ZION CALCULATION COVER SHEET

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ZION NUCLEAR STATION

Zion Calculation No.: 22S-B-008M-092

DESCRIPTION CODE.: M03

SYSTEM CODE: RH

TITLE: RHR pump available NPSH during the post-LOCA recirculation phase

REFERENCE NUMBERS

Type	Number	Type	Number
DBDR	DBD-008 Ref. 8.013	NTS	295-140-96-9606593.2
LINE	1(2)SI007-18"	DBDR	DBD-004 Ref. 8.00586
LINE	1(2)SI008-18"		
LINE	1(2)SI007-20"		
LINE	1(2)SI008-20"		
NTS	295-140-96-9606593.1		

COMPONENT EPN: / DOCUMENT NUMBERS:

EPN	Comp Type	Component Number	Doc Type	Document Number
1(2)RH001	pump		CALC	RFS-CW-647
1(2)RH002	pump		PROC	ES-1.3, Rev. 6
			CALC	SCA, Rev. 0

REMARKS:

REV. NO.:	REVISION	APPROVED	DATE
0	Original Issue	Jim Orlakis	12/12/96
1	Include sump screen head loss	Jim Ashley	01/06/97
2	Added Water Inflow to Sump and Determined Acceptable Blockage Percentage	Jim Ashley (signature)	1-17-97

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CALCULATION TITLE PAGE

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☒ SAFETY RELATED ☐ REGULATORY RELATED ☐ NON- SAFETY RELATED

CALCULATION TITLE: RHR pump available NPSH during the post-LOCA recirculation phase

STATION/UNIT: ZION / B SYSTEM ABBREVIATION: RH

EQUIPMENT NO.: (IF APPL.) PROJECT NO.: (IF APPL.) 4928

REV: 0 STATUS: Superseded QA SERIAL NO. OR CHRON NO. N/A DATE: 12/12/96

PREPARED BY: Brian Jelke DATE: 12/9/96

REVISION SUMMARY: Original Issue

ELECTRONIC CALCULATION DATA FILES REVISED:
(Name.ext/size/date/hour:min/verification method/remarks)

DO ANY ASSUMPTIONS IN THIS CALCULATION REQUIRE LATER VERIFICATION YES ☐ NO ☒

REVIEWED BY: Patrick M. Donnelly DATE: 12/10/96
REVIEW METHOD: Detailed Design Review COMMENTS (C, NC OR CI): NC

APPROVED BY: Jim Orlakis DATE: 12/12/96

COMMONWEALTH EDISON COMPANY
CALCULATION TITLE PAGE

CALCULATION NO. 22S-B-008M-092 PAGE NO.: 3 OF 14

REV: 1 STATUS: Superseded QA SERIAL NO. OR CHRON NO. N/A DATE: 1-17-97

PREPARED BY: Brian Jelke DATE: 01/05/97

REVISION SUMMARY: Revise head loss calculation to include sump screen losses.

ELECTRONIC CALCULATION DATA FILES REVISED:
(Name.ext/size/date/hour:min/verification method/remarks)

DO ANY ASSUMPTIONS IN THIS CALCULATION REQUIRE LATER VERIFICATION YES ☐ NO ☒

REVIEWED BY: Patrick Donnelly DATE: 01/05/97
REVIEW METHOD: Detailed Design Review COMMENTS (C, NC OR CI): NC

APPROVED BY: J.C. Ashley DATE: 01/06/97

REV: 2 STATUS: Approved QA SERIAL NO. OR CHRON NO. N/A DATE: 1-17-97

PREPARED BY: Patrick Donnelly Patrick Donnelly DATE: 01/17/97

REVISION SUMMARY: Added Calculation of Inflow into the Sump and Determined Acceptable Sump Screen Blockage Percentage

ELECTRONIC CALCULATION DATA FILES REVISED:
(Name.ext/size/date/hour:min/verification method/remarks).

DO ANY ASSUMPTIONS IN THIS CALCULATION REQUIRE LATER VERIFICATION YES ☐ NO ☒

REVIEWED BY: Brian Jelke Brian Jelke DATE: 1-17-97
REVIEW METHOD: Detailed Design Review COMMENTS (C, NC OR CI): CI

APPROVED BY: J. C. Ashley DATE: 1-17-97

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DESCRIPTION	PAGE NO.	SUB-PAGE NO.

1. PURPOSE/OBJECTIVE

The purpose of this calculation is to determine the Net Positive Suction Head (NPSH) available to the RHR pumps during the post-LOCA recirculation phase of operation. This will resolve issues raised by a PIF on the subject and evaluated in Operability Assessment ER9606593. This topic was originally covered in Reference 1 and is discussed in UFSAR Section 6.0.1.4 (Ref. 5.13).

The purpose of Revision 1 of this calculation is to include the losses due to the containment recirculation sump screens in the available NPSH calculation. Although this is a very minor contribution to the total flowpath losses, it is appropriate to include it.

The purpose of Revision 2 of this calculation is three fold. The first part of this revision will be to revise the pressure loss across the Upper Sump Screen by determining the available flow area from as-built field measurements (See attachment B). The second part of this revision of the calculation is to verify that adequate water will flow into the sump to maintain sump level during the post-LOCA recirculation phase of ECCS operation. The final part of the revision will determine the percent of blockage of the upper mesh sump screen that can be tolerated and still provide an NPSH in excess of the required NPSH for the RHR Pumps.

2. METHODOLOGY/ACCEPTANCE CRITERIA

2.1. The available NPSH can be determined from the following equation

$NPSH = h_a - h_{vpa} + h_{st} - h_{fs}$ Ref. 5.2, p1-11

Where: h_a = absolute pressure on the surface of the liquid supply level.

h_{vpa} = the head corresponding to the vapor pressure of the liquid at the temperature being pumped.

h_{st} = static height in feet that the liquid supply level is above the pump centerline.

h_{fs} = all suction line losses including entrance losses and friction.

