

SECTION

SHEET 1 OF
ATTACHMENTS

$$\begin{array}{r} 7 \\ \cancel{6} \\ \hline 2 \end{array}$$
DATE _____

DESIGN REVIEW

10/22/97

25w 4/8/96

PURPOSE: CASE 1) Injection Phase
Determine the Refueling Water Storage Tank (RWST) water level necessary to supply adequate NPSH for the (A) Containment spray (CTS) Pumps, (B) Safety Injection (SI) Pumps and (C) Residual Heat Removal (RHR) Pumps. This calculation is being performed in response to R.B. Bennett's memo dated March 6, 1995.

CASE 2) Recirculation Phase
Determine the Containment sump water level necessary to supply adequate NPSH for the CTS (A) and RHR (B) Pumps.

RESULTS: CASE 1) Injection Phase

| | PUMP NO. | PUMP NAME | FLOW (GPM) | NPSH _{available} (FEET) | NPSH _{required} (FEET) | RWST LEVEL REQUIRED (ELEVATION) |
|-----|----------|-----------|------------|----------------------------------|---------------------------------|---------------------------------|
| (A) | PP-9 | CTS | 3200 | 46.06 | 9 | 610.25 FEET ₁ |
| (B) | PP-26 | SI | 650 | 31.75 | 22 | 610.25 FEET ₁ |
| (C) | PP-35 | RHR | 4500 | 45.22 | 19 | 610.25 FEET ₁ |

CASE 2) Recirculation Phase

| | PUMP NO. | PUMP NAME | FLOW (GPM) | NPSH _{available} (FEET) | NPSH _{required} (FEET) | CONTAINMENT SUMP LEVEL (ELEVATION) |
|-----|----------|-----------|------------|----------------------------------|---------------------------------|------------------------------------|
| (A) | PP-9 | CTS | 3200 | 23.39 | 9 | 595.5 Feet ₁ |
| (B) | PP-35 | RHR | 4500 | 21.89 | 19 | 595.5 FEET ₁ |

Note:

Although the NPSH determined by the calculation is adequate, the calculation does/did not account for vortexing conditions. Caution should be taken by the operator in severe conditions when the level approaches the general level of the top of the outlet pipe. Under these conditions any unusual fluctuations in pump flow, pressure, vibration, and/or driver power are indication of vortexing. When this occurs the pump flow should be throttled until smooth operation is restored, observing the minimum flow requirements, or operation should be terminated.

ASSUMPTIONS:

- 1) RWST water level is at minimum elevation (bottom of pipe) 611.25' (24" Suction Pipe Center Line) - 1' (radius of 24" pipe) = 610.25' (See reference 5A).
- 2) Temperature of water in the RWST is 100°F (For injection phase T = 85°F based on RWST temp low alarm (Ref. 7) + 15°F conservatism). Vapor pressure of water at 100 °F is 2.21 ft = .94925 PSI x 2.323 ft/lb/in² (conversion factor for water at 100 °F)



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- 3) Temperature of water in containment sump is 190°F (for recirculation phase) based on Unit 2 FSAR figure 14.3.4-4 (containment integrity analysis) vapor pressure of water at 190 °F is 22.285 ft = 9.34 PSI x 2.386 ft/lb/in² (conversion factor for water at 190 °F). Reference 6.
- 4) Pressure on RWST is 0 psig (14.7 PSIA 33.96 Feet)
- 5) For the purpose of this calculation (Severe accident analysis) it is assumed that only one RHR pump is in operation, during the injection phase, and all other safety pumps are running.
- 6) Pressure in containment is 0 psig (14.7 PSIA 33.96 feet).

INPUTS:

- 1) CTS Pump Centerline Elevation = 574'-6"(ref 5C)
- 2) SI Pump Centerline Elevation = 589'-2 1/2"(ref 5D)
- 3) RHR Pump Centerline Elevation = 575'-0"(ref 5E)
- 4) Centerline of 24" SI Outlet from RWST = 611'-3" (ref 5A)
- 5) Containment sump water elevation 595.5' (Centerline of 24" recirc sump suction line) See reference 5B.
- 6) H_{fs} (Head Loss due to Friction in piping and fittings) for the following cases is taken from reference 4:
CASE 1A - H_{fs} = 21.44 feet
CASE 1B - H_{fs} = 21.04 feet
CASE 2A - H_{fs} = 9.29 feet
- 7) H_{fs} (Head Loss due to Friction in piping and fittings) for CASE CASE 1C and CASE 2B are as follows:
CASE 1C - H_{fs} = 21.78 feet (Attachment 1)
CASE 2B - H_{fs} = 10.29 feet (Attachment 2)

The H_{fs} for these two cases could not be taken from reference 4 because the assumptions were not the same as for this calculation.

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CALCULATION:

$$NPSH = H_a - H_{vpa} + H_{st} - H_{fs}$$

where:

H_a = Absolute pressure (in feet of liquid being pumped) on the surface of the liquid supply level.

H_{vpa} = The head in feet corresponding to the vapor pressure of the liquid at the temperature being pumped.

H_{st} = Static head in feet that the liquid supply level is above or below the pump centerline or impeller eye.

H_{fs} = All suction line losses (in feet) including entrance losses and friction losses through pipe, valves and fittings, etc. Friction is determined with both trains of SI, RHR, CC and CTS pumps operating, thus providing worst case (highest) friction values.

CASE 1A

CTS Pump (Suction source RWST)

Given:

H_a = 14.7 PSIA, 33.96 Feet (RWST open to atmosphere)

H_{vpa} = .95 psia, 2.21 Feet (Vapor pressure of water at 100°F from Ref.6 see assumption 2 for basis of 100°F temperature)

H_{st} = 610.25 (assumption 1) - 574.5 (input 1)
= 35.75 Feet

H_{fs} = 21.44 Feet @ 3200 gpm (input 6)

$NPSH_{available}$ = 33.96 - 2.21 + 35.75 - 21.44 Feet
= 46.06 Feet @ 3200 gpm

$NPSH_{REQUIRED}$ = 9 Feet @ 3200 gpm (see reference 1)

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CASE 1B

SI Pump (Suction source RWST)

Given:

$$H_a = 14.7 \text{ PSIA, } 33.96 \text{ Feet (RWST open to atmosphere)}$$

$$H_{vpa} = .95 \text{ psia, } 2.21 \text{ Feet (Vapor pressure of water at } 100^\circ\text{F from Ref.6 see assumption 2 for basis of } 100^\circ\text{F temperature)}$$

$$\begin{aligned} H_{st} &= 610.25 \text{ (assumption 1)} - 589.208 \text{ (input 2)} \\ &= 21.04 \text{ Feet} \end{aligned}$$

$$H_{fs} = 21.04 \text{ Feet @ 650 gpm (input 6)}$$

$$\begin{aligned} \text{NPSH}_{\text{available}} &= 33.96 - 2.21 + 21.04 - 21.04 \text{ Feet} \\ &= 31.75 \text{ Feet @ 650 gpm} \end{aligned}$$

$$\text{NPSH}_{\text{REQUIRED}} = 22 \text{ Feet @ 650 gpm (see reference 3)}$$

CASE 1C

RHR Pump (Suction source RWST)

