2. To: (Receiving Organization) SNF Project		3. From: (Originating Organization) NHC-Modeling Team		4. Related EDT No.: N/A	
5. Proj./Prog./Dept./Div.: SNF W-441		6. Design Authority/Design Agent/Cog. Engr.: F. J. Heard		7. Purchase Order No.: N/A	
8. Originator Remarks: Transmittal of SNF-5119, Revision 0, "Independent Review & Analysis of the Safety Class Helium System, 30-lb Safety Relief Valve & Vent Path, Tempered Water System, & Process Water Conditioning System at the Cold Vacuum Drying Facility"				9. Equip./Component No.: N/A	
				10. System/Bldg./Facility: CVD 142K	
				12. Major Assem. Dwg. No.: N/A	
				13. Permit/Permit Application No.: N/A	
11. Receiver Remarks: 11A. Design Baseline Document? ☐ Yes ☒ No				14. Required Response Date: N/A	

15. DATA TRANSMITTED					(F)	(G)	(H)	(I)
(A) Item No.	(B) Document/Drawing No.	(C) Sheet No.	(D) Rev. No.	(E) Title or Description of Data Transmitted	Approval Designator	Reason for Transmittal	Originator Disposition	Receiver Disposition
1	SNF-5119		0	Independent Review & Analysis of the Safety Class Helium System, 30-lb Safety Relief Valve & Vent Path, Tempered Water System, & Process Water Conditioning System at ...	S ^N Q	1	1	1

16. KEY		
Approval Designator (F)	Reason for Transmittal (G)	Disposition (H) & (I)
E, S, Q, D OR N/A (See WHC-CM-3-5, Sec. 12.7)	1. Approval 2. Release 3. Information 4. Review 5. Post-Review 6. Dist. (Receipt Acknow. Required)	1. Approved 2. Approved w/comment 3. Disapproved w/comment 4. Reviewed no/comment 5. Reviewed w/comment 6. Receipt acknowledged

17. SIGNATURE/DISTRIBUTION (See Approval Designator for required signatures)											
(G) Reason	(H) Disp.	(J) Name	(K) Signature	(L) Date	(M) MSIN	(G) Reason	(H) Disp.	(J) Name	(K) Signature	(L) Date	(M) MSIN
/	/	Design Authority JJ Irwin	<i>JJ Irwin</i>	9/29/99	R3-86						
/	/	Design Agent CR Miska	<i>CR Miska</i>	9/29/99	R3-86						
1	1	Cog. Eng. FJ Heard	<i>FJ Heard</i>	9/29/99	H0-34						
1	1	Cog. Mgr. JP Sloughter	<i>JP Sloughter</i>	9/29/99	H0-46						
1	1	QA SL Mischke	<i>SL Mischke</i>	9/29/99	R3-86						
1	2	Safety ^N JR Brehm	<i>JR Brehm</i>	11/3/99	R3-26						
		Err.									

18. <i>FJ Heard</i> Signature of EDT Originator Date: 9/29/99	19. <i>JJ Irwin</i> Authorized Representative for Receiving Organization Date: 9/29/99	20. <i>T Cho</i> Design Authority/Cognizant Manager Date: 11/5/99	21. DOE APPROVAL (If required) Ctrl No. _____ ☐ Approved ☐ Approved w/comments ☐ Disapproved w/comments
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- 2.) Recommended units for volumetric flow for a gas system are standard or actual cubic feet per minute or even a mass flow rate of grams per second, but not gallons of helium per minute.

The independent review of CVD-25 and CVD-25-ALT resulted in several comments as follows:

- 1.) There may be an inconsistency between the bases for CVD-25 and CVD-25-ALT, previous on-site analyses, and current regulatory requirements. CVD-25 and CVD-25-ALT assume that the minimum helium flow requirement for the Safety Class Helium system is based on preventing the concentration of Hydrogen within the MCO from exceeding 4% by volume. Previous analyses that have been performed for different projects at Hanford have used 50% of the Lower Flammability Limit (LFL) or 2% hydrogen concentration by volume as the design basis. The National Electrical Code (NEC) recommends 25% of the LFL or 1% hydrogen concentration by volume. It is strongly recommended that the SCHe or CVDF design authority clearly state the design/safety basis for the hydrogen concentration.
- 2.) CVD-25 assumes a SCHe purge flowrate of 1.6 scfm at 273.15° K and 101325 Pa or 1.89 acfm at 323.15° K and 101325 Pa. There is some confusion as to what the SCHe purge flowrate requirement is. CVD-25 must be revised to reflect the final SCHe system design and minimum purge flow rate required to maintain the hydrogen concentration below some percentage of the LFL (see comment #1).

2.2 30-pound Relief Valve and Vent Path

An independent evaluation of the 30-pound Safety Class relief valve and vent path was completed. (The Term "30-pound" refers to the current cracking [differential] pressure setting of 30-psid) The objective of these analyses was to determine the maximum flow rate for hydrogen should the relief valve open. The analyses were done for three gases: air, helium and hydrogen. Air was analyzed for comparison to the vendor supplied flow curves. Helium was analyzed should the various helium systems over-pressurize the MCO. Hydrogen was analyzed to determine the response of the relief valve should exothermic chemical reactions between uranium metal and water over-pressurize the MCO. Mixtures were not analyzed, but could be accommodated in future analyses.

The analyses were performed for a series of MCO internal pressures ranging from a minimum value of 45.35-psia (31.00-psig) to a maximum value of 94.35-psia (80.00-psig). The minimum value corresponds to the upstream pressure (including system backpressure) at which the first indication of flow occurs. The maximum valve corresponds to a system pressure differential of 80-psid, which results in a fully open relief valve. The relief valve can be expected to open approximately 50% above the setpoint if it has not been recently cycled. After the initial operation, the relief valve can be expected to open within plus or minus 5% of the setpoint.

All of the analyses were performed for a compressible isothermal system at 60° F (15.6° C, 288.7° K) with an outlet pressure boundary condition of 14.35-psia. (Standard conditions are defined as 60° F (15.6° C, 288.7° F) at 14.696 psia.)

It must be emphasized that the results of these analyses should be considered approximate. The final installation drawings were not yet available and some of the piping lengths and tubing inner diameters were assumed.

The results of the 30-pound Safety Class relief valve and vent path analyses indicate:

- 1) The maximum compressible hydrogen mass flow rate is 2.6540 gm/s (66.0854 scfm) given a differential pressure of 80-psid across the 30-pound relief valve and process vent. The corresponding discharge volumetric flow rate is 67.68 acfm (14.35 psia, 60° F).
- 2) Most of the total pressure drop occurs across the relief valve and the final 40 feet of ½-inch (0.370 inches ID) stainless steel tubing.
- 3) The hydrogen mass flow rate is very sensitive to the length and inner diameter of the discharge line. The sensitivity was determined to be approximately 0.8% increase in the hydrogen flow rate per foot of decrease for the discharge line.
- 4) The relief valve setpoint must be adjusted downward to accommodate an initial cracking pressure 50% greater than the nominal setpoint and to assure proper interaction with the upstream rupture disk open. The safety relief valve can be expected to open approximately 50% above the nominal setpoint if it has not been recently cycled. It is also possible that the upstream 30-psid rupture disk could open and the safety relief valve would not respond with the current setpoint.

Two recommendations are made:

- 1) The MCO relief valve setpoint should be set to 20-psig to accommodate an increase in the initial cracking pressure and to assure proper interaction with upstream rupture disk (See Item #4 above).
- 2) The relief valve (PV-CK-*112) and process vent should be reanalyzed once the final design and installation drawings are available.

2.3 Tempered Water System

An independent evaluation of the Tempered Water (TW) system was completed. The TW system was analyzed assuming a 148-inch long 1-inch inner diameter Teflon lined flexible connecting line for the lower port and a revised seal ring assembly per drawing H-1-83275, Revision 0. The objective of these analyses was to determine the total system flow and the affect(s) of proposed design changes for the lower flexible line connection and upper seal ring assembly to the MCO transport cask. The analyses were performed for system temperatures of

The technical calculation CVD-1 (Merrick and Company, Revision 3) "Pump TW-P-3*14 Sizing" was also reviewed.

The network flow analyses indicate:

- 1.) The Tempered Water system was found to meet the design specifications for a minimum flow rate greater than 15 gpm. At 50° F (10 °C), the cask flow was determined to be 21.52 gpm. At 122 °F (50 °C), the cask flow was determined to be 23.00 gpm. The proposed design changes setting the length of the flexible line for the lower port at 148-inches with an inner diameter of 1-inch and revisions to the upper seal assembly are acceptable.
- 2.) The maximum pressure drop across the cask annulus ranged from 26.467 psid at 50 °F (10 °C) to 24.123 psid at 122 °F (50 °C). These values reflect the total predicted pressure drop from the lower port quick disconnect to the inlet of the discharge line at the upper seal ring. Any mechanical restraint to prevent the MCO from being ejected from the cask must be based on the maximum pressure difference plus some uncertainty.
- 3.) Approximately 93% of the pressure drop across the MCO/transport cask occur over the lower quick disconnect fitting and the small cylindrical annulus (1/8-inch gap) under the MCO. The small gap is maintained by a series of thin washers located on the upper interior surface of the transport cask's base. It is possible that with continued use these small washers will be worn down or deformed or sediment may accumulate. Since the pressure drop is inversely related to the square of the area, it is possible that the TW system flow rate will begin to decrease and the time to process each MCO will increase.
- 4.) The minimum flow of 15 gpm is meet for line diameters as small as 3/4-inch. However, for the 3/4-inch flexible line at 50 °F (10 °C), the Safety Relief Valve will require a higher setting of 40-psid to prevent relief flow.

The following recommendations are made:

- 1.) The cracking pressure setting for safety relief valve (SRF-3*11) must be revised from 30-psid to 35-psid. It is strongly recommended that a cracking pressure of 40-psid be considered. A cracking pressure setting of 35-psid provides an operational margin of approximately 1.38-psid at 10 °C and 3.33-psid at 50 °C. The current setting of 30-psid will allow the safety relief valve to open and most of the flow will bypass the remaining system. A cracking pressure setting of 40-psid provides additional margin for reduced system flow conditions due to higher than expected system resistance and may prevent spurious cycling during pump startup or valve changes, which were not investigated.

- 2.) The MCO/transport cask lower spacers should be increased to the maximum allowable thickness greater than the current value of 1/8-inch. Sediment should not be allowed to accumulate within the MCO/transport cask.
- 3.) CVD-1 (Revision 3) is out-of-date and does not reflect the current design of the TW system. Specifically, the recirculation leg is no longer located immediately after the pump and has been relocated after the cooler. In addition, the pump curve is based on a 4½-inch impeller diameter. The reference design is based on a 5½ -inch impeller diameter. Finally, the flow coefficients appear to have been based on smaller diameter valves and should be revised upward to reflect the larger diameter piping. It is recommended that CVD-1 be revised and brought "up-to-date" with the current design. In addition, it is recommended that CVD-1 continued to be verified until a consistent design calculation and review can be performed

2.4 Process Water Conditioning System

An independent evaluation of the Process Water Conditioning (PWC) system was completed. The primary objectives of these analyses were to determine the suction and supply side system flow rates and pressures during bulk water removal from the MCO, filtration flow through the Ion Exchange Module (IXM), and final transfer the system. Secondary objectives were simulating the deionized (DI) water flush of PWC-*01-SS-1 and estimating the system temperatures during steady-state operations. The technical calculations CVD-18A (Revision 3) "Size PWC-EJR-4031" and CVD-18B "Size PWC-P-4035/6" were also reviewed.

The network flow analyses indicate:

- 1) The PWC system was found to meet the 5-gpm design criteria for bulk water removal from a MCO. The estimated suction side system flow rate is approximately 7-gpm at 50 °F (10 °C) and 7.3-gpm at 122 °F (50 °C).
- 2) The 6-gpm deionized water flush was successfully simulated. The deionized water flush will flow in the proper direction as long as a positive MCO cover gas pressure is maintained and the PWC suction side is operating. If both conditions are not met, the MCO will begin to fill. The fill level will depend on whether the MCO is vented and the pressure of the deionized water source at the top of the long dip tube.
- 3) It is not clear that sufficient volume exists in PWC-TK-4032 and PWC-TK-4033 to accommodate an increase in the bulk water removed from a MCO partially loaded with short sections of fuel assemblies, single inner/outer elements, or empty locations. The nominal bulk water volume of 150 gallons plus the 80 gallon DI flush nearly utilizes the total working volume of 236 gallons within the Safety Class receiver tanks PWC-TK-4032 and PWC-TK-4033.
- 4) The jet pump supply side volumetric flow rate was determined to be 42.88–gpm at a supply pressure of 50-psig at 122 °F (50 °C).

Figure 4-4. Photograph of Seal Ring Assembly
First Article Testing

Seal Ring interface

5.0 RESULTS

The results of the independent review are presented in Section 5.1. The results of the network flow analyses are presented in Section 5.2.

5.1 Independent Review of Design Calculation CVD-1

An independent review was performed for design calculation: CVD-1 (Revision 3), "Pump TW-P-3*14 Sizing" dated August 12, 1998. The basis to CVD-1 is sound, but depends strongly on the system design and the assumed pressure drop across the transport cask. Random spot checks of the results as revealed no calculational errors. However, it must be emphasized that CVD-1 (Revision 3) does not reflect the current procurement specification for the Tempered Water system. Specifically, the recirculation leg is no longer located immediately after the pump and has been relocated after the cooler. In addition, the pump curve is now based on a 5½ -inch impeller diameter rather than a 4½ -inch impeller diameter. Finally, the flow coefficients appear to have been based on smaller diameter valves and should be revised upward to reflect the larger diameter piping.

The most recent and consistent design calculations have not yet been received for review. It is recommended that CVD-1 continued to be verified until a consistent design calculation and review can be performed. Eventually, the design calculation should be brought "up-to-date" with the subject independent. Once a "one-to-one" review is obtained, minor revisions to the TW system can be accepted with or without independent verification: subject to concurrence by the independent reviewer given the proposed design changes.

