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

ATTENTION: T. R. QUAY

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

Dear Mr. Quay:

Enclosed are three copies of the Westinghouse responses to NRC requests for additional information on the AP600 topics. Responses to RAIs 260.34, 952.101 and 952.106 are included in this transmittal.

The NRC technical staff should review these responses as a part of their review of the AP600 design. These responses close the three RAIs.

Please contact Brian A. McIntyre on (412) 374-4334 if you have any questions concerning this transmittal.

Brian A. McIntyre

Brian A. McIntyre, Manager
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/nja

Enclosures

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Question 260.34

Westinghouse states that non-safety-related systems identified during implementation of the process used to determine the regulatory treatment of non-safety-related systems (RTNSS) are classified as AP600 Class D. The staff considers that the QA program applied to RTNSS-identified structures, systems, and componenets (SSCs) should follow guidelines comparable to those of Generic Letter 85-06 regarding anticipated transients without scram, and Regulatory Position 3.5 and Appendix A of Regulatory Guide 1.155, "Station Blackout;" for blackout non-safety-related equipment. Describe how the AP600 quality assurance program that is applied to RTNSS-identified SSCs is comparable to these guidelines.

Response:

This response was provided as a response to DSER open item 17.1.3-1 forwarded by letter NSD-NRC-96-4670 dated March 26, 1996. The requirements to be included in our procedures for QA applied to RTNSS are included as an attachment to the letter for information. These requirements are comparable to those described in Generic Letter 85-06 and Regulatory Guide 1.155.

SSAR Revision: NONE

Question 952.101

Re: PCS Analysis

Provide a commitment to submit calculations of PCCS interior velocities using the WGOTHIC code.

Response: Revision 1

Calculations of the Passive Containment Cooling System interior velocities using the WGOTHIC code were included in WCAP-14382, Revision 0, May 1995, forwarded by letter NTD-NRC-95-4489 of June 20, 1995. The original response, provided in November 1994, referred to a WCAP report which has been superseded.

SSAR Revision: NONE

Question 952.106

The staff has been analyzing the results from the early tests in the ROSA-AP600 test facility. These data have raised a number of questions regarding the response of the AP600 to certain design-basis accidents and transients. These questions are based on the ROSA phenomenology, backed up in most cases with analyses of AP600 response to similar accident scenarios. Westinghouse received documentation and data on ROSA tests at the ROSA review meeting held at the NRC in July 1994, and therefore, has had the opportunity to study and evaluate data from the initial ROSA small-break loss-of-coolant accident (SBLOCA) tests.

The early actuation of the passive residual heat removal (PRHR) system appears to dominate the response of the plant during SBLOCA. The PRHR heat exchangers, combined with cold water injection from the core makeup tanks, initially removed substantially more energy than is being put into the reactor coolant system (RCS), resulting in a substantial subcooling of almost the entire RCS. In addition, the introduction of relatively cold water from the PRHR into the RCS cold legs appears to result in significant thermal stratification in the cold leg piping, with top-to-bottom temperature differences of more than 180 °C. Core makeup tank (CMT) draining appears to be initiated through flashing of the water in the cold leg pressure balance lines, rather than introduction of vapor from the reactor vessel. When the CMTs reach the actuation level of the automatic depressurization system (ADS) and the ADS valves are opened, the subcooled water in the reactor vessel appears to be pulled upward toward the pressurizer, where it can mix with steam in the upper head and upper plenum of the vessel, causing rapid condensation and the potential for significant water hammer. During the last part of the emergency core cooling (ECC) injection phase of an SBLOCA, the staff has also seen evidence of manometric-type oscillations in in-containment refueling storage tank (IRWST) injection flow to the reactor vessel, which appears to be driven by an interaction between IRWST flow, pressurizer level, and exhaust of liquid from the ADS-4 valves.

a. Cold-leg thermal stratification and upper-head water hammer both have the potential to cause significant fluid-structure interactions with resultant high thermally-induced or impact loads. How does Westinghouse propose (1) to evaluate the potential for these types of behavior in separate effects and integral test facilities, (2) to evaluate the loads, and (3) to deal with their possible effects?

b. The dominance of PRHR heat removal, especially during the pre-ADS initiation portion of accidents, is a factor not generally considered in Westinghouse's analyses of design-basis events, most of which assume only one PRHR heat exchanger is available. How will Westinghouse account for these effects in further AP600 design-basis analyses (DBA)? Also, has Westinghouse accounted for possible reactivity addition effects due to the introduction of highly subcooled water from the PRHR system into the reactor vessel?

c. The assumptions for Westinghouse's analysis of a main steamline break (MSLB) include full passive RHR capability at the inception of the event. However, the staff understands Westinghouse's current plans at SPES-2 are to use only one of the three PRHR tubes for the MSLB test, in a manner similar to that used in previous SPES-2 tests. The staff believes that the test conditions should conform as closely as possible to the DBA analysis assumptions (and to probable plant accident response conditions), and therefore, recommends that full simulated PRHR capacity (all 3 tubes) be used in SPES-2 for the MSLB test (Test #12). The staff also recommends that the procedure for heat loss compensation in SPES-2 be re-evaluated for the MSLB test, in order to maximize the potential level shrinkage. Furthermore, the staff recommends that the potential impact of added PRHR heat removal and heat loss compensation be evaluated for other types of transients and accidents, and that additional tests in SPES be considered to assist in the appraisal of such effects.

Response:

The AP600 tests in the ROSA Test Facility are confirmatory in nature and are not part of the AP600 Design Certification review. The following response is provided to the NRC staff phenomological concerns:

a. Programs for evaluation of both thermal stratification and upper-head water hammer have been carried out. The test data collected from both the SPES-2 and the OSU tests were evaluated to determine the potential for these effects in the AP600. The potential for loads from thermal stratification were determined for the plant and are being applied to the structural analyses of affected pipe lines. There is a potential for loads from upper-head water hammer. These loads are considered to be small and within the loading envelope specified for affected equipment.

b. The design has been changed to include only a single PRHR heat exchanger. This design is reflected in the AP600 SSAR. The non-LOCA cooldown safety analyses of the LOFTRAN code, as reported in Chapter 15 of the AP600 SSAR, accounts for the maximum PRHR cooling capability and the resulting reactivity effects of introducing the cooled water from the PRHR system into the reactor vessel and core.

c. In accordance with the above recommendation, the SPES-2 large main steam line break test (SU1512) was performed with all three (3) available PRHR heat exchanger tubes. Also, no heat loss compensation was used after the break valve was opened. That is, all power to the heater rods and pressurizer heaters was stopped immediately after break opening. These two changes were made to maximize the primary system water shrinkage, and to maximize the dependence on CMT makeup. This provided a test which conforms to DBA analysis assumptions as closely as possible.

   Westinghouse also performed a 1-inch cold leg break test at SPES-2 (S01613) which was identical to matrix test no. 1 (S00401) except that three PRHR tubes were used instead of one tube. Pre-test analyses of this test were performed with heat loss compensation at 100kw and 50kw. These analyses clearly showed that reducing heat loss compensation caused the pressure in SPES-2 to fall too rapidly in comparison to AP600 plant analyses (with two PRHRs). This lower pressure resulted in reduced break flows and extended the time at which CMT draindown and ADS actuation were initiated. In comparison, SPES-2 analyses with 150kw heat loss compensation showed good agreement with the AP600 model response.

   The test results are addressed in the SPES Test Data Report, WCAP-14309, Revision 1.

SSAR Rev: None