Public Service

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U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, D.C. 20555

ATTN: Dr. Seymour H. Weiss, Director
Non-Power Reactor, Decommissioning and
Environmental Project Directorate

Docket No. 50-267

SUBJECT: Results of Final Structural Evaluation of PCRV

REFERENCES: 1) NRC Letter, Erickson to Crawford, dated February 8, 1991 (G-91020)

2) PSC Letter, Crawford to Weiss, dated April 26, 1991 (P-91118)

Dear Dr. Weiss:

In Reference 1, the Nuclear Regulatory Commission (NRC) submitted a request for additional information regarding the structural integrity of the Prestressed Concrete Reactor Vessel (PCRV) during decommissioning, with the prestressing tendons detensioned (NRC Question No. 7). Public Service Company of Colorado (PSC) responded to this question in Reference 2, providing results of the preliminary structural evaluation of the PCRV. In its response, PSC stated that "Detailed engineering analyses are currently in progress to confirm the structural integrity of the PCRV based on this dismantlement approach." The final evaluation of the structural integrity of the PCRV has been completed and the results are attached.

Several differences exist between the results of the preliminary evaluation and those of the final evaluation. An incorrect modular ratio was used in the preliminary evaluation to calculate concrete and reinforcing steel stresses by means of the "working stress" method. The working stress method is consistent with the original PCRV concrete and reinforcement design outlined in FSAR Section 5.2. When the modular ratio was corrected and the working stress method applied, the revised concrete and reinforcement stresses changed, most of which were lowered. The attached results of the final evaluation reflect the correct stresses and margins of safety.

The results of the preliminary evaluation, submitted in Reference 2, included evaluation of stresses resulting from an Operating Basis

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Earthquake. The attached results of the final evaluation identify stresses from both the Operating Basis and Design Basis Earthquakes.

Should you have any questions regarding this information, please contact Mr. M. H. Holmes at (303) 620-1701.

Very truly yours,

Don W. Warembourg
Manager, Nuclear Operations

DWW:JRJ/km

Attachment

cc: Regional Administrator, Region IV

Mr. J. B. Baird
Senior Resident Inspector
Fort St. Vrain

Mr. Robert M. Quillin, Director
Radiation Control Division
Colorado Department of Health
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Results of Final Structural Evaluation of the PCRV with the Tendons Detensioned for Decommissioning

Public Service Company of Colorado's (PSC's) response dated April 26, 1991 (P-91118) to question 7 of the NRC's Request for Additional Information dated February 8, 1991, provided the results of the preliminary structural evaluation that was performed to confirm the structural integrity of the PCRV after tendons have been detensioned. Subsequently, the final structural evaluation has been completed. This submittal provides an update of the stress values and the margins of safety that were reported in the April 26, 1991 submittal. Note that the seismic results are now provided for both the Fort St. Vrain (FSV) Operating Basis Earthquake (OBE) and the Design Basis Earthquake (DBE), rather than for the OBE alone.

As stated in the April 26, 1991 submittal, the structural evaluation considered the detensioning and removal of all 24 cross head tendons, all 90 vertical tendons, and all circumferential tendons from group 5 through group 19. In addition, it was conservatively assumed that all circumferential tendons (inner, middle and outer) were detensioned even though it is planned to only detension the inner and middle tendons in the top head and the inner tendons in the belt line region. To evaluate this modified structure, a simplified free-body lumped mass model fixed at the basement floor of the PCRV structure was developed for analysis with the STAAD-III/ISDS[1] computer code. Inputs to the analysis included NRC Regulatory Guide 1.60 (December, 1973) design response spectra normalized to the (FSV) specific "double design earthquake" (DBE) ground motions with Regulatory Guide 1.61 (October, 1973) damping values. Specifically, the FSV OBE ground motions of 0.05g horizontal and 0.033g vertical accelerations and DBE ground motions of 0.10g horizontal and 0.067g vertical accelerations were used in the analysis. In addition, the concrete has a compressive strength of f'c = 6000 psi and the reinforcing steel was conservatively assumed to be Grade 40 steel with a Fy = 40,000 psi, although the FSAR indicates that it is probably Grade 60, or better. The damping values used are 2% horizontal and vertical for the OBE and 2% vertical and 5% horizontal for the DBE.

1. STAAD-III/ISDS, Revision 14.0 is a general purpose structural analysis program for the static and dynamic analysis of statically determinate and indeterminate structures represented by a combination of beam and/or plate elements. It is a proprietary code of Research Engineers, Inc. of Marlton, N.J., Copyright 1991.

The modified structure was conservatively evaluated for the loadings produced by the dead weight of the PCRV structure (assuming the PCRV is flooded with water), PCRV internal components, the lifting operations of the core support floor, and OBE and DBE events.

The resulting forces and moments in each of the individual cross sections of the PCRV were used to develop concrete compressive and reinforcing steel tensile stresses. In the development of the concrete and reinforcing steel stresses, all vertical, cross-head and circumferential pre-stressing tendons were considered detensioned. The resulting concrete compressive and reinforcing steel tensile stresses are provided below:

Cross Section	Loading	Concrete Compressive Stress (psi)	Reinforcing Steel Tensile Stress (psi)
Top Head	DW	16.7	0.0
	Lift	7.7	0.0
	OBE Seismic[2]	22.0	10.2
	DBE Seismic[2]	25.1	23.7
Belt Line Region	DW	134.6	0.0
	Lift	6.1	0.0
	OBE Seismic[2]	298.9	814.8
	DBE Seismic[2]	381.5	1,268.0

To determine margins of safety, the worst case load combinations of dead weight, lift loads, and OBE and DBE seismic events were considered using the following equations, consistent with the "Building Code Requirements for Reinforced Concrete," ACI 318-83 (Revised 1986), American Concrete Institute, Detroit, Michigan:

EQ-1: $U_1 = 0.75\ (1.4\ DW + 1.7\ Lift + 1.87\ OBE\ seismic)$

EQ-2: $U_2 = 0.75\ (1.4\ DW + 1.7\ Lift + 1.4\ DBE\ seismic)$

2. Includes the effects of Dead Weight (DW).

The total combined concrete compressive stress was compared to the "Limit Condition 2" compressive stress allowable of 0.85 f'c or 5100 psi as outlined by Section E.1.2.6.2 of the FSV FSAR. The reinforcing steel allowable tensile stress was considered to be 90% of the yield stress of Grade 40 steel, or 36,000 psi. The margins of safety, where margin = allowable stress/combined actual stress, are summarized below:

	Concrete		Reinforcing Steel	
Section	EQ-1	EQ-2	EQ-1	EQ-2
Top Head	87.6	95.0	2517	1447
Belt Line Region	8.97	9.28	31.5	27.0

In summary, the structural evaluation has determined that the resulting concrete compressive and reinforcing steel tensile stresses are well within allowable limits. Furthermore, adequate margin of safety exists for all loading conditions specified. The potential for cracking of concrete in the modified top head and beltline regions has been reviewed and, considering the relatively low tensile stress in a conservative number of reinforcing bars, cracking due to tension in the concrete is not expected.