ever is greater	2 line volumes or 2 minutes of flow, which-ever is greater	N/A	N/A	N/A	N/A	2 line volumes or 2 minutes of flow, which-ever is greater	2 line volumes or 2 minutes of flow, which-ever is greater
Flow Velocity ($^{ft}/_{sec}$)	–	–	–	N/A	N/A	N/A	N/A	4 to 6	4 to 6
Temperature (°F)	–	102 to 130	102 to 130	N/A	N/A	N/A	N/A	102 to 130	102 to 130
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
Density ($^{grams}/_{cc}$)	< 1	< 1	< 1	N/A	N/A	N/A	N/A	< 1	< 1
Volume % Solids	< 0.01	< 0.01	< 0.01	N/A	N/A	N/A	N/A	< 0.01	< 0.01
Mass % Water	100	100	100	N/A	N/A	N/A	N/A	100	100
Mass % Completely Insoluble Solids	0	0	0	N/A	N/A	N/A	N/A	0	0

4.2.6 ACC-401 Transfer Line Flush

Transfer System Process Flow Line-up	Line-up Notes and General Procedure
Air-Powered Transfer Line Flush	This line-up is established immediately upon loss of electrical power, or loss of dilution water supply. Pumps P-350, P-401 and P-402 are de-energized • approximately 90 gallons from ACC-401 (i.e., the contents of of ACC-401) is flushed in this direction • 102 °F to 130 °F

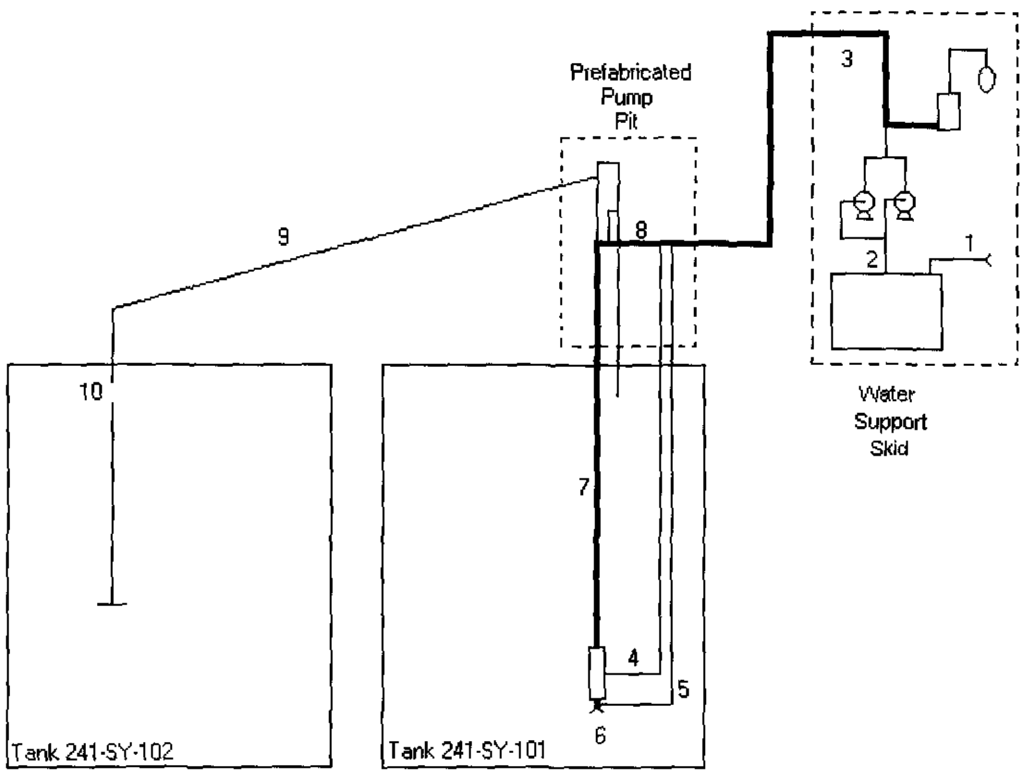


Permissible Process Limits for ACC-401 Transfer Line Flush

Flow Parameter	Water Skid Inlet (1)	Water Skid Outlet (2)	PPP Water Supply Line (3)	Transfer Pump Internal Flush Line (4)	Transfer Pump Water Supply Line (5)	Transfer Pump Waste Inlet (6)	Transfer Pump Outlet (7)	Flush Cross-Connect (8)	Transfer Line (9)
Flow Rate	–	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Flush Volume	2 line volumes or 2 minutes of flow, which-ever is greater	2 line volumes or 2 minutes of flow, which-ever is greater	2 line volumes or 2 minutes of flow, which-ever is greater	N/A	N/A	N/A	N/A	2 line volumes or 2 minutes of flow, which-ever is greater	2 line volumes or 2 minutes of flow, which-ever is greater
Flow Velocity (ft/sec)	–	–	–	N/A	N/A	N/A	N/A	4 to 6	4 to 6
Temperature (°F)	–	102 to 130	102 to 130	N/A	N/A	N/A	N/A	102 to 130	102 to 130
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
Density (grams/cc)	< 1	< 1	< 1	N/A	N/A	N/A	N/A	< 1	< 1
Volume % Solids	< 0.01	< 0.01	< 0.01	N/A	N/A	N/A	N/A	< 0.01	< 0.01
Mass % Water	100	100	100	N/A	N/A	N/A	N/A	100	100
Mass % Completely Insoluble Solids	0	0	0	N/A	N/A	N/A	N/A	0	0

4.2.7 ACC-401 Transfer Line Back-Flush

Transfer System Process Flow Line-up	Line-up Notes and General Procedure
Air-Powered Transfer Line Flush	This line-up is established immediately upon loss of electrical power, or loss of dilution water supply. Pumps P-350, P-401 and P-402 are de-energized • approximately 90 gallons from ACC-401 (i.e., the contents of of ACC-401) is flushed in this direction • 102 °F to 130 °F • to be performed after the ACC-401 transfer line flush per Section 4.2.6



Permissible Process Limits for ACC-401 Transfer Line Back-Flush

Flow Parameter	Water Skid Inlet (1)	Water Skid Outlet (2)	PPP Water Supply Line (3)	Transfer Pump Internal Flush Line (4)	Transfer Pump Water Supply Line (5)	Transfer Pump Waste Inlet (6)	Transfer Pump Outlet (7)	Flush Cross-Connect (8)	Transfer Line (9)
Flow Rate	–	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Flush Volume	2 line volumes or 2 minutes of flow, which-ever is greater	2 line volumes or 2 minutes of flow, which-ever is greater	2 line volumes or 2 minutes of flow, which-ever is greater	N/A	N/A	2 line volumes or 2 minutes of flow, which-ever is greater	2 line volumes or 2 minutes of flow, which-ever is greater	2 line volumes or 2 minutes of flow, which-ever is greater	N/A
Flow Velocity ($^{ft}/_{sec}$)	–	–	–	N/A	N/A	–	4 to 6	4 to 6	N/A
Temperature (°F)	–	102 to 130	102 to 130	N/A	N/A	102 to 130	102 to 130	102 to 130	N/A
Viscosity (cP)	–	0.50 to 0.62	0.50 to 0.62	N/A	N/A	0.50 to 0.62	0.50 to 0.62	0.50 to 0.62	N/A
Density ($^{grams}/_{cc}$)	< 1	< 1	< 1	N/A	N/A	< 1	< 1	< 1	N/A
Volume % Solids	< 0.01	< 0.01	< 0.01	N/A	N/A	< 0.01	< 0.01	< 0.01	N/A
Mass % Water	100	100	100	N/A	N/A	100	100	100	N/A
Mass % Completely Insoluble Solids	0	0	0	N/A	N/A	0	0	0	N/A

4.2.8 Waste Transfer

Transfer System Process Flow Line-up	Line-up Notes and General Procedure
Waste Transfer	This line-up is used to generate, control, and transfer waste slurry from tank 241-SY-101 to tank 241-SY-102. 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. Process Flows 1, 2, 3, and 5: <70 gpm; 102 °F to 130 °F Process Flow 6: <140 gpm Process Flow 7 and 9: <210 gpm Process Flow Ratios: P-350 intake + P-350 dilution = P-350 discharge 0.5 < (P-350 intake / P-350 dilution) < 2

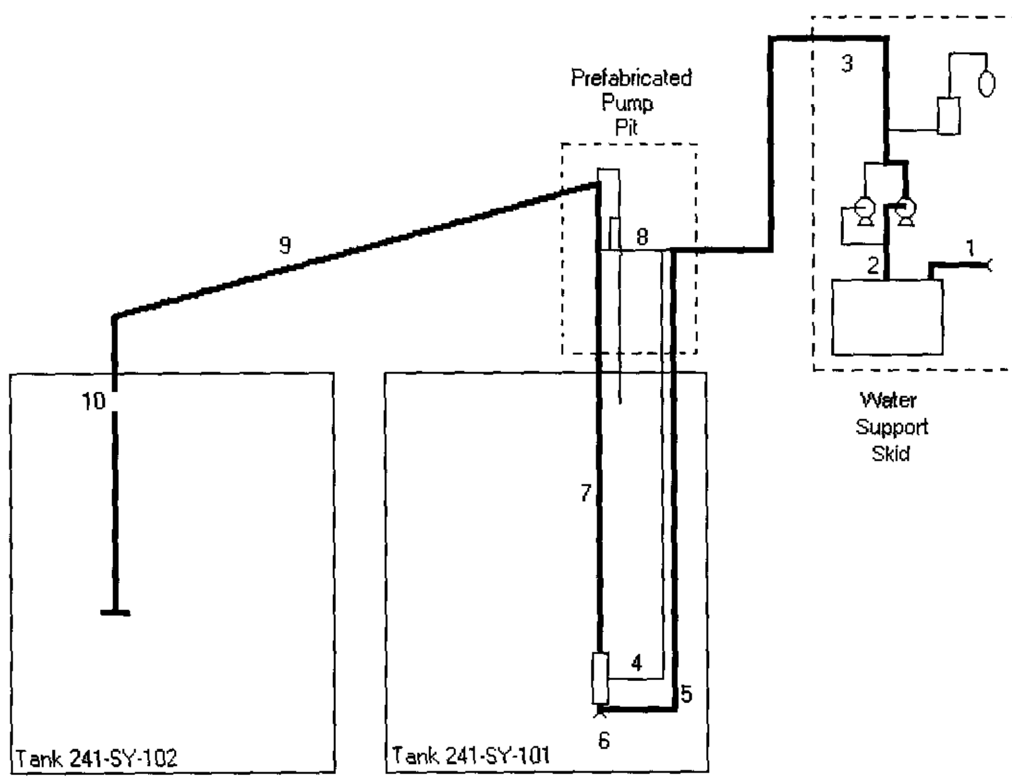


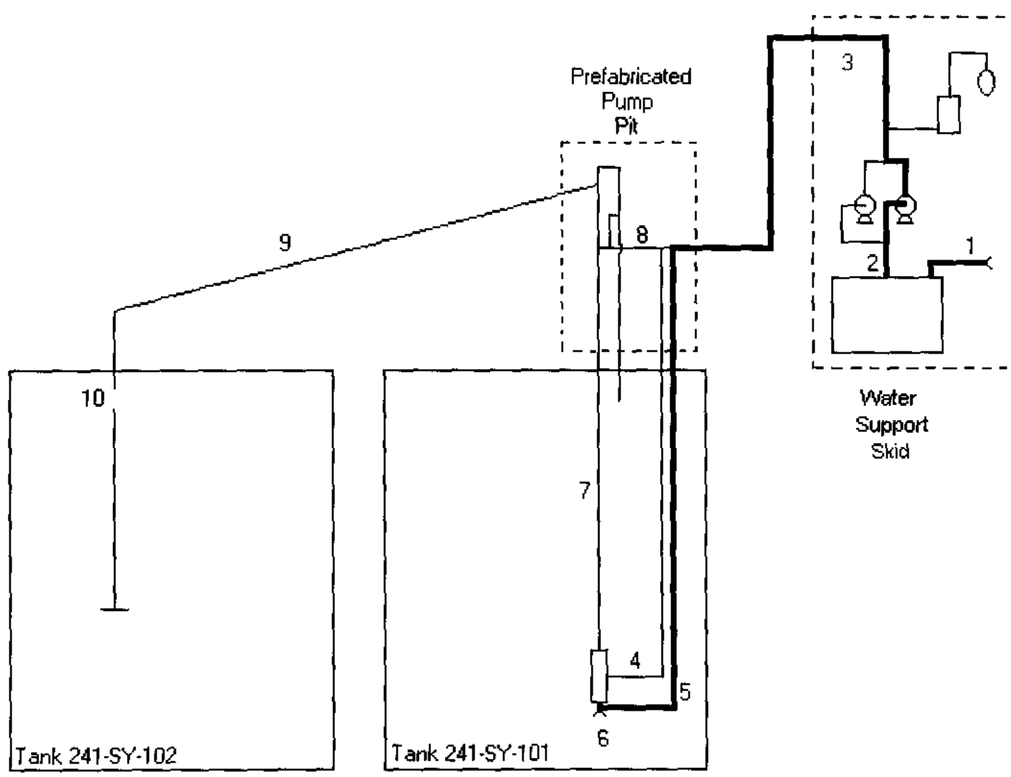
Table 4-2. Permissible Process Limits for Waste Transfer