5.2 Tempered Water (TW) System

The reference Tempered Water system network flow model, as discussed in Section 4.2, was used to determine the steady-state isothermal system flow rate for two system temperatures: 50 °F (10 °C) and 122 °F (50 °F). The safety relief valve (SRV-3*11) cracking pressure is set at 35-psid. A major determinant for acceptable TW system performance is the flow rate through the MCO/Transport Cask. The results of these analyses are discussed in following paragraphs and presented in Tables 5-1 and 5-2 and Figures 5-1 and 5-2.

The differential pressure across the MCO/Transport Cask is the controlling resistance. Less important differential pressures are associated with the cooler (TW-CLR-3*10) and heater (TW-HTR-3*11). The settings for the flow control valve (FCV-3*18) and Safety Relief Valve (SRV-3*11) are also important in fine tuning the flow rate and preventing spurious relief valve operation. The input filenames for the reference design analyses are TW06A.FTH and TW06B.FTH. The output files for the reference design analyses are attached as Appendices C and D.

System and transport cask flows of 27.52 and 21.52 gpm, respectively, are obtained at 50 °F (10 °C). The differential system pressure at SRV-3*11 is 33.62-psid and provides an operational margin of 1.38-psid. The differential pressure drops across the cooler and heater are 6.32 and 0.27-psid, respectively. Figure 5-1 presents a plot of the pump curve versus the total system curve. The operating point is at the intersection of the two curves: 27.52 gpm at 101.05 feet (43.81-psid).

System and transport cask flows of 29.00 and 23.00 gpm, respectively, are obtained at 122 °F (50 °C). The differential system pressure at SRV-3*11 is 31.67-psid and provides an operational margin of 3.33-psid. The differential pressure drops across the cooler and heater are 6.94 and 0.30-psid, respectively. Figure 5-2 presents a plot of the pump curve versus the total system curve. The operating point is at the intersection of the two curves: 29.00 gpm at 99.77 feet (42.74-psid).

The current setting of 30-psid will allow the safety relief valve to open and most of the flow will bypass the remaining system. A cracking pressure setting of 35-psid provides some margin. However, a cracking pressure of 40-psid will provide additional margin and may prevent spurious cycling during pump startup or valve changes, which were not investigated.

Table 5-1 presents the results of a "mini"-sensitivity analysis. Additional analyses were performed for two diameters (i.e., 1½- and ¾-inches) at two system temperatures (i.e., 50 °F and 122 °F). The results are compared with the 1-inch reference design. For each case, the flexible supply line was assumed 148-inches in length. One end is connected to the Hanson fitting at the lower connection port. The other end is attached to a 1½ -inch Schedule 40 rigid pipe 116-inches in length that descends from the Process Hood flange fitting. The minimum flow of 15 gpm is met for line diameters as small as ¾-inch. However, for the ¾-inch flexible line at 50 °F (10 °C), the Safety Relief Valve will require a higher setting of 40-psid to prevent relief flow. One trend is noticeable: as the line diameter decreases the system flow decreases and the system pressure increases at the safety relief valve. For line diameters ¾-inches or smaller, the Safety Relief Valve (SRV-3*11) will require a higher setting (i.e., cracking pressure) to prevent relief flow.

Increased system pressure at the safety relief valve can also be obtained via decreased flow area under the MCO within the Transport Cask. The spacer washers can be worn down or become deformed or sediment may accumulate with use. The MCO/Transport Cask pressure drop is inversely related to the square of the flow area. Hence, a small change in the flow area under the MCO will have a significant affect on the pressure drop and flow rate.

Table 5-1. Tempered Water System Flow Rates and System Pressures for
Various Flexible Supply Line Diameters

System Temperature, °F (°C)	50 (10)	122 (50)
1.5-Inch Inner diameter		
System Flow (gpm)	28.409	29.823
Transport Cask Flow (gpm)	22.409	23.823
ΔP Across SRV-3*11 (psid)	32.622	30.731*
1.0-Inch Inner Diameter		
System Flow (gpm)	27.516	29.002
Transport Cask Flow (gpm)	21.516	23.002
ΔP Across SRV-3*11 (psid)	33.620*	31.670*
0.75-Inch Inner Diameter		
System Flow (gpm)	25.083	26.693
Transport Cask Flow (gpm)	19.083	20.693
ΔP Across SRV-3*11 (psid)	36.205**	34.204*

* 35-psid cracking pressure

** 40-psid cracking pressure

Figure 5-1. Pump Curve vs. System Curve for Reference Design at 50 °F (10 °C)

Figure 5-2. Pump Curve vs. System Curve for Reference Design at 122 °F (50 °C)

6.0 CONCLUSIONS

An independent evaluation of the Tempered Water (TW) system was completed. The TW system was analyzed assuming a 148-inch long 1-inch inner diameter Teflon lined flexible connecting line for the lower port and a revised seal ring assembly per drawing H-1-83275, Revision 0. The objective of these analyses was to determine the total system flow and the affect(s) of proposed design changes for the lower flexible line connection and upper seal ring assembly to the MCO transport cask. The analyses were performed for system temperatures of 50 °F (10 °C) and 122 °F (50 °C), with an atmospheric pressure boundary condition of 14.35 psia.

The technical calculation CVD-1 (Merrick and Company, Revision 3) "Pump TW-P-3*14 Sizing" was also reviewed.

The network flow analyses indicate:

- 1) The Tempered Water system was found to meet the design specifications for a minimum flow rate greater than 15 gpm. At 50 °F (10 °C), the cask flow was determined to be 21.52 gpm. At 122 °F (50 °C), the cask flow was determined to be 23.00 gpm. The proposed design changes setting the length of the flexible line for the lower port at 148-inches with an inner diameter of 1-inch and revisions to the upper seal assembly are acceptable.
- 2) The maximum pressure drop across the cask annulus ranged from 26.467 psid at 50 °F (10 °C) to 24.123 psid at 122 °F (50 °C) for the reference lower port and seal ring assembly. These values reflect the total predicted pressure drop from the lower port quick disconnect to the inlet of the discharge line at the upper seal ring. Any mechanical restraint to prevent the MCO from being ejected from the cask must be based on the maximum pressure difference plus some uncertainty.
- 3) Approximately 93% of the pressure drop across the MCO/transport cask occur over the lower quick disconnect fitting and the small cylindrical annulus (1/8-inch gap) under the MCO. The small gap is maintained by a series of thin washers located on the upper interior surface of the transport cask's base. It is possible that with continued use these small washers will be worn down or deformed or sediment may accumulate. Since the pressure drop is inversely related to the square of the area, it is possible that the TW system flow rate will begin to decrease and the time to process each MCO will increase.
- 4) The minimum flow of 15 gpm is meet for line diameters as small as 3/4-inch. However, for the 3/4-inch flexible line at 50 °F (10 °C), the Safety Relief Valve will require a higher setting of 40-psid to prevent relief flow.

The following recommendations are made:

- 1) The cracking pressure setting for safety relief valve (SRF-3*11) must be revised from 30-psid to 35-psid. It is strongly recommended that a cracking pressure of 40-psid be considered. A cracking pressure setting of 35-psid provides an operational margin of approximately 1.38 psi at 10 °C and 3.33 psi at 50 °C. The current setting of 30-psid will allow the safety relief valve to open and most of the flow will bypass the remaining system. A cracking pressure setting of 40-psid provides additional margin for reduced system flow conditions due to higher than expected system resistance and may prevent spurious cycling during pump startup or valve changes, which were not investigated.
- 2) The MCO/transport cask lower spacers should be increased to the maximum allowable thickness greater than the current value of 1/8-inch. Sediment should not be allowed to accumulate within the MCO/transport cask.
- 3) CVD-1 (Revision 3) is out-of-date and does not reflect the current design of the TW system. Specifically, the recirculation leg is no longer located immediately after the pump and has been relocated after the cooler. In addition, the pump curve is based on a 4½-inch impeller diameter. The reference design is based on a 5½ -inch impeller diameter. Finally, the flow coefficients appear to have been based on smaller diameter valves and should be revised upward to reflect the larger diameter piping. It is recommended that CVD-1 be revised and brought "up-to-date" with the current design. In addition, it is recommended that CVD-1 continued to be verified until a consistent design calculation and review can be performed.

7.0 REFERENCES

"Flow of Fluids Through Valves, Fittings, and Pipe", Technical Paper Number 410, Crane Company, Chicago, Illinois, 1991.

Miller, D. S., "Internal Flow Systems", Second Edition, Published by BHRA (Information Services), Cranfield, UK, 1990.

Idelchik, I. E., "Handbook of Hydraulic Resistance", Third Edition, CRC Press, Ann Arbor, Michigan, 1994.

"Procurement Specification for the Fabrication, Acceptance Testing, and Shipment of the Cold Vacuum Drying Facility Process Equipment Skid", W-441-P5, Revision 2, Merrick and Company, dated September 23, 1998.

Appendix A
Vendor Data Sheets

Kevin Babbitt

33/34

TW-P-3 1/4

SNF-5119
Revision 0

Post-It™ brand fax transmittal memo 7671 # of pages 1	
To: Kevin Babbitt	From: John Gami/0
Co: Merrick	Co: Temple Industrial
Dept:	Phone: (602) 731-1433
Fax: 505-662-3851	Fax:

IMPELLER	T-X374"	TYPE
4" -S 1/2"	CURVE BASED ON WATER AT 20°C EFFICIENCIES SHOWN ARE OVERALL WIRE TO WATER	CCA
		SPEED
		3450rpm

DATE	CURVE No
NOV1993	4207 116

104

ESTIMATED PRESSURE DROP
IN CIRCULATION HEATERS10 FPS
MAT thru
Nozzle

Pressure Drop

Pressure drop is shown above for water as a function of inlet/outlet size, and GPM flow. Pressure drop (ΔP) varies with the density of the fluid which is related to water thru the specific gravity ratio.

For fluids other than water, multiply the pressure drop from the above chart by the specific gravity of the fluid.

Example:

40 GPM of #2 fuel oil flows thru a model CFMS748A10 circulation heater (3" flange, inlet/outlet 1" NPT).

1. From Chart CH-2: $\Delta P = 5.2$ psi for water
2. For fuel oil: $\Delta P = (\text{Sp.Gr.})(5.2)$
 $= (.86)(5.2) = 4.5$ psi

From Table PL-1

Oil Density = 53.9 lbs/Cu Ft

$$\text{Sp.Gr.} = \frac{\text{Fluid Density}}{\text{Density of Water}}$$

$$= \frac{53.9}{62.4} = .86$$

MADE IN
USA

35/36

SPECIFICATION SHEET

ULTRAFLEX

TW-CLR-3110

DATE: 05/11/1996
CUSTOMER: DAVE MUNGER

SNF-5119
Revision 0

PROPOSAL NO. 0000067-18A R00
ITEM NUMBER **A**
SALES TECH. DLC

MODEL NO: UFX-18-5 FRAME TYPE: UP **PLATES PER UNIT: 49** **MAX FRAME CAPACITY = (65)**
NO. OF UNITS IN PARALLEL: 1 HEAT TRANSFER AREA: 91.0 SQ FT / UNIT
RUN NUMBER: 333972 R

* PERFORMANCE	*** HOT SIDE *****	COLD SIDE ***
* FLUID CIRCULATED	* WATER	* WATER
TOTAL FLOW RATE	20.00	20.00 * GPM
UNIT FLOW RATE	20.00	20.00 * GPM
SPECIFIC HEAT	1.00	1.00 * BTU /LB °F
SPECIFIC GRAVITY	1.00	1.00 *
THERMAL CONDUCTIVITY	0.34	0.34 * BTU/HR FT °F
VISCOSITY	1.20	1.30 * CP AT AVG TEMP
INLET TEMPERATURE	68.00	41.00 * °F
OUTLET TEMPERATURE	44.60	64.38 * °F
PRESSURE DROP	4.72	4.66 * PSI
HEAT EXCHANGED	234567.6	***** BTU/HR UNIT
DESIGN "U" VALUE	713.5	***** BTU/HR SQ FT °F
* CONSTRUCTION		* PASS ARRANGEMENTS
DESIGN PRESSURE	75	3 X 3
TEST PRESSURE	113	* PSIG
DESIGN TEMPERATURE	150	* °F
UNIT NET WEIGHT	755	* POUNDS

* UNIT DIMENSIONS	* NOZZLE SPECIFICATIONS
A * 6.56"	LOCATION M1 H/O- 2"-ELE
B * 31.50"	LOCATION S2 C/O- 2"-STR
C * 36.13"	LOCATION S3 H/I- 2"-STR
T * 0.88"	LOCATION M4 C/I- 2"-ELE

* MATERIALS

PLATES	* 304 SS
GASKETS	* NBR
NOZZLES	* HOT-316LSS COLD-316LSS
FRAME	* CS EPOXY PAINTED
BAR	* CS EPOXY PAINTED WITH STAINLESS GUIDES
BOLTS	* ZN PLATED CS

* REMARKS: **TWR-CLR-3110**

\$ 3,063.00

• ADD \$68.00 PER UNIT FOR 2" FLANGED NOZZLES

• ADD \$345.00 FOR 304SS TIE BOLTS

The SUPERCHANGER performance guarantee is based on the accuracy of supply product and operating conditions in conformance with the above.

