NE-014
(02/95)

NUCLEAR ENGINEERING DEPARTMENT

Calculation Cover Sheet
Cook Nuclear Plant

N________ SECTION

CALCULATION No. NESM961021AF	INDIANA MICHIGAN POWER COMPANY
SAFETY RELATED YES X NO ___	UNIT No. 1&2
SYSTEM ECCS	CALCULATED BY: [signature] 10/30/96 DATE
TITLE CCP NPSH	VERIFIED BY: [signature] 11/27/96 DATE
RFC/MM/PM/PR/CR/TM No. DB-12-ECCS-24	
FILE LOCATION NESM Calc files	APPROVED BY: [signature] 12/2/96 DATE

CALCULATION DESCRIPTION: This calculation determines the NPSH available to the CCPs and was performed as a result of DBD action item DB-12-ECCS-24.

METHOD OF VERIFICATION: ALTERNATE CALCULATION ________ DESIGN REVIEW JJR 11/27/96

REVISION

NO.	REASON FOR CHANGE	Calculated By	Date	Verified By	Date	Approved By	Date

9808100115 980817
PDR ADOCK 05000315
H PDR

Design Inputs

Required pump flows and CCP NPSH obtained from the various pump curves are as follows:

Containment Spray Pump - 3200 gpm (SD-12-CTS-100,Rev 0, 6.1)
Safety Injection Pump - 650 gpm (SD DCC-NEMH111 Rev 16, 3.4.2.b.12)
Residual Heat Removal Pump - 4500 gpm (SD-12-RHR-100,Rev 0, 8.0)
Centrifugal Charging Pump - 550 gpm (SD DCC-NEMH111,Rev 16, 3.4.1A)
Centrifugal Charging Pump NPSH required - 22 ft abs @ 550 gpm

Calculation NEMP950501JEW approved 4/11/96 performed for severe accident setpoints. Note 100°f water temperature obtained from this calculation.

Suction piping configuration (length, dia, fittings, etc) obtain from the isometric drawings.

References

Containment Spray Pump - Byron Jackson Pump curve T-32913-1
Safety Injection Pump - Pacific Pump curve 34554D
Residual Heat Removal Pump - Ingersoll-Rand Pump curve N-318
Centrifugal Charging Pump - Pacific Pump curve 34617I

Isometric Drawings

2-SI-53 2-SI-6 2-SI-43 2-CS-79 2-CS-80
2-CS-81

Hydraulic friction loss program HFLC5 will be used to determine the frictional losses thru suction piping. HFLC5 is an inhouse developed program which was approved for use on Feb 28, 1988. This program was validated and approved in accordance with the requirements of GP 2.6 Software Quality assurance Standard in use in 1988.

Description

Purpose:

DBD action item DB-12-ECCS-24 "Centrifugal Charging Pump Available NPSH Calculation" indicated that an NPSH available calculation for the CCPs could not be found. The action item requested that a calculation be prepared which would determine the NPSH available to the CCPs during the Injection Phase.

This calculation will determine the NPSH available to the CCPs based on providing flow to two trains of safeguards pumps (containment spray, safety injection, residual heat removal, and centrifugal charging).

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DF 4/30/96

Method:

In order to obtain the frictional losses associated with the suction piping the isometric drawings were used to obtain the piping configuration. The sketch (pg 4) shows the flow path and branching flows to the other safeguard pumps. The data obtained from the isometric drawings was compiled on the attached "pipe Friction Calculation Data Sheets". The totals shown on these sheets is used as input to HFLC5.

HFLC5 calculates the segments frictional losses and is based on the Dracy-Weisbach formula

$$H = f\frac{L}{D}\frac{V^2}{2g}$$

where: H- frictional loss in feet
f- friction factor, dimensionless
L- pipe length in feet
D- pipe diameter in feet
V- pipe velocity in feet/sec
g- gravitational constant, 32.174 feet/sec^2

The NPSH available is then determined as follows:

$$NPSH_a = H_p - H_{VPA} + H_{st} - H_{fs}$$

where: $NPSH_a$ - net positive suction head available in ft abs
H_p - atmospheric pressure in ft
H_{VPA} - vapor pressure of water
H_{st} - static elevation difference in feet
H_{fs} - friction losses in feet

Assumptions:

1 - RWST water level is at minimum elevation (bottom of pipe) and is determined as 611.25' (24" suction pipe center line) - 1' (radius of 24" pipe) results in 610.25'. This is conservative since in normal ECCS operation the CCPs are transfered to the recirculation sump/RHR before the RWST level reaches Lo-Lo or elevation 613.0'.

2 - RWST temperature is 100°f for conservatism. Vapor pressure at 100°f is .94925 psia or 2.21' based on multiplying by the conversion factor 2.323 ft for 100°f water.

