ATTACHMENT 5

CALCULATION OF BREAK FLOW DURING POSTULATED ALTERNATE HIGH-HEAD RECIRCULATION

CONSOLIDATED EDISON COMPANY OF NEW YORK,
INDIAN POINT UNIT NO. 2
DOCKET NO. 50-247
JANUARY, 1997

CON EDISON CALCULATION / ANALYSIS
COVER SHEET

12/27/96

Calculation Number: FPX-00139-00
Entry Date: 12/24/96

Type: CA34
PIPE FLOW

Project Number: NONE
Document Page : 8
Old Calculation:

Modification: NONE
Scanned: N
Revision:

Title MAXIMUM FLOW THROUGH LINE #183 (HIGH HEAD RECIRC)

Drawings
9321-2580

Component Type	Component Description
PIPE	PIPE

Component Style	Style Description
PIPE	PIPE OR PIPING

System	Description
SIS	SAFETY INJECTION

Structure	Description
PAB	PRIMARY AUXILIARY BUILDING

Preparer: KIMBALL
Signature: [signature]

Update Date
12/27/96

Reviewer: SHALABI
Signature/Date: [signature] / 12/30/96

Approval/Date [signature] / 12/30/96

Confirm. Required? NO

Concurrence (If Required)

CON EDISON CALCULATION/ANALYSIS

Description of Change Sheet

Calculation No: FPX-00139-00

Revision No.	Description of Change	Reason for Change
00	ORIGINAL ISSUE	

CON EDISON CALCULATION/ ANALYSIS SUMMARY SHEET	CALCULATION NO FPX-00139-00	REV 00	PAGE 3 OF 8
PREPARER/DATE I. Kimball 12/30/96	REVIEWER/DATE K. Shalabi 12/30/96		CLASS A
SUBJECT/TITLE Maximum Flow Rate Through Line #183.			PROJECT NO
			MOD NO N/A REV

OBJECTIVE OF CALCULATION

The objective of this calculation is to determine the maximum flow rate through line #183 for the following scenario:
A total loss of all the weld around the first elbow on line #183 off line #155 for the high head recirc mode.

CALCULATION METHOD/ASSUMPTIONS

An analytical flow vs. head loss calculation is made using Cameron Hydraulic Data methods.

1. Because of the low flow calculated for the small leak area, only the losses associated with the flow within the elbow/pipe joint will be considered.
2. The calculation assumes a conservative value for pressure at the elbow by not including any system friction losses .
3. The differences in density and viscosity of pure water and 2000 ppm borated water are assumed to have no effect on the flow.

DESIGN BASIS AND REFERENCES

The design basis is not applicable for this calculation.

1. Cameron Hydraulic Data, 1977.
2. Piping Handbook, Crocker & King, 5th Edition.

CONCLUSIONS

The calculated flow for loss of all weld is **0.75 gpm**.

Calculate maximum flow rate through 2" line #183 for loss of all weld around elbow.
(See Figure #1, page 8)

Use $h_l = K\ V^2/2g$ for the areas along the flow path (i.e. at the entrance, the "reducing elbow," and exit) — Ref. 1, p. 3-102

and $h_l = 0.002083L\ (100/C)^{1.85} q^{1.85}/d^{4.8655}$ for the friction loss along the area inside of the elbow, — Ref. 1, p. 3-7

where,
h_l = head loss, in feet,
K = friction coefficient for losses at piping anomolies,
V = velocity of flow, in ft/sec,
g = acceleration of gravity, in ft/sec^2
L = length of pipe, in feet
C = roughness constant for type of pipe
q = flow, in gpm
d = diameter of pipe.

