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Subject: Westinghouse Response to NRC RAI Letter No. 3 on WCAP-17524, Revision 1, "AP1000 Core Reference Report" (Non-Proprietary)

By letter dated October 15, 2014 the NRC issued Request for Additional Information (RAI) letter No. 3 for the review of Westinghouse topical report WCAP-17524, Revision 1 "AP1000 Core Reference Report." Enclosed is the non-proprietary version of the Westinghouse response to the RAI, "Westinghouse Response to NRC RAI Letter No. 3 on WCAP-17524, Revision 1, 'AP1000 Core Reference Report.'"

If you have any questions or require additional information, please contact Keith Drudy at (412) 374-5841.

Very truly yours,

J A Gresham

James A. Gresham, Manager

Regulatory Compliance

Enclosures

cc: Bruce Bavol, NRC

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Westinghouse Response to NRC RAI Letter No. 3 on WCAP-17524, Revision 1, "AP1000 Core Reference Report" (Non-Proprietary)

November 2014

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CRR-029

In the Chapter 15 FSAR mark-ups found in Appendix B of WCAP-17524-P, several design basis accidents (e.g. 15.2.7, 15.5.1, 15.5.2, 15.4.6, and 15.6.2) now include descriptions of required operator actions that were not listed in the certified design. Section 15.0.13 contains a high level description of the operator actions and the associated change roadmap (page B-3 of WCAP-17524-P) summarizes the change as being consistent with the Westinghouse response to RAI-SRP15.0-SRSB-03, Rev. 2 from the DCD Rev. 19 review. The change roadmap for each of the affected design basis accidents identifies the operator actions as editorial changes. The staff notes that the response for SRP15.0-SRSB-03 Rev. 2 states that only Chapter 15.6.2 ("Radiological Consequences of the Failure of Small Lines Carrying Primary Coolant Outside Containment") assumes operator action.

a) Are these required operator actions new to the core reference report or are they part of the DCD licensing basis? Describe the actions, including references to DCD documentation if applicable, and whether they are credited in the safety analyses intended to be included in the licensing basis for COL applications based on the DCD.

b) Explain how the Chapter 15 FSAR changes listed in Appendix B of the core reference report support the Section 6.3.4 statement that "the passive core cooling system can maintain safe shutdown conditions for 72 hours after an event without operator action and without both nonsafety-related onsite and offsite power".

Westinghouse Response to CRR-029

<u>Part a</u>

The operator actions presented in the Core Reference Report (CRR) WCAP-17524-P, Revision 1 are consistent with those previously presented in Revision 19 of the Design Control Document (DCD) for the **AP1000**® Pressurized Water Reactor (PWR), as well as prior revisions of the AP600 and **AP1000** PWR DCDs. This history is included in the staff's assessment of the AP600 and **AP1000** designs as presented in their associated Safety Evaluation Reports (SER). The following excerpt is from Section 15.2.5.1 of the SER for the AP600 PWR (NUREG-1512):

> *In an NRC quality control inspection at Westinghouse from November 17 through 21, 1997, the staff found that in some scenarios, operator actions are necessary (opening of the reactor vessel head vents) to prevent the pressurizer from overfilling with water. However, the applicant had not provided a technical specification or an ITAAC for the reactor vessel head vents (RVHV) to ensure that they will reliably function as assumed in the design basis analysis. In Westinghouse letter DCP/NRC-1248, dated February 6, 1998, the applicant's response to RAI 440.753F proposed limiting conditions for operation in TS 3.4.17 to require that the RVHVs be operable for Modes 1 through 3. In addition, the TS LCO is applicable in Mode 4 when the RCS is not being cooled by the normal decay heat removal system (RNS). The surveillance requirements are specified to be consistent with the inservice testing program. The staff has reviewed the proposed TS and found that the LCOs, required actions, and surveillance requirements are consistent with a typical TS for the RVHVs.*

This discussion is continued in Section 5.4.12.1 of the SER for the **AP1000** PWR (NUREG-1793):

> *The RVHVS is primarily used during plant startup to properly vent air from the RV head and to fill the RCS. The RVHVS valves also provide an emergency letdown path with a letdown flow rate within the capabilities of the normal makeup system to prevent pressurizer overfill following long-term loss of heat sink events....In addition to the normal venting procedures during startup, the AP1000 RVHVS could also be used under a design-basis accident scenario. During an accident, the AP1000 design relies on the passive safety-related systems, such as the PRHR HX, to provide the safety-related function of core cooling. Therefore, the design does not require the SG U-tubes to be vented to provide coolability of the core. However, the RVHVS is used under loss of heat sink events where the pressurizer level can increase and eventually become water solid, following long-term operation of the CMTs. To avoid this occurrence, the functional restoration guidelines for a high pressurizer level in the ERG requires that the RV vent flow be established to provide a bleed path, in response to high-pressurizer level conditions, to reduce the RCS inventory and prevent pressurizer overfill. When the pressurizer level is sufficiently reduced, the operator recloses the head vent valves. In this case, the operator uses pressurizer level as the primary indication to control operation of the RV head vent.*

