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Energy Systems

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U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

ATTENTION: R. W. BORCHARDT

SUBJECT: WESTINGHOUSE RESPONSES TO NRC REQUESTS FOR ADDITIONAL INFORMATION ON THE AP600

Dear Mr. Borchardt:

Enclosed are three copies of the Westinghouse responses to NRC requests for additional information on the AP600 from your letters of January 18, 1994, January 26, 1994, February 24, 1994 and March 1, 1994. This completes the responses for the January 18th and February 24th letters.

A listing of the NRC requests for additional information responded to in this letter is contained in Attachment A.

These responses are also provided as electronic files in WordPerfect 5.1 format with Mr. Hasselberg's copy.

If you have any questions on this material, please contact Mr. Brian A. McIntyre at 412-374-4334.

Brian A. McIntyre / for

Nicholas J. Liparulo, Manager
Nuclear Safety & Regulatory Activities

/nja

Enclosure

cc: B. A. McIntyre - Westinghouse
F. Hasselberg - NRR

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NTD-NRC-94-4105
ATTACHMENT A
AP600 RAI RESPONSES
SUBMITTED APRIL 21,1994

| RAI No. | Issue |
|---|---|
| 220.040 | Concrete cracking effects in seismic analysis |
| 440.048R01 | Assumptions on available equipment/boron dilution |
| 952.037 | OSU facility orifice plate information |
| 952.038 | OSU valves with significant flow loss |
| 952.039 | OSU MOV opening/closing rates |
| 952.040 | OSU heater rod power profile |
| 952.041 | OSU drawings LKL930104 & LKL930105 |
| 952.049 | SPES-2 test conditions |
| 952.050 | SPES-2, Basis for fuel rod stored energy |
| 952.051 | SPES-2, Secondary side mass |
| 952.052 | SPES-2, Basis for pressurizer water level |
| 952.053 | SPES-2, Secondary side conditions |
| 952.054 | SPES-2, Scaling rationale |
| 952.055 | SPES-2, Delayed neutron simulation |
| 952.056 | SPES-2, Basis for heat loss compensation |
| 952.057 | SPES-2, Secondary side relief valve closing setpts |
| 952.058 | SPSE-2, Pump coastdown |
| 952.059 | SPES-2, Pressurizer heater rods |

Question 220.40

Discuss the effects of concrete cracking for the seismic analysis of all AP600 Category I structures (Section 3.8.3 of the SSAR).

Response:

As discussed in SSAR Subsections 3.7.2.5 and 3.7.2.9, the effects of concrete cracking are included as one contributor to the 15% broadening of the floor response spectra in order to account for seismic model uncertainties. This is consistent with the ASCE Working Group's recommendations as reported in the commentary to the draft ASCE 4 (Draft 7/30/93), which states: "Therefore, the concensus was that the 15% peak broadening of instructure response spectra.....will also account for the variation in structural properties, and no additional peak broadening is necessary to account for the frequency variation due to concrete stiffness changes."

SSAR Revision: None

Question 440.48

The analysis of a single steam generator tube rupture (SGTR) event is presented in Section 15.6.3 of the SSAR, with a detailed description of the assumptions and results in Sections 15.6.3.2.1.2 and 15.6.3.2.1.3. Among the assumptions listed in Section 15.6.3.2.1.2 is the availability of offsite power or onsite ac power, since both the chemical and volume control system (CVS) and startup feedwater system (SFWS) are assumed to be available. These assumptions are inconsistent with the guidance in the Standard Review Plan to include consideration of a loss of offsite power. They are also in conflict with Commission guidance on the use of non-safety equipment for limiting design faults, and with the EPRI Passive Plant Utility Requirements Document (URD), Volume III, Chapter 5, Paragraph 1.2.2, that states that only safety-related equipment is assumed to be available for LDB events. In addition, Westinghouse's analysis includes opening the steam generator PORV, which appears to be in conflict with Paragraph 4.2.5 of Chapter 3 of Volume III of the URD, which indicates that passive plants should be able to sustain a single SGTR without lifting steam generator relief valves. Provide the following information:

a. The staff understands that the assumption of CVS flow tends to increase the primary-to-secondary break flow, thus maximizing inventory loss from the primary system. However, makeup from the CVS also delays the injection of makeup flow from the core makeup tanks (CMTs), and thus reduces the possibility that the CMTs will drain to the automatic depressurization system (ADS) first stage actuation setpoint. Present a new analysis assuming no onsite or offsite ac power availability to demonstrate that the AP600 is capable of being brought to a stable condition with (a) no operator action and (b) use of passive safety systems only.

b. Why does the AP600 design comply with the EPRI URD requirement for no steam generator relief valve actuation in the event of a single SGTR?

c. The staff notes that Westinghouse's SGTR analysis requires flow from the secondary system back into the primary to stabilize the system near the end of the event. Describe how the effects of boron dilution on reactivity that can result from this backflow are accounted for in the analysis model.

