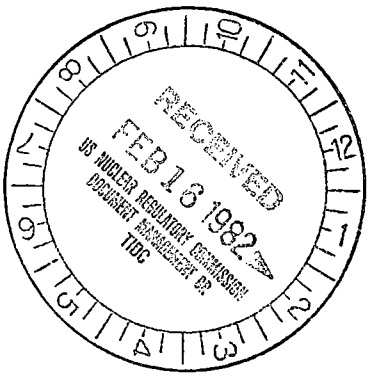
Consumers Power Company

General Offices: 212 West Michigan Avenue, Jackson, MI 49201 • (517) 788-0550



February 9, 1982

Dennis M Crutchfield, Chief
Operation Reactor Branch No 5
Nuclear Reactor Regulation
US Nuclear Regulatory Commission
Washington, DC 20555

DOCKET 50-255 - LICENSE DPR-20 -
PALISADES PLANT - SEP TOPIC III-6, SEISMIC DESIGN CONSIDERATIONS

On January 29, 1982, a telephone conference call was held between the NRC, Consumers Power Company, and their respective consultants to discuss several open items in SEP Topic III-6. One of the items discussed concerned an NRC request for additional calculations which addressed selected reactor internal components. This analysis was telecopied to the NRC and its consultant prior to the conference call.

By this letter, the analysis discussed during the call is formally submitted. As you will note, the attached sketches and pages 1 through 4 provide the compression flange buckling analysis for the lower support beam. Pages 5 and 6 provide a stability analysis for the core support columns. We believe that submission of this information now closes the last remaining questions on reactor internals seismic design.