3 - RWST is open to atmosphere

4 - For purposes of this calculation it is assumed that all safeguards pumps are operating. That is, 2 safety injection, 2 residual heat removal, 2 containment spray, and 2 centrifugal charging pumps.

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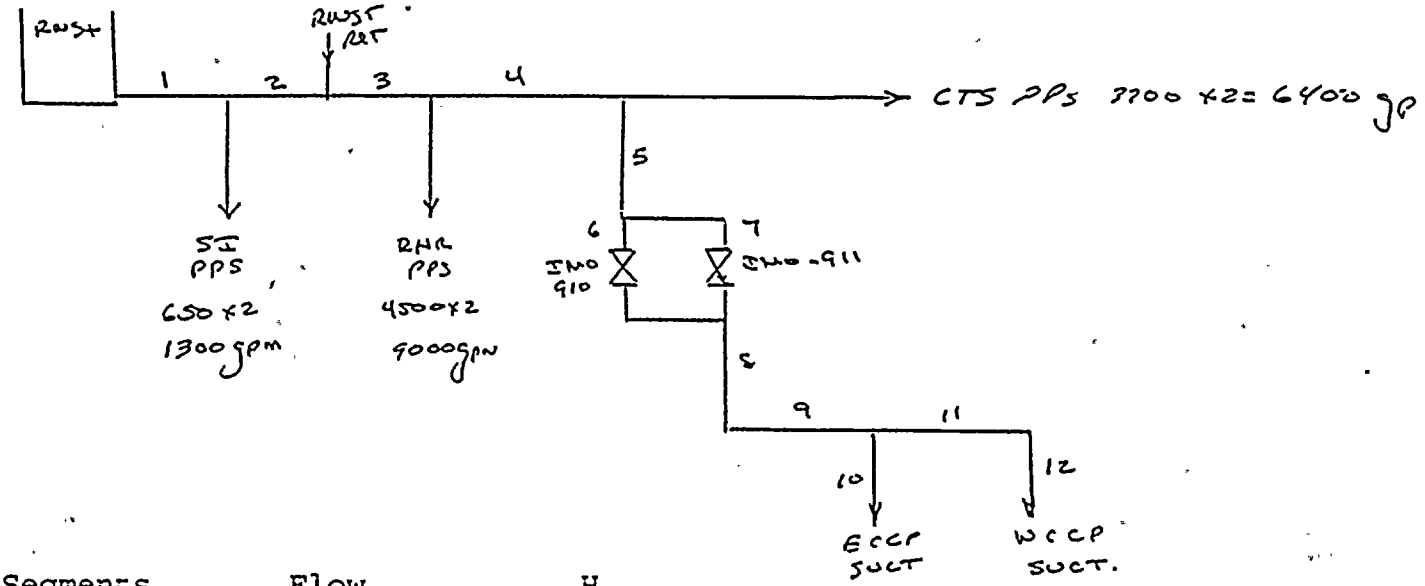
Conclusions:

This results of this calculation indicate that the NPSH available to the charging pumps exceeds the NPSH required by approximately 7' absolute (6.97' East pp and 6.55' West pp) at the CCP flow of 550 gpm.

Calculation:



Segments	Flow	H_f
1	17,800	11.71
2	16,500	.68
3	16,500	.7
4	7,500	.15
5	1,100	1.54
6	550	.21
7	550	.33
8	1,100	3.04
9	1,100	.74
10	550	1.64
11	550	.24
12	550	.56
13	550	1.26

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

H_a = 33.96 ft

H_{vpa} = .95 psia or 2.21 ft

H_{st} = 610.25 - 592.5 = 17.75 ft

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The friction loss for each pump is determined by adding the respective line segments to that pump. That is for the east CCP add segments 1 thru 5 and 7 thru 10 and for the west CCP add segments 1 thru 5 and 7 thru 9 and 11 thru 13.

H_{fs} ECCP = 11.71 + .68 + .7 + .15 + 1.54 + .33 + 3.04 + .74 + 1.64

= 20.53 ft

H_{fs} WCCP = 11.71 + .68 + .7 + .15 + 1.54 + .33 + 3.04 + .74 + .24 + .56 + 1.26

= 20.95 ft

$NPSH_a$ ECCP = 33.96 - 2.21 + 17.75 - 20.53

= 28.97 ft abs

$NPSH_a$ WCCP = 33.96 - 2.21 + 17.75 - 20.95

= 28.55 ft abs

$NPSH_r$ at 550 gpm is 22 ft

Therefore, the $NPSH_a$ exceeds the $NPSH_r$ by 6.97 ft abs and 6.55 ft abs for the ECCP and WCCP respectively.