So, for our case, in the direction of the flow,
$h_l = K_{ent}\ V_{ent}^2/2g + K_{elb}\ V_{ent}^2/2g + K_{red}\ V_{ent}^2/2g + 0.002083L\ (100/C)^{1.85} q^{1.85}/d^{4.8655} + K_{exit}\ V_{exit}^2/2g.$

Combining,
$h_l = (K_{ent} + K_{elb} + K_{red})\ V_{ent}^2/2g + 0.002083L\ (100/C)^{1.85} q^{1.85}/d^{4.8655} + K_{exit}\ V_{exit}^2/2g.$ (Eq. 1)

Use,
$K_{ent} = 0.5$, — Ref. 1, p. 3-108
$K_{elb} = 0.81$, — Ref. 1, p. 3-104
$K_{red} = 0.5(1 - d_{H1}^2/d_{H2}^2)$,)(Eq. 2) — Ref. 1, p. 3-109
and,
$K_{exit} = 1$. — Ref. 1, p. 3-108

Since we are actually dealing with an annular space essentially between to different diameter pipes, we want to use the hydraulic diameter, D_h, to calculate the equivalent pipe diameter for the loss of weld area (i.e. d, from Eq. 1). And since we know that,

$D_h = 4\ R_h$,
and
R_h = Area/Wetted Perimeter
$= \pi/4\ (d_2^2 - d_1^2)/\pi(d_2 + d_1)$
$= (d_2 + d_1)(d_2 - d_1)/4(d_2 + d_1)$
$= (d_2 - d_1)/4$,

where, d_2 = 2.416" for the inside diameter of the 2" elbow, and d_1 = 2.375" for the outside diameter of the 2" pipe.
So, the hydraulic diameter,
$D_h = 4\ R_h$
$= 4\ (d_2 - d_1)/4$
$= d_2 - d_1$
= 2.416 - 2.375" Ref. 2, p. 7-48,49
= 0.041", or 0.00342 ft
$= d = d_{H1}$
This value will be used for d in Eq. 1 for the friction loss of the flow between the pipe and elbow.

For Eq. 2, since this is effectively a sudden contraction from the annulus area between the end of the 2" pipe and the butt of the elbow insert (defined by welding procedures as 1/16") to the annulus between the pipe OD and elbow ID, we can use the two hydraulic diameters for this calculation. Although the 1/16" gap is not oriented properly to be able to use a large and small radius/diameter, it can be closely approximated by using the value similar to that just calculated. That is, (see Fig. #1) since the space between the pipe OD and elbow ID and the gap are similar,
then we can say,
$(d_2 - d_1)/2$ = 1/16", or
$d_2 - d_1$ = 1/8"
= 0.125", or 0.01042 ft
$= d_{H2}$

So, for Eq. 2,

$K_{red} = 0.5(1 - d_{H1}^2/d_{H2}^2)$
$= 0.5(1 - 0.041^2/.125^2)$
$= 0.5(1 - 0.1076) = 0.5(0.8924)$
$= 0.4462.$

Which gives us for Eq. 1,

$h_l = (K_{ent} + K_{elb} + K_{red})\, V_{ent}^2/2g + 0.002083L\,(100/C)^{1.85} q^{1.85}/\, d_{H1}^{4.8655} + K_{exit}\, V_{exit}^2/2g$
$h_l \quad (0.5 + 0.81 + 0.4462)\, V_{ent}^2/2g + 0.002083L\,(100/C)^{1.85} q^{1.85}/\, d_{H1}^{4.8655} + (1)\, V_{exit}^2/2g.$
$\quad 1.7562\, V_{ent}^2/2g + 0.002083L\,(100/C)^{1.85} q^{1.85}/\, d_{H1}^{4.8655} + V_{exit}^2/2g.$ (Eq. 3)

Now, for the velocity of the flow at the entrance and exit, we can use

$V \quad 0.4085q/d_H^2$ (Eq. 4)

where,

d_H = the hydraulic diameter for that portion of the "pipe."

So, by substituting Eq. 4 into Eq. 3 for each V, we get,

$h_l = 1.7562\,(0.4085q/d_{H2}^2)^2/2g + 0.002083L\,(100/C)^{1.85} q^{1.85}/\, d_{H1}^{4.8655} + (0.4085q/d_{H1}^2)^2/2g$
$= 1.7562\,[(0.4085)^2 q^2/d_{H2}^4]/2g + 0.002083L\,(100/C)^{1.85} q^{1.85}/\, d_{H1}^{4.8655} + [(0.4085)^2 q^2/d_{H1}^4]/2g$
$= 1.7562\,(0.1669)q^2/[(0.125^4)2(32.174)] + 0.002083L\,(100/C)^{1.85} q^{1.85}/\, d_{H1}^{4.8655} +$
$\quad (0.1669)q^2/[(0.041^4)2(32.174)]$
$\quad 18.76\, q^2 + 0.002083L\,(100/C)^{1.85} q^{1.85}/\, d_{H1}^{4.8655} + 923\, q^2.$