Appendix B

Pressure Drop Calculation for MCO/Transport Cask

Updated Pressure Drop

PRESSURE DROP CALC THRU TRANSPORT CASK FOR TEMPERED WATER FLOW AT 50F (10C)														7/22/99
Flow Component or Location	Flow, gpm	Cv	K	L/D	Hyd. Dia. - in	Area sq. ft.	Vel. - fps	Temp. Deg. C	Density lbm/ft^3	KINEMATIC VISCOSITY FT^2/SEC	Re	Friction Factor f	Delta P (psi)	
Inlet	20	-		-	-	-	-	10C	62.4	1.41E-05	-	-		
Quick Disconnect	20	7.2		-				10C	62.4	1.41E-05		-	7.716	
90 Deg. Elbow, Mitered	20			72	0.63	0.002	20.58	10C	62.4	1.41E-05	76644	0.0279	5.724	
Sudden Expansion	20		0.72		2.5	0.034	1.31	10C	62.4	1.41E-05	19314	0.0245	1.802	
1 Velocity Head For Bull Head Turn	20		1		0.63	0.002	20.58	10C	62.4	1.41E-05	76644	0.0279	2.853	
Sharp 90 Deg. Turn Under MCO	20			90	0.125	0.003	16.34	10C	62.4	1.41E-05	12071	0.0405	6.559	
Flow under MCO @ 6 inch radius	20			17	0.125	0.033	1.36	10C	62.4	1.41E-05	1006	0.0562	0.012	
Flow under MCO @ 9 inch radius	20			13	0.125	0.049	0.91	10C	62.4	1.41E-05	671	0.0622	0.004	
Flow under MCO @ 12 inch radius	20			13	0.125	0.065	0.68	10C	62.4	1.41E-05	503	0.1272	0.005	
90 Deg. Turn @ MCO Edge	20			30	0.25	0.065	0.68	10C	62.4	1.41E-05	1006	0.0636	0.006	
Sudden Expansion	20		1		1.19	0.319	0.14	10C	62.4	1.41E-05	982	0.0464	0.002	
MCO-Cask Annulus	20			125	1.19	0.319	0.14	10C	62.4	1.41E-05	982	0.0652	0.0011	
MCO Head - Cask Forging Annulus														
- sudden contraction	20		0.5		0.25	0.066	0.68	10C	62.4	1.41E-05	1001	0.0640	0.002	
- MCO-Cask annulus, 4 inches	20			16	0.25	0.066	0.68	10C	62.4	1.41E-05	1001	0.0640	0.0032	
- 45 Deg. elbow, mitered (2)	20			25	0.25	0.066	0.68	10C	62.4	1.41E-05	1001	0.0693	0.011	
- MCO-Cask annulus, 8 inches	20			32	0.25	0.069	0.64	10C	62.4	1.41E-05	951	0.0673	0.0060	
Outlet	20	-		-	-	-	-	10C	62.4	1.41E-05	-	-		
90 Deg. Turn @ MCO Edge	20			30	0.25	0.069	0.64	10C	62.4	1.41E-05	951	0.0673	0.006	
Sudden Expansion	20		1		0.6	0.165	0.27	10C	62.4	1.41E-05	956	0.0467	0.0009	
Flow above MCO @ 12 inch radius	20			5	0.6	0.157	0.28	10C	62.4	1.41E-05	1006	0.0636	0.0002	
Flow above MCO @ 9 inch radius	20			5	0.6	0.118	0.38	10C	62.4	1.41E-05	1341	0.0523	0.0003	
Flow above MCO @ 6 inch radius	20			7	0.6	0.079	0.57	10C	62.4	1.41E-05	2012	0.0472	0.001	
Sharp 90 Deg. Turn Into Lid	20			90	1	0.005	8.17	10C	62.4	1.41E-05	48286	0.0305	1.235	
Sudden Contraction	20		0.5		0.63	0.002	20.58	10C	62.4	1.41E-05	76644	0.0186	0.519	
												Total Pressure Drop =	26.467	

10C	62.4	1.41E-05
50C	61.65	6.24E-06

Updated Pressure Drop

PRESSURE DROP CALC THRU TRANSPORT CASK FOR TEMPERED WATER SYSTEM AT 122F (50C)												7/22/99
Flow Component or Location	Flow, gpm	Cv	K	L/D	Hyd. Dia. - in	Area sq. ft.	Vel. - fps	Temp. Deg. C	Density lbm/ft ³	KINEMATIC VISCOSITY FT ² /SEC	Friction Factor f	Delta P (psi)
Inlet	20	-	-	-	-	-	-	50C	61.65	6.24E-06	-	-
Quick Disconnect	20	7.2	-	-	-	-	-	50C	61.65	6.24E-06	-	7.623
90 Deg. Elbow, Mitered	20	-	-	72	0.63	0.002	20.58	50C	61.65	6.24E-06	0.0238	4.833
Sudden Expansion	20	-	0.72	-	2.5	0.034	1.31	50C	61.65	6.24E-06	0.0208	1.78
1 Velocity Head For Bulb Head Turn	20	-	1	-	0.63	0.002	20.58	50C	61.65	6.24E-06	0.0238	2.819
Sharp 90 Deg. Turn Under MCO	20	-	-	90	0.125	0.003	16.34	50C	61.65	6.24E-06	0.0343	5.477
Flow under MCO @ 6 inch radius	20	-	-	17	0.125	0.033	1.36	50C	61.65	6.24E-06	0.0458	0.009
Flow under MCO @ 9 inch radius	20	-	-	13	0.125	0.049	0.91	50C	61.65	6.24E-06	0.0507	0.003
Flow under MCO @ 12 inch radius	20	-	-	13	0.125	0.065	0.88	50C	61.65	6.24E-06	0.0563	0.002
90 Deg. Turn @ MCO Edge	20	-	-	30	0.25	0.065	0.88	50C	61.65	6.24E-06	0.0282	0.003
Sudden Expansion	20	-	1	-	1.19	0.319	0.14	50C	61.65	6.24E-06	0.0388	0.002
MCO-Cask Annulus	20	-	-	125	1.19	0.319	0.14	50C	61.65	6.24E-06	0.0289	0.0005
MCO Head - Cask Forging Annulus	20	-	-	-	-	-	-	-	-	-	-	-
- sudden contraction	20	-	0.5	-	0.25	0.066	0.88	50C	61.65	6.24E-06	0.0283	0.002
- MCO-Cask annulus, 4 inches	20	-	-	16	0.25	0.066	0.88	50C	61.65	6.24E-06	0.0283	0.0014
- 45 Deg. elbow, mitered (2)	20	-	-	25	0.25	0.066	0.88	50C	61.65	6.24E-06	0.0579	0.009
- MCO-Cask annulus, 8 inches	20	-	-	32	0.25	0.069	0.84	50C	61.65	6.24E-06	0.0298	0.0028
Outlet	20	-	-	-	-	-	-	-	-	-	-	-
90 Deg. Turn @ MCO Edge	20	-	-	30	0.25	0.069	0.84	50C	61.65	6.24E-06	-	-
Sudden Expansion	20	-	1	-	0.6	0.165	0.27	50C	61.65	6.24E-06	0.0298	0.002
Flow above MCO @ 12 inch radius	20	-	-	5	0.6	0.157	0.28	50C	61.65	6.24E-06	0.0390	0.0009
Flow above MCO @ 9 inch radius	20	-	-	5	0.6	0.118	0.38	50C	61.65	6.24E-06	0.0282	0.0001
Flow above MCO @ 6 inch radius	20	-	-	7	0.6	0.079	0.57	50C	61.65	6.24E-06	0.0426	0.0002
Sharp 90 Deg. Turn Into Lid	20	-	-	90	1	0.005	8.17	50C	61.65	6.24E-06	0.0385	0.001
Sudden Contraction	20	-	0.5	-	0.63	0.002	20.58	50C	61.65	6.24E-06	0.0280	1.04
											0.0159	0.513
Total Pressure Drop =												24.123

10C	62.4	1.41E-05
50C	61.65	6.24E-06

Appendix C

Steady-State Results (TW06B.FTH) for Reference Tempered Water System at 50 °F (10 °C)

TEMPERED WATER SYSTEM - DESIGN AS OF 072299 - 10C

Title: TEMPERED WATER SYSTEM - DESIGN AS OF 072299 - 10C

Analysis run on: 7/29/99 10:34:10 AM

Input File: C:\FATHOM\TEMPERED\TW06B.FTH

Execution Time= 0.60 seconds
Total Number Of Head/Pressure Iterations= 3
Total Number Of Temperature Iterations= 0
Total Number Of Flow Iterations= 2
Number Of Pipes= 101
Number Of Junctions= 98
Pressure Tolerance= 1E-08 relative change
Mass Flow Rate Tolerance= 1E-08 relative change
Relaxation= .2

Constant Fluid Property Model

Fluid: Water at 1 atm
Temperature: 10 deg. C
Density= 999.7596 kg/m3
Viscosity= 1.316777E-03 kg/sec-m
Vapor Pressure= .17055 psia
Gravitational Acceleration= 1 g
Atmospheric Pressure= 14.35 psia

Total Inflow= 3.82633 lbm/sec
Total Outflow= 3.82633 lbm/sec
Maximum Pressure is 56.1886 psia at Junction 1 Outlet
Minimum Pressure is 7.92120 psia at Junction 46 Inlet

Junction 6 Loss Results:

Pipe 21 -9.58137E-03 feet, -4.15279E-03 psid, K= -0.0536228
Pipe 12 0.321007 feet, 0.139132 psid, K= 4.16361

Junction 7 Loss Results:

Pipe 14 0.0925180 feet, 0.0400995 psid, K= 1.20000

Junction 12 Loss Results:

Pipe 82 0.0770983 feet, 0.0334162 psid, K= 1.00000
Pipe 96 0.0657687 feet, 0.0285057 psid, K= 1.00000

Junction 32 Loss Results:

Pipe 34 0.214417 feet, 0.0929333 psid, K= 1.20000

Junction 41 Loss Results:

Pipe 44 0.702090 feet, 0.304302 psid, K= 0.708131

Junction 103 Loss Results:

Pipe 22 0.196549 feet, 0.0851888 psid, K= 1.10000

Junction 105 Loss Results:

Pipe 26 0.214417 feet, 0.0929333 psid, K= 1.20000

PUMP SUMMARY

Jct	Flow (gal/min)	DP (psid)	DH (feet)	Speed (%)	ideal hp (hp)	NPSHA (feet)	NPSHR (feet)
1	27.516	43.809	101.08	100.00	0.70308	32.427	N/A

VALVE SUMMARY

Jct	Type	Flow (gal/min)	DP (psid)	DH (feet)	P Inlet (psia)	Cv	K	State
4	REGULAR	27.516	6.1846E-03	0.014269	55.762	350.00	0.048829	Open
5	REGULAR	27.516	6.1846E-03	0.014269	48.142	350.00	0.048829	Open
9	RELIEF	0.0000	33.620	77.567	46.433	N/A	0.0000	Closed
19	FCV	6.0000	33.562	77.435	46.593	1.0360	1004.4	Open
23	REGULAR	21.516	0.038284	0.088329	47.431	110.00	0.089089	Open
72	REGULAR	0.0000	30.108	69.467	38.441	N/A	0.0000	Closed By User
73	REGULAR	0.0000	30.103	69.455	38.439	N/A	0.0000	Closed By User

Jct	Type	Flow (gal/min)	DP (psid)	DH (feet)	P Inlet (psia)	Cv	K	State
86	REGULAR	21.516	0.038284	0.088329	12.834	110.00	0.089089	Open
107	REGULAR	27.516	0.062612	0.14446	14.592	110.00	0.089089	Open
117	REGULAR	21.516	0.038284	0.088329	10.874	110.00	0.49434	Open
119	REGULAR	0.0000	N/A	N/A	N/A	N/A	0.0000	Closed By User

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TEMPERED WATER SYSTEM - DESIGN AS OF 072299 - 10C

