5

ENGINEERING CHANGE NOTICE

Page 1 of 3

1. ECN 653987

Proj. ECN

2. ECN Category (mark one)	3. Originator's Name, Organization, MSIN, and Telephone No.	4. USQ Required?	5. Date
Supplemental ○	GL Hickman, FDNW, S7-70 376-3509	◉ Yes ○ No	10/13/99
Direct Revision ◉			
Change ECN ○	6. Project Title/No./Work Order No.	7. Bldg./Sys./Fac. No.	8. Approval Designator
Temporary ○	241-SY-101 RAPID Mitigation 4851-23 CACN 108976 BA10	241-SY/WST/200W	SQ
Standby ○	9. Document Numbers Changed by this ECN (includes sheet no. and rev.)	10. Related ECN No(s).	11. Related PO No.
Supersedure ○	HNF-4972, Revision 1,	N/A	N/A
Cancel/Void ○			

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

13a. Description of Change

13b. Design Baseline Document? ◉ Yes ○ No

This change modifies tables and text to reflect a new set point on the water skid heat trace controllers TIC-410, TIC-413, TIC-414, and TIC-415. The set points were changed from 139F to 125F. It also changes text related to heat trace control loops HT1 and HT2. The setpoint was changed from 130F to ~~125F~~ 140F GLH 10/14/99

Pressure loop PI-368 is no longer going to be calibrated based on this revision.

Temperature control loop TC-411 is no longer to be calibrated and can be adjusted by operations.

Flow totalizer and indicator FQIT-367 has an increased tolerance due to greater calibration inaccuracies.

The Range on SY101-WT-PI-368 has been increased to 0-200psig.

Numerous editorial changes (fixing typos, more detailed explanations etc.)

14a. Justification (mark one)	14b. Justification Details
Criteria Change ○	See page 3/3 for further details
Design Improvement ◉	This modification will not change collective dose since it has no impact on radiological sources, contamination control, or shielding.
Environmental ○	
Facility Deactivation ○	
As-Found ○	The design verification selected by HNF-IP-0842, Section IV 4.2.4, was an ~~informal~~ independent review.
Facilitate Const. ○	
Const. Error/Omission ○	
Design Error/Omission ○	USQ-TF-99-0796

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

M.L. MCELROY	S7-07	(1)	S.D. Estey	R2-11
M.F. ERHART	S7-70	(1)	J.R. BIGGS	S7-70
R.W. REED	T4-08	(1)	K.S. WITWER	S7-70
C.E. HANSON	S7-70	(1)	J.R. LAPOINTE	R2-88
W.J. POWELL	S7-70	(1)	D.B. SMET	R1-56
C. D. JACKSON	S7-34	(1)	M.H. BROWN	T4-07
PROJECT FILES	S7-70	(1)	G.L. HICKMAN	S7-70
CENTRAL FILES	B1-07	(1)		
(ORIG + 1)				

RELEASE STAMP

DATE: OCT 18 1999 STA: 4 HANFORD RELEASE ID: 2

A-7900-013-1

A-7900-013-2 (10/97)

ENGINEERING CHANGE NOTICE

1. ECN (use no. from pg. 1): 653987

16. Design Verification Required	17. Cost Impact		18. Schedule Impact (days)
	ENGINEERING	CONSTRUCTION	
(●) Yes	Additional ( ) $ N/A	Additional ( ) $ N/A	Improvement ( )
( ) No	Savings ( ) $ N/A	Savings ( ) $ N/A	Delay ( ) N/A

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	☒ wjp 10/14/99	ASME Coded Item	☐
Const. Spec.	☐	Engineering Procedure	☐	Human Factor Consideration	☐
Procurement Spec.	☐	Operating Instruction	☐	Computer Software	☐
Vendor Information	☐	Operating Procedure	☒	Electric Circuit Schedule	☐
OM Manual	☐	Operational Safety Requirement	☐	ICRS Procedure	☐
FSAR/SAR	☐	IEFD Drawing	☐	Process Control Manual/Plan	☒
Safety Equipment List	☐	Cell Arrangement Drawing	☐	Process Flow Chart	☐
Radiation Work Permit	☐	Essential Material Specification	☐	Purchase Requisition	☐
Environmental Impact Statement	☐	Fac. Proc. Samp. Schedule	☐	Tickler File	☐
Environmental Report	☐	Inspection Plan	☐	_____	☐
Environmental Permit	☐	Inventory Adjustment Request	☐	_____	☐

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
HNF-4264/1, PROCESS CONTROL PLAN	CALIBRATION DATA SHEETS: WT-6337 WT-6341 WT-6379	TO-430-100, TRANSFER PROCEDURES
TO-430-190 PROCEDURE FOR OP. THE WATER SKID	WT-6339 WT-6342 WT-6340 WT-6233	

21. Approvals

	Signature	Date
Design Authority WJ POWELL	WJ Powell	10/13/99
Cog. Eng. MF ERHART	MF Erhart	14-OCT 99
Cog. Mgr. RW REED	RW Reed	13Oct99
QA ML McELROY	M.L. McElroy	10-14-99
Safety CD JACKSON	C.D. Jackson	10/14/99
Environ.	C.E. Hanson	
Other ~~INFORMAL~~ REVIEW CE HANSON		10/13/99
DB SMET	For Dawn Smet Per Telecon	10/13/99
MH Brown	M.H. Brown	11-13-99
Independent Reviewer	C.C. Scalefani	10-15-99

	Signature	Date
Design Agent GL HICKMAN	G.L. Hickman	10/13/99
PE		
QA		
Safety		
Design		
Environ.		
Other		

DEPARTMENT OF ENERGY

Signature or a Control Number that tracks the Approval Signature

ADDITIONAL

CONTINUED FRO PAGE 1, BLOCK 14b, JUSTIFICATION DETAILS:

THE HOSE MATERIAL ASSOCIATED WITH THE WATER SKID HAS A TEMPERATURE LIMITATION OF 158F PER THE MANUFACTURES SPECIFICATION. MARGIN AND INSTRUMENT ERROR MAKES THE LIMIT 125F. THE INITIAL CONCERN OF LOW WATER TEMPERATURE IS MET BY CONTROL OF THE SOURCE HOT WATER TEMPERATURE.

CALIBRATION ERROR OF FQIT-367 IS POSTULATED TO BE GREATER THAN ORIGINALLY UNDERSTOOD. THIS ERROR INCREASES THE ERROR OF ALL READINGS IN THIS LOOP.

PRESSURE INDICATOR PI-368 IS USED QUALITATIVELY. CALIBRATION IS NOT REQUIRED.

THE SETPOINT OF THE TRANSFER HOSE HEAT TRACE IS RETURNED TO THE MANUFACTURERS INITIAL VALUE.

THE CALCULATED PRESSURE RANGE OF THE TRANFERRED WASTE HAS BEEN INCREASED.

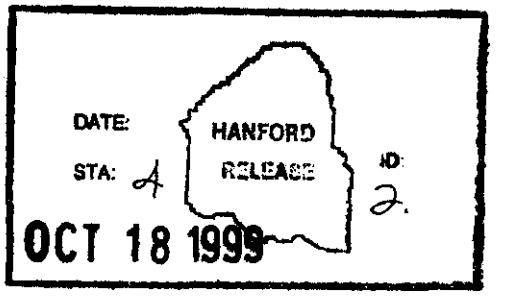
Set Point Calculations for RAPID Project

G. L. Hickman, Flour Daniel Northwest, Inc.
Lockheed Martin Hanford Company, Richland, WA 99352
U.S. Department of Energy Contract DE-AC06-96RL13200

EDT/ECN: 653987 **UC:** 2030
Org Code: 79000 **Charge Code:** HN4851-23 108976/ BA10
B&R Code: EW3120071 **Total Pages:** 57

Key Words: RAPID, waste transfer; SY-Farm, 241-SY-101, Set-Points, Set Range

Abstract: The Respond and Pump in Days (RAPID) project was initiated to pump part of the contents of tank 241-SY-101 into tank 241-SY-102. This document establishes the basis for all set points and ranges used in the RAPID project.



10/18/99
Release Approval — Date

Release Stamp

Approved for Public Release

RECORD OF REVISION

(1) Document Number: HNF-4972

(2) Title: SET-POINT CALCULATION FOR RAPID PROJECT

Change Control Record

(3) Revision	(4) Description of Change - Replace, Add, and Delete Pages	Authorized for Release	
		(5) Cog. Engr.	(6) Cog. Mgr. Date
0	(7) EDT 627421	MF ERHART	RW REED
1	ECN 653968 ADDED NUMEROUS EDITORIAL AND OTHER MINOR CHANGES TO THE OVERALL DOCUMENT ADDED		
	SECTIONS FOR THE HOUR METERS AND PRESSURE RELIEF DEVICES. REMOVED HOLDS HNT-5087, -5088,AND -5089	MF ERHART	RW REED
2 RS	MADE EXTENSIVE REVISIONS TO FQIT-367,TIC-410,HT1, HT2,TC-411,TIC-413,TIC-414,TIC-415, AND PI-368		
	MADE NUMEROUS EDITORIAL CHANGES THROUGHOUT THE DOCUMENT. AFFECTED PAGES i-6, 8-10,12,18-20,22-25		
	28,30,35,40-44,46,48-49,51,53-54,11,14,15 ECN-653987 653987 ST-10-18-99.	MF ERHART MF Erhart	RW REED 13Oct99 RW Reed

TABLE OF CONTENTS

SET POINT CALCULATIONS FOR THE RAPID PROJECT

1.0 INTRODUCTION

There are 25 instrument and/or control loops utilized by the Respond and Pump in Days (RAPID) project. These range from the simple indication loop with two components to complex indication, control, and alarm loops with up to eight components. Several loops include safety class elements. This document is intended to describe the loops in full and to provide the basis for each of the element setpoints, ranges and accuracies identified in the RAPID project Master Equipment List (MEL). These values are developed in two steps. First, the base value is identified with reference to the supporting document providing that value. Second, a spreadsheet calculation is performed on each element and loop, utilizing a standard methodology described below, that takes into account known and suspected variance in output and establishes the actual setpoint used on a given element. The results of the spreadsheet are reported directly in this document.

This document is organized as follows. A summary of this document with all setpoints, ranges, and loop accuracies is given in Section 2. Section 3 has a detailed explanation of the methodology for determining the setpoint and allowable value for each element and/or loop. Section 4 has a detailed description of each loop, including the way an error provided by any given element cascades through the rest of the loop. Within each loop section, the base value for the setpoint is defined and the results of the setpoint and allowable limit calculation are given. Setpoint values for pressure relief devices are found in Section 5. References are found in Section 6.

2.0 DOCUMENT RESULTS

Values calculated and presented in this document are based on the best available information during the design phase of this project. It is recognized that system testing and actual transfers will likely result in the need to adjust some of the values given.

Tag/EIN	Set Range	Set Point	Calibration Tolerance	Display Accuracy (Absolute)	Display Accuracy %
SY272-WT-VFD-350	0-130A	N/A	N/A	N/A	N/A
SY461-WT-II-350	0-130A	N/A	4%	+/- 5.24 A	+/- 4.0%.
SY101-WT-FE-367	0-310 GPM	N/A	(1)	N/A	N/A
SY101-WT-FQIT-367 (2)	0-310 GPM	N/A	5.00%	+/- 15.5 GPM (4)	+/- 12.9 %
SY101-WT-FQIT-367 (3)	0-10^9 Gal.	N/A	5.00%	N/A	+/- 5.02% (5)
SY101-WT-FI-367A	0-310 GPM	N/A	1.00%	+/- 17.36 GPM (4)	+/- 14.5% (4)
SY461-WT-FI-367B	0-310 GPM	N/A	N/A	N/A	N/A
SY461-WT-FQI-367	0-10^9 Gal.	N/A	N/A	N/A	N/A
(1) The element is integral to the transmitter. Calibration and accuracy are dealt with on the transmitter.					
(2) As a flow rate.					
(3) As a flow total.					
(4) Accuracy rating assumes flow rate above 20% of full scale.					
(5) Reading accuracy assumes flow rate above 20% of full scale and is listed as a percent of flow.					

Continued on following page

Tag/EIN	Set Range	Set Point	Calibration Tolerance	Display Accuracy (Absolute)	Display Accuracy %
Continued from previous page					
POR32-RW-FE-418	0-30 ft/s	N/A	(1)	N/A	N/A
POR32-RW-FQIT-418 (2)	0-273 gpm	N/A	N/A	N/A	N/A
POR32-RW-FQIT-418 (3)	0-10^9 gal	N/A	N/A	N/A	N/A
POR32-RW-FI-418	0-273 gpm	N/A	N/A	N/A	N/A
POR32-RW-FQI-418	0-10^9 gal	N/A	N/A	N/A	N/A
POR32-RW-FE-419	0-30 ft/s	N/A	(1)	N/A	N/A
POR32-RW-FQIT-419 (2)	0-273 gpm	N/A	1% (8)	+/- 2.81 GPM	+/- 4.68% (10)
POR32-RW-FQIT-419 (3)	0-10^9 gal	N/A	1% (9)	N/A	+/- 1.16%
SY101-WT-FI-419	0-273 gpm	N/A	1% (8)	+/- 8.15 GPM	+/- 13.58% (10)
SY461-RW-FIY-419 (4)	0-273 gpm	N/A	1% (8)	+/- 3.92 GPM	+/- 6.53% (10)
SY461-RW-FIY-419 (5)	N/A	65 gpm	1% (8)	N/A	N/A
SY461-RW-FIY-419 (6)	N/A	25 gpm	1% (8)	N/A	N/A
SY461-RW-FAH-419 (5)	N/A	N/A	N/A	N/A	N/A
SY461-RW-FAL-419 (6)	N/A	N/A	N/A	N/A	N/A
POR32-RW-HM-401	0-10^4 hrs	N/A	N/A	N/A	N/A
POR32-RW-HM-402	0-10^4 hrs	N/A	N/A	N/A	N/A
SY101-WT-LDE-365	N/A	5/8"	N/A	N/A	N/A
SY101-WT-LDSTA-365	N/A	10 k ohm	N/A	N/A	N/A
LDK-365 (7)	N/A	N/A	N/A	N/A	N/A
SY101-WT-LDA-365A (7)	N/A	N/A	N/A	N/A	N/A
SY461-WT-LDA-365B (7)	N/A	N/A	N/A	N/A	N/A
SY101-WT-LDE-366	N/A	1/2"	N/A	N/A	N/A
SY101-WT-LDSTA-366	N/A	10 k ohm	N/A	N/A	N/A
LDK-366 (7)	N/A	N/A	N/A	N/A	N/A
SY101-WT-LDA-366A (7)	N/A	N/A	N/A	N/A	N/A
SY461-WT-LDA-366B (7)	N/A	N/A	N/A	N/A	N/A
(1) The element is integral to the transmitter. Calibration and accuracy are dealt with on the transmitter.					
(2) As a flow rate.					
(3) As a flow total.					
(4) As a flow indicator					
(5) As a high flow switch					
(6) As a low flow switch					
(7) Leak Detector Alarms are triggered by resistance between the electrodes dropping below 10 k ohm. Any liquid waste reaching both electrodes would drop the resistance below the trigger point, causing the alarms to annunciate.					
(8) Tolerance is 1% of full scale when flow is above 20% of full scale.					
(9) Tolerance is 1% of reading					
(10) % of reading at 60gpm.					
Continued on following page					