Given:

$$H_a = 14.7 \text{ PSIA, } 33.96 \text{ Feet (RWST open to atmosphere)}$$

$$H_{vpa} = .95 \text{ psia, } 2.21 \text{ Feet (Vapor pressure of water at } 100^\circ\text{F from Ref.6 see assumption 2 for basis of } 100^\circ\text{F temperature)}$$

$$\begin{aligned} H_{st} &= 610.25 \text{ (assumption 1)} - 575 \text{ (input 3)} \\ &= 35.25 \text{ Feet} \end{aligned}$$

$$H_{fs} = 21.78 \text{ Feet @ 4500 gpm (input 7)}$$

$$\begin{aligned} \text{NPSH}_{\text{available}} &= 33.96 - 2.21 + 35.25 - 21.78 \\ &= 45.22 \text{ Feet @ 4500 gpm} \end{aligned}$$

$$\text{NPSH}_{\text{REQUIRED}} = 19 \text{ Feet @ 4500 gpm (see reference 2)}$$



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CASE 2A

CTS (SUCTION SOURCE CONTAINMENT SUMP)

Given:

$$H_a = 14.7 \text{ PSIA, } 33.96 \text{ Feet (assumption 6)}$$

$$H_{vpa} = 9.34 \text{ psia, } 22.285 \text{ Feet (assumption 3)}$$

$$\begin{aligned} H_{st} &= 595.5 \text{ Feet (input 5)} - 574.5 \text{ Feet (Input 1)} \\ &= 21 \text{ Feet} \end{aligned}$$

$$H_{fs} = 9.29 \text{ Feet (input 6)}$$

$$\begin{aligned} \text{NPSH}_{\text{available}} &= 33.96 - 22.285 + 21 - 9.29 \text{ Feet} \\ &= 23.39 \text{ ft} \end{aligned}$$

$$\text{NPSH}_{\text{REQUIRED}} = 9 \text{ Feet @ } 3200 \text{ gpm (see reference 1)}$$

CASE 2B

RHR (SUCTION SOURCE CONTAINMENT SUMP)

Given:

$$H_a = 14.7 \text{ PSIA, } 33.96 \text{ Feet (assumption 6)}$$

$$H_{vpa} = 9.34 \text{ psia, } 22.285 \text{ Feet (assumption 4)}$$

$$\begin{aligned} H_{st} &= 595.5 \text{ Feet (assumption 3)} - 575 \text{ Feet (input 3)} \\ &= 20.5 \text{ Feet (see assumption 3)} \end{aligned}$$

$$H_{fs} = 10.29 \text{ Feet (input 7)}$$

$$\begin{aligned} \text{NPSH}_{\text{available}} &= 33.96 - 22.285 + 20.5 - 10.29 \text{ Feet} \\ &= 21.89 \text{ ft} \end{aligned}$$

$$\text{NPSH}_{\text{REQUIRED}} = 19 \text{ Feet @ } 4500 \text{ gpm (see reference 2)}$$

JEW 4/6/96

The CALCULATION DATA SHEETS for the above cases 1C and 2B are included as Attachments 1 and 2) . This data was compiled and entered into an INPUT file for the HFLC5 software. The INPUT data is shown on the above attachments right before the HFLC5 results. The input file includes the following:

Line 1: Fluid Temperature (degrees F), Pipe Roughness (ft), 1st segment, last segment

Subsequent lines in the input provides the following data for each of the segments identified in Line 1.

Design Flow (gpm), Min. Flow, Max. Flow, Flow Increment,
Pipe I.D., Pipe Length (ft), Total K Factors, Total L/D
Factors

The HFLC5 software calculates the total friction loss in feet of each pipe segment for the range of flows provided. The output of the software program for cases 1C and 2B are shown in Attachment 1 and 2.

REFERENCES:

- 1) Byron Jackson Pump performance curve T-32913-1
- 2) Ingersoll-Rand company Pump performance curve No. N-318 (typical for unit 1 and 2) in the Residual Heat Removal Pump (PP-35) instruction manual.
- 3) Pacific Pump performance curve 34554D (typical for unit 1 and 2) in Safety Injection pump (PP-26) instruction manual.
- 4) M.J.Treza calculation dated 6/16/72 located in NEMP Nuclear Safeguards calculation file.
- 5) Drawings:
 - A) 2-5353-10 24" SI outlet from RWST details.
 - B) 1-2-5338-7 Containment sump RHR Suction line details.
 - C) 2-CTS-13 CTS Pump centerline
 - D) 2-SI-10 (sh. 1 of 2) SI Pump centerline
 - E) 2-RH-15(sh.1 of 2) RHR Pump centerline
- 6) Ingersoll-Dresser Pumps Cameron Hydraulic Data ,18th edition.
- 7) System Description DCC-NEMH104 Rev 7. dated May 14, 1993.
- 8) HFLC5 Pipe Friction Calculation Software. This software has preprogrammed resistance factors for piping, various fittings, and valves other than diaphragm valves. (Source: HEP&T File 13.22.2.1 for Software QA Information)

| PIPE SEG NO | 5 | PIPE DIA(ID-IN) = 11.938 | | | | |
|-------------|----------|--------------------------|---------|----------|-----|--------|
| FLOW-GPM | VEL(FPS) | LHD(FT) | KHD(FT) | LDHD(FT) | TOT | HD(FT) |



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| | | | | | |
|-------------|----------|--------------------------|---------|----------|------------|
| 4500.0 | 12.90 | .00 | 2.43 | 2.53 | 4.96 |
| PIPE SEG NO | 6 | PIPE DIA(ID-IN) = 13.124 | | | |
| FLOW-GPM | VEL(FPS) | LHD(FT) | KHD(FT) | LDHD(FT) | TOT HD(FT) |
| 100.0 | 10.67 | .44 | .00 | 3.38 | 3.82 |
| PIPE SEG NO | 7 | PIPE DIA(ID-IN) = 13.124 | | | |
| FLOW-GPM | VEL(FPS) | LHD(FT) | KHD(FT) | LDHD(FT) | TOT HD(FT) |
| 4500.0 | 10.67 | .69 | .00 | 1.69 | 2.38 |
| PIPE SEG NO | 8 | PIPE DIA(ID-IN) = 13.124 | | | |
| FLOW-GPM | VEL(FPS) | LHD(FT) | KHD(FT) | LDHD(FT) | TOT HD(FT) |
| 4500.0 | 10.67 | .07 | .00 | .48 | .56 |