Pipe	Vol. Flow (gal/min)	dP Total (psid)	dP Friction (psid)	dP Gravity (psid)	dH (feet)	Max Pres. (psia)	Min Pres. (psia)	P Inlet (psia)	P Outlet (psia)
1	27.51634	0.1522336304	0.1522336304	0.0000000	0.3512354716	13.67463	13.52240	13.67463	13.52240
2	27.51634	0.5532051921	0.3410084248	0.2121968	0.7867792062	56.18857	55.63537	56.18857	55.63537
3	27.51634	0.4708130062	0.2902199328	0.1805931	0.6695993171	55.63537	55.16455	55.63537	55.16455
4	27.51634	0.0059014857	0.0059014857	0.0000000	0.0136159868	55.62935	55.62344	55.62935	55.62344
5	27.51634	-0.4525066316	0.0260648951	-0.4785715	0.0601372752	56.02390	55.57139	55.57139	56.02390
6	27.51634	0.0088522285	0.0088522285	0.0000000	0.0204239802	55.97184	55.96299	55.97184	55.96299
7	27.51634	0.5919765234	0.0084353061	0.5835412	0.0194620513	56.02340	55.43142	56.02340	55.43142
8	27.51634	0.5919764638	0.0084353061	0.5835412	0.0194620513	49.10825	48.51627	49.10825	48.51627
9	27.51634	0.1523429304	0.0078686476	0.1444743	0.0181546491	48.16772	48.01538	48.16772	48.01538
10	27.51634	0.4141827226	0.0213928856	0.3927898	0.0493579523	48.00920	47.59501	48.00920	47.59501
11	27.51634	0.0059018685	0.0059018685	0.0000000	0.0136168700	47.54296	47.53706	47.54296	47.53706
12	6.00000	0.8768818378	0.0235797968	0.8533021	0.0544036230	47.49117	46.61428	47.49117	46.61428
13	0.00000	0.2144541591	0.0000000000	0.2144542	0.0000000000	46.64770	46.43325	46.64770	46.43325
14	6.00000	0.0142227449	0.0142227449	0.0000000	0.0328149075	46.57418	46.55996	46.57418	46.55996
15	0.00000	0.0000000000	0.0000000000	0.0000000	0.0000000000	46.43325	46.43325	46.43325	46.43325
16	6.00000	0.0029960559	0.0029960559	0.0000000	0.0069125403	12.99773	12.99474	12.99773	12.99474
17	0.00000	0.0000000000	0.0000000000	0.0000000	0.0000000000	12.81370	12.81370	12.81370	12.81370
18	0.00000	-0.2144541591	0.0000000000	-0.2144542	0.0000000000	13.02815	12.81370	12.81370	13.02815
19	6.00000	0.0149713103	0.0149713103	0.0000000	0.0345420076	12.99474	12.97977	12.99474	12.97977
20	6.00000	-0.1617837995	0.0007499342	-0.1625337	0.0017302582	13.23045	13.06866	13.06866	13.23045
21	21.51634	0.0056179939	0.0056179939	0.0000000	0.0129619108	47.59042	47.58480	47.59042	47.58480
22	21.51634	0.0224719793	0.0224719793	0.0000000	0.0518476516	47.55297	47.53050	47.55297	47.53050
23	21.51634	-0.4554914236	0.0163077880	-0.4717992	0.0376255469	47.90080	47.44531	47.44531	47.90080
24	21.51634	-0.4697864652	0.0020127476	-0.4717992	0.0046438382	48.41684	47.94706	47.94706	48.41684
25	21.51634	0.1732909083	0.0062422110	0.1670487	0.0144021128	46.71848	46.54519	46.71848	46.54519
26	21.51634	0.0012484430	0.0012484430	0.0000000	0.0028804245	46.45226	46.45101	46.45226	46.45101
27	21.51634	0.0636017621	0.0636017621	0.0000000	0.1467428375	44.93708	44.87348	44.93708	44.87348
28	21.51634	0.0099875443	0.0099875443	0.0000000	0.0230433959	45.12993	45.11994	45.12993	45.11994
29	21.51634	1.2144287825	0.0405744016	1.1738544	0.0936138030	45.08811	43.87368	45.08811	43.87368
30	21.51634	0.0199750885	0.0199750885	0.0000000	0.0460867919	43.84185	43.82188	43.84185	43.82188
31	21.51634	4.0356407166	0.1348318607	3.9008090	0.3110858753	43.79005	39.75441	43.79005	39.75441
32	21.51634	0.0049937721	0.0049937721	0.0000000	0.0115216980	39.72258	39.71758	39.72258	39.71758
33	21.51634	1.0101586580	0.0349562541	0.9752024	0.0806515377	39.68575	38.67559	39.68575	38.67559
34	21.51634	0.0022352014	0.0022352014	0.0000000	0.0051570867	38.58266	38.58043	38.58266	38.58043
35	21.51634	0.0024968861	0.0024968861	0.0000000	0.0057608490	38.58043	38.57793	38.58043	38.57793
36	21.51634	0.0024968861	0.0024968861	0.0000000	0.0057608490	38.57793	38.57543	38.57793	38.57543
37	21.51634	-0.9402459860	0.0349564068	-0.9752024	0.0806518901	39.51568	38.57543	38.57543	39.51568
38	21.51634	0.0049937721	0.0049937721	0.0000000	0.0115216980	39.48385	39.47886	39.48385	39.47886
39	21.51634	-4.0100684166	0.1435709596	-4.1536393	0.3312488414	43.44211	39.43204	39.43204	43.44211
40	21.51634	-0.9213255644	1.5979470015	-2.5192726	3.6868047300	43.80754	42.88622	42.88622	43.80754
41	21.51634	6.9631094933	0.0012484430	6.9618611	0.0028804245	17.78344	10.82033	17.78344	10.82033
42	21.51634	0.0099875443	0.0099875443	0.0000000	0.0230433959	10.82033	10.81035	10.82033	10.81035
43	21.51634	0.0012489904	0.0012489904	0.0000000	0.0028816874	10.75801	10.75676	10.75801	10.75676
44	21.51634	0.0106002931	0.0106002931	0.0000000	0.0244571382	10.10017	10.08957	10.10017	10.08957
45	21.51634	1.7936184406	0.0599252731	1.7336931	0.1382603928	10.25273	8.45911	10.25273	8.45911
46	21.51634	0.0106002931	0.0106002931	0.0000000	0.0244571382	7.93180	7.92120	7.93180	7.92120
47	21.51634	-0.3521212041	0.2618956864	-0.6140169	0.6042492363	8.48810	8.13598	8.13598	8.48810
48	21.51634	0.0106002931	0.0106002931	0.0000000	0.0244571382	8.03134	8.02074	8.03134	8.02074
49	21.51634	0.0299626365	0.0299626365	0.0000000	0.0691301964	8.19396	8.16400	8.19396	8.16400
50	21.51634	0.0911363065	0.0911363065	0.0000000	0.2102709074	8.13217	8.04103	8.13217	8.04103
51	0.00000	0.2167116404	0.0000000000	0.2167116	0.0000000000	38.65538	38.43866	38.65538	38.43866
52	0.00000	0.2167116404	0.0000000000	0.2167116	0.0000000000	8.33519	8.11848	8.33519	8.11848
53	21.51634	0.0024968861	0.0024968861	0.0000000	0.0057608490	8.04103	8.03854	8.04103	8.03854

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Pipe	Vol. Flow (gal/min)	dP Total (psid)	dP Friction (psid)	dP Gravity (psid)	dH (feet)	Max Pres. (psia)	Min Pres. (psia)	P Inlet (psia)	P Outlet (psia)
54	0.00000	0.2167116404	0.0000000000	0.2167116	0.0000000000	38.65787	38.44116	38.65787	38.44116
55	0.00000	0.2167116404	0.0000000000	0.2167116	0.0000000000	8.33269	8.11598	8.33269	8.11598
56	21.51634	0.0151373725	0.0151373725	0.00000000	0.0349251487	8.03854	8.02340	8.03854	8.02340
57	21.51634	-1.3561910391	0.0524346083	-1.4086256	0.1209778308	9.34776	7.99157	7.99157	9.34776
58	21.51634	0.0049937721	0.0049937721	0.00000000	0.0115216980	9.31593	9.31094	9.31593	9.31094
59	21.51634	-3.7509958744	0.1498131752	-3.9008090	0.3456509649	13.03010	9.27911	9.27911	13.03010
60	21.51634	0.0049937721	0.0049937721	0.00000000	0.0115216980	12.99827	12.99328	12.99827	12.99328
61	21.51634	0.0149813183	0.0149813183	0.00000000	0.0345650982	12.96145	12.94647	12.96145	12.94647
62	21.51634	-0.1740056276	0.0065875575	-0.1805932	0.0151989009	12.79103	12.61703	12.61703	12.79103
63	27.51634	0.1666252017	0.0086063333	0.1580189	0.0198566475	55.87782	55.71119	55.87782	55.71119
64	27.51634	0.0236059427	0.0236059427	0.00000000	0.0544639473	55.65914	55.63553	55.65914	55.63553
65	27.51634	0.0068732966	0.0068732966	0.00000000	0.0158581619	48.49870	48.49183	48.49870	48.49183
66	6.00000	-0.0878013670	0.0024952183	-0.0902966	0.0057570011	13.05233	12.96453	12.96453	13.05233
68	27.51634	0.2088613063	0.0034366481	0.2054247	0.0079290804	48.47425	48.26538	48.47425	48.26538
69	21.51634	0.4738408625	0.0020416388	0.4717992	0.0047104965	48.15062	47.67678	48.15062	47.67678
70	21.51634	0.1868756711	0.0424011722	0.1444745	0.0978285526	47.18813	47.00126	47.18813	47.00126
71	21.51634	0.4545282722	0.1272035241	0.3273247	0.2934856750	46.96297	46.50844	46.96297	46.50844
73	21.51634	0.1510541737	0.1510541737	0.00000000	0.3485142133	46.04754	45.89648	46.04754	45.89648
74	0.00000	0.0000000000	0.0000000000	0.00000000	0.0000000000	38.75304	38.75304	38.75304	38.75304
75	0.00000	0.0000000000	0.0000000000	0.00000000	0.0000000000	38.65288	38.65288	38.65288	38.65288
76	21.51634	0.0037453293	0.0037453293	0.00000000	0.0086412740	39.44703	39.44328	39.44703	39.44328
77	21.51634	0.0112359878	0.0112359878	0.00000000	0.0259238215	39.44328	39.43204	39.44328	39.43204
78	0.00000	0.0000000000	0.0000000000	0.00000000	0.0000000000	10.83420	10.83420	10.83420	10.83420
79	0.00000	0.0000000000	0.0000000000	0.00000000	0.0000000000	10.83420	10.83420	10.83420	10.83420
80	21.51634	0.0149813183	0.0149813183	0.00000000	0.0345650982	10.29954	10.28456	10.29954	10.28456
81	21.51634	0.0049937721	0.0049937721	0.00000000	0.0115216980	8.23078	8.22579	8.23078	8.22579
82	6.00000	-1.1469699144	0.0054393159	-1.1524092	0.0125496626	14.35002	13.20305	13.20305	14.35002
84	21.51634	0.0313665755	0.0313665755	0.00000000	0.0723693832	12.91464	12.88327	12.91464	12.88327
85	0.00000	0.0000000000	0.0000000000	0.00000000	0.0000000000	12.96072	12.96072	12.96072	12.96072
86	21.51634	0.0074906587	0.0074906587	0.00000000	0.0172825480	12.88327	12.87578	12.88327	12.87578
87	21.51634	0.0318008810	0.0318008810	0.00000000	0.0733714188	12.43606	12.40426	12.43606	12.40426
88	21.51634	0.0318008810	0.0318008810	0.00000000	0.0733714188	12.36598	12.33418	12.36598	12.33418
89	21.51634	0.0024968768	0.0024968768	0.00000000	0.0057608275	12.54422	12.54172	12.54422	12.54172
90	0.00000	0.0000000000	0.0000000000	0.00000000	0.0000000000	12.61917	12.61917	12.61917	12.61917
91	21.51634	0.0024968861	0.0024968861	0.00000000	0.0057608490	12.54172	12.53923	12.54172	12.53923
92	21.51634	0.0349564068	0.0349564068	0.00000000	0.0806518901	12.50740	12.47244	12.50740	12.47244
93	21.51634	-0.1394805163	0.0049937721	-0.1444743	0.0115216980	12.58009	12.44061	12.44061	12.58009
94	21.51634	0.0049937721	0.0049937721	0.00000000	0.0115216980	10.80129	10.79629	10.80129	10.79629
95	21.51634	0.0012484430	0.0012484430	0.00000000	0.0028804245	8.42728	8.42603	8.42728	8.42603
96	21.51634	-1.5589896441	0.0087834606	-1.5677731	0.0202653180	14.35002	12.79103	12.79103	14.35002
97	0.00000	0.0000000000	0.0000000000	0.00000000	0.0000000000	47.52276	47.52276	47.52276	47.52276
98	0.00000	0.0000000000	0.0000000000	0.00000000	0.0000000000	46.62263	46.62263	46.62263	46.62263
99	27.51634	0.0000218847	0.0000218847	0.00000000	0.0000504927	14.34678	14.34676	14.34678	14.34676
100	27.51634	0.1522327811	0.1522327811	0.00000000	0.3512335120	13.82687	13.67463	13.82687	13.67463
101	0.00000	0.0000000000	0.0000000000	0.00000000	0.0000000000	14.37744	14.37744	14.37744	14.37744
103	27.51634	0.3129246831	0.3129246831	0.00000000	0.7219840212	14.20240	13.88948	14.20240	13.88948
104	27.51634	-0.2304449975	0.2029781938	-0.4334232	0.4683140080	14.52288	14.29244	14.29244	14.52288
105	0.00000	0.0000000000	0.0000000000	0.00000000	0.0000000000	No Solution	No Solution	No Solution	No Solution

Pipe	Reynolds No.	Mass Flow (lbm/sec)	Velocity (feet/sec)	Dyn. Pres. (psia)	T Inlet (deg. F)	T Outlet (deg. F)	Resistance (sec ² /ft ⁵)	f	fL/D	K
1	6.29850E+04	3.826331	10.214790	0.70280689	50.0000	50.0000	93.4507615	0.0252469	0.21660804	0
2	8.01835E+04	3.826331	16.554880	1.84598958	50.0000	50.0000	209.3328320	0.0259093	0.18472934	0
3	8.01835E+04	3.826331	16.554880	1.84598958	50.0000	50.0000	178.1555998	0.0259093	0.15721645	0