Tag/EIN	Set Range	Set Point	Calibration Tolerance	Display Accuracy (Absolute)	Display Accuracy %
Continued from previous page					
POR32-RW-LE-416 (1)	N/A	N/A	N/A	N/A	N/A
POR32-RW-LAHH-416 (1)	N/A	74"	N/A	N/A	N/A
POR32-RW-LAH-416 (1)	N/A	64"	N/A	N/A	N/A
POR32-RW-LAL-416 (1)	N/A	36"	N/A	N/A	N/A
POR32-RW-LALL-416 (1)	N/A	30"	N/A	N/A	N/A
SY101-WT-PE-368	N/A	N/A	N/A	N/A (5)	N/A
SY101-WT-PI-368	0-200 psig	N/A	N/A	N/A	N/A
SY101-WT-PS-370	N/A	15 psig	5% (3)	N/A	NA
SY101-WT-PAH-370A	N/A	N/A	N/A	N/A	NA
SY461-WT-PAH-370B	N/A	N/A	N/A	N/A	NA
SY101-WT-PS-371	N/A	15 psig	5% (3)	N/A	NA
SY101-WT-PAH-371A	N/A	N/A	N/A	N/A	NA
SY461-WT-PAH-371B	N/A	N/A	N/A	N/A	NA
POR32-RW-PIT-417	0-250 psig	N/A	5% (2)	+/- 12.51 psig	+/-6.25% (4)
POR32-RW-PI-417	0-250 psig	N/A	5% (2)	+/- 17.97 psig	+/-8.99% (4)
POR32-RW-PE-420	NA	N/A	N/A	N/A (5)	N/A
SY101-WT-PI-420	0-250 psig	N/A	5% (2)	+/- 12.5 psig	+/- 6.25% (4)
SY101-WT-TE-369	N/A	N/A	N/A	N/A	N/A
SY101-WT-TT-369	32-212°F	N/A	1% (2)	N/A	N/A
SY101-WT-TI-369A	32-212°F	N/A	1% (2)	+/- 7.76°F	+/-5.96% (6)
SY461-WT-TI-369B	32-212°F	N/A	1% (2)	+/- 3.05°F	+/-2.35% (6)
(1) The level element has four independent trip points, set at the values shown for the alarms.					
(2) As a percent of full scale					
(3) As a percent of setpoint					
(4) At 200 psig					
(5) Calibrated with the pressure indicator. Calibration tolerance is incorporated in the pressure indicator.					
(6) At 130°F					
Continued on following page					

Tag/EIN	Set Range	Set Point	Calibration Tolerance	Display Accuracy (Absolute)	Display Accuracy %
Continued from previous page					
SY101-WT-TE-373	N/A	N/A	N/A	N/A	N/A
SY101-WT-TT-373	32-212°F	N/A	1% (1)	N/A	N/A
SY101-WT-TI-373	32-212°F	N/A	1% (1)	+/- 7.76°F	+/- 5.97% (2)
SY461-RW-TIY-373	32-212°F	N/A	1% (1)	+/- 3.06°F	+/- 2.35% (2)
SY101-WT-TAL-373A	N/A	114°F	N/A	N/A	N/A
SY101-WT-TAL-373B	N/A	114°F	N/A	N/A	N/A
POR32-RW-TC-401	N/A	N/A	N/A (3)	N/A	N/A
POR32-RW-AC-401	N/A	N/A	N/A (3)	N/A	N/A
POR32-RW-TE-410	N/A	N/A	N/A	N/A	N/A
POR32-RW-TIC-410	32-212°F	125°F	5% (4)	+/- 27.7°F	+/- 21.31% (2)
POR32-RW-TE-411A	N/A	N/A	N/A	N/A	N/A
POR32-RW-TE-411B	N/A	N/A	N/A	N/A	N/A
POR32-RW-TC-411	32-212°F	Control Point = 118°F Shut Off = 132°F (5)	5% (4)	N/A	N/A
POR32-RW-TE-412	N/A	N/A	N/A	N/A	N/A
POR32-RW-TI-412	32-212°F	N/A	5% (4)	+/- 27.7°F	+/- 21.31% (2)
POR32-RW-TE-413	N/A	N/A	N/A	N/A	N/A
POR32-RW-TIC-413	32-212°F	125°F	5% (4)	+/- 27.7°F	+/- 21.31% (2)
POR32-RW-TE-414	N/A	N/A	N/A	N/A	N/A
POR32-RW-TIC-414	32-212°F	125°F	5% (4)	+/- 27.7°F	+/- 21.31% (2)
POR32-RW-TE-415	N/A	N/A	N/A	N/A	N/A
POR32-RW-TIC-415	32-212°F	125°F	5% (4)	+/- 27.7°F	+/- 21.31% (2)
TS-HT1	N/A	140°F	N/A (3)	N/A	N/A
TS-HT2	N/A	140°F	N/A (3)	N/A	N/A
Continued on following page					

(1) As a percent of full scale

(2) At 130°F

(3) Factory calibrated, will not be field calibrated

(4) As percent of span

(5) Control Point is maintained by operations and is a recommendation only. Shut off value is an operational limit.

Tag/EIN	Set Range	Set Point	Calibration Tolerance	Display Accuracy (Absolute)	Display Accuracy %
Continued from previous page					
POR32-RW-PRV-401	N/A	200 psig	N/A	N/A	N/A
POR32-RW-PRV-402	N/A	200 psig	N/A	N/A	N/A
POR32-RW-PRV-403	N/A	200 psig	N/A	N/A	N/A

3.0 SETPOINT CALCULATION METHODOLOGY

The primary basis for the methodology used in this document is a draft instruction for instrument setpoint calculations provided by Equipment Engineering. It is based on ANSI/ISA-S67.04-Part I-1994, "Setpoints for Nuclear Safety-Related Instrumentation."

The first step is to identify and quantify each of the various uncertainties associated with each element in an instrument loop or channel. These may include reference accuracy, temperature effect, radiation effect, seismic effect, humidity effect, calibration uncertainty, power supply effect, and drift. In addition, any known bias is quantified. From these values, two calculations are performed on each element. The first is a square root of the sum of squares of all the uncertainties, resulting in an accuracy value for a given element. The second is a drift calculation, which is simply the manufacturers drift value in percent of the upper range limit (URL) multiplied by the URL divided by the span. This value is multiplied by the expected time interval for the instrument to be used divided by the manufacturers time interval. These two calculations provide the element accuracy and drift for any given element. It should be noted that most instruments used in this system have no measurable drift. They are either solid state devices or items that do not drift. The effect of drift is only calculated for those instruments with published drift data.

From the above values, a channel or loop drift can be calculated using a square root of the sum of the squares methodology. Loop accuracy is similarly defined as the square root of the sum of squares of the loop elements, plus the combined element bias. The total channel or loop uncertainty is then the square root of the sum of the squares of the channel accuracy and drift, plus the total bias. From this value the trip setpoint is found by adding the base alarm or control setpoint with the channel uncertainty and the margin. The allowable value is found by adding the trip setpoint with the channel uncertainty.

4.0 LOOP DESCRIPTION AND SETPOINT DEFINITION

4.1 CURRENT LOOP

4.1.1 NEXT GENERATION TRANSFER PUMP AMPERAGE DRAW, LOOP 350

LOOP DESCRIPTION

This is a simple indication loop composed of the sensing element and an indicator. The sensing element in this system is SY272-WT-VFD-350, which sends a 4-20mA signal proportional to the motor current to SY461-WT-II-350. SY461-WT-II-350 converts the 4-20mA signal into a digital display of 0-130A.

SETPOINT BASIS

The motor is capable of drawing between 0 and 120 A. The indication on SY461-WT-II-350 is intended for diagnostic purposes only and qualitative values will be sufficient. As such, a display accuracy of ±5% is considered sufficient.

SETPOINT VALUES

The primary consideration is that the current level used by the transfer pump SY101-WT-P-350 is correctly displayed on SY461-WT-II-350. As such, the 4-20mA input to SY461-WT-II-350 has been set to display 0-130A which envelops the expected amperage draw of SY101-WT-P-350.

The accuracy of the SY272-WT-VFD-350 is derived below:

VFD-350 ACCURACY		Robicon	ID-PWM454GT, 125 hP
	Common Unit Value, Amps		Source/Reason
	Random	Bias	
Reference Uncertainty	0.13		Based on a phone call with Koley Engineered Products, Inc., the accuracy of the 4-20mA output is 10 bit accuracy (.1%). Output range is 4-20mA for 0-130A draw on the pump. .1% of 130A is .13A
Temperature Effect	0.00		Temperature in the cabinet is within the limits of the VFD (0-40C ambient), no effect.
Radiation Effect	0		VFD is in a low radiation environment
Seismic/Vibration	0		System is shut down on seismic events, no impact.
Humidity Effect	0		Allowable humidity is 95%, non condensing. The MCC is a low humidity environment.
Calibration Uncertainty	0.65		Device will not be calibrated. Factory calibration is assumed to be within .5%
Power Supply Effect	0		VFD requires 460/480 VAC +/- 10%. No effect.
Element Accuracy	0.66	0	

The accuracy of SY461-WT-II-350 is derived below:

II-350 ACCURACY		Newport Electronics	INFP-0210-C2
	Common Unit Value, Amps		Source/Reason
	Random	Bias	
Reference Uncertainty	0.0065		.005% of reading. Maximum value of 130A used.
Temperature Effect	0.00		The accuracy is based on a 25C temperature. Span error is 20 ppm/C. The 350B panel is assumed to have a maximum temperature of 92F, or 8.33C above 25C. The error is expected to be no greater than 0.0002 A
Radiation Effect	0		DACs is a low radiation environment, no effect anticipated.
Seismic/Vibration	0		System is shut down on seismic events, no impact.
Humidity Effect	0		Device is rated for 95% non condensing at 40C. Low Humidity environment, no effect.
Calibration Uncertainty	5.2		4% of full scale (5.2A)
Power Supply Effect	0		As long as within required values on voltage supply, no effect. Voltage range for the instrument is 115V+/- 10% and 49 to 100 Hz.
Element Accuracy	5.20	0	

The display accuracy of SY461-WT-II-350 is a combination of both SY272-WT-VFD-350 and SY461-WT-II-350 and is given in the table below:

II-350 Loop Accuracy		
	Value	Units
Loop Accuracy	5.24	Amps
Loop Drift	0	Amps
Total Loop Uncertainty	5.24	Amps

This gives a worst case inaccuracy of 5.24 A at 130 A draw. This value equates to just over 4% error at full scale.

4.2 FLOW LOOPS

4.2.1 WASTE TRANSFER FLOW RATE AND TOTALIZER, LOOP 367

LOOP DESCRIPTION

This loop is composed of a sensing element, SY101-WT-FE-367, a flow indicating totalizer, SY101-WT-FQIT-367, a total flow display, SY461-WT-FQI-367, and two flow indicators, SY101-WT-FI-367A and SY461-WT-FI-367B. SY101-WT-FE-367 is located in the prefabricated pump pit, SY101-WT-ENCL-350. SY101-WT-FQIT-367 is mounted just outside the transfer pump pit control panel, SY101-WT-CP-350A. SY101-WT-FI-367A is mounted on SY101-WT-CP-350A. SY461-WT-FQI-367 and SY461-WT-FI-367B are mounted on the DACS trailer control panel, SY461-WT-CP-350B.

SY101-WT-FE-367 converts the flow into a series of pulses proportional to the flow rate and sends the pulses to SY101-WT-FQIT-367. SY101-WT-FQIT-367 converts the pulsed signal into a digital display of the flow rate or a flow total. It also sends a pulsed signal to SY461-WT-FQI-367. SY101-WT-FQIT-367 also outputs a 4-20mA signal to both SY101-WT-FI-367A and SY461-WT-FI-367B. SY461-WT-FQI-367 converts the pulsed signal received from SY101-WT-FQIT-367 into a digital display representing total flow. Both SY101-WT-FI-367A and SY461-WT-FI-367B convert the 4-20mA signal received from SY101-WT-FQIT-367 into a digital display of the flow rate.

SETPOINT BASIS

SY101-WT-FQIT-367 and SY101-WT-FI-367A are to be used for process control and material balance. SY101-WT-FI-367A will be calibrated. SY101-WT-FQIT-367 will be functionally checked and its accuracy verified by comparison to POR32-RW-FQIT-419. SY461-WT-FQI-367 and SY461-WT-FI-367B are for information only and will not be calibrated. The error is checked during transfer by doing material balance calculations in accordance with the process control plan.

There are two types of information presented in this loop, the flow rate, and the total flow. The principle consideration for the flow rate in this section of the transfer process is to maintain flow at greater than 6 ft/s (Process Control Plan, HNF-4264, Rev. 0, Section 2.1.3) to prevent settling in the line. The anticipated flow rates are between 90 gpm and 180 gpm, with a nominal value of 120 gpm (Process Control Plan, HNF-4264, Rev. 0, Section 8.3.1). This is based on dilution ratios between 0.5 and 2:1 of water and waste and a waste flow rate of 60 gpm. Technically, there is no upper limit on the flow rate other than pump capabilities. The maximum pump rate of the dilution pump is 70 gpm leading to a maximum flow rate of 210 gpm based on a 2:1 dilution ratio (Process Control Plan, HNF-4264, Rev. 0, Section 5.7). As such, the flow rate base values for SY101-WT-FQIT-367, SY101-WT-FI-367A, and SY461-WT-FI-367B are 0-210gpm.

The flow totalization function of SY101-WT-FQIT-367 is merely a displayed value. The critical element of a totalizer is that the maximum displayed value exceeds the expected total flow. The total flow transferred is anticipated to be 200kgal (Process Control Plan, HNF-4264, Rev. 0, Section 1). Enveloping values would require a display of a maximum of 450kgal. This is based on a maximum anticipated waste transfer of 150kgal (Process Control Plan, HNF-4264, Rev. 0, Section 7.0) and a dilution ratio of 2:1. The total flow on SY101-WT-FQIT-367 and SY461-WT-FQI-367 can be displayed to 9 digits.

SETPOINT VALUES

There are four points where data is displayed. The four points are SY101-WT-FQIT-367, SY461-WT-FQI-367, SY101-WT-FI-367A and SY461-WT-FI-367B. SY101-WT-FQIT-367 presents two separate types of information, flow rate and total flow. SY101-WT-FI-367A provides flow rate information. Accuracy and calibration information for SY101-WT-FQIT-367 and SY101-WT-FI-367A are presented below. SY461-WT-FQI-367 and SY461-WT-FI-367B are for information only, they will not be calibrated and no accuracy information is developed.