Response (Revision 1):

a. An analysis has been performed to demonstrate that the AP600 is capable of being brought to a stable condition with no operator action, using passive safety systems only and assuming no onsite or offsite power is available. Consistent with a complete loss of onsite/offsite power the CVS is not operational. This results in reduced margin to the low CMT level ADS setpoint. The analysis also incorporates other conservative analysis assumptions that result in reduced margin to the low CMT level ADS setpoint. These include the assumed failure of the ruptured steam generator PORV in the open position at reactor trip (to lower the RCS pressure so as to increase CMT injection flow), reduced steam condensation in the CMT (to increase the injection of CMT makeup flow), and reduced decay heat (to minimize RCS heatup and thus lower RCS pressure). This analysis incorporates PRHR initiation on a CMT actuation signal. The analysis demonstrates that there is still significant margin to the ADS setpoint, and that the passive safety systems are capable of bringing the AP600 to a stable condition without operator action. The sequence of events for this analysis is presented in Table 440.48-1. Transient plots of primary pressure and ruptured SG secondary pressure and CMT volume, presented in Figures 440.48-1 and 440.48-2, show the plant response.

b. The ALWR URD requires that the plant be capable of accepting a steam generator tube rupture without lifting steam safety valves. This requirement is met by the combination of plant trip and turbine bypass actuation preventing the steam side safety valves from lifting. The URD also requires that for steam generator tube rupture events without assumed operator actions water relief via the safety valves or PORVs must be prevented on a best estimate basis. This is demonstrated by the steam generator overfill analysis discussed in Section 15.6.3.2 of the SSAR.

c. The SSAR SGTR analysis was performed to conservatively calculate the offsite radiological doses using the LOFTTR2 program. This analysis model does not track boron with the break flow. A calculation has been performed to determine the RCS boron concentration throughout the design basis SGTR transient utilizing a mass balance which accounts for the RCS boron addition and removal during the transient. The SGTR transient presented in Reference 440.48-1 was used for this calculation. Figure 440.48-3 presents the RCS boron concentration for the transient. This calculation demonstrates that the dilution due to back flow from the secondary system does not result in an appreciable reduction in RCS boron concentration. The initial reduction in the overall RCS boron concentration resulting from the reverse break flow is compensated for by boration from the CMT. Thus, the reverse break flow predicted to occur as the AP600 primary and secondary pressures stabilize near the end of the event does not present a reactivity concern.

Table 440.48-1

| Event | Time (sec) |
|---|---|
| Double ended SG tube rupture | 0 |
| Reactor trip on low pressurizer pressure | 659 |
| Reactor coolant pumps and main feedwater pumps coastdown | 659 |
| Faulted SG power operated relief valve (PORV) fails open | 660 |
| Low-1 pressurizer pressure core makeup tank (CMT) actuation signal | 692 |
| CMT injection begins and passive residual heat removal (PRHR) system is actuated | 692 |
| Faulted SG PORV block valve closes on low steam line pressure signal | 1130 |
| Minimum CMT water volume (1570 $ft^3$) | 1660 |

References:

440.48-1 Letter NTD-NRC-94-4064, N. J. Liparulo to R. W. Borchardt, February 1994.

