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Dwight E. Nunn
Vice President

August 25, 2000

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

Subject: Docket Nos. 50-361 and 50-362
Response to the Request for Additional Information (RAI)
Proposed Technical Specification Change Number NPF-10/15-516
Reduce the Minimum Boltup Temperature for Reactor Vessel Head Bolts When They Are Tensioned
San Onofre Nuclear Generating Station Units 2 and 3

References:

1) Letter dated May 3, 2000 from R. W. Krieger (SCE) to Document Control Desk (USNRC), Subject: Docket Nos. 50-361 and 50-362, Proposed Technical Specification Change Number NPF-10/15-516, Reduce the Minimum Boltup Temperature for Reactor Vessel Head Bolts When They Are Tensioned

2) Letter dated June 12, 2000 from L. Raghavan (USNRC) to Harold B. Ray (SCE), Subject: San Onofre Nuclear Generating Station Units 2 and 3, Request for Additional Information Re: Reactor Vessel Minimum Boltup Temperature (TAC NOS. MA8882 and MA8883)

Enclosed is the Response to the RAI to Amendment Application Number 199 to Facility Operating License NPF-10, and Amendment Application Number 184 to Facility Operating License NPF-15, for the San Onofre Nuclear Generating Station, Units 2 and 3, respectively. The Amendment Applications consist of Proposed Technical Specification Change Number (PCN)-516 (Reference 1). PCN-516 is a request to revise Technical Specification (TS) 3.4.3, "RCS Pressure and Temperature (P/T) Limits". Specifically, the Proposed Change would reduce the minimum boltup temperature from 86^0F to 65^0F. To complete their review the NRC requested additional information (Reference 2). The requested information was discussed in various telephone conversations between SCE and the NRC. The response to the NRC RAI as well as additional information concerning the issues is provided in the enclosure.

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If you have any questions regarding this response, please contact me or Mr. Jack L. Rainsberry (949) 368-7420.

Sincerely,

Enclosure

cc:

E. W. Merschoff, Regional Administrator, NRC Region IV
J. A. Sloan, NRC Senior Resident Inspector, San Onofre Units 2 and 3
L. Raghavan, NRC Project Manager, San Onofre Units 2 and 3
S. Y. Hsu, Department of Health Services, Radiologic Health Branch

Subscribed on this 25th day of August, 2000.

Respectfully submitted,
SOUTHERN CALIFORNIA EDISON COMPANY

By: ____________________
Dwight E. Nunn

State of California
County of San Diego
On 8/25/2000 before me, Mariane Sanchez,

personally appeared Dwight E. Nunn, personally known to me to be the person whose name is subscribed to the within instrument and acknowledged to me that he executed the same in his authorized capacity, and that by his signature on the instrument the person, or the entity upon behalf of which the person acted, executed the instrument.

WITNESS my hand and official seal.

Signature ____________________

MARIANE SANCHEZ
Commission #1196482
Notary Public - California
San Diego County
My Comm. Expires Oct 14, 2002

ENCLOSURE

RESPONSE TO THE NRC RAI

REGARDING

AMENDMENT APPLICATIONS 199 AND 184

(PCN-516)

The NRC's Request for Additional Information (RAI) requested the following:

"Attachment 1, Calculation M-DSC-373, reported that the safety margins for the flange-to-shell joint is 1.51. This is based on a postulated surface flaw depth of 1/10 the wall thickness (T), consistent with that used in a report by ABB Combustion Engineering (CE), Calculation No. RS-706, "Appendix G Evaluation," dated August 13, 1981. Please confirm that the CE report using the 1/10T flaw has been approved by NRC. Further, the reported safety margin of 1.51 is less than the safety factor of 2 specified in Appendix G. Please provide justification. Please be advised that if the plane strain fracture toughness (K_{IC}) has been used in demonstrating structural integrity of the closure flange region, then a request for exemption from the Appendix G analysis has to be submitted."

SCE Response

NRC Question #1:

Please confirm that the CE report using the 1/10T flaw has been approved by NRC.

SCE Response to Question #1:

There is no record that the subject CE calculation associated with the reactor vessel flange has been previously submitted to the NRC. SCE also believes that these calculations are consistent throughout the industry and in accordance with the ASME Code.

NRC Question #2:

Further, the reported safety margin of 1.51 is less than the safety factor of 2 specified in Appendix G. Please provide justification.

SCE Response to Question # 2:

The minimum boltup temperature (MBT) is determined from Article G-2222(c) of Appendix G. The application of MBT is limited to the situation when the flange is only loaded by full bolt preload and a vessel pressure that is less than 20% of the preoperational hydrotest pressure. The MBT establishes the minimum metal temperature when the reactor vessel head studs can be tensioned.

Per G-2222(c), the MBT is determined from the RT_{NDT} of the material and temperature measurement uncertainties, as defined in Eq. 4-1 of Calculation M-DSC-373. Therefore, consideration of postulated flaw size, fracture toughness of the material, and analysis safety factor, are not relevant to the calculation of MBT.

The fracture mechanics calculations under boltup-only conditions were included in Calculation M-DSC-373 to verify that reasonable safety margins exist at MBT. As stated in M-DSC-373, these calculations were included for completeness in an appendix and are for information only. They are not required by Appendix G and therefore not needed to show compliance to Appendix G.