The accuracy of SY101-WT-FE-367 is incorporated in the accuracy of SY101-WT-FQIT-367. When SY101-WT-FQIT-367 acts in a total flow display mode the accuracy is calculated as follows:

FQIT-367 ACCURACY		Yokogawa	AE14-DA1A/FF1/FN1
	Common Unit Value, %		Source/Reason
	Random	Bias	
Reference Uncertainty	0.5		+/-0.5% of reading
Temperature Effect	0.00		This Yokogawa instrument is rated for -20 to 60C. The expected temperature is within the limits of the device, therefore no effect.
Radiation Effect	0		Radiation should have no effect on the flow element. The transmitter is located in a low radiation environment. No effect.
Seismic/Vibration	0		System is shut down on seismic events, no impact.
Humidity Effect	0		This unit is rated between 5 and 95%, non-condensing humidity. It is installed in a low humidity environment, no effect.
Calibration Uncertainty	5		5% of full scale. This encompasses error from the M&TE equipment used, including FQIT-419. (4x1.16%)
Power Supply Effect	0		The Yokogawa is rated to receive 100 to 240VAC at 47-63 Hz. As long as within required values on voltage supply, there is no effect.
Element Accuracy	5.02	0	

The accuracy of the display is given below:

FQIT-367 Loop Accuracy		
	Value	Units
Loop Accuracy	5.02	%
Loop Drift	0	%
Total Loop Uncertainty	5.02	%

This indicates that the total flow displayed on SY101-WT-FQIT-367 gives a total flow accuracy of 5.02% of total flow. It is understood that this value represents idealized conditions. These conditions, primarily at start up and shut down, are far from ideal. Variations are not quantifiable but are to be expected.

The accuracy of the flow rate displayed on SY101-WT-FQIT-367 is calculated below:

FQIT-367 ACCURACY		Yokogawa	AE14-DA1A/FF1/FN1
	Common Unit Value, GPM		Source/Reason
	Random	Bias	
Reference Uncertainty	0		Included in the calibration uncertainty.
Temperature Effect	0.00		This Yokogawa instrument is rated for -20 to 60C. The expected temperature is within the limits of the device, therefore no effect .
Radiation Effect	0		Radiation should have no effect on the flow element. The transmitter is located in a low radiation environment. No effect.
Seismic/Vibration	0		System is shut down on seismic events, no impact.
Humidity Effect	0		This unit is rated between 5 and 95%, non condensing humidity. It is installed in a low humidity environment, no effect.
Calibration Uncertainty	15.5		5% of full scale. This encompasses error from the M&TE equipment used, including FQIT-419. (4x2.81gpm)
Power Supply Effect	0		The Yokogawa is rated to receive 100 to 240VAC at 47-63 Hz. As long as within required values on voltage supply, there is no effect.
Element Accuracy	15.5	0	

The overall loop accuracy is then found:

FQIT-367 Loop Accuracy		
	Value	Units
Loop Accuracy	15.5	GPM
Loop Drift	0	GPM
Total Loop Uncertainty	15.5	GPM

This indicates that flow rate readings on SY101-WT-FQIT-367 can be expected to read within 15.5 gpm. At a normal flow of 120 gpm, this display is within ±12.9%.

Inaccuracies from SY101-WT-FQIT-367 will cascade down to SY101-WT-FI-367A. The accuracy of the flow rate displayed on SY101-WT-FI-367A, using the above values from SY101-WT-FQIT-367, is calculated below:

FI-367A ACCURACY		Newport Electronics	558B-ET-IS1-SPC18
	Common Unit Value, GPM		Source/Reason
	Random	Bias	
Reference Uncertainty	1.21		.1% of flow rate, plus one digit. Conservatively assumed maximum flow of 210 gpm.
Temperature Effect	7.08		The accuracy is based on a 25C temperature. Zero error is +/- .3 count/C. Span error is .015% Span/C. These two errors can be combined using the square root of the sum of the squares method. The 350A panel is assumed to have a self heating temperature rise of 15F. The Functional Requirements Document gave an acceptable ambient transfer temperature range of 20-100F. The greatest temperature difference is 23.33C. Based on these extremes and the equations, a maximum error is 7.08 gpm and occurs at 20F with a maximum flow of 210 gpm and a span of 310gpm.
Radiation Effect	0		The panel meter is located in a low radiation environment.
Seismic/Vibration	0		System is shut down on seismic events, no impact.
Humidity Effect	0		The panel meter is rated for 95% humidity, at 40C. It is located in a low humidity environment, no effect
Calibration Uncertainty	3.1		1% of full scale (310gpm)
Power Supply Effect	0		As long as within required values on voltage supply, no effect.
Element Accuracy	7.82	0	

The overall loop accuracy is then found:

FI-367A Loop Accuracy		
	Value	Units
Loop Accuracy	17.36	GPM
Loop Drift	0	GPM
Total Loop Uncertainty	17.36	GPM

This gives a maximum error of any reading of SY101-WT-FI-367A as 17.36 gpm. At an average flow rate of 120gpm, this represents a 14.5% error.

4.2.2 DILUTION WATER FLOW RATE AND TOTALIZER, WATER SKID, LOOP 418

LOOP DESCRIPTION

This loop is composed of a sensing element, POR32-RW-FE-418, a flow indicating totalizer, POR32-RW-FQIT-418, a total flow display, POR32-RW-FQI-418, and a flow indicator, POR32-RW-FI-418. POR32-RW-FE-418 and POR32-RW-FQIT-418 are located on the water skid. POR32-RW-FQI-418 and POR32-RW-FI-418 are mounted in the water support skid electrical enclosure, POR32-RW-CP-401.

POR32-RW-FE-418 converts the flow into a series of pulses proportional to the flow rate and sends the pulses to POR32-RW-FQIT-418. POR32-RW-FQIT-418 converts the pulsed signal into a digital display of the flow rate or a flow total. It also sends a 4-20mA signal to both POR32-RW-FQI-418 and POR32-RW-FI-418. POR32-RW-FQI-418 converts the 4-20mA signal received from POR32-RW-FQIT-418 into a digital display of the total flow. POR32-RW-FI-418 converts the 4-20mA signal received from POR32-RW-FQIT-418 into a digital display of the flow rate.

SETPOINT BASIS

Information displayed by POR32-RW-FQIT-418, POR32-RW-FQI-418, and POR32-RW-FI-418 are for information only and these instruments will not be calibrated.

4.2.3 DILUTION WATER FLOW RATE AND TOTALIZER, VALVE STAND, LOOP 419

LOOP DESCRIPTION

This loop is composed of a sensing element, POR32-RW-FE-419, a flow indicating totalizer, POR32-RW-FQIT-419, a flow indicator, SY101-WT-FI-419, a flow indicator with contacts out SY461-RW-FIY-419, two relays, 2K2 and 2K3, and two windows on annunciator SY461-WT-ANN-350B, SY461-RW-FAL-419 and SY461-RW-FAH-419. POR32-RW-FE-419 and POR32-RW-FQIT-419 are located on the water supply valve and instrumentation stand assembly skid. POR32-RW-FI-419 is located in the SY-101 transfer pump pit control panel, SY101-WT-CP-350A. SY461-RW-FIY-419, relays 2K2 and 2K3, SY461-RW-FAL-419 and SY461-RW-FAH-419 are mounted in the DACS trailer control panel, SY461-WT-CP-350B.

POR32-RW-FE-419 converts the flow into a series of pulses proportional to the flow rate and sends the pulses to POR32-RW-FQIT-419. POR32-RW-FQIT-419 converts the pulsed signal into a digital display of the flow rate or a flow total. It also sends a 4-20mA signal to both SY101-WT-FI-419 and SY461-RW-FIY-419. SY101-WT-FI-419 converts the 4-20mA signal received from POR32-RW-FQIT-419 into a digital display of the flow rate. SY461-RW-FIY-419 converts the 4-20mA signal received from POR32-RW-FQIT-419 into a digital display of the flow rate and also trips contacts for a low and high flow rate. The tripped contacts on SY461-RW-FIY-419 in turn trip relays 2K2 and 2K3 respectively actuating alarms SY461-RW-FAL-419 and SY461-RW-FAH-419 in SY461-WT-ANN-350B.

SETPOINT BASIS

There are two types of information presented in this loop, the flow rate, and the total flow. Additionally, there are alarm points for both high and low flow. The principle consideration for the flow rate in this section of the transfer process is to provide sufficient diluent to maintain the proper dilution ratios and the minimum flow of 6 ft/s in the transfer line to prevent settling (Process Control Plan, HNF-4264, Rev. 0, Section 2.1.3). The maximum flow rate of diluent is 70 gpm due to pump and heater limitations. The anticipated flow rates are between 30 gpm and 70 gpm, with a nominal value of 60 gpm (Process Control Plan, HNF-4264, Rev. 0, Section 8.3.1). This is based on dilution ratios between 0.5 and 2:1 of water and waste and a projected waste flow rate of 60 gpm. As such, the flow rate base values for POR32-RW-FQIT-419and SY101-WT-FI-419 are 0-70gpm.

The flow totalization function is merely a displayed value of the diluent. The critical element of a totalizer is that the maximum displayed value exceeds the expected total flow. The total waste transferred is anticipated to be 200kgal with an anticipated dilution ration of 1:1 (Process Control Plan, HNF-4264, Rev. 0, Section 1). The maximum anticipated total flow of waste is 150kgal. With a maximum dilution ratio of 2:1, the maximum diluent flow is 300kgal (Process Control Plan, HNF-4264, Rev. 0, Section 7.0). The total flow displayed on for POR32-RW-FQIT-419 exceeds the maximum expected total flow.

The alarm points are based on the minimum and maximum flows of diluent. These values are 20 gpm and 70 gpm respectively. The 20 gpm is defined by the minimum flow rate of 60 gpm to maintain the minimum 6 ft/s flow velocity (Process Control Plan, HNF-4264, Rev. 0, Section 2.1.3) and the minimum dilution ration of .5:1 diluent to waste (Process Control Plan, HNF-4264, Rev. 0, Section 7.2). The maximum flow rate of 70 gpm is a function of the diluent pump and heaters.

SETPOINT VALUES

There are three points where data is displayed in this loop. Flow rate is displayed by POR32-RW-FQIT-419, SY101-WT-FI-419, and SY461-RW-FIY-419. The total flow is only displayed on by POR32-RW-FQIT-419. Alarms for both high and low flows are triggered via SY461-RW-FIY-419.

The accuracy of POR32-RW-FE-419 is incorporated in the accuracy of POR32-RW -FQIT-419. When POR32-RW -FQIT-419 acts in a total flow display mode the accuracy is calculated as follows:

FQIT-419 ACCURACY		Brooks	3525C3B1B111A
	Common Unit Value, %		Source/Reason
	Random	Bias	
Reference Uncertainty	0.5		+/-0.5% of flow rate.
Temperature Effect	0.25		Brooks flow transmitter gives a maximum change of +/-0.25% change over the operating temperature.
Radiation Effect	0		The transmitter and element are located in a low radiation environment, no effect.
Seismic/Vibration	0		System is shut down on seismic events, no impact.
Humidity Effect	0		The transmitter is capable of handling 0-100% humidity at 150F. No effect.
Calibration Uncertainty	1		1% of URL
Power Supply Effect	0		Power requirements are 90-250VAC, 50-60 Hz. No effect.
Element Accuracy	1.15	0	

The drift for this device is calculated below:

FQIT-419 DRIFT		Brooks	3525C3B1B111A
	Value	Units	Source/Reason
Mfr value in % URL	0.1	%	Stability rate of +/- 0.1% per 6 mo.
URL	273	GPM	Flow element limitation
Span	273	GPM	
Test Interval	12	mo.	Recall interval is 1 yr.
Mfr Interval	6	mo.	Brooks has a drift rate given in 6 mo. interval
Element Drift	0.20	%	

The overall display accuracy for total flow is:

FQIT-419 Loop Accuracy		
	Value	Units
Loop Accuracy	1.15	%
Loop Drift	0.2	%
Total Loop Uncertainty	1.16	%

This indicates that the total flow displayed on POR32-RW-FQIT-419 is accurate to within 1.16%. It is understood that this value is given under idealized conditions. The conditions of this system, primarily at start up and shut down are far from ideal. These variations are not quantifiable but are to be expected.

Flow rate is also displayed by POR32-RW-FQIT-419. The accuracy of the display is calculated below:

FQIT-419 ACCURACY		Brooks	3525C3B1B111A
	Common Unit Value, GPM		Source/Reason
	Random	Bias	
Reference Uncertainty	0.35		+/-0.5% of flow rate. The maximum flow rate is 70 gpm. The maximum error is 1.365 gpm at 273 gpm (273x0.5%).
Temperature Effect	0.18		Brooks flow transmitter gives a maximum change of +/-0.25% change over the operating temperature. This equates to 0.175 gpm.
Radiation Effect	0		The transmitter and element are located in a low radiation environment, no effect.
Seismic/Vibration	0		System is shut down on seismic events, no impact.
Humidity Effect	0		The transmitter is capable of handling 0-100% humidity at 150F. No effect.
Calibration Uncertainty	2.73		1% of URL (273 gpm)
Power Supply Effect	0		Power requirements are 90-250VAC, 50-60 Hz. No effect.
Element Accuracy	2.76	0	

The drift of this instrument is given by:

FQIT-419 DRIFT		Brooks	3525C3B1B111A
	Value	Units	Source/Reason
Mfr value in % URL	0.1	%	Stability rate of +/- 0.1% per 6 mo.
URL	273	GPM	Flow element limitation
Span	273	GPM	
Test Interval	12	mo.	Recall interval is 1 yr.
Mfr Interval	6	mo.	Brooks has a drift rate given in 6 mo. interval
Element Drift	0.55	GPM	

The overall accuracy of the flow rate reading on POR32-RW-FQIT-419 is given below:

FQIT-419 Loop Accuracy		
	Value	Units
Loop Accuracy	2.76	GPM
Loop Drift	0.546	GPM
Total Loop Uncertainty	2.81	GPM

This indicates that flow rate readings on POR32-RW-FQIT-419 can be expected to read within 2.81 gpm. At a typical reading of 60 gpm, the displayed value is ±4.68% of the actual flow rate.