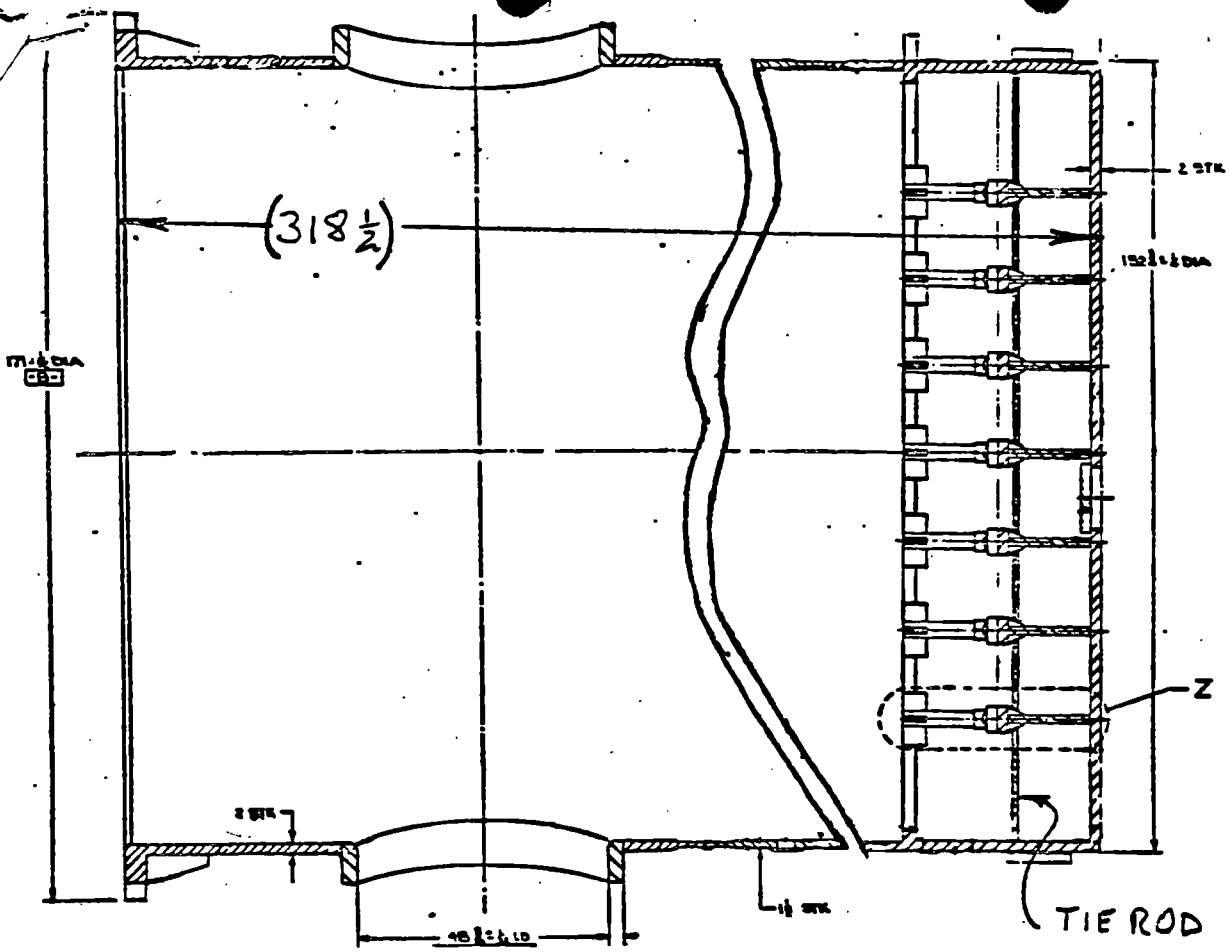
Robert A Vincent

Robert A Vincent
Staff Licensing Engineer

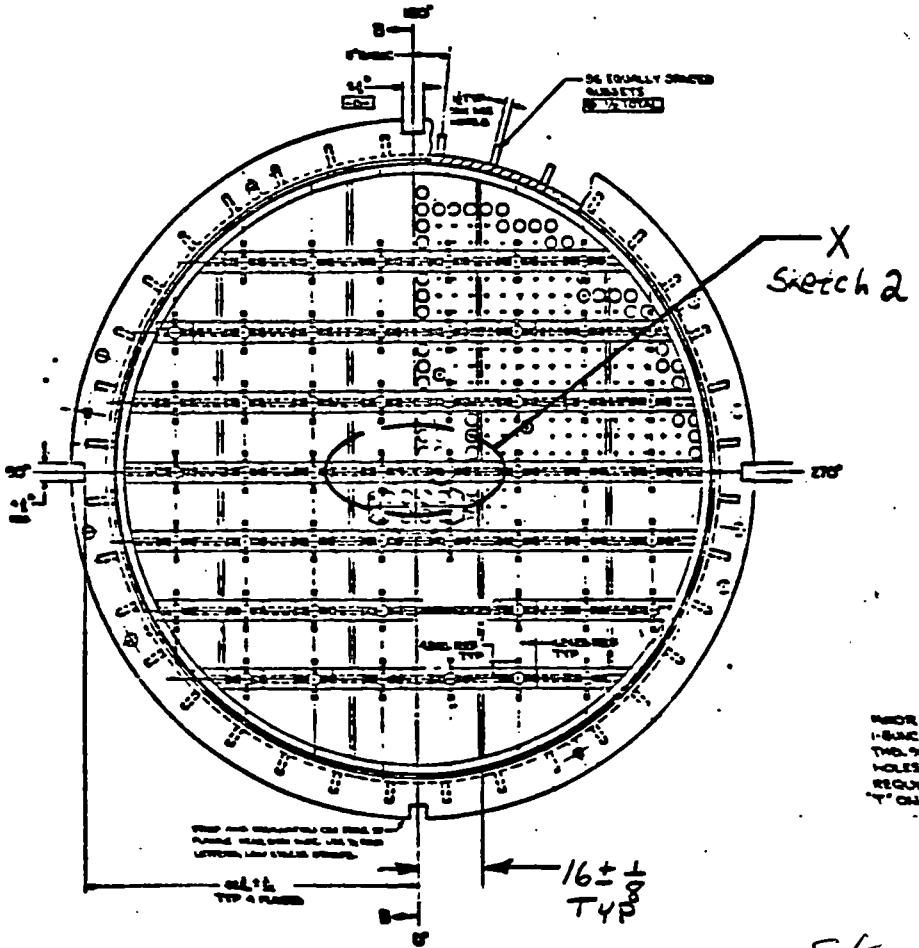
CC Administrator, Region III, USNRC
NRC Resident Inspector - Palisades