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c:\calc\ccpnp

PIPE FRICTION CALC - INPUT FILE IS-c:\calc\ccpnpsh

INPUT DATA FOR THE HFLC5 SYS. RES. CALC.
CONSISTS OF THE FOLLOWING DATA:
T - TEMPERTURE 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
100.00	.00015	1	13

QDES	QMIN	QMAX	QDELT	D	L	K	L/D
.00	17000.00	17800.00	200.00	23.250	221.33	1.00	148.00
.00	16000.00	16500.00	500.00	23.250	6.00	.00	20.00
.00	16000.00	16500.00	500.00	23.250	7.81	.00	20.00
.00	7000.00	7500.00	500.00	23.250	6.35	.00	20.00
.00	1000.00	1100.00	100.00	7.981	13.55	.44	80.00
.00	500.00	550.00	50.00	7.981	8.00	.00	53.00
.00	500.00	550.00	50.00	7.981	8.00	.00	93.00
.00	1000.00	1100.00	100.00	7.981	12.94	.00	235.00
.00	1000.00	1100.00	100.00	7.981	1.20	.00	60.00
.00	500.00	550.00	50.00	6.065	19.00	.00	133.00
.00	500.00	550.00	50.00	7.981	15.96	.00	52.00
.00	500.00	550.00	50.00	6.065	12.71	.22	20.00
.00	500.00	550.00	50.00	6.065	9.35	.00	113.00

FOLLOWING IS HFLC5 RESULTS

WATER TEMP.(F) = 100.00
DENSITY(LBM/CUFT) = 62.00
ABS VISCOSITY(LBM/SEC/FT) = .460533E-03
PIPE ABS ROUGHNESS(FT) = .150000E-03

PIPE SEG NO 1 PIPE DIA(ID-IN) = 23.250

FLOW-GPM	VEL(FPS)	LHD(FT)	KHD(FT)	LDHD(FT)	TOT HD(FT)
17000.0	12.85	3.54	2.56	4.59	10.70
17200.0	13.00	3.63	2.63	4.70	10.95
17400.0	13.15	3.71	2.69	4.80	11.20
17600.0	13.30	3.79	2.75	4.91	11.45
17800.0	13.45	3.88	2.81	5.02	11.71

PIPE SEG NO 2 PIPE DIA(ID-IN) = 23.250

FLOW-GPM	VEL(FPS)	LHD(FT)	KHD(FT)	LDHD(FT)	TOT HD(FT)
16000.0	12.09	.09	.00	.55	.64
16500.0	12.47	.09	.00	.59	.68

PIPE SEG NO 3 PIPE DIA(ID-IN) = 23.250

FLOW-GPM	VEL(FPS)	LHD(FT)	KHD(FT)	LDHD(FT)	TOT HD(FT)
16000.0	12.09	.11	.00	.55	.66
16500.0	12.47	.12	.00	.59	.70

PIPE SEG NO 4 PIPE DIA(ID-IN) = 23.250

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FLOW-GPM	VEL(FPS)	LHD(FT)	KHD(FT)	LDHD(FT)	TOT HD(FT)
7000.0	5.29	.02	.00	.11	.13
7500.0	5.67	.02	.00	.13	.15