REYNOLDS NUMBER FRICTION FACTOR TABLE

| PIPE SEG | DES. FLOW | RE.NO. | F-FACTOR | HEAD LOSS |
|----------|-----------|-----------|----------|-----------|
| 1 | 13300.0 | 2621750.0 | .0122 | 7.20 |
| 2 | 12000.0 | 2365488.0 | .0123 | .05 |
| 3 | 12000.0 | 2365488.0 | .0123 | 1.07 |
| 4 | 4500.0 | 1556536.0 | .0136 | 1.74 |
| 5 | 4500.0 | 1727601.0 | .0138 | 4.96 |
| 6 | 4500.0 | 1571480.0 | .0136 | 3.82 |
| 7 | 4500.0 | 1571480.0 | .0136 | 2.38 |
| 8 | 4500.0 | 1571480.0 | .0136 | .56 |

Total H_{fs} = 21.78 Feet



PIPE FRICTION CALCULATION DATA SHEETS

SHEET 2 OF 10
PLANT COOK
BY SW DATE 4/4/96
REF 960601JEW

SYSTEM: ECCS UNIT: 2
PIPE SEGMENT TO & FROM: From RWST to 8" SI TAKE-OFF
REF.: 2-SI-53 (sh 1.072, 2.072) 12-5353, 12-5354, 12-5355, 2-5#15
FLUID TEMP (°F): 85° PIPE ABS. ROUGHNESS (FT): .00015 PIPE SEGMENT NUMBER: 1
DESIGN FLOW: 13300 MINIMUM FLOW: 13300 MAXIMUM FLOW: 13300 FLOW INCREMENT: 0
PIPE I.D. (IN): 23.25 PIPE EL: 611'-3" TO EL: 585'-1 1/2"

STRAIGHT PIPE LENGTHS FITTINGS NUMBER *K OR L/D Σ K Σ L/D

| | | | | | |
|----------|----------------------------------|------|---|-----|-----|
| 4'-0" | GATE VALVE | | 13 | | |
| 8'-4" | GLOBE VALVE | | 340 | | |
| 46'-6" | BUTTERFLY VALVE | | 40 | | |
| 2'-6" | SWING CHECK | | 135 | | |
| 2'-9" | 90° STD. ELBOW | | 30 | | |
| 29'-3" | 90° S.R. ELBOW | 11 | 50 | | 100 |
| 64'-0" | 90° L.R. ELBOW | 1111 | 20 | | 80 |
| 89'-3" | 45° STD. ELBOW | 1 | 16 | | 16 |
| 3'-3" | 45° S.R. ELBOW | | 26 | | |
| | 180° CLOSE RETURN | | 50 | | |
| | STD. TEE RUN | | 20 | | |
| | STD. TEE BRANCH | | 60 | | |
| | * MITRE BENDS | | 1.2 (1-cosθ) | | |
| | * LATERAL > OUTLET | | 1.0 | | |
| | * LATERAL > INLET | | 0.5 | | |
| | * STRAIGHT RUN LATERAL | | 0.15 | | |
| | * PIPE ENTR PROJ. INWD. | | 0.78 | | |
| | * " " SHARP EDGE | | 0.50 | .5 | |
| | * " " WELL ROUND | | 0.04 | | |
| | * PIPE EXIT SHARP EDGE | | 1.0 | | |
| | * ORIFICE (C _D = .61) | | 2.69 RF/B ⁴ | | |
| | * SUDDEN CONTRACTION + | | .5(1-B ²) | | |
| | * SUDDEN INCREASE + | | (1-B ²) ² | | |
| | * VALVE, MISCELLANEOUS | | 891.4 d ⁴ /C _v ² | | |
| | MISC. | | | | |
| 247'-34" | 35° MISC. FITTINGS | 1 | 9 | | 9 |
| TOTALS | | | | 0.5 | 205 |

* ITEMS ARE "K" VALUES ONLY

+ BASED ON SMALLER PIPE DIAMETER

B = d/D

RF = RECOVERY FACTOR

PIPE FRICTION CALCULATION DATA SHEETS

Att. 1
SHEET: 000K
PLANT: 000K
BY: OW DATE: 4/14/96
UNEMP: 95050126W

SYSTEM: E C C S UNIT: 2
PIPE SEGMENT TO & FROM: From 2" SI TAKE-OFF to 12" RWST RETURN from 2" H K
D REF.: 2-SI-6
FLUID TEMP (°F): 85° PIPE ABS. ROUGHNESS (FT): .00015 PIPE SEGMENT NUMBER: 2
① DESIGN FLOW: 12.000 ② MINIMUM FLOW: 12.000 ③ MAXIMUM FLOW: 12.000 ④ FLOW INCREMENT: 0
⑤ PIPE I.D. (IN): 23.25 PIPE EL: 535'-13" TO EL: 535'-13"

STRAIGHT PIPE LENGTHS FITTINGS NUMBER *K OR L/D Σ K Σ L/D

| | | | | |
|--------|----------------------------------|--------------------------------------|-------|-------|
| 6' | GATE VALVE | 13 | | |
| | GLOBE VALVE | 340 | | |
| | BUTTERFLY VALVE | 40 | | |
| | SWING CHECK | 135 | | |
| | 90° STD. ELBOW | 30 | | |
| | 90° S.R. ELBOW | 50 | | |
| | 90° L.R. ELBOW | 20 | | |
| | 45° STD. ELBOW | 16 | | |
| | 45° S.R. ELBOW | 26 | | |
| | 180° CLOSE RETURN | 50 | | |
| | STD. TEE RUN | 20 | | |
| | STD. TEE BRANCH | 60 | | |
| | * MITRE BENDS | 1.2 (1-cosθ) | | |
| | * LATERAL OUTLET | 1.0 | | |
| | * LATERAL INLET | 0.5 | | |
| | * STRAIGHT RUN LATERAL | 0.15 | | |
| | * PIPE ENTR PROJ. INWD. | 0.78 | | |
| | * " " SHARP EDGE | 0.50 | | |
| | * " " WELL ROUND | 0.04 | | |
| | * PIPE EXIT SHARP EDGE | 1.0 | | |
| | * ORIFICE (C _d = .61) | 2.69 RF/B ⁴ | | |
| | * SUDDEN CONTRACTION + | .5(1-B ²) | | |
| | * SUDDEN INCREASE + | (1-B ²) ² | | |
| | * VALVE, MISCELLANEOUS | 891.4 d ⁴ /Q ² | | |
| | MISC. | | | |
| TOTALS | ⑥ 6' | | ⑦ 0.0 | ⑧ 0.0 |