When the pressure exceeds the 20% limit, the vessel pressure (P) and metal temperature (T) are defined by the P-T curves. The P-T curves for the flange region were established in ABB/CE Calculation RS-706, "Appendix G Evaluation," dated August 13, 1981, using 1/10T flaw depth, K_{IR} reference toughness curve, and safety factor of 2 on primary stress, in compliance with Appendix G. The use of a postulated flaw less than 1/4T is permitted under Article G-2120, on an individual case basis, provided that the smaller postulated flaw size can be ensured by inspection.

NRC Question #3:

Please be advised that if the plane strain fracture toughness (K_{IC}) has been used in demonstrating structural integrity of the closure flange region, then a request for exemption from Appendix G analysis has to be submitted.

SCE Response to Question # 3:

The plane strain fracture toughness (K_{IC}) is not used to determine MBT nor in the calculation of the P-T heatup/cooldown curves.

Additional Information

Evaluation of the Minimum Allowable Pressure

A P-T evaluation was performed for SONGS Units 2 & 3 representing one point on the P-T curve at fluid temperature of 126°F, which corresponds to the minimum allowable pressure inside the reactor vessel. An axisymmetric finite element model of the reactor vessel wall at the belt line, including the 7/32" stainless steel cladding, was generated using the finite element program ANSYS. The model was used to calculate the temperature time history at the following locations:

1. The cladding-base metal interface,
2. The $T_w/4$ location,
3. The $3T_w/4$ location, and
4. The outside surface.

Where T_w is the vessel's base metal wall thickness. Thermal transient analyses were performed based on a heatup rate of 60°F/hr, and initial temperatures of 65 and 86°F. The temperature at the $T_w/4$ and $3T_w/4$ locations, and the temperature differential ΔT_w through the wall were calculated when the fluid temperature reached 126°F.

Based on the results of the thermal transient analysis described above, the allowable pressure was calculated as follows:

- Using Appendix G, Code Year 1989, the value of $M_t = 0.34$ was obtained.
- The value of $K_{IT} = M_t \times \Delta T_w$ was calculated.

- The value of K_{IR} was calculated using the formula from Appendix G based on the specific values of RT_{NDT} for Units 2 and 3.
- Based on Appendix G, $K_{IP} = (K_{IR} - K_{IT})/2$ was calculated.
- The value of $M_m = 2.7$ was obtained from Appendix G, and the stress $\sigma = K_{IP}/M_m$ was calculated.
- Finally, the allowable pressure, P, was calculated:

$$P = \sigma \; T_w/R_i$$

where R_i is the inside radius of the vessel.

Results of the evaluation for SONGS Units 2 & 3 are summarized below.

P-T Calculation Summary – SONGS UNIT 2

Fluid temperature = 126°F
Heatup rate = 60°F/hr

RT_{NDT} = 106.5°F @ 3T/4
Yield strength = 50 ksi

Vessel dimensions:

Inside radius (R_i) = 86.2 in.
Cladding thickness = 7/32 in.
Outside radius (R_o) = 94.84 in.
Wall thickness (Tw) = 8.625 in.

M_m = 2.7 (ASME APP G, 1989)
M_t = 0.34 (ASME APP G, 1989)

An axisymmetric finite element model was used to calculate the temperature distribution in the vessel wall. The model included the 7/32" stainless steel cladding. Results are given below.

Results Summary

Initial temp. °F	Calculated temperatures °F			K_{IR} ksi (in)$^{1/2}$	K_{IP} (1) ksi (in)$^{1/2}$	K_{IT} ksi (in)$^{1/2}$	2x K_{IP}+ K_{IT} ksi (in)$^{1/2}$	Allowable P (2) psi
	T/4	3T/4	ΔT_w					
86	109.2	97.8	23.8	37.83	14.86	8.1	37.83	550
65	106.5	91.9	29.8	36.93	13.41	10.1	37.9	497

Notes:
(1) $2K_{IP} = K_{IR} - K_{IT}$
(2) P is based on: $P = \sigma T_w / R_i$, $\sigma = K_{IP}/M_t$

P-T Calculation Summary – SONGS UNIT 3

Fluid temperature = 126°F
Heatup rate = 60°F/hr

RT_{NDT} = 99.8°F @ 3T/4
Yield strength = 50 ksi

Vessel dimensions:

Inside radius (R_i) = 86.2 in.
Cladding thickness = 7/32 in.
Outside radius (R_o) = 94.84 in.
Wall thickness (T_w) = 8.625 in.

M_m = 2.7 (ASME APP G, 1989)
M_t = 0.34 (ASME APP G, 1989)

An axisymmetric finite element model was used to calculate the temperature distribution in the vessel wall. The model included the 7/32" stainless steel cladding. Results are given below.

Results Summary

Initial temp. °F	Calculated temperatures °F			K_{IR} ksi (in)$^{1/2}$	K_{IP} (1) ksi (in)$^{1/2}$	K_{IT} ksi (in)$^{1/2}$	2x K_{IP}+ K_{IT} ksi (in)$^{1/2}$	Allowable P (2) psi
	T/4	3T/4	ΔT_w					
86	109.2	97.8	23.8	38.96	15.4	8.1	38.9	571
65	106.5	91.9	29.8	37.96	13.9	10.1	37.9	515

Notes:
(1) $2K_{IP} = K_{IR} - K_{IT}$
(2) P is based on: $P = \sigma T_w / R_i$, $\sigma = K_{IP}/M_t$