AFT Fathom 3.0 Output
NUMATEC HANFORD CORPORATION

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Pipe	Reynolds No.	Mass Flow (lbm/sec)	Velocity (feet/sec)	Dyn. Pres. (psia)	T Inlet (deg. F)	T Outlet (deg. F)	Resistance (sec ² /ft ⁵)	f	fL/D	K
4	4.10380E+04	3.826331	4.336393	0.12665856	50.0000	50.0000	3.6227102	0.0250053	0.04659366	0
5	4.10380E+04	3.826331	4.336393	0.12665856	50.0000	50.0000	16.0003035	0.0250053	0.20578867	0
6	4.10380E+04	3.826331	4.336393	0.12665856	50.0000	50.0000	5.4340654	0.0250053	0.06989049	0
7	3.19648E+04	3.826331	2.630870	0.04662041	50.0000	50.0000	5.1781317	0.0231486	0.18093591	0
8	3.19648E+04	3.826331	2.630870	0.04662041	50.0000	50.0000	5.1781317	0.0231486	0.18093591	0
9	4.10380E+04	3.826331	4.336393	0.12665856	50.0000	50.0000	4.8302803	0.0250053	0.06212488	0
10	4.10380E+04	3.826331	4.336393	0.12665856	50.0000	50.0000	13.1323246	0.0250053	0.16890202	0
11	4.10380E+04	3.826331	4.336393	0.12665856	50.0000	50.0000	3.6229452	0.0250053	0.04659366	0
12	1.37340E+04	0.834340	2.227358	0.03341622	50.0000	50.0000	304.4325171	0.0313319	0.70563986	0
13	0.00000E+00	0.000000	0.000000	0.00000000	50.0000	50.0000	0.0000000	0.0000000	0.00000000	0
14	1.37340E+04	0.834340	2.227358	0.03341622	50.0000	50.0000	183.6260956	0.0313319	0.42562403	0
15	0.00000E+00	0.000000	0.000000	0.00000000	50.0000	50.0000	0.0000000	0.0000000	0.00000000	0
16	1.37340E+04	0.834340	2.227358	0.03341622	50.0000	50.0000	38.6812847	0.0313319	0.08960506	0
17	0.00000E+00	0.000000	0.000000	0.00000000	50.0000	50.0000	0.0000000	0.0000000	0.00000000	0
18	0.00000E+00	0.000000	0.000000	0.00000000	50.0000	50.0000	0.0000000	0.0000000	0.00000000	0
19	1.37340E+04	0.834340	2.227358	0.03341622	50.0000	50.0000	193.2906256	0.0313319	0.44802529	0
20	8.94844E+03	0.834340	0.945560	0.00602221	50.0000	50.0000	9.6822017	0.0334150	0.12452809	0
21	3.20896E+04	2.991991	3.390833	0.07744438	50.0000	50.0000	5.6402467	0.0259540	0.07254230	0
22	3.20896E+04	2.991991	3.390833	0.07744438	50.0000	50.0000	22.5609905	0.0259540	0.29016922	0
23	3.20896E+04	2.991991	3.390833	0.07744438	50.0000	50.0000	16.3723829	0.0259540	0.21057418	0
24	2.09252E+04	2.991991	1.441836	0.01400261	50.0000	50.0000	2.0207200	0.0271691	0.14374093	0
25	3.20896E+04	2.991991	3.390833	0.07744438	50.0000	50.0000	6.2669363	0.0259540	0.08060255	0
26	3.20896E+04	2.991991	3.390833	0.07744438	50.0000	50.0000	1.2533881	0.0259540	0.01612051	0
27	4.92509E+04	2.991991	7.987431	0.42972580	50.0000	50.0000	63.8536878	0.0258763	0.14800545	0
28	3.20896E+04	2.991991	3.390833	0.07744438	50.0000	50.0000	10.0271048	0.0259540	0.12896409	0
29	3.20896E+04	2.991991	3.390833	0.07744438	50.0000	50.0000	40.7351163	0.0259540	0.52391663	0
30	3.20896E+04	2.991991	3.390833	0.07744438	50.0000	50.0000	20.0542096	0.0259540	0.25792818	0
31	3.20896E+04	2.991991	3.390833	0.07744438	50.0000	50.0000	135.3659280	0.0259540	1.74101532	0
32	3.20896E+04	2.991991	3.390833	0.07744438	50.0000	50.0000	5.0135524	0.0259540	0.06448205	0
33	3.20896E+04	2.991991	3.390833	0.07744438	50.0000	50.0000	35.0947153	0.0259540	0.45137433	0
34	3.20896E+04	2.991991	3.390833	0.07744438	50.0000	50.0000	2.2440550	0.0232339	0.02886201	0
35	3.20896E+04	2.991991	3.390833	0.07744438	50.0000	50.0000	2.5067762	0.0259540	0.03224102	0
36	3.20896E+04	2.991991	3.390833	0.07744438	50.0000	50.0000	2.5067762	0.0259540	0.03224102	0
37	3.20896E+04	2.991991	3.390833	0.07744438	50.0000	50.0000	35.0948687	0.0259540	0.45137433	0
38	3.20896E+04	2.991991	3.390833	0.07744438	50.0000	50.0000	5.0135524	0.0259540	0.06448205	0
39	3.20896E+04	2.991991	3.390833	0.07744438	50.0000	50.0000	144.1396423	0.0259540	1.85385885	0
40	5.16642E+04	2.991991	8.789378	0.52034742	50.0000	50.0000	1604.2764493	0.0207495	3.07092307	0
41	3.20896E+04	2.991991	3.390833	0.07744438	50.0000	50.0000	1.2533881	0.0259540	0.01612051	0
42	3.20896E+04	2.991991	3.390833	0.07744438	50.0000	50.0000	10.0271048	0.0259540	0.12896409	0
43	3.20896E+04	2.991991	3.390833	0.07744438	50.0000	50.0000	1.2539377	0.0259540	0.01612051	0
44	4.92509E+04	2.991991	7.987431	0.42972580	50.0000	50.0000	10.6422807	0.0258763	0.02466758	0
45	3.20896E+04	2.991991	3.390833	0.07744438	50.0000	50.0000	60.1626363	0.0259540	0.77378459	0
46	4.92509E+04	2.991991	7.987431	0.42972580	50.0000	50.0000	10.6422807	0.0258763	0.02466758	0
47	3.44428E+04	2.991991	3.906390	0.10278468	50.0000	50.0000	262.9330519	0.0227500	2.54800302	0
48	4.92509E+04	2.991991	7.987431	0.42972580	50.0000	50.0000	10.6422807	0.0258763	0.02466758	0
49	3.20896E+04	2.991991	3.390833	0.07744438	50.0000	50.0000	30.0813182	0.0259540	0.38689229	0
50	3.20896E+04	2.991991	3.390833	0.07744438	50.0000	50.0000	91.4972963	0.0259540	1.17679733	0
51	0.00000E+00	0.000000	0.000000	0.00000000	50.0000	50.0000	0.0000000	0.0000000	0.00000000	0
52	0.00000E+00	0.000000	0.000000	0.00000000	50.0000	50.0000	0.0000000	0.0000000	0.00000000	0
53	3.20896E+04	2.991991	3.390833	0.07744438	50.0000	50.0000	2.5067762	0.0259540	0.03224102	0
54	0.00000E+00	0.000000	0.000000	0.00000000	50.0000	50.0000	0.0000000	0.0000000	0.00000000	0
55	0.00000E+00	0.000000	0.000000	0.00000000	50.0000	50.0000	0.0000000	0.0000000	0.00000000	0
56	3.20896E+04	2.991991	3.390833	0.07744438	50.0000	50.0000	15.1973315	0.0259540	0.19546120	0
57	3.20896E+04	2.991991	3.390833	0.07744438	50.0000	50.0000	52.6423012	0.0259540	0.67706147	0

AFT Fathom 3.0 Output
NUMATEC HANFORD CORPORATION

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Pipe	Reynolds No.	Mass Flow (lbm/sec)	Velocity (feet/sec)	Dyn. Pres. (psia)	T Inlet (deg. F)	T Outlet (deg. F)	Resistance (sec ² /ft ⁵)	f	fL/D	K
58	3.20896E+04	2.991991	3.390833	0.07744438	50.0000	50.0000	5.0135524	0.0259540	0.06448205	0
59	3.20896E+04	2.991991	3.390833	0.07744438	50.0000	50.0000	150.4065833	0.0259540	1.93446147	0
60	3.20896E+04	2.991991	3.390833	0.07744438	50.0000	50.0000	5.0135524	0.0259540	0.06448205	0
61	3.20896E+04	2.991991	3.390833	0.07744438	50.0000	50.0000	15.0406591	0.0259540	0.19344615	0
62	2.49948E+04	2.991991	2.057203	0.02850569	50.0000	50.0000	6.6136507	0.0265376	0.23109626	0
63	4.10380E+04	3.826331	4.336393	0.12665856	50.0000	50.0000	5.2831191	0.0250053	0.06794909	0
64	4.10380E+04	3.826331	4.336393	0.12665856	50.0000	50.0000	14.4908409	0.0250053	0.18637464	0
65	3.19648E+04	3.826331	2.630870	0.04662041	50.0000	50.0000	4.2192701	0.0253950	0.14743106	0
66	1.37340E+04	0.834340	2.227358	0.03341622	50.0000	50.0000	32.2151033	0.0313319	0.07467088	0
68	3.19648E+04	3.826331	2.630870	0.04662041	50.0000	50.0000	2.1096349	0.0253950	0.07371553	0
69	2.09252E+04	2.991991	1.441836	0.01400261	50.0000	50.0000	2.0497257	0.0271691	0.14580420	0
70	4.92509E+04	2.991991	7.987431	0.42972580	50.0000	50.0000	42.5691227	0.0258763	0.09867030	0
71	4.92509E+04	2.991991	7.987431	0.42972580	50.0000	50.0000	127.7073757	0.0258763	0.29601092	0
73	4.92509E+04	2.991991	7.987431	0.42972580	50.0000	50.0000	151.6524974	0.0258763	0.35151294	0
74	0.00000E+00	0.000000	0.000000	0.00000000	50.0000	50.0000	0.0000000	0.0000000	0.00000000	0
75	0.00000E+00	0.000000	0.000000	0.00000000	50.0000	50.0000	0.0000000	0.0000000	0.00000000	0
76	3.20896E+04	2.991991	3.390833	0.07744438	50.0000	50.0000	3.7601645	0.0259540	0.04836153	0
77	3.20896E+04	2.991991	3.390833	0.07744438	50.0000	50.0000	11.2804934	0.0259540	0.14508460	0
78	0.00000E+00	0.000000	0.000000	0.00000000	50.0000	50.0000	0.0000000	0.0000000	0.00000000	0
79	0.00000E+00	0.000000	0.000000	0.00000000	50.0000	50.0000	0.0000000	0.0000000	0.00000000	0
80	3.20896E+04	2.991991	3.390833	0.07744438	50.0000	50.0000	15.0406591	0.0259540	0.19344615	0
81	3.20896E+04	2.991991	3.390833	0.07744438	50.0000	50.0000	5.0135524	0.0259540	0.06448205	0
82	1.37340E+04	0.834340	2.227358	0.03341622	50.0000	50.0000	70.2255687	0.0284583	0.16277363	0
84	3.20896E+04	2.991991	3.390833	0.07744438	50.0000	50.0000	31.4908181	0.0259540	0.40502782	0
85	0.00000E+00	0.000000	0.000000	0.00000000	50.0000	50.0000	0.0000000	0.0000000	0.00000000	0
86	3.20896E+04	2.991991	3.390833	0.07744438	50.0000	50.0000	7.5203291	0.0259540	0.09672307	0
87	4.92509E+04	2.991991	7.987431	0.42972580	50.0000	50.0000	31.9268439	0.0258763	0.07400273	0
88	4.92509E+04	2.991991	7.987431	0.42972580	50.0000	50.0000	31.9268439	0.0258763	0.07400273	0
89	3.20896E+04	2.991991	3.390833	0.07744438	50.0000	50.0000	2.5067669	0.0259540	0.03224102	0
90	0.00000E+00	0.000000	0.000000	0.00000000	50.0000	50.0000	0.0000000	0.0000000	0.00000000	0
91	3.20896E+04	2.991991	3.390833	0.07744438	50.0000	50.0000	2.5067762	0.0259540	0.03224102	0
92	3.20896E+04	2.991991	3.390833	0.07744438	50.0000	50.0000	35.0948687	0.0259540	0.45137433	0
93	3.20896E+04	2.991991	3.390833	0.07744438	50.0000	50.0000	5.0135524	0.0259540	0.06448205	0
94	3.20896E+04	2.991991	3.390833	0.07744438	50.0000	50.0000	5.0135524	0.0259540	0.06448205	0
95	3.20896E+04	2.991991	3.390833	0.07744438	50.0000	50.0000	1.2533881	0.0259540	0.01612051	0
96	2.49948E+04	2.991991	2.057203	0.02850569	50.0000	50.0000	8.8182518	0.0265376	0.30812836	0
97	0.00000E+00	0.000000	0.000000	0.00000000	50.0000	50.0000	0.0000000	0.0000000	0.00000000	0
98	0.00000E+00	0.000000	0.000000	0.00000000	50.0000	50.0000	0.0000000	0.0000000	0.00000000	0
99	1.64111E+04	3.826331	0.693478	0.00323924	50.0000	50.0000	0.0134342	0.0272002	0.00675613	0
100	6.29850E+04	3.826331	10.214790	0.70280689	50.0000	50.0000	93.4502401	0.0252469	0.21660804	0
101	0.00000E+00	0.000000	0.000000	0.00000000	50.0000	50.0000	0.0000000	0.0000000	0.00000000	0
103	6.29850E+04	3.826331	10.214790	0.70280689	50.0000	50.0000	192.0932310	0.0252469	0.44524988	0
104	6.29850E+04	3.826331	10.214790	0.70280689	50.0000	50.0000	124.6010276	0.0252469	0.28881073	0
105	0.00000E+00	0.000000	0.000000	0.00000000	50.0000	50.0000	0.0000000	0.0000000	0.00000000	0

Pipe	fL/D + K	Length (feet)	Hyd. Diameter (inches)	Flow Area (feet ²)	Roughness	Fluid	Density Avg (kg/m ³)	Viscosity Avg (kg/sec-m)	Junctions (Up, Down)
1	0.21660804	0.7500000	1.049000	0.00600176	.00015 feet	Water at 1 atm	999.760	1.31678E-03	108, 1
2	0.18472934	0.4895833	0.824000	0.00370324	.00015 feet	Water at 1 atm	999.760	1.31678E-03	1, 97
3	0.15721645	0.4166666	0.824000	0.00370324	.00015 feet	Water at 1 atm	999.760	1.31678E-03	97, 61
4	0.04659366	0.2500000	1.610000	0.01413771	.00015 feet	Water at 1 atm	999.760	1.31678E-03	4, 15
5	0.20578867	1.1041666	1.610000	0.01413771	.00015 feet	Water at 1 atm	999.760	1.31678E-03	15, 16
6	0.06989049	0.3750000	1.610000	0.01413771	.00015 feet	Water at 1 atm	999.760	1.31678E-03	16, 62
7	0.18093591	1.3463541	2.067000	0.02330281	Smooth	Water at 1 atm	999.760	1.31678E-03	62, 98

