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ARTHUR E. LUNDVALL, JR.
VICE PRESIDENT
SUPPLY

September 21, 1982

Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Attn: Mr. Robert A. Clark, Chief
Operating Reactors Branch #3
Division of Licensing

Subject: Calvert Cliffs Nuclear Power Plant
Units Nos. 1 & 2; Dockets Nos. 50-317 and 50-318
Request for Additional Information
Containment Structure Surveillance

Reference 1: NRC letter dated June 22, 1982 from R. A. Clark to A. E. Lundvall, Jr., Request for Additional Information

Gentlemen:

Attached for your use is the additional information you requested by Reference 1 with regard to our containment tendon surveillance program. We have enclosed a copy of the "CCNPP Unit 1 Five-Year Tendon Surveillance Report" which was specifically requested by your Question #5.

If there are any questions concerning the information provided, please contact Mr. Bruce Montgomery at 234-5289.

Very truly yours,

Arthur E. Lundvall, Jr.

A001

AEL/BSM:gvg

Attachment and Enclosure (As stated)

Limited Dist

cc: J. A. Biddison, Jr., Esquire (w/o encl.)
G. F. Trowbridge, Esquire "
Mr. D. H. Jaffe - NRC "
Mr. R. E. Architzel - NRC "
Mr.N. D. Romney, NRC "

RESPONSE TO JUNE 22, 1982 NRC QUESTIONS

(Three Year Tendon Surveillance ,Unit 1 Containment)

Question 1

The Calvert Cliffs FSAR gives the following shrinkage and creep values based on test data as:

Dome Tendons	146.7×10^{-6} in/in
Hoop Tendons	248.6×10^{-6} in/in
Vertical Tendons	137.5×10^{-6} in/in

However, reference 2 provides the following values for shrinkage and creep of concrete:

Loaded @ 180 days	335.0×10^{-6} in/in
Loaded @ 365 days	200.0×10^{-6} in/in

Compare the latter values with those stated in the FSAR. Explain and justify the deviations. Include a discussion of the source of the data and the test procedures upon which they are based.

Response 1

Concrete creep and shrinkage are time dependent functions, their values are determined from tests on concrete cylinders made from the design mix used in the construction of the Calvert Cliffs containments. The values obtained from these tests are based on uniaxial compression tests of the concrete. The concrete mix design used for the containment walls and dome was of the D-2 class with a maximum size aggregate of 1 1/2".

In order to comply with the design criteria an independent organization was retained to perform tests on concrete to establish physical properties of the concrete to be used in the construction of the Calvert Cliffs containment structures.

The selected organization was the University of California at Berkley. Tests were conducted and the results published in 1971.* There were 3 sets of tests performed on specimens of concrete at the ages of 28, 180 and 365 days. The concrete specimens at the age of 28 days were under stress for 337 days, those at the age of 180 days were under stress for 185 days, and those at the age of 365 days were under stress for 64 days.

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* Report to Bechtel Corporation of STUDIES OF CONCRETE FOR CALVERT CLIFFS NUCLEAR CONTAINMENT VESSEL, 1 1/2 in. maximum size aggregate. Final Report by David Pirtz, University of California, Davis Hall, Berkley, California; August 1971.

The data obtained indicated a decrease in creep and shrinkage values with the increase of the age of concrete at the time of loading.

Thus for prestress losses due to creep and shrinkage, the values of 335×10^{-6} in/in for concrete loaded at 180 days and 200×10^{-6} for concrete loaded at 365 days were used, since they more appropriately represent those at the time of actual transfer of prestress to the containment structure.

The values given in the FSAR were deduced from tests conducted on concrete at the age of 28 days, which was the only test data available at the time the FSAR was submitted. Given the fact that the subsequent values used were from a wider data base than those from the time of the FSAR, their greater reliability adds to the assurance that the structural integrity of the Calvert Cliffs containment will be maintained during the life of the plant.

Question 2

Comparison of the Calvert Cliffs FSAR and references 1 and 3 yields the following data:

Average Design Prestress Force @ 40 Years

		HOOP	DOME	VERTICAL
	FSAR	6.75 k/wire	7.3 k/wire	7.3 k/wire
(1)	Ref. 1	6.55 k/wire	6.77 k/wire	7.05 k/wire
(2)	Ref. 3	5.96 k/wire	6.87 k/wire	6.91 k/wire

(1) Taken from Fig. 5-1 thru 5-3 of Ref. 1.

(2) Values based on Tendon Force provided in Ref. 3 divided by assumed average tendon consisting of 90 wires.

Explain and justify the significance of lower lift-off forces and design prestressing forces as proposed in reference 3 as they relate to the required safety of the containment against all postulated accidents and loading combinations.

Response 2

It should be noted that there is a typographical error in the data presented in Question 2. In Reference 3 the dome prestressing force @ 40 years is 6.17 k/wire rather than 6.87 k/wire.