SSAR Revision: NONE

Figure 440.48-1
RCS and Ruptured Loop SG Pressure

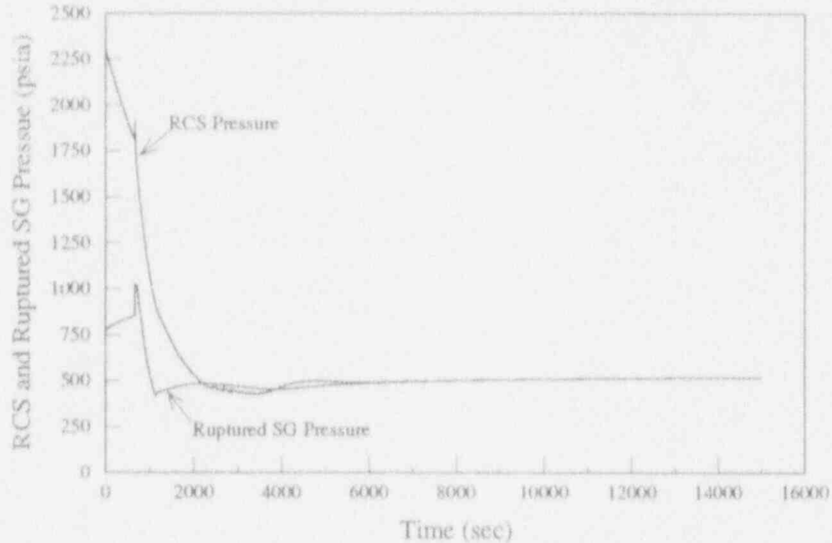



Figure 440.48-2
CMT Water Volume

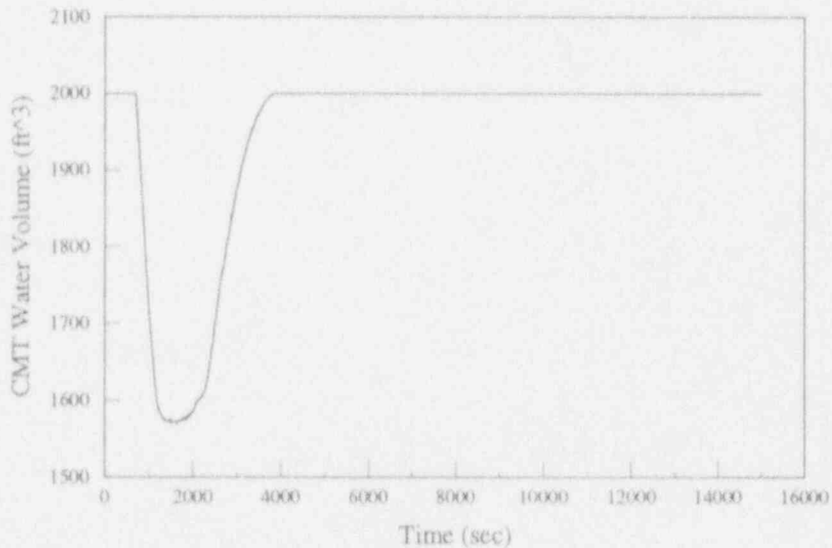
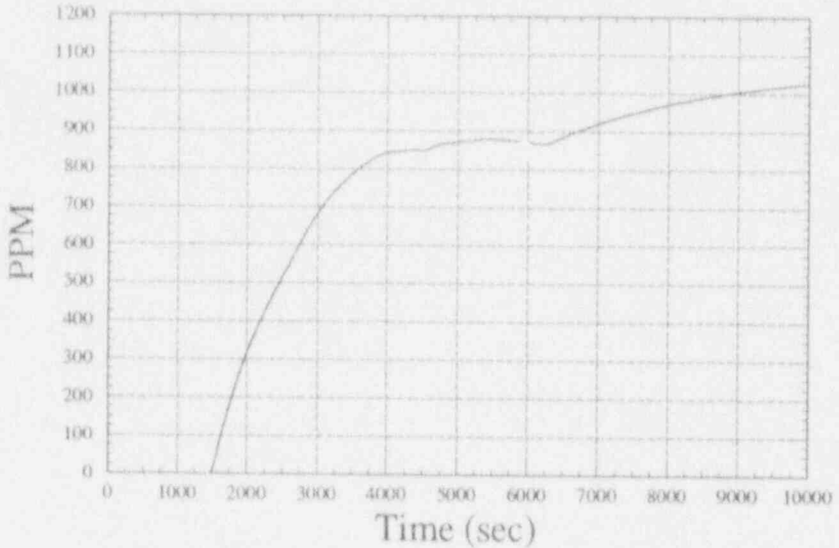


Figure 440.48-3
RCS Boron Concentration



Question 952.37

Supply the calculated hole size of the various orifice plates for the OSU/APEX facility, including the respective desired pressure drop and the location to be installed. The staff understands that all orifices may not be installed prior to preoperational testing. Is that correct?

Response:

The requested information was provided via Westinghouse letter NTD-NRC-94-4070, dated April 12, 1994.

SSAR/PRA Revision: None

Question 952.38

Identify any valves in the OSU/APEX facility that may have significant flow losses as a result of their design. Provide an estimate of the expected pressure drop.

Response:

The requested information was provided via Westinghouse letter NTD-NRC-94-4070, dated April 12, 1994.

SSAR/PRA Revision: None

Question 952.39

Provide the valve opening and closing rates for the motor-operated valves used in the OSU/APEX facility.

Response:

The requested information was provided via Westinghouse letter NTD-NRC-94-4070, dated April 12, 1994.

SSAR/PRA Revision: None

Question 952.40

Provide the planned power to each radial zone of the core heater rods of the OSU/APEX facility. If specific measurements or design requirements have been made of the axial power profile, provide these values.

Response:

The requested information was provided via Westinghouse letter NTD-NRC-94-4070, dated April 12, 1994.