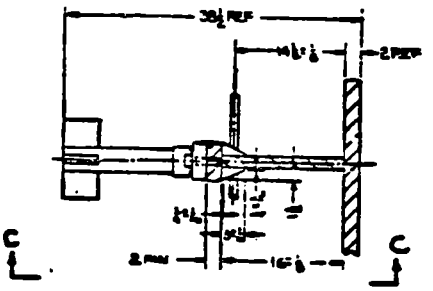
ATTACHMENTS - 8 Pages

A035
S
1/1

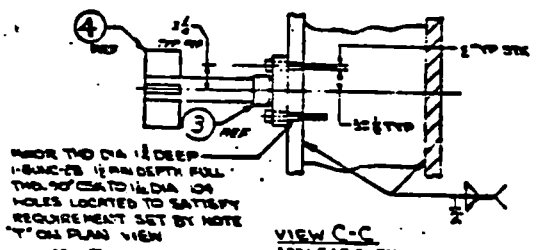


SECTION B-B



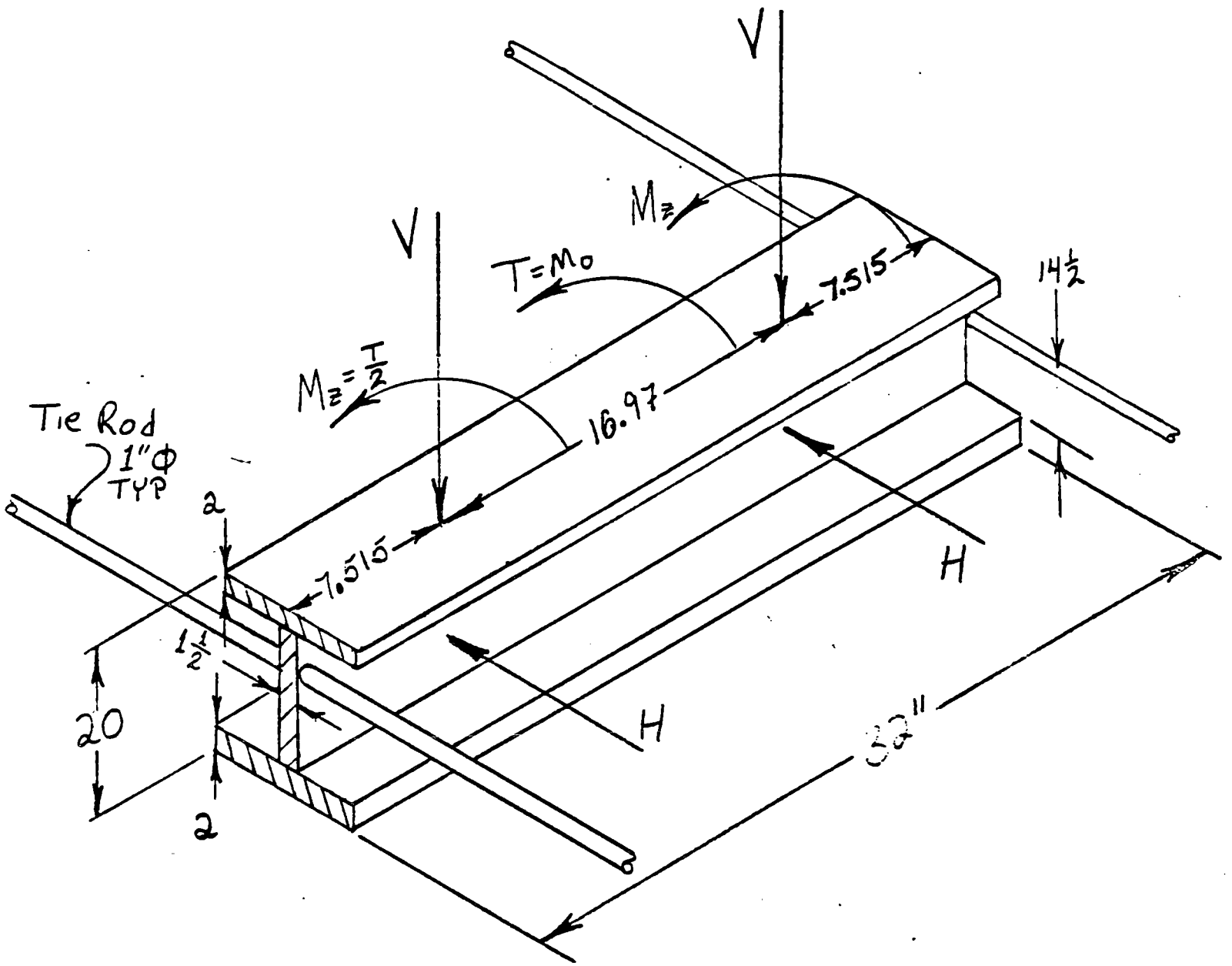


DETAIL Z
DIMS SHOWN TYP
FOR ALL COLUMNS
SCALE: EIGHTH



VIEW C-C
SCALE: EIGHTH

Sketch 1



Sketch 2 - Detail X

taken from Sketch 1

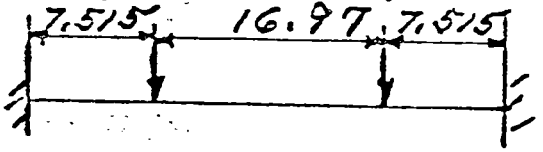
STABILITY OF LOWER SUPPORT BEAMS

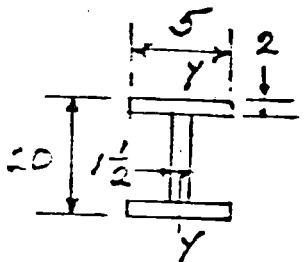
VERTICAL LOAD ON COLUMN DUE TO SSE:
$V = 5585\,(.34) = 1899$ LBS.