The data given in the three documents referenced below were derived as shown in Table 2-1:

Table 2-1

Average Design Prestress Force @ 40 Years

Ref/Source	Hoop	Dome	Vertical
FSAR pg. 5-43	137.25ksi x 0.04908 in^2 = 6.74 k/wire	148.92ksi x 0.04908 in^2 = 7.31 k/wire	148.36ksi x 0.04908 in^2 = 7.28 k/wire
3 Yr. Sur. Report Fig. 5-1, 2 & 3 (Ref. 1)	Design Prestressing Force = 6.55 k/wire	Design Prestressing Force = 6.77 k/wire	Design Prestressing Force = 7.05 k/wire
Letter Olson (BG&E) to Clark (NRC) 01/08/82 pp 3/4 6-8a (Ref. 3)	536 k/90 wires = 5.96 k/wire	555 k/90 wires = 6.17 k/wire	622 k/90 wires = 6.91 k/wire

The normalized lift-off forces (See attachment 1 of Ref. 2 response to question B.6) obtained from the three year tendon surveillance of the Calvert Cliffs Unit 1 Containment are given in Table 5-3 (Ref. 1). These values are acceptable as compared to the average prestress forces per tendon shown in Figures 4.6-1, 4.6-2, and 4.6-3 of reference 3.

As a result of a reanalysis of the containment structure (June 1977) for which all postulated accident and loading combinations were considered, the design prestress forces for each family of tendons yield values in force per tendon or force per wires as given in reference 3 and in Table 2-1 above.

Comparing the normalized lift-off forces obtained in the three year surveillance (Ref. 1 Table 5-3) and those from reference 3 and Table 2-1 above it is evident that the postulated safety margins are well within predicted limits and the structural integrity of the containment is maintained.

Question 3

In reference 1, it is shown that, of the 30 hoop tendons tested for lift-off, 16 tendons had values below the lower bound for lift-off forces based on expected losses. Of these 16 tendons indicated, 10 are located between buttresses 5 and 1. When compared to the design prestressing force discussed in the Calvert Cliffs FSAR, six of the hoop tendons (all located between butresses 5 and 1) had lift-off forces below the design value.

Considering the contribution to loss of prestress over 40 years from all sources (creep and shrinkage of concrete, relaxation of prestressing steel, elastic shortening of concrete, and normalization factors resulting from tendon stressing sequence), and, which effect all tendons preportionately, answer the following:

a. Explain why 16 of the 30 hoop tendons tested (53%) experienced such a significant and disproportionately large loss of prestress after only three years of service;

b. Explain the significance of the fact that 10 of the 16 tendons in question (63%) are located between buttresses 5 and 1;

c. Discuss the capability of the hoop tendons having a required final prestress force at 40 years equal to or greater than the required design prestressing force as expressed in the Calvert Cliffs FSAR, given the large losses occurring after three years.

d. Describe proposed remedial actions, if any.

Response 3

As stated in the response to Question 2 the normalized lift-off forces given in Table 5-3 of reference 1 are all above the average design prestress force level at 40 years. The average prestress forces at 40 years obtained from the reanalysis of the containment structure include contributions from loss of prestress over 40 years from all sources such as creep and shrinkage of concrete, relaxation of prestressing wires, elastic shortening of concrete, and normalizing factors (See attachment 1 of Ref. 2, response to question B.6) resulting from the tendon stressing sequence. This is in compliance with the acceptance criteria for the containment prestressing system which require that safety margins as postulated must be within predicted limits, thus ensuring the integrity of the structure.

Question 4

In reference 1 it is shown that all six of the dome tendons tested for lift-off had values below the required final prestress force as expressed in the Calvert Cliffs FSAR. Answer the following:

a. Explain why all of the dome tendons tested experienced a loss of prestress in three years that was significantly greater than the losses expected over 40 years;

b. Discuss the effect of these losses on required containment capacity under all postulated loading conditions over the service life of the structure.

c. Describe proposed remedial actions, if any.

Response 4

Similarly to Questions 2 and 3, the response to Question 4 is that the normalized lift-off forces given in Table 5-3 of reference 1 are all above the average design prestress force level at 40 years.

This is in compliance with the acceptance criteria for the containment prestressing system which requires that safety margins as postulated must be within predicted limits, thus ensuring the integrity of the structure.

Question 5

Provide a copy of the "Calvert Cliffs Unit 1 Containment Structure Post Tensioning System Five Year Surveillance" report for SEB review.

Response 5

Please find a copy of the requested report as enclosed by our transmittal letter. Also, please note the letter dated April 5, 1979, from Mr. B. C. Rudell to Mr. D. T. Ward (see the next to last section in Volume 2 of the report) which states:

> "There is no evidence of abnormal degradation of the containment structure. All tendons checked for lift-off force during this surveillance, using the recalibration data for the twelve inch stroke ram, have a lift-off force between 6760 (minimum) and 8700 (maximum) pounds per tendon wire. All tendon wires removed are free of corrosion and demonstrated to have a tensile strength greater than the guaranteed ultimate strength of the wire (240 Ksi.). No apparent changes have occurred in the visual appearance of the end anchorages. Chemical analysis of the sheathing filler shows concentrations of chlorides, nitrates, and sulfides to be less than ten parts per million. The sheathing filler contained less than ten percent water."

References:

(1) Bechtel Report, "Calvert Cliffs, Unit 1 Containment Structure Post Tensioning System Three Year Surveillance", dated May 1977.

(2) Letter from A. E. Lundvall of BG&E to R. W. Reid of NRC, dated October 20, 1978.

(3) Letter from R. C. L. Olson of BG&E to R. A. Clark of NRC, dated January 8, 1982.