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July 26,1985

In reply, please
refer to LAC-11053

DOCKET NO. 50-409

U. S. Regulatory Commission
Attn. Mr. John Zwolinski, Chief
Operating Reactor Branch #5
Division of Nuclear Reactors
Washington, DC 20555

SUBJECT: DAIRYLAND POWER COOPERATIVE
LA CROSSE BOILING WATER REACTOR (LACBWR)
SEP TOPIC III.5.A
EFFECTS OF PIPE BREAK ON STRUCTURES,
SYSTEMS AND COMPONENTS INSIDE CONTAINMENT

REFERENCE: (1) Telecon of December 19, 1985,[4]
Ilene McKenna to Christians

Gentlemen:

Your request for additional information (Reference 1) on SEP Topic III.5.a, specifically, jet impingement effects on the HPCS suction line, has been reviewed. Enclosed is the evaluation of the worst case scenario for jet impingement on the HPCS suction line. During this evaluation, it was found that, although the HPCS suction line proper would not be adversely affected by any postulated jet impingement, two branch lines attached to HPCS suction line are routed unacceptably close to the main steam line to shutdown condenser. These branches are the 2 inch line that supplies emergency makeup water to the seal injection system and the 2 inch line that provides for rejecting primary water from the purification system to the overhead storage tank. A steam jet induced failure in either of these pipes could cause water to be diverted from the HPCS system. DPC will prepare a facility change to re-route the 2 branch lines to a location that will eliminate them as a potential problem. When this is accomplished, the most limiting case scenario appears to be a break in the high energy portion of the ACS line at the point of minimum separation between ACS and HPCS. This is the scenario analyzed in the enclosure to this letter. By demonstrating that no adverse consequences can be expected for this most limiting case,jet impurgement concerns for other locations can be dispatched easily using geometrical or effects type arguments using the analyzed case as a basis.

A035
1/1

If you have any questions, or if we can be of further assistance, please call.

Very truly yours,

DAIRYLAND POWER COOPERATIVE

James W. Taylor
General Manager

JWT:REC:sks
Enclosure

cc: James G.Keppler, Region III
NRC Resident Inspector
Walter Paulson, LACBWR Project Manager

EVALUATION OF JET IMPINGEMENT
EFFECTS ON HPCS SUCTION LINE
DUE TO BREAK IN ADJACENT
ACS LINE

ASSUMPTIONS

- a break occurs in the high energy portion of the ACS line
- break occurs at point of minimum separation between the two lines
- steam jet impinges directly on the HPCS line, i.e., the jet axis is normal to the pipe axis
- steady state thrust is considered for reactor pressure = 1265 psia.
- drag coefficient C_D for HPCS pipe = 1.5
- jet load on pipe is considered to be a concentrated load
- a dynamic load factor of 2 is applied in the determination of load on the pipe to account for sudden loading.

RESULTS

- pipe thrust load on HPCS line - 2606 lbs.
- maximum bending stress - 26.75 ksi
- allowable stress per ASME Code, Section III Subsection NB, for Level A Service Limits = 1.55_m = 30 ksi
- therefore, stress from applied thrust less than allowable stress

HPCS JET IMPINGEMENT THRUSTLOADS

JET THRUST LOAD ON
HIGH PRESSURE CORE SPRAY
SUCTION LINE DUE TO BREAK IN ACS LINE

1. STATEMENT OF PROBLEM -

   Determine the load on the HPCS suction line due to jet impingement from a postulated break in the adjacent high energy section of the alternate core spray line.

2. ASSUMPTIONS -

   2.1 One dimensional, steady-flow

   2.2 Steam behaves as ideal gas with specific heat ration $k = 1.3$

   2.3 Assumed break is a circular break with flow area = transverse flow area of ACS pipe.

   2.4 Results steam jet is oriented such that it impinges directly on the HPCS line (axis of steam jet normal to axis of HPCS pipe.

   2.5 The drag coefficient for the immersed pipe (cylinder) is conservatively taken to be $C_D = 1.5$ (Perry's chem. engr. hdbk, 5th Edition, Page 5-62)

REF.