Fluid/Flow Parameter	**Pump P-350 Dilution Water Flow**	**Pump P-350 Waste Inlet**	**Pump P-350 Discharge; Transfer Line**
Flow Rate	$^1/_3$ R to $^2/_3$ R not to exceed 70 gpm	$^1/_3$ R to $^2/_3$ R	R
Flow Velocity ($^{ft}/_{sec}$)	–	–	≥ 6
Temperature (°F)	102 to 130	–	–
Viscosity (cP)	0.50 to 0.62	50 to 200	2 to 15
Density ($^{grams}/_{cc}$)	< 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
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

4.2.9 Tank Water Addition via Transfer Pump Dilution Line

Transfer System Process Flow Line-up	Line-up Notes and General Procedure
Tank Water Addition Through Vent Line	This line-up is used to supply tank back-dilution water to the convective waste using the normal dilution water supply line to pump P-350. 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: • 102 °F to 130 °F • flow rate not to exceed 70 gpm

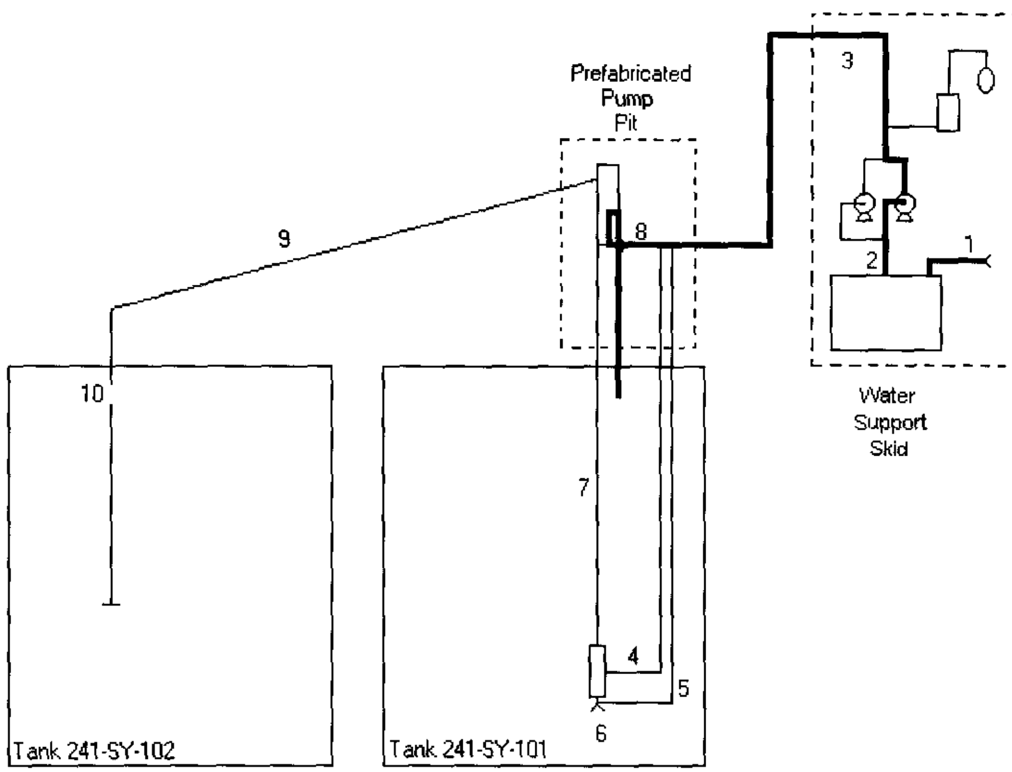


Permissible Process Limits for
Tank Water Addition via Transfer Pump Dilution Line

Flow Parameter	Water Skid Inlet (1)	Water Skid Outlet (2)	PPP Water Supply Line (3)	Transfer Pump Internal Flush Line (4)	Transfer Pump Water Supply Line (5)	Transfer Pump Waste Inlet (6)	Transfer Pump Outlet (7)	Flush Cross-Connect (8)	Transfer Line (9)
Flow Rate	–	< 70 gpm	< 70 gpm	N/A	< 70 gpm	N/A	N/A	N/A	N/A
Flush Volume		See process memo	See process memo	N/A	See process memo	N/A	N/A	N/A	N/A
Flow Velocity ($^{ft}/_{sec}$)	–	–	–	N/A	–	N/A	N/A	N/A	N/A
Temperature (°F)	–	102 to 130	102 to 130	N/A	102 to 130	N/A	N/A	N/A	N/A
Viscosity (cP)	–	0.50 to 0.62	0.50 to 0.62	N/A	0.50 to 0.62	N/A	N/A	N/A	N/A
Density ($^{grams}/_{cc}$)	< 1	< 1	< 1	N/A	< 1	N/A	N/A	N/A	N/A
Volume % Solids	< 0.01	< 0.01	< 0.01	N/A	< 0.01	N/A	N/A	N/A	N/A
Mass % Water	100	100	100	N/A	100	N/A	N/A	N/A	N/A
Mass % Completely Insoluble Solids	0	0	0	N/A	0	N/A	N/A	N/A	N/A

4.2.10 Tank Water Addition via Transfer System Vent Line

Transfer System Process Flow Line-up	Line-up Notes and General Procedure
Tank Water Addition Through Vent Line	This line-up is used to supply tank back-dilution water directly to the top of the crust. 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: • Water temperature for tank back-dilution water added directly to the top of the crust must be less than 130°F. • flow rate not to exceed 70 gpm (since the vent line is 1 inch ID, actual water addition rate may be significantly less than this value).



Permissible Process Limits for Tank Water Addition via Transfer System Vent Line

Flow Parameter	Water Skid Inlet (1)	Water Skid Outlet (2)	PPP Water Supply Line (3)	Transfer Pump Internal Flush Line (4)	Transfer Pump Water Supply Line (5)	Transfer Pump Waste Inlet (6)	Transfer Pump Outlet (7)	Flush Cross-Connect (8)	Transfer Line (9)
Flow Rate	–	< 70 gpm	< 70 gpm	N/A	N/A	N/A	N/A	< 70 gpm	N/A
Flush Volume		See process memo	See process memo	N/A	N/A	N/A	N/A	See process memo	N/A
Flow Velocity (ft/sec)	–	–	–	N/A	N/A	N/A	N/A	–	N/A
Temperature (°F)	–	102 to 130	102 to 130	N/A	N/A	N/A	N/A	102 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	N/A
Density (grams/cc)	< 1	< 1	< 1	N/A	N/A	N/A	N/A	< 1	N/A
Volume % Solids	< 0.01	< 0.01	< 0.01	N/A	N/A	N/A	N/A	< 0.01	N/A
Mass % Water	100	100	100	N/A	N/A	N/A	N/A	100	N/A
Mass % Completely Insoluble Solids	0	0	0	N/A	N/A	N/A	N/A	0	N/A

5.0 CONTRACTOR PRUDENT 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 FSAR (LMHC 1999b) and TSRs (LMHC 1999c) are applicable. The basis for contractor prudent controls are 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.*

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

5.1 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 as follows:

<u>HNF-IP-1266, 5.12.3.C.3.c</u>

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 (FQIT-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 comply with Table 5-1:

Table 5-1. Material Balance for Leak Detection

Time of Material Balance Measurement	Volumetric Discrepancy (241-SY-102 current – 241-SY-102 initial) waste level x 2,750 – FQIT-367
30 minutes	≤ 1400 gallons
60 minutes	≤ 1400 gallons
(1 + 2n) hours n = 1, 2, 3,...	≤2000 gallons

Material Balance Monitoring Criteria

If the volumetric discrepancies of Table 5-1 are exceeded, the following inspections must occur: The leak detector annunciators and transfer line must be visually inspected concurrently with the material balance frequency of Table 5-1. Stop transfer if these inspections show evidence of a leak. If these inspections show no evidence of a leak, the waste transfer can continue.

In order to perform this material balance within the constraints imposed by saltwell pumping, either of the following options must be used:

1) Saltwell pumping must be suspended during tank 241-SY-101 waste transfer operations.
2) An acceptable method must be devised to preserve the capability of tank 241-SY-102 level to serve as a material balance measurement for the tank 241-SY-101 waste transfer.

5.2 ALLOWABLE VOLUME OF WASTE TRANSFERRED OUT OF TANK 241-SY-101

In order to maintain the necessary operational performance of the mixer pump in light of possible encroachment of the crust on the mixer pump suction, the waste conditions must be maintained in a condition such that water addition to the convective waste must be capable of raising the bottom of the crust to a 295 inch level. This level is specified as the lowest crust level at which acceptable mixer pump operation has been demonstrated to date. Controls to ensure this are specified as Contractor imposed prudent controls necessary to safely operate as follows:

HNF-IP-1266, 5.12.3.C.2.o

The maximum volume of WASTE that can be transferred from Tank 241-SY-101 shall not exceed 96,000 gallons (Barton 1999). The RAPID Mitigation Sytem shall be placed under administrative lock in accordance with Chapter 5.20 within 8 hours following the transfer of the maximum volume of WASTE.

HNF-IP-1266, 5.12.3.C.3.j

WASTE transfers from 241-SY-101 shall be monitored to ensure that the maximum volume of WASTE approved for transfer is not exceeded (see requirement 5.12.3.C.2.o on page 6).

The waste transfer from 241-SY-101 shall be monitored using the transfer line flow meter (SY101-WT-FQIT-367) and dilution water flow totalizer (POR32-RW-FQIT-419). These instruments are designated as safety-class SSCs. The waste transfer must be stopped in time to satisfy the following equation:

$$A - B < C$$

Where

A = volume change as indicated transfer line flow meter (SY101-WT-FQIT-367)
B = volume indicated by totalized flow from FQIT-419
C = 96,000 gallons

Additionally, the total volume of waste must include allowance for the volume that may be siphoned in the time period between shutdown of the transfer pump and the establishment of the Administrative Lock on the system As discussed in Section 6.6, the RAPID transfer system operating procedure must explicitly require the time at which the status of pump P-350 and valves V-362 and V-351 is changed to be recorded.

5.3 ALLOWABLE VOLUME OF TANK 241-SY-101 DILUTION

In order to provide maximum confidence for mixer pump operability following tank back-dilution activities, it has been determined that the crust in the tank should not sink prior to its properties being sufficiently altered so that mixer pump operation will not be significantly impeded. The bulk density of the crust in the preexisting condition is estimated to be on the order of 1.4 gm/cc whereas the convective waste density is on the order of 1.6 gm/cc. The objective is to prevent the convective waste from decreasing below the bulk crust density until such time as such an action is desired and the safety basis adequately describes the event. This requirement is implemented as a Contractor Prudent Control as follows:

HNF-IP-1266, 5.9.3.C

1.b) The TRG shall identify mixer pump operating parameters (e.g., pump motor current, pump discharge pressure), and shall establish limits for the selected parameters to prevent pump damage. These operating parameters shall be monitored during mixer pump operation, and the mixer pump shall be shut down if the established limits are exceeded.

