Tennessee Valley Authority, Post Office Box 2000, Spring City, Tennessee 37381

DEC 01 1994

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

Gentlemen:

In the Matter of the Application of	)	Docket Nos. 50-390
Tennessee Valley Authority	)	50-391

WATTS BAR NUCLEAR PLANT (WBN) - NUREG-0737 ITEM II.D.1, TESTING OF PRESSURIZER RELIEF AND SAFETY VALVES (TAC M79992)

During a telephone conversation on September 20, 1994, NRC and TVA personnel discussed a number of questions and comments concerning WBN's implementation of NUREG-0737 Item II.D.1 for performance testing of pressurizer relief and safety valves. The questions and comments resulted from the NRC staff's review of a TVA letter dated July 19, 1994, on the subject issue. The NRC staff requested that TVA submit a written response for three of the issues that were discussed in the telephone conversation on September 20, 1994.

The enclosure to this letter describes the three issues and presents a detailed response for each one.

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If you have any questions about the information provided in this letter, please telephone John Vorees at (615) 365-8819.

Sincerely,

Dwight E. Nunn
Vice President
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Enclosure
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ENCLOSURE

ISSUES RELATED TO NUREG-0737 ITEM II.D.1
AS DISCUSSED IN A TELEPHONE CONVERSATION ON SEPTEMBER 20, 1994
(TAC M79992)

NRC ISSUE 1:

In Response No. 6 of TVA's letter dated July 19, 1994, it is stated that the maximum piping forces are produced in less than approximately 1 second after valve opening, which would be before liquid water is discharged from the power-operated relief valves (PORVs) and/or pressurizer safety valves (PSVs). For some transients, however, the valve inlet conditions transition to water. For these transients, the initial PORV/PSV inlet conditions could be liquid if the valves close then open after liquid discharge begins. Do the analyzed steam discharge loads also bound those due to the PORV/PSV liquid discharge events?

TVA RESPONSE:

WBN's fluid transient analysis only considered steam discharge from the PORVs and PSVs (except for the low-temperature cases that evaluated PORV actuation during operation of the cold overpressure mitigation system (COMS)). This approach is justified because fluid acceleration is the principal contributor to the maximum piping forces. The greatest acceleration during the transient occurs within the first second after valve actuation.

As noted in the statement of the issue, valve inlet conditions do transition from steam to liquid water for some transients such as a feedwater line break (FWLB) accident. However, the approved computer models for the various accident transients that are evaluated in Chapter 15 of the Final Safety Analysis Report, including the FWLB transient, indicate that neither the PORVs nor the PSVs would ever open under liquid water conditions. Steam-to-water transition occurs after the valve is already open. Also, once the valve is open the pressure increase associated with the transient quickly stabilizes at a transitional equilibrium value. System pressure then remains at this equilibrium value without any significant fluctuation that could induce cycling (i.e., closing and then reopening) of the valve. The results of the computer analyses show that the valve remains open until water discharge is complete at the end of the transient. TVA confirmed the above information in a telephone conversation with Westinghouse Electric Corporation, who performed the various Chapter 15 accident analyses for WBN.

NRC ISSUE 2:

In Response No. 7 of TVA's letter dated July 19, 1994, it was stated that the maximum calculated plant PORV flow rate used in the piping analysis was 233,333 lb/hr. This is the PORV rated flow with the 0.9 derating factor removed (i.e., 210,000 lb/hr ÷ 0.9). Based on a comparison of the actual flow rates for the EPRI test valve to the rated flow of the EPRI test valve, is removing the 0.9 derating factor conservative for estimating maximum plant piping loads? That is, was the measured flow for the EPRI test valve less than or equal to the rated flow divided by 0.9? Alternately, TVA's response to Question No. 2 in its submittal of December 26, 1992, mentioned testing by Target Rock on a Watts Bar plant-specific PORV. Was the measured flow in these tests less than or equal to the rated flow divided by 0.9? If not, provide information to justify the conservatism of the piping thermal-hydraulic and structural analyses.

TVA RESPONSE:

The EPRI test valve was a prototype valve, and its rated flow was not stated in any of the EPRI test reports. Note that the prototype valve tested by EPRI was very similar to the PORVs which are installed at WBN. This similarity was described in detail in Response No. 10 of TVA's letter dated December 26, 1992, and Response No. 2 of TVA's letter dated July 19, 1994.

Without a specific numerical value for rated flow, it is not possible to use the EPRI tests to quantify the conservatism that results from removing the 0.9 derating factor. However, it is possible to show that the flow rate used for WBN's fluid transient piping analysis is reasonable and generally conservative based on a comparison with the measured flow rate for the EPRI test valve.