STEADY-STATE THRUST NORMAL TO PLANE OF BREAK

$$T = A_B\left(P_B + \frac{\rho V_B^2}{g_c}\right) \quad \text{Eq. (1)}$$

where A_B = break flow area
P_B = pressure at break opening
V_B = average velocity across break opening
ρ = density

FOR SATURATED STEAM, ASSUMING CHOKED FLOW, CRITICAL EXIT VELOCITY = $V_B = \sqrt{kRTg_c}$

$$T = A_B(1+k)P_B \quad \text{Eq. (2)}$$

SINCE CRITICAL FLOW CONDITIONS EXIST AT EXIT

$$P_E/P_0 = \left[2/(k+1)\right]^{k/k-1} \quad \text{Eq. (3)}$$

COMBINING EQUS (2) & (3)

$$T = P_0 A_B (1+k)\left[2/(k+1)\right]^{k/(k-1)}$$

$$\underline{T = 1.26\ P_0 A} \quad (\text{using } k = 1.3) \quad \text{Eq. (4)}$$

THE LOAD ON OBJECTS SUBMERGED IN FLUID WITH VELOCITY V

$$F = \frac{C_D}{2} \frac{\rho V_B^2}{g_c} A_P \quad \text{Eq. (5)}$$

REF

Solving for $\rho \frac{V_B^2}{g_c}$ in (1) yields:

$$\rho \frac{V_B^2}{g_c} = \frac{(T - P_B A_B)}{A_B}$$

However, at the target location, $V_T = V_B \frac{A_B}{A_j}$ where A_j is the cross-sectional area of the steam jet at the target

$$\therefore \rho \frac{V_T^2}{g_c} = \rho \frac{V_B^2}{g_c} \frac{A_B^2}{A_j^2} = \frac{T - P_B A_B}{A_B} \frac{A_B^2}{A_j^2}$$

Substituting in Eq. (5)

$$F = \frac{C_D}{2} (T - P_B A_B) \frac{A_B A_P}{A_j^2}$$

Since $P_B = P_0 [2/(k+1)]^{k/k-1}$, $k = 1.3$

and $T = 1.26 P_0 A_B$

$$\Rightarrow F = \frac{C_D}{2} (1.26 P_0 A_B - 0.546 P_0 A_B) \frac{A_P}{A_j} \frac{A_B}{A_j}$$

$$F = \frac{C_D}{2} (.714 P_0 A_B) \frac{A_P}{A_j} \frac{A_B}{A_j} \quad \text{or} \qquad \text{Eq (6)}$$