1.c) the mixer pump performance parameters (e.g., pump motor current, pump discharge pressure, waste thermocouple response), and shall be monitored and the TRG shall review the data quarterly for signs of degradation that could affect continued control of gas retention at depth and prevention of buoyant displacement gas release events.

1.d) The TRG shall direct corrective actions to restore mixer pump operation and performance, as necessary.

1.e) Back dilution of the Tank 241-SY-101 WASTE with water following the transfer of waste from the tank shall be limited and controlled in accordance with A through C below.

A. The maximum volume of back dilution water that can be added on top of the crust is 30,000 gallons (Barton 1999).
B. The maximum volume of back dilution water that can be added low in the tank (via the 241-SY-101 mixer pump burrowing ring or the WASTE transfer pump) is 72,000 gallons (Barton 1999).
C. Back dilution water additions to Tank 241-SY-101 shall be monitored and limited to the maximum allowable volumes as specified in A and B above.

The following notes apply to initial tank back-dilution:

1. Water addition to the convective waste is at an elevation of 96 inches when added via the transfer pump P-350.
2. Water addition to the convective waste is at an elevation of 9 inches when added via the mixer pump burrowing ring.
3. Water addition to the top of the crust, as added via the transfer system vent line isolation valve V-355, is limited to 30 kgal.

6.0 PROCESS CONTROL

WASTE TRANSFER

The expected waste level in tank 241-SY-101 prior to transfer will be about 450 inches. A transfer of about 96 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. The original range of the initial waste transfer volume (100 to 150 kgal) was 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 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 dilution might create interference problems between the crust and the mixer pump inlet and may create untoward impacts on DST operational volume and planning.

For the subsequently identified issue of potential crust sinking prior to sufficient analysis of the event, the initial waste transfer volume was refined and stated as 96 kgal (Barton 1999).

The removal of the waste volume from tank 241-SY-101 will reduce the heat load and eventually 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, reduction of tank 241-SY-101 heat-loss rate via reduction of the tank annulus or primary ventilation-rates may be considered.

Tank 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.

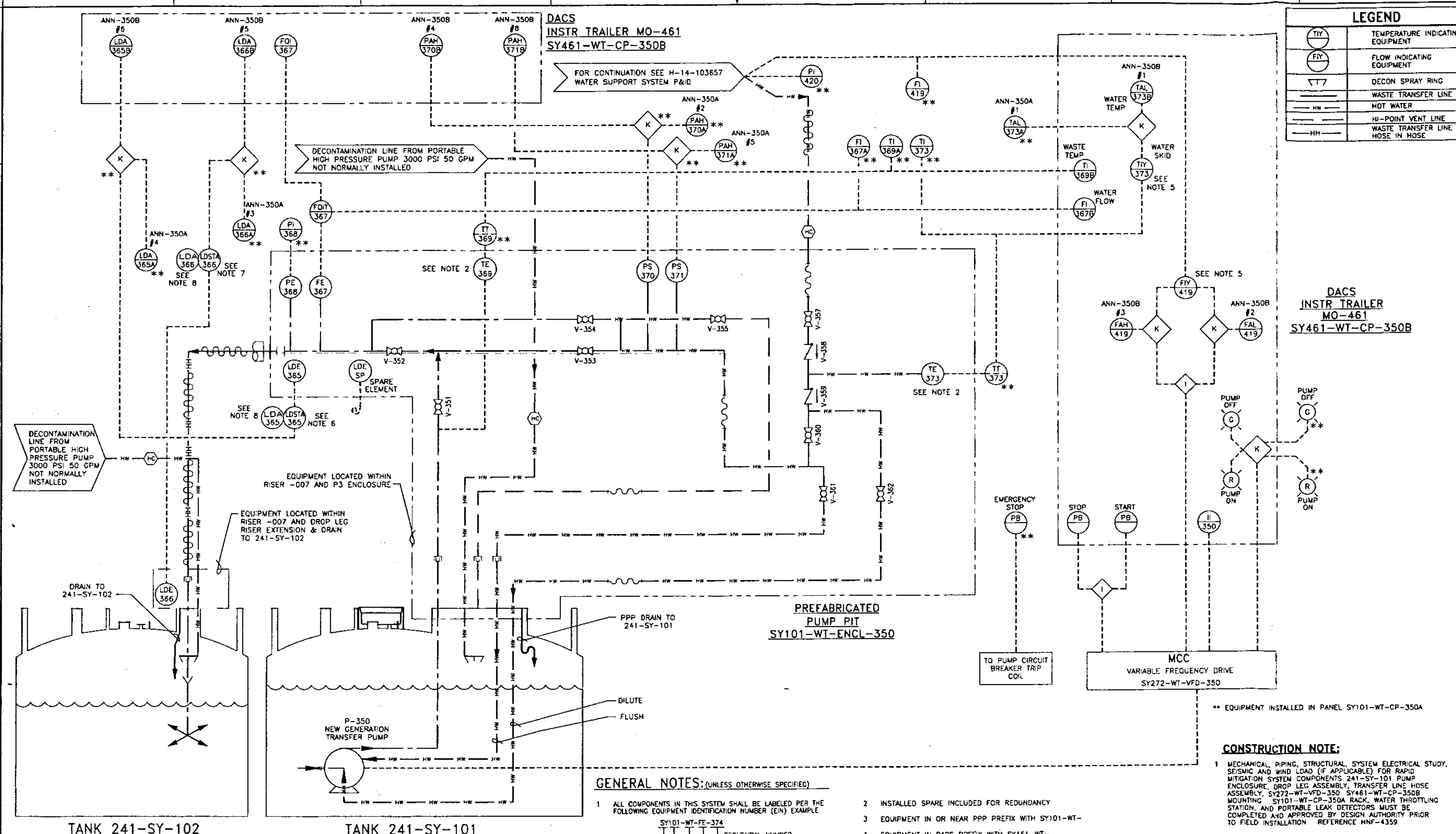
(4) Heated water dilution and flush capabilities to either protect against the insertion of saturated salt solutions in system transfer lines - or - to remove these solutions immediately should an upset condition introduce them to the transfer lines.

(5) An nitrogen powered, 90-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 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 process control concern during transfer is control of the in-line dilution of waste pumped from tank 241-SY-101. Specifically, controlling the in-line 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. The ideal slurry density range with which to operate the transfer system and the in-line dilution to achieve this density are discussed in Section 6.1.

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.



VALVE	NOMENCLATURE
V-351	2" TRANSFER PUMP ISOLATION VALVE
V-352	2" TRANSFER LINE ISOLATION VALVE
V-353	2" TRANSFER 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

GENERAL NOTES: (UNLESS OTHERWISE SPECIFIED)

1. ALL COMPONENTS IN THIS SYSTEM SHALL BE LABELED PER THE FOLLOWING EQUIPMENT IDENTIFICATION NUMBER (EIN) EXAMPLE
   SY101-WT-FE-374
   - SEQUENTIAL NUMBER
   - COMPONENT IDENTIFIER
   - SYSTEM DESIGNATOR
   - STRUCTURE LOCATION
   - TANK FARM

   COMPONENTS ON THIS SYSTEM DRAWING SHALL ONLY SHOW THE COMPONENT IDENTIFIER AND SEQUENTIAL NUMBER (EXAMPLE FE-374)
2. INSTALLED SPARE INCLUDED FOR REDUNDANCY
3. EQUIPMENT IN OR NEAR PPP PREFIX WITH SY101-WT-
4. EQUIPMENT IN DACS PREFIX WITH SY461-WT-
5. TOTALIZING INSTRUMENT WITH AUXILARY CONTACTS
6. PORTABLE LEAK DETECTOR STATION POR23-WST-LDSTA-101
7. PORTABLE LEAK DETECTOR STATION POR24-WST-LDSTA-101
8. SEE DRAWING H-2-34965 FOR LEAK DETECTION DESIGN
9. CALCULATIONS FOR THE MECHANICAL, PIPING, STRUCTURAL, ELECTRICAL, SEIMIC AND WIND LOAD (IF APPLICABLE) FOR RAPID MITIGATION SYSTEM COMPONENTS, SEE HNF-4359

CONSTRUCTION NOTE:

1. MECHANICAL, PIPING, STRUCTURAL, SYSTEM ELECTRICAL STUDY, SEISMIC AND WIND LOAD (IF APPLICABLE) FOR RAPID MITIGATION SYSTEM COMPONENTS 241-SY-101 PUMP ENCLOSURE, DROP LEG ASSEMBLY, TRANSFER LINE HOSE ASSEMBLY, SY272-WT-VFD-350 SY461-WT-CP-350B MOUNTING SY101-WT-CP-350A RACK, WATER THROTTLING STATION, AND PORTABLE LEAK DETECTORS MUST BE COMPLETED AND APPROVED BY DESIGN AUTHORITY PRIOR TO FIELD INSTALLATION REFERENCE HNF-4359

SEE CONSTRUCTION NOTE 1

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

REF NUMBER	TITLE
H-2-37770	SY TANK FARM DWG TREE
H-14-103558	RAPID MITIGATION DWG TREE
HNF-4359	SY101 TRANSFER SYS CALCS
H-14-020000	TANK FARMS SYSTEM P&ID DRAWING LEGEND

REFERENCES

DWG NO	TITLE

DRAWING TRACEABILITY LIST — NEXT USED ON

REVISIONS: S 1 REV'D PER ECN 653842 CWH 8/99

NAME: LD BURRIS; W SHEPHERD; J AMMERMAN

U.S. DEPARTMENT OF ENERGY
Richland Operations Office
RAPID MITIGATION SYSTEM P&ID
F 241-SY 7004 H-14-103656 1
NONE 626348 SHEET 1 OF 1

H-14-103656

LINE CHART

LINE NAME	DESIGN CONDITION	CATEGORY	INSULATION	HEAT TRACE WATTS/FOOT	FLUID	LINE SIZE	LENGTH
L-1	200 PSIG, 130° F OPERATING	N	2"	9	WATER	2" CS PIPE, SCH. 40, ASTM A-106, GR B	A/R
L-2	ATMOSPHERIC, 130° F OPERATING	D	2"	9	WATER	2" CS PIPE, SCH 40, ASTM A-106, GR B	A/R
L-3	TANK HEAD, 130° F OPERATING	D	2"	9	WATER	2" CS PIPE, SCH 40, ASTM A-106, GR B	A/R
L-4	200 PSIG, 130° F OPERATING	N	2"	9	WATER	2" CS PIPE, SCH 40, ASTM A-106, GR B	A/R
L-5	200 PSIG, 130° F OPERATING	N	NO	NO	NITROGEN	PIPE/TUBING	A/R

GENERAL NOTES: (UNLESS OTHERWISE SPECIFIED)

1▷ CALIBRATION OF INDIVIDUAL COMPONENTS SHALL BE REQUIRED, TRACEABLE TO NIST STANDARDS WITH CORRECTED DATA

2▷ GOVERNMENT FURNISHED EQUIPMENT, SEE CVI FILE 50071

3▷ THERMOCOUPLE TE-410, TE-415 PROVIDED AS AN INTEGRAL PART OF HOSE

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

△ POR32-RW-FE-374
- 374 – SEQUENTIAL NUMBER
- FE – COMPONENT IDENTIFIER
- RW – SYSTEM DESIGNATOR
- POR32 – STRUCTURE LOCATION

POR-32 DESIGNATES SY TANK FARM USE
POR-33 DESIGNATES 200 AREA COLD TEST FACILITY USE

COMPONENTS ON THIS SYSTEM DRAWING SHALL ONLY SHOW THE COMPONENT IDENTIFIER AND SEQUENTIAL NUMBER (EXAMPLE: FE-374).