The NPSH equation given in UFSAR Section 6.0.1.4 combines the absolute pressure term and the vapor pressure term given above into the term $h_{subcooling}$. As given in the UFSAR the equation then becomes,

$NPSH = h_{subcooling} + h_{el} - h_{HL}$ Ref. 5.13, p6.0-7

Where: $h_{subcooling}$ = the difference between the atmospheric pressure in the containment and the vapor pressure of the sump water.

$h_{el} = h_{st}$ = static height in feet that the liquid supply level is above the pump centerline.

$h_{HL} = h_{fs}$ = all suction line losses including entrance losses and friction.

For conservatism no credit is taken for any elevated containment pressures which may exist following a LOCA, nor is any credit taken for the pressure caused by the air that is present in the containment free volume prior to the LOCA. The sump water is assumed to be saturated and hence, any steam pressure on the surface of the sump water is canceled out by the vapor pressure of the water being pumped (i.e. $h_{subcooling} = 0$). The NPSH equation then becomes:

$NPSH = h_{st} - h_{fs} = h_{el} - h_{HL}$

The total pipe losses can be expressed as the sum of the losses in different line sizes:

$h_{fs} = h_f(20") + h_f(18") + h_{screens}$

Where: $h_f(20")$ = 20" pipe loss including pipe entrance

$h_f(18")$ = 18" pipe loss including pipe exit

$h_{screens}$ = containment recirculation sump losses due to screens

The pipe friction losses are based on the following equation:

$h_f = K * V^2/2g$ Ref. 5.2, p3-110

Where: K = the total loss coefficient due to pipe length, valves and fittings

V = the fluid velocity

$g = 32.2\ ft/s^2$, the gravitational constant (Ref. 5.2)

The sump screen losses for the existing screens were calculated in References 5.14 and 5.15. However, the Reference 5.14 calculations are based on a 15,000 gpm flowrate and the Reference 5.15 calculations are based on a 9500 gpm flowrate. This calculation will be made based upon 2 RHR pumps operating at 4500 gpm each for a total of 9000 gpm. For the lower Sump Screen the information in References 5.15 and 5.17 will be utilized to determine the pressure drop across this screen. Nominal screen mesh sizes are shown in Reference 5.16.

For the Upper Screen the screen mesh resistance coefficient (K) is determined from actual field measurements. This "K" factor is determined by finding the average open area of each cell of the mesh and dividing this area by the total cell area between consecutive wires in the mesh. The ratio of these areas gives the resistance coefficient as provided on Page 17 of Reference 5.17. Then the head loss across the screen is determined in the same way as the pipe losses are calculated as shown above.

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The acceptance criteria is to ensure the available NPSH remains above the required value from the manufacturer's pump curve. UFSAR Table 6.0-1 indicates the required NPSH for the RHR pumps during the post-LOCA recirculation phase is 19 ft at a flowrate of 4500 gpm. Page 4-2 of the RHR DBD (Reference 5.3) indicates that the required NPSH is 20 ft at a flowrate of 4500 gpm. The NPSH value can be read from the pump curves (Attachment A) but the resolution of the curve is difficult. The required NPSH appears to fall between 19 and 20 ft at 4500 gpm for all RHR pumps. Using 20 ft as a requirement is conservative. The UFSAR should be updated to match the DBD (NTS item 295-140-96-9606593.1 and 295-140-96-960593.2).

This calculation will determine the available NPSH at the RHR pump "runout flow" of 4500 gpm and compare it to the required NPSH of 20 ft at the "runout flow" of 4500 gpm as intended in UFSAR Table 6.0-1.

2.2. The rate of water inflow into the sump can be determined by modeling the sump outer mesh screen as a rectangular weir and calculating the flow rate of water across the weir for various heights of water on the Containment floor. This is accomplished by using the table on Page 2-10 of Reference 5.2. The effective flow length around the perimeter of the open area of the sump is calculated from field measurements. For various heights and the effective length, the flow into the sump is determined. The flow rate per unit length of sump opening is conservatively calculated using a per length flow rate of an opening that is smaller than any of the sections of the sump. This is required because of the non-linearity of the tabulated data (i.e.: A weir length twice a given length will have more than twice the flow rate of the given length.). A required height for the 9000 gpm flow rate is thus found.

To this height is added an additional height of water due to the friction between the Containment floor and the water, and the head loss of the pressure drop across the mesh screen is also included. This required height is compared the available effective height (open vertical in the screen mesh) that exists when the RHR Pumps are transferred to the recirculation mode (Reference 5.4 - Page 4). The acceptance criteria for this portion of the calculation is that the available effective height exceeds the required height of the water on the Containment floor.

2.3. The amount of blockage, that can be tolerated and still have available NPSH exceed the required NPSH, can be calculated by an iterative process. The required NPSH is subtracted from the available NPSH (No blockage condition) to determine how much additional head loss can be tolerated. A percent of the available open area is picked and a resistance coefficient (K) is determined from the ratio of the available open area to the total open area using the graph on Page 17 of Reference 5.17. The fluid velocity across the available open area for a flow of 9000 gpm is calculated. The pressure drop is then calculated from the equation is Section 2.1 of this calculation. This iterative process is continued until the pressure drop for a specified percentage of blockage is equal to the difference between the available NPSH and the required NPSH.

The acceptance criteria for this section of the calculation is to have the greatest percent of blockage of the open area on the upper sump screen and still meet the NPSH requirements. This calculation will determine this percentage of blockage.

REVISION NO.	2			

3. ASSUMPTIONS AND LIMITATIONS

3.1. The sump water is saturated and hence, any steam pressure on the surface of the sump water is canceled out by the vapor pressure of the water being pumped.

3.2. Containment wide range level is greater than 1 ft above the containment floor (elevation 568') prior to going to recirculation. (Reference 5.4, p4)

3.3. Reducer angles (Calculation Section 6.3) are assumed to be 45°.

3.4. The longest pipe lengths between units and trains are used to maximize the pressure drops.

3.5. The containment sump screens remain sufficiently clear of debris to provide an adequate source of water to the RHR suction piping.

