Consumers Power Company

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April 6, 1976

Director of Nuclear Reactor Regulation
Att: Mr Robert A. Purple, Chief
Operating Reactor Branch No 1
US Nuclear Regulatory Commission
Washington, DC 20555

DOCKET 50-255, LICENSE DPR-20 -
PALISADES PLANT - CORRECTIONS TO ALLOWABLE
TUBE WALL DEGRADATION ANALYSIS

Our letter of February 12, 1976 transmitted a request titled "Analysis To Determine Allowable Tube Wall Degradation for Palisades Steam Generators." Following submission of that report, a number of errors have been observed and corrections made by letter dated March 22, 1976. This letter corrects an additional error (which was discussed previously with members of your staff).

The following pages have been revised correcting this error:

Title Page
Sheet 13
Sheet 14
Figure A.18
Figure A.19
Figure A.19A (New Page)

The border has been marked where changes were made and the corrected pages are attached.

David A. Bixel
Assistant Nuclear Licensing Administrator

CC: JGKeppler, USNRC

3490

POWER SYSTEMS

NUCLEAR POWER SYSTEMS

COMBUSTION ENGINEERING, INC.
COMPONENTS ENGINEERING
Chattanooga, Tennessee

E-2809

ANALYSIS TO DETERMINE ALLOWABLE TUBE WALL DEGRADATION FOR PALISADES STEAM GENERATORS

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January 29, 1976

Revision 1, March 5, 1976

Revision 2, March 30, 1976

a. LOCA + SSE - Bend Region (Cont'd)

The corresponding axial and hoop pressure stresses are:

$$\sigma_{Axial} = \frac{PR_i}{2t} = 2.2 \text{ ksi}$$

and

$$\sigma_\theta = \frac{PR_i}{t} = 4.4 \text{ ksi}$$

The resultant stress intensity is formed by the combination of the total compressive bending stress and the tensile hoop pressure stress. Figure A.19A presents the stress intensities determined for the healthy tube geometry and a 64% degraded tube. Results for the degraded tube indicate a stress intensity of 74.3 ksi.

The specified Appendix F faulted condition allowable for membrane stress is

$$S_{memb} = .7\ S_u = 2.4\ S_m = 56 \text{ ksi}$$

The membrane plus bending allowable is taken as

$$S_{memb + bend} = f_s \times S_{memb}$$

where f_s is the appropriate shape factor shown in Figure A.21. From this figure for the degraded tube with an axial membrane stress of 6.1 ksi

$$\sigma_m / \sigma_y = .2$$

and

$$f_s = 1.44$$

DESCRIPTION PALISADES STEAM GENERATOR

a. LOCA + SSE - Bend Region (Cont'd)

The corresponding allowable membrane plus bending stress intensity is

$$S_{memb + bend} = 1.44(56) = 80.6 \text{ ksi}$$

which exceeds the elastically calculated stress in the degraded tube.

The results of the elastic LOCA + SSE analysis are summarized in Figure A.19.

b. NRC Staff (Knight's) Criteria - Straight Region

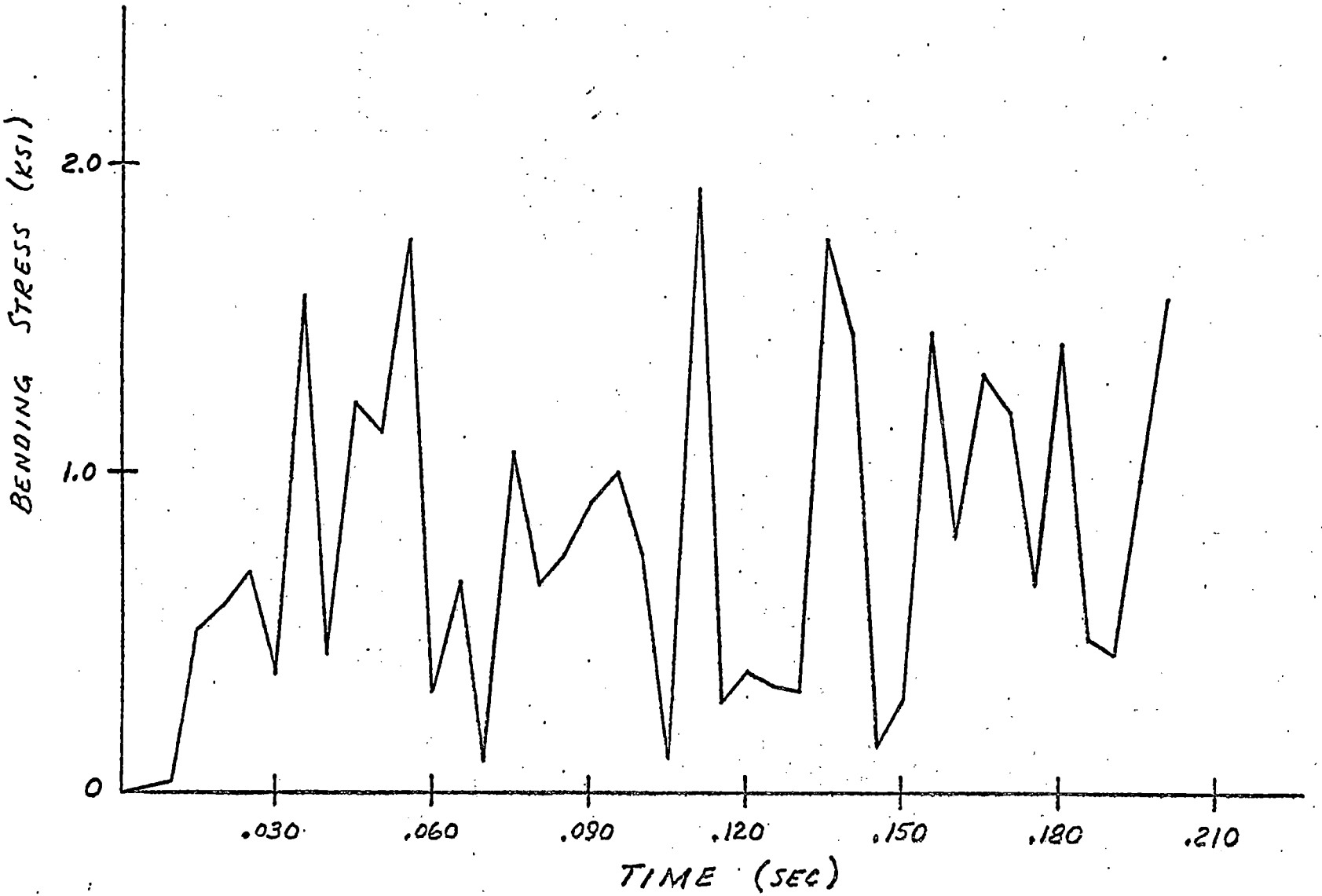
The controlling criteria for the vertical straight tube spans is Number 2 in Figure A.20, which requires a factor of 3 to exist between normal operating pressure differentials and the ultimate strength of the tube material. This would seem to be overly conservative since the principal behind it is taken from Section III which is a construction code. The Inservice Inspection Code, Section XI tends to be more realistic and would seem more appropriate for criteria of this type however, it offers no specific guidance at this time.