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Pipe	fl/D + K	Length (feet)	Hyd. Diameter (inches)	Flow Area (feet ²)	Roughness	Fluid	Density Avg (kg/m ³)	Viscosity Avg (kg/sec-m)	Junctions (Up, Down)
8	0.18093591	1.3463541	2.067000	0.02330281	Smooth	Water at 1 atm	999.760	1.31678E-03	98, 20
9	0.06212488	0.3333333	1.610000	0.01413771	.00015 feet	Water at 1 atm	999.760	1.31678E-03	63, 5
10	0.16890202	0.9062499	1.610000	0.01413771	.00015 feet	Water at 1 atm	999.760	1.31678E-03	5, 18
11	0.04659366	0.2500000	1.610000	0.01413771	.00015 feet	Water at 1 atm	999.760	1.31678E-03	18, 6
12	0.70563986	1.9687499	1.049000	0.00600176	.00015 feet	Water at 1 atm	999.760	1.31678E-03	6, 7
13	0.00000000	0.5000000	1.049000	0.00600176	.00015 feet	Water at 1 atm	999.760	1.31678E-03	7, 8
14	0.42562403	1.1874999	1.049000	0.00600176	.00015 feet	Water at 1 atm	999.760	1.31678E-03	7, 19
15	0.00000000	0.0833333	1.049000	0.00600176	.00015 feet	Water at 1 atm	999.760	1.31678E-03	8, 9
16	0.08960506	0.2500000	1.049000	0.00600176	.00015 feet	Water at 1 atm	999.760	1.31678E-03	19, 11
17	0.00000000	1.7499999	1.049000	0.00600176	.00015 feet	Water at 1 atm	999.760	1.31678E-03	9, 10
18	0.00000000	0.5000000	1.049000	0.00600176	.00015 feet	Water at 1 atm	999.760	1.31678E-03	10, 11
19	0.44802529	1.2499999	1.049000	0.00600176	.00015 feet	Water at 1 atm	999.760	1.31678E-03	11, 13
20	0.12452809	0.5000000	1.610000	0.01413771	.00015 feet	Water at 1 atm	999.760	1.31678E-03	64, 110
21	0.07254230	0.3750000	1.610000	0.01413771	.00015 feet	Water at 1 atm	999.760	1.31678E-03	6, 21
22	0.29016922	1.5000000	1.610000	0.01413771	.00015 feet	Water at 1 atm	999.760	1.31678E-03	21, 103
23	0.21057418	1.0885416	1.610000	0.01413771	.00015 feet	Water at 1 atm	999.760	1.31678E-03	103, 66
24	0.14374093	1.0885416	2.469000	0.03324831	.00015 feet	Water at 1 atm	999.760	1.31678E-03	66, 99
25	0.08060255	0.4166666	1.610000	0.01413771	.00015 feet	Water at 1 atm	999.760	1.31678E-03	68, 105
26	0.01612051	0.0833333	1.610000	0.01413771	.00015 feet	Water at 1 atm	999.760	1.31678E-03	105, 70
27	0.14800545	0.5000000	1.049000	0.00600176	.00015 feet	Water at 1 atm	999.760	1.31678E-03	25, 26
28	0.12896409	0.6666666	1.610000	0.01413771	.00015 feet	Water at 1 atm	999.760	1.31678E-03	26, 27
29	0.52391663	2.7083332	1.610000	0.01413771	.00015 feet	Water at 1 atm	999.760	1.31678E-03	27, 28
30	0.25792818	1.3333333	1.610000	0.01413771	.00015 feet	Water at 1 atm	999.760	1.31678E-03	28, 29
31	1.74101532	9.0000000	1.610000	0.01413771	.00015 feet	Water at 1 atm	999.760	1.31678E-03	29, 31
32	0.06448205	0.3333333	1.610000	0.01413771	.00015 feet	Water at 1 atm	999.760	1.31678E-03	31, 30
33	0.45137433	2.3333332	1.610000	0.01413771	.00015 feet	Water at 1 atm	999.760	1.31678E-03	30, 32
34	0.02886201	0.1666667	1.610000	0.01413771	.000005 feet	Water at 1 atm	999.760	1.31678E-03	32, 33
35	0.03224102	0.1666667	1.610000	0.01413771	.00015 feet	Water at 1 atm	999.760	1.31678E-03	33, 34
36	0.03224102	0.1666667	1.610000	0.01413771	.00015 feet	Water at 1 atm	999.760	1.31678E-03	34, 74
37	0.45137433	2.3333332	1.610000	0.01413771	.00015 feet	Water at 1 atm	999.760	1.31678E-03	74, 37
38	0.06448205	0.3333333	1.610000	0.01413771	.00015 feet	Water at 1 atm	999.760	1.31678E-03	37, 36
39	1.85385885	9.5833328	1.610000	0.01413771	.00015 feet	Water at 1 atm	999.760	1.31678E-03	39, 76
40	3.07092307	12.3333326	1.000000	0.00545415	Smooth	Water at 1 atm	999.760	1.31678E-03	76, 40
41	0.01612051	0.0833333	1.610000	0.01413771	.00015 feet	Water at 1 atm	999.760	1.31678E-03	40, 78
42	0.12896409	0.6666666	1.610000	0.01413771	.00015 feet	Water at 1 atm	999.760	1.31678E-03	78, 42
43	0.01612051	0.0833333	1.610000	0.01413771	.00015 feet	Water at 1 atm	999.760	1.31678E-03	117, 41
44	0.02466758	0.0833333	1.049000	0.00600176	.00015 feet	Water at 1 atm	999.760	1.31678E-03	41, 118
45	0.77378459	4.0000000	1.610000	0.01413771	.00015 feet	Water at 1 atm	999.760	1.31678E-03	43, 96
46	0.02466758	0.0833333	1.049000	0.00600176	.00015 feet	Water at 1 atm	999.760	1.31678E-03	45, 46
47	2.54800302	14.0000000	1.500000	0.01227184	Smooth	Water at 1 atm	999.760	1.31678E-03	46, 47
48	0.02466758	0.0833333	1.049000	0.00600176	.00015 feet	Water at 1 atm	999.760	1.31678E-03	47, 81
49	0.38689229	2.0000000	1.610000	0.01413771	.00015 feet	Water at 1 atm	999.760	1.31678E-03	48, 49
50	1.17679733	6.0833330	1.610000	0.01413771	.00015 feet	Water at 1 atm	999.760	1.31678E-03	49, 50
51	0.00000000	0.5000000	1.049000	0.00600176	.00015 feet	Water at 1 atm	999.760	1.31678E-03	34, 73
52	0.00000000	0.5000000	1.049000	0.00600176	.00015 feet	Water at 1 atm	999.760	1.31678E-03	73, 50
53	0.03224102	0.1666667	1.610000	0.01413771	.00015 feet	Water at 1 atm	999.760	1.31678E-03	50, 53
54	0.00000000	0.5000000	1.049000	0.00600176	.00015 feet	Water at 1 atm	999.760	1.31678E-03	33, 72
55	0.00000000	0.5000000	1.049000	0.00600176	.00015 feet	Water at 1 atm	999.760	1.31678E-03	72, 53
56	0.19546120	1.0104166	1.610000	0.01413771	.00015 feet	Water at 1 atm	999.760	1.31678E-03	53, 82
57	0.67706147	3.4999998	1.610000	0.01413771	.00015 feet	Water at 1 atm	999.760	1.31678E-03	82, 55
58	0.06448205	0.3333333	1.610000	0.01413771	.00015 feet	Water at 1 atm	999.760	1.31678E-03	55, 56
59	1.93446147	10.0000000	1.610000	0.01413771	.00015 feet	Water at 1 atm	999.760	1.31678E-03	56, 57
60	0.06448205	0.3333333	1.610000	0.01413771	.00015 feet	Water at 1 atm	999.760	1.31678E-03	57, 58
61	0.19344615	1.0000000	1.610000	0.01413771	.00015 feet	Water at 1 atm	999.760	1.31678E-03	58, 59

AFT Fathom 3.0 Output
NUMATEC HANFORD CORPORATION

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Pipe	fl/D + K	Length (feet)	Hyd. Diameter (inches)	Flow Area (feet ²)	Roughness	Fluid	Density Avg (kg/m ³)	Viscosity Avg (kg/sec-m)	Junctions (Up, Down)
62	0.23109626	1.4999999	2.067000	0.02330281	.00015 feet	Water at 1 atm	999.760	1.31678E-03	92, 111
63	0.06794909	0.3645833	1.610000	0.01413771	.00015 feet	Water at 1 atm	999.760	1.31678E-03	61, 14
64	0.18637464	0.9999999	1.610000	0.01413771	.00015 feet	Water at 1 atm	999.760	1.31678E-03	14, 4
65	0.14743106	1.0000000	2.067000	0.02330281	.00015 feet	Water at 1 atm	999.760	1.31678E-03	20, 17
66	0.07467088	0.2083333	1.049000	0.00600176	.00015 feet	Water at 1 atm	999.760	1.31678E-03	13, 64
68	0.07371553	0.5000000	2.067000	0.02330281	.00015 feet	Water at 1 atm	999.760	1.31678E-03	17, 63
69	0.14580420	1.1041666	2.469000	0.03324831	.00015 feet	Water at 1 atm	999.760	1.31678E-03	99, 67
70	0.09867030	0.3333333	1.049000	0.00600176	.00015 feet	Water at 1 atm	999.760	1.31678E-03	67, 23
71	0.29601092	1.0000000	1.049000	0.00600176	.00015 feet	Water at 1 atm	999.760	1.31678E-03	23, 68
73	0.35151294	1.1874999	1.049000	0.00600176	.00015 feet	Water at 1 atm	999.760	1.31678E-03	70, 25
74	0.00000000	0.5000000	1.049000	0.00600176	.00015 feet	Water at 1 atm	999.760	1.31678E-03	32, 71
75	0.00000000	0.5000000	1.049000	0.00600176	.00015 feet	Water at 1 atm	999.760	1.31678E-03	74, 75
76	0.04836153	0.2500000	1.610000	0.01413771	.00015 feet	Water at 1 atm	999.760	1.31678E-03	36, 77
77	0.14508460	0.7500000	1.610000	0.01413771	.00015 feet	Water at 1 atm	999.760	1.31678E-03	77, 39
78	0.00000000	1.0000000	1.049000	0.00600176	.00015 feet	Water at 1 atm	999.760	1.31678E-03	119, 79
79	0.00000000	1.0000000	1.049000	0.00600176	.00015 feet	Water at 1 atm	999.760	1.31678E-03	79, 41
80	0.19344615	1.0000000	1.610000	0.01413771	.00015 feet	Water at 1 atm	999.760	1.31678E-03	118, 43
81	0.06448205	0.3333333	1.610000	0.01413771	.00015 feet	Water at 1 atm	999.760	1.31678E-03	81, 48
82	0.16277363	0.5000000	1.049000	0.00600176	Smooth	Water at 1 atm	999.760	1.31678E-03	110, 12
84	0.40502782	2.0937499	1.610000	0.01413771	.00015 feet	Water at 1 atm	999.760	1.31678E-03	59, 83
85	0.00000000	1.0000000	1.049000	0.00600176	.00015 feet	Water at 1 atm	999.760	1.31678E-03	83, 84
86	0.09672307	0.5000000	1.610000	0.01413771	.00015 feet	Water at 1 atm	999.760	1.31678E-03	83, 85
87	0.07400273	0.2500000	1.049000	0.00600176	.00015 feet	Water at 1 atm	999.760	1.31678E-03	85, 86
88	0.07400273	0.2500000	1.049000	0.00600176	.00015 feet	Water at 1 atm	999.760	1.31678E-03	86, 87
89	0.03224102	0.1666667	1.610000	0.01413771	.00015 feet	Water at 1 atm	999.760	1.31678E-03	87, 88
90	0.00000000	0.5000000	1.049000	0.00600176	.00015 feet	Water at 1 atm	999.760	1.31678E-03	88, 91
91	0.03224102	0.1666667	1.610000	0.01413771	.00015 feet	Water at 1 atm	999.760	1.31678E-03	88, 89
92	0.45137433	2.3333332	1.610000	0.01413771	.00015 feet	Water at 1 atm	999.760	1.31678E-03	89, 90
93	0.06448205	0.3333333	1.610000	0.01413771	.00015 feet	Water at 1 atm	999.760	1.31678E-03	90, 92
94	0.06448205	0.3333333	1.610000	0.01413771	.00015 feet	Water at 1 atm	999.760	1.31678E-03	42, 117
95	0.01612051	0.0833333	1.610000	0.01413771	.00015 feet	Water at 1 atm	999.760	1.31678E-03	96, 45
96	0.30812836	1.9999999	2.067000	0.02330281	.00015 feet	Water at 1 atm	999.760	1.31678E-03	111, 12
97	0.00000000	0.5000000	1.610000	0.01413771	.00015 feet	Water at 1 atm	999.760	1.31678E-03	103, 104
98	0.00000000	0.5000000	1.610000	0.01413771	.00015 feet	Water at 1 atm	999.760	1.31678E-03	105, 106
99	0.00675613	0.0833333	4.026000	0.08840460	Smooth	Water at 1 atm	999.760	1.31678E-03	12, 114
100	0.21660804	0.7500000	1.049000	0.00600176	.00015 feet	Water at 1 atm	999.760	1.31678E-03	107, 108
101	0.00000000	1.0000000	1.049000	0.00600176	.00015 feet	Water at 1 atm	999.760	1.31678E-03	109, 108
103	0.44524988	1.5416666	1.049000	0.00600176	.00015 feet	Water at 1 atm	999.760	1.31678E-03	113, 107
104	0.28881073	0.9999999	1.049000	0.00600176	.00015 feet	Water at 1 atm	999.760	1.31678E-03	115, 113
105	0.00000000	0.2500000	1.049000	0.00600176	.00015 feet	Water at 1 atm	999.760	1.31678E-03	80, 119

Pipe	Pipe Material	Pipe Nominal Size	Pipe Type- Schedule	Name	Status	P Stag. In (psia)	P Stag. Out (psia)
1	Steel	1 inch	schedule 40	Pipe	Normal	14.37744	14.22521
2	Steel	3/4 inch	schedule 40	Pipe	Normal	58.03456	57.48136
3	Steel	3/4 inch	schedule 40	Pipe	Normal	57.48136	57.01054
4	Steel	1-1/2 inch	schedule 40	Pipe	Normal	55.75601	55.75010
5	Steel	1-1/2 inch	schedule 40	Pipe	Normal	55.69805	56.15055
6	Steel	1-1/2 inch	schedule 40	Pipe	Normal	56.09850	56.08965
7	Steel	2 inch	schedule 40	Pipe	Normal	56.07001	55.47804
8	Steel	2 inch	schedule 40	Pipe	Normal	49.15487	48.56289
9	Steel	1-1/2 inch	schedule 40	Pipe	Normal	48.29438	48.14204
10	Steel	1-1/2 inch	schedule 40	Pipe	Normal	48.13586	47.72167
11	Steel	1-1/2 inch	schedule 40	Pipe	Normal	47.66962	47.66372