3.6. An absolute pipe roughness, ε , of .0018 was selected for use in determining the pipeline and fitting friction factors. This is a reasonable value since a typical absolute pipe roughness for commercial steel is .00015 (Ref. 5.11). Since the roughness selected is just over one order of magnitude greater than the estimated roughness for a new pipe, increased roughness due to pipe age and service should be adequately accounted for. The RHR system is not expected to be significantly fouled since the water used is primary grade.

3.7. For purposes of determining the kinematic viscosity, the temperature of sump water at the time of recirculation is assumed to be a minimum of 150°F. This maximizes the friction factor and resistance of the pipe and fittings. This is conservative according to data from Reference 5.12.

3.8. For the calculation of flow into the sump the bottom 0.5 inches of water on the Containment floor does not flow into the sump, in order to account for the friction between the water and the Containment floor.

3.9. The flow rate of water into the sump for each foot of length of weir is assumed to be equal to the per foot flow rate of a three (3) foot weir for a given depth.

3.10. The pressure drop due to the blockage of the available open area in the mesh screen is calculated as an additional pressure drop across an unblocked screen mesh.

4. DESIGN INPUT

4.1. Containment floor is at elevation 568' (Reference 5.5).

4.2. RHR pump centerline elevation is at 544' (Reference 5.6).

5. REFERENCES

5.1. "NPSH Calculation - Containment Sump to RHR Pump," Westinghouse Calculation RFS-CW-647, dated 8/26/68. (DBD-ZI-008, Ref. 8.013)

5.2. Cameron Hydraulic Data," Edited by C. Heald, 18th Edition, 1994.

5.3. "Residual Heat Removal System," DBD-ZI-008, Rev. A, 12/18/92.

5.4. "Transfer to Cold Leg Recirculation," Emergency Operating Procedure ES-1.3 Rev. 6, 2/6/93.

5.5. Sargent & Lundy Drawing B-278, Rev. H, 2/27/73.

5.6. Kellogg Isometric Drawings
1-6-10 Rev. 5, 3/4/71
1-6-11 Rev. 6, 3/4/71
2-6-8 Rev 5, 3/4/71.

5.7. Zion Piping Design Table "AA" Stainless Steel, Rev. 10/15/92.

5.8. Zion Piping Design Table "L" Stainless Steel, Rev. 10/15/92.

5.9. Sargent & Lundy Drawings
B-219 Rev. S, 8/28/75.
B-223 Rev. L, 8/21/72.
B-242 Rev. J, 8/21/72.

5.10. Stone & Webster Drawings
RH-2, 4 & 6 p 3-5, 11/13/81.
2RH-2, 10/25/82.

5.11. "Flow of Fluids Through Valves, Fittings and Pipe," Crane Technical Paper No. 410, 1988.

5.12. "Transmittal of Sump Temperature Data," NFS letter NFS:PSA:95-056, dated 5/16/95.

5.13. UFSAR Section 6.0.1.4, May 1996.

5.14. "Recirculation Sump Screen," S&L Calculation, DBD-ZI-004 Reference number 8.00586.

5.15. "Containment Recirculation Sump Screen Flow Head Loss," S&L Calculation SCA Rev. 0, dated 7/21/79.

5.16. Sargent & Lundy Drawing B-278 Rev. H, 2/27/73.

5.17. "Pressure Drop: Fittings, Valves and Discontinuities," Sargent & Lundy Mechanical Engineering Standard MES-2.16 Rev. E, 6/25/91.

6 CALCULATIONS

6.1. Static elevation head

The static elevation head is calculated from Design Inputs 1 and 2.
h_{st} = 569 - 544 = 25 ft

6.2. 20" Pipe losses: 1(2)SI007-20"-AA, 1(2)SI008-20"-AA (Ref. 5.6)

Pipe schedule = standard (Ref. 5.7)
Pipe ID = 19.25 in (Ref. 5.2 p7-11)
Velocity, V = 4500 gpm * m/60sec * ft^3/7.48052g / $\pi((19.25/12)^2/4)$ ft^2 = 4.96 ft/s
Reynolds number, Re = DV/v (Ref. 5.2 p1-5)
Kinematic viscosity, v = 0.44 centistokes = 4.7E-6 ft^2/s (Ref. 5.2, p4-4, 4-27)
(viscosity at 150 F results in conservative (maximum) friction factor)
Re = DV/v = (19.25/12)(4.96)/4.7E-6 = 1.69E6
Relative roughness = ε/D = 0.0018/19.25 = 0.0001
f = 0.013 (maximum) (Ref. 5.11 pA-24)
Maximum Pipe length = 51.69' (for any of the 4 lines) (Ref. 5.9)
k_1 = f(L/D) = 0.013(51.69/(19.25/12)) = 0.42
k_2 = 0.78 for an inward projecting pipe entrance (Ref. 5.2, p3-116)
$h_f(20") = (k_1 + k_2) * (V)^2/2g$
$h_f(20") = (0.42 + 0.78) * (4.96)^2/2*32.2 = 0.46$ ft

6.3. 18" pipe losses: 1(2)SI007-18"-L, 1(2)SI008-18"-L (Ref. 5.6)

The total pipe length is summed from dimensions on drawings in Reference 10 and the maximum value was selected.