The EPRI tests measured the actual flow through the test valve as 162,000 - 171,844 lbm/hr.* The throat diameter for the test valve was 1.69 inches,** which gives a valve throat area of 2.243 in^2. The throat diameter for each of WBN's PORVs is 2.00 inches, which gives a valve throat area of 3.142 in^2. The predicted flow for a WBN PORV with conditions similar to the EPRI tests is the measured flow of the test valve multiplied by the ratio of the valve throat areas, i.e., (162,000 - 171,844 lbm/hr) x (3.142 in^2 / 2.243 in^2). This gives a predicted flow of 226,930 - 240,720 lbm/hr, which corresponds closely with the PORV flow rate of 233,333 lb/hr that was used in WBN's fluid transient piping analysis.

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* - Refer to Interim Report EPRI-NP-2628-LD, "Safety and Relief Valve Test Report," PWR Valve Program Staff, Electric Power Research Institute, September 1982.

** - Refer to EPRI-NP-2292, "EPRI PWR Safety and Relief Valve Test Program, Valve Selection/Justification Report," MPR Associates, Inc., December 1982.

NRC ISSUE 3:

In Response No. 7 of TVA's letter dated July 19, 1994, the peak system pressure in the six thermal-hydraulic analyses was provided. The peak pressures given in Response No. 7 for Cases 2 and 4 were not consistent with Response No. 6. In Response No. 7, the peak system pressure for Case 4 is 2374.7 psia while in Response No. 6 the system pressure for Case 4 is 2445.6 psia when the PSVs close, for example. In addition, the peak system pressures in Response No. 7 are not consistent with those given in the table on Page E1-21, Response No. 13B, of TVA's submittal dated December 26, 1992. Please clarify the apparent inconsistencies.

TVA RESPONSE:

The peak system pressures that were listed in Response No. 7 of TVA's letter dated July 19, 1994, for Cases 2 and 4 are correct. For Case 2, which evaluates PORV closing with steam discharge conditions, the peak system pressure is 2525 psia. This is the initial pressure that is assumed to exist with the PORV open at the beginning of Case 2. As Case 2 progresses, pressure decreases to 2400 psia and the PORV closes. The description of Case 2 in Response No. 6 is consistent with Response No. 7. Although the PORV closing pressure of 2400 psia was mentioned first when describing Case 2 in Response No. 6, the response continued the description of Case 2 by stating: "The initial conditions for the case assume that the transient occurs after a steady-state run at a reservoir pressure of 2525 psia."

For Case 4, which evaluates PSV closing with steam discharge conditions, the peak system pressure is 2374.7 psia, as stated in Response No. 7. The description of Case 4 in Response No. 6 was in error where it stated that the PSVs close at 2445.6 psia. The description of Case 4 in Response No. 6 should read as follows:

Case 4 - This case simulates the PSVs closing after the pressure has been reduced to 95% of their setpoint pressure of 2485 psig (i.e., to 2374.7 psia). The initial conditions for the case assume that the transient occurs after a steady-state run at a reservoir pressure of 2374.7 psia. The initial fluid temperature is 673°F and the fluid is saturated. The PORVs remain closed throughout the transient.

Response No. 13B on Page E1-21 of TVA's letter dated December 26, 1992, listed the peak pressure in the thermal-hydraulic analysis for the PSV cases as 2748.2 psia and for the PORV cases as 2524.6 psia. These peak pressures were input assumptions for the thermal-hydraulic analysis. For PSV actuation, the peak pressure was assumed to be 10% greater than the PSV setpoint pressure of 2485 psig. For PORV actuation, the peak pressure was assumed to be 1% greater than 2485 psig. The specific pressurizer pressure time-history that was modeled in the computer input for the thermal-hydraulic analysis was based on a linear ramp rate of 54 psi/sec from the initial pressure to the peak pressure. Pressurizer pressure was then assumed to remain at this peak value until the end of the computation. The ramp rate of 54 psi/sec is a conservative maximum value as explained in Response No. 5 of TVA's letter dated July 19, 1994.

The terminology "peak system pressure" which was used as a table column heading and in the immediately preceeding text of Response No. 7 in TVA's letter dated July 19, 1994, is inaccurate. Each pressure that was listed in the table is actually the pressure which corresponds to the peak calculated flow rate for a particular thermal-hydraulic analysis case. Typically, this pressure is the initial pressure since the greatest flow rate occurs just after the valve opens for valve opening cases and before it begins to close for valve closing cases. Using more accurate terminology, the table in Response No. 7 is as follows:

CASE	DESCRIPTION	PEAK CALCULATED FLOW RATE[1] (lb/hr)	CORRESPONDING SYSTEM PRESSURE (psia)	OVER-PRESSURE (%)
1	PORV opening - steam discharge	233,333	2420	0
2	PORV closing - steam discharge	Note 2	2525	0
3	PSV opening - steam discharge	466,667	2574.3	3
4	PSV closing - steam discharge	Note 2	2374.7	3
5	PORV closing - subcooled water discharge	Note 2	849.7	0
6	PORV opening - subcooled water discharge	Note 2	605	0
7	PORV opening - two-phase fluid discharge	Note 2	750	0

Notes:

[1] Calculated flow rate is the valve's rated flow with the derating factor of 0.9 removed.

[2] Flow rate value is calculated by the computer program using the appropriate valve discharge coefficient.