In spite of the aforementioned conservatism, the tubes are shown to possess a capacity for sustaining 64% degradation and still meet the required safety margins.

LOCA SHAKING BENDING STRESS

PALISADES TUBE ROW 110

NODE 16



SUMMARY
ELASTIC STRESS ANALYSIS
WORST CASE TUBE ROW 110

HEALTHY TUBE

$t = .048$ IN
$R_o = .375$ IN
$Z = .0175$ IN^3

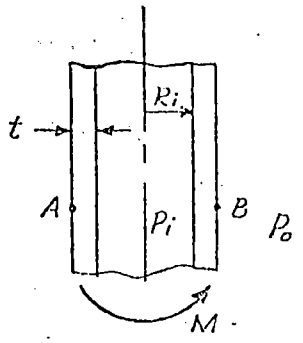
LOADING	STRESS DIRECTION	STRESS (KSI)
LOCA RAREFACTION	AXIAL	± 20.0
LOCA SHAKING	AXIAL	± 2.0
PRESSURE	AXIAL	2.2
	HOOP	4.4
SSE SEISMIC	AXIAL	± 1.0

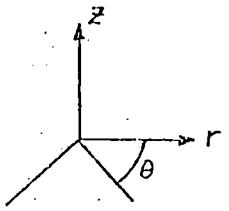
64 % DEGRADED TUBE

$t = .01728$ IN
$R_o = .34428$ IN
$Z = .00597$ IN^3

LOADING	STRESS DIRECTION	STRESS (KSI)
LOCA RAREFACTION	AXIAL	± 58.6
LOCA SHAKING	AXIAL	± 5.9
PRESSURE	AXIAL	6.1
	HOOP	12.2
SSE SEISMIC	AXIAL	± 2.9

COMBINED STRESS INTENSITY





HEALTHY TUBE

Loading	Type of Stress	Stress (ksi) Point A	Stress (ksi) Point B
LOCA Rarefaction LOCA Shaking SSE Seismic	$\sigma_z = \pm \frac{M}{z}$	+23.0	-23.0
Pressure	$\sigma_z = \frac{(P_i-P_o)R_i}{2t}$	+ 2.2	+ 2.2
	$\sigma_\theta = \frac{(P_i-P_o)R_i}{t}$	+ 4.4	+ 4.4
	$\sigma_r = -P_o$	- 0.77	- 0.77

	Point A	Point B
Stress Intensity	[23+2.2-(-0.77)] = 26.0	[-23+2.2-(4.4)] = 25.2

64% DEGRADED TUBE

Loading	Type of Stress	Stress (ksi) Point A	Stress (ksi) Point B
LOCA Rarefaction LOCA Shaking SSE Seismic	$\sigma_z = \pm \frac{M}{z}$	+67.4	-67.4
Pressure	$\sigma_z = \frac{(P_i-P_o)R_i}{2t}$	+ 6.1	+ 6.1
	$\sigma_\theta = \frac{(P_i-P_o)R_i}{t}$	+12.2	+12.2
	$\sigma_r = -P_o$	- 0.77	- 0.77

	Point A	Point B
Stress Intensity	[67.4+6.1-(-0.77)] = 74.3	[-67.4+6.1-(12.2)] = 73.5