Pipe schedule = 40 (Ref. 5.8)
Pipe ID = 16.876 in (Ref. 5.2 p7-11)
Velocity = 4500 gpm * m/60sec * ft^3/7.48052g / $\pi((16.876/12)^2/4)$ ft^2 = 6.45 ft/s
Reynolds number, Re = DV/v (Ref. 5.2 p1-5)
Kinematic viscosity, v = 0.44 centistokes = 4.7E-6 ft^2/s (Ref. 5.2, p4-4, 4-27)
(viscosity at 150 F results in conservative (maximum) friction factor)
Re = DV/v = (16.876/12)(6.45)/4.7E-6 = 1.93E6
Relative roughness = ε/D = 0.0018/16.876 = 0.0001
f = 0.013 (maximum) (Ref. 5.11 pA-24)
Maximum Pipe length = 71.92' (for any of the 4 lines) (Ref. 5.10)
k_1 = f(L/D) = 0.013(71.92/(16.876/12)) = 0.66

Fitting summary (Ref. 5.2, 5.6)

Fitting	L/D	number	total L/D	k
20x18 reducer	-	1	-	0.07*
18x14 reducer	-	1	-	0.1*
gate valve	8	1	8	0.104
LR elbow	14	4 (max)	56	0.728
SR elbow	20	2	40	0.52
FTR	20	6	120	1.56
Pipe exit	-	1	-	1
				sum k_2 = 4.082

*k (reducer) = $.8\sin(\theta/2)(1-d_1^2/d_2^2) = .8\sin(45/2)(1-(16.876/19.25)^2) = 0.07$ (Ref. 5.2, p3-118)
assume $\theta = 45°$

$h_f(18") = (k_1 + k_2) * (V)^2/2g$

$h_f(18") = (0.66 + 4.082) * (6.45)^2/2*32.2 = 3.06$ ft

6.4. Sump Screen Losses

1/2" (upper) screen
The screen total area for each screen cell is calculated in Reference 5.15. The actual open area of an average cell is determined by averaging the measurements taken at the sump screen (Provided in Attachment B).

For the cells of the mesh:

$(\text{width})_{aver}$ =(1/12)[378+395+393+391+396+375+408+385+382+394+387+309] = 389.5 mils

$(\text{height})_{aver}$ =(1/12)[384+380+385+374+393+377+383+389+374+408+379+385] = 384.25 mils

the nominal size of the mesh is: width = 500 mils and height = 500 mils (Ref. 5.14)

$\therefore A_{open}/A_{total} = (389.5)(384.25)/[(500)(500)] = .5987 \approx 0.600$

From Page 17 of Ref. 5.17 for A_{open}/A_{total} = 0.600 K= 1.0

Next, determine the A_{total} from the as-built measurements using the minimum of the measured values of the screen perimeter:

P = (52 3/16 + 52 3/16 + 49 5/16 + 58 5/16 + 71 7/16 + 51 13/16) = 333 36/16 inches
or P = 335 1/4 inches = 335.25 inches
The height of the mesh screen is 12 inches = 1 foot
$\therefore A_{total}$ = 1.0 ft.[335.25 in] * ft./12in. = 27.94 ft.^{2}

$\therefore A_{open} = (0.6)\ A_{total} = (0.6)(\ 27.94\ ft.^2) = \underline{16.76\ ft.^2}$

Velocity, V = 9000 gpm * m/60sec * ft^3/7.48052g / (16.76) ft^2 = 1.196 ft/s

$h_{screen} = (1.0)(1.196)^2 / 64.4 = 0.022$

3/8" Lower Screen

3/8" Screen open area, A_0 = 17.87 ft^2 (Ref. 5.15)

K = 1.0 (Ref. 5.17)

Velocity, V = 9000 gpm * m/60sec * ft^3/7.48052g / (17.87) ft^2 = 1.12 ft/s

$h_{screen} = 1.0\ (1.12)^2 / 64.4 = 0.019$

6.5. Available NPSH

NPSH = 25 - 0.46 - 3.06 - 0.022 - 0.019 = 21.439 ft > 20 ft

6.6. Calculation of Containment Floor Flood Height Necessary for a 9000 GPM Flow into the Sump

Q = 9000 gpm = 9000 gal/min * min/60 sec * ft^3/7.48052 gal = $\underline{20.05\ ft^3/sec}$

From the previous section the average width opening is 389.5 mils.

$\therefore l_{open}/\ l_{total}$ = (389.5)/(500.0) = 0.779 and the total perimeter is 335.25 inches = 27.94 ft.

$\therefore l_{open}$ = (0.779)(27.94 ft.) = 21.77 ft.

Using the table on Page 2-10 of Reference 5.2, flow rates for various heights of water can be determined. A conservative value of flow rate into the sump can be made by using the 3 foot length weir flow rate.

Checking this - the shortest length of sump section is 49 5/16 inches = 4.109 ft. and

(0.779)(4.109) = 3.20 ft. (Hence, using the 3 foot weir flow rate will be conservative.)

Since the open section of each length of sump screen is greater than 3 feet, using one third of the 3 foot flow rate will provide a conservative flowrate. The data, for a given height can be tabulated with Q being the flow rate per foot of length for a 3 foot weir.

Height (in.)	Length (feet)	Q (gpm/ft.)	Q_{total} (gpm)
5.00	21.77	391.67	8,526.66
6.00	21.77	511.67	11,139.06
7.00	21.77	642.67	13,990.85
5.50	21.77	450.67	9,811.09
5.25	21.77	420.67	9157.99

Using the requirement that there is no flow in the bottom 0.5 inches of water, the minimum height of water becomes 5.75 inches. The pressure drop across the screen mesh is 0.022 ft. = 0.264 in. Therefore, add an additional 0.3 in for the pressure drop to get a required height of 6.05 in.

Because of the horizontal wires in the mesh, the total effective height available is not the full 12 inches. Calculating this height:

$h_{eff} = [(384.25) / (500)] * (12 \text{ in.}) = 9.22$ in.

Note that 384.25 is the average vertical open length (mils) in the mesh, and 500 is the nominal centerline-to-centerline distance (mils) between wires in the mesh. The 12 inches is the height of the mesh screen.

Thus, there is 9.22 inches of height available. Since only 6.05 inches of water is needed, the flow into the sump will be able to maintain sump level.

6.7. Calculation of Percent of Blockage that will still Provide the Required NPSH

The available NPSH is 21.439 feet, and the required NPSH is 20.0 feet. Thus, there is 1.439 feet of additional pressure drop available. The total available open area is 16.76 ft., and the required flow rate is $Q = 20.05$ ft^3/sec. Now it is necessary to iterate to find the allowed blockage:

Let the blockage be 75% $\therefore A_{open}/A_{total} = 0.25$ from Reference 5.17 K = 10

$\therefore A_{open} = (0.25)(16.76 \text{ ft.}) = 4.19$ ft.