Inaccuracies from POR32-RW-FQIT-419 will cascade down to SY101-WT-FI-419 and SY461-RW-FIY-419. The accuracy of the flow rate displayed on SY101-WT-FI-419, using the above values from POR32-RW-FQIT-419, is calculated below:

FI-419 ACCURACY		Newport Electronics	558B-ET-IS1-SPC18
	Common Unit Value, GPM		Source/Reason
	Random	Bias	
Reference Uncertainty	1.07		.1% of flow rate, plus one digit. Conservatively assumed maximum flow of 70 gpm.
Temperature Effect	7.06		The accuracy is based on a 25C temperature. Zero error is +/- .3 count/C. Span error is .015% Span/C. These two errors can be combined using the square root of the sum of the squares method. The 350A panel is assumed to have a self heating temperature rise of 15F. The Functional Requirements Document gave an acceptable ambient transfer temperature range of 20-100F. The greatest tempurature difference is 23.33C. Based on these extremes and the equations, a maximum error is 7.08 gpm and occurs at 20F with a maximum flow of 70 gpm and a span of 273gpm.
Radiation Effect	0		The panel meter is located in a low radiation environment.
Seismic/Vibration	0		System is shut down on seismic events, no impact.
Humidity Effect	0		The panel meter is rated for 95% humidity, at 40C. It is located in a low humidity environment, no effect
Calibration Uncertainty	2.73		1.0% of full scale (273gpm)
Power Supply Effect	0		As long as within required values on voltage supply, no effect.
Element Accuracy	7.65	0	

The accuracy of the readout from SY101-WT-FI-419 is found below:

FI-419 Loop Accuracy		
	Value	Units
Loop Accuracy	8.13	GPM
Loop Drift	0.546	GPM
Total Loop Uncertainty	8.15	GPM

This indicates that flow rate on SY101-WT-FI-419 is within 8.15 gpm. At a reading of 60 gpm, this equates to an error of ±13.58%.

The accuracy of the flow rate displayed on SY461-RW-FIY-419, using the above values from POR32-RW-FQIT-419, is calculated below:

FIY-419 ACCURACY		Newport Electronics	INFP-0210-C2
	Common Unit Value, GPM		Source/Reason
	Random	Bias	
Reference Uncertainty	0.0035		.005% of reading. Maximum value of 70 gpm used.
Temperature Effect	0.00		The accuracy is based on a 25C temperature. Span error is 20 ppm/C. The 350B panel is assumed to have a maximum temperature of 92F, or 8.33C above 25C. The error is expected to be no greater than 0.0002 gpm
Radiation Effect	0		DACs is a low radiation environment, no effect anticipated.
Seismic/Vibration	0		System is shut down on seismic events, no impact.
Humidity Effect	0		Device is rated for 95% non condensing at 40C. Low Humidity environment, no effect.
Calibration Uncertainty	2.73		1% of full scale
Power Supply Effect	0		As long as within required values on voltage supply, no effect. Voltage range for the instrument is 115V+/- 10% and 49 to 100 Hz.
Element Accuracy	2.73	0	

The accuracy of the readout from SY461-RW-FIY-419 is found below:

FIY-419 Loop Accuracy		
	Value	Units
Loop Accuracy	3.88	GPM
Loop Drift	0.546	GPM
Total Loop Uncertainty	3.92	GPM

This indicates that flow rate on SY461-RW-FIY-419 is within 3.92 gpm. At an expected flow rate of 60 gpm, this display is within ±6.53%.

The setpoints for SY461-RW-FAL-419 and SY461-RW-FAH-419 calculated below:

FAL-419 Setpoint		
	Value	Units
Alarm Point	20	GPM
Loop Uncertainty	3.92	GPM
Margin	1	GPM
Setpoint	24.92	GPM
FAH-419 Setpoint		
	Value	Units
Alarm Point	70	GPM
Loop Uncertainty	3.92	GPM
Margin	1	GPM
Setpoint	65.08	GPM

The setpoints for these two alarms will be set at 25 gpm and 65 gpm on SY461-RW-FIY-419.

4.3 HOUR METER LOOPS

4.3.1 WATER SKID PUMP 401 OPERATING TIME, LOOP 401

This is a simple indication loop consisting of a sensing and display meter, POR32-RW-HM-401. It displays the time that pump POR32-RW-P-401 is powered. The purpose of this display is to track the number of hours each pump runs. This loop is for information only and will not be calibrated or maintained. The anticipated duration of a given transfer is between 30 and 80 hours. The display is capable of 99,999.9 hours has sufficient resolution and enough capacity for the application. The hour meter is located in the water skid control panel, POR32-RW-CP-401.

4.3.2 WATER SKID PUMP 402 OPERATING TIME, LOOP 402

This is a simple indication loop consisting of a sensing and display meter, POR32-RW-HM-401. It displays the time that pump POR32-RW-P-401 is powered. The purpose of this display is to track the number of hours each pump runs. This loop is for information only and will not be calibrated or maintained. The anticipated duration of a given transfer is between 30 and 80 hours. The display is capable of 99,999.9 hours has sufficient resolution and enough capacity for the application. The hour meter is located in the water skid control panel, POR32-RW-CP-401.

4.4 LEAK DETECTION LOOPS

4.4.1 PPP LEAK DETECTOR, LOOP 365

This loop is composed of an electrode sensing element, SY101-WT-LDE-365, leak detector circuitry mounted in a cabinet SY101-WT-LDSTA-365, with an alarm strobe mounted on top, LDA-365, a trip relay LDK-365 (1K1), a window on annunciator SY101-WT-ANN-350A, SY101-WT-LDA-365A, and a window on annunciator SY461-WT-ANN-350B, SY461-WT-LDA-365B. SY101-WT-LDE-365 is located in the prefabricated pump pit, SY101-WT-ENCL-350. SY101-WT-LDSTA-365 is freestanding, located near the prefabricated pump pit, SY101-WT-ENCL-350 with LDA-365 mounted on top. LDK-365 (1K1) and SY101-WT-LDA-365A are located in the SY-101 transfer pump pit control panel, SY101-WT-CP-350A. SY461-WT-LDA-365B is mounted in the DACS trailer control panel, SY461-WT-CP-350B.

LOOP DESCRIPTION

In the presence of waste, SY101-WT-LDE-365 will sense a resistance of less than 10kΩ and trip the associated circuitry in SY101-WT-LDSTA-365. The internal circuitry initiates the alarm LDA-365 and

trips relay LDK-365 (1K1). When relay LDK-365 (1K1) is tripped, it causes annunciation of both SY101-WT-LDA-365A and SY461-WT-LDA-365B.

SETPOINT BASIS

The leak detector must detect a presence of waste material within the prefabricated pump pit at a level of 5/8" above the drain (Safety Equipment List for the 241-SY-101 RAPID Mitigation Project, HNF-4531, Rev. 1). It does this with an electrode and associated circuitry designed to trip in the presence of a less than 10kΩ resistance (HNF-SD-WM-ER-736, Intrinsically safe leak detector circuit design description).

SETPOINT VALUES

There are two independent variables associated with accurate detection and annunciation of a leak. These are the position of the electrode and the functionality of the leak detection circuitry. The position of the electrode is set by design and limited to less than 2" in the BIO.

The leak detection circuitry is designed to trip upon the resistance between the electrode dropping below 10kΩ. The resistance of the waste can be expected to be significantly less than 100Ω. As long as the circuit is properly hooked up, powered, and functioning, it will detect the presence of any leak that impacts the electrode. The circuit is failsafe and is tested on a periodic basis to assure continued function. This circuit is not calibratable.

4.4.2 ASSD RISER LEAK DETECTOR, LOOP 366

LOOP DESCRIPTION

This loop is composed of an electrode sensing element, SY101-WT-LDE-366, leak detector circuitry mounted in a cabinet SY101-WT-LDSTA-366, with an alarm strobe mounted on top, LDA-366, a trip relay LDK-366 (1K2), a window on annunciator SY101-WT-ANN-350A, SY101-WT-LDA-366A, and a window on annunciator SY461-WT-ANN-350B, SY461-WT-LDA-366B. SY101-WT-LDE-366 is located in SY102 riser 007 extension. SY101-WT-LDSTA-366 is freestanding, located near the riser extension with LDA-366 mounted on top. LDK-366 (1K2) and SY101-WT-LDA-366A are located in the SY-101 transfer pump pit control panel, SY101-WT-CP-350A. SY461-WT-LDA-366B is mounted in the DACS trailer control panel, SY461-WT-CP-350B.

In the presence of waste, SY101-WT-LDE-366 will sense a resistance of less than 10kΩ and trip the associated circuitry in SY101-WT-LDSTA-366. The internal circuitry initiates the alarm LDA-366 and trips relay LDK-366 (1K2). When relay LDK-366 (1K2) is tripped, it causes annunciation of both SY101-WT-LDA-366A and SY461-WT-LDA-366B.

SETPOINT BASIS

The leak detector must detect a presence of waste material within the anti syphon slurry distributor riser extension at a depth of 1/2" above the drain (Safety Equipment List for the 241-SY-101 RAPID Mitigation Project, HNF-4531, Rev. 1). It does this with an electrode and associated circuitry designed to trip in the presence of a less than 10kΩ resistance (HNF-SD-WM-ER-736, Intrinsically safe leak detector circuit design description).

SETPOINT VALUES

There are two independent variables associated with accurate detection and annunciation of a leak. These are the position of the electrode and the functionality of the leak detection circuitry. The position of the electrode is set by design and limited to less than 2" in the BIO.

The leak detection circuitry is designed to trip upon the resistance between the electrode dropping below 10kΩ. The resistance of the waste can be expected to be significantly less than 100Ω. As long as the circuit is properly hooked up, powered, and functioning, it will detect the presence of any leak that impacts the electrode. The circuit is failsafe and is tested on a periodic basis to assure continued function. This circuit is not calibratable.

4.5 LEVEL LOOP

4.5.1 WATER SKID STORAGE TANK LEVEL INDICATION, LOOP 416

LOOP DESCRIPTION

This loop consists of a sensing element and switch POR32-RW-LE-416, four indicating lights, a high level, POR32-RW-LAH-416, a high high level POR32-RW-LAHH-416, a low level POR32-RW-LAL-416, and a low low level POR32-RW-LALL-416, four alarm strobe lights, a low low level POR32-RW-LALL-416A, a low, high, and high high, POR32-RW-LXA-416A, a second low low , POR32-RW-LALL-416B, a second low, high, and high high, POR32-RW-LXA-416B, and an alarm horn POR32-RW-YAH. POR32-RW-LE-416, POR32-RW-LALL-416B, and POR32-RW-LXA-416B are located on the water support skid. POR32-RW-LAH-416, POR32-RW-LAHH-416, POR32-RW-LAL-416, POR32-RW-LALL-416, POR32-RW-LALL-416A, POR32-RW-LXA-416A, and POR32-RW-YAH-416 are all located in or on the water support skid electrical enclosure POR32-RW-CP-401.

POR32-RW-LE-416 senses the level of raw water in the tank on the water skid. At various levels, switches in POR32-RW-LE-416 change state, causing the various indicator and alarm strobe lights, and the alarm horn to come on.

SETPOINT BASIS

The primary purpose of this loop is to provide indication that the level of the dilution water tank is getting too high or low. There are several concerns related to the level of the tank. These include:

1) The need to retain adequate volumetric capacity to flush the transfer pump and lines. This volume includes flushing the transfer line three times with a total volume of approximately 75 gallons and flushing the transfer pump and prefabricated pump pit piping at approximately 500-600 gallons. This total volume is estimated at 700 gallons.

2) The tank must have the capacity to provide this volume even if the upstream primary heated water source fails.

3) There must be sufficient surge capacity such that inlet water temperature transients are minimized by the large thermal mass of the water in the tank.

4) The maximum level in the tank must be kept below the overflow point.

5) The minimum water level must be sufficient to prevent damage to the heat panels and the fiberglass tank wall.

6) There needs to be sufficient volume in the operating range to prevent nuisance alarms.

The relationship between the level and the volume of the tank is derived as follows:

1) The tank has a seven foot inner diameter and is seven feet high at the intersection between the dome and the wall.

2) The bottom drain is located one inch above the bottom.

3) The top overflow is located five and a half inches below the seven foot level.

This gives an effective available height of 77 ½" (84"-1"-5 ½"). The available volume is approximately 1859 gallons [{$(\pi/4)*(84")^2*77.5"$}/{$231in^3/gal$}]. Divided by the effective height of 77 ½", the height to volume ratio is approximately 1in=24gallons.

SETPOINT VALUES

There are four setpoints associated with this loop. The Magnetrol level switch has an accuracy of approximately 1/16" based on the instrument, the probe, the fluid being measured, and the tank configuration and material. Under the environmental conditions, there are no other significant inaccuracies. The setpoints are based on engineering judgement and the rational is given below. The level setpoints for the tank are primarily for information and as a consequence, the precision of the setpoint is not necessary. Therefore, the values developed will be used rather than developing alarm points that take error and margin into account. These values will take into account the points raised in the previous section. This loop will be functionally checked during operation and will not be calibrated on any scheduled basis.

Low Low Level Setpoint

The value for the low low level setpoint is developed as follows. A minimum of 700 gallons is needed to allow for flushing. 700 gallons is approximately 29". With the 1" offset from the bottom for the drain, a setpoint of 30" is sufficient. It should be noted that the high temperature sensor, POR32-RW-TE-411B is located at 25" up from the bottom of the tank.

Tripping this setpoint is considered an emergency condition. This is the only alarm point which alarms the red strobe lights, POR32-RW-LALL-416A and POR32-RW-LALL-416B. Also tripped are indicating light POR32-RW-LALL-416 and the alarm horn POR32-RW-YAH-416.

Low Level Setpoint

The low level alarm point is set 6" above the low low setpoint, or 36" above the bottom of the tank. The 6" gives approximately 2 ½ minutes for an operator to respond to a low level alarm before the low low alarm engages, assuming no flow into the tank and full flow out. This 2 ½ minutes is a buffer period for the operator to take action to maintain a normal tank level or to terminate the transfer if necessary. This alarm point trips the yellow strobe lights, POR32-RW-LXA-416A and POR32-RW-LXA-416B. Also tripped are indicating light POR32-RW-LAL-416 and the alarm horn POR32-RW-YAH-416. If POR32-RW-SOV-401 is closed, it is opened. Closure could have automatically occurred if the level had reached the high high setpoint.

High Level Setpoint

The high level alarm point is set 28" above the low level setpoint, or 64" above the bottom of the tank. This corresponds to an additional 672 gallons of water. Typically the operator will throttle the globe valve POR32-RW-V-401, to control flow into the tank such that the inflow and outflow are balanced. If the tank is at midpoint between high and low level (50"), it would take an error of 15% (10gpm) approximately 34 minutes to reach an alarm point. This should provide sufficient time for operators to make adjustments.

This alarm point trips the yellow strobe lights, POR32-RW-LXA-416A and POR32-RW-LXA-416B. Also tripped are indicating light POR32-RW-LAH-416 and the alarm horn POR32-RW-YAH-416.

High High Level Setpoint

The high high level alarm point is set 10" above the high level setpoint, or 74" above the bottom of the tank. At 74", the highest operational level in the tank, the water is approximately 4 inches below the overflow level. This additional volume above the high setpoint provides the operator with approximately 24 minutes of time to correct the flow rates, based on a 10gpm flow rate surplus. Once the alarm engages, POR32-RW-V-401 closes and the yellow strobe lights, POR32-RW-LXA-416A and POR32-RW-LXA-416B are engaged. Also tripped are indicating light POR32-RW-LAHH-416 and the alarm horn POR32-RW-YAH-416.