From Fig. #1,

$L = (5/8" - 1/16")/12$
$= (0.625 - .0625)/12$
$\quad (0.5625)/12 = 0.04688'.$

Since this is not new piping, use C = 100. Ref. 1, p. 3-8

So,

$h_l = 18.76\, q^2 + 0.002083L\,(100/C)^{1.85} q^{1.85}/\, d_{H1}^{4.8655} + 923\, q^2.$
$= 18.76\, q^2 + 0.002083(0.04688) q^{1.85}/\,(0.041)^{4.8655} + 923\, q^2$
$\quad 18.76\, q^2 + 548.5\, q^{1.85} + 923\, q^2$
$= 941.8\, q^2 + 548.5\, q^{1.85}.$

Since the shut-off head for the RHR Pumps is 150 lbs,
assume pressure inside the VC is 50 lbs, and
because the pipe is located higher than the full sump (77' - 51'),
we can conservatively say h_L = RHR Pump discharge pressure + Maximum VC Pressure + Elevation differences,

or h_L = 150 lbs + 52 lbs + (51' - 77')
= 202 lbs - 26'
= 202 (2.46) -26
= 497 -26 = 471

Which gives us the following:

$$471 = 941.8\, q^2 + 548.5\, q^{1.85}.$$

However, the Hazen and Williams formula for friction loss assumes water at 60°F. As noted in the reference, the friction for water can decrease as much as 40% between 32 and 212°F. Thus, to account for the increased temperature of the water in our case (260°F), — Ref. 1, p. 3-7

(260 60)/(212-32) x 40% =
200/180 x 0.4 =
0.444, say 44.4%.

So,

$$466 = (1.00-0.444)\,(941.8\, q^2 + 548.5\, q^{1.85})$$
$$466 = 523.64\, q^2 + 304.97\, q^{1.85}$$

Substituting for q by trial and error, we get

q = 0.7388 gpm, say **0.75 gpm.**

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SUBJECT/TITLE Maximum Flow Rate Through Line #183.			PROJECT NO
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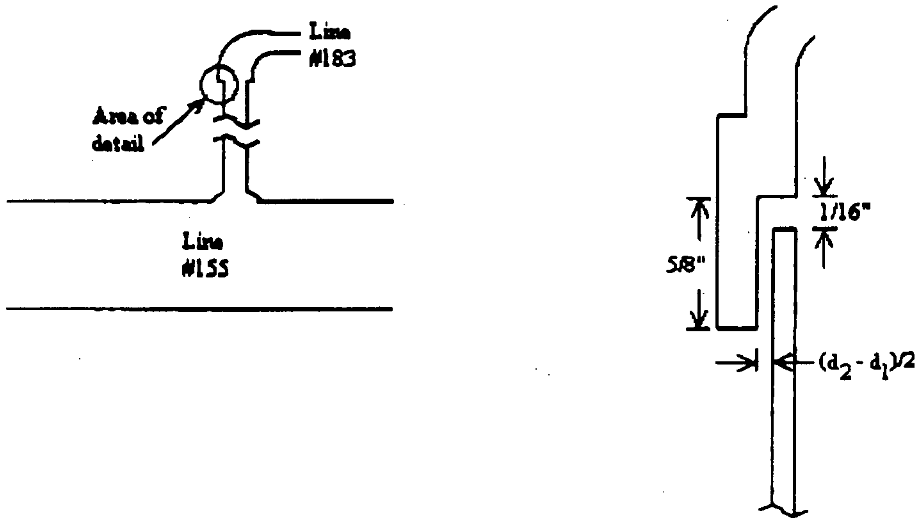