△ 5 LEVEL ALARM HIGH-HIGH, LAHH-416, WILL CLOSE SOV-401 AND ALARM STROBES LXA-416A, LXA-416B AND HORN YAH-416

△ 6. LEVEL ALARM HIGH, LAH-416, WILL ALARM STROBES LXA-416A, LXA-416B AND HORN YAH-416.

△ 7. LEVEL ALARM LOW, LAL-416, WILL OPEN SOV-401 AND ALARM STROBES LXA-416A, LXA-416B AND HORN YAH-416.

△ 8. LEVEL ALARM LOW-LOW, LALL-416, WILL SHUT OFF HEAT TRACING FOR TK-401 VIA TEMPERATURE CONTROLLER TC-411 AND ALARM STROBES LALL-416A, LXA-416B AND HORN YAH-416.

REV 0 OF THIS DOC REDRAWN FROM CVI FILE NUMBER 50071
HILINE 9903-LMH-046C1 REV 2
FOR CROSS REFERENCE DRAWING INFORMATION SEE DRAWING NUMBER H-14-103558.

PARTS/MATERIAL LIST

NOTE	QTY REQD (-010)	REF DES	PART/DASH NUMBER	NOMENCLATURE/DESCRIPTION	MATERIAL/REFERENCE	SHEET	ITEM NO
	1	SKID-1	9903-LMH-046A	MOBILE WATER SUPPORT SKID	HILINE	2	1
	1	SKID-2	9903-LMH-046I	VALVE & INSTRUMENTATION STAND	HILINE	2	2
	1	TK-401	2▷	TANK	JUSTIN		3
	1	TK-402	T 10LSE	NITROGEN TANK W/VALVE	NORCO		4
	1	SG-401	2▷	SIGHT GLASS	JUSTIN		5
	1	HOSE-1	P/O 106976	2" HOSE, 150 FT HEAT-TRACED	TECHNICAL HEATERS		6
	1	HOSE-3	P/O 106976	2" HOSE, 15 FT HEAT-TRACED	TECHNICAL HEATERS		7
	1	HR-1	9903-LMH-046J	HOSE REEL 1 (MODIFIED)	HANNAY		8
	1	ACC-401	8524-249-03	ACCUMULATOR, 75 GALLON	US FILTER		9
	2	P-401,2	160-338	PUMP W/BASE	EDWARDS MANUFACTURING		10
	2	MC-401,402	6SE32224DG40	PUMP DRIVES	SIEMENS		11
	1	SOV-401	9150312236MT/ER5001M	SOLENOID OPERATED VALVE	JAMESBURY		12
	1	V-401	F007C02TY	GLOBE VALVE, 2"-150LB RF	VELAN		13
2▷	1	V-410	FSCP-AE3LG/5005/T1G/SRG2-FS1008-1	GLOBE VALVE, 2"	FISHER CONTROLS		14
	8	V-402-9	CR1703020F83000	BALL VALVE, 2" FULL PORT THREADED	TYCO		15
	2	PRV-401,2	9128EDM01	PRESSURE RELEASE VALVE, 1 1/4" BRONZE, 200 PSIG, 86 GPM	KUNKLE		16
△	1	PRV-403	6010DC01-KM0200	PRESSURE RELEASE VALVE	KUNKLE		17
	1	PCV-401	21850	PRESSURE CONTROL VALVE 50 TO 850 PSIG	SHAVROCK		18
△	1	REG-402	0781-9134	REGULATOR, 0-250 PSIG	VICTOR		19
△	2	STR-401,402	20-11M-01	"Y" STRAINER, 2" CAST	MUELLER		20
△ 2▷	2	FE/FOIT-418,419	7402D	FLOW METER	BROOKS		21
1▷	1	TE-412	AFGMOTFXXXVJ300	T/C, J-TYPE, 8'6"	WATLOW		22
	1	LE-416	842-100-C00	LEVEL ELEMENT	MAGNETROL		23
3▷	2	TE-410,415	j16spfa-alpfa	THERMOCOUPLE	Cobra Wirer & Cable		24
△ 2▷	2	TE-411A,411B	GFE W/ TK-401	HEAT CONTROL (BULB/CAP)	JUSTIN		25
1▷	1	TE-413	72XJWGB012A	T/C, J-TYPE,HOSE CLAMP STYLE	WATLOW		26
1▷	1	TE-414	70XJTUD012A	T/C, J-TYPE, WASHER TYPE	WATLOW		27
△ 1▷	1	PIT-417	EJA-430A-EAS4B-92EA/FF1/D1	PRESSURE INDICATING TRANSMITTER	YOKOGAWA		28
△	1	FO-401	9903-LMH-046H	ORIFACE PLATE, CUSTOM	HILINE		29
	1	CP-401	9903-LMH-046E	CONTROL SYSTEM	HILINE		30
	2	V-412,13	2▷	SIGHT GLASS VALVES	JUSTIN		31
	2	V-411,14		1" BALL VALVE, 600 W.O.G.	COM'L		32
	1	HR-2	9903-LMH-046J	HOSE REEL 2 (MODIFIED)	HANNAY		33
	1	HOSE-2	P/O 106976	2" HOSE, 125 FT. HEAT-TRACED	TECHNICAL HEATERS		34
	3	V-415-17		1/2" BALL VALVE, 600 W.O.G	COM'L		35

REFERENCES

REF NUMBER	TITLE
H-14-103558	RMS DWG TREE/LIST
H-2-37770	SY DWG INDEX
HNF-4359	RAPID MITIGATION STRUCTURAL ANALYSIS CALCS
HNF-4043	SPEC FOR SY-101 RAPID MIT WATER SUPPLY SKID

NEXT USED ON H-14-103605

DWG NO | TITLE — DRAWING TRACEABILITY LIST

REVISIONS

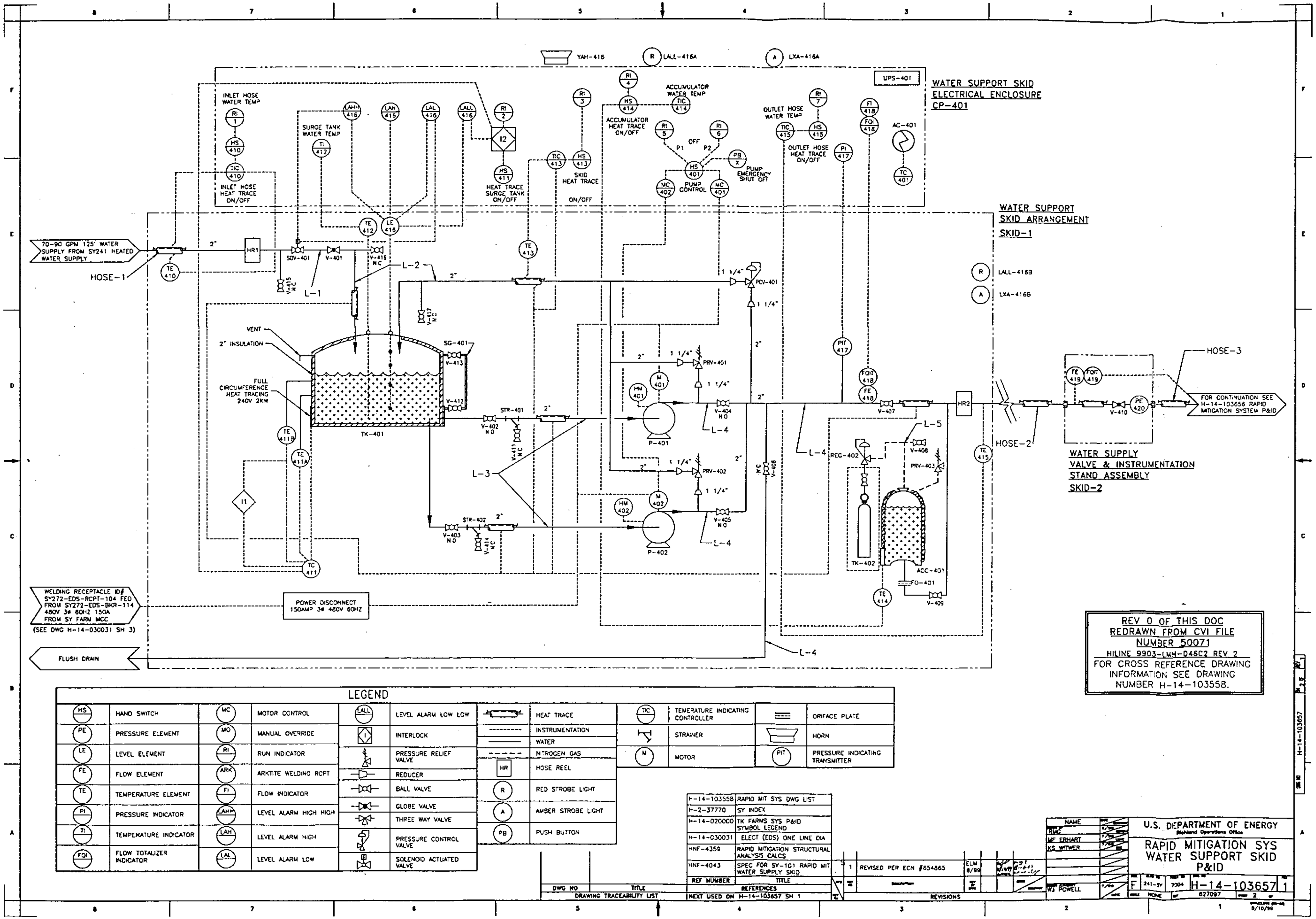
1	PER ECN #654865 MODIFIED DRAWING	ELM 7/26/99	

NAME: RMG; ME ERHART; KS WITWER; WJ POWELL

U.S. DEPARTMENT OF ENERGY
Richland Operations Office

RAPID MITIGATION SYS WATER SUPPORT SKID P&ID

F | 241-SY | 7004 | H-14-103657 | 1
SCALE NONE | 627097 | SHEET 1 OF 2


WATER SUPPORT SKID ELECTRICAL ENCLOSURE CP-401
WATER SUPPORT SKID ARRANGEMENT SKID-1
WATER SUPPLY VALVE & INSTRUMENTATION STAND ASSEMBLY SKID-2
70-90 GPM 125' WATER SUPPLY FROM SY241 HEATED WATER SUPPLY
HOSE-1
HOSE-2
HOSE-3
FOR CONTINUATION SEE H-14-103656 RAPID MITIGATION SYSTEM P&ID
WELDING RECEPTACLE ID# SY272-EDS-RCPT-104 FED FROM SY272-EDS-BKR-114 480V 3Ø 60HZ 150A FROM SY FARM MCC (SEE DWG H-14-030031 SH 3)
POWER DISCONNECT 150AMP 3Ø 480V 60HZ
FLUSH DRAIN
TK-401
TK-402
ACC-401
P-401
P-402
REV 0 OF THIS DOC REDRAWN FROM CVI FILE NUMBER 50071
HILINE 9903-LMH-046C2 REV 2
FOR CROSS REFERENCE DRAWING INFORMATION SEE DRAWING NUMBER H-14-103558.
LEGEND
HAND SWITCH
PRESSURE ELEMENT
LEVEL ELEMENT
FLOW ELEMENT
TEMPERATURE ELEMENT
PRESSURE INDICATOR
TEMPERATURE INDICATOR
FLOW TOTALIZER INDICATOR
MOTOR CONTROL
MANUAL OVERRIDE
RUN INDICATOR
ARKTITE WELDING RCPT
FLOW INDICATOR
LEVEL ALARM HIGH HIGH
LEVEL ALARM HIGH
LEVEL ALARM LOW
LEVEL ALARM LOW LOW
INTERLOCK
PRESSURE RELIEF VALVE
REDUCER
BALL VALVE
GLOBE VALVE
THREE WAY VALVE
PRESSURE CONTROL VALVE
SOLENOID ACTUATED VALVE
HEAT TRACE
INSTRUMENTATION
WATER
NITROGEN GAS
HOSE REEL
RED STROBE LIGHT
AMBER STROBE LIGHT
PUSH BUTTON
TEMERATURE INDICATING CONTROLLER
STRAINER
MOTOR
ORIFACE PLATE
HORN
PRESSURE INDICATING TRANSMITTER
H-14-103558 RAPID MIT SYS DWG LIST
H-2-37770 SY INDEX
H-14-020000 TK FARMS SYS P&ID SYMBOL LEGEND
H-14-030031 ELECT (EDS) ONE LINE DIA
HNF-4359 RAPID MITIGATION STRUCTURAL ANALYSIS CALCS
HNF-4043 SPEC FOR SY-101 RAPID MIT WATER SUPPLY SKID
REF NUMBER
REFERENCES
NEXT USED ON H-14-103657 SH 1
DWG NO
TITLE
DRAWING TRACEABILITY LIST
1 REVISED PER ECN #654865
REVISIONS
U.S. DEPARTMENT OF ENERGY
Richland Operations Office
RAPID MITIGATION SYS WATER SUPPORT SKID P&ID
H-14-103657
WJ POWELL
KS WITWER
MF ERHART

BACK-DILUTION OF TANK 241-SY-101 WASTES

Following the initial transfer of waste from tank 241-SY-101, in-situ water dilution of the remaining waste in the tank will be performed. It is planned that any additional transfer out of tank 241-SY-101 will be followed by back-dilution.