$\therefore V = Q/A_{open} = 20.05/4.19 = 4.79$ ft./sec. (Ref. 5.11)

$\therefore h_{bloc} = (10)(4.79)^2/64.4 = 3.56$ ft.

This value exceeds the allowed pressure drop.

Let the blockage be 70% $\therefore A_{open}/A_{total} = 0.30$ from Reference 5.17 $K = 6.5$

$\therefore A_{open} = (0.30)(16.76ft.) = 5.028$ ft.

$\therefore V = Q/ A_{open} = 20.05/5.028 = 3.99$ ft./sec.

$\therefore h_{bloc} = (6.5)(3.99)^2/64.4 = 1.607$ ft.

This value exceeds the allowed pressure drop.

Let the blockage be 68% $\therefore A_{open}/A_{total} = 0.32$ from Reference 5.17 $K = 5.8$

$\therefore A_{open} = (0.32)(16.76ft.) = 5.363$ ft.

$\therefore V = Q/ A_{open} = 20.05/5.363 = 3.74$ ft./sec.

$\therefore h_{bloc} = (5.8)(3.74)^2/64.4 = 1.259$ ft.

This value is below the allowed pressure drop.

Let the blockage be 69% $\therefore A_{open}/A_{total} = 0.31$ from Reference 5.17 $K = 6.0$

$\therefore A_{open} = (0.31)(16.76ft.) = 5.196$ ft.

$\therefore V = Q/ A_{open} = 20.05/5.196 = 3.86$ ft./sec.

$\therefore h_{bloc} = (6.0)(3.86)^2/64.4 = 1.39$ ft.

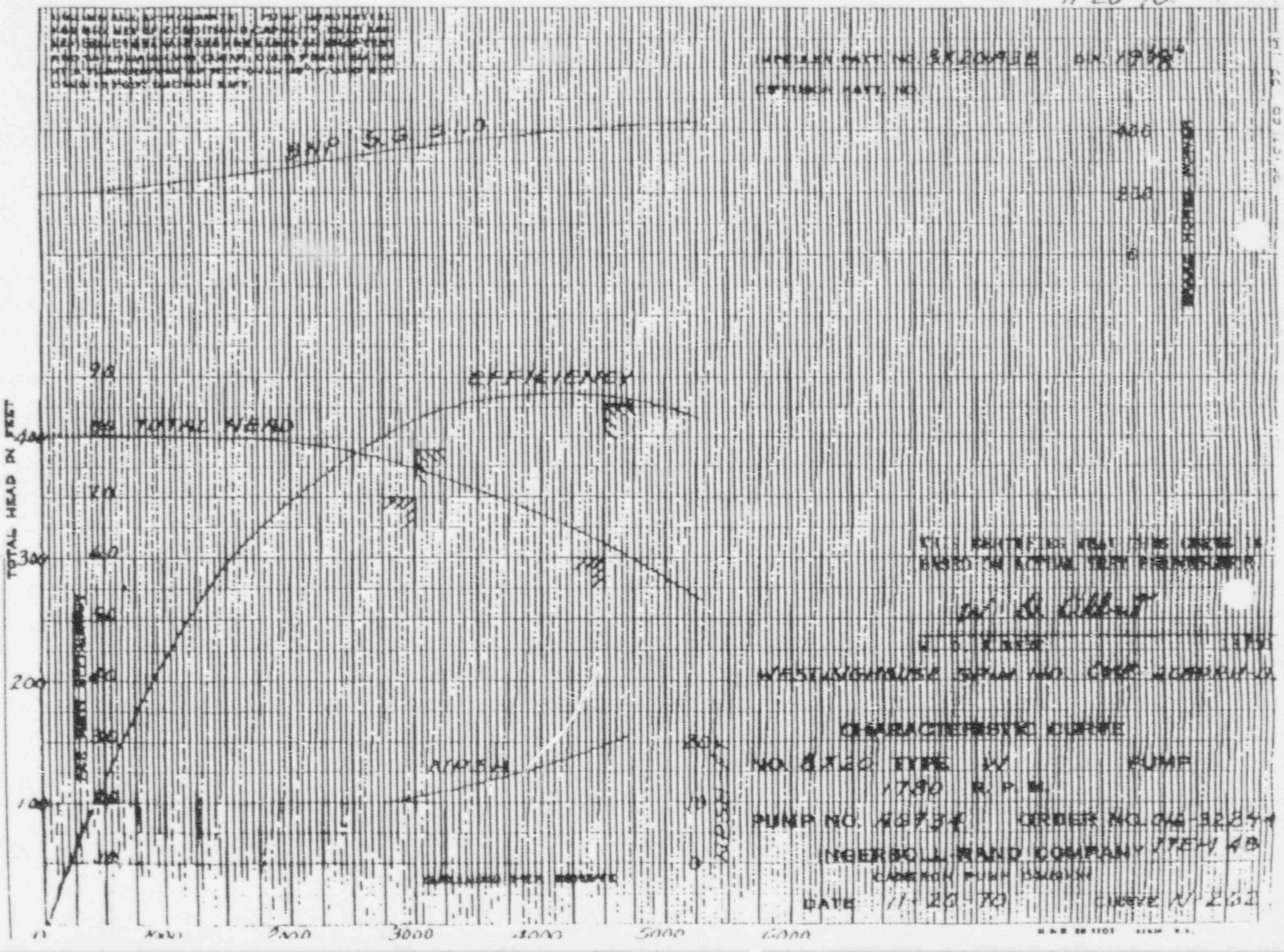
This value is in close approximation to the allowed pressure drop, and it does not exceed it. This value should be used. The 69% blockage of the open area will still allow the required NPSH to be met.

7. SUMMARY AND CONCLUSIONS

The results of this calculation show that the RHR pumps have adequate NPSH (> 20 ft) during the post-LOCA recirculation phase at a flow rate of 4500 gpm. The results of this calculation also show that there is sufficient flow into the sump to maintain the sump level during the post-LOCA recirculation phase of the RHR Pumps, and this calculation shows that 69% of the open area on the upper screen can be blocked and still provide sufficient pressure to meet the required NPSH of the RHR Pumps at the 4500 gpm flow rate.