A longer buffer period of 10 inches between the high level and the high high level, as opposed to the 6 inches used between the low and low low levels, is needed due to other operational concerns. Closing POR32-RW-SOV-401stops the inflow of dilution water. When the flow drops below 15 gpm, the low flow interlock for flow from the heater to the water skid tank will turn off the heaters. The heaters must be manually reset following the reestablishment of flow. POR32-RW-SOV-401 is reopened when the tank has drained to the low level setpoint. It would take approximately 15 minutes to drop the level of the tank from the high high setpoint to the low setpoint assuming 60 gpm outflow. This is sufficient time for the hot water heaters to cool down and allow temperatures of the diluent to drop below acceptable values.

The tank has adequate surge capacity to overcome temperature transients. As an example, if the tank is at the midpoint, 50", at 130°F, it would take 4 minutes adding 32°F water, to drop the temperature of the tank twenty degrees.

4.6 PRESSURE LOOPS

4.6.1 WASTE TRANSFER PRESSURE IN THE PPP, LOOP 368

LOOP DESCRIPTION

This is a simple indication loop, consisting of a pressure element, SY101-WT-PE-368 and a pressure indicator, SY101-WT-PI-368. SY101-WT-PE-368 is located in the prefabricated pump pit, SY101-WT-ENCL-350. SY101-WT-PI-368 is located in the SY-101 transfer pump pit control panel, SY101-WT-CP-350A. The pressure element, SY101-WT-PE-368, sends out a millivolt signal proportional to the operating pressure in the piping manifold. The millivolt signal is received by the pressure indicator, SY101-WT-PI-368, which converts it into a digital display in psig.

The primary function of this loop is to provide some indication of flow restriction in the transfer line. This would be identified by a rise in operating pressure, the greater the restriction, the higher the pressure. The expected operating pressure at this point is a function of head loss through the transfer line and is calculated to be 20-100 psig in revision 0E of HNF-4359, the Design Calculation for the SY101 RAPID Mitigation Project. The instrument was initially selected to ensure that it could read over the maximum output pressure of the pump, on the order of 275 psig. Because the expected operating range is significantly lower and accuracy of the reading is not critical, the display range is to be set at 0-200 psig.

SETPOINT VALUES

The information read on SY101-WT-PI-368 is for qualitative, rather than quantitative, purposes. The accuracy of the reading is of little importance. Consequently, the factory calibration of both SY101-WT-PE-368 and SY101-WT-PI-368 is considered sufficient and no further calibration is required.

4.6.2 BACK FLOW WASTE DETECTION IN THE PPP, LOOP 370

LOOP DESCRIPTION

This is primarily an alarm loop to indicate abnormal conditions. It consists of a pressure switch, SY101-WT-PS-370, a relay, PSK-370 (1K3), a window on annunciator SY101-WT-ANN-350A, SY101-WT-PAH-370A, and a window on annunciator SY461-WT-ANN-350B, SY461-WT-PAH-370B. SY101-WT-PE-370 is located in the prefabricated pump pit, SY101-WT-ENCL-350. PSK-370 (1K3) and SY101-WT-PAH-370A are located in the SY-101 transfer pump pit control panel, SY101-WT-CP-350A. SY461-WT-PAH-370B is mounted in the DACS trailer control panel, SY461-WT-CP-350B.

The purpose of this loop is to detect possible waste migration toward the raw water system. If, during a transfer, waste moves back through the flush cross connect line toward prefabricated pump pit supply line, the pressure in that line will increase until it trips SY101-WT-PS-370, opening the NC contact and dropping out relay PSK-370 (1K3). When relay PSK-370 (1K3) is tripped, it causes annunciation of both SY101-WT-PAH-370A and SY461-WT-PAH-370B.

SETPOINT BASIS

The pressure switch is to switch at 15 psig (Safety Equipment List for the 241-SY-101 RAPID Mitigation Project, HNF-4531, Rev. 1). The authorization basis is the BIO, which calls for values less that 20psig. An accuracy of 1.5psig is sufficient, provided the setpoint, coupled with any error and calibration, maintains the values set in the authorization value.

SETPOINT VALUES

The setpoint of SY101-WT-PS-370 is established by examining the accuracy of the pressure switch and giving an acceptable margin. The critical issue is that the 20 psig value established in the BIO cannot be violated. As such, the project SEL gave a setpoint of 15 psig. To ensure that the switch actuates no higher than 15 psig, the actual setpoint is set at 15 psig minus the error and the margin. These values are developed as follows:

PS-370 ACCURACY		SOR	6AP-JF2-U8-C1A-X
	Common Unit Value, PSIG		Source/Reason
	Random	Bias	
Reference Uncertainty	0.3		+/- 0.3 psig per SOR
Temperature Effect	0.00		Ambient temperature limits on the device is -40 to 167F. Anticipated temperature is 130F. No effect.
Radiation Effect	0		This is purely a mechanical device, no anticipated effect due to radiation.
Seismic/Vibration	0		System is shut down on seismic events, no impact.
Humidity Effect	0		No effect.
Calibration Uncertainty	0.75		5% of set point
Power Supply Effect	0		As long as within required values on voltage supply, no effect. Voltage range for the instrument is 115V+/- 10% and 49 to 100 Hz.
Element Accuracy	0.81	0	

As this element has no documented drift, the loop accuracy is purely a function of the switch accuracy:

PS-370 Loop Accuracy		
	Value	Units
Loop Accuracy	0.81	PSIG
Loop Drift	0	PSIG
Total Loop Uncertainty	0.81	PSIG

The setpoint of 15 psig is acceptable.

4.6.3 BACKFLOW WASTE DETECTION IN THE PPP, LOOP 371

LOOP DESCRIPTION

This is primarily an alarm loop to indicate abnormal conditions. It consists of a pressure switch, SY101-WT-PS-371, a relay, PSK-371 (1K4), a window on annunciator SY101-WT-ANN-350A, SY101-WT-PAH-371A, and a window on annunciator SY461-WT-ANN-350B, SY461-WT-PAH-371B. SY101-WT-PE-371 is located in the prefabricated pump pit, SY101-WT-ENCL-350. PSK-371 (1K4) and SY101-WT-PAH-371A are located in the SY-101 transfer pump pit control panel, SY101-WT-CP-350A. SY461-WT-PAH-371B is mounted in the DACS trailer control panel, SY461-WT-CP-350B.

The purpose of this loop is to detect possible waste migration toward the raw water system. If, during a transfer, waste moves back through the flush cross connect line toward prefabricated pump pit supply line, the pressure in that line will increase until it trips the trips SY101-WT-PS-371, opening the NC contact and dropping out relay PSK-371 (1K4). When relay PSK-370 (1K4) is tripped, it causes annunciation of both SY101-WT-PAH-371A and SY461-WT-PAH-371B.

SETPOINT BASIS

The pressure switch is to switch at 15 psig (Safety Equipment List for the 241-SY-101 RAPID Mitigation Project, HNF-4531, Rev. 1). The authorization basis is the BIO, which calls for values less that 20psig. An accuracy of 1.5psig is sufficient, provided the setpoint, coupled with any error and calibration, maintains the values set in the authorization value.

SETPOINT VALUES

The setpoint of SY101-WT-PS-371 is established by examining the accuracy of the pressure switch and giving an acceptable margin. The critical issue is that the 20 psig value established in the BIO cannot be violated. As such, the project SEL gave a setpoint of 15 psig. To ensure that the switch actuates no higher than 15 psig, the actual setpoint is set at 15 psig minus the error and the margin. These values are developed as follows:

PS-371 ACCURACY		SOR	6AP-JF2-U8-C1A-X
	Common Unit Value, PSIG		Source/Reason
	Random	Bias	
Reference Uncertainty	0.3		+/- 0.3 psig per SOR
Temperature Effect	0.00		Ambient temperature limits on the device is -40 to 167F. Anticipated temperature is 130F. No effect.
Radiation Effect	0		This is purely a mechanical device, no anticipated effect due to radiation.
Seismic/Vibration	0		System is shut down on seismic events, no impact.
Humidity Effect	0		No effect.
Calibration Uncertainty	0.75		5% of set point
Power Supply Effect	0		As long as within required values on voltage supply, no effect. Voltage range for the instrument is 115V+/- 10% and 49 to 100 Hz.
Element Accuracy	0.81	0	

As this element has no documented drift, the loop accuracy is purely a function of the switch accuracy:

PS-371 Loop Accuracy		
	Value	Units
Loop Accuracy	0.81	PSIG
Loop Drift	0	PSIG
Total Loop Uncertainty	0.81	PSIG

The setpoint of 15 psig is acceptable.

4.6.4 DILUTION WATER PRESSURE, WATER SKID, LOOP 417

LOOP DESCRIPTION

This is a simple indication loop, consisting of a pressure indicating transmitter, POR32-RW-PIT-417 and a pressure indicator, POR32-RW-PI-417. POR32-RW-PIT-417 is located on the water skid. POR32-RW-PI-417 is mounted in the water support skid electrical enclosure, POR32-RW-CP-401. The pressure indicating transmitter, POR32-RW-PIT-417, converts the pressure of the raw water into a digital display and a proportional 4-20mA signal. The 4-20mA signal is converted to a digital read out, in psig, by the pressure indicator, POR32-RW-PI-417.

SETPOINT BASIS

The design pressure of the water skid piping is set to 200 psig (Procurement Specification, HNF 4043, Section 3.2.2).

SETPOINT VALUES

There are two points where information is displayed on this loop, POR32-RW-PIT-417 and POR32-RW-PI-417. The inaccuracy of the transmitter, POR32-RW-PIT-417, will cascade down and degrade the accuracy of the reading on and POR32-RW-PI-417.

The accuracy of POR32-RW-PIT-417 is given below:

PIT-417 ACCURACY		Yokogawa	EJA-430A-EAS4B-92EA/FF1/D1
	Common Unit Value, PSIG		Source/Reason
	Random	Bias	
Reference Uncertainty	0.1875		Published data gives an accuracy of pressure reading at +/-0.075% of the span. The span is 0-250 psig which gives an error of .1875 psig
Temperature Effect	0.22		The ambient temperature effect is +/-[0.084% of Span + 0.017% URL] for a chage of 50F. These values are combined using the square root of the sum of the squares. With a span of 250 psig and a URL of 430 psig, and conservatively taking worst value, the maximum error is +/- 0.2224 psig
Radiation Effect	0		This element should be stable for the limited duration of radiation exposure.
Seismic/Vibration	0		System is shut down on seismic events, no impact.
Humidity Effect	0		The device is rated for 5-100% RH at 40C. No effect.
Calibration Uncertainty	12.5		5% of full scale.
Power Supply Effect	0.043		+/- 0.005% of URL per volt. Conservatively assume 2 volts.
Element Accuracy	12.50	0	

This device has published drift information and is incorporated below:

PIT-417 DRIFT		Yokogawa	EJA-430A-EAS4B-92EA/FF1/D1
	Value	Units	Source/Reason
Mfr value in % URL	0.1	%	Stability rate of +/- 0.1% of URL per 24 mo.
URL	430	PSIG	0-430 psig
Span	250	PSIG	0-250 psig
Test Interval	12	mo.	Recall interval is 1 yr.
Mfr Interval	24	mo.	Yokogawa has a drift rate given in 24 mo. interval
Element Drift	0.37	PSIG	

Combining these elements, an overall accuracy of the reading is established as follows:

PIT-417 Loop Accuracy		
	Value	Units
Loop Accuracy	12.50	PSIG
Loop Drift	0.3698	PSIG
Total Loop Uncertainty	12.51	PSIG

This gives a maximum uncertainty of the reading on POR32-RW-PIT-417 as ±12.51 psig. At 200 psig, the pressure relief setting, this would be an error of 6.25%.

The accuracy of the pressure displayed on POR32-RW-PI-417 is now developed. The first step is to calculate the element accuracy of POR32-RW-PI-417, and then combine that value with the error from POR32-RW-PIT-417. This is done below:

PI-417 ACCURACY		Red Lion	CUB4LP00
	Common Unit Value, PSIG		Source/Reason
	Random	Bias	
Reference Uncertainty	1.25		Published data gives an accuracy of the reading at +/-(0.1% + 1 digit) at 23C and less than 85% RH. With a span of 0-250 psig this equates to 1.25
Temperature Effect	2.96		Temperature effect error is in two forms. Zero offset at 0.2 digits/C and span error at 100ppm/C. These values are combined using the square root of the sum of the squares method. The temperature in the water skid panel is limited to 100F or 38C. This gives a temperature rise of 15C and an error of 2.96 psig.
Radiation Effect	0		The indicator is in a low radiation environment. No effect.
Seismic/Vibration	0		System is shut down on seismic events, no impact.
Humidity Effect	0		Device is rated for 85% RH max, non condensing from 0-60C. It is mounted in a low humidity environment. No effect.
Calibration Uncertainty	12.5		5% of URL (250 psig)
Power Supply Effect	0		No data available, no anticipated effect.
Element Accuracy	12.91	0	

The combined loop accuracy is given below:

PI-417 Loop Accuracy		
	Value	Units
Loop Accuracy	17.97	PSIG
Loop Drift	0.3698	PSIG
Total Loop Uncertainty	17.97	PSIG

This gives a maximum uncertainty of the reading on POR32-RW-PI-417 as ±17.97 psig. At 200 psig, the pressure relief setting, this would be an error of 8.99%.

4.6.5 DILUTION WATER PRESSURE, VALVE AND INSTRUMENT STAND, LOOP 420

LOOP DESCRIPTION

This is a simple indication loop, consisting of a pressure element, POR32-RW-PE-420 and a pressure indicator, SY101-WT-PI-420. POR32-RW-PE-420 is located on the water supply valve and instrumentation stand assembly skid. SY101-WT-PI-420 is located in the SY-101 transfer pump pit control panel, SY101-WT-CP-350A. The pressure element, POR32-RW-PE-420, sends out a millivolt signal proportional to the operating pressure in the water supply valve and instrumentation stand assembly skid piping. The millivolt signal is received by the pressure indicator, SY101-WT-PI-420, which converts it into a digital display in psig.

SETPOINT BASIS

The design pressure of the valve and instrument stand piping is set to 200 psig (Procurement Specification, HNF 4043, Section 3.2.2).

SETPOINT VALUES

There is one point where data is displayed in this loop. Output pressure is displayed by SY101-WT-PI-420. The accuracy of SY101-WT-PI-420 is affected by the cascading effects of any error found in the output of POR32-RW-PE-420. Each element accuracy is developed below, and then the loop accuracy, as displayed on SY101-WT-PI-368, is developed.