SSAR/PRA Revision: None

Question 952.41

Provide Drawings LKL 930104 (referenced in Note 5 on LKL 920200, sheet 4) and LKL 930105 (referenced in Note 7 on LKL 920200, sheet 2).

Response:

The requested information was provided via Westinghouse letter NTD-NRC-94-4070, dated April 12, 1994.

SSAR/PRA Revision: None

Question 952.49

Provide the following information on the SPES-2 test conditions.

a. Break geometry
   1. Target break mass flow at specified conditions.
   2. Scaling criteria for break area.
   3. Break length-to-diameter ratio.
   4. Break geometry, e.g., beveled orifice, etc.

b. Core power decay
   1. Basis for core power decay, viz. exposure, fuel makeup, steady-state conditions.
   2. Scaling basis, e.g., how should stored energy be considered?

c. Trace heating - Should trace heating be used and, if so, using what scaling basis? Provide a description of the control logic.

d. Initial conditions
   1. Pressurizer level (Based on what? Scaled gas volume? Scaled liquid volume? Height?)
   2. Initial thermodynamic conditions in primary and secondary, e.g., pressure and temperature.
   3. Initial flow conditions.
   4. Secondary water level or mass level?
   5. Pressurizer heater level.
   6. Tank water levels, e.g., IRWST
   7. Back pressure setpoints for breaks.

e. Boundary conditions
   1. Trip points and time delays for all equipment, e.g., pressurizer heaters, S-valves (CMT, IRWST, PRHR, and isolation valves), ADS, scram, turbine stop valve, secondary SRVs and PORVs, pumps, and accumulators.
   2. Pump coastdown curves.
   3. Pressurizer heater controls.
   4. Secondary valve closure controls.
   5. Core power control.

f. ADS
   1. The basis for design.
   2. Scaling requirements for ADS orifices, including target mass flows at specified conditions.

g. SRVs & PORVs - Target mass flows at specified conditions.

Response:

The requested information was provided via Westinghouse letter NTD-NRC-94-4070, dated April 12, 1994.

SSAR/PRA Revision: NONE

Question 952.50

What basis was used for determining the quantity of fuel rod stored heat used to program the SPES-2 heater rods? Provide the quantity and distribution of AP600 ruel rod stored heat that was simulated.

Response:

The requested information was provided via Westinghouse letter NTD-NRC-94-4070, dated April 12, 1994.

SSAR/PRA Revision: NONE

Question 952.51

How much mass was simulated in the SPES-2 secondary?

Response:

The requested information was provided via Westinghouse letter NTD-NRC-94-4070, dated April 12, 1994.

SSAR/PRA Revision: NONE

Question 952.52

Define the basis for determining the pressurizer water level.

Response:

The requested information was provided via Westinghouse letter NTD-NRC-94-4070, dated April 12, 1994.

SSAR/PRA Revision: NONE

Question 952.53

How were the secondary conditions determined for the first SPES-2 test?

Response:

The requested information was provided via Westinghouse letter NTD-NRC-94-4070, dated April 12, 1994.

SSAR/PRA Revision: NONE

Question 952.54

Provide the scaling rationales for designing the experiment and the SPES-2 facility so that a similar scaling rationale can be used to define the ROSA/AP600 experiments.

Response:

The requested information was provided via Westinghouse letter NTD-NRC-94-4070, dated April 12, 1994.

SSAR/PRA Revision: NONE

Question 952.55

How is heating by delayed neutrons simulated in the SPES-2 power decay?

Response:

The requested information was provided via Westinghouse letter NTD-NRC-94-4070, dated April 12, 1994.

SSAR/PRA Revision: NONE

Question 952.56

What is the basis for the heat loss compensation programmed into the SPES-2 heater rods? What is the relationship between the heat loss compensation assigned to the SPES-2 heater rods and the heat loss compensation from the trace heaters?

Response:

The requested information was provided via Westinghouse letter NTD-NRC-94-4070, dated April 12, 1994.

SSAR/PRA Revision: NONE

Question 952.57

What are the closing setpoints for the secondary safety relief valves (SRVs) and the pilot-operated relief valves (PORVs)?

Response:

The requested information was provided via Westinghouse letter NTD-NRC-94-4070, dated April 12, 1994.

SSAR/PRA Revision: NONE

Question 952.58

How is the pump speed ramped to zero rpm?

Response:

The requested information was provided via Westinghouse letter NTD-NRC-94-4070, dated April 12, 1994.

SSAR/PRA Revision: NONE

Question 952.59

Are the pressurizer heater rods used to compensate for heat loss from the SPES-2 pressurizer?

Response:

The requested information was provided via Westinghouse letter NTD-NRC-94-4070, dated April 12, 1994.

SSAR/PRA Revision: NONE