Final

CURVE NO. N-262
DATE 11-20-70



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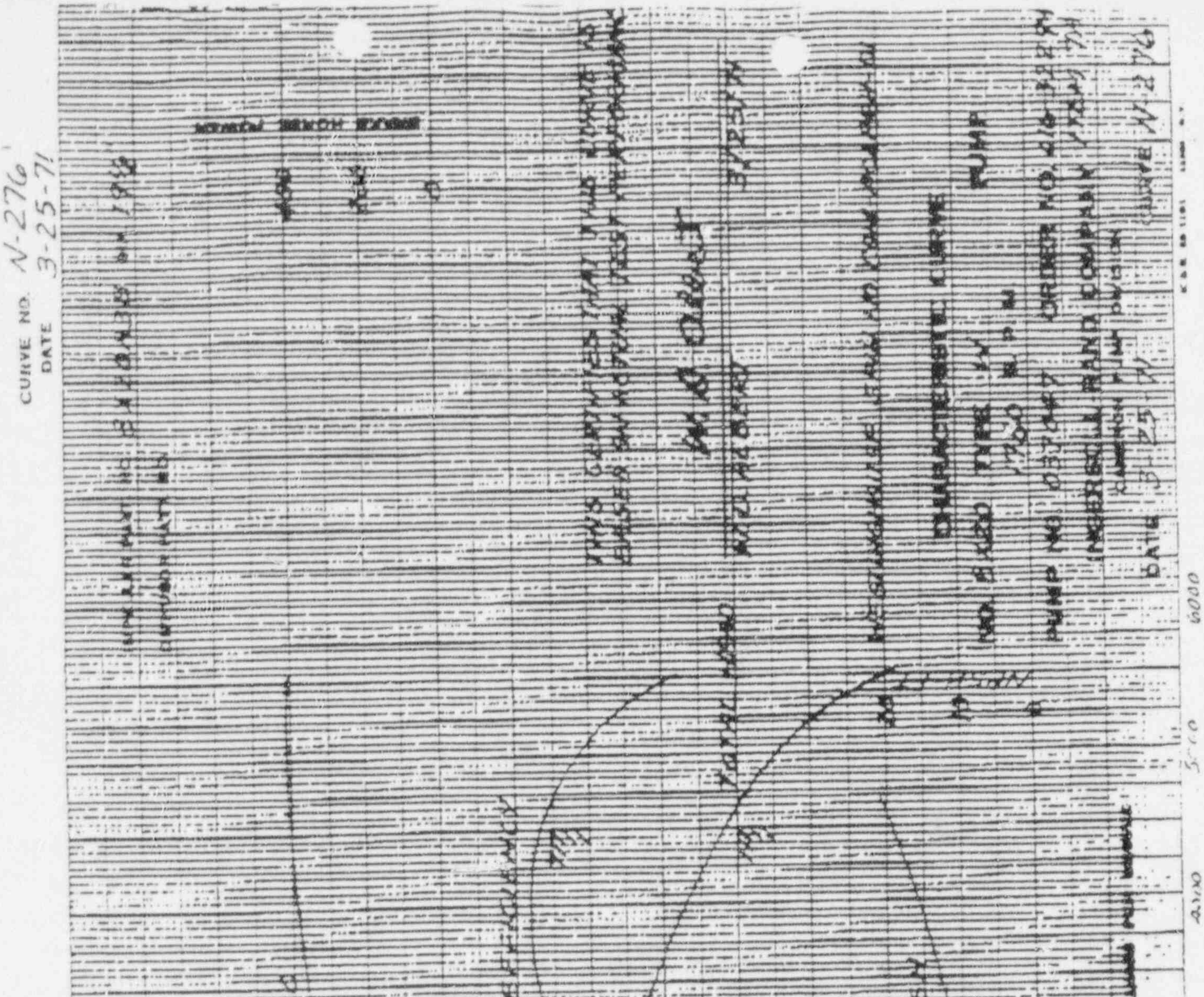