PIPE SEG NO 5 PIPE DIA(ID-IN) = 7.981

FLOW-GPM	VEL(FPS)	LHD(FT)	KHD(FT)	LDHD(FT)	TOT HD(FT)
1000.0	6.41	.20	.28	.79	1.28
1100.0	7.05	.24	.34	.96	1.54

PIPE SEG NO 6 PIPE DIA(ID-IN) = 7.981

FLOW-GPM	VEL(FPS)	LHD(FT)	KHD(FT)	LDHD(FT)	TOT HD(FT)
500.0	3.21	.03	.00	.14	.17
550.0	3.53	.04	.00	.17	.21

PIPE SEG NO 7 PIPE DIA(ID-IN) = 7.981

FLOW-GPM	VEL(FPS)	LHD(FT)	KHD(FT)	LDHD(FT)	TOT HD(FT)
500.0	3.21	.03	.00	.25	.28
550.0	3.53	.04	.00	.30	.33

PIPE SEG NO 8 PIPE DIA(ID-IN) = 7.981

FLOW-GPM	VEL(FPS)	LHD(FT)	KHD(FT)	LDHD(FT)	TOT HD(FT)
1000.0	6.41	.19	.00	2.34	2.53
1100.0	7.05	.23	.00	2.81	3.04

PIPE SEG NO 9 PIPE DIA(ID-IN) = 7.981

FLOW-GPM	VEL(FPS)	LHD(FT)	KHD(FT)	LDHD(FT)	TOT HD(FT)
1000.0	6.41	.02	.00	.60	.61
1100.0	7.05	.02	.00	.72	.74

PIPE SEG NO 10 PIPE DIA(ID-IN) = 6.065

FLOW-GPM	VEL(FPS)	LHD(FT)	KHD(FT)	LDHD(FT)	TOT HD(FT)
500.0	5.55	.30	.00	1.06	1.36
550.0	6.11	.36	.00	1.28	1.64

PIPE SEG NO 11 PIPE DIA(ID-IN) = 7.981

FLOW-GPM	VEL(FPS)	LHD(FT)	KHD(FT)	LDHD(FT)	TOT HD(FT)
500.0	3.21	.06	.00	.14	.20
550.0	3.53	.08	.00	.17	.24

PIPE SEG NO 12 PIPE DIA(ID-IN) = 6.065

FLOW-GPM	VEL(FPS)	LHD(FT)	KHD(FT)	LDHD(FT)	TOT HD(FT)
500.0	5.55	.20	.10	.16	.47
550.0	6.11	.24	.13	.19	.56

PIPE SEG NO 13 PIPE DIA(ID-IN) = 6.065

FLOW-GPM	VEL(FPS)	LHD(FT)	KHD(FT)	LDHD(FT)	TOT HD(FT)
500.0	5.55	.15	.00	.90	1.05
550.0	6.11	.18	.00	1.09	1.26

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PIPE FRICTION CALCULATION DATA SHEETS

NESN § 61021AF
SHEET 8 OF 20
PLANT Cook
BY AC DATE 10/20/96

SYSTEM : RC. P = NPSH CALCULATION UNIT : 2

PIPE SEGMENT TO & FROM : FROM RWST TO SI PP TAKE-OFF

DWG . REF. : 2-SI-53 1 of 2 2-SI-6

FLUID TEMP (°F) : 100 PIPE ABS. ROUGHNESS (FT) : _____ PIPE SEGMENT NUMBER : 1

(1) DESIGN FLOW : 1 (2) MINIMUM FLOW : 1000 (3) MAXIMUM FLOW : 1300 (4) FLOW INCREMENT: 1000

(5) PIPE I.D. (IN) : 24"ϕ 13-14 2325 PIPE EL. : 611-3 TO EL. : 585-1 7/16"

STRAIGHT PIPE LENGTHS	FITTINGS	NUMBER	*K OR L/D	Σ K	Σ L/D
2'-6"					
46'-6"	GATE VALVE		13		
4.95'	GLOBE VALVE		340		
7'-7"	BUTTERFLY VALVE		40		
	SWING CHECK		135		
31'-0"	90° STD. ELBOW		30		
64'-0"	90° S.R. ELBOW		50		
59'-3"	90° L.R. ELBOW	5	20		100
2'-3 9/16"	45° STD. ELBOW	3	16		48
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		
	* " " WELL ROUND		0.04		
	* PIPE EXIT SHARP EDGE	1	1.0		
	* ORIFICE (C_D = .61)		2.69 RF/β⁴		
	* SUDDEN CONTRACTION +		.5(1-β²)		
	* SUDDEN INCREASE +		(1- β²)²		
	* VALVE, MISCELLANEOUS		891.4 d^4/C_v^2		
	MISC.				
TOTALS (6) 321.33				(7)	(8) 148

* ITEMS ARE "K" VALUES ONLY + BASED ON SMALLER PIPE DIAMETER

β = d/D RF = RECOVERY FACTOR

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PIPE FRICTION CALCULATION DATA SHEETS

NESW 961021AF
SHEET 9 OF 20
PLANT Cook
BY MC DATE 10/30/96

SYSTEM : CCP NPSH CALC. UNIT : 2

PIPE SEGMENT TO & FROM : FROM SI P.P. TARGET TO RWST RT

DWG . REF. : 2-SI-6

FLUID TEMP (°F) : _____ PIPE ABS. ROUGHNESS (FT) : _____ PIPE SEGMENT NUMBER : 5

(1) DESIGN FLOW : _____ (2) MINIMUM FLOW : 1000 (3) MAXIMUM FLOW : 17000 (4) FLOW INCREMENT : 1000

(5) PIPE I.D. (IN) : 24 Ø A-5 23.25" PIPE EL. : 585-1 7/16 TO EL. : 585-1 7/16

STRAIGHT PIPE LENGTHS	FITTINGS	NUMBER	*K OR L/D	Σ K	Σ L/D
6'-0	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	1	20		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/β^4		
	* SUDDEN CONTRACTION +		.5(1-β^2)		
	* SUDDEN INCREASE +		(1- β^2)^2		
	* VALVE, MISCELLANEOUS		891.4 d^4/C_v^2		
	MISC.				
TALS (6) 6				(7)	(8) 20

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

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PIPE FRICTION CALCULATION DATA SHEETS