AFT Fathom 3.0 Output
NUMATEC HANFORD CORPORATION

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Pipe	Pipe Material	Pipe Nominal Size	Pipe Type-Schedule	Name	Status	P Stag. In (psia)	P Stag. Out (psia)
12	Steel	1 inch	schedule 40	Pipe	Normal	47.52458	46.64770
13	Steel	1 inch	schedule 40	Pipe	Closed By J9	46.64770	46.43325
14	Steel	1 inch	schedule 40	Pipe	Normal	46.60760	46.59338
15	Steel	1 inch	schedule 40	Pipe	Closed By J9	46.43325	46.43325
16	Steel	1 inch	schedule 40	Pipe	Normal	13.03115	13.02815
17	Steel	1 inch	schedule 40	Pipe	Closed By J9	12.81370	12.81370
18	Steel	1 inch	schedule 40	Pipe	Closed By J9	12.81370	13.02815
19	Steel	1 inch	schedule 40	Pipe	Normal	13.02815	13.01318
20	Steel	1-1/2 inch	schedule 40	Pipe	Normal	13.07469	13.23647
21	Steel	1-1/2 inch	schedule 40	Pipe	Normal	47.66787	47.66225
22	Steel	1-1/2 inch	schedule 40	Pipe	Normal	47.63042	47.60795
23	Steel	1-1/2 inch	schedule 40	Pipe	Normal	47.52276	47.97825
24	Steel	2-1/2 inch	schedule 40	Pipe	Normal	47.96106	48.43084
25	Steel	1-1/2 inch	schedule 40	Pipe	Normal	46.79593	46.62263
26	Steel	1-1/2 inch	schedule 40	Pipe	Normal	46.52971	46.52845
27	Steel	1 inch	schedule 40	Pipe	Normal	45.36681	45.30320
28	Steel	1-1/2 inch	schedule 40	Pipe	Normal	45.20737	45.19739
29	Steel	1-1/2 inch	schedule 40	Pipe	Normal	45.16556	43.95113
30	Steel	1-1/2 inch	schedule 40	Pipe	Normal	43.91930	43.89932
31	Steel	1-1/2 inch	schedule 40	Pipe	Normal	43.86749	39.83185
32	Steel	1-1/2 inch	schedule 40	Pipe	Normal	39.80002	39.79503
33	Steel	1-1/2 inch	schedule 40	Pipe	Normal	39.76320	38.75304
34	Steel	1-1/2 inch	schedule 40	Pipe	Normal	38.66011	38.65787
35	Steel	1-1/2 inch	schedule 40	Pipe	Normal	38.65787	38.65538
36	Steel	1-1/2 inch	schedule 40	Pipe	Normal	38.65538	38.65288
37	Steel	1-1/2 inch	schedule 40	Pipe	Normal	38.65288	39.59312
38	Steel	1-1/2 inch	schedule 40	Pipe	Normal	39.56129	39.55630
39	Steel	1-1/2 inch	schedule 40	Pipe	Normal	39.50949	43.51956
40	Cylindrical Pipe	None	None	FLEX LINE - LOWER	Normal	43.40657	44.32789
41	Steel	1-1/2 inch	schedule 40		Normal	17.86089	10.89778
42	Steel	1-1/2 inch	schedule 40	Pipe	Normal	10.89778	10.88779
43	Steel	1-1/2 inch	schedule 40	Pipe	Normal	10.83545	10.83420
44	Steel	1 inch	schedule 40	Pipe	Normal	10.52990	10.51930
45	Steel	1-1/2 inch	schedule 40	Pipe	Normal	10.33017	8.53656
46	Steel	1 inch	schedule 40	Pipe	Normal	8.36152	8.35092
47	Cylindrical Pipe	None	None	FLEXLINE-UPPER	Normal	8.23876	8.59089
48	Steel	1 inch	schedule 40	Pipe	Normal	8.46107	8.45047
49	Steel	1-1/2 inch	schedule 40	Pipe	Normal	8.27141	8.24144
50	Steel	1-1/2 inch	schedule 40	Pipe	Normal	8.20961	8.11848
51	Steel	1 inch	schedule 40	Pipe	Closed By J73	38.65538	38.43866
52	Steel	1 inch	schedule 40	Pipe	Closed By J73	8.33519	8.11848
53	Steel	1-1/2 inch	schedule 40	Pipe	Normal	8.11848	8.11598
54	Steel	1 inch	schedule 40	Pipe	Closed By J72	38.65787	38.44116
55	Steel	1 inch	schedule 40	Pipe	Closed By J72	8.33269	8.11598
56	Steel	1-1/2 inch	schedule 40	Pipe	Normal	8.11598	8.10084
57	Steel	1-1/2 inch	schedule 40	Pipe	Normal	8.06901	9.42520
58	Steel	1-1/2 inch	schedule 40	Pipe	Normal	9.39337	9.38838
59	Steel	1-1/2 inch	schedule 40	Pipe	Normal	9.35655	13.10755
60	Steel	1-1/2 inch	schedule 40	Pipe	Normal	13.07572	13.07072
61	Steel	1-1/2 inch	schedule 40	Pipe	Normal	13.03889	13.02391
62	Steel	2 inch	schedule 40	Pipe	Normal	12.64553	12.81954
63	Steel	1-1/2 inch	schedule 40	Pipe	Normal	56.00448	55.83785
64	Steel	1-1/2 inch	schedule 40	Pipe	Normal	55.78580	55.76219
65	Steel	2 inch	schedule 40	Pipe	Normal	48.54531	48.53844

AFT Fathom 3.0 Output
NUMATEC HANFORD CORPORATION

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Pipe	Pipe Material	Pipe Nominal Size	Pipe Type-Schedule	Name	Status	P Stag. In (psia)	P Stag. Out (psia)
66	Steel	1 inch	schedule 40	Pipe	Normal	12.99794	13.08575
68	Steel	2 inch	schedule 40	Pipe	Normal	48.52087	48.31200
69	Steel	2-1/2 inch	schedule 40	Pipe	Normal	48.16462	47.69078
70	Steel	1 inch	schedule 40	Pipe	Normal	47.61786	47.43098
71	Steel	1 inch	schedule 40	Pipe	Normal	47.39270	46.93817
73	Steel	1 inch	schedule 40	Pipe	Normal	46.47726	46.32621
74	Steel	1 inch	schedule 40	Pipe	Closed By J71	38.75304	38.75304
75	Steel	1 inch	schedule 40	Pipe	Closed By J75	38.65288	38.65288
76	Steel	1-1/2 inch	schedule 40	Pipe	Normal	39.52447	39.52073
77	Steel	1-1/2 inch	schedule 40	Pipe	Normal	39.52073	39.50949
78	Steel	1 inch	schedule 40	Pipe	Closed By J80+	10.83420	10.83420
79	Steel	1 inch	schedule 40	Pipe	Closed By J80+	10.83420	10.83420
80	Steel	1-1/2 inch	schedule 40	Pipe	Normal	10.37699	10.36200
81	Steel	1-1/2 inch	schedule 40	Pipe	Normal	8.30823	8.30323
82	Steel	1 inch	schedule 40	Pipe	Normal	13.23647	14.38344
84	Steel	1-1/2 inch	schedule 40	Pipe	Normal	12.99208	12.96072
85	Steel	1 inch	schedule 40	Pipe	Closed By J84	12.96072	12.96072
86	Steel	1-1/2 inch	schedule 40	Pipe	Normal	12.96072	12.95323
87	Steel	1 inch	schedule 40	Pipe	Normal	12.86579	12.83399
88	Steel	1 inch	schedule 40	Pipe	Normal	12.79571	12.76390
89	Steel	1-1/2 inch	schedule 40	Pipe	Normal	12.62167	12.61917
90	Steel	1 inch	schedule 40	Pipe	Closed By J91	12.61917	12.61917
91	Steel	1-1/2 inch	schedule 40	Pipe	Normal	12.61917	12.61667
92	Steel	1-1/2 inch	schedule 40	Pipe	Normal	12.58484	12.54989
93	Steel	1-1/2 inch	schedule 40	Pipe	Normal	12.51806	12.65754
94	Steel	1-1/2 inch	schedule 40	Pipe	Normal	10.87873	10.87374
95	Steel	1-1/2 inch	schedule 40	Pipe	Normal	8.50473	8.50348
96	Steel	2 inch	schedule 40	Pipe	Normal	12.81954	14.37853
97	Steel	1-1/2 inch	schedule 40	Pipe	Closed By J104	47.52276	47.52276
98	Steel	1-1/2 inch	schedule 40	Pipe	Closed By J106	46.62263	46.62263
99	Steel	4 inch	schedule 40	Pipe	Normal	14.35002	14.35000
100	Steel	1 inch	schedule 40	Pipe	Normal	14.52967	14.37744
101	Steel	1 inch	schedule 40	Pipe	Closed By J109	14.37744	14.37744
103	Steel	1 inch	schedule 40	Pipe	Normal	14.90521	14.59229
104	Steel	1 inch	schedule 40	Pipe	Normal	14.99524	15.22569
105	Steel	1 inch	schedule 40	Pipe	Closed By J80+	No Solution	No Solution

AFT Fathom 3.0 Output
NUMATEC HANFORD CORPORATION

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7/29/99

TEMPERED WATER SYSTEM - DESIGN AS OF 072299 - 10C

Jct	P Inlet (psia)	P Stag. In (psia)	P Outlet (psia)	P Stag. Out (psia)	dP (psid)	T Inlet (deg. F)	T Outlet (deg. F)	dH (feet)	dT (deg. F)
1	13.52240	14.22521	56.18857	58.03456	-43.80935669	50.0000	50.0000	-101.0775347	0
4	55.63553	55.76219	55.62935	55.75601	0.00618457	50.0000	50.0000	0.0142691	0
5	48.01538	48.14204	48.00920	48.13586	0.00618457	50.0000	50.0000	0.0142691	0
6	47.58955	47.66372	47.58955	47.66372	See General	50.0000	50.0000	See General	0
7	46.63285	46.64770	46.63285	46.64770	See General	50.0000	50.0000	See General	0
8	46.43325	46.43325	46.43325	46.43325	0.00000000	50.0000	50.0000	0.00000000	0
9	46.43325	46.43325	12.81370	12.81370	33.61954880	50.0000	50.0000	77.5674734	0
10	12.81370	12.81370	12.81370	12.81370	0.00000000	50.0000	50.0000	0.00000000	0
11	13.01330	13.02815	13.01330	13.02815	0.00000000	50.0000	50.0000	0.00000000	0
12	14.33148	14.35002	14.33148	14.35002	See General	50.0000	50.0000	See General	0
13	12.97977	13.01318	12.96453	12.99794	0.01523780	50.0000	50.0000	0.0351568	0
14	55.71119	55.83785	55.65914	55.78580	0.05205667	50.0000	50.0000	0.1201058	0
15	55.62344	55.75010	55.57139	55.69805	0.05205667	50.0000	50.0000	0.1201058	0
16	56.02390	56.15055	55.97184	56.09850	0.05205667	50.0000	50.0000	0.1201058	0
17	48.49183	48.53844	48.47425	48.52087	0.01757590	50.0000	50.0000	0.0405513	0
18	47.59501	47.72167	47.54296	47.66962	0.05205667	50.0000	50.0000	0.1201058	0
19	46.55996	46.59338	12.99773	13.03115	33.56222916	50.0000	50.0000	77.4352248	0
20	48.51627	48.56289	48.49870	48.54531	0.01757590	50.0000	50.0000	0.0405513	0
21	47.58480	47.66225	47.55297	47.63042	0.03182964	50.0000	50.0000	0.0734378	0
23	47.00126	47.43098	46.96297	47.39270	0.03828384	50.0000	50.0000	0.0883290	0
25	45.89648	46.32621	44.93708	45.36681	0.95940578	50.0000	50.0000	2.2135539	0
26	44.87348	45.30320	45.12993	45.20737	0.09582885	50.0000	50.0000	0.2210976	0
27	45.11994	45.19739	45.08811	45.16556	0.03182964	50.0000	50.0000	0.0734378	0
28	43.87368	43.95113	43.84185	43.91930	0.03182964	50.0000	50.0000	0.0734378	0
29	43.82188	43.89932	43.79005	43.86749	0.03182964	50.0000	50.0000	0.0734378	0
30	39.71758	39.79503	39.68575	39.76320	0.03182964	50.0000	50.0000	0.0734378	0
31	39.75441	39.83185	39.72258	39.80002	0.03182964	50.0000	50.0000	0.0734378	0
32	38.71862	38.75304	38.71862	38.75304	See General	50.0000	50.0000	See General	0
33	38.62345	38.65787	38.62345	38.65787	0.00000000	50.0000	50.0000	0.00000000	0
34	38.62096	38.65538	38.62096	38.65538	0.00000000	50.0000	50.0000	0.00000000	0
36	39.47886	39.55630	39.44703	39.52447	0.03182964	50.0000	50.0000	0.0734378	0
37	39.51568	39.59312	39.48385	39.56129	0.03182964	50.0000	50.0000	0.0734378	0
39	39.43204	39.50949	39.43204	39.50949	0.00000000	50.0000	50.0000	0.00000000	0
40	43.80754	44.32789	17.78344	17.86089	26.46700478	50.0000	50.0000	61.0650280	0
41	10.73731	10.83420	10.73731	10.83420	See General	50.0000	50.0000	See General	0
42	10.81035	10.88779	10.80129	10.87873	0.00906099	50.0000	50.0000	0.0209056	0
43	10.28456	10.36200	10.25273	10.33017	0.03182964	50.0000	50.0000	0.0734378	0
45	8.42603	8.50348	7.93180	8.36152	0.14195555	50.0000	50.0000	0.3275218	0
46	7.92120	8.35092	8.13598	8.23876	0.11215843	50.0000	50.0000	0.2587734	0
47	8.48810	8.59089	8.03134	8.46107	0.12981705	50.0000	50.0000	0.2995156	0
48	8.22579	8.30323	8.19396	8.27141	0.03182964	50.0000	50.0000	0.0734378	0
49	8.16400	8.24144	8.13217	8.20961	0.03182964	50.0000	50.0000	0.0734378	0
50	8.08406	8.11848	8.08406	8.11848	0.00000000	50.0000	50.0000	0.00000000	0
53	8.08156	8.11598	8.08156	8.11598	0.00000000	50.0000	50.0000	0.00000000	0
55	9.34776	9.42520	9.31593	9.39337	0.03182964	50.0000	50.0000	0.0734378	0
56	9.31094	9.38838	9.27911	9.35655	0.03182964	50.0000	50.0000	0.0734378	0
57	13.03010	13.10755	12.99827	13.07572	0.03182964	50.0000	50.0000	0.0734378	0
58	12.99328	13.07072	12.96145	13.03889	0.03182964	50.0000	50.0000	0.0734378	0
59	12.94647	13.02391	12.91464	12.99208	0.03182964	50.0000	50.0000	0.0734378	0
61	55.16455	57.01054	55.87782	56.00448	1.00606430	50.0000	50.0000	2.3212050	0
62	55.96299	56.08965	56.02340	56.07001	0.01963208	50.0000	50.0000	0.0452954	0
63	48.26538	48.31200	48.16772	48.29438	0.01762252	50.0000	50.0000	0.0406589	0