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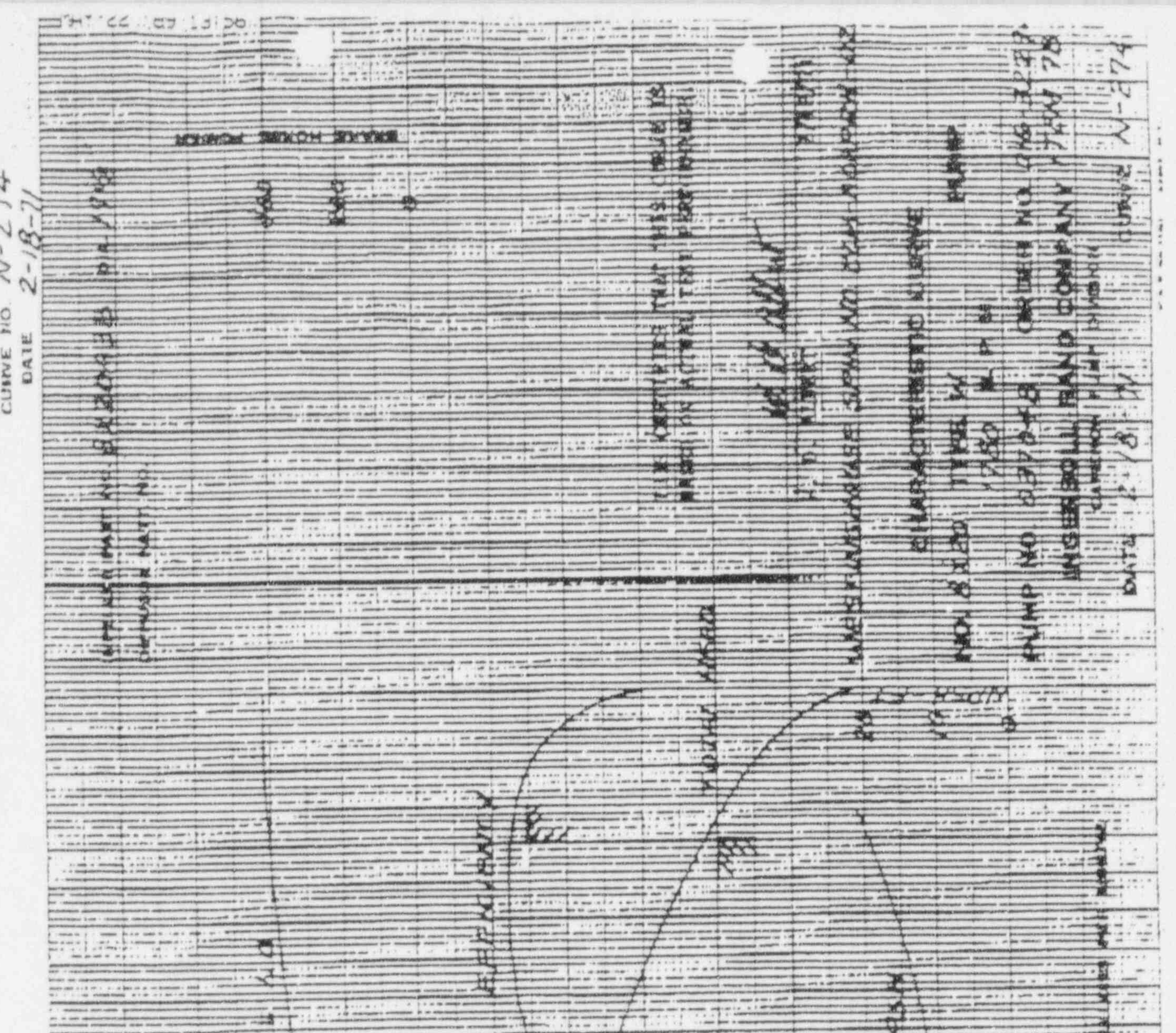

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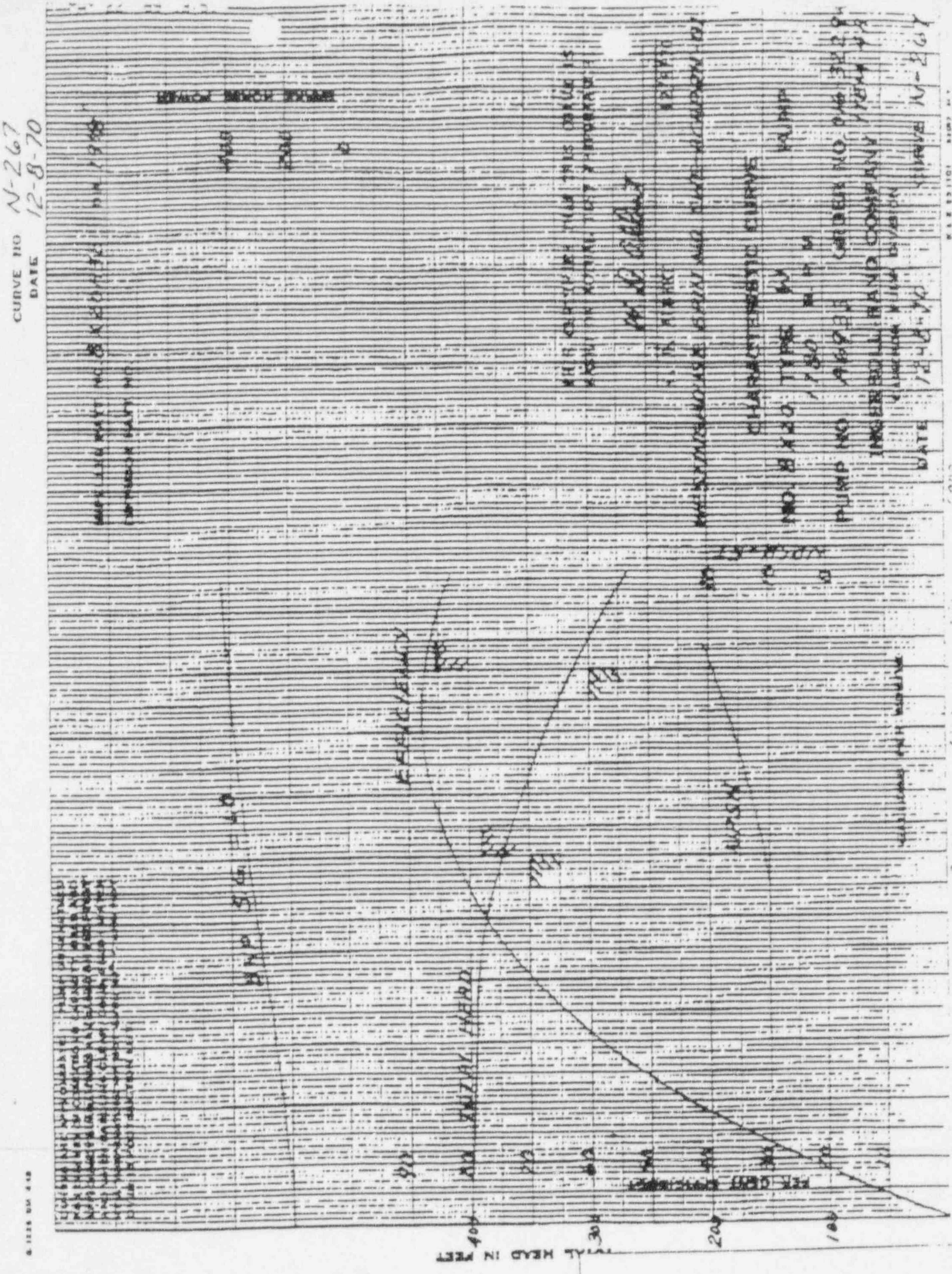
Comed Calculation No:
225-B-008M-042 Rev 2



ATTACHMENT A PAGE: A4
Comed Calculation No:
22S-B-0WM-092 Rev 2

Exhibit A
NEP-04-04
Revision 1

WALKDOWN OBSERVATION RECORD

Type of Walkdown: Designers (Study, Designer's, Installer's, User's) **Date of Walkdown:** 1-10-97

Design Change No.: N/A

Participants:

Department	Name (Printed)	Signature
DE	D N Carter	D Carter
DE	R. Snyder	Russ Snyder

Significant Observations:
[Use additional pages if necessary. Note, if attachments are expected to be used as controlled design input for calculations (i.e., dimensional data, etc.), then the attachments must be properly prepared and reviewed/verified.]