NESM 961021AF
SHEET 10 OF 20
PLANT COOK
BY MF DATE 10/30/96

SYSTEM : CCP NON ESS. UNIT : 2

PIPE SEGMENT TO & FROM : FROM EAST RT TO REAR BRG THRUST

DWG . REF. : 2-SI-1

FLUID TEMP (°F) : _____ PIPE ABS. ROUGHNESS (FT) : _____ PIPE SEGMENT NUMBER : 3

(1) DESIGN FLOW : _____ (2) MINIMUM FLOW : 1000 (3) MAXIMUM FLOW : 17000 (4) FLOW INCREMENT : 1000

(5) PIPE I.D. (IN) : 24.0 x .14 23.25 PIPE EL. : 585'-7 1/2" TO EL. : 586'-7 1/2"

STRAIGHT PIPE LENGTHS	FITTINGS	NUMBER	*K OR L/D	Σ K	Σ L/D
7'-9 3/4"	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	1	20		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/β^4		
	* SUDDEN CONTRACTION +		.5(1-β^2)		
	* SUDDEN INCREASE +		(1- β^2)^2		
	* VALVE, MISCELLANEOUS		891.4 d^4/C_V^2		
	MISC.				
TOTALS (6) 7.81				(7)	(8) 20

* ITEMS ARE "K" VALUES ONLY

+ BASED ON SMALLER PIPE DIAMETER

β = d/D RF = RECOVERY FACTOR

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PIPE FRICTION CALCULATION DATA SHEETS

PLANT Comanche Peak
BY DC DATE 03/26/96

SYSTEM : CCP SUCTION UNIT : 2

PIPE SEGMENT TO & FROM : FROM PUMP TAIL PIPE TO CCP TAIL PIPE

DWG . REF. : 2-SI-6

FLUID TEMP (°F) : _____ PIPE ABS. ROUGHNESS (FT) : _____ PIPE SEGMENT NUMBER : 4

(1) DESIGN FLOW : _____ (2) MINIMUM FLOW : 1000 (3) MAXIMUM FLOW : 8000 (4) FLOW INCREMENT : 1000

(5) PIPE I.D. (IN) : 24 Std 23.25 PIPE EL. : 585-1 7/16 TO EL. : 582-1 7/16

STRAIGHT PIPE LENGTHS	FITTINGS	NUMBER	*K OR L/D	Σ K	Σ L/D
6'-4 1/4"					
	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	1	20		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/β^4		
	* SUDDEN CONTRACTION +		.5(1-β^2)		
	* SUDDEN INCREASE +		(1- β^2)^2		
	* VALVE, MISCELLANEOUS		891.4 d^4/C_V^2		
	MISC.				
(6) TALS 6.35				(7)	(8)

* ITEMS ARE "K" VALUES ONLY

+ BASED ON SMALLER PIPE DIAMETER

β = d/D RF = RECOVERY FACTOR

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PIPE FRICTION CALCULATION DATA SHEETS

DESN 9610 21 AF
SHEET 12 OF 20
PLANT COOK
BY AE DATE 10/28/96

SYSTEM : CCP NPSH UNIT : 2

PIPE SEGMENT TO & FROM : COOK CCP TRAIN B/D TO TEE (INU-910 911)

DWG . REF. : 2-ISI-6.2-SI-43

FLUID TEMP (°F) : _____ PIPE ABS. ROUGHNESS (FT) : _____ PIPE SEGMENT NUMBER : 5

① DESIGN FLOW : _____ ② MINIMUM FLOW : 100 ③ MAXIMUM FLOW : 1300 ④ FLOW INCREMENT : 100

⑤ PIPE I.D. (IN) : 80 A-3 7.981 PIPE EL. : 585 - 1 7/16 TO EL. : 583 - 6

STRAIGHT PIPE LENGTHS	FITTINGS	NUMBER	*K OR L/D	Σ K	Σ L/D
16"					
2'-9/16"	GATE VALVE		13		
10'-2"	GLOBE VALVE		340		
	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		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/β^4		
	* SUDDEN CONTRACTION +	8x24	.5(1-β^2)	.44	
	* SUDDEN INCREASE +		(1- β^2)^2		
	* VALVE, MISCELLANEOUS		891.4 d^4/C_v^2		
	MISC.				
TALS ⑥ 13.55				⑦ .44	⑧ 80