* ITEMS ARE "K" VALUES ONLY + BASED ON SMALLER PIPE DIAMETER
B = d/D RF = RECOVERY FACTOR

PIPE FRICTION CALCULATION DATA SHEETS

Att. 1

SHEET 1 OF 1
PLANT COOK
BY JS DATE 4/14/96
INRMP 950501SEW

SYSTEM: ECCS UNIT: 2
PIPE SEGMENT TO & FROM: From Top 12" W5-85-000 to TEE in 12" R42 T-1
DIP REF.: 2-SI-6
FLUID TEMP (°F): 85 PIPE ABS. ROUGHNESS (FT): .00015 PIPE SEGMENT NUMBER: 3
DESIGN FLOW: 12.000 MINIMUM FLOW: 12.000 MAXIMUM FLOW: 12.000 FLOW INCREMENT: 0
PIPE I.D. (IN): 23.5 PIPE EL: 555.17 TO EL: 555.17

STRAIGHT PIPE LENGTHS FITTINGS NUMBER *K OR L/D Σ K Σ L/D

| | | | | |
|---------------|----------------------------------|---|------------|-----------|
| <u>16'-0"</u> | GATE VALVE | 13 | | |
| | GLOBE VALVE | 340 | | |
| | BUTTERFLY VALVE | 40 | | |
| | SWING CHECK | 135 | | |
| | 90° STD. ELBOW | 30 | | |
| | 90° S.R. ELBOW | 50 | | |
| | 90° L.R. ELBOW | 20 | | |
| | 45° STD. ELBOW | 16 | | |
| | 45° S.R. ELBOW | 26 | | |
| | 180° CLOSE RETURN | 50 | | |
| | STD. TEE RUN | 20 | | |
| | STD. TEE BRANCH | 60 | | |
| | * MITRE BENDS | 1.2 (1-cosθ) | | |
| | * LATERAL OUTLET | 1.0 | | |
| | * LATERAL INLET | 0.5 | | |
| | * STRAIGHT RUN LATERAL | 0.15 | | |
| | * PIPE ENTR PROJ. INWD. | 0.78 | | |
| | * " " SHARP EDGE | 0.50 | | |
| | * " " WELL ROUND | 0.04 | | |
| | * PIPE EXIT SHARP EDGE | 1.0 | | |
| | * ORIFICE (C _D = .61) | 2.69 RF/B ⁴ | | |
| | * SUDDEN CONTRACTION + | .5(1-B ²) | | |
| | * SUDDEN INCREASE + | (1-B ²) ² | | |
| | * VALVE, MISCELLANEOUS | 891.4 d ⁵ /C _v ² | | |
| | MISC. | | | |
| TOTALS | <u>16'-0"</u> | | <u>0.0</u> | <u>60</u> |

* ITEMS ARE "K" VALUES ONLY

+ BASED ON SMALLER PIPE DIAMETER

B = d/D

RF = RECOVERY FACTOR

PIPE FRICTION CALCULATION DATA SHEETS

Page 1

PLANT COOK
BY SW DATE 4/4/96
NEMP 95050132W

SYSTEM: ECCS UNIT: 2
PIPE SEGMENT TO & FROM: From 2nd Floor TIE to 14X12 823 E23:2
D REF.: 1-5415, 2-5415
FLUID TEMP (°F): 85 PIPE ABS. ROUGHNESS (FT): .0005 PIPE SEGMENT NUMBER: 4
DESIGN FLOW: 4500 MINIMUM FLOW: 4500 MAXIMUM FLOW: 4500 FLOW INCREMENT: 0
PIPE I.D. (IN): 13.25 PIPE EL: 583'-1 7/8 TO EL: 591'-0

STRAIGHT PIPE LENGTHS FITTINGS NUMBER *K OR L/D Σ K Σ L/D

| | | | | | |
|--------|----------------------------------|---|---|-------|--------|
| 0'-10" | GATE VALVE | | 13 | | |
| | GLOBE VALVE | | 340 | | |
| 1'-8" | BUTTERFLY VALVE | | 40 | | |
| | SWING CHECK | | 135 | | |
| | 90° STD. ELBOW | | 30 | | |
| | 90° S.R. ELBOW | | 50 | | |
| | 90° L.R. ELBOW | 1 | 20 | | 20 |
| | 45° STD. ELBOW | 1 | 16 | | 16 |
| | 45° S.R. ELBOW | | 26 | | |
| | 180° CLOSE RETURN | | 50 | | |
| | STD. TEE RUN | | 20 | | |
| | STD. TEE BRANCH | | 60 | | |
| | * MITRE BENDS | | 1.2 (1-cosθ) | | |
| | * LATERAL OUTLET | | 1.0 | | |
| | * LATERAL INLET | | 0.5 | | |
| | * STRAIGHT RUN LATERAL | | 0.15 | | |
| | * PIPE ENTR PROJ. INWD. | | 0.78 | | |
| | * " " SHARP EDGE | 1 | 0.50 | 5 | |
| | * " " WELL ROUND | | 0.04 | | |
| | * PIPE EXIT SHARP EDGE | | 1.0 | | |
| | * ORIFICE (C _D = .61) | | 2.69 RF/B ⁴ | | |
| | * SUDDEN CONTRACTION + | | .5(1-β ²) | | |
| | * SUDDEN INCREASE + | | (1-β ²) ² | | |
| | * VALVE, MISCELLANEOUS | | 891.4 d ⁵ /C _v ² | | |
| | MISC. | | | | |
| TOTALS | (6) 2.5' | | | (7) 5 | (8) 36 |

* ITEMS ARE "K" VALUES ONLY

+ BASED ON SMALLER PIPE DIAMETER

β = d/D

RF = RECOVERY FACTOR

PIPE FRICTION CALCULATION DATA SHEETS

Att 1

PLANT 600K
BY SW DATE 4/14/96
ITEM 960501JEW

SYSTEM: EACS UNIT: 2
PIPE SEGMENT TO & FROM: From (14x12) 20' to TEF 1-5-R 1.25'
REF.: 2-52-9
FLUID TEMP (°F): 25 PIPE ABS. ROUGHNESS (FT): .00015 PIPE SEGMENT NUMBER: 5
DESIGN FLOW: 4500 MINIMUM FLOW: 4500 MAXIMUM FLOW: 4500 FLOW INCREMENT: 0
PIPE I.D. (IN): 11.253 PIPE EL: 591'-0" TO EL: 591'-0"