In early May 1999, the TAP recommended that the project develop and evaluate potential solutions to the problem posed by gas retention as soon as possible and before proceeding with tank back-dilution following the first small transfer (150K gal). At that time the Project Plan proposed a six-month interval between the first transfer and the first tank back-dilution.

Since that time, the project has completed dilution studies on core samples, evaluated the effects of applying dilution water to the surface of the crust, and determined the effect of the mechanical mitigation arm on gas releases and disruption of the crust. In addition, since then, the tank characteristics have changed dramatically. The surface level rise has stopped (in fact, it has decreased about three inches since mid-May 1999), and the tank started releasing more gas than is being generated.

Soon (days) after the initial 96 kgal waste transfer from tank 241-SY-101, up to 72 kgal of water (Barton 1999) will be introduced into tank 241-SY-101 in both the mixed slurry layer via the transfer pump (P-350) or the tank 241-SY-101 mixer pump burrowing ring. Additionally, up to 30 kgal of water is to be added on top of the crust via valve V-355.. The tank back-dilution plan has up to 30 kgal of water being added on top of the crust and approximately 30 kgal being added to the convective waste through the transfer pump. Any further water addition (up to a total of 72,000 gallons) to the mixed slurry layer through the transfer pump or mixer pump burrowing ring will be based upon the tank conditions and/or as a mixer pump operation recovery action.

The initial waste transfer and tank back-dilution is only a first step in a series of two or more transfers from tank 241-SY-101 (totaling at least 300 kgal), each followed by tank back-dilution, needed to remediate crust growth and gas retention. It is currently anticipated that the majority of dilution water during the follow-on dilution sequences can be made directly to the convective layer wastes with the intention of sinking the softened and minimized volume of remaining crust.

Over the period of the remediation project, various reasoning and objectives for tank 241-SY-101 tank back-dilutions have been postulated:

1) Maintain mixer pump function by preventing the convective waste from transitioning to non-convective waste due to the expected bulk temperature decrease following the initial transfer.
2) Maintain mixer pump function by displacing the crust such that the solids in the crust do not interfere with the mixer pump inlet.
3) Maintain mixer pump function by preventing the formation of additional solids and/or trapped gas in the crust.

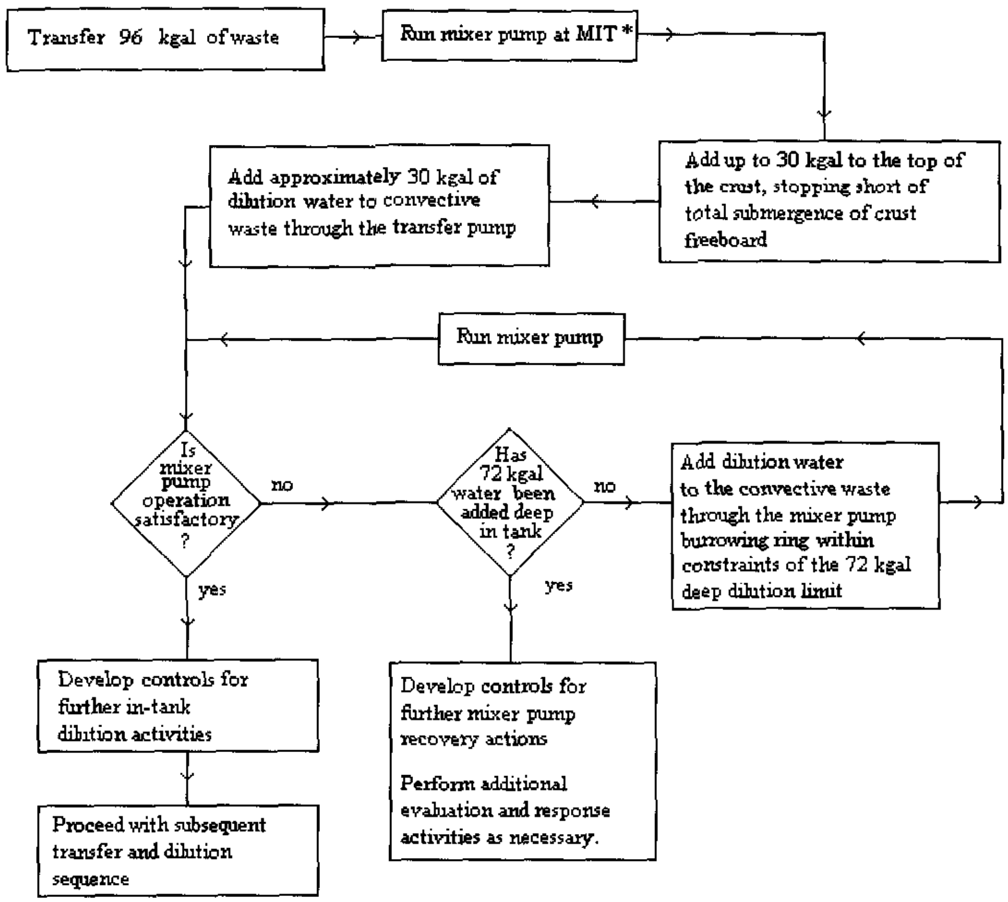
4) Attempt some amount of degassing of the crust.
5) Dissolve soluble solids not necessarily in the crust.
6) Reduce gas generation rates in the tank by reducing the concentrations of chemical reactants and reducing the radioactive source terms.
7) Establish physical conditions in the tank that prevent the occurrence of BD GRE's, or at least greatly reduce their severity.
8) Drive the bulk tank waste density towards a value (i.e., < 1.41 SpG) not requiring special waste transfer analysis per the RPP Waste Compatibility Program.
9) Ultimately eliminate the need for mixer pump operation.

These objectives may not be listed in order of priority and may change depending upon the specific tank back-dilution sequence taking place.

The tank 241-SY-101 Surface-Level-Rise Remediation Project recognizes that transfer of 96 kgal of waste will not fully resolve the issues associated with the gas retained in the crust of tank 241-SY-101 and its associated level growth. The Project Plan states that dilution will be evaluated following the initial transfer and that a series of transfer / dilutions steps will be used to resolve the level rise and buoyant displacement-gas release event (BD-GRE) issues. However, at the time it was envisioned that the dilution process would not be performed until conditions had been evaluated for a few months after the initial transfer. The plan was based on a philosophy of taking small steps, evaluating the effects and adjusting the plan as required. Since the Project Plan was written the understanding of the conditions in the tank has increased. It is considered safely achievable to initiate dilution within days after the initial transfer with the intent to complete all transfer/dilution steps to remediate the tank in FY 2000. This would be nearly one year ahead of the schedule in the project plan.

The SLRRP objectives will necessitate at least two sequences of transfer & dilution operations. The logic of the tank back-dilution process is shown in Figure 6.3:

Figure 6-3. Initial Tank Back-Dilution Logic



*optional - depending upon time since last mixer pump run

This initial dilution logic was selected because:

1) It can be implemented quickly and at low cost.
2) It makes maximum use of existing equipment and procedures.
3) It will ensure that the crust is raised away from the mixer pump suction and slightly diluted to combat against the effects of waste cooling expected to follow the waste transfer.
4) It will dissolve solids in the tank in a manner judged to represent minimum project risk (by preventing sinking of the crust until significant crust and convective waste dissolution has occurred).

Some points regarding the logic of the first tank back-dilution shown in Figure 7-3 need additional emphasis. The addition of water to the top of the crust will be in a controlled manner such that a portion of the crust freeboard remains visible. It is expected that dissolution of the crust freeboard will occur fairly rapidly and any dissolution of the freeboard will reduce the bulk density of the crust. Therefore, adding water to the point of total submergence of the crust results in the needless volume addition to the volume of tank 241-SY-101, since it is believed that any excess water added to the top of the crust can perform no other dissolution of tank solids. Additionally, the maturation of safety basis controls will only permit the initial addition of 30 kgal to the top of the crust. Water addition to the convective wastes will be specified based upon ongoing analysis. Currently, the convective waste dilution water additions are envisioned as an initial 30 kgal through the transfer pump. If needed for recovery of mixer pump operation, another 42 kgal may be added through the mixer pump burrowing ring. Maturation of the ongoing analyses and revision of Contractor approved prudent controls may alter these allowable dilution water volumes.

Any dilution of the convective waste necessitated by mixer pump operation recovery actions is likely to be via the mixer pump burrowing ring. The concern is that the mixer pump may not be providing the desired agitation of the tank waste. Therefore, if the water were added through the transfer pump, there is the potential that no or insufficient dilution would occur in the convective waste below the 96" level in the tank. By adding this water through the mixer pump burrowing ring, the lower regions of the convective layer will at least be agitated by the buoyant displacement of the water as it rises through the convective waste.

Desired effects of crust dilution are to: (1) directly address the mixer pump clearance issue by dissolving the "solids" matrix of the bubbly slurry, both releasing trapped gas in the crust and raising the elevation of the bottom of the crust, (2) to help in creating a direct path for the released gas to escape from the crust to the tank headspace, (3) to help remove trapped gas volume in the crust by absorption of soluble gases in the dilution water (N_2, N_2O, NH_3), (4) to reduce the bulk density of the crust to minimize the probability of unintended sinking of the crust.

Table 6-1 lists physically possible tank back-dilution options.

Table 6-1 Tank Back-Dilution Options

Water Addition Location
Transfer Pump to convective waste layer
Mixer Pump Burrowing Ring to convective waste layer (this option applies only for recovery of mixer pump operation or performance)
MMA to crust
Mixer Pump Inlet to bottom of crust
Transfer System Vent to top of crust

6.1 OPERATIONAL CONTROL SCHEME

Devices and Monitoring Parameters for Process Control

The control devices listed in Table 6-2 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 6-2 Transfer System Flow Control Devices

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

The instruments listed in Table 6-3 monitor the process parameters of the transfer system. These parameters are concerned with control of the waste dilution and transfer rate.