AFT Fathom 3.0 Output
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Jct	P Inlet (psia)	P Stag. In (psia)	P Outlet (psia)	P Stag. Out (psia)	dP (psid)	T Inlet (deg. F)	T Outlet (deg. F)	dH (feet)	dT (deg. F)
64	13.05233	13.08575	13.06866	13.07469	0.01106077	50.0000	50.0000	0.0255196	0
66	47.90080	47.97825	47.94706	47.96106	0.01719265	50.0000	50.0000	0.0396671	0
67	47.67678	47.69078	47.18813	47.61786	0.07292558	50.0000	50.0000	0.1682549	0
68	46.50844	46.93817	46.71848	46.79593	0.14223924	50.0000	50.0000	0.3281763	0
70	46.45101	46.52845	46.04754	46.47726	0.05119074	50.0000	50.0000	0.1181080	0
71	38.75304	38.75304	38.75304	38.75304	0.00000000	50.0000	50.0000	0.0000000	0
X72	38.44116	38.44116	8.33269	8.33269	30.10846901	50.0000	50.0000	69.4666631	0
X73	38.43866	38.43866	8.33519	8.33519	30.10347557	50.0000	50.0000	69.4551421	0
74	38.61846	38.65288	38.61846	38.65288	0.00000000	50.0000	50.0000	0.0000000	0
75	38.65288	38.65288	38.65288	38.65288	0.00000000	50.0000	50.0000	0.0000000	0
76	43.44211	43.51956	42.88622	43.40657	0.11299136	50.0000	50.0000	0.2606952	0
77	39.44328	39.52073	39.44328	39.52073	0.00000000	50.0000	50.0000	0.0000000	0
78	10.82033	10.89778	10.82033	10.89778	0.00000000	50.0000	50.0000	0.0000000	0
79	10.83420	10.83420	10.83420	10.83420	0.00000000	50.0000	50.0000	0.0000000	0
80	No Solution	No Solution	No Solution	No Solution	No Solution	No Solution	No Solution	No Solution	No Solution
81	8.02074	8.45047	8.23078	8.30823	0.14223924	50.0000	50.0000	0.3281763	0
82	8.02340	8.10084	7.99157	8.06901	0.03182964	50.0000	50.0000	0.0734378	0
83	12.92630	12.96072	12.92630	12.96072	0.00000000	50.0000	50.0000	0.0000000	0
84	12.96072	12.96072	12.96072	12.96072	0.00000000	50.0000	50.0000	0.0000000	0
85	12.87578	12.95323	12.43606	12.86579	0.08743471	50.0000	50.0000	0.2017305	0
86	12.40426	12.83399	12.36598	12.79571	0.03828384	50.0000	50.0000	0.0883290	0
87	12.33418	12.76390	12.54422	12.62167	0.14223924	50.0000	50.0000	0.3281763	0
88	12.58475	12.61917	12.58475	12.61917	0.00000000	50.0000	50.0000	0.0000000	0
89	12.53923	12.61667	12.50740	12.58484	0.03182964	50.0000	50.0000	0.0734378	0
90	12.47244	12.54989	12.44061	12.51806	0.03182964	50.0000	50.0000	0.0734378	0
91	12.61917	12.61917	12.61917	12.61917	0.00000000	50.0000	50.0000	0.0000000	0
92	12.58009	12.65754	12.61703	12.64553	0.01200388	50.0000	50.0000	0.0276955	0
96	8.45911	8.53656	8.42728	8.50473	0.03182964	50.0000	50.0000	0.0734378	0
97	55.63537	57.48136	55.63537	57.48136	0.00000000	50.0000	50.0000	0.0000000	0
98	55.43142	55.47804	49.10825	49.15487	6.32316875	50.0000	50.0000	14.5888997	0
99	48.41684	48.43084	48.15062	48.16462	0.26622316	50.0000	50.0000	0.6142336	0
103	47.48834	47.52276	47.48834	47.52276	See General	50.0000	50.0000	See General	0
104	47.52276	47.52276	47.52276	47.52276	0.00000000	50.0000	50.0000	0.0000000	0
105	46.58821	46.62263	46.58821	46.62263	See General	50.0000	50.0000	See General	0
106	46.62263	46.62263	46.62263	46.62263	0.00000000	50.0000	50.0000	0.0000000	0
107	13.88948	14.59229	13.82687	14.52967	0.06261235	50.0000	50.0000	0.1444601	0
108	14.06508	14.37744	14.06508	14.37744	0.00000000	50.0000	50.0000	0.0000000	0
109	14.37744	14.37744	14.37744	14.37744	0.00000000	50.0000	50.0000	0.0000000	0
110	13.23045	13.23647	13.20305	13.23647	0.00000000	50.0000	50.0000	0.0000000	0
111	12.79103	12.81954	12.79103	12.81954	0.00000000	50.0000	50.0000	0.0000000	0
113	14.52288	15.22569	14.20240	14.90521	0.32047996	50.0000	50.0000	0.7394157	0
114	14.34676	14.35000	14.34676	14.35000	0.00000000	50.0000	50.0000	0.0000000	0
115	14.35000	14.35000	15.34665	15.34665	0.35140345	50.0000	50.0000	0.8107627	0
117	10.79629	10.87374	10.75801	10.83545	0.03828384	50.0000	50.0000	0.0883290	0
118	10.08957	10.51930	10.29954	10.37699	0.14231488	50.0000	50.0000	0.3283508	0
X119	No Solution	No Solution	10.83420	10.83420	No Solution	No Solution	-459.6700	No Solution	No Solution

Jct	Vol. Flow Through Junction (gal/min)	Mass Flow Through Junction (lbm/sec)	Heat Rate Into System (Btu/s)	Elevation (feet)	Junction Type	Loss Factor (K)
1	27.51634	3.826331	0	1.33333	Pump	0.00000
4	27.51634	3.826331	0	2.60417	Valve	0.0488287
5	27.51634	3.826331	0	5.00000	Valve	0.0488287
6	N/A	N/A	0	5.90625	Tee or Wye	See General
7	N/A	N/A	0	7.87500	Tee or Wye	See General

Jct	Vol. Flow Through Junction (gal/min)	Mass Flow Through Junction (lbm/sec)	Heat Rate Into System (Btu/s)	Elevation (feet)	Junction Type	Loss Factor (K)
8	0.00000	0.000000	0	8.36979	Bend	0.00000
9	0.00000	0.000000	0	8.36979	One Way Valve	0.00000
10	0.00000	0.000000	0	8.36979	Bend	0.00000
11	N/A	N/A	0	7.87500	Tee or Wye	See General
12	N/A	N/A	0	4.63281	Branch	See General
13	6.00000	0.834340	0	7.87500	Bend	0.456000
14	27.51634	3.826331	0	2.60417	Bend	0.411000
15	27.51634	3.826331	0	2.60417	Bend	0.411000
16	27.51634	3.826331	0	1.50000	Bend	0.411000
17	27.51634	3.826331	0	4.19271	Bend	0.377000
18	27.51634	3.826331	0	5.90625	Bend	0.411000
19	6.00000	0.834340	0	7.87500	Control Valve	1004.37
20	27.51634	3.826331	0	4.19271	Bend	0.377000
21	21.51634	2.991991	0	5.90625	Bend	0.411000
23	21.51634	2.991991	0	5.15104	Valve	0.0890890
25	21.51634	2.991991	0	6.29167	General Component	2.23260
26	21.51634	2.991991	0	6.29167	Area Change	0.223000
27	21.51634	2.991991	0	6.29167	Bend	0.411000
28	21.51634	2.991991	0	9.00000	Bend	0.411000
29	21.51634	2.991991	0	9.00000	Bend	0.411000
30	21.51634	2.991991	0	18.00000	Bend	0.411000
31	21.51634	2.991991	0	18.00000	Bend	0.411000
32	N/A	N/A	0	20.25000	Tee or Wye	See General
33	N/A	N/A	0	20.25000	Tee or Wye	See General
34	N/A	N/A	0	20.25000	Tee or Wye	See General
36	21.51634	2.991991	0	18.00000	Bend	0.411000
37	21.51634	2.991991	0	18.00000	Bend	0.411000
39	21.51634	2.991991	0	18.00000	General Component	0.00000
40	21.51634	2.991991	0	2.60417	General Component	50.8641
41	N/A	N/A	0	18.66667	Tee or Wye	See General
42	21.51634	2.991991	0	18.66667	Bend	0.117000
43	21.51634	2.991991	0	18.66667	Bend	0.411000
45	21.51634	2.991991	0	22.66667	Area Change	1.83300
46	21.51634	2.991991	0	22.66667	Area Change	0.261000
47	21.51634	2.991991	0	21.25000	Area Change	1.26300
48	21.51634	2.991991	0	21.25000	Bend	0.411000
49	21.51634	2.991991	0	21.25000	Bend	0.411000
50	N/A	N/A	0	21.25000	Tee or Wye	See General
53	N/A	N/A	0	21.25000	Tee or Wye	See General
55	21.51634	2.991991	0	18.00000	Bend	0.411000
56	21.51634	2.991991	0	18.00000	Bend	0.411000
57	21.51634	2.991991	0	9.00000	Bend	0.411000
58	21.51634	2.991991	0	9.00000	Bend	0.411000
59	21.51634	2.991991	0	9.00000	Bend	0.411000
61	27.51634	3.826331	0	2.23958	Area Change	0.545000
62	27.51634	3.826331	0	1.50000	Area Change	0.155000
63	27.51634	3.826331	0	4.66667	Area Change	0.378000
64	6.00000	0.834340	0	7.66667	Area Change	0.331000
66	21.51634	2.991991	0	4.81771	Area Change	0.222000
67	21.51634	2.991991	0	4.81771	Area Change	5.20800
68	21.51634	2.991991	0	5.90625	Area Change	0.331000
70	21.51634	2.991991	0	6.29167	Area Change	0.661000
71	0.00000	0.000000	0	20.25000	Dead End	0.00000
X72	0.00000	0.000000	0	20.75000	Valve	0.00000

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NUMATEC HANFORD CORPORATION

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Jct	Vol. Flow Through Junction (gal/min)	Mass Flow Through Junction (lbm/sec)	Heat Rate Into System (Btu/s)	Elevation (feet)	Junction Type	Loss Factor (K)
X73	0.00000	0.000000	0	20.75000	Valve	0.00000
74	N/A	N/A	0	20.25000	Tee or Wye	See General
75	0.00000	0.000000	0	20.25000	Dead End	0.00000
76	21.51634	2.991991	0	8.41667	Area Change	1.45900
77	21.51634	2.991991	0	18.00000	General Component	0.00000
78	21.51634	2.991991	0	18.66667	General Component	0.00000
79	0.00000	0.000000	0	18.66667	Bend	0.00000
80	0.00000	0.000000	No Solution	18.66667	Dead End	0.00000
81	21.51634	2.991991	0	21.25000	Area Change	0.331000
82	21.51634	2.991991	0	21.25000	Bend	0.411000
83	N/A	N/A	0	9.00000	Tee or Wye	See General
84	0.00000	0.000000	0	9.00000	Dead End	0.00000
85	21.51634	2.991991	0	9.00000	Area Change	1.12900
86	21.51634	2.991991	0	9.00000	Valve	0.0890890
87	21.51634	2.991991	0	9.00000	Area Change	0.331000
88	N/A	N/A	0	9.00000	Tee or Wye	See General
89	21.51634	2.991991	0	9.00000	Bend	0.411000
90	21.51634	2.991991	0	9.00000	Bend	0.411000
91	0.00000	0.000000	0	9.00000	Dead End	0.00000
92	21.51634	2.991991	0	8.66667	Area Change	0.155000
96	21.51634	2.991991	0	22.66667	Bend	0.411000
97	27.51634	3.826331	0	1.82292	General Component	0.00000
98	27.51634	3.826331	0	2.84635	General Component	135.631
99	21.51634	2.991991	0	3.72917	General Component	19.0124
103	N/A	N/A	0	5.90625	Tee or Wye	See General
104	0.00000	0.000000	0	5.90625	Dead End	0.00000
105	N/A	N/A	0	6.29167	Tee or Wye	See General
106	0.00000	0.000000	0	6.29167	Dead End	0.00000
107	27.51634	3.826331	0	1.33333	Valve	0.0890890
108	N/A	N/A	0	1.33333	Tee or Wye	See General
109	0.00000	0.000000	0	1.33333	Dead End	0.00000
110	6.00000	0.834340	0	7.29167	General Component	0.00000
111	21.51634	2.991991	0	8.25000	General Component	0.00000
113	27.51634	3.826331	0	1.33333	Bend	0.456000
114	27.51634	3.826331	0	4.63281	Assigned Pressure	0.00000
115	27.51634	3.826331	0	4.63281	Reservoir	0.500000
117	21.51634	2.991991	0	18.66667	Valve	0.494340
118	21.51634	2.991991	0	18.66667	Area Change	0.331176
X119	0.00000	0.000000	No Solution	18.66667	Valve	0.00000

Jct	Pipes (+ = In, - = Out)	Name	Status
1	1,-2	TW-P-3*14	Normal
4	64,-4	TW-V-*036(NO)	Normal
5	9,-10	TW-V-*037(NO)	Normal
6	-21,11,-12	Tee/Wye	Normal
7	-13,12,-14	Tee/Wye	Normal
8	13,-15	Bend	Closed By J9
9	15,-17	SRV-3*11	Normal
10	17,-18	Bend	Closed By J9
11	16,-19,18	Tee/Wye	Normal
12	82,96,-99	TW-TK-3*12	Normal
13	19,-66	Bend	Normal
14	63,-64	Bend	Normal