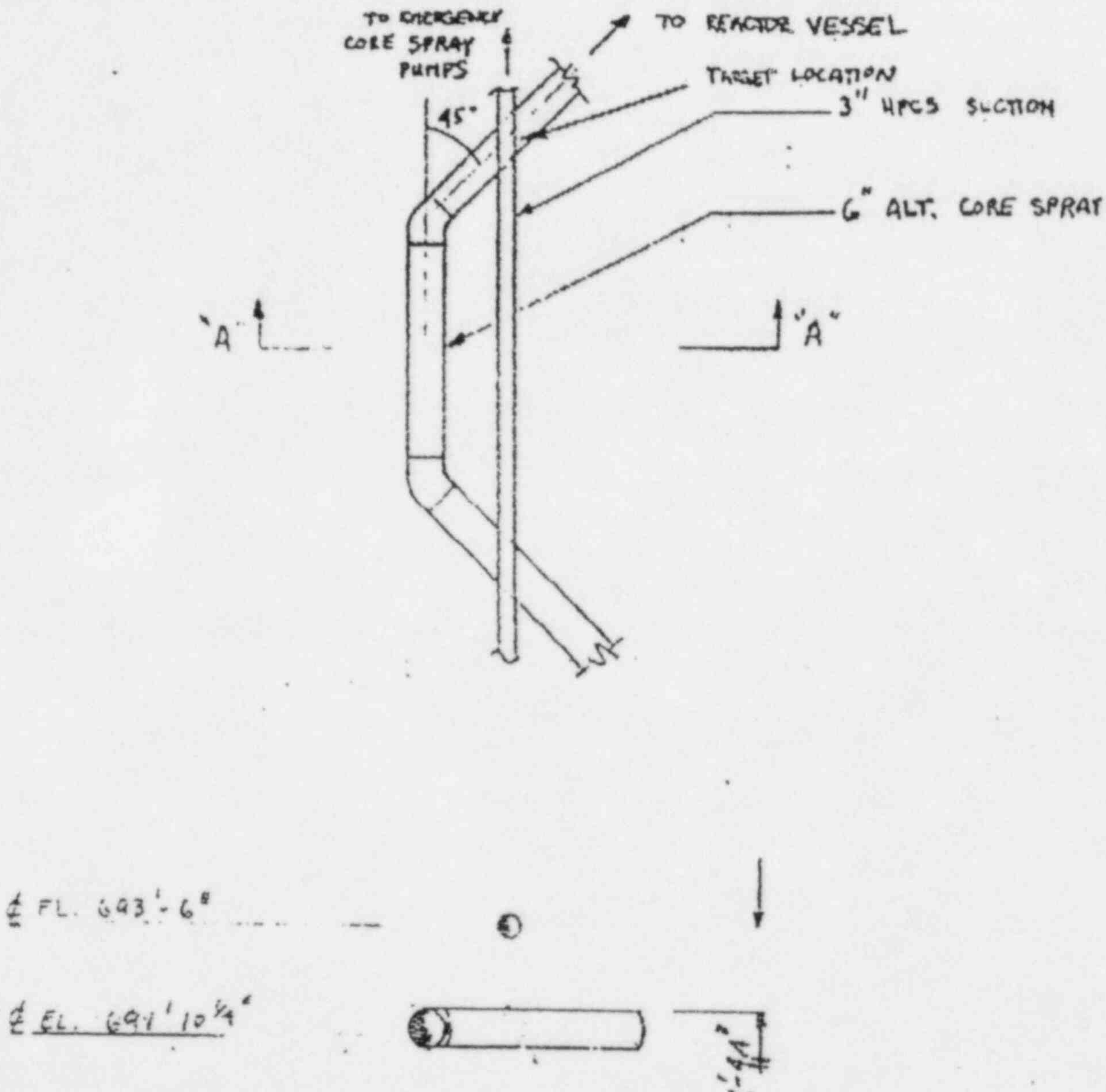
$$F = \frac{C_D}{2} (.567 T) \frac{A_P}{A_j} \frac{A_B}{A_j}$$

By modifying this formula to account for the load being suddenly applied, using a dynamic load factor of 2, we have:

$$F = 2 (C_D/2)(.567 T) \frac{A_P}{A_j} \frac{A_B}{A_j} \qquad \text{Eq (7)}$$

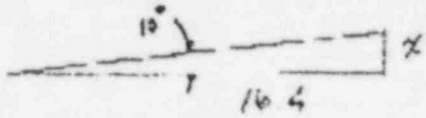
PIPING ARRANGMENT, PARTIAL PLAN AT ELEVATION 684'-0"

REF. 3



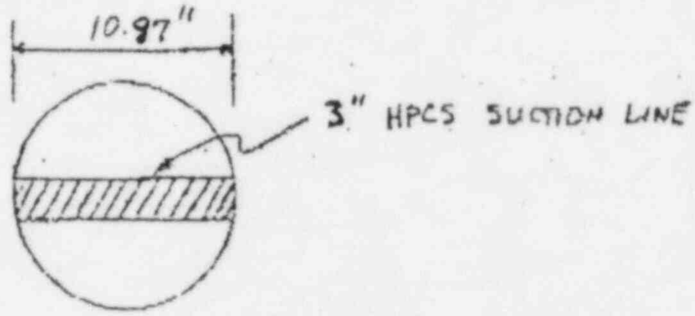
SECTION "A-A"

	REF
Initial jet area = inside transverse area of 6" schedule 160 pipe = 21.15 in^2 (d = 5.189 in)	
At target location, assuming 10° half-angle expansion	4



$16.4 \tan 10° = x = 2.89$

$\therefore A_j$ at target $= [5.189 + 2(2.89)]^2 \frac{\pi}{4} = \underline{\underline{94.5\ in^2}}$



$A_p \approx 3.5'(10.97") = 38.4\ in^2$

From Eq ⑥, applying a DLF = 2

$$F = \frac{2\times1.5}{2}(.74)(1265)(21.15)\left(\frac{38.4}{94.5}\right)\left(\frac{21.15}{94.5}\right)$$

$F = \underline{\underline{2606\ lbs}}$

	REF.