The pressure element, POR32-RW-PE-420, accuracy is given below:

PE-420 ACCURACY		Sensotec	FPG1CN,2U5B6A,1Y
	Common Unit Value, PSIG		Source/Reason
	Random	Bias	
Reference Uncertainty	0.25		Published data gives an accuracy of pressure reading at +/-0.1% of full scale. At a range of 0-250psig maximum error is 0.25 psig.
Temperature Effect	0.00		Conversations with Sensotec indicate that over the temperature range of 30-160F, there is no effect. Waste temperature is within this range.
Radiation Effect	0		This element should be stable for the limited duration of radiation exposure.
Seismic/Vibration	0		System is shut down on seismic events, no impact.
Humidity Effect	0		No effect.
Calibration Uncertainty	0		Calibrated as an integral unit with PI-420
Power Supply Effect	0		Indicator powered, no effect.
Element Accuracy	0.25	0	

The pressure indicator, SY101-WT-PI-420, accuracy is now developed:

PI-420 ACCURACY		Sensotec	AE213-51C-56A-AA923
	Common Unit Value, PSIG		Source/Reason
	Random	Bias	
Reference Uncertainty	0.075		Published data gives an accuracy of pressure reading at +/-0.03% of full scale. At a range of 0-250psig maximum error is 0.25 psig.
Temperature Effect	0.00		Conversations with Sensotec indicate that over the temperature range of 30-160F, there is no effect. Waste temperature is within this range.
Radiation Effect	0		The indicator is in a low radiation environment. No effect.
Seismic/Vibration	0		System is shut down on seismic events, no impact.
Humidity Effect	0		Low humidity environment. No effect.
Calibration Uncertainty	12.5		5% of URL (250psig)
Power Supply Effect	0		No data available, no anticipated effect.
Element Accuracy	12.50	0	

The overall loop accuracy, as indicated on SY101-WT-PI-420 is calculated below:

PI-420 Loop Accuracy		
	Value	Units
Loop Accuracy	12.50	PSIG
Loop Drift	0	PSIG
Total Loop Uncertainty	12.50	PSIG

This indicates that readings on SY101-WT-PI-420 can be anticipated to be within 12.5 psig of actual pressure. At a maximum operating pressure of 200 psig, this is an error of 6.25%.

4.7 TEMPERATURE LOOPS

4.7.1 PPP TRANSFER MATERIAL TEMPERATURE, LOOP 369

LOOP DESCRIPTION

This loop is a simple indicating loop and is composed of a temperature sensing element, SY101-WT-TE-369, a temperature transmitter, SY101-WT-TT-369, and two temperature indicators, SY101-WT-TI-369A and SY461-WT-TI-369B. SY101-WT-TE-369 is located in the prefabricated pump pit, SY101-WT-ENCL-350. SY101-WT-TT-369 and SY101-WT-TI-369A are mounted in the transfer pump pit control panel, SY101-WT-CP-350A. SY461-WT-TI-369B is mounted on the DACS trailer control panel, SY461-WT-CP-350B.

SY101-WT-TE-369 is an RTD, which changes resistance in a circuit proportional to a temperature change. Circuitry within SY101-WT-TT-369 converts that input into a 4-20mA signal proportional to the temperature sensed. The 4-20mA signal is then converted to a digital temperature read out by both SY101-WT-TI-369A and SY461-WT-TI-369B.

SETPOINT BASIS

The transfer temperature is between 110°F and 130°F (Process Control Plan, HNF-4264, Rev. 0, Section 5.7) with a target temperature of 120°F (Process Control Plan, HNF-4264, Rev. 0, Section 2.1.2).

SETPOINT VALUES

The waste temperature being transferred must be displayed on SY101-WT-TI-369A and SY461-WT-TI-369B. To that end, the range of these indicators must envelop the anticipated waste temperature. Temperature indicators TI-369A and TI-369B have been set to a range of 32°F to 212°F, which envelops the anticipated operating conditions.

The accuracy of the reading of SY101-WT-TI-369A is quantified by combining the inaccuracies and drift from each element in the instrument loop. The elements are SY101-WT-TE-369, SY101-WT-TT-369, and SY101-WT-TI-369A. Each element accuracy is given below. Drift values only exist for SY101-WT-TE-369, other elements are assumed to have negligible drift as they are solid state devices.

The accuracy of SY101-WT-TE-369 is as follows:

TE-369 ACCURACY		Pyromation	RBF185RG3-3-9300-3
	Common Unit Value, Degrees F		Source/Reason
	Random	Bias	
Reference Uncertainty	0.12		Published data gives an accuracy of +/- 0.12% at 0C. In other words, the resistance is 100 ohms +/- 0.12F. This offset is constant for the operating range of this process.
Temperature Effect	0.00		No effect.
Radiation Effect	0		This element should be stable for the limited duration of radiation exposure.
Seismic/Vibration	0		System is shut down on seismic events, no impact.
Humidity Effect	0		No effect.
Calibration Uncertainty	0		Non calibratable device.
Power Supply Effect	0		Transmitter powered, no effect.
Element Accuracy	0.12	0	

The drift for SY101-WT-TE-369 is found below:

TE-369 DRIFT		Pyromation	RBF185RG3-3-9300-3
	Value	Units	Source/Reason
Mfr value in % URL	0.009	Degrees F	ISA Text on Temperature Measurement gives 0.05C/yr
URL	900	Degrees F	ISA Text on Temperature Measurement gives URL of 900F
Span	180	Degrees F	180 degrees F
Test Interval	12	mo.	Recall interval is 1 yr.
Mfr Interval	12	mo.	
Element Drift	0.41	Degrees F	

The inaccuracy of SY101-WT-TT-369 is established as follows:

TT-369 ACCURACY		Omega	CCT-20-0/100
	Common Unit Value, Degrees F		Source/Reason
	Random	Bias	
Reference Uncertainty	0.424		Published data gives an accuracy of temperature reading at +/-0.2% of full scale. At a range of 32-212F, the maximum error is 0.36F.
Temperature Effect	0.01		The error is less than 0.015%/C. Assuming a worst case of 115F and a standard temperature of 25C, the error is .0063 degrees.
Radiation Effect	0		The transmitter is in a low radiation environment, therefore no effect.
Seismic/Vibration	0		System is shut down on seismic events, no impact.
Humidity Effect	0		Low humidity environment. No effect.
Calibration Uncertainty	2.12		1% of URL (212F)
Power Supply Effect	0		With power at 115VAC +/-10%, no effect.
Element Accuracy	2.16	0	

The inaccuracy of SY101-WT-TI-369A is given below:

TI-369A ACCURACY		Newport Electronics	558B-ET-IS1-SPC18
	Common Unit Value, Degrees F		Source/Reason
	Random	Bias	
Reference Uncertainty	1.212		.1% of reading, plus one digit. Conservatively assumed maximum temperature of 212F.
Temperature Effect	7.03		The accuracy is based on a 25C temperature. Zero error is +/- .3 count/C. Span error is .015% Span/C. These two errors can be combined using the square root of the sum of the squares method. The 350A panel is assumed to have a self heating temperature rise of 15F. The Functional Requirements Document gave an acceptable ambient transfer temperature range of 20-100F. The greatest tempurature difference is 23.33C. Based on these extremes and the equations, a maximum error is 7.03F and occurs at 20F with a maximum temperature of 212F and a span of 180F.
Radiation Effect	0		The panel meter is located in a low radiation environment.
Seismic/Vibration	0		System is shut down on seismic events, no impact.
Humidity Effect	0		The panel meter is rated for 95% humidity, at 40C. It is located in a low humidity environment, no effect
Calibration Uncertainty	2.12		1.0% of full scale (212F)
Power Supply Effect	0		As long as within required values on voltage supply, no effect.
Element Accuracy	7.44	0	

All of these element inaccuracies are combined to find a loop inaccuracy:

TI-369A Loop Accuracy		
	Value	Units
Loop Accuracy	7.75	Degrees F
Loop Drift	0.405	Degrees F
Total Loop Uncertainty	7.76	Degrees F

This indicates that a typical reading of 130°F could be in error by ±7.75°F, or ±5.96%

The accuracy of the reading of SY101-WT-TI-369B is quantified by combining the inaccuracies and drift from each element in the instrument loop. These elements are SY101-WT-TE-369, SY101-WT-TT-369, and SY101-WT-TI-369A. Accuracies of SY101-WT-TE-369, SY101-WT-TT-369 were given above. The accuracy of SY101-WT-TI-369B and the combined loop accuracy is established below.

TI-369B ACCURACY		Newport Electronics	INFP-0210-C2
	Common Unit Value, Degrees F		Source/Reason
	Random	Bias	
Reference Uncertainty	0.0106		.005% of reading. Maximum value of 212F used.
Temperature Effect	0.00		The accuracy is based on a 25C temperature. Span error is 20 ppm/C. The 350B panel is assumed to have a maximum temperature of 92F, or 8.33C above 25C. The error is expected to be no greater than 0.0002 F
Radiation Effect	0		DACs is a low radiation environment, no effect anticipated.
Seismic/Vibration	0		System is shut down on seismic events, no impact.
Humidity Effect	0		Device is rated for 95% non condensing at 40C. Low Humidity environment, no effect.
Calibration Uncertainty	2.12		1% of full scale
Power Supply Effect	0		As long as within required values on voltage supply, no effect. Voltage range for the instrument is 115V+/- 10% and 49 to 100 Hz.
Element Accuracy	2.12	0	

All of these element inaccuracies are combined to find a loop inaccuracy:

TI-369B Loop Accuracy		
	Value	Units
Loop Accuracy	3.02	Degrees F
Loop Drift	0.405	Degrees F
Total Loop Uncertainty	3.05	Degrees F

This indicates that a typical reading of 130°F could be in error by ±3.05°F, or ±2.35%

4.7.2 PPP DILUTION WATER TEMPERATURE, LOOP 373

LOOP DESCRIPTION

This loop is composed of a temperature sensing element, SY101-WT-TE-373, a temperature transmitter, SY101-WT-TT-373, a temperature indicator, SY101-WT-TI-373, a temperature indicator with contacts out, SY461-RW-TIY-373, a low dilution water temperature relay, 2K4, a window on annunciator SY101-WT-ANN-350A, SY101-WT-TAL-373A, and a window on annunciator SY461-WT-ANN-350B, SY461-WT-TAL-373B. SY101-WT-TE-373 is located in the prefabricated pump pit, SY101-WT-ENCL-350. 2K4, SY461-RW-TIY-373 and SY461-WT-TAL-373B are located in the DACS trailer control panel, SY461-WT-CP-350B. SY101-WT-TI-373 and SY101-WT-TAL-373A are found in the SY-101 transfer pump pit control panel, SY101-WT-CP-350A. SY101-WT-TT-373 is mounted just outside the same panel.

The purpose of this loop is to provide temperature indication and to ensure that the diluent water temperature is maintained in the correct temperature range. If the diluent water temperature drops below a minimum value of 110°F, alarms are to be sounded in the annunciator panels. SY101-WT-TE-373 is an RTD, which changes resistance in a circuit proportional to a temperature change. Circuitry in SY101-WT-TT-373 converts that input into a 4-20mA signal proportional to the temperature sensed. The 4-20mA signal is then converted to a digital temperature read out by both SY101-WT-TI-373 and SY461-RW-TIY-373. SY461-RW-TIY-373 also has trip contacts for a low temperature. The tripped contact in SY461-RW-TIY-373 in turn trips relay 2K4, actuating alarms SY101-WT-TAL-373A and SY461-WT-TAL-373B.

SETPOINT BASIS

The dilution water temperature is to be between 110°F and 130°F (Process Control Plan, HNF-4264, Rev. 0, Section 2.1.1).

SETPOINT VALUES

The dilution water temperature is to be displayed on SY101-WT-TI-373 and SY461-RW-TIY-373. To that end, the range of these indicators must envelop the anticipated water temperature. Temperature indicator SY101-WT-TI-373 has been set to a range of 32°F to 212°F, which envelops the anticipated operating conditions. The alarms, SY101-WT-TAL-373A and SY461-WT-TAL-373B are nominally set for 110°F as this is the low end of the desired temperature range.

The accuracy of the reading of SY101-WT-TI-373 is quantified by combining the inaccuracies and drift from each element in the instrument loop. The elements are SY101-WT-TE-373, SY101-WT-TT-373, and SY461-WT-TIY-373. Each element accuracy is given below. Drift values only exist for SY101-WT-TE-373, other elements are assumed to have negligible drift as they are solid state devices.

The accuracy of SY101-WT-TE-373 is as follows:

TE-373 ACCURACY		Pyromation	RBF185RG3-3-9300-3
	Common Unit Value, Degrees F		Source/Reason
	Random	Bias	
Reference Uncertainty	0.12		Published data gives an accuracy of +/- 0.12% at 0C. In other words, the resistance is 100 ohms +/- 0.12F. This offset is constant for the operating range of this process.
Temperature Effect	0.00		No effect.
Radiation Effect	0		This element should be stable for the limited duration of radiation exposure.
Seismic/Vibration	0		System is shut down on seismic events, no impact.
Humidity Effect	0		No effect.
Calibration Uncertainty	0		Non calibratable device.
Power Supply Effect	0		Transmitter powered, no effect.
Element Accuracy	0.12	0	

The drift for SY101-WT-TE-373 is found below:

TE-373 DRIFT		Pyromation	RBF185RG3-3-9300-3
	Value	Units	Source/Reason
Mfr value in % URL	0.009	Degrees F	ISA Text on Temperature Measurement gives 0.05C/yr
URL	900	Degrees F	ISA Text on Temperature Measurement gives URL of 900F
Span	180	Degrees F	180 degrees F
Test Interval	12	mo.	Recall interval is 1 yr.
Mfr Interval	12	mo.	
Element Drift	0.41	Degrees F	

The inaccuracy of SY101-WT-TT-373 is established as follows:

TT-373 ACCURACY		Omega	CCT-20-0/100
	Common Unit Value, Degrees F		Source/Reason
	Random	Bias	
Reference Uncertainty	0.424		Published data gives an accuracy of temperature reading at +/-0.2% of full scale. At a range of 32-212F, the maximum error is 0.36F.
Temperature Effect	0.01		The error is less than 0.015%/C. Assuming a worst case of 115F and a standard temperature of 25C, the error is .0063 degrees.
Radiation Effect	0		The transmitter is in a low radiation environment, therefore no effect.
Seismic/Vibration	0		System is shut down on seismic events, no impact.
Humidity Effect	0		Low humidity environment. No effect.
Calibration Uncertainty	2.12		1% of URL (212F)
Power Supply Effect	0		With power at 115VAC +/-10%, no effect.
Element Accuracy	2.16	0	

The inaccuracy of SY101-WT-TI-373 is given below:

TI-373 ACCURACY		Newport Electronics	558B-ET-IS1-SPC18
	Common Unit Value, Degrees F		Source/Reason
	Random	Bias	
Reference Uncertainty	1.212		.1% of reading, plus one digit. Conservatively assumed maximum temperature of 212F.
Temperature Effect	7.03		The accuracy is based on a 25C temperature. Zero error is +/- .3 count/C. Span error is .015% Span/C. These two errors can be combined using the square root of the sum of the squares method. The 350A panel is assumed to have a self heating temperature rise of 15F. The Functional Requirements Document gave an acceptable ambient transfer temperature range of 20-100F. The greatest tempurature difference is 23.33C. Based on these extremes and the equations, a maximum error is 7.03F and occurs at 20F with a maximum temperature of 212F and a span of 180F.
Radiation Effect	0		The panel meter is located in a low radiation environment.
Seismic/Vibration	0		System is shut down on seismic events, no impact.
Humidity Effect	0		The panel meter is rated for 95% humidity, at 40C. It is located in a low humidity environment, no effect
Calibration Uncertainty	2.12		1.0% of full scale (212F)
Power Supply Effect	0		As long as within required values on voltage supply, no effect.
Element Accuracy	7.44	0	

All of these element inaccuracies are combined to find a loop inaccuracy:

TI-373 Loop Accuracy		
	Value	Units
Loop Accuracy	7.75	Degrees F
Loop Drift	0.405	Degrees F
Total Loop Uncertainty	7.76	Degrees F

This indicates that a typical reading of 130°F could be in error by ±7.76°F, or ±5.97%

The accuracy of the reading of SY461-WT-TIY-373 is quantified by combining the inaccuracies and drift from each element in the instrument loop. These elements are SY101-WT-TE-373, SY101-WT-TT-373, and SY461-WT-TIY-373. Accuracies of SY101-WT-TE-373, SY101-WT-TT-373 were given above. The accuracy of SY461-WT-TIY-373 and the combined loop accuracy is established below.