Table 6-3 Selected New Instrumentation for RAPID Transfer System (2 Sheets)

Process Parameter	Element and Location	Display and Location
Water Supply Flow rate	*FE-419 FCP	*FIT-419 FCP
Water Supply Flow Totalizer	*FE-419 FCP	*FQI-419 FCP
Water Supply Temperature	*TE-373 PPP	*TI-373 FCP
Water Supply Pressure	*PE-420 FCP	*PI-420 FCP
Transfer Line Flow rate	SY-101-WT-FQIT-367	SY-101-WT-FQIT-367 FCP

Table 6-3. Selected New Instrumentation for RAPID Transfer System (2 Sheets)

Process Parameter	Element and Location	Display and Location
Transfer Line Flow Totalizer	**FE-367 PPP	**FQIT-367 FCP
Transfer Line Temperature	**TE-369 PPP	**TI-369A FCP
Transfer Line Pressure	**PE-368 PPP	**PI-368A FCP
WSS Inlet Hose Temperature	*TI-410 WSS	*TI-410 WSCP
TK-401 Temperature	*TI-412 WSS	*TI-412 WSCP
ACC-401 Temperature	*TE-414 WSS	*TI-414 WSCP
PPP Leak Detection Alarm	**LDE-365 PPP	**LDA-365 FCP
Transfer Line and Drop Leg Leak Detection Alarm	**LDE-366 tank 241-SY-102	**LDA-366 FCP
Transfer Leak-By Pressure Switch/Alarm	**PS-370 PPP	**PAH-370A FCP
TK-401 Low / Low-Low Water Level Alarms	*LE-416 WSS	*LAL-416 / LALL-416 WSCP
TK-401 High / High-High Water Level Alarms	*LE-416 WSS	*LAH-416 / LAHH-416 WSCP

*POR32-RW-
**SY101-WT-

Table 6-4 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 6-4. Tank 241-SY-101 Transfer System Process Control Features

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
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
Tank 241-SY-101 SHMS (H_2)	DCP
Tank 241-SY-101 GMS (NH_3)	DCP
Tank 241-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
TK-401 high - high water level shuts SOV-401	WSS

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

Tables 6-5 through 6-9 provide a summary of the requirements placed upon instrumentation used to support the operation of the transfer system.

Table 6-5. Flow Instrument Loops Performance Per HNF-4972

Instrument Loop	Description	Range of Process Variable	Range of Indication	Accuracy of Indication	Setpoint(s) of Alarm(s) driven by the Instrument Loop
367	Transfer Flow Rate	0 to 210 gpm	0 to 310 gpm	± 15.5 gpm (FQIT-367)	N/A
367	Totalized Transfer Flow	0 to 550 kgal	0 to 10^9 gal	± 5.02 % (FQIT-367)	N/A
418	Water Flow Rate	0 to 70 gpm	0 to 273 gpm	N/A	N/A
418	Totalized Water Flow	0 to 367 kgal	0 to 367 kgal	N/A	N/A
419	Water Flow Rate	0 to 70 gpm	0 to 273 gpm	± 2.81 gpm (FQIT-419)	High: 70 gpm Low: 20 gpm
419	Totalized Water Flow	0 to 367 kgal	0 to 10^9 gal	± 1.16 % (FQIT-419)	N/A

Table 6-6. Leak-Detection Instrument Loops Performance Per HNF-4972

Instrument Loop	Description	Range of Process Variable	Desired Range of Indication	Accuracy of Indication	Setpoint(s) of Alarm(s) driven by the Instrument Loop
365	Leak Detection	[1]	$<{}^5/_8$ inch $\geq{}^5/_8$ inch[1]	N/A	10k ohm
366	Leak Detection	[1]	$<{}^1/_2$ inch $\geq{}^1/_2$ inch[1]	N/A	10k ohm

[1]see Morris (1999)

Table 6-7. Level Detection Instrument Loops Performance Per HNF-4972

Instrument Loop	Description	Range of Process Variable	Desired Range of Indication	Accuracy of Indication	Setpoint(s) of Alarm(s) driven by the Instrument Loop
416	WSS: TK-401 Level High-High Alarm	0 in. to 77.5 in.*	N/A	N/A	74 inches
416	WSS: TK-401 Level High Alarm	0 in. to 77.5 in.*	N/A	N/A	64 inches
416	WSS: TK-401 Level Low Alarm	0 in. to 77.5 in.*	N/A	N/A	36 inches
416	WSS: TK-401 Level Low-Low Alarm	0 in. to 77.5 in.*	N/A	N/A	30 inches

*TK-401 has an effective cylindrical operating height of 77.5 inches

Table 6-8. Pressure Detection Instrument Loops Performance Per HNF-4972

Instrument Loop	Description	Range of Process Variable	Desired Range of Indication	Accuracy of Indication	Setpoint(s) of Alarm(s) driven by the Instrument Loop
368	Transfer Line Pressure Indication	0 to 375 psig	N/A	N/A	N/A
370	Flush Manifold Pressure Sensor	0 to 375 psig	N/A	N/A	15 psig
371	Flush Manifold Pressure Sensor	0 to 375 psig	N/A	N/A	15 psig
417	WSS Discharge Pressure	0 to 200 psig	0 to 250 psig	± 17.97 psig	N/A
420	PPP Water Supply Pressure	0 to 200 psig	0 to 250 psig	± 12.5 psig	N/A

Table 6-9. Temperature Instrument Loops Performance Per HNF-4972

Instrument Loop	Description	Range of Process Variable	Desired Range of Indication	Accuracy of Indication	Setpoint(s) of Alarm(s) driven by the Instrument Loop
369	PPP waste discharge temperature	102° to 130 °F	32° to 212 °F	± 7.76 °F	N/A
373	PPP water supply temperature	102° to 130 °F	32° to 212 °F	± 7.76 °F	114 °F
401	WSS electrical enclosure temperature	N/A	N/A	N/A	N/A
410	WSS water inlet temperature	102° to 130 °F	32° to 212 °F	± 27.7 °F	112 °F
411	TK-401 wall temperature	102° to 130 °F	32° to 212 °F	N/A	132 °F
412	TK-401 water temperature	102° to 130 °F	32° to 212 °F	± 27.7 °F	N/A
413	WSS water outlet temperature	102° to 130 °F	32° to 212 °F	± 27.7 °F	112 °F
414	ACC-401 wall temperature	102° to 130 °F	32° to 212 °F	± 27.7 °F	112 °F
415	WSS outlet flexible hose temperature	102° to 130 °F	32° to 212 °F	± 27.7 °F	112 °F
HT1	Transfer line flex hose heat trace thermostat	102° to 130 °F	N/A	N/A (factory calibrated only)	130 °F
HT2	Transfer line flex hose heat trace thermostat	102° to 130 °F	N/A	N/A (factory calibrated only)	130 °F

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 for fluid flow considerations 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 ≅ 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):

$$DR = \frac{FQIT\text{-}419}{FQIT\text{-}367}$$

Where

DR = dilution ratio
FQIT-419 = indicated dilution water flow rate
FQIT-367 = indicated transfer line flow rate

With this definition, pure water flow corresponds to a dilution ratio of ∞, whereas pure waste flow corresponds to a dilution ratio of zero. Therefore a 1 part waste to 1 part water dilution corresponds to a DR of 0.5 since the indicated transfer line flow rate (FQIT-367) is the sum of equal parts of waste flow (not directly measured) and water flow rate (FQIT-419).

The low dilution limit of one part water to two parts waste (DR = 0.33) 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 limit of two parts water to one part waste (DR = 0.67) is not as time critical as the low-end limit since this results in the relatively slow addition of undesired water volume into the DST system.

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 tank 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 = ∞. Then pump P-350 is started at a low speed that is slowly increased until the desired transfer flow rate (nominally 60 to 120 gpm at the 1:1 dilution) 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.

Section 6.3, 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 6-10:

Table 6-10. Material Balance Indications

Water Supply Flow	Waste Transfer Line Flow	Tank 241-SY-102 Receipt
POR32-RW-FQIT-419 (Service Water Totalized Flow Indicator) Instrument Accuracy ±1.16% of totalized flow*	SY101-WT-FQIT-367 (Waste Transfer Flow Totalizer) Instrument Accuracy ±5.02% of totalized flow*	SY-102-WST-LIT-101 (Tank 241-SY-102 ENRAF™ level gage) Instrument Accuracy ± 0.04 inches (± 110 gal)

*Hickman (1999)

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 expected to be well below 1°F per hour. The 10 °F per hour OSD limit will not be approached during the initial waste transfer from tank 241-SY-101.

6.2 TRANSFER COMPLETION CRITERIA

When the volumetric change indicated by the level rise in tank 241-SY-102 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 transfer volume verification uses the totalized volume transferred to 241-SY-102 and the totalized water addition volume to calculate the volume of waste transferred. Other characterization information as available, may also be used as determined by Process Engineering. Examples could include analysis of the changes in the concentrations of certain analytes

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 96 kgal)

The total volume of transferred waste must include allowance for the volume that may be siphoned in the time period between shutdown of the transfer pump and the establishment of the Administrative Lock on the system. As discussed in Section 6.6, the RAPID transfer system operating procedure must explicitly require the time at which the status of pump P-350 and valves V-362 and V-351 is changed to be recorded.

6.3 DILUTION RATIO VERIFICATION

Good operating practice requires the use for a continuous material balance. The material balance offers a way to double-check the performance of controlling the transfer line dilution ratio using FQIT-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 6-10. This table provides a listing of the instrumentation that will permit transfer operation. In the event of failure of any of these instruments, the transfer must be terminated.

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. Additionally, 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 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. 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.

This confidence suggests that a material balance can provide a check of 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 may indicate an undesired average dilution ratio may have been achieved. Alternatively, a material balance may provide indication of a malfunction of an instrument, a leak in the system, or indication that totalized FQIT-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 versus 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, a continuous material balance can be reasoned. Referring to the definition of the dilution ratio (DR) from Section 6.1:

$$DR = \frac{FQIT-419}{FQIT-367}$$

Totalized (i.e., integrated) values of the respective flow rates serve to indicate the average dilution ratio achieved. This can be accomplished by substituting flow volumes for flow rate in the definition of DR:

FQIT-367 → volume change indicated by SY-102-WST-LIT-101
→ volume change indicated by manually integrated FQIT-367 log readings
FQIT-419 → volume change indicated by FQIT-419
→ volume change indicated by manually integrated FQIT-419 log readings

This expression forms a process control and summarizes the goal of slurry composition control. It indicates that at any time during the waste transfer, the ratio of the volume of water supplied to the PPP to the volume transferred into tank 241-SY-102 must be within the range of 0.33 to 0.67.
The only volumetric measurement of the transfer flow that is qualified as Safety Class is FQIT-367. Therefore, the ENRAF gage in tank 241-SY-102 could only be used to terminate the transfer if it indicates that the total volume has been transferred <u>and</u> that this volume is less than that indicated by FQIT-367. The transfer volume as indicated by SY-102-WST-LIT-101 cannot be used to extend the transfer beyond the limiting volume as indicated through the use of the FQIT-367 indication.

With this limitation, the following data sources can be used at the shift manager's discretion to terminate the transfer when the material balance calculated using any of the data sources indicates that the desired volume has been moved from tank 241-SY-101 to tank 241-SY-102:

<u>Tank 241-SY-102 volume increase</u>
a) SY-102-WST-LIT-101 (SY-102 ENRAF™)
b) SY101-WT-FQIT-367
c) Manually integrated SY101-WT-FQIT-367 log readings

<u>Volume of water supplied to the PPP</u>
a) POR32-RW-FQIT-419
b) Manually integrated POR32-RW-FQIT-419 log readings

It should be noted that this process control <u>differs</u> from the AC requirements of Sections 6.1 and 6.2:

a) Section 6.1 specifies an AC to provide a material balance for a leak-detection function. The absolute value of:

$$(\text{FQIT} - 367) - \frac{2750 \text{ gal}}{\text{in}} (\Delta \text{ level per } \text{SY} - 102 - \text{WST} - \text{LIT} - 101)$$

is monitored and additional leak-detection activities are specified if the magnitude of the value exceeds a certain limit at the time of observation.

b) Section 6.2 places an AC on the value of the total volume of material removed from tank 241-SY-101 as measured by $((\text{FQIT-367}) - (\text{FQIT-419}))$.

6.4 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 (taken from HNF-IP-1266)

(3) The not-to-exceed level rise 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.)

6.5 CONTROL OF TANK BACK-DILUTION ACTIVITIES

In order to achieve the final condition, the remediation project is currently planning to transfer at least 300 kgal of waste with subsequent tank back-dilution of a similar volume of water. This transfer/dilution process will have to be done in steps approximately no larger than 150 kgal because of several considerations:

1) constraints on drawdown of tank 241-SY-101 to protect the mixer pump operation
2) the available space in the receiver tank, 241-SY-102
3) constraints on adding water to tank 241-SY-101 intended to prevent inadvertent sinking of the crust.