The head vent operator action is also discussed by the staff in the SER for the **AP1000** PWR in relation to the Tech Specs:

> *The purpose of TS 3.4.16 is to ensure operability of the manually operated RVHVs so that the control room staff can open them to prevent overfilling of the pressurizer during RCS coolant addition transients.*

Both the DCD Rev. 19 and CRR analyses require the following operator actions to meet Chapter 15 acceptance criteria:

- Isolation of sample line break
    - Credited in Section 15.6.2, "Failure of Small Lines Carrying Primary Coolant Outside Containment"
- Isolation of dilution sources
    - Credited in Section 15.4.6, "Chemical and Volume Control System Malfunction that Results in a Decrease in the Boron Concentration in the Reactor Coolant System"; specifically, for a subset of cases analyzed for Modes 1 and 2
- Opening of the reactor vessel head vent valve to prevent event propagation as a result of pressurizer filling
    - Described in Sections 15.5.1, "Inadvertent Operation of the Core Makeup Tanks During Power Operation" and 15.5.2, "Chemical and Volume Control System Malfunction That Increases Reactor Coolant Inventory"

For the first two actions listed above, the manner in which these operator actions are presented in Appendix B of WCAP-17524-P is the same as that presented in the corresponding section of DCD Rev. 19. In Section 15.6.2, operator action is credited to isolate a sample line break within 30 minutes to meet dose limit criteria. In the DCD Rev. 19 analysis of the "Chemical and Volume Control System

Malfunction that Results in a Decrease in the Boron Concentration in the Reactor Coolant System" event (Section 15.4.6), some of the cases analyzed required operator actions. An example is the case modeling Mode 1 operation with automatic rod control. The DCD Rev. 19 analysis demonstrates that there is sufficient time for operator actions to occur to prevent a loss of shutdown margin.

The third operator action credited in Chapter 15 of DCD Rev. 19 prevents pressurizer overfill by opening the reactor vessel head vent valve. This operator action was discussed in the text for both the inadvertent actuation of a core makeup tank (Section 15.5.1) and the chemical and volume control system malfunction that increases reactor coolant inventory (Section 15.5.2) events. For each of these events in DCD Rev. 19, the case presented was one that is more limiting (i.e., reaches a higher peak pressurizer water volume) than the cases that required operator action. For instance, Section 15.5.1.3 of DCD Rev. 19 describes the operator actions as follows:

> *For such events, the operator would take action to reduce the increase in coolant inventory. As the pressurizer water level would increase above the high pressurizer water level that normally isolates chemical and volume control system makeup, the normal letdown line could be placed into service to reduce the increase in coolant inventory. If letdown could not be placed into service, the operator could use the safety related reactor vessel head vent valves to reduce the increase in coolant inventory. For these events, following the procedures outlined in the Emergency Response Guidelines AFR-I.1, there is sufficient time for the operator to mitigate the consequences of this event, and the results of such an event have a greater margin to pressurizer overfill than that presented in this analysis.*

Based in part on the informal feedback from the staff during the review of Revision 17 of the DCD and lessons learned identified via Westinghouse's corrective action program, the CRR presents the limiting cases for the analyses in DCD Section 15.5.1 and 15.5.2 as those with the minimum time requirement for operator action instead of the case with the highest final pressurizer water volume. Furthermore, the CRR provides additional details describing the operator action to open the reactor vessel head vent valve and ensures that these operator actions are consistent with the symptoms of the event seen by the operators. Therefore, in both the DCD Revision 19 and CRR analyses for Sections 15.5.1 and 15.5.2, operator actions are required to show that the pressurizer does not reach a water solid condition; the difference is the manner in which they are presented.

While no additional operator actions are added in the CRR analyses, one additional event, the "Loss of Normal Feedwater Flow" event (Section 15.2.7), credits the same operator action modeled in Section 15.5.1 and 15.5.2: the opening of the reactor vessel head vent valve. The more limiting results are primarily due to the inclusion of the effects of containment back pressure on the Passive Residual Heat Removal Heat Exchanger (PRHR HX) operation which results in a reduction in the PRHR HX heat transfer relative to the DCD Rev. 19 analysis. For the CRR, the loss of normal feedwater (Section 15.2.7), inadvertent actuation of a core makeup tank (Section 15.5.1), and chemical and volume control system malfunction (Section 15.5.2) analyses, the credited operator action is based upon the high-2 pressurizer water level setpoint providing indication to the operator that a potential over-filling event is underway.

Part b

The changes to the text pertaining to required operator actions in the CRR are consistent with those required for DCD Rev.19 as shown in response to part (a) above. As such, the relationship between Section 6.3.4 and Chapter 15 is unchanged. Section 6.3.4, "Post-72 hour Actions," is discussing the ability of the PXS to maintain water supply without operator action in order to satisfy the success criteria associated with adequate core cooling. This text is not meant to imply that no operator actions are required to satisfy the more restrictive Chapter 15 acceptance criteria. Therefore, the required operator actions in Chapter 15 of the licensing basis do not conflict with the statement quoted from Section 6.3.4.