* ITEMS ARE "K" VALUES ONLY

+ BASED ON SMALLER PIPE DIAMETER

β = d/D , RF = RECOVERY FACTOR

Rev. 5/94

PIPE FRICTION CALCULATION DATA SHEETS

DESMG 1021AF
SHEET 13 OF 20
PLANT Cook
BY AF DATE 03/96

SYSTEM : CCP NOSH UNIT : 2

PIPE SEGMENT TO & FROM : FROM TCC TO TCC THRU 2MO-910

DWG . REF. : 2-SI-413

FLUID TEMP (°F) : _____ PIPE ABS. ROUGHNESS (FT) : _____ PIPE SEGMENT NUMBER : 6

(1) DESIGN FLOW : _____ (2) MINIMUM FLOW : 100 (3) MAXIMUM FLOW : 1300 (4) FLOW INCREMENT: 100

(5) PIPE I.D. (IN) : 30 A-3 7.981 PIPE EL. : 585-6 TO EL. : 585-6

STRAIGHT PIPE LENGTHS	FITTINGS	NUMBER	*K OR L/D	Σ K	Σ L/D
15'-1" 16" 12" 3'-6"	GATE VALVE 2MO-910		13		13
	GLOBE VALVE		340		
	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		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-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/β^4		
	* SUDDEN CONTRACTION +		.5(1-β^2)		
	* SUDDEN INCREASE +		(1- β^2)^2		
	* VALVE, MISCELLANEOUS		891.4 d^4/C_V^2		
	MISC.				
TOTALS (6) 8				(7)	(8) 53

* ITEMS ARE "K" VALUES ONLY

+ BASED ON SMALLER PIPE DIAMETER

β = d/D RF = RECOVERY FACTOR

Rev. 5/94

PIPE FRICTION CALCULATION DATA SHEETS

NSSN 9610 21 AF
SHEET 14 OF 20
PLANT Catawba
BY LC DATE 01/30/96

SYSTEM : CCP NPSH CALC UNIT : 2

PIPE SEGMENT TO & FROM : FROM TEE IN TO CV THRU 2CH-911

DWG . REF. : 2-SS-43

FLUID TEMP (°F) : ___ PIPE ABS. ROUGHNESS (FT) : ___ PIPE SEGMENT NUMBER : 7

(1) DESIGN FLOW : ___ (2) MINIMUM FLOW : 100 (3) MAXIMUM FLOW : 1300 (4) FLOW INCREMENT : 100

(5) PIPE I.D. (IN) : SCH 40 - 3 7.981 PIPE EL. : 588-6 TO EL. : 588-6

STRAIGHT PIPE LENGTHS	FITTINGS	NUMBER	*K OR L/D	Σ K	Σ L/D
4-6 12" 16⅝" 18"	GATE VALVE 2CH-911		13		13
	GLOBE VALVE		340		
	BUTTERFLY VALVE		40		
	SWING CHECK		135		
	90° STD. ELBOW		30		
	90° S.R. ELBOW		50		
	90° L.R. ELBOW	/	20		70
	45° STD. ELBOW		16		
	45° S.R. ELBOW		26		
	180° CLOSE RETURN		50		
	STD. TEE RUN		20		60
	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/β^4		
	* SUDDEN CONTRACTION +		.5(1-β^2)		
	* SUDDEN INCREASE +		(1- β^2)^2		
	* VALVE, MISCELLANEOUS		891.4 d^4/C_v^2		
	MISC.				
TALS (6) 8				(7)	(8) 93

* ITEMS ARE "K" VALUES ONLY + BASED ON SMALLER PIPE DIAMETER

β = d/D RF = RECOVERY FACTOR

Rev. 5/94

PIPE FRICTION CALCULATION DATA SHEETS

NESW 9610 21MC
SHEET 15 OF 20
PLANT Comc
BY AF DATE 10/30/96

SYSTEM : CCP NPSH UNIT : 2

E SEGMENT TO & FROM : FROM TEE TO TEE

DWG . REF. : 2-ST-43 2-CS-79

FLUID TEMP (°F) : ______ PIPE ABS. ROUGHNESS (FT) : ______ PIPE SEGMENT NUMBER : 8

(1) DESIGN FLOW : ______ (2) MINIMUM FLOW : 100 (3) MAXIMUM FLOW : 1300 (4) FLOW INCREMENT: 100

(5) PIPE I.D. (IN) : 8Φ A-3 7.981 PIPE EL. : 588-6 TO EL. : 596-4 5/16

STRAIGHT PIPE LENGTHS	FITTINGS	NUMBER	*K OR L/D	Σ K	Σ L/D
19"					
	GATE VALVE		13		
7'-10 5/16	GLOBE VALVE		340		
2'	BUTTERFLY VALVE		40		
16"	SWING CHECK 15-C 80&CS		135		135
	90° STD. ELBOW		30		
	90° S.R. ELBOW		50		
	90° L.R. ELBOW	1	20		20
	45° STD. ELBOW		16		
	45° S.R. ELBOW		26		
	180° CLOSE RETURN		50		
	STD. TEE RUN	1	20		20
	STD. TEE BRANCH	1	60		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 EDGE		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.				
ALS (6) 12.94				(7)	(8) 235