Many options are available to accomplish the dilution process. The selection of the specific option is dependent upon the specific goals of each step. The project has considered many variables including location, rate, temperature, method of mixing, volume per step, etc. Different method/condition of water addition may be used as the project progresses down this path consistent with the project philosophy of taking small steps quickly.

Initially, dilution water will be added directly on the top of the crust without controls specified on the water temperature. Depending upon the behavior of the visible portions of the crust, up to 30 kgal may be added in this fashion. At the nearest convenient opportunity, operation of the mixer pump will be investigated.

Following this, 30 kgal of water heated to the bulk tank temperature will be injected into the mixed slurry layer at an elevation of 8 ft through the inlet of the transfer (P-350) pump. The water thus introduced will be buoyant with respect to the surrounding convective waste. Buoyant mixing will occur as the water the plume rises through the convective layer to the base of the crust.

The concept to verify mixer pump operability will be to, after initial waste transfer, review the mixer pump operating parameters following each pump run for evidence of mixer pump performance degradation. This review after each pump run will continue until the TRG determines that changed tank conditions have not significantly degraded the capability of the mixer pump to perform its intended function. In addition, the normal quarterly review of mixer pump performance would continue. If the analysis shows the mixer pump operation to be degraded, an additional 42 kgal of dilution water may be added to the convective waste through the mixer pump burrowing ring.

The dilution water will be introduced at a moderate rate, limited to 70 gpm by system design. The indications used to monitor and initiate control responses to the water addition rate are discussed in Section 7.6. Primarily, the control responses intend to ensure tank atmospheric fuel concentrations remain below 25% LFL.

6.6 INHERENT OPERATIONAL CONCERNS

Tank to Tank Siphoning

It has been determined (Meyer & Biggs 1999) that at the point of transfer pump (P-350) shutdown following a waste transfer, while dilution water is still supplied to the PPP, siphoning action between tanks 241-SY-101 and -102 will continue to "transfer" waste from tank to tank at rates of up to 8 gpm (on an undiluted basis). This equates to the 2,000 gallon capacity of TK-401 being capable of siponing up to 1150 gallons of waste to tank 241-SY-101. It is noted that active measures are required to stop the siphoning action. Unless the dilution water is running more than 40 gpm, waste siphoning will occur when the transfer pump is stopped. (At greater than 40 gpm, the water flow to pump P-350 exceeds the siphon flow rate, preventing waste from entering the pump). This could result in the transfer pump filling with waste when 241-SY-101 siphons to 241-SY-102.

The impact of the siphoning potential is addressed in the TSR for Administrative Lock on tank farm equipment. For implementation of AC 5.20 for the Tank 241-SY-101 RAPID Mitigation System, the Administrative Lock condition is demonstrated by:

Removing and securing the motive force (i.e., electrical power) from the pump

AND

Closing and securing either Valve V-362 or V-351 and securing either in the closed position to remove the motive force for siphoning.

Securing of the motive force to the transfer pump is accomplished by application of an Administrative Lock condition, either with an installed lock mechanism on the pump's motor controller OR by stationing a qualified operator to maintain the motive force in a secure configuration. Securing of the valve in the closed position is accomplished by application of an Administrative Lock condition with an installed lock mechanism on the valve. Application of the Administrative Lock Program requirements to the designated valves is a contractor-imposed prudent control necessary to safely perform crust growth remediation actions for Tank 241-SY-101 (French 1999).

This interpretation requires the assumption that for any condition of the transfer system when the transfer line is full and dilution water supplied to the transfer pump, siphoning at 8 gpm occurs during the time period between stopping the transfer pump and establishing the TSR Administrative Lock per AC 5.20. The operational implication of these prudent contractor imposed controls is that the status of pump P-350 (on / off), valve V-262 (open / shut) and valve V-351 (open / shut) must be chronologically qualified. Associating the status changes of these three pieces of equipment with a time stamp allows determination of the amount of time the RAPID transfer system is maintained in a configuration allowing the possible siphoning of waste at 8 gpm. Therefore the RAPID transfer system operating procedure must explicitly require the time at which the status of pump P-350 and valves V-362 and V-351 is changed to be recorded.

Flushing of the RAPID transfer system (including pump P-350) must be performed following termination of waste transfer operations. The establishment of a hydraulic lock must follow the completion of flushing operations on pump P-350. Specifically, hydraulic lock is placed on pump P-350 whenever the RAPID transfer system is returned to the stand-by configuration (i.e., all process valves are shut - see Section 4.2.1).

<u>Process Volumetric Measurements</u>

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 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 6.4 and 6.5, 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, and cannot discern densities or mass flow rates. Level changes in tank 241-SY-102, while measured easily, do not account for changes in waste density or gas content. 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 ends up may never be completely addressed. It is expected 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 of the pump will be entrained. 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, the 25% lower flammability limit (LFL) and ignition controls established for remediation activities (French 1999) control any undesired effects that may result.

Cold testing of the transfer pump has shown the potential for leakage around the 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 tank 241-SY-101.

7.0 OPERATIONS PLAN

7.1 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 should also be performed prior to any operation of the transfer pump. 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 bi-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 bi-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.

The bi-weekly flushing requirement will be reviewed for applicability based upon completion of the following activities:

- The initial waste transfer
- The spare transfer pump is available.

7.2 A DISCUSSION OF FLOW AND TEMPERATURE MEASUREMENT ERROR

The operation of the transfer system magnetic flow meters (FE-367, FE-419) will be verified under actual system conditions. The general technique will be to compare the indicated dilution water and waste slurry flow rates and volumes from the respective magnetic flow meters to the volume changes indicated by 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 and should not be less than 20 gpm during transfer operations. The dilution water flow rate measurement is provided with alarms (SY-461-RW-FAL-419 and -FAH-419) to notify the operator when water is supplied to the PPP at flow rates less than 20 gpm or greater than 70 gpm. These alarm setpoints are 25 gpm and 65 gpm to account for inaccuracies in the alarm circuitry (Hickman 1999).

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.

Additional considerations are required for the magnetic flow meters used in the transfer operations. These are the accuracies of the installed flow-rate displays available to the Farm Control Panel (SY101-WT-CP-350A) operator. These accuracies are rounded to the next highest integer gpm flow rate as determined from the project instrument setpoint basis document (Hickman 1999). This results in accuracies of ± 3 gpm for FQIT-419 and ± 16 gpm for FQIT-367. It is noted that more accurate flow-rate indications are available within these instrument loops, but these indications are not readily accesible to the operator at the valve and instrument control stand.

Although it is expected that any bias in the two flow instruments will be in the same direction, this cannot be assured. Therefore, an actual dilution ratio (DR) value could be significantly different from the indicated DR value:

Indicated: $$DR = \frac{\text{FQIT-419}}{\text{FQIT-367}} = \frac{60\text{ gpm}}{120\text{ gpm}} = 0.50$$

Actual: $$DR = \frac{60 \pm 3\text{ gpm}}{120 \pm 16\text{ gpm}} = 0.42 \text{ to } 0.61$$

Indicated: $$DR = \frac{\text{FQIT-419}}{\text{FQIT-367}} = \frac{30\text{ gpm}}{60\text{ gpm}} = 0.50$$

Actual: $$DR = \frac{30 \pm 3 \text{ gpm}}{60 \pm 16 \text{ gpm}} = 0.27 \text{ to } 0.75$$

Additionally, there are volumetric flow (i.e., critical velocity) concerns arising from the inaccuracy of the FQIT-367 indication:

Indicated: FQIT-367 = 60 gpm

Actual: FQIT-367 = 44 gpm

These considerations combine to show that in order to maintain > 6 ft/sec in the transfer line <u>and</u> ensure that the dilution ratio limits are satisfied in the presence of these flow rate measurement errors, steady state operations during waste transfer should strive to:

1) maintain the indicated flow rate on FQIT-367 > 80 gpm
2) maintain the value of DR as close to 0.5 as possible.

This recommendations should ensure that, over a reasonably steady a period of waste transfer operations, the transfer line critical velocity will be satisfied and that the low dilution limit of one-part water : two-parts waste (DR = 0.33) will not be violated:

$(80 - 16) \text{ gpm} = 64 \text{ gpm} \rightarrow v > 6 \text{ ft/sec}$

$$DR = \frac{40 - 3 \text{ gpm}}{80 + 15 \text{ gpm}} > 0.33$$

It is noted that if a transfer line flow rate of less than 80 gpm is used, the indicated DR should be maintained above 0.50 to ensure that the actual DR does not drop below 0.33.

This process control dilution/flush water temperature range of 102 °F to 130 °F must be adjusted to account for the TI-373 loop inaccuracy. This inaccuracy is specified to the nearest integer temperature as ± 8 °F. Therefore the water supply temperature as indicated on TI-373 at the instrumentation and valve control stand should be maintained between 102 °F and 130 °F to ensure that water of at least 102 °F and not more than 130 °F is supplied to the PPP.

However, it should be noted that the instrument loop 373 drives the dilution water low temperature alarms (SY101-WT-TAL-373A and B). The uncertainty of these alarms is ± 4 °F (Hickman 1999). With this consideration, it may be prudent to try to maintain dilution water temperature as indicated on TI-373 so as not to interfere with these alarms.

7.3 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 before the PPP low water temperature alarm (TAL-373A/B) activates, or the preheat operation must be repeated.

7.4 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

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.

At the beginning of the initial transfer, particular attention will be paid to the off gassing from both tanks. This will add confidence that adverse or otherwise difficult to control gas concentrations and emissions are unlikely to occur during the waste transfer.

7.5 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.

7.5.1 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 170 inches (468 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 393 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 102 °F. This preheat is accomplished by performing three system flushes/preheats in rapid succession. These are:

(1) Transfer Line Flush or Preheat (Section 4.2.2)

(2) Transfer Line Back-Flush or Preheat (Section 4.2.3)

(3) Pump P-350 Purge (Section 4.2.4)

Next, the Waste Transfer (Section 4.2.8) 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.

7.5.2 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 4.2.1). The operations required to return the transfer system to the Stand-By condition are:

(1) Transfer Line Flush or Preheat (Section 4.2.2)

(2) Pump P-350 Discharge Line Flush or Preheat (Section 4.2.3)

(3) Pump P-350 Purge (Section 4.2.4)

(4) Perform the Siphon Break Valve Operations

(5) Establish the Stand-By Configuration (Section 4.2.1)

In order to minimize waste concentrations in the transfer line in preparation 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 and maintained for a few minutes, pump P-350 can be stopped.

7.5.3 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 4.2.6).

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 4.2.1). 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.

7.5.4 Tank Farm Access Considerations during Transfer Operations

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 operator presence 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.

7.5.5 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 FQIT-367).
- Tank 241-SY-101 hydrogen concentration (GMS-1/-2)
- Tank 241-SY-101 ammonia concentration (GMS-1/-2)
- Tank 241-SY-102 hydrogen concentration (SHMS-E+)
- Tank 241-SY-102 ammonia concentration (SHMS-E+)
- SY-Farm stack hydrogen concentration (GMS-2)
- SY-Farm stack ammonia concentration (GMS-2)

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

7.6 TANK BACK-DILUTION OPERATIONS

7.6.1 Tank Back-Dilution Start-Up

Start-up of tank back-dilution is equivalent to performing typical flushes of the transfer system within required water flow rate and temperature limits. The flow rate (10 to 60 gpm) is controlled with flow control valve V-410.

7.6.2 Tank Back-Dilution Shut-Down

Shut-down of tank back-dilution is performed by shutting flow control valve V-410 and stopping the running water supply pump on the WSS.

7.6.3 Tank Farm Access Considerations during Tank Back-Dilution Operations

The design of the flexible hose arrangement of the dilution water line offers no structural protection from vehicular contact. Because of the susceptibility of the dilution system to vehicular damage, as a minimum, the control provided by TSR AC 5.10.2.b (LMHC 1999c) must be followed.

Tank back-dilution 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. Adequate data logging must be performed periodically per Section 8.5.5.