TIY-373 ACCURACY		Newport Electronics	INFP-0210-C2
	Common Unit Value, Degrees F		Source/Reason
	Random	Bias	
Reference Uncertainty	0.0106		.005% of reading. Maximum value of 212F used.
Temperature Effect	0.00		The accuracy is based on a 25C temperature. Span error is 20 ppm/C. The 350B panel is assumed to have a maximum temperature of 92F, or 8.33C above 25C. The error is expected to be no greater than 0.0002 F
Radiation Effect	0		DACs is a low radiation environment, no effect anticipated.
Seismic/Vibration	0		System is shut down on seismic events, no impact.
Humidity Effect	0		Device is rated for 95% non condensing at 40C. Low Humidity environment, no effect.
Calibration Uncertainty	2.12		1% of full scale
Power Supply Effect	0		As long as within required values on voltage supply, no effect. Voltage range for the instrument is 115V+/- 10% and 49 to 100 Hz.
Element Accuracy	2.12	0	

All of these element inaccuracies are combined to find a loop inaccuracy:

TIY-373 Loop Accuracy		
	Value	Units
Loop Accuracy	3.03	Degrees F
Loop Drift	0.405	Degrees F
Total Loop Uncertainty	3.06	Degrees F

This indicates that a typical reading of 130°F could be in error by ±3.06°F, or ±2.35%

From the above, the alarm setpoints for SY101-WT-TAL-373A and SY461-WT-TAL-373B are established below:

TAL-373A Setpoint		
	Value	Units
Alarm Point	110	Degrees F
Loop Uncertainty	3.06	Degrees F
Margin	1	Degrees F
Setpoint	114.06	Degrees F
TAL-373B Setpoint		
	Value	Units
Alarm Point	110	Degrees F
Loop Uncertainty	3.06	Degrees F
Margin	1	Degrees F
Setpoint	114.06	Degrees F

A setpoint of 114°F will be sufficient.

4.7.3 WATER SKID CONTROL PANEL TEMPERATURE CONTROL, LOOP 401

LOOP DESCRIPTION

This loop is intended to maintain the temperature in the water support skid electrical enclosure, POR32-RW-CP-401, at an acceptable level. Cooling of the cabinets, particularly in the summer, is the primary concern. Because of the self heating of all the electrical equipment within the enclosure, it is not necessary to provide additional heating, even in winter. The loop consists of two elements, a sensor, POR32-RW-TC-401, and a fan, POR32-RW-AC-401. When the sensor reaches a preset temperature of 85°F, the sensor allows power to go to the fan, providing forced convective cooling of the components within the cabinet. Both of these elements are found within POR32-RW-CP-401.

SETPOINT BASIS

This setpoint was established by the supplier of the water skid control panel, HiLine Engineering, and is intended to maintain the panel temperatures such that the electronic instrumentation and indication is able to properly function.

SETPOINT VALUES

The setpoint is established by HiLine and is deemed adequate. This loop is not going to be calibrated or maintained.

4.7.4 WATER SKID INLET HOSE HEAT TRACE CONTROL, LOOP 410

LOOP DESCRIPTION

This is an indicating and control loop consisting of two elements. The sensing element, POR32-RW-TE-410 is a type "J" thermocouple, affixed to the inlet hose. The temperature indicating controller, POR32-RW-TIC-410, is mounted in the water support skid electrical enclosure, POR32-RW-CP-401.

The temperature in the water line is detected by POR32-RW-TE-410, which develops a voltage potential, proportional to the temperature. This potential is detected by POR32-RW-TIC-410, which converts that

signal into a digital output. POR32-RW-TIC-410 also attempts to maintain the temperature at a setpoint, developed below.

SETPOINT BASIS

The dilution water temperature is to range between 110°F and 130°F (Process Control Plan, HNF-4264, Rev. 0, Section 2.1.1). In addition, there is a limitation of 158°F for the hose material.

SETPOINT VALUES

The dilution water temperature at the inlet to the water skid is to be displayed on POR32-RW-TIC-410. To that end, the range of this indicator must envelop the anticipated water temperature. Temperature indicator POR32-RW-TIC-410 has been set to a range of 0°F to 212°F, which envelops the anticipated operating conditions.

The accuracy of the reading is a function of the error found in POR32-RW-TE-410 and POR32-RW-TIC-410. Each element accuracy is developed below, followed by the loop accuracy.

The accuracy of POR32-RW-TE-410 is as follows:

TE-410 ACCURACY		Cobra Wirer and Cable	jl6spfa-alpfa
	Common Unit Value, Degrees F		Source/Reason
	Random	Bias	
Reference Uncertainty	5.9	7.5	Random- The accuracy of a thermocouple is within 1% of the absolute temperature. At 130F, this is 5.9F Bias- Each connecting jack is assumed to act as a cold junction with an error of 2.5F per junction. An assumed 3 junctions exist for this element.
Temperature Effect	0.00		This is a temperature sensing device, no effect
Radiation Effect	0		Located in a low radiation environment, no effect.
Seismic/Vibration	0		System is shut down on seismic events, no impact.
Humidity Effect	0		No effect.
Calibration Uncertainty	0		Non calibratable device.
Power Supply Effect	0		Self powered, no effect.
Element Accuracy	5.90	7.5	

The accuracy of POR32-RW-TIC-410 is as follows:

TIC-410 ACCURACY		Watlow	V4TH-CDAA-AARG
	Common Unit Value, Degrees F		Source/Reason
	Random	Bias	
Reference Uncertainty	1.35		Published data gives an accuracy of +/- 0.1% of span. The span for a type J thermocouple is 1350F, so an error of up to 1.35F can be expected.
Temperature Effect	6.60		Accuracy is given for 77F. The maximum temperature in the panel is assumed to be 110F. The temperature effect is +/-0.2F/F.
Radiation Effect	0		The indicator is in a low radiation environment. No effect.
Seismic/Vibration	0		System is shut down on seismic events, no impact.
Humidity Effect	0		Low humidity environment. No effect.
Calibration Uncertainty	9		5% of calibration scale (32-212F, 180F)
Power Supply Effect	0		No data available, no anticipated effect.
Element Accuracy	11.24	0	

The loop accuracy as displayed on POR32-RW-TIC-410 is:

TIC-410 Loop Accuracy		
	Value	Units
Loop Accuracy	20.20	Degrees F
Loop Drift	7.5	Degrees F
Total Loop Uncertainty	27.70	Degrees F

This value of ± 27.7°F at a nominal value of 130°F is an error of ±21.31%.

The heat output of the heat trace on this system is insufficient to have any significant effect on water temperature under operating conditions. However, if the heat trace is left on when the system is not operating, degradation of the hose material is possible. The rated temperature at pressure is 158°F. The setpoint will be placed below that value by a margin and all estimated errors. The control setpoint for POR32-RW-TIC-410 is established as follows:

TIC-410 Setpoint		
	Value	Units
Alarm Point	158	Degrees F
Loop Uncertainty	27.70	Degrees F
Margin	5.3	Degrees F
Setpoint	125	Degrees F

A setpoint of 125°F is to be used.

4.7.5 WATER SKID STORAGE TANK HEAT TRACE CONTROL, LOOP 411

LOOP DESCRIPTION

This loop consists of a controller, POR32-RW-TC-411, and two sensing elements, POR32-RW-TE-411A and POR32-RW-TE-411B. There are actually two independent loops. The first is the control loop consisting of POR32-RW-TC-411 and POR32-RW-TE-411A. The temperature of the tank surface is sensed by the capillary tube sensor, POR32-RW-TE-411A, which transmits a pressure to the POR32-RW-TC-411. The controller energizes/de-energizes the heat trace depending upon the sensed temperature and the setpoint.

The second loop is to prevent damage to the fiberglass tank by shutting off the heat trace if it gets to a predetermined temperature. That temperature is sensed by the capillary tube sensor, POR32-RW-TE-411B, which transmits a pressure to the POR32-RW-TC-411. The controller de-energizes the heat trace depending upon reaching and the setpoint.

SETPOINT BASIS

The dilution water temperature is to range between 110°F and 130°F (Process Control Plan, HNF-4264, Rev. 0, Section 2.1.1). In addition, by engineering judgement, the tank must be kept below 140°F as a system protection value.

SETPOINT VALUES

Temperature Control

The critical value is for the waste solution to remain above the temperature where precipitation of solids might occur. This point is approximately 110°F. The control setpoint will be placed above that value by a margin and all estimated errors. This loop is calibrated as a single unit.

The error of POR32-RW-TE-411A and POR32-RW-TE-411B are calculated as follows:

TE-411A&B ACCURACY		Justin	UE-55
	Common Unit Value, Degrees F		Source/Reason
	Random	Bias	
Reference Uncertainty	3.9		+/- 3% of reading at mid 50% range. Typical reading is 130F.
Temperature Effect	0.00		This is a temperature sensing device, no effect
Radiation Effect	0		Located in a low radiation environment, no effect.
Seismic/Vibration	0		System is shut down on seismic events, no impact.
Humidity Effect	0		No effect.
Calibration Uncertainty	0		Calibrated with TC-411
Power Supply Effect	0		Self powered, no effect.
Element Accuracy	3.90	0	

The accuracy of POR32-RW-TC-411 is given below:

TC-411 ACCURACY		Hotfoil	C-4058
	Common Unit Value, Degrees F		Source/Reason
	Random	Bias	
Reference Uncertainty	0		Calibrated with TE-411A
Temperature Effect	0.00		No data available, no anticipated effect.
Radiation Effect	0		The indicator is in a low radiation environment. No effect.
Seismic/Vibration	0		System is shut down on seismic events, no impact.
Humidity Effect	0		Low humidity environment. No effect.
Calibration Uncertainty	6		5% of Setpoint, 120°F.
Power Supply Effect	0		No data available, no anticipated effect.
Element Accuracy	6.00	0	

The loop accuracy is developed below:

TC-411 Loop Accuracy, for control		
	Value	Units
Loop Accuracy	7.16	Degrees F
Loop Drift	0	Degrees F
Total Loop Uncertainty	7.16	Degrees F

A setpoint of 118°F is recommended to ensure the tank water temperature in the tank remains above 110°F. Operations can adjust the temperature controller to maintain water temperatures. It is understood that the heat trace used on the tank acts primarily as a thermal shield and will have negligible effect on water temperature during operation. When the system is down, the heat trace could heat the tank to a temperature capable of damaging the tank. To prevent damage to the tank, a high temperature shut off is provided.

High Temperature Shut Off

The critical value is to remain below the critical value for the fiberglass tank. This point is approximately 140°F. The operating limit will be placed below that value by a margin and all estimated errors. The operating limit for emergency shut off is then 140F-7.16°F or 132.84°F, rounded down to 132°F.

4.7.6 WATER SKID STORAGE TANK WATER TEMPERATURE, LOOP 412

LOOP DESCRIPTION

This is a simple indication loop to provide the operator the temperature of the water in the tank. It consists of a sensing element, POR32-RW-TE-412, a type "J" thermocouple, submersed in TK-401. The temperature indicator, POR32-RW-TI-412, is mounted in the water support skid electrical enclosure, POR32-RW-CP-401.

The temperature in the tank is detected by POR32-RW-TE-412, which develops a voltage potential proportional to the temperature. This potential is detected by POR32-RW-TI-412, which converts that signal into a digital output.

SETPOINT BASIS

The dilution water temperature is to range between 110°F and 130°F (Process Control Plan, HNF-4264, Rev. 0, Section 2.1.1).

SETPOINT VALUES

The dilution water temperature in TK-401 is to be displayed on POR32-RW-TI-412. To that end, the range of this indicator must envelop the anticipated water temperature. Temperature indicator POR32-RW-TI-412 has been set to a range of 0°F to 212°F, which envelops the anticipated operating conditions.

The accuracy of the reading is a function of the error found in POR32-RW-TE-412 and POR32-RW-TI-412. Each element accuracy is developed below, followed by the loop accuracy.

The accuracy of POR32-RW-TE-412 is as follows:

TE-412 ACCURACY		Watlow	AFGMOTFXXXVJ300
	Common Unit Value, Degrees F		Source/Reason
	Random	Bias	
Reference Uncertainty	5.9	7.5	Random- The accuracy of a thermocouple is within 1% of the absolute temperature. At 130F, this is 5.9F Bias- Each connecting jack is assumed to act as a cold junction with an error of 2.5F per junction. An assumed 3 junctions exist for this element.
Temperature Effect	0.00		This is a temperature sensing device, no effect
Radiation Effect	0		Located in a low radiation environment, no effect.
Seismic/Vibration	0		System is shut down on seismic events, no impact.
Humidity Effect	0		No effect.
Calibration Uncertainty	0		Non calibratible device.
Power Supply Effect	0		Self powered, no effect.
Element Accuracy	5.90	7.5	

The accuracy of POR32-RW-TI-412 is as follows:

TI-412 ACCURACY		Watlow	V4TH-CDAA-AARG
	Common Unit Value, Degrees F		Source/Reason
	Random	Bias	
Reference Uncertainty	1.35		Published data gives an accuracy of +/- 0.1% of span. The span for a type J thermocouple is 1350F, so an error of up to 1.35F can be expected.
Temperature Effect	6.60		Accuracy is given for 77F. The maximum temperature in the panel is assumed to be 110F. The temperature effect is +/-0.2F/F.
Radiation Effect	0		The indicator is in a low radiation environment. No effect.
Seismic/Vibration	0		System is shut down on seismic events, no impact.
Humidity Effect	0		Low humidity environment. No effect.
Calibration Uncertainty	9		5% of calibration scale (32-212F, 180F)
Power Supply Effect	0		No data available, no anticipated effect.
Element Accuracy	11.24	0	

The loop accuracy as displayed on POR32-RW-TI-412 is:

TI-412 Loop Accuracy		
	Value	Units
Loop Accuracy	20.20	Degrees F
Loop Drift	7.5	Degrees F
Total Loop Uncertainty	27.70	Degrees F

This value of ±27.7 °F at a nominal value of 130°F is an error of ± 21.31%.