* ITEMS ARE "K" VALUES ONLY

+ BASED ON SMALLER PIPE DIAMETER

β = d/D RF = RECOVERY FACTOR

Rev. 5/94

PIPE FRICTION CALCULATION DATA SHEETS

VBM 960102 IAP
SHEET 16 OF 20
PLANT Cook
BY SC DATE 10/30/96

SYSTEM : CCP NOS 4 UNIT : 2

PIPE SEGMENT TO & FROM : FROM TEE TO "E" CCP TAKE OFF

DWG . REF. : 2-CS-79

FLUID TEMP (°F) : _____ PIPE ABS. ROUGHNESS (FT) : _____ PIPE SEGMENT NUMBER : 9

(1) DESIGN FLOW : _____ (2) MINIMUM FLOW : 100 (3) MAXIMUM FLOW : 1300 (4) FLOW INCREMENT : 100

(5) PIPE I.D. (IN) : SCH S-3 7.981 PIPE EL. : 596-4 5/16 TO EL. : 596-4 5/16

STRAIGHT PIPE LENGTHS	FITTINGS	NUMBER	*K OR L/D	Σ K	Σ L/D
14"					
	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	1	60		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/β^4		
	* SUDDEN CONTRACTION +		.5(1-β^2)		
	* SUDDEN INCREASE +		(1- β^2)^2		
	* VALVE, MISCELLANEOUS		891.4 d^4/C_V^2		
	MISC.				
TOTALS (6) 1.2				(7)	(8) 60

* ITEMS ARE "K" VALUES ONLY

+ BASED ON SMALLER PIPE DIAMETER

β = d/D RF = RECOVERY FACTOR

Rev. 5/94

NSSmQ61021AC
SHEET 17 OF 20
PLANT Cook
BY [illegible] DATE 10/30/96

PIPE FRICTION CALCULATION DATA SHEETS

SYSTEM : CCP NPSH   UNIT : 2

PIPE SEGMENT TO & FROM : FROM "E" CCP TAKEOFF TO "E" CCP SUCTION

DWG . REF. : 2-CS-79 , 2-CS-80

FLUID TEMP (°F) : ______ PIPE ABS. ROUGHNESS (FT) : ______ PIPE SEGMENT NUMBER : 10

(1) DESIGN FLOW : ______ (2) MINIMUM FLOW : 100 (3) MAXIMUM FLOW : 700 (4) FLOW INCREMENT: 100

(5) PIPE I.D. (IN) : 6"Ø S-1? 6.065   PIPE EL. : 596-4 5/16 TO EL. : 592-6

STRAIGHT PIPE LENGTHS	FITTINGS	NUMBER	*K OR L/D	Σ K	Σ L/D
10.3"	GATE VALVE 15650655		13		13
5' 10 13/16"	GLOBE VALVE		340		
6'-5"	BUTTERFLY VALVE		40		
4.8'	SWING CHECK		135		
12 5/8"	90° STD. ELBOW		30		
	90° S.R. ELBOW		50		
	90° L.R. ELBOW	3	20		60
	45° STD. ELBOW		16		
	45° S.R. ELBOW		26		
	180° CLOSE RETURN		50		
	STD. TEE RUN		20		
	STD. TEE BRANCH	1	60		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 EDGE		1.0		
	* ORIFICE (C_D = .61)		2.69 RF/β^4		
	* SUDDEN CONTRACTION +		$.5(1-\beta^2)$		
	* SUDDEN INCREASE +		$(1-\beta^2)^2$		
	* VALVE, MISCELLANEOUS		$891.4\ d^4/C_v^2$		
	MISC.				
TOTALS (6) 19				(7)	(8) 133

* ITEMS ARE "K" VALUES ONLY

+ BASED ON SMALLER PIPE DIAMETER

β = d/D   RF = RECOVERY FACTOR

Rev. 5/94

PIPE FRICTION CALCULATION DATA SHEETS

NESU 961021 AF
SHEET 18 OF 20
PLANT COOK
BY AFC DATE 10/30/96

SYSTEM : CCP-05 UNIT : 2

PIPE SEGMENT TO & FROM : FROM "S" CCP TAKEOFF TO UNIT

DWG. REF. : 2-CS-79

FLUID TEMP (°F) : _____ PIPE ABS. ROUGHNESS (FT) : _____ PIPE SEGMENT NUMBER : 15

(1) DESIGN FLOW : _____ (2) MINIMUM FLOW : 100 (3) MAXIMUM FLOW : 700 (4) FLOW INCREMENT : 100

(5) PIPE I.D. (IN) : 8d A-3 7.981 PIPE EL. : 596-4 5/16 TO EL. : 596-9 5/16

STRAIGHT PIPE LENGTHS	FITTINGS	NUMBER	*K OR L/D	Σ K	Σ L/D
15'-11 1/2"	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	2	16		32
	45° S.R. ELBOW		26		
	180° CLOSE RETURN		50		
	STD. TEE RUN	1	20		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/β⁴		
	* SUDDEN CONTRACTION +		.5(1-β²)		
	* SUDDEN INCREASE +		(1- β²)²		
	* VALVE, MISCELLANEOUS		891.4 d^4/C_V^2		
	MISC.				
(6) 15.96				(7)	(8) 52