REFERENCES

1. NUREG - 0800, STANDARD REVIEW PLAN, SECTION 3.6.2

2. PERRY'S CHEMICAL ENGINEER'S HANDBOOK, 5TH ED. p 5-62.

3. LACBWR PIPING DRAWINGS
   41- 503363
   41- 503370

4. SRP 3.6.2 (See Ref. 1.)

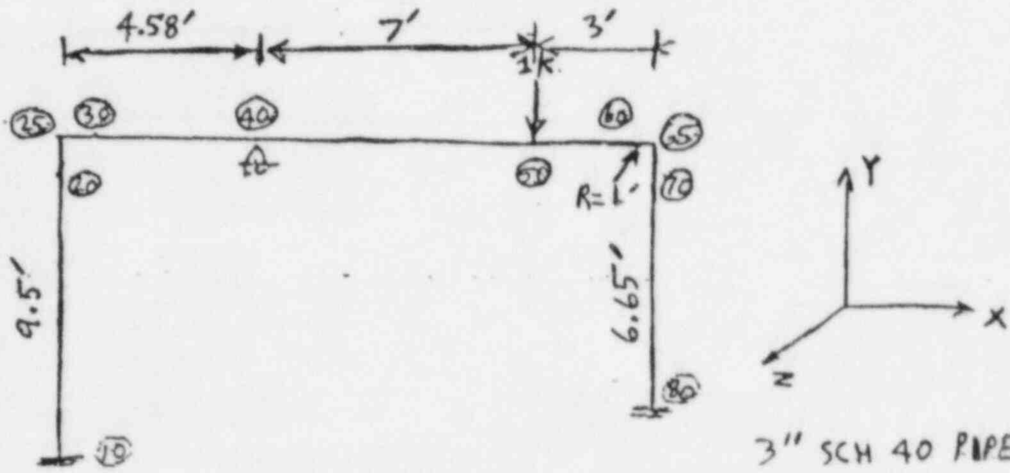
EFFECT OF ACS PIPE BREAK IN HPCS LINE

STATEMENT OF THE PROBLEM:

At El. 693.5' in the Containment Building, the 3" HPCS line is 1" above the ACS line. A break in the ACS line at this location will induce a steam jet which causes a thrust load at mode 50 (in the attached model). Configuration of the HPCS piping at the area of interest is attached. To simplify the analysis, HPCS line is assumed to be fixed at two ends, mode 10 and mode 80. Along the horizontal pipe, there is a support at mode 40, which supports the pipe in vertical and lateral directions. The steam jet will hit HPCS line at mode 50, which is 7' from the support.

Thrust load caused by the steam jet, estimated by Craig Finnan experienced a magnitude of 2,606 k. Effect of this thrust load on HPCS line is evaluated on next page.

EFFECT OF ACS PIPE BREAK ON HPCS LINE



3" SCH 40 PIPE
304 SS
$S = 1.724 \text{ in}^3$

10, 80 : Fixed support (anchor)

40 : support in vertical (Y) & lateral (Z) direction

Model was run by PIPESD to see effect of 1 unit load at node 50 in vertical direction:

From output S6100ME, max bending moment occurs at node 50

$$M = 17{,}699 \text{ lb-in} = 17.699 \text{ K-in}$$

Max bending stress caused by 1K load at node 50

$$\sigma = \frac{M}{S} = \frac{17.699}{1.724} = 10.266 \text{ Ksi}$$

From Craig Finnan steam jet calculation, possible thrust force at node 50 is: F = 2.606 K.

Actual max bending stress at node 50:

$$\sigma = 10.266 \times 2.606 = 26.753 \text{ Ksi}$$

Allowable stress $1.5\, S_m = 1.5 \times 20 \text{ Ksi} = 30 \text{ Ksi}$

$$\sigma = 26.753 \text{ Ksi} < 30 \text{ Ksi}$$

OK