7.6.4 Monitored Parameters for Tank Back-Dilution 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-101 1-A and 1-C ENRAF levels
- FCP water supply totalized flow (from FE-419).
- WSS water supply totalized flow (from FE-418).
- Tank 241-SY-101 hydrogen concentration
- Tank 241-SY-101 ammonia concentration
- SY-Farm stack hydrogen concentration
- SY-Farm stack ammonia concentration

7.7 MONITORING AND RESPONSE PLAN

Table 7-1 provides summary guidance as to the proper response if a monitored parameter is outside its expected range. During the transfer operation, besides the operating staff, representatives from the following organizations will be available and will be able to support process changes as needed.

Project management
Process Engineering
Operations Management
Cognizant Engineer
Technology Support

These representatives will be knowledgeable of the logic behind the summary tables as well as the supporting analysis that has been performed.

In general if the transfer conditions are outside expected conditions and can not be easily brought into range the transfer will be stopped, the condition evaluated and the necessary adjustments made to maintain control of the condition in the tanks. Tables 7-2 and 7-3 describe the major instruments whose indication may trigger remediation system action.

If the response action is to terminate the waste transfer the following general guidance is provided for system restart:

> Following shutdown of the tank 241-SY-101 to tank 241-SY-102 transfer due to abnormal or anomalous tank 241-SY-101 conditions, the Technical Review Group (TRG) will review the tank data. Under these conditions, restart must be authorized by the TRG. Unscheduled meetings may be held to review abnormal occurrences, restarts, changes to procedures, etc; actions shall be ratified at the regular meetings.

Table 7-1. Transfer System Key Process Control Variables*

Instrument	Description	Low Limit	Low Limit Response	High Limit	High Limit Response
FQIT-367	Transfer Line Flow Rate	60 gpm (transfer only)	Increase transfer flow rate (and water flow rate if needed)	210 gpm (transfer only)	Reduce transfer pump flow rate
FQIT-367	Totalized Transfer Line Flow	N/A	N/A	603 kgal	Place transfer system in Stand-By configuration
FQIT-419	Water Flow Rate	20 gpm (transfer only)	Increase water flow rate	70 gpm	Reduce water flow rate
FQIT-419	Totalized Water Flow	N/A	N/A	402 kgal	Place transfer system in Stand-By configuration
TI-373	PPP Water Supply Temperature	102°F	Take actions to prevent solids precipitation in transfer line (see Notes)	130°F	Take actions to prevent, or minimize the volume of, excessively hot water entering tank 241-SY-101
PI-368	Transfer Line Pressure Indication	N/A	N/A	> 15 psig increase per hour or day (at constant transfer line flow rate)	Notify shift manager for evaluation

Notes: Transfer system corrective actions may include:

- increase/decrease water supply flow rate and/or temperature to the WSS
- increase/decrease water supply flow rate to the PPP
- increase/decrease transfer line flow rate to tank 241-SY-102
- energize/deenergize applicable water-skid heat traces
- energize/deenergize PPP water supply hose heat trace

If the waste transfer system operation cannot be readily brought back into control by some combination of the above corrective actions, the activity will be terminated and the transfer system placed in the Stand-By configuration (Section 4.2.1). Where circumstances permit, a controlled transfer shutdown (Section 7.5.2) would be preferred over an off-normal transfer shutdown (Section 7.5.3).

Other transfer system instrumentation exists, but these instruments are not used as primary process control indications. However, this additional instrumentation may be used to initiate corrective actions on the transfer system. Tables 6-5 through 6-9 provide a listing of these system specific instruments, their process and instrument response ranges, and alarm setpoints (where applicable).

The instrumentation listed in this table are the most time critical for the RAPID transfer system. As such, upset conditions must be addressed quickly or the onset of functional impairment of the transfer system could rapidly develop.

Table 7-2. Existing SY-Farm Level Instrumentation

Instrument	Description	Low Limit	Low Limit Response	High Limit	High Limit Response
tank 241-SY-102 ENRAF™	Waste level	170 inches	Do not initiate transfer until tank level >170 inches	393 inches	(1)
tank 241-SY-101 1-A ENRAF™	Waste level	(2)	(1)	(1)	(1)
tank 241-SY-101 1-C ENRAF™	Waste level	(1)	(1)	(1)	(1)
tank 241-SY-101 in-tank video camera	Waste level	(1)	(1)	(1)	(1)
tank 241-SY-102 waste level change & FQIT-367 reading	Material Balance for Leak Detection	N/A	N/A	(3)	(4)

Notes:

(1) Terminate waste transfer and place the system in the Stand-By configuration.

(2) The waste level measurements and observations in tank 241-SY-101 are not provided with any quantitative limits, but rather, to indicate the occurrence of any "step changes" larger than those associated with the slow rate of waste removal. Such changes would indicate the occurrence of discrete events of significant size, which are associated with negative connotations for control of the waste behavior. Examples could be:

- Indication of a sudden release of a sizeable gas volume due to a short term level drop that is much more rapid than the steady rate of waste removal.
- Indication of a sudden release of a sizeable gas volume due to the observation of significant splashing or splattering.
- Indication of crust bridging or adhesion due to lack of a steady level drop or video evidence of significant crust cracking or shifting. It is expected that the observers (Operations Management, Process Engineering, Project Management, etc) will evaluate the relative rates of level change with respect to the pumping rate in tank 241-SY-101. If the bridging approaches 5 inches less level drop than waste removed the transfer will be shutdown and the conditions monitored/evaluated until the waste surface settles to nearly balance transfer out or the TRG has an adequate understanding of the reason for the abnormal condition. Video evidence of crust cracking or shifting will be evaluated against similar guidelines but will also be compared to the headspace gas concentration as reported in DACS.

(3) [tank 241-SY-102 current waste level – tank 241-SY-102 initial waste level] x 2,750 gal/in – FQIT-367

$\leq$ 1400 gal @ 30 minutes
$\leq$ 1400 gal @ 60 minutes
$\leq$ 2000 gal @ $\geq$2 hours

(4) Inspect leak detectors and transfer line. If leak is detected, terminate waste transfer and place the system in the Stand-By configuration.

Table 7-3. Existing SY-Farm Gas Monitoring Instrumentation

Instrument	Description	Low Limit	Low Limit Response	High Limit	High Limit Response
SY-Farm GMS-1 and GMS-2	Tank 241-SY-101 hydrogen concentration	N/A	N/A	6900 ppm (alarm setpoint to anticipate the 25% LFL condition)	(1)
SY-Farm GMS-2	Tank 241-SY-101 ammonia concentration	N/A	N/A	3000 ppm	(1)
SY-Farm SHMS-E+ (local indication)	Tank 241-SY-102 hydrogen concentration	N/A	N/A	6250 ppm (alarm setpoint to anticipate the 25% LFL condition)	(1)
SY-Farm SHMS-E+ (local indication)	Tank 241-SY-102 ammonia concentration	N/A	N/A	3000 ppm	(1)
SY-Farm GMS-2	SY-Farm ventilation stack ammonia concentration	N/A	N/A	1000 ppm	(1)
IH Portable Ammonia Monitor	SY-Farm area/ground ammonia concentration	N/A	N/A	25 ppm	(2)
				250 ppm	(3)
IH Portable VOC Monitor	SY-Farm area/ground VOC concentration	N/A	N/A	2 ppm	(2)
				25 ppm	(3)

Notes:

(1) Terminate waste transfer and place the system in the Stand-By configuration.

(2) Respiratory protection required in-farm.

(3) Detection of 250 ppm ammonia or 25 ppm VOC at ground level requires immediate transfer system shutdown and tank farm evacuation.

(4) In-Tank gas monitoring may be the only effective means to indicate the onset of an upset conditions. Even if gas concentration levels are well below the limits of this table, particular attention will be paid to the dynamic variations in the values as indicators of the need for process control actions.

8.0 OFF- NORMAL CONDITIONS

8.1 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 6,900 ppm H_2 in tank 241-SY-101 and 6,250 ppm H_2 in tank 241-SY-101 or the SY-Farm stack). 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.

8.2 EXCESSIVE SY-FARM VENTILATION SYSTEM AMMONIA OR VOC EMISSIONS

This condition is the result of the agitation and chemical alteration of the tank 241-SY-101 wastes as they commingle with the wastes in tank 241-SY-102. The condition is defined as 3,000 ppm NH_3 in tank 241-SY-101 headspace or 1000 ppm NH_3 in the SY-Farm stack. Therefore, the recovery action will be either a controlled reduction of the rate or shutdown of tank 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 or 2 ppm VOC at ground level requires mask use in-farm
- Detection of 250 ppm ammonia or 25 ppm VOC at ground level requires immediate transfer system shutdown and tank farm evacuation

8.3 LOSS OF SY-FARM PRIMARY VENTILATION

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

8.4 LOSS OF SY-FARM ANNULUS VENTILATION

The concern is 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.

8.5 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 ACC-401 transfer line flush. Once power is restored, the normal sequence of system flushes should be performed as soon as possible.

8.6 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 the low water flowrate interlock does not operate properly, the operator response is to stop pump P-350 as soon as possible. This will be immediately followed by a transfer line flush. Once the system water supply is restored, the normal sequence of system flushes should be performed as soon as possible. These actions are designed to minimize the probability of salt precipitation in the transfer line resulting in a line plug.

8.7 LOSS OF P-350 PUMP

The normal sequence of system flushes should be performed as soon as possible. This action is designed to minimize the probability of salt precipitation in the transfer line resulting in a line plug.

8.8 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.

8.9 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-401, 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.

8.10 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 alarm upon detection of 15 psi. Upon an alarm, the normal procedures to shutdown, 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 before waste transfer operations can resume. 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 0.011M □ [NO₂⁻] □ 5.5M < 2.5 [for solutions below 167□F, the [OH⁻] limit is 8.0M] 0.1 ([NO3⁻]) □ [OH⁻] < 10M [OH⁻] + [NO2⁻] □ 0.4 ([NO₃⁻]) 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 pit 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 pit. 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 Temperature gradients of soln. in tanks solution 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 ≤ 55°F/ft ≤ 55°F/ft	Thermocouple trees installed in tanks. Temperatures taken per procedure TO-040-660 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	$\leq$ 5.9 in. w.g.	*Calibrated* differential pressure gauges are used for each filter to monitor the pressure drop. *Gauges are read* daily.	OSD-T-151-00007 7.3.1
	Pressure drop across any other filter	$\leq$ 4.0 in. w.g.		
	Total *pressure* drop across filters in a series	$\leq$ 5.9 in. w.g.		
Air Inlet Temperature	Air Inlet Temperature to HEPA Filter	$\leq$ 230 °F	Temperatures are checked to determine the operating condition of the heater per applicable procedures, work plans, work packages or other documentation.	
Filter Efficiency	Single *HEPA Filter System*	99.95% of particles between 0.1		
	Multiple HEPA Filter System			
Gaseous Discharges from Ventilation System	Hydrogen Concentration	H2: 25% LFL		
	Ammonia Concentration	*HN3*: 25 ppm/250 ppm		
Maximum permissible concentration of radionuclides	VOC Concentration	VOC: 2 ppm / 25 ppm	*Except for krypton-85: Not to exceed a combined release of *4E+06* Ci/yr.	
	Annual Average Concentrations*	Not to exceed 1 time the DCG-Public Value of *WHC-CM-7-5*, Appendix C, 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.	
	Weekly Average *concentrations**	Not to exceed *10* times the *annual* average administrative control value (ACV) concentrations for that stack at point of release.		
	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.		

[1]LMHC, 1997, *Operating Specifications of the 241-AN, AP, AW, AY, AZ & SY Tank Farms*, OSD-T-151-00007, Rev. H-21, Lockheed Martin Hanford Corporation, Richland, Washington.
[2]Noorani, Y. G., 1997, *TWRS 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 SY 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 Caustic 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	No confined space work	Appendix F, III.B.3
Asbestos	Anything painted pink is assumed to contain asbestos. This material is not to be disturbed.	Warning signs at SY 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

[1]Carls, D. R., 1995, *Tank Farms Health and Safety Plan*, WHC-SD-WM-HSP-002, Rev. 2J, Westinghouse Hanford Company, Richland, Washington.

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