TOTAL VERT. LOAD = 5585 + 1899 = 7,484 LBS.
BENDING MOMENT ON BEAM
= 7,484 (65.89 + 48.92 + 31.95 + 14.98)
= 1,210,462 IN LBS.

$$\sigma_b = \frac{1,210,462\,(10)}{2,199} = 5,659 \text{ psi.}$$

STABILITY OF LONGEST (CENTER) BEAM:
WHEN M_o ACTS IN THE LATERAL DIRECTION TO THE BEAM:
MAX. UNBRACED SPAN 19 32 INS.





BEAM SECTION

REF. 3, PAGE 194

$M_z = 2(5170) + 2(2094)10$
$= 52,220$ IN LBS.

$b = 5$ INS. $t = 2$ INS. $w = 1.5$ INS. $L = 32$ INS

$d = 20 - 2 = 18$ INS. $h = 20$ INS

$$I_y = \frac{2\,(5)^3(2)}{12} + \frac{16\,(1.5)^3}{12} = 46 \text{ IN}^4$$

$$K_T = \frac{1}{3}\left[2bt^3 + (h-2t)w^3\right] = \frac{1}{3}\left[2(5)2^3 + 16(1.5)^3\right]$$

$$= 45 \text{ IN.}^4$$

$$I_w = \frac{I_y d^2}{4} = \frac{46(18)^2}{4} = 3726 \text{ IN}^6$$

$$\lambda = \sqrt{\frac{GK_T}{EI_w}} = \sqrt{\frac{45}{2.6(3726)}} = .0682 \frac{1}{\text{IN.}}$$

FLANGE BENDING STRESS AT CENTER OF SPAN:

$$\sigma_{bw} = \frac{bd}{8}\frac{E}{G}\frac{\lambda}{K_T} M_z \tanh \frac{\lambda L}{2}$$

$$= \frac{5(18)}{8}(2.6)\frac{(.0682)}{45}(52{,}220)\tanh 1.0912$$

$$= 1{,}846 \text{ psi.}$$

FLANGE SHEAR STRESS DUE TO WARPING:

$$\tau_{VW} = \frac{b^2 d}{16}\frac{E}{G}\frac{\lambda^2}{K_T} M_z$$

$$= \frac{5^2(18)}{16}(2.6)\frac{(.0682)^2}{45}(52{,}220)$$

$$= 395 \text{ psi.}$$

ST. VENANT SHEAR AT MID WIDTH OF FLANGE AT CENTER OF SPAN:

$$\tau_{VS} = \frac{M_z t}{K_T}\left[1 - \frac{\cosh \lambda L}{\cosh \lambda L}\right] = 0$$

FLANGE BENDING DUE TO VERTICAL LOADS: (PAGE 7)

$$\sigma_b = 5{,}659 \text{ psi.}$$

FLANGE BENDING DUE TO LATERAL LOAD:

$H = 2,094$ LBS.

REF. 2 PAGE 2-125 #17

$a = 24.485$ INS. $\quad b = 7.515$ INS.

$$R_1 = \frac{Hb^2}{L^3}(3a+b) = \frac{H(7.515)^2[3(24.485)+7.515]}{32^3}$$

$$= .14\,H$$

$$M_{AT\ CENTER} = 2\left[.14\,H\frac{L}{2} - \frac{Ha b^2}{L^2}\right]$$

$$= 2\left[.14(16)H - \frac{24.485(7.515)^2 H}{32^2}\right]$$

$$= 2\left(2.24\,H - 1.35\,H\right) = 1.78\,H$$

$$= 1.78(2,094) = 3,727 \text{ IN-LBS.}$$

$$\sigma_b = \frac{Mc}{I} = \frac{3,727(1.5)}{46} = 122 \text{ psi}$$

MAX. STRESS IN BEAM COMPRESSION FLANGE:

$$\sigma_L = 1,846 + 5,659 + 122$$

$$= 7,627 \text{ psi.}$$

PER XVII-2110 OF REF. 4, TO AVOID COMPRESSION FLANGE BUCKLING, THE ALLOWABLE STRESS MUST BE LIMITED TO TWO-THIRDS OF THE CRITIOAL BUCKLING STRESS.