STRAIGHT PIPE LENGTHS FITTINGS NUMBER *K OR L/D Σ K Σ L/D

| | | | | |
|--------|----------------------------------|---|----------|----------|
| | GATE VALVE | 13 | | |
| | GLOBE VALVE | 340 | | |
| | BUTTERFLY VALVE | 40 | | |
| | SWING CHECK | 135 | | |
| | 90° STD. ELBOW | 30 | | |
| | 90° S.R. ELBOW | 50 | | |
| | 90° L.R. ELBOW | 20 | | |
| | 45° STD. ELBOW | 16 | | |
| | 45° S.R. ELBOW | 26 | | |
| | 180° CLOSE RETURN | 50 | | |
| | STD. TEE RUN | 20 | | |
| | STD. TEE BRANCH | 60 | | |
| | * MITRE BENDS | 1.2 (1-cosθ) | | |
| | * LATERAL > OUTLET | 1.0 | | |
| | * LATERAL > INLET | 0.5 | | |
| | * STRAIGHT RUN LATERAL | 0.15 | | |
| | * PIPE ENTR PROJ. INWD. | 0.78 | | |
| | * " " SHARP EDGE | 0.50 | | |
| | * " " WELL ROUND | 0.04 | | |
| | * PIPE EXIT SHARP EDGE | 1.0 | | |
| | * ORIFICE (C _d = .61) | 2.69 RF/B ⁴ | | |
| | * SUDDEN CONTRACTION (14x12) 1 | .5(1-B ²) | .094 | |
| | * SUDDEN INCREASE + | (1-B ²) ² | | |
| | * VALVE, MISCELLANEOUS | 891.4 d ⁴ /C _v ² | | |
| | MISC. | | | |
| | IMO-390 (40=21) 1 | | | 21 |
| | SI-148 (30RE-12.55) (40=50) 1 | | | 50 |
| TOTALS | (0) 0.0 | | (0) .094 | (0) 71.0 |

* ITEMS ARE "K" VALUES ONLY
B = d/D RF = RECOVERY FACTOR

* BASED ON SMALLER PIPE DIAMETER



PIPE FRICTION CALCULATION DATA SHEETS

Sheet 1 of 1
PLANT COOK
BY HW DATE 11/19/96
NE 195056156W

SYSTEM: ECCS UNIT: 2
PIPE SEGMENT TO & FROM: FROM TEE (L-1-1) TO TEE R-1-1
D REF.: 2-S-9
FLUID TEMP (°F): 85 PIPE ABS. ROUGHNESS (FT): 0.0001 PIPE SEGMENT NUMBER: 6
DESIGN FLOW: 4500 MINIMUM FLOW: 4500 MAXIMUM FLOW: 4500 FLOW INCREMENT: 0
PIPE I.D. (IN): 13.124 PIPE EL: 591 TO EL: 535.8

STRAIGHT PIPE LENGTHS

FITTINGS

NUMBER

*K OR L/D

Σ K

Σ L/D

| | | | | |
|----------|----------------------------------|---|-----|-----|
| 0' - 12" | GATE VALVE | 13 | | |
| 3' - 7" | GLOBE VALVE | 340 | | |
| 14' - 8" | BUTTERFLY VALVE | 40 | | |
| | SWING CHECK | 135 | | |
| | 90° STD. ELBOW | 30 | | |
| | 90° S.R. ELBOW | 50 | | |
| | 90° L.R. ELBOW | 20 | | 20 |
| | 45° STD. ELBOW | 16 | | |
| | 45° S.R. ELBOW | 26 | | |
| | 180° CLOSE RETURN | 50 | | |
| | STD. TEE RUN | 20 | | |
| | STD. TEE BRANCH | 60 | | 120 |
| | * MITRE BENDS | 1.2 (1-cosθ) | | |
| | * LATERAL OUTLET | 1.0 | | |
| | * LATERAL INLET | 0.5 | | |
| | * STRAIGHT RUN LATERAL | 0.15 | | |
| | * PIPE ENTR PROJ. INWD. | 0.78 | | |
| | * " " SHARP EDGE | 0.50 | | |
| | * " " WELL ROUND | 0.04 | | |
| | * PIPE EXIT SHARP EDGE | 1.0 | | |
| | * ORIFICE (C _D = .61) | 2.69 RF/B ⁴ | | |
| | * SUDDEN CONTRACTION + | .5(1-B ²) | | |
| | * SUDDEN INCREASE + | (1-B ²) ² | | |
| | * VALVE, MISCELLANEOUS | 891.4 d ⁴ /C _V ² | | |
| | MISC. | | | |
| TOTALS | 19.75 | | 0.0 | 140 |

* ITEMS ARE "K" VALUES ONLY

B = d/D

RF = RECOVERY FACTOR

+ BASED ON SMALLER PIPE DIAMETER



PIPE FRICTION CALCULATION DATA SHEETS

Att. 1

PLANT COOK
BY OW DATE 4/4/96
NKEN 960501SEW

SYSTEM: FCCS

UNIT: _____

PIPE SEGMENT TO & FROM: FROM TEE (R42 EAW SURF) TEE (LINE FROM REELING SURF)

REF.: 2-51-9, 2-51-8, 2-5415

FLUID TEMP (°F): 85 PIPE ABS. ROUGHNESS (FT): 0.00015 PIPE SEGMENT NUMBER: 17

DESIGN FLOW: 4500 MINIMUM FLOW: 4500 MAXIMUM FLOW: 4500 FLOW INCREMENT: 0

PIPE I.D. (IN): 13.124 PIPE EL: 545'-8 5/8" TO EL: 575'-0"

STRAIGHT PIPE LENGTHS

FITTINGS

NUMBER

*K OR L/D

Σ K

Σ L/D

| | | | | | |
|-----------|----------------------------------|----|---|-----|----|
| 10'-9" | GATE VALVE (1A0-310) | 1 | 18 ¹⁰ | | 10 |
| 7'-0 3/4" | GLOBE VALVE | | 340 | | |
| 10'-8" | BUTTERFLY VALVE | | 40 | | |
| 2'-8" | SWING CHECK | | 135 | | |
| | 90° STD. ELBOW | | 30 | | |
| | 90° S.R. ELBOW | | 50 | | |
| | 90° L.R. ELBOW | 11 | 20 | | 40 |
| | 45° STD. ELBOW | | 16 | | |
| | 45° S.R. ELBOW | | 26 | | |
| | 180° CLOSE RETURN | | 50 | | |
| | STD. TEE RUN | 1 | 20 | | 0 |
| | STD. TEE BRANCH | | 60 | | |
| | * MITRE BENDS | | 1.2 (1-cosθ) | | |
| | * LATERAL > OUTLET | | 1.0 | | |
| | * LATERAL > INLET | | 0.5 | | |
| | * STRAIGHT RUN LATERAL | | 0.15 | | |
| | * PIPE ENTR PROJ. INWD. | | 0.78 | | |
| | * " " SHARP EDGE | | 0.50 | | |
| | * " " WELL ROUND | | 0.04 | | |
| | * PIPE EXIT SHARP EDGE | | 1.0 | | |
| | * ORIFICE (C _D = .61) | | 2.69 RF/B ⁴ | | |
| | * SUDDEN CONTRACTION + | | .5(1-B ²) | | |
| | * SUDDEN INCREASE + | | (1-B ²) ² | | |
| | * VALVE, MISCELLANEOUS | | 891.4 d ⁴ /Q _V ² | | |
| | MISC. | | | | |
| TOTALS | | | | 0.0 | 70 |