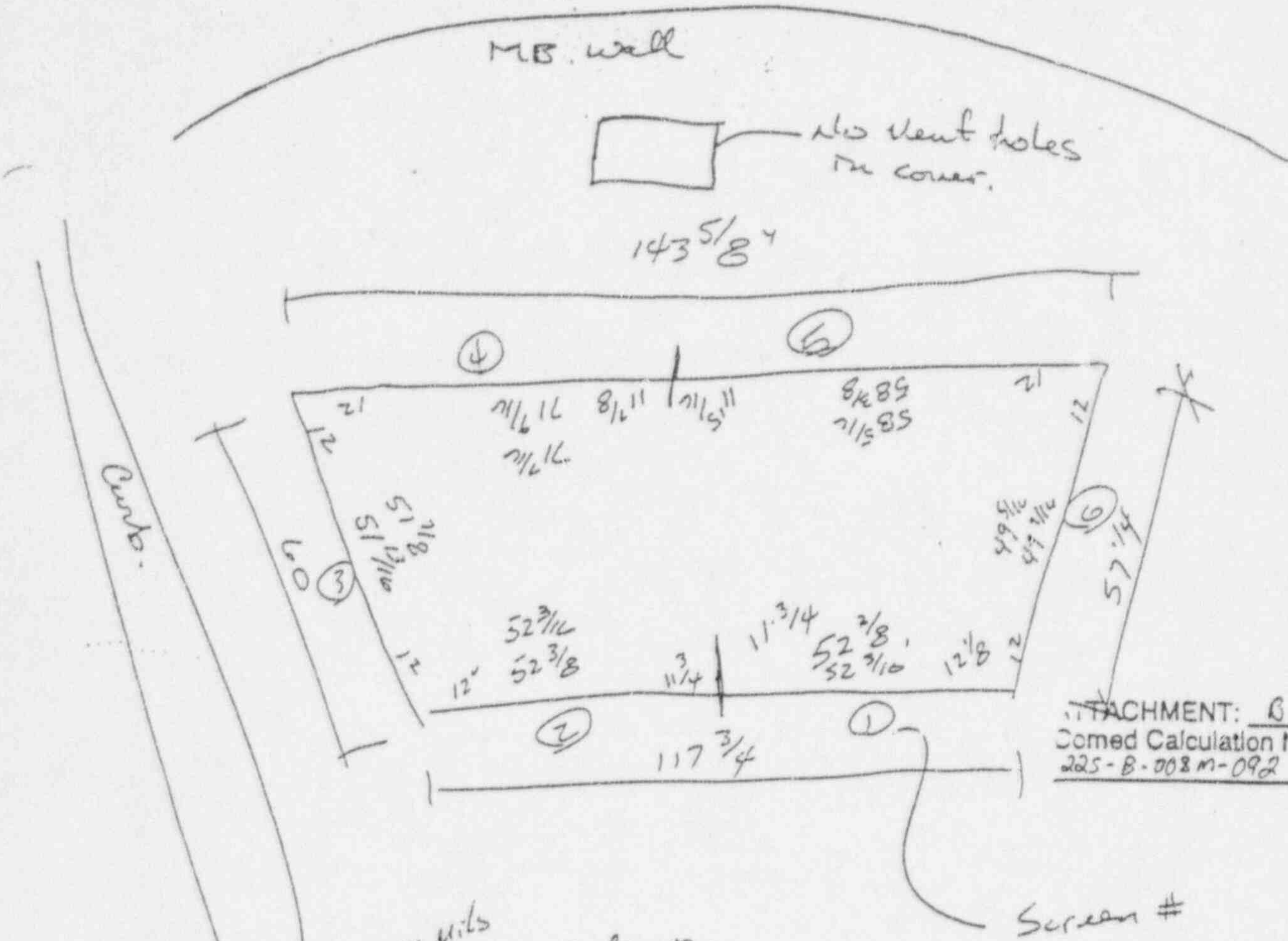
- Sump Screen sizes determined.
- See attached sheets.
-

ATTACHMENT: B PAGE: 81
Comed Calculation No: 22S-B-008M-092 Rev 2

Pg 1/2

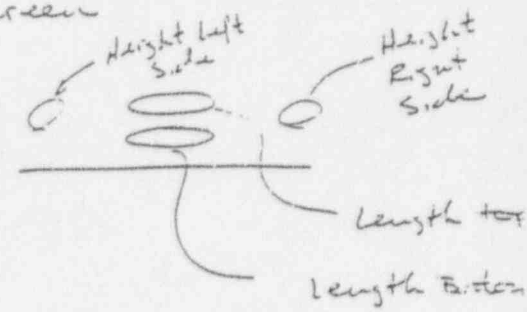
BJ 1-15-97

~~ATTACHMENT: PAGE: Comed Calculation No: Rev~~



ATTACHMENT: B PAGE: 82
Comed Calculation No: 225-B-008M-092 Rev 2

Dimensions shown for each Screen



All dimensions of over all screen sizes are in inches

Screen	Opening Size in Mils W	Opening Size in Mils H	Wire thickness in Mils
1	378	384	117
	395	380	115
2	393	385	123
	391	374	099
3	396	393	115
	375	377	123
4	408	383	102
	385	389	105
5	382	374	109
	394	408	111
6	~~4??~~ 387	379	95
	390	355	111

PREPARED BY [signature]
DATE 1-10-97

REVIEWED BY [signature]
DATE 1-10-97