Figure #1

ATTACHMENT 6

ELBOW RESTRAINT

CONSOLIDATED EDISON COMPANY OF NEW YORK,
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DOCKET NO. 50-247
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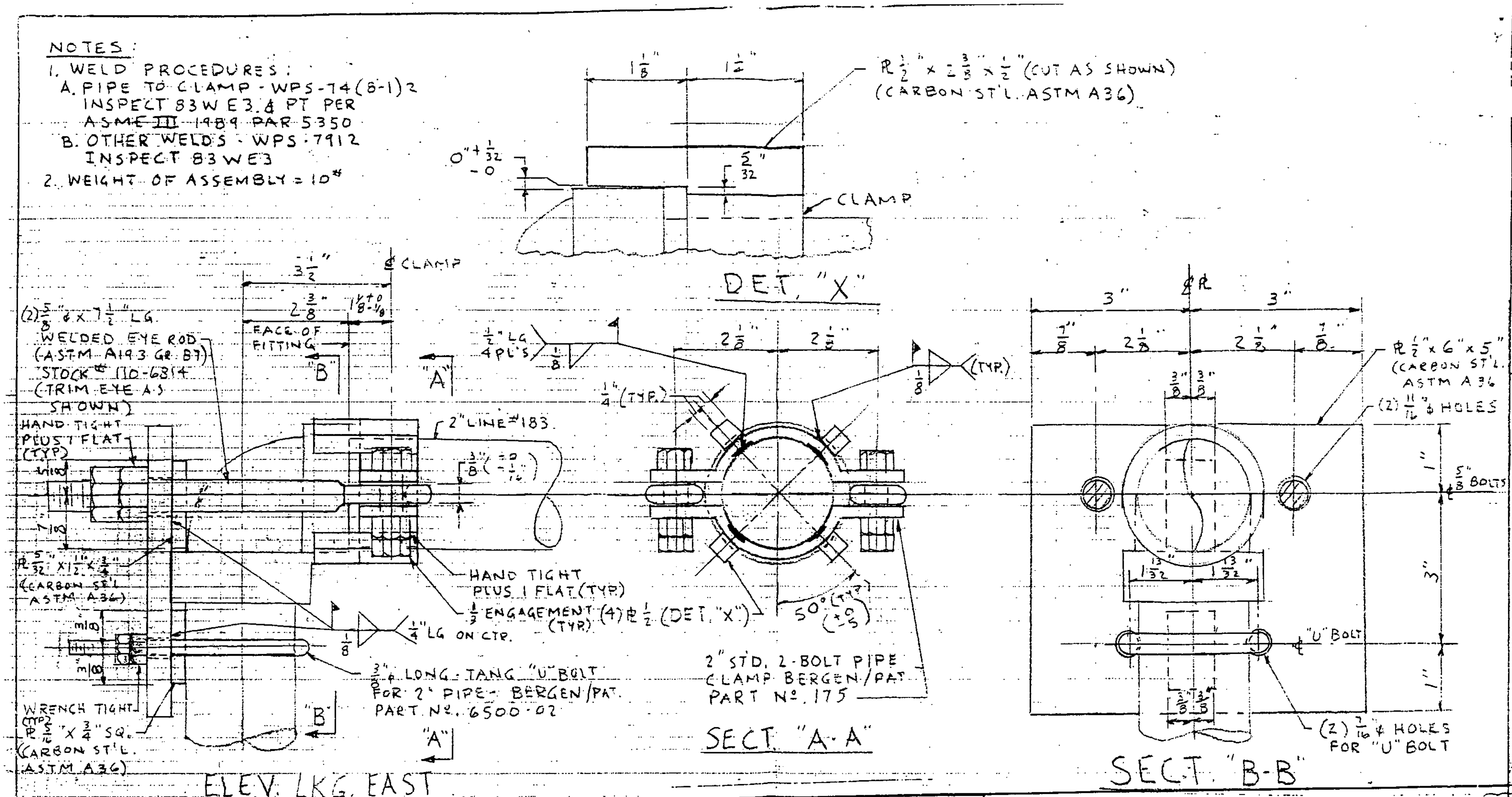

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NONE — MOD. PROC.

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				R-00 12/23/96	R-00 12/23/96	THIS REVISION IS CLASS "A" PER CI-240-1 RELEASE FOR CONSTRUCTION P.N.: NONE
	REVIEW		APPROVALS			RECORDED

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