* ITEMS ARE "K" VALUES ONLY

B = d/D

RF = RECOVERY FACTOR

+ BASED ON SMALLER PIPE DIAMETER



DATA SHEETS

HT. 1

PLANT CORR
BY OW DATE 4/4/96
NCEMP 9503015EW

SYSTEM: ECCS UNIT: 2
PIPE SEGMENT TO & FROM: From Tee (Line from Recirc) to 2HR PUMP 2E
D/E: 2-SI-8
FLUID TEMP (°F): 85 PIPE ABS. ROUGHNESS (FT): .00015 PIPE SEGMENT NUMBER: 8
DESIGN FLOW: 4500 MINIMUM FLOW: 4500 MAXIMUM FLOW: 4500 FLOW INCREMENT: 0
PIPE I.D. (IN): 13.124 PIPE EL: 575'-0" TO EL: 575'-0"

STRAIGHT PIPE LENGTHS

FITTINGS

NUMBER

*K OR L/D

Σ K

Σ L/D

| | | | | |
|--------|----------------------------------|---|-----|----|
| 2'-9" | | | | |
| - 4" | GATE VALVE | 13 | | |
| - 3" | GLOBE VALVE | 340 | | |
| | BUTTERFLY VALVE | 40 | | |
| | SWING CHECK | 135 | | |
| | 90° STD. ELBOW | 30 | | |
| | 90° S.R. ELBOW | 50 | | |
| | 90° L.R. ELBOW | 20 | | |
| | 45° STD. ELBOW | 16 | | |
| | 45° S.R. ELBOW | 26 | | |
| | 180° CLOSE RETURN | 50 | | |
| | STD. TEE RUN | 20 | | |
| | STD. TEE BRANCH | 60 | | |
| | * MITRE BENDS | 1.2 (1-cosθ) | | |
| | * LATERAL OUTLET | 1.0 | | |
| | * LATERAL INLET | 0.5 | | |
| | * STRAIGHT RUN LATERAL | 0.15 | | |
| | * PIPE ENTR PROJ. INWD. | 0.78 | | |
| | * " " SHARP EDGE | 0.50 | | |
| | * " " WELL ROUND | 0.04 | | |
| | * PIPE EXIT SHARP EDGE | 1.0 | | |
| | * ORIFICE (C _D = .61) | 2.69 RF/B ⁴ | | |
| | * SUDDEN CONTRACTION + | .5(1-B ²) | | |
| | * SUDDEN INCREASE + | (1-B ²) ² | | |
| | * VALVE, MISCELLANEOUS | 891.4 d ⁴ /C _V ² | | |
| | MISC. | | | |
| TOTALS | | | 0.0 | 20 |

* ITEMS ARE "K" VALUES ONLY

+ BASED ON SMALLER PIPE DIAMETER

B = d/D

RF = RECOVERY FACTOR



rhROUT

NEMP950501JEW

Attachment 2

Page 1 of 6

ju 4/4/96

PIPE FRICTION CALC - INPUT FILE IS-rhrrecir

INPUT DATA FOR THE HFLC5 SYS. RES. CALC.
CONSISTS OF THE FOLLOWING DATA:

T - TEMPERATURE DEG F
E - PIPE ABSOLUTE ROUGHNESS (FT.)
N - FIRST PIPE SEGMENT NUMBER
N1 - LAST PIPE SEGMENT NUMBER
QDES - DESIGN FLOW THRU PIPE SEGMENT (GPM)
QMIN - MINIMUM FLOW THRU PIPE SEGMENT (GPM)
QMAX - MAXIMUM FLOW THRU PIPE SEGMENT (GPM)
QDELT - FLOW INCREMENT THRU PIPE SEGMENT (GPM)
D - PIPE SEGMENT INTERNAL DIA. (IN.)
L - PIPE SEGMENT LENGTH (FT.)
K - PIPE SEGMENT K FACTORS
L/D - PIPE SEGMENT L/D FACTORS

FOLLOWING IS YOUR INPUT DATA

| T | E | N | N1 |
|--------|--------|---|----|
| 190.00 | .00015 | 1 | 4 |

Post-It™ brand fax transmittal memo 7671

of pages >

| | | | |
|-------|--------------|---------|-------|
| To | A. Feliciano | From | Ripak |
| Co. | | Co. | |
| Dept. | Buchanan | Phone # | |
| Fax # | 284-5574 | Fax # | |

| QDES | QMIN | QMAX | QDELT | D | L | K | L/D |
|---------|---------|---------|-------|--------|-------|-----|--------|
| 7700.00 | 7700.00 | 7700.00 | .00 | 17.124 | 26.66 | .97 | 10.00 |
| 7700.00 | 7700.00 | 7700.00 | .00 | 16.876 | 26.15 | .00 | 100.00 |
| 4500.00 | 4500.00 | 4500.00 | .00 | 13.124 | 42.93 | .20 | 160.00 |
| 4500.00 | 4500.00 | 4500.00 | .00 | 13.124 | 3.33 | .00 | .00 |

FOLLOWING IS HFLC5 RESULTS

WATER TEMP.(F) = 190.00
DENSITY(LBM/CUFT) = 60.32
ABS VISCOSITY(LBM/SEC/FT) = .217609E-03
PIPE ABS ROUGHNESS(FT) = .150000E-03

| PIPE SEG NO | 1 | PIPE DIA(ID-IN) = | 17.124 |
|-------------|--------|-------------------|--------|
| FLOW-GPM | 7700.0 | VEL(FPS) | 10.73 |
| | | LHD(FT) | .42 |
| | | KHD(FT) | 1.73 |
| | | LDHD(FT) | .22 |
| | | TOT HD(FT) | 2.38 |

| PIPE SEG NO | 2 | PIPE DIA(ID-IN) = | 16.876 |
|-------------|--------|-------------------|--------|
| FLOW-GPM | 7700.0 | VEL(FPS) | 11.04 |
| | | LHD(FT) | .44 |
| | | KHD(FT) | .00 |
| | | LDHD(FT) | 2.38 |
| | | TOT HD(FT) | 2.83 |

| PIPE SEG NO | 3 | PIPE DIA(ID-IN) = | 13.124 |
|-------------|--------|-------------------|--------|
| FLOW-GPM | 4500.0 | VEL(FPS) | 10.67 |
| | | LHD(FT) | .92 |
| | | KHD(FT) | .35 |
| | | LDHD(FT) | 3.74 |
| | | TOT HD(FT) | 5.01 |

| PIPE SEG NO | 4 | PIPE DIA(ID-IN) = | 13.124 |
|-------------|--------|-------------------|--------|
| FLOW-GPM | 4500.0 | VEL(FPS) | 10.67 |
| | | LHD(FT) | .07 |
| | | KHD(FT) | .00 |
| | | LDHD(FT) | .00 |
| | | TOT HD(FT) | .07 |