4.7.7 WATER SKID INTERNAL HOSES HEAT TRACE CONTROL, LOOP 413

LOOP DESCRIPTION

This is an indicating and control loop consisting of two elements. The sensing element, POR32-RW-TE-413 is a type "J" thermocouple, affixed to the inlet hose. The temperature indicating controller, POR32-RW-TIC-413, is mounted in the water support skid electrical enclosure, POR32-RW-CP-401.

The temperature in the water line is detected by POR32-RW-TE-413, which develops a voltage potential, proportional to the temperature. This potential is detected by POR32-RW-TIC-413, which converts that signal into a digital output. POR32-RW-TIC-413 also attempts to maintain the temperature at a setpoint, developed below.

SETPOINT BASIS

The dilution water temperature is to range between 110°F and 130°F (Process Control Plan, HNF-4264, Rev. 0, Section 2.1.1). In addition, there is a limitation of 158°F for the hose material.

SETPOINT VALUES

The dilution water temperature downstream of the water skid pumps is to be displayed on POR32-RW-TIC-413. To that end, the range of this indicator must envelop the anticipated water temperature. Temperature indicator POR32-RW-TIC-413 has been set to a range of 0°F to 212°F, which envelops the anticipated operating conditions.

The accuracy of the reading is a function of the error found in POR32-RW-TE-413 and POR32-RW-TIC-413. Each element accuracy is developed below, followed by the loop accuracy.

The accuracy of POR32-RW-TE-413 is as follows:

TE-413 ACCURACY		Watlow	72XJWGB012
	Common Unit Value, Degrees F		Source/Reason
	Random	Bias	
Reference Uncertainty	5.9	7.5	Random- The accuracy of a thermocouple is within 1% of the absolute temperature. At 130F, this is 5.9F Bias- Each connecting jack is assumed to act as a cold junction with an error of 2.5F per junction. An assumed 3 junctions exist for this element.
Temperature Effect	0.00		This is a temperature sensing device, no effect
Radiation Effect	0		Located in a low radiation environment, no effect.
Seismic/Vibration	0		System is shut down on seismic events, no impact.
Humidity Effect	0		No effect.
Calibration Uncertainty	0		Non calibratable device.
Power Supply Effect	0		Self powered, no effect.
Element Accuracy	5.90	7.5	

The accuracy of POR32-RW-TIC-413 is as follows:

TIC-413 ACCURACY		Watlow	V4TH-CDAA-AARG
	Common Unit Value, Degrees F		Source/Reason
	Random	Bias	
Reference Uncertainty	1.35		Published data gives an accuracy of +/- 0.1% of span. The span for a type J thermocouple is 1350F, so an error of up to 1.35F can be expected.
Temperature Effect	6.60		Accuracy is given for 77F. The maximum temperature in the panel is assumed to be 110F. The temperature effect is +/-0.2F/F.
Radiation Effect	0		The indicator is in a low radiation environment. No effect.
Seismic/Vibration	0		System is shut down on seismic events, no impact.
Humidity Effect	0		Low humidity environment. No effect.
Calibration Uncertainty	9		5% of calibration scale (32-212F, 180F)
Power Supply Effect	0		No data available, no anticipated effect.
Element Accuracy	11.24	0	

The loop accuracy as displayed on POR32-RW-TIC-413 is:

TIC-413 Loop Accuracy		
	Value	Units
Loop Accuracy	20.20	Degrees F
Loop Drift	7.5	Degrees F
Total Loop Uncertainty	27.70	Degrees F

This value of ± 27.7 °F at a nominal value of 130°F is an error of ± 21.31%.

The heat output of the heat trace on this system is insufficient to have any significant effect on water temperature under operating conditions. However, if the heat trace is left on when the system is not operating, degradation of the hose material is possible. The rated temperature at pressure is 158°F. The setpoint will be placed below that value by a margin and all estimated errors. The control setpoint for POR32-RW-TIC-413 is established as follows:

TIC-413 Setpoint		
	Value	Units
Alarm Point	158	Degrees F
Loop Uncertainty	27.70	Degrees F
Margin	5.3	Degrees F
Setpoint	125	Degrees F

A setpoint of 125°F is to be used.

4.7.8 WATER SKID ACCUMULATOR HEAT TRACE CONTROL, LOOP 414

LOOP DESCRIPTION

This is an indicating and control loop consisting of two elements. The sensing element, POR32-RW-TE-414 is a type "J" thermocouple, affixed ACC-401. The temperature indicating controller, POR32-RW-TIC-414, is mounted in the water support skid electrical enclosure, POR32-RW-CP-401.

The temperature in the accumulator is detected by POR32-RW-TE-414, which develops a voltage potential, proportional to the temperature. This potential is detected by POR32-RW-TIC-414, which converts that signal into a digital output. POR32-RW-TIC-414 also attempts to maintain the temperature at a setpoint, developed below.

SETPOINT BASIS

The dilution water temperature is to range between 110°F and 130°F (Process Control Plan, HNF-4264, Rev. 0, Section 2.1.1).

SETPOINT VALUES

The dilution water temperature at the accumulator is to be displayed on and POR32-RW-TIC-414. To that end, the range of this indicator must envelop the anticipated water temperature. Temperature indicator POR32-RW-TIC-414 has been set to a range of 0°F to 212°F, which envelops the anticipated operating conditions.

The accuracy of the reading is a function of the error found in POR32-RW-TE-414 and POR32-RW-TIC-414. Each element accuracy is developed below, followed by the loop accuracy.

The accuracy of POR32-RW-TE-414 is as follows:

TE-414 ACCURACY		Watlow	70XJTUD012
	Common Unit Value, Degrees F		Source/Reason
	Random	Bias	
Reference Uncertainty	5.9	7.5	Random- The accuracy of a thermocouple is within 1% of the absolute temperature. At 130F, this is 5.9F Bias- Each connecting jack is assumed to act as a cold junction with an error of 2.5F per junction. An assumed 3 junctions exist for this element.
Temperature Effect	0.00		This is a temperature sensing device, no effect
Radiation Effect	0		Located in a low radiation environment, no effect.
Seismic/Vibration	0		System is shut down on seismic events, no impact.
Humidity Effect	0		No effect.
Calibration Uncertainty	0		Non calibratable device.
Power Supply Effect	0		Self powered, no effect.
Element Accuracy	5.90	7.5	

The accuracy of POR32-RW-TIC-414 is as follows:

TIC-414 ACCURACY		Watlow	V4TH-CDAA-AARG
	Common Unit Value, Degrees F		Source/Reason
	Random	Bias	
Reference Uncertainty	1.35		Published data gives an accuracy of +/- 0.1% of span. The span for a type J thermocouple is 1350F, so an error of up to 1.35F can be expected.
Temperature Effect	6.60		Accuracy is given for 77F. The maximum temperature in the panel is assumed to be 110F. The temperature effect is +/-0.2F/F.
Radiation Effect	0		The indicator is in a low radiation environment. No effect.
Seismic/Vibration	0		System is shut down on seismic events, no impact.
Humidity Effect	0		Low humidity environment. No effect.
Calibration Uncertainty	9		5% of calibration scale (32-212F, 180F)
Power Supply Effect	0		No data available, no anticipated effect.
Element Accuracy	11.24	0	

The loop accuracy as displayed on POR32-RW-TIC-414 is:

TIC-414 Loop Accuracy		
	Value	Units
Loop Accuracy	20.20	Degrees F
Loop Drift	7.5	Degrees F
Total Loop Uncertainty	27.70	Degrees F

This value of ± 27.7 °F at a nominal value of 130°F is an error of ± 21.31%.

There is limited impact on the system if the water in the accumulator as long as the temperature is within the range of 90 to 160 °F. For consistency, the setpoint for this controller is to be the same as the others on the water skid, 125°F.

4.7.9 WATER SKID OUTLET HOSE HEAT TRACE CONTROL, LOOP 415

LOOP DESCRIPTION

This is an indicating and control loop consisting of two elements. The sensing element, POR32-RW-TE-410 is a type "J" thermocouple, affixed to the outlet hose. The temperature indicating controller, POR32-RW-TIC-415, is mounted in the water support skid electrical enclosure, POR32-RW-CP-401.

The temperature in the water line is detected by POR32-RW-TE-415, which develops a voltage potential, proportional to the temperature. This potential is detected by POR32-RW-TIC-415, which converts that signal into a digital output. POR32-RW-TIC-415 also attempts to maintain the temperature at a setpoint, developed below.

SETPOINT BASIS

The dilution water temperature is to range between 110°F and 130°F (Process Control Plan, HNF-4264, Rev. 0, Section 2.1.1). In addition, there is a limitation of 158°F for the hose material.

SETPOINT VALUES

The dilution water temperature at the outlet of the water skid is to be displayed on POR32-RW-TIC-415. To that end, the range of this indicator must envelop the anticipated water temperature. Temperature indicator POR32-RW-TIC-415 has been set to a range of 0°F to 212°F, which envelops the anticipated operating conditions.

The accuracy of the reading is a function of the error found in POR32-RW-TE-415 and POR32-RW-TIC-415. Each element accuracy is developed below, followed by the loop accuracy.

The accuracy of POR32-RW-TE-415 is as follows:

TE-415 ACCURACY		Cobra Wirer and Cable	jl6spfa-alpfa
	Common Unit Value, Degrees F		Source/Reason
	Random	Bias	
Reference Uncertainty	5.9	7.5	Random- The accuracy of a thermocouple is within 1% of the absolute temperature. At 130F, this is 5.9F Bias- Each connecting jack is assumed to act as a cold junction with an error of 2.5F per junction. An assumed 3 junctions exist for this element.
Temperature Effect	0.00		This is a temperature sensing device, no effect
Radiation Effect	0		Located in a low radiation environment, no effect.
Seismic/Vibration	0		System is shut down on seismic events, no impact.
Humidity Effect	0		No effect.
Calibration Uncertainty	0		Non calibratible device.
Power Supply Effect	0		Self powered, no effect.
Element Accuracy	5.90	7.5	

The accuracy of POR32-RW-TIC-415 is as follows:

TIC-415 ACCURACY		Watlow	V4TH-CDAA-AARG
	Common Unit Value, Degrees F		Source/Reason
	Random	Bias	
Reference Uncertainty	1.35		Published data gives an accuracy of +/- 0.1% of span. The span for a type J thermocouple is 1350F, so an error of up to 1.35F can be expected.
Temperature Effect	6.60		Accuracy is given for 77F. The maximum temperature in the panel is assumed to be 110F. The temperature effect is +/-0.2F/F.
Radiation Effect	0		The indicator is in a low radiation environment. No effect.
Seismic/Vibration	0		System is shut down on seismic events, no impact.
Humidity Effect	0		Low humidity environment. No effect.
Calibration Uncertainty	9		5% of calibration scale (32-212F, 180F)
Power Supply Effect	0		No data available, no anticipated effect.
Element Accuracy	11.24	0	

The loop accuracy as displayed on POR32-RW-TIC-415 is:

TIC-415 Loop Accuracy		
	Value	Units
Loop Accuracy	20.20	Degrees F
Loop Drift	7.5	Degrees F
Total Loop Uncertainty	27.70	Degrees F

This value of ± 27.7 °F at a nominal value of 130°F is an error of ± 21.31%.

The heat output of the heat trace on this system is insufficient to have any significant effect on water temperature under operating conditions. However, if the heat trace is left on when the system is not operating, degradation of the hose material is possible. The rated temperature at pressure is 158°F. The setpoint will be placed below that value by a margin and all estimated errors. The control setpoint for POR32-RW-TIC-415 is established as follows:

TIC-415 Setpoint		
	Value	Units
Alarm Point	158	Degrees F
Loop Uncertainty	27.70	Degrees F
Margin	5.3	Degrees F
Setpoint	125	Degrees F

A setpoint of 125°F is to be used.

4.7.10 TRANSFER LINE HEAT TRACE CONTROL, LOOP HT1

LOOP DESCRIPTION

There are two heat trace and heat trace control loops on the transfer line, each affecting roughly one half of the length of the line. These are loops HT1 and HT2. HT1 is a simple thermostatic control loop consisting of a temperature sensing bulb buried in the insulation of the transfer line, and an associated switch TS-HT1. When the temperature exceeds a set value, the switch opens the contactor, CON-HT1 and prevents power from getting to the heat trace. When the line has cooled below the hysterisis band of the switch, the switch resets and CON-HT1 closes, providing power to the heat trace.

SETPOINT BASIS

The transferred waste temperature is to range between 110°F and 130° (Process Control Plan, HNF-4264, Rev. 0, Section 5.7) with a target temperature of 120°F (Process Control Plan, HNF-4264, Rev. 0, Section 2.1.2).

SETPOINT VALUES

It is critical that the temperature of the transferred waste remain above 110°F, the estimated precipitation point of the material. The temperature switch is factory calibrated and the temperature bulb and switch will be disposed of with the transfer line. The error of the settings are unknown but are assumed to be within a few degrees. A setpoint of 140°F is considered acceptable.

4.7.11 TRANSFER LINE HEAT TRACE CONTROL, LOOP HT2

LOOP DESCRIPTION

There are two heat trace and heat trace control loops on the transfer line, each affecting roughly one half of the length of the line. These are loops HT1 and HT2. HT2 is a simple thermostatic control loop consisting of a temperature sensing bulb buried in the insulation of the transfer line, and an associated switch TS-HT2. When the temperature exceeds a set value, the switch opens the contactor, CON-HT2 and prevents power from getting to the heat trace. When the line has cooled below the hysterisis band of the switch, the switch resets and CON-HT2 closes, providing power to the heat trace.

SETPOINT BASIS

The transferred waste temperature is to range between 110°F and 130° (Process Control Plan, HNF-4264, Rev. 0, Section 5.7) with a target temperature of 120°F (Process Control Plan, HNF-4264, Rev. 0, Section 2.1.2).

SETPOINT VALUES

It is critical that the temperature of the transferred waste remain above 110°F, the estimated precipitation point of the material. The temperature switch is factory calibrated and the temperature bulb and switch will be disposed of with the transfer line. The error of the settings are unknown but are assumed to be within a few degrees. A setpoint of 140°F is considered acceptable.

5.0 PRESSURE RELIEF SETPOINTS:

There are several pressure relief and control devices on the water skid. The skid design pressure was 200 psig. Pressure relief valves POR32-RW-PRV-401, POR32-RW-PRV-402, and POR32-RW-PRV-403 are set at 200 psig.

6.0 REFERENCES:

1) H-14-10656, Revision 1, Sheet 1
2) H-14-10657, Revision 1, Sheet 2
3) HNF-4264, Revision 0