PER SECT. XVII-2214.1, REF. 4, THE BEAM MEETS ALL REQUIREMENTS FOR A COMPACT SECTION (AS FOLLOWS):

1. FLANGE IS CONTINUOUSLY WELDED TO WEB.

2. WIDTH THICKNESS RATIO

$$= \frac{.5(5)}{2} = 1.25 < \frac{65}{\sqrt{17}} = 15.8$$

3. NOT APPLICABLE

4. $\frac{20}{1.5} = 13 < \frac{257}{\sqrt{17}} = 62$

5. LATERALLY UNSUPPORTED LENGTH = 32 IN.

$$32 < \frac{76(5)}{\sqrt{17}} = 92$$

6. NOT APPLICABLE

THEN $F_b = .66 S_y \left(\frac{4}{3}\right) = .88 S_y$

ALLOWABLE STRESS $= \frac{2}{3} F_b = \frac{2}{3}(.88)17{,}000$

$= 9{,}973$ psi.

CALCULATED STRESS = 7,627 psi.
FLANGE WILL NOT BUCKLE.

C.S. COLUMN:

$$C_c = \left(\frac{2\pi^2 E}{S_y}\right)^{\frac{1}{2}} = \left(\frac{2\pi^2 (25.2)10^3}{17}\right)^{\frac{1}{2}} = 171$$

AT UNDERCUT:

$$A = \frac{\pi}{4}(1.8125)^2 = 2.58\ IN^2$$

$$I = \frac{\pi}{64}(1.8125)^4 = .53\ IN^4$$

$$r = \sqrt{\frac{I}{A}} = \sqrt{\frac{.53}{2.58}} = .453\ INS$$

$$\frac{KL}{r} = \frac{1.2(9.875)}{.453} = 26$$

EQ. 4 REF 4

$$F_a = \frac{\left[1 - \left(\frac{KL}{r}\right)^2 / 2C_c^2\right] S_y}{\frac{5}{3} + \frac{3\left(\frac{KL}{r}\right)}{8C_c} - \frac{\left(\frac{KL}{r}\right)^3}{8C_c^3}}$$

$$= \frac{\left(1 - \frac{26^2}{2(171)^2}\right)17}{\frac{5}{3} + \frac{3(26)}{8(171)} - \frac{26^3}{8(171)^3}} = \frac{16.8}{1.72}$$

$$= 9.767\ ksi$$

FOR SOLID ROUND BARS $F_b = .75F_y$ (XVII 2214.3)

CORE SUPPORT COLUMN.
COMBINED AXIAL COMPESSION AND BENDING - REF. 4 - XVII-2215

AT UNDERCUT:
SINCE ENDS ARE RESTRAINED $C_m = .85$
$K = 1.2$ REF. 2 TABLE C1.8.1
$f_a = 2,900$ psi. $f_b = 8,837$ psi.

EQ. 20:

$$\frac{f_a}{F_a} + \frac{C_m f_b}{\left(1 - \frac{f_a}{F_e'}\right) F_b} \leq 1$$

$$F_e' = \frac{12\pi^2 E}{23\left(\frac{K l_b}{r_b}\right)^2} = \frac{12\pi^2 (25.2)10^3}{23\left(\frac{(1.2)(9.875)}{.453}\right)^2}$$

$$= 190 \text{ ksi.}$$

INCREASE 1/3 FOR SSE. CONDITIONS:

$$F_e' = \frac{4}{3}(190) = 301 \text{ ksi.}$$

EQ. 20: $$\frac{2,900}{\frac{4}{3}(9767)} + \frac{.85(8837)}{\left(1 - \frac{2,900}{301,000}\right).75(17,000)1.53}$$

$$= .22 + .45 = .67 < 1.0$$

COLUMN IS STABLE

LICENSING CORRESPONDENCE - RECORD SUMMARY

DATE:

DOCKET 50-255 LICENSE DPR-20
PALISADES PLANT

SUMMARY: SEP Topic III-6, Seismic Design — Provides CE calculations for two items in the reactor internals.

COMMITMENTS MADE:

none

Previous NRC/CPCo Correspondence:
Phone call 1/29/82
Meeting with NRC 11/6/81

AIR No. —

UFI No. —

Individuals Providing Information:
CE (Davison)

Concurrences:
—

Originator:
RA Vincent

Special Distribution:
—

Individuals Assigned Responsibility for Implementing Commitments:
NA

Cost/Budget Impact:

	Actual/Potential
Year(s)	NA
Materials/Parts	
Labor	
Capital	
Contractors	