REYNOLDS NUMBER FRICTION FACTOR TABLE

| SEG | DES. FLOW | RE.NO. | F-FACTOR | HEAD LOSS |
|-----|-----------|-----------|----------|-----------|
| 1 | 7700.0 | 4243402.0 | .0126 | 2.38 |
| 2 | 7700.0 | 4305761.0 | .0126 | 2.83 |
| 3 | 4500.0 | 3235750.0 | .0132 | 5.01 |



gw 4/4/96

4500.0

3235750.0

.0132

.07

Total $H_{ss} = 10.29$ Feet

PIPE FRICTION CALCULATION

DATA SHEET

SHEET 3 OF 6
 PLANT COK
 BY JW DATE 4/4/96
 NEMP 95030 JSEW

From Containment Sump to ICM 301

KG. REF. 1-2-5338-7

LIQUID TEMP. (F) 190 PIPE ABS. ROUGHNESS (FT) .00015 PIPE SEGMENT NUMBER 1
 LIQUID FLOW (GPM) 7700 PIPE I.D. (IN) (18.50) 17.124 ID PIPE EL. 595'-6" TO EL. 599'-9"

STRAIGHT PIPE LENGTHS FITTINGS NUMBER *K OR L/D ΣK ΣL/D

| | | | | | |
|--------------|--|---|---|------|------|
| 0 - 22 1/8" | GATE VALVE (ICM-301) * 1/2 = 10 | 1 | 13 | | 10 |
| 20' - 1 1/2" | GLOBE VALVE | | 340 | | |
| 1' - 9 1/2" | BUTTERFLY VALVE | | 40 | | |
| 0' - 9 1/2" | SWING CHECK | | 135 | | |
| 2' - 1 3/4" | 90° STD. ELBOW | | 30 | | |
| | 90° S.R. ELBOW | | 50 | | |
| | 90° L.R. ELBOW | | 20 | | |
| | 45° STD. ELBOW | | 16 | | |
| | 45° S.R. ELBOW | | 26 | | |
| | 180° CLOSE RETURN | | 50 | | |
| | STD. TEE RUN | | 20 | | |
| | STD. TEE BRANCH | | 60 | | |
| | * MITRE BENDS | | 1.2(1-COS θ) | | |
| | * LATERAL < OUTLET | | 1.0 | | |
| | * LATERAL < INLET | | 0.5 | | |
| | * STRAIGHT RUN LATERAL | | 0.15 | | |
| | * PIPE ENTR PROJ. INWD. | 1 | 0.78 | | |
| | * " " SHARP EDGE | | 0.50 | | |
| | * " " WELL ROUND | | 0.04 | | |
| | * PIPE EXIT SHARP EDGED | | 1.0 | | |
| | * ORIFICE (C _D = .61) | | 2.69 RF/β ⁴ | | |
| | * SUDDEN CONTRACTION 1 - 24x/8 | 1 | .5(1-β ²) | | |
| | * SUDDEN INCREASE 1 - (22.876x 17.124) | | (1-β ²) ² | .19 | |
| | * VALVE, MISCELLANEOUS | | 891.4 d ⁴ /C _v ² | | |
| | MISC | | | | |
| Σ 26.66 | | | | Σ 78 | Σ 10 |

* ITEMS ARE "K" VALUES ONLY
 β = d/D RF = RECOVERY FACTOR 1 BASED ON SMALLER PIPE DIAMETER



PIPE FRICTION CALCULATION

DATA SHEET

Att. 2

SHEET 4 OF 6
PLANT COOK
BY QAL DATE 4/4/26
NEL 9505015EW

YS 0 From Item 306 to CTS TAKE (18" x 18" x 14" TEE)

FIG. REF. 2-SI-7: Sh. 1 of 2 REV: 2 2-3415-15

FLUID TEMP. (F) 190 PIPE ABS. ROUGHNESS (FT) .00015 PIPE SEGMENT NUMBER 2

FLUID FLOW (GPM) 7700 PIPE I.D. (IN) (18"OD) 16-876 PIPE EL. 589'-9" TO EL. 586'-5 1/2"

STRAIGHT PIPE LENGTHS FITTINGS NUMBER *K OR L/D ΣK ΣL/D

| | | | | |
|-------------|---|---|-------|-------|
| 2'-27 1/16" | GATE VALVE | 13 | | |
| 21'-4 1/2" | GLOBE VALVE | 340 | | |
| 2'-6 7/8" | BUTTERFLY VALVE | 40 | | |
| | SWING CHECK | 135 | | |
| | 90° STD. ELBOX | 30 | | |
| | 90° S.R. ELBOX | 50 | | |
| | 90° L.R. ELBOX | 20 | 11 | 40 |
| | 45° STD. ELBOX | 16 | | |
| | 45° S.R. ELBOX | 26 | | |
| | 180° CLOSE RETURN | 50 | | |
| | STD. TEE RUN | 20 | | |
| | STD. TEE BRANCH | 60 | 1 | 60 |
| | * MITRE BENDS | 1.2(1-COS θ) | | |
| | * LATERAL < OUTLET | 1.0 | | |
| | * LATERAL < INLET | 0.5 | | |
| | * STRAIGHT RUN LATERAL | 0.15 | | |
| | * PIPE ENTR PROJ. INWD. | 0.78 | | |
| | * " " SHARP EDGE | 0.50 | | |
| | * " " WELL ROUND | 0.04 | | |
| | * PIPE EXIT SHARP EDGED | 1.0 | | |
| | * ORIFICE (C _D = .61) | 2.69 RF/β ⁴ | | |
| | * SUDDEN CONTRACTION † <u>(16.376 x 13.124)</u> | 5(1-β ²) | 19.8 | |
| | * SUDDEN INCREASE † | (1-β ²) ² | | |
| | * VALVE, MISCELLANEOUS | 891.4 d ⁴ /C _v ² | | |
| | MISC | | | |
| Σ 26.15 | | | 0.095 | Σ 100 |

* ITEMS ARE *K* VALUES ONLY † BASED ON SMALLER PIPE DIAMETER
β = d/D RF = RECOVERY FACTOR

100-100



PIPE FRICTION CALCULATION

DATA SHEET

Att. 2

SHEET 5 OF 6
PLANT COOK
BY ju DATE 4/4/96
PENL 250581360

YST From TEE (CTS TAKE-OFF) + 0. Top (section of RHR PP 2W-14" line
From RWST 2.3" RHR MINI-FLOW
K.G. REF. 2-SI-D. Sh. 1 of 2 r. 2