TOTALS

* ITEMS ARE "K" VALUES ONLY

+ BASED ON SMALLER PIPE DIAMETER

β = d/D RF = RECOVERY FACTOR

Rev. 5/94

PIPE FRICTION CALCULATION DATA SHEETS

NSSM-66021AF
SHEET 19 OF 20
PLANT Cook
BY MF DATE 4/3/96

SYSTEM: CCP NPSH UNIT: 2

PIPE SEGMENT TO & FROM: FROM UNIT 2 TIE TO 'W' CCP SUCTION

DWG. REF.: 2-CC-79

FLUID TEMP (°F): _____ PIPE ABS. ROUGHNESS (FT): _____ PIPE SEGMENT NUMBER: 18

(1) DESIGN FLOW: _____ (2) MINIMUM FLOW: 100 (3) MAXIMUM FLOW: 700 (4) FLOW INCREMENT: 100

(5) PIPE I.D. (IN): Cd. A-3 6.065 PIPE EL.: 596-4 5/16 TO EL.: 597- 5/16

STRAIGHT PIPE LENGTHS	FITTINGS	NUMBER	*K OR L/D	Σ K	Σ L/D
2'-2½"	GATE VALVE		13		
10'-6"	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	1	20		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/β⁴		
	* SUDDEN CONTRACTION + 6"		.5(1-β²)	.2188	
	* SUDDEN INCREASE +		(1- β²)²		
	* VALVE, MISCELLANEOUS		891.4 d^4/C_V^2		
	MISC.				
TALS (6) 12.71				(7) .2188	(8) 20

* ITEMS ARE "K" VALUES ONLY

+ BASED ON SMALLER PIPE DIAMETER

β = d/D RF = RECOVERY FACTOR

Rev. 5/94

PIPE FRICTION CALCULATION DATA SHEETS

DESM9610 21 AF
SHEET 20 OF 20
PLANT Ccnc
BY AC DATE 4/3/96

SYSTEM : CCP NPSH UNIT : 2

PIPE SEGMENT TO & FROM : FROM 'N' CCP TO CORE TO W CCP SUCTION

DWG. REF. : 2-CS-79 2-CS-81

FLUID TEMP (°F) : _____ PIPE ABS. ROUGHNESS (FT) : _____ PIPE SEGMENT NUMBER : ~~12~~ 13

(1) DESIGN FLOW : _____ (2) MINIMUM FLOW : 100 (3) MAXIMUM FLOW : 700 (4) FLOW INCREMENT : 100

(5) PIPE I.D. (IN) : 60 A-3 6.065" PIPE EL. : 597.5/12 TO EL. : 592-6

STRAIGHT PIPE LENGTHS	FITTINGS	NUMBER	*K OR L/D	Σ K	Σ L/D
3'-6"					
4.12	GATE VALVE 12" 6,13 25 S.		13		13
12 5/12	GLOBE VALVE		340		
	BUTTERFLY VALVE		40		
	SWING CHECK		135		
	90° STD. ELBOW		30		
	90° S.R. ELBOW		50		
	90° L.R. ELBOW	2	20		40
	45° STD. ELBOW		16		
	45° S.R. ELBOW		26		
	180° CLOSE RETURN		50		
	STD. TEE RUN		20		
	STD. TEE BRANCH	1	60		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/β^4		
	* SUDDEN CONTRACTION +		.5(1-β^2)		
	* SUDDEN INCREASE +		(1- β^2)^2		
	* VALVE, MISCELLANEOUS		891.4 d^4/C_v^2		
	MISC.				
(6) 0.35				(7)	(8) 113

* ITEMS ARE "K" VALUES ONLY + BASED ON SMALLER PIPE DIAMETER

β = d/D RF = RECOVERY FACTOR

NE-015
(02/95)

DONALD C. COOK NUCLEAR PLANT

NESM _____ Section

DESIGN VERIFICATION CHECKLIST - CALCULATIONS

Calculation Number NESM961021AF Rev. 0

John J. Ribek 11/27/96
Signature of Verifier Date

1.0 Were the inputs correctly selected, incorporated and documented into the calculation? Yes V N/A ___

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

2.0 Are assumptions necessary to perform the calculation adequately described and reasonable? Yes V N/A ___

Basis: The assumptions are appropriate and their basis is well defined.

3.0 Are the applicable codes, standards and regulatory requirements identified and requirements for design met? Yes ___ N/A V

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

4.0 Was an appropriate design method used? Yes ___ N/A V

Basis: This is not a design process

5.0 Is the output reasonable compared to input? Yes V N/A ___

Basis: The outputs are consistent w/the inputs.

6.0 Are the results numerically correct? Yes V N/A ___

Basis: Arithmetic check of inputs and calc.