FLUID TEMP. (F) 190° PIPE ABS. ROUGHNESS (FT) .00015 PIPE SEGMENT NUMBER 3
FLUID FLOW (GPM) 4500 PIPE I.D. (IN) (14" O.D.) 13.124 I.D. PIPE EL. 581'-5 1/8" TO EL. 575'-2"

STRAIGHT PIPE LENGTHS FITTINGS NUMBER *K OR L/D ΣK ΣL/D

| | | | | | |
|------------|--|---|-------------------|-----|-----|
| 3'-0" | GATE VALVE (2-R1-12x10) $\frac{1}{2}D = 10$ | 1 | 10 | | 10 |
| 6'-11 1/8" | GLOBE VALVE | | 340 | | |
| 14'-8" | BUTTERFLY VALVE | | 40 | | |
| 6'-4" | SWING CHECK | | 135 | | |
| 4'-6" | 90° STD. ELBOW | | 30 | | |
| 0'-14" | 90° S.R. ELBOW | | 50 | | |
| 1'-2" | 90° L.R. ELBOW | 1 | 20 | | 120 |
| 5'-2" | 45° STD. ELBOW | | 16 | | |
| | 45° S.R. ELBOW | | 26 | | |
| | 180° CLOSE RETURN | | 50 | | |
| | STD. TEE RUN | 1 | 20 | | 20 |
| | STD. TEE BRANCH | | 60 | | |
| | * MITRE BENDS | | 1.2(1-COS θ) | | |
| | * LATERAL < OUTLET | | 1.0 | | |
| | * LATERAL < INLET | | 0.5 | | |
| | * STRAIGHT RUN LATERAL | | 0.15 | | |
| | * PIPE ENTR PROJ. INWD. | | 0.78 | | |
| | * " " SHARP EDGE | | 0.50 | | |
| | * " " WELL ROUND | | 0.04 | | |
| | * PIPE EXIT SHARP EDGED | | 1.0 | | |
| | * ORIFICE ($C_D = .61$) | | $2.69 RF/\beta^4$ | | |
| | * SUDDEN CONTRACTION $\frac{1}{2} \frac{1-\beta^2}{\beta^4}$ | | $.5(1-\beta^2)$ | | |
| | * SUDDEN INCREASE $\frac{1}{2} \frac{1-\beta^2}{\beta^4}$ | | $(1-\beta^2)^2$ | | |
| | * VALVE, MISCELLANEOUS | | $891.4 d^4/C_v^2$ | | |
| | MISC | | | | |
| Σ 42, 93 | | | 170 | 170 | 160 |

* ITEMS ARE "K" VALUES ONLY 1 BASED ON SMALLER PIPE DIAMETER
β = d/D RF = RECOVERY FACTOR FK-3-1-72

PIPE FRICTION CALCULATION

DATA SHEET

Att. 2

SHEET 6 OF 6
PLANT COO K
BY GW DATE 4/4/21
NEN1950501JEW

From Tee (from RUST 1 3/4" MINIFLOW) to RHR PUMP 2W

W.G. REF. 2-51-7 d 1052 s.v. 2

FLUID TEMP. (F) 190 PIPE ABS. ROUGHNESS (FT) .00015 PIPE SEGMENT NUMBER 4
FLUID FLOW (GPM) 4500 PIPE I.D. (IN) (14" ID) 13.124 ID PIPE EL. 575'-2" TO EL. 575'-0"

STRAIGHT PIPE LENGTHS FITTINGS NUMBER *K OR L/D ΣK ΣL/D

| | | | | |
|-----------------|----------------------------------|---|-----|-----|
| 2'-0" 0'-16" | GATE VALVE | 13 | | |
| | GLOBE VALVE | 340 | | |
| | BUTTERFLY VALVE | 40 | | |
| | SWING CHECK | 135 | | |
| | 90° STD. ELBOW | 30 | | |
| | 90° S.R. ELBOW | 50 | | |
| | 90° L.R. ELBOW | 20 | | |
| | 45° STD. ELBOW | 16 | | |
| | 45° S.R. ELBOW | 26 | | |
| | 180° CLOSE RETURN | 50 | | |
| | STD. TEE RUN | 20 | | |
| | STD. TEE BRANCH | 60 | | |
| | * MITRE BENDS | 1.2(1-COS θ) | | |
| | * LATERAL 4 OUTLET | 1.0 | | |
| | * LATERAL 4 INLET | 0.5 | | |
| | * STRAIGHT RUN LATERAL | 0.15 | | |
| | * PIPE ENTR PROJ. INXD. | 0.78 | | |
| | * " " SHARP EDGE | 0.50 | | |
| | * " " WELL ROUND | 0.04 | | |
| | * PIPE EXIT SHARP EDGED | 1.0 | | |
| | * ORIFICE (C _D = .61) | 2.69 RF/β ⁴ | | |
| | * SUDDEN CONTRACTION † | .5(1-β ²) | | |
| | * SUDDEN INCREASE † | (1-β ²) ² | | |
| | * VALVE, MISCELLANEOUS | 891.4 d ⁴ /C _v ² | | |
| | MISC | | | |
| Σ | | 3,33 | 0.0 | 6.0 |

* ITEMS ARE *K* VALUES ONLY † BASED ON SMALLER PIPE DIAMETER
β = d/D RF = RECOVERY FACTOR

Section _____

DESIGN VERIFICATION CHECKLIST - CALCULATIONS

Calculation Number WEMP 950501NEW

Rev. 0

John J. R. J. R. J.
Signature of Verifier

4/10/06
Date

1.0 Were the inputs correctly selected, incorporated and documented into the calculation?

Yes ☒ N/A ☐

Basis: The inputs are consistent with the hydraulic analysis used for this calculation

2.0 Are assumptions necessary to perform the calculation adequately described and reasonable?

Yes ☒ N/A ☐

Basis: The assumptions are appropriate and reasonable. Their basis is well defined where necessary.

3.0 Are the applicable codes, standards and regulatory requirements identified and requirements for design met?

Yes ☐ N/A ☒

Basis: There are no codes, standards or regulatory requirements applicable to this calculation.

4.0 Was an appropriate design method used?

Yes ☐ N/A ☒

Basis: This is not a design process.

5.0 Is the output reasonable compared to input?

Yes ☒ N/A ☐

Basis: The outputs are consistent with the inputs.

6.0 Are the results numerically correct?

Yes ☒ N/A ☐

Basis: check of calculation arithmetic when appropriate. Outputs of the previously verified computer program HF LCS are assumed to be correct